

Final project report

<i>Project ID</i>	2006/2.01
<i>Title</i>	Upper Atmosphere Measurements and Space Weather
<i>Institution</i>	Istituto Nazionale di Geofisica e Vulcanologia, Roma
<i>Email</i>	giorgiana.defranceschi@ingv.it
<i>Duration:</i>	3 years
<i>Assigned funding</i>	€ 150.000,00

Activities and results

One of the main objectives of space weather is the detection, forecasting and errors mitigation of the ionosphere perturbations over different time and space scales that can affect satellite based systems as well as radio communications. To achieve this goal it is important to develop and maintain a multi-instrument network of ground based station (ionosondes, riometers, GISTM, etc..) over Arctic and Antarctica with a good spatial/temporal coverage able to furnish experimental observations to a suitable database. Such a database represent the first step for developing new models as well as to test the existing ones for further improvements. This project is working in such direction since the beginning of 90's and its team of scientists and technicians has matured the right expertise to give a concrete contribution to the international scientific community. The technological and scientific achievements obtained in these years are visible looking at the huge amount of publications on international journals and at presentations at European and extra-European conferences. The international collaborations are opening also the participation to significant projects in the frame of FP7 (Space, Transport and Galileo Calls), ESA and ASI. Recently the know how reached in the field of monitoring and investigation of the polar ionosphere by ground based stations, particularly by GISTM network, allowed the establishment of a SCAR Action Group titled GPS for Weather and Space Weather Forecast led by INGV (<http://www.scar.org/researchgroups/gpsforweather.html>), having the main objective of bipolar ionospheric imaging and Space Weather ionospheric models.

INGV is also involved in assessing the TEC for the estimation of the Faraday Rotation error on satellites signals with the use of the data acquired at DomeC in the frame of DOMEX-2: long time stability of L-band emission at Dome-C Antarctica, ESA project

http://earth.esa.int/workshops/smos09/pres/2_Paloscia_DomeC.pdf.

Moreover INGV is associated partner of the EISCAT_3D Preparatory Phase (EC-FP7), a project that is planning an European three-dimensional imaging radar for atmospheric and geospace research.

Products

A – papers in scientific magazines

1. AA.VV. Antartide, un osservatorio naturale per comprendere la Terra, PNRA 2009.
2. Alfonsi, L., De Franceschi, G., De Santis, A.: Geomagnetic and ionospheric data analysis over Antarctica: a contribution to the long term trends investigation, *Ann. Geophys.*, 26, 1173-1179, 2008.
3. Alfonsi Lu., Kavanagh A.J., Amata E., Cilliers P., Correia E., Freeman M., Kauristie K., Liu R., Luntama J.-P., Mitchell C.N., Zherebtsov G.A.. Probing the high latitude ionosphere from ground-based observations: The state of current knowledge and capabilities during IPY (2007-2009), *Journal of Atmospheric and Solar-Terrestrial Physics*, 70, 18, 2293-2308, doi:10.1016/j.jastp.2008.06.013, 2008.
4. Aquino M., Monico J.F.G., Dodson A.H., Marques H., De Franceschi G., Alfonsi Lu., Romano V., Andreotti M., Improving the GNSS Positioning Stochastic Model in the Presence of Ionospheric Scintillation, *Journal of Geodesy (2009)*, doi: 10.1007/s00190-009-0313-6.
5. Beniguel Y., Romano V., Alfonsi Lu., Aquino M., Bourdillon A., Cannon P., De Franceschi, Dubey S, Forte B., Gherm V.E., Jakowski N., Materassi M., Noack T., Pozoga M., Rogers N.C., Spalla P., Strangeways H.J., Warrington M., Wernik A., Wilken V., Zernov N.N. (2009), Ionospheric scintillation monitoring and modelling, *Annals of Geophysics*, 52, 3/4, 2009.

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- Burston, R., I. Astin, C. Mitchell, Alfonsi Lu., T. Pedersen, and S. Skone (2009), Correlation between scintillation indices and gradient drift wave amplitudes in the northern polar ionosphere, *J. Geophys. Res.*, *114*, A07309, doi:10.1029/2009JA014151.
- da Silva Heloísa Alves, Paulo de Oliveira Camargo, João Francisco Galera Monico, Marcio Aquino, Haroldo Antonio Marques, Giorgiana De Franceschi, Alan Dodson, Stochastic Modelling Considering Ionospheric Scintillation Effects on GNSS Relative and Point Positioning, *Advances in Space Research* *45* 1113–1121, 2010.
- De Franceschi G., L. Alfonsi, V. Romano, M. Aquino, A. Dodson, C. N. Mitchell, A. W. Wernik (2008), Dynamics of high latitude patches and associated small scale irregularities, *Journal of Atmospheric and Solar-Terrestrial Physics*, doi:10.1016/j.jastp.2007.05.018, *70*, 6, 2008, 879-888.
- Forte Biagio, Massimo Materassi, Lucilla Alfonsi, Vincenzo Romano, Giorgiana De Franceschi, Paolo Spalla, Optimum parameter for estimating phase fluctuations on transionospheric signals at high latitudes, *Advances in Space Research*, 2010, ISSN 0273-1177, DOI: 10.1016/j.asr.2010.04.033.
- Materassi M., Alfonsi Lu., De Franceschi G., Romano V., Mitchell C.N., Spalla P. Detrend effect on the scalograms of GPS amplitude scintillation, *J. Adv. Space Res.*(2009), doi:10.1016/j.asr.2008.01.023.
- Romano V., S. Pau, M. Pezzopane, E. Zuccheretti, B. Zolesi, G. De Franceschi, and S. Locatelli, The electronic Space Weather upper atmosphere (eSWua) project at INGV: advancements and state of the art, *Ann. Geophys.*, *26*, 345–351, 2008.
- Romano V., A. Salvati, S. Massetti, IDIPOS: a proposal for an Italian database infrastructure for polar observation sciences, *XXX SCAR Open Science Conference, St. Petersburg, July 8-11, 2008b*.
- Spogli L., Alfonsi Lu., G. De Franceschi, V. Romano, M. H. O. Aquino, A. Dodson, Climatology of GPS Ionospheric Scintillations over high and mid-latitude European Regions, *Ann. Geophys.*, *27*, 3429–3437, 2009.
- Spogli, L.; Alfonsi Lu.; De Franceschi, G; Romano, V; Aquino, M; Dodson, A: Climatology of GNSS ionospheric scintillation at high latitudes, *WPP-302 Proceedings of the 2nd International Colloquium Scientific and Fundamental Aspects of the Galileo Programme COSPAR Colloquium, Padua 14-16 Ottobre 2009b*.
- Spogli L., Alfonsi Lu., G. De Franceschi, V. Romano, M. H. O. Aquino, A. Dodson, Climatology of GNSS ionospheric scintillation at high and mid-latitudes under different solar activity conditions, *Nuovo Cimento della Società Italiana di Fisica B-General Physics Relativity Astronomy And Mathematical Physics And Methods*, Vol. *125 B*, N. 5-6, 2010.
- Wernik Andrzej, L. Alfonsi, M. Materassi, Scintillation modelling using in-situ data, *Radio Science*, Vol. *42*, RS1002, doi:10.1029/2006RS003512, 2007.
- Yin P., Mitchell C.N., Alfonsi Lu., De Franceschi G., Romano V., Sarti P., Negusini M., Capra A., Ionospheric imaging over Antarctica, *Journal of Atmospheric and Solar-Terrestrial Physics*, *Journal of Atmospheric and Solar-Terrestrial Physics* *71* (2009) 1757–1765.

B - capitoli di libri

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C - proceedings di congressi internazionali

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D - atti di convegni nazionali

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E - carte tematiche

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F - brevetti, prototipi e database

- The Electronic Space Weather Upper Atmosphere System (eSWua, www.eSWua.ingv.it).
- ESKIMO web and ftp server (www.eskimo.ingv.it)

G - mostre, organizzazione convegni, editing ed altro

- October 2007. Radio Interview given to Ecoradio net on the Antarctic Research (V.Romano).
- December 2007. TV interview given to SAT2000 on the Antarctic Research (L. Alfonsi).
- May 2008. Outreach Seminars on the Antarctic Research at "scuola media inferiore di Palombara Sabina" and at "IPSAR "Mezzaluna" (Mentana, Rome) (V. Romano e L. Alfonsi).
- May 2008. Outreach Seminars on the Antarctic Research in the frame of "Fiera della Scienza", at "Istituto Comprensivo di Riano (Rome)", in collaboration with Comune di Riano and of the Dept. "Scienze matematiche, fisiche e naturali" of Università di Roma Tor Vergata (V. Romano).
- 2008: Realization of the Italian version of a series of Japanese comics books (G. De Franceschi, L. Alfonsi) <http://www.scostep.ucar.edu/comics/booklets.html>
- 2008-2009: TV interviews given to TV2000 net on the Antarctic Research (L. Alfonsi).
- August 2009 Seminar on "Ionospheric monitoring and studies by means of GNSS receivers" at the National University of Tucuman, Argentina (V. Romano).
- September 2009; September 2010: Outreach seminars held during "La notte europea dei Ricercatori" (L. Spogli,

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- V. Romano, L. Alfonsi).
9. October 2009: Outreach event in the frame of the IPY International polar week at INGV Conference Room (<http://apecs.is/outreach/490-scheduled-presentations-for-the-polar-lecture-series-4-9-october-2009>, L. Alfonsi, V. Romano)
 10. February 2010: Outreach seminar on the Antarctic research at "Esopo" Secondary School, Rome (V. Romano).
 11. March 2010: Outreach Seminars on the Antarctic Research in the frame of "Settimana di Cultura Scientifica e Tecnologica" (V. Romano).
 12. October 2010: PhD Course on Ionospheric Scintillation at the National University of Tucuman, Argentina (V. Romano).
 13. December 2010 "Polar Science at INGV", Agenda 2011 press (L. Alfonsi, V. Romano et al.)

H - attività di formazione (tesi di dottorato, assegni di ricerca, etc.)

1. n.1 assegno di ricerca dal 1 settembre 2008 al 30 settembre 2010 al Dott. Luca Spogli. Argomento dell'assegno e' stato lo sviluppo del sistema di trattamento e gestione dei dati ionosferici per accrescere la funzionalita' del Data Base esistente su eSWua (<http://www.eswua.ingv.it>). Durante l'attivita' svolta e' stato sviluppato il concetto di climatologia di scintillazione ionosferica polare GBSC (Ground Based Scintillation Climatology) che e' stata oggetto di numerose presentazioni e pubblicazioni.

Research units

Unit 1- Stazioni di misura Resp Vincenzo Romano INGV-

Enrico Zuccheretti I TECNOLOGO INGV Giuseppe Tutone CTER INGV Massimiliano Cerrone CTER INGV Fawzi Doumaz I RICERCATORE INGV Umberto Sciacca I TECNOLOGO INGV Michael Pezzopane RICERCATORE INGV James Arokiasamy TECNOLOGO INGV Phil Wilkinson Research Director IPS (AU) Susan Skone Professor Un. Calgary (CA) Silvia Pau CTER INGV Alberto Salvati TECNOLOGO CNR-SRC

Unit 2- Scintillazioni ionosferiche Resp Lucilla Alfonsi INGV

Giulio Fontana CTER INGV Cathryn Mitchell Professor UN. Bath (UK) Andrzej Wernik Professor SRC-Warsaw (PO) Massimo Materassi RICERCATORE ISC-CNR (Firenze) Paolo Spalla I RICERCATORE IFAC-CNR (Firenze), Luca Spogli RICERCATORE- INGV

Unit 3- Analisi dati ionosferici Resp Bruno Zolesi INGV

Loredana Perrone RICERCATORE INGV Marco Pieterlla RICERCATORE INGV Giulio Fontana CTER INGV Michael Pezzopane RICERCATORE INGV, Stamatias Kouris Salonicco UN. SALONICCO (Gr)

Date: 28 February 2011

Notes