Commission G

IRI Workshop Report

International Reference Ionosphere Workshop 2009, Kagoshima, Japan, November 2-7, 2009

The 2009 URSI/COSPAR Workshop on the International Reference Ionosphere (IRI) was held at Kagoshima University in Kagoshima, Japan from November 2 to 7, 2009. IRI is a joint project of the International Union of Radio Science (URSI) and the Committee on Space Research (COSPAR). Annual meetings are the primary venue for the improvement of the IRI representation of ionospheric parameters, such as electron density, electron temperature, ion composition and ion temperatures and total electron content (TEC). The special emphasis of the 2009 Workshop was on (1) regional modeling of the ionosphere and (2) ionosphere/atmosphere/ geosphere coupling studies for improvement of IRI. Other topics of interest for the workshop included comparisons of IRI with other models and with satellite/ground observations, proposed changes to the IRI models for improved performance and accuracy, and applications of the model in the many areas of interest. The workshop homepage with more information and workshop details is at http://www.ep.sci.hokudai.ac.jp/~iri2009/. The workshop received financial support from the following sponsors: COSPAR, URSI, Kagoshima Prefecture, Kagoshima City, Hokkaido University, Japan Aerospace Exploration Agency (JAXA), Kagoshima University, National Institute of Information and Communications Technology (NICT), Air Force Office of Scientific Research, Society of Geomagnetism and Earth, Planetary and Space Sciences, Society for Promotion of Space Science, Hombo Shoten Company Ltd, Keirinkan Company Ltd, AD Company Ltd, Elm Company Ltd. The workshop was a great success with 113 participants from 20 countries including many students and several first time IRI contributors from Japan, China, Taiwan, Korea, Thailand, Malaysia, and Phillipines. The 117 presentations were grouped into one poster session and three oral sessions covering the topics "Structure and Dynamics of the Ionosphere", "Solar and Geomagnetic Variability of the Ionosphere", and "Ionosphere-Thermosphere Coupling". A Final Discussion session reviewed the presented results and came up with proposals for future improvements of IRI.

Papers presented at the workshop were based on data from many ground stations and satellites including ionosonde stations, incoherent scatter radars, and the Alouette, ISIS, AE-C, Akebono, CHAMP, GPS, ROCSAT-1, Demeter, DMSP, TIMED, IMAGE, COSMIC, and TOPEX/Jason satellites. Radio occultation measurements from the COSMIC constellation are a promising new data source for improvements of the global representation of the topside and plasmaspheric electron density in IRI and were extensively discussed during the meeting. Comparisons with ionosonde and incoherent scatter radar data are helping to correct and improve the COSMIC data analysis scheme. Test computations in an IRI ionosphere were also used to evaluate the density re-construction technique. Agreement with ionosonde bottomside profiles is generally below the 10% level but larger discrepancies are found in the topside when comparing with incoherent scatter radar measurements. Demeter launched in 2004 and still operating is another global data source for IRI covering the recent extended low solar minimum. First comparisons presented at the meeting show that IRI electron densities are higher than the Demeter measurements and electron temperatures are lower. Data from several new ionosonde stations were presented at the meeting and compared with IRI. This includes the Korean Anyang station (geographic latitude=37.4N, longitude=127E; geomagnetic latitude=27.7N), the Thai Chumphon station (10.7N, 99.4E; 3.2S), the Thai Chiang Mai station (18.8N, 98.9E; 13.2N), and the Indonesian Katotabang station (0.2S, 100.3E; 10.1S). The last three are aligned along the 100 degree meridian and they are part of the South East Asian Low-latitude IOnospheric Network (SEALION) network that also include the Vietnamese stations in Phu Thuy (21.03°N, 105.96°E) and Bac Lieu (9.30°N, 105.71°E). Data from these stations are of particular interest for modeling the Equatorial Anomaly in the Asian sector.

During the Final Discussion session the Working Group decided on several improvements for the next release of the model. Most importantly the improved representation of the seasonal and solar cycle variations of the bottomside electron density profile as modeled by Altadill et al. (Ebro Observatory, Spain) based on ionosonde data will be introduced into IRI. For the F peak the goal is to introduce the neural Network models of McKinnell (South Africa) and Oyeyemi (Nigeria) into IRI. These models are based on a much large volume of data than the original CCIR and URSI models and they have proven to be superior to the older models. At

auroral latitudes IRI-2010 will benefit from the efforts of two groups using TIMED data. Mertens et al. (NASA Langley, USA) have used SABER data for the development of an E-peak storm model and Zhang and Paxton (APL/JHU, USA) have developed a model for the auroral particle energies and fluxes and the auroral boundaries based on GUVI data. With the inclusion of auroral boundaries and the description of the expansion of the oval with magnetic activity, the IRI team can now focus on the representation of characteristic structures like the sub-auroral Ne depletion (trough) and Te enhancement. In the topside the Vary-Chap approach of Reinisch and Huang (UML) for Ne has reached a high degree of maturity but still needs a global study of the relationship between the topside and bottomside scale height. Several presentations during the workshop reported on sporadic E occurrence statistics, a parameter not yet included in IRI. This information would be important for HF communication, especially over long distances. A good approach would be to model the occurrence probability at different frequencies.

For the electron temperature IRI-2010 will include the new model that Truhlik et al. (IAP, Czech Republic) presented at the meeting. The model is based on a large volume of in situ measurements from different satellites and the main improvement over its predecessor is the inclusion of the solar activity dependence of Te. The same needs now also to be done for the ion temperature. A better model is also scheduled to be included for the molecular ion densities in the bottomside ionosphere. This has long been a weak point of IRI because of the limited availability of reliable data for these parameters. The new model is based on the well established photochemistry in this region and on normalizing the chemical equilibrium calculation to the IRI electron density (Richards and Bilitza, George Mason U, USA). In the D-region the model of Friedrich (TH Graz, Austria) for the transition height from molecular to cluster ions will be a new addition to IRI.

The meeting program and logistics were expertly handled by the Local Organization Committee chaired by Shigeto Watanabe (Hokkaido U., Japan). The LOC also organized a very informative scientific excursion to the Yamagawa Radio Observatory of the National Institute of Information and Communication Technology (NICT) with a visit and luncheon at the Ibusuki resort. A new feature was the awarding of Best Student Paper Awards. The first recipients were Y. Y. Sun (National Central U., Taiwan) "The comparison of Low latitude Spread-F measured by IRI2007, FORMOSAT-1 and GPS ground-based receivers during solar maximum", A. Ichihara (Nagoya U., Japan) "Nighttime medium-scale traveling ionospheric disturbances propagating northward observed by the SuperDARN Hokkaido HF radar and GEONET", T. Kondo (Hokkaido U., Japan) "Thermospheric zonal neutral wind and zonal plasma drift controlled by F-region dynamo", N. Kitamura (Tohoku U., Japan) "Solar zenith angle dependence of the electron density profile in the polar topside ionosphere during geomagnetically quiet periods in the solar maximum".

Papers from the 2007 IRI Workshop have now been published in two issues of Advances in Space Research:

Bilitza D., Jan Laštovička, B. Reinisch, (eds.), Ionosphere - Modelling, Forecasting, and Telecommunications I, Advances in Space Research, Volume 43, Number 11, Pages 1595-1846, 2 June 2009.

Reinisch, B., Bilitza D., Jan Laštovička, (eds.), Ionosphere - Modelling, Forecasting, and Telecommunications II, Advances in Space Research, Volume 44, Number 6, Pages 641-774, 2 June 2009.

The papers from the Kagoshima Workshop will be published in a special issue of "Earth, Planet, Space" (EPS). The next IRI meetings are planned as follows:

2010   COSPAR Scientific Assembly, Bremen, Germany, July 18-25, 2010,
            2-day session on IRI in the auroral and polar ionosphere. (MSO: Bilitza)
2011   1-week workshop at the Hermanus Observatory in Hermanus, South-Africa (MSO: McKinnell)
2013   University of Warmia and Mazury in Olsztyn, Poland (MSO: Krankowski)