Data sharing of in-situ measurements following GEO and FAIR principles in the solar energy sector

Lionel Menard

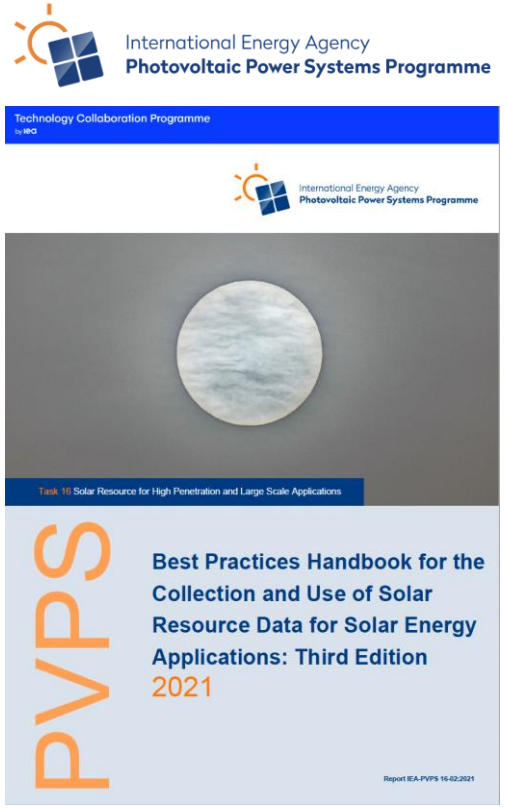
MINES Paris PSL University

Learn more here:

lionel.menard@minesparis.psl.eu

Operational activities

- **In-situ measurements** are **key** in the **solar energy** sector
- **In-situ measurement** in conjunction with satellite data and meteorological model provides **information-content** to **assess the solar energy potential supporting solar energy business***
- Ground based irradiance **in-situ observations** are used **operationally** since 2014 to provide quarterly **Evaluation and Quality Assurance (EQA) reports*** in support of **Copernicus CAMS Radiation Services** (CRS)



* https://tinyurl.com/26mzvfj7
* https://atmosphere.copernicus.eu/supplementary-services

Main motivation

Transition from using internal ground based in-situ measurement in **heterogeneous CSV format**

Towards a **open** and **full FAIR** principles implementation in **practice**

L o g i c a l D a t a W o r k f l o w

"Metadata and data should be well-described"

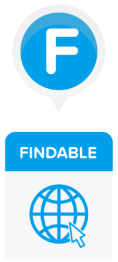
Raw **CSV** from **data logger** into **CF-NetCDF** format

"User needs to know how they can be accessed"

CF-NetCDF deployed on a **Thredds Data Server**

"Data need to interoperate with applications"

Remotely access via Notebooks, Web App, Desktop Panoply,…



"Metadata and data should be easy to find"

Search & discovery metadata in a catalogues GEO Portal and Knowledge Hub

In practice !

NetCDF format for **metadata** and **data** encoding (self-content, self-described) conform to the **CF-conventions**

- **libinsitu**: a **free an open** (BSD 2-Clause License) **library**
  - Transform **raw** input files **into NetCDF** format
  - A set of CLI utilities and **Python** functions to :
    - **Explore & query** NetCDF files
    - **Export** it to various formats (CSV, JSON, text, pandas Dataframes)
    - **Flag data** with quality checks
    - Produce **graphs** for visual quality control
  - **Enriched metadata** framework for networks and their stations
  - **Propose vocabularies for solar data**, on top of **CF conventions**
  - Doc: https://libinsitu.readthedocs.io/en/latest/index.html
  - Source code: https://git.sophia.mines-paristech.fr/oie/libinsitu/

In practice !

Accessible via the **Thredds Data Server** enabling data and metadata operations (Download, subset, access with **OPeNDAP framework**,…

- **Thredds Data Server** hosts ground-based in-situ measurements

- **10 Networks**: BOM, BSRN, enerMENA, NREL_MIDC, SAURAN, SOLRAD, SURFRAD, IEA-PVPS,….
- **320 stations** – Range from 1992-2022 – Minutes time span –
- Provided **variables** – GHI, DHI, DNI, Temp, RH, P, WS, WD

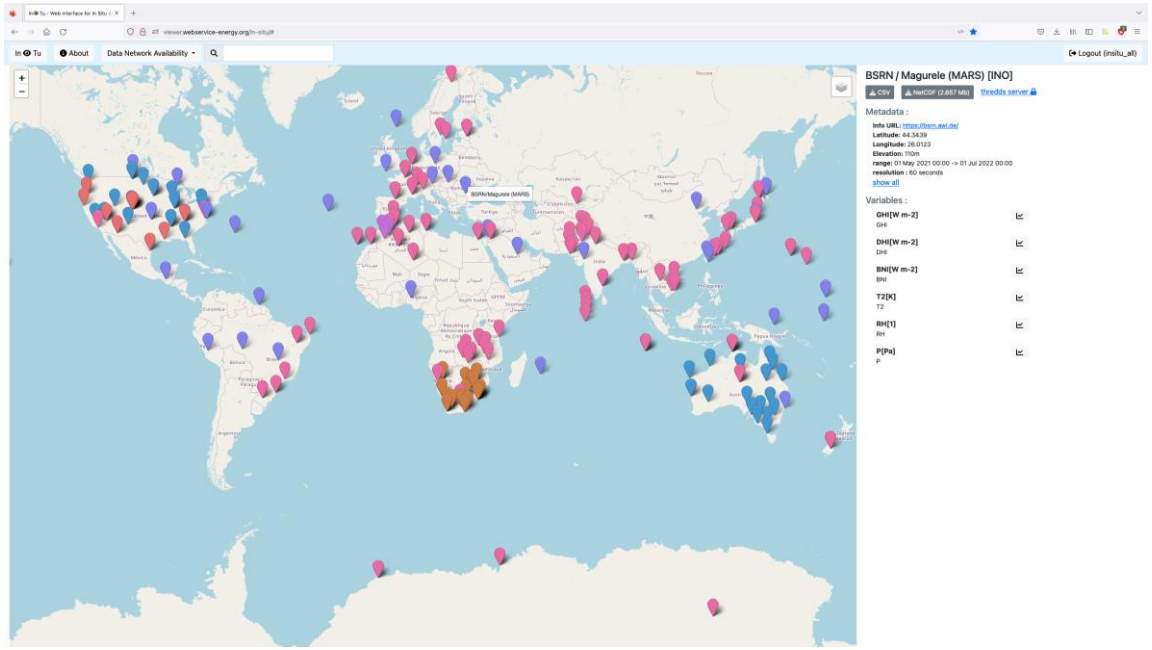
- CF-NetCDF **storage 11 times average lower** (68GB|6GB) than raw CSV
- **Free** and **restricted** access policies

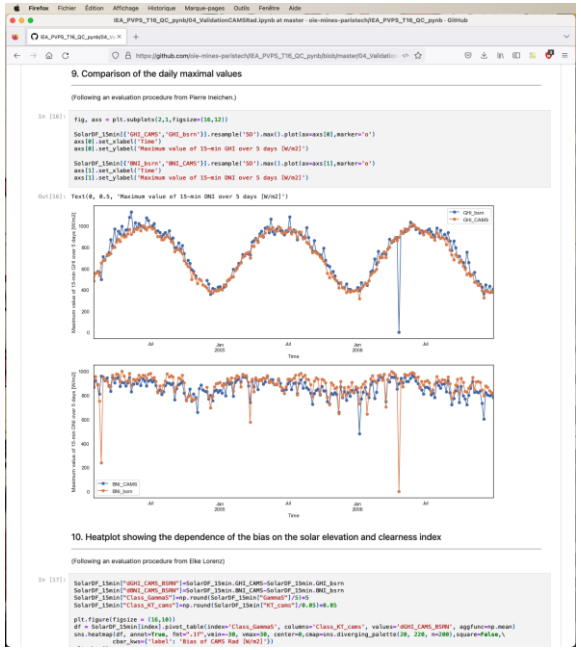
- http://tds.webservice-energy.org/thredds/in-situ.html

In practice !

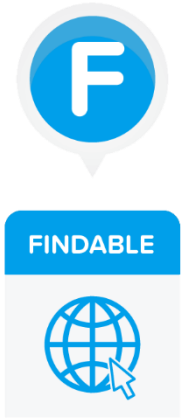
Processes made remotely possible via **Notebooks**, API (Python R,…), Matlab, **Web App**, Desktop Panoply,…

- **Web application, Jupyter Notebooks (The Wow effects!)**
  - **OPeNDAP** enable **remote query** from CF-NetCDF / Thredds
  - Web App: http://viewer.webservice-energy.org/in-situ/
    - Source code of the Web App on GitHub: https://git.sophia.mines-paristech.fr/oie/insitu-webapp
  - Jupyter Notebook QC procedure on GitHub: https://github.com/oie-mines-paristech/IEA_PVPS_T16_QC_pynb





In practice !



Findable via metadata in a **catalogues** (webservice-energy and GEO), **DOI** and landing page **GEO Portal and Knowledge Hub**

- Create **awareness**:
  - **Metadata records** on webservice-energy GEO community catalogue :
    - https://tinyurl.com/5y96ecm6
  - Visible on the **GEO Portal** Harvesting (Thredds and GeoNetwork):
    - https://bit.ly/3tesqKC
  - Created a **GEO Knowledge Hub** Package:
    - https://gkhub.earthobservations.org/records/ykmr8-x3064
  - Free and open **working paper**:
    - https://doi.org/10.23646/AC2M-8504
  - Dialog engagement via a **free and public mailing-list**:
    - https://groupes.minesparis.psl.eu/wws/info/solar-insitu

Challenges

- Move towards **standard and interoperable practices**
- Needs to accommodate existing practices **WHILE** demonstrating new opportunities and benefits to **practitioners**
- **Engage** with ground-based networks

Opportunities

- **Libinsitu** ! Use it… **It's FREE**
- **New breath** for station networks
- **Low hanging fruits** of untapped virtual networks **PV plants** (cf. E.C. funded project ConnectinGEO)
- **Dialog** with other communities IAEA Marine Radioactivity Information System (***MARIS***)

Roadmap

On-going:

- Strengthen **exchanges** with **group of experts** (IEA, BSRN…)
- **Liaise** with **network operators** (BSRN, BOM, NCAR, NREL,…)
- **Aggregate external data** on Web Client (La Réunion Univ., Norwegian Met. Institute)

Planned:

- **Link** with **institutional partners** (JRC, World Bank, Copernicus In-Situ…)
- **Exchange** with **standardization communities** (CF community, WMO…)
- **Support** interested **stakeholders** to adopt/implement our tool