Fiducial Reference Measurement Concept

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FIDUCIAL

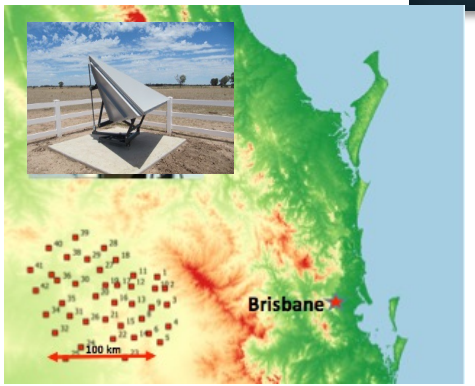
fi·du·cial *(adj)* *Regarded or employed as a standard of reference, as in surveying.*

[Late Latin fdcilis, from Latin fdcia, *trust*, from fdere, *to trust*; seebheidh- in Indo-European roots.]

- Cal/Val activities are a key component of a satellite mission, giving credibility to the mission data. For ESA's EO mission they usually are a complementary effort of:
  - ESA and ESL/DISC/MPC expert teams
  - Independent validation teams and ESA campaigns
  - **FRMs (Fiducial Reference Measurements)**
- Maintaining quality is all about a regular stream of verification and validation data that can be used to check mission and product performance. Optimally:
  - Validate satellites with standard data that we can be trusted → **FIDUCIAL**
  - fundamental traceability and uncertainty budgets for ground measurements used

Fiducial Reference Measurements (FRM)

"Fiducial Reference Measurements (FRM) are a suite of independent, fully characterized, and traceable ground measurements that follow the guidelines outlined by the GEO/CEOS Quality Assurance framework for Earth Observation (QA4EO). These FRM provide the maximum Return On Investment (ROI) for a satellite mission by delivering, to users, the required confidence in data products, in the form of independent validation results and satellite measurement uncertainty estimation, over the entire end-to-end duration of a satellite mission.."



->In short: FRMs are tailored and fully characterized measurements in support of satellite Cal/Val, directly mimicking the satellite sensor measurements when possible. «FRM4» projects : preparatory R&D activities

Fiducial Reference Measurements (FRM)

The defining **characteristics for FRM** are:

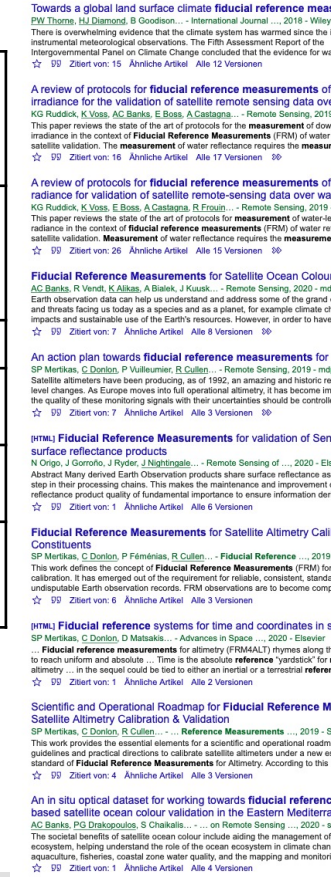
- FRM measurements should ideally have ***documented SI traceability*** using metrology standards and/or community recognised best practices;
- FRM measurements are ***independent*** from the satellite geophysical retrieval process;
- An ***uncertainty budget*** for all FRM instruments, and derived measurements, is available and maintained;
- FRM measurement ***protocols, procedures*** and community-wide management practices (measurement, processing, archive, documents, etc.) are defined, published and adhered to by FRM instrument deployments;
- FRM are ***accessible*** to other researchers allowing independent verification of processing systems;
- FRM are ***required*** to determine the in-orbit uncertainty characteristics of satellite geophysical measurements via independent validation activities.

Selection of FRM4 and FRM Projects run by the ESA SPPA team:

http://frm4ghg.aeronomie.be/	The focus of the "FRM Ground-Based FTIR Greenhouse Gas Observations" (FRM4GHG) project is the intercomparison of instruments and harmonization of products and retrievals from ground based FTIR systems → Greenhouse Gas. New project starting 2021, 4 years duration.
http://frm4doas.aeronomie.be/	The "FRM for Ground-Based DOAS Air-Quality Observations" project aims at the harmonization of the retrievals from UV-Visible ground based spectrometers (MAXDOAS or Pandora) -> the standards of FRMs for NO2 and ozone. New project starting 2021, 4 years duration.
FRM4SAR	Best practice for deploying an a site (and analysis) for accurate geometric calibration.
FRM4RADAR -> see following presentation	Mini observation network for validation/ verification of cloud profile measurements from space (EarthCARE CPR L2A etc) integrated and fully compatible with ACTRIS-Cloudnet
https://www.pandonia-global-network.org/	PGN is a joint ESA-NASA ground-based remote sensing network for trace gases and atm composition. The main instrument of Pandonia is the Pandora-1S/2S system.
FRM4VEG https://frm4veg.org/	Protocols for traceable in-situ measurements of vegetation-related parameters, to support the validation of Copernicus products from Sentinel-2, -3, and PROBA-V and optical Sensor TPMs. Characterisation of Sites.

FRM4DOAS

fiducial reference temperature measurements



FRM: Conclusions

- Fiducial Reference Measurements (FRM) are tailored and fully characterized measurements in support for satellite Cal/Val, and may be considered a sub-set of ‘in-situ’ measurements.
- They are a prioritized suite of measurements to demonstrate that mission products meet the mission’s requirements.
- The FRM are essential for the validation of satellite measured parameters, in particular for missions aiming to respond to long-term public needs (e.g. Sentinel missions, meteorological missions).
- The FRM shall meet specific mission requirements in terms of accuracy and traceability