REGIONAL WORKSHOP ON GNSS AND SPACE WEATHER

9 - 13 MAY 2022

RABAT, MOROCCO

CLAUDIO CESARONI – claudio.cesaroni@ingv.it

Istituto Nazionale di Geofisica e Vulcanologia

INGV was founded in 2000 (Law n.381 of 29 Sep. 1999) through a process of merging, reorganizing and rationalizing the entire national research network that revolves around:

- the assessment and mitigation of seismic and volcanic risk,
- the investigation of geophysical, seismic and volcanic phenomena, and
- the understanding of the mechanisms that control the evolution our planet.

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INGV is composed (as for April 2021) by:

833 personnel units with permanent contracts,
90 personnel units with temporary contracts
+ 195 other units (research grants, collaborators and cooperating scientists).

Summing up to 1118 personnel units (scientists, technicians, administratives).

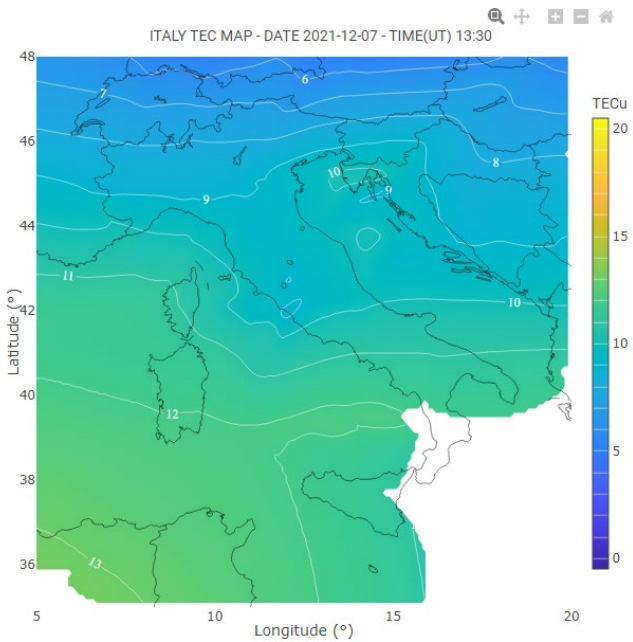
Upper Atmosphere Physics and radiopropagation group

The group manages the instruments and infrastructure related to research and services on Ionosphere and Space Weather
About 20 people (scientists, engineers, technician…) led by C.Cesaroni

Main research topics:

- Ionospheric physics
- HF radio communication
- Space Weather
- Ionospheric modelling
- Ionospheric scintillation
- Total Electron Content (TEC)
- Termosphere-Ionosphere coupling
- Automatic ionogromas scaling
- Ionospheric turbolence
- Litosphere_Atmosphere-Ionosphere coupling

eSWua electronic SPACE WEATHER upper atmosphere

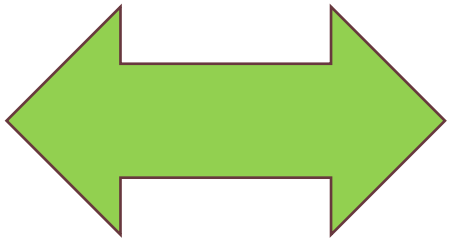


ASI – INGV collaboration

In 2017 Italian Space Agency and Istituto Nazionale di Geofisica e Vulcanologia (INGV) signed a framework agreement (valid for 5 years) to collaborate in fields of common interest including:

- Research on geophysical phenomenon;
- Development of innovative geophysical monitoring systems;
- Development of innovative systems for Earth Observation, Space geodesy and telecommunications;
- **Research activities in the field of Sun-Earth interaction and monitoring system for Space Weather**;
- Research and development of Earth Observation system for seismic and volcanic risk management;
- Research for new Earth Observation space missions;
- ….

Agenzia Spaziale Italiana



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The Broglio Space Center

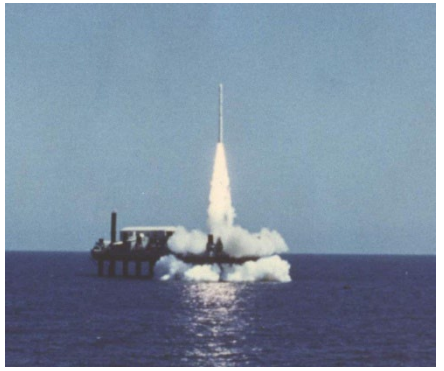
The Luigi Broglio Space Centre (BSC) is an Italian-owned spaceport near Malindi, Kenya, named after its founder and Italian space pioneer Luigi Broglio. Developed in the 1960s through a partnership between the University of Rome La Sapienza's Aerospace Research Centre and NASA, the BSC served as a spaceport for the launch of both Italian and international satellites.

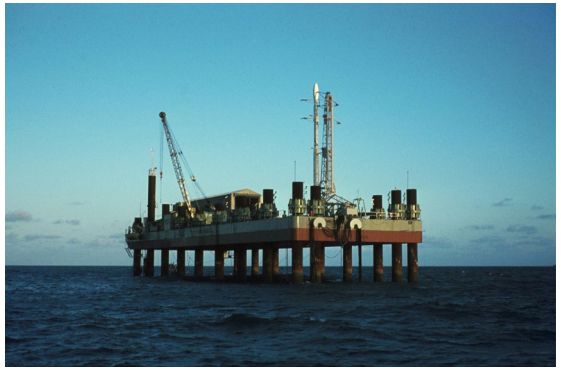
Number of launches: 27 (9 with NASA Scout Launcher): 100% success.

Primarily sounding rockets including the Nike Apache, Nike Tomahawk, Arcas and Black Brant launchers

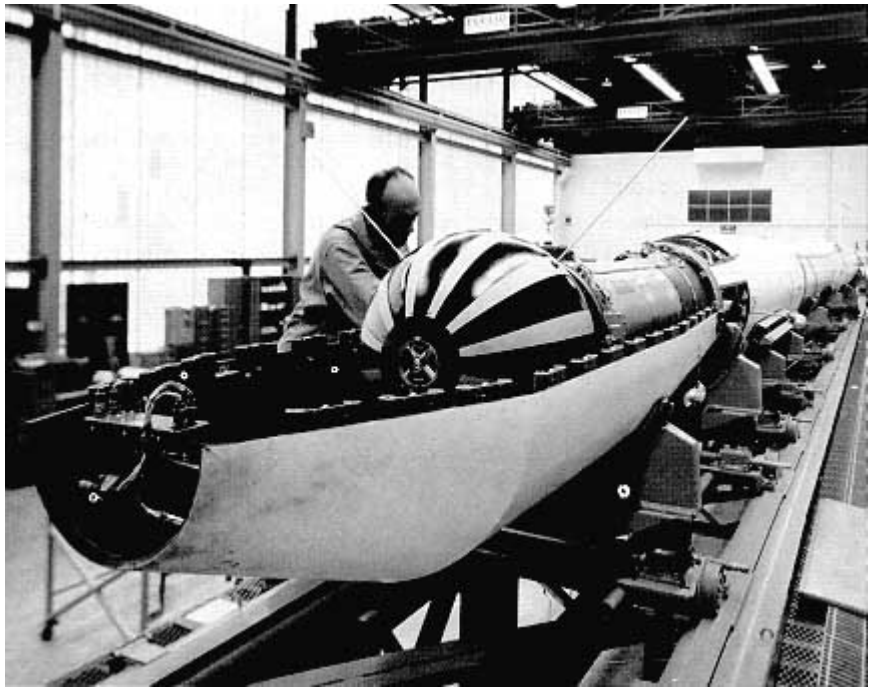
List of launches carried out at Broglio Space Center

N°	Launch vehicle	Satellite
1	Scout SV 153	SM 2, San Marco 2 (IT), 26 Dec. 1967
2	Scout SV 175	UHURU, Small Astronomic Satellite (USA), 12 Dec.1970
3	Scout SV 173	SM 3, San Marco 3 (IT), 24 April 1971
4	Scout SV 163	SS 1, Small Scientific Satellite (USA), 15 Nov. 1971
5	Scout SV 170	SAS 2, Small Astronomic Satellite (USA), 15 Nov. 1972
6	Scout SV 190	SM 4, San Marco 4 (IT), 18 Feb. 1974
7	Scout SV 187	UK 5, United Kingdom 5 (UK), 15 Oct. 1974
8	Scout SV 194	SAS 3, Small Astronomic Satellite (USA), 8 May 1975
9	Scout SV 206	SM 5, San Marco 5 (IT), 25 March 1988

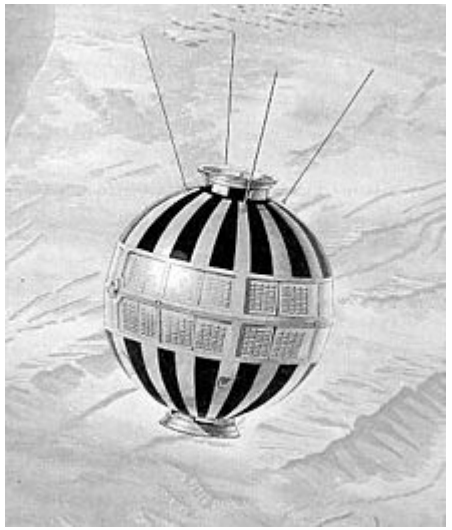


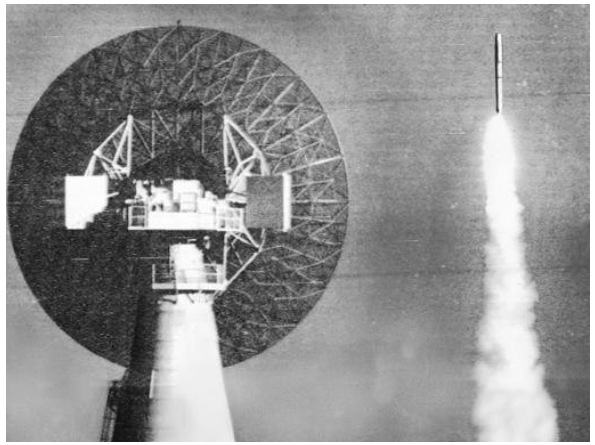


The San Marco project



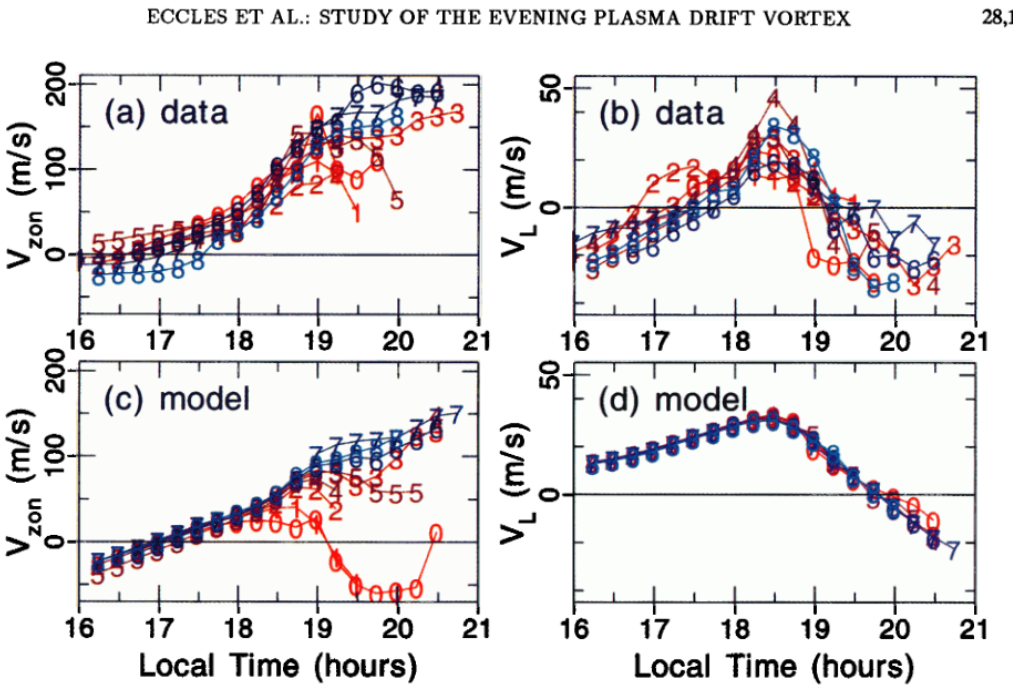
San Marco I was launched on a U.S. four-stage solid propellant Scout booster from Wallops Island by an all-Italian crew on 15 December 1964. It was put into a 206 km x 820 km orbit, slightly more elliptical than the planned 215 x 680 km orbit, with an inclination of 37.79 degrees and a period of 95 minutes.



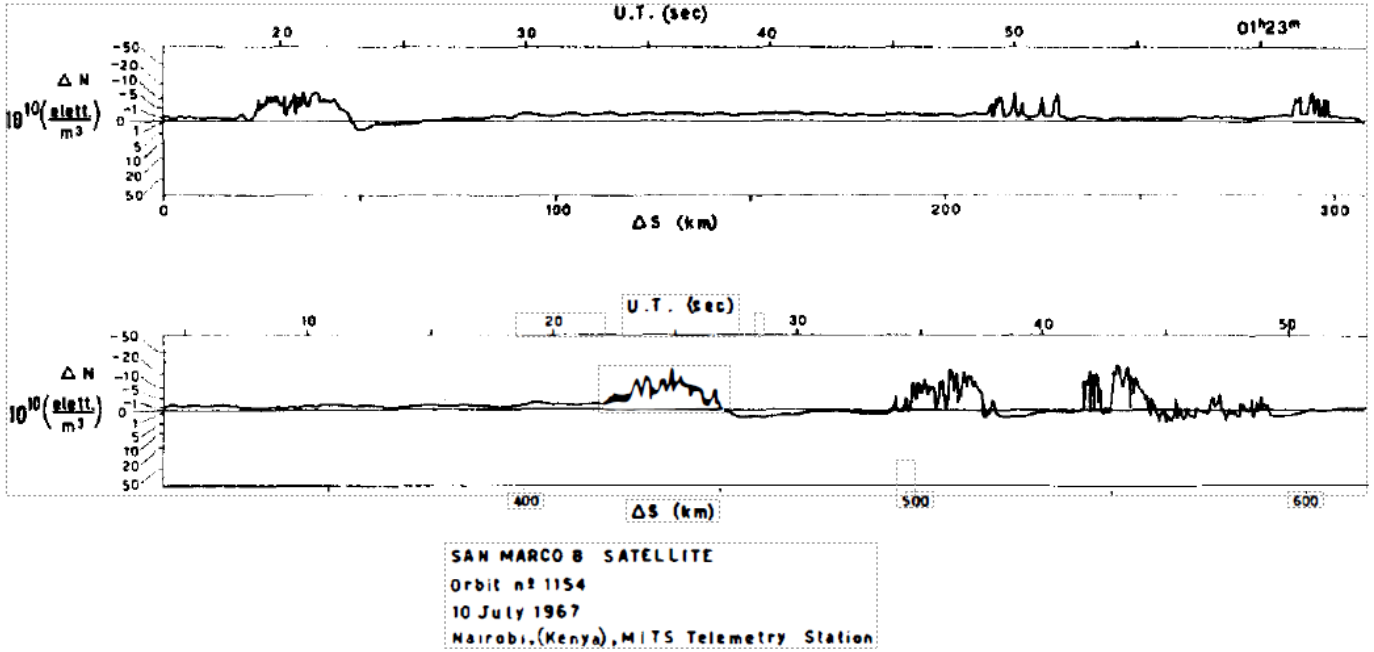


The air-drag experiment operated as planned until 30 December 1964 when transmissions were terminated to allow the ionospheric experiment to operate. It operated for the scheduled two weeks and was turned off, at this point the batteries were nearly exhausted.

Ionospheric studies exploiting San Marco satellites data



Eccles, J. V., Maynard, N., & Wilson, G. (1999). Study of the evening plasma drift vortex in the low-latitude ionosphere using San Marco electric field measurements. Journal of Geophysical Research: Space Physics, 104(A12), 28133-28143.



Checcaoci, P. F. (1969). Direct detection of ionospheric irregularity. Journal of Atmospheric and Terrestrial Physics, 31(8), 1131-1133.

Role of the Italian Space Agency (ASI)

The Luigi Broglio Space Centre (BSC) is managed by the Italian Space Agency since 2004 based on the inter-government agreement initially signed by Italy and Kenya in 1995.

At present, the main activities carried out at BSC include:

- Support to the operations of several scientific and operational programs (ESA, NASA, CNES, CLTC, Space X) by using ground based remote sensing facilities;
Scientific and technological research in the fields of space and aerospace;
Scientific and technological cooperation with Kenyan institutions (e.g. KSA, Universities) for different activities including training

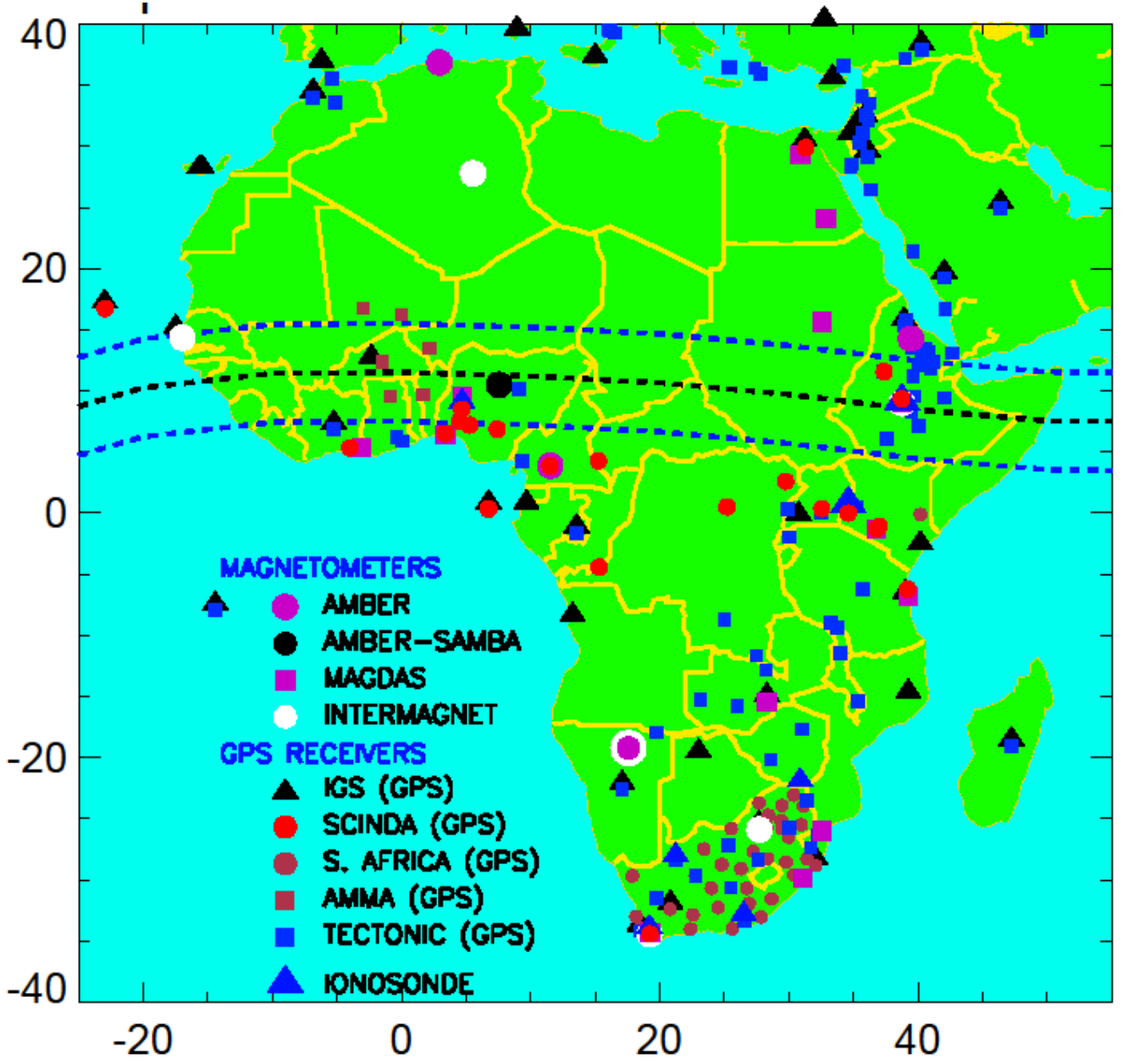
NORISK project

New Observatory for Real-time Ionospheric Sounding over Kenya (NORISK) is a 3 years project (KOM 12 November 2021) with the following objectives:

O1. Design and development of a new ionospheric observatory in BSC;

O2. Development of models and algorithms for the low-latitude ionospheric monitoring and research by exploiting data from the new observatory;

O3. Training of a new generation of Space Weather scientists in Eastern Africa.



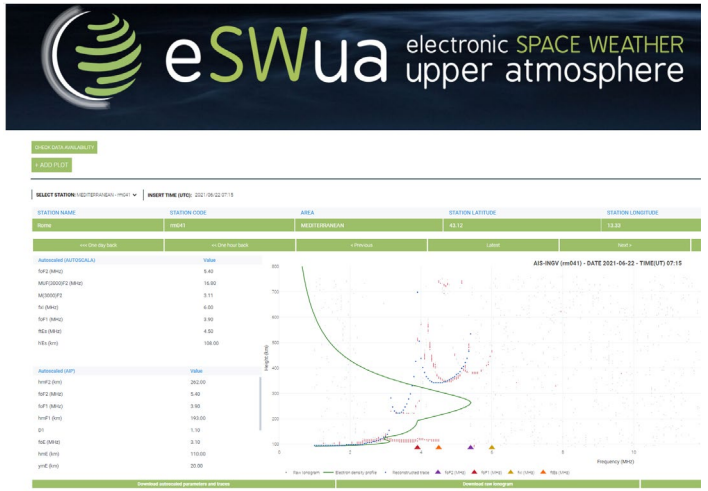
New ionospheric observatory @ BSC

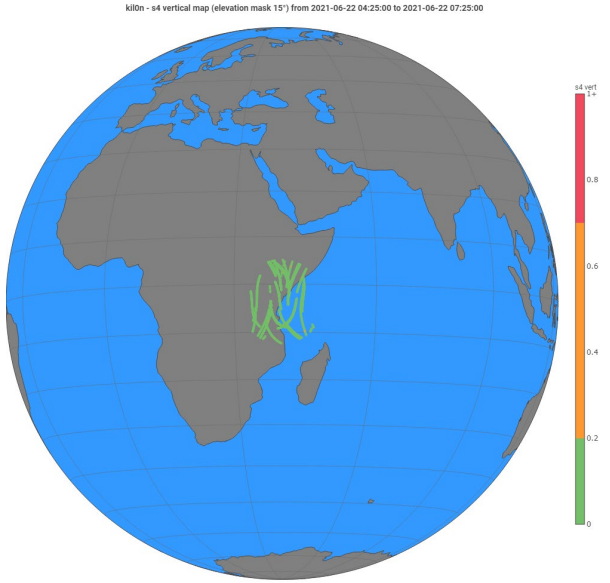
Data (ionosonde and GNSS) and products (TEC scintillation) will be stored in:

- A local processing and storage facility;
- The Italian INGV SWIT (Space Weather Information Technology) infrastructure.

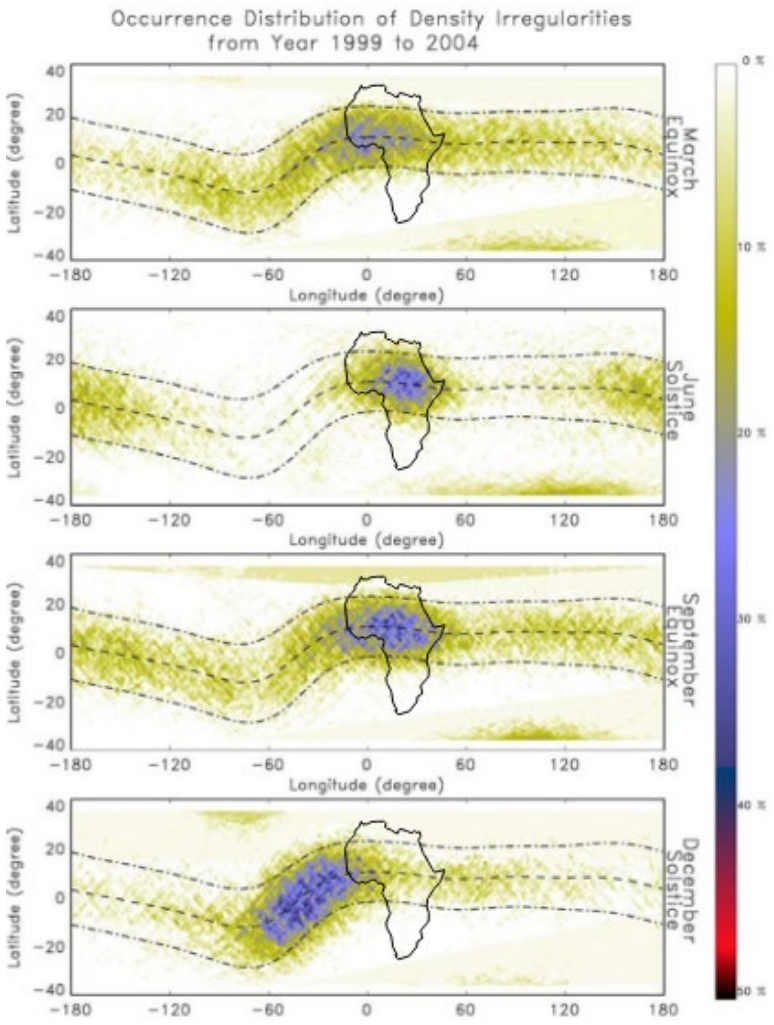
They will be available in real-time through:

- A dedicated GUI installed on local facility;
- The eSWua webportal (www.eswua.ingv.it);
- The eSWua web service (http://ws-eswua.rm.ingv.it/)

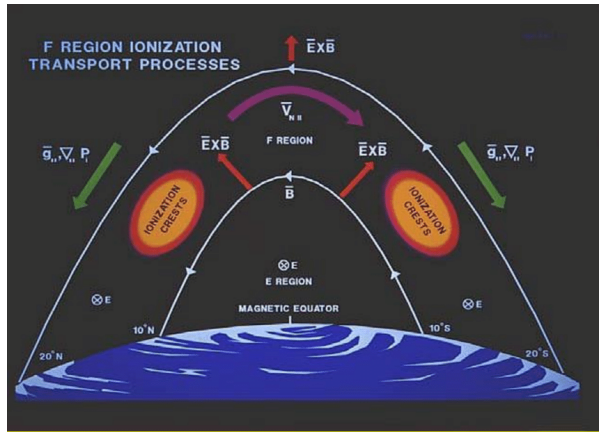


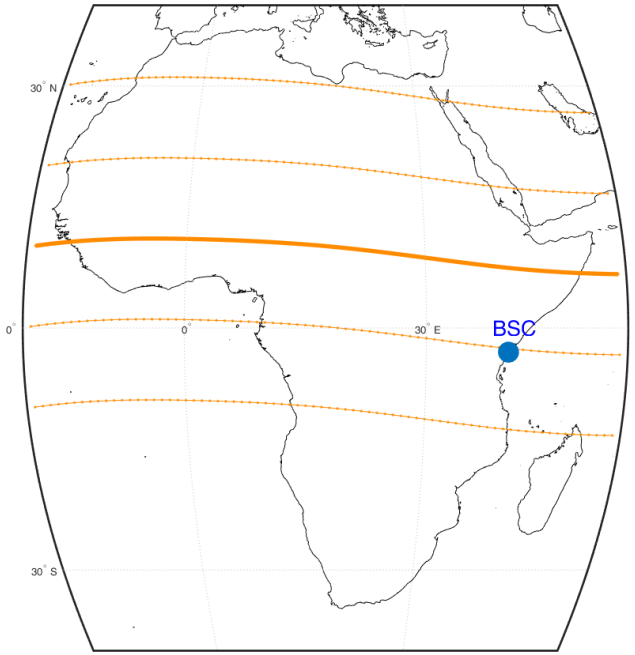


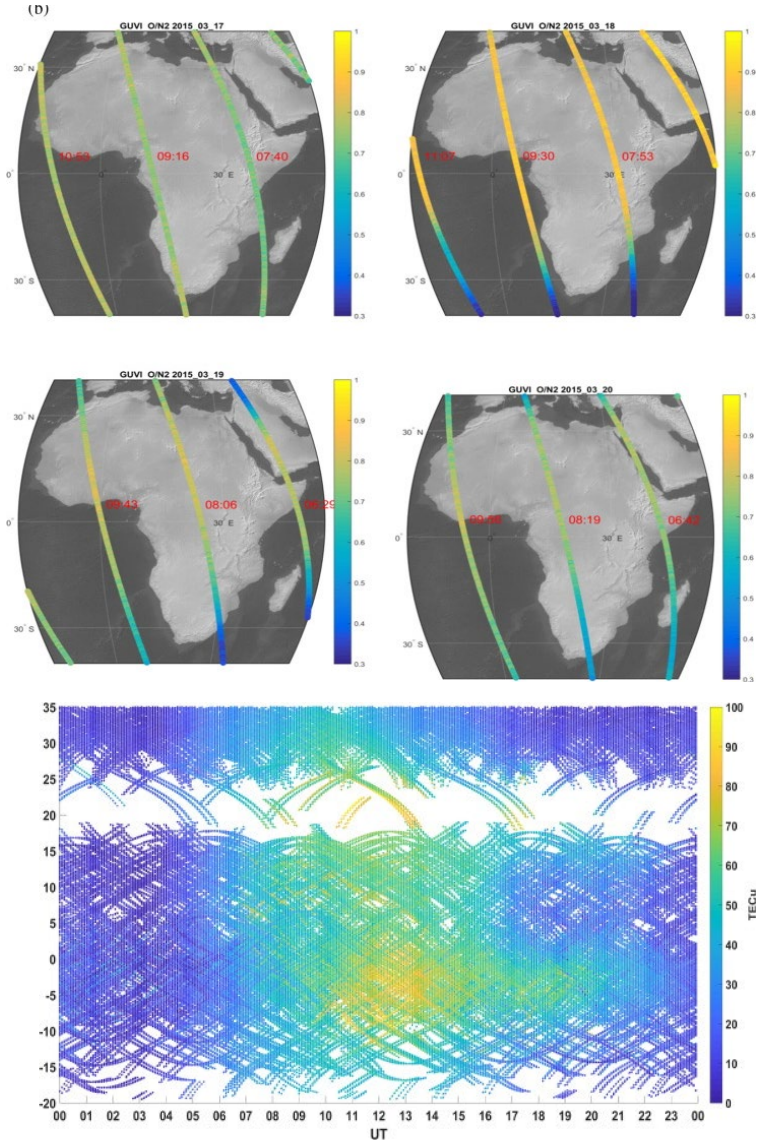
Low-latitude ionosphere monitoring and research



Adapted from Su, 2005







Olwendo, O. J., & Cesaroni, C. (2016)

Training for Space Weather scientists

NORISK foresees the organization of 2 capacity building workshops for Eastern Africa young scientists:

1. Capacity buuilding workshop @ BSC, Malindi, Kenya (2023)
2. Capacity building workshop @ ICTP, Trieste, Italy (2024)

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Work Breakdown Structure

WP1
Management
C. Cesaroni (INGV)

- Task 1.1 Management
- Task 1.2 Techinical coordination

WP2
Design and realization of the observatory @ BSC
C. Cesaroni (INGV)

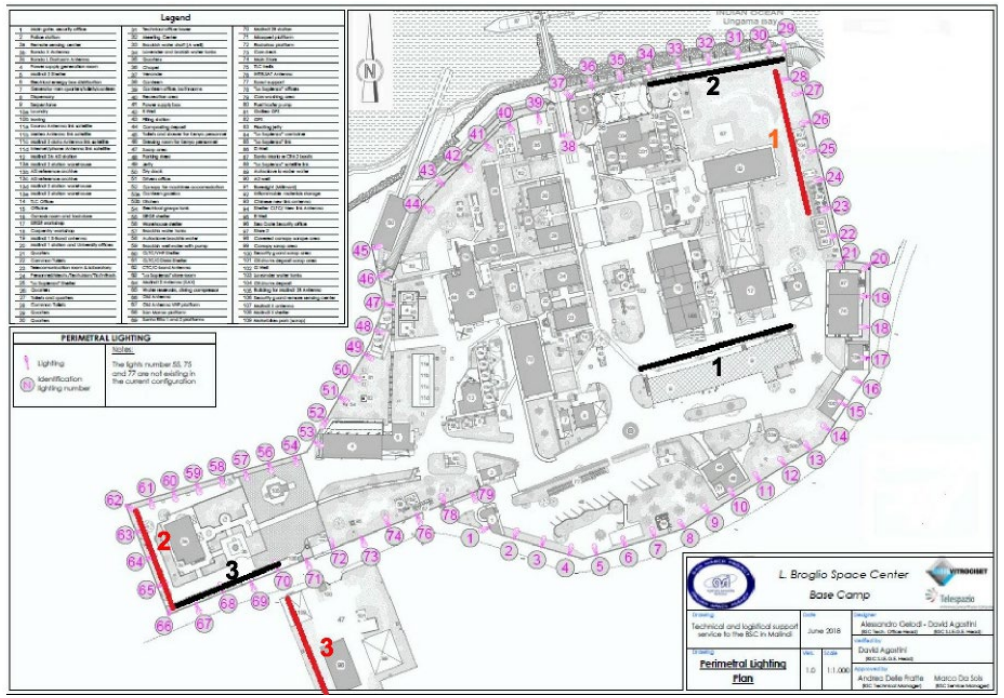
- Task 2.1 Environmental impact and design of the observatory
- Task 2.2 Provision of instruments and equipment
- Task 2.3 Deployment and test of the instruments

WP3
Data Processing , modelling and development of products
L. Spogli (INGV)

- Task 3.1 Design and implementation of the data processing algorithms
- Task 3.2 Design and realization of the data assimilation algorithms
- Task 3.3 Design and realization of the DBs for data and products
- Task 3.4 Peoducts validation

WP4
Dissemination and training
L. Alfonsi (INGV)

- Task 4.1 Dissemination
- Task 4.2 Organization of the CBW @ BSC
- Task 4.3 Organization of the CBW @ ICTP



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NORISK
NEW OBSERVATORY FOR REAL-TIME IONOSPHERIC SOUNDING OVER KENYA

D 1.1 – Report sui requisiti di osservatorio

Autori	
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Enrico Zuccheretti (INGV)	enrico.zuccheretti@ingv.it
Versioni	
Versione 1.0	21/02/22

D1.1 – Report sui requisiti di osservatorio

Accomplished tasks so far…

WP1 – Coordination

- Managing of the project and communication with ASI
- Assigning the post-doc position (Dr. Daniel Okoh)

WP2 – Design and realization of the ionospheric observatory @ BSC

- Remote and physical survey for the installation of the ionosonde (logistic and electromagnetic evaluation)
- Preparation of the call for ionosonde provision
- Acquisition of the hyper convergent ICT infrastructure (on its way to BSC)
- **Installation of the GNSS receiver for scintillation monitoring**
- Report on the observatory needs (D1.1)

WP 4 – Dissemination and Training

- Preparation of the logo and corporate material
- Preparation of a contribution for a paper (Baki et al., 2022) describing the SW in Africa (submitted to Atmosphere)
- Several presentation during workshops

On going activities…

WP1 – Coordination

- Managing of the project and communication with ASI

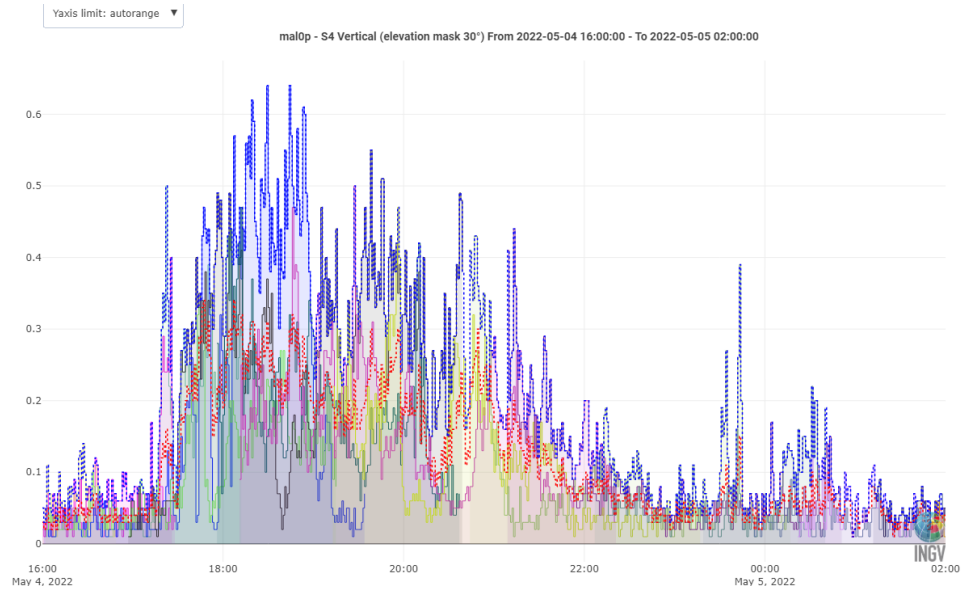
WP2 – Design and realization of the ionospheric observatory @ BSC

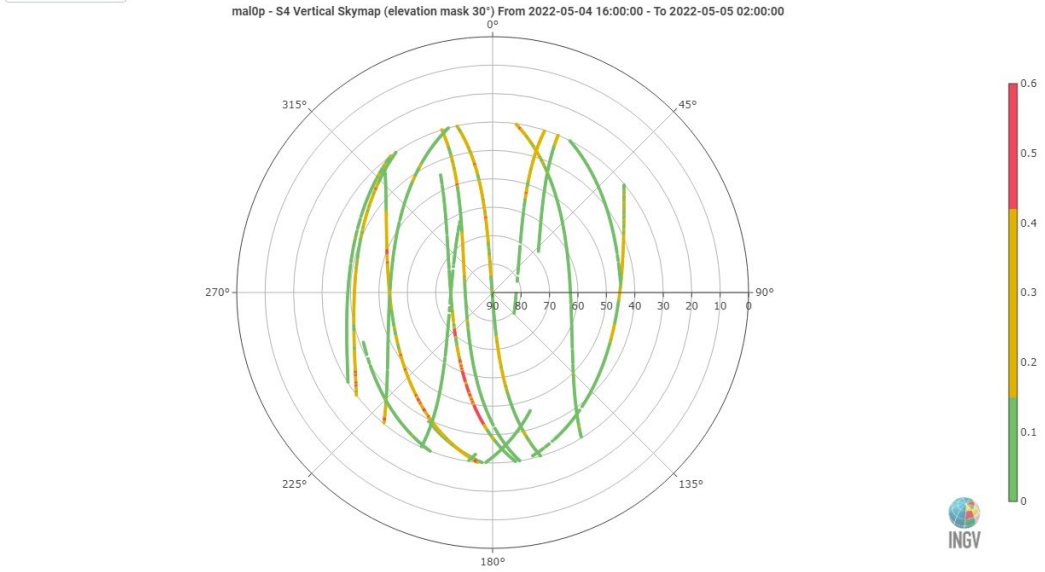
- Installation of the ICT hyperconvergent infrastructure
- Testing and validation of the GNSS receiver data
- **Provision of the ionosonde system**

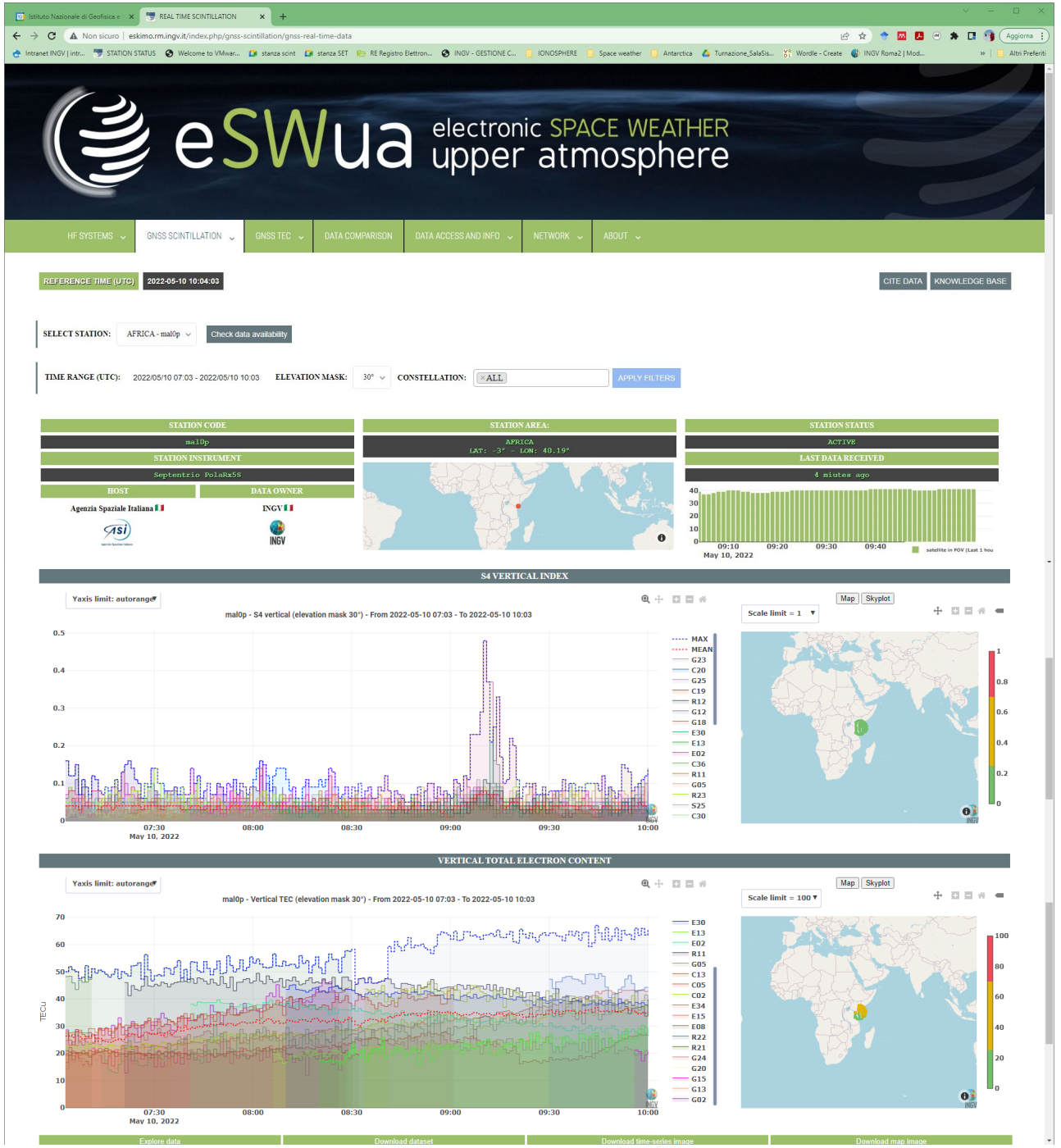
WP 4 – Dissemination and Training

- Design of the project website
- Dissemination of the project activities

GNSS data available @ eswua.ingv.it







THANKS FOR YOUR ATTENTION!

QUESTIONS?