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UNIWERSYTET WARMIŃSKO-MAZURSKI W OLSZTYNIE

IRI Workshop 2013

June 24-28, 2013

University of Warmia and Mazury in Olsztyn

International Reference Ionosphere (IRI) Workshop 2013
"IRI and GNSS"

24 – 28 June 2013, Olsztyn, Poland

Welcome

Welcome to the International Reference Ionosphere (IRI) Workshop 2013, held at the University of Warmia and Mazury in Olsztyn, Poland from 24 – 28 June 2013. The meeting is hosted by the Department of Astronomy and Geodynamics; the Honorable Patronage is taken by the Rector of the University of Warmia and Mazury in Olsztyn, Prof. Ryszard Górecki and President of Olsztyn, Dr. Piotr Grzymowicz. Over 100 participants from 24 countries registered for the symposium. Over 60 oral and 20 poster presentations will be given during the one-week meeting at the Kortowo campus.

The local organizing committee has been led by Prof. Andrzej Krankowski with effort from Dr Irina Zakharenkova, Dr Iurii Cherniak, Dr Leszek Błaszkiewicz, Dr Rafał Sieradzki, Tomasz Sidorowicz, Katarzyna Burska and others. The scientific program committee has been led by Prof. Lee-Anne McKinnell, Dr Vladimir Truhlik, Prof. Shigeto Watanabe, Prof. Dieter Bilitza, Prof. Andrzej Krankowski, Prof. Bodo Reinisch with substantial input from the rest of the IRI Group.

We would like to welcome you for an Ice Breaker Reception on Monday and the Workshop Dinner on Wednesday that is organized by INS and Leica Geosystems Poland at Hotel Park, respectively. On Wednesday for those interested in events, the Town Hall of Olsztyn has organized a visit to the Astronomy Observatory and Planetarium and sightseeing of Olsztyn's Old Town as well.

Lunch will be provided as a part of registration at the Mathematics and Computer Sciences building.

The local organizing committee is delighted to be hosting you during this one-week meeting. Please, do not hesitate to ask us, as we hope you will enjoy the meeting, events and time you spend in Olsztyn.

We wish you rewarding debates and an unforgettable stay in Olsztyn!

Prof. Andrzej Krankowski

Head of the Local Organizing Committee

SPONSORS

Workshop Dinner sponsor

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Whether you want to capture airborne data for an agricultural area, of a city or to record changes in a disaster area, you need reliable measurements and solutions for your entire workflow. When it has to be right, more geospatial professionals turn Leica Geosystems to help them collect, analyze and present spatial information. From terrestrial and GNSS surveying solution, through GIS, 3D laser scanning, metrology and airborne sensors, to integrated software for measuring, analyzing and presenting spatial information in 2D and 3D, Leica Geosystems is trusted worldwide to deliver unmatched precision, seamless integration and superior customer support. For more information, see Leica's website at www.leica-geosystems.pl

Ice Breaker sponsors

INS Ltd. - Provider of GNSS systems.

Since 1995, INS has provided it's clients with the most sophisticated GNSS (Global Navigation Satellite System) technology. So far, we have delivered over 5200 systems for nearly 500 clients in Europe. Our extensive list of customers includes research centers, Universities, military and other governmental organizations in Poland. We also work with private business sectors. The received reference letters and other written testimonies confirm reliability, professionalism and the commitment with which we complete every project.

IFEN GNSS Software receivers SX-NSR and GNSS Simulators NAVX-NCS are used by the University of Warmia and Mazury in Olsztyn and the Air Force Institute of Technology for the analysis of new GPS, GLONASS and Galileo signals, investigation of interferences affecting satellite signals, and experimentation with new positioning algorithms.

SEPTENTRIO PolaRxS and JAVAD Sigma-G3T 100 Hz receivers installed in 2011 as the test bench at the Satellite Observatory in Lamkówko (LAMK) are connected to the rubidium atomic frequency standard and collect GNSS observations as well as ionospheres' parameters (TEC and scintillation parameter S4).

National Space Organization (NSPO) in Taiwan was established in 1991. The vision is to become a center of innovation and excellence for space technology and conduct space programs with Taiwan's strength and global competitiveness. The mission is to establish indigenous space technology, fulfill pronounced societal impacts, and promote frontier space science research. As the integration center and responsible for the promotion and execution of satellite programs, NSPO has completed the establishment of various infrastructure for satellite development including the satellite integration and test facility, ground control system and several professional laboratories. FORMOSAT-1 was successfully launched on January 27 1999 to carry out scientific missions of ionospheric plasma structure and dynamics and completed five and a half year mission operation; FORMOSAT-2, a high resolution optical remote sensing satellite with second payload for detection of upper atmospheric (or lower ionospheric) lightning sprite phenomena, was launched on May 21 2004 to start carrying out a five year mission; the major mission of FORMOSAT-3 (or FORMOSAT-3/COSMIC, F3/C) is to deploy six micro-satellites for building a global atmosphere and ionosphere measuring network that was successfully launched on April 15 2006.

Successfully launched in April 2006, F3/C is the first ever satellite constellation observing system for meteorology, ionosphere, and climate utilizing the GPS Radio Occultation (RO) technique. For the past 7 years, F3/C had accumulated over 7 million atmospheric and ionospheric data profiles. Currently, there are over 2,100 registered users from 67 countries are using F3/C data for the real-time forecasting

applications as well as meteorology, climate, and space weather researches. The RO weather data had been praised as "The Most Accurate Earth Thermometer in Space" and is regarded as one of the most influential data systems for the weather forecast, climate observation and ionospheric space weather study.
In this IRI workshop 2013, contributions to ionospheric communities by FORMOSAT-1, -2, and -3 are summarized, and scientific missions probing the ionosphere of FORMOSAT-5 and FORMOSAT-7/COSMIC-2 are introduced.

Events sponsor

Olsztyn is the largest city and the capital of region of Warmia and Mazury. In the city of 660 years history live over 170 thousand people. Most famous monuments of Olsztyn are gothic castle, Cathedral of Saint Jacob and Upper Gate located on the boarder of old city walls.

The biggest advantage of the city is its unique location among the forests and the lakes. 12 (and some people say that even 15!) lakes and City Forest – one of the biggest European park are located within the borders of Olsztyn. To accent those advantages, the vision of Olsztyn development extracts to the conception of city garden. The defensive architecture of the XIV-century's Warmia, unrepeatable XIX- and XX-century secession and interesting performances, concerts and exhibitions – all of that cause tourists, who want cameral atmosphere and tranquillity, to seek in Olsztyn the possibility of the escape from the daily routine's noise. Strolling through the streets of the Old City they may admire the rests of city walls, castle's massive construction or overlooking the buildings cathedral's copula. Facing the original astronomical plaque (totally unique hand-made by Nicolaus Copernicus!) they have a chance to feel the blow of the history and later discover its present "face" at Olsztyn's planetarium.

Nicolaus Copernicus is the most famous person in the history of Olsztyn, where he managed goods and defended the city from Teutonic forces. Here he carried out his great researches and wrote magnificent works. Today four Olsztyn's colleges maintain this science tradition. Over 45 thousands people study in the largest of them – University of Warmia and Mazury.

Olsztyn is worth visiting – genuinely "Naturally Garden!".

VENUE and REGISTRATION

Venue and registration will be held at building of FACULTY OF MATHEMATICS AND COMPUTER SCIENCES (RCI), University of Warmia and Mazury in Olsztyn, Słoneczna 54



ICE BREAKER RECEPTION and WORKSHOP DINNER

Ice Breaker Reception: Monday 24 June 2013, Meet at 7:00 pm at Hotel Park

Workshop Dinner: Wednesday 26 June 2013, Meet at 7:00 pm at Hotel Park


WORKSHOP EVENTS

Olsztyn sightseeing on Wednesday, 2:30 pm. More information about these tours will be provided during the workshop. Registration for those interested in these events will be at the registration desk on Monday, 24 June.

In Olsztyn we recommend (see on appendix Olsztyn plan):

Malta Café

Olsztyn, Lelewela 6A St.

Przystań

Olsztyn, Żeglarska 2 St.

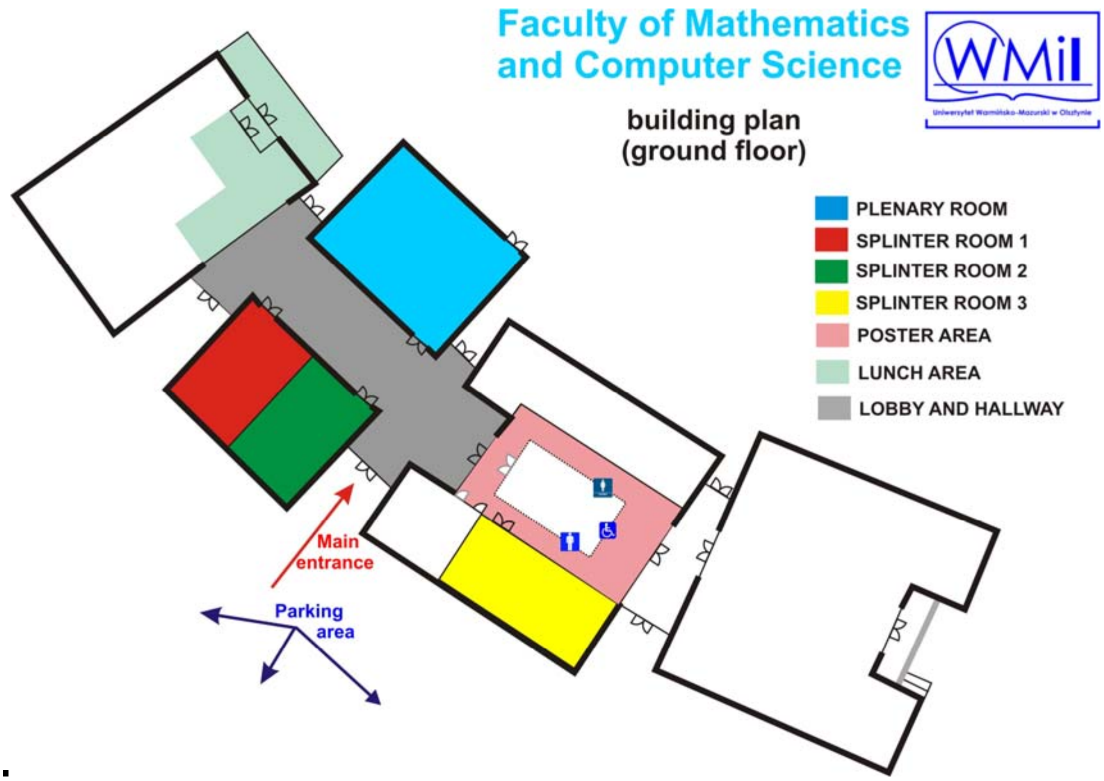
Karczma Jana

Olsztyn, Kołłątaja 11 St.

Highlander

Olsztyn, Stare Miasto 29/32

Plan of the FACULTY OF MATHEMATICS AND COMPUTER SCIENCES (RCI) building



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WIRELESS for VISITORS

Network: Goście/Guests

User name: iri2013@guests.uwm.edu.pl

Password: iri2013

Local Organizing Committee

Organizing Commitee Chair

Prof. Andrzej Krankowski

Organizing Commitee Members

Dr. Irina Zakharenkova

Dr. Iurii Cherniak

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INTERNATIONAL REFERENCE IONOSPHERE (IRI) 2013 WORKSHOP PROGRAMME

Monday
24 June 2013

8:00 - 9:00 **Registration**
9:00-10:00 **Opening Ceremony**

10:00-10:30 Coffee break

10:30-11:00 **International Reference Ionosphere - status report 2013**
Dieter Bilitza and Lee-Anne McKinnell

Session 1. Improvement of IRI with GNSS data
Chairperson: Lee-Anne McKinnell

11:00-11:20 **IGS/GNSS monitoring of the ionosphere for improving IRI Model**
Andrzej Krankowski, Rafal Sieradzki, Iurii Cherniak, Irina Zakharenkova

11:20-11:40 **Variability of Total Electron Content over Nigeria: A comparison with IRI2012 model**
Oyeyemi, E.O., Rabiu, A.B., Adewale, A.O., Akala, A.O.

11:40-12:00 **Variability of Total Electron Content over Malaysian Sector: Comparison between observation and IRI model**
Nyanasegari Bhoo Pathy, Mustafa Din Subari, Noordin Ahmad, Tajul Ariffin Musa, and Shien Kwun Leong

12:00-12:20 **GPS ionospheric mapping and tomography: A case of study to routinely determine ionospheric average electron density profiles**
Patrick Sibanda, Mark B. Moldwin, Endawoke Yizengaw and L. A. McKinnell

12:20-2:00 Lunch

2:00-2:20 **Prediction of foF2 from GPS TEC over Africa**
Nicholas Ssessanga, Lee-Anne McKinnell

2:20-2:40	**Comparative study of ionosphere/plasmasphere electron content variability** Irina Zakharenkova, Iurii Cherniak, Tamara Gulyaeva, Andrzej Krankowski, and Irk Shagimuratov
2:40-3:00	**Variation of GPS-TEC in Hainan and comparisons with IRI TEC** XiaoWang, JiankuiShi, and Guojun Wang
3:00-3:20	**Ionospheric longitudinal variations at midlatitudes and IRI** Shunrong Zhang, Anthea Coster, and Ziwei Chen
3:20 - 3:50	Coffee break

Session 3. Real-Time IRI and the Representation of Storm effects
Chairperson: Bodo Reinisch

3:50-4:10	**Evaluating Electron Density Peak Height Analytical Model (OE_hmF2) for Real-time IRI** D. Altadill., E. Blanch, M. Mosert, D. Buresova, T. L. Gulyaeva, E. Gularte, R. G. Ezquer, A. M. Gulisano
4:10-4:30	**Global Characteristics of Ionosphere-Plasmasphere Storms** T.L. Gulyaeva, F. Arikan, I. Stanislawska and L.V. Poustovalova
4:30-4:50	**Ionospheric E-region and its electrodynamics during geomagnetic storm on May 1–3, 2010** Bessarab F.S., Korenkov Y.N., Klimenko V.V., Klimenko M.V., Vorobjov V.G., Yagodkina O.I., Zhang Y., Paxton L.J.
7:00	Welcome reception

Tuesday
25 June 2013

Session 3. Part 2.
Chairperson: Bodo Reinisch

9:00-9:20 **Under the Hood of Real-Time Assimilative IRI: Nonlinear Error Compensation Technique**
Ivan Galkin, Bodo Reinisch, Xueqin Huang, Artem Vesnin, Sergey Fridman, Dieter Bilitza, Carlo Scotto, Michael Pezzopane, Bruno Zolesi, and Silvio Bianchi

9:20-9:40 **Timeline of January 2013 Sudden Stratospheric Warming Event as seen in Real-Time Assimilative IRI and GPS Data**
Larisa Goncharenko, Ivan Galkin, Artem Vesnin, and Bodo Reinisch

9:40-10:00 **Ionospheric response to magnetic disturbances under low solar activity conditions and STORM model corrections for the disturbed periods**
D. Buresova, M. Mosert, E. Gularte, and L.-A. McKinnell

Session 2. GNSS monitoring of ionosphere (TEC, Fluctuation and scintillation effects)
Chairperson: Shigeto Watanabe

10:00-10:20 **GPS phase difference variations and phase scintillation index: A comparison**
Reza Ghoddousi-Fard, Paul Prikryl, and François Lahaye

10:20-10:50 Coffee break

10:50-11:10 **Spread-F signature and GPS scintillation occurrences under the southern crest of the ionospheric anomaly**
L. Alfonsi, L. Spogli, M. Pezzopane, V. Romano, E. Zuccheretti, G. De Franceschi, M. A. Cabrera and R. G. Ezquer

11:10-11:30 **Ionospheric perturbations analysis in the South East Asia Region**
A. García-Rigo, J.M. Juan, J. Sanz, and M. Hernández-Pajares

11:30-11:50 **Outline on gAGE/UPC on-going activities in GNSS monitoring of ionosphere**
A. García-Rigo, M. Hernández-Pajares, J.M. Juan, and J. Sanz

11:50-12:10 **Comparison of ionospheric parameters derived from GNSS Radio Occultation and ionosonde data over equatorial and mid-latitude regions**
John Bosco Habarulema, Lee-Anne McKinnell, and Endawoke Yizengaw

12:10-12:30 **Carrier-phase accurate TEC maps from multi-GNSS data**
Sören Klose, Markus Bradke, Markus Ramatschi

12:30-2:00 Lunch

Chairperson: Vladimir Truhlik

2:00-2:20 **Ionospheric Observations by NICT**
Mamoru Ishii, Takuya Tsugawa, Hisao Kato, Tsutomu Nagatsuma, and Takashi Maruyama

2:20-2:40 **Dense Regional And Worldwide INternational GNSS-TEC observation (DRAWING-TEC) project**
Takuya Tsugawa, Michi Nishioka, Susumu Saito, Akinori Saito, Yuichi Otsuka, and Mamoru Ishii

2:40-3:00 **Longitudinal variations of mid-latitude trough structures**
B. Matyjasiak, D. Przepiórka, H. Rothkaehl, A. Krankowski, J.-Y. Liu

3:00-3:20 **The properties of the midlatitude trough region during increase of geomagnetic activities**
D. Przepiórka, B. Matyjasiak, H. Rothkaehl, A. Krankowski, J.-Y. Liu, B. Atamaniuk, R. Sieradzki

3:20 - 3:50 Coffee break

3:50 - 5:50 **POSTERS SESSION**
Chairperson: Vladimir Truhlik

Wednesday
26 June 2013

Chairperson: Ivan Galkin

9:00-9:20 **Ionospheric delay gradient monitoring for aeronautical applications in Thailand**
Sarawoot Rungraengwajiake, Pornchai Supnithi, Susumu Saito, Nattapong Siansawasdi, Apithep Saekow

9:20-9:40 **A User Friendly Web-Service for GPS-TEC: IONOLAB-TEC**
Feza Arikan, Umut Sezen,Orhan Arikan, Orhan Uğurlu, and Amirmahdi Sadeghimorad

9:40-10:00 **Ionospheric plasma bubbles simultaneously observed by multi-instruments in Hainan region**
Guojun Wang, Jiankui Shi, Xiao Wang, Sheping Shang, Zhengwei Cheng

10:00-10:20 **Definite and indefinite components of the ionosphere GPS TEC variability monitored around the time of strong earthquakes**
Sergey Pulinets, Dmitry Davidenko

10:20-10:50 Coffee Break

10:50-11:10 **Ionosphere research with the use of LOFAR**
Leszek P. Błaszkiewicz

11:10-11:30 **Ionospheric Results of FORMOSAT-3**
Tiger J. Y. Liu, G. S. Chang, S. J. Yu, T.Y. Liu

Session 4. Modeling of the high-latitude ionosphere
Chairperson: Ivan Galkin

11:30-11:50 **A study of the ionospheric parameters in the polar cap and cusp over a solar cycle**
Lindis Merete Bjoland[1], Vasyl Belyey[1], Unni Pia Løvhaug[1] and Cesar La Hoz[1]

11:50-12:10 **Determining the equatorward and poleward boundaries of the auroral oval from CHAMP field-aligned currents signatures**
Chao Xiong, Hermann Lühr, Patricia Ritter

12:10 – 2:00 Lunch

2.30 – 5.30 Excursion to the Olsztyn Old city

7:00 Workshop Dinner

Thursday
27 June 2013

Session 7. New inputs for IRI
Chairperson: David Altadill

9:00-9:20 **Validating the Vary-Chap model of the topside ionosphere electron density profile**
Bodo Reinisch, Patrick Nsumei, Xueqin Huang, and Dieter Bilitza

9:20-9:40 **On improving the topside ionospheric modelling by selecting an optimal electron density profiler**
Tobias Verhulst and Stan Stankov

9:40-10:00 **GNSS derived TEC data ingestion into IRI 2012**
Migoya-Orué, Yenca, Nava, Bruno, Radicella, Sandro and Alazo-Cuartas, Katy

10:00-10:20 **Electron density and temperature observed by satellites and incoherent scatter radars**
Shigeto Watanabe, Yoshihiro Kakinami, Huixin Liu

10:20-10:50 Coffee Break

10:50-11:10 **Towards better description of solar activity variation in IRI topside ion composition model**
Vladimir Truhlik, Dieter Bilitza, and Ludmila Triskova

11:10-11:30 **Latitudinal and Altitudinal Changes of Day-to-Day Variability of Electron Densityin the Topside Ionosphere**
Dieter Bilitza, Boding Liu and Joseph E. Rodriguez

11:30-11:50 **An analysis of the variability of the critical frequency of the F2-region on quiet conditions**
M. Mosert, D. Bilitza, E. Gularte, D. Altadill , D. Buresova , K.Alazo , R.Ezquer, M.A.Cabrera, E. Zuccheretti, M. Pezoppane, A.M. Gulisano, P. Marcó, L-A. McKinnell

11:50-12:10 **Assessment of the monthly mean variability of the F2 peak parameters based on COSMIC / FORMOSAT-3 radio occultation profiles**
Claudio Brunini, Francisco Azpilicueta, Dieter Bilitza, Diego Janches

12:10-12:30 **The use of simulated ionograms and the identification of long term variations in the ionosphere**
Carlo Scotto

12:30 – 2:00 Lunch

Session 5. Mapping of ionospheric peak parameters
Chairperson: Dalia Buresova

2:00-2:20 **Online Regional foF2 and hmF2 Maps from IRI-Plas: IONOLAB-MAP**
Umut Sezen, Onur Cilibas, Feza Arikan, and Tamara L. Gulyaeva

2:20-2:40 **A comparison of the LPIM-COSMIC F2 peak parameters determinations against the IRI(CCIR) and EBRO predictions**
F. Azpilicueta, D. Altadill, C. Brunini, J.M. Torta and E. Blanch

2:40-3:00 **Global model SMF2 of the F2 layer peak height based on the satellite data**
Karpachev A.T., Shubin V.N., Tsybulya K.G.

3:00-3:20 **The Variation of Critical Frequency of E layer over the Magnetic Equatorial Region, Chumphon, Thailand**
Poramintra Wongcharoen, Prasert Kenpankho, Kasemsuk Sepsirisuk, Pornchai Supnithi, Suthichai Noppanakeepong, Somkiat Lerkvaranyu, Takuya Tsugawa, Tsutomu Nagatsuma

3:20-3:50 Coffee break

3:50-4:10 **Regional modeling of ionospheric peak parameters using B-spline expansions**
Michael Schmidt, Denise Dettmering, Wenjing Liang, and Denise Schmidt

4:10-4:30 **Morphology and dynamics of the Weddell Sea and Yakutsk anomalies from the satellite data**
Karpachev A.T., Klimenko M.V., Klimenko V.V., and Ratovsky K.G.

4:30-4:50 **Formation of Weddell Sea and Yakutsk anomalies in foF2 diurnal variations and there manifestation in the topside ionosphere**
Klimenko V.V., Klimenko M.V., Karpachev A.T., Ratovsky K.G., Zakharenkova I.E., Cherniak Iu.V., and Stepanov A.E.

4:50-5:10 **Comparative analysis of two new empirical models IRI-Plas and NGM (the Neustrelitz Global Model)**
Maltseva O.A., Mozhaeva N.S., and Nikitenko T.V.

Friday
28 June 2013

Session 6. The ionosphere and IRI during the recent solar cycle
Chairperson: Hanna Rothkaehl

9:00-9:20 **The O^+/H^+ transition height, global protonospheric/plasmaspheric electron content at recent solar cycles during quiet and stormtime periods**
Klimenko M.V., Klimenko V.V., Cherniak Iu.V., Zakharenkova I.E., and Ratovsky K.G.

9:20-9:40 **Ionospheric storms on the background of low and medium solar activity**
Iurii Cherniak, Irina Zakharenkova, Andrzej Krankowski, and Irk Shagimuratov

9:40-10:00 **Improving the representation of solar forcing in IRI**
Dieter Bilitza and Steven Brown

10:00-10:20 **Diurnal, seasonal and solar activity pattern of ionosphere disturbances from Irkutsk Digisonde data**
Konstantin Ratovsky, Andrey Medvedev, and Maxim Tolstikov

10:20 - 10:50 Coffee break

10:50-11:10 **Statistical analysis of wave activity in ionosphere from 2003-2012 Digisonde observations**
Konstantin Ratovsky, Maxim Tolstikov, and Andrey Medvedev

11:10-11:30 **The Occurrence of Equatorial Spread-F at the Conjugate Stations in Southeast Asia**
Somjai Klin-ngam, Pornchai Supnithi, Sunti Tuntrakoo, Takuya Tsugawa, Takashi Maruyama and Tsutomu Nagatsuma

Session 8. IRI applications

Chairperson: Sergey Pulinets

11:30-11:50 **Online Slant TEC Computation from IRI-Plas: IRI-Plas-STEC**
Orhan Arikan, Hakan Tuna, Feza Arikan, Tamara L. Gulyaeva, and Umut Sezen

11:50-12:10 **Testing the IONORT-ISP system: comparison between synthesized and measured oblique ionograms**
Alessandro Settimi, Michael Pezzopane, Marco Pietrella, Cesidio Bianchi, Carlo Scotto, Enrico Zuccheretti, and John P. Maktris

12:10-12:30 **Comparing IRI-2012 and higher order functions of Regional Empirical Ionospheric model with foF2 measured in Pakistan**
Ghulam Murtaza, Madeeha Ashfaque, Ayyaz Ameen

12:30-2:00 Lunch

2:00-4:00 **FINAL DISCUSSIONS**

Posters Session

Authors are requested to display posters by 9:00 am on Monday, June 24, and remove by 12:00 pm on Friday June 28. All posters should be on display for entire workshop. Authors requested to be available at their posters during the assigned session.

P1) GNSS scintillation and TEC gradient over Brazil
Claudio Cesaroni, Luigi Ciraolo, Carlo Scotto, Giorgiana De Franceschi, Lucilla Alfonsi, Luca Spogli, Joao Francisco Galera Monico, Marcio Aquino, Bruno Bougard

P2) IRI-TEC versus GPS-TEC for Nigerian SCINDA GPS Stations
Daniel Okoh, Lee-Anne McKinnell, Pierre Cilliers, Bonaventure Okere, Chinelo Okonkwo

P3) Ionosphere anomalies during the SURA – ISS experiments program
Ruzhin Yu.Ya., Smirnov V.M., and Depuev V.H.

P4) Comparison of TEC value from GNSS permanent station and IRI model
Oksana Grynyshyna-Poliuga, Mariusz Pozoga, Lukasz Tomasik

P5) The high-latitude TEC variations during September 2011 geomagnetic events observed by GPS
Irk Shagimuratov, Andrzej Krankowski, Galina Yakimova, Iurii Cherniak and Nadezhda Tepenitsyna

P6) Procedure transformation the parameters of the ionosphere with GNSS -observations
Stepan Savchuk, Liubov Yankiv-Vitkovska, Volodymyr Pauchok

P7) Determination of the parameters of the ionosphere on the SULP-station
Liubov Yankiv-Vitkovska

P8) Comparison of GPS based TEC measurements with the IRI-2007 Models for the period of low to high solar activity (2009-2012) at Surat located in the northern crest of equatorial anomaly in Indian region
Sheetal P Karia, Nilesh C Patel, and Kamlesh N Pathak

P9) Global ionospheric response to the geomagnetic storm on September 26-29, 2011 and its influence on HF radio wave propagation
Kotova D.S., Klimenko M.V., Klimenko V.V., Zakharov V.E., Bessarab F.S., Nosikov I.A., and Ratovsky K.G.

P10) The model study of the mesospheric tides influence on the spectral characteristics of tides and planetary waves in the thermosphere-ionosphere system
Karpov I.V., Bessarab F.S, Korenkov Yu.N., Klimenko V.V, and Klimenko M.V.

P11) Some frequency parameters of Es layers at Kaliningrad station in summer and winter period of 2008 – 2010 and its connection with SSW events
Korenkova N.A., Leschenko V.S., Cherniak Iu.V., Korenkov Y.N.

P12) Global ionospheric response to SSW events during recent extended solar minima conditions
Klimenko M.V., Korenkov Yu.N., Bessarab F.S., Klimenko V.V., Karpov I.V., Ratovsky K.G., Korenkova N.A., Zakharenkova I.E., and Shcherbakov A.A.

P13) A comparison of the ionosphere F2-layer electron peak density and total electron content variations calculated by the theoretical UAM and empirical IRI models and GPS TEC observations
M.G. Botova, A.A. Namgaladze, B.E. Prokhorov

P14) The GRL/UWM service of the TEC fluctuations monitoring
Sieradzki R., Cherniak Iu., Krankowski A.

P15) Analyses of vertical TEC values obtained from EGNOS messages and real values from GNSS receivers
Lukasz Tomasik, Anna Swiatek, Leszek Jaworski

P16) Scintillation monitoring using 1-second TEC measurement
Mariusz Pozoga, Maricin Grzesiak

P17) Joint use of the IRI model and satellite data to estimate the total electron density
Maltseva O.A., Mozhaeva N.S., and Zbankov G.A.

P18) IRI-2011 ray paths simulation for mid-latitude SuperDARN station in Poland
Grzegorz Góral, Piotr Koperski, Marek Kubicki and Anna Odzimek

P19) Comparison of electron density profiles: modeled and real using, raw ionograms from Hornsund and Warsaw VISRC2 ionosondes
Lukasz Tomasik, Michal Szwabowski, Mariusz Pozoga and Andrzej Rokicki

P20) Response of equatorial ionosphere to geomagnetic storms: The Betatron induced changes during ionospheric storms
Joseph Lemaire

IRI Workshop 2013

Presentation Abstracts

Intro

International Reference Ionosphere - status report 2013

Dieter Bilitza[1,2] ***and Lee-Anne McKinnell***[3]

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[2]Heliophysics Science Division, Code 672, NASA, GSFC, Greenbelt, Maryland, USA (dieter.bilitza-1@nasa.gov)

[3]South African National Space Agency (SANSA) Space Science, PO Box 32, Hermanus, 7200, South Africa (lmckinnell@sansa.org.za)

Abstract

This presentation will review the status of the International Reference Ionosphere project and model with special emphasis on activities during the last two years. We will discuss the most important IRI improvements and parameter additions that were accomplished during this time period. An example is the accurate representation of ionosphere conditions during the recent highly unusually low and extended solar minimum. In addition we will also review the status of several ongoing collaborative projects that promise significant future improvements for the IRI model including the coupling of IRI to plasmaspheric models, and the development of IRI Real-Time. IRI-related meetings and workshops during this 2-year time period will be discussed and results will be summarized including the latest information about publication of the papers from these meetings. A few recent applications of the IRI model will be highlighted and we will also report usage statistics. The talk is intended as an introduction for the IRI 2013 Workshop.

Session 1

IGS/GNSS monitoring of the ionosphere for improving IRI Model

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Abstract

The International GNSS Service (IGS) Ionosphere Working Group routinely provides the users global ionosphere maps (GIMs) of vertical total electron content (vTEC). The IGS GIMs are provided with spatial resolution of 5.0 degrees x 2.5 degrees in longitude and latitude, respectively. The current temporal resolution is 2 hours, however, 1-hour maps are delivered as a pilot project. There are three types IGS GIMs: the final, rapid and predicted. The latencies of the IGS ionospheric final and rapid products are 10 days and 1 day, respectively. The predicted GIMs are generated for 1 and 2 days in advance. There are four IGS Associate Analysis Centres (IAACs) that provide ionosphere maps computed with independent methodologies using GNSS data. These maps are uploaded to the IGS Ionosphere Combination and Validation Center at the GRL/UWM (Geodynamics Research Laboratory of the University of Warmia and Mazury in Olsztyn, Poland) that produces the IGS official ionospheric products, which are published online via ftp and www.

On the other hand, the increasing number of permanently tracking GNSS stations near the North Geomagnetic Pole allow for using satellite observations to detect the ionospheric disturbances at high latitudes with even higher spatial resolution. In the space weather service developed at GRL/UWM, the data from the Arctic stations belonging to IGS/EPN/POLENET networks were used to study TEC fluctuations and scintillations. Since the beginning of 2013, a near real-time service presenting the conditions in the ionosphere has been operational at GRL/UWM www site. The rate of TEC index (ROTI) expressed in TECU/min is used as a measure of TEC fluctuations. For each day the daily map of the ionospheric fluctuations as a function geomagnetic local time is created.

This presentation shows the architecture, algorithms, performance and future developments of the IGS GIMs and this new space weather service at GRL/UWM. There are also comparisons between GNSS TEC and IRI model presented for the period of 1998-2012. The analyses of the results show that GNSS-derived monthly TEC medians and ROTI maps may be used by IRI community in order to update the IRI model, in particular at high latitudes.

Session 1

Variability of Total Electron Content over Nigeria: A comparison with IRI2012 model

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Abstract

Variability of vertical total electron content (VTEC) over four GPS stations in Nigeria during low solar activity period is presented in this paper. Aanalysis of diurnal and seasonal variations (during day and night), and relative deviations between the experimental VTEC values and those obtained by the IRI2012 model has been carried out. The results obtained show that there is pre-sunrise deviation between IRI2012 model predictions and GPS VTEC values. This deviation could arise because either the peak electron density of the F2 region (NmF2) or the shape of the electron density profile, or both, is not well modelled.

Session 1

Variability of Total Electron Content over Malaysian Sector: Comparison between observation and IRI model

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Abstract

The International Reference Ionosphere (IRI) model has been recognized as the international standard for specifying Earth's ionospheric parameters. However, the performance of the model needs careful validation due to very few observational data contributed from South-East Asia for model development. This work presents the performance evaluation of IRI-2007 and IRI-2012 in estimating ionospheric Total Electron Content (TEC) over Malaysian sector. For this purpose, TEC values during the initial phase of Solar Cycle 24 from dual-frequency GPS data in this sector have been compared with TEC estimated from IRI-2007 and IRI-2012 models using the IRI01-corr option for the topside electron density. For the bottomside thickness, the B0 table and newly introduced ABT-2009 option is selected for IRI-2007 and IRI-2012, respectively. The results show that equatorial TEC over Malaysia exhibits semi-annual, annual, and seasonal variations with maximum values appearing during equinoctial months and minimum during solstitial months. Ionospheric TEC produced by both IRI models are in good agreement with observed TEC. The highest correlation is noticed during solstitial months with correlation coefficient equals to 0.986 and 0.990 for IRI-2007 and IRI-2012, respectively. Strong correlation is also observed during post-sunset and post-midnight periods. The lowest correlation is recorded during equinoctial months with correlation coefficient equals to 0.956 and 0.961 for IRI-2007 and IRI-2012, respectively. Strong disagreements are found during maximum and minimum ionization hours. In addition, TEC calculations from IRI-2012 are better than IRI-2007 for diurnal variation. On the contrary, IRI-2007 is more sensitive in presenting daily variation of TEC. This work reveals that IRI models are capable of predicting TEC over Malaysia sector with good correlation in most cases.

Session 1

GPS ionospheric mapping and tomography: A case of study to routinely determine ionospheric average electron density profiles

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Abstract

Knowledge of the ionospheric electron density distribution and its fluctuations are essential for models such as the international reference ionosphere (IRI) predicting ionospheric characteristics for radio wave propagation and for other applications such as satellite tracking and navigation, etc. Global Navigation Satellites System (GNSS) observations provide a key data set that can be used to improve ionospheric models including the IRI model. Using the data from the recently installed Africa Array Global Positioning System (GPS) stations in the Central-Southern Africa region, we calculate three-hour average N_e profiles over this wide region using ionospheric tomography. The advantage of tomographic ionospheric N_e profiles is that they provide information of the N_e distribution up to global positioning system (GPS) orbiting altitude (with the coordination of space-based GPS tomographic profiles), and can be incorporated into the next generation of the IRI model. Since it uses real measurement data, tomographic average N_e profiles describe the ionosphere during quiet and disturbed periods. The computed average Ne profiles are compared with IRI model profiles. The study provides key information on the ionospheric electron density distribution and its fluctuations and how it compares with the IRI model in this region. This knowledge is essential in the adaptation of the IRI to enable data ingestion and assimilation necessary for transforming it into a real-time or near-real time ionospheric ionization electron density characterization model.

Session 1

Prediction of foF2 from GPS TEC over Africa

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Abstract

The International Reference Ionospheric (IRI) model has been one of the most consistent in predicting ionospheric parameters over most of the geographical locations around the world. However, the model fails to predict accurately in regions where data was not available during its development, hence the use of data from Global Positioning System (GPS) receivers and other models. This paper describes a method (TEC2F2) of extracting foF2 values from GPS Total Electron Content (TEC). The method was first developed over the region of South Africa using the available Ionosondes stations; Grahamstown (33 .2^0 S, 26.3^0 E), Hermanus (34.4^0 S, 19.2^0 E), Louisvale (28.5^0 S, 21.2^0 E) and Madimbo (-30.9^0 S, 22.2^0 E), to verify the results. The analysis of the results showed that the TEC2F2 method was more accurate at predicting the foF2 parameter over South Africa than the IRI-2007 model. The application of this method over the rest of Africa is proposed in order to more accurately predict the foF2 parameter in regions where Ionosondes do not exist.

References

D. Bilitza K. Rawer and S. Ramakrishnan. Goals and status of the international reference ionosphere. Rev. Geophys., 16:177–181, 1978

D.Bilitza and B.W. Reinisch. International Reference Ionosphere 2007: Improvements and new parameters, Adv. Space. Res., 42, 599-609, 2008

J. O. Adeniyi and I. A. Adimula, “Comparing the F2-layer model of IRI with observations at Ibadan,” Advances in Space Research, vol. 15, no. 2, pp. 141–144, 1995.

Liu, J. Y., H. F. Tsai, and T. K. Jung. Total electron content obtained by using the global positioning system. Terr. Atmos. Oceanic Sci., 7, 107-1 17, 1996

Comparative study of ionosphere/plasmasphere electron content variability

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Abstract

Lee et al. (2013) compared global plasmaspheric total electron content with the ionospheric TEC simultaneously measured by Jason-1 satellite during the declining phase of solar cycle 23 (2002–2009) to investigate the global morphology of the plasmaspheric density in relation to the ionosphere.

In the given report we used the International Reference Ionosphere Extended to Plasmasphere (IRI-Plas) model (Gulyaeva et al., 2002) to obtain model-derived estimates of plasmaspheric and ionospheric TEC. IRI-Plas was developed within the framework of Project WD 16457 of International Standardization Organization, ISO. One of the main advantages of IRI-Plas that it has the plasmasphere extension and is able to provide electron density profiles and total electron content at altitudes of 80 to 35,000 km for any location of the Earth. To make comparison with Jason-1 data possible, some changes in the default parameters were done: the ionosphere was considered within altitudes' limits of 100-1,336 km, plasmasphere – from 1,336 km (Jason-1 orbit) up to 20,000 km (GPS orbit). IRI-Plas results were retrieved for different seasons and different solar activity conditions. Main peculiarities of the IRI-Plas-derived ionosphere/plasmasphere electron content variability for solar minimum and solar maximum conditions are discussed; obtained results were compared with Jason-1 observations.

References.

Lee H.-B., Jee G., Kim Y.H., Shim J.S.. Characteristics of global plasmaspheric TEC in comparison with the ionosphere simultaneously observed by Jason-1 satellite. *Journal of Geophysical Research*: *Space Physics*, V. 118, 1–12, doi:10.1002/jgra.50130, 2013.

Gulyaeva T.L., Huang X., Reinisch B.. Ionosphere-Plasmasphere Model Software for ISO. *Acta Geod. Geoph. Hung.*, 37 (2-3), 143-152, 2002.

Session 1

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

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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 2005-2012. 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; (5) the differences between ITEC and GPS-TEC decrease from 2005 to 2009; but the differences between IRI-TEC and ITEC/GPS-TEC increase from 2005 to 2009.

Session 1

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.

Session 1

GNSS derived TEC data ingestion into IRI 2012

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Abstract

Experimental vertical total electron content (VTEC) data given by IGS AC has been ingested into the IRI. Grids of effective input parameter values that allow minimizing the difference between the experimental and modeled vertical TEC have been defined.

Making use of the experience gained with this technique of model adaptation applied to NeQuick model, it has been found possible to compute the IRI world grids of effective ionization parameters (IG). A detailed description of the basic technique is given in Nava et al, 2005. The IG grids thus obtained can be interpolated in space and time to calculate the 3D electron density given by IRI at any location and therefore the TEC along any ground-to-satellite ray-path for a given epoch.

A comparison between experimental and model-retrieved foF2 values has been made. In particular, data from about 20 worldwide ionosondes for selected periods of high and moderate to low solar activity has been utilized and the performance differences will be discussed. The results show that the use of the ingestion scheme enhances the performance of the model if compared with its standard use based on solar activity drivers (R12 and F10.7), especially for high solar activity. As an example, the mean and standard deviation of the differences between experimental and reconstructed F2-peak values for one day of year 2000 give 0.05MHz and 1.25MHz for ingested IRI, to be compared to -1.05MHz and 1.07MHz (IRI with R12) and -1.07MHz and 1.07MHz (IRI with F10.7).

References.

Nava, B., P. Coïsson, G. Miró Amarante, F. Azpilicueta, and S. M. Radicella (2005), A model assisted ionospheric electron density reconstruction method based on vertical TEC data ingestion, Ann. Geophys.48(2),313–320.

Session 1

IRI-TEC versus GPS-TEC for Nigerian SCINDA GPS Stations

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Abstract

Following the recent proliferation of dual-frequency GPS receiver systems across the African continent, there is a growing number of papers that compare Total Electron Content (TEC) values derived from the International Reference Ionosphere (IRI) model with those obtained from the GPS receiver measurements. In Nigeria, there are currently 5 SCINDA (Scintillation Network Decision Aid) GPS stations located at Nsukka (6.87°N, 7.38°E), Ilorin (8.50°N, 4.55°E), Akure (7.25°N, 5.20°E), Lagos (6.45°N, 3.38°E), and Ile-Ife (7.47°N, 4.57°E). GPS-TEC data are available from the first 4 stations, but not from the last station. In this work we report an investigation of IRI-TEC versus GPS-TEC comparisons for these stations, and further review differences and similarities observed between them. Since a major interest in our work is to use the GPS measurements to improve the predictions of the IRI model for the region, we present a detailed regression analysis of differences between the two sources in a manner that will benefit this application. Diurnal data from most of the stations reveal the IRI model does worst during the periods 04:00 UT to 08:00 UT (corresponding to when the TEC gradients are highest), and that the NeQuick topside option of the IRI generally performed better for the region than the IRI2001 or the IRI01-cor options.

Session 2

GPS phase difference variations and phase scintillation index: A comparison

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Abstract

GPS phase difference variations computed from stations tracking at 1Hz are employed to derive proxy phase scintillation indices. Rate of change of GPS phase differences at two frequencies over 1 sec are used over 30-60 sec to retrieve the proxy indices.

In this presentation proxy indices retrieved from geodetic receivers and phase scintillation index (σ_φ) from collocated scintillation receivers tracking at 50Hz are compared. This includes moderately disturbed ionospheric conditions when near-Earth interplanetary coronal mass ejections affected the ionosphere. Synoptic and localized comparisons are carried out to study ionospheric events.

Possibility of detecting regions subjected to ionospheric phase scintillations using the proxy indices is discussed. This has been motivated by promising global coverage in geomagnetic latitude and time over 24 hours using current global International GNSS Service (IGS) network that includes 1Hz stations, producing a data source for near-real-time spatiotemporal monitoring of ionospheric GPS phase disturbances. These ionospheric disturbances' indices are now being continuously monitored at the Geodetic Survey Division of Natural Resources Canada using Real-Time IGS network.

Session 2

Spread-F signature and GPS scintillation occurrences under the southern crest of the ionospheric anomaly

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Abstract

Data recorded from October 2010 to September 2011, a period of increasing low-medium solar activity, from an AIS-INGV (Advanced Ionospheric Sounder-Istituto Nazionale di Geofisica e Vulcanologia) ionosonde and a GISTM (GPS Ionospheric Scintillation and TEC Monitor) scintillation receiver, both located at the low-latitude station of Tucumán (26.9°S, 294.6°E, mag. Lat. 15.5°S), Argentina, under the southern crest of the ionospheric anomaly, were analyzed to perform a spread-F and GPS scintillation statistics of occurrence. Spread-F signatures recorded by the ionosonde were classified into four types: strong range spread F (SSF), range spread-F (RSF), frequency spread-F (FSF) and mixed spread-F (MSF). Concerning the GPS observations, the σ_Φ index, marker of the phase scintillations, the S_4 index, marker of the amplitude scintillations, and the rate of TEC (ROT) parameter, marker of the TEC gradients causing scintillations, were considered. The analysis shows that the occurrence of all four types of spread-F are higher in summer and lower in winter, while the occurrence of scintillations presents a peak at equinoxes in the postsunset sector and a minimum in winter. The correspondence between SSF and scintillations seems to be systematic, and a possible correlation between S_4 and FSF peaks is envisaged at the terminator. Besides the long-term analysis, the investigation focused also on two particular periods, from 12 to 16 March 2011, and from 23 to 25 September 2011, both of them characterized by a moderate geomagnetic activity: the simultaneous presence of SSF signatures and scintillation phenomena allows to discuss the role of Travelling Ionospheric Disturbances as a strong candidate causing ionospheric irregularities.

Session 2

Ionospheric perturbations analysis in the South East Asia Region

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Abstract

In nominal conditions, ionospheric models are able to predict the ionospheric delays affecting GNSS signals with a certain degree of accuracy but, sometimes, the estimated values are clearly degraded. The degradation is especially critical when large gradients of Electron Content (EC) are present due to ionospheric perturbations affecting in a local or global context. The capabilities to detect and mitigate those perturbations are of great interest since they can produce a significant impact on GNSS navigation performance.

Some of the main ionospheric high frequency perturbations are Traveling Ionospheric Disturbances (TIDs), solar flares related overionization and scintillations. The first two of them can be detected by using simple methods working at 30 seconds sampling rate. In this work, and in order to detect the above mentioned ionospheric high frequency perturbations, the Single Receiver TID Index (SRTI) will be used. As it was shown in the past, SRTI ionospheric activity index is linked to the performance of precise navigation techniques such as Real Time Kinematics (RTK), Network RTK (like Virtual Reference Station, VRS), or Wide Area RTK (WARTK).

By using the SRTI index, in this presentation, the ionospheric perturbations will be analysed and characterised in both temporal and spatial domains for GPS data gathered in the South East Asian (SEA) Region along a whole solar cycle. The obtained results at such low latitudes will also be compared to those obtained in the past for mid-latitudes at Europe.

The results show that the ionospheric perturbations at low latitudes, like in the case of the SEA Region receivers, will mainly occur near the equinoxes and at night, after the Solar Terminator. No significant ionospheric perturbations are found outside these periods for the low latitude receivers in consideration. In addition, the ionospheric perturbations are clearly dependent on the solar cycle activity. Maximum solar activity conditions lead to an increase of the ionospheric perturbations and vice versa for minimum solar activity conditions.

Finally, a comparison of the results obtained using SRTI and the new ionospheric activity index AATR (for Along Arc vertical TEC Rate indicator) will be provided as well as an outline of the differences between both methods.

Session 2

Outline on gAGE/UPC on-going activities in GNSS monitoring of ionosphere

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Abstract

The group of Astronomy and GEomatics (gAGE) is currently working on two main fronts related to GNSS monitoring of the ionosphere:

On the one hand, gAGE is working on the characterisation of the ionosphere in real time. Firstly, this includes the generation of ionospheric global VTEC maps at different time resolutions. In the frame of the IGS Ionospheric Working Group, gAGE not only continues providing rapid, final and 2-days ahead predicted products but also real time global ionospheric maps (labelled URTG), global ionospheric maps at 15 minutes time resolution (UQRG) and at 1 hour time resolution (UHRG). Secondly, that also includes the detection of ionospheric local and global perturbations by applying multiple monitoring techniques. For instance, the Rate Of TEC Index (ROTI), the GNSS Solar Flare Activity Indicator (GSFLAI), the Sunlit Ionosphere Sudden TEC Enhancement Detector (SISTED), or the Single Receiver Medium Scale Travelling Ionospheric Disturbance index (SRMTID).

On the other hand, gAGE is also working on real time corrections for both precise navigation (Fast Precise Point Positioning; FPPP) and standard navigation. This includes the generation in real time of precise orbits and clocks, and also regional ionospheric models. The accuracy of these models is at the level of or better than 1 TECU. In this context, a new ionospheric activity index has been developed, called Along Arc vertical TEC Rate indicator (AATR). This index enables predicting the performance of the ionospheric models in an easy way.

Examples on the above mentioned scientific topics will be given in this presentation.

Session 2

Comparison of ionospheric parameters derived from GNSS Radio Occultation and ionosonde data over equatorial and mid-latitude regions

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Abstract

This paper will present comparative results obtained from GNSS Radio Occultation (RO) data and ionosonde data over equatorial and mid-latitude regions. Due to lack of enough ground-based observations over the African region, efforts are underway to utilize RO data in ionospheric modeling and it is therefore important to first establish its reliability levels with respect to ionosonde data. Comparative results for critical frequency of the F2 layer (foF2) and hmF2 from both datasets will be discussed in this presentation.

Session 2

Carrier-phase accurate TEC maps from multi-GNSS data

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Abstract

To compute carrier-phase accurate products from multi-GNSS observations (e.g. orbits, clocks, positions, water-vapor and TEC maps), in post-processed and real-time mode, it is necessary to solve the un-differenced observation equations precisely in terms of PPP (precise point positioning).

For that purpose, we are developing a new multi-GNSS data processing system, at the GFZ. The new system is using a SQL-database for the storage of the GNSS raw-data and the station/satellite meta-data. Currently, we have assimilated the site-log files of more than 1500 stations (IGS, EUREF, SAPOS, GFZ, etc.) into our “SeMISys” (Sensor Meta Information System) SQL database.

Observation data from the past can be transferred from RINEX-2.11/RINEX-3.01 files into the database, using a Perl-script. Real-time data from RTCM-3-MSM streams of the GFZ Ntrip-Caster is first converted to RINEX-3.01, using the open-source software “rtcm3torinex” (http://software.rtcm-ntrip.org), and then, using the same Perl-script, the data is streamed - in real-time - into the database.

This new data handling system has many advantages. First, it allows a consistent handling of all the new multi-GNSS observable types (about 230 different observables, ftp://ftp.unibe.ch/aiub/rinex/rinex301.pdf). Second, it unifies the data access on both sides of the database, the input data format for files and real-time streams is RINEX-3.01, and all parts of the processing software (e.g. EPOS-8, EPOS-RT) can use the common SQL-interface to access the data, regardless of the programming language, and regardless of post-processing or real-time applications. Furthermore, intermediate processing results (cleaned raw-data, flags, ambiguities, biases, residuals, orbits, clocks, positions, etc.) can be stored consistently in the database, and are available for next processing steps and further purposes (analysis, debugging, re-processing, comparison, documentation, product generation, etc.). With that, modularization and parallelization of the software is much easier possible. Nevertheless, the database also synchronizes the real-time data and stores time-stamps for the incoming data. With this, a replay of the real-time data flow can be achieved, necessary for debugging of the real-time processing software.

Using this new multi-GNSS data processing system, now all available observation data can be used e.g. for the estimation of carrier-phase accurate TEC maps. We will present first results, post-processed and also in real-time.

Session 2

Dense Regional And Worldwide INternational GNSS-TEC observation (DRAWING-TEC) project

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Abstract

Two-dimensional ionospheric total electron content (TEC) maps have been derived from ground-based GNSS receiver networks and applied to studies of various ionospheric disturbances since mid-1990s. For the purpose of monitoring and researching ionospheric disturbances which can degrade GNSS navigations and cause loss-of-lock on GNSS signals, National Institute of Information and Communications Technology (NICT), Japan has developed TEC maps over Japan using the dense GPS network, GEONET, which consists of more than 1,200 GPS receivers and is operated by Geospatial Information Authority of Japan (GSI). Currently, we are providing high-resolution two-dimensional maps of absolute TEC, detrended TEC with 60, 30, 15-minute window, rate of TEC change index (ROTI), and loss-of-lock on GPS signal over Japan in realtime basis. These data and quick-look maps are archived and available in the website of NICT (http://wdc.nict.go.jp/IONO/).

NICT has collected all the available GNSS receiver data in the world to expand the TEC observation area. Figure 1 shows the distribution of the GNSS stations (more than 6,000 stations as of 2012) whose data are collected by NICT. These GNSS data are provided by IGS, UNAVCO, SOPAC, and other regional data centers. Currently, however, dense GNSS receiver networks are available only limited areas such as Japan, North America, and Europe as shown in Figure 1. More GNSS receiver data are needed especially in the sparse regions (ex. Asia, Oceania, Africa, and South America) to study the overall spatial structure and temporal evolution of various ionospheric disturbances. The difficulty of collecting GNSS receiver network data in these regions attributes mainly to the two reasons: (1) a lack of information sharing of domestic GNSS receiver network in the international ionospheric researcher community and (2) a government and/or a data provider policy to provide the original GNSS data only for domestic researchers. In order to overcome this difficulty and to expand the high-resolution TEC observation area, NICT has recently started a project, Dense Regional And Worldwide INternational GNSS-TEC observation (DRAWING-TEC). This project mainly consists of the following three items:

1. Standardizing GNSS-TEC data for high-resolution TEC maps.
2. Developing a new high-resolution TEC mapping technique using the standardized TEC data.
3. Sharing the standardized TEC data and the data or the information of GNSS receiver network among the international ionosphere and GNSS researcher community.

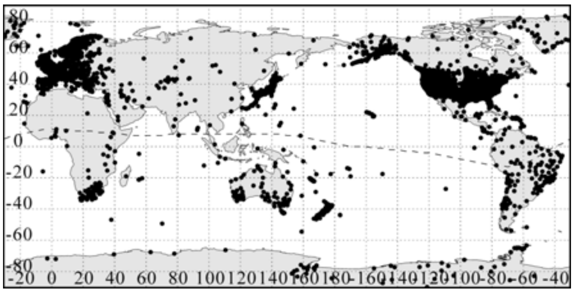

Figure 1. Global GNSS receiver networks collected by NICT (more than 6,000 receivers as of Jan. 2013).

Session 2

Longitudinal variations of mid-latitude trough structures

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Abstract

The mid-latitude electron density trough observed in the topside ionosphere has been shown to be the near-Earth signature of the magnetospheric plasmapause, and thus its behaviour can provide useful information about the magnetospheric dynamics, since its existence is dependent on magnetospherically induced motions. Mid-latitude trough is mainly the night-time phenomenon, which detailed characteristics and features depend on the solar cycle, season, time of the day and many others.

The trough is narrow in latitudes but extended in longitudes. The main ionospheric trough features is very dynamic structure. It is well-known fact that the trough structure moves to the lower altitudes both with increasing the level of geomagnetic activity as with increasing the time interval from the local magnetic midnight. However the longitude dependence of the main ionospheric structures has been detected still the source of this physical phenomena is not well understood.

Using the DEMETER in situ satellite measurements, GPS observations collected at IGS/EPN network, and the data retrieved from FORMOSAT-3/COSMIC radio occultation measurements the mid-latitude trough characteristics with regard to the geographic and magnetic longitude at fix local time has been presented.

Session 2

The properties of the midlatitude trough region during increase of geomagnetic activities

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Abstract

The increase of the Sun activities cause the enhancement of the solar wind pressure which result in the compression of the Earth's magnetosphere and forcing all the magnetospheric structures to move towards the Earth. The most of the energy injected to the ionosphere at the beginning of the storm is deposited at high latitudes. That triggers processes such as turbulence or wave-particle interactions, that can be observed in the region of the mid-latitude trough.

In this presentation, based on the selected number of geomagnetic storms, we analize the energy deposition in areas adjacent to the structure of the main ionospheric trough. The investigation confirmed the storm-phase dependence of the trough properties.

We have selected a number of geomagnetic storms that have occurred between years 2005 and 2010, it is when the DEMETER was operational. The special emphasizes has been placed on analysis of behavior main ionospheric trough region during different phase of solar cycle. We have tried to estimate how much time the system, by means of the plasma located in the trough region, needs to dissipate the energy deposited during the storm and return to its pre-storm state.

For our studies we have analyzed DEMETER mission measurements, in particular data taken from ISL, IAP and IDP experiments, GPS observations collected at IGS/EPN network employed to reconstruct diurnal variations of TEC using all satellite passes over individual GPS stations GPS observation carried out at the Antarctic and Arctic IGS (International GNSS Service) stations used to study TEC fluctuations in the high latitude ionosphere, and the data retrieved from FORMOSAT-3/COSMIC radio occultation measurements.

Session 2

Ionospheric delay gradient monitoring for aeronautical applications in Thailand

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Abstract

The Global Navigation Satellite System (GNSS), of which the Global Positioning System (GPS) is a prime example, has been widely utilized in many applications. One of challenging applications is the navigation for aviation, especially for the landing precision. It is well known that the ionospheric delay is the largest error sources for common GPS receivers. In order to mitigate the errors in the aviation purpose, the Satellite-Based Augmentation System (SBAS) and Ground-Based Augmentation System (GBAS) have been developed to provide the differential corrections and the integrity information to the receiver equipped on the aircraft. For GBAS, the reference stations at known locations installed on the runway area are used to calculate the differential corrections which are then broadcast to the aircrafts in the nearby area. However, the ionospheric irregularities can cause the error of differential corrections, which affect the integrity of the system. The previous studies demonstrate that the severe ionospheric disturbance, storm-enhance density (SED), observed in the mid-latitude regions during geomagnetic storms caused large ionospheric spatial gradients. In the equatorial and low-latitude regions, however, the equatorial ionospheric anomaly (EIA) and plasma bubble occurrence are common and potentially may cause the ionospheric delay gradient. Unfortunately, the delay gradient issues have not been well studied in this region. In this work, we compute the ionospheric delay gradient during the plasma bubble occurrence using GPS data obtained from monitoring stations near Suvarnabhumi international airport, Bangkok, Thailand. The dual-frequency GPS measurements at the 1-Hz sampling intervals are used for the TEC (Total Electron Content) estimation, which is a proportional to the ionospheric delay. Then, the ionospheric delay gradients can be estimated using a single difference of ionospheric delays. The results show that for September equinox 2011 the maximum ionospheric delay gradient can reach 192 mm/km during the plasma bubble occurrence.

Session 2

A User Friendly Web-Service for GPS-TEC: IONOLAB-TEC

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Abstract

Total Electron Content (TEC), which corresponds to total number of electrons on a ray path, is one of the most important parameters for observation and monitoring the variability of ionosphere. The world-wide dual-frequency ground based GPS receivers provide a cost-effective means for estimation and monitoring TEC. Although the general formulation of estimation of TEC from a single GPS receiver using the pseudorange and phase delay is seemingly simple, there are various aspects that complicate actual computation of TEC such as interfrequency receiver bias and satellite bias computation, choice of mapping function and peak height of ionosphere for ionospheric piercing point.

In this study, a robust, automatic, online computation routine for estimation of near-real time TEC from any desired IGS and/or EUREF station is introduced. This web service is available from www.ionolab.org. The user friendly interface enables the interactive choice a GPS station or multiple stations, and computation can be performed for a day or a number of days. The TEC estimates are computed as IONOLAB-TEC according to the scientific methods discussed in [1-4]. The IONOLAB-TEC computation includes the satellite bias values provided from IONEX files and receiver bias values are computed as IONOLAB-BIAS [5].

The online computation allows IONOLAB-TEC values to be compared with TEC estimates from IGS analysis centers, in the format that is available from JPL, ESA, IGS, UPC and CODE.

The output can be obtained either in graphical form that can be observed online or IONOLAB-TEC estimates can be provided in an excel file which will be written directly into a filename and directory that is specified by the user. Since its first introduction in 2009, the service is improved with cycle slip repairs, automatic receiver bias computation and use of rapid ephemeris data.

This study is supported by grants from TUBITAK 105E171, 109E055, 110E296 and 112E568.

References:

1. ARIKAN, F., Erol, C.B., Arıkan, O., Regularized estimation of vertical total electron content from Global Positioning System data, Journal of Geophysical Research, 108(A12), 1469-1480, (2003).
2. ARIKAN, F., Erol, C. B., Arıkan, O., Regularized estimation of vertical total electron content from GPS data for a desired time period, Radio Sci., 39, RS6012, (2004).

3. ARIKAN, F., Arıkan, O., Erol, C. B., Regularized estimation of TEC from GPS data for certain midlatitude stations and comparison with the IRI model, Adv. Space Res., (2007).
4. NAYİR, H., Arikan, F., Arikan, O., Erol, C. B., Total Electron Content Estimation with Reg-Est, J. Geophys. Res., 112, A11313, (2007).
5. ARIKAN, F., Nayir, H., Sezen, U., Arıkan, O., Estimation of Single Station Inter-frequency Receiver Bias Using GPS-TEC, Radio Science, 43, RS4004, (2008).

Session 2

Ionospheric plasma bubbles simultaneously observed by multi-instruments in Hainan region

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Abstract

Based on the data observed by DPS-4 ionosonde and GPS scintillation monitor at Hainan station (19.5° N, 109.1° E, Dip lat. 9° N), as well as ROCSAT-1 IPEI instrument, the ionospheric F layer irregularities (ionospheric plasma bubbles), which occurred in Hainan region on 23 April 2004, have been analyzed. The results showed that the Strong range Spread F (SSF) observed by ionosonde first occurred at 14:30 UT and lasted at 17:45 UT; the total duration of SSF was about 3.5 hours. The occurrence starting time of observed ionospheric scintillation was earlier than that of SSF, and the occurrence ending time of scintillation was later than that of SSF. During 16:33-16:34 UT, the satellite ROCSAT-1 passed over Hainan station and in site detected two bubbles (one big and another little), the east-west sizes of which were about 220 km and 35 km, respectively. By our analysis, the SSF and scintillation were produced by the bubbles detected by ROCSAT-1, which means we found the important evidence of bubbles simultaneously observed by ionosonde, GPS scintillation monitor, and satellite in Hainan region.

Session 2

Definite and indefinite components of the ionosphere GPS TEC variability monitored around the time of strong earthquakes

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Abstract

In early papers the ionospheric variability associated with seismic activity was considered as some chaotic positive and negative deviations from undisturbed level. But later the local timed dependence of the seismo-ionospheric variations was revealed. It is different for different areas of the globe, and strongly depends on the latitude. For low latitude earthquakes the magneto-conjugated effects are observed regularly. But for middle-latitude earthquakes the seismo-ionospheric anomaly looks like a spot of positive or negative deviation "hanged" over the earthquake preparation area and persisting from 4 till 12 hours.

It was determined recently that for the specific regions ionospheric effects have a feature of self-similarity. In the given region they appear at the same local time and have the same sign of deviation (positive or negative). It looks similar to development of magnetic storm effect (positive and negative phases of the storm). This similarity permitted to identify the pattern of seismo-ionospheric variation which we name "precursor mask". We demonstrated several masks for ionospheric precursors using the data of GPS TEC monitoring, especially in Europe. The feature of ionospheric variability we name as Definite component of the seismo-ionospheric variability

At the same time the physical nature of ionospheric anomalies emergence before earthquakes implies the existence of strong spatial variability of ionospheric parameters over the earthquake preparation zone. This effect we named the spatial scintillation variability and developed the special Spatial Scintillation Variability Index (SSVI) which we determine as the Indefinite component of the seismo-ionospheric variability.

Session 2

Ionosphere research with the use of LOFAR

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Abstract

The Low Frequency Array (LOFAR) is one of the most powerful radio astronomical tools. This fully digital scientific instrument consists of dozens of stations deployed across Europe (three stations will be located in Poland). Each station are two separate areas with groups of antennas (typically there are 96 individual antennas in each group) work in two frequency ranges. High frequency Band Antennas (HBA) are able to detect a signal in the range between 120 and 240 MHz. Low frequency Band Antennas (LBA) work in the range between 10 and 80 MHz.

However, the key research projects are related to the study of astrophysical objects, the range of operating frequency of the LOFAR telescope allows for strong interaction with the results of the ionospheres' investigations. LOFAR also gives the possibility to study subtle state of the ionosphere by analyzing the results of radio astronomical observations.

During my presentation I will show scientific and technical issues related to the LOFAR telescope, as well as the possibilities of using this tool to study the structure and dynamics of the Earth's ionosphere.

Session 2

Ionospheric Results of FORMOSAT-3

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Abstract

The FORMOSAT-3/COSMIC (F3/C) constellation lunched on 15 April 2007, which consists of six micro-satellites in the low-earth orbit, is capable of monitoring the ionosphere by using the powerful technique of radio occultation. With more than 1500 observations per day, it provides an excellent opportunity to monitor three-dimensional structures and dynamics in the electron density and scintillation of the ionosphere. Many prominent features of equatorial ionization anomaly, plasma cave, middle latitude trough, the Weddell Sea anomaly, sudden stratospheric warming, irregularity, etc. in the ionosphere are observed. The results can be cross-compared with those of the international reference ionosphere. Finally, simulation results of ionospheric observations by the F3/C follow-on, FORMOSAT-7, are presented.

Session 2

GNSS scintillation and TEC gradient over Brazil

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Abstract

Irregularly structured ionospheric regions can cause diffraction and scattering of trans-ionospheric radio signals that, in this case, can present random temporal fluctuations in both amplitude and phase, known as ionospheric scintillations. Ionospheric scintillations may cause problems such as signal power fading, phase cycle slips, receiver loss of lock, etc., and degrade the quality, availability and robustness of the GNSS's (Global Navigation Satellite Systems). As modern society is becoming more and more GNSS-reliant, ionospheric irregularities and scintillation are now considered one of the key issues among the space weather hazards. In this contest, CALIBRA project (Countering GNSS high Accuracy applications Limitations due to Ionospheric disturbances in BRAzil) aims to develop counter-measures to mitigate the effects of scintillation and TEC gradients on GNSS precise positioning in the frame of FP7 GALILEO funding.

This work focuses on the relationship between calibrated TEC gradients and S_4 scintillation index by investigating the ionosphere over Sao Paolo region (Brazil), using simultaneously multi-constellation receivers of the GEGE GNSS network and Septentrio PolaRxS multi-frequency receivers located in Presidente Prudente and São José dos Campos.

Being located nearly below the magnetic equator, ionosphere over Sao Paolo region is affected by severe scintillations, associated with the southern crest of the Equatorial Ionisation Anomaly (EIA) mainly due to the equatorial plasma bubbles formation occurring during the post sunset hours.

Calibration of GNSS TEC measurements is carried out in order to estimate and eliminate contributions of Differential Code Bias and multi-path delay. The complex algorithm applied to calibrate our TEC values was developed using the so-called leveling process (Ciraolo et al. 2007). Interpolating TEC values on a regular spaced grid we are able to estimate TEC spatial gradients. In this paper we present a comparison between TEC gradients and S_4 values under different scintillation conditions to investigate deeper the cause-effect mechanisms involved.

The preliminary results confirm the correspondence between severe TEC gradients and intense scintillations and provide new insights on the temporal and spatial behavior of the Brazilian ionosphere.

References.

L. Ciraolo, F. Azpilicueta, C. Brunini, A. Meza, S. M. Radicella, Calibration errors on experimental slant total electron content (TEC) determined with GPS. J Geodesy (2007) 81:111–120DOI 10.1007/s00190-006-0093-1

Session 2

Comparison of GPS based TEC measurements with the IRI-2007 Models for the period of low to high solar activity (2009-2012) at Surat located in the northern crest of equatorial anomaly in Indian region

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Abstract

The measurements of Total Electron Content (TEC) are conducted at Surat (Geographic Lat. 21.16 N, Long. 72.78 E,), India, which is in the northern crest of equatorial anomaly region, for a period of four years from low to high solar activity (2009-2012) using a Global Positioning System (GPS) receiver. These results are compared with the TEC derived from IRI-2007 using three different options of topside electron density; NeQuick, IRI01-corr, and IRI-2001 We conclude that the measured TEC matches well with the IRI-Models for the years of low solar activity (2009 and 2010). During the low solar activity period the seasonal variation in TEC matches well with the IRI Models for all the seasons. However, there is some deviation in measured TEC with model with increase in solar activity for the year 2011. In 2011, the measured TEC matches with IRI Models during summer season, and the TEC deviates with the model TEC during winter and equinox season. In 2012 the measured TEC matches with the models for the both summer and winter season, with slight deviation in equinox. The percentage deviation of the TEC is also obtained. It is found that the percentage deviation was more for the high solar activity period 2011 than other years. We conclude that the deviation in TEC from IRI Models increases with increase in solar activity.

Session 2

Scintillation monitoring using 1-second TEC measurement

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Abstract

Availability 1-second TEC values measured by the permanent GNSS stations allows to map scintillation parameters over a wide area. The EUREF Permanent Network includes over 60 station that provide such temporal resolution. For analysis the spectral index and intensity of fluctuations computed from TEC spectra were used. Such large number of measurement points allows for both: the analysis of the dependence of scintillation parameter on measurement geometry as well as its changes between different localizations. It will also give a mapping of TEC scintillation parameters and its time evolution over Europe.

Session 2

Ionosphere anomalies during the SURA – ISS experiments program

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Abstract

Artificial substorms were repeatedly stimulated when series of ionospheric experiments with the ionosphere heating facility SURA were carried out in frames of SURA – ISS (the International Space Station) program. Substorms were observed at higher latitudes to the north from the SURA facility location (56.1°N; 46.13°E). The effect was directly proved by localization of an artificial aurora (ISS onboard optical measurements) and specific substorm-like magnetic field variations which were identical in a form, amplitude and temporary parameters (IZMIRAN and GEOMAGNET network observations). The analysis of ionosphere state under quiet geomagnetic conditions was made according to DEMETER satellite, IZMIRAN ionosonde and GPS network data. It has revealed that the plasmasphere border was observed in the northern direction 150-200 km apart from the SURA heating facility.

A beam radio tracing was accomplished, the horizontal gradient of F2 layer critical frequencies in plasmapause area (based on a full data complex) being considered. The possibility of ionosphere modification in the north direction from the SURA facility by means of redistribution and refocusing of radio emission radiated by the SURA was confirmed. The IRI - 2000 model calculations for geophysical conditions during SURA − ISS experiment did not confirm the fact of localization of the observed gradient and, in an indirect way, the plasmapause position. Thus, the abnormal ionosphere condition within the plasmasphere border, registered in experiments for premidnight conditions, was not confirmed by the model and therefore demands its further studies.

Session 2

The high-latitude TEC variations during September 2011 geomagnetic events observed by GPS

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Abstract

In the report the observations of TEC for quiet and disturbed ionosphere during several geomagnetic storms in September 2011 are presented. The GPS observations of Greenland network were used to represent the diurnal TEC variations at the high latitude ionosphere. This network provides unique opportunity to monitor TEC variability in polar ionosphere on a regular base. GPS stations have latitudinal distribution over the range 60-83°N (65-87° Corrected Geomagnetic Latitude) near of 30-40 longitudes. It covers subauroral, auroral and polar ionosphere. In contrast to the ionosonde measurements, GPS provides ionospheric measurements with high temporal resolution even during severe geomagnetic conditions. The analysis showed, that though the GPS satellite orbit inclination is 55°, ground-based GPS measurements can be effectively used for imaging of the high latitude ionosphere. TEC variations for discussed equinox period demonstrated diurnal course until 87° geomagnetic latitude, that was more pronounced towards lower latitudes. There are presented the features of the day-by-day TEC variations in subauroral auroraland polar ionosphere.

The Greenland GPS stations are located closely with one another along latitude. The distance between stations is about 1-2°. Such spacing provides detailed structure of latitudinal TEC profiles to be analyzed. During quiet condition night-time profiles showed increase of TEC towards the higher latitude, daytime profiles revealed TEC decrease toward high latitude. During storm the structure of latitudinal TEC profiles was essentially changed with agreement to the development of geomagnetic storm. In the report features of TEC behavior at high latitude ionosphere for September 2011 events were discussed.

Session 2

The GRL/UWM service of the TEC fluctuations monitoring

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Abstract

Increasing number of the GNSS permanent stations around the North Geomagnetic Pole allow currently for monitoring of the TEC fluctuations in this region. In order to use the capabilities of the ionospheric research, which are offered through the GNSS observations at high latitudes, the new ionospheric service was established at Geodetic Research Laboratory University of Warmia and Mazury. The service constitutes also the realization of the IGS Ionosphere Working Group resolution, which have postulated the creating of the new ionospheric product – map of TEC fluctuations. The main products of presented service are the maps of TEC variability observed for northern hemisphere. For the routine generation of the product, the data from about 170 permanent stations belong to different networks are used. The maps are based on the well-known ionospheric indices: rate of TEC and rate of TEC index and their modifications. They show the conditions in the ionosphere as a function of geomagnetic latitude (from 55 degree to the North Geomagnetic Pole) and magnetic local time. At present the product is created in two versions: daily and 6-hour period. The final results are written in modified for this purpose IONEX format. In the presentation the applied algorithm and first results are shown.

Session 2

Analyses of vertical TEC values obtained from EGNOS messages and real values from GNSS receivers

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Abstract

The main task of the PECS EEI project was the improvement of ionospheric corrections in EGNOS system for Eastern Poland. During measurement campaign the database of TEC values from April 2012 to December 2012 for six GNSS receivers was created. This paper presents comparison between TEC values obtained for GNSS receiver position by the EGNOS algorithm and real values obtained from GNSS measurements. The results can be applied for improvement of W-index calculation and for build an alternative ionospheric corrections algorithm for chosen IGP mask.

Session 2

Determination of the parameters of the ionosphere on the SULP-station

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Abstract

One of the major problems in the study of physical processes in the Sun-Earth (solar corona, solar wind, the plasma membrane of the Earth and other planets) is to develop applications, prognostic aspects of research required earth science, space, energy, climatology, etc. Applied party is the weakest link of solar-terrestrial relationships, firstly, because of the exceptional complexity of the central object of the system - the Sun and the impossibility of constructing an adequate model his behavior even for a short time, and secondly, because of the complexity of the simulation of interaction heliophysical perturbation of plasma membranes Earth.

The property of the ionosphere - change the characteristics of radio waves passing through it - making it the study and control of important practices and radar measurements. A considerable variability parameters ionosphere caused substantial need current information about its characteristics with acceptable accuracy to practice. Since the Earth's ionosphere is an indicator various kinds of technological and anthropogenic processes on Earth, meteorological processes and environmental management, this feature is used in the implementation of international and national programs related to the study of the risks and consequences of natural and man-made disasters monitoring of the environment, development and upgrading of seismological observations and earthquake prediction.

In this connection wide use of global navigation satellite systems (GNSS) particular attention shall determine the system parameters of the ionosphere by analyzing the properties of the received signals from GNSS-satellites. The appearance of satellite navigation systems that operate in two or more of coherent signals opens new opportunities for remote sensing of the ionosphere of the Earth. The implementation these possibilities is of practical interest only if not get the original measurement information without more material and time costs and develop appropriate methodologies and programs calculation parameters ionosphere.

The authors examined the use of GNSS satellite measurements at permanent stations for monitoring the ionosphere. As a result of research was improved algorithm for determining the parameters of the ionosphere, developed and realized in practice software for regular computing the parameters of the ionosphere – slant (*STEC*) and vertical (*VTEC*) values of total electron content and proved in practical use on SULP-station.

Session 2

Procedure transformation the parameters of the ionosphere with GNSS –observations

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Abstract

The solving problem coordinate-time supports based on continuous GNSS observations are based on the processing of large data sets of measurements. One of the possible results of this processing there are numerical characteristics which are influence on signal propagation in ionosphere - the value of TEC (STEC and VTEC - total electron content).

These characteristics reflect the dynamics of the ionization of the atmosphere, which is important in terms monitoring near-Earth space. For each hour intervals of 1 s on a separate station are creating two files which are processed in real-time with slant (STEC) and reduced to the zenith - vertical (VTEC) values of the total electron content.

The array of values TEC (STEC and VTEC) such significant, that there is actual task of preparing these parameters the ionosphere for their further analysis and use. To solve this problem, we proposed methodology based on a set of programs that make VTEC measurement data into a form comfortable for analysis. The program which are reading data from those text files "automatically generates a" two programs of computation Matlab. On the one hand - a usual format change data in a text file. In terms of computing - a record of data in the form of is clearly announced large numerical arrays.

The first of these programs using assignment operators are described the discrete functionalities dependence VTEC change over time. These two-dimensional arrays of data, time series clearly announced in the text of the program. A next of these time series constructed spline interpolation at all their sites. In the second program executed described above spline approximation with a wider step determining the functional dependencies. In this approximation is also used a weak smoothing.

A compensated for specific measurement data errors due to the peculiarities of electronic tract antenna-receiver and near environment of the station. Simultaneously, another approximation calculated with considerable smoothing of the spline data. It is necessary to allocate daily change of the parameter VTEC. As a result of consistent execution of these two programs created two objects spline- approximation. One of them with high precision approximates the measurement data. Other - contains approximation of smoothed values of data measurement.

Through this approach for further calculations VTEC enough to read the named objects approximations of their files and identify VTEC at an arbitrary point in time due to computing spline functions according to their argument, as defined by splines reflect changes VTEC analytically given functions.

The technique of offers a flexible information-computational tool for further analysis of the data accumulated during the continuous VTEC.

Session 3

Evaluating Electron Density Peak Height Analytical Model (OE_hmF2) for Real-time IRI

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Abstract

Recent works of Ebre team resulted in a new global scale analytical formulation of the quiet pattern of the electron density peak height (hmF2Q) and a regional scale analytical formulation of its disturbed pattern during intense geomagnetic storms (ΔhmF2). Combining both models, the hmF2Q which is bounded to the local time, season and solar activity, and ΔhmF2 which is bounded to the local-time, season and to the conditions of the interplanetary magnetic field, a forecasting tool for hmF2 has been developed (OE_hmF2 model). The main purposes of this work are to compare and validate the OE_hmF2 analytical formulation at different latitudes evaluating its performance for disturbed intervals occurred during the current solar cycle and aiming at improving the hmF2 prediction in the frame of the International Reference Ionosphere. Comparisons are made also with the IZMIRAN hmF2top model which estimates the anticorrelated effects of hmF2 in relation to foF2 under stormy conditions.

Session 3

Global Characteristics of Ionosphere-Plasmasphere Storms

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Abstract

Dedicated to 100-years of Professor Karl Rawer

GPS-derived global ionospheric maps of the vertical total electron content, GIM-TEC, are used for derivation of global W-index maps and the planetary index of the ionospheric perturbations, Wp. Both GIM-TEC and W-index maps are provided in IONEX format (-87.5:2.5:87.5º in latitude, and -180.0:5.0:180.0□E in longitude) with 1h UT time step. W-index as a measure of the ionosphere-plasmasphere state is generated at each grid point of a map with relevant thresholds so that W=±1 for the quiet state, W=±2 for the moderate disturbance, W=±3 for the moderate ionospheric storm, and W=±4 for the intense ionospheric storm. Then the planetary differential Wp index is obtained from W index map as a span between the maximum positive W-index and minimum negative W-index weighted by the occurrence of the both signs storm values on the map. In the present study the cells on the Earth under positive storm conditions (W = 3 and 4) and negative storm conditions (W = -3 and -4) are identified for each day and month during 1999-2012 from which more than 270 planetary ionospheric storms have been detected using the Wp index. These storms are compared with the magnetospheric storms specified by the ring current Dst index, auroral electrojet AE and other indices. A probability of the positive and negative W-index storm characteristics are modeled analytically by method of superposed epoch with the start time of the epoch defined at the peak of the Wp storm. The planetary W-index discloses the storms which may belong either to magnetosphere or the ionosphere-plasmasphere system or the both providing broader proxy index driving the space weather than the geomagnetic indices alone. Global maps for W index might be used in operational regime for the future upgrade of ground segment of GPS+Galileo L1/L5 global service.

This study is supported by the joint grant of TUBITAK 112E568 and RFBR 13-02-91370-CT_a. The numerical ionosphere maps, indices and Catalogue of the ionosphere-plasmasphere storms are provided at *http://www.izmiran.ru/services/iweather/*, *http://www.ionolab.com* and *http://www.cbk.waw.pl/*

Session 3

Ionospheric E-region and its electrodynamics during geomagnetic storm on May 1–3, 2010

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Abstract

This report presents the simulation results of the electron density, ion and electron temperature and densities of minor neutral components at heights of the ionospheric E-region during geomagnetic storm on May 1-3, 2010. The nitric oxide distributions are an important factor in the ion-chemical reactions of the E-region ionosphere. For this investigation we used the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP) developed in West Department of IZMIRAN. GSM TIP model simulations were performed using two empirical models of high-energy electron precipitation. The temporal and spatial distributions of the lower ionosphere parameters and minor neutral species are presented. Their analyses and interpretation were executed. GSM TIP model results of E-region parameters are compared with IRI-2012 model. The differences between model results are discussed. In addition we considered the GSM TIP spatial and temporal distribution of the auroral and equatorial electrojets during this storm period.

These investigations were supported by RFBR Grant № 12-05-31217 and RAS Program 22.

Session 3

Under the Hood of Real-Time Assimilative IRI: Nonlinear Error Compensation Technique

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Abstract

Development of a near-real-time (nRT) extension for the IRI has led us to a novel assimilative modeling principle: a smooth transformation (“morphing”) of 2D global climatological maps of the ionospheric characteristics in the IRI to match all available observations. The essence of our morphing principle is to compute corrections to the coefficients of the diurnal/spatial expansions used in the original empirical maps, and keeping the well-proven formalism of the expansion functions unchanged. The corrections are carefully selected to minimize the cumulative error (differences between observation and model values at all sensor sites and measurement times) while preserving the key climatology features captured by the empirical maps.

This paper discusses details of a Nonlinear Error Compensation (NEC) technique for morphing CCIR (or URSI) foF2 maps used in the IRI into matching the 24-hour sliding window of foF2 measurements provided by the Global Ionospheric Radio Observatory (GIRO). The GIRO database at UMLCAR collects nRT data feeds from ~50 ionosondes, mostly Digisondes®, operating around the world. The NEC uses a two-phase computational scheme: (1) for each GIRO sensor site, the 24-hour history of differences between observed and model foF2 values is used to obtain coefficients of its 6^{th}-order diurnal harmonic representation, and (2) each of the coefficients is then interpolated to the 2D global grid, requiring that the differences vary smoothly and fade slowly to zero (i.e., no correction to the model) in areas where no measured data are available. The 2D grid is then expanded in the classic 76-coefficient CCIR spatial representation. The spatial interpolation algorithm of the NEC method employs a non-linear neural network optimizer that iteratively converges to the state of its minimum energy where all criteria of smoothness and fading are satisfied optimally. Computational challenges encountered while developing the algorithms for the 2-step scheme are discussed, and the final assimilation results are presented.

Session 3

Timeline of January 2013 Sudden Stratospheric Warming Event as seen in Real-Time Assimilative IRI and GPS Data

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Abstract

A major and long-lasting sudden stratospheric warming event occurred in January 2013, peaking between Jan 6-20, 2013. This event triggered significant wave activity at ionospheric heights with various time scales ranging from tidal (~8 and 12 hr) to non-tidal (>24 hr). While such wave activity can be observed by multiple instruments, those allowing a global view of the ionospheric plasma dynamics are of most interest as they provide a deeper insight to the processes of wave generation and propagation. Until recently, global maps of GPS-derived total electron content (TEC) have been most readily available for monitoring the large-scale ionospheric processes. This paper presents first-light analysis of the global 15-minute cadence timelines of foF2 maps (corresponding to the global peak ionospheric density) produced for December 2012 (quiet) and January 2013 (active) periods by the IRI Real-Time Assimilative Model (IRTAM). A comparative analysis with GPS-derived TEC maps for the same period of time is performed as an independent validation. The IRTAM empirical-model formalism avoids uncertainties of the evolving theoretical understanding of the thermosphere-ionosphere coupling processes, and its assimilative capability yields fine temporal resolution to specify the ionospheric processes as they evolve.

Our preliminary results indicate a large variety of ionospheric anomalies observed in different longitudinal sectors between January 9-20, 2013 These anomalies cannot be fully accounted for by neither seasonal change nor solar flux and geomagnetic activity, and indicate contributions to ionospheric variability from wave activity of lower atmospheric origin.

Session 3

Ionospheric response to magnetic disturbances under low solar activity conditions and STORM model corrections for the disturbed periods

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Abstract

The paper focuses on differences in ionospheric reaction to weak magnetic disturbances above selected ionospheric stations located within the Northern and Southern Hemisphere. We analysed the variability of the critical frequency *foF2* and the F layer peak height *hmF2* obtained for different latitudinal/longitudinal sectors of both hemispheres for main and recovery phases of magnetic disturbances, which occurred within the last prolonged solar cycle minimum. Measured values of *foF2* are compared with the IRI STORM model outputs and with the observations for the minimum of solar cycles 21/22 and 22/23. Our results show that also minor-to-moderate magnetic disturbance could significantly affect ionospheric peak parameters. An efficiency of model corrections for selected events was insufficient. The paper also deals with the latitudinal/longitudinal and seasonal dependence of the ionospheric reaction.

Session 3

Global ionospheric response to the geomagnetic storm on September 26-29, 2011 and its influence on HF radio wave propagation

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Abstract

In this study, we have investigated the global ionospheric response to the geomagnetic storm on September 26–29, 2011 using GSM TIP (Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere) and IRI 2012 simulation results. In addition, we used the ground-based ionosonde and GPS receiver data at different locations for comparison GSM TIP and IRI 2012 model results with observations. We present an analysis of the physical mechanisms responsible for the global ionospheric response to geomagnetic storm at different storm phases. We used the obtained GSM TIP and IRI 2012 simulation results as a medium for HF radio wave propagation at different latitudes in quiet geomagnetic conditions, and during main and recovery phases of geomagnetic storm. To solve the problem of the radio wave propagation we used Zakharov's (I. Kant BFU) model based on the approach of geometric optics. In this model the solution of the eikonal equation for each of the two normal modes is reduced using the method of characteristics to the integration of the six ray equation system for the coordinates and momentum. All model equations of this system are solved in spherical geomagnetic coordinate system by the Runge–Kutta method. In this study, the complex refractive indices of the ordinary and extraordinary waves at ionospheric heights were calculated by two different ways: (1) using the global first-principal model of the thermosphere-ionosphere system; (2) using IRI 2012 and MSIS models, that describes the parameters of an inhomogeneous anisotropic medium during geomagnetic storm. A comparison of the ordinary and extraordinary modes of HF radio ray paths in quiet and disturbed conditions has been done. We considered in more detail the features of the radio ray paths in the presence of *F*3 layer in the equatorial ionosphere. It is shown that the results obtained using the radio propagation and GSM TIP models adequately describe the HF radio ray paths in the Earth's ionosphere and can be used in the different applications.

These investigations were carried out at a financial support of RFBR Grant No. 12-05-31217 and RAS Program 22.

Session 4

A study of the ionospheric parameters in the polar cap and cusp over a solar cycle

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Abstract

Incoherent scatter radar measurements are an important source for studies of ionospheric plasma parameters. Data from the EISCAT Svalbard radar (ESR), which covers the polar cap and cusp, can be used to obtain information about the electron density, electron- and ion temperature, and line-of-sight plasma velocity from an altitude of about 50 and up to 1600 kilometers. We have developed a software package that will be used to download and process data obtained from the EISCAT radars. The software is able to produce daily, seasonal and solar cycle variations of the measured plasma parameters. We will investigate the long-term trends of these parameters and compare our results with previously published results. The ESR radar has been operational since 1996, which implies that by using this software package, data that cover more than one solar cycle can be obtained. This data set will give a unique overview of the ionosphere over Svalbard during a whole solar cycle.

The results obtained from this long-term study will be compared with the International Reference Ionosphere (IRI) model. If possible, the results will also be used to improve the accuracy of the IRI model at high latitudes.

Session 4

Determining the equatorward and poleward boundaries of the auroral oval from CHAMP field-aligned currents signatures

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Abstract

In this study we focus on the boundaries of the auroral oval, which will be one of the future issues of the International Reference Ionosphere (IRI) model. Based on 10 years of magnetic field observations from CHAMP, medium-scaled field-aligned currents (MSFAC) are derived. A method is introduced to determine the equatorward and poleward boundaries of auroral oval from MSFAC signatures. The thresholds in MSFAC density used in this method for boundary detection are chosen posteriorly. They are based on a correlation analysis between the latitude of the boundaries and geomagnetic indices. Boundaries are detected more reliably on the night side, when the solar zenith angle is above 90°. The latitude of the boundaries is closely controlled by magnetic activity, while the dependence on solar activity is insignificant. Further, the boundaries we determined by the MSFAC signatures will be compared with existing models and other observations. Our final aim is to propose a new model of the auroral boundaries from MSFAC signatures, which could later be implemented in the IRI model.

Session 4

A comparison of the ionosphere F2-layer electron peak density and total electron content variations calculated by the theoretical UAM and empirical IRI models and GPS TEC observations

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Abstract

This paper presents the numerical modeling results on the F2-layer electron peak density (NmF2) and total electron content (TEC) variations obtained with using the global Upper Atmosphere Model of the Earth. Two versions of the UAM were used: 1) with the empirical thermospheric NRLMSIS-00 model for neutral components (UAM-TM) and 2) with the theoretically calculated thermosphere parameters and 3D circulation (UAM-TT).

The model calculations have been carried out for equinox and solstice conditions and two levels of solar activity (F10,7 ~ 90 and F10,7 ~ 180).

The global maps of the NmF2 and TEC were analyzed. The results of the TEC and NmF2 modeling were compared with the data obtained from the empirical ionospheric model IRI-2007 and GIM (Global Ionosphere Maps) of the TEC provided by the NASA in IONEX format derived from IGNSS network data.

It was shown that:

1) the quantitative agreement between the values NmF2 and TEC for the UAM-TM and UAM-TT, IRI-2007 and TEC GPS is satisfactory at low latitudes (±30º) in the daytime in all seasons at different levels of solar activity;

2) the best agreement between the values NmF2 for the UAM-TM and IRI-2007 (the ratio is 0,8–1,0) and the UAM-TM and TEC GPS (the ratio is 0,9–1,4) takes place for the winter conditions at low solar activity;

3) the worst agreement between the values NmF2 and TEC for the UAM-TM and UAM-TT, IRI-2007 and TEC GPS takes place in the main ionospheric trough and polar caps regions where the UAM NmF2 and TEC values are much lower than those by IRI and GPS.

We consider that this difference is related with a shortage of ionospheric observations at the polar caps.

Session 4

Comparison of electron density profiles: modeled and real using, raw ionograms from Hornsund and Warsaw VISRC2 ionosondes

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Abstract

Ionograms data allows verification of the real shape electron density with profile predicted by models. To perform the tests based on the assumed density profiles the synthetic ionograms were calculated and compared to measured values. To achieve the best accordance with measured ionogram the model parameters were fitted. The data were collected by two ionosondes VISRC2, located in high latitude region (Hornsund – South Spitsbergen) and middle latitude (Warsaw). For tests the electron density profiles were used from common available models. Result presents degree of compatibility of theoretical models to observed data.

Session 5

Online Regional foF2 and hmF2 Maps from IRI-Plas: IONOLAB-MAP

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Abstract

One of the important improvements in monitoring the ionospheric structure and variability near real-time is the Global Ionospheric Maps (GIM) that are estimated from various International GPS Service (IGS) stations. GIMs are provided from IGS analysis center site `ftp://cddis.gsfc.nasa.gov/gps/products/ionex/' as Total Electron Content (TEC) that corresponds to total number of electrons for a given ray path. The unit of TEC is TECU and 1 TECU = $10^{16}$ el/m$^2$. GIM can be downloaded in `IONEX' format with a temporal resolution of 2 hours and spatial resolution of 5^0 in longitude and 2.5^0 in latitude. Since GIM provides only the global distribution of TEC, other major ionospheric parameters such as critical layer frequencies and heights are not available in this format.

A new approach in assimilating GIM-TEC into IRI model gave rise to International Reference Ionosphere Extended to Plasmasphere (IRI-Plas) model [1,2]. IRI-Plas is accepted as a standard ionospheric model in [3]. In IRI-Plas, the physical model is extended beyond ionosphere, into plasmasphere to the Middle Earth Orbit (MEO) of 20,200 km which is the orbit of Global Positioning System (GPS) satellites.

In this study, IONOLAB group is presenting a unique Space Weather service which is available online and near real-time where IRI-Plas foF2, hmF2 and TEC maps will be provided for the user defined region, date and time period with the ingestion of GIM-TEC at www.ionolab.org. The maps will be either in graphical form or as a text file in IONEX format and spatial resolution. The user can choose hourly GIM-TEC from UPC `uhrg' or with two-hourly GIM-TEC from NASA-JPL provided at the web site of ftp://cddis.gsfc.nasa.gov/gps/products/ionex/. The output TEC, foF2 and hmF2 can be obtained either in graphical form that can be observed online or the maps can be provided in IONEX numerical map format which will be written directly into a filename and directory that is specified by the user. This unique service will be in use for ionospheric monitoring and variability analysis.

This study is supported by grants from TUBITAK109E055, Joint TUBITAK 110E296 and RFBR 11-02-91370-CTa and Joint TUBITAK 112E568 and RFBR 13-02-91370-CT_a.

References:

1. Gulyaeva, T.L., F. Arikan and I. Stanislawska (2011), Inter-hemispheric imaging of the ionosphere with the upgraded
IRI-Plas model during the space weather storms, Earth Planets Space , 63 , 929-939.

2. Gulyaeva, T. L. (2012), Empirical model of ionospheric storm effects on the F2 layer peak height associated with changes of peak electron density, J. Geophys. Res., 117 , A02302, doi:10.1029/2011JA017158.

3. Gulyaeva, T. L., and D. Bilitza (2012), Towards ISO Standard Earth Ionosphere and Plasmasphere Model, In: New Developments in the Standard Model, edited by R.J. Larsen, 1-39, NOVA, Hauppauge, New York, Available at https://www.novapublishers.com/catalog/product_info.php?products_id=35812.

Session 5

A comparison of the LPIM-COSMIC F2 peak parameters determinations against the IRI(CCIR) and EBRO predictions

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Abstract

On April 2006, Taiwan and US jointly launched the COSMIC/Formosat-3 (C/F3) mission, consisting on six identical micro-satellites each one carrying a set of advanced GPS receivers that continuously record the measurements to all the observed GPS satellites. The C/F3 mission team routinely processes the TEC measurements with an Abel's inversion technique and makes available to the community (at http://www.cosmic.ucar.edu/) electron density distribution files estimated for each radio occultation (RO) event. Contrarily to what could be expected, retrieving the F2 peak parameters from these data files is not as simple as seeking for the height in which the electron density determination reaches its maximum. For retrieving the F2 peak information we have used the La Plata Ionospheric Model (LPIM) that performs several verification and validation tests over the data and finally by means of a Least Squares scheme fits the F2 peak parameters of a modified Chapman layer profile that better reproduces the observations. LPIM is a development of the GESA group of the Universidad Nacional de La Plata, Argentina, with more than 15 years of continuous enhancement. It is a very powerful tool for assimilating TEC and electron density estimations from many different data sources.

In the context of the present work we have applied the LPIM to a C/F3 data series that goes from January 2008 to October 2012 obtaining F2 peak parameters values (LPIM-C/F3) for each RO event occurred during this period. This presentation aims to assess the quality of the F2 peak parameters estimations by comparing them with the widely used IRI(CCIR) hmF2 and NmF2 predictions and with the hmF2 predictions by the model developed by the Ebro team. The analysis is applied on a global scale, understanding the behavior of the different geomagnetic regions. The effect of the seasons and the solar activity levels is also considered. Finally, we explore the possibility of using the LPIM-C/F3 estimations to produce new sets of data grids/maps of the hmF2 and NmF2, along with their standard deviation estimations, and we present some preliminary results.

Session 5

Ionospheric Observations by NICT

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Abstract

National Institute of Information and Communications Technology (hereafter NICT) has been operational observation of ionosphere since IGY (1957) in five domestic observatories and Syowa station, Antarctica. One of the domestic observatories, Akita was closed on 1993 but others, Wakkanai, Kokubunji, Yamagawa, Okinawa and Syowa has been operated continuously. These initial results, the ionogram images can be seen on the web site in real time. In addition we have manual scaling for these data for major parameters.

As research activities we operate ionospheric observation in Southeast Asia, Thailand, Vietnam, Indonesia, Philippine and China. The purpose of the observation is to research the generating/glowing mechanism of equatorial plasma bubbles (EPB) which can be major threat of satellite positioning system e.g., GPS. EPB makes significantly large gradient in the horizontal distribution of electron density in the ionosphere which causes the disabilities of loss of lock or large error of satellite positioning. Our target is to have a probability forecast of EPB occurrence with researching what the trigger of EPB generation. These observation starts on early 2000s and we already have fairly large dataset over ten years.

We think that these dataset of ionospheric observation in Japan, Antarctica and Southeast Asia can be contribute to improve IRI model. Most of the domestic measurement data are already scaled manually which can input the model immediately. Antarctic measurement results are also available and their contribution will be large because the distribution of observatories is much sparse in Antarctica.

We will introduce the present status of our observation and data archive and discuss future use in IRI model improvement.

Session 5

Global model SMF2 of the F2 layer peak height based on the satellite data

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Abstract

We propose a global median model SMF2 (Satellite Model of the F2 layer) of the ionospheric *F*2-layer height maximum (h_mF2). New model based on topside sounding data for high solar activity obtained onboard the Interkosmos-19 (170.000 h_mF2 values) and GPS radio-occultation data mainly for low solar activity periods provided by GPS receivers onboard satellites CHAMP (□300.000), GRACE (□100.000) and COSMIC (□2.800.000). The radio-occultation data were preprocessed to remove cases where the absolute maximum of the electron density lies outside the *F*2 region. Ground-based ionospheric sounding data were used for comparison and validation. Spatial dependence of h_mF2 is modeled by a Legendre-function expansion. Temporal dependence, as a function of Universal Time (UT), is described by a Fourier expansion. Inputs of the model are: geographical coordinates, month number and $F_{10.7A}$ solar activity index. The model is designed for quiet geomagnetic conditions ($K_p \leq 3$).

SMF2 agrees well with the International Reference Ionosphere model (IRI) in those regions, where the ground-based ionosonde network is dense. Maximal difference between the models is found in the equatorial belt, over the oceans and the polar caps. Standard deviations of the radio-occultation and Digisonde data from the predicted SMF2 median for low solar activity are 10–16 km for all seasons, against 26.6 km for IRI-2007. Average relative deviations are 3–4 times less than for IRI-2007, 3–4% against 9–12%. At high solar activity standard deviations in the new model reach 25 km, but in IRI-2007 they are about 2 times more. Mean relative deviations at high solar activity are approximately 2 times less than for IRI-2007. Therefore, the proposed h_mF2 model is significantly more accurate than IRI-2007.

Session 5

Morphology and dynamics of the Weddell Sea and Yakutsk anomalies from the satellite data

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Abstract

This report presents the morphology and dynamics of the Weddell Sea anomaly (WSA) in the Southern Hemisphere and the Yakutsk anomaly (YA) in the Northern Hemisphere. Both anomalies are identified as an excess of nighttime *foF*2 values over daytime ones. In order to investigate WSA and YA location and dynamics we generate global maps of *foF*2 and h_mF2 in the Northern and Southern Hemispheres for the local summer conditions according to the Interkosmos-19 satellite data for high solar activity. The temporal dynamics (occurrence, variations and disappearance) of both anomalies is considered. Both anomalies are also presented in the terms of longitudinal variations in *foF*2 and h_mF2. For the first time we clearly identified the areas of both anomalies. The WSA covers the longitudes of 180-360°E and latitudes of 40-80°S, the maximal effect (up to ~ 4.5 MHz) is observed at longitudes of 250–300°E and latitudes of 60–70°S (50–55° ILAT). The YA is weaker than WSA, but it takes up a significant area in the Northern Hemisphere: at longitudes of 90°–210°E and latitudes of 47–72°N. The maximal difference between nighttime and daytime *foF*2 values, Δ*foF*2 = (2.0–2.5) MHz, is achieved over Yakutsk and Magadan stations. At high solar activity, both anomalies exist throughout the local summer. The YA as well as the WSA are also pronounced at low solar activity, as shown using the Yakutsk and Magadan ionosonde and CHAMP satellite data. Both anomalies are insufficiently well represented in the IRI 2012 model.

Session 5

The Variation of Critical Frequency of E layer over the Magnetic Equatorial Region, Chumphon, Thailand

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Abstract

In this research paper presents the observed critical frequency of E layer (*foE*) over Chumphon, Thailand which is located at nearly the magnetic equator (lat. 10.72° long. 99.37° dip. 3°) during September 2004 to August 2005. The *foE* is one of the essential parameters in the International Reference Ionosphere (IRI) model. We investigate the variation of the observed *foE* by comparing to the Sun spot number, ionospheric index, and 10.7 cm. flux into four seasons, March equinox, September equinox, June solstice and December solstice. Due to the essential of accurate on IRI model can be used to apply in communication such as it may be implied tendency of phenomena in E layer effect on high frequency communication over the magnetic equatorial region, Chumphon, Thailand. We find that the trend of *foE* observation from September 2004 to August 2005 is similar to the values computed from the IRI model. The variation of the *foE* is at the highest level during the September equinox compared with other seasons. The maximum *foE* is during 13:00h-14:00h, the peak ionization level daily for all seasons. The maximum *foE* is seen in June solstice when the sun position is orthogonal to the equator.

Keywords – *E layer; critical frequency of E layer; magnetic equator; IRI model; Sun spot number; ionospheric index; 10.7 cm. flux*

Session 5

Formation of Weddell Sea and Yakutsk anomalies in *foF*2 diurnal variations and there manifestation in the topside ionosphere

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Abstract

The main objective of our studies is to describe the main formation mechanisms of Weddell Sea Anomaly (WSA) and Yakutsk Anomaly (YA) using the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP). Firstly, we needed to check the possibility for reproduction the spatial structure of these anomalies in *foF*2 using GSM TIP model. For this purpose, we compared the GSM TIP model results with IRI empirical model, and different observation data (Intercosmos-19 and COSMIC satellites, DPS-4 ionosondes). The GSM TIP simulations qualitatively reproduce the main morphological characteristics of the WSA and YA for the maximum and minimum of solar activity. This fact allowed using the GSM TIP model to explain the formation mechanisms of these anomalies. In addition we estimate the manifestation of these anomalies in the topside ionosphere, ionospheric and total electron content using GSM TIP model results, incoherent scatter radar, COSMIC and GPS TEC observations.

Session 5

Regional modeling of ionospheric peak parameters using B-spline expansions

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Abstract

The peak electron density NmF2 and the peak density height hmF2 of the F2-layer are two of the most important ionospheric parameters. Thus, the ability to model and predict the spatial and temporal variations of these parameters is essential for ionospheric research. In our approach, the vertical distribution of the electron density is represented by the combination of a F2 Chapman layer function and an exponential plasmasphere model. The key parameters of this approach, e.g., hmF2, are described as series expansions in terms of tensor products of three one-dimensional endpoint-interpolating B-splines depending on longitude, latitude and time, respectively. In opposite to the classical spherical harmonics B-spline functions are characterized by their compact support. This localizing feature enables an appropriate handling of data gaps and allows the application of a multi-scale representation.

In the first part of this contribution we present in detail our extended electron density model. In the second part we describe the estimation of the unknown series coefficients for the key parameters from the combination of terrestrial GNSS data, occultation measurements from LEO satellites and observations from dual-frequency altimetry missions. In this context we emphasize the distinct sensitivities regarding ionospheric parameters of the observation techniques; furthermore, we discuss how the different spatial and temporal resolutions of the observation types can be handled. Finally we outline how Kalman filtering can be used for near real-time applications and how data compression techniques can be applied efficiently. The procedures will be demonstrated using simulated and partly real data related to an appropriate region in South America including the Equatorial Anomaly.

Session 5

Comparing IRI-2012 and higher order functions of Regional Empirical Ionospheric model with foF2 measured in Pakistan

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Abstract

Critical frequency of F2 layer (foF2) acquired by three ionosonde stations (Karachi, Multan \& Islamabad) in Pakistan is compared with foF2 obtained from global ionospheric model IRI-2012 and computed from higher order function of regional empirical ionospheric model. The foF2 data has been compared at different phases of solar cycle such as solar maximum and downleg of cycle 23, deep solar minimum and upleg of cycle 24. Different available sets of Empirical Orthogonal Functions (EOFs) of regional model are used for the comparison. The higher order computational sets did not show any significant deviation with respect to linear expansion of EOFs for foF2. Both models revealed good agreement with the observed values for Multan (30.18°N, 71.48°E). However for Karachi (24.95°N, 67.13°E) and Islamabad (33.75°N, 73.13°E), considerable deviations between the models and observed values are noted at the downleg of cycle 23. A small deviation at Islamabad during deep solar minimum is also noted. For most of the cases, overestimation by models is noted during pre to post noon whereas underestimation by the regional model is observed during few hours before and after the sunrise.

Session 6

Improving the representation of solar forcing in IRI

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Abstract

The International Reference Ionosphere model currently uses several solar and ionospheric indices to describe the variations of ionospheric parameters with solar variability. These indices are used at an averaging level of 81 days or even a whole year. We have investigated the performance of these different indices at different averaging lengths using over 30 years of ionosonde foF2 data from the three stations Boulder, Jicamarca, and Grahamstown employing daily and monthly averages of foF2. In addition to the indices currently used in IRI our study also included indices composed of measured EUV fluxes. However, coverage gaps during the last two solar cycle maxima introduce uncertainties for these indices. We get the best results with Lyman alpha (121.5nm) fluxes at an averaging length of about 81 days (3 solar rotations). They provide better results than the proposed MgII-core-wing-flux-ratio and the 10.7cm fluxes (F10.7). The ionospheric-effective solar index IG, that is based on ionsonde data from five selected stations, performs almost equally well as the Lyman-alpha flux index. Surprisingly, we find that the monthly IG index performs as well if not better than the 12-month running mean of monthly IG that is currently used in IRI. This opens interesting possibilities for using a GIRO-based IG index (IGiro) that could be determined by averaging across a global selection of ionosonde stations available on the Global Ionospheric Radio Observatory (GIRO) at a much higher time resolution (down to 15 minutes) in near real-time. Most importantly such a new index could be designed such that it would not be limited by the constraints of the current IG index which is determined with only noon data and with using the CCIR maps and thus should not be applied for nighttime and/or URSI maps.

Session 6

Assessment of the monthly mean variability of the F2 peak parameters based on COSMIC / FORMOSAT-3 radio occultation profiles

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Abstract

In this paper we explore the monthly mean variability of the F2 peak parameters based on N_mF2 and h_mF2 values retrieved from COSMIC / FORMOSAT-3 radio occultation profiles (hereafter, the 'measured profiles'). The retrieving method utilized in this work relies on fitting each measured profile with the La Plata Ionospheric Model. The fitting procedure, complemented with appropriated statistical tests, enables automatic scanning of the measured profiles, elimination of measured electron densities and/or entire electron density profiles suspected to be misleading, and inferring validated N_mF2 and h_mF2 parameters accompanied with estimated errors.

The study is restricted to quiet geomagnetic days (defined by $A_p \leq 15$), low solar activity conditions (defined by $-20 \leq IG_{12} < 40$), and mid- and low-latitude regions (defined by $-60° \leq modip \leq +60°$). The application of these restrictions leads to a dataset of $\approx 5 \times 10^5$ N_mF2 and h_mF2 validated measured values, that spans from January 1, 2007 to April 4, 2010. The variability index is computed from the residual of these values with respect to their mean. Variability indexes for N_mF2 and h_mF2 are computed for each month, each latitudinal band of 10° *modip*, and for Local Time intervals around noon (defined by $10^h \leq LT \leq 14^h$) and midnight ($22^h \leq LT \leq 02^h$).

We discuss the method used to retrieve and validate the measured parameters, the definition and computation of the variability index, and the obtained results. The study shows that N_mF2 varies from ~20% to ~50% during noontime, with maximums at the northern and southern sides of the equatorial anomaly in both equinoxes; and from ~30% to 80% at midnight, with maximums in the equatorial and low-latitude regions; while h_mF2 varies from ~5% to 10% during both, noon and midnight, with maximums located in the region where the spatial gradient of h_mF2 takes its largest values.

Session 6

Ionospheric storms on the background of low and medium solar activity

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Abstract

The recent extended solar minimum and new 24th solar cycle give us an opportunity to carry out the comparative study of the ionosphere disturbances at background of extremely low and medium solar activity. To study the global structure of ionospheric disturbances we used data provided by different ground-based and satellite ionosphere measurements. It was processed the data from European, American, Japanese, and Australian ionosonde networks as a benchmark data source. The ionosphere modification on a global scale have been checked with use of Global Ionospheric Maps, provided by international GNSS Service, and data from FORMOSAT-3/COSMIC RO mission. Additionally for estimation of the electron density dynamic at high latitudes there were analyzed TEC fluctuations maps, created by IGS/EPN, PBO and POLENET data. As case study events there have been selected geomagnetic disturbances, occurred during the years 2008-2013, with significant ionospheric responses. The global maps of TEC were used in order to estimate large scale storm effects, ionosonde data gives possibilities to study the local peculiarities of the ionosphere disturbances (two parameters have been processed – the NmF2 and hmF2). Additionally for analysis of the height ionospheric structure we combined ionosonde-derived data with the Ne profiles from FORMOSAT-3/COSMIC RO measurements and global distribution of electron density at selected altitudinal intervals. It was resulted that selected moderate geomagnetic storms (Kp ~ 6) lead to the different ionospheric response (positive and negative) over European, American, Japan and Australian areas. The global pattern and local temporal and quantitative characteristics of the ionosphere disturbances during selected storms were revealed. For example geomagnetic storm October 11, 2008 lead to short time positive ionospheric disturbance over Europe in TEC values with factor 2, foF2 - with factor 1.5-1.8 and uplifting of F2 layer maximum up to 100 km. Additionally it was carried out the comparison of the ionosondes-derived foF2 values with IRI-2007 model, that have the storm-time option. It was obtained the qualitative agreement between the ionosonde-derived foF2 values and model calculations for cases of negative ionospheric storms. The best agreement between model and observations results corresponds to the Northern Hemisphere mid-latitude stations.

We acknowledge the Australian IPS Radio and Space service and the National Institute of Information and Communications Technology (NICT) in Japan for providing ionosonde data. The authors would like to thank B.W. Reinisch and the Center of Atmospheric Research, University of Massachusetts Lowell for the ionogram data of DIDBase. We are also grateful to International GNSS Service (IGS) for GPS TEC products.

Session 6

The O^+/H^+ transition height, global protonospheric/plasmaspheric electron content at recent solar cycles during quiet and stormtime periods

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Abstract

The Total Electron Content (*TEC*) is one of the most important parameters used in the ionospheric studies. In fact, the *TEC* consists of ionospheric electron content (*IEC*) and plasmaspheric/protonospheric electron content (*PEC*). What is the *PEC* contribution to the *TEC*? Most of studies that addressed this issue were model/data comparisons or observational studies for very limited geographic locations. There were only few studies that try to resolve this issue in global scale. However, there was not even one investigation that analyzes the global first-principal model/data comparisons of *PEC* estimations. We tried to perform such study using GPS *TEC* observations, FORMOSAT-3/COSMIC radio occultation measurements, and simulation results derived using the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP). GSM TIP model results are retrieved for different seasons and magnetic activities. We used incoherent scatter radar data in order to examine our estimation of protonospheric/plasmospheric electron content. In addition our model study coincide with recent observation results that the O^+/H^+ transition height at recent extended solar minimum is much lower than predicted transition height. We concluded that to predict the *TEC* values one must take into account the protonospheric/plasmaspheric contribution in addition to the ionospheric one, especially during solar minimum conditions.

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Session 6

Diurnal, seasonal and solar activity pattern of ionosphere disturbances from Irkutsk Digisonde data

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Abstract

The topic of this paper is an analysis of diurnal, seasonal and solar activity pattern of ionospheric disturbances obtained from Irkutsk Digisonde data. The disturbance is the deviation of ionosphere characteristic from its 27-day running median value (under assumption that 27-day running medians are associated with climatological specifics of the diurnal, seasonal, and long-term solar activity variations). Here we study both absolute and relative disturbances of the peak electron density (NmF2). The high- and low-frequency parts of disturbances are studied separately. The high-frequency part (periods from 0.5 to 6 hours) is mainly caused by traveling ionospheric disturbances associated with internal gravity waves. The low-frequency part is assumed to be due to geomagnetic storms effects, planetary waves and short-term solar activity variations. The reasons of the obtained diurnal, seasonal and solar activity pattern of ionospheric NmF2 disturbances are discussed.

Session 6

Statistical analysis of wave activity in ionosphere from 2003-2012 Digisonde observations

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Abstract

Routine ionosonde observations provide long series of electron density data. The automated method for extracting wavelike disturbances of electron density has been developed. The wave-like disturbances are assumed to be associated with traveling ionospheric disturbances (TIDs) caused by internal gravity waves. The method is based on the spectral analysis of electron density series with 12 hour Blackman window. We used four criteria for the presence of TID.

1) The local spectral maxima coincide at three heights as a minimum.
2) The amplitude of local maximum is more than 3% of zero harmonic amplitude.
3) The amplitude of local maximum is more than 20 % greater than neighbor amplitudes.
4) The apparent vertical velocity is less then 1000 km/h.

Finally, we obtained diurnal, seasonal and solar activity pattern of wave activity (number of TIDs) and TID characteristics (period, amplitude, vertical velocity). In the paper we discuss the day-night and summer-winter differences as well as solar and geomagnetic activity dependence of the wave activity.

Session 6

The Occurrence of Equatorial Spread-F at the Conjugate Stations in Southeast Asia

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Abstract

The equatorial spread-F (ESF) phenomenon refers to the ionospheric instability centered on the magnetic equator and spreading across an area 10 to 15 degrees north and south of magnetic equator. The pulses reflected from the F-layer are spreaded to be diffuse traces after the local sunset. The major mechanism that plays the important role is the well known generalized Rayleigh-Taylor (R-T) instability, which is mainly caused by pre-reversal electric field enhancement (PRE) indicating the uplift F-layer bottom side. In this study, the probability of ESF occurrence at the conjugate points in the northern and southern hemispheres and around the magnetic equator of Southeast Asia are presented. The ionogram data during minimum solar activity from September 2008 to April 2009 are recorded by the FW/CW ionosondes, which are installed at three conjugate stations : Chiang Mai (18.76 ^{o}N, 98.93 ^{o}E, dip 12.7^{o}), Thailand, Chumphon (10.72 ^{o}N, 99.37 ^{o}E, dip 3.0^{o}), Thailand and Kototabang (0.20 ^{o}S, 100.32 ^{o}E, dip -10.1^{o}), Indonesia. The Spread-F signatures are manually categorized into three types: the frequency spread-F (FSF), the range spread-F (RSF) and the mixed spread-F (MSF). The observation results compare the occurrence of each ESF type after the local sunset over the conjugate stations by the monthly average percentage. We found that FSF is a dominant signature for all of the conjugate stations, Kototabang, Chiangmai and Chumphon, respectively, and the highest percentage is in February 2009 at the southern hemisphere station : Kototabang. While the RSF is higher at the station around the magnetic equator than stations in the southern and northern hemisphere. The RSF occurrence percentage is at the maximum level in March 2009 at Chumphon. In addition, we also analyze the monthly mean virtual height of F-layer bottom side (h'F) with the RSF occurrence at all three stations.

Session 6

Global ionospheric response to SSW events during recent extended solar minima conditions

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Abstract

The interrelation between Sudden Stratospheric Warming (SSW) and ionosphere is a very important scientific objective for ionospheric forecast. The IRI 2012 model included the influence of minor and major SSWs on the variations of electron density of ionospheric D region. This report presents a study of ionospheric response to the SSWs that occurred during minimum of recent solar cycle. The prolonged continuous minimum of solar and geomagnetic activity of the years 2007–2009 allows to examine more carefully the relationship between SSW and processes in the different ionospheric layers, as this period minimized solar and magnetospheric sources in the ionospheric variability. The global observation data of the total electron content (TEC) derived from GPS TEC measurements, electron density vertical profiles and electron temperature derived from Irkutsk incoherent scatter radar and ground-based ionosondes above different mid- and low-latitude locations were utilized. We attempted to reproduce the main characteristics of global ionospheric 2008 and 2009 SSW response using the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP) in order to examine different hypothesis concerning to formation mechanisms of ionospheric variability. GSM TIP simulation reproduces the global negative response of the *F*2 region electron density and predicts the positive response of electron temperature at 300 km during SSW event. In addition, we consider in details the variability of the mid-latitude sporadic *E* layer and the equatorial *F*3 layer characteristics before and during SSW events.

These investigations were carried out at a financial support of RFBR Grants No. 12-05-31217 and 12-05-00392 and RAS Program 22.

Session 6

The model study of the mesospheric tides influence on the spectral characteristics of tides and planetary waves in the thermosphere-ionosphere system

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Abstract

This report presents the investigation results of the mesospheric tide influence on the tidal variations and planetary waves in the thermosphere-ionosphere system. The model study was performed using the Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP). In the presented model runs, the mesospheric diurnal and semi-diurnal tidal variations were taken into account in the spatial-temporal distributions of atmospheric parameters at the lower boundary of the GSM TIP model (80 km). For this purpose, we applied the different middle atmosphere models. The different modes of migrating and non-migrating tidal variations in the thermosphere are extracted from simulation results. The spectral analysis of tidal variations and mean fields give the possibility reveal the main features of vertical distribution of tidal and planetary waves in the thermosphere, and the role of the mesospheric tides in these processes. Special attention was paid to the direct excitation of non-migration tidal waves in the thermosphere due to the interaction of tidal and planetary waves, as well as interactions of neutral and charged components in the upper atmosphere. We propose a physical interpretation of the identified tidal variations in the thermosphere. In addition, we present the comparison of the global ionospheric maps obtained using two GSM TIP model runs (with and without the mesospheric tides) and IRI model in order to estimate whether accounting mesospheric tides improves the calculation results using the model GSM TIP.

These investigations were carried out at a financial support of RFBR Grants No. 12-05-31217 and 12-05-00392 and RAS Program 22.

Session 7

Latitudinal and Altitudinal Changes of Day-to-Day Variability of Electron Density in the Topside Ionosphere

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Abstract

The International Reference Ionosphere (IRI) describes the monthly average behavior of Earth's ionosphere based on most of the accessible and reliable ground and space observations of ionospheric parameters. IRI is doing an excellent job in accurately representing these average conditions as countless comparisons with additional data have shown and as acknowledged by the fact that international organizations (COSPAR, URSI, ISO, ECSS) have accepted IRI as their ionosphere standard. However, with our ever-increasing dependence on space technology it has become important to go beyond the monthly averages and to provide a description of the day-to-day variability of the ionosphere. We have used electron density profiles deduced from Alouette 1,2 and ISIS 1,2 topside sounder ionograms to investigate the altitudinal and latitudinal changes in day-to-day variability of the electron density in the topside ionosphere. We use the relative standard deviation (PV=standard deviation/mean) around the monthly mean as measure for ionospheric variability and find that the topside PV increases with altitude up to a maximum value of about 50% before decreasing again towards higher altitudes; the height of this maximum changes with latitude and season. Latitudinal peaks of PV are found at the outer flanks of the anomaly peaks. PV decreases with solar activity in the lower topside and increases in the upper topside.

Some frequency parameters of Es layers at Kaliningrad station in summer and winter period of 2008 – 2010 and its connection with SSW events

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Abstract

This study demonstrates some parameter variability of sporadic *E* layers that is placed in the context of atmosphere-ionosphere coupling at Kaliningrad station (20° E, 54° N) during summer and winter seasons 2008 – 2010 years. This period is characterized solar minimum and quiet geomagnetic conditions. The statistical experimental results of probability observations of Es (PEs) and frequency (foEs) are shown. The differences between summer and winter diurnal variations PEs and foEs are interpreted for period under study.

At present, the consensus is that the layer formation and altitude descent is driven mainly by the global system of tidal winds in the lower thermosphere. The main part of the paper is the observational effects of planetary waves on sporadic *Es* connected with sudden stratosphere warming (SSW) events. The results of comparisons *Es* parameters with SSW have occurred at February 2008, January 2009 and the end of January – beginning of February 2010 are presented. The wavelet analyses of *Es* parameters for the mentioned above SSW periods are performed and discussed.

Session 7

An analysis of the variability of the critical frequency of the F2-region on quiet conditions

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Abstract

The need of a better description of the variability of ionospheric parameters has been pointed out in the framework of the IRI Task Force Activities and IRI Workshops. The users of the IRI model not only need to know the monthly average of the ionospheric parameter but also the average deviations from this monthly average. Although many efforts have been done in the past, the IRI model does not provide yet information of the variability. This topic was particularly discussed during the international **RAPEAS** (**R**ed **A**rgentina **P**ara el **E**studio de la **A**tmósfera **S**uperior) meeting organized by CONICET and La Plata University during November 2012. The present paper is a result of the contributions of many colleagues (most of them participating in the meeting) and its objective is to contribute to the formulation of a model of the variability of foF2 for quiet conditions (only days with daily Ap at or below 15 are considered). The variability index used in our analysis is the relative standard deviation STD/mean (in units of %). The foF2 database includes quiet-time hourly values from stations located between 50.0° N and 68.1° S. The variability of the parameter is being analyzed as a function of local time, season, solar activity and modip. We will present first results from this RAPEAS study project. The plan is to establish a table of the representative values for a wide range of conditions and then use an interpolation scheme similar to the one used for the bottom-side thickness parameter B0 in IRI.

Session 7

Validating the Vary-Chap model of the topside ionosphere electron density profile

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Abstract

The Vary-Chap model of the topside ionosphere electron density profile is an empirical model that is derived from analyzing some 80,000 profiles measured by the topside sounder on the ISIS-2 satellite. The electron density distribution is represented by a Chapman profile with a continuously varying shape function S(h):

$$\frac{N(h)}{N_m} = [S(h)]^{-1/2} \exp\left\{\frac{1}{2}[1 - Y - \exp(Y)]\right\}; \qquad Y = \frac{1}{h_m}\int_{h_m}^{h} [S(h)]^{-1}\, dh$$

The shape function S(h) is derived from the measured profiles, parameterized, and modeled as function of local time, latitude, and season [Nsumei et al., 2012, Radio Science doi:10.1029/2012RS004989]. The ISIS-2 profiles extend to 1,400 km, and a smooth transition is provided to empirical plasmasphere density models [Reinisch et al., 2007, Adv. Space Res., 39]. The Vary-Chap N(h) model can be used to describe the topside electron density distribution in the IRI model where N_m and h_m are specified for each point in time and location by the CCIR or URSI coefficients. Similarly, the Vary-Chap model can be used to represent the topside profiles above ionosonde stations that measure N_m and h_m. The Global Ionosphere Radio Observatory (GIRO) Digisonde stations [Reinisch and Galkin, 2011, *Earth Planets Space* doi:10.5047/eps.2011.03.001] will replace the currently used Chapman function (with constant scale height H) with the Vary-Chap model function.

To validate the Vary-Chap model, comparisons were made with the measured ISIS profiles for different local times, latitudes, and seasons.

Session 7

The use of simulated ionograms and the identification of long term variations in the ionosphere

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Abstract

Using a long temporal series of simulated ionograms it is demonstrated that the accuracy of h_mF2 from ionosonde measurements would be adequate to observe a long-term trend of -14 km/century. This result is discussed on the light of geomagnetic control hypothesis.

Session 7

Towards better description of solar activity variation in IRI topside ion composition model

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Abstract

The IRI model describes ion composition in the topside ionosphere and it has been employed in various studies, like propagation of radio waves close to LHR etc.

More specifically, in IRI-2012 there are two options for the ion composition for the topside ionosphere: a) TTS-2003 model (Triskova et al., 2003) and b) DY-1985 model.

Using new C/NOFS CINDI data it was found that IRI predicted values of ion composition did not fully reflect the extremely low solar activity conditions during the years 2008 and 2009 (Heelis et al., 2008; Klenzing et al., 2011).

We present a revised ion composition model which was included in IRI as the TTS-2003 option. We employed a better description of solar activity variation based on assumption of a linear dependence of logarithm of absolute densities of individual ion species (H^+, O^+, He^+ and N^+) on the F10.7 index which holds very well (Truhlik et al., 2005). The revised model employs revised data from Atmosphere Explorer C&E and Intercosmos 24 satellites on absolute ion densities unlike the relative densities employed in the TTS-2003 model. As the output, the model produces relative densities which are calculated as fractions of densities of individual ion species normalized in sum to 1. Absolute densities are then obtained from IRI electron density model (e.g. NeQuick option etc.).Validation of the revised ion composition model is presented, especially the attention is paid to the upper transition height. We also discuss a possible inclusion of newly available C/NOFS data into a future version of the model.

References.

Heelis, R.A., Coley, W.R., Burrell, A.G., Hairston, M.R., Earle, G.D., Perdue, M.D., Power, R.A., Harmon, L.L., Holt, B.J., Lippincott, C.R., 2009. Behavior of the O+-H+ transition height during the extreme solar minimum of 2008. Geophys. Res. Lett. 36, doi:10.1029/2009GL038652.

Klenzing, J., F. Simões, S. Ivanov, R. A. Heelis, D. Bilitza, R. Pfaff, and D. Rowland (2011), Topside equatorial ionospheric density and composition during and after extreme solar minimum, J. Geophys. Res., 116, A12330, doi:10.1029/2011JA017213.

Triskova, L., V. Truhlik. and J. Smilauer (2003), An empirical model of ion composition in the outer ionosphere, Adv. Space Res., 31, No. 3, pp. 653-663, doi:1O.1016/S0273-1177(03)00040-1

Truhlik V., L. Triskova, and J. Smilauer, Manifestation of solar activity in the global topside ion composition - a study based on satellite data, Annales Geophysicae, 23, 2511-2517, 2005.

Session 7

On improving the topside ionospheric modelling by selecting an optimal electron density profiler

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Abstract

Since the electron density distribution in the topside ionosphere cannot be measured directly by ground-based ionosondes, other techniques and methods are applied. In theoretical as well as in empirical modeling, to obtain the electron density between the ionospheric density peak and the upper transition level, the following theoretical profilers have been traditionally used during the years: Exponential, Epstein, Chapman-α and Chapman-β. Each of these four well-known profilers can be used for the purpose, but they yield different electron density profile shapes. To investigate which profiler is more suitable under what geospace environment conditions, we used the NSSDC database of topside ionograms. Each of the topside electron density profiles in the database was fitted with each of the four theoretical models. An analysis was then made to study the influence of all kinds of external factors (solar and geomagnetic activity, local time, etc.) on the best-fitting profiler. Several of these influences can clearly be seen in this study. However, from a modelling point of view, the correlations are not strong enough to be used as a basis for the selection of a profiler. An analysis is presented of possible reasons for this, and remedies are suggested. Finally, it is demonstrated that a more useful procedure for selecting the best profiler is to use the clear correlations of the topside profile shape with other characteristics of the local ionosphere – for instance, the height and density of the F_2 peak, the upper transition level, etc. Implementing different topside profilers, and selecting the most appropriate one for a given set of conditions, can significantly improve the modelling experience.

Session 7

Electron density and temperature observed by satellites and incoherent scatter radars

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Abstract

Electron temperature (T_e) in the ionosphere is basically determined by the balance between the heating by photoelectrons, cooling through Coulomb collisions with ions and heat conduction along the magnetic field lines. Many studies have shown a negative correlation between the electron density (N_e) and T_e during daytime because cooling through Coulomb collision increases with increase of N_e. On the other hand, Kakinami et al. [JGR 2011] showed clear positive correlation when the daytime Ne is significantly high ($>10^6$ cm^{-3}) using HINOTORI satellite observations. The correlation turns positive irrespective of latitude, longitude, season, solar flux levels, and magnetic activity levels. We will show additional evidences that the positive correlations are detected in several satellites and incoherent scatter radars. The results indicate that additional heating mechanism exists in high N_e region or neutral temperature affects T_e through ion temperature.

Session 7

Response of equatorial ionosphere to geomagnetic storms: The Betatron induced changes during ionospheric storms

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Abstract

During geomagnetic storms drastic changes are experienced by the critical radio frequency (foF2), by the peak height (h_mF2) of the electron density distribution and by the total electron content (TEC). These changes depend on latitude, local time, seasons, etc... They have been reported in a number of publications on ionospheric storms observations.

Upward and downward drifts of ionization are observed during ionospheric storm events. They are usually attributed to the action of a Disturbance Dynamo (DD). The effects of DD are observed after SSCs and southward turnings of the B_z-component of the IMF. For some authors DDs are presumed to be consequences of "*undershielding*" or "*overshielding"* . How these shieldings are set up from a physical point of view is not explained, it is a "*not yet clearly determined*" process. The electric field generated during "*undershielding/overshielding"* is called "*Prompt Penetration Field* (PPF)" since it penetrates promptly into the equatorial region of the ionosphere down to low altitudes. *Fejer et al. (2007)* postulated that "*short lasting PPF ionospheric electric fields are caused by unsteady ring currents during the geomagnetic storms*".

Others have considered that the observed rises of h_mF2 during main phases of storms should be attributed to "*direct transmission of the eastward zonal component of the Interplanetary Electric Field* (*IEF)*" deep into the equatorial ionosphere…

However, the "*incompleteness in the current comprehension of the physical processes governing the equatorial and low latitude ionosphere during magnetically disturbed times*" was pointed out by *Fejer et al. (2007)*.

We propose here that the Betatron mechanism induced by decreasing Dst-magnetic field contributes to uplift ionospheric electrons and ions at the onset of storm main phases. The Betatron mechanism has similar effects as the hypothetical "*transmission of the IEF"* or "*undershielding*" quoted above. Indeed, at the onset of the Ring Current growth a time dependent electromagnetic field - with a zonal (eastward) electric field component - is emitted as a result of the enhancement of the RC intensity. Like other electromagnetic waves this electromagnetic signal propagates with speed of light, or almost. It propagates from the Ring Current region in all directions, including toward the ionosphere. It has an eastward directed electric field component and exerts a ponderomotive force that lifts up electrons and ions in the equatorial ionosphere.

Conversely, at onset of recovery phases a reverse electromagnetic pulse is generated by the increasing B_z magnetic field component, initiated at the decay of the RC intensity. This reverse elmg field variation carries a westward zonal electric component that down-lifts the guiding centers of plasma particles in the ionospheric and plasmaspheric regions at low latitudes. This down-lift contributes to lower the altitude of h_mF2.

Lemaire et al. (2005)* pointed out that, in addition to the acceleration (and deceleration) of charged particles, the Betatron mechanism induces vertical drifts of guiding centers and mirror points in the equatorial region, during geomagnetic/ionospheric storm events. These vertical drifts add to those attributed to the DD and TAD ionization transport that is considered to drive heated plasma from the auroral zone toward the equator. The relative importance of vertical drifts due to DD and TAD equatorial transport ought be compared to those induced by the Betatron mechanism, and inferred in the current presentation.

*** Lemaire J.F, Batteux S.G. & Slypen I.N. (2005)** *J. Atmosph.& Solar Terrestrial Physics, pp. 719;*
doi: 10.1016/S0273-1177(03)00099-1)

Session 8

Online Slant TEC Computation from IRI-Plas: IRI-Plas-STEC

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Abstract

Slant Total Electron Content (STEC) is defined as the line integral of electron density on a ray path that joins a point on the ground with another point in plasmasphere. Typically, STEC corresponds to the total number of electrons in a cylinder of 1 m^2 base area between a GPS receiver and the GPS satellite. STEC is usually computed using the pseudorange and phase delay recorded by the dual-frequency ground based GPS receiver. Since the ray path that joins the satellite to the ground receiver is very long and it traverses different layers of ionosphere, STEC contains the inherent spatial variability of ionosphere. Therefore, STEC is usually converted to Vertical TEC (TEC) through the use of 'mapping functions' that modify the STEC values only by the elevation angle. The assumption of azimuthal homogeneity of ionosphere may not be valid for all elevation angles. In order to facilitate the investigation of model based azimuthal homogeneity of ionosphere, and the temporal and spatial variability of STEC, a new algorithm has been developed to compute STEC from International Reference Ionosphere Extended to Plasmasphere (IRI-Plas) program. The results of STEC calculation with IRI_Plas-STEC code can be reached online from www.ionolab.org through a user-friendly graphical interface. Without the need for any download, the user can choose online, any position on the earth in geodetical coordinates (which can also be chosen as an IGS or EUREF GPS receiver) and any date. IRI-Plas-STEC can be computed for a specific location, time and date by specifying either the local elevation and azimuth angles or the PRN number GPS receiver. For the choice specific elevation and azimuth angle, STEC is provided as the value in the screen. For the GPS PRN number option, the path of GPS receiver over the chosen coordinate is provided along with IRI-Plas-STEC output with respect to time. The user can also choose to specify the location, date, the elevation and azimuth angles, and the IRI-Plas-STEC can be computed with respect to time. In the other two options, for any user specified location, date and time, the IRI-Plas-STEC will be provided with respect to the elevation and/or azimuthal angle variation. This unique space weather service can be extended to provide any IRI-Plas value along the STEC ray path depending on the demands from the users in the future.

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Session 8

Testing the IONORT-ISP system: comparison between synthesized and measured oblique ionograms

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Abstract

The three-dimensional (3-D) electron density representation of the ionosphere computed by the assimilative IRI-SIRMUP-P (ISP) model was tested using IONORT (IONOspheric Ray-Tracing), a software application for calculating a 3-D ray-tracing for high frequency (HF) waves in the ionospheric medium. A radio link was established between Rome (41.8°N, 12.5°E) in Italy, and Chania (35.7°N, 24.0°E) in Greece, within the ISP validity area, and for which oblique soundings are conducted. The ionospheric reference stations, from which the autoscaled *fo*F2 and *M*(3000)F2 data and real-time vertical electron density profiles were assimilated by the ISP model, were Rome (41.8°N, 12.5°E) and Gibilmanna (37.9°N, 14.0°E) in Italy, and Athens (38.0°N, 23.5°E) in Greece. IONORT was used, in conjunction with the ISP and the International Reference Ionosphere (IRI) 3-D electron density grids, to synthesize oblique ionograms. The comparison between synthesized and measured oblique ionograms, both in terms of the ionogram shape and the maximum usable frequency characterizing the radio path, demonstrates both that the ISP model can more accurately represent real conditions in the ionosphere than the IRI, and that the ray-tracing results computed by IONORT are reasonably reliable.

Session 8

Comparative analysis of two new empirical models IRI-Plas and NGM (the Neustrelitz Global Model)

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Abstract

Models of the ionosphere play an important role in various applications so much interest is in their modification, testing, identification of new uses. The report focuses on testing and comparative analysis of the two models of the ionosphere that have appeared in recent years. One of them is the version IRI-Plas of the IRI model, and the second is the NGM model (the **N**eustrelitz **G**lobal **M**odel). Both of them define characteristics such as the critical frequency foF2, the maximum height hmF2 of the F2 layer, the total electron content TEC, but they are based on different experimental data and approaches. The largest differences are associated with determination of the TEC parameter. In the IRI model it is determined by integrating N(h)-profiles. The NGM model is a global empirical model. The given report supposes to provide a comparison of both models with experimental data for different levels of solar activity and various locations on the globe. The comparison was carried out by the absolute deviation between the experimental and computed values of the parameters and their absolute and relative dispersions. Found that for some levels of solar activity and the places in the world there may be individual (within 2-4 hours) periods when the NGM model gives better results than the IRI model. But, in general, for the parameter foF2, deviations |ΔfoF2| of the NGM model in most cases in 1.5-4 times higher than for the IRI model. Situation for the TEC parameter is better, but only with respect to the IRI-Plas model, but not in the IRI2001model. This situation may be due to the choice of a global map of CODE as the basis for the model of the TEC(NGM). Special attention is paid to discussion of the behavior of models during periods of low activity due to two reasons: 1) characteristics of the deviation between experimental and model parameters in an unusually long period of low solar activity, 2) according to the forecast, in the next decade is expected to lower activity than in the 23 and 24 cycles. It is shown that the NGM model does not provide improvement from the IRI model in low solar activity that would be expected from the principle of building the NGM model.

Session 8

Joint use of the IRI model and satellite data to estimate the total electron density

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Abstract

The total electron content TEC is an important parameter to evaluate the accuracy of positioning, determining the state of the ionosphere, so a large number of papers were devoted both to the experimental study and the modeling of the behavior of the TEC. It is possible to point out at least three ways to determine the TEC: 1) measurements, 2) the integration of theoretical or model N(h)-profiles, and 3) an empirical model. This paper estimates the compliance of the experimental and simulated values of the TEC. As experimental values, global maps of JPL, CODE, UPC, ESA are used the spread of values of which can be up to 2-3 times, and the weighted average IGS. As a model, the version IRI-Plas of the IRI model is used, representing the second method of determining the TEC, and its adaptation to plasma frequencies measured by satellites CHAMP and DMSP. The third method is an empirical model NTCM-GL (the Global Neustrelitz TEC Model). The focus of the given report is on the second way in which is conducted: a) comparison of N(h)-profiles with incoherent scatter radar data, b) assessment of the scatter of N(h)-profiles corresponding to different values of the TEC (from the set of the first group) for adapting the model IRI -Plas to experimental values of foF2, hmF2, c) estimate of the value of TEC(fne) in adapting the model to the plasma frequency fne of satellites. Values of TEC(NTCM-GL) were calculated for all specific days using the F10.7 index. For several stations in different places on the globe, it is shown that the range of TEC(fne) is in most cases in the range of global maps, although TEC(fne) do not coincide with the values of IGS. Most of TEC(NTCM-GL) values are outside of this range. The values of TEC(fne) can be considered as independent estimate of the TEC. If the TEC community will offer some value as a reference of TEC, the TEC(fne) can be used to refine plasmaspheric part of the N(h)-profile.

Session 8

IRI-2011 ray paths simulation for mid-latitude SuperDARN station in Poland

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Abstract

Simulation of radio ray paths in IRI2011 ionosphere is performed in order to identify possible ionospheric backscatter echo for hypothetical mid-latitude SuperDARN station placed in Wierzbowa (51, 39°N 15, 76°E), Poland. Computation is made with the use of Virginia Tech ray tracing software (courtesy of S. Larquier). Results for different boresights, season, local time, solar cycle phase and geomagnetic activity are presented. Radar capabilities are analysed in the context of possible applications like monitoring of local ionosphere for Poland, monitoring of ionosphere for European Galileo system, input to ESA Space Situation Awareness System.

IRI Workshop 2013

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