Experiments in soil physics – results

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2.09.2013

CONTENT

1. Important dates in our soil project

2. Results in brief

3. Future plans

Experiments in soil physics – results

Work in IMGW – PIB :

- November 2012 – first meeting after General Meeting in Lugano 2012.
- February 2013 – IMGW-PIB and IA PAN signed a contract.
- IMGW and IA PAN have cooperated formally since March 2013.
- March 2013 – meeting in Lublin, the concept of early experiments.
- June 2013 – we have started to cooperate with Satellite Remote Sensing Center.
- August 2013 – meeting with EUROTECH company – plans to start a collaboration.
- During COSMO year we have been working on theoretical aspects of soil physics

Data from Satellite Remote Sensing Center

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Data from satellite

Data we have received from MetOp-A

Element's of orbit MetOp-A

- Epoch: 22 August 2013 19:37:55
- Eccentricity: 0.0000457
- inclination: 98.7074°
- perigee height: 820 km
- apogee height: 820 km
- right ascension of ascending node: 293.6326°
- argument of perigee: 183.6942°
- revolutions per day: 14.21488536
- mean anomaly at epoch: 176.4232°

Experiments in soil physics – results

Information come from Product User Manual – PUM – 14 (Product H14 – SM-DAS-2)
„EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Managment (page 6 documentation)

…is produced by a specific production chain which is being developed by ECMWF.
Its production is based on Simplifield Extand Kalman Filter

Based on the radar scatterometer embarked on Met-Op

Product is assimilated in the ECMWF LDAS

From meteorological stations

SYNOP
T2m RH2m
Snow Depth

Noaa/NESDIS
IMS snow cover

SM-OBS-1:
ASCAT
Surface SM

Surface:
0-2cm

ECMWF NRT
Atmospheric conditions

Data Assimilation:
EKF Soil Moisture
Analysis

Quality Control → use data when:
- Topographic complexity ≤ 20
- Wetland Fraction ≤ 15
- Noise level ≤ 8
- Snow free conditions
- Unfrozen soil

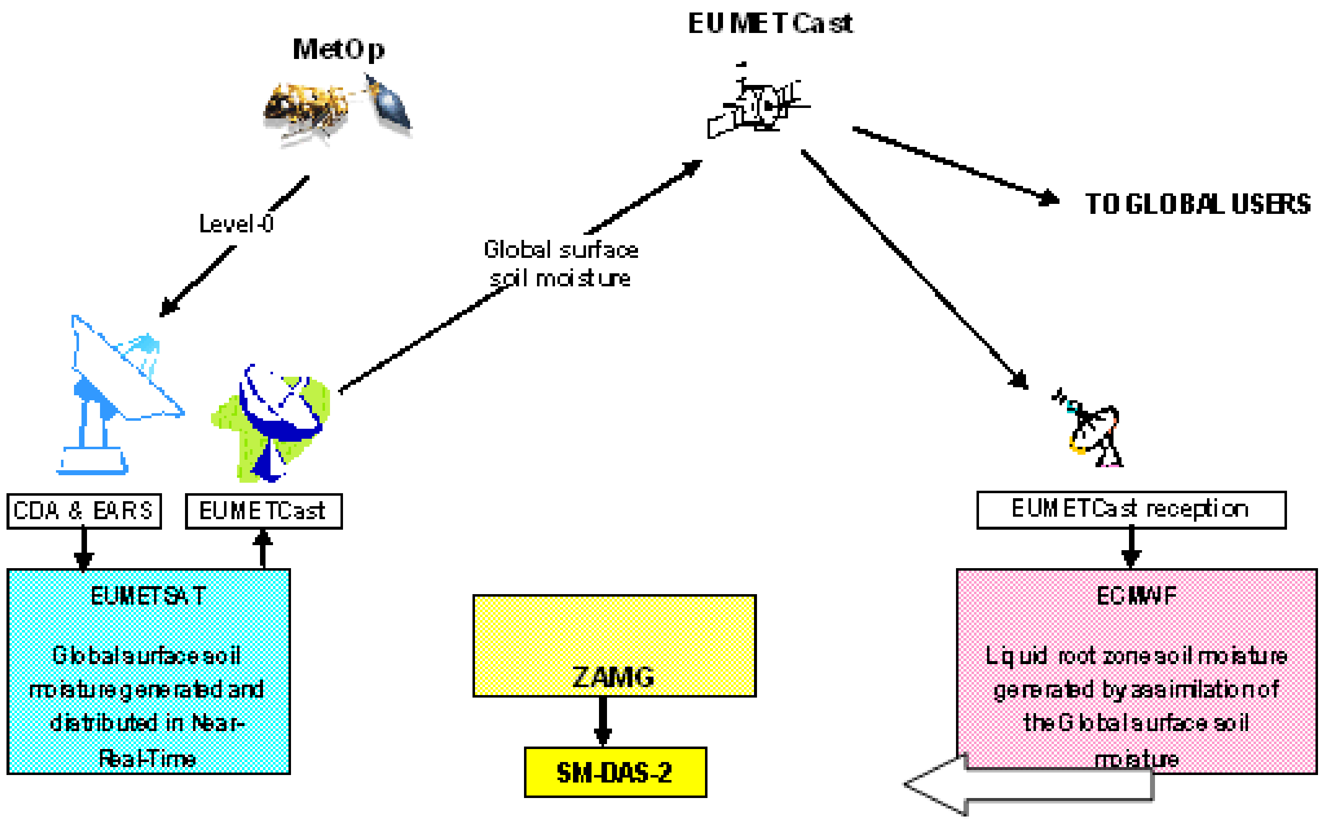
SM-DAS-2:
Soil Moisture
Profile

Root zone:
4 layers
0-7cm
7-28 cm
28-100 cm
100-289cm

Swath surface product SM-OBS-1 → Global Daily root zone product SM-DAS-2

Experiments in soil physics – results

Information come from Product User Manual – PUM – 14 (Product H14 – SM-DAS-2)
„EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Managment (Page 10 documentation)



Conceptual architecture of SM-DAS-2 production chain

Product operational characteristics

- Observing cycle: 24 h
- Horisontal resolution: 25 km
- The soil profile is computed for four layers:

a) surface to 7 cm
b) 7 cm to 28 cm
c) 28 cm to 100 cm
d) 100 cm to 289 cm

Statistic score

- Mean Bias: 0,043.
- Standard Deviation: 0,246.
- Correlation Coefficient: 0,71.
- Root Mean Square Difference: 0,203 or 0,047 m3/m3.

Methodology:

- We chose data from different seasons:

a) January, April, August, December in 2012.

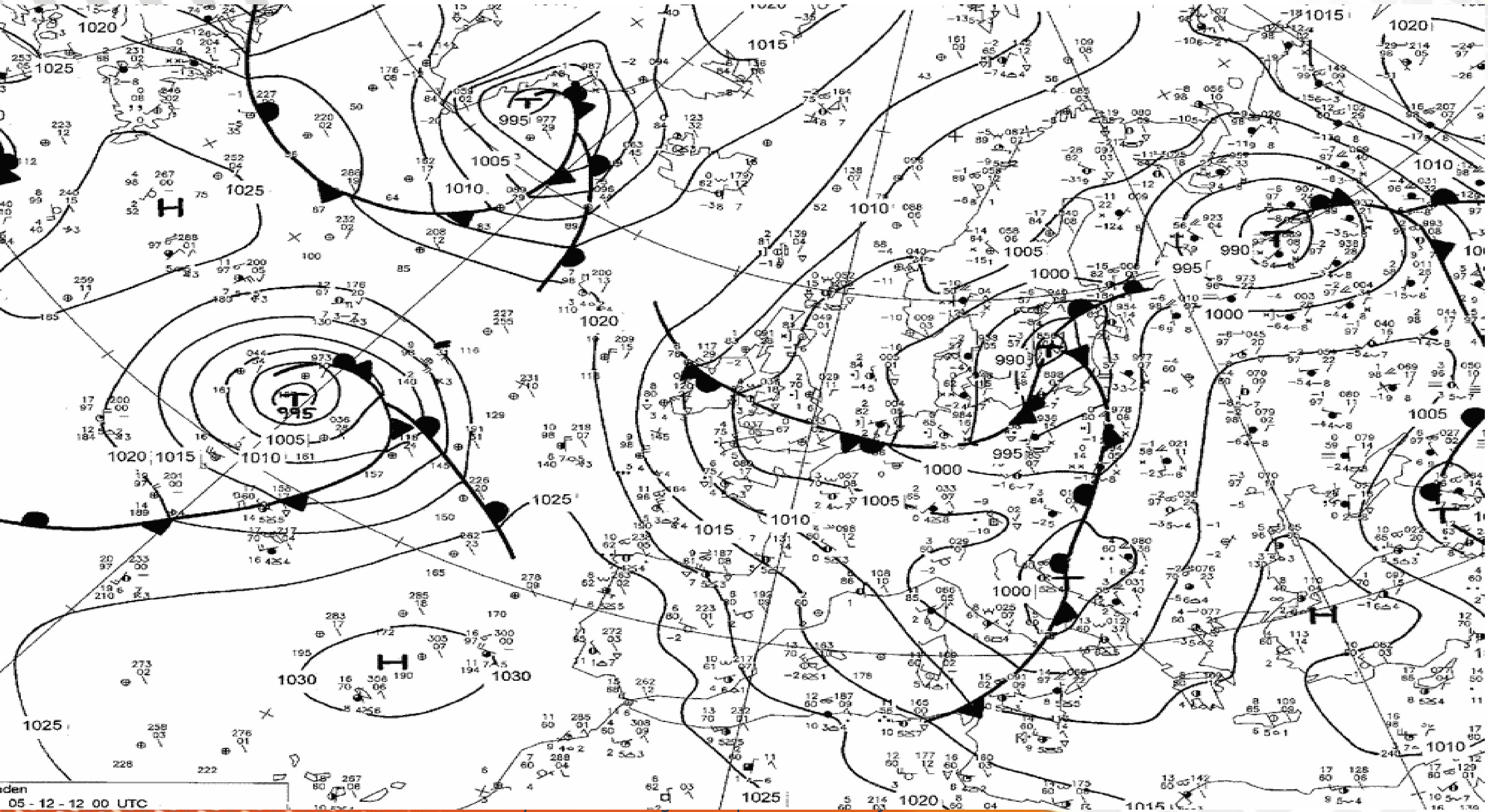
b) Comparison between data from model and satelitte.

c) We analized Standard Deviation (SD), Correlation Coefficient (CC), Root Mean Square (RMS), vertical and horizontal profiles.

d) Today I will present only selected results.

Experiments in soil physics – results

Results 5 XII 2012 – synoptic analyses



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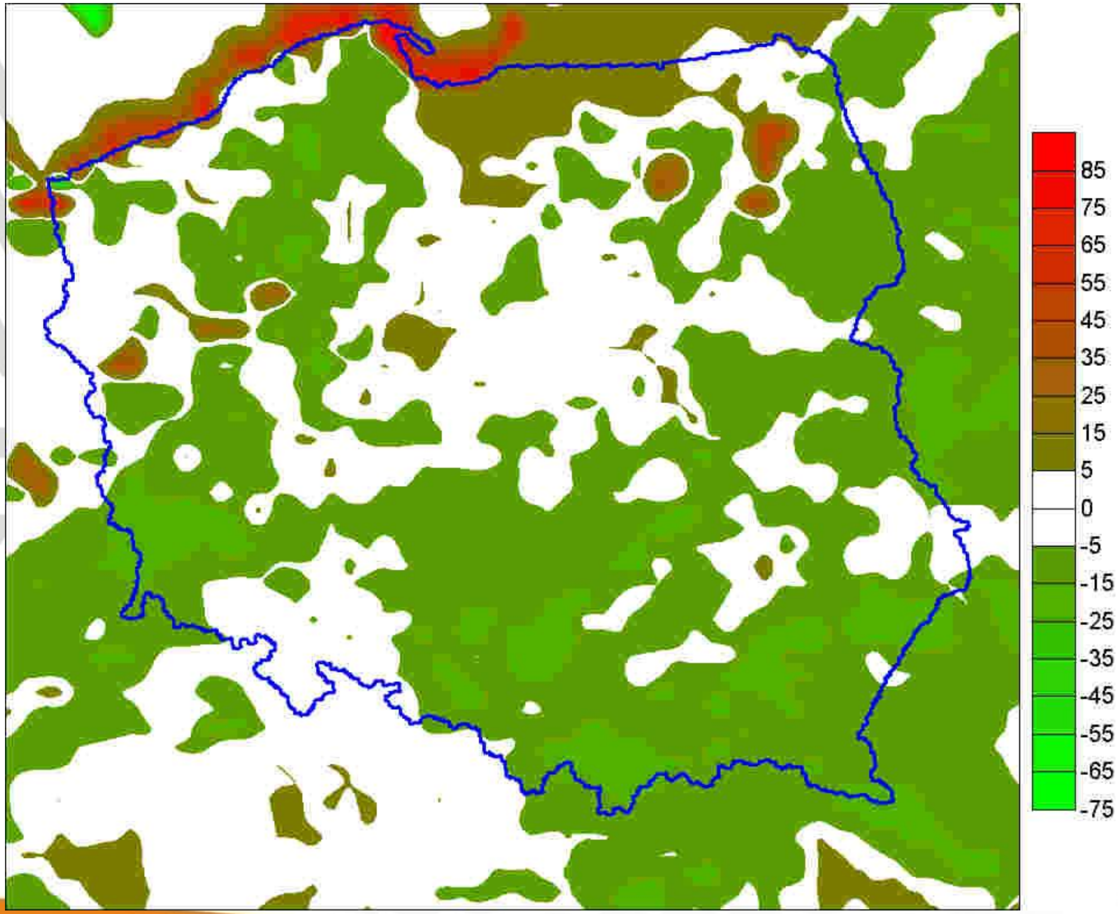
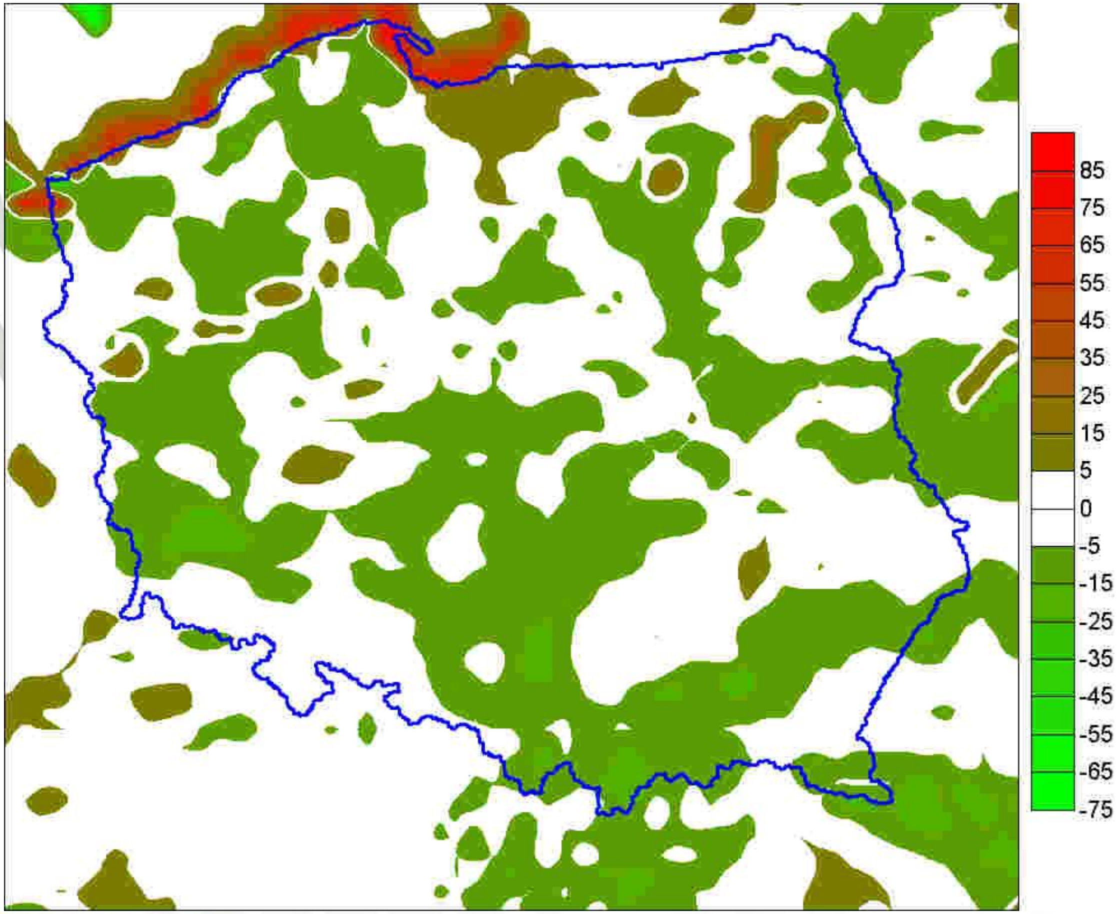
Results 5 XII 2012 – difference SWC (0-7 cm)



Correlation Coefficient: 0,8255

Experiments in soil physics – results

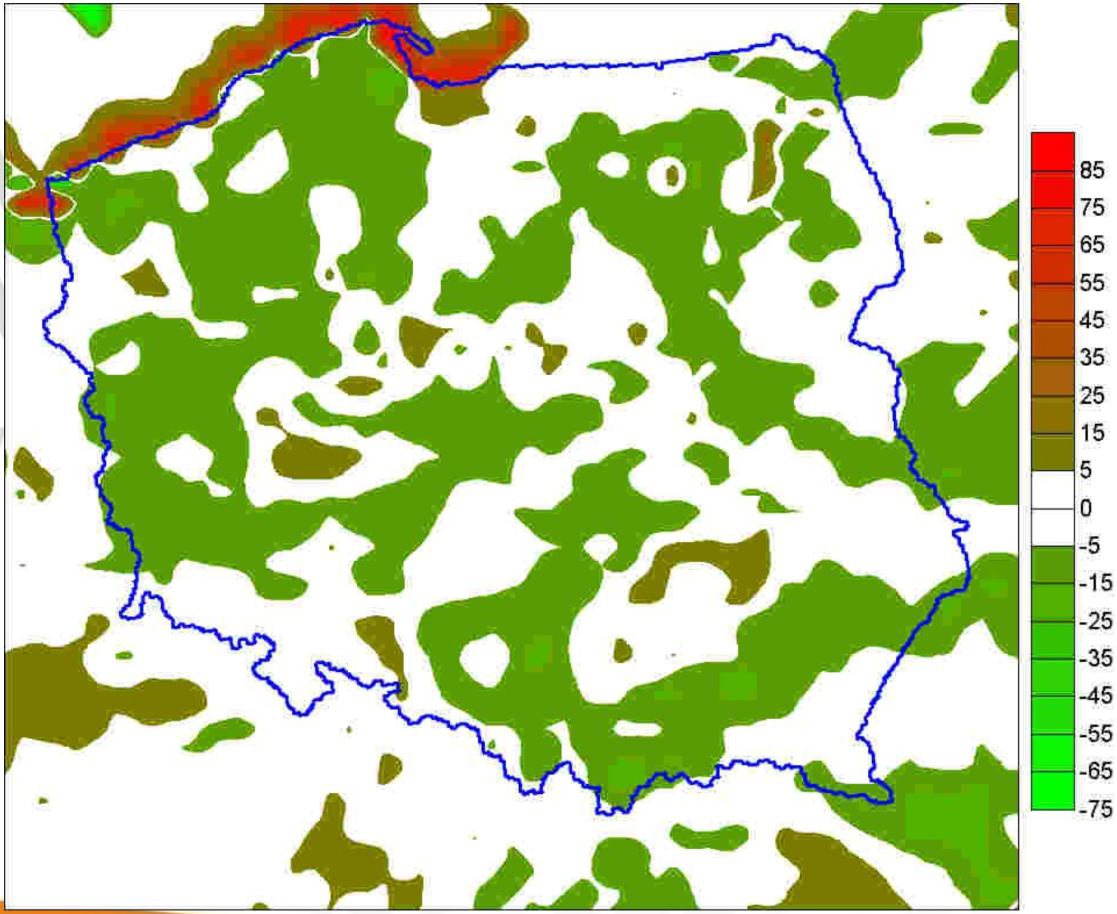
Results 5 XII 2012 – difference SWC (7-28 cm)



Correlation Coefficient: 0,8482

Experiments in soil physics – results

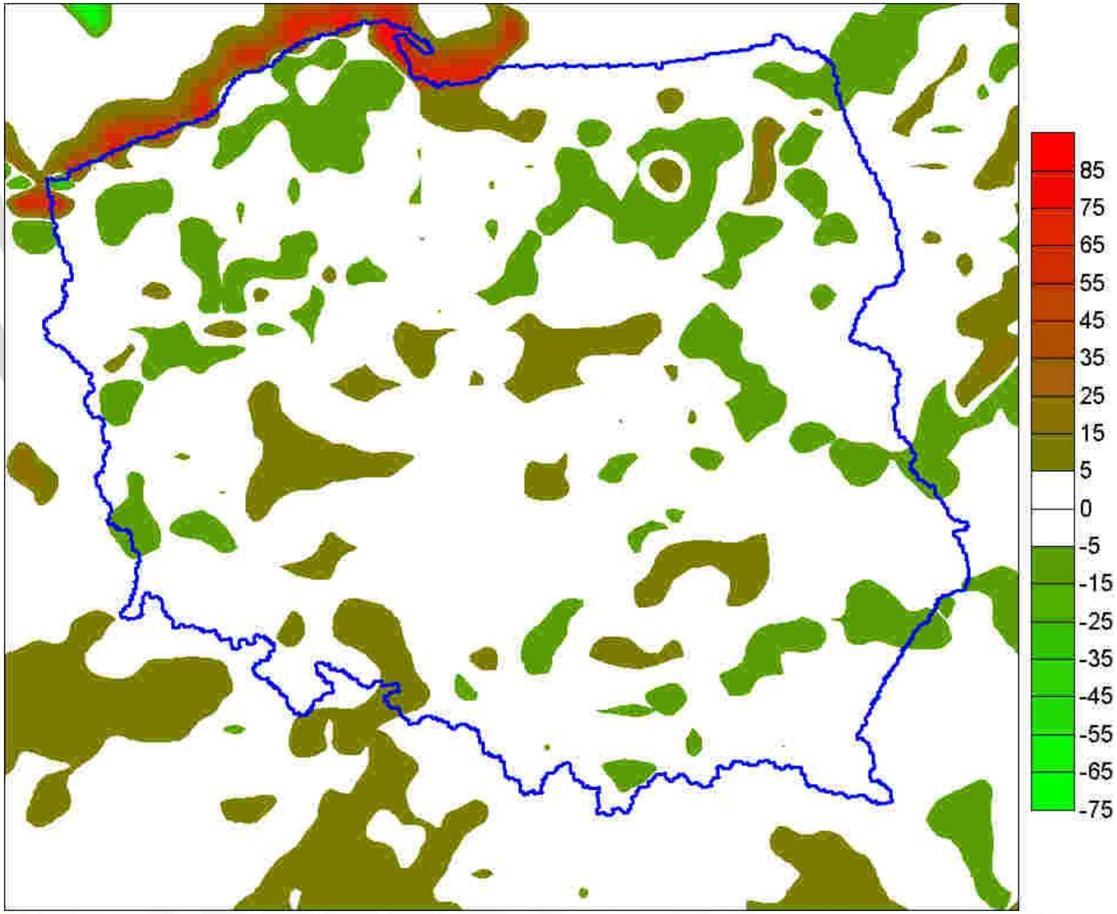
Results 5 XII 2012 – difference SWC (28-100 cm)



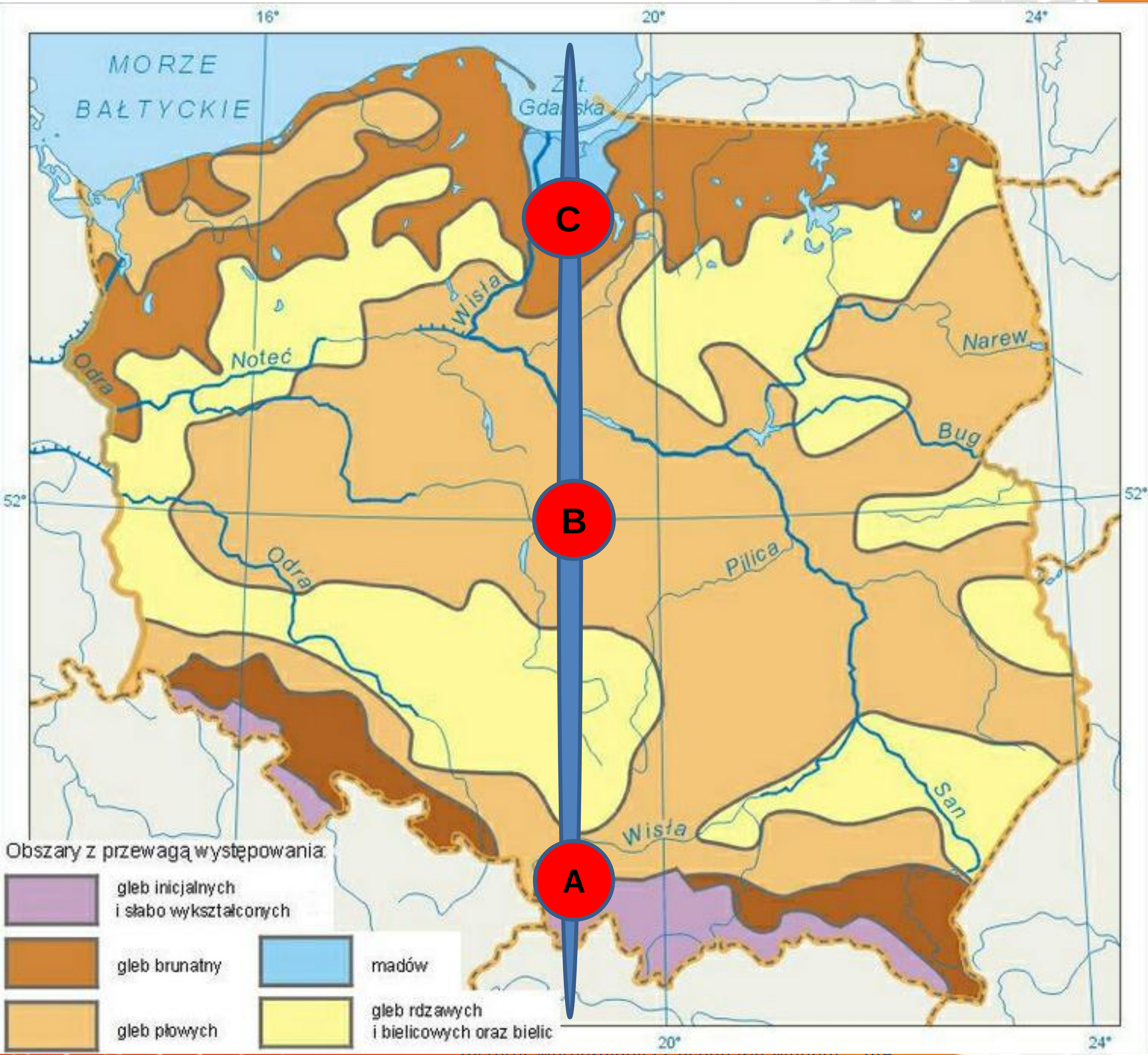
Correlation Coefficient: 0,8551

Experiments in soil physics – results

Results 5 XII 2012 – difference SWC (100-289 cm)



Correlation Coefficient: 0,8684


MORZE
BAŁTYCKIE
Zat. Gdańska
Wisła
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Odra
Narew
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Pilica
Wisła
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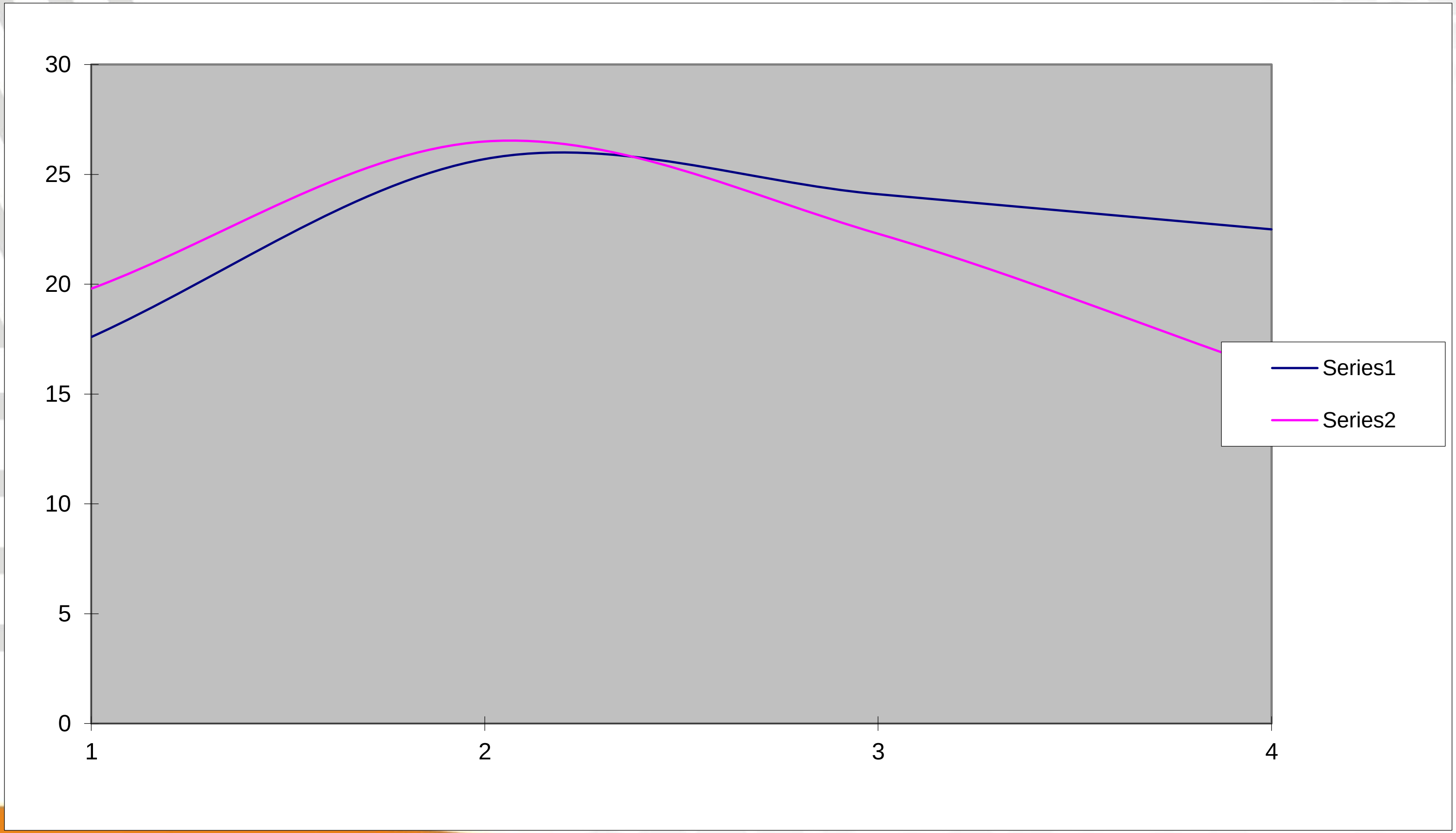
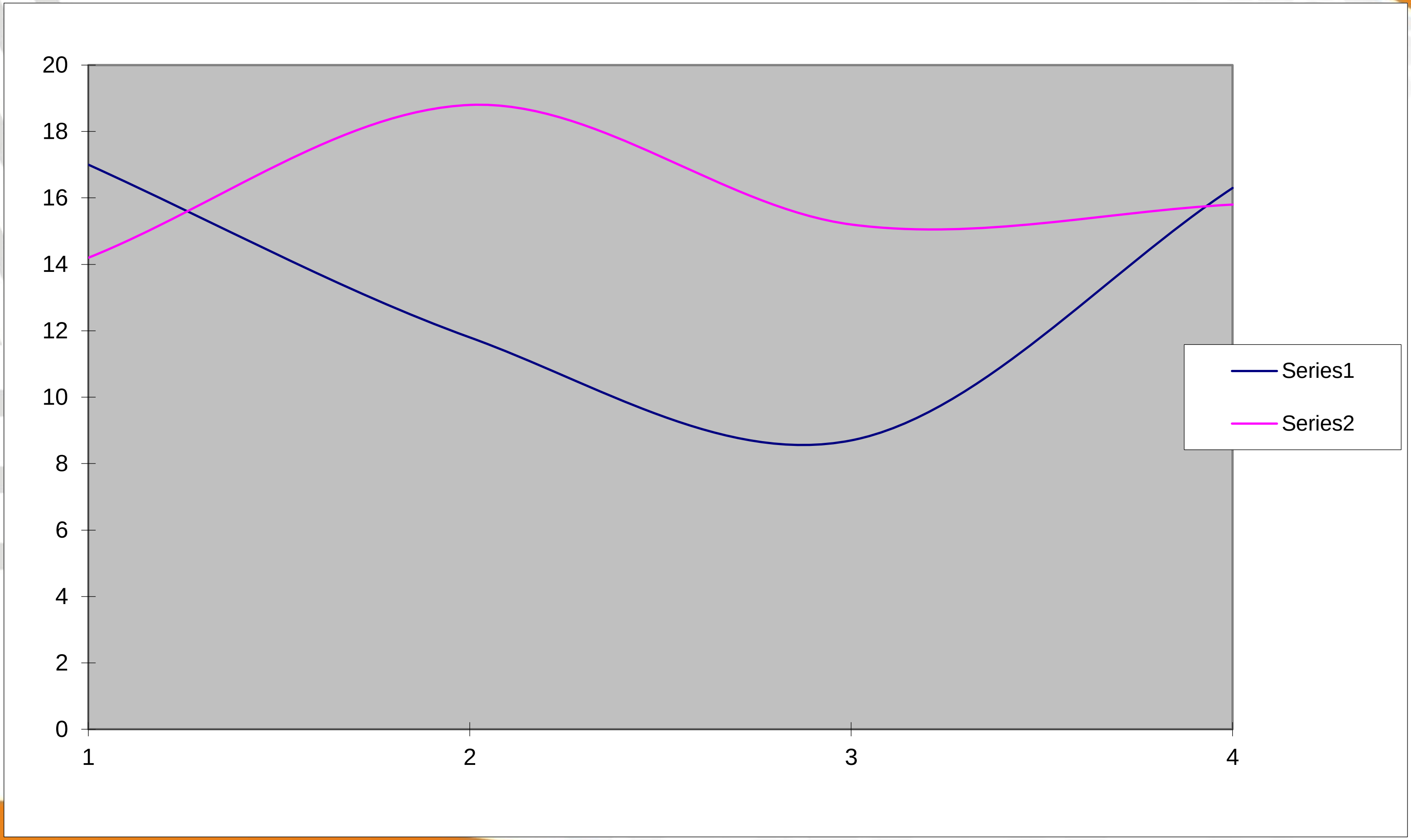
C
B
A
Obszary z przewagą występowania:
gleb inicjalnych i słabo wykształconych
gleb brunatny
madów
gleb płowych
gleb rdzawych i bielicowych oraz bielic

Results 5 XII 2012 – profile soil water content (SWC) (A)



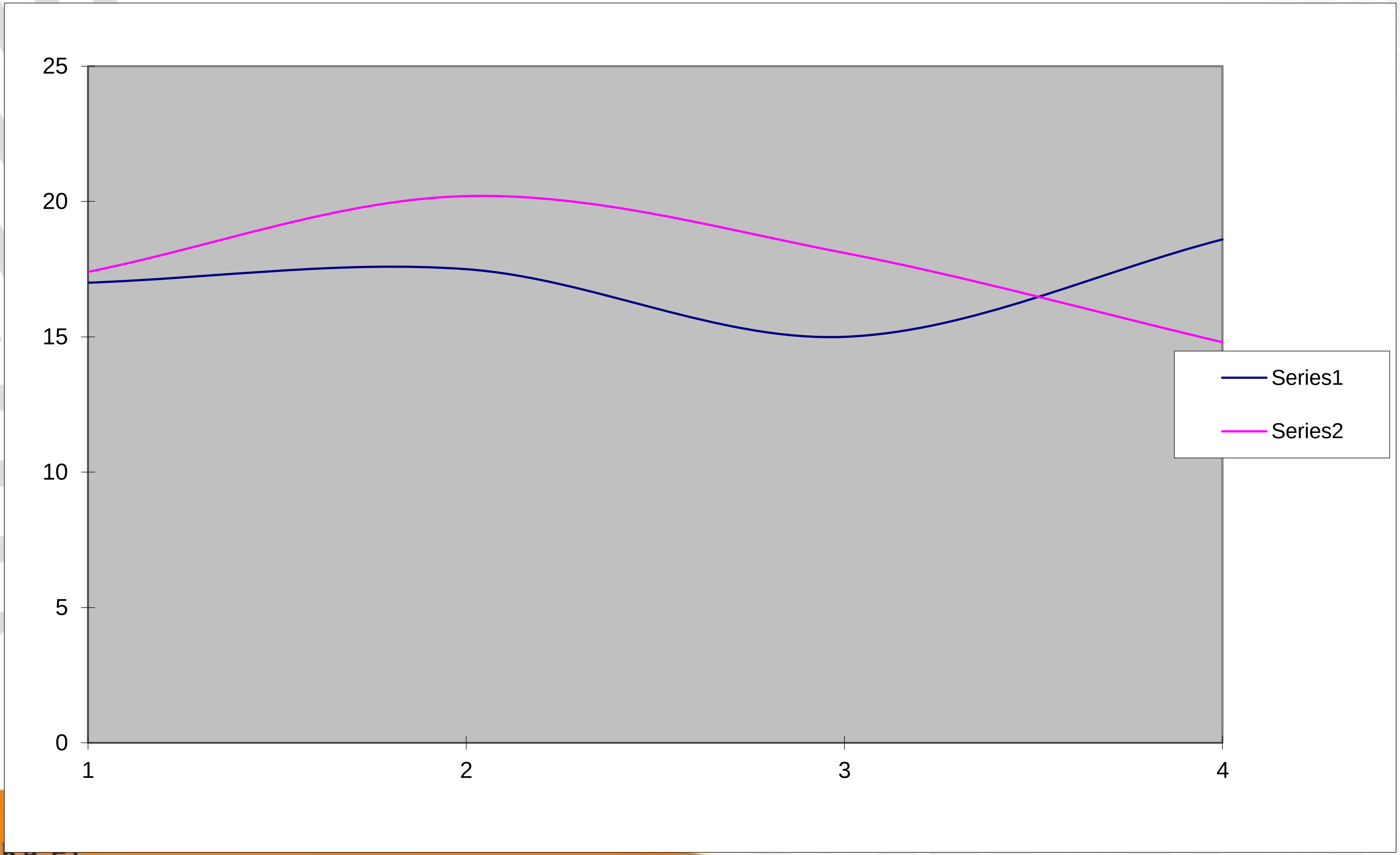
Experiments in soil physics – results

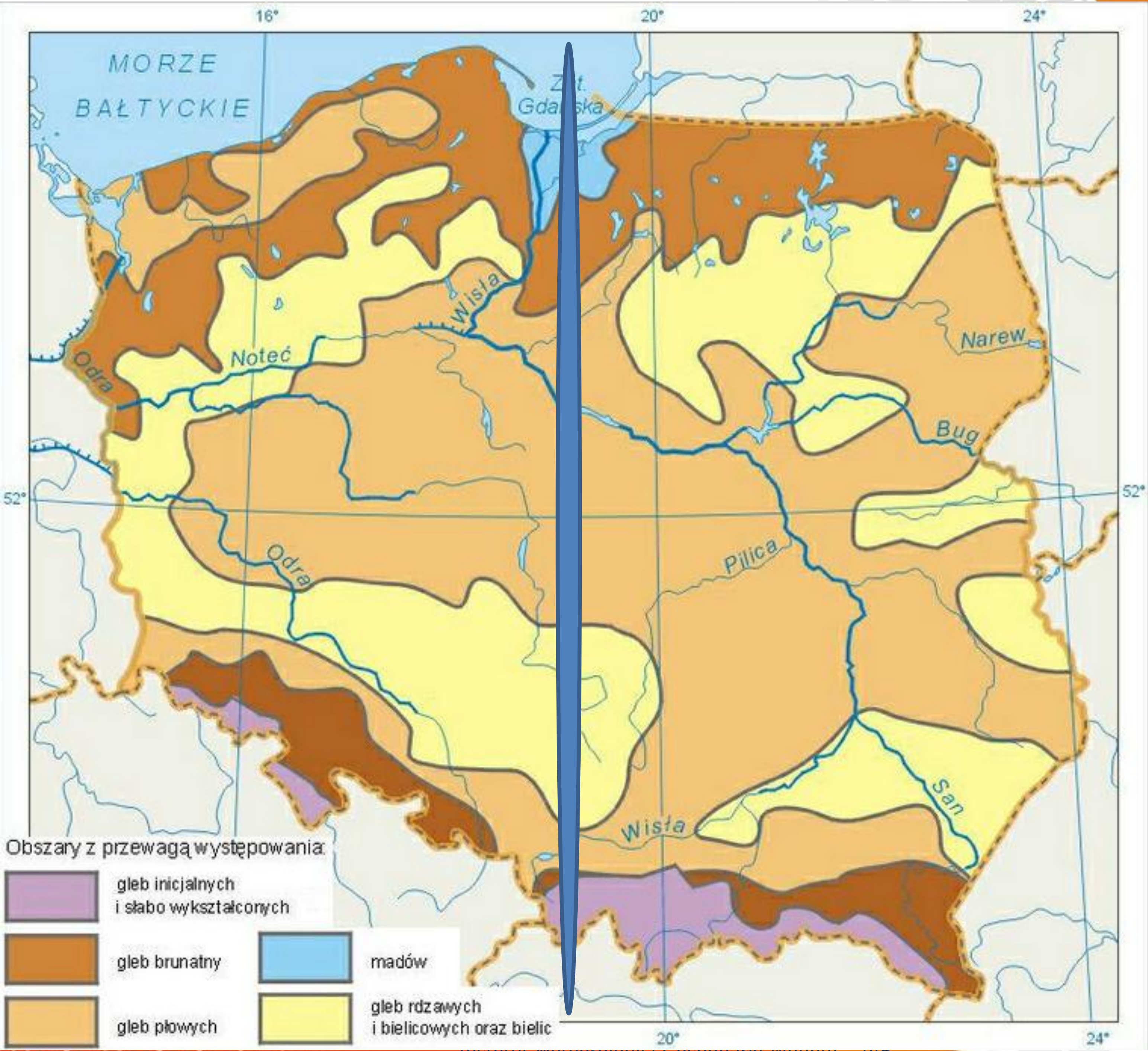
Results 5 XII 2012 – profile SWC (B)



Experiments in soil physics – results

Results 5 XII 2012 – profile SWC (C)




MORZE BAŁTYCKIE
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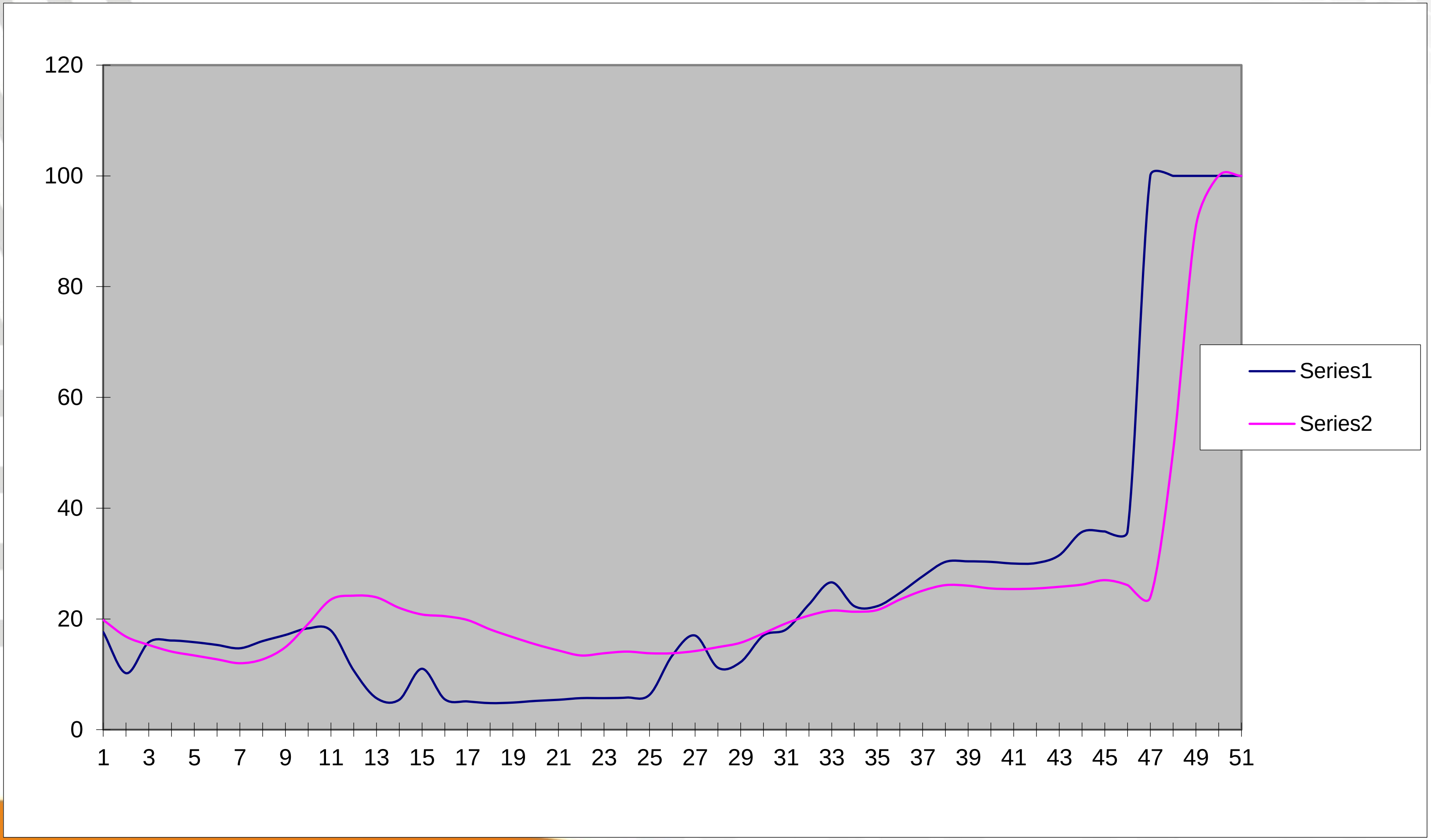
Pilica
San
16°
20°
24°
52°
Obszary z przewagą występowania:
gleb inicjalnych i słabo wykształconych
gleb brunatny
madów
gleb płowych
gleb rdzawych i bielicowych oraz bielic

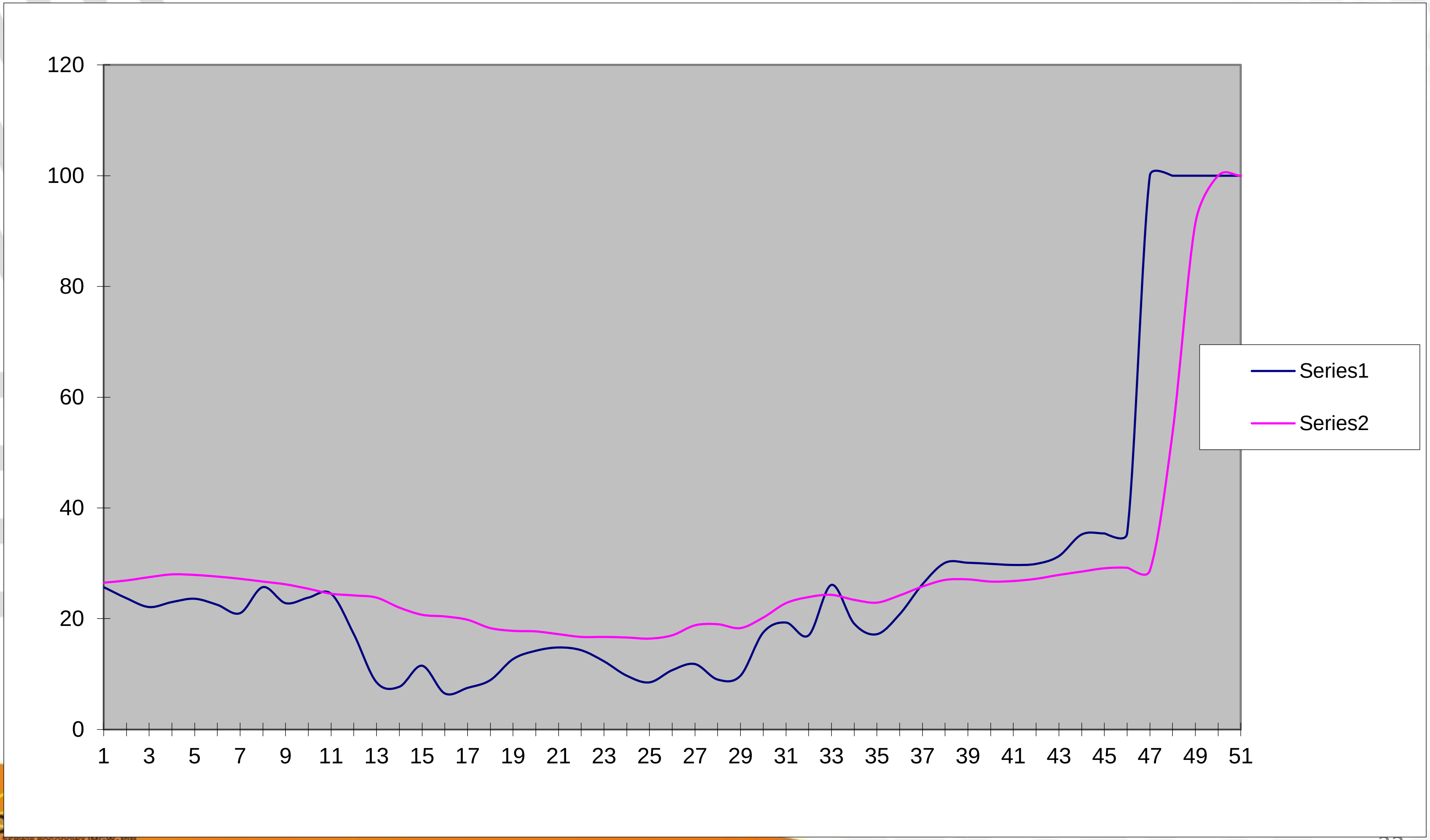
Experiments in soil physics – results

Results 5 XII 2012 – cross section profile SWC (0-7cm)



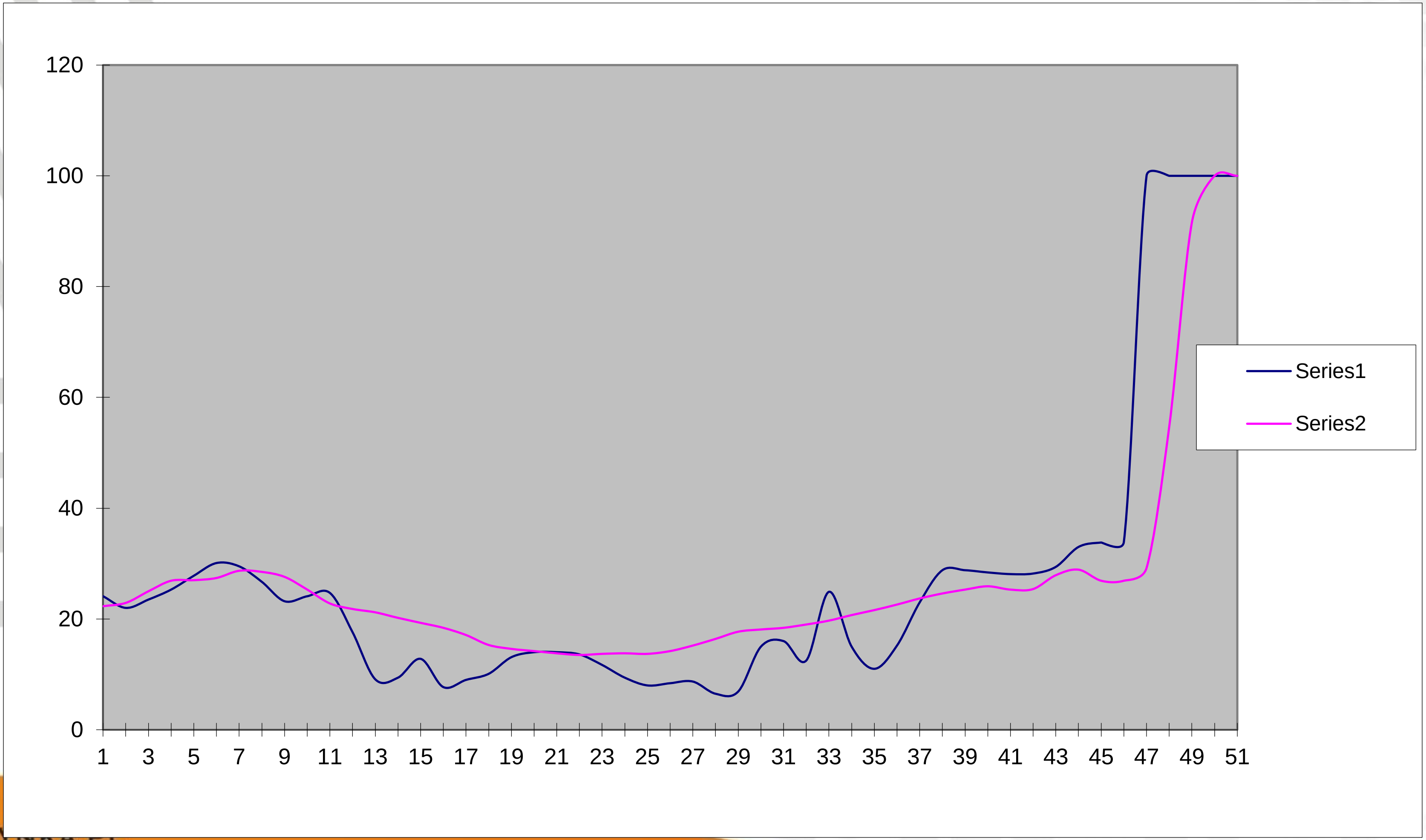
Experiments in soil physics – results

Results 5 XII 2012 – cross section profile SWC (7-28 cm)



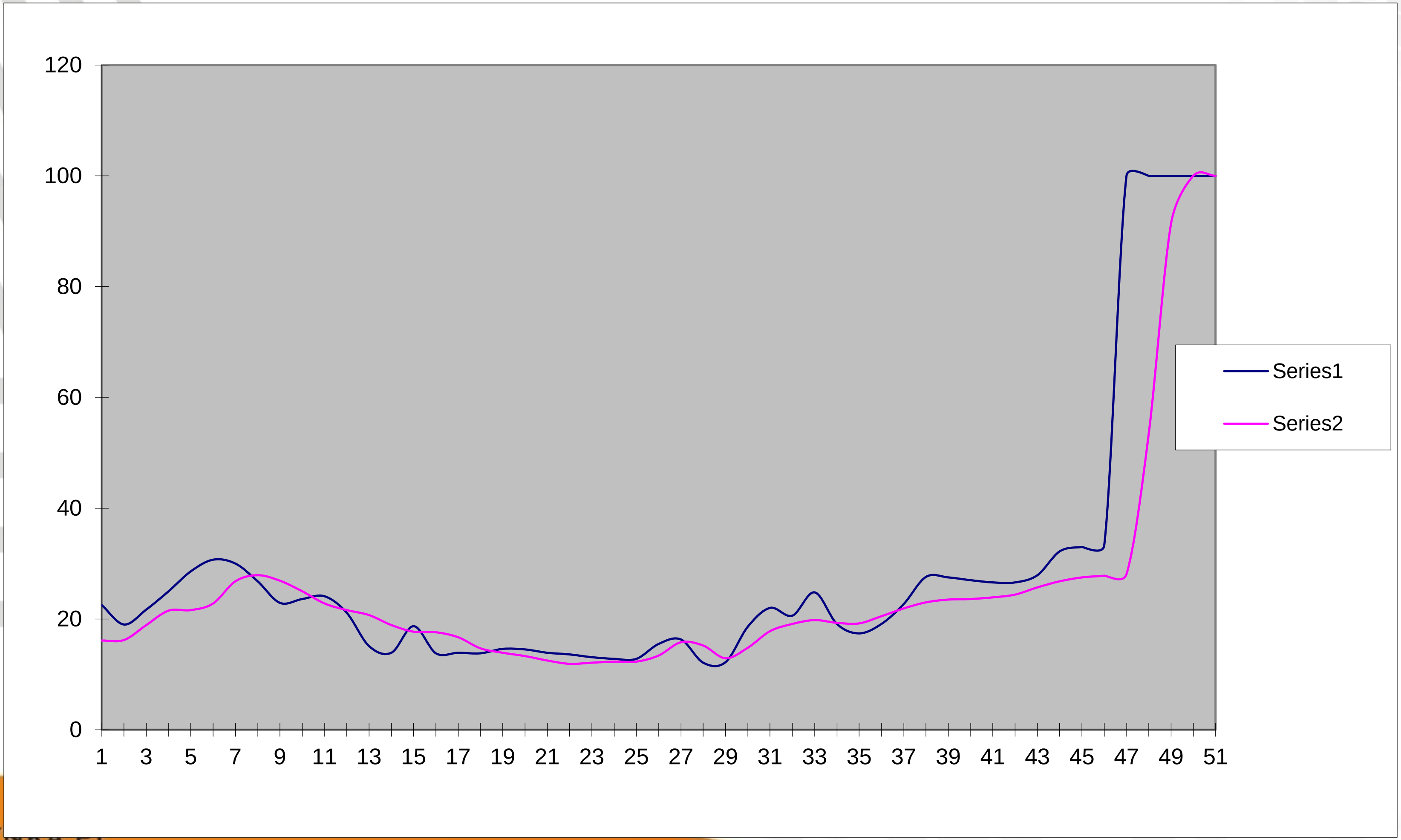
Experiments in soil physics – results

Results 5 XII 2012 – cross section profile SWC (28-100 cm)



Experiments in soil physics – results

Results 5 XII 2012 – cross section profile SWC (100-289 cm)



Summary of the part one:

- For the rest of data we received similar results.

Summary of the part one:

- **Generally:**

a) Overestimated soil water content nearby sea area of Poland.

b) Underestimated soil water content nearby mountain area and central part of Poland.

- **In detail:**

a) Overestimated or underestimated SWC depends on kind of soil and sort of cover by plants and seasons etc.:

b) for Stagnogleyic Luvisols, Haplic Phaeozems, Haplic Podsols, Cambic Arenosols, – underestimated

c) for Eutric Cambisols, Haplic Luvisols – overestimated

Data from IA PAN

prof. Sławiński, K. Lamorski, A. Mazur, G. Duniec

Experiments in soil physics – results

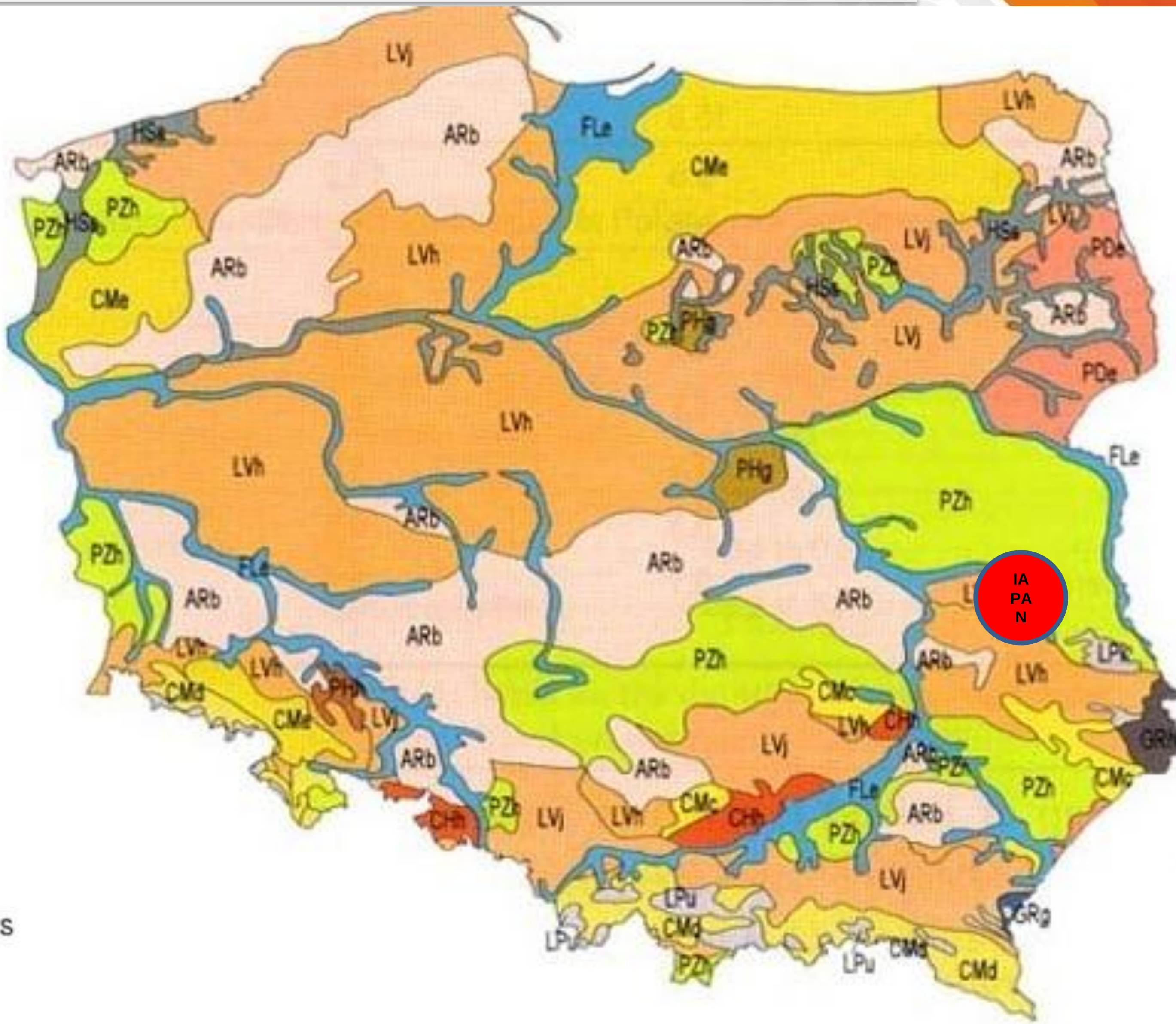
Data from Institute of Agrophysics PAN

- Data come from 4 different places in Poland

- Geographical coordinates:

a) λ=23º 06' 14.2'' φ=51º 28' 55.2'' undergroud station; soil: sand in pinery
b) λ=23º 06' 50.5'' φ=51º 28' 23.7'' overground station; soil: peat
c) λ=23º 07' 35.5'' φ=51º 27' 40.1'' overground station; soli: peat under grass
d) λ=23º 08' 6.542'' φ=51º 27' 12.424'' underground station; soli: rendzic

Experiments in soil physics – results



- ARb - Cambic ARENOSOLS
- CHh - Haplic CHERNOZEMS
- CMe - Eutric CAMBISOLS
- CMd - Dystric CAMBISOLS
- CMc - Calcaric CAMBISOLS
- FLe - Eutric FLUVISOLS
- GRg - Gleyic GREYZEMS
- GRh - Haplic GREYZEMS
- HSs - Terric HISTOSOLS

- LPk - Rendzic LEPTOSOLS
- LPq - Lithic LEPTOSOLS
- LPu - Umbric LEPTOSOLS
- LVh - Haplic LUVISOLS
- LVj - Stagnic LUVISOLS
- PDe - Eutric PODZOLUVISOLS
- PHg - Gleyic PHAEOZEMS
- PHh - Haplic PHAEOZEMS
- PZh - Haplic PODZOLS

Data from Institute of Agrophysics PAN

- Our colleagues (prof. C. Sławiński, dr K. Lamorski) measured:
- Temperature at 10 cm underground
- Soil water content at 10 cm underground
- The first part of data comes from January 2008 to December 2009.
- Now we have measured temperature and soil water content at depth of 10 cm from April 2013. We will plan to extend our measurement on different points which will be on different depth and we will choose other points.

Experiments in soil physics – results

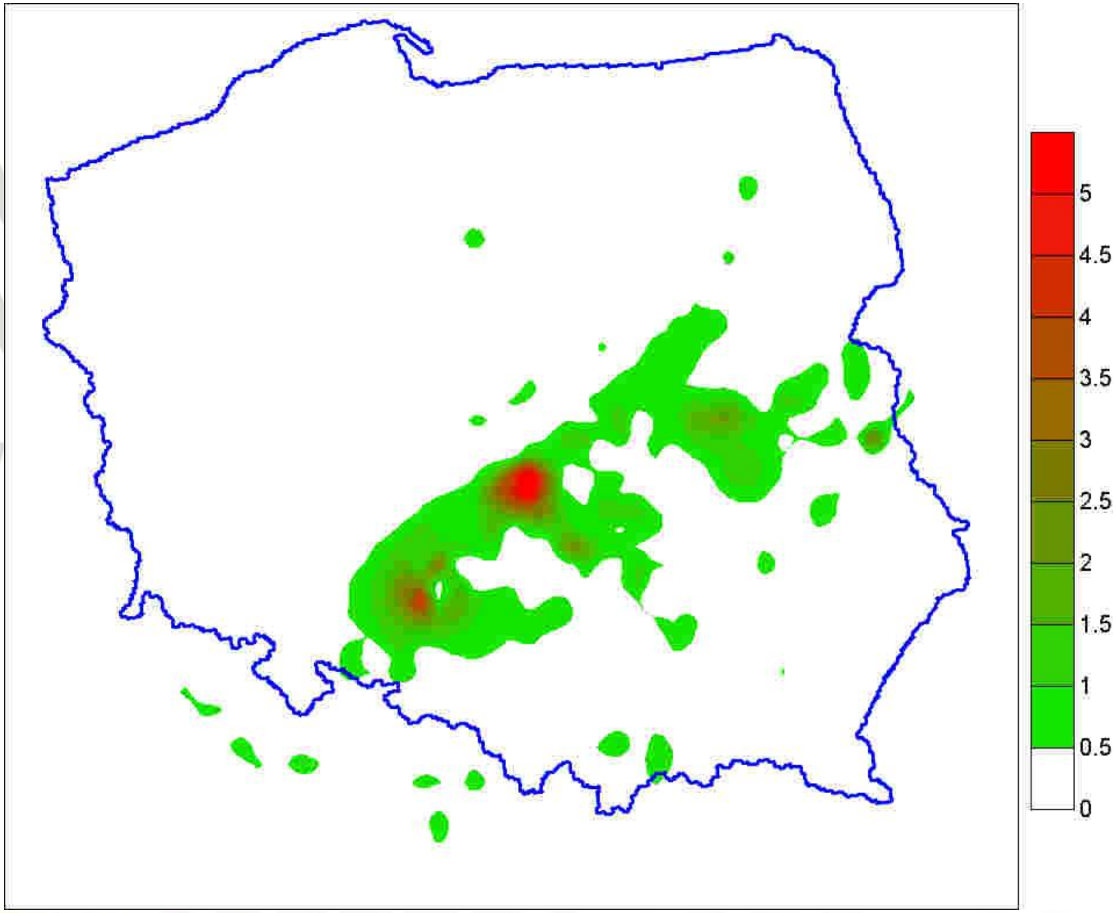
Data from Institute of Agrophysics PAN

- We compared results from COSMO model with results which we received from COSMO model after changing initial data.

- We analysed: mean bias, Standard Deviation (SD), Correlation Coefficient (CC), Root Square Difference (RMSD), vertical and horizotal profiles.

Experiments in soil physics – results

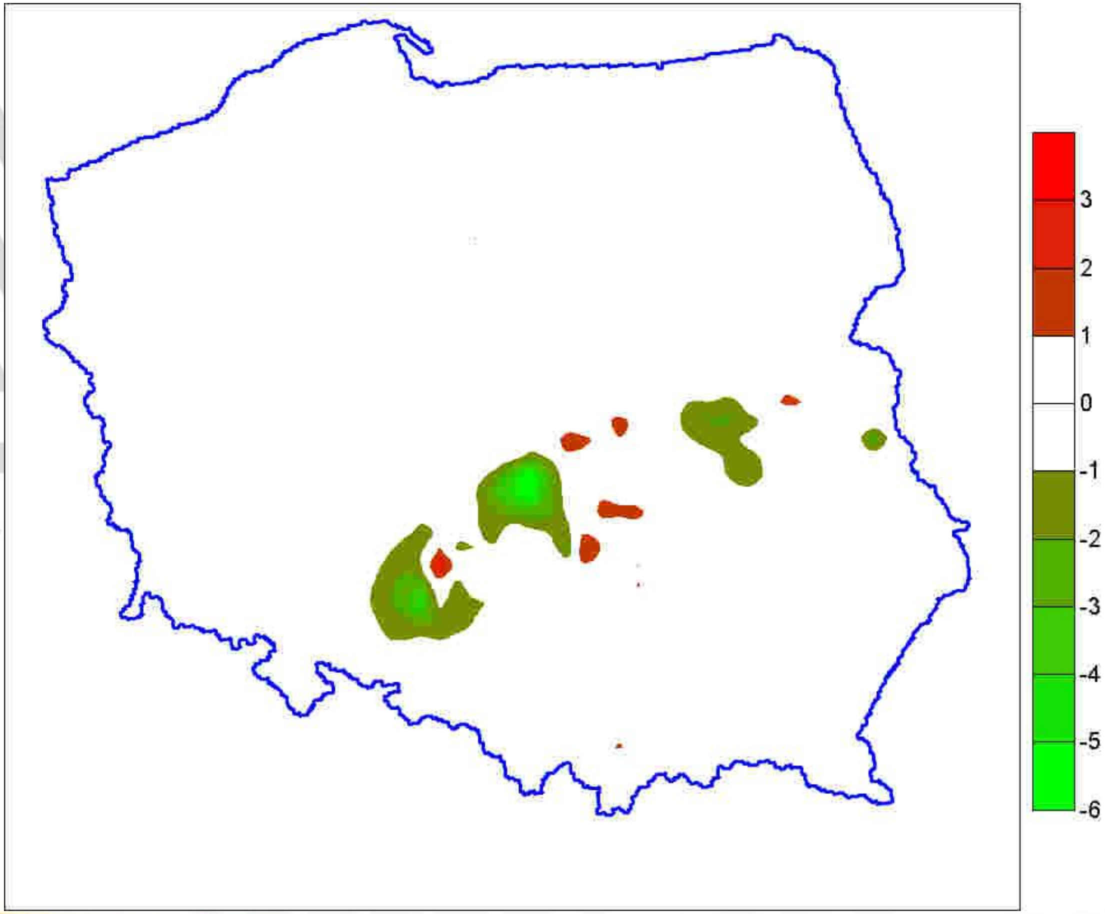
Results 14 VIII 2008 – humidity – Mean absolute error



grid spacing – 14 km

Experiments in soil physics – results

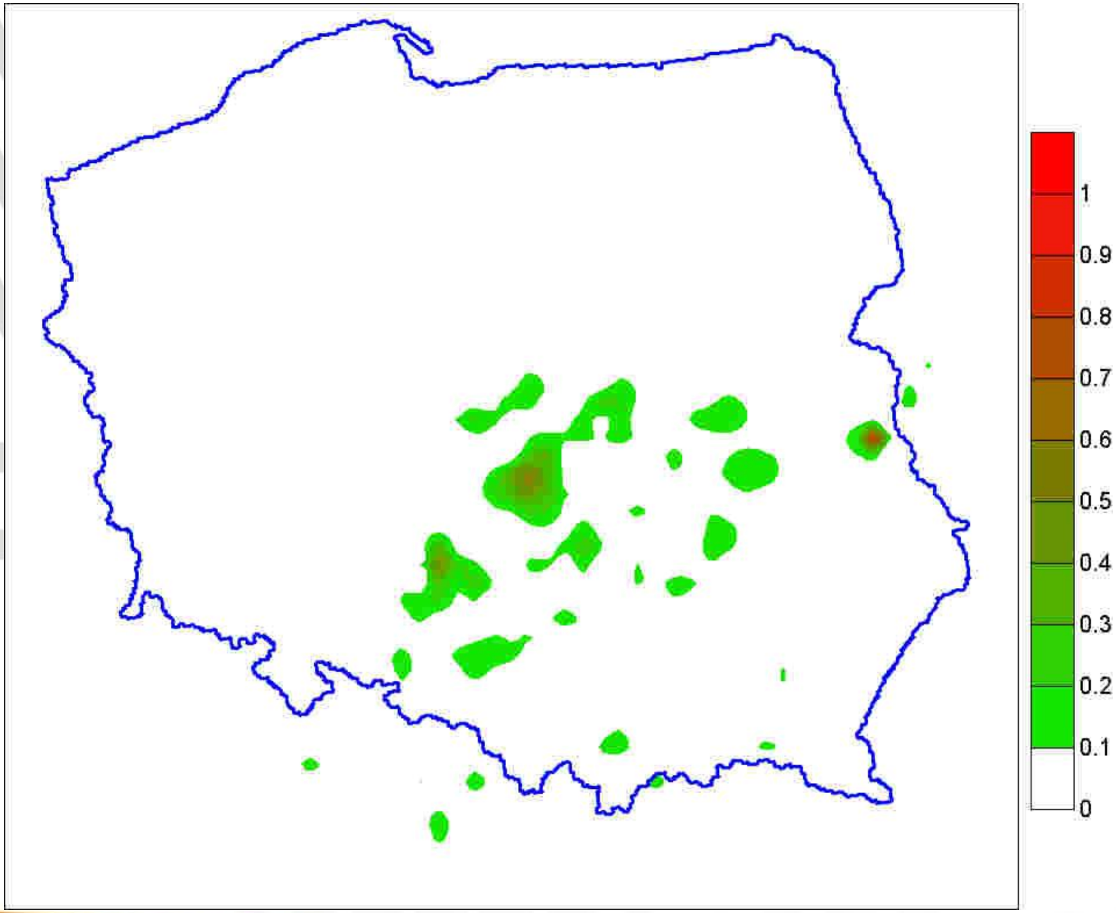
Results 14 VIII 2008 – humidity – difference



grid spacing – 14 km

Experiments in soil physics – results

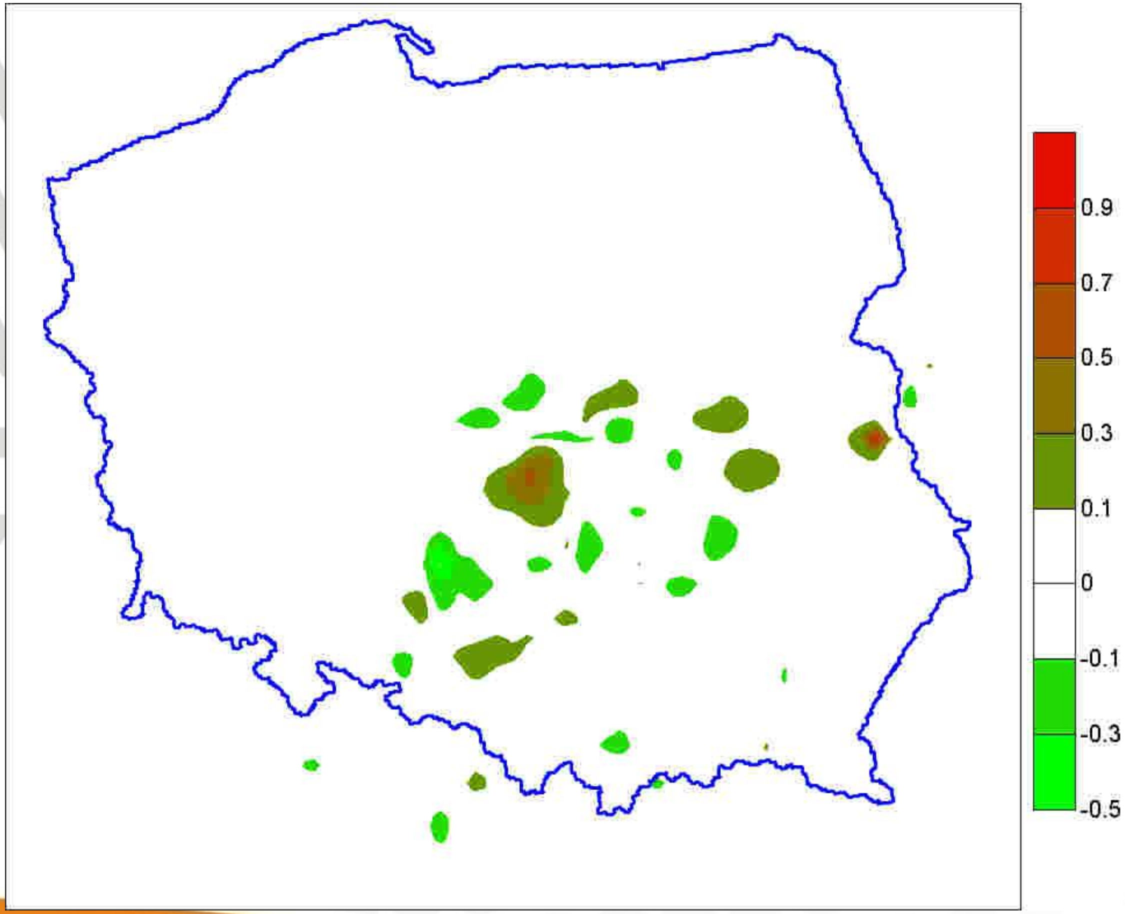
Results 14 VIII 2008 – temperature at 2 m – Mean absolute error



grid spacing – 14 km

Experiments in soil physics – results

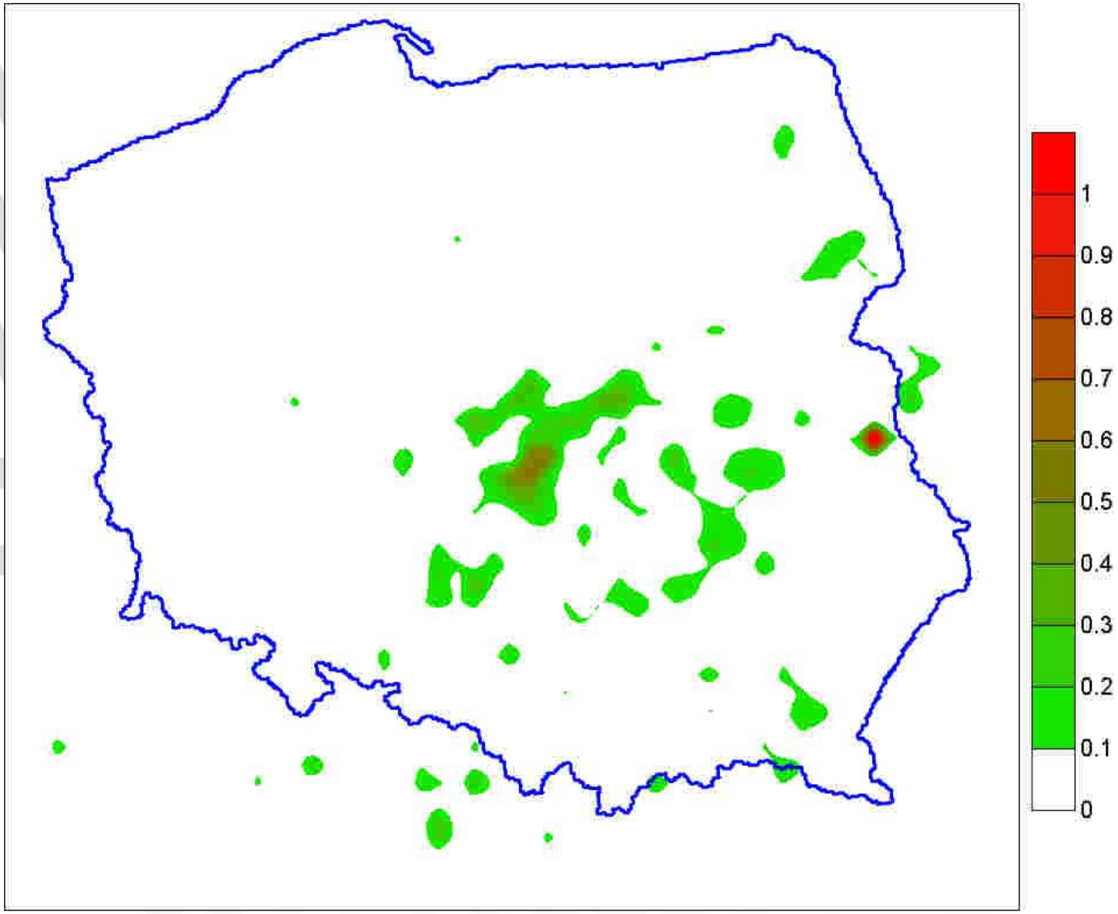
Results 14 VIII 2008 – temperature at 2 m – difference



grid spacing – 14 km

Experiments in soil physics – results

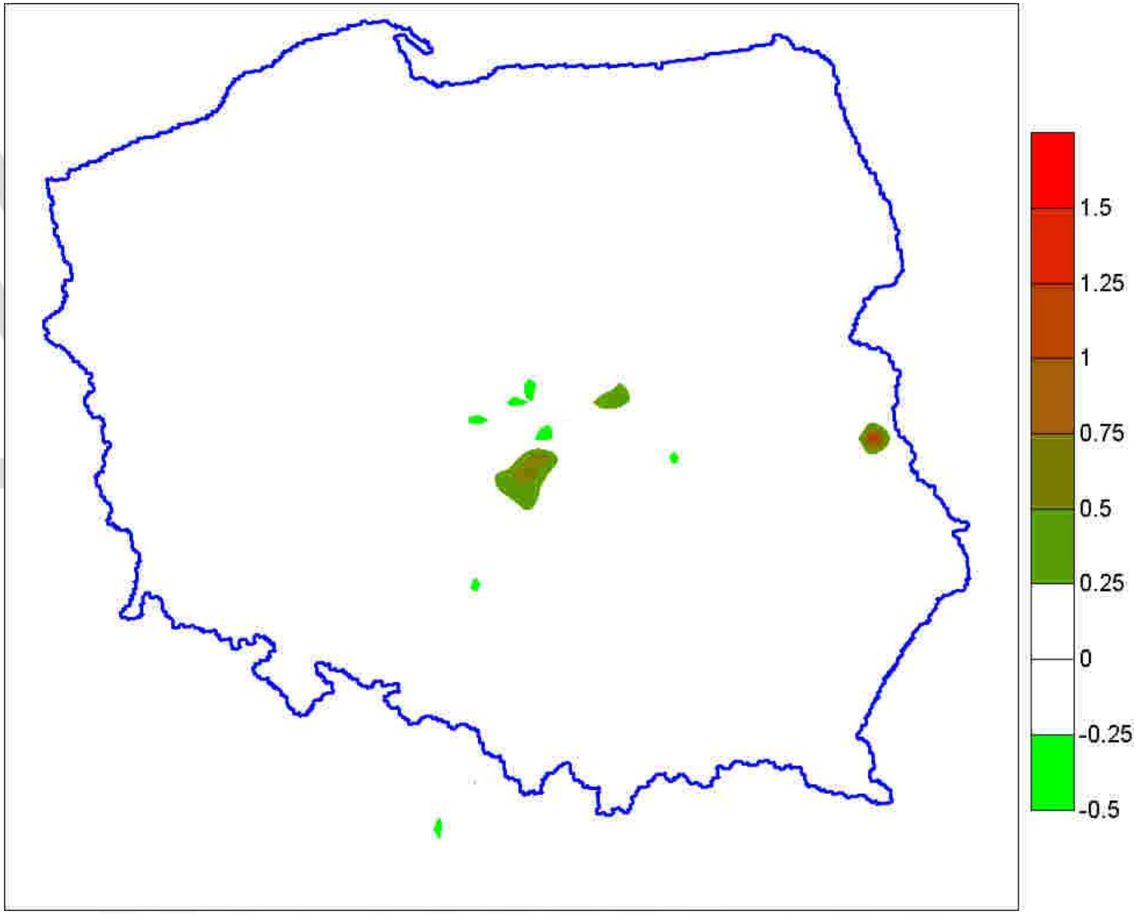
Results 14 VIII 2008 – soil temp. – mean absolute error



grid spacing – 14 km

Experiments in soil physics – results

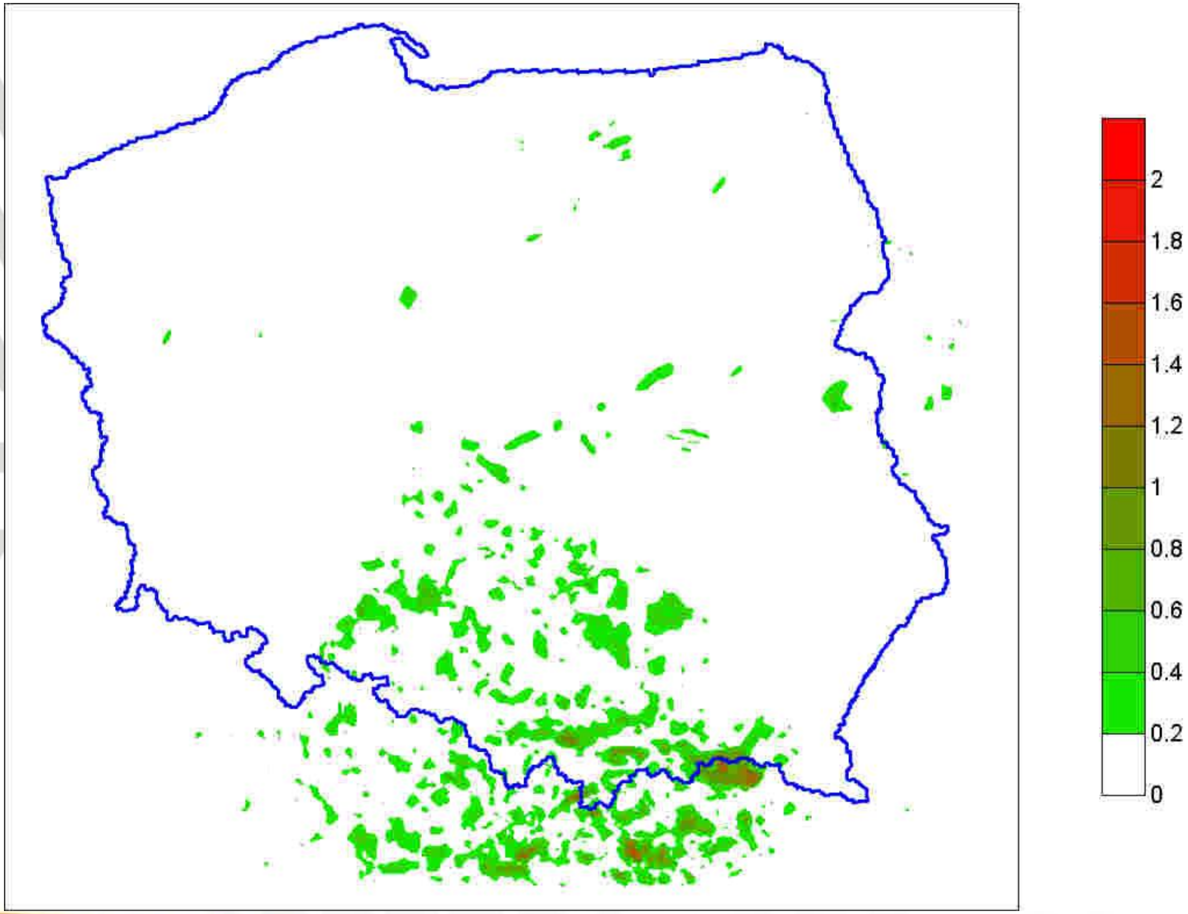
Results 14 VIII 2008 – soil temperature – difference



grid spacing – 14 km

Experiments in soil physics – results

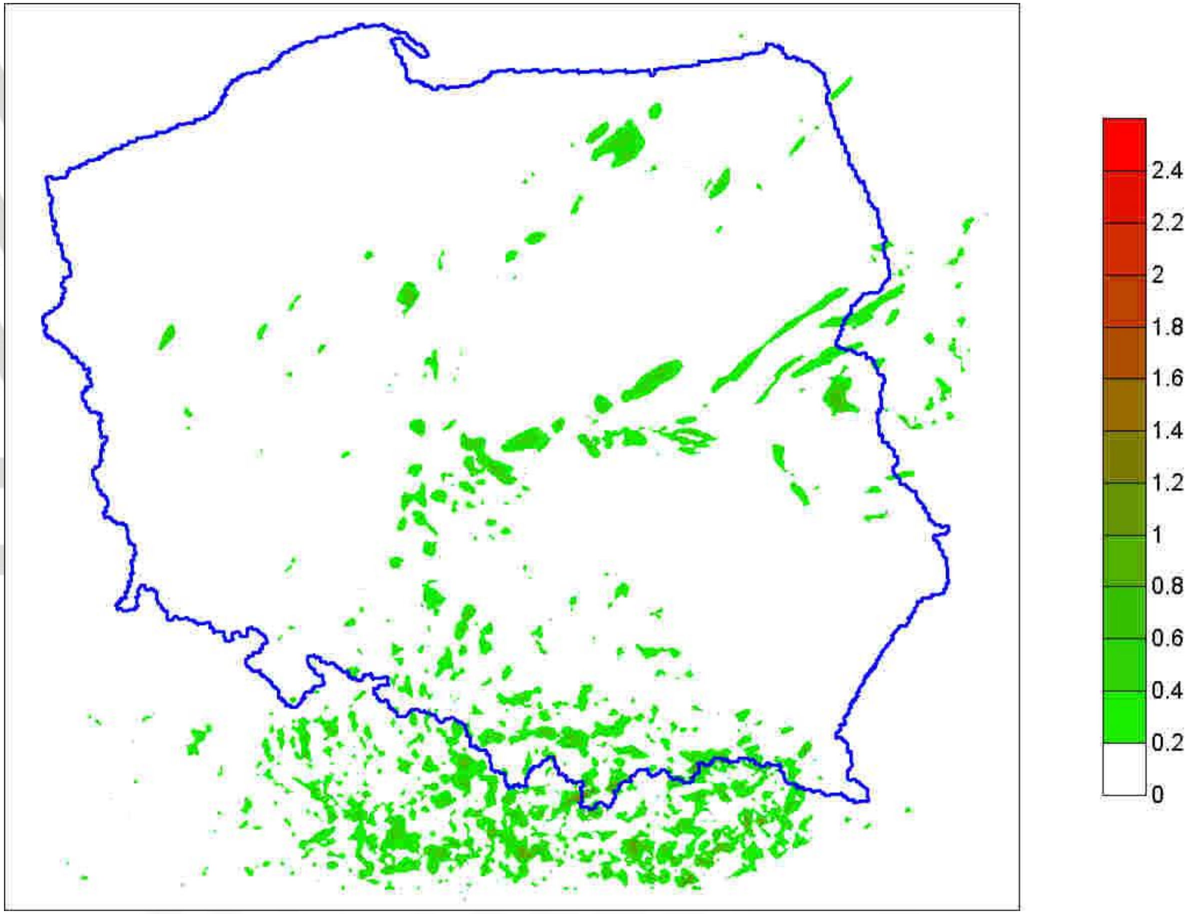
Results 14 VIII 2008 –temp. at 2 m – mean absolute error



grid spacing – 2,8 km

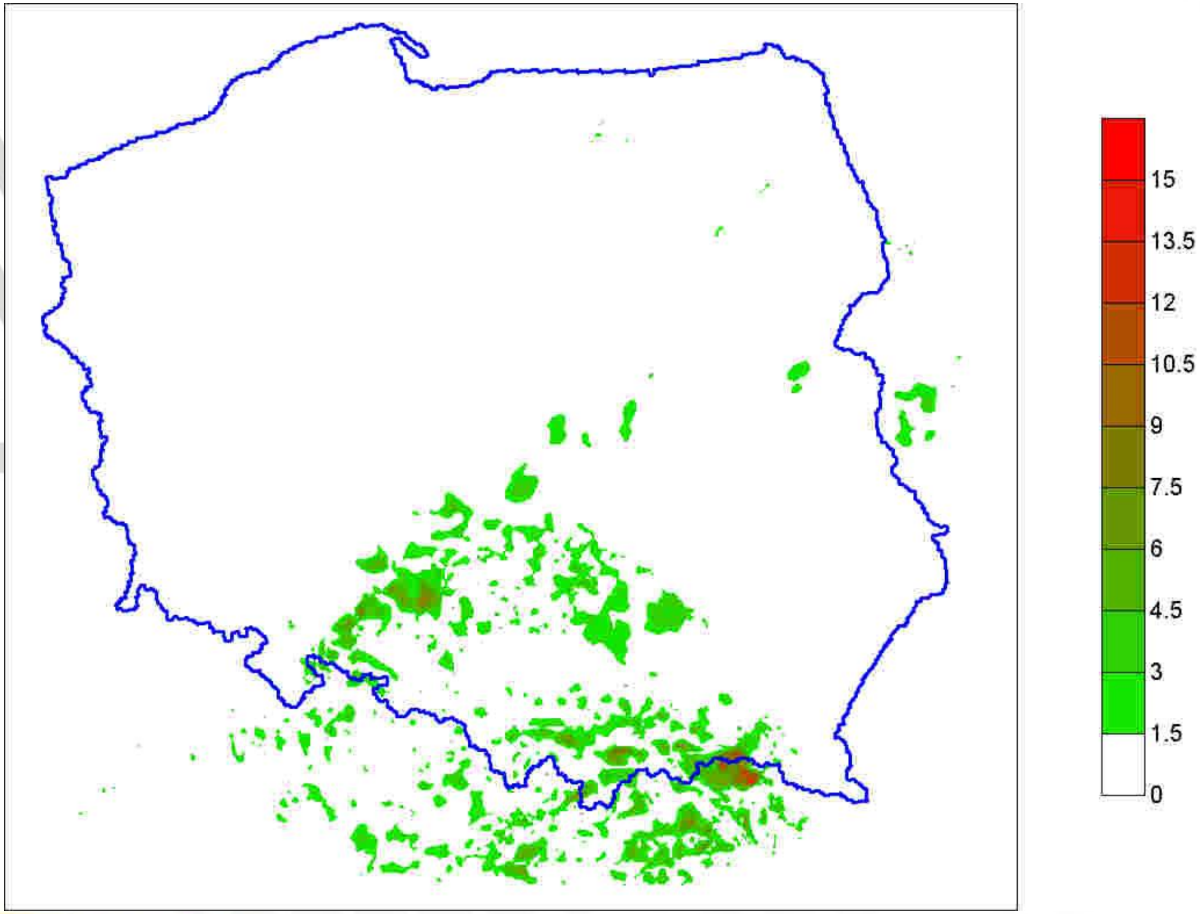
Experiments in soil physics – results

Results 14 VIII 2008 – soil temperature – mean abs. error



grid spacing – 2,8 km

Results 14 VIII 2008 – humidity – mean absolute error



grid spacing – 2,8 km

Summary of the second part:

a) ”Injected” values propagate during forecast(s).

b) It shows important role of proper initialization of soil (boundary) conditions.

c) Higher resolution results differ from rough ones because of more detailed description of topography and soil properties, not only due to increased resolution itself.

Theoretical aspect:

- Based on data I pointed out that hydraulic conductivity should depend on temperature too.

$$K = K_0 e^{f(\theta)} \left(\frac{T}{T_0} \right)^{\varepsilon}$$

$$\frac{\partial \theta}{\partial t} = K_0 e^{f(\theta)} \left(\frac{T}{T_0} \right)^{\varepsilon} \left[\frac{\partial f(\theta)}{\partial z} \frac{\partial \theta}{\partial z} + \frac{\varepsilon}{T} \frac{\partial T}{\partial z} + \frac{\partial^2 \theta}{\partial z^2} \right]$$

Theoretical aspect:

- We would like to test this formula for different kind of soil e.g.:

a) Sand
b) Clay
c) Umbric Leptosols
d) …..

Experiments in soil physics – results

CONTENT

1. We have done scientific books review which focus on soil physics:

2. Below I present list scientific book:

a) Daniel Hillel – Soil physics

b) Daniel Hillel – Introduction to Environmental Soil Physics

c) Daniel Hillel – Soil in the Environment: Crucible of Terrestial Life

d) Ning Lu, William Likos – Unsaturated soil mechanics

e) D. E. Radcliffe – Soil Physics with Hydrus: Modeling and Applications

f) D. J. Stensrud – Parameterization Scheme

g) Brutsaert – Evaporation intio the Atmosphere

Experiments in soil physics – results

h) Kirkham – Principles of Soil and Plant Water Relations

i) J. Bear, A Cheng – Modeling Groundwater Flow and Contaminant Transport

j) J. Bear – Dynamic of Fluid in Porous Media

k) Jaworski – Evaporate – Polish book

l) Warrick – Soil Water Dynamics

m) Mazor – Global Water Dynamics – Shallow and Deep Groundwater

n) Miyazaki – Water flow in soil

o) Chen – Computational methods for multiphase flows in porous media

p) Zachar – Soil errosion

Experiments in soil physics – results

q) Mikelic, Fasano – Filtration in Porous Media and Industrial Application

r) Marinoschi – Functional apprach to nonlinear models of water flow in soil.

s) T. Schanz – Theoretical and Numerical Unsaturated Soil Mechanics

t) A. Verruijt – An introduction to Soil Dynamics

u) A. Verruijt – Soil Mechanics

v) A. Verruijt – Computational Geomechanics

w) Das, Raman – Principles of Soil Dynamics

x) Das – Fundamental of Soil Dynamics

y) Nield, Bejan – Convection in porous Media

Experiments in soil physics – results

z) Pinder, Gray – Essential of multiphase flow

i) Rodriguez, Porporato – Ecohydrology of Water – Controlled Ecosystems Soil Moisture and Plant Dynamics

ii) Alvarez – Benedi, Munoz-Carpena – Soil Water Salute Process Characterization – An Integrated Approach

iii) Kersebaum, Hecker, Mirschel, Wegehenkel –Modeling water and nutrient dynamics in soil crop system

iv) Shukla – Principles of Soil Physics

v) Pachepsky, Radcliffe, Selim – Scaling Methods in Soil Physics

EUROTECH

dr Bohdan J. Naumienko
International Projects Coordinator

Future with EUROTECH

- EUROTECH developed and introduced to Polish Army **VERMIN** Aircraft Target System consists of aerial unmanned platform, ground control station and pneumatic launcher. One system is able to control a few aircraft targets simultaneously on testing/firing space. Aircraft Target can be used for radar guided systems or infrared homing missiles.

- Experienced Eurotech's team provide full service from conceptual design through production to maintenance and service.

Experiments in soil physics – results

Future with EUROTECH

POGODYNKA.PL
SERWIS POGODOWY IMGW-PIB

Warsaw University of Life Science

Future with SGGW

- In September 2013, we will meet with Chancellor from Warsaw University of Life Science (SGGW) (Faculty of Civil and Environmental Engineering).

- Researchers from SGGW interest in soil project. At the moment I don’t know how many people would like to join us. I can tell more after meeting…

Future in soil physics

- We would like to prepare new soil experiment:

a) new mathematical description/parameterization of soil physics processes for bare soil,

b) implementation to COSMO model and tests,

c) new numerical methods on which we will work with our co-workers from IA PAN.

Thank you for your attention

Grzegorz Duniec, Andrzej Mazur
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