Institute of Meteorology and Water Management
National Research Institute, Poland

GCOM-W1 after the first winter – discussion on snow depth product

Piotr Struzik

Institute of Meteorology and Water Management – NRI,

Satellite Remote Sensing Centre,

Kraków, Poland

POGODYNKA.PL
SERWIS POGODOWY IMGW-PIB

Presentation outline:

1. GCOM-W1 satellite
2. Snow in Poland – good validation area.
3. Why we need snow properties retrieval from microwave sensors ?
4. GCOM-W1 snow depth – outcome from the first winter of this satellite and comparison to selected other satellite snow products.
5. Conclusions.

GCOM-W1

Global Change Observation Mission 1st – Water “SHIZUKU” (GCOM-W1) launched on May 18, 2012.

How to get data: please register at the SHIZUKU data provision website: https://gcom-w1.jaxa.jp

More about the SHIZUKU – JAXA Satellite Applications Mission Directorate I website: http://www.jaxa.jp/projects/sat/gcom_w/index_e.html

AMSR2 will succeed most of the characteristics of AMSR-E, with some important improvements. Major changes from AMSR-E include the larger main reflector with 2.0m diameter, addition of 7.3GHz channels, 12bit quantization for all channels, and improvements in calibration system.

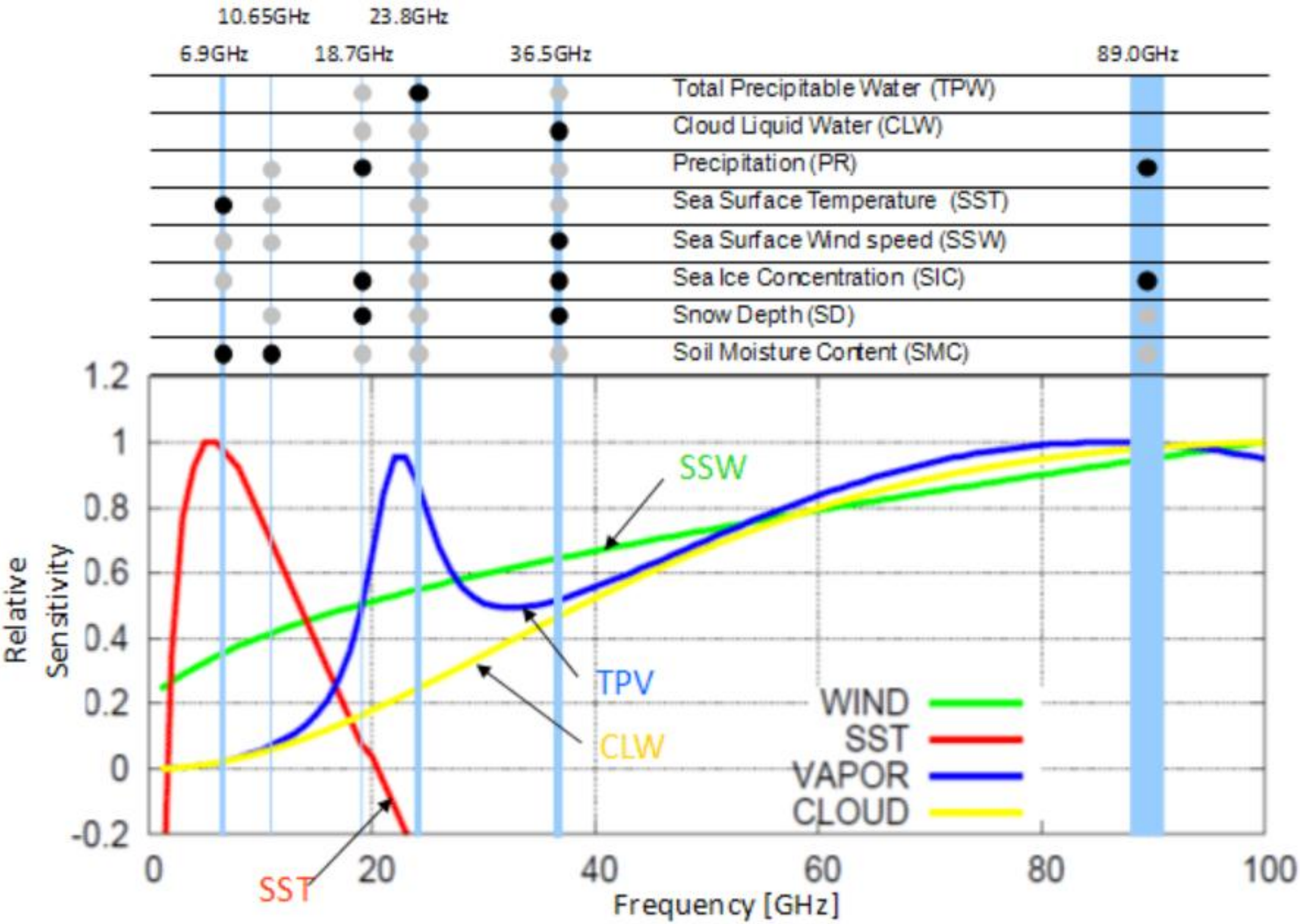
Observation frequency (GHz)	6.925	7.3	10.65	18.7	23.8	36.5	89.0(A)	89.0(B)
Observation polarization	Vertical and horizontal polarizations							
Measuring range (K)	2.7 - 340							
Temperature resolution (K)	0.34	0.43	0.7	0.7	0.6	0.7	1.2	1.2
Instantaneous view angle (Az×El)	35×62	34×58	24×42	14×22	15×26	7×12	3×5	3×5
Measurement width (km)	1450							

Products available on JAXA FTP server since 2.07.2012:

Level 1: Brightness temperatures L1B

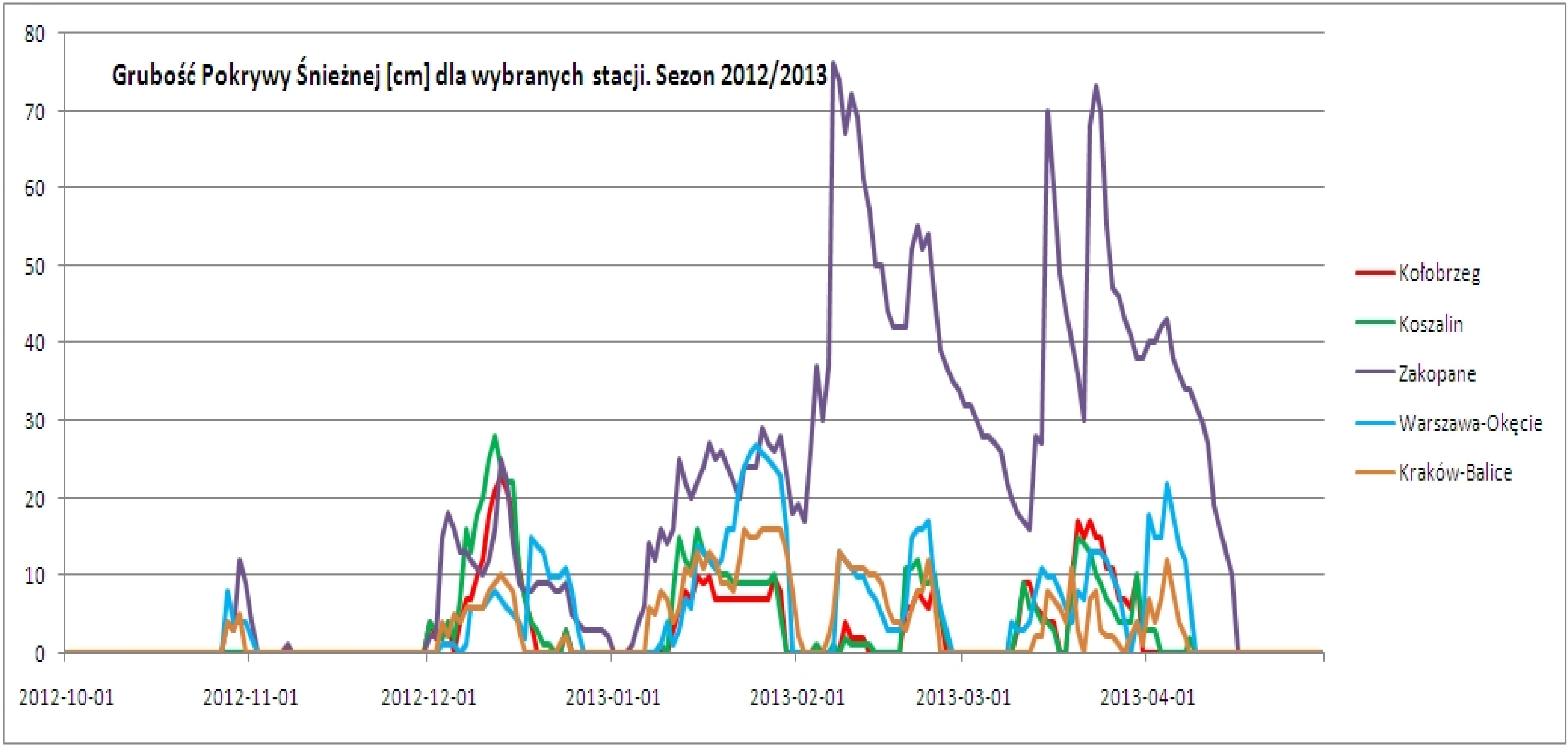
Level 2 Products: CLW, PRC, SIC, SMC, SND, SST, SSW, TPW

Level 3 Global products (Ascending and Descending pass) interpolated to regular grid (Equirectqngular) and Polar (EASE) with resolution of 0.1 and 0.25 deg:
CLW, PRC, SIC, SMC, SND, SST, SSW, TPW, Brightness temperatures in all channels (and polarizations)

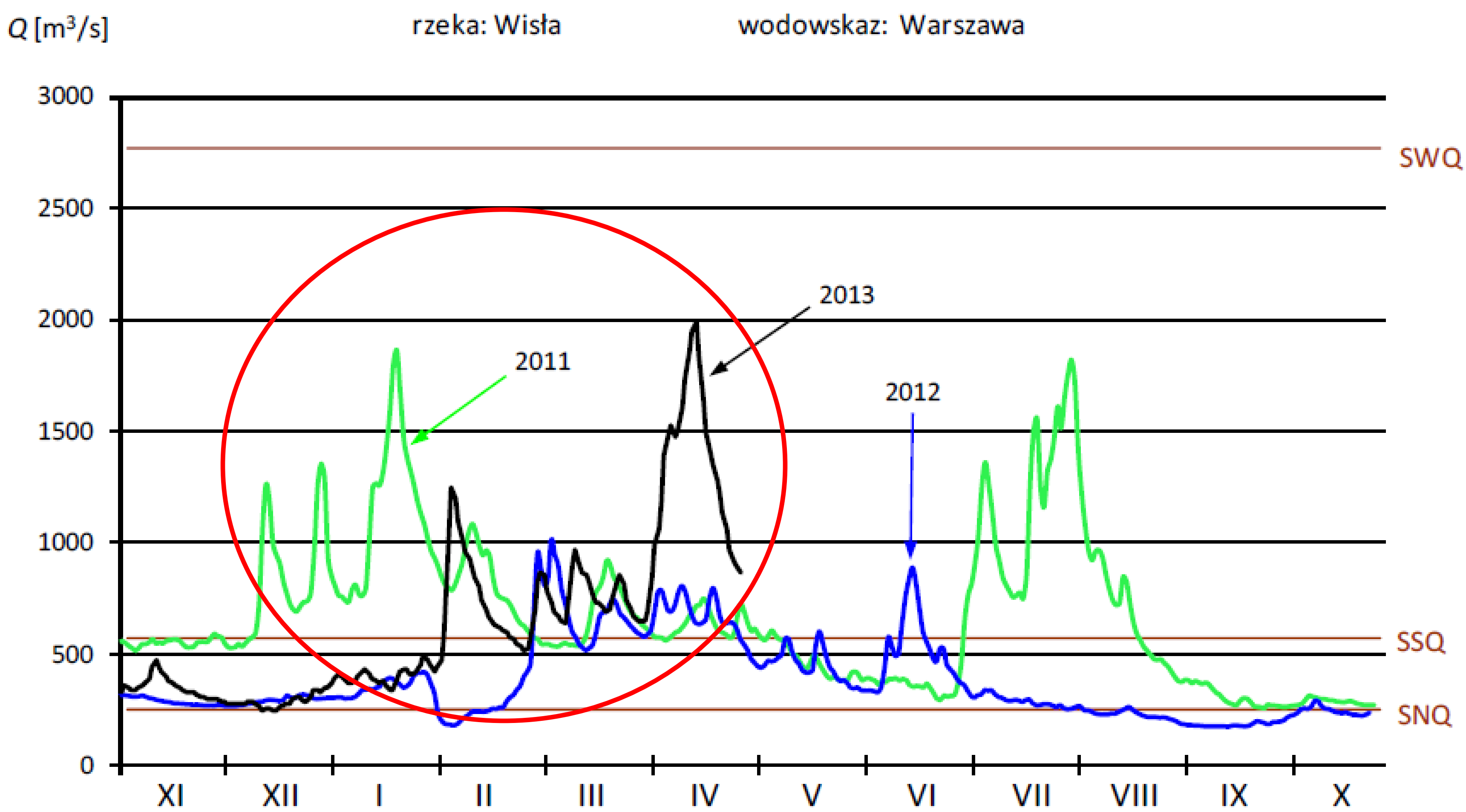

10.65GHz
23.8GHz
6.9GHz
18.7GHz
36.5GHz
89.0GHz
Total Precipitable Water (TPW)
Cloud Liquid Water (CLW)
Precipitation (PR)
Sea Surface Temperature (SST)
Sea Surface Wind speed (SSW)
Sea Ice Concentration (SIC)
Snow Depth (SD)
Soil Moisture Content (SMC)
SSW
TPV
CLW
SST
WIND
SST
VAPOR
CLOUD
Relative Sensitivity
Frequency [GHz]
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
20
40
60
80
100

Snow depth in Poland:

Poland is very interesting area for satellite snow cover products validation, due to variable snow cover during winter, relatively long snow season and repeated snow fall/snow melt periods during winter.

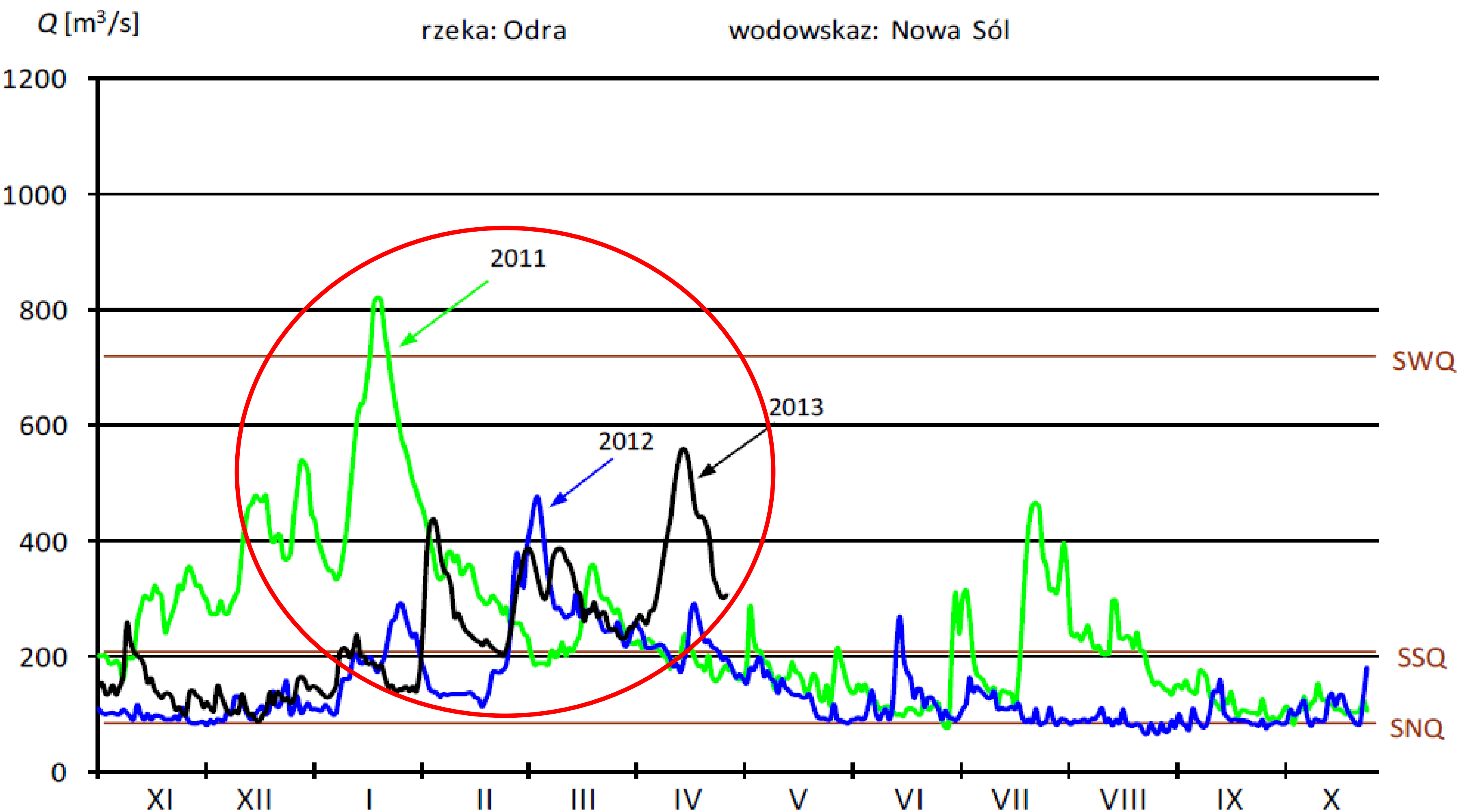


Wisła River



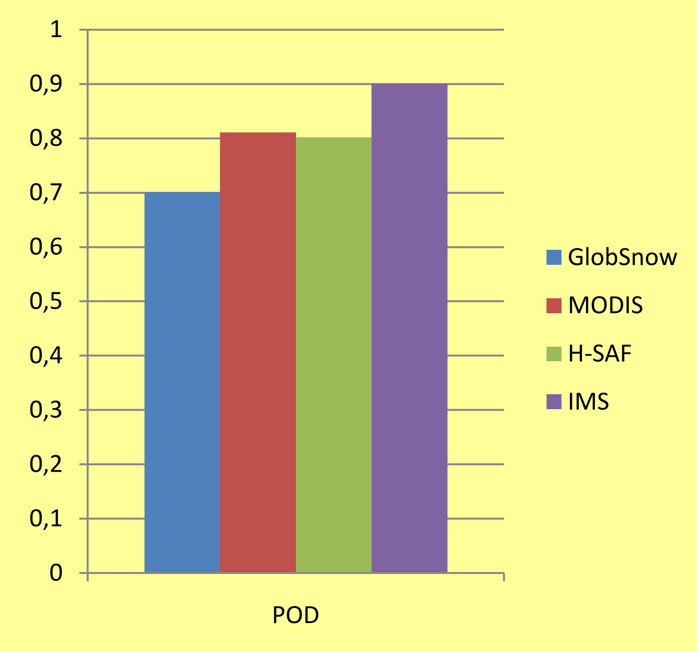
Discharge in Warsaw for the years: 2011, 2012 and winter/spring 2013

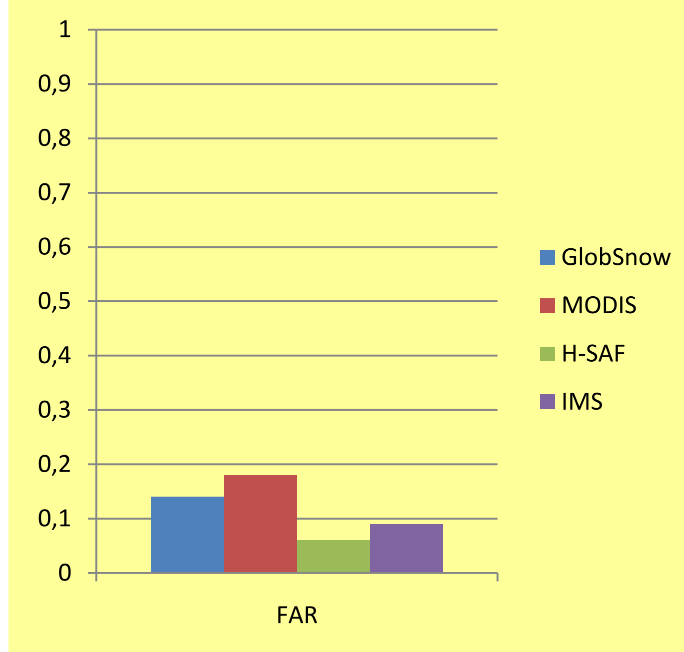
Odra River



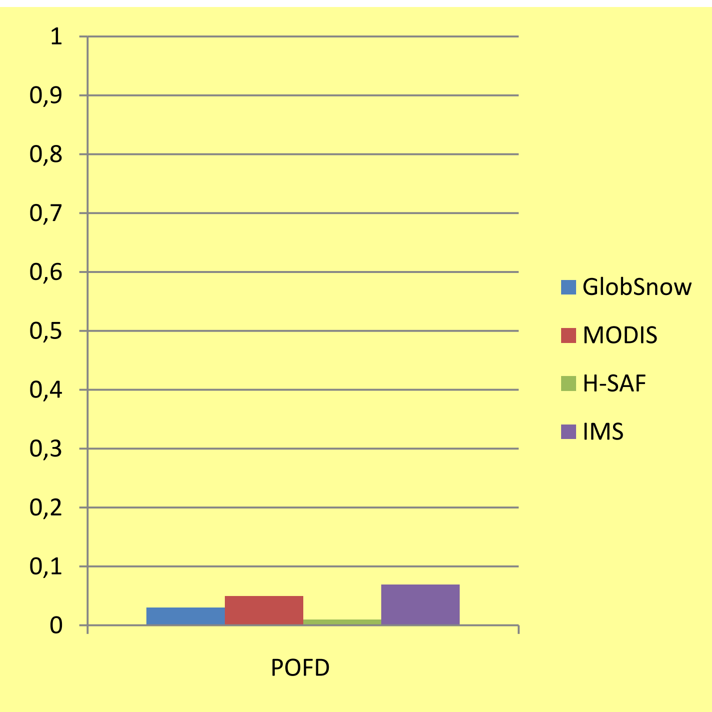
Discharge in Nowa Sól for the years: 2011, 2012 and winter/spring 2013

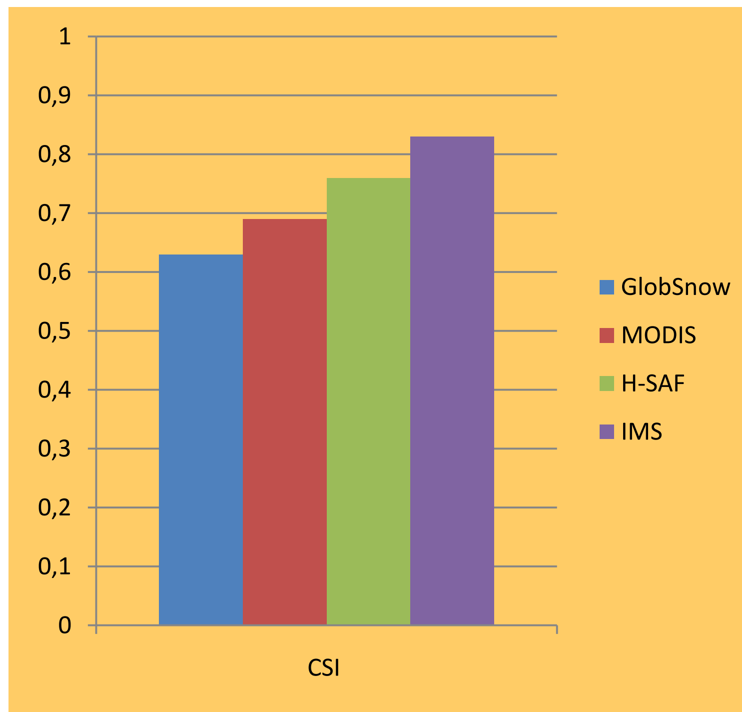
Why we need microwave observations for operational hydrological applications ?

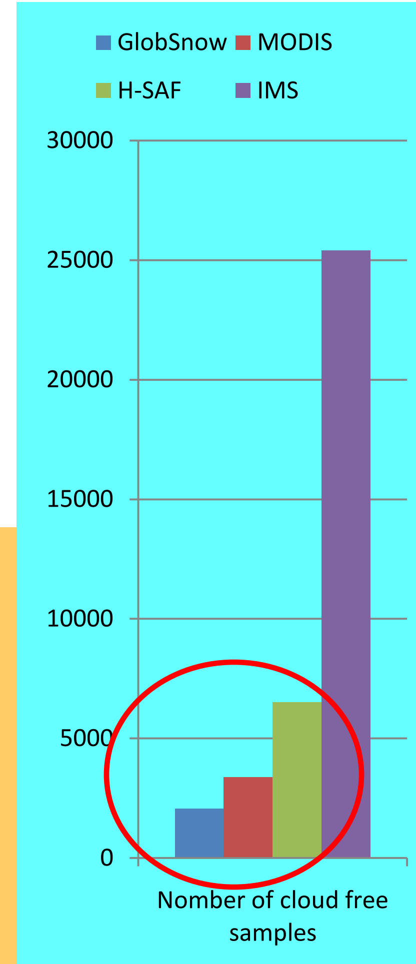




Comparison of satellite snow extent products- winters 2010-2012







Comparison of selected satellite snow cover products

Product	Availability of historical data	Geographical coverage - projection	Physical value	Spatial resolution	Known limitations
JAXA GCOM-W1 SND – Snow Depth	Since 2.07.2012 HDF5	Global, Equi-rectangular, Polar Stereographic N and S	Snow depth [cm]	Level 3 products: 0.1 deg, 0.25 deg	Melting snow – presence of water, large diffrerences between ascending and descending passes
GLOBSNOW – SWE (Snow Water Equivalent)	29.09.1979 – 8.04.2012 NetCDF, HDF 1-01.2013 –now NetCDF	25-84 N; 0-360 E Equi-rectangular Northern Hemisphere Polar Stereogr. N	Snow Water Equivalent [mm]	25 km	Mountainous area rejected, artificial discontinuity of snow cover, melting snow, high artificial peaks at spring time.
H-SAF – H-13 Snow Water Equivalent	1.02.2009 - now GRIB2	Europe Equi-rectangular	Snow Water Equivalent [mm]	0.25 deg	Artificial discontinuity of snow cover, melting snow, high artificial peaks

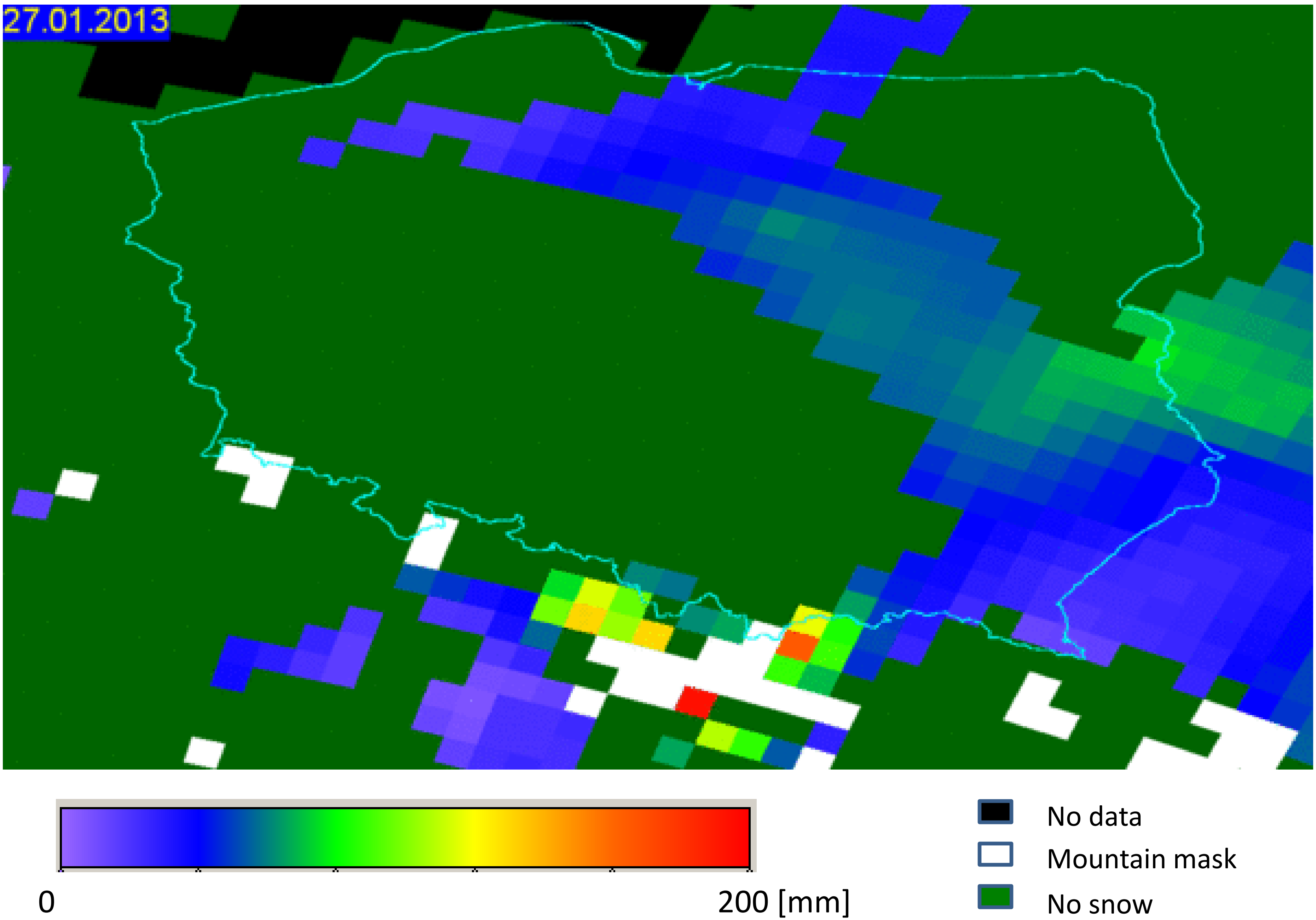
Differences of algorithms:

GCOM-W1 SND - AMSR2 Tb18V – Tb36V and Tb10V-Tb36V, with corrections for dry/wet soil. Very good documentation. Snow depth instead of SWE (clarified by larger amount of this measurement important for validation).

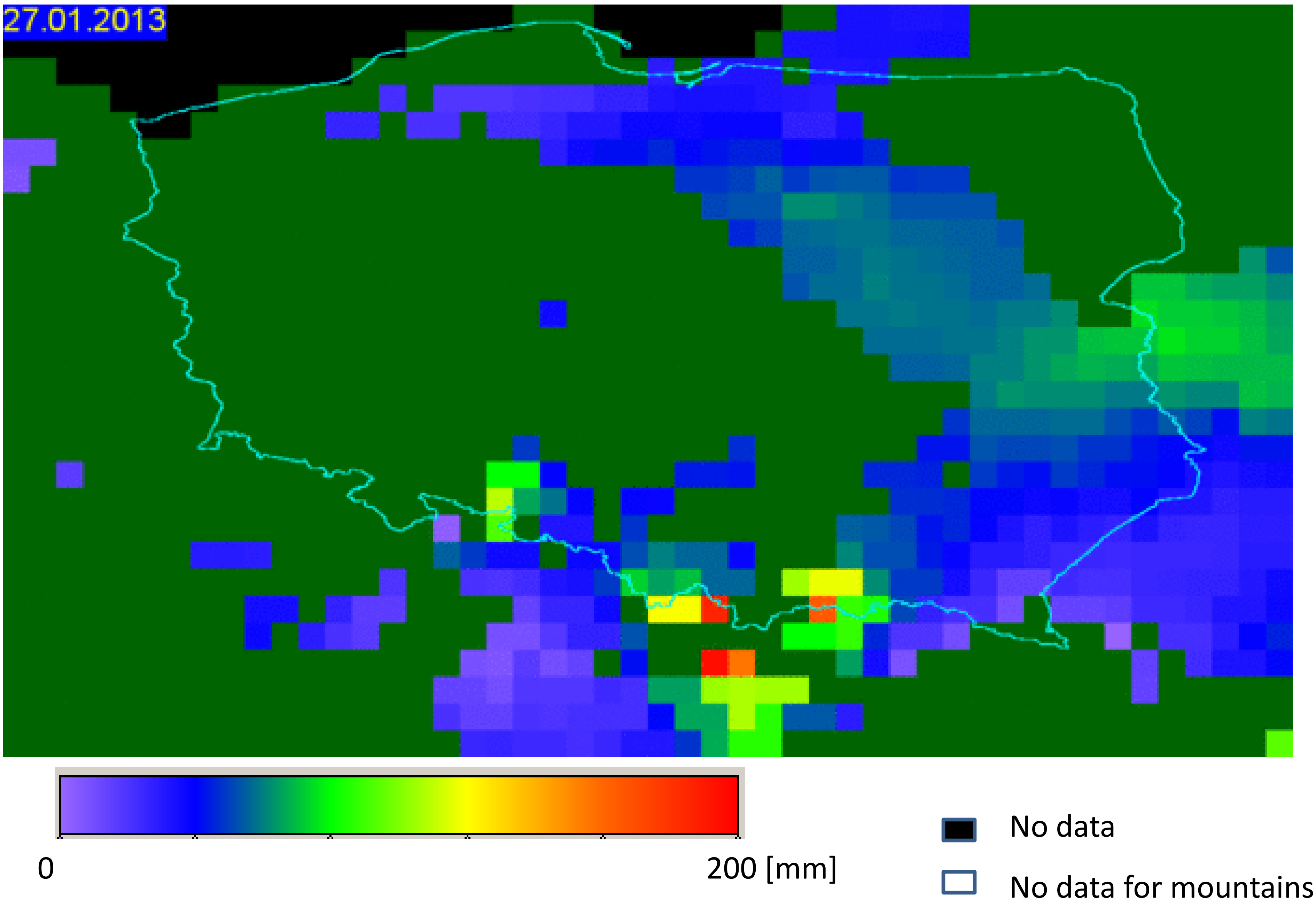
GlobSnow – HUT Snow emmision model - combination of ground based data and satellite microwave radiometer-based measurements (SMMR, SSM/I, AMSRE -- 18.7 GHz and 36.5 GHz). Lack of documentaton for recent products.
Mountinous region blanked.

H-SAF H13 – simlar algorithm to GlobSnow. Merged two products: Flat/forested area (FMI) and Mountainous area (TSMS). Used satellite data AMSRE/AQUA, since 2012 SSMIS on DSMP.

GlobSnow Snow Water Equivalent [mm] - example from last winter (27.01.2013)

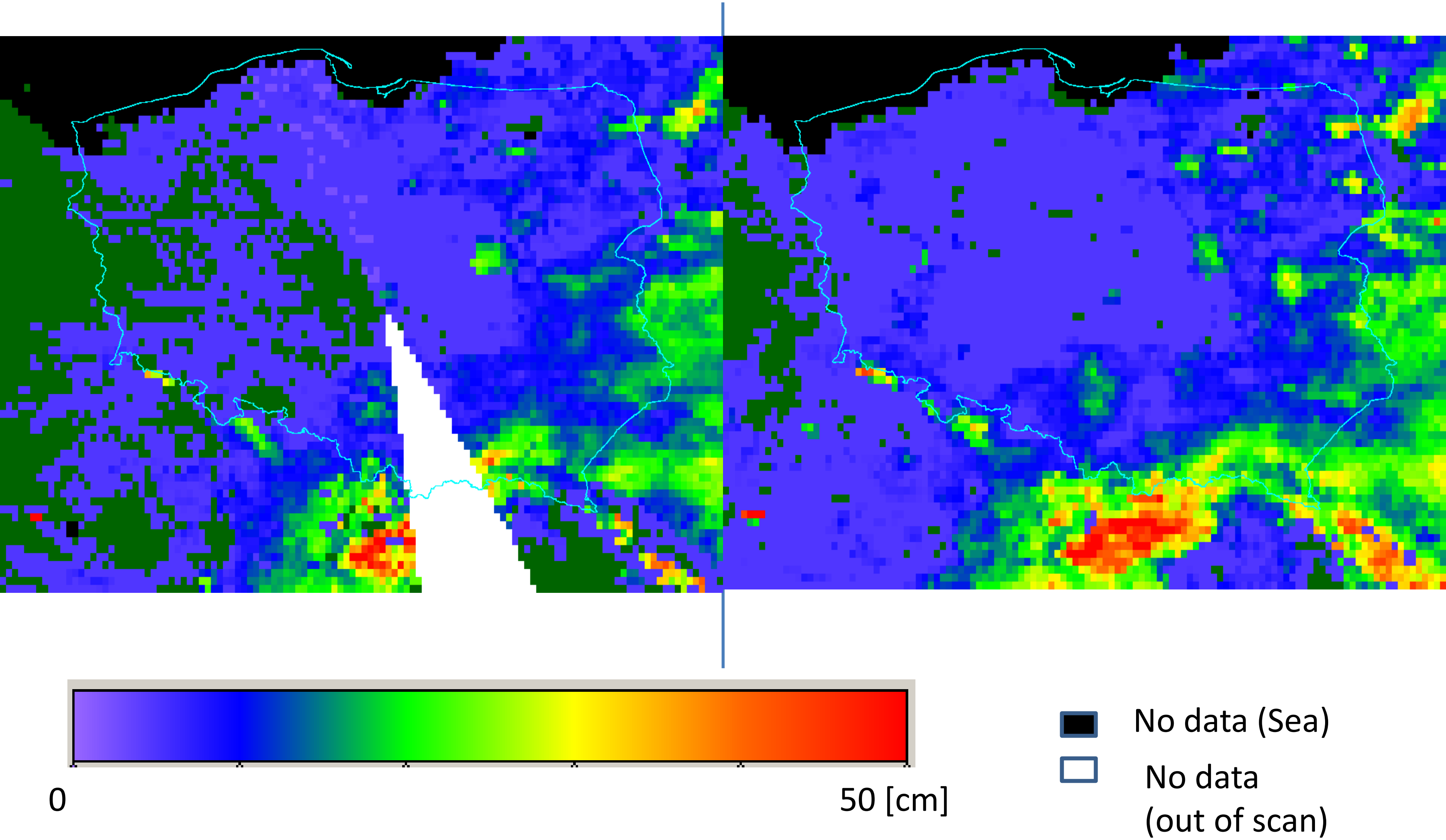


H-SAF Snow Water Equivalent [mm] – example from last winter (27.01.2013)



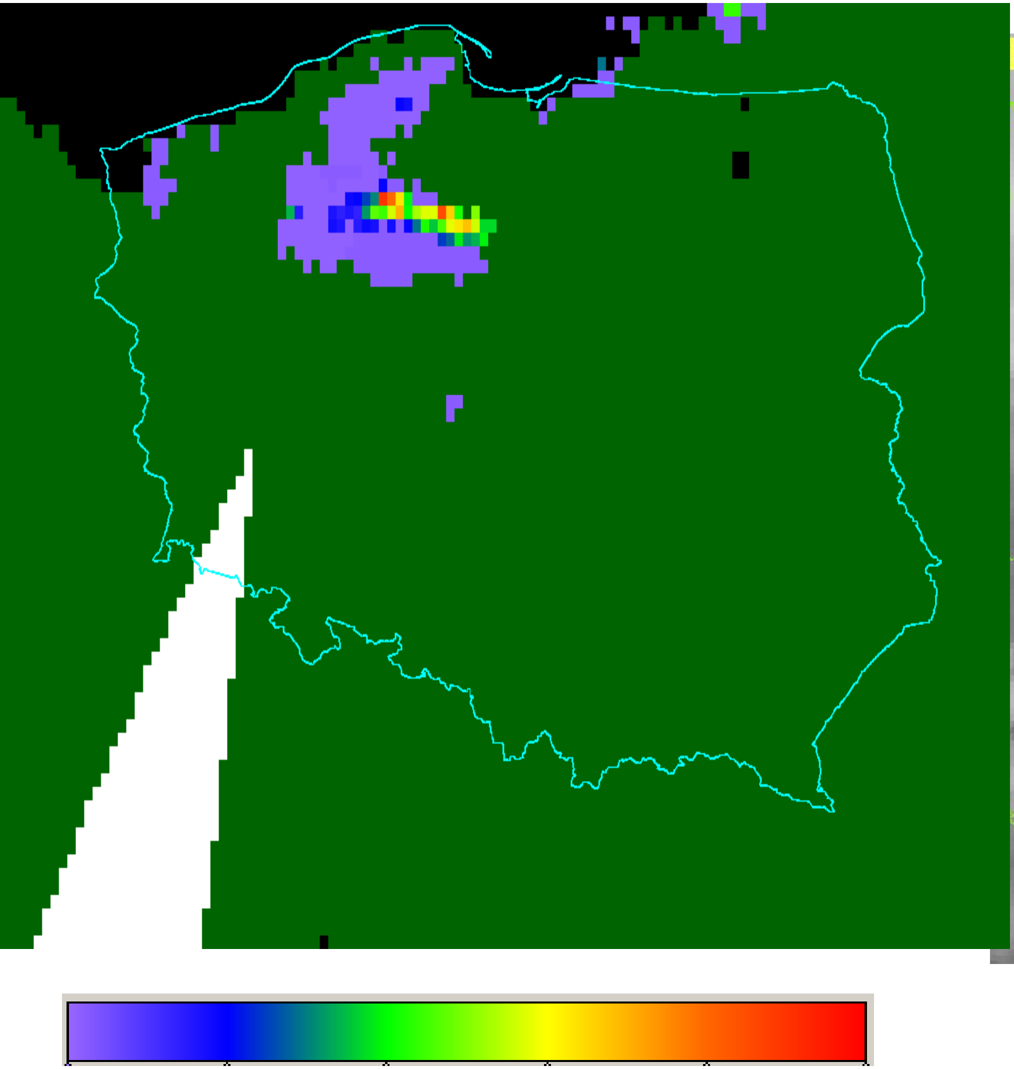
JAXA GCOM-W1 Snow depth – example from the first winter of this satellite (27.01.2013)

Ascending pass (left), Descending pass (right)

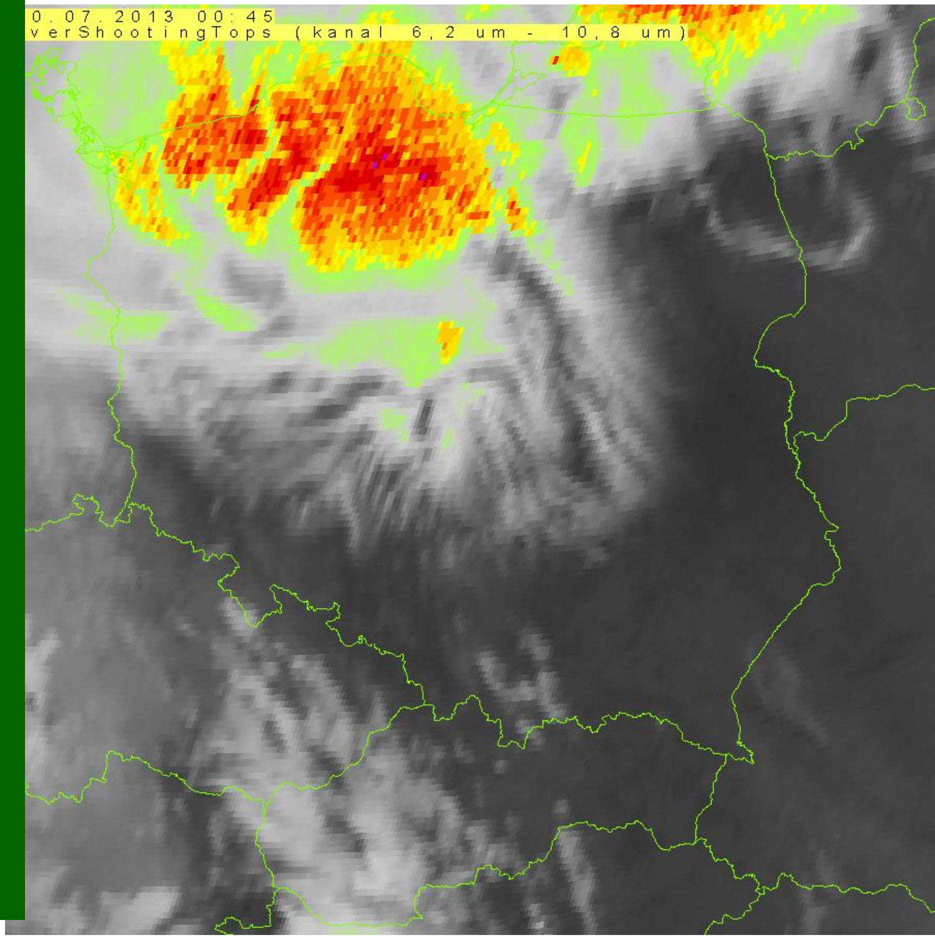


Snow cover in summer ?

High convective clouds are detected as snow (example from 30.07.2013).



0 100 [cm]



Meteosat WV-IR

Found limitations from eyeball verification

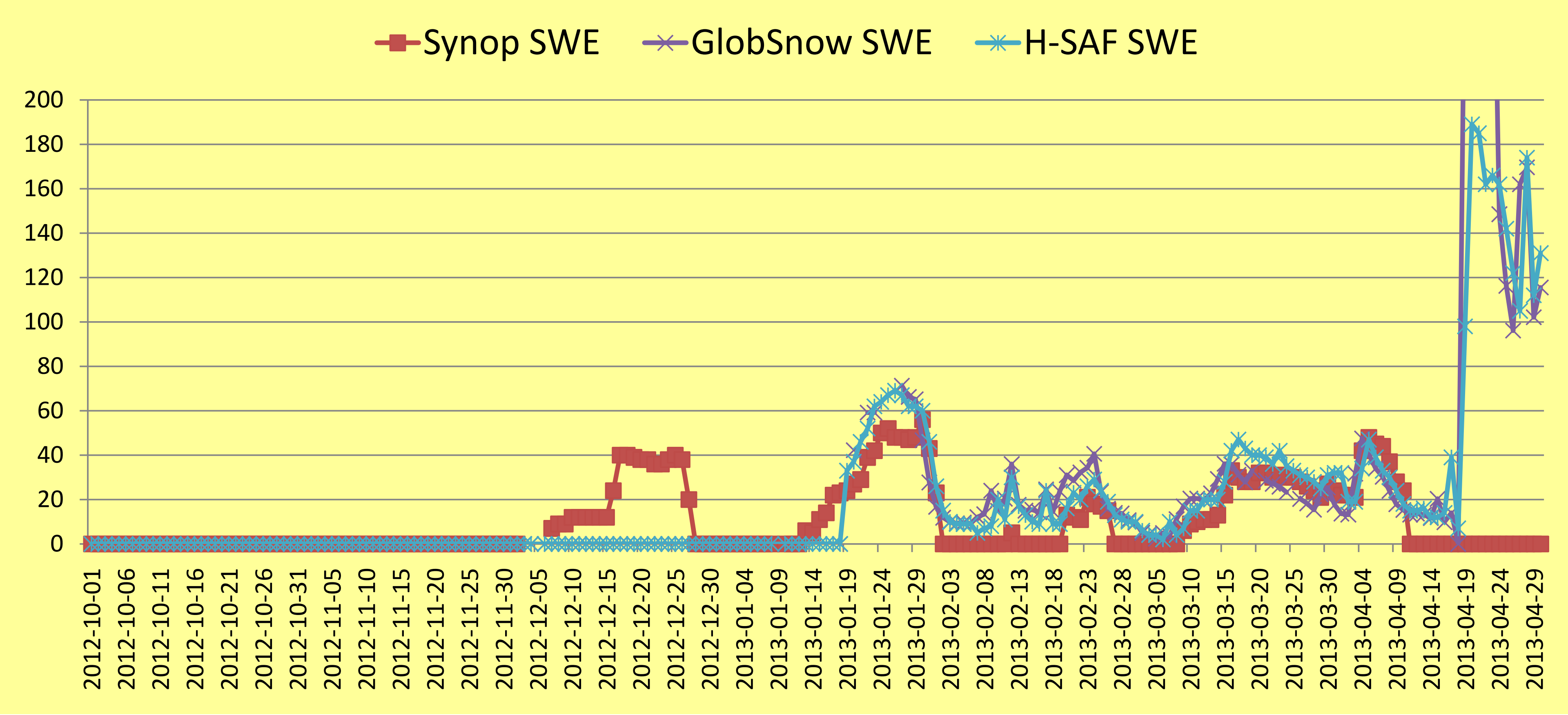
GlobSnow and H-SAF H-13

- Artificial structures not connected with snow presence – “snow-like” and “snow-dislike” areas through the whole winter,
- high peaks of SWE (up to 350 mm),
- declared combined use of Synop observations and satellite retrievals – it looks,that only small part of stations is used,
- poor resolution (20-25 km) – not acceptable for smaller cachments.
- GlobSnow – lack of mountainous area,
- H-SAF H13 – problems with mountain mask and merging of FMI and TSMS products,
- Product availability: Globsnow SWE – 3 days timeliness,
- Product availability: H-SAF H-13 – next day 8:20 UTC.

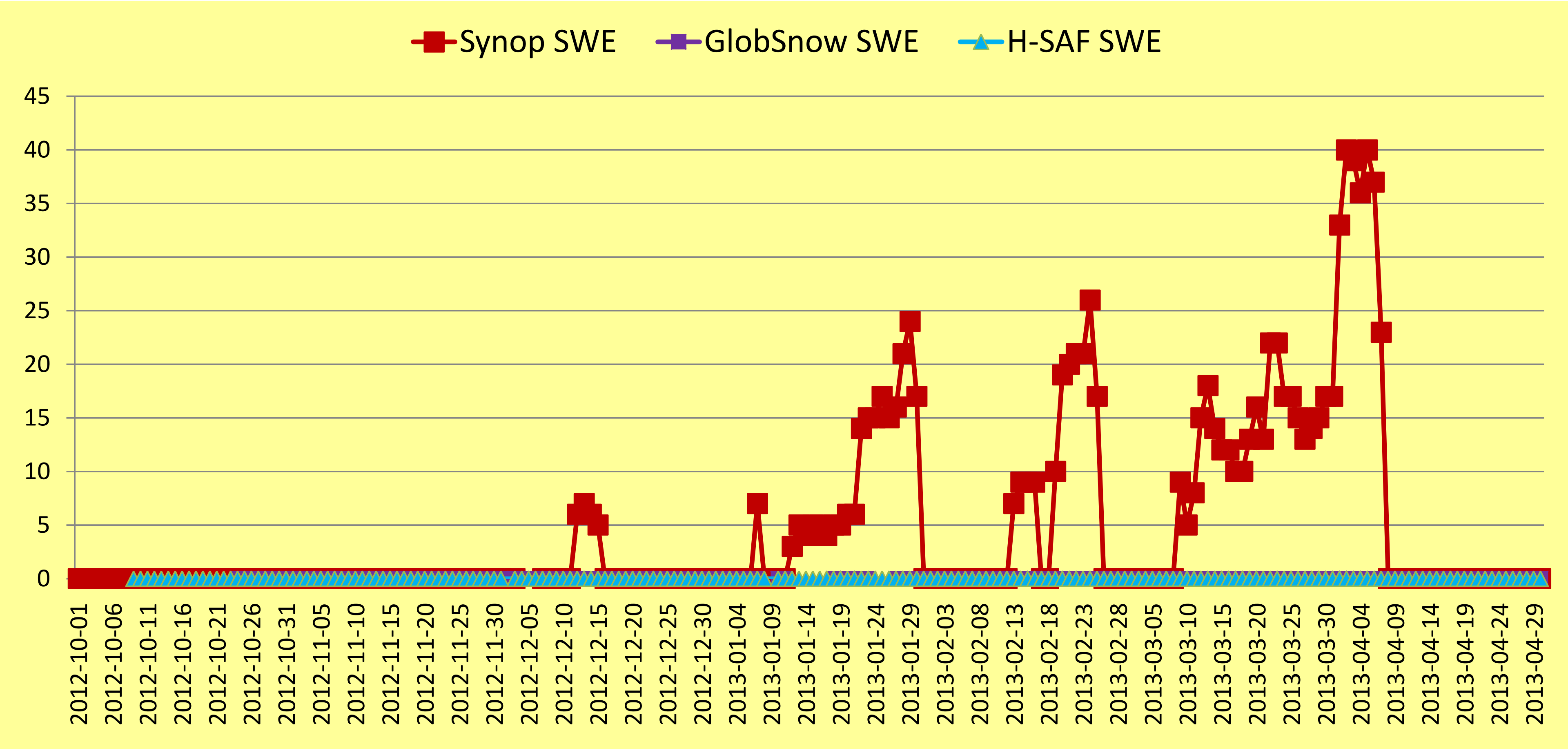
GCOM-W1:

- Better spatial representation of snow cover,
- Descending pass (at night) better then ascending (at day) but frequent large difference difficult for operational applications,
- Problems at higher temperatures - melting snow,
- Lack of thin snow cover detection – minimal depth is 5 cm,
- Differences in geographical navigation between ascending and descending passes at level 3 products.
- Product available at ~17:00 UTC next day.

Snow Water Content on 1.10.2012-30.04.2013 at Włodawa Synop station – comparison to GlobSnow SWE and H-SAF SWE (H-13 product).

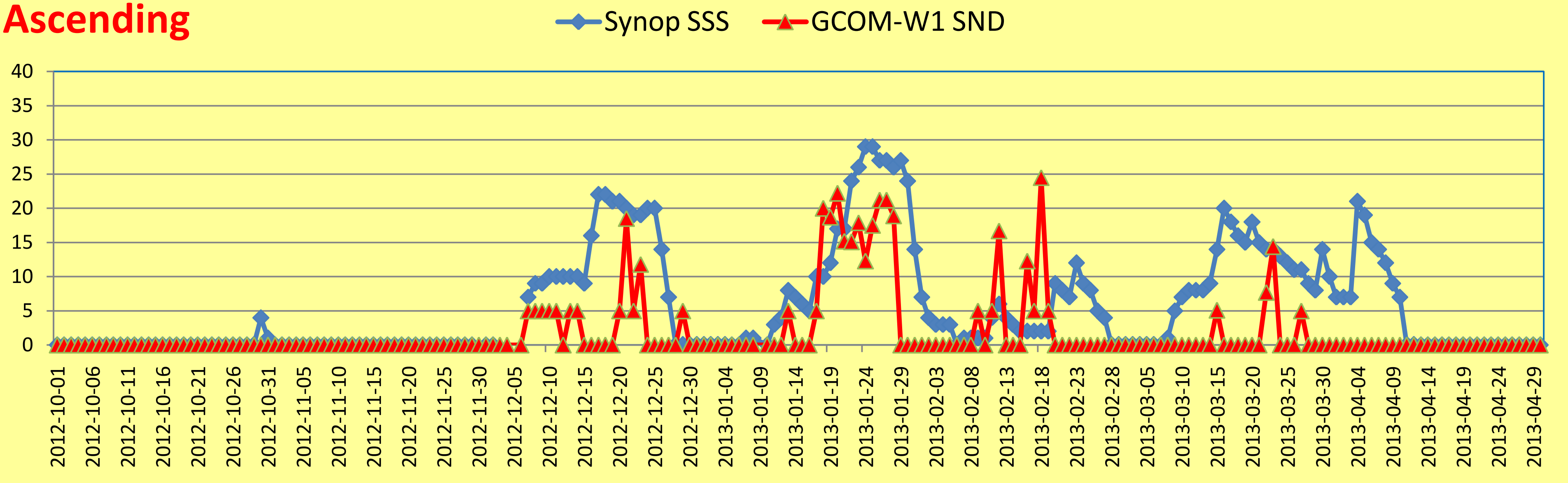


Snow Water Content on 1.10.2012-30.04.2013 at Koło Synop station – comparison to GlobSnow SWE and H-SAF SWE (H-13 product).

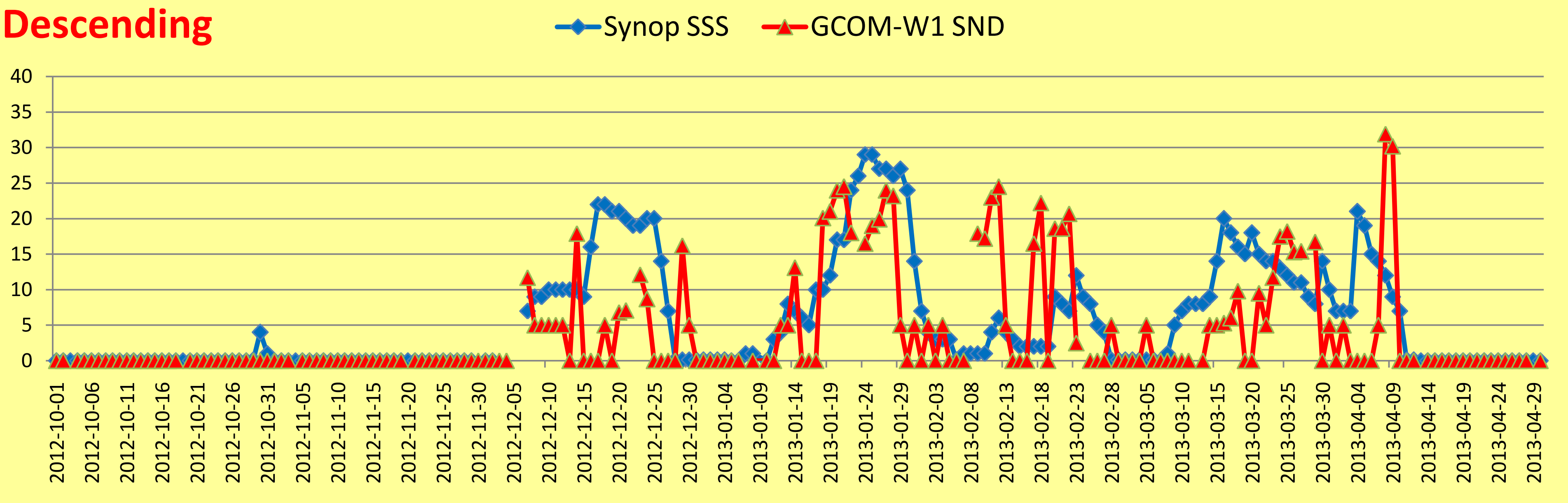


Snow depth on 1.10.2012-30.04.2013 at Włodawa Synop station – comparison to GCOM-W1 Snow Depth product

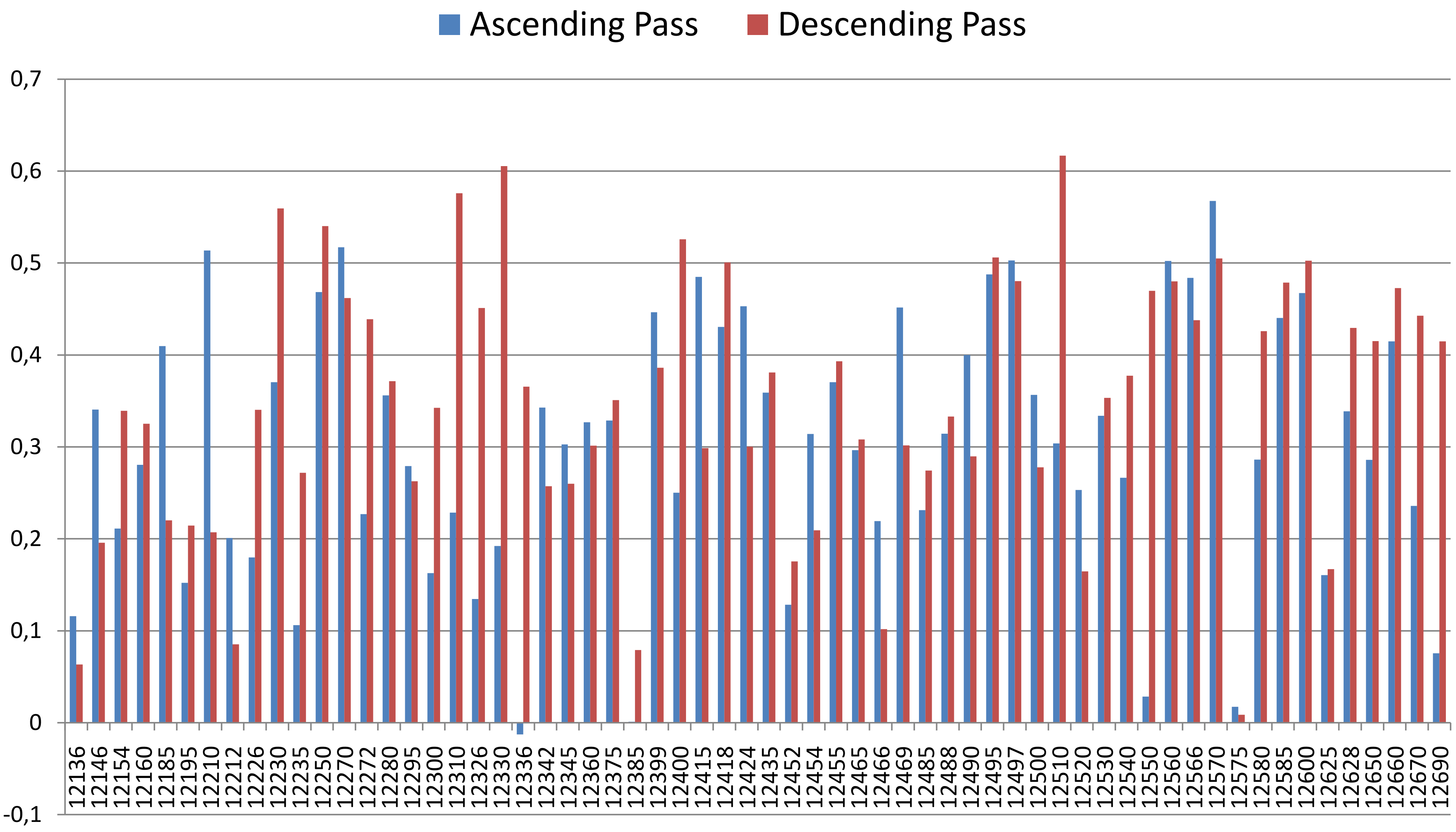
Ascending



Descending

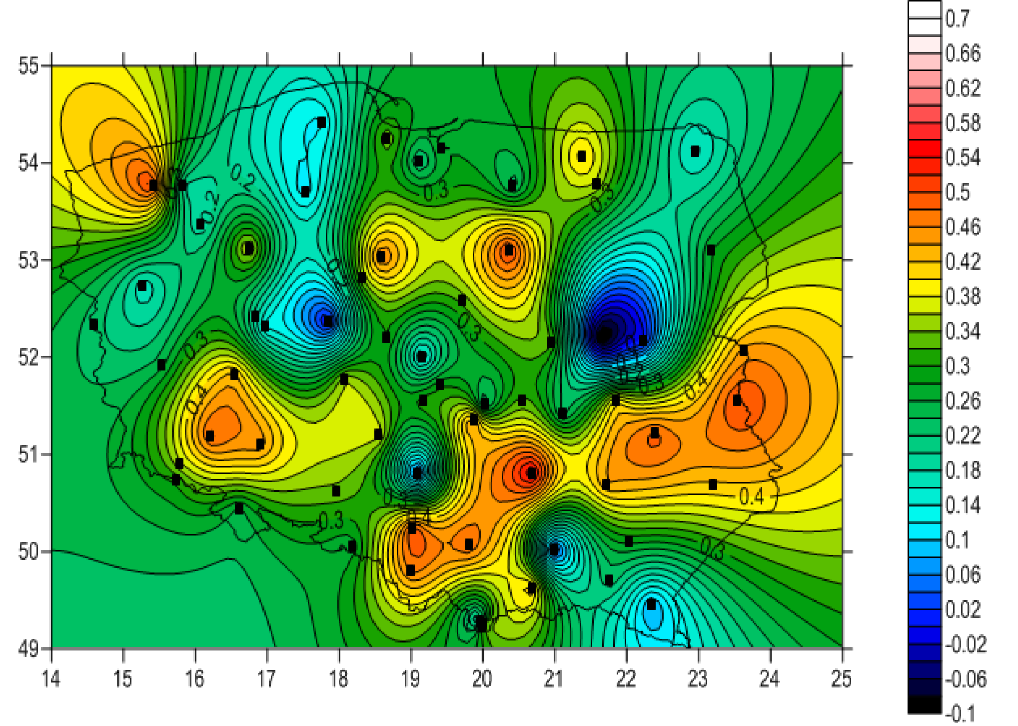


Correlation Coefficient for snow depth measured at the ground and retrieved by GCOM-W1 SND product – all analyzed Synop stations

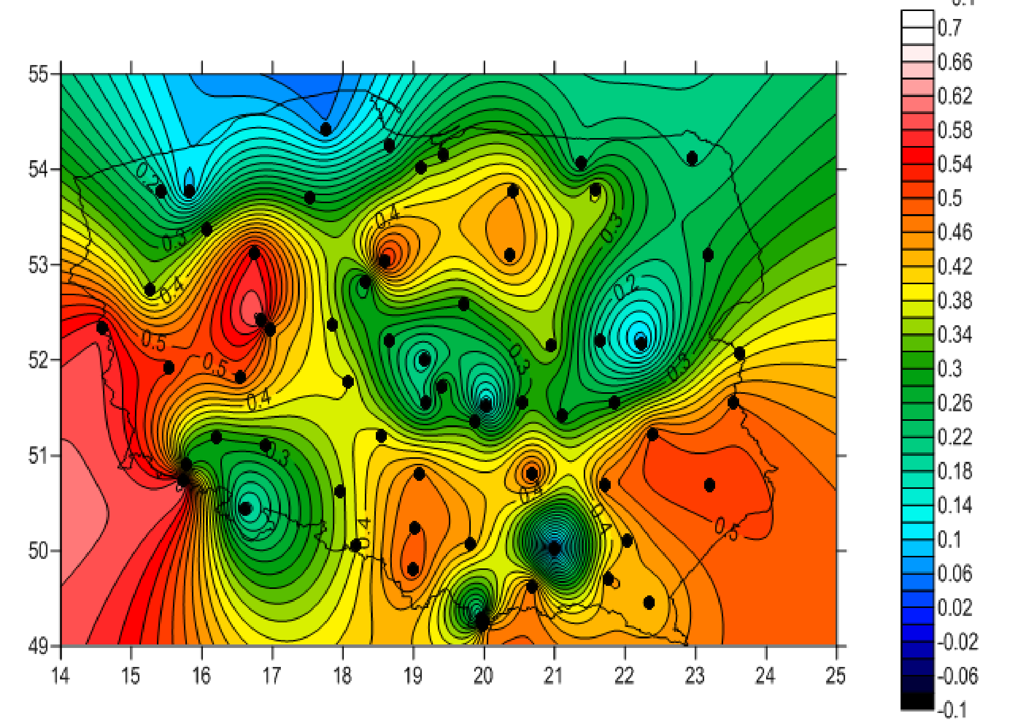


Validation of GCOM-W1 SND against Synop snow depth – Corelation coefficient

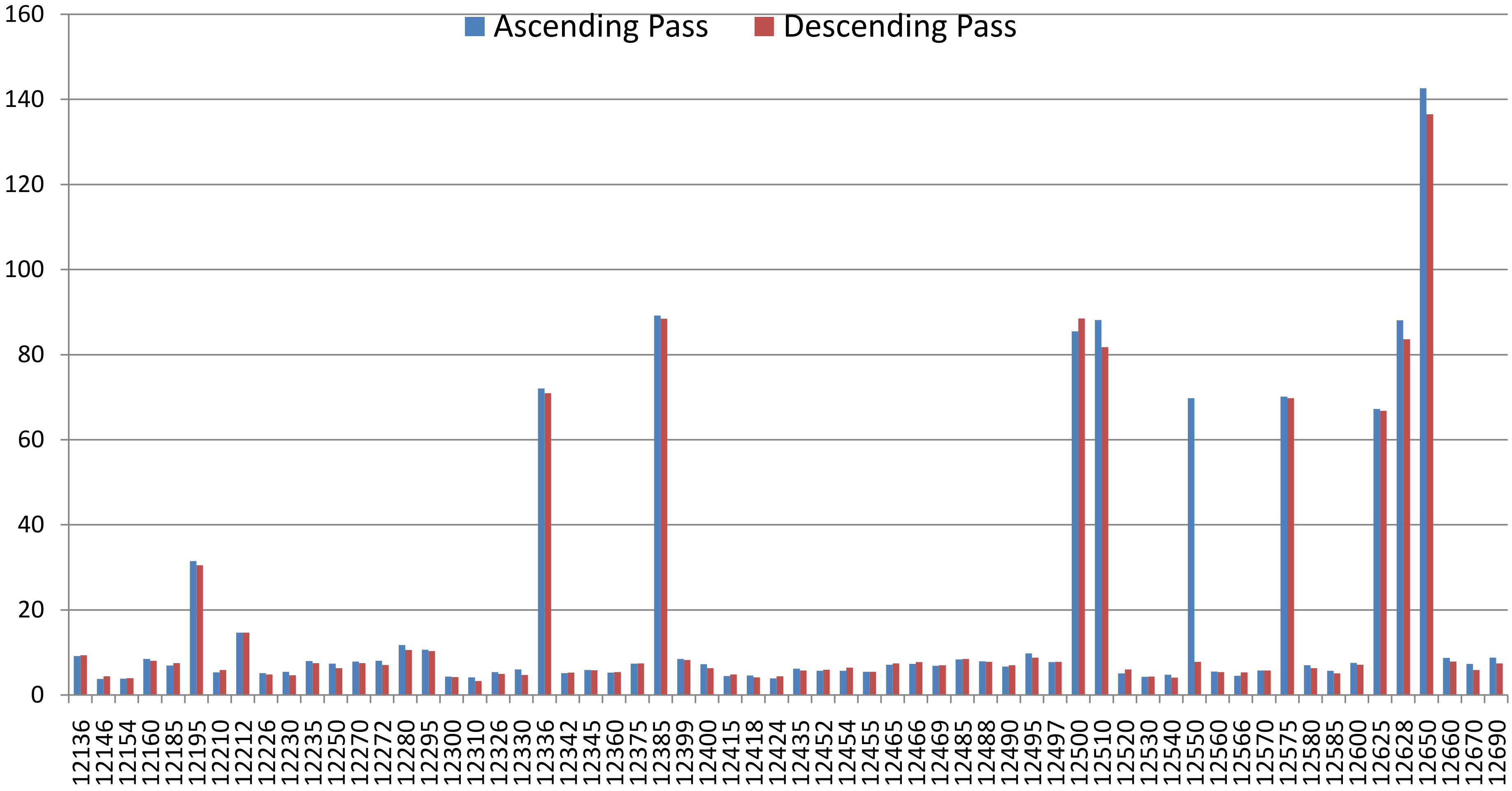
Ascending pass
12:00-13:00



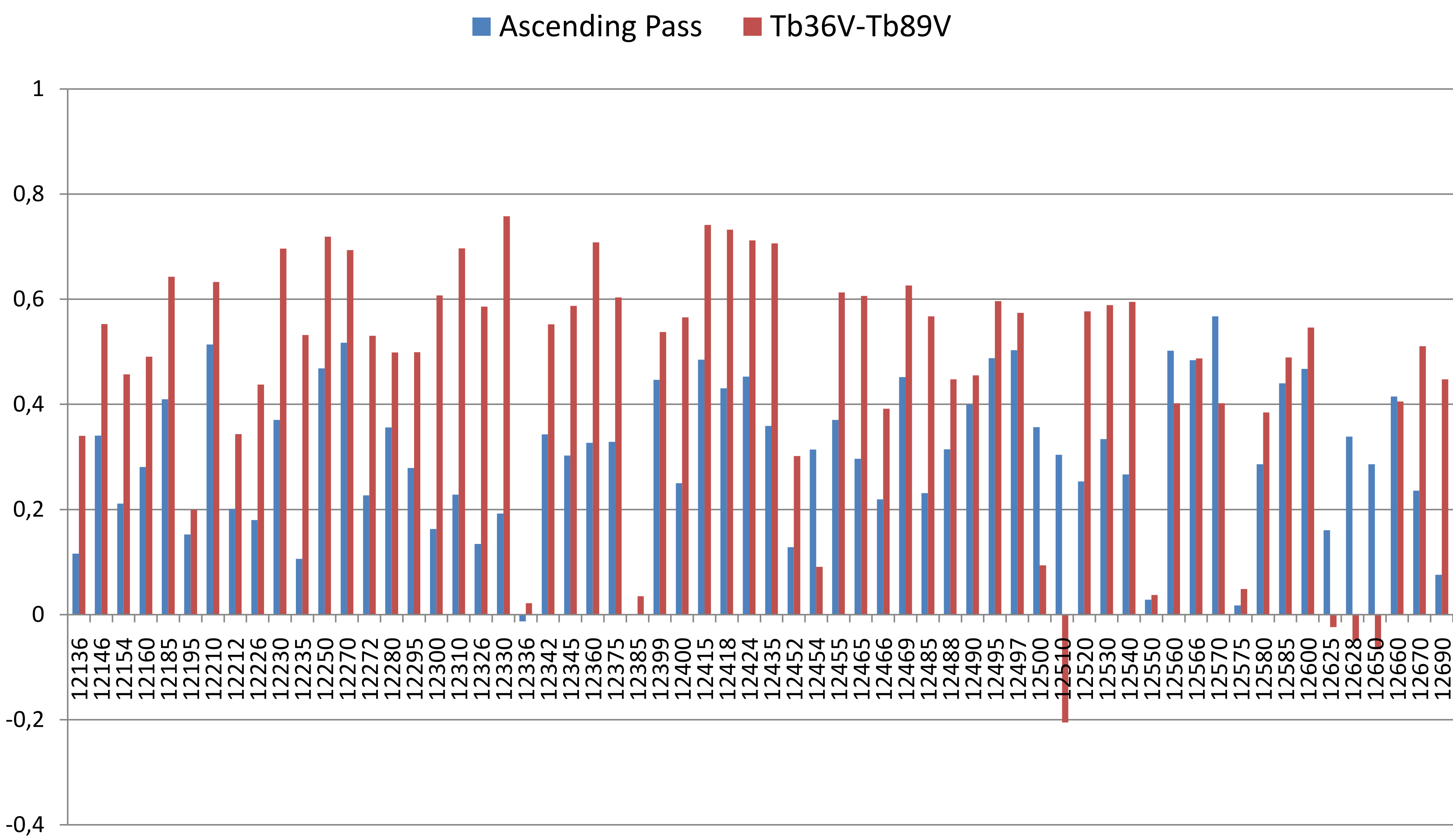
Descending pass
0:30-1:30



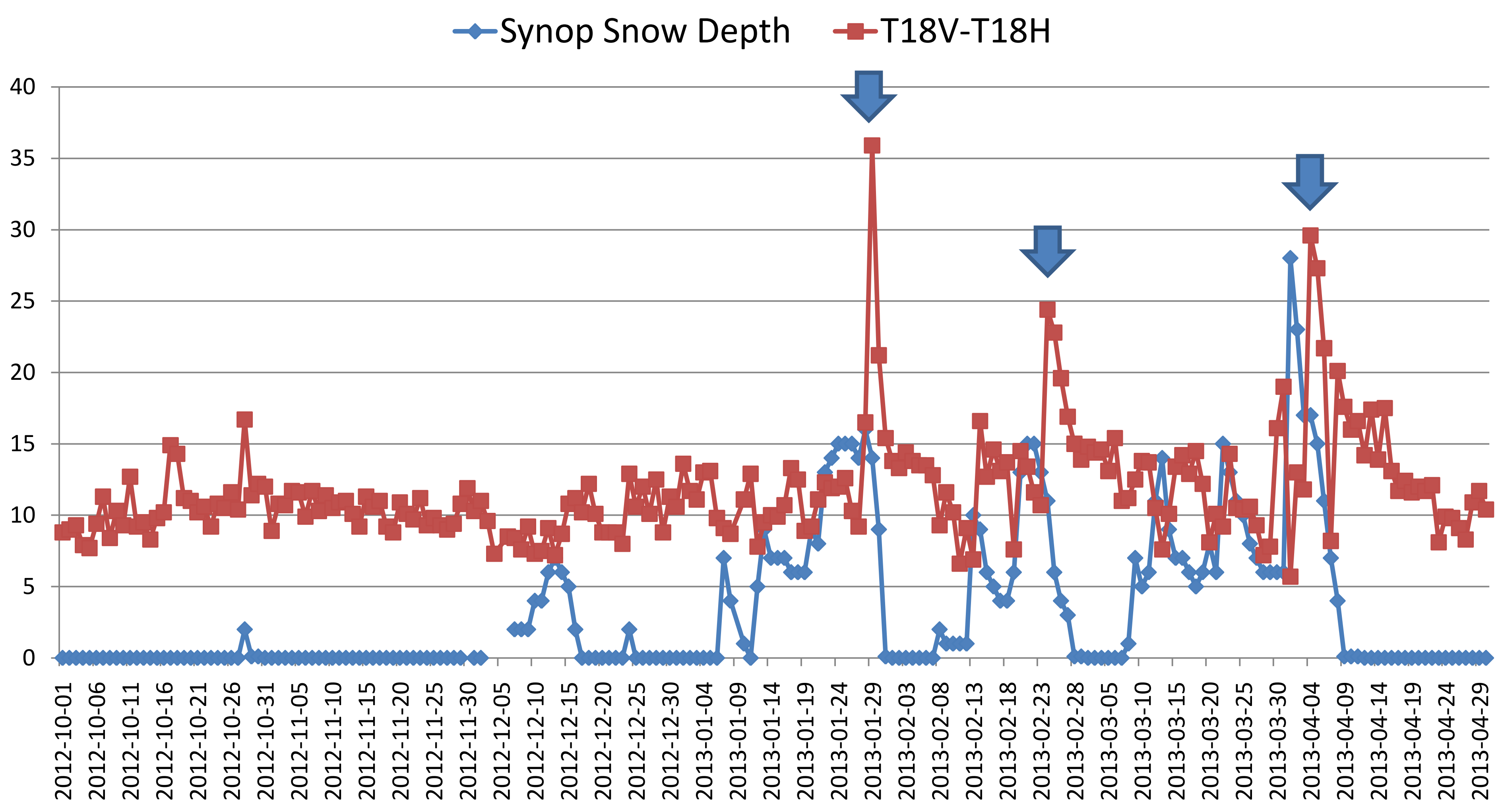
RMSE [cm] for all analyzed Synop stations



Possibilities for improvement of Snow Depth Product – comparison of Correlation Coefficient between mesured snow depth at the ground (Synop SSS) and: GCOM-W1 SND and calculated Tb36V-Tb89V.
Better results for shallow snow cover.

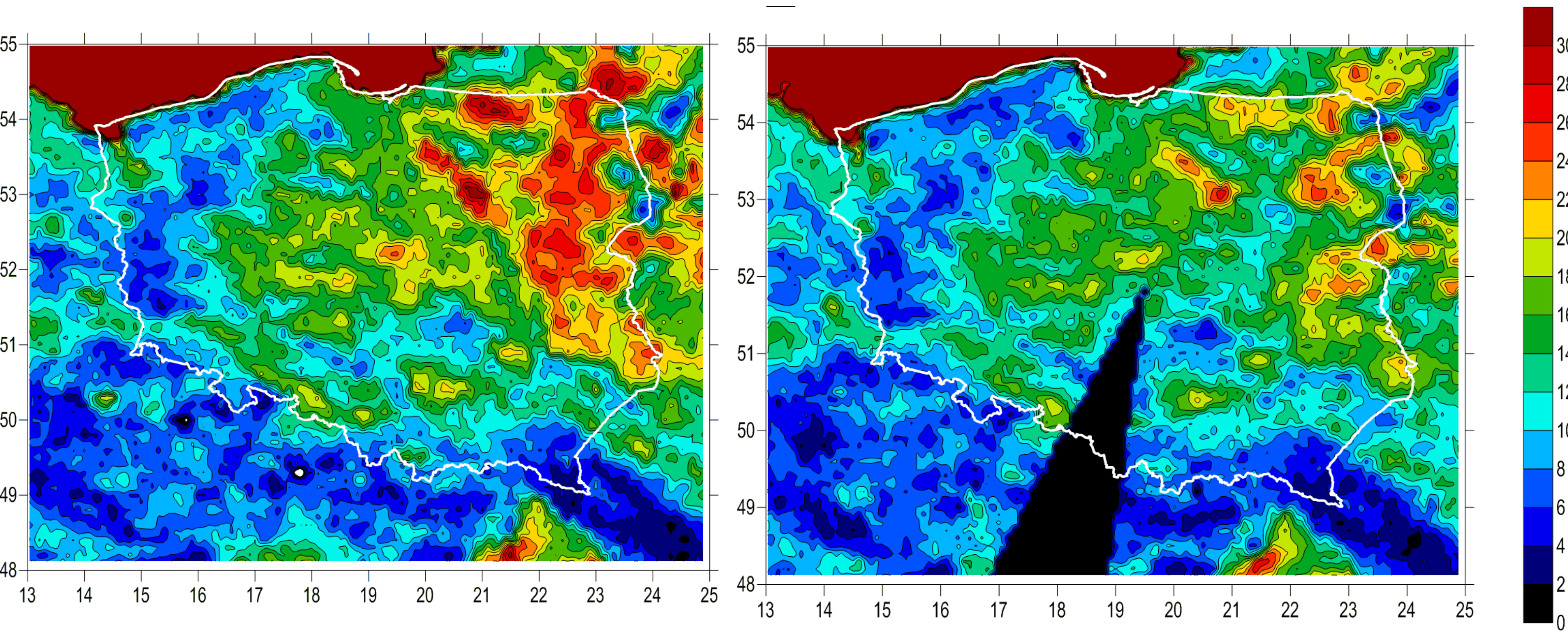


Melting snow detection – use of similar tests like to precipitation retrieval (V-H) – Stronger effect for lower frequences.



Snow melting processes seen by AMSR2 of GCOM-W1

Difference 18V-18H on 11.04.2013 – wet snow indicated by high difference of temperature



Conclusions:

1. There is still lack of satellite product which can satisfy hydrological expectations concerning snow water monitoring in temperate zone (e.g. Central Europe).
2. Interesting results were found in GCOM-W1 Snow Depth product.
3. Estimation of water amount in melting snow is still a challange – most importatnt for hydrologists !
4. For shallow snow cover better results could be obtained from T36V-T89V or T23V-T89V, then from usually used T18V-T36V.
5. Big problem with representative ground measurements for validation of MW observation with pixel size of 10-30 km.

Instytut Meteorologii i Gospodarki Wodnej

Państwowy Instytut Badawczy

Thank you for your attention

Piotr Struzik
Institute of MeteorologY and Water Management
State Research Institute
Satellite Remote Sensing Centre
30-215 Kraków, ul. P. Borowego 14
Tel. (12) 63-99-125
piotr.struzik@imgw.pl
www.imgw.pl
www.pogodynka.pl

POGODYNKA.PL
SERWIS POGODOWY IMGW-PIB