Institute of Meteorology and Water Management
National Research Institute

The role of snow cover in hydrological forecasting – the example from Poland

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Plan:

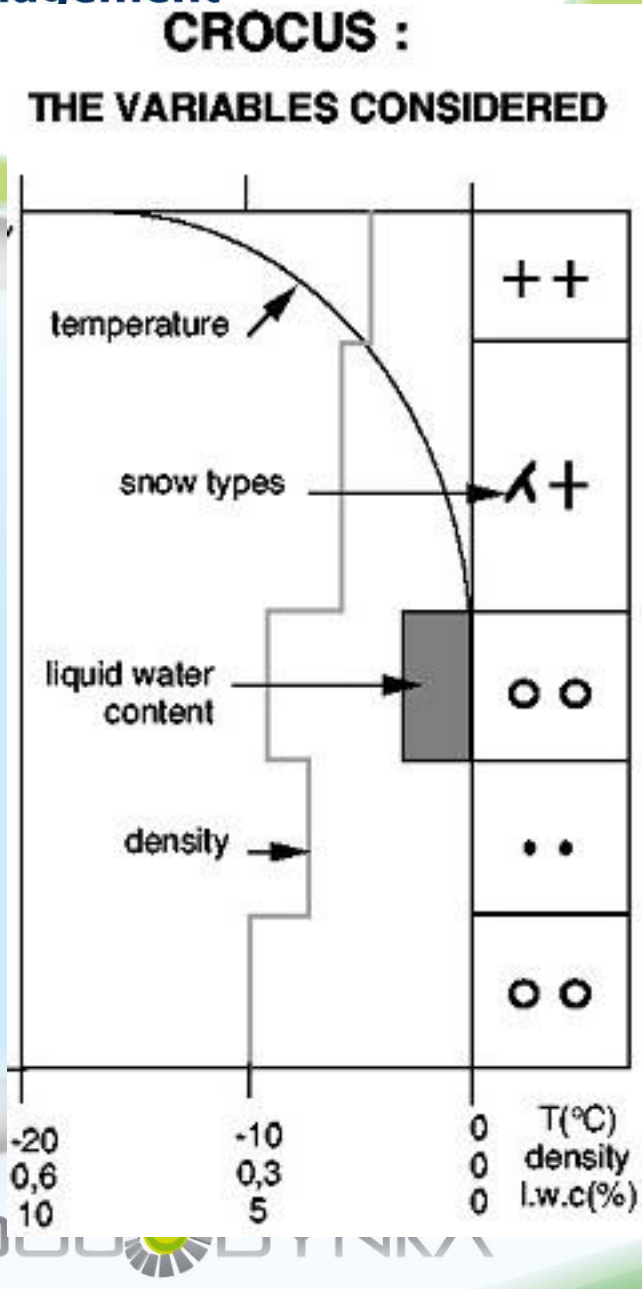
1. Motivation
2. CROCUS
3. Work already done
4. Validation results
5. Point values from the model
6. Future plans

Motivation:

1. No operational model of snow
2. 20 years of CROCUS runs
3. Availability of SURFEX code in ALADIN consortium
4. Well documented project with existing tools to visualize results

CROCUS

Crocus is a thermodynamic-based computer model able to simulate the energy and mass balance of the snowpack. Its main purpose is to accurately describe the time evolution of the physical properties of the inner snowpack (thermal conduction, radiative transfer) based on a semi-quantitative description of the time evolution of the morphological properties of the snow grains along with snow metamorphism.



CROCUS

INPUT variables, from atmospheric model or observations:

Air temperature
Air relative humidity
Wind speed
Snowfall rate
Rainfall rate
Incoming solar radiation (visible + near-infrared)
Incoming atmospheric radiation (thermal infrared)

CROCUS

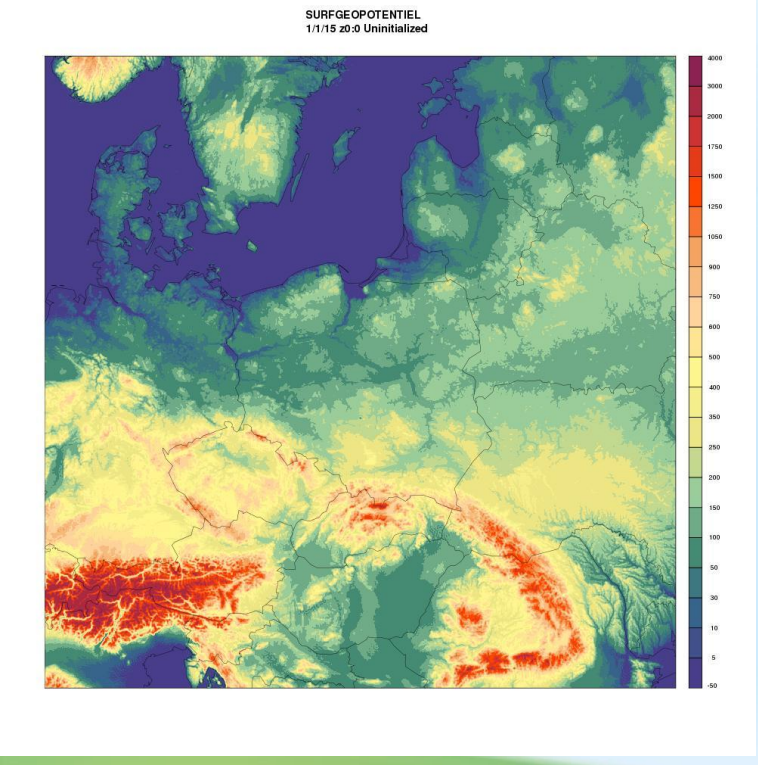
Model output

integrated physical properties at the scale of the whole snowpack (snow depth, snow water equivalent, surface temperature, albedo ...)
inner snowpack physical properties, from which a profile of the physical properties of snow can be inferred
an overview of the energy and water flux at the snowpack boundaries (atmosphere and ground)

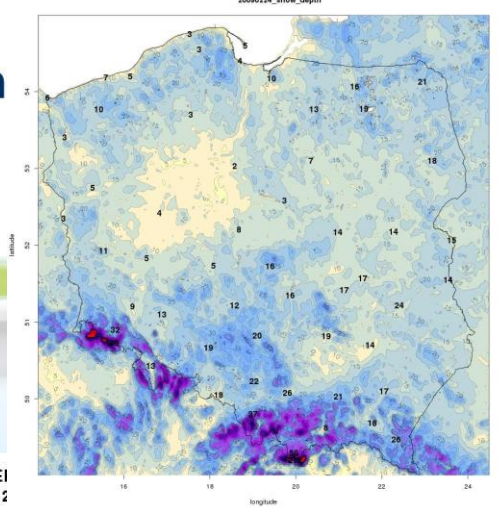
Work already done:

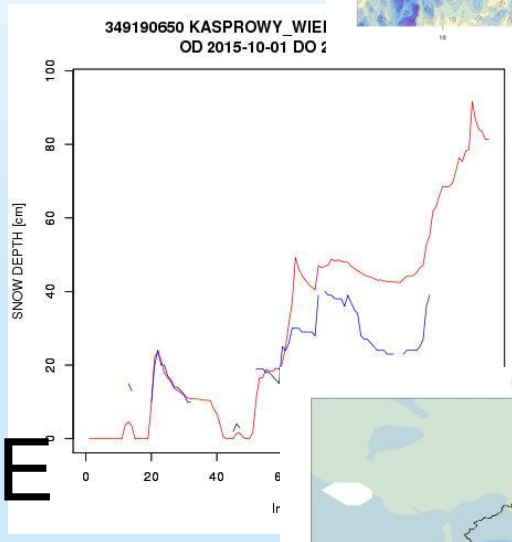
1. Installation of SURFEX offline
2. Coupling to AROME model with help from Meteo France team
3. Results for winter 2008/2009, 2015/2016 and 2016/2017 (validation in progress)
4. New products for hydrological departments

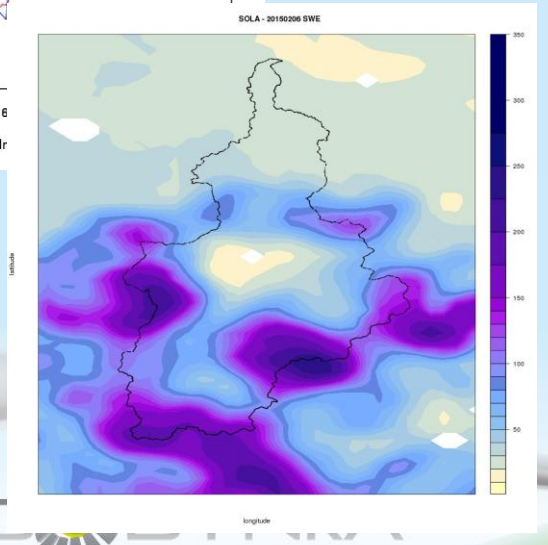
Pre-operational runs



PREP
PGD
OFFLINE







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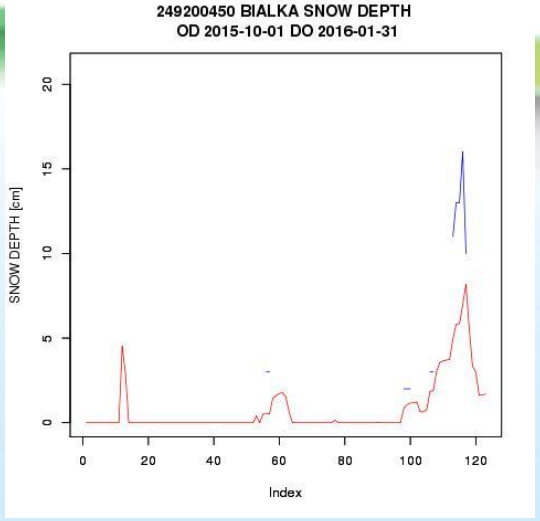

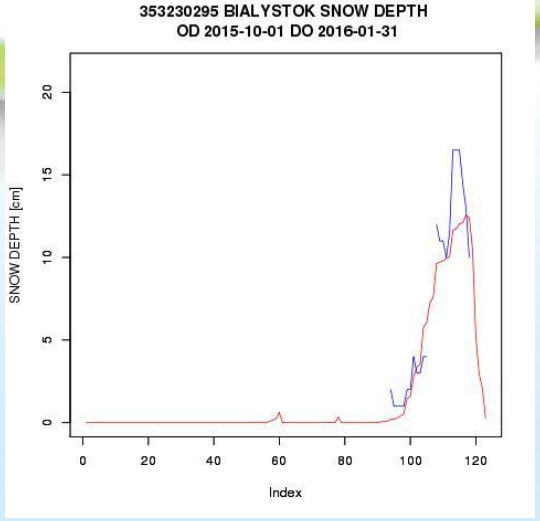

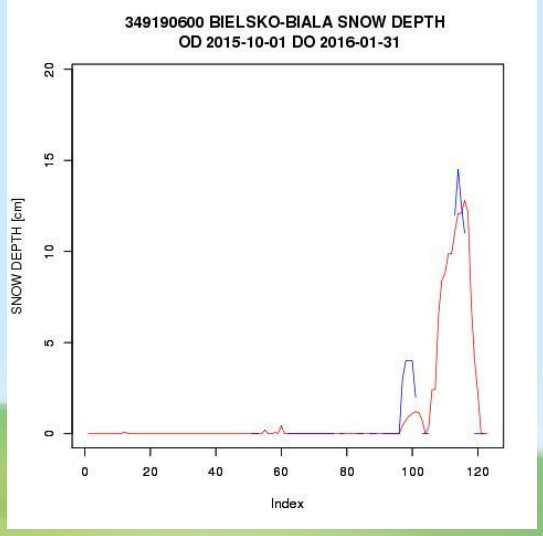

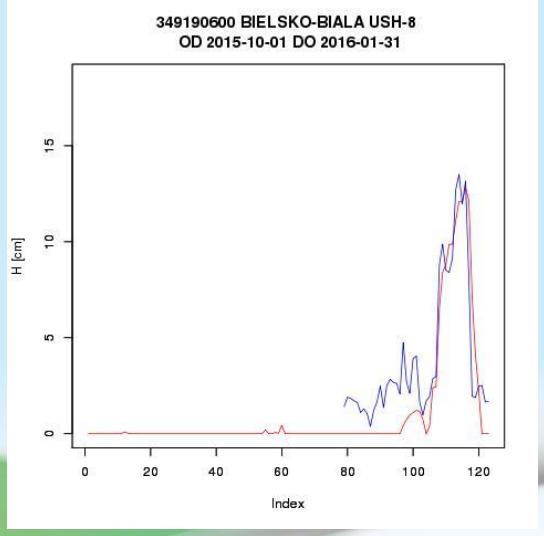

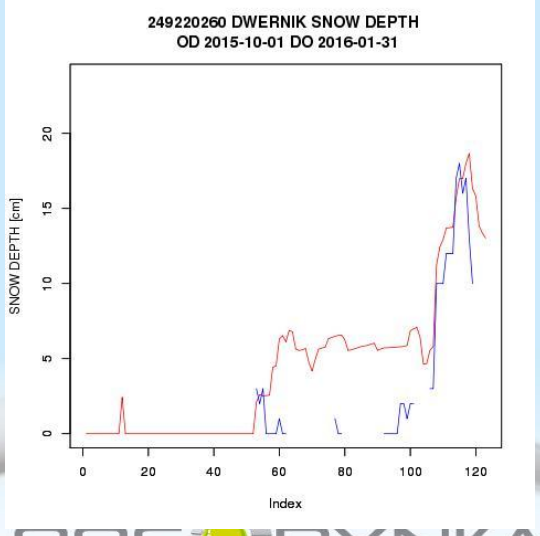

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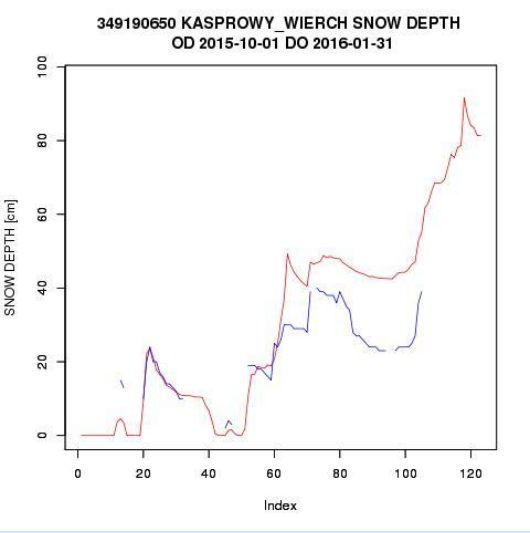
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SNOW DEPTH [cm]
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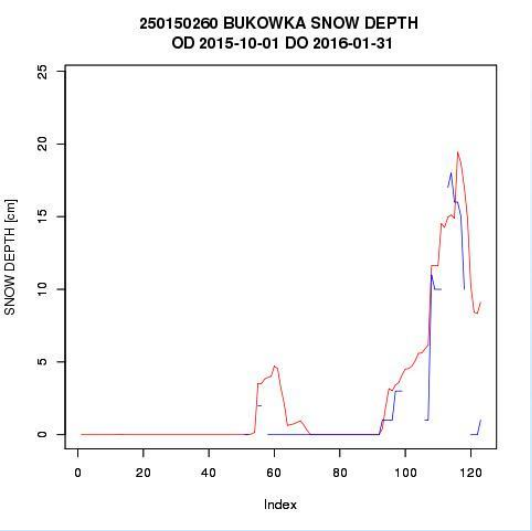
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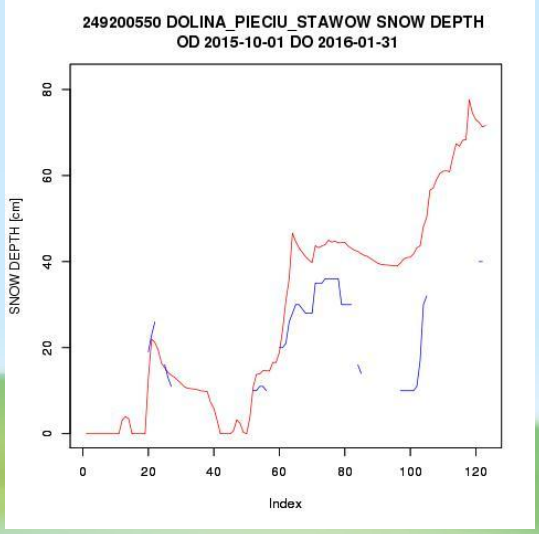
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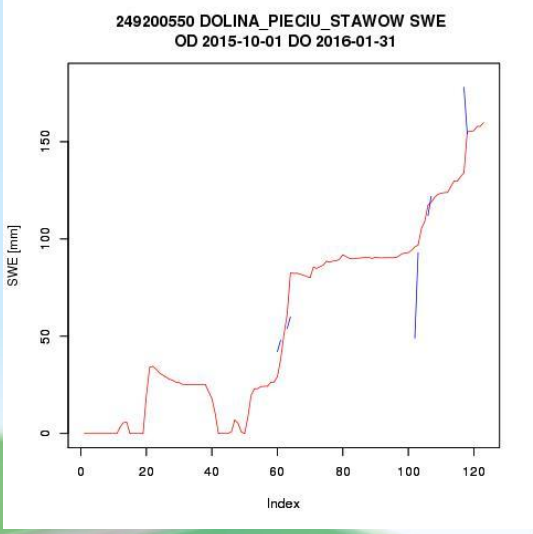
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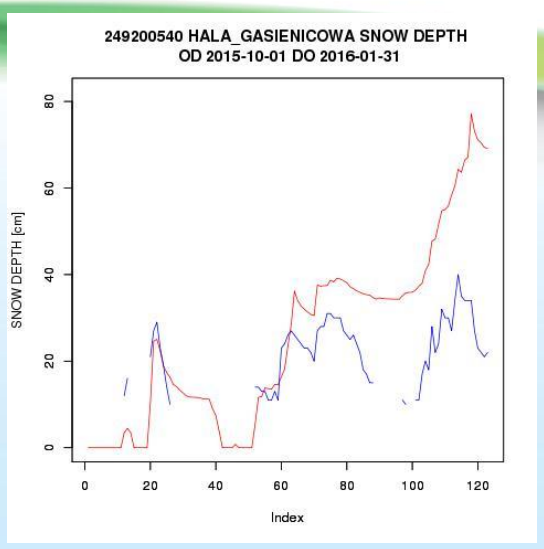
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SNOW DEPTH [cm]
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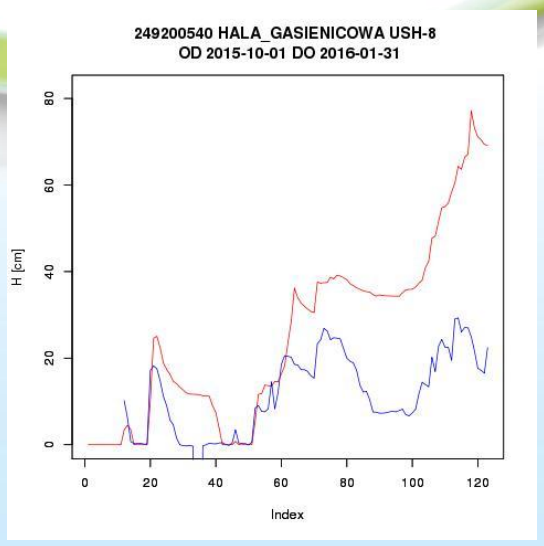
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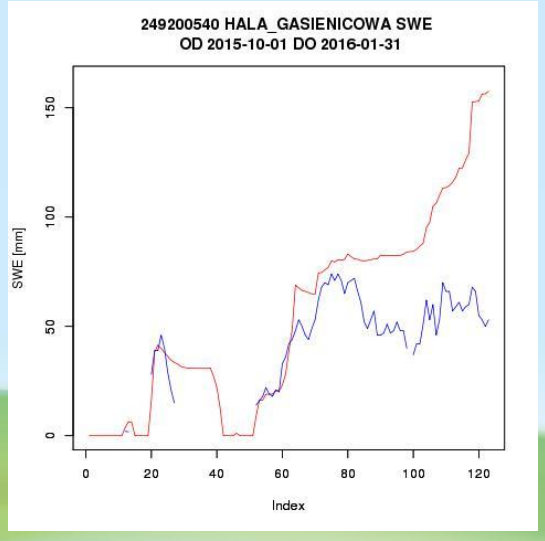
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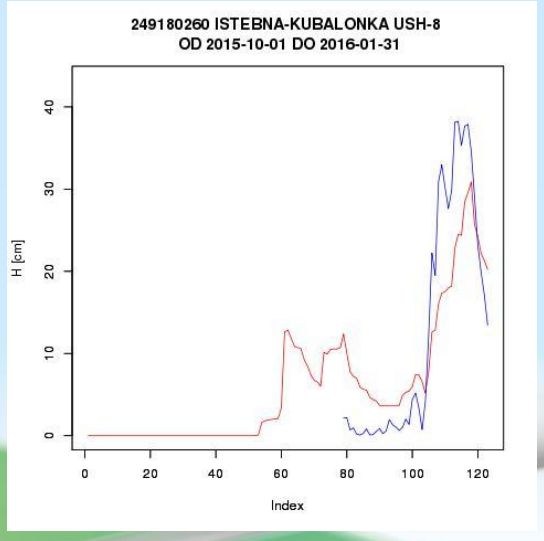
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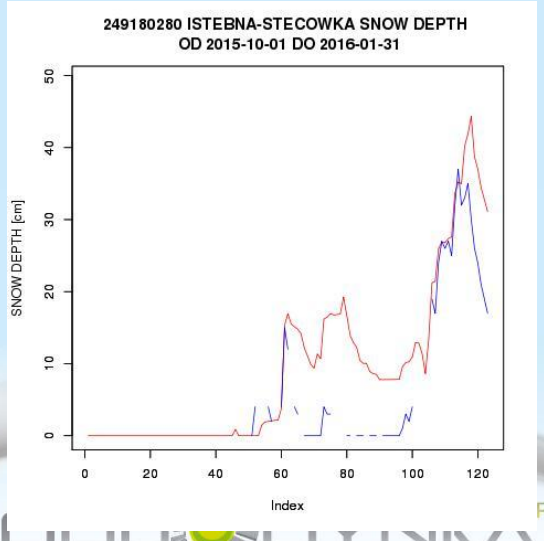
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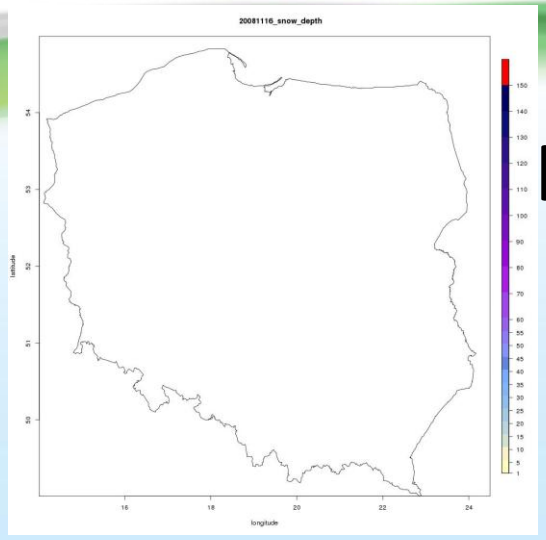

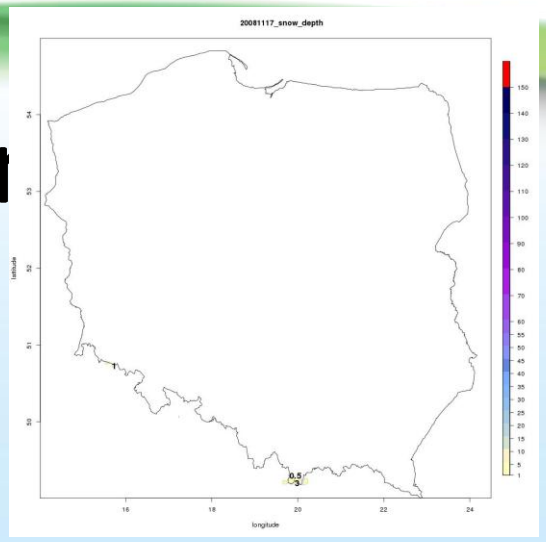

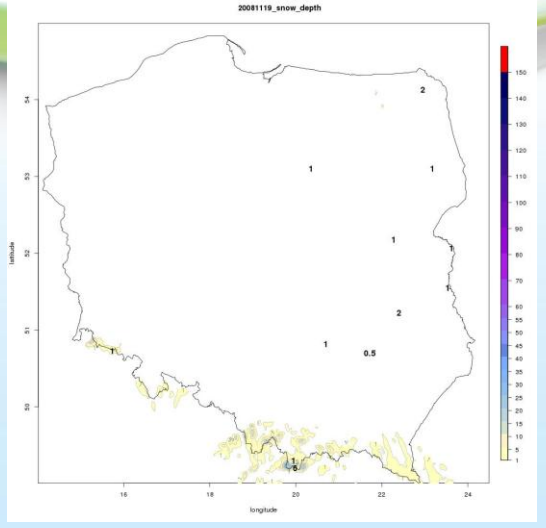

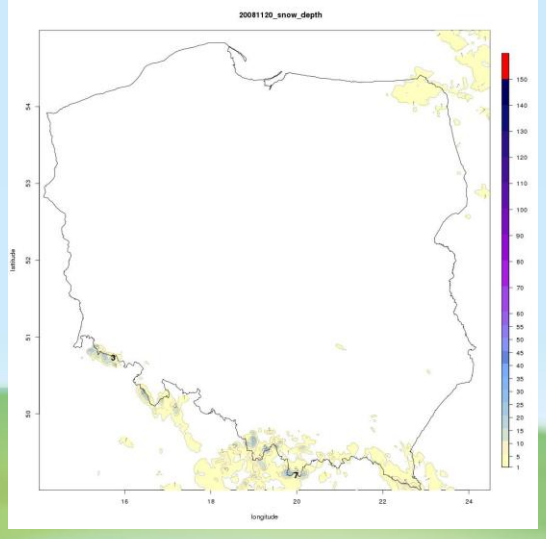

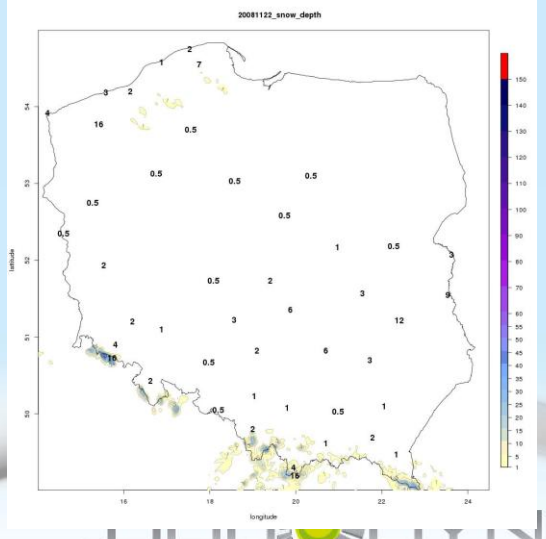

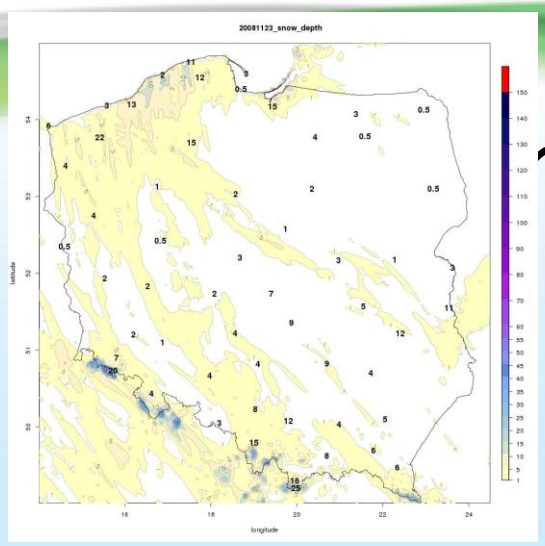
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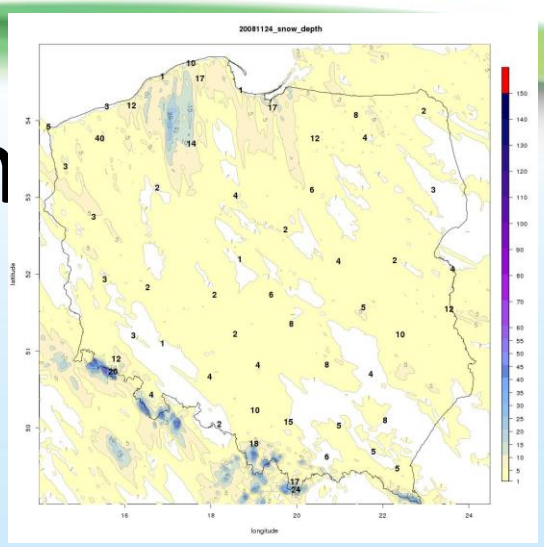
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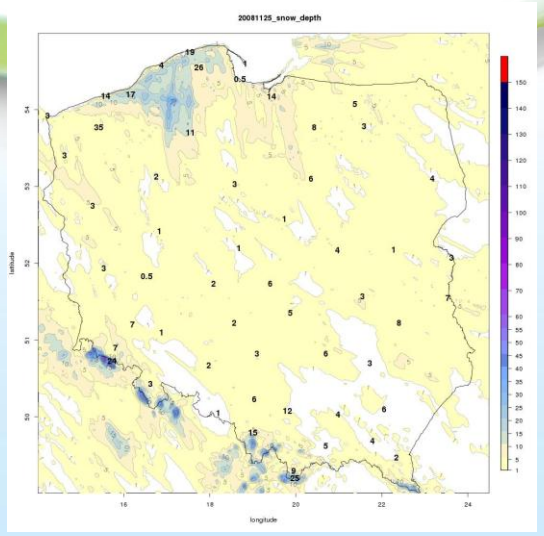
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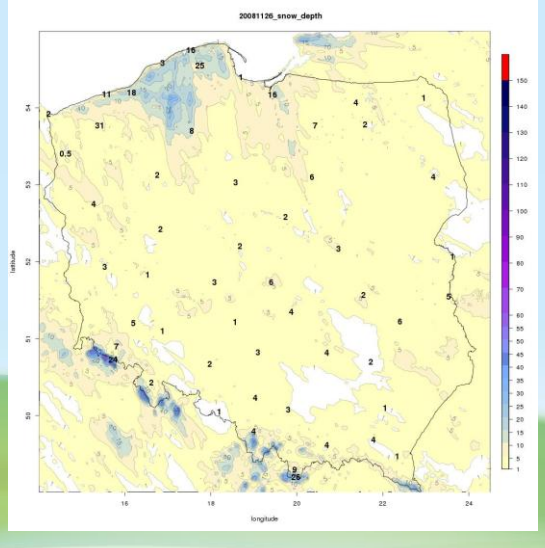
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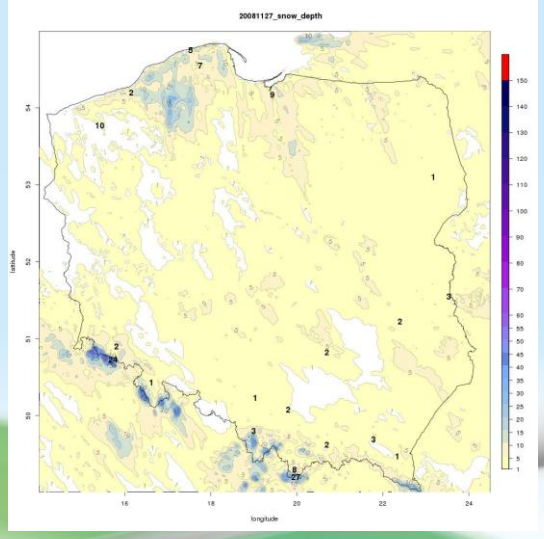
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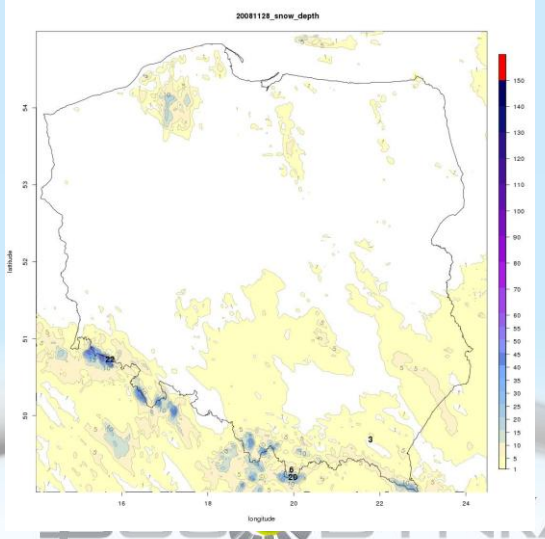
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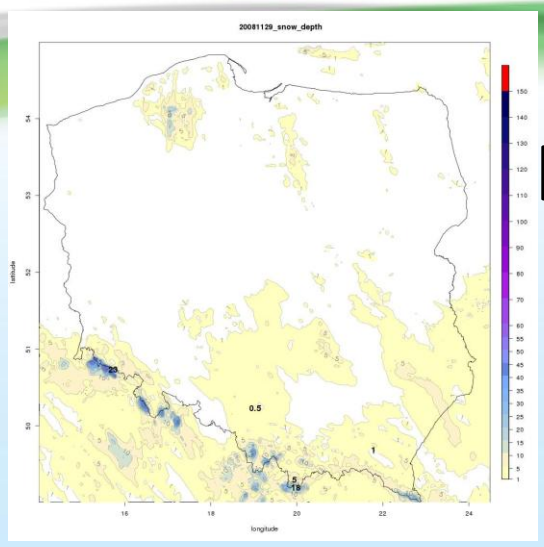
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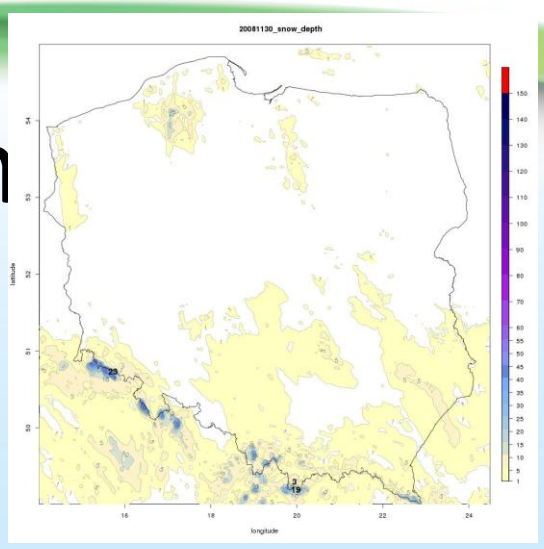
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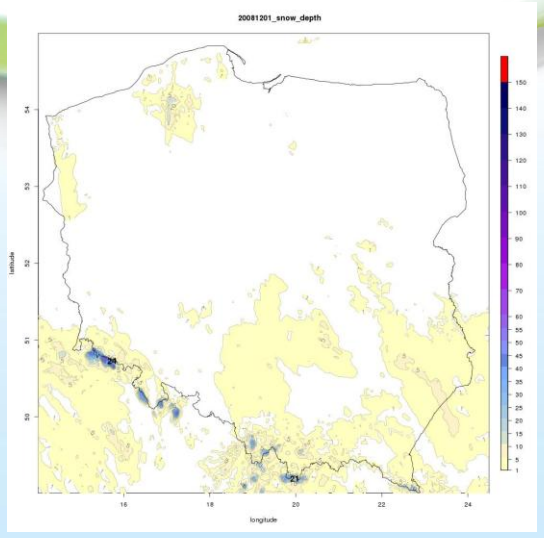
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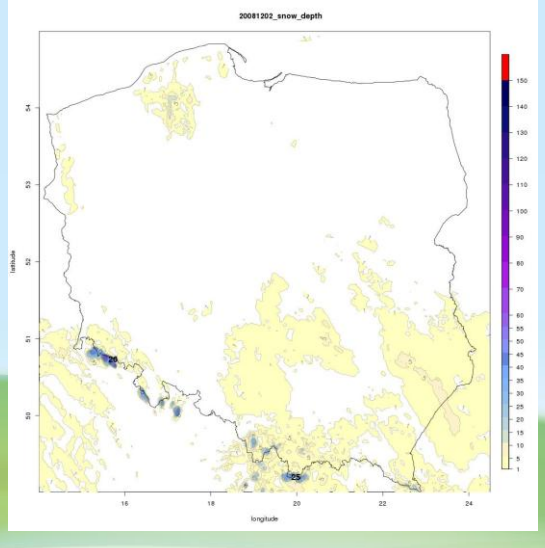
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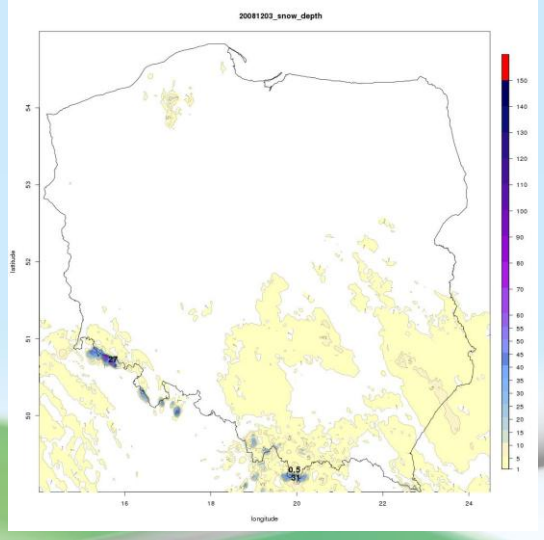
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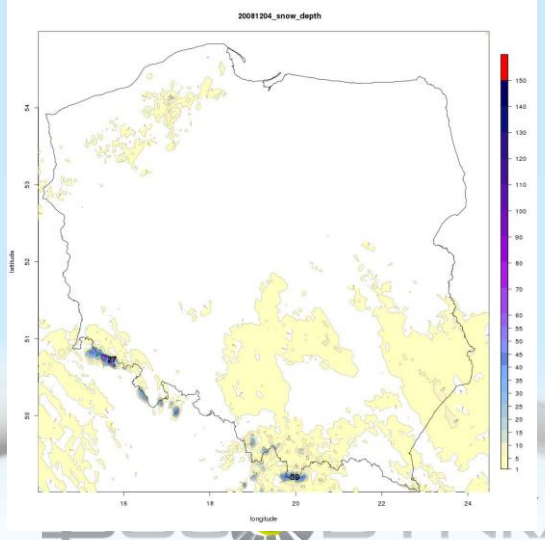
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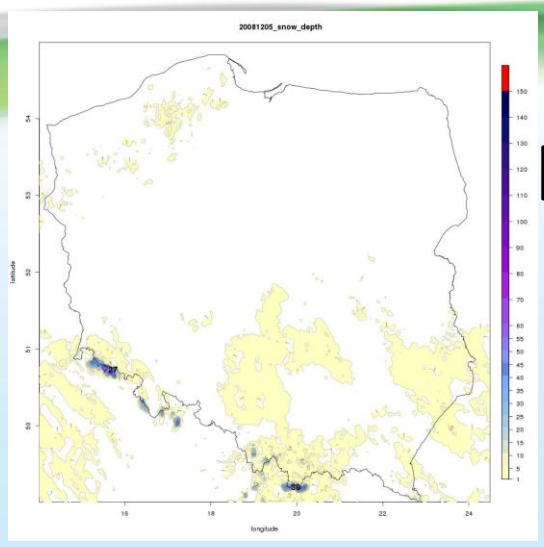
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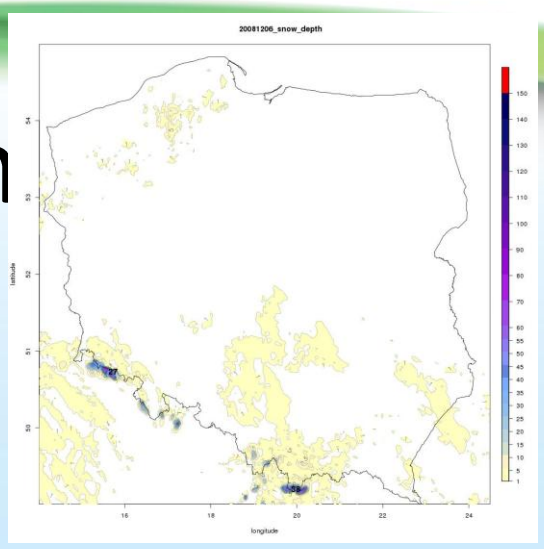
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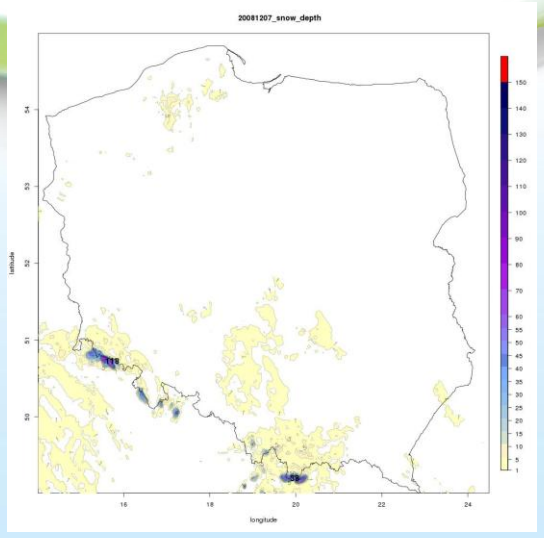
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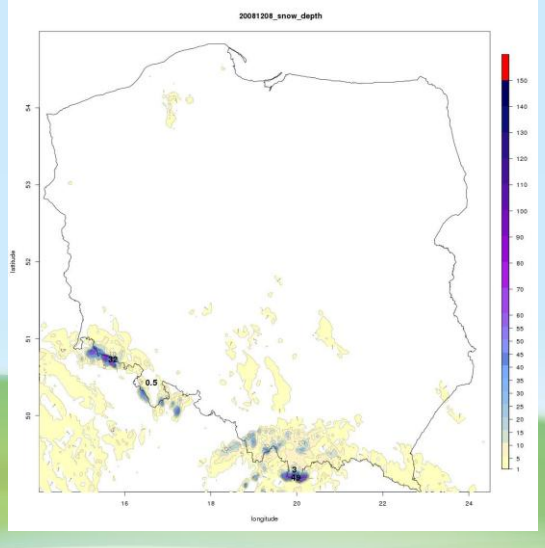
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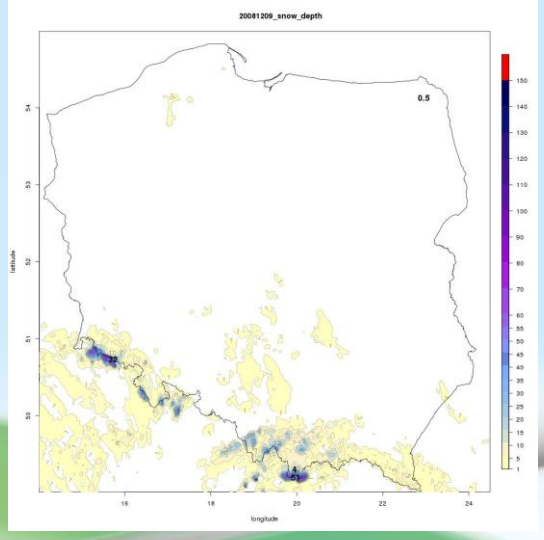
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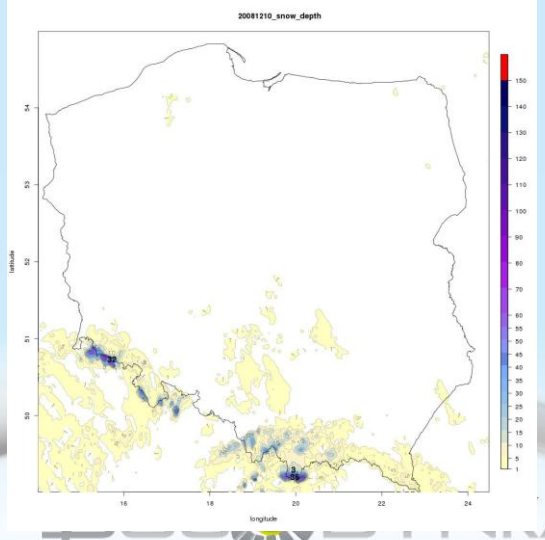
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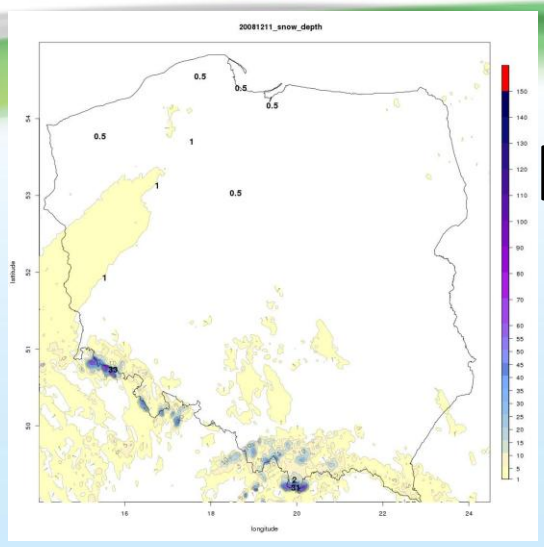
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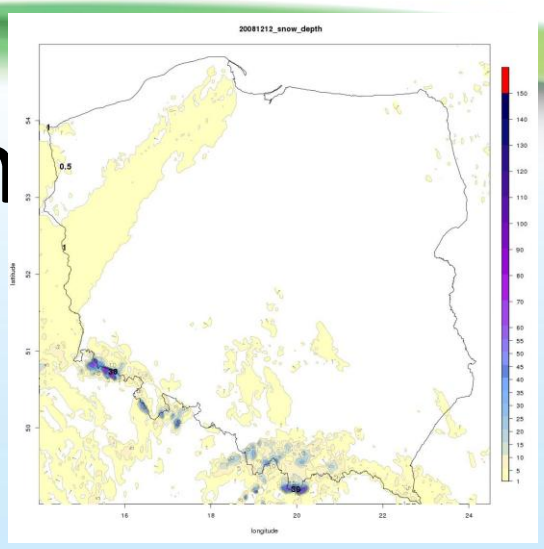
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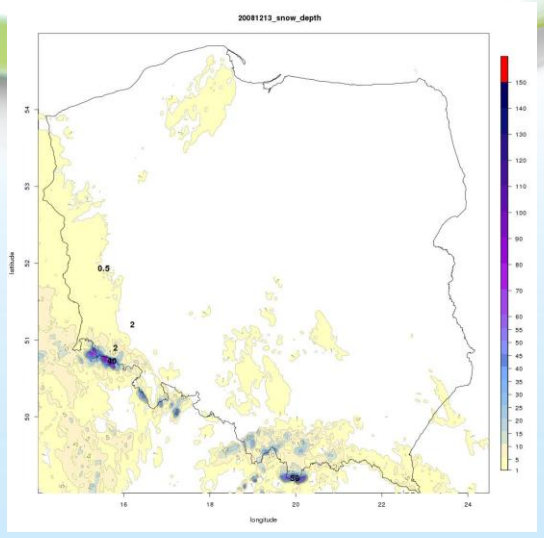
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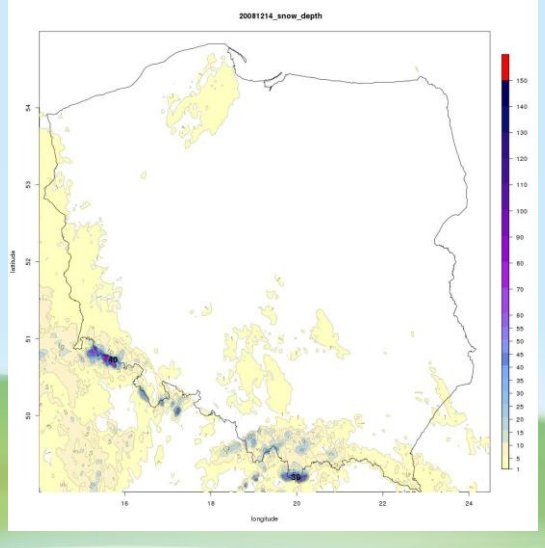
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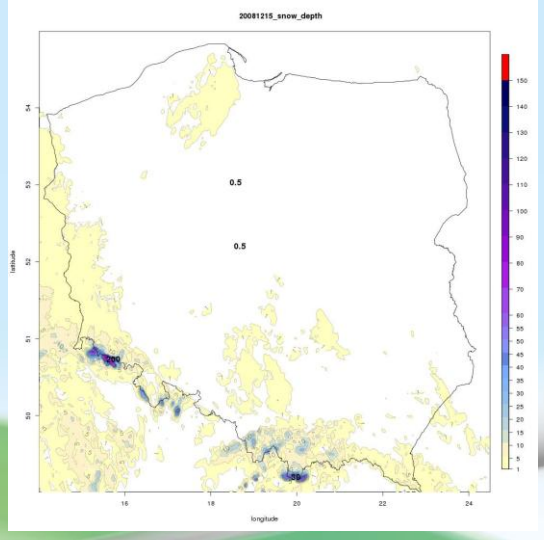
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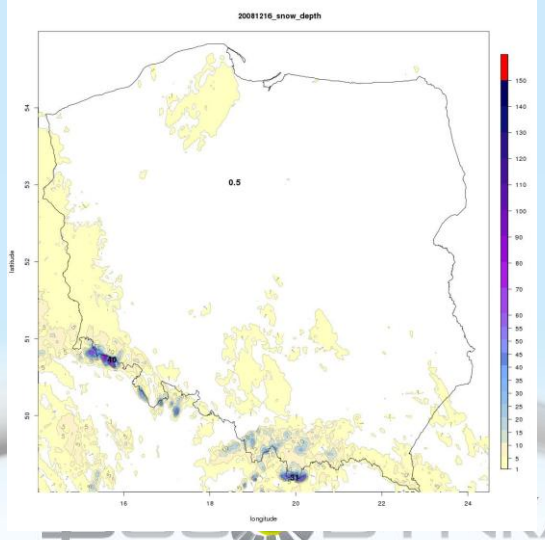
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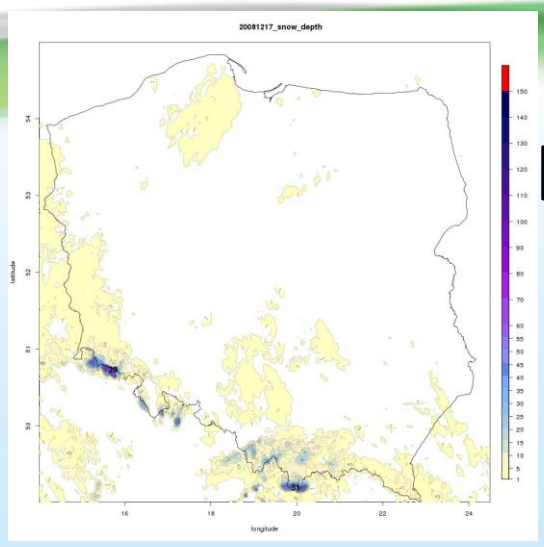
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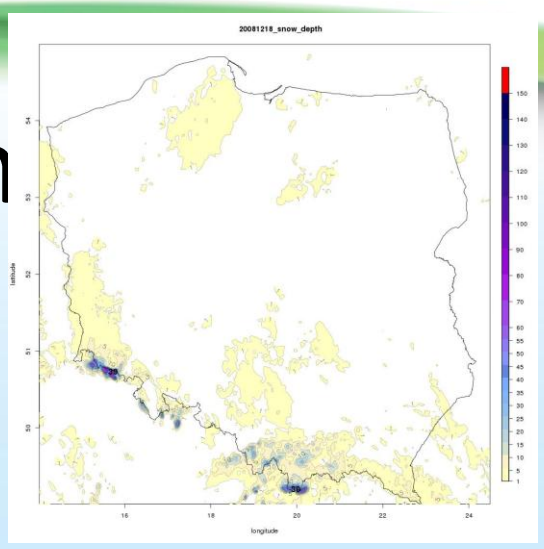
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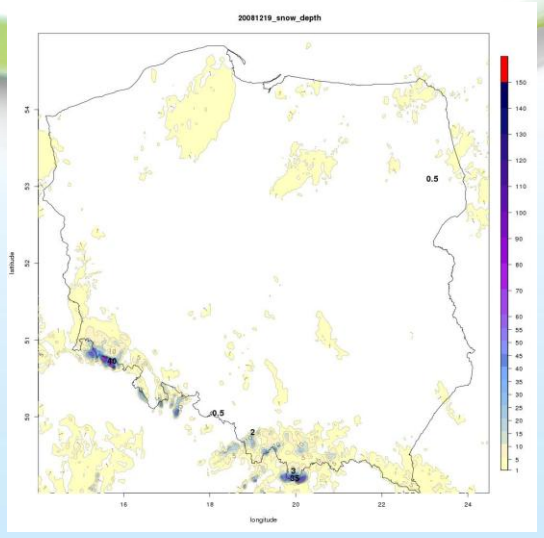
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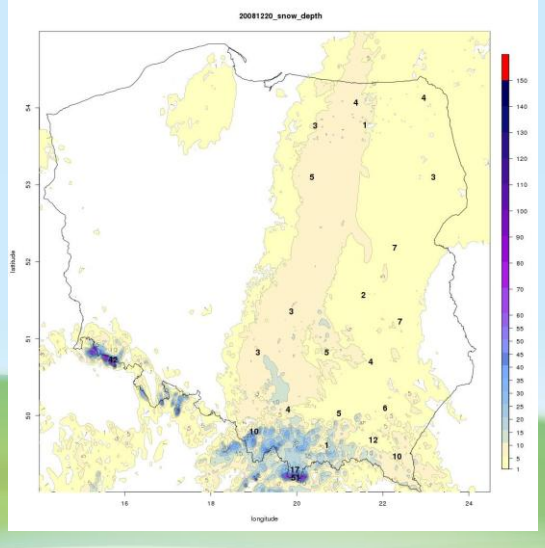
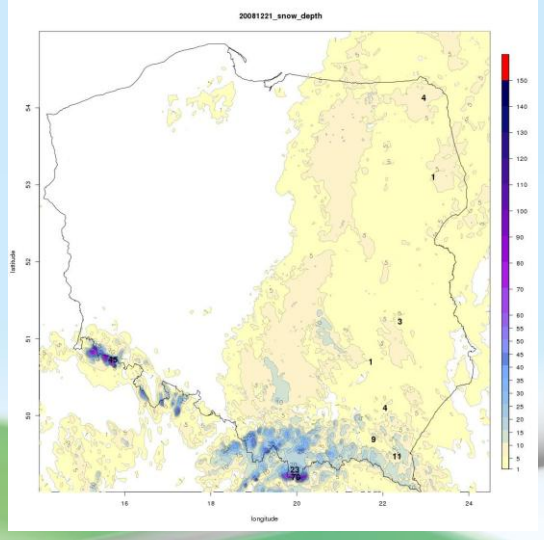
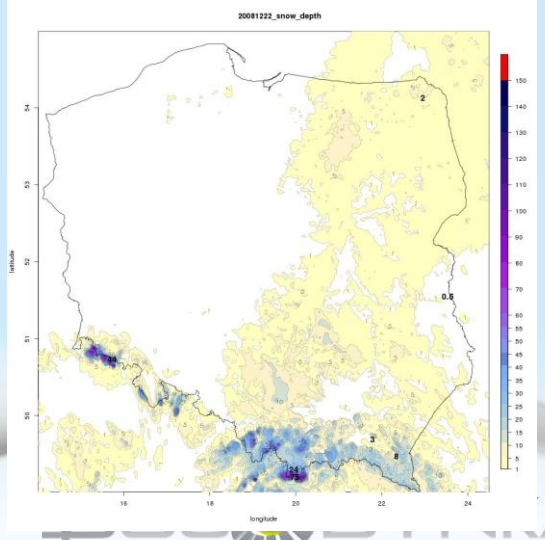
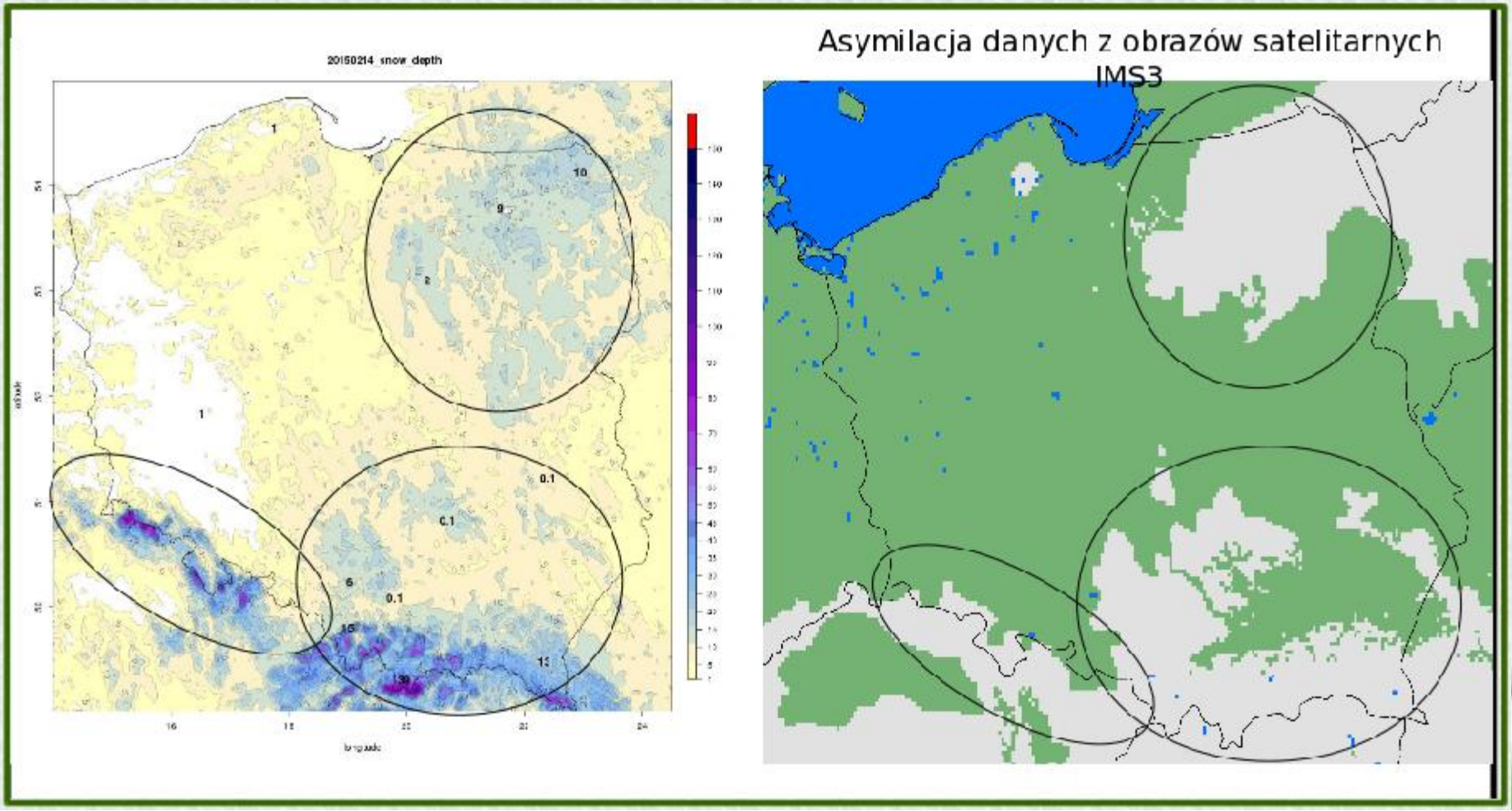

20081220_snow_depth
latitude
longitude

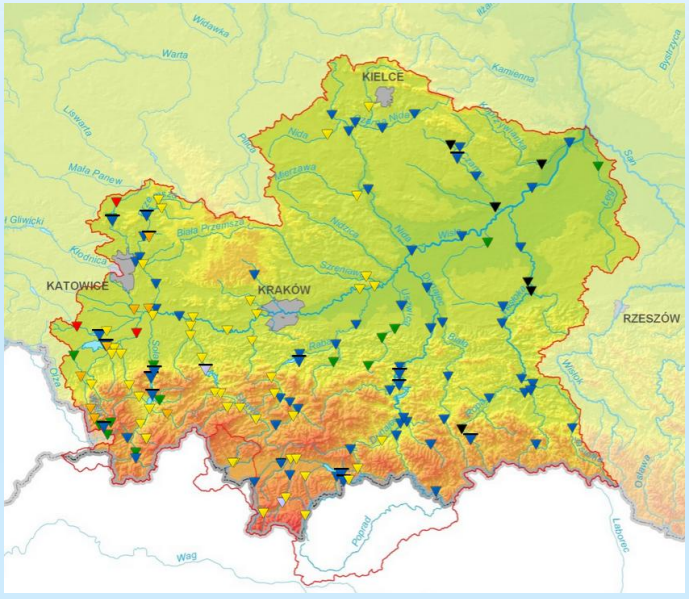

20081221_snow_depth
latitude
longitude

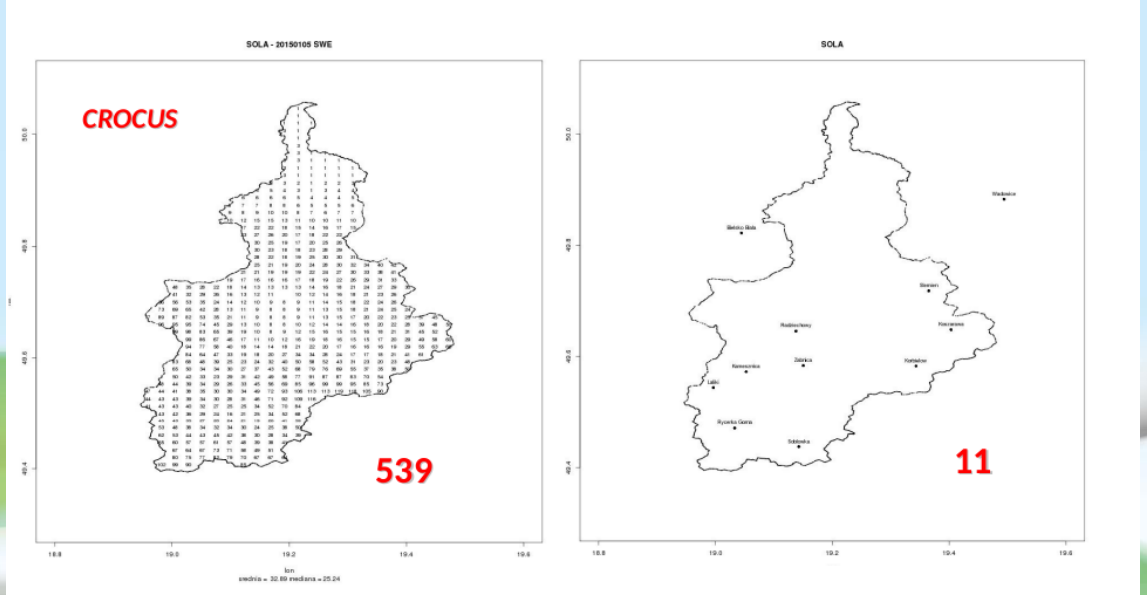

20081222_snow_depth
latitude
longitude

Validation

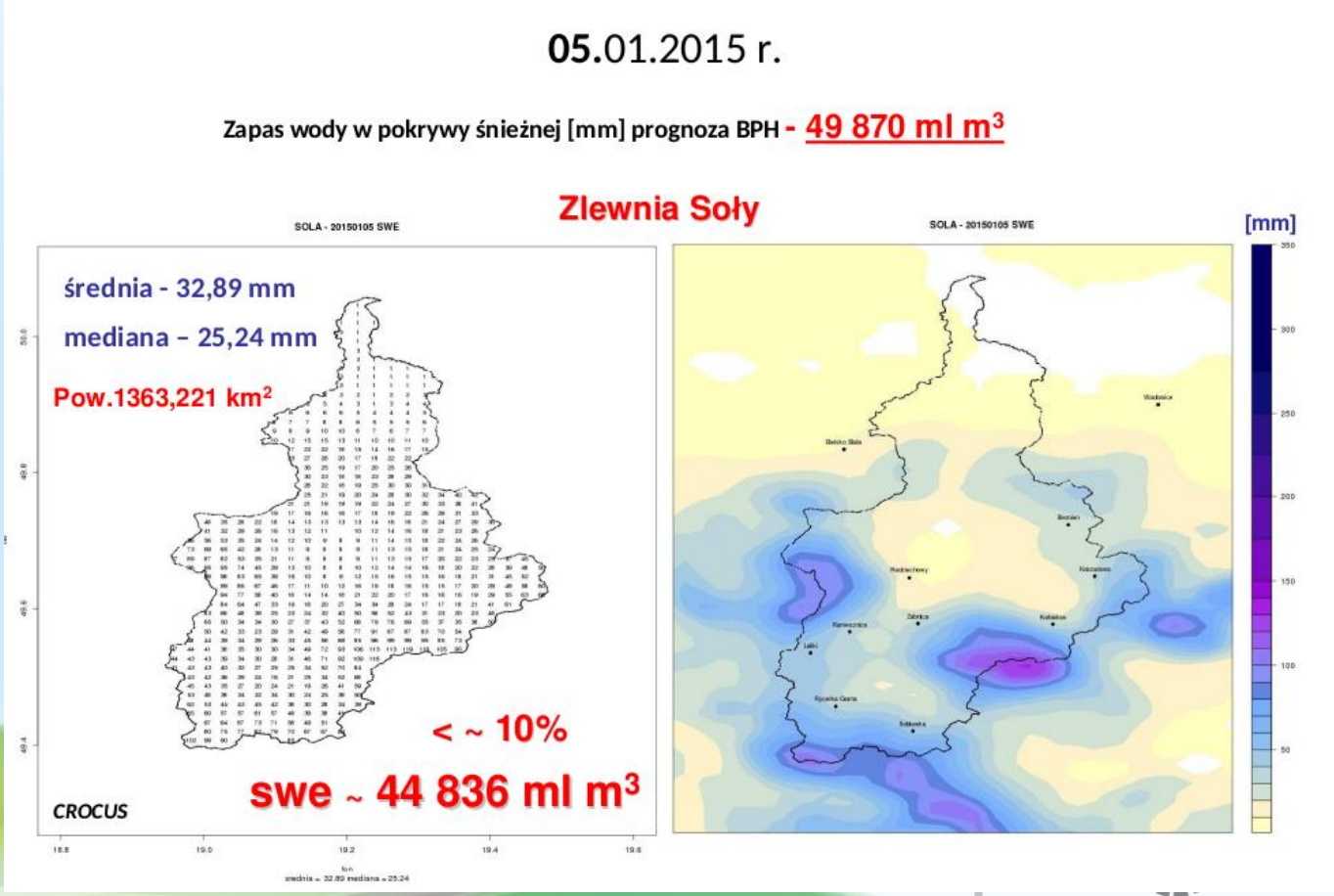

20150214 snow depth
Asymilacja danych z obrazów satelitarnych
IMS3

Validation

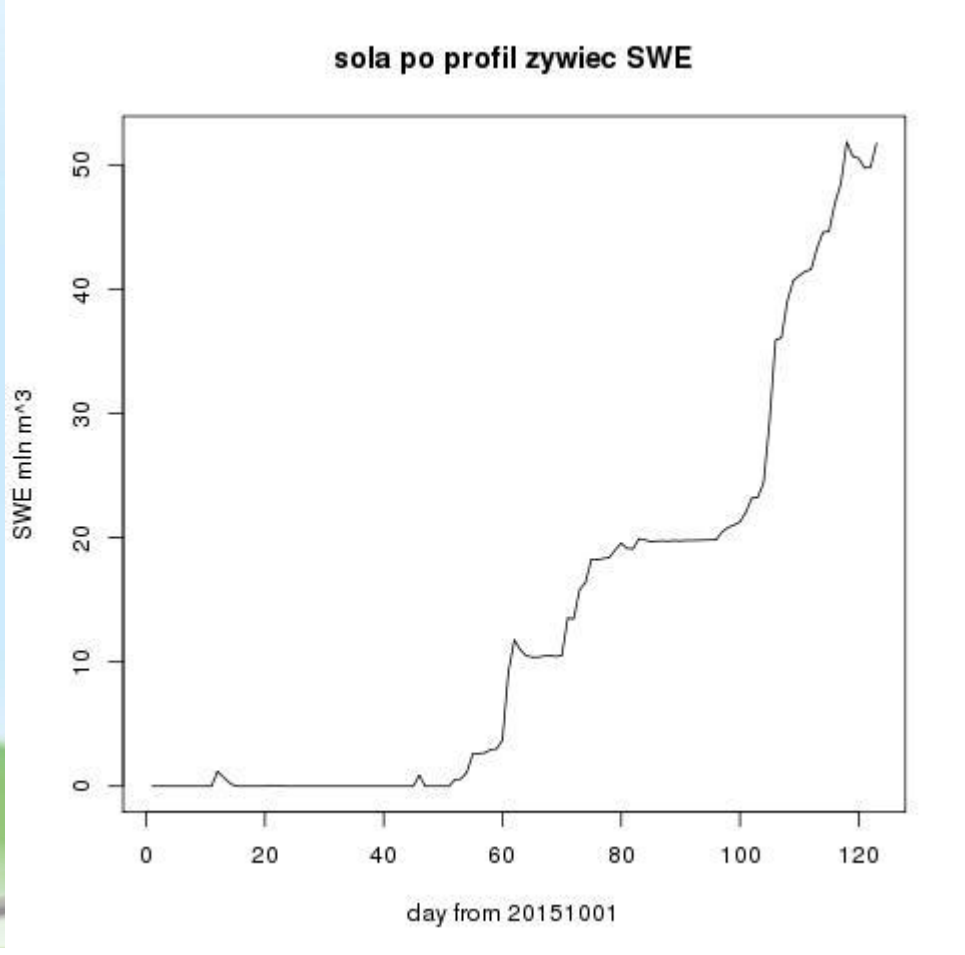

KIELCE
KATOWICE
KRAKÓW
RZESZÓW
Warta
Wisła
Pilica
Nida
Nidzica
Mała Panew
Biała Przemsza
Kłodnica
Szreniawa
Dunajec
Poprad
Wag


SOLA - 20150105 SWE
CROCUS
539
SOLA
11

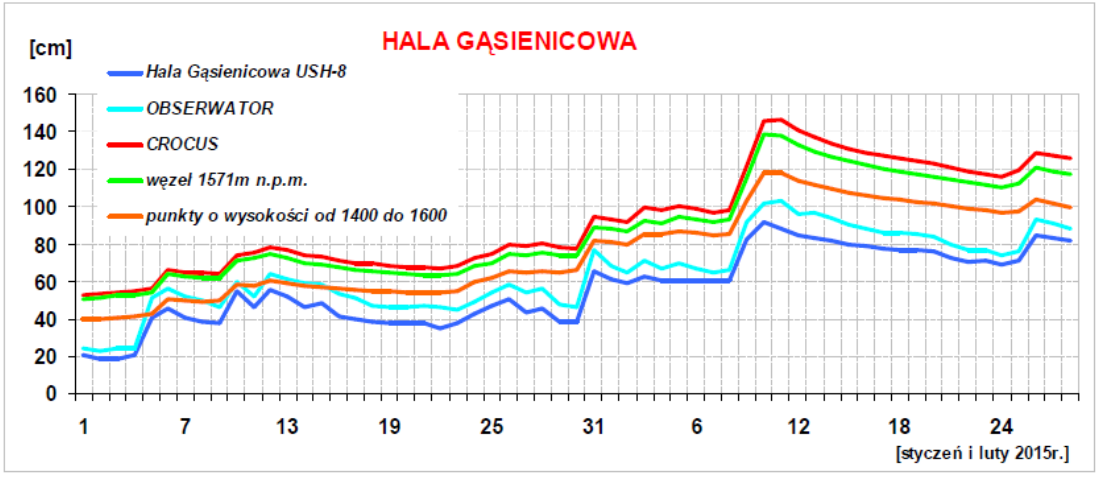
Validation

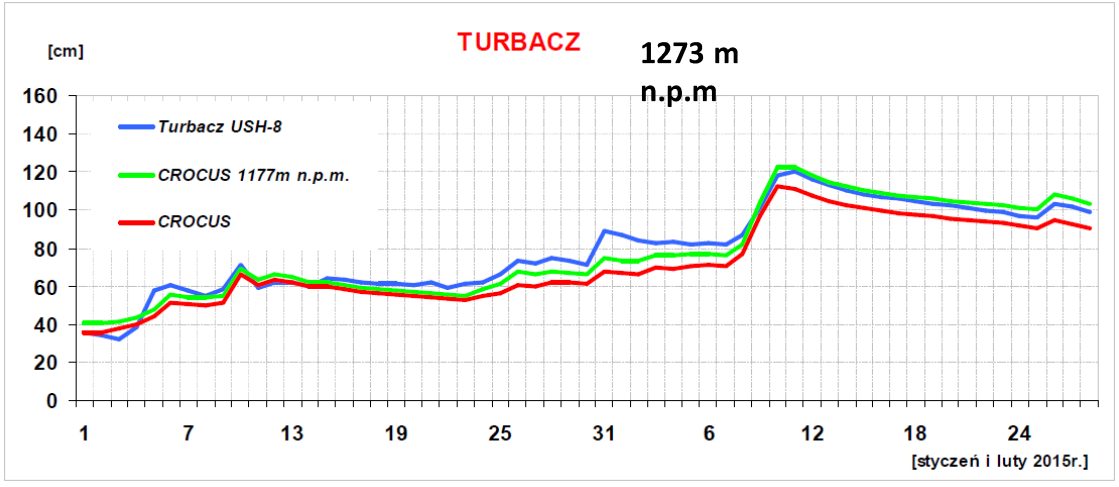

05.01.2015 r.
Zapas wody w pokrywy śnieżnej [mm] prognoza BPH - 49 870 ml m3
Zlewnia Soły
SOLA - 20150105 SWE
średnia - 32,89 mm
mediana – 25,24 mm
Pow.1363,221 km2
< ~ 10%
swe ~ 44 836 ml m3
CROCUS
SOLA - 20150105 SWE
[mm]

Validation


sola po profil zywiec SWE
SWE mln m^3
0
10
20
30
40
50
0
20
40
60
80
100
120
day from 20151001

Point values from the model





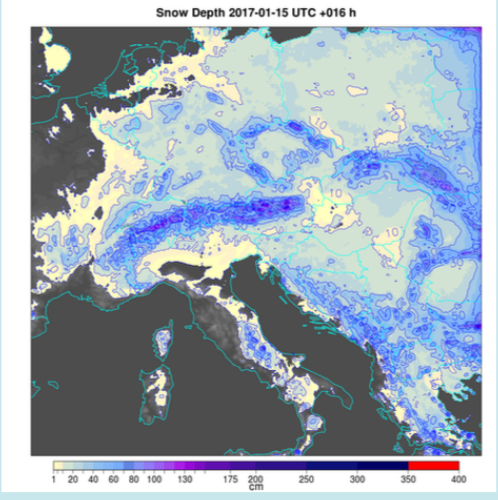
Cooperation with Slovenia

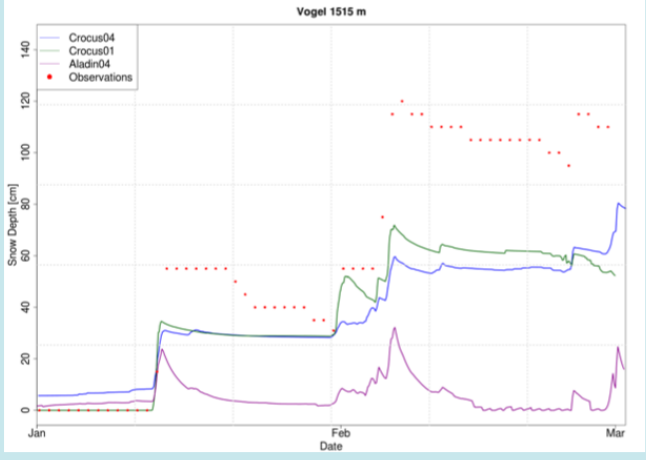
CROCUS snow model

Performance of snow model Crocus (offline SURFEX) was evaluated over the winter 2017:

- the model is either coupled to INCA analysis or ALADIN forecast,
- snow analysis and forecast is produced for each grid point of the model,
- results are generally encouraging.

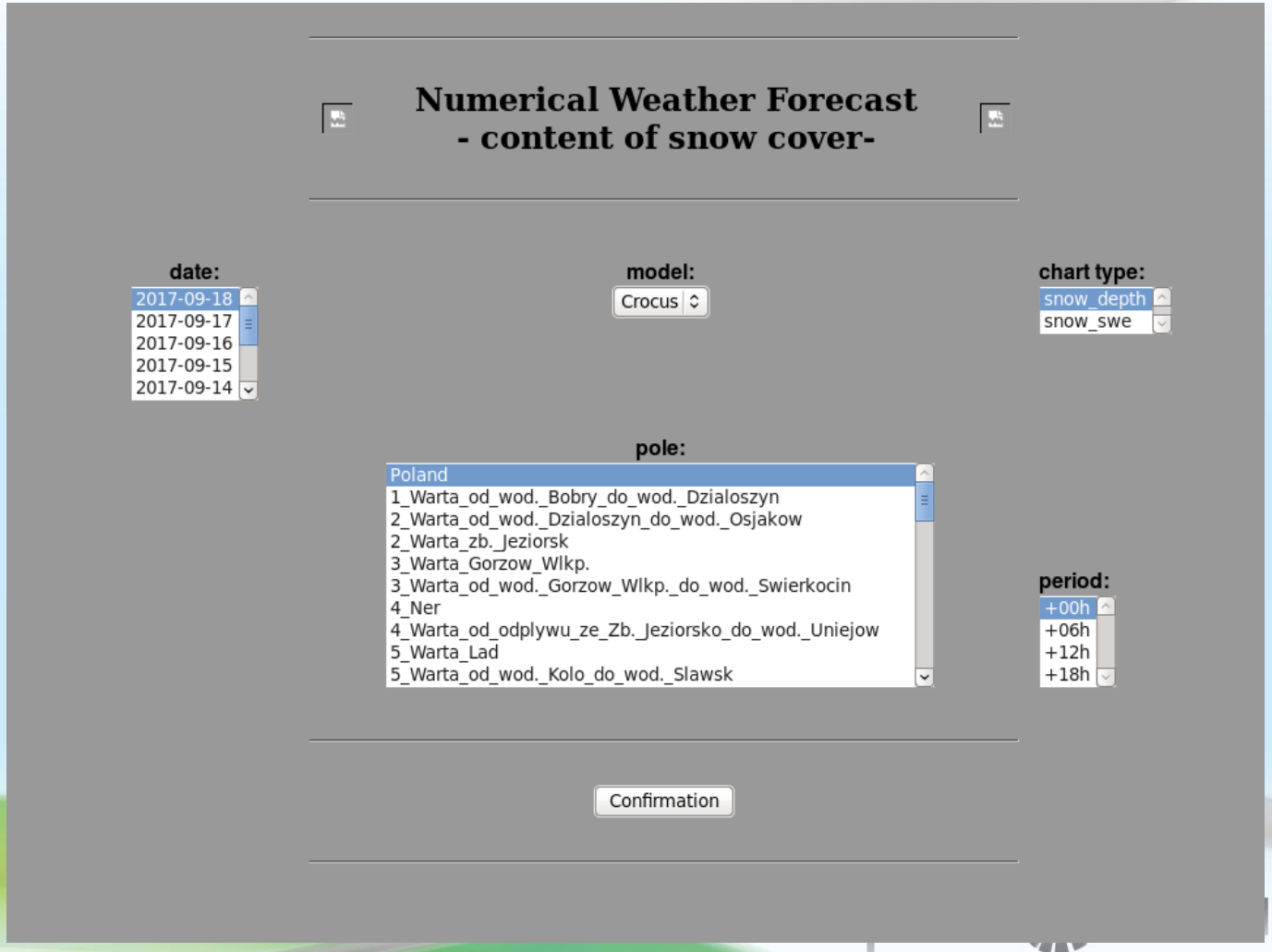
The model will be used primarily as a snow product for hydrology and as a tool in snow avalanche risk diagnosis and forecasting, but could later also be used as snow analysis for ALADIN.





An example of snow depth forecast on ALADIN domain on 2017-01-15 (left) and performance of Crocus analysis for January-February 2017 on Slovenian mountain station Vogel. Crocus is coupled with ALADIN (Crocus04) or INCA analysis (Crocus01). Estimated snow depth from ALADIN is also shown (Aladin04). Points are snow depth observations.

Web page


Numerical Weather Forecast
- content of snow cover-
date:
2017-09-18
2017-09-17
2017-09-16
2017-09-15
2017-09-14
model:
Crocus
chart type:
snow_depth
snow_swe
pole:
Poland
1_Warta_od_wod._Bobry_do_wod._Dzialoszyn
2_Warta_od_wod._Dzialoszyn_do_wod._Osjakow
2_Warta_zb._Jeziorsk
3_Warta_Gorzow_Wlkp.
3_Warta_od_wod._Gorzow_Wlkp._do_wod._Swierkocin
4_Ner
4_Warta_od_odplywu_ze_Zb._Jeziorsko_do_wod._Uniejow
5_Warta_Lad
5_Warta_od_wod._Kolo_do_wod._Slawsk
period:
+00h
+06h
+12h
+18h
Confirmation

Future plans:

1. Operational version of CROCUS
2. Coupling with INCA
3. CROCUS for climatology in Poland