Copernicus Climate Change Service (C3S) Energy Seminar

Climate Change

Global Solar PV Indicator

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PROGRAMME OF THE EUROPEAN UNION
Copernicus Europe's eyes on Earth
IMPLEMENTED BY ECMWF
ICS Inside Climate Service
ARMINES

Goals for this session:

Introduce the Global Solar PV indicator

Target topics:

- Context on the technology and the indicator itself
- Modelling workflow
- Some practical considerations
- Expectations for the future

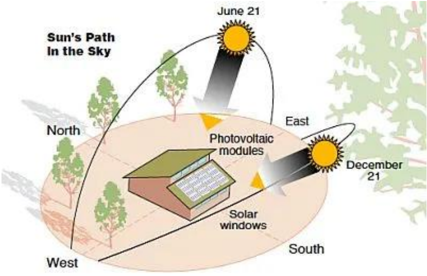
Giving context to the technology

PV is known for its modularity and adaptability, so it is easy to find it in very different contexts

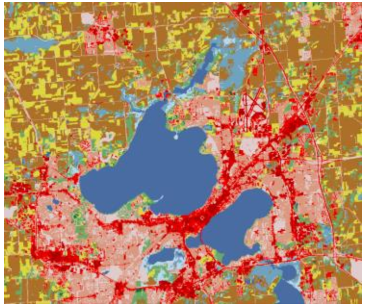
Giving context to the environmental factors

Different levels of dependency towards three main factors

Weather



Angle of incidence



Land use

Giving context to the indicator

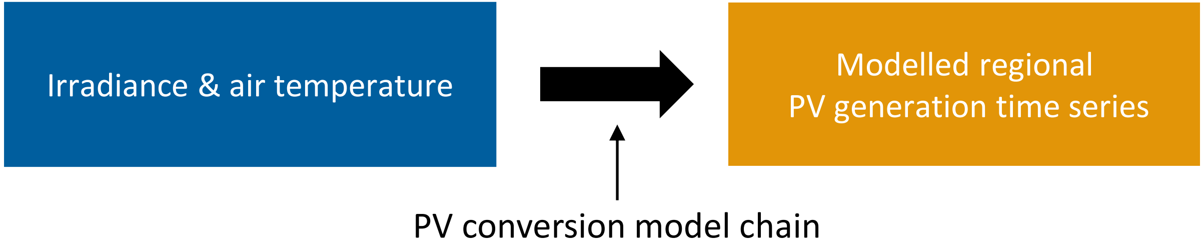
Capacity Factor, the expected generation per unit of installed capacity

- Wh/Wp, or any equivalent (e.g., kWh/kWp, MWh/MWp, etc.)
- Allows to compare regions and even time periods
- Adapts to end-user scenario, since:

$$PV_{generation} = \text{Capacity Factor} \times \text{Installed Capacity}$$

Modelling workflow

Physically-based approach, based on own methodology, doi: 10.5194/asr-15-51-2018



Considered losses: optical, thermal, electric (DC & AC)

Not considered: module degradation, curtailment, shading, coupling to storage

Data streams

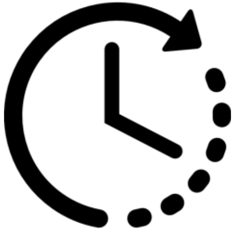
Aiming for historical, operational, and prospective analysis

Historical: ERA5 reanalysis* (1950 onwards)

Climate projections: CMIP6** (up to 2100)

For 2023, monthly averaged values are expected

Later it will be improved to hourly



* Hersbach et al. (2020), doi: 10.1002/qj.3803

** Eyring et al. (2016), doi: 10.5194/gmd-9-1937-2016

PV geometry

Considers a plausible regional-level PV module tilt and orientation representation

- Location-specific distribution
  - Centered in 70% optimal tilt and South orientation
  - Derived & expanded from real installations in

Looking for complementary data sets to increase robustness

BDAPPV
BASE DE DONNÉES D'APPRENTISSAGE PROFOND PV
Un outil aux service de tous.

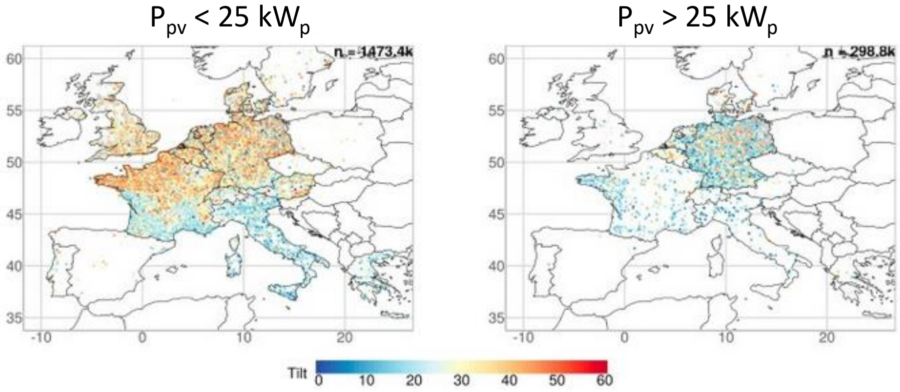
PVOutput

Images generated in dezgo.com

Climate Change

PV geometry

An example from Killinger et al. (2018)*



* doi: 10.1016/j.solener.2018.08.051

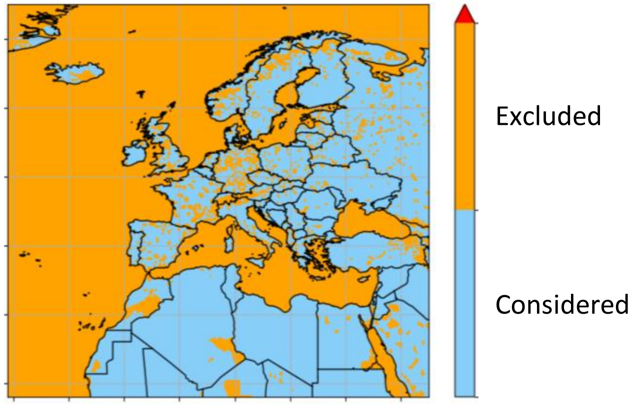
Exclusion areas

Leveraging on diverse data:

- Land use (X water bodies, protected areas)
- Orography (X high-slope, high elevation)

⚙ Expected to refine this with high-resolution PV deployment data

- Chile is a particular case where we can find PV at very high elevation levels



Some computational aspects

Lots of calculations implied:

- 3 dimensions: time, space, and module tilt/orientation (due to mix)

Need for optimizing and parallelizing our code (interacting with ICS Inside Climate Service)

Ongoing efforts to make computations more efficient

Some methodological aspects

Being a physically-based approach:

- PV data is mostly used for setting up assumptions and validation
- Extending assumptions in time and space, less dependent on data issues (lack of data, low quality data)
- It does not assimilate curtailment, malfunction, & storage effects (which is good and bad)

Take-away message

⚙ Overview of the Solar PV indicator and its modelling workflow

⌛ Exciting new things in the pipeline

- Improve time resolution to hourly
- Contribute to future CDS toolbox: modelling of specific PV technologies
  - Tracker, possibly bifacial, floating

Would like to thank the C3S team for their collaboration

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