Optimal Interpolation (OI)

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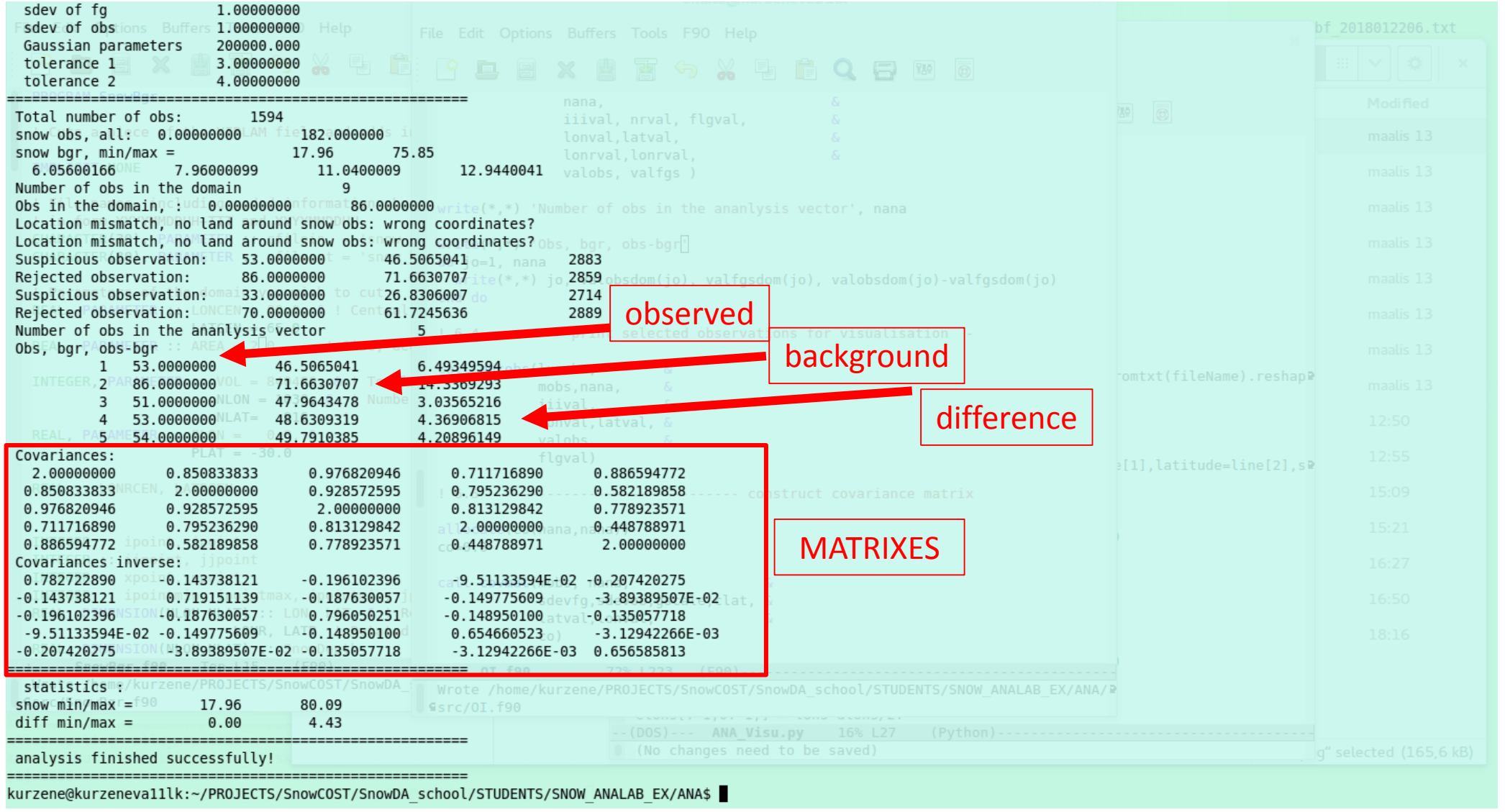
COST Training school on snow observation and data assimilation, 12.3.- 16.3.2018 Bormio, Italy

Introduction

- OI - method for assimilation of ground observations in NWP models
- Principle
  - Based on comparing observation data with background data (previous model forecast)
    - Distance between observations (vertical and horizontal) is calculated
    - $f(\rho) = \exp(-\frac{\rho^2}{2L^2})$, L – horizontal length scale
    - Matrix is created for all points
    - Matrix is inverted
    - Values for the whole grid are calculated
- Possibility to change parameters to have the best performance

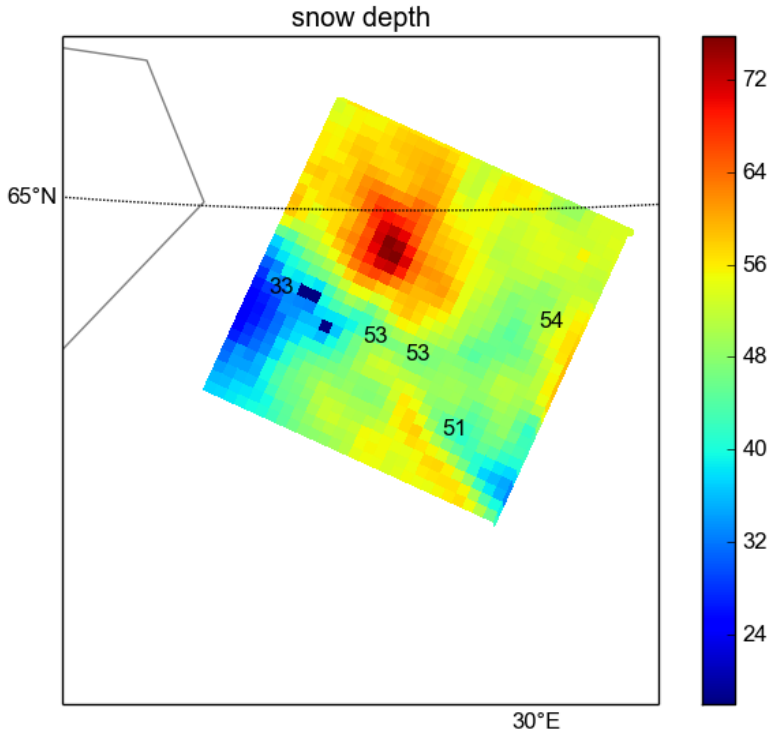
Example of small area



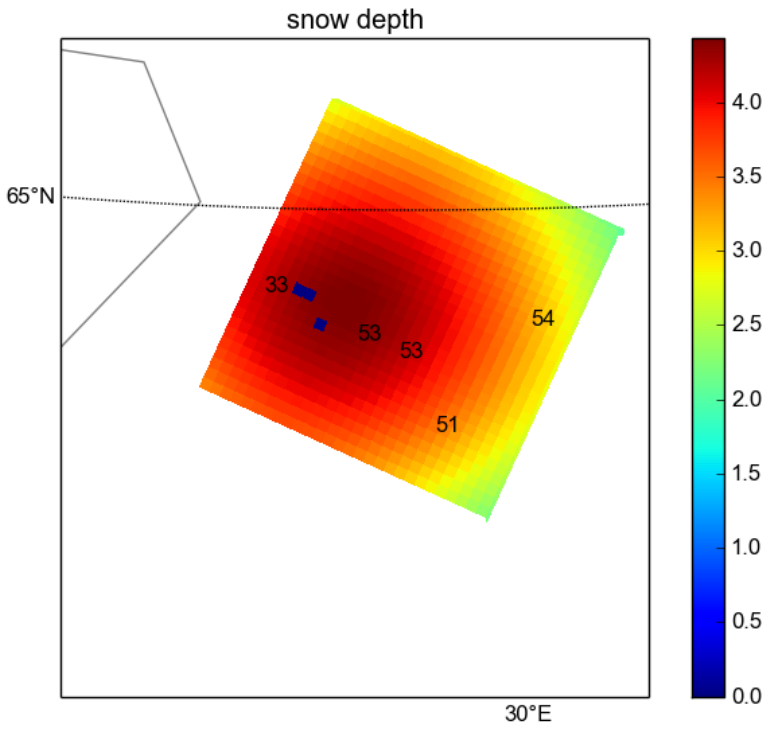

```
 sdev of fg             1.00000000
 sdev of obs            1.00000000
 Gaussian parameters    200000.000
 tolerance 1            3.00000000
 tolerance 2            4.00000000
=========================================================
 Total number of obs:        1594
 snow obs, all:   0.00000000      182.000000
 snow bgr, min/max =              17.96       75.85
   6.05600166     7.96000099       11.0400009       12.9440041
 Number of obs in the domain           9
 Obs in the domain,  :    0.00000000      86.0000000
 Location mismatch, no land around snow obs: wrong coordinates?
 Location mismatch, no land around snow obs: wrong coordinates?
 Suspicious observation:   53.0000000      46.5065041          2883
 Rejected observation:     86.0000000      71.6630707          2859
 Suspicious observation:   33.0000000      26.8306007          2714
 Rejected observation:     70.0000000      61.7245636          2889
 Number of obs in the ananlysis vector          5
 Obs, bgr, obs-bgr
           1   53.0000000      46.5065041      6.49349594
           2   86.0000000      71.6630707      14.3369293
           3   51.0000000      47.9643478      3.03565216
           4   53.0000000      48.6309319      4.36906815
           5   54.0000000      49.7910385      4.20896149
 Covariances:
   2.00000000      0.850833833      0.976820946      0.711716890      0.886594772
  0.850833833       2.00000000      0.928572595      0.795236290      0.582189858
  0.976820946      0.928572595       2.00000000      0.813129842      0.778923571
  0.711716890      0.795236290      0.813129842       2.00000000      0.448788971
  0.886594772      0.582189858      0.778923571      0.448788971       2.00000000
 Covariances inverse:
  0.782722890     -0.143738121     -0.196102396     -9.51133594E-02 -0.207420275
 -0.143738121      0.719151139     -0.187630057     -0.149775609     -3.89389507E-02
 -0.196102396     -0.187630057      0.796050251     -0.148950100     -0.135057718
  -9.51133594E-02 -0.149775609     -0.148950100      0.654660523     -3.12942266E-03
 -0.207420275     -3.89389507E-02 -0.135057718     -3.12942266E-03  0.656585813
=========================================================
 statistics :
 snow min/max =      17.96       80.09
 diff min/max =       0.00        4.43
=========================================================
 analysis finished successfully!
=========================================================
kurzene@kurzeneva11lk:~/PROJECTS/SnowCOST/SnowDA_school/STUDENTS/SNOW_ANALAB_EX/ANA$
```

Example of small area

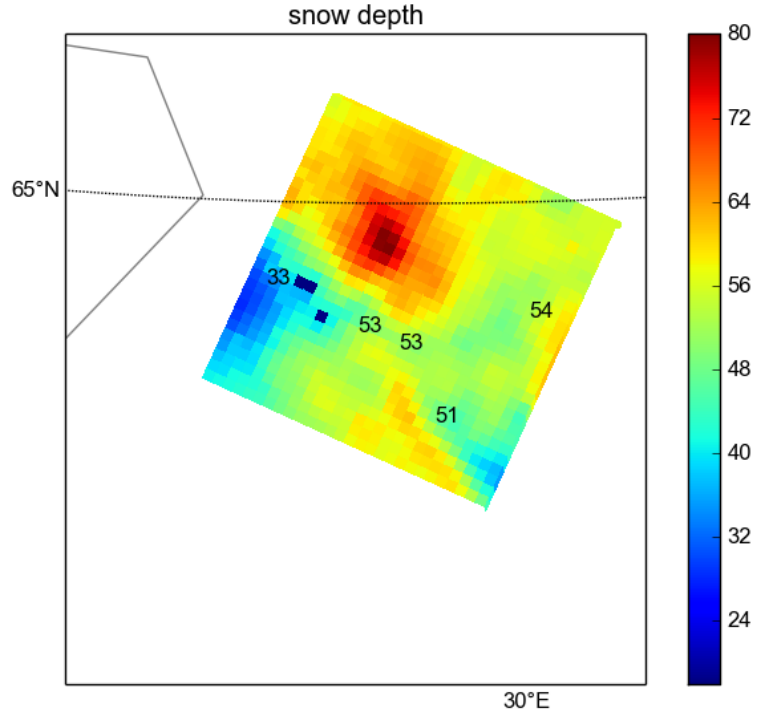
Background



Difference



Analysis



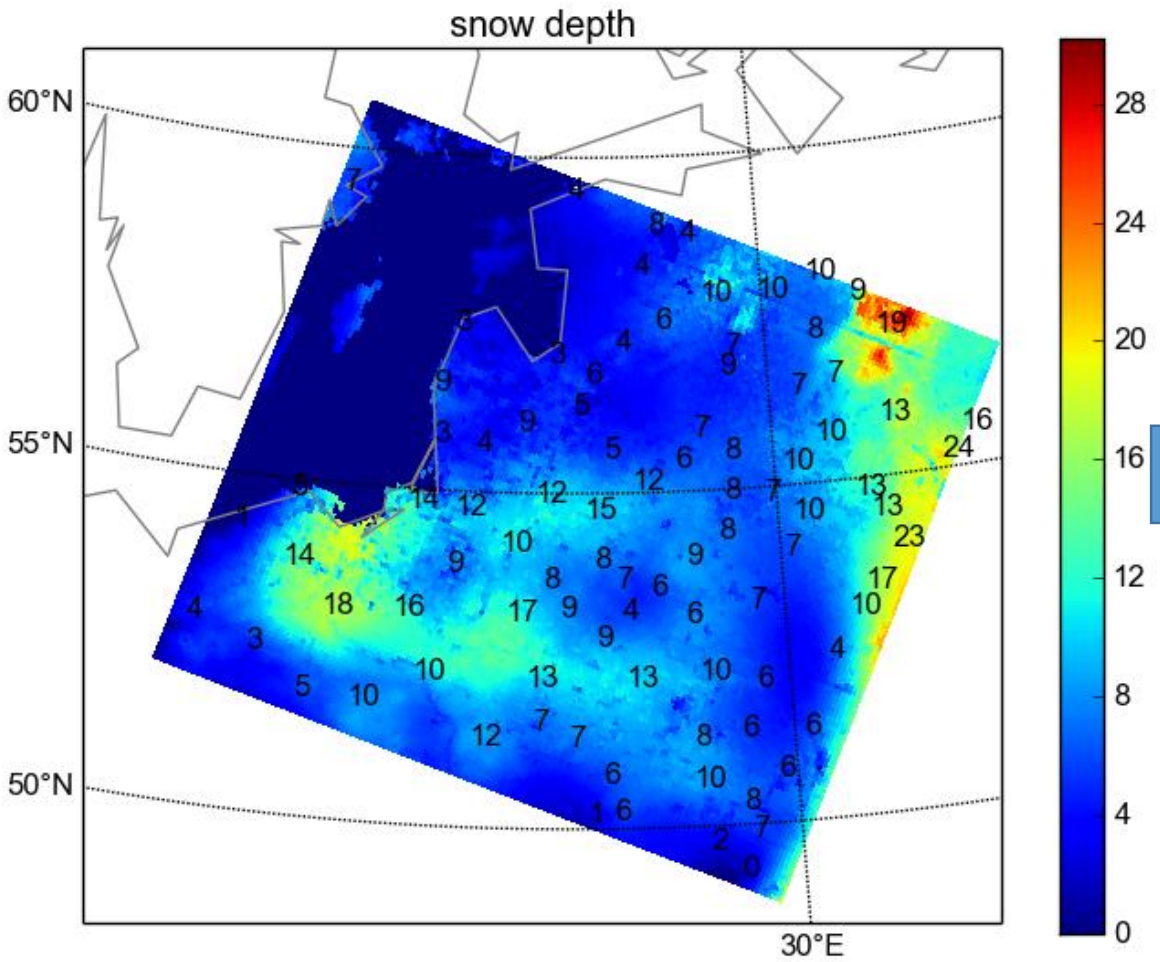
Experiments

- Testing parameters
  - Observation error
  - Background error
  - Scale
  - Tolerances
- Testing parameters in different regions
- Adjusting mask for the best visualization
- Testing computational time

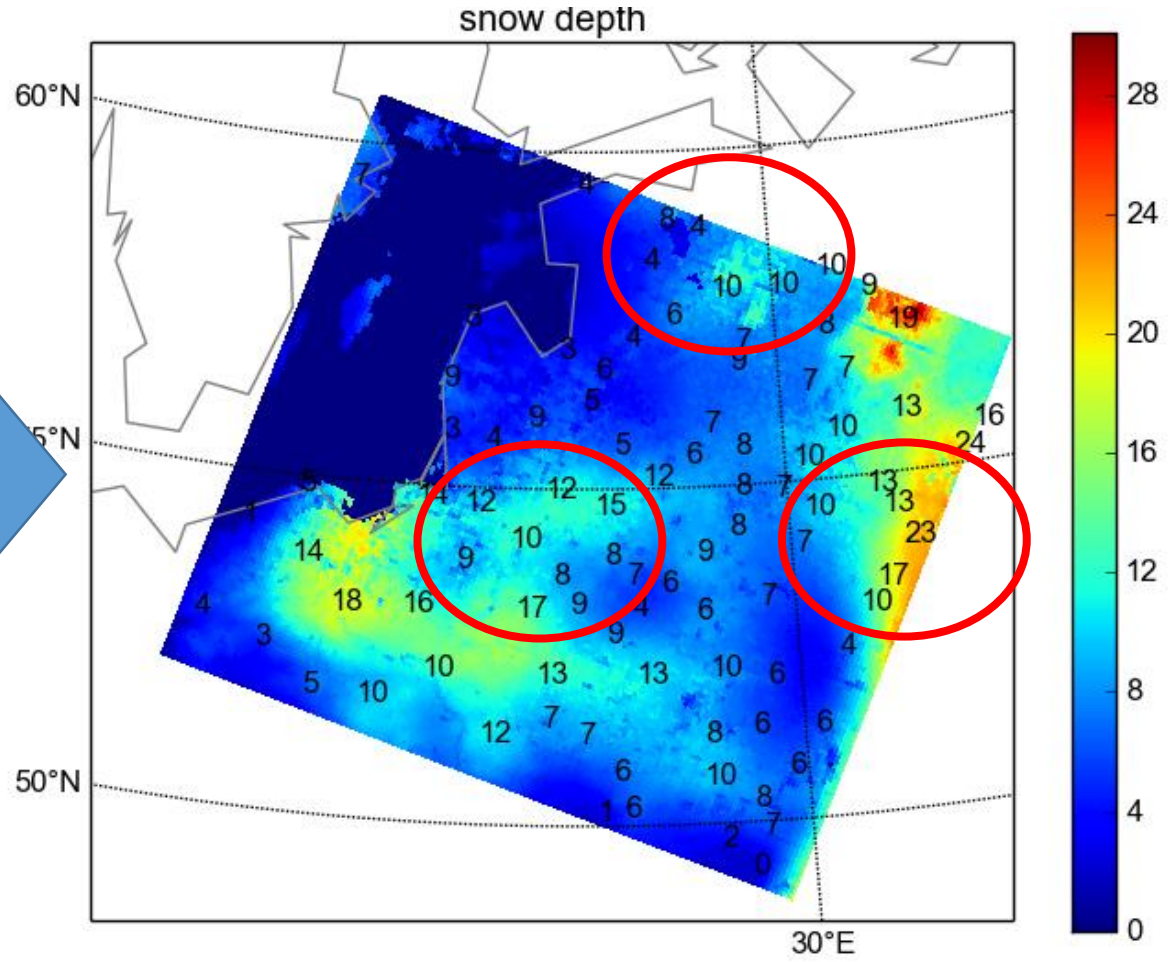
Start point

Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

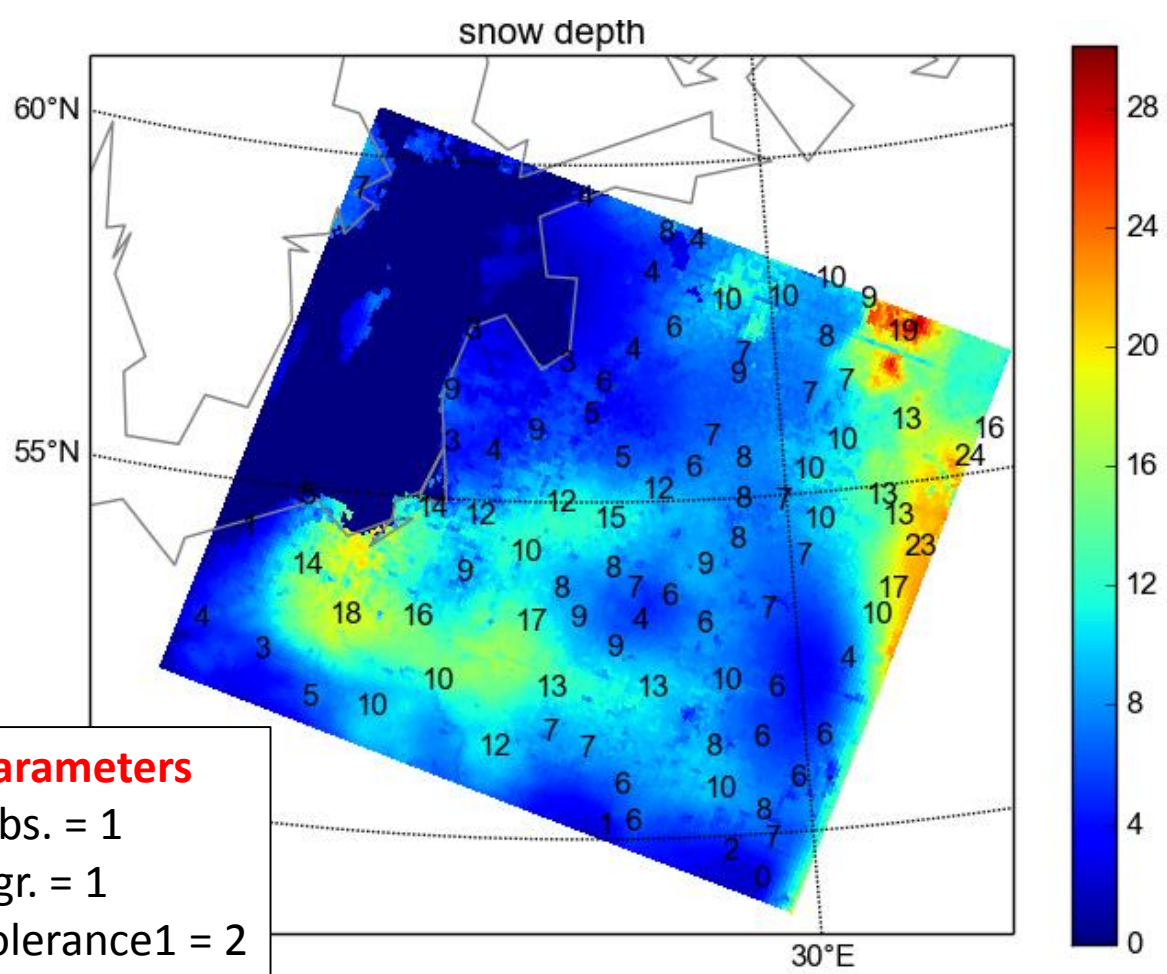
Background



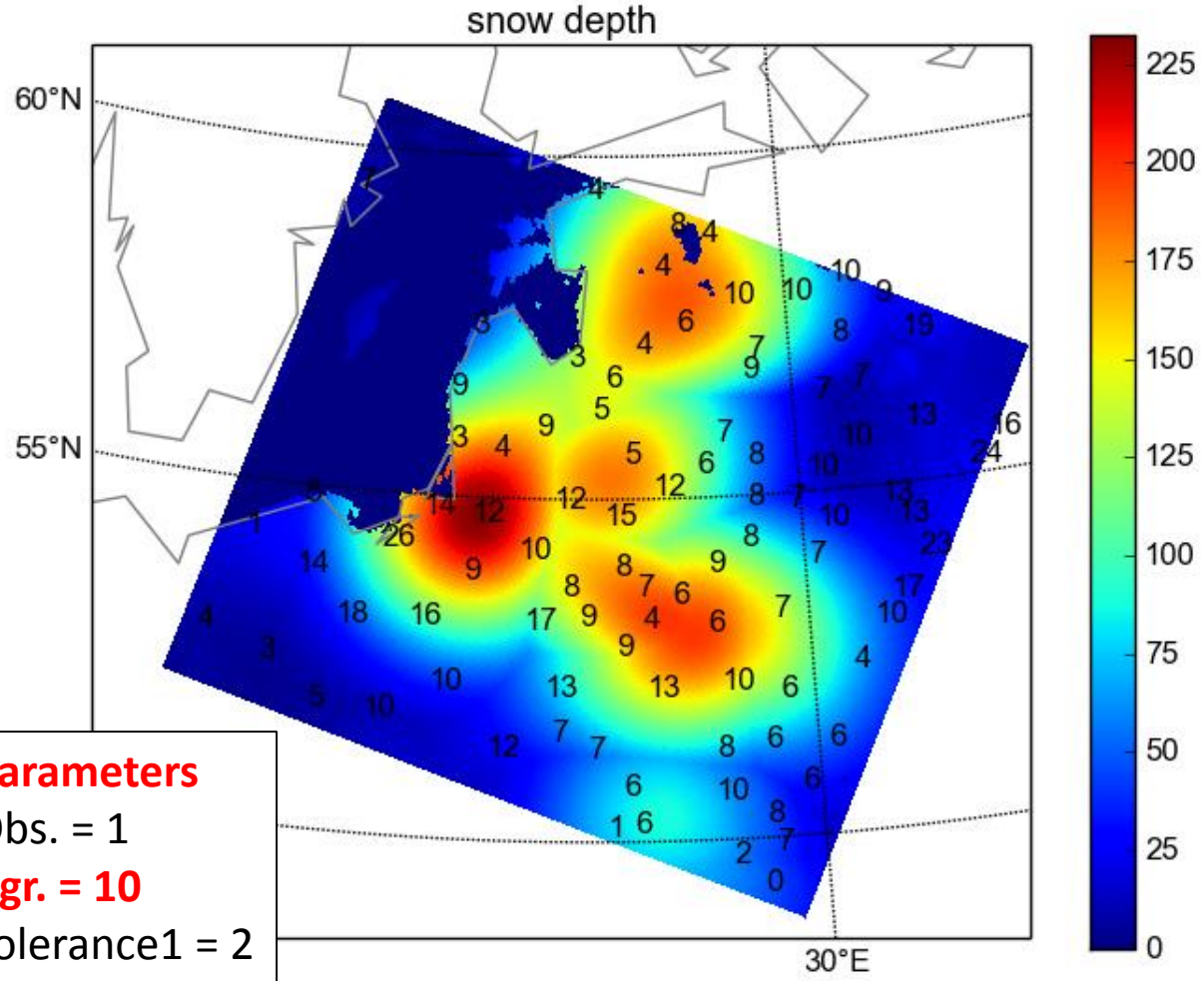
Analysis



Experiment 1.

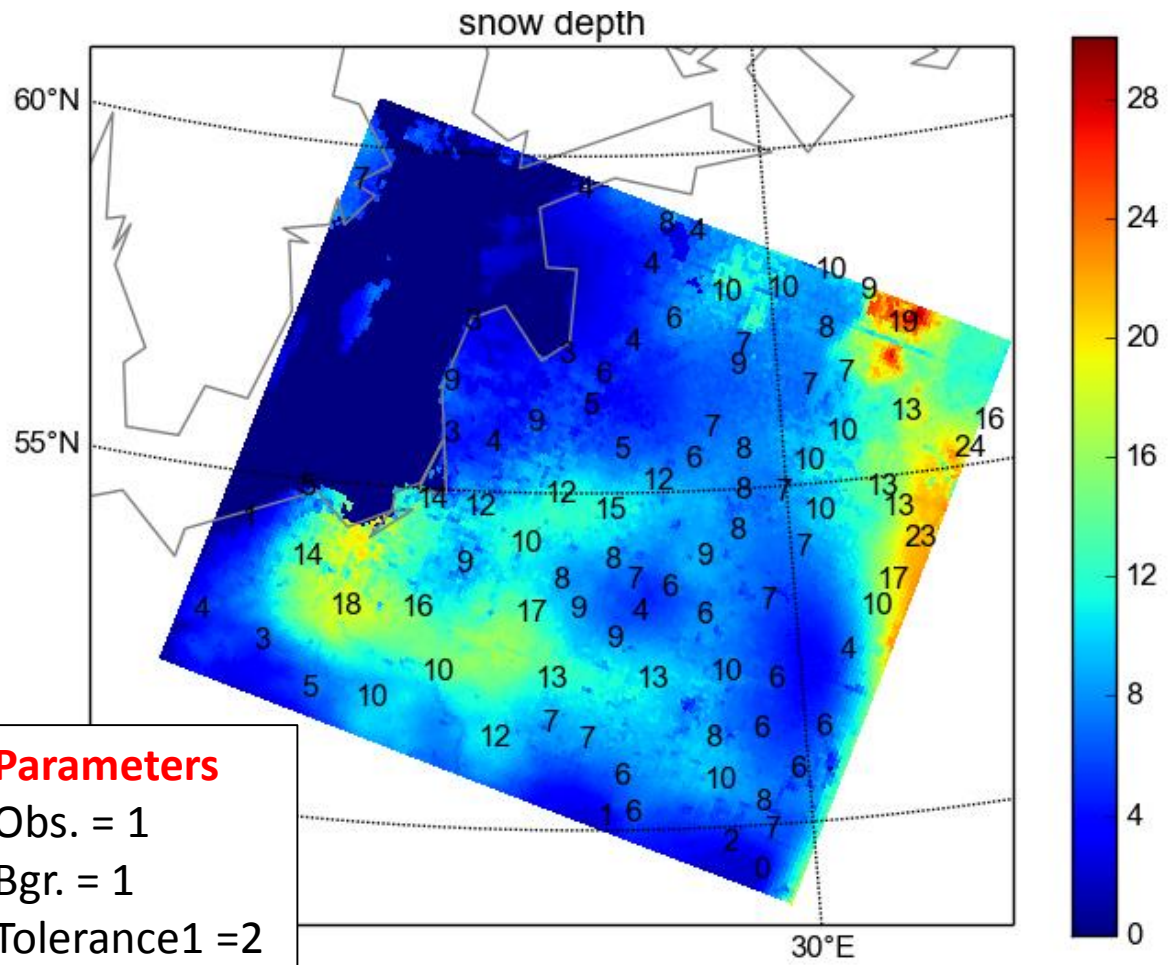


Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

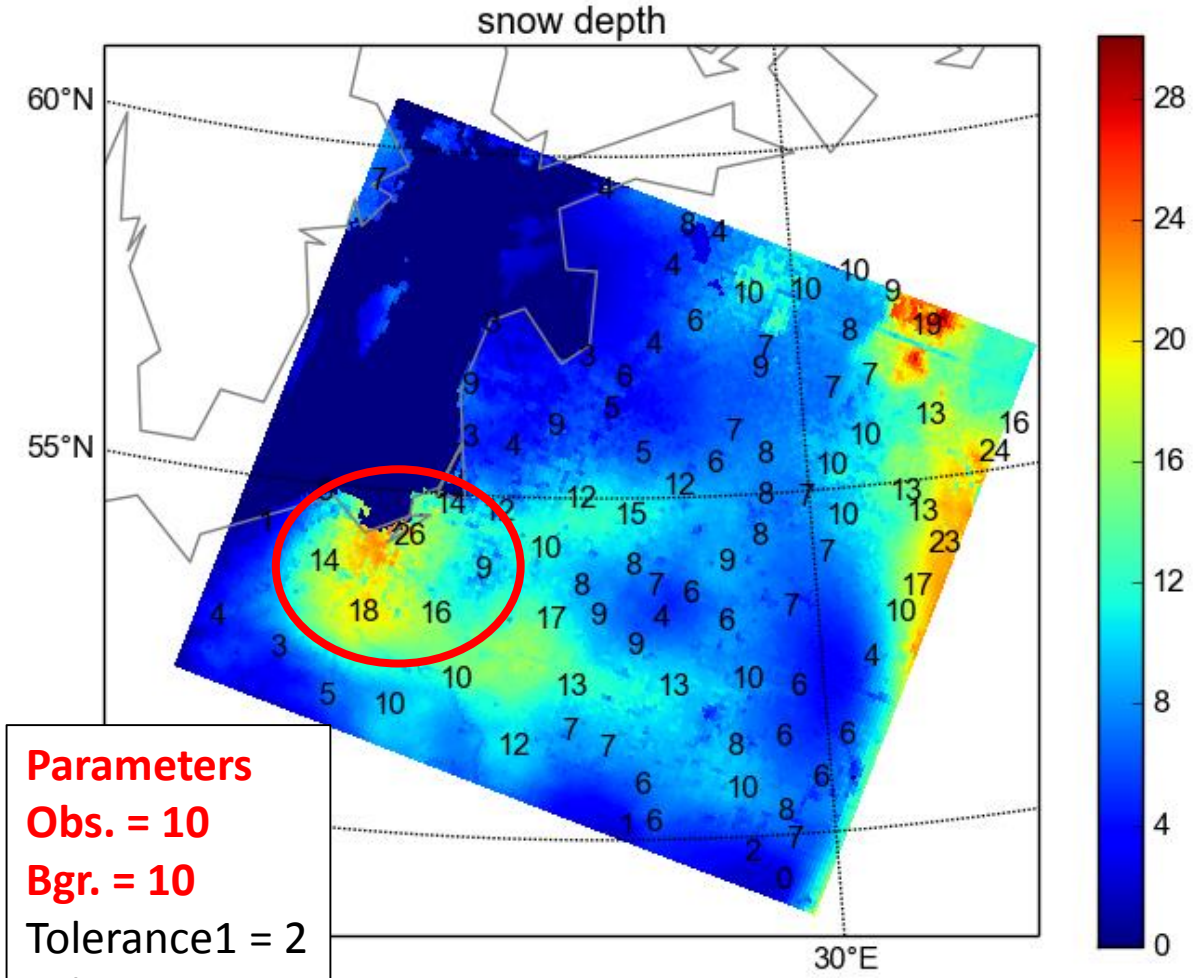


Parameters
Obs. = 1
Bgr. = 10
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

Experiment 3.



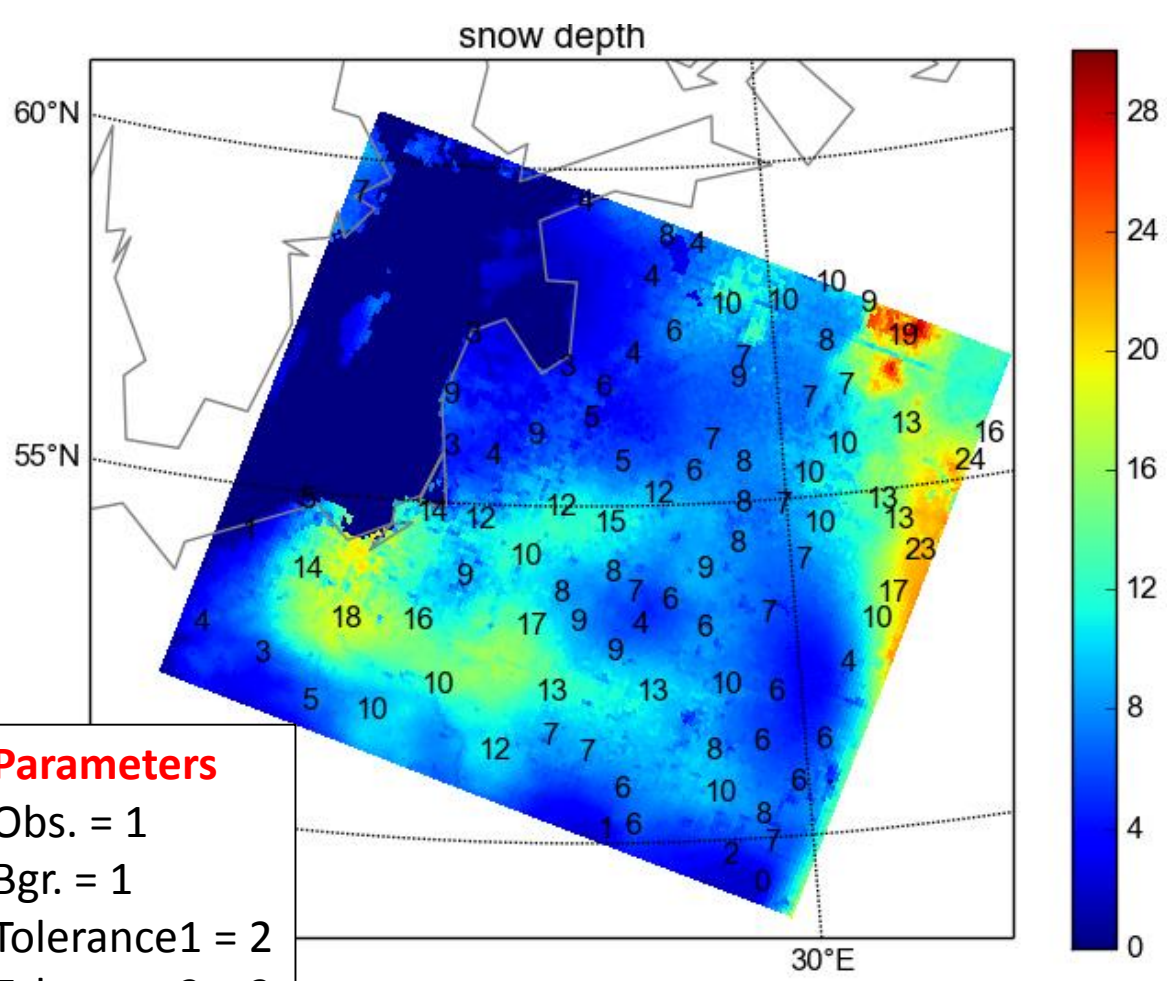
Parameters
Obs. = 1
Bgr. = 1
Tolerance1 =2
Tolerance2 = 3
Scale=20000



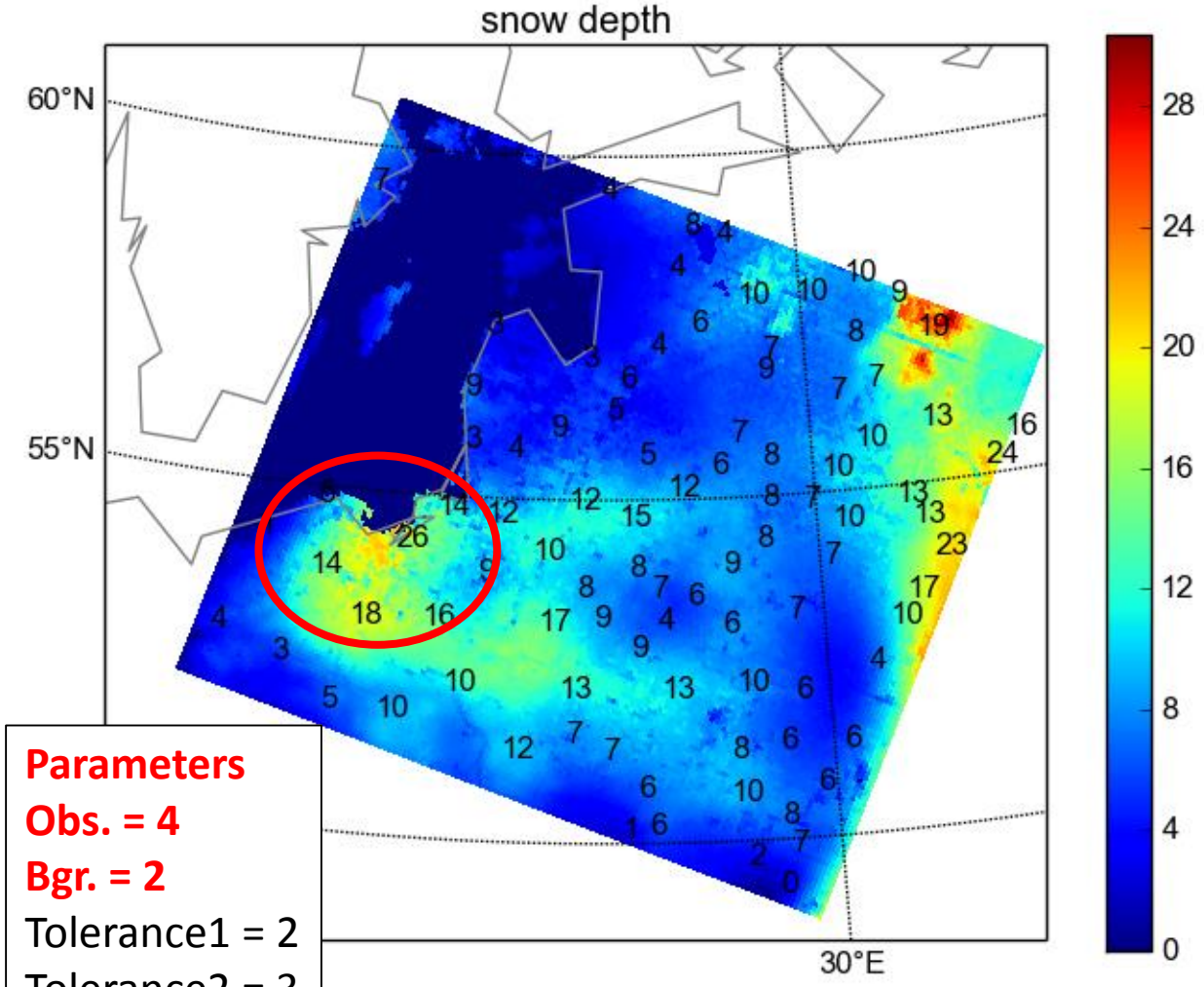
Parameters
Obs. = 10
Bgr. = 10
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

Experiment 4.

Obs. are more important

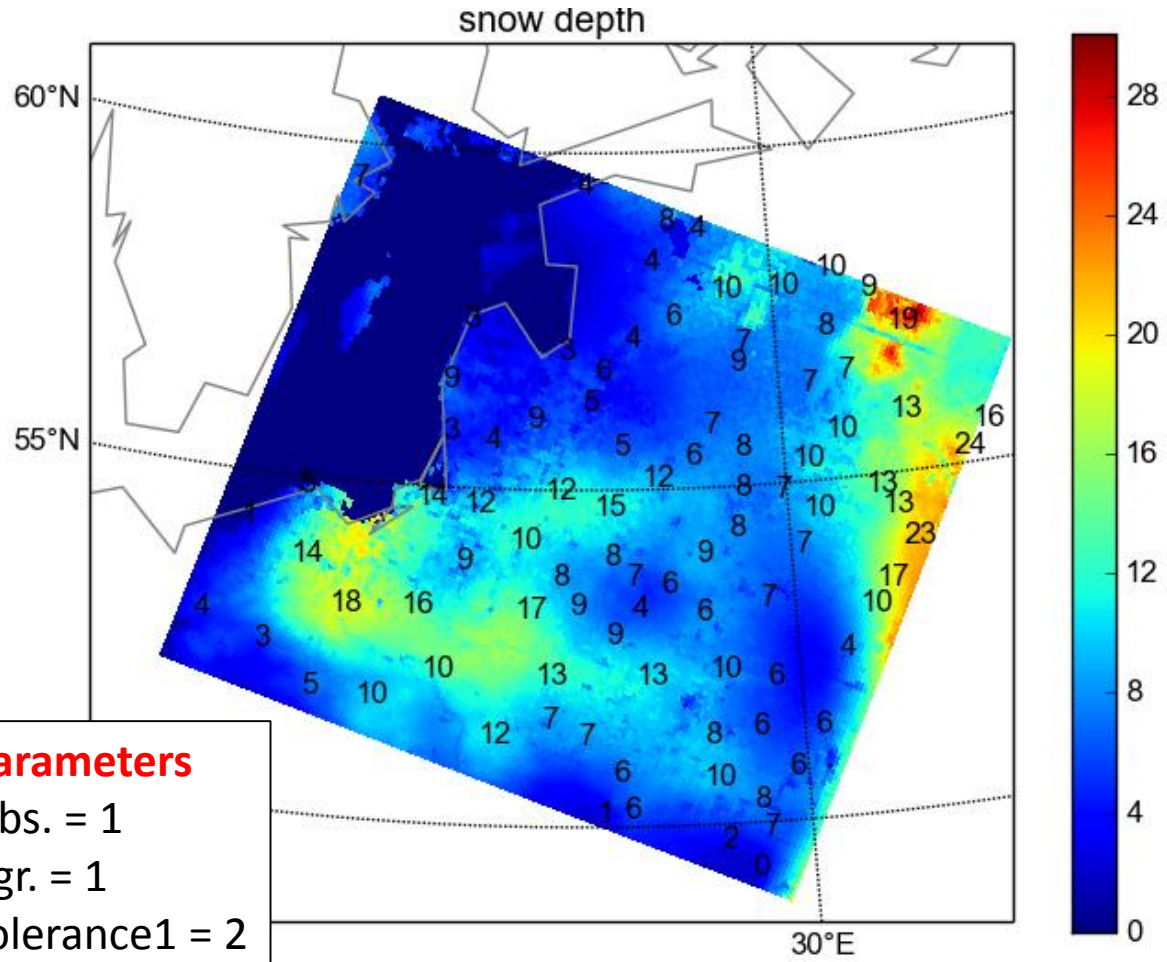


Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000



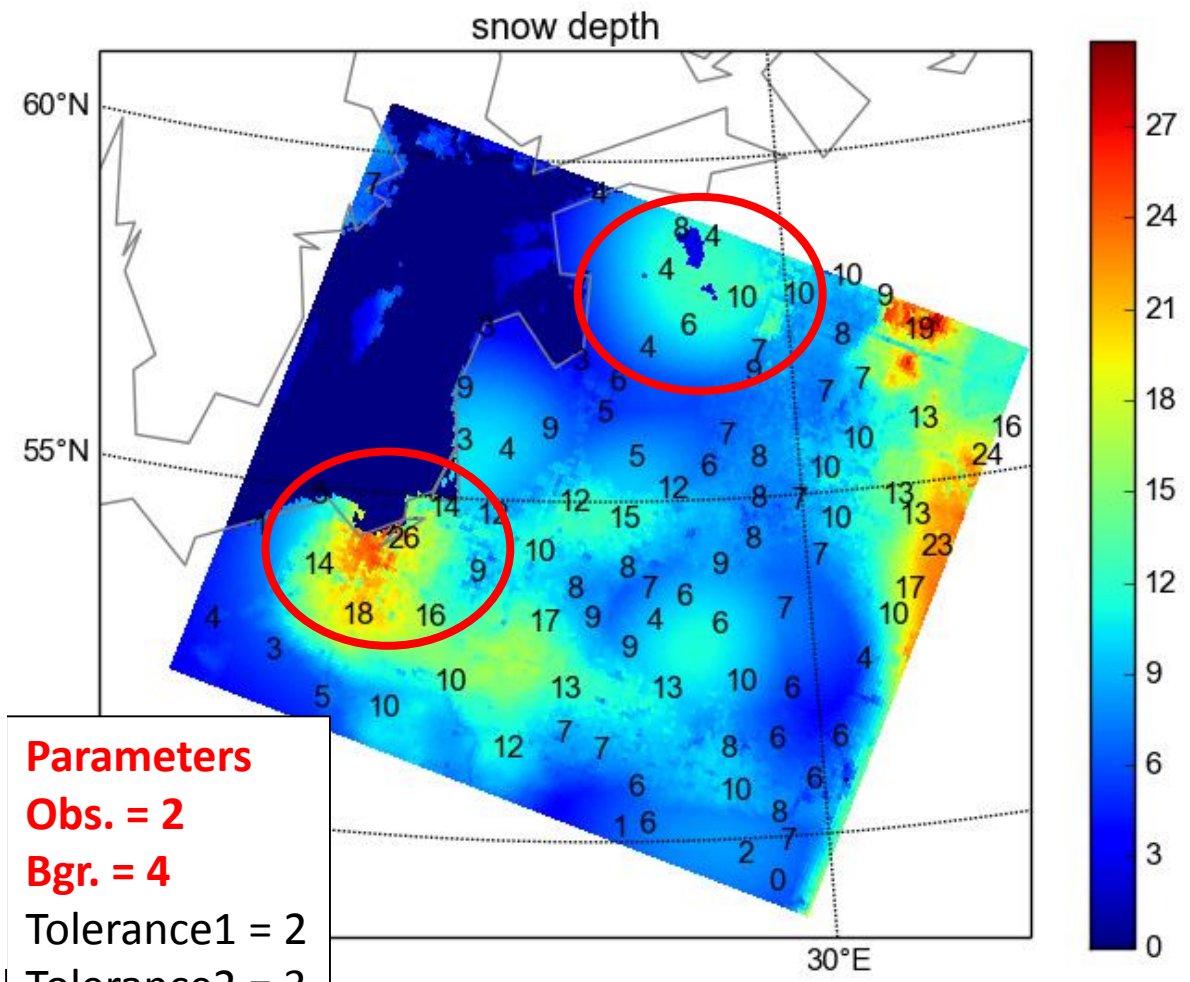
Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

Experiment 5.



Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

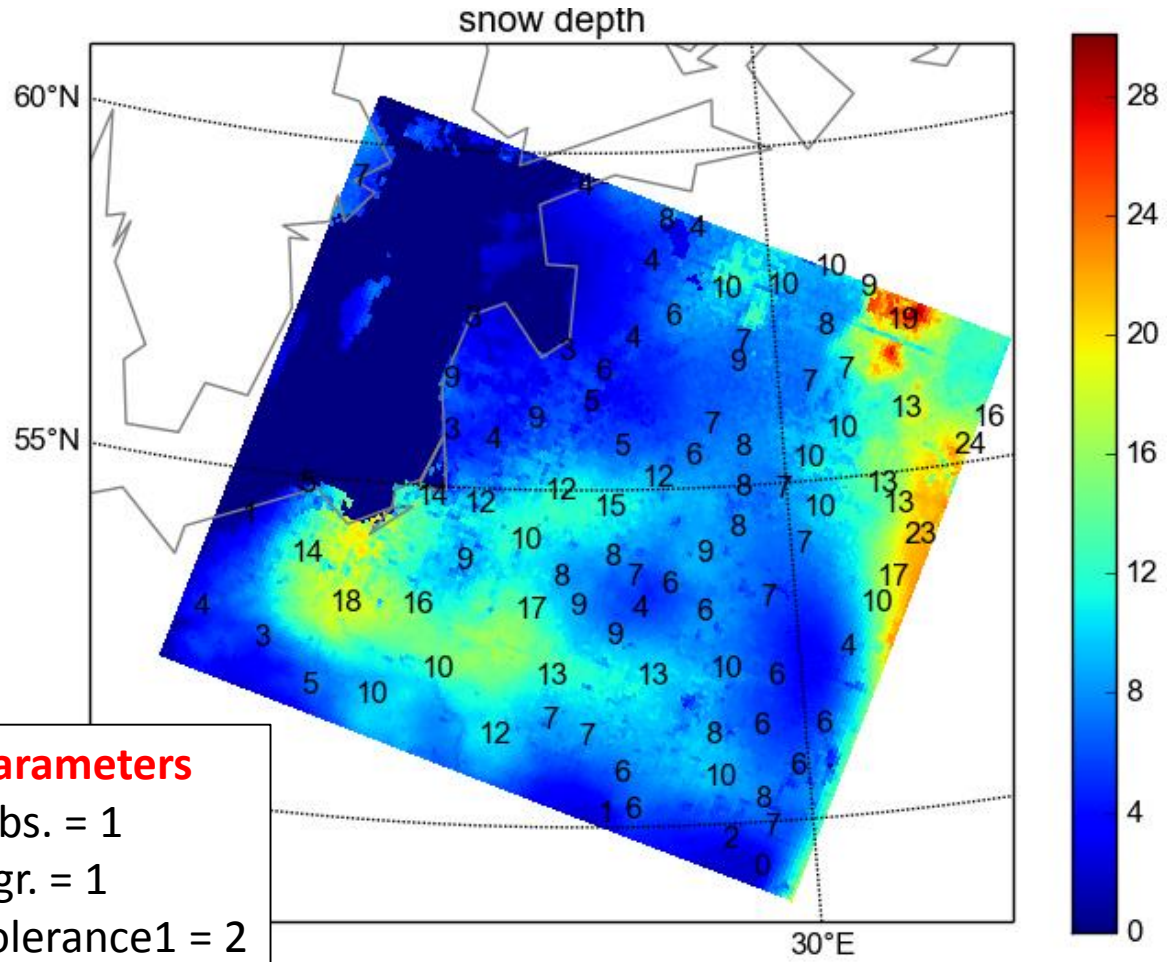
Smoothed



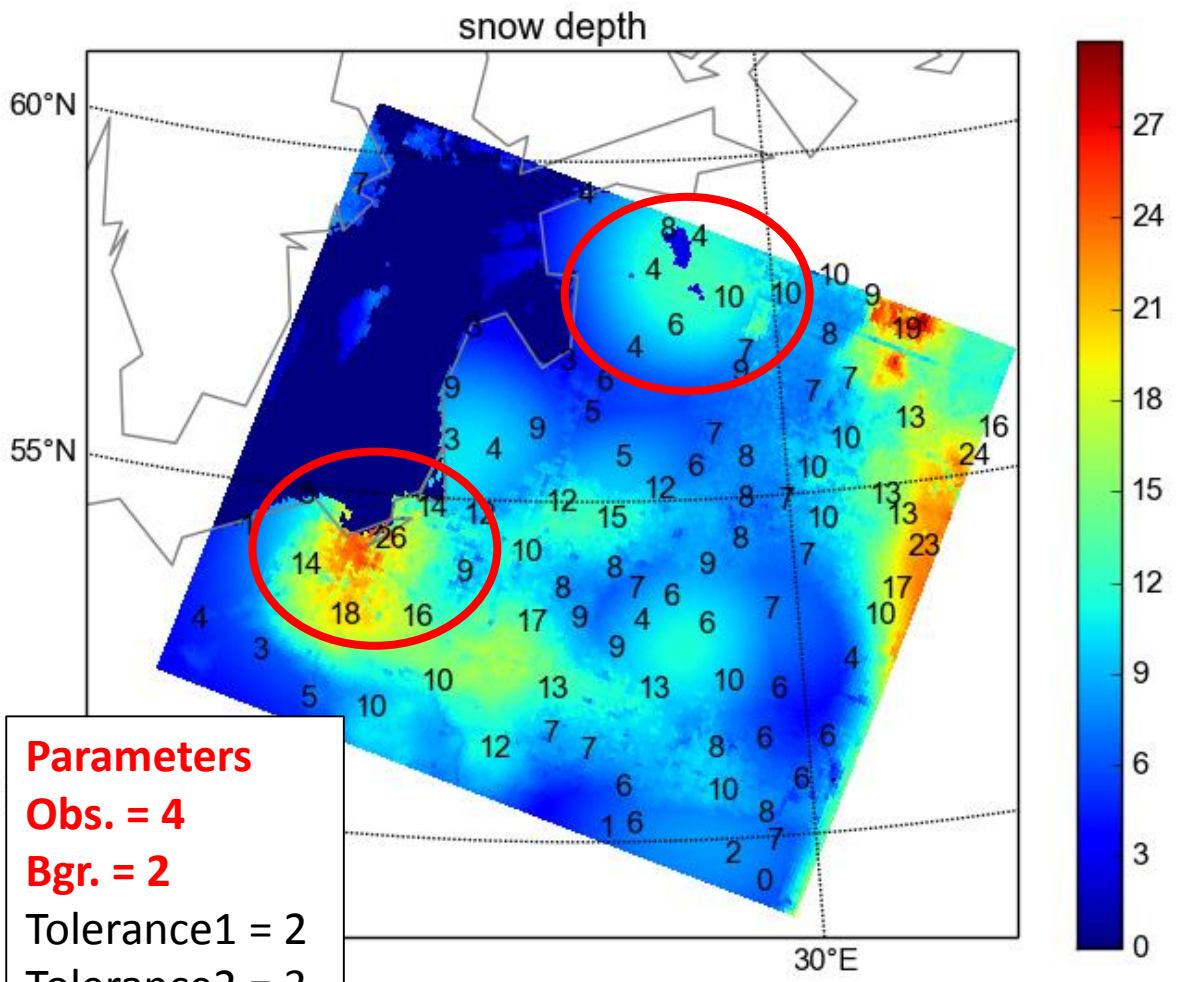
Parameters
Obs. = 2
Bgr. = 4
Tolerance1 = 2
Tolerance2 = 3
Scale=200000

Experiment 6.

Smoothed?

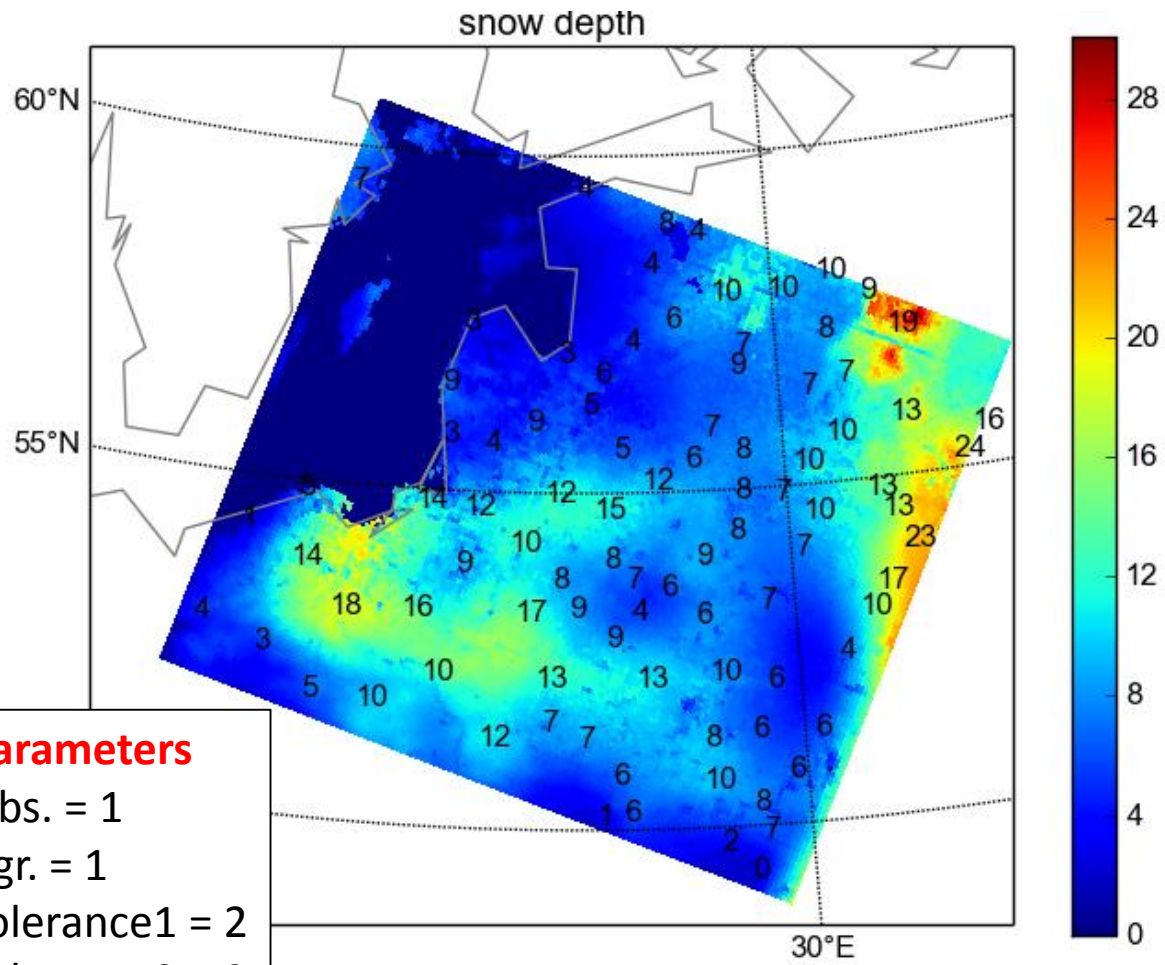


Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

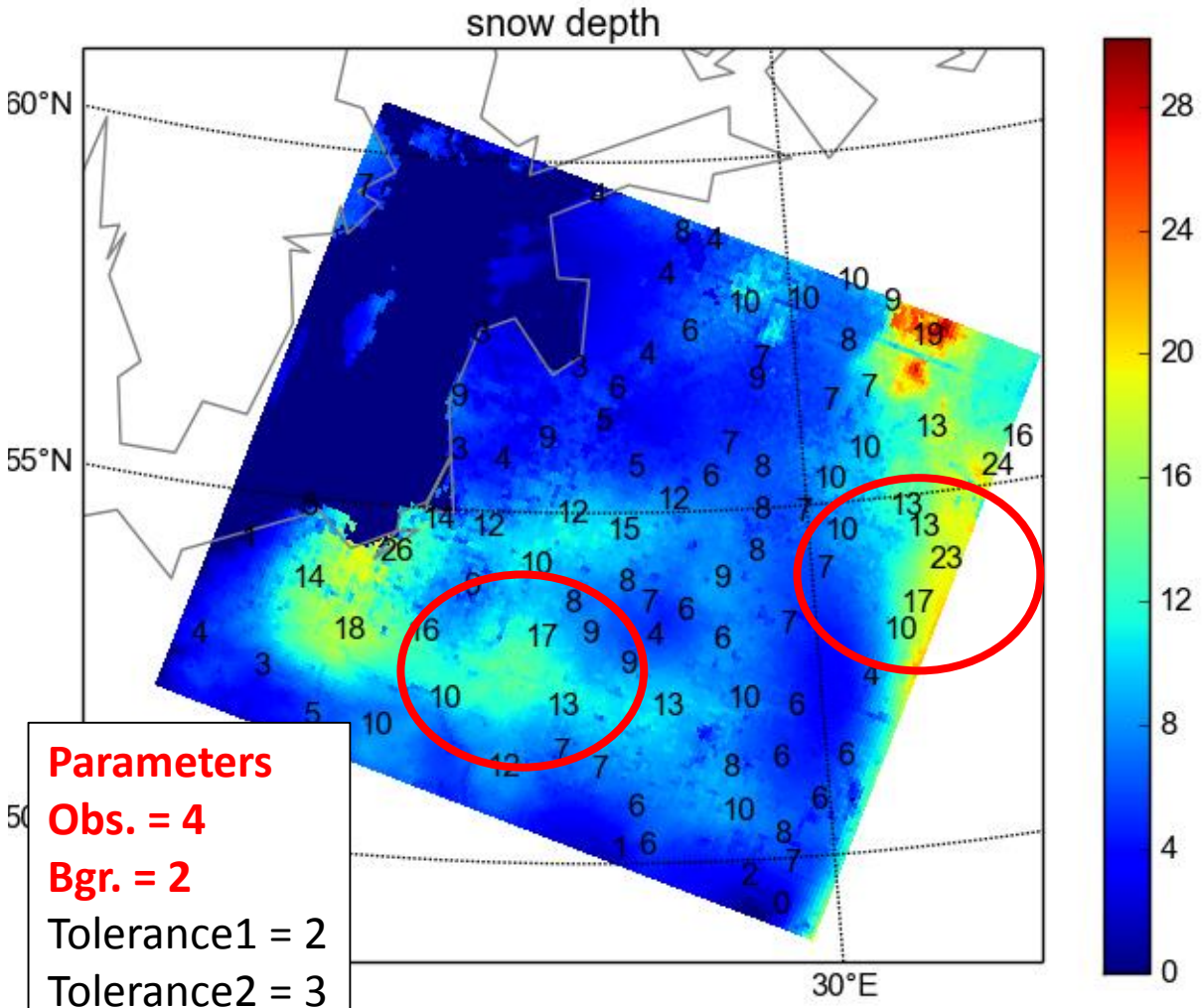


Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 2
Tolerance2 = 3
Scale=2000000

Experiment 7.

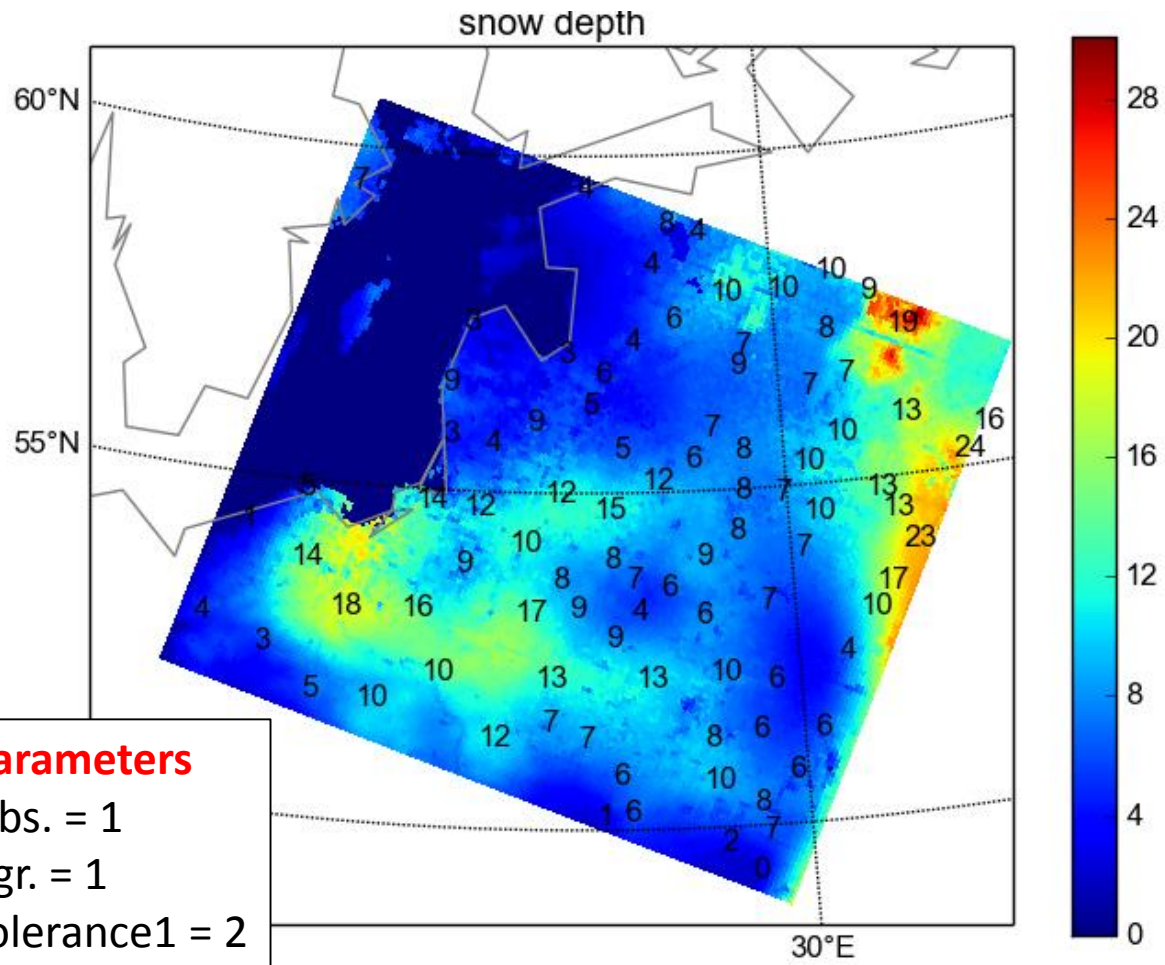


Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000



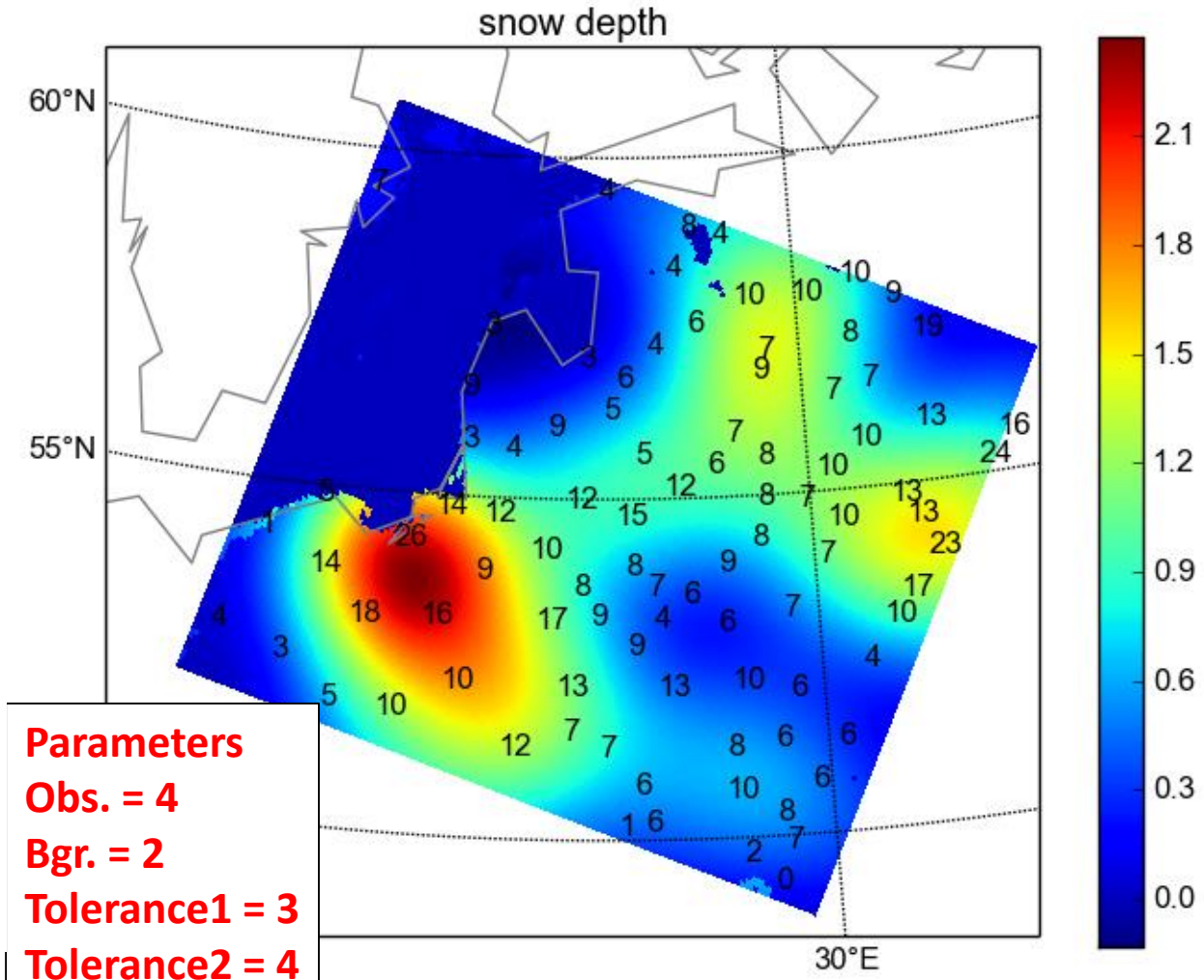
Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 2
Tolerance2 = 3
Scale=2000

Experiment 8.



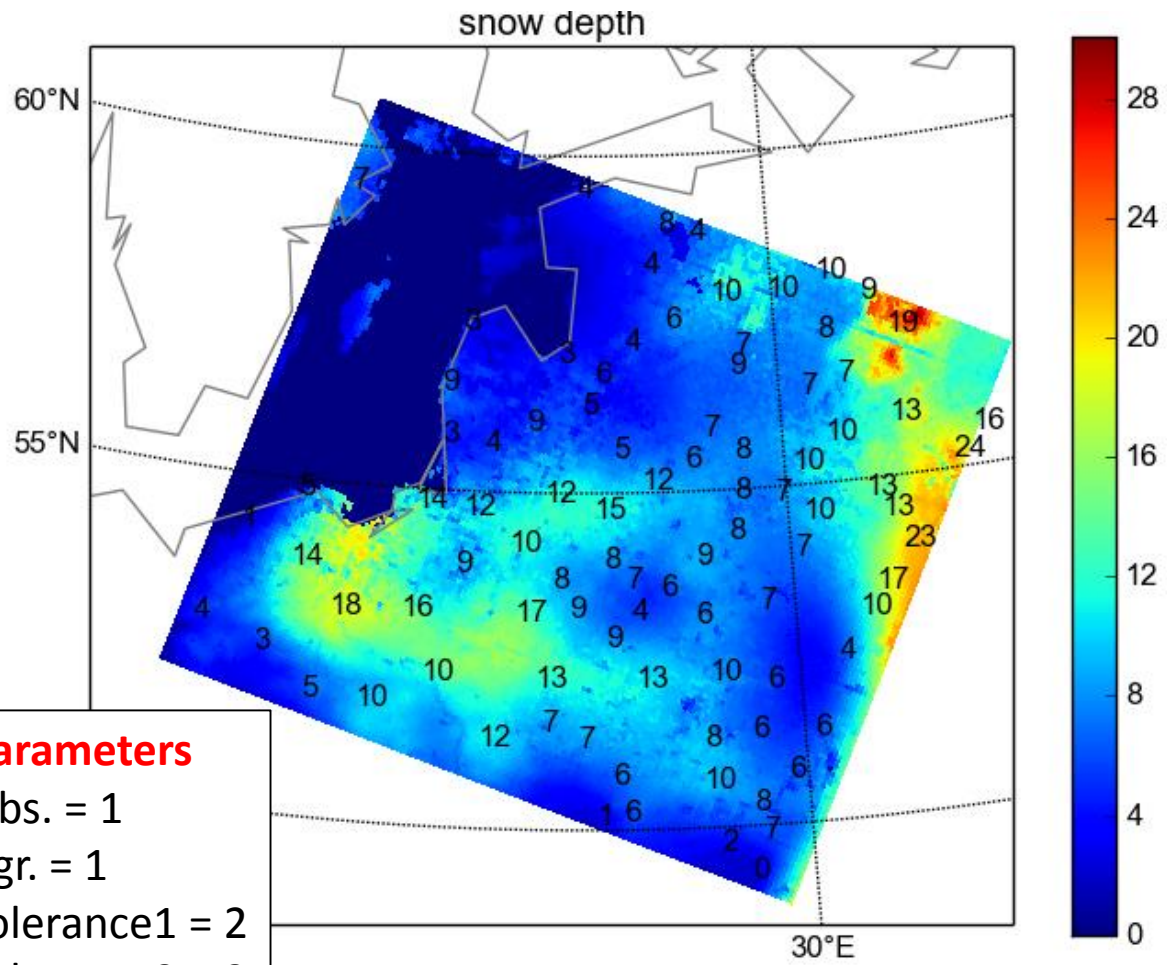
Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

Difference

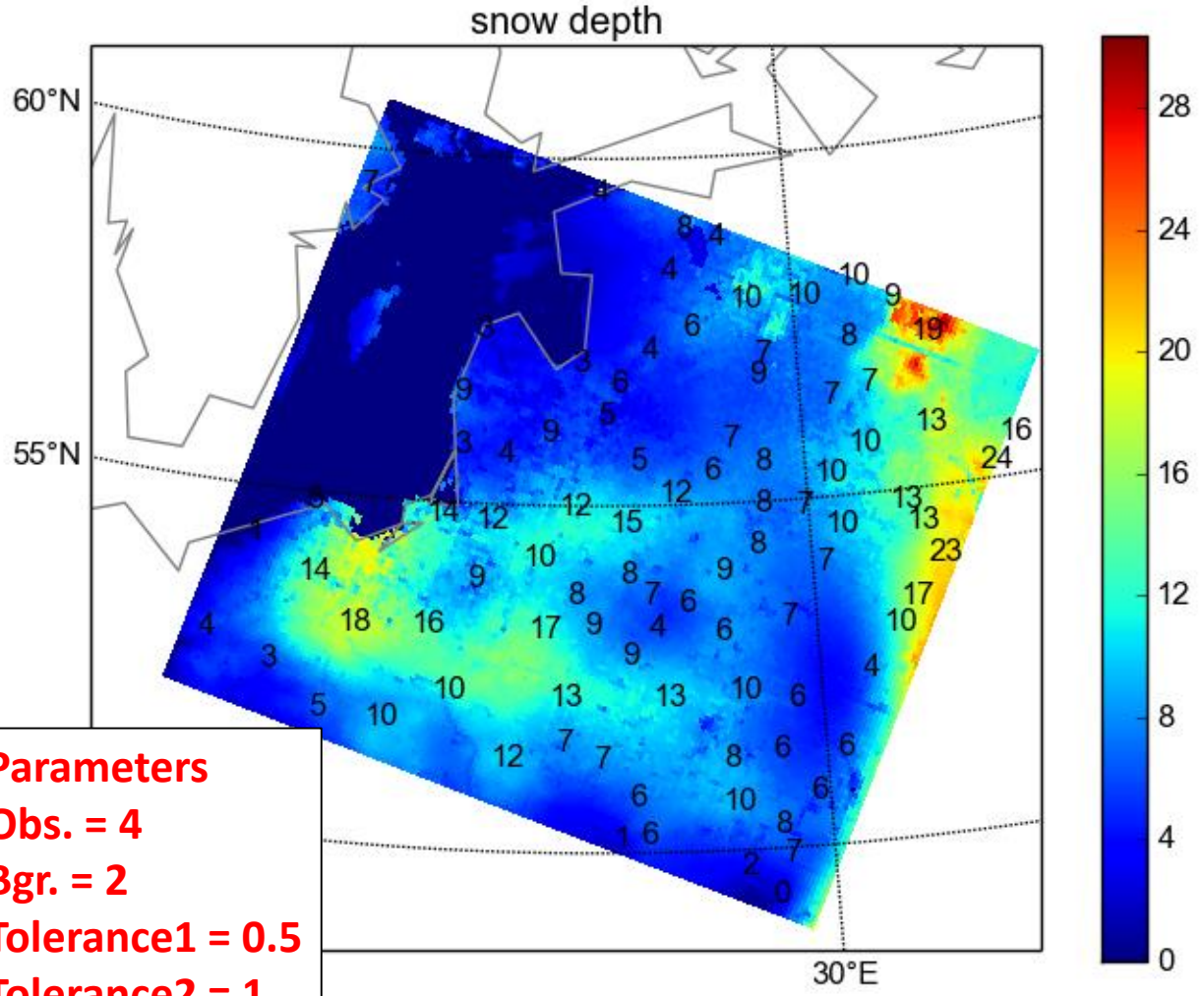


Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 3
Tolerance2 = 4
Scale=20000

Experiment 9.

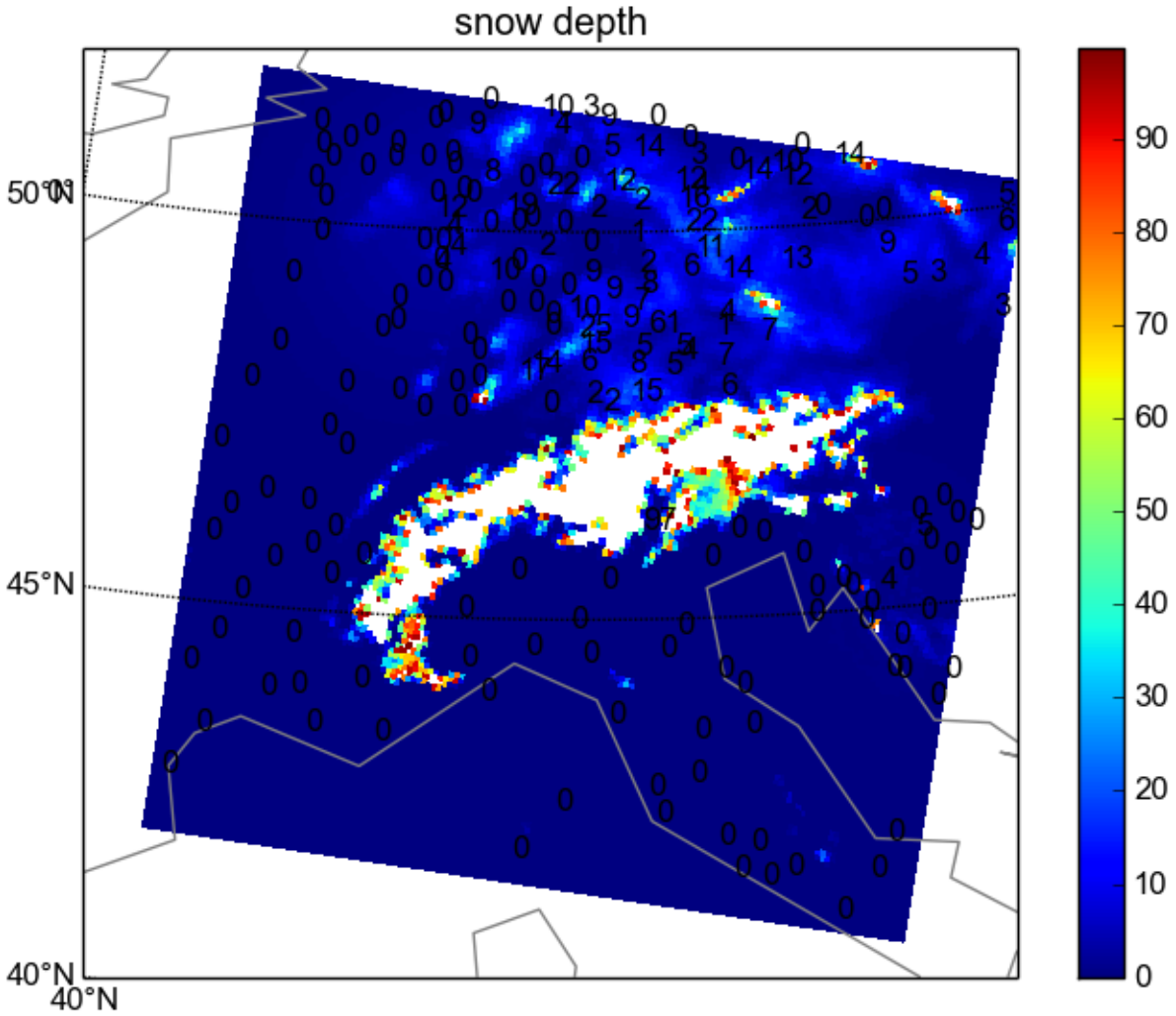


Parameters
Obs. = 1
Bgr. = 1
Tolerance1 = 2
Tolerance2 = 3
Scale=20000



Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 0.5
Tolerance2 = 1
Scale=20000

Experiment 10. – Alps (Reduced area)



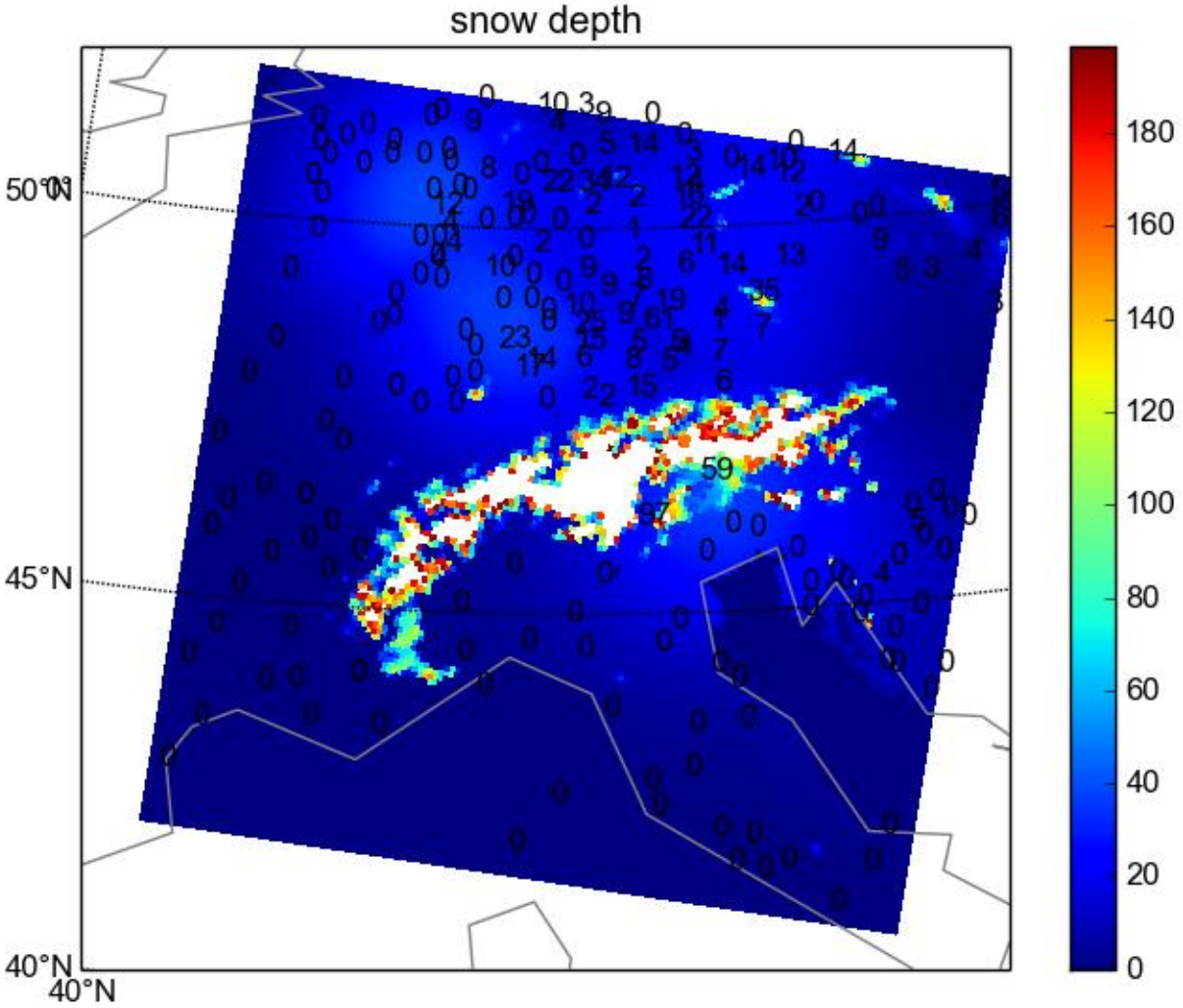
Parameters
Obs. = 4
Bgr. = 2
Tolerance1 = 0.5
Tolerance2 = 1
Scale=20000

All pixels > 100 cm are white (mask)

Mountains are problematic for modeling because of presence of glaciers

Many stations were rejected

Experiment 11. – Alps (Reduced area)

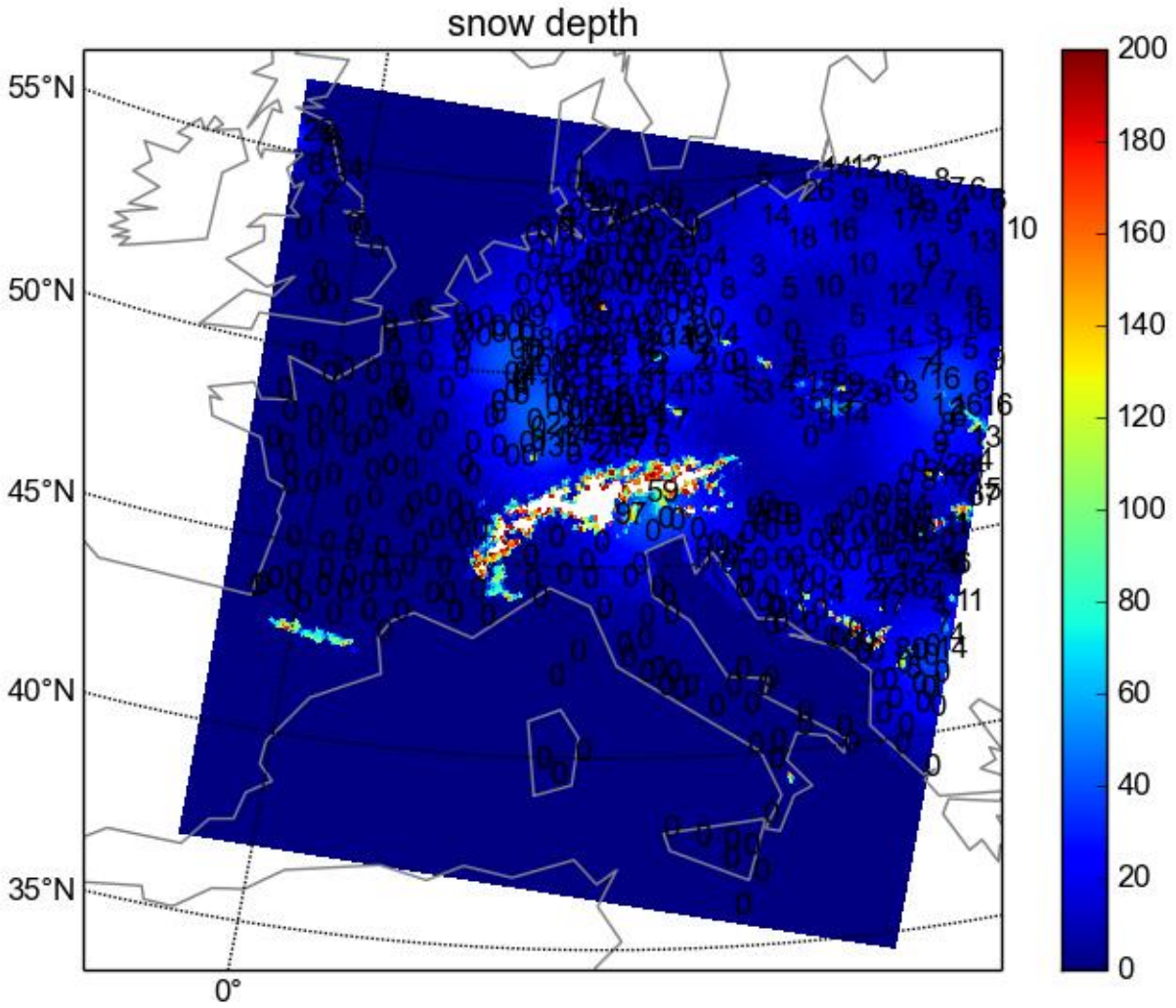


Parameters
Obs. = 2
Bgr. = 4
Tolerance1 = 2
Tolerance2 = 3
Scale=20000

All pixels > 200 cm are white (mask)

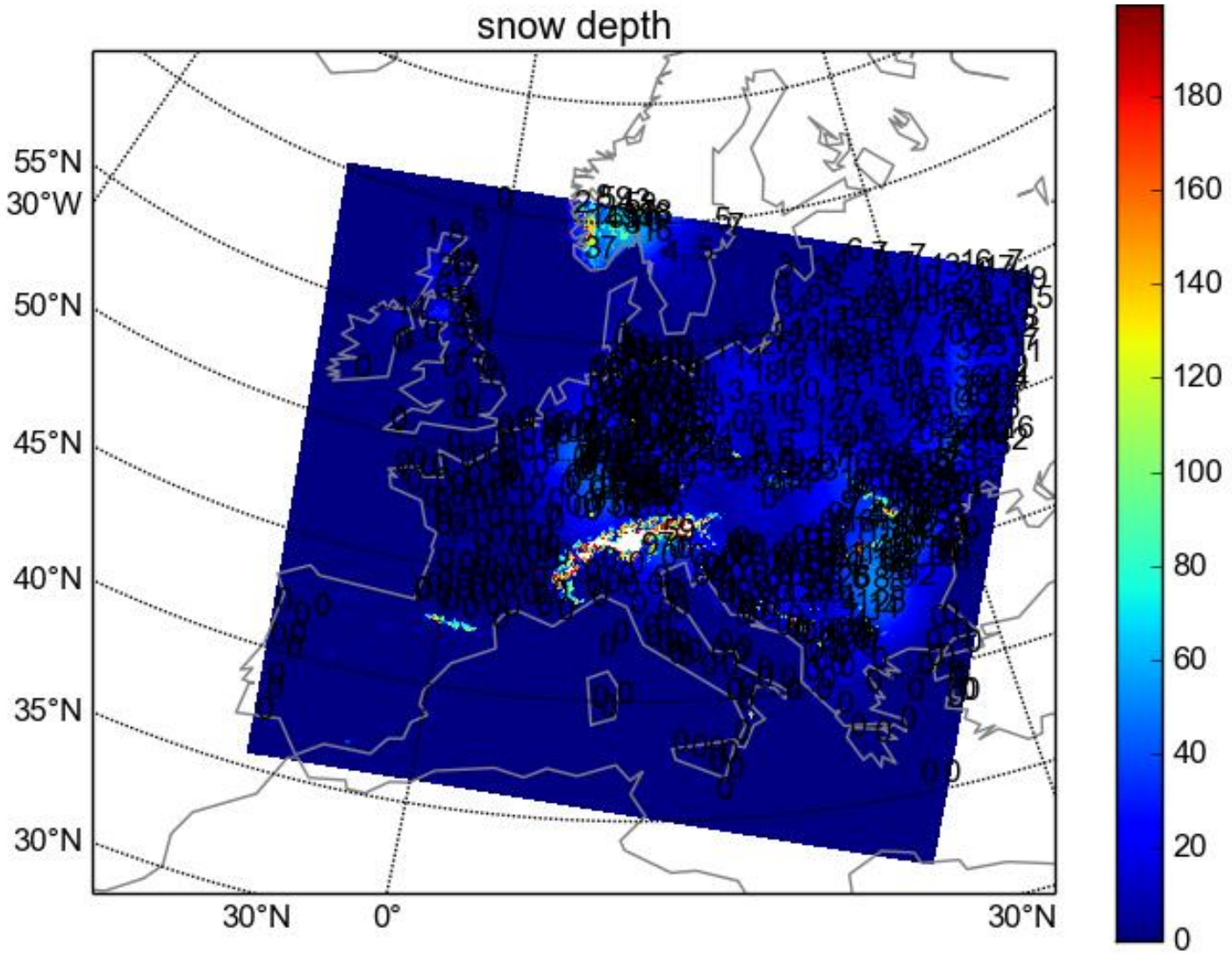
Mountains are problematic for modeling because of presence of glaciers

Experiment 12. – Large area, 555 observations



Computing time – acceptable

Experiment 13. – Large area, 800 observations



Computing time – still acceptable

Conclusion:

- Optimal Interpolation is a useful method to assimilate snow data in NWP model
- Parameters should be tested to have the best results
- It is hard to find parameters that can be applied in different regions with the same quality
- Computational time is acceptable also in large areas

Thank you for your attention