Evaluation of IFS surface radiation from the ground and satellite

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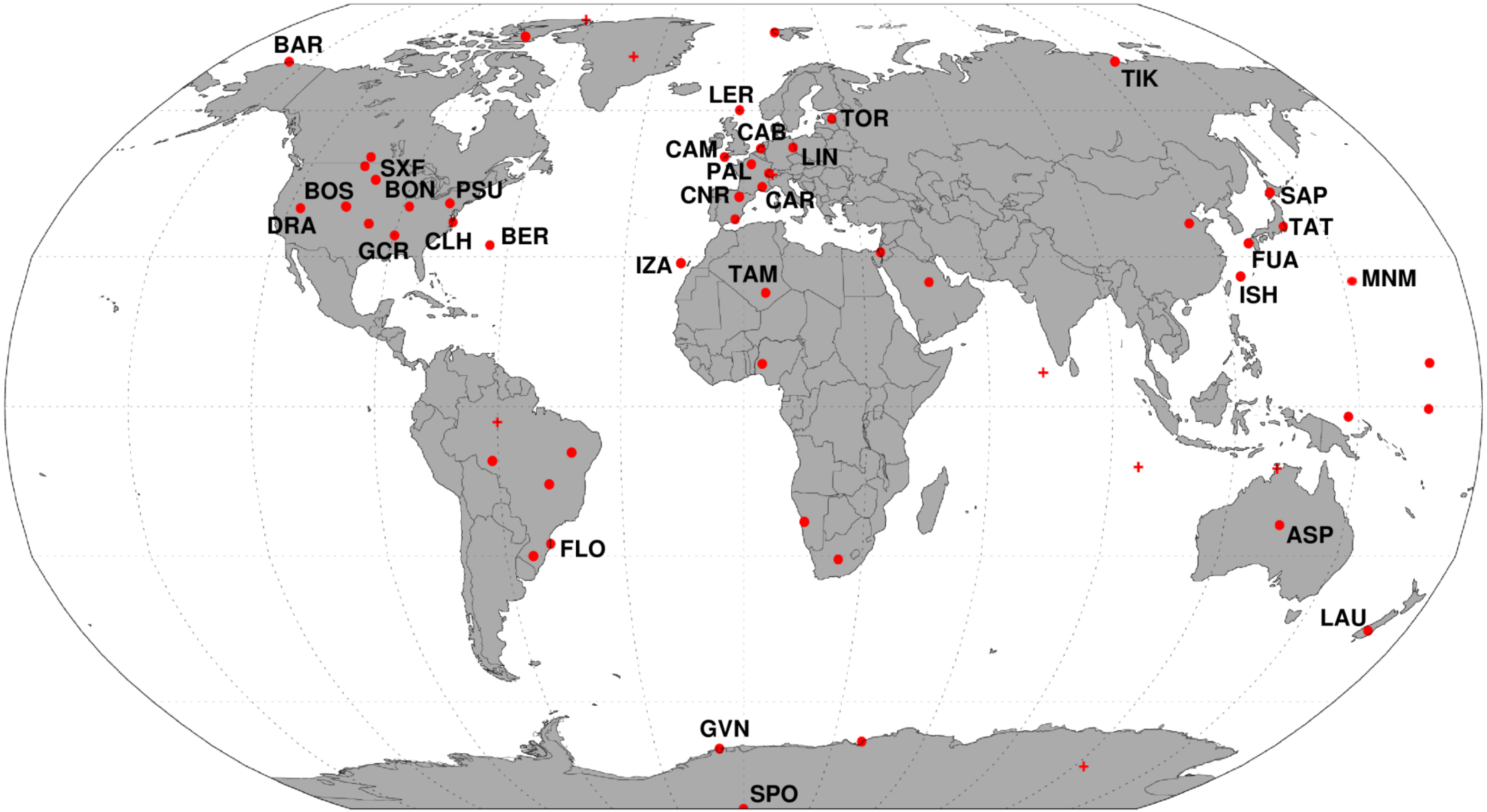
ECMWF

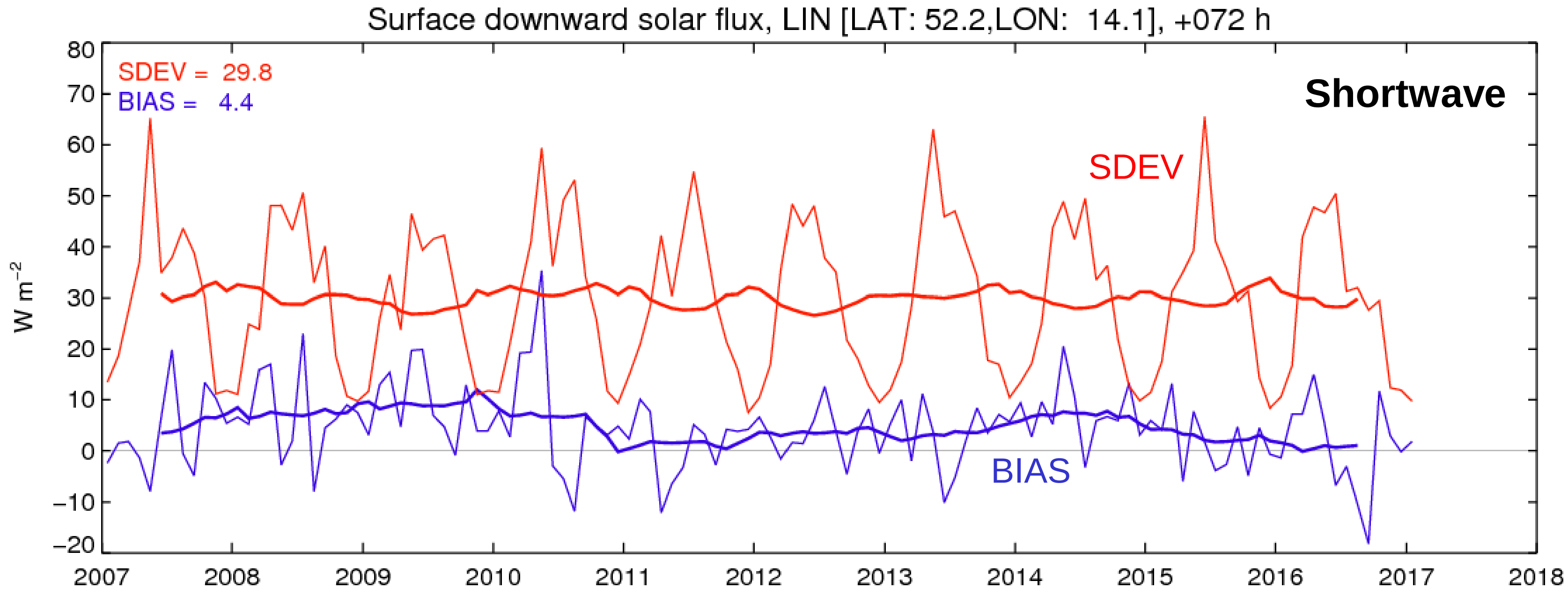
Overview

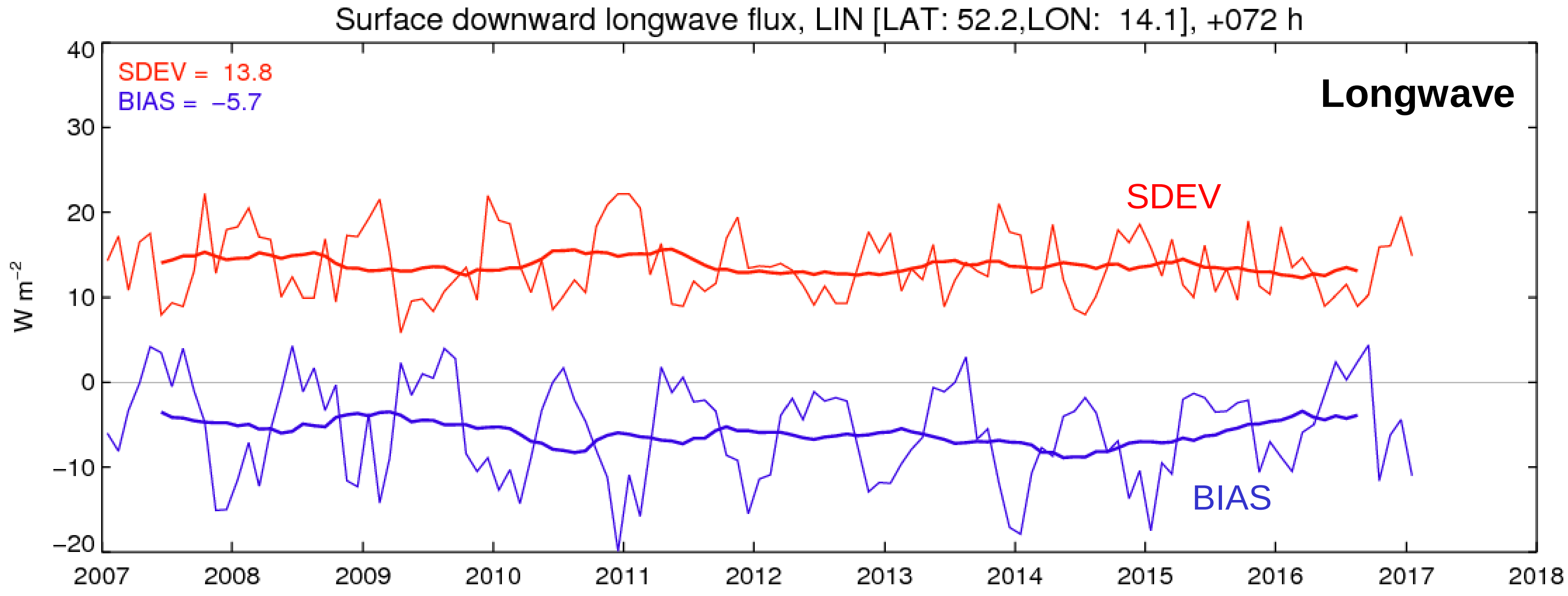
- Monitoring of radiation biases (BSRN)
- Attribution of 2m temperature biases (SYNOP, BSRN, CM SAF)
- Evaluation of cloud/radiation predictability (CM SAF)
- Scale-dependence of cloud/radiation forecast skill (CM SAF)
- Summary

Baseline Surface Radiation Network



BSRN station Lindenberg (Germany)



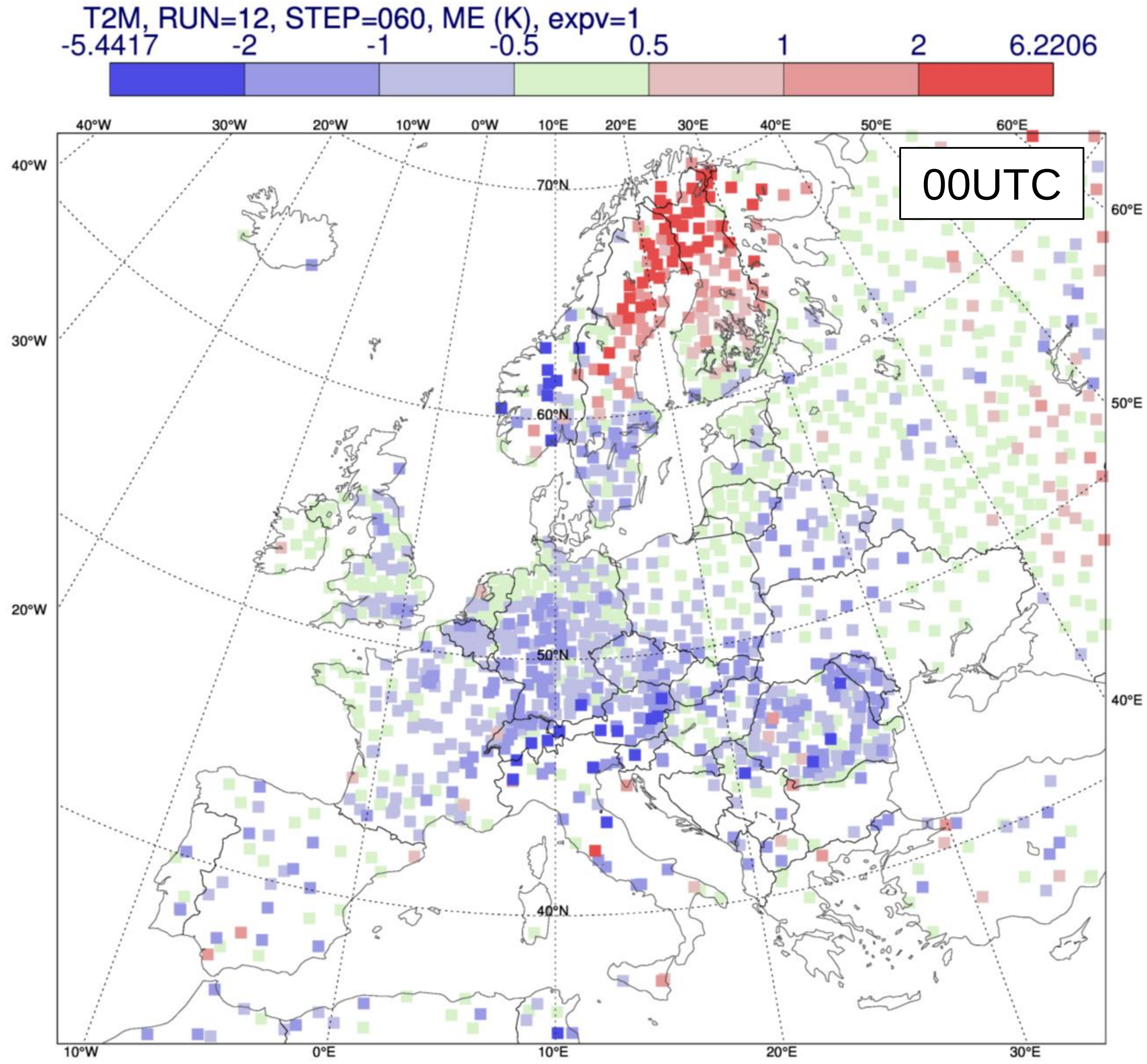


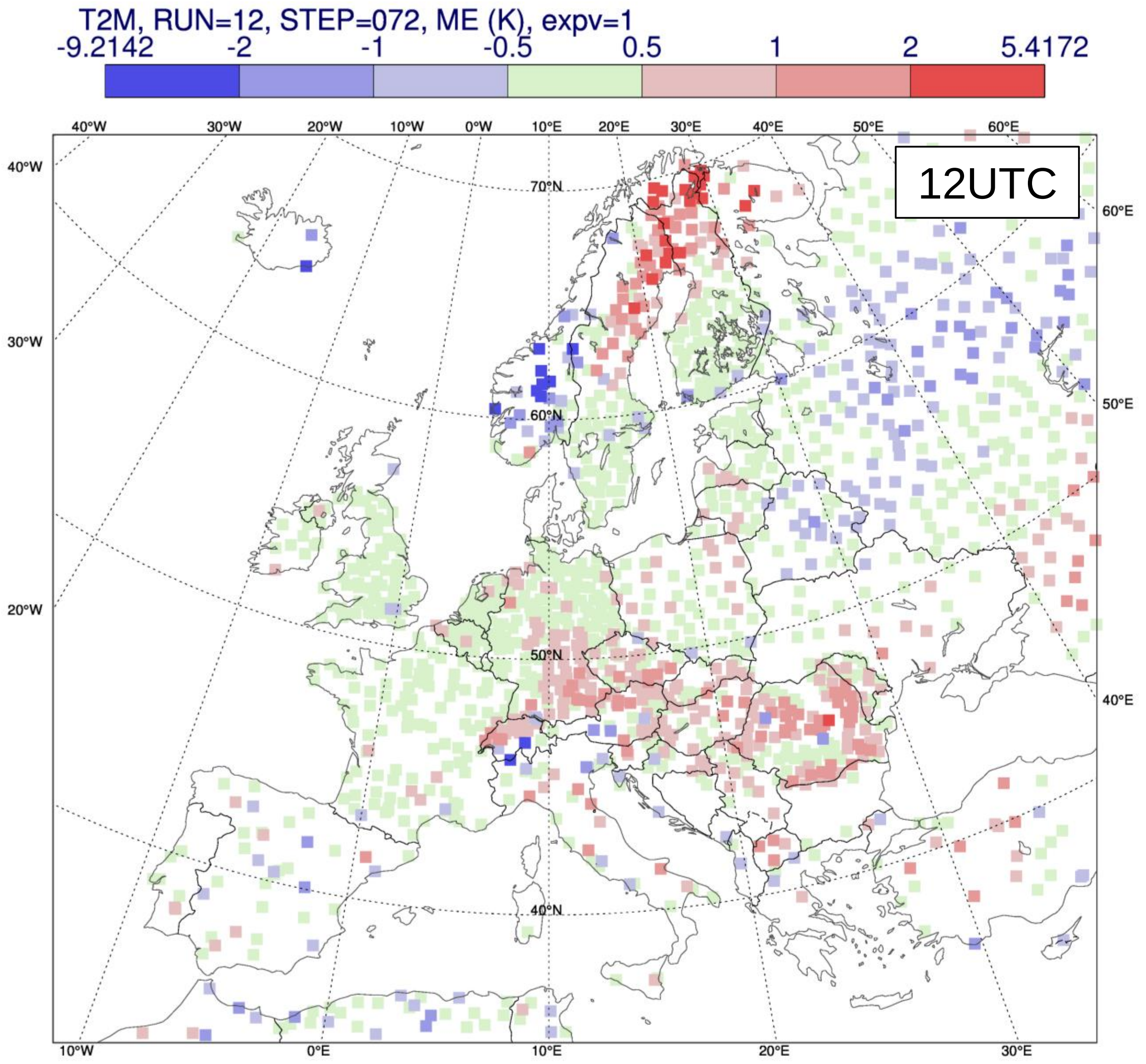
SW bias ~0 Wm^{-2}
LW bias -5 Wm^{-2}
e.g.
Cabauw (Netherlands)
Lindenberg (Germany)
Palaiseau (France)
Toravere (Estonia)
Tateno (Japan)
Florianopolis (Brazil)

5-15 Wm^{-2} underestimation of LW flux except Minami-Torishima (Pacific)

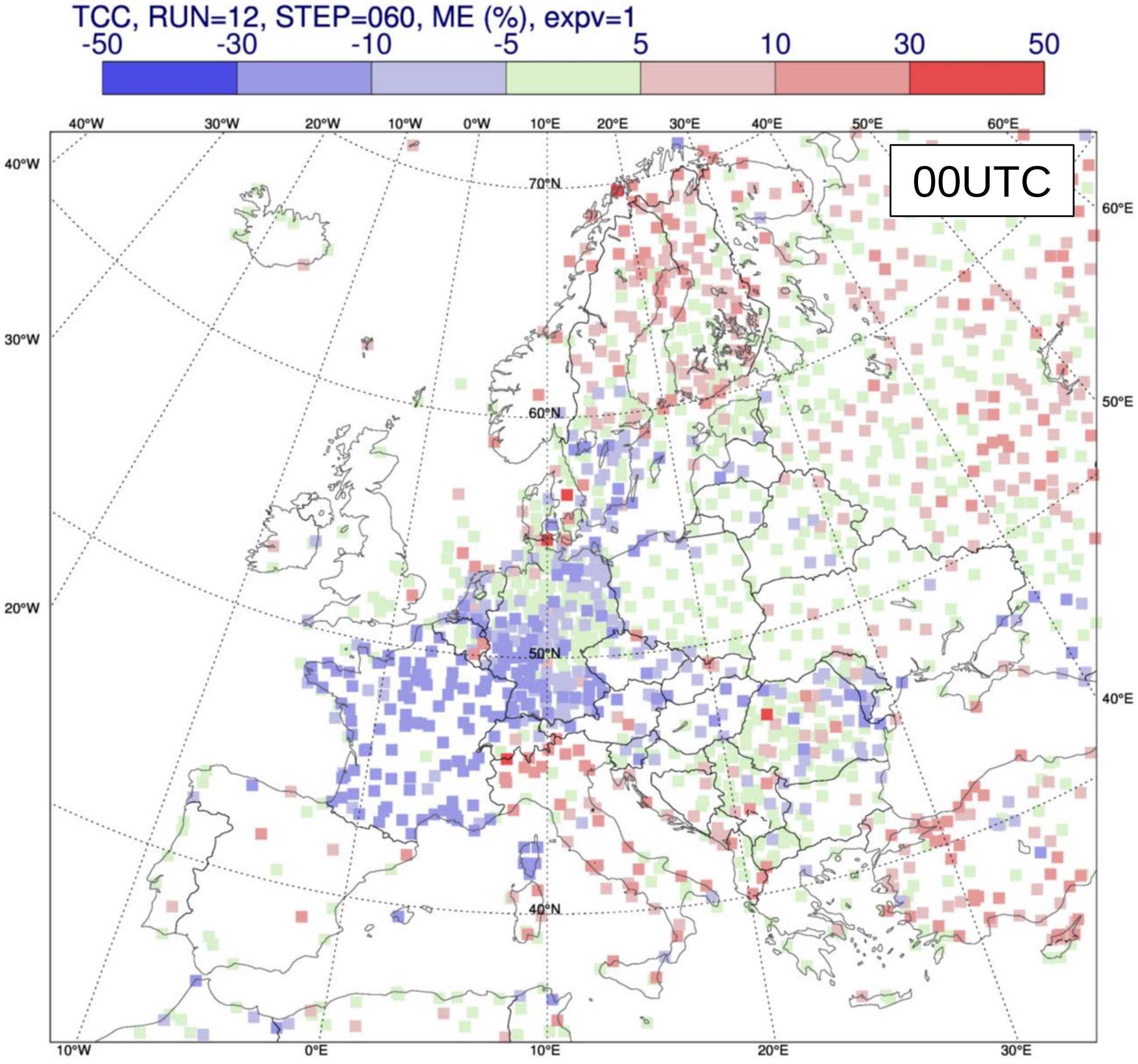
0-15 Wm^{-2} overestimation of SW flux

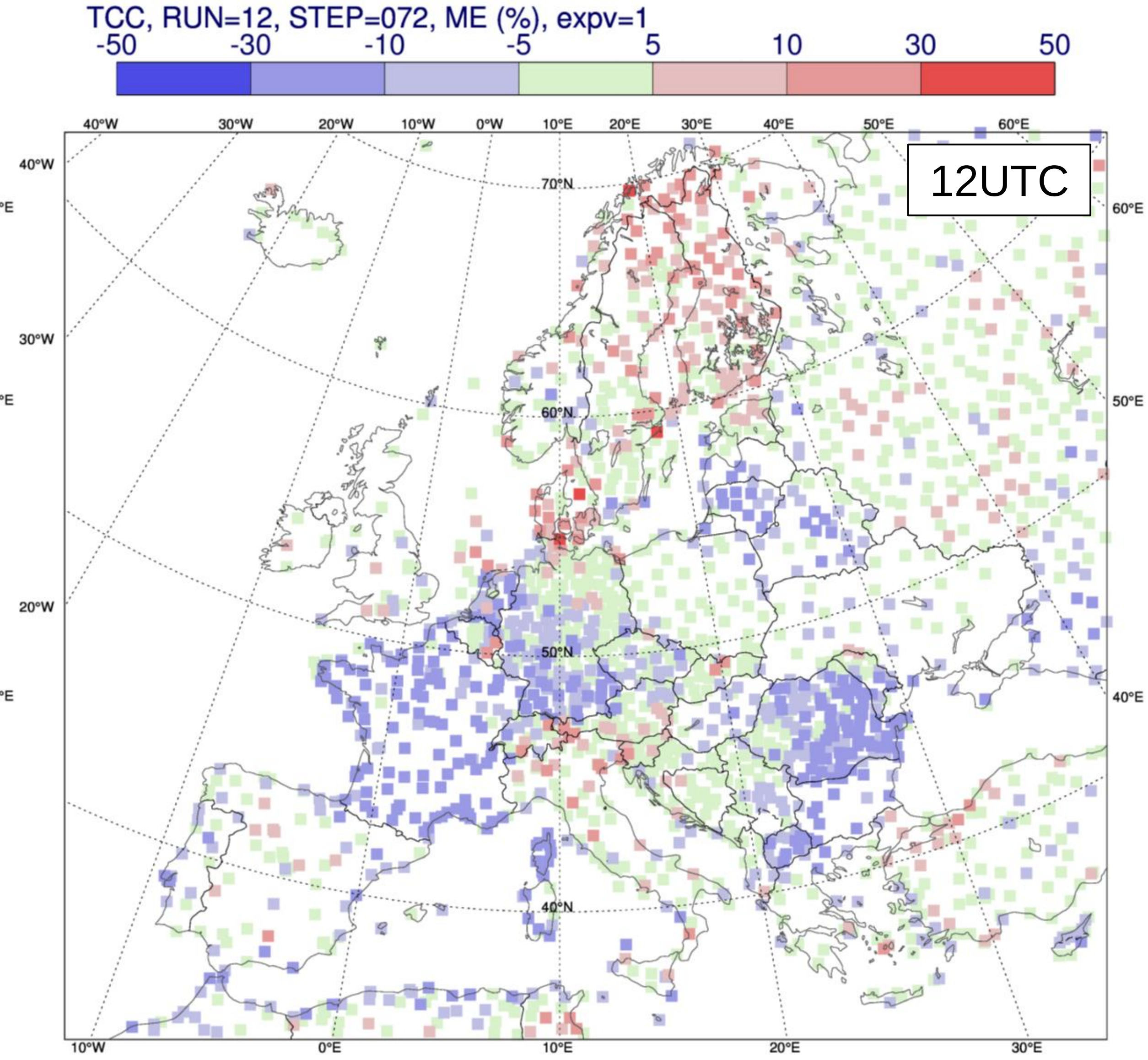
2m temperature, bias, DJF 2017-18



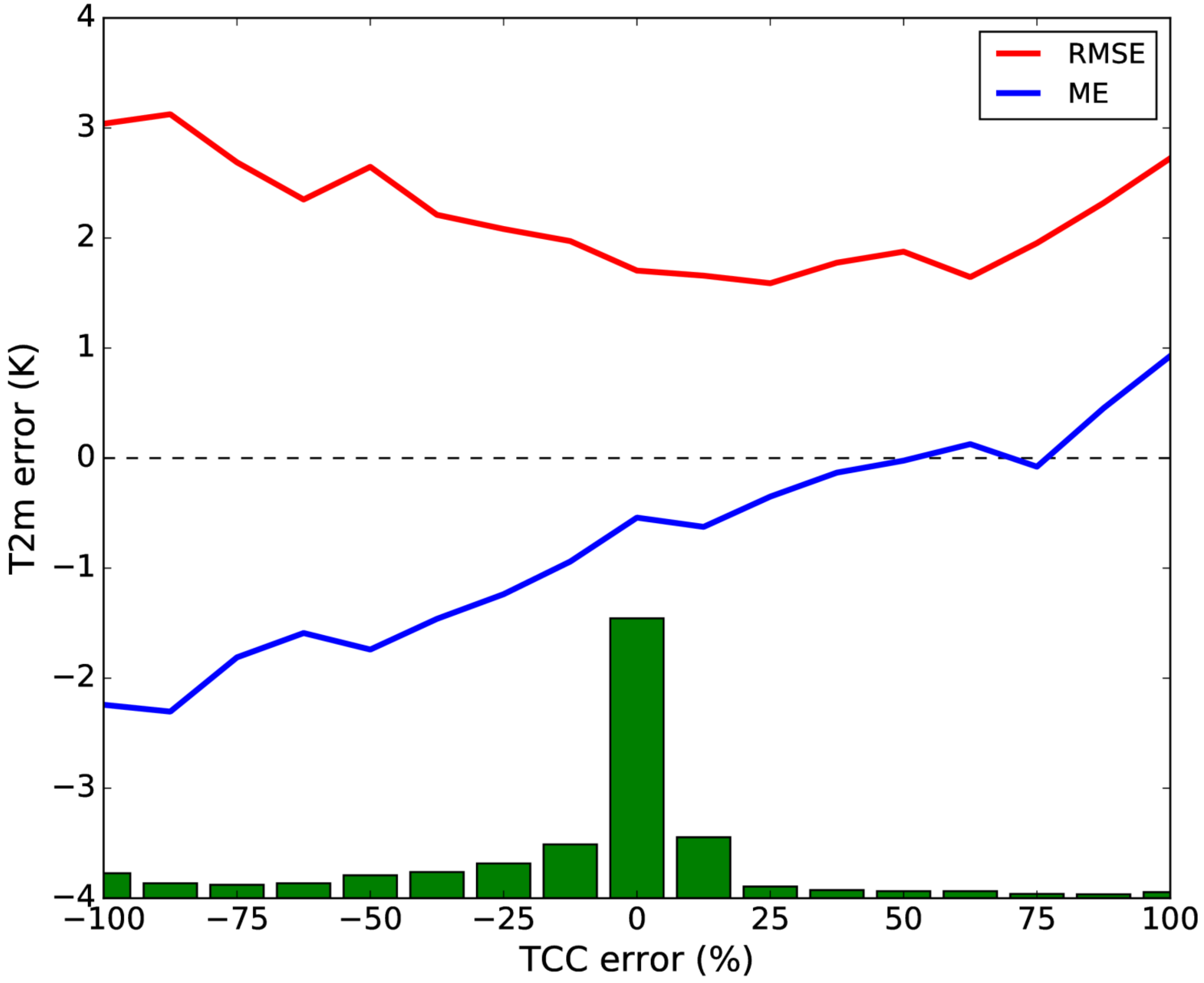


Total cloud cover, bias, DJF 2017-18





T2m Bias DJF 2016-17 00UTC, dependence on cloud error



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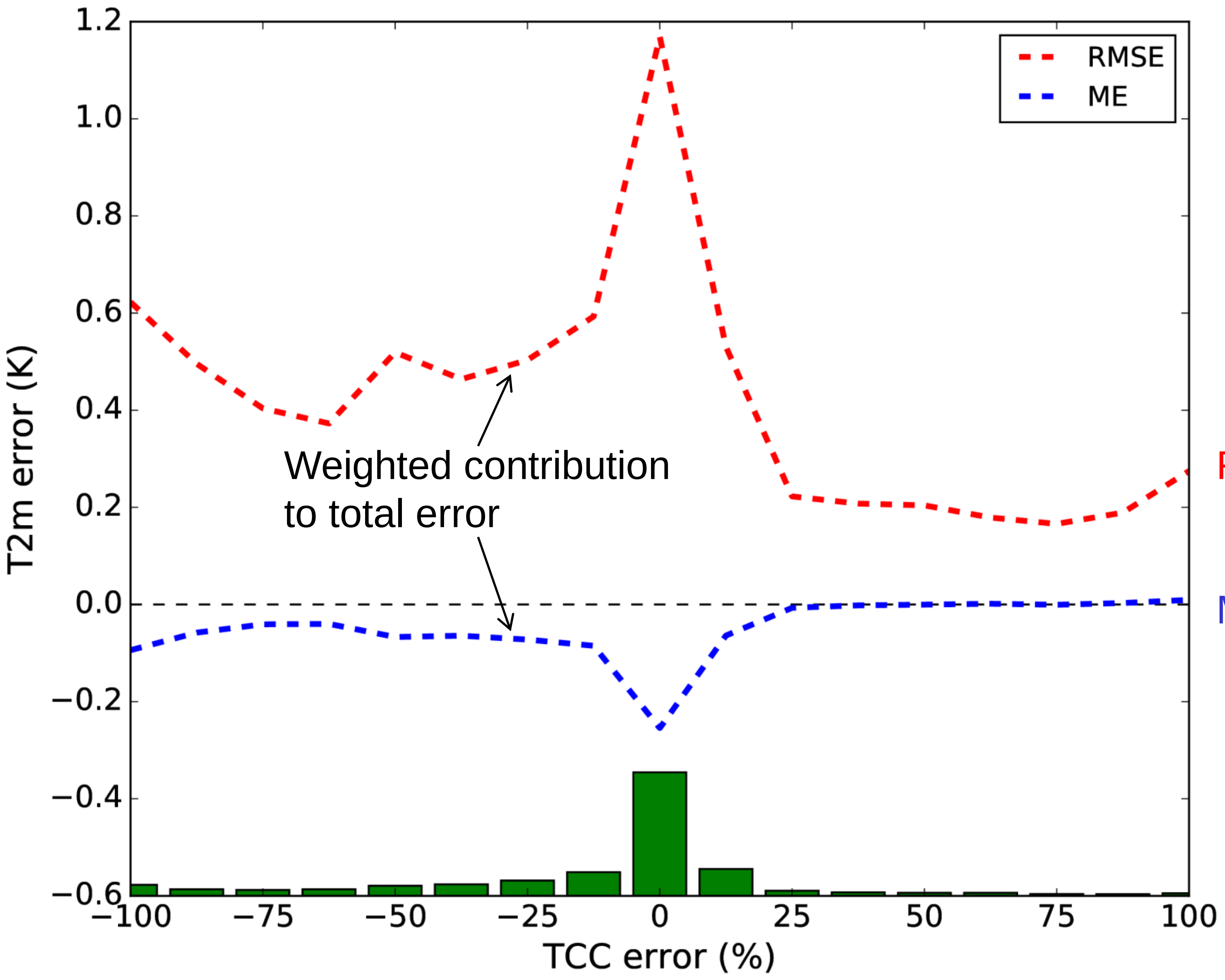
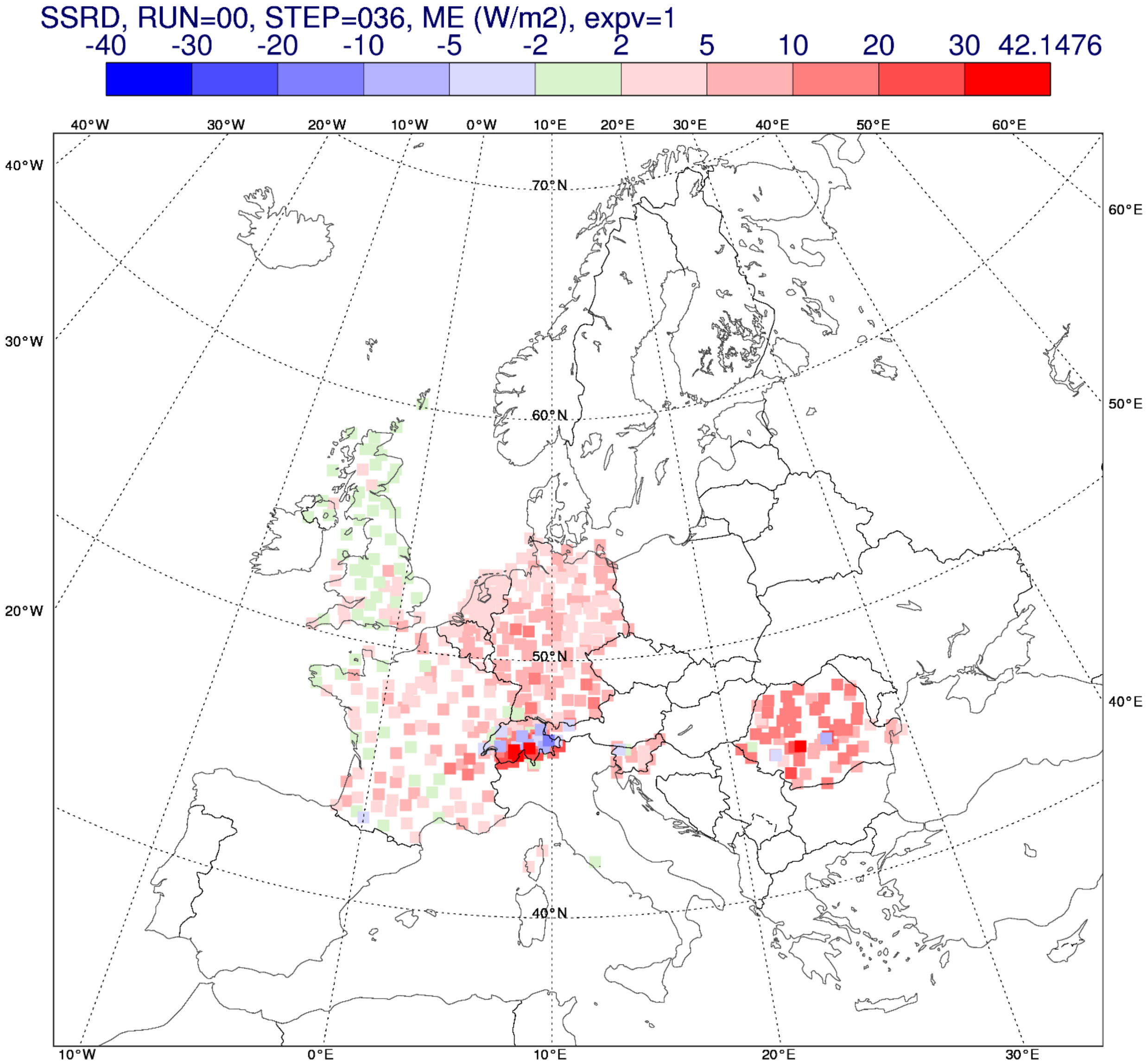
T2m Bias DJF 2016-17 00UTC, dependence on cloud error



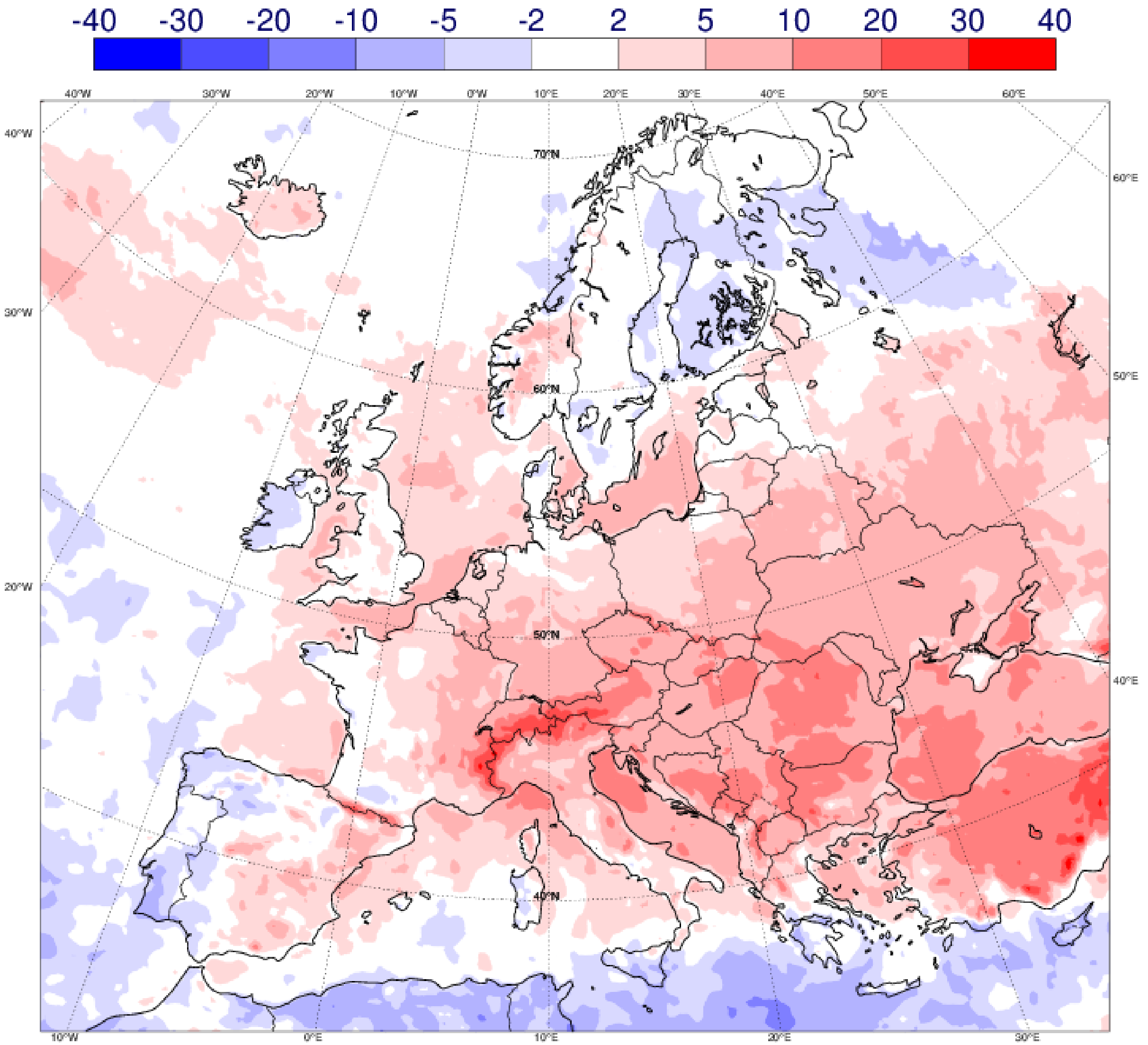
RMSE = 1.99 K

ME = -0.84 K

Bias in downward solar radiation at the surface, NDJ 2017-18

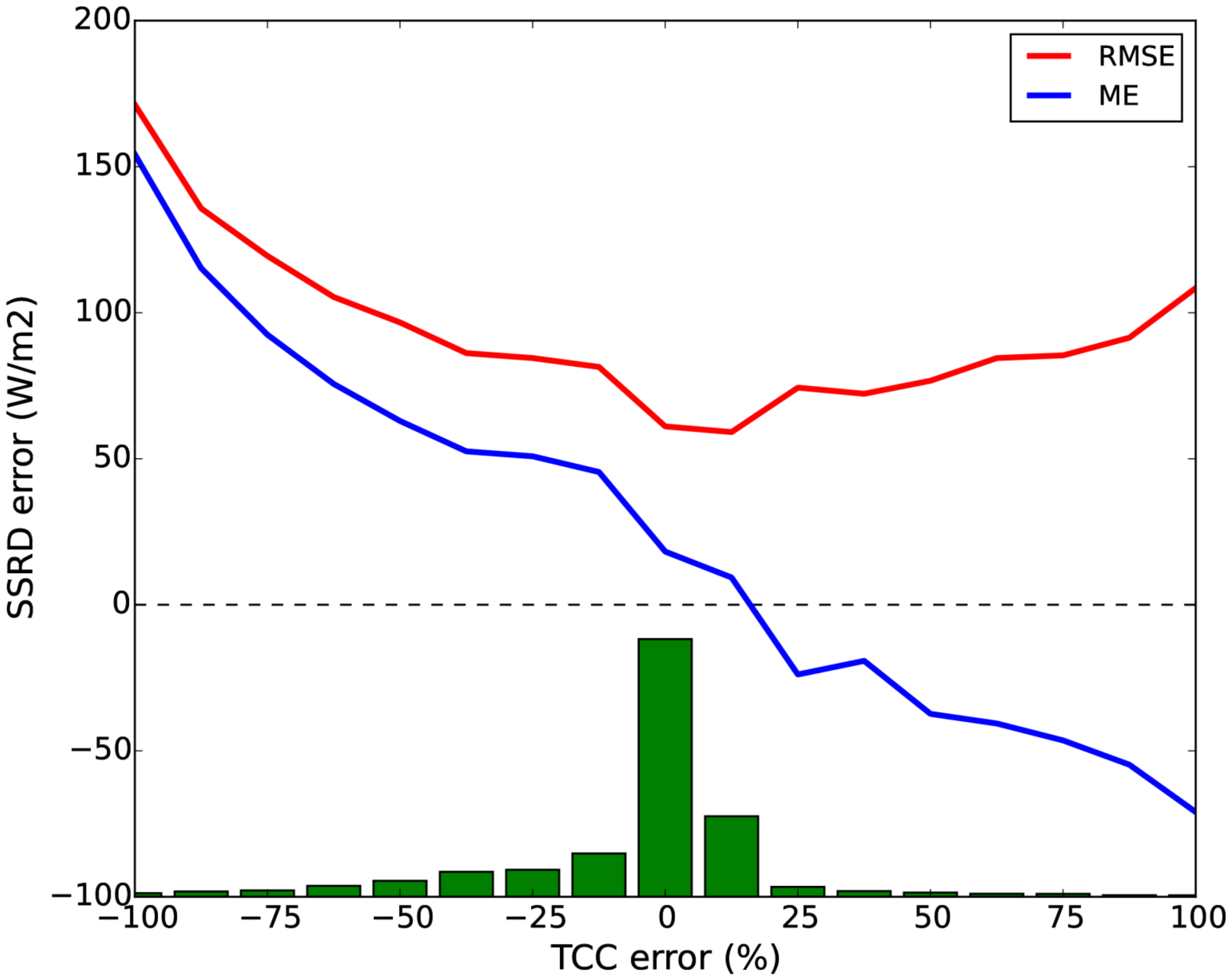


SYNOP

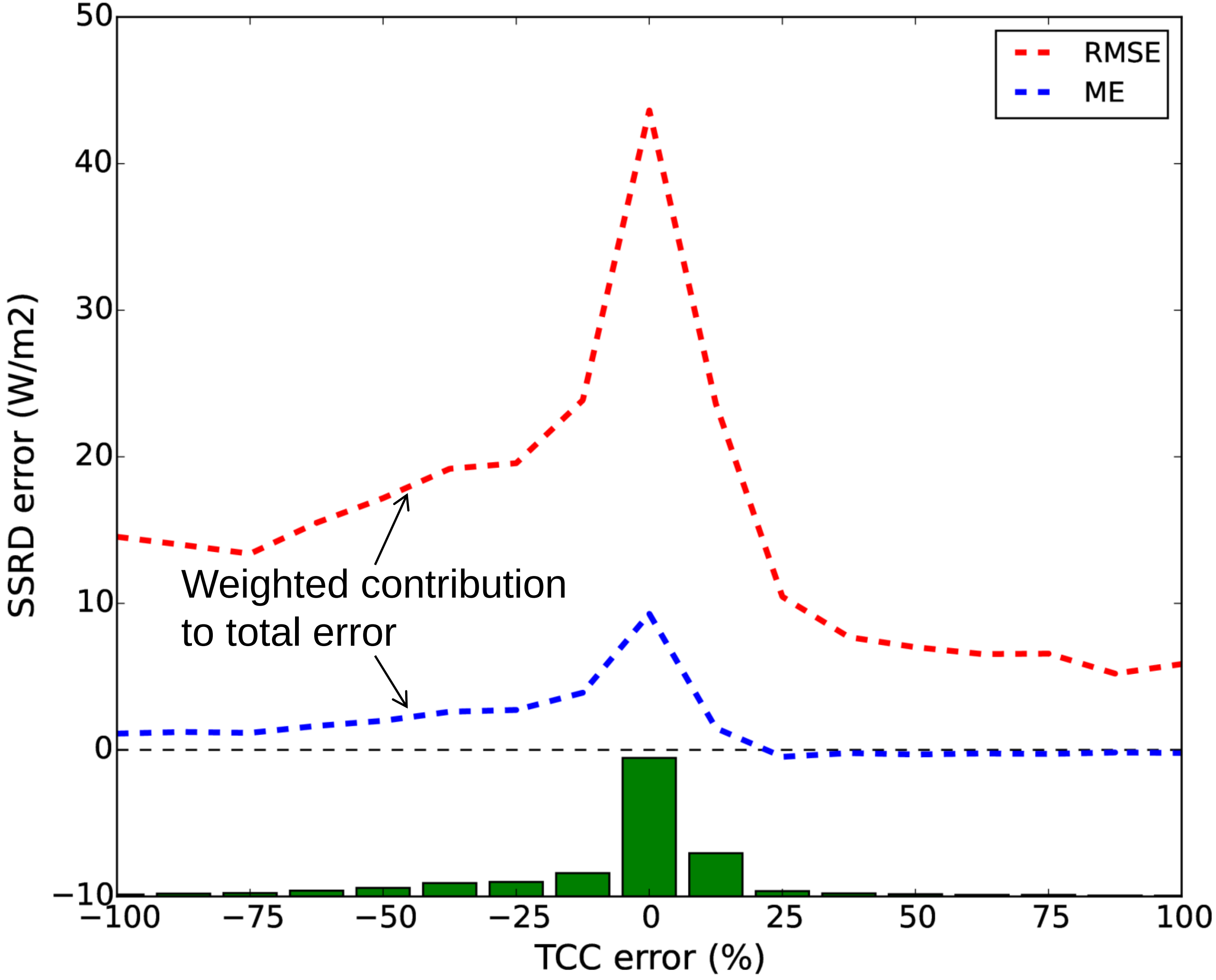


CM SAF

Solar flux downward, bias NDJ 2017-18 12UTC, dependence on cloud error



Solar flux downward, bias NDJ 2017-18 12UTC, dependence on cloud error



RMSE = 73 Wm^{-2}

ME = 25 Wm^{-2}

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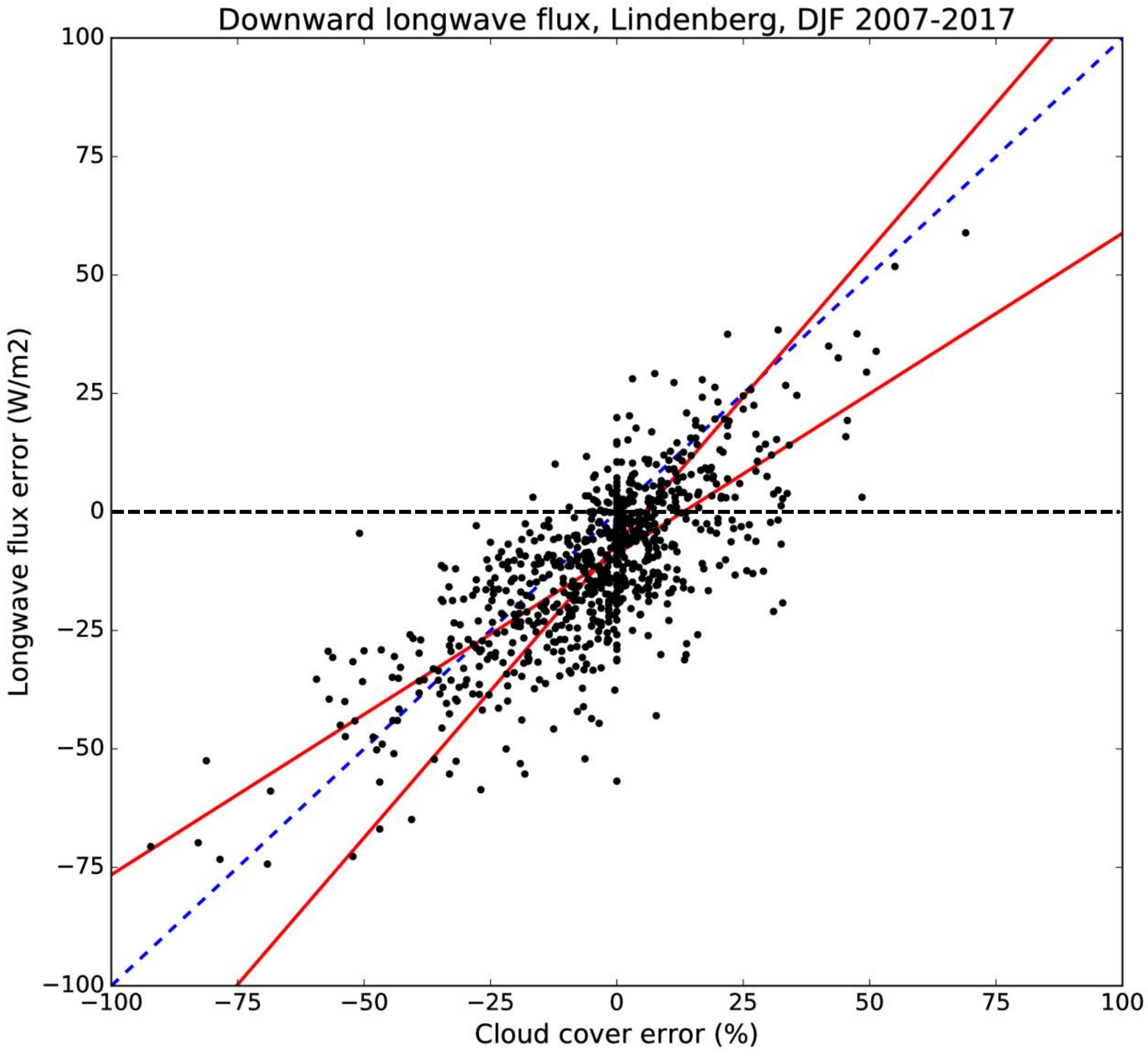
Longwave flux error: dependence on cloud error (BSRN Lindenberg)



-10 Wm^{-2} lw flux bias when TCC is correct

→ bias in cloud type / cloud base height?

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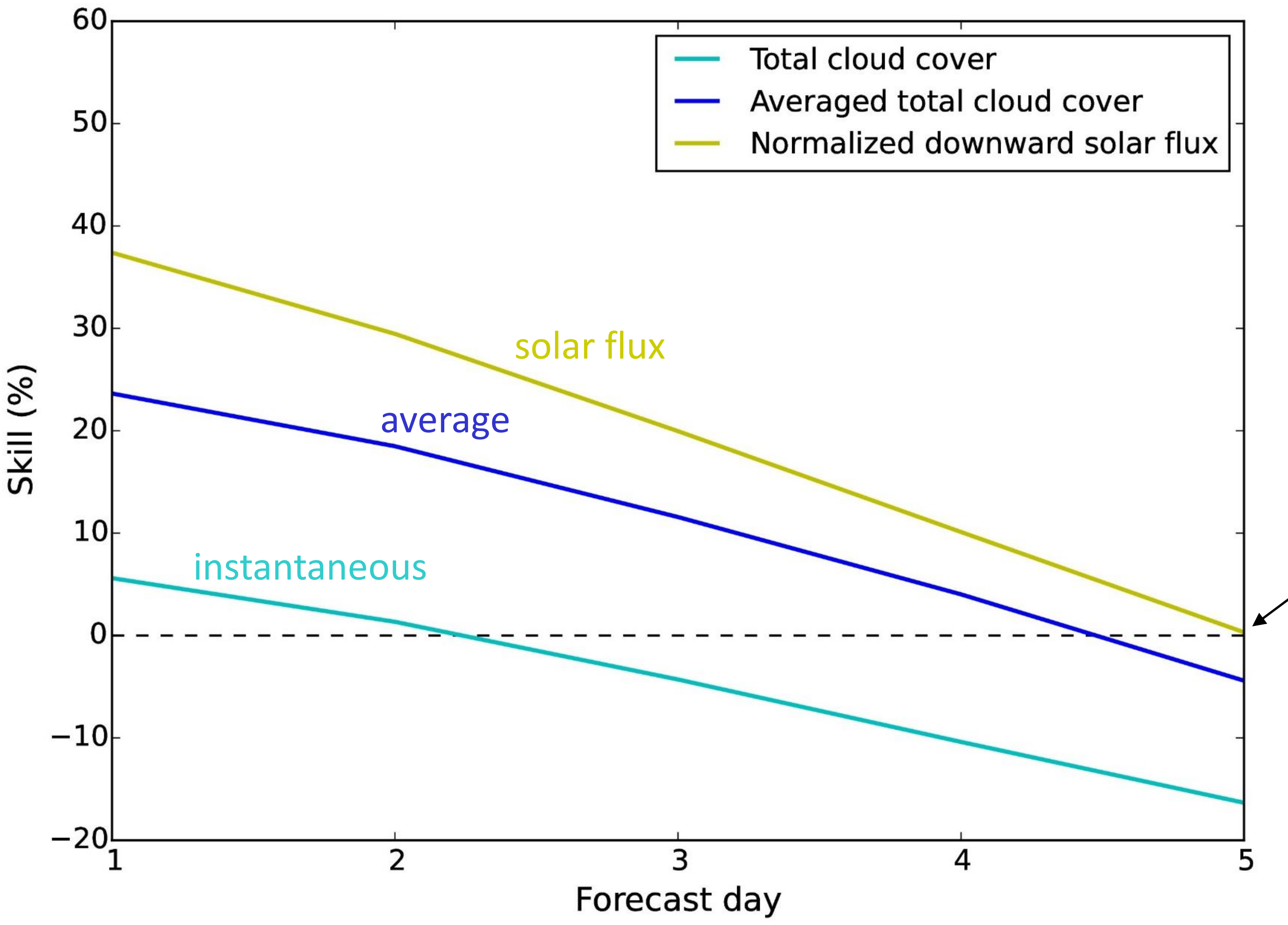
Solar radiation predictability

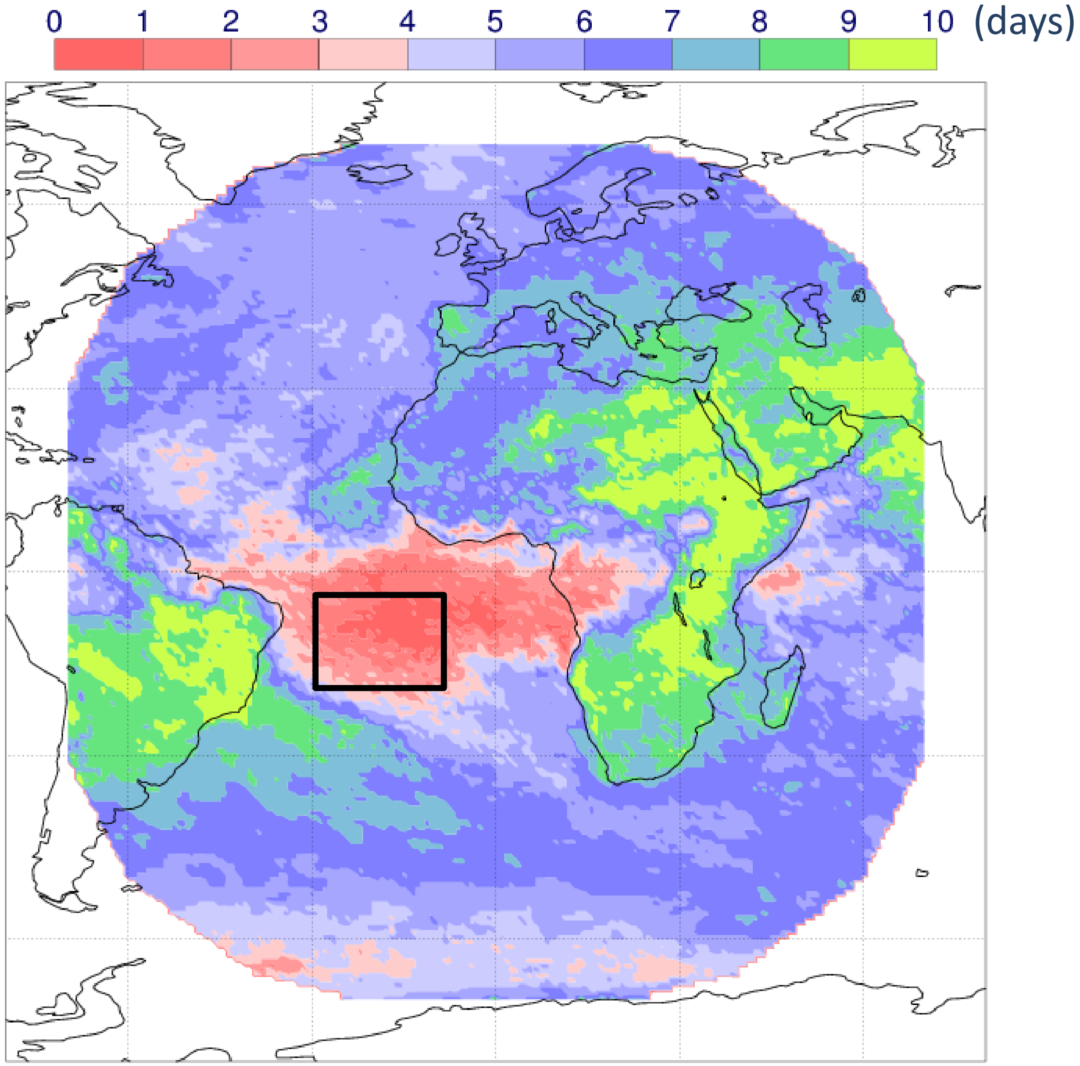
Cloud and solar radiation forecast skill



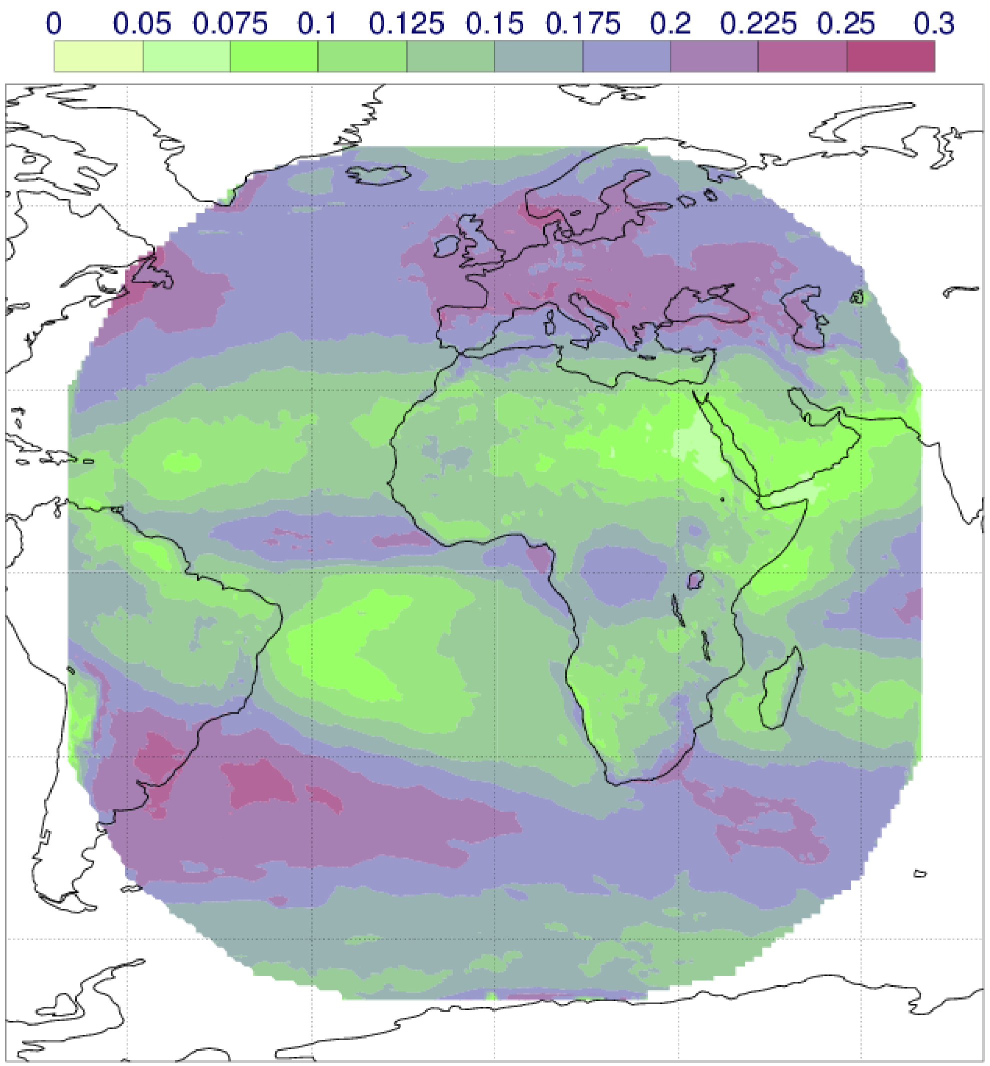
Forecast skill horizon
Buizza and Leutbecher (2015)

ECMWF Newsletter No 143 (2015)

Forecast skill horizon of downward solar radiation

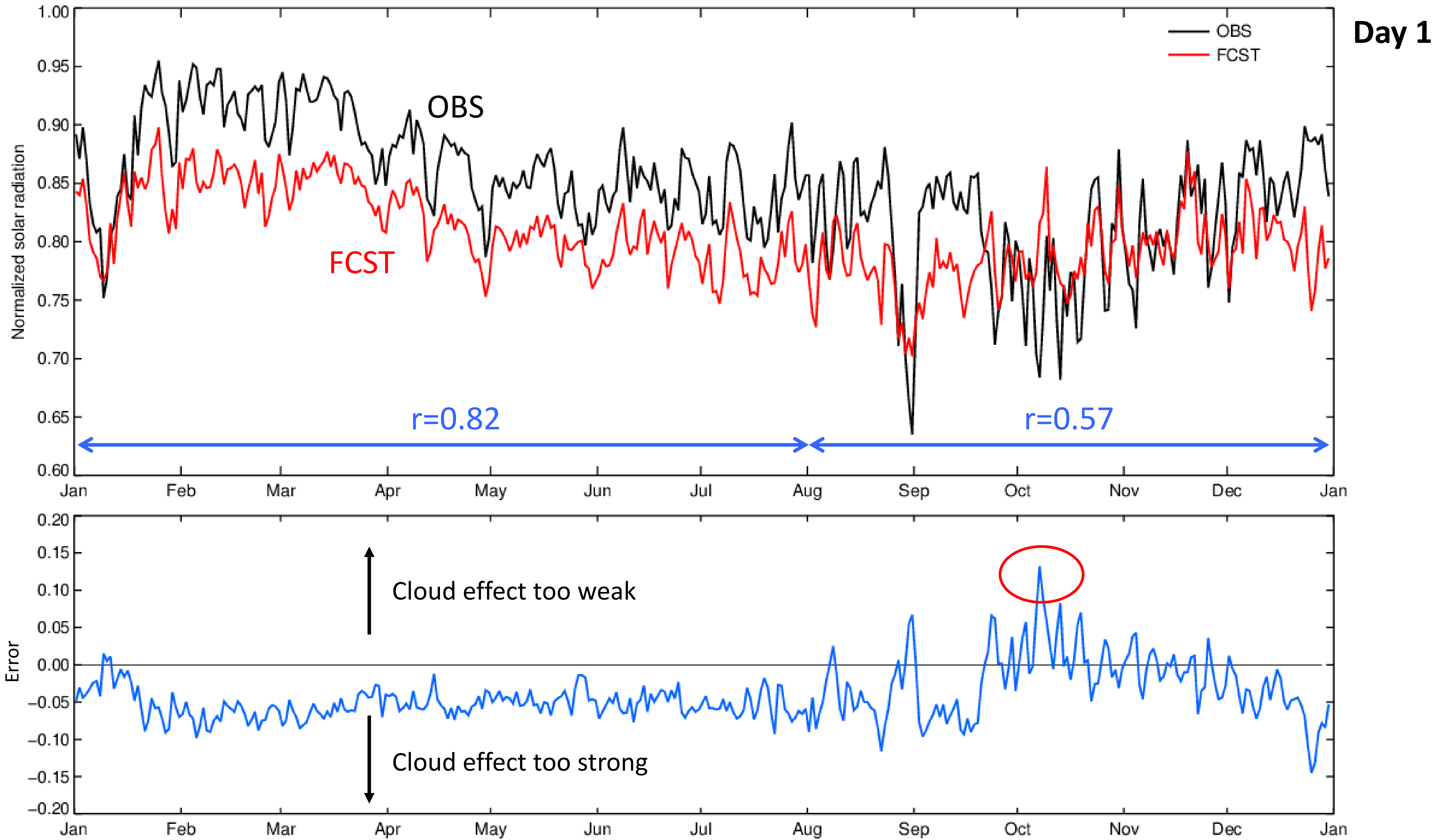


Skill horizon (ACC<0.3)

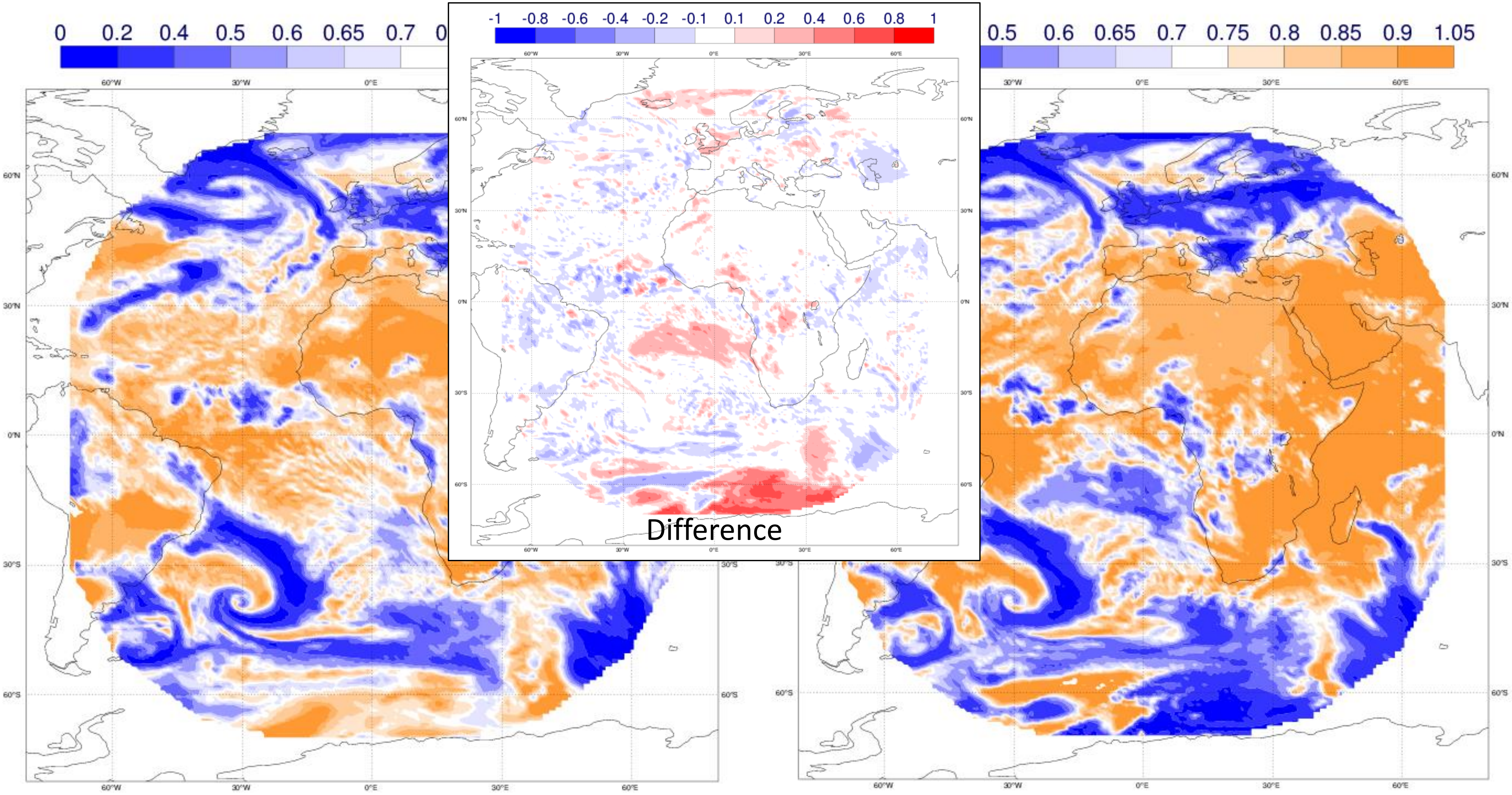


Observed variability (sub-monthly)

Seasonal changes in large-scale error characteristics



Normalized downward solar radiation (7 Oct 2016)

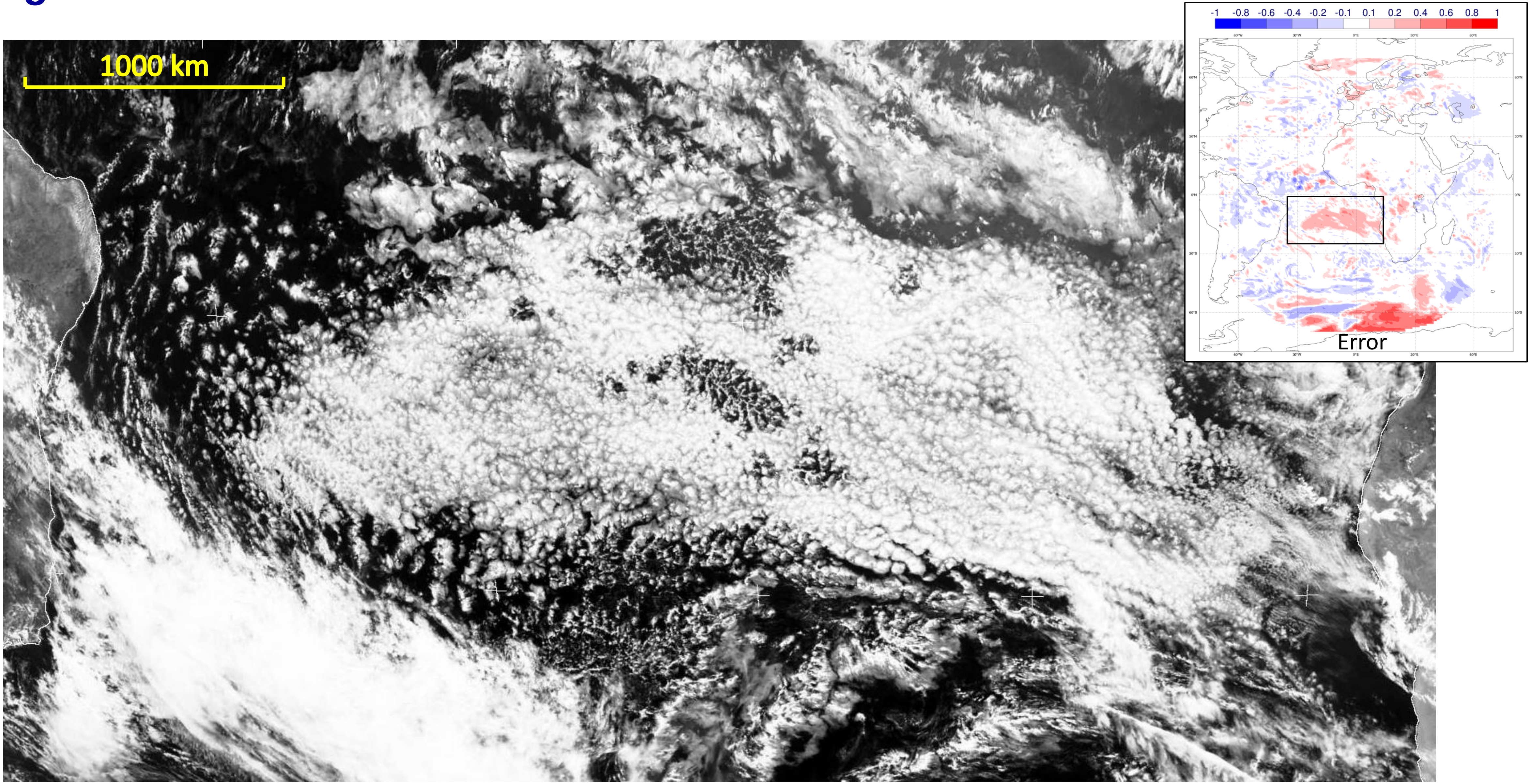


Difference

Forecast

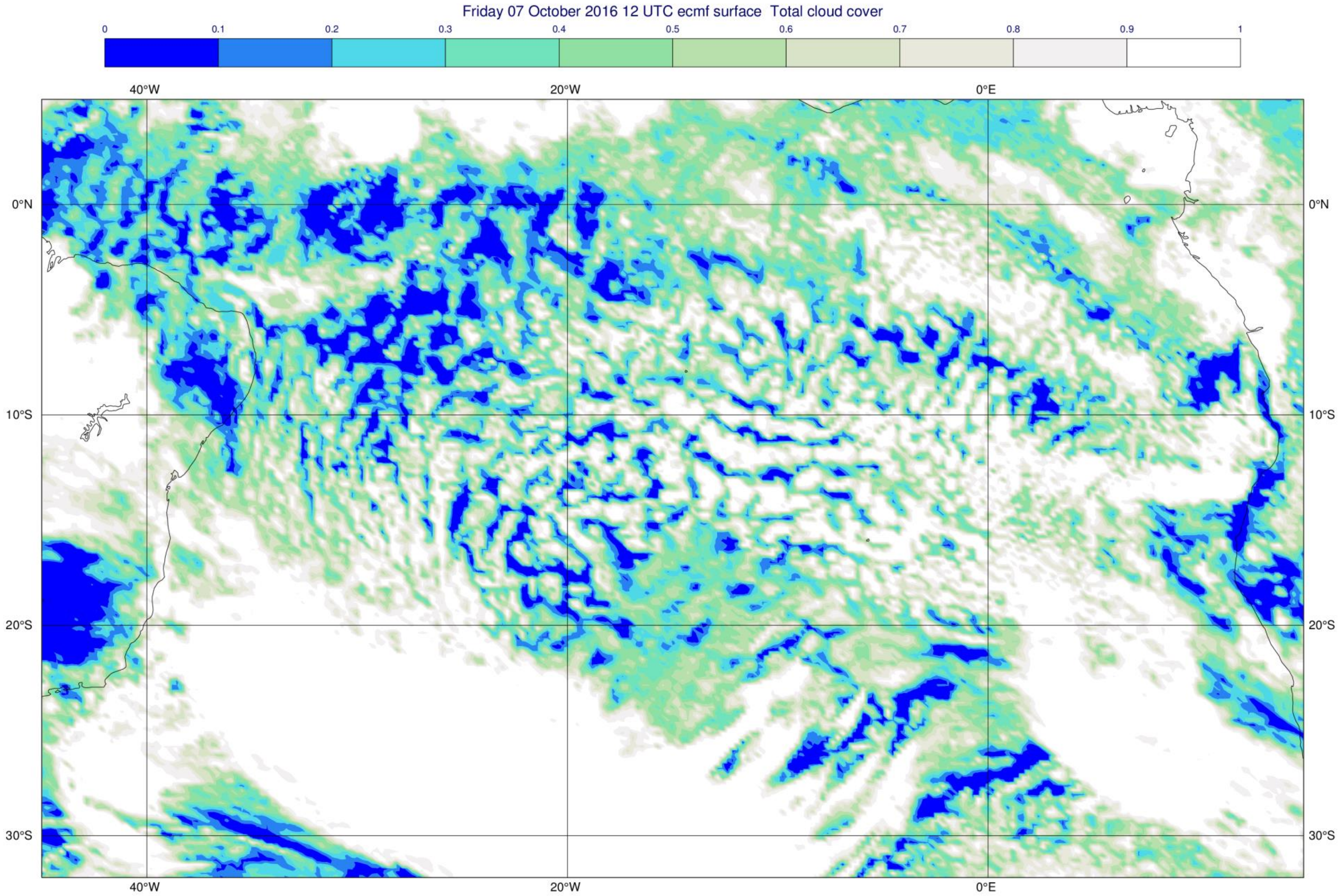
Observed

Large area of closed-cell convection



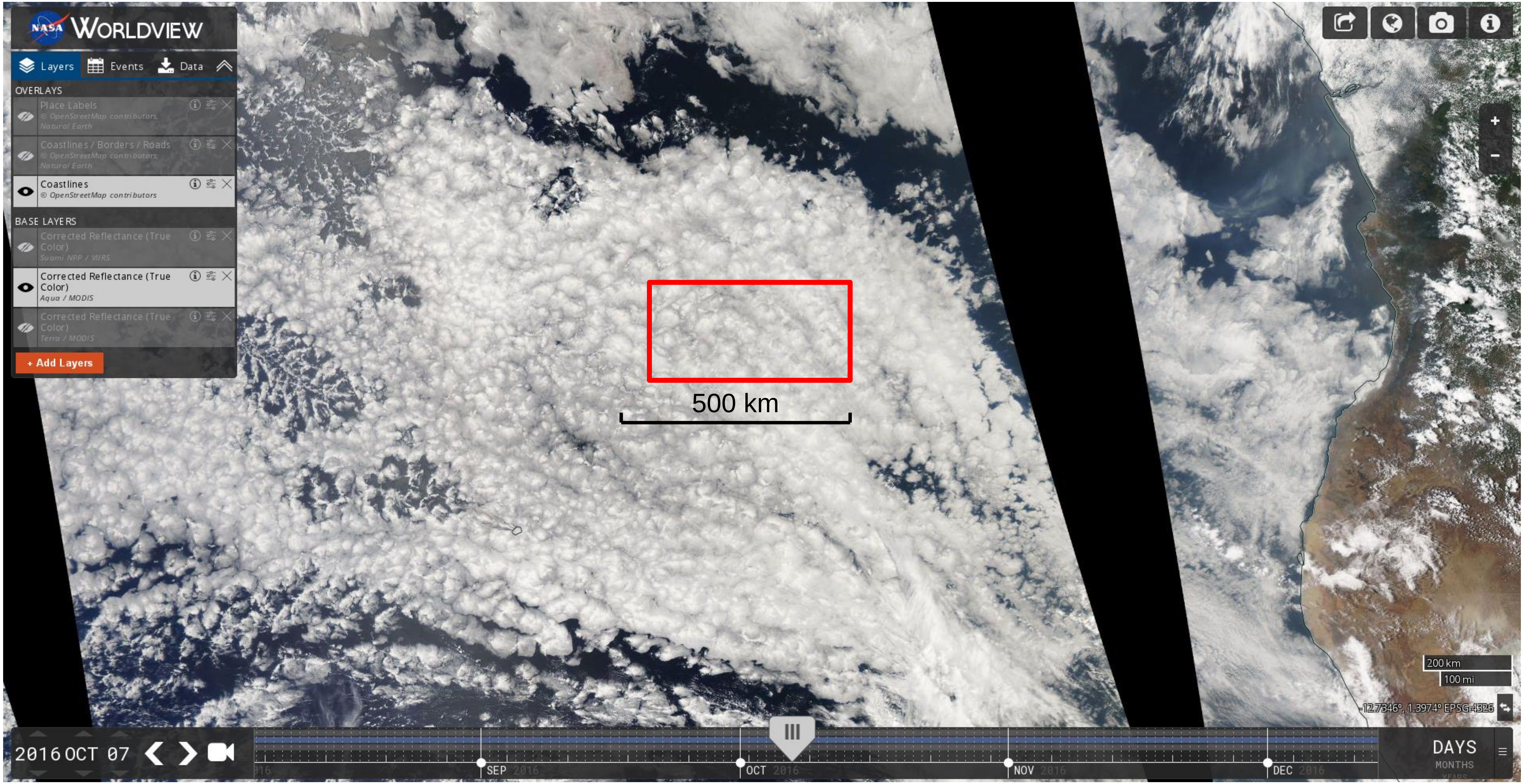
SEVIRI Ch1 - 7 Oct 2016 12 UTC

Cloud fraction: forecast 00 UTC +12 h

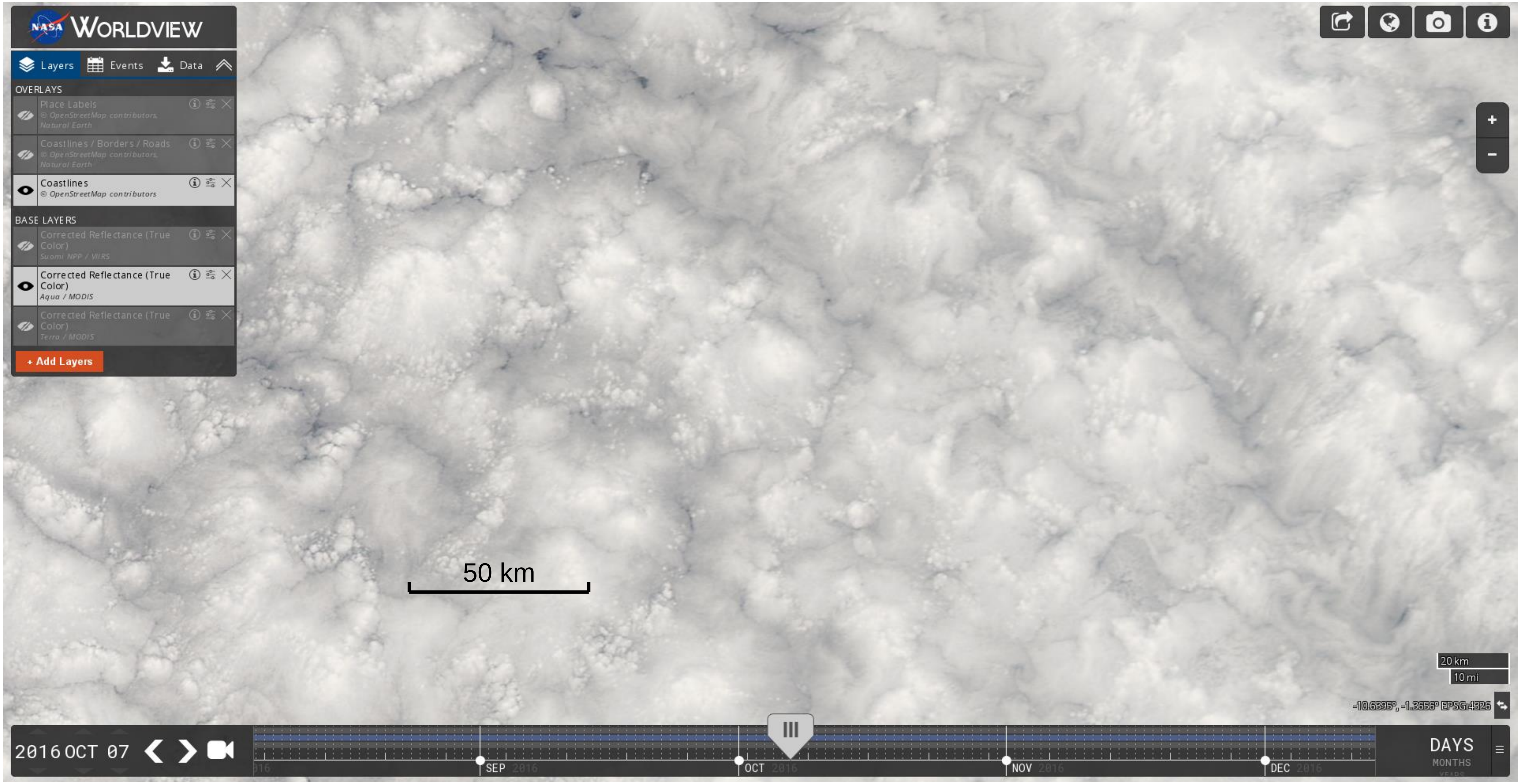


2016/10/07
12 UTC

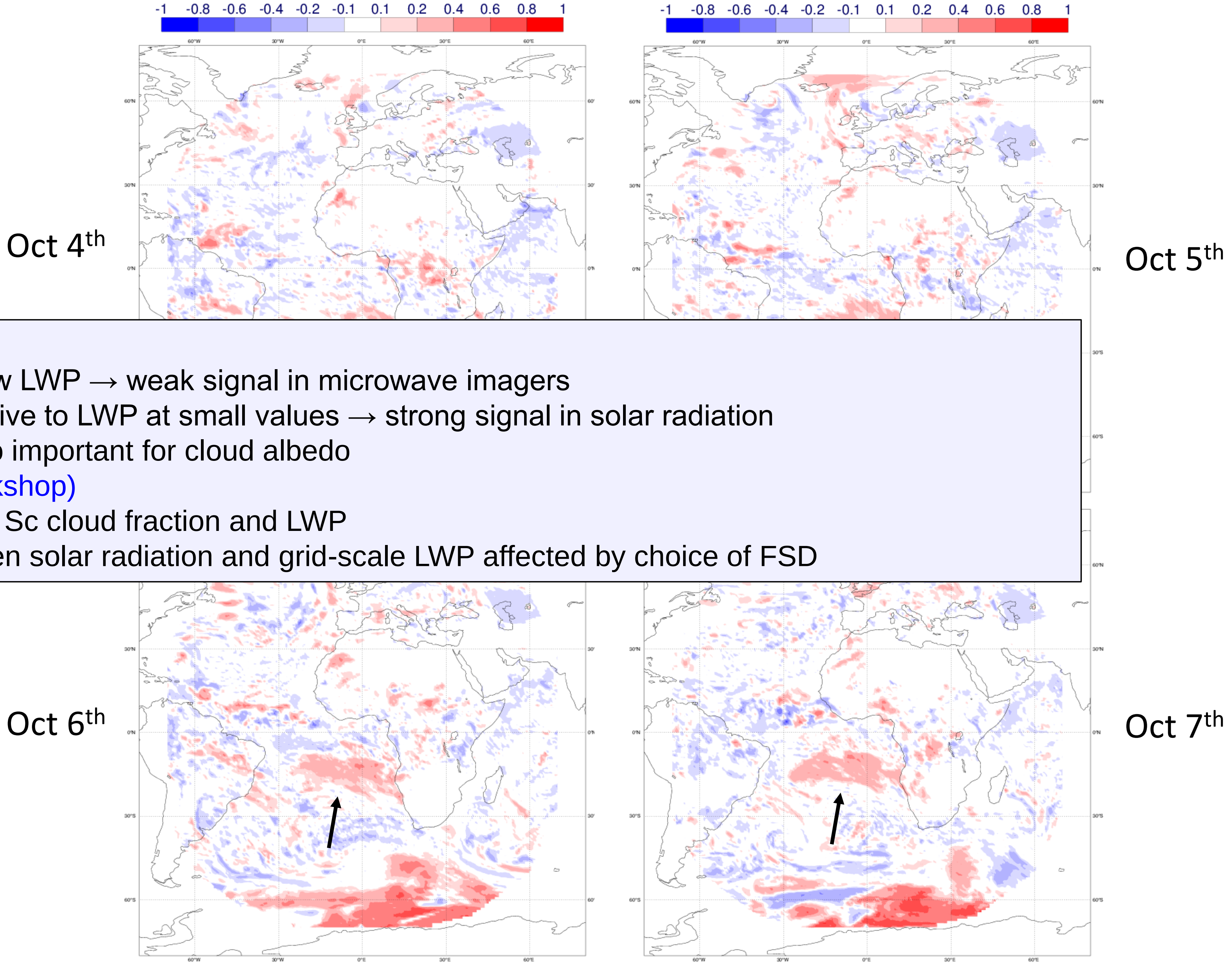
Aqua / MODIS - 7 Oct 2016



Aqua / MODIS - 7 Oct 2016



Error evolution



K. Lonitz

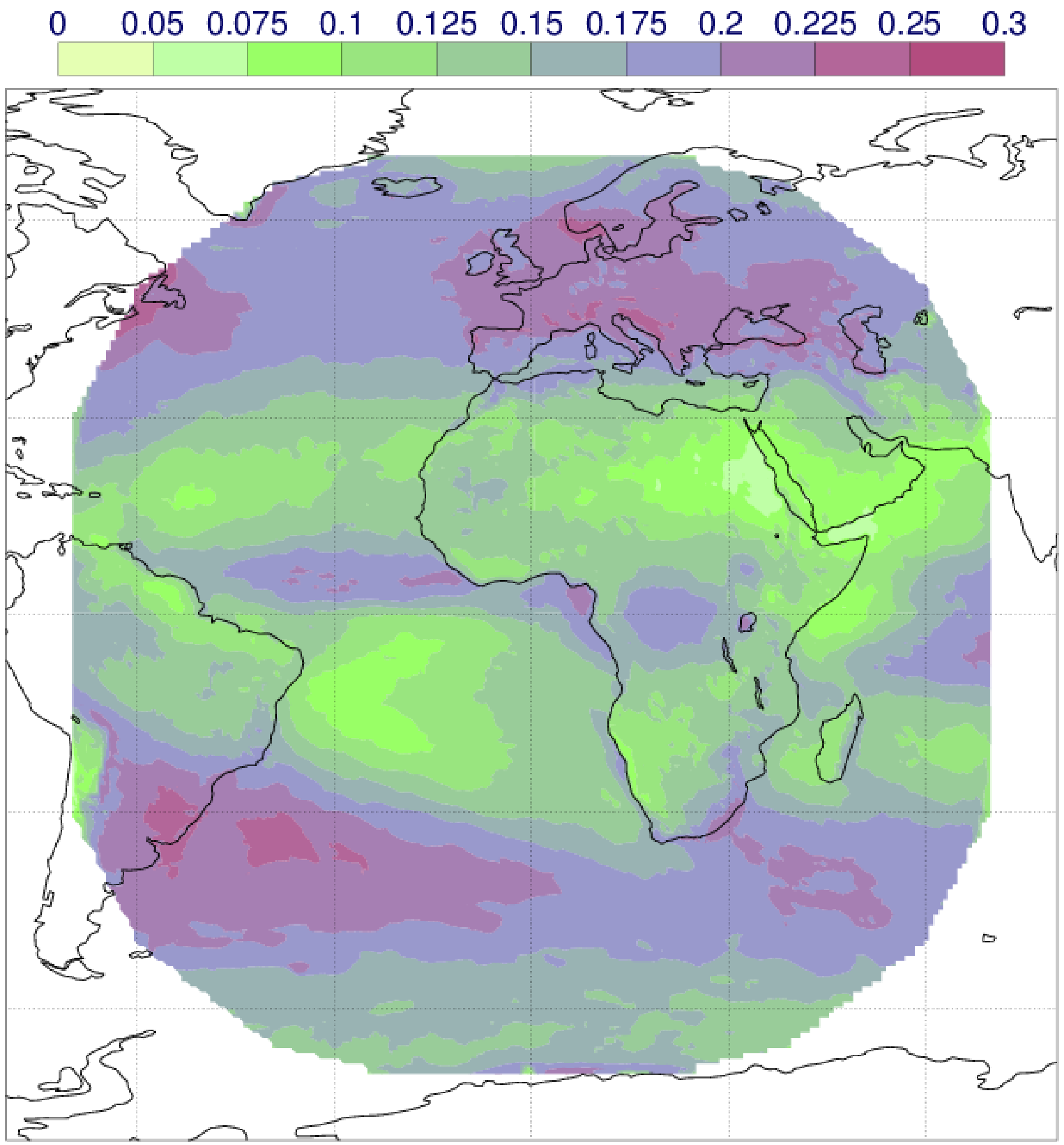
- Sc typically have low LWP → weak signal in microwave imagers
- Cloud albedo sensitive to LWP at small values → strong signal in solar radiation
- Effective radius also important for cloud albedo

M. Ahlgrimm (this Workshop)

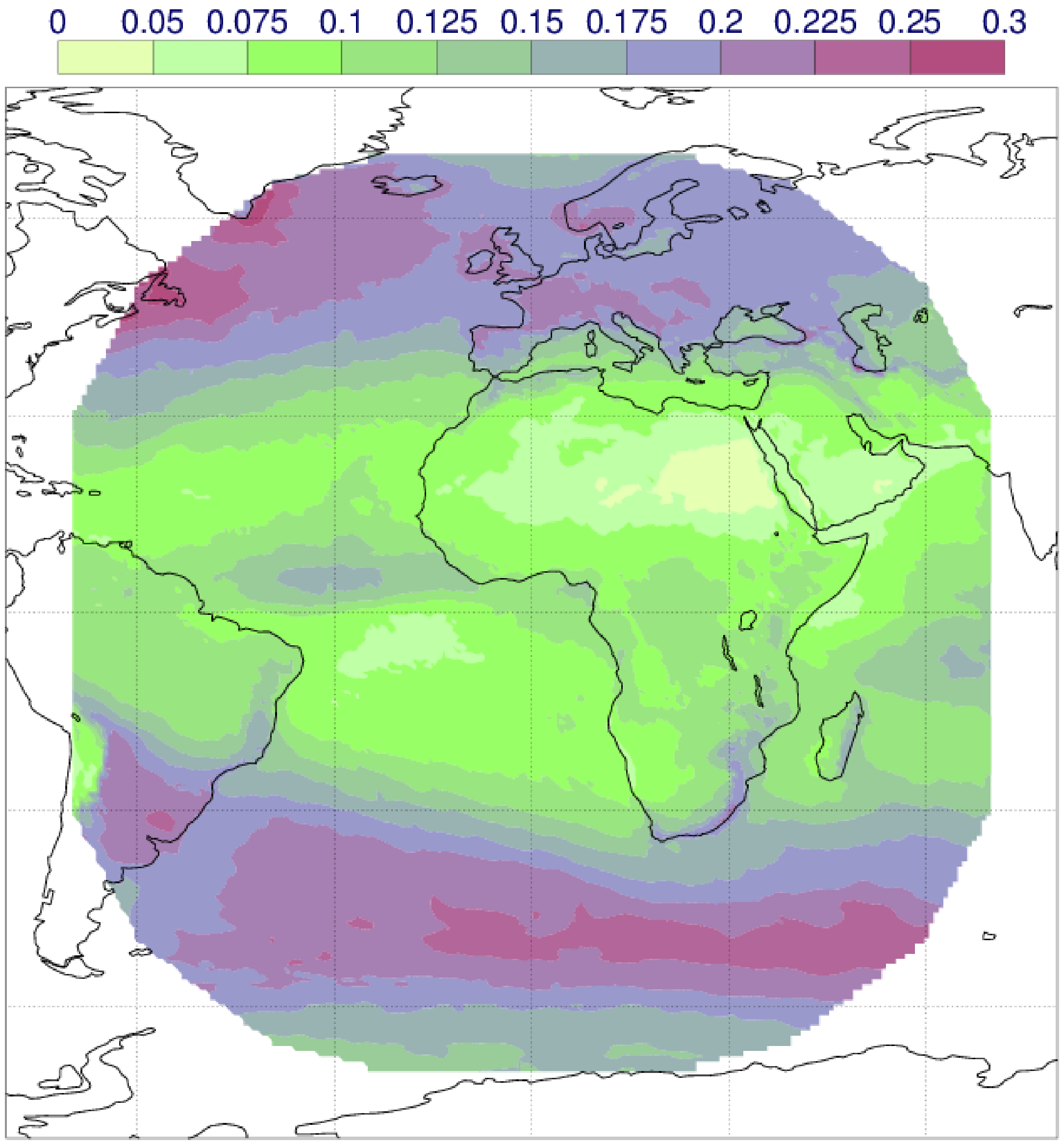
- IFS underestimates Sc cloud fraction and LWP
- Relationship between solar radiation and grid-scale LWP affected by choice of FSD

Solar radiation - activity

Standard deviation of obs and fcst (2012-2016) - activity

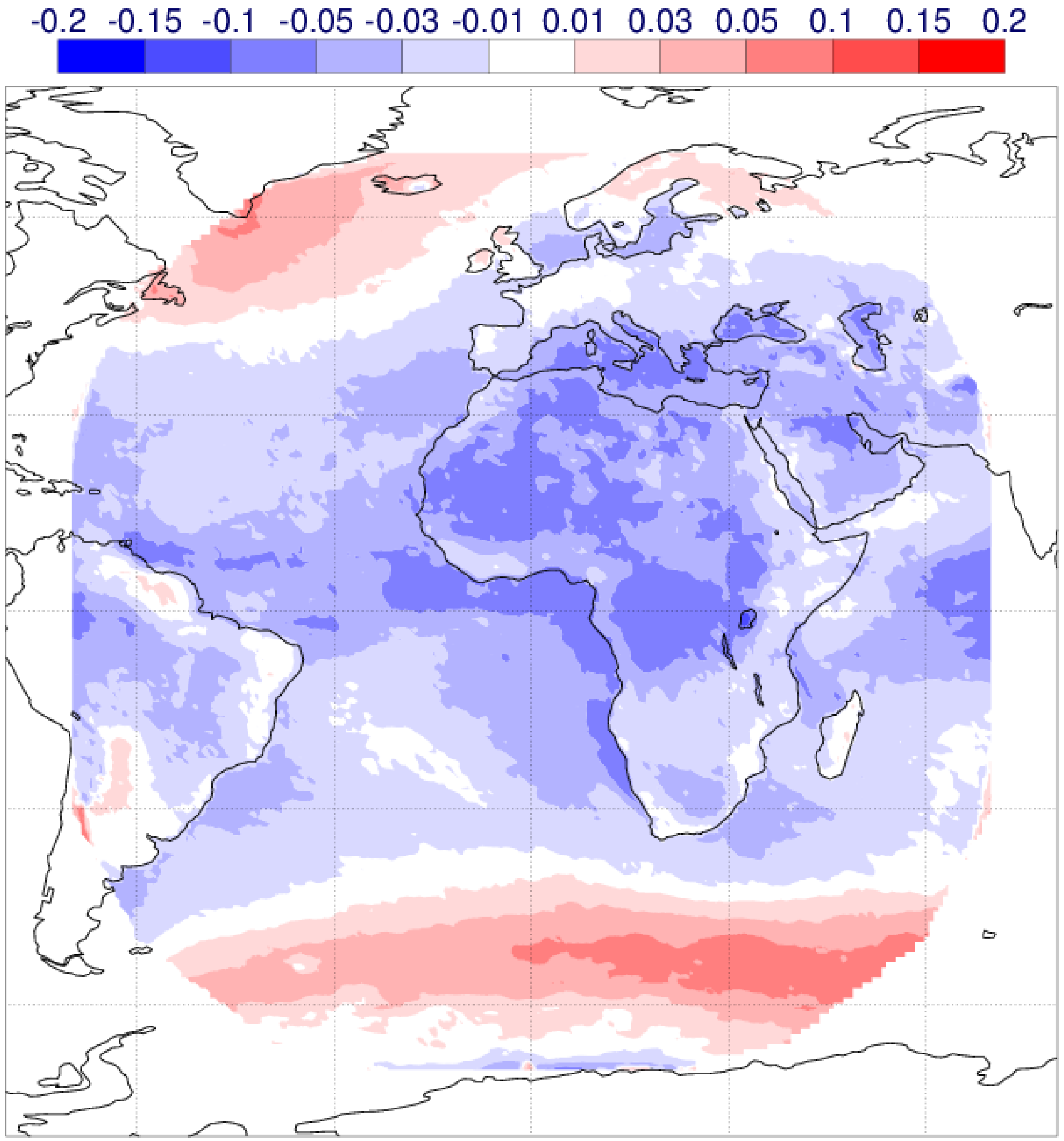


Observed SDEV

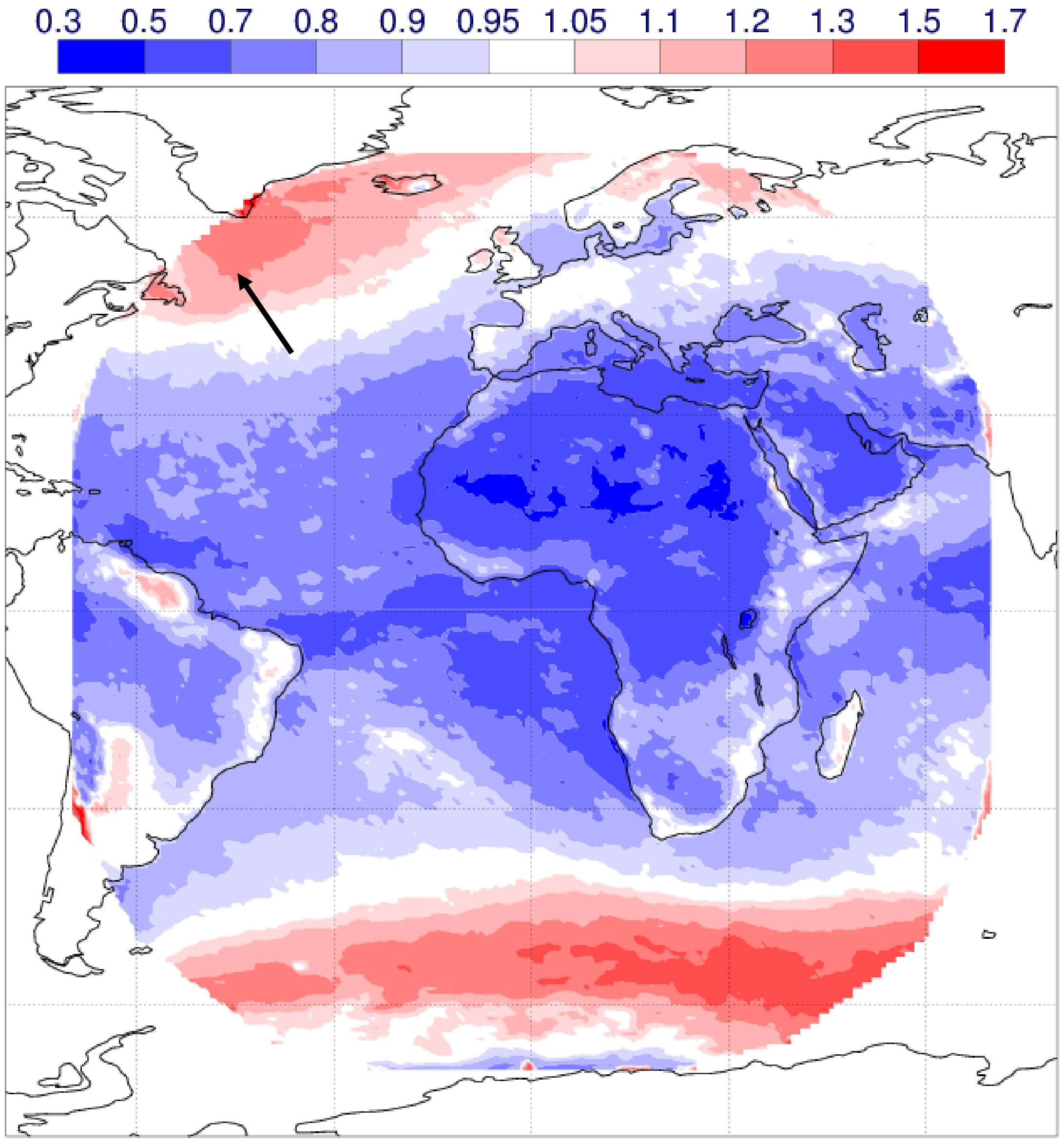


Forecast SDEV

Difference and ratio of standard deviations (activities)

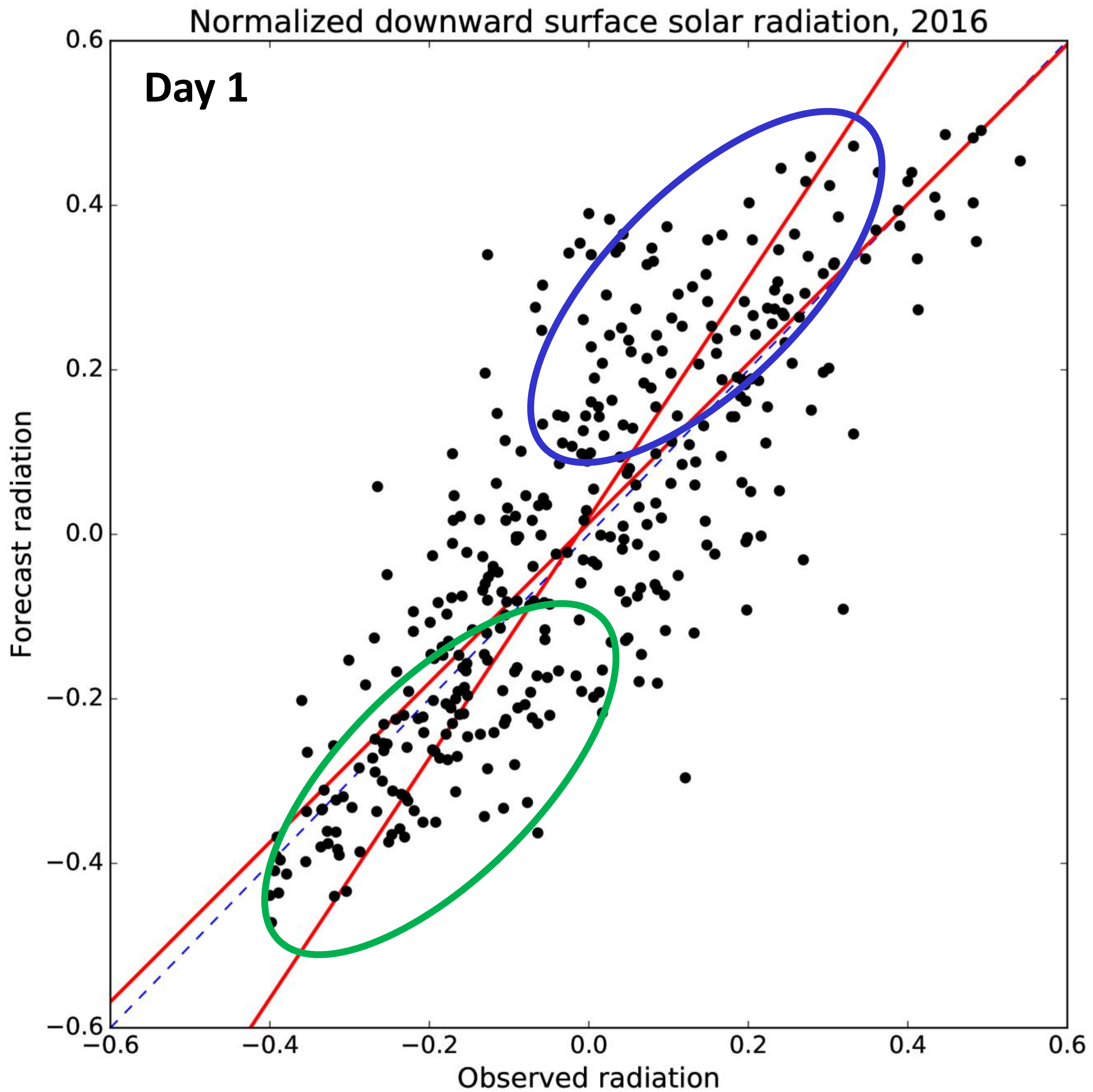


SDEV_fc – SDEV_ob



SDEV_fc / SDEV_ob

North Atlantic near Greenland [45W,50N]

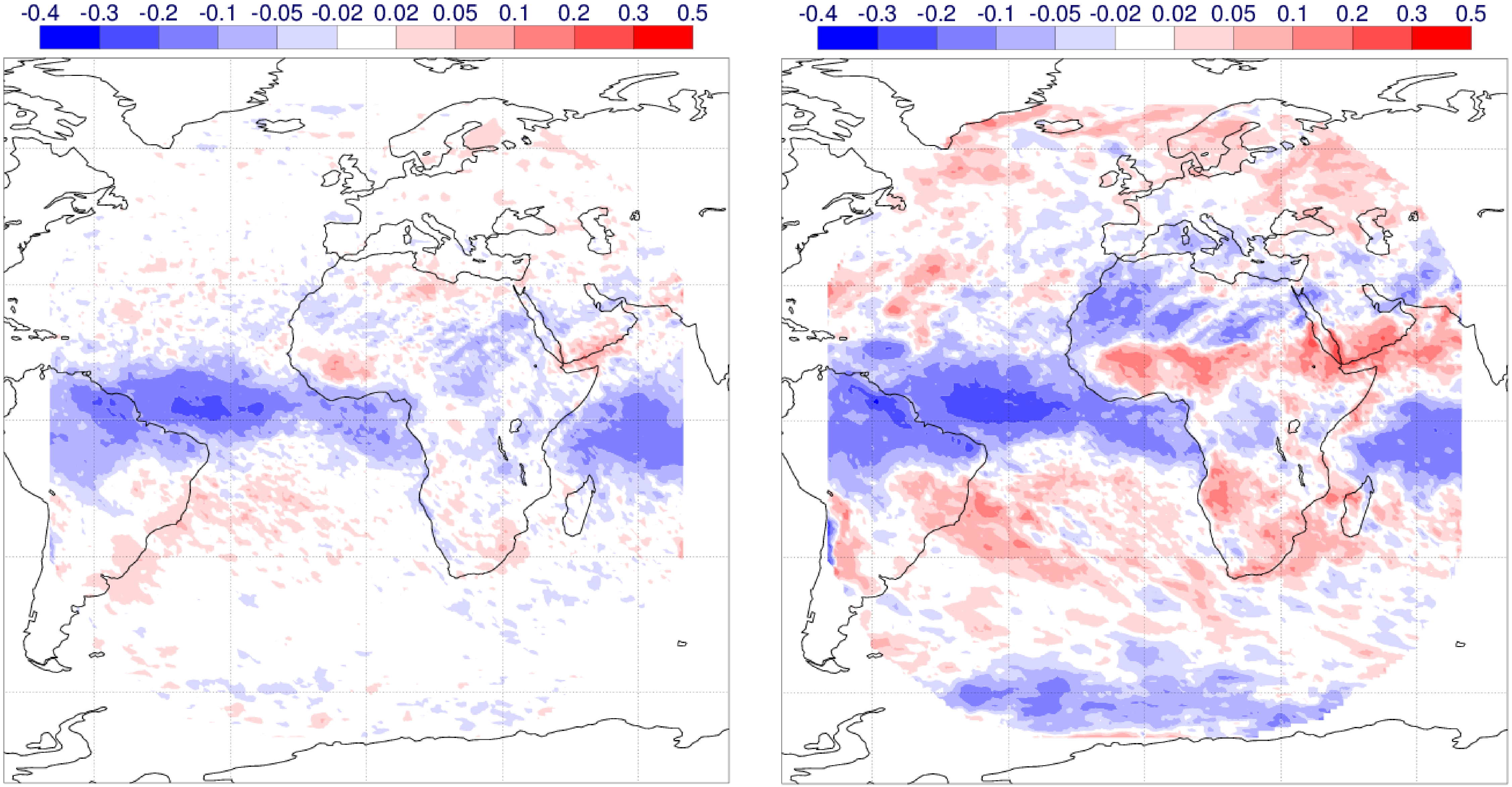


Conditional bias:

← Cloud radiative effect too weak when less cloudy

← Cloud radiative effect too strong when cloudier

Evolution of activity with lead time

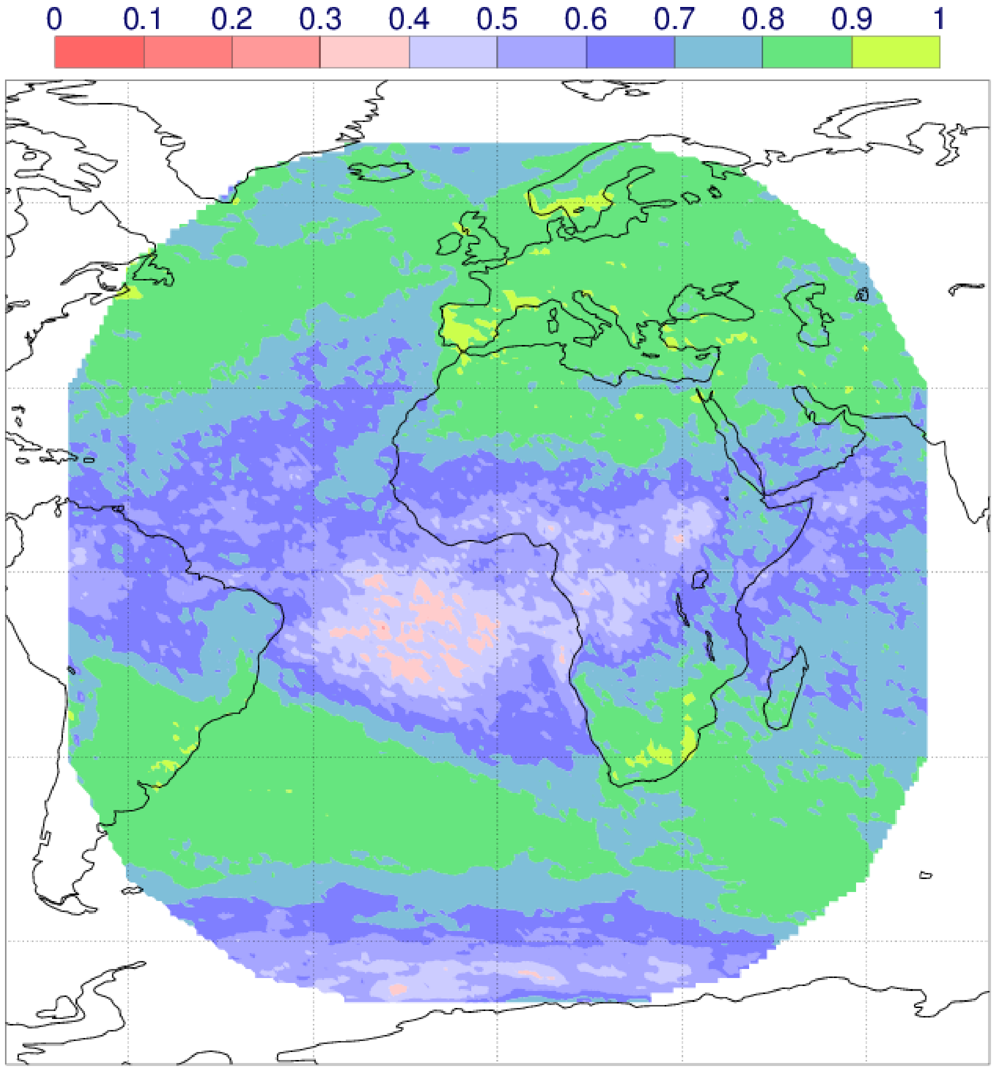


Day 2 – Day 1

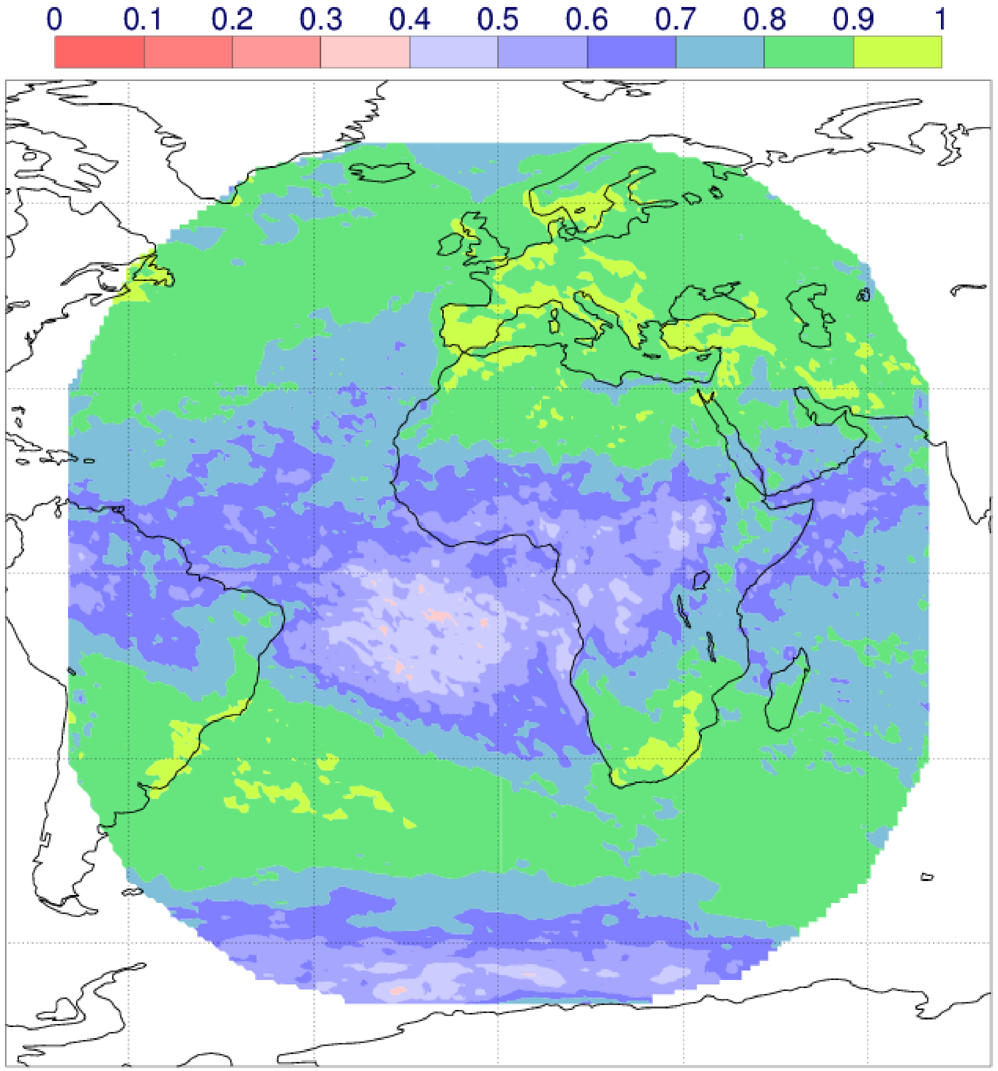
Day 10 – Day 1

Scale-dependence of forecast skill

Downward solar radiation, anomaly correlation

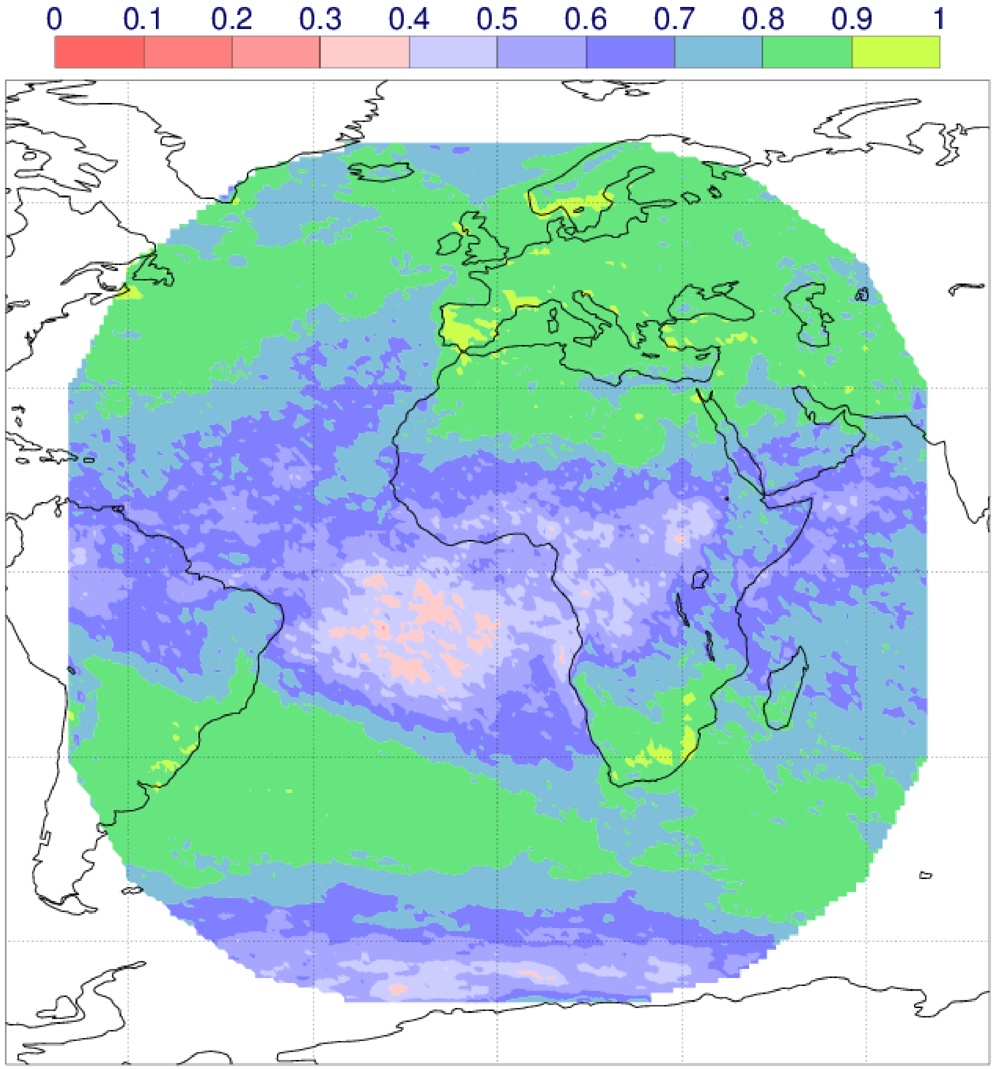


ACC at 16 km

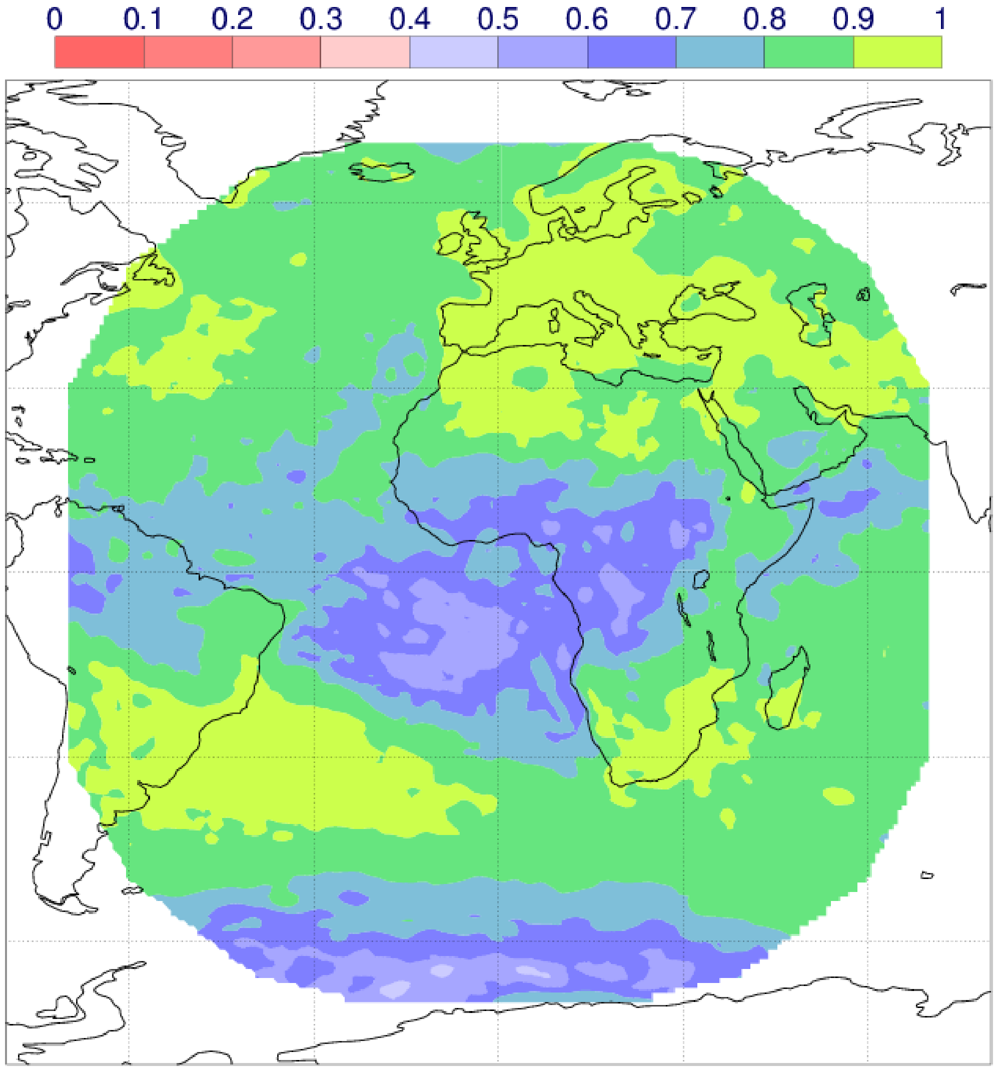


ACC at 80 km

Downward solar radiation, anomaly correlation

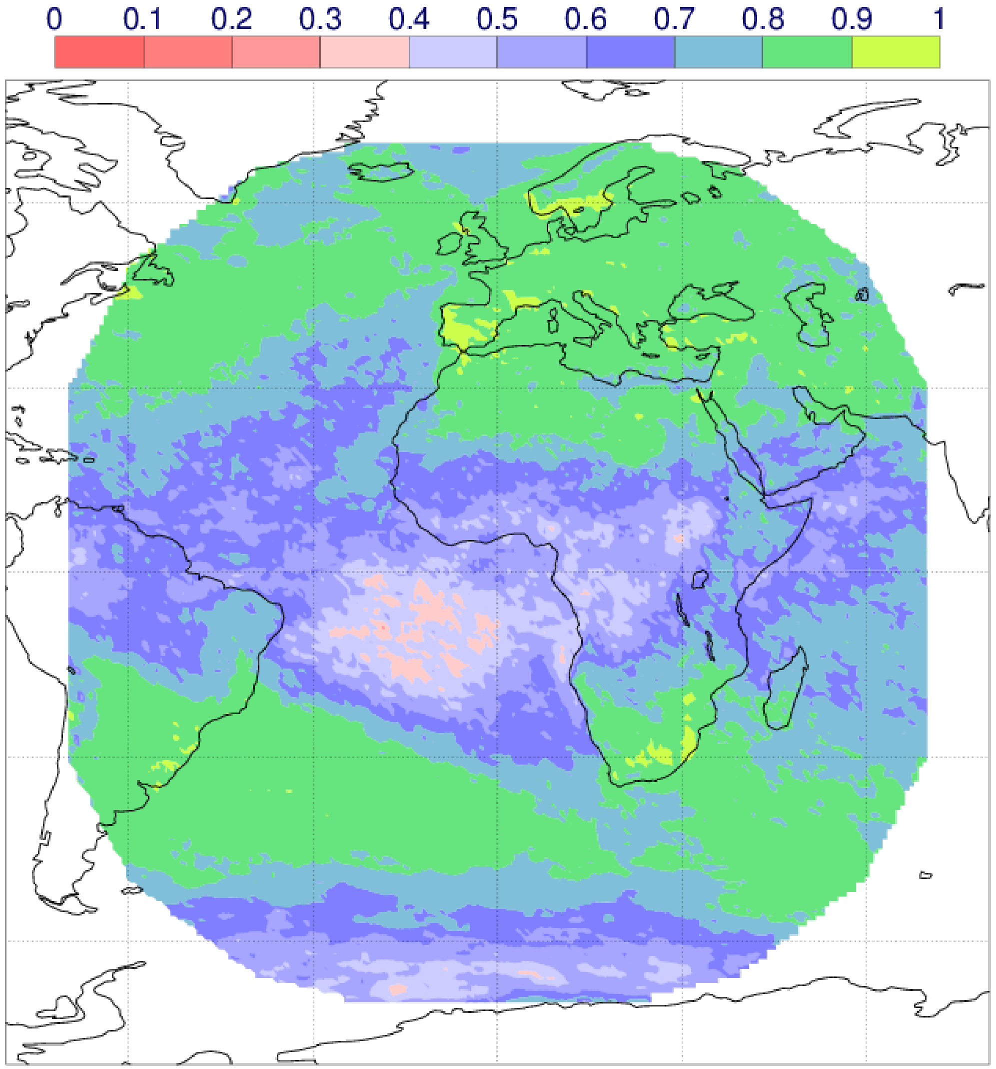


ACC at 16 km

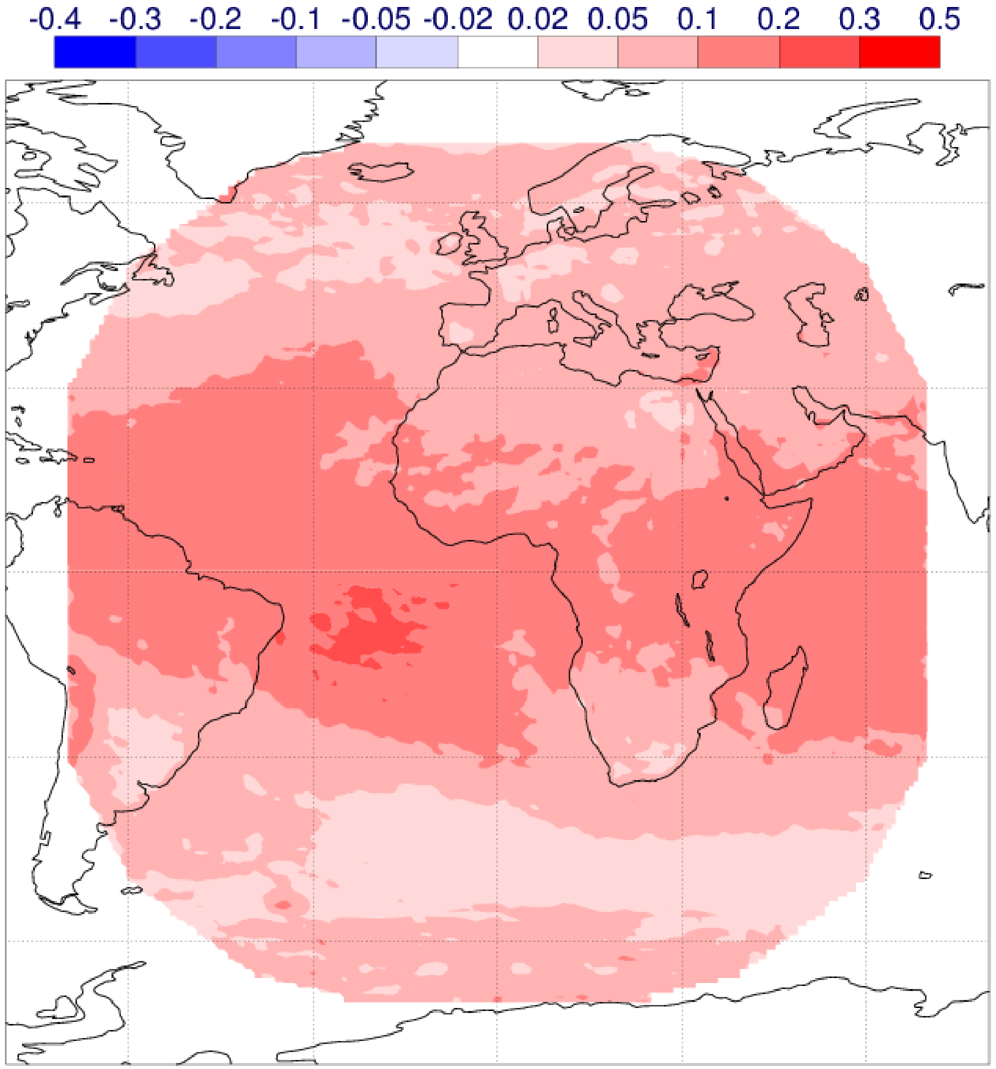


ACC at 300 km

Downward solar radiation, anomaly correlation



ACC at 16 km

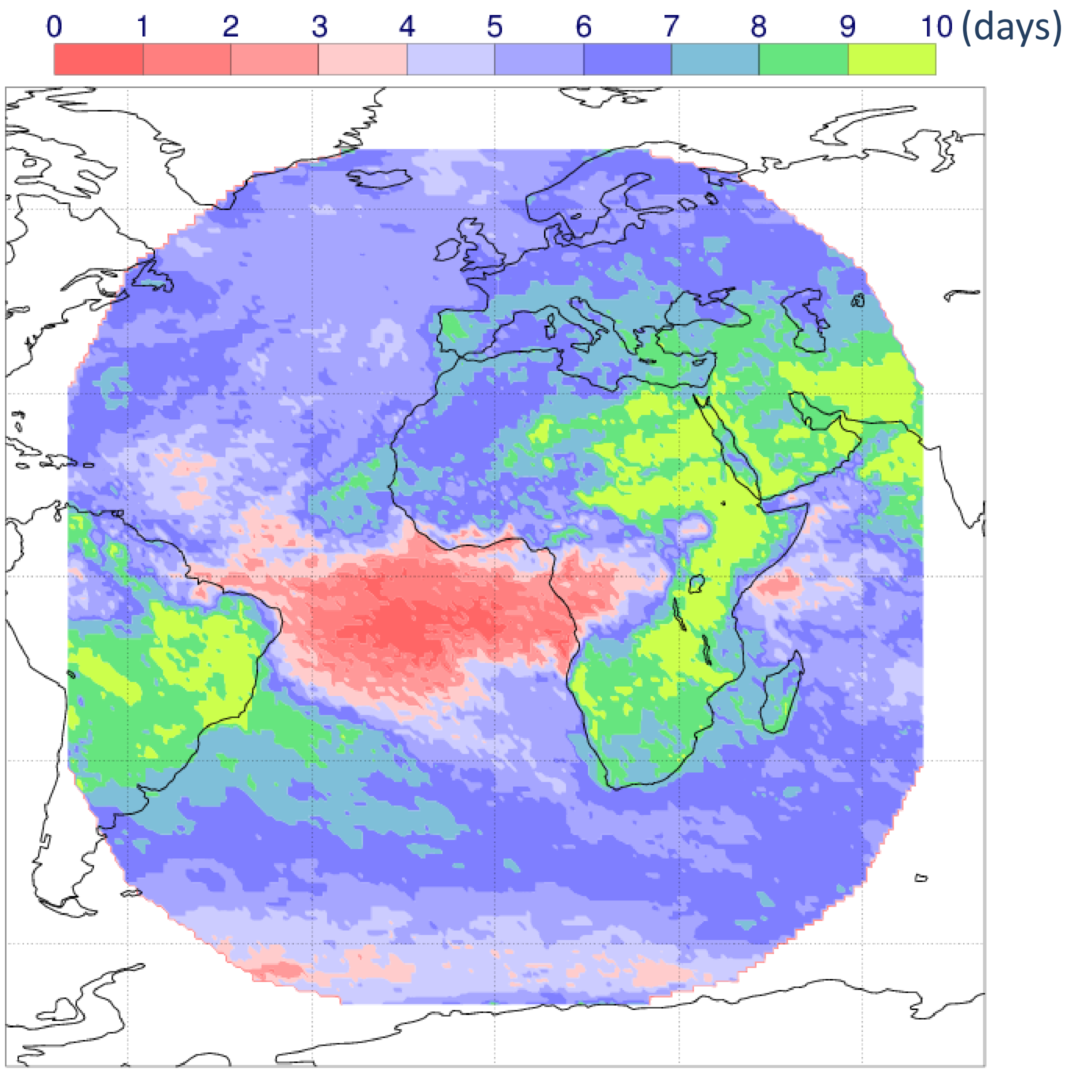


ACC(300 km) – ACC(16 km)

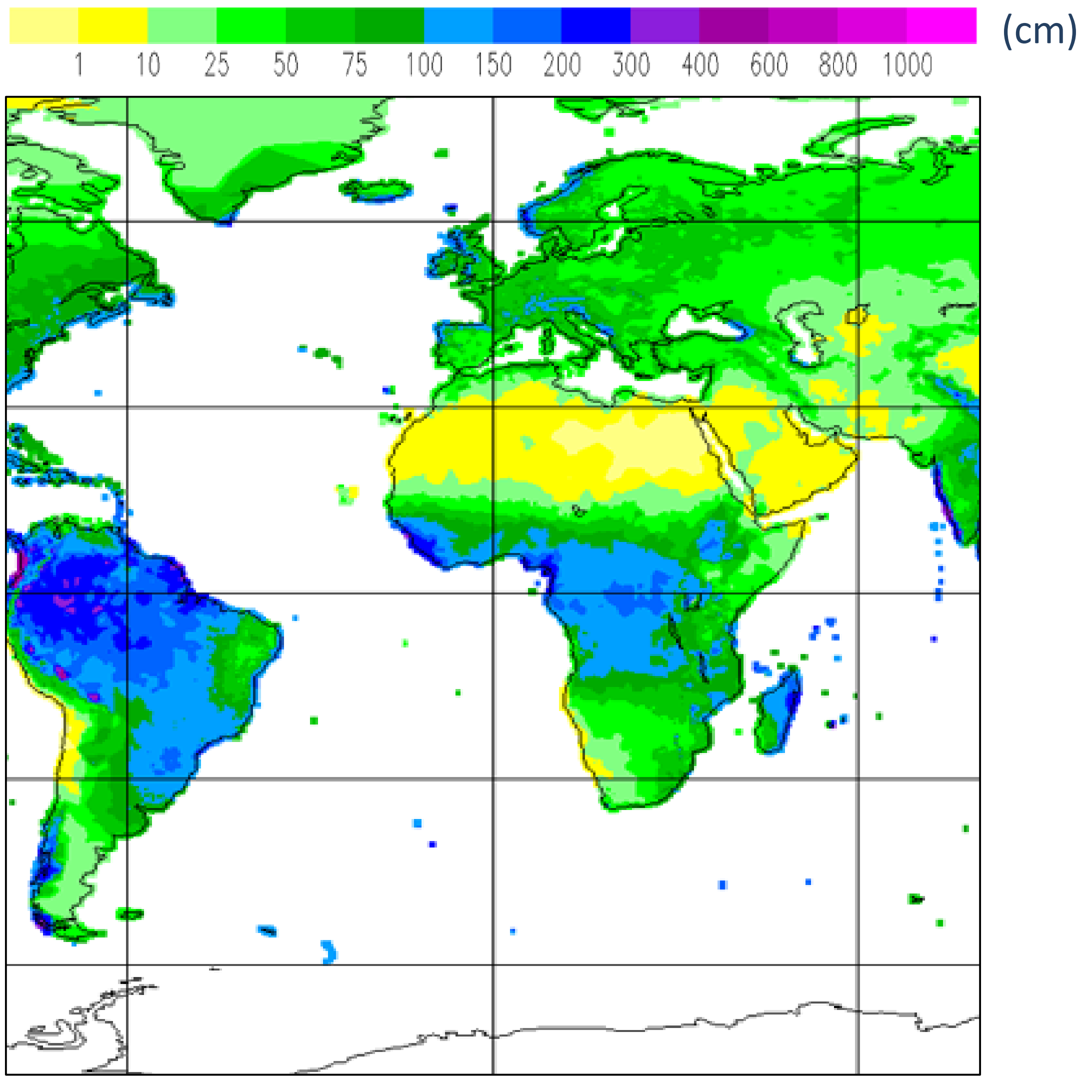
Summary

- BSRN: consistent biases in sw (+) and lw (-) in IFS across regions
- SYNOP downward solar: good agreement with satellite data
- Wintertime T2m biases at least partly due to lack of cloud cover/optical depth
- Subtropical South Atlantic has shortest forecast skill horizon for cloudiness
- Skill already low at day 1 → assimilation issue?
- Substantial drop in skill from 300 km to 16 km, more than in the Southern Ocean

Forecast skill horizon for downward solar radiation

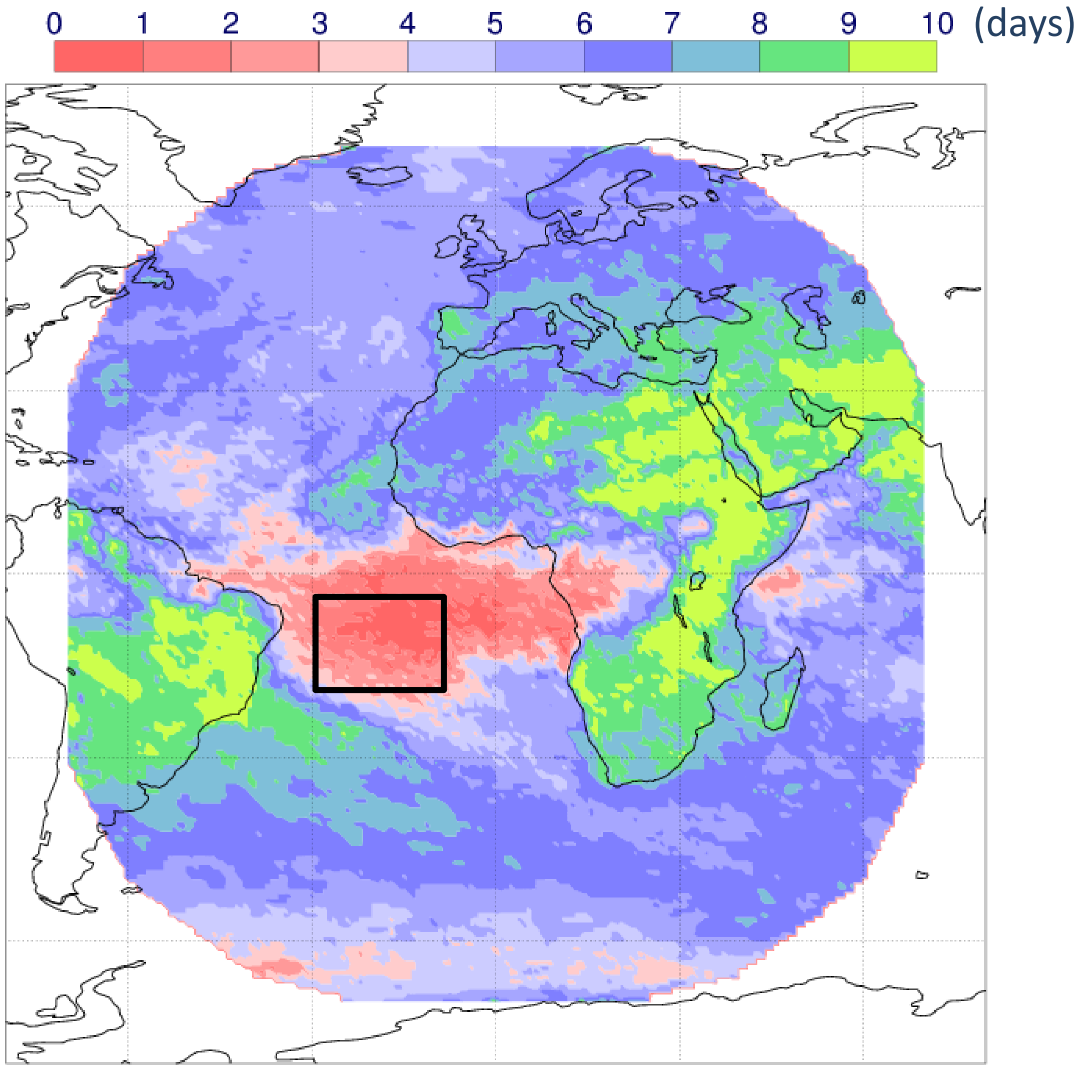


Skill horizon (ACC<0.3)

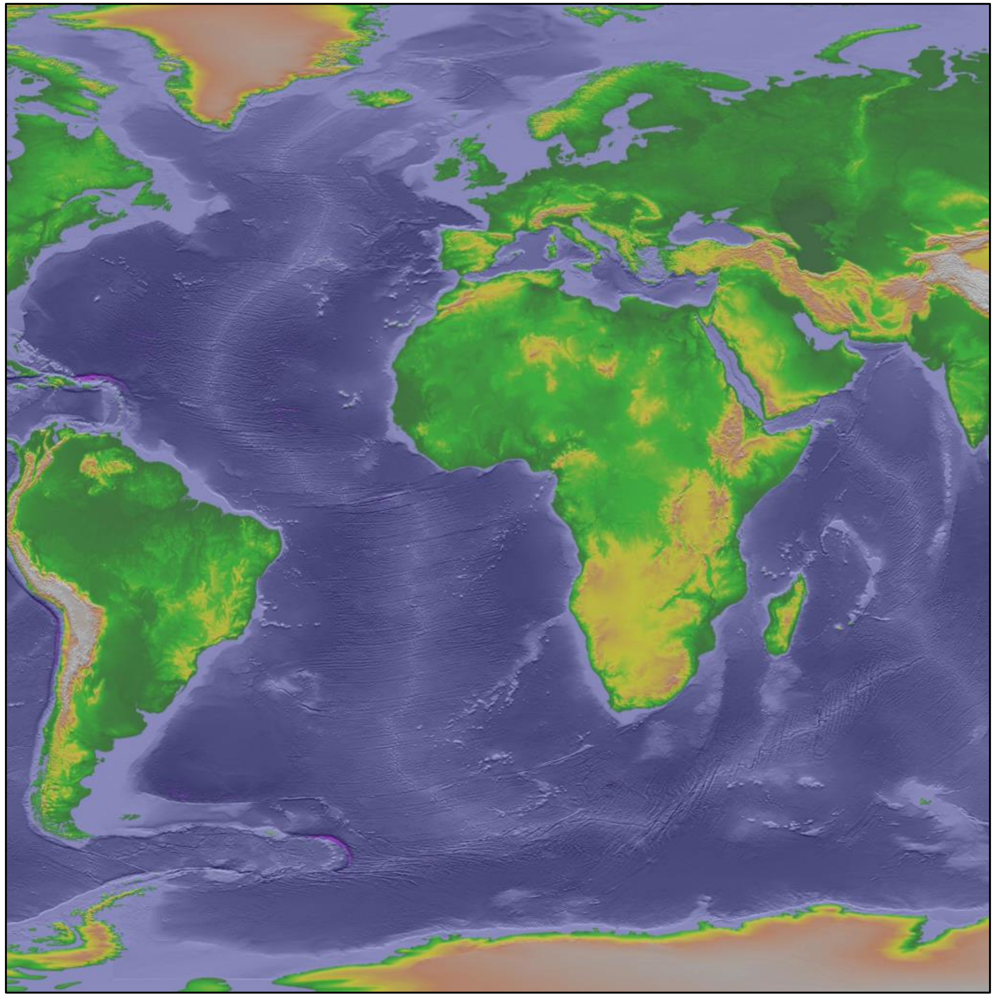


Annual precipitation

Forecast skill horizon for downward solar radiation



Skill horizon



Topography