Instytut Meteorologii i Gospodarki Wodnej
Państwowy Instytut Badawczy

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

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1. Our Group from IMGW cooperate with colleagues from Institute of Agrophysics Polish Academy of Science

2. We prepared project „New approach to parameterization of Physical Processes in soil in numerical model”.

3. Project started in August 2012.

4. Project will finish in 2015.

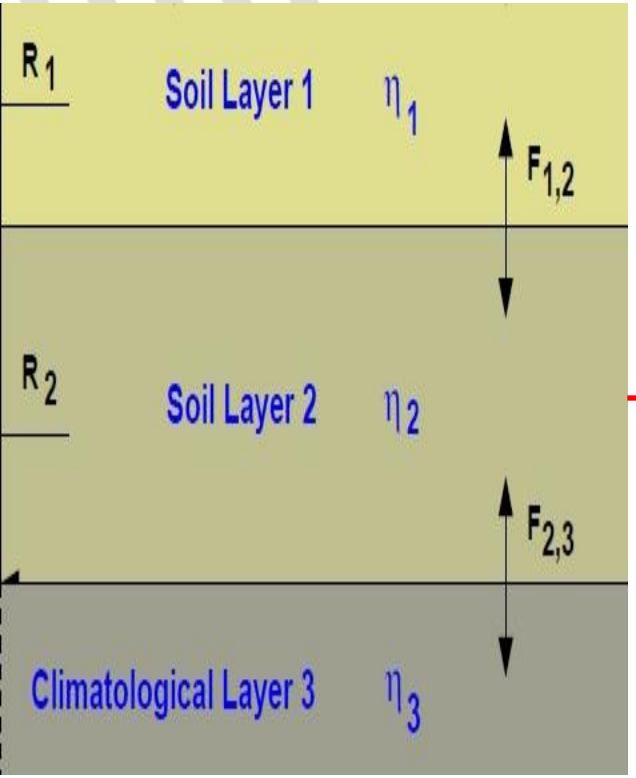
Introduction

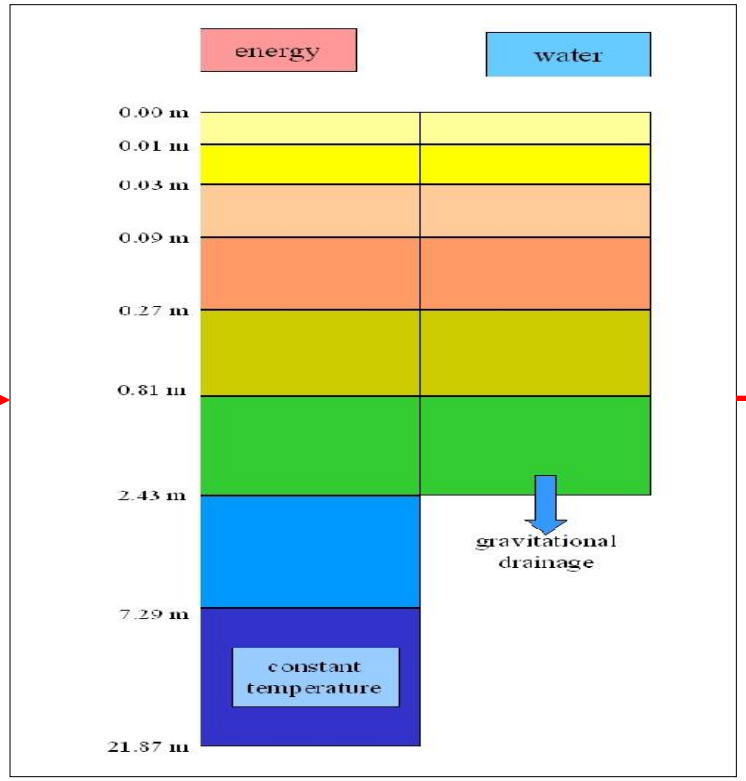
Basic facts:

- We must be honest – multi-level soil model TERRA_ML is (still!) a weak point in COSMO .
- Thus, there is a need for improvement – via proper initialization, more reliable data, new parametrization etc.
- In a reference version of COSMO soil model is based on 7-level structure. Substantial change (years ago) from 2 (TERRA) to 7 levels (TERRA_ML) made a huge difference in results.
- Maybe it is now the time to go further?
- … or maybe we should try another type of approach?

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

More soil levels – a way to improvement?





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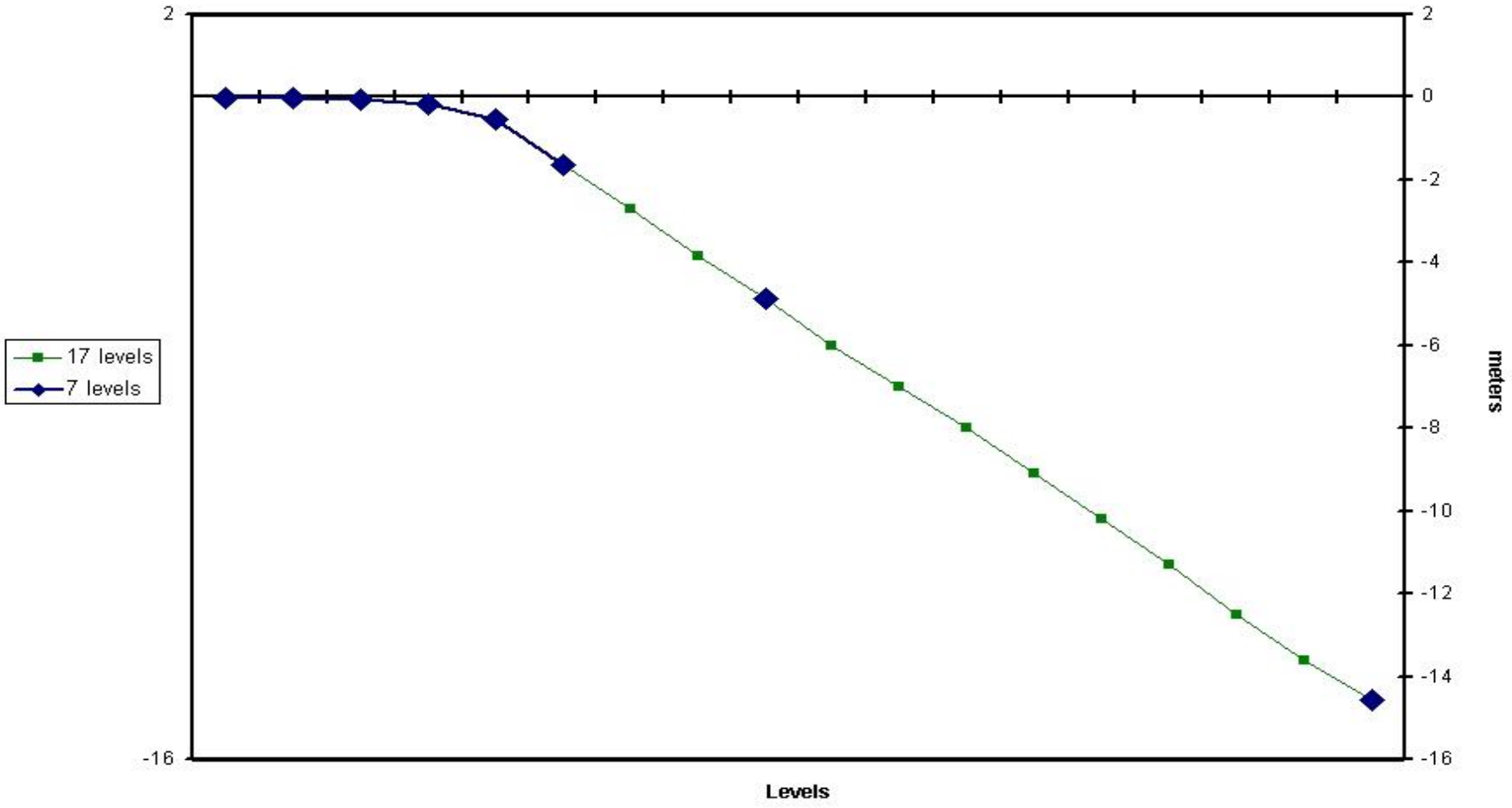
More soil levels – a way to improvement?

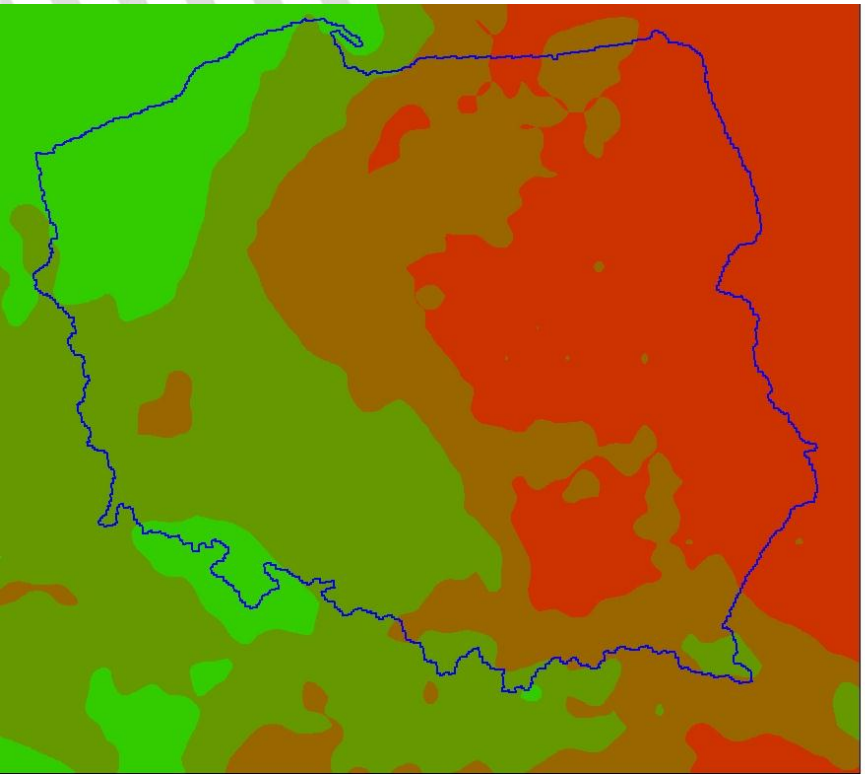


Preliminary results (case studies)

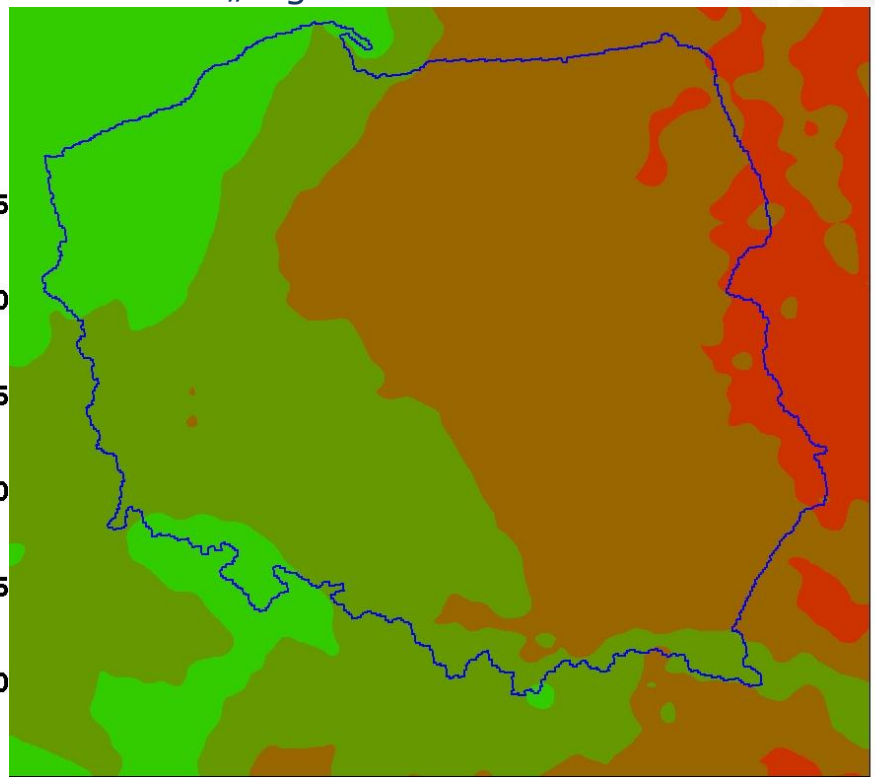
1. Fields selected to assess – Temp 2m, Dew point 2m, windspeed, cloud cover, pressure at MSL.
2. Almost no visible effect during winter and spring (January, February, March).
3. Surprisingly significant impact during summer (May to July) – especially on Temp/Dew pt. 2m.
4. Changes mostly observed at mid latitudes (in-between seashore and mountains).
5. Improvement in forecast vs. observations in most cases – decrease of mean error and RMSE.
6. Computing time increased by less than 10% (from 5 to 8%).

Preliminary results (case studies)
Temperature at 2m agl, 2012.07.29, 09:00 UTC

Reference forecast



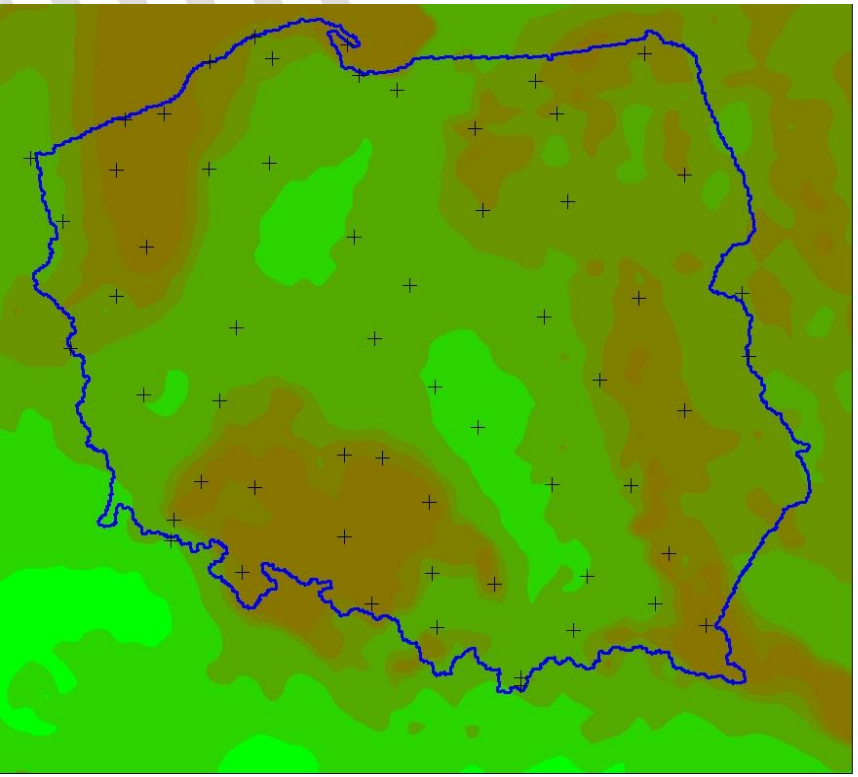
„High-resolution”-levels forecast

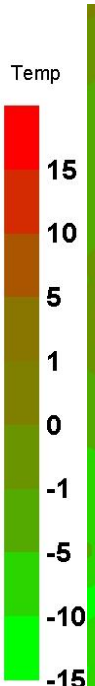


Preliminary results (case studies)

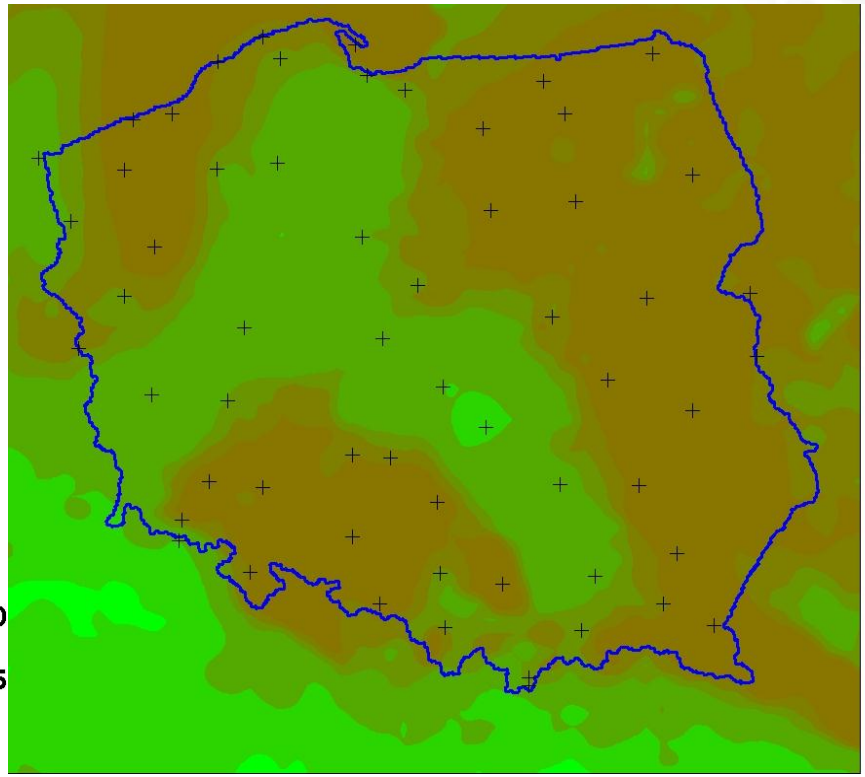
Temperature at 2m agl, 2012.07.29, 09:00 UTC, Observed-Forecasted

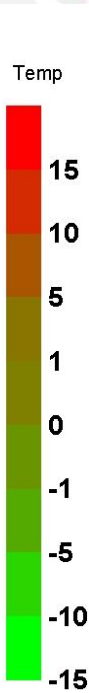
Reference forecast





„High-resolution"-levels forecast





Basic statistics against measurements at stations (+)

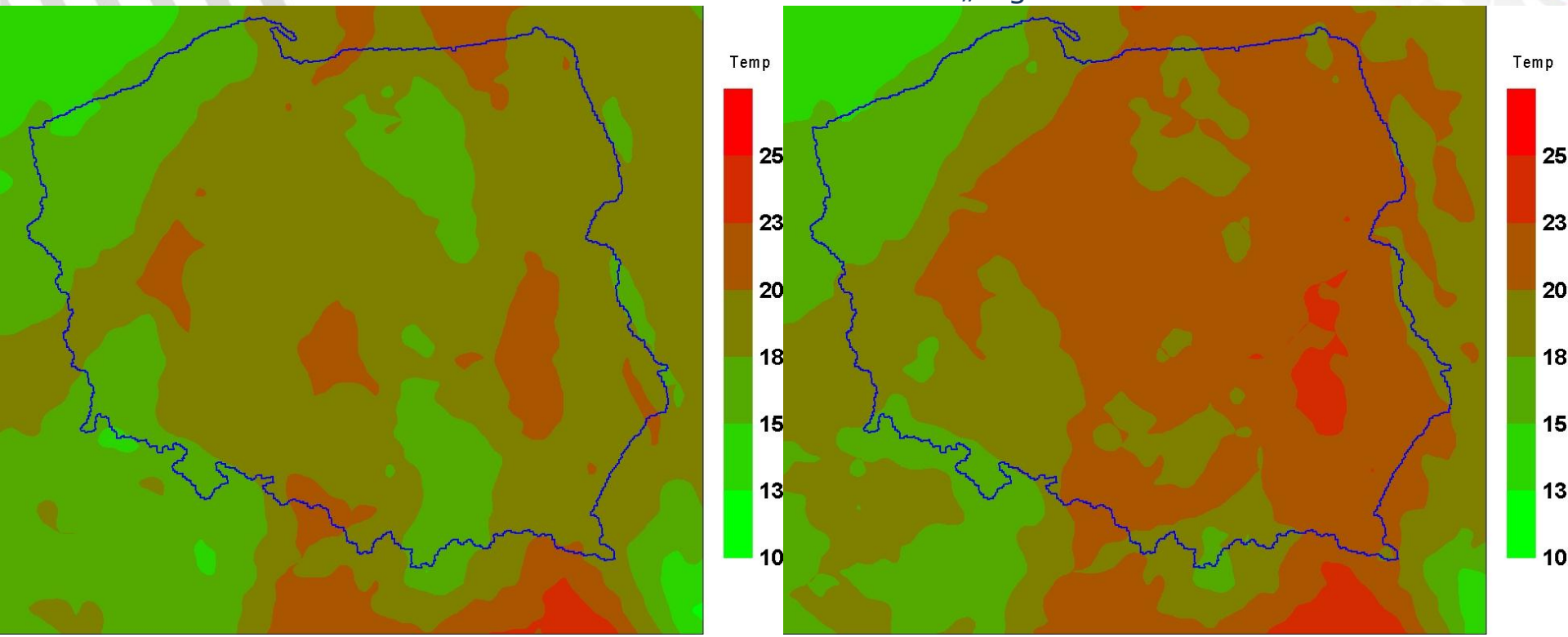
Mean Error		RMSE	
Ref.	HRL	Ref.	HRL.
-0.9	0.4	6.9	6.0

Preliminary results (case studies)

Dew point temperature at 2m agl, 2012.07.29, 09:00 UTC

Reference forecast

„High-resolution”-levels forecast



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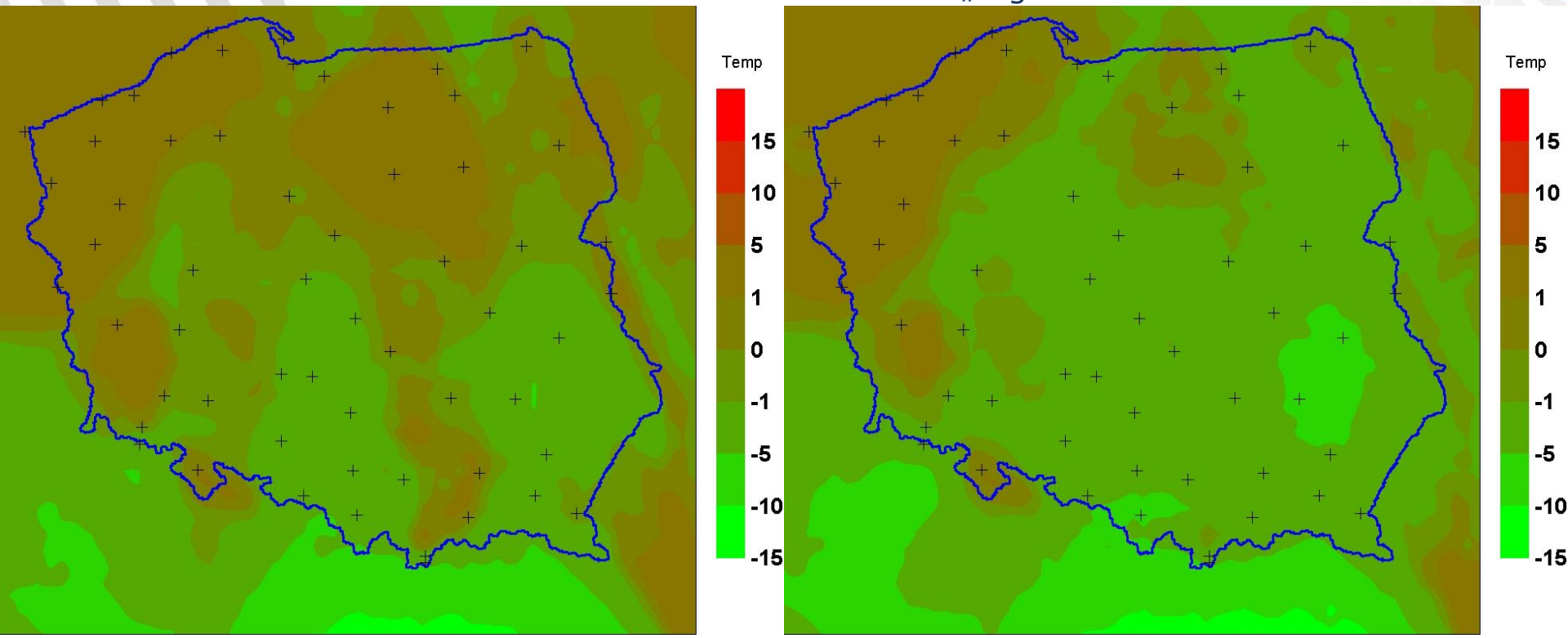
Preliminary results (case studies)

Dew point temperature at 2m agl, 2012.07.29, 09:00 UTC , Observed-Forecasted

Reference forecast

„High-resolution"-levels forecast



Basic statistics against measurements at stations (+)

Mean Error		RMSE	
Ref.	HRL	Ref.	HRL.
-1.4	1.1	7.4	6.6

New parameterization: physical aspects – what we would like to change ?

- **improvement of present parameterization ?**
- **new parameterization from the begining ?**
- **short plan and deadline**

Basing on overhaul physical phenomena in soil we would like to prepare new parameterization.

We took into consideration:

I) physical processes in soil

- ✓ microphysics processes in soil
- ✓ dynamics fluid in porous media
- ✓ soil dynamics

II) water cycle in soil

III) soil – plant – water relation

III. Soil – Plant – Water interract (At the moment we are working on preparation of mathemetical formula parameterization) – We (I and PAS) are responsibility for working on this point.

1. Evaporation from different surfaces (new mathematical description) (We will have finished this part of our work by the end of (~)November 2012):

- Evaporation of intercept water
- Evaporation from free water surface
- Evaporation from snow and ice
- Evaporation from urban territories

New approach (ctnd.)

2. Movement of water in soil during evaporation (new mathematical description) (We will have finished work by the end of January 2013):

- Bare soil evaporation
- Soil water content profiles during bare soil evaporation
- Transport of water and heat in an unsatured porous media
- New parameterization of hydraulic diffusivity and of hydraulic conductivity
- Transit of water from groundwater to the atmosphere

New approach (ctnd.)

3. Movement of water in the soil root zone during transpiration (new mathematical description) (We will have finished work by the end of March 2013):

- Water in a soil root zone
- Water movement in a soil – root system
- Water uptake by plant roots

New approach (ctnd.)

4. Roots system (new mathematical description) (we will have finished work by the end of May 2013):

- Root growth
- Spatial root variability
- Vertical distribution of root
- Root system and water in soil
- Influence of soil temperature on root growth
- Root anatomy
- Preparation equation for water movement to plant roots

New approach (ctnd.)

5. The role of plants in transport processes in the soil-plants-atmosphere system (new mathematical description) (we will have finished work by the end of July 2013):

- Transport of water from soil through plants to the atmosphere
- Stem and leaf anatomy
- The ascent of water in plants
- Transpiration control by stomata
- Transpiration control by stomata
- Conopy and stomata conductivity during transpiration

✓ Stomata resistant

✓ Resistance of leaves and canopies for wator vapor movement to the atmosphere

New approach (ctnd.)

6. Net radiation of evaporation surface (new mathematical description) (we will finish by the end of August 2013):

- albedo
- roughness lenght
- Leaf Area Index of evaporation surface

7. Potential evaporation of homogeneous & heterogenous surface (new mathematical description) (we will finish by the end of September 2013):

8. Interception reservoir, infiltration of rain and runoff from interception reservoir (new mathematical description) (we will finish by the end of December 2013):

- New parameterization interception reservoir content

… infiltration rate

… surface runoff

… soil layers.

New approach (ctnd.)

9. Thermal processes (new mathematical description) (we will finish by the end of January 2014):

- New parameterization of the heat conductivity
- New approach to upper boundary condition(s)
- New approach to lower boundary condition(s)
- Transport heat in soil
- Water balance and energy balance

I. Physical processes in soil (preliminary results by the end of February 2013) (For this part of work will be responsible Andrew):

- The solid phase

✓ Mechanical analysis

✓ Soil structure and aggregation

✓ Particle size distribution

✓ Fluid dynamics in porous media

✓ Freezing and thawing processes in the soil

- The liquid phase

✓ Flow water in satured and unsatured soil

- The gaseous phase

✓ Movement and exchange of gases in the soil

II. Water cycle in soil (preliminary results by the end of June 2013) (on this part of our project will be working Andrew):

- We will take into consideration:

✓ Entry water into soil

✓ Surface runoff and water erossion

✓ Redistribution of water in soil

✓ Groudwater frainage

✓ Wind erosion

Plans

1. By the end of January 2014 we want to prepare a new parameterization

2. By the end of June 2015:

- Implementation and choose appropriate data
- Tests
- Analysis and verification of results which we will receive (hopefully!).

3. Parallel project which we carry out in our group is parameterization of electrical aspects of clouds. At the moment I am approaching to finish theoretical work and by the end the first quarter of next year I will receive preliminary results.

Thank you for your attention

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