Some further major changes in int2lm V2.03

Ulrich Blahak
Deutscher Wetterdienst, Offenbach

Modifications with considerable influence on results

- **Concerning non-hydrostatic input models (COSMO, ICON, UM, CM):**
  - Methods of adapting vertical profiles to new orography (deeper valleys, higher mountain tops in COSMO orography) **--- all 3D variables except pressure**
  - Profiles of **W blended to „terrain following“ values** (according to U and V) near the surface
  - Computation of (hydrostatically balanced) pressure: **pressure no longer interpolated but computed analytically** from interpolated profiles of T and QV **– this is a bugfix rather than a change!**
- **Concerning ICON input only:**
  - Bugfix:
    - Surface temperature T_SO (initial data) should be adapted to the new orography by way of conservation of differences to near-surface atm. T_{ke}.
    - But for ICON input, this was done wrong so that effectively T_SO was not adapted but only horizontally interpolated!
  - Adaptation to high-resolution near-surface T_{ke} only near the soil surface. At deeper layers blending to a climatological height correction

Pressure computation

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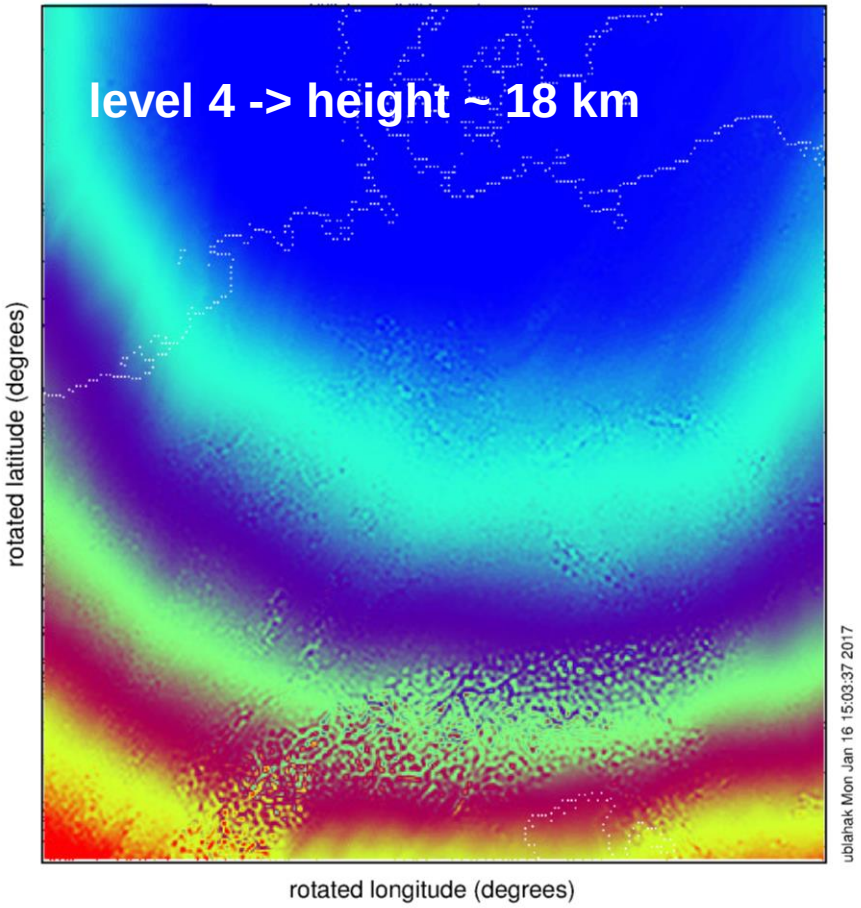
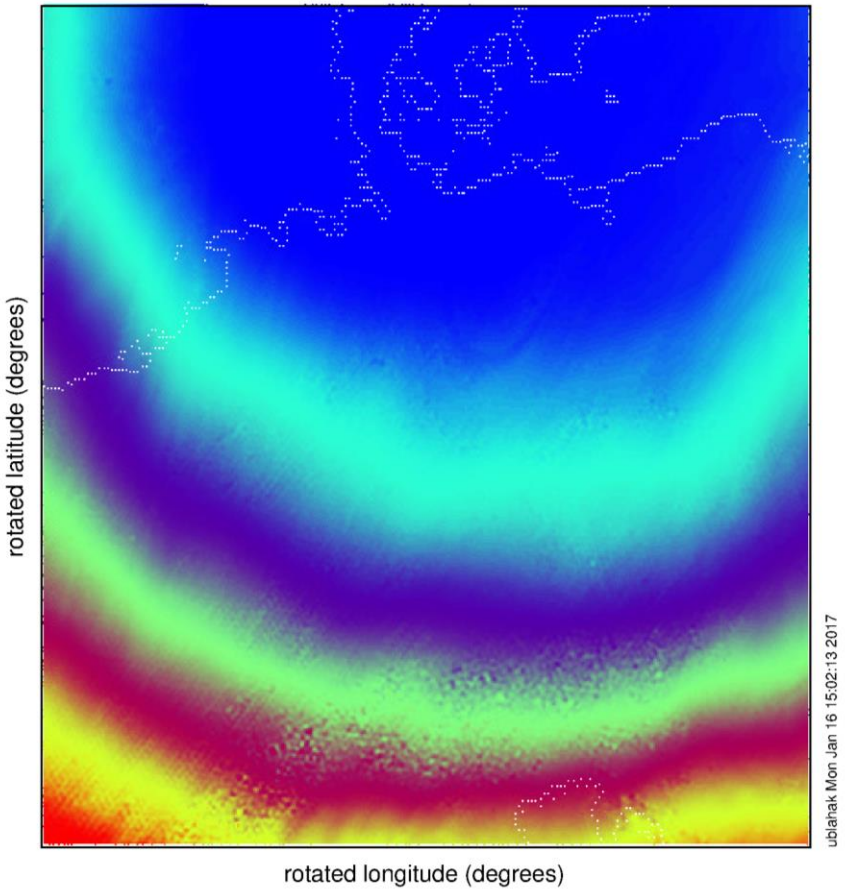
OLD deviation from reference pressure (Pa)



Range of deviation from reference pressure: 320 to 420 Pa
Range of rotated longitude: -5 to 5.5 degrees
Range of rotated latitude: -5 to 6.5 degrees
Current time: 0 seconds since 2016-04-25 00:00:00
Current level: 3
Frame 1 in File TEST_V2.03_ref_ptest_ncdf/laf2016042500.nc

NEW deviation from reference pressure (Pa)



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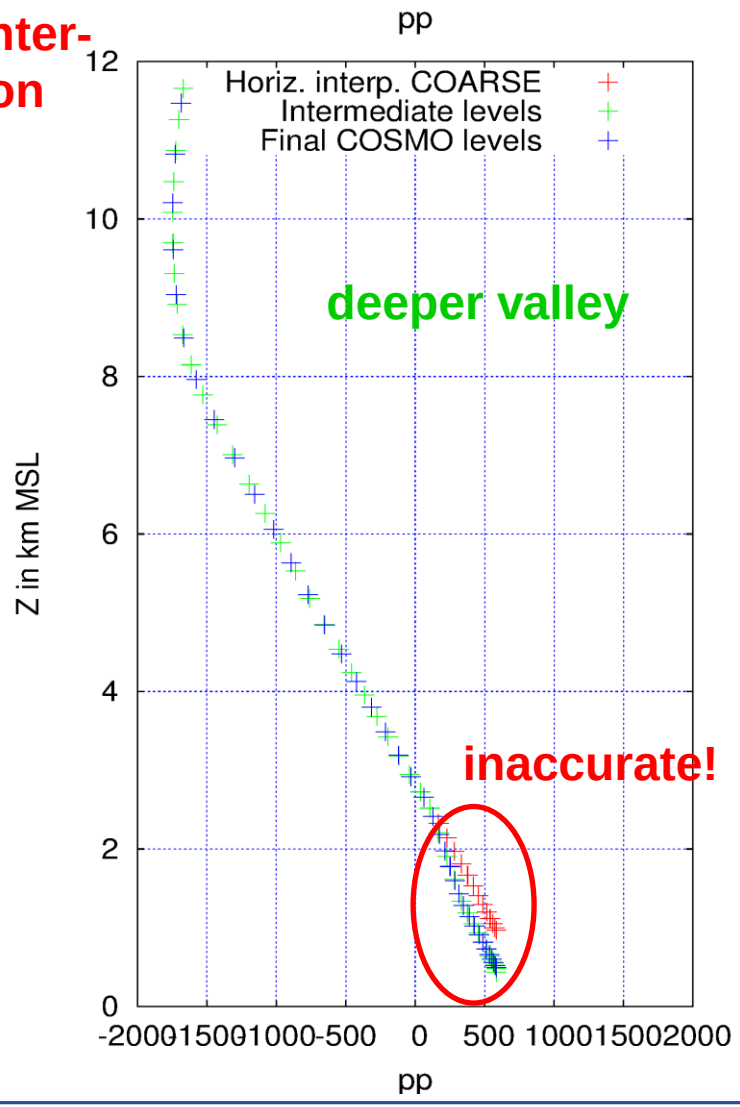
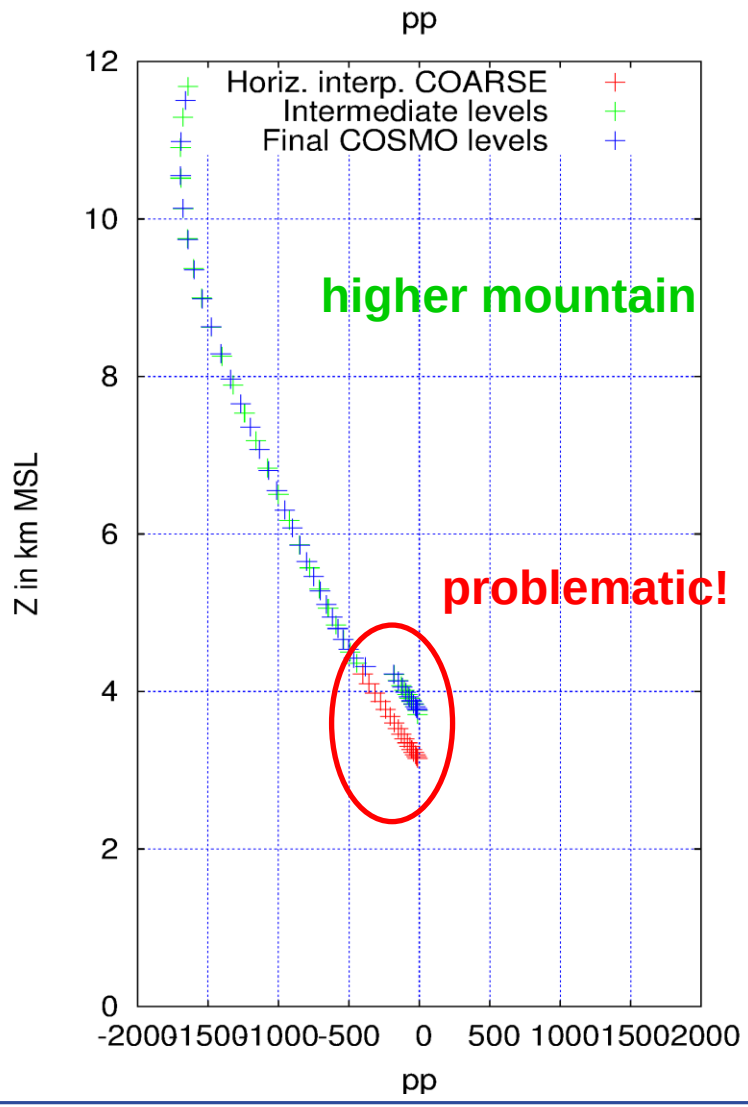
Frame 1 in File TEST_IEU2DE_2016042500_V2.03_test_ptest-itype2_simply-inte

Pressure computation

OLD inter-polation of PP





Pressure computation

➔ **New: PP is no longer interpolated, but analytically computed** (integrated) from hydrostatic equation, based on the before interpolated T- and QV profiles:

$$\frac{\partial p}{\partial z} = -g \frac{p(z)}{R_D\, T(z)\, (1 + 0.61\, q_v(z) - q_x(z))} = -g \frac{p(z)}{R_D\, T_v(z)}$$

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If $T_v(z) = T_v(z_1) - \gamma_v\, (z_2 - z_1)$ is assumed in layer from z_1 to z_2

$$\text{with } \gamma_v = \frac{T_v(z_1) - T_v(z_2)}{z_2 - z_1}$$

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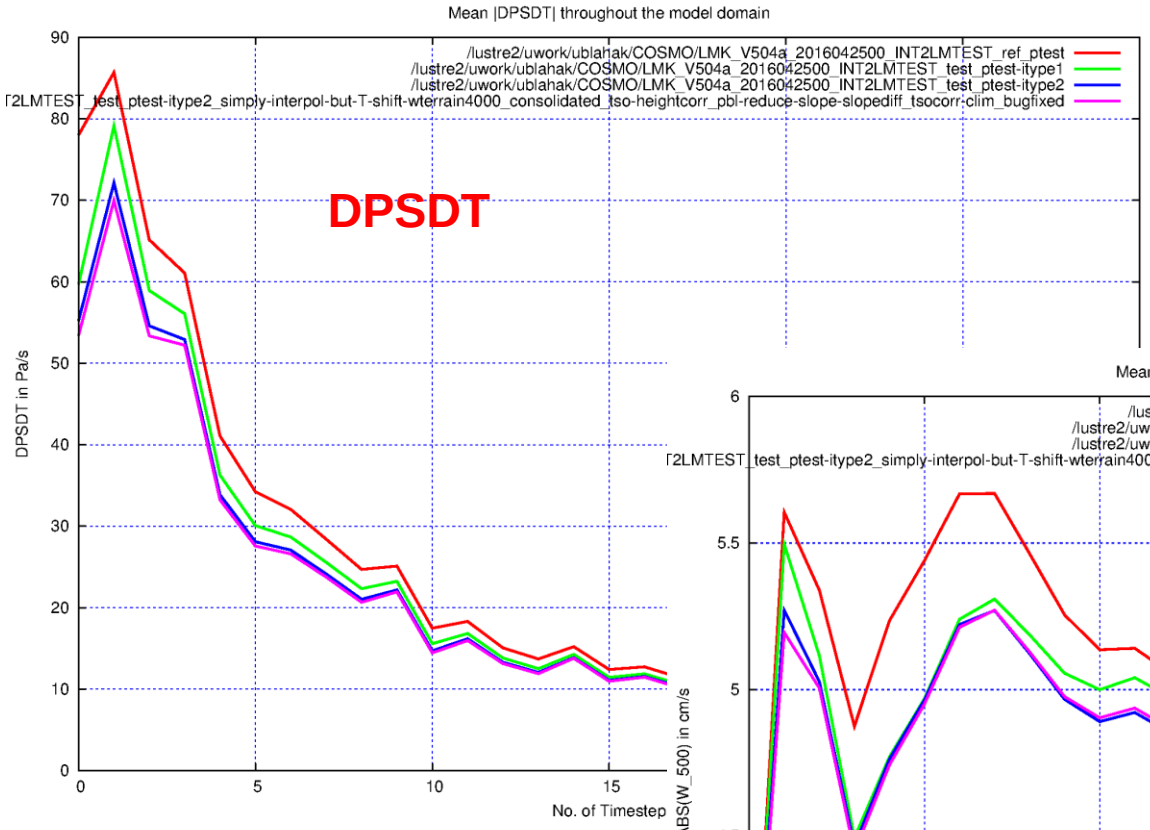
$$\text{with } \gamma_v = \frac{T_v(z_1) - T_v(z_2)}{z_2 - z_1}$$

Then the solution of this DGL for $p(z_2)$ is

$$p(z_2) = p(z_1) \left(1 - \frac{\gamma_v}{T_v(z_1)}\,(z_2 - z_1)\right)^{\frac{g}{R_d\,\gamma_v}}$$

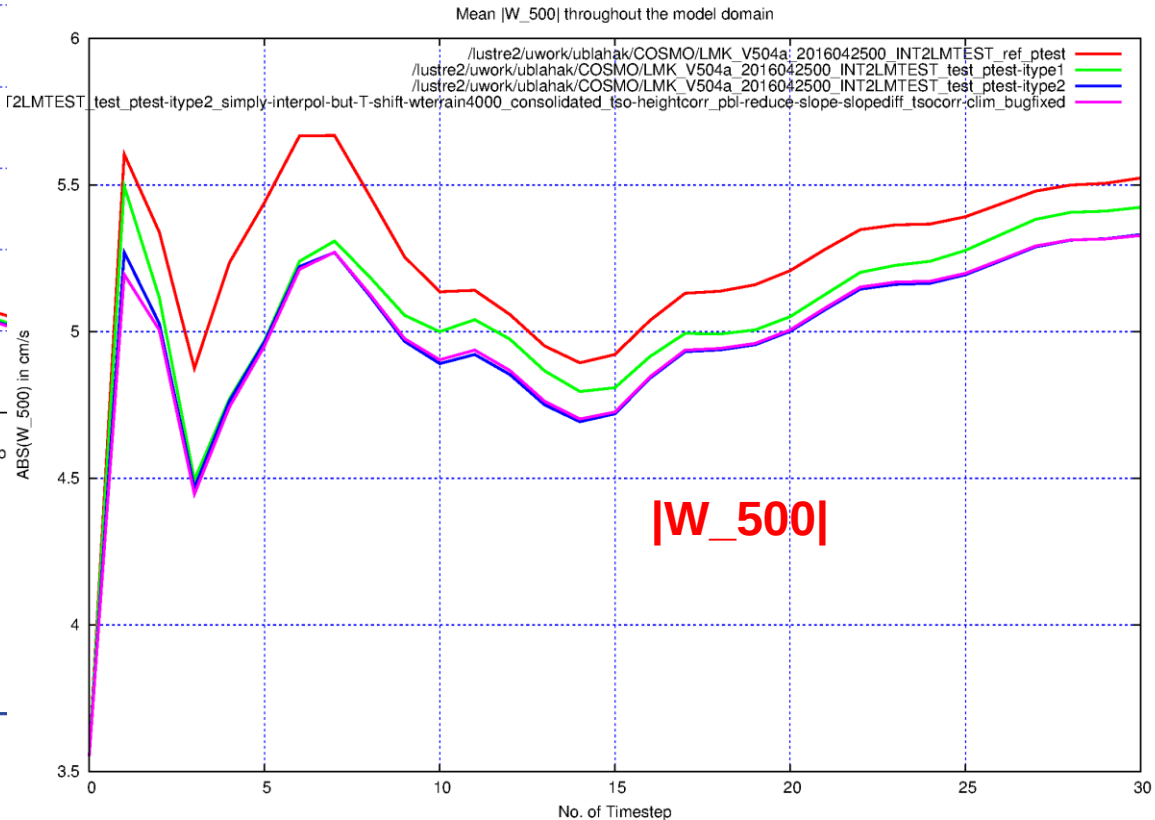
Resulting noise in COSMO-DE



OLD PP

NEW PP

NEW PP +
NEW PROFILE METHODS
(see following slides)

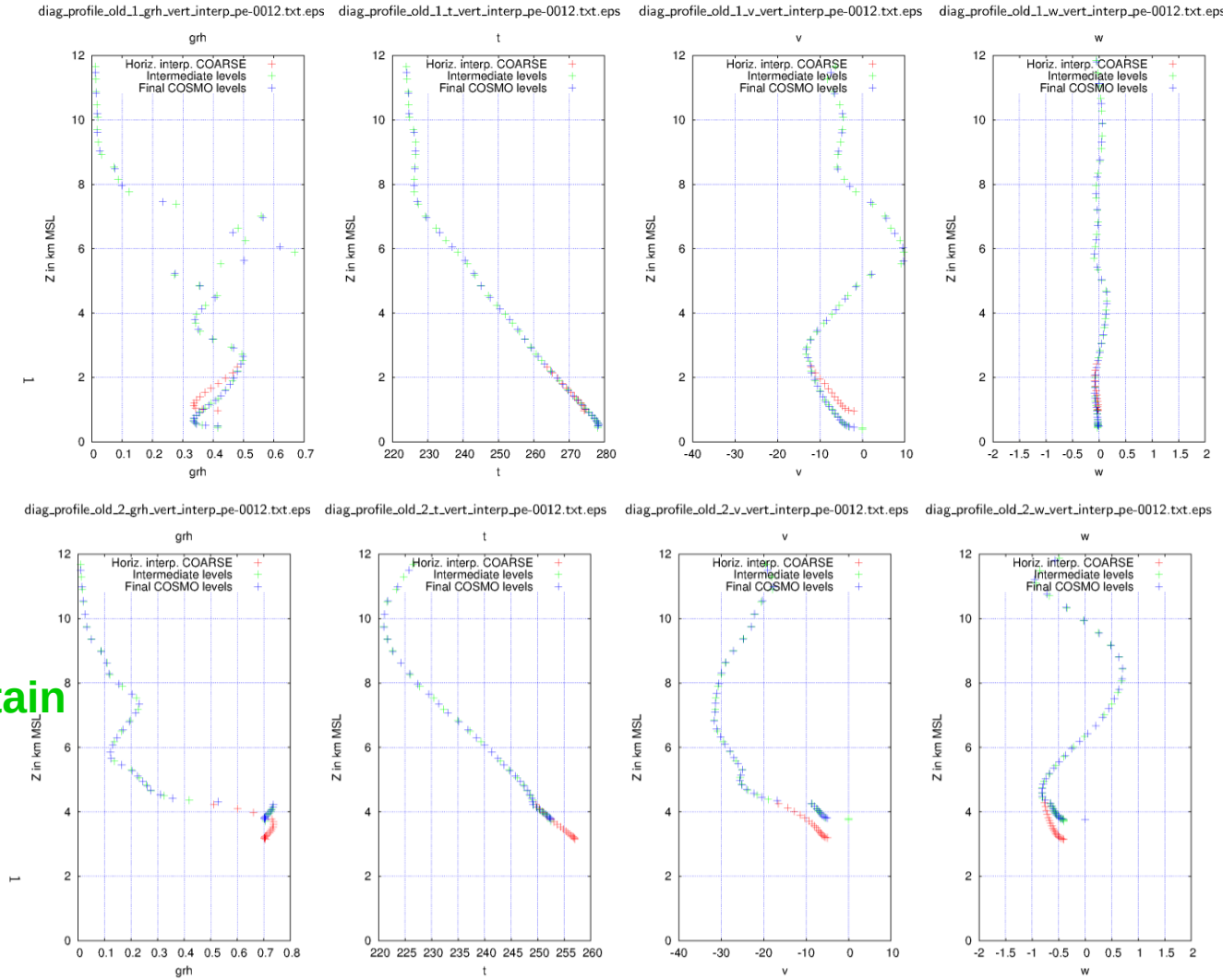


New profile methods for other vars

OLD

deeper valley

higher mountain



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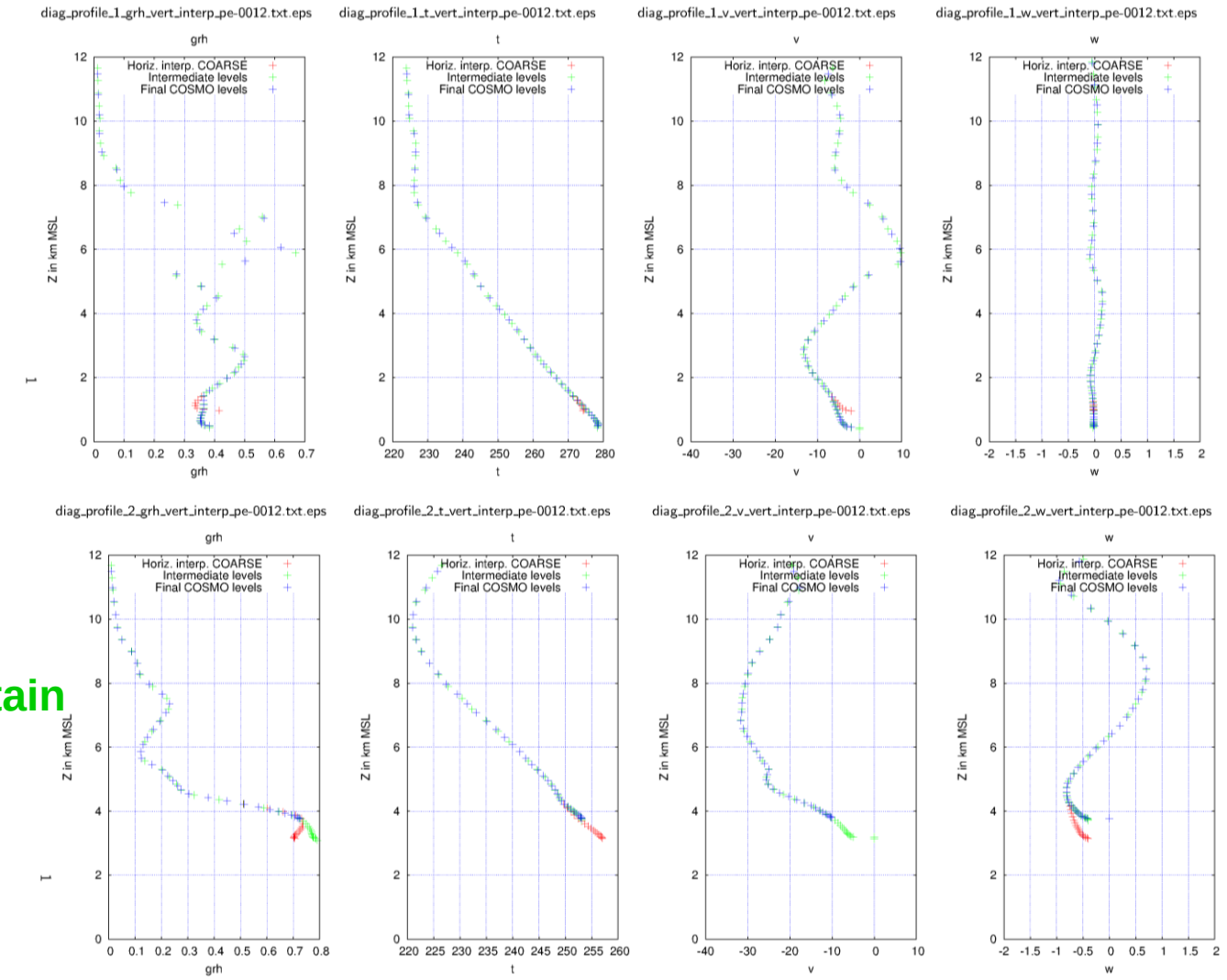
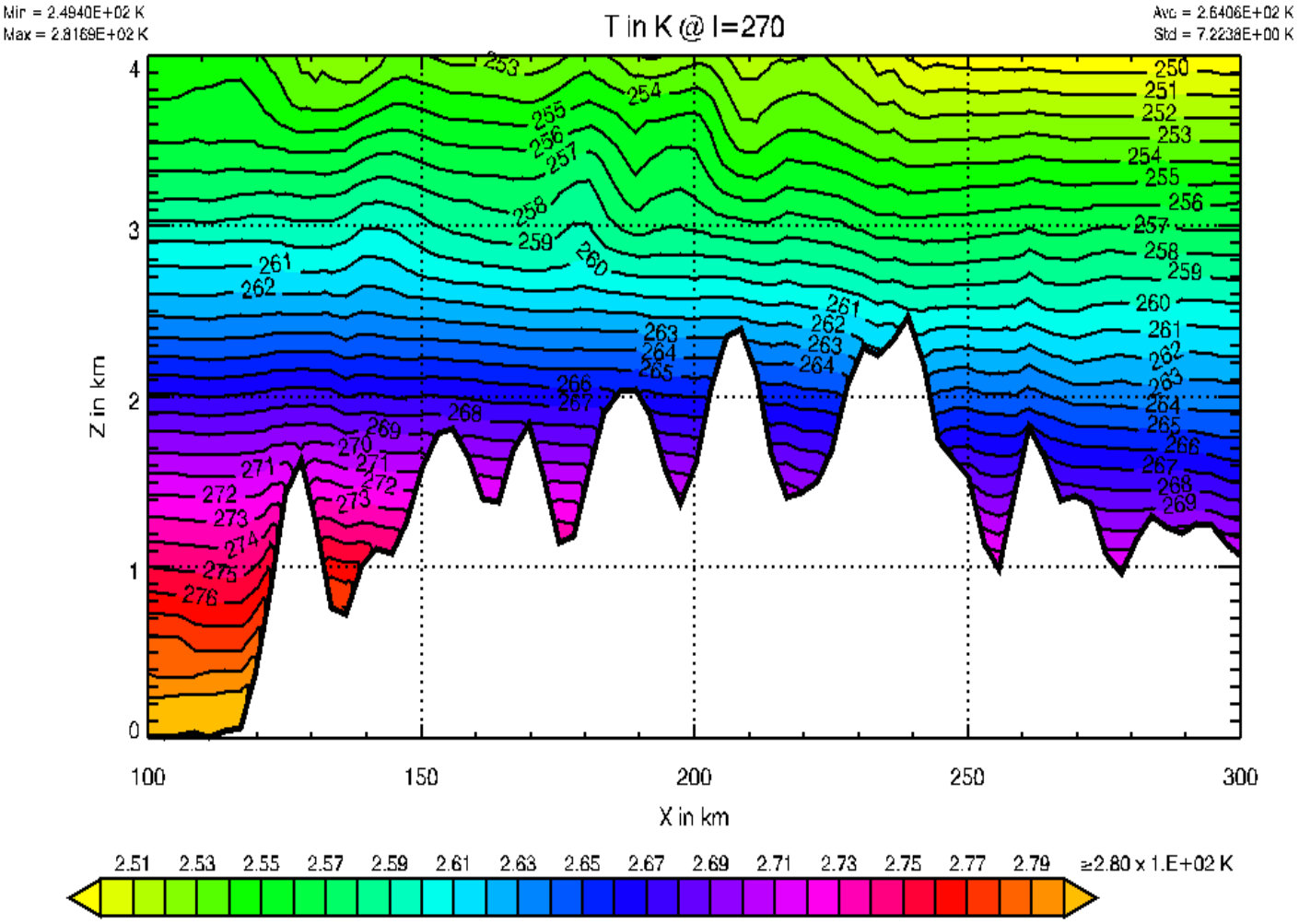


New profile methods: example for T



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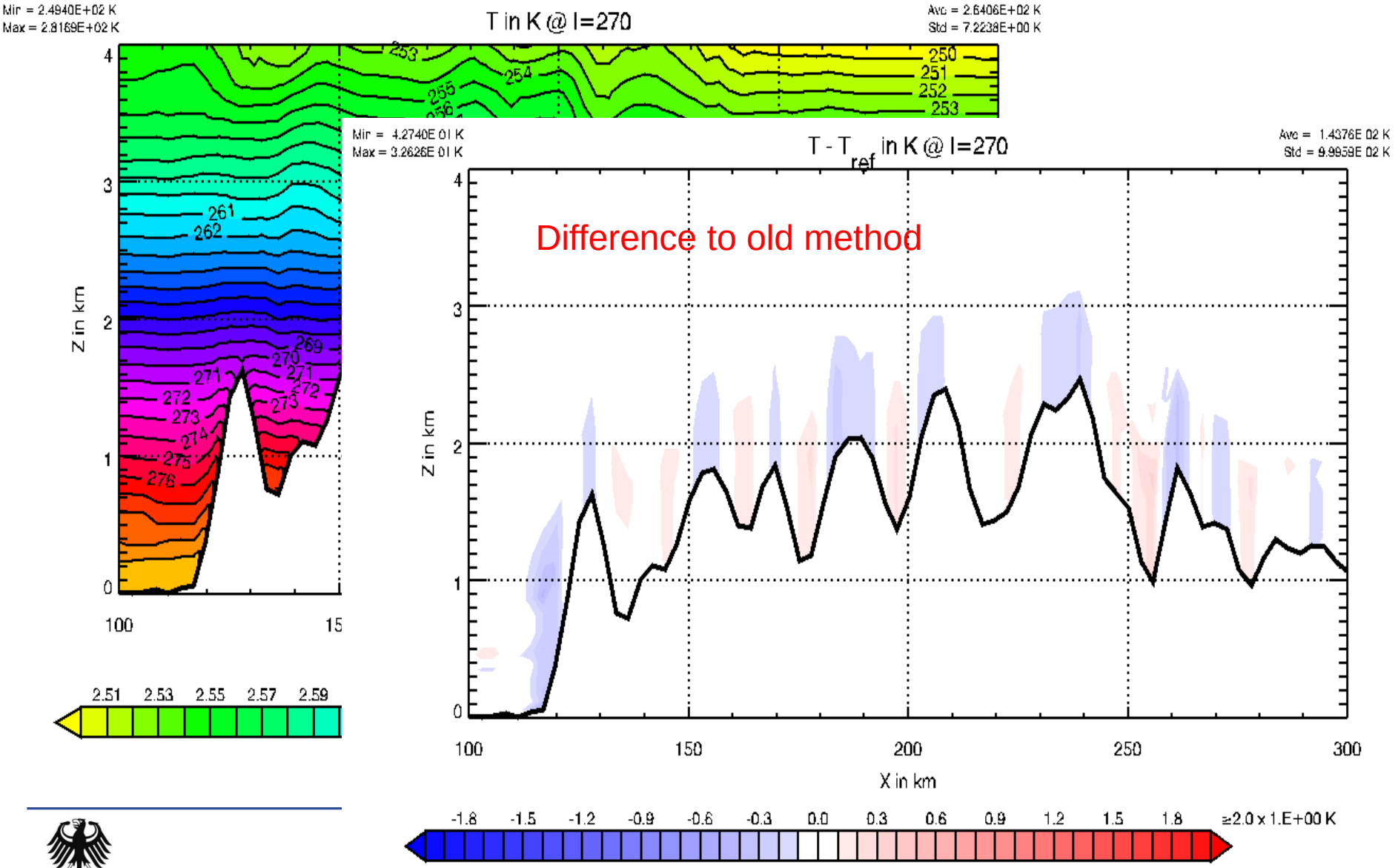
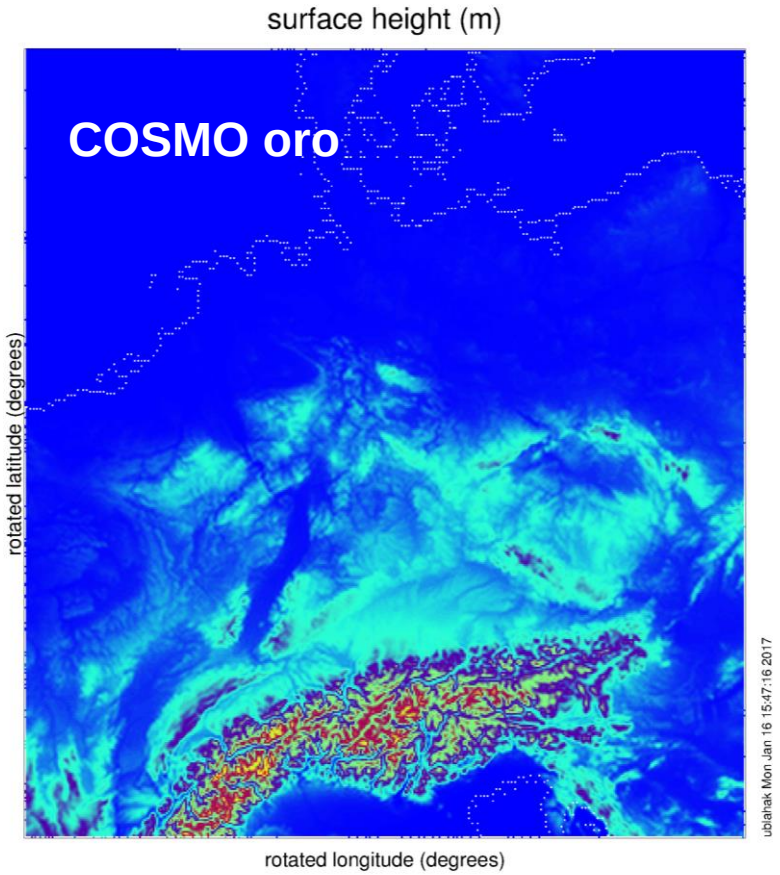


Soil temperature bug:



Range of surface height: -5.56387 to 3883.06 m
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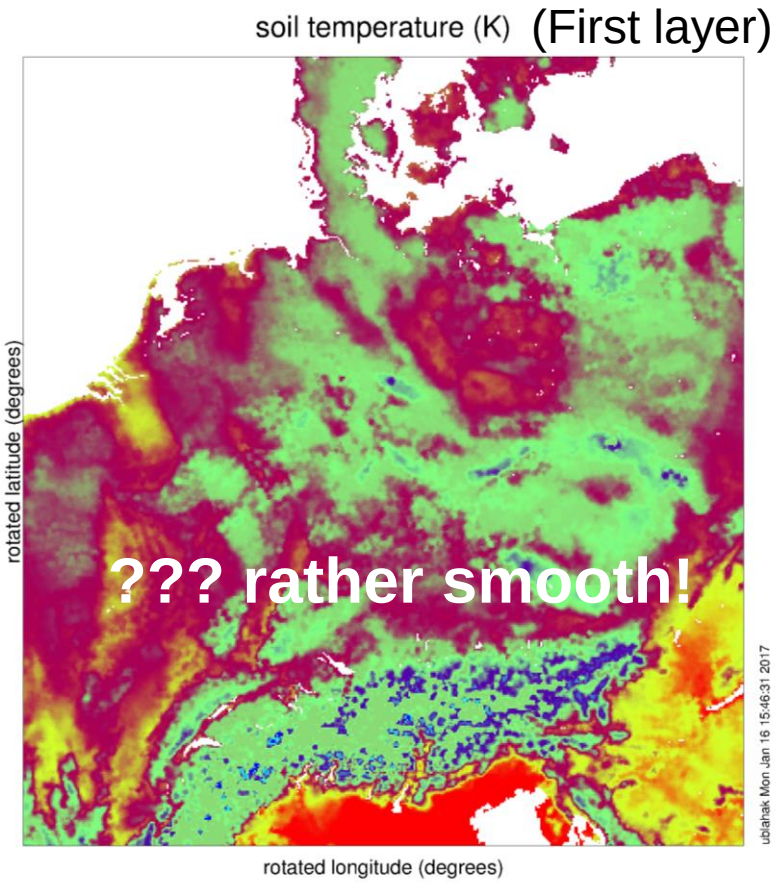
Frame 1 in File TEST_IEU2DE_2016042500_V2.03_test_ptest-itype2_simply-interpol-



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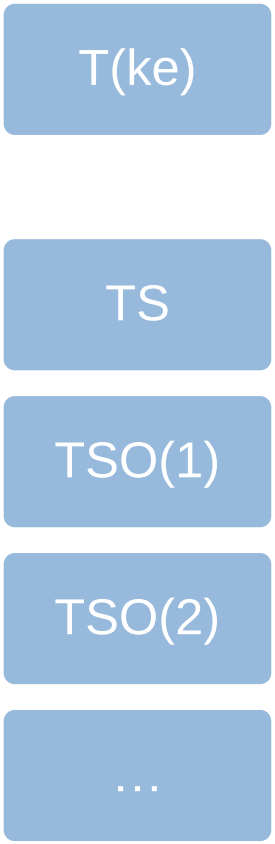
Current depth of soil layers: 0.005 m
Frame 1 in File TEST_IEU2DE_2016042500_V2.03_test_ptest-itype2_simply-interpol-wte

Soil temperature bug

➔ **Intended method** of adapting T_SO to new orography based on conserved differences to lowest atm. T (no vertical interp. for ICON/COSMO input!)



Coarse grid

Soil temperature bug

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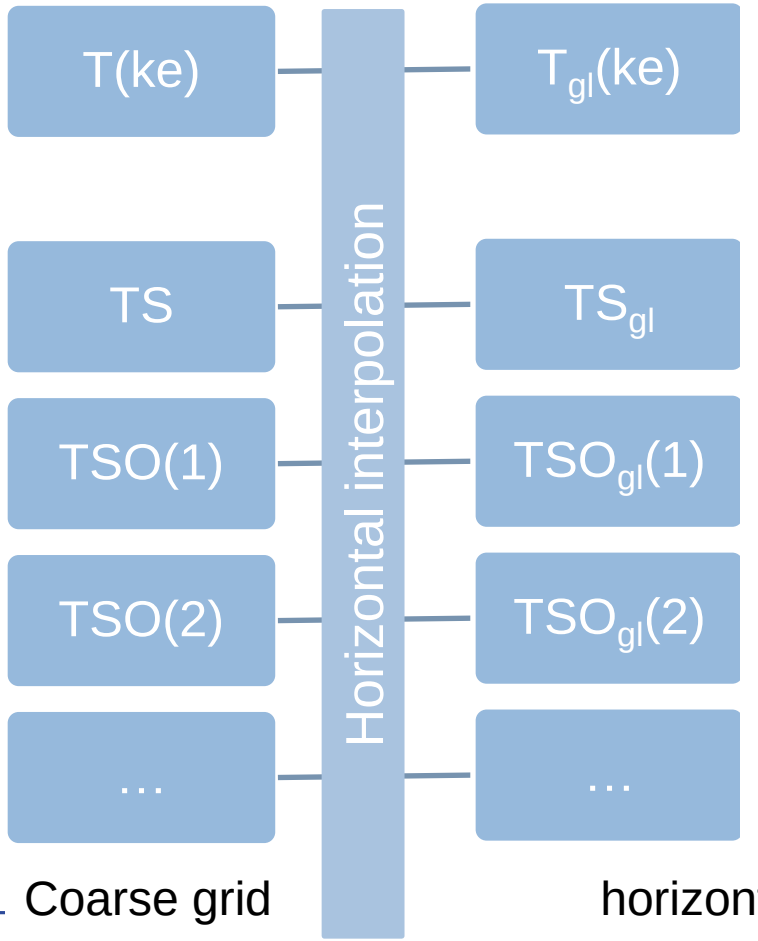

Coarse grid horizontal COSMO grid

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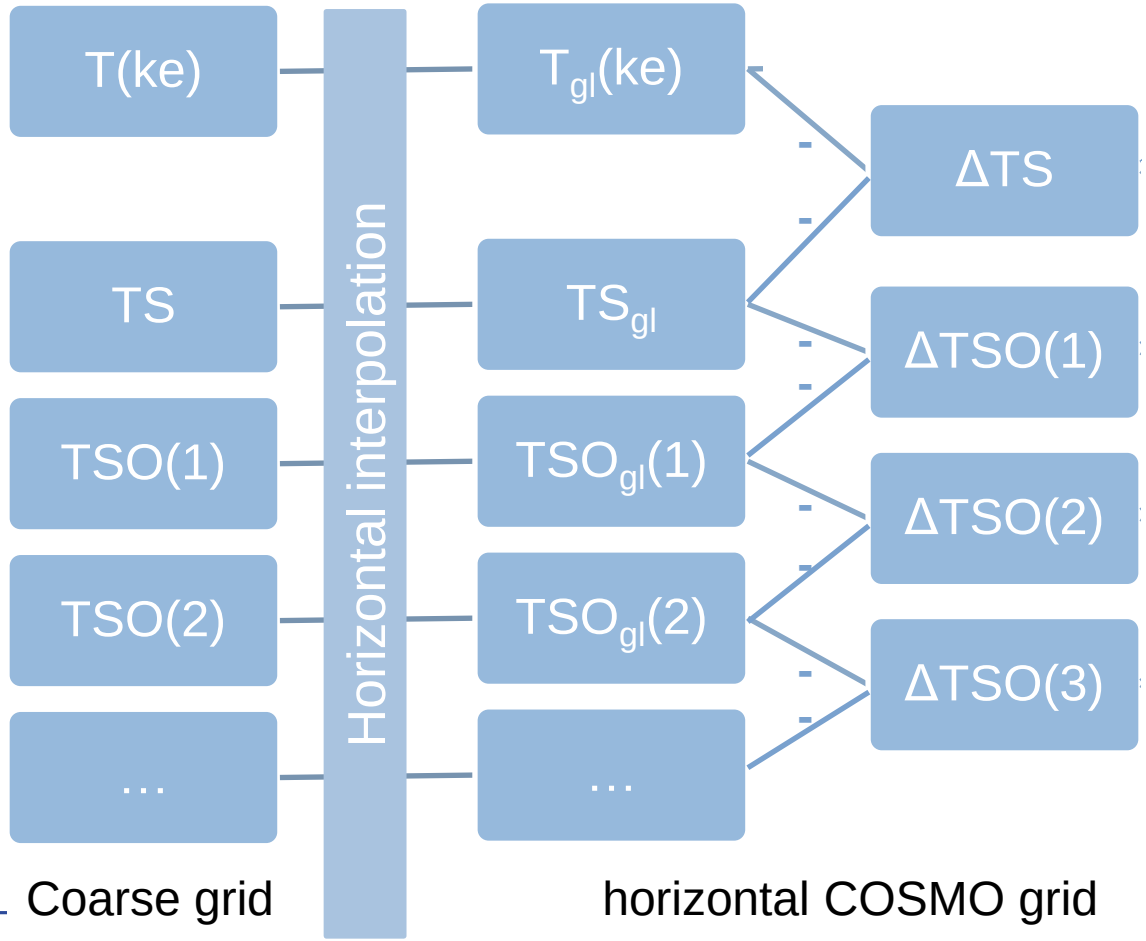

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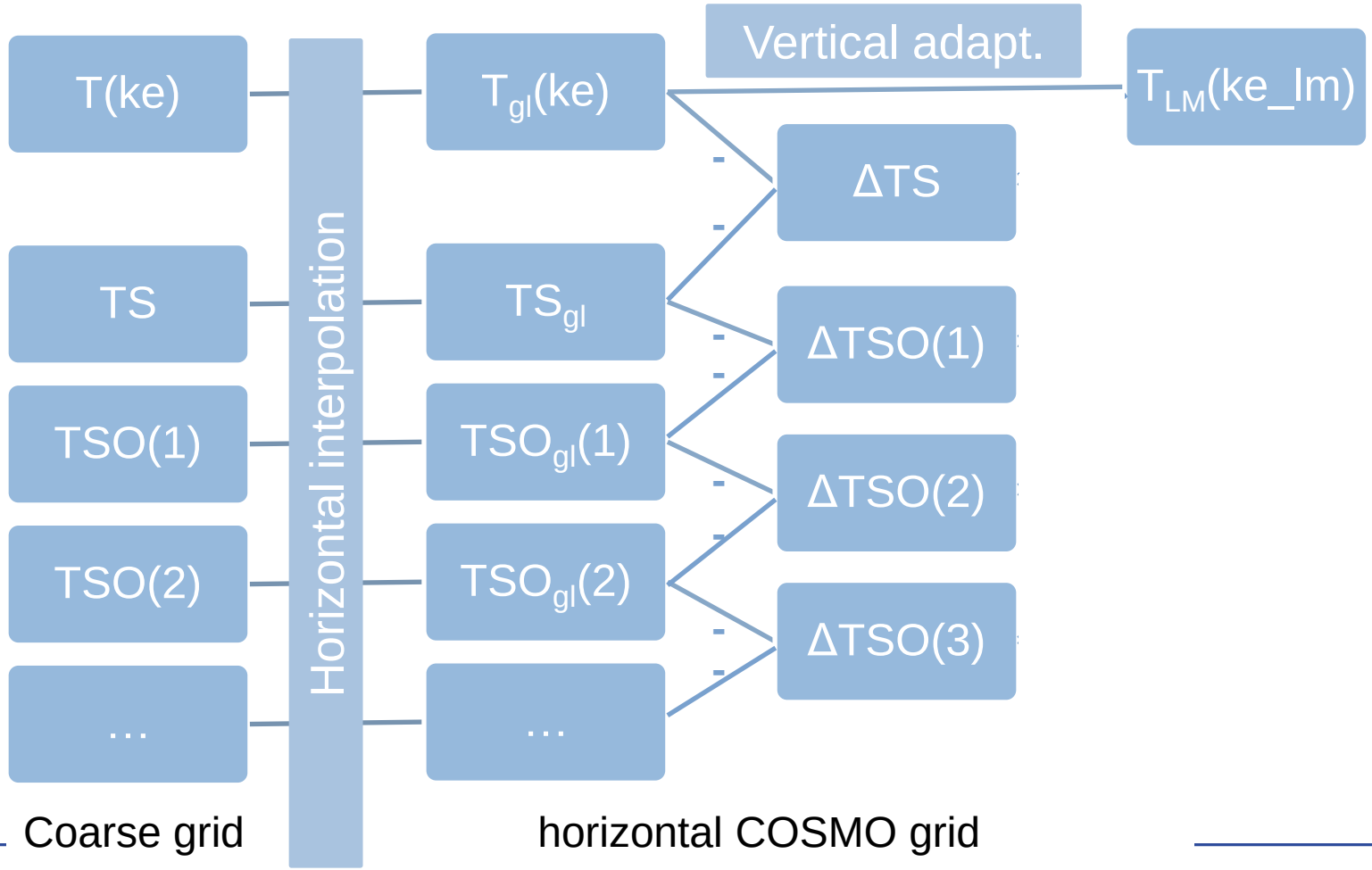

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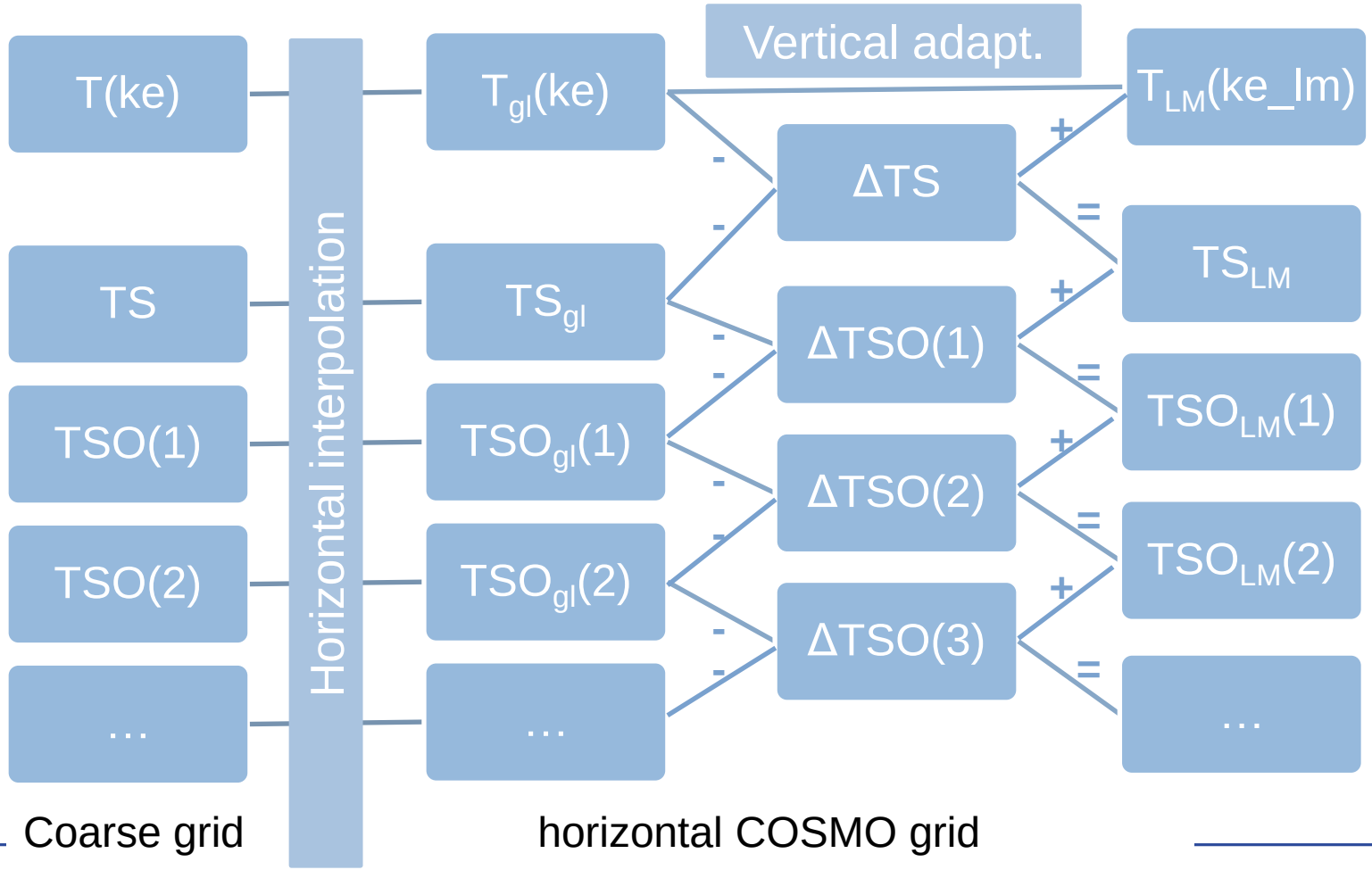
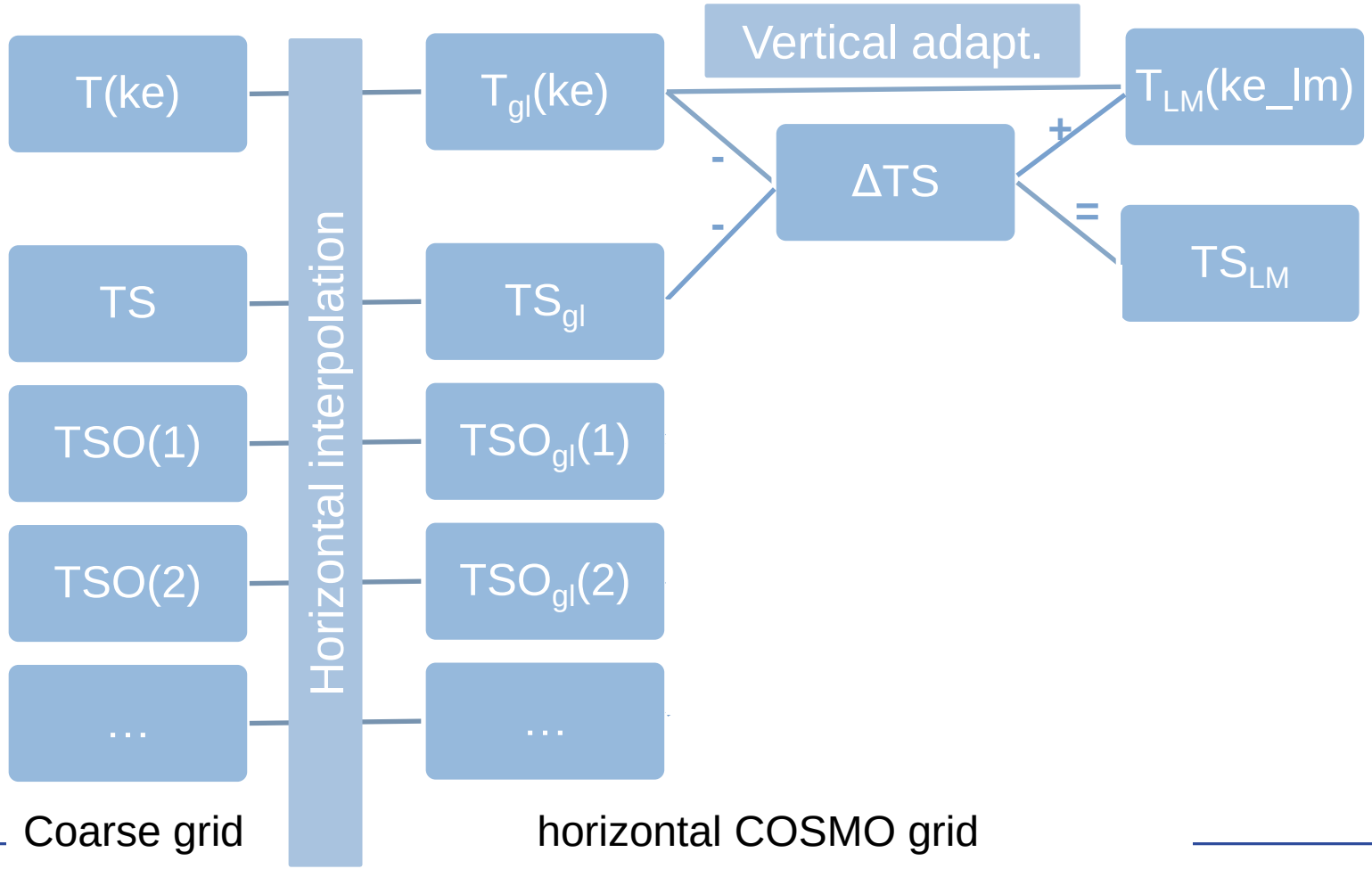


Soil temperature bug

➔ **Buggy method:**

Soil temperature bug

➔ **Buggy method: so far correct …**



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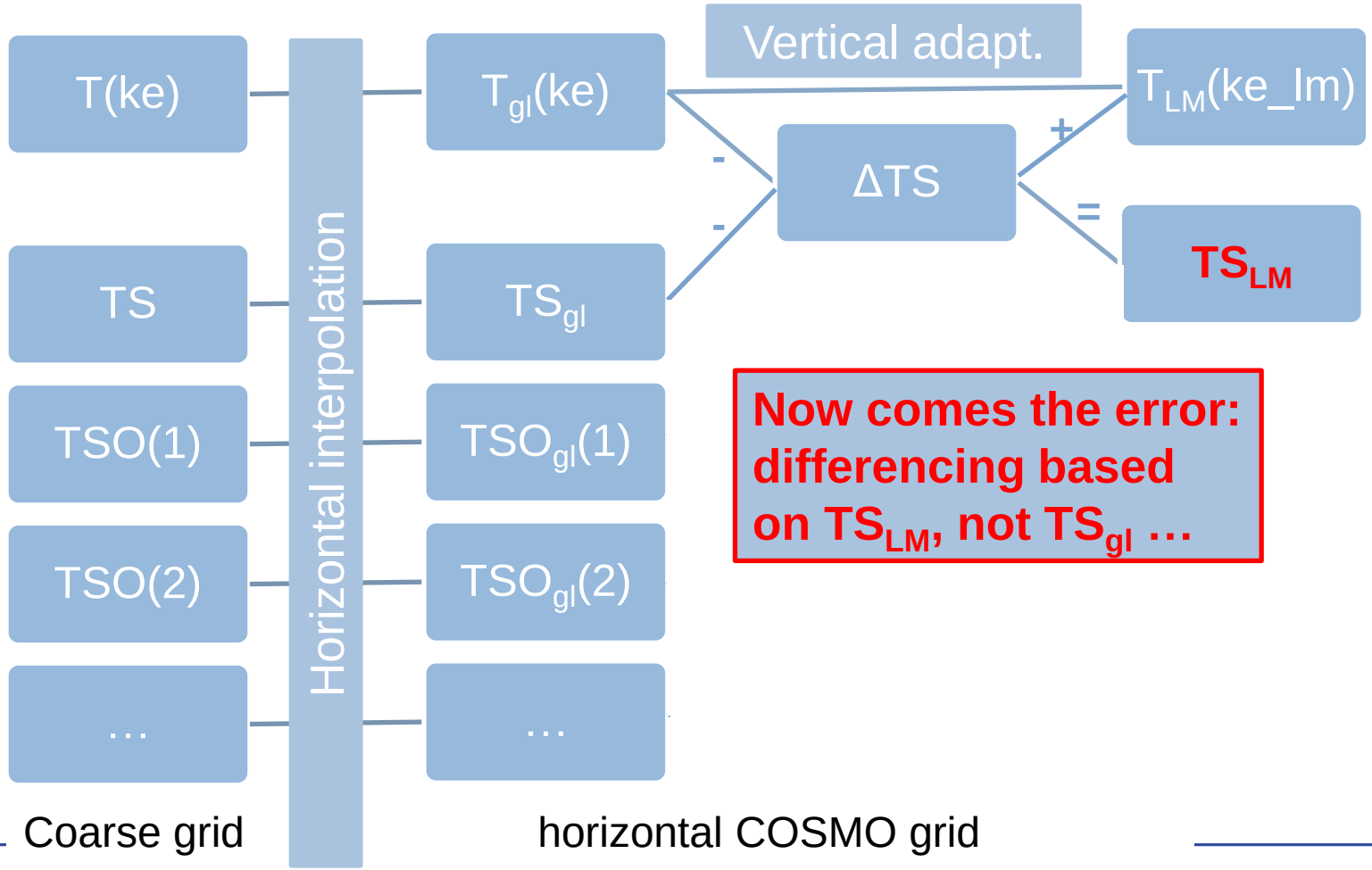

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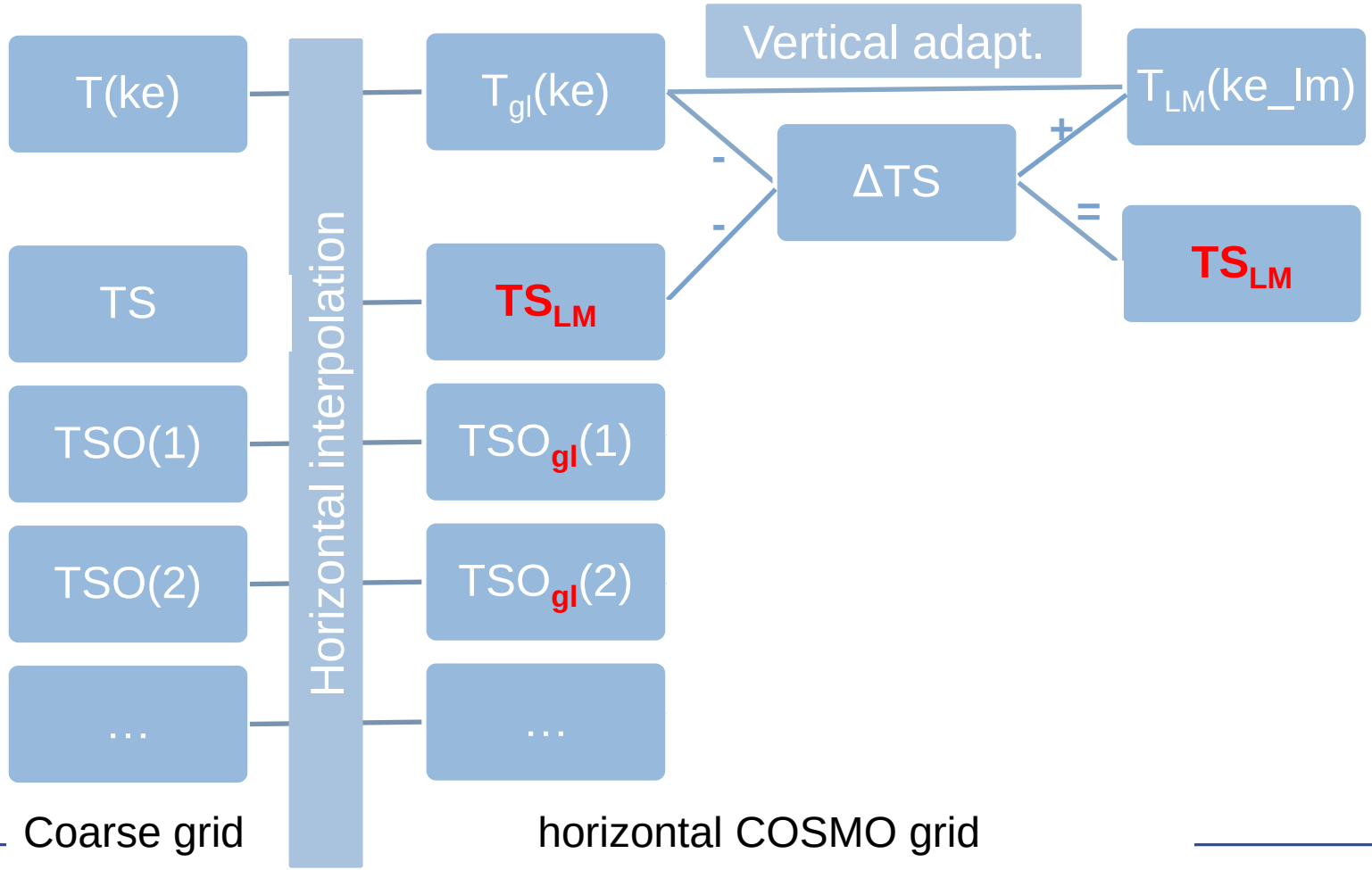

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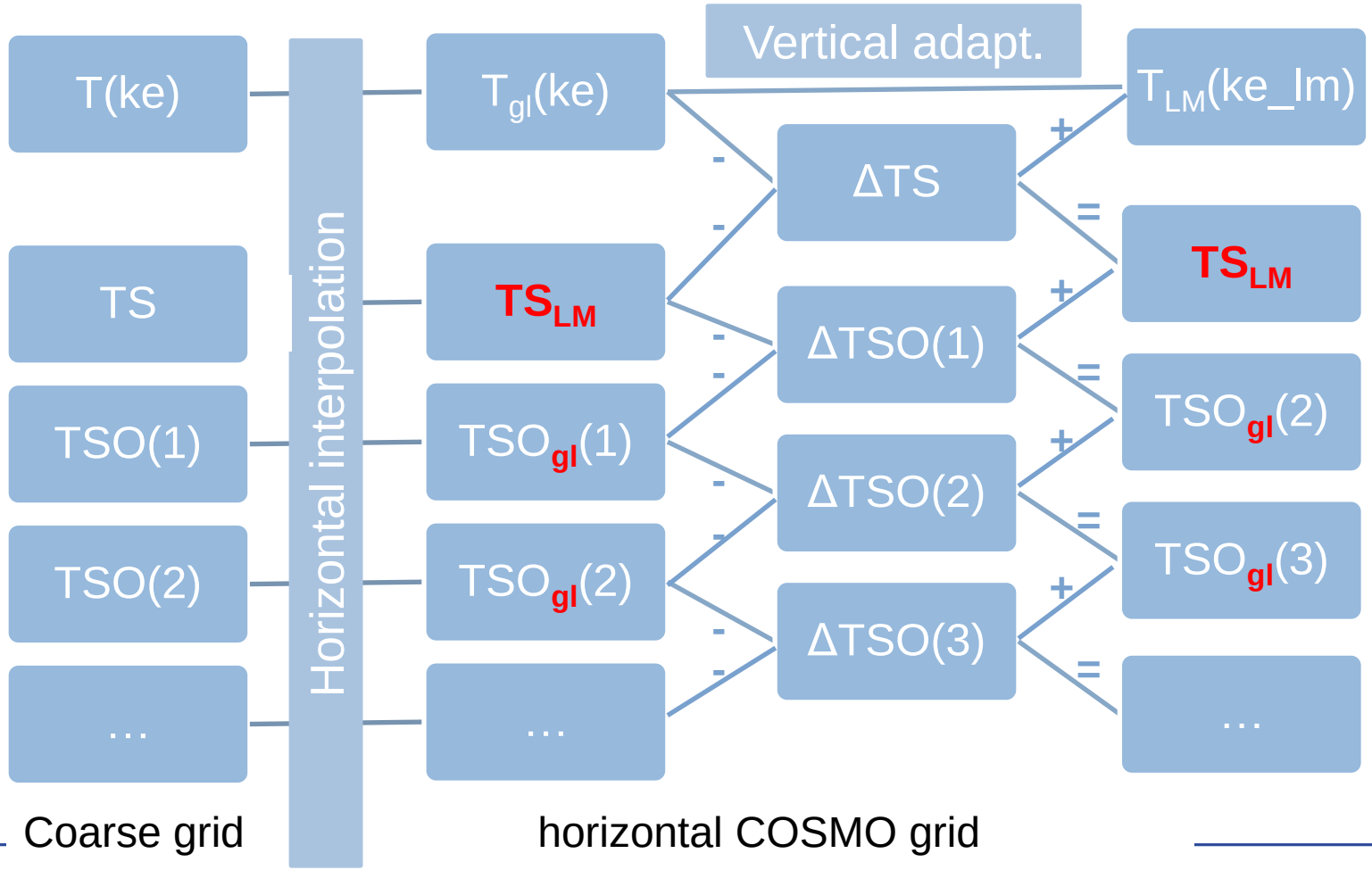

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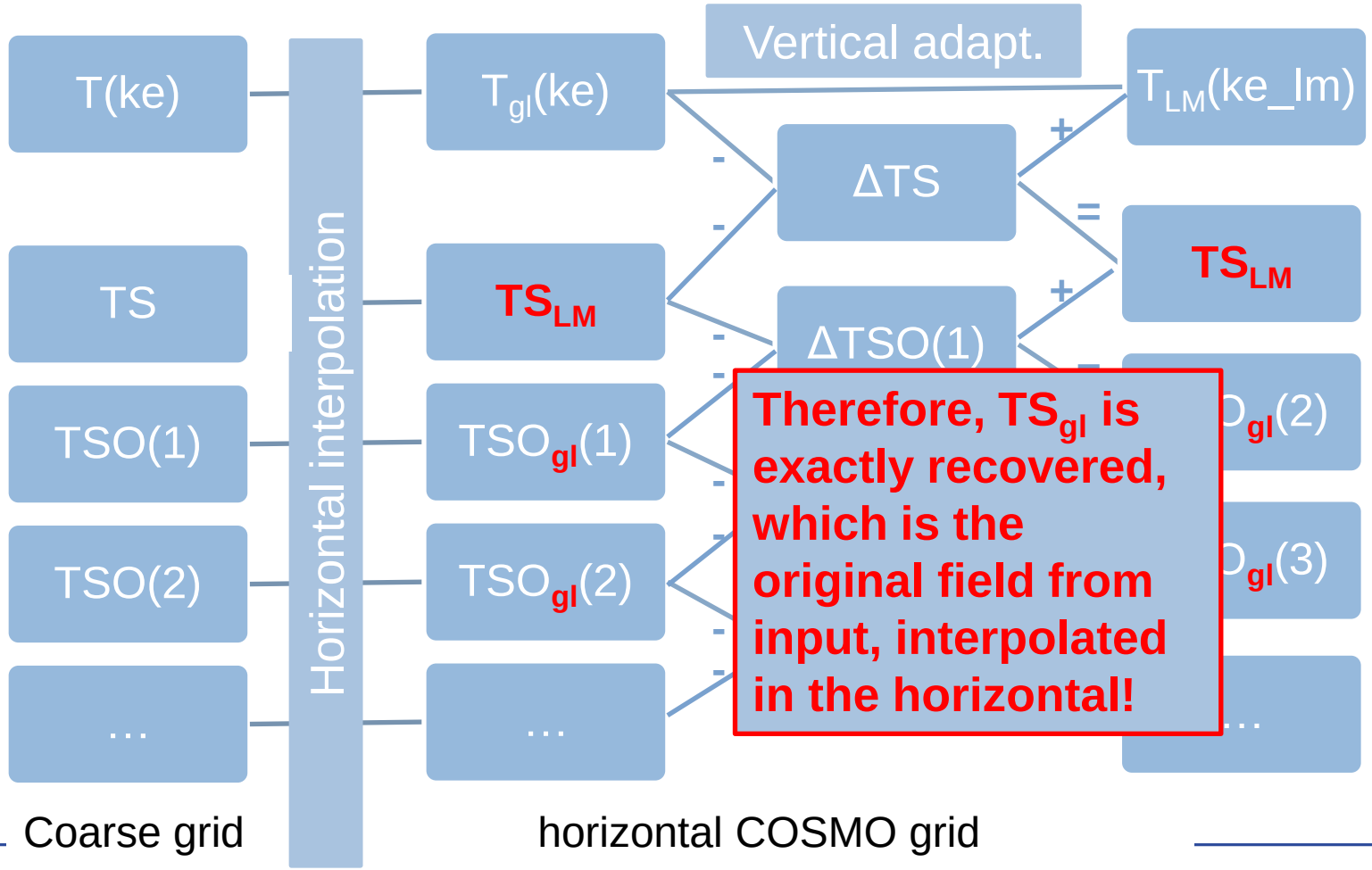

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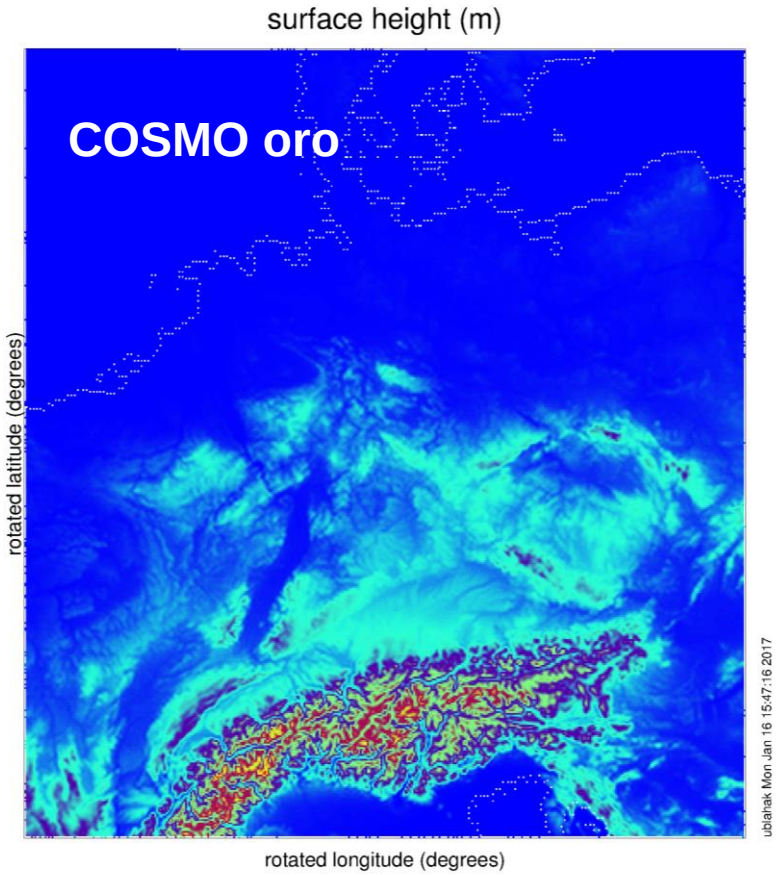

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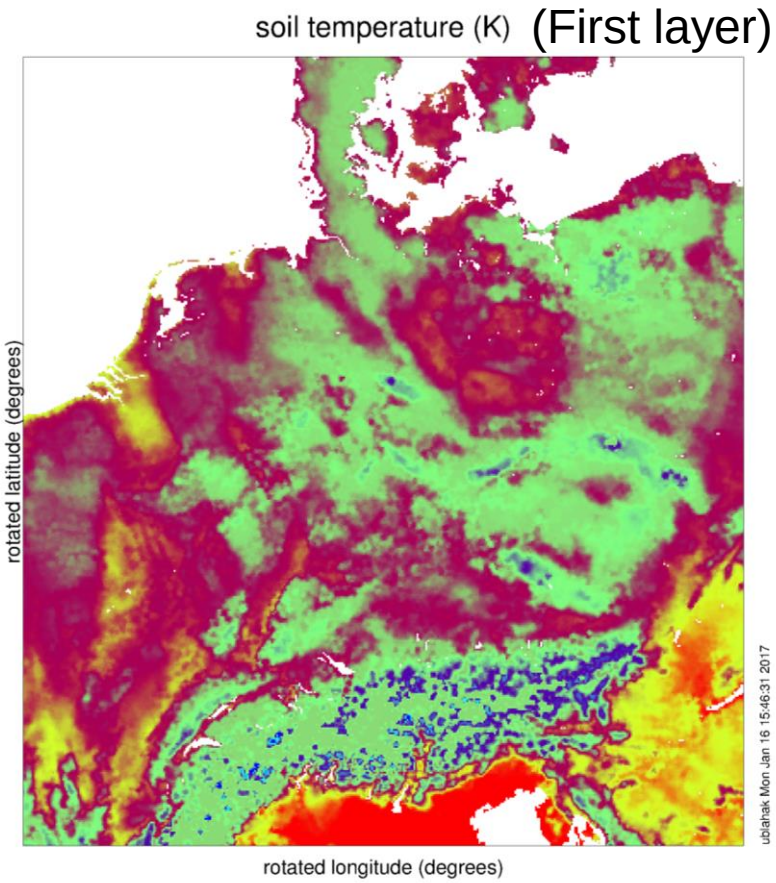

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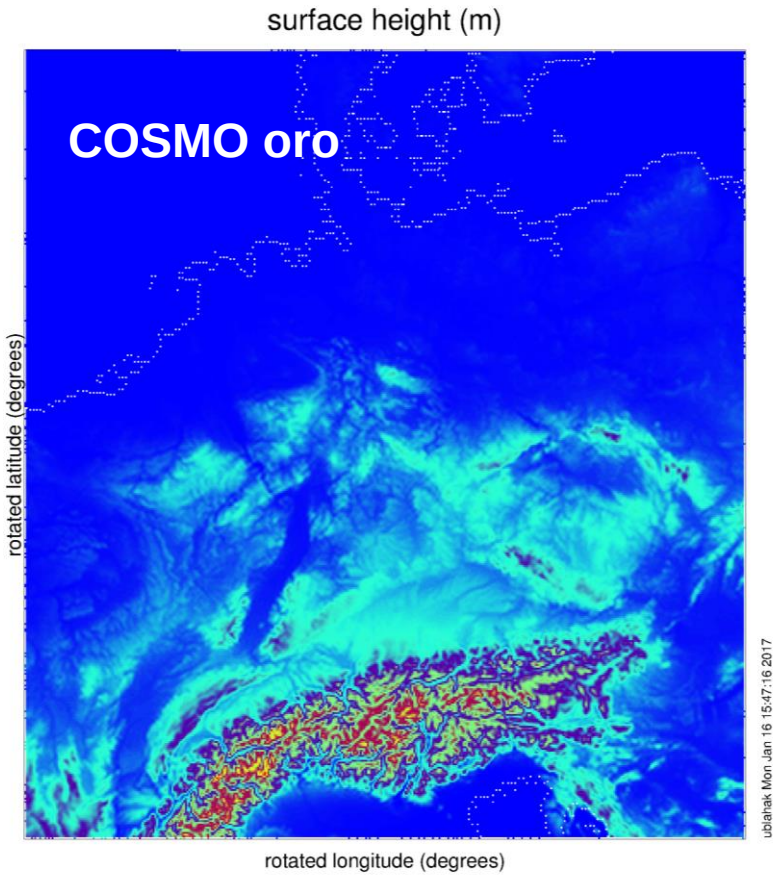
Current depth of soil layers: 0.005 m
Frame 1 in File TEST_IEU2DE_2016042500_V2.03_test_ptest-itype2_simply-interpol-wte

Soil temperature bug fixed



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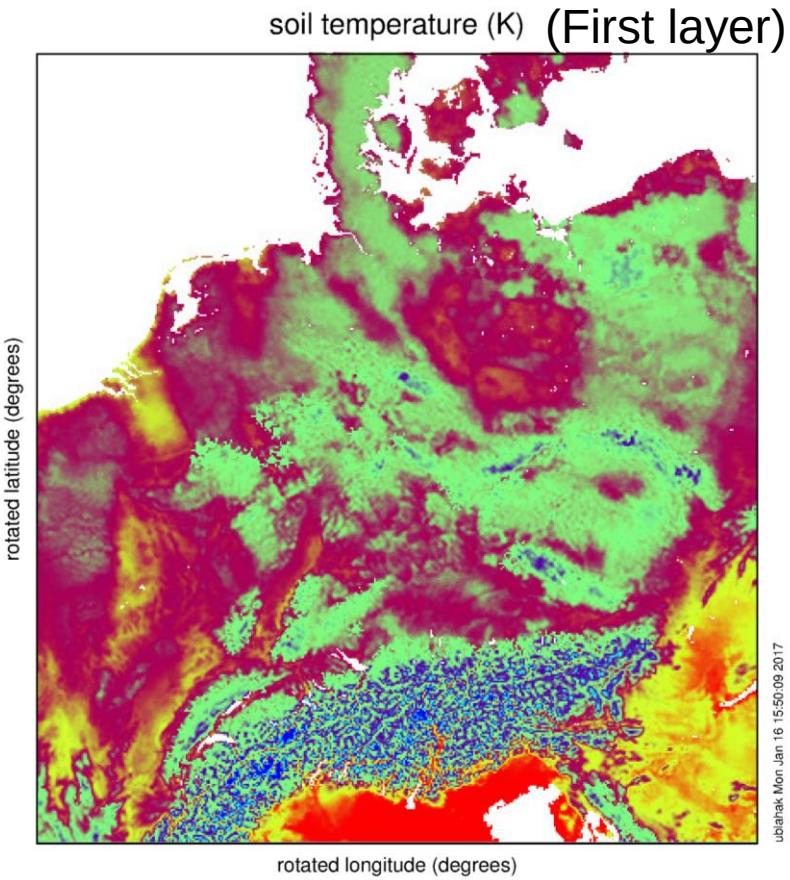

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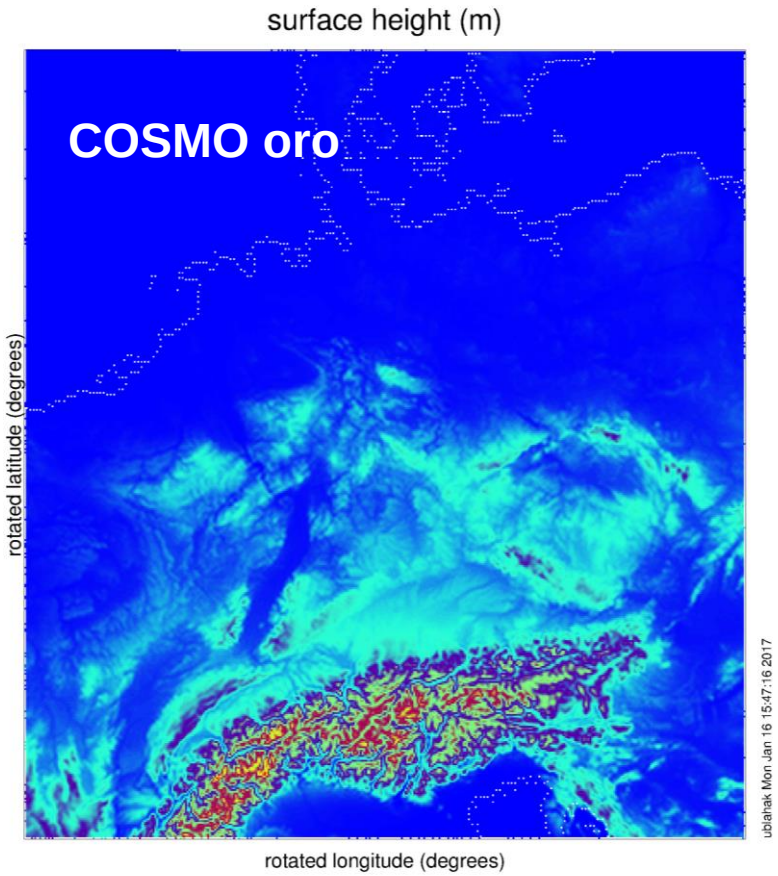
Soil temperature bug fixed



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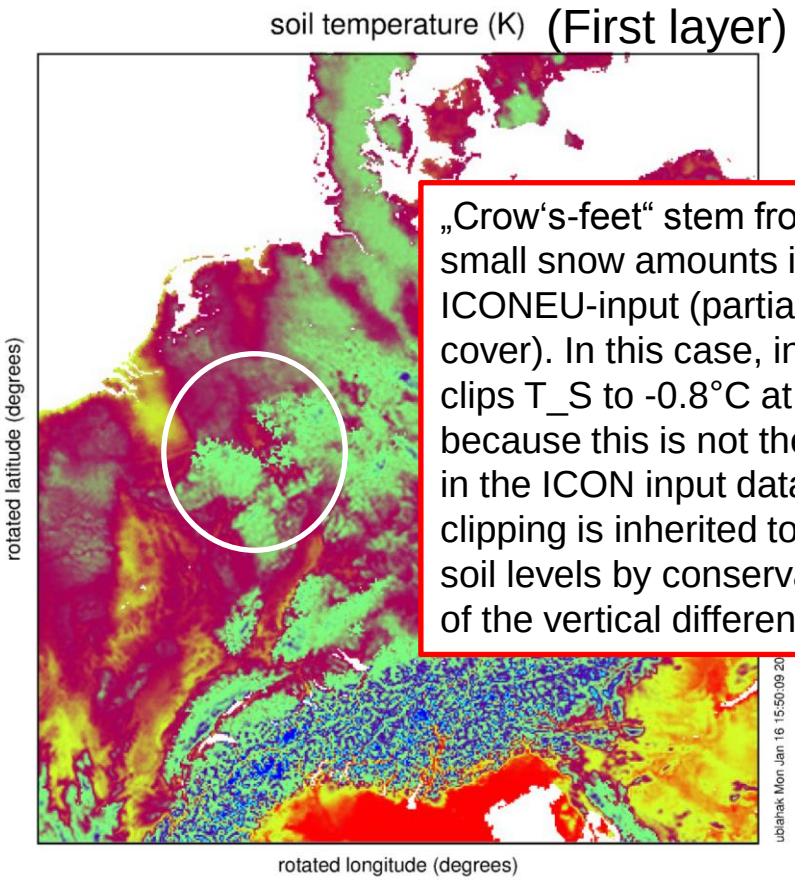

„Crow‘s-feet“ stem from small snow amounts in ICONEU-input (partial snow cover). In this case, int2lm clips T_S to -0.8°C at, and because this is not the case in the ICON input data, the clipping is inherited to the soil levels by conservation of the vertical differences!

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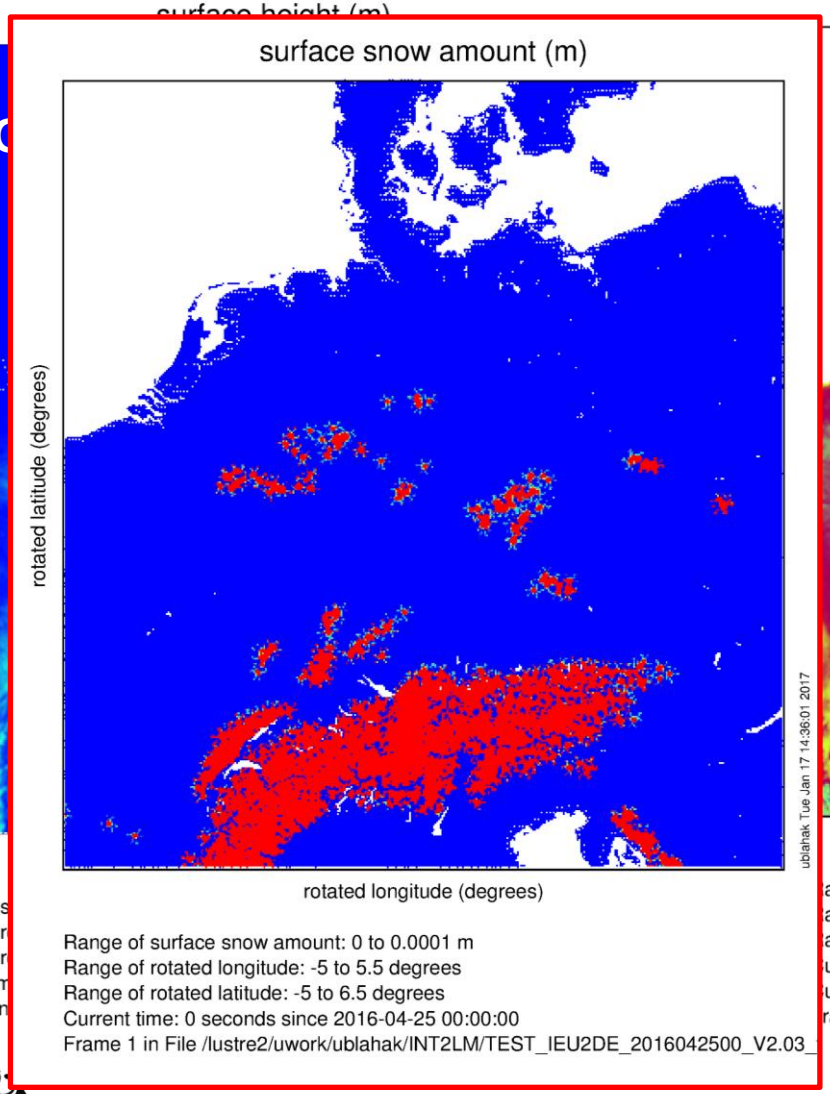

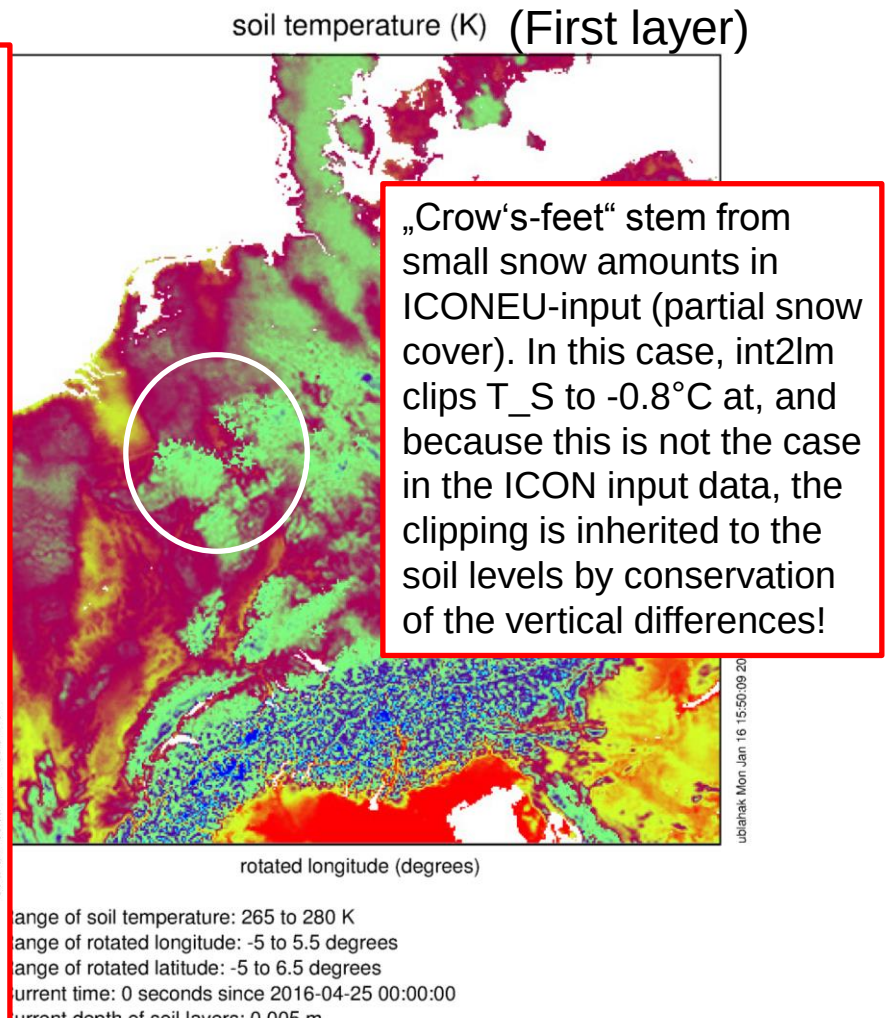

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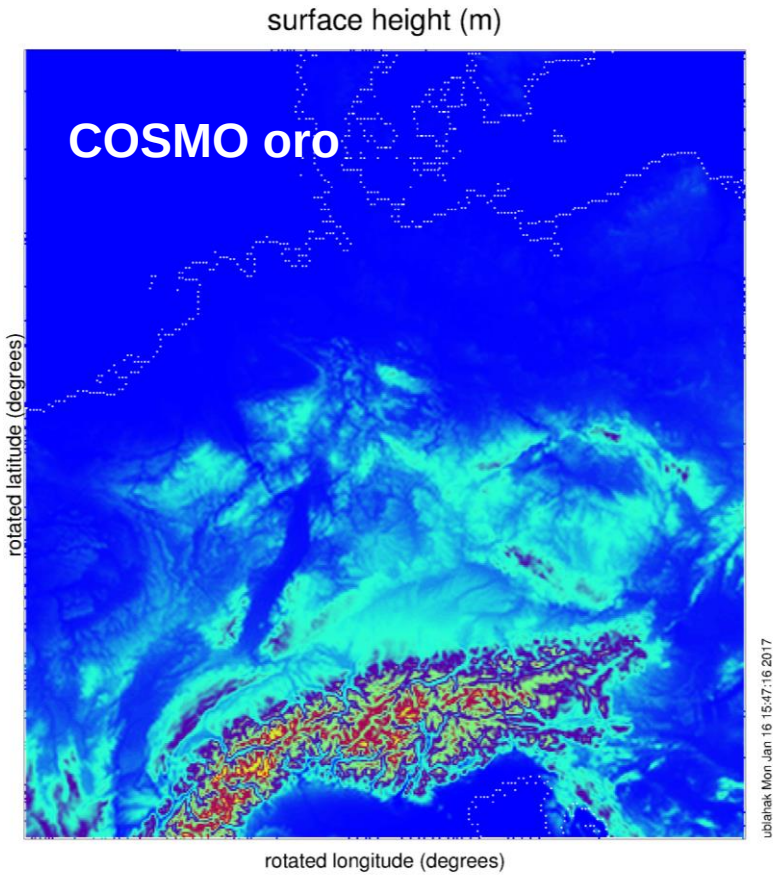
Clipping of T_S to -0.8°C removed



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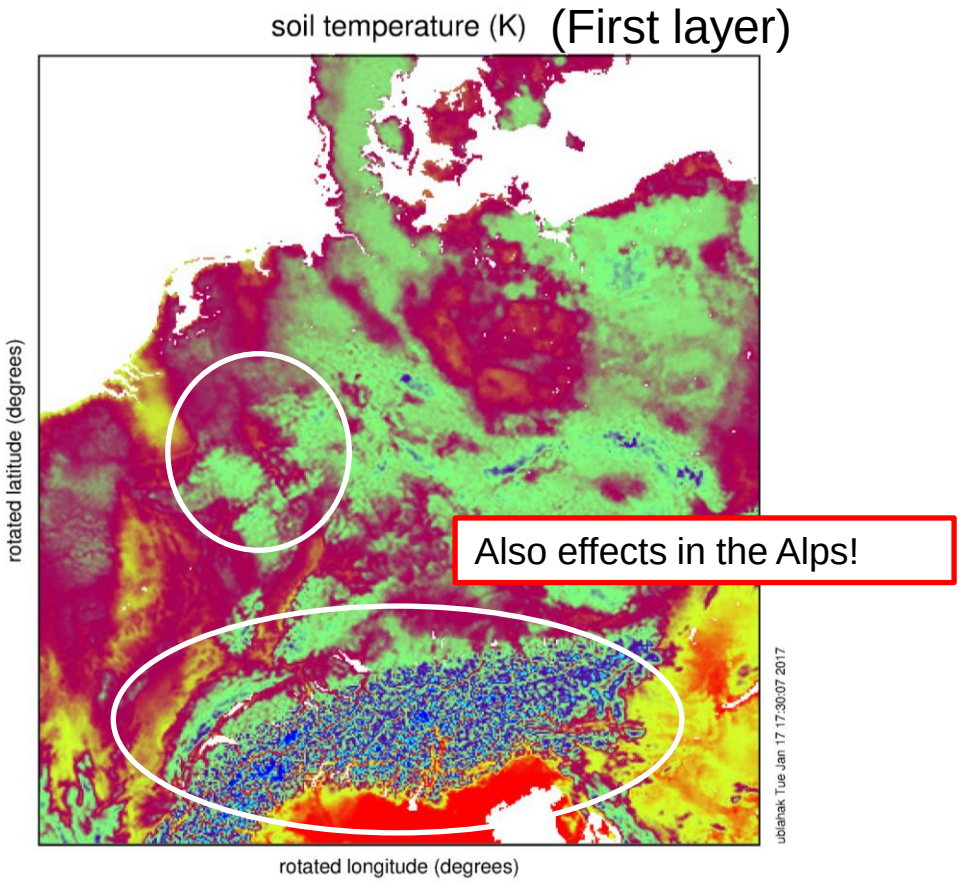

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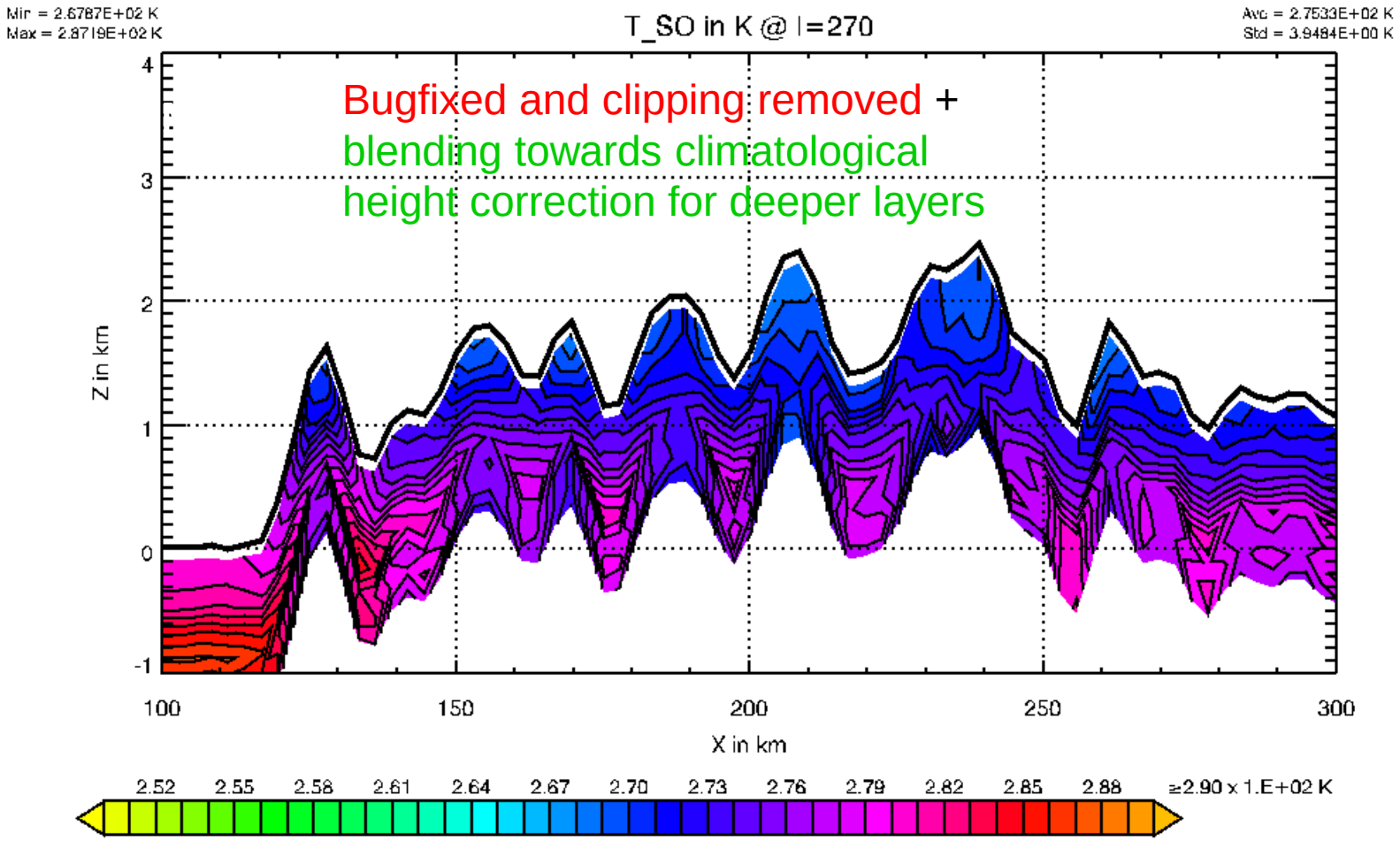
Soil temperature bugfixed and blending to climatological height correction

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



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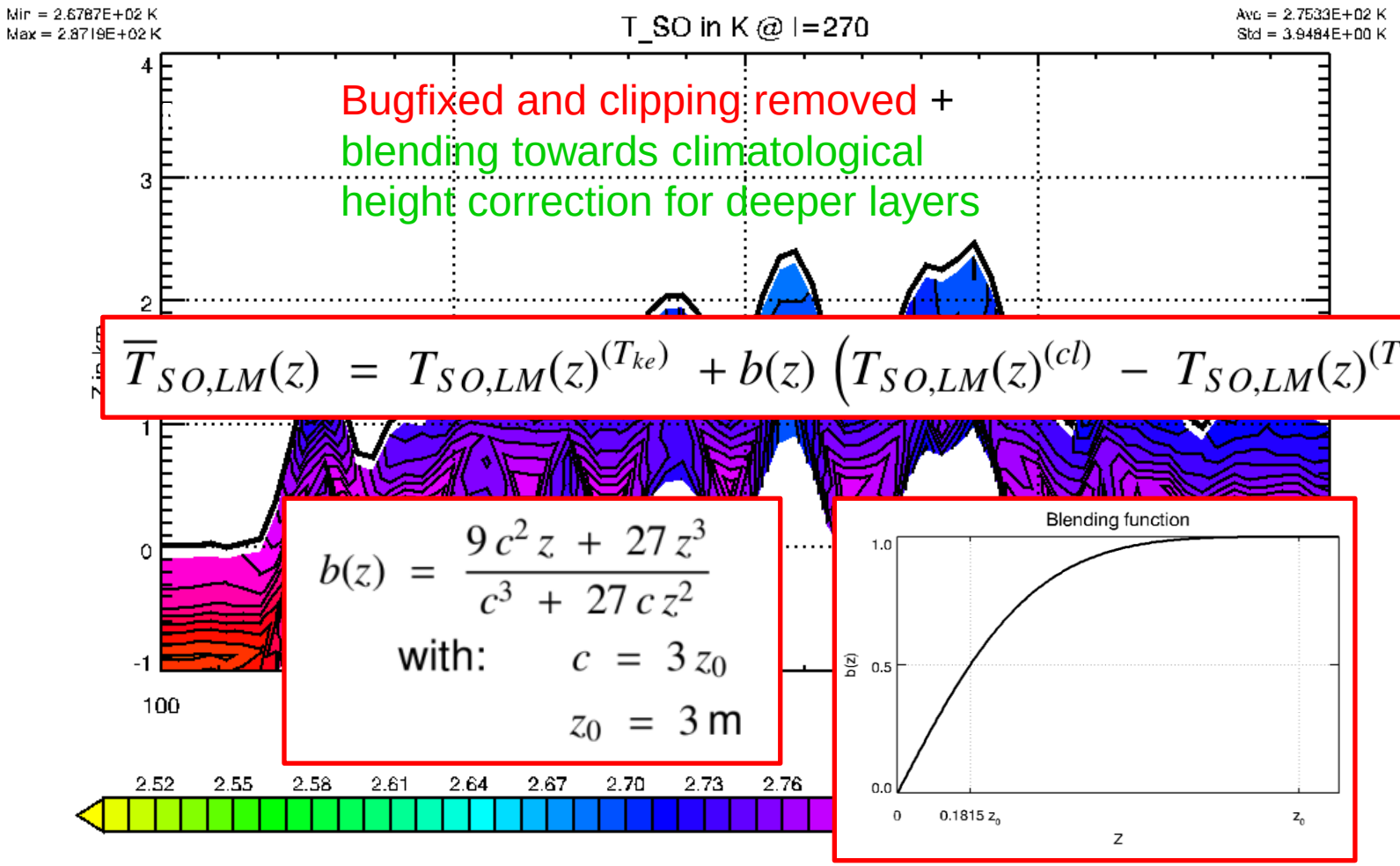

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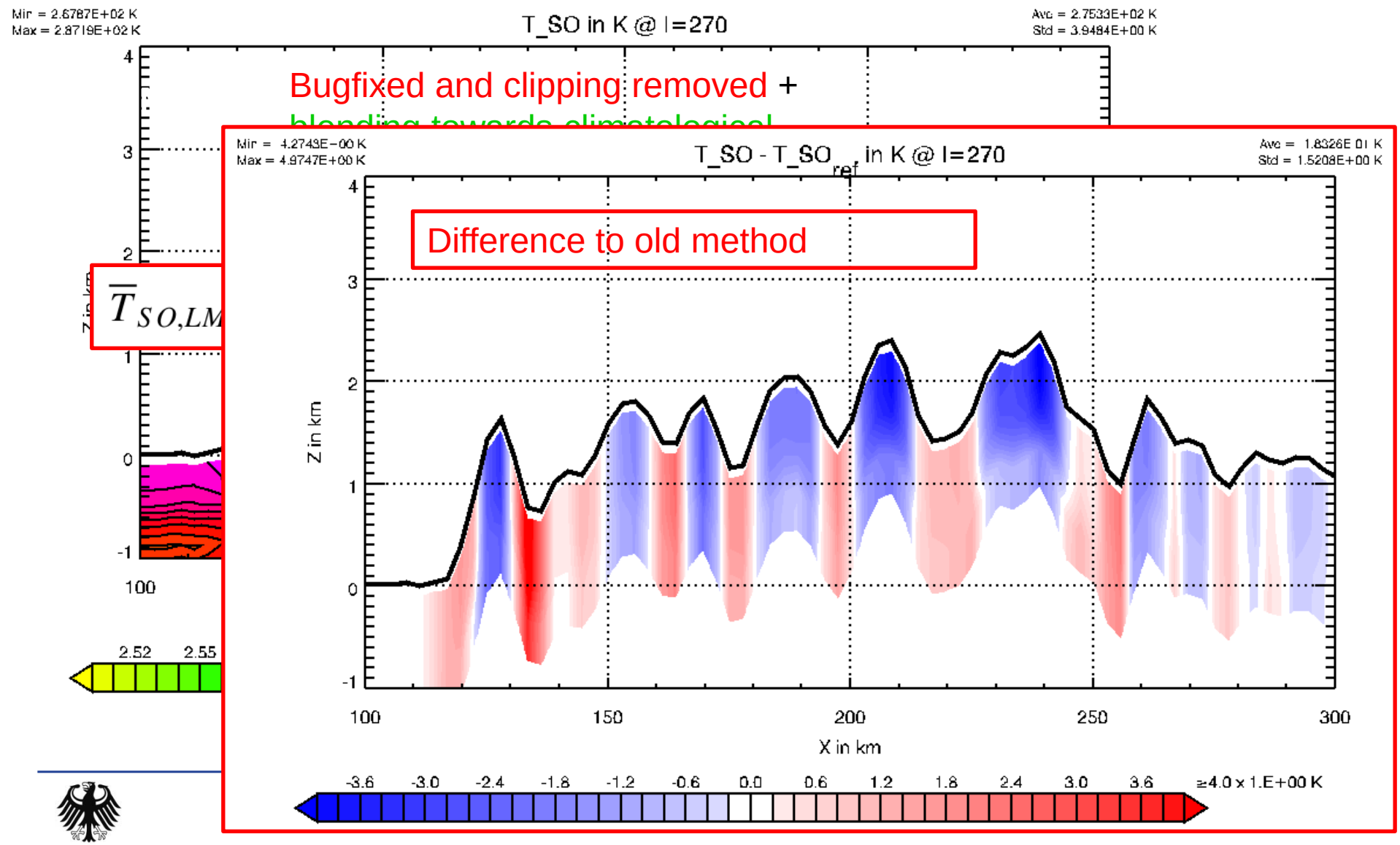

New namelist parameters (/CNTRL/)

PARAMETER	DEFAULT	TYPE	MEANING
itype_profiles_vert_interp	2	INT	1 = old method 2 = new method
itype_balance_pp	2	INT	1 = old method (for Leapfrog) 2 = new method (for RK-core)
itype_fast_waves_lm	2	INT	If itype_balance_pp = 2: 1 = „old“ RK fast waves solver 2 = „new“ RK fast waves solver (SC-form)
lmultlay_deepsoil_clim_hcorr	.TRUE.	L	Whether or not to blend the T_SO height adaption from conservation of vertical differences to the T_{ke} near the surface towards a climatological height correction (-0.007 K/m) at deeper layers.

Eliminated: lbalance_pp (because this has to be done always!)

Summary

- **Non-hydrostatic input models:**
  - Pressure now spatially much more smooth over mountains
    - less initial noise if COSMO starts from interpolated analysis
    - less noise at the boundaries
  - New methods for vertical interpolation of the other 3D fields also lead to a reduction of the initial noise
  - Blending to terrain-following W near the surface also reduces noise
- **ICON input:**
  - Now soil temperature T_SO in initial data is truly adapted to the COSMO orography and near-surface T
  - Option to blend T_SO from pure T_{ke} –difference conservation near the surface to a pure climatological height correction at larger depth