

# **GINESTRA – MIMOSA - MEDSTEC** **COMPETENCE SURVEYS WITHIN THE ESA** **ALCANTARA INITIATIVES**



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**TENTH EUROPEAN SPACE WEATHER WEEK.**

| Antwerp, 19<sup>th</sup> November 2013



# WHAT?

## MIImOSA

Monitoring Ionosphere Over South America

## GINESTRA

Ground-based Ionosphere monitoring  
NEtworks in SouthEastern Asia: a survey

## MEDSTEC

Towards Mapping of Electron Density,  
Scintillation and Total Electron Content

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ALCANTARA

ESA'S ALCANTARA: A BRIDGE TO INTERNATIONAL RESEARCH PARTNERS  
Science is universal language, which can serve as a bridge between cultures and extends beyond national limits. Researchers all over the world work together in their quest for fundamental knowledge e.g. on our origins, the evolution of our environment and the aspects affecting our quality of life. They also investigate the technology that will help us shape our future.

Alcantara bridge, Spain

Space is also a world-wide enterprise with a global reach. At the European Space Agency, a 20-country multinational organisation, the thrill of people of all backgrounds and nationalities working together is a usual element in every project that is undertaken. ESA has built its success on such multinational environment in the last four decades. The Agency enables its member countries to work as partners, for them to develop programmes of interest to all of them. Beyond its member states, ESA also interfaces with international partners world-wide in order to carry out joint space missions, instrument collaborations, joint operations and data analysis.

More about Alcantara...  
Who can participate?  
Alcantara FAQ  
Two types of studies  
Announcement of Opportunity  
Announcement of Opportunity 2012  
Related Links  
EO - Benefiting our economy  
TIGER  
TIGER II

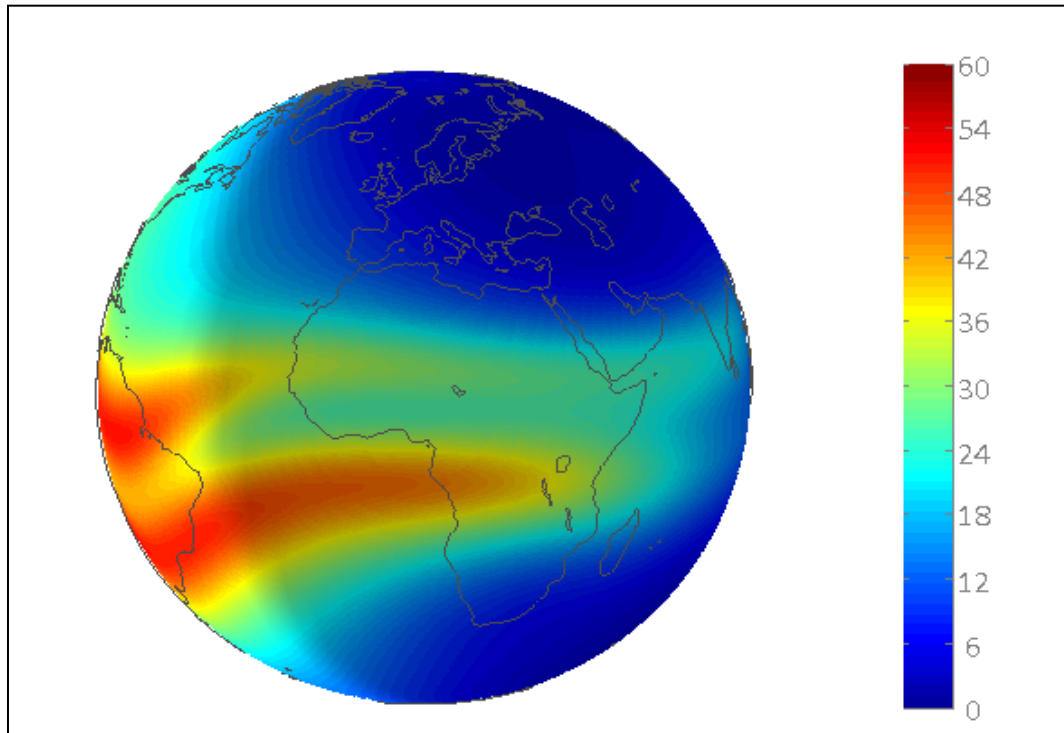
are **competence surveys** funded by ESA in the frame of ESA Alcantara General Studies Programme and addressed to the assessment of the current capabilities on ionospheric monitoring in **South America, South-Eastern Asia and Africa**.

The projects started between October and November 2012 and ended between June and July 2013. The final meeting has been held in ESTEC on November the 4<sup>th</sup>.

## WHY?

The surveys have been committed in order to understand how the existing facilities can be integrated with new installations, to effectively support and/or improve **space weather activities oriented to assist GNSS operations**.

Space weather issues are of particular importance in the sectors considered in the surveys because those regions are characterized by the presence of the **Equatorial Ionospheric Anomaly (EIA)** which results into two crests of enhanced electron density located at  $\pm 15^\circ$  off the magnetic equator.



# WHO?



## Istituto Superiore Mario Boella

Experience in project coordination with SEA institutions on GNSS; long-lasting scientific cooperation on GNSS topics in the region.

## Istituto Nazionale di Geofisica e Vulcanologia



Scientific background: monitoring and analysis of ionospheric events, scintillation monitoring

## University of Bath



Scientific background: monitoring and analysis of ionospheric events, scintillation monitoring; data combination

## Politecnico di Torino



Technological background: development of algorithms for GNSS receivers and GNSS signal processing techniques for remote sensing applications

## University of Nottingham



Expertise on the study and mitigation of ionospheric irregularities effects on radio signal propagation.

## ESA



Interest on global ionospheric monitoring for missions and projects in Satellite Navigation, Satellite Communications, Earth Observation and Space Situational Awareness

## Local and other supporting institutions



Hanoi University of Science and Technology - NAVIS Centre



Universidade Estadual Paulista "Julio de Mesquita Filho" (UNESP)



Instituto Nacional de Pesquisas Espaciais (INPE)



UNIVERSIDAD NACIONAL  
DE TUCUMÁN PEDES IN TERRA AD SIDERA VISUS

Universidad Nacional de Tucuman (UNT)



South African National Space Agency



Boston College



University of Lagos



Fugro

# HOW?

- **Review the open literature** in the field of ionospheric monitoring, study and forecasting produced from data acquired in the considered areas;
- Report **peculiarities of the regional ionosphere** of interest for the GNSS operations;
- Identify geographical **sectors not yet (or only partially) monitored**;
- Identify **existing GNSS networks** which can provide ionospheric data or other ionospheric observing systems;
- Interact with the **local experts** in the field;
- Suggest **future development** to advance the current state of the art.

# Literature Review

The review was done collecting recent (since 2000 up to mid 2013) papers found through the use of keywords and selected on the basis of the scientific expertise of the Consortia.

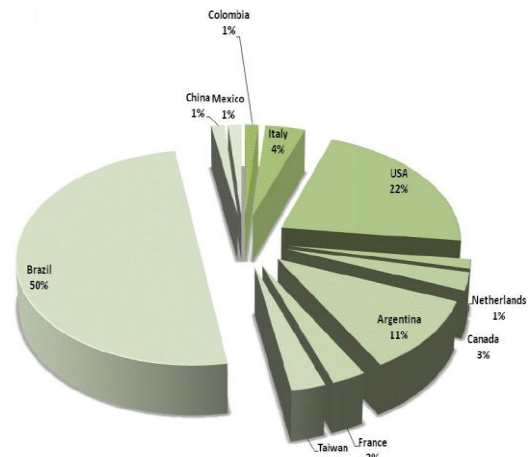
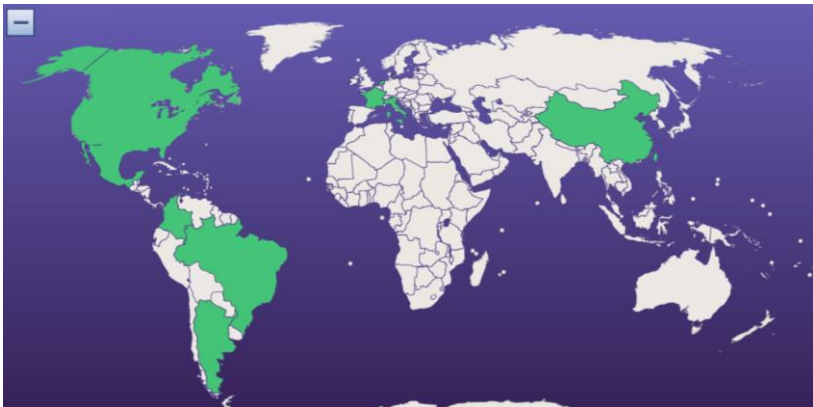
The selected papers describe investigations based on observations performed by:

- ✓ GPS receivers,
- ✓ Optical measurements (scanning photometers and all sky imagers),
- ✓ Magnetometers,
- ✓ Ionosondes,
- ✓ Radars
- ✓ GPS Radio Occultation.

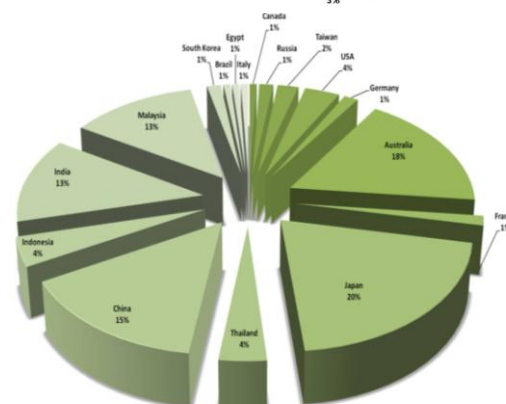
The collections count:

- **74** papers authored by **South American** scientists;
- **142** papers authored by **Asian (with focus on south-eastern countries)** scientists;
- **40** papers authored by **African** scientists.

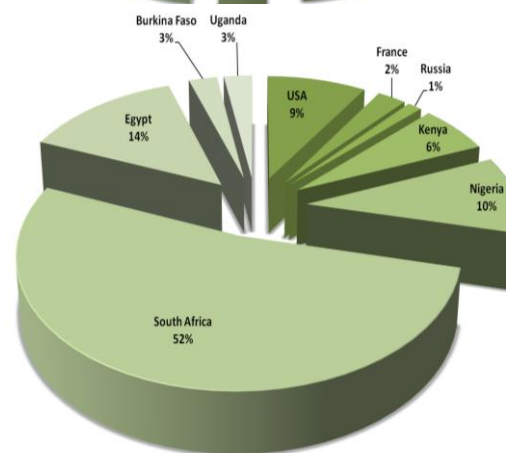
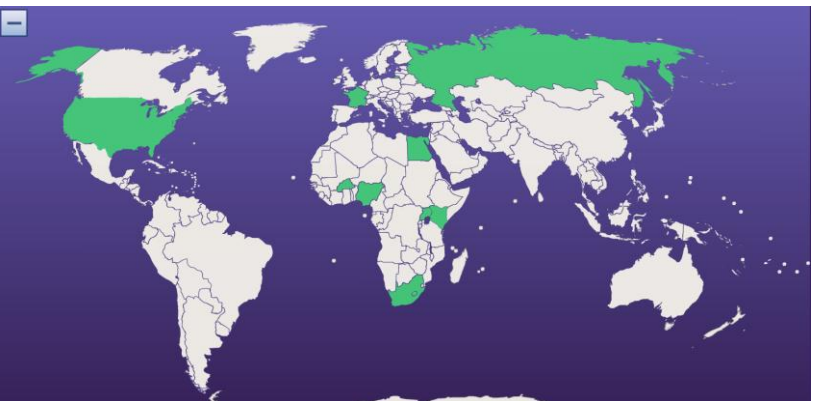
# Literature Review First authorships distribution



**MImOSA**



**GINESTRA**

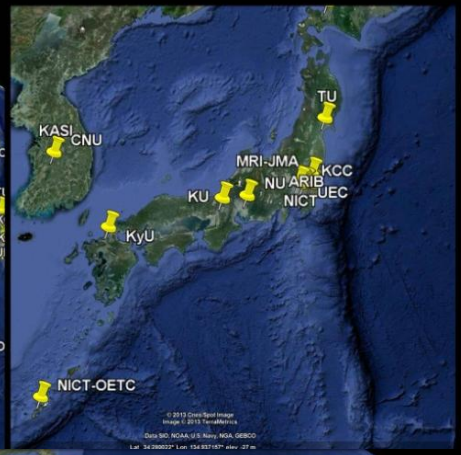
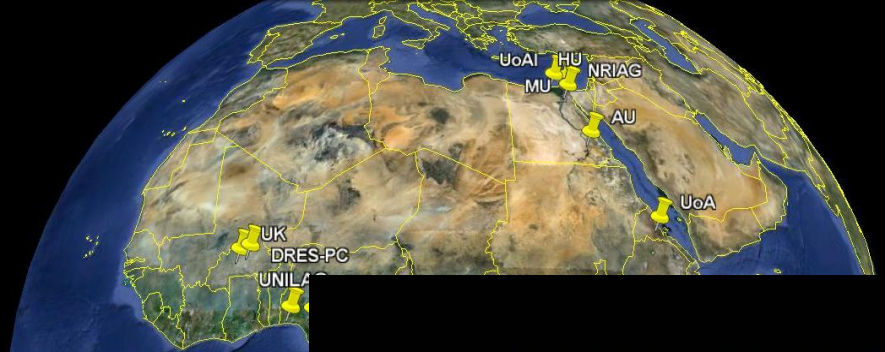


**MEDSTEC**



# Literature Review

## Identification of Institutions and relevant scientists



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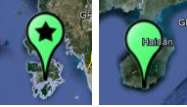

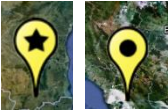


Data: SIO, NOAA, U.S. Navy, NGA, GEBCO  
©2013 Google  
©2013 Cnes-Spot Image  
US Dept of State - Geographer

©2010 Google

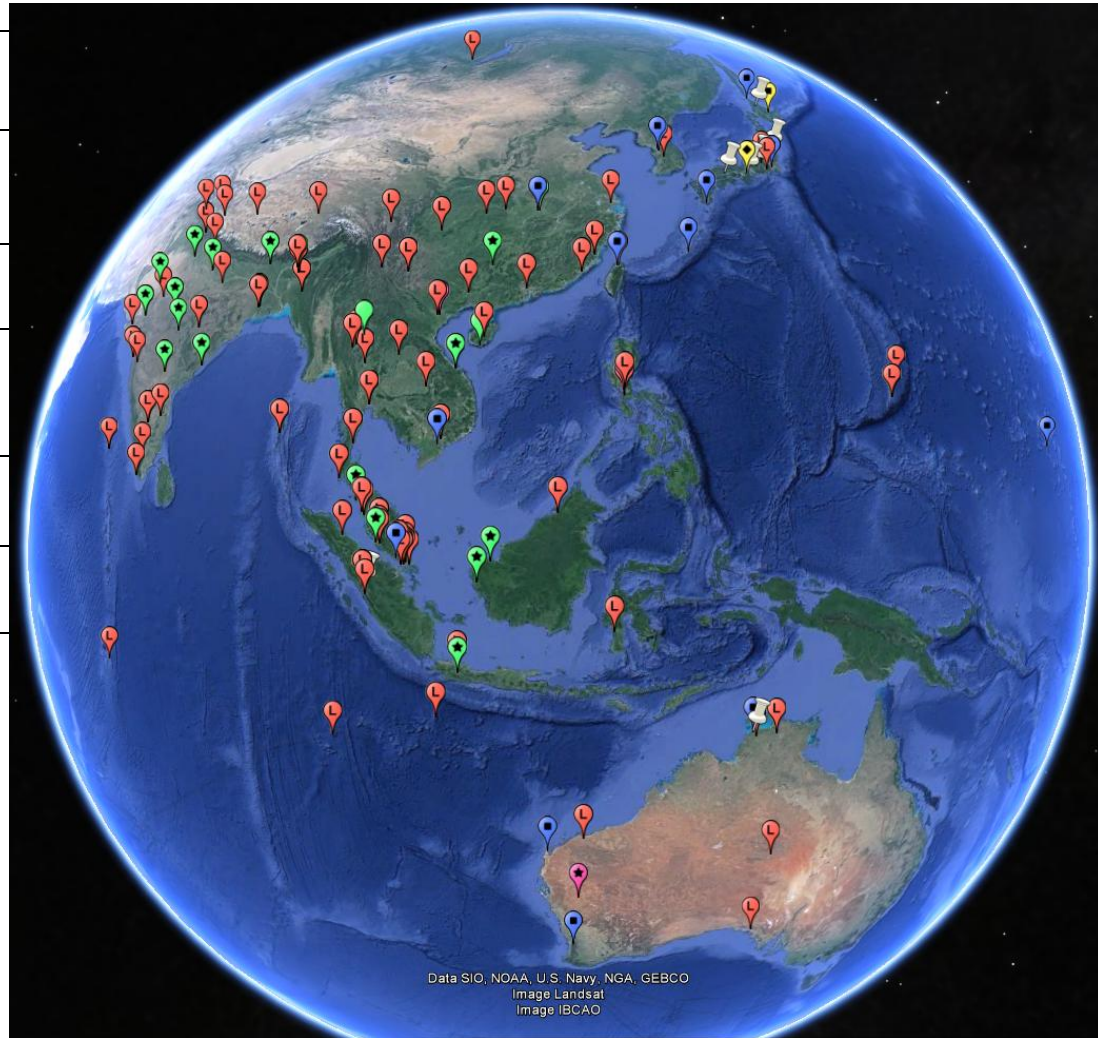
Lat -13.377436° Lon -64.818041° elev 149 m

Alt 10842.39 km

# Literature Review Identification of instruments

	Standard GNSS receiver
	GNSS Scintillation Monitor Left: GISTM; right: GISM
	Ionosonde
	Radar system Left: MST radar Right: Equatorial Atmospheric Radar
	Sky Imager
	Magnetometer

-  Ginestra.kmz
-  Radar
-  GPS Scintillation Monitor
-  GPS rx
-  Ionosondes
-  Magnetometer
-  Sky Imager



[Video](#)

# Contact with local experts

The project teams interacted with the local experts by e-mail contacts, organizing **workshops** in the regions of interest and circulating a **questionnaire**.



Hanoi  
(Vietnam)



São José dos  
Campos  
(Brazil)



Hermanus  
(South Africa)

The image shows two pages of a questionnaire document. The top page has a header with logos and the title "Ground-based Ionosphere monitoring Networks in Southeastern Asia: a survey (GINESTRA)". Below the title is a large box containing the word "QUESTIONNAIRE". The bottom page contains a "Context" section, a "DISCLAIMER" section, and a footer with project details. The text is small but legible.

# Key findings

- ✓ In many countries not all the observatories are properly equipped – consequently, **lack of data sets** (researchers working on old data)
- ✓ **Set up** of networks for data sharing and services **welcomed**, but some limitations from national regulations
- ✓ **Small active scientific community** – not a popular field among young people
- ✓ Europe is perceived as a **reference for training** – Actions to facilitate visits and study periods in EU
- ✓ Outreach particularly important, raising **Government awareness, future funding**
- ✓ **Personal connections** are key
- ✓ Some countries are collecting **data**, but do **not** make it **publically available**
- ✓ **Lack of cooperation**, need of strategic thinking
- ✓ **Data connectivity** is a serious problem in the remote areas
- ✓ Remote areas are **human resources demanding** to maintain the stations and the data flow.

# Proposed Pilot Projects

## GINESTRA

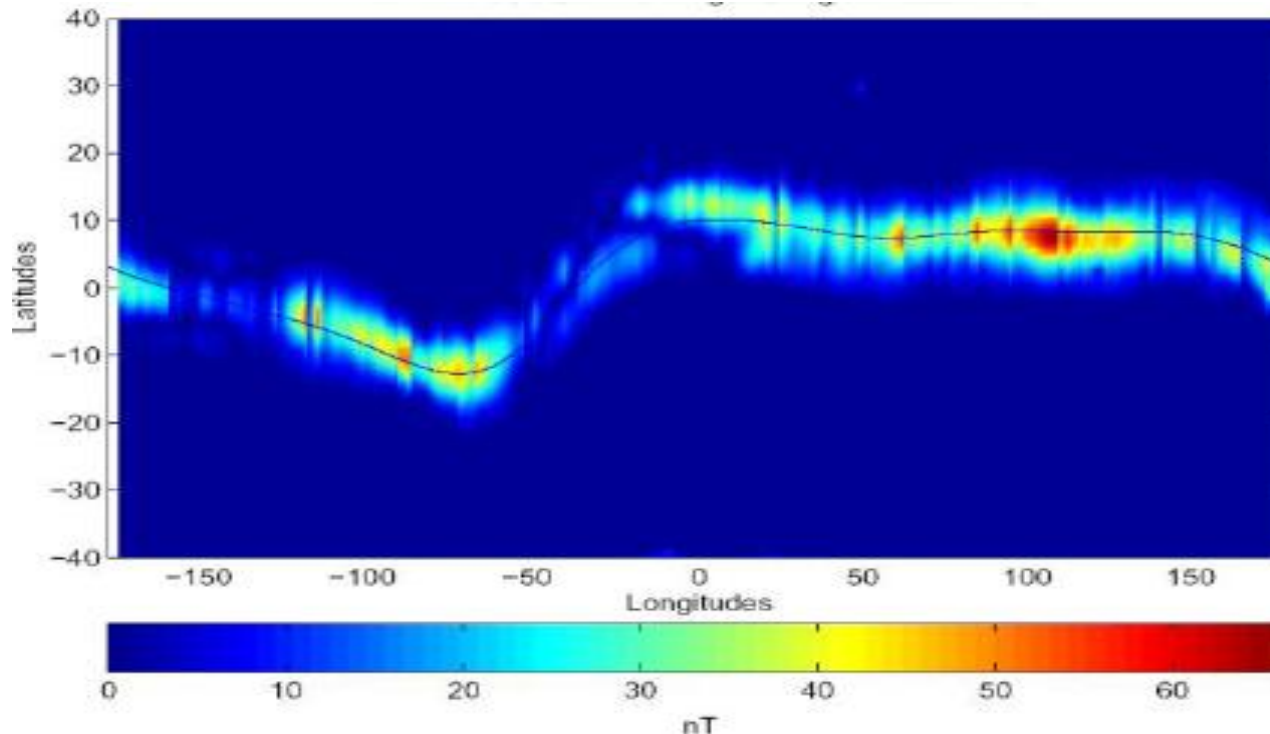
### Background

South-eastern Asia ionosphere: EIA + strong amplitude magnetic signature of EEJ over Vietnam.

Enhancement of EEJ signature around 100°E confirmed by CHAMP sat – **unknown origin**, but verified relation between EEJ and EIA from TEC measurements along Indian longitudes

### Proposed topic

To perform **regional measurements of TEC and geomagnetic field**, so as to track EIA evolution and help positioning electron density high gradients within the region.



Noon EEJ magnetic signature in August and September 2001 derived by CHAMP satellite measurements. From Doumouya and Cohen, 2004

# Proposed Pilot Projects

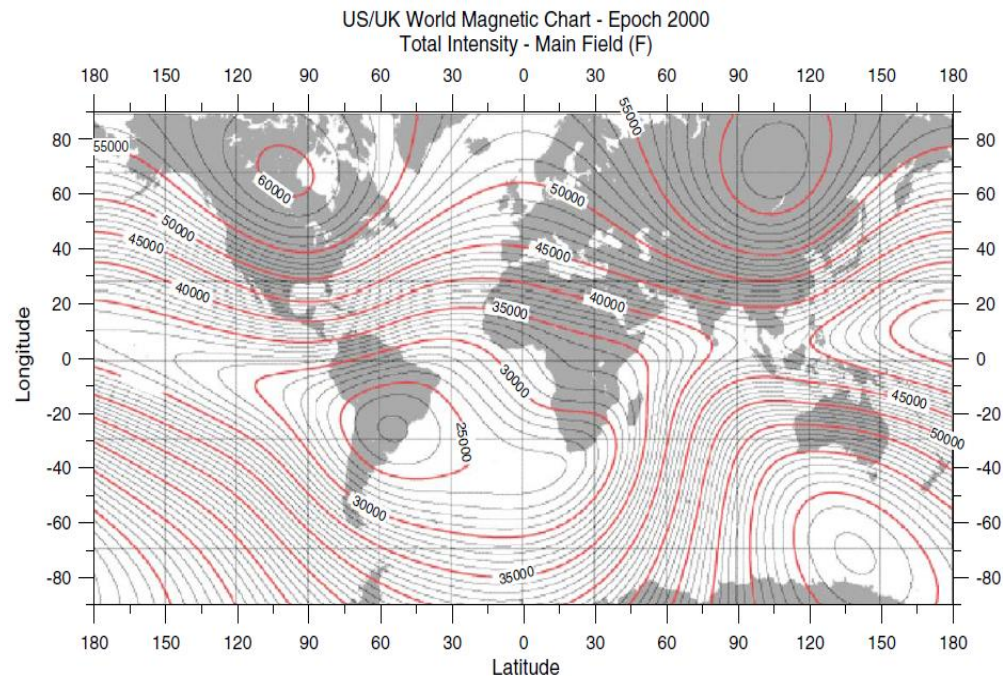
## MImOSA

### Background

South America: EIA + **South Atlantic Magnetic Anomaly (SAMA)**, a zone where, being the magnetic field strength almost half of what it is when compared to other regions, a large amount of high energy particles penetrate into the upper atmosphere and ionosphere.

### Topic

A federation of European and South American networks and individual instruments, including those already in place and new installations to monitor the southern and northern crests of the EIA and the SAMA.



# Proposed Pilot Projects

## MEDSTEC

### Background

MIDAS (Multi-Instrument Data Analysis System) produces 4D space weather maps from the signals pass through ionosphere and received on Earth by network of scientific receivers. The signals are delayed by different amounts of electron density, this tells us the make-up of the ionosphere.

### Topic

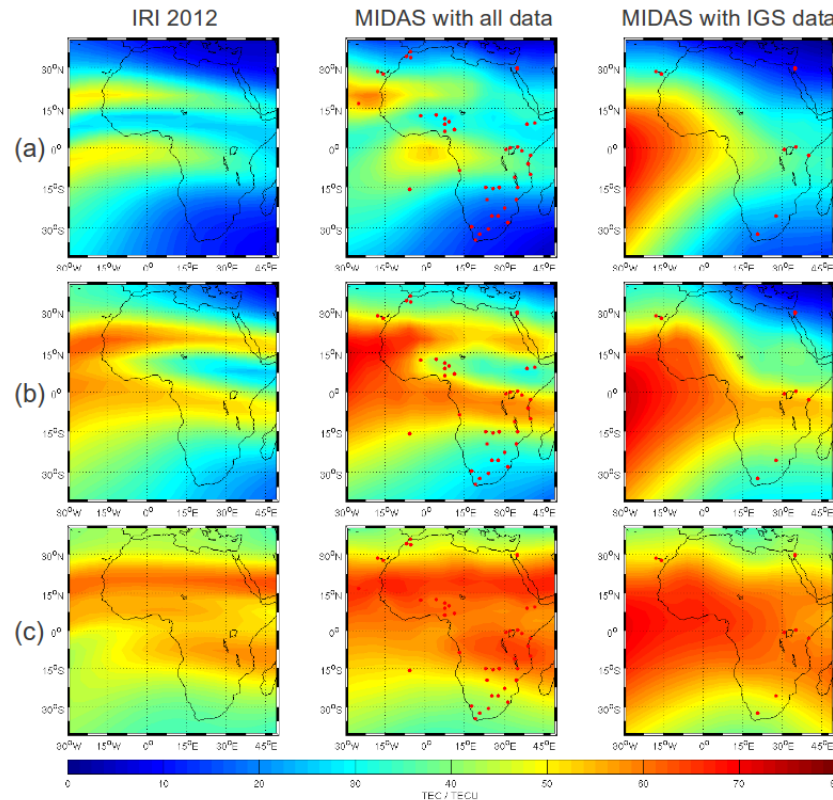
Extend the receivers coverage to give improved ionospheric results – particularly in - Algeria, Egypt, D. R. Congo and Niger

Left: IRI simulations

Middle: MIDAS reconstructions based on all the available data

Right: MIDAS reconstructions based on just IGS data

Acknowledgement: Alex Chartier, Bath



Thanks for your attention!

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