European DIgital upper Atmosphere Server

DIAS

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In this issue:

DIAS is a demonstration project co-funded by the eContent programme of the European Commission, of two years duration (2004 - 2006).

DIAS consortium members:

- National Observatory of Athens, Greece (Co-ordinator)
- University of Athens, Department of Telecommunication and Informatics, Greece
- Rutherford Appleton Laboratory, Council for the Central Laboratory of the Research Councils, UK
- National Institute of Geophysics and Volcanology, Italy
- Swedish Institute of Space Physics, Sweden
- Leibniz Institute of Atmospheric Physics, Germany
- Space Research Center, Polish Academy of Sciences, Poland
- Blustaff S.p.A., Italy

DIAS data contributors:

- Pruhonice Ionospheric Station Institute of Atmospheric Physics, Czech Republic
- Observatori de l'Ebre, Spain

NEWS

DIAS Final Conference

The DIAS Final Conference will be held on **18 and 19 May 2006 in Rome**, having as basic objectives the full demonstration of the DIAS system in terms of products and services and the presentation of the exploitation efforts in order to ensure the continuation of the service after the phase sponsored by EC. Bringing together data providers and users from large institutions and companies, the DIAS Final Conference may represent a unique opportunity to demonstrate and test all products and services released by DIAS and to express the users' needs, opinions and comments, as well as to make direct contact with the most important potential users.

The first day of the Final Conference will be held at the Conference Hall of the Istituto Nazionale di Geofisica e Vulcanologia, where the DIAS members will give detailed presentations on the technical achievements. The second day will be held at the Hotel Forum, in the centre of Rome, and will be devoted to the demonstrations of the system and to discussions with users, emphasizing on users' experience for DIAS products and services in use.

All of the DIAS potential users are cordially invited to attend the DIAS Final Conference. To register, please visit the DIAS web site:

http://www.iono.noa.gr/DIAS

where you may find more information on the agenda and local organizing arrangements.

DIAS Web Demonstrator and DIAS server prototype

Two interfaces are available to evaluate DIAS services. The WEB DEMONSTRATOR is available to **anyone** who would like to view a display of all the DIAS services in their final form. This Demo gives the opportunity to explore the DIAS products and services for a pre-selected period (from 5th to 14th of September 2005).

The SERVER PROTOTYPE offers, to **registered users**, online access to added-value products of real-time ionospheric data over Europe.

DIAS Training kit

The training kit for DIAS user includes a new release of DIAS brochure and the demonstration CD of DIAS products and services.
It is possible to receive the web demo CD asking for it at the address: dias@ingv.it.

TUTORIAL

Scientific models for the development of DIAS products and services

DIAS products and services provide a range of new and improved ionospheric mapping, now-cast and forecasting services using data from a number of European Ionospheric Sounder stations. They are based on following scientific models published in international journals (see References):

- **SIRM family of models including:**
  - Simplified Ionospheric Regional Model - **SIRM**;
  - Real-time updating of the Simplified Ionospheric Regional Model – **SIRMUP**
  - **MUF-SIRM&LKW** and **MUF-SIRMUP&LKW** maps of the basic Maximum Usable Frequency;
- Three dimensional instantaneous model of the ionospheric electron density - **Ne3D**;
- Geomagnetically Correlated Autoregression Model - **GCAM**;
- Ionospheric Activity index - **AI**.

These products and services are provided on line at DIAS system (see http://www.iono.noa.gr/DIAS) in:

- **Time-Plot format**. This option concerns prediction/forecasting over single ionospheric stations;
- **Map format**. This option concerns 2D view (longitude versus latitude) of the predicted/forecast ionospheric conditions over Europe.
- **Text format**. Both the above options provide the user the possibility to download the data in text format.

DIAS SIRM hourly maps of foF2 and M(3000)F2 long-term prediction are monthly median foF2 and M(3000)F2 ionospheric maps over the European area for different solar epochs based on Simplified Ionospheric Regional Model (see Figure 1). Test results for SIRM long-term mapping of foF2 and M(3000)F2 give the rms error: σ(foF2)=0.6 MHz and σ(M(3000)F2)=0.11

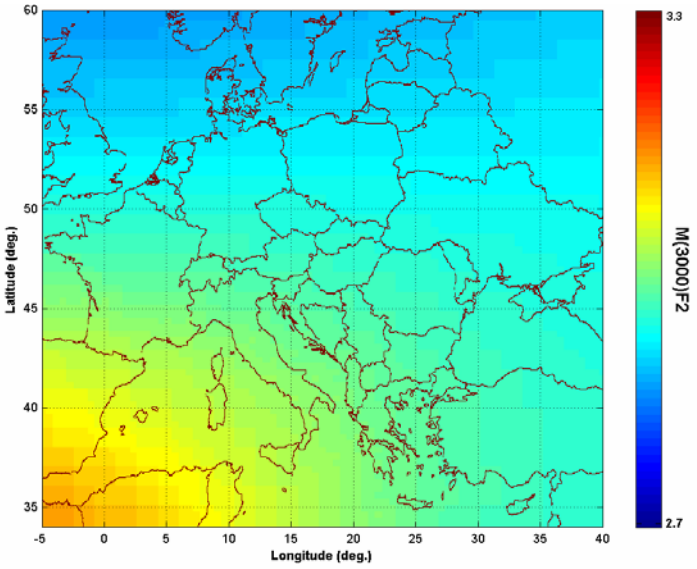

Fig.1. SIRM ionospheric map of the M(3000)F2 over Europe from 5^0 W to 40^0 E in longitude and from 34^0 N to 60^0 N in latitude on 18 August 2001 at 0900UT.

SIRMUP 15 min maps of foF2 and M(3000)F2 now-casting are maps over the European area of foF2 and M(3000)F2 for individual epochs for the now-casting frequency management. They are produced by real-time updating of the SIRM - SIRMUP with autoscaled ionospheric parameters observed by DIAS ionosondes (see Figure 2). The SIRM updating method (**SIRMUP)** is based on the idea that real time values of foF2 and M(3000)F2 at one location can be determined from the SIRM model by using an effective sunspot number, Reff, instead of the 12-month smoothed sunspot number, R12.

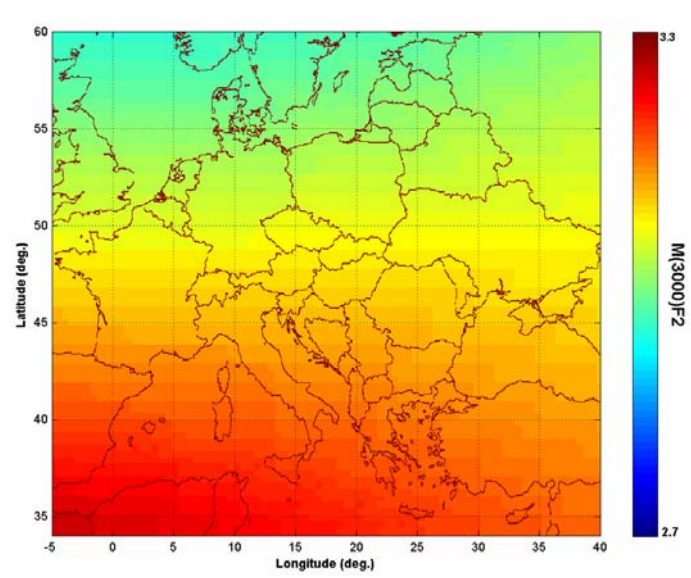

Fig. 2. Maps of M(3000)F2 on 18 August 2001 at 0900UT generated by SIRMUP.

The method of determining Reff is introduced to give the best fit between model calculation and actual measurements obtained from a grid of ionosondes located in the mapping area (see Figure 3).

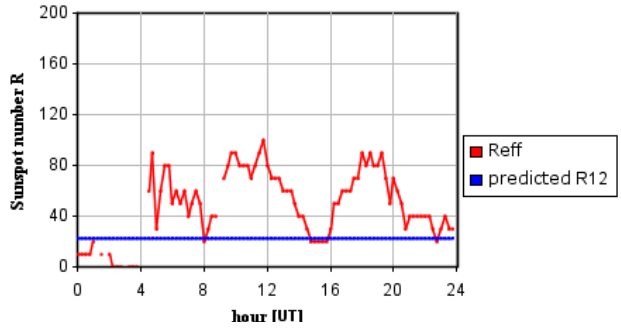

Fig 3. Reff and R12 on 12 September 2005.

MUF-SIRM&LKW and MUF-SIRMUP&LKW produce maps of **hourly MUF long-term prediction and now-casting**, respectively. It is the method producing a grid of the basic MUF values for a given transmission point in the European area and accompanied map. Predicted foF2 and M(3000)F2 for a given epoch come from the SIRM and SIRMUP family of models. Chapman model is used for foE required input values and Lockwood empirical formulas are used to calculate the basic MUF for a transmission between two given points (see Figure 4). Test RMS results for MUF by SIRM&LKW have shown a strong seasonal variations being greater during winter and lower during summer with 1.5 MHz in average.

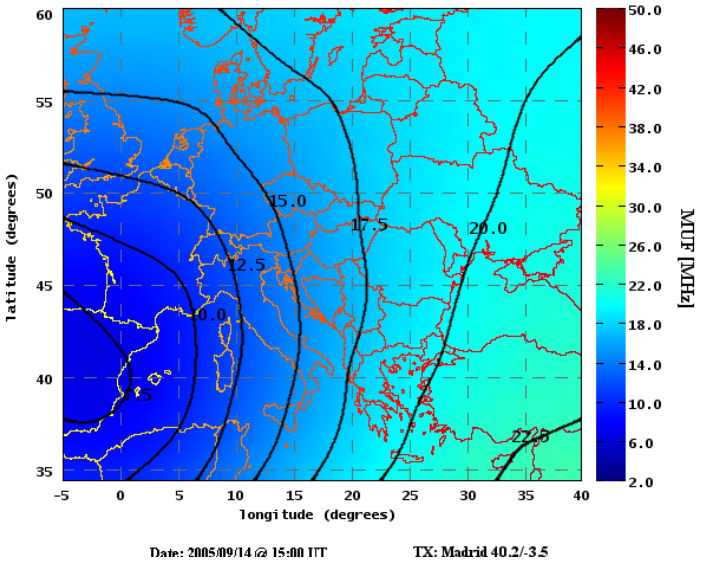

Fig. 4. An example of MUF map for 14 September 2005 at 1500UT (TX: Madrid 40.2^0 N, 3.5^0 E).

Ne3D 15 min maps of electron density are generated by a three dimensional model of the ionospheric electron density by using real-time calculated electron density profiles from DIAS ionosondes and the NeQuick model as the background model to add data during the interpolation procedure (see Figure 5).

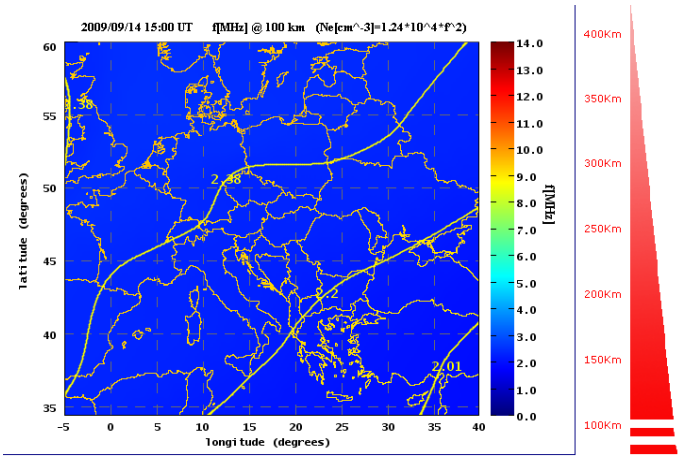

Fig. 5. An example of Ne map for 14 September 2005 at 1500 UT

Statistical analysis of the accuracy shows that:

- the method gives a shift that grows with height from about +5% at lower heights up to +25% at the height of maximum electron density;
- RMS of relative error strongly depends on height and ranges from 20% at height of E layer, 80% at 200 km, 40% at 250 km and higher grows rapidly above 100% above hmaxF2

Plots of foF2 forecasted values in each DIAS station location, calculated following the Geomagnetically

Correlated Auto-regression Model – GCAM, NOA development of Muhtarov et al., method, 2002.

Ionospheric forecast maps over the European area representative of foF2 conditions up to 24-hours ahead for use in spectrum management. They are based on the SIRMUP technique, using the GCAM forecasted values at the location of DIAS ionosondes for the updating of the grid (see Figure 6).

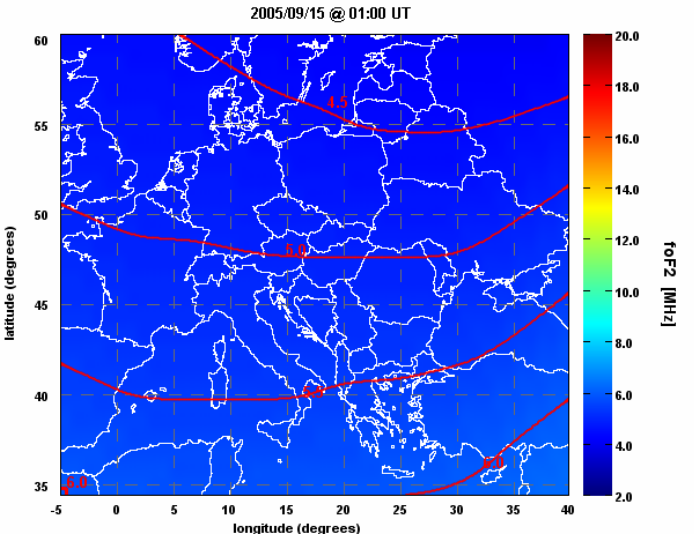

Fig. 6. foF2 forecast map over the European area representative Ionospheric conditions on 15 September 2005 at 0100 UT.

GCAM proved to perform successful predictions under all possible ionospheric conditions. In particular, during:

- **Quiet geomagnetic conditions**, the relative deviation of the predicted from the observed values estimated to be about **10%** especially in short-term forecasting **from 1 to 12 hours ahead**. **Disturbed geomagnetic conditions**, the GCAM succeed in following up the disturbance onset and recovery. The relative deviations show a **slightly higher than 10% values**, giving again better results for short-term forecasting **from 1 to 12 hours ahead**.

Real-time Ionospheric alert index (AI_R) provides every 15 minutes a representative picture of the disturbed ionosphere over Europe. The AI_R is calculated at multiple stations simultaneously according to the formula:

$AI_R(t) = 100^* (foF2(t)-foF2med)/foF2med$

where foF2(t) is the current observed value at each station and the foF2med is the 30-day running median.

Forecasted Ionospheric alert index (AI_F) provides every hour the forecasting of ionospheric activity up to 24 hours ahead calculated according to the formula:

$AI_F(t+s) = 100^*(foF2^f(t+s)- foF2\ med(t+s))/foF2\ med(t+s)$

where $foF2^f$ (t+s) is the forecasted value s steps ahead and foF2 med(t+s) is the 30 days running median for the hour under forecast.

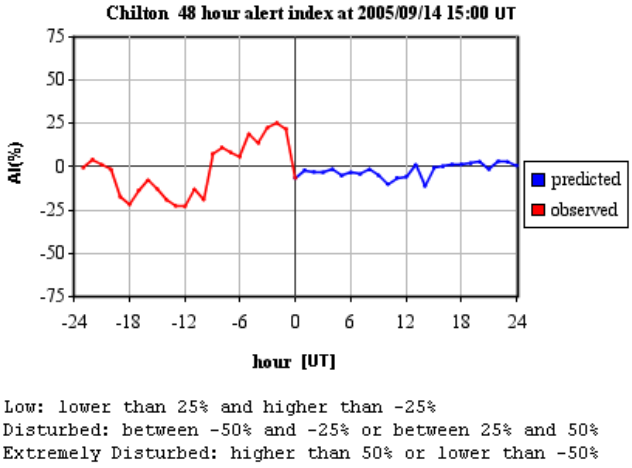

Fig. 7. Ionospheric Activity index, observed and predicted at Chilton station.

Criteria for ionospheric activity are defined as follows (see Figure 7):

AI(foF2) within ±25% - low ionospheric activity
AI(foF2) within ±25% to ±50% - disturbed ionospheric conditions
AI(foF2) beyond ±50% - extremely disturbed ionospheric conditions

These three disturbance levels: "low" – "disturbed" – "extremely disturbed" are not seriously affected by a mean error of about 5 % for the estimated AI indices.

Subject to future considerations and collaborations with organizations from outside Europe (e.g. Australia, USA) could be the application of these **DIAS Scientific Models for products and services** in generating maps of ionospheric characteristics at different regions all over the world providing that required input ionospheric data are available.

References

Belehaki A., Lj. R. Cander, B. Zolesi, J. Bremer, C. Juren, I. Stanislawska, D. Dialetis, and M. Hatzopoulos, DIAS Project: The establishment of a European digital upper atmosphere server; *J. Atmos. Solar-Terr. Phys., 67, 1092-1099, 2005.*

Leitinger, R., Radicella, S., Nova, B., Electron density models for assessments studies – new developments, Acta Geodetica Hungarica, 37(2-3), 183-193, 2002.

Lockwood, M., A simple M-factor algorithm for improved estimation of the basic maximum usable frequency of radio waves reflected from the ionospheric F region, Proc. IEE, Vol. 130F, 296-302, 1983.

Muhtarov, P., I. Kutiev, and Lj. R. Cander, Geomagnetically correlated autoregression model for short-term prediction of ionospheric parameters, Inverse Problems, 18, pp. 49-65, 2002.

Stanislawska, I., Juchnikowski, G., Hanbaba, R., Rothkaehl, H., Sole, G., Zbyszynski, Z., COST251 Recommended Instantaneous Mapping Model of Ionosphere Characteristics – PLES, Phys. Chem. Earth(C), Vol.25, No.4, pp.291-294, 2000.

Stanisławska I., G. Juchnikowski, and Z. Zbyszyński, 2001, Generation of instantaneous maps of ionospheric characteristics, Radio Sci., 36(5), 1073-1981

Tsagouri, I., B. Zolesi, A. Belehaki, and Lj. R. Cander, Evaluation of the performance of the real-time updated Simplified Ionospheric Regional Model for the European area, J. Atmos. Sol-Terr. Phys., 67(12), pp. 1137-1146, 2005.

Zolesi, B., A. Belehaki, I. Tsagouri and Lj.R. Cander, 2004, Real-time updating of the Simplified Ionospheric Regional Model for operational applications, Radio Science, 39, RS2011, doi:10.1029/2003RS002936

Zolesi, B., Lj.R. Cander and G. de Franceschi, 1996, On the potential applicability of the simplified ionospheric regional model to different midlatitude areas, Radio Science, 31, 3, 547-552

Zolesi, B., Lj.R. Cander and G. de Franceschi, 1993, Simplified ionospheric regional model for telecommunication applications, Radio Science, 28, 4, 603-612

Zolesi, B., Lj.R. Cander and G. De Franceschi, 1999, The Improved SIRM, a simple Ionospheric model for the extended regional European Area, Paper presented during the poster session at the URSI, XXVI General Assembly, Toronto, Ontario, Canada

RELATED CONFERENCES

- International Advanced School on Space Weather
  Abdus Salam International Center for Theoretical Physics
  Trieste, Italy
  2 - 19 May 2006
  http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a05201

- IEE Ionospheric Radio Systems and Techniques conference
  London, UK
  18 - 21 July 2006
  http://conferences.iee.org/IRST2006/

- 36th COSPAR Scientific Assembly
  Beijing, China
  16 - 23 July 2006
  http://www.cospar2006.org/

- Third CNES Workshop On Earth-Space Propagation
  Toulouse, France
  25 - 27 September 2006
  http://www.cnes.fr/

- Course on "Solar - Terrestrial Physics" - Advanced School in Space Environment - 2006
  L'Aquila, Italy
  10 - 16 September 2006
  http://www.cifs-isss.org/

- IRI Workshop 2006 - New Measurements for Improved IRI TEC Representation
  Buenos Aires, Argentina
  16 - 20 October 2006
  http://www.casleo.gov.ar/WSIRI2006 (not yet operable)

PRESENTATION OF DIAS RESULTS IN INTERNATIONAL MEETINGS

3rd EGU Assembly (Vienna, Austria, 2 - 7 April 2006), session ST5.7 "Measurements of ionospheric parameters influencing radio systems"
"Ionospheric specification and forecasting based on observations from European ionosondes participating in DIAS project"
A. Belehaki, Lj. Cander, B. Zolesi, J. Bremer, C. Juren, I. Stanislawska, D. Dialetis and M. Hatzopoulos

PUBLISHED PAPERS ABOUT DIAS

"*DIAS Project: The establishment of a European digital upper atmosphere server*", Belehaki A., Cander Lj., Zolesi B., Bremer J., Juren C., Stanislawska I., Dialetis D., Hatzopoulos M., Journal of Atmospheric and Solar-Terrestrial Physics, Vol. 67, no. 12, pp. 1092-1099, 2005.

CALL FOR CONTRIBUTIONS TO DIAS NEWSLETTER

If you would like to submit a short contribution for the next issue of the DIAS newsletter, please contact the editorial office: DIAS@ingv.it.

The goal of DIAS is to develop a pan-European digital data collection on the state of the upper atmosphere, based on historical data collections and on real-time information provided by ionospheric stations belonging to Public European Research Institutes. DIAS services, such as radio propagation characteristics for the European region, ionospheric maps, alerts and warnings for ionospheric disturbances, etc., will be useful for large number of HF communication and navigation systems users and will contribute to the formation of a network of public research institutes and private sector users. For the effective exploitation of DIAS products and services a network of users will be established that will work together with DIAS data providers to bring out the full potential of this type of information.

Detailed information about the project can be found on DIAS home page (http://www.iono.noa.gr/DIAS/).

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This issue of the DIAS newsletter has been edited by Lucilla Alfonsi and Silvia Pau, INGV- Italy.
The "DIAS Final Conference" in the "NEWS section" has been edited by Anna Belehaki, NOA - Greece.