

NWP model validation of shortwave radiation processes with satellite data

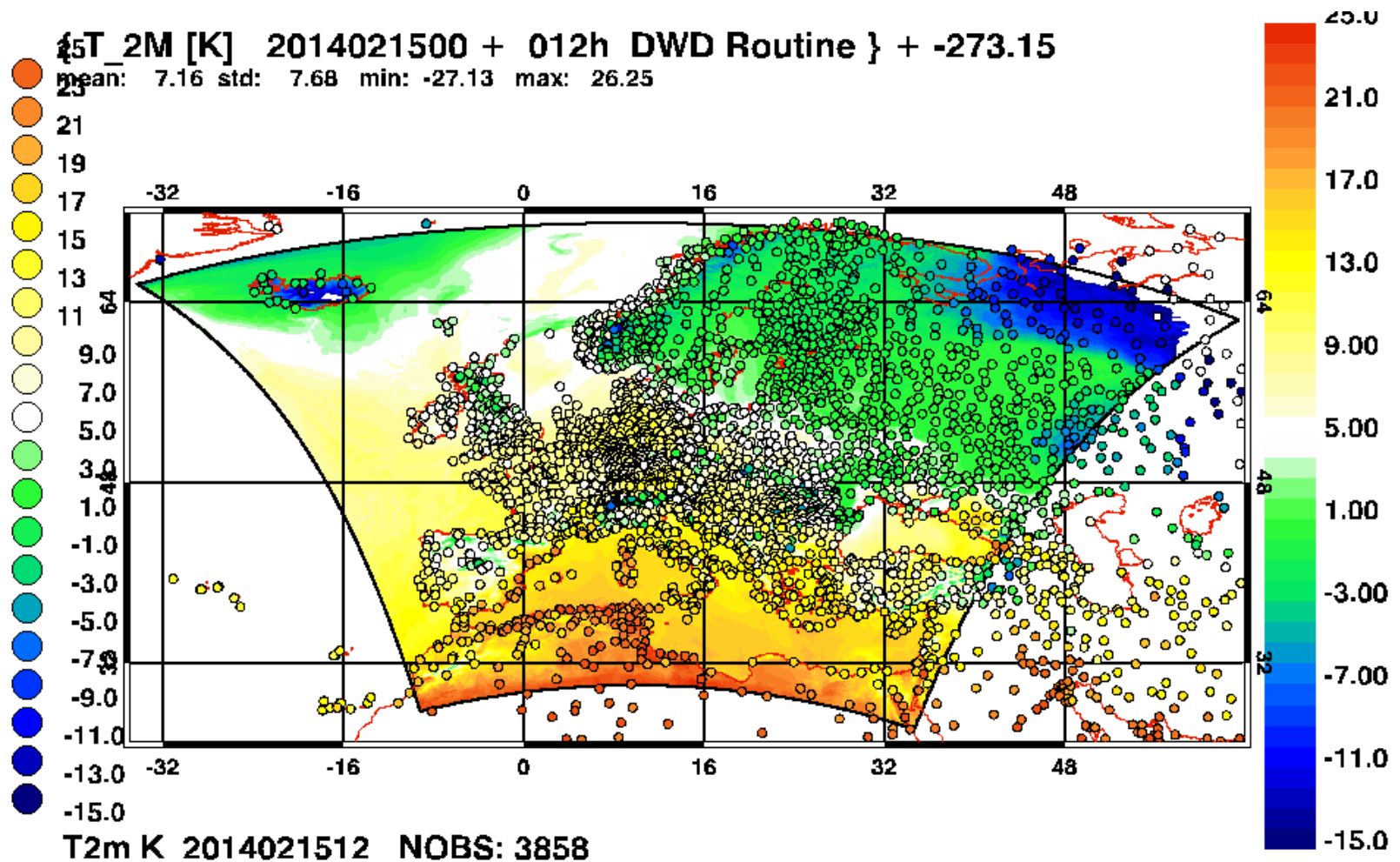
Frank Brenner
Deutscher Wetterdienst

**CMSAF
User
Workshop**

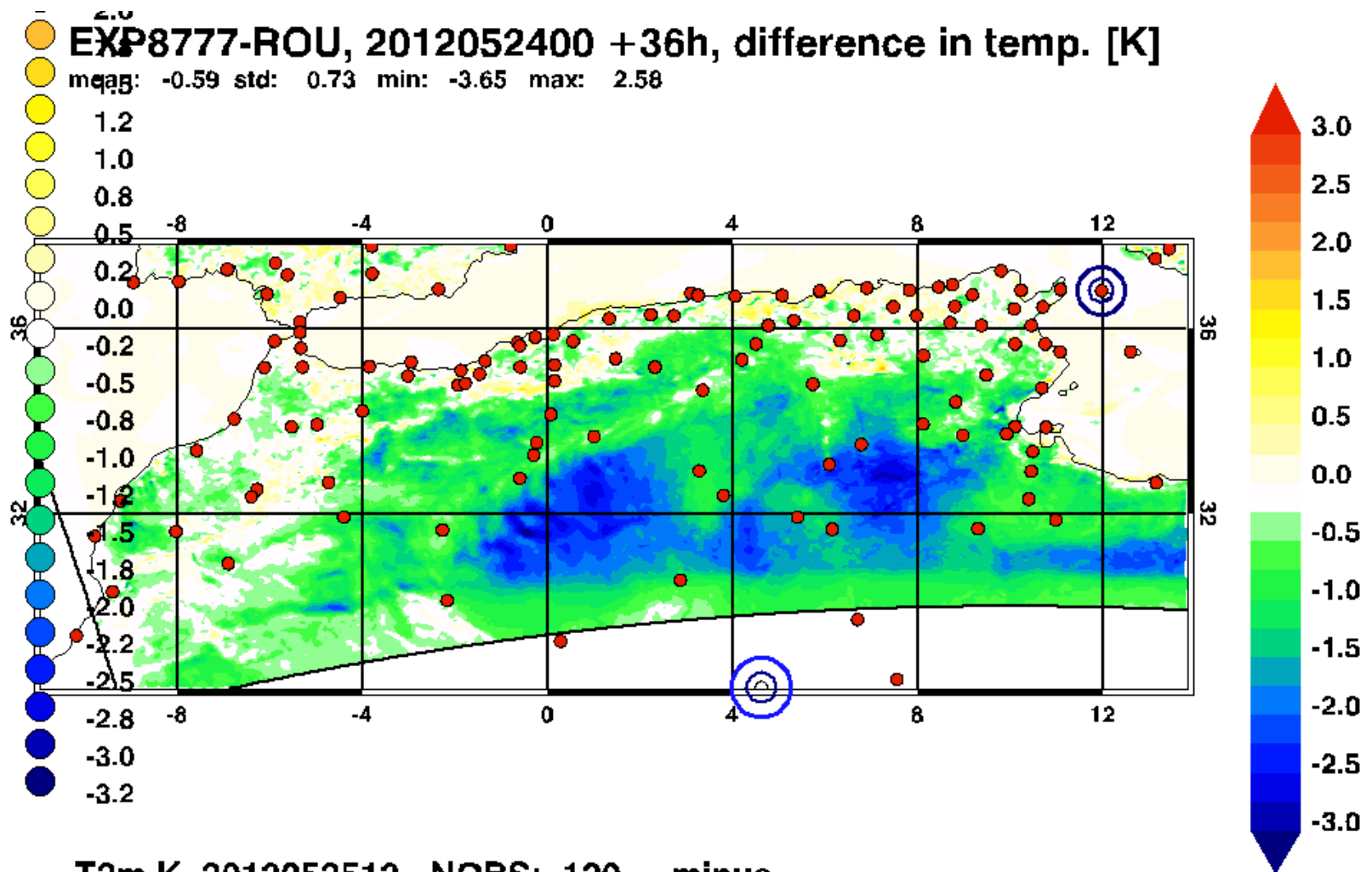
11.03.2014
Grainau



Verification with synop data



Verification with synop data



Motivation

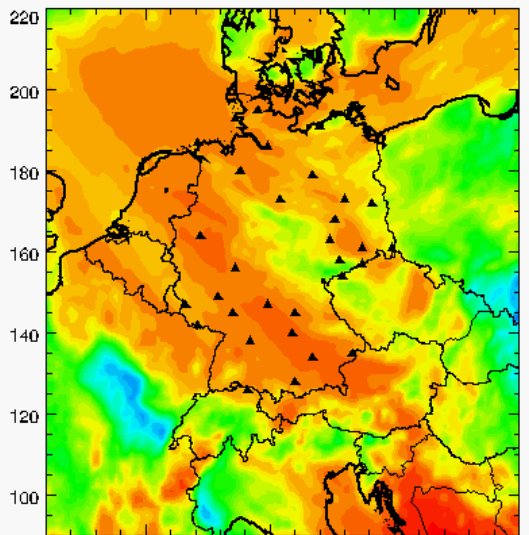


0 50 100 150 200 250 300

Date: 20120812 COSMO run: 20120812, 00 UTC

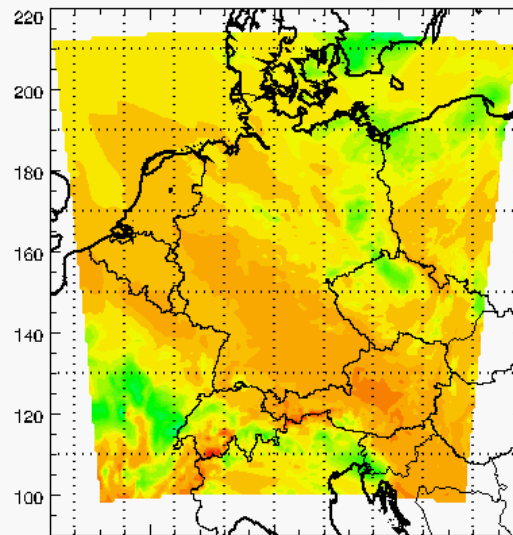
COSMO_DE_ROU_20120812.nc

CMSAF SIS, daily average



150 200 250 300

CDE ROU, daily average



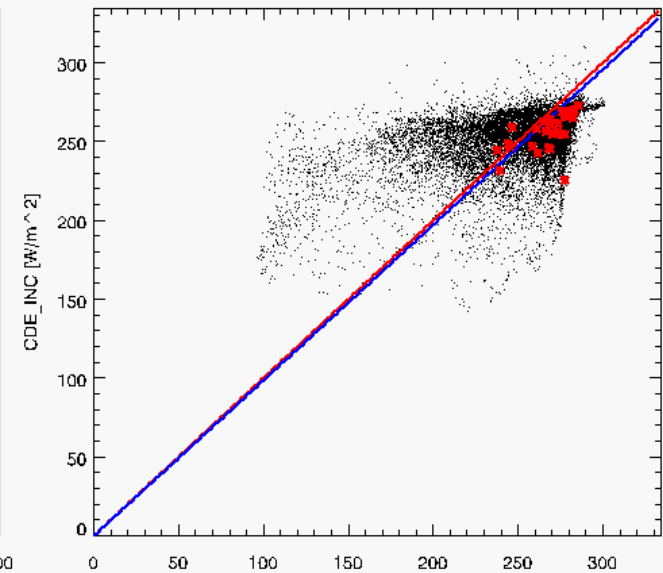
150 200 250 300

RMSE: 29.4429

SatData Mean: 253.010

BIAS: -0.303344

Fit durch [0,0]: $f(x) = 0.98572620 \cdot x$

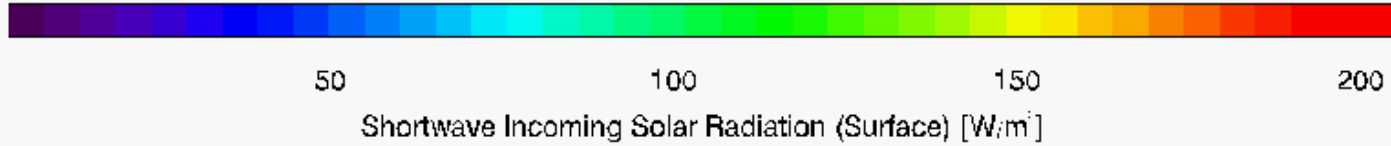


Downward, shortwave, global radiation at the surface: CMSAF vs. COSMO DE

- Ground based pyranometer stations marked inside the plots

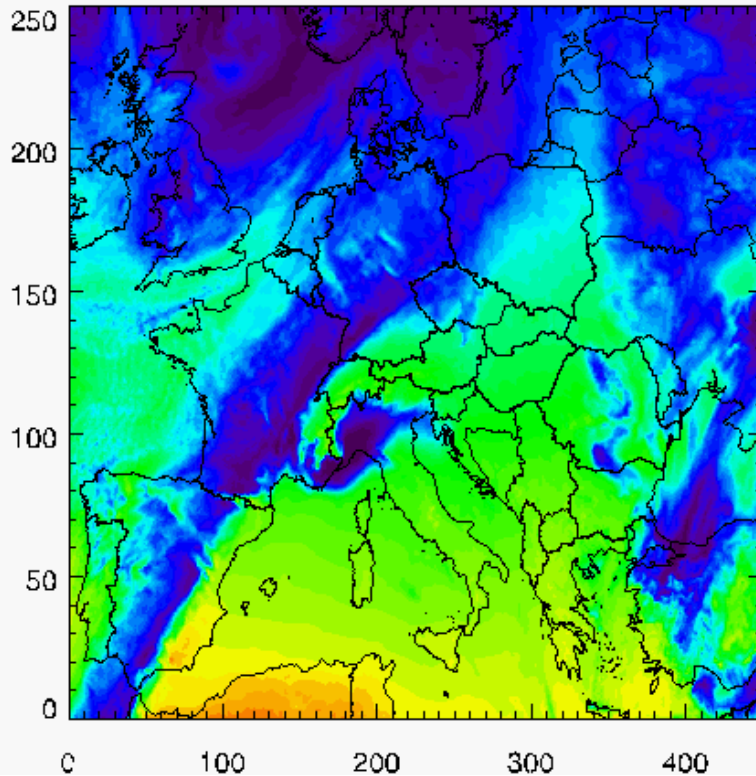


COSMO EU vs CMSAF

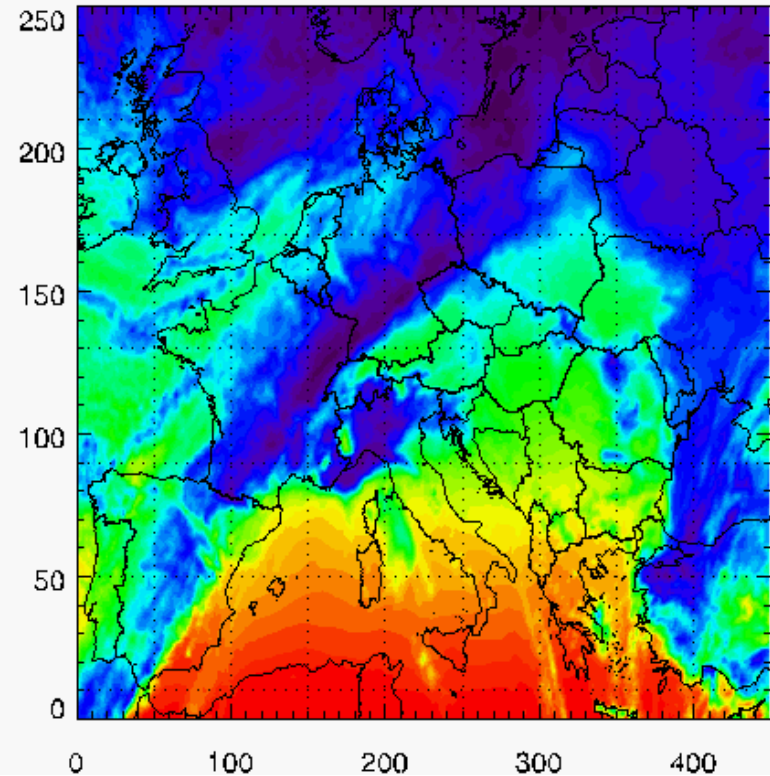


Date: 20140215 COSMO run: 20140215, 00 UTC

GEU Incoming solar radiation, daily average



CMSAF SIS, daily average



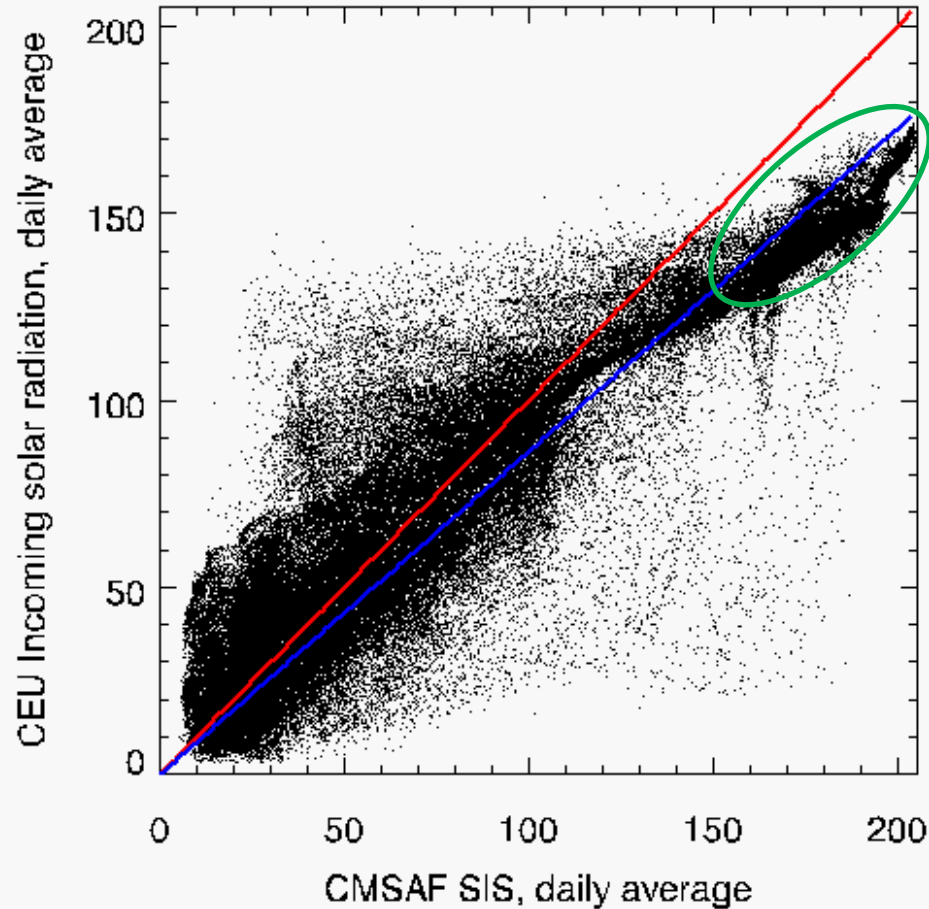
Fit durch [0,0]: $f(x) = 0.86328025 \cdot x$

BIAS: -5.68764

CMSAF SIS, daily average Mean: 82.0575

RMSE: 24.1835

CEU Incoming solar radiation, daily average Mean: 76.3697



Model underestimates radiation.
reason: too much aerosols

COSMO DE vs CMSAF

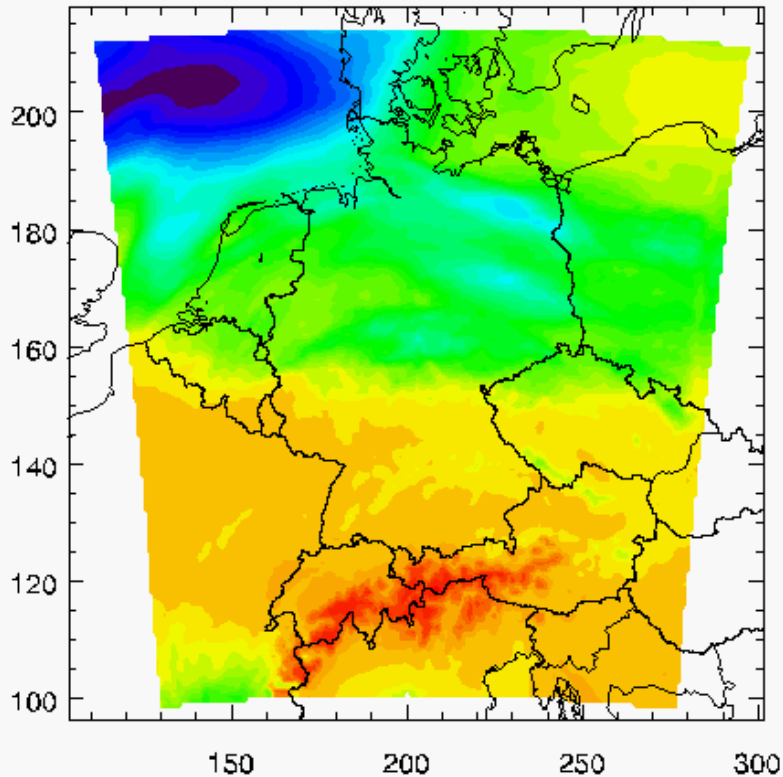


0 50 100 150 200 250 300

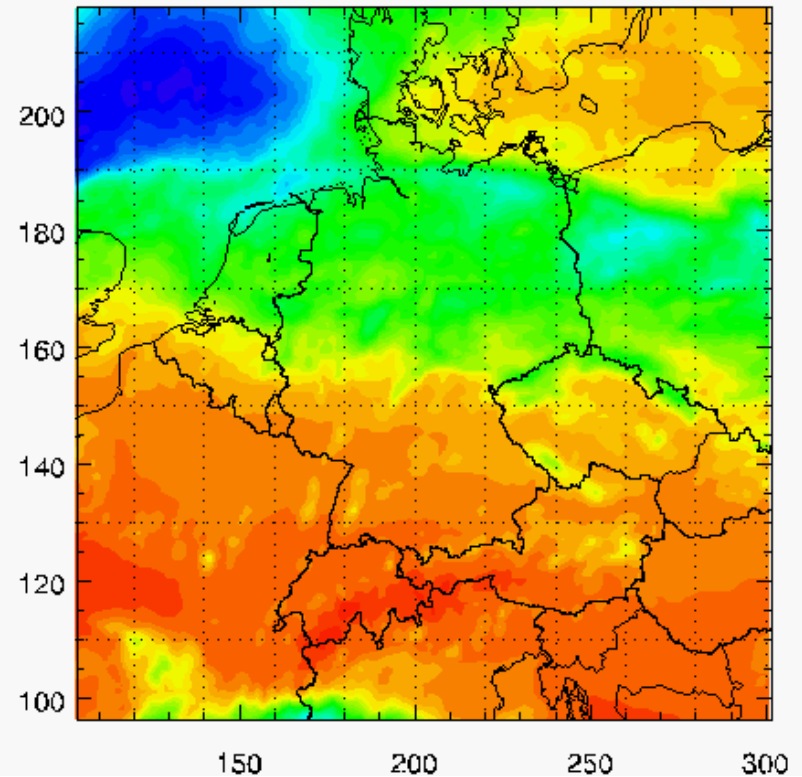
Shortwave Incoming Solar Radiation (Surface) [W/m^2]

Date: 20130425 COSMO run: 20130425, 00 UTC

GDE Incoming solar radiation, daily average



CMSAF SIS, daily average



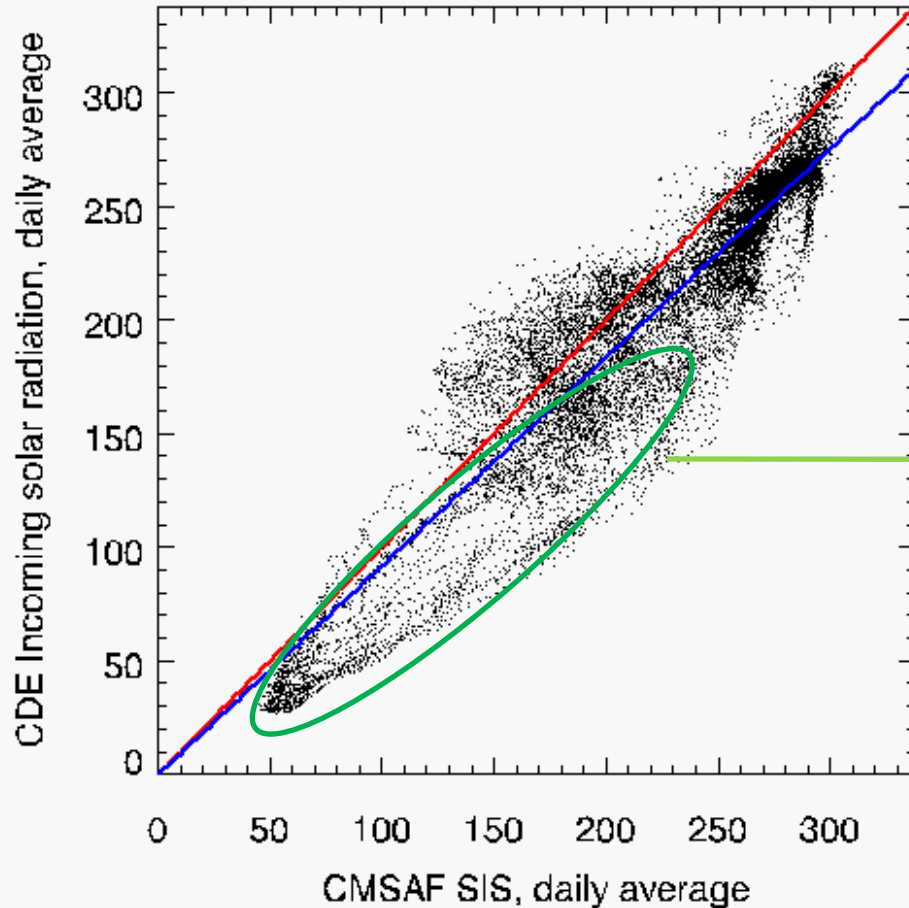
Fit durch [0,0]: $f(x) = 0.91822677 \cdot x$

BIAS: -19.4720

CMSAF SIS, daily average Mean: 232.092

RMSE: 28.4490

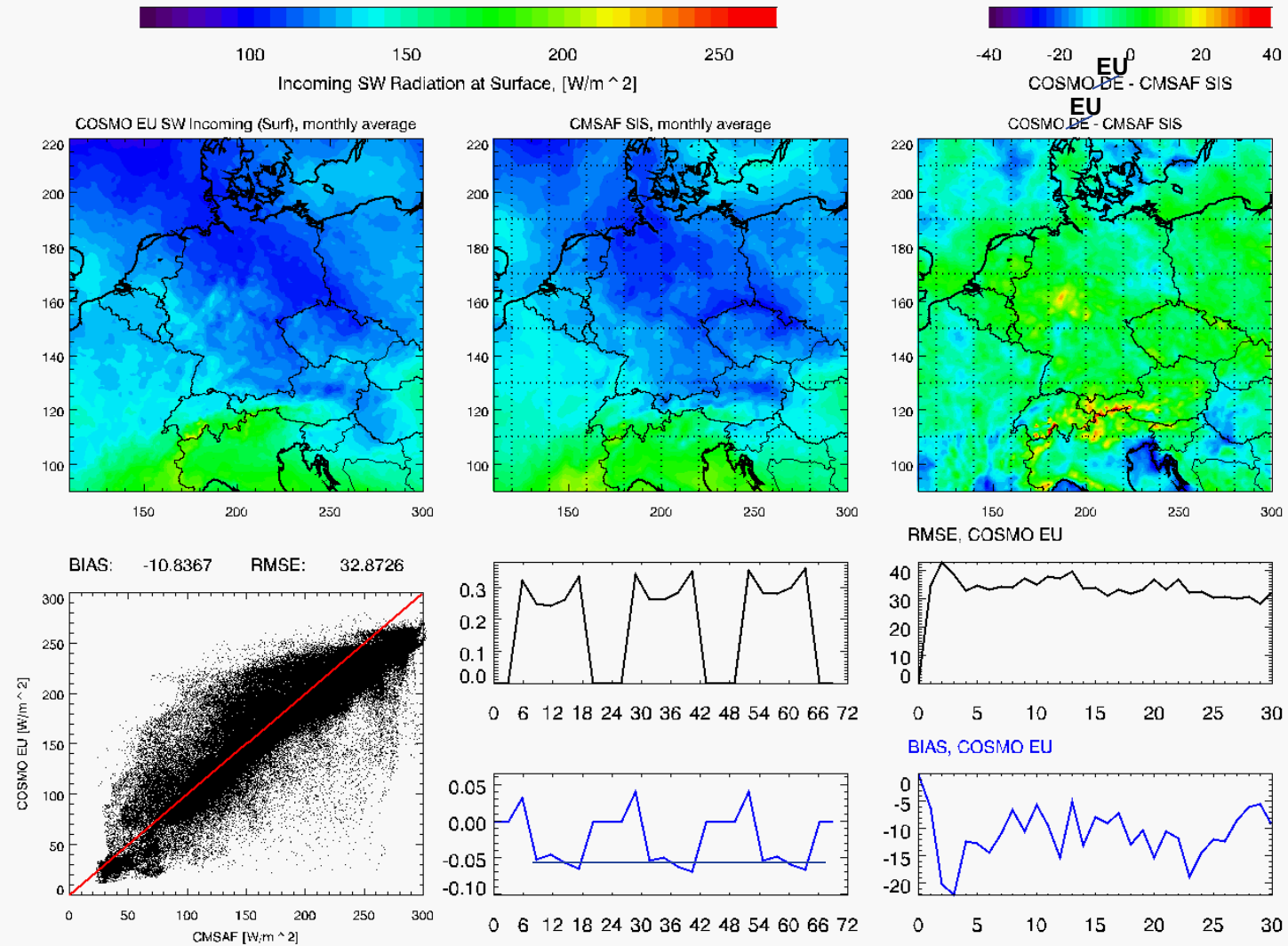
CDE Incoming solar radiation, daily average Mean: 212.621



Could have many reasons, for example:

- too many clouds
- too thick clouds
- too much scattering / absorption inside the clouds
- **combination of those above**

Verification with satellite data

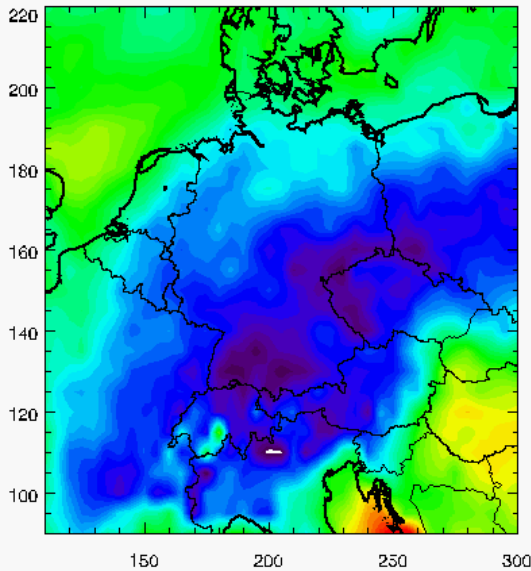


ICON exp vs CMSAF, sw rad, surf

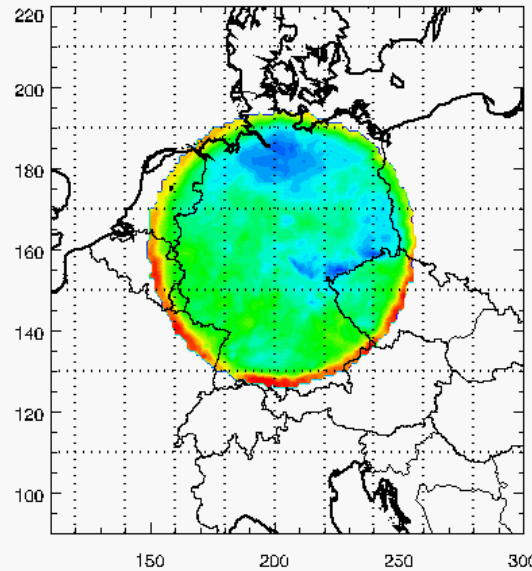


140 160 180 200 220

CMSAF SIS, monthly average



ICON EXP SW Incoming (Surf), monthly average

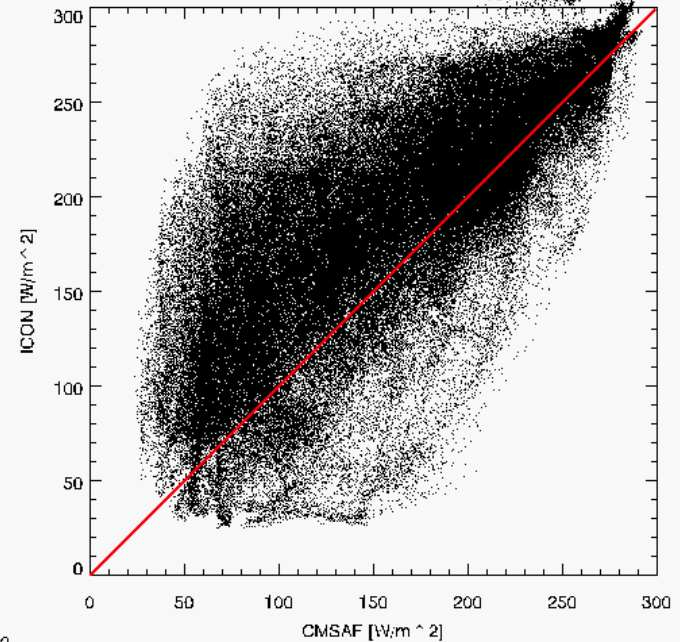


RMSE: 33.9714

SatData Mean: 159.672

BIAS: 28.2420

Fit durch [0,0]: $f(x) = 1.1714064 \cdot x$



Incoming, shortwave, global radiation at the surface: CMSAF SIS vs. ICON experiment

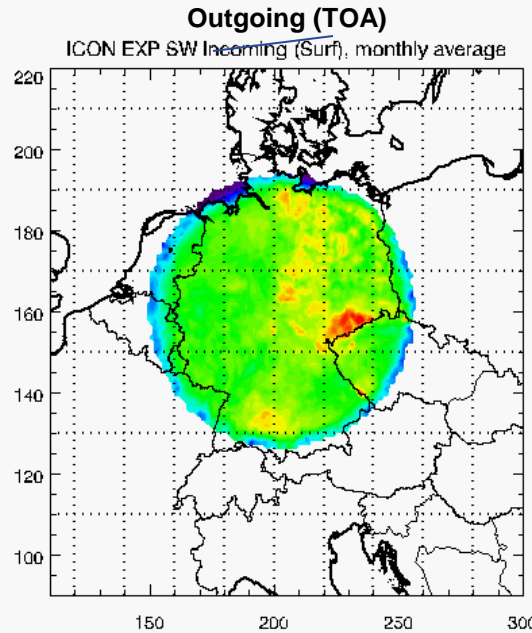
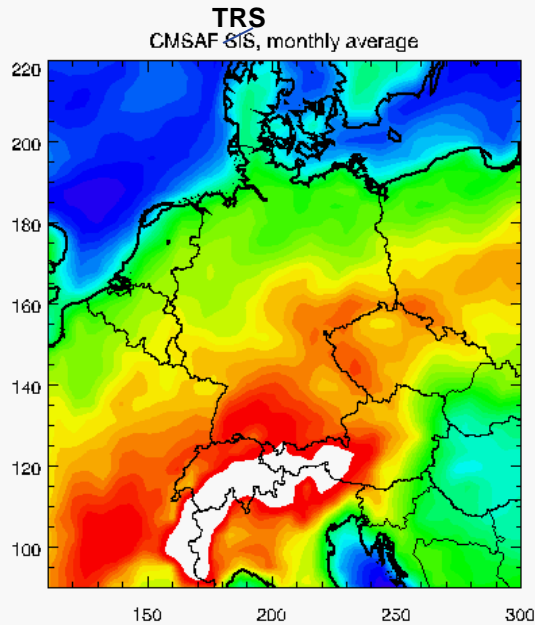
Very high values at the borders of the experiment are caused by nudging problems



ICON exp vs CMSAF, sw rad, toa



80 100 120 140 160

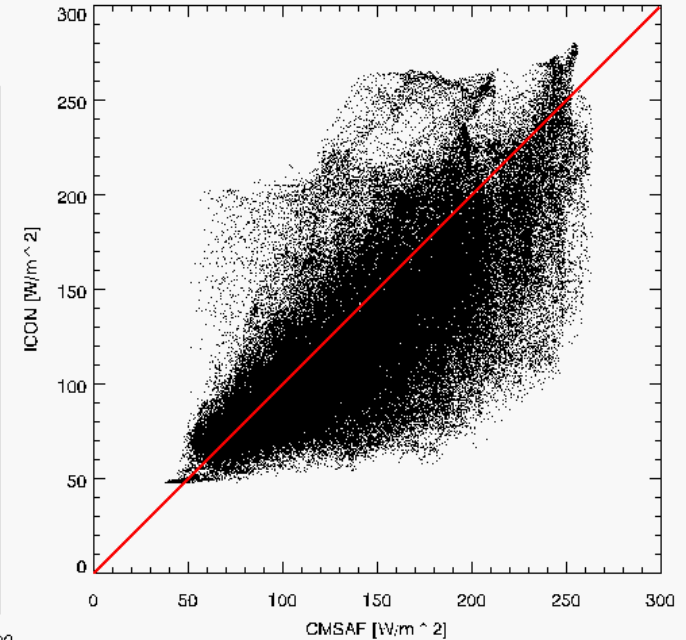


RMSE: 19.8336

SatData Mean: 141.310

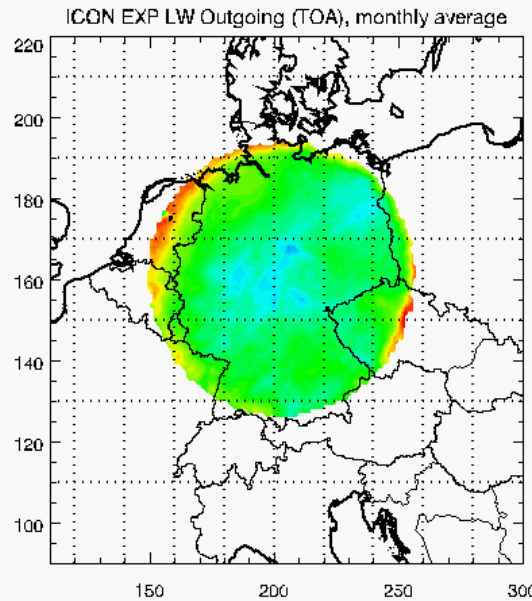
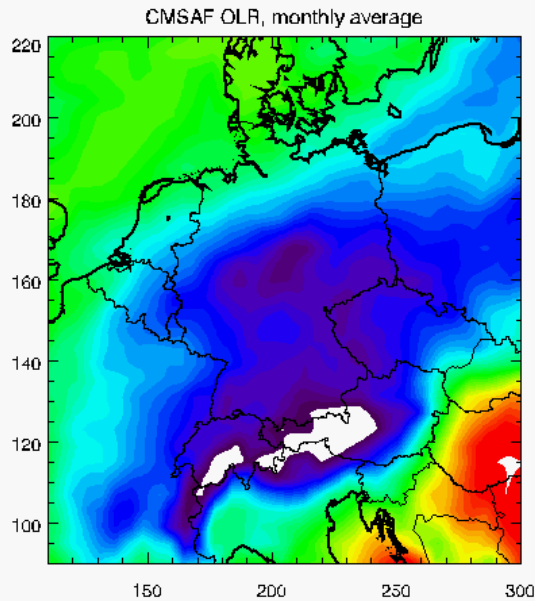
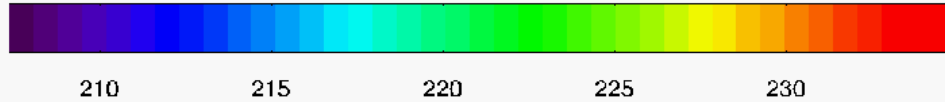
BIAS: -14.3343

Fit durch [0,0]: $f(x) = 0.89596181 \cdot x$



Outgoing, shortwave, global radiation, TOA: CMSAF TRS vs. ICON experiment

ICON exp vs CMSAF, lw rad, toa

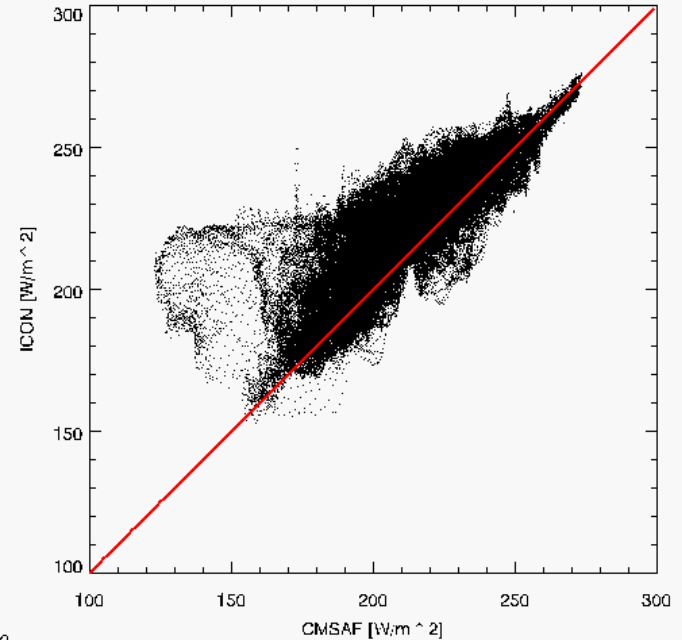


RMSE: 9.59456

SatData Mean: 212.844

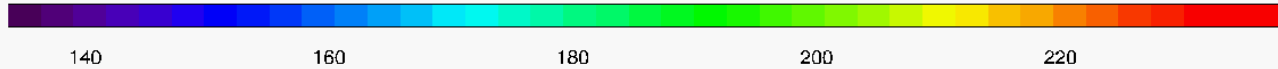
BIAS: 9.10511

Fit durch [0,0]: $f(x) = 1.0426418 \cdot x$

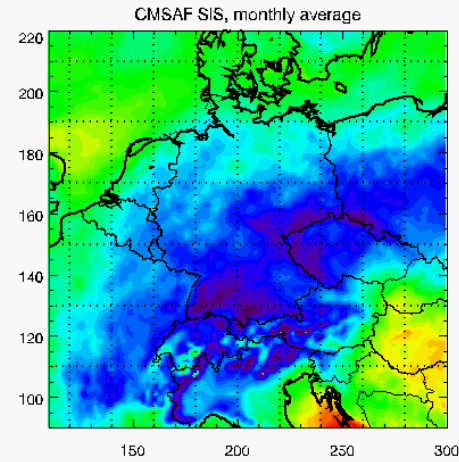
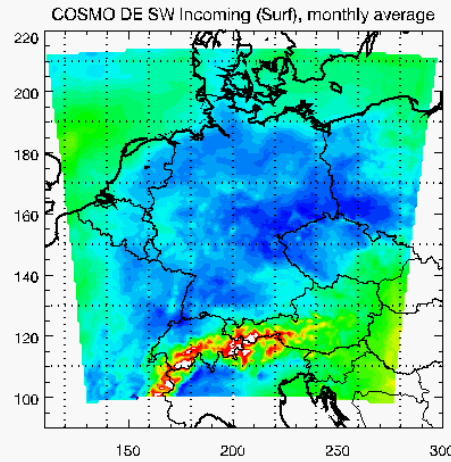
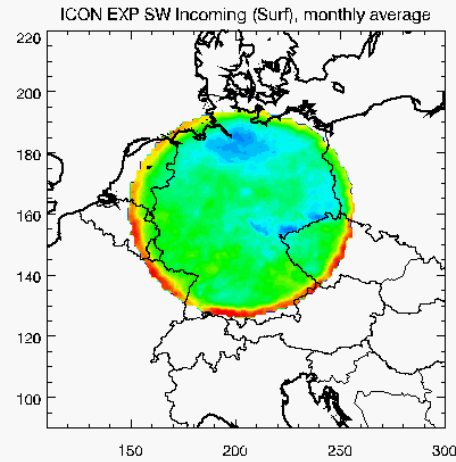


Outgoing, longwave radiation, TOA: CMSAF OLR vs. ICON experiment

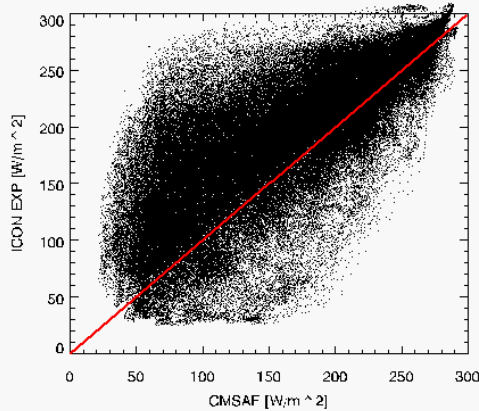
ICON vs COSMO DE vs CMSAF



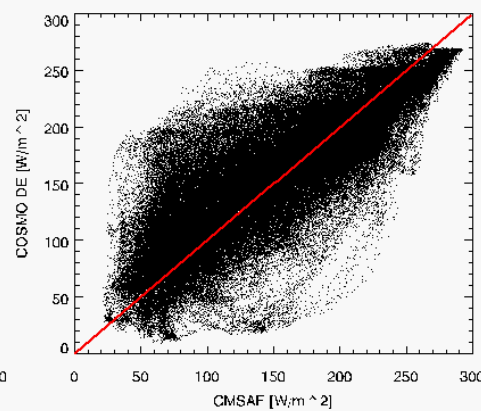
COSMO DE SW Incoming (Surf), monthly average



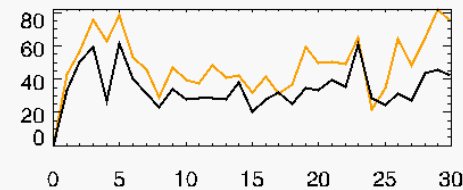
BIAS: 27.2990 RMSE: 48.5084



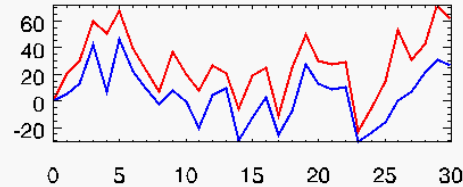
BIAS: 4.75038 RMSE: 34.2510

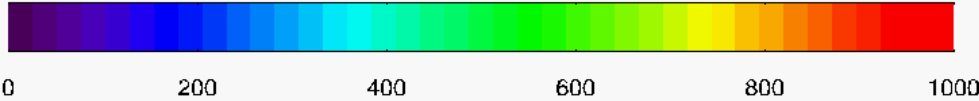


RMSE, ICON RMSE, COSMO DE



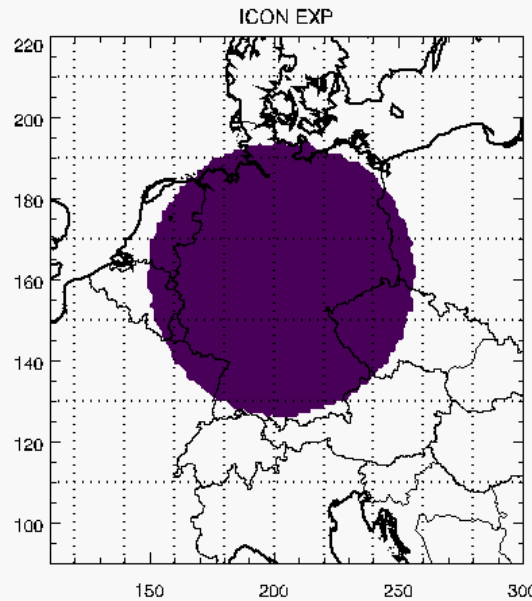
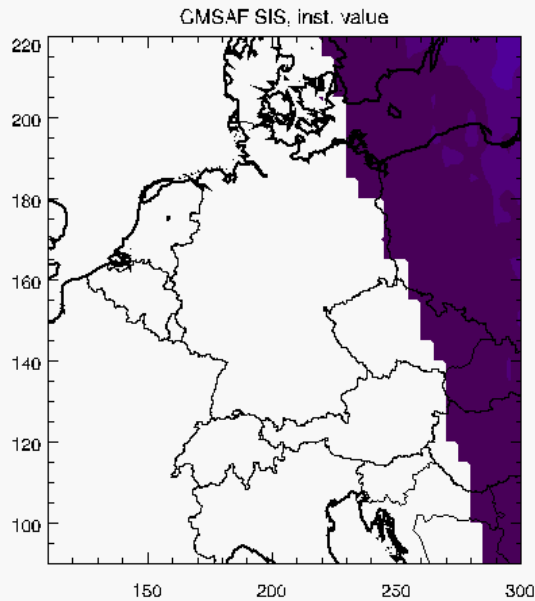
BIAS, ICON BIAS, COSMO DE





Date: 20130424

/e/uscratch/dklocke/HDCP2/experiments/hdcp2-germany_776km-diam_2499m_0424/rad004.nc

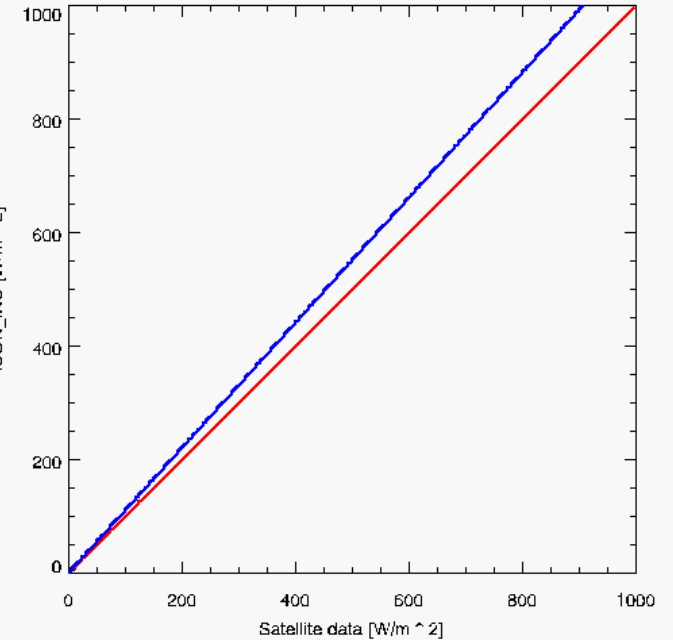


RMSE: 3.91351

SatData Mean: 3.84343

BIAS: 2.47341

Fit durch [0,0]: $f(x) = 1.1015367 \cdot x$

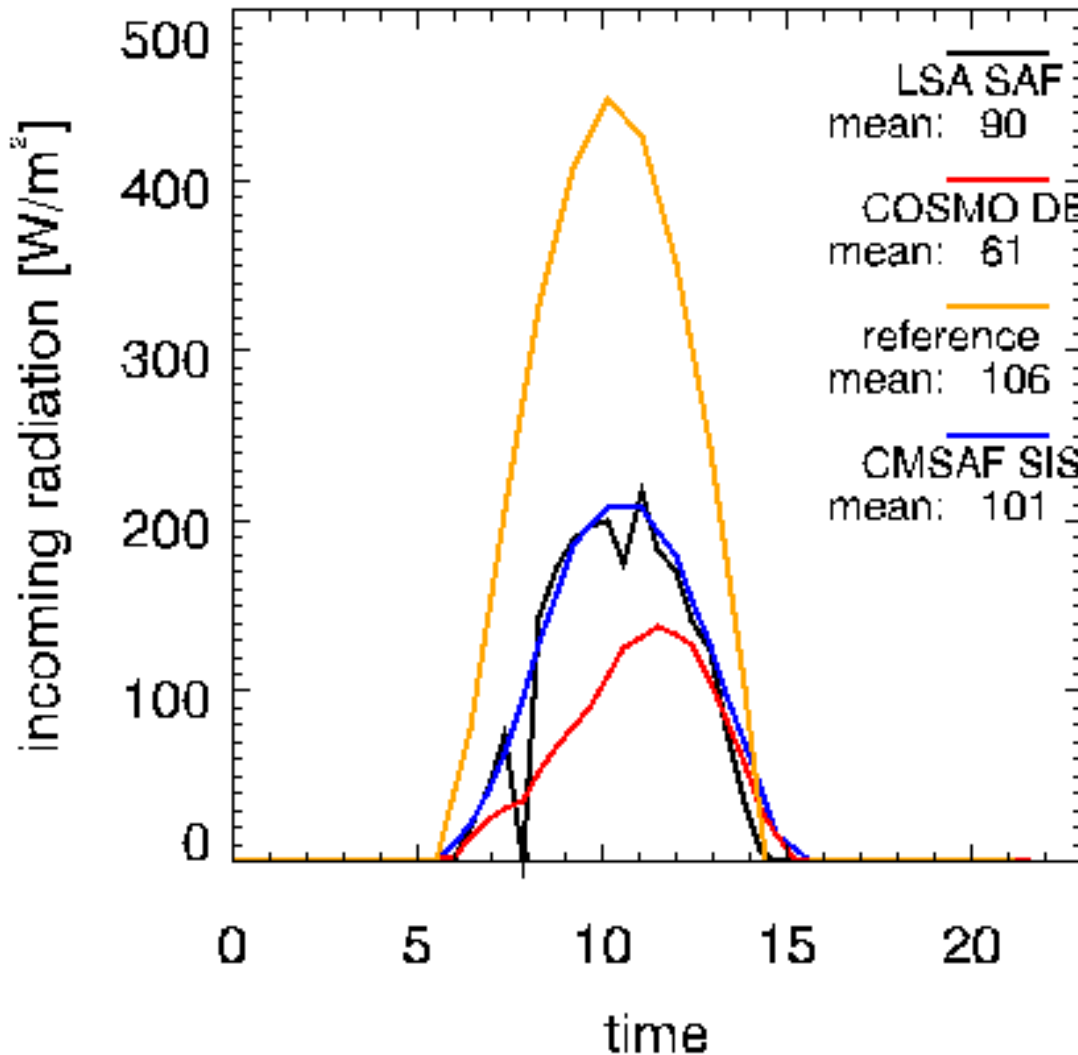


Diurnal cycle of radiation data: CMSAF SIS vs. ICON Experiment

Instantaneous values!



Diurnal cycles



How to calculate the clear sky diurnal cycle:

- 1) 2 years of satellite data
- 2) Pick clear sky radiation for every Pixel and every timestep
- 3) Interpolate and store coefficients

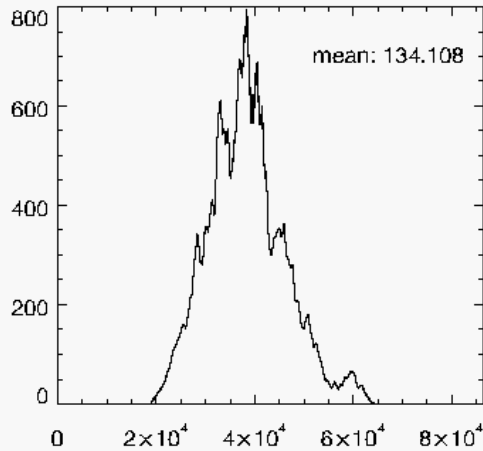
$$\text{SIS} = F(\text{day}, \text{hour}, \text{lat}, \text{lon})$$

Comparing temporal resolutions

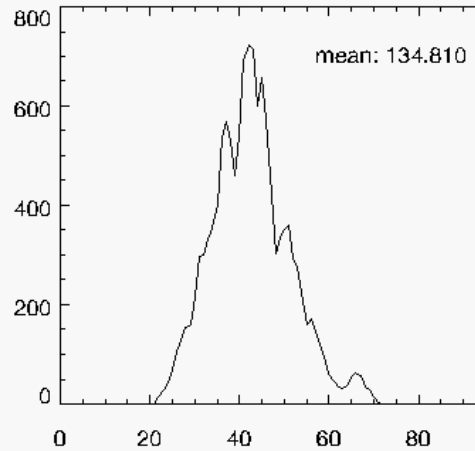
Date: 20130408

incoming direct + diffuse, shortwave radiation at surface, [W/m²]

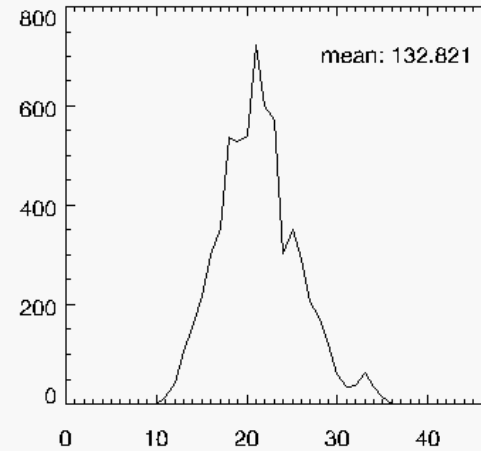
PYR, resolution = 1s



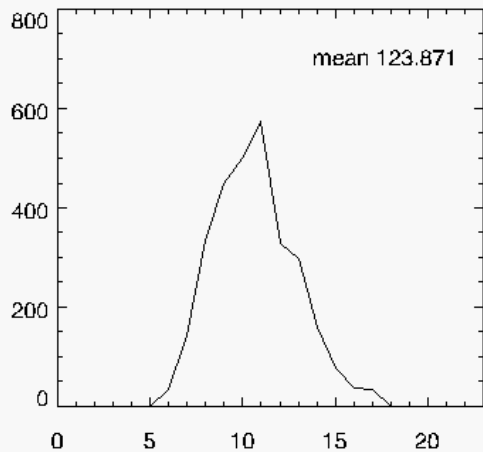
PYR, resolution = 15min



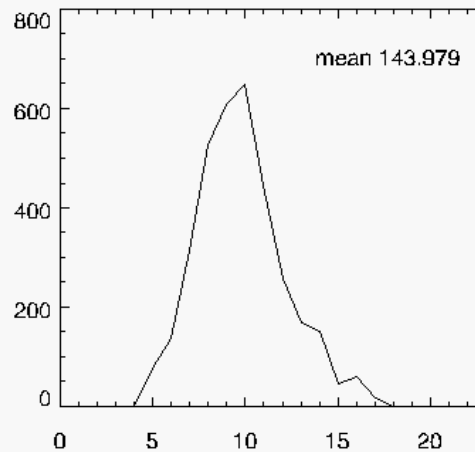
PYR, resolution = 30min



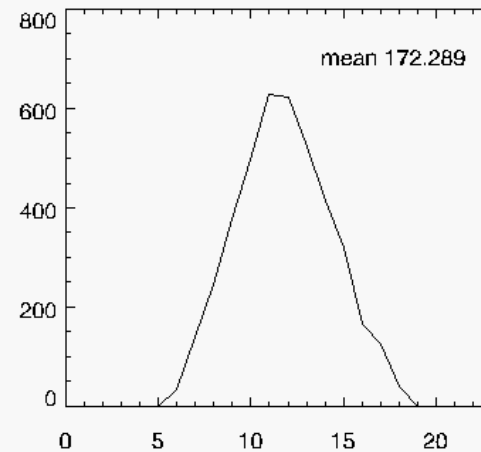
PYR, resolution = 1h



CMSAF, resolution = 1h



COSMO DE, resolution = 1h



Thank you for your attention

