



Overview

PITHIA-NRF Project

PITHIA-NRF is a Research Infrastructure project funded by the European Commission Horizon 2020 Programme, aiming at building a distributed network that integrates into a unified research environment all key observing facilities, data collections, data processing tools, and prediction models dedicated to ionosphere, thermosphere and plasmasphere research. Through the integration of different assets, the project offers R&D services to expert and early-career researchers and to software and instrument development professionals, enabling leading edge research and fostering innovation.

PITHIA-NRF has the ambition to become the European hub that will act as facilitator for coordinated observations, for data processing tools and modelling advances, and for software and data-products standardization, and will advise on the transitioning of models to operations providing e-Science supporting tools so that models can reach the desired accuracy and standards.

This e-newsletter aims at communicating to all stakeholders the project developments, specifically regarding the TransNational Access programme, the e-science services, the Training, Dissemination and Communication Activities and potential for collaboration within the Innovation Framework of the project.

– Dr. Anna Belehaki, Coordinator of the PITHIA-NRF project

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Imprint

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**Plasmasphere Ionosphere
Thermosphere Integrated
Research Environment and
Access services: a Network of
Research Facilities**

PITHIA-NRF Project

PITHIA-NRF aims at building a European distributed network that integrates observing facilities, data processing tools and prediction models dedicated to ionosphere, thermosphere and plasmasphere research.

PITHIA-NRF Newsletter

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Project News

French EGI member to Provide Cloud Resources for the PITHIA Community

EGI and PITHIA-NRF have signed a Service Level Agreement that governs the provisioning of cloud resources to support the development and operation of the PITHIA e-Science Centre. The agreement describes the provided IT services, documents service level targets, and specifies the responsibilities of EGI in serving the PITHIA community. Through the agreement, PITHIA-NRF community users will have access to EGI Cloud Compute and Online Storage services provided by IN2P3-IRES (France). Current resources include four virtual machines with 12 CPU cores and 60GB of online storage. The allocation is expected to grow according to the future needs of the PITHIA user community. The cloud resources for the PITHIA e-Science Centre are covered by the PITHIA-NRF project budget until March 2025.

The selection of the provider started with gathering the requirements for the resources needed to host the PITHIA e-Science Centre, and was finalised by picking the provider that appreciated the interest in the project of the local universities from its country, particularly the University of Strasbourg, and thus committed to keep supporting the e-Science Centre beyond the project's lifetime. The provider will contribute computation and storage facilities accessible through the EGI Federation supported cloud, as well as offer support for the integration with other services—such as MiCADO, EMGREPO, etc.—needed for the e-Science Centre.

IN2P3-IRES is one of the federated cloud providers of the EGI infrastructure. The cloud service is based on OpenStack, and provides both web-based graphical user interfaces and application programming interfaces for users to work with the offered services, which include user authentication, virtual machine deployment, management and scaling, data ingestion, and more.

Various EGI tools will be provided for use by the e-Science Centre:

- EGI Check-in for authentication of users and user management,
- The EGI Applications Database for cataloguing and sharing virtual machines,
- The EGI Accounting service to track the use of services and produce usage reports,
- EGI Service Monitoring to gain insights into the health of the PITHIA e-Science Centre.

All the above allow IN2P3-IRES to efficiently support the PITHIA-NRF project, the development and operation of the e-Science Centre, and makes it possible for the project's technical and management teams to monitor and track usage of the cloud resources the project consumes, ensuring optimal performance and minimising downtime.

Project Achievements

Report on Socioeconomic Impacts of Upper Atmosphere Effects

The near-Earth space environment undergoes daily changes driven by variable conditions in the Sun. Explosive eruptions of energy from the Sun causing minor solar storms on Earth are relatively common and of little consequence. On the contrary, rarely occurring superstorms generate physical changes in the Earth's upper atmosphere detrimental to satellites, signals from global navigation systems, and radio systems.

While these events' physics and engineering repercussions have been studied extensively, this is not the case for the related socioeconomic ramifications, despite the growing dependencies on these technologies. Therefore, a report was compiled in the framework of the project which identifies the infrastructures vulnerable to upper atmosphere effects and quantifies their impacts on LEO satellites, systems offering PNT services, and radio systems through a systematic literature review.

In summary, it was found that the costs associated with the risks posed to critical space-borne and ground-based technologies by upper atmospheric events are high, comparable to those of terrestrial hazards like tsunamis, earthquakes, or floods. Nevertheless, the quantification of the socioeconomic impacts is not yet mature, partly because of the lack of important modelling information and modern society's lack of experience with extreme space-weather events. Governments, asset owners, and business managers need advances in this area to mitigate the risks posed by upper atmosphere space-weather.



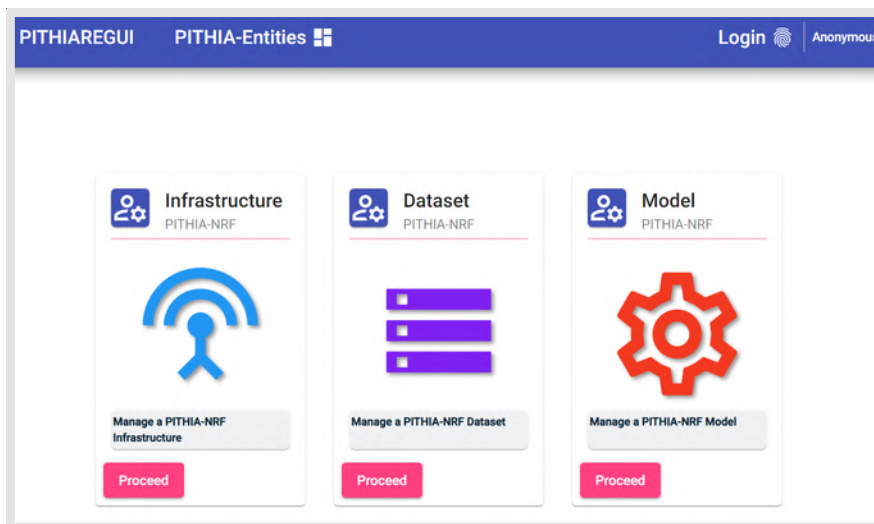
Pietro Vermicelli (SET) reviews the socio-economic effects of space weather at the first Innovation Day in Rome.

The PITHIA-NRF Knowledge Book

A high-level description platform for PITHIA-NRF entities has been implemented and released. The platform provides details on the Infrastructures, Datasets and Models, constituting, this way, the PITHIA-NRF Knowledge Book.

The description of each asset consists of entries regarding basic and advanced information as follows:

- The basic info per **infrastructure** includes the type (ionospheric sounder, incoherent scatter radar, CDSS, GNSS, ASC, EFM, etc.) model and name of the instrument, its operational status (active, inactive or in maintenance) and location, as well as the operator's contact info. The advanced info provides technical details such as installation date, frequency values (operation, sampling, scan), derived products, S/W, O/S, archiving.
- The basic info per **dataset** includes its name, temporal (real-time or historical) and spatial (regional or global) coverage, its availability status (online or offline), as well as the operator's contact info. The advanced info includes details regarding the temporal and spatial data availability, data levels, the observed properties, the collections in which it belongs, and the observation facilities from which it derives.
- The basic info per **model** includes its name, its availability status (online or offline), as well as the operator's contact info. The advanced info includes details on the model input and output, its runtime and the possible modes of use (via GUI, download, clone, etc.).



The project beneficiaries have full access to the platform, so that they can register and update their assets, whereas anonymous users can effectively query and view information.

The PITHIA-NRF Knowledge Book is a useful tool for the different users, especially for the TNA participants and the e-Science Centre users.

First PITHIA-NRF Innovation Day

The First Innovation Day of the PITHIA-NRF project took place in Rome on June 21, 2022. The event was organised as a hybrid meeting due to COVID-19 restrictions. In-person attendees convened at the Industrie Fluviali Conference Hall while others joined through a dedicated Zoom virtual room. More than eighty people registered for the event, representing over forty institutions located all around the world. Representatives of SMEs, large companies, and space agencies, among others, were present at the event, highlighting the PPP with GNSS, aerospace, and defence sectors' interest in PITHIA-NRF's services.

The event had a twofold aim: to understand PITHIA-NRF users' needs and informing users of the project's innovative potential. The first part of the meeting saw the project coordinator Anna Belehaki (NOA) drawing attention to the scientific and operational challenges posed by modelling the coupled Plasmasphere-Ionosphere-Thermosphere system and how PITHIA-NRF will work towards addressing them. Next, by presenting some particular use cases, Barbara Matyjasiak (CBK-PAN) exemplified the project's innovation potential for external users. Finally, Pietro Vermicelli (SET) introduced PITHIA-NRF's findings on the socioeconomic impacts of space weather.

Work by dr. ing. B. A.

Calibration and validation of HF radio equipment

Node - Non-gov organisation example

MEDECINS SANS FRONTIERES

HF radio waves

Ionosphere

F region

Continuous coverage

Right: Illustration of ionospheric reflection of HF radio signal. Right: Ambulance antenna gain versus distance (Credits: B. Witvliet, GHIC 2021).

HF radio uses radio wave refraction in the ionosphere to cover large distances. It is used by humanitarian organizations such as Médecins sans Frontières (MSF), who provide basic healthcare in poor and remote regions.

Reported so called consistent 'Dead Zones' - no signal reception in the short distance from the station

Possible causes were examined:

1. Ambient electromagnetic noise
2. Propagation above the critical frequency of the ionosphere
3. Antenna characteristics

Work by dr. ing. B. A. Witvliet (b.a.witvliet@utwente.nl)

FIRST INNOVATION DAY
PITHIA-NRF
A HORIZON 2020 PROJECT
21 June 2022 | ROME
INDUSTRIE FLUVIALI

Barbara Matyjasiak (CBK-PAN) showcases how PITHIA-NRF expertise in radio science can support NGOs using HF radio equipment.

An open discussion session ensued allowing users to relate their experiences with the challenges posed by the upper atmosphere and more. Klaus Sievers, a retired commercial pilot, introduced the audience to space weather's impacts on aviation. Then, Roberto Ronchini, head of the Satellite Navigation unit in Telespazio SpA, spoke about Telespazio's research initiatives on the ionosphere for commercial applications. PITHIA-NRF could support both with its network of ionosondes, GNSS receivers, and LOFAR telescope.

The third and last talk by Andrea Perronace, a European patent attorney at Jacobacci & Partners, diverged from the others and explored another critical theme: protecting intellectual property rights. To this end, he presented the new Unitary Patent System expected to enter into force in early 2023 in the participating EU countries. The topic was all the more relevant as, after the coffee break, the B2B meeting session rounded off a successful First Innovation Day.

After the event, feedback was collected from the participating external stakeholders through a short questionnaire. The overall appreciation was very high. All participants who filled out the questionnaire expressed their interest in attending another Innovation Day. For one third of the external participants, this event was their first introduction to the project, indicating a successful campaign of the consortium members to invite new stakeholders and potential end-users. The responses further demonstrated a very large active interest in the project's work. The vast majority believes that the e-Science Center will be useful to them, considers providing data collections and models to the e-Science Center, and appreciates the TNA program as a venue to participate in project activities.

Outreach activities

The **Istituto Nazionale di Geofisica e Vulcanologia** is now partner of AMSAT Italia, a cultural association that aims to gather fans of advanced radio communication techniques, in particular those in space-related fields, and to collaborate with national and international organisations having the same purposes. AMSAT Italia is in charge of selecting the Italian schools that apply to host a radio amateur link with the International Space Station in the framework of the ARISS program. In this way the students have the amazing possibility to talk directly with the astronauts on board the ISS to ask them any curiosity about their incredible zero-gravity experience!

In early 2022 eight applications from primary to high schools were selected that had the possibility to talk with Samantha Cristoforetti, the Italian astronaut taking the ISS command last Spring. Even though the COVID 19 restrictions did not allow a large in-person participation, the links were established with success and to great satisfaction of the students and their teachers.



Credits: AMSAT Italia



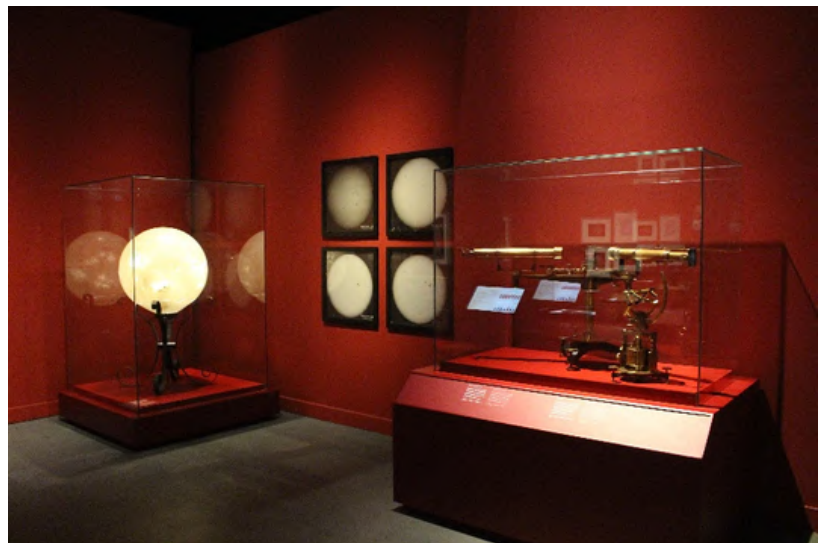
Samantha Cristoforetti on board the ISS (credit: ESA)

Once selected for the contact, the schools were trained to be prepared for the event. The preparation included not only the radio link technical details, but offers also the possibility to learn about the environment in which the ISS orbits. The ISS flies inside the ionosphere, so the kids learn what the ionosphere is and how its disturbed conditions can modify the plans of the astronauts. INGV introduced the pupils to the space weather issues affecting the upper atmosphere sector where the ISS is orbiting.

During the meeting INGV explained how international collaborations, like the one established within PITHIA-NRF, are fundamental to monitor, understand, and countermeasure the space weather effects.

The **OEbro** team contributed to the Exhibition “The Sun. Living with our star” in CosmoCaixa (https://cosmocaixa.org/es/p/el-sol_a33511124).

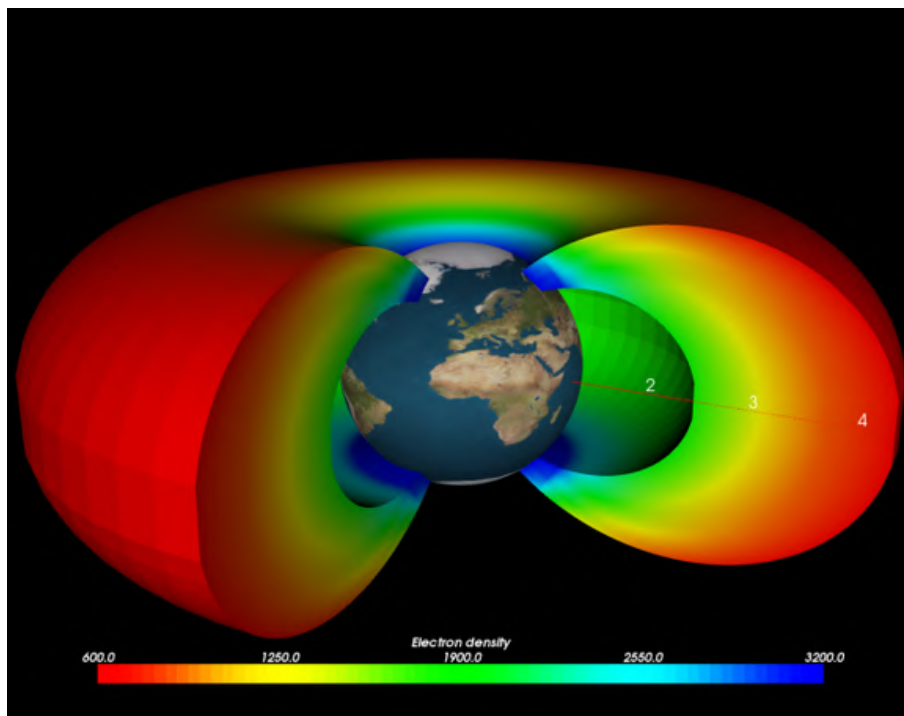
This is an exhibition organised by the CosmoCaixa museum of the Bank Foundation “La Caixa” in Barcelona in collaboration with the Science Museum of London. At the exhibition some of the historic instruments for solar observation and research were shown, together with historical pictures of the Sun and a Cristal Sphere dated 1928 representing the Sun with its sunspots as observed in July 1928.



The **OEbro** team also contributed to the event “Pint of Science Spain 2022” in May. This is an scientific popularisation activity organised in the bars for general public.

The OEbro contribution of this year was devoted to the Moon and its effects on Earth.

BIRA-IASB released a [new video](#) about the plasmasphere, explaining for a general audience what the plasmasphere is and its link to the ionosphere, how the plasmasphere is disturbed during geomagnetic storms, and what its consequences are for satellite based technologies.



The three dimensional dynamic Belgian SWIFF Plasmaspheric Model (BSM) developed at the Royal Belgian Institute for Space Aeronomy.

The video also describes the three dimensional dynamic model of the plasmasphere that has been developed at the Royal Belgian Institute for Space Aeronomy, which has recently had various improvements. This model will soon be available on the PITHIA-NRF platform and provides already real time animations on the Space Situational Awareness website of the European Space Agency.

Recent publications

Here we list only the articles published since the last issue of this newsletter. A full list of publications, presentations and reports related to PITHIA-NRF can be found on the [project website](#).

- B.A. Witvliet: "Near Vertical Incidence Skywave – The propagation mechanism, the impact of antenna, backscatter and solar flares", Nordic HF 2022, Fårö, Sweden, 16 August 2022.
- B.A. Witvliet (2022): "Ambient Outdoor Electromagnetic Noise Measurements – in the conflicting perspective of spectrum planners and spectrum users", Nordic HF 2022, Fårö, Sweden, 15 August 2022.
- M. Hernández-Pajares et al.: "Wide-Area GNSS Corrections for Precise Positioning and Navigation in Agriculture", Remote Sens.14(16), 3845, [doi:10.3390/rs14163845](https://doi.org/10.3390/rs14163845).
- S. Lo et al.: "A systematic study of 7 MHz greyline propagation using amateur radio beacon signals", Atmosphere, 13(8), 1340, [doi:10.3390/atmos13081340](https://doi.org/10.3390/atmos13081340).
- V. de Paula et al.: "Detection of Solar Flares from the Analysis of Signal-to-Noise Ratio Recorded by Digisonde at Mid-Latitudes", Remote Sens. 14(8), 1898, [doi:10.3390/rs14081898](https://doi.org/10.3390/rs14081898).
- E. Monte-Moreno et al.: "Forecast of the Global TEC by Nearest Neighbour Technique", Remote Sens.14(6), 1361, [doi:10.3390/rs14061361](https://doi.org/10.3390/rs14061361).

Upcoming Events

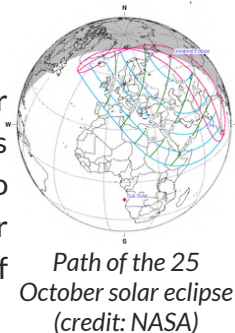
18th European Space Weather Week

The ESWW 2022 will take place October 24–28 in Zagreb, Croatia. The PITHIA-NRF Community will participate in the ESWW 2022 with various contributions:

- S. Poedts: “The ESA Virtual Space Weather Modelling Centre-Part 3” (Session CD2, October 25).
- E. Pica, C. Cesaroni, V. Romano et al.: “The INGV eSWua network: observing the ionosphere from ground-based infrastructures” (Space Weather Forum—Observation Forum, October 26).
- I. Häggström: “PITHIA-NRF offer access to European upper atmosphere research facilities” (Session SWR4, poster).
- P. Vermicelli, S. Mainella, L. Alfonsi et al.: “The Socioeconomic Impacts of the Upper Atmosphere Effects on LEO Satellites, Communication and Navigation Systems” (Session SWR4, poster).

Solar Eclipse of October 25

On 25 October 2022 a solar eclipse will occur over Europe. Various consortium partners are planning a dedicated campaign to observe the effects of this event on the upper atmosphere, in particular with the goal of studying travelling ionospheric disturbances.



4th PITHIA-NRF TNA Call

The third call for TNA projects within the PITHIA-NRF project closed on September 15. The fourth call will be opened in January 2023. Please watch the [project website](#) for updates.

March 2023: meetings in Brussels

The 1st High-Profile meeting, the 2nd Innovation Day, the 4th Training for Partners Workshop and the 3rd Workshop on the Optimisation of Observing strategies will all be held together with the General Assembly of the project. This joint meeting will take place in Brussels during one week in March 2023. The final dates and other details will be announced soon through the [PITHIA-NRF website](#).

May 2023: 1st PITHIA-NRF School in Rome

The 1st PITHIA-NRF Training School will be held in Rome, May 29th - June 1st 2023. This school will offer theoretical lectures on the Ionosphere-Thermosphere-Plasmasphere as parts of the coupled Sun-Earth system; courses on data and models in PITHIA-NRF e-science and hands-on sessions will be also organised. Registration will open in January 2023. Further notices will be given at: <https://tinyurl.com/1stPithiaSchool>.

Imprint

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