

Status of the tile approach within the COSMO model

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Motivation

- One profile of temperature and moisture in the soil for snow covered and snow-free parts → by any partial snow cover the soil temperature can not exceed 0°C (equivalent to instantaneous horizontal heat transfer)
- LES (Mironov & Sullivan, Stoll & Porte-Agel) show enhanced mixing in horizontally-heterogeneous SBL as compared to horizontally-homogeneous SBL

Tiled Surface Scheme within the 3d COSMO model

Number of tiles should not be large (computational efficiency)

Surface types with the largest possible difference in the surface temperature (→ in fluxes) should be chosen

At first:

- **lake/land**

(the largest difference in the heat capacity → thermal inertia)

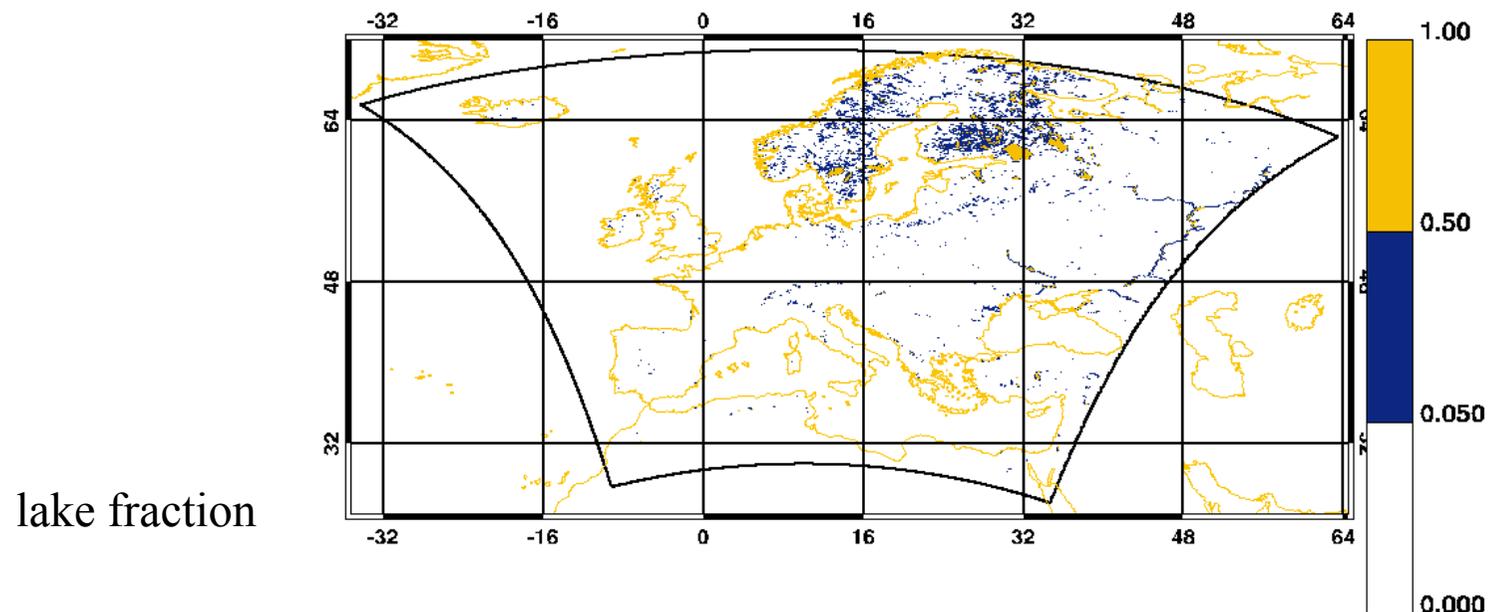
- **snow/snow-free**

(the largest difference in the heat conductivity)

Tiled Surface Scheme within the 3d COSMO model: lake/land

Grid-scale lakes (lake fraction > 0.5) are already treated within the COSMO with Flake model;

however, numerous subgrid-scale water bodies (lake fraction < 0.5) are ignored:



Parallel experiment 8330 is set up
(COSMO-EU domain, V4_18, running since 01.04.2011)

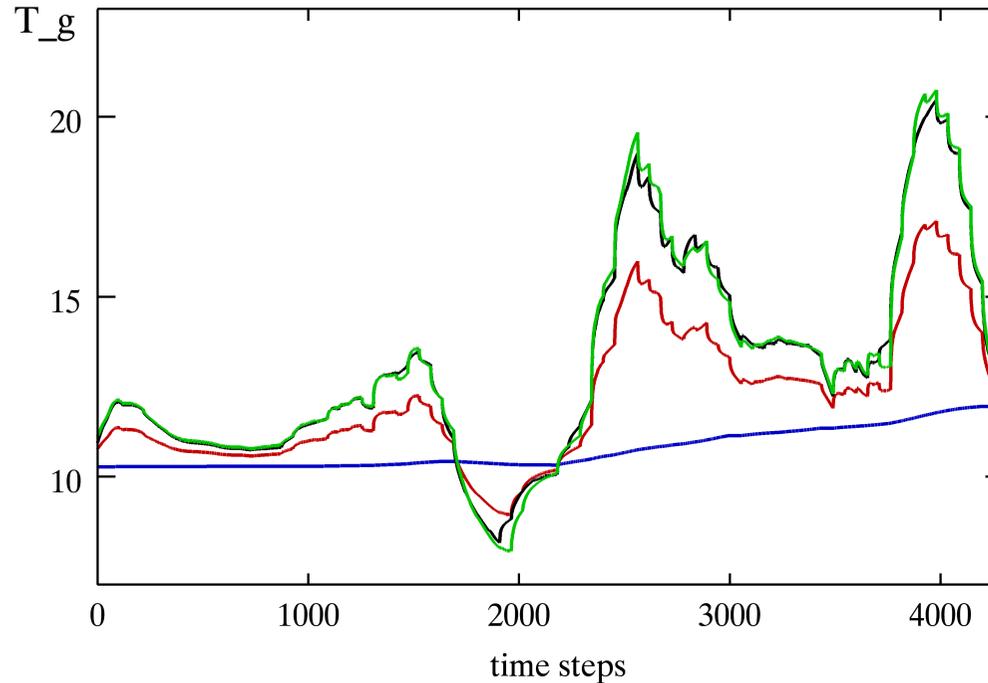
with 2 tiles: lake/land ($ns_stat = 2$, $ns_snow = 0$)

Tiled Surface Scheme within the 3d COSMO model: lake/land

COSMO-EU
forecast

started
16.05.2011
at 12 UTC

grid point
(293,387)
38% lake,
62% land



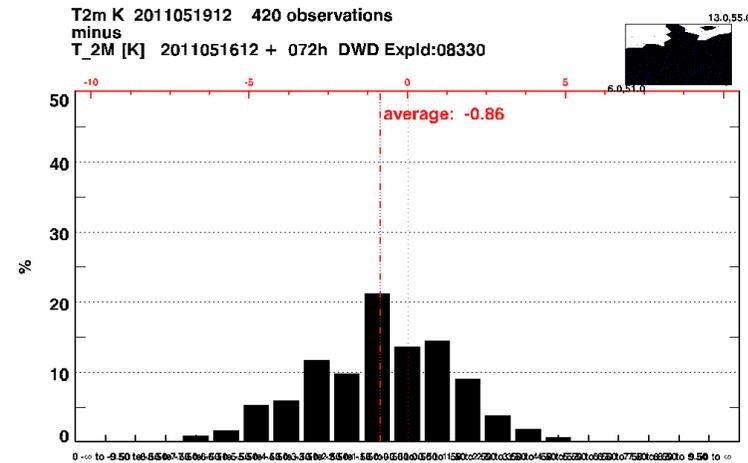
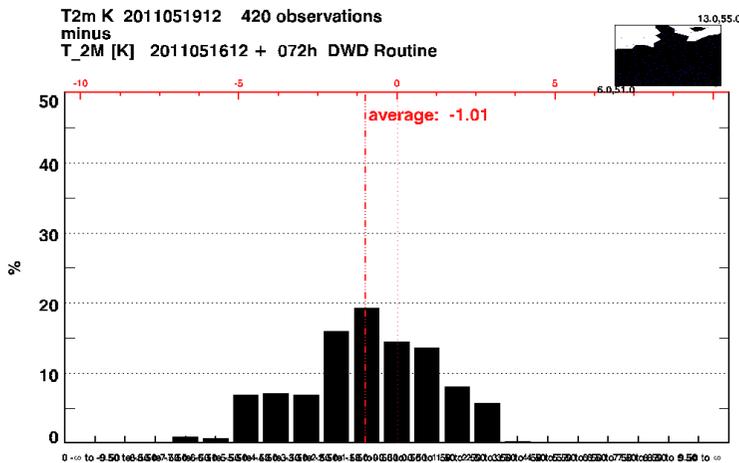
Black – routine

Exp 8330:

Red – mean

Green – tile “land”

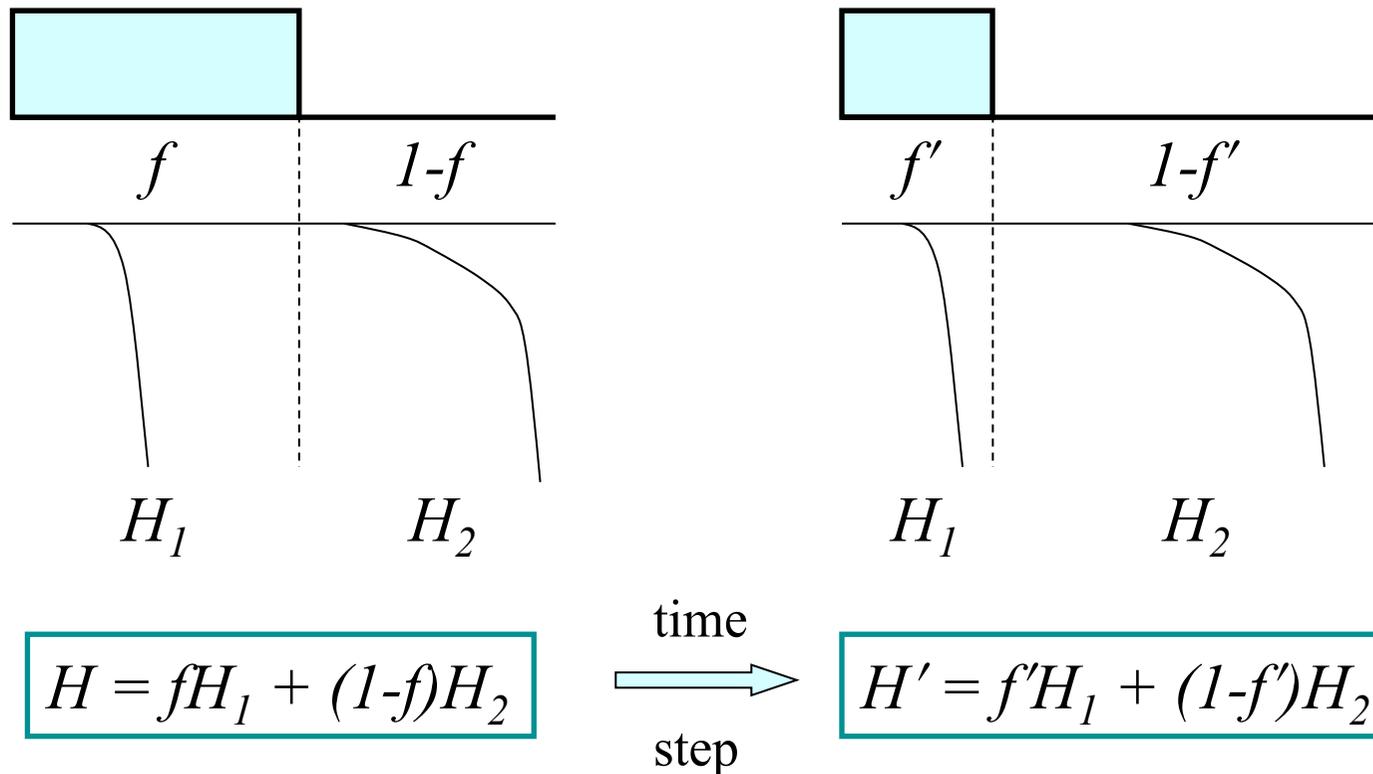
Blue – tile “lake”



Tiled Surface Scheme within the 3d COSMO model: snow/snow-free surface

Parallel experiment 8601 is set up
(COSMO-EU domain, V4_16, running since 16.12.2010)

with 2 tiles: snow/snow-free ($ns_stat = 1, ns_snow = 1$)

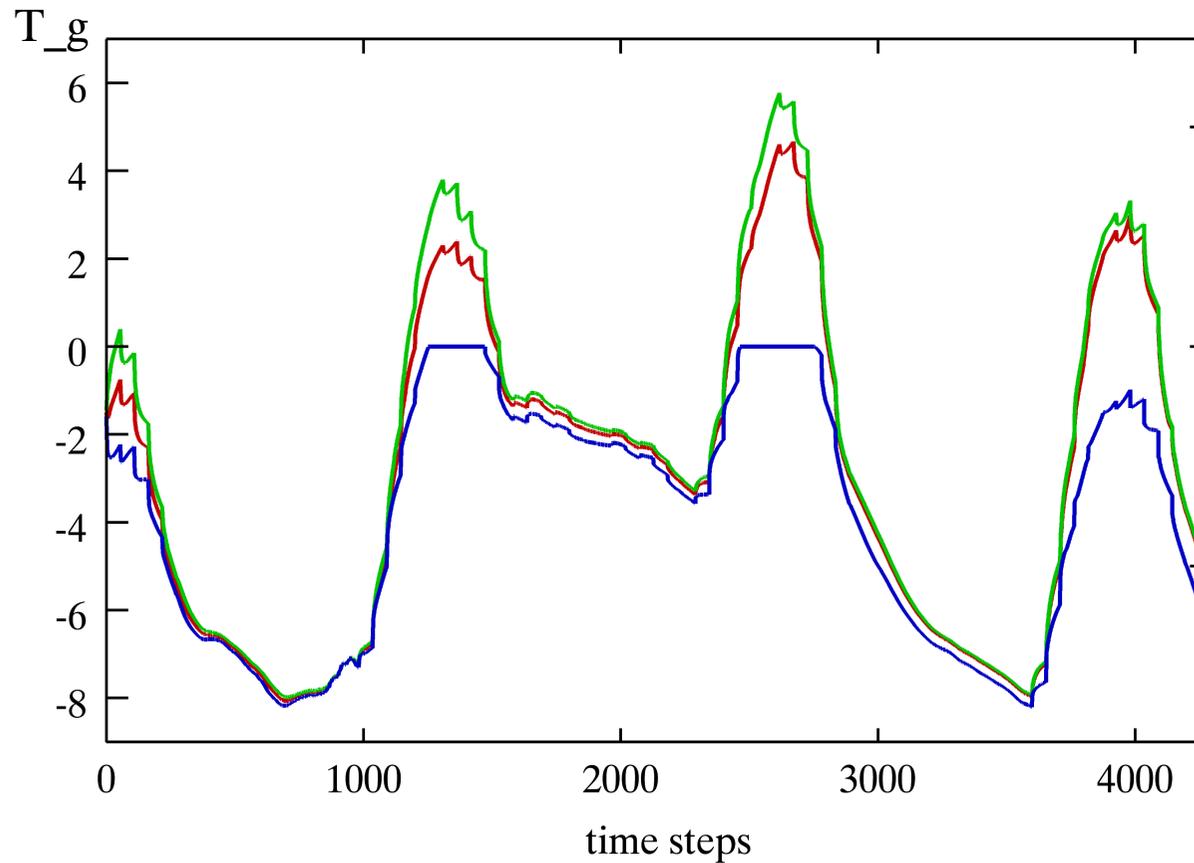


$\Delta H = H' - H$ should be added to the growing tile

Tiled Surface Scheme within the 3d COSMO model: snow/snow-free surface

COSMO-EU forecast, started 26.02.2011 at 12 UTC

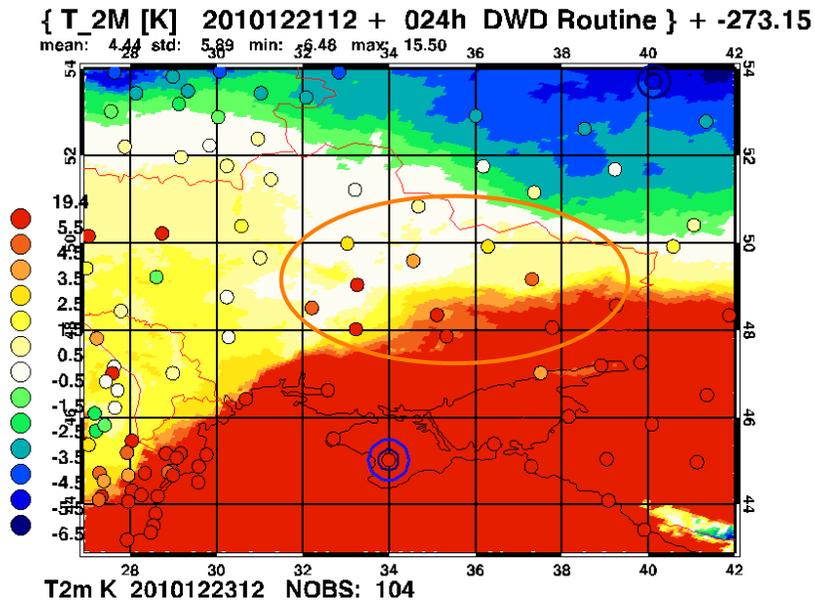
grid point (347,352) 45% snow at the beginning



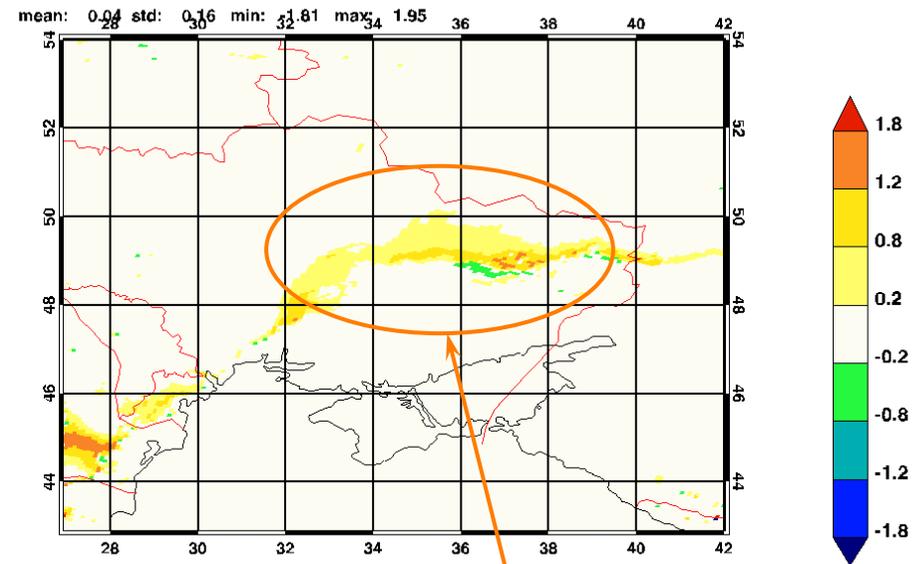
Exp 8008: **red** – mean, **green** – tile “snow-free”, **blue** – tile “snow”

Tiled Surface Scheme within the 3d COSMO model: snow/snow-free surface

COSMO-EU forecast, started 21.12.2010 at 12 UTC + 24 h

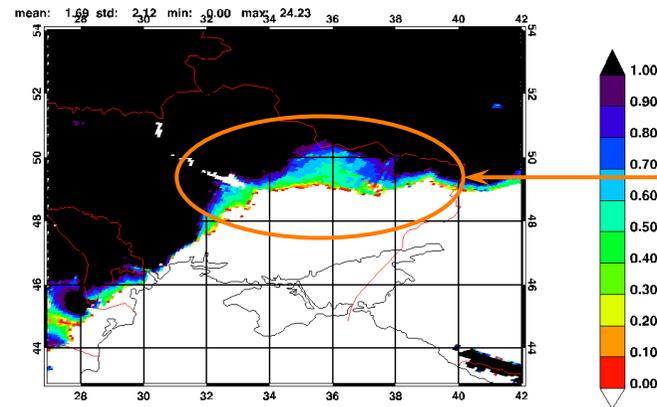


T_2m (routine, observations)



T_2m difference (Exp-Routine)

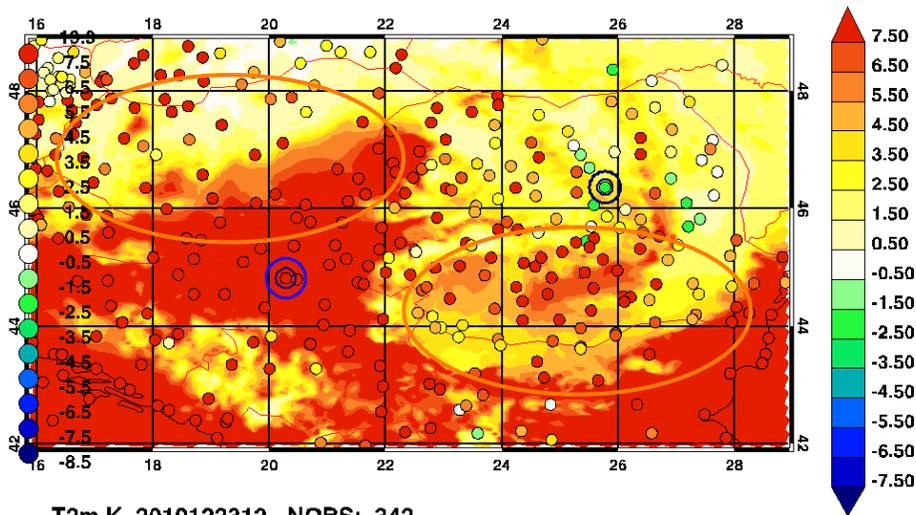
snow cover
fraction



Tiled Surface Scheme within the 3d COSMO model: snow/snow-free surface

COSMO-EU forecast, started 21.12.2010 at 12 UTC + 24 h

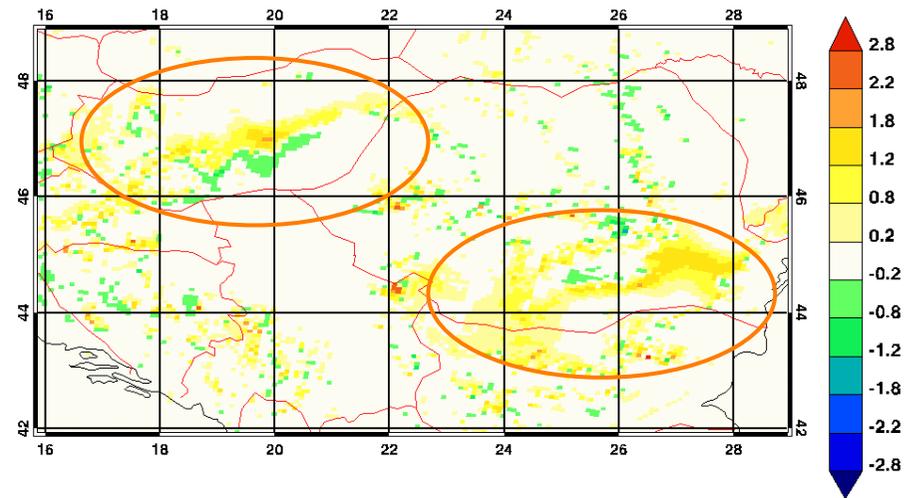
{ T_2M [K] 2010122112 + 024h DWD Routine } + -273.15
mean: 5.68 std: 3.97 min: -0.90 max: 16.61



T2m K 2010122312 NOBS: 342

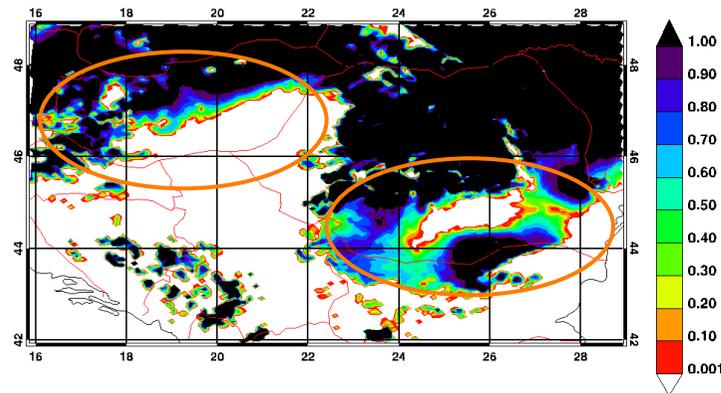
T_2m (routine, observations)

mean: 0.12 std: 0.32 min: -1.41 max: 3.04



T_2m difference (Exp-Routine)

mean: 0.87 std: 1.25 min: 0.00 max: 11.43



snow cover
fraction

Conclusions

- Tile/mosaic approach is implemented into the COSMO model
- Experiments (lake/land, snow/snow-free) are running, results are reasonable, they are monitored

Thank you for your attention!

Thanks to Jochen Förstner, Thomas Hanisch, Jürgen Helmert,
Dmitrii Mironov and Bodo Ritter!

Tiled Surface Scheme within the 3d COSMO model

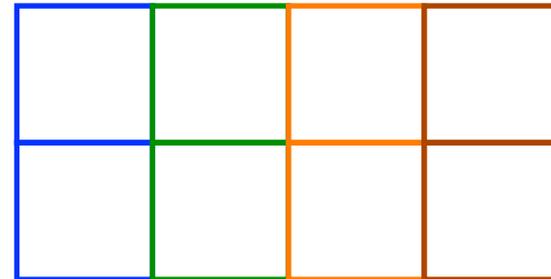
Examples of set up:

Mosaic: without snow tiles (standard)



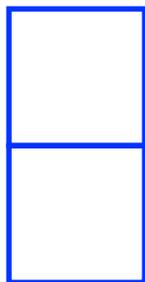
$$ns_stat = N, ns_snow = 0$$

with snow tiles



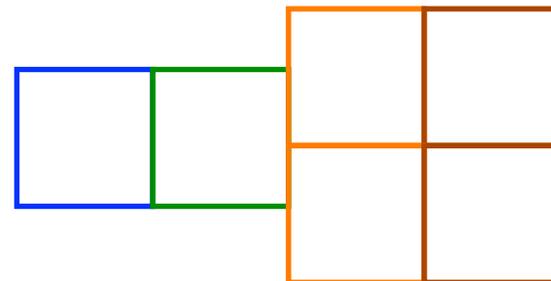
$$ns_stat = N, ns_snow = N$$

Tiles: only two tiles “snow/no snow”



$$ns_stat = 1, ns_snow = 1$$

general case



$$ns_stat = N, ns_snow = M \leq N$$

Without sub-grid refinement: $ns_stat = 0, ns_snow = 0$

Tiled Surface Scheme within the 3d COSMO model: lake/land

Parallel experiment 8330 is set up
(COSMO-EU domain, V4_16, running since 01.04.2011)

with 2 tiles: lake/land ($ns_stat = 2$, $ns_snow = 0$)

For sub-grid lakes (lake fraction < 0.5)

- lake depth is set to 10 m
- on the zero time step, the **cold start** is performed:

lake surface temperature = $\text{MAX}(\text{surface air temperature, freezing point})$

lake bottom temperature = $+4^{\circ}\text{C}$ (temperature of maximal water density)

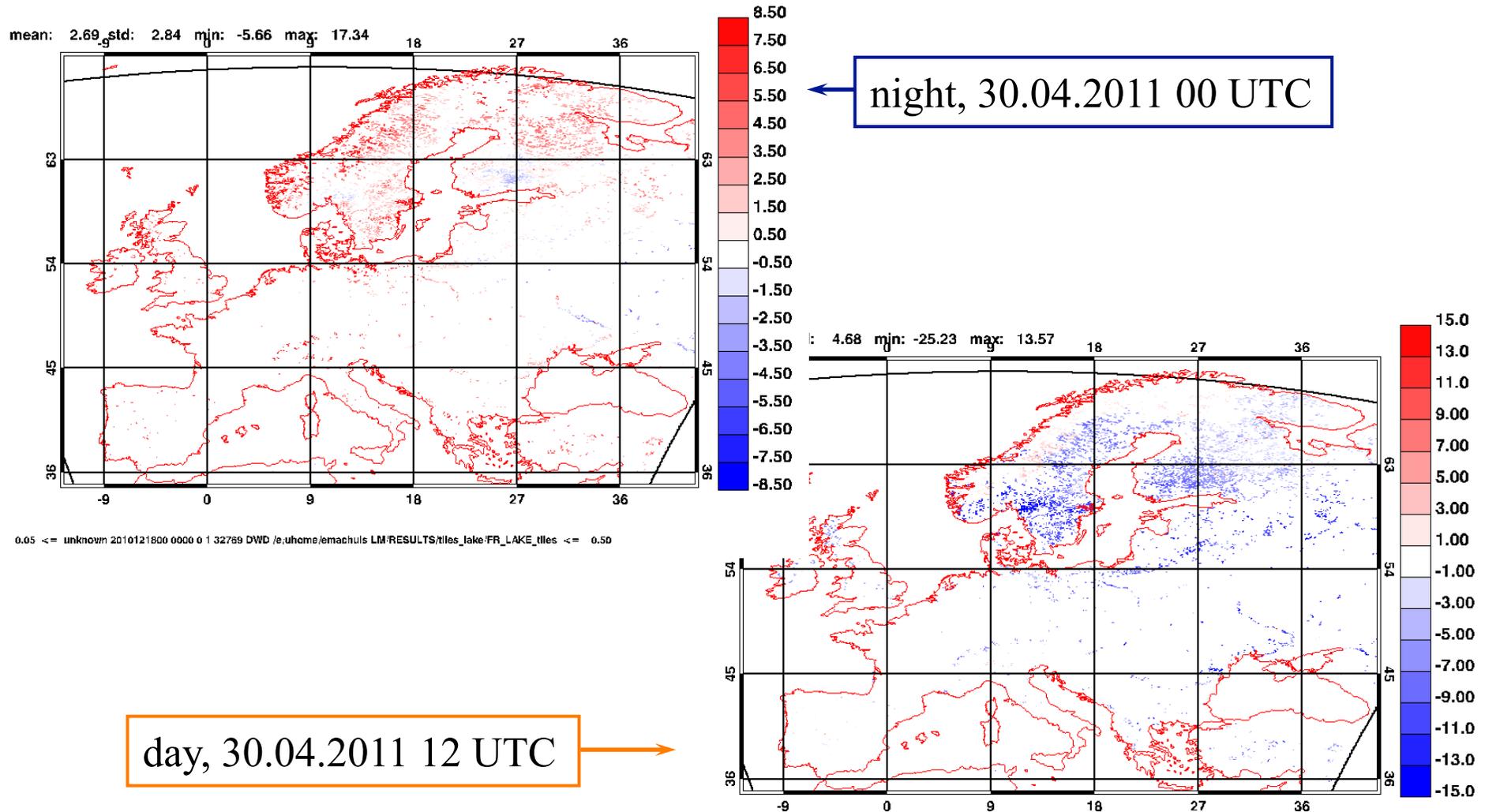
mixing depth = 8 m

ice depth = 0 m

shape factor $C_T = 0.5$ (default)

Tiled Surface Scheme within the 3d COSMO model: lake/land

Difference in surface temperature between lake tile and land tile

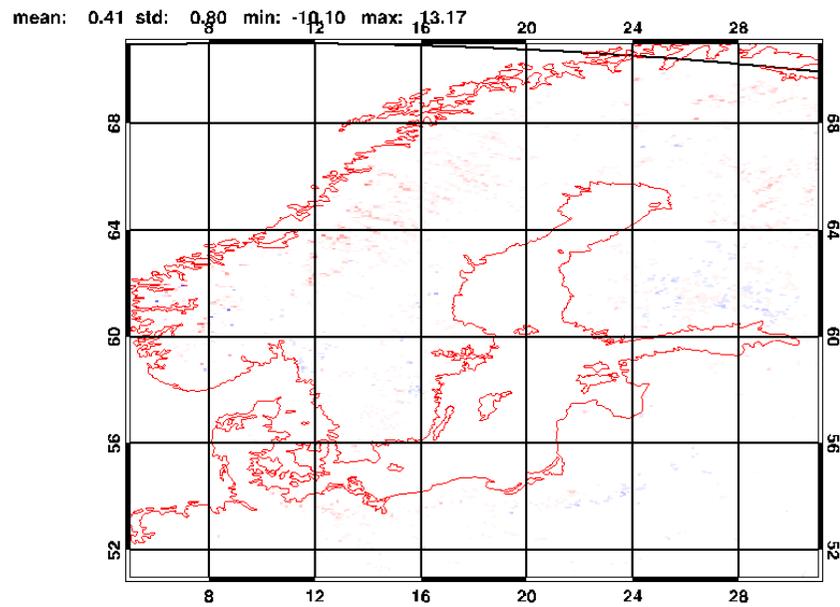


night, 30.04.2011 00 UTC

day, 30.04.2011 12 UTC

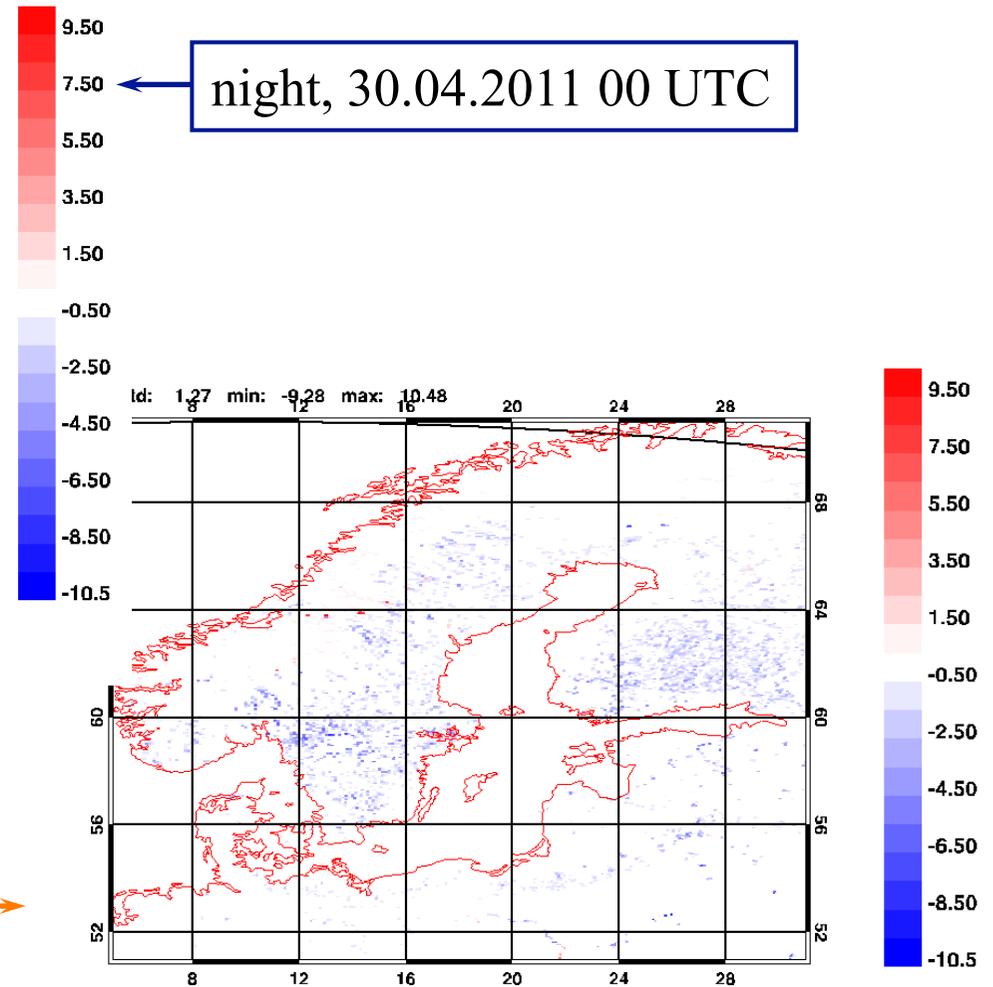
Tiled Surface Scheme within the 3d COSMO model: lake/land

Difference in surface temperature between experiment with tile approach (mean over two tiles) and control experiment



0.05 <= unknown 2010121800 0000 0 1 32789 DWD /e.uhome/emachulis LM/RESULTS/tiles_lake/FR_LAKE_tiles <= 0.50

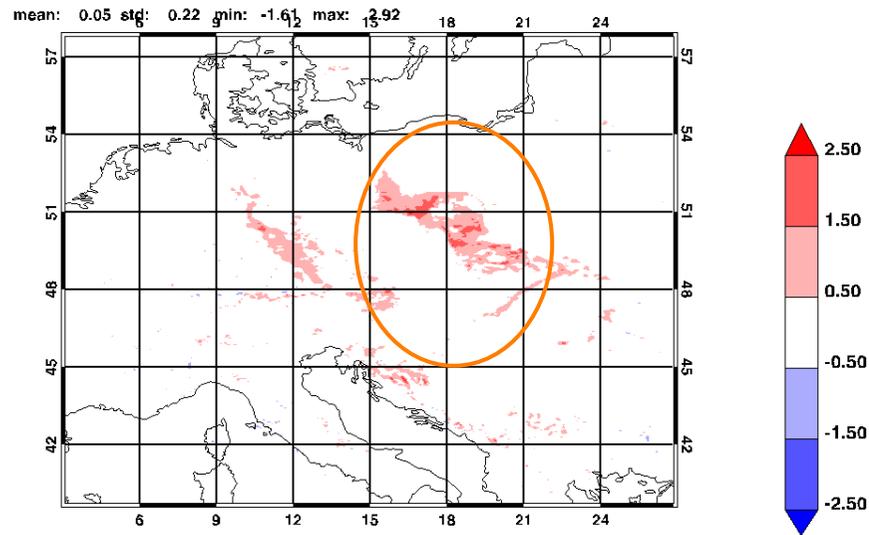
day, 30.04.2011 12 UTC



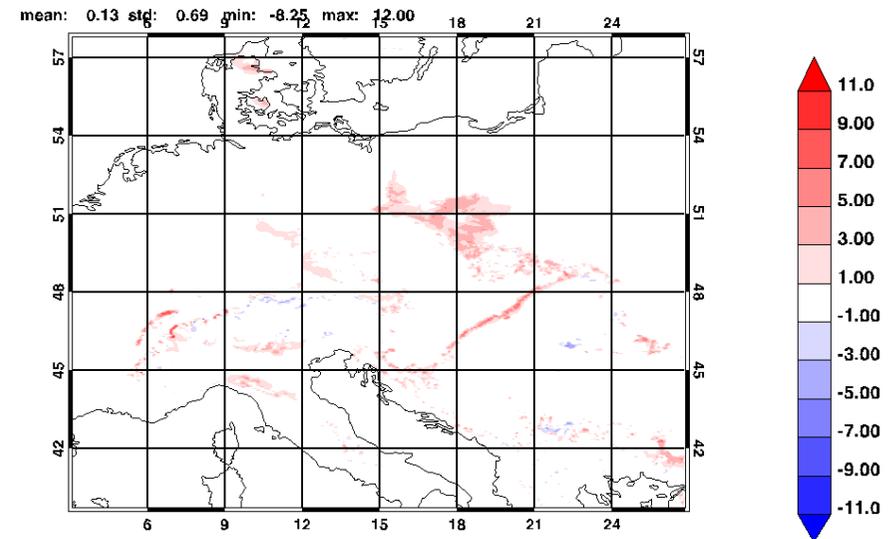
0.05 <= unknown 2010121800 0000 0 1 32789 DWD /e.uhome/emachulis LM/RESULTS/tiles_lake/FR_LAKE_tiles <= 0.50

Tiled Surface Scheme im 3d COSMO Modell

COSMO-EU Vorhersage, gestartet am 26.02.2011, 12 UTC + 24 h

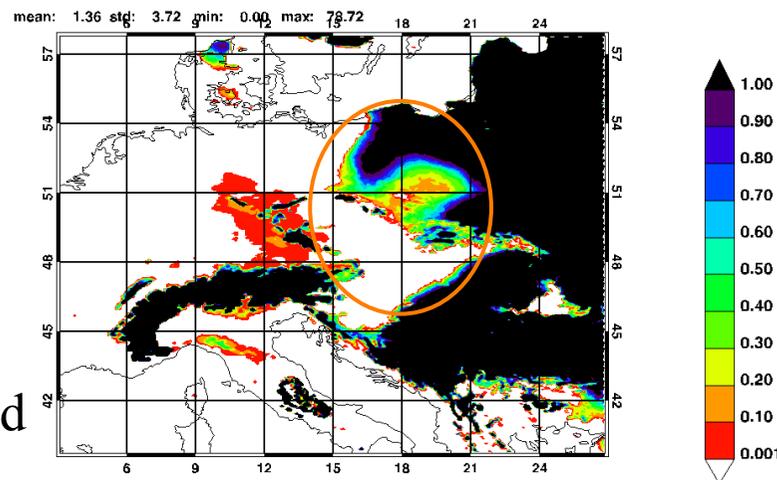


T_2m Differenz (Exp-Routine)



W_SNOW Differenz (Exp-Routine)

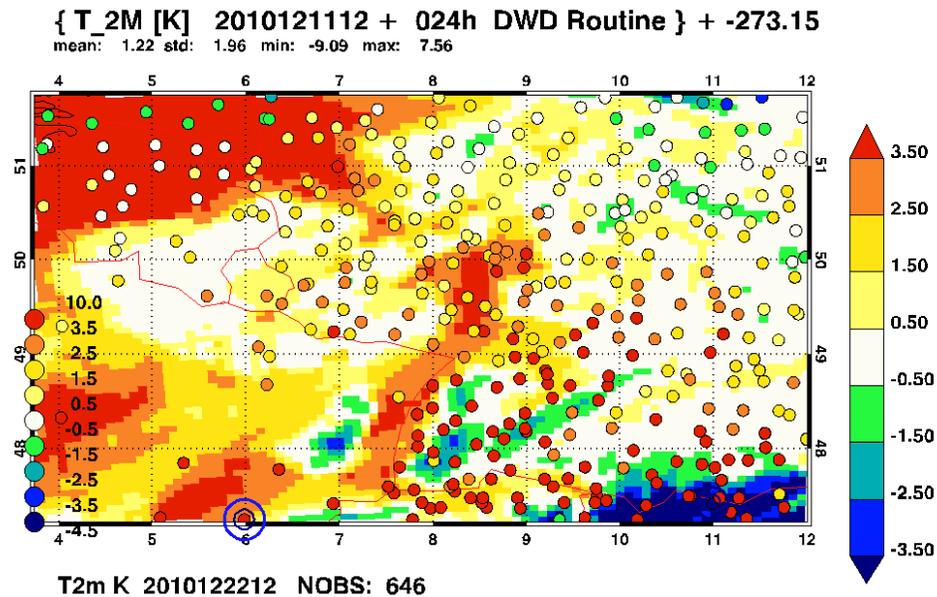
Schnee-
bedeckungsgrad



T_2m ist höher
im Experiment,
obwohl es ein bisschen
mehr Schnee gibt

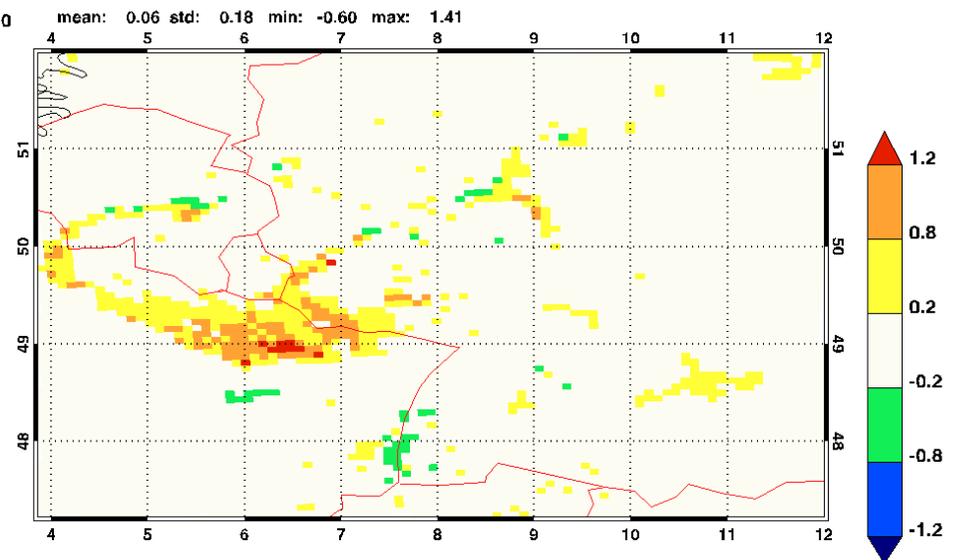
Tiled Surface Scheme im 3d COSMO Modell

COSMO-EU Vorhersage, gestartet am 11.12.2010, 12 UTC + 24 h

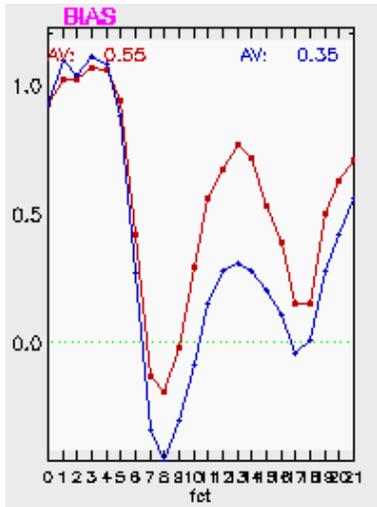


T_{2m} (Routine, Beobachtungen)

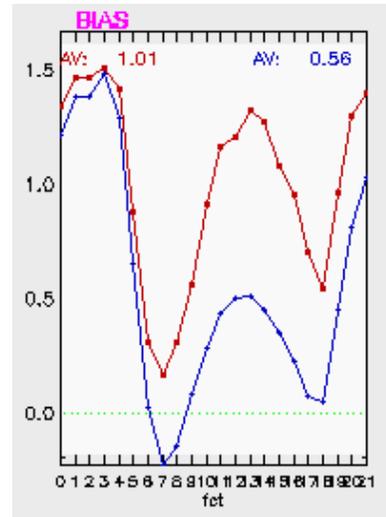
T_{2m} Differenz (Exp-Routine)



Tiled Surface Scheme within the 3d COSMO model: results



April 2011



May 2011

Routine COSMO-EU and COSMO-DE

Tiled Surface Scheme within the 3d COSMO model: results

