



ISTITUTO NAZIONALE
DI GEOFISICA E VULCANOLOGIA



Agenzia
Spaziale
Italiana



2ND COS WORKSHOP

27 MAY 2023

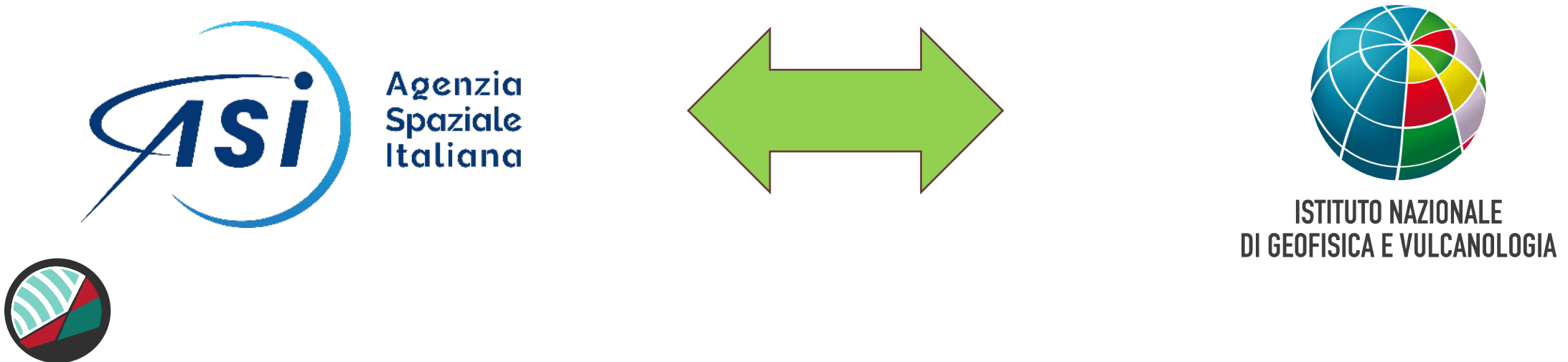
INGV, ROMA

CLAUDIO CESARONI - claudio.cesaroni@ingv.it

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;
-



Luigi Broglio - Malindi Space Center

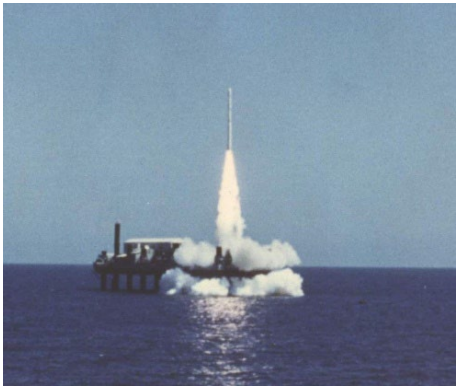
The Luigi Broglio Space Centre (BSC) is an Italian-owned spaceport near Malindi, Kenya, named after its founder and Italian space pioneer Luigi Broglio. Developed in the 1960s through a partnership between the University of Rome La Sapienza's Aerospace Research Centre and NASA, the BSC served as a spaceport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

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

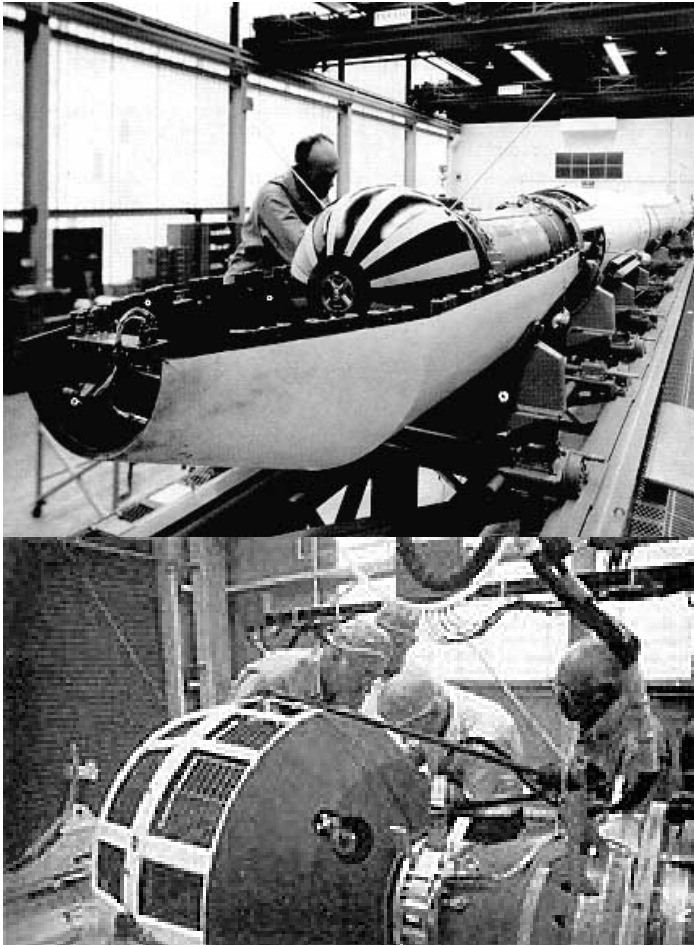
Primarily sounding rockets including the Nike Apache, Nike Tomahawk, Arcas and Black Brant launchers

List of launches carried out at Broglio Space Center

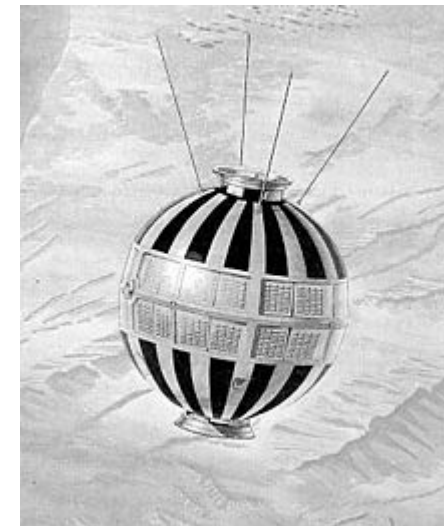
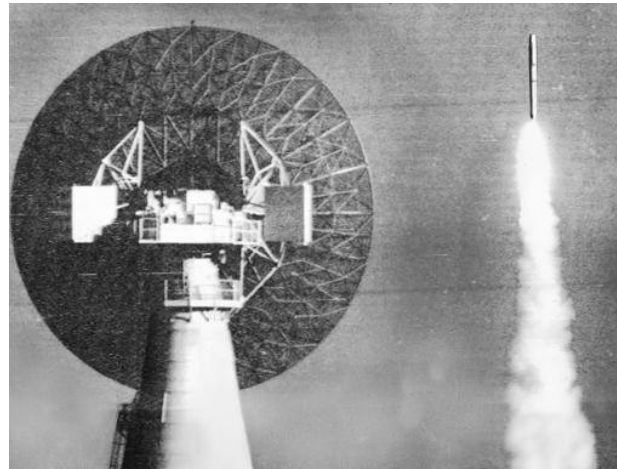
N°	Launch vehicle	Satellite
1	Scout SV 153	SM 2, San Marco 2 (IT), 26 Dec. 1967
2	Scout SV 175	UHURU, Small Astronomic Satellite (USA), 12 Dec.1970
3	Scout SV 173	SM 3, San Marco 3 (IT), 24 April 1971
4	Scout SV 163	SS 1, Small Scientific Satellite (USA), 15 Nov. 1971
5	Scout SV 170	SAS 2, Small Astronomic 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 and the ionospheric research



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.

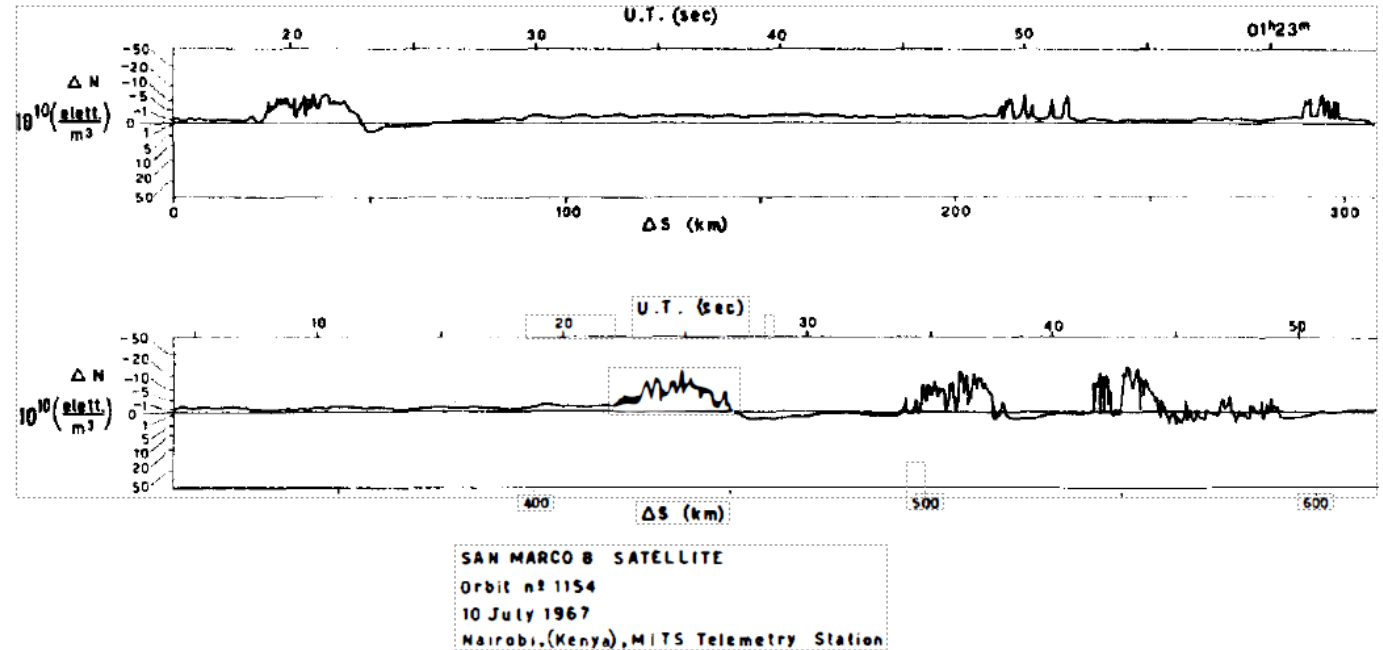
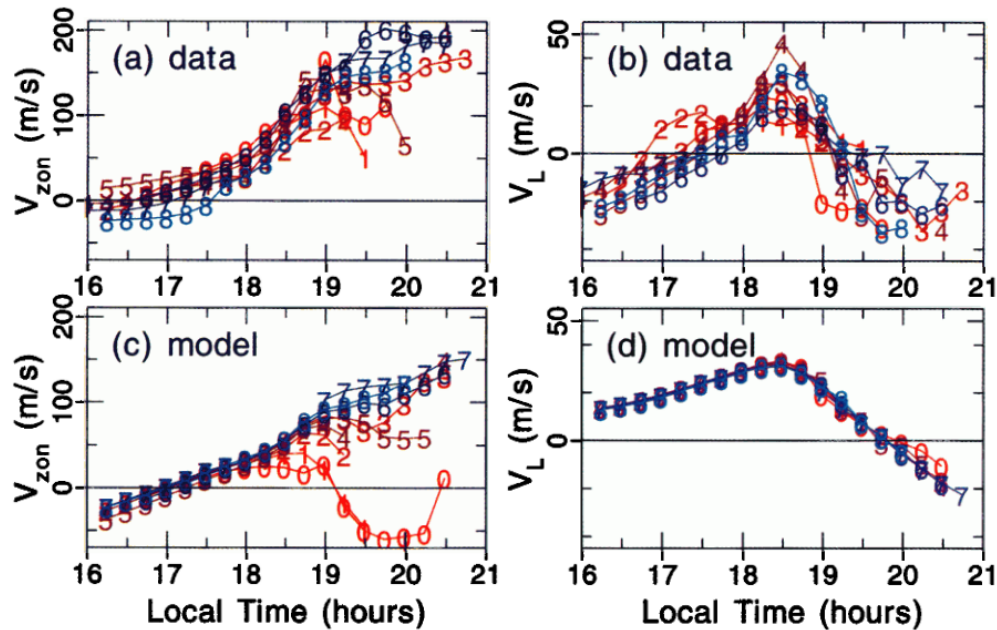


The air-drag experiment operated as planned until 30 December 1964 when transmissions were terminated to allow the ionospheric experiment to operate. It operated for the scheduled two weeks and was turned off, at this point the batteries were nearly exhausted.

Ionospheric studies exploiting San Marco satellites data

ECCLES ET AL.: STUDY OF THE EVENING PLASMA DRIFT VORTEX

28,1



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.

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



Luigi Broglio - Malindi Space Center today

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

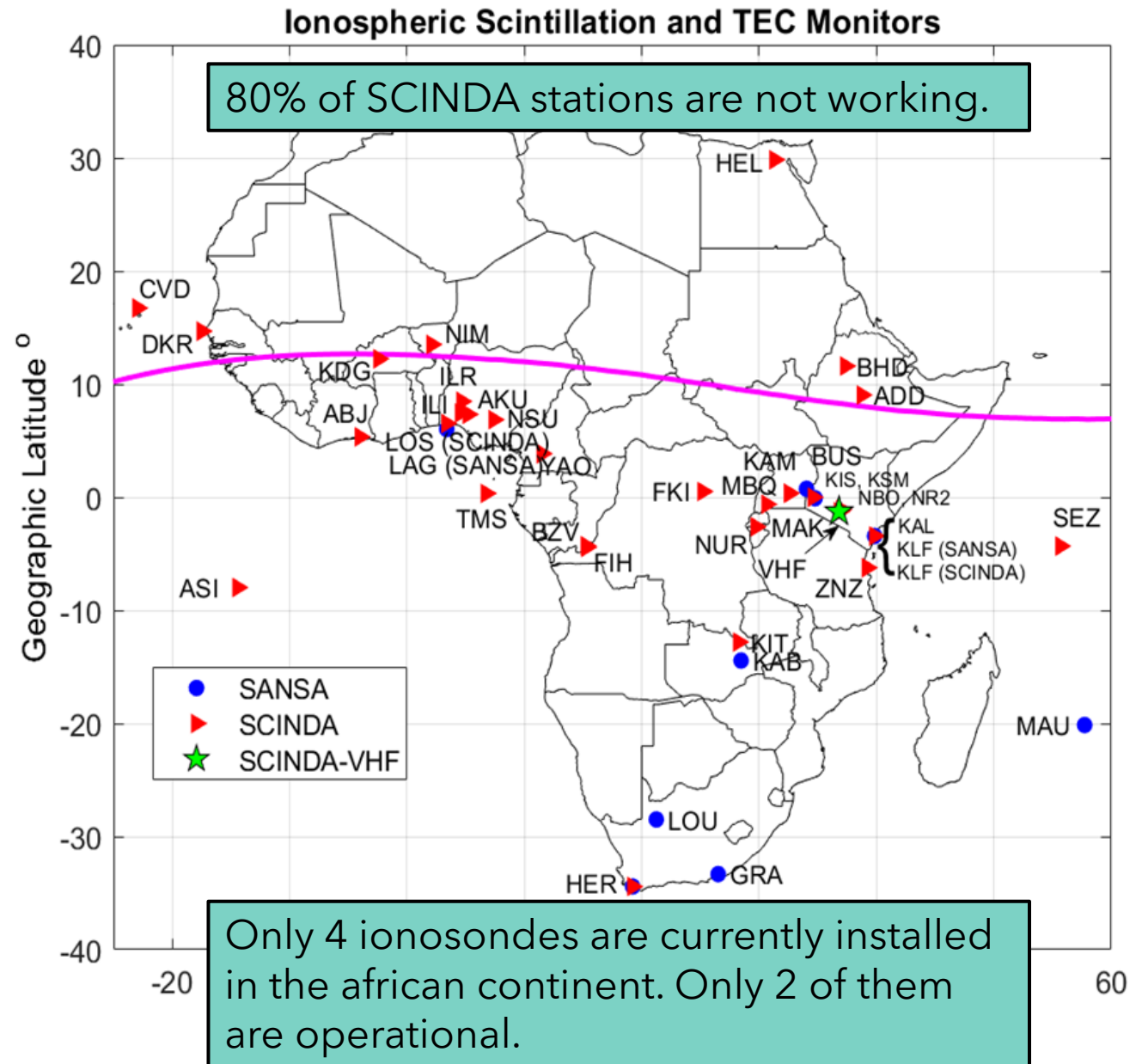
Accordo attuativo 2021-28-HH.0

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

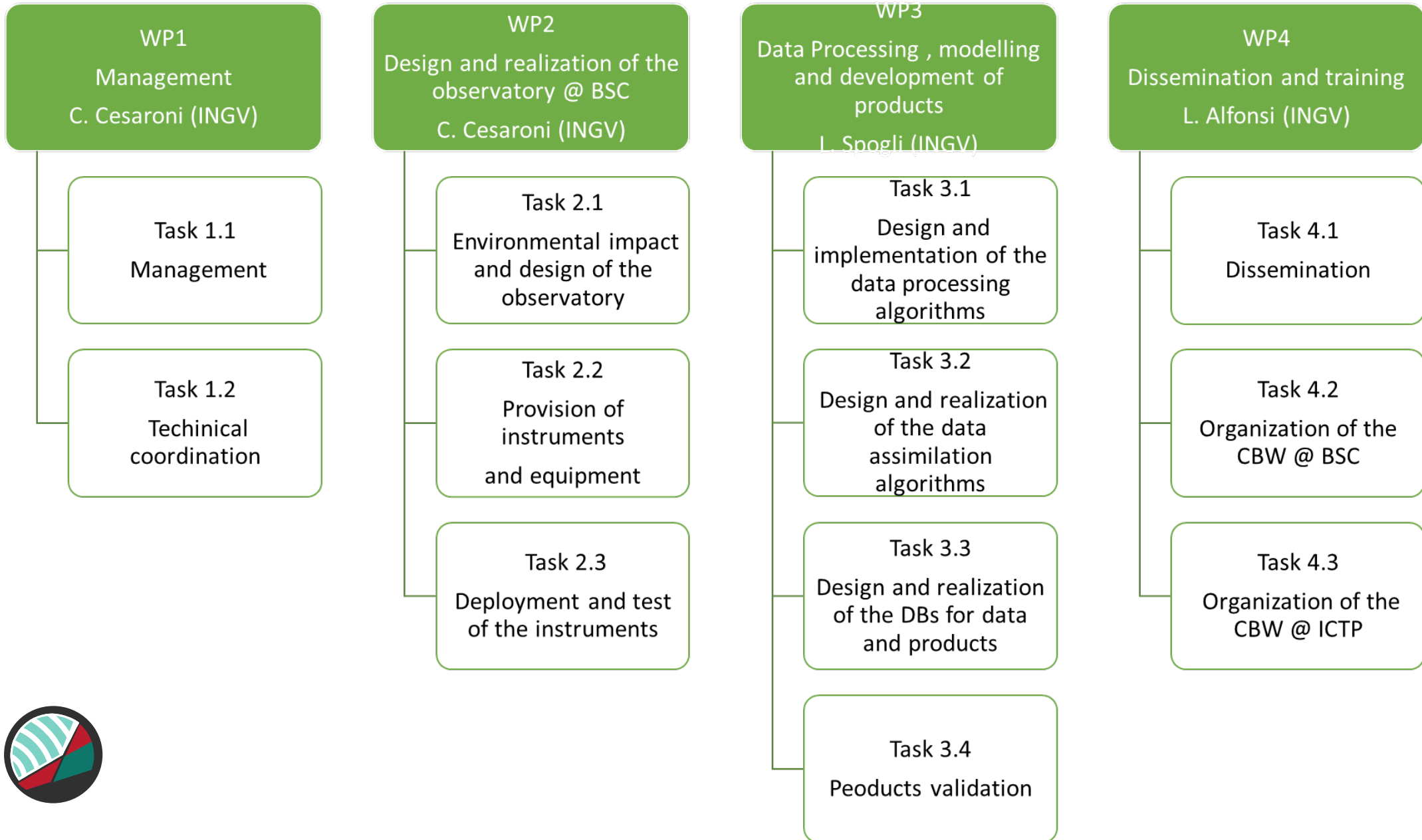
O1. Design and development of a new ionospheric observatory in BSC;

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.



Work Breakdown Structure



Participants



Claudio Cesaroni

Enrico Zuccheretti

Lucilla Alfonsi

Emanuele Pica

Luca Spogli

Vincenzo Romano



Giancarlo Santilli

Jahjah Munzer

Alessandra Di Cecco



Andrew Nyawade



Bruno Nava



Joseph Olwendo



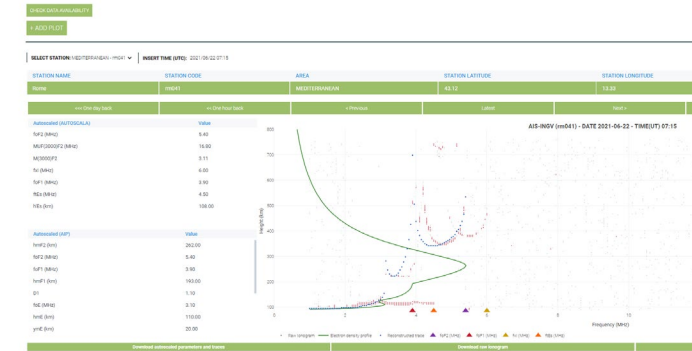
O1. New ionospheric observatory @ BSC

Data (ionosonde and GNSS) and products (TEC and 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/>)



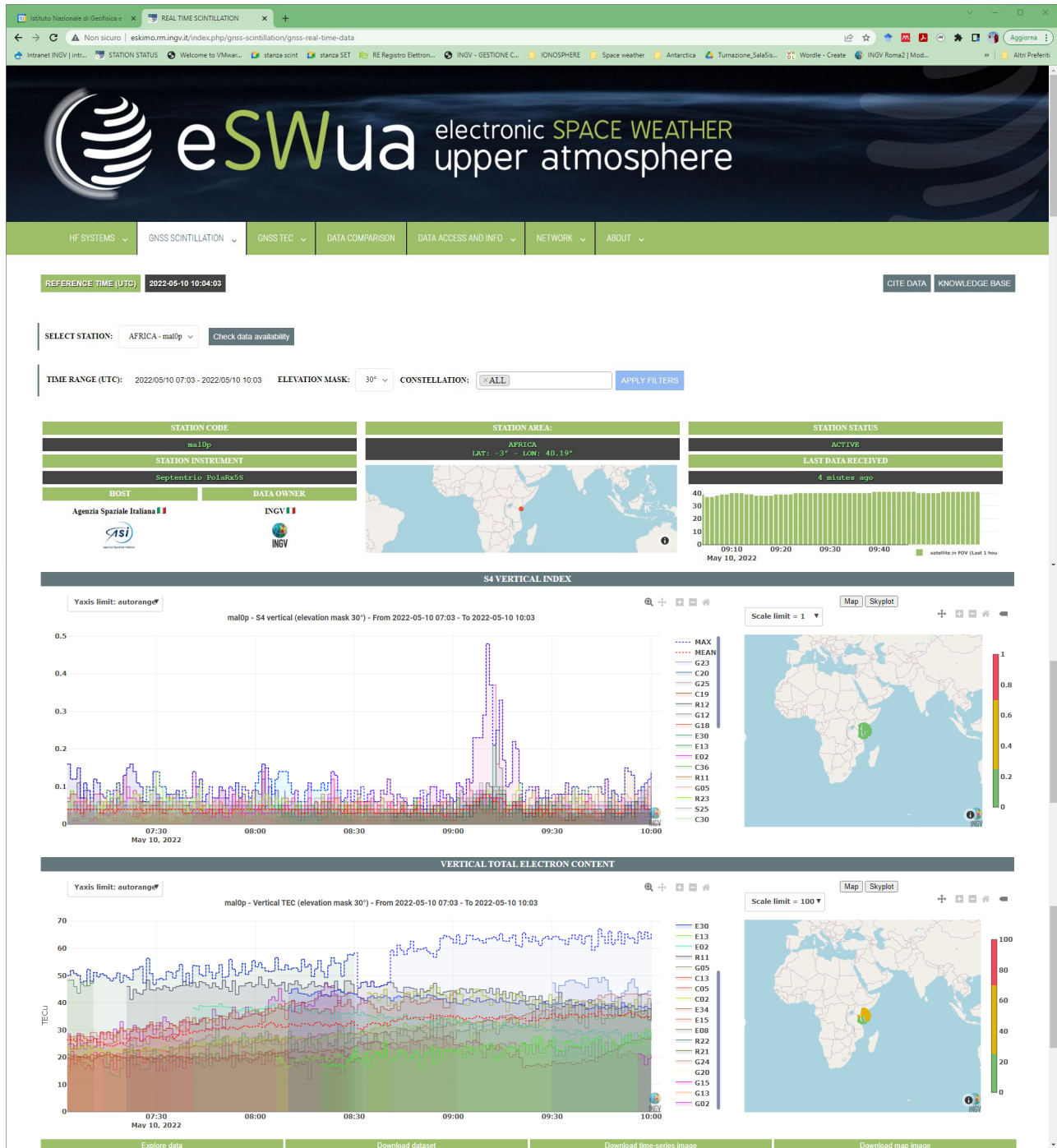
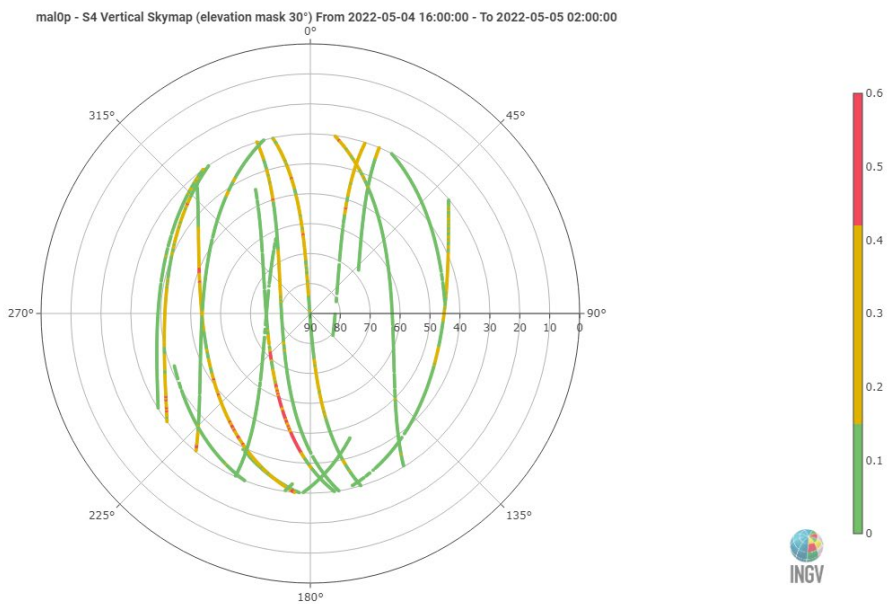
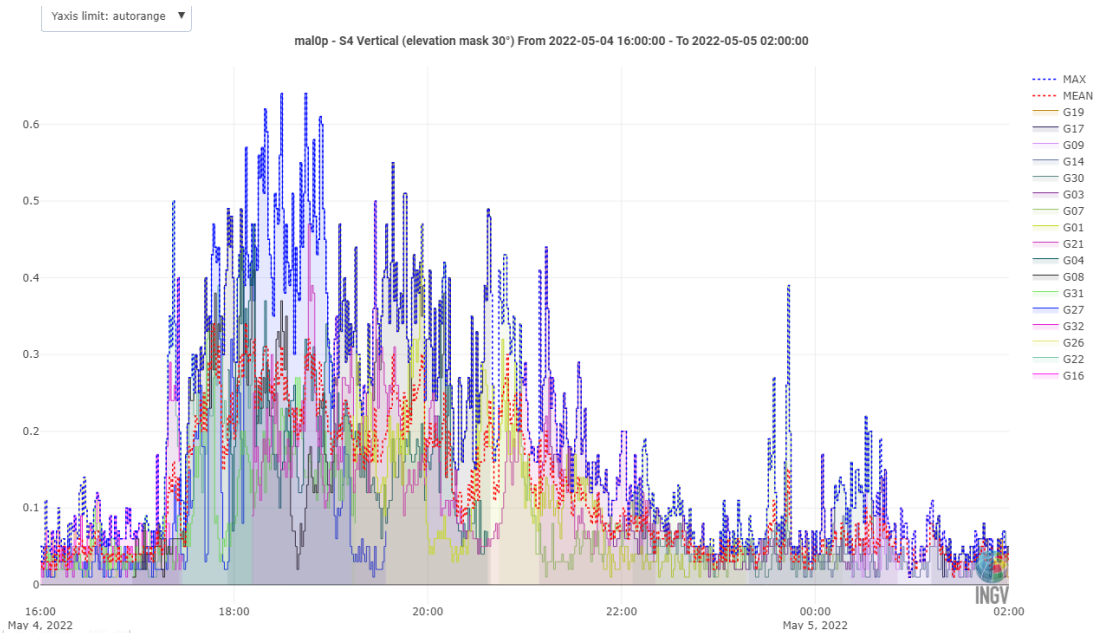
kilOm - s4 vertical map (elevation mask 15°) from 2021-06-22 04:25:00 to 2021-06-22 07:25:00



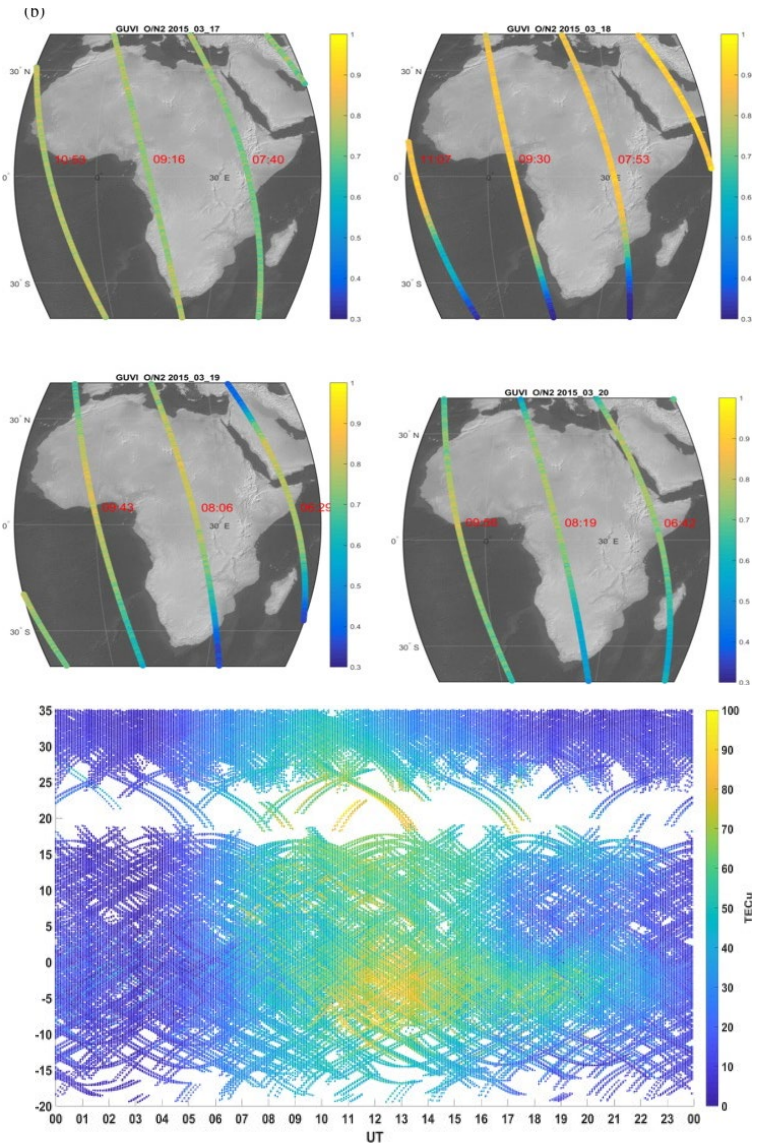
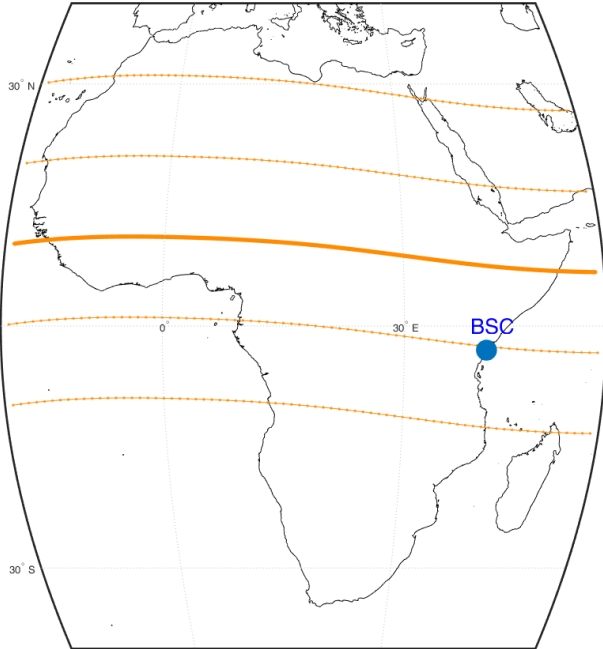
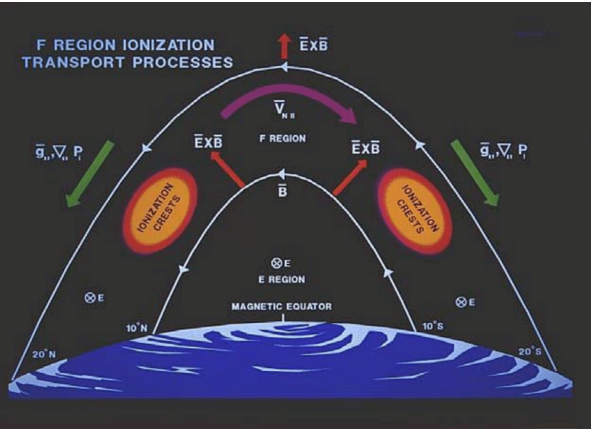
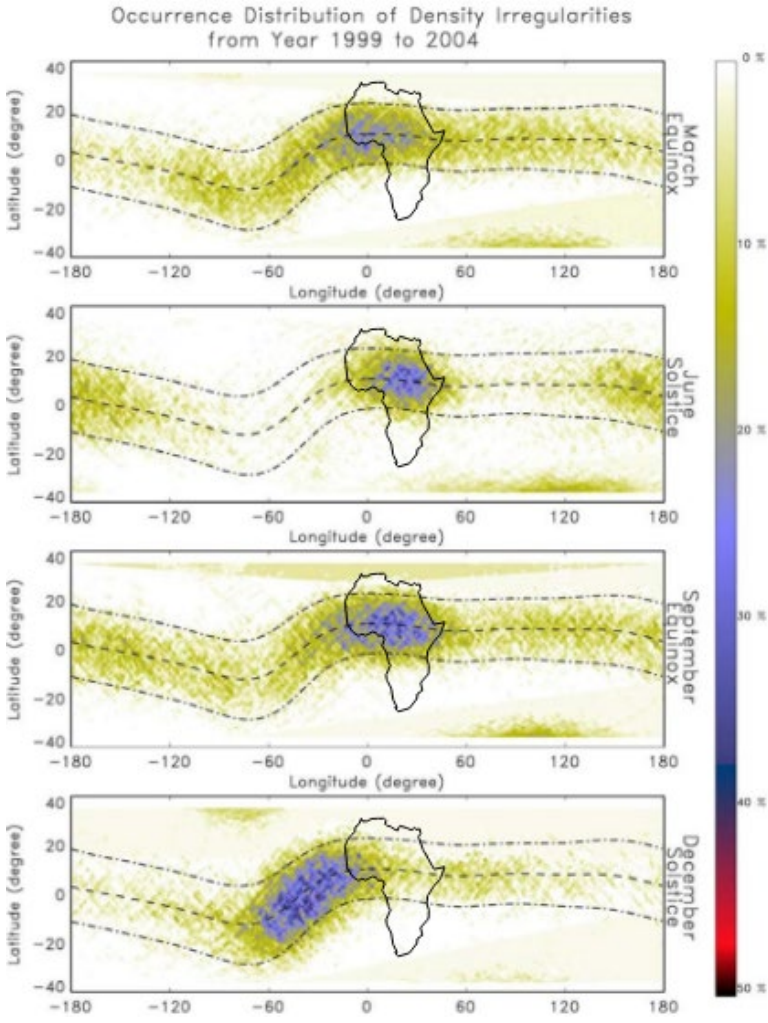
O1. New ionospheric observatory @ BSC



GNSS data available @ eswua.ingv.it



O2. Low-latitude ionosphere monitoring and research



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



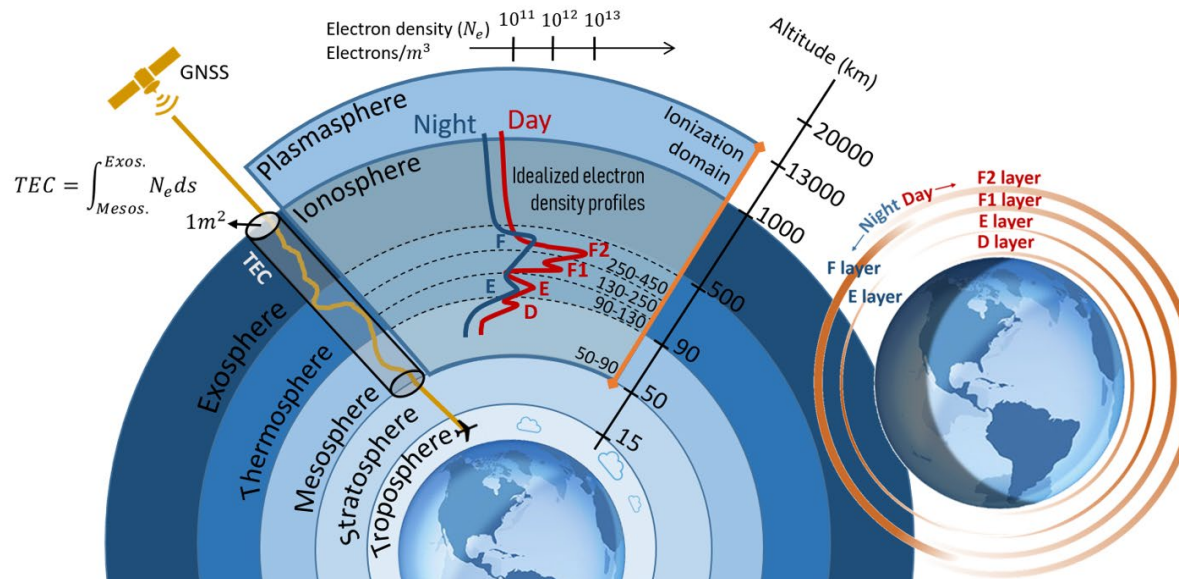
Adapted from Su, 2005

O2. Low-latitude ionosphere monitoring and research

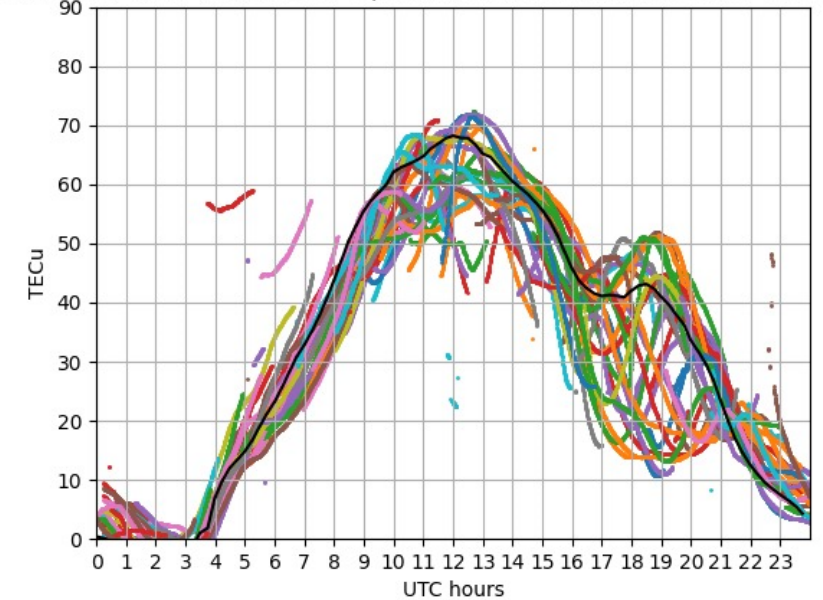
Given the dispersive nature of the ionosphere, it is possible to retrieve the Total Electron Content (TEC) by using GNSS signals at 2 different frequencies.

Unfortunately, the TEC estimated from GNSS code and phase measurements suffers from the so-called Differential Code Biases.

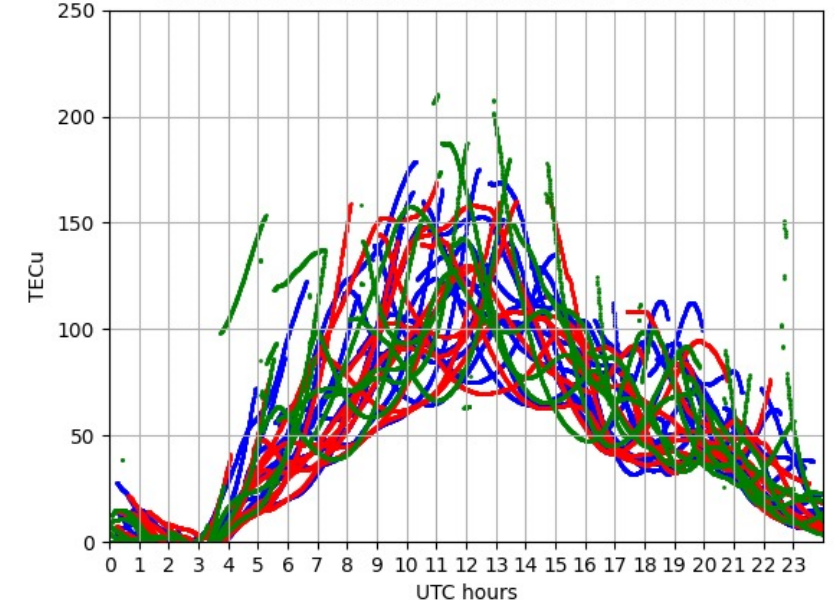
In the frame of NORISK we are developing a new algorithm based on the technique introduced by Ciruolo et al., 2007 in order to minimize the impact of the DCBs.



Calibrated VTEC and Vertical Equivalent MAL200KEN 20230207 000149 UTC



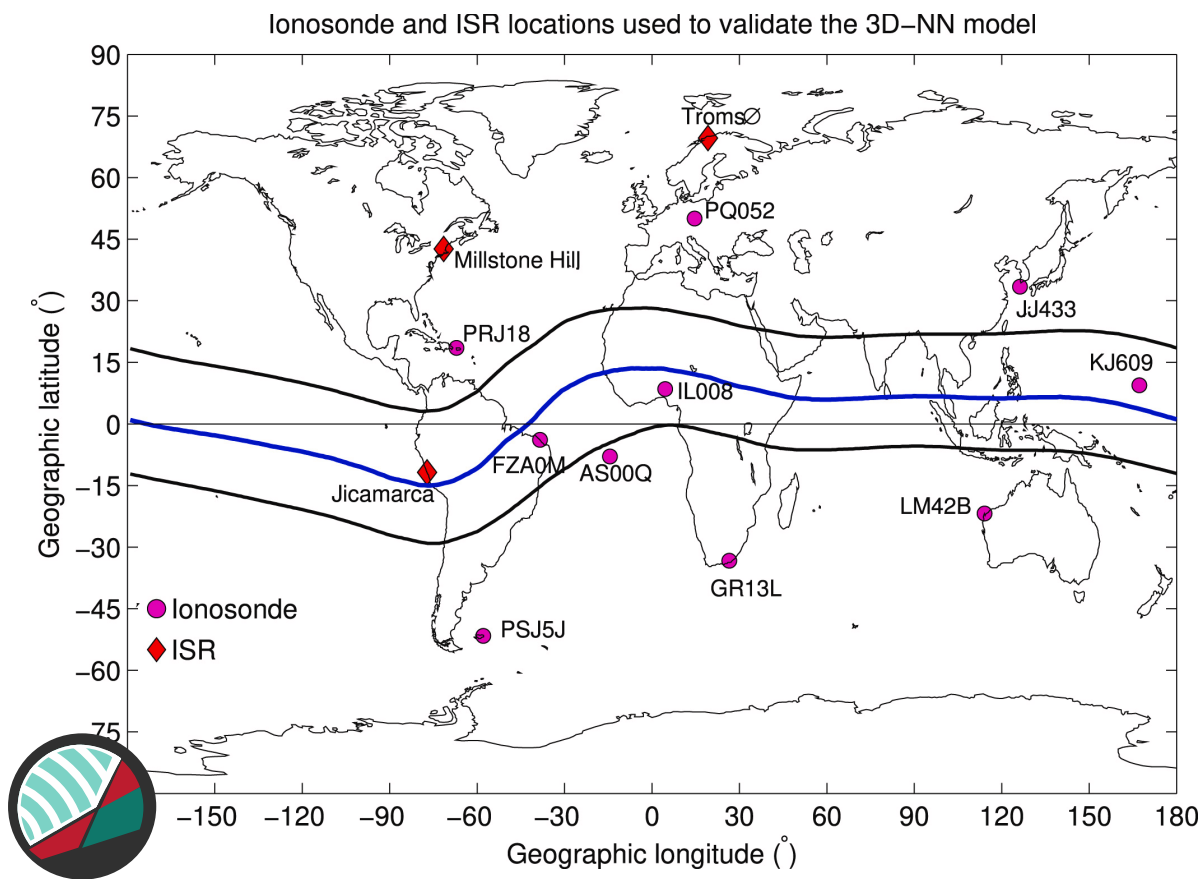
Calibrated TEC MAL200KEN 20230207 000149 UTC



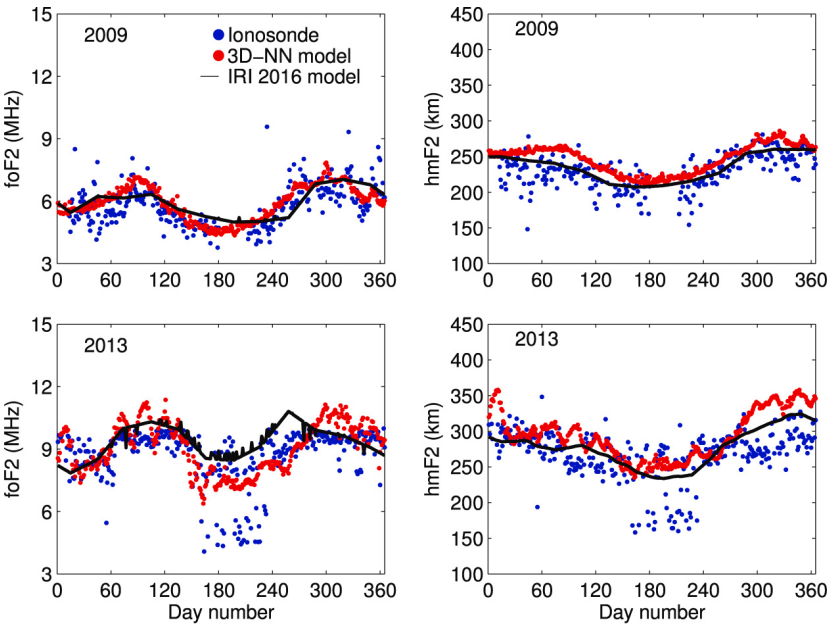
O2. Low-latitude ionosphere monitoring and research

Ionosonde data are crucial for ionospheric model development and validation

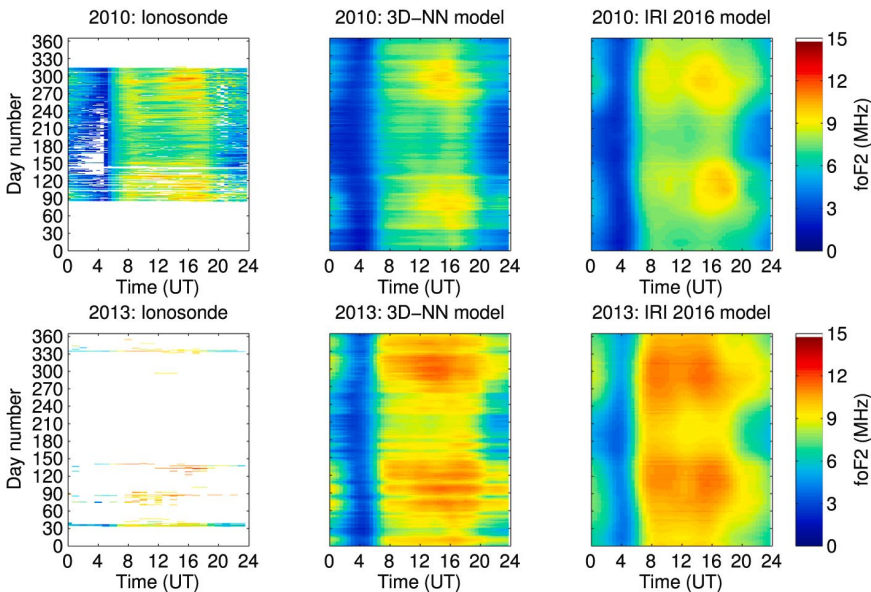
At present, almost no data are available in the African low latitude region



Habarulema et al., 2021



(b) foF2 and hmF2 over GR13L at 1200 UT

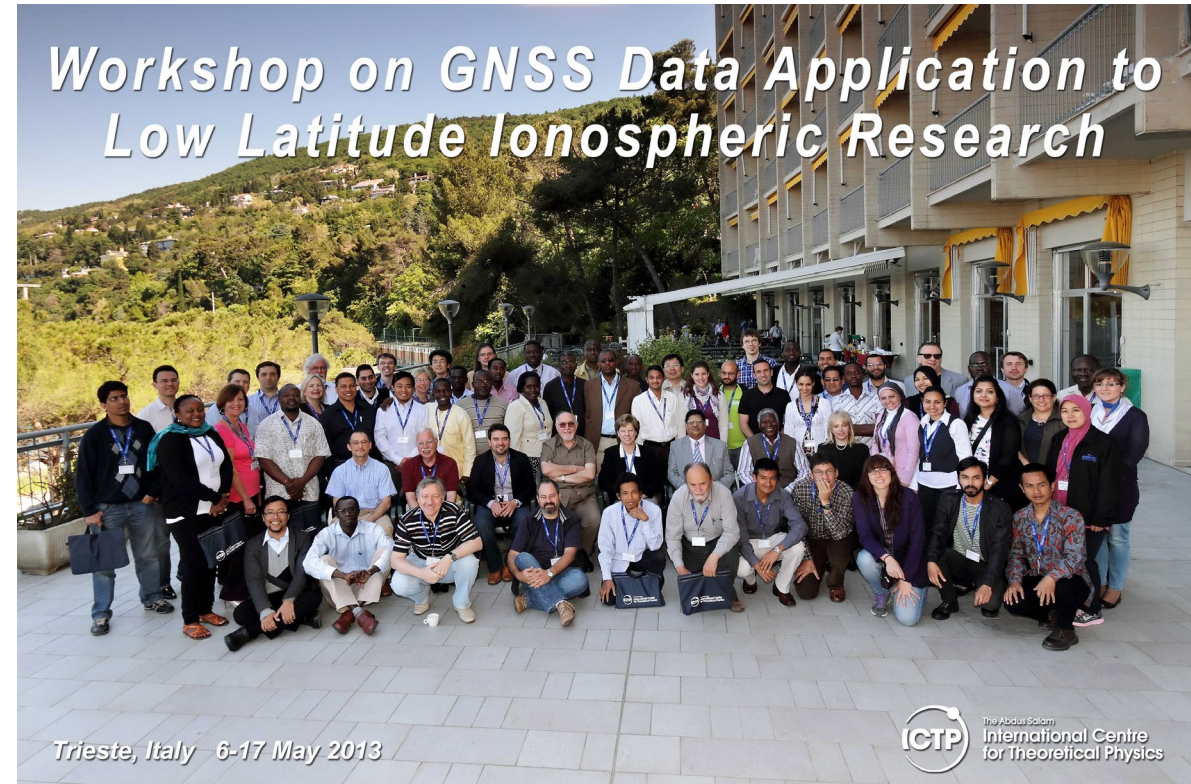


(d) 2010 and 2013 foF2 over IL008 (8.5°N, 4.5°E).

O3. Training for Space Weather scientists

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

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



O3. Training for Space Weather scientists

Eastern Africa Capacity Building Workshop on Space Weather and Low-latitude Ionosphere

3 - 12 October 2023

Luigi Broglio - Malindi Space Centre, Kenya



Further information:
<http://indico.ictp.it/event/10216/>
smr3882@ictp.it

Space Weather and Sun-Earth coupling
GNSS fundamentals
HF Systems generalities
The Low latitude ionosphere
Ionospheric monitoring, modelling and forecasting
ICT infrastructure for space weather data sharing



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G. SANTILLI, ASI, Italy



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DI GEOFISICA E VULCANOLOGIA



Dissemination and communication activities

- Invited talk @ KSA Space Weather Capacity Assessment Workshop 24 March 2022
- Talk @ Pwani University Council
- Talk @ Regional Workshop on GNSS and Space Weather, Rabat, Morocco, 9-13 May 2022
- Poster @ 28th IUGG General Assembly, Berlin, Germany, 11-20 July 2023
- Contribution to the paper The Status of Space Weather Infrastructure and Research in Africa by Baki et al., submitted
- Logo and corporate materials
- Website norisk.rm.ingv.it (under construction)



NORISK NEW OBSERVATORY
FOR REAL-TIME
IONOSPHERIC SOUNDING
OVER KENYA

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Project ▾

Research ▾

Observatory ▾

Capacity Building ▾



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THANKS FOR YOUR ATTENTION!

QUESTIONS?