Priority Project T²RC² : preliminary tests of cloud-radiation parameters in ICON-DE

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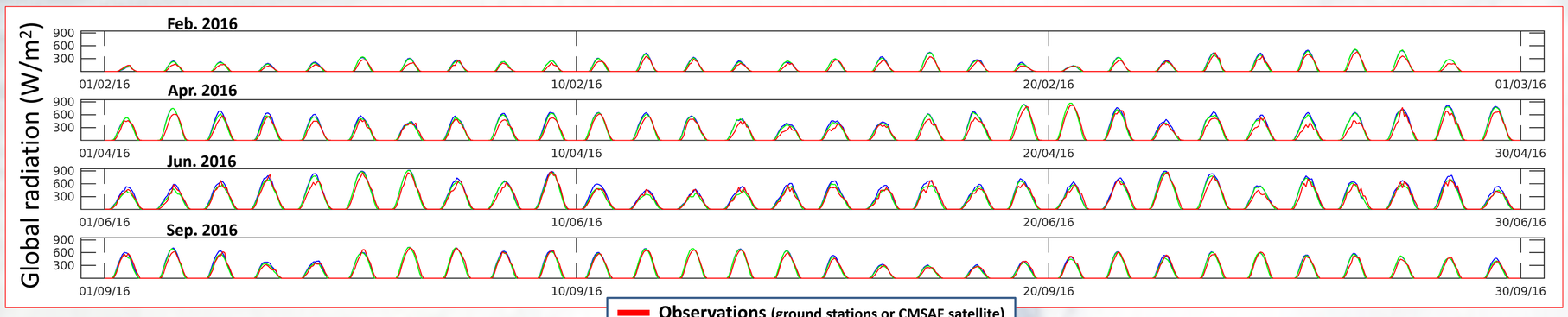
Overview

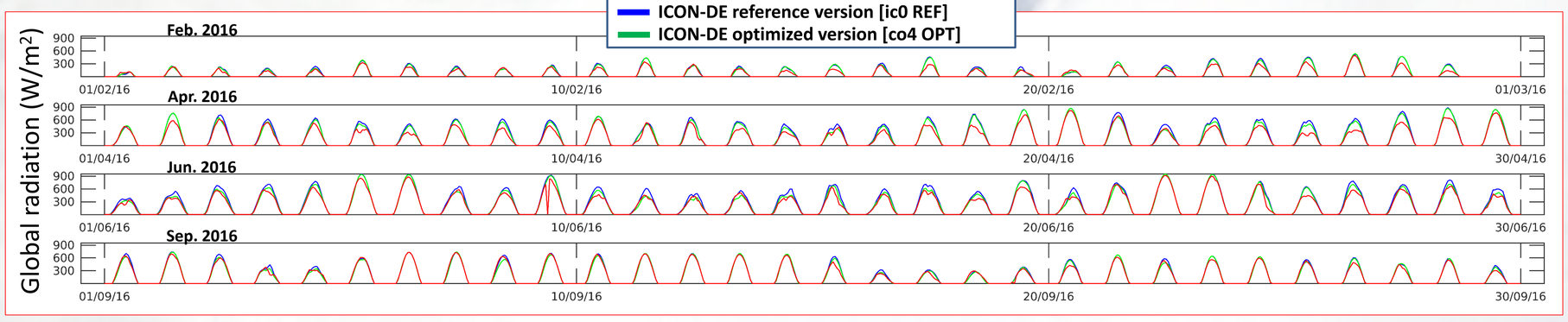
Priority Project "Testing and Tuning of Revised Cloud Radiation Coupling" (T^2RC^2) aims at the development of the new cloud-radiation coupling scheme in COSMO and its implementation into ICON. The new scheme includes revised sub-grid scale clouds effect on radiation, detailed optical properties for liquid and frozen particles of different sizes, more accurate representation of aerosol effects on cloud microphysics, etc. From algorithmical point of view, the new scheme contains many cloud-radiation dependencies which contribution is described by about thirty parameters. Besides, different options are activated using ten logical switches. This makes the tuning of the scheme a difficult problem. Last year, the parameters which have particularly high influence on the radiative fluxes in the model underwent massive tuning via comparison of COSMO-DE forecasts against global radiation observations.
Part of the new cloud-radiation coupling scheme is already implemented in ICON. Here, the influence of the relevant parameters on global radiation forecasts of ICON-DE is being tested.
We present preliminary verification results of ICON-DE tests for several month during 2016.

Time series for verification

Global radiation *averaged* over 27 ground stations over Germany

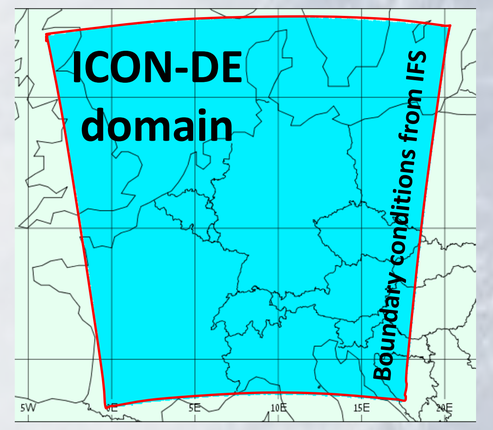


Global radiation from CMSAF satellite, *averaged* over Offenbach, Lindenberg and Munich 100X100 km² areas



Abstract

- *We have verified 10 versions of ICON-DE ~2.8km resolution, driven by IFS.*
- *These versions differ by cloud-radiation parametrizations.*
- *Global radiation forecasts were verified against 27 ground stations over Germany and against CMSAF satellite.*
- *Verification periods: February, April, June and September 2016.*
- *The model global radiation was compared to observations only in cases of adequate forecast of cloudiness.*



ICON cloud-radiation parameters

inwp_cldcover	irad_calc_opt	lrad_use_largesizeapprox	radqc_fact, radqi_fact	qvsat_fact_sgscl_rad
Cloud cover diagnostics [1] ICON scheme (by M. Köhler) [3] COSMO new scheme (by U. Blahak)	**Method for calculating cloud optical properties** [0] Reff from (a), fits from (a) [1] Reff from (b), fits from (c) [2] Reff from (b), fits from (c), with qr,qs,qg [5] Reff from (b), fits from (a) (a) Roeckner et al., 2003 (MPI report 349) (b) Fu, 1996; Fu et al., 1998; Fu, 2007 (c) Muskatel and Blahak (2017)	**Application of large size approximation** (instead of fits) for species larger than 150um [True/False]	**Sub-grid variability factor for liquid and ice water contents** [0.4-0.9]. Tuning parameter	**Scaling factor for sub-grid scale liquid water content** [0.005-0.02]. Tuning parameter

Verified ICON versions

Version	inwp_cldcover	irad_calc_opt	lrad_use_largesizeapprox
REF ic0	1	0	F
ic1	1	1	F
ic2	1	5	F
ic3	1	2	F
ic4	1	2	T
co0	3	0	F
co1	3	1	F
co2	3	5	F
co3	3	2	F
co4	3	2	T

Calibrating parameters of version co4

Version	radqc_fact, radqi_fact	qvsat_fact_sgscl_rad
co4	0.5	0.01
co4_a	0.4	0.01
co4_b	0.9	0.01
co4_c	0.5	0.005
co4_d	0.5	0.02
co4_e	0.9	0.02

Calibration result

co4 OPT vs. ground stations	0.52	0.014
co4 OPT vs. CMSAF satellite	0.79	0.009

How to calibrate?

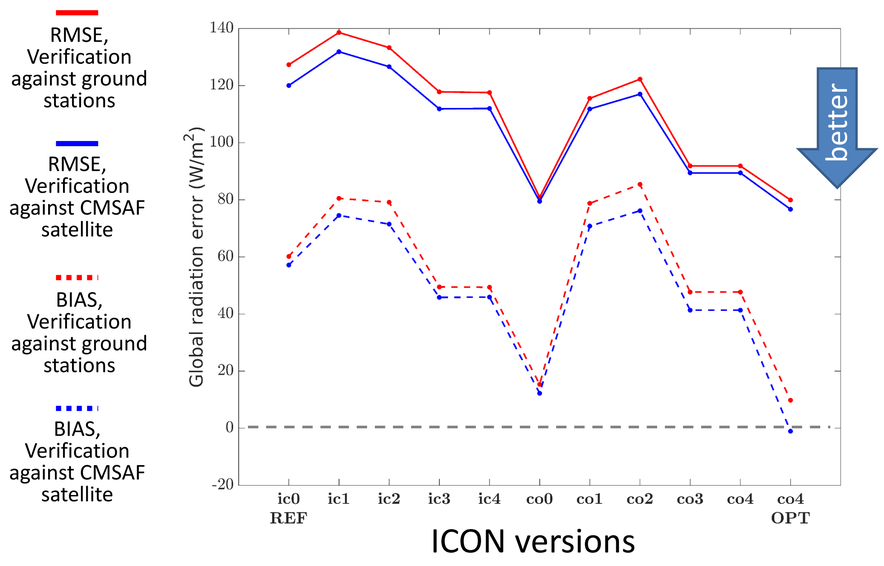
Meta-Model

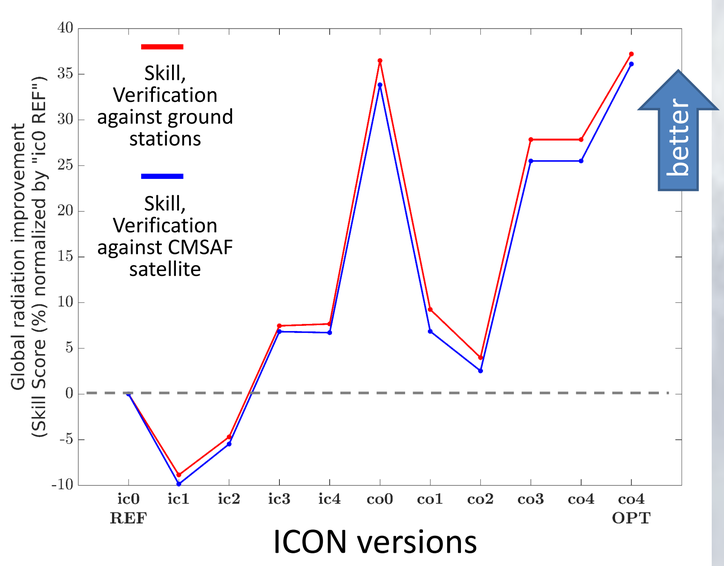
- *For co4 version, 2 continuous parameters were calibrated.*
- *First, several parameters combinations were chosen according to specific design (Voudouri et al. 2017). For each combination, ICON-DE runs were performed.*
- *For every hour at every grid point, the forecast of global radiation is then interpolated in parameters space using 2nd order polynomial.*
- *These interpolations yield a "guess" for the global radiation for any chosen parameters combination (Meta-Model).*

Optimization

- *The parameters space is then sampled by large number of parameter combinations. For each combination the Meta-Model is verified against hourly observations data.*
- *The seek of the optimal parameters combination is performed by convergence algorithm (Khain et al. 2017).*
- *Finally the parameters combination which yields the optimal Meta-Model guess is defined.*

Results





Conclusions

- **ICON-DE global radiation forecasts were verified during 4 month of 2016 over Germany.**
- **The verification included several ICON-DE versions, which differ by cloud-radiation parametrizations.**
- **One of the versions (co4) was optimized via calibration of 2 continuous parameters.**
- **Generally, ICON-DE overestimates the global radiation by 10-80 W/m². The RMSE varies between 80-140 W/m².**
- **COSMO cloudiness scheme shows better skill then ICON's.**
- **ICON-DE "co0" version shows very good results, having no bias on average.**
- **The calibration of 2 continuous parameters improved ICON-DE "co4" version (eliminating positive bias of 40 W/m²).**