

TERRA - Recent developments at DWD

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- Strategic goal: COSMO model with redesigned data structure and improved physics components from ICON
- Main aims:
 - Improvement of COSMO model forecast skills in boundary-forcing from ICON,
 - Reduction of code maintainance for unified physics components
- Development steps:
 - Technical implementation: new interfaces, merge and adaption
 - Numerical experiments: Hindcasts, BACY, NUMEX
 - Verification: web-based app using feedback files from model runs

Physics in COSMO 5.5

Process	Scheme	Model
Radiation	RRTM (later with McICA & McSI)	ICON
	δ two-stream	COSMO
Sub-grid scale orographic drag	blocking, GWD	ICON/COSMO
Microphysics	prognostic: water vapor, cloud water, cloud ice, rain and snow	ICON/COSMO
Convection	mass-flux shallow and deep Tiedtke-Bechtold	ICON
	Tiedke, (Tiedtke-Bechtold)	COSMO
Turbulent transfer	prognostic TKE	ICON/COSMO
Land	tiled TERRA + soil moisture analysis	ICON
	TERRA	COSMO

/TUNING/	OPER_NOW	TEST_OLD	REF_NEW	TEST_NEW	TEST_I300m	Explanation
tkhmin	0.4	0.4	0.75	0.75	0.75	-
tkmmin	0.4	0.4	0.75	0.75	0.75	-
rat_sea	20.0	20.0	7.5	7.5	7.5	-
pat_len	500.0	500.0	750.0	750.0	750.0	-
tur_len	150.0	150.0	500.0	500.0	300.0	-
a_hshr	0.2	0.2	2.0	2.0	2.0	-
c_soil	1.0	1.0	1.75	1.75	1.75	-
wichfakt	0.0	NA	NA	NA	NA	-

- Model sensitivity study using several configurations
- Adaptions needed in
 - COSMO Namelist
 - Int2Im Namelist

/PHYCTL/	OPER_NOW	TEST_OLD	REF_NEW	TEST_NEW	TEST_I300m	Explanation
itype_vdif	-2	-1	1	1	1	-
ltkeshs	.FALSE.	.FALSE.	.TRUE.	.TRUE.	.TRUE.	-
itype_sher	1	1	0	0	0	-
imode_tran	1					
imode_turb	1					
icldm_tran	0					
lconf_avg	.TRL					
itype_albedo	3					
itype_aerosol	1					
itype_root	1					
itype_heatcond	1					
itype_evsl	2					
cwimax_ml	-					
idiag_snowfrac	-					
lemiss	.FAL					
lstomata	.FALSE.	.FALSE.	.FALSE.	.TRUE.	.TRUE.	-
lmulti_layer	.TRUE.	NA	NA	NA	NA	-

/CONTRL/	OPER_NOW, TEST_OLD	REF_NEW	TEST_NEW	Explanation
lbdclim	.TRUE.	.TRUE.	.TRUE.	Use the climate mode because we run for 3 months
lssso	.TRUE.	.TRUE.	.TRUE.	SSO_STDH and SSO_SIGMA are used by new schemes
itype_albedo	3	3	3	-
itype_aerosol	1	2	2	2 activates the Tegen climatology
itype_ndvi	0	0	1	1 activates a yearly cycle for PLCOV and LAI based on an averaged ndvi ratio.
itype_rootdp	0	0	4	4 takes the input from the external data set without modifications. This is done in the COSMO-Model now.
lemiss	.FALSE.	.FALSE.	.TRUE.	take a map from the external parameters for the thermal radiative surface emissivity.
lstomata	.FALSE.	.FALSE.	.TRUE.	take a map from the external parameters for the minimum stomata resistance of plants.

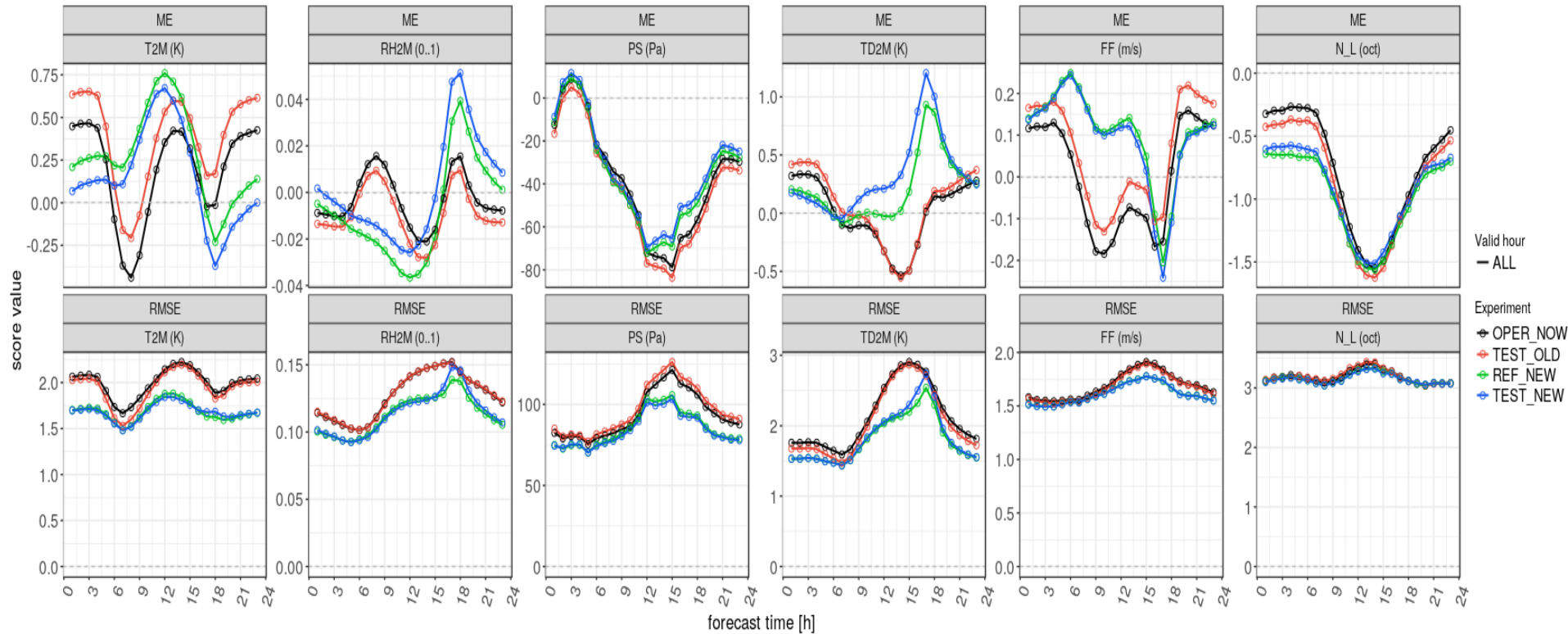
U. Schättler



Hindcasts

- Hindcast period March, April, May 2016
- Sensitivity study for several configurations
- Mean error and RMSE for selected parameters

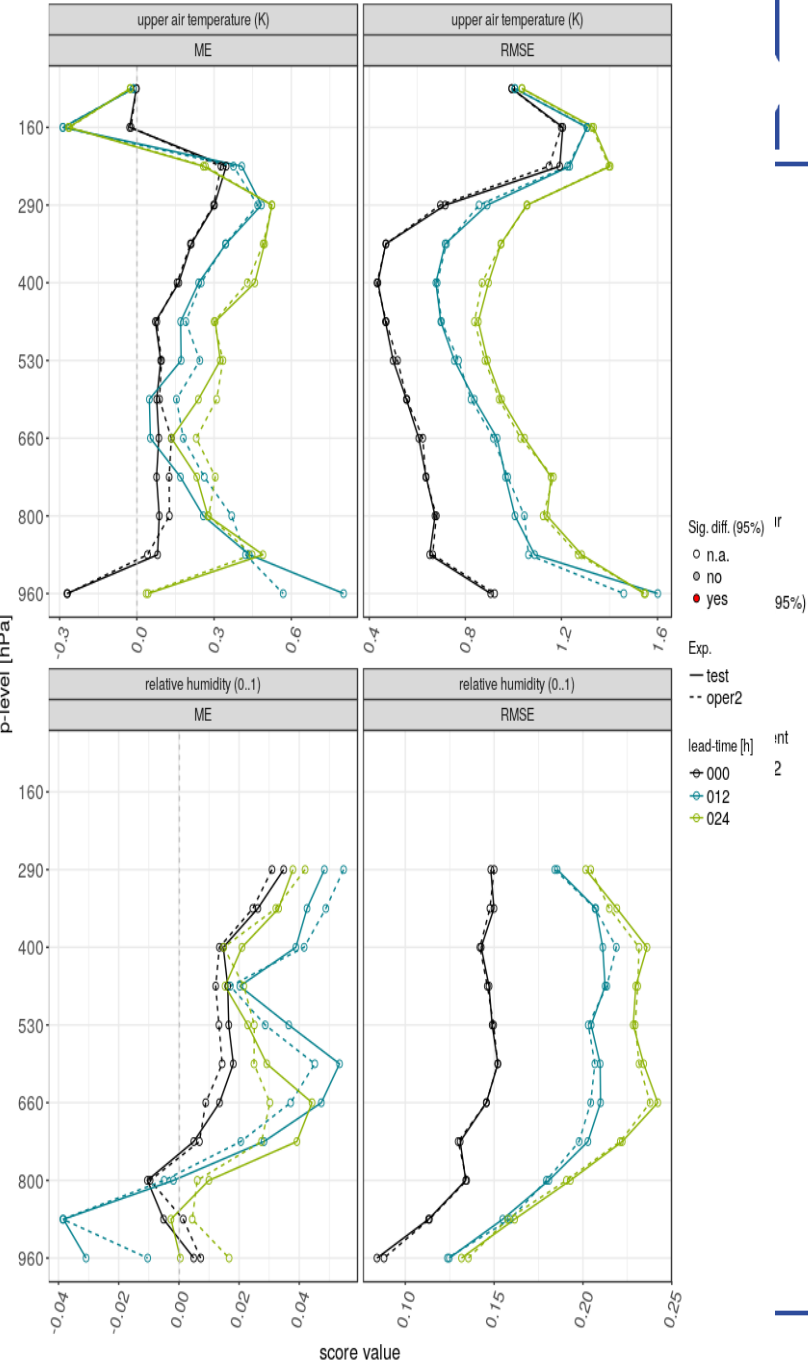
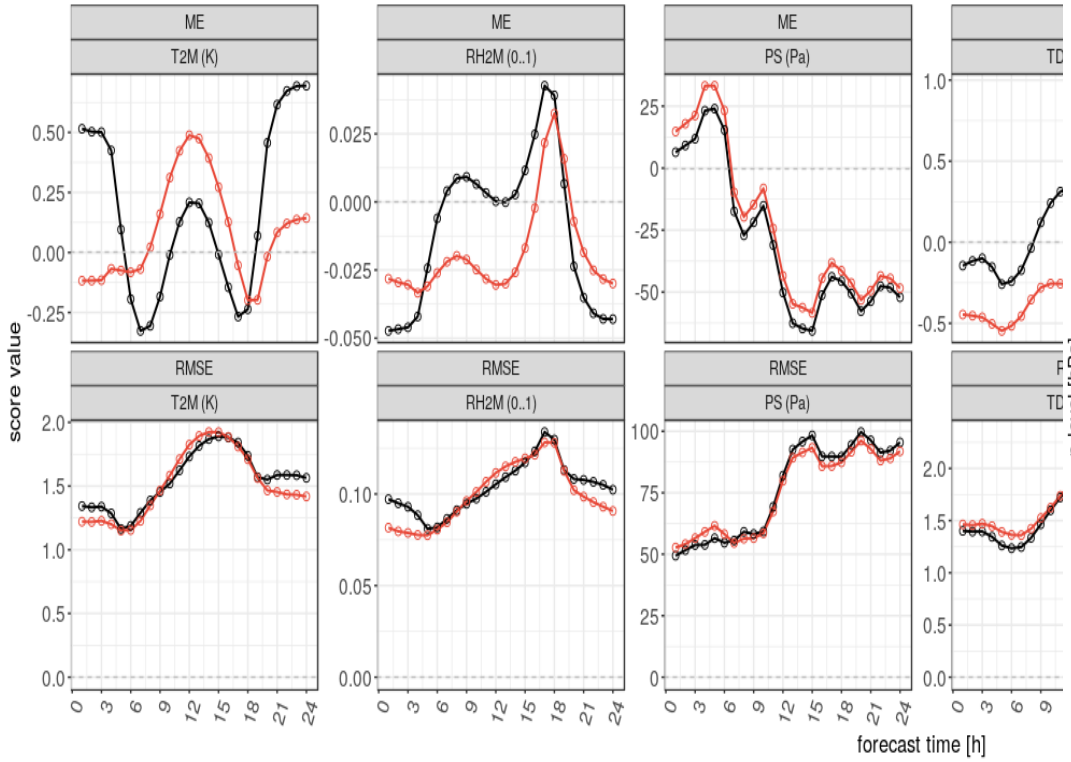
2016/03/01-01UTC - 2016/05/30-09UTC
INI: 00 UTC, DOM: ALL, STAT: ALL



BACY

2016/05/20 - 2016/07/01
 INI: 00 UTC, DOM: ALL

2016/05/20-07UTC - 2016/07/01-00UTC
 INI: 00 UTC, DOM: ALL, STAT: ALL

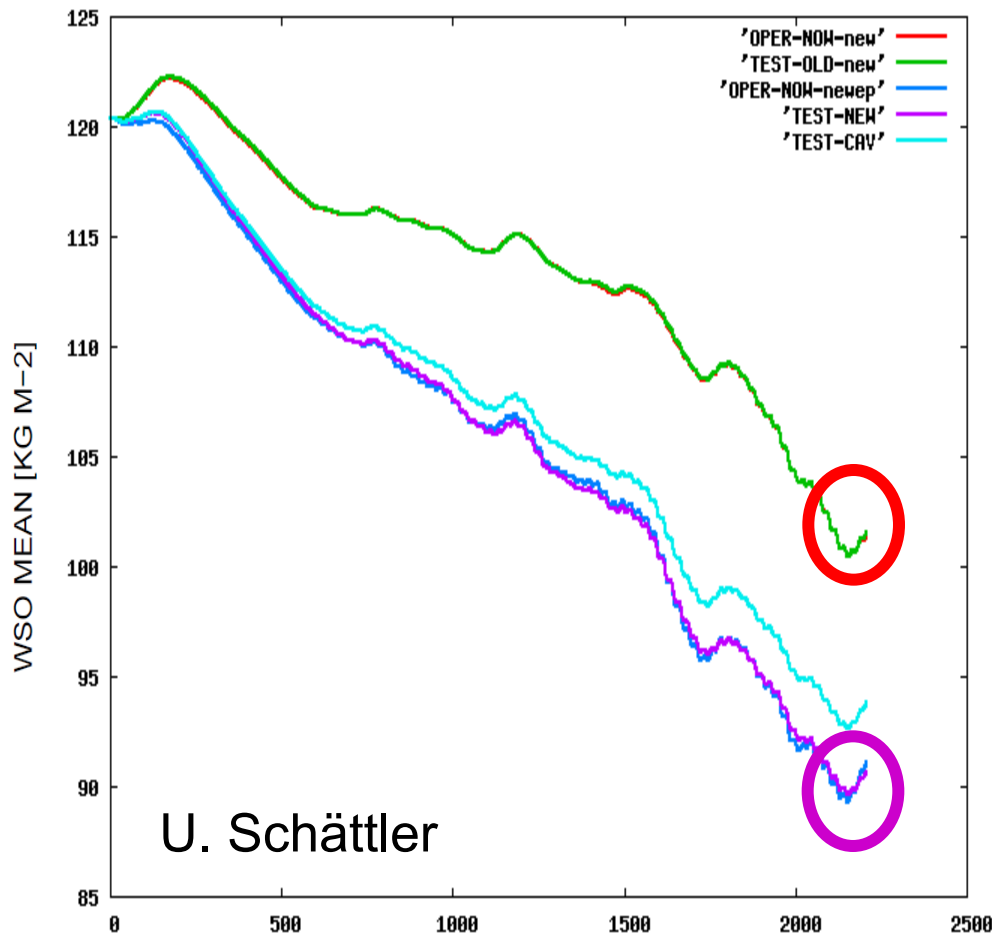


Sig. diff. (95%)
 ○ n.a.
 ● no
 ● yes

Exp.
 — test
 - - oper2

lead-time [h]
 ● 000
 ● 012
 ● 024

DOMAIN AVERAGED SOIL MOISTURE 27-81 cm



1. OPER-NOW: wet soil

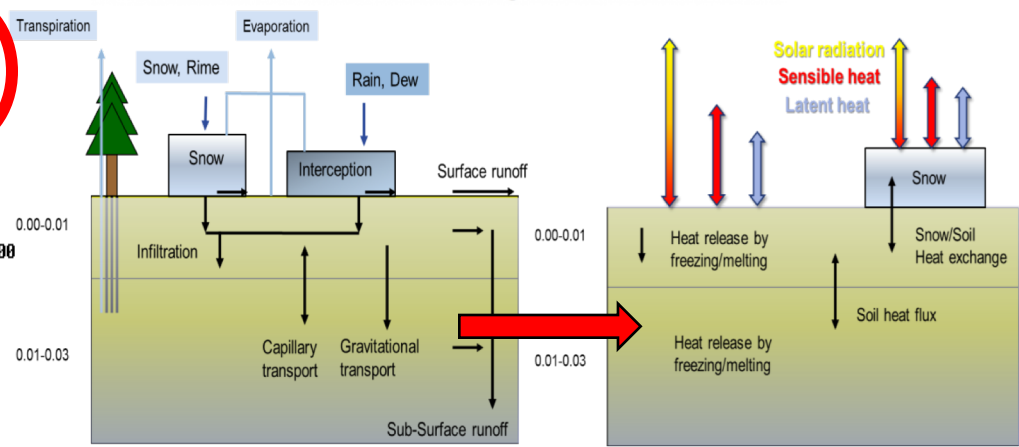
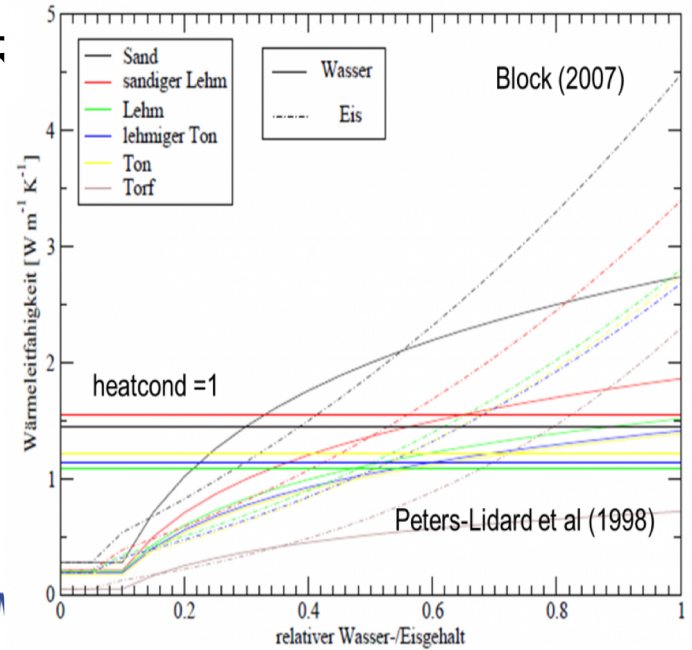
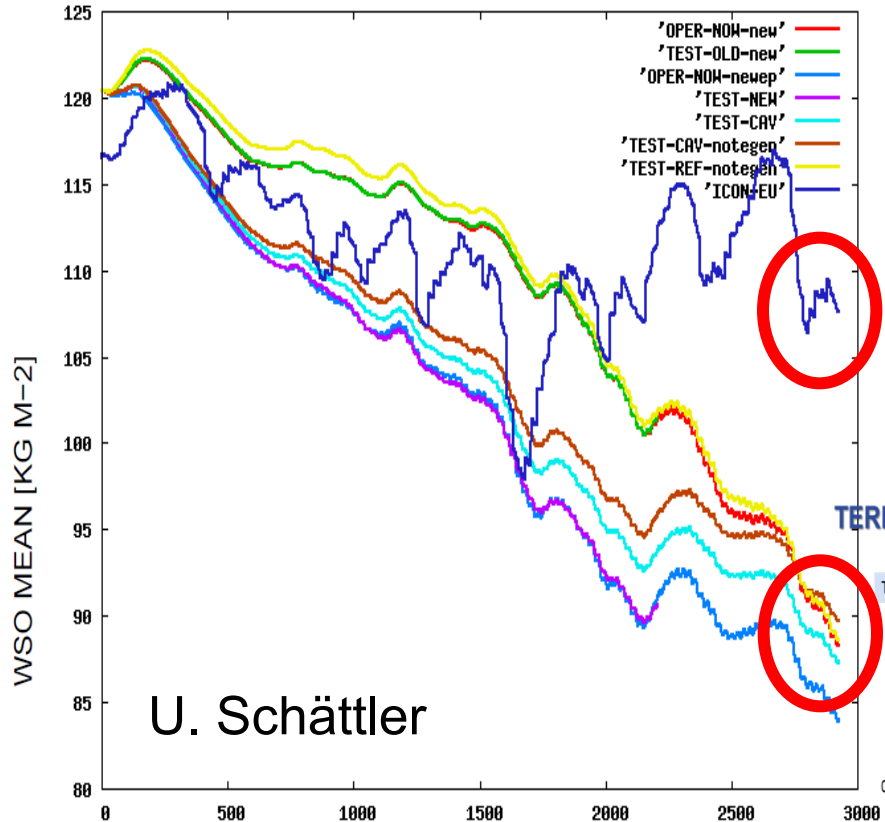
- COSMO 5.4 with operational configuration

2. TEST-NEW: dry soil

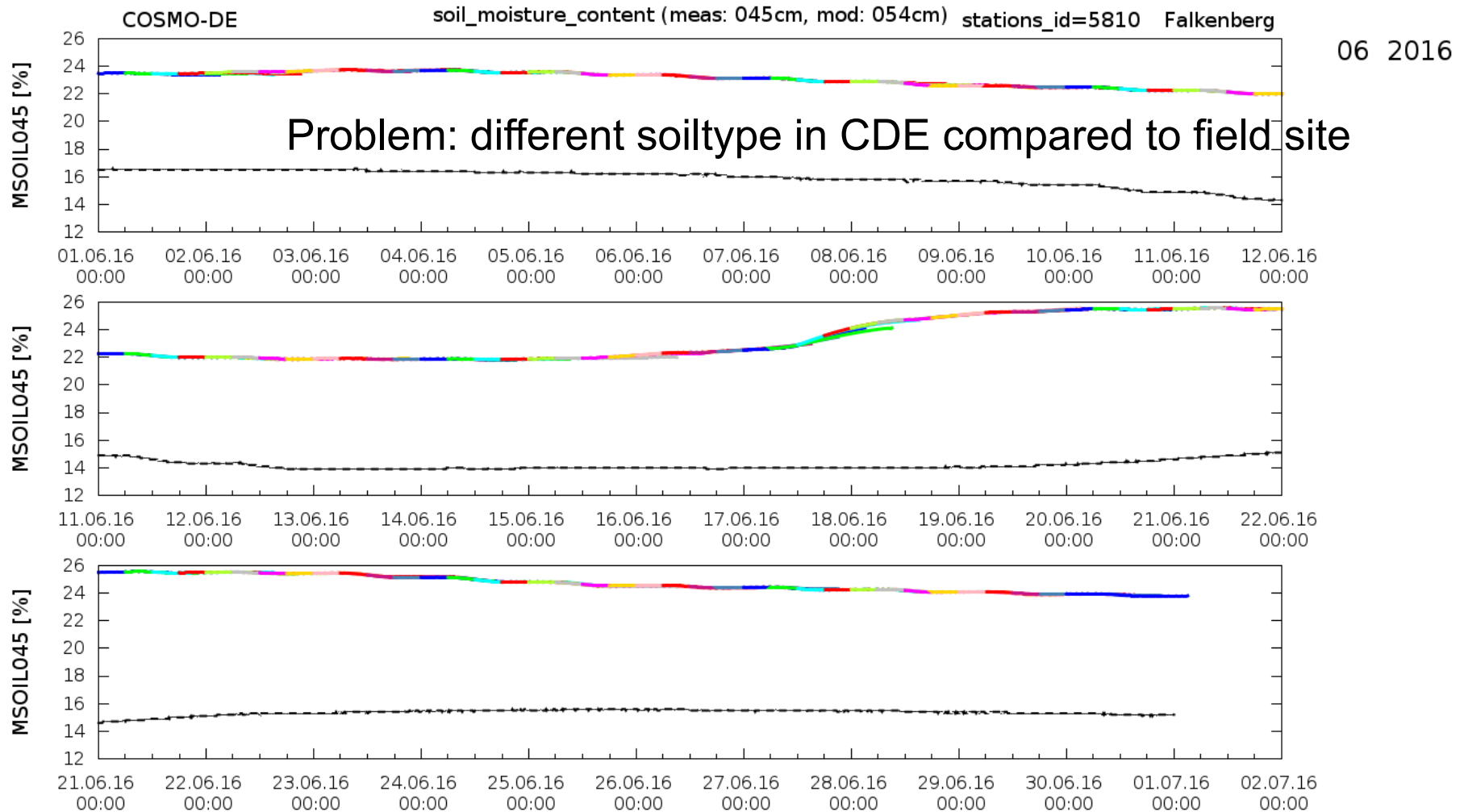
- COSMO pre5.5 with ICON setup

Processes

DOMAIN AVERAGED SOIL MOISTUF



Model validation: W_SO in CDE

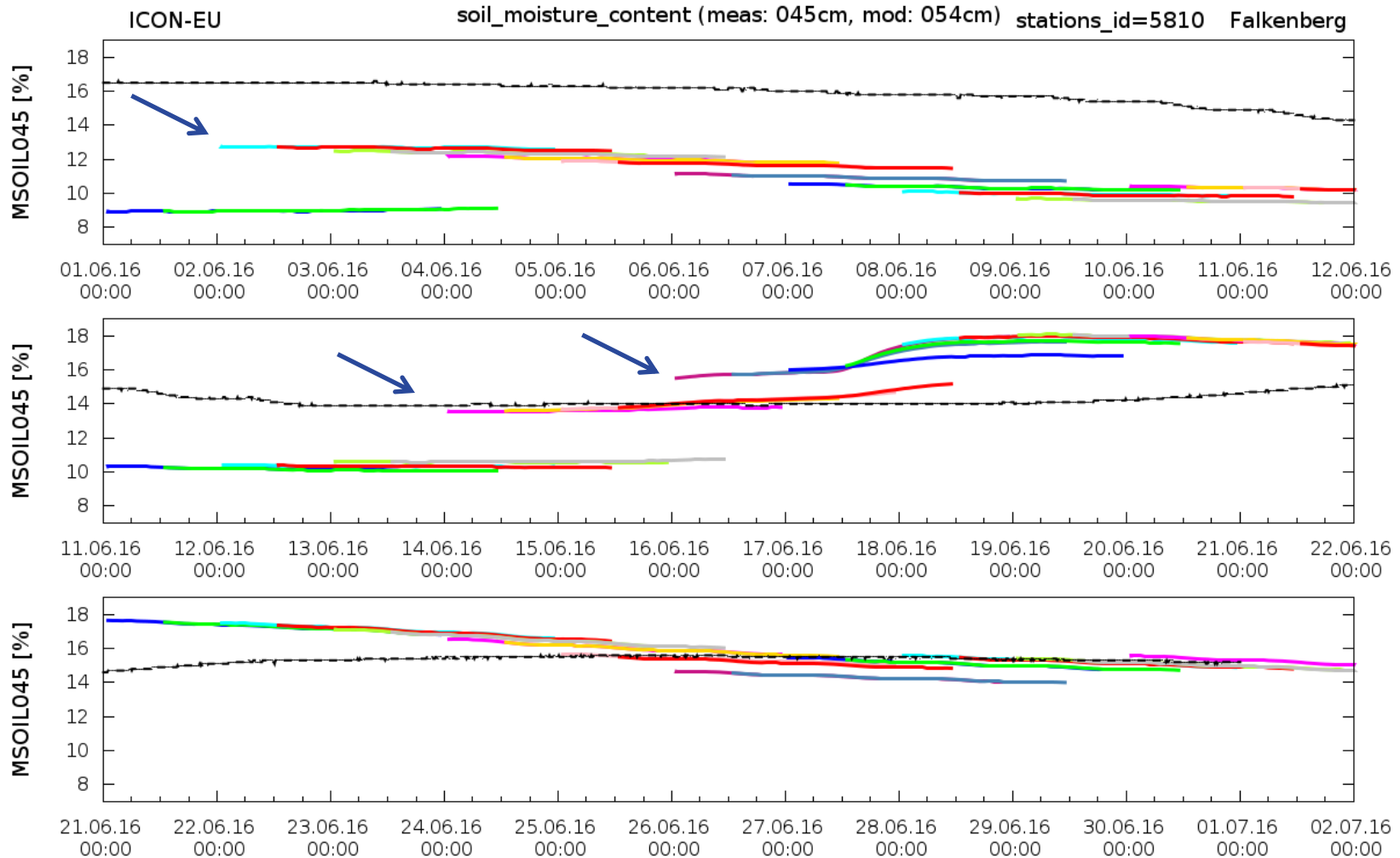


C.Becker DWD
Fr 15. Jul 03:04:55 UTC 2016

Model validation by C. Becker, Lindenberg

Model validation: W_SO in IEU

06 2016



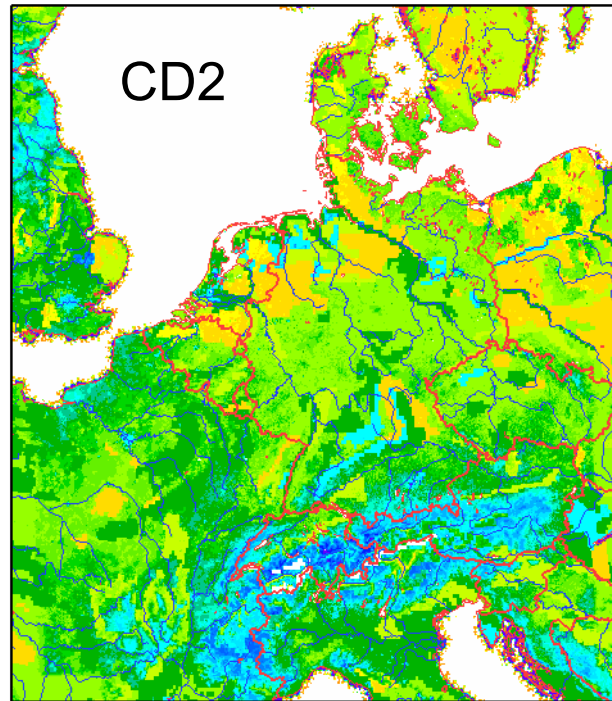
C.Becker DWD
Fr 15. Jul 03:06:09 UTC 2016

Model validation by C. Becker, Lindenberg



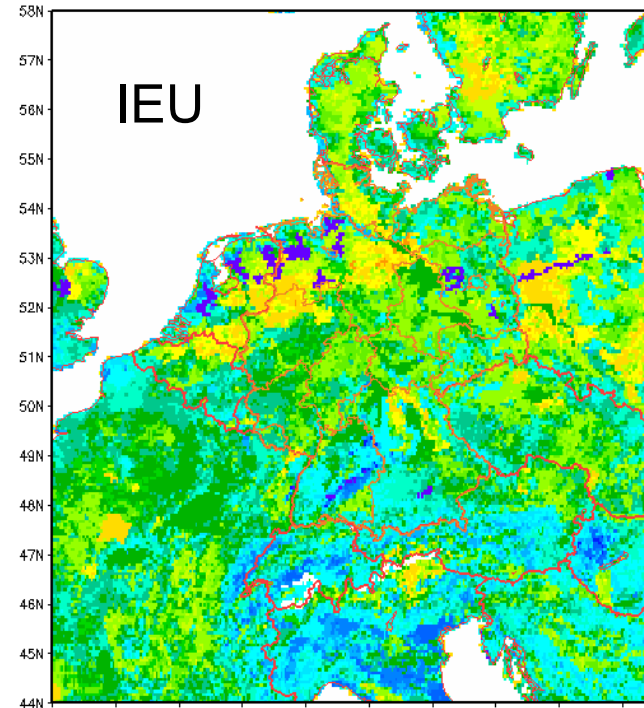
Model validation: W_SO in CD2

Start time: 23.08.2018 00:00 UTC COSMO-D2_Routine
Forecast time: 23.08.2018 00:00 UTC
soil moisture in lev=4 (27.0-81.0cm) [kg/m³]



W_SO(L4)(C-DB): Mean: 120.563 Min: 0 Max: 801.201 Sigma: 91.6153
W_SO(L4): Mean: 119.793 Min: 0 Max: 811.979 Sigma: 101.676

Start time: 23.08.2018 00:00 UTC ICON-EU Routine
Forecast time: 23.08.2018 00:00 UTC
soil moisture in lev=4 (27.0-81.0cm) [kg/m³]

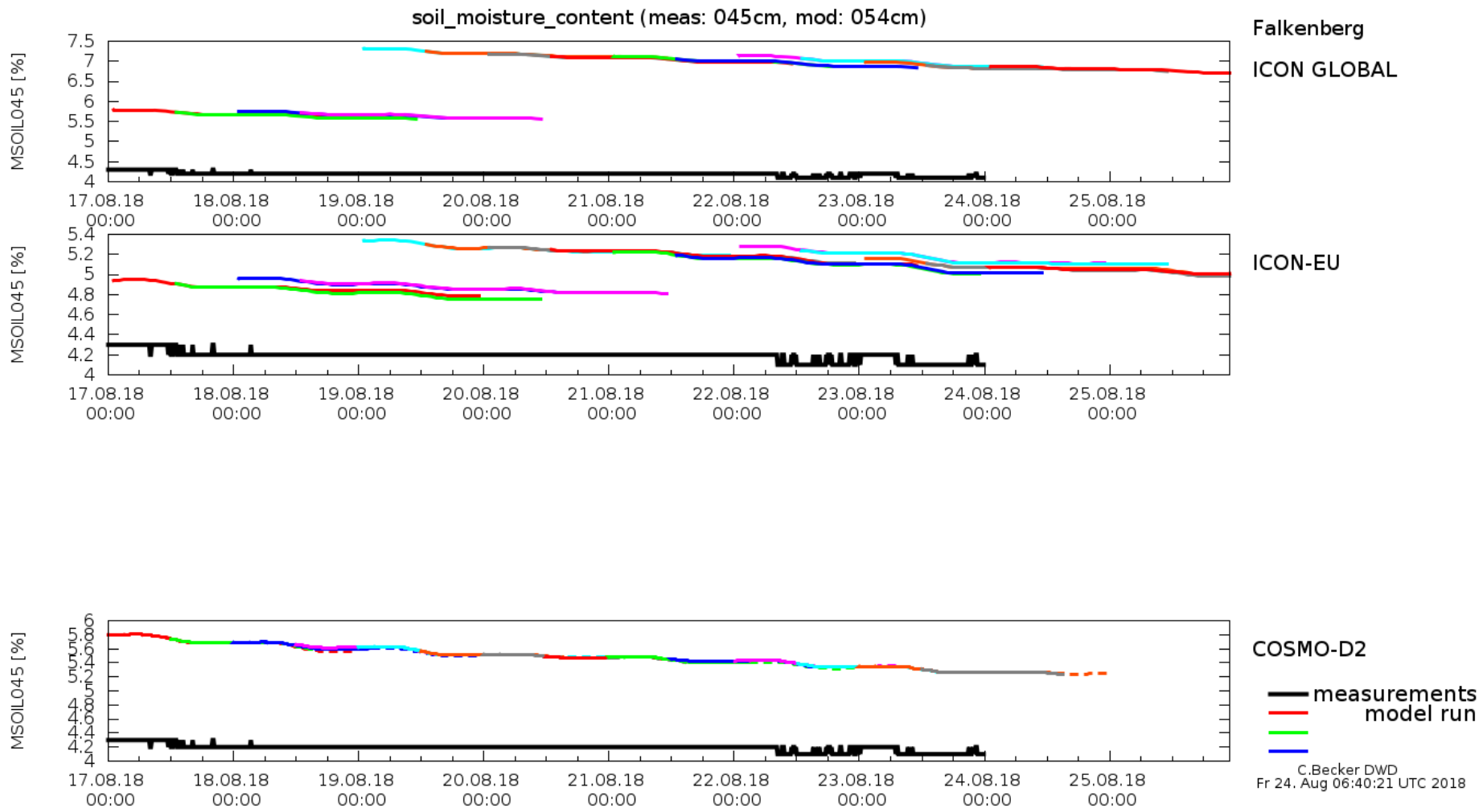


W_SO(L4): Mean: 141.162 Min: 0 Max: 686.053 Sigma: 107.647

Comparison of W_SO, August, 23, 2018 for 27-81cm.

Plots: M. Baldauf

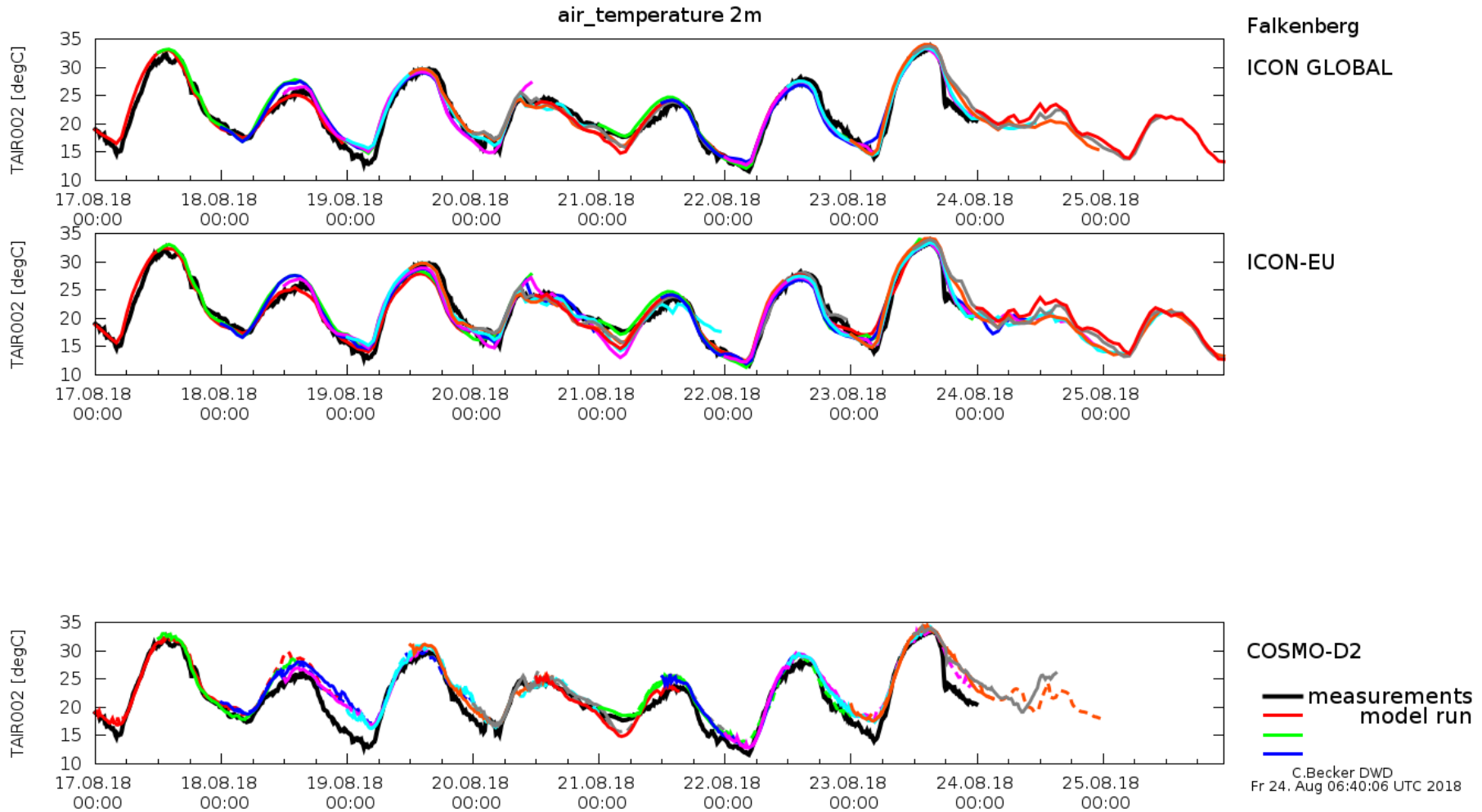
Model validation: RAO field site



Model validation by C. Becker, Lindenber

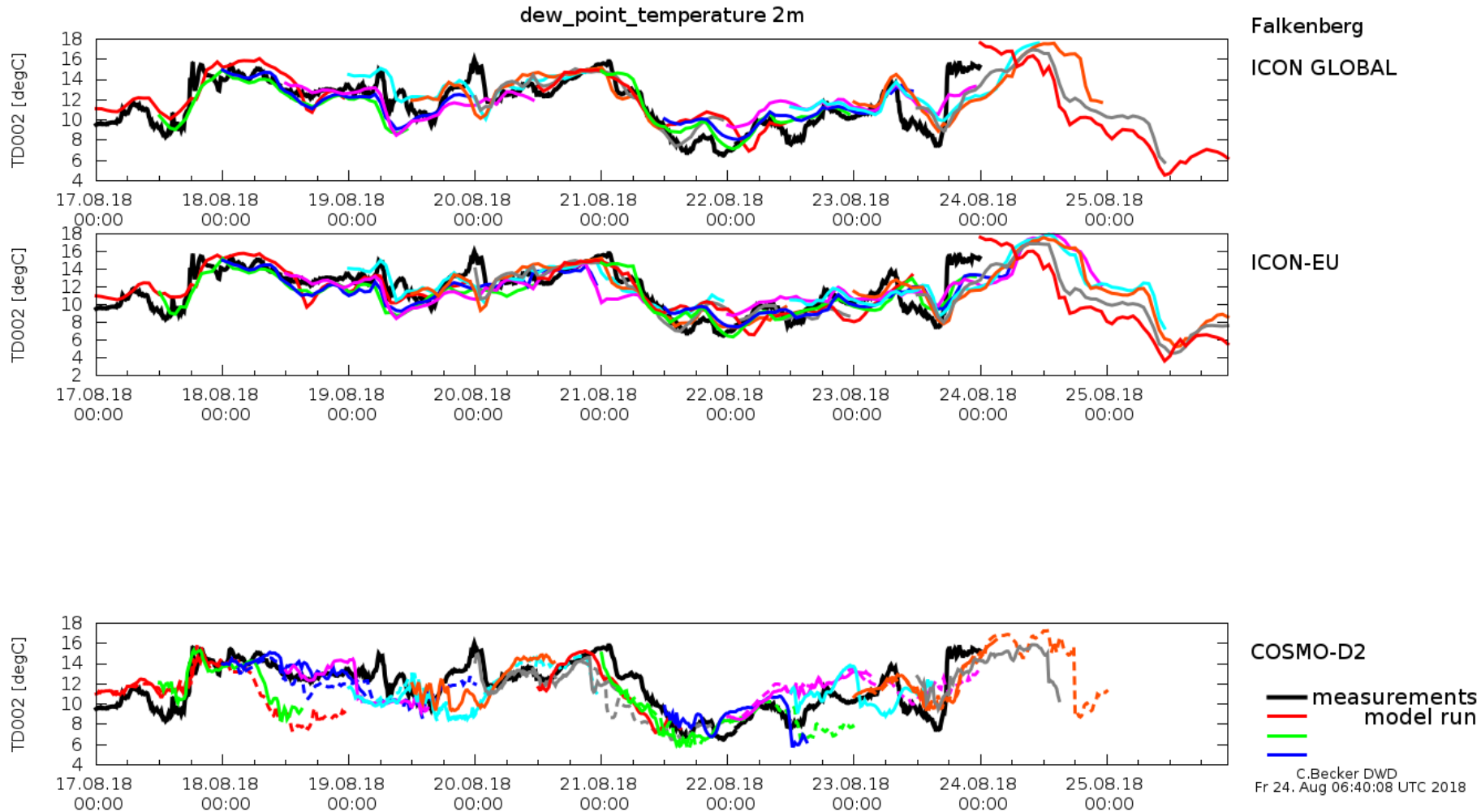


Model validation: RAO field site



Model validation by C. Becker, Lindenberg

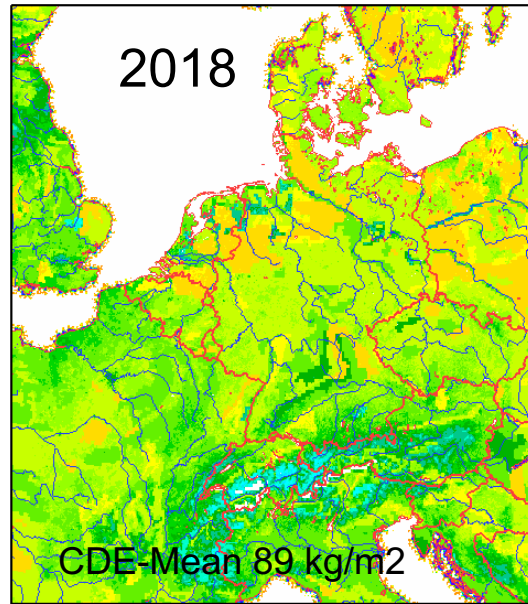
Model validation: RAO field site



Model validation by C. Becker, Lindenber

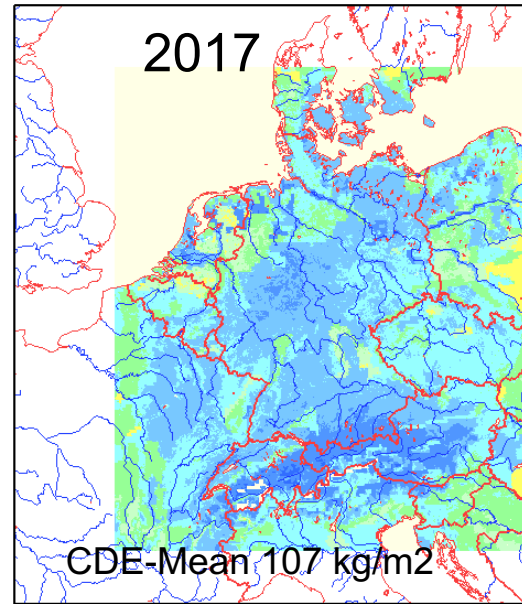
Model validation: W_SO

Start time: 23.08.2018 00:00 UTC
Forecast time: 23.08.2018 00:00 UTC
soil moisture in z=9-81cm [kg/m³]
COSMO-D2_Routine



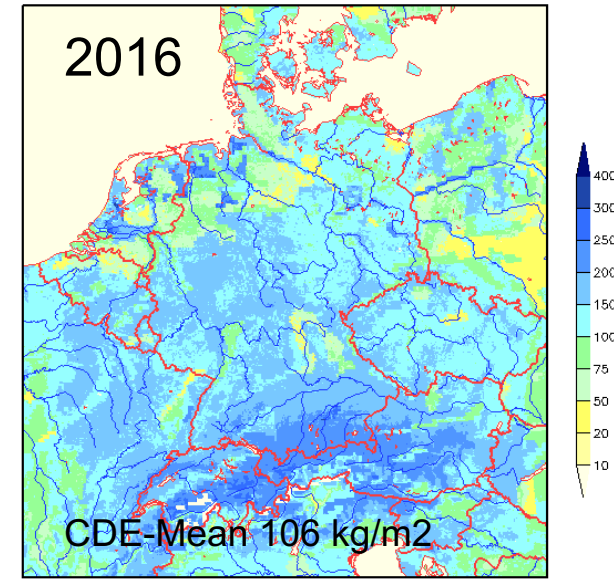
W_SO(L4-5)(C-Mean): 89.449 Min: 0 Max: 572.105 Sigma: 69.9642
W_SO(L4-5): Mean: 88.672 Min: 0 Max: 579.824 Sigma: 73.2751

Start time: 23.08.2017 00:00 UTC
Forecast time: 23.08.2017 00:00 UTC
soil moisture in z=9-81cm [kg/m³]
COSMO-DE_Routine



W_SO(L4-5): Mean: 107.447 Min: 0 Max: 370.379 Sigma: 70.3703

Start time: 23.08.2016 00:00 UTC
Forecast time: 23.08.2016 00:00 UTC
soil moisture in z=9-81cm [kg/m³]
COSMO-DE_Routine



W_SO(L4-5): Mean: 106.359 Min: 0 Max: 388.195 Sigma: 69.7539

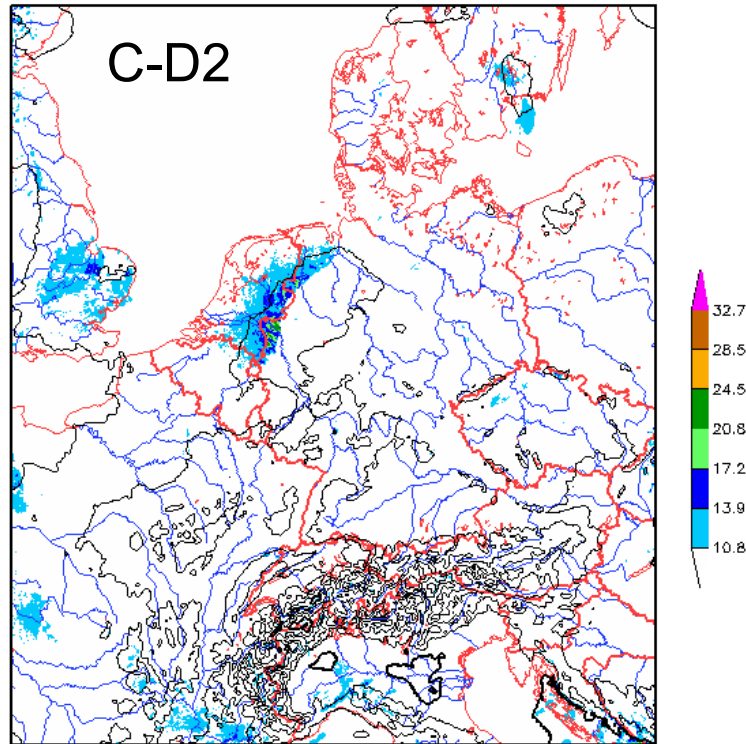
Comparison of W_SO, August, 23 for 9-81cm
Dry soil in CDE domain in Summer 2018

Plots: M. Baldauf



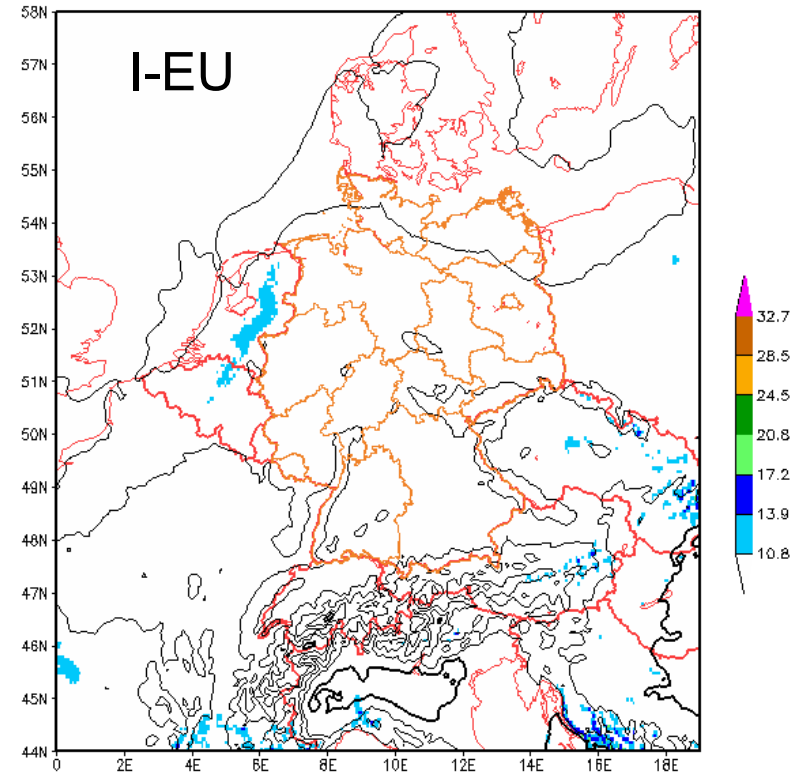
Differences in Gusts for C-D2 and I-EU

Start time: 24.07.2018 06:00 UTC COSMO-D2_Routine
 Forecast time: 24.07.2018 18:00 UTC
 max |v| in 10 m [m/s] (shaded) MSL Pressure [hPa] (dist. isol. 2.0 hPa)



vmax_10m(C-D2):	Mean: 5.09558	Min: 0.251963	Max: 24.9502	Sigma: 2.33541
vmax_10m:	Mean: 5.44532	Min: 0.251963	Max: 24.9502	Sigma: 2.56966
PMSL:	Mean: 1012.82	Min: 1007.87	Max: 1021.84	Sigma: 1.26525

Start time: 24.07.2018 06:00 UTC ICON-EU Routine
 Forecast time: 24.07.2018 18:00 UTC
 max |v| in 10 m [m/s] (shaded) MSL Pressure [hPa] (dist. isol. 2.0 hPa)



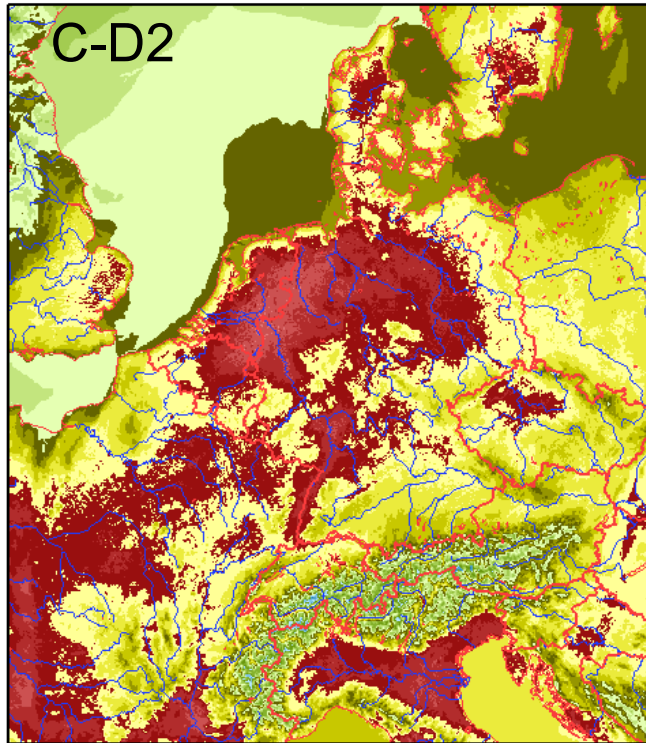
vmax_10m:	Mean: 5.01391	Min: 0.372389	Max: 20.1595	Sigma: 2.21722
PMSL:	Mean: 1013.07	Min: 1009.1	Max: 1020.72	Sigma: 1.32431

M. Baldauf



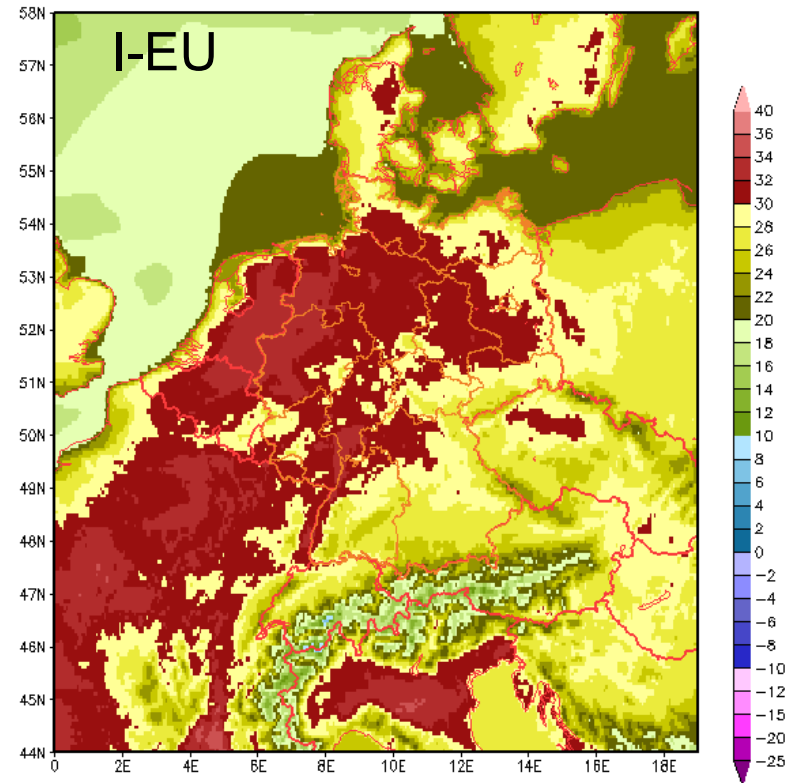
One reason: T2m difference

Start time: 24.07.2018 06:00 UTC COSMO-D2_Routine
Forecast time: 24.07.2018 14:00 UTC
temperature in 2m [°C]



T_{2m}(C-DE): Mean: 26.3527 Min: -0.159674 Max: 37.0005 Sigma: 4.89097
T_{2m}: Mean: 25.7198 Min: -0.159674 Max: 37.0005 Sigma: 5.0178

Start time: 24.07.2018 06:00 UTC ICON-EU Routine
Forecast time: 24.07.2018 14:00 UTC
temperature in 2m [°C]



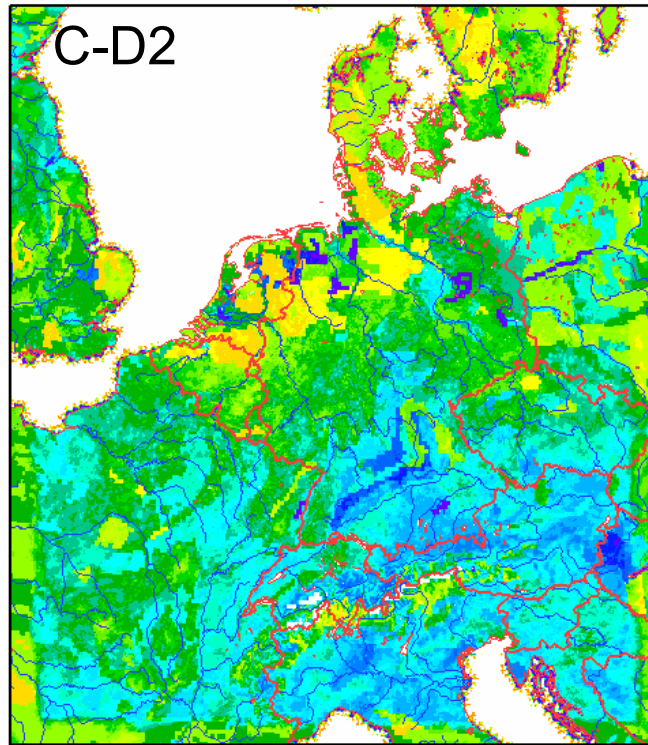
T_{2m}: Mean: 25.8699 Min: 6.33065 Max: 35.0982 Sigma: 4.8858

T_{2m}: in C-D2 ca. 2K higher than ICON-EU

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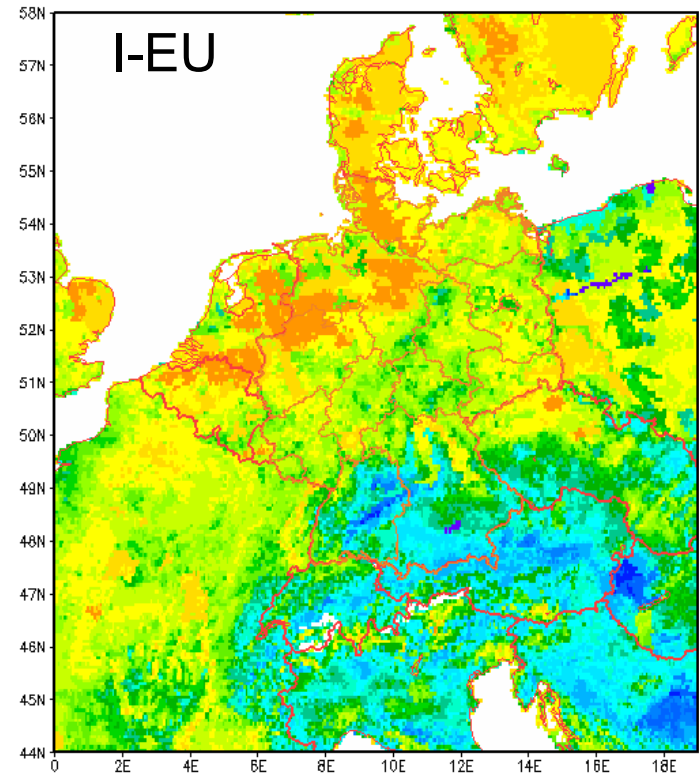
Soli moisture: top soil dry in I-EU

Start time: 24.07.2018 06:00 UTC COSMO-D2_Routine
 Forecast time: 24.07.2018 06:00 UTC
 soil moisture in lev=8 (0.0-1.0cm) [kg/m³]



W_SO(L8)(C-D2): Mean: 164.337 Min: 0 Max: 737.72 Sigma: 111.732
 W_SO(L8): Mean: 153.024 Min: 0 Max: 778.003 Sigma: 116.578

Start time: 24.07.2018 06:00 UTC ICON-EU Routine
 Forecast time: 24.07.2018 06:00 UTC
 soil moisture in lev=8 (0.0-1.0cm) [kg/m³]



W_SO(L8): Mean: 100.551 Min: 0 Max: 650.122 Sigma: 94.4921

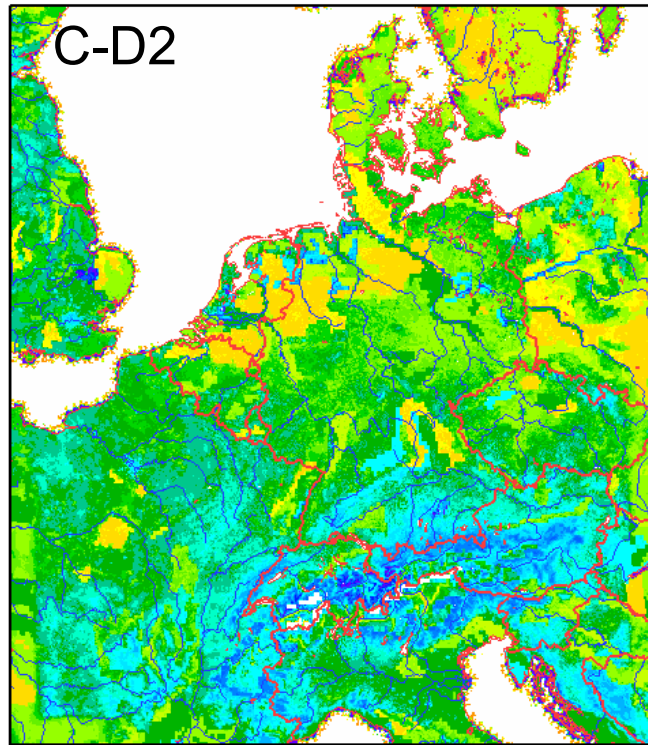
C-D2 in first 3 layers (0-9cm) not so dry as I-EU!

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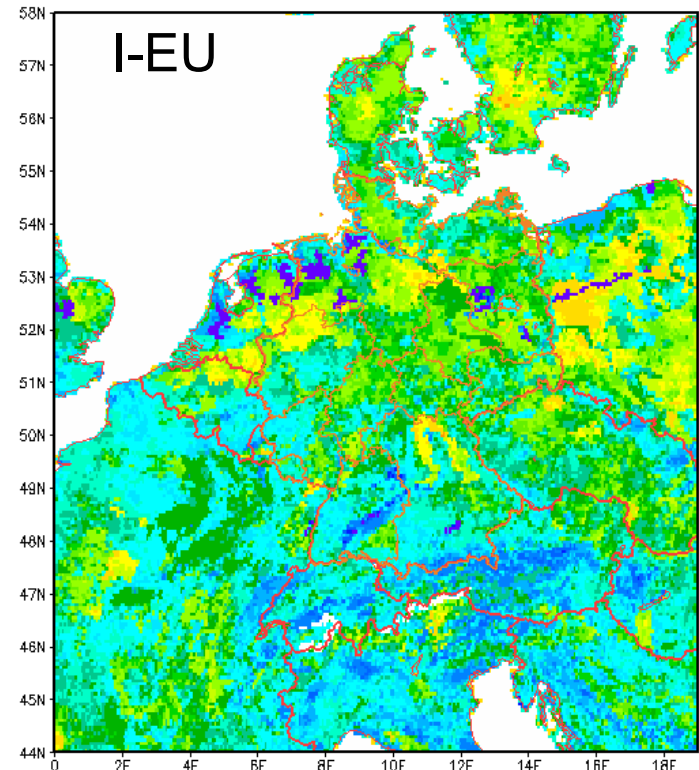
Root zone soil moisture dry in C-D2

Start time: 24.07.2018 06:00 UTC COSMO-D2_Routine
 Forecast time: 24.07.2018 06:00 UTC
 soil moisture in lev=4 (27.0-81.0cm) [kg/m³]



W_SO(L4)(C-D2): Mean: 140.188 Min: 0 Max: 801.201 Sigma: 100.931
 W_SO(L4): Mean: 136.326 Min: 0 Max: 811.979 Sigma: 109.122

Start time: 24.07.2018 06:00 UTC ICON-EU Routine
 Forecast time: 24.07.2018 06:00 UTC
 soil moisture in lev=4 (27.0-81.0cm) [kg/m³]



W_SO(L4): Mean: 154.349 Min: 0 Max: 667.014 Sigma: 113.832

Root zone level 5 (27-81cm) in CD2 dryer than in I-EU

M. Baldauf

- TERRA: *unified* COSMO / ICON version: running in C-D2 (COSMO configuration) [**better COSMO scores**]
- Work on *canopy* features in TERRA (M. Raschendorfer, J.-P. Schulz, J. Helmert) [**work in progress**]
- Improved *snow evaporation* in forests (G. Zängl) [**in ICON**]
- Revised diurnal cycle of plant *evapotranspiration* (G. Zängl) [**in ICON**]
- Bug fix in *soil water budget* (L.Schlemmer, J. Helmert, G. Zängl)[**done**]
- **EXTPAR**: Merging with ETH, MPI (K. Osterried, L. Kornblueh, J. Helmert) [**work in progress**]
 - code evaluation (MPI option), Python
 - TestSuite,
 - new DEM (DLR, Airbus) (M. Köhler)
- COSMO soil issues: impact on gusts in C-D2 (M. Baldauf)

Summary

- Work on **snow [almost finished]** and **vegetation [ongoing]** in TERRA
- Unified **EXTPAR as community project**
- Problem: Missing soil-moisture analysis in COSMO:
 - Dry root-zone soil moisture in C-D2 leads to less evapotranspiration compared to I-EU
 - Overestimation of T-2M (against verification) and sensible heat flux
 - Impact on land-sea interaction and development of gusts
- Outlook:
 - New meeting of AG TERRA in DWD (Q4/2018)
 - Revision of ICON developments for COSMO
 - Roadmap of new developments
 - I-EU soil-moisture relaxation for I-D2