Towards FAIR GNSS data: challenges and open problems

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Nowadays, we measure positions on Earth's surface thanks to Global Navigation Satellite Systems (GNSS) e.g. GPS, GLONASS, and Galileo. Activities such as navigation, mapping, and surveying rely on permanent GNSS tracking stations located all over the world.
The Royal Observatory of Belgium (ROB) maintains and operates a repository containing data from hundreds of GNSS stations belonging to the European GNSS networks (e.g. EUREF, Bruyninx et al., 2019).

ROB's repository contains GNSS data that are openly available and rigorously curated. The curation data include detailed GNSS station descriptions (e.g. location, pictures, and data author) as well as quality indicators of the GNSS observations.

However, funders and research policy makers are progressively asking for data to be made *Findable, Accessible, Interoperable, and Reusable (FAIR)* and therefore to increase data transparency, discoverability, interoperability, and accessibility.

In particular, within the GNSS community, there is no shared agreement yet on the need for making data *FAIR*. Therefore, turning GNSS data *FAIR* presents many challenges and, although *FAIR* data has been included in EUREF's strategic plan, no practical roadmap has been implemented so far. We will illustrate the specific difficulties and the need for an open discussion including also other communities working on *FAIR* data.

For example, making GNSS data easily *findable* and *accessibl*e would require to attribute persistent identifiers to the data. It is worth noting that the International GNSS Service (IGS) is only now beginning to consider the attribution of DOIs (Digital Object Identifiers) to GNSS data, mainly to allow data citation and acknowledgement of data providers. Some individual GNSS data repositories are using DOIs (such as UNAVCO, USA). Are DOIs the only available option or are there more suitable types of URIs (Uniform Resource Identifiers) to consider?

The GNSS community would greatly benefit from *FAIR* data practices, as at present, (almost) no licenses have been attributed to GNSS data, data duplication is still an issue, historical provenance information is not available because of data manipulations in data centres, citation of the data providers is far from the rule, etc.

To move further along the path towards *FAIR* GNSS data, one would need to implement standardised metadata models to ensure data *interoperability*, but, as several metadata standards are already in use in various scientific disciplines, which one to choose?

Then, to facilitate the *reuse* (and long-term preservation) of GNSS data, all metadata should be properly linked to the corresponding data and additional metadata, such as provenance and license information. The latter is a good example up for discussion: despite the fact that 'CC BY' license is already assigned to some of the GNSS data, other licenses might need to be enabled.

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