

Use of atmospheric remote sensing for solar energy purposes – Experiences made in the ENVISOLAR project

**M. Schroedter-Homscheidt et al., DLR
D. Heinemann et al. Univ. Oldenburg
L. Wald et al., Ecole des Mines des Paris**

11 May 2006

European Space Agency (ESA)

Earth Observation Market Development Program (EOMD)

Rationale:

Support **industrial use** of **Earth Observation** based information

Consortium:

- **Earth observation data providers**
- **market players** using EO data and selling **end user services**
- **key customers** using such services, **downstream business**

Typical EOMD workpackages

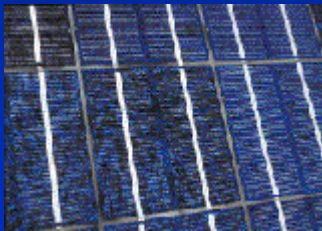
- build up **integrated** service chain from EO provider to market player
- **upgrade** both EO provider and market player service chains
- perform a **science review**
- set up a **business plan** for market player services
- create **example customer product**
- do **market trials** with key customers
- **learn** from market trials and improve service chains
- do **again market trials**
- do **marketing** and **promotion** for market player services
- **revise** your **business plan**

clouds
water vapour
aerosols
ozone



direct/diffuse irradiance at the ground
spectral information
temporal/spatial variability

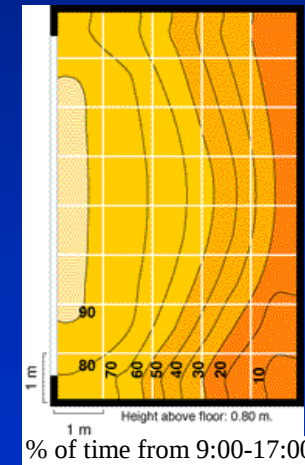
photovoltaics



solar thermal
electricity



daylight
availability
-> utilities / buildings



Copyright Satellight service

Planning

Long term
time series



Politics
estimate potential
map resources

Engineering
site selection
optimise plants according
to local resource characteristics

Investment decision

Plant management

Near Real Time



**performance
monitoring**

Forecast
hours to days



**optimized plant
management**

load forecast

grid stability

energy trading

Solar Investment Services

- "Premium" site audit for investment decision (for large solar plants)
- Webservice based yield estimation (for smaller plants)



Plant Management Services

- Fault detection -> reliable alarms, assure investment
- Performance check for smaller plants -> first estimates

Services for Utilities

- Irradiance forecasting for load
and gas consumption forecasts

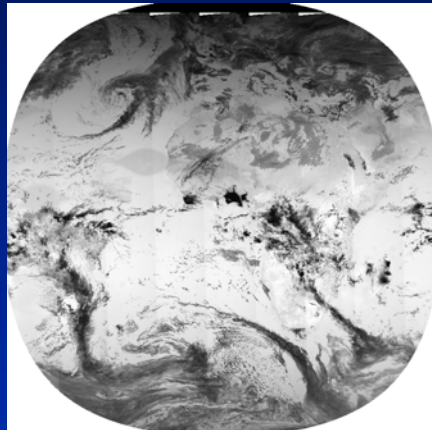


Services for Science and Consulting

- Time series, maps and statistics of irradiance,
direct and diffuse components, spectral components



Requirement: **Quality of hourly satellite based data** needs to be improved

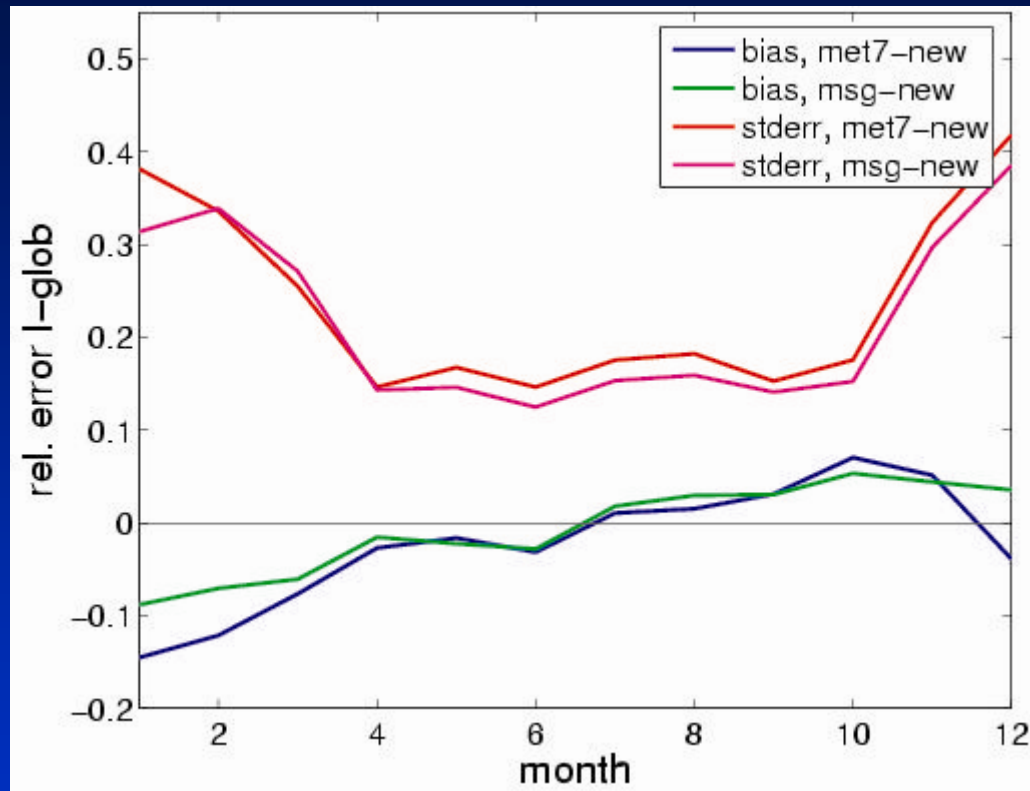


0 1200 W/m²

Feb 15, 2004; hourly radiation
11 - 12:00 true solar local time
HELIOSAT-2 in HelioClim-2 chain
(SoDa service)



- a) MSG provides 4 images per hour
instead of 2 images per hour before
-> better representation of variation inside one hour
- b) MSG offers HRV channel with 1 km resolution
-> better spatial resolution



MSG vs METEOSAT-7

- extended Heliosat-1 method
- snow detection included
- basic cloud height information

	MET-7	MET-8/HRV
bias	-1.2%	0.4%
stderr	19.5%	17.8%

for hourly data

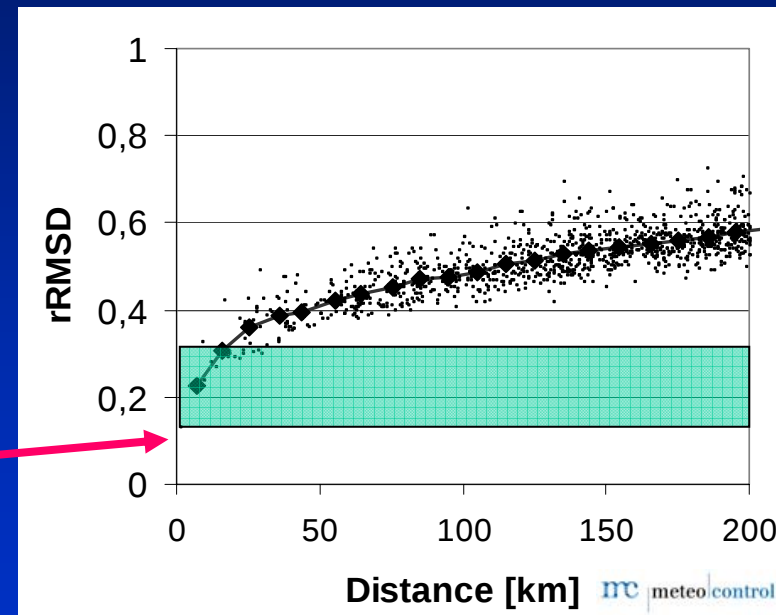
data: 20 DWD ground stations, 2005

ENVISOLAR science review (A. Zelenka):

RMSE is mainly due to missfit
between ground measurement (point)
and satellite measurement (pixel average)

*Typical RMSE
of hourly irradiances
15 % to 30 %*

*Theoretical
lower limit of
RMSE is approx. 15 %*



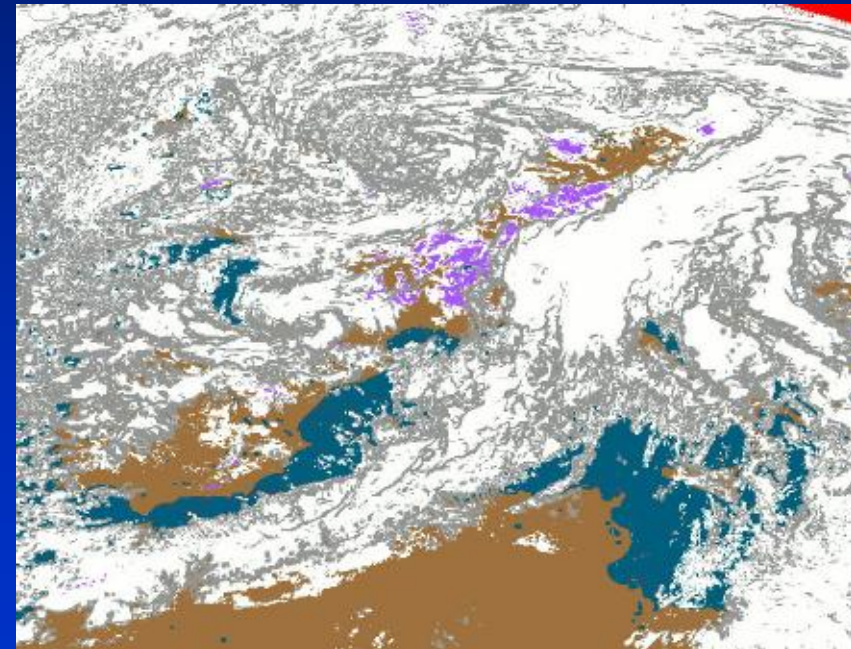
**rRMSD for German weather stations, 1.1.2005-31.12.2005
using hourly global irradiance values**

Requirement: **Snow detection** needs to be included

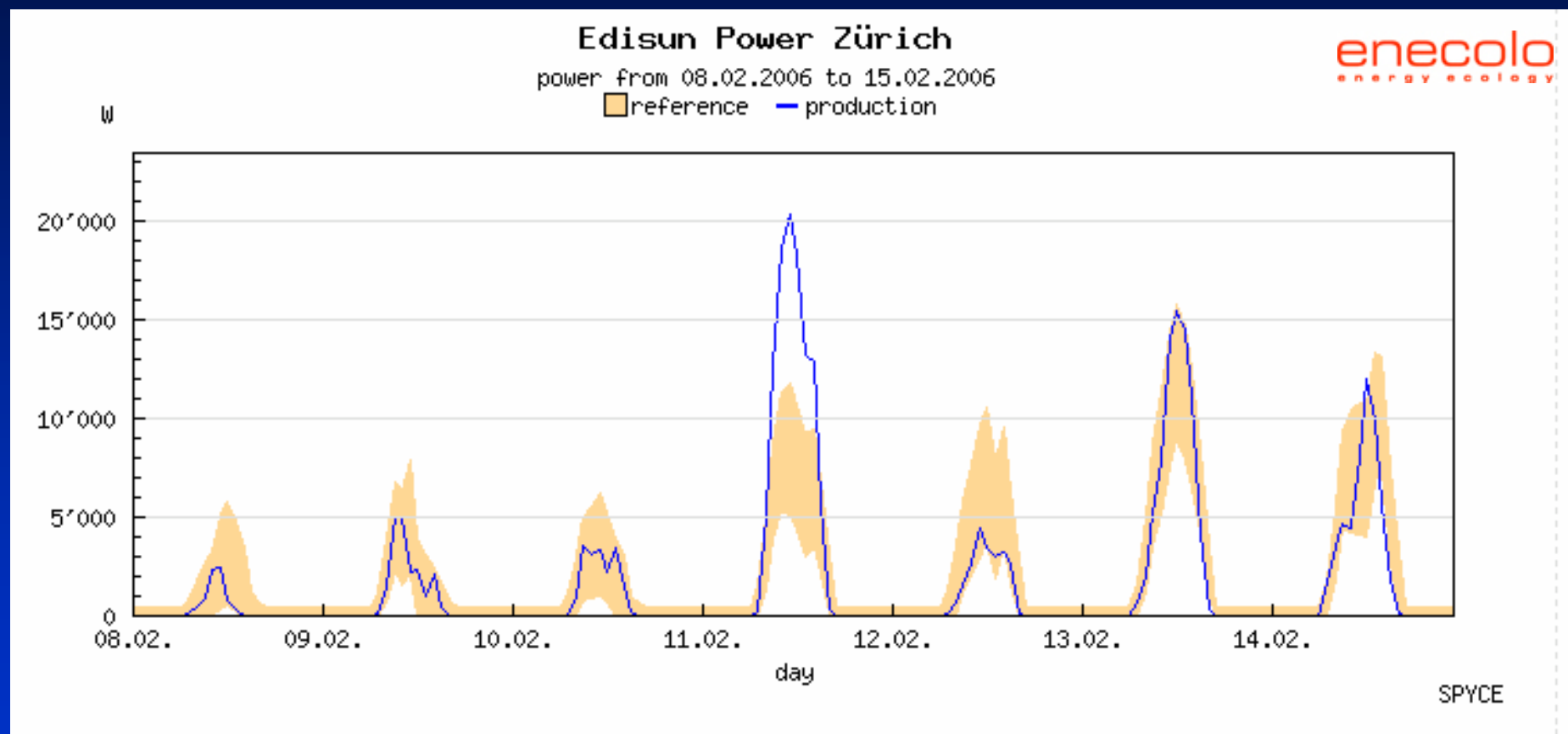
MSG spectral resolution allows
detection of snow and clouds



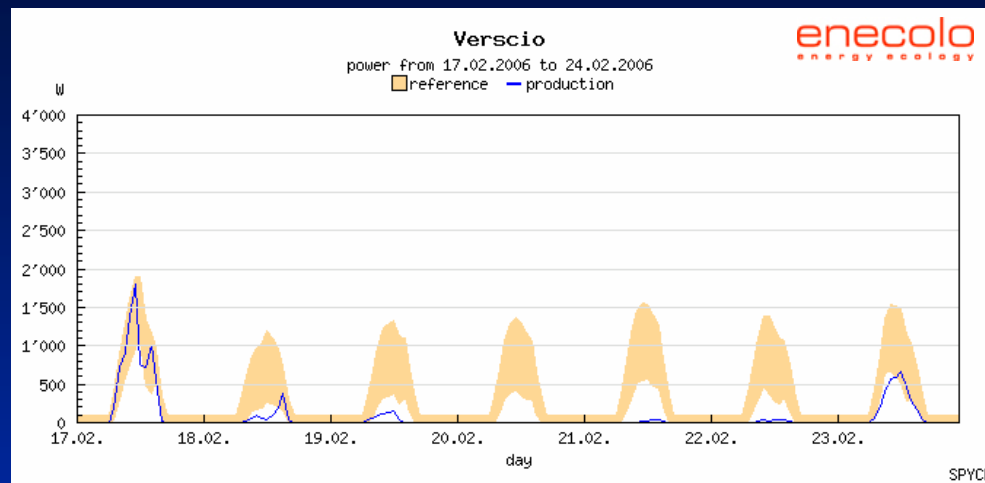
MSG, 26 Nov 2005, 12 UTC



white, grey = clouds blue = snow



11 Feb 06, snow cover interpreted as cloud



20 – 22 Feb 06, snow cover
reducing PV output,
no maintenance needed

Verscio: from 17.02.2006 to 23.02.2006

type of error	17.02.	18.02.	19.02.	20.02.	21.02.	22.02.	23.02.
data transmission failed							
snowcover							
control devices							
defect inverter							
grid outage							
shading							
high temperature							
hot inverter							
power limitation							
high losses at low power							
MPP tracking							
string defect							
module defect							
soiling							
degradation							
unknown failure							
system status							

PV system status

- 😊 = no problems
- 😬 = failure suspected
- 😬 = failure present
- 😬 = grave failure
- = no data

probability of failure

- green = none
- yellow = low
- orange = medium
- red = high
- = no data

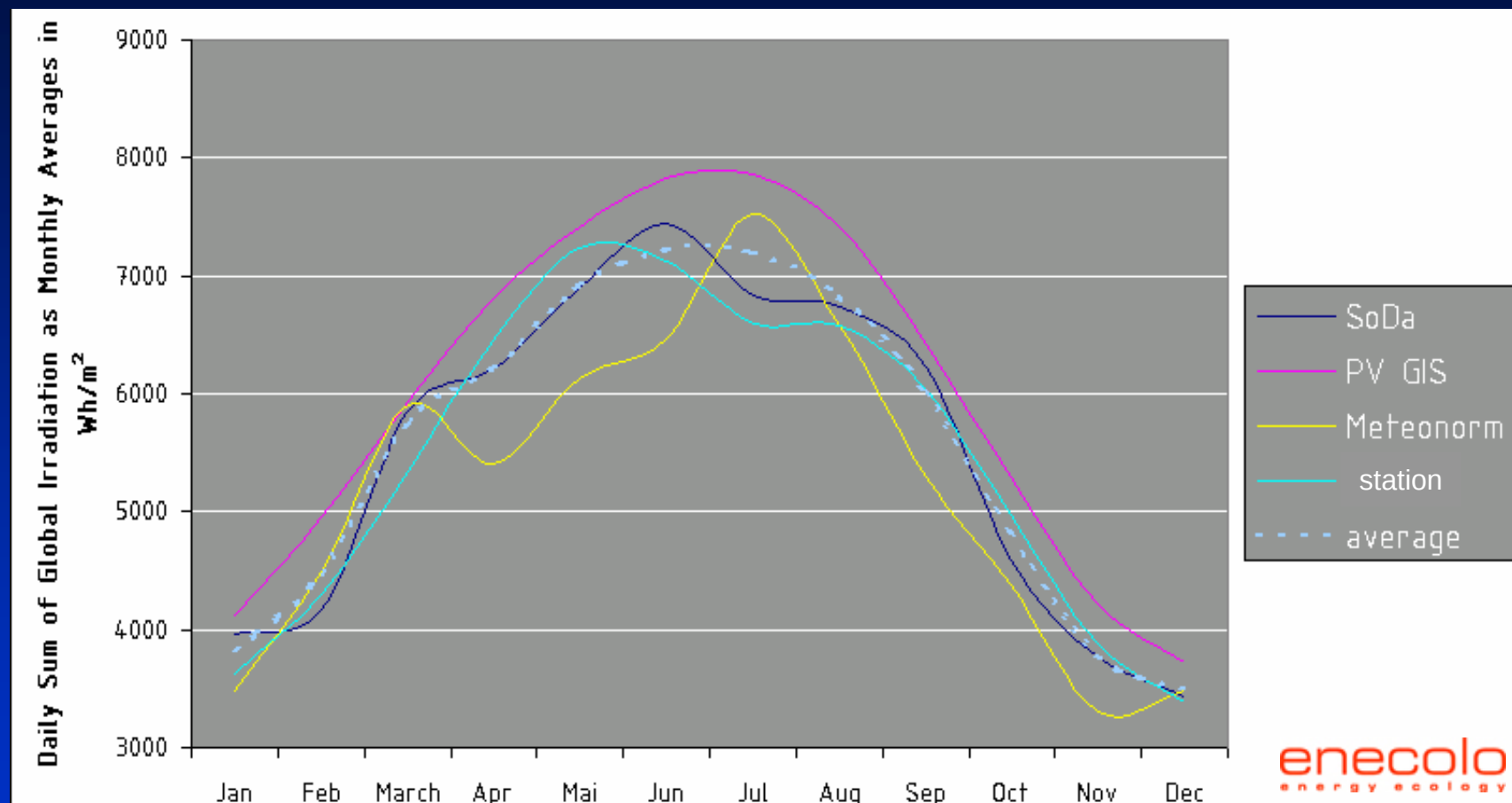
enecolo
energy ecology

Requirement: **Quality of hourly satellite based data** needs to be improved

ENVISOLAR science review (A. Zelenka):

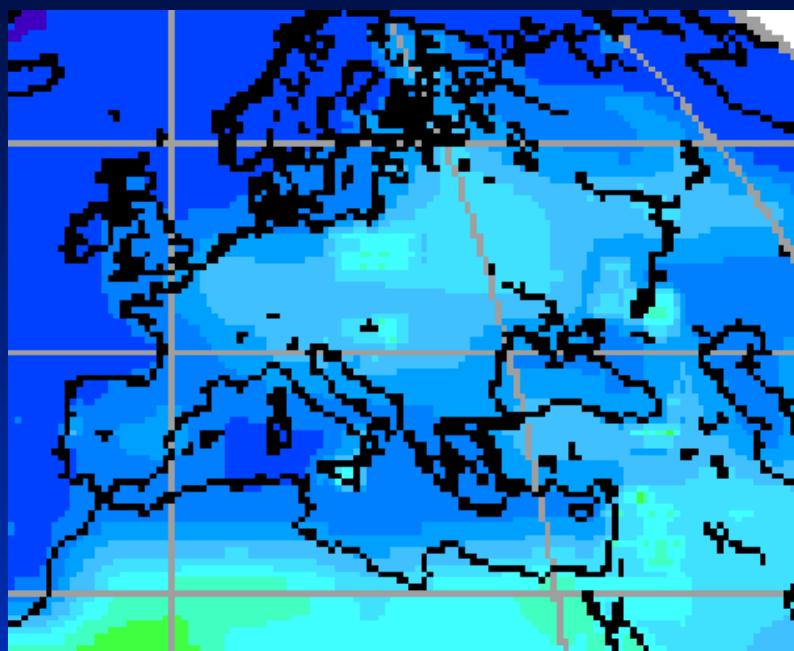
Mean bias error (0 % to ± 20 %)
is mainly due to wrong clear sky parameters
aerosols and water vapour.

-> new HELIOSAT-3 input parameters

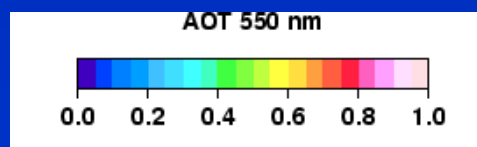


*based on
satellite
met. stations
met. stations*

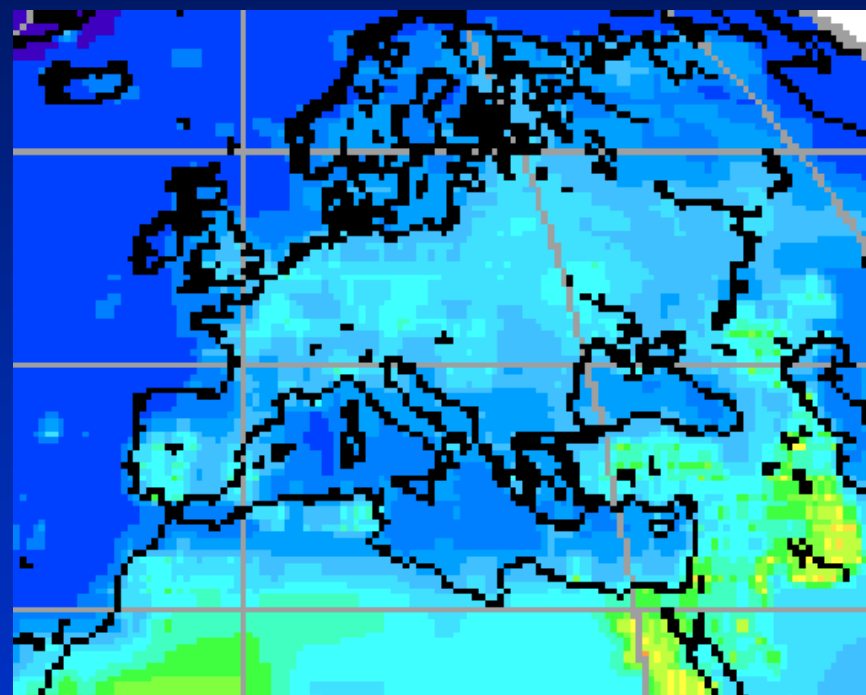
Comparison of global irradiation from different data sources
for a location on the Canary Islands



SUMMER – GADS Climatology
Europe subset



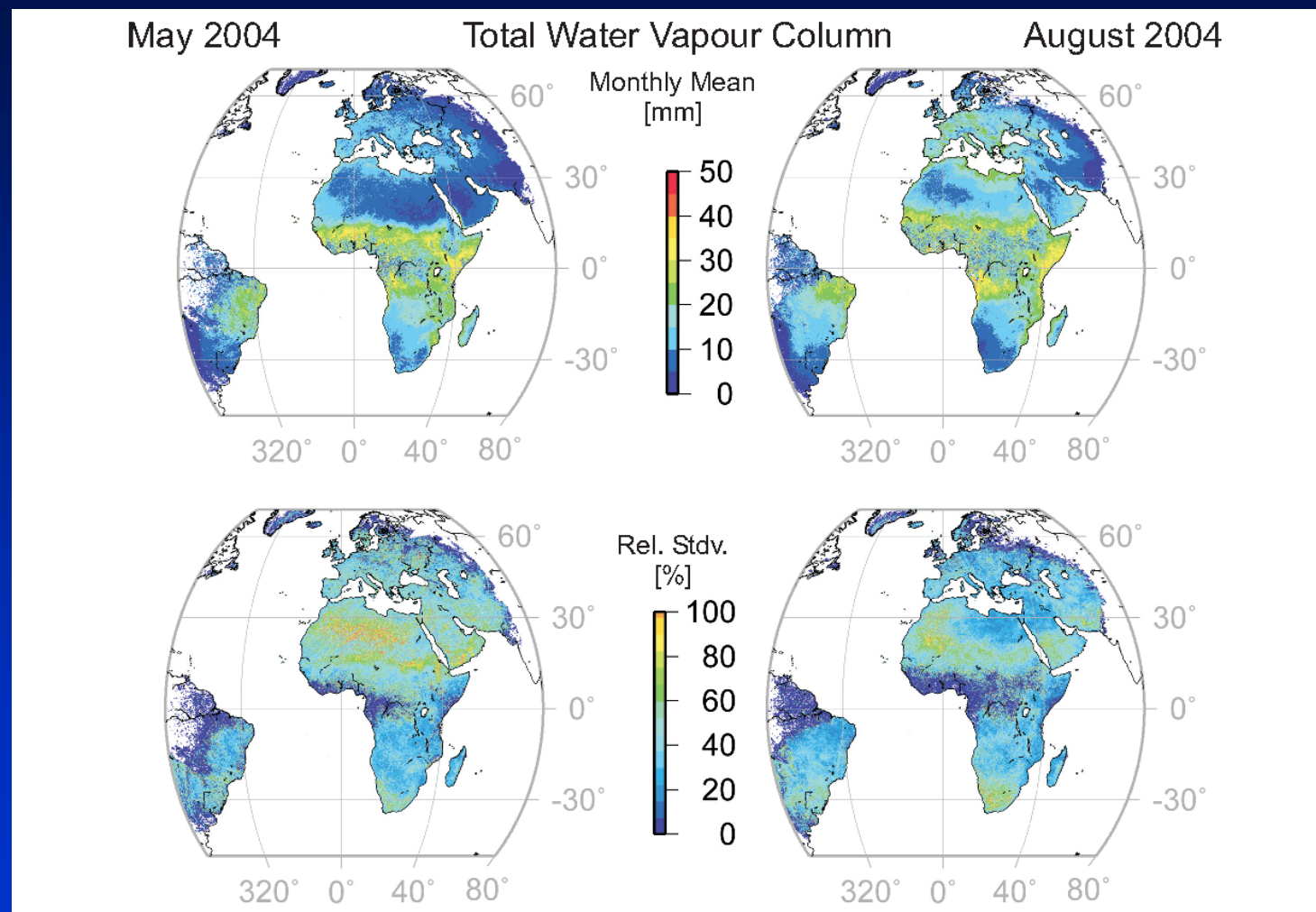
New:
ENVISAT aerosol optical thickness
early Sept 2005 after 4 months of assimilation



- preliminary –
currently both lv2 and lv3 in validation

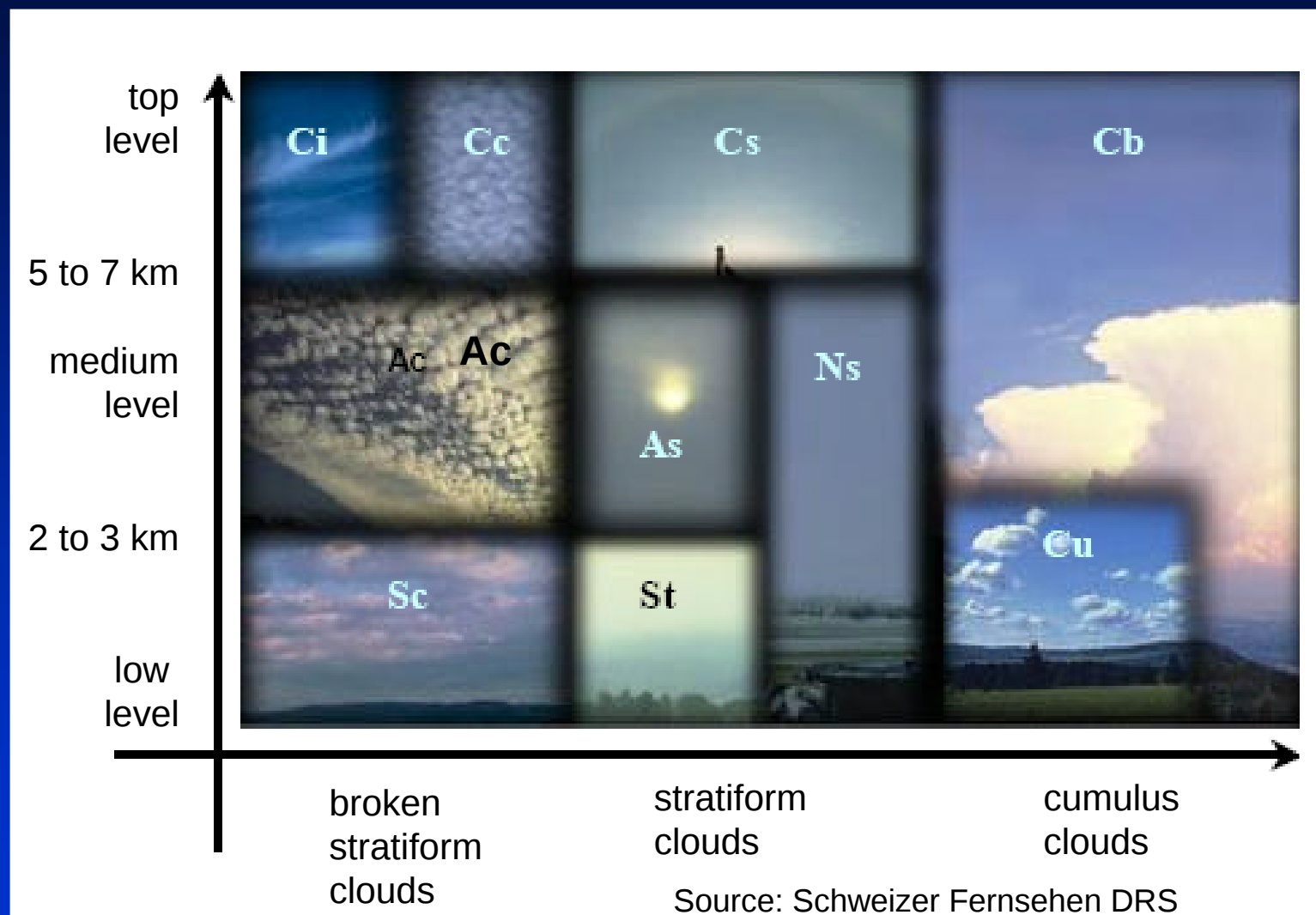
MSG allows
retrieval
of water vapour

needed in
clear sky
situations

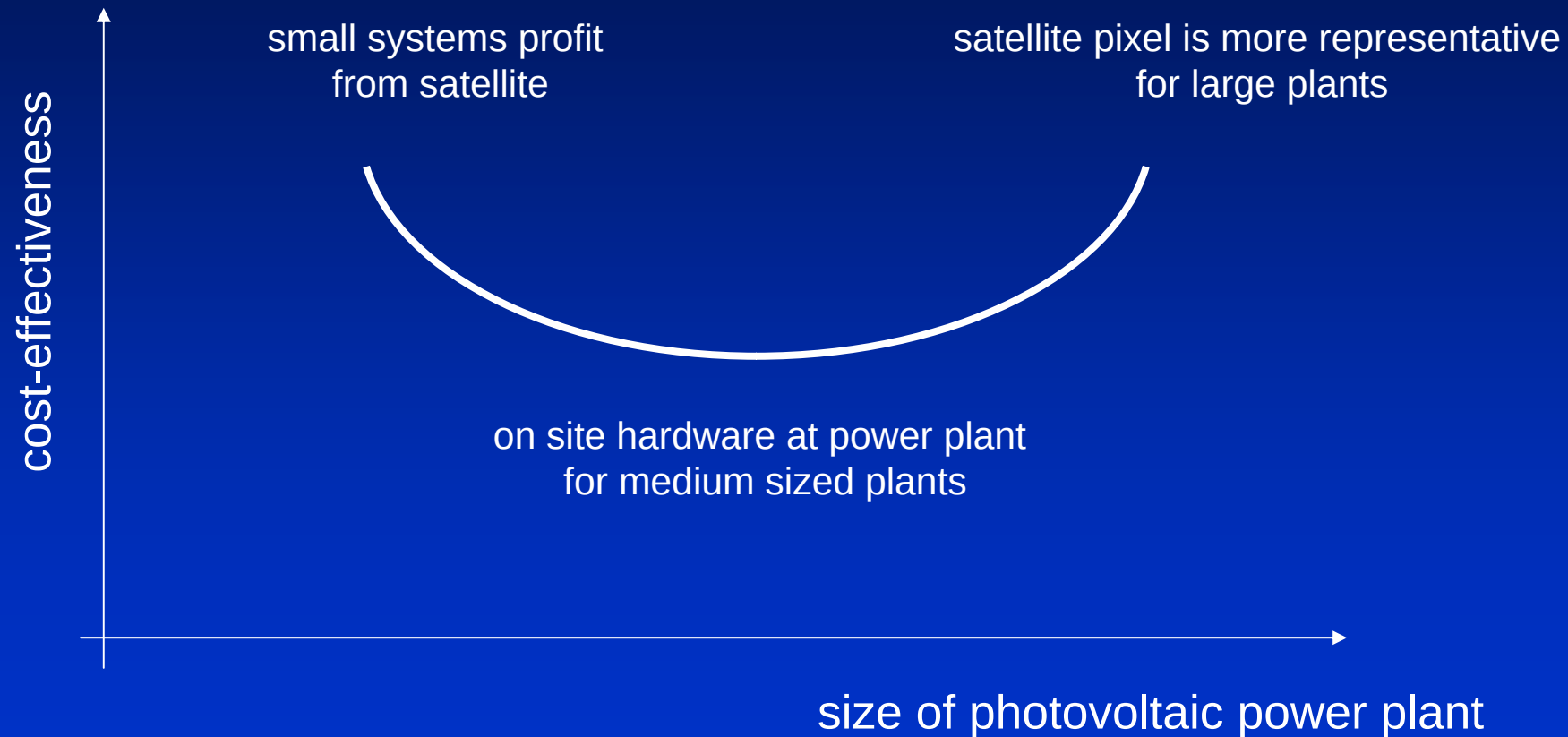


MSG-APOLLO
allows
more detailed
description
of clouds

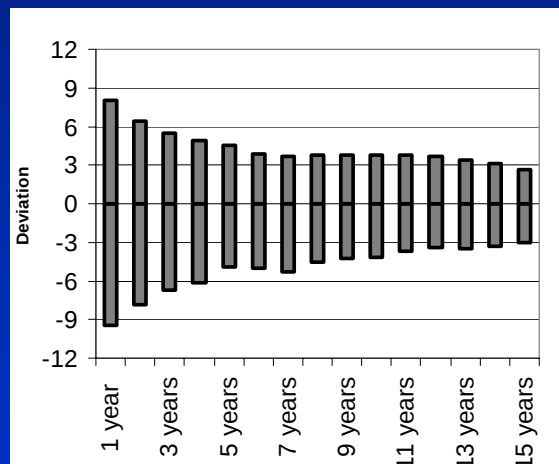
- height level
- stratiform or cumulus



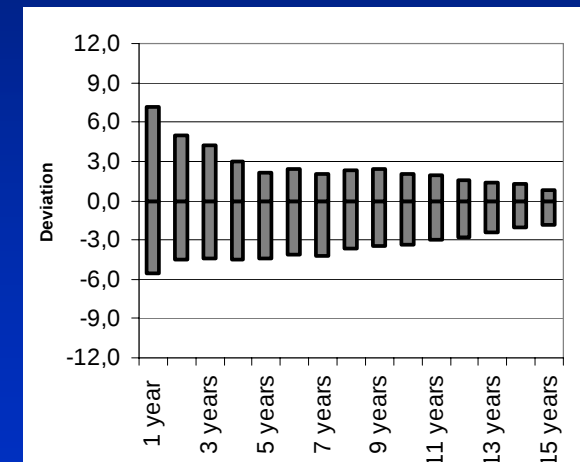
- basic costs for satellite data very high → critical in start phase
- efficient and low cost monitoring of PV systems in areas without many other plants to compare with
- automatisisation of failure detection possible
- reliability and accuracy of irradiance data is crucial
 - integration of near real time aerosol data
 - snow detection
- both bias and standard deviation needs to be low



- long-term time series are crucial for yield estimates and investment decisions
- accurate means are needed, standard deviation is not as important
- due to investment volume, price sensitivity is lower than in plant management



Deviation in % of the yearly mean global irradiance
derived from time series of different lengths
Freiburg, Germany



Deviation in % of the yearly mean global irradiance
derived from time series of different lengths
Madrid, Spain

Thank you