

## **Revision of the COSMO External Parameters and Land- Surface Scheme**

J. Helmert, G. Vogel, H. Asensio, B. Fay, B. Ritter

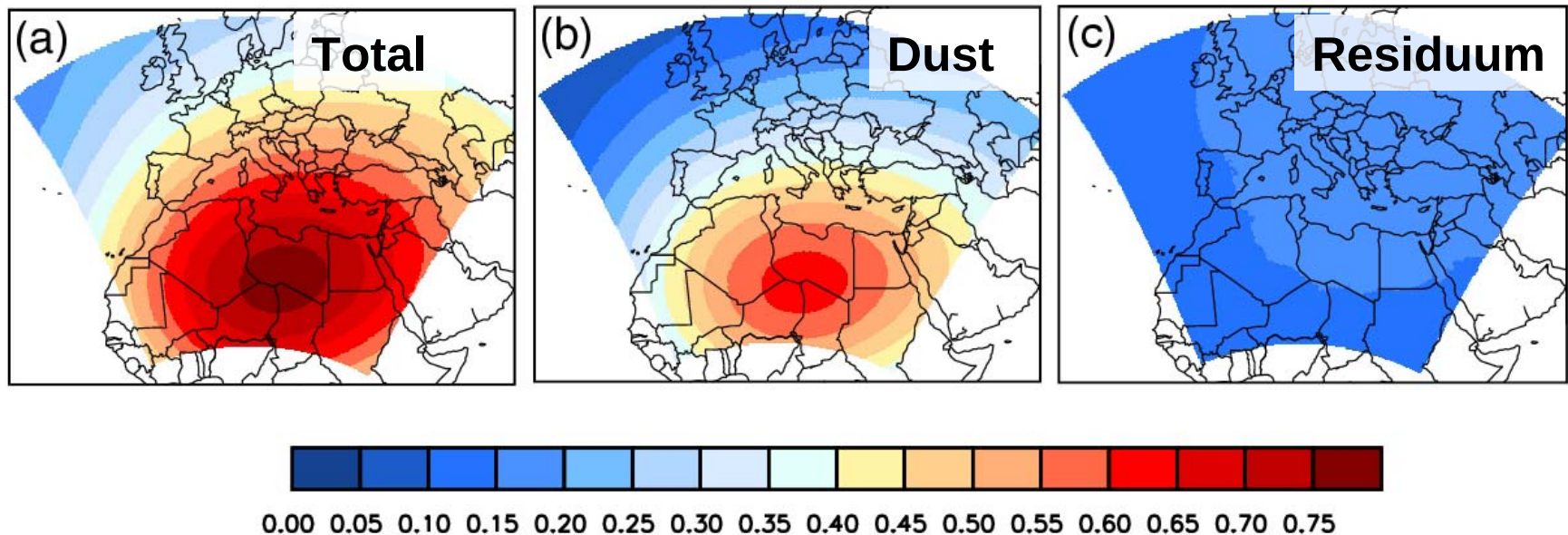
## Outline

- Adaptions in external parameters of COSMO
- Experiment 7146: aerosol climatology, June 2009
- Experiment 7224: aerosol + TERRA adaptions, June 2009

## Adaptions in external parameters of COSMO

- Aerosol climatology
- Emissivity
- Vegetation climatology (LAI, PLCOV),
- Minimum stomatal resistance
- Climatological soil temperature

## Aerosol optical depth @ 550 nm



Optical thickness  $\tau(550 \text{ nm})$

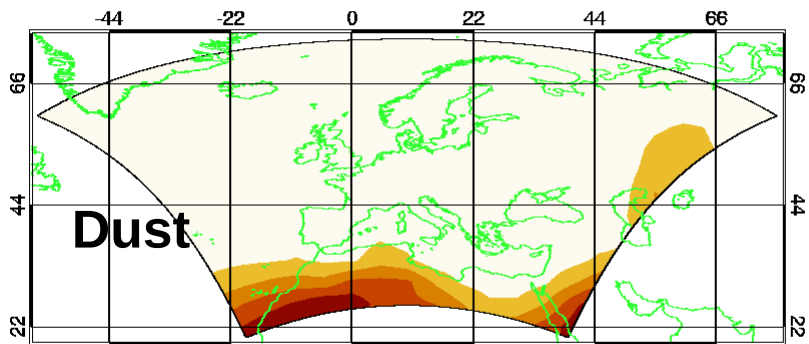
Total=Urban+Dust+Land+Maritim

*Helmert et al. (2007)*

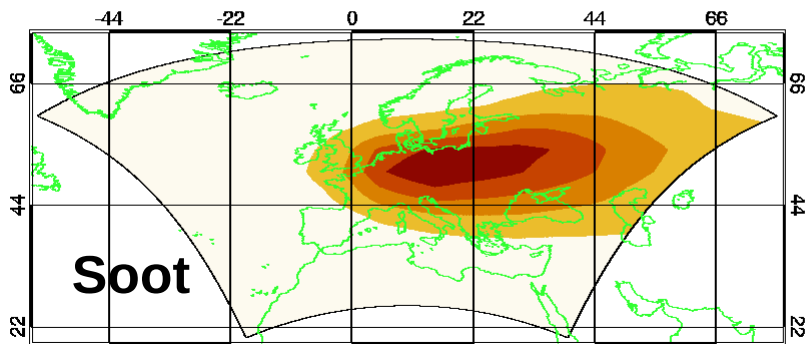
# Aerosol climatology (Tegen et al., 1997) optical depth @ 550 nm

Lambert-Beer:  $I = I_0 e^{-\tau z}$

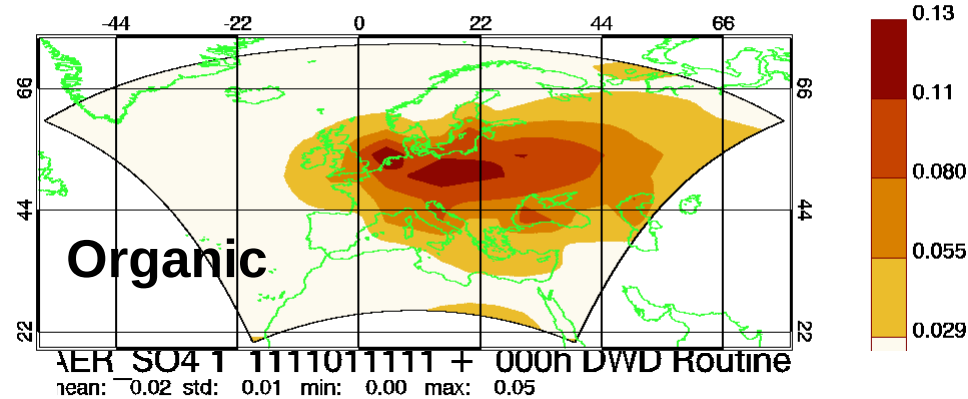
AER DUST 1 1111011111 + 000h DWD Routine  
mean: 0.02 std: 0.02 min: 0.00 max: 0.11



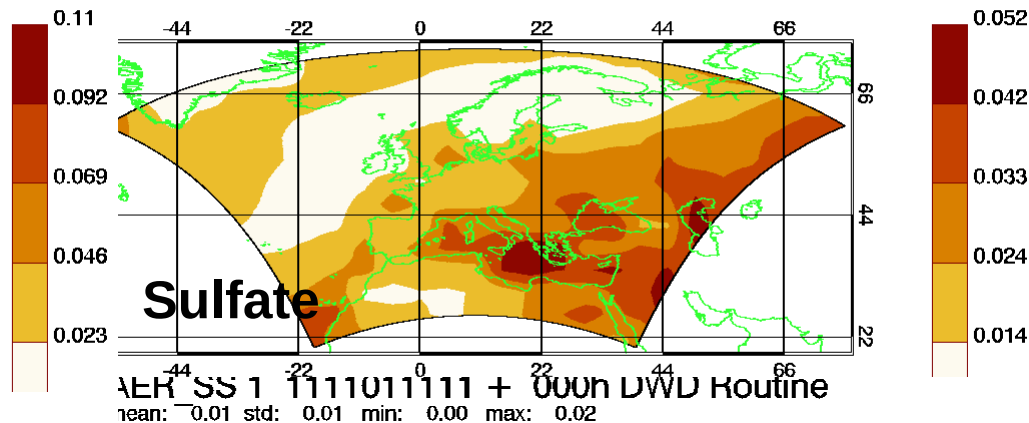
AER BC 1 1111011111 + 000h DWD Routine  
mean: 0.01 std: 0.01 min: 0.00 max: 0.04



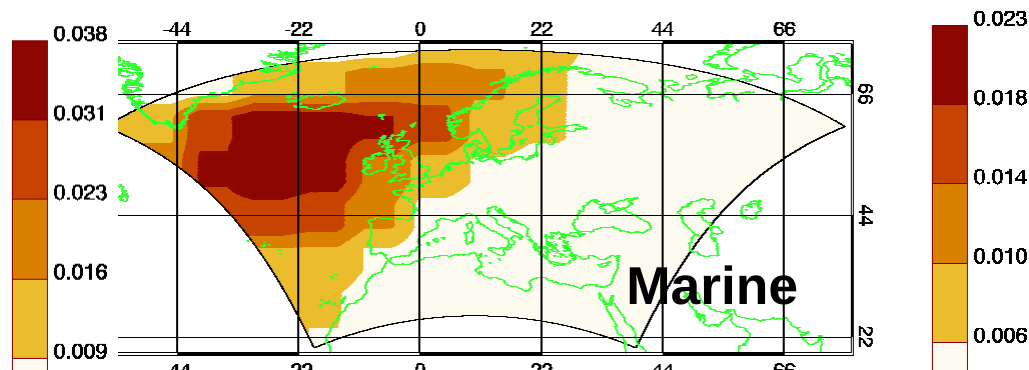
AER ORG 1 1111011111 + 000h DWD Routine  
mean: 0.03 std: 0.03 min: 0.00 max: 0.13



AER SO4 1 1111011111 + 000h DWD Routine  
mean: 0.02 std: 0.01 min: 0.00 max: 0.05

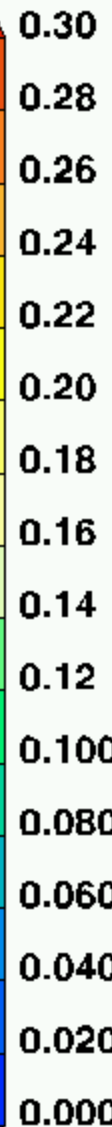
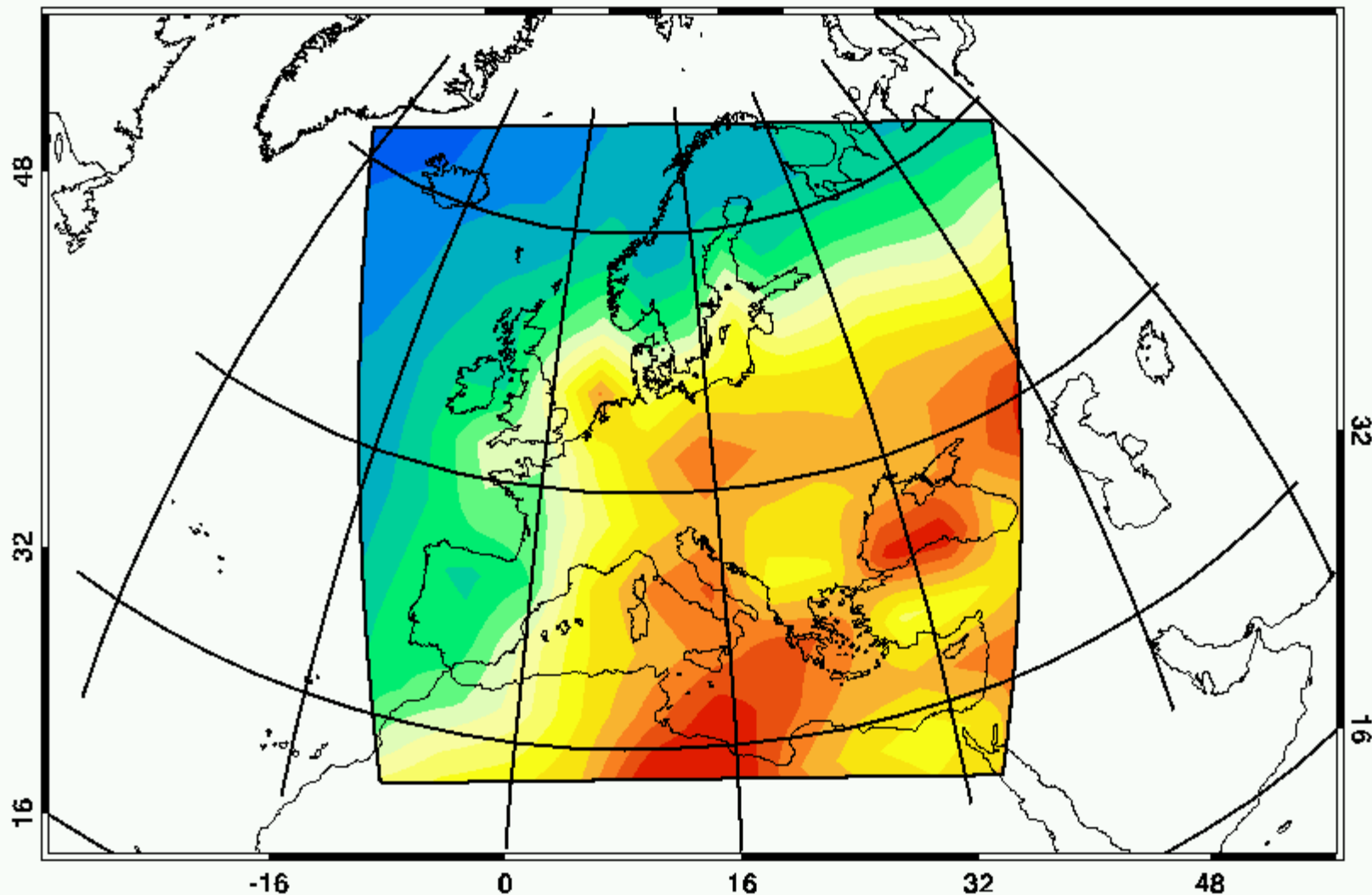


AER SS 1 1111011111 + 000h DWD Routine  
mean: 0.01 std: 0.01 min: 0.00 max: 0.02



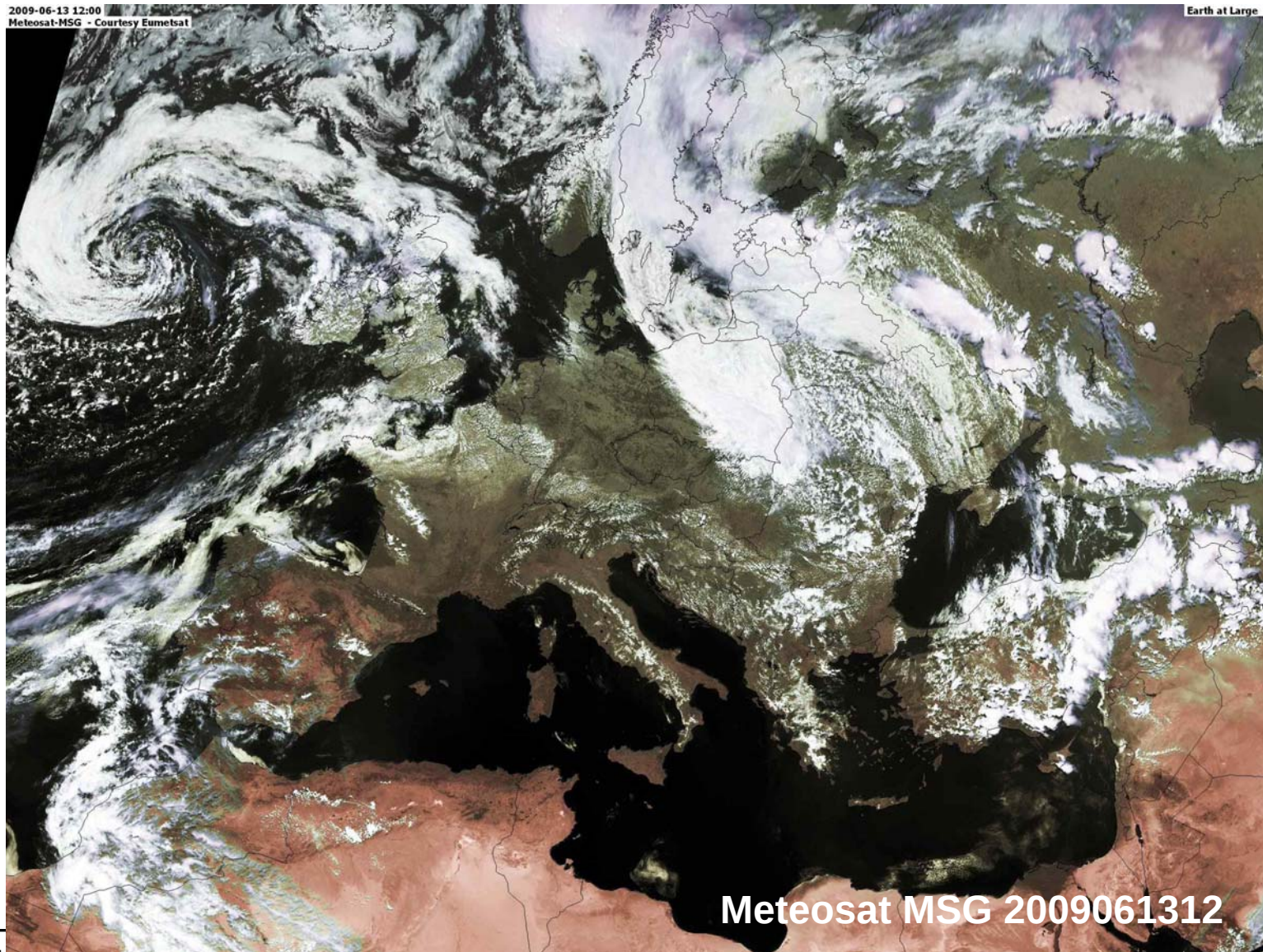
**AER SUM 200901061200 EXP 7146**

mean: 0.17 std: 0.08 min: 0.03 max: 0.33  
-32 -16 0 16 32 48 64



2009-06-13 12:00  
Meteosat-MSG - Courtesy Eumetsat

Earth at Large

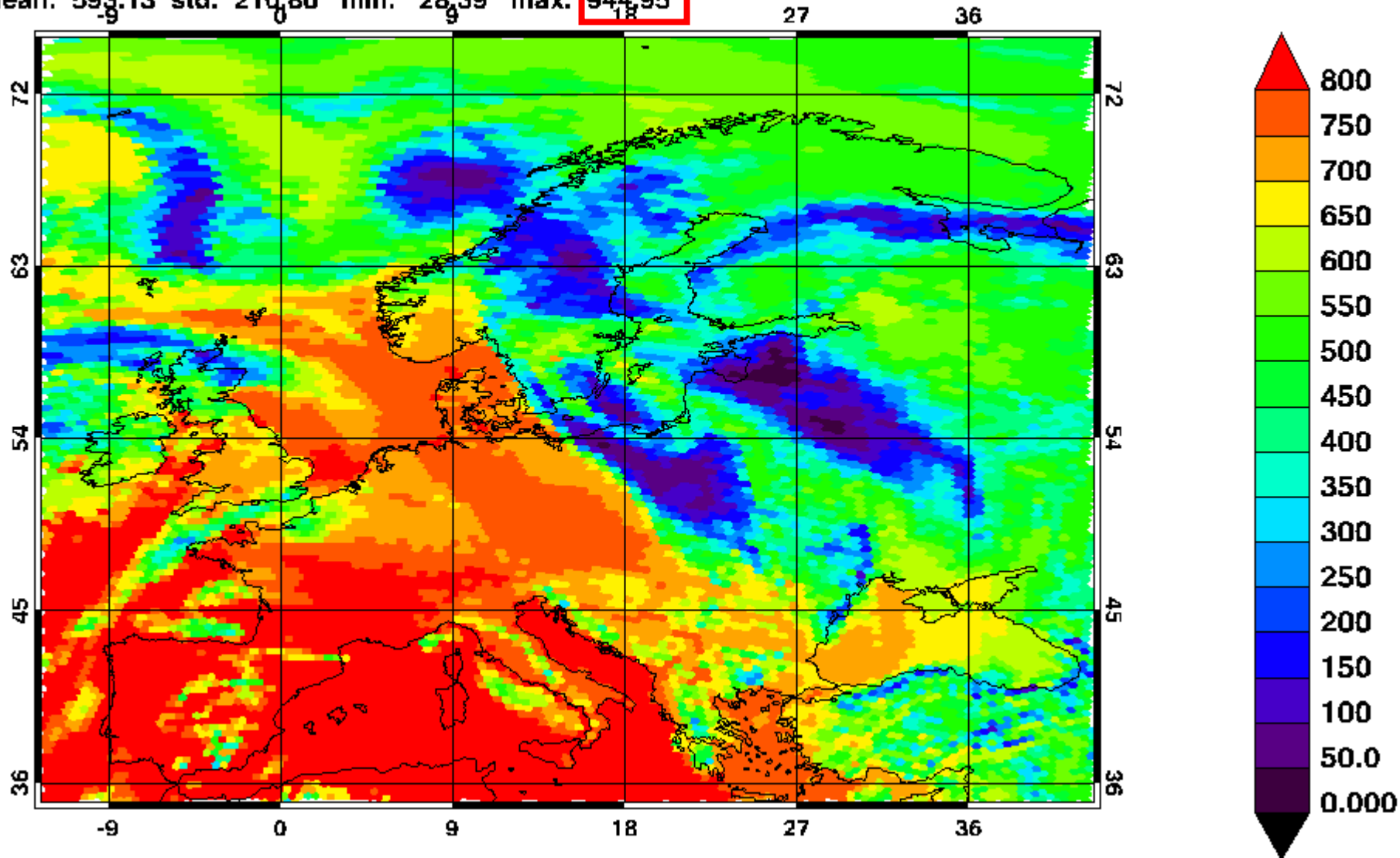


Meteosat MSG 2009061312

ASOB\_S [W/(m\*\*2)] 2009061312 + 001h DWD Routine

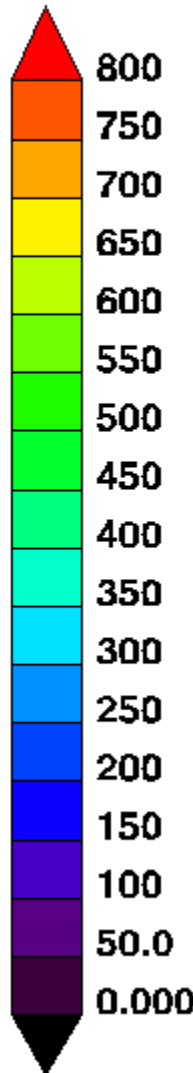
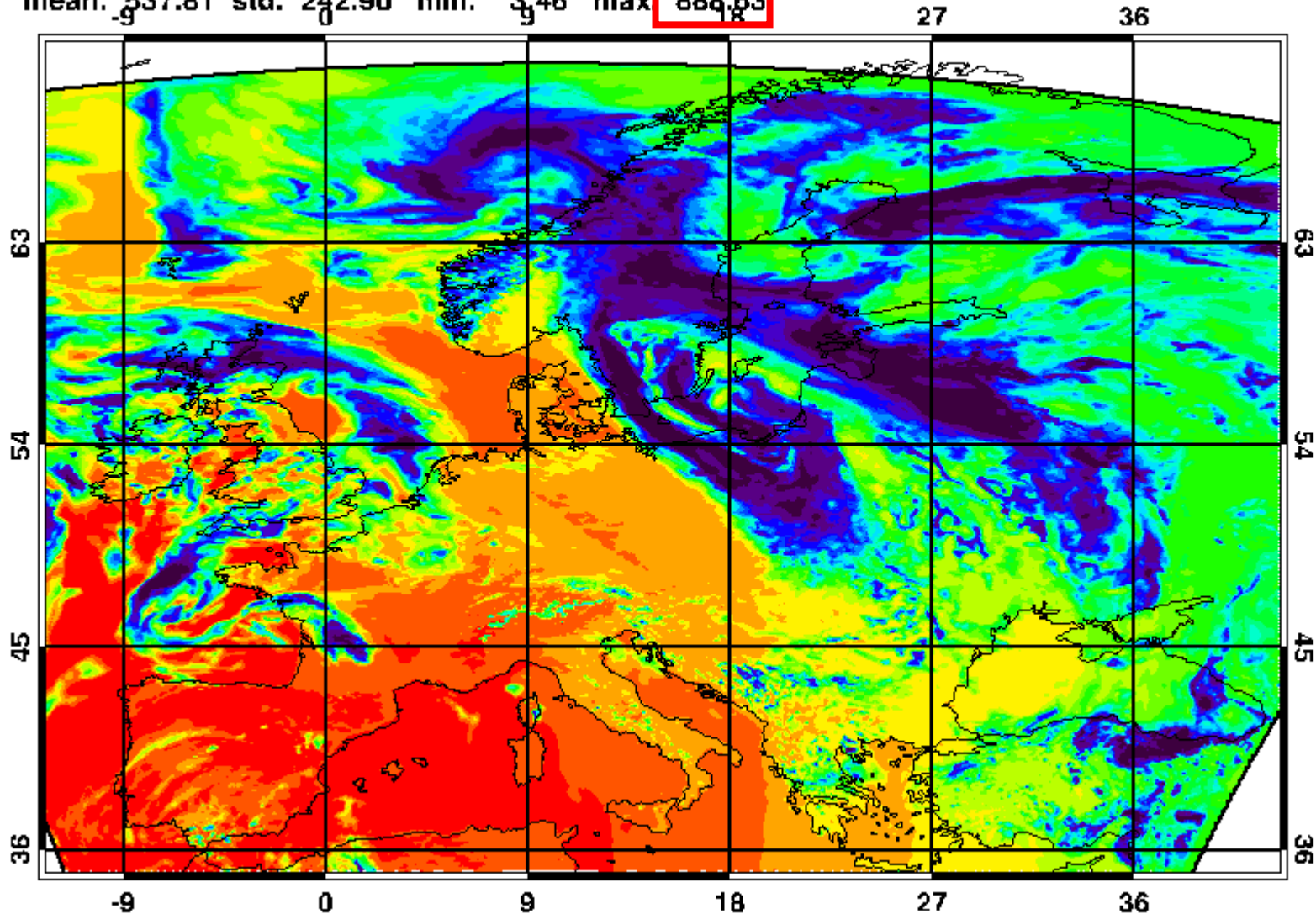
GME

mean: 593.13 std: 210.86 min: 28.39 max: 944.95



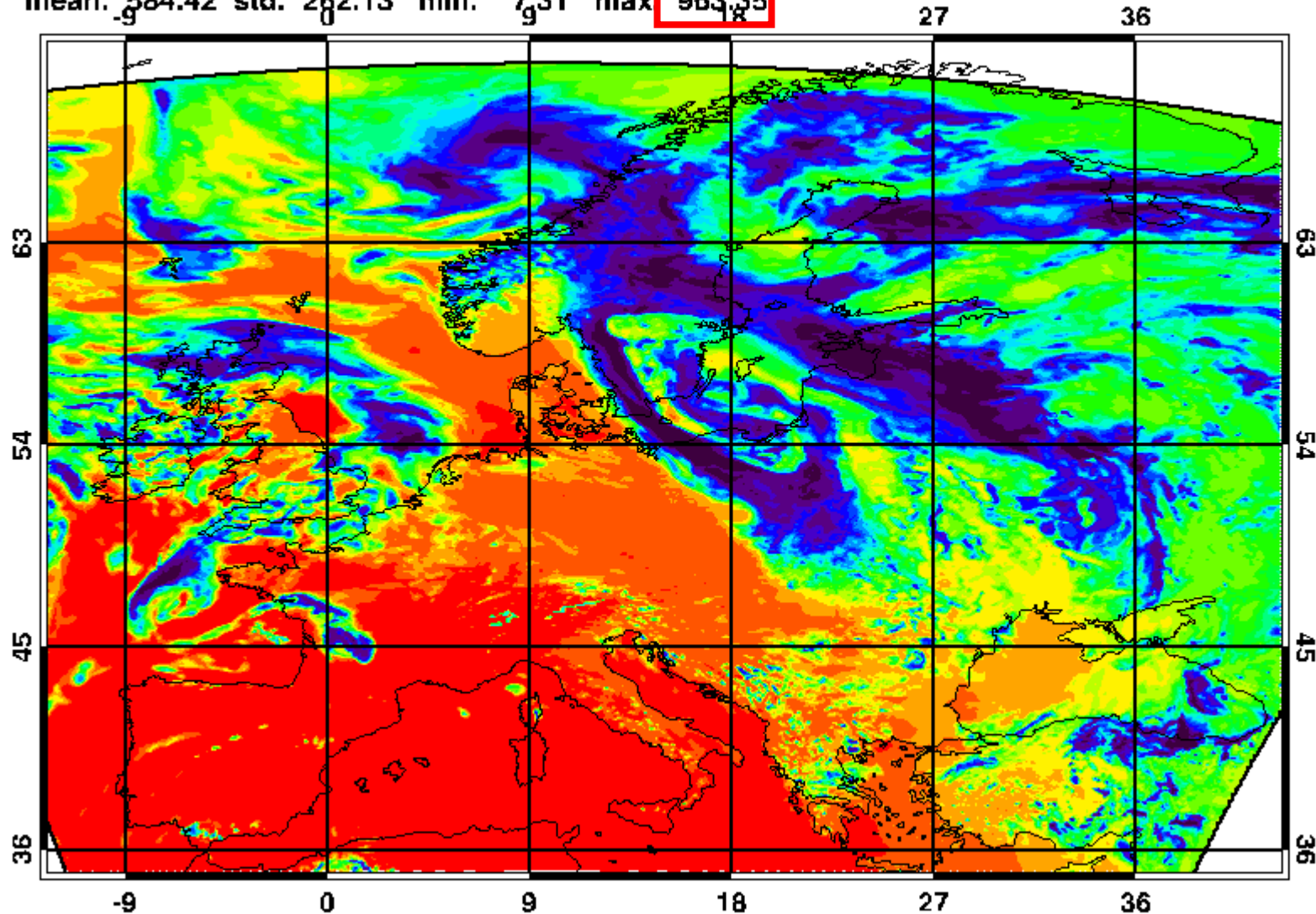
**ASOB\_S [W/(m\*\*2)] 2009061312 + 001h DWD Routine**

mean: 537.81 std: 242.90 min: 3.46 max: 888.63



ASOB\_S [W/(m\*\*2)] 2009061312 + 001h DWD Expld:07146

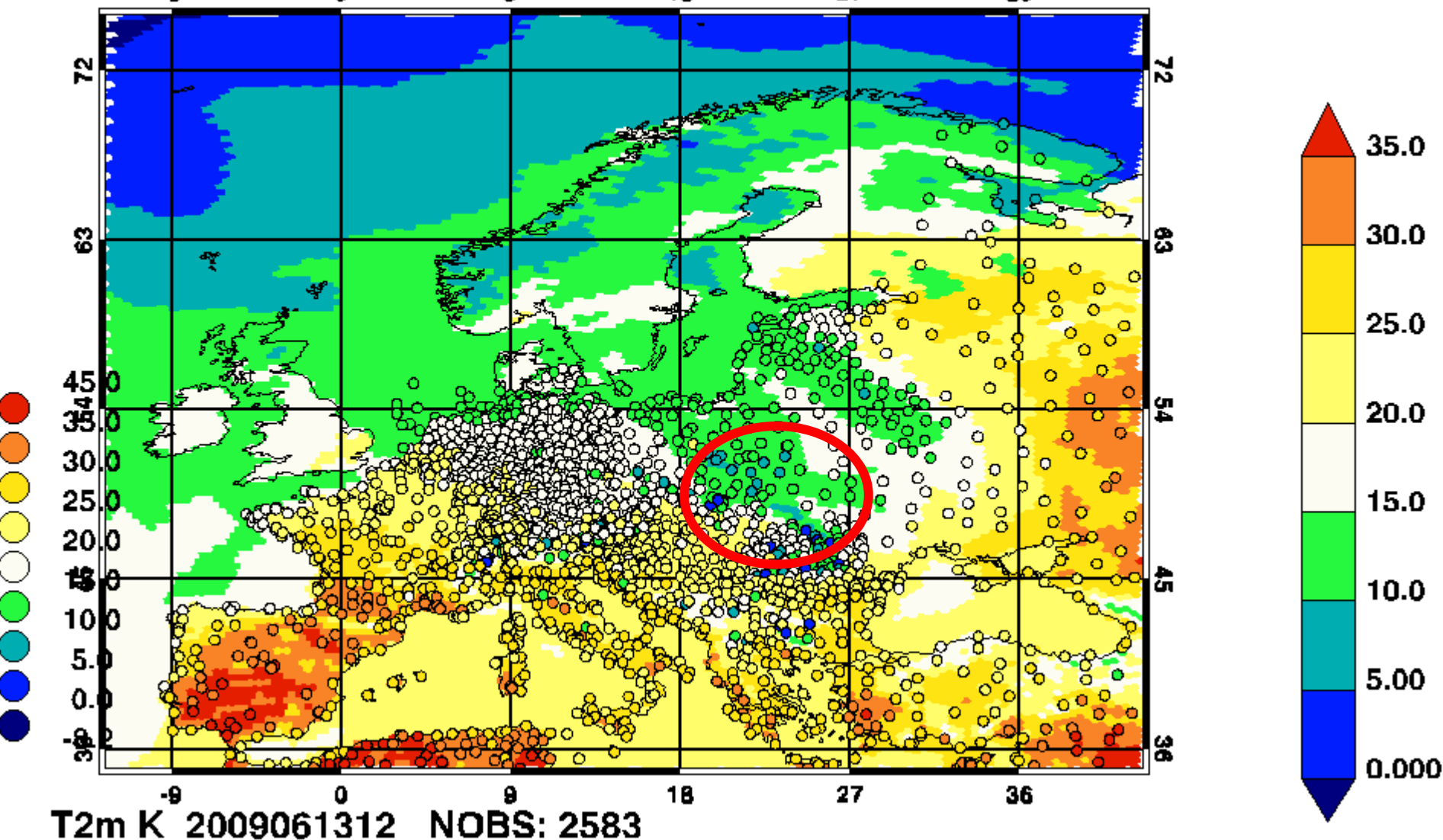
mean: 584.42 std: 262.13 min: 7.31 max: 963.35



{ T\_2M [K] 2009061312 + 000h DWD Routine } + -273.15

mean: 18.39 std: 7.95 min: -0.75 max: 38.86

GME



T2m K 2009061312 2583 observations

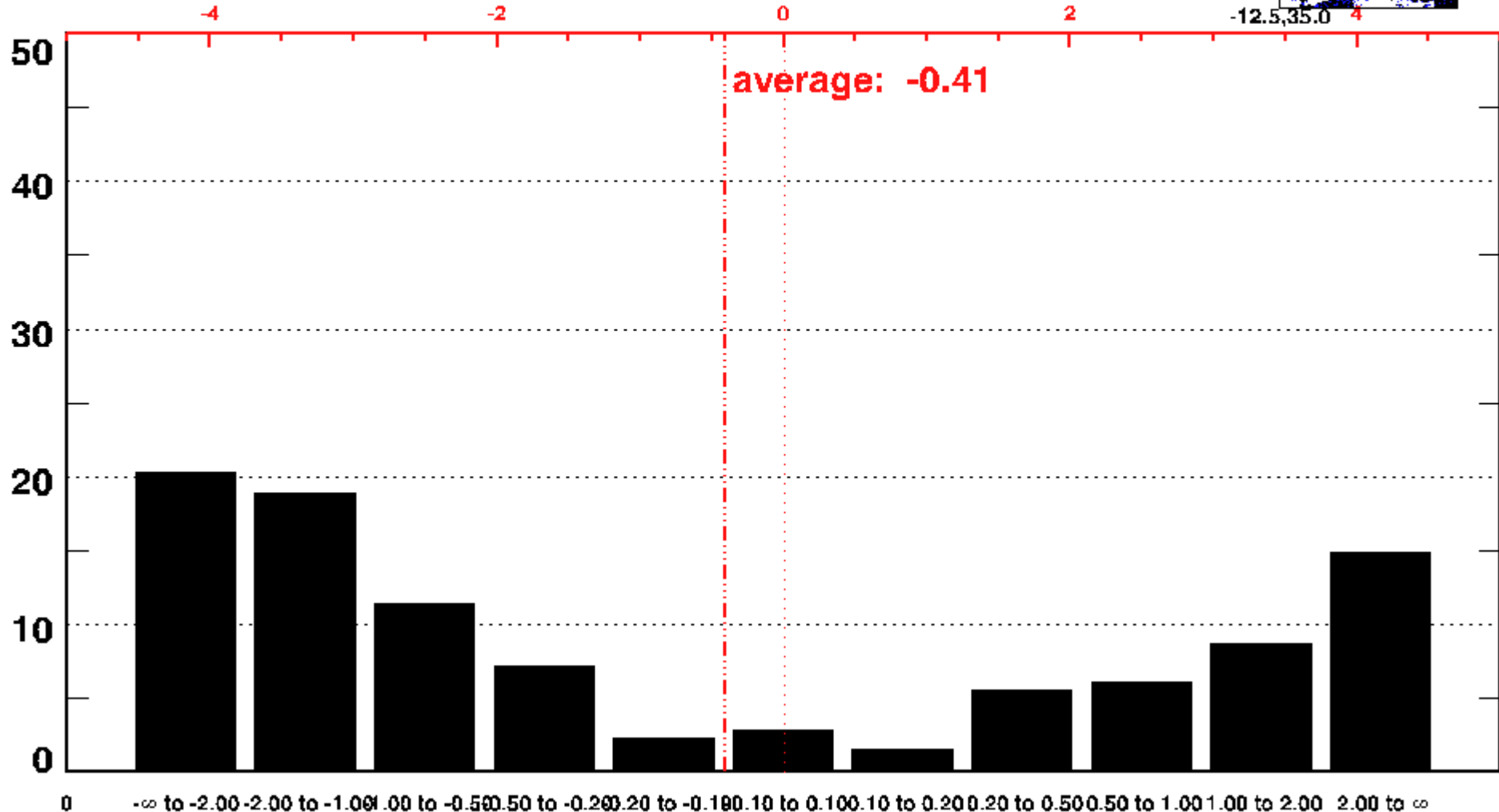
minus

T\_2M [K] 2009061312 + 000h DWD Routine **GME**

42.5,75.0



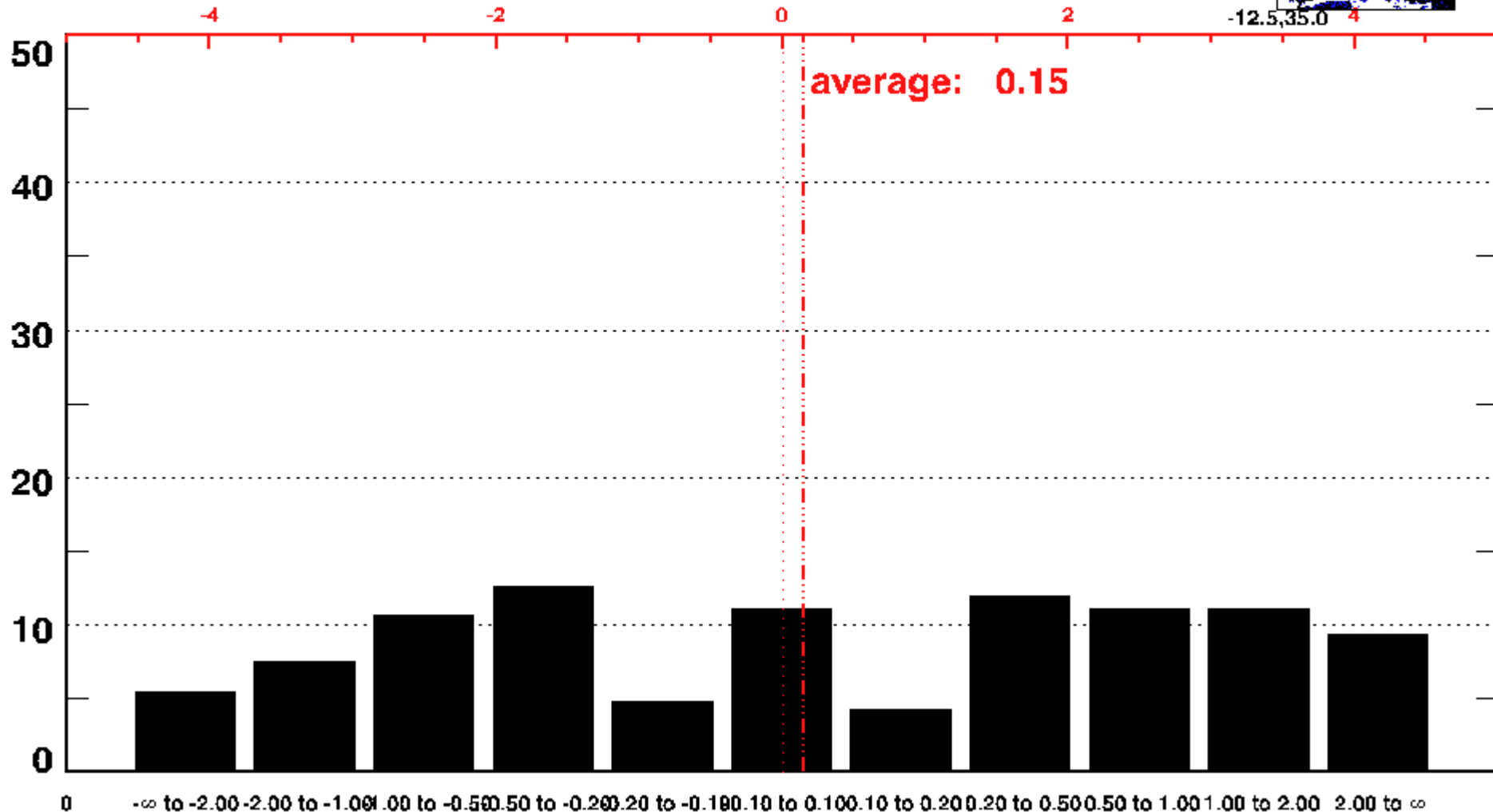
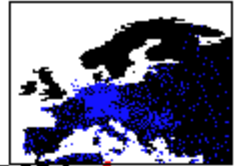
-12.5,35.0



T2m K 2009061312 2576 observations

minus

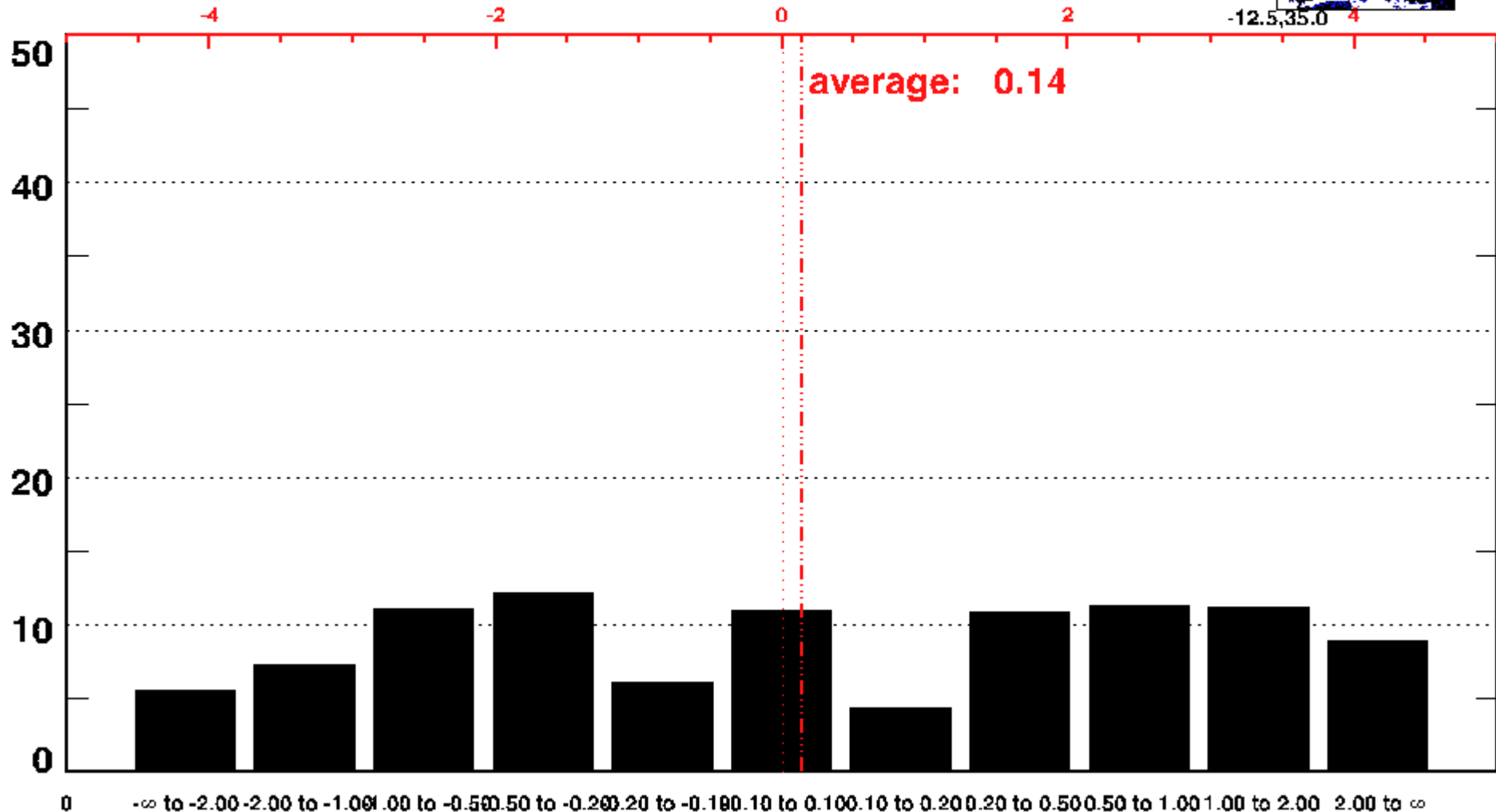
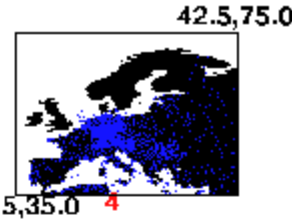
T\_2M [K] 2009061312 + 000h DWD Routine COSMO-EU



T2m K 2009061312 2576 observations

minus

T\_2M [K] 2009061312 + 000h DWD **EXP** COSMO-EU

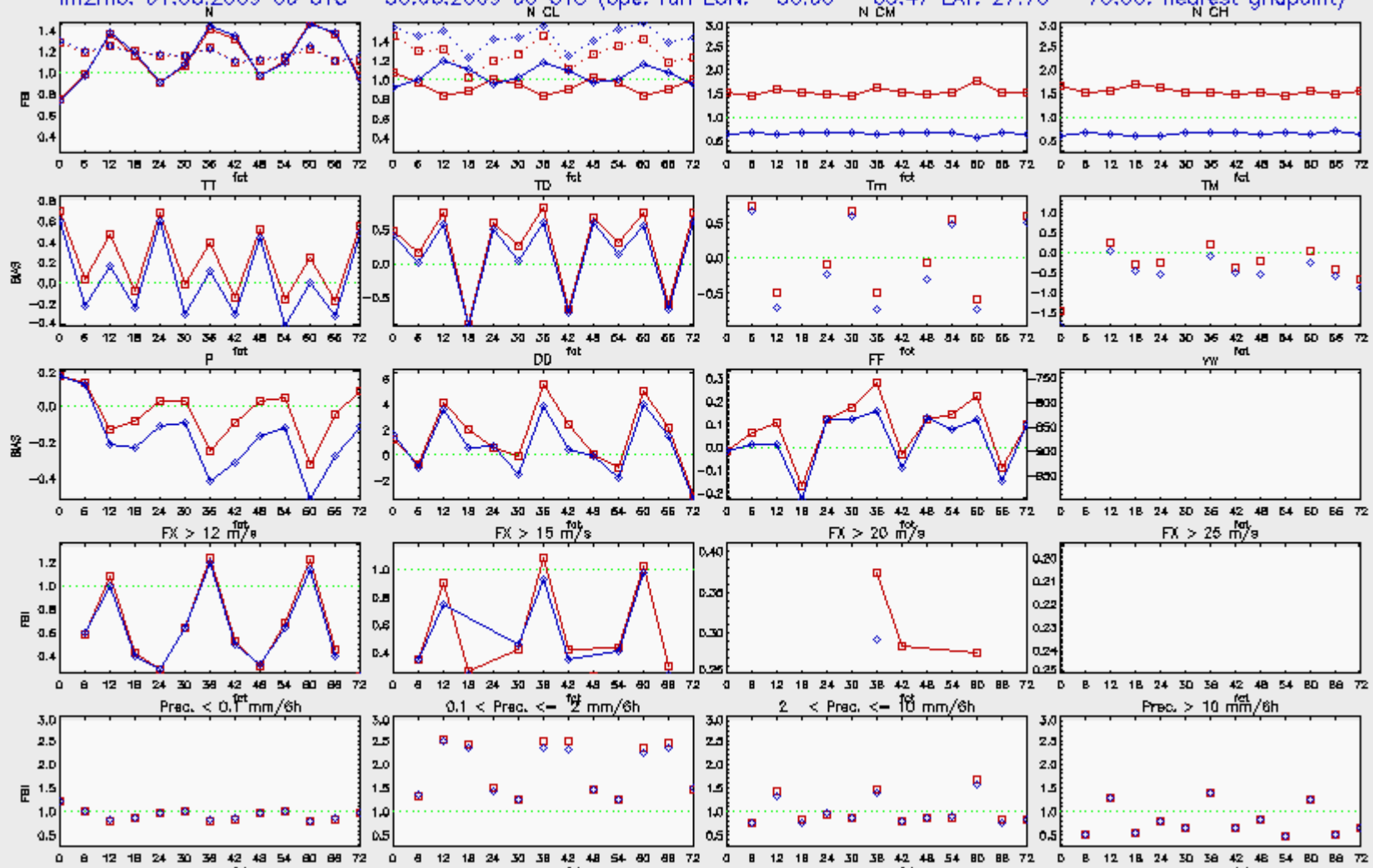


## Verifikation COSMO-EU Start 00 UTC: LM2MO, alle Stationen

LM2MO: 01.06.2009 00 UTC – 30.06.2009 00 UTC (exp. run 7146: nearest gridpoint)

Plottime: 04.02.2010 08:57:55 MEZ

lm2mo: 01.06.2009 00 UTC – 30.06.2009 00 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)

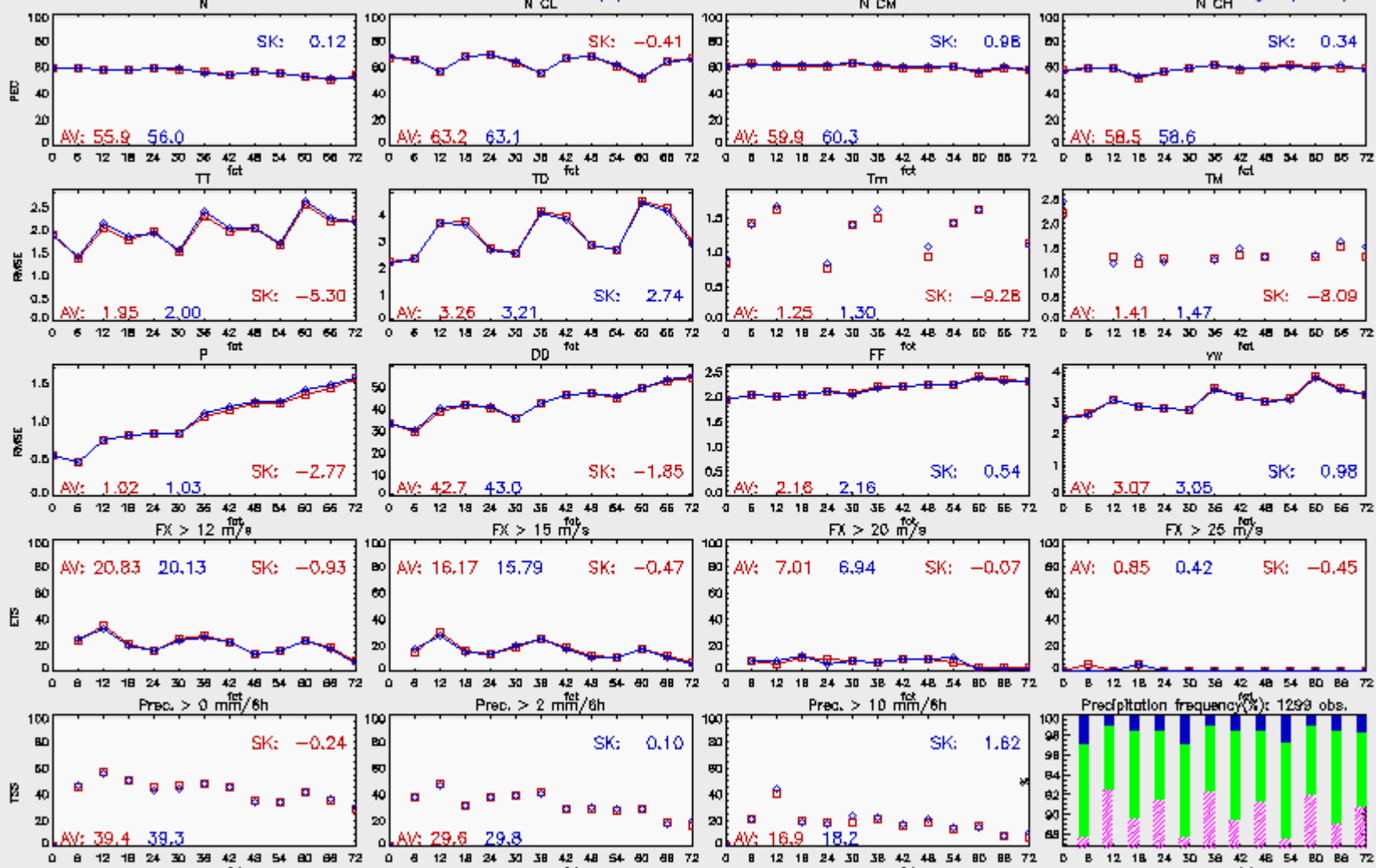


## Verifikation COSMO-EU Start 00 UTC: LM2MO, alle Stationen

LM2MO: 01.06.2009 00 UTC – 30.06.2009 00 UTC (exp. run 7146: nearest gridpoint)

Plottime: 04.02.2010 08:57:55 MEZ

lm2mo: 01.06.2009 00 UTC – 30.06.2009 00 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)



## COSMO-EU Exp 7224

## Tested adaption in int2Im and TERRA

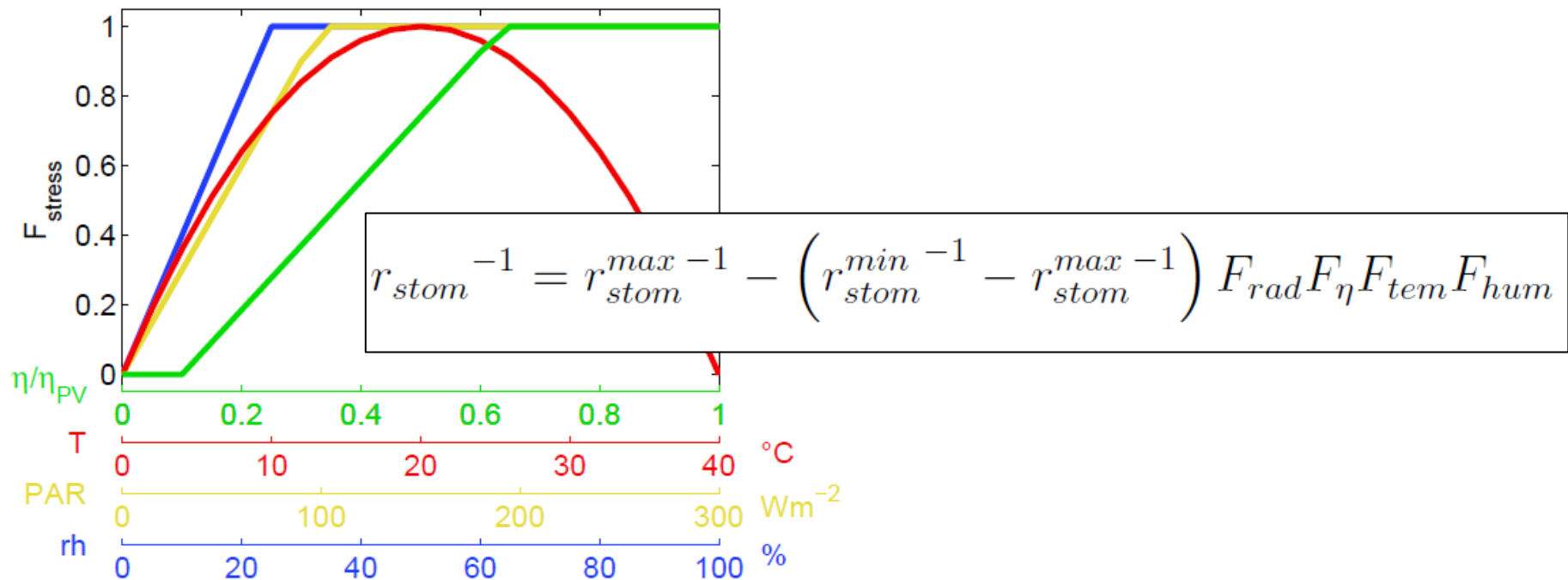
- Aerosol climatology, Emissivity, Vegetation climatology (LAI, PLCOV), Minimum stomatal resistance
- Non-uniform root distribution
- Ground water with upward diffusion
- Soil moisture dependent heat conductivity

## BATS Plant transpiration (Dickinson, 1984)

$$E_{trans}^{dick} = -\rho (q_{atm} - q^*(T_s)) \left( \frac{1}{r_{ca} + \frac{1}{f_{LAI}} (r_{lc} + r_{stom})} \right)$$

$r_{stom}$  stomatal resistance  
 $r_{lc}$  res. btw. leaves and canopy air  
 $r_{ca}$  res. btw. canopy air and atm. level

## BATS Plant transpiration

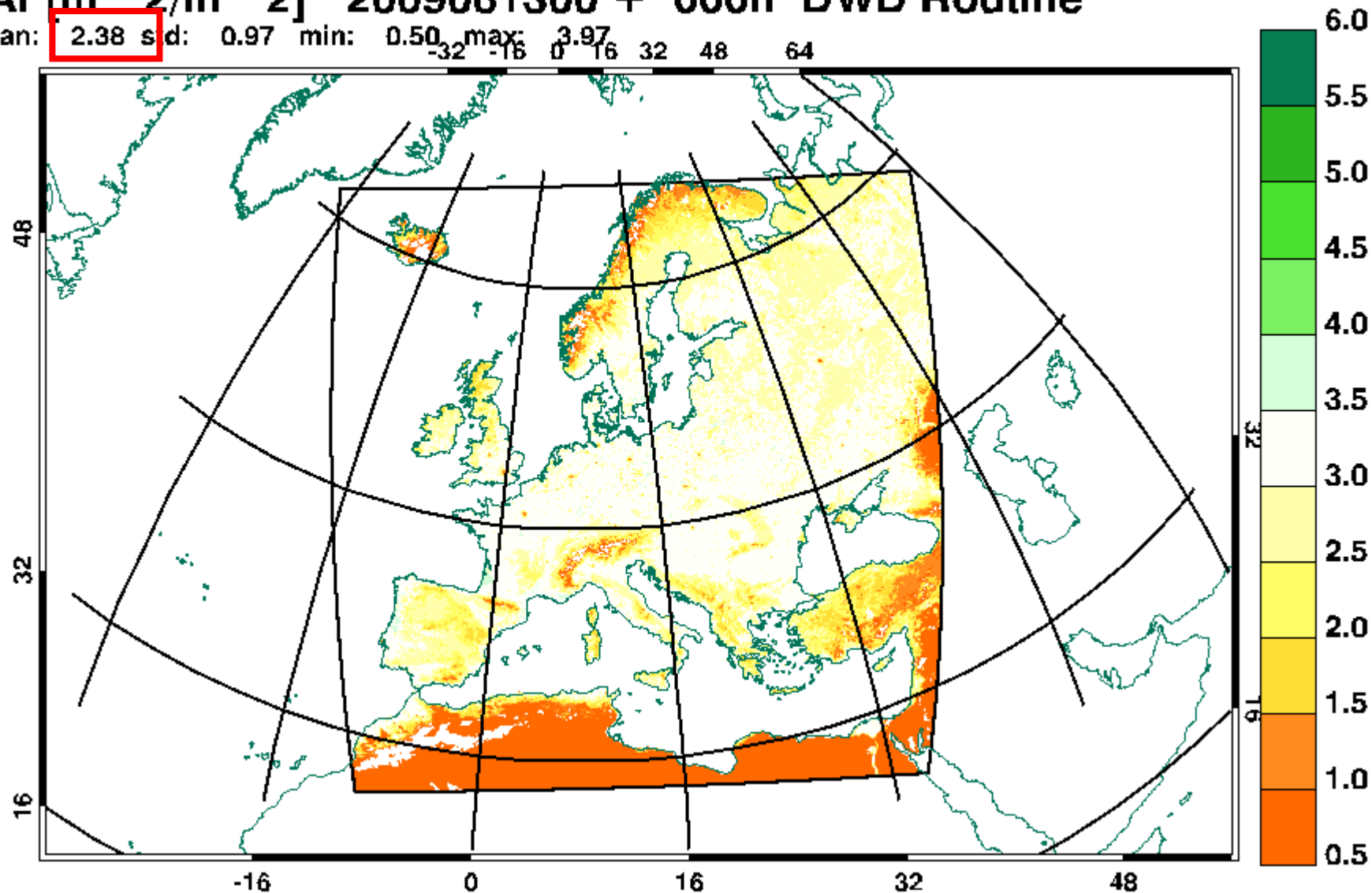


Parameterisation curves of the four stress factors limiting plant transpiration: soil moisture stress (green), temperature stress (red), insolation stress (yellow) and humidity stress (blue). Note, that low values indicate stress. (Curve of soil moisture stress is not exact; soil moisture threshold values are slightly soil type dependent.)

Figure taken from Ament, 2006

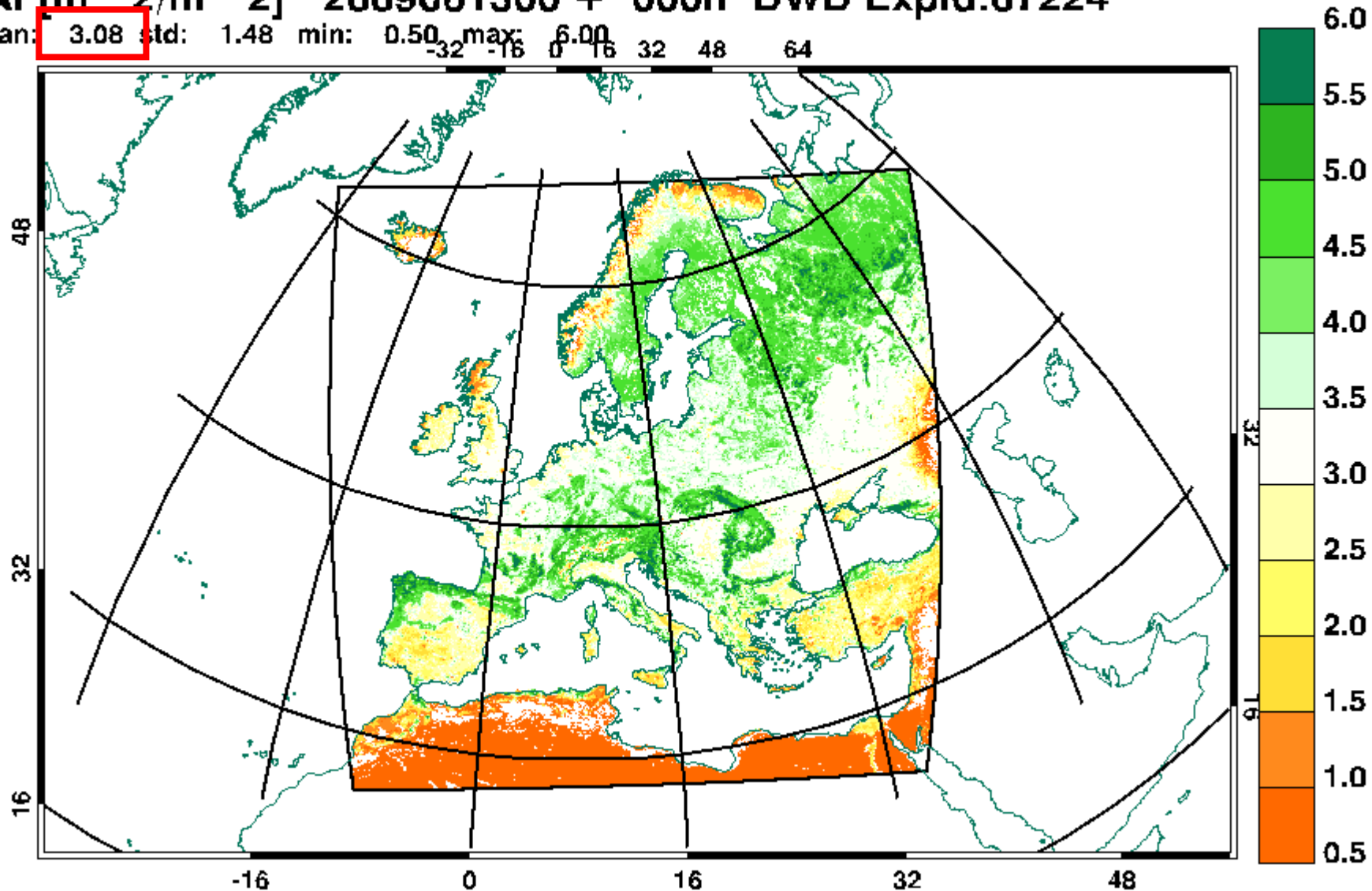
LAI [m\*\*2/m\*\*2] 2009061300 + 000h DWD Routine

mean: 2.38 sd: 0.97 min: 0.50 max: 3.97



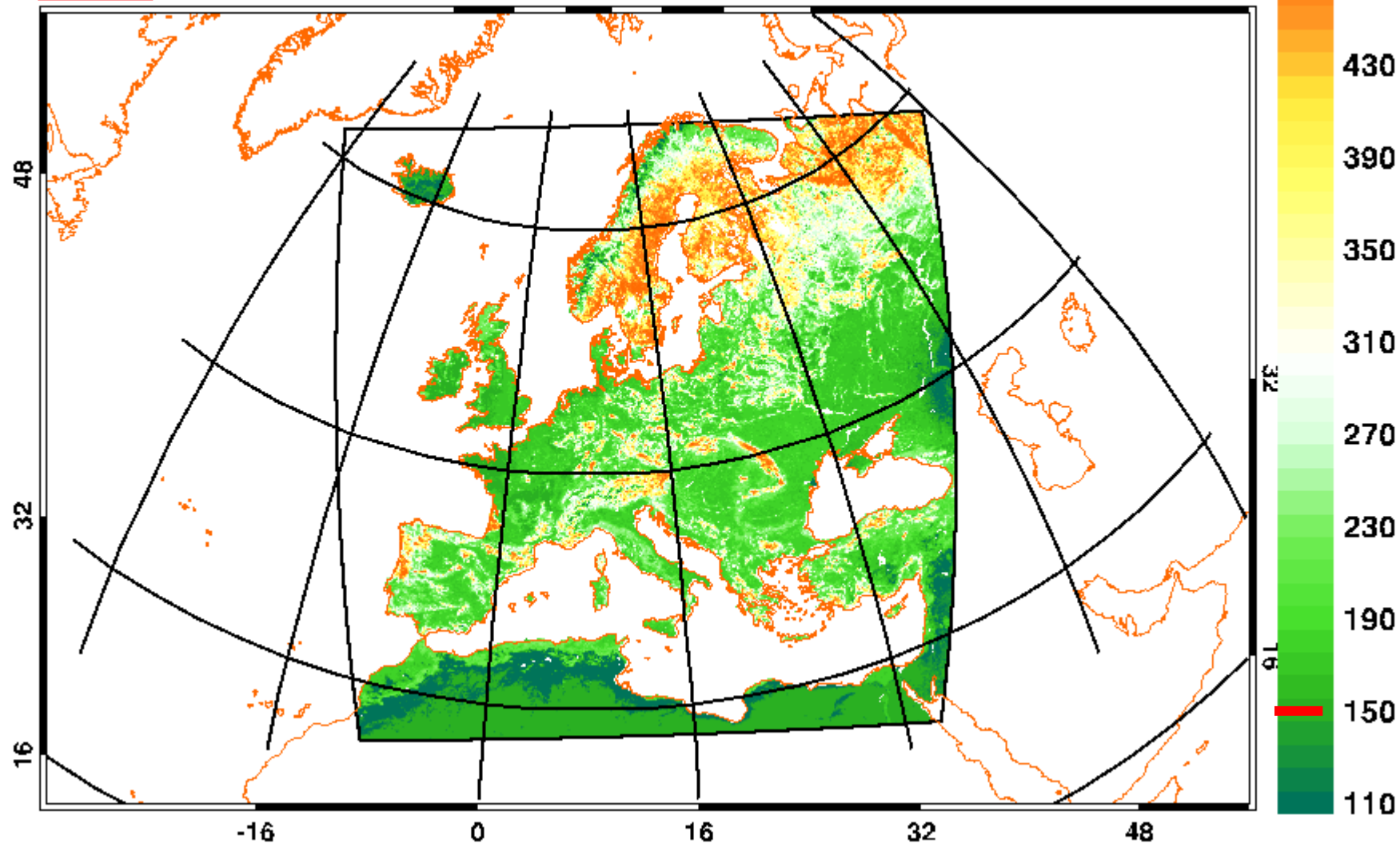
LAI [m\*\*2/m\*\*2] 2009061300 + 000h DWD Expld:07224

mean: 3.08 std: 1.48 min: 0.50 max: 6.00



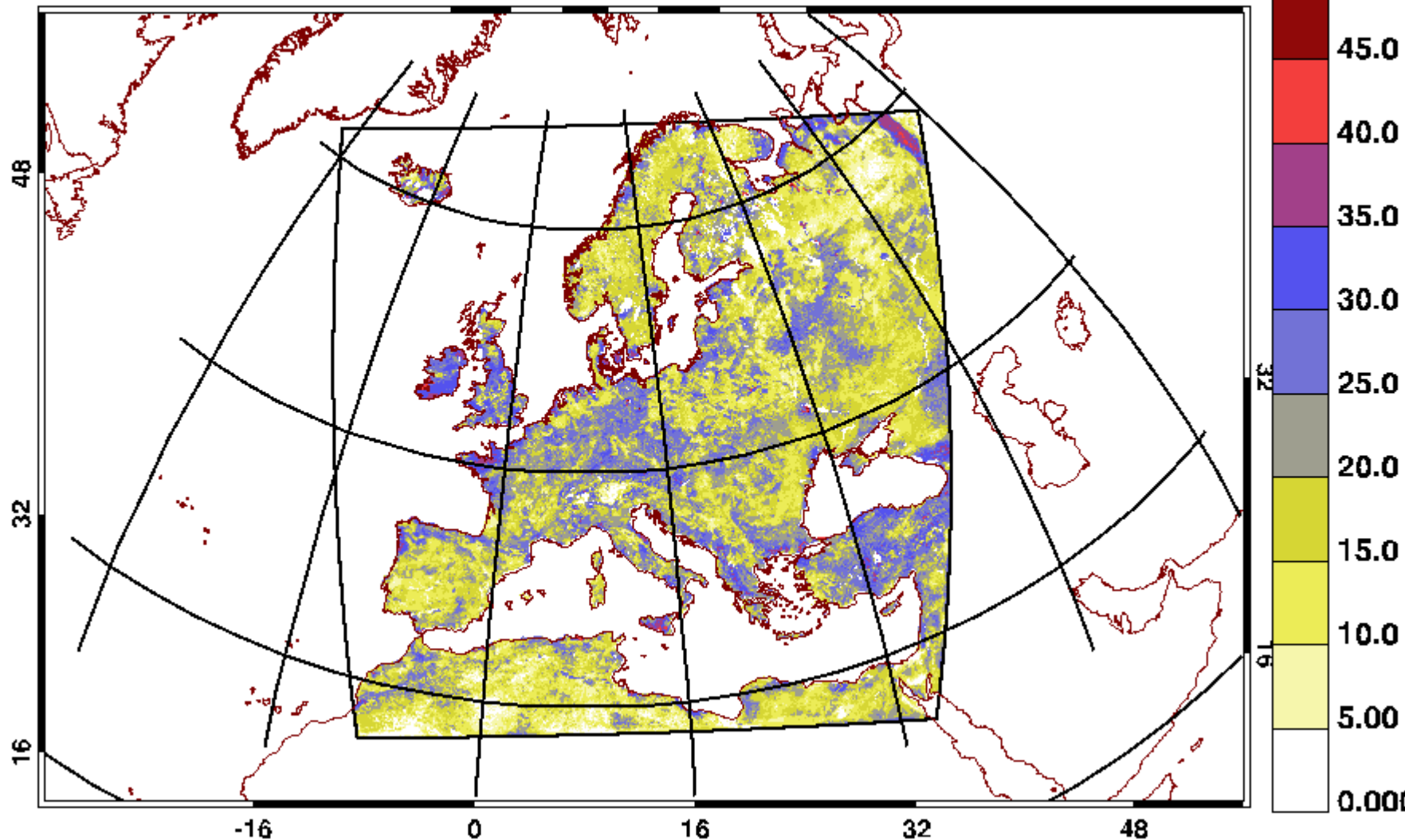
**PRS\_MIN [s/m] 2009061300 + 000h DWD Expld:07224**

mean: **237.36** std: 101.44 min: 110.00 max: 500.00  
-32 -16 0 16 32 48 64



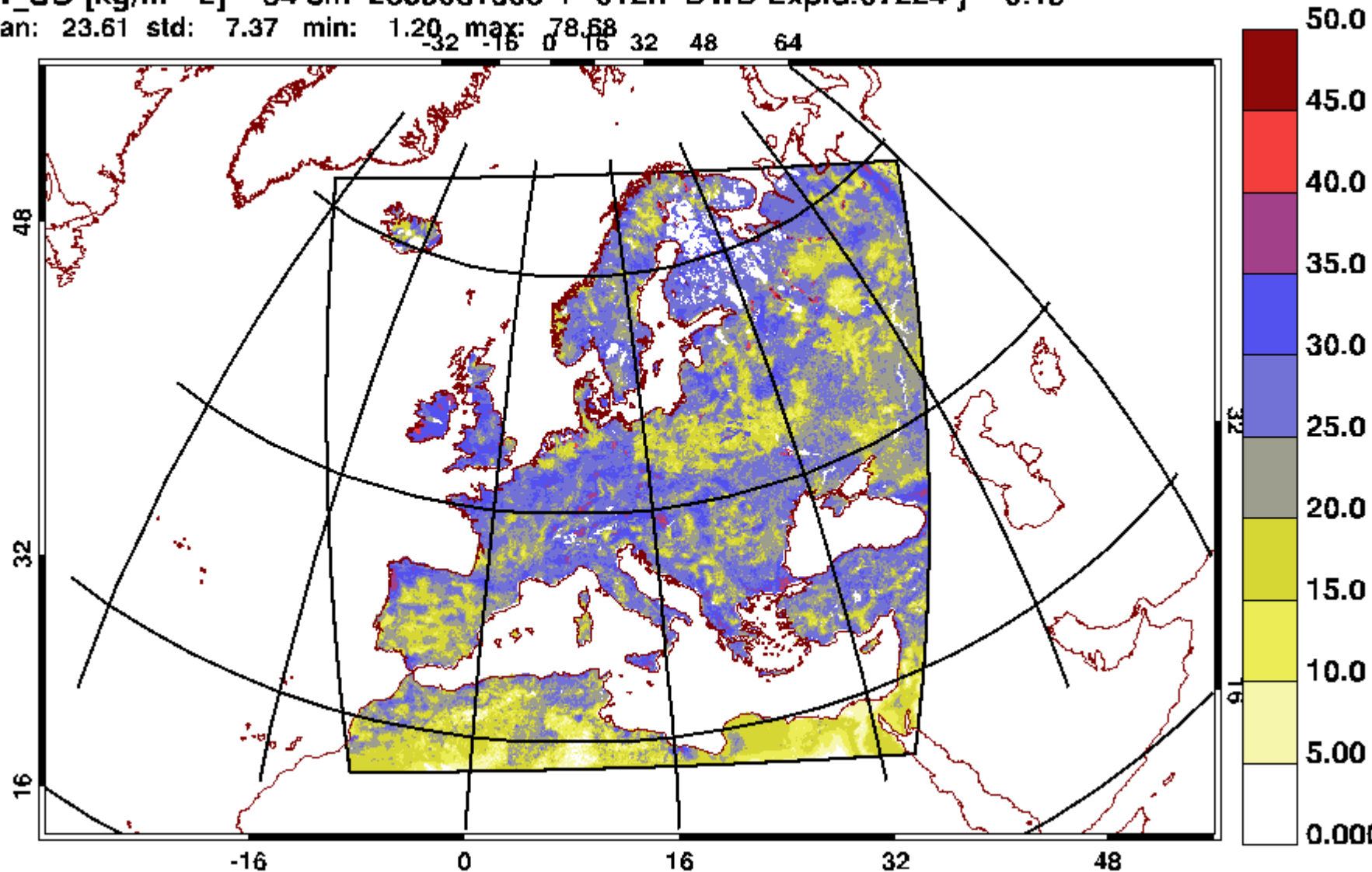
{ W\_SO [kg/m\*\*2] 54 cm 2009061300 + 012h DWD Routine } \* 0.19

mean: 19.03 std: 7.90 min: 1.21 max: 84.01  
-32 -16 0 16 32 48 64



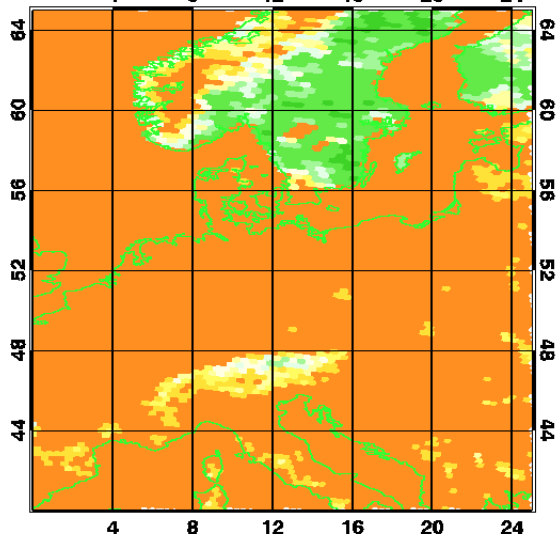
{ W\_SO [kg/m\*\*2] 54 cm 2009061300 + 012h DWD Expld:07224 } \* 0.19

mean: 23.61 std: 7.37 min: 1.20 max: 78.68



**FOREST E 1 0001010100 + 000h DWD Routine**

mean: 0.09 std: 0.21 mig: 0.00<sub>2</sub> max<sub>16</sub> 0.80<sub>20</sub> 24

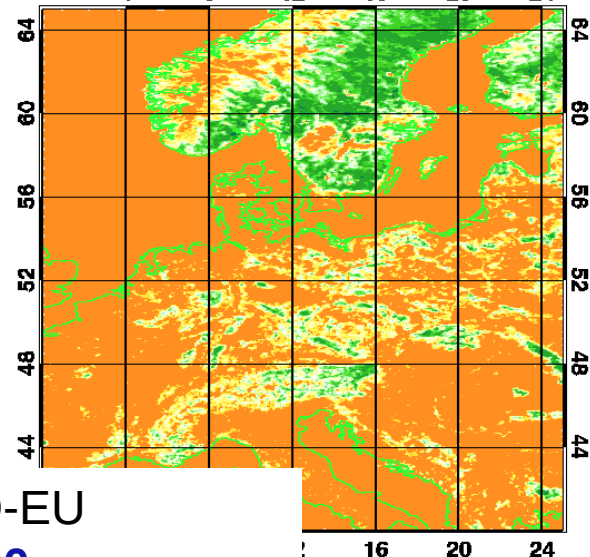


GME ni 256

Land Use Data: **GLCC**

**FOREST E 1 2001010100 + 000h DWD Routine**

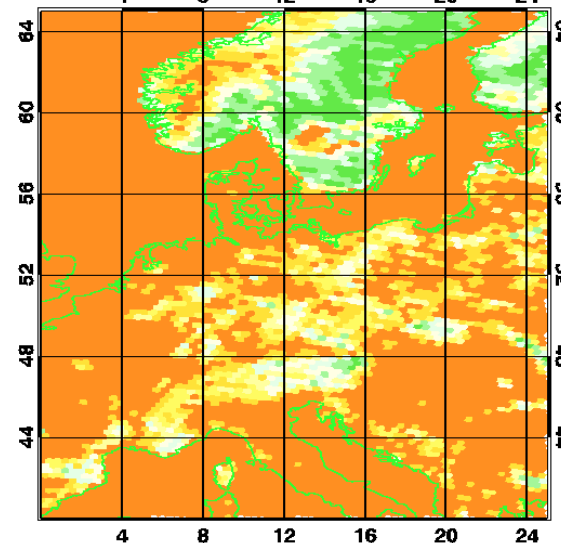
mean: 0.15 std: 0.28 mig: 0.00<sub>2</sub> max<sub>16</sub> 1.00<sub>20</sub> 24



COSMO-EU  
**GLC2000**

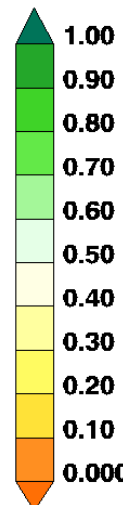
**FOREST E 1 0001010100 + 000h DWD Routine**

mean: 0.13 std: 0.20 mig: 0.00<sub>2</sub> max<sub>16</sub> 0.79<sub>20</sub> 24



GME ni 256

Land Use Data: **GLC2000**

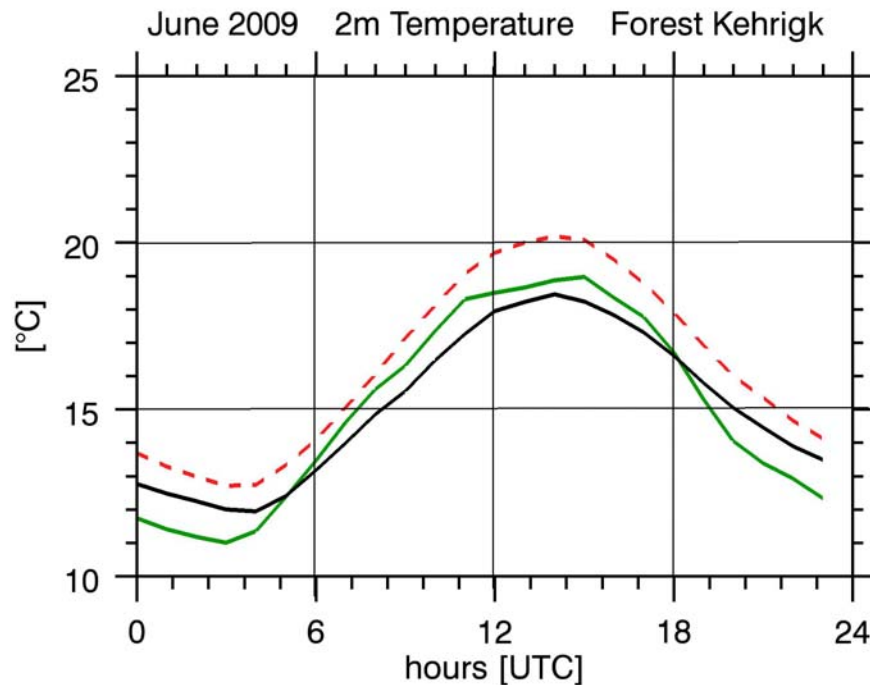


**Uncertainties in  
external Parameters**

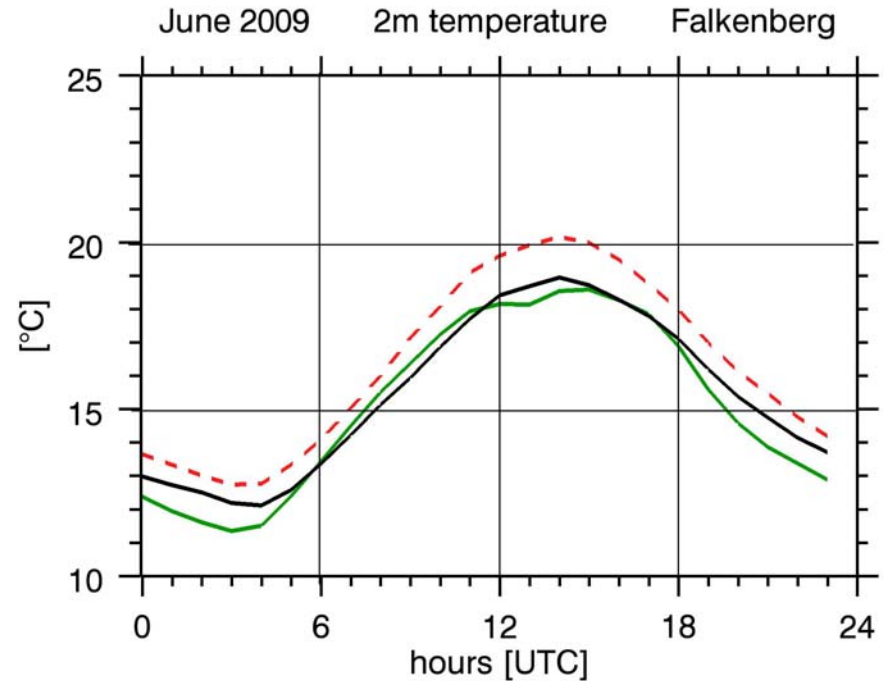


## **Comparison of Exp 7224 with routine COSMO-EU in June 2009 for Falkenberg and Forest sites**

## 2m - Temperature



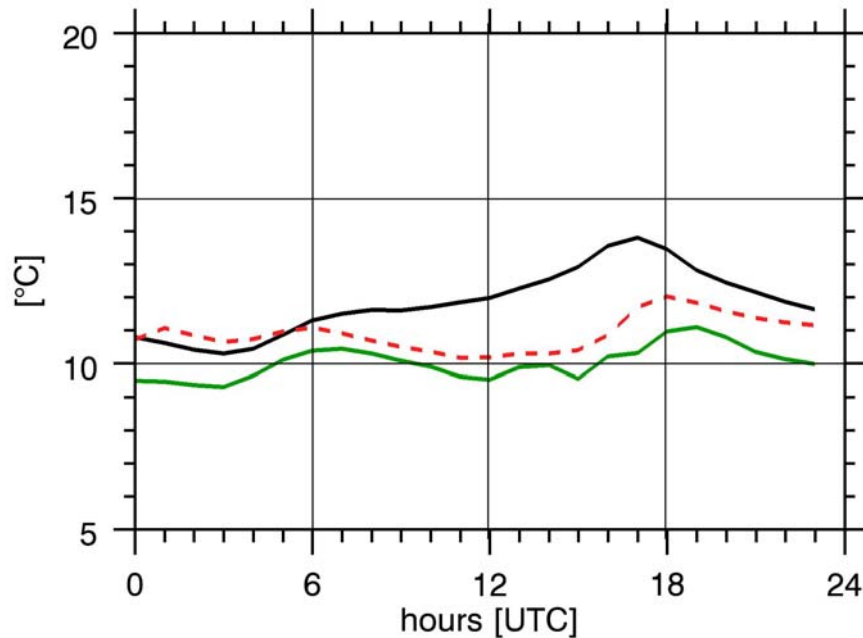
— measurement  
— COSMO-EU  
- - - EXP 7224



— measurement  
— COSMO-EU  
- - - EXP 7224

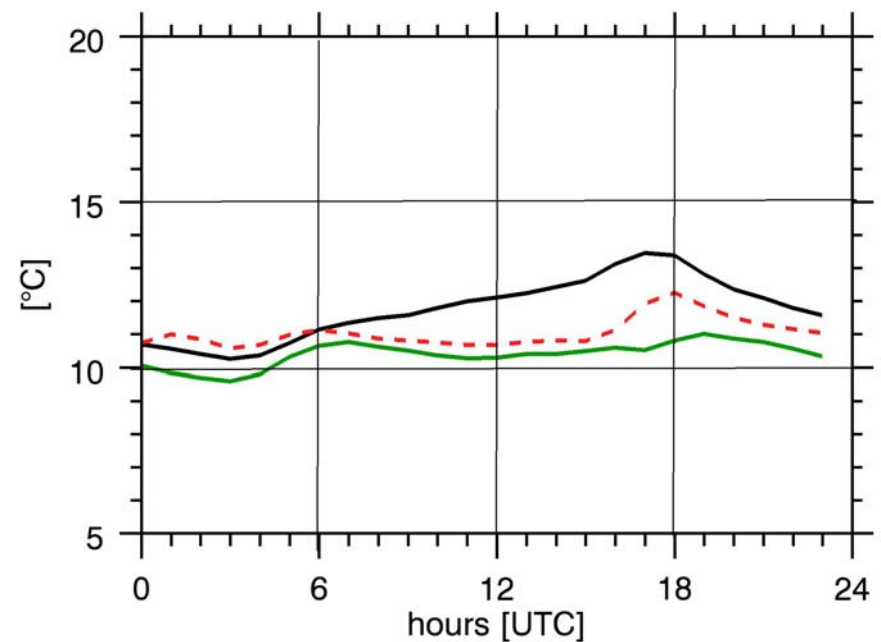
## 2m – Dewpoint Temperature

June 2009 2m Dewpoint temperature Forest Kehrigk



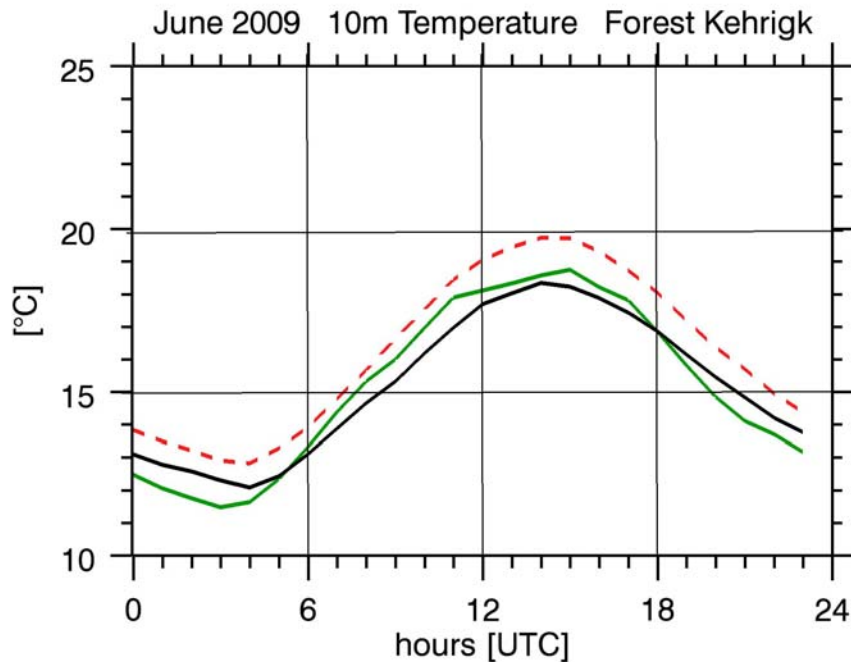
— measurement  
— COSMO-EU  
- - - EXP 7224

June 2009 2m Dewpoint temperature Falkenberg

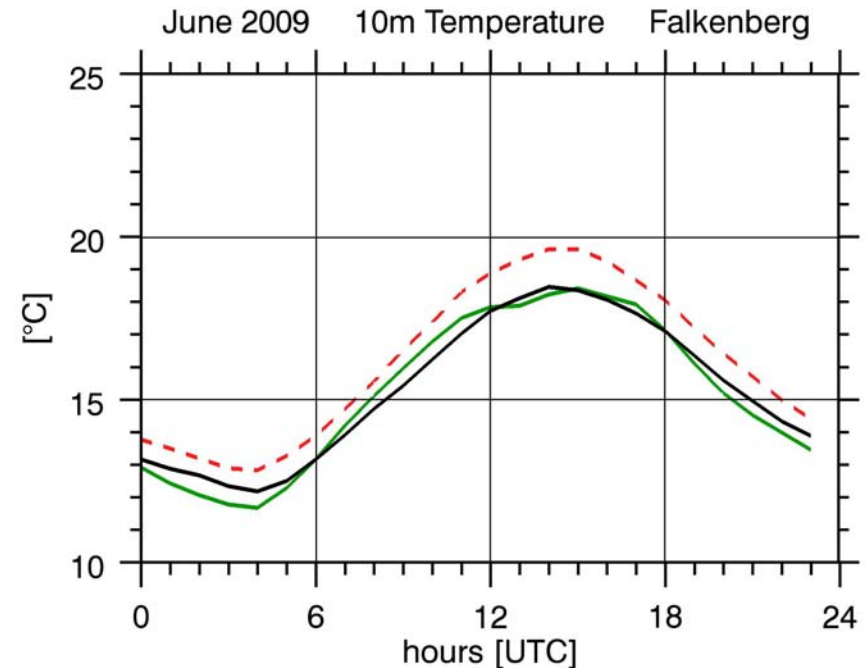


— measurement  
— COSMO-EU  
- - - EXO 7224

## 10m - Temperature

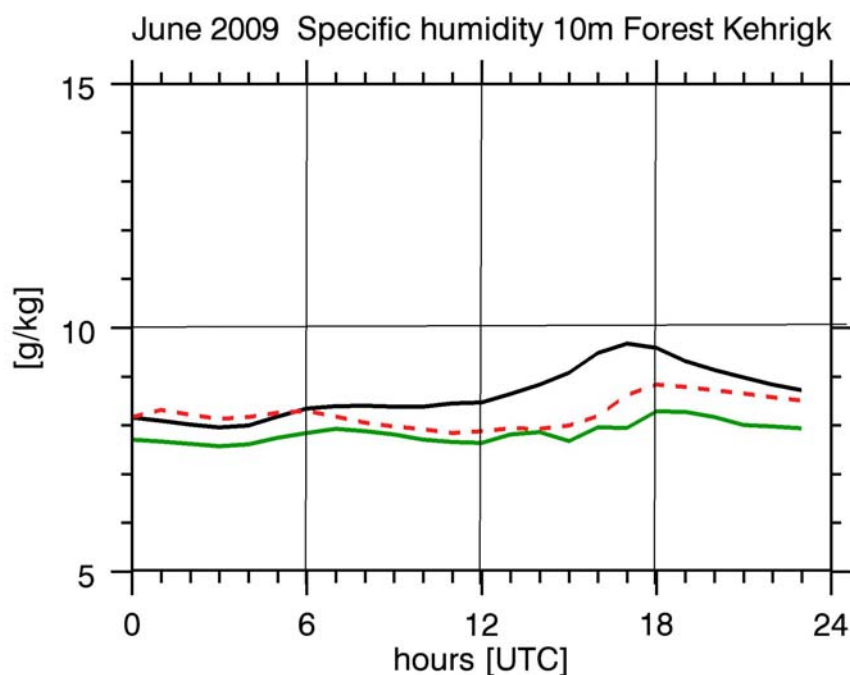


— measurement  
— COSMO-EU  
- - - EXP 7224

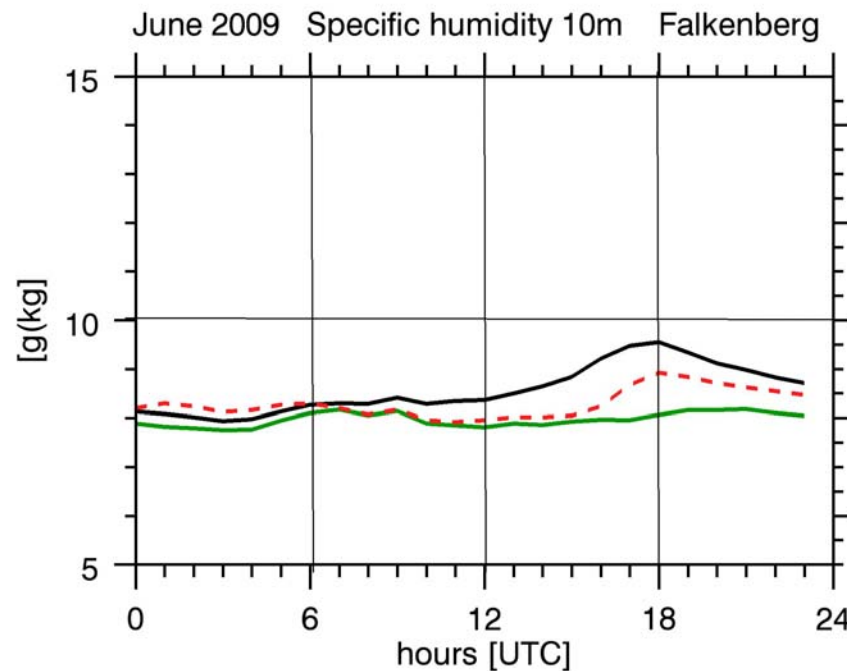


— measurement  
— COSMO-EU  
- - - EXP 7224

## 10m – Specific Humidity

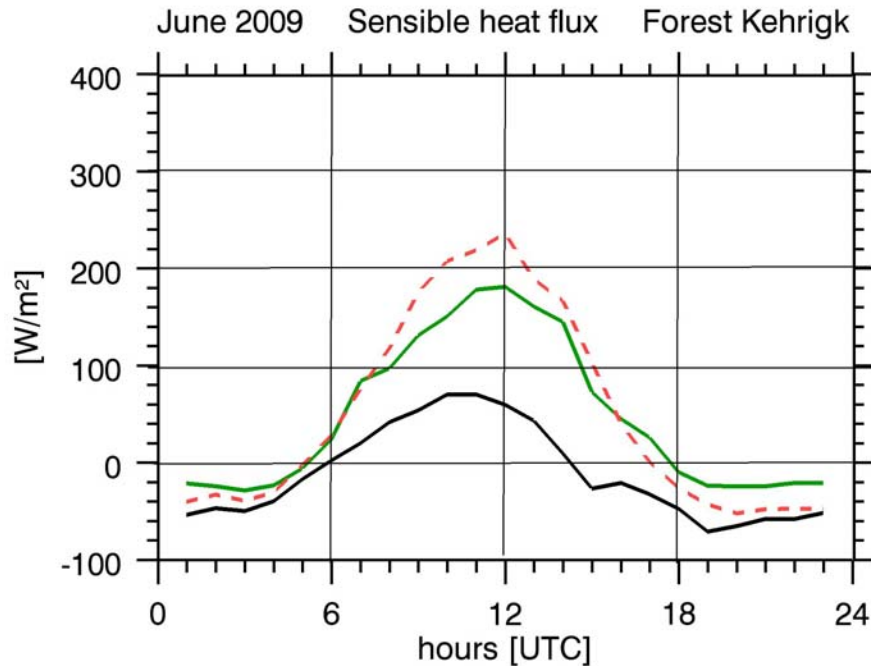


— measurement  
— COSMO-EU  
- - - EXP 7224

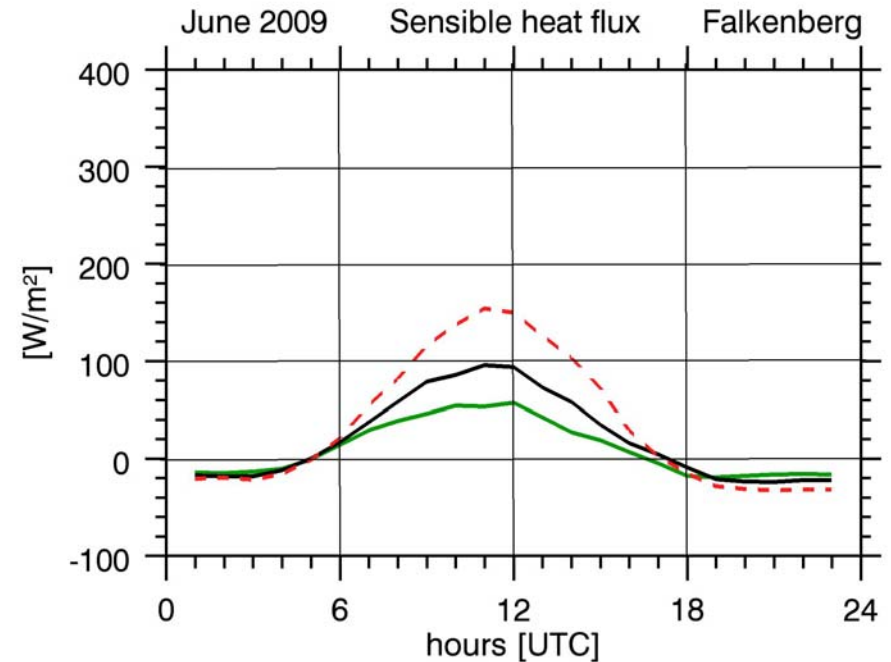


— measurement  
— COSMO-EU  
- - - EXP 7224

## Sensible Heat Flux

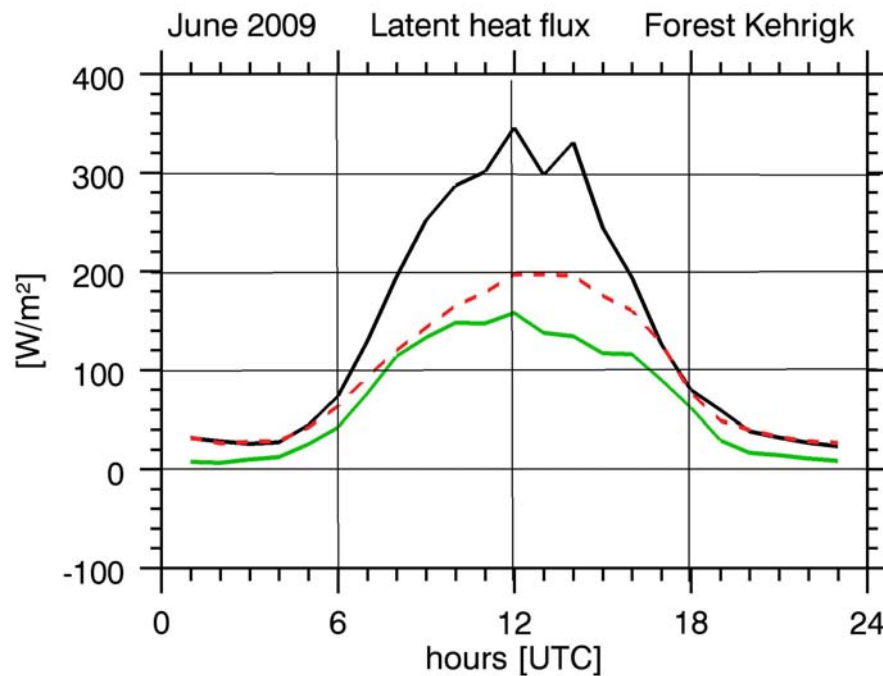


— measurement  
— COSMO-EU  
- - - EXP 7224

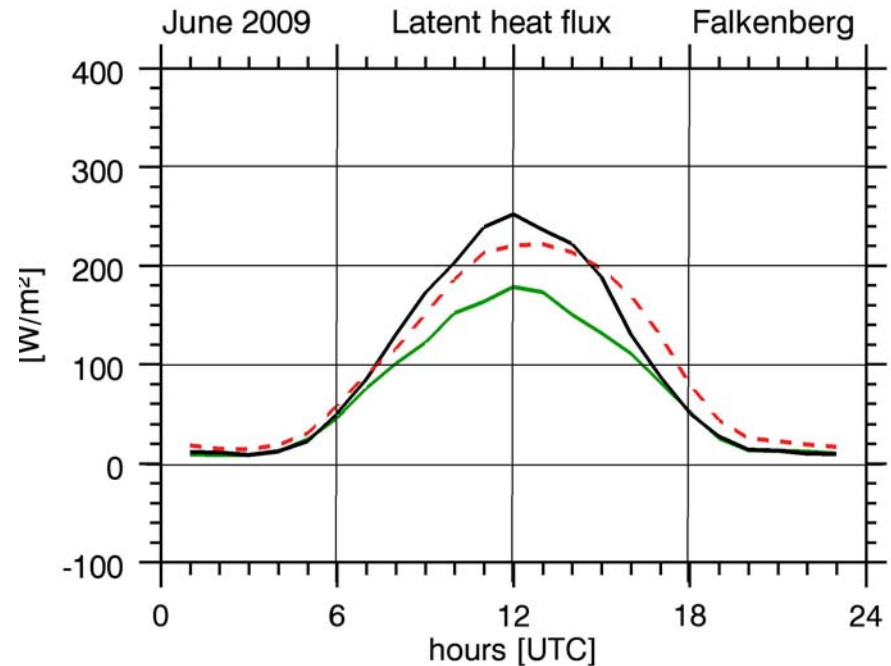


— measurement  
— COSMO-EU  
- - - EXP 7224

## Latent Heat Flux

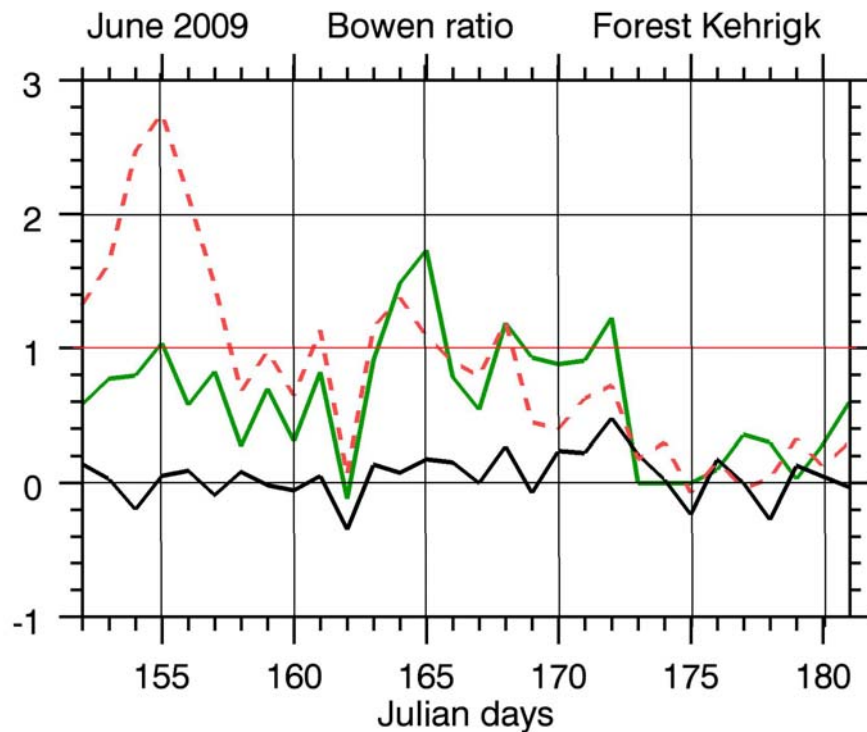


— measurement  
— COSMO-EU  
- - - EXP 7224

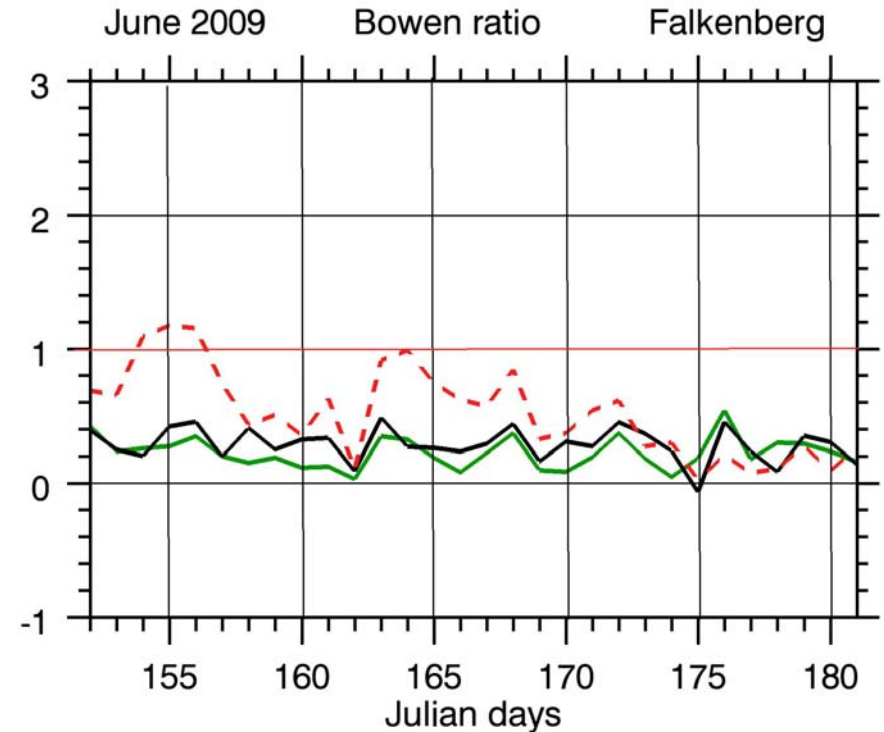


— measurement  
— COSMO-EU  
- - - EXP 7224

## Bowen ratio

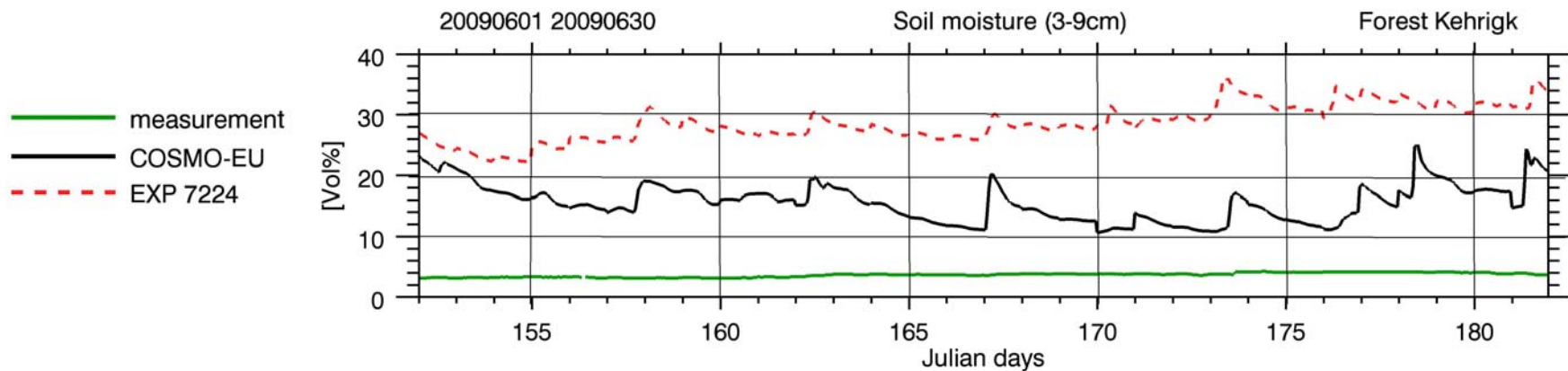
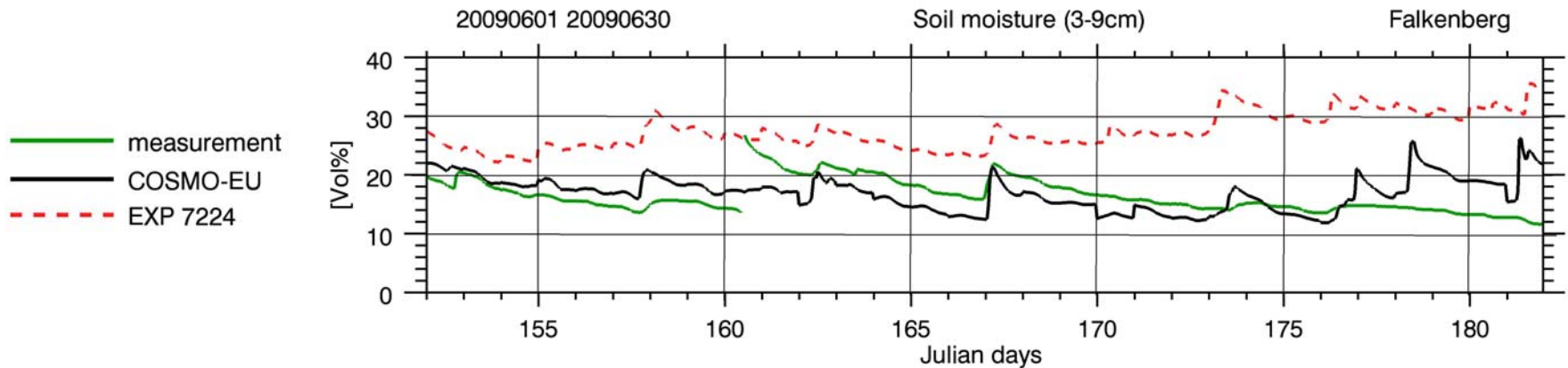


— measurement  
— COSMO-EU  
- - - EXP 7224

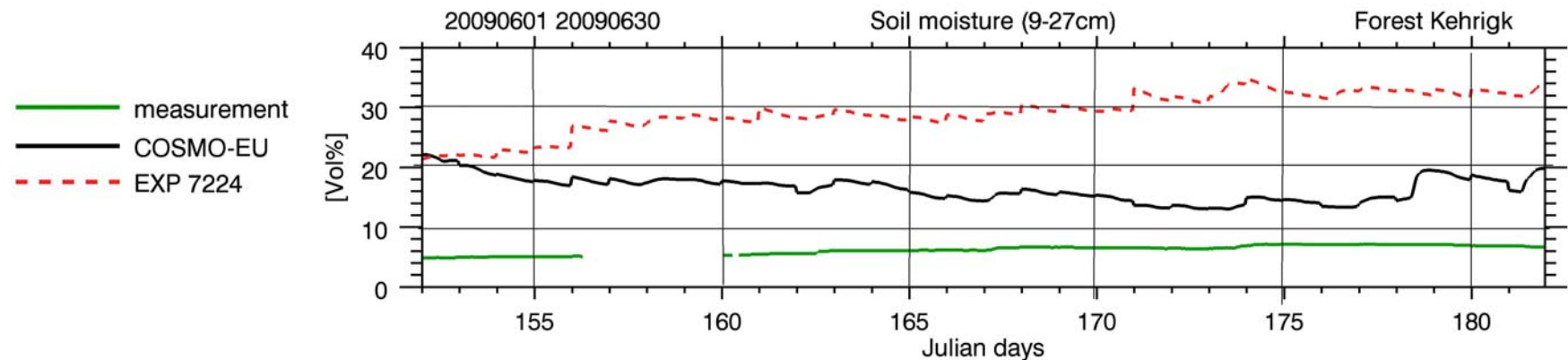
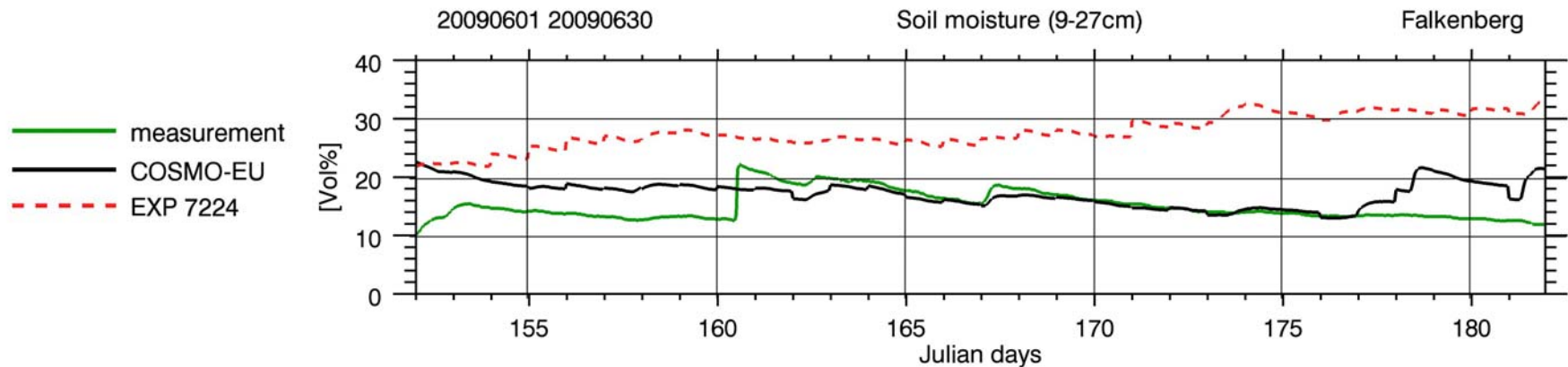


— measurement  
— COSMO-EU  
- - - EXP 7224

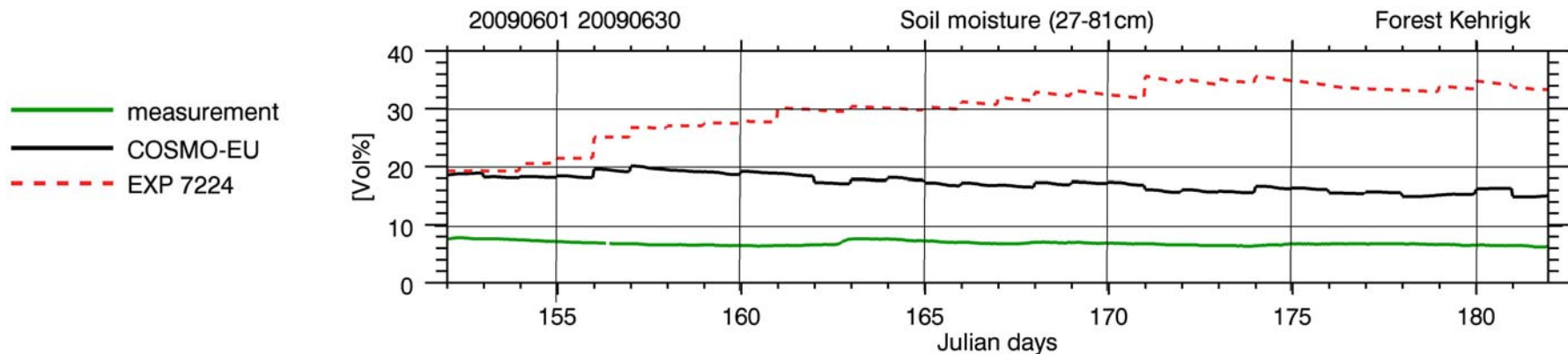
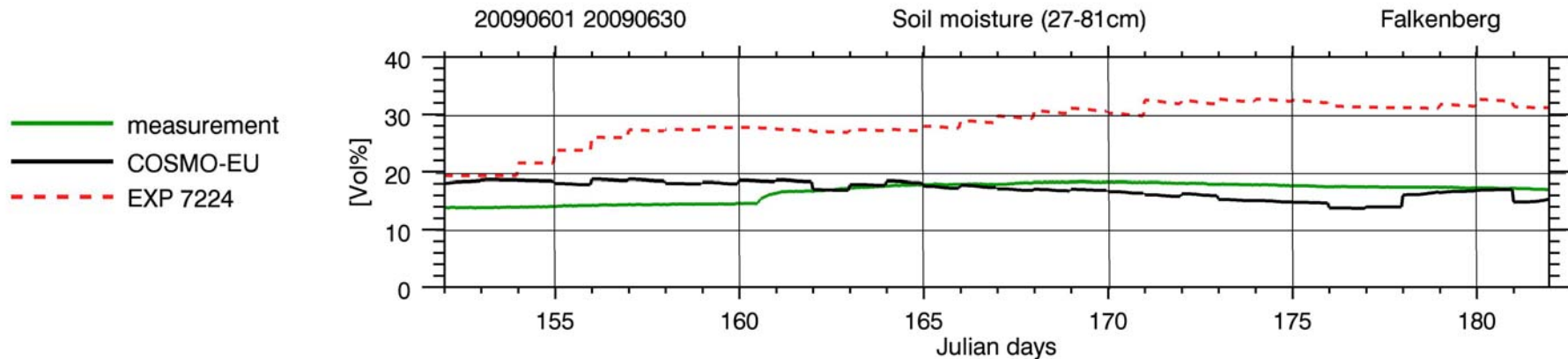
## Soil Moisture 6cm



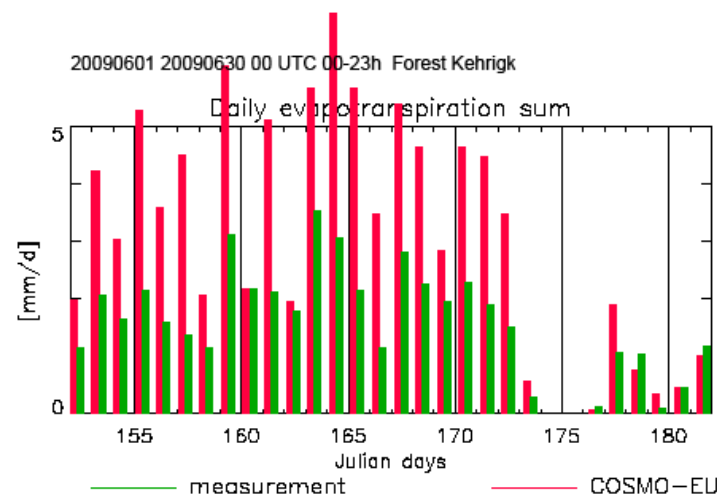
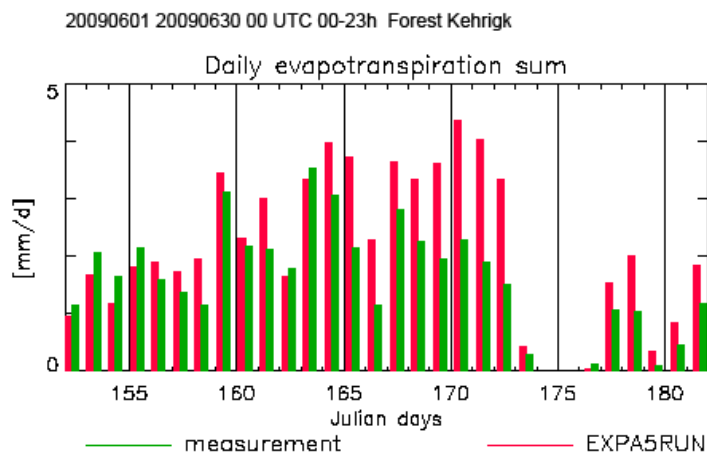
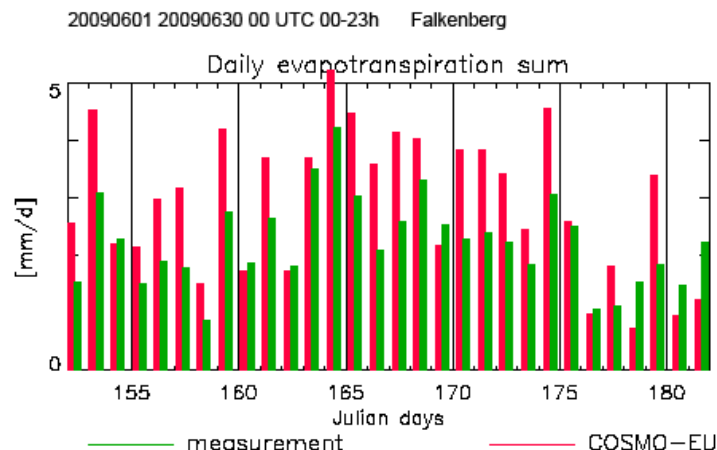
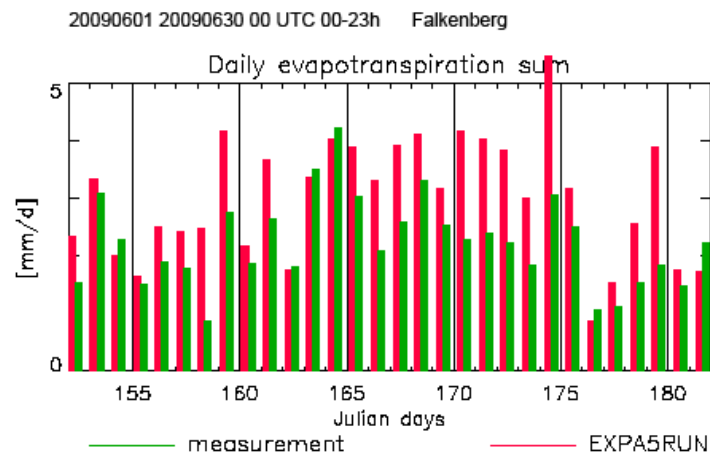
## Soil Moisture 18cm



## Soil Moisture 54cm

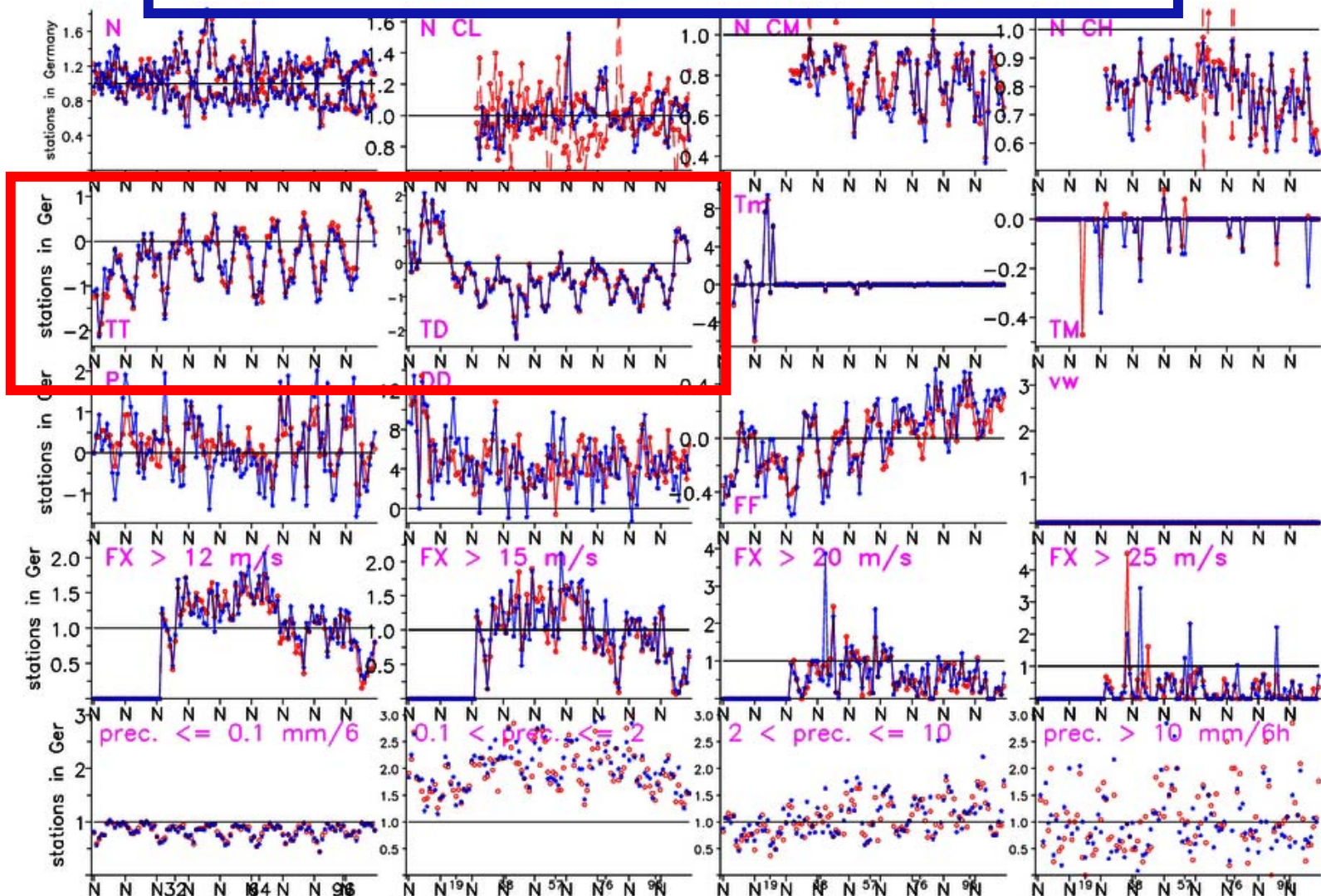


## Evapotranspiration



# Long term verification - CEU Bias

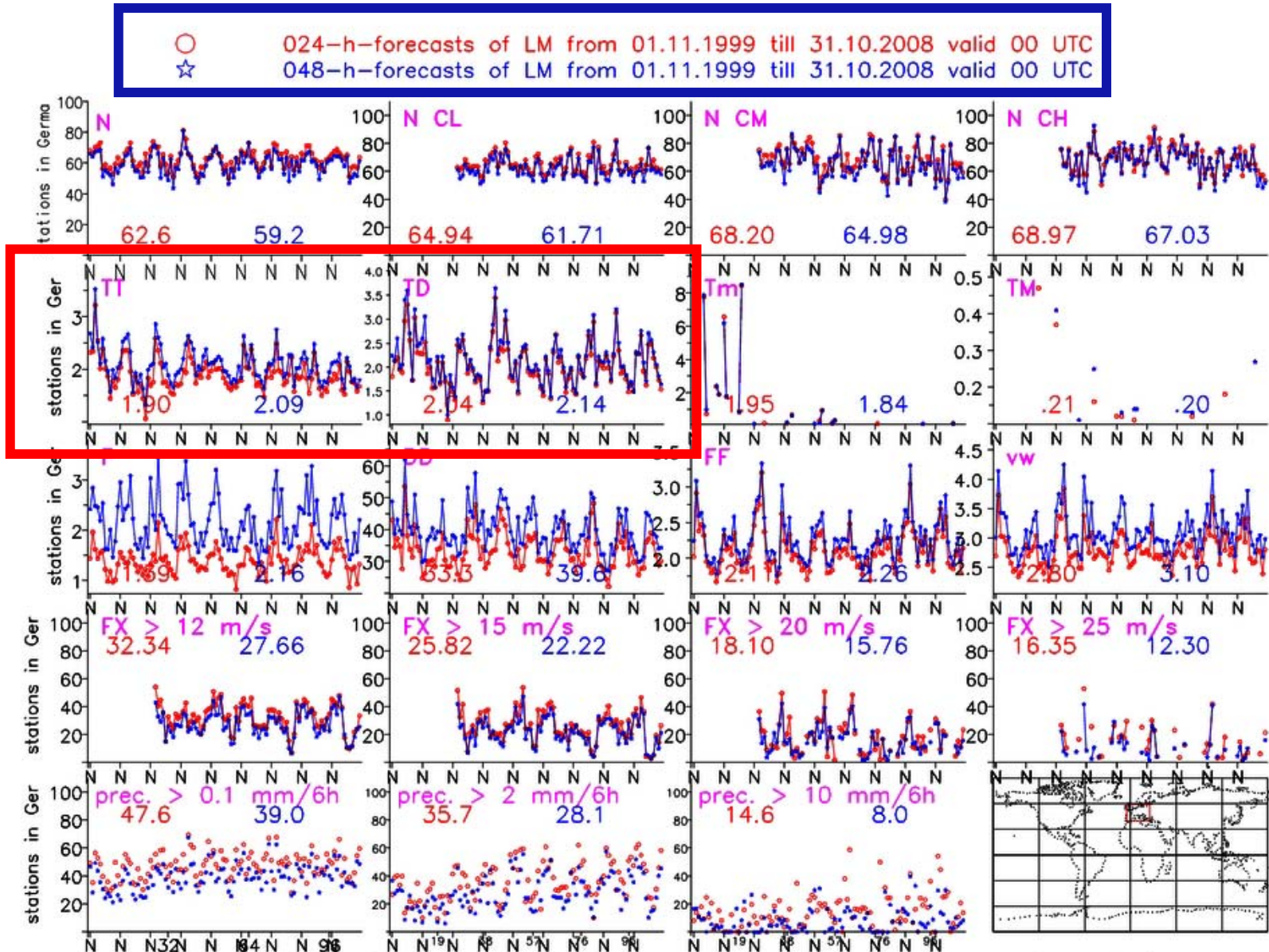
- 024-h-forecasts of LM from 01.11.1999 till 31.10.2008 valid 00 UTC
- 048-h-forecasts of LM from 01.11.1999 till 31.10.2008 valid 00 UTC



Results of verification of forecasts for local weather elements at surface stations

frequency bias for cloud covers (—: 0-2/8, - - : 7-8/8), gusts

# Long term verification - CEU RMSE



Results of verification of forecasts for local weather elements at surface stations

TSS for precipitation, percent correct for cloud covers, FTS for snow, RMSE for other elements

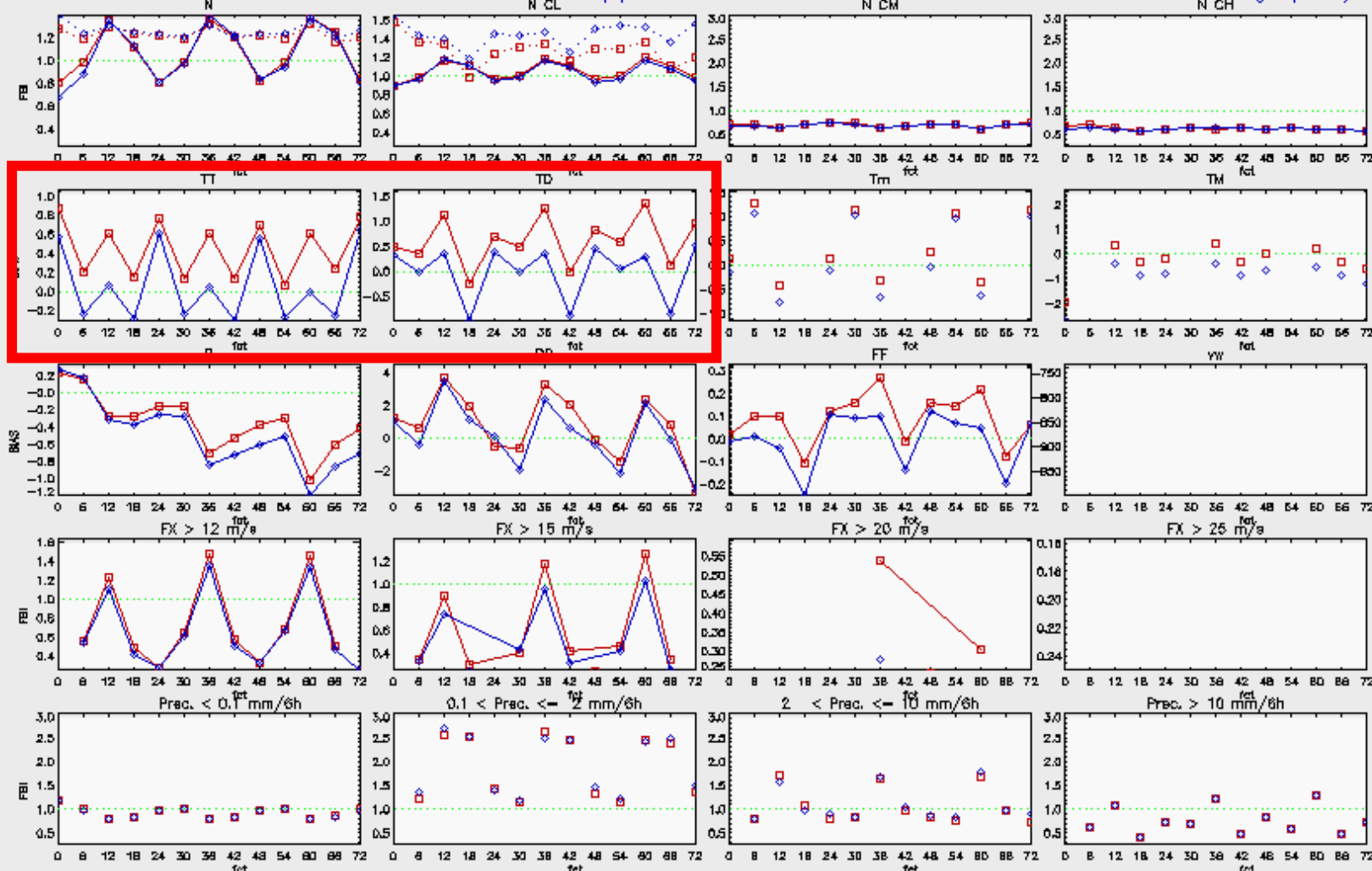
# Deutscher Wetterdienst Verification Exp 7224 Bias



LM2MO: 01.06.2009 00 UTC - 01.07.2009 00 UTC (exp. run 7224: nearest gridpoint)

lm2mo: 01.06.2009 00 UTC - 01.07.2009 00 UTC (ope. run LON: -30.00 - 63.47 LAT: 27.70 - 70.00: nearest gridpoint)

Plottime: 14.02.2010 08:49:40 MEZ



Results of verification of forecasts for local weather elements at surface stations  
FBI for cloud covers gusts and precipitation, BIAS for other elements  
all stations



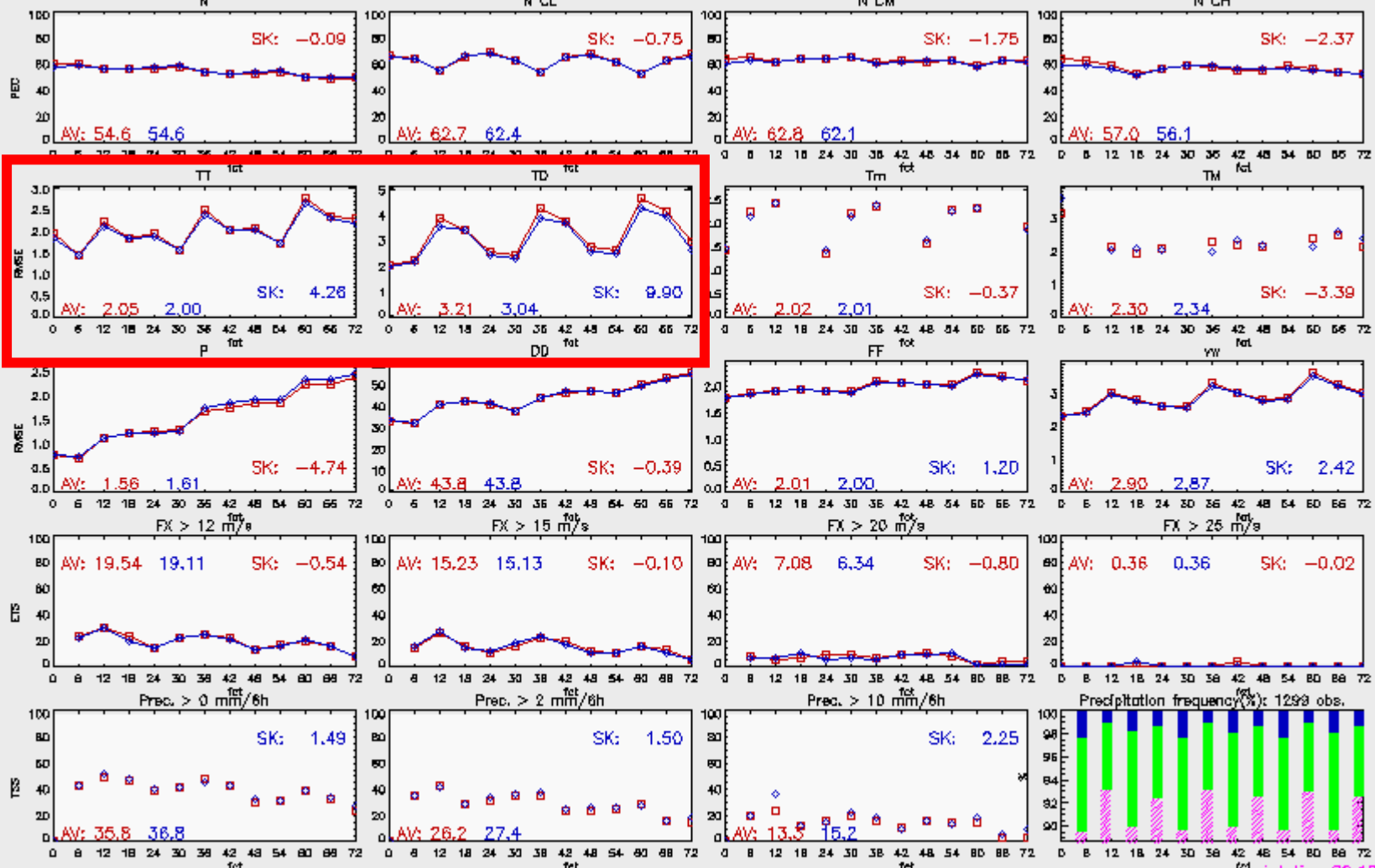
# Deutscher Wetterdienst Verification Exp 7224 Bias



LM2MO: 01.06.2009 00 UTC – 01.07.2009 00 UTC (exp. run 7224: nearest gridpoint)

Plottime: 14.02.2010 08:49:40 MEZ

lm2mo: 01.06.2009 00 UTC – 01.07.2009 00 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)



no precipitation 82.18%  
0.1–2 mm: 9.24%  
3–10 mm: 7.01%  
> 10 mm: 1.57%

## Summary and Conclusions

- Tested combination of external parameters and TERRA adaption could lead to increase in PRS/LAI ratio
- Impact: less evapotranspiration, dry and warm PBL
- SMA tries to compensate T2M-Bias, wet soil