ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

The INGV Arctic Ionospheric data management system and its synergy with the Italian NADC

AUTHORS:

Emanuele Pica [1] (emanuele.pica@ingv.it), Vincenzo Romano [1,2] (vincenzo.romano@ingv.it), Carlo Marcocci [1] (carlo.marcocci@ingv.it), Claudio Cesaroni [1] (claudio.cesaroni@ingv.it), Ingrid Hunstad [1] (ingrid.hunstad@ingv.it).

[1] Istituto Nazionale di Geofisica e Vulcanologia, Roma, IT

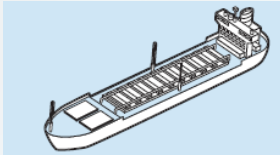[2] SpacEarth Technology Srl, Roma, IT

Effects of Space Weather

MARITIME ROUTES

Ionospheric disturbances can cause degradation in GNSS range measurements and, in critical circumstance, loss of lock by the receiver on the GNSS signals with critical consequences for the navigation systems in the maritime polar routes.
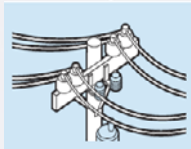
AVIATION

Space weather storms can interrupt HF communications, degrade the performance of the navigation systems and affect flight-critical electronic systems. Crews and passengers in the northern polar routes can experience high radiation exposure levels during these events.
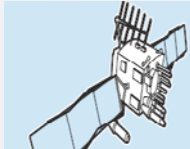
POWER GRIDS	HUMAN SPACE ACTIVITIES	SATELLITES OPERATIONS	NAVIGATION SYSTEMS	HF COMMUNICATIONS

INGV ionospheric observatories in the Arctic

The polar regions are a privileged place for the ionospheric monitoring and the scientific research in the field of the Space Weather. The INGV permanent observatories in the Svalbard (and soon in the Thule airbase, Greenland) provide near real-time information to constantly monitor the ionosphere in the northern hemisphere and contribute, with the other observatories of the INGV network, to the Space Weather services realized in the framework of international collaborations like the PECASUS* consortium.

| ARCTIC - SVALBARD ISLANDS (NORWAY)			
Location	Instrument Code	Year	Instrument
NY-ÅLESUND - DIRIGIBILE ITALIA ARCTIC STATION (Latitude: 78° 54' N ; Longitude: 11° 55' E)	NYA0P	2003-2018	GPS IONOSPHERIC SCINTILLATION AND TEC RECEIVER
	NYA1	2009-2019	GPS IONOSPHERIC SCINTILLATION AND TEC RECEIVER
	NYA0P	2019-present	MULTI-GNSS IONOSPHERIC SCINTILLATION AND TEC RECEIVER
	NYA1P	2019-present	MULTI-GNSS IONOSPHERIC SCINTILLATION AND TEC RECEIVER
LONGYEARBYEN (Latitude: 78°13' N ; Longitude: 15°38' E)	LYB0	2006-2018	GPS IONOSPHERIC SCINTILLATION AND TEC RECEIVER
	LYB0P	2019-present	MULTI-GNSS IONOSPHERIC SCINTILLATION AND TEC RECEIVER

* http://pecasus.eu/

The Space Weather Information Technology (SWIT) system

❏ **ACQUISITION AND TRANSMISSION LAYER**: real-time processing, near real-time data transmission (15 minutes or less).

❏ **DATABASE MANAGEMENT SYSTEM LAYER**: data storing and preservation; allows to easily retrieve, analyse and compare spatially and temporally distributed ionospheric data.

❏ **POST-PROCESSING LAYER**: higher-level data and ionospheric space weather targeted products.

❏ **ACCESS AND DISSEMINATION LAYER**: open and unrestricted access to data and services
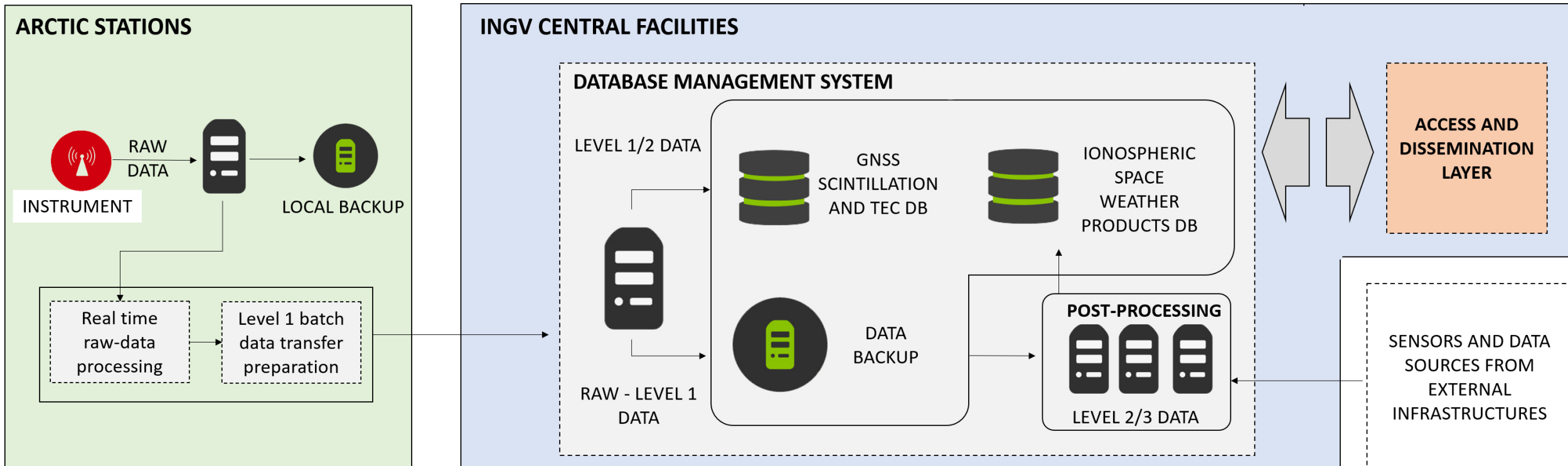
Access and dissemination layer
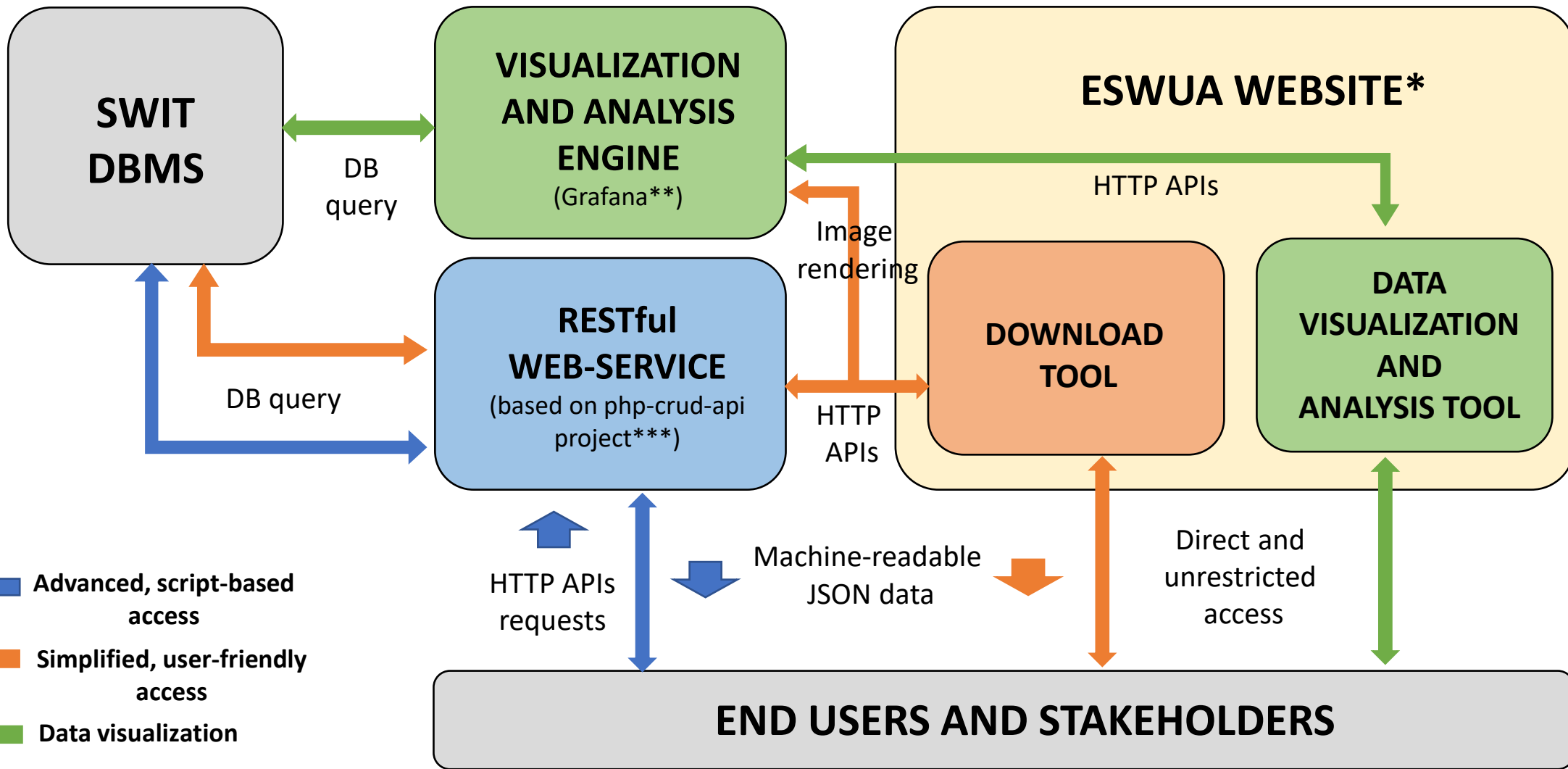
* The new eSWua website will be online soon ** https://github.com/mevdschee/php-crud-api   *** https://grafana.com/

# eSWua website: near real-time data visualization and access

This example shows the near real-time scintillation data (in the image are visible the S_4 and σ_φ scintillation index and the station parameters) for the Lyb0p instrument in Longyearbyen. The data can be filtered by area, station, time, GNSS constellation, etc. The GUI provides highly dynamic panels and make it possible to navigate the values of the represented data. Other tools allow to retrieve the datasets in the JSON interchange format and the rendering of static images.

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    "dt": "2020-04-29 05:45:00",
    "svid": 7,
    "rxstate": 630,
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    "averageI1": 37.4,
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    "phi03I1": 0.071,
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    "phi30I1": 0.075,
    "phi60I1slant": 0.075,
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    "sigmaccdI1": 0.331,
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    "tec0": 13.066,
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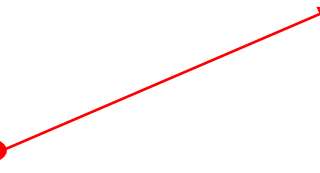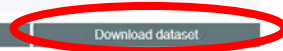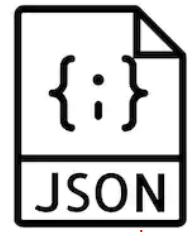
eSWua website: the download tool and examples of visual alerts for scintillations monitoring over Arctic region

Scinitillation and TEC data

SELECT DATA LEVEL:

Scinitillation and TEC parameters (LEVEL-I data)
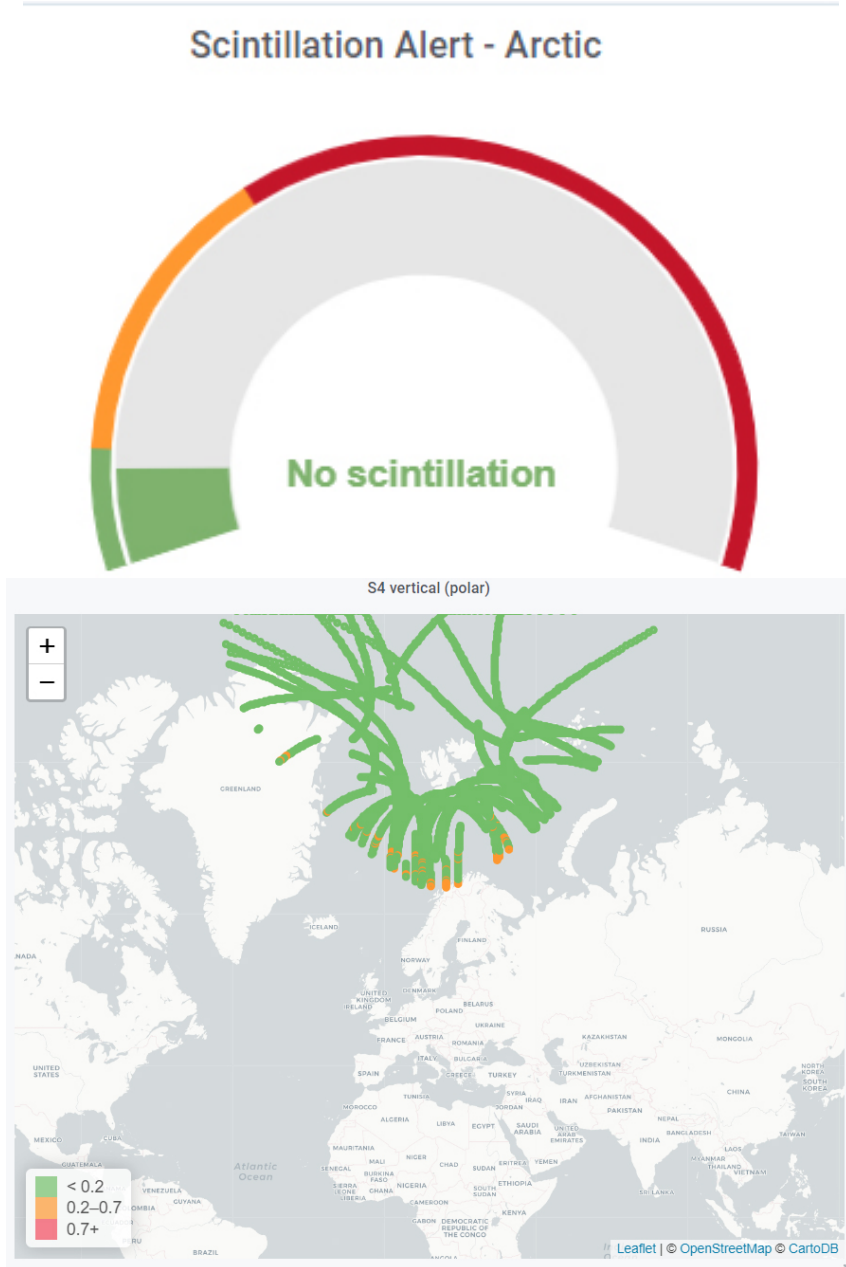
SELECT STATION:

nya1p (Septentrio) - ARCTIC

INSERT TIME RANGE (UTC):

2020/04/29 07:51 - 2020/04/29 08:51

CHOSE PARAMETERS:

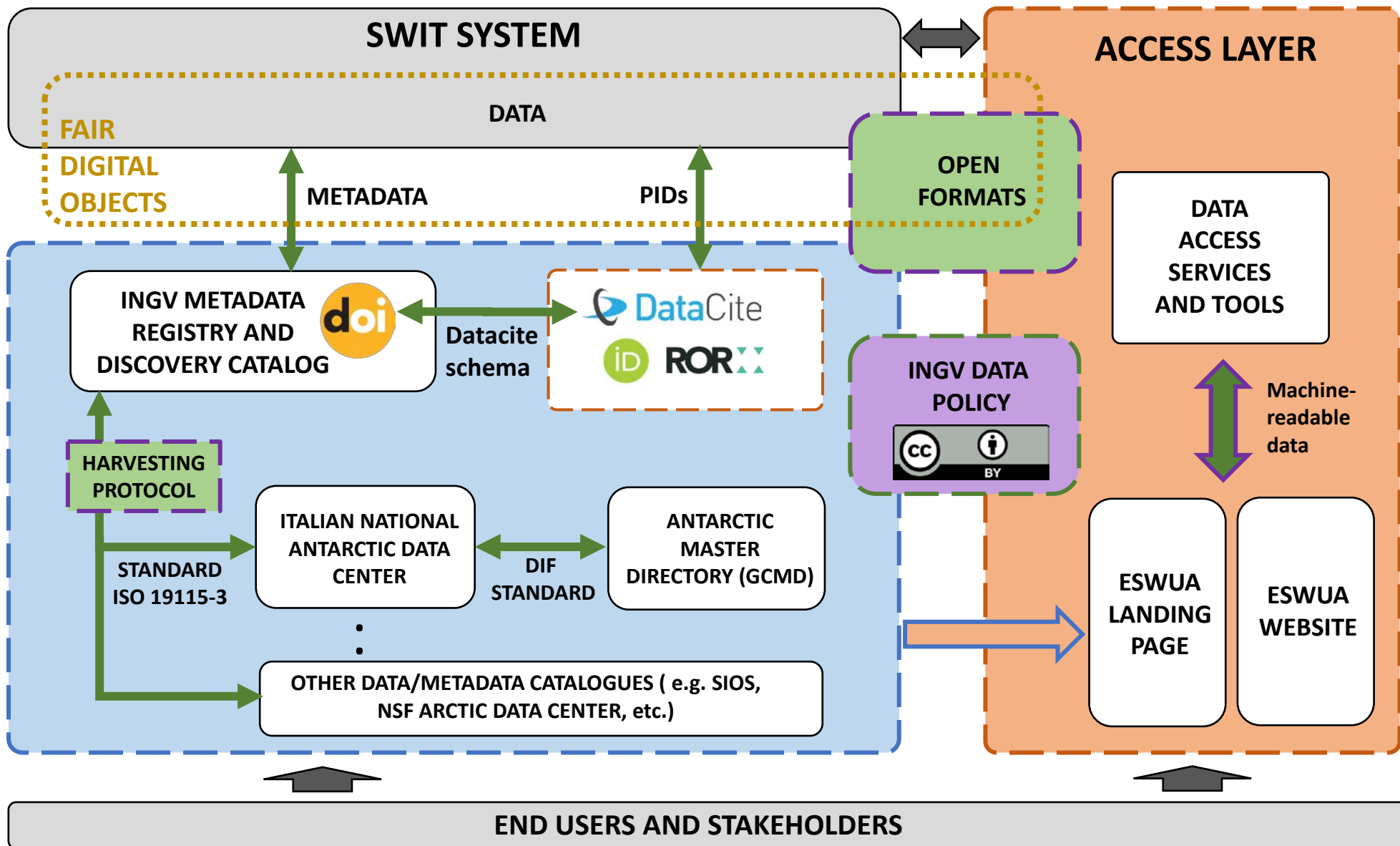×phi60_l1_vert ×stec ×vtec ×s4_l2_slant

CHOSE CONSTELLATIONS:

×GPS ×GALILEO ×BEIDOU

CONFIRM   RETRIEVE DATA

Scintillation Alert - Arctic

No scintillation

S4 vertical (polar)

< 0.2
0.2–0.7
0.7+

Leaflet | © OpenStreetMap © CartoDB

The path towards a FAIR ecosystem for the INGV Ionospheric data

SWIT SYSTEM

ACCESS LAYER

FAIR DIGITAL OBJECTS

DATA

METADATA

PIDs

OPEN FORMATS

A conceptual view of the SWIT-eSWua ecosystem and an abstraction of its FAIR components

INGV METADATA REGISTRY AND DISCOVERY CATALOG

doi

Datacite schema

DataCite

iD ROR

DATA ACCESS SERVICES AND TOOLS

INGV DATA POLICY

Machine-readable data

HARVESTING PROTOCOL

STANDARD ISO 19115-3

ITALIAN NATIONAL ANTARCTIC DATA CENTER

DIF STANDARD

ANTARCTIC MASTER DIRECTORY (GCMD)

ESWUA LANDING PAGE

ESWUA WEBSITE

OTHER DATA/METADATA CATALOGUES (e.g. SIOS, NSF ARCTIC DATA CENTER, etc.)

END USERS AND STAKEHOLDERS

Color legend

Findable

Accessible

Interoperable

Reusable

The Italian National Antarctic Data Center (NADC)

Besides the Arctic stations, the SWIT system also manages the data acquired by several INGV ionospheric instruments installed in the Antarctic region; this data will be also included in the Italian National Antarctic Data Center. The NADC is the ICT infrastructure designed to gather, handle, publish and provide access to the large amount of scientific data collected by several projects in the framework of the Italian Antarctic National Research Program (PNRA). Aim of the infrastructure is to provide a single integrated system that allows the final users to easily access and share data wherever they are stored. The Infrastructure is adopting the ISO 19115-3/INSPIRE standard for the metadata and will rely on the GeoNetwork opensource software as catalog application.
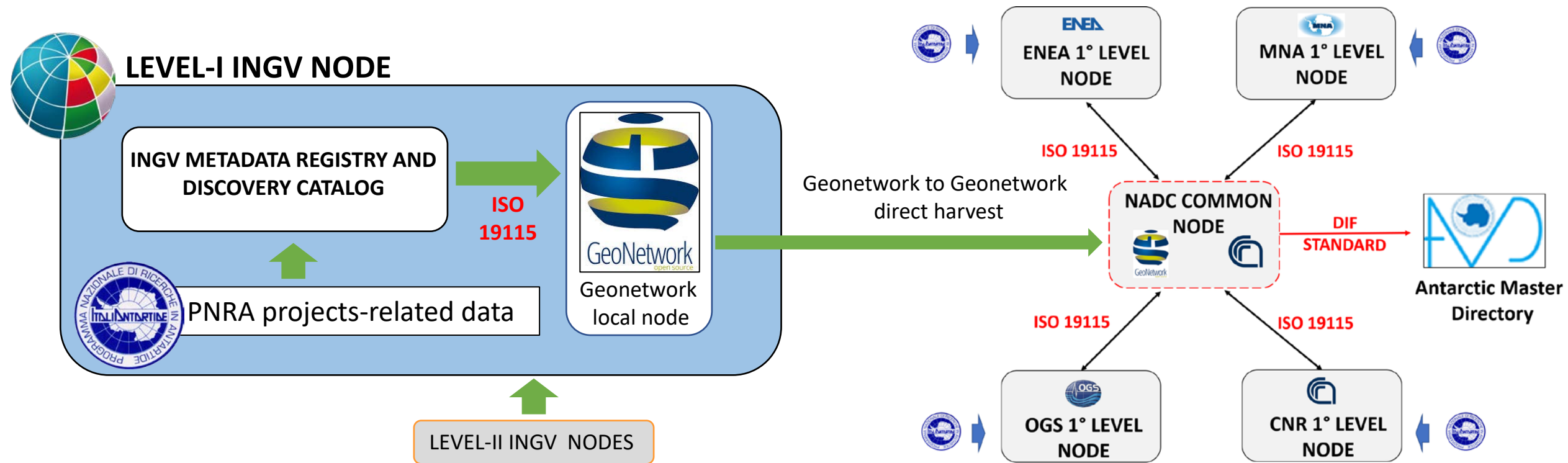
Final remarks

❑ Regular ionospheric observations in the Arctic region can provide timely information for the monitoring, forecasting and mitigation of the effects on modern technologies (such as telecommunication systems, power networks and in general systems relying on satellite navigation) during Space Weather events.

❑ The SWIT (Space Weather Information Technology) system coupled with the eSWua (electronic Space Weather upper atmosphere) web-platform enable the management of the near real-time ionospheric data collected by the INGV network and allow the open access to this information.

❑ A FAIR-oriented development approach is adopted, aimed at Open Science principles. FAIR Digital Objects can only exist in a FAIR ecosystem which includes services that provide persistent identifiers, metadata specifications, stewardship, actionable policies, etc.

❑ The experience gained with the Italian National Antarctic Data Center is essential to improve the interoperability of the SWIT-eSWua system and to foster new collaborations with the Arctic data centers.