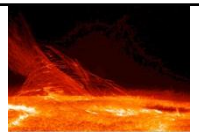
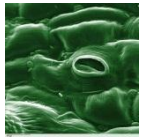
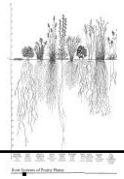
New external parameters, model layers and model physics adaptions in the COSMO model

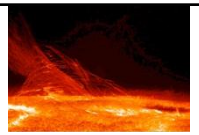
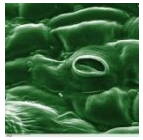
J. Helmert
for the COSMO-COLOBOC Team
and the
COSMO-DE-L65 Team
with contributions from the
AG Evaluierung, VBZ-Sofortberichte, K. Stephan, FE15 Verification

Model configuration - ROUTI

parameter / model	COSMO	GME
aerosol 	fixed	climatology
emissivity 	const.	field
vegetation cycle 	empirical function	NDVI climatology
minimum stomatal resistance 	const.	field
vegetation albedo 	const.	const
root profile 	uniform	exponential
reduced minimum turbulent diffusion tkhmin, tkmmin (m**2/s)	1., 1.	0.4, 1.

source of pictures: wikipedia

Model configuration - ROUTI

parameter / model	COSMO	GME
aerosol 	climatology	climatology
emissivity 	field	field
vegetation cycle 	NDVI climatology	NDVI climatology
minimum stomatal resistance 	field	field
vegetation albedo 	field	const
root profile 	exponential	exponential
reduced minimum turbulent diffusion tkhmin, tkmmin (m**2/s)	0.1, 0.1	0.4, 1.

source of pictures: wikipedia

History

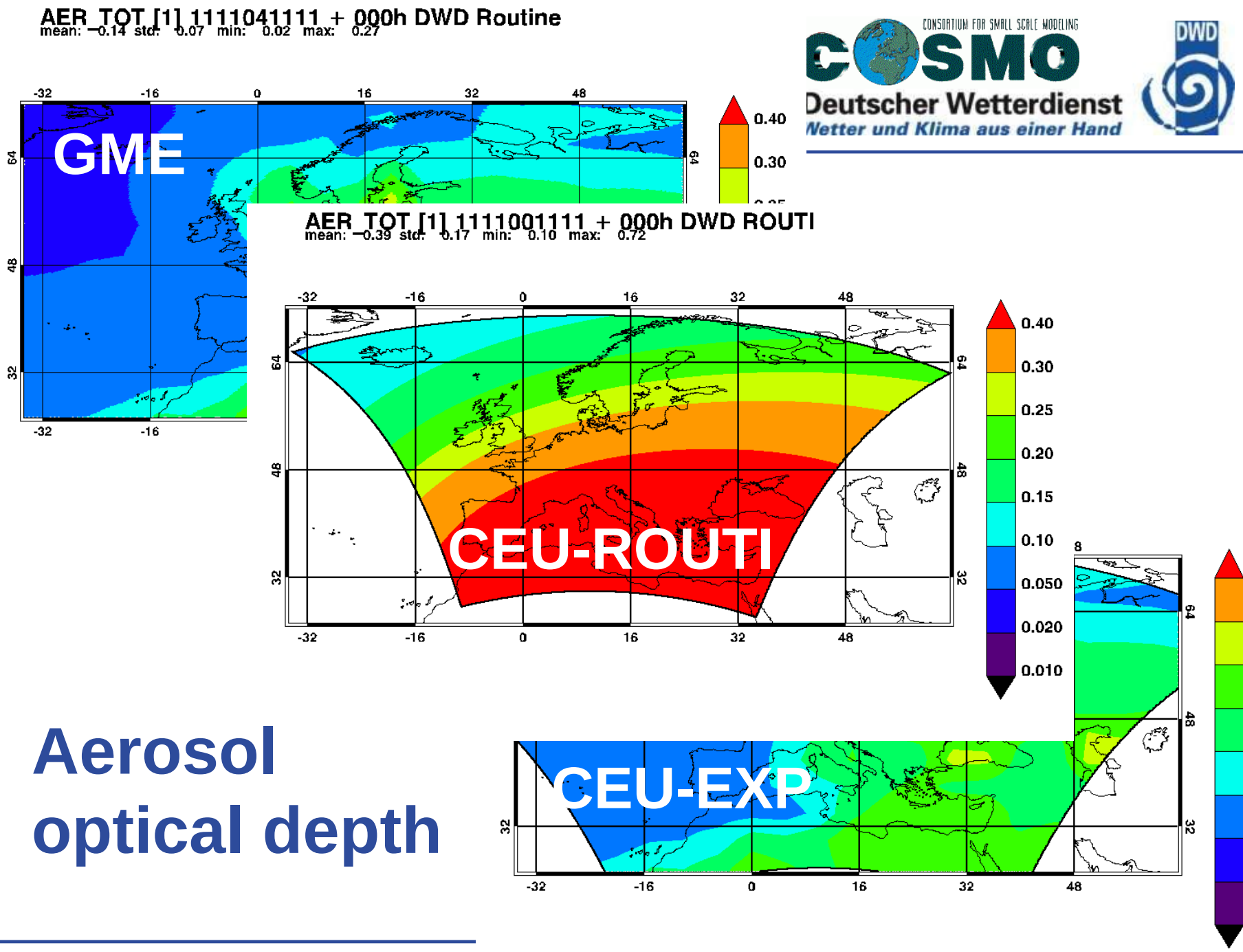
- Operational implementation in GME
  2007 vegetation climatology, 2009 aerosol climatology

- With the advent of the new EXTPAR numerical experiments within the COSMO COLOBOC project

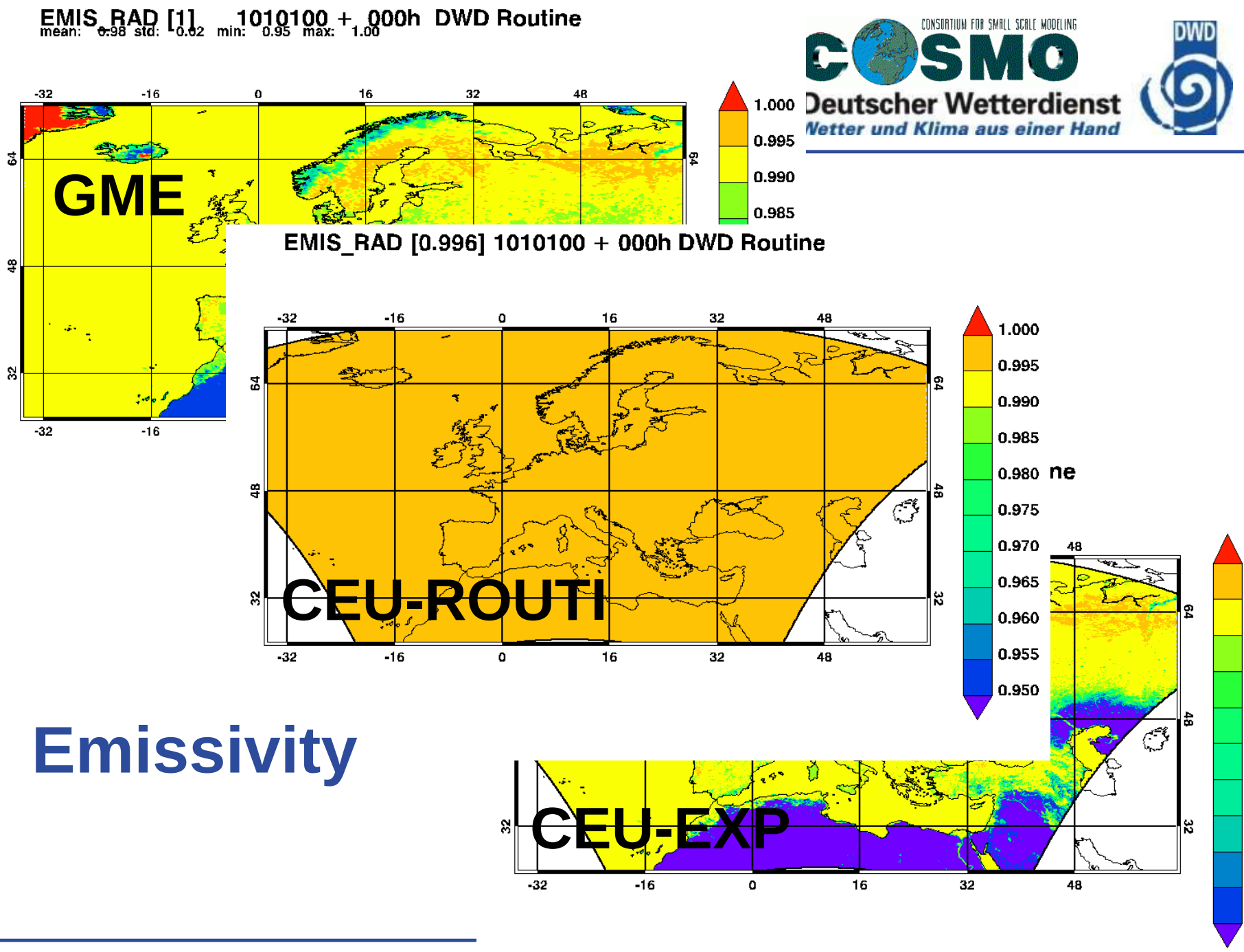
- Experiments in parallel-suite of COSMO-EU 29.03.-21.08.2012
  Reduced minimum diffusion coeff. since 19.06.2012
- Experiments in parallel-suite of COSMO-DE 23.04.-21.08.2012
  Reduced minimum diffusion coeff. since 19.06.2012

- Experiments in configuration of COSMO-DE L65 28.06.2012-

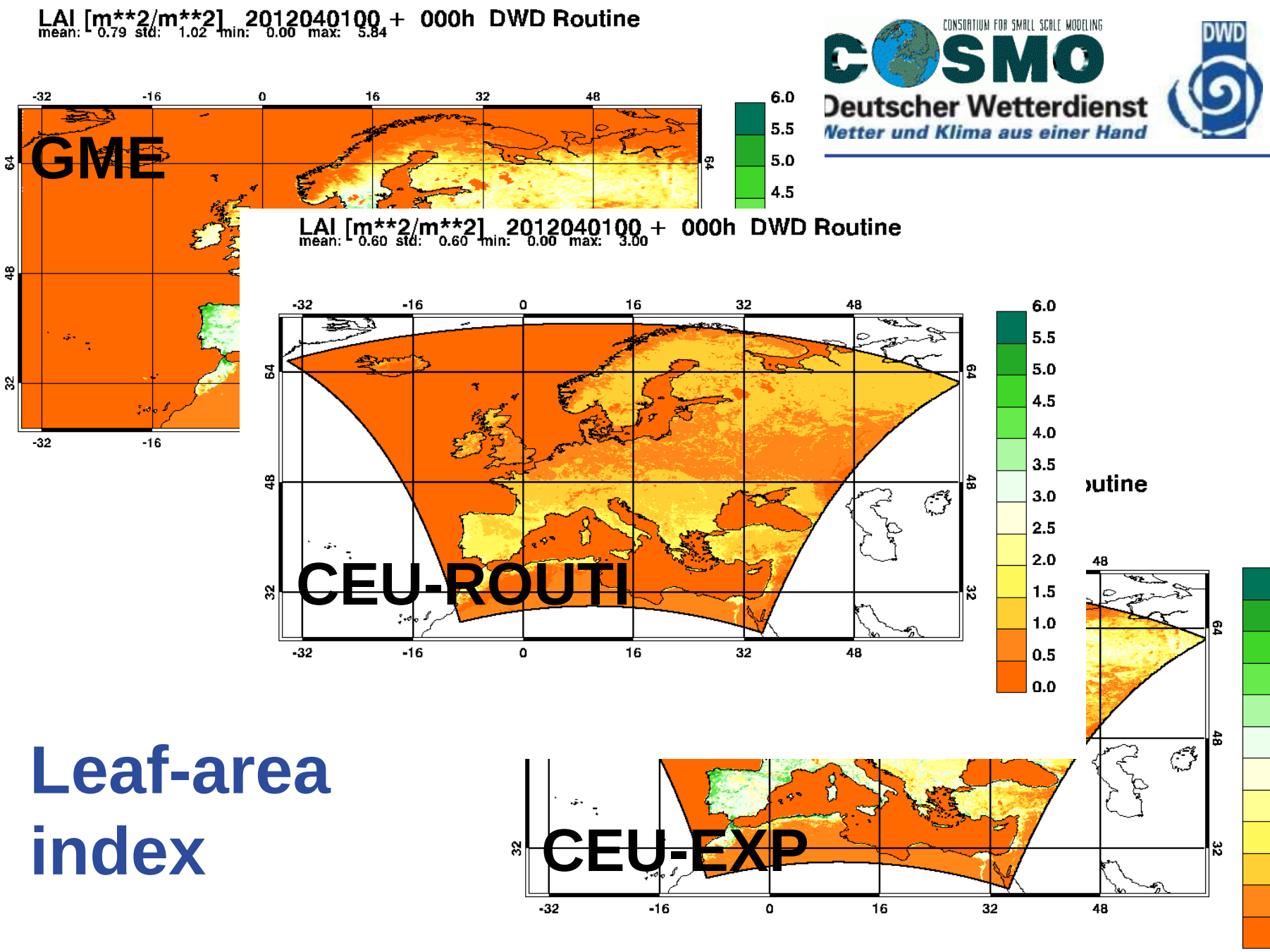
+ changed cloud cover of ice clouds



Aerosol optical depth

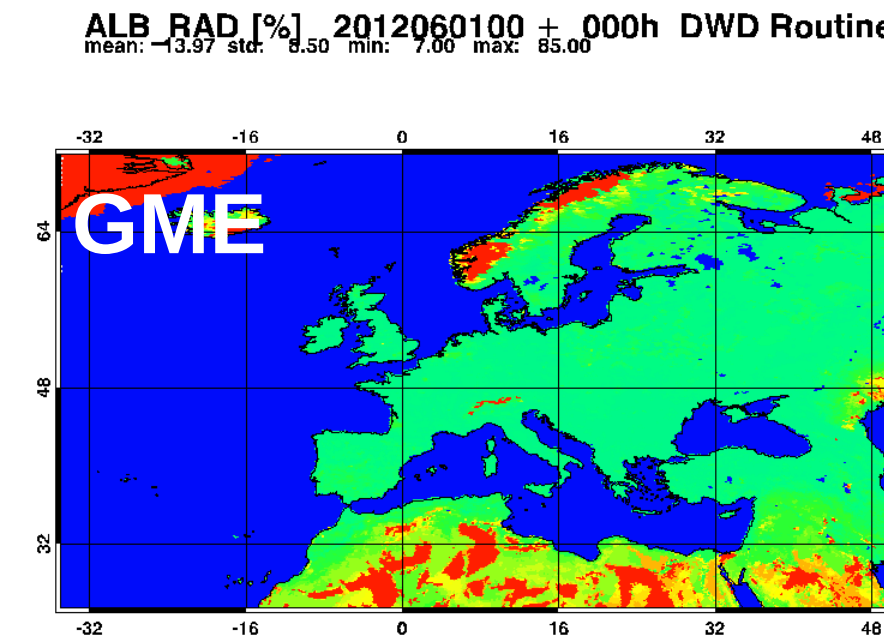

EMIS_RAD [1] 1010100 + 000h DWD Routine
mean: 0.98 std: 0.02 min: 0.95 max: 1.00
GME
1.000
0.995
0.990
0.985
EMIS_RAD [0.996] 1010100 + 000h DWD Routine
CEU-ROUTI
CEU-EXP
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950

Emissivity



CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

Leaf-area index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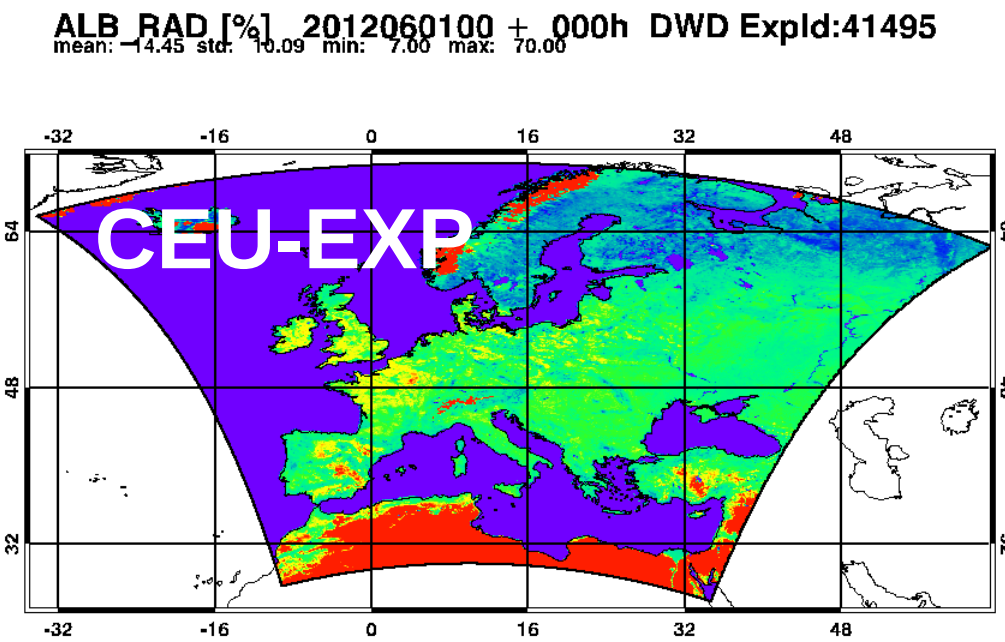
GME
-32 -16 0 16 32 48
64 48 32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CEU-EXP
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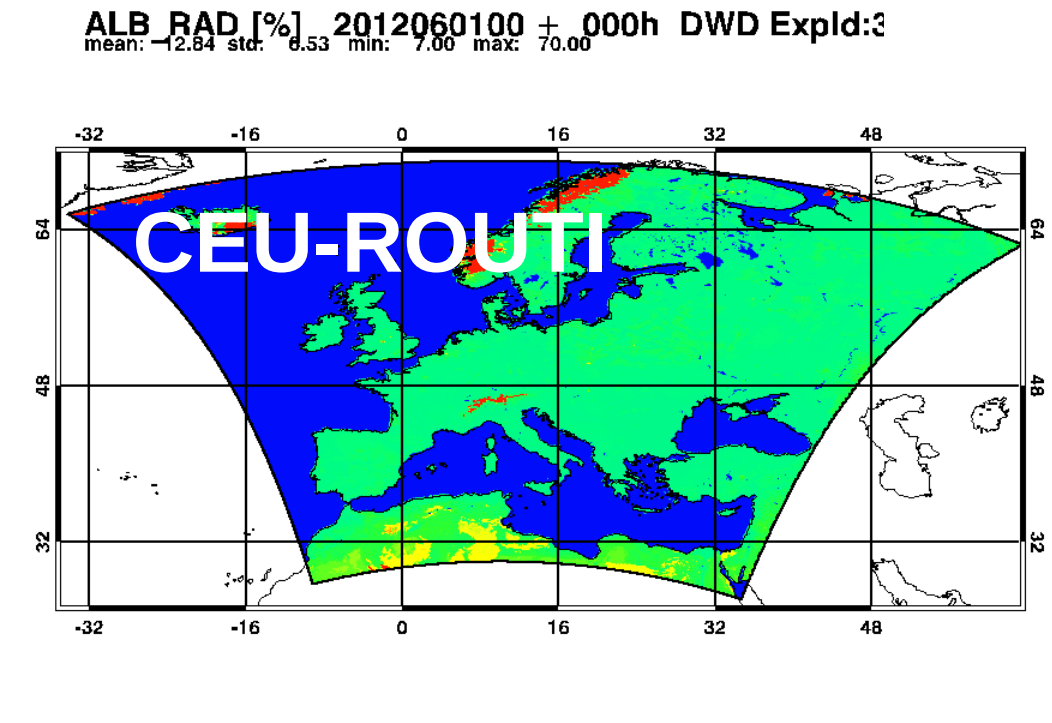
64 48 32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CEU-ROUTI
-32 -16 0 16 32 48
64 48 32


23.5
22.0
20.5
19.0
17.5
16.0
14.5
13.0
11.5
10.0
8.5
7.0

Albedo

Motivation

Monitoring - Mozilla Firefox

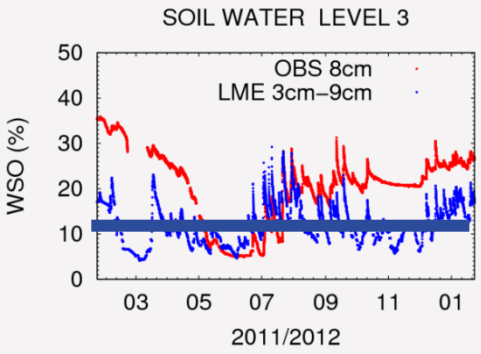
Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

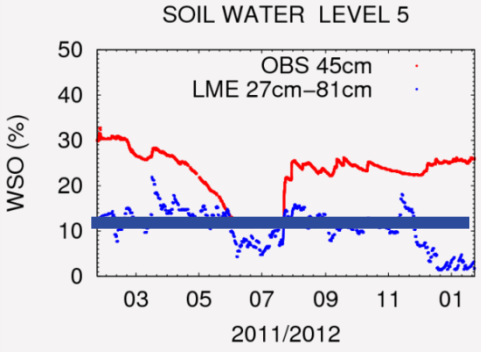
http://oflxs04.dwd.de/~jhelmert/Web-Site/Monitoring.html

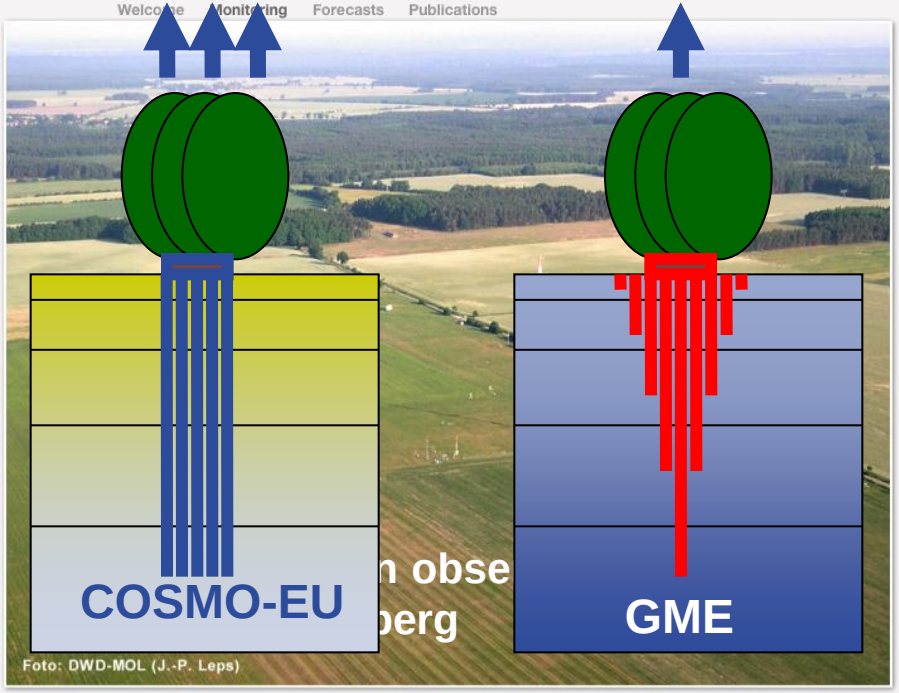
Wetter und Klima - Deutscher ... | Monitoring

Welcome Monitoring Forecasts Publications

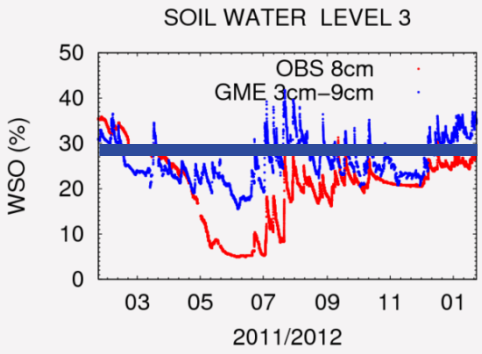
RAO / COSMO-EU

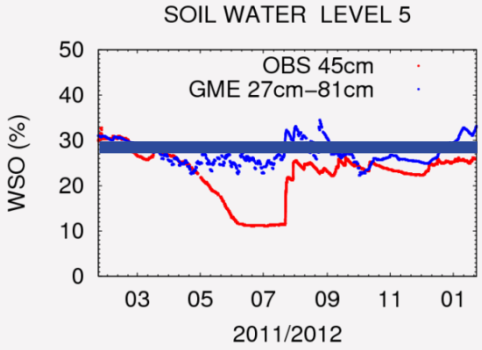






RAO / GME





Model configuration operational

Fertig

Motivation

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

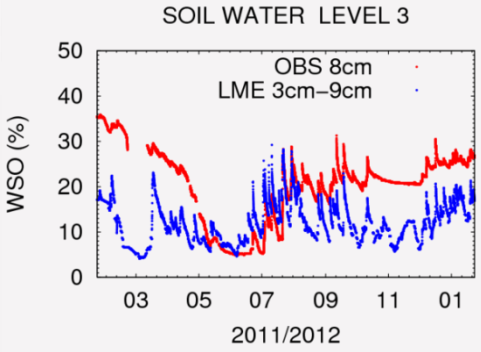
Monitoring - Mozilla Firefox

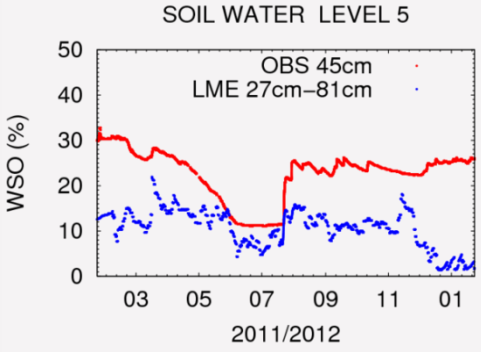
Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

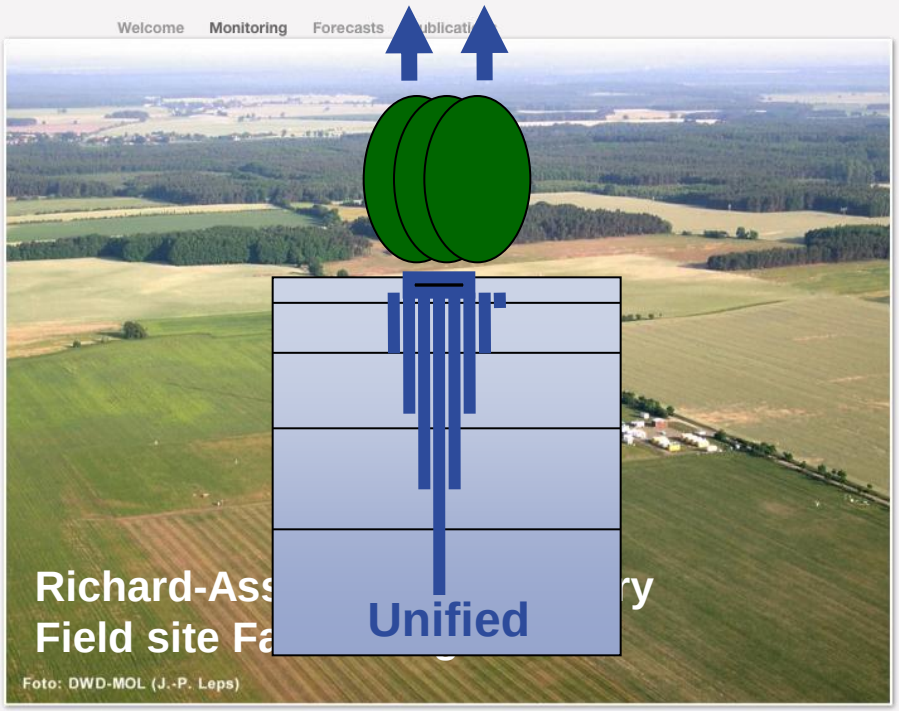
http://oflxs04.dwd.de/~jhelmert/Web-Site/Monitoring.html

Wetter und Klima - Deutscher ... | Monitoring

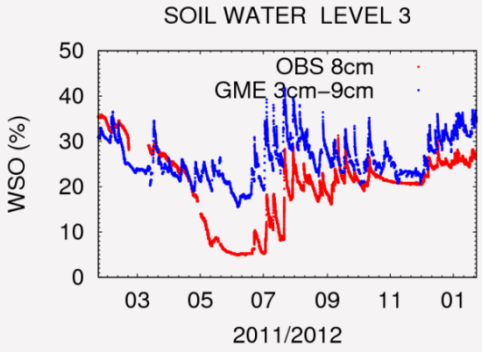
RAO / COSMO-EU

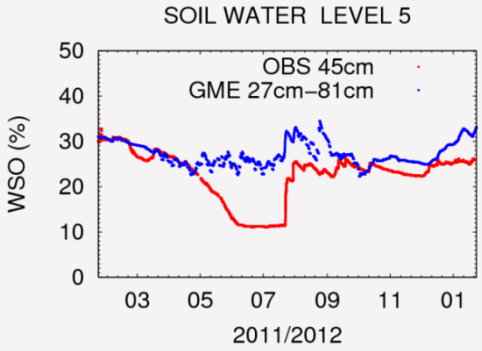






RAO / GME

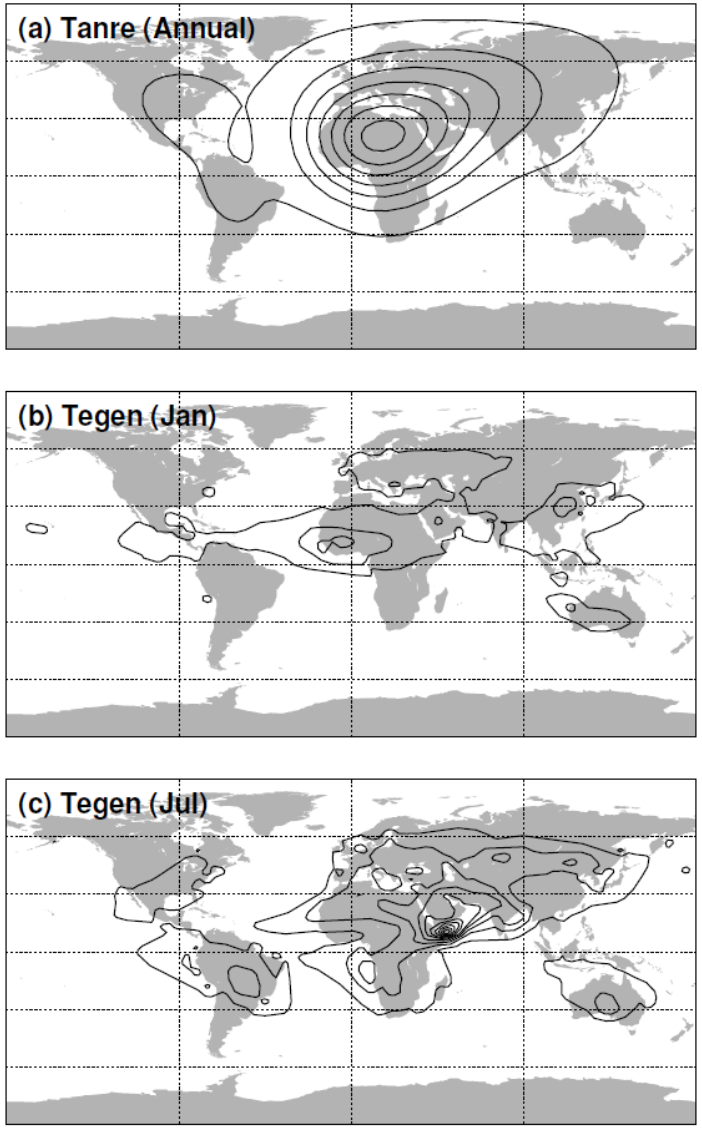




Model configuration experiment

Fertig

Model configuration: Aerosol



Understanding the Local and Global Impacts of Model Physics Changes: An Aerosol Example

M.J. Rodwell and T. Jung

Research Department

Published in *Quart. J. Roy. Meteorol. Soc.*, **134**, 1479–1497 (2008)

December 2008

Figure 1: Optical depths at 550 nm associated with the model aerosol climatology. (a) The 'old' annually-fixed climatology of Tanre et al. (1984). (b) The 'new' January climatology of Tegen et al. (1997). (c) The 'new' July climatology of Tegen et al. (1997). The smallest contour is 0.1 and the contour interval is 0.1.

Theory

• The troposphere is not in a radiative equilibrium and a net radiative cooling rate is balanced by convective transfer from the surface with positive net radiative imbalance (D. Hartmann, Global Physical Climatology,1994).

• Reduced optical depth with aerosol climatology further destabilize the atmosphere - heating the surface, increase sensible and latent heat fluxes (Rodwell and Jung, 2008).

• Convection tries to restore radiative-convective equilibrium by cooling the surface and heating the mid-to-upper troposphere (Rodwell and Jung, 2008).

Theory

Mechanism: according to Rodwell and Jung, 2008

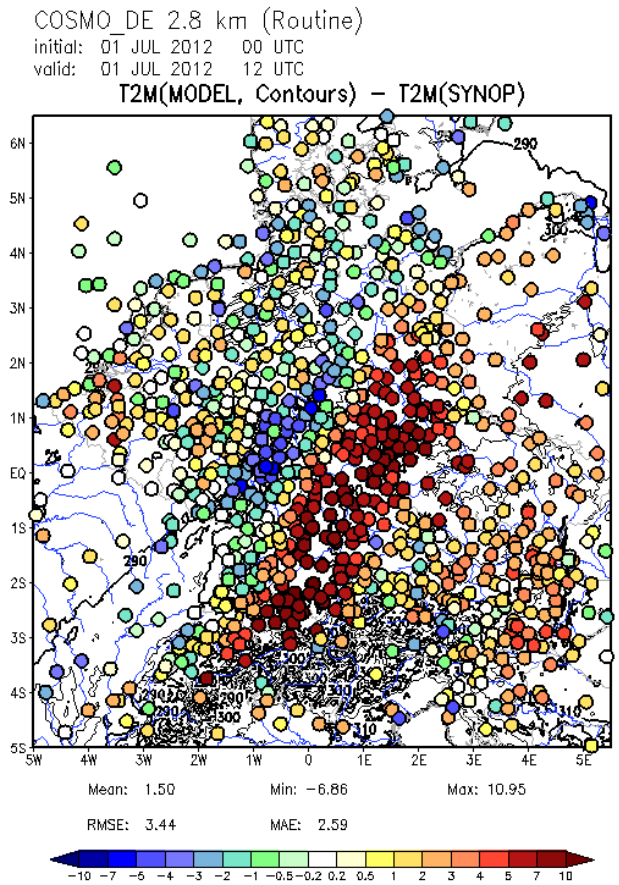
• Initialisation: Thermal destabilisation of the vertical profile leads to an enhancement of convection that tries to restore radiative-convective equilibrium

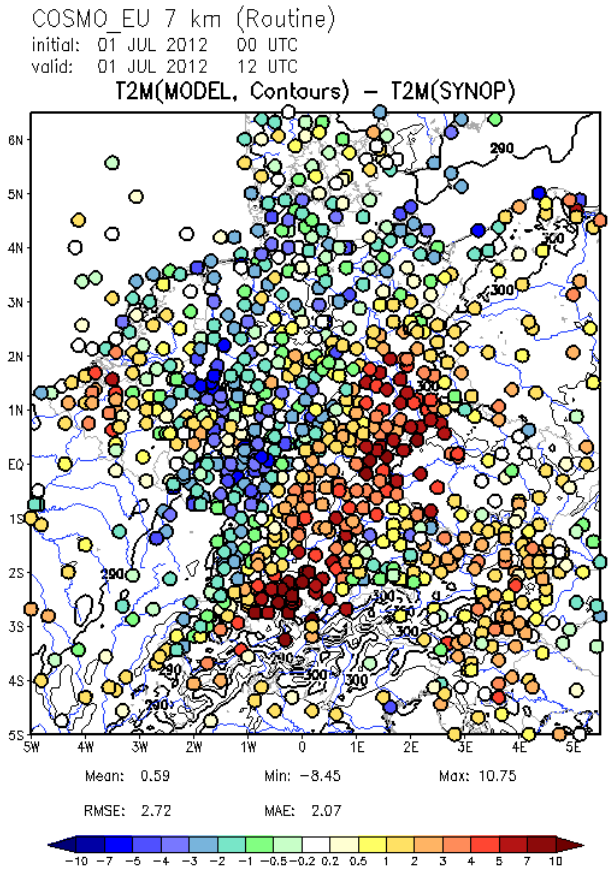
• Interaction with large-scale dynamics: Reduction of absorbing aerosol leads to a direct cooling of the lower troposphere that limits a strengthening of ascent.

• With less ascent large-scale convergence is reduced during the simulation

Monitoring K. Stephan
CDE/CEU ROUTI 00 + 12h
Meteosat VIS 12 UTC

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

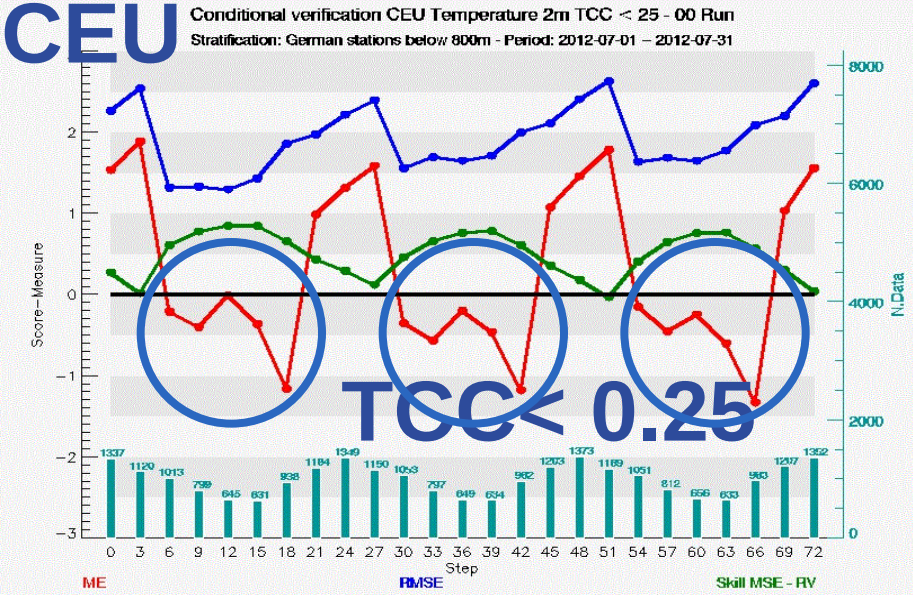


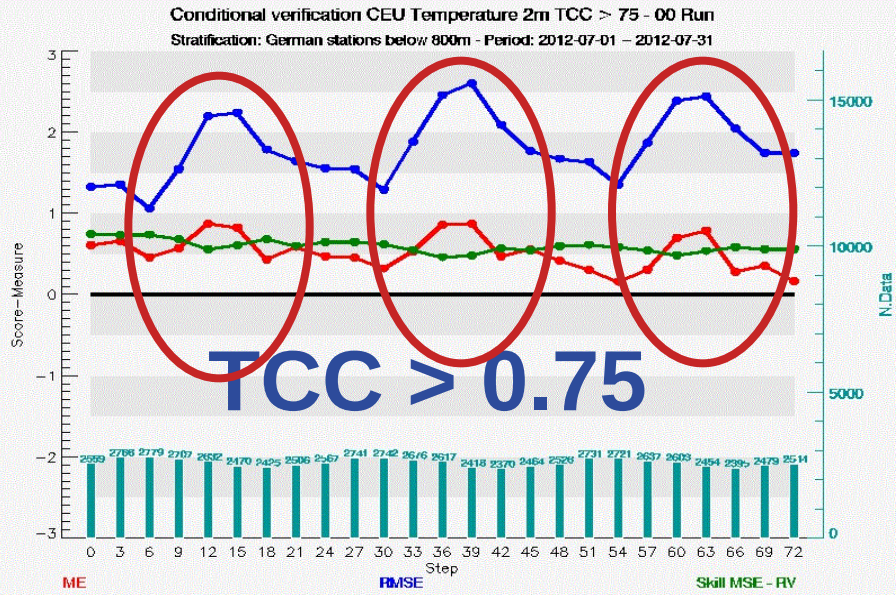


COSMO T_2m-mean error in summer with observed cloud coverage (U. Damrath)

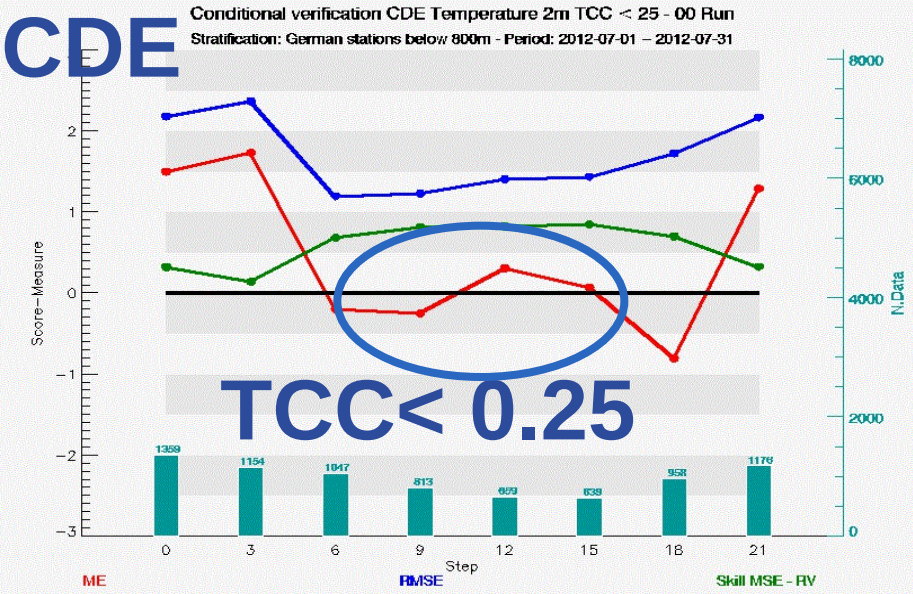
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

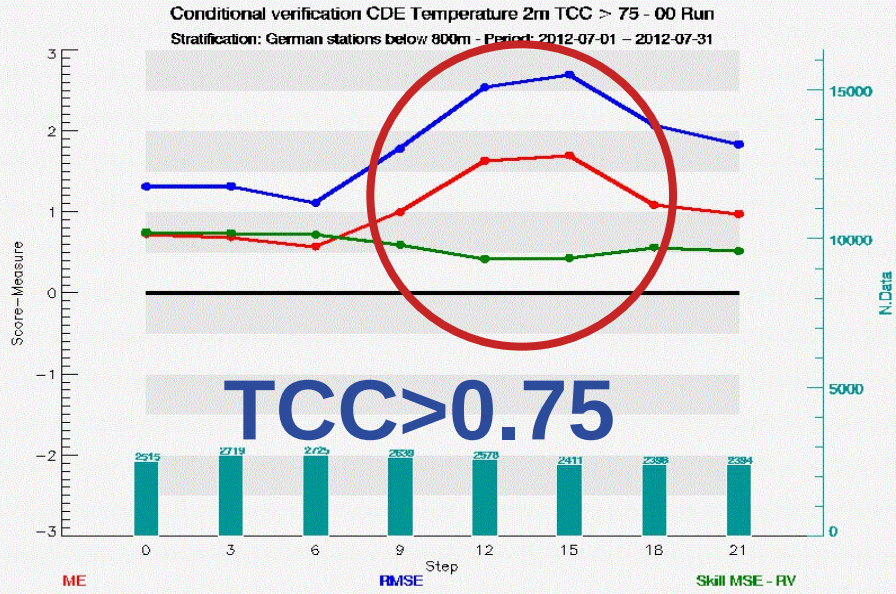
CEU

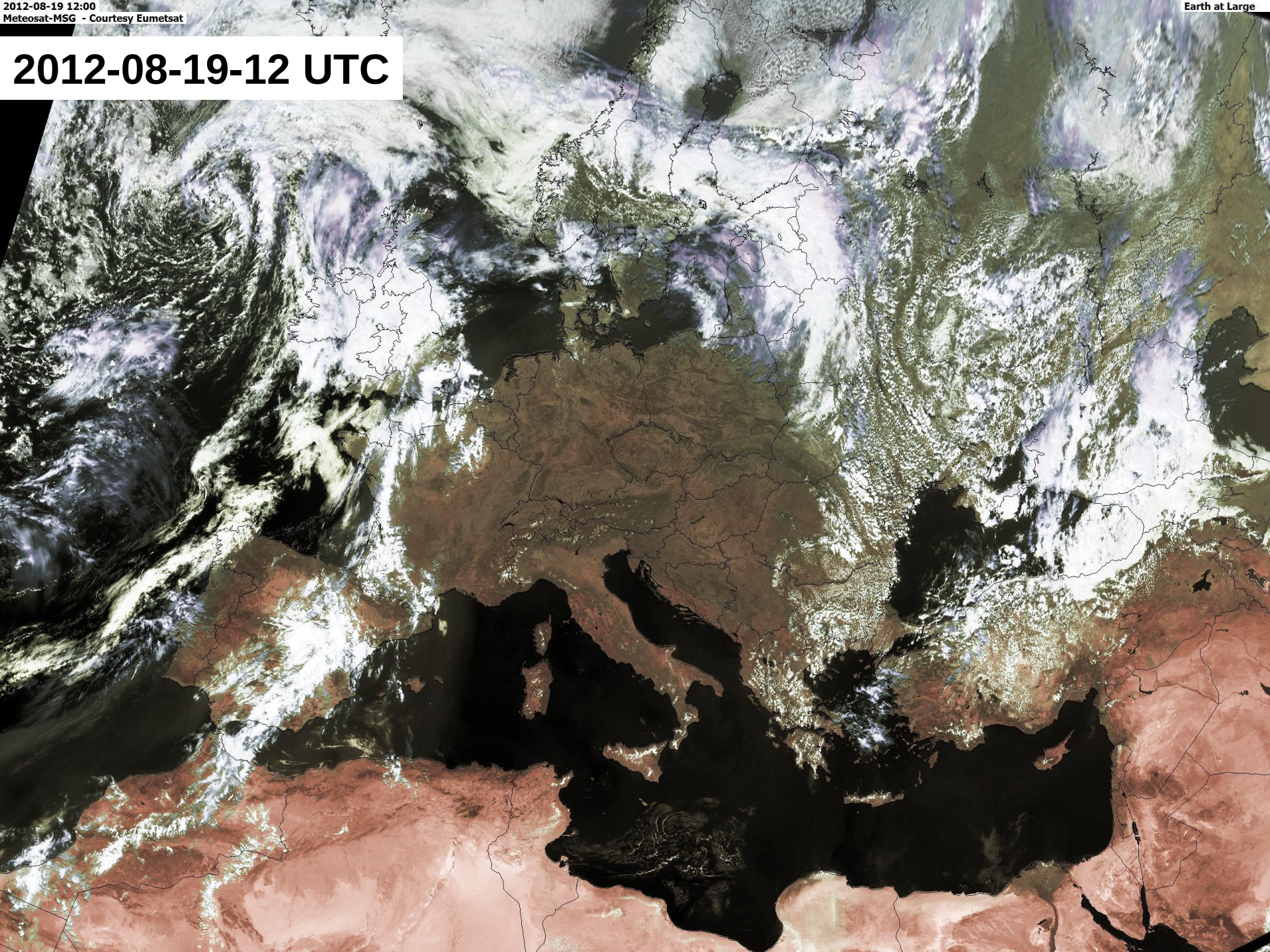




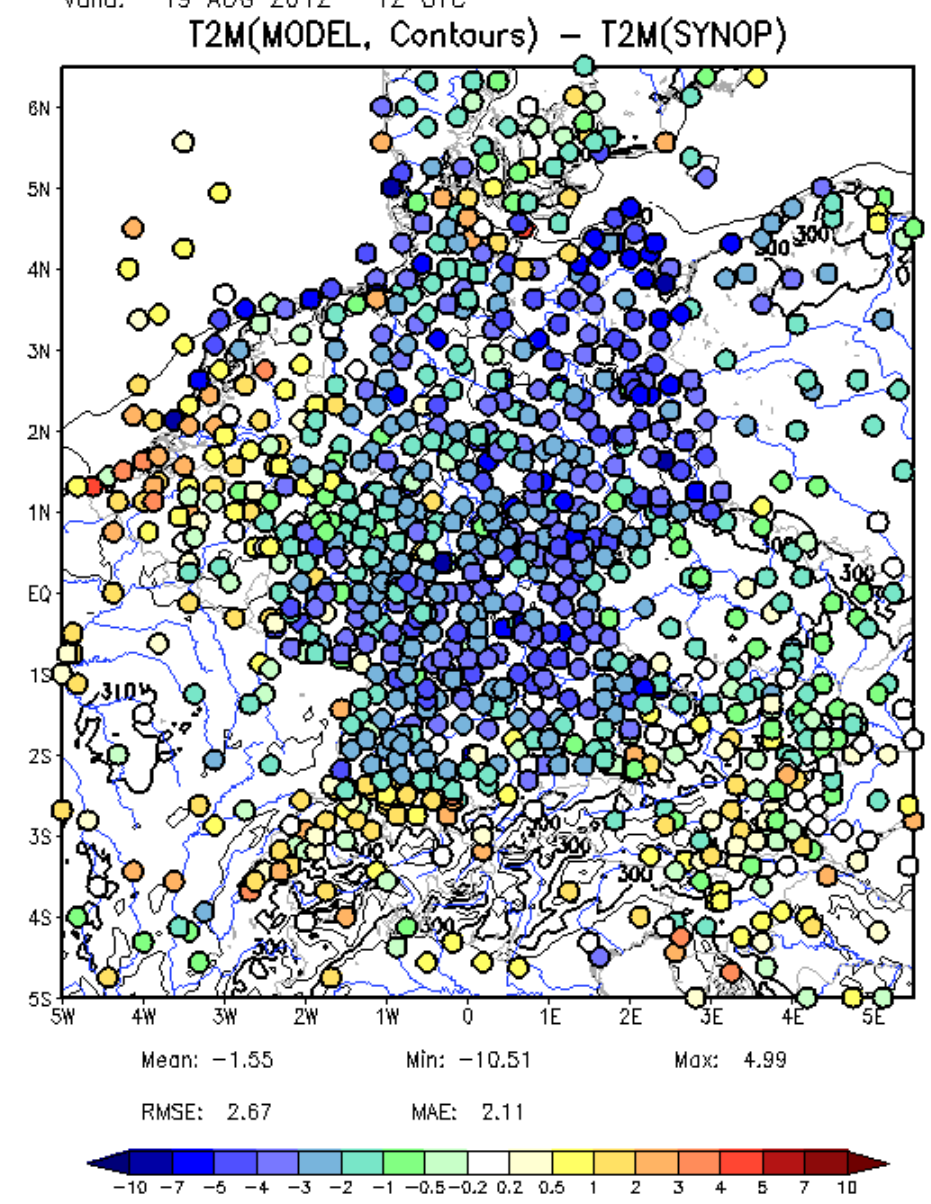
CDE

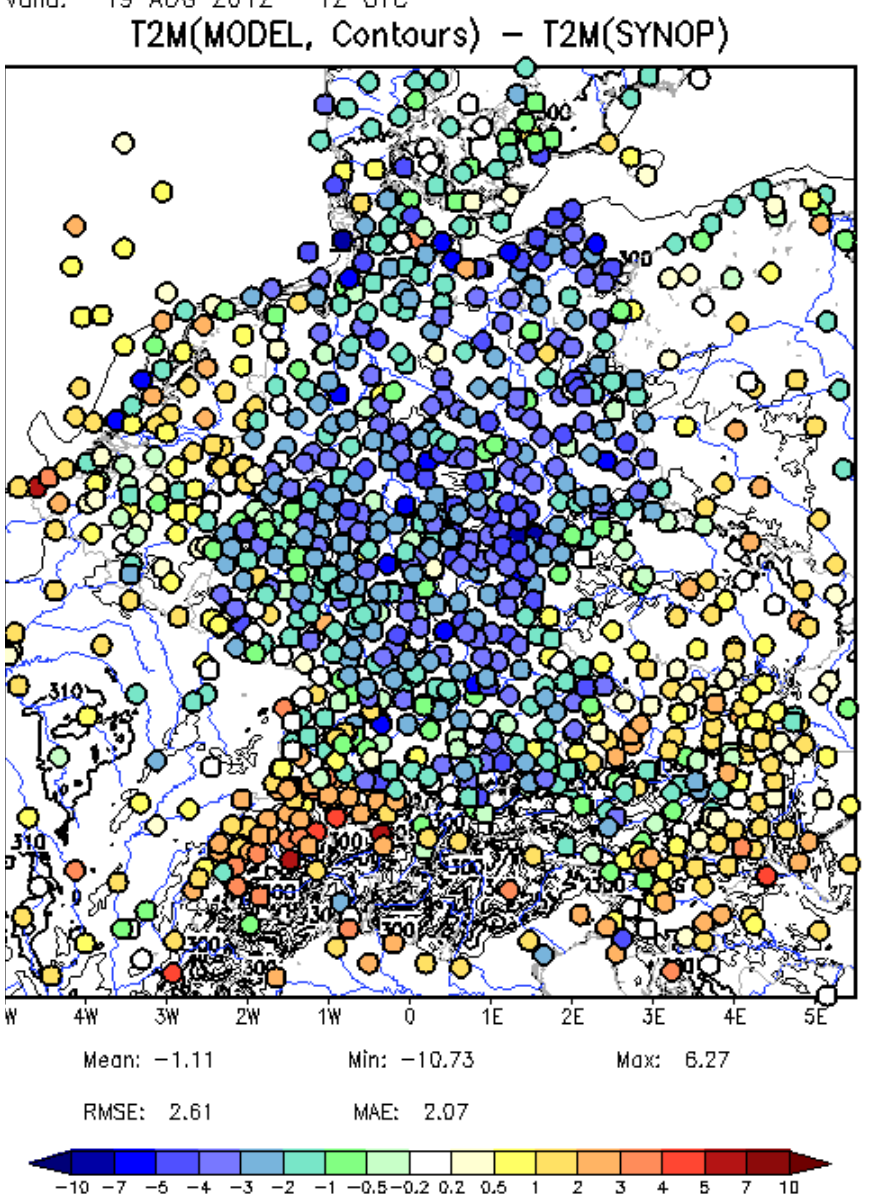





2012-08-19 12:00
Meteosat-MSG - Courtesy Eumetsat
Earth at Large
2012-08-19-12 UTC

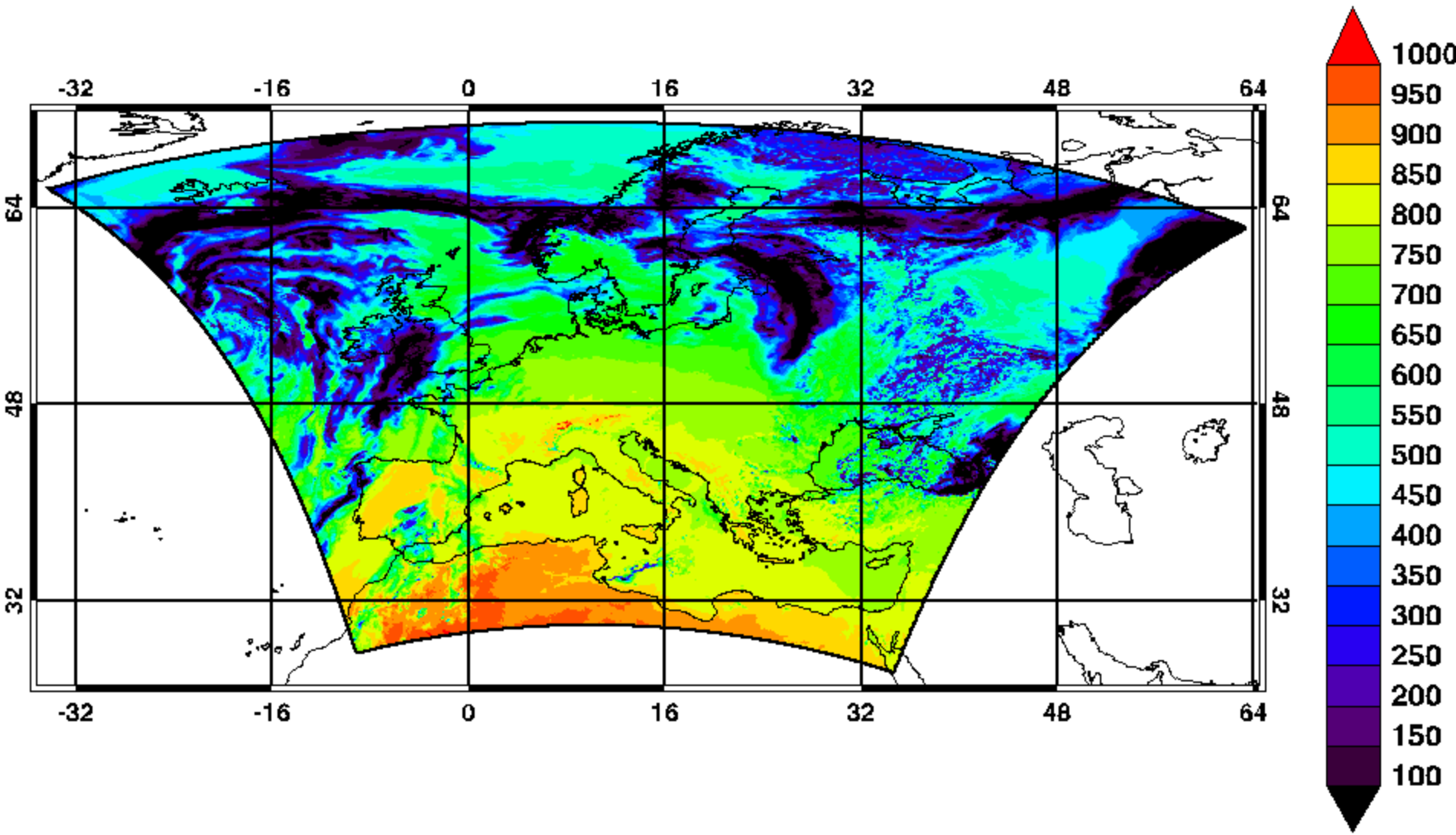
Monitoring
K. Stephan





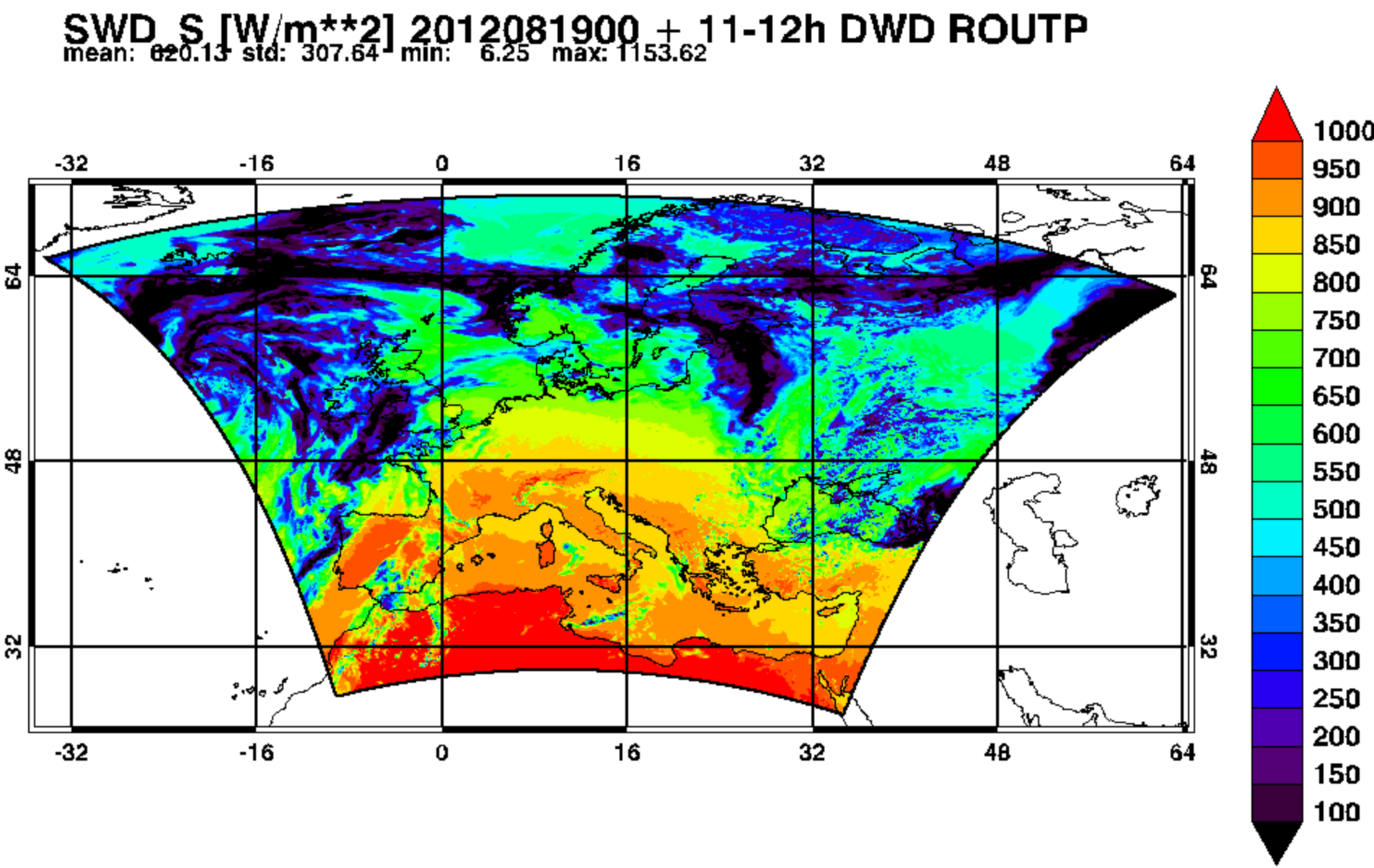
Solar downward radiation

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



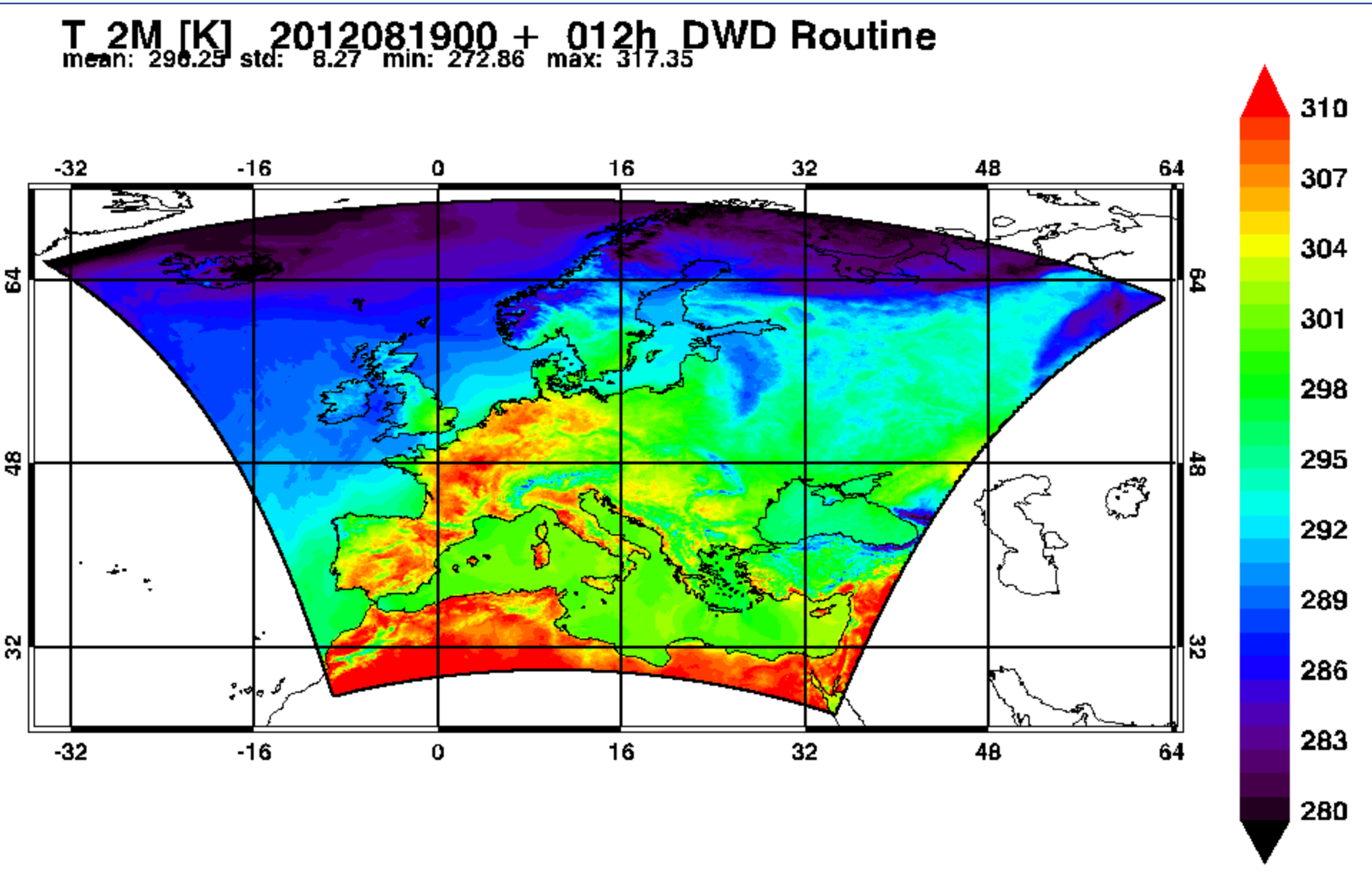
Solar downward radiation

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



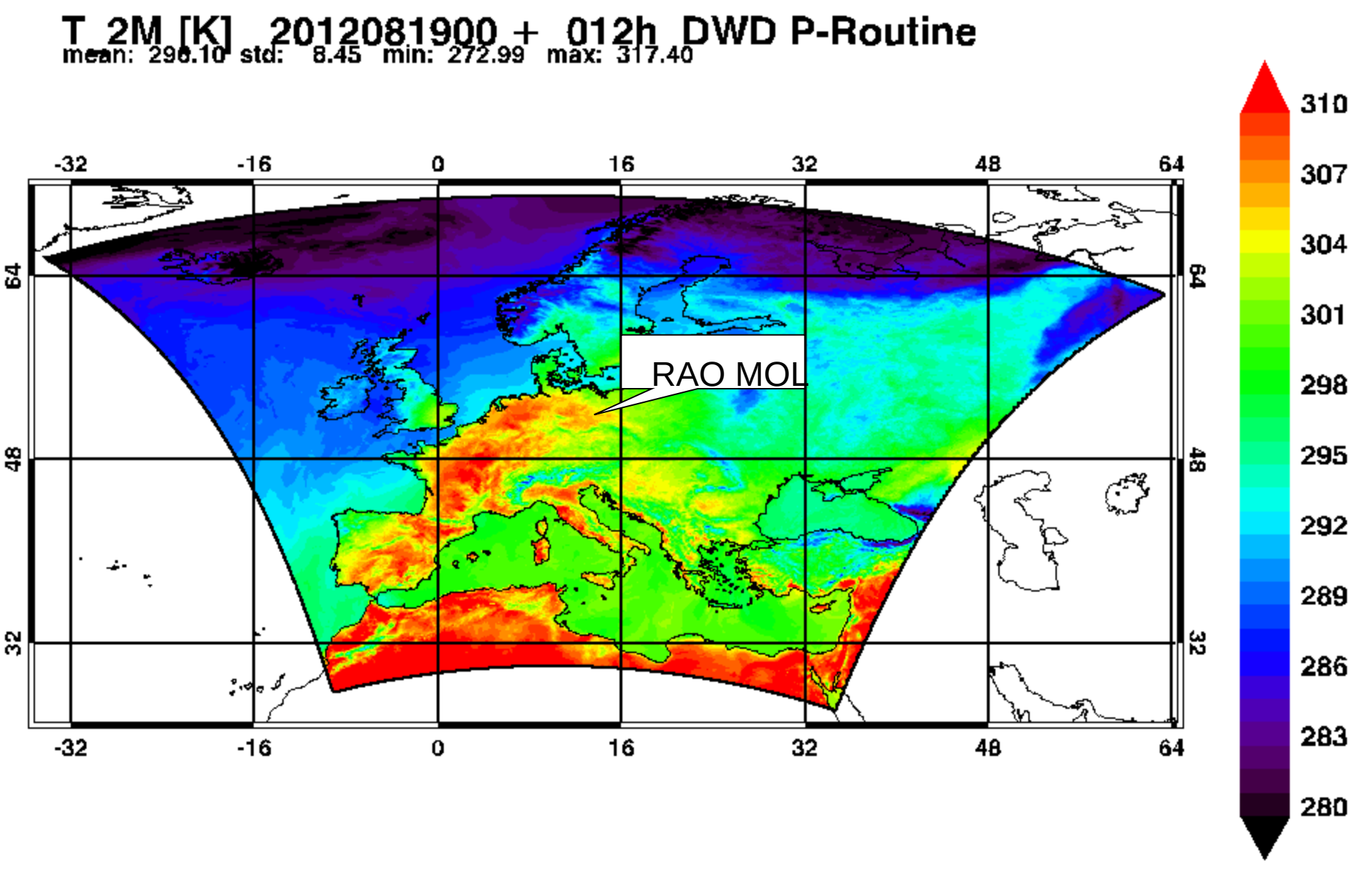
2m-temperature

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

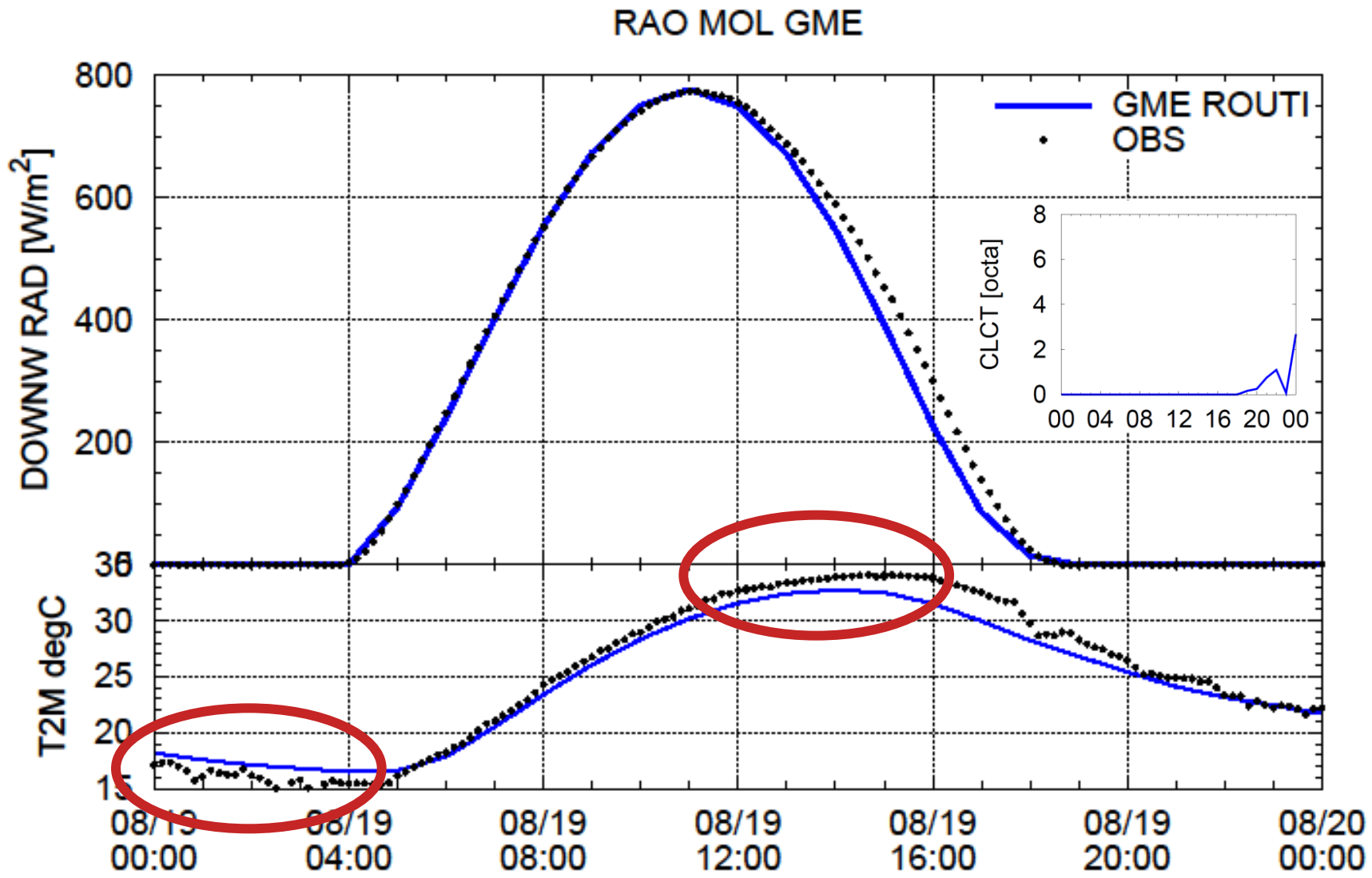


2m-temperature

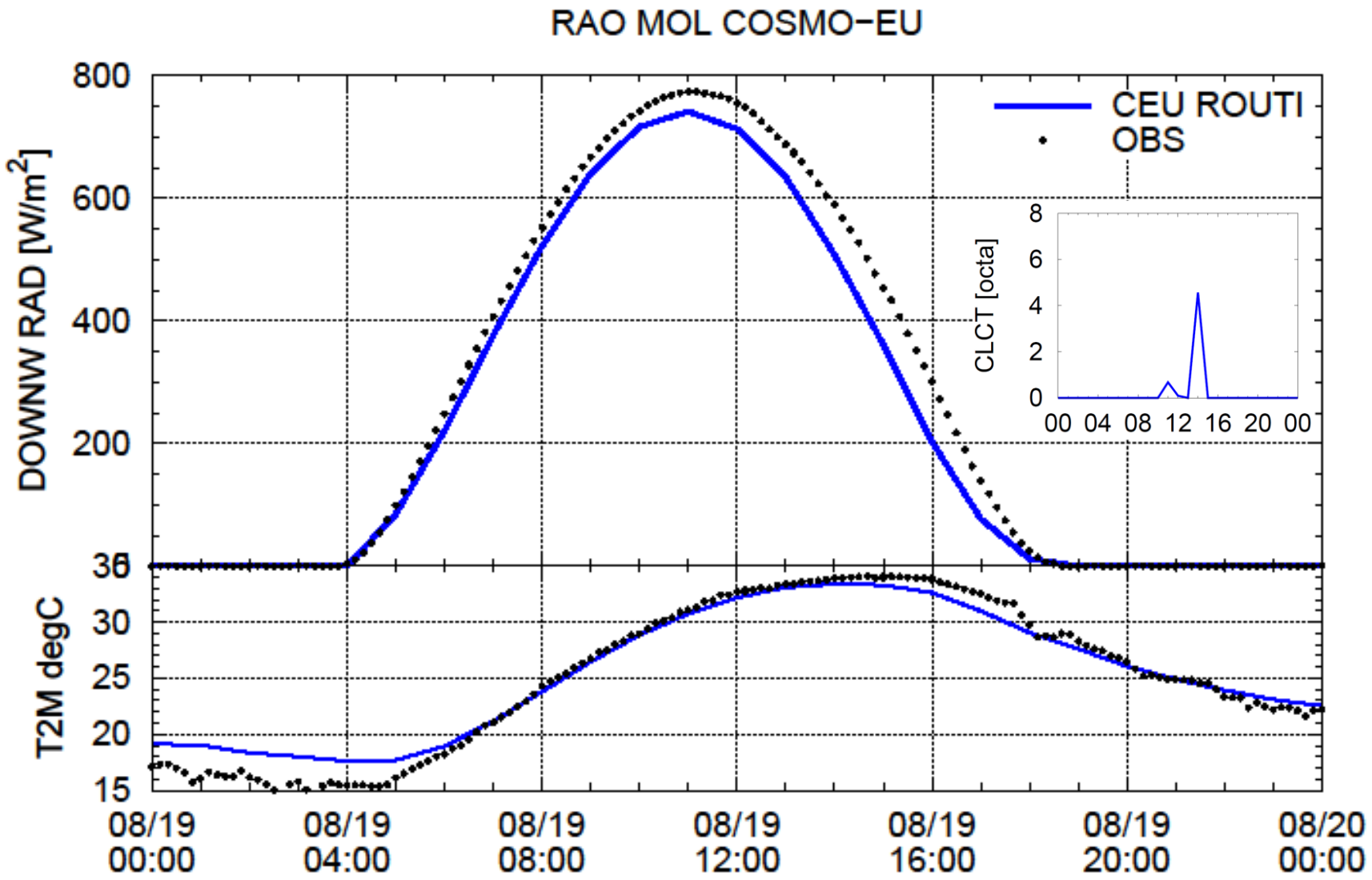
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



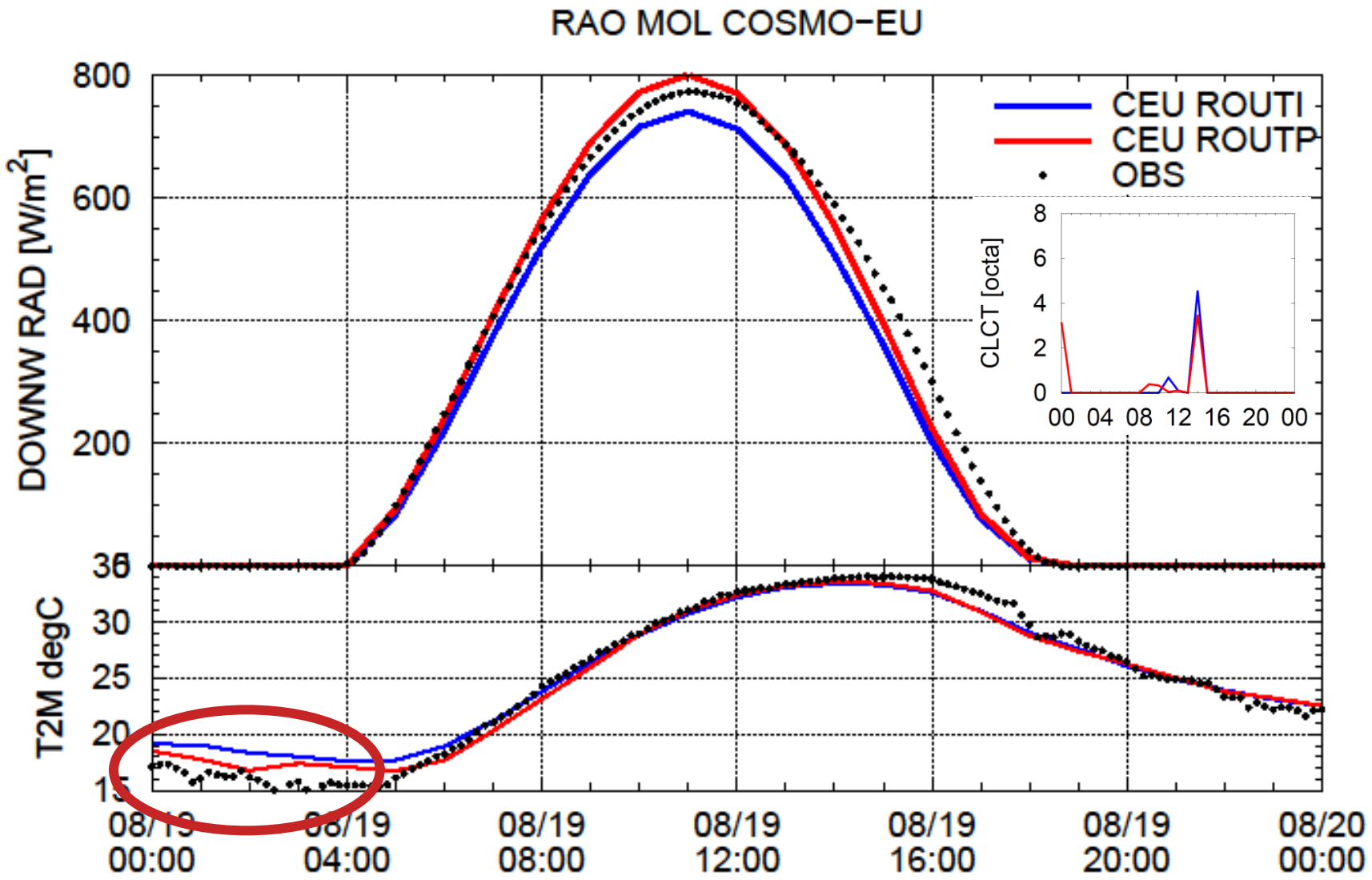
Solar downward radiation and 2m-temperature



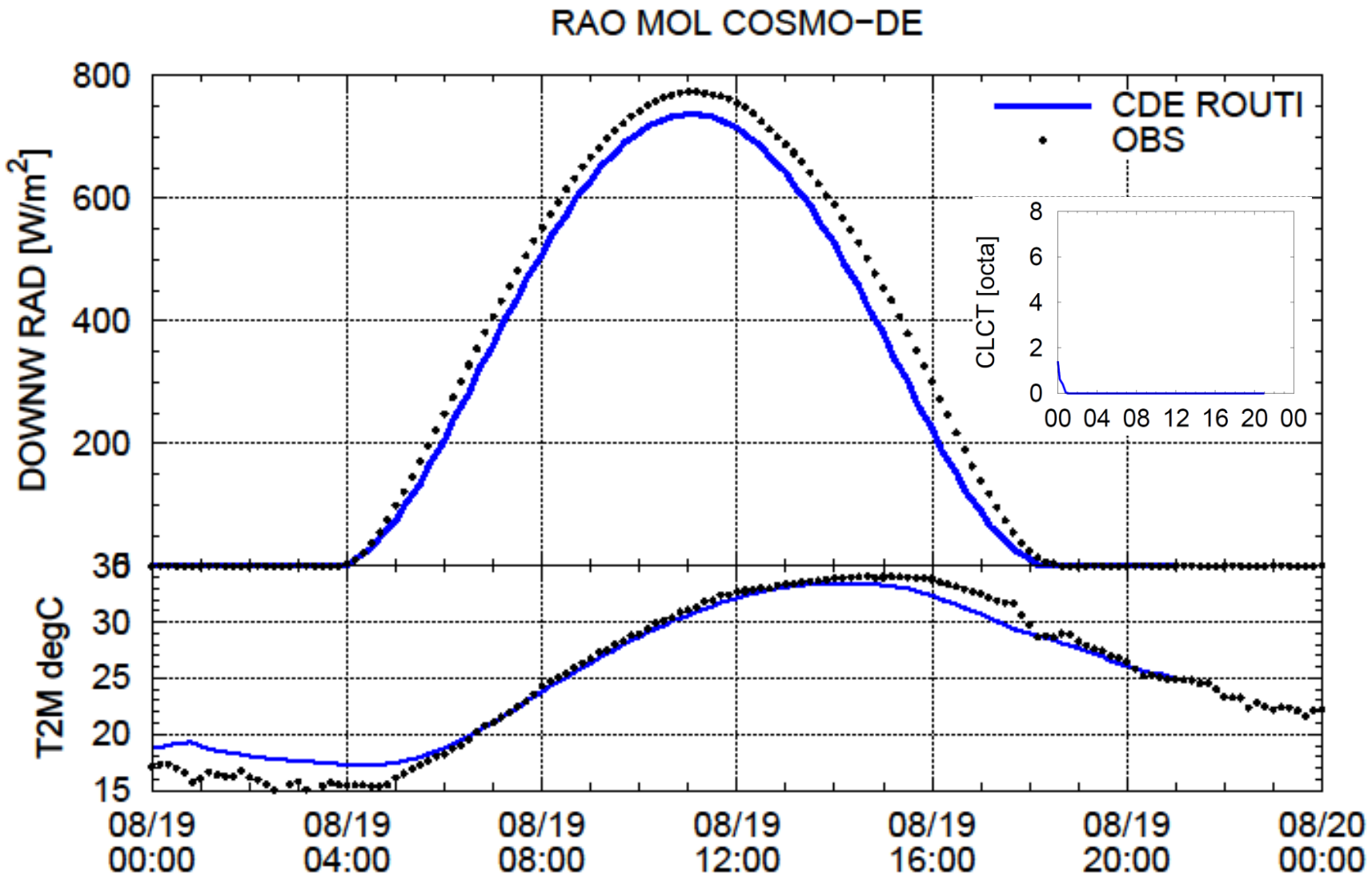
Solar downward radiation and 2m-temperature



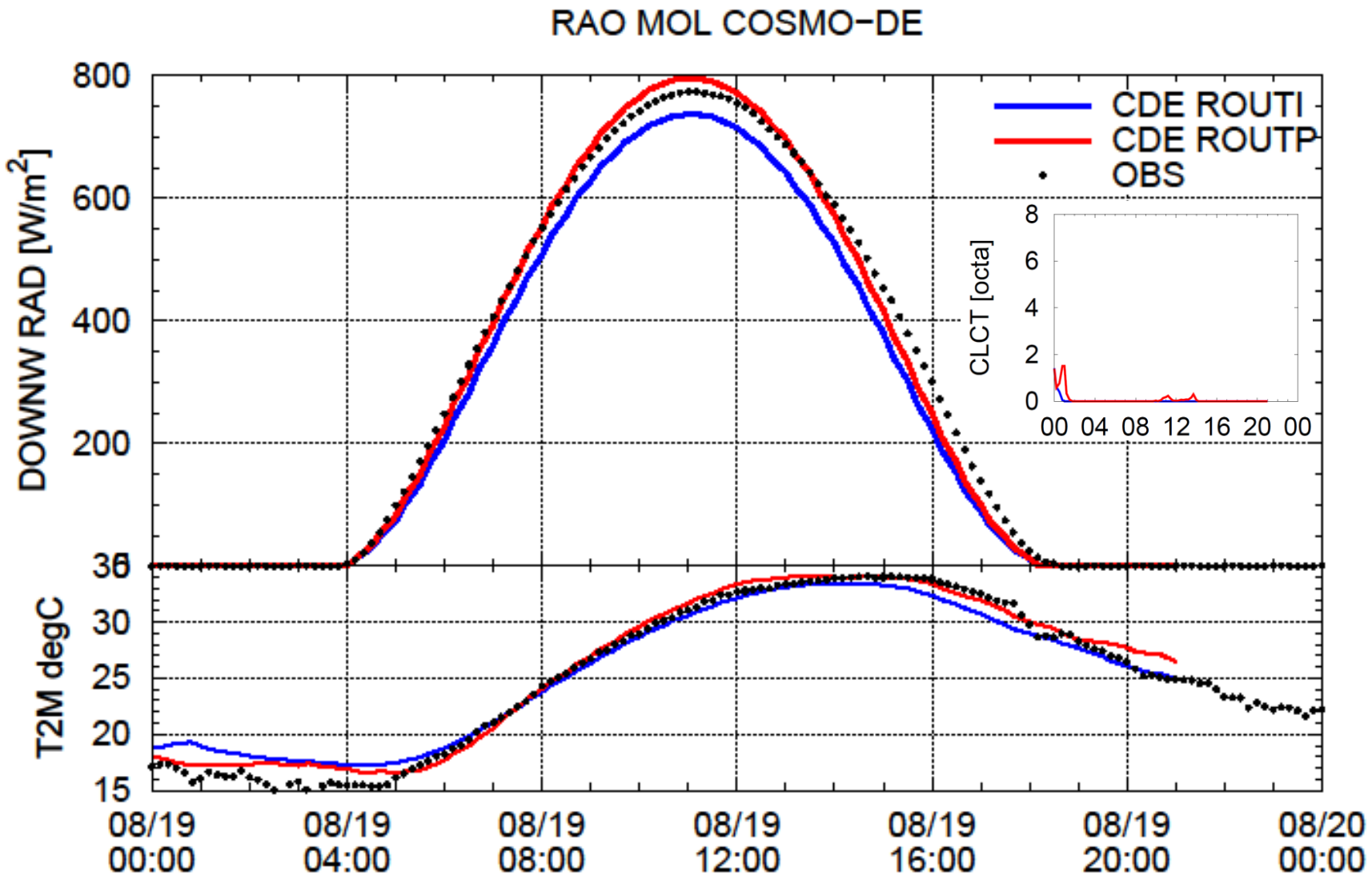
Solar downward radiation and 2m-temperature



Solar downward radiation and 2m-temperature



Solar downward radiation and 2m-temperature



Verification

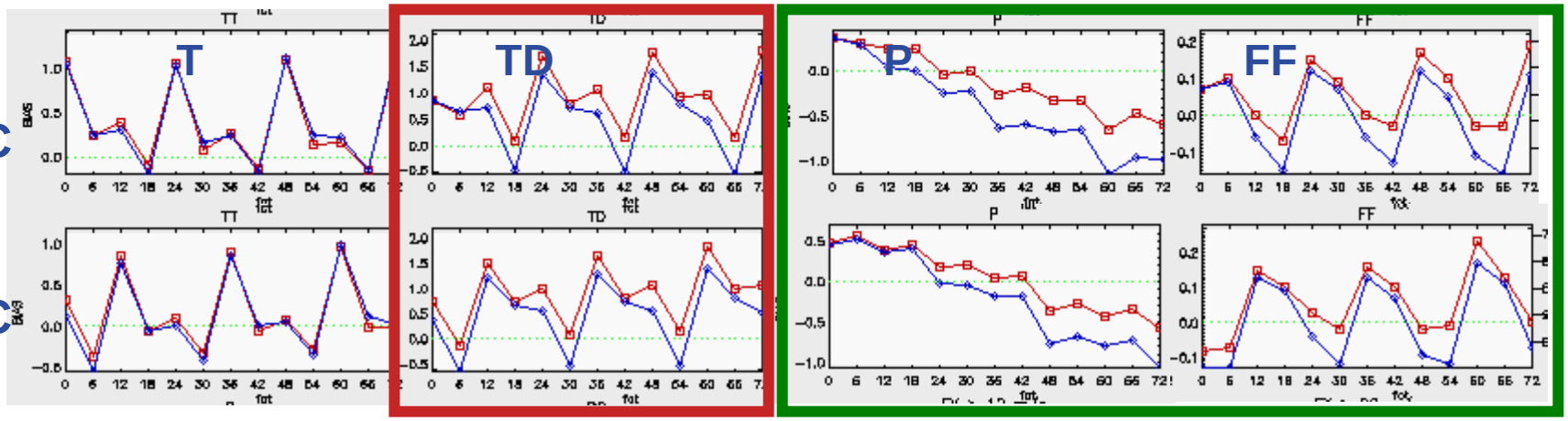
CEU 00/12 UTC LM2
19.07.-19.08. ROUTI - ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

BIAS

00 UTC

12 UTC



RMSE

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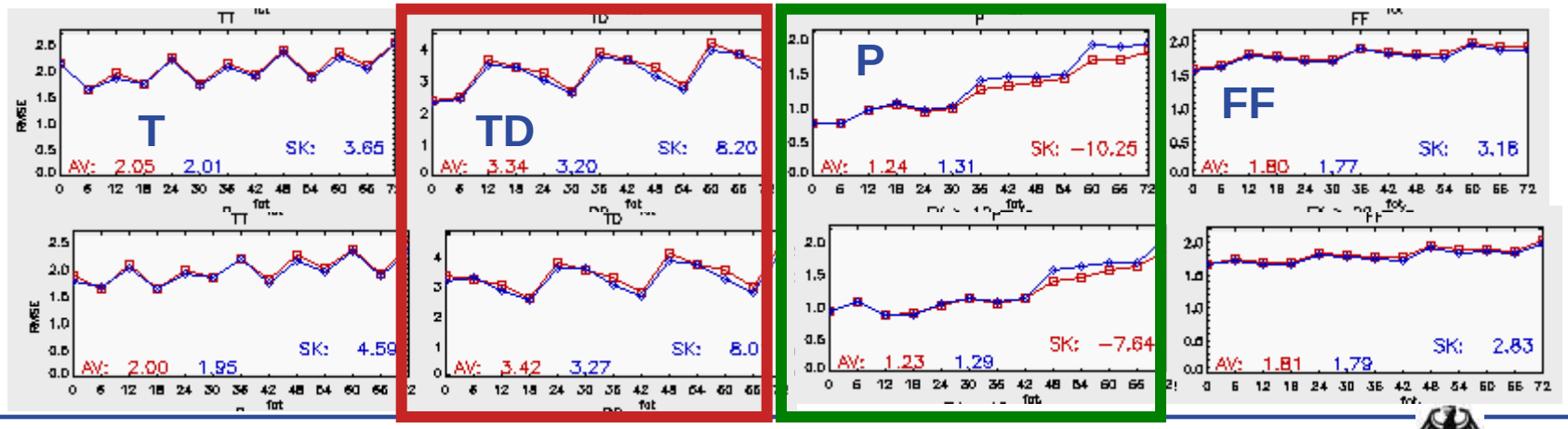


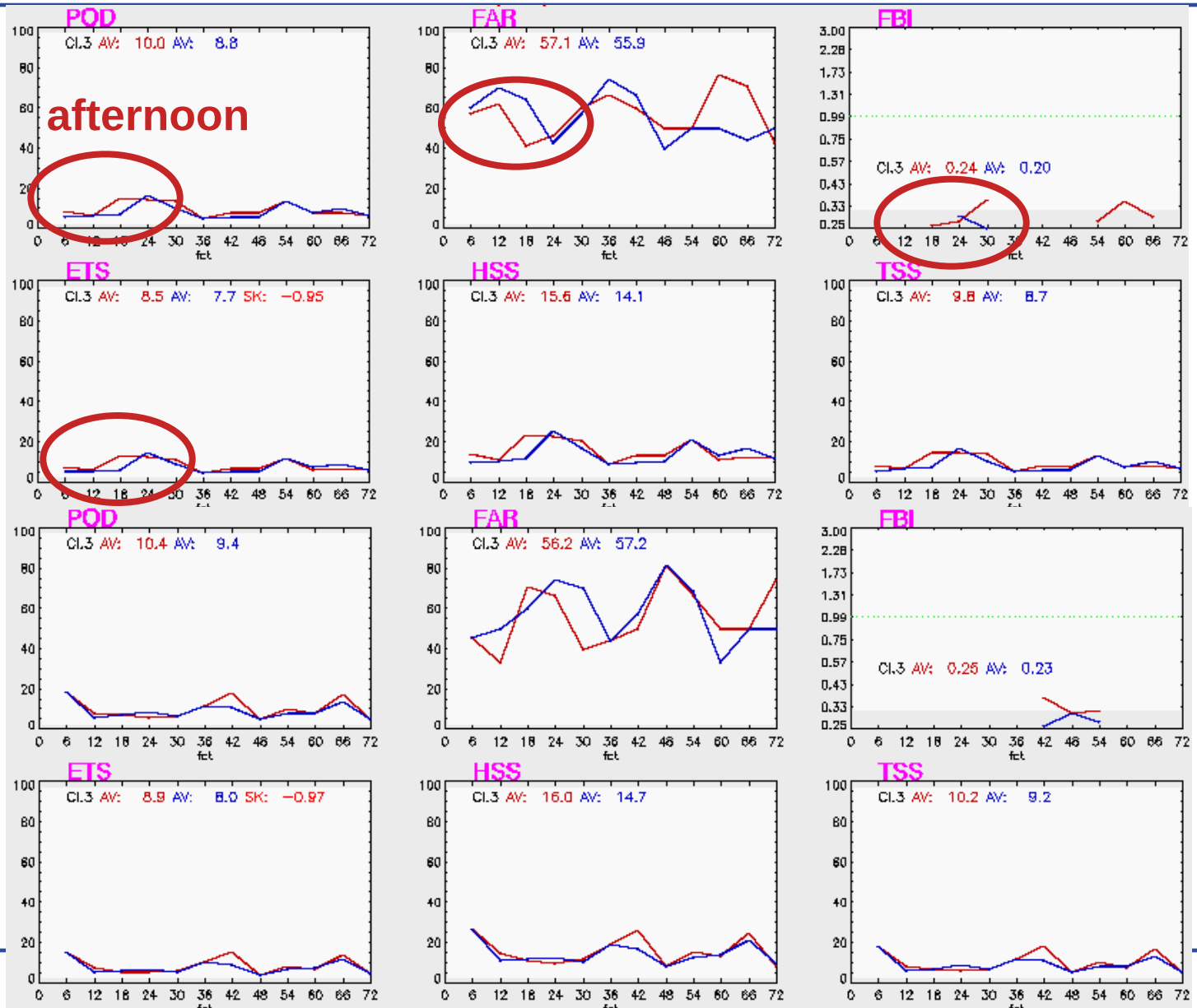
CEU 00/12 UTC LM2
19.07.-19.08. ROUTI - ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Gusts
> 20 m/s

12 UTC



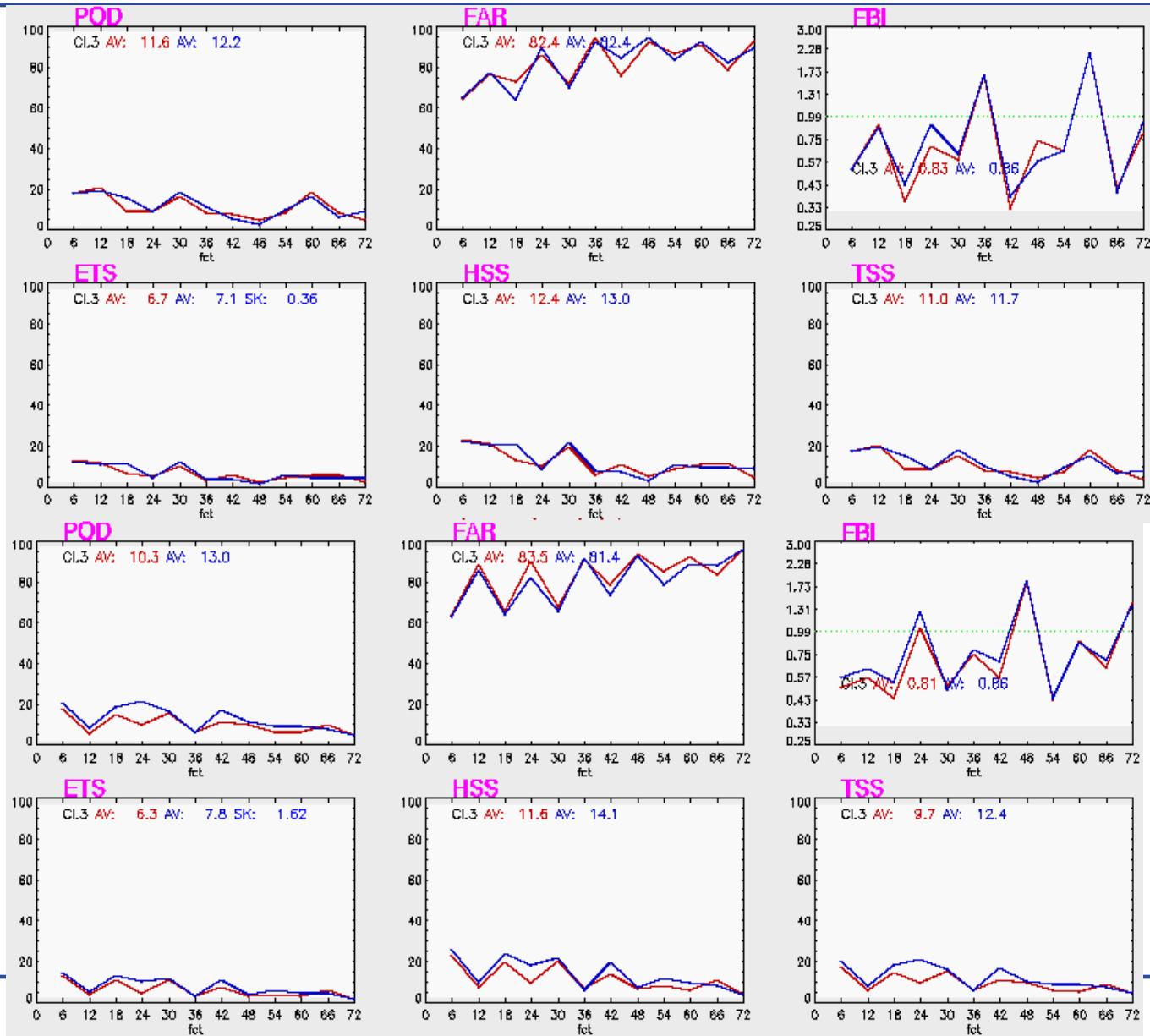
CEU 00/12 UTC LM2
19.07.-19.08. ROUTI - ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Precip
> 10 mm/6h

12 UTC



CDE 00 UTC Germany

20.06.-21.08. ROUTP 01.07.-14.08. CDEL65

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

ROUTI
ROUTP

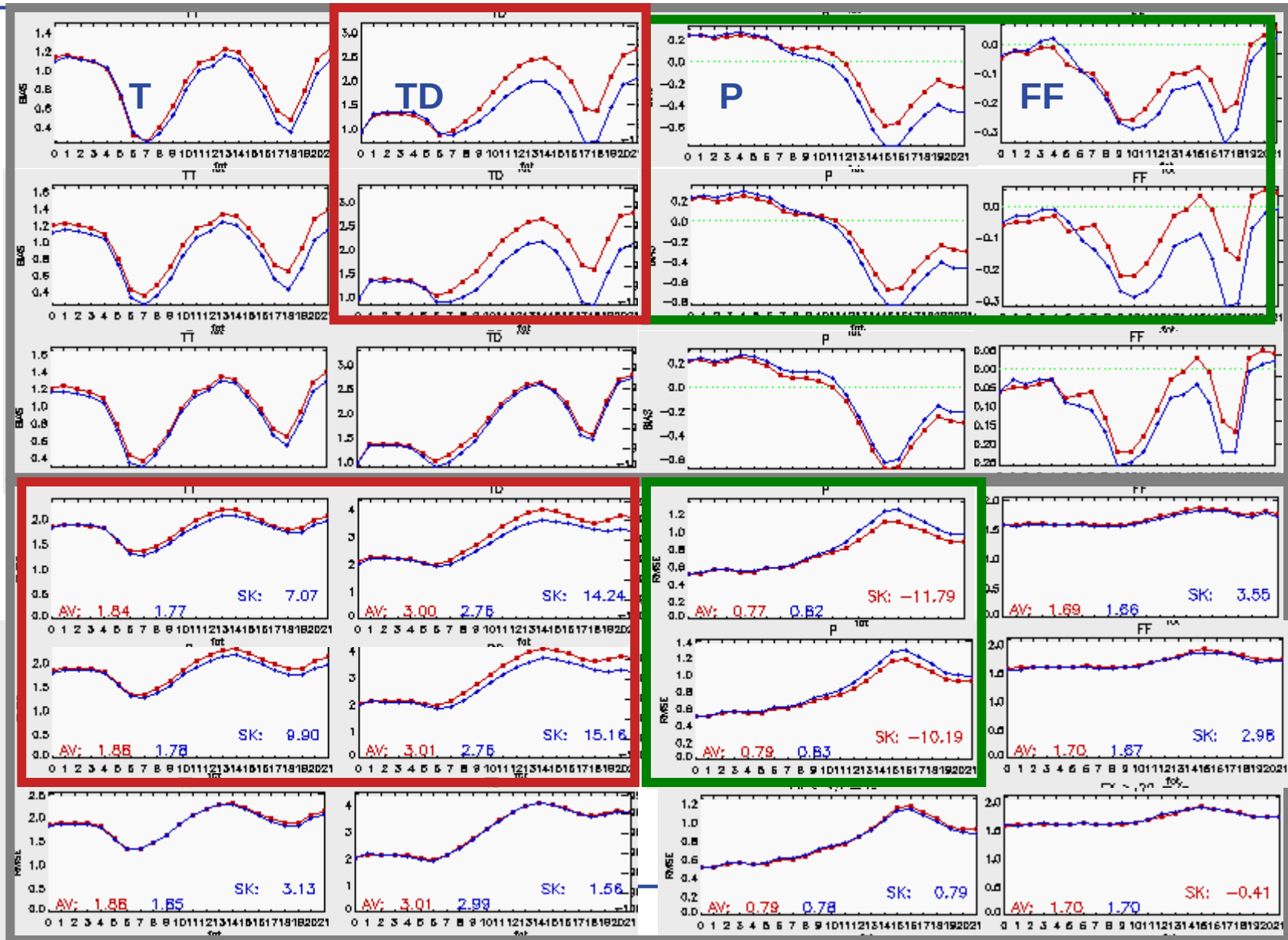
ROUTI
CDEL65

ROUTP
CDEL65

ROUTI
ROUTP

ROUTI
CDEL65

ROUTP
CDEL65



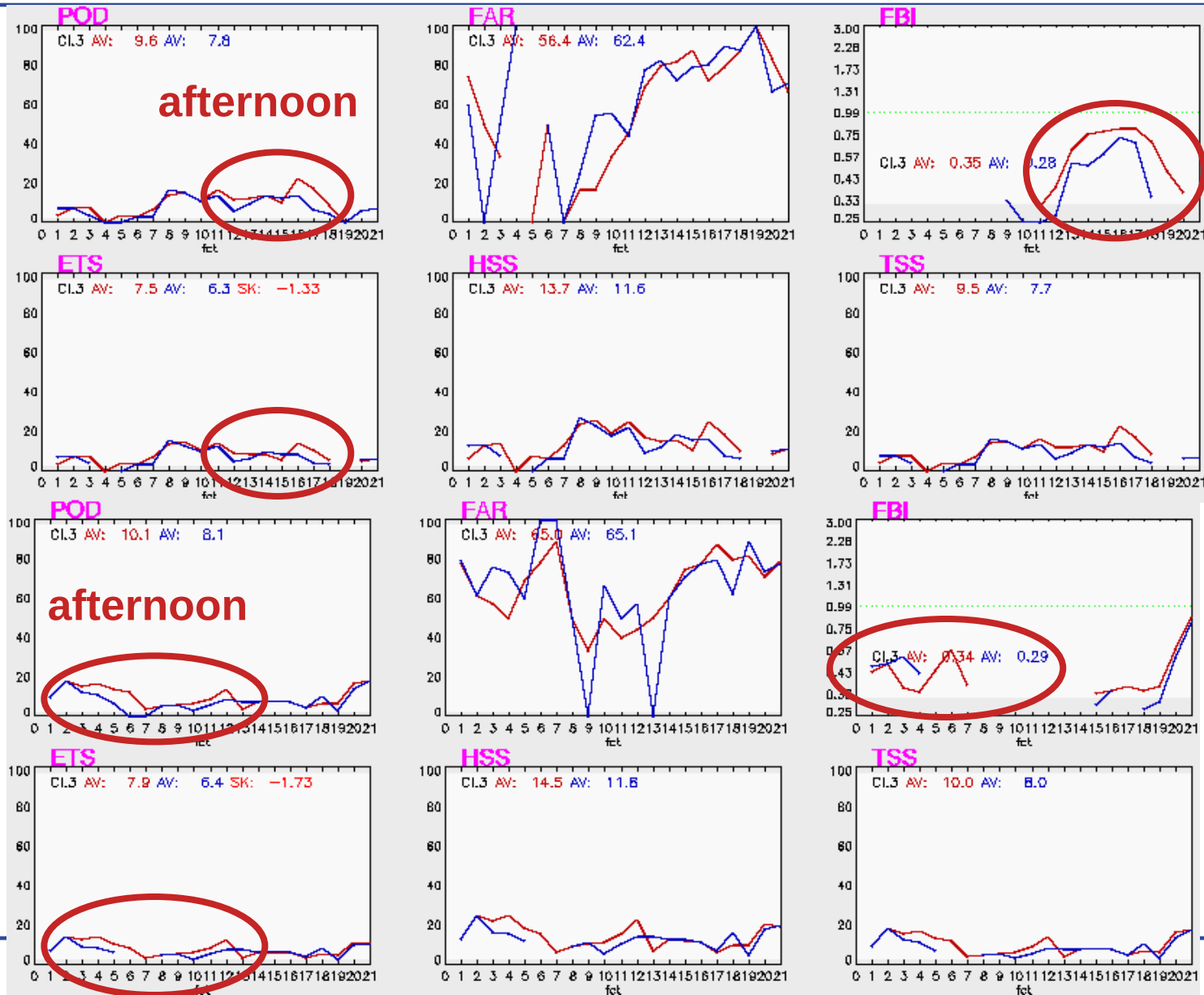
CDE 00/12 UTC DE
20.06.-21.08. ROUTI - ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Gusts
> 20 m/s

12 UTC



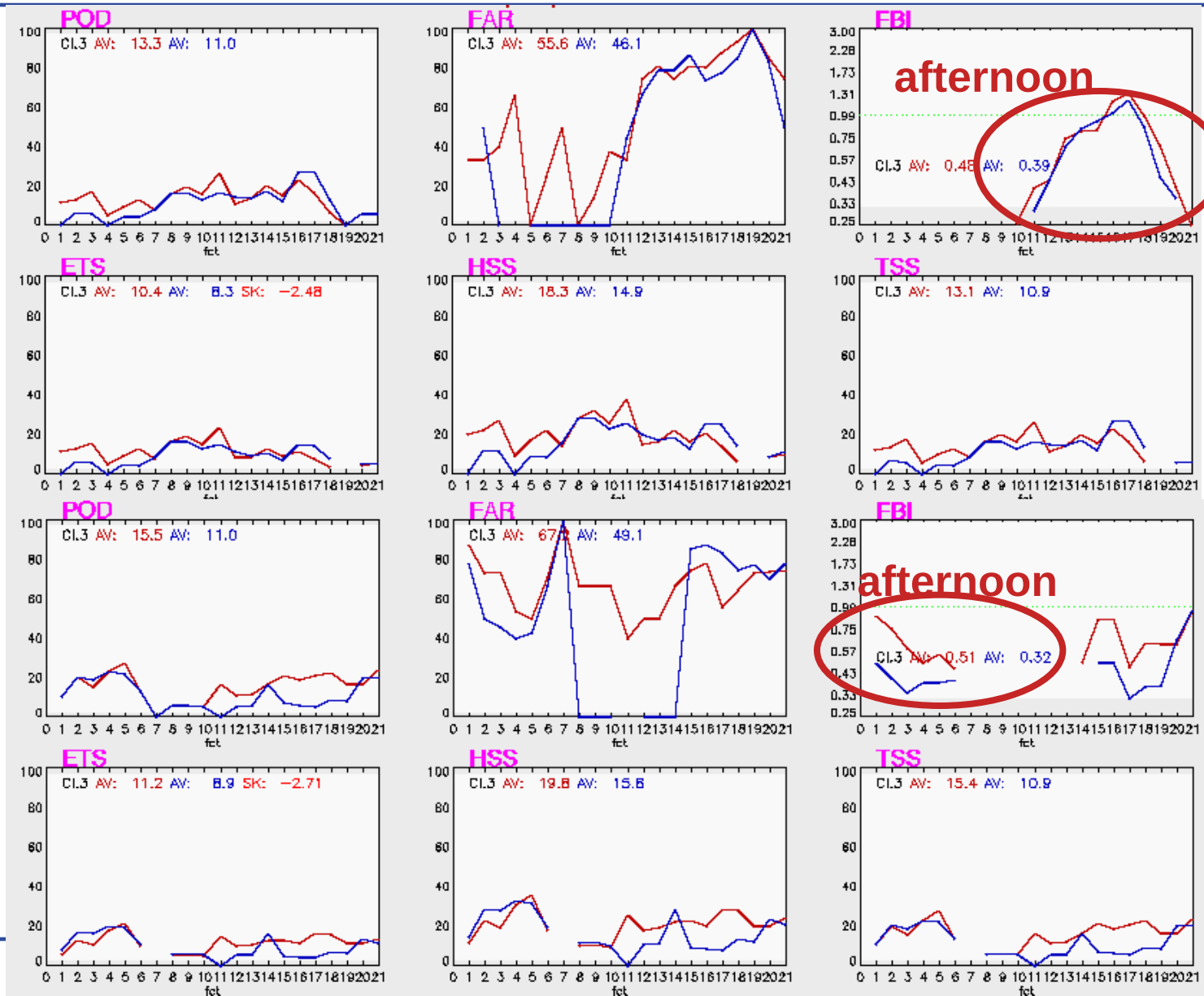
CDE 00/12 UTC DE
01.07.-14.08. ROUTP – CDEL65

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Gusts > 20 m/s

12 UTC



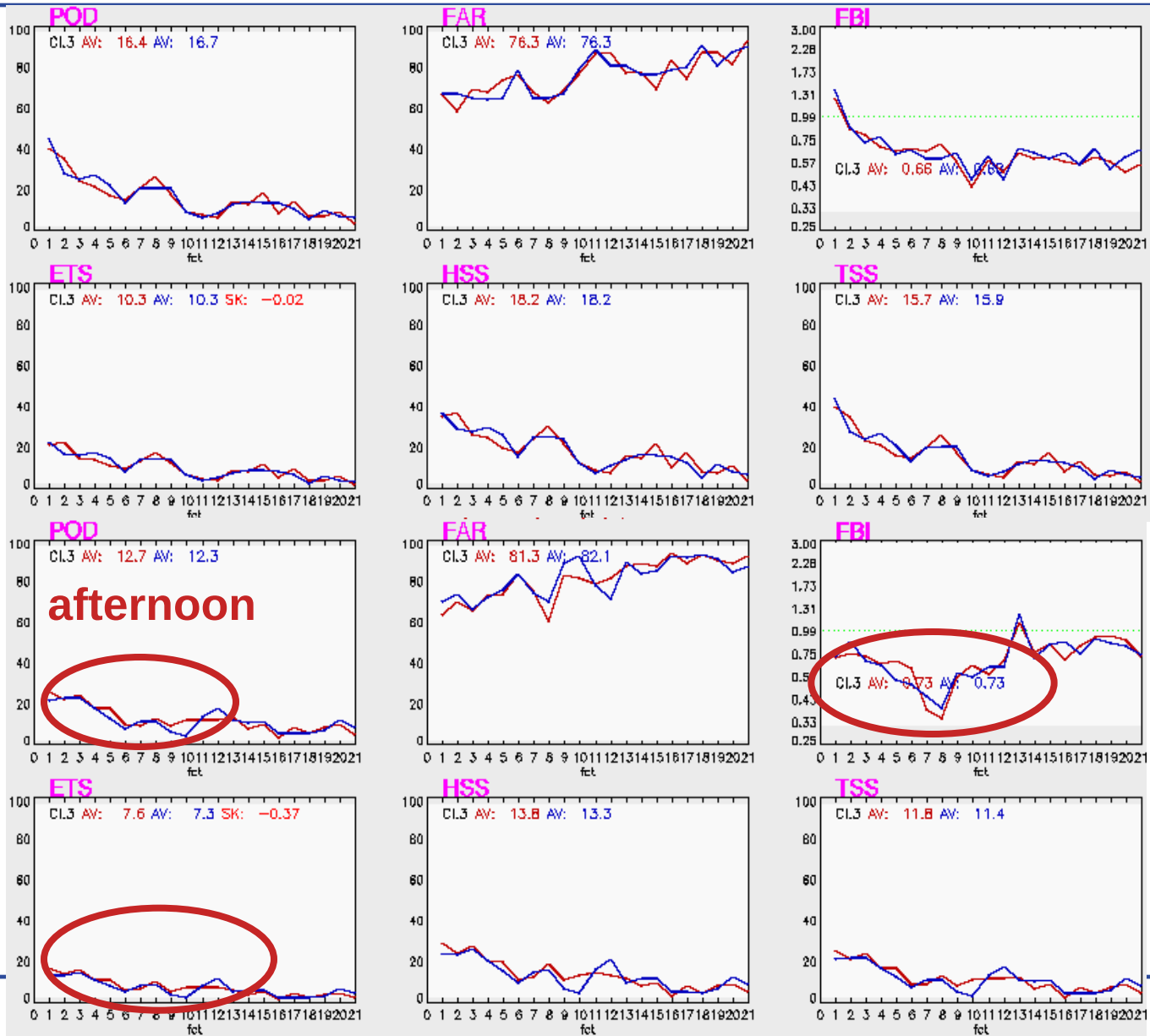
CDE 00/12 UTC DE
20.06.-21.08. ROUTI - ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Precip
> 10 mm/1h

12 UTC



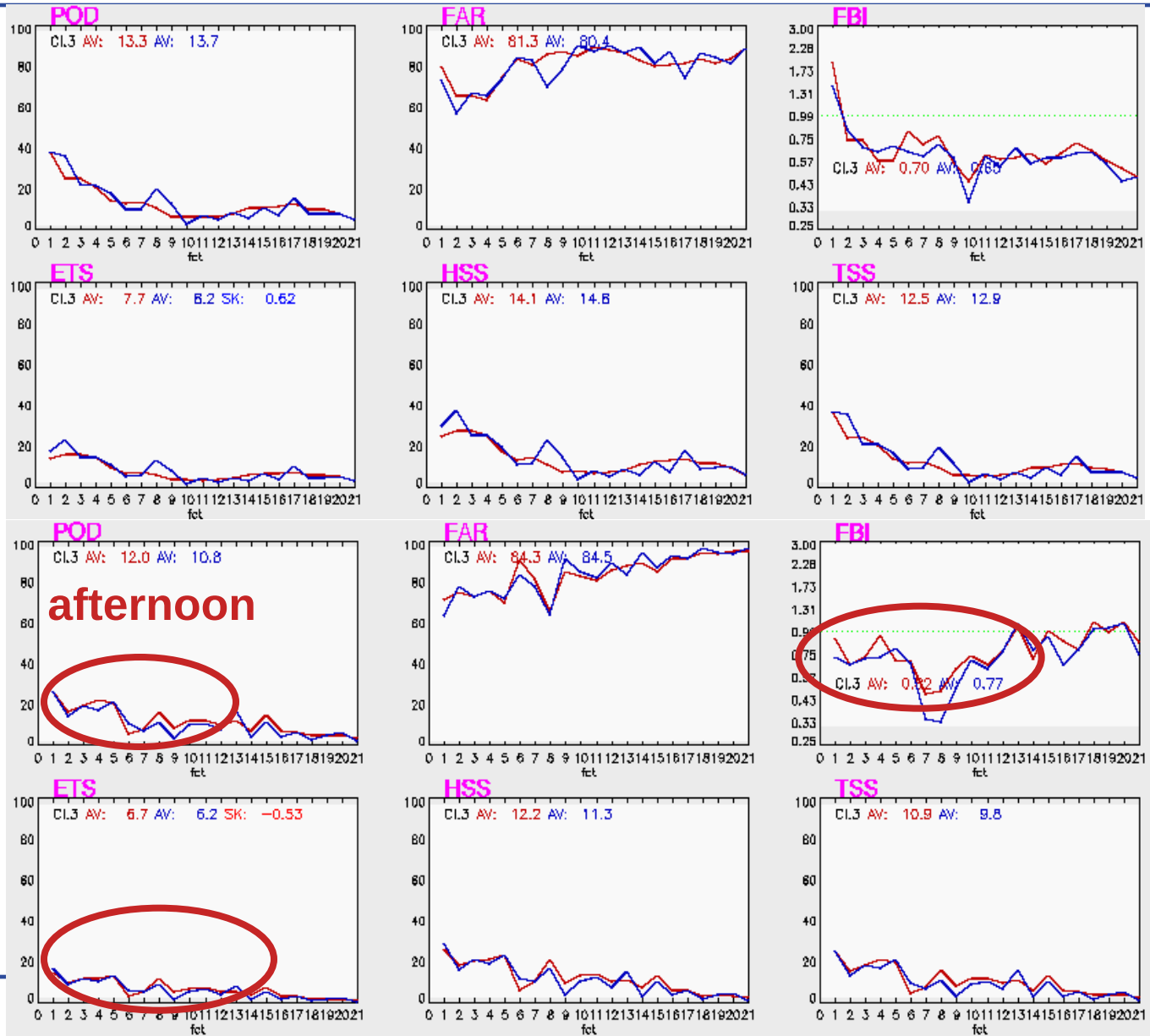
CDE 00/12 UTC DE
01.07.-14.08. ROUTP – CDEL65

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

00 UTC

Precip
> 10 mm/1h

12 UTC



Legend

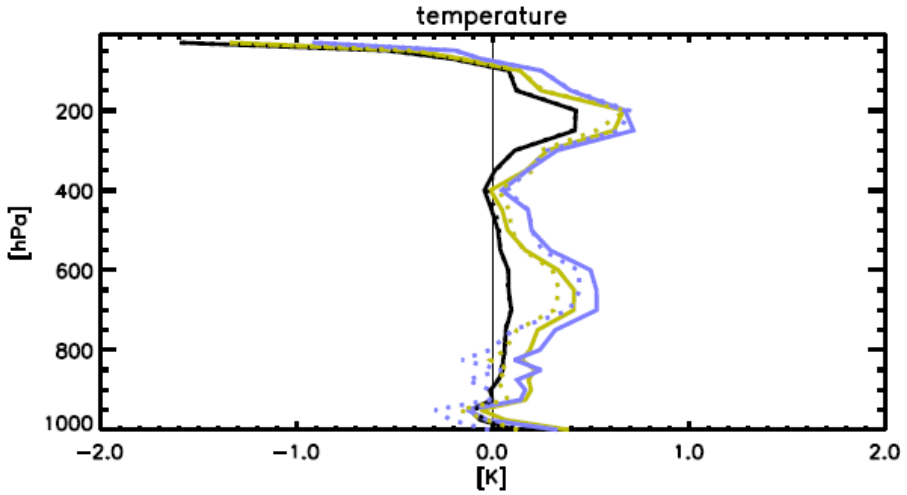
LME All 0812
+ 48 H
+ 24 H
+ 00 H

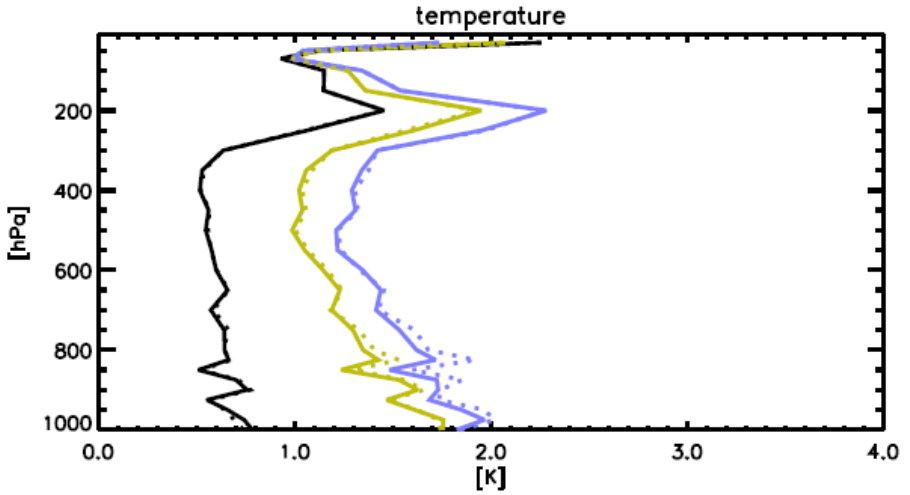
LME_PARA All 0812
+ 48 H
+ 24 H
+ 00 H

Observation

MEAN ERROR (model – obs)
ROOT MEAN SQUARE ERROR
010812 – 230812 00 UTC

created at Thu Aug 23 15:37:59 2012 by Deutscher Wetterdienst





Legend

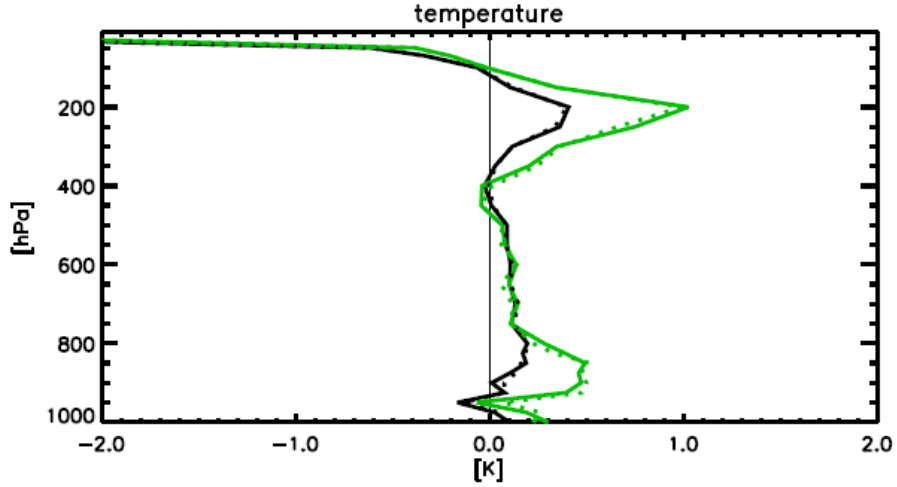
LMK All 0812
+ 12 H
+ 00 H

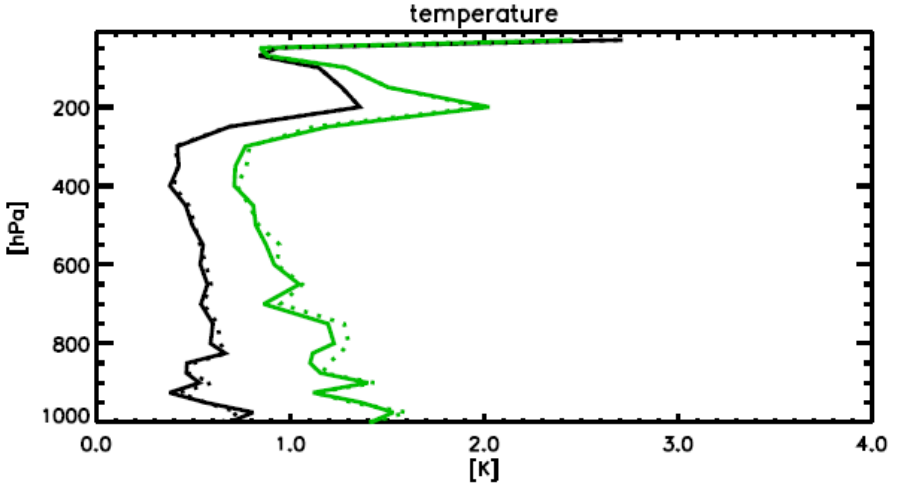
LMK_PARA All 0812
+ 12 H
+ 00 H

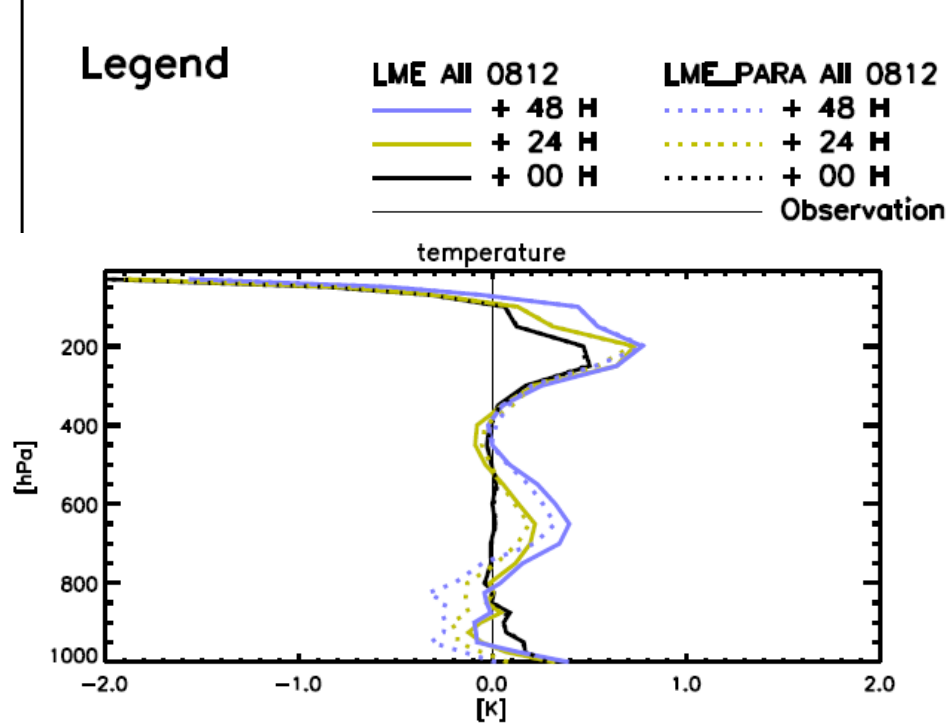
Observation

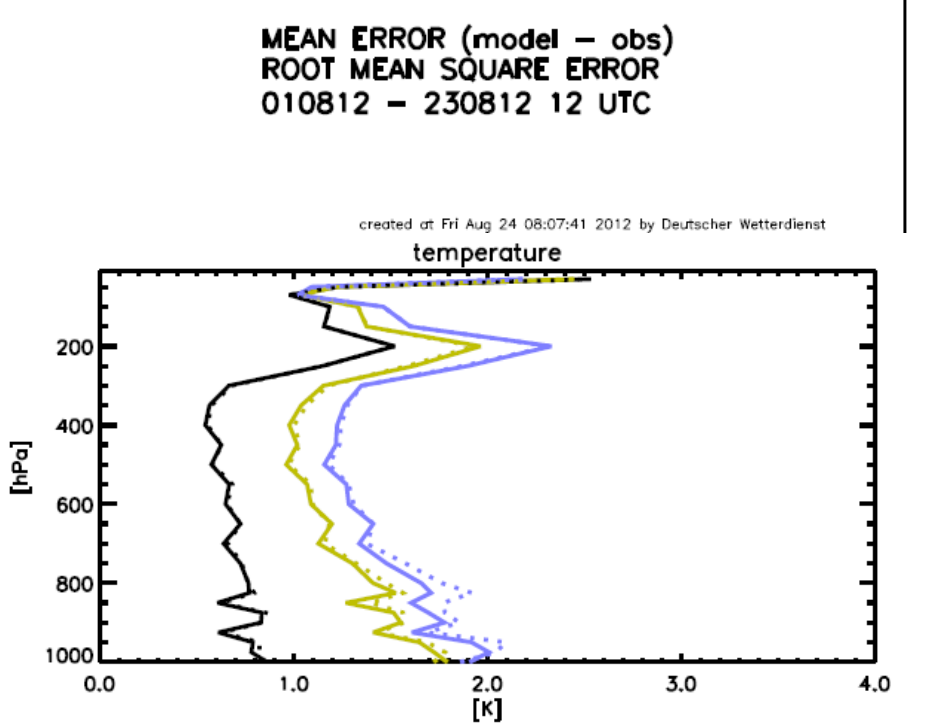
MEAN ERROR (model – obs)
ROOT MEAN SQUARE ERROR
010812 – 230812 00 UTC

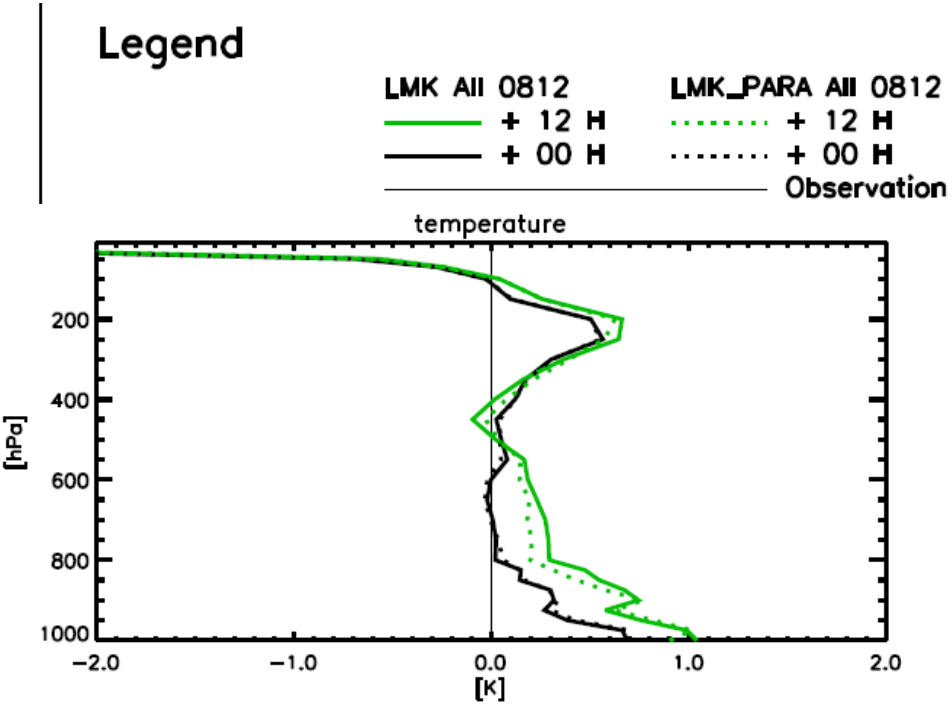
created at Thu Aug 23 15:37:01 2012 by Deutscher Wetterdienst

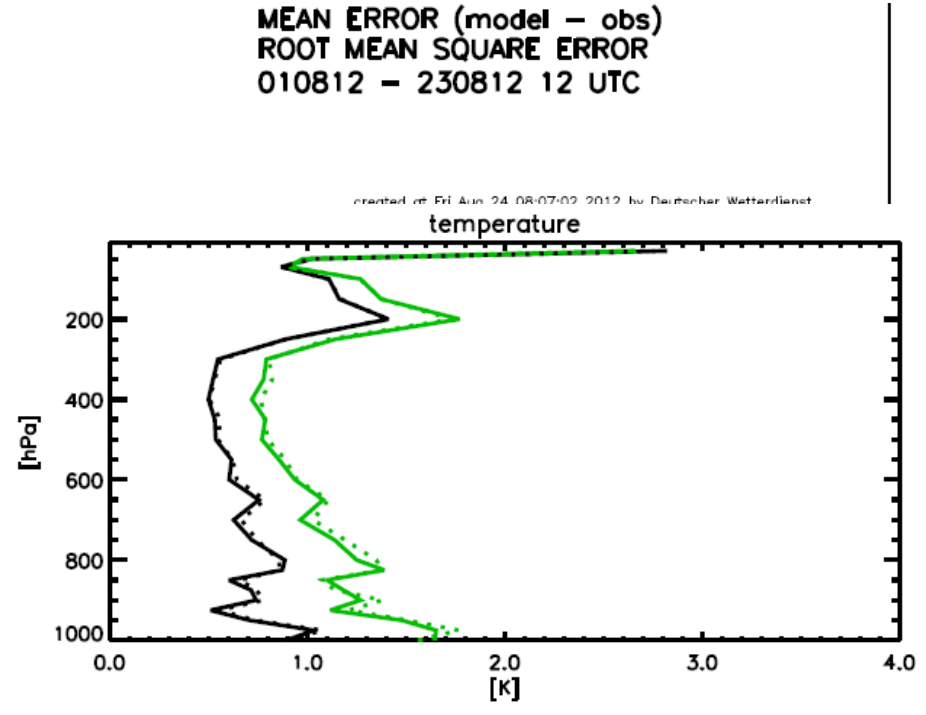





Legend
LME All 0812
+ 48 H
+ 24 H
+ 00 H
LME_PARA All 0812
+ 48 H
+ 24 H
+ 00 H
Observation
temperature
[hPa]
[K]


MEAN ERROR (model – obs)
ROOT MEAN SQUARE ERROR
010812 – 230812 12 UTC
created at Fri Aug 24 08:07:41 2012 by Deutscher Wetterdienst
temperature
[hPa]
[K]

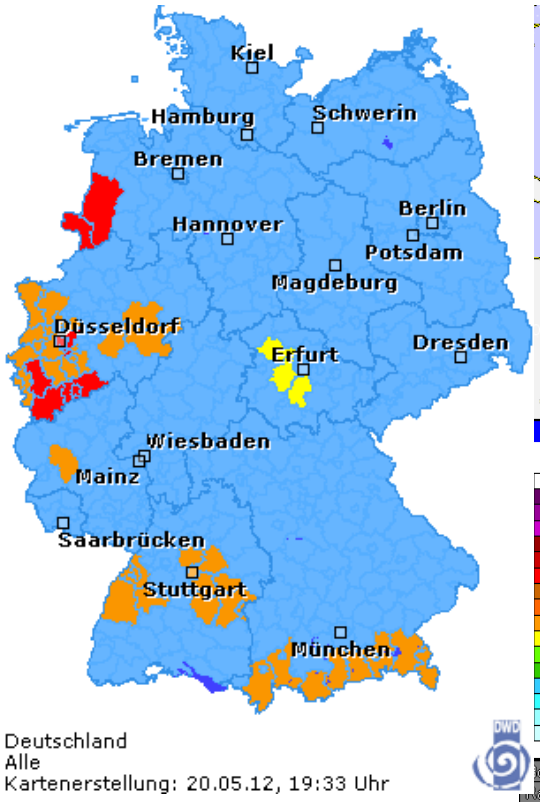

Legend
LMK All 0812
+ 12 H
+ 00 H
LMK_PARA All 0812
+ 12 H
+ 00 H
Observation
temperature
[hPa]
[K]


MEAN ERROR (model – obs)
ROOT MEAN SQUARE ERROR
010812 – 230812 12 UTC
temperature
[hPa]
[K]

Severe weather case studies

Case Study
COSMO-DE Precipitation
20.05.2012

Case Study 20120520



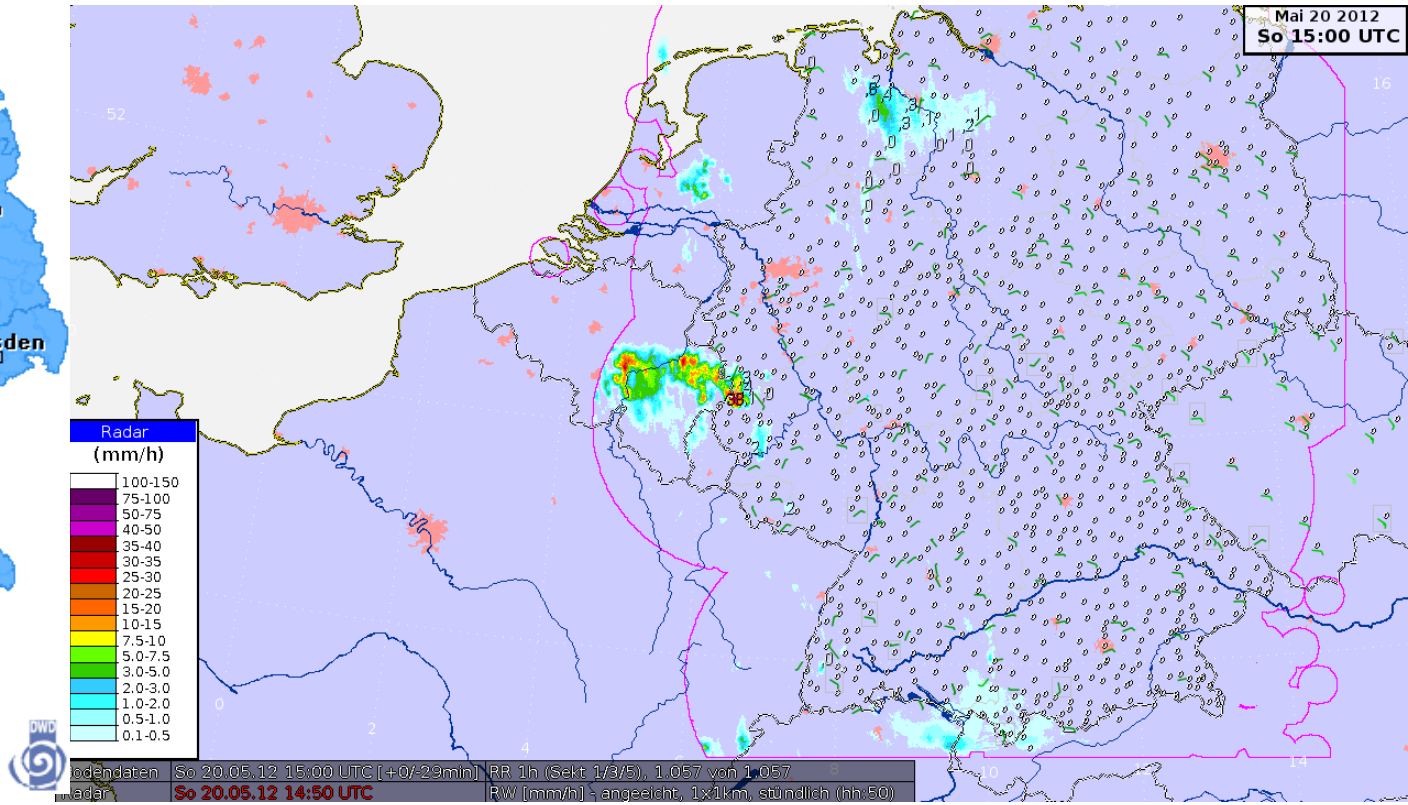
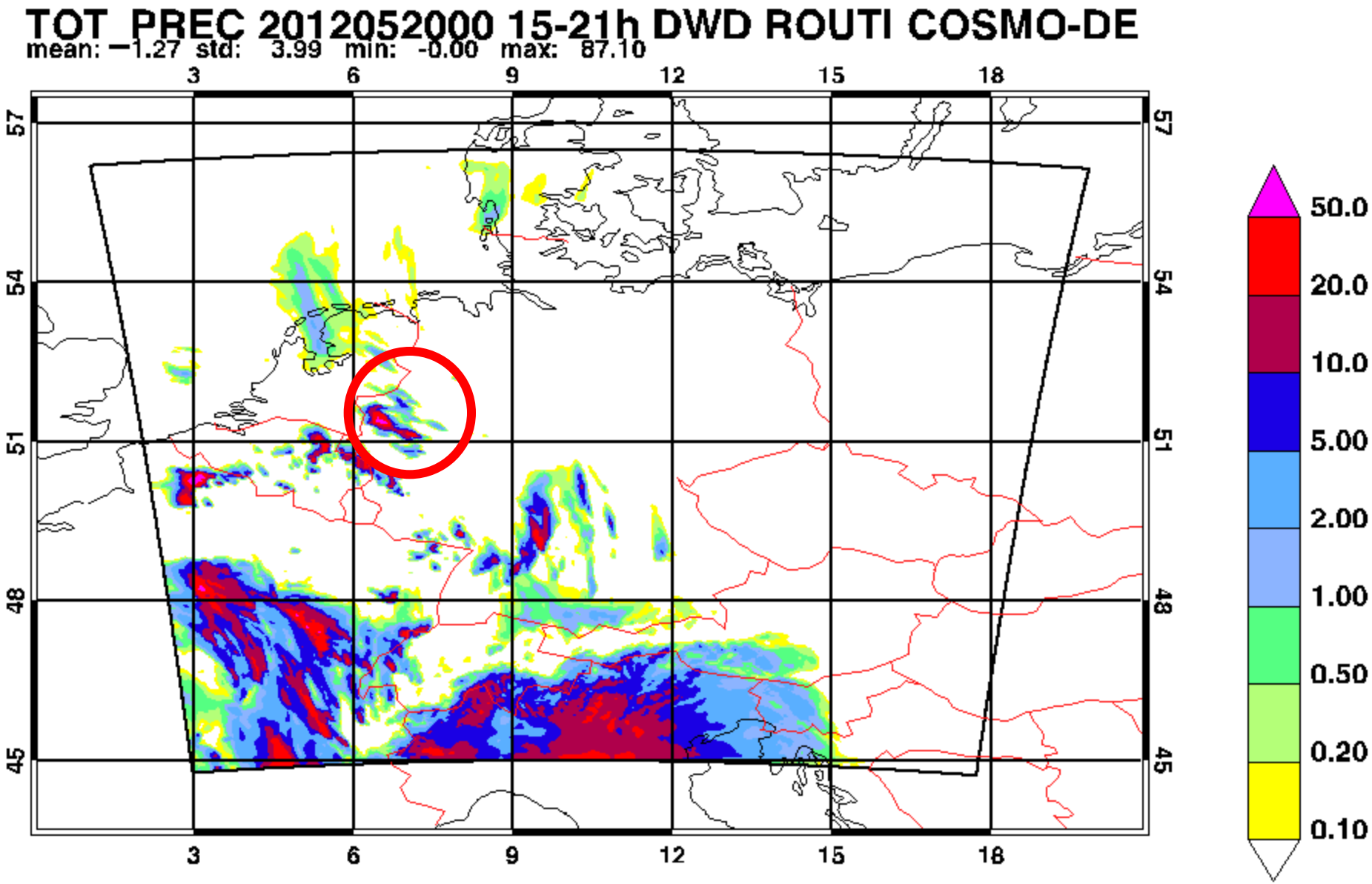


Abb3: 1. std. Niederschläge Messnetz, angeeichtes Niederschlagsbild RW [mm/h]

Quelle: Sofortbericht 20.05.2012

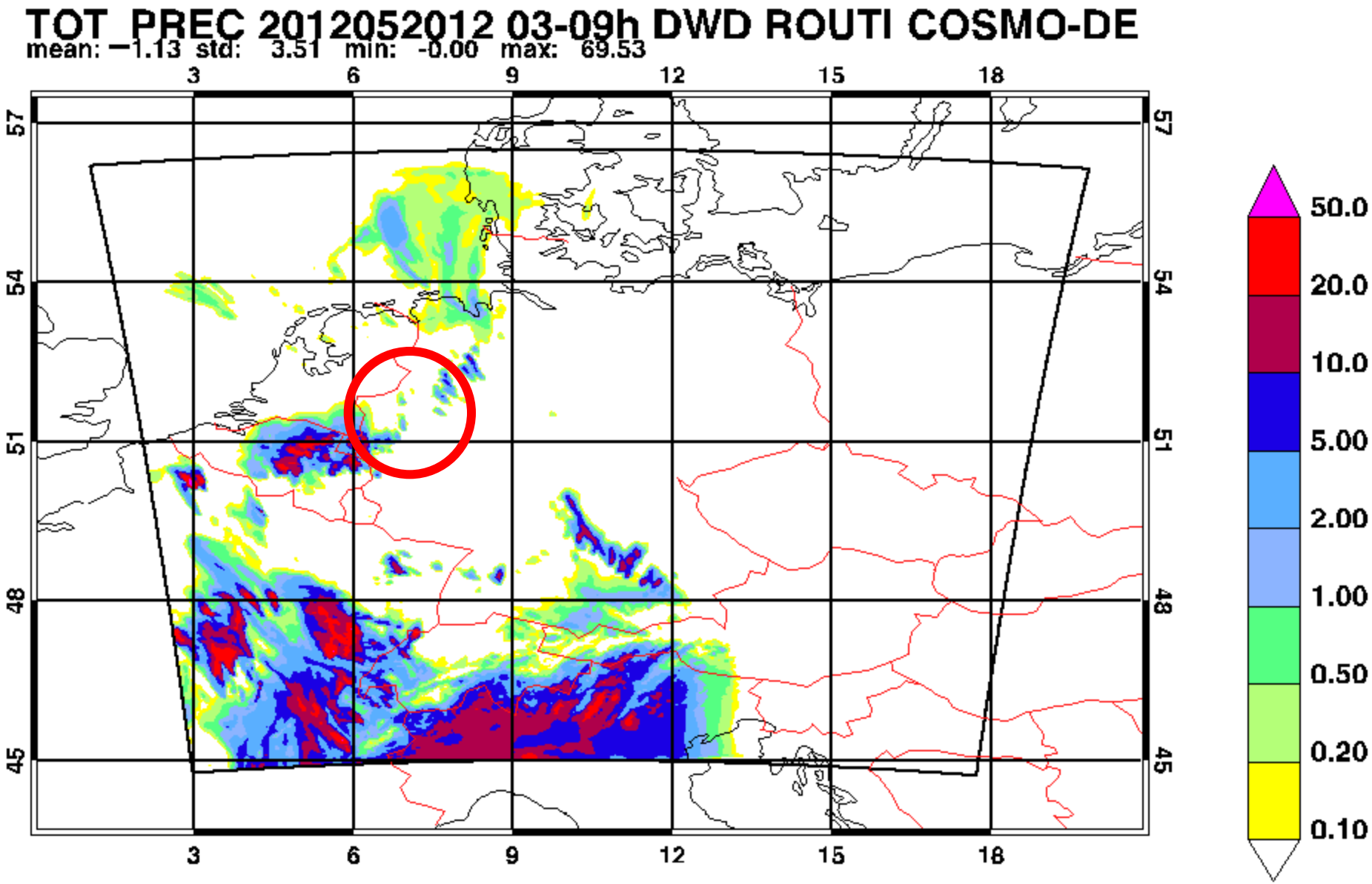
Case Study 20120520 6h TOTPREC
00 UTC run ROUTI

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



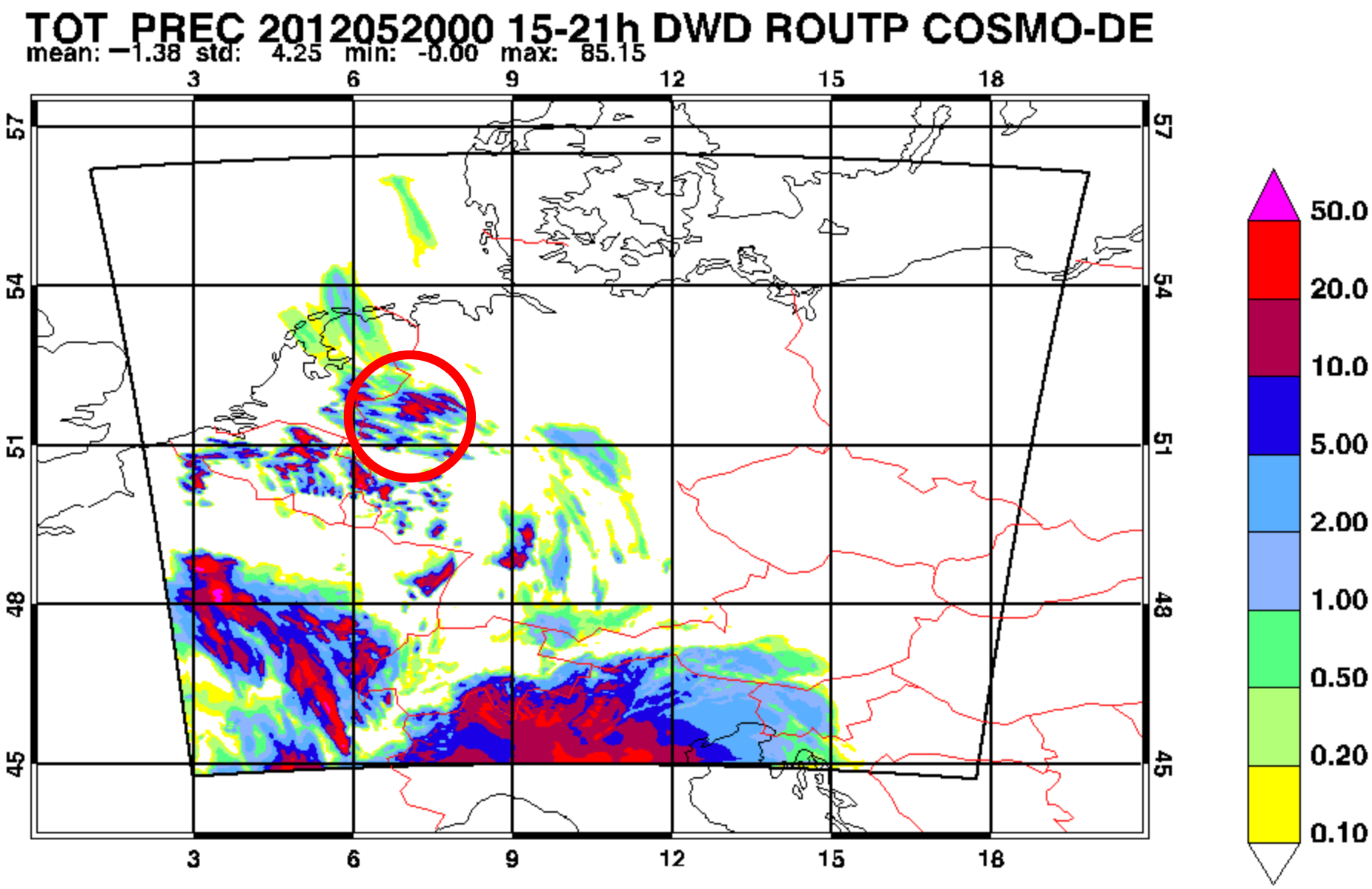
Case Study 20120520
12 UTC run ROUTI

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



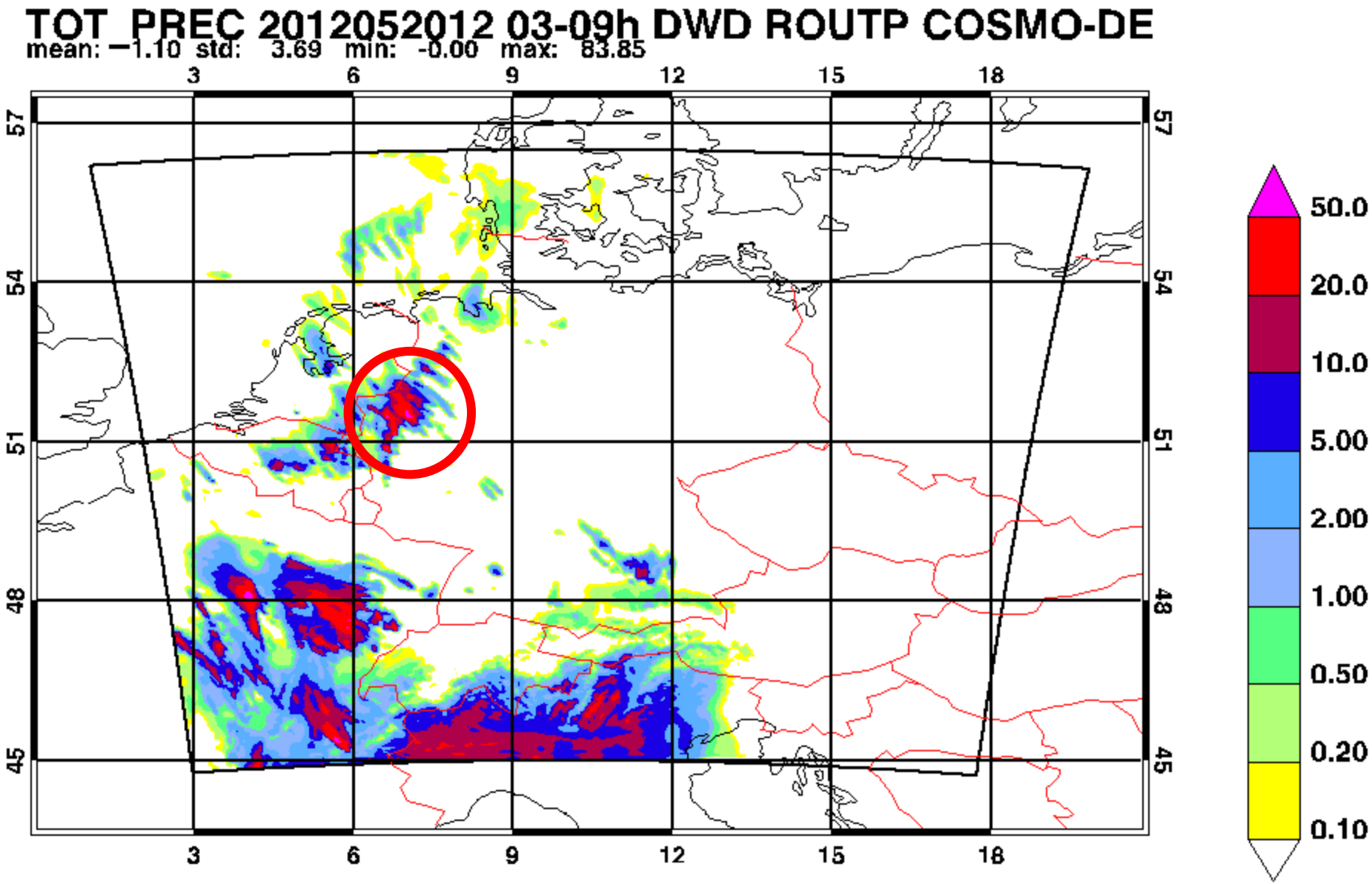
Case Study 20120520
00 UTC run ROUTP

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

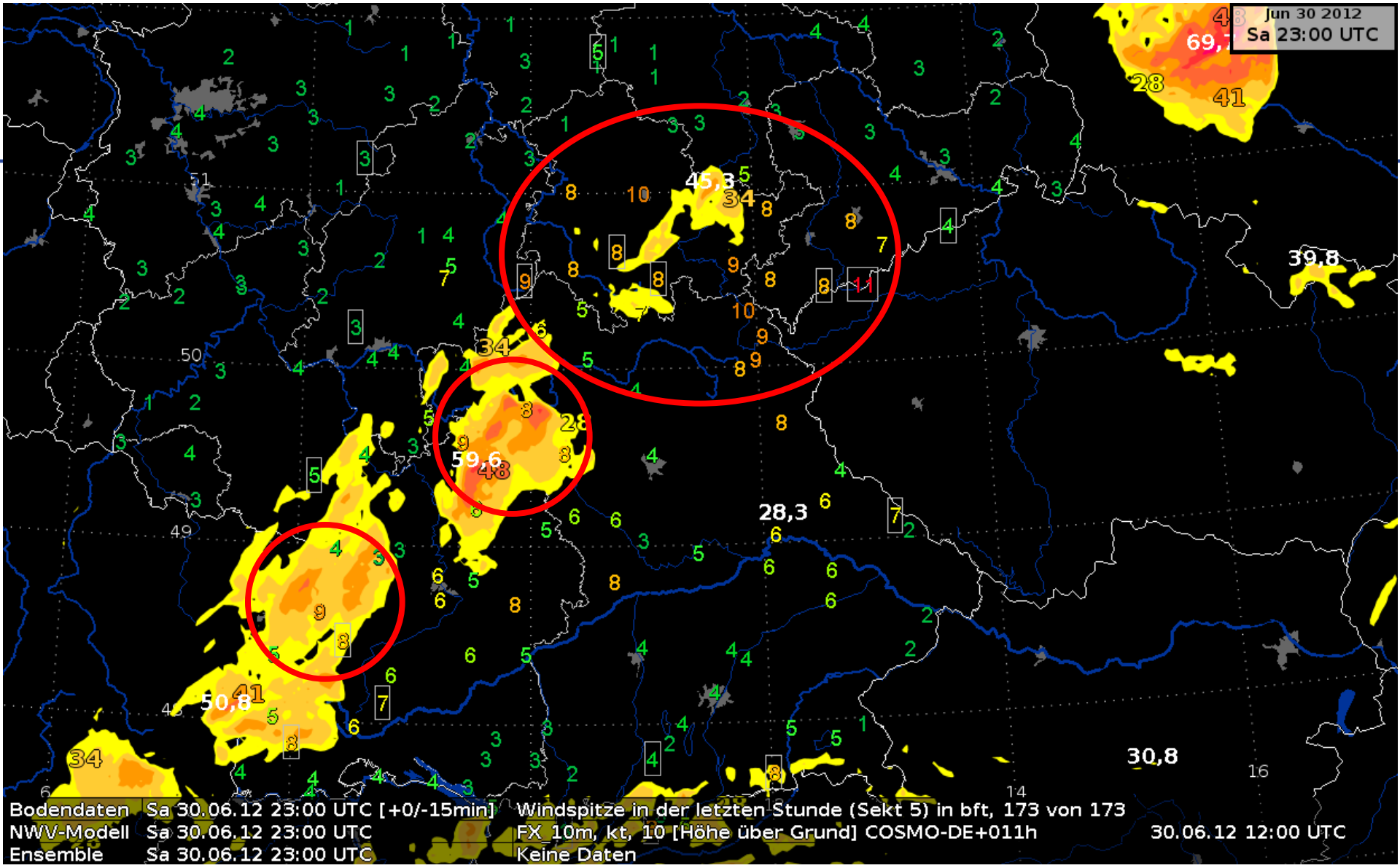


Case Study 20120520
12 UTC run ROUTP

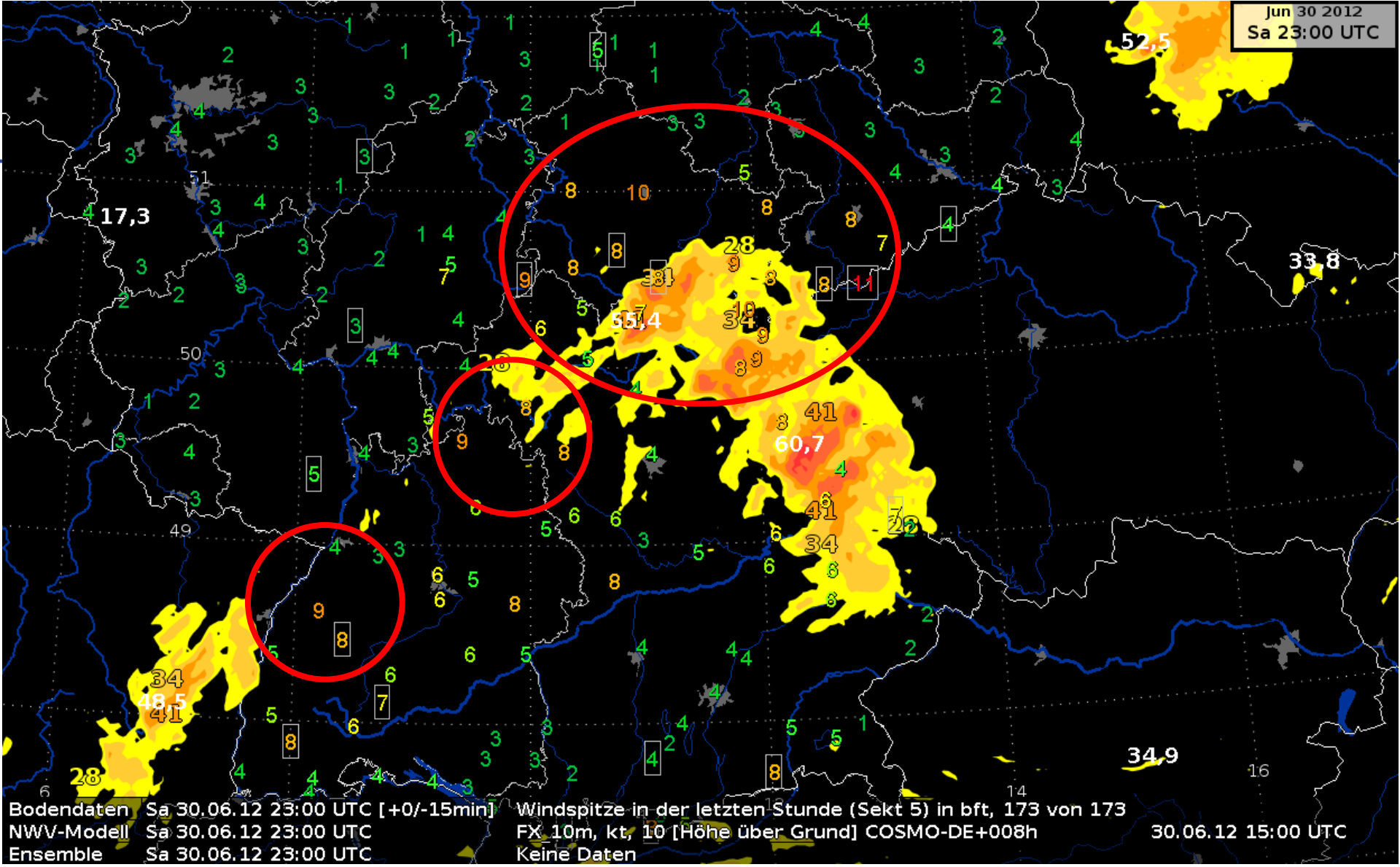
CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



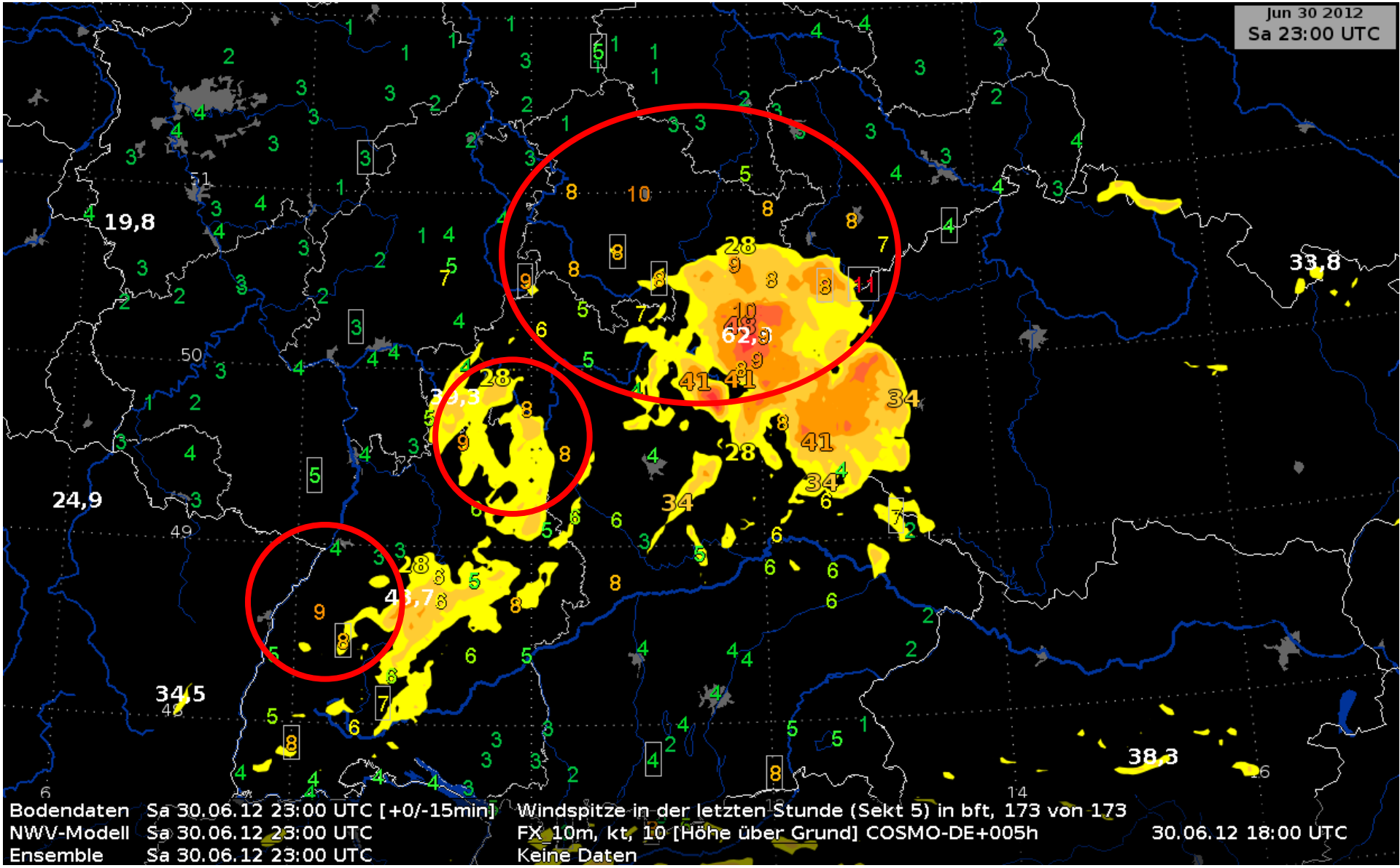
Case Study
COSMO-DE Gusts
30.06.2012



fx, 30.06.2012, 23 UTC (Beobachtungen) + COSMO-DE, 30.06., 12 + 11 H



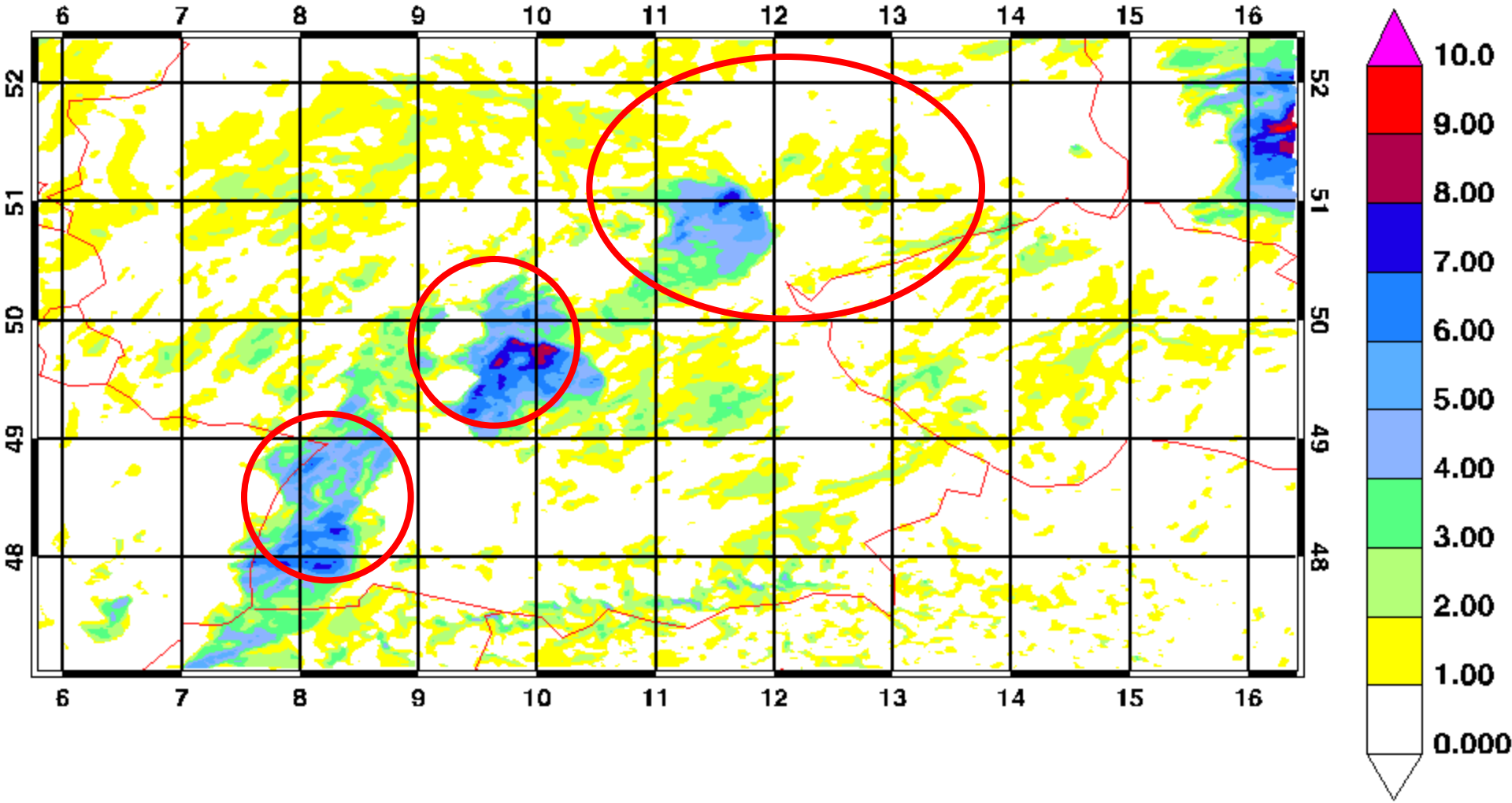
fx, 30.06.2012, 23 UTC (Beobachtungen) + COSMO-DE, 30.06., 15 + 08 H



fx, 30.06.2012, 23 UTC (Beobachtungen) + COSMO-DE, 30.06., 18 + 05 H

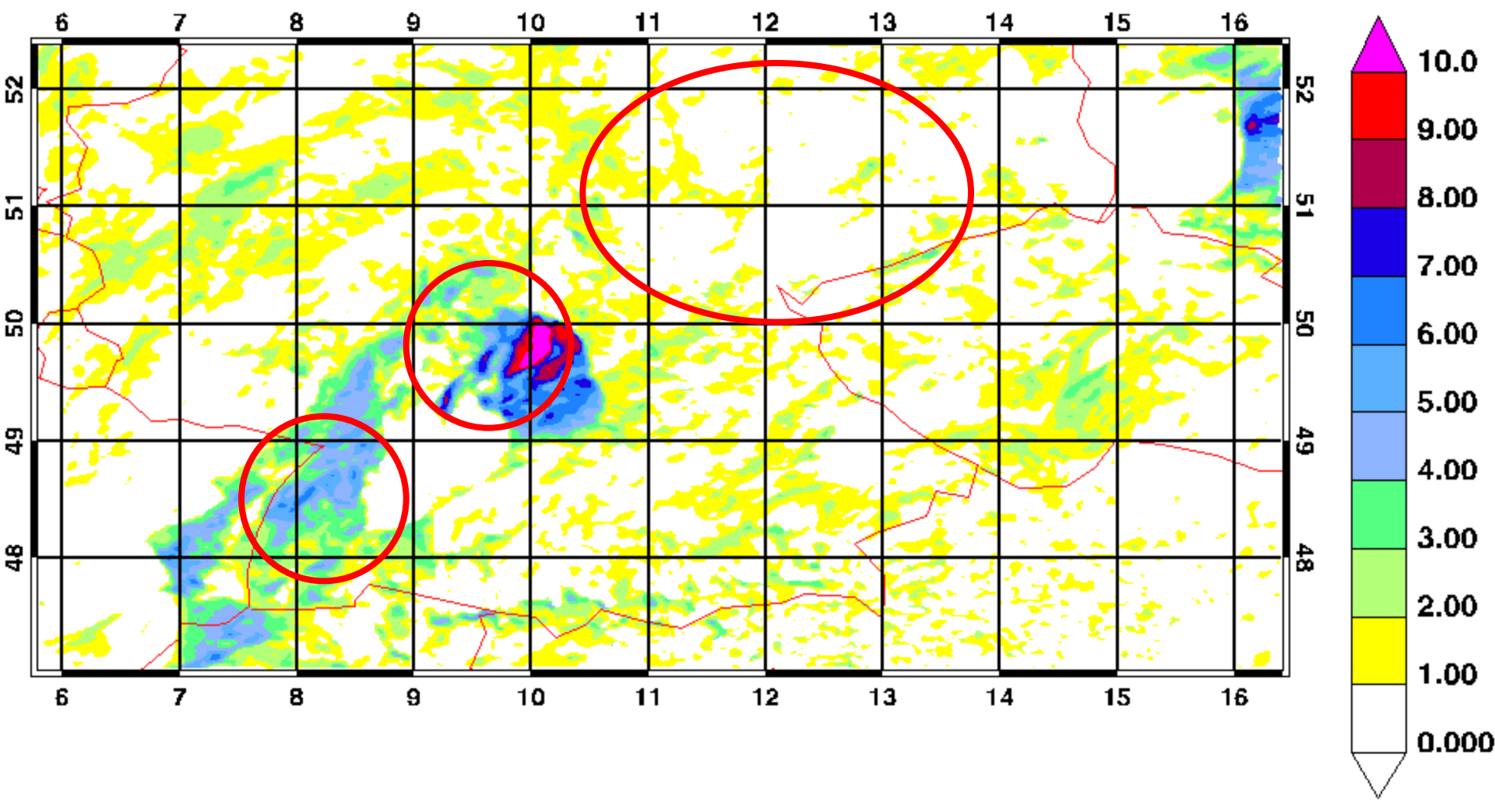
CDE 12 UTC RUN 1h VMAX

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



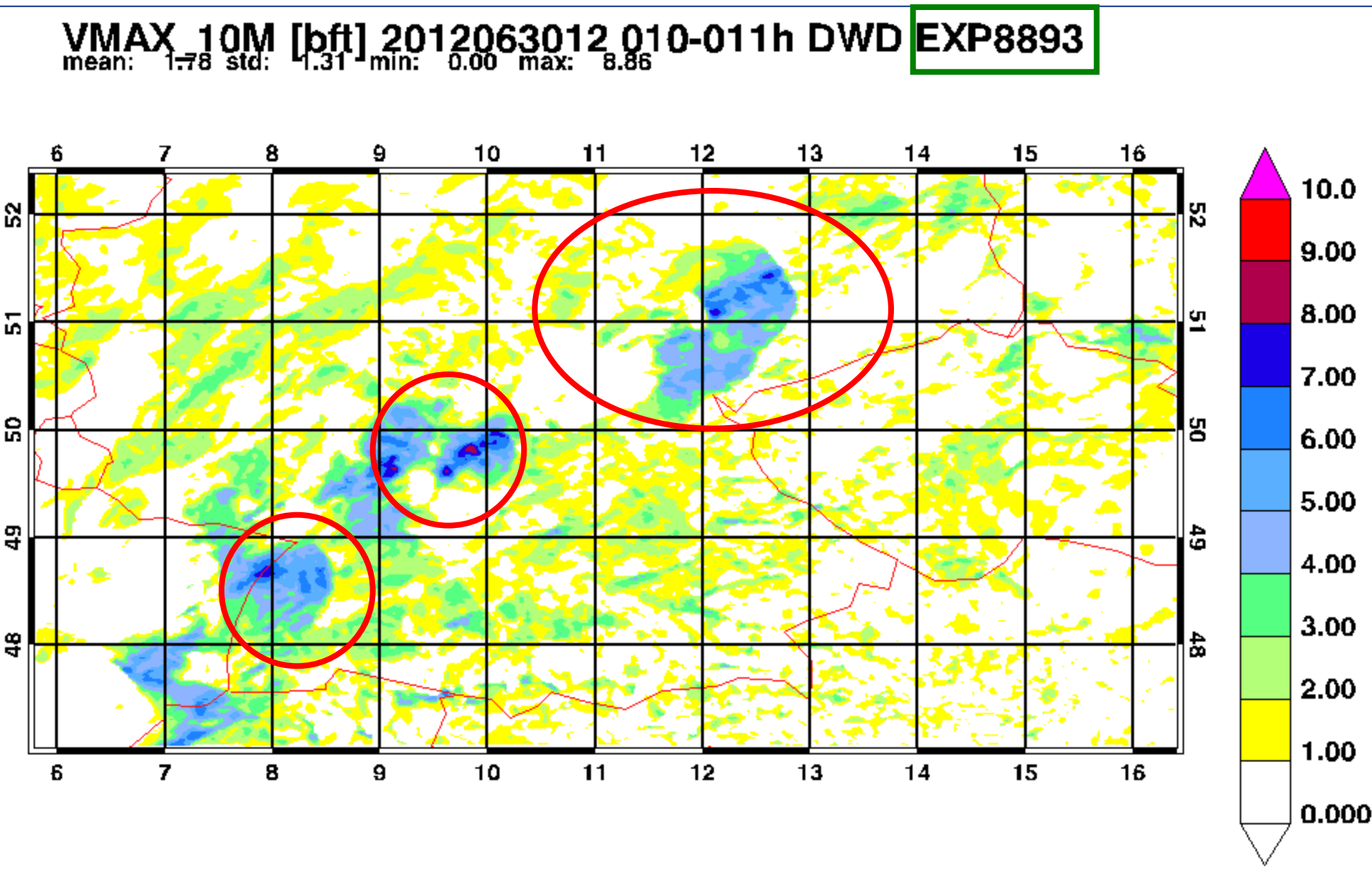
CDE 12 UTC RUN 1h VMAX

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

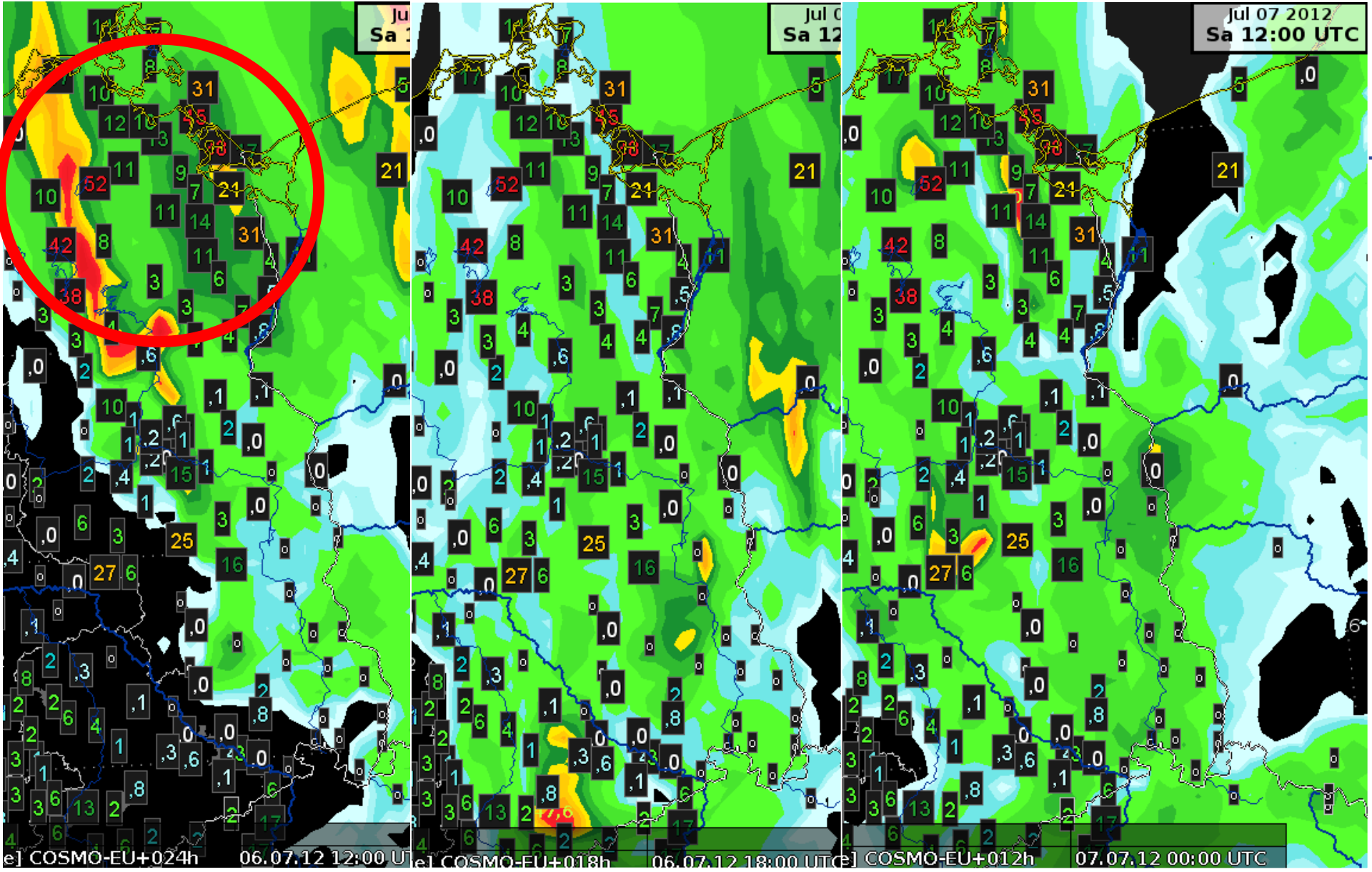


CDE 12 UTC RUN 1h VMAX

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



Case Study
COSMO-EU/DE Precipitation
07.07.2012

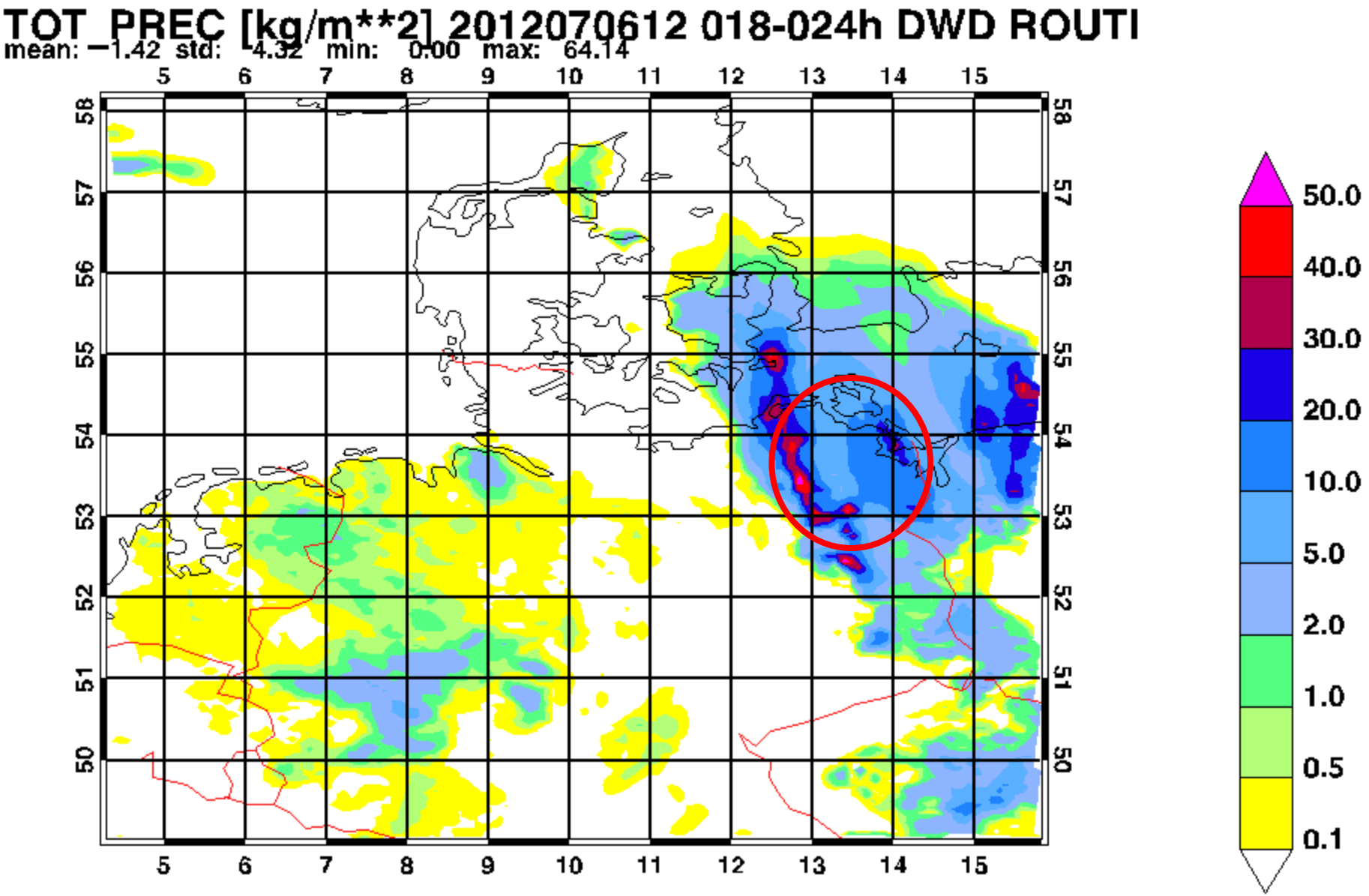


07.07., 12 UTC: 6-std. Niederschlag (Beobachtungen) + COSMO-EU

06.07., 12 UTC **06.07., 18 UTC** **07.07., 00 UTC**

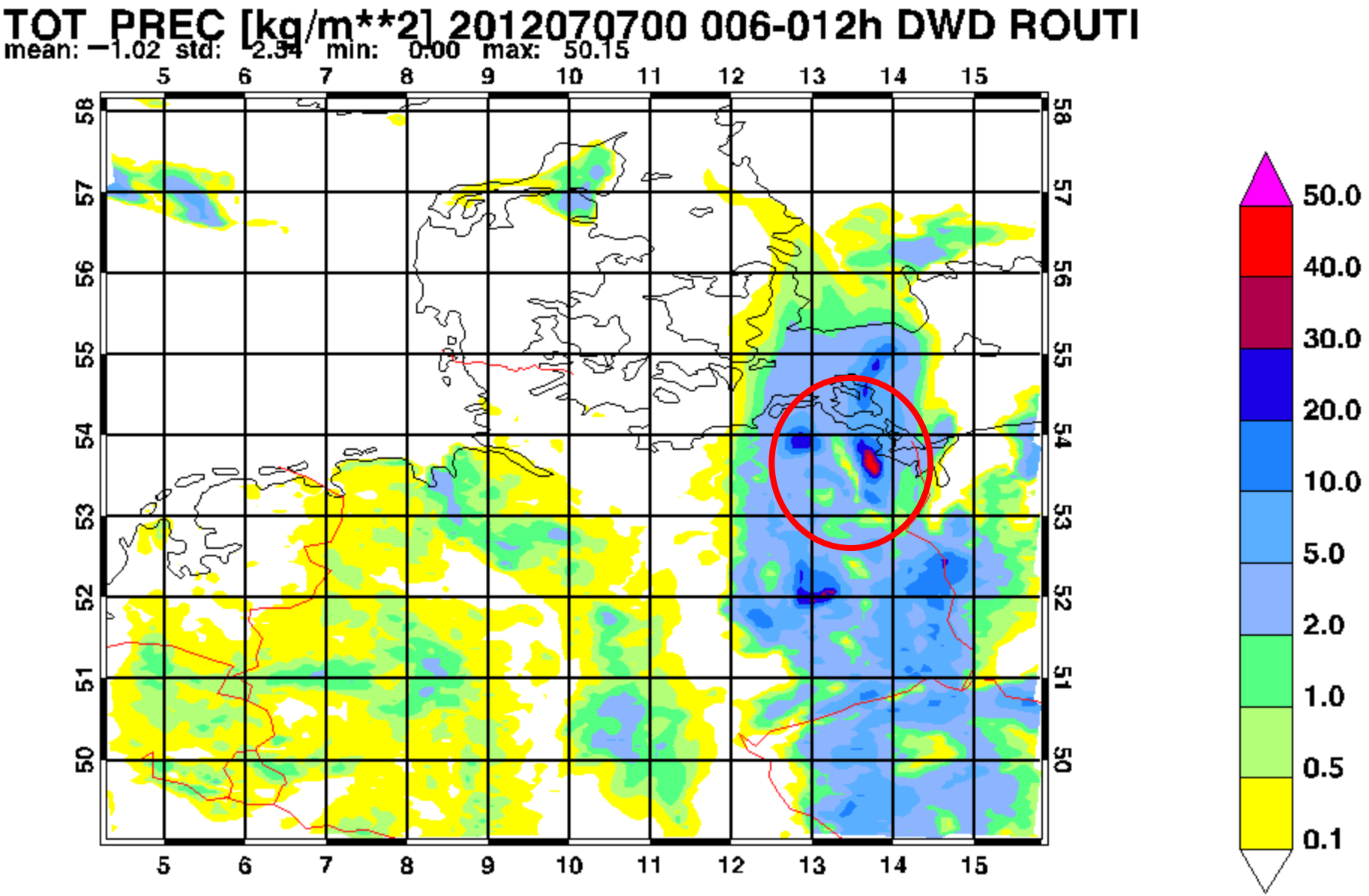
CEU 12 UTC RUN 6h TOT_PREC

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



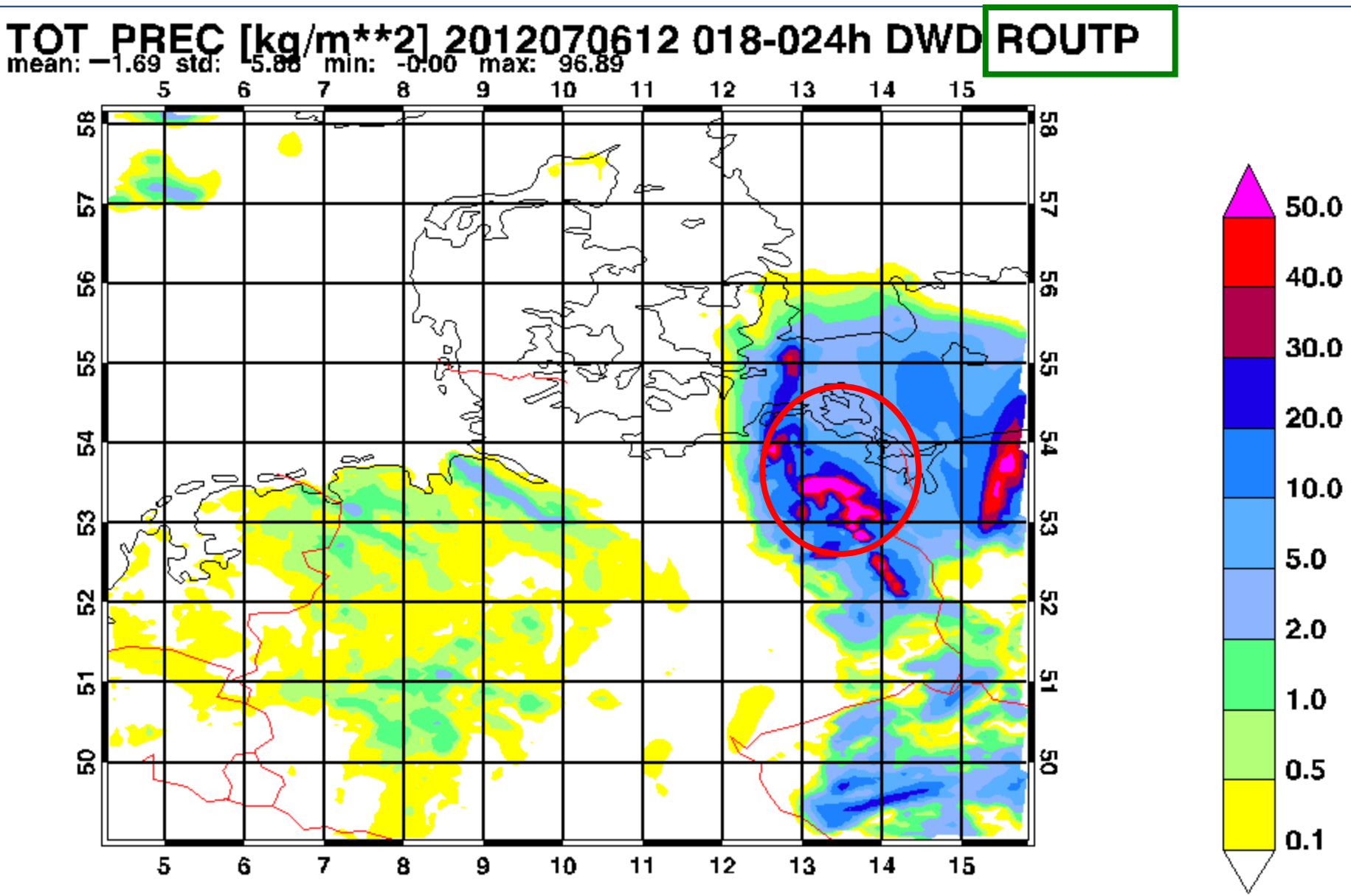
CEU 00 UTC RUN 6h TOT_PREC

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



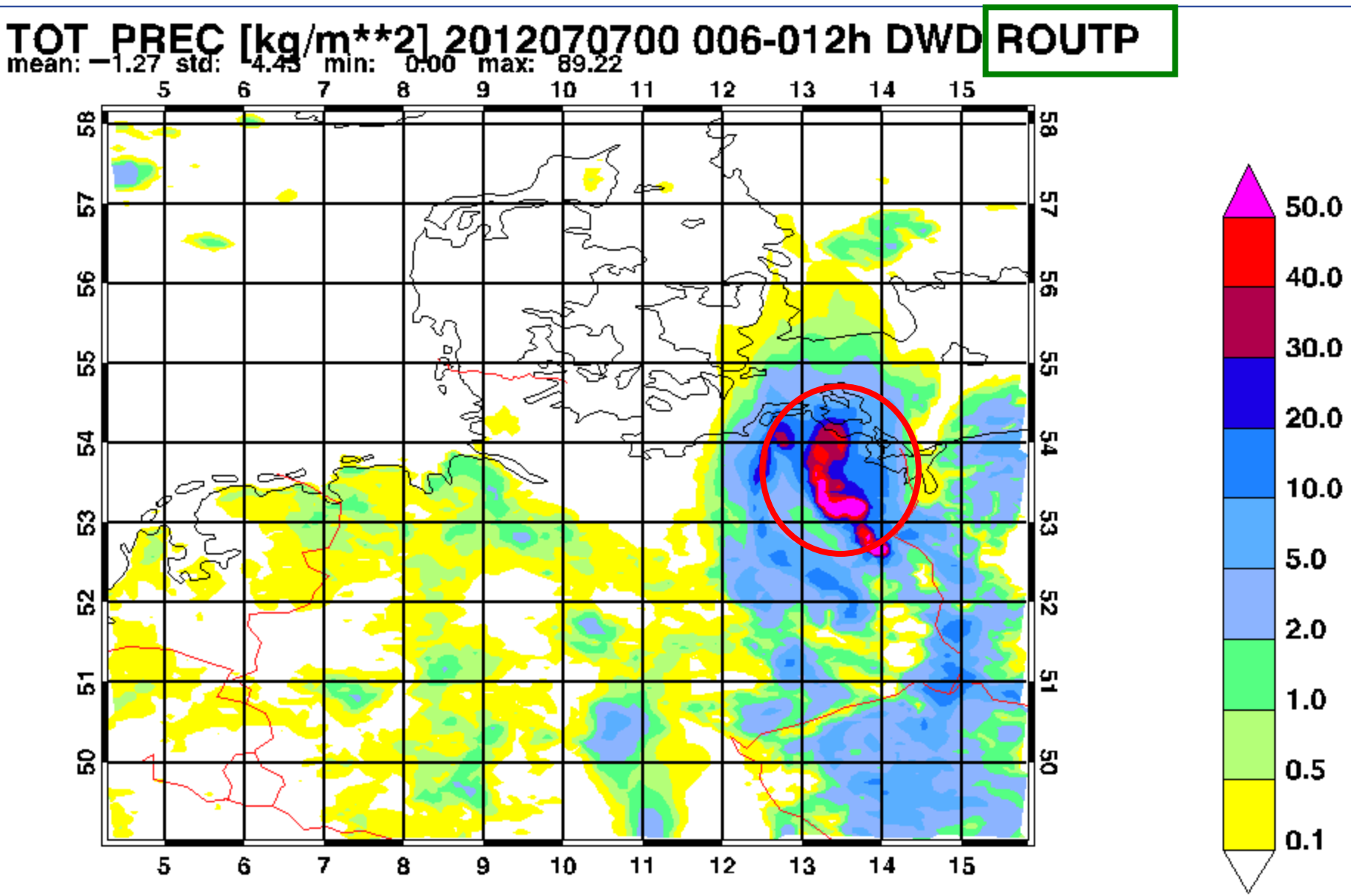
CEU 12 UTC RUN 6h TOT_PREC

CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



CEU 00 UTC RUN 6h TOT_PREC

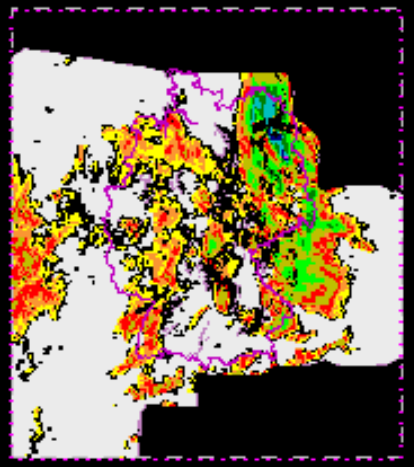
CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

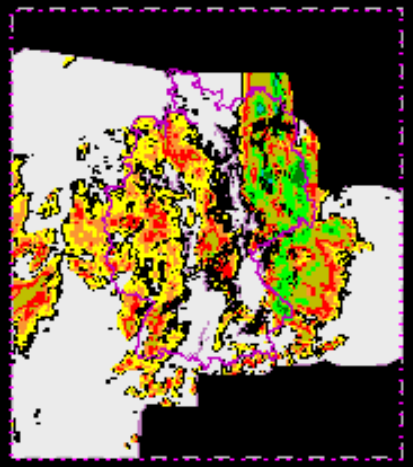


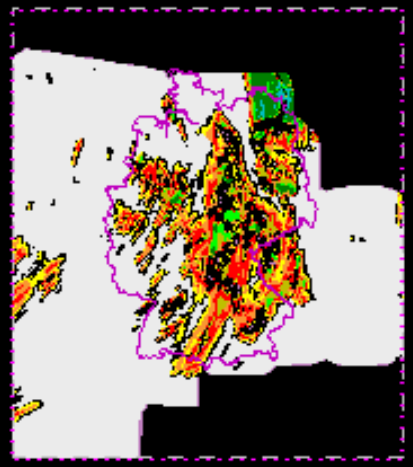
Experiment: PARA NP:126181
AV: 0.948 MA:89.210 STD: 0.608

Routine: lm2mo NP:126181
AV: 0.766 MA:41.180 STD: 0.562

RADAR NP:126181
AV: 0.581 MA:37.210 STD: 0.510







0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

Routine−PARA
AV: 0.12 MIN:−32.61 MAX: 85.88

-10
-5
-2
-1

1
2
5
10

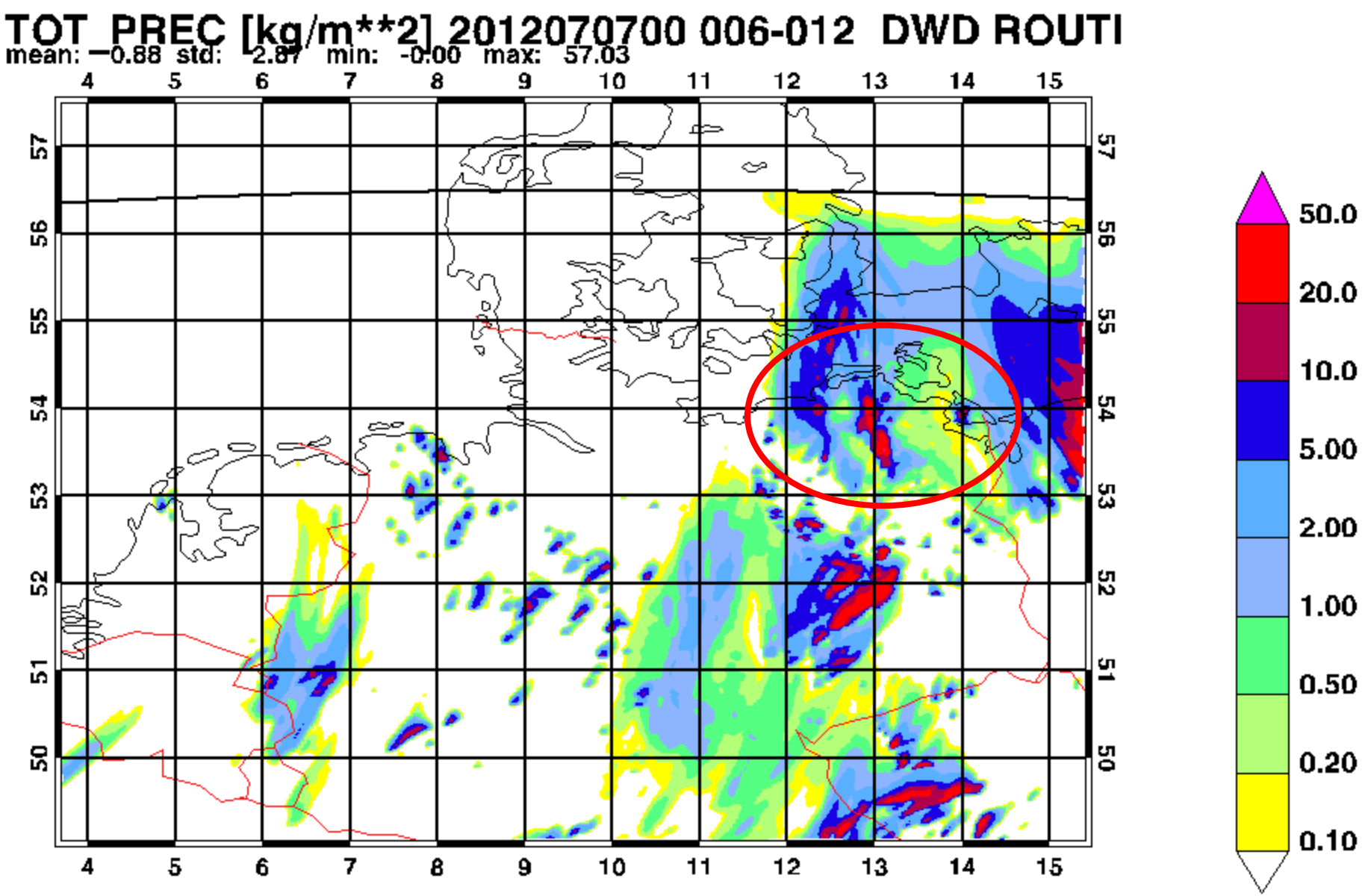
Mod Thr	PARA	lm2mo	
0.0	1.65	1.70	FBI
0.5	1.56	1.58	
1.0	1.55	1.53	
2.0	1.84	1.86	
5.0	1.62	1.46	
10.0	0.90	0.48	
20.0	1.89	0.45	
50.0	---	---	
100.0	---	---	
0.0	18.64	18.75	ETS
0.5	13.52	14.42	
1.0	13.48	15.72	
2.0	15.64	15.79	
5.0	18.98	9.66	
10.0	20.37	6.64	
20.0	4.30	6.98	
50.0	---	---	
100.0	---	---	

Forecasts of precipitation Start: 07.07.2012 00 UTC VV=006 - VV=012

Plot time: 09.07.2012 06:51:38 MESZ

CDE 00 UTC RUN 6h TOT_PREC

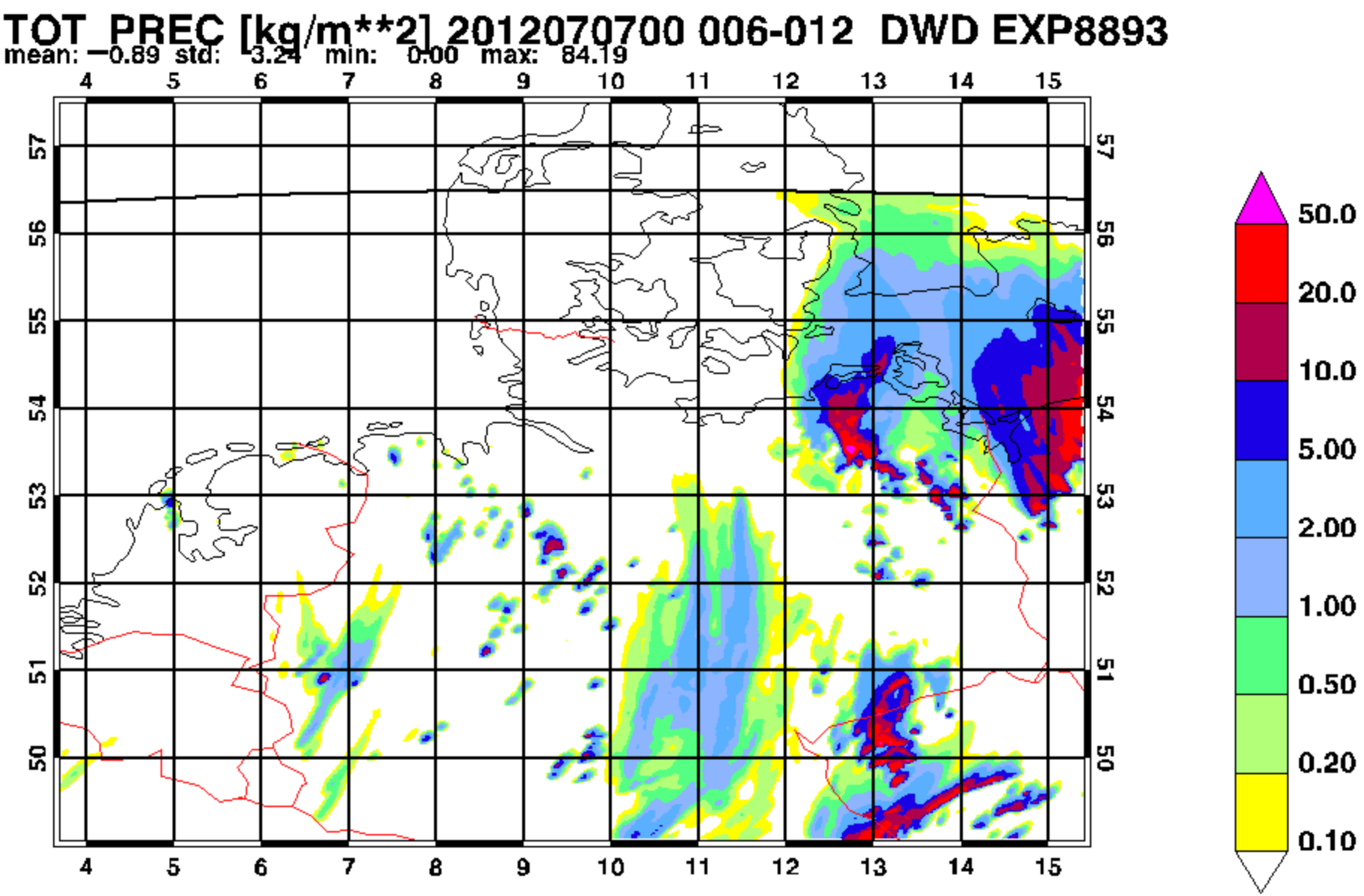
CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD



CDE 00 UTC RUN 6h TOT_PREC

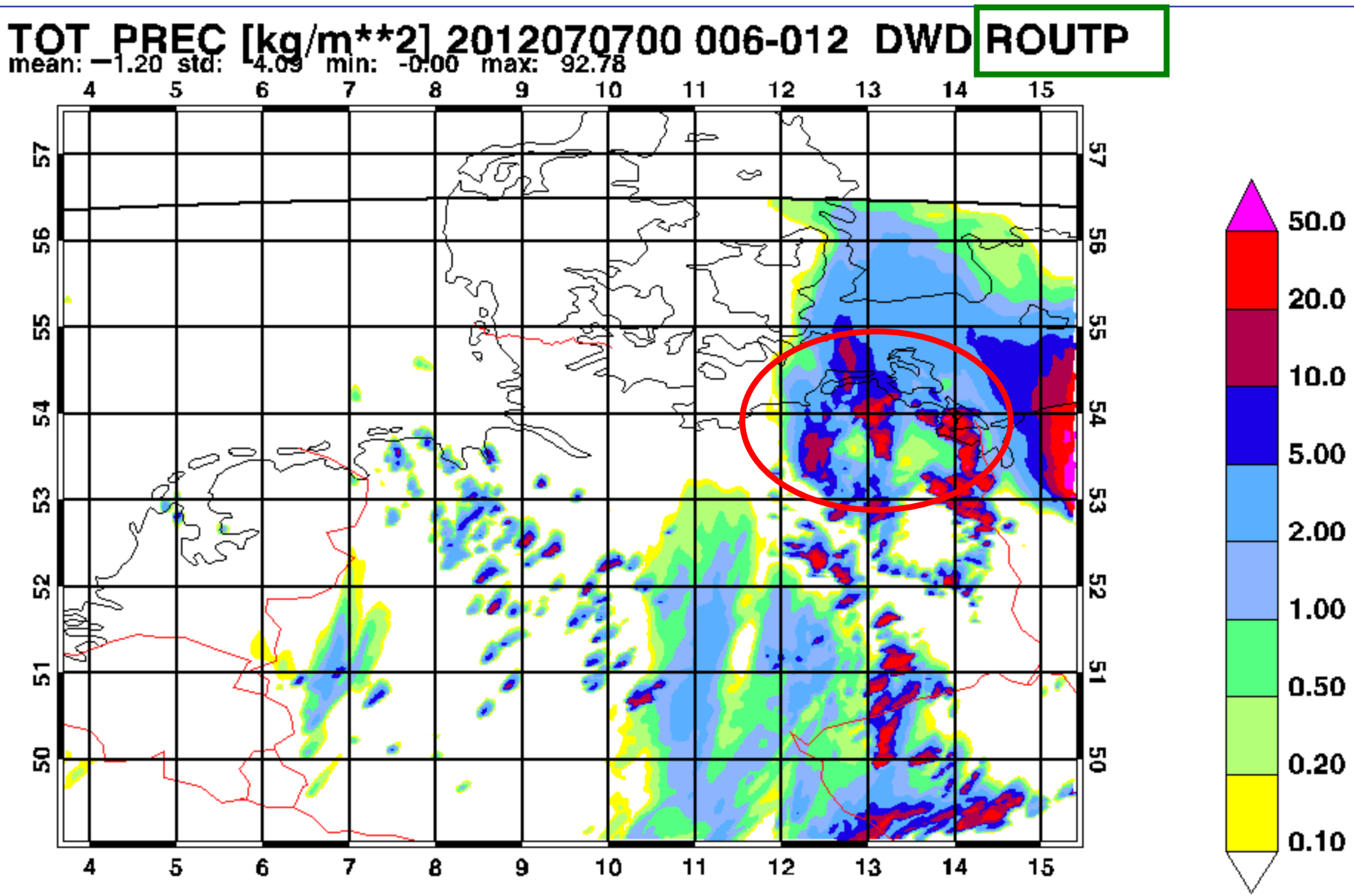
CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD



CDE 00 UTC RUN 6h TOT_PREC

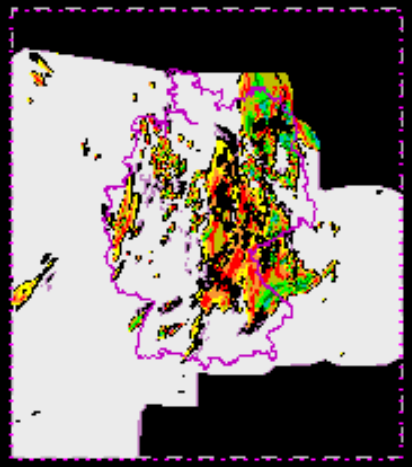
CONSORTIUM FOR SMALL SCALE MODELING
COSMO
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

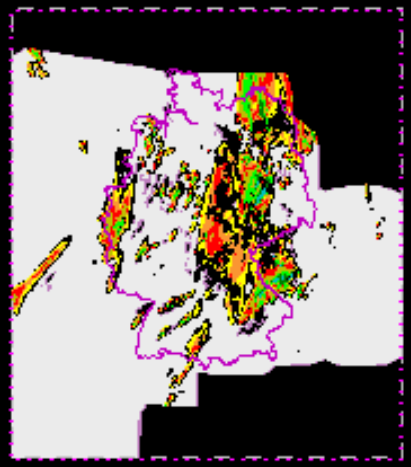


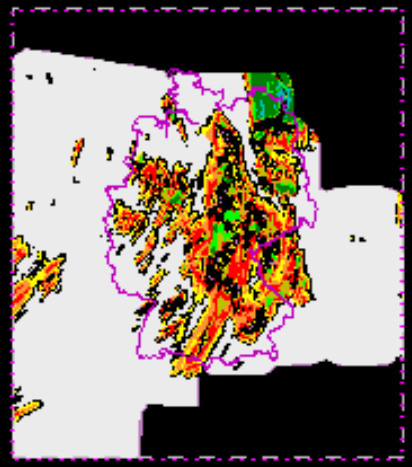
Experiment: para NP:125742
AV: 0.526 MA:75.670 STD: 0.496

Routine: lm3mo NP:125739
AV: 0.382 MA:57.030 STD: 0.428

RADAR NP:126181
AV: 0.581 MA:37.210 STD: 0.510

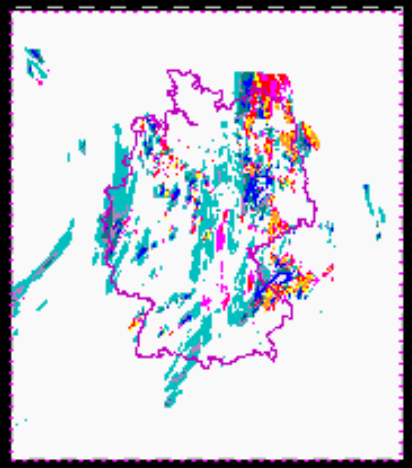






0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

Routine−para
AV: 0.09 MIN:−57.02 MAX: 75.02



-10
-5
-2
-1

1
2
5
10

Mod Thr	para	lm3mo	
0.0	0.71	0.72	
0.5	0.74	0.67	
1.0	0.81	0.67	
2.0	0.99	0.78	
5.0	0.99	0.73	FBI
10.0	0.75	0.40	
20.0	1.37	0.68	
50.0	---	---	
100.0	---	---	
0.0	36.34	33.97	
0.5	32.91	25.56	
1.0	28.53	18.14	
2.0	25.38	11.48	
5.0	14.35	4.76	ETS
10.0	8.13	2.88	
20.0	4.17	3.06	
50.0	---	---	
100.0	---	---	

Forecasts of precipitation Start: 07.07.2012 00 UTC VV=006 - VV=012

Plot time: 09.07.2012 07:21:33 MESZ

Conclusions

COSMO model configuration with new aerosol climatology - operational in GME, ECMWF

- improves reliability of forecasts in severe weather situations claimed by forecasters
- higher model forecast consistency between runs
- more reasonable physics, sharing between GME and COSMO
- higher RMSE for T_2M and TD_2M but improved verification scores for pressure, mean wind bias and strong gusts

Thank you