The correction of initial values of temperature at low model levels and soil

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Abstract

Values of temperature at low model levels which came from Global Modeling technology of DWD for COSMO-Ru have large errors in the initial field. Especially high disagreement between T2m observations and initial data obtained during cold period. It leads to serious errors in T2m forecast. To improve temperature at low model levels we suppose to include a procedure of additional assimilation of T2m, based on synoptic measurements. During the experiments the optimal amount of corrected low model atmospheric levels was determined**.** Correction increment decreases with height according to the logarithmic profile. Besides, it is necessary to correct soil temperature. We do it by distribution of temperature increment from the surface to the deep layers with linear decreasing of correction increment.

Special “correction module” for soil and air temperature was developed. Results for the 1-29 February 2012 have shown that forecast started from the corrected initial fields significantly improved. Especially correction of initial temperature field has an impact on midday forecast. The influence of corrected temperature of air and soil is kept up to 72 hours. Detailed assessment has been done for warm period (1-31 July 2014) and for some autumn’s days. We did experiments with different initial data: GME data, corrected temperature and soil field and temperature field obtained after nudging. Results show that correction of soil temperature is very significant, otherwise air can “forget” any changes done at the first time-step of the forecast. Besides, we assessed influence of corrected temperature on the precipitation.

The idea is to correct initial values of temperature at low model levels and in soil by using observations (temperature at 2 meters)

Algorithm:

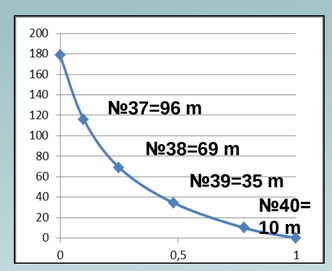
1) **Calculation of the increment for t2m:**
- Calculation of model temperature at 2 meters according to logarithmic profiler;
- Bilinear interpolation of T2m field to the stations.

2**) Horizontal extrapolation** according to the Cressman scheme;

3) **Vertical extrapolation** of the temperature increment to the lowest model level and surface temperature. For the level=10 m increment is taken with coefficient 1. 3 different approaches were developed to the extrapolation of T2m to the surface level: T_surface=T2m; T_surface=T_surface+dT2m; logarithmic profiler between T2m and T_40_level.

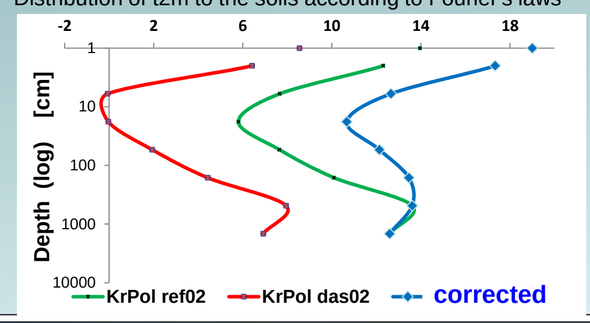
4) **Vertical extrapolation to the others atmospheric levels.** During the experiments the optimal amount of corrected levels was determed=4 levels from surface. Increment decreases with H according to Monin-Obukhov theory (logarithmic temperature profile).

5) **Vertical extrapolation to the soil**. It linear extrapolation for 7 levels



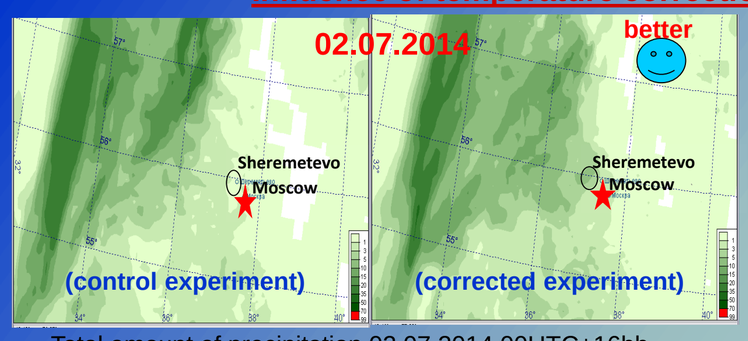
Dependence of coefficient for T correction from logH

Correction of temperature in soils:
Distribution of t2m to the soils according to Fourier's laws

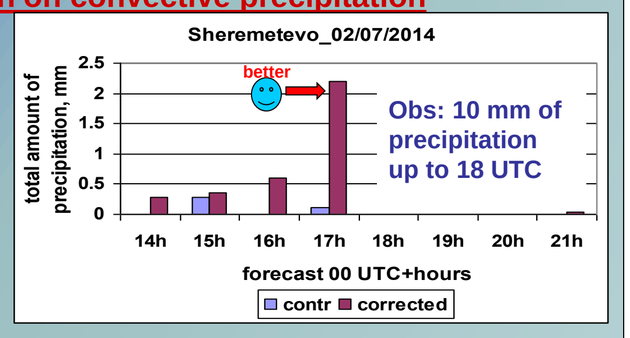


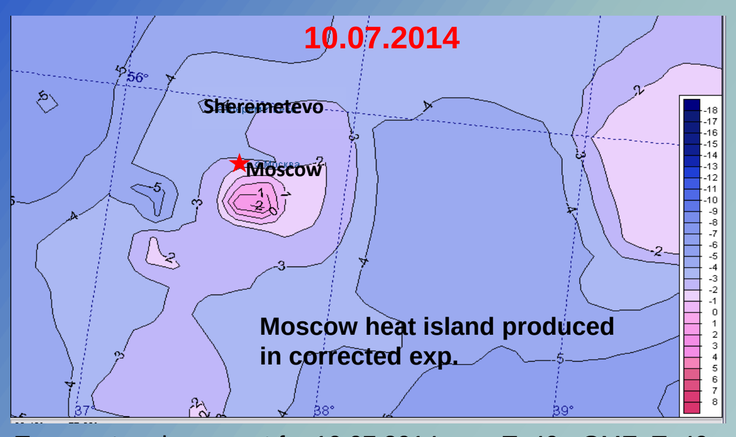
Studied period	Experiment types
1-31 July 2014	1) Control (contr); 2) Corrected by proposed model (corr); 3) Data assimilation (nudging) – DAS
28.10.2014	1) Control (contr); 2) Corrected by proposed model (corr); 3) Data assimilation (nudging) – DAS; 4) DAS+corr; 5) DAS+correction of soil only (coupling of correction module with DAS system.

Influence of temperature correction on convective precipitation

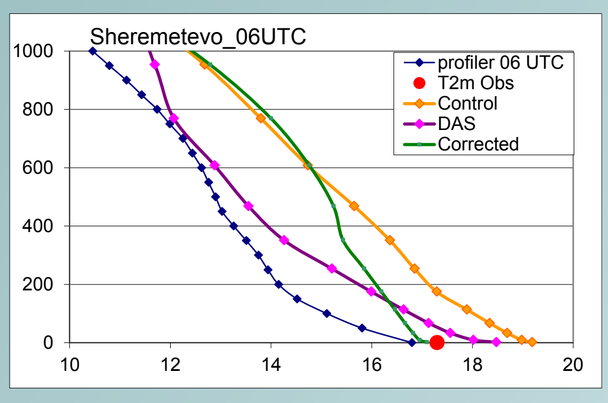


Total amount of precipitation 02.07.2014 00UTC+16hh

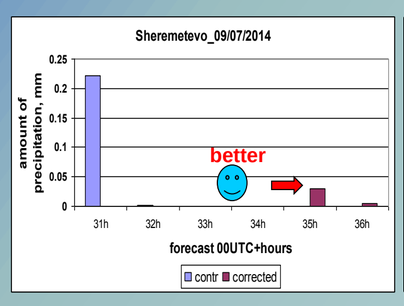


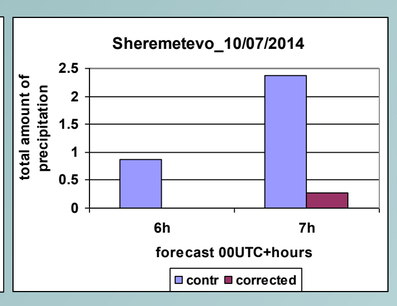


Temperature increment for 10.07.2014 corr_T_40 - GME_T_40



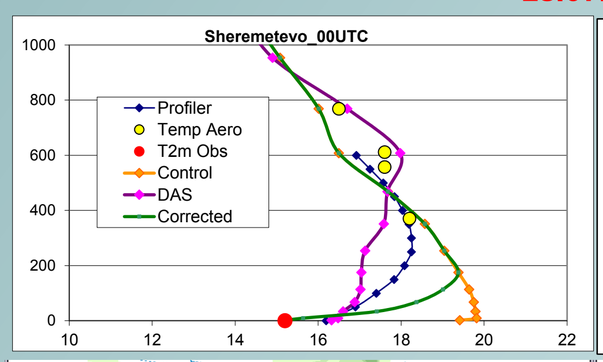
Temperature vertical profiles in different exp. from 10.07.2014 00UTC+ 6,7 hh

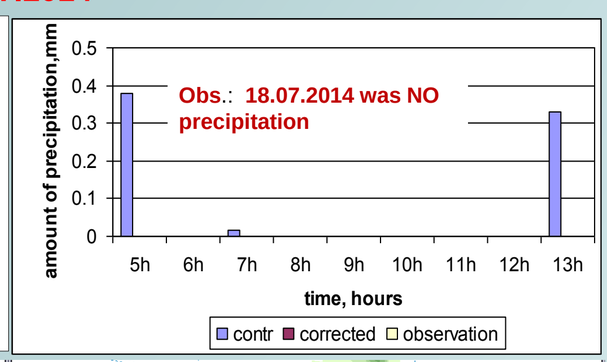


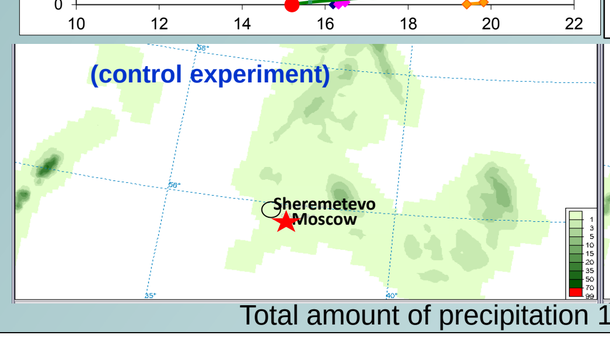


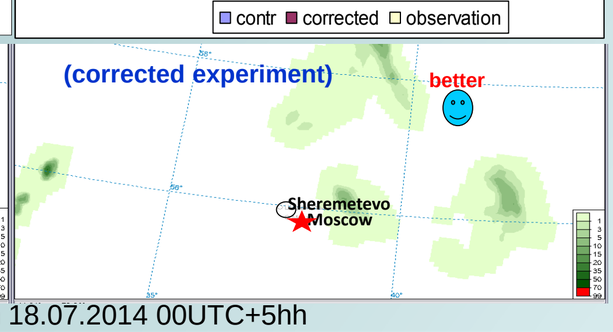
Obs.: **18UTC 10.07.2014 precipitation = 0.1 mm**, thus in **control** exp., started from 09.07 00UTC+31…36 hh and **control** exp., started from 10.07 .2014 00UTC+ 6,7 hh precipitation were overestimated. **In corrected exp. – better.**

18.07.2014







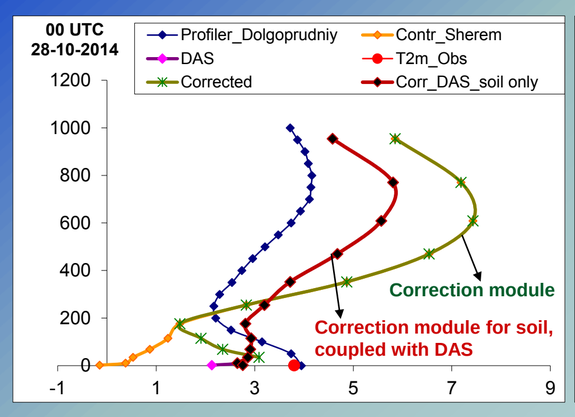


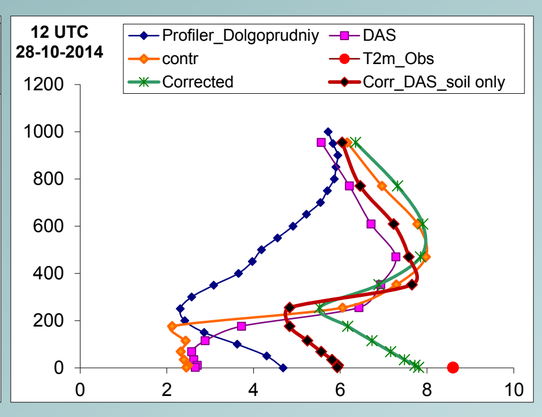
Total amount of precipitation 18.07.2014 00UTC+5hh

Soil memory and influence of soil temperature to the T2m

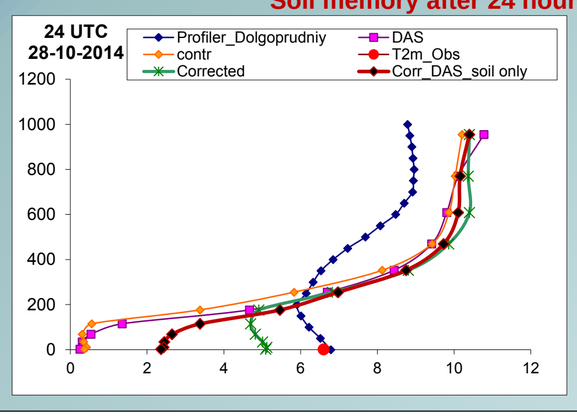
T2m error in control initial field = 4 ºC
T2m increment in correction exp.=3,2 ºC
T2m increment in DAS + soil corr. exp.=2,8 ºC

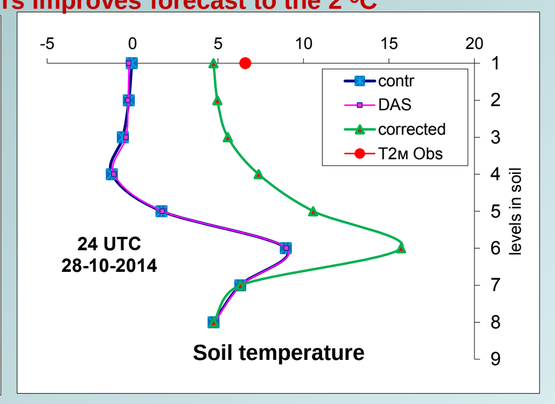
If we corrected only soil temperature, we improve forecast up to 4 ºC



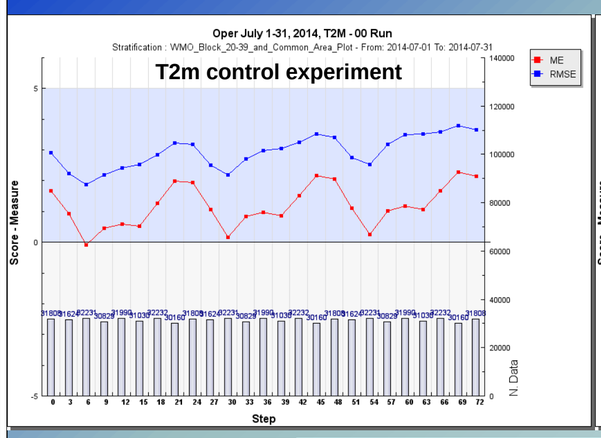


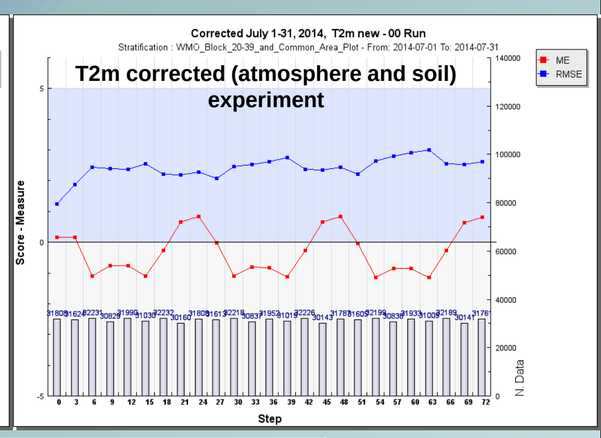
Soil memory after 24 hours improves forecast to the 2 ºC

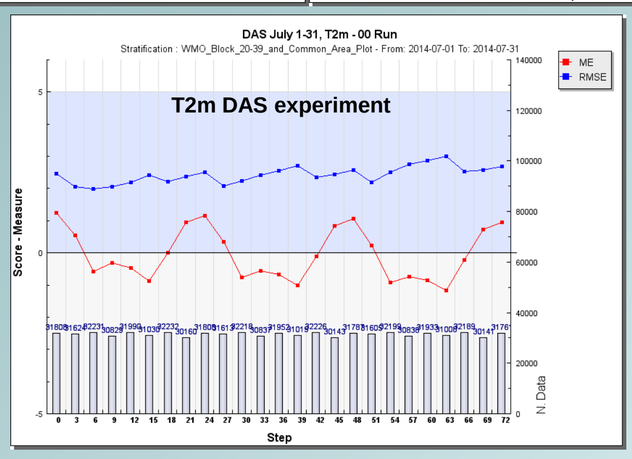




Verification of T2m by VERSUS, 1-31 July 2014
COSMO-Ru7 domain (700x620 grid cells)







Conclusions:

- Temperature at low model levels and in soil **can be corrected using synoptic observation** (t2m).
- Special module for such correction **was developed** in Russian Hydrometcentre.
- This module technically **is ready for operational use.**
- This module was tested (for COSMO-Ru7) and show good results: initial field of temperature **can be improved**, and quality of T2m forecast increases **up to 5ºC**.
- **Coupling with DAS is possible.** In order not to change temperature stratification in atmosphere, we can correct only temperature of soil. Soil memory in cold period is about 24-72 hours; during summer – 12-24 hours. Soil temperature effects T2m.
- In some cases **convective precipitation changes due to changes in temperature profiles**. During July 2014 (studied period) **all changes in precipitation** (time and amount) **lead to better forecast**.
- Verification of model results for July 2014, COSMO-Ru7 domain (700x620 grid cells) shows **reduction of ME and RMSE (by 1-1.5 ºC) if we using correction module**. Besides correction module can **improve initial data** in comparison with using only DAS (reduce errors **by 1-1.5 ºC**).

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