

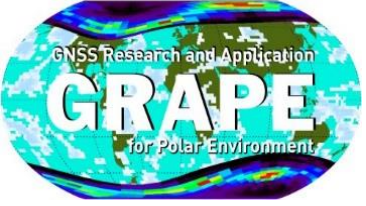
“GNSS Research and Application for Polar Environment” (GRAPE)

A joint SSG PS and GS Expert Group

Giorgiana De Franceschi, Istituto Nazionale di Geofisica e Vulcanologia, giorgiana.defranceschi@ingv.it

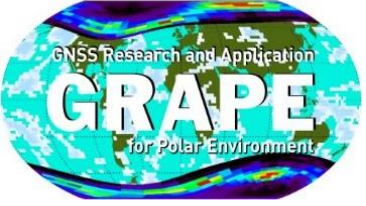
URSI AT-RASC, GRAN CANARIA, EXPOMELONERAS, 18-22 MAY 2015





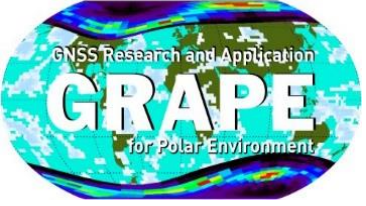
GRAPE main objectives:

- Create and maintain distributed **networks** of specialized **GPS/GNSS** Ionospheric Scintillation and TEC Monitors
- Identify and quantify mechanisms that cause **scintillation** and control **interhemispheric** differences, asymmetries and commonalities
- Develop **ionospheric** scintillation climatology, tracking and mitigation **models** to improve prediction capabilities of **space weather**.
- Retrieve **tropospheric PWV** for input to **weather forecast** models and to develop **regional PWV climatology** for atmospheric sensing in remote areas.




GRAPE structure

- **WG1-** Solar-Terrestrial interactions and ionospheric effects in the current solar-cycle
(chair: Paul Prikryl- Canada, co-chair: Emilia Correia- Brazil)
- **WG2-** Lower atmosphere delay in GNSS based systems
(chair: Monia Negusini – Italy)
- **WG3-** Modelling and models testing
(chair: Cathryn Mitchell UK, co-chair Marcin Grzesiak, Poland)
- **WG4-** GNSS Data management strategy.
(chair: Vincenzo Romano-Italy, co-chair: Pierre Cilliers-South Africa)
- **WG5-** Coordination with other programs inside and outside SCAR
(chair: Maurizio Candidi Italy)



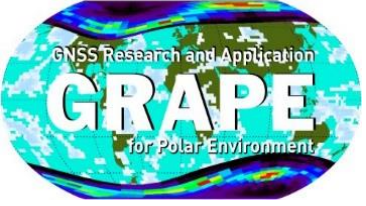
GNSS network – Northern hemisphere



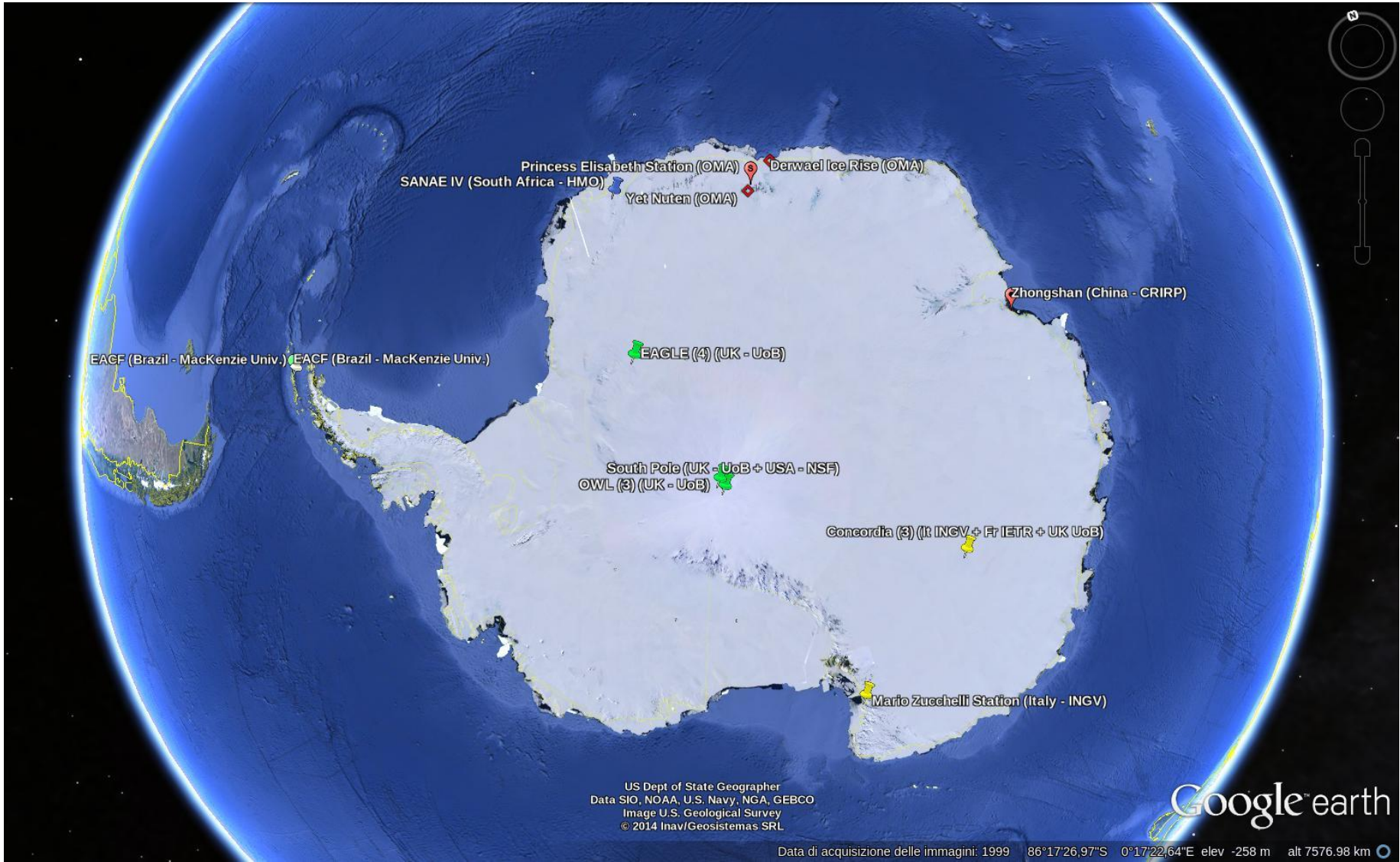

GISTM receivers


CJW-1 receiver

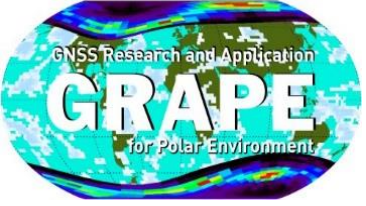

PolaRxs receivers



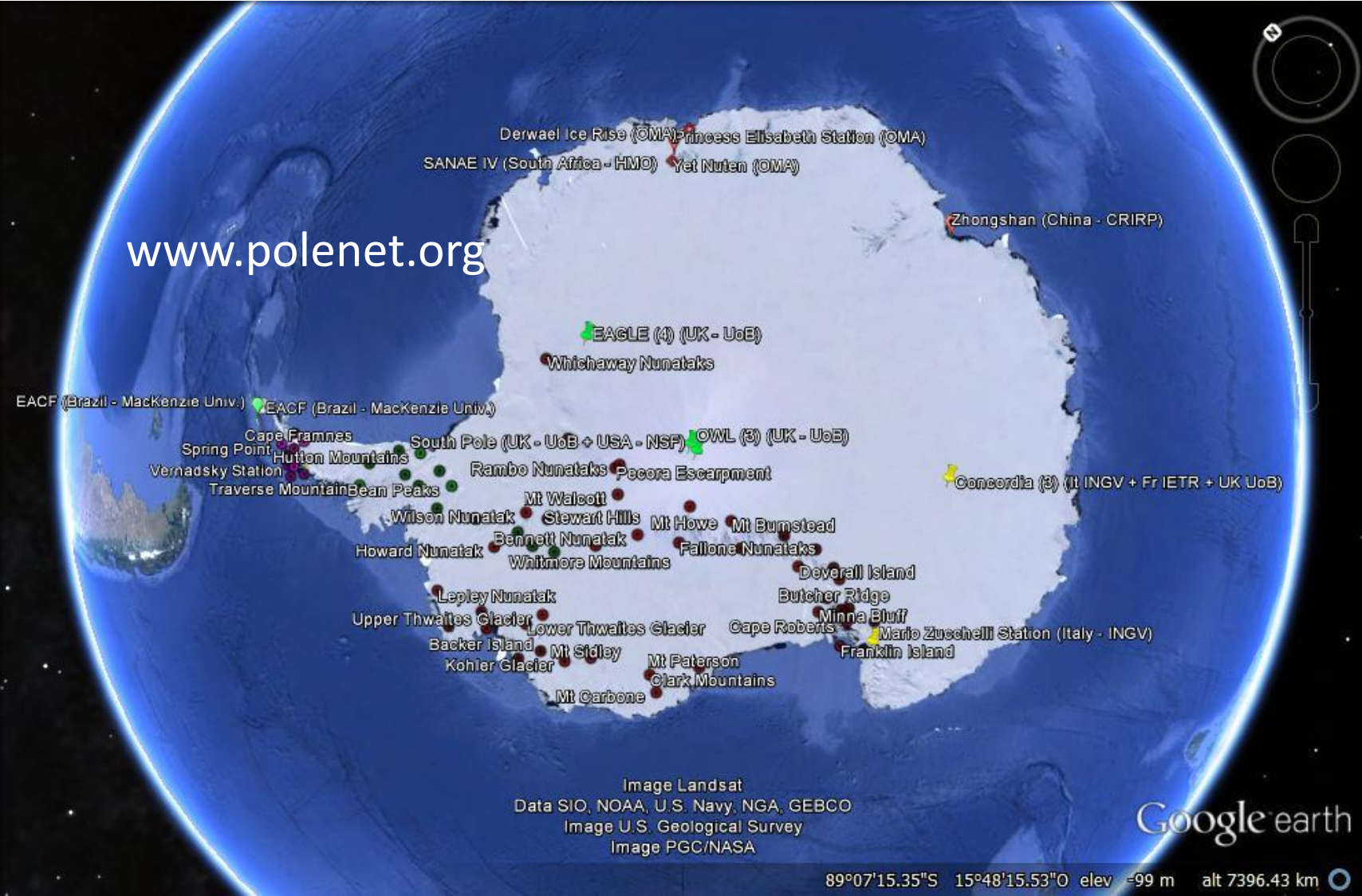
GNSS network – Southern hemisphere



GISTM receivers	CJW-1 receiver	Javad receiver	PolaRxs receiver	Trimble receivers



GNSS network – Southern hemisphere



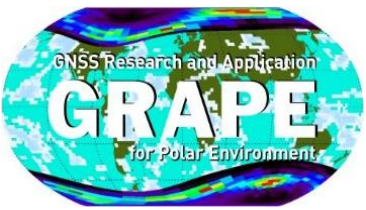
GISTM receivers

CJW-1 receiver

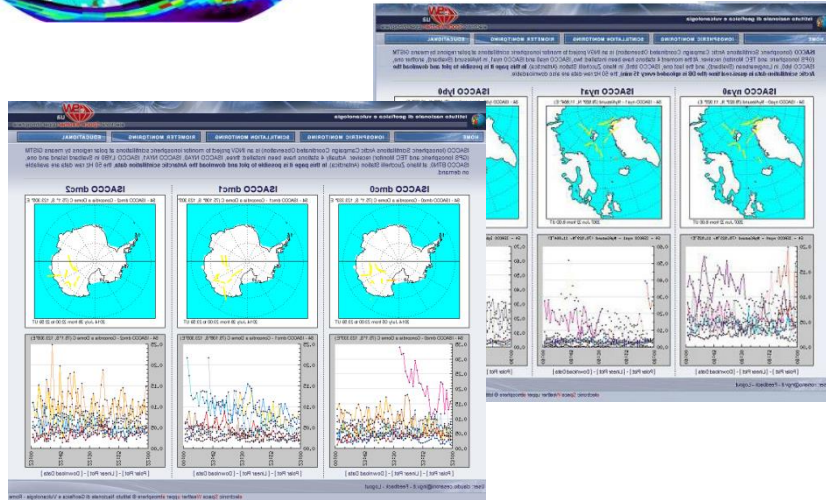
Javad receiver

PolaRxs receiver

Trimble receivers



eSWua
www.eswua.ingv.it



Madrigal home page

Choose instrument type:
Ground Based Satellite Receivers

McMurdo Scintillation Receiver [2011-2013]

Year: 2013
Month: January

Selected Instrument:

- McMurdo Scintillation Receiver
- PI: Allan T. Weatherwax - please contact before using this data

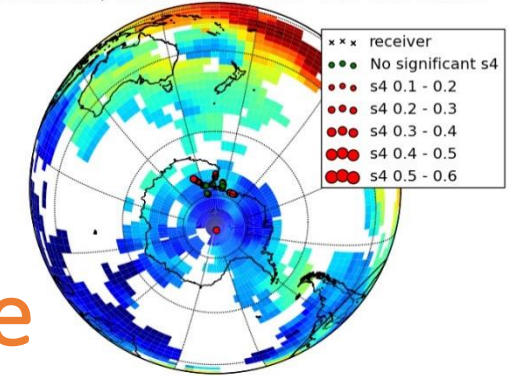
Experiment: Scintillation: 2013-01-01 00:00:46 - 2013-01-01 23:59:46
 Select File:
 1721_2_00 gps_all_out ionospheric scintillation - Final

Download data Print data View info Show Plots

January 2013

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Scintillation/TEC map for 2013-01-01 00:00:46 - 2013-01-01 00:20:46



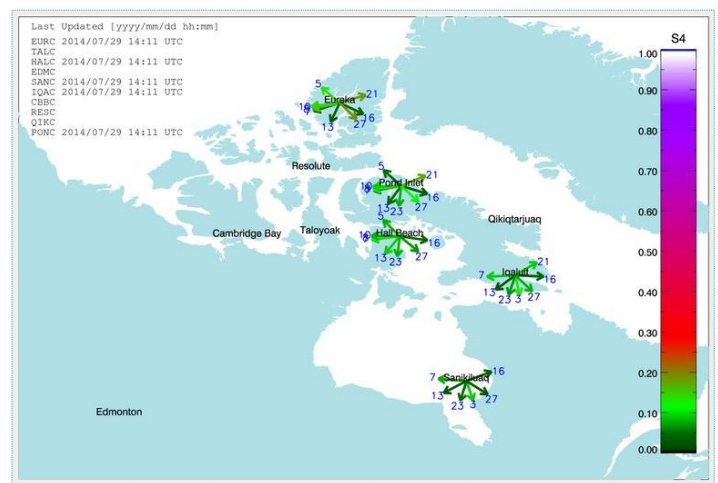
Madrigale
<http://cedar.openmadrigal.org/>

CHAIN
the Canadian High Arctic Ionospheric Network

Home About People Instruments Stations Data Products Photos Publications Software

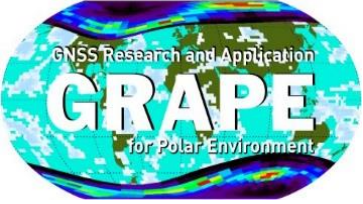
Welcome to the Canadian High Arctic Ionospheric Network

Real-time Scintillation Activity in the Polar Cap



CHAIN
<http://chain.physics.unb.ca/chain/>

DATA from the network are available on request;
visit the GRAPE web



GRAPE 2012-2015 RESULTS (1/2)

- **WEB** www.grape.scar.org , contribution to www.scar.org pages
- **Outreaches** –INGV

Welcome to GRAPE

GRAPE (GNSS Research and Application for Polar Environment) is a joint GeoSciences and Physical Sciences Expert Group lasting from 2012 to 2015.
Contact: Giordiana De Franceschi (e-mail: giordiana.defranceschi@ingv.it).

The International Polar Year (IPY) and International Heliophysical Year (IHY) initiatives left an important heritage in terms of data sharing, expertise exchange and increasing awareness of the current scientific capabilities. In particular, the GWSWF SCAR Action Group took advantage of the Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research (ICESTAR) and the Polar Earth Observing Network (POLENET) experiences that lead to creation of working groups on specific themes such as the use of geodetic data to study weather and space weather events. The multidisciplinary approach of IPY is the key in overcoming relevant difficulties, above all, the poor coverage of Antarctica. GRAPE Expert group intend to continue to follow this route, intensifying the efforts to build a robust network of collaborations in order to answer a variety of space weather related needs through ad hoc data sharing and model development.

Main Objectives

- Create and maintain distributed networks of specialized GPS/GNSS Ionospheric Scintillation and TEC Monitors particularly at high latitudes.
- Identify and quantify mechanisms that cause scintillation and control interhemispheric differences, asymmetries and commonalities in scintillation occurrence and intensity as a result of the geospace environment conditions.
- Develop ionospheric scintillation climatology, tracking and mitigation models to improve prediction capabilities of space weather.
- Retrieve tropospheric PWV for input to weather forecast models and to develop regional PWV climatology for atmospheric sensing in remote areas.

26 | 31 MARZO 2012 SCIENZAPERTA
INCONTRI CON IL PIANETA TERRA
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

Con SCIENZAPERTA l'INGV si propone di aprire al pubblico le proprie Sedi per mostrare i luoghi della ricerca scientifica, offrendo eventi, percorsi e visite guidate. In ogni sede si avvicenderanno programmi scientifici con l'obiettivo comune di incuriosire, interessare ed emozionare il pubblico, per presentare la ricerca come patrimonio di tutti. "La scienza aumenta quando la si distribuisce" (Giulio di Champsaur).

coordinamento scientifico [Giuliana D'Addezo](mailto:Giuliana.D'Addezo@ingv.it) | INGV

L'Istituto Nazionale di Geofisica e Vulcanologia per l'edizione 2012 di ScienzaAperta organizza un ricco programma di iniziative di comunicazione rivolte al grande pubblico per diffondere la conoscenza scientifica, creare curiosità attorno al mondo della ricerca, raccontare le scoperte scientifiche e dialogare con la comunità. L'obiettivo è quello di accrescere la percezione dell'importanza delle Scienze della Terra nell'ambito delle attività e del radicamento nella società.

29 MARZO
giovedì

09.30 | 12.30
Percorsi didattici per le scuole

20.00 | 22.00
Incontro scientifico-Concerto
"Viaggio musicale tra i terremoti italiani"
Nora Iggies voce, tamburello
Massimiliano Felice, organetto
Italia 2011
Marta Ricci, voce, chitarra, tamburello

30 MARZO
venerdì

09.30 | 12.30
Percorsi didattici per le scuole

20.00 | 22.00
Incontro scientifico-Concerto
"Onde, simpatia e musica"
"Il Coro dell'Angolo",
direttore Antonino D'Amico
Incontro con i ricercatori
Esperimenti interattivi

31 MARZO
sabato

11.00 | 18.00
Laboratori aperti all'INGV

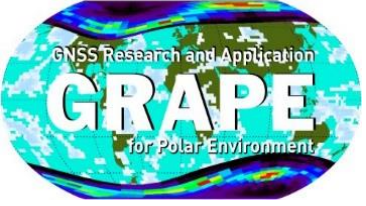
Proiezione documentario scientifico:
"Sulle tracce dei ghiacciai"
di M. Sbroletto e P. Aralia, Italia 2010
Al termine domande e risposte
con i ricercatori INGV

Sede INGV - Roma
Via di Vigna Murata 605
tel. 06 51860777 | fax 06 51860770

Progetto grafico: Laboratorio Grafica & Immagini INGV

Federazione Sviluppo scientifico

Istituto Nazionale di Geofisica e Vulcanologia



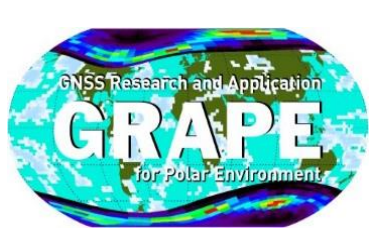
GRAPE 2012-2015 RESULTS (2/2)

➤ Publications (full list at www.grape.scar.org) > 20 papers

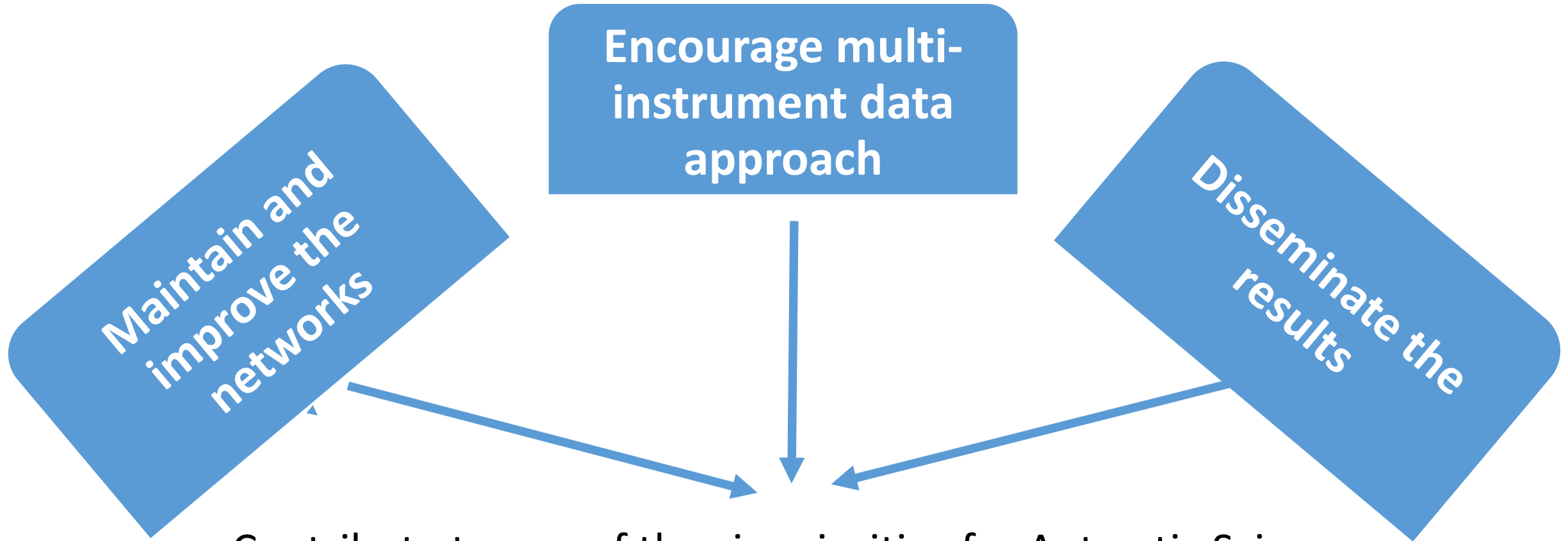
- Grape, Solar Terrestrial Physics in an operational environment- **Special Issue Annals of Geophysics Vol. 56, No2 (2013)** DOI:10.4401/ag-6366 , Ed G. De Franceschi, M. Candidi,
- Papers on *JGR, JASTP, Ann. Geophys., Space Weather, Adv. in Space Res., Radio Sci., etc.*

➤ Conferences, Meetings, Workshops

- IPY 2012 Conference (Montreal, Canada)
- XXXII SCAR OSC 2012 (Portland, Oregon - USA): GRAPE Oral Session, Grape Satellite Meeting
- XXXIII SCAR OSC 2014 (Auckland, New Zealand): GRAPE Oral and Poster Session, GRAPE Satellite Meeting
- DemoGRAPE project (PNRA): KoM , Rome, Italy, 9-10 October 2014
- **URSI AT RASC 2015 (Gran Canaria, Spain): GRAPE Oral session Tuesday 19 May, 14.00 – 17.40 Room 9**



GRAPE future activities



Contribute to one of the six priorities for Antarctic Science
Theme: Observe space and the Universe

Solar events impact on global communications and power systems

TABLE OF ACTIVITIES

Country	Projects (acronym, starting-end date, 1-sentence description)	Experimental Infrastructure, Station name and coordinates (IF APPLICABLE)	Contact person(s)
Argentina	Permanent Measurements: Ionospheric vertical sounding, Cosmic noise for ionospheric absorption, relative magnetic field components and absolute magnetic measurements.	Ionosonde, magnetometers, riometer, at Belgrano II Base, Nunatak Bertrab (bahia Vashel), costa Confin (Tierra de Coats) (77°51'S 34°33'W), San Martin Base, Islote Barry - islote San Martin (caleta Sanaviron, paso Mottet), islotes Debenham (bahia Margarita, costa Fallieres), (68°08'S 67°06'W)	agulisano@dna.gov.ar diegogi@dna.gov.ar
Belgium	Permanent GNSS network in the frame IceCon project (Constraining Ice Mass Change in Antarctica - since 2012)	GNSS receivers at Derwael Ice Rise (70.14S; 26.2 E), Yet Nuten (72.20S;22.6E), Princess Elisabeth Station (71.5S;23.2E)	nicolas.bergeot@oma.be
Brazil	1) Sun-Earth connections inside the INCT-APA (National Institute of Science and Technology - Environment Antarctic Research, since 2009). 2) Characterization of the ionosphere dynamics over Antarctic region and your connection with the South America (monitoring the ionosphere using radio sounding techniques since 2013). 3) Monitoring the ionosphere using VLF and GPS-TEC receivers in Antarctica (since 2004).	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)	ecorreia@craam.mackenzie.br
Canada	Canadian High Arctic Ionospheric Network (CHAIN) - An array of ground-based radio instruments including high data-rate Global Positioning System ionospheric scintillation and total electron content monitors and Canadian Advanced Digital Ionosondes operating since 2008	chain.physics.unb.ca/chain/pages/stations/	paul.prikryl@unb.ca

TABLE OF ACTIVITIES

Country	Projects (acronym, starting-end date, 1-sentence description)	Experimental Infrastructure, Station name and coordinates (IF APPLICABLE)	Contact person(s)
Italy	1) DemoGRAPE (GRAPE Demonstrator), 2014-2016; 2) ISACCO (Ionospheric Scintillation Arctic and Antarctic Campaign Coordinated Observation), Permanent GNSS network, Since 2003; 3) IDIPOS (Italian Database Infrastructure for Polar Observation Sciences), Italian Antarctic Data Infrastructure 2012-2014	Ionosonde, GNSS for TEC and scintillation monitoring at Mario Zucchelli Station (74.7S, 164.1E, Antarctica); NyAlesund (79.9N, 11.9E,;Svalbard), Longyearbyen (78.2N, 15.9E; Svalbard), Concordia Station (75.1S, 123.3E, Antarctica,)	lucilla.alfonsi@ingv.it, vincenzo.romano@ingv.it, claudio.cesaroni@ingv.it
	1) VLNDEF (Geodetic and geophysical survey for geodynamical modelling of Northern Victoria Land) since 1999; 2)MALOX (Mass Lost in wind fluX), 2014-2016		negusini@ira.inaf.it
Poland	MISTECS (Monitoring Ionospheric Scintillation and TEC on Spitsbergen)	Ionosonde and GNSS receivers for TEC and scintillation monitoring, Hornsund (77.0 N; 15.33E)	pajak@cbk.waw.pl
South Africa	1) Polar and high latitude ionospheric scintillation studies using permanent GNSS network in Antarctica, Marion Island, and Gough Island since 2006 2) SCAR DemoGRAPE (GPS research for Polar Environment) partner since 2012	HF radar, Magnetometers, GNSS receivers for TEC and scintillation monitoring at SANAE (Antarctica,72.0°S, 2.5°W), Marion Island (Indian Ocean, 46.87° S, 37.86°E) and Gough Island (Atlantic Ocean, 40.34°S, 9.88°W)	pjckilliers@sansa.org.za, sltoz@sansa.org.za, mkosch@sansa.org.za
UK	GNSS network in the frame of a EPSRC funded project, "GNSS scintillation: detection, forecasting and mitigation"	GNSS for TEC and scintillation monitoring at: Trondheim (63.42N; 10.41E, Norway); Lerwick (60.15N; 01.13W, UK);	sreeja.veetil@nottingham.ac.uk marcio.aquino@nottingham.ac.uk

GRAPE scientific session URSI AT RASC

14:00 GF1.1 (invited) THE CHANGING POLAR IONOSPHERE: A COMPARATIVE CLIMATOLOGY OF SOLAR CYCLES 23 AND 24

A. G. Burrell, T. K. Yeoman, S. E. Milan, M. Lester

Department of Physics and Astronomy, University of Leicester, Leicester, United Kingdom

14:20 GF1.2 GNSS scintillation case studies at high latitudes following solar events of January 2014

L. Spogli¹, L. Alfonsi¹, D. Di Mauro¹, C. Cesaroni¹, P. J. Cilliers², E. Correia³, K. Oksavik^{4,5}, P. Prikryl⁶, V. Romano¹,
G. De Franceschi¹

¹Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

14:40 GF1.3 (invited) GROUND BASED WATER VAPOR RETRIEVAL IN ANTARCTICA

M. Negusini¹, B. H. Petkov², P. Sarti¹, C. Tomasi²

¹Institute of Radio Astronomy, National Institute of Astrophysics, Bologna, Italy

15:00 GF1.4 GPS PHASE SCINTILLATION AT HIGH LATITUDES: DEPENDENCE ON THE INTERPLANETARY MAGNETIC FIELD

P. Prikryl^{1,2}, A. McCaffrey¹, P. T. Jayachandran¹, E. G. Thomas³, J. M. Ruohoniemi³

¹Physics Department, University of New Brunswick, Fredericton, NB, Canada

²Geomagnetic Laboratory, Natural Resources Canada, Ottawa, ON, Canada

16:00 GF2.1 THE NATURE OF GPS RECEIVER BIAS VARIABILITIES: AN EXAMINATION IN THE POLAR CAP REGION AND COMPARISON TO INCOHERENT SCATTER RADAR

D. R. Themens¹, P. T. Jayachandran¹, R. B. Langley², M. J. Nicolls³

¹Department of Physics, University of New Brunswick, Fredericton, Canada

16:20 GF2.2 INTERNATIONAL CLOUD INFRASTRUCTURE FOR SPACE WEATHER DATA MANAGEMENT: THE DEMOGRAPE CHALLENGE

O. Terzo¹, P. Ruiu¹, L. Alfonsi², V. Romano², L. Spogli²

¹*Advanced Computing and Electromagnetism (ACE), ISMB Research Center, Turin, Italy*

16:40 GF2.3 MULTI-SCALE ANALYSIS OF RAW SCINTILLATION DATA: TOWARDS REMOTE SENSING OF IONOSPHERIC TURBULENCE

M. F. D. Materassi¹, L. Alfonsi², L. Spogli²

¹*Institute for Complex Systems of the National Research Council, Florence, Italy*

17:00 GF2.4 BENEFITS OF GNSS SOFTWARE RECEIVERS FOR IONOSPHERIC MONITORING AT HIGH LATITUDES

N. Linty¹, R. Romero¹, F. Dovic¹, L. Alfonsi²

¹*Department of Electronics and Telecommunications, Politecnico di Torino, Torino, Italy*

17:20 GF2.5 Triple splitting and z-rays in automatic scaling of polar ionograms

C. Scotto

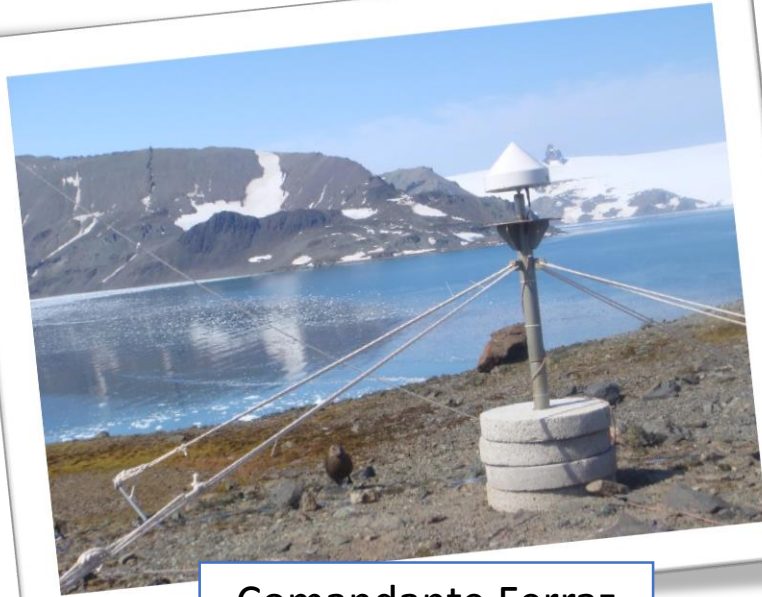
Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

17:40 GF2.6 THE USE OF SINGLE STATION GPS RECEIVER BIAS ESTIMATION TECHNIQUES IN THE POLAR CAP AND AURORAL OVAL REGIONS

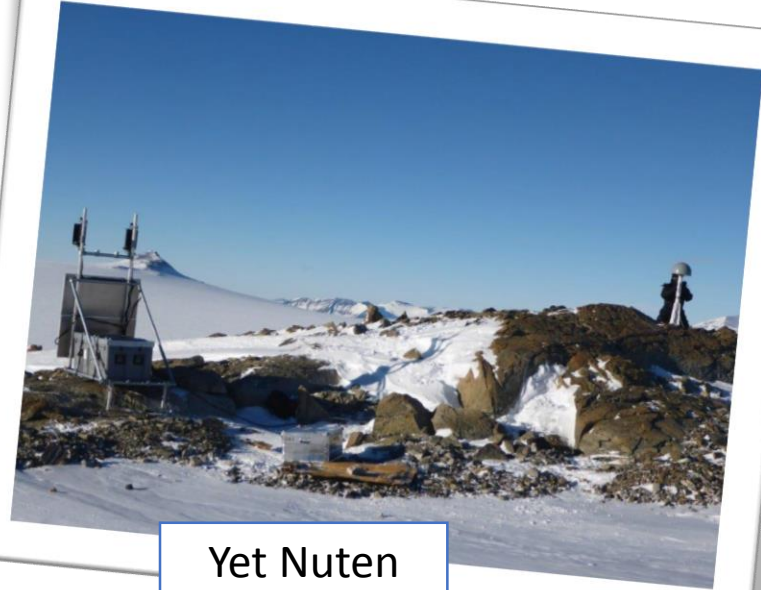
D. R. Themens¹, P. T. Jayachandran¹, R. B. Langley²

¹*Department of Physics, University of New Brunswick, Fredericton, NB, Canada*

**T
H
A
N
K
S**



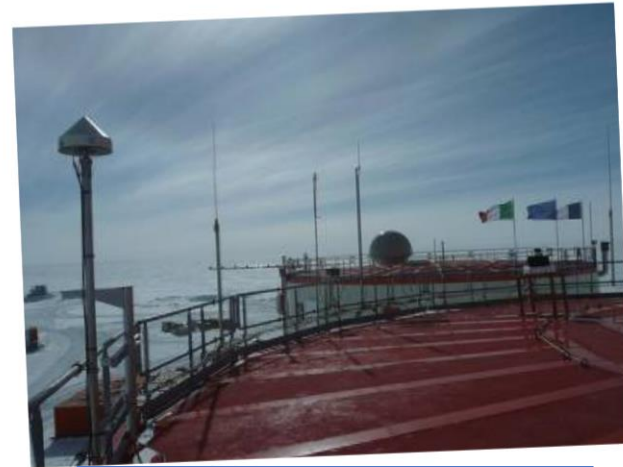
Comandante Ferraz



Yet Nuten



Mario Zucchelli Station



Concordia DMC Station