International Reference Ionosphere 2015 (IRI2015) Workshop

A COSPAR Capacity - Building Program

KMITL, Bangkok Thailand, November 2-13, 2015

Technical Program

KMITL 55th ANNIVERSARY 1960 - 2015

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International Reference Ionosphere 2015 Workshop
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Faculty of Engineering
King Mongkut's Institute of Technology
Ladkrabang, Bangkok, Thailand
November 2-13, 2015

LIVE IN KMITL


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MESSAGE FROM THE HONORARY CHAIR

Welcome to the Kingdom of Thailand, the Land of Smiles. On behalf of the King Mongkut's Institute of Technology Ladkrabang (KMITL), it is my greatest pleasure to welcome all participants to the 18th International Reference Ionosphere (IRI 2015) Workshop from 2-13 November, 2015. KMITL is one of the leading research universities of Thailand and we aim to be a Top Ten University in ASEAN by 2020. This is the first time that the prestigious conference has been organized in Southeast Asia.

KMITL has participated in the Southeast Asia Low-Latitude Ionospheric Observation Network (SEALION) project since 2005 due to its unique location in the world as well as the importance of research in ionosphere and its connectedness with other layers of atmospheres such as plasmasphere and troposphere. The ionospheric and GNSS data center hosted on our campus is the first of its kind in Thailand. In addition, KMITL manages the Chumphon Ionospheric Observation Station with a number of equipment such as the Ionosonde and GNSS receivers on our Chumphon campus in the South. The wide range of applications in radio propagation, Space Weather, GNSS technology, better understanding in disasters all lead to increased interests among researchers worldwide.

This event aims to be a forum of domestic and International researchers to discuss recent research results and, most importantly, on the improvement and extensions of the IRI model, a standard empirical model for ionospheric data. Another aspect of this conference is to update on the status of monitoring stations worldwide and data exchange. Besides science and engineering advancement, I would like to encourage all the participants to bring the utilization of the knowledge to the society at large.

The ideal timing of this conference also coincides with an auspicious event at KMITL as the 13th of November, 2015, is our first-ever graduation ceremony to be held at the new KMITL Conventional Hall. On this Friday, we are excited and honored to welcome Her Royal Highness Princess Maha Chakri Sirindhorn for the opening of four new buildings and present the diplomas to the new graduates from the Class of 2015. The participants of the IRI 2015 Workshop have been invited to attend the morning Welcome ceremony at the front of KMITL Conventional Hall.

I sincerely believe that this conference will bring about increased domestic and International collaboration among our Institutes. We also hope that you will be visiting researchers at our Institute in the very near future. The organization of this event certainly cannot be achieved without hard work by all committee members and sponsors; I wish to thank those who helped organize this conference

Professor Dr. Suchatvee Suwansawat
President
King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand

MESSAGE FROM THE DEAN
OF FACULTY OF ENGINEERING

On behalf of Faculty of Engineering, KMITL, I am pleased to be the main host of this exciting conference, the COSPAR Capacity-Building Workshop from 2-6 November, 2015, and 18th International Reference Ionosphere 2015 (IRI 2015) Workshop from 2-13 November, 2015. This event is organized as a part of the year-long celebration of the 55th anniversary of Faculty of Engineering, KMITL, in 2015. Starting from a humble beginning during its inception as a Telecommunication Training Institute, our Faculty of Engineering is now one of the premier engineering and science schools in Thailand.

It is my pleasure to witness the ever increased collaboration between our Faculty and the International partners such as National Institute of Information and Communication Technology (NICT), Japan, Japan Aerospace Exploration Agency (JAXA), Japan, as well as ASEAN countries. At present, there is an intense interest in the study of ionosphere and the upper atmosphere related to radio propagation especially in the GNSS applications. The deterioration of GNSS signals due to the fluctuation of the ionospheric characteristics affect the position accuracy, therefore, a wide range of applications such as aeronautical navigation and radio transmission are degraded. To better understand these phenomena, we need a network of monitoring stations to share data among involved countries.

I would like to offer my deepest appreciation to the efforts by the Department of Telecommunications, committee members, sponsors and volunteers who help make this conference possible. I truly wish that this conference will enhance International collaboration and inspire young researchers and students to make progress in this field. Bangkok and other destinations in Thailand offer unique attractions and pleasure to visitors; I certainly hope that you find some time to visit these places.

Associate Professor Dr. Komsan Maleesee
Dean of Faculty of Engineering Professor
King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand

WELCOME MESSAGE

Dear IRI-2015 Workshop Participants,

On behalf of the Organizing Committee I like to extend a warm welcome to you to the 18th International Reference Ionosphere (IRI) Workshop at the King Mongkut's Institute of Technology Ladkrabang (KMITL). This is the first time that the IRI workshop is organized in the framework of the Capacity-Building Workshop Program of the Committee on Space Research (COSPAR). Our workshop format with first a lecture and study week and then a week-long international science meeting is ideally suited for the regional capacity building goals of the COSPAR program. It also works well for the IRI project that urgently needs the data and modeling inputs from the South-East-Asian sector for an increased accuracy of space weather predictions in this region. With this in mind, I like to extend an especially warm welcome to the young space scientist, who will be attending the first week training and study sessions and will report on the results of their studies during a special session in the second week. Let me also take this occasion to announce that there will be prices awarded to the best of the study teams. We have an exciting program ahead of us with lectures, demonstration of online services, student studies, and talks and posters by international experts. I want to direct your special attention to the final event of this workshop, which, as always, is the 'Final Discussions' session to which all participants are invited. Here we will discuss improvements and new inputs to the IRI model based on the presentations during this workshop and work out plans for future collaborative efforts within the IRI community.

I know I speak for all of you when I thank the local organizers for their invitation to the beautiful city of Bangkok and for the excellent support they have provided in preparing the workshop. I welcome you all and look forward to very productive IRI workshop days.

Dieter Bilitza
Executive Secretary,
COSPAR/URSI IRI Working Group

Welcome, 欢迎, Vítejte, Willkommen, स्वागत, Selamat datang, Benvenuto, ようこそ, 환영, mile widziany, Добро пожаловат, Bienvenida, Hoşgeldiniz, Chào mừng, maligayang pagdating, ยินดีต้อนรับ

MESSAGE FROM THE GENERAL CHAIRS

Sa-wa-dee krab!!

First of all, I would like to thank the *COSPAR/URSI IRI Working Group* to give this precious opportunity to KMITL to host the International Reference Ionosphere 2015 (IRI 2015) Workshop in Bangkok, Thailand.

The aim of the IRI 2015 Workshop is to bring together researchers, engineers and students in the field of ionospheric study and related areas to discuss new results, improvement of the IRI model and applications. Under the theme "Improved Accuracy in the Equatorial Region and Progress toward a Real-time IRI Model," a large portion of presentations will focus on the ionospheric research in the equatorial and low-latitude region as well as the Real-time IRI model.

We would like to especially thank the Faculty of Engineering, KMITL, for the financial and personnel support throughout the preparation of the conference. Special acknowledgments are given to COSPAR, KMITL Research Fund, other financial sponsors and Technical sponsors. We appreciate the attendance by all paper presenters and participants who join together to share their experiences and invaluable insights. We thank Professor Dr. Dieter Bilitza and the International Technical Committee members on the efforts in careful planning of the Technical Program during this entire week. The organization of the conference would not be possible without the local organizing committee members and volunteers, we thank you all for the hard work.

Lastly, if there are any inconveniences or mishaps during the conference, we would like to apologize for them in advance. We hope you have the fruitful weeks ahead and have pleasant stay at KMITL and in Thailand.

Associate Professor Dr.
Chuwong Phongcharoenpanich

Associate Dean, Faculty of Engineering
KMITL, Thailand
General Chair

Professor Dr.
Chalermchon Satirapod

Faculty of Engineering
Chulalongkorn University, Thailand
General Chair

Associate Professor Dr.
Pornchai Supnithi

Faculty of Engineering
KMITL, Thailand
General Chair

MESSAGE FROM THE INTERNATIONAL TECHNICAL COMMITTEE MEMBERS

Dear IRI-2015 Workshop Participants,

On behalf of the International Technical Program Committee, it is our great pleasure to welcome you to KMITL, Thailand, for the 18th International Reference Ionosphere 2015 (IRI- 2015) Workshop and to feature a wide range of research areas in Space science, ionospheric modeling, and IRI improvements and extensions. Special emphasis will be on improvements of IRI in the equatorial region and on the progress towards a Real-Time IRI. In keeping with its long history, IRI-2015 has been fortunate to receive 72 oral papers and 44 posters to the main technical program after a thorough review process.

This year, the submitted papers and posters were from over 25 countries. The International Technical Program Committee of IRI-2015 workshop are from academic, industrial, and research organizations around the globe. This year, the team research awards and poster awards will be presented at the workshop.

Besides the main technical program, there are two interesting excursion programs at the Thailand Earth Resources Satellite Ground Station at Ladkrabang (Ladkrabang Satellite Ground Station) and Electrical and Electronic Product Testing Center (PTEC). We are especially pleased to bring you to the site visit at the Thailand Satellite Ground Station and the largest Chamber Vacuum Room in Southeast Asia.

In addition, we would like you to join us to welcome Her Royal Highness Princess Maha Chakri Sirindhorn's visit in front of KMITL Conventional Hall. Last, but not the least, we would like to thank the authors for their continuing support in submitting their hard work and original contributions to this workshop. We hope that you enjoy the technical program, as well as the overall experiences of attending IRI-2015 Workshop in KMITL, Thailand. We Love KMITL! We Love Thailand! and We Love You!

Assistant Professor Dr. Prasert Kenpankho
Faculty of Industrial Education, King Mongkut's Institute of Technology Ladkrabang
Program Management Board (PMB) Director,
Asia-Pacific Space Cooperation Organization (APSCO)
A representative of the IRI-2015 Workshop International Technical Committee

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WORKSHOP PROGRAM

International Reference Ionoshere 2015 (IRI2015) Workshop
"Improved Accuracy in the Equatorial Region and Progress Towards a Real-Time IRI Model"

A COSPAR CAPACITY – BUILDING PROGRAM

Date: **November 2-13, 2015**
Location: **Faculty of Engineering**
King Mongkut's Institute of Technology Ladkrabang

TRAINING SESSION

Date/Time	Sunday, 1 November 2015
18:30-21:00	Ice Breaker

Date/Time	Monday, 2 November 2015
08:15-09:00	Registration
09.00-09.30	Place : **Computer Room #109**, 12-Story Engineering Lecture Building **OPENING SESSION** **09.00-09.20 Welcome Remark by** Assoc. Prof. Dr. Pornchai Supnithi : IRI2015 General Co-Chairs Prof. Mariano Mendez: COSPAR Prof. Dieter Bilitza: George Mason University, USA, and COSPAR/URSI IRI Working Group **09.20-09.30 Opening Remark by** Assoc. Prof. Dr. Komsan Maleesri : Dean, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang
09.30-10.00	**Lecture on** *IONOSPHERE-AN INTRODUCTION* by Prof. Bodo Reinisch : University of Massachusetts, Lowell, USA
10.00-10.30	*Coffee / Tea*
10.30-11.30	**Lecture on** *IRI-INTRODUCTION AND OPEN PROBLEMS* by Prof. Dieter Bilitza : George Mason University, NASA, USA
11.30-12.00	**Lecture on** *COMPARISON OF IRI WITH IONOSONDE DATA FROM ASIAN SECTOR* by Dr. Prasert Kenpankho : King Mongkut's Institute of Technology Ladkrabang, Thailand
12:00-14:00	*Lunch Time*
14.00-14.30	**Lecture on** *IRIWEB AND RELATED ONLINE SERVICES* by Prof. Dieter Bilitza : George Mason University, NASA, USA
14.30- 15.00	Forming teams and assigning research tasks
15.00-17.30	Team Work

Date/Time	Tuesday, 3 November 2015
09.00-10.00	**Lecture on** *IONSONDE MEASUREMENTS* by Prof. Bodo Reinisch : University of Massachusetts, Lowell, USA
10.00-10.30	*Coffee / Tea*

10.30-11.30	**Lecture on** *REAL-TIME IRI* by Dr. Ivan Galkin : University of Massachusetts, Lowell, USA
11.30-12.00	**Lecture on** *IONOSONDES IN ASIAN SECTOR* by Dr. Pornchai Supnithi : King Mongkut's Institute of Technology Ladkrabang, Thailand
12:00-14:00	*Lunch Time*
14.00-15.00	**Lecture on** *IONOSONDE DATA ONLINE : GIRO / SPIDR* by Dr. Ivan Galkin : University of Massachusetts, Lowell, USA
15.00-17.30	Team Work

Date/Time	Wednesday, 4 November 2015
09.00-10.00	**Lecture on** *GNSS DATA AND IONOSPHERIC STUDIES* by Prof. Andrzej Krankowski : University of Warmia and Mazury in Olsztyn, Poland
10.00-10.30	*Coffee / Tea*
10.30-11.30	**Lecture on** *IRREGULARITIES AT EQUATORIAL LATITUDES* by Dr. Pornchai Supnithi : King Mongkut's Institute of Technology Ladkrabang, Thailand
11.30-12.00	**Lecture on** *TEC COMPARISONS WITH IRI IN ASIAN SECTOR* by Dr. Prasert Kenpankho : King Mongkut's Institute of Technology Ladkrabang, Thailand
12:00-14:00	*Lunch Time*
14.00-15.00	**Lecture on** *ACCESS TO GNSS DATA* by Prof. Andrzej Krankowski : University of Warmia and Mazury in Olsztyn, Poland
15.00-17.30	*Team Work*

Date/Time	Thursday, 5 November 2015
09.00-12.00	**Excursion :** *Ladkrabang Satellite Ground Station*
12:00-14:00	*Lunch Time*
14.00-15.00	**Lecture on** *COUPLING BETWEEN IONOSPHERE AND THERMOSPHERE AT LOW LATITUDES* by Prof. Shigeto Watanabe: Hokkaido University, Japan
15.00-16.00	**Lecture on** *ION DENSITIES AND PLASMA TEMPERATURES* by Dr. Vladimir Truhlik : Institute of Atmospheric Physics, Czech Republic
16.00-18.00	*Team Work*

Date/Time	Friday, 6 November 2015
09.00-10.00	**Lecture on** *SOLAR IRRADIANCE AND UPPER ATMOSPHERIC CHEMISTRY* by Dr. Takashi Maruyama : National Institute of Information and Communications Technology (NICT), Japan
10.00-10.30	*Coffee / Tea*
10.30-11.30	**Lecture on** *INCOHERENT SCATTER RADAR* by Dr. Susumu Saito : Electronic Navigation Research Institute (ENRI), Japan

11.30-12.00	**Lecture on** *IONOSPHERIC STORMS* by Dr. Takashi Maruyama : National Institute of Information and Communications Technology (NICT), Japan
12:00-14:00	*Lunch Time*
14.00-15.00	**Lecture on** *ACCESS TO INCOHERENT SCATTER DATA* by Dr. Susumu Saito : Electronic Navigation Research Institute (ENRI), Japan
15.00-17.00	*Team Work and Presentations Practice*

GENERAL TIMETABLE FOR IRI2015 WORKSHOP

Date/Time	Monday, 9 November 2015
08:00-09:00	Registration
09.00-09.35	Place : **Auditorium #3, 2nd Floor**, 12-Story Engineering Lecture Building **OPENING SESSION** **09.00-09.05 Introductory Remark by** Assoc. Prof. Dr. Pornchai Supnithi, IRI2015 General Co-Chairs **09.05-09.10 Introductory Remark by** Prof. Dieter Bilitza, Executive Secretary of URSI/COSPAR IRI Working Group, George Mason University and NASA, USA **09.10-09.15 Message from** Asst. Prof. Dr. Prasert Kenpankho, A representative of the Technical Program Committee **09.15-09.25 Welcome Remark by** Assoc. Prof. Dr. Komsan Maleesri : Dean, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang **09.25-09.35 Opening Remark by** Prof. Dr. Suchatvee Suwansawat: President of King Mongkut's Institute of Technology Ladkrabang
09.35-09.45	Token of Appreciation to Sponsors
09.45-10.00	Group Photo
10.00-10.30	*Coffee / Tea*
Session 1: Chairperson:	**Improved Accuracy of IRI at Equatorial Latitudes - I** **Bodo Reinisch**
10.30-10.40	The International Reference Ionosphere: Model Update 2015 ***Dieter Bilitza*** ID: 22O
10.40-10.55	Performance of the IRI-2012 model in the equatorial region: Variations with longitude and solar activity ***Jeffrey Klenzing***, *Andréa Hughes, Dieter Bilitza, Angeline Burrell, and Russell Stoneback* ID: 78O

10.55-11.10	Topside electron density profiles over Chumphon, Thailand and comparison with the IRI-2012 and NeQuick 2 models ***Punyawi Jamjareegulgarn***, *Pornchai Supnithi, Mamoru Ishii, and Takashi Maruyama* ID: 47O
11.10-11.25	Ionospheric ceiling over the magnetic equator: A missing concept in IRI ***Takashi Maruyama***, *Pornchai Supnithi, and Tharadol Komolmis* ID: 26O
11.25-11.40	Validation of IRI-2012 and IRI-2007 model in determining TEC at an anomaly crest station in India ***Nilesh C Patel***, *Sheetal P Karia, and Kamlesh N Pathak* ID: 14O
11.40-11.55	Performance of IRI-2012 model in predicting ionospheric electron density and various ionospheric parameters over the equatorial and low latitude sectors ***K.Venkatesh*** *and P.R. Fagundes* ID: 4O
11:55-13:30	*Lunch Time*
Session 2: Chairperson:	**Improved Accuracy of IRI at Equatorial Latitudes - II** **Pornchai Supnithi**
13.30-13.45	Effect of ionospheric irregularities on GPS signals during declining phase of solar cycle 23 at crest of EIA, Bhopal ***Azad Ahmad Mansoori***, *Pramod Kumar Purohit, and Ashok Kumar Gwal* ID: 2O
13.45-14.00	IRI consistently underestimates TEC at 95°E during the ascending half of the solar cycle 24 ***Pradip Kumar Bhuyan***,*GeetashreeKakoty and Rumajyoti Hazarika* ID: 18O
14.00-14.15	Ionospheric irregularity observations using FS3/COSMIC radio occultation data ***Lung-Chih Tsai***, *S.-Y. Su, and C. H. Liu* ID: 55O
14.15-14.30	An Empirical Model of FORMOSAT-3/COSMIC Occultation Scintillation ***Shih-Ping Chen***, *Dieter Bilitza, and Jann-Yenq Liu* ID: 8O
14.30-14.45	Global Ionosphere Spread-F observed by the COSMIC GPS radio occultation technique: A great possibility for incorporating them into the International Reference Ionosphere (IRI) model ***P. S. Brahmanandam***, *G. Uma, D. S. V. V. D. Prasad, and Y. H. Chu* ID: 73O
14.45-15.00	Comparative studies between equatorial spread F derived by the International Reference Ionosphere and the S4- index observed by FORMOSAT-3/COSMIC during the solar minimum period of 2007 - 2009 ***G. Uma***, *P. S. Brahmanandam, D. S. V. V. D. Prasad, and Y. H. Chu* ID: 75O
15.00-15.30	*Coffee / Tea*

Session 3: Chairperson:	**Improved Accuracy of IRI at Equatorial Latitudes - III** **Shunrong Zhang**
15.30- 15.45	The Correlation between Ionospheric Scintillations and Irregularities at Low Latitude ***Wang Zheng***, *Shi Jiankui, Wang Guojun and Wang Xiao* ID: 12O
15.45- 16.00	Simple ionospheric delay model associated with equatorial plasma bubble occurrence using NeQuick 2 model ***Sarawoot Rungraengwajiake,*** *Pornchai Supnithi, and Susumu Saito* ID: 79O
16.00- 16.15	Assessment of GNSS Ionospheric Scintillation and TEC Monitoring using the Multi-Constellation GPStation-6 Receiver ***Rod MacLeod*** ID: 81O
16.15- 16.30	Variations of the electron density of ionospheric F2-layer (NmF2) in the region of the equatorial anomaly crest during storm periods and comparison with IRI2012 ***Elijah Oyeyemi***, *John Bosco Habarulema.J.B, Patrick Sibanda, and Paul Obiakara* ID: 7O
16.30- 16.45	New Proposed GPS Receiver Bias Estimation Method for the Equatorial Latitude Region ***Prasert Kenpankho*** *and Pornchai Supnithi* ID: 69O
16.45- 17.00	Comparisons of IRI- 2012 Model TEC predictions with GPS TEC measurements observed at Guntur, India ***D. VenkataRatnam*** ID: 9O
17.00-17.05	**Depart to reception session**
17.20-20.00	**Welcome reception**

Date/Time	Tuesday, 10 November 2015
Session 4: Chairperson:	**Progress towards real-time IRI** **Jeff Klenzing**
09.00-09.15	Real-time Global Above-peak Variability of Ionosphere as seen by Assimilative IRI ***Ivan Galkin***, *Bodo Reinisch, Jens Berdermann, Norbert Jakowski, Xueqin Huang, Artem Vesnin, and Dieter Bilitza* ID: 57O
09.15-09.30	Regional optimization of IRI-2012 output (TEC, foF2) using derived GPS-TEC ***N.Ssessanga***, *Yong Ha Kim, and Jaemin Kim* ID: 1O
09.30-09.45	Adapting the IRI model to improve estimation of ionospheric parameters and its validation with COSMIC and ionosonde data ***John Bosco Habarulema*** *and Nicholas Ssessanga* ID: 29O

09.45-10.00	Data Assimilation for Regional TEC Estimation and Mapping over Thailand ***Somjai Klinngam****, Pornchai Supnithi, Athiwat Chiablaem, Takuya Tsugawa, Mamoru Ishii, and Takashi Maruyama* ID: 80O
10.00-10.30	*Coffee / Tea*
10.30-10.45	Features of assimilation of the total electron content in the IRI model in low and equatorial latitudes ***Olga Maltseva*** *and Natalia Moshaeva* ID: 16O
10.45-11.00	Development of real-time GPS-TEC monitoring system incorporating ionospheric 3D tomography over Japan ***Shota Suzuki****, Suzumu Saito, Akinori Saito, Chen Chieh-hung, Gopi Seemala, and Mamoru Yamamoto* ID: 62O
11.00-11.15	3D electron density estimation in the ionosphere by using IRI-Plas model and GPS-TEC measurements ***Hakan Tuna****, Orhan Arikan, and Feza Arikan* ID: 37O
11.15-11.30	Ionospheric longitudinal variations at midlatitudes and IRI ***Shunrong Zhang****, Anthea Coster, and Ziwei Chen* ID: 30O
11.30-11.45	Simulated East-west differences in F-region peak electron density at Far East mid-latitude region ***Zhipeng Ren****, Biqiang Zhao, Weixing Wan, and Libo Liu* ID: 50O
11.45-12.00	Online IRI-plas interface service by IONOLAB ***Feza Arikan****, T.L. Gulyaeva, Cenk Toker, Umut Sezen, Harun Artuner* ID: 40O
12:00-13:30	*Lunch Time*
Session 5: Chairperson:	**F-peak modeling and comparisons** **Lee-Anne McKinnell**
13.30-13.45	Development of neural network for foF2 parameter at conjugate points in Southeast Asia and its comparison with the IRI-2012 model ***Noraset Wichaipanich****, Pornchai Supnithi, Mamoru Ishii, and Takashi Maruyama* ID: 33O
13.45-14.00	Variations of ionospheric peak parameters observed by ionosonde at Hainan Station from 2002 to 2012 ***G. J. Wang****, J. K. Shi, X. Wang, Z. Wang* ID: 13O
14.00-14.15	foF2 and NmF2 trends at low- and mid-latitude for the last three solar minima and comparison with IRI model ***Luigi Perna****, and Michael Pezzopane* ID: 17O

14.15-14.30	Weddell Sea, Yakutsk and mid-latitude summer evening anomalies in foF2 and TEC diurnal variations ***Maxim Klimenko***, *Vladimir Klimenko, Konstantin Ratovsky, Alexander Karpachev, Irina Zakharenkova, Iurii Cherniak, Yury Yasyukevich, Nikolay Chirik* ID: 24O
14.30-14.45	Study on Ionosphere Earthquake Precursor and IRI ***K-.I.Oyama***, *H.K.Fang, Y. Yakinami, K.Ryu,C.H Chen, H Liu, and J.Y.Liu* ID: 49O
14.45-15.00	A Statistical Study on Relationship between Earthquakes and Ionospheric F2 Region Critical Frequencies ***Tuba Karaboga***, *Murat Canyilmaz, and Osman Özcan* ID: 59O
15.00-15.30	*Coffee / Tea*
Session 6: Chairperson:	**Description of plasma temperatures and ion composition in IRI** **Shigeto Watanabe**
15.30- 15.45	Comparisons of SWARM Electron Temperature Data with IRI ***Vladimir Truhlik***, *Dieter Bilitza, Claudia Stolle, Stephan Buchert, Ales Bezdek, Katerina Podolska, Ludmila Triskova* ID: 77O
15.45- 16.00	Effect of solar activity on ionospheric electron and ion temperatures and comparison with IRI-2012 model ***D K Sharma*** *and Malini Aggarwal* ID: 34O
16.00- 16.15	Correction of heating rate of thermal electron by photoelectron ***Yoshihiro Kakinami***, *and Shigeto Watanabe* ID: 45O
16.15- 16.30	Modeling of the upper transition height from the topside electron density profiles ***Vladimir Truhlik***, *Ludmila Triskova, Dieter Bilitza, Dmytro Kotov, Robert F. Benson, Phillip Chu, Yongli Wang, Oleksandr Bogomaz, and Igor Domnin* ID: 76O
16.30- 16.45	Storm-time enhancement in thermsopheric nitric oxide (NO) and its impact to ionospheric NO+ ***Yongliang Zhang***, *and Larry J. Paxton* ID: 31O
16.45- 17.00	O(1S) Dayglow as a proxy to thermospheric dynamics: Ionospheric response to geomagnetic disturbances across Indian latitudes ***Sumedha Gupta***, *and A.K Upadhayaya* ID: 51O
17.00- 17.15	The Effect on Sporadic-E of Quasi Biennial Oscillation ***Ramazan Atıcı*** *and Selçuk Sağır* ID: 10O
17.15- 17.30	Ionosonde-based indices for improved representation of solar cycle variation in IRI ***Steven Brown*** *and Dieter Bilitza* ID: 82O

17.30- 17.45	Co-located fossil bubbles and SSTID structure at low latitudes: A case study ***Kornyanat Watthanasangmechai***, *Mamoru Yamamoto, Roland Tsunoda, Akinori Saito, Tatsuhiro Yokoyama, Mamoru Ishii, and Pornchai Supnithi* ID: 63O

Date/Time	**Wednesday, 11 November 2015**
Session 7: Chairperson:	**TEC and Topside modeling and comparisons** **Feza Arikan**
09.00-09.15	IRI Total Electron Content in the Canadian Sector: A comparison to GPS observations and recommendations ***David R. Themens***, *P.T. Jayachandran* ID: 46O
09.15-09.30	Topside electron density: comparison between Irkutsk incoherent scatter radar measurements, ionosonde observations, GSM TIP simulations and IRI predictions ***K.G. Ratovsky***, *A.V. Medvedev, S.S. Alsatkin, M.V. Klimenko, V.V. Klimenko, and A.V. Oinats* ID: 15O
09.30-09.45	A comparison of measured TEC data with results based on the IRI and NeQuick 2 ionospheric models over the transition regions between mid and low latitude regions using a chain of stations near the geographic meridian of 28o situated in the Southern hemisphere ***Patrick SIBANDA*** ID: 60O
09.45-10.00	Comparison of GPS TEC variations with Holt-Winter method and IRI-2012 over Langkawi during high solar activity ***Nouf Abd Elmunim***, *Mardinah Abdullah, and Alina Hasbi* ID: 11O
10.00-10.30	*Coffee / Tea*
10.30-10.45	IRI 2012 vTEC evaluation using the NeQuick topside option and F2 layer experimental parameters ***Katy Alazo-Cuartas***, *Bruno Nava B., Sandro M. Radicella, Yenca Migoya-Orue'* ID: 83O
10.45-11.00	Improved IONOLAB-TEC space weather service ***Feza Arikan***, *Umut Sezen, Cenk Toker, Harun Artuner, Gurhan Bulu, and Secil Karatay* ID: 41O
11.00-11.15	Variation of GPS-TEC in Hainan and comparisons with IRI model predictions ***XiaoWang***, *JiankuiShi, and Guojun Wang* ID: 70O
11.15-11.30	Variation of the topside and plasmaspheric electron content derived from the podTEC observations of COSMIC LEO satellites ***Man-Lian Zhang***, *Libo Liu, Weixing Wan, and Baiqi Ning* ID: 65O

11.30-11.45	Global feature of ionospheric slab thickness derived from observations of GIM TEC and COSMIC radio occultations ***Libo Liu***, *He Huang* ID: 48O
11.45-12.00	Comparison of GPS Derived TEC with the TEC Predicted by IRI 2012 Model Over the Eastern Africa Region ***Emmanuel Daudi***, *Christian B.S.Uiso, and Patrick Sibanda* ID: 28O
12:00-13:30	*Lunch Time*
13.30-17.00	Excursion (Ladkraband Satellite Ground Station or PTEC)
17:00-19:00	Depart to Banquet session (Yodpiman Pier)
19:00-21:30	*Banquet (Chaopraya River Cruise)*

Date/Time	**Thursday, 12 November 2015**
Session 8: Chairperson:	**Description of the ionosphere below the F-peak** **Ivan Galkin**
09.00-09.15	Comparison between bottomside parameter B0, B1 and IRI-2012 model: B0, B1 and ΔH at an equatorial electrojet station ***Saeed Abioye Bello***, *Mardina Abdullahi, Nurul Shazana Abdul Hamid, and Isaac Abiodun Adimula* ID: 27O
09.15-09.30	Variability of the bottomside (B0,B1) parameters obtained from FMCW ionosonde and GPS based ground observations over Chumphon, Thailand ***Punyawi Jamjareegulgarn***, *Pornchai Supnithi, Mamoru Ishii, and Takashi Maruyama* ID: 44O
09.30-09.45	Bottomside electron density profiles over Dibrugarh and comparison with the IRI ***Bitap Raj Kalita*** *and Pradip Kumar Bhuyan* ID: 23O
09.45-10.00	The effect of QBO on foE ***Selçuk Sağır*** *and Ramazan Atıcı* ID: 21O
10.00-10.30	*Coffee / Tea*
10.30-10.45	Modeling of the anomalous variations of Very Low Frequency (VLF) radio wave signals associated with solar-flare, solar-eclipse and possible pre-seismic events ***Suman Ray***, *Sourav Palit, Suman Chakraborty, Sudipta Sasmal, and Sandip Kumar Chakrabarti* ID: 58O
10.45-11.00	Modelling of sub-ionospheric VLF signal anomalies associated with precursory effects of the latest earthquakes in Nepal ***Sudipta Sasmal***, *Suman Chakraborty, Sourav Palit, Suman Ray, Soujan Ghosh, and Sandip K. Chakrabarti* ID: 52O
11.00-11.15	Reconstruction of model based electron density distribution from ionosonde data ***Gokhan Gok***, *Orhan Arikan, Feza Arikan, Z. Mosna* ID: 38O

11.15-11.30	Investigation of vertically propagating convectively generated short (~2-3 hr) period gravity waves in the atmosphere-ionosphere system ***M. Arunachalam Srinivasan*** ID: 35O
11.30-11.45	A novel approach to development of ionospheric random field model using GPS-TEC data ***Ozan Koroglu***, *Feza Arikan* ID: 39O
11.45-12.00	Fostering research aptitude to high school students through space weather competition ***Mardina Abdullah***, *Rosadah Abd Majid, Badariah Bais, Alina Marie Hasbi, Nor Syaidah Bahri* ID: 19O
12:00-13:30	*Lunch Time*
Session 9: **Student Presenations** Chairperson: **Prasert Kenpankho**	
13.30-13.43	Team 1
13.43-13.56	Team 2
13.56-14.09	Team 3
14.09-14.22	Team 4
14.22-14.35	Team 5
14.35-14.48	Team 6
14.48-15.01	Team 7
15.01-15.30	*Coffee / Tea*
Session 10: **Poster Session** Chairperson: **Vladimir Truhlik**	
15.30- 17.30	Poster Session

Date/Time	**Friday, 13 November 2015**
08.00-09.45	**Welcome Her Royal Highness Princess Maha Chakri Sirindhorn's visit (In front of KMITL Conventional Hall)**
9.45-10.15	*Coffee / Tea*
Session 11: **IRI - New Inputs and Applications** Chairperson: **Koh-Ichiro Oyama and Dieter Bilitza**	
10.15-10.30	Upper Boundary of Ionosphere ***Shigeto Watanabe*** ID: 67O
10.30-10.45	An empirical model of the occurrence of an additional layer in the ionosphere from the occultation technique: preliminary results ***Biqiang Zhao***, *Jie Zhu, Xinan Yue, and Weixing Wan* ID: 42O
10.45-11.00	Ionospheric responses to the solar EUV irradiance variations on the solar cycle and solar rotation timescales ***Yiding Chen***, *Libo Liu, Huijun Le, and Weixing Wan* ID: 54O

11.00-11.15	Routine ionospheric observation at Syowa station, Antarctica: More than 50 years of operation for space weather monitoring ***Tsutomu Nagatsuma***, *Hiromitsu Ishibashi, Takumi Kondo, Hisao Kato, Takahiro Naoi, and Michi Nishioka* ID: 64O
11.15-11.30	Wave Propagation Modeling for Anisotropic and Inhomogeneous Ionosphere using IRI-Plas-G ***Esra Erdem***, *Feza Arikan* ID: 36O
11.30-11.45	Applying the nudged elastic band method for point-to-point ray path calculation using IRI modeled ionosphere ***Igor Nosikov***, *Pavel Bessarab, Maksim Klimenko, and Nikolay Chirik* ID: 25O
11.45-12.00	The study of the Residual of the Klobuchar Model in TaiWan ***Jinghua LI***, *Qingtao WAN, Xiaolan WAN, Jie ZHANG, and Jiangtao FAN* ID: 61O
12.00-12.15	The dependence of GPS-TEC derivation on ionospheric height assumption ***Guanyi Ma***, *Qingtao Wan, Xiaolan Wang, Jinghua Li, and Jiangtao Fan* ID: 68O
12.15-13.00	**FINAL DISCUSSIONS and IRI BUSINESS MEETING**
13:00-14:30	*Lunch Time*
14.30	**Adjourn**

POSTER:	**ID: 1P** Ionospheric effects of Total Solar Eclipse on 22 July, 2009 observed over crest of EIA, Bhopal ***Rafi Ahmad***, *Azad Ahmad Mansoori, Pramod Kumar Purohit and Ashok Kumar Gwal*
	ID: 3P Earthquake linked signatures in the equatorial ionosphere ***P. Gurram***, *B. Kakad, V. Yadav and D. S. Ramesh*
	ID: 4P Study of the Equatorial Electrojet (EEJ) effects along 210° meridian magnetic, comparison results in West Africa ***F. Grodji***, *V. Doumbia, K. Shiokawa and K. Yumot*
	ID: 5P Study of the influences of eruptive solar events on geomagnetic field variations at low and mid latitudes ***Zillé Ange François***
	ID: 6P Role of low latitude Es layers in the equinoctial asymmetry of ESF irregularities as studied using field line integrated conductivities ***Sreeba Sreekumar*** *and S.Sripathi*
	ID: 7P Assessment of solar activity and Earth's magnetic field effects over ionospheric conductivity variations using IRI and SUPIM models ***Blas F. de Haro Barbas***, *Bruno Zossi, Ana G. Elias and Marta Zossi*

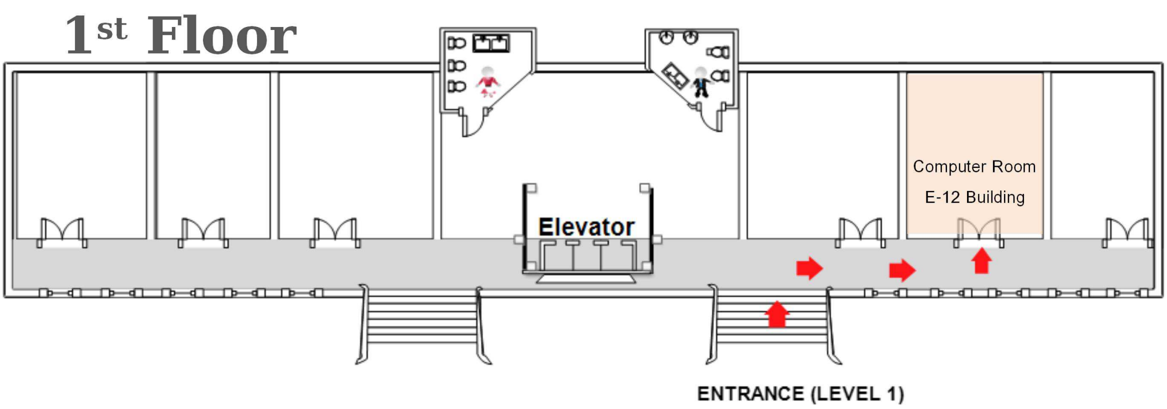
POSTER:	**ID: 8P** A comparison of TEC predicted by IRI-2012 with that measured at three different stations within EIA region in the Indian sector for the years 2010-2012 ***Sheetal P Karia,*** *Nilesh C Patel and Kamlesh N Pathak*
	ID: 9P The IONORING project: exploiting the Italian geodetic GPS network for ionospheric purposes ***Claudio Cesaroni****, Michael Pezzopane, Lucilla Alfonsi, Luca Spogli, Vincenzo Romano, Antonio Avallone and Alessandro Settimi*
	ID: 10P Characterization of hmF2 and comparison with IRI model for the last solar minima at Rome and Gibilmanna stations ***Michael Pezzopane*** *and Luigi Perna*
	ID: 11P Comparison of mid-latitude ionospheric F region peak critical frequencies, heights and topside Ne profiles from IRI2012 model prediction with ground based ionosonde and Alouette II observations ***Galina Gordiyenko*** *and Artur Yakovets*
	ID: 12P Fifty eight years of Alma-Ata ionospheric observations ***Galina Gordiyenko,*** *Artur Yakovets and Yuriy Litvinov*
	ID: 13P Correction factors for the topside IRI electron density during the recent solar minimum derived from CHAMP and GRACE observations ***Chao Xiong****, Dieter Bilitza, Hermann Lühr and Yi-Wen Liu*
	ID: 14P Achievement of a short term three dimensional electron density mapping of the ionosphere in the European sector: comparisons with the IRI model for moderate geomagnetic conditions ***Marco Pietrella***
	ID: 15P Ionospheric response to the solar eclipse of 20 march 2015: importance of autoscaled data and their assimilation for obtaining a reliable modelling of the ionosphere ***Marco Pietrella,*** *Michael Pezzopane1 and Alessandro Settimi*
	ID: 17P Variation of the total electron content and ionospheric scintillation during the magnetic storm on March 2015 observed in the Southeast Asia region ***Tran Thị Lan,*** *Le Huy Minh, R. Fleury, Y. Otsuka, Le Truong Thanh, Nguyen Ha Thanh*
	ID: 18P A new topside profiler based on Alouette/ISIS topside sounding ***Jie Zhu,*** *Biqiang Zhao, Weixing Wan, Baiqi Ning and Shunrong Zhang*
	ID: 19P An ionospheric assimilation model along 120° E meridian plane ***Huijun Le,*** *Libo Liu, Zhipeng Ren, Yiding Chen, Lianhuan Hu and Weixing Wan*

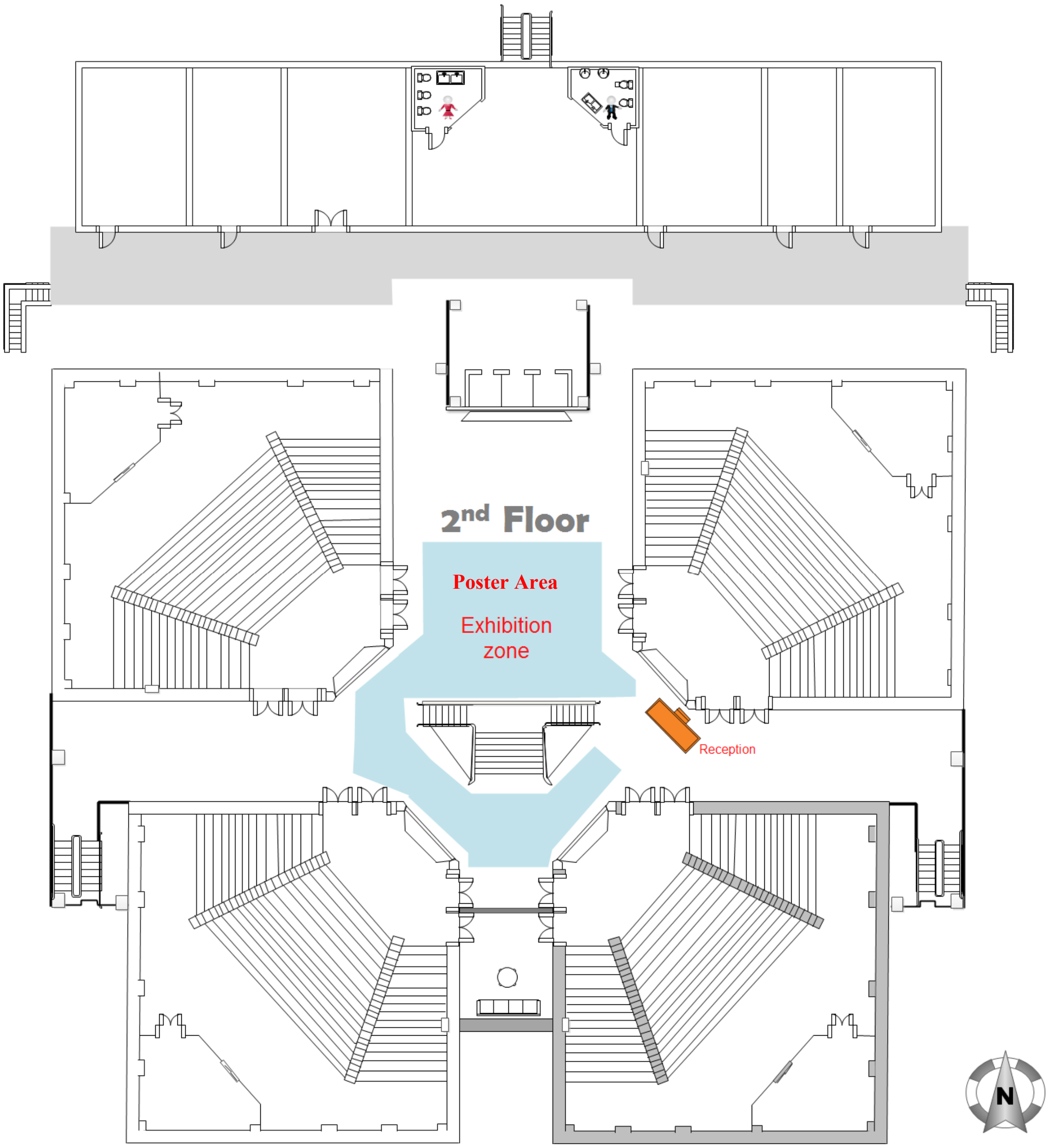
POSTER:	ID: 20P Comparison of GPS-TEC with IRI TEC over Fuzhou Region in China ***Wan Qingtao,*** *Ma Guanyi, Li Jinghua, Wang Xiaolan, Fan Jiangtao and Zhang Jie*
	ID: 21P Sporadic E layer features over two mid-latitude ionospheric stations during the 20 March 2015 solar eclipse ***Michael Pezzopane,*** *Marco Pietrella, Alessio Pignalberi and Roberta Tozzi*
	ID: 22P Detecting Solar Wind Activity using Magnetometer Kototabang Observatory ***Afrizal B***
	ID: 23P Co-seismic Ionosphere Disturbances at the Equatorial Ionization Anomaly Region under Geomagnetic Quiet and Storm Conditions ***T.L. Gulyaeva,*** *F. Arikan and I. Stanislawska*
	ID: 24P Comparative study Ionospheric TEC variation with IRI model 2012 at Manado and Pontianak Stations over Indonesia ***Dessi Marlia***
	ID: 25P Assessment of IRI model over the Indian region using satellite measurements ***Malini Aggarwal,*** *D.K. Sharma and Ananna Bardhan*
	ID: 26P Using measurements of the IAR emission frequency structure to evaluate the ion composition above the ionosphere ***Alexander Potapov,*** *Tatyana Polyushkina, Alexey Oinats, Ravil Rakhmatulin and Tero Raita*
	ID: 27P Variability of the Terrestrial Ionosphere as observed in COSMIC data ***Andréa Hughes,*** *Jeffrey Klenzing, Russell Stoneback and Dieter Bilitza*
	ID: 28P The response of the total electron content over Europe to solar eclipse of March 20, 2015 ***Shagimuratov Irk,*** *Cherniak Iurii, Zakharenkova Irina, Yakimova Galina and Tepenitzina Nadezhda*
	ID: 29P A comparison of delay gradient near Suvarnabhumi international airport in Thailand ***Acharaporn Bumrungkit,*** *Sarawoot Rungraengwajiake, Pornchai Supnithi, Nattapong Siansawasdi and Apithep Saekow*
	ID: 30P Study of GPS positioning accuracy when utilizing Klobuchar model with ionospheric conditions in Thailand ***Sutat Jongsintawee,*** *Pornchai Supnithi and Sarawoot Rungraengwajiake*

POSTER:	**ID: 31P** The Quantity of TEC over Chiang-Mai near the Epicenter of Strong Earthquake in Northern Thailand ***P. Wongcharoen,*** *A. Chiablaem and P. Supnithi*
	ID: 32P Variation of the ionospheric TEC using GPS measurements in Thailand ***Athiwat Chiablaem,*** *Prasert Kenpankho, Pornchai Supnithi and Chaiwat Panachat*
	ID: 33P Total Electron Content (TEC) and Rate of TEC Index (ROTI) Analyzing based on Hadoop Technology ***Athipu Mongkolkachit,*** *Prasert Kenpankho and Pornchai Supnithi*
	ID: 34P A Study of Ground Facility Error and Residual Ionospheric Error in GBAS Error Model near Suvarnabhumi International Airport, Thailand ***Chayanan limjumroonrat,*** *Sarawoot Rungraengwajiake, Pornchai Supnithi, Wisanu Supanunt, Apithep Saekow and Susumu Saito*
	ID: 36P IRI model application for Over the Horizon Radar ray path determination using URSI and CCIR options ***Zenón Saavedra****, Mariano Fagre, Ana G. Elías, Miguel A. Cabrera, and Gerardo L. Flores Ivaldi*
	ID: 37P Evaluation of the IRI-2012 model during intense geomagnetic storms ***Mariano Fagre****, Zenón Saavedra, Gerardo L. Flroes Ivaldi, Ana G. Elías and Miguel A. Cabrera*
	ID: 38P Slant total electron content modeling for low latitude and equatorial region ***Scidá Luis A.,*** *Ezquer Rodolfo G., Cabrera Miguel A., Jadur Camilo, Sfer Ana M.* **(Oral Paper ID: 6O)**
	ID: 39P Morphological study on the total electron content (TEC) of ionosphere over dynamically active polar region ***Shreedevi P.R.****, Raj Kumar Choudhary* **(Oral Paper ID: 43O)**
	ID: 40P Comparative study of COSMIC/FORMOSAT-3, incoherent scatter radar, ionosonde and IRI model electron density vertical profiles during the solar activity growth period ***A.A. Shcherbakov****,K.G. Ratovsky, C.H. Lin, A.V. Dmitriev, A.V. Suvorova, S.S. Alsatkin, A.V. Oinats* **(Oral Paper ID: 20O)**
	ID: 42P VHF scintillation observations over a typical Indian low latitude station during half-a-solar cycle and their comparisons with S4-index measured using the COSMIC RO technique ***D. S. V. V. D. Prasad****, V. K. D. Srinivasu, P. S. Brahmanandam, and G. Uma* **(Oral Paper ID: 71O)**

POSTER:	**ID: 43P** Global S4- index variations at F-region altitudes observed using the FORMOSAT-3/ COSMIC GPS RO technique during a solar minimum year ***G. Uma***, *P. S. Brahmanandam, D. S. V. V. D. Prasad, and Y. H. Chu* **(Oral Paper ID: 74O)**
	ID: 44P Global S4- index variations at E-region altitudes observed using the FORMOSAT-3/ COSMIC GPS RO technique during a solar minimum year ***P. S. Brahmanandam***, *G. Uma, D. S. V. V. D. Prasad, and Y. H. Chu* **(Oral Paper ID: 72O)**
	ID: 46P Observations of Plasmaspheric Electron Content over Addis Ababa during 2010 - 2013 ***A. O. Akala***, *S. P. Karia, E. W. Ojutalayo* **(Oral Paper ID: 5O)**
	ID: 47P Modeling solar flare induced lower ionospheric changes and effect on VLF propagation: A comparative study of ionization by enhanced X-ray and Lyman-α ***Sourav Palit***, *Suman Ray, and Sandip K. Chakrabarti* **(Oral Paper ID: 66O)**
	ID: 48P The disturbances of the ionosphere over Kaliningrad in periods of storm weather conditions *Ivan Karpov,* ***Olga Borchevkina****, Ruslan Dadashev, Alexander Radievski* **(Oral Paper ID: 32O)**
	ID: 49P Observational evidences of unusual outgoing longwave radiation (OLR) and atmos-pheric gravity waves (AGW) as precursory effects of the latest earthquakes in Nepal ***Suman Chakraborty***, *Sudipta Sasmal, Soujan Ghosh, and Sandip K. Chakrabarti* **(Oral Paper ID: 53O)**

WORKSHOP FLOORPLAN




2nd Floor
Poster Area
Exhibition zone
Reception
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GENERAL INFORMATION

The COSPAR Capacity-Building Workshop and IRI (International Reference Ionosphere) 2015 Workshop will be organized during 2-13 November, 2015 on the campus of King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. The theme of the IRI 2015 Workshop is **"Improved Accuracy in the Equatorial Region and Progress Towards a Real-time IRI Model"** and the workshop website is at **http://www.iri2015.kmitl.ac.th**.

TRAINING SESSION

The **first week** during **2-6 November, 2015**, is the training session supported by COSPAR. The intent is to teach graduate students and young researchers the basics of ionospheric monitoring and modeling and familiarize the attendants with the most important online databases of ionospheric ground and space data such as LEO satellites, GNSS and web interfaces to ionospheric models. The course includes lectures covering issues related to the equipment and data analysis used to monitor the ionosphere from the ground and from space and the representation of ionospheric parameters in the models like the International Reference Ionosphere (IRI). Lectures will be supplemented by hand-on tutorials and teams of 3-4 students will work on specific modeling problems. The teams will report their activities and present their results in a dedicated session at the end of the workshop.

PRESENTATION WEEK

The **second week** during **9-13 November, 2015**, is organized as a regular presentation week IRI Workshop where participants present their newest research related to improvements and additions to the IRI model and ionospheric modeling in general. This will provide the students with an opportunity to get to know the leading experts in the field and learn what the most pressing needs today are and goals in ionospheric model development.

SCOPE OF IRI 2015 WORKSHOP

The objective of IRI 2015 Workshop is to provide a venue to bring together a wide audience of academics and researchers from around the world to meet and discuss the latest ideas and present research results related to Space, ionospheric modeling, and IRI improvements and extensions. Special emphasis will be on improvements of IRI in the equatorial region and on the progress towards a real-time IRI. It is also our intention to enhance the research collaboration worldwide. The topics include:

1. Ionospheric observation
2. Ionosphere-Troposphere Coupling
3. Topside and bottomside profiles
4. Global representation of peak parameters
5. Representation of ion composition
6. Representation of plasma temperatures
7. IRI and GNSS
8. Real-time IRI
9. IRI Applications
10. New Inputs for IRI
11. Space Weather Education
12. Effects of Ionosphere on GNSS (aeronautical, satellite, etc.)
13. Space Weather applications (disasters, satellite, communications)

JOURNAL PUBLICATION

The authors of accepted abstract at the IRI 2015 Workshop are encouraged to submit the full paper to the special issue of Journal of "Advances in Space Research." More information will be given at the conference and afterward.

WORKSHOP VENUE

The location of the **training session** is at **Computer Room #109 on the first floor of the Engineering Instructional Building** (the *last* room on the right corridor of the 1st floor).

The venue of the **Presentation Week IRI 2015 Workshop** is at the **Auditorium #3, Engineering Instructional Building**.

KMITL is located in Lat Krabang District, about 5 kilometers from the Suvarnabhumi International Airport (approximately 25-30 kilometers in the eastern direction from downtown of Bangkok). The campus has a local train station (Phra Chom Klao station) right at the center of campus. The Workshop venue is about 10 minutes on foot from Phra Chom Klao station, 5-10 minutes by taxi from the neighboring hotels around KMITL, and 30 minutes on foot from the hotels around KMITL to the Workshop Venue. The free transportation will be provided in the morning before the Workshop and evening after the Workshop.

CLOTHING SUGGESTION

The typical temperature in November is around 30 degrees celcius (90s F) with higher humidity than the mid-latitude countries**.** Although in November, the weather can be a bit cooler with lower humidity, actual weather condition may vary. Thin or cotton clothes are generally recommended. Light-weight linen and rayon are equally comfortable. In addition, since strong sunlight is normal, be sure to wear the sun block lotions or even use umbrella (it is normal here), if preferable. During the conference, long pants and shirts/polo shirts are recommended. Jeans can possibly get by, but please do not wear T-shirts, shorts or sandals since the locals deem such dressing inappropriate in university. Both the Computer Room #109 and the Auditorium #3 are air-conditioned and some participants may wear a jacket in the conference room.

Important: During the **Welcome session of the Her Royal Highness Princess Maha Chakri Sirindhorn on 13th November, 2015, from 08.00-09.40 am**, **please wear polite clothes, jackets or National dress.** All participants to the IRI 2015 Workshop have been *personally* invited by the KMITL President and we have already reserved the space at the Pavilion for you in front of the new KMITL Conventional Hall, about 10-minute walk to the Workshop Venue. On this day, we will not provide the free shuttle bus since there may be heavy traffic around the university. Our students will walk with you from the hotel to the Pavillion and will hand out the invitation card and entrance ribbons to all you before entering the Pavillion.

REGISTRATION AND ACCOMODATION

WORKSHOP REGISTRATION

The IRI 2015 Workshop is fully supported by both financial sponsors and technical sponsors, therefore, there is NO registration fee for participating the IRI 2015 Workshop.

REGISTRATION DESK

The registration area of the training session is in front of Computer Room #109 on the First Floor of the Engineering Instructional Building (12-storeys).
The registration area of the second week (Presentation week) of the IRI 2015 Workshop is located in front of the Auditorium #3 of the Engineering Instructional Building.

BADGE POLICY

At the registration, a personalized name badge with a Wi-Fi account and some useful information such as Vicinity Map will be provided to all participants.

HOTEL ACCOMODATION

A list of nearby hotels can be found following the "Accommodation" link on the IRI 2015 web site (URL: http://www.iri2015.kmitl.ac.th/index.php/travel-info/accommodation). There are 3 nearby hotels recommended below; however the presenters can reserve any hotels freely. As for three suggested hotels, all the rates include breakfast and round trip transfer at Suvarnabhumi Airport.

Suggestion at the Airport upon arrival:

After you leave the Immigration area, pick up your luggage and enter the Arrival Hall, please proceed to the "Meeting Point" on the same floor between Gate 3 and 4 on the second floor and look for the signboard "IRI 2015 Workshop." Make sure that you take shuttle bus of your hotel since the participants stay at three different hotels.

Suvarnabhumi Suite Hotel

Room Types and Rates are shown below:

Room Types	Room Rates
Superior – Double	1,300 THB/night
Superior – Twin	1,300 THB/night
Deluxe – Double	1,700 THB/night
Deluxe – Twin	1,700 THB/night

Email: rsvn@suvarnabhumisuite.com **or** info@suvarnabhumisuite.com**,** Tel + (66) 23274444

Princess Suvanarbhumi Airport Residence Hotel
Note that Princess Suvanarbhumi Airport Residence Hotel is far from Soi Latkrabang 15 about 1.6 kilometers (please see the google map)

Room Types and Rates are shown below:

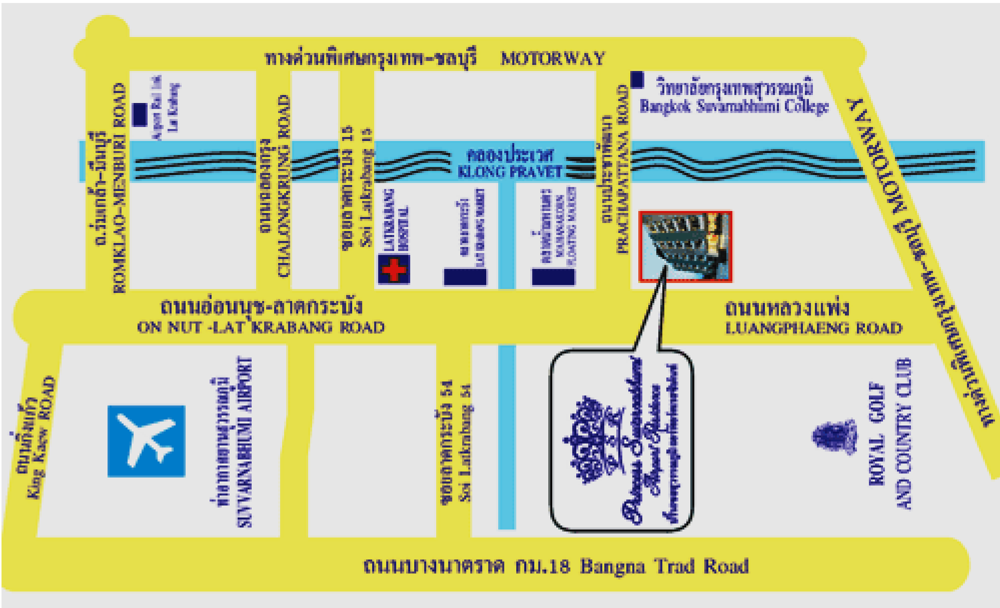
Room Types	Room Rates
Superior – Double	1,200 THB/night
Superior – Twin	1,200 THB/night

Email: princessairport111@gmail.com, Tel + (66) 21729919

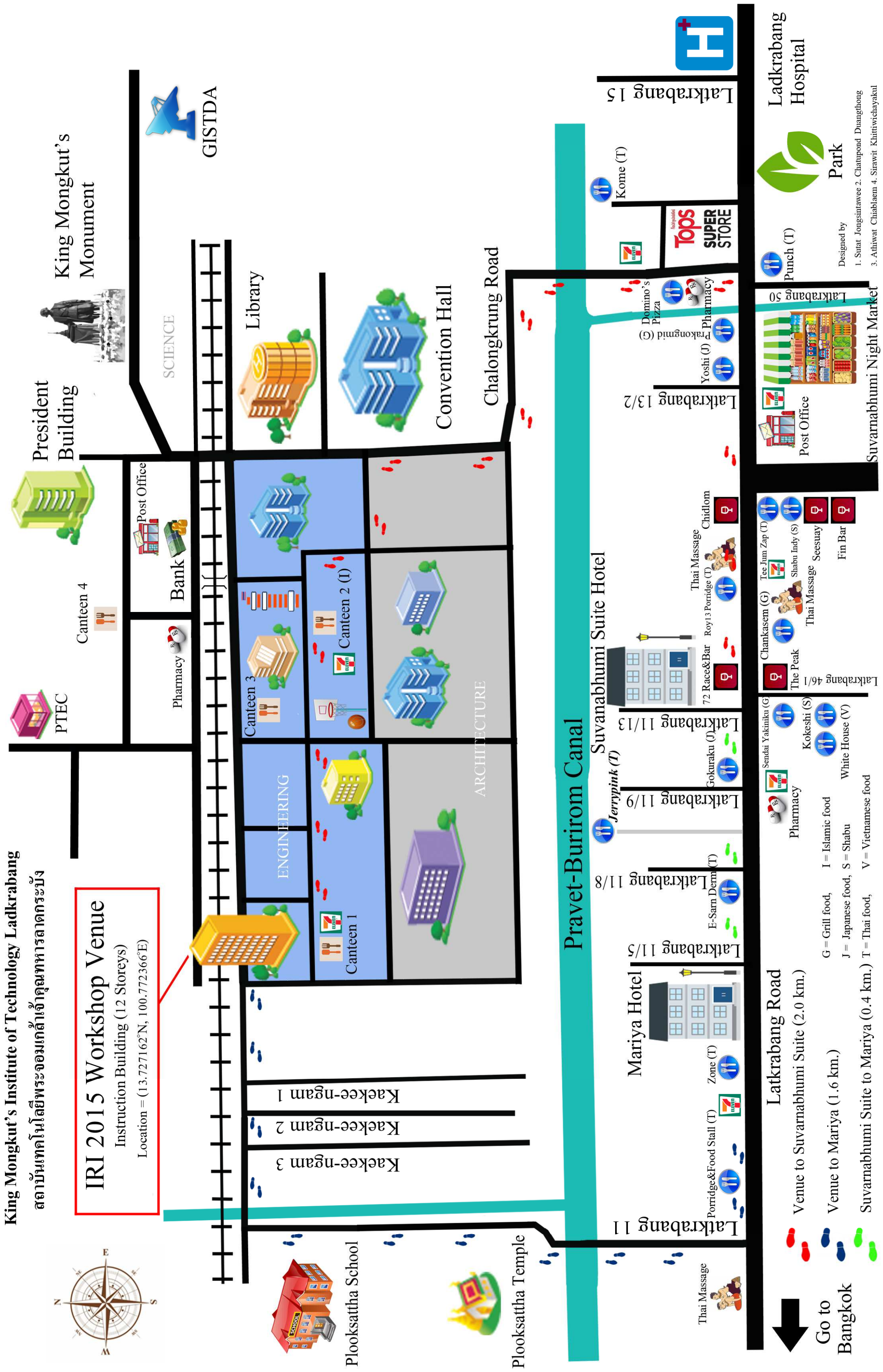
Mariya Boutique Residence Hotel
Room Types and Rates are shown below:

Room Types	Room Rate
Superior – Double	1,200 THB/night
Deluxe – Double	1,400 THB/night
Deluxe – Twin	1,400 THB/night

Email: reservation@mariyahotel.com , Tel +(66) 23267854(-55)



VICINITY MAP



PRESENTATIONS

The presentations will be held in the second week during November 9-13, 2015 which is organized as a regular IRI Workshop with scientists presenting their newest research related to improvements and additions to the IRI model, ionospheric monitoring and modeling. Presentations consist of oral and poster sessions. The formal language for all presentations is English. The details of each session are as follows:

ORAL SESSION

The oral sessions are aimed to exchange knowledge and promote discussions among the participants. The speakers should limit their talk to 10-12 minutes and 3-5 minutes for questions and discussions. A laptop computer and a projector will be available in the auditorium. Authors are expected to bring their presentation files and a backup copy on USB flash memory. Around 10-20 minutes prior to the session, authors should copy his/her files to the provided computers or test the connection of his/her laptop computers.

POSTER SESSION

The poster session is in the Session #10. It is held on Thursday, November 12th, 2015, during 15:30-17:30 LT in front of the Auditorium #3. Please post your poster at the assigned board starting from the afternoon of the *first day* of the Workshop and remove it after the Poster session on Thursday. The tapes and scissors will be provided after lunchtime on Monday, November 9th.

TRAINEE PRESENTATIONS

Trainees participating in the training session during the first week have been divided into several groups duirng 2-6 November, 2015. Each group is assigned to present the research/study results in the Session #9 which is scheduled on Thursday, November 12th, 2015, during 13:30-15:00 LT. Everyone is invited to participate and join the discussions during this session.

Note: Since a large number of abstracts were submitted in the IRI 2015 Workshop and they highly exceed highly our limited time slots to host the oral presentation, we thus need to change a few oral presentations to poster sessions instead. Please note the this decision is NOT based on the quality of the abstracts, but rather on the flow of the Technical program or allowing more countries to be able to participate in the oral presentation.

SOCIAL PROGRAM

1. THE TRAINING WEEK (First Week)

Ice Breaker

The Ice Breaker is held on Sunday, November 1st, 2015, during 18:30-21:00 LT. It is the first informal meeting where the lecturers and trainees will meet altogether before starting COSPAR Training Workshop on the next day. All of them should introduce themselves and state something about their experience or expections at the IRI 2015 Workshop. We will wait for all of you at the lobby of Suvarnabhumi Suite Hotel at 18.00 hr, and then walk together to the reserved restaurant, Jerry Pink Restaurant, on Ladkrabang 11/9 Lane, a few blocks from Suvarnabhumi Suite Hotel.

Excursion

The Excursion for COSPAR Capacity-Building Workshop will be at **Ladkrabang Satellite Ground Station** on Thursday, November 5th during 09:00-12:00 LT. It is located near to the Workshop venue.

2. The Presentation Week (IRI 2015 Workshop)

Opening Ceremony

For the second week of the IRI 2015 Workshop, the opening ceremony is held on Monday, November 9th, 2015, from 09:00 - 10:00 LT.

Welcome Reception

The welcome reception is held on Monday, November 9 during 17:20-20:00 LT (the first day of IRI 2015 Workshop). We prepare a cocktail party for all participants at the **ARCHITECTURAL CONVENTION HALL**, about 200 meters from the Workshop Venue as seen on the map.

Lunch and Coffee Services

Coffee breaks will be available for all IRI 2015 participants in front of the Auditorium area. The buffet lunch will be provided at Room #703 with the vegetarian and halal options.

Dinner
The IRI 2015 Workshop does not provide dinner to participants during 9-13 November, 2015, except at the Welcome session (light snacks) on Monday and the Workshop banquet on Wednesday. For other days, you have ample options as follow.

1. The Workshop venue is close to several university canteens, coffee shops and convenience stores, you can purchase light or heavy dinner here, the food generally costs about $1.2 – $2.
2. The Kay-Kee college street (about 5-minute walk) also has plenty of local food and is full of students especially after sunset.
3. The Ladkrabang Road near your hotels is surrounded by local eateries, restaurants and pubs. There is also a TOP supermarket nearby. The neighborhood is especially lively at night time.
4. The 7-11 convenience stores have light snacks and food available.
5. You can stroll around the Suvarnabhumi Night Market near your hotels as well.

Workshop Excursion
The IRI 2015 Workshop excursion is at the **Ladkrabang Satellite Ground Station (GISTDA) and PTEC** on Wednesday, November 11th, 2015, during 13:30-17:00 LT. They are located near the Workshop venue. There will be signup sheets at the Registration Desk. **You can attend one place only.**

Workshop Banquet (Chaopraya River Cruise)
The IRI 2015 Workshop Banquet is scheduled on Wednesday, November 11 during 19:00- 21:30 LT. The cruise will leave from **Yod Pimaan Pier** near the **Pakklongtalad Market (the city flower market)** at 19.30 LT. A bus service to Yod Pimaan Pier is scheduled to leave after the IRI 2015 Workshop excursion around 16:30 LT. There is no charge for Banquet for all presenters but the accompanying persons may need to pay about $US 25 ($US1 is about 35 bahts). Bookings can be reserved at the Registration Desk by Tuesday, November 10th at noon. If you plan to arrive at the Yod Piman Pier yourself, please show up at the registration desk of the Pier by 19.00 LT. After the Banquet, the bus will bring all the participants back to your hotels in KMITL areas.

Welcome Session for Her Royal Highness Princess Maha Chakri Sirindhorn
On Friday, November 13 during 08:00-09:45 LT, all participants have been graciously invited to welcome Her Royal Highness Princess Maha Chakri Sirindhorn's visit at the Pavilion in front of the new KMITL Conventional Hall. This event is the great honor to welcome Her Royal Highness on our campus. Please wear polite clothes, jackets or National dress. All participants to the IRI 2015 Workshop have been personally invited by the KMITL President and we have already reserved the space at the Pavilion for all of you in front of the new KMITL Conventional Hall, about 10-15 minute walk from your hotels. Due to the foreseen heavy traffic on campus, our students will walk with you from the Hotels to the Pavillion, then give out the Entrance invitation cards and ribbons to all of you. After the event, we will proceed to the Workshop Venue to start the first session.

Final Discussions and IRI Business Meeting
The last part of the Session #12 is devoted to the final discussions and IRI business meeting. It is scheduled on Friday, November 13th, 2015, during 12:15-13:00 LT. The IRI 2015 participants have been invited to participate and discuss altogether in this session.

TOUR PROGRAMS
We plan to contact the Local Tour Company to set up Tour Desk at the Venue. Should you plan to visit Bangkok yourself, please read more details beneath the title "TRANSPORTATION TO DOWNTOWN BANGKOK" which is the information provided above **OR** ask of our staffs on the travel information.

ACCESS TO IRI 2015 WORKSHOP VENUE

FROM THE SUVARNABHUMI SUITE HOTEL OR MARIYA BOUTIQUE RESIDENCE HOTEL TO VENUE

Option 1: Free Shuttle Bus
The Workshop provides morning shuttle bus from these hotels to the Workshop venue as well as the evening shuttle bus on the way back.

Option 2: On Foot
It is generally safe to walk near or around the campus even at night time. However, you may find that car drivers and especially motorcycle riders may drive rather fast and are not as courteous as those in many countries. It is good to be alert especially while crossing the street.

From Mariya Boutique Residence Hotel:
It is located on Ladkrabang Road near Ladkrabang Lane 11/5 (small gray star on the left side of the map below). The participants can walk toward the Workshop venue and come back the hotel by either 1) walking on Ladkrabang 11 Lane **OR** 2) walking on Ladkrabang Road toward the Suvanarbhumi Suite Hotel, then turning left, and going straight ahead on Chalongkrung Road for about 1 kilometer. The Workshop venue is located in the Faculty of Engineering areas of which the gate is opposite to the new KMITL Convention hall (big gray star on the map). From this gate, it will be a 10-minute walk) The No.1 option is the path with small blue arrows on the left side of the map. Although it is shorter than the No.2 option, the No.2 option is easier to walk.

From Suvanarbhumi Suite Hotel:
It is located on Ladkrabang road near Ladkrabang Lane 11/9 (small gray star in the middle of the map below). The participants can walk toward the Workshop similar to the directions given from the Mariya Boutique Residence Hotel. Please look at the small red arrows on the right side of the map.

From Princess Suvanarbhumi Airport Residence Hotel:
It is also located on Ladkrabang Road near Ladkrabang Lane 19. Although it does not appear on the map, its location is shown with the small gray star on the right side of the map below. The participants can walk toward the Workshop venue by walking along the Ladkrabang road as well.

Option 3: Taxi (All taxis are metered)
Tell the driver you need to go to "Prajomklao Ladkrabang" or "Techno" (Thai name) or King Mongkut's Institute of Technology Ladkrabang (English name) and show the map above. The taxi fare is about 40-50 bahts ($1.2 – $1.5).

Option 4: Bus

- **From Suvanarbhumi suite Hotel AND Mariya Boutique Residence Hotel**
  Take the small bus No. 1013 (as shown below) at the bus stop in front of the hotels to the bus stop opposite to KMITL Convention hall – gray star on the above map) and then walk into the Faculty of Engineering areas following the black arrow toward the Engineering Instruction Building (12-storey building). The bus fare is 11 bahts (30 cents). **Note**: The bus number 1013 is the small bus as shown on figure below, **Warning: DO NOT GET ON THE "BIG" BUS NO. 1013**.

- **From Princess Suvanarbhumi Airport Residence Hotel**
  It's easy to take the **WHITE MINI-BUS** (Huatakae - IPLACE) as shown on the figure below at the bus station which is located at the opposite side of the hotel. The minibus fare is 7 bahts.

From downtown

All taxis are metered taxis. You can wave to any passing taxis, or ask the hotel concierge to call taxis for you. Additionally, you can use 'GrabTaxi', 'Uber', or 'All Thai Taxi' mobile applications (downloadable on Androids or IOS) to reserve metered taxis in advance. In this case, a surcharge of 25-35 bahts is typically added to the actual metered fare. If the taxis take the Expressway, additional fees will be made depending on the distance and how many sections of the Expressways are used.

Option 1: Taxi

Tell the taxi driver that you want to go to Prajomklao Ladkrabang (Thai name) or King Mongkut's Institute of Technology Ladkrabang (English name). From downtown Bangkok, the fare is about 200-250 bahts (excluding the expressway fares, if used)

Option 2: Airport Rail Link + Taxi

1. Take the Airport Rail Link to Ladkrabang Station (Please look at the map beneath titled "TRANSPORTATION TO DOWNTOWN BANGKOK and subtitled "PUBLIC TRANSPORTATION MAP" in the next topic). Once you arrive this station, go downstairs to Level 1, there will be a TAXI stand.
2. Take the taxi to KMITL. The distance is around 4-5 kilometers. The taxi fare is about 70 bahts ($US 2).

From airport (Taxi only)

When arriving at the airport, please proceed to Level 1 (the taxi stand). Tell the driver you need to go to Prajomklao Ladkrabang (Thai name) or King Mongkut's Institute of Technology Ladkrabang (English name). The taxi fare is about 80 bahts. **Note that** an airport fee of 50 bahts will be additionally charged on top of the taxi meter fee.

From Jinda village or Area Surrounding Ladkrabang hospital or Top Supermarket

Option 1: Mini-Bus

It's easy to take the **WHITE MINI-BUS** (Huatakae - IPLACE) as shown in the latest figure above at the bus station which is located on the opposite side of the hotel. **Note that** this hotel is a bit distant from Soi Latkrabang 15 on the right hand for about 1.6 kilometers which disappears in the map above. The minibus fare is 7 bahts.

Option 2: Taxi

Tell the taxi driver that you want to go to Prajomklao Ladkrabang (Thai name) or King Mongkut's Institute of Technology Ladkrabang (English name). The taxi fare is about 40 bahts.

TRANSPORTATION TO DOWNTOWN BANGKOK

PUBLIC TRANSPORTATION MAP

BTS

The BTS "Skytrain" as it's commonly called is a cheap and convenient way to get around Bangkok. There are two lines currently in operation with a central hub at Siam Station, home to shopping, hotels, and restaurants. **The train runs from 06:00 LT to 24:00 LT every day**.

BTS Skytrain Passes

One-day pass 140 bahts (about 4 US dollars)

1. Valid for unlimited rides on the date of issue or registration only
2. Non-refundable
3. Available at all BTS Ticket Offices

Single Journey Ticket

1. This ticket is valid for a single journey, with fare according to chosen destination. **(Ticket starts 15 bahts up to 42 bahts per journey)**
2. Valid for travel on date of purchase only.
3. Ticket will be retained at an Automatic Gate upon exit.
4. Single Journey Tickets can be purchased at any Ticket Issuing Machine (TIM), Integrated Ticketing Machine (ITM) and Ticket Vending Machine (TVM).

Link: http://www.bts.co.th/customer/en/main.aspx

MRT

The Metropolitan Rapid Transit, or MRT, is Bangkok's underground train system and another inexpensive and comfortable way to elude the masses when commuting in Bangkok. Similar to the BTS, MRT is easy to access and equally easy to navigate, and the two rail systems synch up at three main transfer stations: Silom (MRT)/Sala Daeng (BTS), Sukhumvit (MRT)/Asoke (BTS), Chatuchak Park (MRT)/Mo Chit (BTS). The MRT also operates from 06:00 LT to 24:00 LT every day.

One Day Pass

1. One day unlimited trips (Start from the time you first enter the paid area to midnight of that day)
2. Issued at Ticket Office
3. The card can be used in all 18 MRT stations Cost 120 Bahts
4. No Deposit, Non-addable and Nonrefundable

Unlimited 3 consecutive days

1. Unlimited 3 consecutive days travel (Start from the time you first enter the paid area to midnight of the 3rd day)
2. Issued at Ticket Office
3. The card can be used in all 18 MRT stations Cost 230 Bahts
4. No Deposit, Non-addable and Nonrefundable

Single Journey Token

1. This ticket is valid for a single journey, with fare according to chosen destination. **(Ticket starts at 16 bahts up to 42 Bahts per journey)**
2. Valid for travel on date of purchase only.
3. Ticket will be retained at an Automatic Gate upon exit.

Link: http://www.bangkokmetro.co.th/

AIRPORT RAIL LINK

The Airport Rail Link is a train system which runs from just north of downtown to Suvarnabhumi International Airport and back. Airport link runs from 06:00 LT to 24:00 LT every day as well. **(Ticket starts at 15 bahts up to 45 Bahts per journey)**

Link: http://www.srtet.co.th/th/

TAXI

In Bangkok, one word comes to mind with respect to taxi cabs, and that's "everywhere." A litany of pink, yellow, blue and other colorful **"taxi-meters"** ferry locals and tourists around the city. Fares start at 35 Bahts **(just over $1 US)**, and it's not uncommon to ride an hour or more across the city for just a few bucks. On arrival, you'll have to pay the fare on the meter, plus an airport surcharge of 50 baht that is not shown on the meter. Typical cost: 250 to 400 bahts in total (including metered fare, surcharge and tolls) depending on distance and traffic conditions and not include tollway or expressway.

LOCAL TRAIN

1. The local train timetable from Lat Krabang station to Phra Chom Klao (KMITL) station starts at the local times (LT): 6.55, 7.31, 8.06, 8.51, 11.02, 12.57, 13.42, 16.12, 17.21, 17.58, 18.34, 19.11 and 19.22 (last time). Note that Lat Krabang station of the local train is connected to Airport Rail Link (Lat Krabang station). The ticket charge is about 10 bahts.
2. On the other hand, the local train timetable from Phra Chom Klao (KMITL) station to Lat Krabang station starts at the local times (LT): 6.02, 6.28, 7.04, 7.37, 8.07, 9.14, 11.10, 13.18, 14.37, 16.12, 17.09 and 18.45 (last train).

Link: http://www.railway.co.th/home/Default.aspx

ACCESS TO DOWNTOWN BANGKOK FROM SUVARNABHUMI AIRPORT

Located on the 15th kilometer of Bangna-Trad Road, just 25 kilometers from downtown Bangkok, Suvarnabhumi Airport is easily accessible via a series of 5 highways both directly from Bangkok and its surroundings. Access roads include:

1. AIRPORT SHUTTLE BUS

Free shuttle bus service is provided for passengers and airport staff. Express route connects the main terminal directly to the transport center. Ordinary route connects to other airport facilities. For passenger convenience shuttle buses serving Suvarnabhumi airport are low-floor type.

2. PUBLIC TAXI

Public taxis can be found on 1st floor (Arrivals).

- Contact Taxi counter, Level 1 - Ground Level, near entrances 3, 4, 7 and 8.
- Pick up area: taxi stand Level 1 - Ground Level
- Taxi fare: metered taxi fare plus 50 Bahts airport surcharge, and expressway fees.
- Passenger drop off at Departures (level 4 - outer curb)

3. PUBLIC BUS
11 Bus routes operated by BMTA serve the airport's dedicated bus terminal. There are also direct long-distance services to Pattaya, Talad Rong Kluea and Nong Khai

No.549 - Suvarnabhumi Airport - Minburi
No.550 - Suvarnabhumi Airport - Happy Land
No.551 - Suvarnabhumi Airport - Victory Monument (Expressway)
No.552 - Suvarnabhumi Airport - On Nut BTS station
No.553 - Suvarnabhumi Airport - Samut Prakan
No.554 - Suvarnabhumi Airport - Don Muang Airport (Expressway)
No.555 - Suvarnabhumi - Rangsit (Expressway)
No.556 - Suvarnbhumi - Southern Bus Terminal (Expressway)
No.557 - Suvarnbhumi - Suvarnabhumi - Wongwien Yai
No.558 - Suvarnabhumi - Central Rama 2
No.559 - Suvarnabhumi - Future Park Rangsit

4. PUBLIC BUS SERVICE TO OTHER PROVINCES:
No.389 - Suvarnabhumi Airport - Pattaya
No.390 - Suvarnabhumi Airport - Talad Rong Kluea
No.390 - Suvarnabhumi Airport - Nong Khai

5. SHUTTLE BUS EXPRESS ROUTE:
1. Passenger terminal
2. Car rental center
3. Public transportation center and bus terminal

Link: http://bangkok.sawadee.com/airport/trans.htm

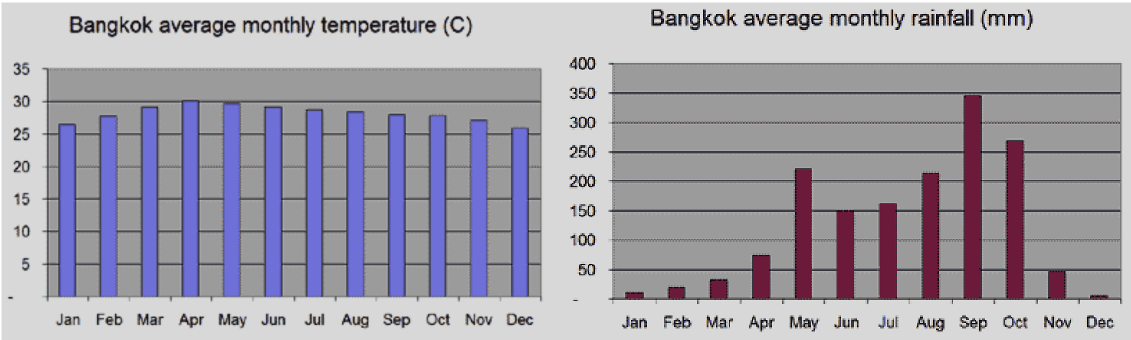
WHERE TO GO?

Thailand is a regional hub in Southeast Asia, favored by both leisure and business travelers for its unparalleled natural beauty and diversity. Its mountains, streams, forests, parks, beaches, islands and coastline provide opportunity for an endless variety of activities and attractions. In the cities, tourists are often struck by the combination of ancient traditions side-by-side with every modern amenity you could ask for, seduced by the many charms of the warm, service-oriented locals.
The country is usually classified into five geographical regions, each with distinct culture, history, geography, and attractions.
The central region, which includes Bangkok, is often called the "rice bowl" of Thailand owing to its being the most fertile area of the country. It is also chock full of historical sites, ornate Buddhist architecture, and still persisting traditional ways of life. Key destinations include Ayutthaya, the ancient capital; Hua Hin, a laid-back beach town 150 kilometers from Bangkok; and Amphawa, a traditional floating market near Samut Songkhram.
The northern region is mountainous and is the most heavily forested area of the country. Trekking, motorcycle touring, visiting hill tribe villages, and mountain climbing top the list of activities for visitors. A rich cultural and historical tapestry in the region makes northern Thailand one of the most interesting places to visit in Thailand. Chiang Mai, Chiang Rai, the Golden Triangle, and Sukhothai top the list of must-see locations.
Thailand's northeast – known as Isan – is a region of 20 provinces that offers an easy-going lifestyle steeped in traditions with unique food, culture, and even language due to a strong influence from neighboring Laos. Visitors to Isan experience fantastic temples, amazing national parks, wild and exotic festivals and celebrations, and true immersion into the Thailand of old.
The southeast, which is comprised of hilly countryside and coastline from Bangkok to the Cambodian border, is characterized by beaches, national park land, delicious fruit, seafood, and a relaxed pace. The region is geared towards tourism and in fact is home to Thailand's largest tourist-oriented city,

Pattaya. A slew of beautiful offshore islands attract sea-lovers from abroad and all over Thailand, too. Like the north, this area of the country is a great spot for the outdoorsman.
The southern region is all about the sun-and-fun options that Thailand has in spades. Up and down the Gulf of Thailand and the Andaman Sea, beaches and resorts tempt visitors with a dizzying array of seaside fun. Phuket is perhaps the most famous, but there are countless places to escape and indulge in your beach-bum fantasies. There are also some important cities, such as Hat Yai, which is a melting pot of cultures and a great place to get off the beaten path.

WEATHER

Thailand has a subtropical climate. Temperatures in Bangkok are typically warm and humid. The cool season period is from October to February. In November, the average temperature in Thailand (Bangkok) is 28°C (82°F), comprised of an average high of 31°C (87°F) and low of 24°C (75°F). The average rain fall is 40 mm. Thus, the clothing should be comfortable clothes. To protect your skin from sunburn or some unexpectedly rain, we suggest you to keep an umbrella during this time.



Oral Abstracts

Session 1: Improved Accuracy of IRI at Equatorial Latitudes - I

Paper # 22O

The International Reference Ionosphere: Model Update 2015

Dieter Bilitza [1,2]

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Abstract

This talk is intended as an introduction to the 2015 IRI Workshop. It will review recent activities of the IRI Working Group including meetings, new members, publications and usage statistics. The current status of the model will be discussed and some of the ongoing improvement project will be highlighted. With the 2012 Version of the IRI model several improvements were introduced for the bottomside and topside ionosphere. I will briefly review these improvements and discuss their benefits and shortcomings. Since the release of the IRI-2012 code a number of bugs have been removed and speed-ups have been introduced in response to feedback and requests from users. The most important ones will be listed here. An outlook will be given regarding the next major release of the IRI model and the improvements and additions it is scheduled to include. One of the most exciting new projects is the development of the Real-Time IRI, which is also one of the main topics of this workshop. A brief overview will be given with more to come in specialized talks during the workshop.

Paper # 78O

Performance of the IRI-2012 model in the equatorial region: Variations with longitude and solar activity

Jeffrey Klenzing[1], Andréa Hughes[2], Dieter Bilitza[1,3], Angeline Burrell[4], and Russell Stoneback[5]

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Email: dieter.bilitza-1@nasa.gov
[4]Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH, UK,
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Email: rstoneba@utdallas.edu

Abstract

The International Reference Ionosphere (IRI) is the internationally recognized model for calculating empirical ionospheric parameters such as plasma density, composition, and temperature. Estimates of the topside F-region ion density rely on accurately predicting the peak density and height of the F-layer and describing how the density decays with altitude. The latest incarnation of the IRI model (IRI-2012) includes two options to estimate the F-peak and three options to shape the topside profile. Previously it was shown that IRI overestimated the topside ionospheric densities during solar minimum between cycles 23 and 24, and the relative performances of the three topside shaper functions were compared. Here we reconstruct maps of the ionosphere near the magnetic equator using information about the F-peak from the Formosa Satellite-3/ Constellation Observing System for Meteorology, Ionosphere, and Climate (FORMOSAT-3/COSMIC) and ion densities above 400 km from the Coupled Ion-Neutral Dynamics Investigation (CINDI) instrument on the Communication/Navigation Outage Forecasting System (C/NOFS) satellite. By simultaneously comparing the both the peak ionospheric density and the topside ion densities, we can better evaluate the combinations of the component models in IRI-2012.

Paper # 47O

Topside electron density profiles over Chumphon, Thailand and comparison with the IRI-2012 and NeQuick 2 models

Punyawi Jamjareegulgarn[1], ***Pornchai Supnithi***[1], ***Mamoru Ishi***[2], ***and Takashi Maruyama***[2]

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Abstract

Topside electron density profiles over Chumphon station, Thailand (geographic latitude: 10.72°N, 99.37°E) are studied and compared those profiles with the IRI-2012 and NeQuick 2 models. These profiles are depicted by using some expressions of NeQuick topside, the F2 layer peaks from FMCW ionosonde, and the TEC from JAVAD GPS receiver. Because of the bottomside thickness (B0) unavailability on FMCW ionosonde at Chumphon station, the B0 must be computed by using the ionosonde data, the TEC, and 12-month smoothed relative sunspot number (Rz12). This work is a pioneer study about topside electron density profiles of Thailand; hence those of March in 2007 are only chosen to be a case study preliminarily. Some local times are taken into account for drawing the topside electron density profiles, i.e., 00:00 LT, 04:00 LT, 08:00 LT, 12:00 LT, 16:00 LT, and 20:00 LT. Note that the monthly median ionospheric parameters of both the IRI-2012 model and the observations are analyzed so as to compare those topside electron density profiles and topside TEC with NeQuick 2 model. Moreover, topside electron density profiles and topside TEC of the IRI-2012 model are drawn and computed by some equations of NeQuick topside with adaption of k, while those of Chumphon station are also done by some equations of NeQuick topside (Coïsson et al., 2009). After plotting topside electron density profiles and computing the topside TEC, our results show that 1) the averaged positive differences of topside TEC between the IRI-2012 and NeQuick 2 models are 10%; 2) topside electron density profiles over Chumphon station are the nearest to those of the IRI-2012 and NeQuick 2 models at 12:00 whose topside TEC differences are 2.47 and 1.69, respectively; 3) the topside TEC differences between Chumphon station and the IRI-2012 model being less than 20% occur until local noontime to midnight whose average is about 14%. In contrast, those are approximately 74% and 26% at 04:00 LT and 08:00 LT, respectively; 4) the topside TEC differences between Chumphon station and NeQuick 2 model can be found during post-sunrise hours and post-sunset hours whose average is about 9%. On the other hand, those are approximately 28% and 51% at midnight and 04:00 LT, respectively; 5) for all the local times, the topside TEC values of both the IRI-2012 and NeQuick 2 models overestimate those of Chumphon station, except the period of pre-sunrise hours. The main cause is due to the abnormal peak of ionospheric slab thickness during the pre-sunrise hours in equatorial latitude region, for example, Chumphon station, Thailand.

Paper # 26O

Ionospheric ceiling over the magnetic equator: A missing concept in IRI

***Takashi Maruyama*[1], *Pornchai Supnithi*[2], *and Tharadol Komolmis*[3]**

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Abstract

The ionospheric peak height (*hmF*2) is susceptible to external forces such as zonal electric fields, meridional neutral winds, and gravitational forces. At the magnetic equator, where the geomagnetic field is parallel to the ground, the vertical $\mathbf{E}\times\mathbf{B}$ drift due to the zonal electric field is thought to be the primary factor that controls the *hmF*2. However, this is not always true and the gravitational force has a significant effect under several conditions. Equatorial plasma is closely connected with the low-latitude ionosphere through the diffusion along the magnetic field. Equatorial anomaly of ionospheric critical frequency (*foF*2) is produced by the combined effect of upward $\mathbf{E}\times\mathbf{B}$ drift and field aligned diffusion (the fountain effect). The noon bite-out of *foF*2 is another manifestation of the fountain effect. Meanwhile, not much attention has been paid to hmF2 variations associated with the fountain effect.

Recently, three papers concerning the ionosheric height variations were published. There found a significant qualitative discrepancy regarding the daytime *hmF*2 at equatorial latitudes among those works and also the IRI model. Hoque and Jakowski (2012) model predicts a single peak of daytime *hmF*2 at the geomagnetic equator. Maruyama et al. (2014) found that the noontime *hmF*2 at the magnetic equator is limited to a level, which is often lower than *hmF*2 at low latitudes. This limitation was referred to as the ionospheric ceiling. First principles simulations using various models by Fang et al. (2013) reproduced both single equatorial peak and trough of *hmF*2 around noon, depending on the model. On the other hand, the IRI model shows a hint of daytime equatorial depression of *hmF*2, but the latitudinal profile exhibits a single peak near the magnetic equator.

These qualitative discrepancies might be due to inadequate data points, unsuitable data analysis, and different formulation of the physics behind. The analysis of data from the low latitude meridional ionosonde network with a help of SAMI2 simulations revealed that the enhanced diffusion of plasma toward low latitudes is responsible for the ionospheric ceiling.

References

M. M. Hoque, and N. Jakowski (2012), *Ann. Geophys.*, *30*, 797-809, doi:10.5194/angeo- 30-797-2012.

T.-W. Fang. et al. (2013), *Geophys. Monogr. Ser.*, vol. 201, edited by J. D. Huba et al., pp. 133-144, AGU, Washington, D. C., doi:10.1029/2012GM001280.

T. Maruyama, J. Uemoto, M. Ishii, T. Tsugawa, P. Supnithi, and T. Komolmis (2014), *J. Geophys. Res.*, *119*, 10,595-10,607, doi: 10.1002/2014JA020215.

Paper # 14O

Validation of IRI-2012 and IRI-2007 model in determining TEC at an anomaly crest station in India

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Abstract

The paper presents the ionospheric variations in terms of total electron content (TEC) derived from a dual frequency GPS receiver that are conducted at Surat (21.16^0 N Geographic latitude, 72.78^0 E Geographic longitude) in India, which is situated under the northern crest of Equatorial Ionisation Anomaly (EIA) region, for a period of three years (January 2010 - December 2012) during ascending phase of 24^{th} solar cycle. In this comparison plasmaspheric electron content (PEC) contribution to the GPS-TEC have been removed. These results are compared with the TEC predicted from two versions International Reference Ionosphere (IRI) models: the IRI-2007 and IRI-2012. For the monthly comparison of GPS-TEC with IRI modeled TEC both modeled TEC overestimates in June-2012 and underestimates TEC in November-2011, December-2011 and March-2011. For all other months modeled TEC matches well. In the seasonal comparison the peak time appears ~1h later than actual peak time in winter 2010 and equinox 2011. However, the seasonal variation of the TEC for all the three years matches well with IRI-2012 model compared to IRI-2007 model. Further, the mean annual TEC predicted well by both the versions of the IRI model.

Paper # 4O

Performance of IRI-2012 model in predicting ionospheric electron density variability and various ionospheric parameters over the equatorial and low latitude sectors

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Abstract

Over the equatorial and low latitude sectors, accurate modeling of characteristic variations of EIA is more important to arrive at the correct estimation of range delays required for the communication and navigation applications. The Total Electron Content (TEC) data from a chain of Global Positioning System (GPS) receivers at seven identified locations from equator to the anomaly crest and beyond along 315˚ E geographic longitude in the Brazilian sector is considered. The performance of the latest available IRI-2012 has been investigated during 2010-2013 in the increasing phase of the 24^{th} solar cycle. A study on the morphological variations of the GPS measured and IRI-2012 modeled TEC revealed that the performance of the IRI-2012 is improved during low solar activity periods compared to that during the increased solar activity years. The strength and the locations of the EIA crest are nearly well represented by the model during the low solar activity while the model underestimates the peak TEC at the EIA during the increased solar activity conditions. The deviations between the GPS measured and model derived TEC are more during equinoctial and summer months at and around the anomaly crest locations. Comparative study on the modeled and experimentally derived vertical electron density profiles reveals that the model performs better in the prediction of NmF2 and hmF2 than in the prediction of TEC during day-time hours. Further, it is observed that the IRI-2012 show considerable deviations in the estimation of the bottom side profile parameters while more discrepancies are observed in the prediction of topside effective scale height values particularly during day-time hours. Simultaneous comparison of various ionospheric parameters from measurements and IRI-2012 model reveals that the discrepancies in the estimation of topside scale height contributes significantly for the deviations in the estimation of accurate TEC over the equatorial and low latitude sectors.

Oral Abstracts

Session 2: Improved Accuracy of IRI at Equatorial Latitudes - II

Paper # 2O

Effect of ionospheric irregularities on GPS signals during declining phase of solar cycle 23 at crest of EIA, Bhopal

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Abstract

The present investigation is dedicated to the evaluation of GPS performance under disturbed geomagnetic conditions at the equatorial region. When GPS signals encounter the ionospheric irregularities of different size developed during high geomagnetic or solar activity, they undergo rapid changes in their phase and amplitude, known as scintillations. We have studied the occurrence characteristics of scintillation events during geomagnetic storms of different intensity at the crest of equatorial anomaly station Bhopal (23.2N, 77.6E).

A dual frequency GPS receiver was installed and operated at the Space Science Laboratory, Department of Physics and Electronics, Barkatullah University, Bhopal during the year 2004 and 2005. We have selected thirty one geomagnetic storms that occurred during this period. To accomplish this study we have used two data sets: Disturbed Storm Time (DST) index and Amplitude Scintillation (S4) index. The geomagnetic storm activity is characterized by the DST index and the evaluation of GPS performance during disturbed geomagnetic condition is realized through S4 index. We then classified these geomagnetic storms and scintillation events into weak, moderate and intense and weak, moderate and strong according to DST index and S4 index respectively.

During all the storm events we observed a good number of scintillation events. The maximum percentage (60%) was of weak category while the least percentage (15%) was of strong category. We then performed the correlation analysis between the storm intensity index DST and scintillation index S4, to find out the impact of storm intensity on the occurrence of scintillation events. A good correlation was observed between the number of S4 occurrences and peak values of DST index during the moderate and intense storms for all the three types of scintillations. Forecasting of the scintillation occurrence for the local time, season, solar cycle and during the geomagnetic disturbances are very important for the radio communication. This study will contributes to the knowledge of equatorial ionospheric scintillation and help us to improve our receivers to be adequate in such adverse space weather conditions.

Key Words: GPS, Scintillation, Geomagnetic Storm

Paper # 18O

IRI consistently underestimates TEC at 95°E during the ascending half of the solar cycle 24

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Abstract

It is now generally established that a longitudinal wave like structure with 90° in phase and varying amplitudes exists along the crest of the equatorial ionization anomaly. The enhancements are found to be strongest in the noontime hours at 100°E and weakest at 10°E. In view of these observations, measurement of ionospheric density and related parameters around 100°E assumes significance from the perspective of IRI simulations i.e. whether the IRI is able to capture the enhanced density and the local time effect at the peak locations of the wave number 4 structure. TEC measured at Dibrugarh (27.5°N, 94.9°E, MLAT 17.6°N) using a GSV4004B receiver during the ascending half of the solar cycle from 2009 to 2014 has been used to assess the predictability of the IRI. The station is normally located at the poleward edge of the northern EIA and lies within the peak longitudinal wave number four structure. The measured data are compared with the IRI-2001, IRI-corr and IRI-NeQuick. IRI-corr and IRI-NeQuick TEC are nearly equal at all local times, season and year of observation. On the other hand IRI-2001 simulated TEC are always higher than that simulated by the other two versions. The IRI-corr and IRI-NeQuick underestimates the TEC at about all local times irrespective of the level of solar activity. IRI-2001 slightly overestimates in the morning hours of moderate solar activity years 2011-12. The discrepancy between model and measured TEC is high (~15 TECU) in the evening hours of solstice months while in the equinoctial evenings the offset could be as high as ~25 TECU. Both observed and model TEC exhibits a nonlinear correlation with F10.7 cm solar flux while variation with EUV flux is linear. The consistent underestimation of the TEC at this longitude by the IRI is attributed to the inability of the model to reproduce the wave number four structures in electron density.

Paper # 55O

Ionospheric irregularity observations using FS3/COSMIC radio occultation data

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Abstract

The FormoSat-3/ Constellation Observing System for Meteorology, Ionosphere and Climate (FS3/COSMIC) has been proven a successful mission on profiling and modeling of ionospheric electron density by the radio occultation (RO) technique. In this study we report limb-viewing observations of the GPS L-band scintillation since the mid of 2006 using FS3/COSMIC data and propose to include the resulting scintillation climatology in the future IRI. Generally the FS3/COSMIC has performed >1000 ionospheric RO observations per day. The near-vertical profiles of S4 scintillation index can be retrieved too at dual L-band frequencies. There are only a few percentage of FS3/COSMIC RO observations having >0.04 S4 values on average. However, six typical areas at (2±12°N, -160±20°E), (-10±15°N, -60±30°E), (13±12°N, 10±30°E), (40±10°N, 30±24°E), (45±10°N, 130±15°E), and (2±13°N, 168±12°E) have been designated to have much higher percentage of strong L-band scintillation. Those equatorial-to-low latitude areas are in good agreements with previous ionospheric irregularity studies using in-situ Ionospheric Plasma and Electrodynamics Instrument (IPEI) data from the ROCSAT1 mission. The local-time and seasonal distributions of large S4 RO observations at each designated area have been studied and presented. Furtherrmore, we expect that the future COSMIC follow-on mission could perform much more GNSS RO observations at a factor >5 than COSMIC and can provide valuable data to scintillation climatology research.

Keywords: ionospheric irregularity, radio occultation observation, COSMIC

Paper # 8O

An Empirical Model of FORMOSAT-3/COSMIC Occultation Scintillation

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Abstract

Occultation radio scintillation of GPS L1-band (1.575GHz) has been recorded by FORMOSAT-3/COSMIC (F3/C) in S4 index for over 8 years since 2007. Massive data (~4000 profiles daily) collected by six LEO satellites allow us to observe scintillation distribution in 3D globally.With F3/C's high spatial and temporal resolution, especially upon the oceanic region that cannot be provided by ground-based observation, the F3/C occultation scintillation can be consider as one of the option updating existing scintillation model. In the first part of this presentation, the method we simulateground-based scintillation observation by F3/CS4 indexwill be introduced. The second part will be the scintillation model based on F3/C S4 index, and the comparison betweenthe model and several ground-based observation cases. IRI-2012 ESF occurrence rate will bealsoprovided as a reference.

Paper # 73O

Global Ionosphere Spread-F observed by the COSMIC GPS radio occultation technique: A great possibility for incorporating them into the International Reference Ionosphere (IRI) model

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ABSTRACT

After Abdu et al. (2000) no considerable research work on IRI spread F over the Brazilian sector has been appeared in the literature on the similar lines primarily due to the lack of continuous and global database. Although CHAMP, ROCSAT-1, and DMSP series of satellites have provided a wealth of information on ionosphere irregularities, meager temporal and spatial coverage of them have hampered so as to provide global statistics of ionosphere irregularities. With the advent of the COSMIC radio occultation (RO) technique with six satellites constellation, it has become possible for us to have the global database of S4-index (scintillation index) from June 2006 to date. By utilizing this database, we can study the different aspects of the S4-index distributions over the globe including, local time, latitudinal, seasonal and solar activity variations. By incorporating these trends in the recent IRI model (IRI-2012), users can access S4-index databases directly from the IRI-2012 model, along with the regular ionosphere parameters. Further, near real-time S4-index data may also be provided in near feature once COSMIC-2 RO technique becomes commissioned as the latency period of this yet to be flown technique is only 30 minutes.

Paper # 75O

Comparative studies between equatorial spread F derived by the International Reference Ionosphere and the S4- index observed by FORMOSAT-3/COSMIC during the solar minimum period of 2007–2009

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ABSTRACT

The International Reference Ionosphere (IRI) model includes an option for spread- *F* occurrence (spread-F represents the ionospheric turbulence state) prediction and this option was introduced for IRI-2007 and IRI-2012 modes. In this paper, an attempt is made to cross-examine the spread-*F* occurrence derived by the IRI-2007 and the ionospheric scintillations in terms of the maximum value of the *S*4 index (*S*4max) between 150–350-km altitudes, calculated from fluctuations of the signal-to-noise ratio (SNR) intensity in the L1 channel of GPS radio occultation signals using FORMOSAT-3/COSMIC (F3/C) satellites during the low sunspot years 2007–2009. The *S*4max maintains a fairly good consistency with spread-*F* occurrence simulated by IRI-2007 in the Brazilian region. The global *S*4 index can be considered as a viable source of database to be incorporated into the global IRI spread-*F* prediction scheme owing to fact that the F3/C satellites can provide an unprecedented global database including the *S*4- index.

Oral Abstracts

Session 3: Improved Accuracy of IRI at Equatorial Latitudes - III

Paper # 12O

The Correlation between Ionospheric Scintillations and Irregularities at Low Latitude

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Abstract

With data of GPS amplitude scintillations and spread F from the low latitude station Vanimo (2.7°S, 141.3°E; mag. latitude 11°S) in the Southern Hemisphere in 2003, we statistically analyzed the characteristics of scintillations and SF and their correlation. The results showed that the SF had four types: FSF, RSF, MSF and SSF, whereof the BSF never occurred. SSF and scintillations ($S4 \geq 0.3$) usually occurred simultaneously and had similar periods and trends. Only the SSF had a high correlation (coefficient 0.7199 and $p=0.0189$) with the scintillation, while the other three types of SF were uncorrelated with the scintillation. However, some other previous researchers reported that the scintillation was independent from the SF. For this view, we made a statistics and found that the SSF occurrences were no more than 20% in the all types of SF at Vanimo in each season in 2003. Since the previous researchers considered the all types of SF together to do statistics, and we found only the SSF had a high correlation with the scintillation, so they got the result that the scintillation was independent from the SF. With in-situ plasma density data from ROCSAT-1 satellite, we presented a case that the scintillation and the SSF were simultaneously observed with the equatorial plasma bubbles. This confirmed that both the scintillation and the SSF were caused by plasma bubbles (depletion) at low latitude.

In general, ionospheric scintillations at low latitude are considered as signatures of equatorial plasma bubbles. In this paper, with GPS amplitude scintillation and the in situ measurement plasma blob by ROCSAT-1 satellite over Vanimo station, we performed a case study on the concurrent observation of scintillations and a plasma blob, which provided the first time evidence that scintillations were associated with plasma blobs in the low-latitude ionosphere. We also found that the in situ blob was with a size of about 800 km in F layer, and the ion density inside the blob was severely disturbed. With further analysis, we found the blob was mainly formed by the upgoing O^+ ions which were caused by eastward polarization electric field.

Paper # 79O

Simple ionospheric delay model associated with equatorial plasma bubble occurrence using NeQuick 2 model

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Abstract

The ionospheric error is still a significant potential error for high accuracy GPS applications, especially for the aviation navigation. Although the ground-based augmentation system (GBAS) and satellite-based augmentation system (SBAS) can mitigate the ionospheric errors in almost all the situations, the non-uniform characteristics can pose integrity threats for high-precision automatic landing of CAT-II/III of GBAS. The extensive previous studies show that the extreme ionospheric anomaly events driven by the corona mass ejection (CME) observed in mid-latitude regions can cause unacceptable position errors, if they are undetected. Since these rare events caused by the storm enhanced density (SED), the suddenly increasing of electron density can cause the extreme ionospheric delay gradient at the boundaries, which impacts the broadcast differential corrections of GBAS ground facility. For the equatorial and low-latitude regions, it is known that the equatorial plasma bubble (EPB) can also cause the same impact due to the depletion region of electron density at bottom side. In order to study its impact on GBAS, the ionospheric delay generated by the three-dimensional EPB model has been developed based on the background electron density generated from the NeQuick model combined with the rectangular shape of depletion region of electron density.

In this work, we improve this EPB model by utilizing the NeQuick2 model associated with the ellipsoid shape of depletion region of electron density for the bubble simulation. In addition, the transition function based on the modified sigmoid function is also developed for generating the scintillation phenomena of ionospheric delay. From the results, we show the ionospheric delay in terms of slant total electron content (STEC) estimated from the model by utilizing the numerical integration based on Simpson's rule. The simulation results show that the ionospheric delay decreases around 40% and also fluctuates during the satellite pass over the bubble region, resembling the phenomenon of plasma bubble.

Paper # 81O

Assessment of GNSS Ionospheric Scintillation and TEC Monitoring using the Multi-Constellation GPStation-6 Receiver

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Abstract

Ionospheric disturbances induce rapid fluctuations in the phase and the amplitude of received GNSS signals. Given the predictable impact of the Ionosphere on the GNSS signals, these signals provide an excellent tool for ionospheric monitoring on a global and continuous basis. The more recent launches of the regional Japanese QZSS and Chinese BeiDou satellites allows integration of their signals into TEC and Scintillation measurements primarily in the Asian region.
This paper shows GNSS ionospheric scintillation and TEC results using NovAtel's GPStation-6 next generation monitor that incorporates a modern receiver design with the ability to track multi-constellation, multi-frequency, GNSS measurements. Examples of these new robust and less noisy ionospheric measurements are provided that shows that Asia is now the most interesting region for such monitoring.

Keywords: ionosphere; GNSS; amplitude scintillation; phase scintillation; total electron content (TEC); space weather; monitoring.

Paper # 7O

Variations of the electron density of ionospheric F2-layer (NmF2) in the region of the equatorial anomaly crest during storm periods and comparison with IRI 2012

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Abstract

The variations of electron density of ionospheric F2-layer (NmF2) during geomagnetic storm periods are investigated using ionosonde observations from six ionospheric stations in the region of equatorial anomaly crest. The stations are Port Moresby (geographic coordinate, 9.4^{o}S, 147.1^{o}E, magnetic coordinate, 18.3^{o}S, 219.5^{o}E), Vanimo (geographic coordinates, 2.7^{o}S, 141.3^{o}E, magnetic coordinates, 12.3^{o}S, 212.5^{o}E), Tahiti (geographic coordinates, 17.7^{o}S, 210.1^{o}E, magnetic coordinates, 15.2^{o}S, 284.4^{o}E), Okinawa (geographic coordinates, 26.3^{o}N, 127.8^{o}E, magnetic coordinates, 15.5^{o}N, 196.9^{o}E), Maui (geographic coordinates, 20.8^{o}N, 203.5^{o}E, magnetic coordinates, 21.2^{o}N, 269.6^{o}E), Taipei (geographic coordinates, 25.0^{o}N, 121.5^{o}E, magnetic coordinates, 13.8^{o}N, 190.9^{o}E). Median values of NmF2 are obtained at each hour during each storm period and compared with the International Reference Ionosphere (IRI2012 model) predictions. Both the IRIcor and NeQuick options of the IRI model were considered in the analysis. Data from the following years are considered based on availability: 1979, 1980, 1989, 1990, 1999, 2000, 2001, 2002 and 2003.
Comparison of the observed values with the IRI predictions revealed that both options follow the general trend of variation of electron density. Details of the statistical analysis of the accuracy of the IRI model predictions are presented.

Paper # 69O

New Proposed GPS Receiver Bias Estimation Method for the Equatorial Latitude Region

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ABSTRACT

In this research paper, we propose the new method of GPS receiver bias estimation which is Lagrange interpolation. This new method is used to find the derivatives and integrals of discrete functions in GPS data. In this method, GPS receiver bias data is given only at discrete points time and bias values. At the equatorial latitude region, Thailand, there are six data points which are selected for the GPS receiver biases at the first point, pre-sunrise point, noontime pint, post-sunset point, midnight point, and the last point in each day. We present the equation for the 5^{th} order Lagrange polynomial interpolation for GPS receiver bias estimation at the Equatorial latitude region. From the results and comparisons among the polynomial VTEC method, the minimization of standard deviation of VTEC method, median cut method, and Lagrange interpolation method show that the calculated time for median cut method is faster than the other methods. Lagrange interpolation method gives more GPS receiver biases than others. For the median value of GPS receiver bias, polynomial VTEC method shows higher value than the others, but the minimization of standard deviation of VTEC method gives the lowest value. However, the different values of GPS receiver biases among four methods are not more than -1 ns.

Paper # 9O

Comparisons of IRI- 2012 Model TEC predictions with GPS TEC measurementsobserved at Guntur, India

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Abstract

Vertical TEC measurements obtained from GPS station located at the K L University, Guntur (16.44° N, 80.62° E) are considered for comparison with IRI 2012 TEC values. K L University GPS station region falls under the transition zone of Equatorial Ionization Anomaly (EIA) phenomena between the equatorial trough and the anomaly crest in the low latitude Indian region. There is a need to investigation on diurnal, seasonal variations, solar activity dependence of TEC and including effects of space weather related events to TEC and modeling of TEC values for now and forecasting applications. In this paper, day to day and seasonal variations of VTEC (Vertical TEC) and the effect of VTEC due to space weather events like Geo magnetic storms are analyzed.It is observed that VTEC values show higher values in equinoctial months than during winter and summer seasons. The variations of VTEC during 17th March, 2013, 29th June, 2013, 19th February, 2014 and 27th February, 2014 storms are analyzed. Significant deviations in VTEC during the main phase of the storms are observed. It is found that the response of ionospheric TECconsists of effects of both enhancement and depletions in ionosphericstructures (positive and negative storms).The outcome of these results would be useful for improving IRI model for optimum representation of low latitude ionosphere.

Oral Abstracts

Session 4: Progress towards real-time IRI

Paper # 57O

Real-time Global Above-peak Variability of Ionosphere as seen by Assimilative IRI

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Abstract

Real-time 3D diagnostics of the Earth's ionosphere is a challenging task, given the dilemma of data availability in real-time. Latency of delivering spacecraft sensor data to the ground for assimilation in ionospheric models will unlikely break the 1-2 hour barrier in foreseeable future. Meanwhile, statistical studies of assimilating past data suggest that 4 hour old data simply brings no improvement to the climatological specification, and the effect from assimilation drops in half within 2 hours of delay in data arrival. Thus, the development efforts for a Real-Time International Reference Ionosphere (IRI) have been focusing on the assimilation of data streams from the ground-based observatories, in particular the Global Ionospheric Radio Observatory (GIRO, http://giro.uml.edu) with its ~50 ground-based ionosonde sites in 26 countries. In 2013, the IRI-based Real-Time Assimilative Modeling (IRTAM) project began publishing global maps of the peak density and height in the ionosphere with a 15 minute cadence and a 7 minute delay from real time. The IRTAM's presentations of the ionospheric peak variability, both in its density and height, bring an intuitive, immediate insight in the ionospheric weather. Difference maps of the peak density vs its climatology reflect unusual plasma production, loss, and horizontal transport processes, while the vertical plasma restructuring can be observed in the dynamics of the peak altitude changes. Next stages of the IRTAM project aim to describe processes of the F-region plasma compression or expansion, as well as plasma variability above the peak. Such specification is accomplished by computing assimilative maps of profile shape metrics: the slab thickness, τ, and the F2 layer bottomside half-thickness, B_0. Although both shape metrics describe the profile only approximately, their weather-climate difference maps do shed light on the underlying processes of ionospheric plasma dynamics. Practical questions of building and interpreting τ and B_0 maps are discussed. Real-time GNSS TEC data are required to build the maps; the topside/plasmaspheric contributions are estimated from simultaneous knowledge of the bottomside and total ionospheric content to glean behavior of the plasma above the peak. In the current implementation, TEC data are acquired only retrospectively from the CEDAR Madrigal repository at the MIT Haystack observatory; real-time sources of TEC data are actively pursued.

Paper # 1O

Regional optimization of IRI-2012 output (TEC, foF2) using derived GPS-TEC

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http://plus.cnu.ac.kr/english/index.jsp

Abstract

Accurate measurement and determination of the state of ionosphere has become a key point as ground-based communication systems become more space dependent. However, due to a limited infrastructure a number of global models have been developed with extensive interpolation techniques to comprehensively describe ionospheric dynamics. As a result, most global models don't perform adequately in regions with a paucity of ionospheric measurements. In this paper, the most recent International Reference Ionosphere (IRI-2012) model output, Total Electron Content (TEC) and F2 layer critical frequency (foF2), are optimized (over a range of 120˚ E - 150˚ E and 20˚ N - 50˚ N, in longitude and latitude respectively). To obtain the optimal solution two input parameters, 12-month running mean Sun Spot Number (R12) and ionospheric index (IG12), are adjusted in relation to derived Global Positioning System (GPS) vertical TEC (VTEC). The results are compared to measured TEC and foF2 from GPS receivers and ionosondes respectively. The analysis shows that the modified IRI-2012 model is more accurate at estimating both TEC and foF2 values than the original model during geomagnetic quiet and disturbed days.

Paper # 29O

Adapting the IRI model to improve estimation of ionospheric parameters and its validation with COSMIC and ionosonde data

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Abstract

This paper reports on the adaptation and modification of the International Reference Ionosphere (IRI-2012 model) with the use of total electron content (TEC) data derived from the Global Navigation Satellite System (GNSS), and most importantly its subsequent validation with both radio occultation (COSMIC) and ionosonde data . By adjusting the solar activity indices used within the standard IRI 2012 model with the aim of minimising error differences between IRI TEC and GNSS TEC, the adjusted indices are implemented into the IRI 2012 model on a regional scale and results for electron density (Ne) profiles, maximum height of the F2 layer (hmF2), TEC and critical frequency of the F2 layer (foF2) generated. Validation was done by direct comparison with ionosonde and COSMIC derived data parameters. The modified IRI 2012 model gave a maximum improvement of about 16%, 2% and 20% in estimating TEC over the equatorial, low and mid-latitude regions respectively during the storm period of 09 March 2012. An important result observed during our candidate period of study is that COSMIC data provides NmF2 and hmF2 closer to ionosonde data even during the disturbed period, and is hence a suitable dataset that can be incorporated into the IRI model to improve its performance. The Ne profiles from the modified IRI 2012 model accurately approximates ionosonde Ne profiles especially below 300 km altitude, but underestimates the ionosonde NmF2 and hence foF2 in mid-latitude regions. In most cases both standard and modified IRI 2012 models match COSMIC data for topside electron density representation.

Paper # 80O

Data Assimilation for Regional TEC Estimation and Mapping over Thailand

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Abstract

The radio communications including the global navigation satellite system (GNSS) are generally impacted by the ionospheric effects, particularly, the global positioning system (GPS). The satellite signal is transmitted through the equatorial and low-latitude region called the equatorial ionization anomaly (EIA) region with high ionospheric electron density variation. A significant parameter for studying the ionospheric irregularities and characteristics is the ionospheric total electron content (TEC). Although, several international models can predict the TEC around the world, the regional TEC estimation is indispensable for high accuracy and efficiency of regional communications improvement. In this work, we perform the regional vertical TEC (VTEC) estimation method using the adjusted spherical harmonic model (ASHM) over Thailand. Besides, we assimilate the observed VTEC data together with the estimated VTEC data from the latest version of the International Reference Ionosphere (IRI-2012) model. We compute the VTEC recorded by the dual-frequency GPS receivers, which are installed at 12 GPS base stations in Thailand: 11 stations are provided by the Department of Public Works and Town & Country Planning (DPT) and one station is at King Mongkut's Institute of Technology Ladkrabang (KMITL) as part of the South East Asia Low-latitude ionospheric Network (SEALION) project, which is conducted by the National Institute of Information and Communications Technology (NICT), Japan. We use the 15-degree ASHM to estimate VTEC on July 8, 2012, when it is the quiet day and during the period of the high solar activity, over Thailand with the geographic range of 0° to 25° north and 95° to 110° east in latitude and longitude, respectively. Furthermore, the observed median VTEC is assimilated with the monthly median VTEC which is predicted by the IRI-2012 model for the regional VTEC two-dimension map over Thailand with a spatial resolution of 2.5° x 2.5° in latitude and longitude and time resolution of 2 hours. The results show that the maximum error of 15-degree ASHM estimation is approximately decreased from 2.5 TECU (6%) to 2 TECU (4.5%) when the observed VTEC is changed to the median value in grid. In addition, the estimation error is continuously decreased to be 0.35 TECU (0.7%), if the investigated VTEC is assimilated with the IRI model prediction.

Paper # 16O

Features of assimilation of the total electron content in the IRI model in low and equatorial latitudes

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Abstract

Assimilation of the total electron content TEC is now a mainstream in modeling the ionosphere. The results of TEC assimilation are relevant to real time applications. As an example, the simplest procedure of assimilation can be considered: the use of the equivalent slab thickness (τ(IRI)) of the IRI model to obtain (recover) critical frequency foF2(rec) = TEC(obs)/τ(IRI) from the observed values of TEC(obs). In the presented paper, for this purpose we use the median (τ(med)) of the experimental equivalent slab thickness τ(obs), the IRI-Plas model and global maps of TEC. Absolute and relative deviations of the foF2 values, which are calculated using τ(IRI) and τ(med), from experimental foF2(obs) are evaluated. Conformity of (case 1) median values, (case 2) values of the IRI model for individual days and measurements, (case 3) foF2, calculated using τ(med) and TEC(obs), and foF2(obs) is estimated. To compare results, the efficiency factor Keff of use τ(med) in comparison with τ(IRI) is introduced as a quotient from division of absolute deviations |ΔfoF2| for a case 2 in relation to a case 3. Deriving the results, the data more than of 10 stations is used. When comparison is performed for the IRI-Plas model including a plasmaspheric part, it allows to estimate differences between N(h)-profiles. The synchronism of variations of δfoF2 and δTEC during disturbances of April 2014 and March 2015 is in focus. Lower latitude estimations are compared with typical values for middle-latitude stations. It is shown that: (1) differences between values of τ(med) and τ(IRI) are much more than in middle latitudes, and unlike papers in which indicated lack of latitudinal dependences of τ(med), essential differences from station to station are obtained, (2) differences connected with differences of global maps of TEC and shape of N(h)-profiles are less than in the middle latitudes, (3) the factor Keff exceeds 1 everywhere, prominent diurnal and seasonal courses were not found, in the cycles including periods 2001-2011, 2002-2012, dependence of Keff on solar activity is characterized by maxima 2.5-3 in 2001-2002 and values in a range 1.5-1.7 during the rest of the cycle. It repeats dependences of |ΔfoF2| with maximum values 2-2.5 MHz in 2001-2002 for med (case 1) and τ(IRI) (case 2) and 0.7-1.0 MHz during the rest of the cycle, σ(foF2) makes accordingly 30-35 % and 15-20 %, values for τ(med) are accordingly 1 MHz, 0.5-0.7 MHz and 10-15 %. (4) Unlike the middle latitudes where values for cases 1 and 3 are sometimes comparable, in low latitude and equatorial regions values for τ(med) almost always are less than values for med. The least values are typical for the Cocos station, the largest - for the Niue station. For this station all values of |ΔfoF2| and σ (foF2) are higher in 2 times. The factor Keff lies between 2 and 3. (5) When compared δfoF2 and δTEC, for example for stations Kwajalein, Niue, Vanimo, during disturbances cases are frequent when δfoF2 and δTEC of different stations vary in opposite phase. Therefore all estimations increase.

Paper # 62O

Development of real-time GPS-TEC monitoring system incorporating ionospheric 3D tomography over Japan

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Abstract

Recently, a three-dimensional GPS ionospheric tomography technique is developed which uses TEC data from the dense GPS receiver network, GPS Earth Observation Network (GEONET) in Japan. It uses the least squares fitting method constrained by the spatial gradient, and does not require an ionospheric model as the initial guess that could bias the reconstruction of electron density. This calculation used the data obtained from 650 GPS receivers. On the other hand, real-time differential 2D-TEC mapping service started since 2013 by Electric Navigation Research Institute (ENRI). The TEC data are obtained every second from GEONET, but limited from only 200 stations. And the estimation of absolute TEC is not included in this system. In this study, we develop the new real-time ionospheric monitoring system that includes both absolute TEC estimation and ionospheric 3D tomography analysis. This system consists of three elements, (i) fast data acquisition and bias estimation, (ii) 2D mapping of absolute TEC every 2 minutes, (iii) the fast 3D tomography from 200 GPS stations. All programs are written in Python. Now (i) and (ii) are implemented and will be started. Binary every-second data attained from GPS stations are directly acquired by multi-threads, and passed to following processes. The instrumental biases of satellites and receivers are estimated by using previous 24 hours data. (iii) is now developed. We have already increased the computation speed of the tomography analysis by using a sparse matrix algorithm when solving the least squares fitting method. It takes less than 5 minutes to calculate a tomography with the CPU of 3.4GHz Intel Core i7. And the stable solutions are obtained by using limited 200 GPS receivers in the simulation. In the meeting, we will show the design of the real-time monitoring system current status of the project.

Paper # 37O

3D electron density estimation in the ionosphere by using IRI-Plas model and GPS-TEC measurements

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Abstract

Estimation of 3D electron density in the ionosphere is a crucial problem for investigating the ionospheric effects on electromagnetic propagation. GPS-TEC measurements are widely used in ionospheric studies for understanding the structure and variability of the electron density distribution in the ionosphere. However, sparsity of the measurements does not allow employing known tomography methods for calculating the 3D electron density distribution. Ionospheric models can estimate monthly averages of 3D electron density distributions based on physical and empirical relations. Nevertheless, these models are not generally compliant to the real measurements obtained from GPS receivers. In this study, a novel method for estimating the 3D electron density distribution in the ionosphere by using both GPS measurements and IRI-Plas model is presented. Proposed method perturbs default ionospheric parameters used in IRI-Plas model over a region of interest by using parametric perturbation surfaces, and iteratively searches for the best physically feasible 3D electron density distribution, which is compliant with the GPS-TEC measurements. The problem is considered as an optimization problem which minimizes a cost function corresponding to the disparity between measurements and the 3D electron density distribution, and the optimization parameters are selected as perturbation surface parameters. Three different optimization methods are examined on both synthetic and real measurement data. Results show that the proposed method can generate 3D electron density distributions which are compliant with both the GPS-TEC measurements and the IRI-Plas model.

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Paper # 30O

Ionospheric longitudinal variations at midlatitudes and IRI

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Abstract

The midlatitude ionosphere has been given a false impression of uninteresting region with known climatology and well-understood processes. Recent progresses in the area that are made as a results of fine spatial and temporal resolutions in observations, however, lead to quite a few exciting discoveries, and some of these are of interest to the ionospheric climatology and modeling community. The longitudinal variation at midlatitudes is among these topics. The midlatitude ionosphere is known to feature substantial differences between the Asian and American sectors caused by the offset between the magnetic and geographic coordinate systems. This paper deals with a new type of ionospheric longitudinal variation at midlatitudes that is associated with magnetic declination and the thermospheric zonal wind. In this paper, we will provide an overview of these longitudinal variations using ground-based observations made by GPS TEC receiver networks over North America and China-Japan longitudinal sectors, as well by incoherent scatter radars. We will also assess the performance of the IRI model for the midlatitude longitudinal variations, and discuss future modeling plans based upon GPS TEC datasets.

Paper # 50O

Simulated East-west differences in F-region peak electron density at Far East mid-latitude region

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Abstract

In the present work, using Three-Dimensional Theoretical Ionospheric Model of the Earth in Institute of Geology and Geophysics, Chinese Academy of Sciences (TIME3D-IGGCAS), we simulated the east-west differences in F-region peak electron density (NmF2) at Far East mid-latitude region. We found that, after removing the longitudinal variations of neutral parameters, TIME3D-IGGCAS can better represent the observed relative east-west difference (Rew) features. Rew is mainly negative (West NmF2 > East NmF2) at noon and positive (East NmF2 > West NmF2) at evening-night. The magnitude of daytime negative Rew is weak at local winter and strong at local summer and the daytime Rew show two negative peaks around two equinoxes. With the increasing of solar flux level, the magnitude of Rew mainly become larger, and two daytime negative peaks slight shifts to June Solstice. With the decreasing of geographical latitude, Rew mainly become positive, and two daytime negative peaks slight shifts to June Solstice. Our simulation also suggested that the thermospheric zonal wind combined with the geomagnetic field configuration play a pivotal role in the formation of the ionospheric east-west differences at Far East mid-latitude region.

Paper # 40O

Online IRI-Plas Interface Service by IONOLAB

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Abstract

International Reference Ionosphere (IRI) is one of the most acknowledged climatic models of ionosphere providing main ionospheric parameters such as monthly averages of the electron density, electron temperature, ion temperature, and ion composition in the altitude range from 50 km to 2,000 km. Recently, additionally parameters such as the Total Electron Content (TEC) within a user defined height range, the occurrence probability for Spread-F and the F1-region, and the equatorial vertical ion drift can also be obtained (http://iri.gsfc.nasa.gov/). The IRI online interface, which is currently available at http://omniweb.gsfc.nasa.gov/vitmo/iri2012_vitmo.html, allows the user to obtain a wide variety of output parameters and optional inputs such as ionospheric, solar and geomagnetic indices, storm models. The outputs can be plotted or saved into text files. Although the options and detailed output parameters are significant for trained and experienced users, the website presents a challenge for application of the model for series of date, time, location, and options. The original model which is developed in FORTRAN is no longer available to the general public and the user is forced to use the model online through the internet link. The internet connection duration, manual input of choices, manual output marking of desired output parameters and insufficient information on the effects of different model or index inputs discourage inexperienced users from benefiting from the most significant ionospheric model. Other two disadvantages of the present form can be listed as the limited height extend and inability to represent the spatio-temporal variability since the empirical model computations are based on monthly median coefficients derived from experiments carried out mostly in North America and Europe. International Reference Ionosphere extended to the Plasmasphere (IRI-Plas) is the recent version of IRI where the region of interest can include plasmasphere up to the height Global Positioning System (GPS) satellite orbit of 20,200 km. GPS derived TEC can be ingested into IRI-Plas for better representation of temporal variations in the ionosphere. The model is provided in FORTRAN as Standard Plasmasphere-Ionosphere Model IRIPlas-SPIM) at http://ftp.izmiran.ru/pub/izmiran/SPIM/. IONOLAB group will provide an online interactive web interface at www.ionolab.org where the user can either download an executable version of IRI-Plas or use the IRI-Plas online similar to the IRI website with basic inputs of location, date, time. The user can also input TEC, foF2 and hmF2 values or, if desired GPS-TEC from Global Ionospheric Maps (GIM) can be automatically ingested similar to the application of IRI-Plas-MAP at www.ionolab.org. IONOLAB-IRI-Plas will provide selected ionospheric parameters according to the updated state of ionosphere in a user-friendly fashion.

This study is supported by the joint TUBITAK 112E568 and RFBR 13-02-91370-CT and joint TUBITAK 114E092 and AS CR 14/001 projects.

Oral Abstracts

Session 5: F-peak modeling and comparisons

Paper # 33O

Development of neural network for foF2 parameter at conjugate points in Southeast Asia and its comparison with the IRI-2012 model

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Abstract

This paper presents the development of Neural Network (NN) model for the prediction of the F2 layer critical frequency (foF2) at conjugate points in Southeast Asia, including Chumphon, Chiang Mai and Kototabang stations, and then compared with the IRI-2012 model and the experimental ones. The feed forward network with backpropagation algorithm has been applied for predicting the foF2 values. NN are trained with the daily hourly values of foF2 during 2004, 2005, 2006 and 2008 and the input parameters affecting to foF2 variability which are the day number (*DN*), the hour number (*HR*), the solar zenith angle (*C*), geographic latitude (θ), magnetic inclination (*I*), magnetic declination (*D*) and the angle of meridian (*M*) relative to the subsolar point, the F10.7 index (*F10.7*), the sunspot number (*SSN*) and the Ap index (*Ap*). The foF2 data of 2007 and 2009 are used for testing the NN model during the foF2 interpolation and extrapolation, respectively. Our results show that the foF2 predicted by both NN and IRI models generally shows the same features as the observed data for three stations. However, the NN model predicts more accurately than the IRI model.

Paper # 13O

Variations of ionospheric peak parameters observed by ionosonde at Hainan Station from 2002 to 2012

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Abstract

Measurements with DPS-4 digisondeat Hainan station (19.5ºN, 109.1ºE) covering a solar cycle (2002-2012) during quiet time are analyzed to explore ionospheric temporal variations in low latitude region. Diurnal, seasonal, and solar activity variations of the ionospheric peak parameters (foF2, hmF2, and Chapman scale Height Hm) are studied. The results show thatthe winter anomaly in the daytime foF2appears in different phases of solar activity and its duration increasesas solar activity increasing.The semiannual anomaly in the diurnal variation of foF2has two maxima in equinox seasons. The foF2 has aclose correlativity with F107p and the correlation coefficients in their diurnal variations arearound 0.7. However, the saturate phenomenon in foF2, which increases with a much lower rate for very high F107p, is not distinctand different from that reported over Millstone Hill.Thevariation rate of foF2 with solar activity exhibits a seasonal and local time variation. The afternoon and evening hmF2 shows a good correlation with F107p (their correlation coefficients more than 0.6), but other time hmF2 is low or poor related to F107p.The prominent characteristic of hmF2 in equinox and summer seasons has a significant pre-reversal enhancement (PRE)in high solar activity period.The diurnal variation of Hmusually has two peaksaround noontime and pre-sunrise. The daytime Hm has an annual variation with maximumin summer andminimumin winter. Although the daytime Hmdepends on solar activity, the correlation coefficient between them is not large due to other factors, such as equatorial fountain effect, meridian wind, and so on. These results are very useful to improve the IRI model.

Paper # 17O

foF2 and *NmF2* trends at low- and mid-latitude for the last three solar minima and comparison with IRI model

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Abstract

The ionospheric plasma is mainly due to the photoionization of atmospheric gases caused by the UV and X electromagnetic radiations coming from the Sun. Because of this strong interaction, the ionospheric variations are strictly connected with solar activity cycles. In general, there is a great interest in studying the ionospheric plasma response to extreme levels of solar activity that is periods of minimum and maximum solar activity. The latest anomalous and prolonged minimum (solar cycle 23/24, years 2008-2009) showed several interesting features such as a record of 266 spotless days in 2008 and a magnetic field at the solar poles approximately 40% weaker than the previous cycle. This work is focused on the ionospheric plasma response to low solar activity conditions and is based on data recorded at two ionospheric stations: Rome (41.8° N, 12.8° E, Italy) and Tucuman (26.9° S, 294.6° E, Argentina). Specifically, the ionospheric characteristics *fo*F2 and *Nm*F2 are considered. The focus is in particular on the last anomalous and prolonged minimum of cycle 23/24 and on the comparison with the previous minima of cycle 21/22 (years 1986-1987) and cycle 22/23 (years 1996-1997). The output of the *International Reference Ionosphere* (IRI) model, for *fo*F2 and *Nm*F2, is also evaluated. In particular, a comparison of the IRI predictions for the last three solar minima can give us crucial information to contribute to the improvement of the IRI capabilities in reliably reproducing the *fo*F2 and *Nm*F2 trends for such extreme levels of solar activity. Some "latitude-dependent" features characterizing the *fo*F2 and *Nm*F2 observations and the IRI outputs are also shown and discussed.

International Reference Ionosphere 2015 Workshop (IRI2015)
"Improved Accuracy in the Equatorial Region and Progress Towards a Real-time IRI Model"

Paper # 24O

Weddell Sea, Yakutsk and mid-latitude summer evening anomalies in *foF2* and *TEC* diurnal variations

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Abstract

In 1958 according to the observations of mid-latitude ionospheric stations Halley Bay and Argentine Island located in the Southern Hemisphere the anomalous diurnal variations of the F2 layer critical frequency (*foF*2) were found in the December-February, when the nighttime *foF*2 values exceed daytime *foF*2 values. Such anomalous ionospheric feature was named as the Weddell Sea Anomaly (WSA). In 1971 Mamrukov firstly described the similar anomalous summer diurnal variations in *foF*2 at Yakutsk ionospheric station. This unusual effect in the Northern Hemisphere was named as Yakutsk Anomaly (YA). Recently, WSA, YA and similar anomalous features in the Europe/Africa, and Central Pacific longitudes of the Northern Hemisphere were identified as Mid-latitude Summer Nighttime Anomaly (MSNA). There are some suggestions that MSNA is a general summertime mid-latitude ionospheric phenomenon featured by a greater ionospheric electron density at night than during daytime and occurred in the mid-latitude regions of the Southern and Northern Hemispheres. We would not use the MSNA term in our report due to the facts that our model results and observation data showed: (1) the WSA and YA are anomalies in the *F*2 layer peak electron density (N_mF2) diurnal variations at sub-auroral latitudes; (2) in the mid-latitudes these anomalies in N_mF2 are manifested in excess of the evening N_mF2 values over noon values. So we called this mid-latitude feature as mid-latitude summer evening anomaly (MSEA). The main objective of our study is to compare the spatial-temporal structure and main formation mechanisms of WSA, YA and MSEA. For this purpose, we compared the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP) results with topside sounding data as well as IRI empirical model results. Also we compared the longitudinal dependence of the N_mF2 and total electron content (*TEC*) seasonal variations at a number of mid-latitude stations in the Northern and Southern Hemispheres in 2009, according to the GSM TIP model results and observational data of the ground network GPS receivers and ionosondes. This allows determine the seasonal development of mid-latitude anomaly in N_mF2 and *TEC* diurnal variations. The GSM TIP simulations qualitatively reproduce the main morphological characteristics of the WSA, YA and MSEA. This fact allowed using the GSM TIP model to explain the formation mechanisms of these anomalies. In addition we discuss the reasons of differences in the seasonal and local time variations in the N_mF2 and *TEC* on the basis of detailed analysis of GSM TIP model results.

This work was supported by RFBR Grants №14-05-00788 and 15-35-20364.

Paper # 49O

Study on Ionosphere Earthquake Precursor and IRI

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Abstract

While we are studying the possible effect of large earthquake on the ionosphere, we found a large difference between observations and IRI. We compared here O+ density measured by DE-2 satellite data with IRI, and electron density measured by CHAMP, and DEMETER. We show some examples of the comparison.
The study on earthquake related ionosphere disturbances needs a good ionosphere model.To accelerate further improvement of Ne and Te of IRI, accumulation of reliable Te and Ne by using tiny satellite might be recommended, and IRI task Group is expected to play the leading role on the tiny satellite constellation.

Paper # 59O

A Statistical Study on Relationship between Earthquakes and Ionospheric F2 Region Critical Frequencies

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Abstract

In this study, variations of the ionospheric F2 region critical frequency (*foF2*) were investigated statistically before four earthquakes (M > 6.0 and D < 50 km) happened in Japan area. *foF2* data was taken from ionosonde stations which is in Japan. Correlation analyses and mean and median based two methods applied to the *foF2* data. Solar and geomagnetic activities were also examined during these periods. We observed that there were anomalous variations on the *foF2* before earthquakes on the quite solar and geomagnetic activities. If it can be shown that these ionospheric perturbations are systematic and related to the earthquakes then these variations could be used for short term earthquake prediction and maybe regarded as ionospheric precursors.

Oral Abstracts

Session 6: Description of plasma temperatures and ion composition in IRI

Paper # 77O

Comparisons of SWARM Electron Temperature Data with IRI

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Abstract

We present comparisons between the electron temperature (Te) measured by the SWARM Langmuir Probes and the IRI (International Reference Ionosphere). IRI includes two options for the electron temperature - TBT-2012 (Truhlik et al., 2012) and Bil-1985 (Bilitza et al., 1985). Both options are used in this study. We found that patterns of SWARM Te and IRI Te are similar however substantially differ in absolute values. The differences between SWARM and IRI Te are dependent on local time and latitude. The smallest differences are observed at high latitudes where SWARM Te is higher than IRI by about 10%. The largest differences were found at low and equatorial latitudes at nighttime, where SWARM Te is more than 100% higher than IRI predicts. We also compare SWARM Te data with quasi-simultaneous C/NOFS ion temperature data at night and low latitudes where thermal equilibrium between electrons and ions can be assumed (Te=Ti). At SWARM altitudes both IRI Te options are mainly based on Atmosphere Explorer-C electron temperature measurement which was successfully validated with ground and space data (e.g. Benson et al., 1977) and therefore can be considered highly reliable. We introduce a correction procedure for the SWARM Te data to obtain a better agreement with IRI.

R. F. Benson et al., 1977: Electron and ion temperatures—A comparison of ground-based incoherent scatter and AE-C satellite measurements, Journal of Geophys. Res., 82, 36, 1977.

Bilitza, D., L. H. Brace, and R. F. Theis, Modelling of ionospheric temperature profiles, Adv. Space Res. 5, 7, 53 - 58, 1985.

Truhlik, V., D. Bilitza, and L. Triskova, A new global empirical model of the electron temperature with inclusion of the solar activity variations for IRI, Earth Planets and Space, 64, 6, 531–543, 2012.

Paper # 34O

Effect of solar activity on ionospheric electron and ion temperatures and comparison with IRI-2012 model

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Abstract

Ionospheric F-region is a very dynamic and highly depends on the solar cycle. In the present study, we investigated the ionospheric temperatures for almost half of the solar cycle from solar minimum to solar maximum activity period (January 1995 to December 2000) satellite data. The data were recorded by the Retarding Potential Analyzer (RPA) payload aboard Indian SROSS-C2 satellite at an average altitude of 500 km over the Indian region. The data analysis in the low-latitude region shows that the nighttime average ionospheric electron and ion temperatures show a positive correlation with solar activity. However, the sunrise peak values show anti-correlation with solar activity. Further the ratio of sunrise average peak value and nighttime average show a negative correlation with the solar activity both for electron and ion temperatures. A sudden enhancement at sunrise has been observed during all seasons, in both electron and ion temperatures. Comparison of the measured ionospheric electron and ion temperatures with the predicted values from the international reference ionosphere (IRI-2012) reveals that the peak during sunrise hours is slightly underestimated by the IRI model.

Keywords: F2 region; Ionospheric temperatures; Solar activity; RPA payload

Paper # 45O

Correction of heating rate of thermal electron by photoelectron

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Abstract

Thermal electrons are heated by photoelectron during daytime in the ionosphere. The heated electrons are mainly cooled through the Column collision with ions especially in the topside ionosphere. The ions lose their energy to neutral atmosphere through the collisions. A cooling rate of thermal electron by the Column collision is proportion square of electron density (Ne) while a heating rate of it by photoelectron is proportion to $Ne^{0.97}$. Therefore electron temperature (Te) decreases with increase of Ne under local thermal equilibrium condition. However, it is found in HINOTORI observation that Te increase with increase of Ne at 600 km (positive correlation) when Ne is larger than 10^6 cm^{-3} (Kakinami et al., 2011). Similar correlations between Ne and Te were also found in CHAMP observations. The correlation was similarly observed in any seasons, longitudes, solar flux F10.7 levels and magnetic disturbance levels in low and mid-latitudes. Further, ion temperature (Ti) and ion density (Ni) also show similar trend, namely, Ti decrease with increase of Ni in low Ni region (negative correlation) while Ti increase with increase of Ni in high Ni region (positive correlation) in low latitudes (Kakinami et al., 2014). In order to understand possible causes of unexpected positive correlation of Te/Ti with Ne, data of incoherent scatter radar in Jicamarca are investigated. Similar positive correlations of Te with Ne are found above 250 km altitude. Moreover, the positive correlations of Ti with Ne are also found. Temperature difference between Ti and neutral atomosphere (Tn) (Ti – Tn) is larger than temperature difference between Te and Ti (Te – Ti) in low density region while Ti – Tn is smaller than Te – Ti in high density region. Here, Tn are calculated with NRLMSIS-00. Assuming local thermal equilibrium, the heating rate by photoelectron is much larger than $Ne^{0.97}$. Further, Tn increase with increase of Ne. These results suggest that the positive correlation arise from higher heating rate by photoelectron than that known now and increase of Tn with Ne. The results also imply that the heating rate known now underestimates actual heating rate and should be corrected.

References

Kakinami et al. (2011), Correlation between electron density and temperature in the topside ionosphere, *Journal of Geophysical Research*, 116, A12331, doi: 10.1029/2011JA016905.

Kakinami et al. (2014), Correlations between ion density and temperature in the topside ionosphere measured by ROCSAT-1, *Journal of Geophysical Research*, 119, 9207-9215, doi: 10.1002/2014 JA020302.

Paper # 76O

Modeling of the upper transition height from the topside electron density profiles

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Abstract

The transition from dominance of heavy atomic ions (mainly O+) to light ions (H+ and He+) is an important boundary representing the transition from the ionosphere to the plasmasphere/inner magnetosphere. It strongly depends on solar and geophysical conditions. In past decades there were numerous studies of this boundary especially its altitude called the upper transition height (h_T). In spite of these efforts, no satisfactory model representation of this parameter has been established so far.

We processed a large data-base of Alouette and ISIS topside sounder electron density profiles and of Formosat-3/COSMIC vertical electron-density profiles Ne(h) using theoretical plasma distribution to fit the vertical density profiles to the Ne(h) profiles and to determine h_T. We also describe our recent efforts to extent the data-base by processing existing digital ionograms especially from ISIS-1 using the Topside Ionogram Scalar with True-Height (TOPIST) software. Global distributions of h_T for primarily low solar activity conditions were modeled using spherical harmonics and the results are presented here. We compare these results with data from other types of measurements (Atmosphere Explorer C&E and C/NOFS satellites, the Kharkiv incoherent scatter radar) and with the AEIKion-13 model that is introduced as an improved IRI2012/TTS-03 option for ion composition. Possible inclusion of the h_T model in IRI is discussed.

Paper # 31O

Storm-time enhancement in thermsopheric nitric oxide (NO) and its impact to ionospheric NO^+

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Abstract

Energetic particle precipitation in the auroral region produces significant nitric oxide (NO) during geomagnetic storms. The NO density peaks are between 100 and 110 km. The enhanced NO density is transported to mid and low latitudes by the storm-time meridian wind and re-distributes globally. The neutral NO is the major source of the E-region NO^+ ion. We will discuss the global distribution of storm-time NO column density enhancement from TIEMD/GUVI measurement and its application for the ionospheric NO^+ specification. Furthermore, due to its strong infrared emission, NO is an energy sink and controls the temperature in the E-region ionosphere.

Paper # 51O

O(^{1}S) Dayglow as a proxy to thermospheric dynamics: Ionospheric response to geomagnetic disturbances across Indian latitudes

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Abstract

Events of ionospheric storms have been investigated across equatorial and low latitudes of Indian region. The deviation in F2 region characteristic parameters (foF2 and h'F) along with modeled O(^{1}S) emission intensities at thermospheric peak heights are examined at equatorial station Thiruvananthapuram (8.5°N, 76.8°E, 0.63S Geomagnetic latitude) and low latitude station Delhi (28.6°N, 77.2° E,19.2 N Geomagnetic latitude) during five geomagnetic storm events. Both positive and negative phases have been noticed during the study. The positive storm phase over equatorial station is found to be more frequent while the drop in ionization in most of the cases was observed at low latitude station. Due to a disturbed electric field the simultaneous height rise have been noticed at both of these stations, with higher amplitude at Delhi in between 0000 to 0600 EMT. Positive deviation in foF2 is also observed across low latitude station, which is attributed to daytime eastward electric field penetrating promptly from high to low latitudes. It is found that the reaction as seen at different ionospheric stations may be quite different during the same storm depending on both the geographic and geomagnetic coordinates of the station, storm intensity and the storm onset time. The IRI-2012 model results at these two stations were found to be following the observed ionospheric deviations. Variations in modeled greenline dayglow intensity at thermospheric peak height at equatorial and low latitude stations during these events showed a decrease coinciding with the onset of the storm. A simulative approach in GLOW model developed by Solomon [Solomon, 1992] is further used to estimate the changes in the volume emission rate (VER) of O(^{1}S) emission under varying geomagnetic conditions. It is found that the O(^{1}S) dayglow thermospheric emission peak retort to the varying geomagnetic conditions.

Paper # 10O

The Effect on Sporadic-E of Quasi Biennial Oscilation

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Abstract

In this study, the relationship between the QBO, which is seen at the equatorial stratosphere, and critical frequency of layer (Es) sporadically observed at the ionospheric E region was analyzed by using multiple regression model. For this analysis, Es layer critical frequency (foEs) obtained from four different stations at equatorial region and QBO measured at 10 hPa altitude values were used. The positive relationship between foEs and QBO was observed at all stations. An increase of 1 m/s at QBO leads to an increase of 0.01 MHz, 0.02 MHz, 0.02 MHz and 0.01 MHz (Jicamarca, Ascension, Manila and Kwajalein) on foEs, respectively. Expect for Manila station, westerly phase of QBO has greater effect on foEs compared to easterly phase of QBO at all other stations. It is seen that the changes occured on foEs can be explained by the QBO at rates 47%, 46 %, 32% and 44% for Jicamarca, Ascension, Manila and Kwajalein stations, respectively.

Paper # 82O

Ionosonde-Based Indices for Improved Representation of Solar Cycle Variations in IRI

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Abstract

In this study new ionospheric indices are presented for the representation of the solar cycle variation of the F2 peak plasma frequency *foF2* and the related F2 peak density *NmF2*. The indices use different groups of ionosonde stations and follow the methodology for the construction of the "global effective sunspot number" (IG) given by Liu et al. [1982]. These new indices are derived using monthly median daytime *foF2* ionosonde measurements from selected ionosonde stations and distinguish between Northern and Southern hemispheres. The effectiveness of these new indices is evaluated with a large volume of ionosonde measurements (96 stations) and their performance is compared to that of the IG12 index, currently used in IRI, and to the widely used F10.7 solar index. For the evaluation, a full model representation is used for *foF2* including annual and semi-annual oscillatory terms, linear solar terms and cross terms. Our study shows that improvements of 1-2% can be achieved with these new indices compared to the IG12 index currently used in IRI. Liu, R., P. Smith, and J. King (1983), a new solar index which leads to improved *foF2* predictions using the CCIR atlas, Telecommun. J., 50, 408–414.

Paper # 63O

Co-located fossil bubbles and SSTID structure at low latitudes: A case study

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Abstract

This paper describes an event study regarding to an achievement on developing the new technique [1] to estimate the bias to make absolute TEC using UHF/VHF radio beacon data in Southeast Asia. The target of this work is the plasma depletion with a large TEC gradient at pre-sunrise that can trouble in radio propagation delay. In this work, we employ ground-based data from beacon receivers, GPS receivers, ionosonde, and equatorial atmospheric radar. Space-based in-situ data are obtained from DMSPF15 satellite. The event was at pre-dawn on 7th March 2012. Thanks to the high spatial resolution of the beacon network, unreported low-amplitude Small-Scale Travelling Ionospheric Disturbance (SSTID) was found to co-locate with fossil bubbles. The edge of fossil bubbles detected by beacon network agreed with the scintillation. GPS network successfully confirmed this event. Further, GPS data revealed similar alignments of fossil bubbles and SSTID. It should be noted that the temporal variation of fossil bubbles and SSTID is neglected owing to restricted GPS observation points. This event is unique and essential to understanding the low latitudes' ionosphere at pre-dawn. Continuously operating ground-based observation in Southeast Asia is significant for space weather forecast.

Reference

[1] K. Watthanasangmechai, M. Yamamoto, A. Saito, T. Tsugawa, T. Yokoyama, P. Supnithi, and C. Yatini, Latitudinal GRBR-TEC estimation based on two-station method in Southeast-Asia region, Radio Science, Vol. 49, No 9, pp. 1–11, doi:10.1002/2013RS005347, 2014

Oral Abstracts

Session 7: TEC and Topside modeling and comparisons

Paper # 46O

IRI Total Electron Content in the Canadian Sector: A comparison to GPS observations and recommendations

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Abstract

Total Electron Content (TEC) measurements from ten dual-frequency GPS receivers in the Canadian High Arctic Ionospheric Network (CHAIN) are used to evaluate the performance of IRI-2007 within the Canadian sector, spanning the polar cap, auroral oval, and sub-auroral regions. In all regions, we see systematic underestimation of daytime TEC, particularly at solar maximum, where summer RMS TEC errors range from up to 10 TECU at sub-auroral stations to up to 14 TECU in the polar cap region. Performance during winter periods was exceptional, with RMS errors well constrained below 2 TECU at all stations. Diurnal variability in TEC is found to be underestimated during equinox periods by up to 40% at sub-auroral latitudes and up to 70% in the polar cap region. During the winter, the IRI performs much better, where diurnal variations are matched to within an overestimation of 40% or an underestimation of 20% across all regions.

Using a CHAIN ionosonde, collocated with the Resolute CHAIN GPS receiver, we are able to diagnose the main contributing layer of the ionosphere to the observed TEC errors. At the Resolute station, the IRI is found to produce bottomside TEC within 1 TECU of observation; however, topside TEC demonstrates significant errors of up to 7 TECU during equinox and summer periods at high solar activity. Winter topside TEC is found to be within 1 TECU, even at solar maximum. Diurnal variability in topside TEC is found to be almost entirely driven by NmF2 variability.

It is also shown that the IRI's use of the highly smoothed IG12 index to drive solar activity can result in significant errors during periods of large amplitude, short-term changes in solar activity. Using a monthly IG index to drive the model, rather than IG12, we find that IRI TEC errors reduce from 5 TECU to less than 1 TECU during a three month, ~100% increase in solar activity between October and December, 2011. Overall, all stations showed an average improvement of 0.33 TECU while using monthly IG rather than the IRI's default IG12 index.

Paper # 15O

Topside electron density: comparison between Irkutsk incoherent scatter radar measurements, ionosonde observations, GSM TIP simulations and IRI predictions

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Abstract

The long-duration Irkutsk incoherent scatter radar measurements allowed us to obtain monthly averaged patterns of diurnal electron density (Ne) variations in the 180-600 km height range for different seasons and solar activity levels. At heights lower than ~ 250 km the Ne diurnal behavior follows solar zenith angle showing one peak in the daytime. The most interesting features were obtained at heights above ~ 280 km. In winter under low solar activity at heights above ~ 350 km the nighttime electron density exceeds the daytime one. In spring and autumn under low solar activity, at heights ~ 300 km and above, the diurnal electron density behavior shows a terdiurnal pattern. In summer the Ne diurnal variations are characterized by the evening peak with the largest evening-to-noon ratio is at ~ 300 km. Under moderate solar activity the evening peak is seen ~ 30 min earlier at 400 km then at 300 km showing "downward propagation". Comparing the radar measurements with GSM TIP simulations and IRI predictions we test how these models reproduces the above-mentioned features. Comparison of the radar and ionosonde measurements allows us to make the mutual calibration of the tools in bottomside case and test the Reinisch and Huang extrapolation technique in topside case.

Paper # 60O

A comparison of measured TEC data with results based on the IRI and NeQuick 2 ionospheric models over the transition regions between mid and low latitude regions using a chain of stations near the geographic meridian of 28^o situated in the Southern hemisphere.

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Abstract

It is well known that the variations of the Earth's ionosphere are complicated and behave quite differently in various regions of the Earth. Over the past several years, the total electron content (TEC) has become an important and readily available parameter used to track the global characteristics of the ionospheric dynamics. In the recent past, a vast body of TEC data has been amassed over the African continent from numerous Global Positioning System (GPS) receiver stations in various locations giving a fair coverage of the mid and low latitude regions. This paper presents results of a comparative investigation of the TEC derived from three different sources namely: the International Reference Ionosphere (IRI) model, the NeQuick 2 model and the GPS measurements. Measured TEC data over a chain of stations near the geographic meridian of 28^o is used and the study highlights the complex ionospheric characteristics of the transition region from mid to low latitude regions and how the commonly used ionospheric models represent the ionospheric behavior in this region.

Paper # 11O

Comparison of GPS TEC variations with Holt-Winter method and IRI-2012 over Langkawi during high solar activity

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Abstract

The total electron content (TEC) is the ionospheric parameter had a main effect of the radio wave propagation. Therefore, it is very important to evaluate a performance of the TEC prediction models for a further improvement of the ionospheric modelling in the equatorial region. This work presents an analysis of the TEC, derived from the GPS Ionospheric Scintillation and TEC Monitor (GISTM) receiver over Malaysia, Langkawi station, at the geographic coordinates (6.19^{o}N, 99.51^{o}E), during 2014. The diurnal, monthly and seasonal variations of the GPS-TEC have been compared with a predicted TEC from the statistical Holt-Winter method and a recent version of the International Reference Ionosphere model (IRI-2012), using three different topside options of an electron density, namely IRI-2001, IRI-01-Corr and NeQuick. It has been observed from the results that the IRI-2001 overestimated argument during the diurnal, monthly and seasonal variations, while IRI-01-corr, NeQuick and Holt-Winter methods showed an underestimated argument compared with the observed GPS-TEC. The maximum peaks of the GPS-TEC were observed in the post-noon, which gave a poor prediction through all the IRI-2012 topside options especially at the IRI-2001 and the minimum was observed during an early morning time. A seasonal variation of the GPS-TEC observed the lowest values during a summer season (May, June, July, August), which is then followed by a winter season (November, December, January and February) and reached its maximum value during an equinox season (March, April, September, October). The IRI-2001 showed the highest value of a percentage deviation comparing with the IRI-01-corr, NeQuick and least on the Holt-winter method. An accuracy of prediction model during a period chosen was approximately found out to be 95% in the Holt-Winter method, 75% in the IRI-01-corr, 73% in the NeQuick and 66% in the IRI-2001 model. Hence, it can be deduced that the Holt-Winter method indicates high performance and better estimate of the TEC prediction comparing with the IRI-01-corr and NeQuick, while the IRI-2001 shows a poor predictive performance in the equatorial region.

Paper # 83O

IRI 2012 vTEC evaluation using the NeQuick topside option and F2 layer experimental parameters

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Abstract

The IRI model includes the NeQuick model topside as the default option for the electron density profile description. The NeQuick topside is characterized by an Epstein layer with a height-dependent thickness parameter related to the bottomside thickness, B2bot, and the F2 layer peak values (foF2, hmF2 and M3000F2). The B2bot parameter could be obtained by an empirical expression or extracted from the ground-based ionosonde measurements. This work analyses the impact of the F2 layer peak values with experimental or modeled B2bot as input for the IRI electron density profile and thus on the corresponding vertical TEC. The study is carried out with data from two mid-latitude ionosonde stations, Roquetes (EB040, lat 40.8 °N, lon 0.3 °E) and Ramey (PRJ18, lat 18.5 °N, 292.9 °E), for the years 2000 and 2004, corresponding to high and moderate solar activity periods. The GPS-derived vTEC obtained from the receivers ebre and pur3, located in the vicinity of EB040 and PRJ18 respectively, have been taken as the reference for the comparison with the modeled TEC. RMS of the differences between the reference TEC and the modeled values using experimental B2bot and only F2 peak values are evaluated. In average, during day-time an improvement of 20% is found; in winter, this improvement is reduced to 5%. At night, the use of experimental B2bot increases the differences by 5% approximately. These results indicate that B2bot is not a major cause for errors in the IRI vertical TEC prediction. Particular examples are presented and discussed in addition to the statistical analysis.

Paper # 41O

Improved IONOLAB-TEC Space Weather Service

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Abstract

Total Electron Content (TEC), which is the users, the website presents a challenge for application of the model for series of date, time, location, and options. The original model which is developed in FORTRAN is no longer available to the general public and the user is forced to use the model online through the internet link. The internet connection duration, manual input of choices, manual output marking of desired output parameters and insufficient information on the effects of different model or index inputs discourage inexperienced users from benefiting from the most significant ionospheric model. Other two disadvantages of the present form can be listed as the limited height extend and inability to represent the spatio-temporal variability since the empirical model computations are based on monthly median coefficients derived from experiments carried out mostly in North America and Europe. International Reference Ionosphere extended to the Plasmasphere (IRI-Plas) is the recent version of IRI where the region of interest can include plasmasphere up to the height Global Positioning System (GPS) satellite orbit of 20,200 km. GPS derived TEC can be ingested into IRI-Plas for better representation of temporal variations in the ionosphere. The model is provided in FORTRAN as Standard Plasmasphere-Ionosphere Model (IRI-Plas-SPIM) at http://ftp.izmiran.ru/pub/izmiran/SPIM/. IONOLAB group will provide an online interactive web interface at www.ionolab.org where the user can either download an executable version of IRI-Plas or use the IRI-Plas online similar to the IRI website with basic inputs of location, date, time. The user can also input TEC, foF2 and hmF2 values or, if desired GPS-TEC from Global Ionospheric Maps (GIM) can be automatically ingested similar to the application of IRI-Plas-MAP at www.ionolab.org. IONOLAB-IRI-Plas will provide selected ionospheric parameters according to the updated state of ionosphere in a user-friendly fashion.

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Paper # 70O

Variation of GPS-TEC in Hainan and comparisons with IRI model predictions

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Abstract

Variations of ionospheric TEC in the low latitude are investigated with the measurements of the dual-frequency GPS receiver in Hainan (19.5ºN, 109.1ºE; Geomagnetic ordinates: 178.95ºE, 8.1ºN) during 2005-2014. They are also compared with the ionogram-derived total electron content (ITEC) obtained with DPS4 digisonde in the same location and the International Reference Ionosphere model predictions (IRI-TEC) with different topside ionosphere options. Results show that (1) GPS-TEC has obvious diurnal and seasonal variations with a peak value at about 1500 LT and higher values in equinox than in summer and winter; there are higher values in spring than in autumn during 2005-2008, but higher values in autumn than in spring during 2009-2012; the total electron contents produced by all techniques (GPS-TEC and IRI-TEC) have similar variation trends; (2) there are systematically differences between ITEC and GPS-TEC; generally, ITEC is smaller/bigger than GPS-TEC during nighttime/daytime; there are smaller differences during nighttime and bigger ones during daytime, smaller differences in winter and bigger ones in other seasons which are different for the different year; (3) there is good linear relationship between ITEC and GPS-TEC; but it seems that GPS-TEC is saturated when ITEC is more than 60 TECUs; (4) generally the IRI predictions with old topside ionosphere option greatly overestimate both ITEC and GPS-TEC values and the IRI predictions with NeQuick topside ionosphere option are good agreement with the GPS-TEC and ITEC.

Paper # 65O

Variation of the topside and plasmaspheric electron content derived from the podTEC observations of COSMIC LEO satellites

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Abstract

An attempt is made to study the variations of the topside and plasmaspheric electron content (TPEC) using electron content data derived from the podTEC observation of the COSMIC low Earth orbit (LEO) satellite to the GPS satellite signals. We first give a brief introduce to the method we used to convert the slant podTEC to the vertical topside and plasmaspheric electron content (TPEC) which corresponds to the vertical integrated electron content from the altitude of the LEO satellite (~ 800km) to that of the GPS satellites (~20200km). Then we used the converted TPEC data of the year 2008 to study the variations of TPEC with the geomagnetic latitude (MLAT), magnetic local time (MLT) and with four different seasons (March equinox, June Solstice, September Equinox and December Solstice). Besides, we made a study on the longitudinal variation of TPEC using the data extracted from two different longitudes (120^0E and 300^0E). Our study showed that: (1) The distribution of the topside and plasmaspheric electron content TPEC is mainly confined to a region of $\pm 45^0$ of the magnetic equator of the Earth; (2) TPEC shows a well-defined diurnal variation pattern with higher values during daytime hours than during nighttime hours. TPEC reaches its peak value at the hour around 12-16MLT, whereas it reaches its minimum value at around 4-5 MLT. (3) TPEC has a lowest value in the June solstice season (May-August) compared with other seasons. (4) TPEC shows an evident longitudinal variation and it has different seasonal variations for different longitudes. We tried to discuss these variation features of TPEC with the coupling mechanism existing between the ionosphere and the plasmasphere.

Paper # 48O

Global feature of ionospheric slab thickness derived from observations ofGIM TECand COSMIC radio occultations

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Abstract

The ionosphere slab thickness τ, defined as the ratio of total electron content (TEC) to the F2-layer peak electron density (NmF2), describes the thickness of the ionospheric profile. In this study,we retrieve ionosphere slab thickness τ from the TEC data obtained from Global Ionospheric Map(GIM) and NmF2 retrieved from the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC)ionospheric radio occultation (IRO) data.
The diurnal, seasonal and solar activity variations of τ are analyzed globally as the excellent spatial coverage of GIM and COSMIC data. The peaks of τ often present at 0400 local time (LT). During solstices, the daytime slab thicknesses in the summer hemisphere are larger than those in the winter hemisphere, except in some high-latitude regions, and an opposite picture is present inthe nighttime slab thickness. The pre-sunrise enhancementof τpresents in all seasons, more remarkable in the winter hemisphere than in the summer hemisphere during solstices. A post-sunset enhancement of τ is quite similar to the pre-sunrise enhancement, but it is not readily observed in equinoxes. It isinterestingthat the slab thickness is enhanced between 0°-120° E and 30°-75° S,just at the east of Weddell Sea Anomaly (WSA), during the southern hemisphere summer. This phenomenon is supposed to be related to the effects caused by the magnetic declinationrelatedplasma vertical drifts.

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Paper # 28O

Comparison of GPS Derived TEC with the TEC Predicted by IRI 2012 Model Over the Eastern Africa Region

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Abstract

Total electron content (TEC) measured using dual-frequency GPS receivers at four stations (Nairobi (1.22°S, 36.89°E), Malindi (2.99°S, 40.19°E), Mtwara (10.26°S, 40.17°E) and Mzuzu (11.43°S, 34.01°E) located within the equatorial and low latitude region over Eastern Africa during 2012–2013 were compared with the IRI 2012 predictions. GPS observations have been obtained from Africa array and IGS networks over the region. Diurnal and seasonal TEC variations have been analyzed for the specified period by grouping months into four groups, March equinox, June solstice, September equinox and December solstice. The results of our study show that the TEC derived from the IRI-2012 model underestimate the TEC values during March equinox, September equinox and December solstice, whereas, it overestimate the values during June Solstice. This over estimation is obvious at the stations far from the equator and the under estimation is mostly during noon hours.

Keywords: GPS TEC measurement; IRI 2012 TEC prediction.

Oral Abstracts

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Paper # 27O

Comparison between bottomside parameter B0, B1 and IRI-2012 model: B0, B1 and ∆H at an equatorial electrojet station

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Abstract

The ionospheric electron density profile for the bottomside F region can be described by its thickness B0 and shape B1 parameters. In this study, the diurnal and seasonal variation of B0 and B1 and their median values are used to validate the three options used in producing B0 and B1 in the newly updated IRI-2012 model. The relationship between the profile parameter B0, B1 and geomagnetic, ∆H are also studied. The profile parameters data are obtained from DPS-4 digisonde while ∆H is obtained from a ground based magnetometer both located at an equatorial electrojet region. Median values of the observational results are compared with the three options of obtaining B0 and B1 parameters in the IRI model. It was observed that the bottomside F2 layer thickness B0 is overestimated during the night time and underestimated during the day time by both BIL-2000 and ABT-2009 option. While a good agreement was observed between the observational result and Gul-1987 option in all the seasons. The profile parameter, B1 was observed to exhibit oscillating pattern, pre-noon and post-sunset peaks which are not fully in agreement with the IRI options. There exist a strong and positive correlation between B0 and geomagnetic, ∆H while the shape parameter B1 exhibits negative correlation with ∆H.

Paper # 44O

Variability of the bottomside (B0, B1) parameters obtained from FMCW ionosonde and GPS based ground observations over Chumphon, Thailand

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Abstract

The diurnal and seasonal variation of bottomside thickness and shape (B0, B1) parameters over Chumphon, Thailand (geographic latitude: 10.72ºN, 99.37ºE) are studied and compared those values with the IRI-2012 model in year 2004. Due to (B0, B1) unavailability on FMCW ionosonde, the proposed B0 values (B0cpn_sim) are computed by using some observed parameters from FMCW ionosonde, total electron content (TEC) from global positioning system (GPS)-based measurement, and some equations of the IRI and NeQuick models. Meanwhile the studied B1 (B1cpn_sim) are computed by using an expression of the IRI model. The simulated (B0, B1) in this study are compared with the (B0, B1) of two options in the IRI-2012 model (ABT-2009 and Bil-2000), namely, (B0_ABT, B1_ABT) and (B0_Bil, B1_Bil) respectively. For comparisons the B0cpn_sim with the B0_ABT and the B0_Bil, their averaged and approximated positive differences are only taken in account and also assumed to be small when they are less than 30 km and vice versa. The results show that (1) the B0cpn_sim values in summer are the highest compared with those in equinox and winter, respectively; (2) the B0_ABT shows better similar trend to the B0cpn_sim than the B0_Bil for all seasons, except 02:00 – 06:00 LT; (3) The B0cpn_sim increases significantly during the pre-sunrise hours for all seasons and during nighttime in the summer, these peaks cannot be found in both B0_Bil and B0_ABT; (4) during 10:00 – 03:00 LT, the small differences between the B0cpn_sim and the B0_ABT are 14 km and 10 km in the equinox and winter, respectively. Their significant differences are 51 km and 45 km in the leftover times for the same seasons successively. In the summer, their small differences are 22 km during 07:00 – 21:00 LT, but their significant differences are approximately 73 km in the leftover times; (5) the durations of the small and significant differences between the B0cpn_sim and the B0_Bil cannot be seen clearly. Most of their small differences can be found in the nighttime, their averages are 16 km and 9 km in the equinox and winter, respectively. Their significant differences are 60 km and 69 km in the daytime for the same seasons successively. In the summer, most of their small differences can be found in the daytime, their averages are 18 km, but their significant differences are 65 km in the nighttime; (6) the B1cpn_sim ranges from 1.9 – 2.6 and have slightly seasonal changes; (7) The B1cpn_sim and B1_Bil values have the similar trends for all seasons, their significant differences is 0.2 – 0.25 at 06:00 LT and 18:00 LT; (8) The B1_ABT has unique seasonal and diurnal variation which is quite different from both B1cpn_sim and B1_Bil. Most of the B1_ABT are the highest in the equinox and winter, but they are overestimation and underestimation of the B1cpn_sim and B1_Bil in the summer.

Paper # 23O

Bottomside electron density profiles over Dibrugarh and comparison with the IRI

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Abstract

The bottom side electron density height profiles areobtained by real height inversion (using POLAN) ofionograms recorded at Dibrugarh(27.5°N, 95°E) from August 2010 to June 2015 during the ascending half of solar cycle 24.The diurnal, seasonal and solar cycle variation of the hourly electron density profiles are investigated and compared with the IRI 2012.It is observed that in generalthe IRI predicted *NmF2* and *hmF2* are similar at night time, slightly higher in the early morning period but lower at day time.The difference between observed *NmF2* and IRI prediction exhibits seasonal variations. The IRI is not able to reproduce the post sunset enhancement of *NmF2* observed in spring equinox. The deviations of IRI from observed values of *NmF2* in the post sunset periodof spring can be higher than 200%.The thickness and shape of the IRI density height profiles are similar to the observed profiles at night time but increasingly deviates from observed profiles as the day progresses and the difference in thickness maximizes in the midday period. IRI profiles generated with input from measured *NmF2* and *hmF2* at Dibrugarh are almost identical to the observed profiles at night time but bottom side thickness is still higher at day time. For quantitative study of the deviations of the bottom side thickness, the observed profiles are fitted to the analytical function used for generating the IRI bottom side density profile and the B0 and B1 parameter for the observed profiles are estimated.The measured B0 is found to be closely correlated with the *hmF2* and its diurnal variation. The diurnal variation of the observed B1 shows higher values in the night time and pre sunrise period. The diurnal variation of observed B0 exhibits a sharp secondary peak in pre-sunrise period followed by a collapse in the early morning period.The day time B0 values predicted by IRI are about 20-30% higher than the observed values in all seasons. The IRI did not reproduce the morning effect in summer and spring and underestimated the morning peak in other seasons.

Paper # 21O

The effect of QBO on f_0E

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Abstract

In the present work, it is statistically investigated relationship with QBO of difference (f_oE_{mea}-f_oE_{IRI}) between critical frequency values of E-region measured (f_oE_{mea}) at Darwin and Casos Island stations and calculated (f_oE_{IRI}) by IRI-2012 ionospheric model. Long-term multiple regression models are used as statistical tool. The "Dummy" variables are added to model in order to see the effect of westerly and easterly directions of QBO. In the result of calculations, it is observed that the changes in difference values of f_oE are explainable by QBO part of about 50-52% for both stations. The relationship between QBO and difference values of f_oE is negative for both stations. The change of 1 ms^{-1} of QBO led to a decrease of 0.008 MHz at Casos Island station and 0.017 MHz at Darwin station in difference values of f_oE. While directions of QBO have effecting on difference values of f_oE at the Darwin station, they have no effect on difference values of f_oE at Casos Island station. It is thought that the formation of the difference values in the f_0E due to not to be included in the IRI-model of all parameters affecting the critical frequency value. Thus, difference values of f_oE may be explainable by QBO which is not included to IRI-model.

Paper # 58O

Modeling of the anomalous variations of Very Low Frequency (VLF) radio wave signals associated with solar-flare, solar-eclipse and possible pre-seismic events

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Abstract

We have observed the anomalous variations of the VLF signals due to different solar events and also due to the possible effect of the pre-seismic activities. VLF signals mainly propagate through the earth-ionosphere wave-guide and the patterns of the VLF signal, mainly depends on the ionization of the ionosphere. During day time, the main source of the ionization of the ionosphere is high energetic solar radiation. But during night, Sun is absent and cosmic rays play an important role. An extra source of ionization (e.g. solar flares, gamma ray bursts, possible seismic events, etc) can change height of ionospheric layers and/or ion densities and these changes can perturb VLF signal amplitude. In this work, we present the effect of the solar eclipse and solar flares on VLF signals. Also we have observed the anomalous phase and amplitude variations which may be associated with pre-seismic activities. We use the IRI-LWPC coupled model to explain these anomalous variations. We found that our theoretically simulated anomalous signal variations matched with our observed signal patterns.

Paper # 52O

Modelling of sub-ionospheric VLF signal anomalies associated with precursory effects of the latest earthquakes in Nepal

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Abstract

We present the perturbations in the propagation characteristics of Very Low Frequency (VLF) signals received at Ionospheric & Earthquake Research Centre (IERC) (Lat. 22.50°N, Long. 87.48°E) during and prior to the latest strong earthquakes in Nepal 12 May 2015 at 12:50 pm local time (07:05 UTC) with magnitude of 7.3 and depth 18 km at southeast of Kodari. The VLF signal emitted from JJI transmitter (22.2 kHz) in Japan (Lat. 32.08°N, Long. 130.83°E) shows strong shift in sunrise and sunset terminator times towards nighttime starting from three to four days prior to the earthquake. The shift in terminator times is numerically simulated using Long Wavelength Propagation Capability (LWPC) code. The electron density variation as a function of height is calculated for seismically quiet days using the Wait's exponential profile and it matches with IRI model. The perturbed electron density is calculated using effective reflection height (h') and sharpness parameter (β) and the rate of ionization due to earthquake is being obtained by the equation of continuity for ionospheric D-layer. We compute the ion production and recombination profiles during seismic and non-seismic conditions incorporating D-region ion chemistry processes and calculate the unperturbed and perturbed electron density profile and ionization rate at different heights which matches with the exponential profile. During the seismic condition, for both the cases, the rate of ionization and the electron density profile differs a lot from the normal value. This is possibly due to the consequence of the seismo-ionospheric coupling processes.

Paper # 38O

Reconstruction of Model Based Electron Density Distribution from Ionosonde Data

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Abstract

Ionosondes are important remote sensing instruments that provide valuable information about the electron density distribution in the ionosphere. Ionosondes transmit modulated HF pulses and record their returns from the ionosphere. Round trip delays of the received echoes at different frequencies in between 1 to 20 MHz range provide information about the vertical profile of the ion distribution which is called ionogram. The process of reconstructing electron density with respect to height is known as the "ionogram scaling" or "true height analysis". In this study, we propose a new model based ionogram scaling technique where the electron density construction problem is cast as a non-convex optimization problem in model parameters. Although the framework allows the use of any existing model for the ionosphere, the performance of the proposed approach is illustrated by using the Chapman model. In search for optimal parameters, corresponding ionosonde measurements are obtained by calculating the propagation integral. For improved stability of the numerical integration, Gauss-Kronrod Quadrature is used. Also, to provide robust reconstruction in the presence of multiple reflections and leakages, measurement weights are introduced in the cost function of the optimization problem. Simulation results based on both synthetic and real ionosonde measurements show that proposed approach provides accurate electron density reconstructions.

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Paper # 35O

Investigation of Vertically Propagating Convectively Generated Short (~2-3 hr) Period Gravity Waves in the Atmosphere-Ionosphere system

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Abstract

Short period gravity waves generated during deep convection shows significant influence on the dynamics of the middle atmosphere. The present study describes the characteristics of vertically propagating short (~2-3 hr) period gravity waves with the help of four deep convective events associated with strong vertical velocities and double pause structures in the stratopause and mesopause altitudes using Indian MST radar, MF radar, Equatorial Electro Jet (EEJ) and Lidar datasets. Among the convective events maximum vertical updraft/downdrafts are found to be ~ +16 ms^{-1}/~ -10 ms^{-1} associated with the cloud top brightness temperature (TBB) of ~185 K/~205 K corresponding to 16-17 May 2006/24 September 2008. For all the cases there exist weak echo regions in the vertical beam SNR obtained from the MST radar leading to strong entrainment of ambient air from the troposphere into the stratospheric region due to the existence of strong updraft velocities. Two dimensional FFT of Rayleigh Lidar temperatures has shown the presence of dominant ~2-3 hr period oscillations associated with vertical wavelengths of ~ 4.2 km and ~7.6 km in the stratospheric region. During all the convective events the EEJ strength is found to be positive except on 16 and 17 May 2006, which is negative (~-38 nT and ~-18 nT) related with type-I and type-II counter electro jet (CEJ) event.

Paper # 39O

A novel approach to development of ionospheric random field model using GPS-TEC data

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Abstract

Ionosphere is composed of a complex plasma structure. This layer is affected by several mechanisms such as geomagnetic effects, solar radiation and seismic activity. Ionosphere is a very important medium for satellite and HF communication, navigation and positioning systems such as GNSS. Therefore, determination of spatio-temporal characteristics of ionosphere due to all the above mentioned effects is an important task. The spatio-temporal properties of ionosphere can be best identified in a statistical manner. Total Electron Content (TEC) is one of the most frequently used parameters for investigating and determining the structure of ionosphere. The TEC can be modeled as a random field composed of a slowly varying trend structure and a fast varying disturbance parameter. In this study, a novel method for modeling the trend structure of TEC random field using probability density functions (pdf) of regional, yearly, seasonal and hourly TEC data is proposed. The regional, yearly, seasonal and hourly pdfs of TEC indicate the variability of random field trend that can be utilized in modeling of ionospheric propagation and HF communication. The proposed method is applied to IONOLAB-TEC data that is collected from the Turkish National Permanent GPS Network (TNPGN)-Active between years 2009 and 2012. IONOLAB-TEC from each station is organized in a database with respect to hours, years, ionospheric seasons and regions that cover 2 degrees in latitude, 3 degrees in longitude. Within-the-hour parametric pdfs are estimated for every region, every season, every hour and year. The results indicate that TEC values have a strong dependence on hourly, seasonal and position of the station. The variability can be modeled as Lognormal and Weibull distributions. The mean and standard deviation of these parametric pdfs demonstrate that regional, seasonal and within-the-hour pdfs can be used as representative distributions for midlatitude regions. The method can be applied to other dense midlatitude GPS networks to obtain a statistical trend model of ionosphere.

This study is supported by a joint grants of TUBITAK 112E568 and RFBR 13-02-91370CT_a and TUBITAK 114E092 and ASCR14/001.

Paper # 19O

Fostering research aptitude to high school students through space weather competition

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Abstract

Cultivating research culture at an early stage is important for capacity building in a community. High school level is the appropriate stage for research to be introduced because of their competitive nature. Space weather competition is one of the ways to foster research aptitude among high school students. This paper presents on how research elements is incorporated through space weather competition where students need to build a system to detect the presence of solar flares utilizing VLF signals reflected from the ionosphere. This competition begins with proposal writing on the space weather related project. The proposal writing requires students to execute an extensive literature review on the given topic. The students also need to conduct the experiments and analyse the data. The result obtained is validated through other observation. At the end of the competition students are expected to write a comprehensive technical report. Through this competition, students learn step by step on how to conduct research in accordance to the guidelines given. From this project it is found that the students were able to conduct research with minimal guidance and enjoyed participating in the competition. In addition to acquiring research aptitude, students also improved their soft skills such as communication, self-confident and team work.

Session 9: Student Presentations

STUDENT PRESENTATION DETAIL

In this session, students will be grouped into 7 teams. Each team should limit their talk to 13 minutes including questions and discussions. The following table is a list of students from international countries.

33 Trainees of the COSPAR training session and the IRI2015 Workshop

No.	Name	Country
1	Azad Ahmad Mansoori	India
2	Rafi Ahmad	India
3	Chinmaya Kumar Nayak	India
4	Nilesh Patel	India
5	Sanjay Kumar	India
6	Malini Aggarwal	India
7	Nicholas Ssessanga	South Korea
8	JeongHeon Kim	South Korea
9	Zhe Yang	Hong Kong
10	Ernest P. Macalalad	Philiphines
11	Wang Zheng	China
12	Bello Saeed Abioye	Malaysia
13	Siti Aminah Bahari	Malaysia
14	Nouf Abd Elmunim Ahmed Ismail	Malaysia
15	Ednofri	Indonesia
16	Dessi Marlia	Indonesia
17	Trang T. Nguyen	Vietnam
18	lan tran	Vietnam
19	Sanit Arunpold	Thailand
20	Sukhanit Skawrattananont	Thailand
21	V Rajesh Chowdhary	Thailand
22	Nakornping Namkam	Thailand
23	Supachai Nakapan	Thailand
24	Noraset Wichaipanich	Thailand
25	Sarawoot Rungruengwajiake	Thailand
26	Somjai Klinngam	Thailand
27	Acharaporn Bumrungkit	Thailand
28	Punyawi Jamjareegulgarn	Thailand
29	Adrian Teck Keng TAN	Singapore
30	Rohaida Binti Mat Akir	Malaysia
31	Suhaila Binti M Buhari	Malaysia
32	Steven Brown	USA
33	Rata Suwantong	Thailand

Poster Abstracts

Session 10: Poster session

Paper # 1P

Ionospheric effects of Total Solar Eclipse on 22 July, 2009 observed over crest of EIA, Bhopal

***Rafi Ahmad*[1], *Azad Ahmad Mansoori*[2], *Pramod Kumar Purohit*[1], *and Ashok Kumar Gwal*[2]**

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Abstract

A solar eclipse provides us with a rare opportunity to study the ionospheric effects associated with an accurately estimated variation of solar radiation during the eclipse period. An exceptionally long total solar eclipse occurred on Wednesday, 22 July 2009, that traversed the eastern hemisphere in a narrow corridor. The Ionosonde observations taken at Space Science Laboratory, Department of Physics and Electronics, Barkatullah University, Bhopal during the three days centered on the total solar eclipse of 22 July 2009 are described. The eclipse was sufficient to decrease the ionization of some regions of ionosphere by the solar disc which was obscured at the maximum phase. The effects on the ionospheric parameters are observed when eclipse reached its maximum totality. A magnetic disturbance occurred during the period of the observation. Therefore the Ionosonde observations are discussed in conjugation with the changes which occurred in the magnetic elements and the ionosphere during the event of the eclipse.

Keywords: Solar Eclipse, Ionospheric Parameters, Ionosonde.

Paper # 3P

Earthquake linked signatures in the equatorial ionosphere

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Abstract

Here, we report the ionospheric observations over Indian region during two major earthquakes occurred at Sumatra, Indonesia on 28 March 2005 (8.6 M_W) and 26 December 2004 (9.1M_W). In this study we used amplitude scintillations on 251MHz transmitted by geostationary satellite UFO10 (71.2°E) and recorded by two spaced receivers closely aligned in magnetic E-W at Tirunelveli (8.7°N, 77.8°E, dip lat. 0.6°N). We also utilized the digisonde data recorded at dip equatorial station Trivandrum during December 2004 and March 2005. The present study reveals the presence of significantly higher plasma drifts in the F-region prior to the occurrence of earthquake on 28 March 2005. Also, the structuring of ionospheric ESF irregularities is found to be considerably different on that day as compared to that on quiet day of corresponding month. The earthquake of 26 December 2004 had triggered the tsunami and its associated effects in the F-region plasma drifts are distinctly observed even after ~18 hours post earthquake. The present observations are compiled based on the available ionospheric ground, satellite and model observations. Pre- and Post earthquake signatures in the equatorial ionosphere associated with these two events are discussed in detail.

Paper # 4P

Study of the Equatorial Electrojet (EEJ) effects along 210° meridian magnetic, comparison results in West Africa

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Abstract

The equatorial electrojet (EEJ) is a daytime ionospheric current that flows along the dip-equator at 105 km altitude. During the International Equatorial Electrojet Year (IEEY) the EEJ magnetic effects have been simultaneously recorded in various longitude sectors. In the present work, magnetically quiet time variations of the horizontal northward (H), eastward (D) and vertical (Z) components observed along 210° MM and in west Africa (meridian 5°W) are analyzed the spatio-temporal features of the EEJ are examined for the two longitudes sectors. The EEJ parameters that are its peak current density, half-width and position of the center are determined. Special characteristics of the EEJ are investigated and compared.

Paper # 5P

Study of the influences of eruptive solar events on geomagnetic field variations at low and mid latitudes.

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Abstract

Solar eruptions are sporadic events that disrupt the solar chromosphere. They emit light rays called solar flares, energetic particles and coronal mass ejections (CMEs) that are large-scale plasma structure propagating through the interplanetary space with a portion of solar magnetic field. These solar events (flares and CMEs) have an impact on the magnetic field of the earth. The purpose of this work is to study the magnetic effet of these eruptive solar events in mid and low latitude.
In the first part, we spot a solar flare and analyze its parameters (location of the active région, start time, X-ray flux, and proton flux). Then we identify the geomagnetic signature of solar flare called solar flare effect (s.f.e) or magnetic hook from magnetogram of H component in different longitude sector; quantify s.f.e amplitude which is denotedΔH_{sfe}. This allows us to determine the occurrence and spatio-temporal characterstics of s.f.e. We show in fact that the influence of solar flare's magnetic fiel dis essentially diurnal low and medium latitude and the amplitude of s.f.e is more important around local noon and dependS on the latitude. It intensifies the middle latitude to the equator.
In the second part, we spot a CME associated with the eruption through the LASCO C2 coronograph observations of the SOHO satellite. For CMEs taking the direction of the earth called geo-effective, we analyze the parameters of the wind (proton density, plasma temperature, wind speed and $\Delta B_Z(IMF)$) in the vicinity of the magnetosphere order identify the signature of the ICME in the wind. We then examine two terrestrial magnetic parameters: the DST and Kp that allow us to characterize the magnetic activity after ICME has come into contact with the magnetopause. We show that geomagnetic effects of CMEs occur day or night in all sectors and the maximum value of south B_Z component that determine a good connection between the lines of interplanetary magnetic field and the lines of geomagnetic field is $\Delta B_Z < -8\ nT$
Finally, a statistical analysis allows us to etablish correlations between certain solar and terrestrial settings. We estimate from this analysis that there is a low linear correlation between X-ray flux and the number of spot in the active area producing solar flare. Are correlated significantly sunspot number and the number of eruption within a single active area. It also notes the existence of a good correlation between the X-ray flux and amplitude of s.f.e in low latitude and between the maximum amplitude of DST during the main phase of a storm and that of the south B_Z component of IMF.

Paper # 6P

Role of low latitude Es layers in the equinoctial asymmetry of ESF irregularities as studied using field line integrated conductivities

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Abstract

In this paper, theoretical investigations on the linear growth rate of local and non local Raleigh-Taylor (RT) instability is presented. While considerable amount of work has been done to understand the linear growth rate of RT instability, it doesn't provide full description of the growth of the plasma irregularities. However, it is assumed that flux tube integrated growth rates, which takes into account the variabilities of different parameters such as flux tube integrated E and F region conductivities, neutral winds and densities provide a more realistic picture of the RT instability growth. Thus while local linear growth rates which provides how the RT instability develops based on local conditions, the flux tube integrated growth rates gives much understanding about the flux tube evolution of RT instability and hence the ESF development. Electron densities and other various atmospheric quantities which are needed for growth rate calculations have been obtained from the IRI and MSISE models. Present study includes the calculation of flux tube integrated growth rates by incorporating the ratio of E and F region conductivities. Though E region is neglected in local linear growth rate calculations, it plays a major role in the field line integrated conductivities. By incorporating different Es layer densities and their thickness using model under field integrated geometry, attempts have been made to study the role of low latitude Es layers in the context of recent observations of equinoctial asymmetry of the ESF irregularities reported. In equinoctial asymmetry in the ESF occurrence it is found that vernal equinox shows significant number of ESF days than autumn equinox. It is believed that Es layers also play important role in ESF occurrence through field integrated conductivities. So, in the present study, attempts are being made to study the role of Es layers in the equinoctial asymmetry of ESF irregularities.

Paper # 7P

Assessment of solar activity and Earth's magnetic field effects over ionospheric conductivity variations using IRI and SUPIM models

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Abstract

In the present work we analyzed the conductivity of the ionosphere which plays a critical role in magnetosphere-ionosphere and thermosphere-ionosphere coupling processes. To calculate the conductivity of ionosphere we used different models involved in the equations of Hall and Pedersen conductivities. The models were NRLMSIS-00, IGRF and to estimate ionospheric electron density (Ne) we used IRI2012 and SUPIM. Comparisons between the two models were made to analyze the contributions that each generate. Solar EUV irradiance and Earth's magnetic field are among the variables involved in these conductivities. This work shows the effect of variations of solar activity and Earth's magnetic field over ionospheric conductivity. The expected consequences of the upper atmosphere cooling due to increasing greenhouse gases concentration is also discussed in comparison to both natural forcings here considered.

Paper # 8P

A comparison of TEC predicted by IRI-2012 with that measured at three different stations within EIA region in the Indian sector for the years 2010-2012.

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Abstract

The present study reports the comparison of GPS measured Total Electron Content (TEC) with that predicted by the latest IRI-2012 model at three different stations located within the Equatorial Ionisation Anamoly region (EIA) in the Indian sector. The data used for the study are from three different stations namely Surat (Geographic latitude 21.16 N, Geographic longitude 72.78E, Geomagnetic latitude 12.90N), Hyderabad (Geographic latitude 17.20N, Geographic longitude 78.30E, Geomagnetic latitude 8.65N) and Bangalore (Geographic latitude 12.58N, Geographic longitude 77.33E, Geomagnetic latitude 4.58N). In this comparison the Plasmaspheric Electron Content (PEC) contribution to the GPS TEC have been removed. The period of comparison is three years for rising solar activity from 2010-2012. Here it is to note that both Hyderabad and Bangalore are IGS station with the station code (HYDE and IISC respectively). The results of the comparison of seasonal variation shows a good agreement between the measured and modeled TEC for all seasons with a slight deviations of (±15%) for all three years at Surat and Bangalore and with a deviation of (±25%) at Hyderabad. The winter anomaly was observed for Surat station for the year 2011 and so the deviations are more for winter 2011.

Paper # 9P

The IONORING project: exploiting the Italian geodetic GPS network for ionospheric purposes

Claudio Cesaroni[1], Michael Pezzopane[1], Lucilla Alfonsi[1], Luca Spogli[1,2], Vincenzo Romano[1,2], Antonio Avallone[1] and Alessandro Settimi[1]

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Abstract

The increasing use of GNSS for navigation and precise positioning leads to the need of more and more accurate knowledge of the morphology and dynamics of the ionosphere. In fact, it is well known that the ionospheric induced delay is the main error on the GNSS precise positioning applications. On the other hand, GNSS signals propagating through the ionosphere are useful to probe the ionization of the upper atmosphere.
RING (Rete Integrata GPS Nazionale) is a dense geodetic network of GPS stations managed by INGV (Istituto Nazionale di Geofisica e Vulcanologia) including about 180 receivers deployed on the whole Italian peninsula. Data acquired by the receivers were initially collected and stored to perform mainly studies focused on crustal deformations, caused both by plates movement and by earthquakes effects.
The main goal of the IONORING (IONOspheric RING) project is to exploit data from the RING network to obtain ionospheric Total Electron Content (TEC) maps with very fine spatial resolution (0.1°x0.1°, lat x long) in near real-time. *Ad hoc* calibration and interpolation algorithms are applied to RINEX data to produce *rapid* and *final* products. The former are generated with a time lag of about 1 hour, the latter, characterized by a higher accuracy, are produced with a time lag of maximum 48 hours. These maps will be useful to support ionospheric error mitigation in precise positioning (rapid product) and to study the ionosphere morphology and dynamics during strong solar and geomagnetic storms affecting the mid-latitude ionosphere (final product).
Maps and data resulting from the data-processing will be available on a dedicated web page through the **e**lectronic **S**pace **W**eather **u**pper **a**tmosphere portal managed by INGV (www.eswua.it).
In this paper, some preliminary results of the IONORING project are presented as well as the ICT interface of the project.

Paper # 10P

Characterization of *hmF2* and comparison with IRI model for the last solar minima at Rome and Gibilmanna stations

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Abstract

The minimum of the last solar cycle 23/24 (years 2008 and 2009) gives us the unique possibility to investigate the ionospheric plasma response for a period of very low and prolonged solar activity. The height of the peak of electron density (*hm*F2) represents maybe the most controversial ionospheric parameter to investigate, owing to its "non-univocal" way to calculate it. In particular, two different methods are usually used to calculate *hm*F2: (1) analytical formulations and (2) ionogram inversion to obtain a vertical electron density profile. Between them the ionogram inversion can be considered the most appropriate way to obtain reliable values for *hm*F2. Unfortunately, there are evident differences in the outputs from different ionogram inversion programs and, moreover, the *automatic inversion* has become a routine operation only in the recent years, making complicated an "inter-minima" comparison for this ionospheric characteristic. From this point of view the evaluation of the *International Reference Ionosphere* (IRI) model response for *hm*F2 is not a trivial problem. In this work we use data from the mid-latitude stations of Rome (41.8° N, 12.8° E, Italy) and Gibilmanna (37.9° N, 14.0° E, Italy), and make a comparison between IRI-CCIR and four different *hm*F2 outputs from ionosonde data: *Shimazaki formula* (analytical), *D55 formula* (analytical), *ARTIST system* (ionogram inversion) and *Autoscala algorithm* (ionogram inversion). The first target is to establish the periods for which we can consider the analytical formulations reliable, thanks to a comparison with *ARTIST* and *Autoscala* outputs for the last solar minimum; this is an important factor to be known to investigate IRI performances for previous minima (cycles 21/22 and 22/23), where only analytical formulations can be used, and compare these to the ones related to the last minimum (cycle 23/24). The second target is to compare, for the last solar minimum, *ARTIST* and *Autoscala* outputs between them and with the IRI model, which is crucial information to contribute to the improvement of the IRI capabilities in reliably reproducing the *hm*F2 trend for such extreme levels of solar activity.

Paper # 11P

Comparison of mid-latitude ionospheric F region peak critical frequencies, heights and topside Ne profiles from IRI2012 model prediction with ground based ionosonde and Alouette II observations

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Abstract

The ionospheric F2 peak parameters recorded by a ground based ionosonde at the low mid-latitude station Alma-Ata [43.25N, 76.92E] (Kazakhstan), and the Alouette II observations have been compared with the latest version of the IRI model, IRI2012 (http://omniweb.gsfc.nasa.gov/vitmo/iri2012_vitmo.html), for quite geomagnetic conditions of winter, equinoxes, and summer months.

It was found that for the Alma-Ata location the IRI2012 model describes the morphology of seasonal and diurnal variations of the foF2 and hmF2 monthly medians quite good. The model errors in the median foF2 prediction vary approximately in the range from about -20% to 36% showing a stable overestimation/underestimation in the median foF2 values mainly during day-time/night-time in winter and summer seasons, and in the March equinox respectively. Deviations between median hmF2 values and model F2 peak heights appear in the range of ±30 km; largest deviations occur during day-time in summer; the IRI2012 model underestimates hmF2 values up to about 200 km. The IRI2012 model mainly overestimates the median hmF2 values in night-time and around sunrise, and underestimates the hmF2 values around sunset hours.

A comparison between the Alouette foF2 observations and IRI2012 predictions shows results that confirm some general tendencies found in the ionosonde and the model data comparison (e.g. a consistent overestimation of the observed foF2 values during day-time in winter and summer seasons), but the model errors are significantly larger. Deviations between the observed hmF2 values and their model predictions are found to be large, between -90 km (in winter) and 126 km (in summer).

The best option for the IRI2012 model in the topside ionosphere for near-noon hours is the IRI01-corr option corrected to the F2-layer peak parameters which up to the altitude of 2000 km predicts the topside Ne profiles very closely to those observed at the Alouette satellite except the summer season when the IRI01-corr option shows a more gradual Ne decay above the F2-peak altitude and consequently can underestimate the measured Ne values up to 60% at ~700 km. For night-time, the best option for the IRI2012 model in the topside ionosphere is the IRI2001 option corrected to the F2-layer peak parameters which showed a good agreement with the Alouette Ne profile from the F2-peak altitude to about 600 km with a sharp change in gradient around, so called, a transition region centering at about 800 km where the profiles change their shape similar to the measured Ne profiles, but the measured Ne values are found to be overestimated at the altitude (and at higher altitudes) up to ~60% at ~800 km.

Paper # 12P

Fifty eight years of Alma-Ata ionospheric observations

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Abstract

We present the Ionospheric Digital Data Base (IDDB) of vertical incidence parameters measured by using a ground based ionosonde observations at the Alma-Ata (Kazakhstan) station [43.25N, 76.92E]. The IDDB contains all available data obtained from 1957 until recently. The most important ionosphere characteristics have been included in the IDDB: foF2, foF1, foE, foEs, fmin, fbEs, h'F1, h'F2, h'E, h'Es, M3000F2. The IDDB documentation includes information about the ionosonde characteristics, vertical incidence parameters, data collection, and format description. Instructions and navigation commands are also provided on-line as context-sensitive help windows inside the IDDB display software. In the individual request graphs of the diurnal distribution for any parameter can be displayed along with the monthly median values.

Paper # 13P

Correction factors for the topside IRI electron density during the recent solar minimum derived from CHAMP and GRACE observations

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Abstract

The International Reference Ionosphere (IRI) is an empirical model based on large collections of satellite and ground-based observations, and it is expected to give a reasonably accurate description of the ionosphere for quiet and moderate geomagnetic conditions. However, our comparisons of IRI predictions with CHAMP and GRACE in-situ electron density measurements during the recent unusually low and extended solar minimum (2008-2009) revealed significant discrepancies at 300-500 km altitudes. Based on nearly 10 years data from CHAMP and GRACE, we have used the data-to-model ratios to established correction factors for the IRI model. These correction factors vary with solar flux levels, local time and modified dip latitude. The results show that at the crest region of the Equatorial Ionization Anomaly (EIA) IRI overestimates the electron density around noon during lower solar activity periods, while it underestimates the electron density after sunset during higher solar activity periods. Around sunrise the IRI always overestimate the electron density in the low- and mid-latitude region irrespective of solar activity. We present functional relations that can be used to improve the representation of the topside ionosphere.

Paper # 14P

Achievement of a short term three dimensional electron density mapping of the ionosphere in the European sector: comparisons with the IRI model for moderate geomagnetic conditions

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Abstract

The procedure followed for the achievement of a short term three dimensional electron density mapping of the ionosphere (***ST-3D-M***) in the European area is described.
It consists of three main steps: 1) *foF2* and *M(3000)F2* short-term forecasts are calculated in *N* ionospheric observatories scattered in the European area; 2) by using the predicted values of *foF2* and *M3000F2* calculated at the step 1, the *foF2* and *M3000F2* short-term forecasts are calculated on a grid of equi-spaced points, by means of an appropriate interpolation algorithm); 3) the *foF2* and *M3000F2* grid data ingestion into IRI model is employed to produce a short term three dimensional (3-D) electron density mapping (***ST-3D-M***) of the ionosphere.
In order to test the goodness of the proposed ***ST-3D-M***, several comparisons between the short term forecasts of the electron density profiles provided by ***ST-3D-M***, and the electron density profiles provided by the *IRI* model and *ARTIST*, were made in the ionospheric observatories of Athens (38°.0′N, 23°.5′E), Chilton (51°.5′N, -0°.6′W), Dourbes (50°.1′ N, 4°.6′E), Pruhonice (50°.0′N, 14°.6′E), Rome (41°.9′N, 12°.5′E), and Tortosa (40°.8′N, 0°.5′E), for a large number of epochs during moderate geomagnetic conditions.

Paper # 15P

Ionospheric response to the solar eclipse of 20 march 2015: importance of autoscaled data and their assimilation for obtaining a reliable modelling of the ionosphere

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Abstract

Even though in Italy the solar eclipse occurred on 20 March 2015 was only partial, with the maximum area of the solar disk obscured by the Moon equal to ~54% at Rome and ~45% at Gibilmanna, the ionospheric plasma was significantly affected all the same.
This work wants to highlight how also for eclipse conditions the availability of autoscaled data and their assimilation in ionospheric models is essential to obtain a representation of the ionosphere as much reliable as possible.
The reference ionospheric stations, providing the ionosonde assimilation data, are those of Rome (41°.8′ N, 12.5′ E) and Gibilmanna (37°.9′ N, 14°.0′ E), Italy, while the truth-station is that of San Vito (40°.6′ N, 17°.8′ E), Italy.
The study is focussed on: a) a comparison between long-term maps and nowcasting maps of *fo*F2 generated over the central Mediterranean area; b) a testing phase of the IRI-SIRMUP-P (ISP) model. With regard to point a), long-term maps generated by the SIRM model will be compared with the nowcasting maps generated by the SIRMUP model. Concerning point b), the nowcasting vertical electron density profiles given as output by the ISP model are compared with the ones provided by the IRI-URSI and the IRI-CCIR models.

Paper # 17P

Variation of the total electron content and ionospheric scintillation during the magnetic storm on March 2015 observed in the Southeast Asia region

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Abstract

The magnetic storm on March 2015 is the big storm during the 24th cycle of the solar activity. The main phase of the storm occurred on 17 March 2015, the amplitude of the horizontal component of the magnetic field recorded at Da Lat observatory (Vietnam) during this storm reachs 450 nT. We present the results of TEC calculation and of the ionospheric scintillation index (S4 and ROTI) using the data from 8 GPS stations in Southeast Asia region in both sides of the magnetic equator. It showed that on the 17 March, on the main phase of the storm, there is an enhancement of the equatorial ionization anomaly; amplitudes of the crests increase and the crests move poleward. On the 18 March on the recovery phase of the storm there is a significant decrease of the equatorial ionization anomaly, its crests move equatoward at distance of about 8 latitudes with respect to the normal postions. The S4 and ROTI indices obtained during this storm show that on the 16 March and 19 March, there are the significant enhancements of ionospheric scintillation activity; on the 17 March the scintillation activity is very weak and on the 18 March the scintillations are inhibited nearly complately.

Keywords: *TEC, Scintillation, Equatorial Ionization Anomaly*

Paper # 18P

A new topside profiler based on Alouette/ISIS topside sounding

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Abstract

A new empirical model of the topside ionospheric density was developed to describe the measured topside profile accurately. This profiler is a composite of two separate layers of different ion species in the topside ionosphere, the O^+ layer and the light-ions (H^+ and He^+) layer. The light-ions layer is characterized by an α-Chapman function with a linearly increasing scale height with altitude. This new model appears to perform the best as compared to five other typical topside profilers in representing data from ISIS-1&2 and Alouette-1&2 observations. We also analyzed the magnetic latitude dependence, seasonal variation, and day-night difference of the characteristic parameters of the light-ions layer during the magnetic quiet (kp<4) and low solar activity (f107<120 solar flux unit, sfu) period within magnetic latitudes from -60° to 90°. The statistical results show the expected different behaviors of light-ions and O^+ parameters. In addition, the portion of the light-ion components contributing to the topside ionospheric TEC was studied also. The results suggest that the light ions make a great contribution to the topside TEC, especially in magnetic low- and middle-latitudes at night.

Paper # 19P

An ionospheric assimilation model along 120° E meridian plane

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Abstract

In this paper we developed a two-dimension ionospheric assimilation model that assimilates the observations of peak electron density of F2-layer (NmF2) and the peak height of F2-layer (hmF2) derived from five ionosonde stations along the 120° E meridian plane, using three-dimensional variation techniques (3DVAR) based on a physics-based ionosphere theoretical model. The assimilation system can well produce the assimilated results along the 120° E meridian plane by using the data of NmF2 and hmF2 at five ionosonde stations from Mohe (52.0° N) to Sanya (18.3° N). The root mean square error (RMSE) of the assimilations with the ionosonde observations is much lower than that of the results from international reference ionosphere (IRI). In addition, we carried out the assimilation test by taking the IRI results as the observations to check the assimilated results in the regions without observations. The assimilated result in southern hemisphere (RMSE=0.29) is much worse than that in northern hemisphere (RMSE=0.10) because no observations in southern hemisphere were used. If the data derived from the four ionosonde stations in Australia are used, the assimilated result in southern hemisphere would be much more advanced. In addition, except for the NmF2 and hmF2, the assimilation model also can adjust the total electron content (TEC). The RMSE of the assimilated TEC with the observed GPS TEC is much lower than that of the TEC from IRI model.

Paper # 20P

Comparison of GPS-TEC with IRI TEC over Fuzhou Region in China

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Abstract

This paper studies the total electron content (TEC) derived from dual-frequency GPS receivers at Fuzhou station (26.1oN，119.3oE). The observation data, 5-8 March, 23-26 June, 10-13 September, and 26-29 December, were selected from the year of 2006. A spherical harmonic expansion is used to represent the vertical TEC. The TECs and the biases of satellites and receivers were determined by using the singular value decomposition (SVD). The derived TEC from GPS is compared with the IRI-2012 model. The results show that the diurnal and seasonal variation of the TEC derived from the IRI-2012 model is agreement with measured TEC from GPS TEC.

Paper # 21P

Sporadic E layer features over two mid-latitude ionospheric stations during the 20 March 2015 solar eclipse

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Abstract

Sporadic E (Es) layer features as recorded at the ionospheric stations of Rome (41.8°N, 12.5°E) and Gibilmanna (37.9°N, 14.0°E), Italy, by the Advanced Ionospheric Sounder (AIS-INGV) are analysed during the solar eclipse of 20 March 2015. It is shown that the strong thermal gradients caused by the solar eclipse have had a large impact on the Es phenomenology even though the maximum area of the solar disk obscured by the Moon was limited to about 54% at Rome and 45% at Gibilmanna.
In particular, the day of the eclipse the Es layer does not show any significant variation in terms of its maximum intensity, but rather in terms of its stability (when talking about stability we mean a series of consecutive ionograms showing the presence of an Es layer). In fact, contrary to what it is usually observed in March 2015, a significant stability of the Es layer around the solar eclipse time, also confirmed by the application of the height-time-intensity (HTI) technique, is clearly observed both in Rome and Gibilmanna.
The signatures of traveling ionospheric disturbances (TIDs) that emerged from a careful analysis of isoheight ionogram plots, suggest the passage of a gravity wave (GW) which is likely to have played a significant role in causing the stabilization of the Es layer.

Paper # 22P

Detecting Solar Wind Activity Using Magnetometer Kototabang Observatory

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Abstract

During year 2013, magnetometer in Kototabang Observatory observed several geomagnetic storms which indicate the solar wind activity. From the magnetometer data we found that there are some large-scale storm was in October 2013, November 2013 and December 2013, and major storms over 100 nT in June 2013and July 2013. This solar wind activities are triggered by the solar activity, such as flares, coronal mass ejection, and coronal holes. Such solar activities will affect the characteristics of the daily variation of magnetic field component, since the CMEs and flares will increase the intensity and the speed of solar wind and the radiation of electromagnetic waves. Data processing is done by converting raw data into ASCII format and then corrects noise by IAGA format data to generate data variation daily then compared with the data Dst index to detect when a large magnetic storms during 2013.

Paper # 23P

Co-seismic Ionosphere Disturbances at the Equatorial Ionization Anomaly Region under Geomagnetic Quiet and Storm Conditions

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Abstract

In this paper the F2 layer critical frequency (foF2) data of the instantaneous Global Ionospheric Maps (GIM-foF2), which are produced with the International Reference Ionosphere extended to Plasmasphere (IRI-Plas) model by assimilating Total Electron Content data from GIM-TEC provided by Jet Propulsion Laboratory of California Institute of Technology (JPL) are analyzed in order to investigate foF2 variations in the Equatorial Anomaly Region (EIA) after the earthquakes of Richter magnitude from M6.0 to M10.0. The GIM-foF2 maps for a period from January, 1999, to now are provided by IZMIRAN at (http://www.izmiran.ru/pub/izmiran/SPIM/Maps/foF2/) and IONOLAB at (http://www.ionolab.org/). The GIM-foF2 maps are compared with instantaneous foF2 maps obtained by assimilation of the ionosonde foF2 data by IRI-CCIR model for 1999-2006 provided at (ftp://ftp.cbk.waw.pl/idce/grid/fof2_maps_99_06/). Based on the global distribution of earthquakes (EQ) in the magnitude M6.0+, the foF2 disturbances are investigated in the EIA region of the intense seismic activity between ±20°N in latitude and 90° to 190°E in longitude. The total set of 1016 earthquakes EQ M6.0+ from January, 1999, to June, 2015, are analyzed out of which 858 'non-storm' EQs and 158 'storm' EQs were specified. The geomagnetic storms affecting the ionosphere are determined with relevant thresholds of AE, aa, ap, ap(τ) and Dst indices. The ionospheric weather Wf-index is produced from GIM-foF2 maps and foF2 anomalies are identified at cells of the map if an instant foF2 is outside of pre-defined bounds of foF2 median (μ) and standard deviation σ, μ±1σ, in the area of 1,000 km radius around the EQ epicenter. Variations of positive and negative co-seismic ionosphere Wf-index anomalies are analyzed in the EIA region in terms of earthquake magnitude, local time, season and solar activity under geomagnetic quiet and storm conditions. Results are presented in the paper.

Paper # 24P

Comparative study Ionospheric TEC variation with IRI model 2012 at Manado and Pontianak Stations over Indonesia

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Abstract

The ionospheric Total Electron Content (TEC) derived by analyzing dual frequency signals from GPS (Global Positioning System) receiver namely GISTM (GPS Ionospheric Scintillations and TEC Monitor from two stations over period 2013. These stations are Manado (geographic latitude 1.34 ^{0} S and 124.82 ^{0} E) and Pontianak (geographic latitude 0.06^0 S and 109.4 ^{0} E) stations over Indonesia . The measured TEC is compared with the TEC derived from the IRI model 2012. Variation of TEC validate to IRI model 2012 at two stations have been compared with the model for there different topside of electron density namely NeQuick, IRI-01-corr and IRI 2012. We present the mean diurnal, monthly, and seasonal variations in the ionospheric TEC during the maximum solar activity periods of 2013.The periods of study are classified into four seasons i.e., December soltstice (November, December, January), March Equinox (February, March, April), June Soltstice (May, June, July), and September Equinox (August, September, October) are done to observe the diurnal, monthly, seasonal variation of electron content over each of the stations. TEC prediction using IRI 2012 model overestimates the observed TEC at Indonesia. TEC from IRI-NeQuick and IRI -01-corr options show a tendency to underestimates the observed TEC during the day time particularly in low latitude region in the maximum solar activity period (2013).

Keywords: Ionosphere, Total Electron Content (TEC), GISTM, IRI model 2012, Solar Activity maximum

Paper # 25P

Assessment of IRI model over the Indian region using satellite measurements

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Abstract

The International Reference Ionosphere (IRI) is recognized as the international standard for representing the Earth's ionospheric parameters. However, the performance of the model needs to be validated due to data scarcity especially in the low-latitude regions. The temporal and spatial variations of ionospheric parameters at mid latitudes are relatively small compared to the equatorial and low-latitude regions, where changes are significant, owing to the dynamical behavior of the ionosphere. In this regard, we carried out the investigation to study the morphological characteristics of varying ionospheric parameters obtained by satellite measurements in the Indian low-latitude regions during different seasons and solar activities. The preliminary results of comparison of observed ionospheric parameters with the latest International Reference Ionosphere (IRI) – 2012 model will be presented.

Paper # 26P

Using measurements of the IAR emission frequency structure to evaluate the ion composition above the ionosphere

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Abstract

Ionospheric Alfven resonator (IAR) is located between the lower ionosphere and the transition area from the ionosphere to the plasmasphere (at middle latitudes), or magnetosphere (at high latitudes). Its walls are sharp gradients in plasma concentration below the F_2 layer at the bottom and at the height of 0.5–1.5 Earth radii above. The resonator captures Alfvén waves ranging from a fraction of a hertz to about 10 Hz. The dynamic range of the IAR emission has the form of a set of fan-shaped bands with frequency varying in accordance with the change of ionospheric parameters, primarily the plasma concentration in the F2 layer of the ionosphere.
In this paper, using the example of two spectrograms calculated from the observations of IAR emissions in the mid-latitudes (Mondy, Eastern Siberia) and in the auroral zone (Sodankylä, Finland), the possibility of obtaining information on the ion composition at altitudes of 2,000 to 6,000 km is shown. The analysis was carried out by comparing the frequency differences Δf between adjacent harmonics measured from spectrograms with the resonator characteristics calculated on the basis of the IRI-2012 model, extrapolated up to a height of 10,000 km. By selecting coefficients in the extrapolation formulae of ion altitude profiles to achieve a minimum discrepancy between the measured Δf frequency and its estimate calculated on the basis of the model the profiles of ion composition in the region above the IRI-2012 model limit height, ie, higher than 2000 km, were obtained.
As a result, the graphics of height variations in relative and absolute concentrations of the three types of ions: oxygen, hydrogen and helium were obtained; changes in altitude profiles of these ions during the transition from daytime to night were followed. Comparison of the profiles obtained for the middle and high latitudes showed a significant difference. For example, if over the obs. Mondy relative content of oxygen ions is close to zero in the entire range of heights, then at high latitudes in the early evening hours, it decreases from over 70% at 2000 km to 20% at an altitude of 4000 km and it slowly falls when approaching the night.

This study was supported by the Grant of the Russian Scientific Foundation (Project No. 14-37-00027) and the ISTP SB RAS.

Paper # 27P

Variability of the Terrestrial Ionosphere as observed in COSMIC data

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Abstract

It is well known that the ionosphere varies with a number of inputs, including longitude, latitude, local time, and the solar cycle. In this study we consider the behavior of the ionosphere during the recent solar minimum in 2008, especially in comparison to periods of higher solar activity (*e.g.*, 2011). Also of interest to our study is the ability of empirical models, such as the International Reference Ionosphere (IRI), to capture this variability in the ionosphere. To accomplish our goal we analyzed radio occultation data from the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) satellite. We considered median electron density values for 81 days surrounding the 2008 and 2011 December solstices. Using the COSMIC dataset, we created global maps of the mid- and low-latitude F-region of the ionosphere, specifically focusing on maximum electron densities (NmF2) and the corresponding altitudes (hmF2). We constructed these maps in Python using the Python Science Analysis Toolkit (pysat). We compare our results with the IRI model and consider ways to improve upon the performance of the model during periods of solar extremes.

Paper # 28P

The response of the total electron content over Europe to solar eclipse of March 20, 2015

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Abstract

We report features of the ionosphere's response to the solar eclipse of March 20, 2015 using GPS measurements. Maximal phase of the eclipse was observed over the north of Europe at ~10 UT. The eclipse took place in the period when the ionosphere changed from local night to day conditions. Besides, this eclipse occurred at the recovery phase of the strong geomagnetic storm of March 17, 2015. The effect of the eclipse was detected in the diurnal GPS TEC variations and even more distinctly in the TEC variations along individual GPS satellite passes. The trough-like variations with a gradual decrease and further TEC increase at the time of the eclipse were observed at latitudes over 50N. We registered the TEC depression of ~ 4-6 TECU at some individual satellite passes over the Kaliningrad station (54N, 20E).
The geomagnetic storm of March 17, 2015 complicated the analyses of the ionospheric effects caused by the eclipse. The superposition of the storm and the eclipse make it difficult to separate TEC changes caused by the eclipse, however variation of the ionosphere's spatial structure was found at the regional TEC maps.
Here, to analyze the spatial TEC distribution during eclipse we generate the TEC maps using the GPS measurements collected from 150-180 GPS stations. The dense European GPS network allows generating the regional TEC maps with high spatial resolution. The spatio-temporal changes of the ionosphere during this eclipse were clearly tracked at the TEC maps with 5 min resolution. The spatial structure of the ionosphere changed essentially during the eclipse comparing with the control days. We found that the GPS TEC gradients were much stronger than during the previous, as well as following days. The complex pattern of the spatio-temporal TEC distribution demonstrates the important role of the dynamics processes in the ionosphere during a solar eclipse.

Paper # 29P

A comparison of delay gradient near Suvarnabhumi international airport in Thailand

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Abstract

The Ground-Based Augmentation System (GBAS) is developed to support the aircraft landing based on the Global navigation satellite system (GNSS). While the GNSS signals from the satellite travel through the ionosphere that consists of many free electrons and ions, the signal is delayed by these electrons, called ionospheric delay. As we know the ionospheric irregularity can distort the quality of the GNSS signals and reducing the efficiency of the GBAS accuracy. The ionospheric delay gradient is an important parameter to provide the reliability of the GBAS.

The large ionospheric delay gradient of 311 mm/km was found on April 14, 2014 in Chennai. This work proposes the ionospheric delay gradient based on the GNSS data near Suvarnabhumi international airport, Thailand compared with the results from Chennai, India on the same date. Three base stations in Thailand are located at 13.7278˚N, 100.7726˚E (KMITL), 13.7356˚N, 100.6611˚E (STFD) and 13.6945˚E (AERO). The ionospheric delay gradients are computed by the STEC data from station pairs using the same satellite. However, the results of ionospheric delay gradient from GNSS receiver in Thailand are less than the results from Chennai. For Thailand, the results are ~100 mm/km in eastward (KMITL - STFD) and ~85 mm/km in northward (KMITL - AERO).

Paper # 30P

Study of GPS positioning accuracy when utilizing Klobuchar model with ionospheric conditions in Thailand

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Abstract

The global navigation system (GPS) is now widely implemented in the smartphones since the GPS receiver module is integrated in a single chip of CPU. However, over billion of smartphones are based on the single-frequency (L1: 1.57542 GHz) GPS receiver. Since the positioning error of single-frequency GPS receiver is mainly caused by the atmospheric delay, especially the ionosphere. The Klobuchar model is well-known model which was developed to compensate for ionospheric delay and is currently used for civilian single-frequency GPS receiver. The coefficients of the model are daily broadcasted in the GPS satellite navigation message for worldwide users. Although the exist remaining errors due to the unique local ionospheric characteristics can cause a significant position error. In this work, we investigate the performance of of Kobuchar model in comparison to the actual ionospheric delays at various stations in Thailand.

Paper # 31P

The Quantity of TEC over Chiang-Mai near the Epicenter of Strong Earthquake in Northern Thailand

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Abstract

The strong earthquake in northern Thailand (the maximum level is 6.3 Richter scale) on 5th May 2014 have the epicenter at Tambon Sai Khao, Phan district of Chiang-Rai, Thailand (19.656°N, 99.67°E). Besides, the earthquakes govern to the acoustic-gravity wave occurrence and it also affects the variation of TEC density in ionosphere. Then, in this article suggest the variation of TEC that is calculated by the data of GPS signal which was received over ionospheric observatory at Chiang-Mai (18.76°N, 98.93°E) and it is one part of SEALION (SouthEast Asia Low-latitude IOnospheric Network) project. According to the investigation of TEC from PRN 7, 8, 9 and 28 respectively, received between 9.00 h - 13.30 h (local time) on 4th May 2014, their denoted the fluctuation of TEC before the earthquake. And similarly, the trend of DST index derive from Kyoto website in same period also indicate the association of TEC and magnetic field variation due to the earthquake.

Paper # 32P

Variation of the ionospheric TEC using GPS measurements in Thailand

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Abstract

The Total Electron Content (TEC) can be measured from the dual-frequency Global Positioning System (GPS) as the ionosphere acts as a main delay in radio wave propagations. This paper presents the seasonal TEC variation that is obtained from 5 GPS-receiver stations, which aredistributed surrounding in Thailand: King Mongkut's Institute of Technology Ladkrabang (KMITL) station, Bangkok, Chiangmai station, Udonthani station, Sisaket station and Songkla station, Thailand, which the TEC data analyzed during 2012-2014, corresponding to the increasing part high of solar activity. For credibility, we compare the observed TEC values with International Reference Ionosphere (IRI) models: IRI-2012 model. The results show the pattern of TEC the maximum difference value during the equinox season, is approximately 14 TECU during daytime. The IRI-2012 TEC is overestimated during 00.00 UT – 03.00 UT and nighttime in equinox season by 0.1-48.7% and 1.2-40.8%. For winter solstice and summer solstice seasons, the IRI-2012 TEC agrees with the observed TEC in the morning, but mostly, it underestimates the observed TEC.

Paper # 33P

Total Electron Content (TEC) and Rate of TEC Index (ROTI) Analyzing based on Hadoop Technology

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Abstract

In the present, the huge of important and volume of GNSS data has increase rapidly every year. For example GNSS data from stations of Thailand, there are around 30 stations from Thai organizations such as Department of Land, the Aeronautical Radio of Thailand, the Royal Thai Navy and the Thai Meteorological Department, as well as, 6 stations from Kyoto University and SEALION project, NICT. By using big data technology, Hadoop which is consisted of Hadoop distributed File System (HDFS) and MapReduce, large scale distributed processing on cluster system, analyzes the GNSS data such as Total Electron Content (TEC) and irregularities of ionosphere, Rate of TEC index (ROTI). They are processed from group of scalable distributed compute nodes and give us good performance analytic results.

Paper # 34P

Study of GBAS protection level near Suvarnabhumi International Airport, Thailand

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Abstract

The next generation aeronautical navigation system employs the Ground-based augmentation system (GBAS) during approach and landing phase. GBAS system consists of the global navigation satellite system (GNSS) based equipment that broadcast the augmentation information to the aircraft to correct the errors in GNSS signal in space. In GBAS, we have to validate the accuracy, integrity, continuity and availability of system. To fulfil the requirement of ICAO SARPs GBAS standard, every airport needs to construct and verify its own GBAS error model for the installation purpose. In this paper, we analyze protection level that calculated from GBAS error model and used to indicate the availability of GBAS. We use GNSS data such as satellite elevation angle, pseudorange and carrier-phase information recorded from 3 stations at the Suvarnnahumi international airport (AERO), King Mongkut's Institute of Technology Ladkrabang (KMIT) and Stamford international university (STFD) in 2014. Then, the ICAO SARPs's algorithms are implemented to analyze the maximum protection level in normal situation without ionospheric disturbance nor failed reference receivers and also analyze protection level during ionospheric disturbance phenomena. The maximum protection level from observed station is analyzed.

Paper # 36P

Evaluation of the IRI-2012 model during intense geomagnetic storms

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Abstract

Intense geomagnetic storms impact the ionosphere causing severe disturbances which, in turn, can affect a wide range of radio systems on which worldwide societies and economies are increasingly dependent. In fact, telecommunications, aircraft safety, navigation and surveillance systems, for example, rely on signals propagating through the ionosphere. So, a continuous ionosphere monitoring is essential, as well as the ability to predict irregularities and disturbances that may affect these systems. The problem of forecasting ionospheric disturbances associated with geomagnetic storms is still a highly topical and complex issue, and IRI-2012 model is a tool very useful for this purpose. Often foF2 ionosonde records present big gaps during an intense perturbation of this kind. For this reason in the present work IRI-2012 foF2 predictions during geomagnetic storms that reached values of DST less than -250 nT are analyzed. For selected mid and high latitude stations experimental foF2 is compared to IRI-2012 output with the empirical ionospheric storm correction model STORM and without it. At the beginning of the storm and during the recovery phase the IRI model with storm correction has a very good agreement with experimental data from the stations aforementioned. Since in many statistical analysis complete data series are needed, IRI-2012 would provide a highly acceptable method to interpolate foF2 missing data in these cases.

Paper # 37P

IRI model application for Over the Horizon Radar ray path determination using URSI and CCIR options

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Abstract

Knowledge of ionosphere conditions is essential for determining HF signal propagation paths. In the case of an Over The Horizon Radar (OTHR), where the ionosphere acts as a reflector, there are two important parameters that depend directly on the F2 layer critical frequency, foF2, and the ionization peak height, hmF2, which are the Maximum Usable Frequency (MUF) and Least Usable Frequency (LUF). OTHR is a HF radar system that covers an area located beyond the horizon line using ionospheric reflection. In the present work, a confidence belt in transmission frequencies to get a stable radar echo is assessed for this kind of radars through MUF and LUF calculations using IRI-2012 with both, CCIR and URSI F peak models for different solar activity levels. A comparative analysis of the results obtained with both F peak models is done for different latitudes. The percentage variation has a strong latitudinal dependence being minima at low latitudes and reaching ~15% for high latitudes depending on solar activity level.

Paper # 38P

Slant total electron content modeling for low latitude and equatorial region

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Abstract

It is well known that predicted values of Slant Electron Content (STEC) are generally obtained by applying a mapping function to modeled VTEC data and only a few ionospheric models are suitable for calculate STEC directly. The use of mapping functions and the presence of horizontal gradients of electron density can leads to significant errors in the models predictions. Moreover equatorial region has special features like fountain effect and equatorial electrojet that cause important deviations to the model calculation due to their particular electrodynamics. In this paper, the Tucumán Ionospheric Model (TIM) is used as a new option for calculating the STEC in low latitude regions (-24 to 24 dip latitude). In order to reduce the errors caused by gradients and mapping functions this model applies a spatial geometry where the ray path trajectory is segmented each 20km and the corresponding electron density values for the resulting segments end points are calculated using the Chapman modified function given by the SLIM model. Finally the electron density values are integrated along the path to obtain the STEC. This work describes the TIM model and test their STEC predictions for five ray paths around the world (totaling sixteen cases studied) which are compared with experimental data from geostationary satellites and with those calculated by the NeQuick model. Moreover the TIM model performance for VTEC predictions is also tested and compared with VTEC data obtained from GPS signals, IRI, and NeQuick models predictions, for six GPS receiver stations during equinox and solstice (totaling twelve cases studied).
Concerning to the TIM model deviations from the experimental data, it can be observed that 53% of STEC determinations have errors less than 30%. Moreover the quality of the predictions are measured by a least squares analysis in which it is observed that TIM explains about 80% of the variability of experimental observations. For the considered cases, in general, TIM reproduces better the experimental data than the other models.

Paper # 39P

Morphological study on the total electron content (TEC) of ionosphere over dynamically active polar region.

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Abstract

Under the aegis of the SPL's Science Program "Energetic coupling between Sun-Earth System" (EcSES), a set of dual frequency GPS Receiver has been installed at Bharti, an Indian Antarctic station located at Larsemann Hills, Antarctica. Bharti, being located at 76 Degree South geomagnetic latitude, mostly remains inside the auroral oval and hence is exposed to the direct impact of the solar wind. However, since the polar cap is a highly dynamic region, the position of Bharti changes quickly from being poleward of the auroral oval to the auroral region or even equatorward of the auroral oval in response to varying IMF Bz conditions. This makes Bharti an ideal location to monitor the impact of solar wind on the terrestrial coupled ionospheric-magnetospheric system. The GPS receiver system is in operation at Bharti since February 2013 and since then it is recording ionospheric parameters like the TEC and ionospheric scintillations regularly.

The TEC of the ionosphere over Bharti, as estimated by the onsite GPS Receiver, shows a consistent seasonal variation with minimum being in June (the local winter month) and maximum in December (the local summer). Morphological comparison between the IRI 2007 model and the GPS TEC shows a qualitative agreement. However, there are significant seasonal differences in the magnitude of the model-derived TEC and GPS-observed TEC. During June, when the solar zenith angle at Bharti is consistently more than 90 degree (i.e. there is no direct solar radiation producing photo-ions), both the GPS observed TEC and model derived TEC agreed well. There was a three fold magnitude difference in the observed and IRI model TEC during December (a summer month which had consistently high solar zenith angle throughout the day). The in-house developed quasi-two dimensional model, where only ion-chemistry was used, also shows the magnitude of the TEC at Bharti location, produced solely due to photochemistry to be comparatively less than that observed by the GPS. It only goes to show that the dynamic nature of Bharti location with respect to the position of polar cap plays an important role on the control of plasma density at the polar region, an aspect which has not been explored so far. An observation of the TEC from the GPS receiver at Bharti gives a new dimension to our understanding about the control of solar dynamics on the plasma density in the Earth's ionosphere.

Paper # 40P

Comparative study of COSMIC/FORMOSAT-3, incoherent scatter radar, ionosonde and IRI model electron density vertical profiles during the solar activity growth period

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Abstract

We have collected about 1000 cases of simultaneous ionospheric observations conducted by Irkutsk incoherent scatter radar (IISR) and COSMIC/FORMOSAT-3 near IISR location for the 2012-2014 periods. The main topic of the paper is a comparative analysis of electron density vertical profiles obtained with COSMIC/FORMOSAT-3, IISR, Irkutsk ionosonde during the solar activity growth period and predicted by IRI model. The analysis is expected to be useful for the following tasks.
(1) Mutual calibration of different methods of ionospheric sounding (incoherent scatter method, radio-occultation technique and vertical sounding in our case).
(2) Studying ionospheric spatial inhomogeneity using the differences between electron density profiles obtained with different tools.
(3) Testing IRI model prediction of bottomside/topside electron density after assimilation of ionosonde peak electron density and the peak height into the model.

The work was supported by the RFBR grant 14-05-92002 HHC_a.

Paper # 42P

VHF scintillation observations over a typical Indian low latitude station during half-a-solar cycle and their comparisions with S4-index measured using the COSMIC RO technique

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Abstract

VHF ionospheric scintillation (244 MHz) measurements made at a typical Indian low latitude station, Waltair (Lat. 17.7^0 N, Long. 83.3^0 E) during a half-a-solar cycle (2008-2013) along with the computed scintillation index (S4-index) and spectral components are reported. An empirical model has been developed using the B-spline technique and this model has well reproduced several important features including local time, seasonal and solar activity variations, which are corroborating with our earlier studies made at this station. On the other hand, scintillation index data from the recent COSMIC radio occultation (RO) technique during 2008- 2013 over Waltair region have been analyzed and developed an empirical model using the B-spline technique. A few comparative studies have been made between these two models and a one-to-one correspondence is observed.

Paper # 43P

Global S4- index variations at F-region altitudes observed using the FORMOSAT-3/COSMIC GPS RO technique during a solar minimum year

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Abstract

Three-dimensional (3D) global morphology and seasonal variations of scintillation index (S4 index) measured from the signal-to-noise ratio (SNR) intensity fluctuations of L1 channel of GPS radio occultation (RO) signals using FORMOSAT-3/COSMIC (in short, F3/C) satellites for a low sunspot year 2008 have been presented. The S4 index, which confined around $\pm 30^0$ magnetic latitudes, is found to start around post-sunset hours (1900 MLT, magnetic local time) and often persists till post-midnight hours (0300 MLT) between 150 and 350 km altitudes during equinox and northern winter seasons, while no activity is observed during southern winter season. However, high latitudes are characterized with no scintillation activity beyond 150 km during any season, which implies that in the solar minimum period the drives of instabilities in the auroral, cusp and polar cap regions, namely the gradient drift and velocity shear, are absent. The S4 index at F- region altitudes during magnetically quiet times is more intense and extends to higher latitudes than that observed during disturbed time consistent with earlier studies. The equatorial S4 index appears below the peak of F2 layer (hmF2) during most of the seasons although the associated intensities and the time of maximum occurrences are relatively higher and earlier during vernal equinox followed by autumn equinox. This equinoctial asymmetry could be primarily attributed to the asymmetries in eastward drift velocities, thermospheric meridional winds and plasma densities. Keeping the importance of these valuable database, we would like to emphasize that the F3/C GPS RO technique can be used to study the ionospheric irregularities at GHz frequency globally directly from the high-rate L1 data, which reiterating its importance as a powerful tool to explore the terrestrial ionosphere on a global scale.

Paper # 44P

Global S4- index variations at E-region altitudes observed using the FORMOSAT-3/COSMIC GPS RO technique during a solar minimum year

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Abstract

GPS radio occultation (GPS RO) method, an active satellite-to-satellite remote sensing technique, is capable of producing accurate, all-weather, round-the- clock, global refractive index, density, pressure, and temperature profiles of the troposphere and stratosphere of the Earth's atmosphere and ionosphere parameters including, peak height and frequencies of the E and F1 and F2-layers, along with amplitude scintillation index (S4-index) at different altitudes. The global maps of S4 index at E region altitudes (between 75 and 125 km) which show strong seasonal variations with highest activity during northern and southern summer solstice in the middle latitudes have been presented. On the other hand, the global characteristics of S4-index show that they appear on both sides of the magnetic equator with less or no activity at and around the equator during equinox seasons. The absence of S4 index along the equator can be understood in terms of the vanishing vertical component of the magnetic field lines that can inhibit the vertical movement and layered deposition of ionized particles of thin irregular electron density layers such as Es-layers (sporadic E-layers).

Paper # 46P

Observations of Plasmaspheric Electron Content over Addis Ababa during 2010–2013

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Abstract

This study presents the plasmaspheric electron content (PEC) observations over Addis Ababa (Lat: 9.03°N, Lon: 38.77° E; Mag. lat: 0.18°N). We used the IRI-Plas model to obtain the daily percentages of PEC at Addis Ababa, and these values were used to derive PEC values from the GPS-observed TEC for 2010–2013. IRI-Plas combines IRI with the Russian Standard Model of the Ionosphere (SMI). Generally, the percentage contributions of PEC were high during nighttime and low during daytime, and recorded the highest during December solstice, and the least during June solstice. When we implemented these percentages on the GPS-observed TEC, the highest PEC values were recorded during the daytime (at times over 10 TECU), and the least during the night time. Seasonally, the highest values were recorded during December solstice, and the least during June solstice. PEC over Addis Ababa is observed to be solar activity dependent. Finally, we validated IRI-2012 Model with the GPS-observed data after the exclusion of PEC on a month-by-month basis.

Paper # 47P

Modeling solar flare induced lower ionospheric changes and effect on VLF propagation: A comparative study of ionization by enhanced X-ray and Lyman-α

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Abstract

The formation and maintenance of the ionosphere is done predominantly by the solar ultraviolet radiation and partly by cosmic ray particles. Ambient characteristics of the ionosphere can be determined by accounting these two ionizing candidates only. Those characteristics are well estimated in observation based empirical models of ionosphere, like IRI model. The propagation of electromagnetic waves in earth-ionosphere waveguide in normal terrestrial and extra-terrestrial situations can be modeled efficiently by such empirical models. The determination of ionospheric characteristics and dynamic behavior at disturbed conditions of either origin and corresponding influences on the radio wave propagation require special treatment. For an example the plasma properties of the D-region of the ionosphere during solar flares is altered by the enhanced soft X-ray radiation and hydrogen Lyman-a emission. For strong flares like M or X class ones the enhanced X-ray by far outpower the increased Lyman-α in producing extra ionization. For weak flares and micro flares increased Lyman-α may possibly play a role. In this paper we have tried to estimate the effect of solar flares on the ionization and electron-ion densities in the lower part of the ionosphere, namely the D region and model corresponding modulation imposed on the Very Low Frequency (VLF) radio wave, which propagates in the wave guides made of ground and the region. We compute the ionization using Geant4 Monte Carlo simulation and use a simplified ion chemistry model (GPI model) to find the changes in electron and ion densities. We have used the Long Wave Propagation Capability (LWPC) code to model the propagation of VLF in modified ionospheric conditions. Our study is conducted for different classes of flares and using Monte-Carlo simulation we have estimated the relative contributions of enhanced soft X-ray and hydrogen Lyman-α line in extra ionization for various classes. We have verified our simulation results with VLF observations.

Paper # 48P

The disturbances of the ionosphere over Kaliningrad in periods of storm weather conditions

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Abstract

The paper presents the results of investigations of ionospheric irregularities arising in periods of meteorological disturbances. The ionosphere observations were made during the periods of weather storms in Kaliningrad from 2011 to 2015. The analysis of ionospheric observations showed that in periods of meteorological storms there was a significant decrease in the amplitude of the diurnal variations of ionospheric parameters f_0F2 and TEC.

The physical interpretation of ionospheric disturbances arising in periods of meteorological storms is offered on the basis of theoretical study of the acoustic-gravity waves (AGWs) propagation from lower to upper atmosphere. The nonhydrostatic model of AGWs propagation in the atmosphere, taking into account nonlinear and dissipative processes that accompany the propagation of waves, was used in the theoretical study. The calculations showed that in the upper atmosphere is formed of a large-scale disturbance over the AGWs source at altitude near 200 km due to the propagation and dissipation of waves.The appearance of these disturbance significant effects on propagation of AGWs and leads to waveguide propagation AGWs, with periods shorter than the period Brunt-Vaisala in the height of perturbed atmosphere. The proposed physical mechanism of formation of the upper atmosphere disturbances, based on the propagation and dissipation of AGWs, may be useful for explaining the ionospheric irregularities arising in periods of meteorological storms.

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Paper # 49P

Observational evidences of unusual outgoing longwave radiation (OLR) and atmospheric gravity waves (AGW) as precursory effects of the latest earthquakes in Nepal

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Abstract

The earthquake preparation processes start almost 1-30 days before its occurrence. Outgoing longwave radiation (OLR) measurement and observation of atmospheric gravity waves (AGW) in Very low frequency (VLF) signals can be used as tools to identify such processes. We studied the recent major earthquake that occurred in Nepal on 12 May 2015 at 12:50 pm local time (07:05 UTC) with magnitude of 7.3 and depth 18 km at southeast of Kodari. Firstly, to study the effects of seismic events on OLR, we have used the NOAA/IR daily (two degree) data from 07/05/15 to 18/05/15 and calculated the Eddy field calculation mean to find the anomalies. We found singularities in Eddy field OLR curves around the earthquake epicentre 3 days prior to the earthquake day and disappearance of such singularities after the event. Such singularities may be associated with the large amount of energy generated by the earthquake. Secondly, we have analysed the Very Low Frequency (VLF) data collected by Ionospheric and Earthquake Research Centre (IERC) (Lat. 22.5°N, Lon. 87.48°E) from the transmitter JJI (22.2 kHz) in Japan to find the presence of atmospheric gravity waves in the ionosphere. We performed FFT (Forward Fourier Transform) analysis on the signal and found significant presence of such waves during the earthquake time from which we can conclude that AGW can be considered as an important parameter in confirming the seismo-ionospheric perturbations.

Oral Abstracts

Session 11: IRI - New Inputs and Applications

Paper # 67O

Upper Boundary of Ionosphere

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Abstract

Electron density at altitudes below 10,000km is estimated from Upper-hybrid resonance (UHR) emission observed by the plasma wave and sounder experiments (PWS) on Akebono satellite from February 22, 1989 to April 23, 2015. The electron density profiles were compared with International Reference Ionosphere model and physical modeling (Plasmasphere Thermosphere model: PTM). The electron densities by the Akebono satellite and the PTM show clearly density gradient change at altitude of ~1500km. The transition may be upper boundary of ionosphere. The altitude depends on local time, latitude, longitude, season, solar activity and magnetic activity.

Paper # 42O

An empirical model of the occurrence of an additional layer in the ionosphere from the occultation technique: Preliminary results

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Abstract

About 8 year electron density profile (EDP) data from the COSMIC/FORMOSAT-3 satellites radio occultation technique were used to investigate the additional stratification of the F2 (the so-called F3 layer) layer over the equatorial and low-latitude ionosphere on a global scale for both the bottomside and topside ionosphere. The F3 layer was recognized through the altitude differential profile featured by two maxima existing from the selected EDP profile. There were ~37,000 (bottomside) and 25,000 (topside) cases of F3 layer selected out of ~1.27million occultation events at equatorial and low-latitude areas during the period of April 2006 to August 2014. The statistical results for the bottomside ionosphere resemble that reported in Zhao et al. (2011a), while in the topside the highest occurrence of F3 layer shows a 3–4 h delay depending on the altitude range of the stratification. The magnetic latitude distribution shows different dependence with a tendency to form a single crest toward high altitude. Also, the seasonal variation is weaker in the topside ionosphere compared to the bottomside one, especially in the high altitude. Then we build up an empirical model of the F3 layer occurrence using the bottomside statistics based on empirical orthogonal function (EOF) decomposition as it gets the inherent characters inside the data set and converges quickly. The model well grasps the main features of the F3 occurrence, e.g., the F3 occurrence's sensitivity on the magnetic latitude. Further, in order to accommodate the ground observation a corrected factor was introduced. As F3 layer is an important phenomenon in the low-latitude ionosphere, we have made an attempt to describe its feature with a consecutive function although future work needs to be done for an overall expression of this structure.

Paper # 54O

Ionospheric responses to the solar EUV irradiance variations on the solar cycle and solar rotation timescales

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Abstract

The variations of the solar extreme ultraviolet (EUV) irradiance, which ionizes the upper atmosphere, significantly affect ionospheric variability. The solar cycle and solar rotation variations of the solar EUV irradiance are the two of the most important variations of EUV. Conventionally, the responses of the ionosphere to the solar cycle and solar rotation variations of EUV are usually not been distinguished.

In this research the responses of the ionosphere to the solar cycle and solar rotation variations of the solar EUV irradiance are comparatively investigated using daily mean global electron content (GEC), daily fluxes of the EUV irradiance observed by the SOHO/SEM, and the $F_{10.7}$ and Mg II proxies. The GEC data were derived from the JPL TEC maps. When using the $F_{10.7}$ and Mg II proxies to measure the solar EUV irradiance, the correlations between the solar rotation variation of GEC and those of the proxies are poorer. An important reason is that the solar rotation EUV–proxy correlations are poorer and variable during the solar cycle; the slopes of the solar rotation EUV versus the proxies vary from solar rotation to solar rotation. It is interesting that the variation slopes of the solar rotation GEC versus the proxies are lower than those of the solar cycle GEC versus the proxies, for which an important reason is that the variation slopes of the solar rotation EUV versus the proxies are generally lower than those of the solar cycle EUV versus the proxies. Therefore, the 0.1–50 nm SOHO/SEM EUV flux was used to measure the solar EUV irradiance to further investigate GEC's responses. GEC is well correlated with EUV on both the solar cycle and solar rotation timescales. However, the responses of GEC to the solar cycle and solar rotation variations of EUV are also significantly different in terms of the following two aspects: (1) There is a significant time lag between the solar rotation variations of GEC and EUV; the lag is dominated by a 1-day lag and generally presents a decrease trend with solar activity decreasing. For the solar cycle variations of GEC and EUV, however, there are no evident time lags. (2) The GEC versus EUV slopes are different for the solar cycle and solar rotation variations of GEC and EUV; the solar cycle GEC versus EUV slope is higher than the solar rotation GEC versus EUV slope, and this difference occurs in different seasons and latitudes. The results present an aspect of the difference between ionospheric climatology and weather.

Paper # 64O

Routine Ionospheric Observation at Syowa Station, Antarctica: More than 50 years of Operation for Space Weather Monitoring

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Abstract

The Earth's ionosphere is one of the important areas for short-wave telecommunications and broadcasting. The condition of the ionosphere varies depending on space weather. National Institute of Information and Communications Technology (NICT) is responsible for Japanese space weather forecast, has been operating routine ionospheric observations over Japan for more than 50 years as monitoring of space weather and radio-wave propagation. Also, NICT has been operating routine ionospheric observations at Syowa station in Antarctica from the early stages of Japanese Antarctic Research Expedition (JARE). These more than 50 years of ionospheric data enables us to study daily, seasonal, solar-cycle dependent, and long-term variations of ionosphere.
In this presentation, we will introduce brief history of routine ionospheric observation at Syowa station, Antarctica, and current status of ionospheric observations at Syowa station.

Paper # 36O

Wave Propagation Modeling for Anisotropic and Inhomogeneous Ionosphere using IRI-Plas-G

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Abstract

An HF radio wave propagation model based on ray tracing for inhomogeneous, anisotropic and time varying ionosphere, namely IONOLAB-RAY, is developed. The modeling approaches of the algorithm will be described in this paper. In the ONOLABRAY algorithm the inhomogeniety of the ionosphere is represented by a spherical 3-D grid structure with a flexible resolution. The physical parameters defining the ionosphere in each voxel of the grid structure covering the region of interest are obtained using the ionosphere model IRI-Plas-G at the preprocess phase of the algorithm. At the main process phase of the algorithm, Snell's law is applied as a ray tracing technique in computation of reflection and transmission between voxels. Snell's law brings an advantage to the algorithm in order to reduce the computational complexity and the runtime. Refractive index of each voxel is calculated by Appleton-Hartree formula, which reflects the anisotropicity of the ionosphere due to geomagnetic field into the model. All of the parameters are calculated for given date and time, so that the time dependency of the ionosphere is also covered in the algorithm. The physical parameters of the ionosphere can be updated with an assimilation of Total Electron Content values to the current conditions. This capability of IONOLAB-RAY algorithm has an important impact in characterization of ionosphere during geomagnetic storm conditions. The algorithm is developed to be modular and with the capability of multiple runs with respect to the variation of input parameters. The algorithm is a basis to further develop a complete software tool which can serve for both wave propagation and channel modeling studies in HF band. In the future studies, the attenuation of signal in dispersive and lossy ionosphere, phase delay, polarization and phase rotation due to Faraday rotation features will also be added both for ordinary and extraordinary ray components. Another highly prospective advantage for IONOLAB-RAY will be the tracing of transionospheric propagation up to GPS satellite height of 20,200 km.

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Paper # 25O

Applying the Nudged Elastic Band Method for Point-to-Point Ray Path Calculation using IRI Modeled Ionosphere

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Abstract

Point-to point ray path calculation problem is widely known in different areas. There are seismic wave's propagation modeling, finding minimum energy paths of chemical reactions, diffusion, spin transitions and etc. Most of the used methods are based on the direct variation principle of the path. But for ionospheric point-to point ray path calculation such approach is not widely known. In current work we demonstrate that such methods can be successfully applied for the ionosphere problem. For that we have chosen the Nudged Elastic Band method, which successfully works in different chemical problems. This approach is based on direct utilization of the variational principle for the optical path (Fermat's principle). The idea is to transform an arbitrary trajectory to an optimal one, while the endpoints of the trajectory are kept fixed according to the boundary conditions. In this study, we propose a version of such a direct variational method, where only transverse displacements of the radio wave ray are used in the optimization algorithm. In our method, a chain of points which gives a discrete representation of the ray is adjusted iteratively to an optimal configuration. The advantages of transverse displacements include better computational efficiency and improved stability as compared to methods based on minimization of the optical path length. The method has been applied to various test problems. The method has also been applied to study point-to-point ionospheric ray path calculations where the properties of the propagation media have been derived using the IRI model.

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Paper # 61O

The study of the Residual of the Klobuchar Model in TaiWan

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Abstract

Ionospheric time delay is the mainly error source in Global Navigation satellite system (GNSS). Ionospheric model is one of the ways to correct the ionospheric time delay. The single-frequency GNSS users modify the ionospheric time delay by receiving the correction parameter of the ionospheric model broadcasted by the satellites. Klobuchar model is widely used in Global Positioning System (GPS) and COMPASS because it is simple and convenient for real-time calculation. Klobuchar model is based on the observation mainly from Europe and USA. Its validation in China has not been fully understood for the complicated temporal and spatial variation of the ionosphere, especially in the south of China.

In this paper, eleven years (2003~2014) data from one GPS receiver located at Taoyuan Taiwan (121°E，25°N) are used to study the long-term variation and distribution of the residual of Klobuchar model in Taiwan. The vertical TEC of the ionospheric piercing point (IPP) is calculated from the dual-frequency GPS observation and the Klobuchar model parameters respectively. The TEC obtained from the observation is used as the reference, and the TEC based on the Klobuchar model is compared with the reference. The residual of the model is defined as the difference between the TEC from Klobuchar model and the reference. The results showed that the variation of the model residual is similar to that of TEC. The residual in the daytime is larger than that at night, and that during the high solar activity years is larger than that in the low solar activity years. The probability density distribution of the residual is scattered in the daytime, especially during the high solar activity years; and the distribution is concentrated at night in the low solar activity years. The TEC from model is smaller than the reference during the 1300~1500BJT in the high solar activity years, the maximum of the bias reached 97TECU. At night of the low activity years (0000~0200BJT), the TEC based on the model is ~5TECU larger than the reference. The special distribution of the residual is studied by calculating the probability density in each 2 degree from 16°N to 32°N. The results showed that the distribution is the most scattered in 20~24°N latitudes and the most concentrated in 30~32°N latitudes. Most of the residual is negative in 20~24°N latitudes, manifesting the estimation from the model is lower than the observations. In low solar activity years, most of the residual during 1300~1500BJT is larger than zero, while in high solar activity years the number of the positive residual is approximate to the negative ones. The research in this paper provides the data to evaluate the validation of the Klobuchar model in Taiwan. How to modify the Klobuchar model or other ionospheric model needs further study in future.

Paper # 68O

The dependence of GPS-TEC derivation on ionospheric height assumption

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Abstract

This paper studies the effects of the thin shell ionospheric height assumption on TEC derivation from a small scale GPS network by applying a grid-based algorithm to the data on several geomagnetic quiet days covering a 10 months' time in 2006. The algorithm arranges unknown TECs and instrumental biases with slant path TEC from GPS receivers' observations into a set of equations by assuming that the TEC is identical at any point within a given grid block and the biases do not vary within a day. Then the TECs and the instrumental biases are determined by using the least squares fitting technique. For different ionospheric height the derived TEC tends to increase with the height, while the trend of TEC variation with time retains. The times at which the TEC peaks or reaches the minimum do not change significantly with the height. The instrumental biases can vary with the height irregularly. The goodness of fit is different for different height. The fitting is generally good when the height is taken from 350 km to 700 km. It has large deviations for the height lower than 350 km. The goodness of fit worsens monotonously when the height decreases from 280 km to 250 km. There does not exist a best thin shell ionospheric height assumption in view of data fitting.

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