Max-Planck-Institut für Meteorologie

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

# TERRA and EXTPAR

## Recent developments at DWD

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

# Content

- Limit maximum of melting snow corresponding to snow heat conduction (1.5 m) - Greenland case (J. Helmert and G. Zängl)

- Adaption of the dry soil heat conduction for deserts, increase from 0.276 W/(m·K) to 0.58 W/(m·K) for dry sand (G. Zängl and J. Helmert)

- Organic components on hydraulic and thermal processes within root zone (J. Helmert)
- Revision of the interception store (G. Zängl)

- Implementation of a canopy layer in TERRA (J. Helmert)

- Bare soil evaporation (J.-P. Schulz)

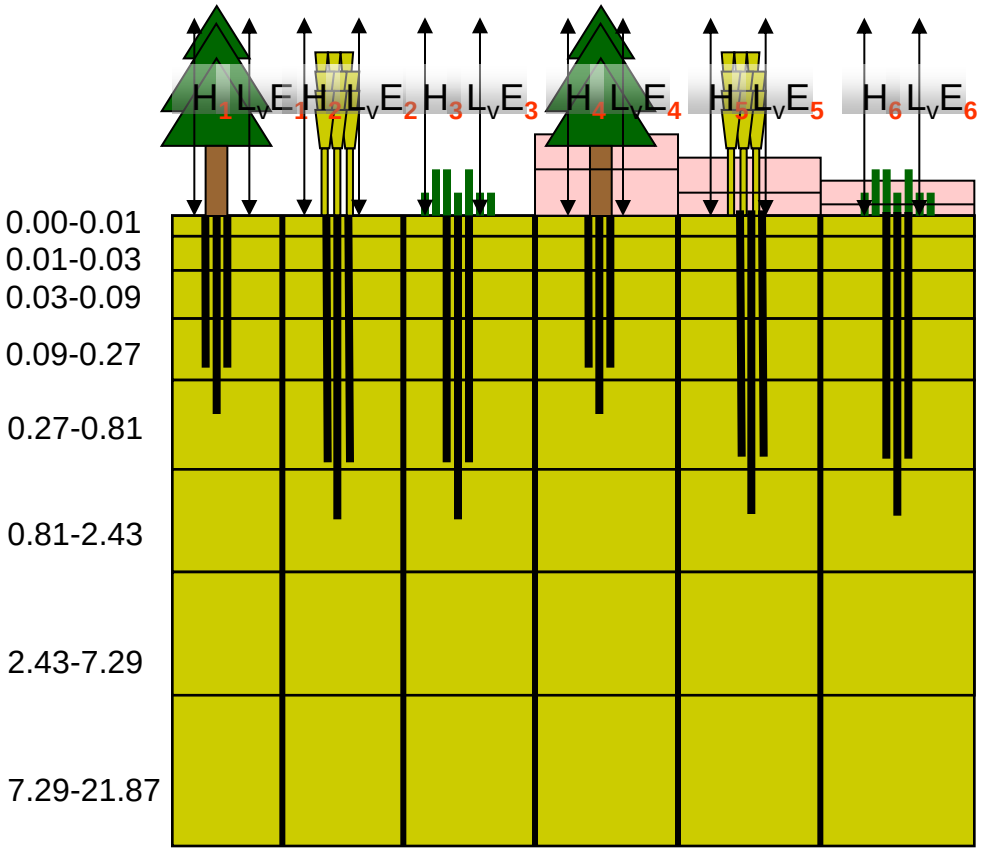
- Soil ice cubes in the deep COSMO-DE soil (J. Helmert and B. Ritter)

# Content

- Further developments and experiments: Urban impact (ICON version), HWSD in COSMO-D2 (long term), Testing of Mires, Treatment of snow in COST ES1404

- EXTPAR: MPI-Version finished (M. Pondkule), modification of the SSO-parameter aggregation - orography filter (D. Reinert, J. Helmert, M. Giorgetta)

# TERRA configuration ICON

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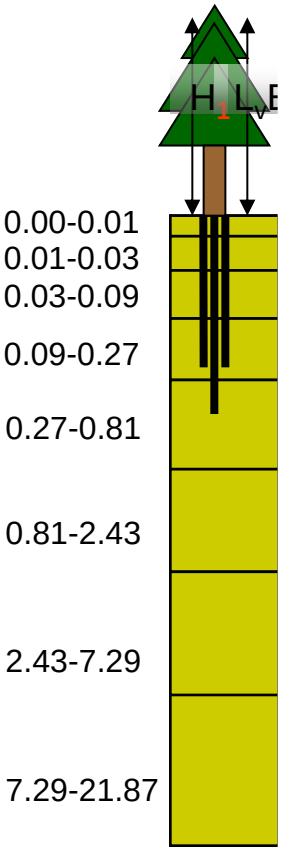
nlev_snow = 3
lmulti_snow = .false.
itype_heatcond = 2
idiag_snowfrac[1] = 20
lsnowtile = .true.
lseaice = .true.
llake = .true.
itype_lndtbl[2] = 3
itype_root = 2 (const)

[1] more advanced parameterization depending on snow depth, accounts also for vegetation and SSO
[2] Tuned version of GlobCover 2009 look-up table by Günther Zaengl (appears to produce the smallest temperature biases)

# TERRA config COSMO 5.4x

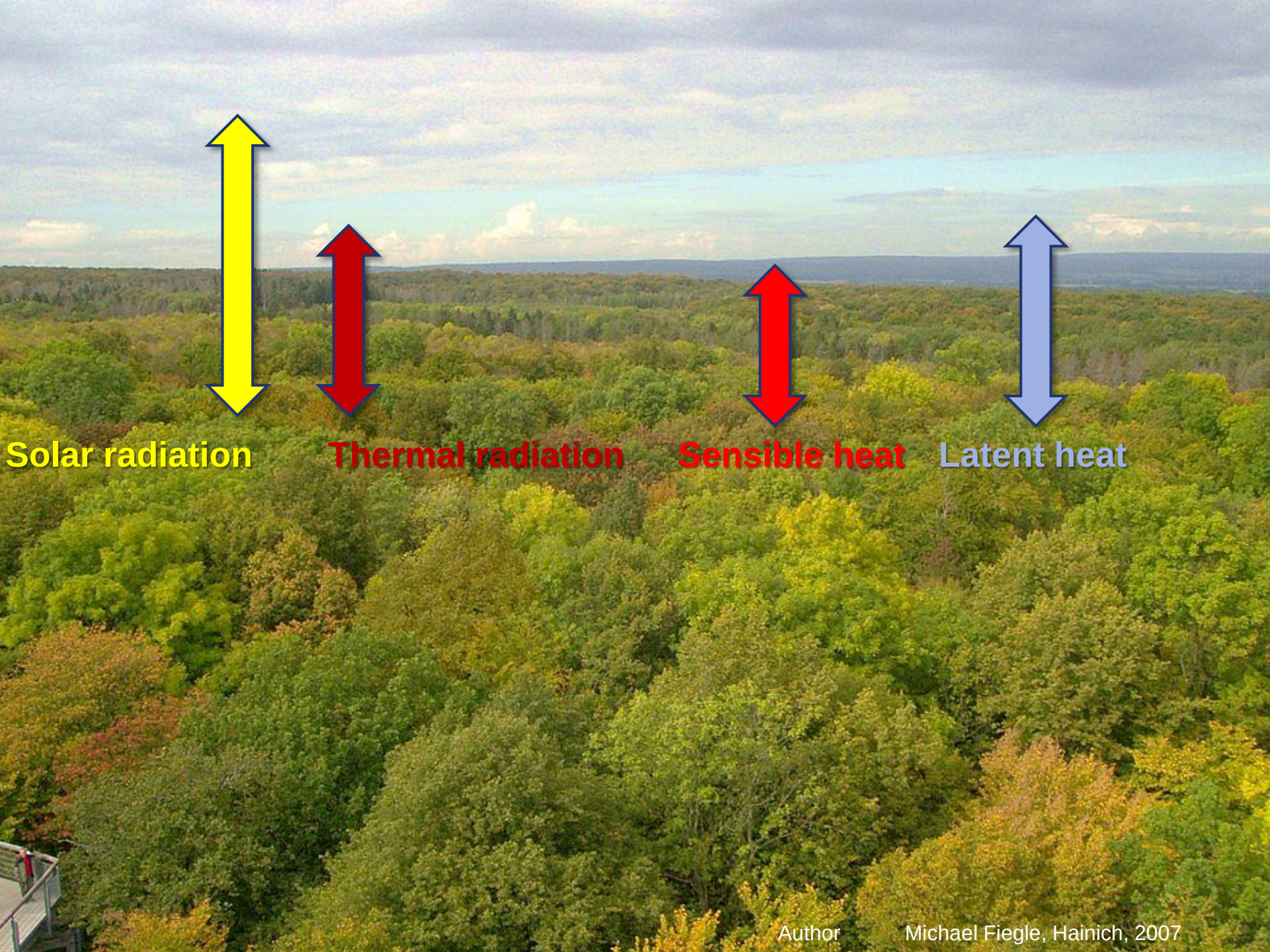





&lnd_nml
~~ntiles = 3~~
nlev_snow = 3
lmulti_snow = .false.
itype_heatcond = 2
~~idiag_snowfrac = 20~~
~~lsnowtile = .true.~~
lseaice = .true.
llake = .true.
~~itype_lndtbl = 3~~
itype_root = 2 (~~const~~ ?)

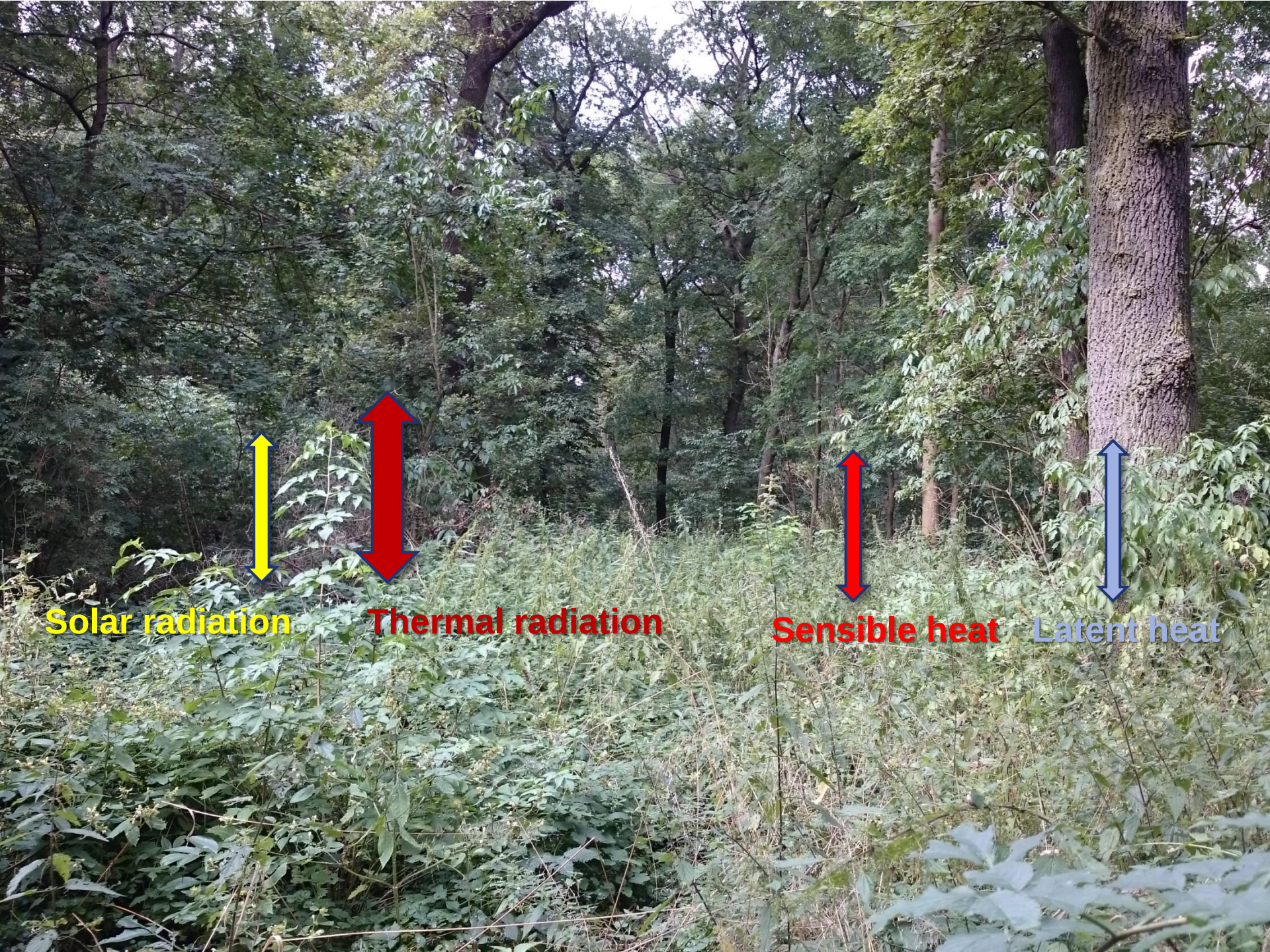
Probably appear in future versions

# Implementation of a canopy layer in TERRA



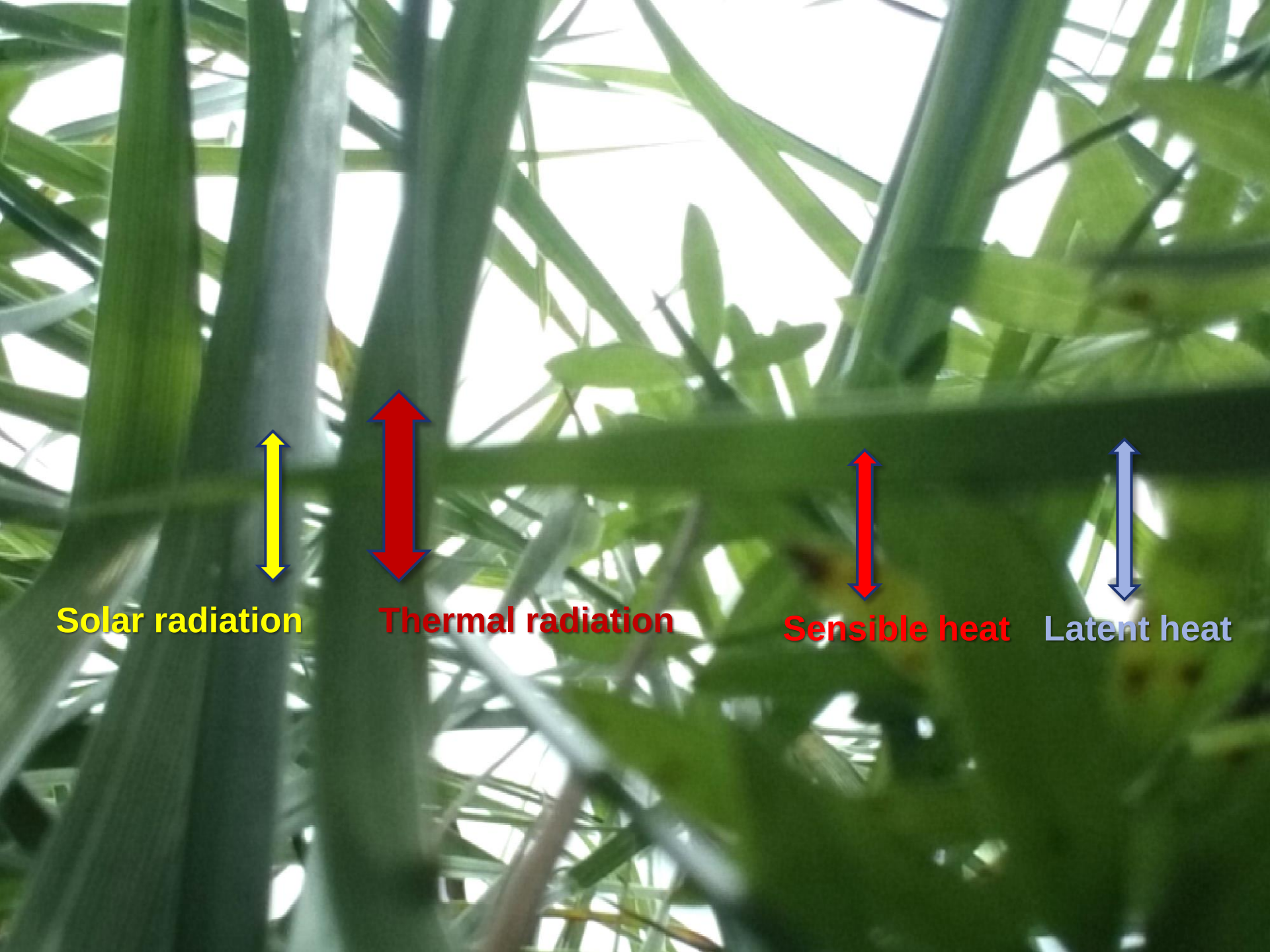

Author Michael Fiegle, Hainich, 2007


Solar radiation
Thermal radiation
Sensible heat
Latent heat

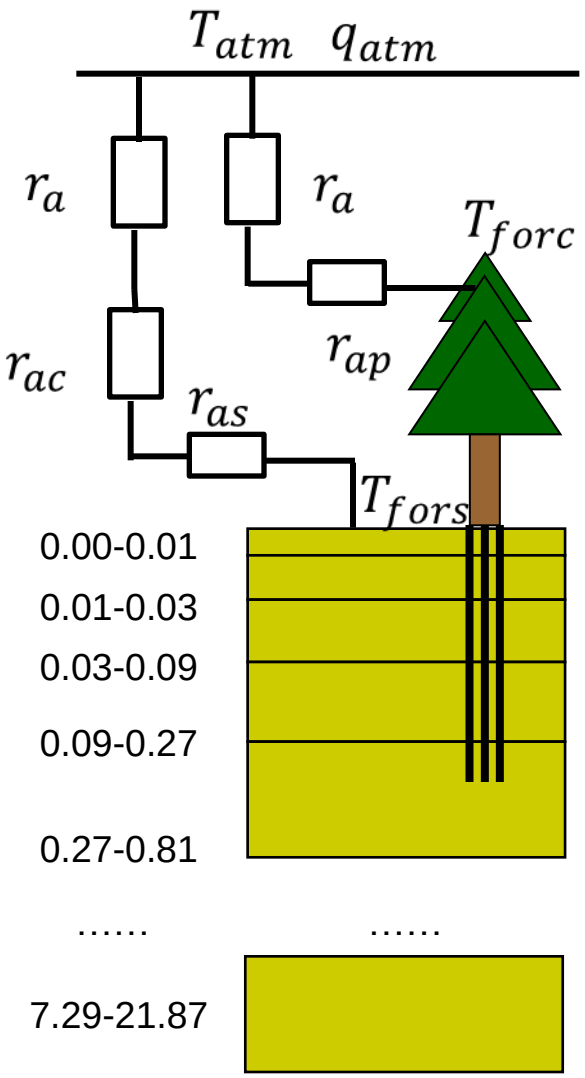

Solar radiation
Thermal radiation
Sensible heat
Latent heat


Solar radiation
Thermal radiation
Sensible heat
Latent heat


r radiation
Thermal radiation
Sensible heat
Latent heat

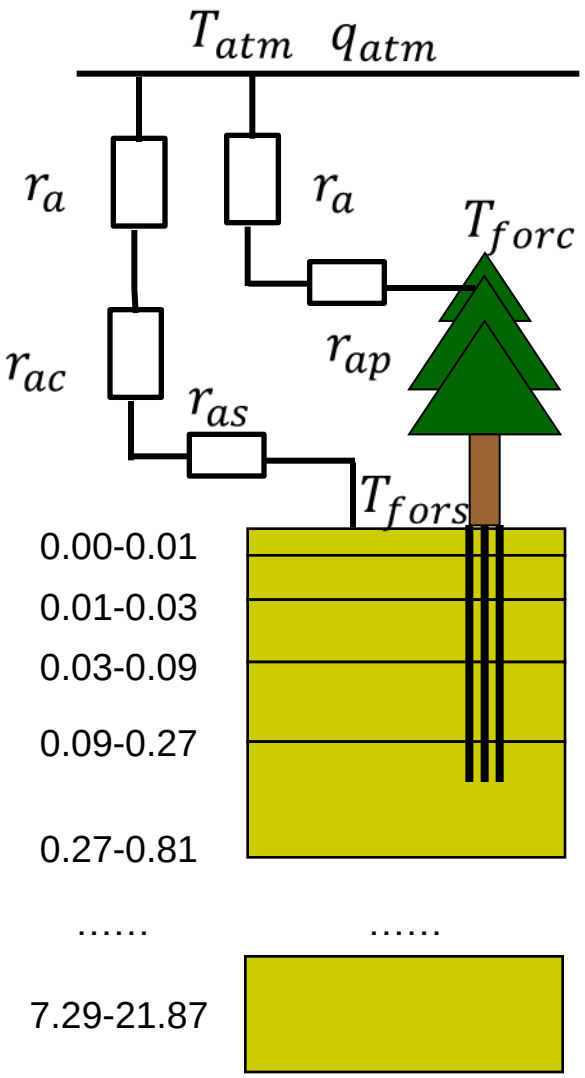

Solar radiation
Thermal radiation
Sensible heat
Latent heat

# Canopy model – Experiment



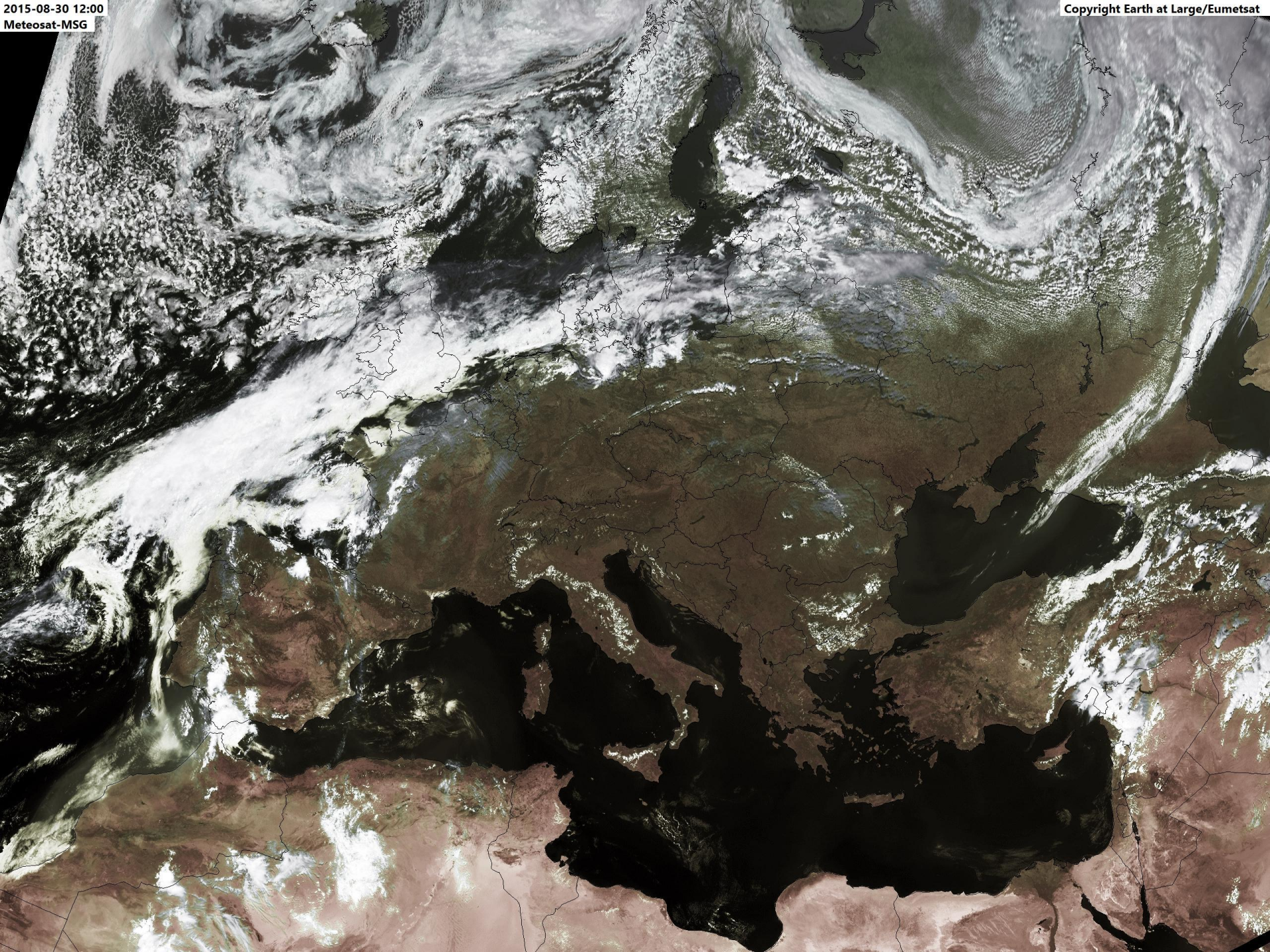

COSMO 5.4b ICON-TERRA runs with canopy scheme
for 2016-08-29 00:00 vv=0-48

# Canopy model – Experiment



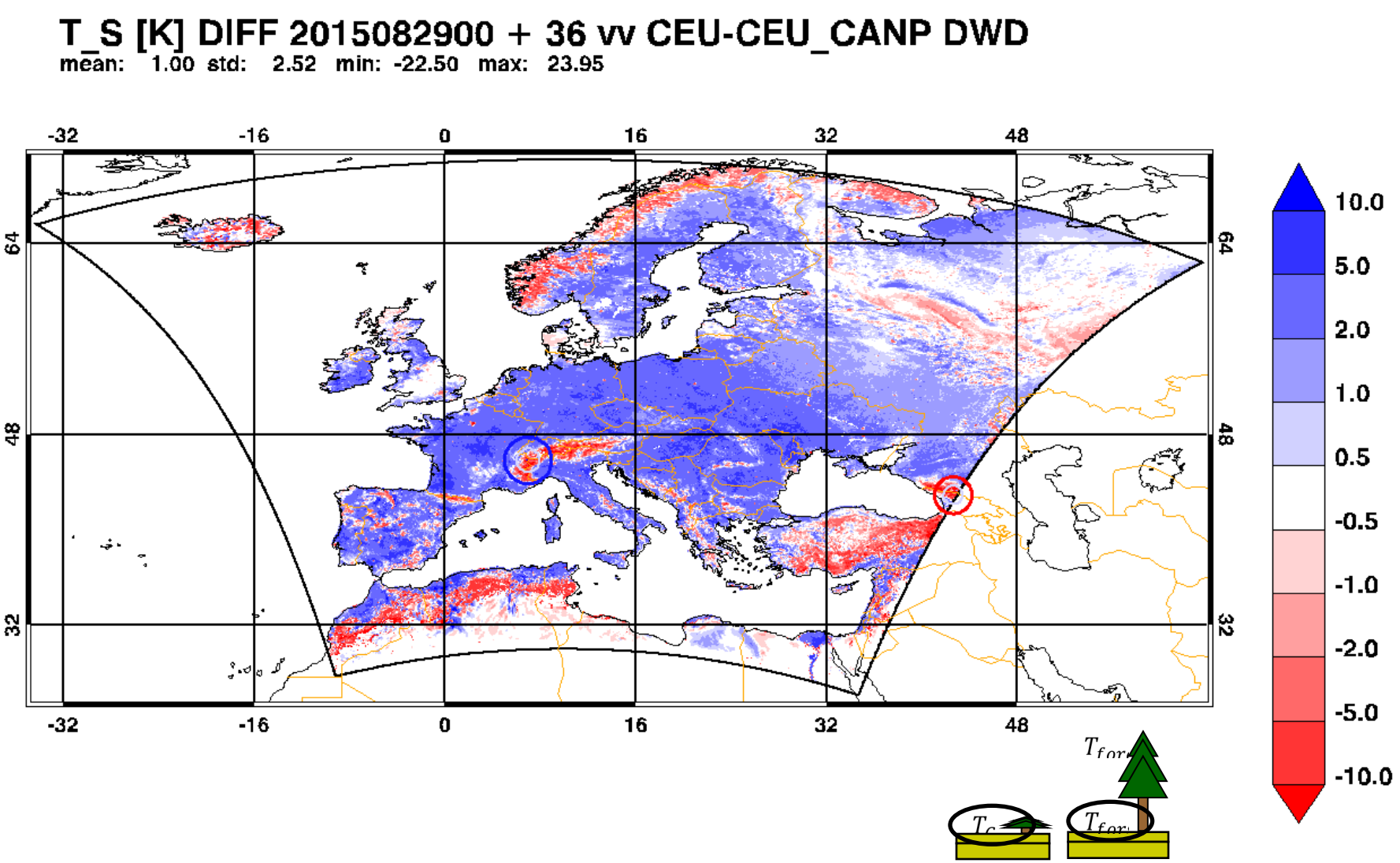

## Current uncertainties and restrictions:

- Canopy height = $TAI^2$ i.e. $TAI=5$ leads to $25m$
- Canopy standing mass: $W_{veg} = 2\ kg/m^2 \cdot TAI^2$
- For non-canopy points is the canopy temperature eq. the snow temperature
- Resistance from transfer scheme is used for atmospheric values
- Sky-view-fraction parameter *0.5* and *0.75* used
- Canopy point, if $SVF < 0.9$
- Ground temperature $T_G$ is the sky-view fraction weighted average of *T_SNOW,T_S* and *T_CANP*


2015-08-30 12:00
Meteosat-MSG
Copyright Earth at Large/Eumetsat

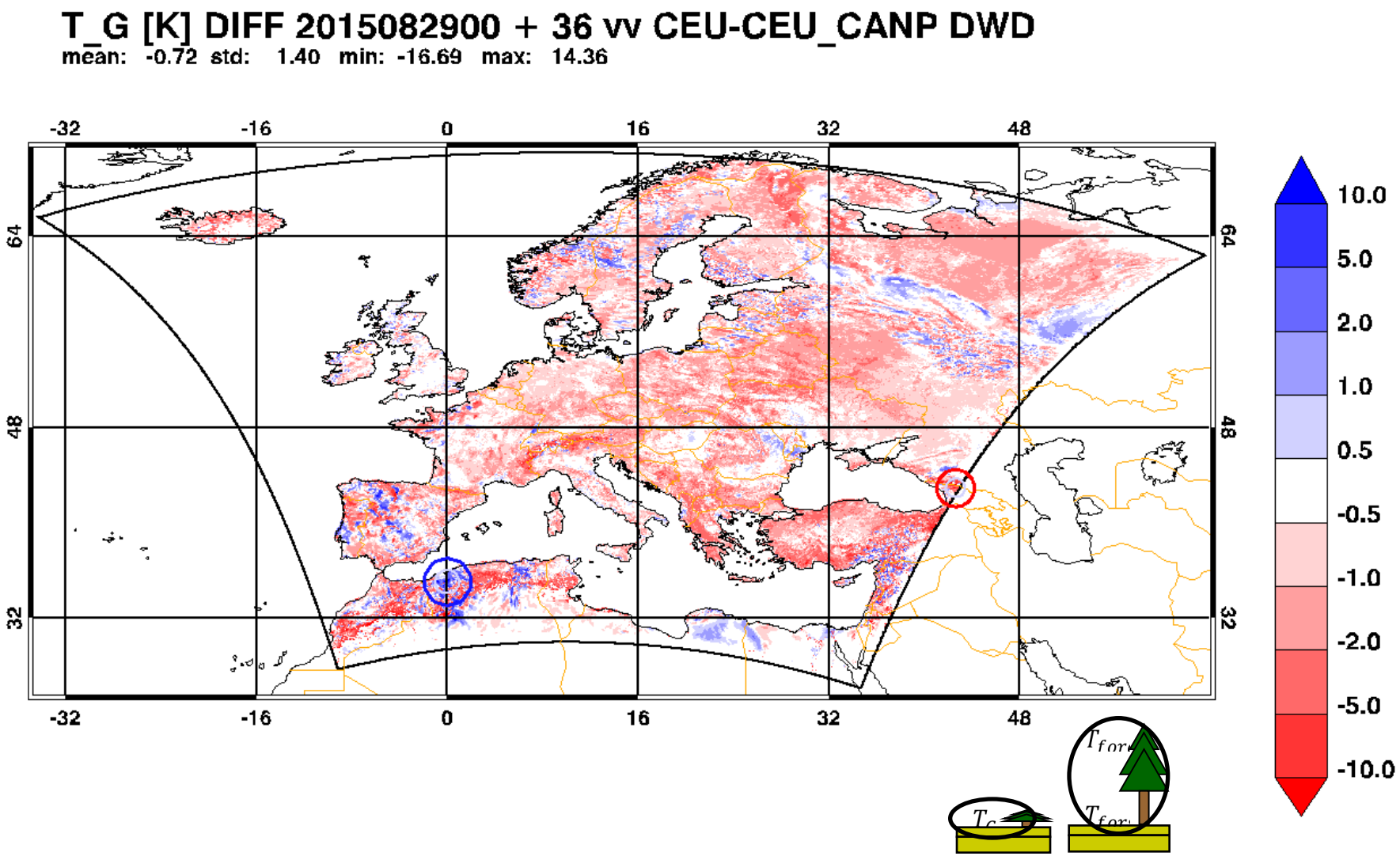
# Results




T_S [K] DIFF 2015082900 + 36 vv CEU-CEU_CANP DWD
mean: 1.00 std: 2.52 min: -22.50 max: 23.95
-32
-16
0
16
32
48
64
48
32
10.0
5.0
2.0
1.0
0.5
-0.5
-1.0
-2.0
-5.0
-10.0

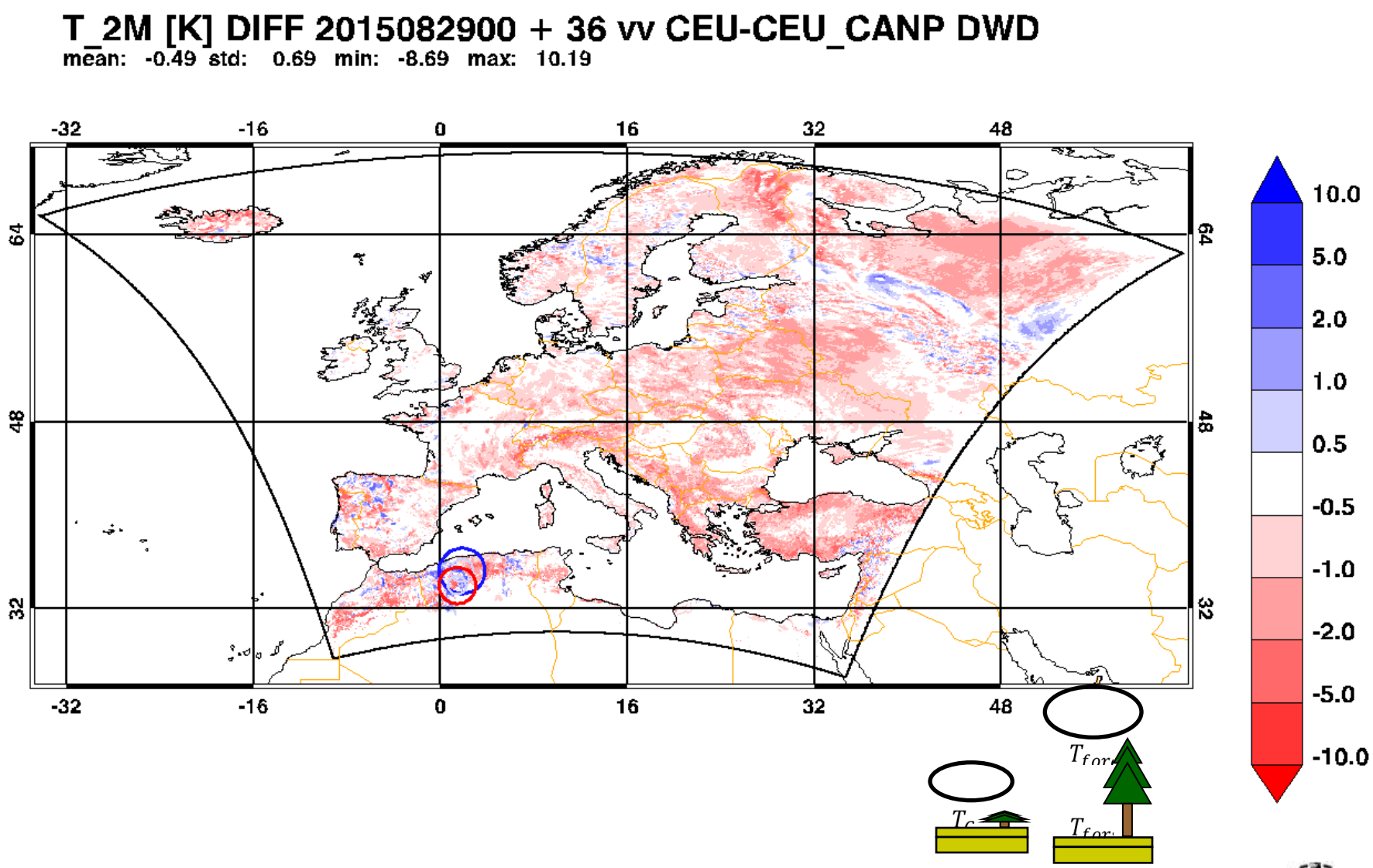
# Results




T_G [K] DIFF 2015082900 + 36 vv CEU-CEU_CANP DWD
mean: -0.72 std: 1.40 min: -16.69 max: 14.36
-32
-16
0
16
32
48
64
48
32
10.0
5.0
2.0
1.0
0.5
-0.5
-1.0
-2.0
-5.0
-10.0

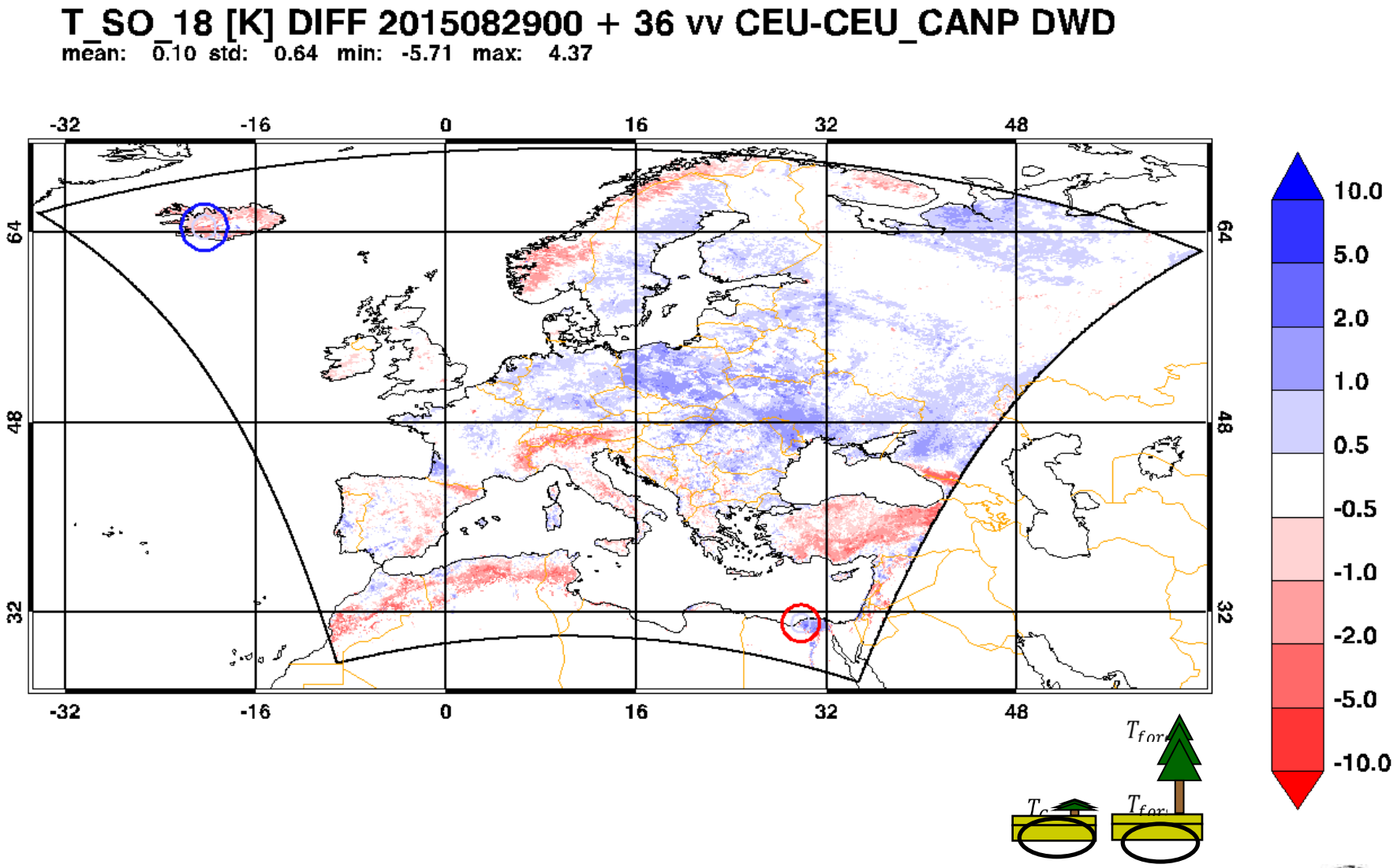
# Results

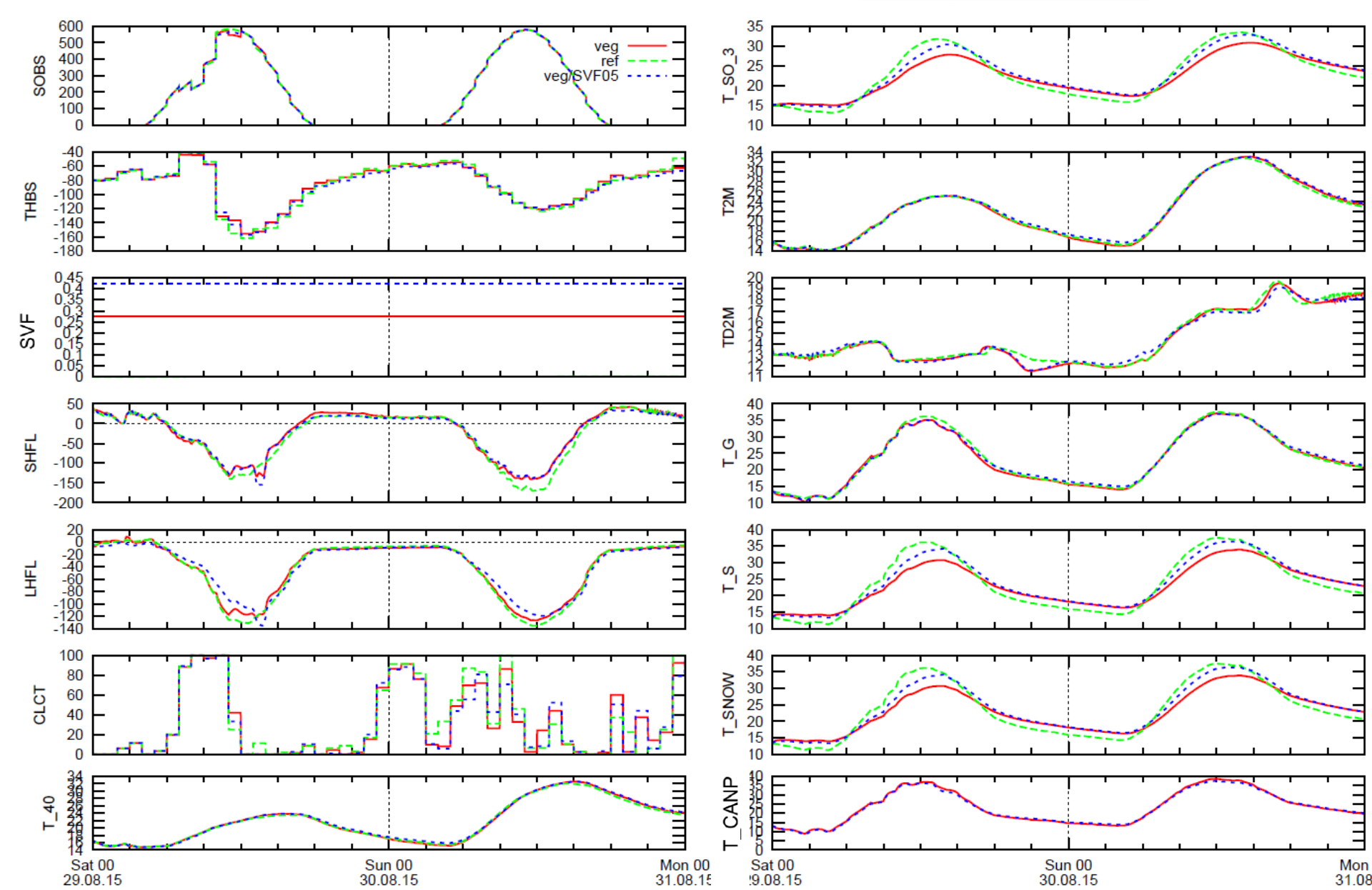



T_2M [K] DIFF 2015082900 + 36 vv CEU-CEU_CANP DWD
mean: -0.49 std: 0.69 min: -8.69 max: 10.19
-32
-16
0
16
32
48
64
48
32
10.0
5.0
2.0
1.0
0.5
-0.5
-1.0
-2.0
-5.0
-10.0

# Results

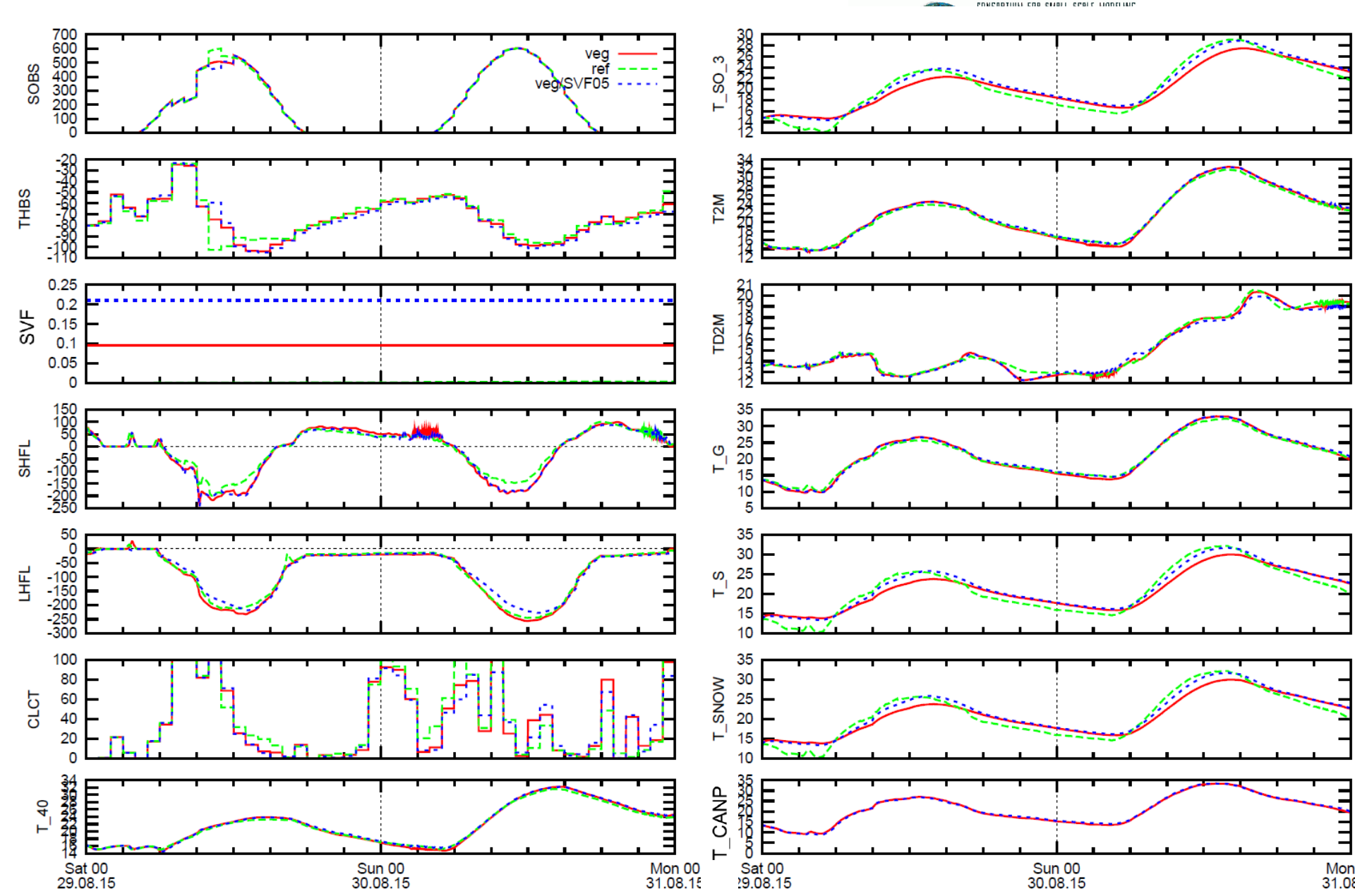



T_SO_18 [K] DIFF 2015082900 + 36 vv CEU-CEU_CANP DWD
mean: 0.10 std: 0.64 min: -5.71 max: 4.37
-32
-16
0
16
32
48
64
48
32
10.0
5.0
2.0
1.0
0.5
-0.5
-1.0
-2.0
-5.0
-10.0




Falkenberg: Lat=52.18°N, Lon=14.08°E, H=70 m. Indices 329 357
Falkenberg: Lat=52.18°N, Lon=14.08°E, H=70 m. Indices 329 357
Falkenberg: Lat=52.18°N, Lon=14.08°E, H=70 m. Indices 329 357

File cosmo_160610_5.04b_veg/M_Falkenberg
File cosmo_160610_5.04b_ref/M_Falkenberg
File cosmo_160610_5.04b_veg/SVF05/M_Falkenberg

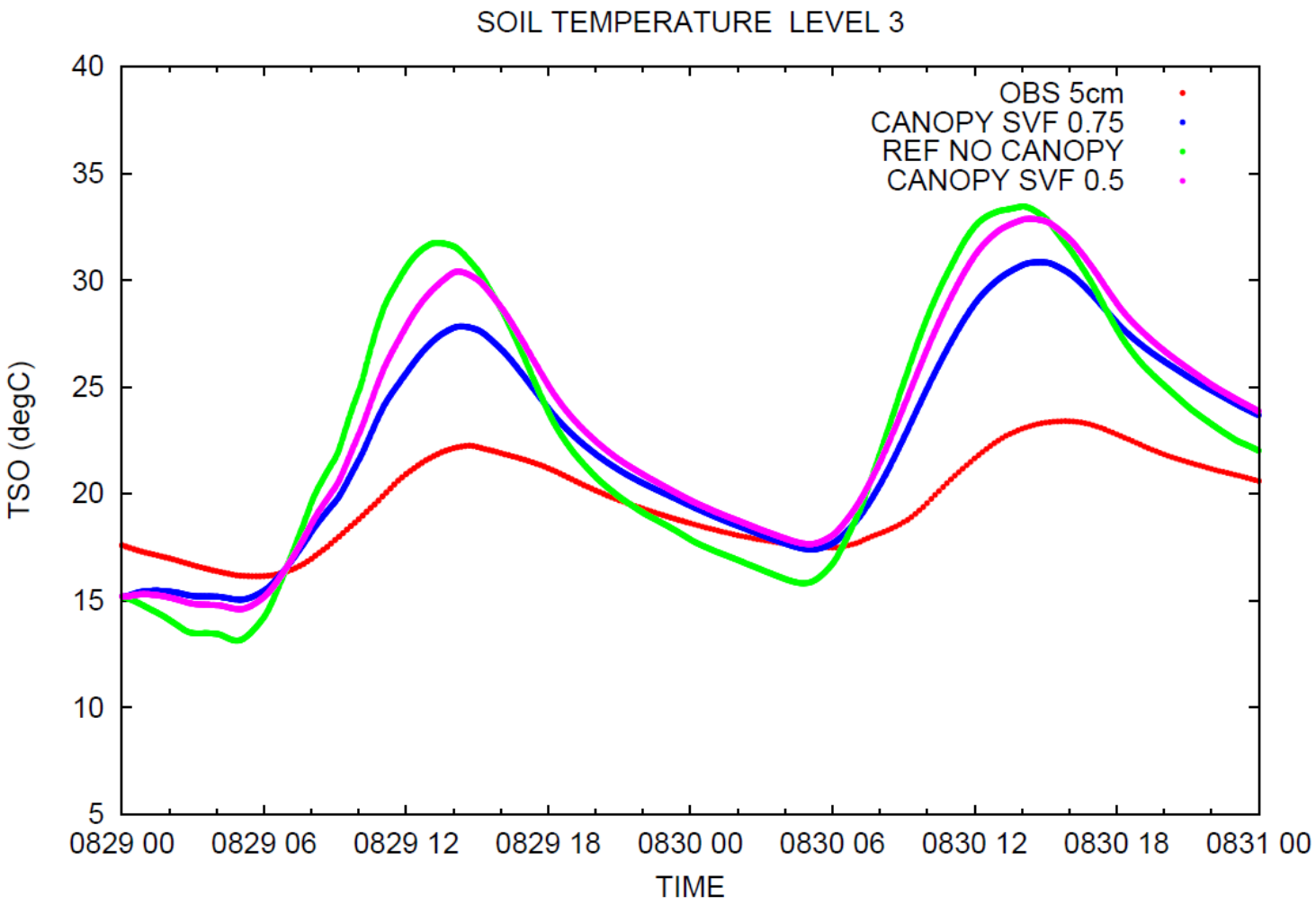



Waldstation Kehrigk: Lat=52.19°N, Lon=13.97°E, H=57 m. Indices 328 357
Waldstation Kehrigk: Lat=52.19°N, Lon=13.97°E, H=57 m. Indices 328 357
Waldstation Kehrigk: Lat=52.19°N, Lon=13.97°E, H=57 m. Indices 328 357

File cosmo_160610_5.04b_veg/M_Waldstation_Kehrig
File cosmo_160610_5.04b_ref/M_Waldstation_Kehrig
File cosmo_160610_5.04b_veg/SVF05/M_Waldstation_Kehrig

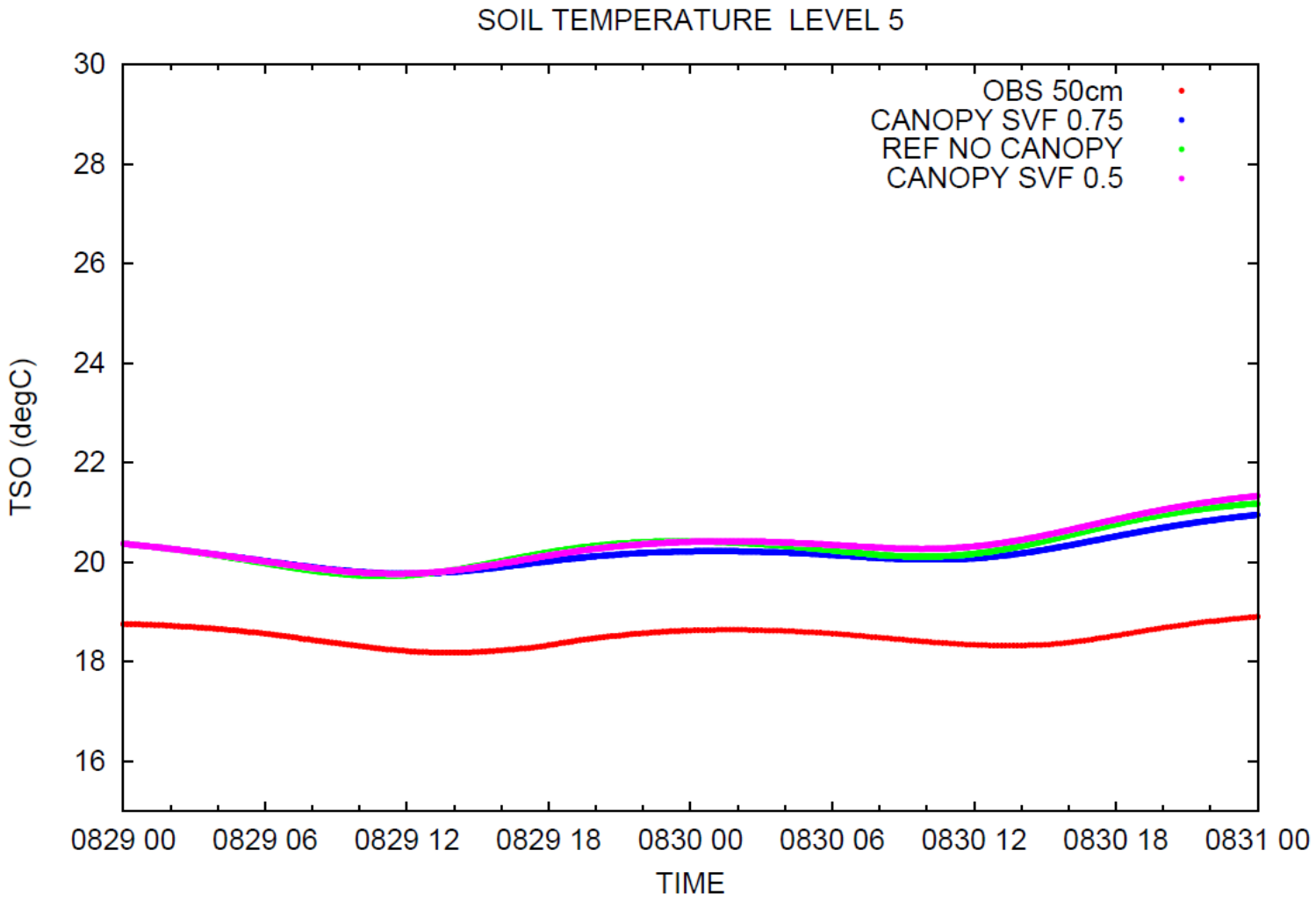
# Results




SOIL TEMPERATURE LEVEL 3
OBS 5cm
CANOPY SVF 0.75
REF NO CANOPY
CANOPY SVF 0.5
TSO (degC)
40
35
30
25
20
15
10
5
0829 00
0829 06
0829 12
0829 18
0830 00
0830 06
0830 12
0830 18
0831 00
TIME

# Results




SOIL TEMPERATURE LEVEL 5
OBS 50cm
CANOPY SVF 0.75
REF NO CANOPY
CANOPY SVF 0.5
TSO (degC)
30
28
26
24
22
20
18
16
0829 00
0829 06
0829 12
0829 18
0830 00
0830 06
0830 12
0830 18
0831 00
TIME

# Frozen soil water in COSMO-DE

# Deep soil ice

Model change COSMO-DE 2012-04-18 12UTC

- FLake for freshwater lakes
- GlobCover 2009 land use data
- Small Orography shift

Soil ice diagnostics in TERRA for T<273.15 K uses the maximum volumetric liquid water content with dependence on soiltyp and soil temperature:

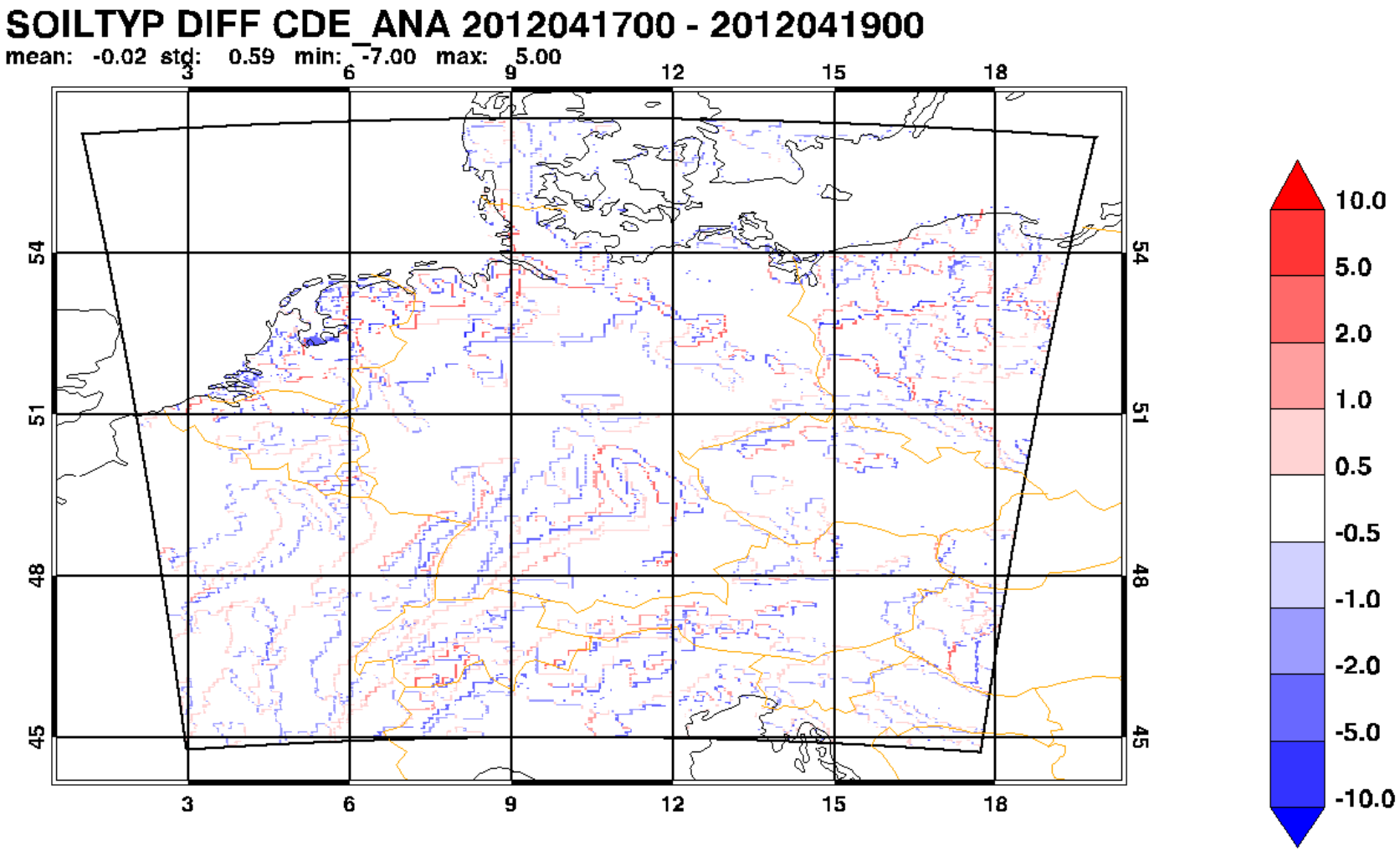
$$W_{l,max} = W_s \left[ \frac{L_f (T - t_0)}{T g \Psi_s} \right]^{-1/b}$$

Pore volume $W_s$
Entry potential $\Psi_s$
Pore size distribution index $b$

Problem: Soiltyp and soil temperature changed for COSMO-DE at 2012-04-18 12UTC

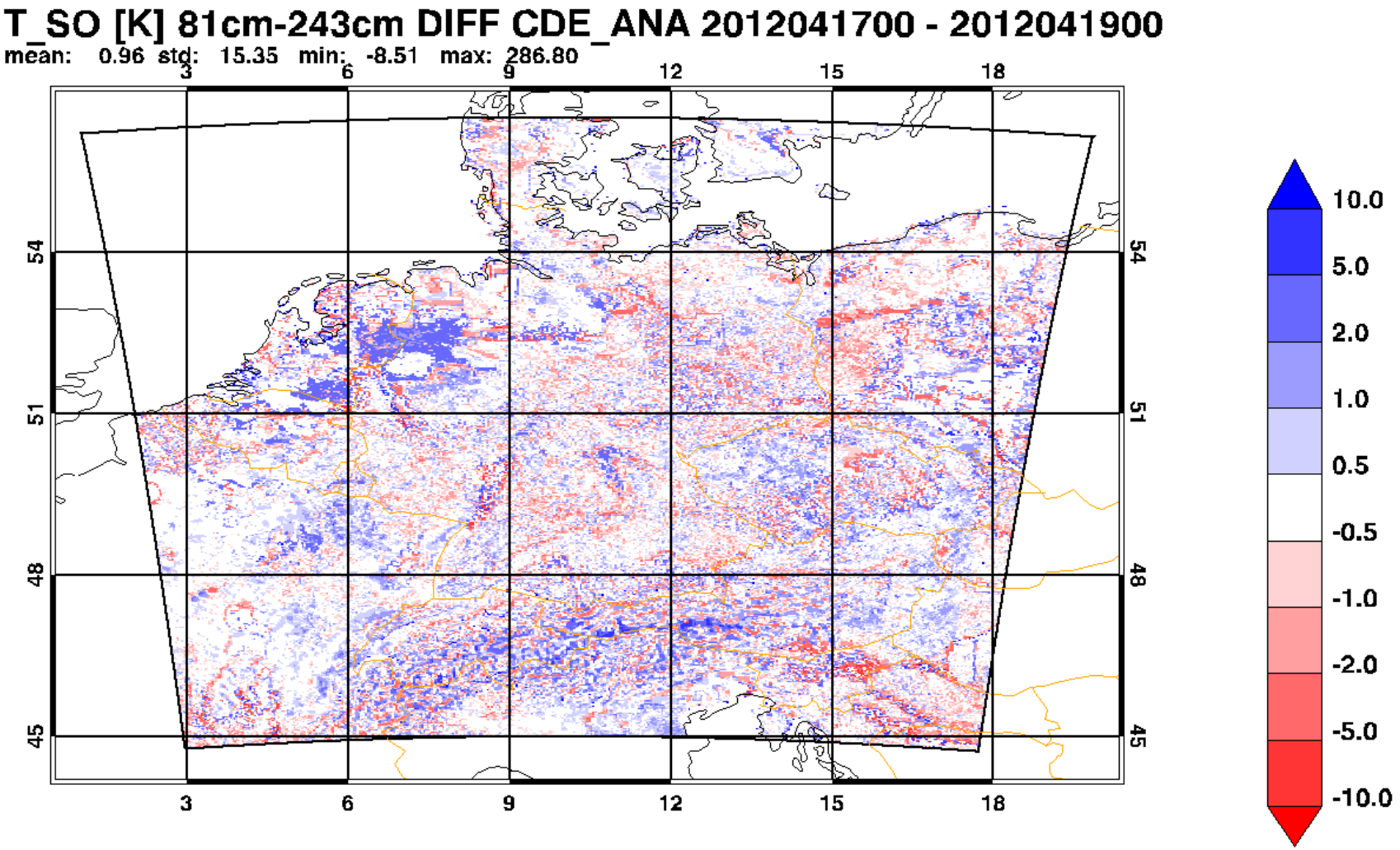
# Deep soil ice





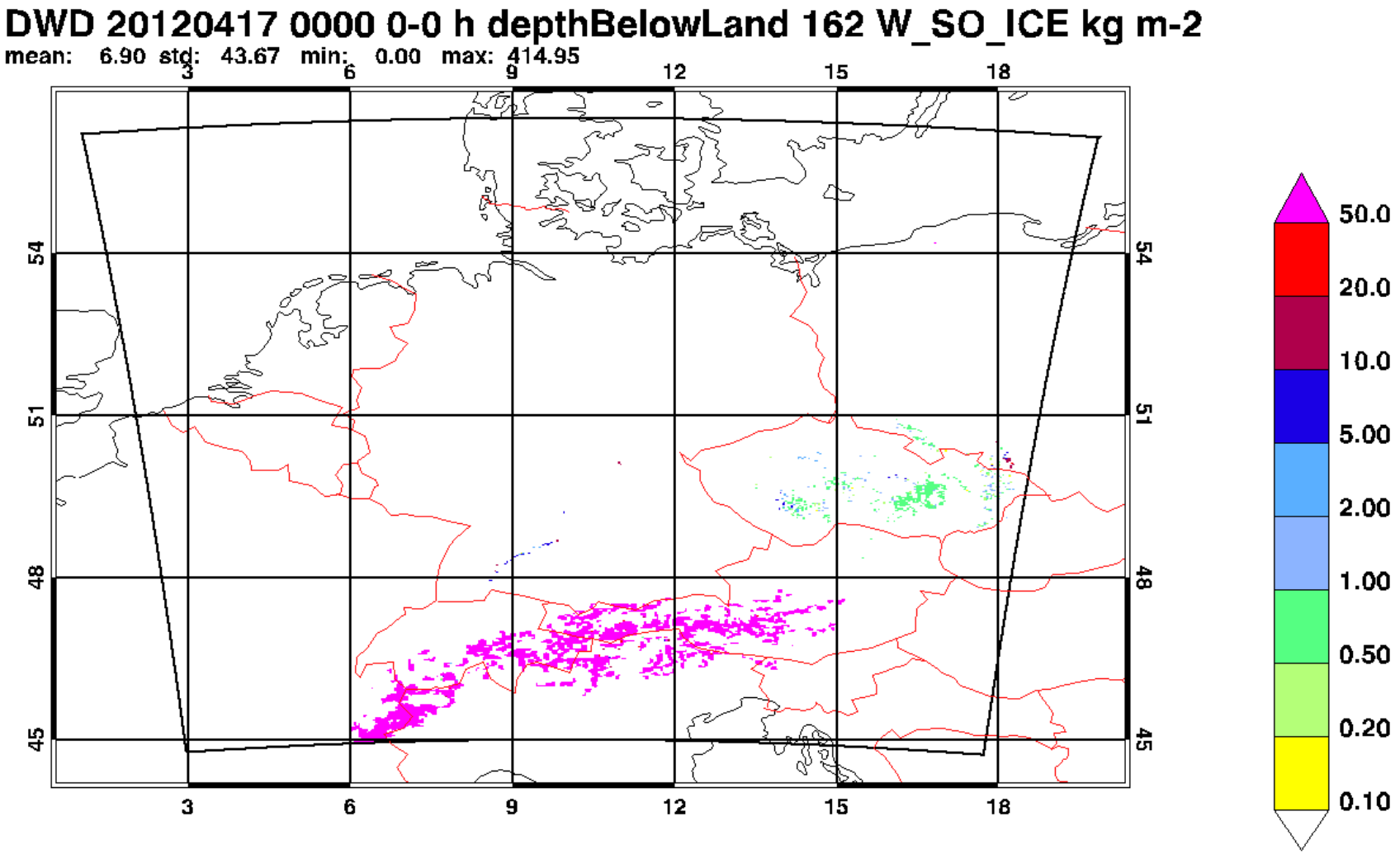
# Deep soil ice





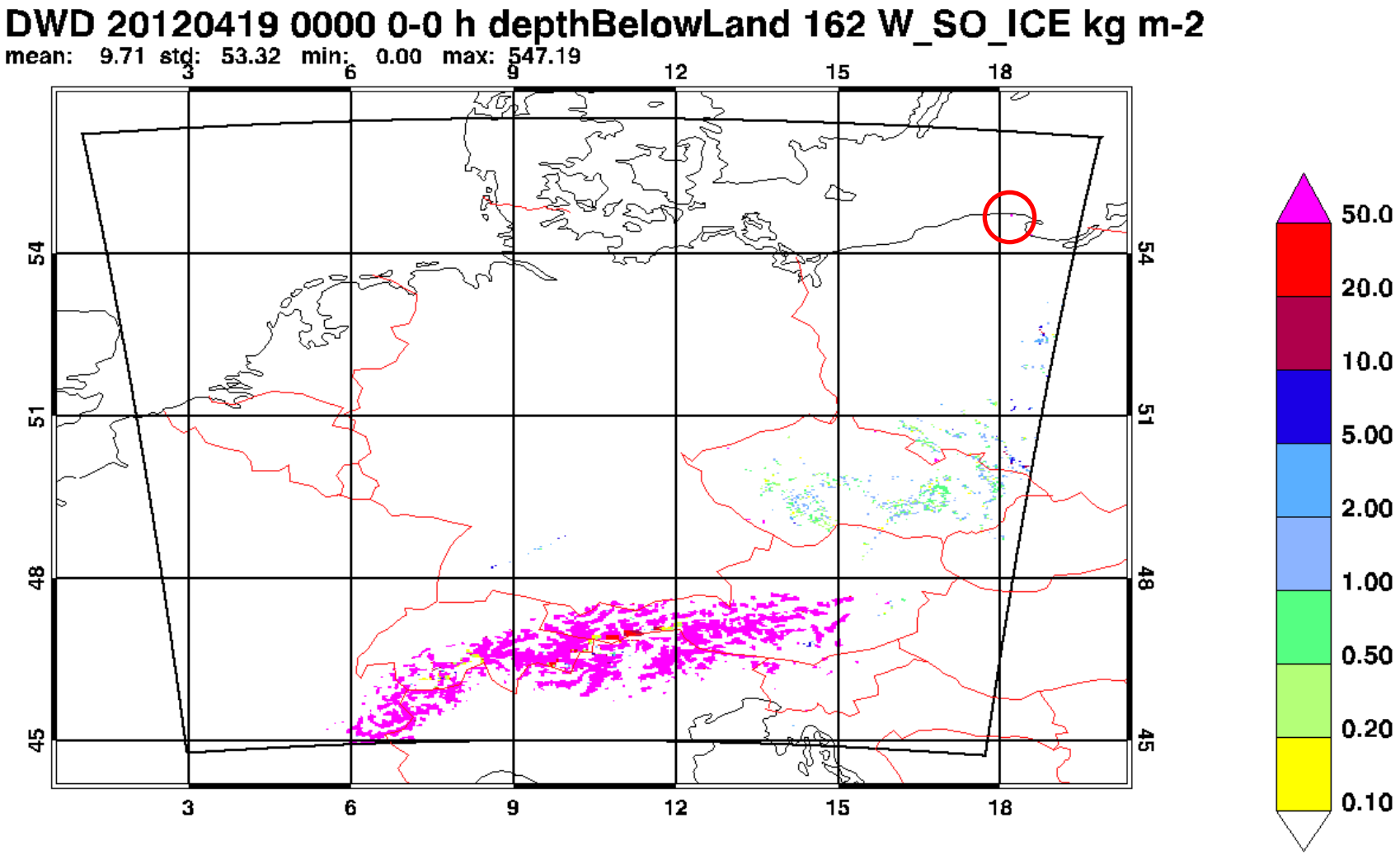
# Deep soil ice





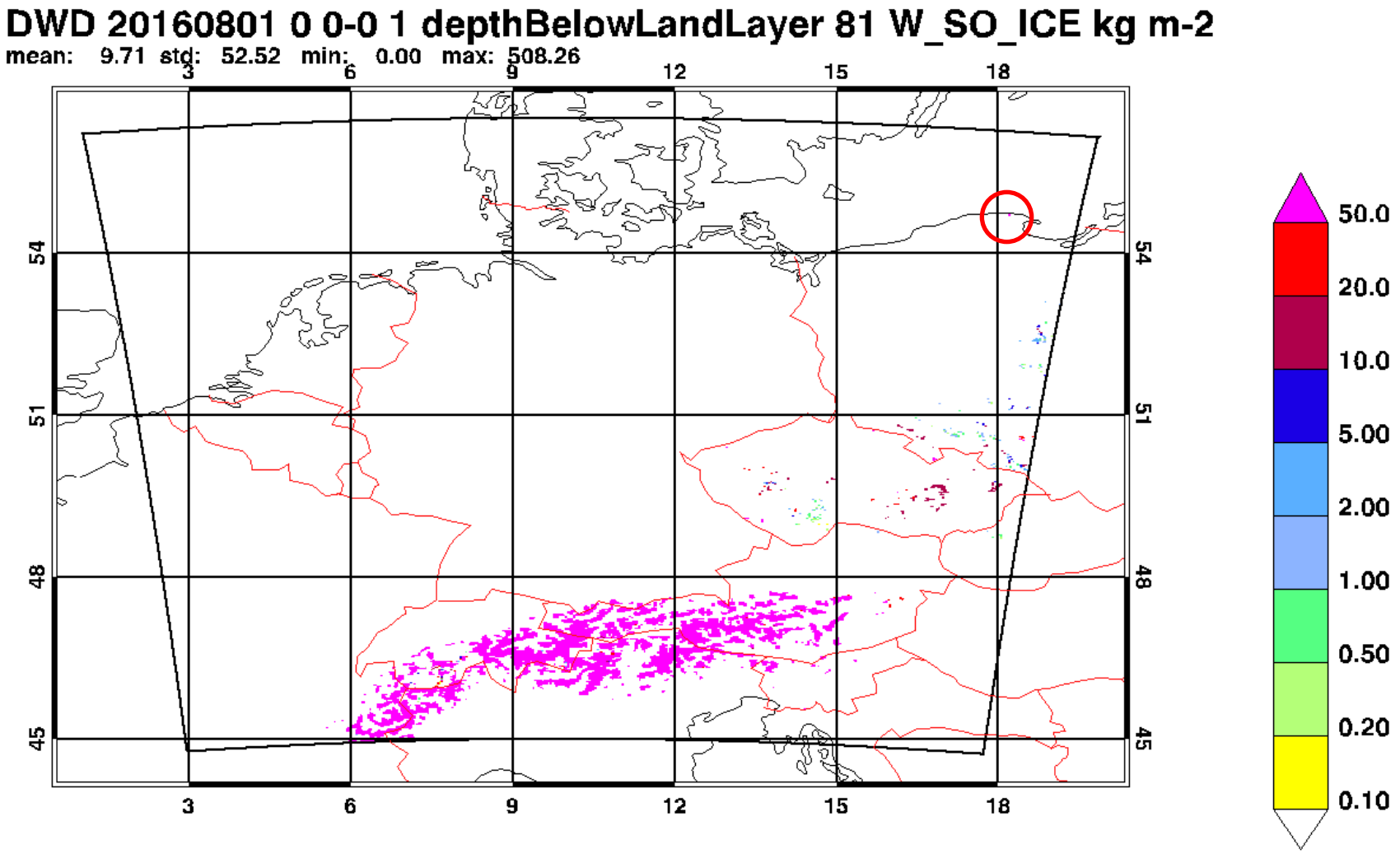
# Deep soil ice





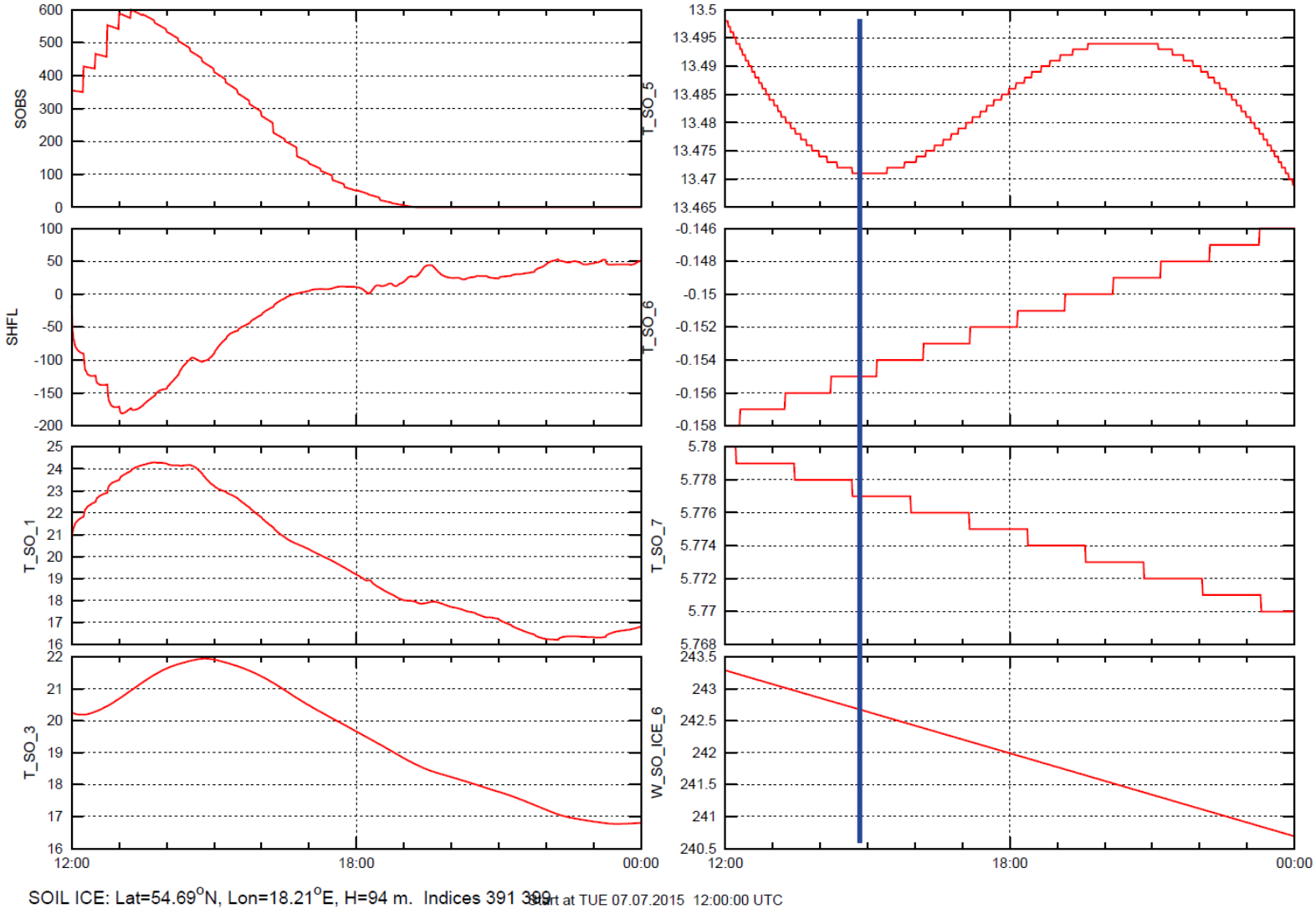
# Deep soil ice





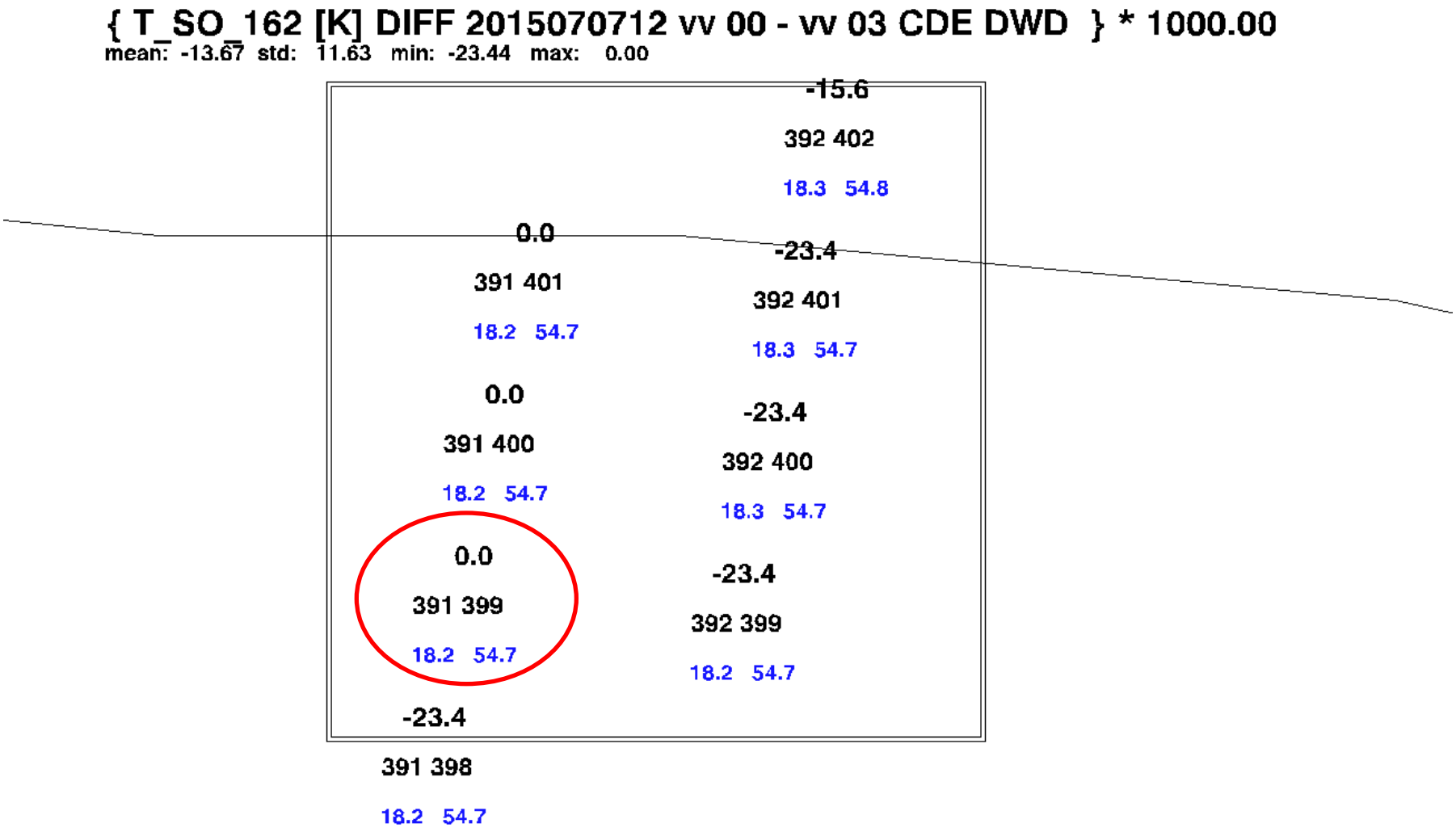
# Deep soil ice





# Deep soil ice





# Deep soil ice



grib_ls -p shortName,units,scaledValueOfFirstFixedSurface,min,max,numberOfBits,packingError lfff00030000

| | | | | | | |
|---|---|---|---|---|---|---|
| T_SO | K | 0 | 265.682 | 322.009 | 16 | 0.00050354 |
| T_SO | K | 5 | 0 | 322.008 | 16 | 0.00390625 |
| T_SO | K | 2 | 0 | 321.102 | 16 | 0.00390625 |
| T_SO | K | 6 | 0 | 317.891 | 16 | 0.00390625 |
| T_SO | K | 18 | 0 | 307.844 | 16 | 0.00390625 |
| T_SO | K | 54 | 0 | 301.664 | 16 | 0.00390625 |
| T_SO | K | 162 | 0 | 293.047 | 16 | 0.00390625 |
| T_SO | K | 486 | 0 | 288.273 | 16 | 0.00390625 |
| T_SO | K | 1458 | 0 | 288.281 | 16 | 0.00390625 |

Problem: GRIB Number of Bits used for T_SO and/or large parameter range for soil below the surface

Solution: data assimilation experiment with increase parameter nrbit from 16 to 32

# EXTPAR

## Modified SSO-parameter

M. Giorgetta, J. Helmert, D. Reinert, G. Zängl, F. Prill

# EXTPAR

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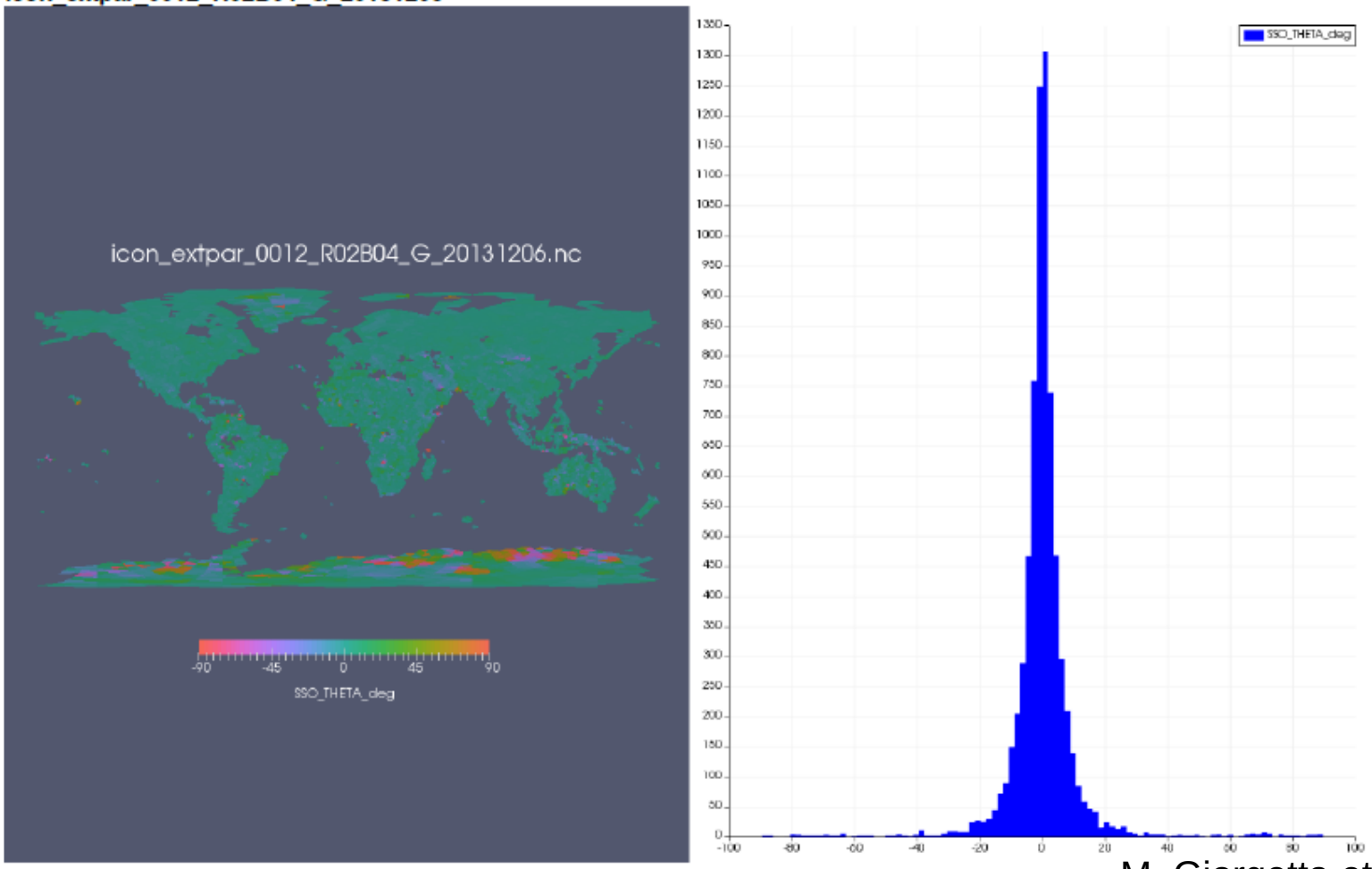
## SSO_THETA

**Icon_extpar_0012_R02B04_G_20131206**

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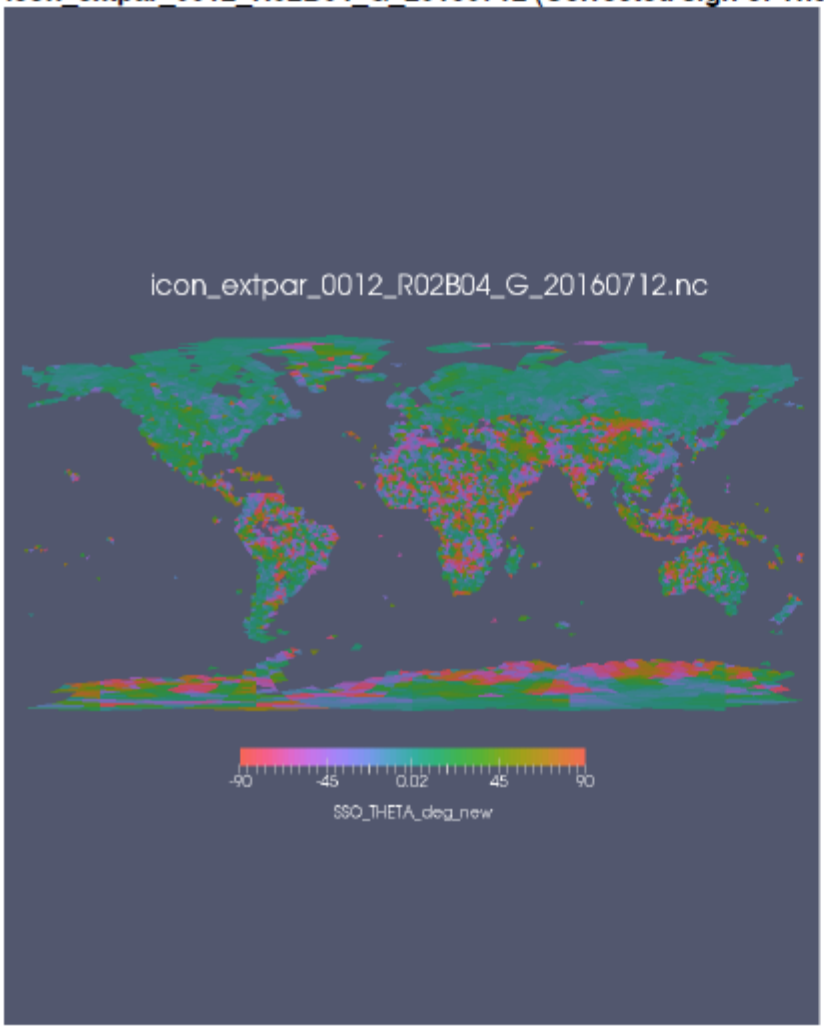
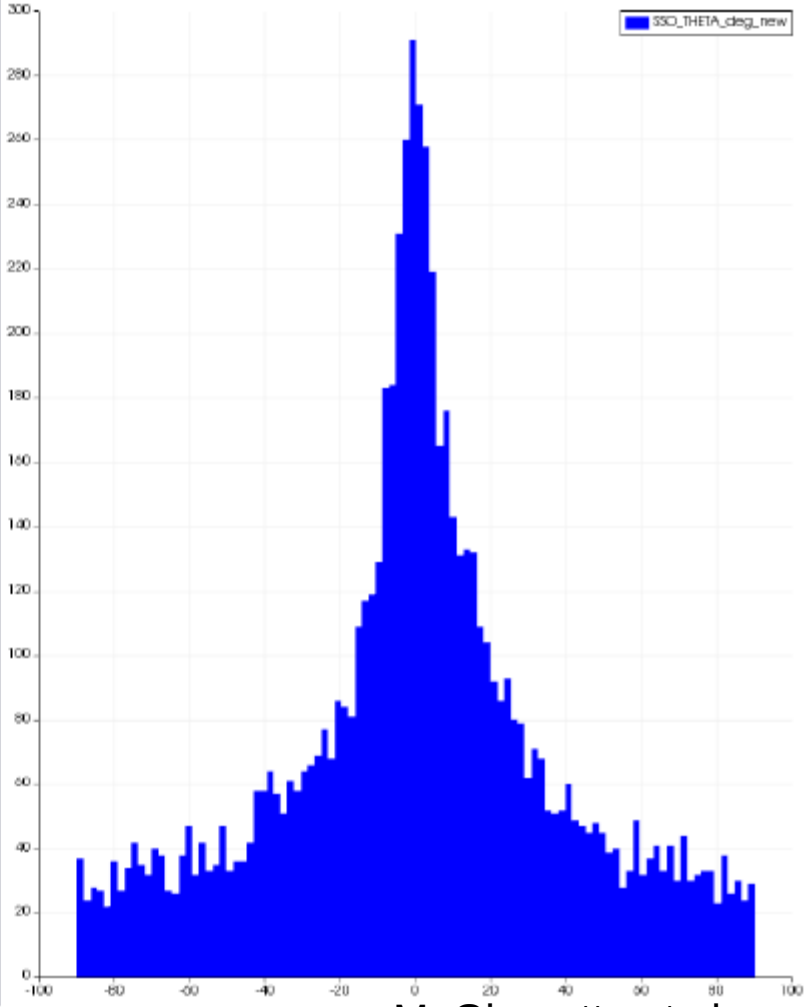
# EXTPAR



Icon_extpar_0012_R02B04_G_20160712 (Corrected sign of Theta and corrected row Index)

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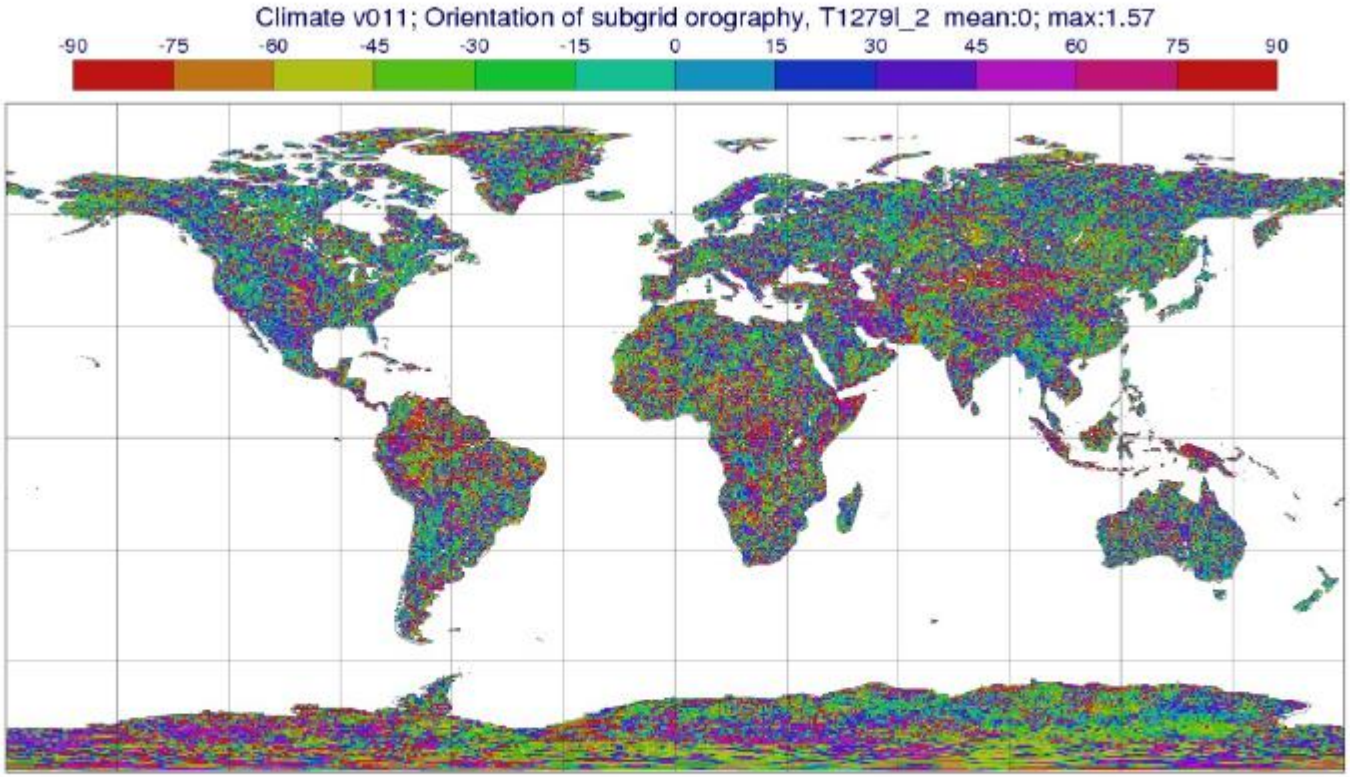


**Figure 11.6** *Orientation $\theta_{GW}$ of sub-grid orography. The field is in radians and has values between $-\frac{1}{2}\pi$ and $\frac{1}{2}\pi$). For clarity the plot has been converted to degrees with values between -90 and +90.*

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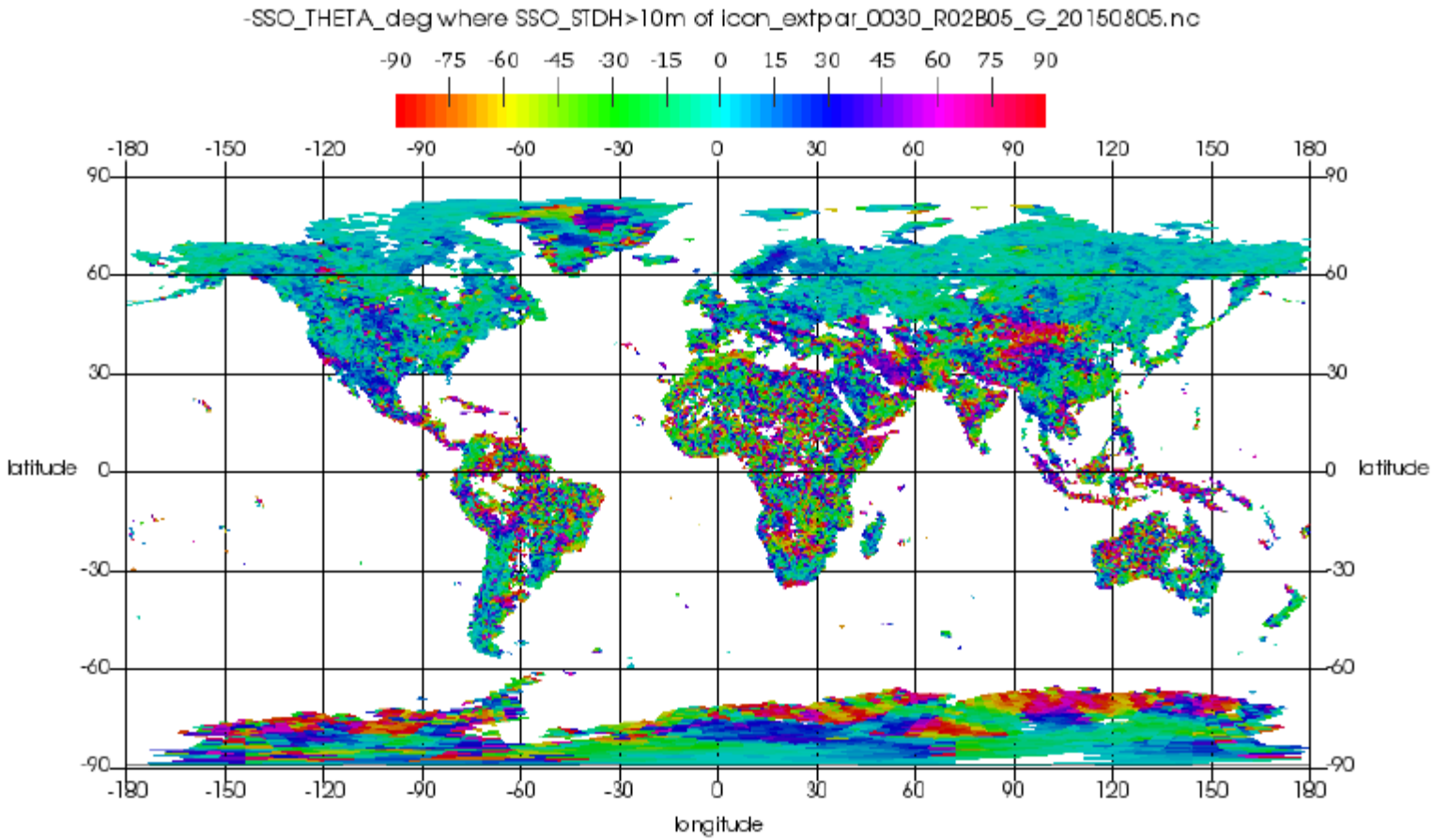
# EXTPAR



**-SSO_THETA in deg of ICON@R2B5**




Here SSO_THETA is compared with a similar colour bar and background, grid etc. For ICON the plots show -SSO_THETA/3.1415926*180 of datasets for R2B5 and R3B7 generated on 2015-08-05. Changing the sign corrects for the orientation error of the y-axis in Extpar. The unit is converted to degree.

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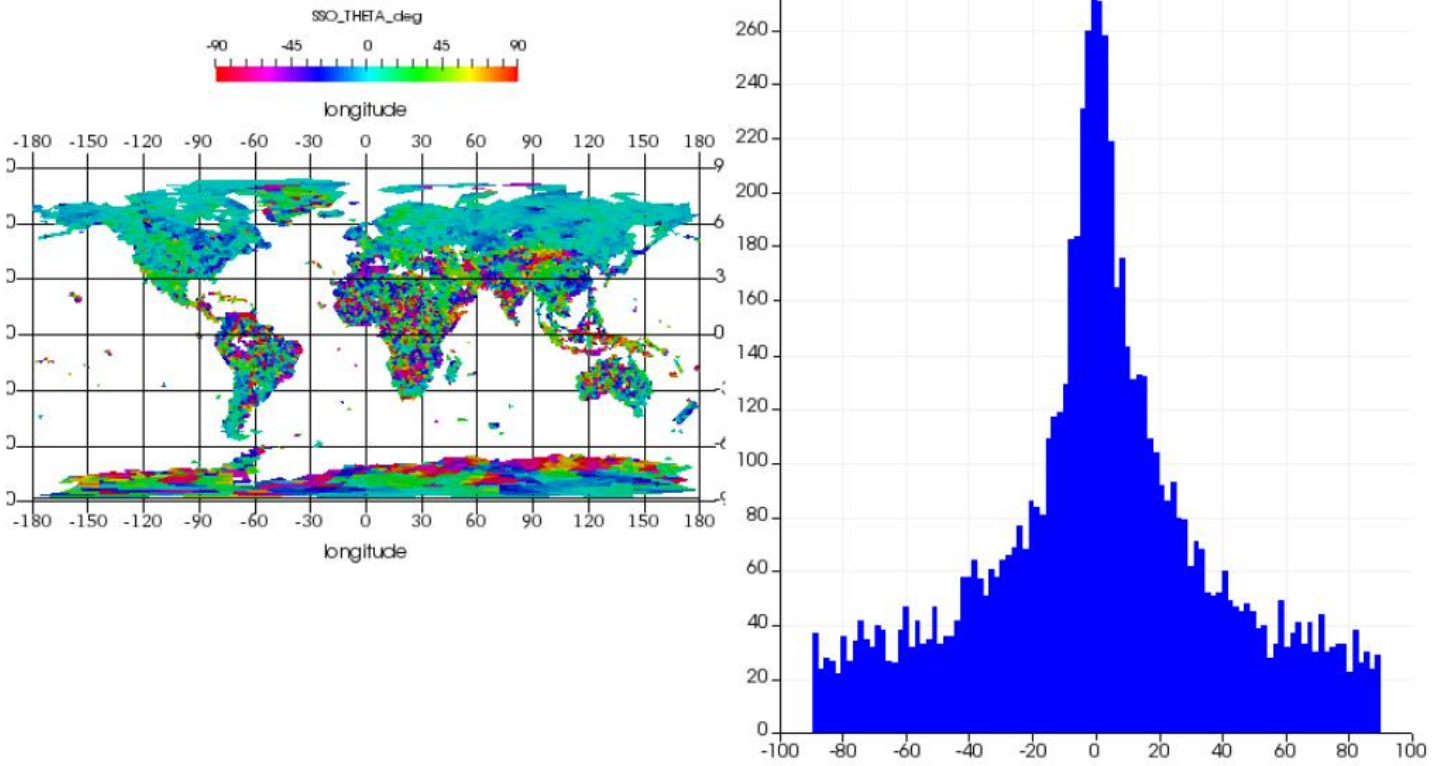
# EXTPAR



**Effect of zonal filtering of GLOBE30 to an effective 1 km resolution**

**SSO_THETA in deg on the 0012_R02B04_G grid, unfiltered**

icon_ssogrid_0012_R02B04_G_20160722_unfiltered.nc

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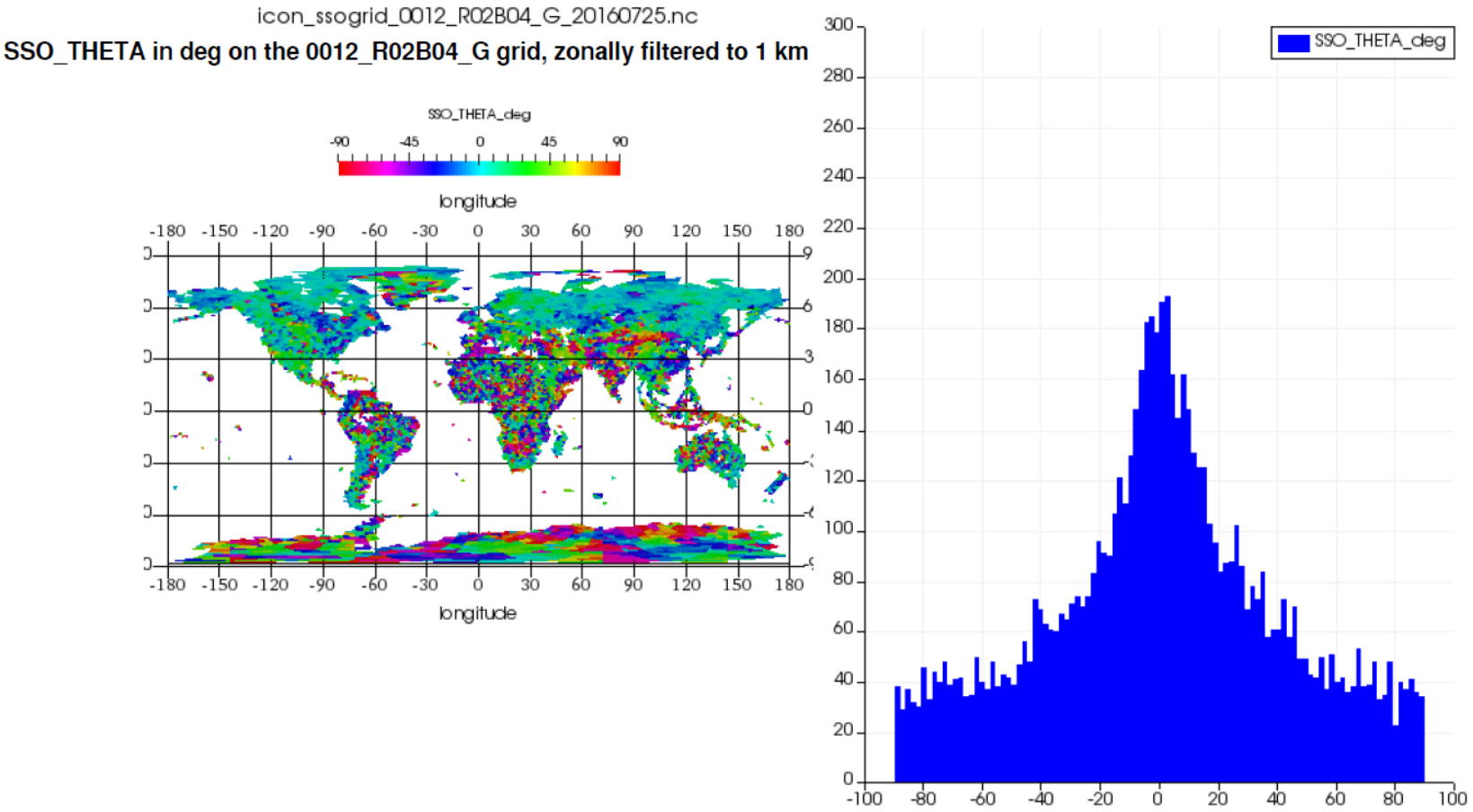
# EXTPAR






The zonal 1 km filtering reduces the decay of SSO_THETA with increasing latitude. The histogram maximum at 0° is reduced from ~290 to ~190, and the histogram counts near +/-90° have increased from ~20 to ~30. Still high angles near +/-90° seem rare in high latitudes in North America and Eurasia compared to the IFS plot.

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