COST 296 Action: **M**itigation of **I**onospheric **E**ffects on **R**adio **S**ystems (MIERS)

Approved Minutes of the 3rd Management Committee Meeting
14-18 November 2005
ESA, Noordwijk, Netherlands

1. Welcome

The participants were welcomed by Lili Cander (COST 296 Chairperson) who thanked everyone for coming and Bertram Arbesser-Rastburg, the local organiser, for his hospitality in hosting the meeting.

2. Approval of the Agenda

The Draft Agenda for the meeting was approved without any amendments, see ANNEX I

3. Adoption of the Minutes of the first MC meeting

The minutes of the Second MC meeting held at the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, 30, 31 May and 1 June 2005 were approved without any amendments.

4. Official status of the COST 296 Action

The Chairperson LC began the proceedings by asking all the participants to introduce themselves and was delighted to welcome some new first time attendees, from Cyprus and Portugal at a COST 296 meeting. See list ANNEX II

Following this LC proceeded to explain the current status of the signatures to the Action, some participating countries still to sign the MoU.

There were several applications from non-COST countries Institutes to join COST296, the Geomagnetic Laboratory, Natural Resources from Canada has sent an expression of interest and was accepted with Larisa Tritchenko as the representative. LC also received an application from Marina Abdula from the University of Kebangsann, Malaysia, this application was accepted in principle but a letter will be sent to Marina explaining the procedure, this will be written by LC with advice from HS.

5. COST296 Budget 1 July to 30 June 2006

LC reported the status of the COST 296 Budget (ANNEX III) and at this meeting three NR from Greece, Poland and Turkey will be reimbursed from the COST 724 budget, this being a COST 296/274 joint Workshop.

6. Short Term Scientific Missions (STSMs)

The funding for STSMs in this F/Y 1 July 2005 to 30 June 2006. It was decided that the maximum reimbursement for STSM would be 900 Euro per mission. Three proposals were introduced a) Turkey to UK; b) Greece to Czech Republic; c) Italy to France. Members were asked to set up a task group to discuss nominations and first proposals to be presented later in the meeting.

7. **Collaboration between COST296 and COST724 Actions**

IS presented new development at the web page http://www.cbk.waw.pl/cost296/ as one of the COST274/296 joint activity.

8. **Joint School of Space Weather**

JL Chairman of the COST724 Action gave an introductory talk on different opportunities for collaboration between COST296 and COST724 Actions. Among others it is planned to hold an ICTP school on Space Weather to be held in mid 2006.

9. **The 2nd ESWW Proceedings of poster COST296/724 papers**

The 2nd ESWW Proceedings available online at ESA - ESTEC web site:
http://www.esa-spaceweather.net/spweather/workshops/workshops.html

10. **Receipt and adoption of the report on COST296 Seminar in Graz**

The full report for this seminar can be found on the COST296 WWW site: http://www.cost296.rl.ac.uk/minutes.htm

11. **Contributions of the COST296 Action to the ITU-R SG3**

11a. **Invited talk: Dr B Arbesser-Rastburg: 'Opportunities for introducing the conclusions of the COST296 Action into the studies of the ITU-R'**

Dr Arbesser-Rastburg, on behalf of Prof Les Barclay (who unfortunately was unable to attend), presented the opportunities for introduction the COST296 conclusions into the studies of the ITU-R. Full talk on COST296 WWW site: http://www.cost296.rl.ac.uk/pdf/ITU_presentation_BER.pdf

11b. **Invited talk: Prof R Leitinger 'Current status of the ITU-R 3L documents relevant to the COST296 Action**

RL presented the current status of the ITU-R 3L documents revenant to COST296.

12. **Receipt and adoption of the progress reports of Working Group Leaders**

WG 1: Ionospheric monitoring and modelling (ANNEX IV)
WG 2: Advanced terrestrial systems (ANNEX V)
WG 3: Space based systems (ANNEX VI)

13. **COST296 website and logo**

COST 296 web site is up and running and managed at RAL http://www.cost296.rl.ac.uk/ It was decided to that the competition for the COST 296 logo would be chosen by NR's voting by correspondence.

14. **Special issues of the international journals related to the COST271/296**

Annals of Geophysics, Vol. 48, June 2005 collects the contributions presented at the Solar-Terrestrial Sciences session ST17 on "Effects of the Ionosphere on Terrestrial and Earth-Space Communications", held during the European Geophysical Society, American Geophysical Union and European Union of Geosciences Joint Assembly (Nice, France, 6 – 11 April, 2003);

Journal of Atmospheric and Solar-Terrestrial Physics, Vol. 67, August 2005 collects the oral contributions presented at the Solar-Terrestrial Sciences session ST14 on "Space weather and RF communications: monitoring and modelling", held during the 1st General Assembly of the European Geosciences Union (Nice, France, 25 – 30 April, 2004);

Bulgarian Geophysical Journal, collects the poster contributions presented at the Solar-Terrestrial Sciences session ST14, **in press.**

15. International meetings relevant to the COST296 Action

Third CNES Workshop on Earth-Space Propagation**,** *Toulouse, France, 22 - 24 February 2006*
The General Assembly 2006 of the European Geosciences Union (EGU)**,** *Vienna, Austria, 02 – 07 April 2006*
COSPAR, Beijing July 2006
IEE Ionospheric Radio Systems and Techniques Conference*, London, UK, 18-21 July 2006*
EGU: Sept 2006 on Long-term trends
IAGA: Sept 2006 taking place in Bulgaria with Dora Pancheva (University of Bath) as point of contact.
IRI, Argentina October 2006
IPY 2007-08 http://www.cost296.rl.ac.uk/pdf/ipy_ihy1.pdf

16. Other documents for consideration

Professor B Reinisch presented his document on 'Ionogram data format changes' this talk can be found at: http://www.cost296.rl.ac.uk/pdf/SAO XML 5.pdf

Dr G De Franceschi presented a report on the IPY and IHY activities that can be found at: http://www.cost296.rl.ac.uk/pdf/ipy_ihy1.pdf

17. Next meetings of the COST296 Action

Norbert Jakowski kindly offered to host the next COST296 MC meeting at Neustelitz from 27 – 29 April 2006. The meeting will be held in the Park Hotel where all participants would stay. More information will be circulated and posted on http://www.cost296.rl.ac.uk/

It is also planned to hold a joint COST296/IRI Workshop in Prague 2007 – more information to come later.

18. Any other business

NR should contact their representative on COST TIST committee before the Annual Review meetings to ensure that they are properly informed about the activties in COST 296.

ANNEX I

COST 296 Action MC meeting 14-15 November 2005
ESA/ESTEC, Noordwijk
Room: Space Expo - Ariane

Approved Agenda

1. Welcome
2. Approval of the Agenda
3. Adoption of the Minutes of the second MC meeting
4. Official status of the COST29 Action
5. COST296 Budget from 1 July 2005 to 30 June 2006
6. Short Term Scientific Missions (STSMs)
7. Collaboration between COST296 and COST724 actions
8. Joint School of Space Weather
9. 2nd ESWW proceedings of poster COST296/724 papers
10. Receipt and adoption of the report on COST296 Seminar in Graz
11. Contributions of the COST296 Action to the ITU- R SG 3

11a. Invited talk: Dr B Arbesser-Rastburg: ‘Opportunities for introducing the conclusions of the COST296 Action into the studies of the ITU-R’

11b. Invited talk: Prof R Leitinger ‘Current status of the ITU-R 3L documents relevant to the COST296 Action’

12. Receipt and adoption of the progress reports of Working Group Leaders

    WG 1: Ionospheric monitoring and modelling
    WG 2: Advanced terrestrial systems
    WG 3: Space based systems

13. COST296 website and logo
14. Special issues of the international journals related to the COST271/296 actions activities
15. International meetings relevant for the COST296 Action
16. Other documents for consideration
17. Next meetings of the COST296 Action
18. Any other business

ANNEX II
COST 296 Action MC meeting 14-15 November 2006
List of Attendees

B Abesser-Rastburg(BA) ESA, Noordwijk, Netherlands
L Alfonsi (LA) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
D Altadill (DA) Observatory de l'Ebre, Roquetes, Spain **(NR)**
J Azevedo (JA) University of Madeira, Madeira, Portugal **(NR)**
Y Beniguel (YB) IEEA, France **(NR)**
A Belehaki (Abe) NOA, Athens, Greece **(NR)**
A Bourdillon (AB) University Rennes 1, France **(Co-Leader WG-2, NR)**
J Boška (JBO) Academy of Sciences of Czech Republic, Prague, Czech Republic **(NR)**
J Bremer (JB) Leibniz-Institute of Atmospheric Physics, Kühlungsborn, Germany **(NR)**
Lj R Cander (LC) Rutherford Appleton Laboratory, Chilton, Didcot, UK **(Chairperson, NR)**
A Casimiro (AC) University of Algarve, Faro, Portugal **(NR)**
G De Franceschi (GD) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
L Ecomomou (LE) (Cyprus) **(NR)**
T Gulyavea (TG) IZMIRAN, Russian Academy of Sciences, Troitsk, Russia
H Haralambous (HH) (Cyprus) **(NR)**
N Jakowski (NJ) DLR/DFD, Neustrelitz, Germany **(Co-Leader WG-3, NR)**
S S Kouris (SK) Aristotelian University of Thessaloniki, Thessaloniki, Greece **(NR)**
A Krankowski (AK) Institute of Geodesy, University of Warmia and Mazury in Olsztyn, Poland
J Laštovička (JL) Academy of Sciences of Czech Republic, Prague, Czech Republic **(Co-Leader WG-1, NR)**
R Leitinger (RL) Karl-Franzens-Universität, Graz, Austria **(Co-Leader WG-1, NR)**
J Lilensten (JLI) CNRS, France (Chairperson COST 724)
A Mikhailov (AM) IZMIRAN, Russian Academy of Sciences, Troitsk, Russia
D Marin (DM) University of Huelva, Huelva, Spain
B Nava (BN) Abdus Salam ICTP, Trieste, Italy
H Nebdi (HN) Royal Meteorological Institute, Brussels, Belgium
R Pirjola (RP) Finnish Meteorological Institute, Helsinki, Finland **(NR)**
S M Radicella (SR) Abdus Salam ICTP, Trieste, Italy
B W Reinisch (BR) ULM, Lowell, Massachussetts, USA
N Rogers (NR) QinetiQ, UK
V Romano (VR) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
H Rothkaehl (HR) Space Research Centre, Warsaw, Poland **(NR)**
P Sauli (PS) Academy of Sciences of Czech Republic, Prague, Czech Republic
I Stanislawska (IS) Space Research Centre, Warsaw, Poland **(Co-Leader WG-1, NR)**
H Strangeways (HR) University of Leeds, Leeds, UK
I Tsagouri (IT) National Observatory of Athens, Greece
E Tulunay (ET) The Middle East Technical University, Ankara, Turkey + TUBITAK-Marmara Research Center, Kocaeli, Turkey **(Co-Leader WG-2, NR)**
Y Tulunay (YT) Istanbul Technical University, Istanbul, Turkey **(NR)**
A Vernon (AV) Rutherford Appleton Laboratory, Chilton, Didcot, UK **(COST296 Secretary)**
R Warnant (RW) Royal Observatory of Belgium, Brussels, Belgium **(NR)**
M Warrington (MW) University of Leicester, Leicester, UK **(NR)**
C Wilson (CW) Rutherford Appleton Laboratory, Chilton, Didcot, UK
N Zaalov (NZ) University of Leicester, Leicester, UK
N Zernov (NZ) St Petersburg University, St Petersburg, Russia
B Zolesi (BZ) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy **(Vice-Chairman, NR)**

NR: National Representative IR: Institute Representative

ANNEX III

COST ACTION 296

BUDGET FOR THE PERIOD JULY 1ST 2005 TO JUNE 30TH 2006

(1)	SECRETARIAT	**7500€**
(2)	WORKSHOP and 3rd MC MEETINGS	**30000€**
(3)	4th MC MEETINGS	**20000€**
(4)	SHORT-TERM SCIENTIFIC MISSIONS	**9000€**
(5)	SEMINAR	**6000€**
TOTAL		**72500€**

PUBLICATIONS SEPARATE BUDGET

ANNEX IV

Working Group 1 – Ionospheric Monitoring and Modelling

Leaders : J. Laštovička (CZ) and I. Stanislawska (PL)

WP1.1 Near Earth space plasma monitoring
Leaders: R. Stamper (UK) and D. Altadill (ES)

WP1.2 Data ingestion and assimilation in ionospheric models
Leaders: D. Buresova (CZ) and B. Nava (IT)

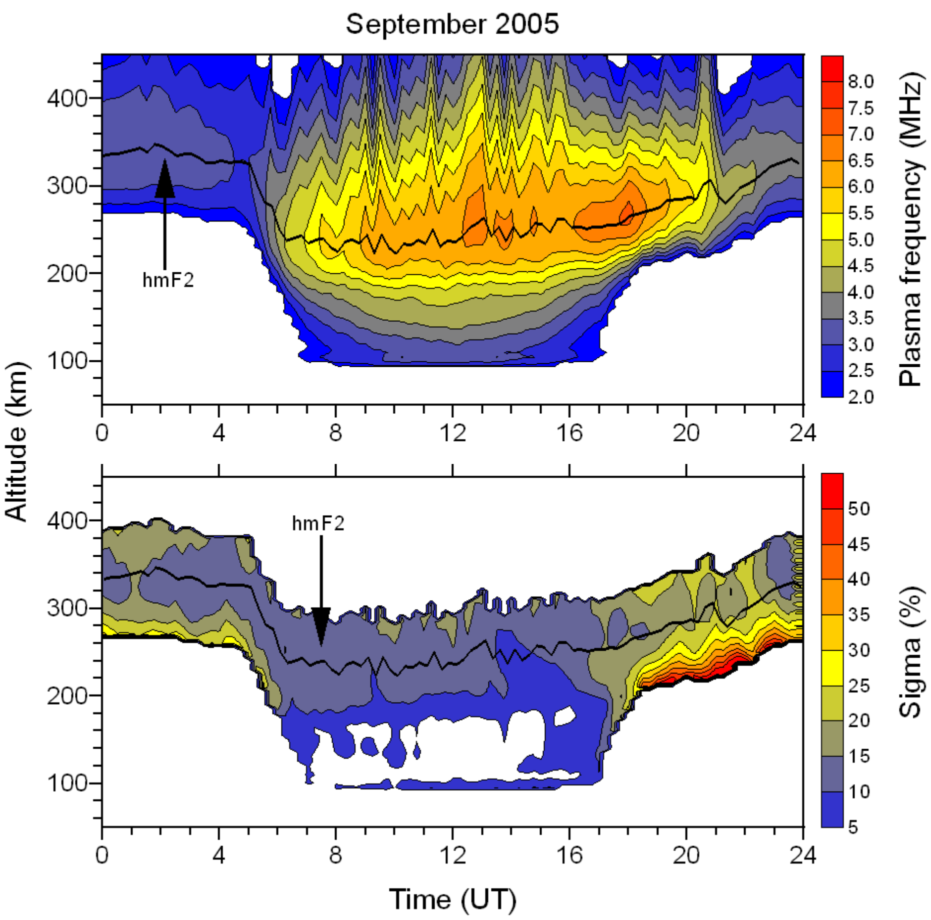
WP1.3 Near Earth space plasma modelling and forecasting
Leaders: I. Kutiev (BG) and H. Strangeways (UK)

WP1.4 Climate of the upper atmosphere
Leaders: J. Bremer (GER) and E. Turunen (FIN)

REPORT ON ACTIVITIES OVER THE PERIOD JUNE-OCTOBER (NOVEMBER) 2005

Monitoring techniques and parameters describing the state of the ionospheric plasma.

The state of ionospheric plasma over the Ebro Observatory is described by the time/altitude electron density variability, including the typical daily pattern, day-to-day variability and typical daily variability.



Maintaining and extending the flow of ionospheric monitoring data to databases.

The COST296 network ionosondes contributed to the COST296 and WDC database at RAL, UK, and some of them contributed to the DIAS prototype database. Ionograms are mostly available at Web sites of individual stations. The ionospheric radio occultation measurements onboard CHAMP has been going on. Automatically retrieved (i.e. not validated) electron density profiles from CHAMP can be directly downloaded via new service SWACI (http://www.kn.nz.dlr.de/swaci/). The validation work has to continue next time.

A new XML-based ionosonde data exchange format SAOXML has been proposed. The new design will allow addition of measurement uncertainties to the data roster, thus making the ionosonde data acceptable to the modern assimilation models based on the Kalman filter method, such as the GAIN.

The experience with the real-time network of 34 digisondes (10 of them are located in Europe) operating in "routine" and "campaign" modes (responding to the automated requests of the "ground truth" data for calibration and validation (CALVAL) of space-borne UV sensors onboard DMSP F-16 spacecraft) has been summarised.

The development of a digisonde network alert system that detects data gaps in the real-time stream of individual contributing digisondes in order to quickly respond to the instrument anomalies. Such a system is very useful in an automated data ingestion system.

A. Krankowski (Institute of Geodesy, University of Warmia and Mazury in Olsztyn, Poland) provides regular ionospheric monitoring over Europe. TEC maps are created from GPS observations collected at IGS/EPN. The large number of GPS stations in Europe provides a good coverage for GPS data and enable to get high-accuracy TEC maps with an error at a level of 1 – 3 TECU. TEC maps are available with a spatial resolution of 100-300 km and a time resolution of 5 min.

Validating the quality and consistency of monitoring data and maps

A comparison study of the true-height electron density profiles derived from ionograms using two different methods POLAN and NHPC (algorithm applied routinely by UMLCAR DGS and DPS sounders) with data from Pruhonice (IPS 42 KEL Aerospace) and Ebro observatory (DGS256) for the high sampling rate campaign "HIRAC/SolarMax" (23-29 April 2001) shows systematic trends. The reflection true-height for a given frequency computed by NHPC is higher for night-time profiles; however, the standard mean deviation is larger in this case and for both observatories. On the contrary, the reflection true-height for a given frequency computed by POLAN at day-time profiles is higher, and the standard mean deviation representing the significance of the result is smaller. Results of two observatories are in good agreement and POLAN-NHPC comparisons demonstrate the importance of careful interpretation of the ionospheric characteristics derived by these techniques.

Results of the first joint analysis of the Digisonde (DPS-4) and new Doppler type system common volume measurements carried out at Pruhonice have been evaluated. The phase path was calculated from both Doppler and digisonde records. Under stormy conditions or presence of a well-developed sporadic E layer, a significant disagreement between both measurements has been found. The discrepancies could be related to the uncertainties of the observational inputs and to the interpretation of the digisonde data. During geomagnetically quiet days, absence of the sporadic E_s, and for high quality ionograms and correct scaling, the electron density profiles, automatically calculated by ARTIST, can be considered reliable.

The tests used to validate the International GNSS Service (IGS) vTEC maps have been applied to assess the accuracy of the European RAL vTEC maps under stormy conditions of 17-21 January 2005. The results show discrepancies between the RAL vTEC maps and the IGS ones which lead to significant RMS and bias values, regarding to the self-consistency and altimeter test respectively, of several TECUs during storm conditions. A Kriging technique applied in this work gave relative improvement up to 26% in the highest stormy conditions.

Disseminating data products

The COST Prompt Ionospheric Database (http://www.ukssdc.ac.uk/prompt_database.html) at RAL continues to receive, catalogue and archive auto-scaled data on a real time basis from ionospheric sounders across Europe. From October 31st 2005 this set has include the Belgian sounder at Dourbes, operated by the Royal Meteorological Institute of Belgium; the full set of contributing instruments now numbers 10 in Europe, at Athens, Chilton, Dourbes, El Arenosillo, Juliusruh, Lycksele, Pruhonice, Rome, Tortosa and Tromsø.

RAL has continued to maintain, support and improve the Space Weather Web Facilities for Radio Communications Users at http://ionosphere.rcru.rl.ac.uk/, which is based on the contributions of a number of COST296 participating institutions. This is 24/7 on-line service that includes the following products:

(1) Interactive forecast maps of foF2, MUF(3000)F2 and ITU-R NeQuick modelled TEC values over Europe based on ionosonde measurements.

(2) Near real-time dynamic system for monitoring ionospheric propagation conditions over Europe.

(3) Near real-time TEC maps over Europe and 24 hours single station plots based on TEC evaluation from IGS GPS measurements.

(4) Near real-time solar-terrestrial and ionospheric indices and warning messages so that ionospheric and trans-ionospheric propagation conditions are known to worldwide users.

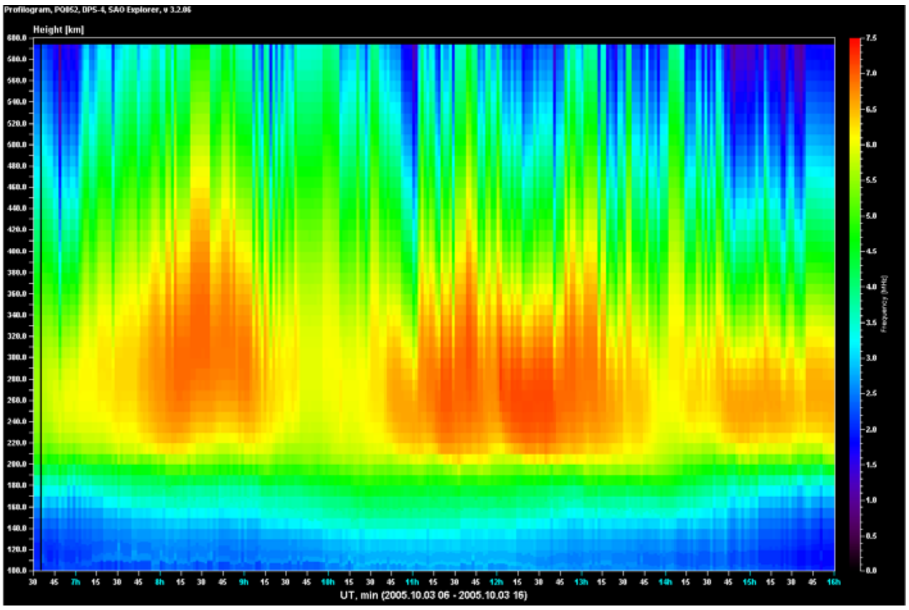
(5) Archive of all data and images.

The Prompt Ionospheric Database service has also been extended to enable users to extract ionospheric profiles from SAO files as calculated by the NHPC algorithm applied by UMLCAR DGS and DPS sounders, in addition to those calculated by POLAN.

RWC Warsaw at http://cbk.waw.pl/rwc and also at ftp://www.cbk.waw.pl/idce/ provides some ionospheric characteristics actual and from the previous 2 months, also 24 hours ahead forecast for European, Asian and Japanese regions at maps and at some ionospheric stations.

Observation campaigns

Rapid VI sounding campaign (5 min. sampling from 1 to 5 October at Ebro, 2 min. sampling from 06:36 to 16:00 UT of 3 October at Pruhonice) was organized and run to follow effects of the solar eclipse of 3 October 2005 over Spain.



Models – development

The development of the Electron Density Assimilative Model (EDAM) has been continued. The model provides a means to assimilate measurements into a background ionospheric model. Results of comparative testing indicate that EDAM can reduce foF2 and MUF errors for HF systems, as well as slant TEC errors.

A new short-term (1-24 h) foF2 forecast method working at the location of an ionosonde station (current foF2 observations are needed) has been developed by Mikhailov.

The first attempt was made to construct a simple physical model of SID in TEC for operational applications.

A method, which, inter alia, allows update IRI bottomside thickness parameter B0 both for quiet and disturbed conditions, was presented (Gulyaeva, 2005).

Currently, some design techniques of parametric identification by cascade modelling of the non-linear processes are developed, i.e. the METU Neural Networks and Cascade Models (METU-NN-C) (Senalp et al., 2005).

Adopting the autocorrelation method in the ionospheric short-term forecasting, a simple and practical forecasting method was put forward — the sectional autocorrelation method, that is, for predictions of one hour to four hours ahead the autocorrelation coefficient of RDF with the "iteration" method is selected, for prediction of more than four hours ahead, the autocorrelation coefficient of foF2 with the "at once" method is used. The prediction precisions have been quantitatively estimated based on the data from Chongqing and Guangzhou Ionosonde Stations. It is shown that the method much improved the predictions for one hour to four hours ahead. For the predictions of more than four hours ahead the prediction error reaches a saturation value, which is still lower than that of the "median" method. This new method could also be applied to the short-term forecasting of other ionospheric parameters.

The Neustrelitz TEC Model (NTC) is currently being upgraded, including extension of the monitored region, standardization of the input/output interface, etc. In combination with the observed TEC data the NTCM model provides maps of measured values near measuring points and model-generated maps of TEC over regions without measurements. The DLR TEC database can serve for verification of the provided ionospheric corrections and for validation of data ingestion and assimilation techniques as well.

Neural network based TEC forecast maps - models are developed in modular structure. The models forecast TEC values of the ionosphere during space weather events. In order to facilitate an easier interpretation of the forecast TEC values, maps of TEC are produced by using surface fitting techniques (Tulunay E. et al., 2005). European area between latitudes 35.5º-47.5º N and longitudes 5.5º-19.5º E is considered. Two case studies have been performed: 10 minutes and one hour in advance TEC forecast maps have been obtained.

Krankowski et al. (2005) presented an alternative method for short-term prediction of TEC. TEC forecasts were made using the Autoregressive Moving Average method (ARMA) for the most disturbed periods of the ionosphere at low, medium and maximum solar activity (from 1995 to 2001).

A new model TSM (Topside Sounder Model) has been developed, providing the plasma density scale height Ts, the O+-H+ transition height Th and their ratio Rt. The previously developed Topside Scale Height (TISH) and Transition Height (TH) models are now combined in a single model, providing optionally the vertical scale height Ts and transition height Th for any set of input parameters: month, local time, geomagnetic latitude, $F_{10.7}$ and Kp. It was found that the scale height and transition O^+-H^+ height, extracted from each individual measured Ne profile, highly correlate, with a correlation coefficient exceeding 0.8 at midlatitudes. The ratio Rt=Ts/Th obtained from the individual profiles is modelled as a function of the same input parameters. The new ratio model Rt is used to develop a profiler, which reconstructs the vertical electron density distribution in the upper ionosphere and plasmasphere, if NmF2 and hmF2 are specified. This profiler can be used by the Digisonde ITEC software, which provides the F2 layer parameters from ionograms. The profiler, named Topside Ionosphere and Plasmasphere Profiler (TIPP) uses either the sech-squared or α-Chapman shape of the F layer.

Model assisted ionosphere electron density reconstruction methods, based on Vertical or Slant TEC data ingestion into NeQuick model have been developed and tested. The results clearly indicate the effectiveness of the ingestion techniques to improve model performances in reconstructing the electron density of the ionosphere. A new topside formulation has been proposed for the NeQuick model and the performance of the Modified NeQuick has been tested through the application of a Slant TEC data ingestion technique.

The results from the Technical University of Catalonia on improving the ionospheric modelling with GPS data are described by Orus et al. (2005a, 2005b), Garcia-Rodriguez et al. (2005) and Hernandez-Pajares et al. (2005b).

Development and improvement of the HF simulator and the transionospheric simulator has continued. A hybrid model for prediction of the ionospheric scintillations was presented (Zhernov et al., 2005).

Models – verification and testing

The comparative analysis of the IRI 2001 model capability to reconstruct the state of ionospheric ionization under quiet and disturbed conditions and the analysis of the effectiveness of the IRI 2001-predicted N(h) profile updating with real-time measurements have been continued. The IRI model calculations are in worse agreement with observations especially during daytime hours at the ionospheric heights from 200 to 400 km, mainly under disturbed conditions. Similar finding has been obtained comparing radio propagation parameters generated by a 2D ray tracing software abcray03 with those predicted by IRI 2001 and NeQuick models.

The operational version of the Polish instantaneous ionospheric 3D mapping model of electron concentration has successfully been tested.

The neurofuzzy techniques have been applied to model and predict the critical frequency of F2 layer, foF2. Firstly, the method is being testing under quiet geomagnetic conditions using foF2 data from Slough ionosonde station and it is providing foF2 forecast with relative mean deviation of around 5% (Andujar et al., 2005a, 2005b).

A good agreement between GPS-derived TEC data and measured foF2 was found to take place for quiet and moderate geomagnetic conditions by Krankowski and Shagimuratov (2005). The rms of foF2 obtained from TEC data and measurements has reached 1.0-1.5 MHz for all middle-latitude European ionosonde stations in November 2003.

HF channels

3D gradient effects on transionospheric paths (such as from GPS) have been determined by ray-tracing through a realistic 3D IRI ionosphere with altitude dependent latitudinal and longitudinal gradients (Strangeways and Nagarajoo, 2005). Determination of the correlation distance in the presence of ionospheric irregularities was made by Strangeways (2005) for spaced antennas on multipath HF links with implications for design of SIMO and MIMO systems.

Long-term trends

To clarify principal differences between results of various authors on trends in foF2, the results obtained by different methods applied by six various teams to a two solar cycle long dataset of high-quality data from Juliusruh were compared by Lastovicka et al. (2005). Some discrepancies were explained and removed. The correction for the solar cycle effect with R or R12 was shown to be evidently worse than that with F10.7 or E10.7. Now the results of five out of six teams agree fairly well, but we have not succeeded to explain much smaller trends obtained by Mikhailov. Anyway, the trends appear to be small (between –0.01 and –0.02 MHz/year for Juliusruh, 1976-1996). There is not agreement as concerns the origin of trends – predominantly anthropogenic or geomagnetic.

Bencze (2005) analyzed long-term trends in the F-region thickness (hmF2-h’F) and deduced thermospheric cooling from the negative trend in the F-region thickness.

Using VHF radar observations strong radar backscatters have been observed during summer months at polar latitudes (polar mesosphere summer echoes, PMSE) and at middle latitudes (mesosphere summer echoes, MSE). These phenomena are strongly connected with ice particles in the cold summer mesopause region and contain therefore information about the temperature, the water content and the electron density in the ionospheric D region. Long-term variations of these echoes are strongly controlled by the solar and geomagnetic activity. After elimination of these influences first information about trends in the mesospheric water vapor content and/or temperature could be derived (Bremer et al., 2005).

Waves

Model calculations show that an infrasonic sinusoidal signal launched at or near the surface is destroyed by nonlinear processes during its upward propagation; it transforms into two, initial and final, impulses. The location of the "transformation region" depends on frequency; its height increases with decreasing frequency. The acoustic waves can heat the upper atmosphere, for example waves with period of 3 min generated by thunderstorms can heat the above-lying atmosphere at a rate up to $\Delta T_a = 48.5$ K/day in the region 245-330 km and, thus, thermally affect the ionosphere (Krasnov et al., 2005). With the Doppler type system we observed S-shaped phenomena and rapid linear shape changes, both on Doppler shift spectrograms at time scales of tens of seconds.

The Matlab codes for fast detection of the acoustic-gravity wave pulses have been developed and successfully tested on the 1-minute sounding campaigns and applied on the data of the solar eclipse 3 October 2005. Description of the codes and included model will be hopefully submitted to publication in November. Codes will be then available on the Web page of the IAP Prague.

Space weather and mid-latitude ionosphere

Two significant effects on the ionospheric state of ionization during superstorm of November 2003 have be observed and analyzed, using data from four European ground ionosondes jointly with GPS data (Blanch et al., 2005). These effects were the presence of strong auroral E layer observed at latitudes as low as 37°N and presence of two thin belts; one of enhanced and other of depressed electron content, both over the mid-latitude European evening sector. Such enhancement of VTEC could be caused by large gravity wave, but only in the case its duration is shorter than a few hours. However the enhancement we have observed was a long lasting effect, so we think that it was caused by storm-induced composition changes. The observed belt with depressed VTEC could be generated by intense convection electric fields as well as through effects of enhanced recombination.

Ionospheric Variability

A simple *f*oF2 variability model has been developed by Fotiadis and Kouris (2005a). In particular, a second order Fourier series scheme is applied separately for upper and lower quartiles and adequately describes the continuous variation of variability with latitude. In order to avoid a segmentation of the day in local time windows, variability is examined in four discrete sections defined solely by solar zenith angle. The variability model is overall successful at midlatitudes (presenting an error of 3-4% in most cases), being though somewhat limited in the geographical regions of high variability boundaries such as the equatorial crest and the high latitude boundary. Furthermore, the consideration of the solar zenith angle seems quite functional except around local sunrise hours.

Variations of slab thickness (Kouris et al., 2005). Using hourly daily GPS measurements of TEC made at different locations and foF2 corresponding data measured at nearby ionospheric stations the slab thickness is calculated .The variations from day-to-day and from hour-to-hour of the counted slab thickness values in each location/month/year are studied and statistically analysed. Examining either monthly median or hourly daily values of slab thickness at two different locations it is found that the differences are around zero. Of course exceptions exist during winter and equinoxes, depending on the local disturbed state.

The results from the Technical University of Catalonia on characterisation of ionospheric variability and applications are described by Blanch et al. (2005) and Hernandez-Pajares (2005a, 2005c).

Climatology and morphology of foF2 ionospheric disturbances

Following the analytical investigation on the climatology of foF2 ionospheric disturbances, where different classes of disturbances were identified, the morphology of long-duration negative foF2 disturbances has been recently revealed (Fotiadis and Kouris, 2005b).

The analysis is based on an ionospheric definition of disturbed conditions independent of any causative mechanism and a feature-guided pattern recognition method. A record of negative disturbances lasting more than 24 hours was first compiled from hourly daily foF2 data (75 ionosonde stations and 3 solar cycles). Disturbances in each month and station are handled separately and 4 local time intervals of disturbance commencement are considered. The disturbance patterns, first grouped according to major characteristic features and then fitted with simple mathematic functions, are finally described by a variation envelope and are provided to radio users along with their distribution in space and time. The present model may complement and improve existing models (e.g. STORM IRI-model), being at the same time a directly operational, non-conditional stand-alone model.

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Working Group 2 - Advanced terrestrial systems
Leaders: Prof A. Bourdillon and Prof E. Tulunay

WP2.1 - Radar and radiolocation
Leaders: Dr C. Bianchi and Dr E.M. Warrington

1. ***Hot clutter modelling for surface wave radar: existing hot clutter models will be evaluated and a new model may be proposed. Models will be validated with the measurements from a basic surface wave set-up. Experimental set-up will be designed and implemented***

   The preliminary plans have been prepared based on the past experience for ionospheric clutter characterisation in relation to surface - wave radar (Y. and E. Tulunay).

2. ***Frequency management of ground-wave and sky-wave radars***

3. ***Angle of arrival measurements for sky-wave signals***

   Work has been conducted on methods to improve angle of arrival measurements for sky-wave signals using co-located antennas. One difficulty is relative to the antenna calibration. New results have been obtained using carefully calibrated antennas (F. Marie, G. Le Bouter, M. Oger, D. Lemur, L. Bertel).

   Published Papers:
   F. Marie, Y. Erhel, L. Bertel, D. Lemur and M. Oger : Beamforming techniques operating on HF collocated antennas, Electronics Letters, volume 41, n°23, pp 1261-1262, November 2005, ISSN 0013 5194.

4. ***Propagation effects that influence radar and radiolocation systems***

   The northerly ionosphere is a dynamic propagation medium that causes HF signals reflected from this region to exhibit delay and Doppler shifts and spreads which significantly exceed those observed over mid-latitude paths. Since the ionosphere is not perfectly horizontally stratified, the signals associated with each propagation mode may arrive at the receiver over a range of angles in both azimuth and elevation. Such large directional spreads may have severe impact on radio systems employing multi-element antenna arrays and associated signal processing techniques since the signal environment is not comprised of a small number of specular components often assumed by the processing algorithms. In order to better understand the directional characteristics of HF signals reflected from the northerly ionosphere, prolonged measurements have recently been made over two paths: (a) from Svalbard to Kiruna, Sweden, and (b) from Kirkenes, Norway to Kiruna. An analysis of these data has been undertaken and the directional characteristics summarised. Consideration has been given to modelling the propagation effects in the form of a channel simulator suitable for the testing of new equipment and processing algorithms.

The propagation mechanisms resulting in off-great circle propagation over northerly paths (such effects are often large, up to 100 degrees from the great circle direction) have been identified and considerable progress made in modelling thsee effects by means of ray-tracing through complex model ionospheres. Further work has commenced directed towards (a) additional measurements along the trough to investigate differences in the propagation characteristics between solar maximum and solar minimum, and (b) development of the ionospheric ray-tracing techniques, in particular to include methods for the prediction of the channel scattering function (delay and Doppler dispersions). (E.M. Warrington, A.J. Stocker, D.R. Siddle and N.Y. Zaalov)

Published and submitted papers

N.Y. Zaalov, E.M. Warrington and A.J. Stocker. A ray-tracing model to account for off-great circle HF propagation over northerly paths. *Radio Science,* 40, RS4006, doi: 10.1029/2004RS003183, 2005.

E.M. Warrington, A.J. Stocker and D.R. Siddle. Measurement and modelling of HF channel directional spread characteristics for northerly paths. *Radio Science (submitted).*

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E.M. Warrington, A.J. Stocker, N.Y. Zaalov and D.R. Siddle. Measurements and simulation of HF off-great circle propagation effects over northerly paths. Ionospheric Effects Symposium, Alexandria, USA, May 2005.

E.M. Warrington, N.Y. Zaalov, A.J. Stocker and D.R. Siddle. Measurements and simulation of HF off-great circle propagation effects over northerly paths (abstract). XXVIIIth General Assembly of the International Union of Radio Science (URSI), October 2005.

E.M. Warrington, N.Y. Zaalov, A.J. Stocker and D.R. Siddle. Measurement and modelling of HF channel directional spread characteristics for northerly paths. XXVIIIth General Assembly of the International Union of Radio Science (URSI), October 2005.

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Propagation effects on radio and radar signal through the ionosphere

HF propagation channel is characterized by its relationship to the ionospheric medium and unluckily the ionosphere is a variable medium in both space and time that changes the propagating signal. While propagating through the ionosphere the signal experiences a series of effects that will be briefly summarised. An idealised homogeneous and stable ionospheric layer is frequency-dispersive so the broad band signal undergoes distortion in time delay. Depending on the ionospheric conditions the signal can be affected by diffraction, scattering and multipath phenomena, which introduce temporal spread and frequency selectivity in the received signal. Temporal variations of the heights and the time varying refractive index of the atmosphere layers make the channel time-varying and induce Doppler-spread and Doppler-shift effects. This propagation effects on the signal affect, communications, navigation, surveillance, remote sensing, radars and radio measurements. Hence, it is necessary to have a more detailed knowledge of the effects of the ionosphere on radio wave propagation and the research of the characteristics of the ionospheric channel. (C. Bianchi)

5. ***The effects of environmental noise on HF radar systems***

Work Package 2.2 - HF/MF communications
Leaders: Prof. Dr. J. M. Andujar and Dr P. Lassudrie-Duchesne

1. ***Digital radio systems – predictions, methods of estimating reliability: experimental studies concerning channel reliability by using existing experimental set-up complied with ITU standards will be conducted in cooperation with University of Leicester, UK.***

As it was agreed during the previous COST 296 MCM, a technical campaign will be conducted between UK and Turkey with the objective of studying the High Frequency (HF) Channel Characterization between UK and Turkey during the total solar eclipse of 29 March 2006. Thus a contribution will be made to HF operators in real life applications.

A formal short-term scientific mission planned between UK and Turkey will be provided as soon as possible with the following details:

Road Map:

1. Mr. Murat Özgür Sarı (MOS) will visit Prof. Mike Warringhton and his Group in order to facilitate the followings
   1.1. Parameters suitable for channel characterization will be specified
   1.2. Transmitter and receiver will be programmed in accordance with 1.1.
2. Mid-inospheric station under the total eclipse part will be specified and contact will start in establishing the relevant data and information
3. Preliminary experiments will start before March 2006 between Leicester and Istanbul in collabiration with TUBITAK MRC and METU.
4. The actual total eclipse experiment will be realised during the week of 29 March 2006.

STSM Hosts: Prof. Dr. M. Warrington, Leicester University, UK, and Prof. Dr. Lj. Cander, RAL, Didcot, UK

Budget Request: Round trip travel between Ankara and Leicester and subsistance for 10 days: 1300 € (amount for travel: 500€ ; amount for subsistence: 800€).

2. ***Wideband propagation modelling and development of a hardware simulator***

The Dr. Angling's contribution (Centre for RF Propagation and Atmospheric Research, Marvern, UK) concerning this term of reference can be resumed as follows:

XIPPT

An IDL GUI (XIPPT) has been developed to demonstrate the use of EDAM predictions. XIPPT provides an interface to QinetiQ's Integrated Propagation Prediction Tool (IPPT) and allows a user to access IPPT's propagation models (Figure 1). Furthermore XIPPT embodies a scheduler that will download EDAM output from an FTP server at set times and call IPPT to perform propagation predictions. IPPT itself has been modified to detect and use the EDAM output if it is present in the IPPT working directory. The aim of this software is to be sufficiently flexible that it can provide a realistic test of the EDAM output, and to be reasonably close to how an operational tool may look, whilst remaining simple enough to demonstrate and place with potential users without extensive training.

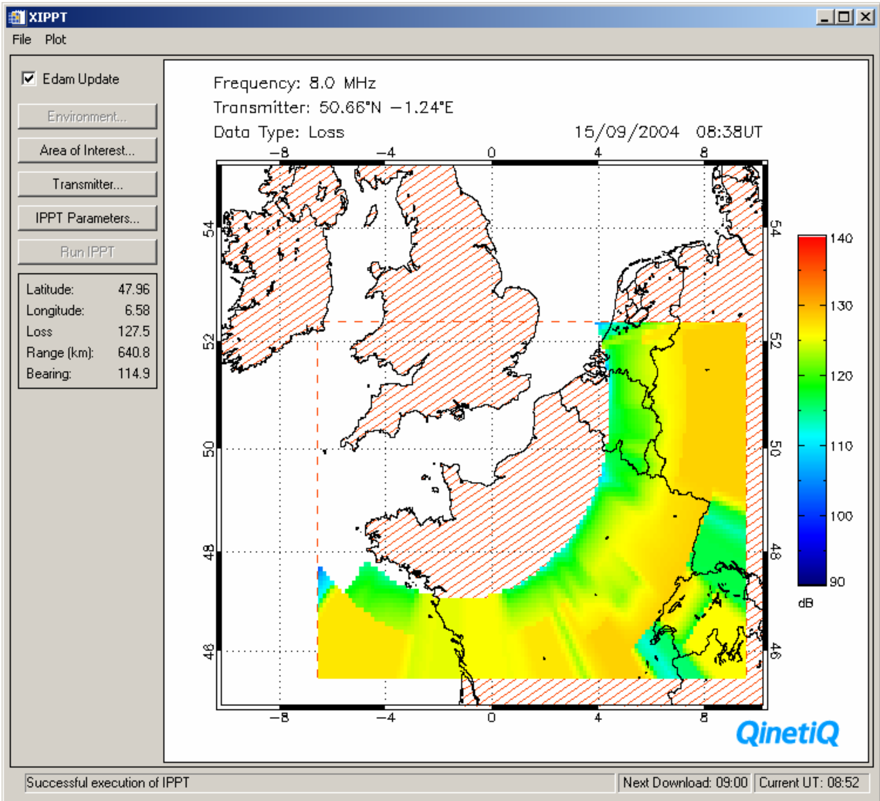

Figure 1: Screengrab of XIPPT showing an HF loss prediction using EDAM output.

TEMPLAR

The Tactical Enhanced Muf Prediction for the Local ARea (TEMPLAR) has also been developed. The tool is based on EDAM and exploits a single GPS receiver to provide a local area (up to 700 km) now-cast of the maximum usable frequency for HF communications operators (Figure 2). Results indicate that the TEMPLAR MUF estimates are susceptible to bias caused by variations in the ionospheric slab thickness (Figure 3). Whilst this can be mitigated by modifying the background model to account for seasonal effects, it is likely that vertical structure information will be required to provide the highest accuracy results.

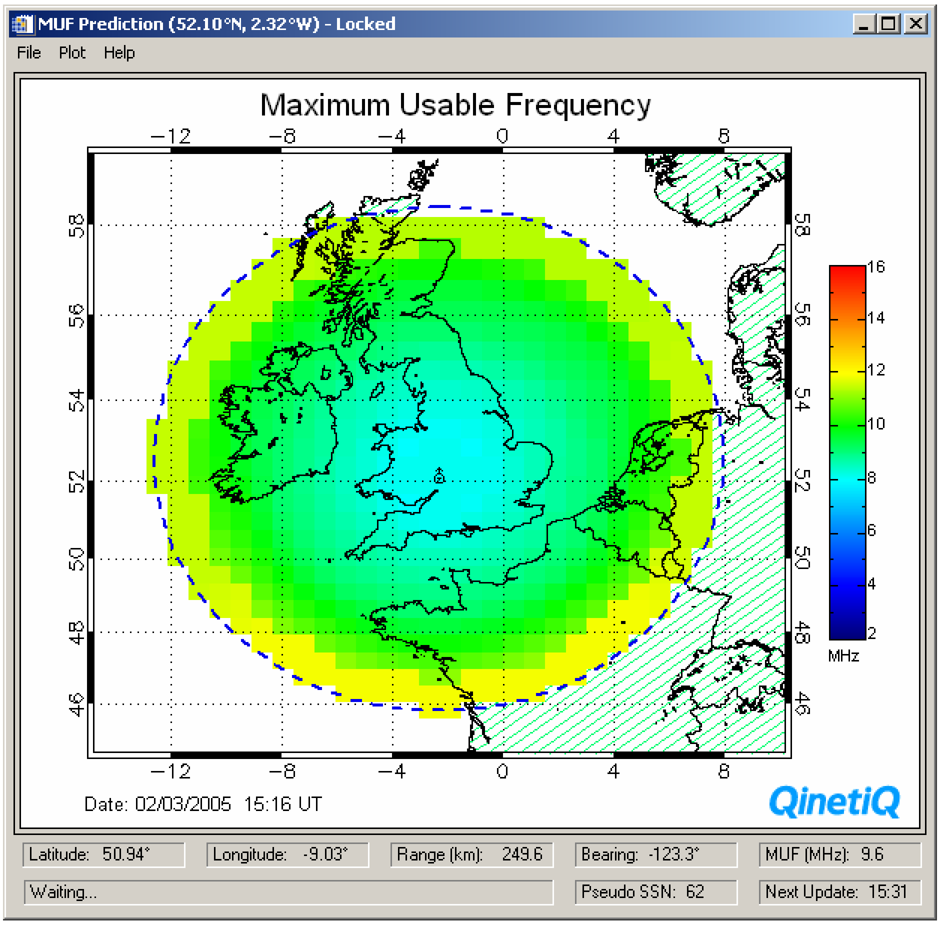

Figure 2: Example TEMPLAR output showing colour coded MUF from a station in Malvern.

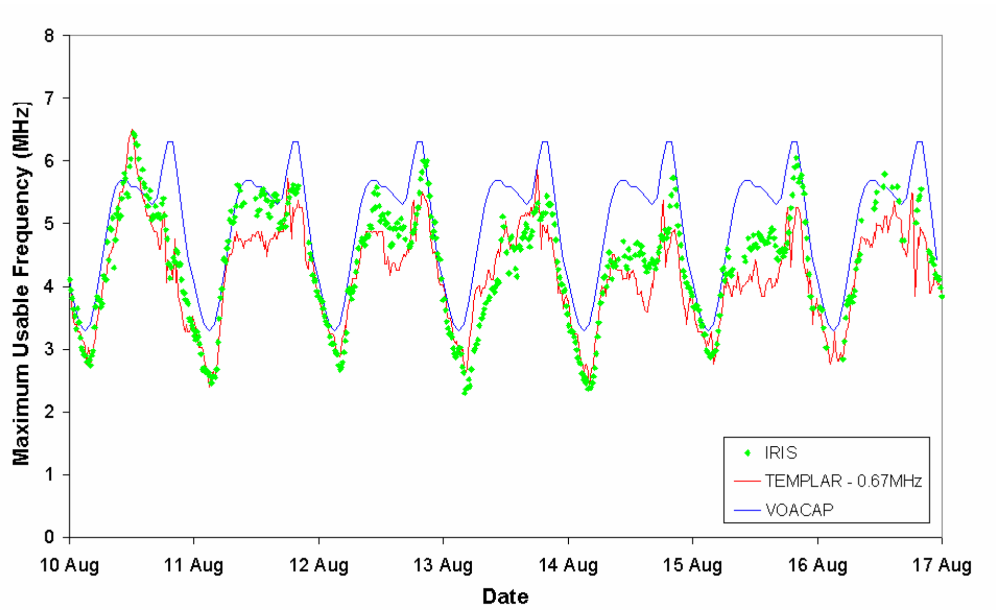

Figure 3: Measured (IRIS) and estimated (TEMPLAR) maximum usable frequency between Inskip and Malvern. VOACAP predicted frequencies are also shown.

3. High data transfer rate system of radio communications through the ionospheric channel

The Group of University of Rennes has been involved in collaboration with the Spanish Group in Huelva in an experiment performed end of august 2005. The objective was to test the transmission of images between Monterfil and Huelva using colocated antennas at the receiving site in Huelva. Work is in progress and results of this experiment will be presented during a

PhD presentation in December and in coming conferences (C. Perrine, Y. Erhel, D. Lemur, M. Oger, L. Bertel).

Sana Salous and Mike Warrington signed up for increasing the tranfer rate of radio communications through the ionospheric channel with their proposed project to the EPSRC to investigate MIMO techniques in the HF band in mind. They are still seeking funding for this work - the proposal was considered by the EPSRC funding panel on the 25 October, and has been deferred to the next panel meeting for consideration. An agreement has also been signed with the Group in Rennes University for cooperation on this thematic.

Published Papers:

C. Perrine, Y. Erhel, D. Lemur, and A. Bourdillon **:** Image transmission through the ionospheric channel**,** Electronics Letters, volume 41, n°2, pp 80-82, January 2005**,** ISSN 0013 5194

Y. Erhel, C. Perrine, D. Lemur, and A. Bourdillon : A blind spatio temporal equalization implemented in an operational system of digital transmission for long range applications, Accepted in Revista A.T.M., Romania, 4 pages, December 2005, ISSN 1453 259X

4. *Gravity and planetary wave and infrasound effects on propagation.*

Czech Group (J. Lastovicka, P. Sauli, J. Boska, D. Buresova, T. Sinderalova and D. Kouba) working on this term of reference points out phenomena which could deteriorate HF communications. Specifically, with the Doppler type system, they observed S-shaped phenomena and rapid linear shape changes, both on Doppler shift spectrograms at time scales of tens of seconds (spectral range of infrasound).

Submitted to publication:

J. Chum, F. Hruška, D. Burešová, J. Laštovička, J Baše, J Maděra, V. Krasnov: Short time phenomena in HF Doppler records; first results of continuous Doppler sounding in the Czech Republic. Ann. Geophysicae.

5. *Extension of existing wideband HF simulators to the MF band*

The team at the University of St. Petersburg, Russia, N. Zernov and V. Gherm, have been working on further development of the general techniques to account for the effects of strong fluctuations of the field amplitude in the problem of HF propagation in the fluctuating ionospheric reflection channel. Their main results can be found in the following papers:

Published Papers:

V.E.Gherm, N.N.Zernov, H. J. Strangeways. HF Propagation in a Wideband Ionospheric Fluctuating Reflection Channel: Physically Based Software Simulator of the Channel, Radio Science, 40(1), RS1001, doi:10.1029/2004RS003093, 2005.

A.A.Bitjukov, V.E.Gherm, N.N.Zernov, Two-frequency, two-position coherence function of the random field: separation of variables in the parabolic equation (in Russian), Radiotekhnika i Elektronika (Russian Academy of Sciences), 50, № 5, 2005.

A.A.Bitjukov, V.E.Gherm, N.N.Zernov, Two-frequency, two-position coherence function of the random field: model problems (in Russian), Radiotekhnika i Elektronika (Russian Academy of Sciences), 50, № 5, 2005.

Presented at meetings:

Results have been also presented at All-Russia Conference on Radio Wave Propagation, held in Joshkar-Ola, Russia in May of 2005:

V.E.Gherm, N.N.Zernov, H.J.Strangeways, Modelling of the Wideband HF Ionospheric Channels of Propagation (in Russian), Proceedings of the 21-st All-Russia Conference on Radio Wave Propagation, v. 2, pp. 316-320. Joshkar-Ola, Russia. May, 25-27, 2005.

WP2.3 - Spectrum management

Leaders: Prof L.W. Barclay and Prof A. M. Casimiro

1. ***Use of GPS to improve HF communications management***

2. ***Adaptive waveform management***

3. ***Effects of infrasound on radio propagation***

4. ***Occupancy determination of HF band for the East Mediterranean conducted using calibrated HF spectrum measurements and HF receiver array***

The preliminary plans have been prepared for COST 296 WP 2.3 based on the past experience for Occupancy determination of HF band for the East Mediterranean conducted using calibrated HF spectrum measurement and HF receiver array. (E. Tulunay)

5. ***Supporting research and application in antenna systems to increase their efficiency and mitigate the propagation errors***

Contact was made with COST 284, as responded, and research in this topic.

6. ***Developing new techniques to analyse the radiation path in the propagation channel***

It is being done research and it is previewed to submit a paper at PIERS 06 with the one year research results.

Information from A. Casimiro

On July, Prof. Barclay and myself participate, at Graz, in the ITU-R Seminar of COST 296 action. I am working on a possible contribution, with Prof. Azevedo, for ITU-R.
Following the decision of the MC meeting in June: “W.P.-2.3 will collaborate with the COST 284 Action”, I was in the Cost 284 meeting that was together with ICECom 2005 conference, on October. I think it was very useful for our COST action, and I will present a report at our meeting.
REPORT OF THE ACTIVITIES TAKEN TO COLABORATE WITH COST 284 ACTION

1- Following the MC meeting decision for WP 2.3 W.P. 2.3 will collaborate with the COST 284 Action I contacted Dr. Mosig, the Chairman of COST 284.

2- He gave me the information that COST 284 is in the last work year, and that they only have two more meeting: one in October 2005 in conjunction with the ICECOM 2005 conference, at Dubrovnik (Croatia), and the last one on November 2006.

3- So it was necessary to me to go to the meeting in October, to accomplish the MC decision.

4- I was very well welcome as a COST 296 member.

5- I participated in the COST 284 MC Meeting, where I presented the reasons of my presence and in the scientific work during the week.

6- They agree with the collaboration and make the suggestion to present a paper in the last meeting in November 2006. Dr. Mosig also stressed that the inter COST collaboration is very useful for COST objectives and for the approval of new COST actions.

7- The collaboration areas where I foresaw collaboration are: the radio astronomy field, the SIMO and MIMO approaches, and array optimization.

8- There was in the program one session entitled “Investigating Long-range Ionospheric Radiolines by Analyzing Maximum Observed Frequencies Daily Variances” where I was particularly interested, but it was a no show

Summary

WP 2.1

Terms of reference	Progress report	Action
1.	Y	
2.	N	To be decided at the next MCM
3.	Y	
4.	Y	
5.	N	To be decided at the next MCM

WP 2.2

Terms of reference	Progress report	Action
1.	Y	
2.	Y	
3.	Y	
4.	Y	
5.	Y	

WP 2.3

Terms of reference	Progress report	Action
1.	N	To be decided at the next MCM
2.	N	To be decided at the next MCM
3.	N	To be decided at the next MCM
4.	Y	
5.	Y	
6.	Y	

ANNEX VI

Working Group 3 Space Based Systems
Leaders: Norbert Jakowski and Reinhart Leitinger

Between MCM 2 and 3 and during MCM3 WG3 has consolidated terms of reference, task lists and participation lists of its three Work Packages which have initiated work on most of the tasks agreed upon in MCM 2 and 3. However, some consolidation and coordination is necessary. We expect progress in all tasks initiated. Two WPs are finalizing products for ITU-R. The WG will participate in organizing and carrying out of special measuring campaigns. Relevant calls for participation will be issued through the COST 296 mailing list and through the COST 206 Web page.

WP3.1 Space Plasma effects
Leaders: Sandro Radicella and Petra Šauli

Task list

1) Large scale effects during severe ionospheric perturbations and their relationships to space weather
2) Medium scale effects/perturbations and analysis of their sources
3) Specific role of acoustic, gravity and planetary waves in the ionospheric plasma
4) Impact studies of different types of effects on trans-ionospheric radio systems and consequences (e.g. on reliability, availability, accuracy)
5) Methods for sensitive measuring and monitoring space plasma effects
6) Variability of the ionospheric plasma during solar/geomagnetic quiet periods
7) Characteristic scales of the ionospheric system – scaling phenomena within ionospheric plasma

Participants
Petra Šauli (Czech Republic)
Sandro Radicella (Italy)
Stanimir Stankov (Germany)
Patrick Lassudrie-Duchessne (France)
Ivan Kutiev (Bulgaria)
Marcio Aquino (UK)
Dalia Burešová (Czech Republic)
Josef Boška (Czech Republic)
Dan Kouba (Czech Republic)
Sergey Pulinets (Mexico)
Pierdavide Coisson (Italy)
Tamara Gulyaeva (Russia)
Jan Laštovička (Czech Republic)

Status
Participation ensured for all tasks.
Coordination and cooperation with WG 1 needed for tasks **1, 2, 3, 6.**
Work initiated for tasks **1, 4, 6, 7.**
Work plan for 2005/2006
continue with cooperative work for tasks **1, 4, 6, 7** and initiate studies in tasks **2, 3, 5.** Establish cooperation work for tasks **1, 2, 3, 6** with WG1.
Remark
For more details see **`http://www.ukssdc.ac.uk/twiki/bin/view/COST296/WP3_1`**

WP 3.2 Mitigation techniques
Leaders: René Warnant and Ulrich Foelsche

Task list
(Principally, Mitigation techniques depend on specific needs in different applications)
1) Discussion and assessment of basic techniques which are based on
- separate models
- operational measurements for real-time corrections
- multiple frequency methods in particular future triple frequency GNSS (Galileo, modernized GPS)

2) Requirements and favourite techniques in specific applications, e.g. radio occultation, GNSS reference networks
3) Higher order ionospheric influences in dual frequency systems with emphasis on precise location finding and on long-term applications
4) Capabilities and remaining weakness points of mitigation techniques under quiet and perturbed ionospheric conditions

Participants
Marcio Aquino (UK)
Ulrich Foelsche (Austria)
Norbert Jakowski (Germany)
Andrzej Krankowski (Poland)
Ivan Kutiev (Bulgaria)
Reinhart Leitinger (Austria)
Juha-Pekka Luntama (Finland)
Bruno Nava (Italy)
Manuel Hernandez Pajares (Spain)
Markus Rieger (Austria)
Hal Strangeways (UK)
René Warnant (Belgium)
Status
Participation ensured for all tasks
Work initiated for 1) through 3) [task 4) depends on results from 1) through 3)]
Work plan for 2005/2006
continue with cooperative work for 1) through 3)

WP 3.3 Scintillation Monitoring and modelling (leaders; Yannick Béniguel and Vincenzo Romano)

Task list
1) Monitoring activities via COST 296 countries:
- Coordinated studies using data from GPS stations at low, middle and high latitudes
- Use of communication links (VHF, …)
- Comparison of the measurement results provided by different kinds of receivers
- Statistical analysis, correlation with space weather effects and other driving forces
- Campaigns and corresponding case studies

2) Scintillation modelling - further needs for improving existing modelling efforts, data base, validation, application tests
3) Physics of small scale ionospheric irregularities, plasma instabilities

Participants

Alfonsi Lucilla (Italy)
Aquino Marcio (UK)
Béniguel Yannick (France)
Bourdillon Alain (France)
Cannon Paul (UK)
De Franceschi Giorgiana (Italy)
Gherm Vadim (Russia)
Jakowski Norbert (Germany)
Krankowski Andrzej (Poland)
Materassi Massimo (Italy)
Rogers Neil (UK)
Romano Vincenzo Italy)
Strangeways Hal (UK)
Warrington Mike (UK)
Weimin Zhen (China)
Wernik Andrzej W. (Poland)
Wilken V. (Germany)
Zernov Nikolay (Russia)

Status
Participation ensured for all tasks
Work initiated for all tasks
Work plan for 2005/2006
Continue with cooperative work for 1) through 3)