



SCAR Group

xxx

SG

PS/LS/GS

Person

xxx

Responsible:

SCAR Executive Committee Meeting 2017

Brno, Czech Republic, 31 July - 2 Aug 2017

SCAR EG "GRAPE" GNSS RESEARCH AND APPLICATION TO POLAR ENVIRONMENT 2016-2017 Report

Report Author(s): Giorgiana De Franceschi, Nicolas Bergeot

Summary of activities from 2016-17 and any other important issues or factors:

GRAPE is a joint Physical Sciences and Geosciences EG aiming to intensify the international efforts to build and coordinate a robust network of collaborations in order to answer a variety of weather and space weather related needs at high latitudes and polar regions (Arctic and Antarctica), through ad hoc data sharing and models development. The main outcome from the activities carried out relies on the increasing interest and participation of the international community to the scientific and business sessions organized within the International Beacon Satellite Symposium 2016 (26 June-1 July, Trieste, IT), the SCAR OSC 2016 (22-26 August, Kuala Lumpur) and the forthcoming URSI GASS 2017 (19-26 August, Montreal, CA) and IAGA 2017 (27 August- 1 September, Cape Town, SA) where a GRAPE mini symposium is planned to attract IAGA community and early stage researchers in South Africa.

Progress and Plans:

Major Activities and Significant Progress from the past year

The observing infrastructures (mainly based on GNSS receivers able to monitor ionospheric TEC and scintillations), managed and upgraded by National Projects, is growing above all over Antarctica however not yet filling the existing

gap between the Northern and Southern Hemispheres. New solutions for data exchange and management in a CLOUD environment addressed to Space Weather products development assisting communications, navigation and positioning are also in progress and tested in two Antarctic infrastructures (EACF, Brazil, SANAIV, South Africa), as well as the development of a novel GNSS software defined radio (SDR) receiver for ionospheric monitoring. URSI AT RASC in 2015 (16-24 May, Gran Canaria, Spain), where a GRAPE scientific session and business meeting were attended by a wide radio science community, has been crucial for the establishment of an international task force devoted to the implementation of a new Scientific Program proposal submitted in May 2017 to SCAR. The proposal, titled RESOURCE (Radio Sciences Research on AntarctiC AtmospherE) aims to improve the current monitoring and knowledge of the Antarctic atmosphere in relation to the Arctic environment in a bipolar framework, achieved using radio sensors and supported by complementary instrumentation. The main goal of the proposal, i.e. to isolate the atmospheric contribution and use it in the study of the near-earth space environment, will pursue the following open questions:

- The understanding of the coupling between the ionosphere and the neutral atmosphere in relation to the inter-hemispheric symmetries and asymmetries;
- The assessment of the impact of the polar atmosphere on the technology and on the humans at ground level or in the geospace environment;
- The investigation of the atmospheric waves and their role in the vertical coupling between the upper and lower atmosphere.

Major Future Initiatives and Actions, including rough timeline, for at least the next 2 years:

Efforts will be addressed to the activities proposed within RESOURCE, builded upon the important GRAPE legacy, firstly by enhancing interactions between the scientists who measure and utilise the entire radio spectrum, either as an auxiliary or principal observation, to study the atmosphere. Another important goal of the GRAPE-RESOURCE community will be the establishment of a closer link with the SAR community in respect to the past, contributing in mitigating the ionospheric effects on SAR images. Among conferences, a scientific session has been planned within SCAR OSC 2018 titled: The Polar Atmosphere and Geospace (Conveners: G. De Franceschi, Yasunobu Ogawa, Emilia Correia, Nicolas Bergeot) as well the GRAPE-RESOURCE (hopefully) satellite meeting. Efforts of GRAPE participants will focus on a training course organized within the International School of Space Science (ISSS <http://www.cifs-iss.org/>) directed by U. Villante (University of L'Aquila). The course titled "The Polar Upper Atmosphere: from science to operational issues" is scheduled in September 2018 at L'Aquila (IT). The course, directed by G. De Franceschi (INGV), M. Mendillo (Boston University, USA), C. Mitchell (University of Bath, UK) aims to foster excitement and encourage involvement of the next generation of space researchers in studies of the geospace environment of Polar Regions.

New outputs and deliverables:

GRAPE WEB www.grape.scar.org (updating is in progress and a new version will be soon available).

Publications, Reports, Conferences Proceeding 2016-2017

- 2016

Alfonsi, L., Cilliers, P. J., Romano, V., Hunstad, I., Correia, E., Linty, N., ... & Riley, P. (2016). First observations of GNSS ionospheric scintillations from DemoGRAPE project. *Space Weather*, 14(10), 704-709, doi:10.1002/2016SW001488.

Correia, E., Quevedo, M.T. , Paz, A. J. . ANTARCTIC ATMOSPHERE RESPONSE TO THE SUN-EARTH INTERACTIONS. Annual Activiry Report - INCT-APA, v. x, p. 15-22, 2016.

Linty, N., Romero, R., Cristodaro, C., DAVIS, F., Bavaro, M., Curran, J. T., ... & Cilliers, P. (2016, May). Ionospheric scintillation threats to GNSS in polar regions: the DemoGRAPE case study in Antarctica. In *Navigation Conference (ENC), 2016 European* (pp. 1-7). IEEE. doi: [10.1109/EURONAV.2016.7530546](https://doi.org/10.1109/EURONAV.2016.7530546)

Linty, N., I. Hunstad, " Installation and configuration of an Ionospheric Scintillation Monitoring Station based on GNSS receivers in Antarctica. *RAPPORTI TECNICI ING V*, 2016, 354: 1-28. N

M. Negusini, B. H. Petkov, P. Sarti and C. Tomasi, (May 2016) "Ground-Based Water Vapor Retrieval in Antarctica: An Assessment," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 54, no. 5, pp. 2935-2948,. doi: 10.1109/TGRS.2015.2509059.

Pignalberi, A ; Pezzopane, M ; Tozzi, R ; De Michelis, P; Coco, I: Comparison between IRI and preliminary Swarm Langmuir probe measurements during the St. Patrick storm period, *Earth, Planets and Space*, 68, 93, doi: 10.1186/s40623-016-0466-5, 2016.

Prikryl, P., Ghoddousi-Fard, R., Ruohoniemi, J. M., Thomas, E. G.: GPS phase scintillation at high latitudes during two geomagnetic storms, Auroral dynamics and space weather, *Geophysical Monograph Series Vol. 215*, Zhang, Y. and Paxton, L.J. (Editors), American Geophysical Union and John Wiley & Sons, Inc., ISBN 978-1-118-97870-2, 2016.

Prikryl, P., et al. (2016), GPS phase scintillation at high latitudes during the geomagnetic storm of 17–18 March 2015, *J. Geophys. Res. Space Physics*, 121, doi:10.1002/2016JA023171.

V. Sreeja (2016), Impact and mitigation of space weather effects on GNSS receiver performance, *Geoscience Letters*, doi: 10.1186/s40562-016-0057-0.

- 2017

Cilliers, P., L. Alfonsi, L. Spogli, G. De Franceschi, V. Romano, I. Hunstad, N. Linty, O. Terzo, F. DAVIS, J. Ward, C. Cesaroni and J.A.E. Stephenson (2017), Analysis of the ionospheric scintillations during 20-21 January 2015 from SANAE by means of

[SCAR EG GRAPE]: 2016-2017 Annual Report, cont.

the DemoGRAPE scintillation receivers, Proceedings of URSI GASS, Montreal 19-26 August 2017, in publications on IEEE Xplore Summary Papers.

Correia, E., L. Spogli, L. Alfonsi, C. Cesaroni, A. Gulisano, E. Thomas, R. Ramirez, and Alexandre Rodel. Ionospheric Response to the 26 September 2011 Geomagnetic Storm In Antarctica. *Annales Geophysicae*. 2017 Submitted

Drews R., Pattyn F., Hewitt I. J., Matsuoka K., Helm V., Berger S., Bergeot N., Favier L., Actively evolving subglacial conduits and eskers initiate ice shelf channels at an Antarctic grounding line, *Nature Communications*, 8, 10.1038/ncomms15228, 2017.

G. Giordanengo, L. Pilosu, L. Mossucca, F. Renga, S. Ciccina, O. Terzo, G. Vecchi, V. Romano, and I. Hunstad, "Energy Efficient System for Environment Observation", the 11th International Conference on Complex, Intelligent, and Software Intensive Systems - CISIS, 07/2017, accepted for publication.

L. Mossucca, L. Pilosu, P. Ruiu, G. Giordanengo, S. Ciccina, G. Vecchi, O. Terzo, V. Romano, L. Spogli, C. Cesaroni, I. Hunstad, and A. Serratore, "Greenlab: autonomous low power system extending multi-constellation GNSS acquisition in Antarctica", Proceedings of URSI GASS, Montreal 19-26 August 2017, in publications on IEEE Xplore Summary Papers.

Pattyn F., Bruyninx C., Tison J.-L., Bergeot N., Favier L., van Dam T., Drews R., Callens D., Philippe M., Matsuoka K. and Hubbard B., Constraining ice mass changes in coastal draining Maud Land, Antarctica (ICECON), final report Brussels : Belgian Science Policy 2009, 2017.

R. Romero, N. Linty, C. Calogero, F. Dosis and L. Alfonsi (2017, January), "On the Use and Performance of new Galileo signals for Ionospheric Scintillation Monitoring over Antarctica", Proceedings of ION ITM 2017, Monterey (CA), January 2017, pp.989-997, <https://www.ion.org/publications/abstract.cfm?articleID=14942>.

Presentations

Bergeot N., Darrouzet F., Rasson J., Tsagouri I., Lichtenberger J., Marqué C., Chevalier J.-M., Martinez A., Katsiyannis T., Bruyninx C., Ranvier S., Lamy H., Tétard C., de Keyser J., Bracke S., Gonsette A. and Belehaki A., GNSS and Space Weather in East Antarctica around the Princess Elisabeth Belgian base, SCAR 2016 Conference, Kuala Lumpur, Malaysia, 20-30 August, 2016.

Bruyninx C., Bergeot N., Van Dam T., Camelbeeck T., Francis O. and Tabibi S., High precision GNSS infrastructure around the Princess Elisabeth Base, BNCGG - BNCAR symposium, Brussels, Belgium, April 29, 2016.

Capra A., A. Zanutta, M. Negusini, S. Gandolfi, F. Salvini, P. Sterzai, L. Vittuari, P. Cianfarra, M. Dubbini, A. Galeandro and F. Mancini, "VLNDEF: An integrated geodetic project and its latest results", poster presentation SCAR Open Science Conference, Kuala Lumpur, Malaysia, 22-26 August 2016.

Chevalier J.-M., Bergeot N., Marqué C., Bruyninx C., Near-real time detection of solar radio burst impacting the GNSS signal reception, ESWW13, Oostende, Belgium, 14-18 November, 2016

[SCAR EG GRAPE]: 2016-2017 Annual Report, cont.

Drews R., Matsuoka K., Martin C., Callens D., Bergeot N. and Pattyn F., Evolution of Derwael Ice Rise in Dronning Maud Land, Antarctica, over the last millennia, BNCGG - BNCAR symposium, Brussels, Belgium, April 29, 2016.

Drews R., Pattyn F., Berger S., Favier L., Matsuoka K. and Bergeot N., Ice-shelf channels: where they originate and how they evolve, BNCGG - BNCAR symposium, Brussels, Belgium, April 29, 2016

Fernandez, José Henrique ; Correia, E. . Relationship between LEPE events in the lower ionosphere and the associated geospace conditions. In: VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016, Jatai. Anais do VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016

Francis O., Van Dam T., Bruyninx C., Bergeot N. and T. Camelbeeck, The GIANT project: why gravity is increasing at the PE station?, BNCGG - BNCAR symposium, Brussels, Belgium, April 29, 2016.

García-Rigo A., Roma-Dollase D., Hernández-Pajares M., Li Z., Terkildsen M., Olivares G., Ghoddousi-Fard R., Dettmering D., Erdogan E., Haralambous H., Béniguel Y., Berdermann J., Kriegel M., Krypiak-Gregorczyk A., Gulyaeva T., Komjathy A., Vergados P., Feltens J., Zandbergen R., Fuller-Rowell T., Altadill D., Bergeot N., Krankowski A., Agrotis L., Galkin I., Orus-Perez R., St. Patrick's Day 2015 geomagnetic storm analysis based on Real Time Ionosphere Monitoring, EGU General Assembly 2017, April 23-28, Vienna, Austria, 2017

G. Heygster, C. Melsheimer, A. Gomes, G. Spreen, M. Negusini, B. H. Petkov and C. Tomasi, "Precipitable Water retrieval over Antarctica from Satellite Microwave Humidity sounders", XXXIInd URSI General Assembly and Scientific Symposium, 19 - 26 of August 2017, Montreal, Canada.

L. Mossucca, L. Pilosu, P. Ruiu, G. Giordanengo, S. Ciccina, G. Vecchi, O. Terzo, V. Romano, L. Spogli, C. Cesaroni, I. Hunstad, and A. Serratore, "GreenLab: autonomous low power system extending multi-constellation GNSS acquisition in Antarctica", XXXIInd URSI General Assembly and Scientific Symposium, 19 - 26 of August 2017, Montreal, Canada.

L. Pilosu, L. Mossucca, A. Scionti, G. Giordanengo, F. Renga, P. Ruiu, O. Terzo, S. Ciccina, and G. Vecchi, "Low Power Computing and Communication System for Critical Environments", 11-th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing - 3PGCIC 2016, Asan, Korea, 11/2016.

L. Pilosu, P. Ruiu, A. Scionti, L. Alfonsi, L. Spogli, V. Romano, F. Dervis, N. Linty, P. Cilliers, P. Riley, J. Ward, E. Correia, J. Henrique, M. Bavaro, J. T. Curran, and J. Fortuny, "DemoGRAPE: A demonstrator of e-science potential in Antarctica", SCAR 2016, Kuala Lumpur, Malaysia, 08/2016.

L. Pilosu, P. Ruiu, A. Scionti, L. Alfonsi, V. Romano, R. Romero, P. Cilliers, H. Theron, E. Correia, and W. Sarjob, "Cloud computing infrastructure for polar GNSS e-science applications", SCAR 2016, Kuala Lumpur, Malaysia, 08/2016.

Prikryl, P., et al., GPS phase scintillation during the geomagnetic storm of March 17, 2015: The relation to auroral electrojet currents, Japan Geoscience Union Meeting, Makuhari Messe, Chiba-city, Japan, May 22-26, 2016.

[SCAR EG GRAPE]: 2016-2017 Annual Report, cont.

Prikryl, P., et al. (presented by Pierre Cilliers), GPS phase scintillation during the geomagnetic storm of March 17, 2015: Interhemispheric comparison and the relation to auroral electrojet currents, SCAR Open Science Conference, Kuala Lumpur, Malaysia, 22-26 August 2016.

Prikryl, P., et al., Geomagnetic storms of March 17, 2013 and 2015: GPS phase scintillation and auroral electrojet currents, JpGU-AGU Joint Meeting 2017, Tokyo, Japan, 20–25 May 2017.

Prikryl, P., et al., Comparison of March 2013 and 2015 storms : GPS phase scintillation and auroral electrojet currents, European Geosciences Union General Assembly 2017 Vienna, Austria, 23–28 April 2017.

Prikryl, P., et al., GPS phase scintillation and auroral electrojet currents during geomagnetic storms of March 17, 2013 and 2015, XXXIInd URSI General Assembly and Scientific Symposium, 19 - 26 of August 2017, Montreal, Canada.

Rodel, A. ; Correia, E. . Caracterização do comportamento da ionosfera durante eventos SFE 'Solar Flare Effect'. In: VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016, Jatai. Anais do VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016.

C. Scarchilli, P. Grigioni, M. Maahn, M. Negusini, S. Argentini, G. Pace, M. Frezzotti, L. De Silvestri, V. Ciardini, A. Galeandro, A. Iaccarino, S. Dolci, M. Proposito, and G. Camporeale, “Solid precipitation estimation during summer snowfall events at a coastal site of the Terra Nova bay area, Antarctica”, poster presented at European Geosciences Union General Assembly 2017 Vienna, Austria, 23–28 April 2017.

Silva, G. A. ; Correia, E. ; A. Rodel . Variabilidade da espessura da ionosfera no setor equatorial americano. In: VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016, Jatai. Anais do VI Simpósio Brasileiro de Geofísica Espacial e Aeronomia, 2016

Tabibi S., Van Dam T., Francis O., Bruyninx C., Bergeot N. and Camelbeeck T., Snow accumulation retrieval in East Antarctica using GNSS-MR, BNCGG - BNCAR symposium, Brussels, Belgium, April 29, 2016.

Data and links:

- GNSS-based (GPS+GLONASS) Total Electron Content data from POLENET, IGS networks, and Belgian stations from 1999 to 2016. The data were processed using the ROB-IONO software (Bergeot et al. 2014). Contact person Nicola Bergeot nicolas.bergeot@oma.be
- Data from Ionosonde, GPS-TEC JAVAD, GNSS for TEC and scintillation, riometers, VLF for ionosphere monitoring at Brazilian Antarctic Station Comandante Ferraz (EACF 62.8S, 58.4W). GNSS for TEC and Scintillation, riometers and VLF at Radio Observatory of Itapetinga (ROI, 23.2S, 46.6W), GNSS for TEC and Scintillation and riometer at Cawame (Roraima-Brazil, 2.82N, 60.76W). Contact person: Emilia Correia ecorreia@craam.mackenzie.br
- Eswua www.eswua.ingv.it (work in progress to upgrade the data base)

- DemoGRAPE, GNSS data during DemoGRAPE campaigns, Contact person Lucilla Alfonsi lucilla.alfonsi@ingv.it

Linkages

Support received for my activity beyond SCAR (eg. Funds from another organization for a workshop):

Italian National Program for Antarctic Researches (PNRA)

List of GRAPE major collaborations with other SCAR groups and with organisations/groups beyond SCAR:

EU PROJECTS and initiatives focusing on GNSS services and Space Weather, URSI COMMISSIONS G and F, IAGA.

Outreach and Capacity Building

Bergeot N., Why do we need to continue scientific research in Antarctica? Cognac Rotary Club, France, March 2, 2016 Presentation on Antarctica research at the Cognac Rotary Club.

Bergeot N., A little detour through Antarctica ? Berkendael prison, Belgium, May 26, 2017 Presentation in the frame of the "Clés pour l'Univers" association to give scientific presentation in closed institutions (here, prison for women).

Spogli Luca, "Space climate and space weather from the Arctic" lecture within the "Master in sustainable development, geopolitics of resources and arctic studies" organized by the Società Italiana per l'Organizzazione Internazionale (The Italian Society for International Organization), Rome July 2016.

ACTIONS

List of people from GRAPE that would be willing to serve as reviewers for the next few years.

Nicolas Bergeot
nicolas.bergeot@oma.be

Lucilla Alfonsi
lucilla.alfonsi@ingv.it

Membership

The complete list of membership is available at www.grape.scar.org
Leadership

