

Earth Observation: New Challenges in Solar Energy Resource

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Laboratory of Atmospheric Physics, University of Patras (in brief)

- **University of Patras (UPAT):** Founded in 1964 (upatras.gr)
The third largest University in Greece, 35 Departments, 178 laboratories and clinics



- **Laboratory of Atmospheric Physics**

Team of 30 researchers (Professors, postdocs, PhD and MSc, Lab assistants)

Research Activities:

Solar Radiation resource forecasting

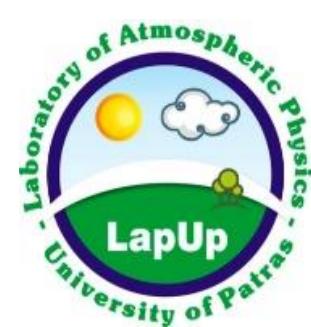
Weather and atmospheric pollution monitoring and modeling

Artificial intelligence methods in atmospheric and environmental physics

Stable isotopes ($\delta^{18}\text{O}$ & $\delta^2\text{H}$) in rain and in atmospheric water vapor

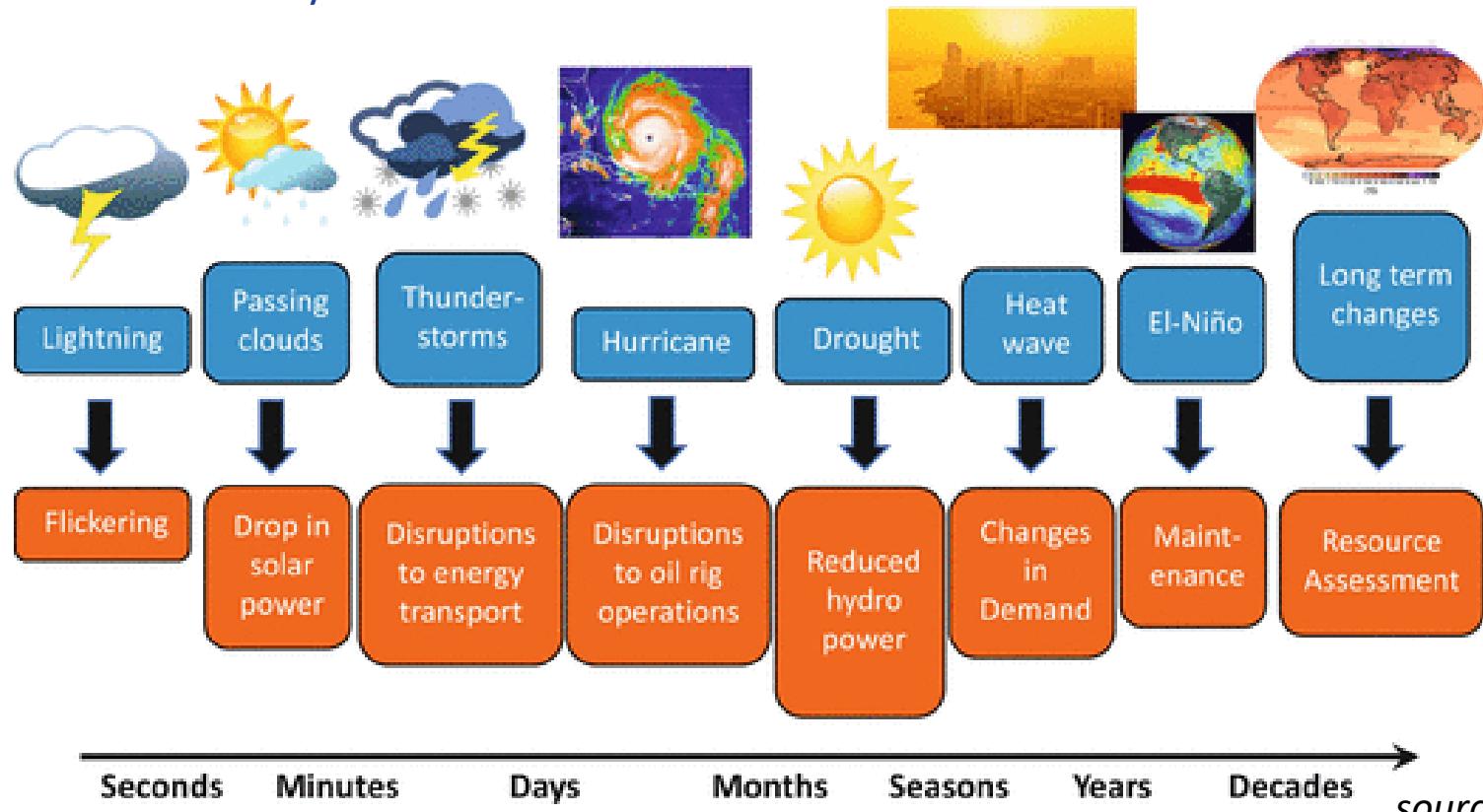
Ultraviolet radiation: Measurements, modeling and biological dose rates

Early warning models of epidemic spread



What is Energy Meteorology?

- **Energy Meteorology is in the interface of renewable energy and atmospheric physics.**
- Atmospheric physics is needed for the **assessment** and **forecasting** of the power output from solar and wind energy systems as well as for the **planning, monitoring, and efficient operation** of these systems.



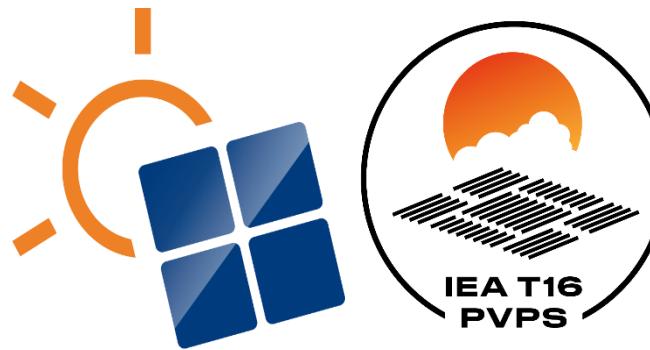
source: WEMC

What energy meteorology offers to the solar sector?

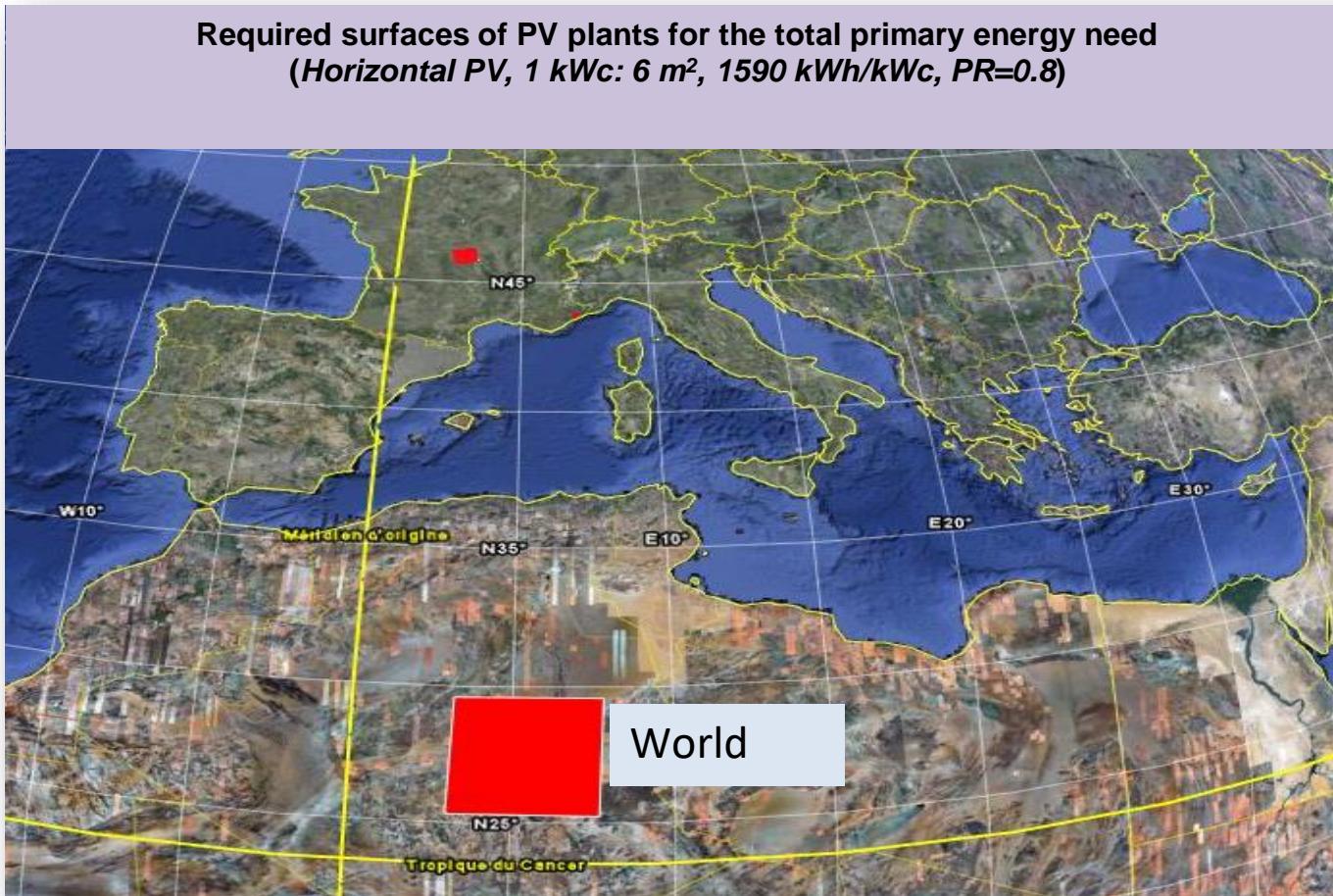
- Higher penetration in the energy mix and efficient grid integration
- Efficient use of large scale applications

Most important:

International collaboration and consensus



Huge quantity of energy from the Sun ($175 \cdot 10^6$ GW)

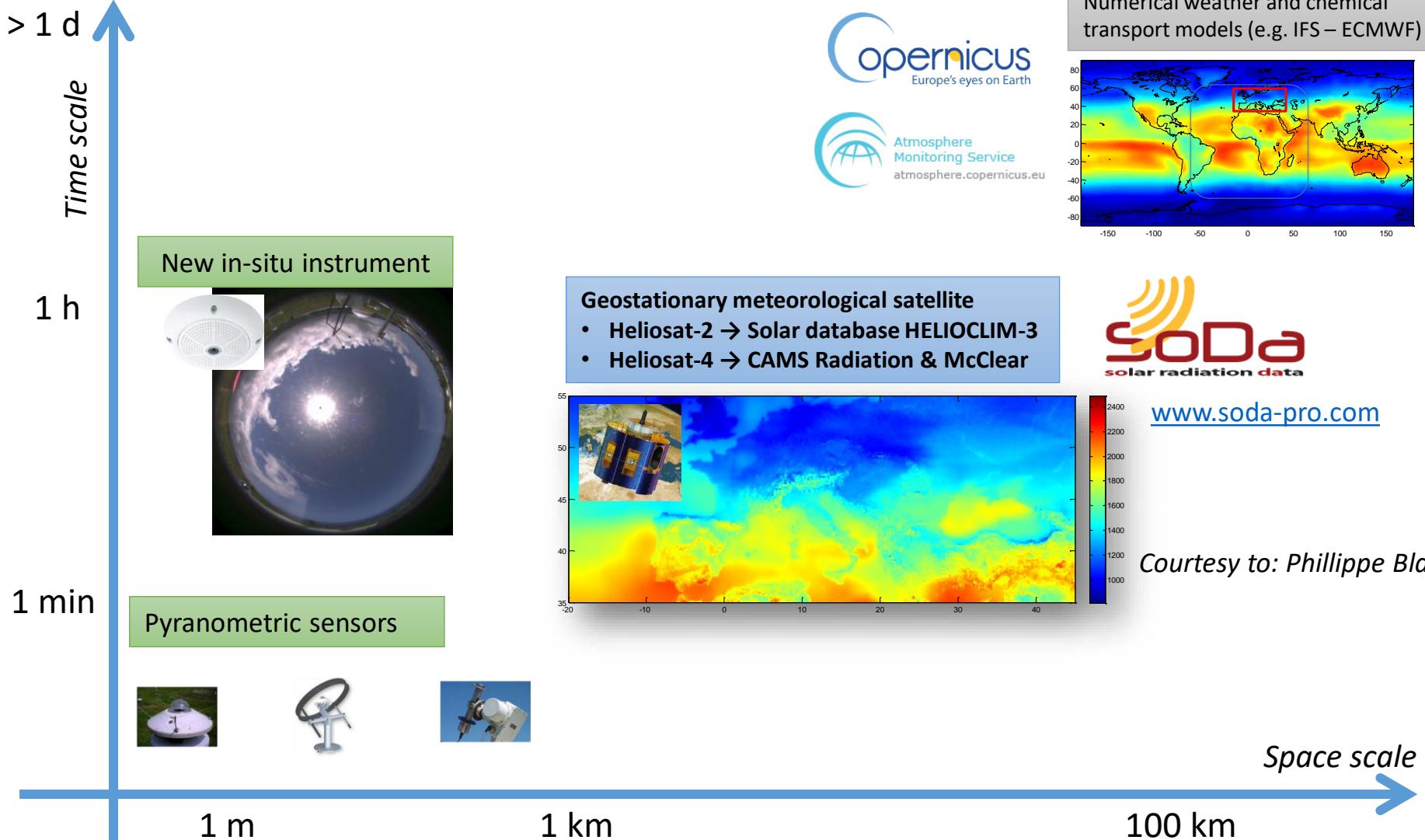


107 TWp @Capacity factor of 18 %, $800 \text{ km} \times 800 \text{ km} = 640,000 \text{ km}^2$

< 1.25 % of the land-use for agriculture, Equivalent of the surface of cities (2015)

Earth Observation systems for Solar Energy

Different time and space scales of solar resource assessment

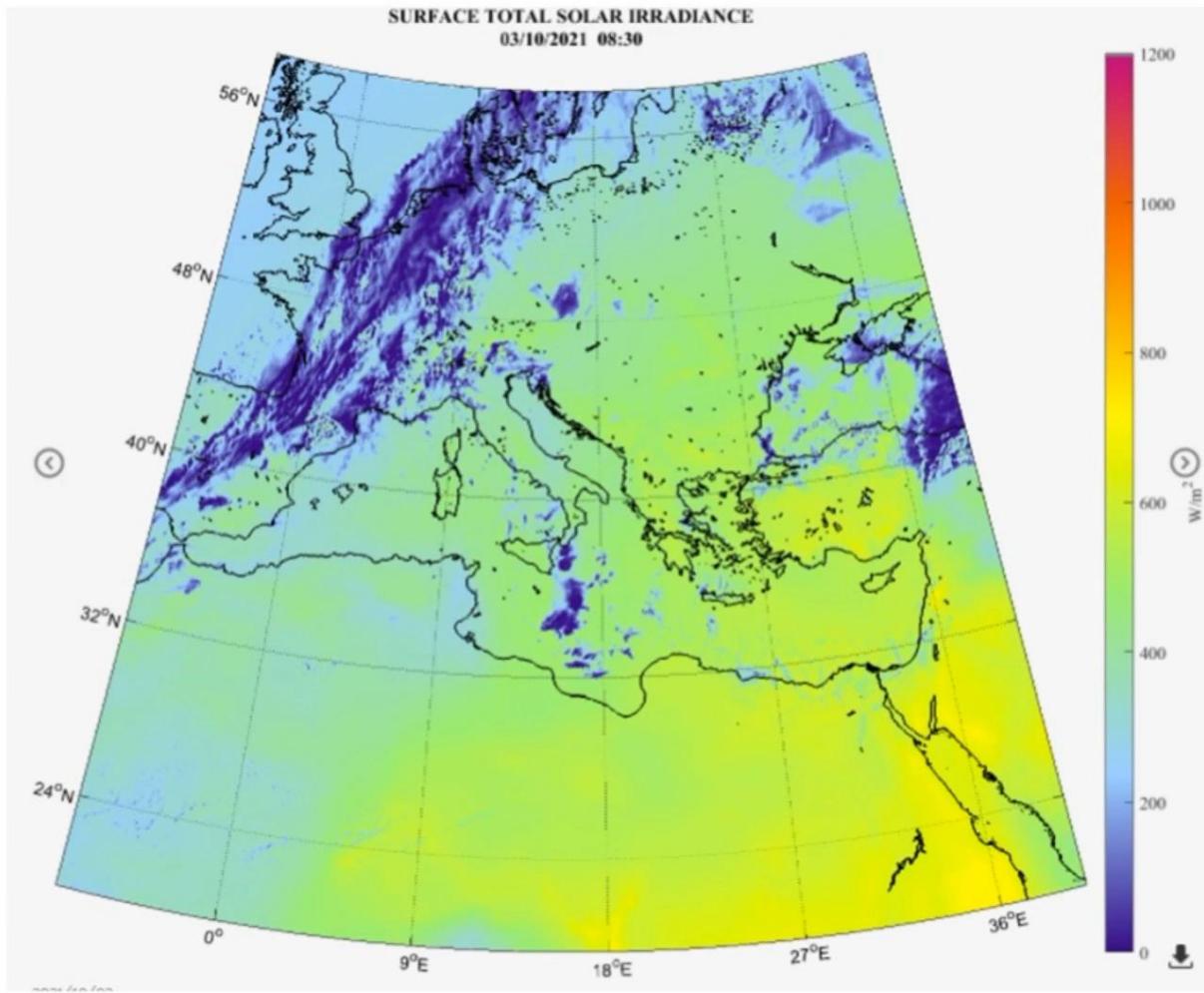


Satellite-derived information: Architecture and Strategy



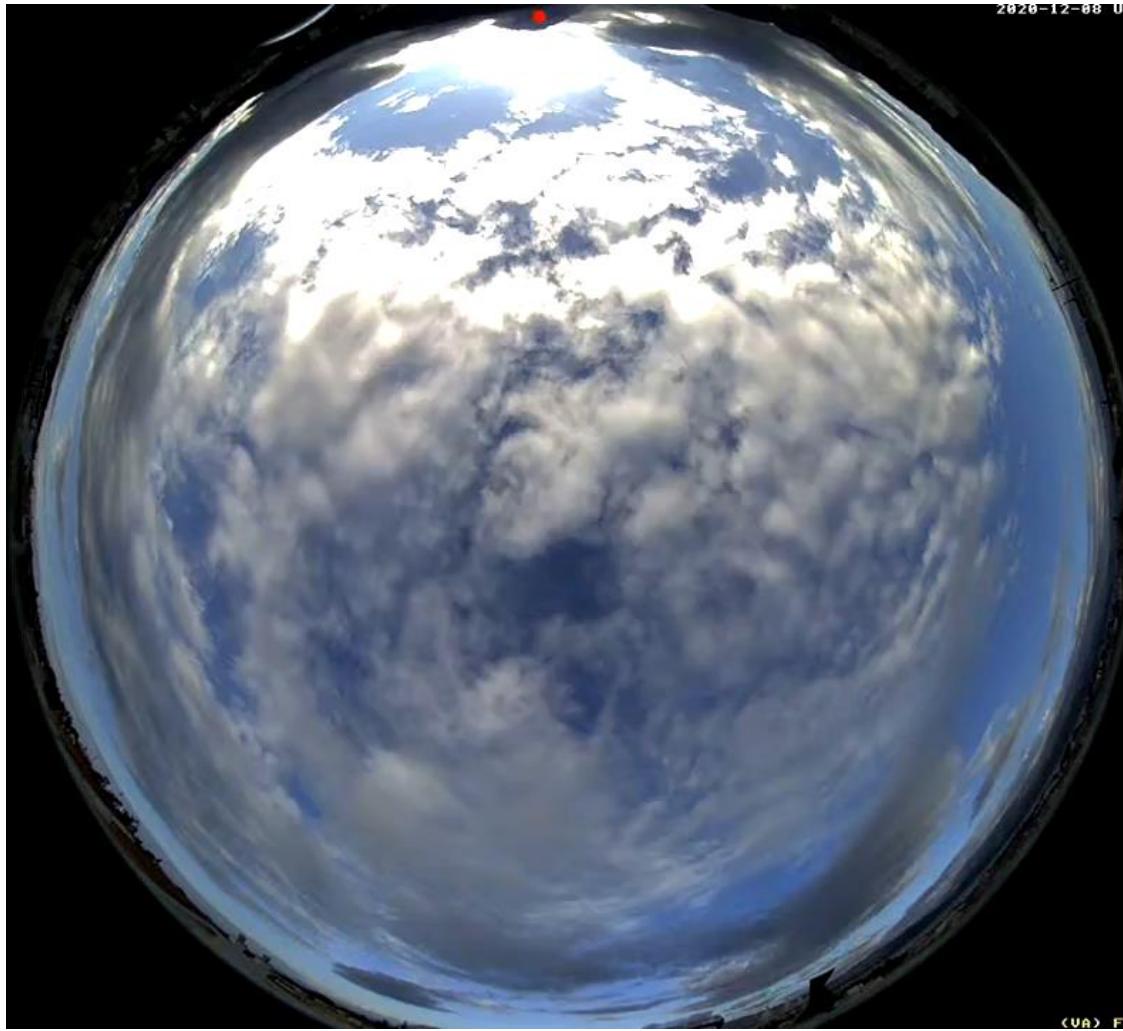
source: BEYOND EO Center

Satellite-derived information: A closer step to city scale?



source: BEYOND EO Center

The ground truth

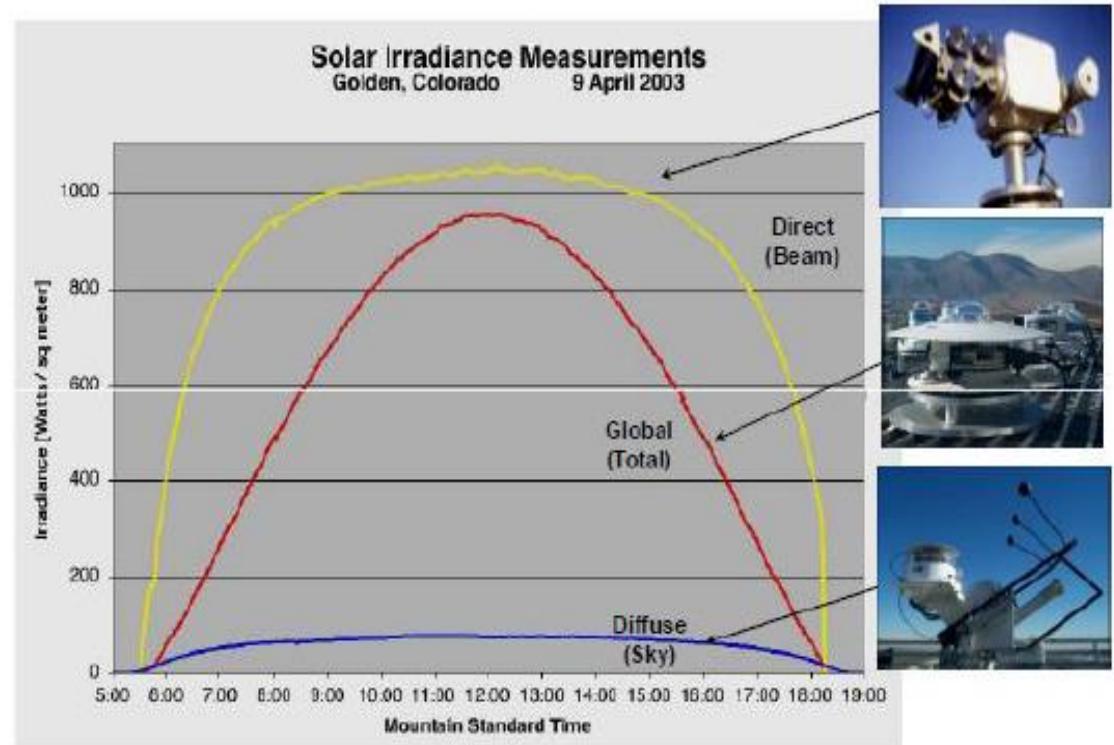


source: DeepSky-project.com

Direct, diffuse and global irradiance

- **Global horizontal irradiance (GHI):** Solar radiation measured with an instrument mounted horizontally
- **Diffuse horizontal irradiance (DHI):** Measured using an instrument that has a shade to block out the direct radiation.
- **Beam normal irradiance (BNI)** is measured using an instrument that tracks the sun and shades out the diffuse, it only records the direct component.

$$\text{GHI} = \text{BNI} \times \cos\theta + \text{DHI}$$



http://www.nrel.gov/midc/srrl_bms

Concentrating solar power and photovoltaics



Source: <https://helioscsp.com/>

CAMS Radiation Service (CRS)

The screenshot shows the top portion of the CRS website. At the top left is the browser's address bar with the URL "Not secure soda-pro.com/web-services/radiation/cams-radiation-service". To the right of the address bar are various browser icons. Below the address bar is a horizontal navigation bar with several items: "Apps", "Ερευνητικές Συνεργ...", "Home - Performanc...", "SpaceTimeWorks, L...", "EU partnerships", "drones", "calls", "conferences 2018", "conferences 2017", "balloons", "International Projects", "cameras&airPollution", and "Copernicus meetin...". On the far right of the navigation bar are links for "Other bookmarks" and "Reading list". Below the navigation bar is the main header area. On the left is the "Atmosphere Monitoring Service" logo. In the center, it says "Implemented by ECMWF as part of The Copernicus Programme". On the right is a search bar with placeholder text "Search...", fields for "Email Address" and "Password", and buttons for "Sign In", "Create Account", and "Forgot Password".

CAMS Radiation Service

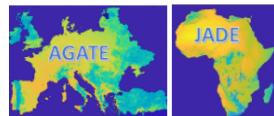
A Copernicus Service

<< Back to SoDa

Copernicus Atmosphere Monitoring Service (CAMS) radiation service provides time series of Global, Direct, and Diffuse Irradiations on horizontal surface, and Direct Irradiation on normal plane (DNI) for the actual weather conditions as well as for clear-sky conditions. The geographical coverage is the field-of-view of the Meteosat satellite, roughly speaking Europe, Africa, Atlantic Ocean, Middle East (-66° to 66° in both latitudes and longitudes). Time coverage is 2004-02-01 up to 2 days ago. Data are available with a time step ranging from 1 min to 1 month. [Licence terms](#)

The CAMS Radiation Service is limited to [100 requests per day](#). As the time of on-the-fly computations is quite high, this limitation prevents our servers from overload, which would endanger the SoDa Service as a whole. Please be aware that any abuse will automatically result in the desactivation of your SoDa account credentials.

Current version is 4.0.



to download a volume of CAMS radiation and CAMS McClear over Europe or Africa

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CAMS Radiation Service (CRS)

You can select site, start/end date and time step

Not secure | soda-pro.com/web-services/radiation/cams-radiation-service

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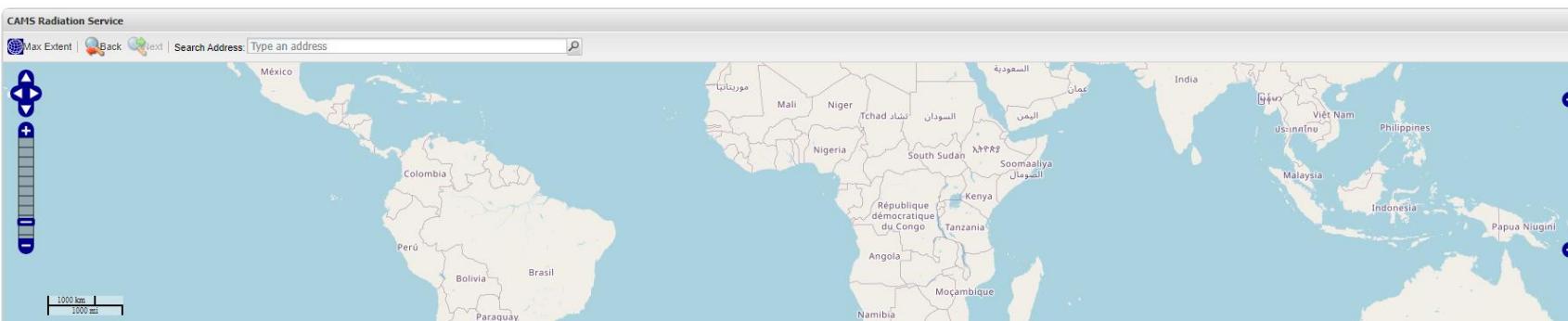
Max Extent | Back | Next | Search Address: Type an address

Latitude (in [-66°, 66°]): Select point in map Start Date (from 2004-02-01): 2004-02-01 Time Reference: Universal Time

Longitude (in [-66°, 66°]): Select point in map End Date (up to today-2): 2004-02-29 Include detailed info on atmosphere (1 min UT.csv): False

Altitude (in meters, Automatic if empty): Automatic Time Step: 15 min Output Format: Comma Separated Value (.csv)

Process



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CAMS Radiation Service (CRS)

*By clicking on proves button, you get the result file (highlighted in blue).
The file is downloaded when you click on it.*

The screenshot shows the CAMS Radiation Service (CRS) interface. At the top, there is a browser header with tabs like "Not secure | soda-pro.com/web-services/radiation/cams-radiation-service", "Apps", and "Other bookmarks". Below the header is a search bar with "Search Address: Type an address" and a magnifying glass icon. The main area features a world map with country boundaries and names. A red crosshair marker is positioned over South America. On the left side of the map is a vertical zoom control with a "1000 km" and "1000 mi" scale bar. Below the map is a search form with the following fields:

Coord: x = 379, y = 1 lat = 25.44294, lon = -90.09576 zoom = 3	Done.	
Latitude (in [-66°, 66°]): -7.92904	Start Date (from 2004-02-01): 2004-02-01	Time Reference: Universal Time
Longitude (in [-66°, 66°]): -54.23639	End Date (up to today-2): 2004-02-29	Include detailed info on atmosphere (1 min UT .csv): False
Altitude (in meters. Automatic if empty): Automatic	Time Step: 15 min	Output Format: Comma Separated Value (.csv)

At the bottom of the form are buttons for "Process" and "Result file".

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L 67°F Mostly sunny ENG 10:53 PM 22/10/2021

The challenge



A solar energy company is considering to build a new solar farm in one of the five following cities: Barcelona (Spain), Ghent (Belgium), Berlin (Germany), Nancy (France), and Nicosia (Cyprus).

Find out which city will provide the highest revenues based on the solar potential and decide where to build their next solar farm!