Atmospheric Remote Sensing using Satellite Navigation Systems

Special Symposium of the URSI Joint Working Group FG

13-15 October 2003

Matera, Italy
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Session W1: Imaging and Data Assimilation (Invited)

Ionosphere Imaging by GPS Measurements on Champ

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GPS measurements onboard the German CHAMP (CHAllenging Minisatellite Payload) satellite provide a good possibility for operational sounding the ionosphere on global scale.

Both the radio occultation measurements in the limb sounding mode and the navigation measurements via the upward looking GPS antenna have a big potential to reconstruct the spatial and temporal distribution of the electron density in the ionosphere. At present about 150 electron density profiles from global scale are routinely retrieved by the processing system in an operational mode and are made available to the international science community via the ISDC of the GFZ Potsdam.

More than 70000 vertical electron density profiles have been obtained since the beginning of ionospheric radio occultation (IRO) measurements on 11 April 2001 by using a model assisted retrieval technique. To improve the initial guess for the inversion procedure, an assisting scale height model of the topside ionosphere in the 450 km height range is under development. Based on the accumulated IRO data set the latitudinal, local time and seasonal variations of the scale height have been obtained and a preliminary model developed.

Radio occultation data products contribute to image the average ionospheric behavior that is valuable for developing and testing ionospheric models.

To obtain information on the spatial and temporal electron density distribution above the CHAMP orbit height, the 0.1 Hz sampled dual frequency navigation measurements are used to derive the total electron content (TEC) along the ray paths between the CHAMP and GPS satellites. After assimilating these integral measurements into the Parameterized Ionospheric Model (PIM) of local electron density it is possible to reconstruct the spatial electron density distribution close to the CHAMP orbit plane.

Additional link related TEC measurements e.g. from other Low Earth Orbiting (LEO) satellites like SAC-C can easily be included to the assimilation process and may improve the reconstruction results. In combination with ground based GPS measurements both techniques can be used to model the entire ionosphere from the bottom side up to GPS orbit heights. GPS measurements on LEO satellites as CHAMP have a big capability to contribute to an operational monitoring of the ionosphere and for providing near-real-time data into forecast models for space weather applications.
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Opening Session

Saab Ericsson Space Activities In Radio Occultation Programmes
Fritz, H.; Saab Ericsson

Design And Development of a Radio Occultation Instrument for Atmospheric Sounding
Ramioli, P.; Zin, A.; Scociga, L.; Barfi, E.; Ghiaudi, P.; Di Cesare, A.; De Cosmo, V.
*Laen S.p.A., **ASI

Session M1: Measurements Using Ground Based Sensors (Invited)

Determination of Atmospheric Water Vapour from GPS Measurements and ECMWF Operational Analyses
Hagerman, S.; Bengtsson, L.; Gendt, G.
*Max Planck Institute for Meteorology, **GeoForschungsZentrum

Results of 2 Years of Near Real Time GPS Data Processing
Pacione, R.; Vespe, F.
*Telespazio S.p.A., **ASI

Estimation of Ionospheric TEC using Ground-Based GPS Networks - Limitations and Accuracies
Skone, Susan; University of Calgary

Use of "Supertruth" Data to Analyze Ionosphere Behavior During Geomagnetic Storms
Nova, B.; Radicella, S. M.; The Abdus Salam ICTP

Characterisation of Ionospheric TEC using EGNOS
Sardon, E.; GMV

Session M2: Young Scientists (Invited)

Evaluating GPS Signal Delays Along Slant Paths – Experimental Results
Yin, P.; Watson, Robert J.; Mitchell, Cathryn N.; Braun, John
*Univ. of Bath / Civil Aviation Univ. of China, **University Corporation for Atmospheric Research

Calibration of GPS Based TEC Measurements from Low Earth Orbit: An Assessment for CHAMP and SAC-C
Helie S., Stolle, C.; Schlüter S., Jakowski N., Reigber Ch.
* GFZ Potsdam, **U Leipzig, ***DLR, IKV

ISACCO (Ionospheric Scintillations Arctic Campaign Coordinated Observations) project at Ny-Ålesund
Alfonsi, L.; Materassi, M.; Werner, A.
*Istituto di Fisica Applicata "Carrara", **Istituto Nazionale di Geofisica e Vulcanologia, ***Space Research Center, Polish Academy of Science

 Ionospheric tomography, 3D and 4D imaging and data assimilation
Materassi, M.; Istituto di Fisica Applicata "Carrara", C.N.R.
Session T1: GNSS Radio Occultation (Invited)

The ESA Radio Occultation Mission ACE+: A Novel System for Benchmark Measurements on Climate Change
Kirchengast, G. *; Hoeg, P. **; The ESA-ACEPASS Study, Science Team***
*University of Graz, **Danish Meteorological Institute, ***U. Graz-DMI-Chalmers. U.T.- U.Bremen-U. Firenze

GPS Radio Occultation with CHAMP: Status, Results and Future Prospects of the Operational Data Analysis
Wickert, J.; Schmidt, T.; Beyerle, G.; Koenig, R.; Pfeiffer, Ch.; GeoForschungszentrum Potsdam

Errors in GNSS Radio occultation Data: relevance of the Geometry of Reference Profiles
Foelsche, U.; Kirchengast, G.; IGAM/University of Graz

Performance of the Improved Abel Transform to Estimate Electron Density Profiles from GPS Occultation Data
Hernandez-Pajares, M. *; Juan, J.M. **; Sanz, J. **; Garcia-Fernandez, M. **
*Technical University of Catalonia (UPC), **GKGE/UPC

Results from CHAMP, SAC/C And IOX: GPS Ionospheric Occultations Obtained by the Abel Inversion And Data Assimilation
Mandrade, J. *; Hajj, G. *; Wilson, B. *; Jiljih, B. *; Strauss, P. **
*Jet Propulsion Laboratory, **Aerospace Corporation

Ionospheric Radio Occultation Measurements in Cœrstedt
Stauning, P.; Danish Meteorological Institute

Session T2: Scintillations (Invited)

A Brief Review of Scintillation Theories - In Memory of Prof. K.C. Yeh
Wernik, A.; Space Research Center, PAS

Results of Statistical Analysis of GPS Ionospheric Scintillation Data in Northern Europe
Dodson, A.; Aquino, M.; Rodriguas, F.; Moore, T.; Waugh, S.
University of Nottingham

The Scintillation and TEC Receiver in Space - CITRIS
Bernhardt, P.; Sietting, C.; Naval Research Laboratory

Simulations of Scintillation Impacts on the ACE+ Water Vapour Retrieval Using the Satellite-to-Satellite Measurements
Hoeg, P. *; Schwabe Loehmann, M. *; Olsen, L. **; Benz, H.-H. *; Steen Nielsen, A. *
*DMI, **University of Aalborg

Session T3: Novel Radio Occultation Techniques

The ACE+ Mission: Status of Preparatory Activities
Silvestrin, P.; Baptista, P.; Floury, N.; Gujario, J.; Sterenborg, G.; Wehr, T.
ESA

Advanced GNSS Receiver for Atmospheric Sounding Preliminary Design in the Framework of the ESA ACE+ Opportunity Mission
Franzoni, G.; Tin, A.; LABEN S.p.A.
Atmospheric Water Vapor Estimate through Mw Attenuation Measurements On Leo-Leo Satellite Configuration
Cucoli, Fabrizio*; Facheris, Luca**
*CNIT-DET-UNIFI, **DET-UNIFI

Session W1: Imaging and Data Assimilation (Invited)

Profiling Tropospheric Refractivity in a Real-Time Regional GPS Network
Skone, S.; Nicholson, N.; University of Calgary

Ionospheric Data Assimilation 3D (IDASD): Derivation and Results
Bust, G.; Gaussian II, T.; Garner, T.; ARL:UT

Ionosphere imaging by GPS Measurements on Champ
Jakowski, N.; Heise, S.; Stankov, S.; Tsybulya, K.
*German Aerospace Center, **GeoForschungsZentrum Potsdam

Combining GPS and Ionoosonde Observations to Perform Ionospheric Tomography
Hernandez-Pajares, M.; Juan, J.M.; Sanz, J.; Garcia-Fernandez, M.
*Technical University of Catalonina (UPC), **GMGE/UPC

Session W2: Space Based GNSS Radio Occultation

Consistency of Horizontal and Vertical Resolution of Meteorological Fields for GPS
Radio Occultation Measurements
Sutera, A.; Petitta, M.; University "La Sapienza"

Characterisation of the GRAS Measurement System and Data Products
Luntiara, J.-P.; Wilson, J. J. W.; EUMETSAT

GNSS Radio Occultation: from the Bending Angles to the Atmospheric Profiles
Vespe, F.; Benedetto, C.; Pacione, R.
*Agenzia Spaziale Italiana, **Telespazio S.p.A.

Analysis of the Performances in Retrieved Atmospheric Profiles with Radio-
Occultation Methods by Considering Different Sources of Error and Different
Processing Techniques
Corrascia-Sanz, G.; Loiselet, M.
*GMV S.A., **ESA/ESTEC

The methods for correcting the reconstruction data in radio occultation experiments
by using regional meteorological models
*M.Lomonosov Moscow State University, **Alfred Wegener Institute for Polar and
Marine Rese

Session W3: Scintillation

Effects of Ionoosopheric Scintillation on GPS Signals at Auroral Latitudes
Forte, B.; Radicella, S.M.; The Abtus Salam ictp

GNSS Satellite to Ground Channel Model Including Ionoospheric Scintillations
Strangeways, H.; Ghem, V.; Zernov, N.
*University of Leeds, **University of St. Petersburg
Session: Poster Session

Coordinated Study of YLF Phenomena at Low Latitude Indian Ground Stations for the Determination of Ionospheric Parameters
Gwai, A.; Barkatullah University

Atmospheric Water Vapor Estimate through Mw Attenuation Measurements on Leo-Leo Satellite Configuration
Cuccoli, F.; Facheris, L.**
*CNIT-DEUT-Unifi,**DEUT-Unifi

Determination of GPS Satellite and Receiver Interfrequency Biases
Dore, R.; Meggs, R.; Mitchell, C.; University of Bath

ISACCO (Ionospheric Scintillations Arctic Campaign Coordinated Observations) project at Ny-Ålesund
De Franceschi, G.; Romano, V.; Alfonsi, L.; Perrone, L.; Fezzopane, M.; Zolesi, B. INGV

OSSE-based Assessment of the Impact of GPS Occultation Measurements on Mesoscale QPF.
D'Isidoro, M.; Buzzi, A.; CNR-ISRAC

On the Prediction of the Excess Doppler Evolution for the Bandwidth Optimization of the LAGRANGE RO Receiver
Notarpietro, R.*; Perona, G.*; Gabella, M.*; Zin, A.*
*Politecnico di Torino,**LaBeri S.p.A.

Validation of a New Method for Ionospheric Electron Density Reconstruction by Means of VI data.
Miro Amarante, M.G.; Radicella, S.M.; Nova, B.; Coisson, P.
Abdus Salam ICTP

A New Model Assisted Method for Ionospheric Electron Density Reconstruction
Nova, B.; Radicella, S.M.; Coisson, P.; Miro Amarante, M.G.; The Abdus Salam ICTP

LAGRANGE Antenna
Valle, P.; Garinci, L.; Vegni, C.; Atenia Spazio S.p.A.

Simultaneous Observations of the Main trough Using GPS Imaging and the Esical Radar
Meggs, R.*; Mitchell, C.*; Howells, V. S. C.*
*University of Bath,**Furniture Appleton Laboratory

Optimal Kalman Filtering for Ultra-Reliable Tracking
Lange, A.; Finnish Meteorological Institute

Radio Tomographic Imaging of Sporadic E-Layers During SEEK2
Bermhardt, P.*; Selcher, C.*; Yamamoto, M.**; Fukao, S.***
*Naval Research Laboratory,**RASC, University of Kyoto,**RASC, University of Kyoto

Opperman, B.; Hermanus Magnetic Observatory

An Assessment of Near Real-Time and Post-Processing Strategies for Tropospheric Delay Estimation from a Planned CGPS Network in the UK
Oriac, E.; Dodson, A.; Bingley, R.; University of Nottingham

Water Vapor Tomography for Air Space Surveillance
Rannat, K.*; Lange, Antti**; Miilda, Peep***
*Marine Systems Institute at Tallinn Tech. Univ.,**Finnish Meteorological Institute,**Institute of Applied Math. at Univ. of Tartu
Temporary Variations of ÓAñ during the Earthquakes on GPS Data
Smirnov, V. *, Russian Academy of Science

Open Loop Techniques for GPS Signals Showing Multipath and Fading
Aparicio, J.M.; Rius, A.; IEEE

Description and Assessment of an Ionospheric GPS Data Assimilation Process
Angling, M.; QinStQ

Applications of Tropospheric Parameters Derived Using the SADC GPS network
Cumbrink, A.; Hartebeesthoek Radio Astronomy Observatory

The Equatorial Ionospheric Scintillations During Geomagnetic Storms
Biktash, L.Z *
*Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Russian Academy of Science (IZMIRA)

Meteorological Applications of the Swedish Ground-Based GPS Network
Elgered, G.; Gradinovsky, L.**; Gustafsson, N. ***; Johansson, J. **; Ridal, M. ***; Stoew. B. **;
*Chalmers University of Technology,**Chalmers,***SMHI

Determination of Errors in Finding Vertical from Slant TEC Due to Horizontal Gradients
Strangeways, H.; Ioannides, R.; University of Leeds

Ground Processor Prototype (GPP) for (GPS) Atmospheric Sonding
Carrascosa, C.; Fernandez, L.; Salcedo, J.M.; Christensen, J **; Hagg. M **; Loiselet M***
*GMV, **SES, ***ESTEC

GNSS Satellite to Ground Channel Model Including Ionospheric Scintillations
Strangeways, H.; Gherm, V.**; Zernov, N. **
*University of Leeds,**University of St. Petersburg

Combining GPS And Ionosonde Observations to Perform Ionospheric Tomography
Garcia-Fernandez, M. Hernandez-Pajares, M; Juan, J.M; Sanz, J.
Research group of Astronomy and Geomatics

Measurement of TEC Deposition Using a Chain of GPS Receivers in South America
Valladares, C.; Doherty, P.; Boston College
Session W4: Applications of Radio Occultation and Tomography

Near Real-time Data Assimilation of GPS ZTD and PW into a Non-hydrostatic Model
Faccani, C.; Ferretti, R.; Paciome, R.; Vespe, F.
*University of L'Aquila, **Telespazio Spa, ***ASI

Diffractive Vector and Scalar Integral Relationships for Bistatic Radio-holographic Remote Sensing of the Atmosphere, Mesosphere and Terrestrial Surface from Space
Pavelyev, A.; Liou, Y.A.
*Institute of Radio Engineering and Electronics, **Center for Space and Remote Sensing Research

Exploring the Use of Radio-Occultation Sounding in the Reconstruction of Mediterranean Hydrological Cycle on Numerical Grids
Speranza, A.; University of Canestino

Imaging or 4D Radio Tomography of the Ionosphere and Data Assimilation
Kunitsyn, V.; Kozharin, M.; Nesterov, I.
M.Lomonosov Moscow State University

Cilliers, P.; Opperman, B.; Smilovic, V.
*University of Pretoria, **Hermanus Magnetic Observatory, ***Russian Academy of Science Moscow

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