

Towards FAIR GNSS data: challenges and open problems

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What about GNSS data?

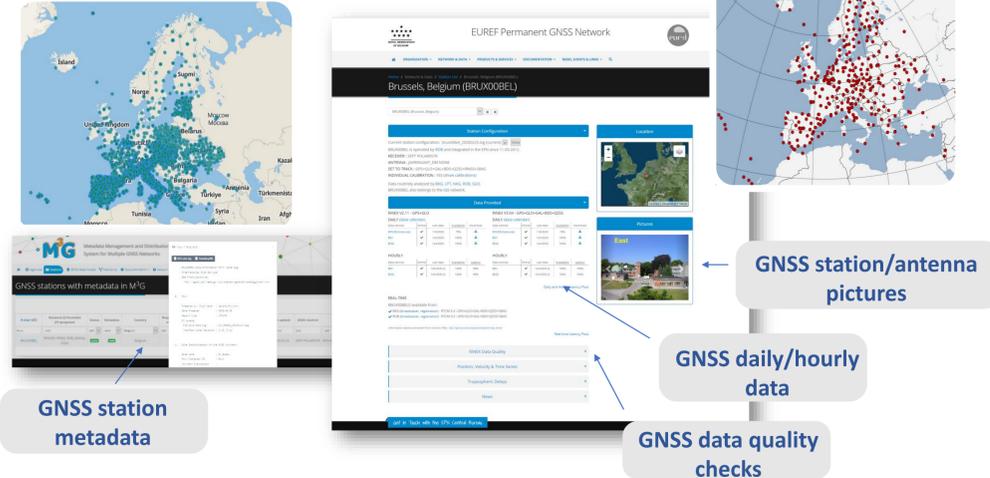
Global Navigation Satellite Systems (GNSS, e.g. GPS or Galileo) allow to measure positions on Earth's surface.

Activities such as geodesy, navigation, mapping and surveying need reliable points of reference provided by permanently tracking GNSS reference stations.

The Royal Observatory of Belgium (ROB) maintains a repository containing several decades of data from the GNSS reference stations belonging to Belgian and European GNSS network (EUREF) GNSS reference stations. All these GNSS data are openly available and ROB has made considerable efforts to ensure that the data passed a rigorous curation process (Bruyninx et al, 2019).

Metadata Management and Distribution System for Multiple GNSS Networks

EUREF Permanent GNSS Network



But... there's still lot that can be improved in the GNSS data management, for example:

- ease the procedure to access to data (especially for new users)
- include information on access rights (data licenses)
- allow citation to recognize the merit of researchers providing the GNSS data

M. D. Wilkinson, M. Dumontier, et al. "The FAIR Guiding Principles for scientific data management and stewardship" Scientific Data 3, 160018 (2016), <https://doi.org/10.1038/sdata.2016.18>
 "Turning FAIR into reality" Final report and action plan from the European Commission expert group on FAIR data, Directorate General for Research and Innovation, <https://doi.org/10.2777/1524>
 C. Bruyninx, L. Legrand, A. Fabian, E. Pottiaux "GNSS Metadata and Data Validation in the EUREF Permanent Network". GPS Sol., 23(4) (2019), <https://doi:10.1007/s10291-019-0880-9>

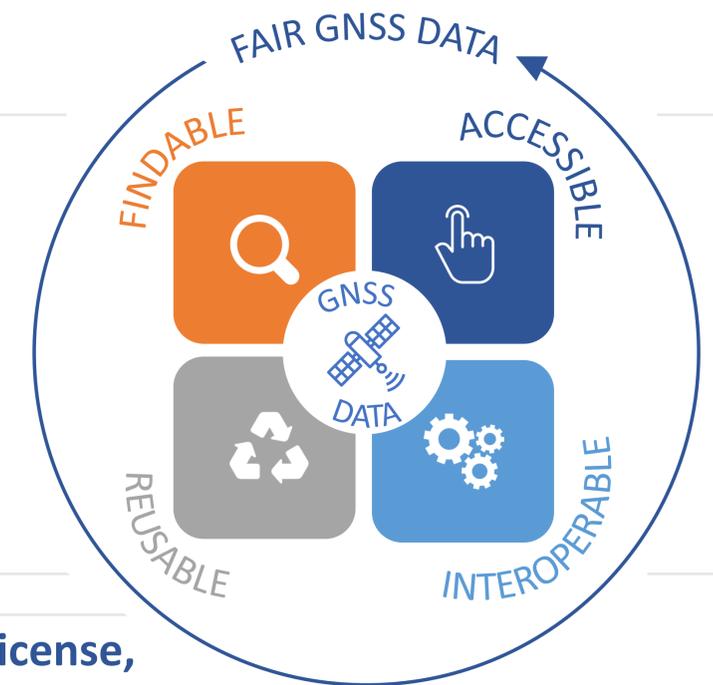
From "FAIR guiding principles" to "turning FAIR into reality"...

FAIR data principles, illustrated by Wilkinson *et al.* in 2016, aim at making data more:

- Findable: attribute persistent identifiers (PDIs) to data and metadata
- Accessible: implement standardized metadata and APIs (Application Program Interface)
- Interoperable: link data and metadata
- Reusable: enrich metadata and documentation, include license and provenance info

Nowadays, FAIR is increasingly becoming a requirement as well as an opportunity for science.

To learn more, have a look at all the contributions in [this session](#).



... it's a long way to go. How to turn GNSS data FAIR?

Translating FAIR general guidelines into practice is an active topic of research.

In 2018, the EU expert group on FAIR data proposed an action plan for the implementation of FAIR. The first step consists in: "Implementing FAIR requires a model for FAIR Digital Objects. These, by definition, have a PID linked to different types of essential metadata including provenance and licencing. The use of community standards and sharing of rich documentation is fundamental for interoperability and reuse of all objects."

However, this is far than enough to implement FAIR GNSS data. Indeed, there is no community-shared agreement on the need for making GNSS data FAIR:

- Which type of PIDs have to be attributed?
- How to extend metadata and include provenance information and license of use?
- How to implement a standardized GNSS metadata model?
- How should the documentation be improved?
- Which APIs need to be developed to facilitate data access?

Which PIDs, license, metadata format and APIs for GNSS data?

- DOIs (Digital Object Identifiers) e.g. [UNAVCO](#), USA is currently doing. Any other? See [Carine's presentation](#).
- 'CC BY' license already assigned to some of GNSS data, any other type e.g. CC0?
- APIs similar to those from [UNAVCO](#), [SEMISYS Potsdam](#), ESA ([OpenSearch](#) and [OData](#)), and [INSPIRE](#)?

FAIR GNSS data in a FAIR ecosystem

"Research data should be made available by means of Trusted Digital Repositories", the EU expert group in FAIR data recommends.

- apply for the [Core Trust Seal](#) (CTS) certification of the GNSS data repository

How to implement FAIRness?

- Closely monitor initiatives from the European Plate Observing System ([EPOS](#))
- Learn from other scientific communities e.g. [ELIXIR](#) (life sciences)