



Max-Planck-Institut
für Meteorologie

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



TERRA and EXTPAR

Recent developments at DWD

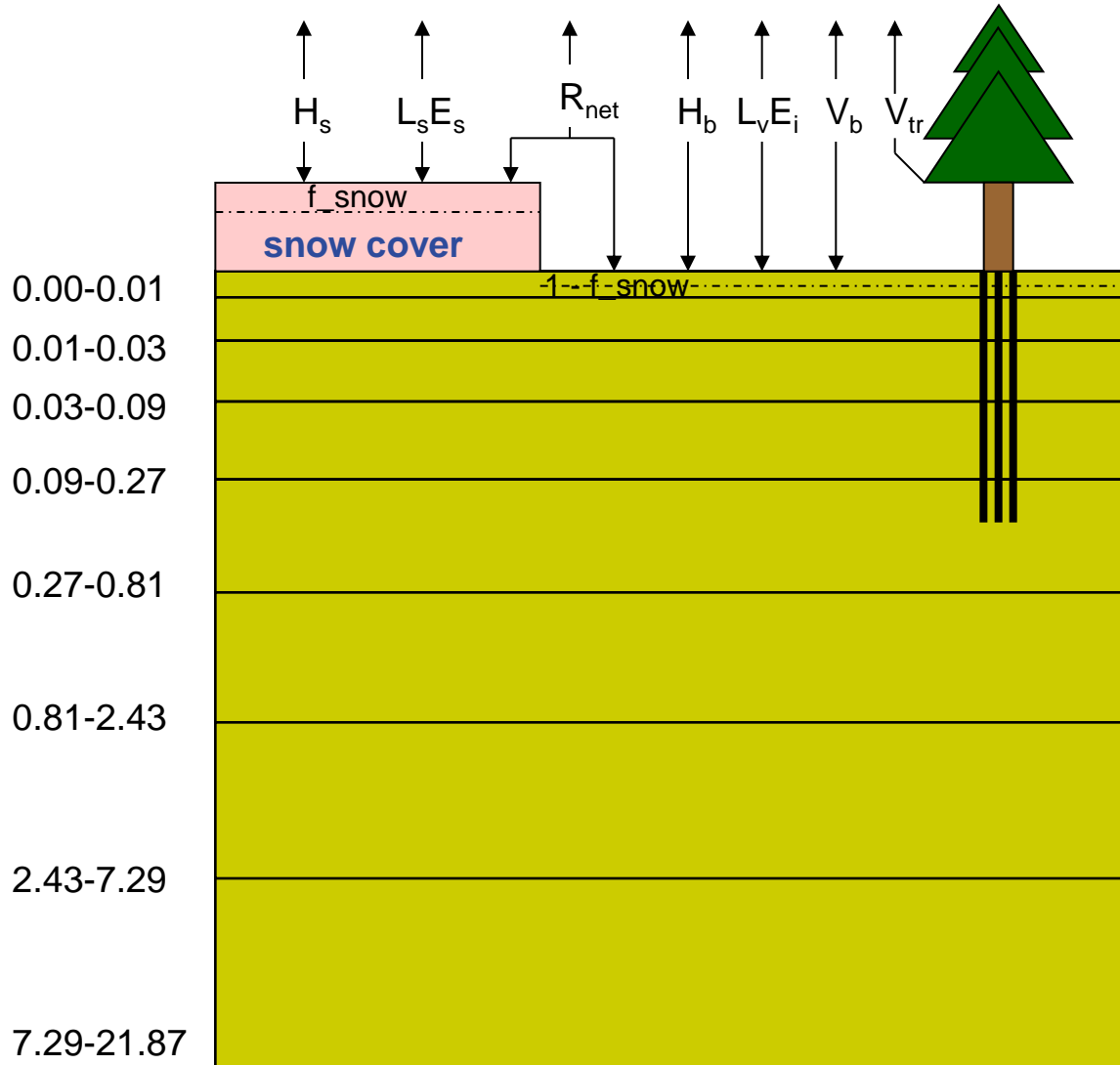
J. Helmert, G. Zängl, D. Reinert, G. Vogel, E. Machulskaya, B. Ritter



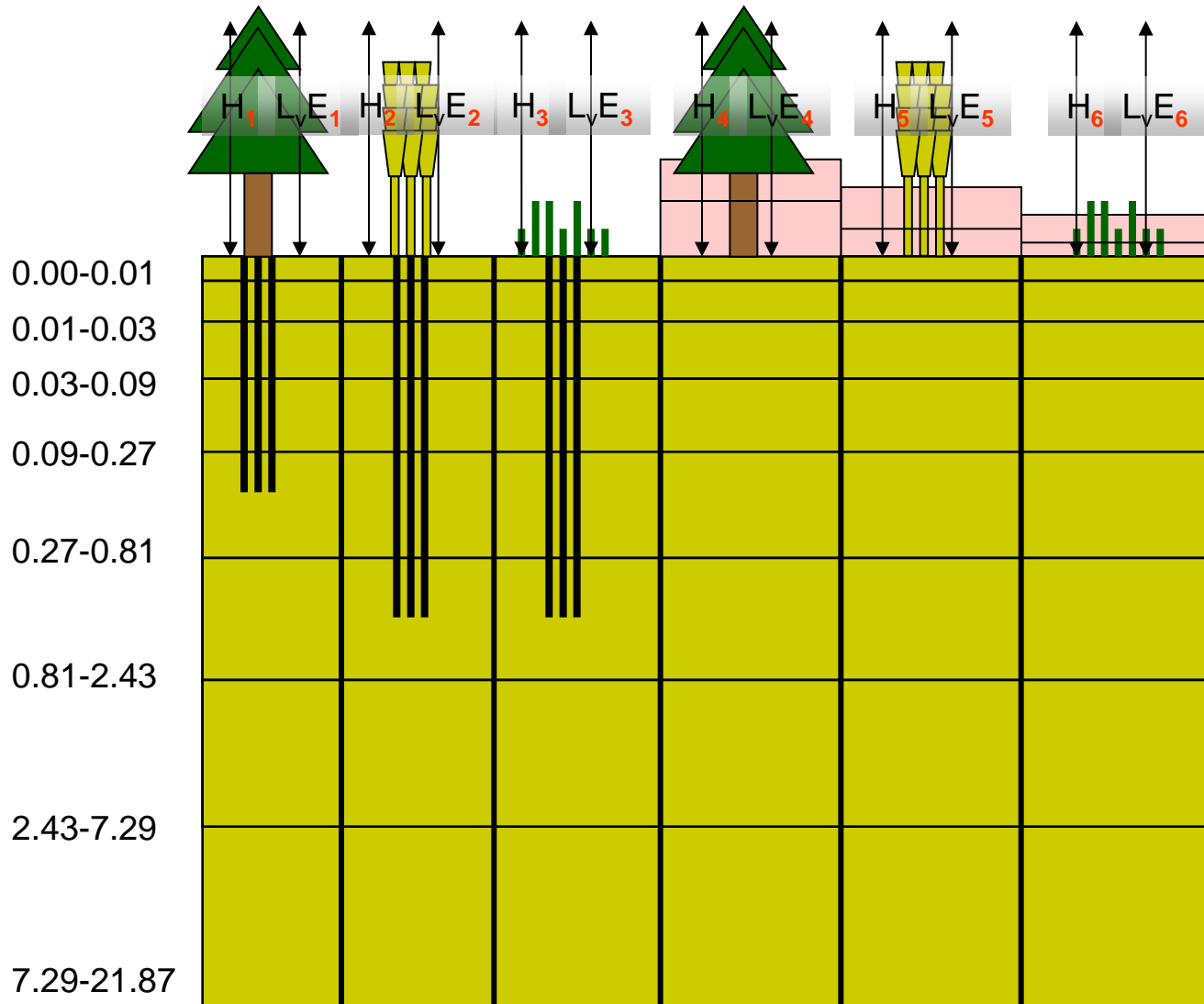
Motivation

**Some slides from presentation at GM 2013
on soil configuration in TERRA-ICON**

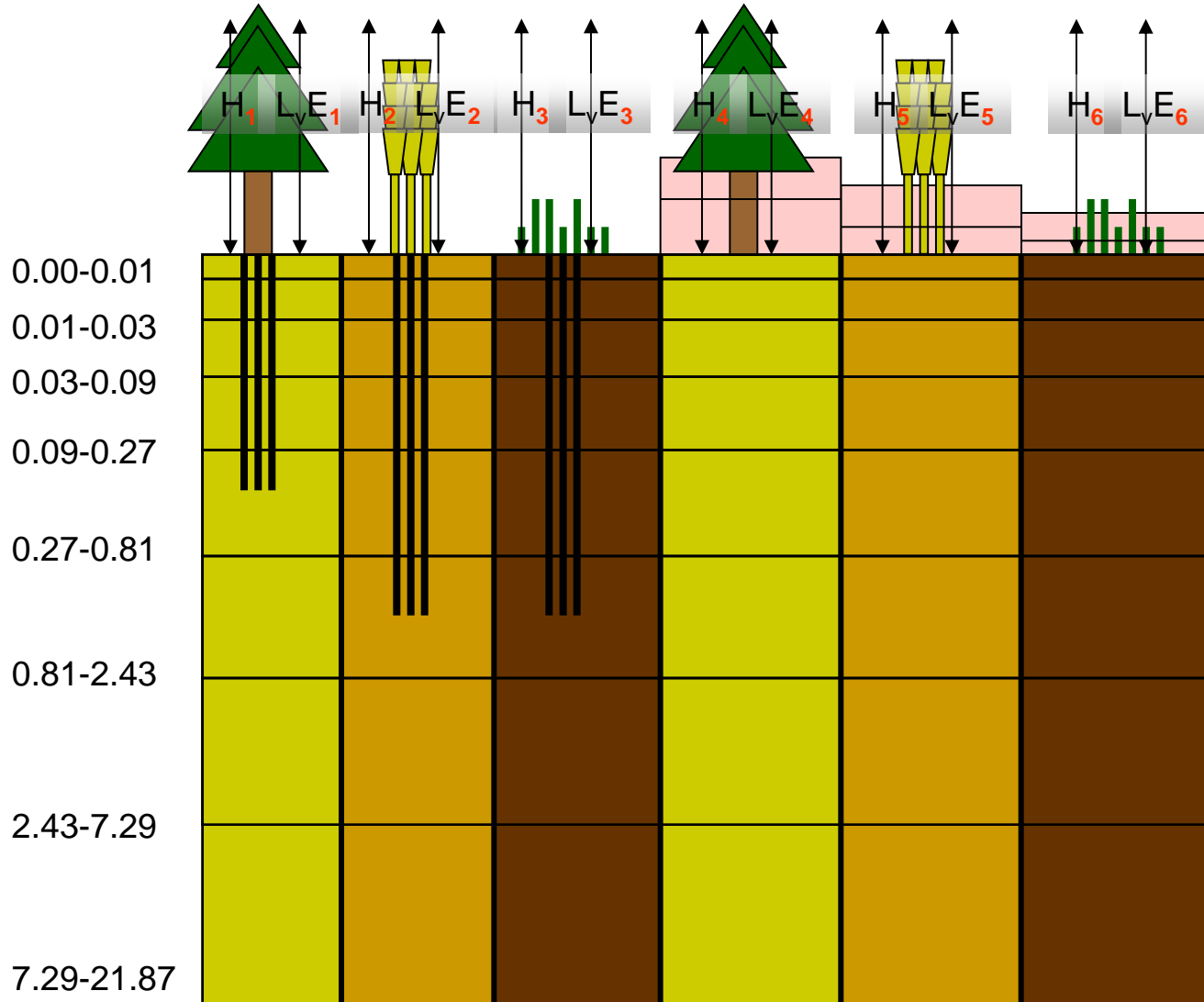
TERRA no-Tiles: HOM-SOIL



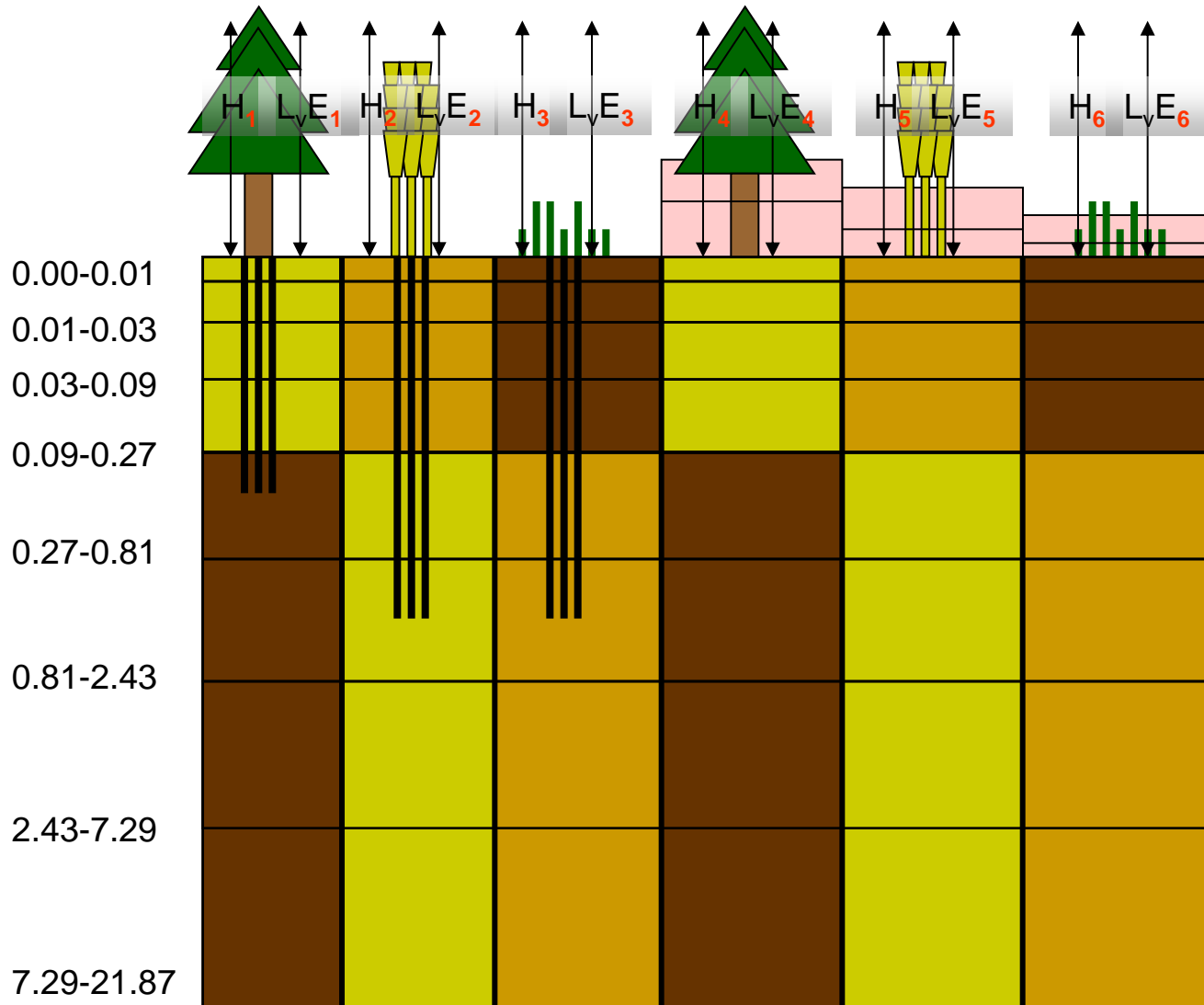
TERRA Tiles: HOM-SOIL



TERRA Tiles: HET-SOIL



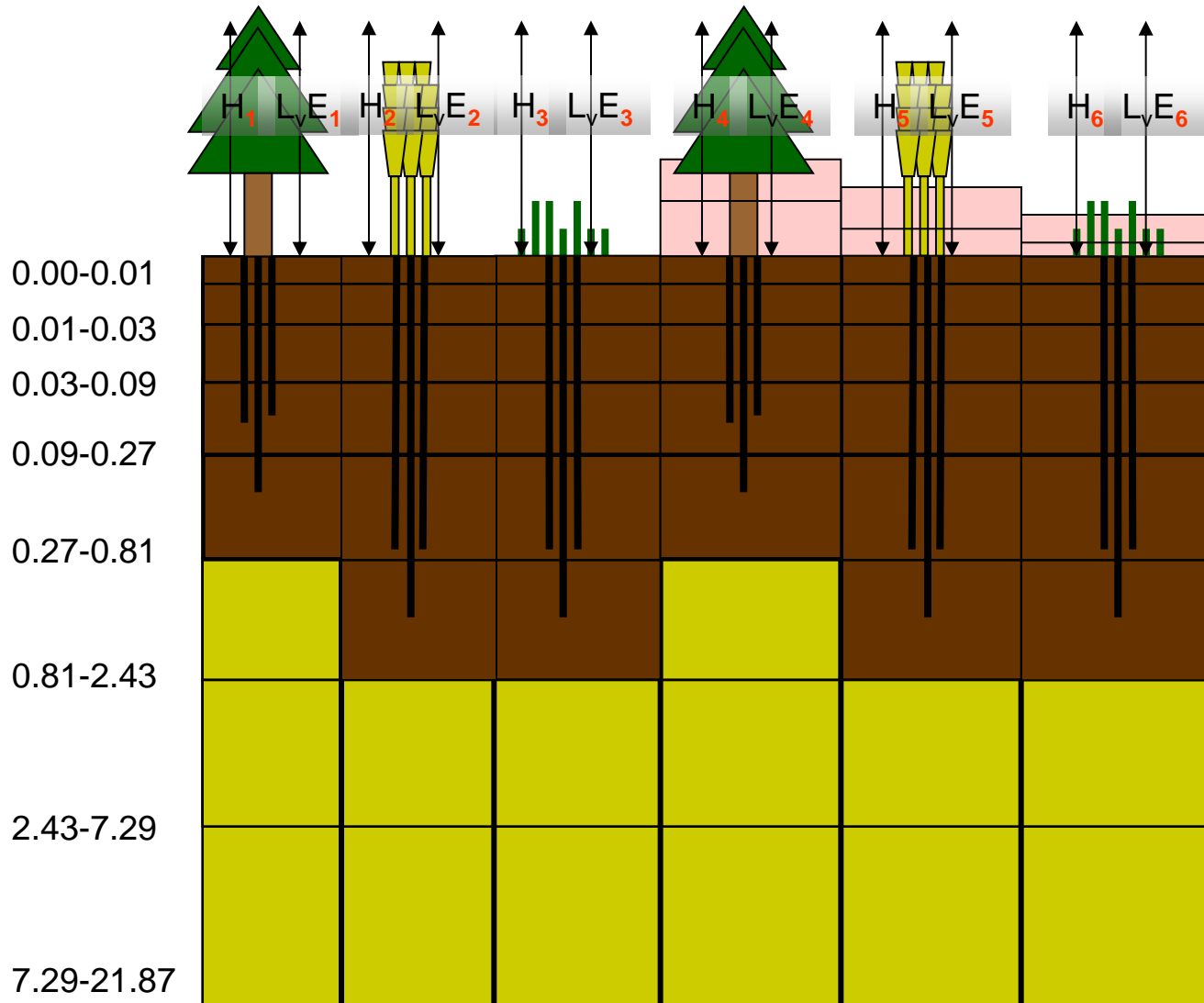
TERRA Tiles: HET+SUB-SOIL



Motivation

TERRA configuration in
ICON preROUTI

TERRA Tiles: ORG-SOIL



Motivation

**TERRA configuration in
ICON preROUTI**

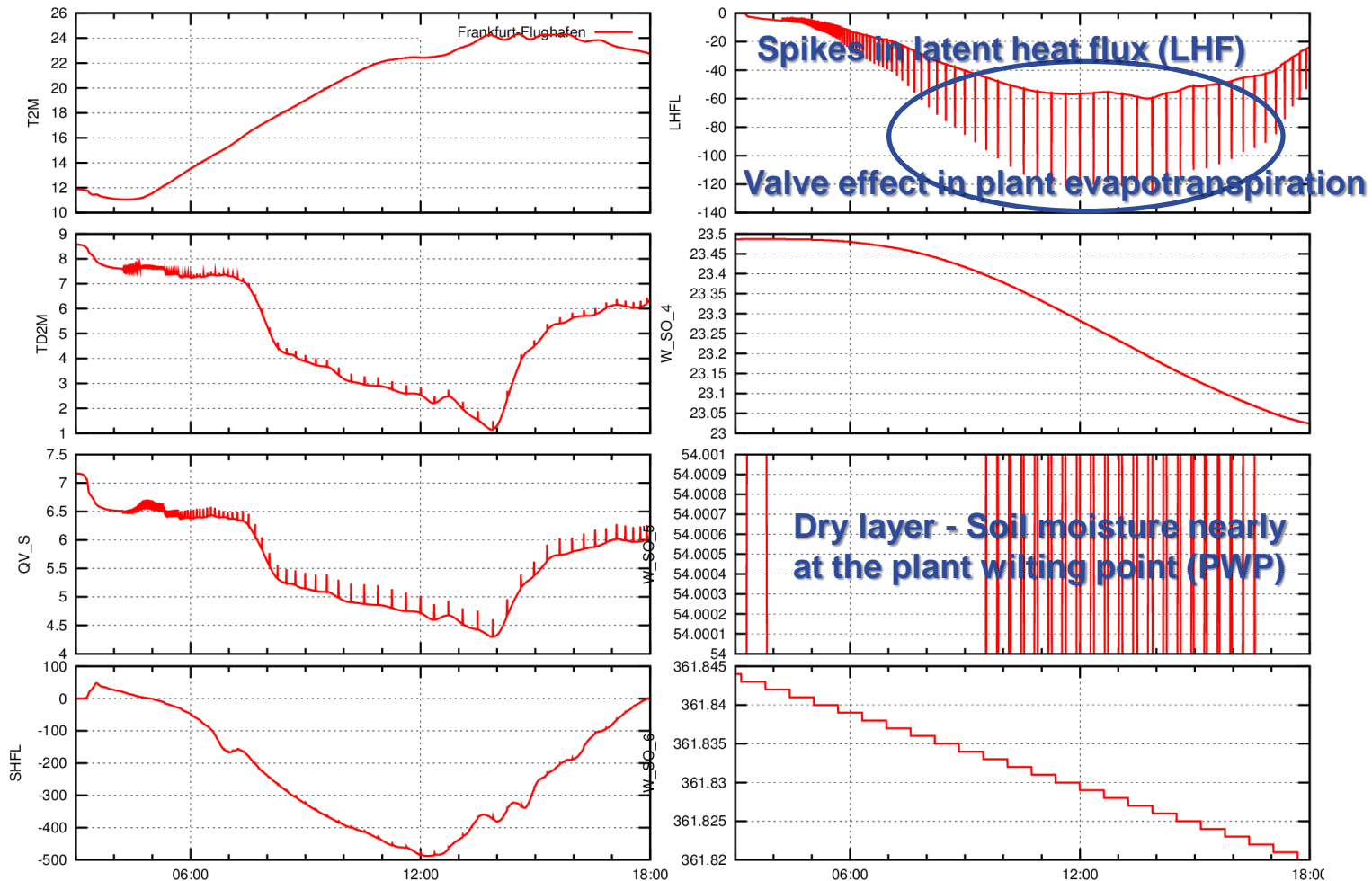
**Modified soil hydraulic conductivity and
transpiration near plant wilting point**

Thermal properties for dry soil

Modified soil hydraulic conductivity and transpiration near plant wilting point

Problem

Spikes in model variables in CDE run 201507103 at grid point Frankfurt



Frankfurt-Flughafen: Lat=50.04°N, Lon=8.60°E, H=107 m. Indices 165-203
Begin at Fri 10-07-2015 03:00:00 UTC

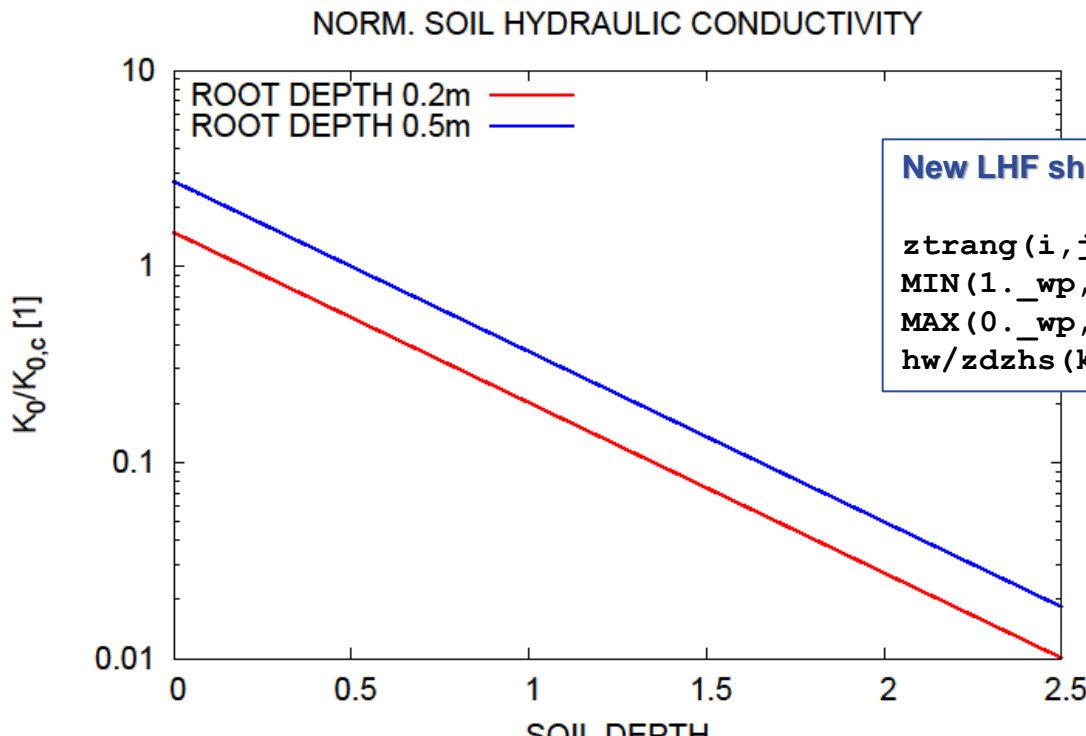


Revised infiltration with smooth LHF shutdown for soil moisture near PWP

$$I'_{max} = \begin{cases} f_r S_{orc} \rho_w K_0(z) & 0 : T_{sfc} \leq T_0 \\ & : T_{sfc} > T_0 \end{cases} \quad (10.3)$$

$$K_w(w_l) = K_0(z) \exp \left[K_1 (w_{PV} - \bar{w}_l) / (w_{PV} - w_{ADP}) \right]$$

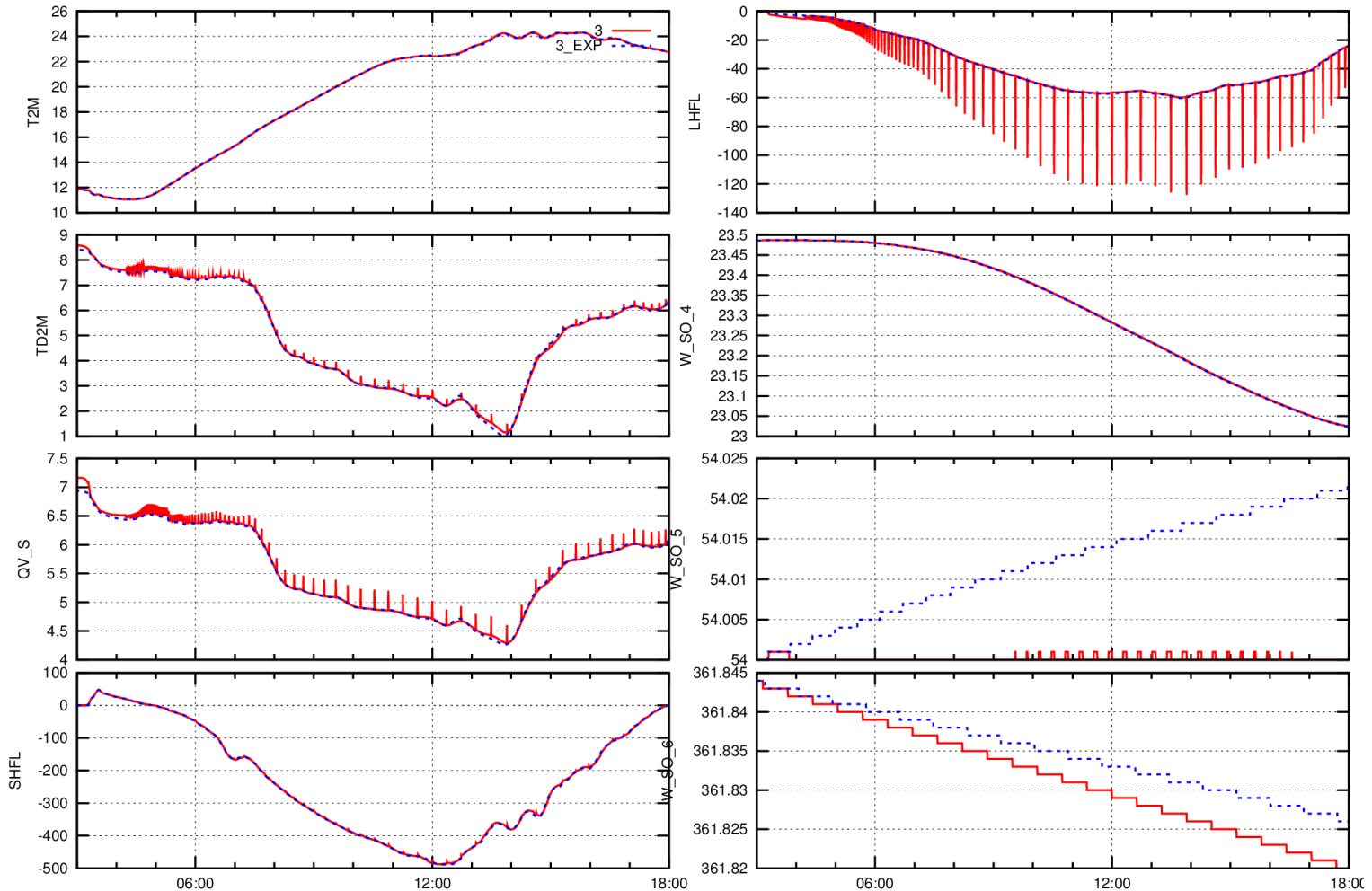
$K_0(z) = K_{0,c} e^{-f(z-d_c)}$ **Profile of sat. hydr. conductivity,**
 Decharme (2006)



New LHF shutdown for soil moisture below 1.05*PWP

```
ztrang(i,j,kso)=ztrang(i,j,kso)* &
MIN(1._wp, &
MAX(0._wp, (zw_fr(i,j,kso)+ztrang(i,j,kso)*zdt dr
hw/zdzhs(kso)-zpwp(i,j))/zpwp(i,j)/0.05_wp
```

Vanished spikes in model variables, smooth refill of dry soil layer



Frankfurt-Flughafen: Lat=50.04°N, Lon=8.60°E, H=107 m. Indices 165 203
 Frankfurt-Flughafen: Lat=50.04°N, Lon=8.60°E, H=107 m. Indices 165 203

Begin at 07.10.2015 03:00:00 UTC

File CDE_2015071003
 File CDE_2015071003_EXP



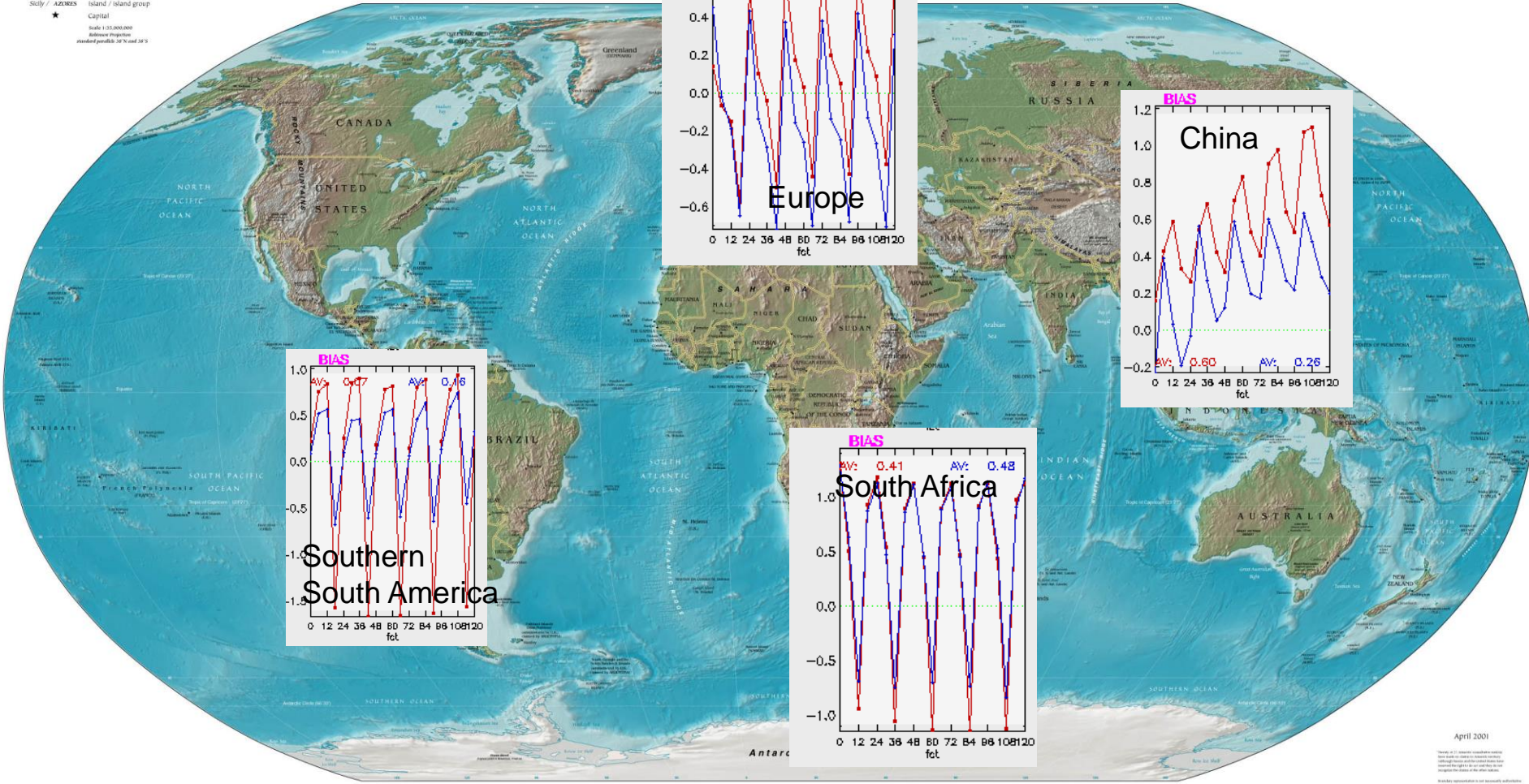
Modified thermal properties for dry soil

Diurnal cycle of the T2M bias



Physical Map of the World, April 2001

AUSTRALIA Independent state
 Bermuda Dependency or area of special sovereignty
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Results of verification of forecasts for local wea
 ICONN: 01.06.2012 00 UTC – 30.06.2012 00 UTC
 I384f: 01.06.2012 00 UTC – 30.06.2012 00 UTC

April 2001

Source: © Deutscher Wetterdienst
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 physical map of the world published
 by the Deutscher Wetterdienst
 in 2001. It is not a legal document
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$$\frac{\partial T_{so}}{\partial t} = \frac{1}{(\rho c)} \frac{\partial}{\partial z} \left(\lambda \frac{\partial T_{so}}{\partial z} \right)$$

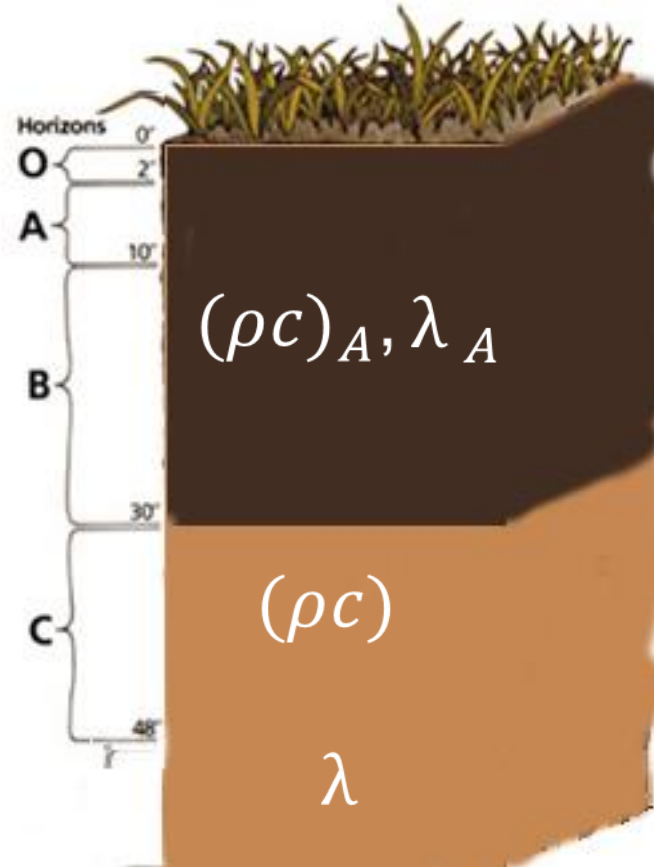
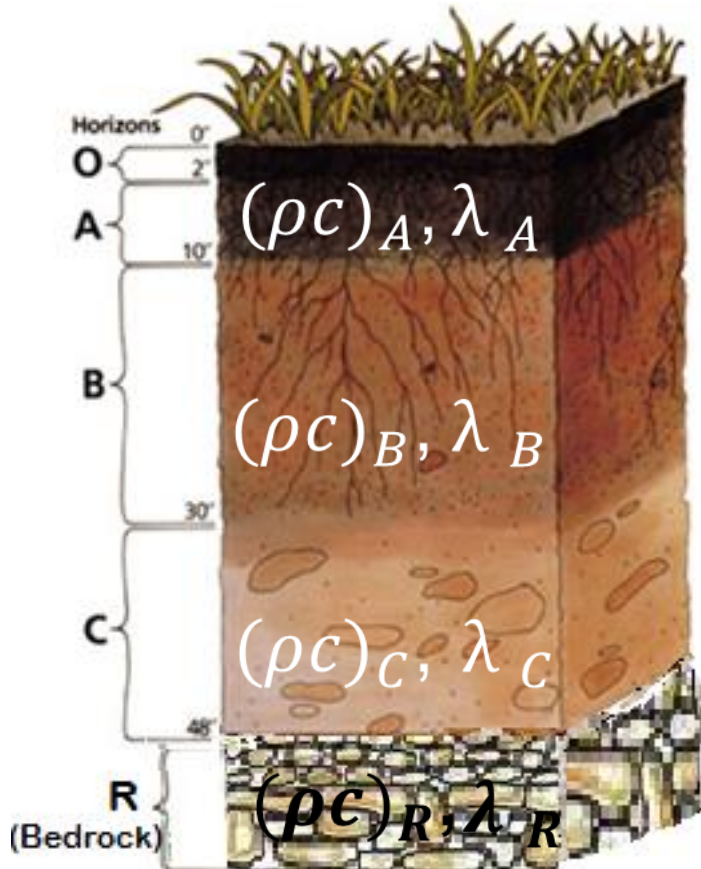
T_{so} is soil temperature

ρc is heat capacity.

λ is heat conductivity.

Soil heat conductivity and heat capacity depend on soil type but are prescribed for the whole soil column.

TERRA Tiles



Appendix A: Details of organic soil parameterisation

$$b = (1 - f_{\text{org}})b_{\text{m}} + f_{\text{org}}b_{\text{o}},$$

$$\psi_{\text{sat}} = \psi_{\text{sat,m}}^{1-f_{\text{org}}} \psi_{\text{sat,o}}^{f_{\text{org}}},$$

$$K_{\text{s}} = K_{\text{s,m}}^{1-f_{\text{org}}} K_{\text{s,o}}^{f_{\text{org}}},$$

$$\theta_{\text{sat}} = (1 - f_{\text{org}})\theta_{\text{sat,m}} + f_{\text{org}}\theta_{\text{sat,o}},$$

$$\theta_{\text{crit}} = \theta_{\text{sat}} \left(\frac{\psi_{\text{sat}}}{3.364} \right)^{1/b},$$

$$\theta_{\text{wilt}} = \theta_{\text{sat}} \left(\frac{\psi_{\text{sat}}}{152.9} \right)^{1/b},$$

$$C_{\text{dry}} = (1 - f_{\text{org}})C_{\text{dry,m}} + f_{\text{org}}C_{\text{dry,o}},$$

$$\lambda_{\text{dry}} = \lambda_{\text{dry,m}}^{1-f_{\text{org}}} \lambda_{\text{dry,o}}^{f_{\text{org}}}.$$

Sarah Chadburn et al., 2015: An improved representation of physical permafrost dynamics in the JULES land-surface model

Subscripts m and o denote values for mineral and organic soils, respectively. K_{s} is the hydraulic conductivity at saturation, θ_{crit} and θ_{wilt} are the moisture contents for the critical point and wilting point, and C_{dry} and λ_{dry} are thermal properties: heat capacity and thermal conductivity of dry soil. The properties for organic soils are as in Dankers et al. (2011) (Table 2). Some of these parameters are given as three different values for different vertical layers of the soil. The division between layers was taken at 0.3 and 1 m.

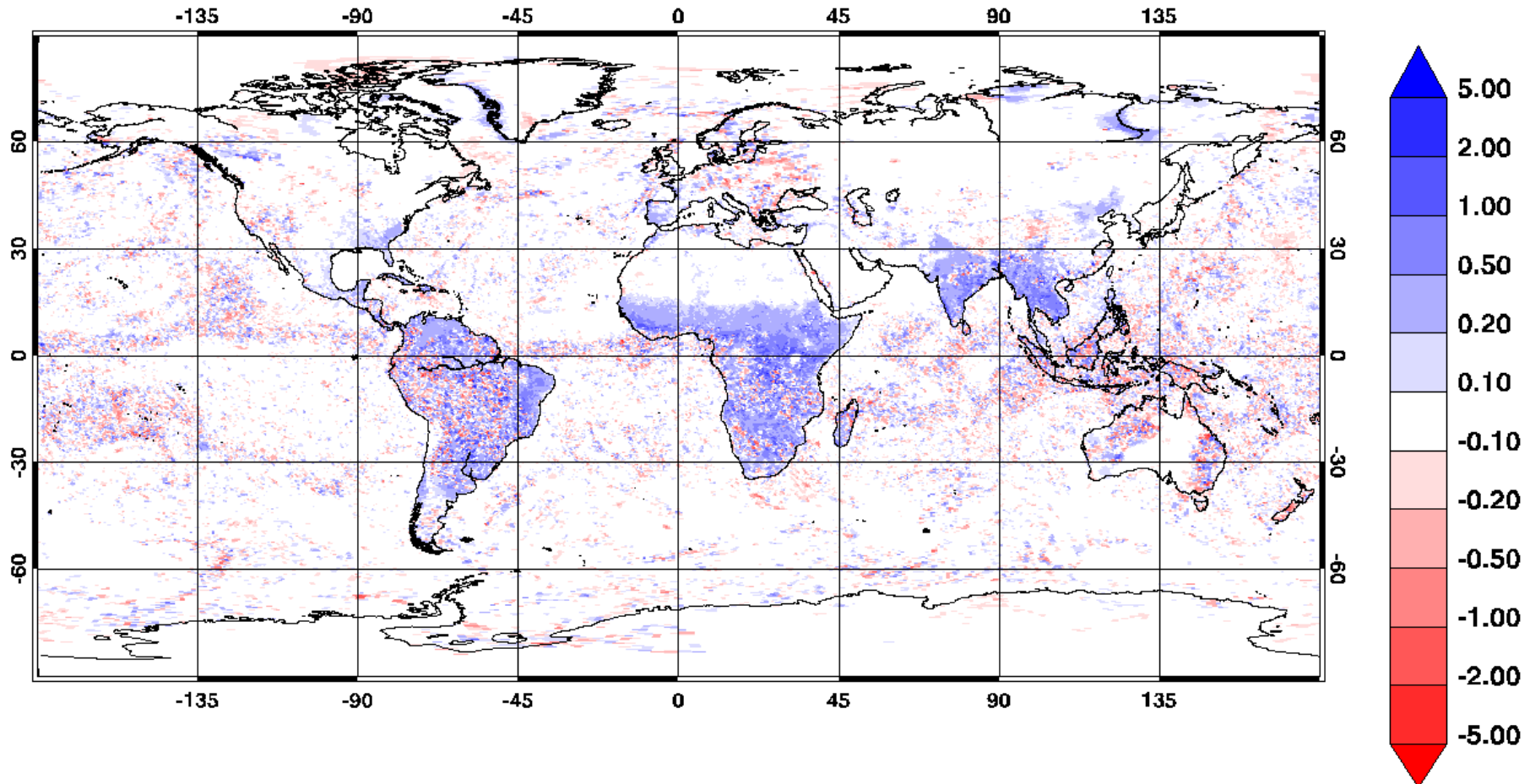
Table 2. Parameters for organic soil used in the SOC experiment. For explanation of the parameters and units, see Table 1.

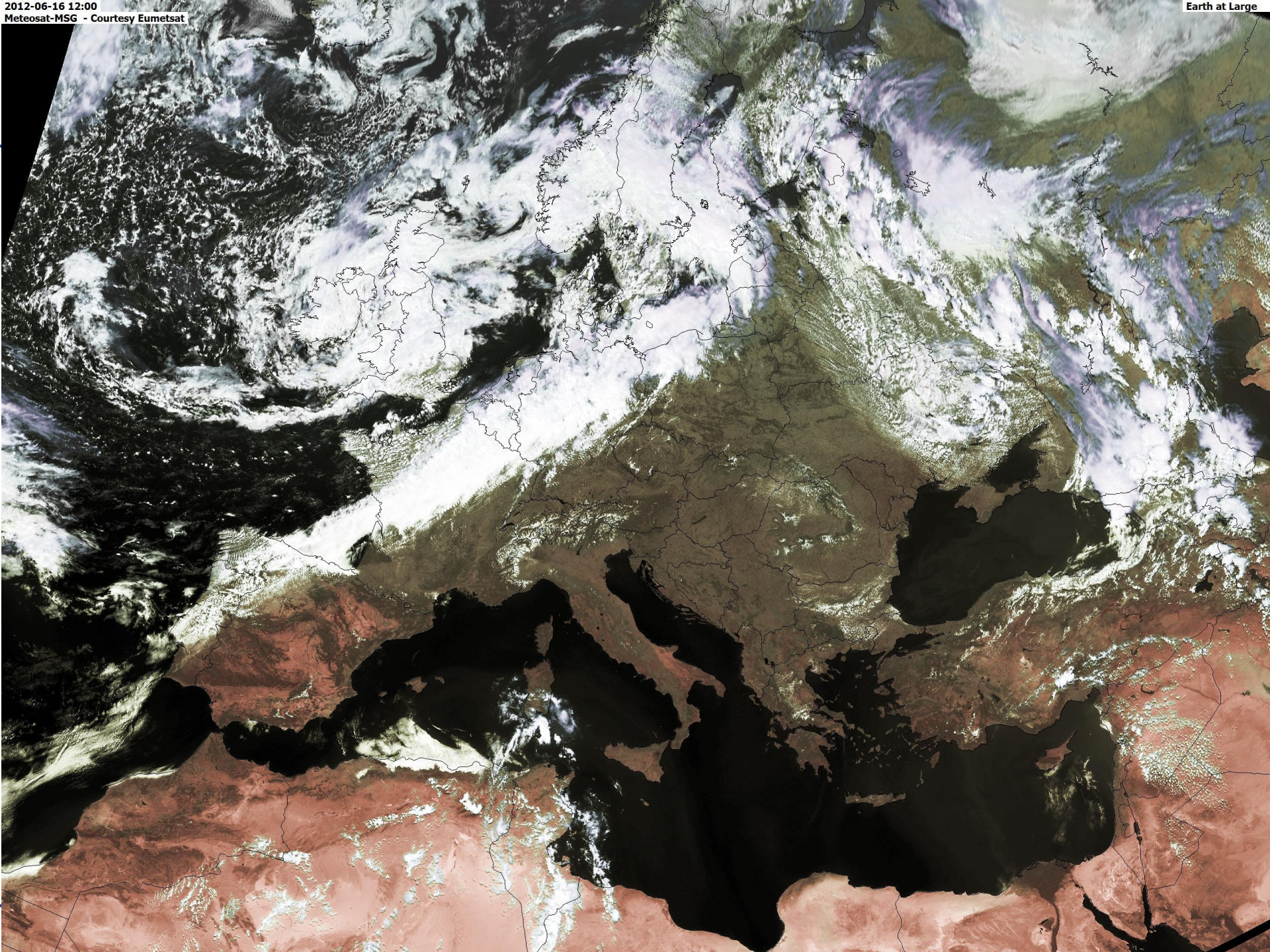
| Parameter | Top layer 0–10 cm | Layer 2 10–35 cm | Layer 3 35–100 cm | Source |
|---------------------|----------------------|---------------------|----------------------|-------------------------|
| b | 2.7 | 6.1 | 12.0 | Letts et al. (2000) |
| Ψ_{s} | 0.0103 | 0.0102 | 0.0101 | Letts et al. (2000) |
| K_{s} | 0.28 | 0.002 | 0.0001 | Letts et al. (2000) |
| θ_{s} | 0.93 | 0.88 | 0.83 | Letts et al. (2000) |
| θ_{c} | 0.11 | 0.34 | 0.51 | ^a |
| θ_{w} | 0.03 | 0.18 | 0.37 | ^a |
| c | 0.58×10^6 | 0.58×10^6 | 0.58×10^6 | Oke (1987) ^b |
| λ | 0.06 | 0.06 | 0.06 | Oke (1987) ^b |

^a Estimated following Cosby et al. (1984), ^b based on Van Wijk and De Vries (1963).

T2M sensitivity - FG cycle

T_2M [K] fc_R02B06.2015012721 + 0003 REF-EXP
mean: 0.03 std: 0.20 min: -3.55 max: 4.29



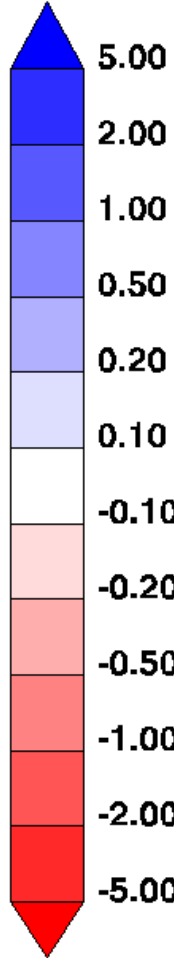
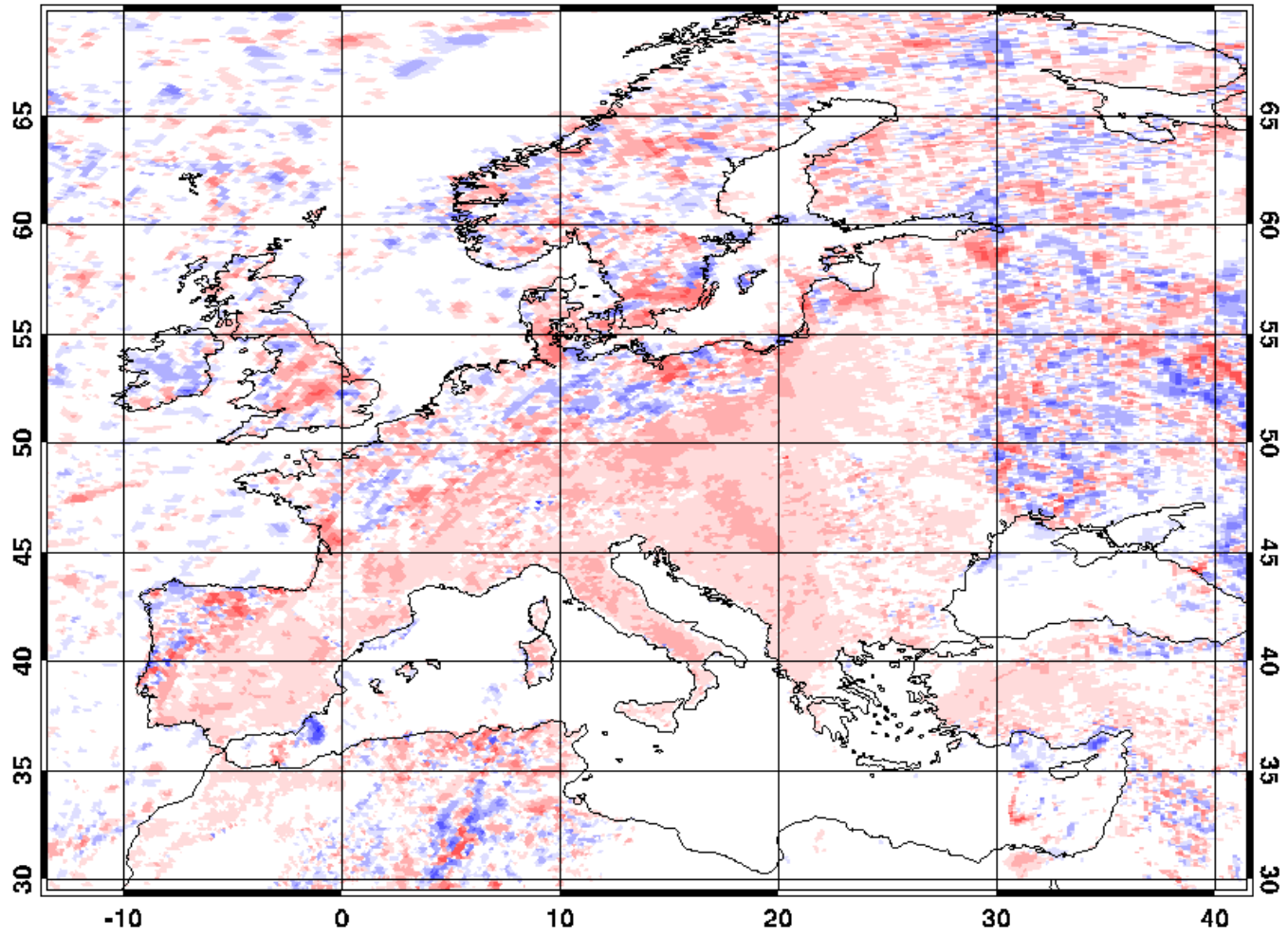


T2M sensitivity - Day



T2M [K] ecmf 2012061500 + 0036 REF-EXP (398-401)

mean: -0.04 std: 0.19 min: -2.19 max: 2.14
-10 0 10 20 30 40

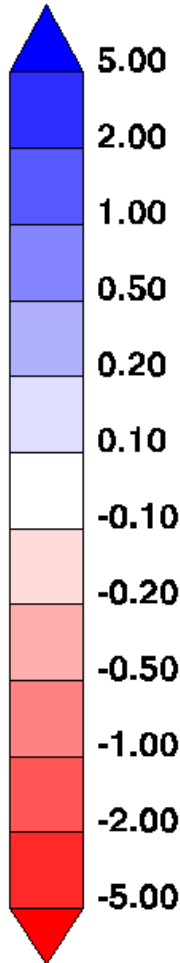
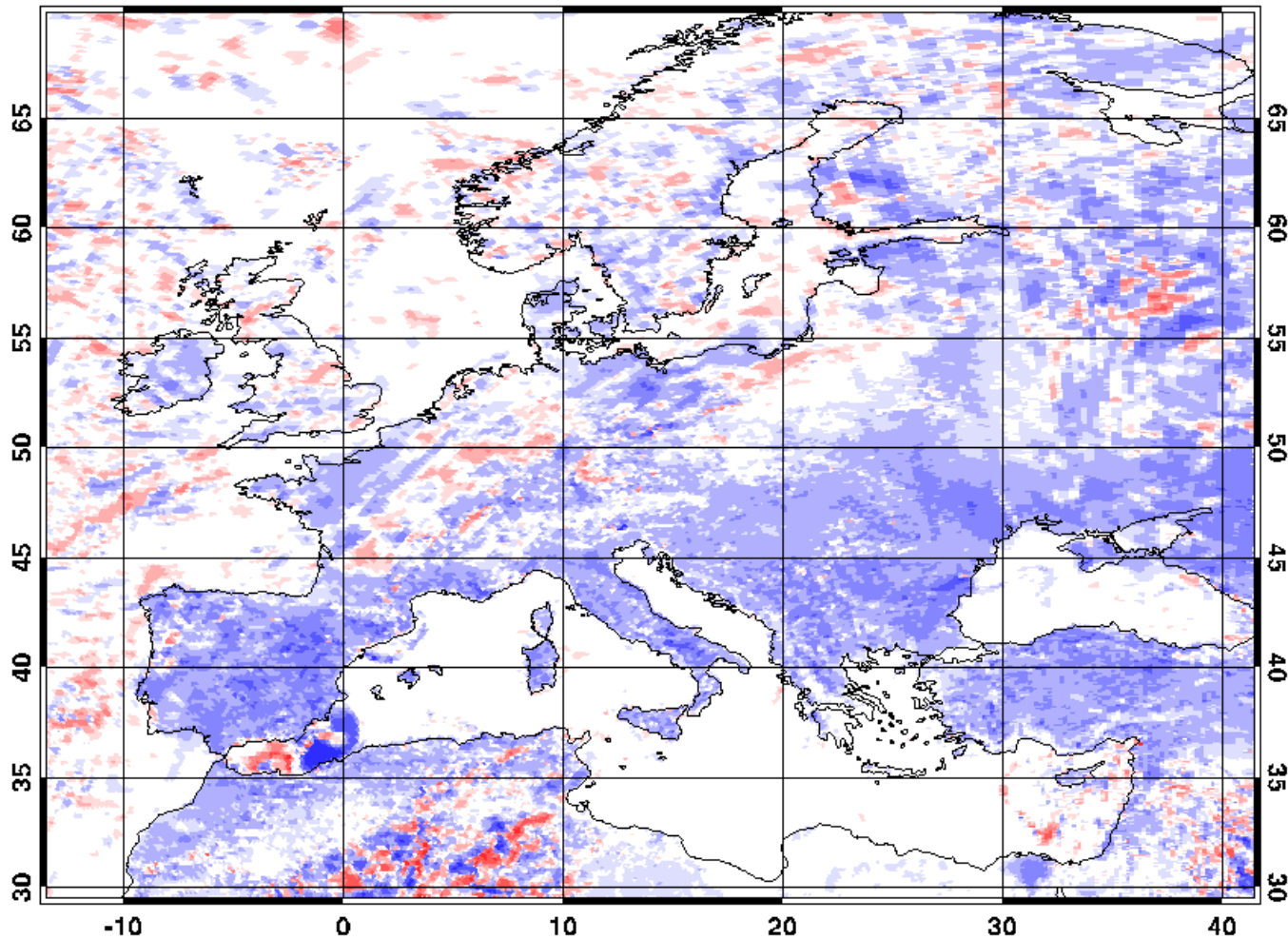


T2M sensitivity - Night



T2M [K] ecmf 2012061500 + 0048 REF-EXP (398-401)

mean: 0.13 std: 0.28 min: -2.91 max: 4.24
-10 0 10 20 30 40

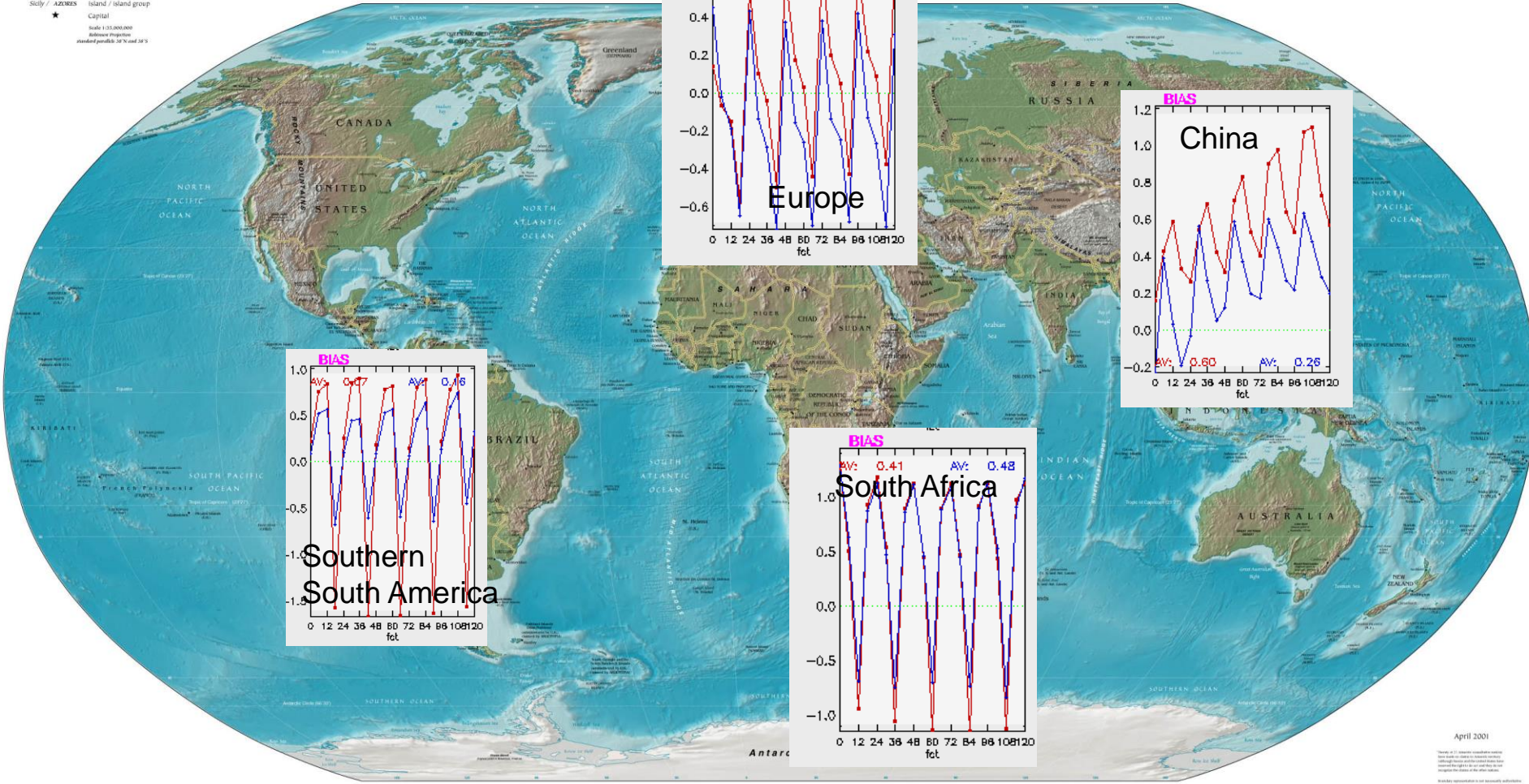


Diurnal cycle of the T2M bias without modification

Physical Map of the World, April 2001

AUSTRALIA Independent state
 Bermuda Dependency or area of special sovereignty
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 ★ Capital
 Scale: 1:10,000,000
 Indicated projection
 standard parallels 36°N and 36°S

Results of verification of forecasts for local wea
 ICONN: 01.06.2012 00 UTC – 30.06.2012 00 UTC
 I384f: 01.06.2012 00 UTC – 30.06.2012 00 UTC



April 2001
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 original map of the world published
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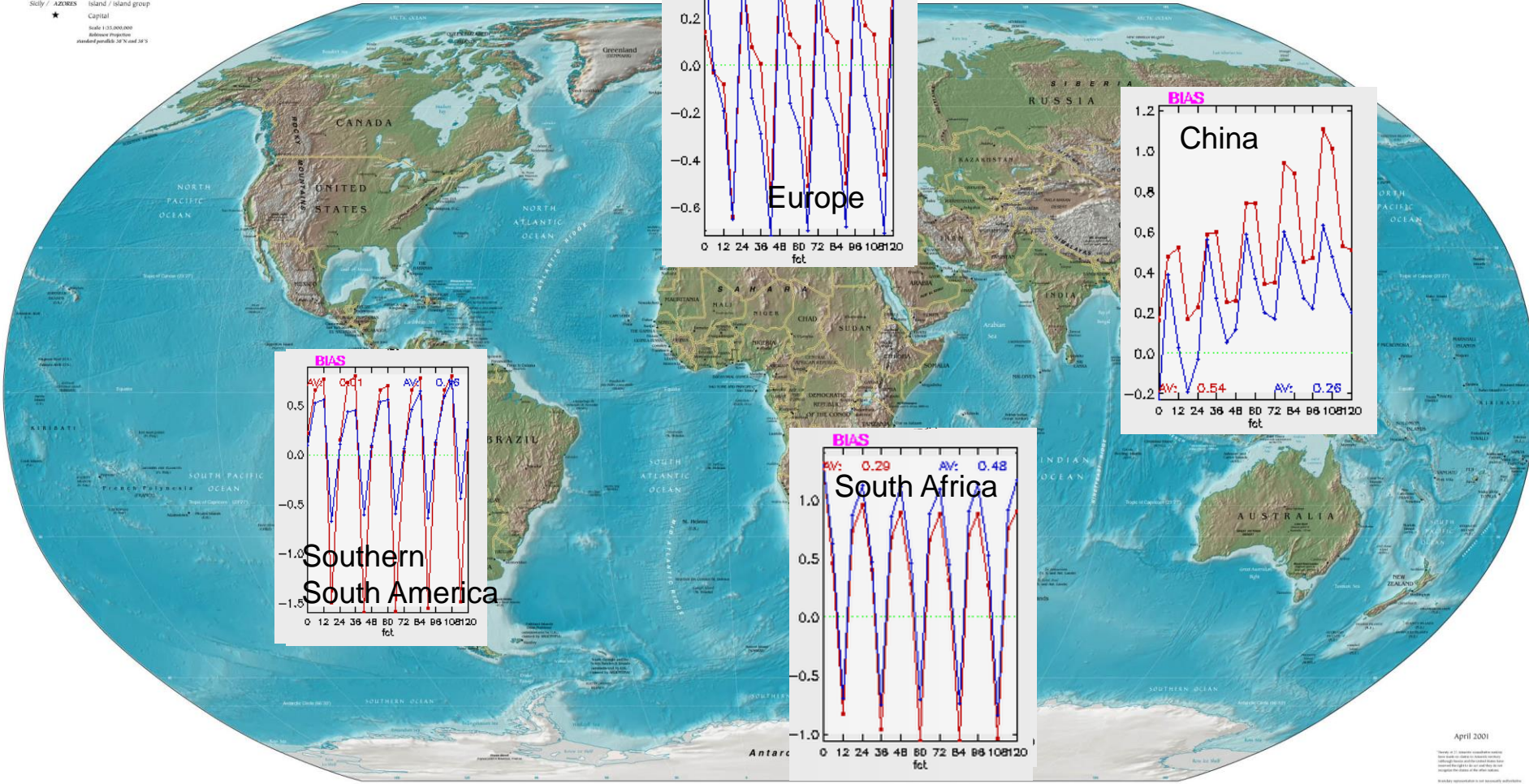


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April 2001

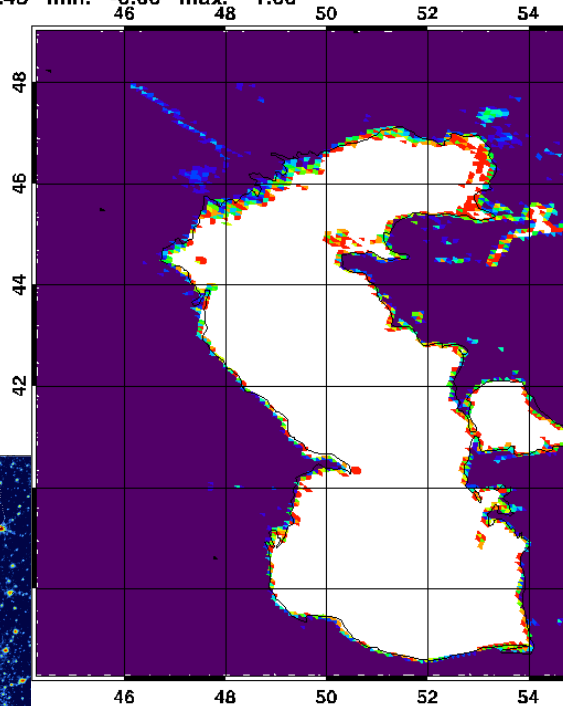
 Thanks to 11 weather modification companies
 for their support and data. The model results
 were verified against the ground truth data.
 The model results were verified against the
 ground truth data of the same period.
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 ground truth data of the same period.



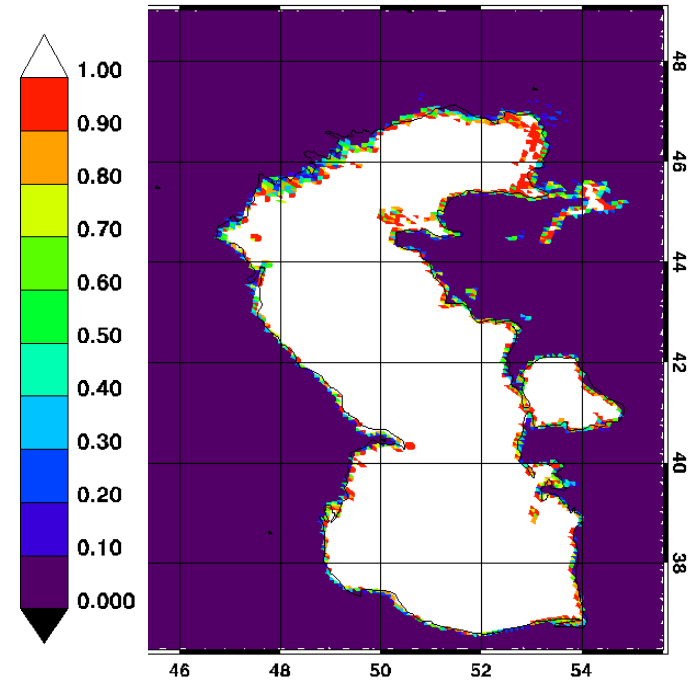
EXTPAR development at DWD

- DWD_V2.4 Modification of Caspian Sea treatment (height below sea level), adaptations for urban fields

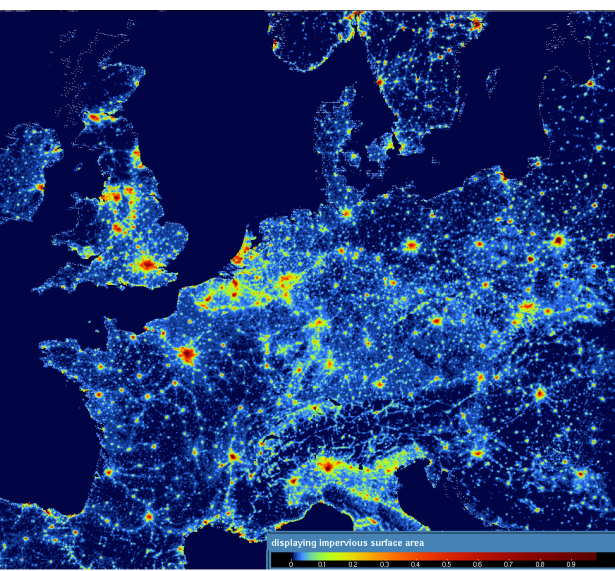
mean: 0.31 std: 0.45 min: -0.00 max: 1.00



.45 min: -0.00 max: 1.00



COSMO-D2: impervious surface area



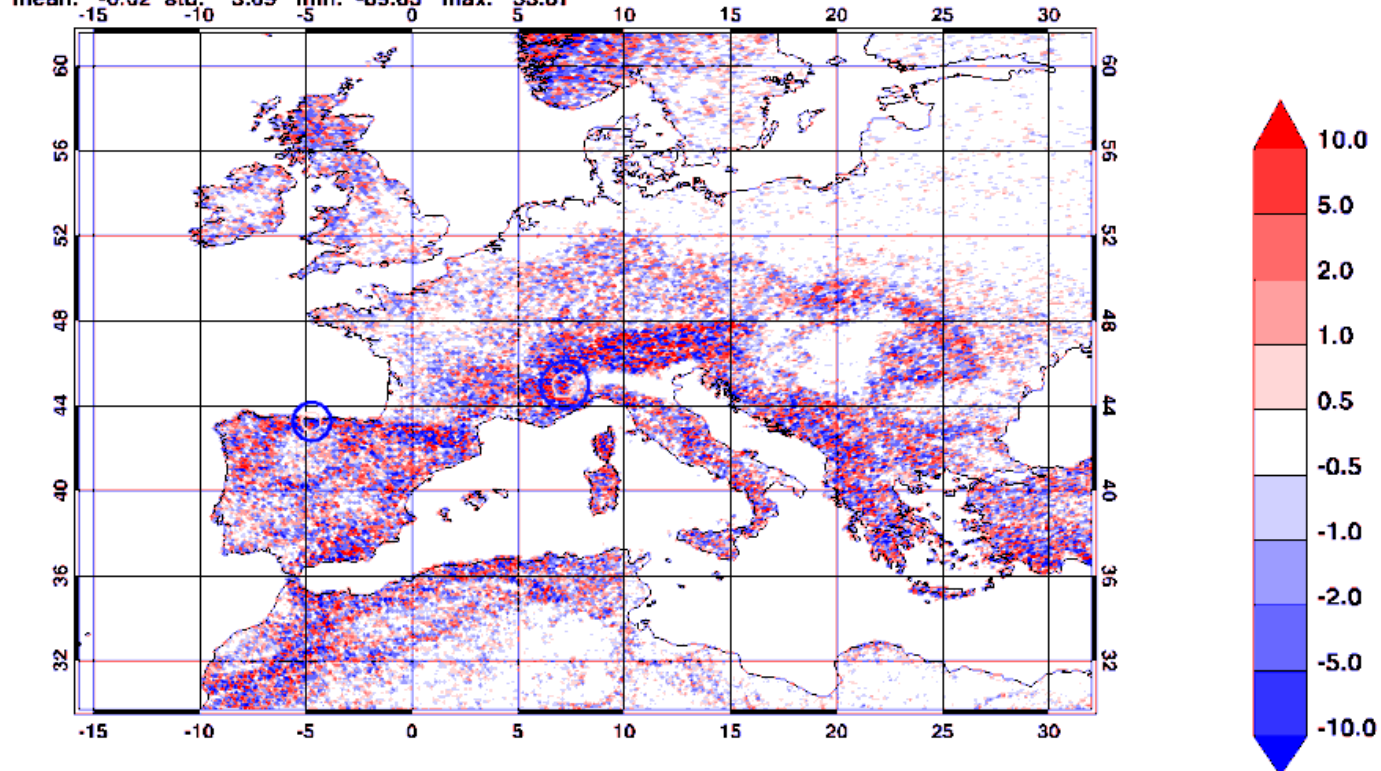
ICON R03B08: Ocean points

(1. - FR_LAND - FR_LAKE) with orography threshold 33m (left) and -25m (right)

- DWD_V2.4 Modification of Caspian Sea treatment (height below sea level), adaptations for urban fields
- DWD_V2.5 Bugfix for index triple j_n, j_c, j_s if $m_{lat} > 1$, ICON only (Th. Raddatz MPI Hamburg)

HSURF V2_4 - preV2_5

mean: -0.02 std: 3.09 min: -69.63 max: 53.87



- Continuous development and improvement of TERRA
- Main focus: Impact of organic components on hydraulic and thermal processes within root zone
- Prerequisite for implementation of the vegetation layer
- Further developments and experiments: Urban impact, HWSD in COSMO-D2, Testing of Mires, treatment of snow by COST ES1404
- EXTPAR: Consolidation of fields within SRNWP and global forecasting centers (NOAA action)