Institute of Meteorology and Water Management
National Research Institute

Snow depth from GCOM-W1 AMSR2 Instrument – experience gained from the last four winters

Piotr Struzik, Monika Pajek

IMWM-NRI, Poland

Satellite Remote Sensing Department, Krakow

POGODYNKA PL

Presentation outline:

- GCOM-W1 snow depth product,
- Snow depth products – last 4 winters.
- SND Version1 vs. Version2,
- Melting snow problem,
- Conclusions

GCOM-W1 data and products availability:

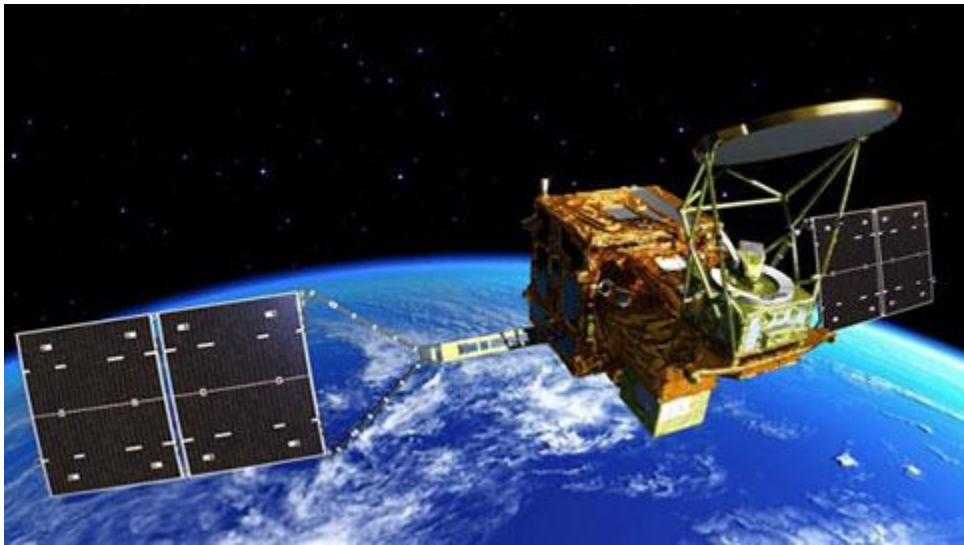
Global Change Observation Mission 1st – Water “SHIZUKU” (GCOM-W1) launched on May 18, 2012.

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

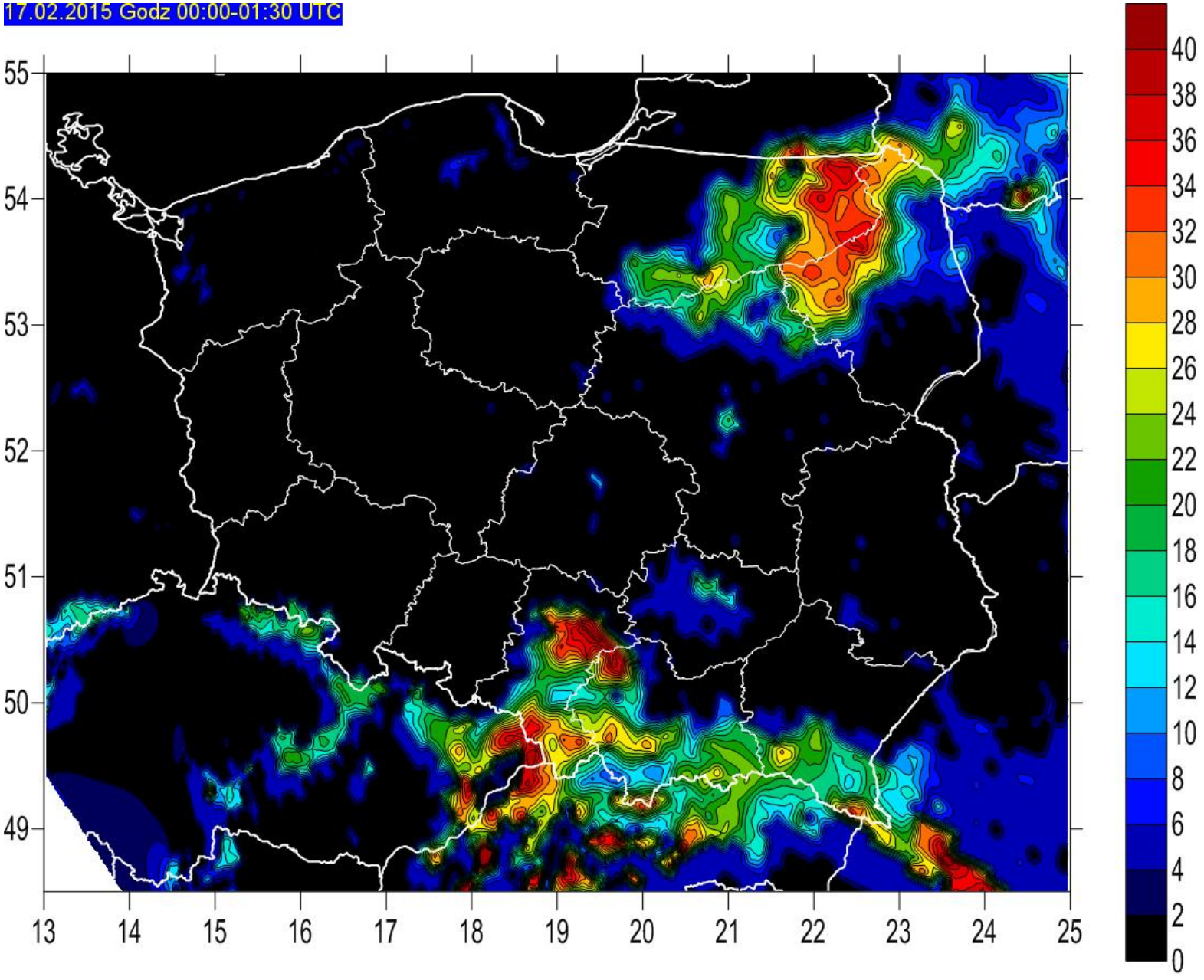
Data archive for entire live of AMSR type instruments
sftp://gcom-w1.jaxa.jp:2051

AMSR - Apr. - Oct.2003
AMSR-E - June 2002 – Oct. 2011
AMSR-2 - July 2012 – now

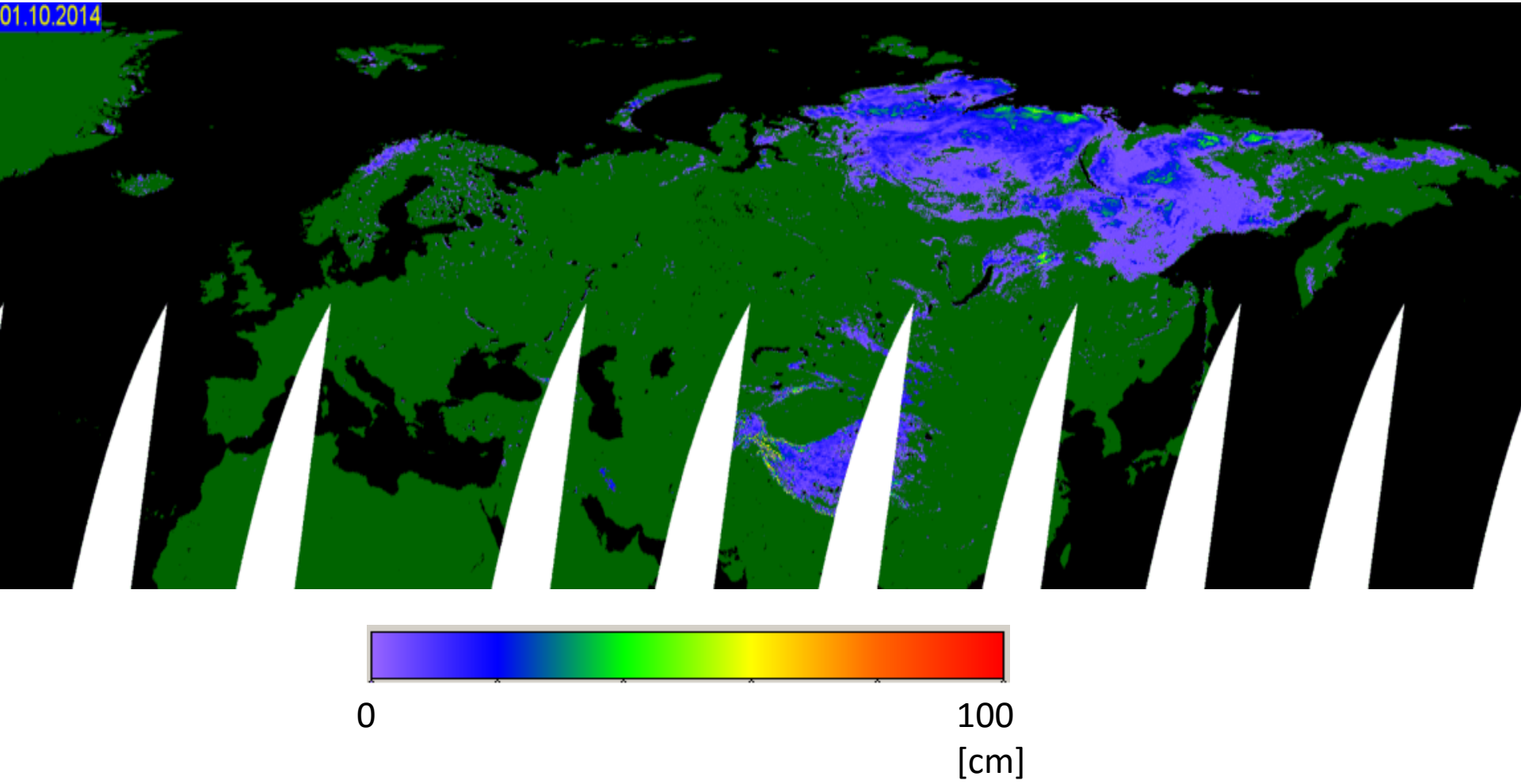
SD = Rc* (Tb19V-Tb37V)
Over forested areas also used:
Tb10V-Tb37V



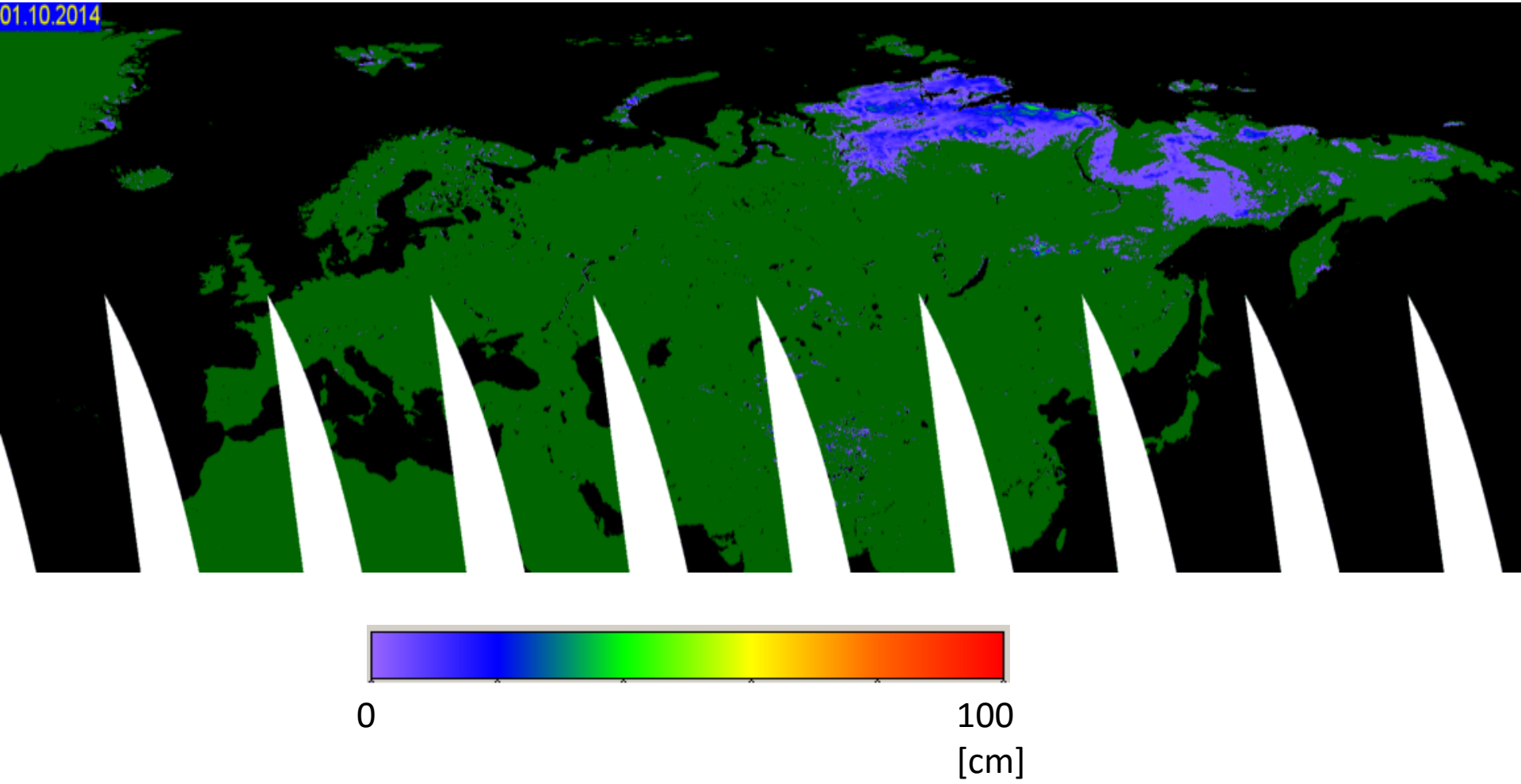
Example of the product presented at IMWM intranet. Image generated from Level 2 SND product.



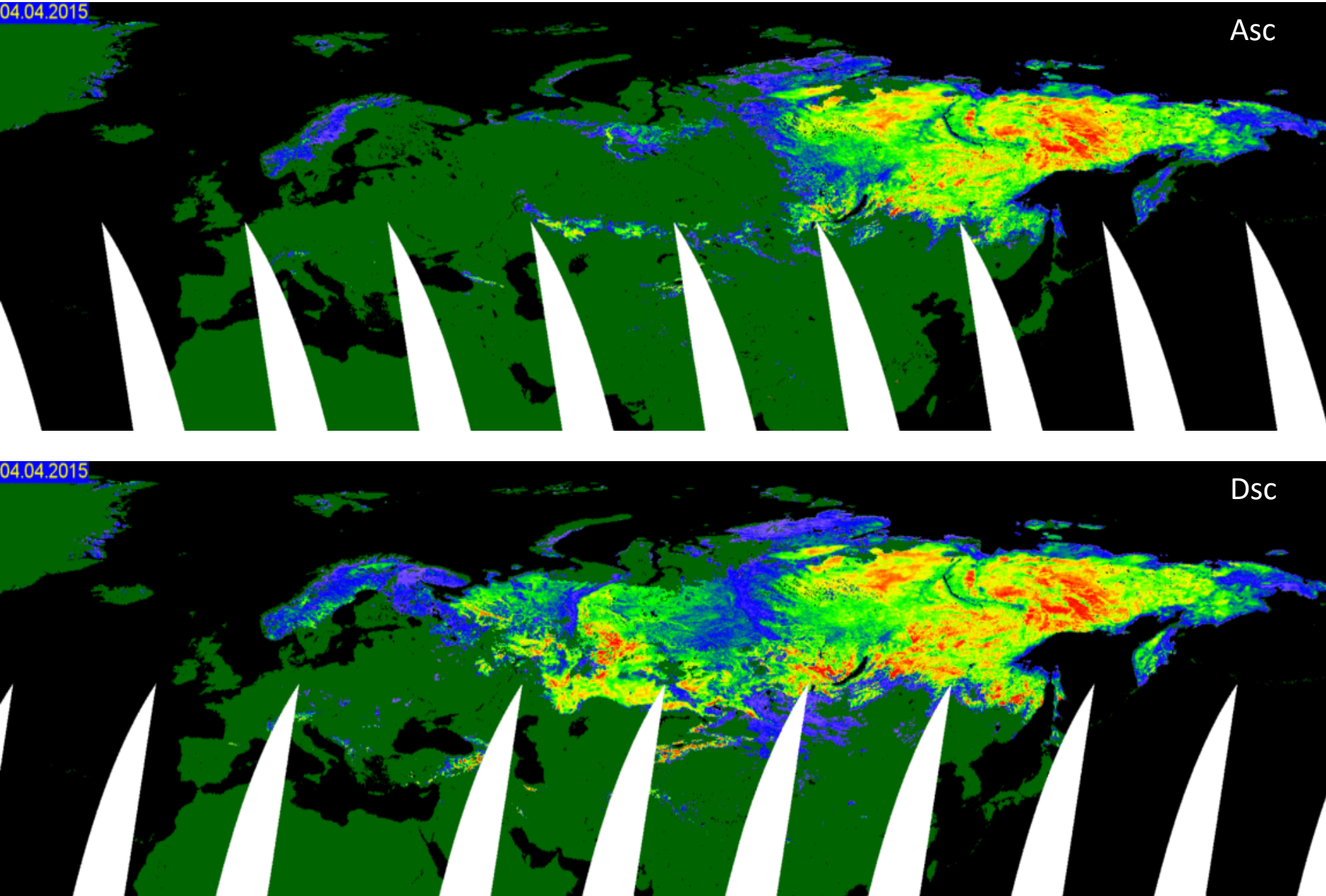
Winter 1.10.2014-31.05.2015 – Snow depth over Eu-Asia
Only Descending passes



Last winter 1.10.2014-31.05.2015 – Snow depth over Eu-Asia
Both Ascending and Descending passes

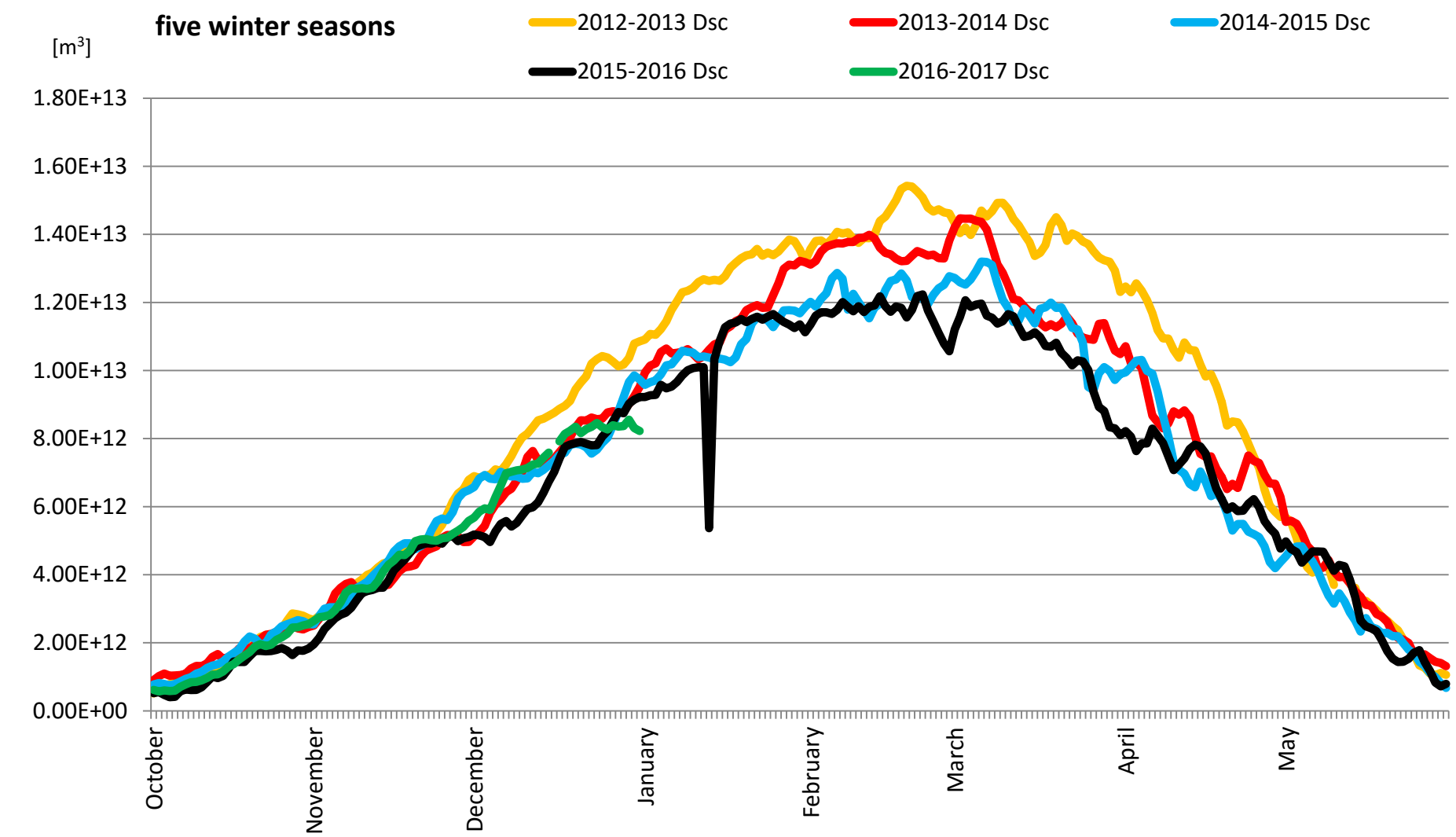


Comparison of snow depth distribution retrieved from ascendig and descending pass -4.04.2015



Northern Hemisphere (25-85N), winters: 2012/2013, 2013/2014, 2014/2015, 2015.2016 and beginning of 2016/2017

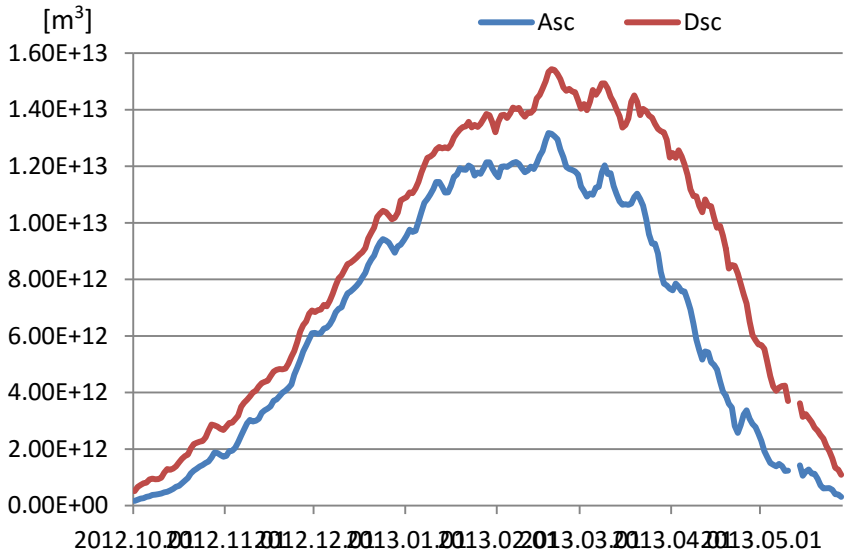
Snow volume [m3] - Descending Pass



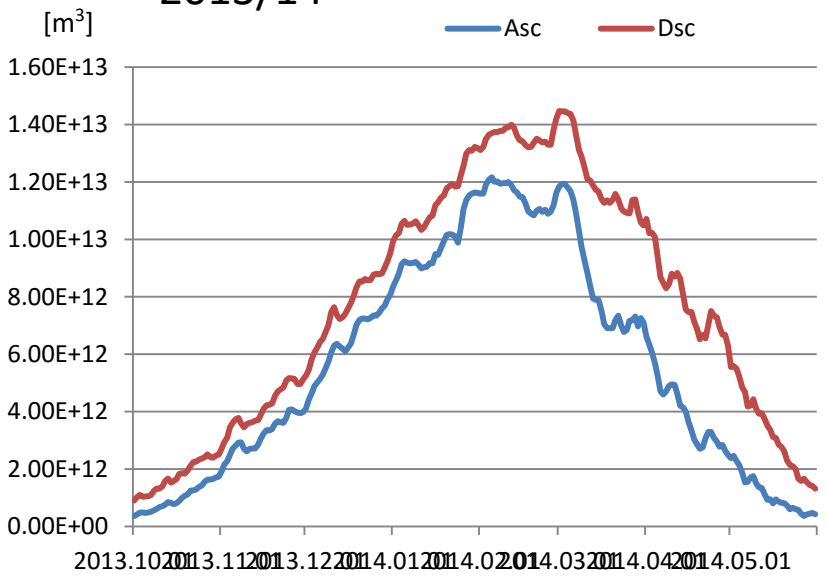
Ascending vs. Descending pass – Northern Hemisphere 20-85N

– phases of snow development !

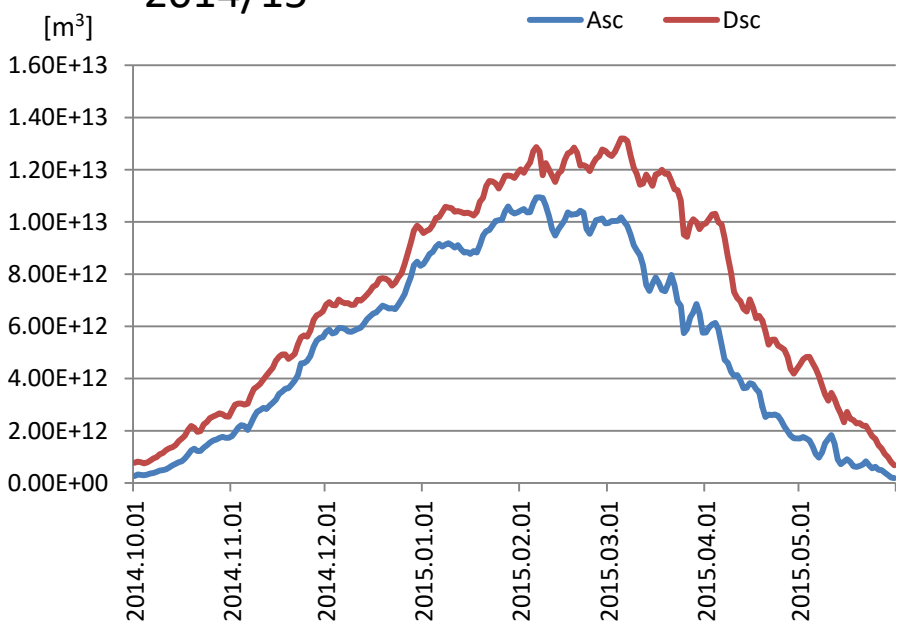
2012/13



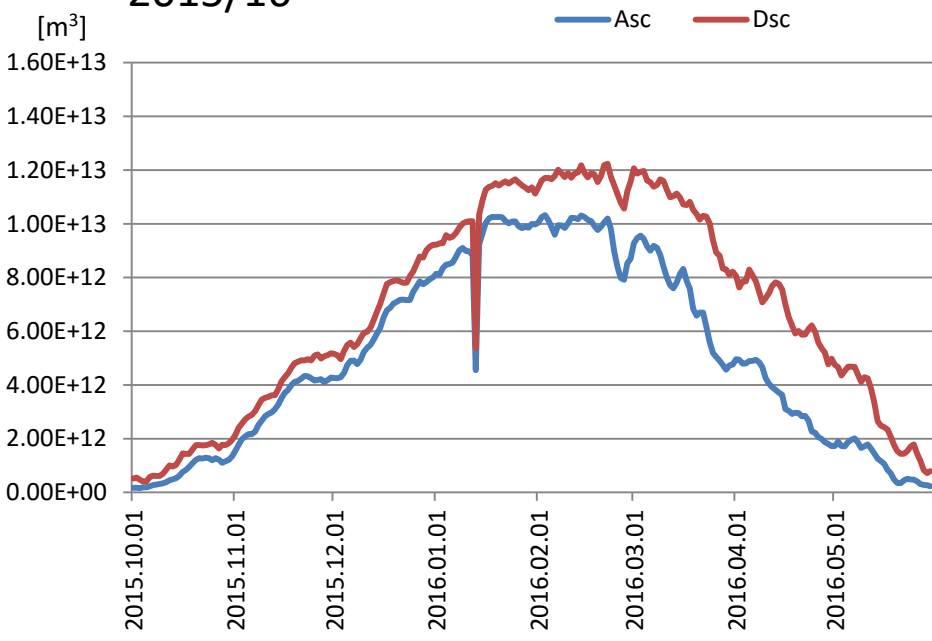
2013/14



2014/15

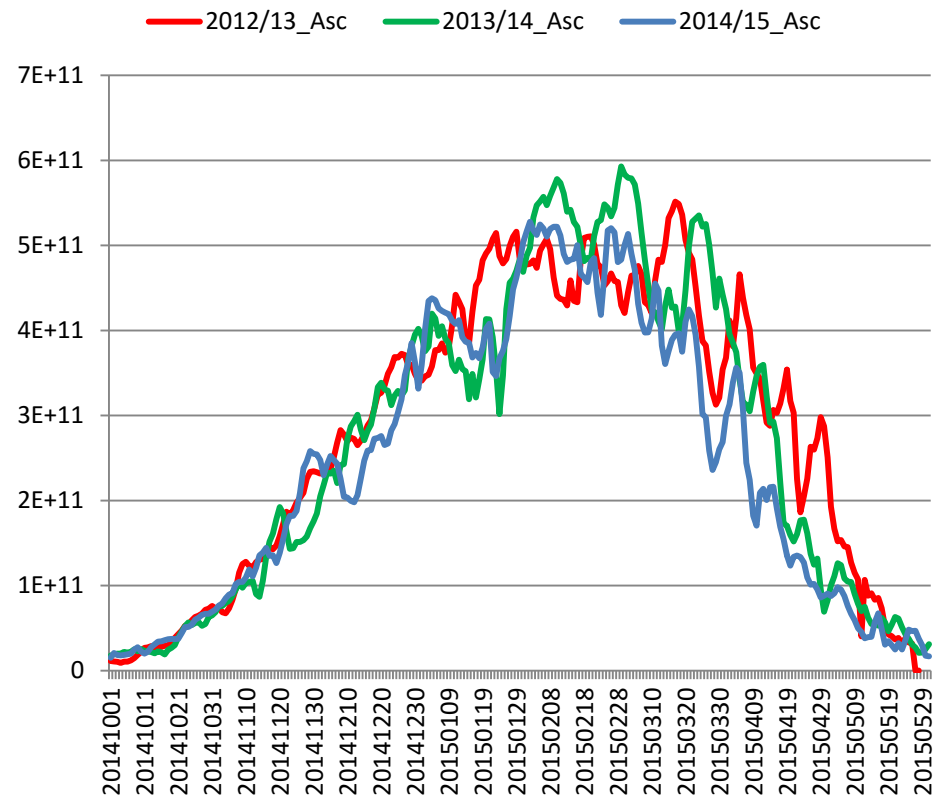


2015/16

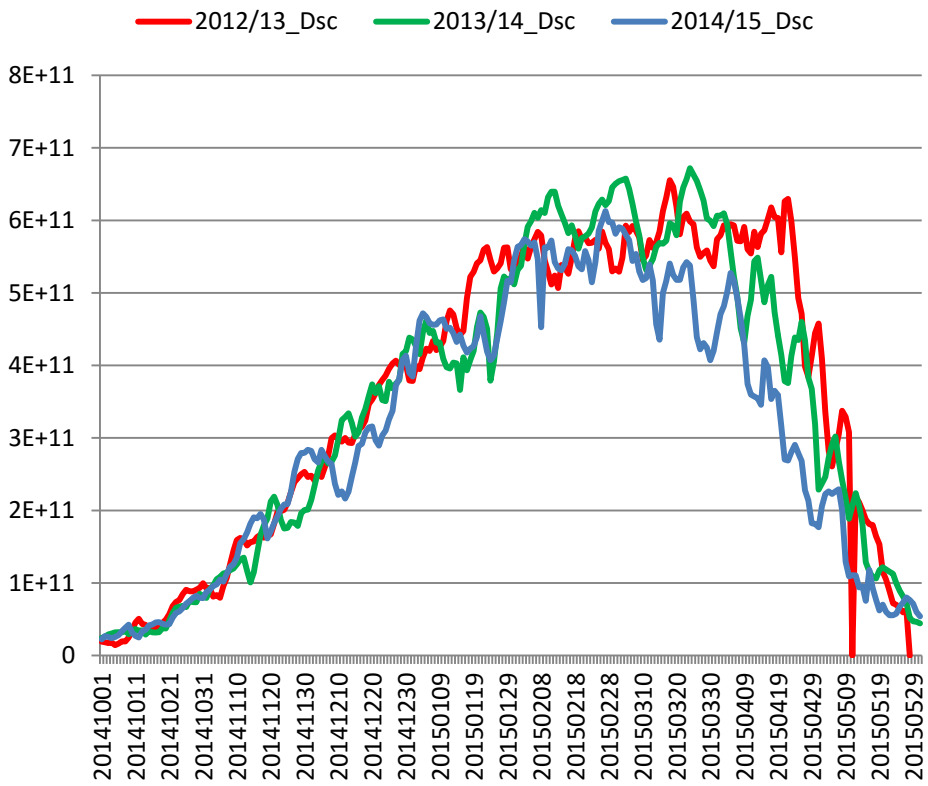


Comparison of snow volume for North America (20-85N) for 3 winters
Ascending and Descending pass

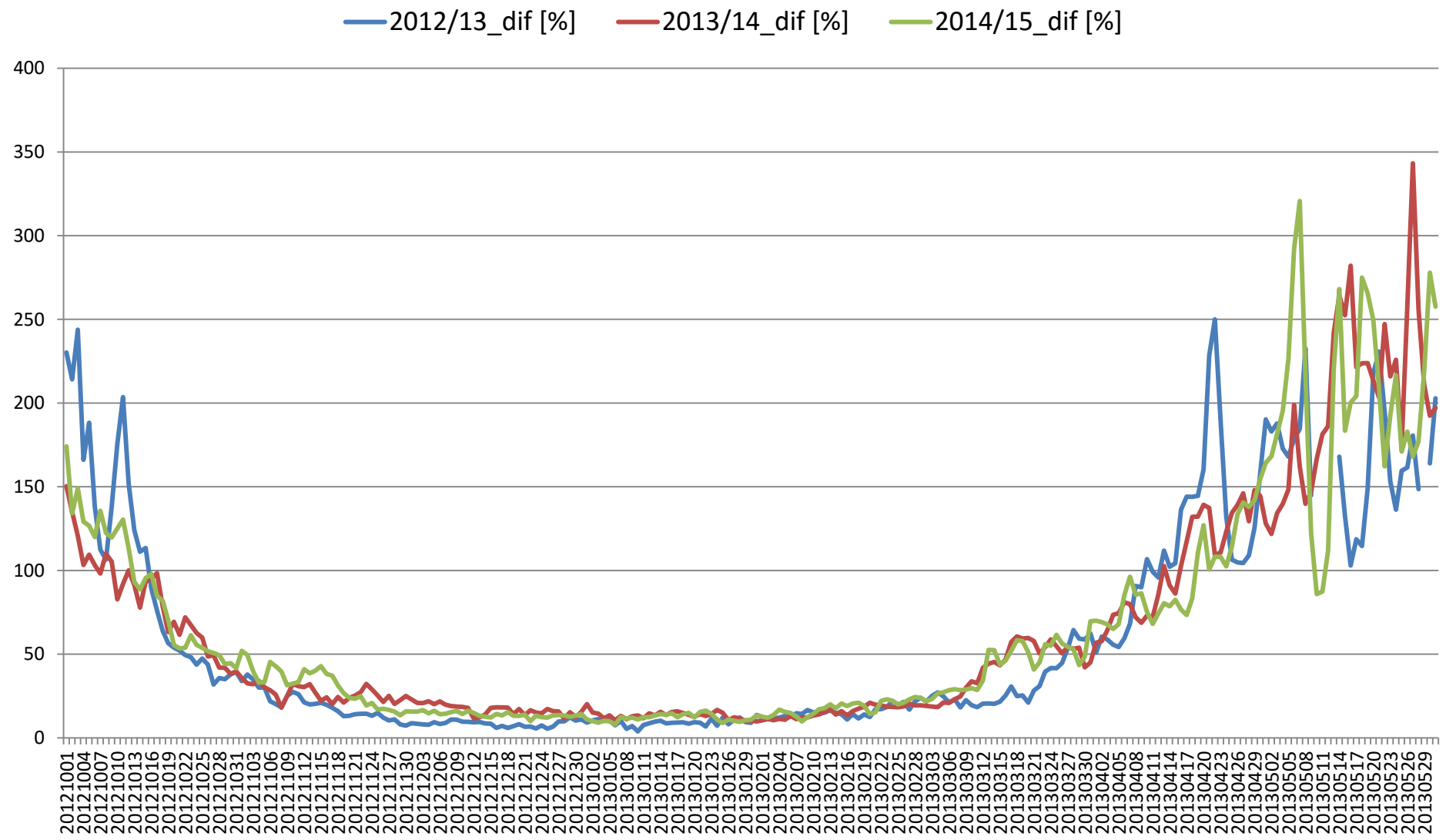
Ascending passes



Descending passes

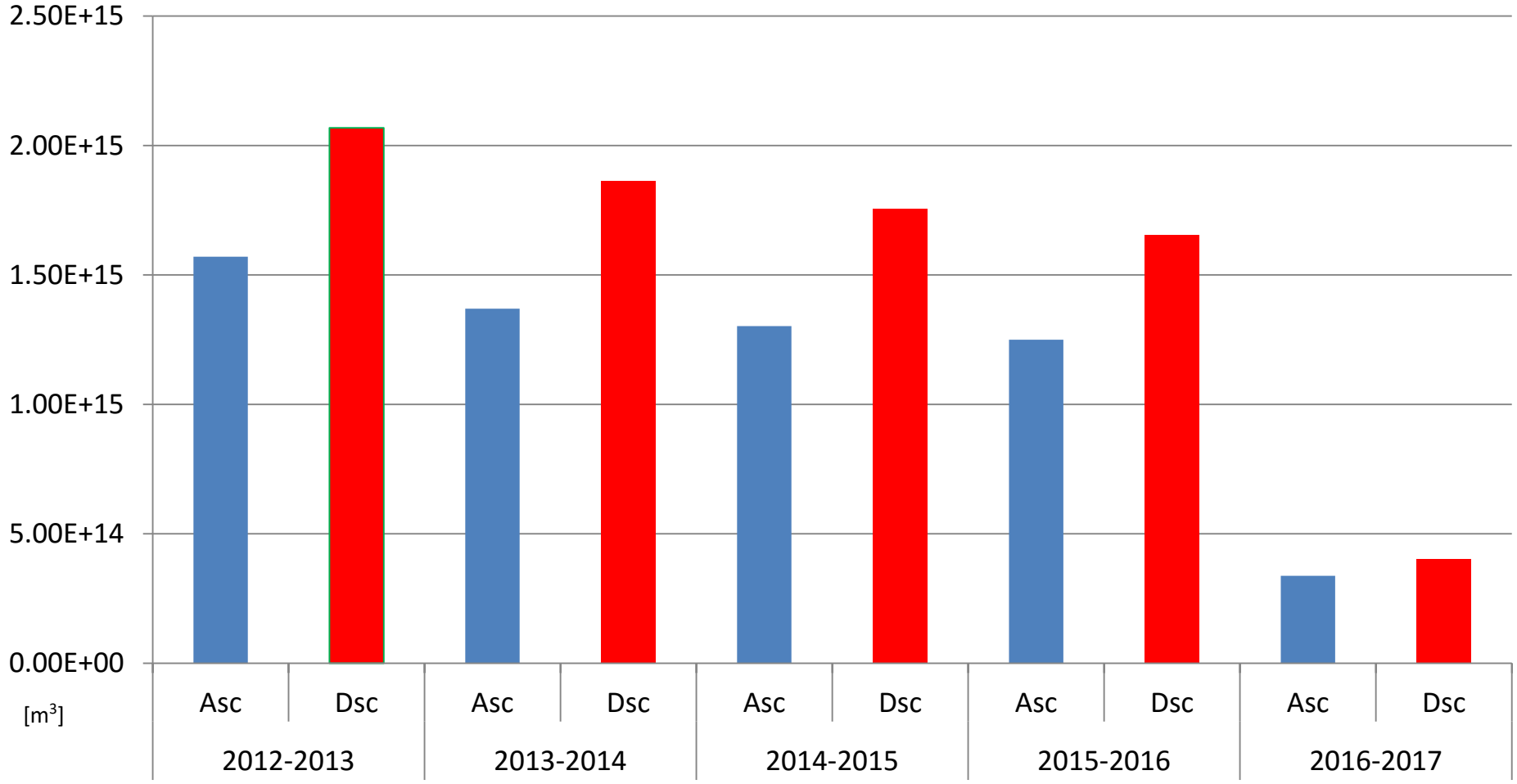


Difference between Snow volume from Descending Pass vs. Ascending Pass
(Dsc-Asc)/Asc [%]

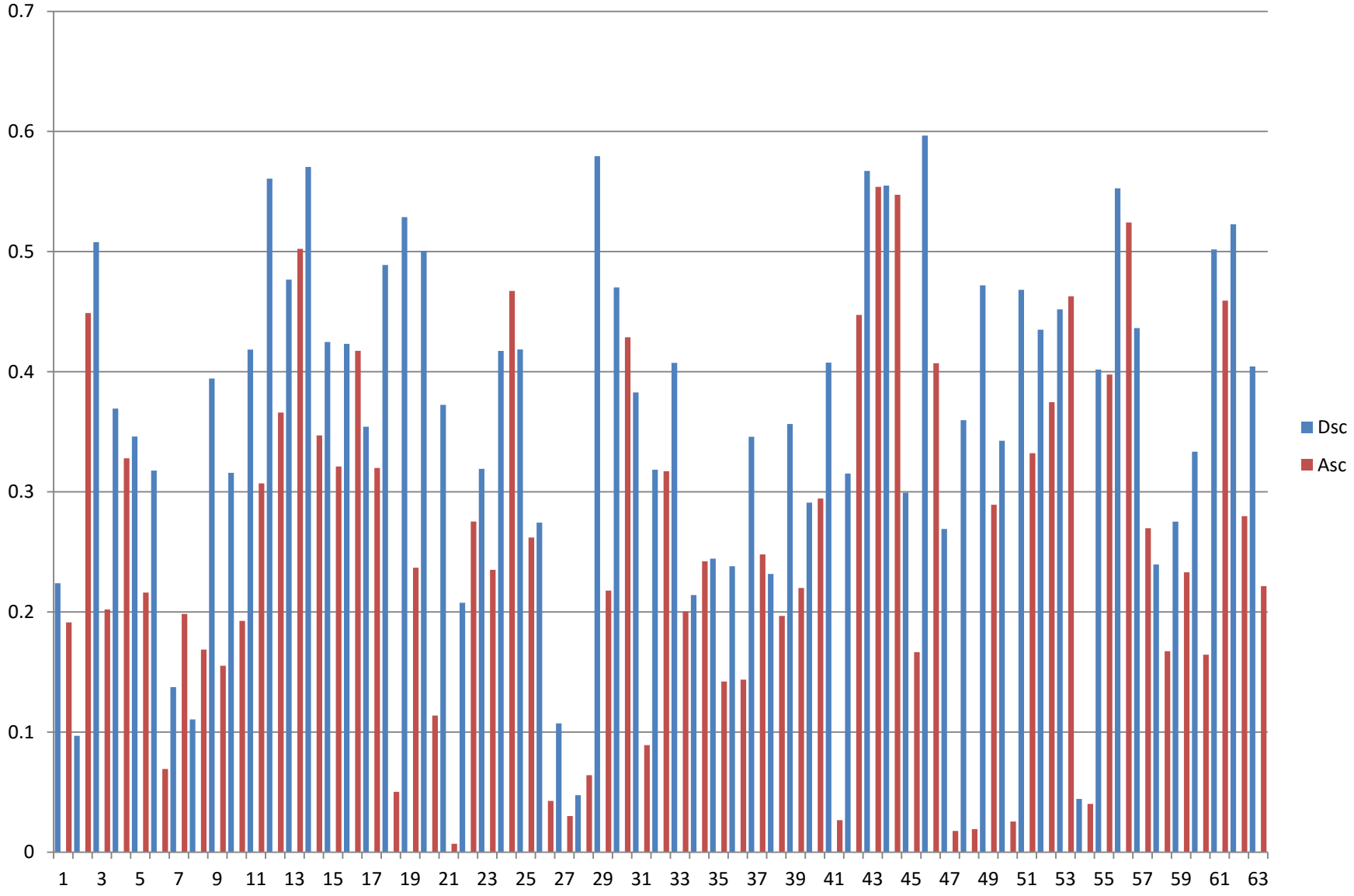


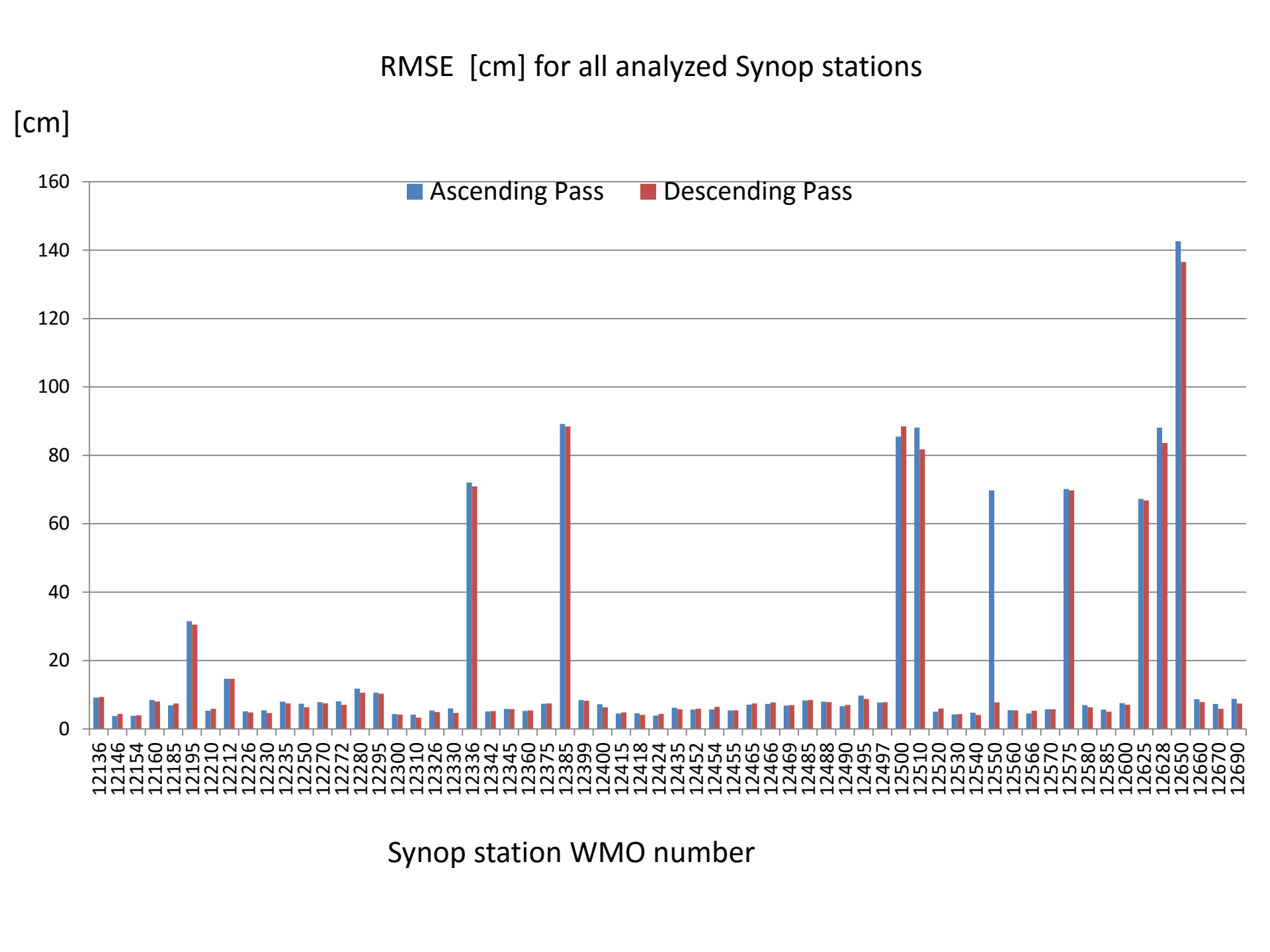
GCOM-W1 SND „Climatology”

Sum of Volume*days for period s: 1 Oct. – 31 May



Correlation coefficient: GCOM-W1 SSS vs. Ground observations
Period: winters 2012/13, 2013/14, 2014/15 (1 Oct - 31 May)



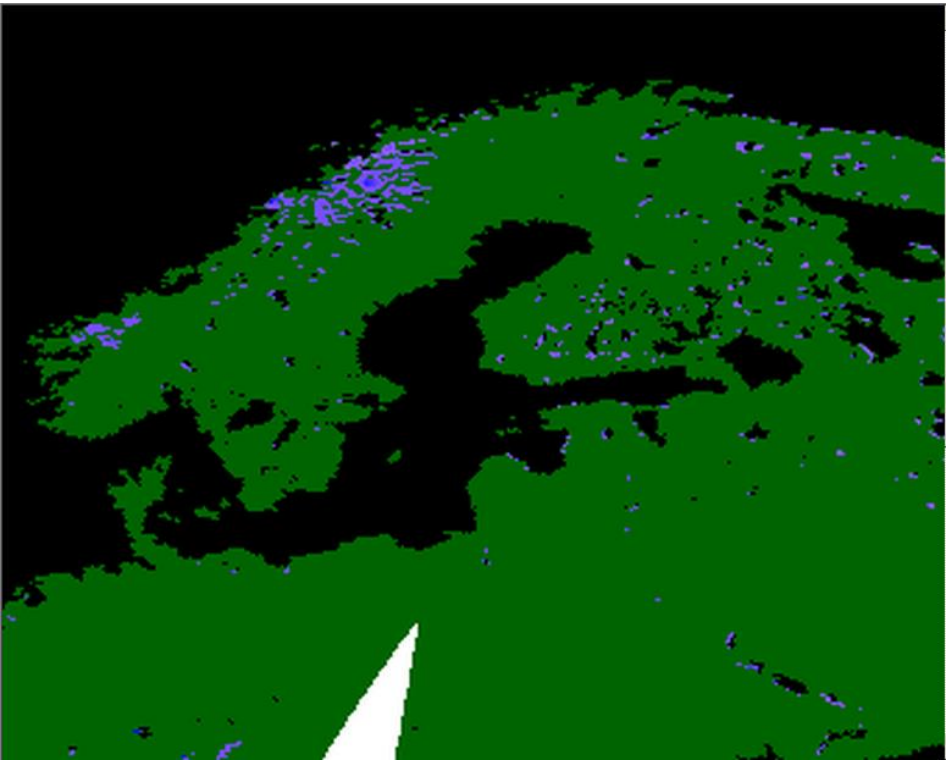

RMSE [cm] for all analyzed Synop stations
[cm]
Ascending Pass
Descending Pass
160
140
120
100
80
60
40
20
0
12136
12146
12154
12160
12185
12195
12210
12212
12226
12230
12235
12250
12270
12272
12280
12295
12300
12310
12326
12330
12336
12342
12345
12360
12375
12385
12399
12400
12415
12418
12424
12435
12452
12454
12455
12465
12466
12469
12485
12488
12490
12495
12497
12500
12510
12520
12530
12540
12550
12560
12566
12570
12575
12580
12585
12600
12625
12628
12650
12660
12670
12690
Synop station WMO number

Differences between Version 1 and Version2 of SND Level 3 Product.

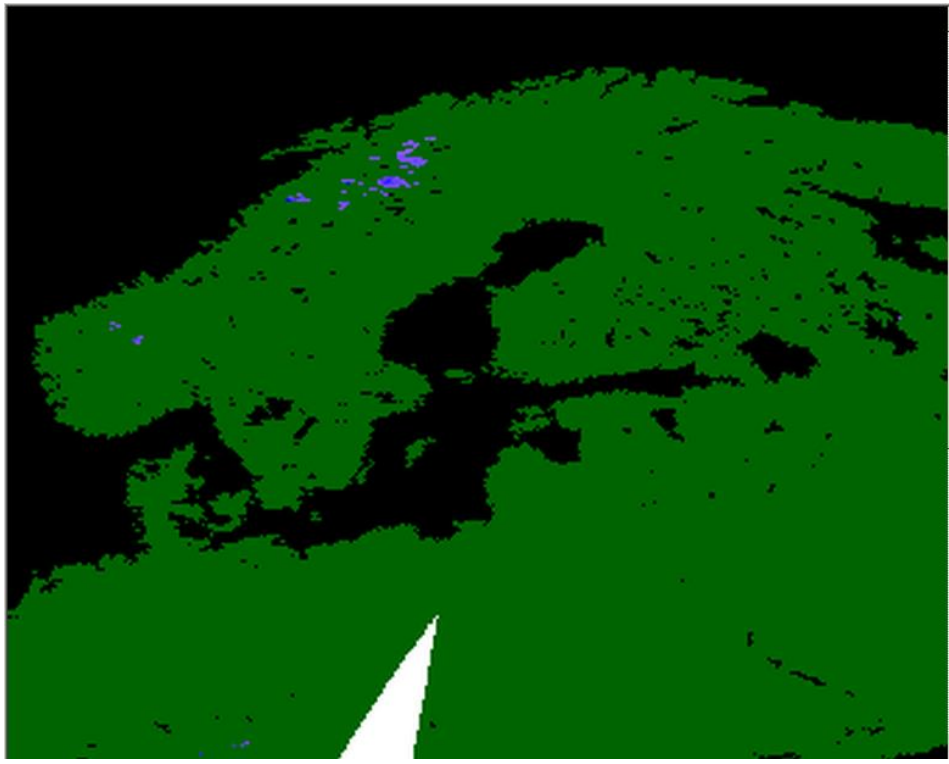
In V2, Globe has 3% more land than in V1 !!!

01.10.2012

V1



V2

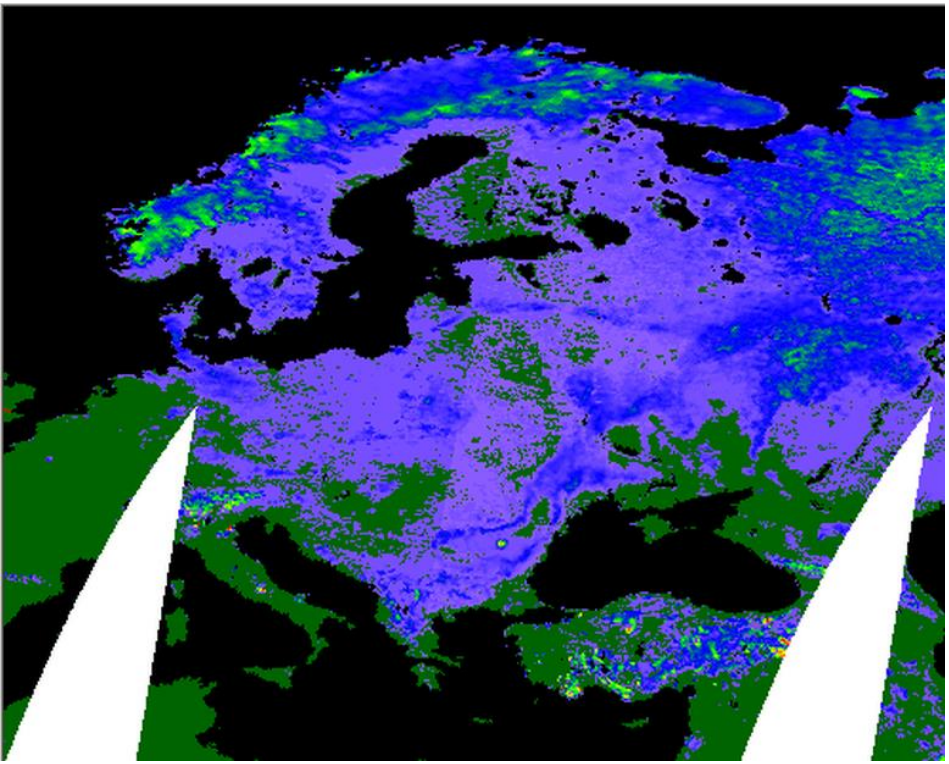


Differences between Version 1 and Version2 of SND Level 3 Product.

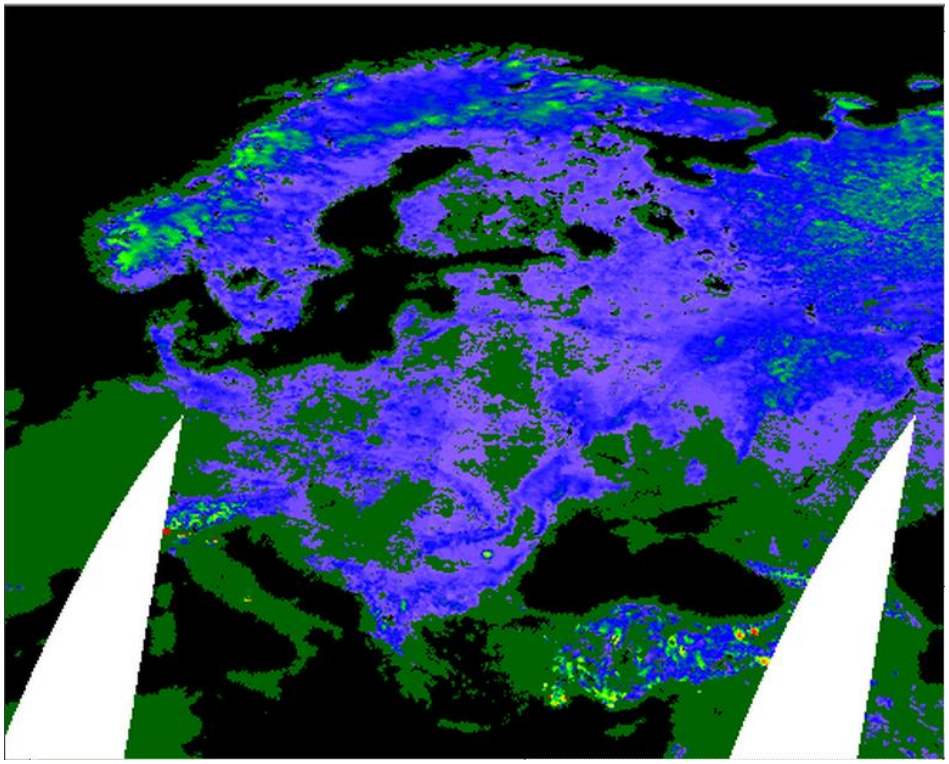
Significantly smaller snow covered area, especially close to the sea coast.

14.12.2012

V1



V2

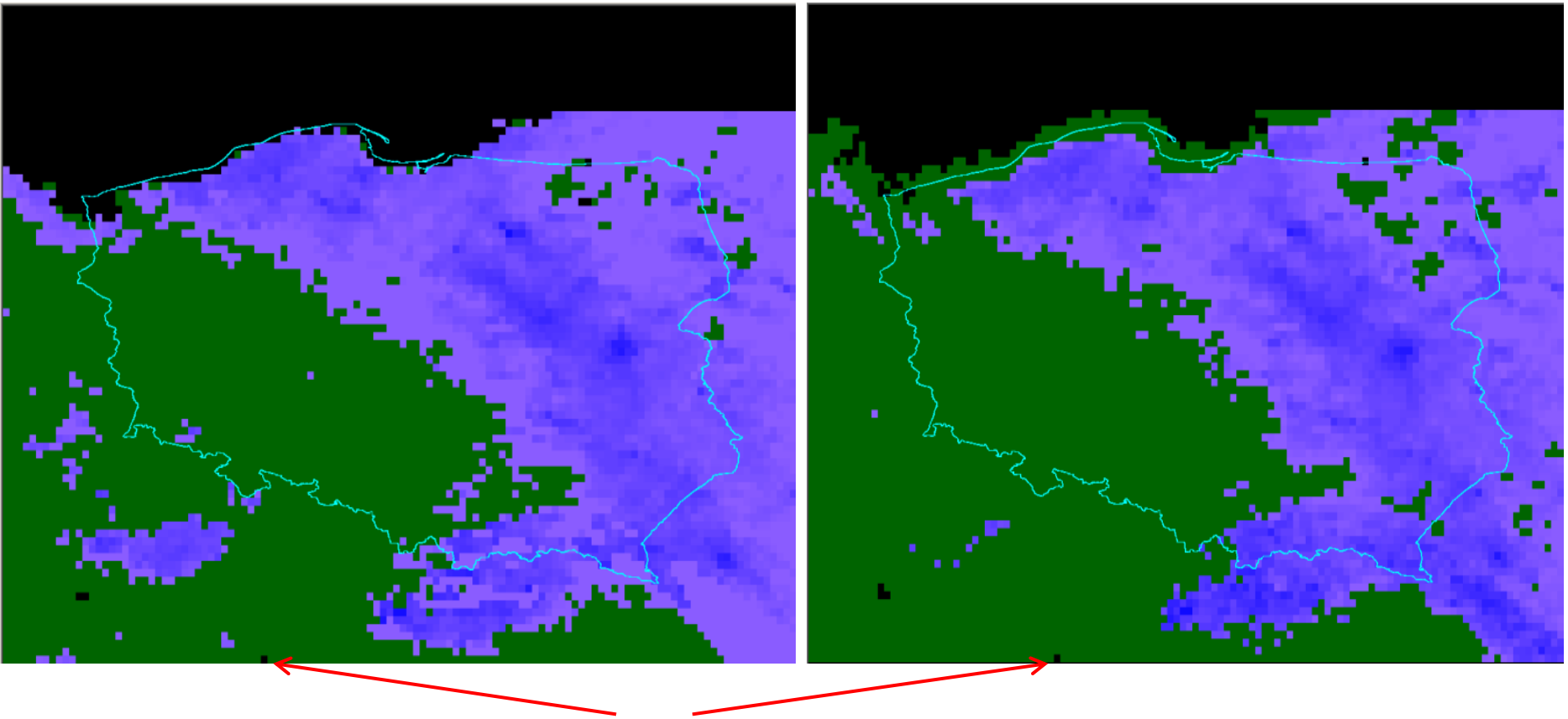


Vesion 2 has problem with snow at the coastal region

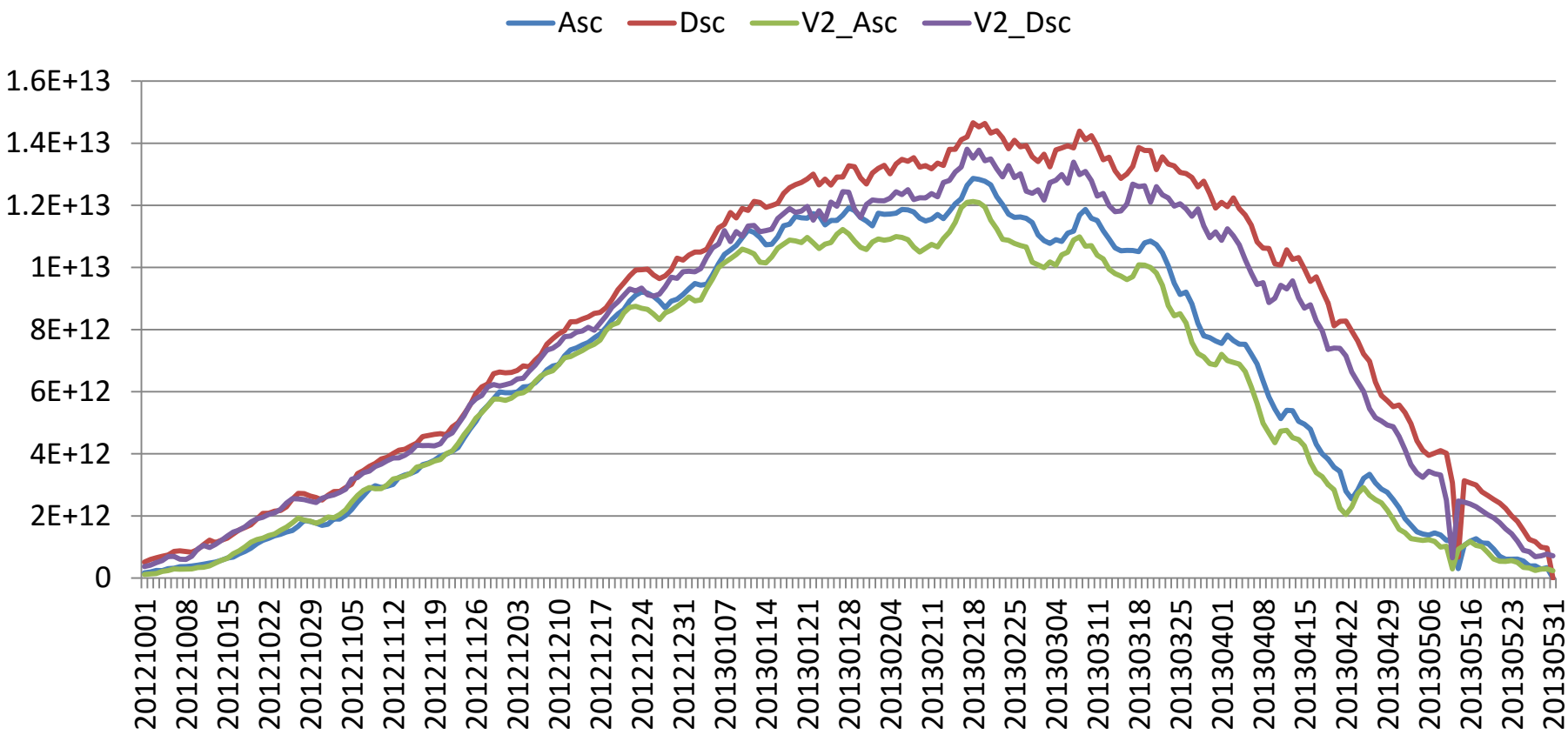
23.12.2012 – area of Poland

V1

V2

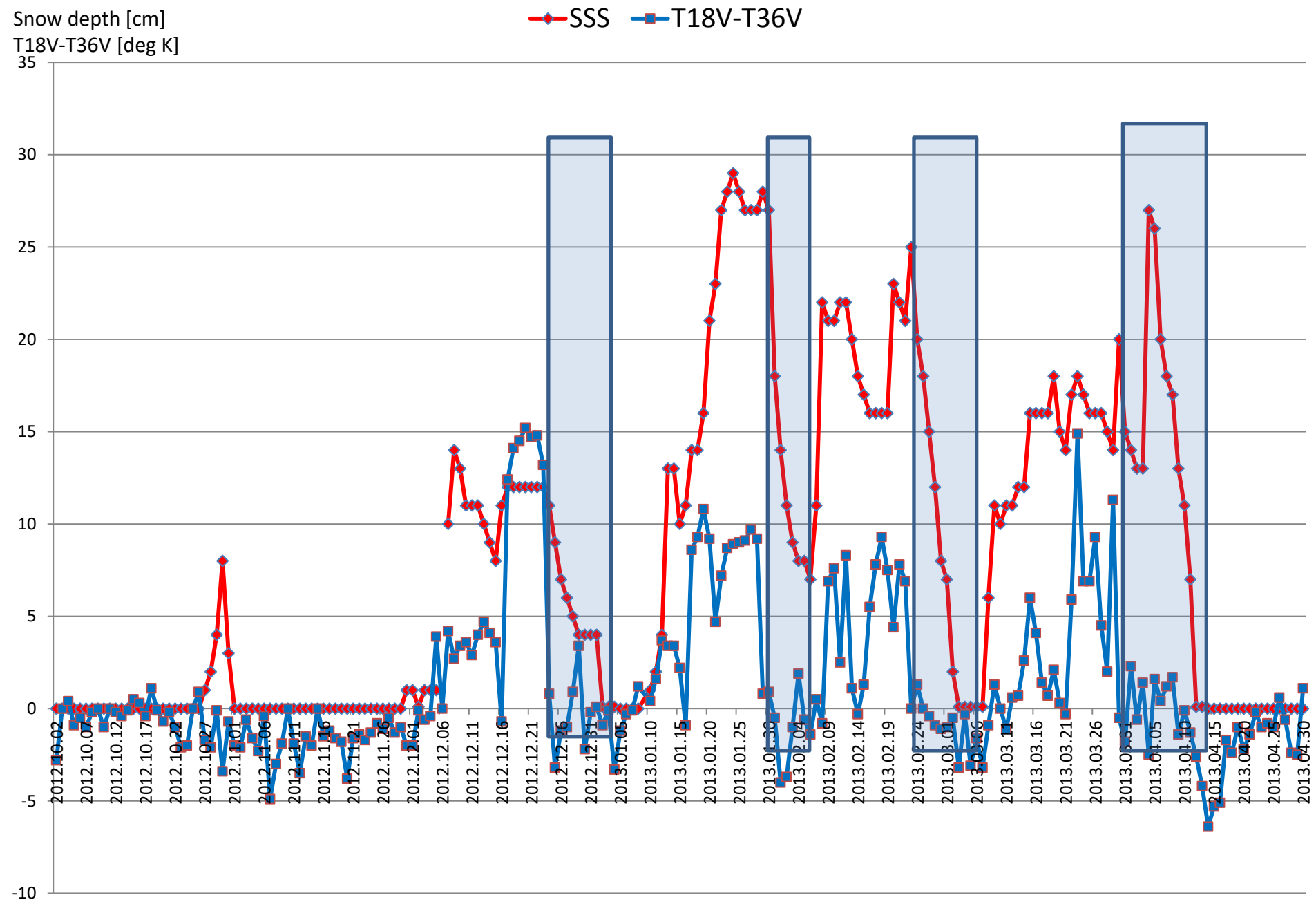


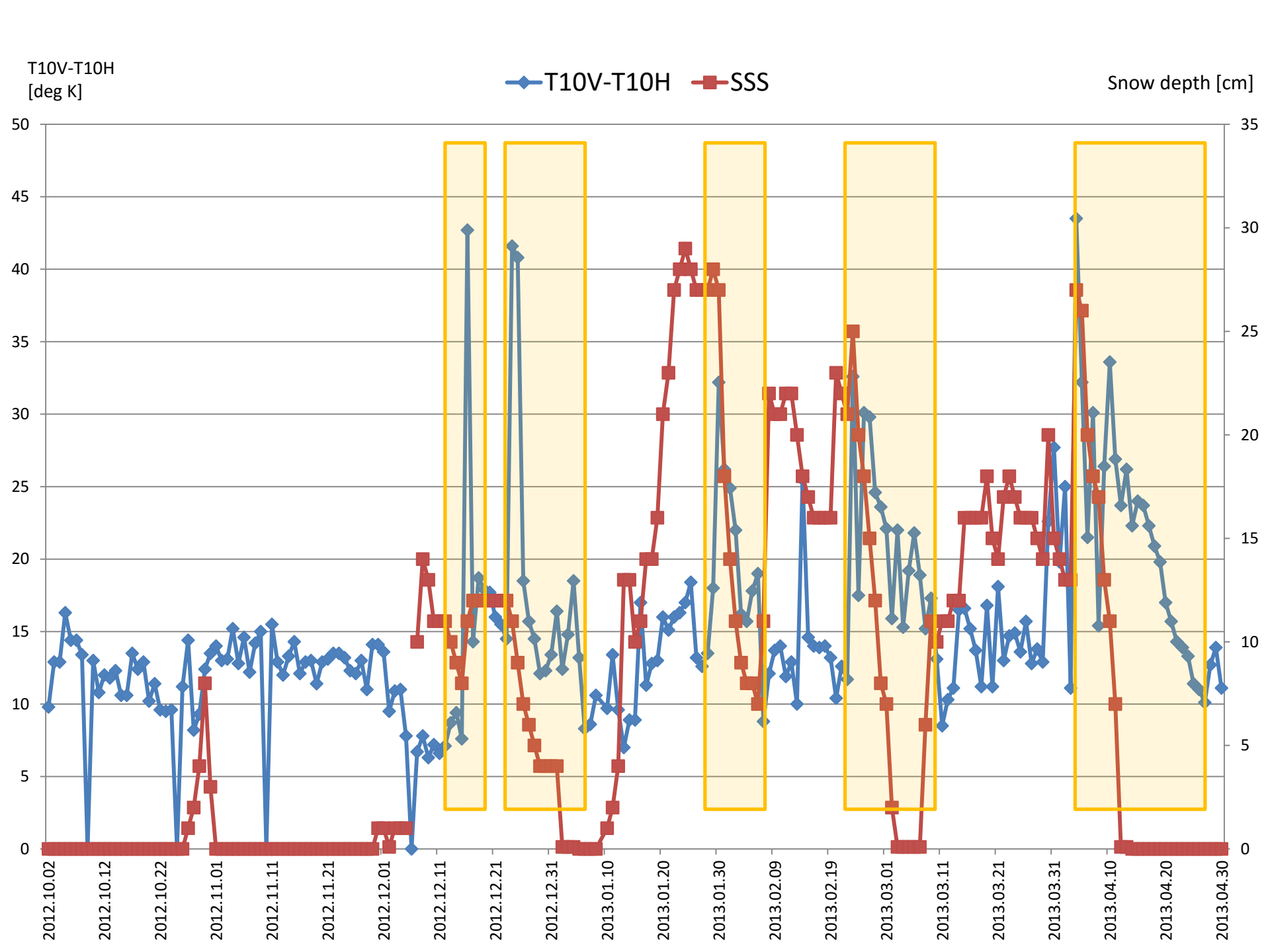
Comparison of snow volume calculated from G-COM-W1 SND product version 1 and 2
Winter 2012/2013



What we can do with wet snow and melting conditions ?

We do not see snow when it's wet or melting !!! Example for Lublin Synop station (WMO No. 12495).




T10V-T10H
[deg K]
T10V-T10H
SSS
Snow depth [cm]
50
45
40
35
30
25
20
15
10
5
0
35
30
25
20
15
10
5
0
2012.10.02
2012.10.12
2012.10.22
2012.11.01
2012.11.11
2012.11.21
2012.12.01
2012.12.11
2012.12.21
2012.12.31
2013.01.10
2013.01.20
2013.01.30
2013.02.09
2013.02.19
2013.03.01
2013.03.11
2013.03.21
2013.03.31
2013.04.10
2013.04.20
2013.04.30

From point observations to catchment values:

- Hydrologists require information over the catchment,
- Runoff is generated from snow melting in the whole catchmnet,
- Specific features for selected point could be minimized,

Wieprz river catchment selected for further analysis:

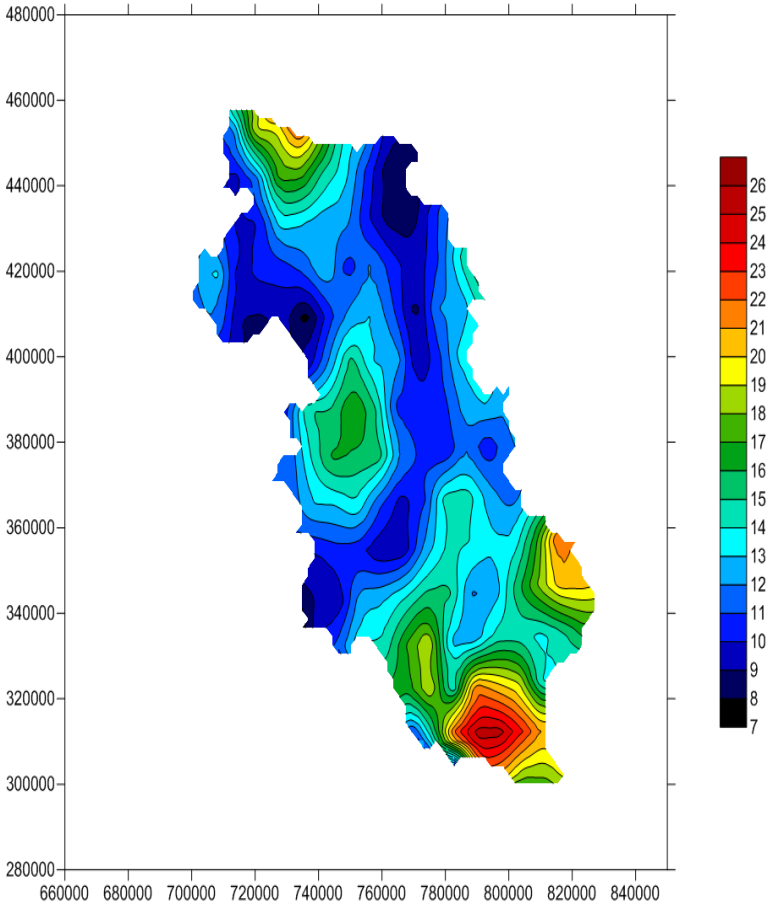
- Located in Central/ Eastern Poland,
- No reservoirs,
- No mountains,
- Sufferd snow melt flood at spring 2013.

From point to catchment observations.

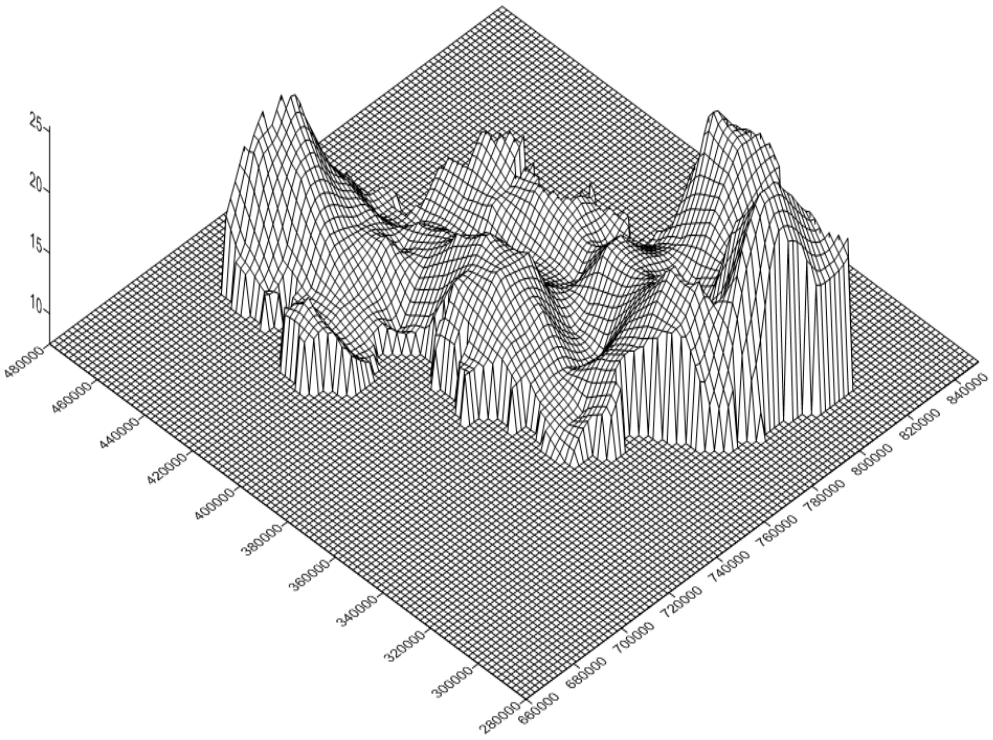
Wieprz river catchment selected - ~10 000 km^2, South East Poland.

GCOM-W1 data reprojected (and interpolated) to UTM projection with 1 km resolution

GCOM-W1 snow depth distribution for selected catchment (Wieprz)
Example from 20.01.2013.



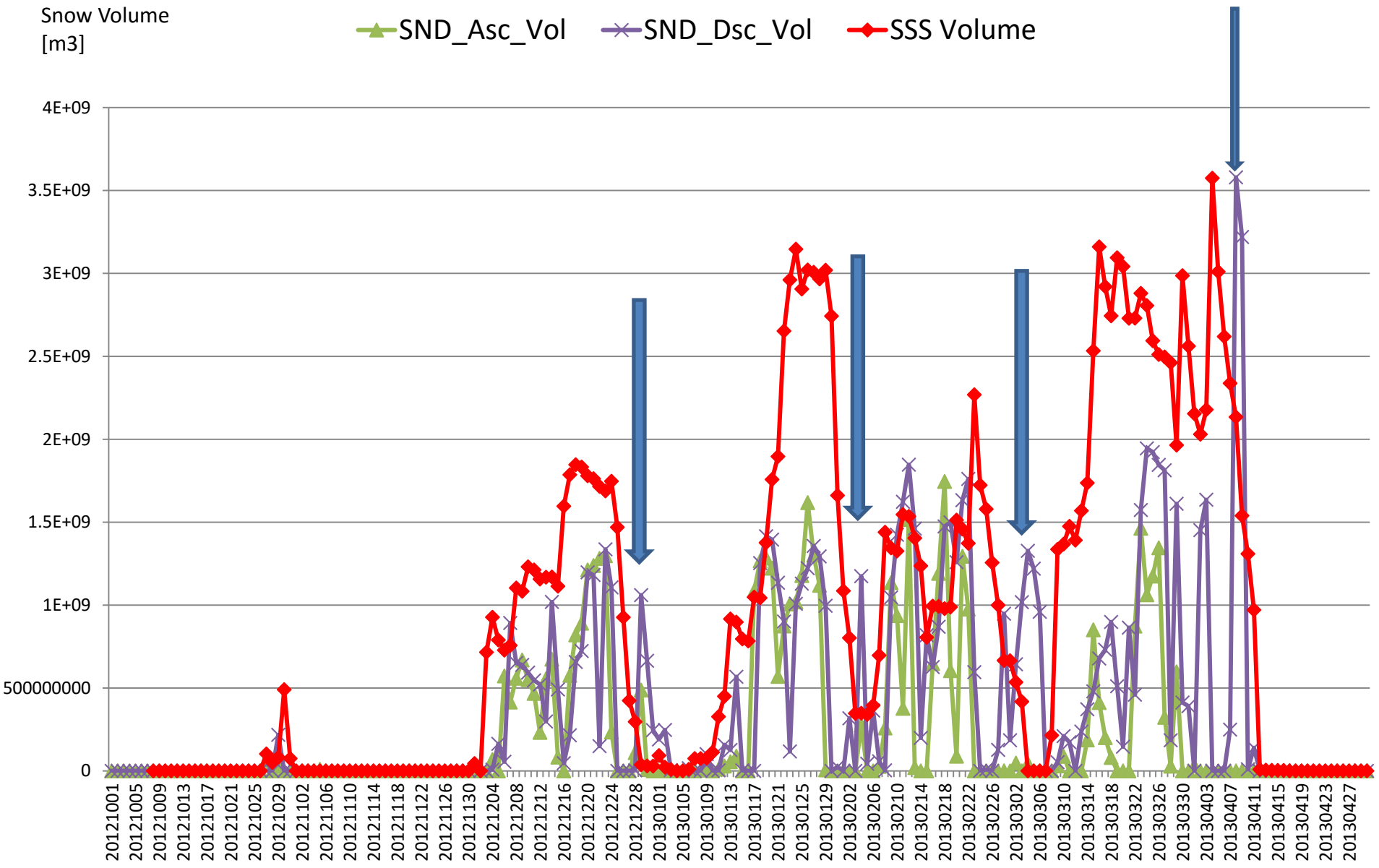
Calculation of snow volume for the whole catchment



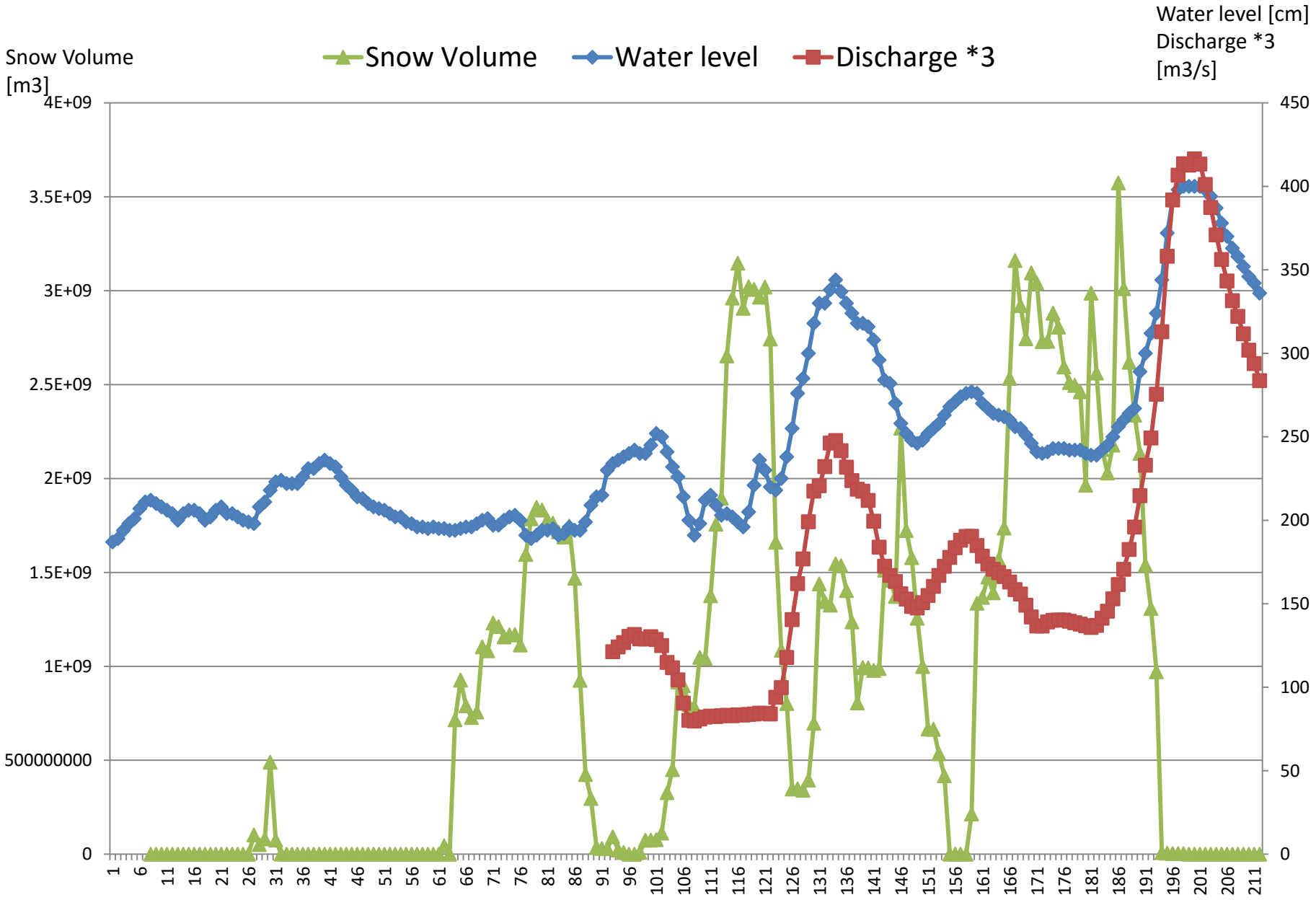
For the whole winter 2012/2013 (1.10.2012- 30.04.2013) were calculated:

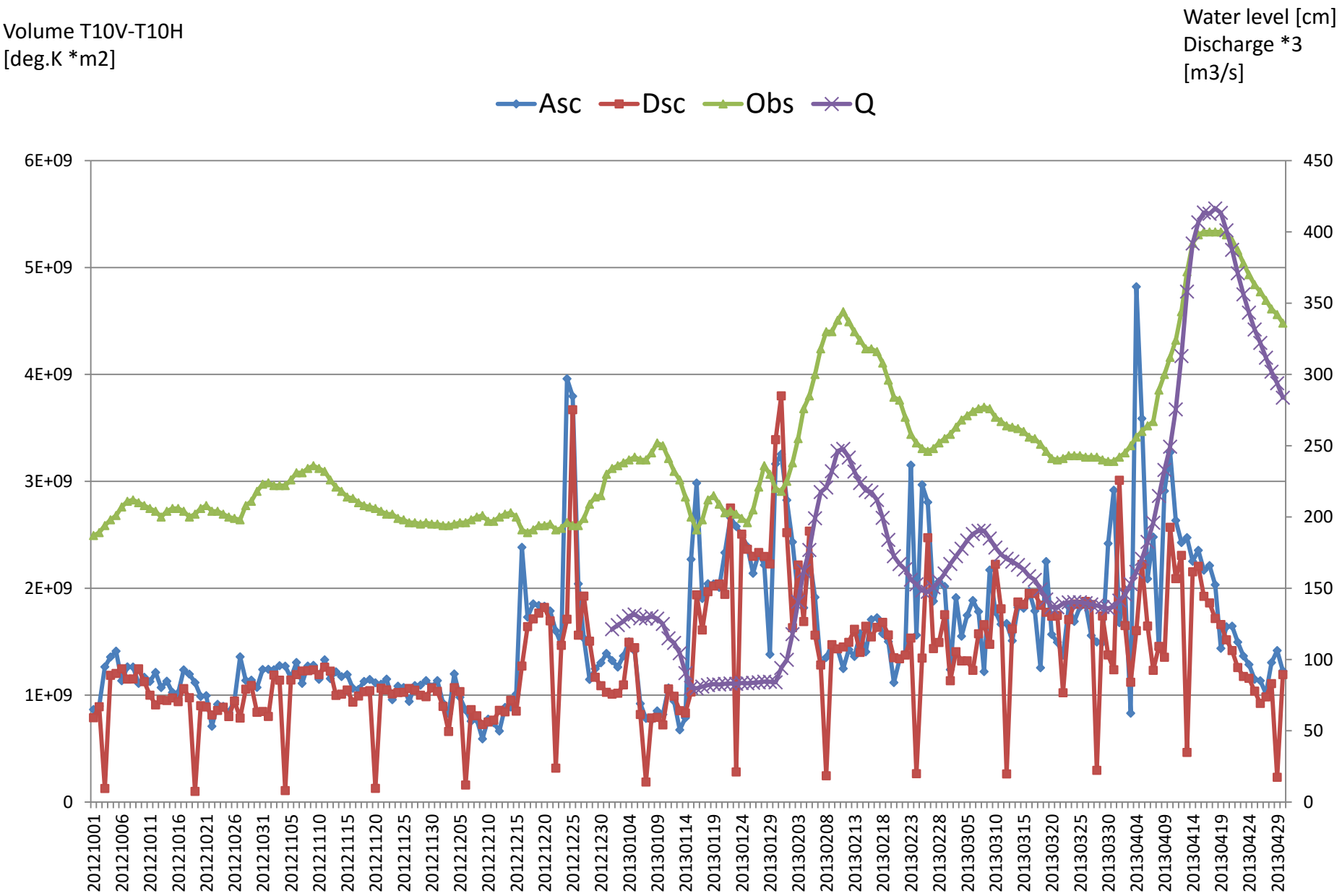
- Snow volume from interpoladed ground observations [m^3],
- Snow volume from JAXA SND product (separately for ascending and descending pass) [m^3],
- Volume under the surface T10V-T10H - supposed to be indicator of water from melting snow [deg. K * m^2],

Comparison of snow Snow volume from ground observations and from GCOM-W1 SND.



Snow volume from ground observations vs. River gage and calculated discharge and from catchment




Volume T10V-T10H
[deg.K *m2]
Water level [cm]
Discharge *3
[m3/s]
Asc
Dsc
Obs
Q
6E+09
5E+09
4E+09
3E+09
2E+09
1E+09
0
450
400
350
300
250
200
150
100
50
0
20121001
20121006
20121011
20121016
20121021
20121026
20121031
20121105
20121110
20121115
20121120
20121125
20121130
20121205
20121210
20121215
20121220
20121225
20121230
20130104
20130109
20130114
20130119
20130124
20130129
20130203
20130208
20130213
20130218
20130223
20130228
20130305
20130310
20130315
20130320
20130325
20130330
20130404
20130409
20130414
20130419
20130424
20130429

Could we make parametrisation of relations between snow volume, snow water equivalent and estimaded water amount in melting snow/soil surface layer ?

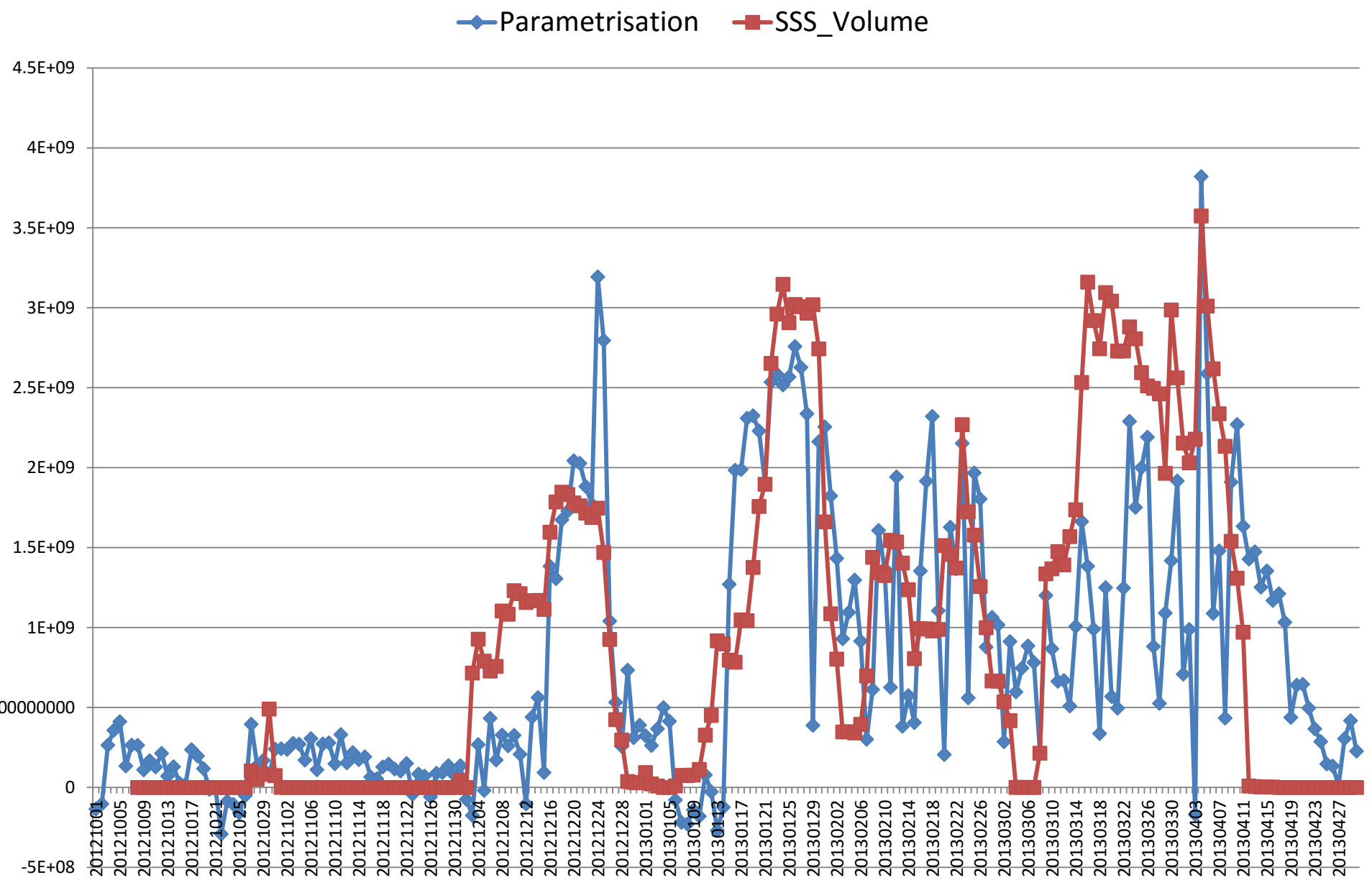
Water amount = A * (T18V-T37V) + B * (T10V-T10H) + C

Water in snow Liquid water

Term C is necessary to compensate background value of T10V-T10H not equal zero in snow free conditions

A= ?
B= ?
C= ?

Example of such parametrisation representing volume of water in snow/upper soil (both frozen and melted)



Conclusions:

1. GCOM-W1 Snow Depth product is much more realistic for European conditions of snow (depth 0-50 cm).
2. Hydrological applications not possible before solving a problem with Ascending/Descending pass differences.
3. Above problem require better modelling of wet and melting snow – direction of work shown.
4. Wet and melting snow is dissepearing from satellite data retrieval methods – gap between volume of water stored in dry snow and river discharge.
5. Presented material could be an inspiration for further studies.
6. Differences between V1 and V2 SND: more land, less snow.
7. Version 1 deleted from JAXA server after reprocessing to Version2 ! Why ???
8. We are waiting for GCOM-W1 SND Version 3 !!!

Thank you
for your attention

Piotr Struzik, Monika Pajek
Institute of Meteorology and Water Management
- National Research Institute
Satellite Remote Sensing Department
30-215 Kraków, ul. P. Borowego 14
Poland
www.imgw.pl
www.pogodynka.pl