New Approach to Parameterization of Physical Processes in Soil in COSMO Model - Preliminary Results

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Summary

In this paper a first try of a new approach to parameterization of physical processes in soil in COSMO model is presented. Authors tried to established whether the increasing of a number of levels in TERRA_LM model would result positively in quality of forecasts.

1 Introduction

Basic facts: we must be honest - multi-level soil model TERRA_ML is (still!) a weak point in COSMO model. Thus, there is a need for improvement - via proper initialization, more reliable data, new parameterization etc.

In a current (reference) version of COSMO soil model is based on 7-level structure. Substantial change (some time ago) from two levels (TERRA) to seven levels (TERRA_ML) made a substantial difference in results.

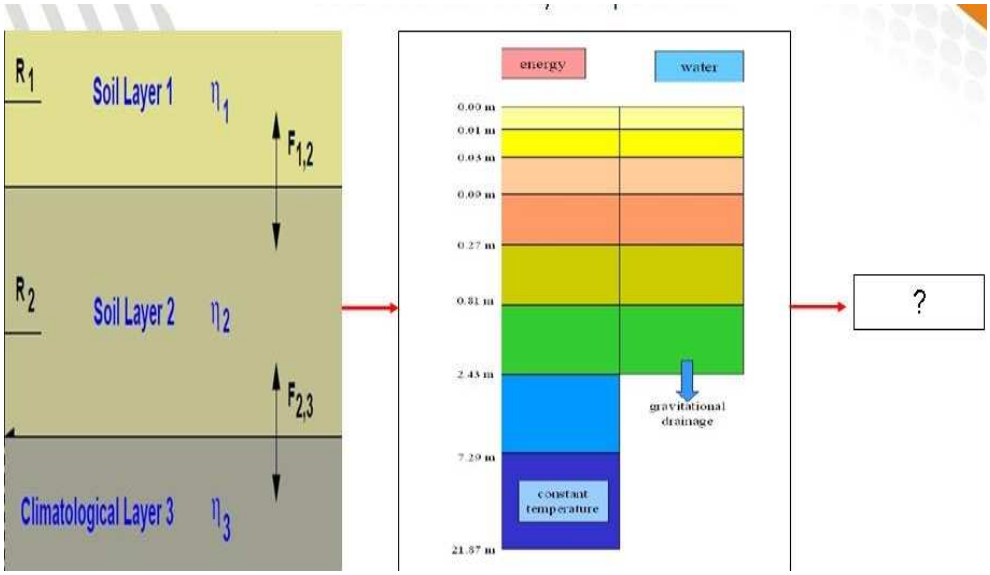

Figure 1: Changes of structure of soil model TERRA in COSMO meteorological model.

Maybe now it is the time to go further, dividing this structure of seven levels into more detailed one? or maybe we should try another type of approach? In this paper authors would like to present preliminary results of this new approach and to draw some outlines of further work.

2 Basic methodology

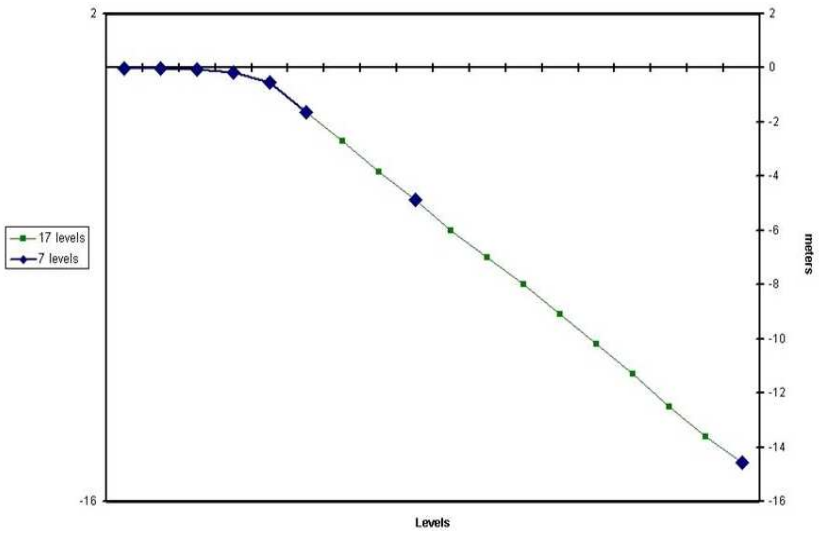

Figure 2: A proposition of a new soil model structure - ten new levels. Solid black horizontal line marks ground level; big blue squares and blue line mark TERRA_ML 7 basic levels; small green squares and green line mark new introduced "detailed" levels.

A fundamental question to answer in this study was whether introduction of more (detailed) soil levels may be a way to improvement of a soil model. Authors agreed to introduce new levels in such a way that a new single-layer depth was uniform and equal to, approximately, 0.5 m. The basic structure of new "detailed" levels is shown in the Figure 2.

3 Preliminary results (case studies)

To assess results fields of air temperature (T2M) and dew point temperature (TD2M) at 2m above ground level, wind speed (U10M) at 10m a.g.l., cloud cover (CLC)and pressure reduced to mean sea level (PMSL) were selected.

At least two model runs every month of first half of 2012 were carried out. First thing that authors were able to find was that during Winter and Spring (January, February, March) there was basically no visible effect comparing reference runs (with 7-level TERRA_LM) and "High-Resolution-Levels" runs (HRL-runs; with 17 levels in soil model). And on the other hand, there were surprisingly significant impact during summer (May to July) - mainly on air temperature and dew point temperature (see figures below). These changes of results were mostly observed at mid latitudes of territory of Poland (in-between seashore and mountains). In most of these cases the changes of results effected in an improvement in forecast vs. observations. Basic statistical parameters - mean error and Root Mean Square Error (RMSE) of forecast - were smaller for HRL-runs in comparison with "reference" forecasts. What also should be noticed, computing time increased on average by less than 10% (from 5 to 8%).

Statistics	Mean Error		RMSE	
	Reference run	HRL-Run	Reference run	HRL-Run
Air temperature	-0.9	-0.4	6.9	6.0
Dew-point temp	-1.4	-1.1	7.4	6.6

Table 1: Basic statistics: forecasts against measurements at stations; 2012.07.29, 09:00 UTC

In next four charts selected results of mentioned comparison are shown.

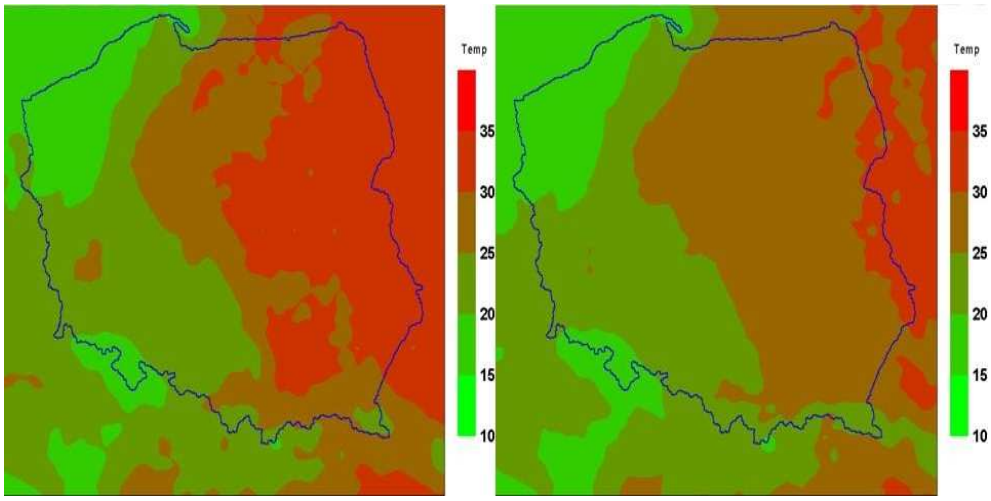

Figure 3: Forecast of air temperature at 2m agl., actual values of T2M, 2012.07.29, 09:00 UTC; reference run (left) vs. "high-resolution-levels" run (right).

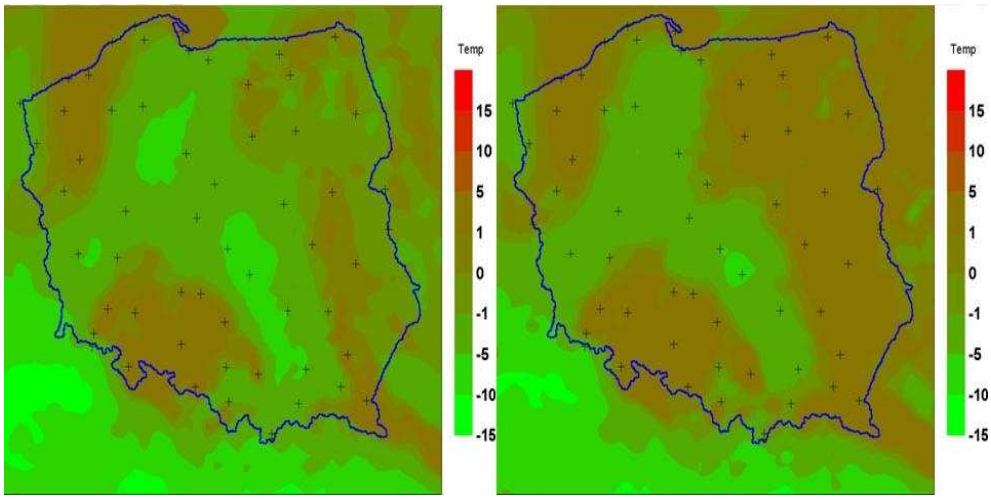

Figure 4: Air temperature at 2m agl., Observed-Forecasted, 2012.07.29, 09:00 UTC; reference run (left) vs. "high-resolution-levels" (right). Crosses mark meteorological stations where observations are continuously carried out.

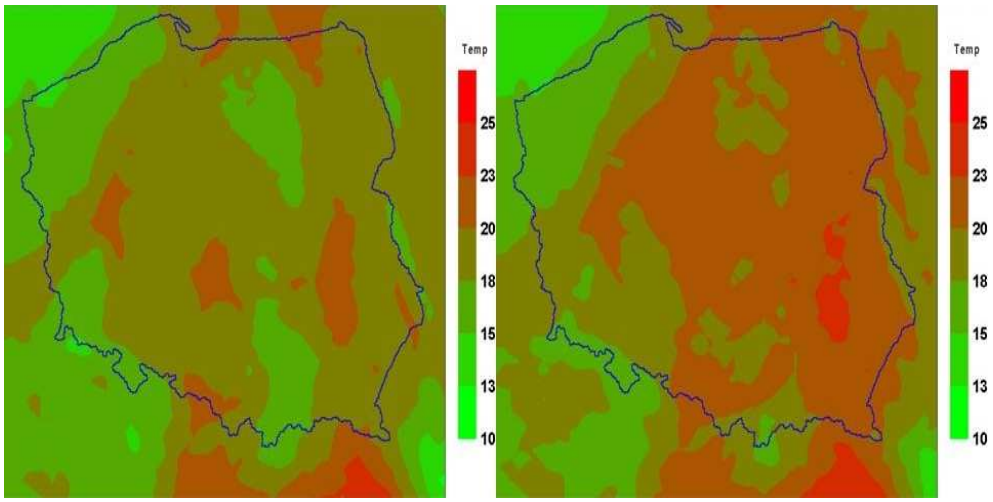

Figure 5: Forecast of dew point temperature at 2m agl., actual values of TD2M, 2012.07.29, 09:00 UTC; reference run (left) vs. "high-resolution-levels" run (right).

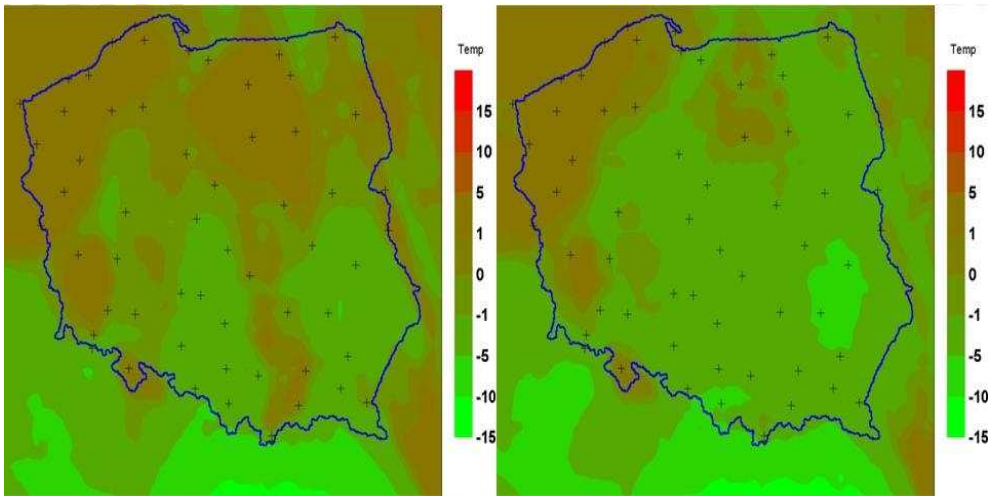

Figure 6: Dew point temperature at 2m agl., Observed-Forecasted, 2012.07.29, 09:00 UTC; reference run (left) vs. "high-resolution-levels" (right).

4 Discussion

In general, the improvement in forecasts is not adequate to authors expectations. Less than half of degree, in case both of temperature and dew point temperature is actually not much, taking into account that other meteorological parameters were not affected so "strong", i.e. changes were not so significant in case of other elements nor other time period. In authors opinion, no changes brought on during Winter/Spring might be a direct effect of "frozen" ground - what could actually stopped most of heat- and water transfer via soil layers. Apparently, this "high-resolution" approach was not a satisfactory step-forward to properly assess soil processes.

After a thorough consideration, authors came to the following conclusion: it seems that in order to obtain valid results, entirely new parameterization of soil processes may be needed to resolve the problem with proper accuracy. So, in authors opinion, this should be a direction for the future.

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