Data Adaptation Techniques for Improving Data Bankability

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Solar Resource Assessment importance

Uncertainty of a solar project

Uncertainty Source	Typical Uncertainty Range
Annual Degradation	0.5-1%
Transposition to Plane of Array	0.5-2%
Energy Simulation, Plant Losses	3-5%
Solar Resource Estimate	5-17%

(1) Schnitzer, M. et al (2011). "Reducing Uncertainty in Bankable Solar Resource and Energy Assessments through On-Site Monitoring" Proceedings of the 2011 ASES National Solar Conference, American Solar Energy Society, 2011.

Solar Resource Time Series

Needs for bankability

Reliability and bankability of any solar energy systems require:

1. Long-term characterization of solar resource
2. Evaluation of the risk

Long time series of hourly or sub-hourly ***accurate*** values of solar irradiance (15-20 years or longer)

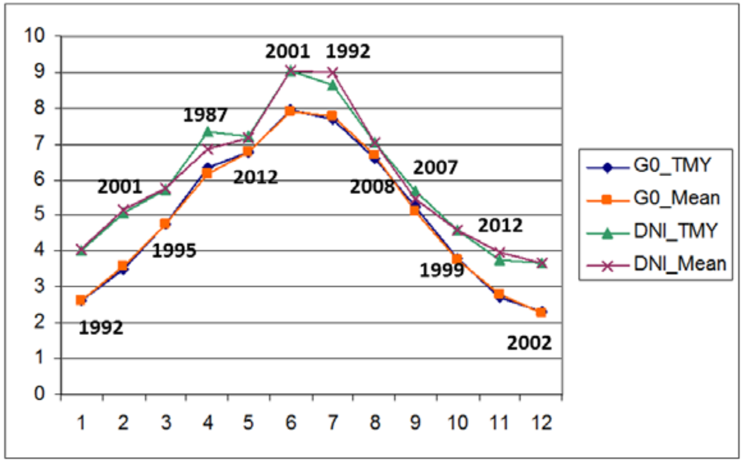
Long-term solar radiation characterization

Typical Meteorological Year, Typical or Representative Solar Radiation Year

- TMY is a method to condense long time series of meteorological variables into one single year that represents the long-term of main variables involved

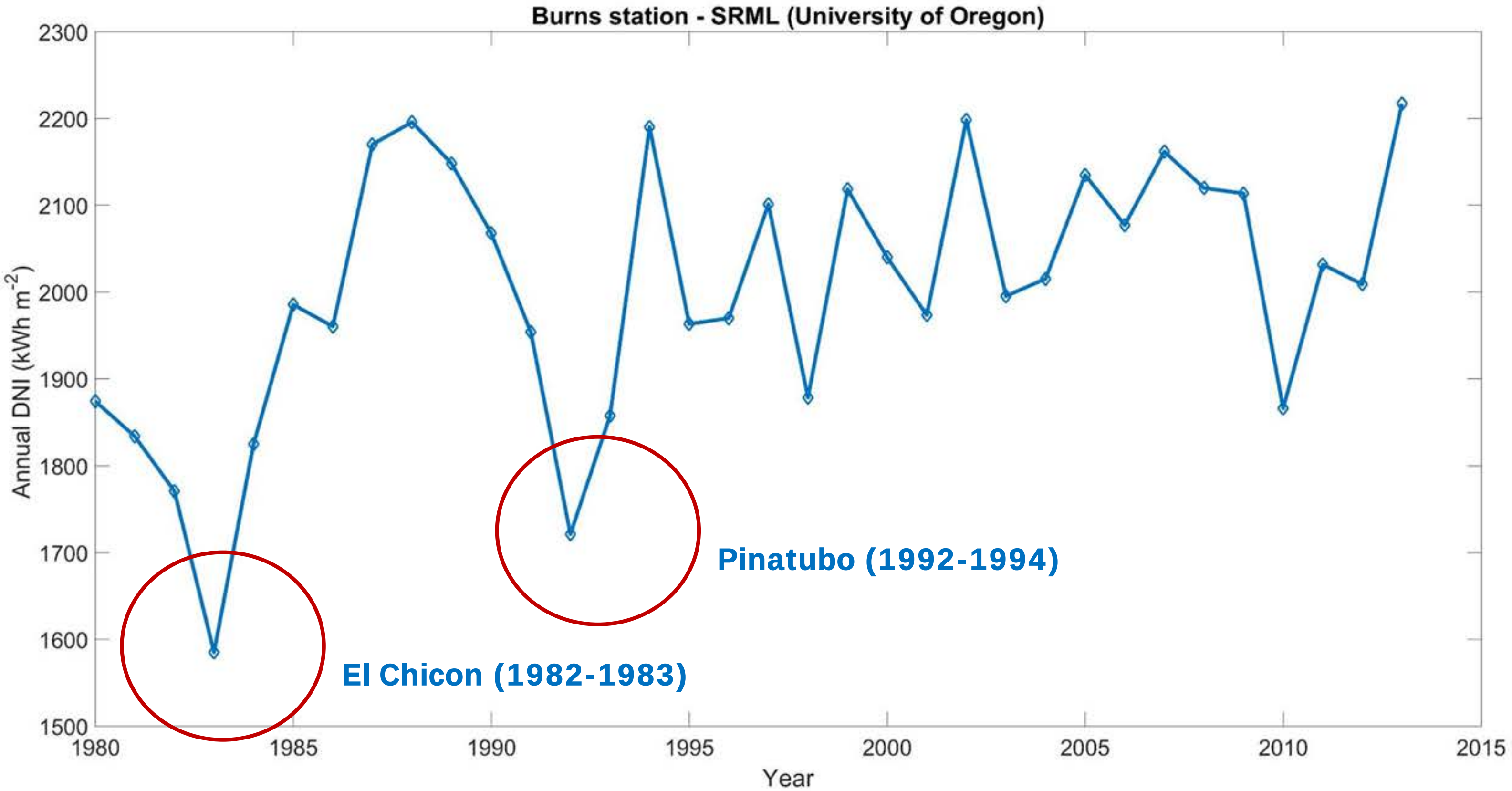
- TMY is usually constructed by the concatenation of 12 months that accomplish statistical properties (FS statistic)

- TMY can be also considered as a format or standard and performance models are prepared to use it (SAM, PVsyst, PV-lib, Greenius,...)



Long-term solar radiation characterization

Inter-annual variability

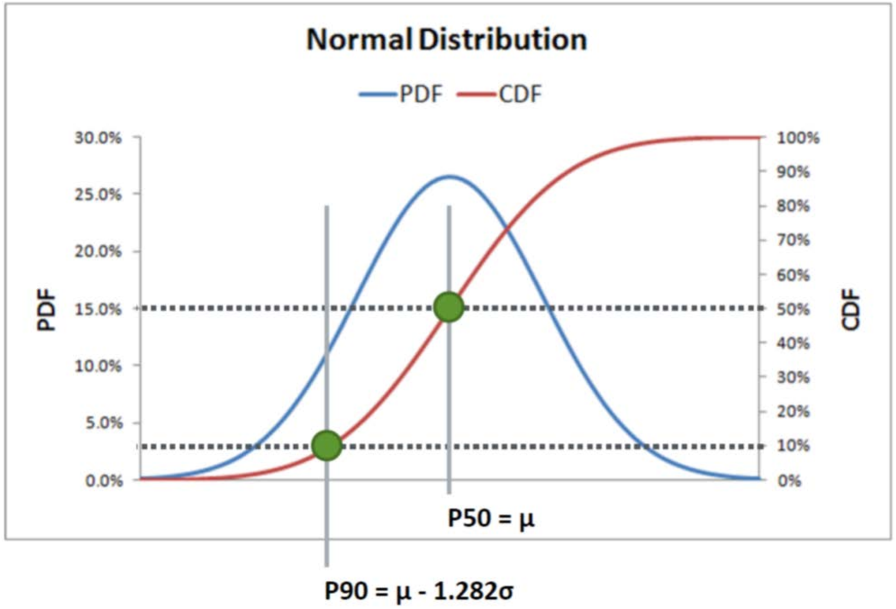


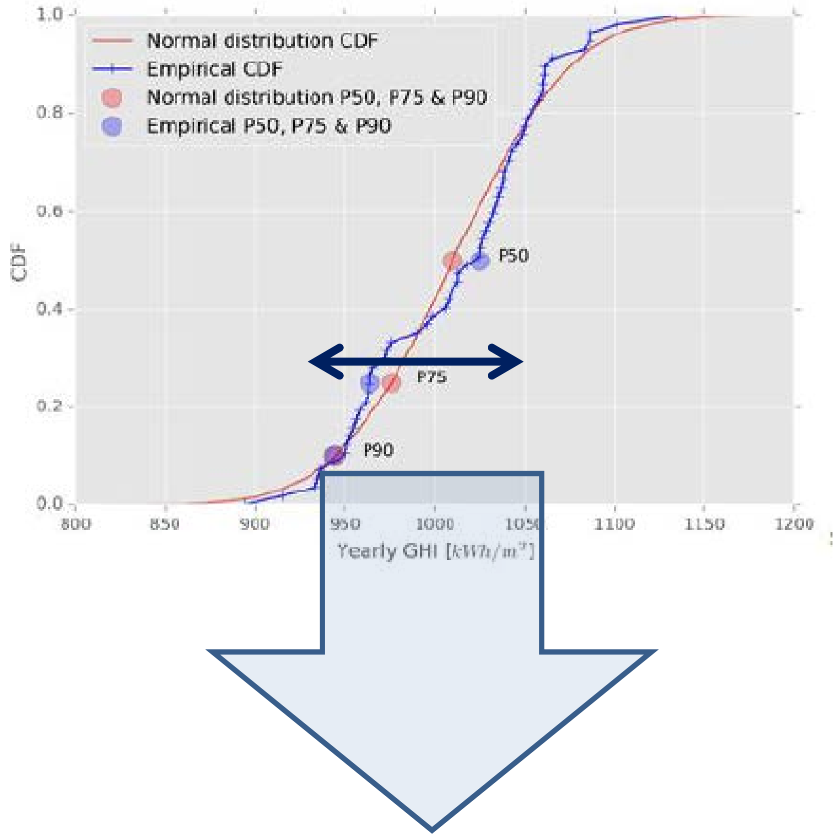
SolarPACES guiSmo project recommends to remove those exceptional years for building a TMY

T. Hirsch, J. Dernsch, T. Fluri, J. García-Barberena, S. Giuliano, F. Hustig-Diethelm, R. Meyer, N. Schmidt, M. Seitz, E. Yildiz, SolarPACES Guideline for Bankable STE Yield Assessment, IEA Technology Collaboration Programme SolarPACES, 2017.

Solar radiation time series

Bankability: TMY, P50, probability of exceedance

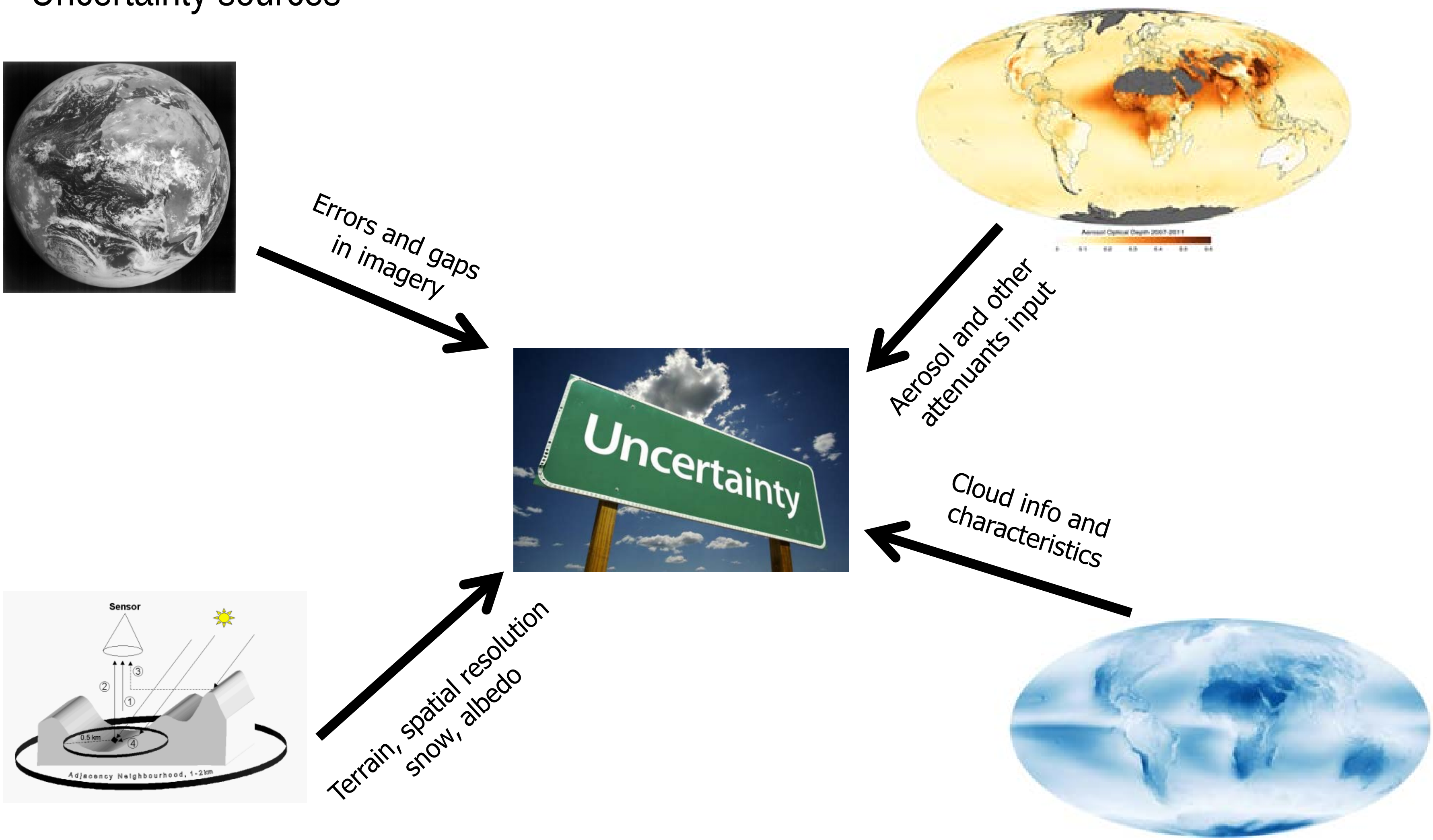




Risk Metric $\sim 100\ \frac{P50-P90}{P50}$

Solar Radiation derived from Satellite Imagery

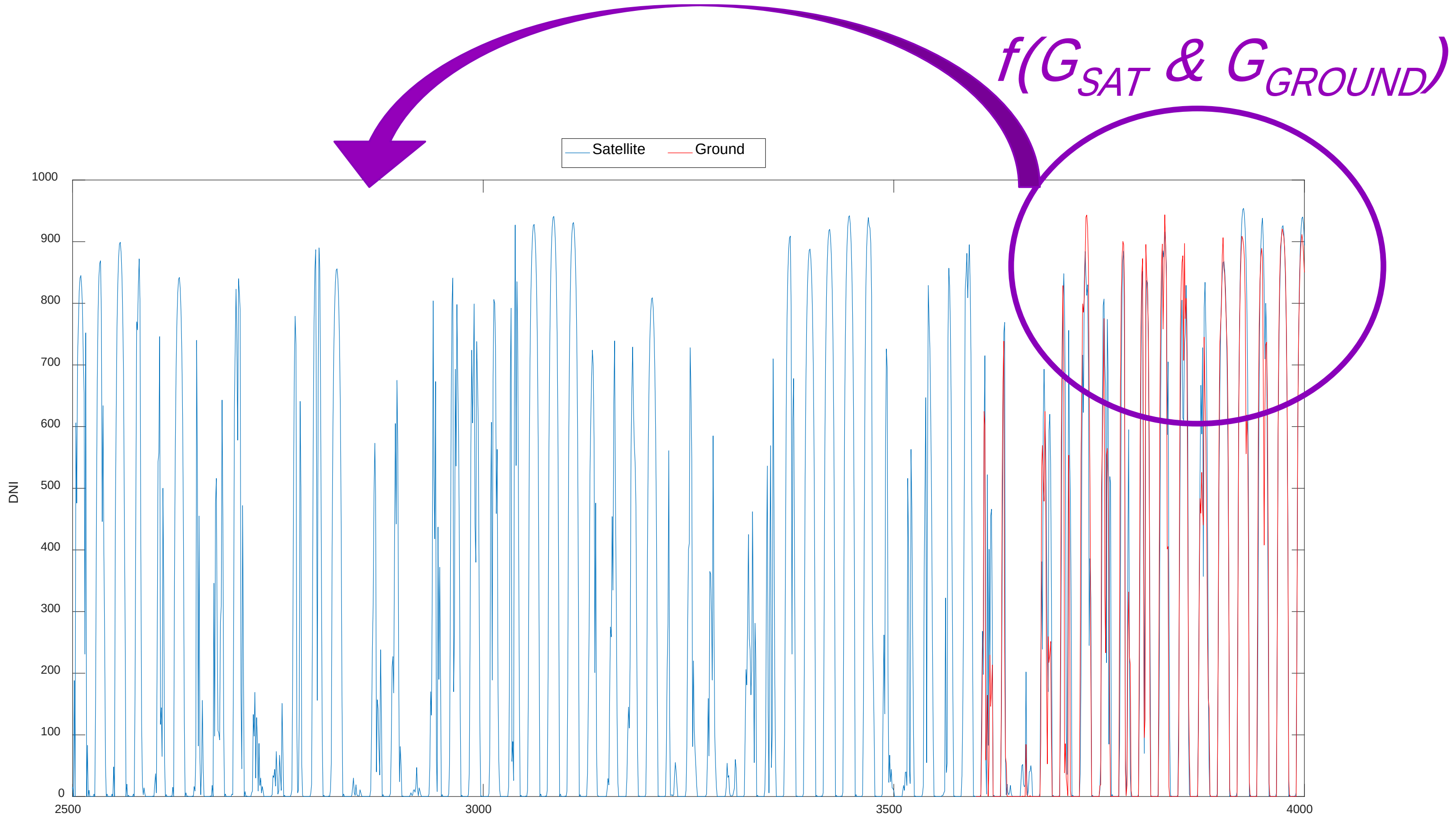
Uncertainty sources



T. Cebecauer, M. Suri, C.A. Gueymard, Uncertainty sources in satellite-derived direct normal irradiance: how can prediction accuracy be improved globally, SolarPACES 2011 Conf. (2011).

Site Adaptation of Solar Radiation datasets

Fundamentals



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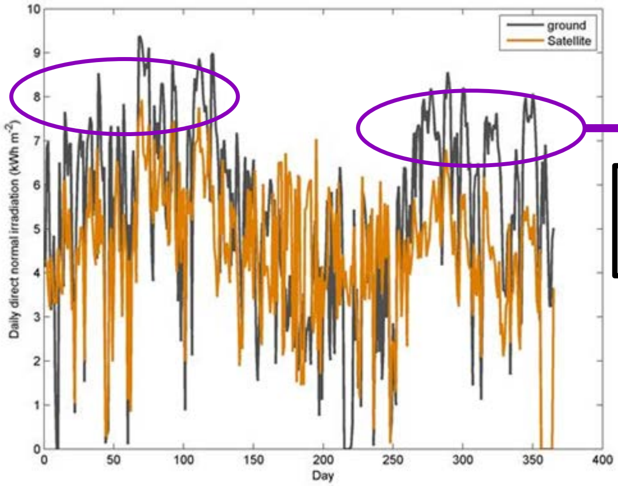
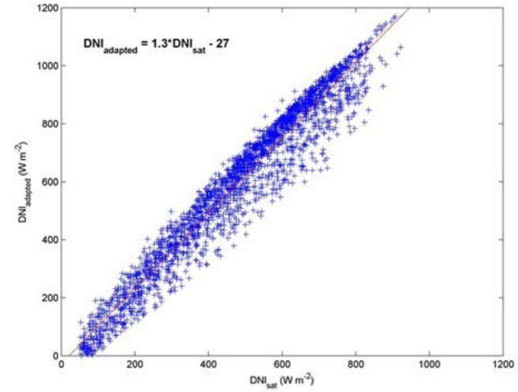
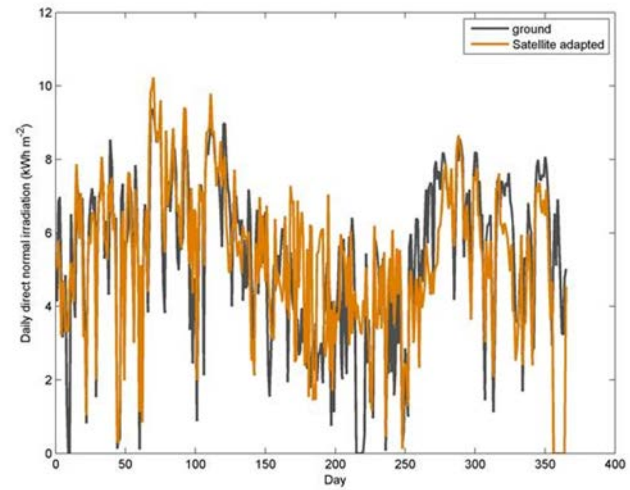
Example: Seasonal correction of near clear sky conditions



Dry Season, clear sky

Ground = 1916 kWh m^{-2}
Satellite = 1621 kWh m^{-2}





Extrapolation to whole dataset

Year	Satellite original	Satellite corrected
2003	1707	1942
2004	1742	1968
2005	1692	1920
2006	1655	1861
2007	1722	1936
2008	1694	1912
2009	1723	1946
2010	1716	1936
2011	1621	1906

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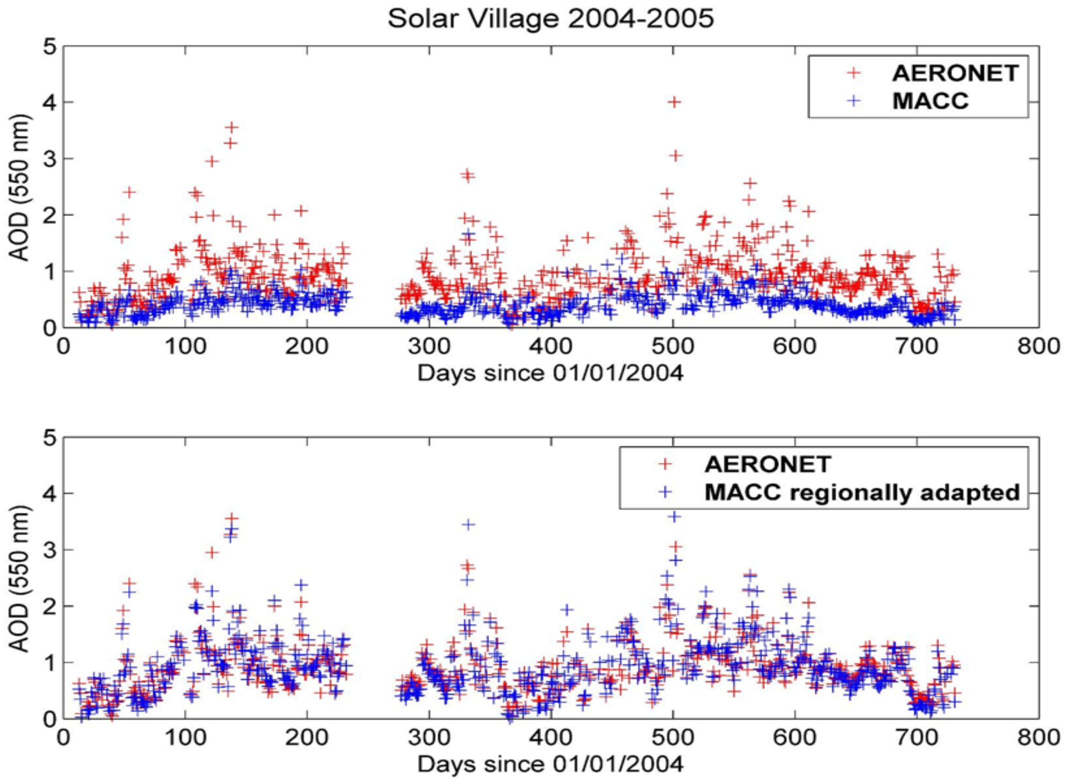
J. Polo, L. Martín, J.M. Vindel, Correcting satellite derived DNI with systematic and seasonal deviations: Application to India, Renewable Energy. 80 (2015) 238–243. doi:http://dx.doi.org/10.1016/j.renene.2015.02.031.

Site Adaptation of Solar Radiation datasets

Correcting Boundary Conditions – site adaptation of input data

Aerosol Optical Depth is a frequent and influencing input in most satellite-based models

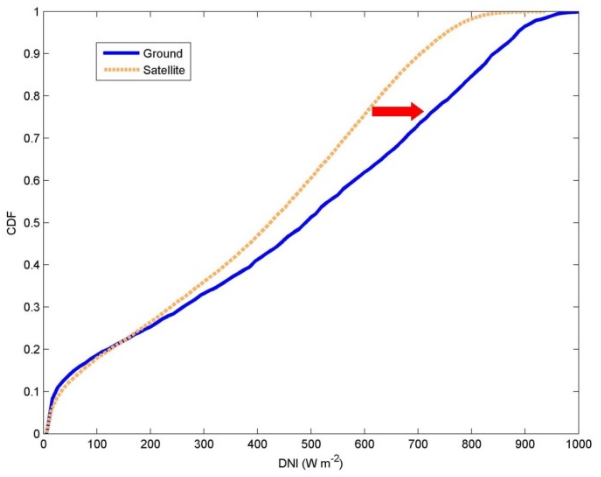
AOD Bias removal



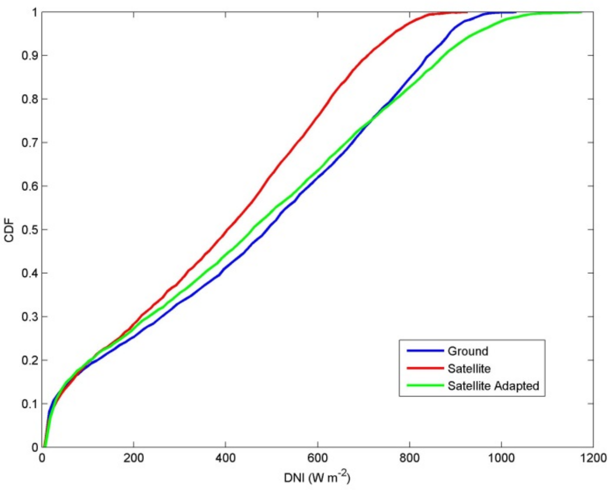
Site Adaptation of Solar Radiation datasets

Correcting Cumulative Distribution Function of data

Methods to improve the CDF of retrieved data that can be applied to the data themselves



Bias removal or seasonal correction (previous example of India) result also in a better fitting of CDF



Site Adaptation of Solar Radiation datasets

Review of techniques

- Physical based methods:
  - Corrections of clear sky transmittance model output
  - AOD bias removal
  - AOD modeled including the altitude effect
  - Calibration of AOD and water vapor retrievals (i.e. MODIS)
- Statistical methods:
  - Bias removal, $y_{new} = y_{sat} - [(a-1)x_{ground} + b]$
  - Non-linear-methods
  - Model output statistics (MOS), or measure-correlate predict (MCP)
- Fitting the CDF (ENDORSE project and SolarGIS methods)
- Adaptation of normalized parameters (Clearness index)

Site Adaptation of Solar Radiation datasets

Future activities within Task 16 IEA-PVPS

- Task 16 IEA-PVPS, “Solar resource for high penetration and large-scale applications”, 2017-2020

- Activity 2.2 “Merging of satellite, weather model and ground data”

    - Benchmarking of methods

    - Recommendations on site adaptation techniques and procedures according to specific characteristics of site (Climatology) and dataset