



Coordinating and integrating state-of-the-art
Earth Observation Activities in the regions of
North Africa, Middle East and Balkans
and Developing Links with GEO related initiatives
toward GEOSS

GEO-CRADLE Project Meeting 2
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Update on the use of EO and Copernicus related products for the energy pilot

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Introduction



In the framework of GEO-CRADLE we introduce the refined Solar Energy Nowcasting System (SENSE) pilot in order to coordinate, improve and support the regional EO infrastructures and capabilities related to "access to energy". The niche for this pilot is the operational, satellite-driven and real-time system for solar energy nowcasting and forecasting.

SENSE will be a starting point for energy related short future investments towards and beyond the implementation of GEO, GEOSS and Copernicus Energy related products and activities and visioning innovative high-end applications and technologies. Towards this direction, the SENSE's refined objectives are:

- ✓ Effective dissemination of the high precision and resolution nowcasting and forecasting solar energy services for the fulfillment of the regional needs taking advantage of the nowadays satellite data and integration (GEOSS), efficient envision of new but crucial model inputs (CAM5) and state-of-the-art real time solar energy calculating system capabilities (SENSE).
- ✓ Development of reliable, high resolution solar Atlases and broader climatology studies (EUMETSAT) for the RoI.
- ✓ Engraving strategy methods of how to integrate such a solar energy nowcasting system into a wider GEOSS driven system in the international scale, making the whole effort of the participating partners "a possession for all time".

Introduction

FOR ACCURATE SURFACE SOLAR INSOLATION FORECASTS,
WE NEED TO UNRAVEL THE COMPLEXITY OF THE
ATMOSPHERE

Our research effort has been geared toward providing a solution to this problem by developing a accurate and fast system for the calculation of surface solar radiation spectra at high resolution and frequency using geostationary satellite data where cloud and aerosol effects are implicit.



BEHIND THE MAPS LIES DEEP SCIENCE

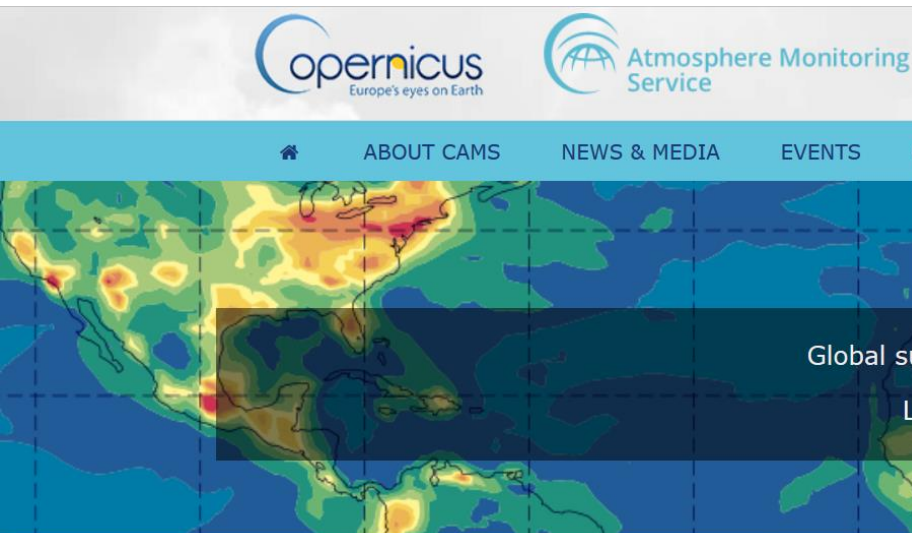
We have developed a new system for satellite retrieval of high frequency, high spatial resolution, direct normal, global and diffuse horizontal irradiance (DNI, GHI and DHI) spectra at the Earth's surface that include the effects of clouds and aerosol. The total DNI, GHI and DHI in each pixel is a reliable estimate of the solar energy, whatever the weather.

The Solar Energy Nowcasting System (SENSE)





Copernicus real time data



Climate and Energy

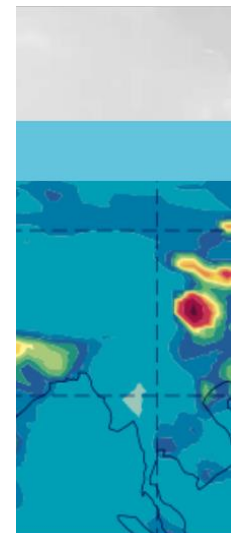
The international community agrees that human reliance on burning fossil fuels for energy is considered to be one of the causes of global climate change, and on the other hand, we face a looming energy crisis as the threat of peak oil approaches.

By 2020, at least 20% of the energy supply in the EU should stem from renewable sources. Wind, a proven source of clean, affordable energy, will play a key role in reaching this binding target. The sun is also an amazing source of sustainable renewable energy: Deserts get more energy from the sun in one day than mankind consumes in one year.

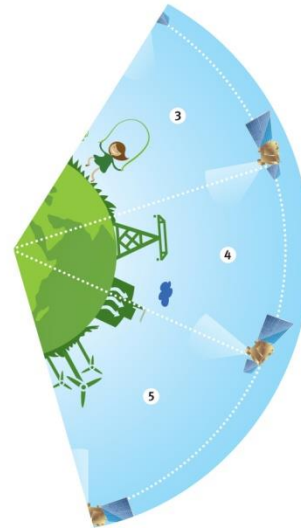
Copernicus can support the efficient exploitation of these renewable energies, which will help to meet the growing global energy demands without increasing CO₂ emissions.

For instance, the Copernicus Marine Environment Monitoring Service provides information relevant to offshore wind farms, such as wind speed, wind fields and wave size and frequency. These parameters are crucial in determining where wind energy can be generated in the most cost-effective way whilst reducing the risks of damage.

Another example is the Copernicus Atmosphere Monitoring Service, which monitors the atmospheric conditions having an impact on the solar radiations that reach the Earth surface and provides the solar energy sector and public authorities with suitable and accurate information for a better management of solar energy.



EO for energy



5 CARBON MANAGEMENT

An icon for carbon management showing a sun, a leaf, and a tree.

3 PUBLIC HEALTH	4 ENERGY MANAGEMENT
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An icon for public health showing a caduceus (a staff with two snakes and wings).An icon for energy management showing a power transmission tower.


UV-index

3 PUBLIC HEALTH

A green icon of a caduceus, a staff with two snakes entwined and wings at the top, symbolizing medicine and public health.

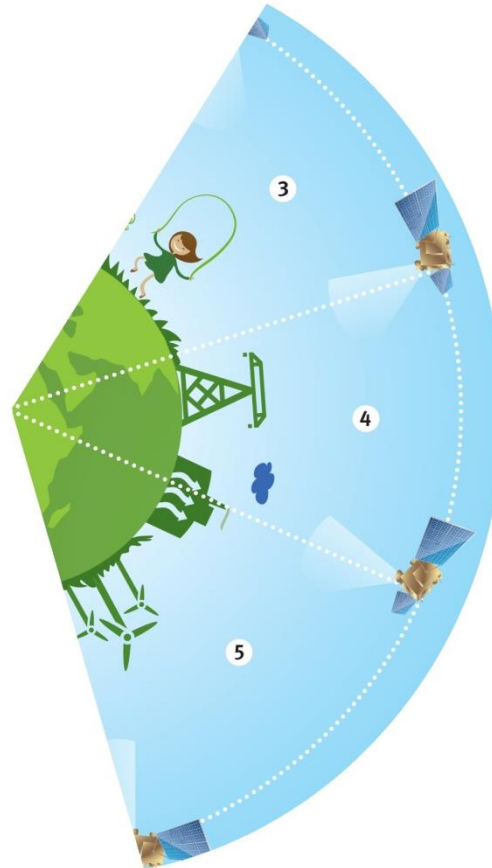
Energy planning

4 ENERGY MANAGEMENT

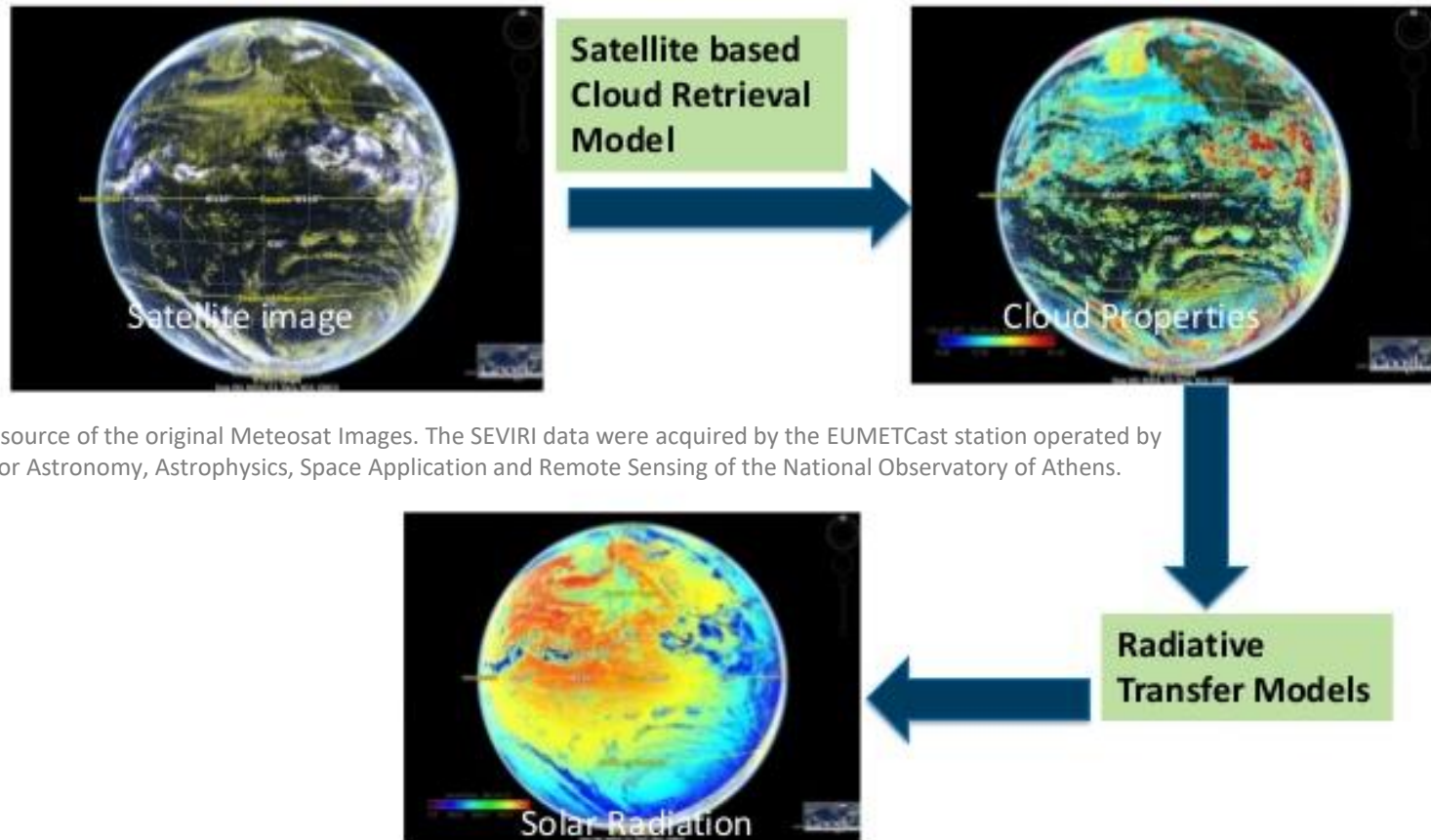
A green icon of a power transmission tower, representing energy management and infrastructure.

Solar energy potential

5 CARBON MANAGEMENT

A green icon showing a sun above three vertical lines, representing solar energy and carbon management.

From EO to SENSE pilot



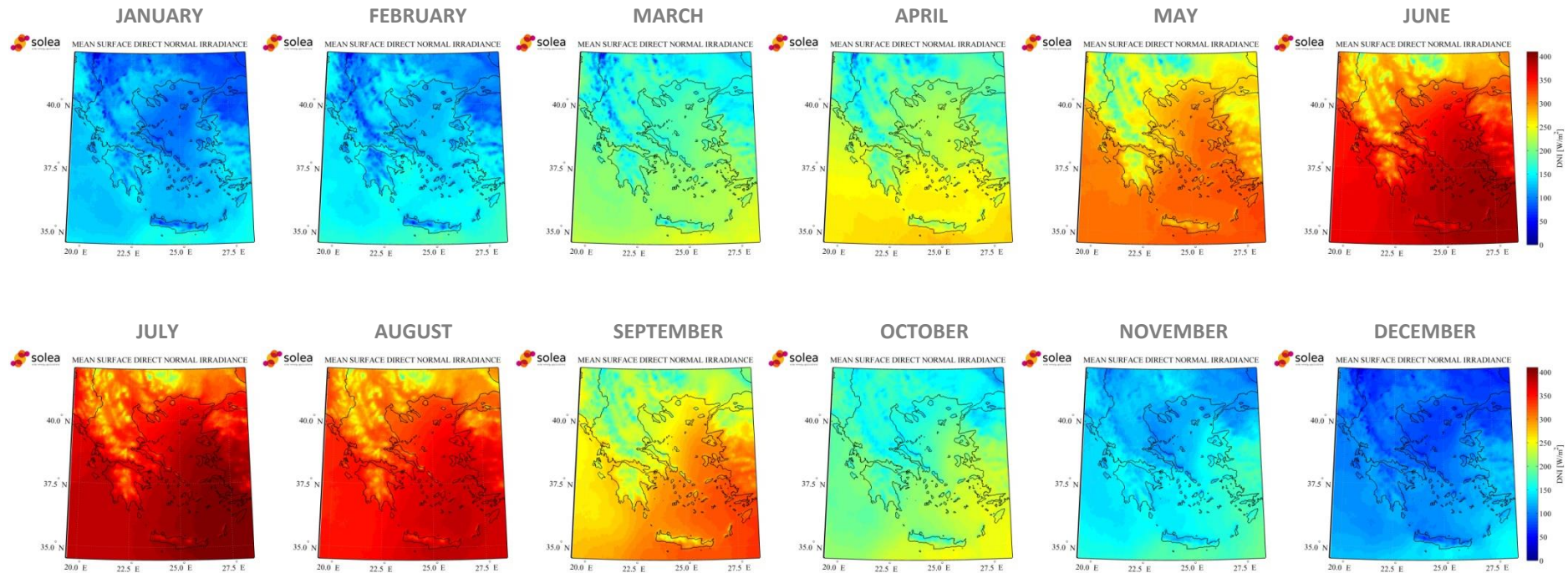
EUMETSAT is the source of the original Meteosat Images. The SEVIRI data were acquired by the EUMETCast station operated by the Institute for Astronomy, Astrophysics, Space Application and Remote Sensing of the National Observatory of Athens.



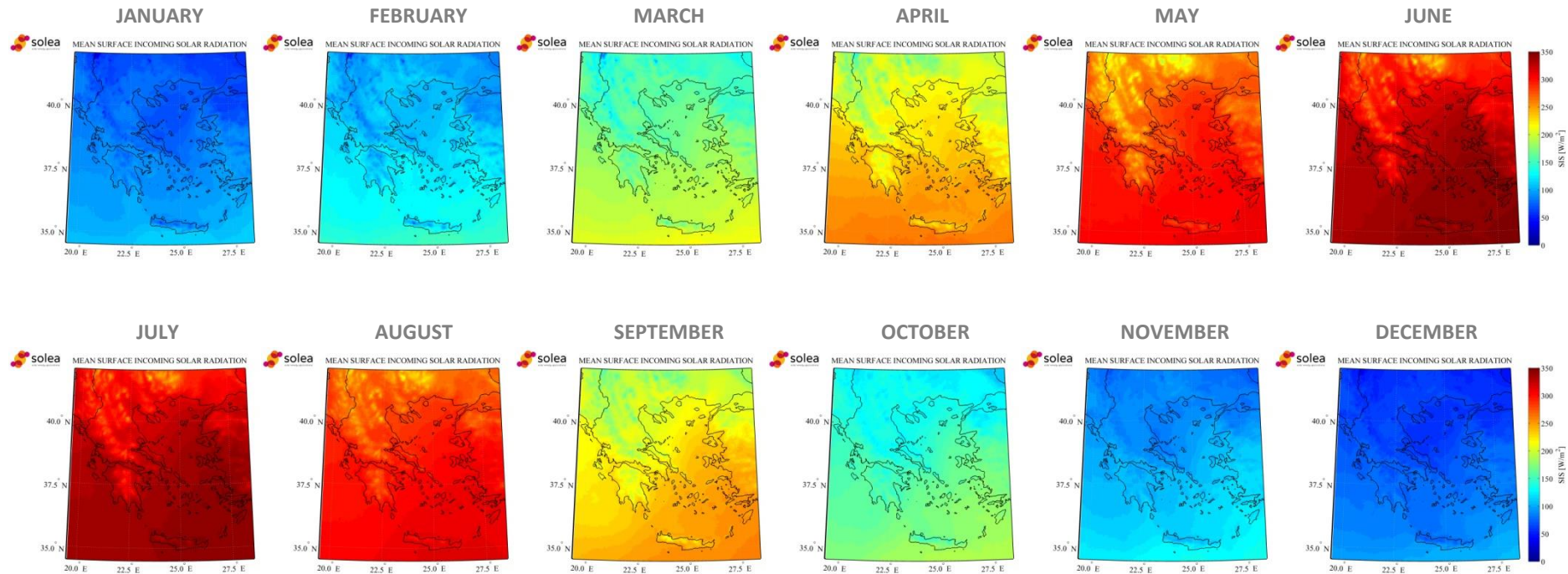
Input Data from MSG & CAMS



Mean monthly climatological maps of DNI



➤ The mean monthly solar energy maps are based on a 15-year complex and highly variable climatology taking into account the clouds and aerosols impact on **Direct Normal Irradiance** and **Global Horizontal Irradiance** (DNI and GHI respectively), while the spatial resolution is almost 5 km, maximizing the exploitative value of the solar energy technologies.



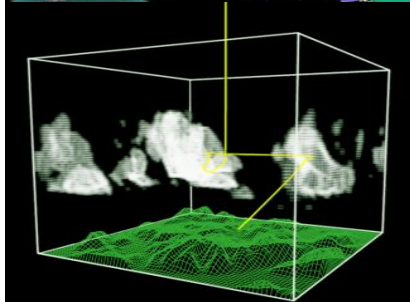
➤ The **Direct Normal Irradiance** applies to Concentrated Solar Plant (CSP) installations while the components of the **Global Horizontal Irradiance** (in terms of Surface Incoming Solar radiation ,SIS) applies to Photovoltaic (PV) installations.

The Solar Energy Nowcasting System

Satellite Data



Radiative Transfer models



Neural networks



➤ The real-time operational system uses a synergy of neural networks (NN), radiative transfer (RT) simulations and real-time satellite retrievals (MSG/SEVIRI, CAMS).

➤ Surface irradiances are produced at high resolution (1nm, 0.05 degrees, 15-min) in real time. The RT-NN solver is capable of producing maps of spectrally-integrated DNI and GHI of the order of 10^4 to 10^5 pixels within 1-min.

Precise assessment of solar energy

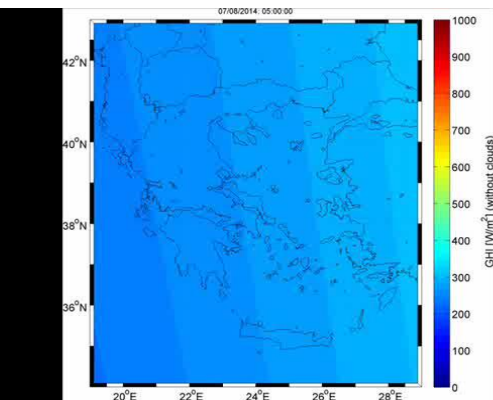


➤ Local or regional maps of the total irradiances provide the capability needed to serve high precision solar power applications for energy planning.

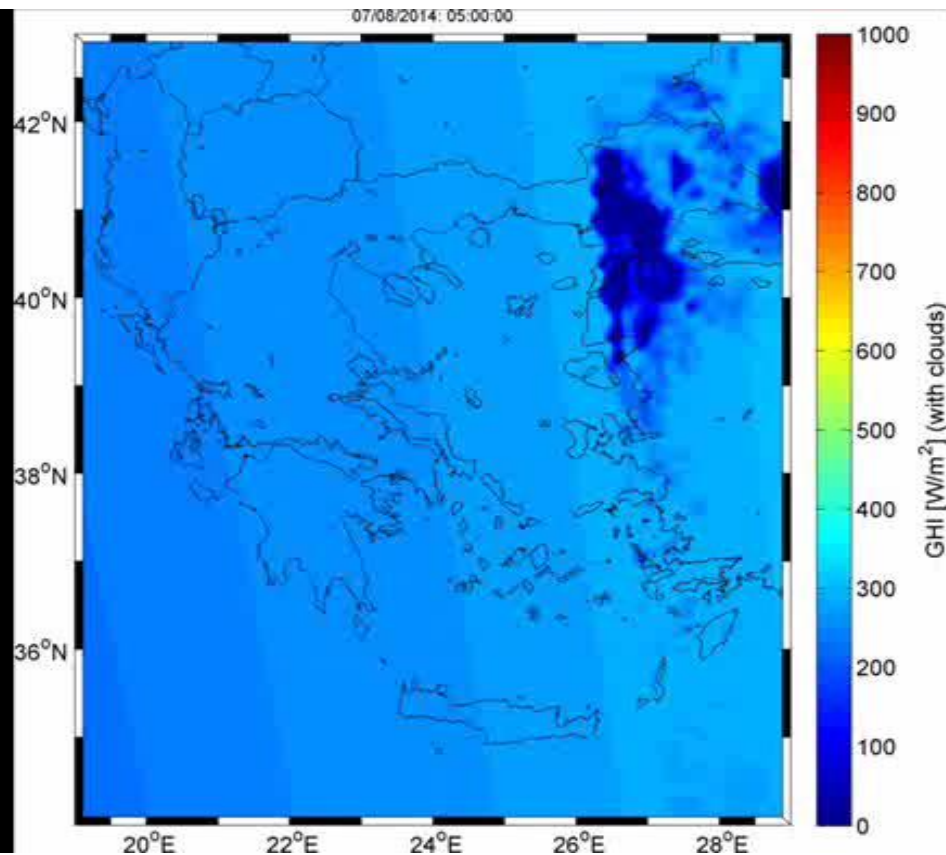
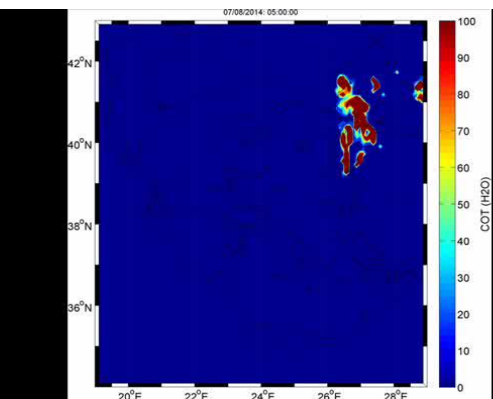
➤ NN is trained on a large-scale (2.5 million record) look-up table (LUT) of clear and cloudy sky radiative transfer simulations to convert satellite cloud and aerosol products directly into solar radiation spectra.

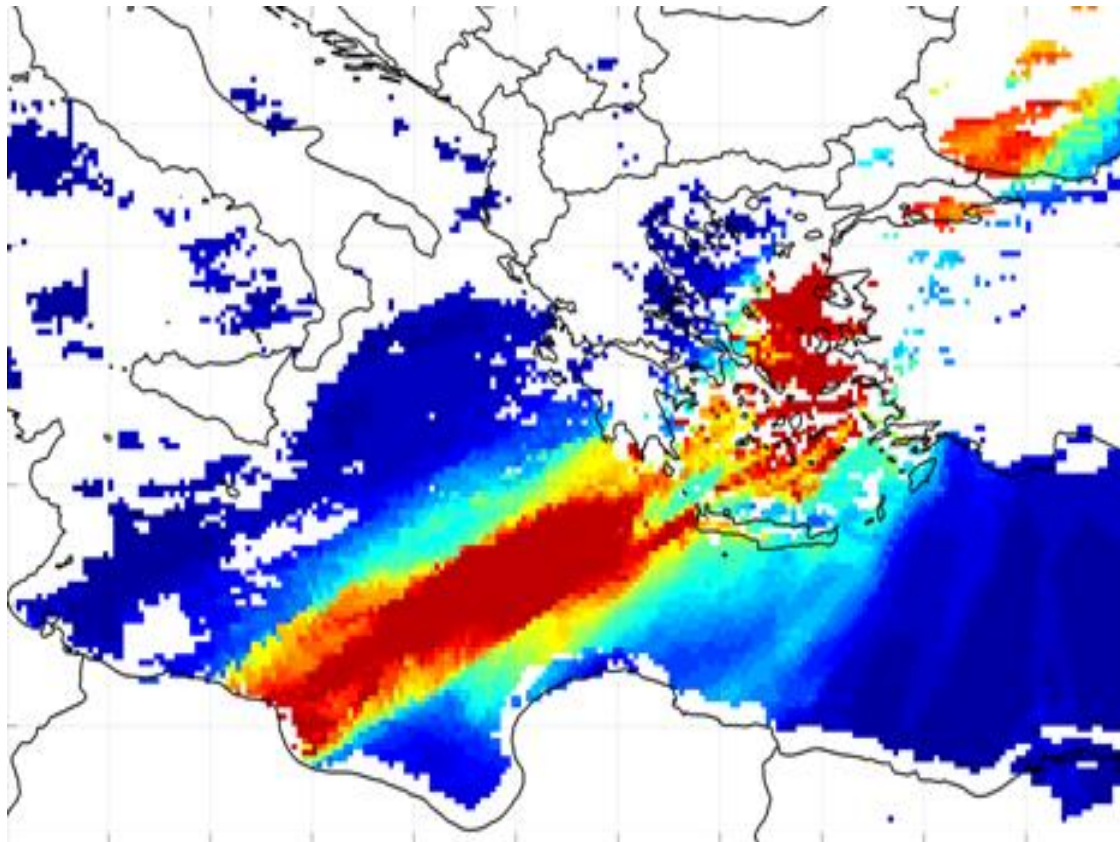
Clouds EO input on energy modeling

Global Horizontal Irradiance



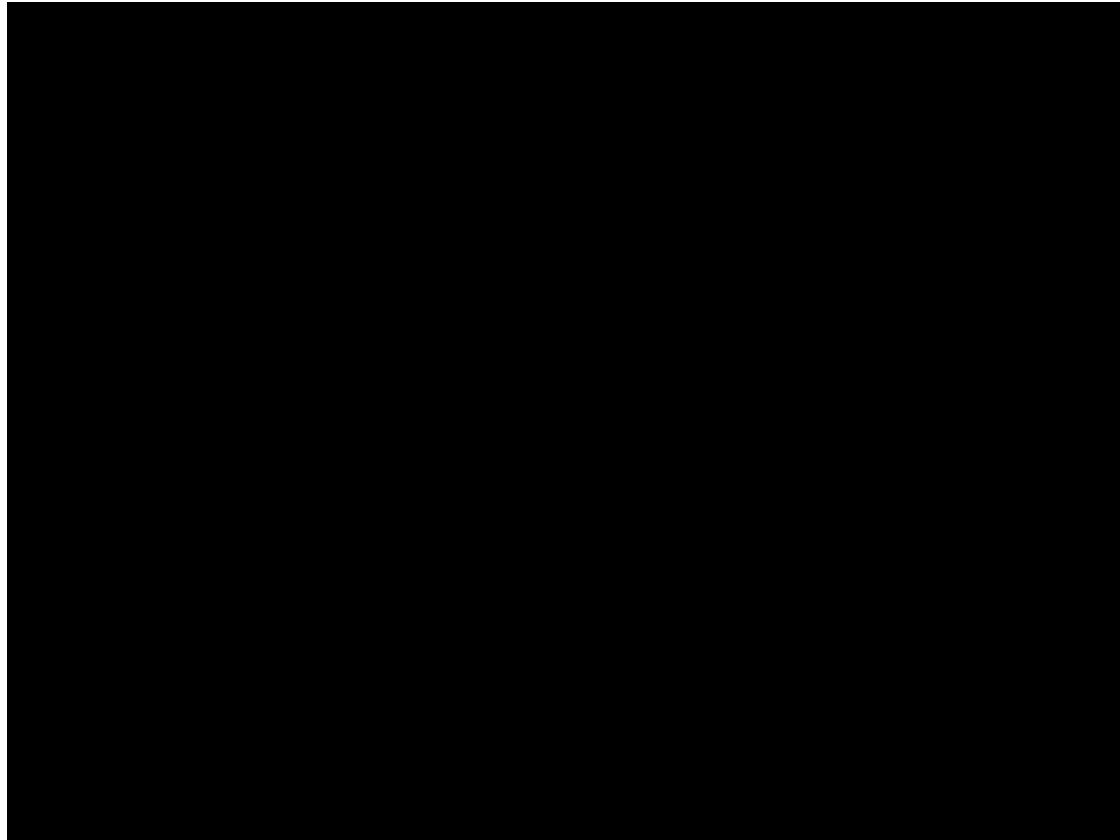
↑ Without clouds ↓ EO data



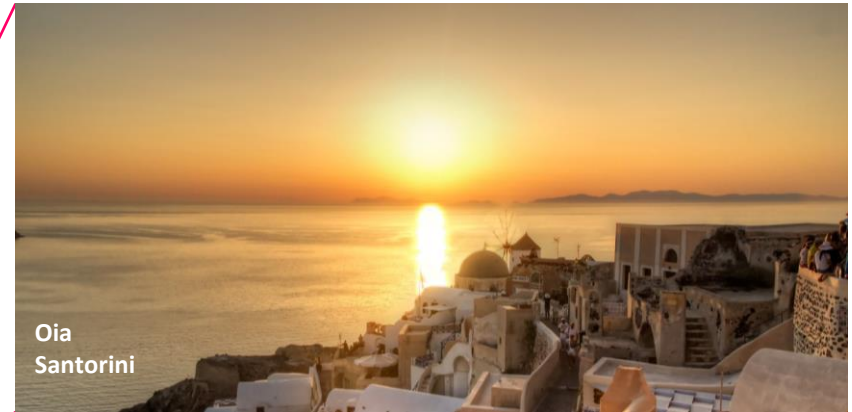
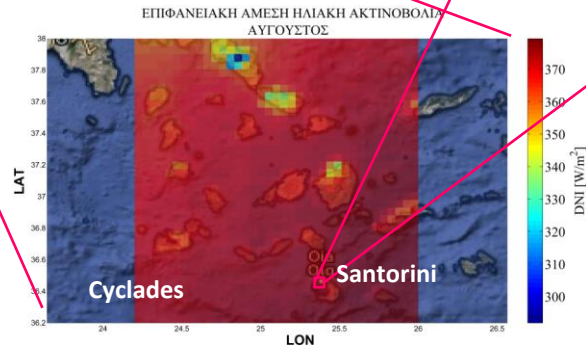
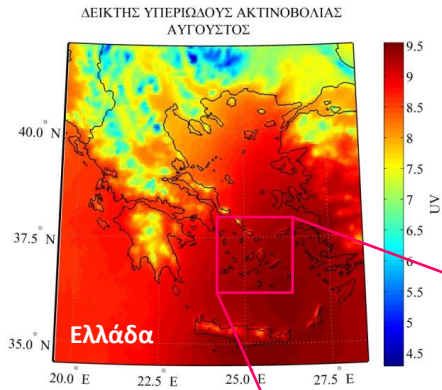




Aerosols CAMS input on energy modeling



UV-index





Major Applications & Contribution to Emerging Technology



The SENSE using EO and Copernicus data is ideal for:

- ➔ realistic assessment of solar energy potential
- ➔ provision of solar energy applications of high precision in real time
- ➔ solar potential forecasts for energy planning

Products

- ✓ Real time nowcasts and short-term forecasts of:
 - cloud cover
 - gridded spectra over the Earth disc
 - gridded solar potential
- health and environmental UV radiation impact measures
- ✓ Continental and local maps of solar products

Applications

- **Location studies** for the placement of CSP plants and CPV installations
- **Large-scale and precise solar energy calculations** to assist Public Authorities in **energy planning** policy
- Supporting the work of **various scientific communities**
- Provision of specialized data of high spectral precision for private and public sectors dealing with **health protection, energy consumption and solar energy exploitation**



Open Discussion

