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

PITHIA-NRF Overview

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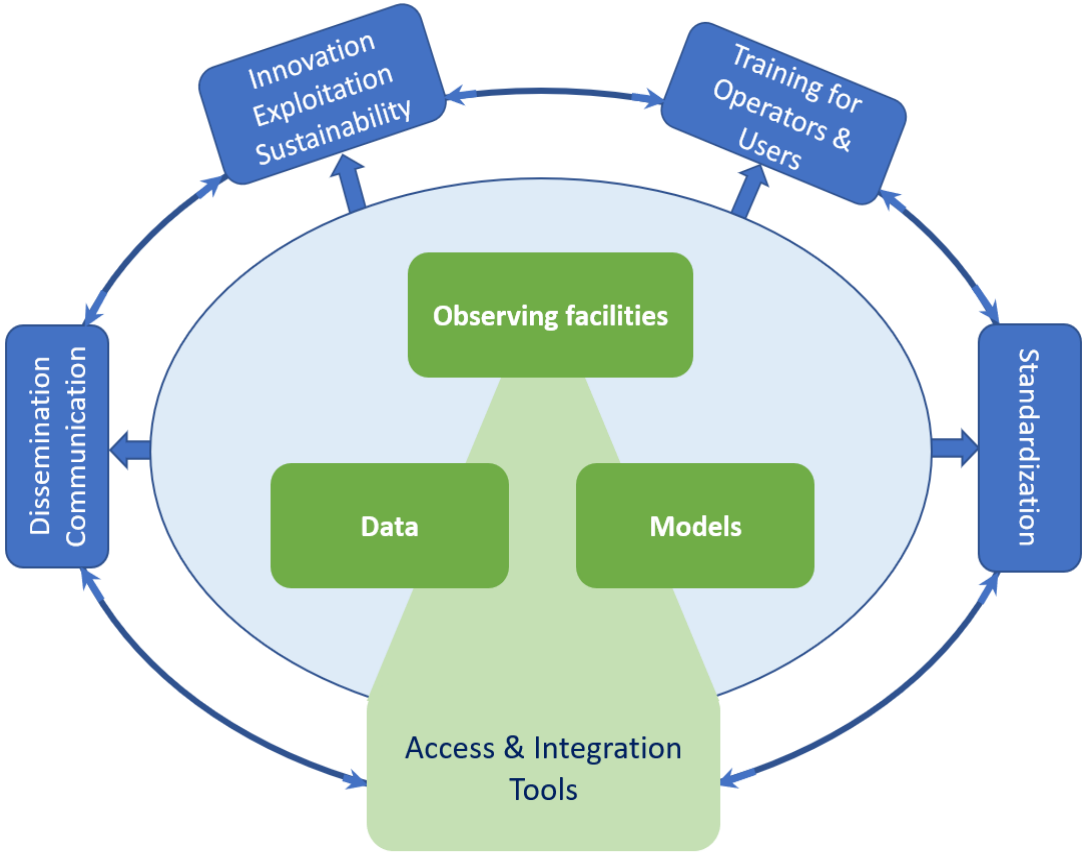
National Observatory of Athens, Greece

Second High Profile Meeting
14 March 2025, Heraklion, Crete, Greece

Overview & Ambition

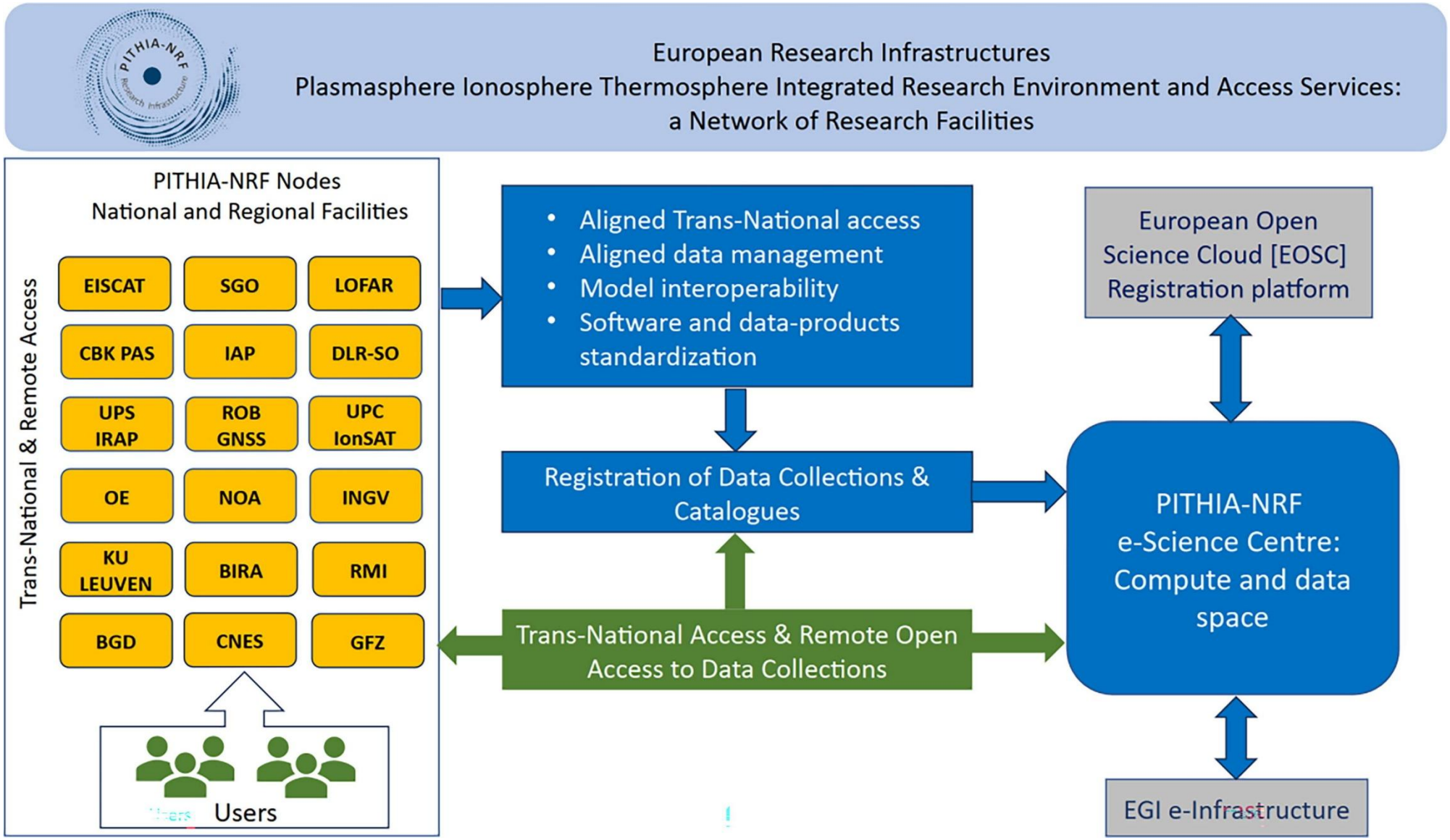


PITHIA-NRF aims at building a European distributed network that **integrates** observing facilities, data processing tools and prediction models dedicated to ionosphere, thermosphere and plasmasphere research.

PITHIA-NRF through **standardization**, open access to relevant **e-services** and **trans-national access** to experimental facilities, has the ambition to become the European hub that will act as facilitator:

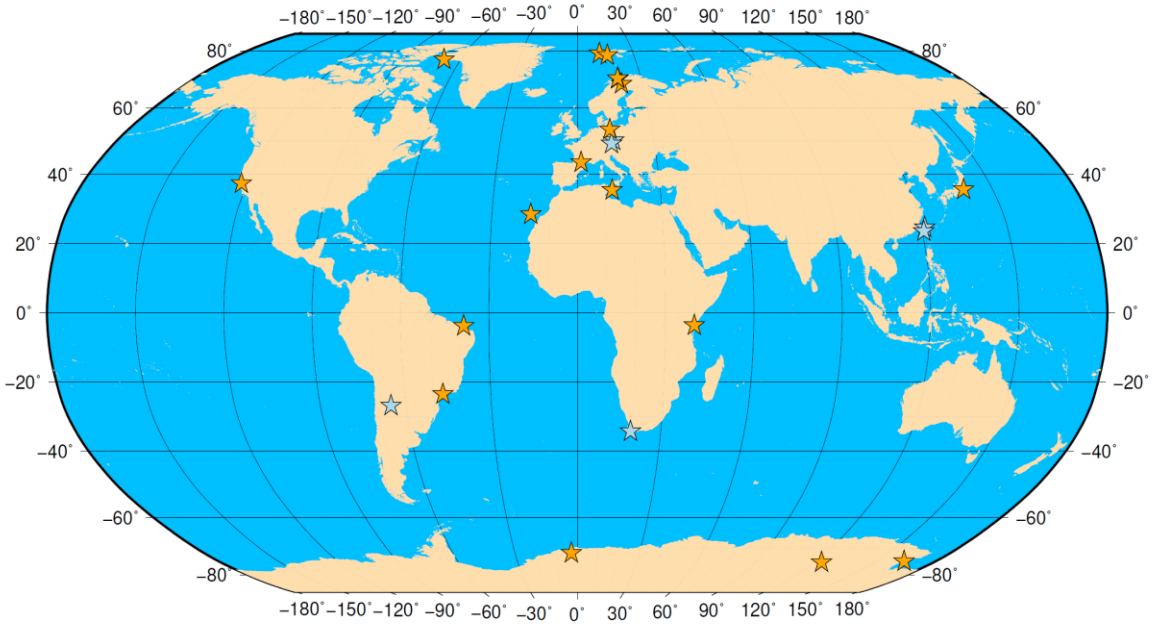
- for coordinated observations
- for data curation
- for software and data-products standardization,
- for facilitating model development and validation, with workflows that allow easy models' testing with alternative data collections.

Integrating facilities, data and models

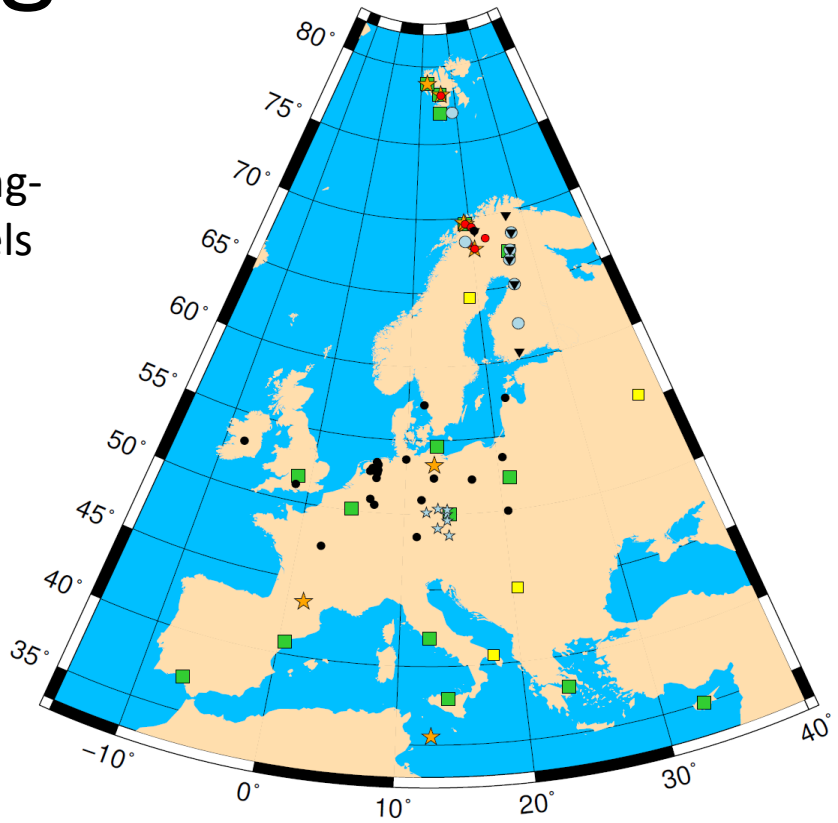


Observing facilities

PITHIA-NRF participating organizations offer access to observing facilities, long-term observational data from ground-based and space experiments, and to models



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

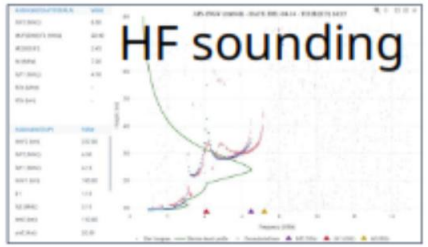


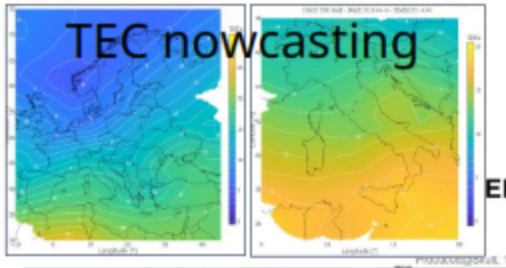
ionosondes with real-time data delivery
ionosondes without real-time data delivery
IAP CDSS transmitters and receivers (on both maps)
INGV + DLR GNSS scintillation receivers (on both maps)
EISCAT transmitters and receivers light blue circles: SGO riometer chain
SGO pulsation magnetometer chain
LOFAR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

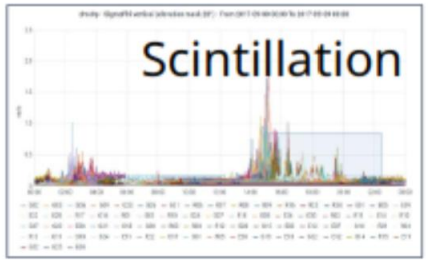
What data collections are provided in PITHIA-NRF and how to access?

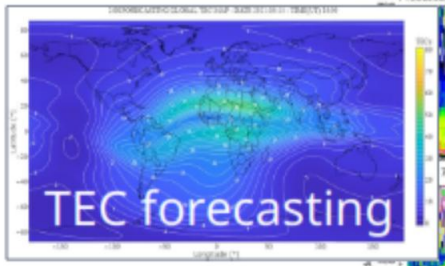
Some examples of the available data collections:

- Ionosonde parameters
  - Derived profiles, skymaps, drifts
  - Archive/Nowcasting/Forecasting
  - Models
- Doppler Sounding
  - Gravity Waves, global propagation
- Incoherent Scatter
  - Ionospheric density, temperature profiles
  - Ionospheric convection
- GNSS/LOFAR
  - TEC, Ionospheric scintillation
    - Local/global maps
- Riometer/Magnetometer networks
  - Absorption, Magnetic fields
- Interhemispheric Modelling

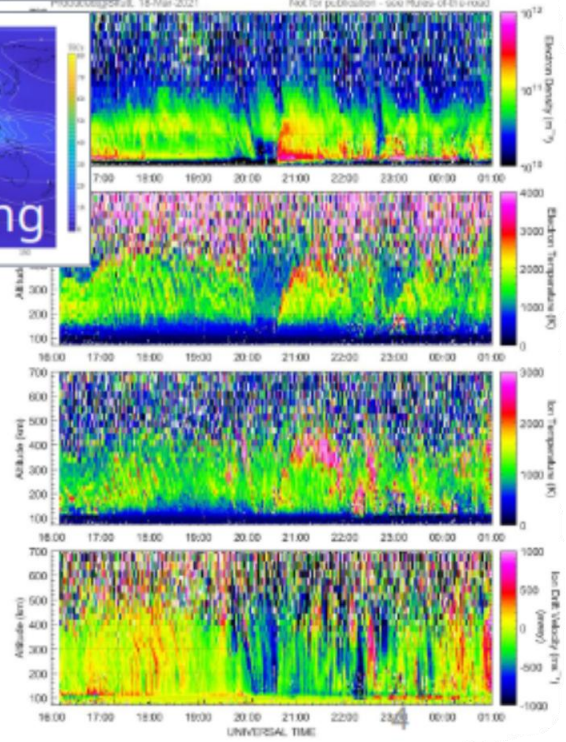




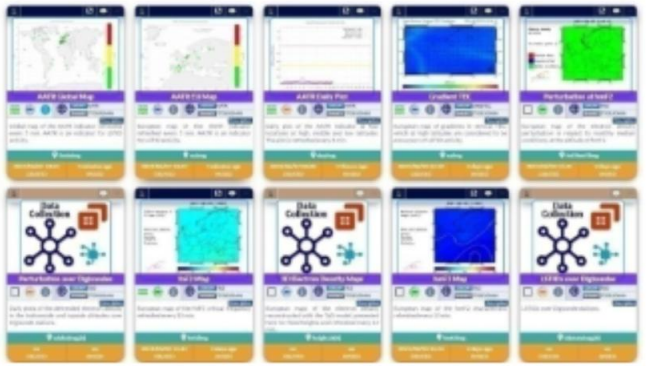




High latitude

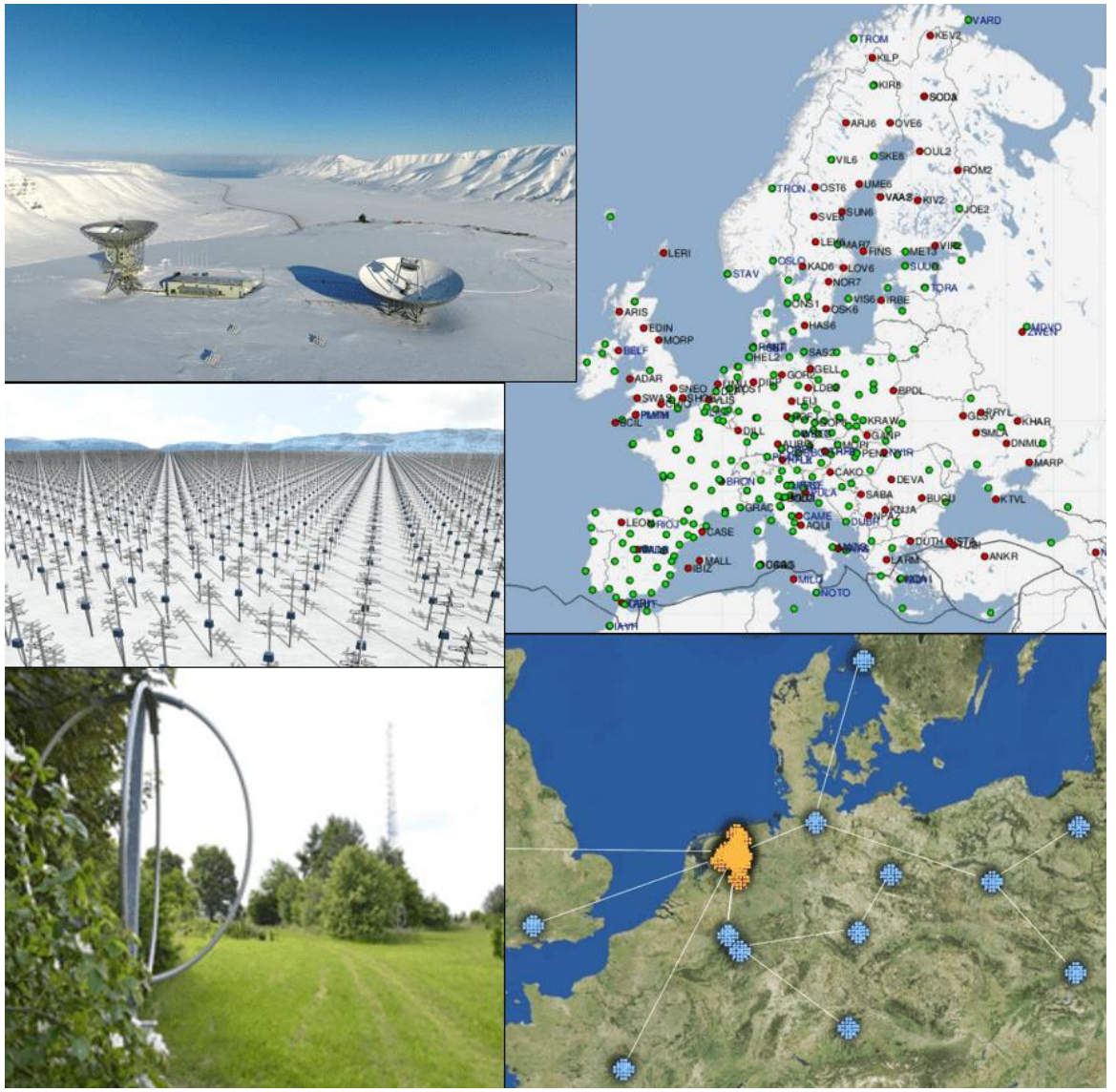


Detection and prediction of TIDs

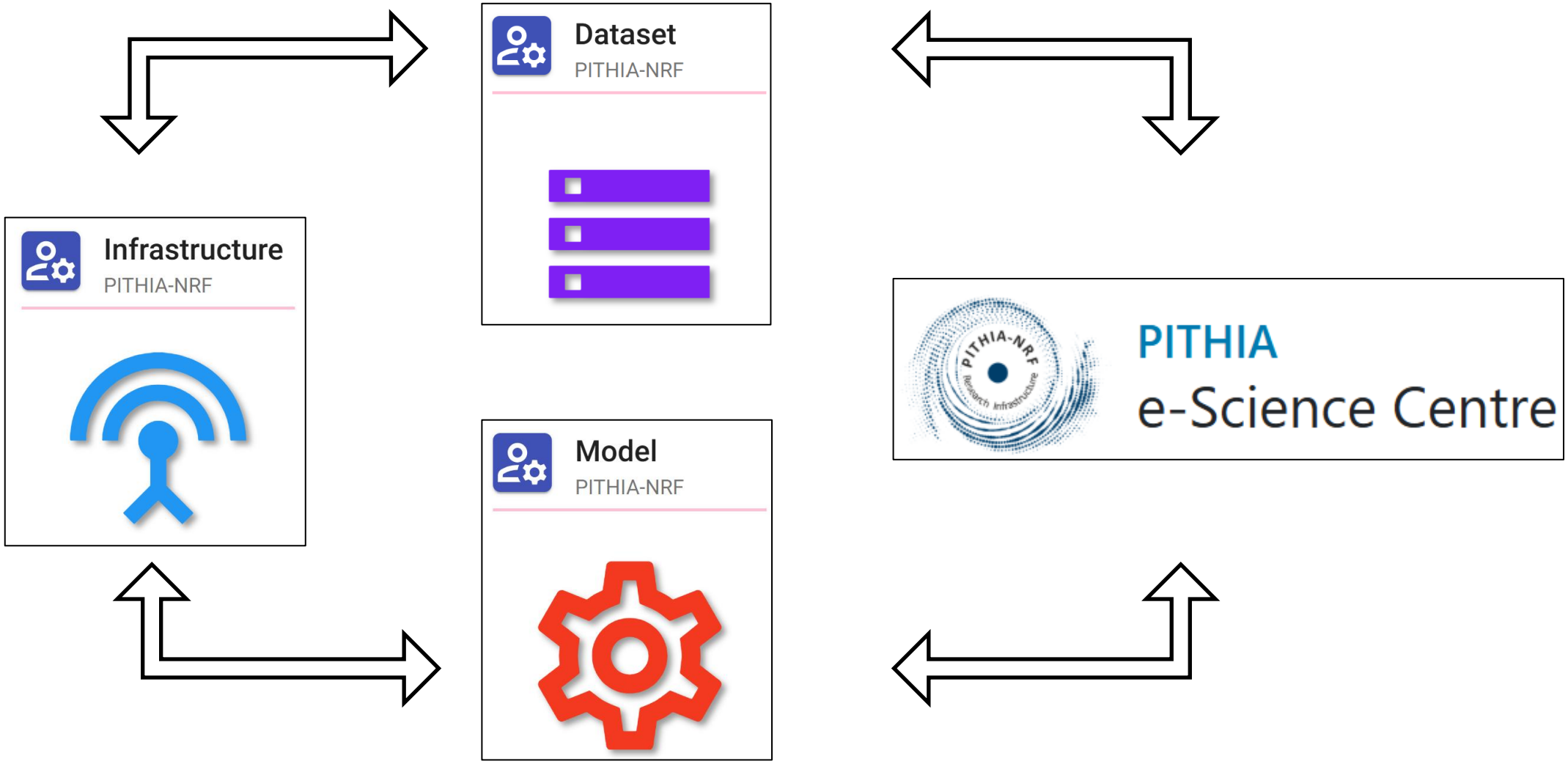


Physical/Virtual Access to facilities TransNational Access Programme

PITHIA-NRF nodes

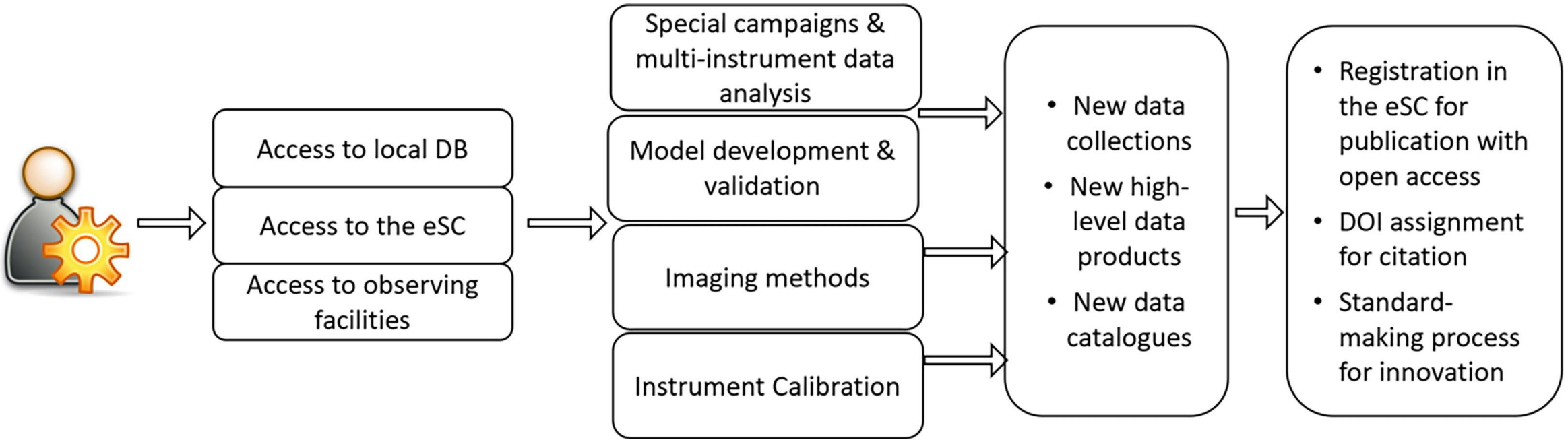


TransNational Access



TransNational Access

The choices available to the users granted with TNA access



Remote access
PITHIA-NRF e-Science center

PITHIA e-Science Centre

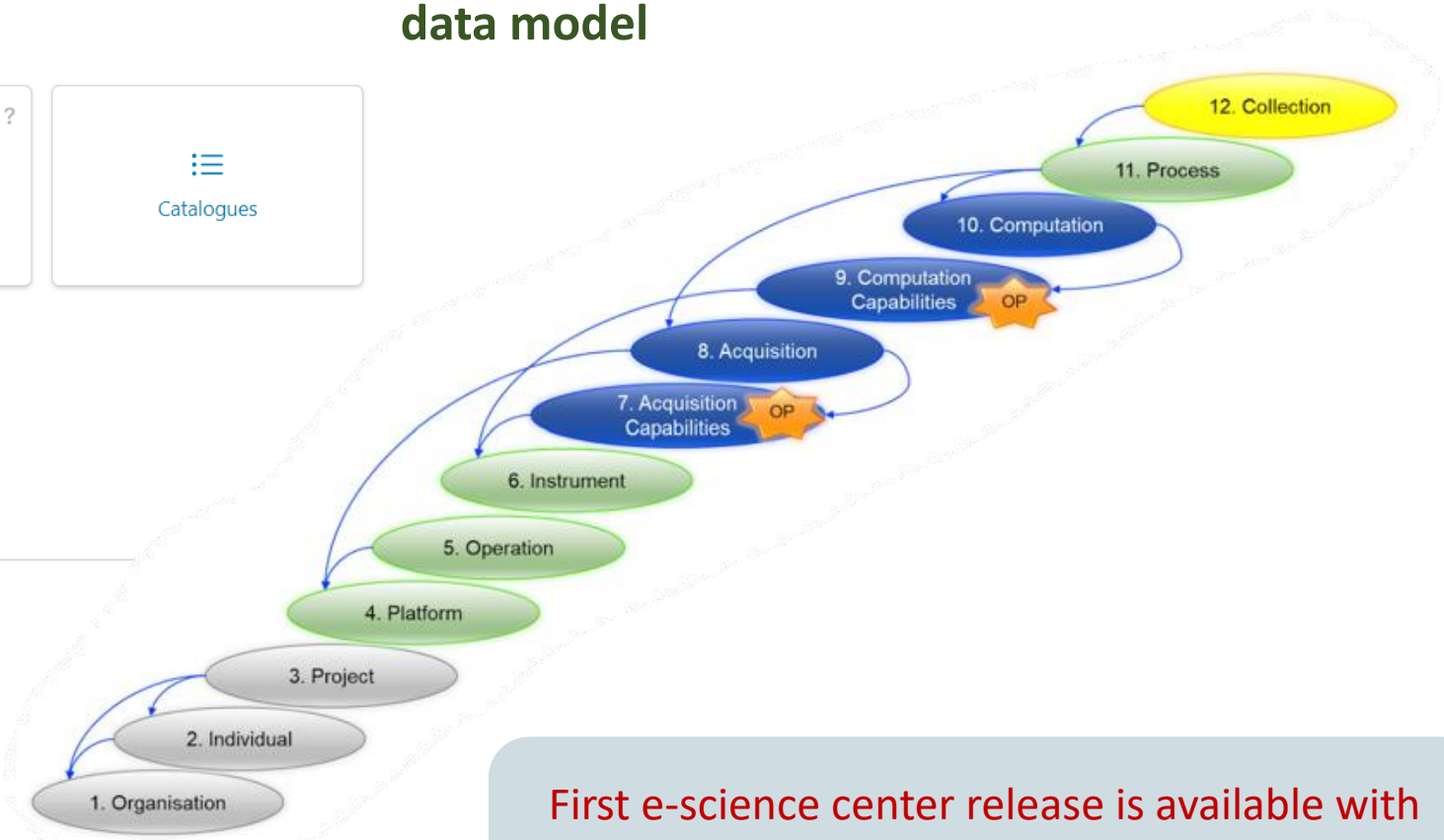
Scientific Metadata

- Search Data Collections by Content
- Data Collection Simple Search
- Data Collections
- Catalogues
- Workflows
- All Scientific Metadata

Space Physics Ontology

- Space Physics Ontology
- Space Physics Ontology Guide

12 STEPS of Registration based on the ESPAS ISO 19156 data model



First e-science center release is available with open use regarding the browsing and access. Data registration is available to authorized users

PITHIA e-Science Centre

Scientific Metadata

Search Data Collections by Content

Data Collection Simple Search

Data Collections

Catalogues

Workflows

All Scientific Metadata

Acquisitions from instruments

Computations from models

Data collections refer to data hosted at the data provider preferred location.
Data corresponding to metadata registered in the eSC can be updated (ex. In real-time)

Data that refer to a specific event or are the result of a specific software process

PITHIA e-Science Centre

Scientific Metadata

Search Data Collections by Content

Data Collection Simple Search

Data Collections

Catalogues

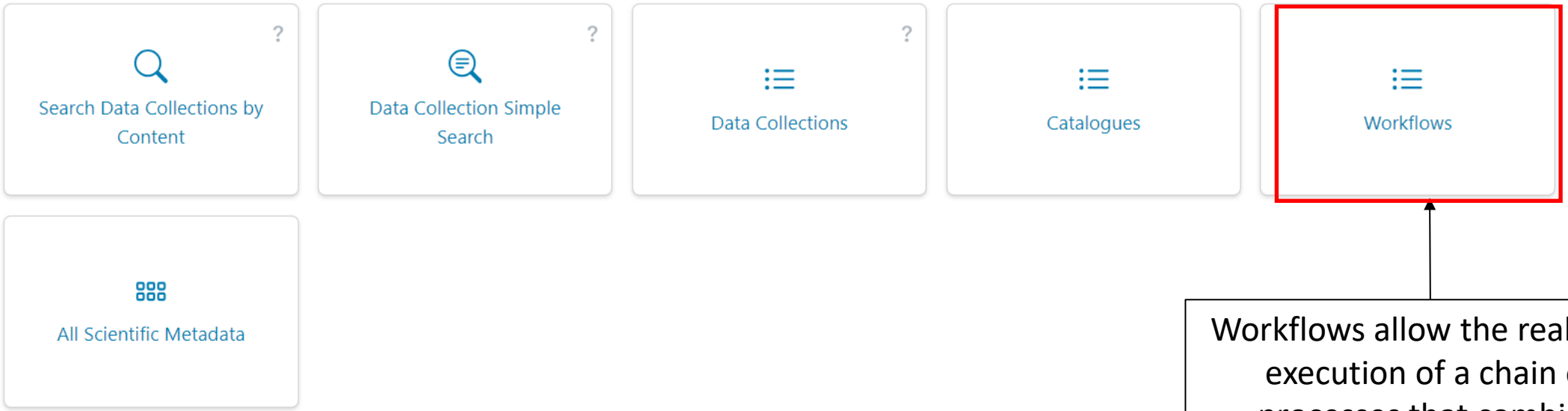
Workflows

All Scientific Metadata

Catalogues refer to a locked dataset; a DOI can be attributed; this dataset can be hosted in EOSC

PITHIA e-Science Centre

Scientific Metadata



Workflows allow the real-time execution of a chain of processes that combine different data collections and software codes

PITHIA-NRF data quality and data management

Data quality

Scientific Quality : Data Quality Flag, Scientific Relevance

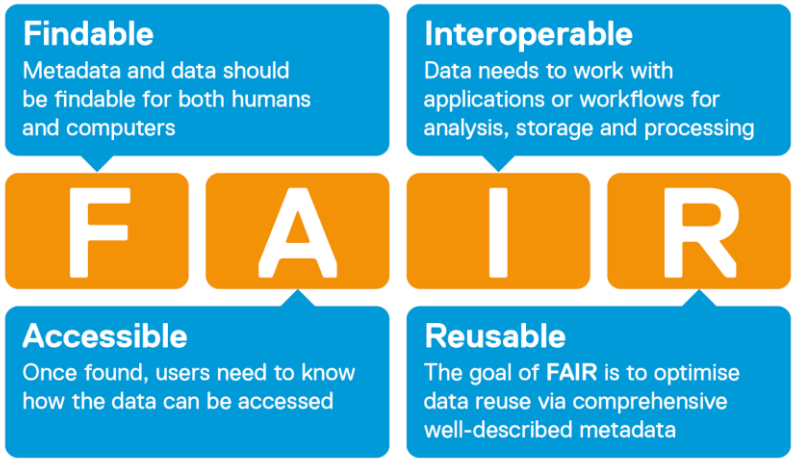
Quality of Metadata : Usage, Scope, Provenance, Persistence, Standardization, Interoperability, Quality, Earliness, Availability

Quality of Data Resources : Quality of data generation, Quality of data repository, Quality of data usage

Compliance to FAIR

Data management

The focus is on FAIRness.



The basic PITHIA-NRF data collections are assessed against a full list of FAIR data maturity model indicators.

Our ambition is to bring PITHIA-NRF facility nodes to achieve FAIRness, through the e-science center.

PITHIA-NRF Training

Training Schools

The First Training School was held in Rome, INGV headquarters, from 29 May to 1 June 2023.

- 30 students
- 14 lectures
- 6 working groups for students

The Second Training School is supported by T-FORS Machine Learning models will be held in KU Leuven, Belgium, from 5 to 9 February 2024.

- 15 students
- 22 lectures
- 5 working groups for students

Training for Partners Workshops

TPW#1, 8-9 November 2021
53 members from the PITHIA-NRF beneficiaries and third parties.

TPW#2, 28-29 March 2022
53 members from the PITHIA-NRF beneficiaries and third parties.

TPW#3, 26-28 September 2022
38 Consortium members and external users. The workshop was held at ASTRON, Dwingeloo, the Netherlands.

TPW#4, 16 March 2023
47 Consortium members and external users. The workshop was held at the Brussels Planetarium, Belgium.

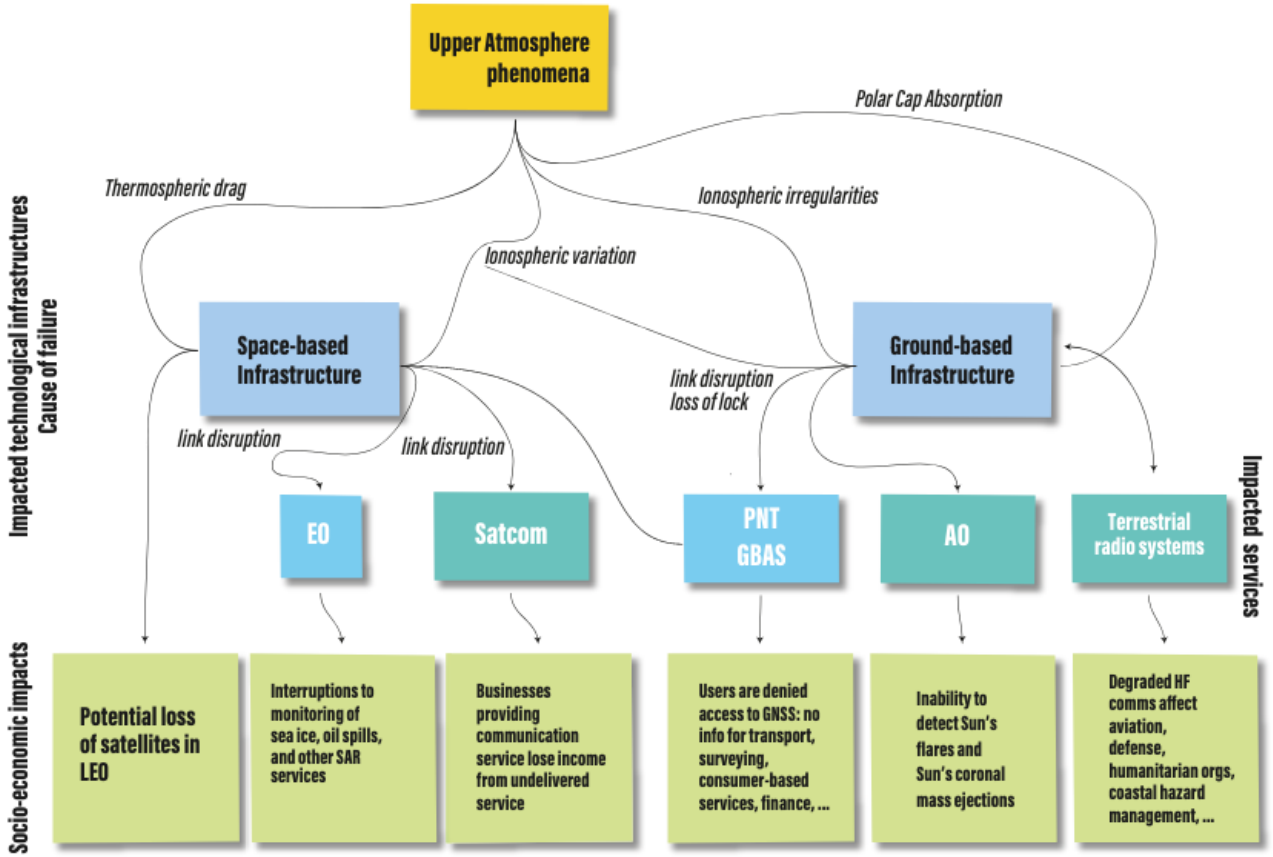
TPW#5, 12-13 September 2023
34 Consortium members and external users. The workshop took place at University of Westminster, London, UK.

Training material is available in the project web site in the form of webinars

PITHIA-NRF Innovation

How PITHIA-NRF services can mitigate the socio-economic impacts of the upper atmosphere effects:

- Standardization of data registration, discovery and access
- Standardization of scientific models' registration, and delivery of high-level data products and workflow solutions
- Standardization of policies for the optimized operation of experimental facilities
- Trans-national access to research facilities for academics and SMEs
- E-science tools to support R&D projects, while ensuring compliance with FAIR criteria.
- Software solutions for new high-level data products
- Support for development and deployment of new experimental facilities.



PITHIA-NRF main achievements

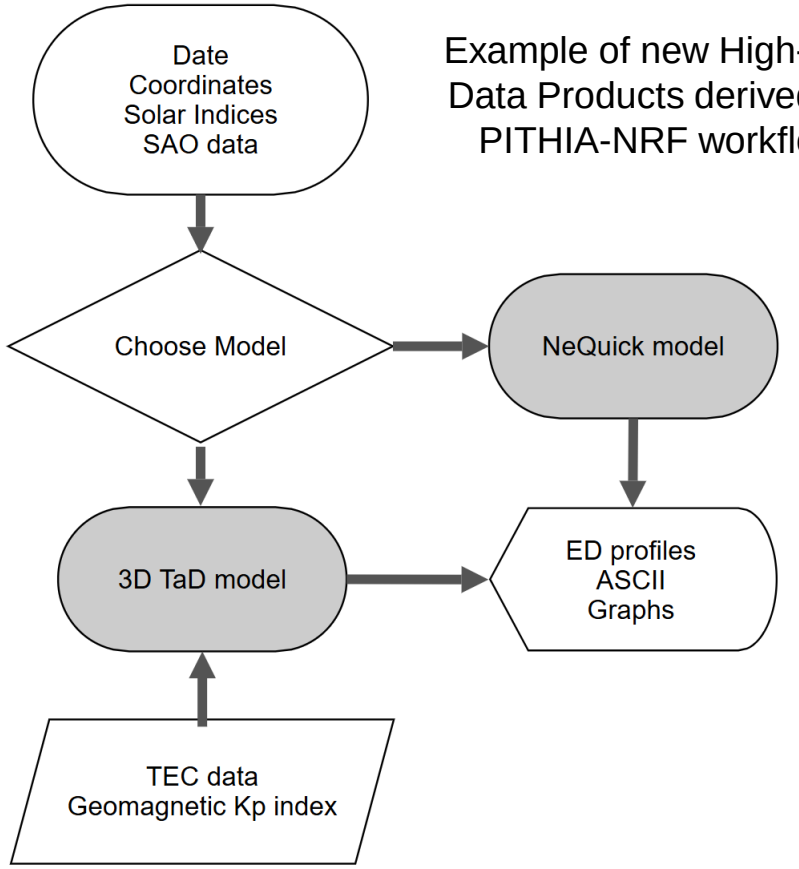
PITHIA-NRF is the research environment that facilitates research advances.

The PITHIA-NRF integrated environment supports:

- Discovery of and access to FAIR data using the **eSC functionalities**
- Organization of special observing campaigns in the **Nodes**
- Access to scientific models – **codes and results**
- **Experimentation** on the development of **new models**, based on registered codes and data collections
- Use of registered data collections (either model results or acquisitions) to create workflows for **new high-level data products**

PITHIA-NRF is a hub for the development and validation of new models and for the derivation of new High-Level Data Products. It can serve as a testbed for research and application projects, such as the ESA SSA SWE network and the PECASUS project.

Example of new High-Level Data Products derived with PITHIA-NRF workflows



The purpose of the High Profile Meeting

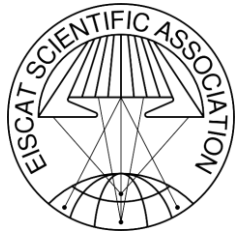
- To inform the wider community about the current capabilities of PITHIA-NRF
- To get updates about ongoing relevant projects and initiatives
- To get input from the stakeholders regarding additional tools recommended for integration
- To discuss the needs of relevant communities for the next releases of PITHIA-NRF, for example:
  - Develop one stop shop for space weather data
  - Provide additional tools for data cleaning and visualization
  - Provide tools for ML models training & retraining
  - Prioritize the development and validation of SW forecasting models
  - Real-time monitoring of experimental facilities
  - Create catalogues of SW events with relevant data collections

PITHIA-NRF consortium

22 Beneficiaries

2 Third Parties

5 External Advisors



Thank you for your attention!

WEB: https://www.pithia-nrf.eu

The PITHIA-NRF project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007599