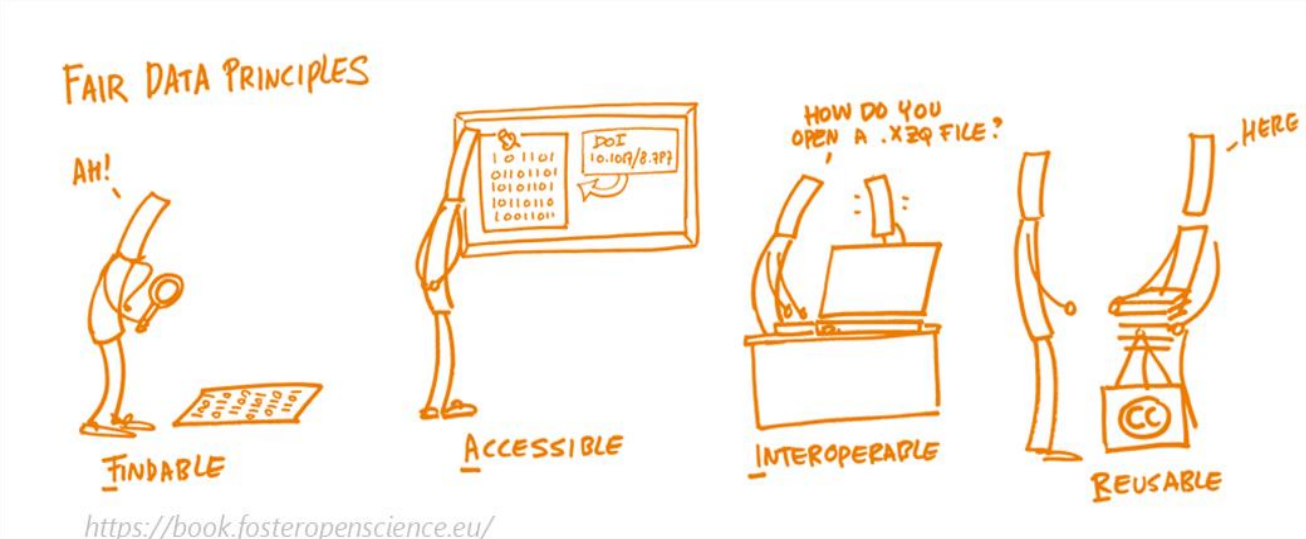
Application of FAIR data principles on the EPN Historical Data Center

A. Miglio, C. Bruyninx, A. Fabian, J. Legrand

Royal Observatory of Belgium



ROYAL OBSERVATORY OF BELGIUM

EUREF Symposium, June 5-7,2024, Barcelona, Spain

EUREF2024

Introduction

Royal Observatory of Belgium has been looking into ways to apply the FAIR data principles on GNSS data since a couple of years

In collaboration with the data stewards of the University of Ghent

to enable and enhance the reuse of data by both humans and machines.

Experiences shared during splinter meetings:

- EUREF 2021 symposium, May 27, 2021
- EUREF 2022 symposium, June 2, 2022

This presentation: show results of the implementation of FAIR data principles applied on the EPN Historical Data Center

EUREF 2021

Resolution No. 2.

The IAG Reference Frame Sub-commission for Europe (EUREF)

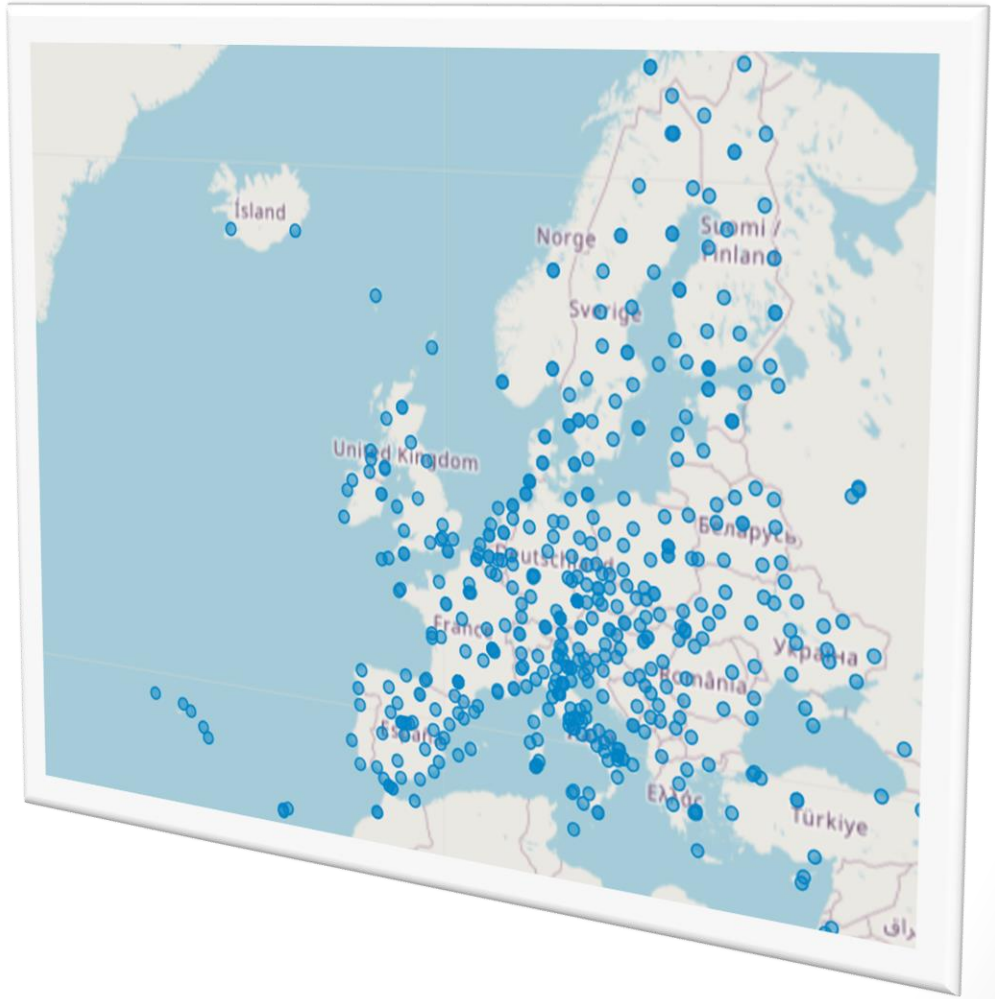
considering that major funding bodies, including the European Commission, promote and require the implementation of FAIR (Findable, Accessible, Interoperable, and Reusable) data principles

and recognising that FAIR data principles increase the value and the reuse of digital resources, by humans as well as machines

encourages the EUREF community to adopt these principles in all aspects of data management

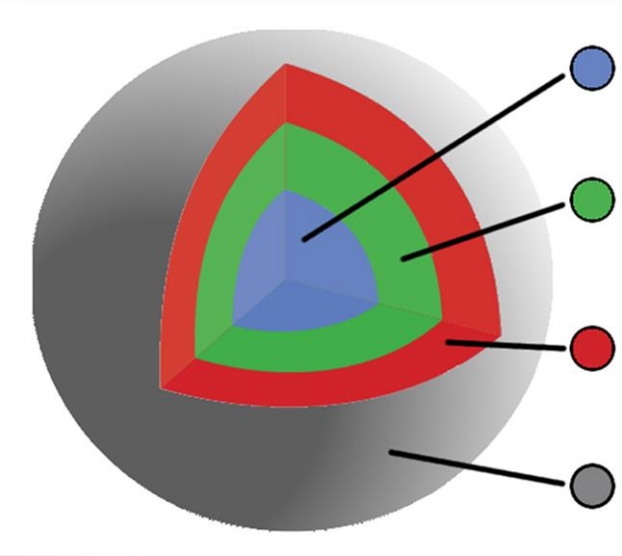
EPN Historical Data Center (HDC)

- Archive of daily RINEX data from EPN stations – to be as complete as possible
- Actively looking for data of EPN stations
  - from before station was included in EPN
  - not available from regional EPN data centers
- 500+ GNSS stations
- 2,5+ million RINEX files
- https://epncb.oma.be/pub/RINEX



Implementation of FAIR data principles

CREATION OF FAIR DIGITAL OBJECTS (FDO)



DATA

METADATA → Standardized metadata

ACCES SERVICES → For humans and machines

PERSISTENT IDENTIFIER → Long-term reference to the (meta)data

Implementation of FAIR data principles

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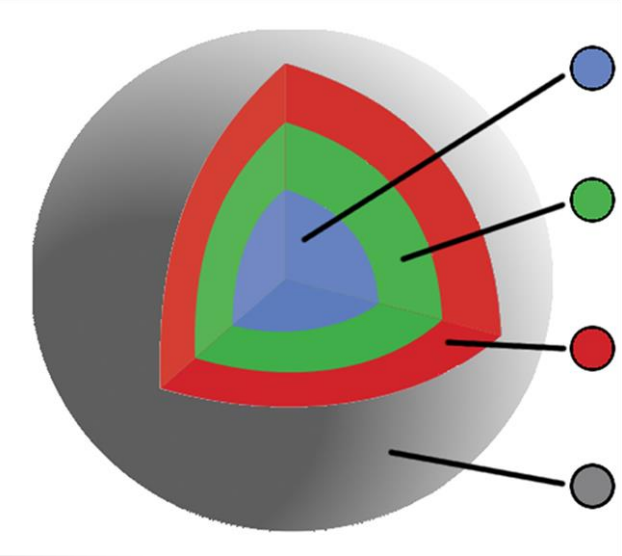

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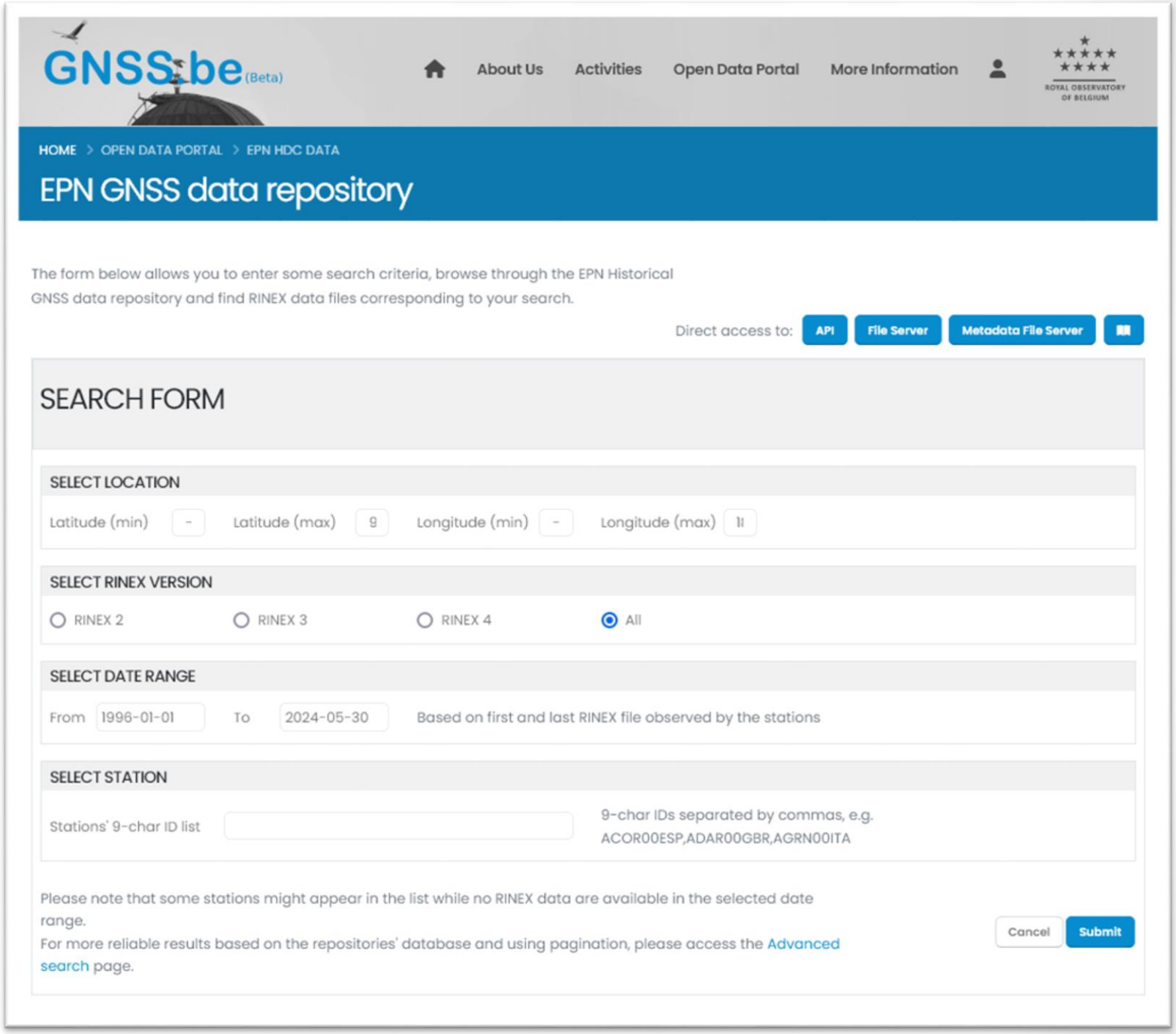
New data portal providing access to GNSS data in historical EPN data center

Beta version!

https://gnss.be/opendataportal/



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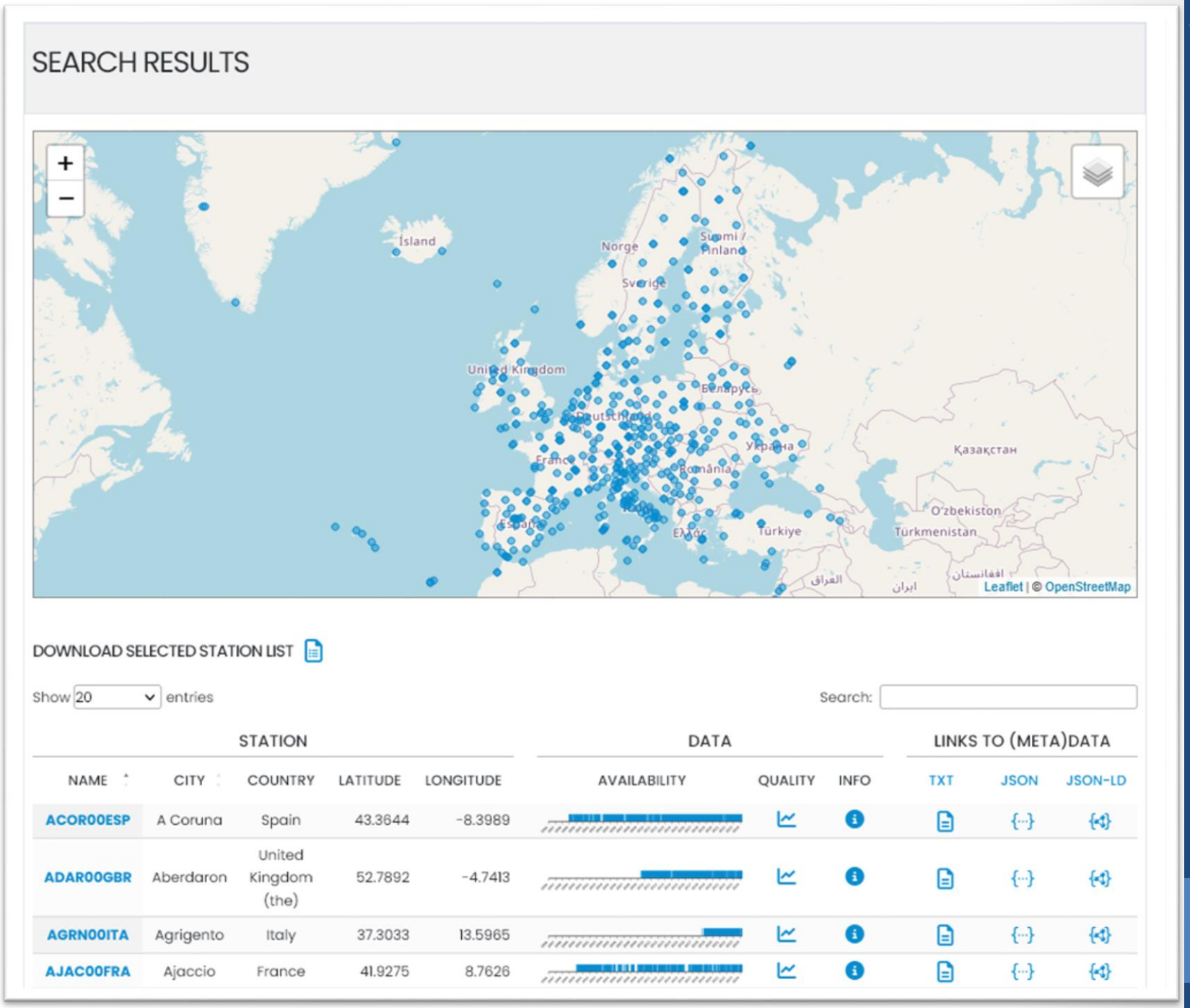

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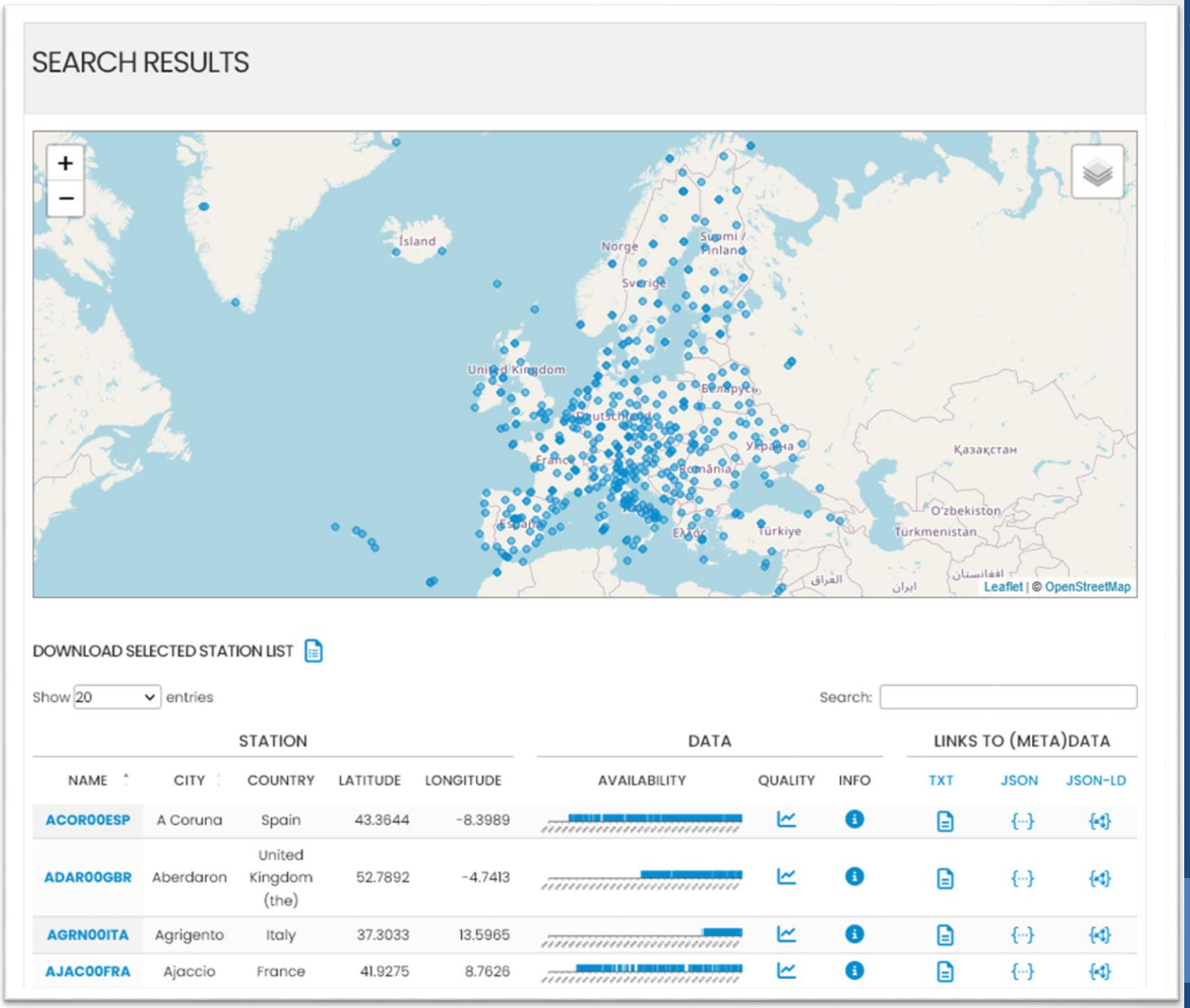

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Data and Metadata Web Services

To access the GNSS data and metadata directly via a RESTful API without need to go through the web portal

DATA REPOSITORY

To access repository metadata

- Publisher, location, list of GNSS stations with datasets, etc.

STATION DATASET (all daily RINEX data of a station)

To access metadata of station's dataset

- DOI, data license, station location, etc.
- Overview of the available RINEX data
- + Link to metadata of repository

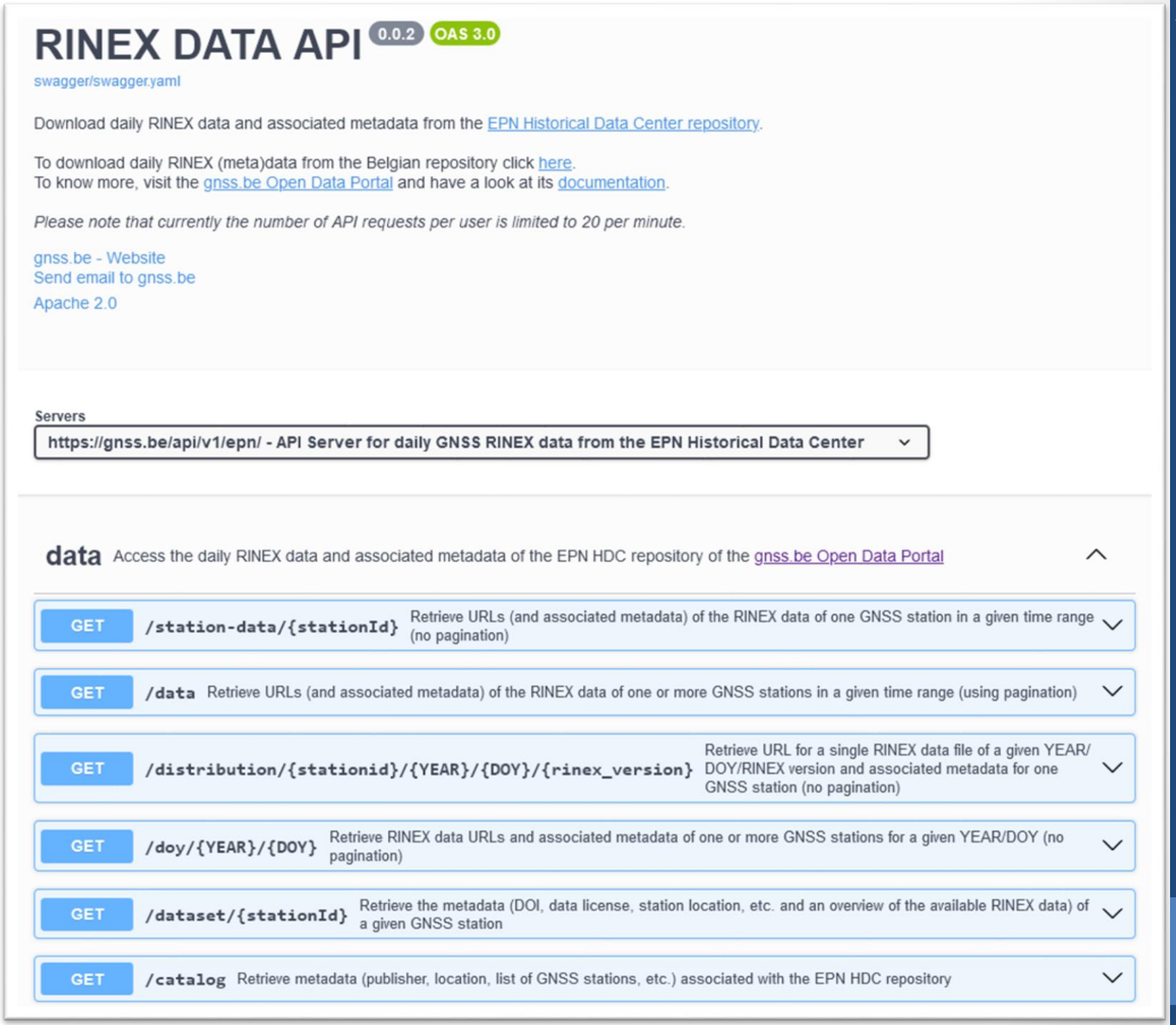
RINEX FILE

To access RINEX data and metadata

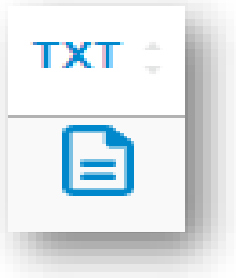
- URL of the RINEX file
- File size
- Last modified date
- + Link to metadata of Station Dataset

Data and Metadata Web Services - Documentation

https://gnss.be/api/v1/epn/doc



Example



RINEX files of ACOR00ESP observed between 1996-01-01 and 2022-12-31 that have been changed after 2023-07-01 ?

Command line

```
curl -X 'GET' 'https://gnss.be/api/v1/epn/station-data/ACOR00ESP
?rinexVersion=all&startDate=1996-01-01&endDate=2022-12-31&changeDate=2023-07-01' -
H'accept: text/plain'
```

Output

```
https://epncb.oma.be/pub/RINEX/2021/319/ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz
https://epncb.oma.be/pub/RINEX/2021/320/ACOR00ESP_R_20213200000_01D_30S_MO.crx.gz
https://epncb.oma.be/pub/RINEX/2021/321/ACOR00ESP_R_20213210000_01D_30S_MO.crx.gz
```

https://github.com/ROB-GNSS/gnss.be-data-API-examples

Example

RINEX files of ACOR00ESP observed between 1996-01-01 and 2022-12-31 that have been changed after 2023-07-01 ?

Command line

```
curl -X 'GET' 'https://gnss.be/api/v1/epn/station-data/ACOR00ESP
?rinexVersion=all&startDate=1996-01-01&endDate=2022-12-31&changeDate=2023-07-01' -
H'accept: application/ld+json'
```

Output ?

Example

JSON-LD

RINEX files of ACOR00ESP
2023-07-01 ?

Command line

```
curl -X 'GET' 'https:/
?rinexVersion=all&star
H'accept: application/
```

Output ?


```
"@graph": [
    {
      "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3",
      "@type": "Distribution",
      "accessURL": {
        "@type": "xsd:anyURI",
        "@value": "https://epncb.oma.be/pub/RINEX/2021/319/ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz"
      },
      "adms:status": {
        "@id": "https://publications.europa.eu/resource/authority/distribution-status/COMPLETED"
      },
      "compressFormat": "application/x-gzip",
      "dataset": {
        "@id": "https://epncb.oma.be/PID/ACOR00ESP"
      },
      "dct:checksum": {
        "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#c
      },
      "dct:conformsTo": {
        "@id": "https://gnss.be/PID/standard#hatanaka"
      },
      "dct:description": "Daily RINEX data of the GNSS station ACOR00ESP for DOY 31      2021",
      "dct:issued": {
        "@type": "xsd:dateTime",
        "@value": "2021-11-15T00:00:00"
      },
      "dct:license": {
        "@id": "https://epncb.oma.be/PID/ACOR00ESP#license"
      },
      "dct:modified": {
        "@type": "xsd:dateTime",
        "@value": "2023-11-17T18:34:21"
      },
      "dct:title": "ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz",
      "downloadURL": {
        "@type": "xsd:anyURI",
        "@value": "https://epncb.oma.be/pub/RINEX/2021/319/ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz"
      },
      "gnss:obsData": {
        "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#obsdata"
      },
```


Standardized metadata schema

Implementation of FAIR data principles

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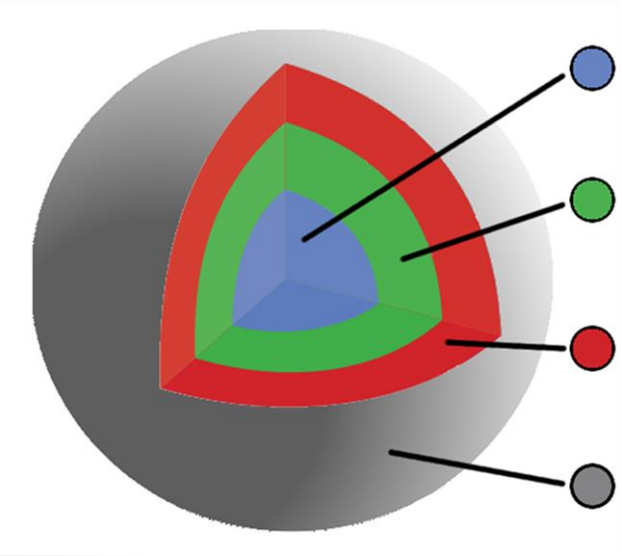

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New DCAT Application Profile (DCAT-AP): GNSS-DCAT-AP

DCAT:

W3C vocabulary designed to facilitate interoperability between data catalogs

DCAT Application **P**rofile =

set of metadata elements, policies and guidelines defined to create a standard metadata schema for a particular application

e.g., GeoDCAT-AP (geospatial datasets, dataset series and services), StatDCAT-AP (statistical data sets)

https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/solution/dcat-application-profile-data-portals-europe/release/211

GNSS-DCAT-AP!

https://doi.org/10.5281/zenodo.7777568

(current version is 0.3)

JSON-LD


```
"@graph": [
  {
    "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#temporal",
    "@type": "PeriodOfTime",
    "endDate": {
      "@type": "xsd:dateTime",
      "@value": "2021-11-15T23:59:30"
    },
    "startDate": {
      "@type": "xsd:dateTime",
      "@value": "2021-11-15T00:00:00"
    }
  },
  {
    "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3",
    "@type": "Distribution",
    "accessURL": {
      "@type": "xsd:anyURI",
      "@value": "https://epncb.oma.be/pub/RINEX/2021/319/ACOR00ESP_R_2
    },
    "adms:status": {
      "@id": "https://publications.europa.eu/resource/authority/dist
    },
    "compressFormat": "application/x-gzip",
    "dataset": {
      "@id": "https://epncb.oma.be/PID/ACOR00ESP"
    },
    "dct:checksum": {
      "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#check
    },
    "dct:conformsTo": {
      "@id": "https://gnss.be/PID/standard#hatanaka"
    },
    "dct:description": "Daily RINEX data of the GNSS station ACOR00ESP for DOY 319 of 2021",
    "dct:issued": {
      "@type": "xsd:dateTime",
      "@value": "2021-11-15T00:00:00"
    },
    "dct:license": {
      "@id": "https://epncb.oma.be/PID/ACOR00ESP#license"
    },
    "dct:modified": {
      "@type": "xsd:dateTime",
      "@value": "2023-11-17T18:34:21"
    },
    "dct:title": "ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz",
    "downloadURL": {
      "@type": "xsd:anyURI",
      "@value": "https://epncb.oma.be/pub/RINEX/2021/319/ACOR00ESP_R_20213190000_01D_30S_MO.crx.gz"
    },
    "gnss:obsData": {
      "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#obsdata"
    },
    "mediaType": "application/octet-stream",
    "temporal": {
      "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#temporal"
    }
  },
  {
    "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#antenna",
    "gnss:igsModelCode": "LEIAT504        LEIS",
    "gnss:marker-arpEastEcc": {
      "@type": "xsd:float",
      "@value": "0.0"
    },
    "gnss:marker-arpNorthEcc": {
      "@type": "xsd:float",
      "@value": "0.0"
    },
    "gnss:marker-arpUpEcc": {
      "@type": "xsd:float",
      "@value": "3.046"
    }
  },
  {
    "@id": "https://epncb.oma.be/PID/2021/319/ACOR00ESP_2021319_01D_30S_R3#obsdata",
```


Standardized metadata schema

GNSS-DCAT-AP

https://doi.org/10.5281/zenodo.7777568

Advantages:

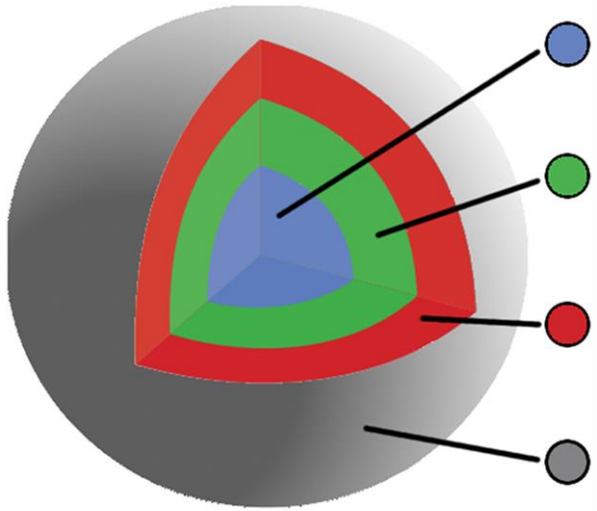
- Combine metadata elements from multiple vocabularies (like DCAT, ISO)
- Extend existing vocabularies or application profiles with domain-specific metadata elements (IGS antenna/receiver types)

Context information:

- File has “completed” status
- Info on compression
- Last modified time
- Link to RINEX file
- Frequency is daily
- Link to station metadata

Implementation of FAIR data principles

CREATION OF FAIR DIGITAL OBJECTS (FDO)



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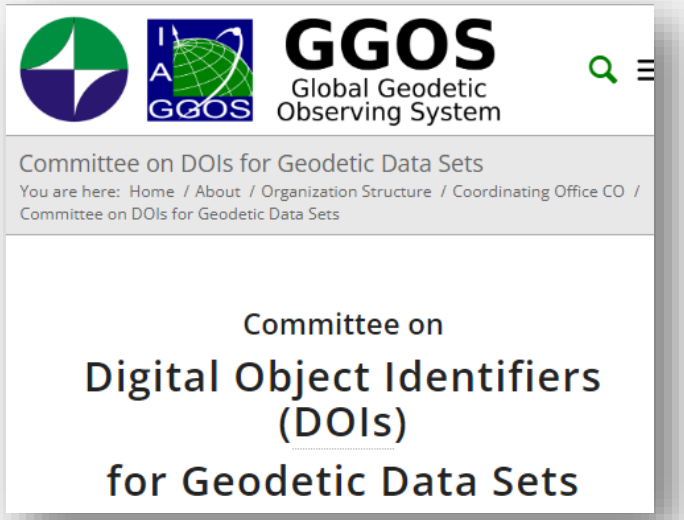
Persistent Identifiers for GNSS Data: Digital Object Identifiers (DOI)



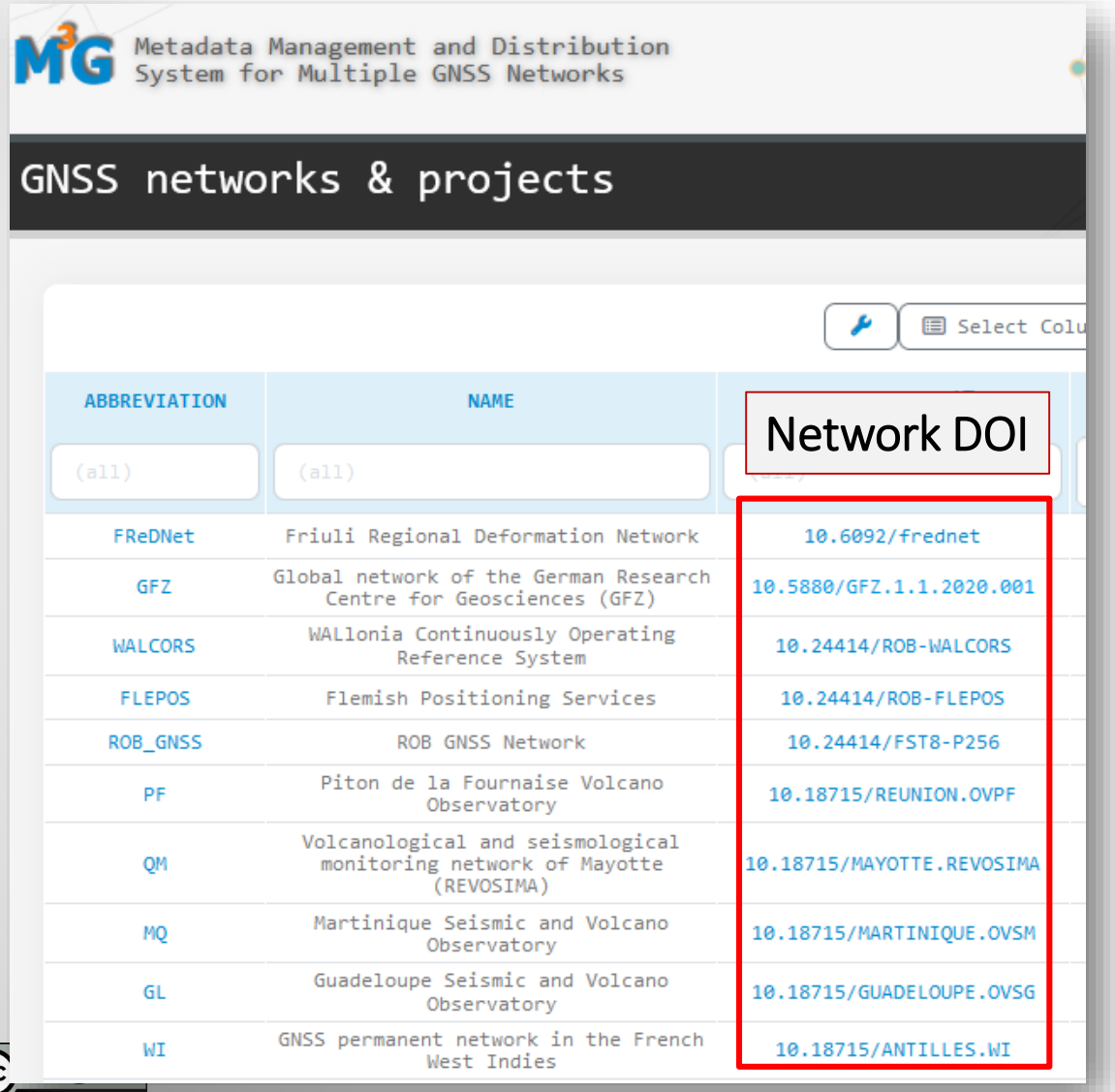
Agreement:

- DOI for dataset of a GNSS station is necessary
- DOI for datasets of GNSS networks should also be allowed!
- Both can be linked with each other

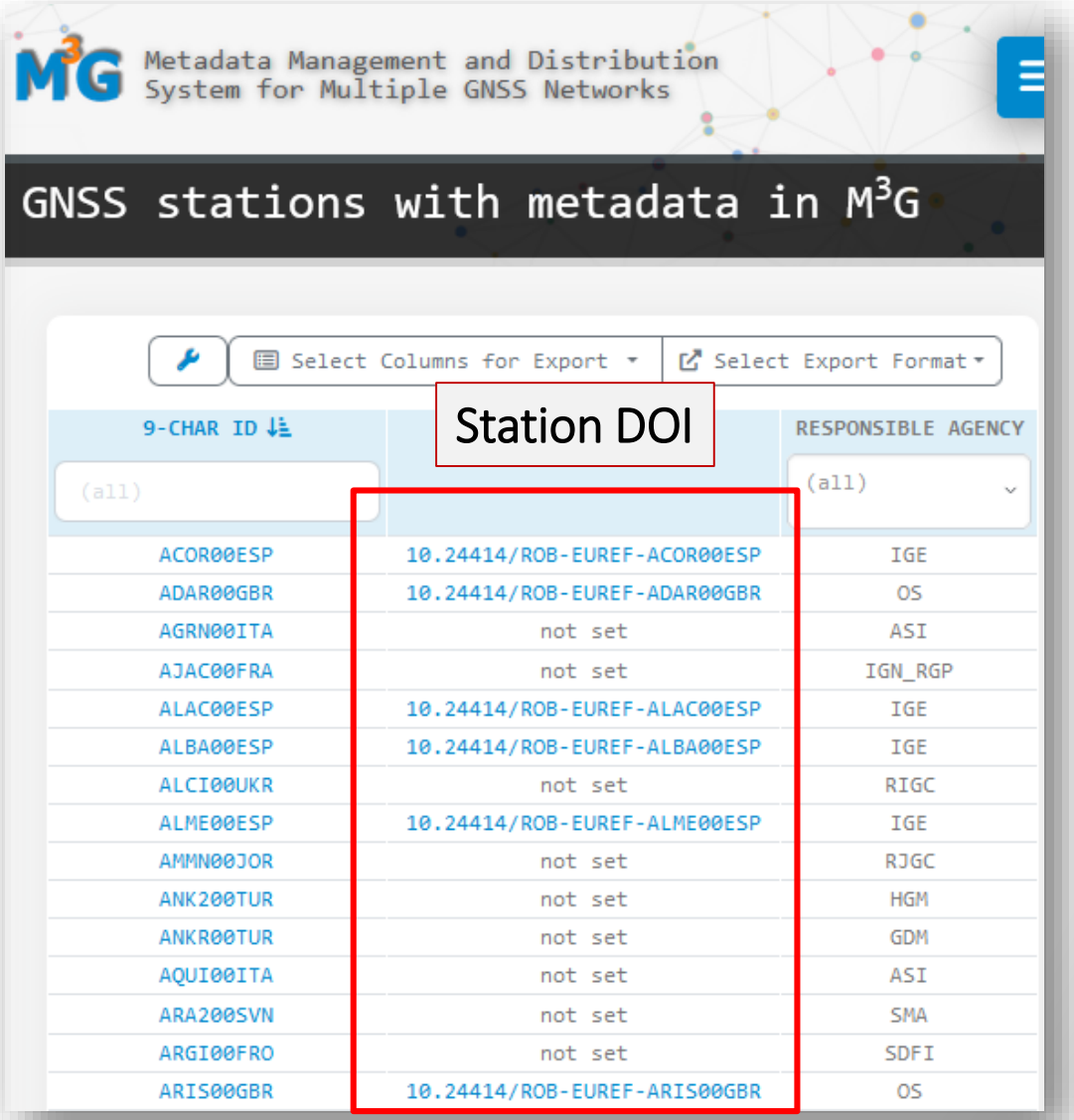
Development of tools to **collect existing DOI in M^{3}G**

M³G - DOI for datasets of GNSS stations/networks

Upgrade of M³G software to allow station/network managers to insert GNSS network and/or GNSS station DOI in M³G



ABBREVIATION	NAME	Network DOI
FReDNet	Friuli Regional Deformation Network	10.6092/frednet
GFZ	Global network of the German Research Centre for Geosciences (GFZ)	10.5880/GFZ.1.1.2020.001
WALCORS	WALlonia Continuously Operating Reference System	10.24414/ROB-WALCORS
FLEPOS	Flemish Positioning Services	10.24414/ROB-FLEPOS
ROB_GNSS	ROB GNSS Network	10.24414/FST8-P256
PF	Piton de la Fournaise Volcano Observatory	10.18715/REUNION.OVPF
QM	Volcanological and seismological monitoring network of Mayotte (REVOSIMA)	10.18715/MAYOTTE.REVOSIMA
MQ	Martinique Seismic and Volcano Observatory	10.18715/MARTINIQUE.OVSM
GL	Guadeloupe Seismic and Volcano Observatory	10.18715/GUADELOUPE.OVSG
WI	GNSS permanent network in the French West Indies	10.18715/ANTILLES.WI



9-CHAR ID	Station DOI	RESPONSIBLE AGENCY
ACOR00ESP	10.24414/ROB-EUREF-ACOR00ESP	IGE
ADAR00GBR	10.24414/ROB-EUREF-ADAR00GBR	OS
AGRN00ITA	not set	ASI
AJAC00FRA	not set	IGN_RGP
ALAC00ESP	10.24414/ROB-EUREF-ALAC00ESP	IGE
ALBA00ESP	10.24414/ROB-EUREF-ALBA00ESP	IGE
ALCI00UKR	not set	RIGC
ALME00ESP	10.24414/ROB-EUREF-ALME00ESP	IGE
AMMN00JOR	not set	RJGC
ANK200TUR	not set	HGM
ANKR00TUR	not set	GDM
AQUI00ITA	not set	ASI
ARA200SVN	not set	SMA
ARGI00FRO	not set	SDFI
ARIS00GBR	10.24414/ROB-EUREF-ARIS00GBR	OS

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New service to provide DOI for EPN stations

Very few DOI inserted in M^{3}G: station managers ask help to get DOI

→ **Development of new service provided to EUREF** based on EPN station metadata input in M^{3}G

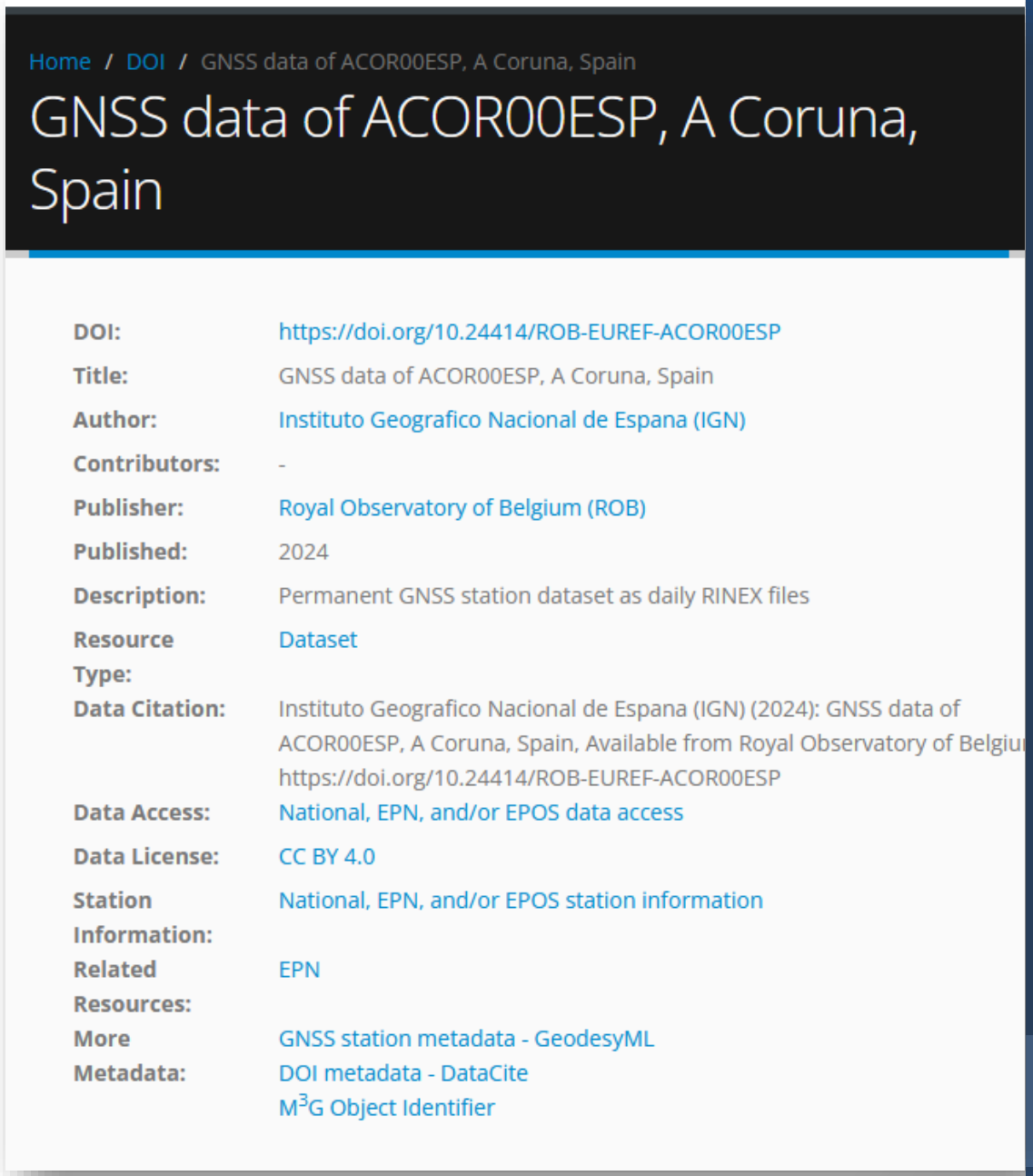
- **to assign DOIs** to datasets of EPN stations in EPN HDC
  - Only if no DOI is already existing
  - Manual process managed by EPN Central Bureau

- to export harmonized/standardized input for other agencies wishing to mint DOI for GNSS data (in concertation with GGOS)

→ **Station DOIs already available for 63 EPN stations**

Example of DOI landing page

https://doi.org/10.24414/ROB-EUREF-ACOR00ESP



Home / DOI / GNSS data of ACOR00ESP, A Coruna, Spain

GNSS data of ACOR00ESP, A Coruna, Spain

DOI:	https://doi.org/10.24414/ROB-EUREF-ACOR00ESP
Title:	GNSS data of ACOR00ESP, A Coruna, Spain
Author:	Instituto Geografico Nacional de Espana (IGN)
Contributors:	-
Publisher:	Royal Observatory of Belgium (ROB)
Published:	2024
Description:	Permanent GNSS station dataset as daily RINEX files
Resource Type:	Dataset
Data Citation:	Instituto Geografico Nacional de Espana (IGN) (2024): GNSS data of ACOR00ESP, A Coruna, Spain, Available from Royal Observatory of Belgiu https://doi.org/10.24414/ROB-EUREF-ACOR00ESP
Data Access:	National, EPN, and/or EPOS data access
Data License:	CC BY 4.0
Station Information:	National, EPN, and/or EPOS station information
Related Resources:	EPN
More Metadata:	GNSS station metadata - GeodesyML DOI metadata - DataCite M^{3}G Object Identifier

Example of DOI landing page

Link to Persistent Identifier of station metadata in M³G

Home / DOI / GNSS data of ACOR00ESP, A Coruna, Spain

GNSS data of ACOR00ESP, A Coruna, Spain

DOI:	https://doi.org/10.24414/ROB-EUREF-ACOR00ESP
Title:	GNSS data of ACOR00ESP, A Coruna, Spain
Author:	Instituto Geografico Nacional de Espana (IGN)
Contributors:	-
Publisher:	Royal Observatory of Belgium (ROB)
Published:	2024
Description:	Permanent GNSS station dataset as daily RINEX files
Resource Type:	Dataset
Data Citation:	Instituto Geografico Nacional de Espana (IGN) (2024): GNSS data of ACOR00ESP, A Coruna, Spain, Available from Royal Observatory of Belgiu https://doi.org/10.24414/ROB-EUREF-ACOR00ESP
Data Access:	National, EPN, and/or EPOS data access
Data License:	CC BY 4.0
Station Information:	National, EPN, and/or EPOS station information
Related Resources:	EPN
More Metadata:	GNSS station metadata - GeodesyML DOI metadata - DataCite M³G Object Identifier

M³G Metadata Management System for Multiple GNSS Networks

Agencies | Stations | Data Centers/Nodes | Networks/Projects | File Server | Documentation | About

GNSS Station - ACOR00ESP

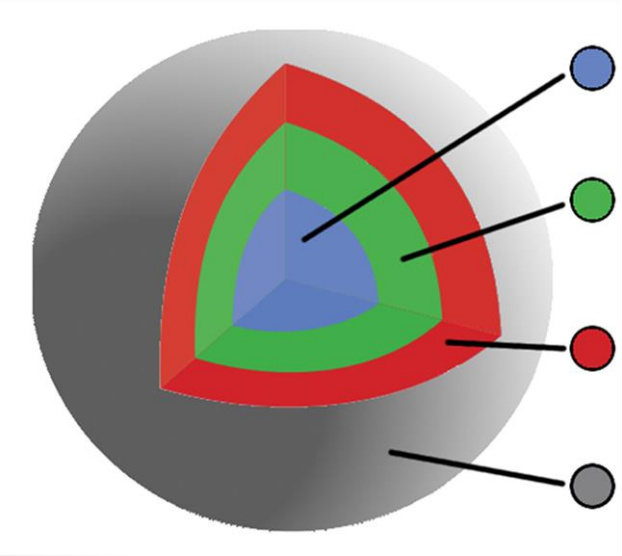
GNSS Station metadata - URI: https://w3id.org/moid/station.5b39c8f1b6ae0c4a3432c612

9-CHAR IDENTIFICATION	ACOR00ESP
IERS DOMES NUMBER	13434M001
SITE LOCATION, COUNTRY	A Coruna, Spain (ESP)
STATION OWNER	Instituto Geografico Nacional de Espana (IGE)
POINT OF CONTACT	ergnss(/at/)mitma.es, Instituto Geografico Nacional de Espana
INSTALLATION DATE	1998-03-06
STATION STATUS	Active
LAST ANTENNA	LEIAT504
LAST RECEIVER	LEICA GR50
LAST TRACKED SATELLITE SYSTEMS	GPS+GLO+GAL+BDS
IGS SITE LOG	View
CHANGE LOG	View
SITE PICTURES	View
DOWNLOAD METADATA FORMAT(S)	GeodesyML, IGS site log, EPOS json
LAST UPDATE OF SITE LOG	2024-04-11
METADATA MAINTAINER	ergnss(/at/)mitma.es, Instituto Geografico Nacional de Espana
DOI DAILY RINEX DATA	https://doi.org/10.24414/ROB-EUREF-ACOR00ESP
DATA LICENSE DAILY RINEX DATA	CC-BY-4.0
EMBARGO PERIOD DAILY RINEX DATA	no embargo period
NETWORK(S)	EPOS, EPN, ERGNSS
PROJECT(S)	E-GVAP, SONEL
EPN DATA ACCESS	EPN-HDC, BEV, BKGE
EPOS DATA ACCESS	ROB-EUREF, IGE, EPOS-GNSS Data Gateway, EPOS Data Portal
STATION INFORMATION	EPN Central Bureau, EPOS Data Gateway
STATION DATA QUALITY	EPN Central Bureau, EPOS Data Quality Monitoring System (ROB-EUREF, IGE)
MAP	

FAIR data principles

GNSS repository

CREATION OF FAIR DIGITAL OBJECTS (FDO)



Standardized metadata schema
- GNSS-DCAT-AP (including e.g. links to site log and data)
- JSON-LD

Humans and machine → web portal and web services
- Search functionality

New service to provide DOI for EPN data (standardization in progress with GGOS/IGS) – contact EPN CB

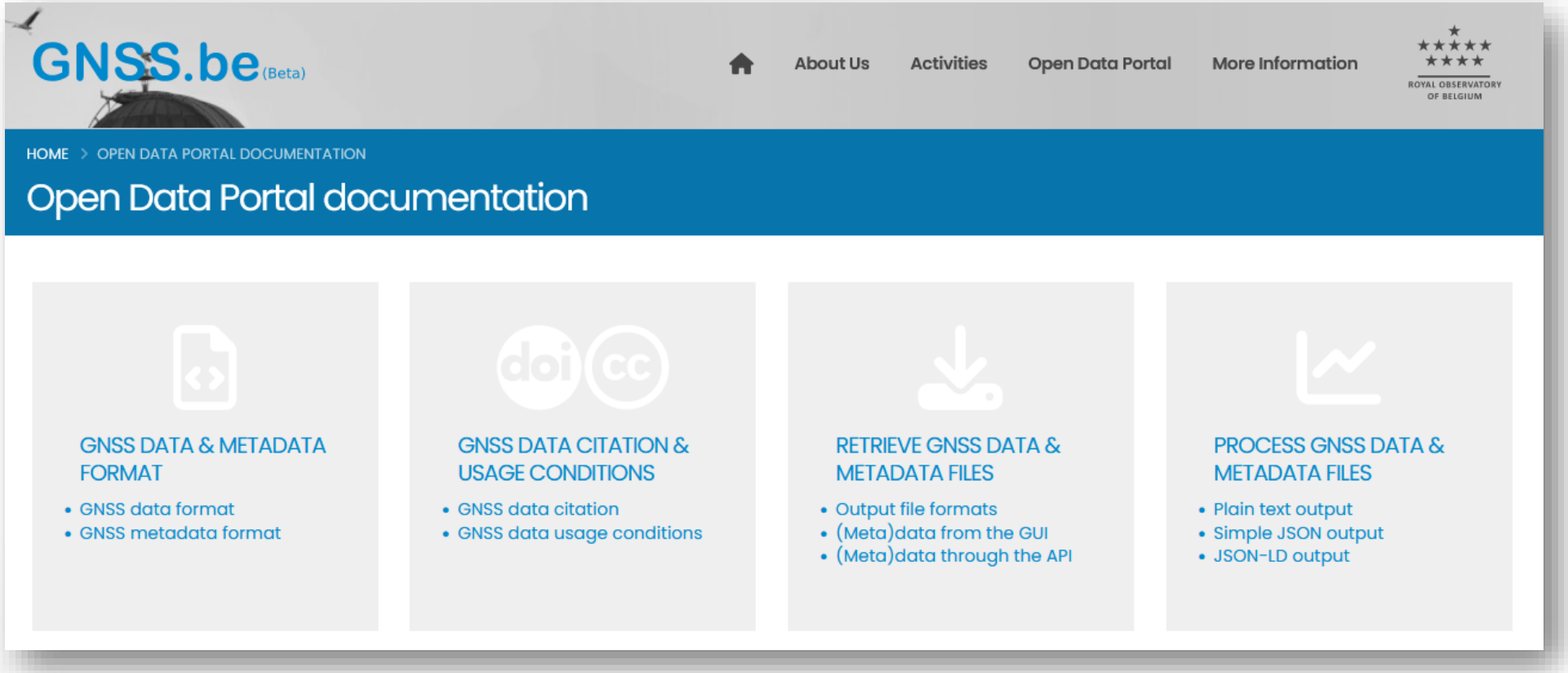
Work to be continued !

- Populate additional optional metadata fields in GNSS-DCAT-AP
  - GNSS data quality indicator
  - File provenance
- Web services: first version
  - Extend search possibilities - add them slowly to ensure service speed is not deteriorated
- Web portal : beta version
  - User friendliness + documentation (examples)
- User authentication????

- Extend GNSS-DCAT-AP for GNSS products?

Data Portal – https://gnss.be/opendataportal

Documentation



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Thank you for your attention

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