



European Union's Horizon 2020 Research and Innovation Programme  
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# PITHIA-NRF

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

Anna Belehaki, PITHIA-NRF coordinator  
Research Director, National Observatory of Athens  
EEAB meeting, 31 March 2022

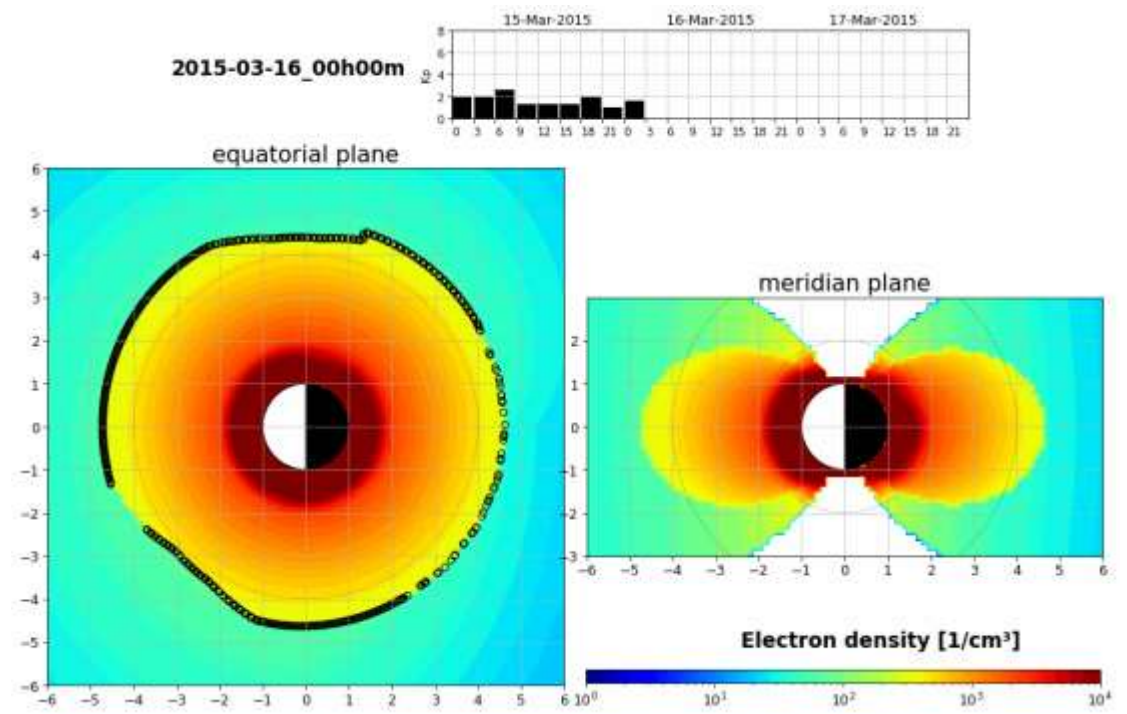
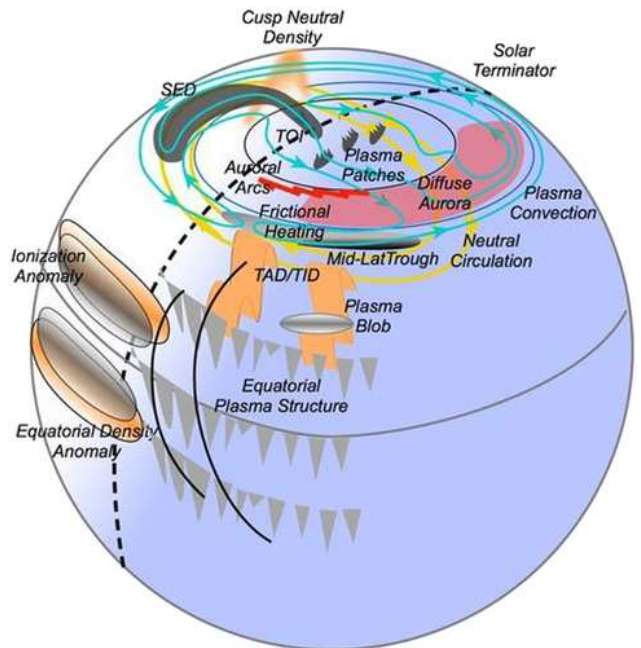


# Scientific challenges

The Earth's Ionosphere, Thermosphere, and Plasmasphere is governed by the complex electrodynamic and photochemical system of the upper atmosphere coupled with variable electromagnetic fields and thermospheric winds.

These physical processes are the source of many **scientific, operational, societal, and environmental challenges** that affect the smooth and uninterrupted operation of critical technological systems and of research infrastructures.

While we understand the broad features of the coupled ionosphere thermosphere plasmasphere system response, we lack the depth of understanding of its variability in long- and short-time scales that would allow us to build **models with real predictive power.**



Courtesy: BIRA-IASB



# PITHIA-NRF consortium

- 22 Beneficiaries
- 2 Third Parties
- 5 External Advisors



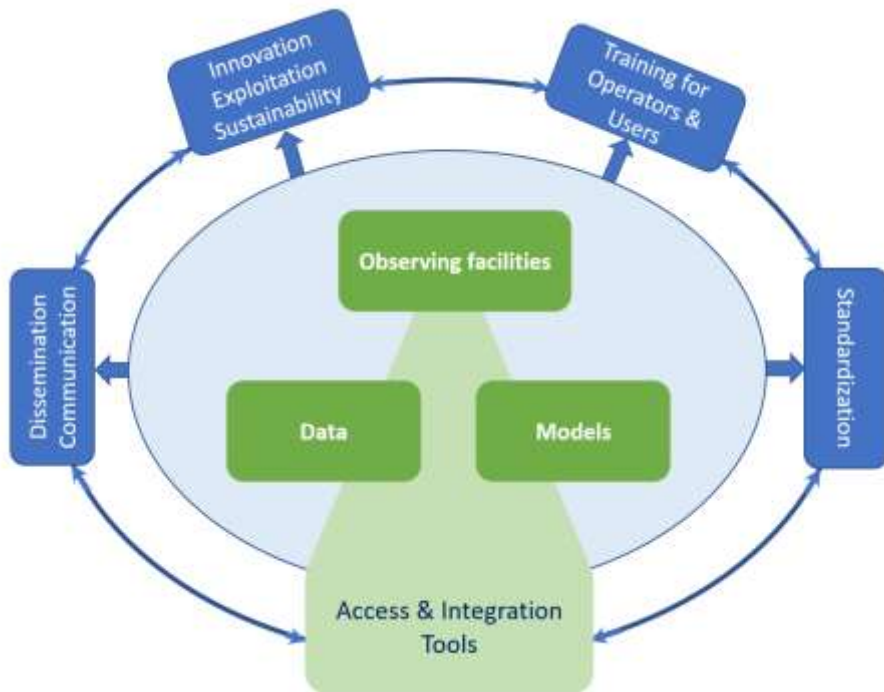
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# Overview & Ambition

PITHIA-NRF has the ambition to facilitate the development of validated prediction models and its transition from research to applications



Europe operates excellent observing facilities and is extremely well-placed in developing ionospheric, thermospheric and plasmaspheric models.

However, more is needed to:

- Support the interoperable use of observing facilities;
- Develop standardized processes that lead to FAIR data and data-products;
- Facilitate the use of scientific models' concepts for experimentation purposes;
- Support space applications developers to implement innovative projects.

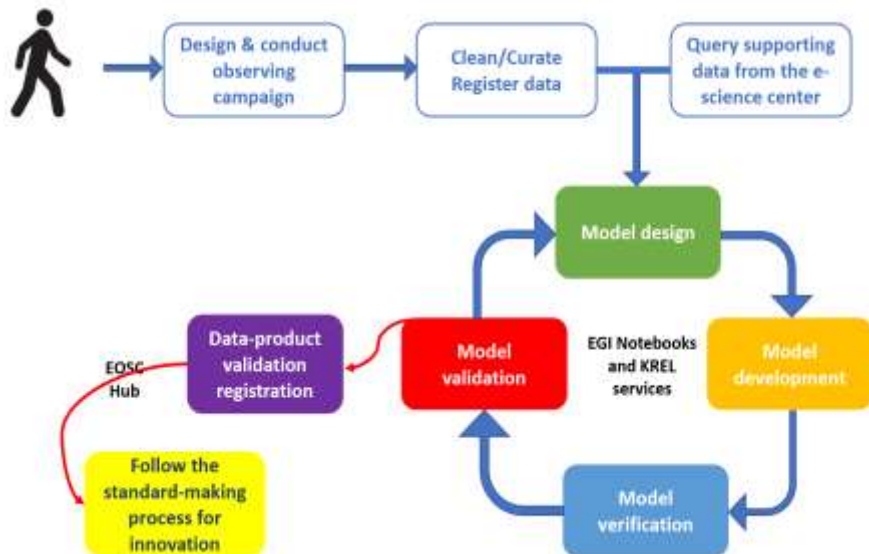
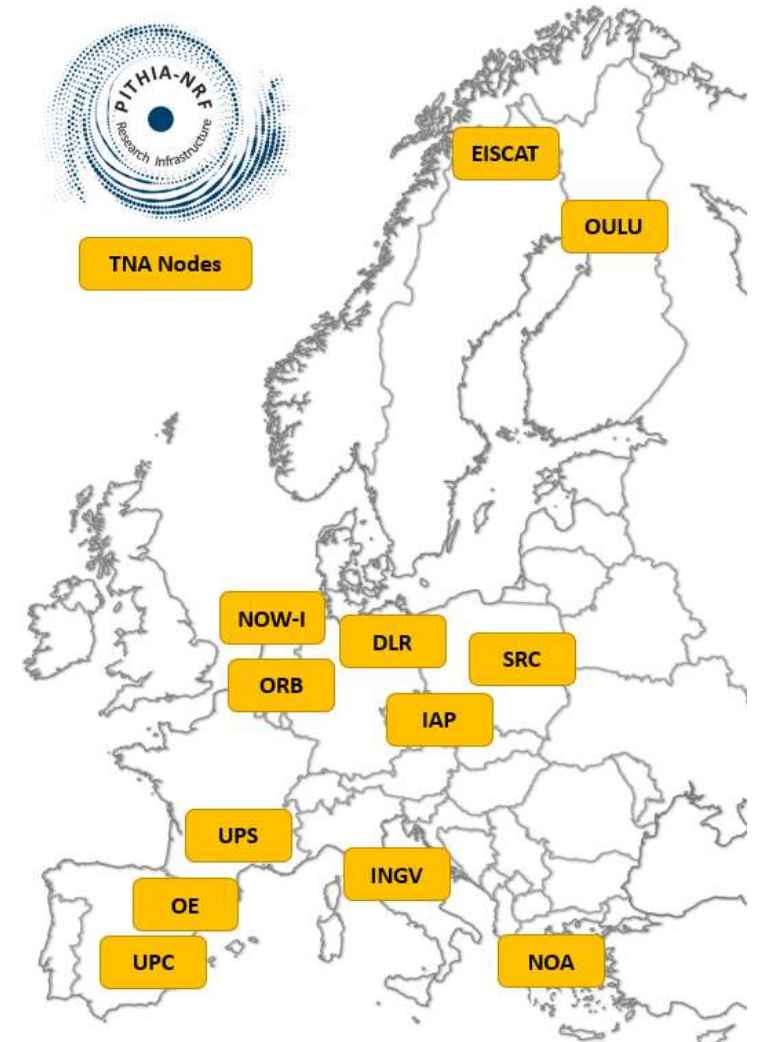
... and all these need to be more reliable.

To achieve this challenge, the scientific research community requires support from a **structured research infrastructure** organized to provide **transnational research services**, including **access** and **standardization**.



# Specific Objective 1

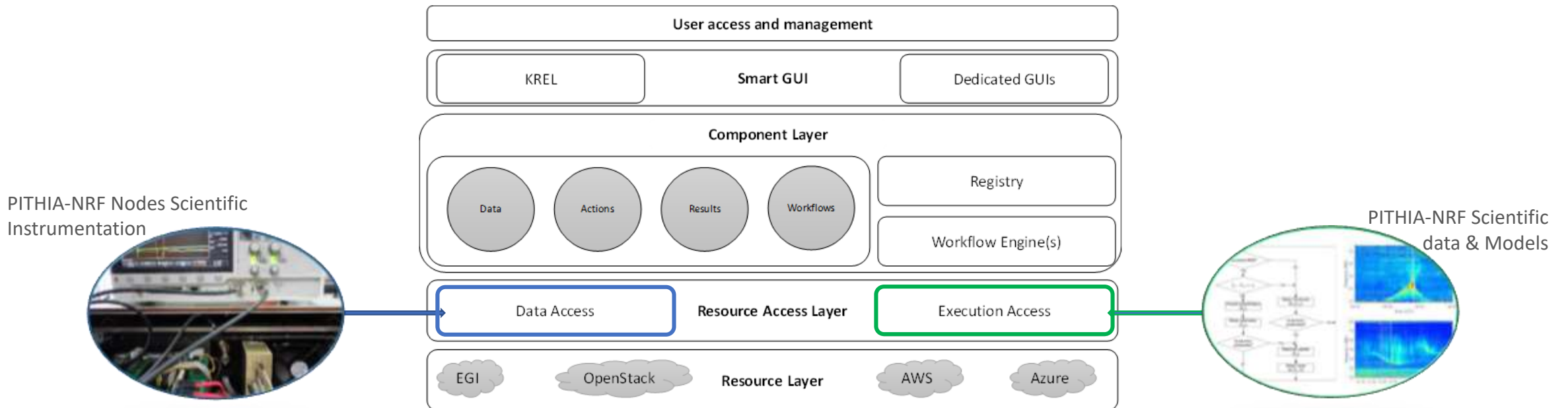
PITHIA-NRF provides **effective and convenient access** to the best European research facilities (nodes) for the upper atmosphere. Access is provided to scientific users, from academia, Small and Medium Enterprises (SMEs), large companies and public organizations. Access is subsidized through the **Transnational Access (TNA) programme**, and gives the possibility for external research teams to perform their own projects working in one of the PITHIA-NRF nodes, learning how to operate the observing facilities end-to-end, i.e. from setting up a special campaign, to the collection, analysis and exploitation of data using the project tools and services.





# Specific Objective 2

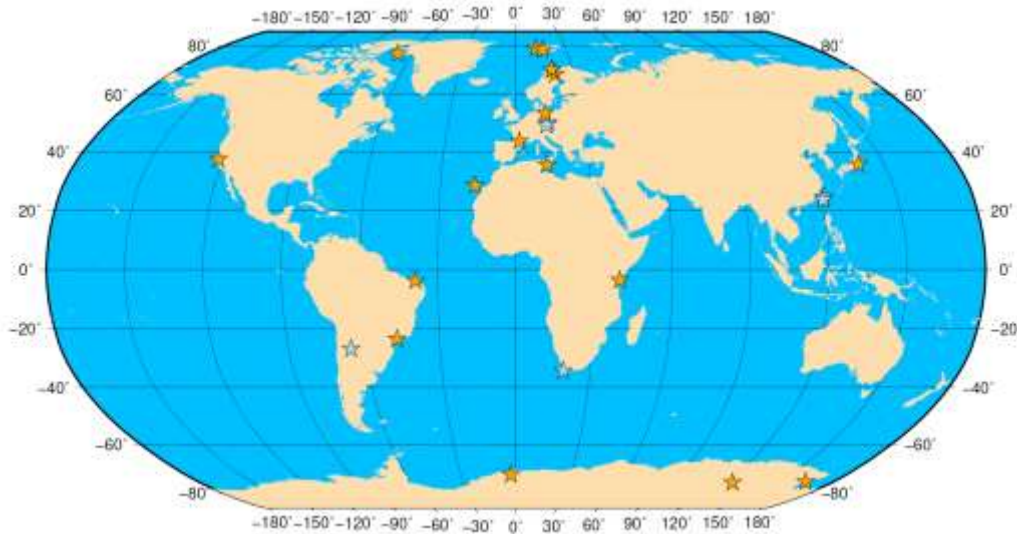
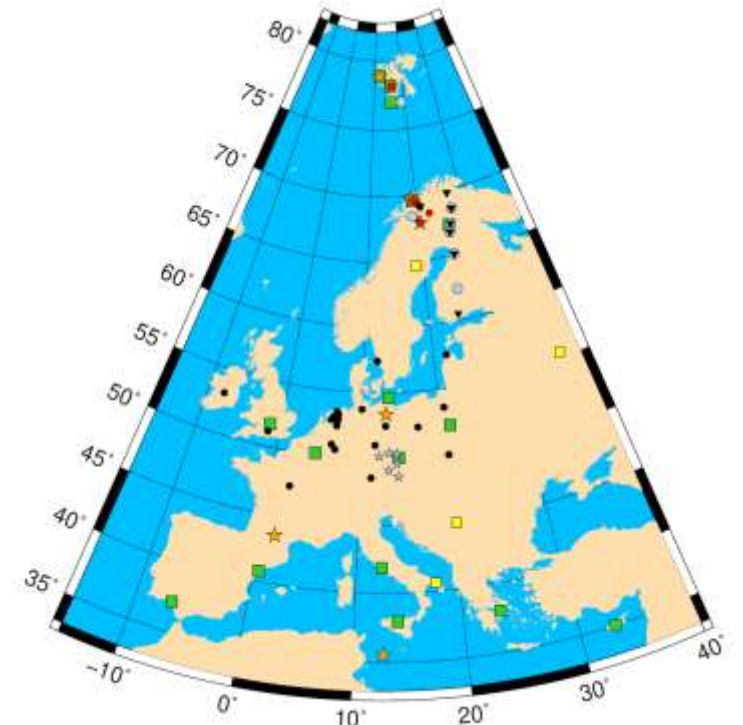
PITHIA-NRF develops **integration tools** that enable the establishment of a comprehensive Research Infrastructure. This set of tools is provided through the PITHIA-NRF **e-science center**, a dedicated knowledge hub that provides open access to FAIR data and higher-level data-products. These tools cover data discovery, data standardization, data quality control, publicly-accessible workflow applications to automate the calculation of data-products, and tools to enable the registration of new datasets and new models. An additional set of integration tools targets to the **optimization of observing strategies** through the release of standardized operation protocols, management tools, and training procedures for operators. These integration tools are expected to lead to the **optimal use and joint development of the PITHIA-NRF observing facilities**.





# Specific Objective 3

Through connection with the European Open Science Cloud, the e-science center of PITHIA-NRF provides **long-term observational data**, required for advancing our knowledge in the Ionospheric, Thermospheric and Plasmaspheric research domain. PITHIA-NRF provides access to data from ground-based instruments such as GNSS ground based receivers, Ionosondes, Digisondes, Dynasondes, Doppler Sounders, Incoherent Scatter Radars, Riometers, All Sky Imagers, and the LOFAR radio telescope. It also provides access to data from satellite experiments, including in situ, Radio Occultation and Topside Sounding observations.



The World map shows GNSS high sampling rate and CDSS sites only.

- ionosondes with real-time data delivery ■
- ionosondes without real-time data delivery ■
- IAP CDSS transmitters and receivers (on both maps) ★
- INGV + DLR GNSS scintillation receivers (on both maps) ★
- EISCAT transmitters and receivers light blue circles: SGO riometer chain ●
- SGO pulsation magnetometer chain ▼
- LOFAR sites and sites associated with LOFAR ●

GNSS sites of standard networks (such as EUREF and IGS) are too numerous to be shown. The ionosondes (mostly Digisondes) with near real-time data provision are owned or operated by consortium partners or outside the consortium but offer free data access.

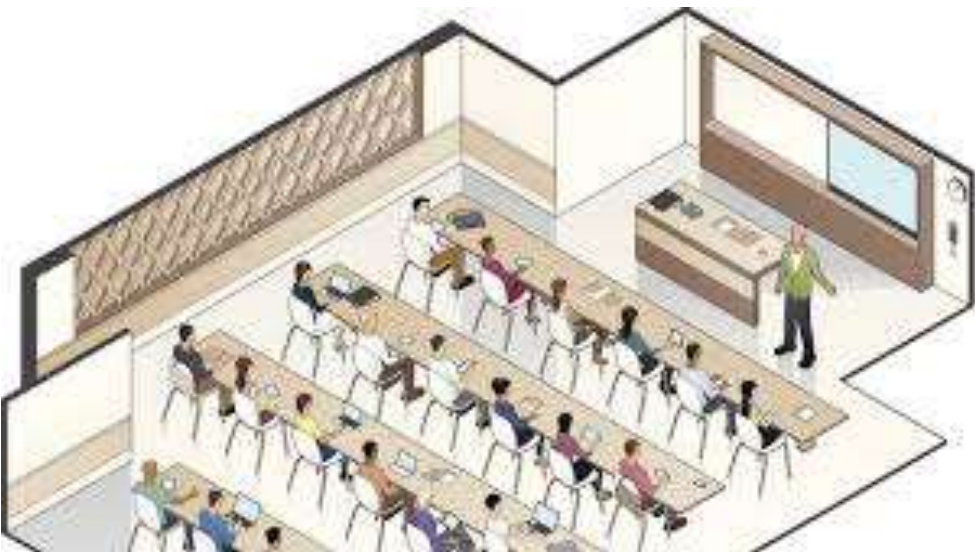


# Specific Objective 4



PITHIA-NRF provides **organized and systematic training** on the use of observing facilities and of the integration tools.

- Training towards project partners in the use of integration tools
- Training towards external users, in particular students, scientists from countries with no tradition in space research, engineers from the R&D departments of private companies and large organizations.



- Training is provided through workshops, schools and webinars.
- To get access to PITHIA-NRF nodes, successful participation to on-site sessions is required.





# Specific Objective 5

PITHIA-NRF builds the **innovation** platform to promote **cooperation between stakeholders** and sets the standards for future collaboration (i.e. the IPR policies for the exploitation of the services). It also provides the **tools** for continuous interaction with users, **promotion** of the PITHIA-NRF activities and services to the public and to the stakeholders, and promotes **joint public-private collaboration** for high-risk innovation and close-to-market activities.

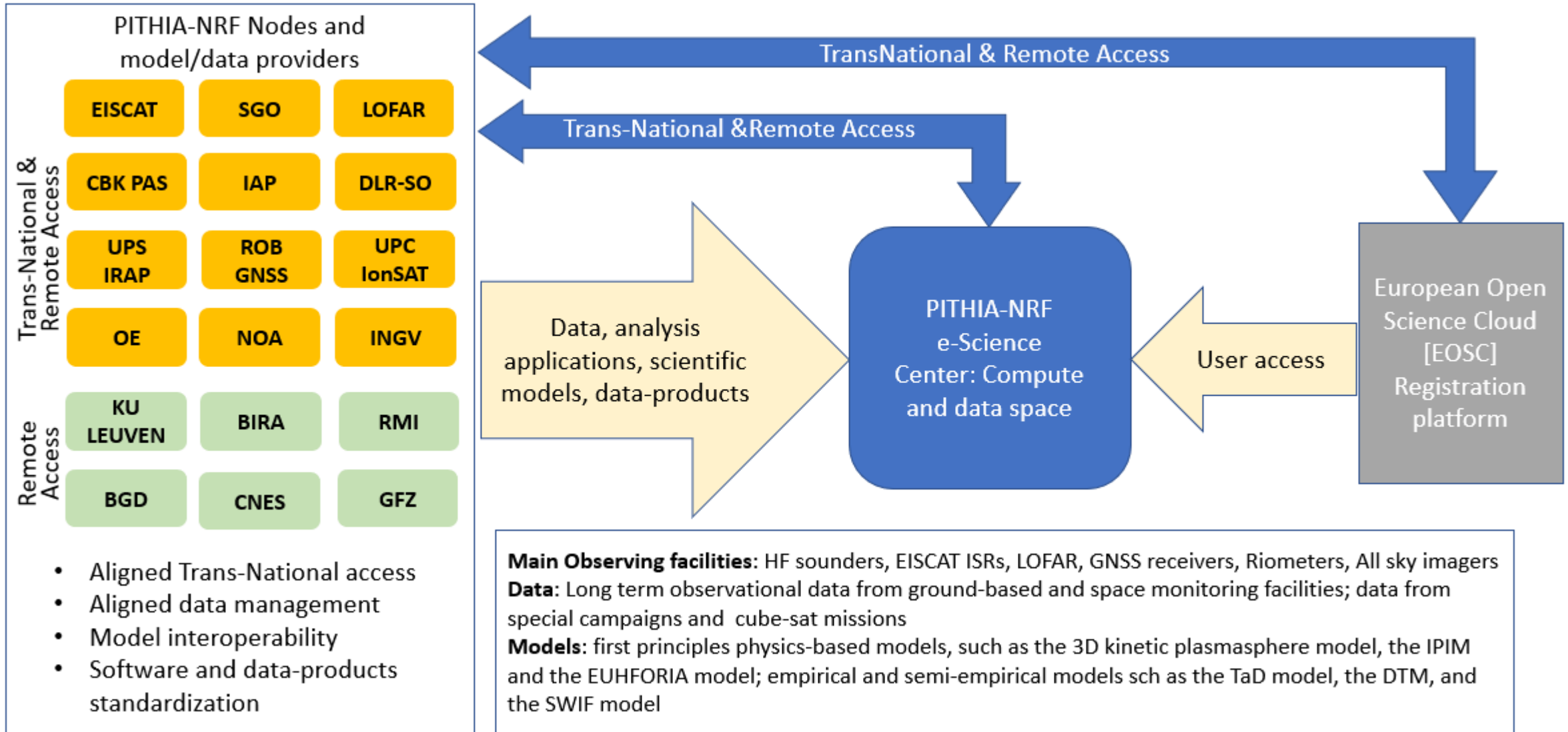


This activity supports the **overarching aim of the PITHIA-NRF project for the establishment of a European distributed research infrastructure that will provide a range of services to the upper atmosphere community for R&D projects.**





# Integrating facilities, data and models





# Expected Impact

Improved **access**

Educate the **new generation of researchers**

Wider **sharing** of information, knowledge and technologies across fields and between academia and non-academic stakeholders

**Integration** of major scientific equipment and standardized management

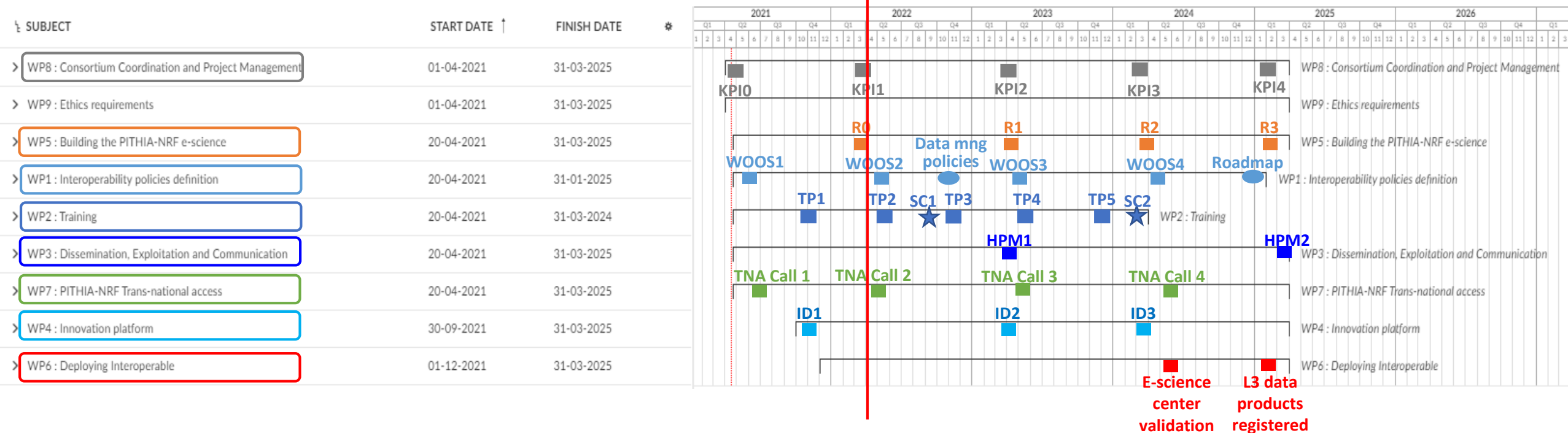
**New services** made available to the wider community

Facilities' operators develop synergies that lead to **economies of scale**



# Gantt chart

We are here



Project implementation period: April 2021 – March 2025



# 1<sup>st</sup> year main achievements

- Preparation of the **PITHIA-NRF nodes to accept external Trans-National users** for the implementation of projects targeted to research advances and innovation
- Development of **tools to communicate with the network** of stakeholders (web site, emailing lists, e-newsletter, leaflet)
- Establishment of a **network of more than 200 stakeholders** who expressed the interest to participate in the project activities
- Definition of standards for the **data interoperability** (data model and domain ontology) and setup of the **training** framework for partners and users
- Definition of procedures for the **optimized operation** of the PITHIA observing facilities
- Approval of the **first Trans-National research projects for implementation** in the PITHIA-NRF nodes
- Development of the **PITHIA e-science center** proof of concept with recommended procedures for the data and models registration
- Publication of more than **10 papers in peer-review journals** acknowledging PITHIA-NRF contribution



# Self-assessment of the progress in respect to the project vision

## Project Vision

Become an internationally-renowned infrastructure for Research and Development leading to excellent research advances in the upper atmosphere and near-Earth space domains;

Provide simple and open access to data and to advanced multidisciplinary services;

Develop novel business practices, project management services and new technologies that together accelerate end-to-end software standardization and instrument development and calibration.

## Relevant Progress

Publication of excellent scientific results in peer review journals;  
Provision of Access to the PITHIA nodes for the implementation of projects aiming at research advances and innovation.

Development of the e-science center proof of concept for registration of datasets and models;

This is planned in WP1 “Interoperability” and WP4 “Innovation”.



# Thank you for your attention!

**WEB:** <https://www.pithia-nrf.eu>



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