

C A M S

Assessment of solar resources

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Space



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C o n t e x t

- Solar farm developers need to make a first assessment of solar resource in order to identify suitable sites.
- Time series of solar data are necessary to produce solar resource assessment reports that are requested by bankers to finance a solar plant
- Copernicus Atmosphere Monitoring Service is useful to do that.
- This assessment is based on several years of solar radiation data.
- Developers analyze the time series data to:
 - Assess daytime, inter-monthly and inter-yearly variabilities.
 - Compare several candidate sites
 - Produce solar resource assessment reports
 - Compare with measurements and assess accuracy
 - Monitor performance of solar PV site



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Use case

- The following example describes how to access solar data from the **CAMS McClear Clear-Sky Irradiation** service.
- This service delivers time series of irradiation:
 - Clear sky conditions
 - Time step ranging from 1 min to 1 month
 - Global, Direct and Diffuse Horizontal Irradiations are provided
 - Data are available from Jan. 2004 up to current day -2.
- **NOTE** that similar data available also corresponding to actual cloud conditions: **CAMS Total-Sky Irradiation** service. Access to Total-Sky data is analogous.



Hands-on demo

- Go to CAMS catalogue (<http://atmosphere.copernicus.eu/catalogue#/>)
- Select Solar radiation.
- Choose Global clear-sky surface solar irradiance.
- Login or register to access the solar radiation service (<http://www.soda-pro.com/webservices/radiation/cams-radiation-service>)
- Choose location on map
- Extract 10 years of data and save it as csv file
- Using MS excel/OpenOffice:
 - aggregate the data on yearly base
 - Calculate the yearly and monthly means
 - build the corresponding inter-monthly and inter-yearly variabilities
 - build the daytime variability



Global Clear-Sky Surface Solar irradiance

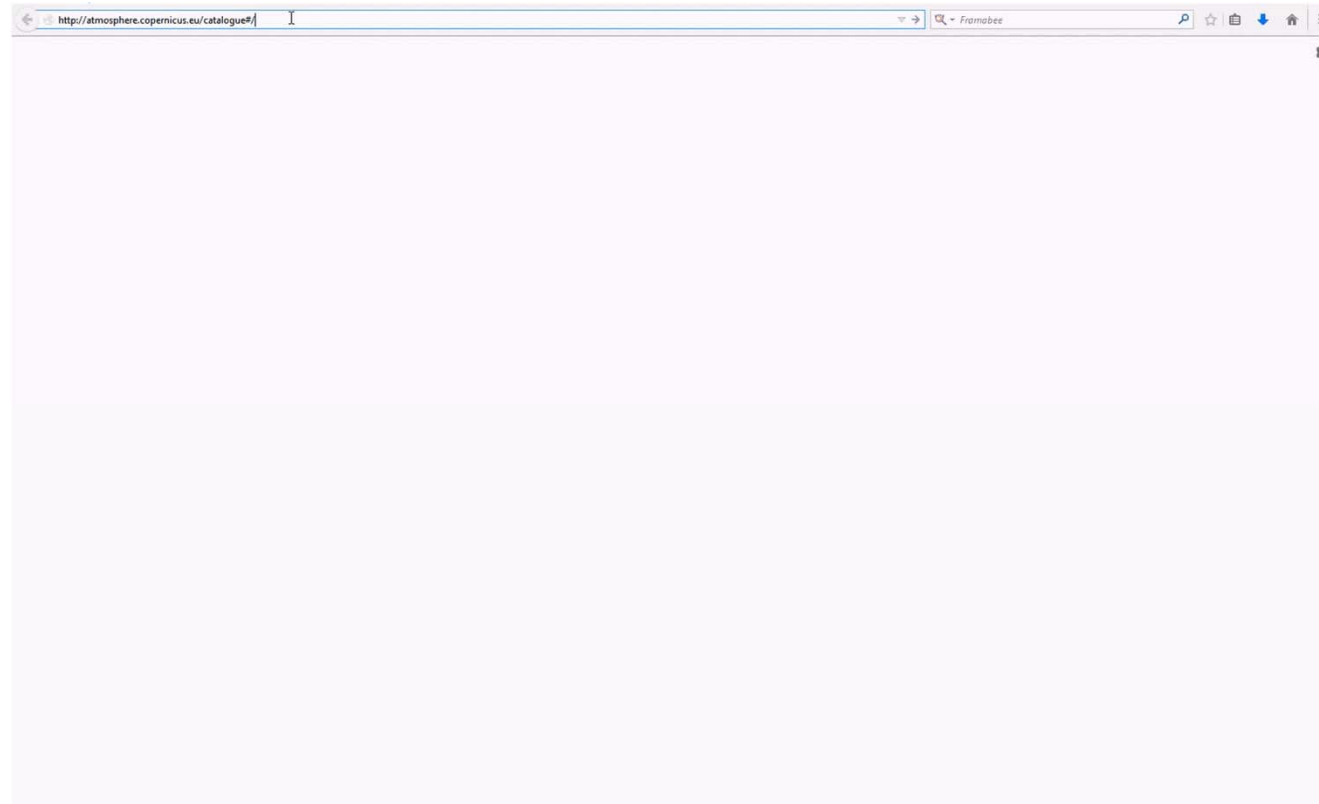
- Video 1 :
 - Access service and download data
- Video 2 :
 - Analyse data in Excel





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Video 1 : Access CAMS service





Video 2 : Data Analysis in Excel

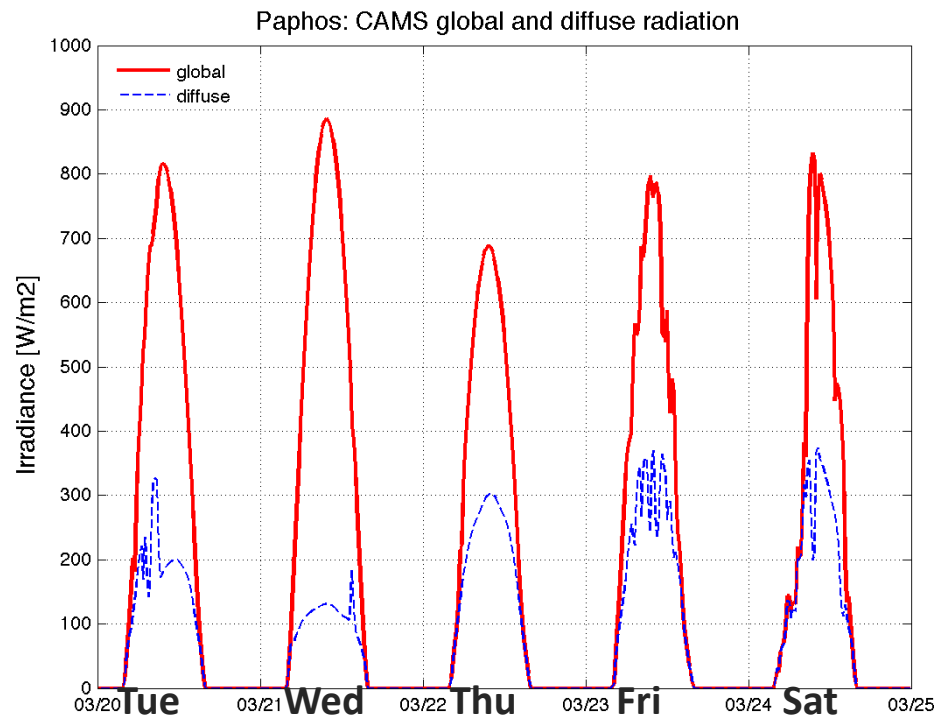
The screenshot shows an Excel spreadsheet with a metadata table. The table contains the following information:

1	# Coding: utf-8
2	# File format version: 2
3	# Title: CAMS McClear v2.7 model of clear-sky irradiation.
4	# Content: A time-series of solar radiation received on horizontal plane and plane always normal to the sun rays at ground level assuming clear sky.
5	# Calls on the McClear clear-sky model. Returns the global, beam and diffuse irradiances integrated over a selected time step,
6	# for a selected location (worldwide coverage) and a selected period.
7	# The research leading to these results has received funding from the European Union within the Copernicus programme.
8	# Provider: MINES ParisTech (France)
9	# More information at: http://www.soda-pro.com/web-services/radiation/cams-mcclear
10	# Date begin (ISO 8601): 2016-05-01T00:00:00.0
11	# Date end (ISO 8601): 2016-10-27T00:00:00.0
12	# Latitude (positive North, ISO 19115): 43.5290
13	# Longitude (positive East, ISO 19115): 1.5295
14	# Altitude (m): 152.00
15	# Time reference: Universal time (UT)
16	#
17	# Encoding partly from D2.8.III.13-14 INSPIRE Data Specification on Atmospheric Conditions and Meteorological Geographical Features - Technical Guidelines (2013-12-10) and CF (Climate and Forecast) metadata (2013-11-11)
18	# CF Standard Names registry of ObservablePropertyValue
19	# http://cfconventions.org/Data/cf-standard-names/27/build/cf-standard-name-table.html
20	# urn:x-inspire:specification:DS-AC-MF:observable-property-name:cf-standard-name:1.6
21	# ObservableProperty
22	# basePhenomenon: "integral_of_surface_downwelling_shortwave_flux_in_air_assuming_clear_sky_wrt_time"
23	# uom: "Wh m-2" [unit]
24	# StatisticalMeasure
25	# statisticalFunction: "sum"
26	# Summarization (integration) period: 0 year 0 month 0 day 0 h 15 min 0 s
27	# noValue: nan
28	#
29	# Columns:
30	# 1. Observation period (ISO 8601)
31	# 2. TOA. Irradiation on horizontal plane at the top of atmosphere (Wh/m2)
32	# 3. Clear sky GHI. Clear sky global irradiation on horizontal plane at ground level (Wh/m2)
33	# 4. Clear sky BHI. Clear sky beam irradiation on horizontal plane at ground level (Wh/m2)
34	# 5. Clear sky DHI. Clear sky diffuse irradiation on horizontal plane at ground level (Wh/m2)
35	# 6. Clear sky BNI. Clear sky beam irradiation on mobile plane following the sun at normal incidence (Wh/m2)



Example #1: Global radiation in Paphos

- CAMS Total-Sky Irradiation, Paphos, last week (accessed Mon 26 March)

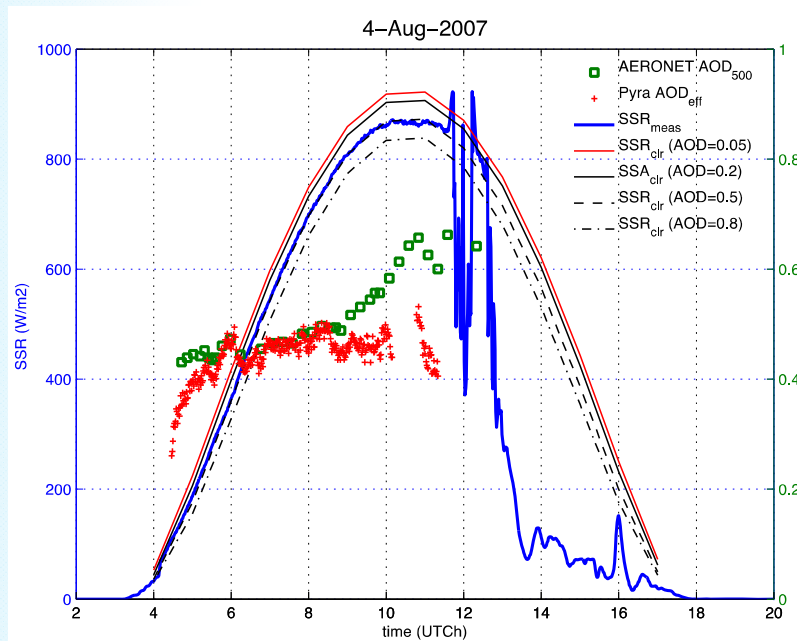




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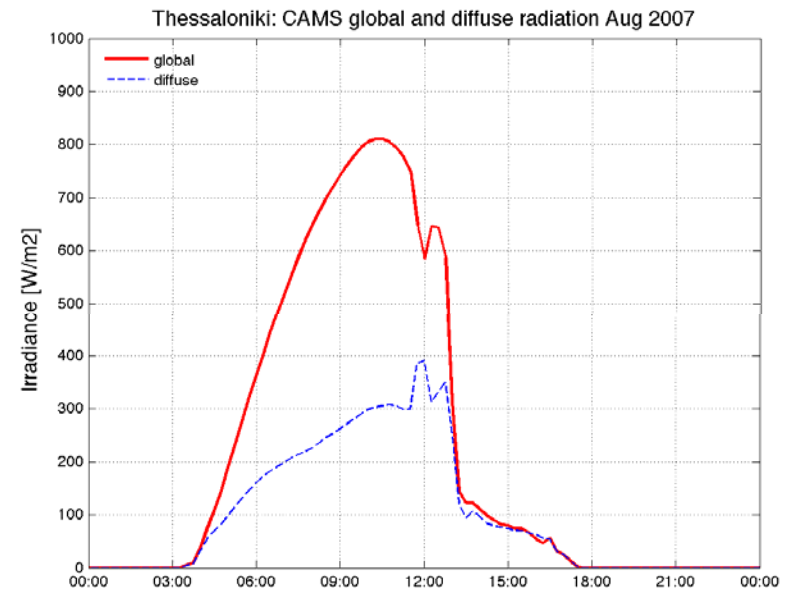
Example # 2: Comparing with measurements

Thessaloniki measured



Lindfors et al., ACP, 2013

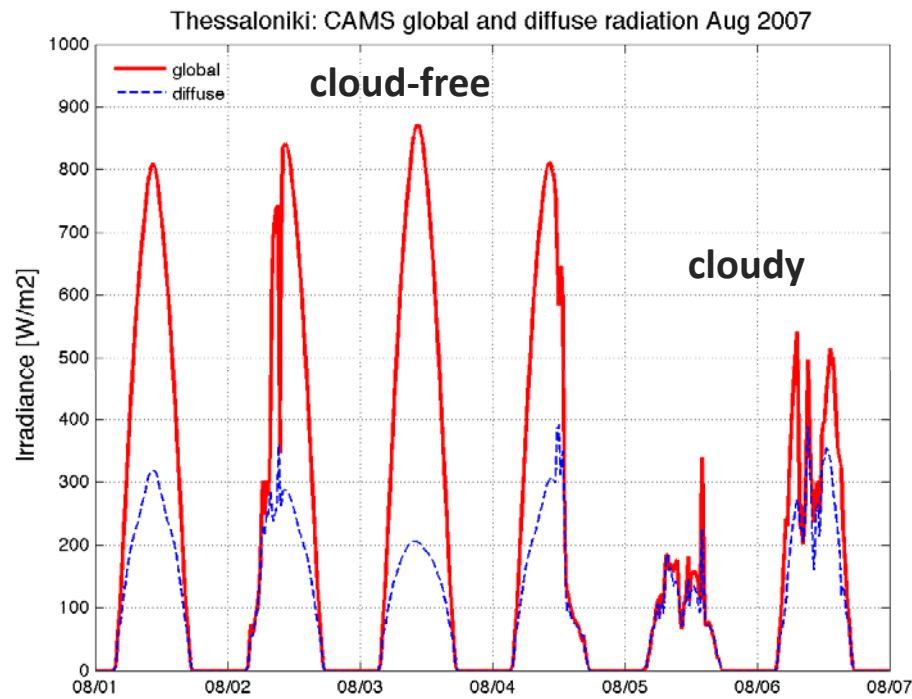
Thessaloniki CAMS





Example #3: Thessaloniki week in Aug 2007

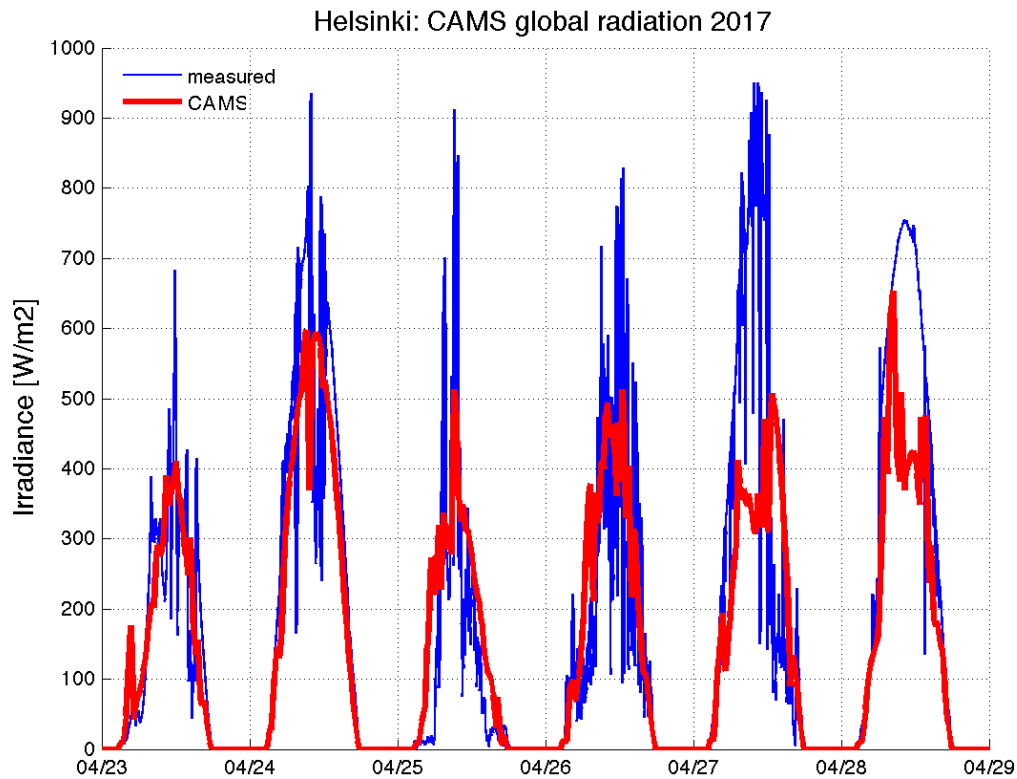
- CAMS Total-Sky Irradiation service





Example #4: Helsinki cmp/w measurements

- Helsinki global radiation April 2017: **measured** and **CAMS Total-**



Geostationary satellite data,
viewing angle becoming more
challenging at higher latitudes.



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Solar radiation components and units

- Solar radiation reaching the surface consists of:
 - **direct radiation** = beam radiation coming directly from the sun without being scattered or absorbed (BHI and BNI in CAMS)
 - **diffuse radiation** = radiation that has been scattered by the atmosphere (DHI in CAMS)
 - **global radiation** = direct + diffuse radiation impinging on horizontal surface (GHI in CAMS)
- CAMS radiation unit
 - Watt-hour [Wh] + definition of period [e.g., hour-start and hour-end]
- Service available at: <http://atmosphere.copernicus.eu/catalogue#/>