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

# TERRA

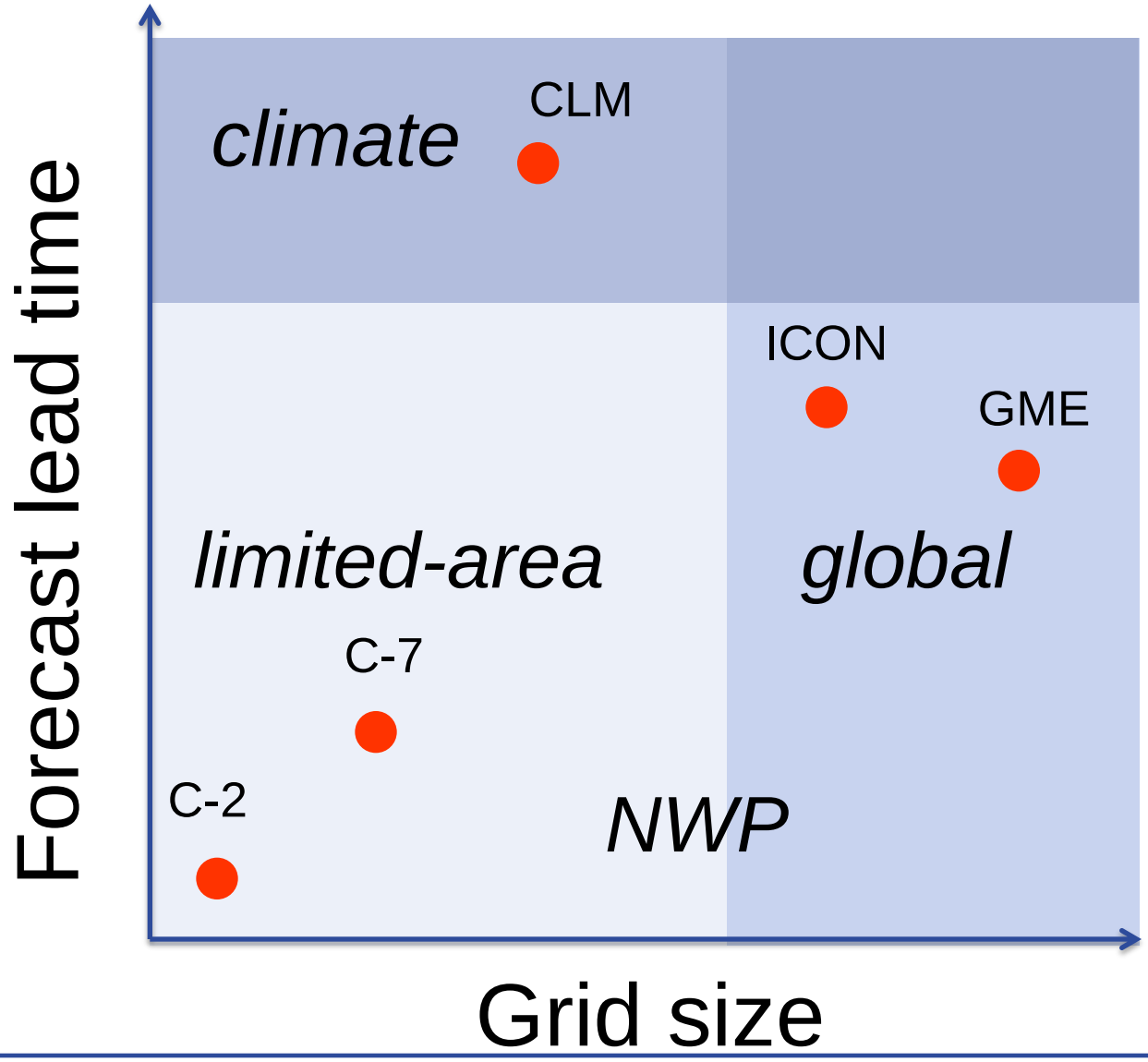
## Soil Vegetation Atmosphere Transfer across Models and Scales

DWD contribution

COSMO-GM 2013

# TERRA – Applications: Scales





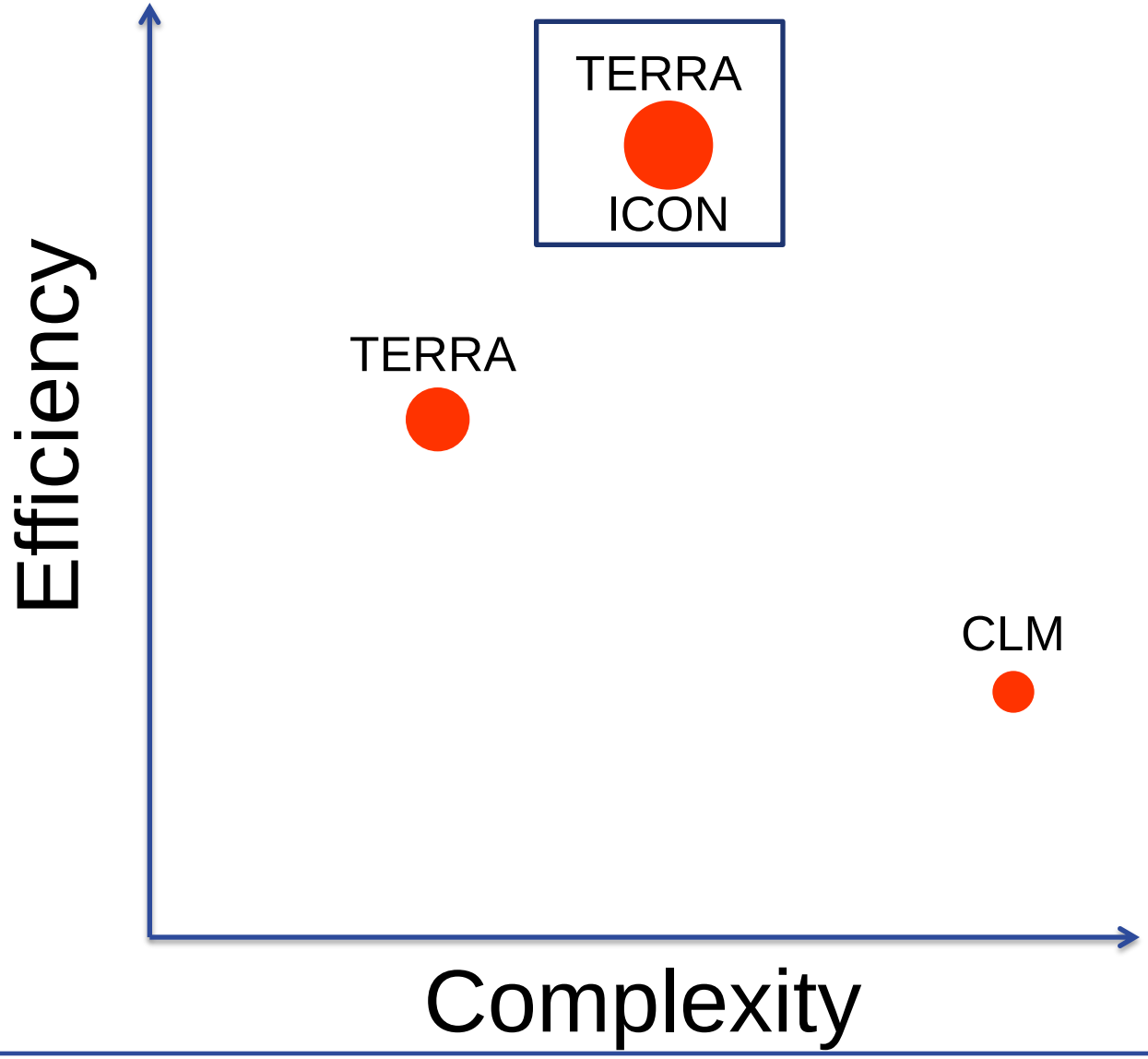
# TERRA - Features



- Efficient and reliable SVAT scheme, includes relevant SVAT processes
- Integrated in the NWP process (DA, MOS, ensemble)
- Long-time experience and development in operational environment exist
- Operational requirements slow down development process
- Basis for external developments - special applications (stream flow, urban model, 3D-soil, dynamic vegetation, soil chemistry)

# TERRA – Efficiency





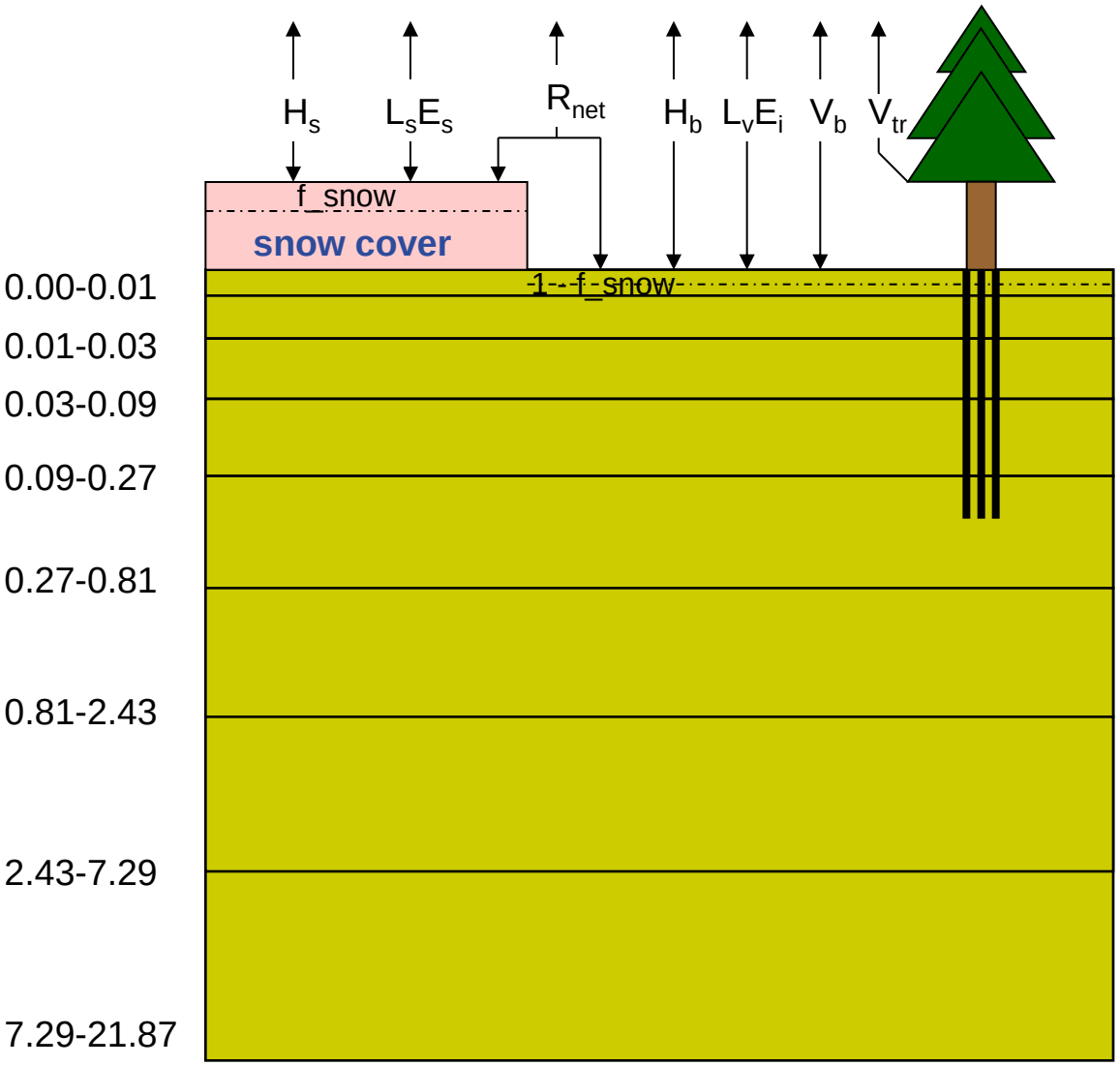
# TERRA – New features



- Surface heterogeneity (TILE approach) and ML-SNOW
- Vegetation (roots, interception, NDVI climatology)
- Application of high-resolution input data sets (GlobCover-land use, HWSD heterogeneous soil)
- One source code – many scales: SCM, 2D, 3D (100m – 100km grid-size)
- Using uncertainties in input data sets for stochastic physics approach and for model calibration
- Model evaluation – IFS analysis, intercomparison, SRNWP

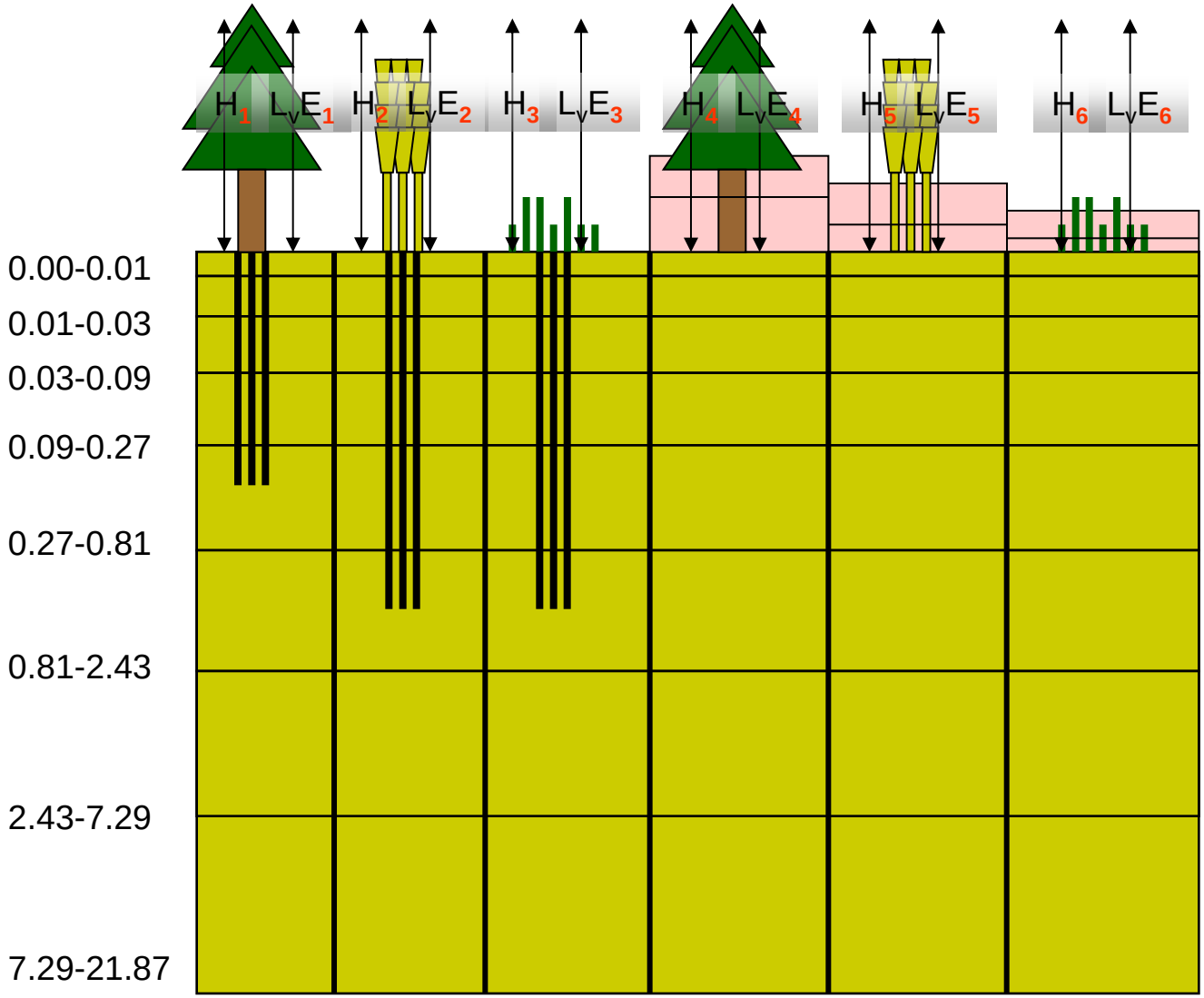
# TERRA no-Tiles: HOM-SOIL





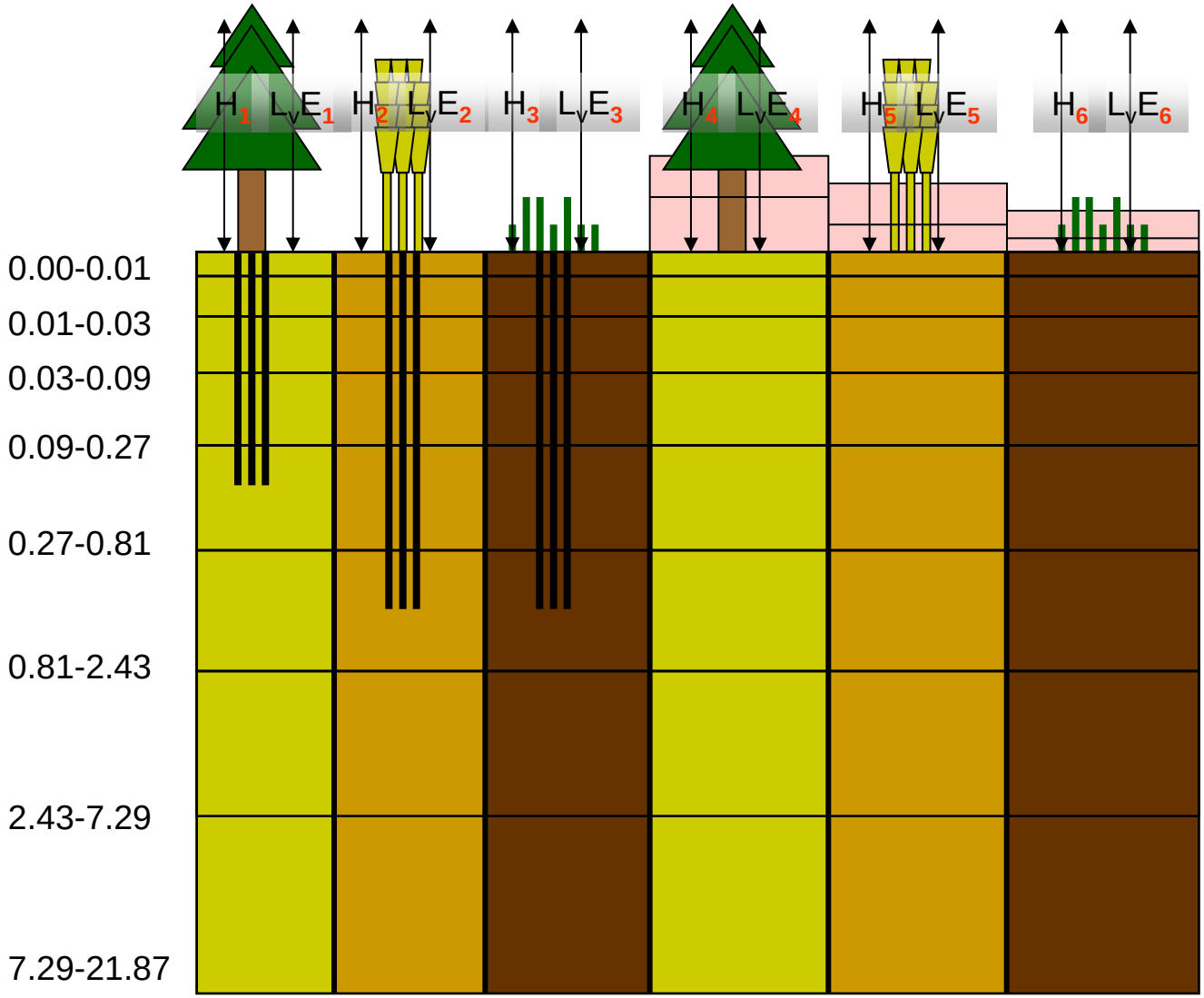
# TERRA Tiles: HOM-SOIL





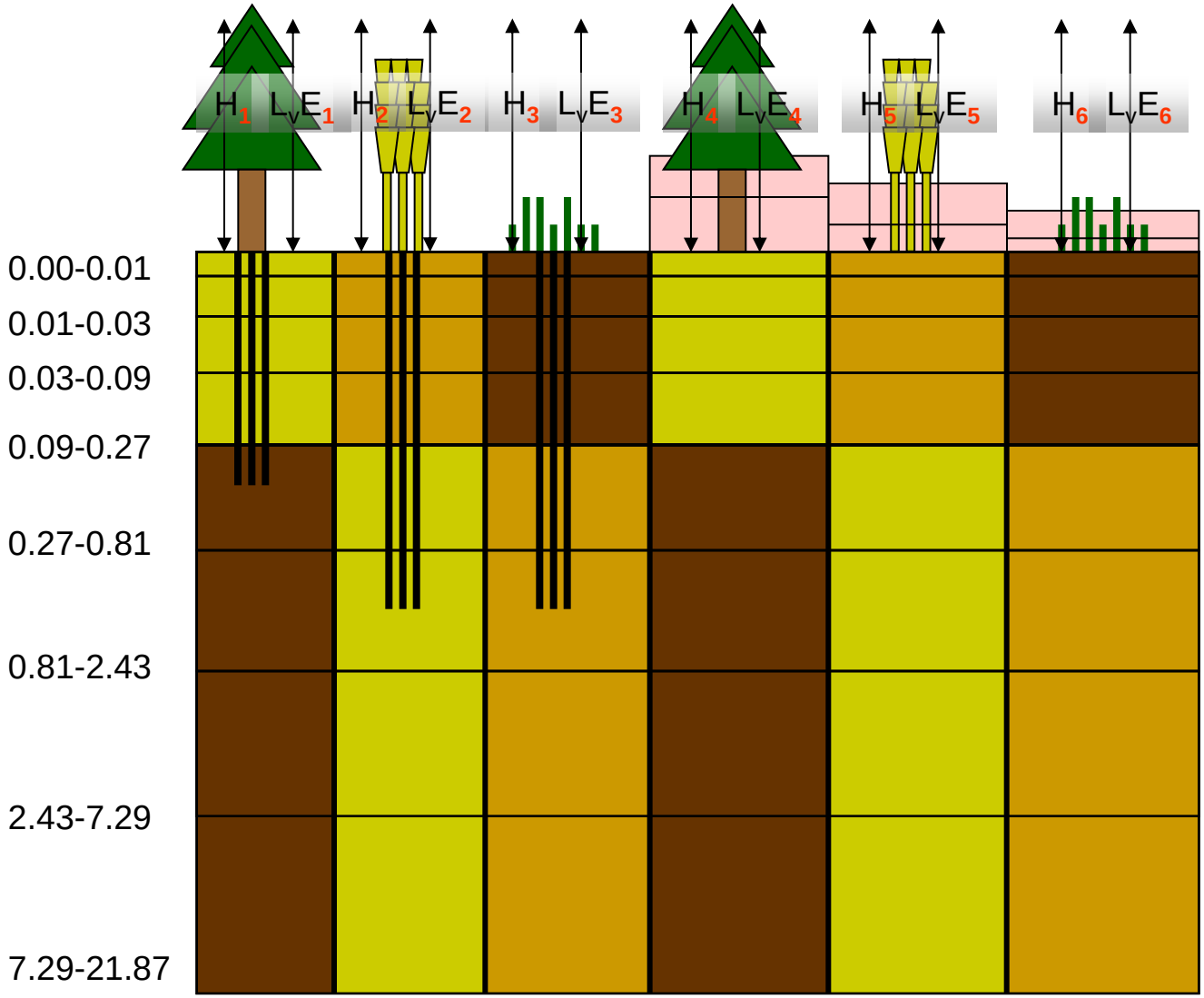
# TERRA Tiles: HET-SOIL





# TERRA Tiles: HET+SUB-SOIL

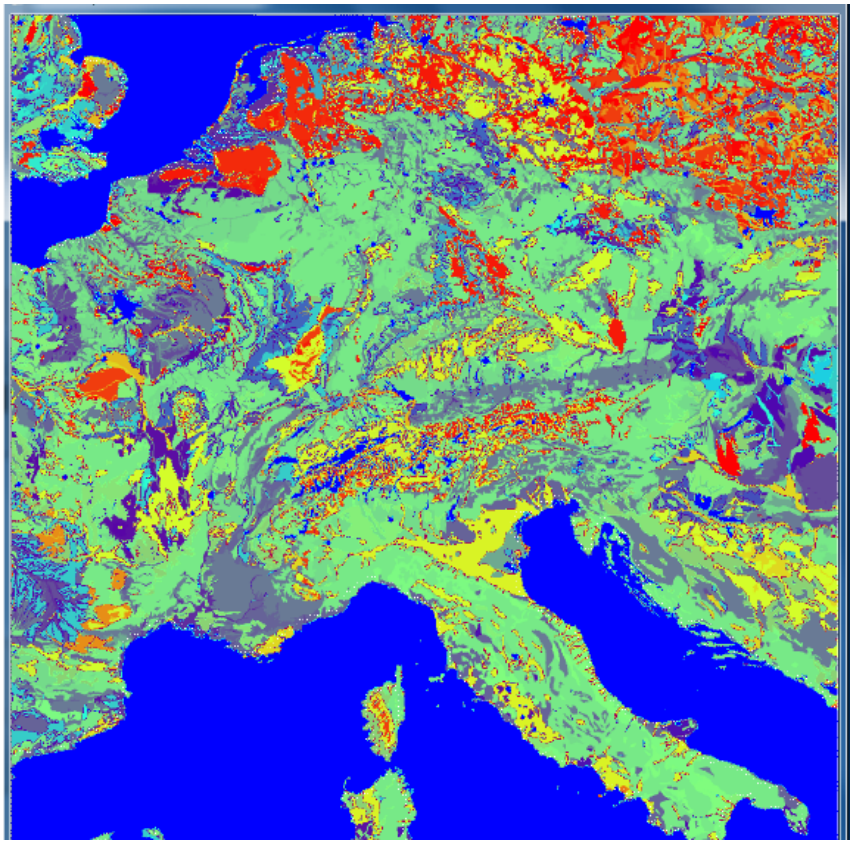




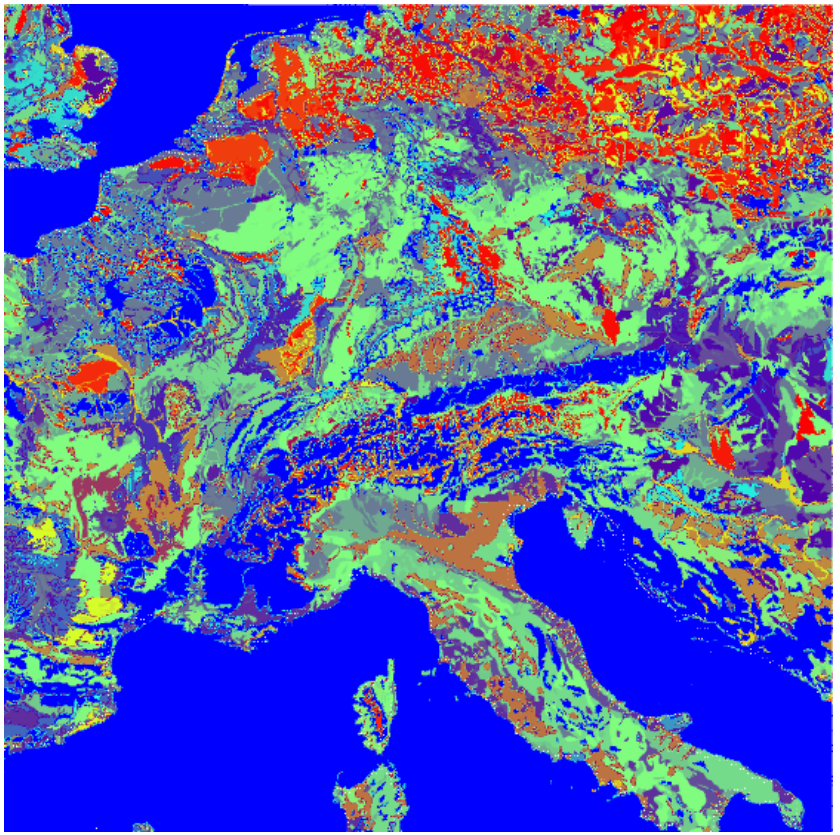
# HWSD – Sand fraction



Sand fraction (0-30cm)

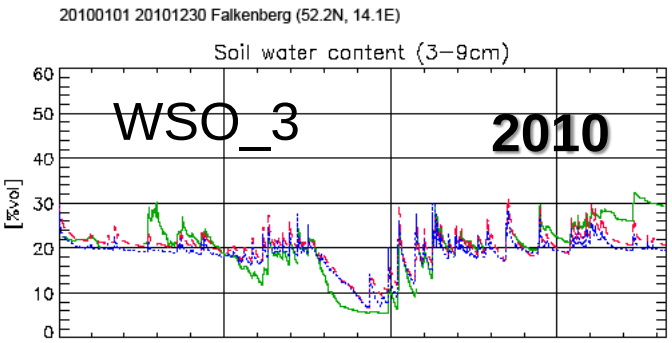


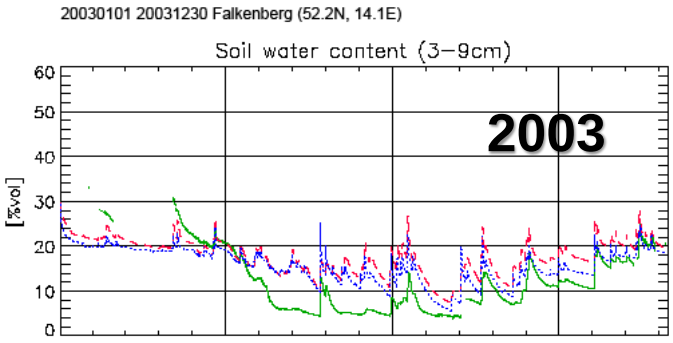
Sand fraction deep soil

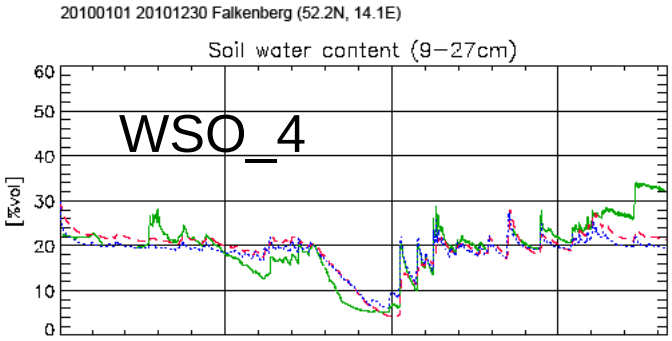


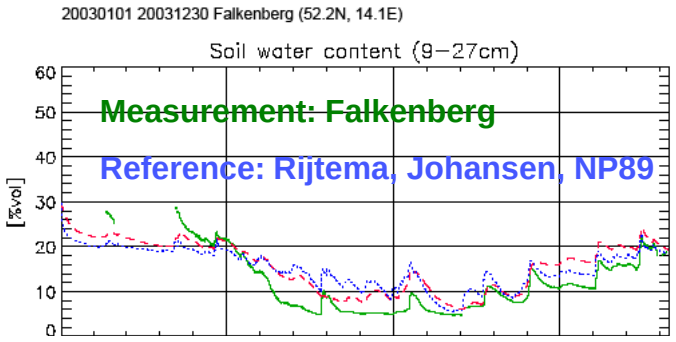
# TERRA – VG hydraulics

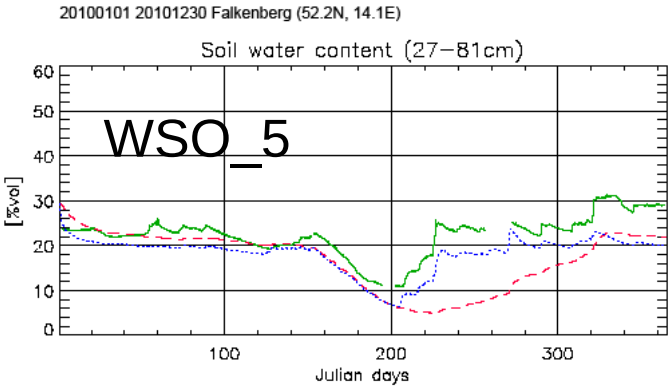


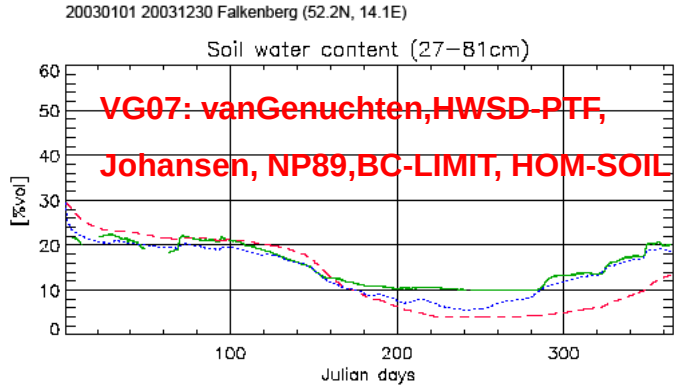


# TERRA – DYN-VEG

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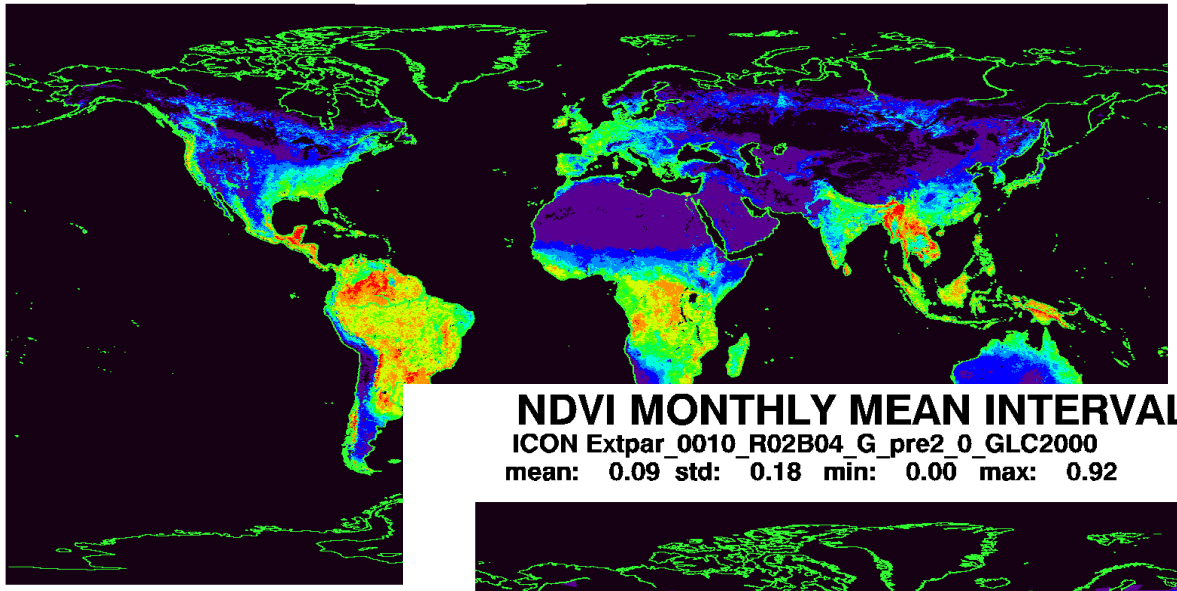
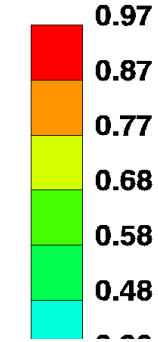
**NDVI MONTHLY MEAN INTERVAL 0-1**
ICON Extpar_0006_R03B07_G_pre2_0_GLC2000
mean: 0.09 std: 0.20 min: 0.00 max: 0.97



2.949.120 cells




**NDVI MONTHLY MEAN INTERVAL 0-1**
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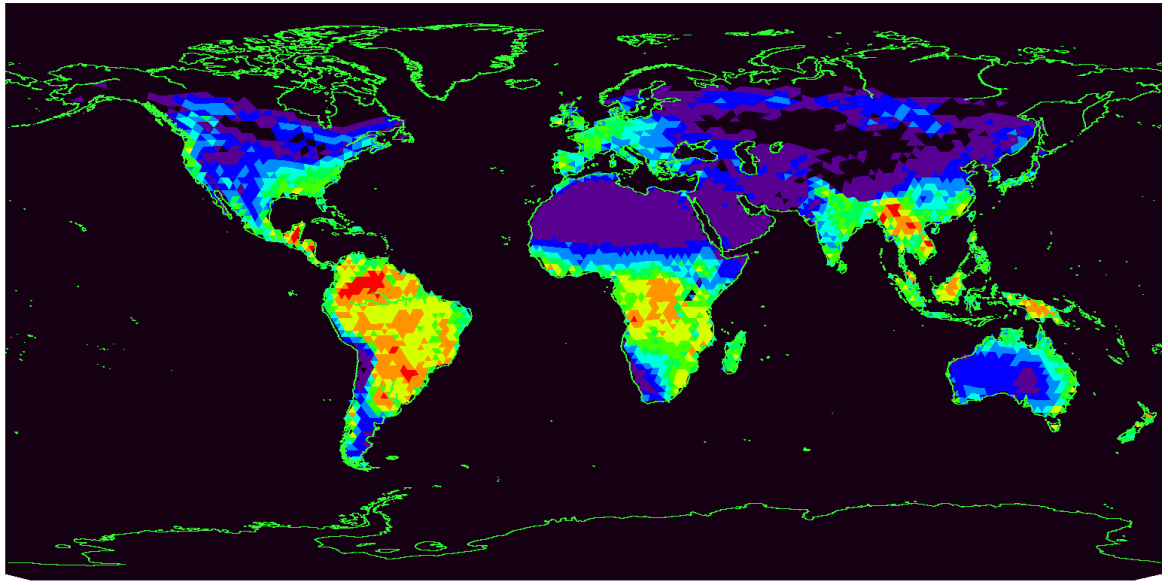
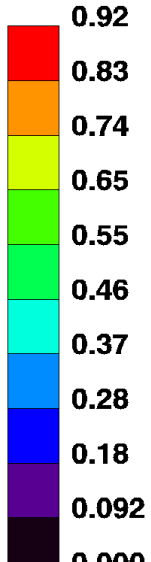
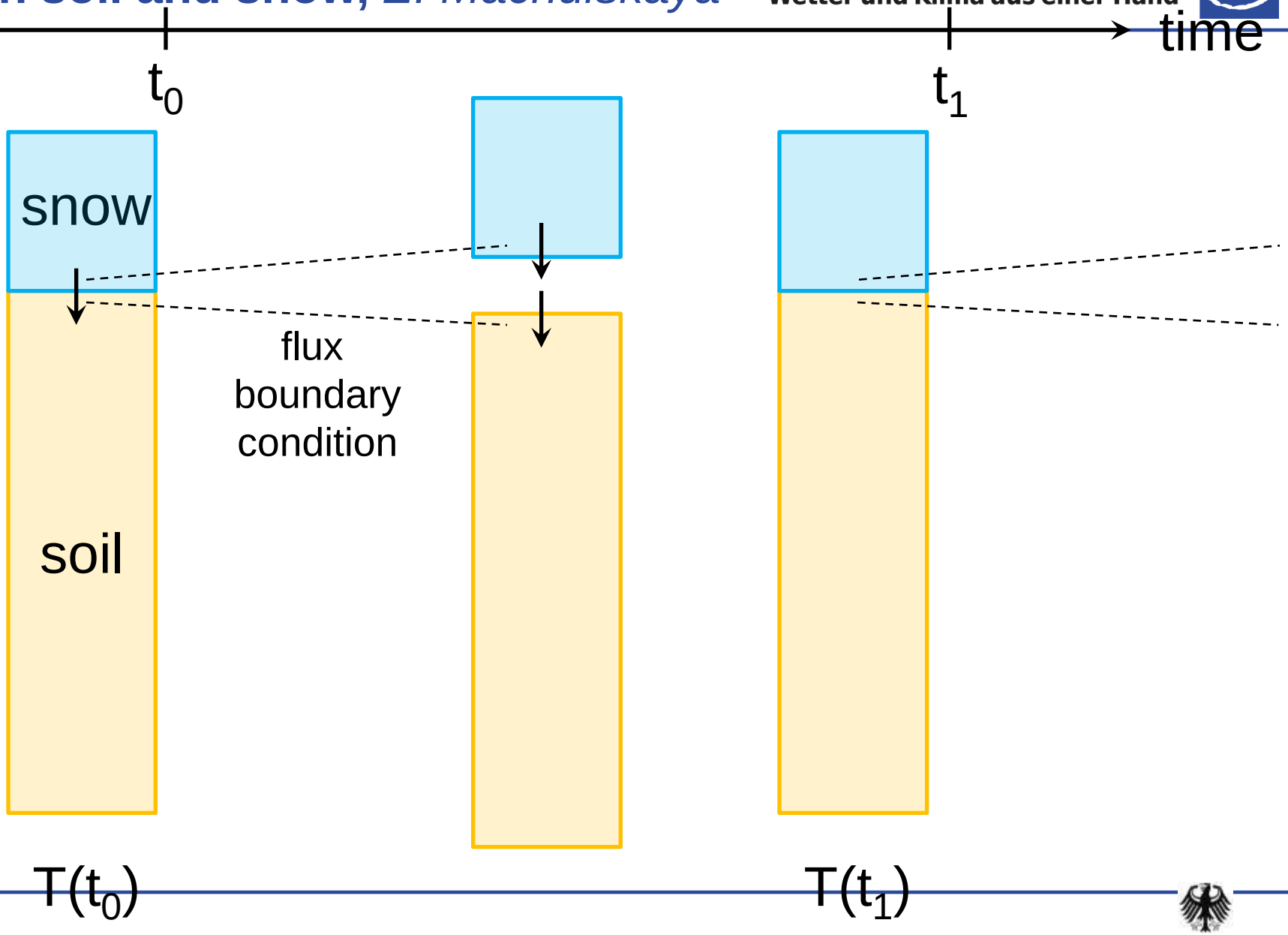


20.480 cells



# Solution of the heat conduction equation in soil and snow, *E. Machulskaya*



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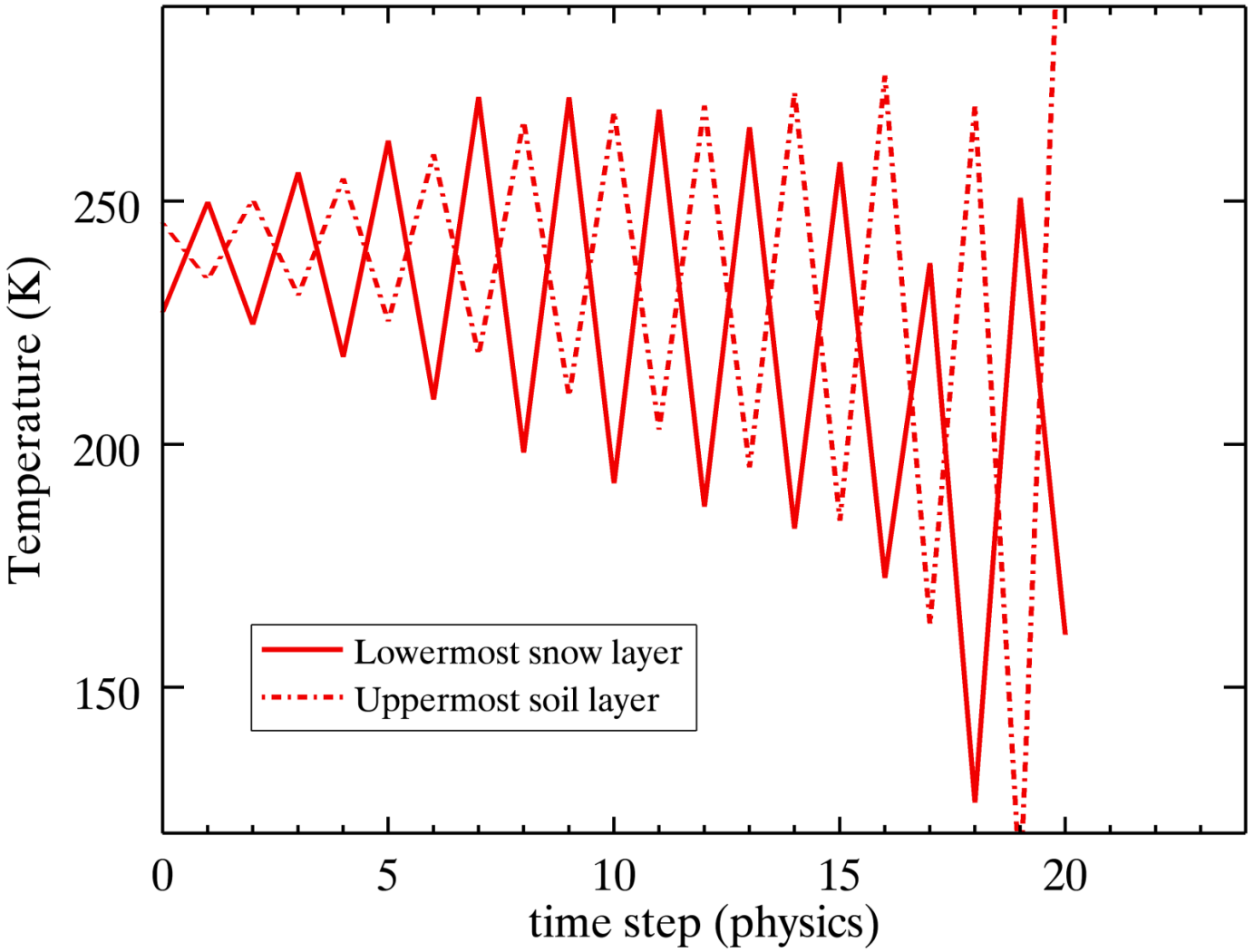

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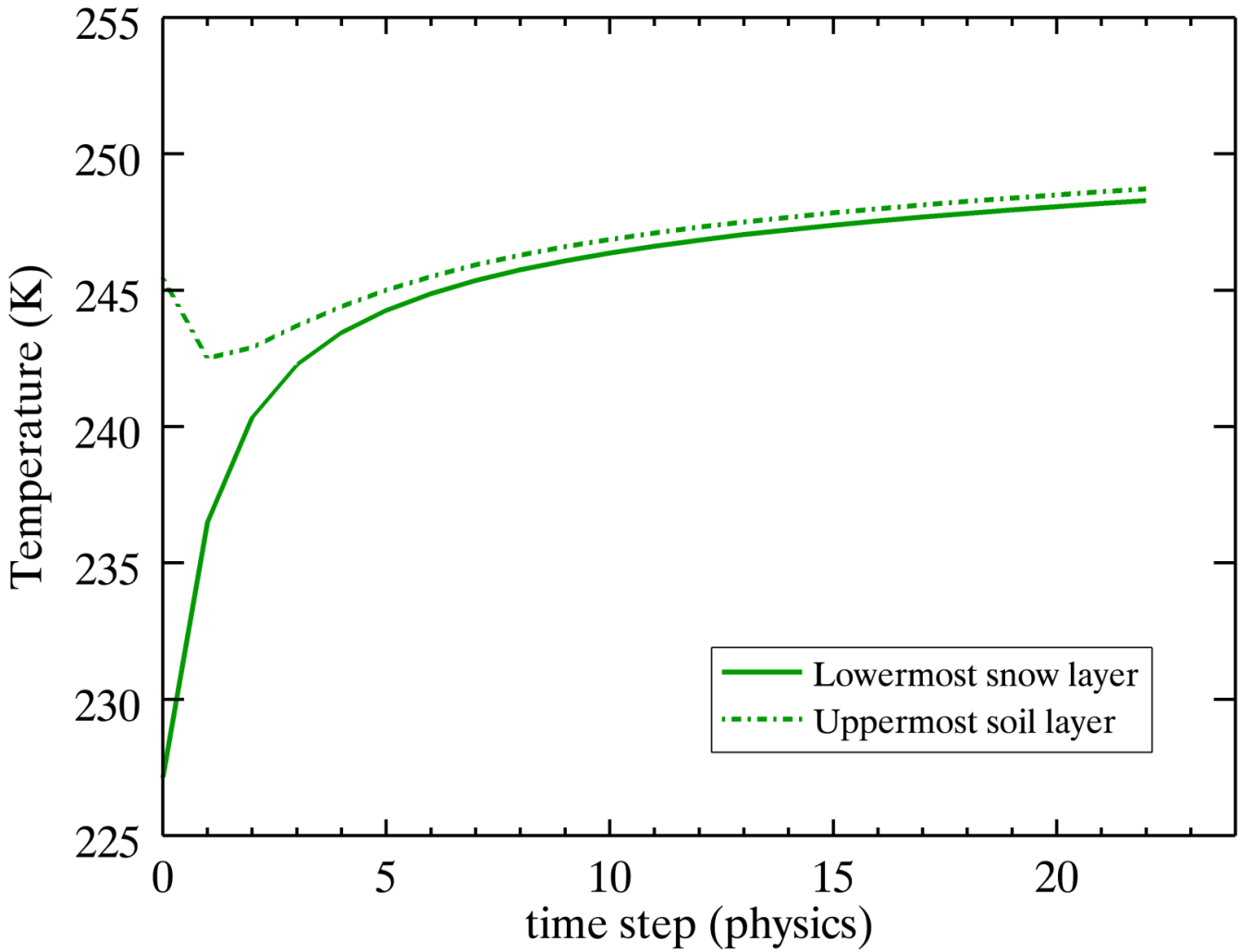
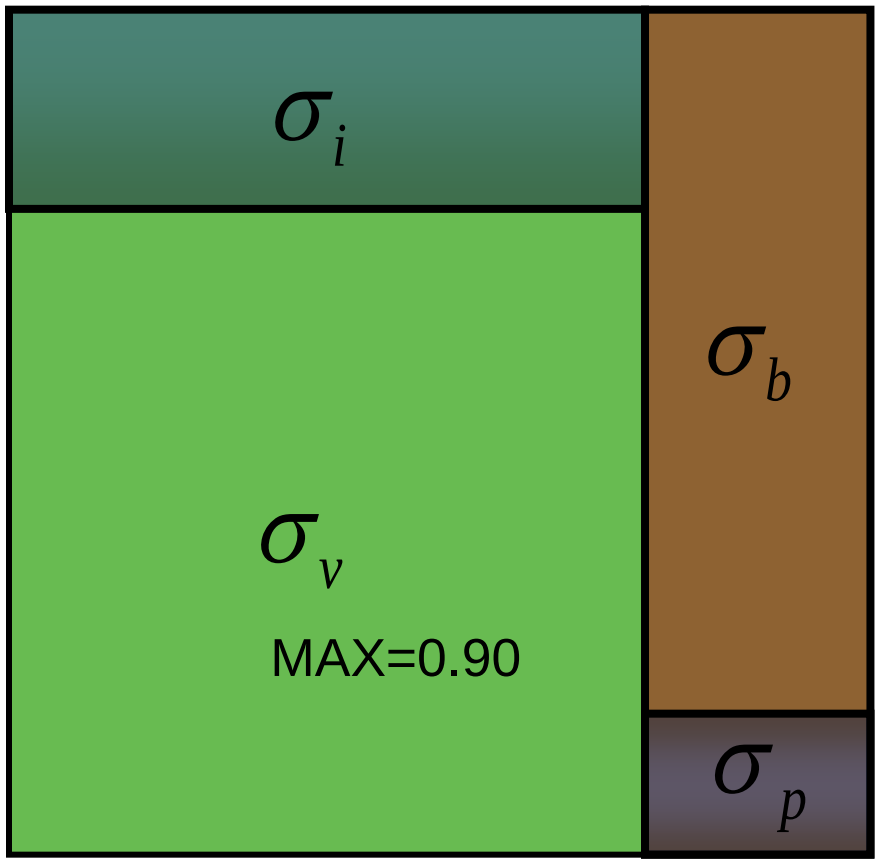


# TERRA - Interception and surface water






➔ Bucket approach for interception and surface water store

$$\frac{\Delta W_i}{\Delta t} = I + E_i - D$$

$$\frac{\Delta W_p}{\Delta t} = D + (1 - \sigma_v) P_r - I_g + E_p$$

# 2 – 4 June 2012 COSMO Falkenberg $W_{i,mx} = 0.0004LAI \quad [\mathrm{m}\ H_2O]$

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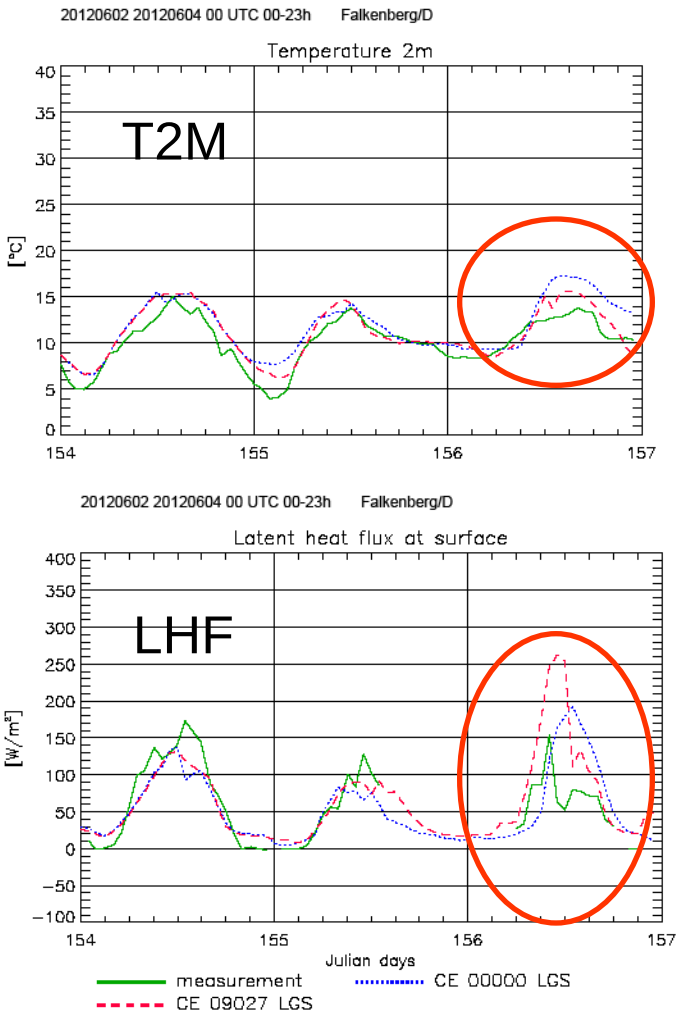


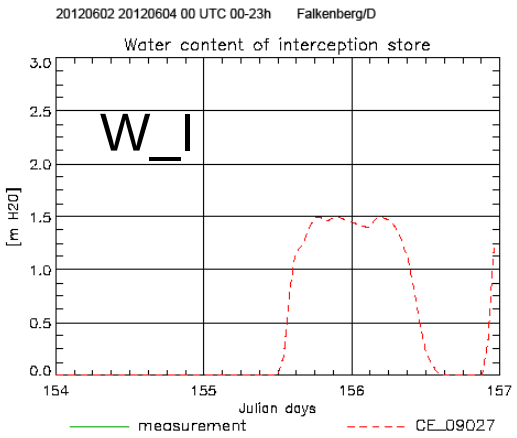


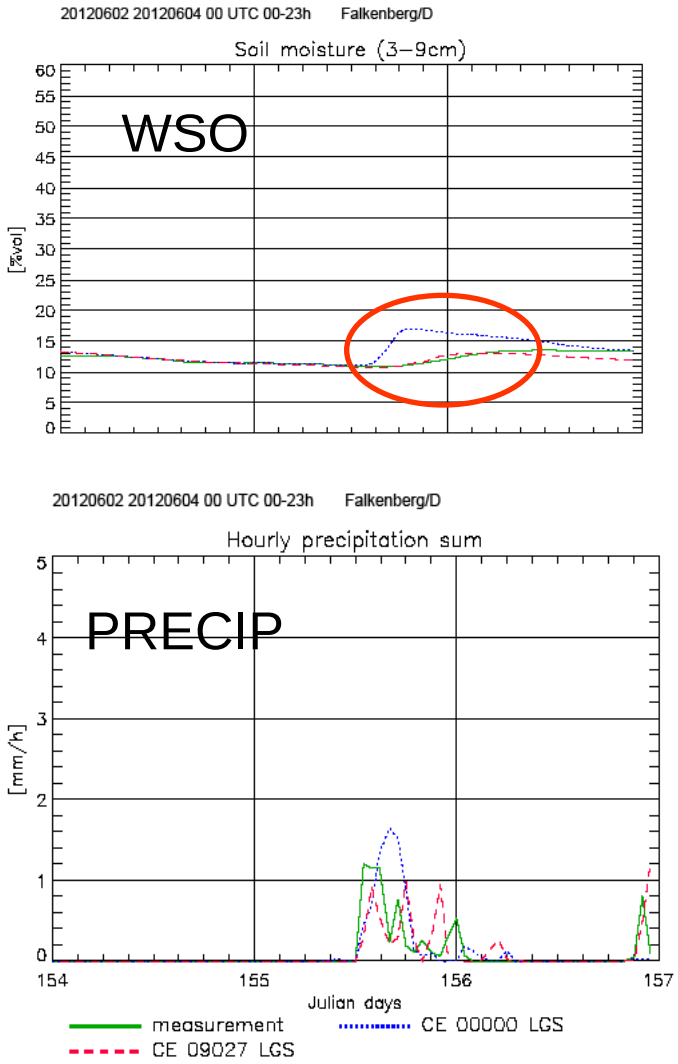

# ICON EXP TOT_PRECIP

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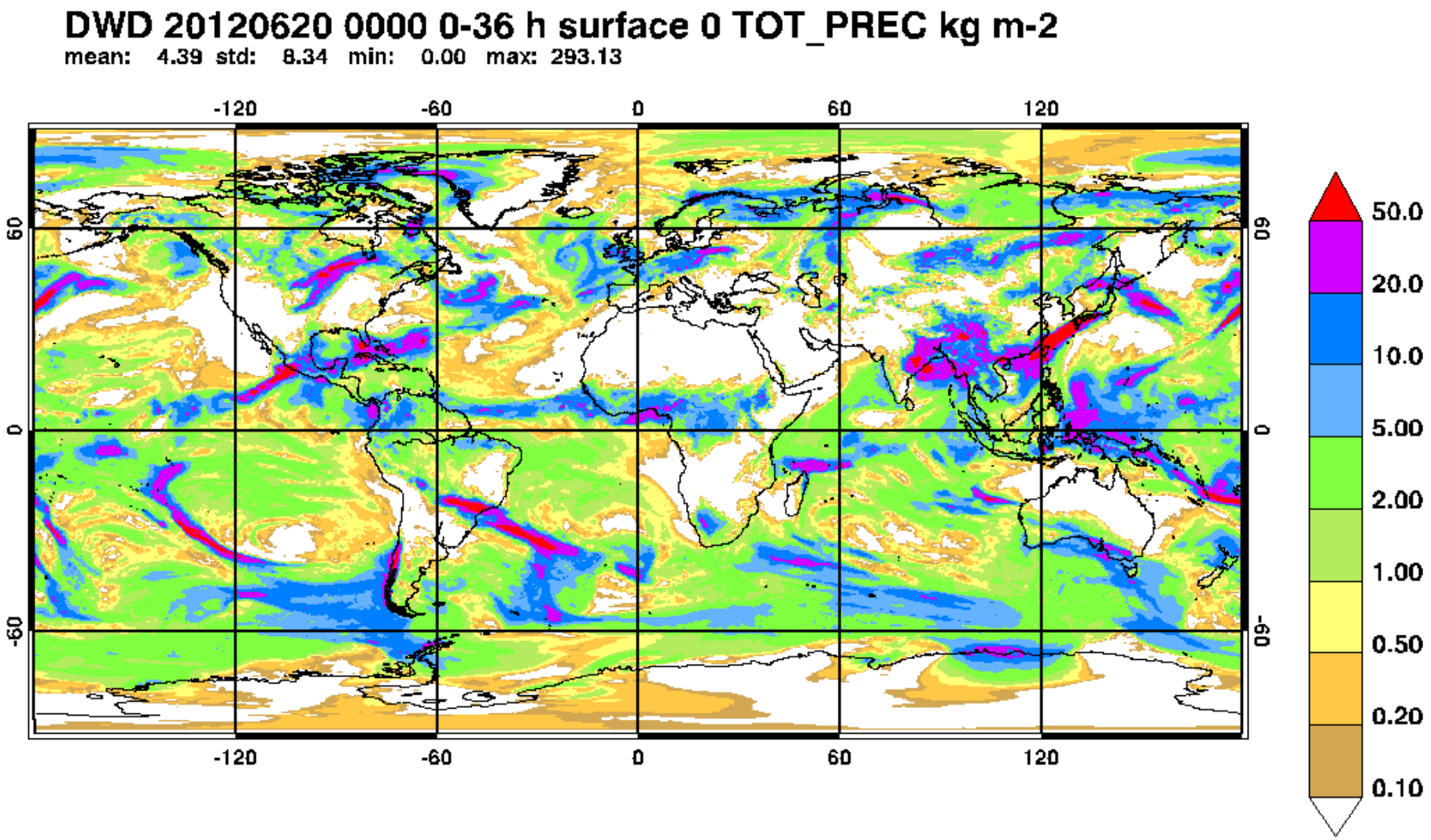

# ICON EXP W_I

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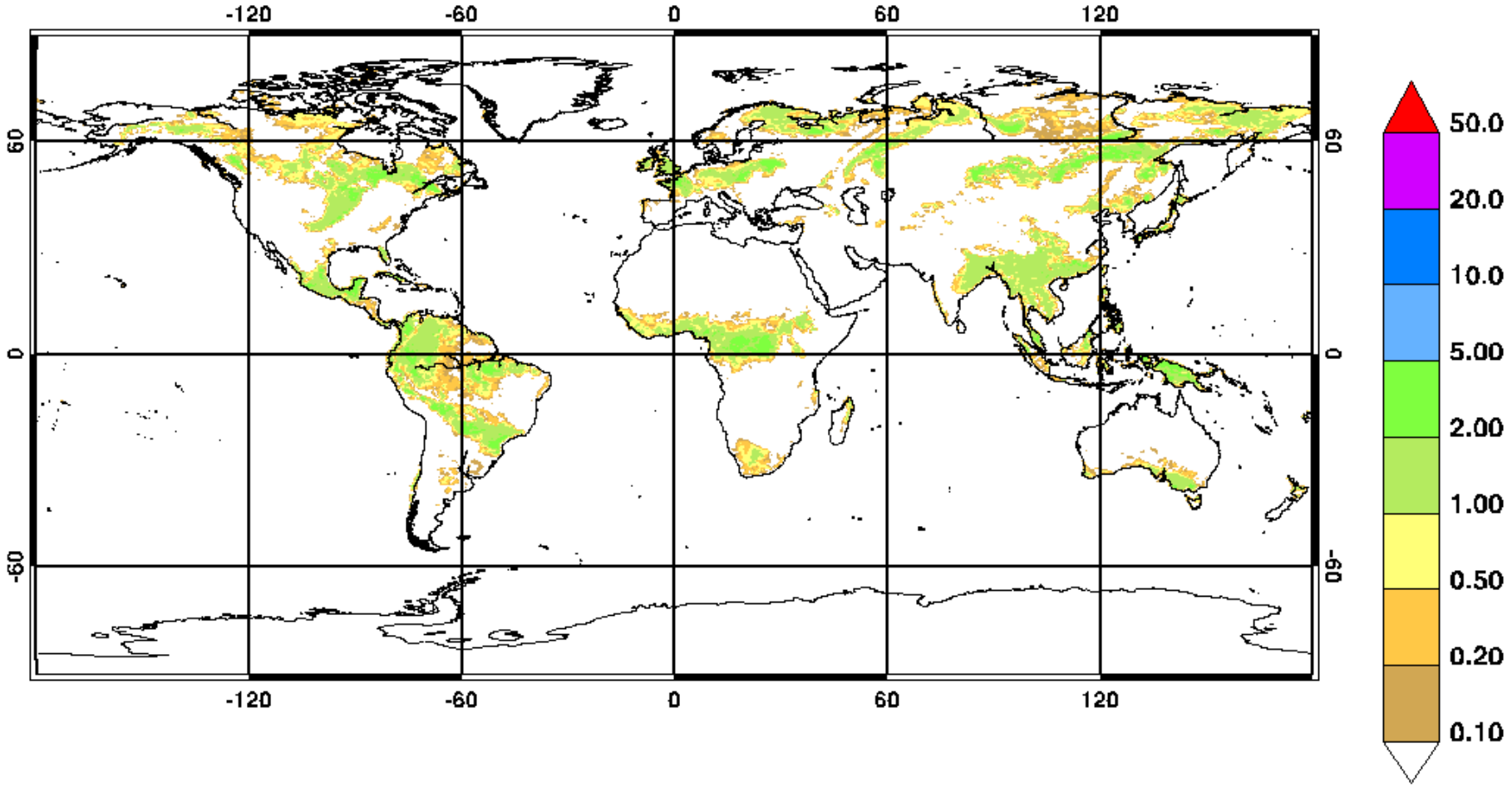
DWD



# ICON DIFF CLCT

CONSORTIUM FOR SMALL SCALE MODELING
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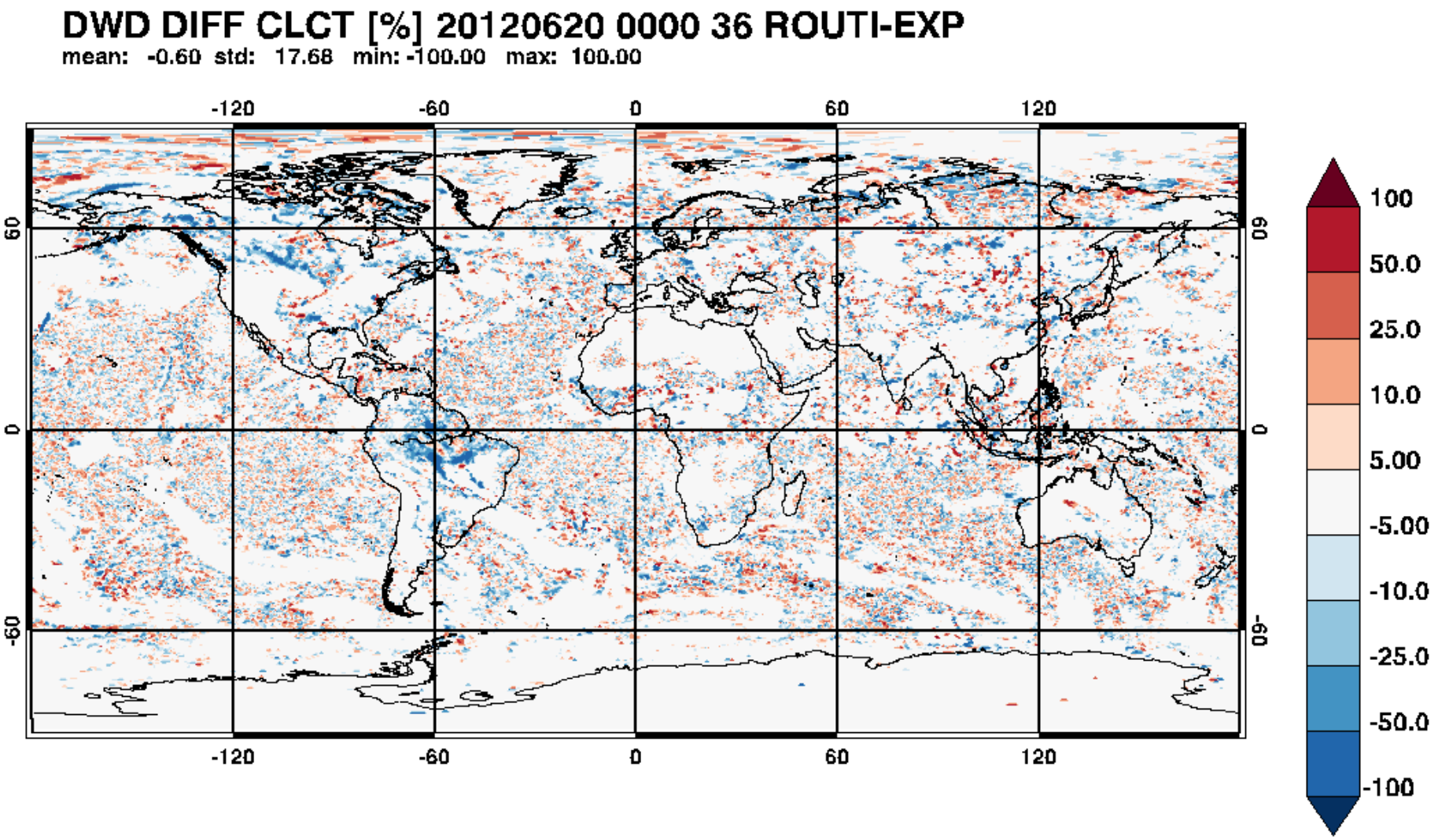


# TERRA - Conclusions

- Efficient and reliable SVAT model
- Continous improvement of ICON version within COSMO using shared physics library 2014
- Integrated in the NWP process
- „State of the art“ SVAT processes for NWP included (TILE, HWSD-SOIL, VEG-DYN, ML-SNOW)
- Active development of new features at NWP centers and research institutes with free of charge support from DWD
- Integration in COSMO and CLM community

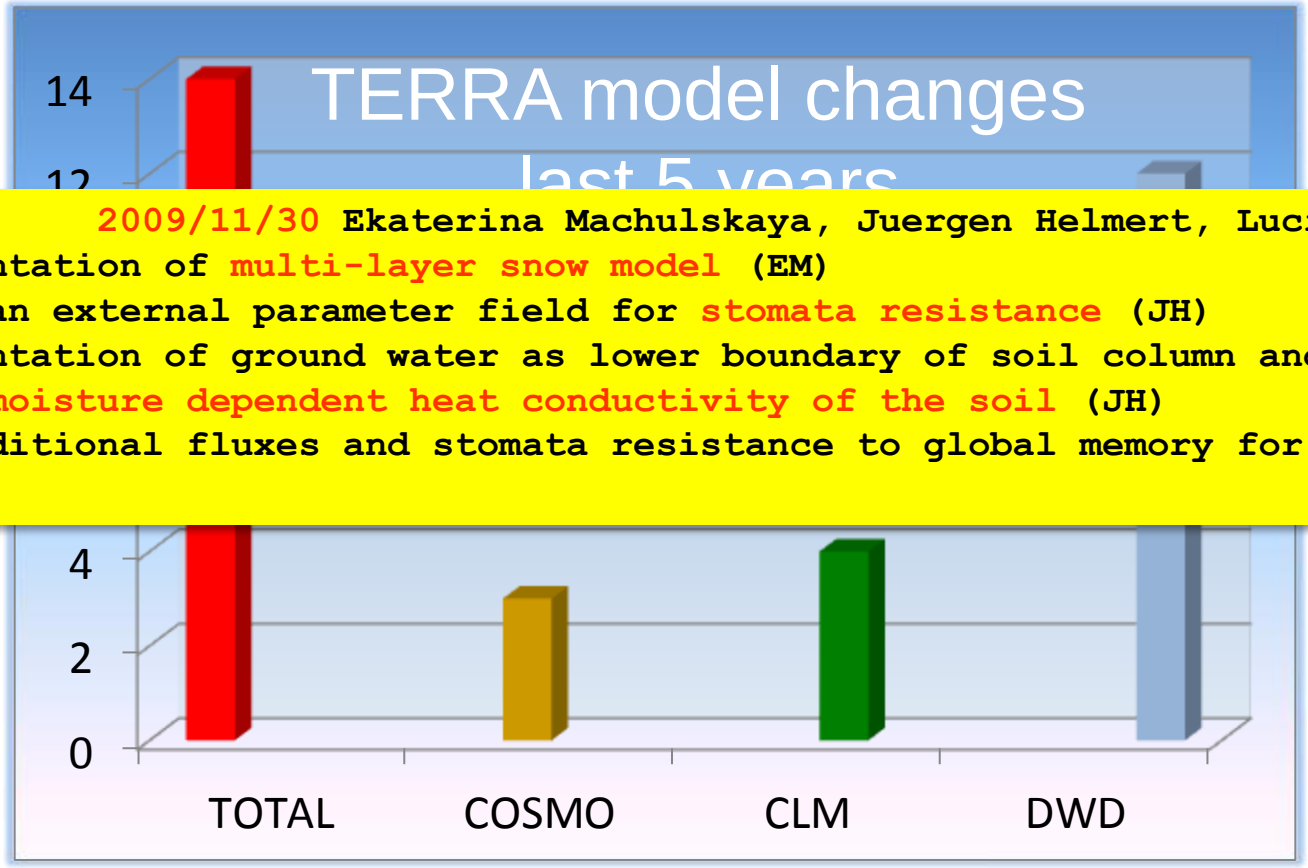
# TERRA - Outlook



- SVAT model intercomparison
- Collaboration with WG3a – Surface Atmosphere Transfer (resolved vegetation)
- Implementation of advanced soil properties data sets (e.g., Harmonized World Soil Database)
- Stochastic physics in TERRA
- Horizontal transports, implementation of soil water interflow, base flow, and ground table.

# TERRA - Summary

State of the art, reliable, and efficient SVAT model, with a growing and vital user and development community




```
! V4_11          2009/11/30 Ekaterina Machulskaya, Juergen Helmert, Lucio Torrisi
!  Implementation of multi-layer snow model (EM)
!  Use of an external parameter field for stomata resistance (JH)
!  Implementation of ground water as lower boundary of soil column and
!    soil moisture dependent heat conductivity of the soil (JH)
!  Save additional fluxes and stomata resistance to global memory for output
(LT)
```