# Satellite Data for Marine Climate Monitoring Purposes

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➢CM SAF products and data sets

➢Applications of satellite data in marine climate monitoring

- Evaluation of instantaneous satellite data by buoy observations
- Evaluation of monthly mean satellite-derived precipitation using the PACRAIN data set
- Analysis of solar surface radiation over land and sea

➢Conclusions

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



**CM SAF**
Climate Monitoring

**Satellite Application Facility on Climate Monitoring**

- There are currently eight SAFs providing products and services on an operational basis

- EUMETSAT-funded consortium

Germany -DWD-
Climate Monitoring

Finland -FMI -
Ozone Monitoring

Italy -SMA-
Hydrology

Denmark -DMI -
GRAS

France -MF-
Ocean and Sea Ice

**EUMETSAT**

Portugal -IM-
Land Surface
Analysis

United Kingdom - UKMO -
Numerical Weather
Prediction

Spain - INM -
Support to Now-
Casting and Very Short
Range Forecasting

Website: **www.cmsaf.eu**

**EUMETSAT =** European Organisation for the Exploitation of

Meteorological Satellites,

founded in 1986

**Main purpose:** Deliver weather and climate-related satellite data,

images and products.

There are two categories of CM SAF products:

1. near real-time data (for data assimilation, quality checks)

2. datasets based on carefully intersensor calibrated radiances (for investigations of climate variability and long-term changes, quality checks of delayed-mode data)

Focus on atmospheric parameters
of the GCOS defined "Essential Climate Variables" - ECVs

- –clouds
- –radiation
- –albedo
- –heat and radiation fluxes at the sea surface
- –global water vapour and temperature profiles

Coverage:
- –globally, 4 km resolution
- –regionally, higher resolution

Where are the data from?

derived from meteorological operational satellites in geostationary and polar orbit

## CM SAF products and data sets

- user-friendly data access via the Web User Interface: wui.cmsaf.eu

- all data is freely available in NetCDF format

- Toolkit (example data + scripts) available: www.cmsaf.eu/tools

**CM SAF**
Climate Monitoring

**Deutscher Wetterdienst**
*Wetter und Klima aus einer Hand*

### Clouds

- cloud cover
- optical depth
- phase
- top height/pressure
- type
- water path

- Cloud information available since 2005
- Daily and monthly means, spatial resolution 15 x 15 km
- Global data set (1982 to today) available in spring 2012

Cloud Fraction (%), CM SAF, July 2010
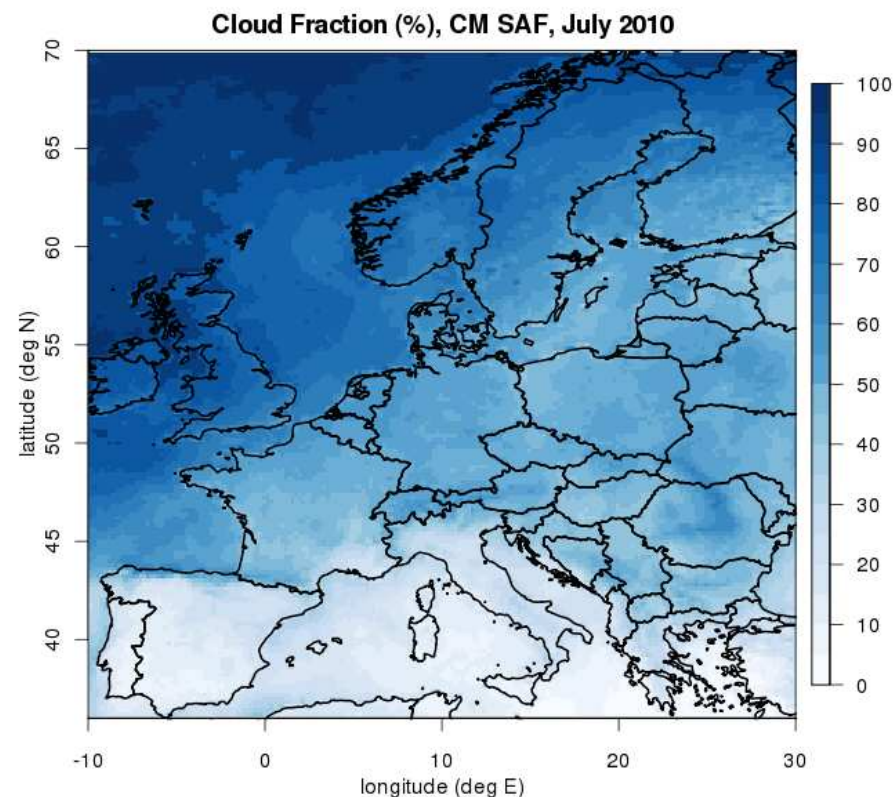
Cloud fraction in %, July 2010

## Radiation

- surface solar irradiance
- Top-of-the atmosphere SW / LW radiation

- Surface radiation information available since 1982 for the "Meteosat full disc"s
- Hourly, daily and monthly means, spatial resolution down to 0.03 deg
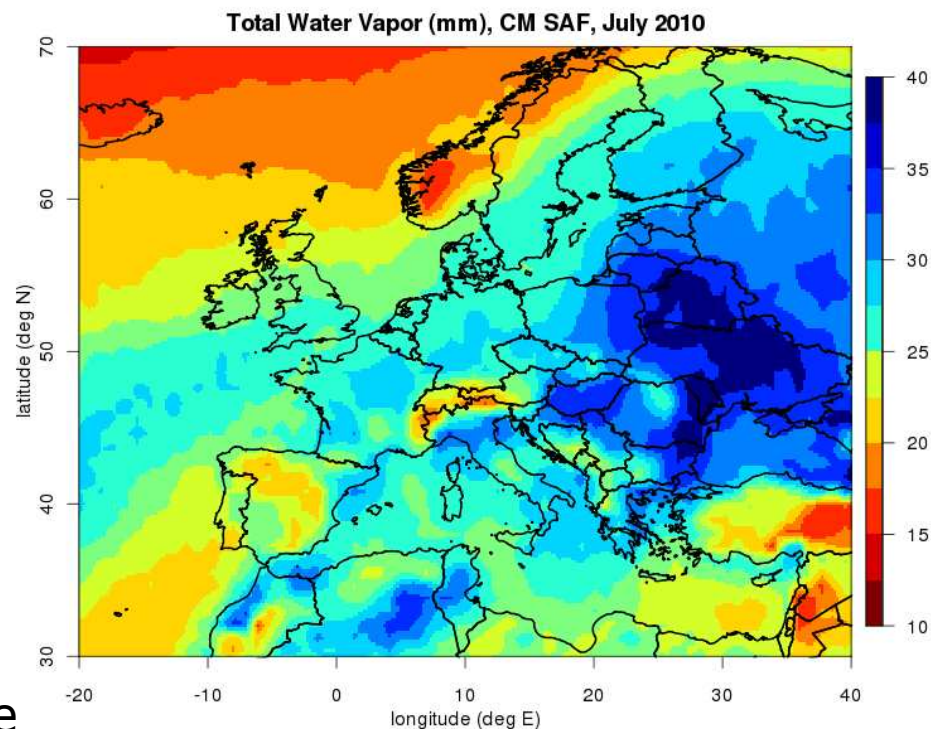- Global data set (1982 to today) available in spring 2012
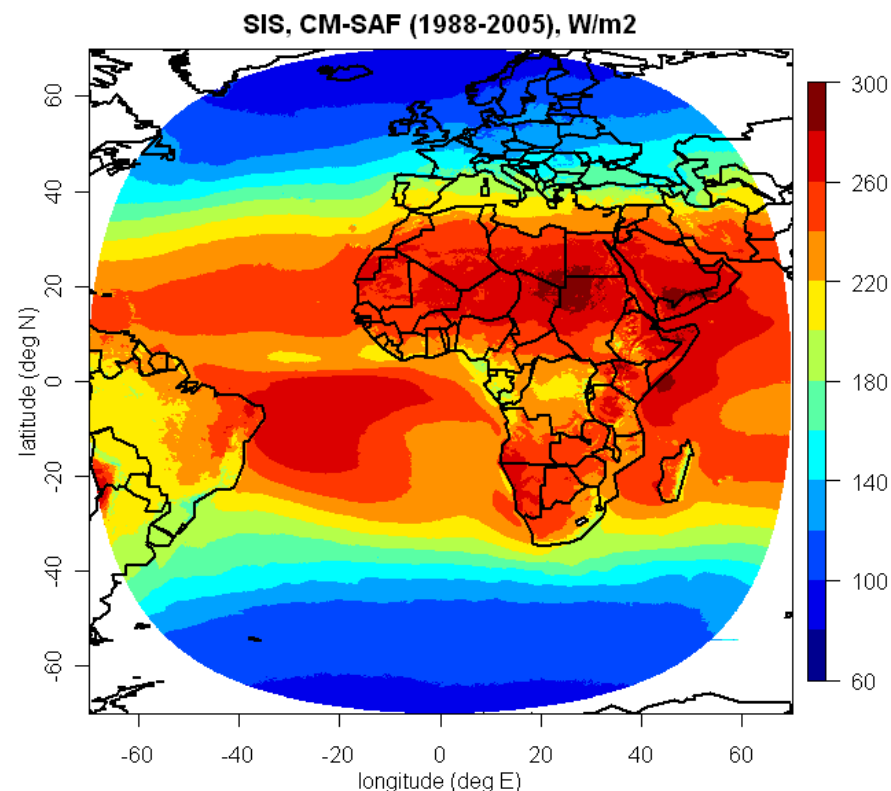


Surface solar irradiance (W/m$^2$), 1988-2005

# Water Vapor

- integrated water vapor
- water vapor / temperature on 5 vertical levels
- precipitation, latent and sensible heat fluxes (ocean only!)



Total water vapor (mm), July 2010

- global water vapor data available since 2004
- ocean only data (= precip, total water, surface heat flux) available since 1987
- Daily and monthly means, spatial resolution 0.5°

## Applications of satellite data in marine climate monitoring

1. Evaluation of instantaneous satellite data (humidity, wind speed) with surface observations from buoys and ships

2. Evaluation of satellite-derived monthly mean precipitation using the PACRAIN data set

3. Analysis of solar surface radiation over land and sea

Match-up between satellite overpasses and buoys /
ships observations, 2001 to 2005

SSM/I : matchup distribution                    2001-01-01 to 2005-12-31

Drifting
Ship
Moored
Tropic
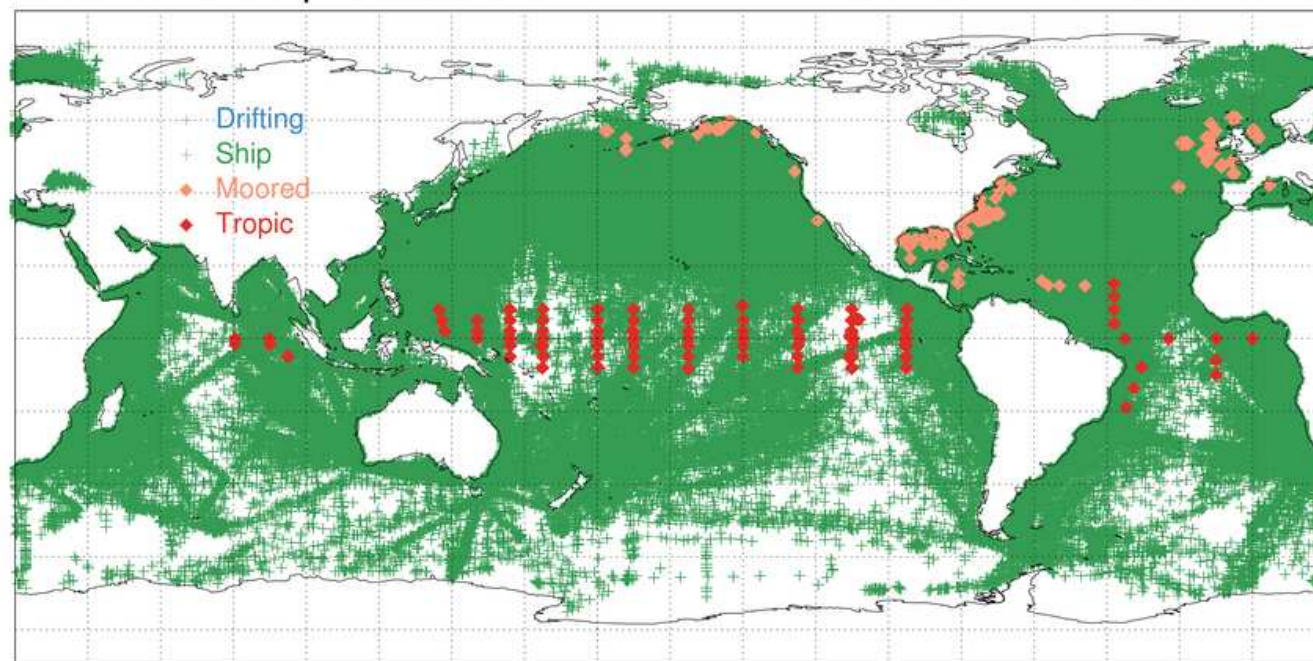
number of obs = 3401533

- max. time difference: 30 min
- max. distance to satellite pixel: 25 km
- nearly 3.500.000 matches in the data base!

Difference between satellite-based humidity and ship observations from 2001 to 2005 incl. 3 difference satellites



KollSat match-up timeseries [2001-01-01 - 2005-12-31]
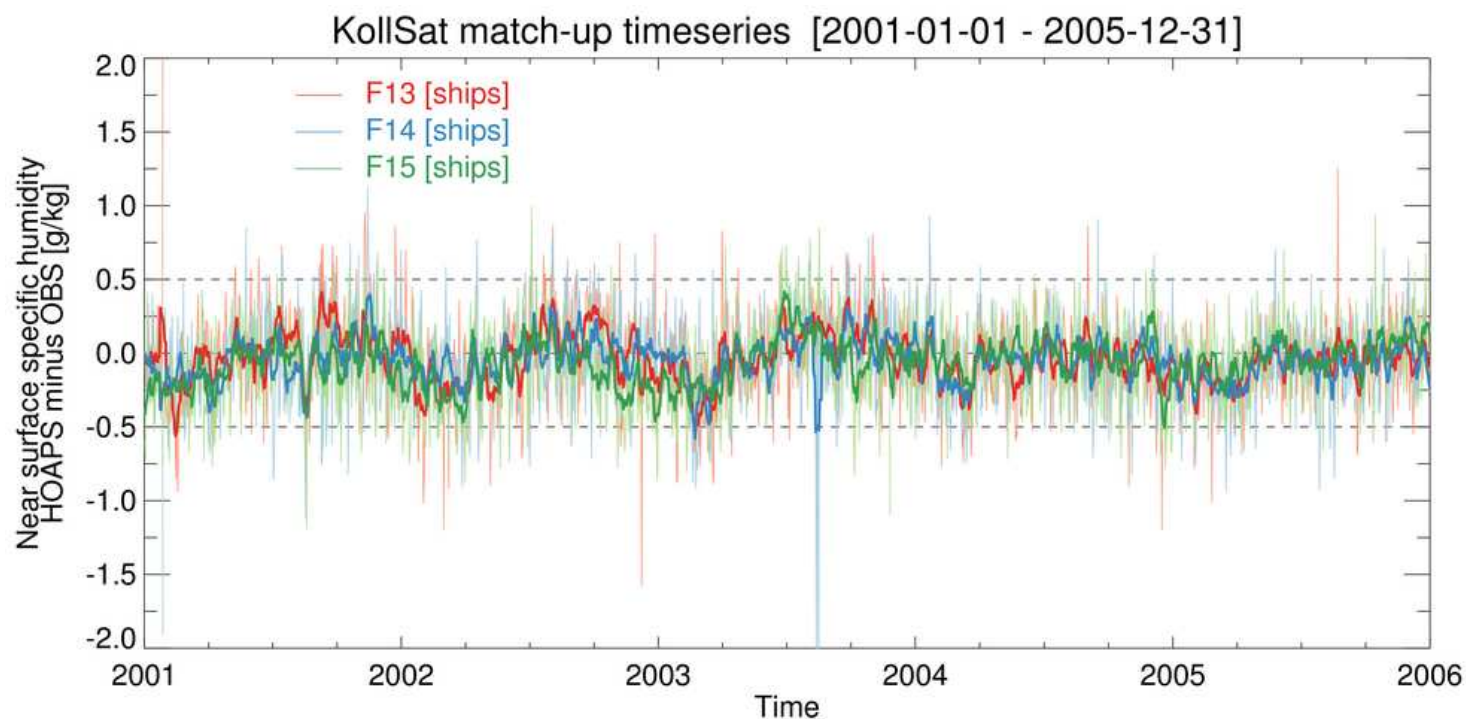
- Small bias: -0.05 g/kg, RSD: 1.52 g/kg
- The difference is temporally constant; comparable for all satellites.

# Hamburg Ocean Atmosphere Parameter and Fluxes from Satellites - HOAPS

- Retrieval of numerous climatological-relevant parameters over the ice-free oceans based on passive microwave measurements

- Parameters: surface humidity, wind speed, integrated water vapor, precipitation, latent and sensible heat flux

- Homogeneous and consistent time series

- Monthly, pentade and twice daily precipitation data on 0.5° grid

- Actual period from mid 1987 to 2005, soon to 2008

Reference: www.hoaps.org, Andersson et al. 2010

# Evaluation with ocean obs

HOAPS−3: Atmospheric specific humidity [g/kg]
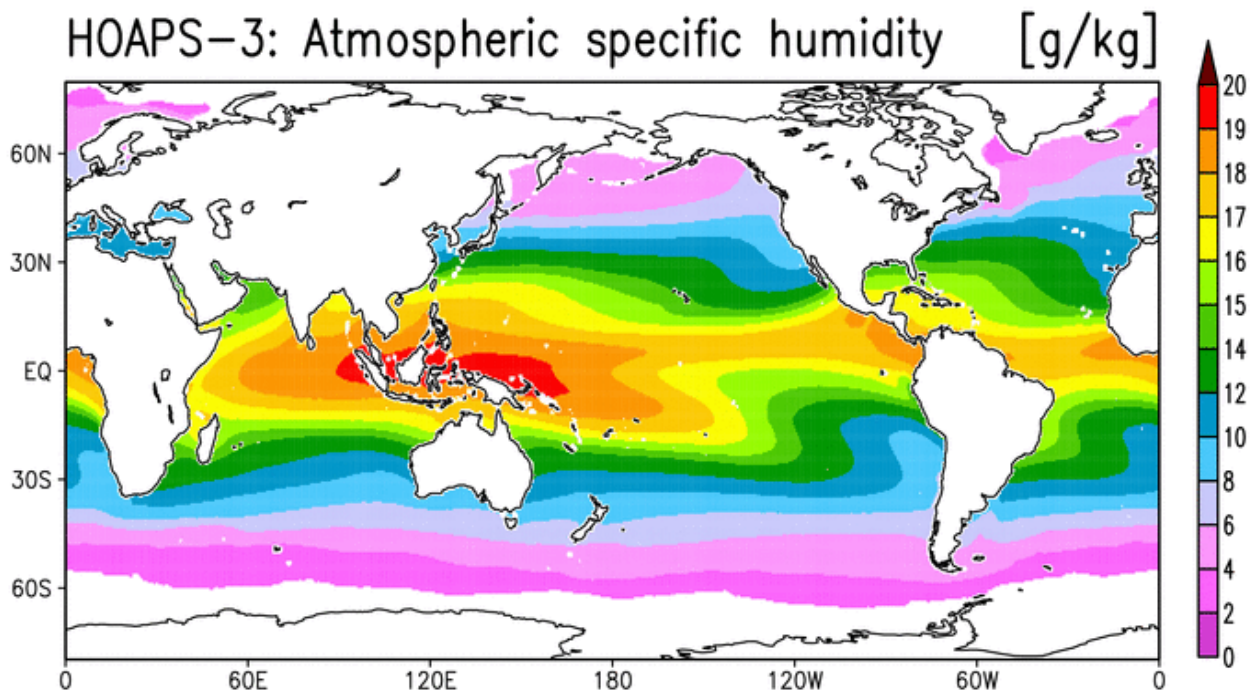


|  | Bias (g/kg) | RSD (g/kg) |
|---|---|---|
| Buoys | -0.34 | 1.55 |
| Ships | -0.05 | 1.52 |

- Evaluation reveals small bias / RSD of satellite retrieval
- bias depends on total water vapor and SST
- Improved error estimate of satellite retrieval possible

HOAPS-3: Wind Speed                                           [m/s]
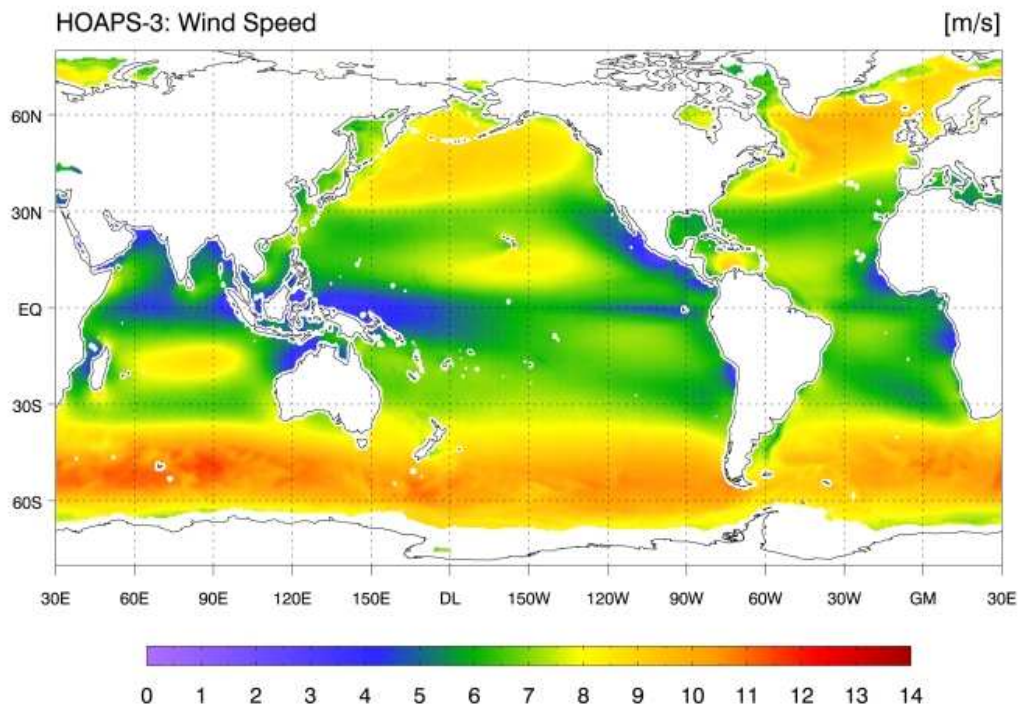
| | Bias (m/s) | RSD (m/s) |
|---|---|---|
| Buoys | 0.29 | 1.51 |
| Ships | 0.47 | 2.30 |

- Evaluation reveals small bias / RSD of satellite retrieval
- bias depends on total water vapor and SST
- Improved error estimate of satellite retrieval possible

1. Evaluation of instantaneous satellite data (humidity, wind speed) with surface observations from buoys and ships
2. Evaluation of satellite-derived monthly mean precipitation using the PACRAIN data set
3. Analysis of solar surface radiation over land and sea

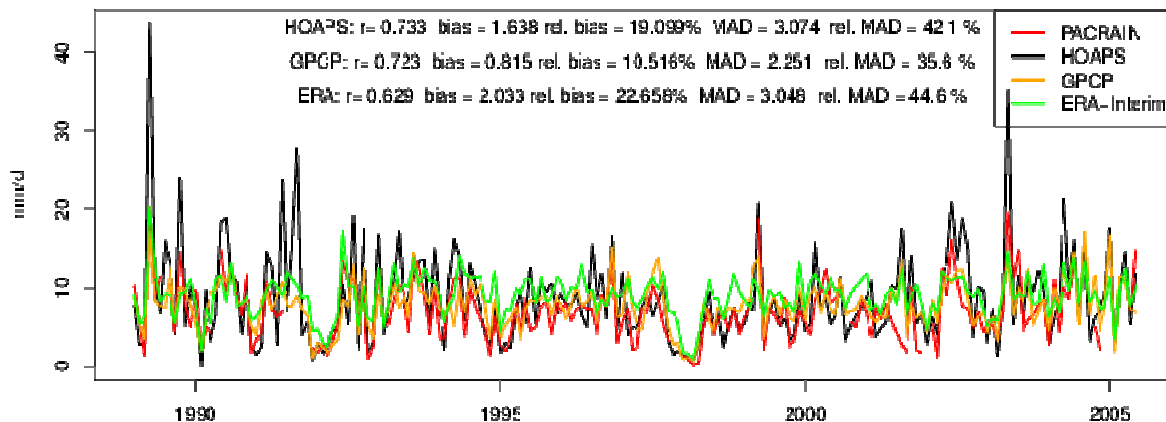## HOAPS precipitation climatology
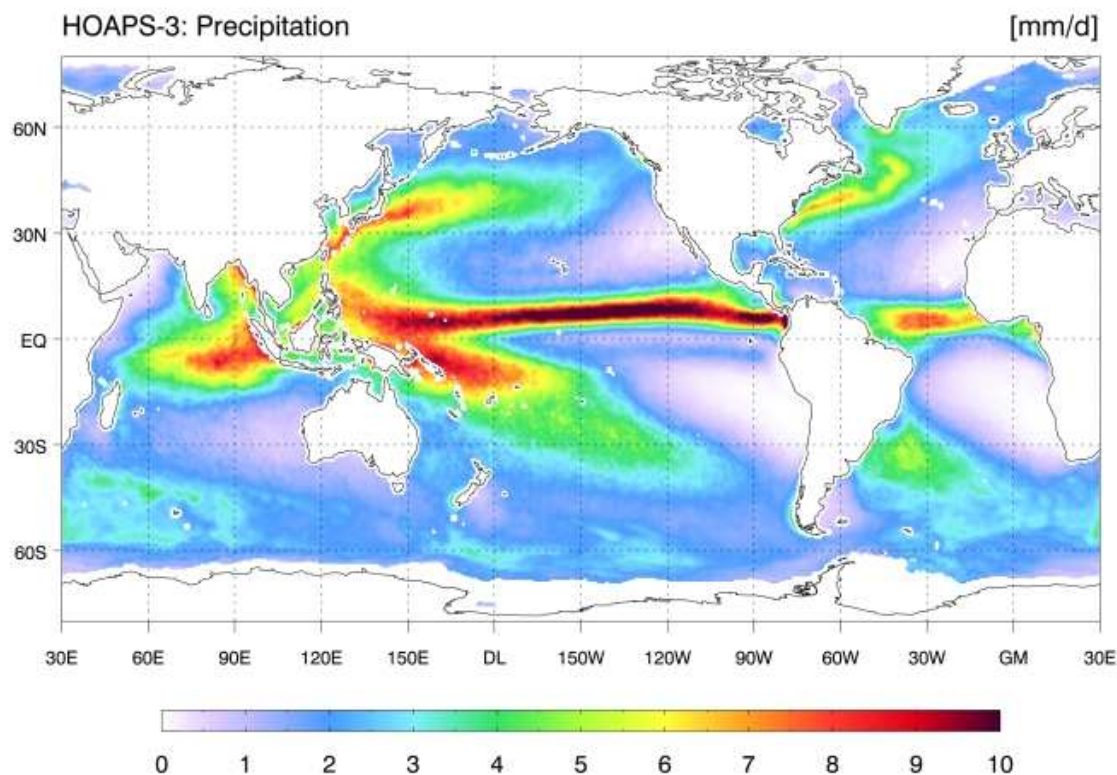


- Only very limited long-term measurements of precipitation available over the oceans

**PACRAIN Atoll Stations**
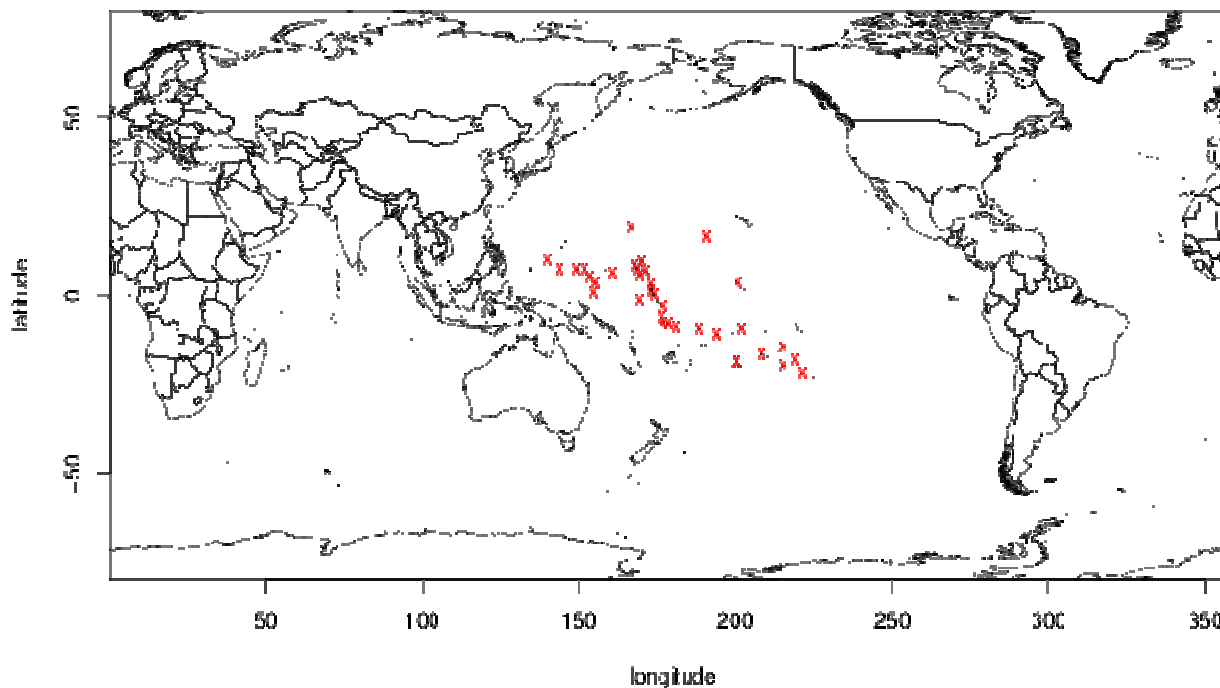


- use of data from The Pacific Rainfall Data Base (PACRAIN) for evaluation (hhtp://pacrain.evac.ou.edu)
- In total 35 stations with measurements of at least 10 years
- Compare time series of monthly means

PACRAIN, US14761

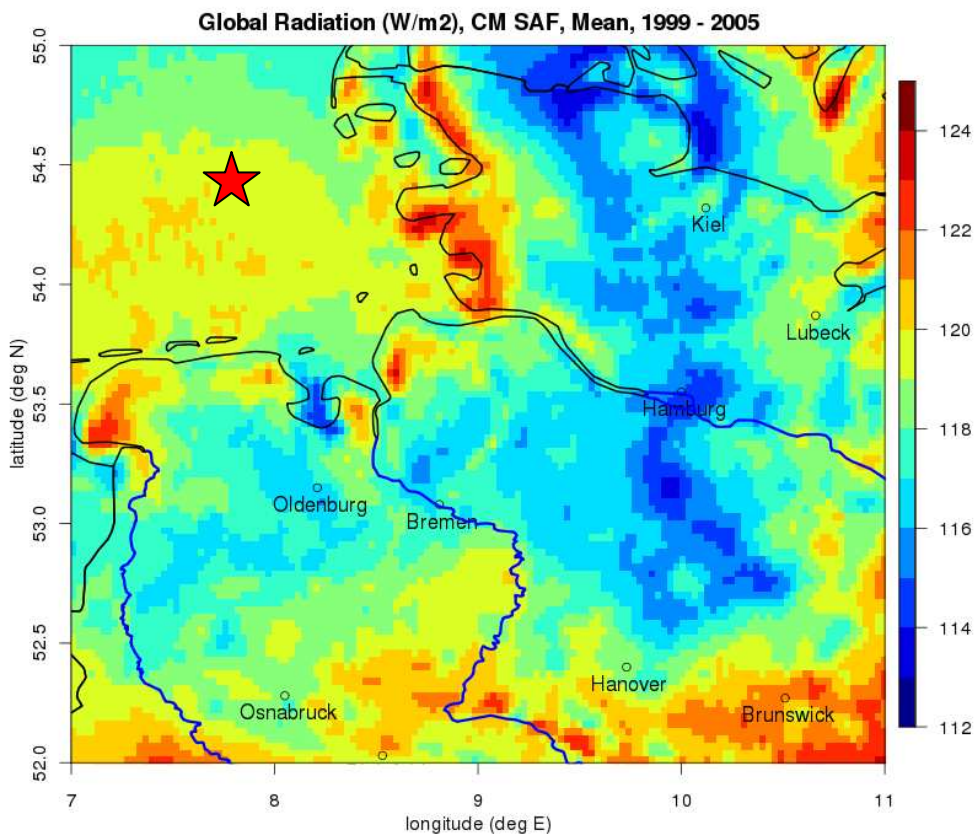- In total 4700 months available for comparison
- Good correlation between the surface measurements and the satellite retrieval
- Small negative bias
- Quality of HOAPS comparable to other data sets: satellite derived (e.g., GPCP) and reanalysis.
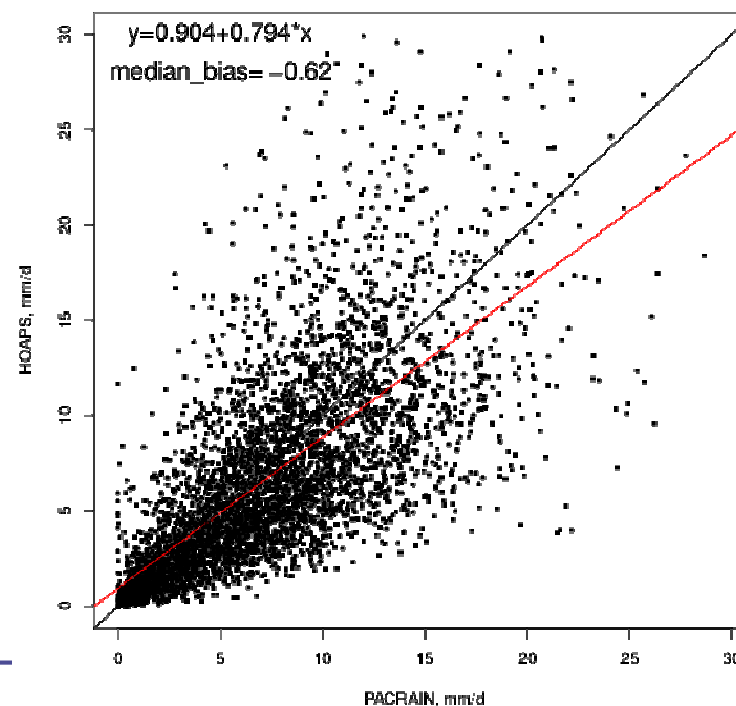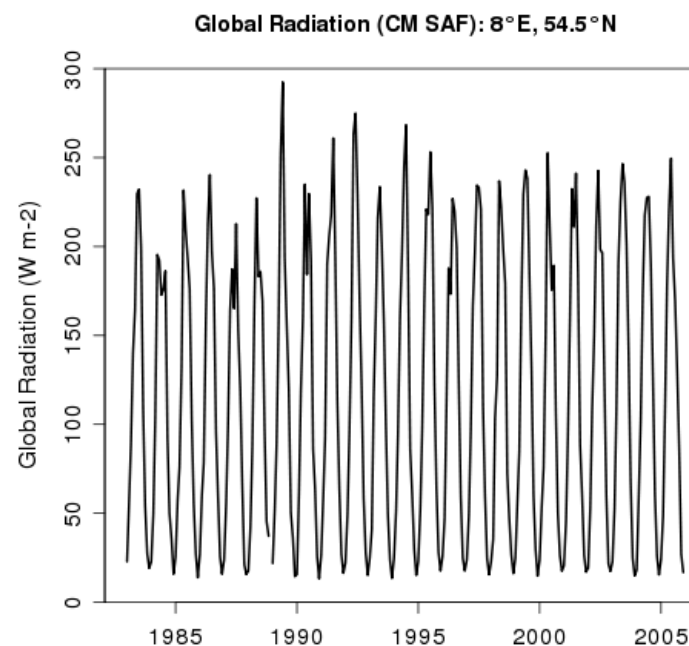
1. Evaluation of instantaneous satellite data (humidity, wind speed) with surface observations from buoys and ships
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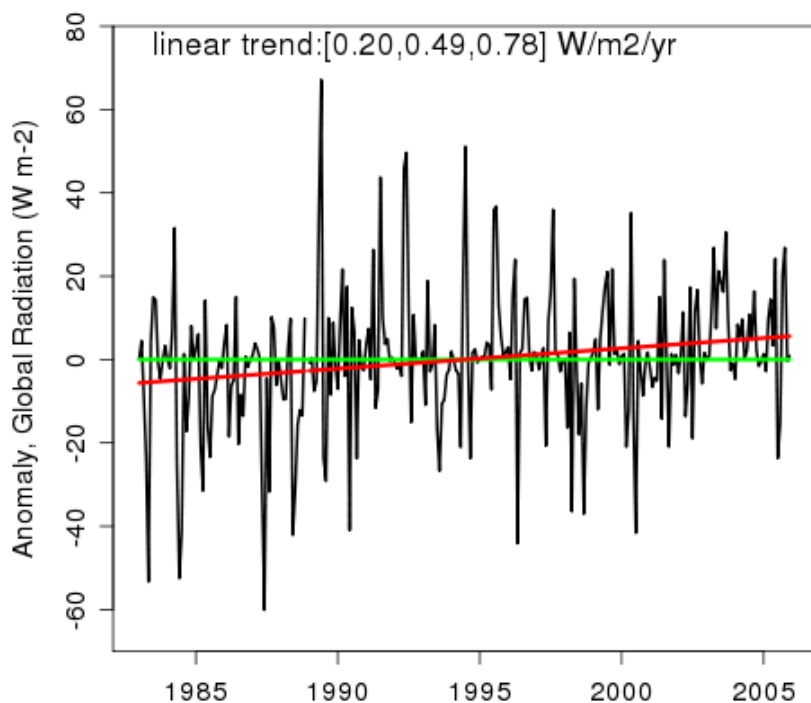3. Analysis of solar surface radiation over land and sea

CM SAF — Climate Monitoring

Deutscher Wetterdienst — *Wetter und Klima aus einer Hand* — DWD



Global Radiation (W/m2), CM SAF, Mean, 1999 - 2005

Global radiation (W/m²), 1999-2005

Global radiation
1983 to 2005

Time Series of monthly mean
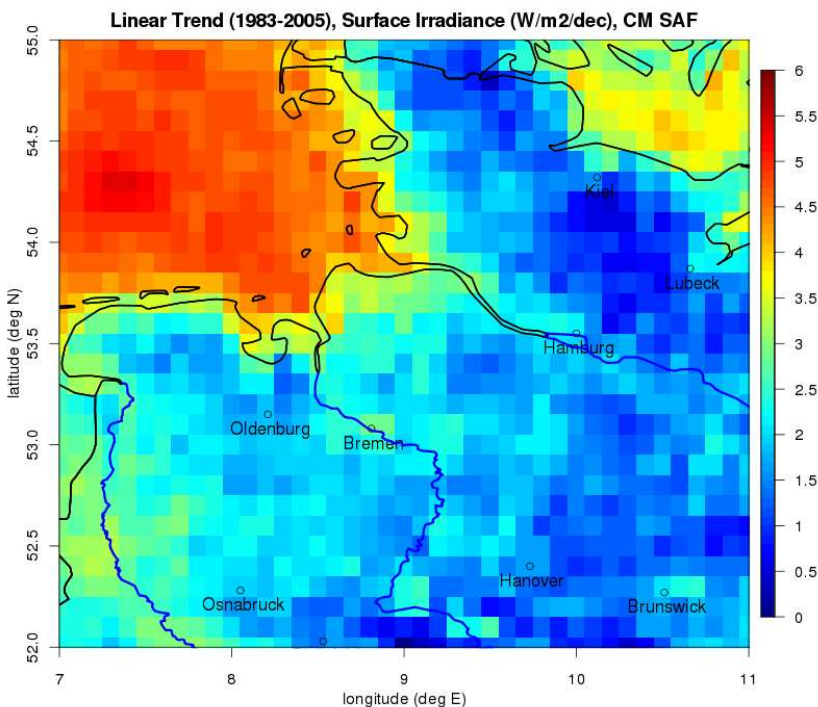global radiation, North Sea



Global Radiation (CM SAF): 8°E, 54.5°N
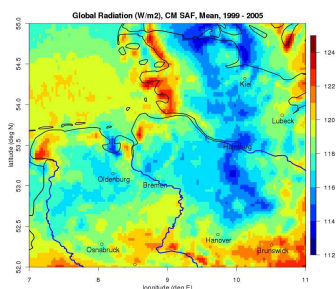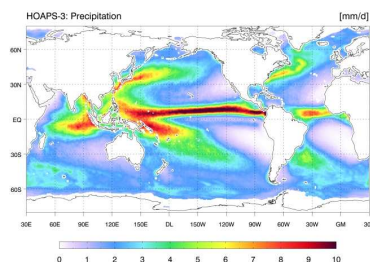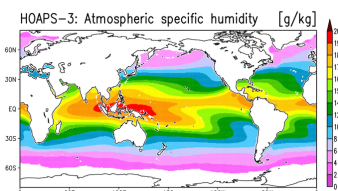
Monthly Anomalies, Global Radiation (CM SAF): 8°E, 54.5°N

linear trend:[0.20,0.49,0.78] W/m2/yr

Linear Trend (1983-2005), Surface Irradiance (W/m2/dec), CM SAF

Anomaly of the monthly mean global radiation

- Large positive linear trend of solar surface radiation over the North Sea

- Satellite-derived products can add useful information to available ocean surface observations
- Satellite-derived products have the quality for climate monitoring
- More surface observations are required to monitor the quality / stability of the satellite-derived products
- Satellite data and in-situ data are necessry partners for CM purposes over the oceans

# Thank you for listening
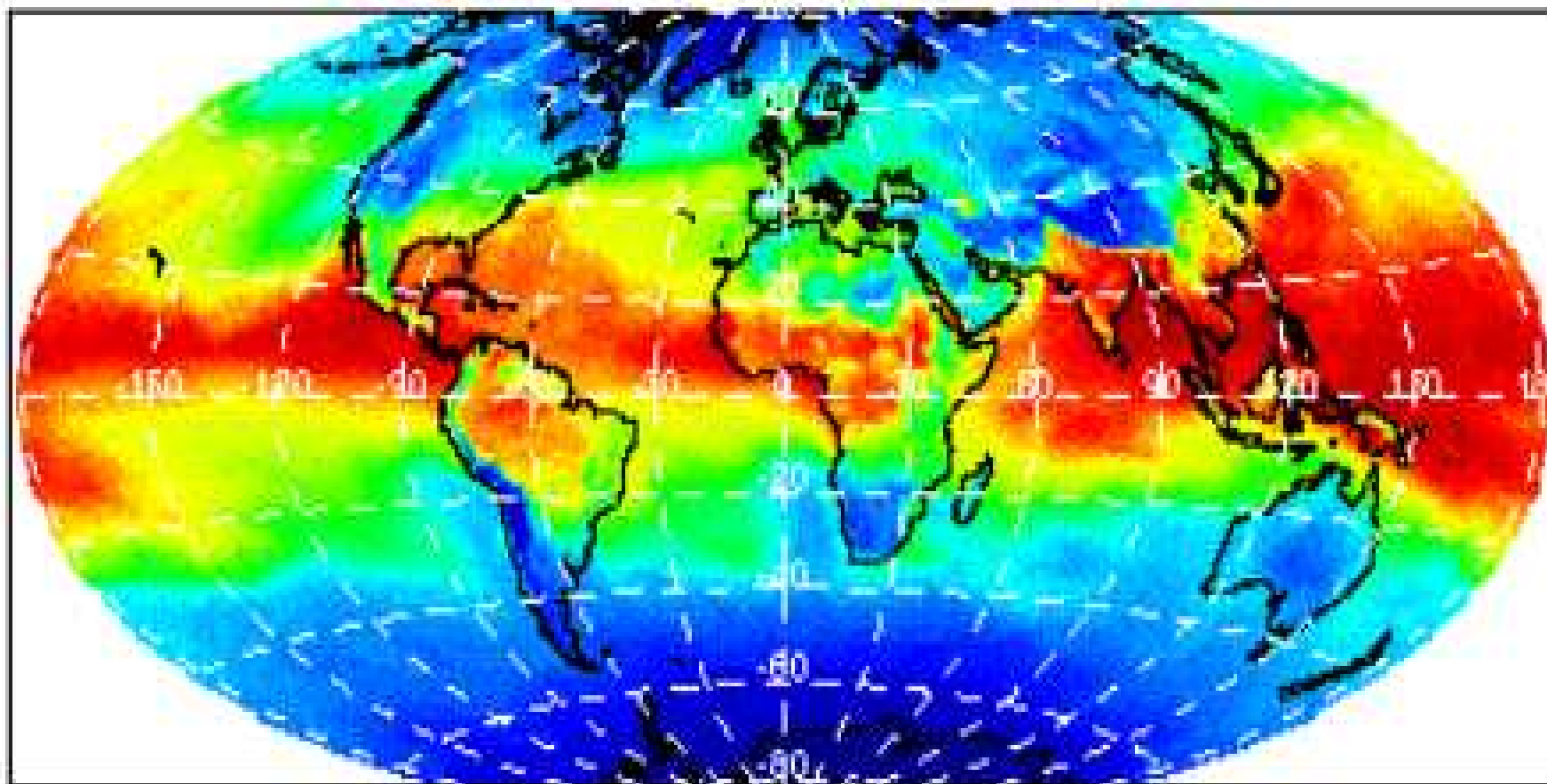


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**www.cmsaf.eu**