



Empowering National Uptake:
Leveraging Earth Observation Data and Knowledge

4 – 6 June 2024 | 08:30 – 18:00

CSIR International Convention Centre, Pretoria, South Africa



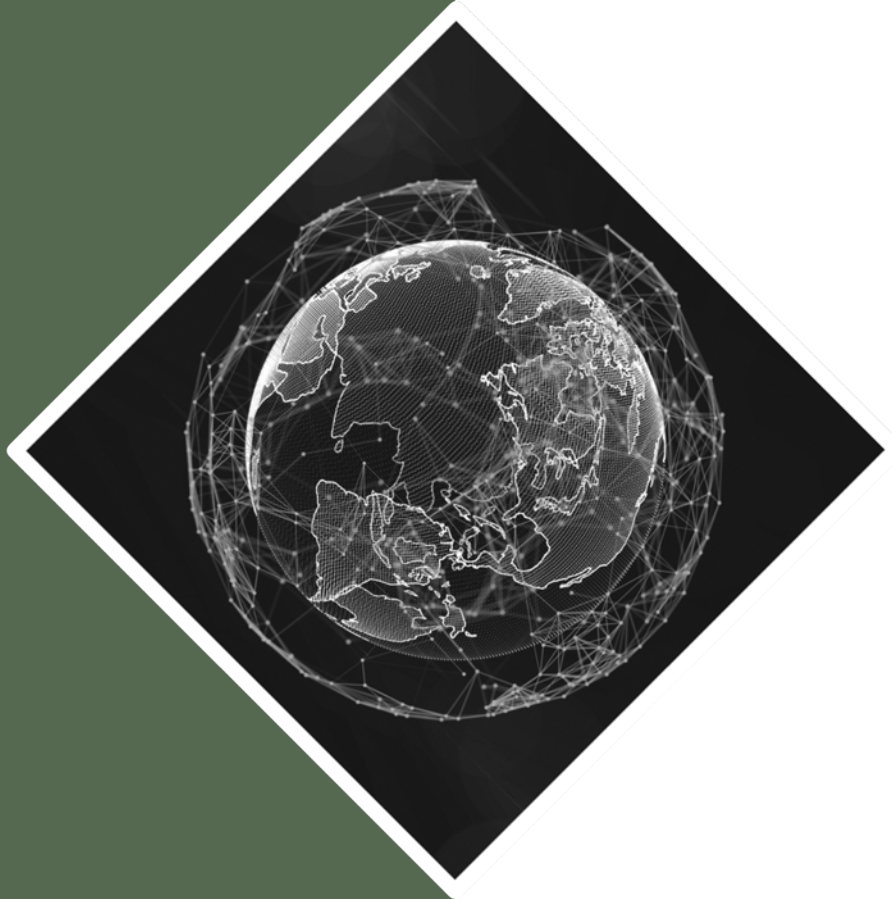
libinsitu

**“ Data sharing of in-situ measurements
following GEO and FAIR principles ”**

Lionel Menard

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Share and access to in-situ measurements



- Various challenges:
 - **Policies** related (Control loss, competitors issue, recognition)
 - Uncertain **funding** for long-term legacy
 - Insufficient **spatial and/or temporal coverage**
 - Heterogeneous **format**, encoding and access
 - Lack of standard **metadata**

In practice you most likely get this....

Index of /aftp/data/radiation/solrad/abq/2002/

Name	Last modified	Size	Description
Parent Directory		-	
abq02032.dat	2015-02-05 15:41	49K	
abq02033.dat	2015-02-05 15:47	59K	
abq02034.dat	2015-02-05 15:47	59K	
abq02035.dat	2015-02-05 15:47	59K	
abq02036.dat	2015-02-05 15:47	59K	
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abq02038.dat	2015-02-05 15:41	59K	
abq02039.dat	2015-02-05 15:41	59K	
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abq02041.dat	2015-02-05 15:41	59K	
abq02042.dat	2015-02-05 15:41	59K	
abq02043.dat	2015-02-05 15:41	59K	
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abq02046.dat	2015-02-05 15:41	59K	

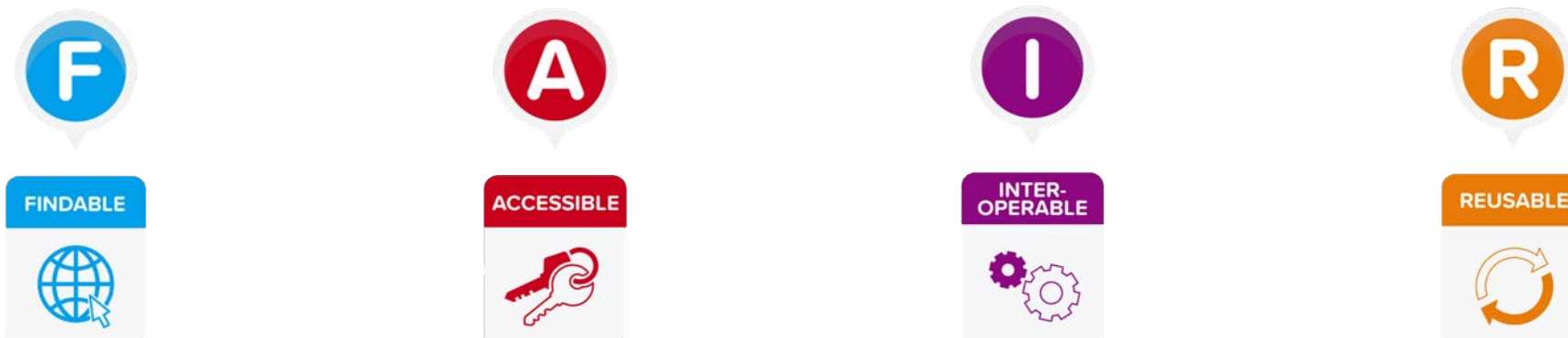
```

Albuquerque
35.03796 -106.62211 1617 -7 version 1
2023 2 1 2 0 0 0.000 89.21 12.4 0 0.8 0 15.2 0 0.2 0 43.0 0 0.504 0.000 0.526 0.032
2023 2 1 2 0 1 0.017 89.36 10.5 0 0.7 0 13.5 0 0.2 0 43.0 0 0.378 0.251 0.421 0.000
2023 2 1 2 0 2 0.033 89.50 9.1 0 0.1 0 12.1 0 0.2 0 43.0 0 0.504 0.126 0.421 0.000
2023 2 1 2 0 3 0.050 89.64 7.6 0 0.0 0 10.6 0 0.2 0 43.0 0 0.504 0.000 0.421 0.015
2023 2 1 2 0 4 0.067 89.77 6.3 0 0.0 0 9.1 0 0.1 0 43.0 0 0.378 0.000 0.526 0.024
2023 2 1 2 0 5 0.083 89.90 4.9 0 0.0 0 7.4 0 0.1 0 43.0 0 0.504 0.000 0.421 0.009
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2023 2 1 2 0 7 0.117 90.98 2.0 0 0.0 0 4.8 0 0.0 0 43.0 0 0.504 0.000 0.210 0.000
2023 2 1 2 0 8 0.133 91.16 0.8 0 0.0 0 3.8 0 0.0 0 43.0 0 0.378 0.000 0.316 0.000
2023 2 1 2 0 9 0.150 91.34 0.0 0 -0.1 0 2.9 0 0.0 0 43.0 0 0.378 0.126 0.316 0.000
2023 2 1 2 0 10 0.167 91.53 -0.4 0 -0.6 0 2.4 0 0.0 0 43.0 0 0.000 0.251 0.105 0.000
2023 2 1 2 0 11 0.183 91.71 -1.0 0 -0.8 0 1.9 0 0.0 0 43.0 0 0.378 0.000 0.210 0.000
2023 2 1 2 0 12 0.200 91.89 -1.3 0 -0.8 0 1.8 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 13 0.217 92.07 -1.3 0 -0.8 0 1.6 0 0.0 0 43.0 0 0.000 0.000 0.210 0.000
2023 2 1 2 0 14 0.233 92.26 -1.3 0 -0.4 0 1.3 0 0.0 0 43.0 0 0.000 0.377 0.210 0.000
2023 2 1 2 0 15 0.250 92.44 -1.3 0 0.0 0 1.1 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
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2023 2 1 2 0 17 0.283 92.81 -1.3 0 0.0 0 1.1 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 18 0.300 92.99 -1.3 0 0.0 0 0.8 0 0.0 0 43.0 0 0.000 0.000 0.105 0.000
2023 2 1 2 0 19 0.317 93.17 -1.3 0 0.0 0 0.7 0 0.0 0 43.0 0 0.000 0.126 0.105 0.000
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2023 2 1 2 0 24 0.400 94.09 -1.3 0 0.8 0 0.4 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 25 0.417 94.28 -1.3 0 0.2 0 0.4 0 0.0 0 43.0 0 0.000 0.251 0.000 0.000
2023 2 1 2 0 26 0.433 94.46 -1.4 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
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2023 2 1 2 0 31 0.517 95.40 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 32 0.533 95.58 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 33 0.550 95.77 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.126 0.000 0.000 0.000
2023 2 1 2 0 34 0.567 95.95 -1.4 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
2023 2 1 2 0 35 0.583 96.14 -1.6 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
2023 2 1 2 0 36 0.600 96.33 -1.7 0 0.0 0 0.4 0 0.0 0 43.0 0 0.126 0.000 0.000 0.000
2023 2 1 2 0 37 0.617 96.52 -1.6 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
2023 2 1 2 0 38 0.633 96.70 -1.4 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
2023 2 1 2 0 39 0.650 96.89 -1.4 0 0.0 0 0.4 0 0.0 0 43.0 0 0.252 0.000 0.000 0.000
2023 2 1 2 0 40 0.667 97.08 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.126 0.000 0.000 0.000
2023 2 1 2 0 41 0.683 97.27 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 42 0.700 97.46 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.000 0.000 0.000 0.000
2023 2 1 2 0 43 0.717 97.64 -1.3 0 0.0 0 0.4 0 0.0 0 43.0 0 0.000 0.126 0.000 0.000
    
```

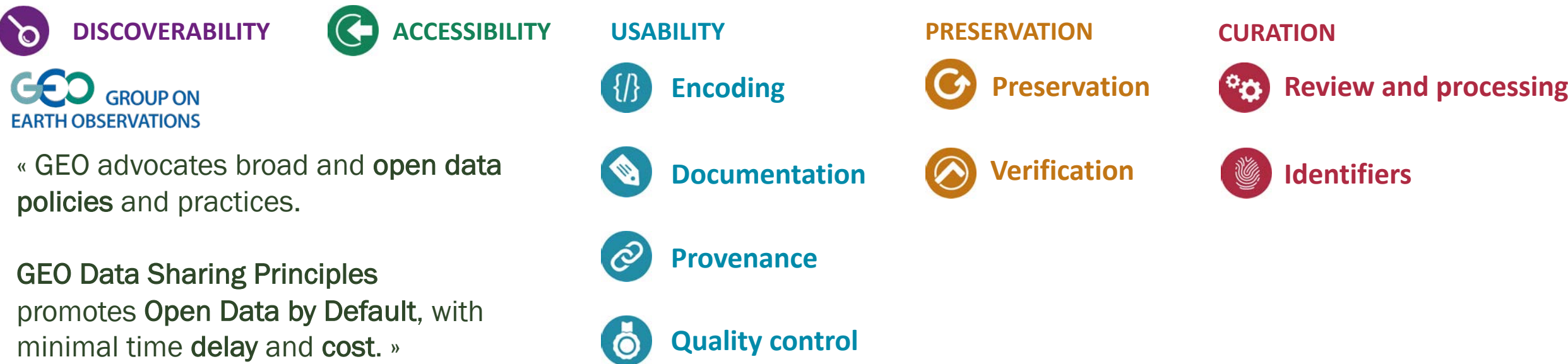
- Mean of Access: FTP, HTTP

- Format: *.dat, CSV

Data Sharing and Data Management Principles



« The FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. »



« GEO advocates broad and open data policies and practices. »

GEO Data Sharing Principles promotes Open Data by Default, with minimal time delay and cost. »

Main motivation

Propose a **methodology** and associated **guidelines**
supported by **free and open-source library and tools**
(**libinsitu**) to transition towards full **FAIR principles**
implementation for **in-situ measurements**

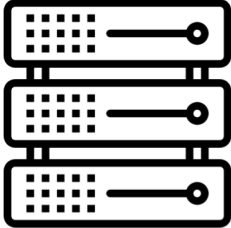


General approach

Consider a practical data workflow



Raw data from data logger



Open standard encoding and access protocol



Agnostic access



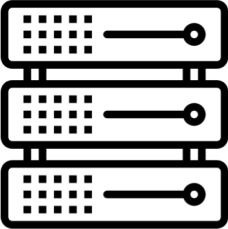
Dissemination search & discovery

General approach

Consider a practical data workflow



Raw data from data logger



Open standard encoding and access protocol



Agnostic access



Dissemination search & discovery



“Metadata and data should be well-described”



“User needs to know how data and metadata can be accessed”



“Data need to interoperate with applications”



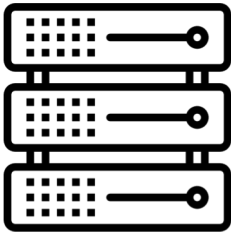
“Metadata and data should be easy to find”

General approach

Consider a practical data workflow



Raw data from data logger



Open standard encoding and access protocol



Agnostic access



Dissemination search & discovery



“Metadata and data should be well-described”

NetCDF format with CF Conventions



“User needs to know how data and metadata can be accessed”

Thredds Data Server



“Data need to interoperate with applications”

Open Source Clients (Desktop, Web,...)

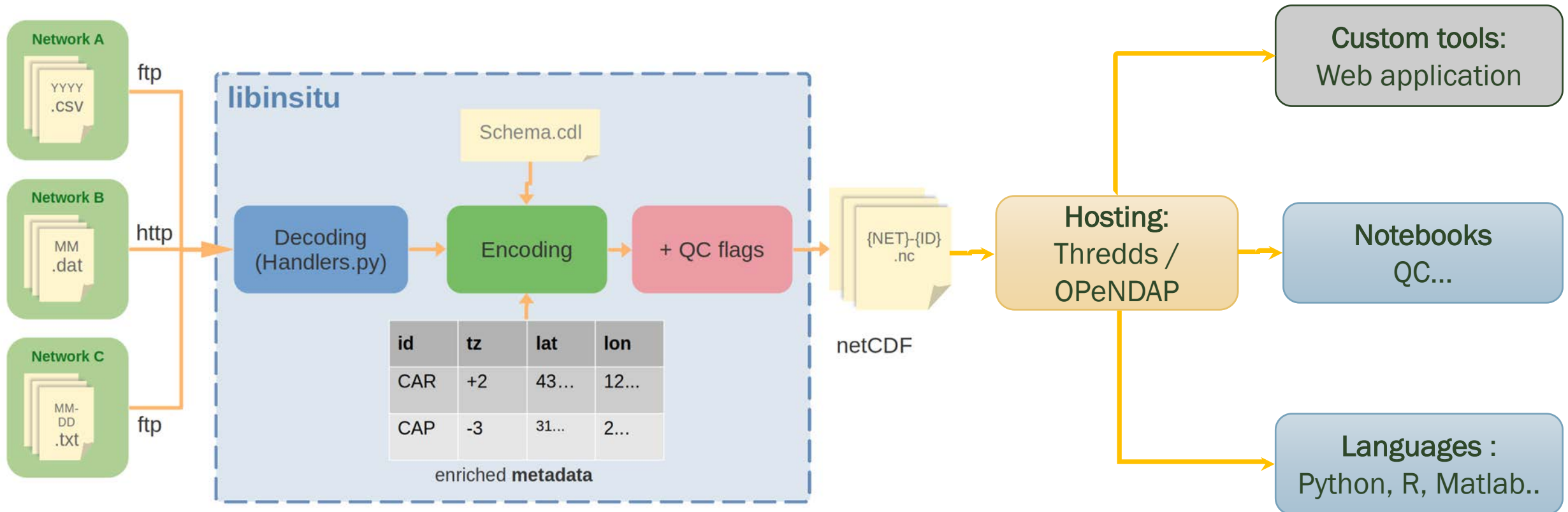


“Metadata and data should be easy to find”

GEO Portal and GEO Knowledge Hub

Operational Pipeline

libinsitu enables a **100% FAIR** approach for in-situ measurements

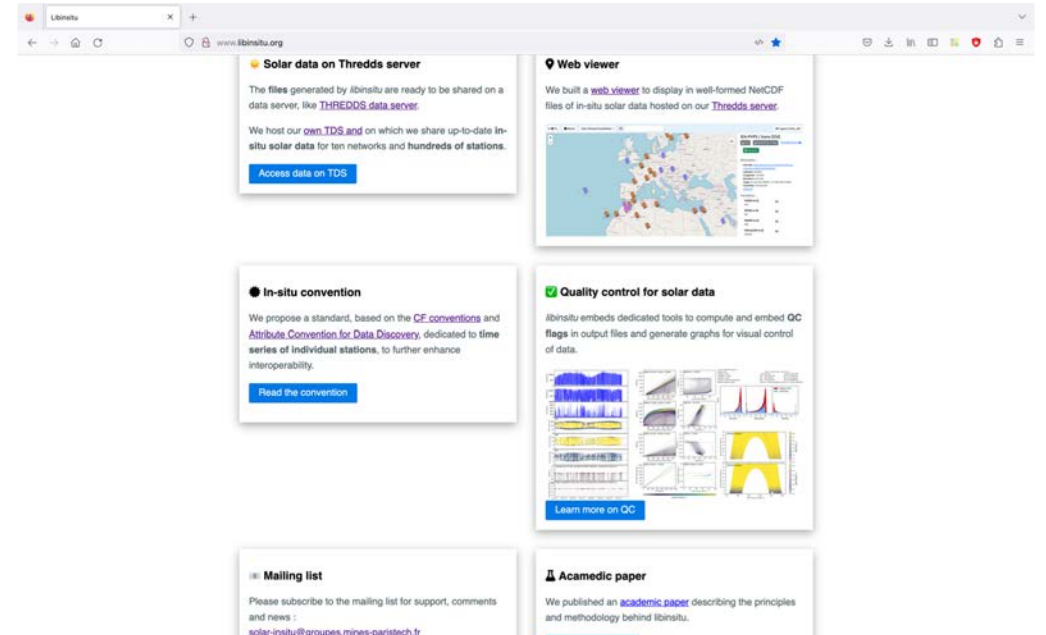
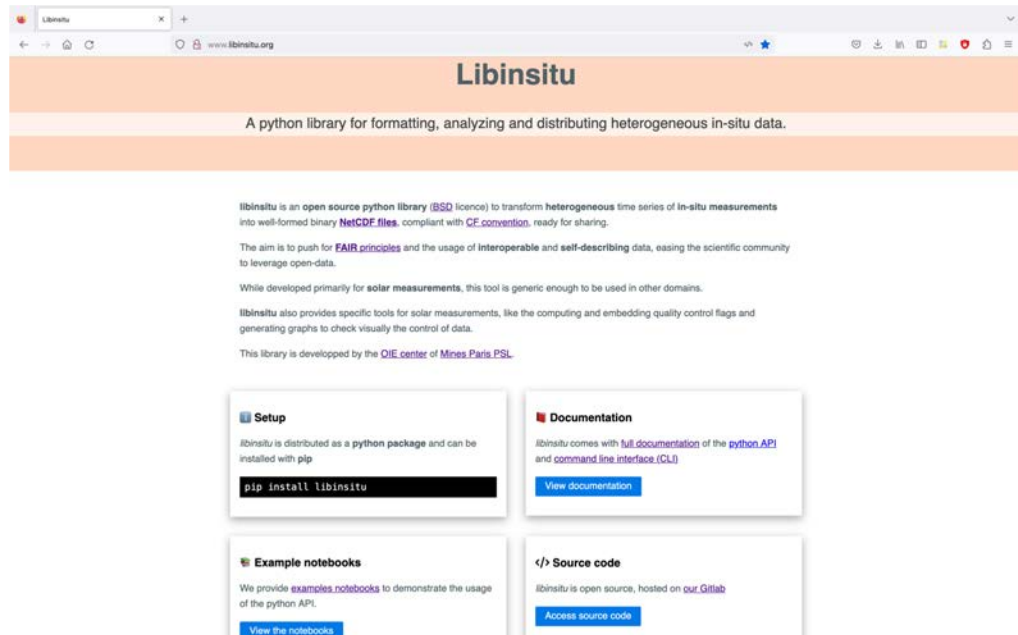




A python library for formatting, analyzing and distributing heterogeneous in-situ data.



- **Python functions and CLI utilities:**
 - **Explore & query** NetCDF files
 - **Export** to various formats
 - (CSV, JSON, text, pandas Dataframes)
 - **Flag data** with quality checks
 - Produce **graphs** for visual quality control
- **Next**
 - **Config files** (no more Python code required)
 - **Docker** (libinsitu+thredds+Web App)
 - **Interactive QC flags** for Copernicus CAMS Service



Thredds Server: hosts ground-based in-situ measurement



- OPeNDAP standard remote query
- 10 Networks
- 320 stations – 1992-2022 - Minutes
- CF-NetCDF storage **11 times average lower** (68GB | 6GB) than raw CSV



Catalog <http://tds.webservice-energy.org/thredds/catalog/solrad-stations/catalog.html>

Dataset: SOLRAD/SOLRAD-TLH.nc

- Data format: netCDF
- Data size: 554.5 Kbytes
- Data type: STATION
- ID: solrad-stations/SOLRAD-TLH.nc

Documentation:

- **summary:** The SOLRAD Network is for monitoring Surface Radiation in the Continental United States, in Collaboration with NOAA's SURFRAD SURFACE RADIATION Budget Measurement Network. For background information on the SOLRAD Network, see: B. B. Hicks, J. J. DeLuise, D. R. Matt, (1996), The NOAA Integrated Surface Irradiance Study (ISIS). A New Surface Radiation Monitoring Program Bulletin of the American Meteorological Society Volume 77, Issue 12, December 1996 pp. 2857-2864.
- <https://gml.noaa.gov/grad/solrad/>

Access:

1. OPeNDAP: [/thredds/codsC/solrad-stations/SOLRAD-TLH.nc](http://thredds.codsC/solrad-stations/SOLRAD-TLH.nc)
2. File Download: [/thredds/fileServer/solrad-stations/SOLRAD-TLH.nc](http://thredds.fileServer/solrad-stations/SOLRAD-TLH.nc)
3. NetcdfSubset: [/thredds/ncss/gird/solrad-stations/SOLRAD-TLH.nc](http://thredds.ncss/gird/solrad-stations/SOLRAD-TLH.nc)

Contributors:

- Dr. Yves-Marie Saint-Drenan (Principal Investigator)
- Prof. Philippe Blanc (Principal Investigator)
- Lionel Menard (Data Manager)

Keywords:

- SOLRAD (DIF)
- Energy (DIF)
- Renewable energy (DIF)
- in-situ (DIF)
- Measurements (DIF)
- Solar (DIF)
- MINES ParisTech (DIF)
- Webservice-Energy (DIF)
- Thredds (DIF)
- TDS (DIF)
- NetCDF (DIF)



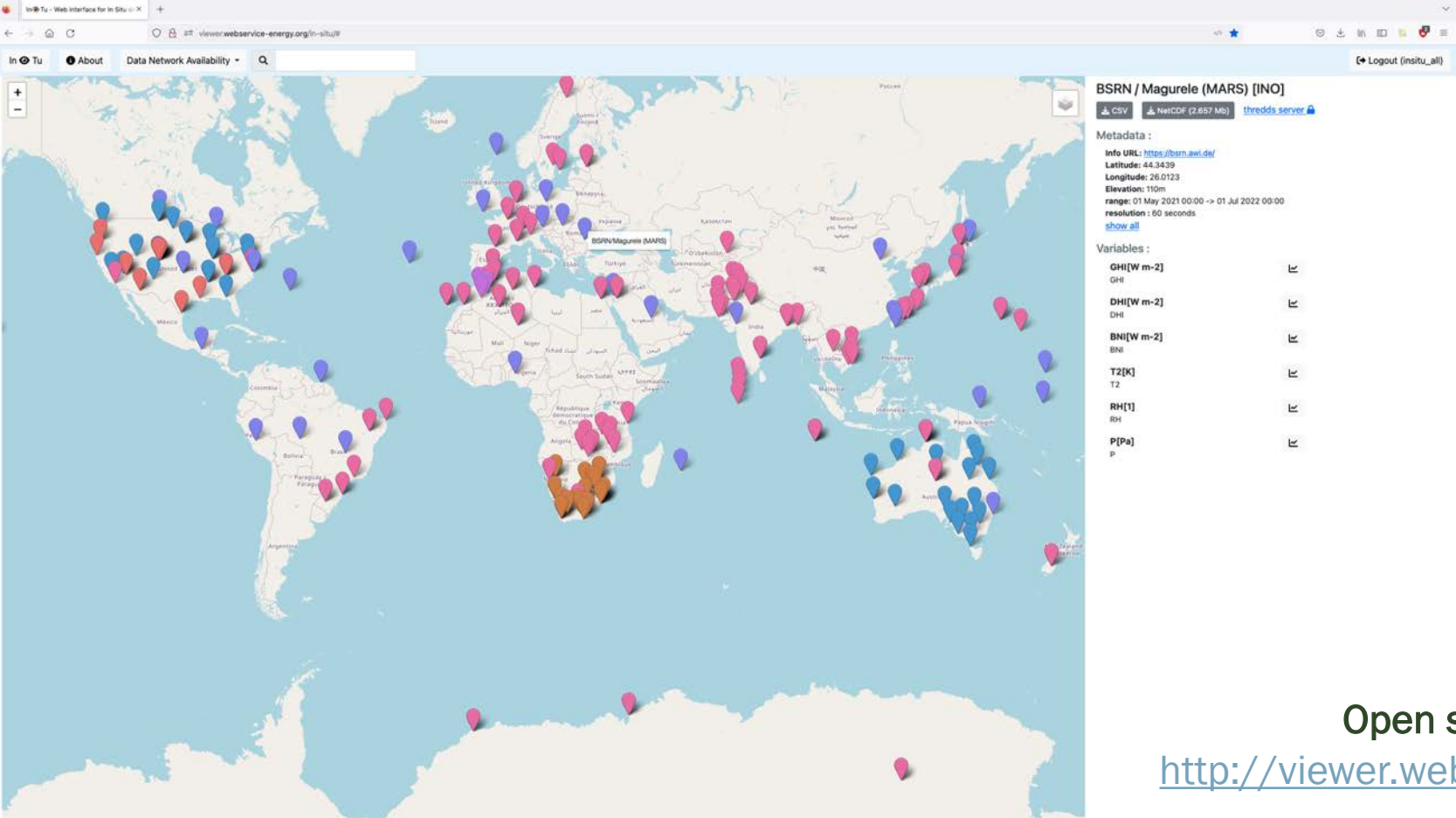
Dataset	Size	Last Modified
In-Situ		--
BOM/		--
BSRN/		--
enerMENA/		--
SKYNET/		--
ESMAP/		--
IEA-PVPS/		--
NREL-MIDC/		--
SAURAN/		--
SOLRAD/		--
SURFRAD/		--

[Webservice-Energy THREDDS Catalog at Webservice-Energy SDI](#) see [Info](#)
[REDDS Data Server \[Version 4.6.16.1 - 2021-02-23T15:50:43-0700\]](#) [Documentation](#)

Open source Web and Jupyter applications – The WOW effect !



- On-the-fly requests to Thredds via OPeNDAP

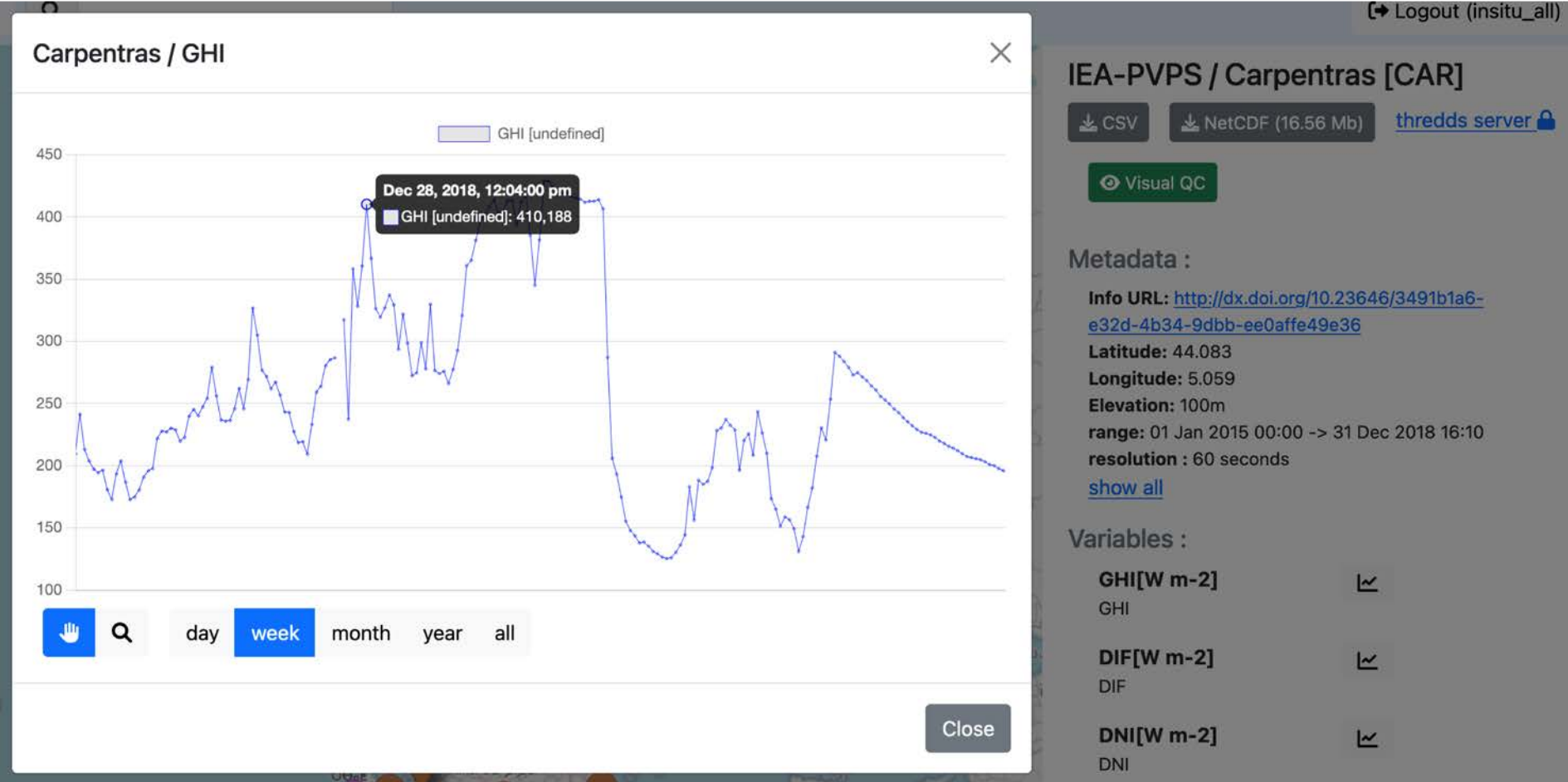


Open source Web App:
<http://viewer.webservice-energy.org/in-situ/>

Open source Web and Jupyter applications – The WOW effect !



- Dynamic graphical display



Client Web open source – L'effet Waouh !



- Dynamic access to metadata and subsetting (Time and variables)



Meta-data : BSRN / Carpentras [CAR]

Network Metadata

Station Metadata

Other

id: BSRN-CAR
title: Timeseries of Baseline Surface Radiation Network (BSRN). Station : Carpentras
summary: Archive of solar radiation networks worldwide provided by the Webservice-Energy initiative supported by MINES Paris PSL. Files are provided as NetCDF file format with the support of a Thredds Data Server.
keywords: meteorology, station, time, Earth Science > Atmosphere > Atmospheric Radiation > Incoming Solar Radiation, Earth Science > Atmosphere > Atmospheric Temperature > Surface Temperature > Air Temperature, Earth Science > Atmosphere > Atmospheric Pressure > Sea Level Pressure
keywords_vocabulary: GCMD Science Keywords
keywords_vocabulary_url: <https://gcmd.earthdata.nasa.gov/static/kms/>
record: Basic measurements (global irradiance, direct irradiance, diffuse irradiance, air temperature, relative humidity, pressure)
featureType: timeSeries
cdm_data_type: timeSeries
product_version: libinsitu 1.4.dev19+gfaabd43.d20230118
Conventions: CF-1.10 ACDD-1.3
publisher_name: Lionel MENARD, Raphael JOLIVET, Yves-Marie SAINT-DRENAN, Philippe BLANC
publisher_email: lionel.menard@mines-paristech.fr, raphael.jolivet@mines-paristech.fr, saint-drenan@mines-paristech.fr, philippe.blanc@mines-paristech.fr
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institution: Meteo France
creator_email: Dr. Amelie Driemel (<https://www.awi.de/ueber-uns/organisation/mitarbeiter/amelie-driemel.html>)

CSV/JSON

Date range
from 01/08/1996 to 01/01/2019

Resolution
15 minutes

Variables

- GHI (GHI)
- DHI (DHI)
- BNI (BNI)
- T2 (T2)
- RH (RH)
- P (P)
- QC (QC)

Meta data

- Include header with meta data
(may cause issues with CSV for some readers)

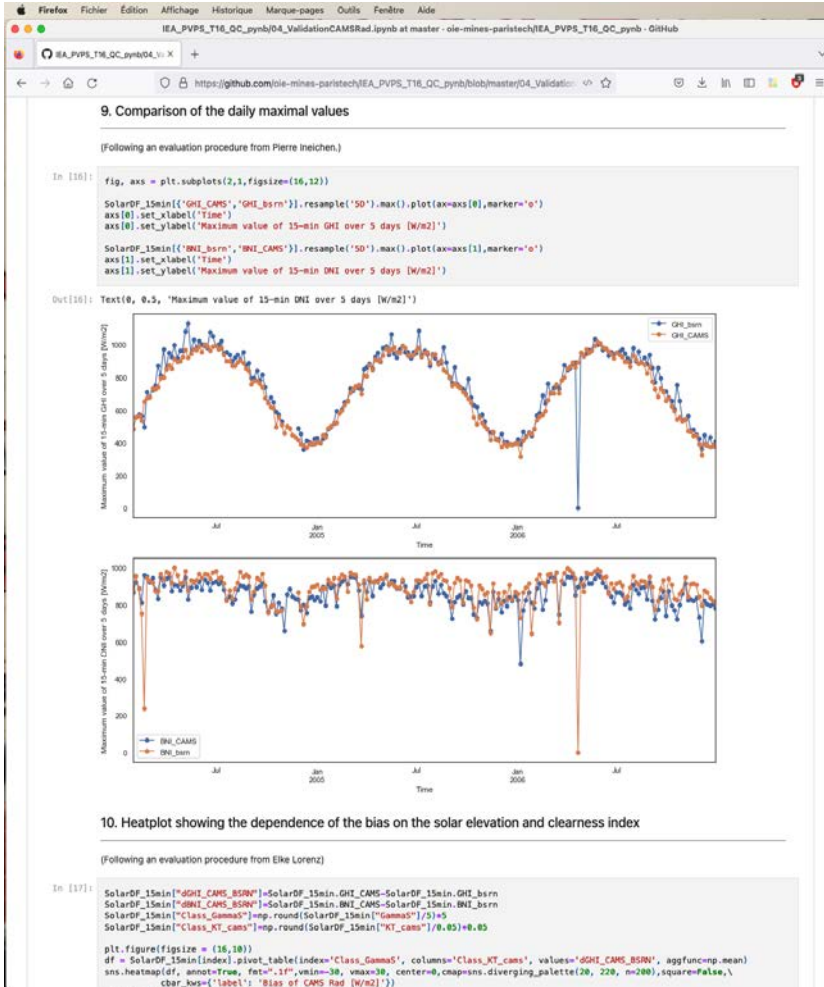
786048 samples

[Download JSON](#) [Download CSV](#) [Close](#)

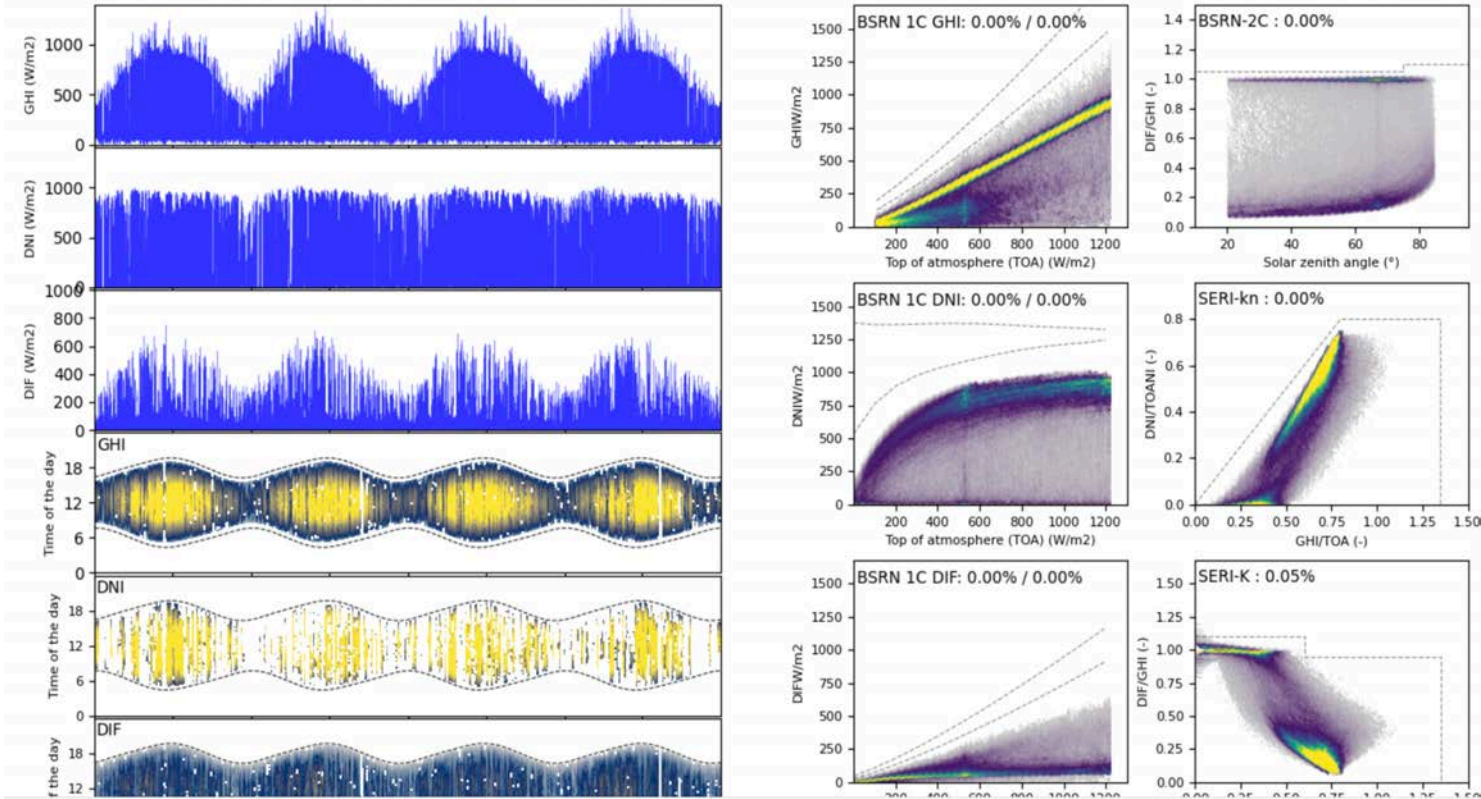
Open source Web and Jupyter applications – The WOW effect !



- Access to open source Jupyter Notebook QC procedure available on GitHub



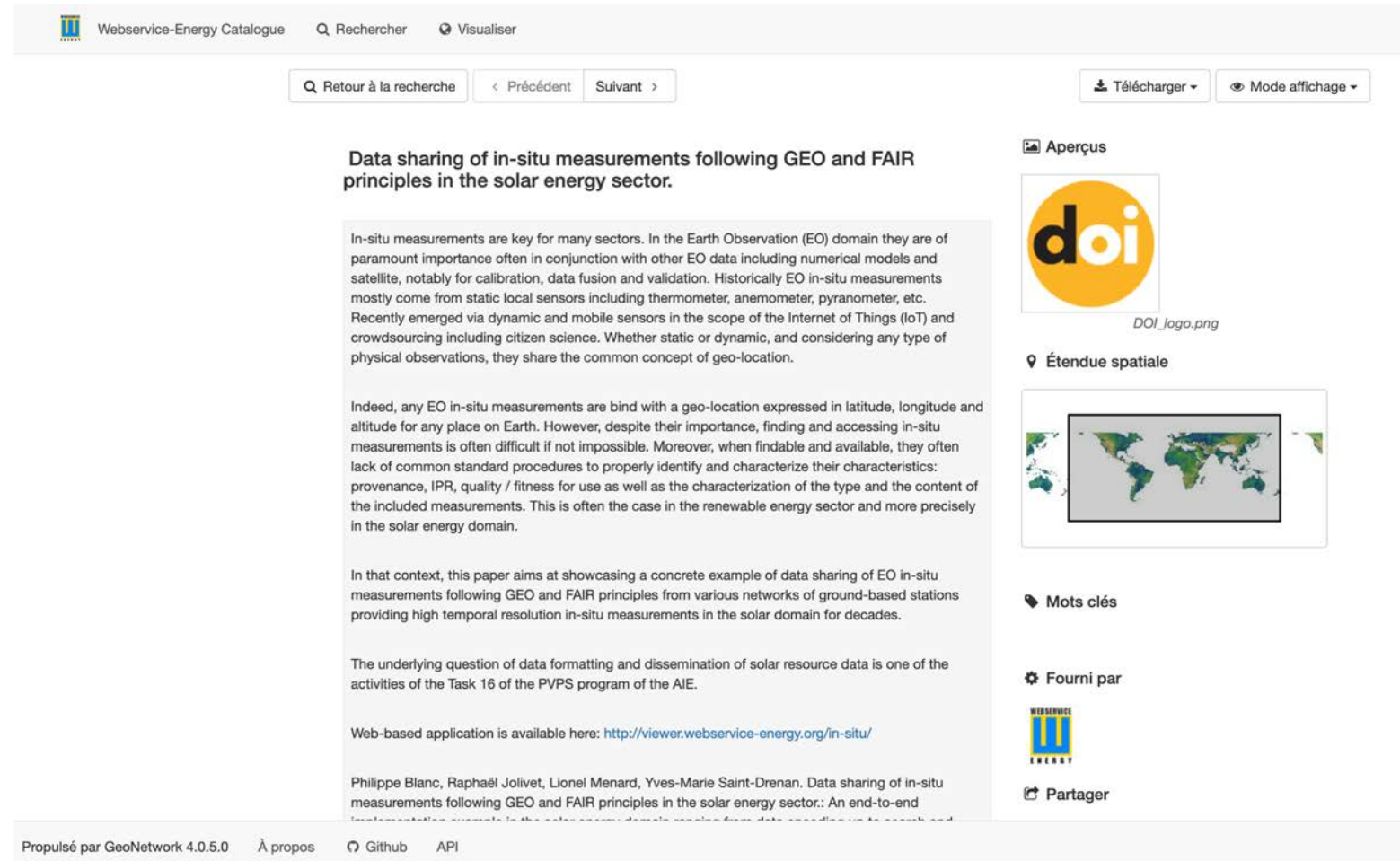
Quality check for station IEA-PVPS / Carpentras [CAR]



Dissemination: GEO Knowledge Hub and GEO Portal



- Metadata records on GEO community catalogue webservice-energy
- Harvested by GEO Portal (DAB)
- GKH Package



The screenshot shows a search results page from the 'Webservice-Energy Catalogue'. The main heading is 'Data sharing of in-situ measurements following GEO and FAIR principles in the solar energy sector.' The page contains several paragraphs of text describing the importance of in-situ measurements in the Earth Observation domain, the challenges of finding and accessing them, and the goal of the paper to showcase a concrete example of data sharing. A link to a web-based application is provided: <http://viewer.webservice-energy.org/in-situ/>. The page also features a sidebar with a 'doi' logo, a world map under 'Étendue spatiale', and 'Mots clés' and 'Fourni par' sections. The footer indicates the page is powered by GeoNetwork 4.0.5.0 and includes links for 'À propos', 'Github', and 'API'.

Dissemination: GEO Knowledge Hub and GEO Portal



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GEOSS Portal

FAIR

FILTERS

Data sharing of in-situ measurements following GEO a...
(Organisation: Webservice Energy Catalog)

In-situ measurements are key for many sectors. In the Earth Observation (EO) domain...

Data sharing of in-situ measurements following GEO and FAIR principles in the solar energy sector. 👁️ 4 ⭐ 0.0

In-situ measurements are key for many sectors. In the Earth Observation (EO) domain they are of paramount importance often in conjunction with other EO data including numerical models and satellite, notably for calibration, data fusion and validation. Historically EO in-situ measurements mostly come from static local sensors including thermometer, anemometer, pyranometer, etc. Recently emerged via dynamic and mobile sensors in the scope of the Internet of Things (IoT) and crowdsourcing including citizen science. Whether static or dynamic, and considering any type of physical observations, they share the common concept

See more

Sources: **GEOSS (1)**

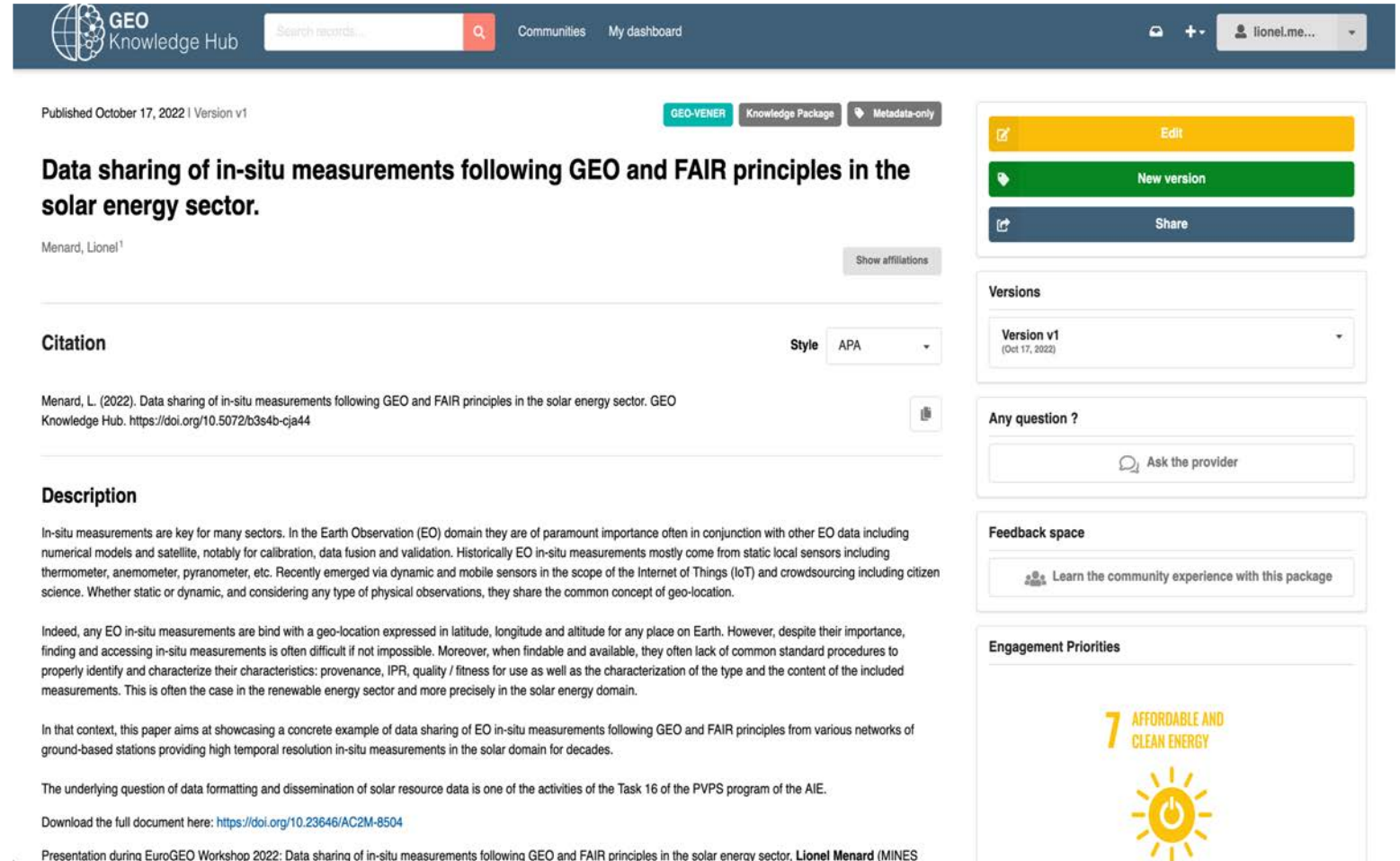
SEE ALSO

- dynamic aspects
- effects and single events
- event
- activities
- physical operations
- manipulation, production, consumption
- trade (services)

Dissemination: GEO Knowledge Hub and GEO Portal



- Metadata records on GEO community catalogue webservice-energy
- Harvested by GEO Portal (DAB)
- GKH Package



The screenshot shows the GEO Knowledge Hub interface. At the top, there is a navigation bar with the GEO Knowledge Hub logo, a search bar, and links for 'Communities' and 'My dashboard'. The user profile 'lionel.me...' is visible in the top right. The main content area displays the title 'Data sharing of in-situ measurements following GEO and FAIR principles in the solar energy sector.' by 'Menard, Lionel'. It includes a 'Citation' section with a citation in APA style: 'Menard, L. (2022). Data sharing of in-situ measurements following GEO and FAIR principles in the solar energy sector. GEO Knowledge Hub. <https://doi.org/10.5072/b3s4b-cja44>'. A 'Description' section follows, discussing the importance of in-situ measurements in Earth Observation and the challenges of data sharing. The right sidebar contains action buttons for 'Edit', 'New version', and 'Share', along with sections for 'Versions', 'Any question?', 'Feedback space', and 'Engagement Priorities'. The 'Engagement Priorities' section features a sun icon and the text '7 AFFORDABLE AND CLEAN ENERGY'.

Final wrap-up

- **libinsitu ! Open, free, documented and exemplified:** www.libinsitu.org
- **FAIR and GEO consistent and efficient pipeline**
 - Storage, download, remote request, extract specific time range, specific parameters,...
- **Thredds server (NetCDF-CF) is currently supporting:**
 - **Validation of Copernicus products: CAMS Radiation and CAMS Mc-Clear**
 - On-going discussion with **in-situ network providers:** BSRN, SKYNET, WMO, SAEON, PV-Live
- **Replicable for any type of in-situ measurement !**
 - Marine Radioactivity Information System (**MARIS**) community
- Free and open **working paper:** <https://doi.org/10.23646/AC2M-8504>
 - 509 Views and 146 Downloads (As per 2024-05-31)
- Dialog engagement via a free and **public mailing-list:**
<https://groupes.minesparis.psl.eu/wws/info/solar-insitu>



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Leveraging Earth Observation Data and Knowledge

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CSIR International Convention Centre, Pretoria, South Africa



Thanks for you attention

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