Norwegian Meteorological Institute
met.no

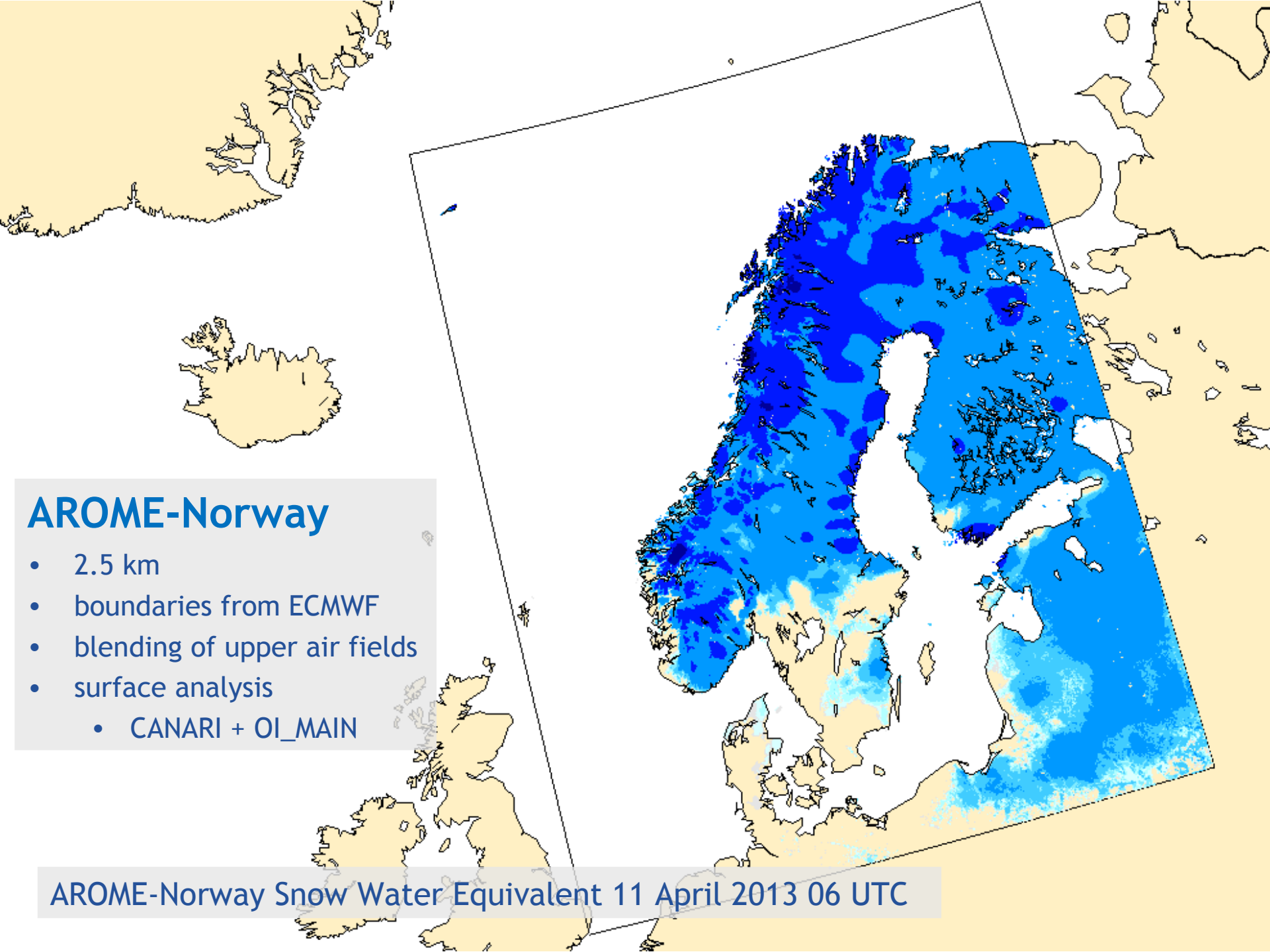
Harmonie snow analysis

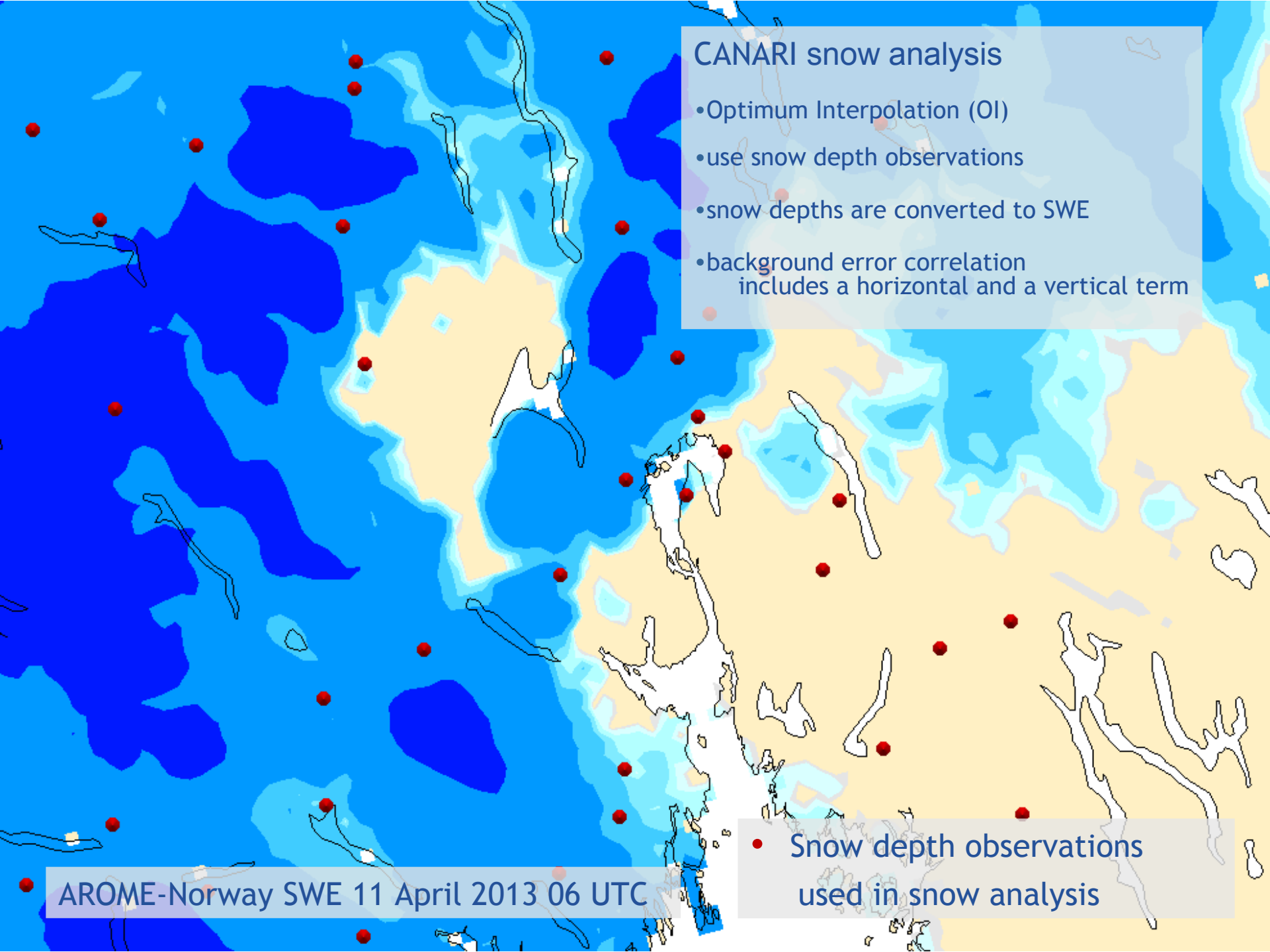
Mariken Homleid

ALADIN/HIRLAM Workshop/ASM, Reykjavik, 15-18 April 2013

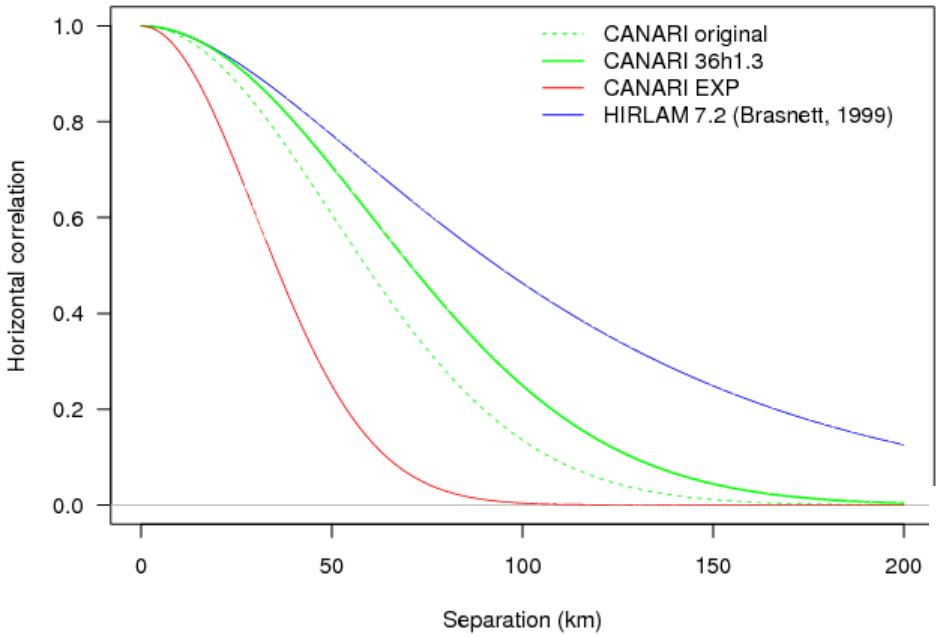
Outline

- Snow status in current cycle of Harmonie – 37h1.2
  - 1-layer snow scheme
  - snow analysis using snow depths observations
  - Permanent snow cover from ECOCLIMAP-1
- Snow depths observations from National Networks are made available on GTS
  - Swedish climate stations from December 2010, used at ECMWF since March 2011
  - Norwegian climate - 'precipitation'- stations from 12. March 2013
- Snow analysis experiments
  - with additional snow depths observations from Norwegian climate stations
  - with CryoRisk satellite data
- Next steps…


AROME-Norway
• 2.5 km
• boundaries from ECMWF
• blending of upper air fields
• surface analysis
• CANARI + OI_MAIN
AROME-Norway Snow Water Equivalent 11 April 2013 06 UTC


CANARI snow analysis
•Optimum Interpolation (OI)
•use snow depth observations
•snow depths are converted to SWE
•background error correlation
includes a horizontal and a vertical term
AROME-Norway SWE 11 April 2013 06 UTC
Snow depth observations
used in snow analysis

Horizontal correlation

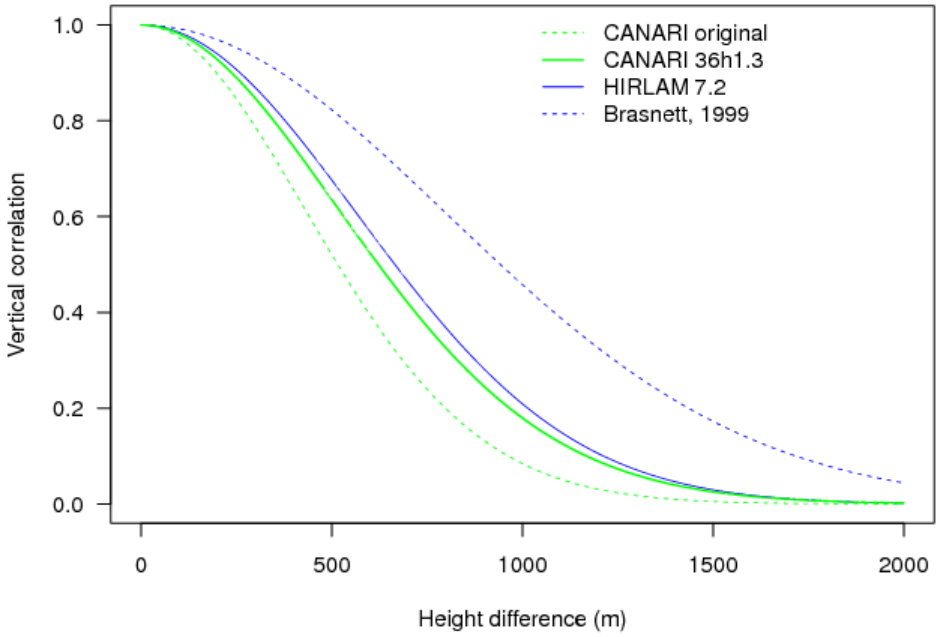


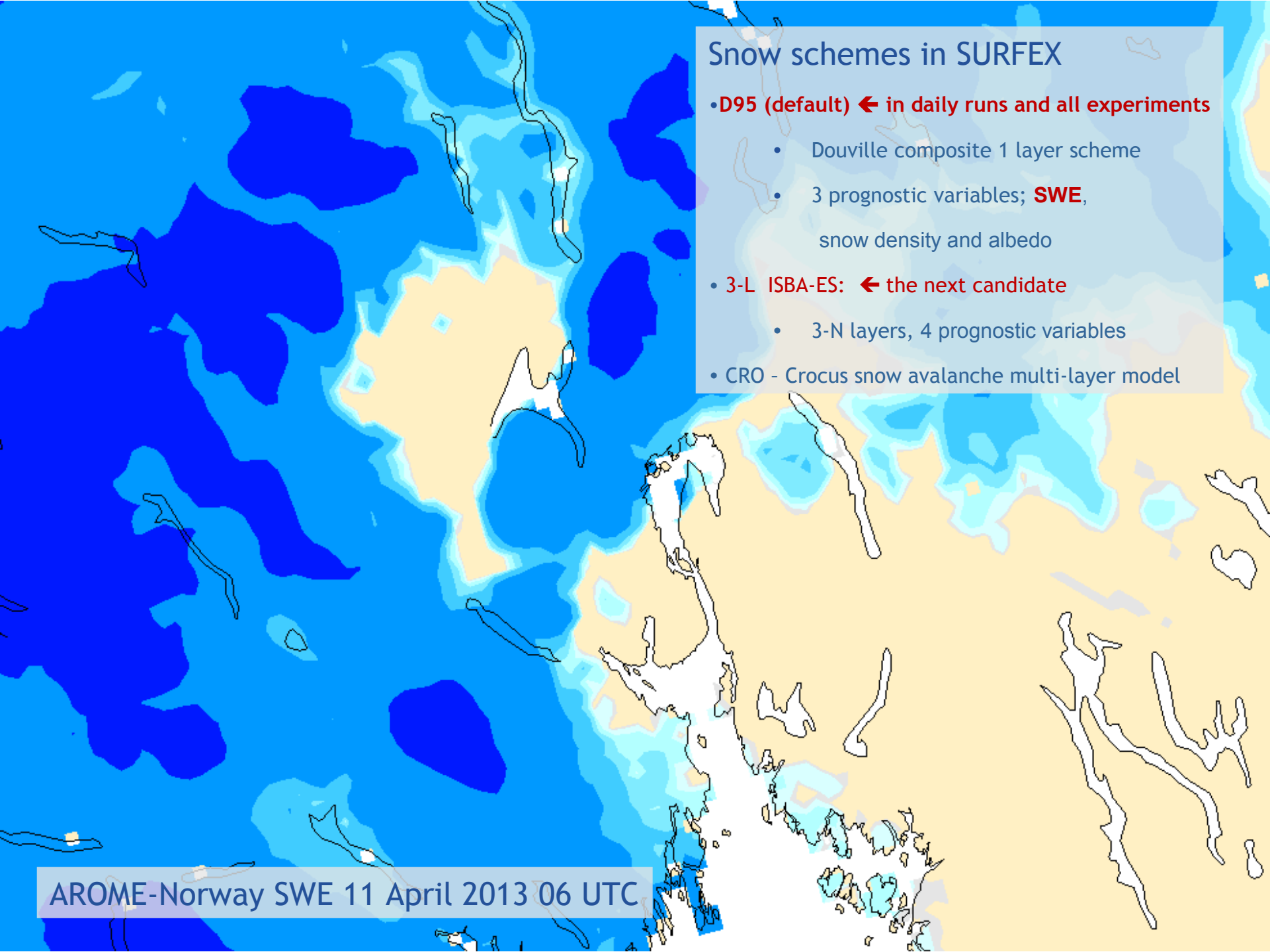
CANARI snow analysis, cont.

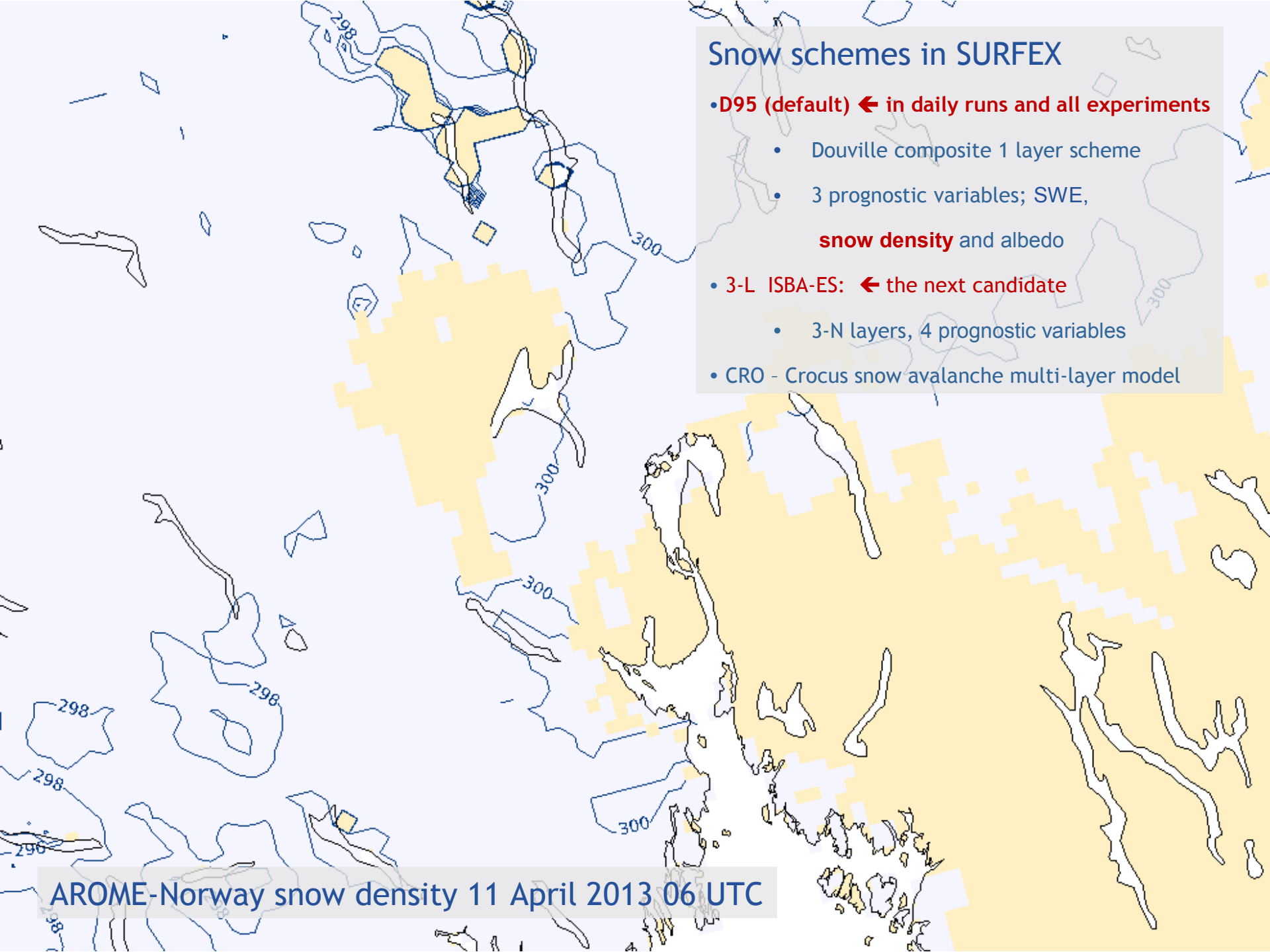
- background error correlation includes a horizontal and a vertical term
- quality control by 1. guess check

OI_main : all snow fields updated

Vertical correlation



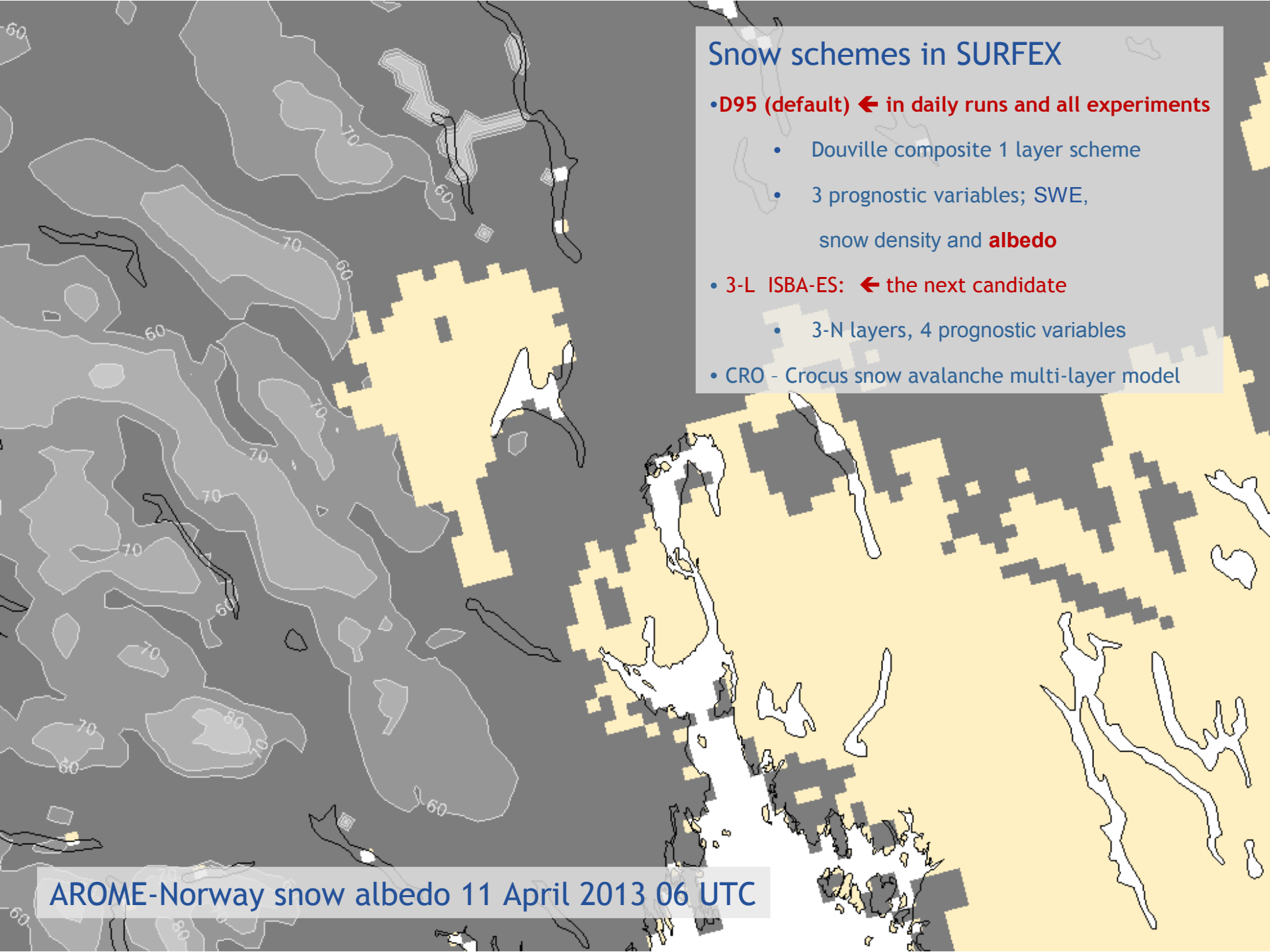

Snow schemes in SURFEX
•D95 (default) ← in daily runs and all experiments
• Douville composite 1 layer scheme
• 3 prognostic variables; SWE,
snow density and albedo
• 3-L ISBA-ES: ← the next candidate
• 3-N layers, 4 prognostic variables
• CRO – Crocus snow avalanche multi-layer model
AROME-Norway SWE 11 April 2013 06 UTC



Snow schemes in SURFEX

- **D95 (default) ← in daily runs and all experiments**
  - Douville composite 1 layer scheme
  - 3 prognostic variables; SWE, **snow density** and albedo
- 3-L ISBA-ES: ← the next candidate
  - 3-N layers, 4 prognostic variables
- CRO – Crocus snow avalanche multi-layer model

AROME-Norway snow density 11 April 2013 06 UTC


Snow schemes in SURFEX
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• 3-L ISBA-ES: ← the next candidate
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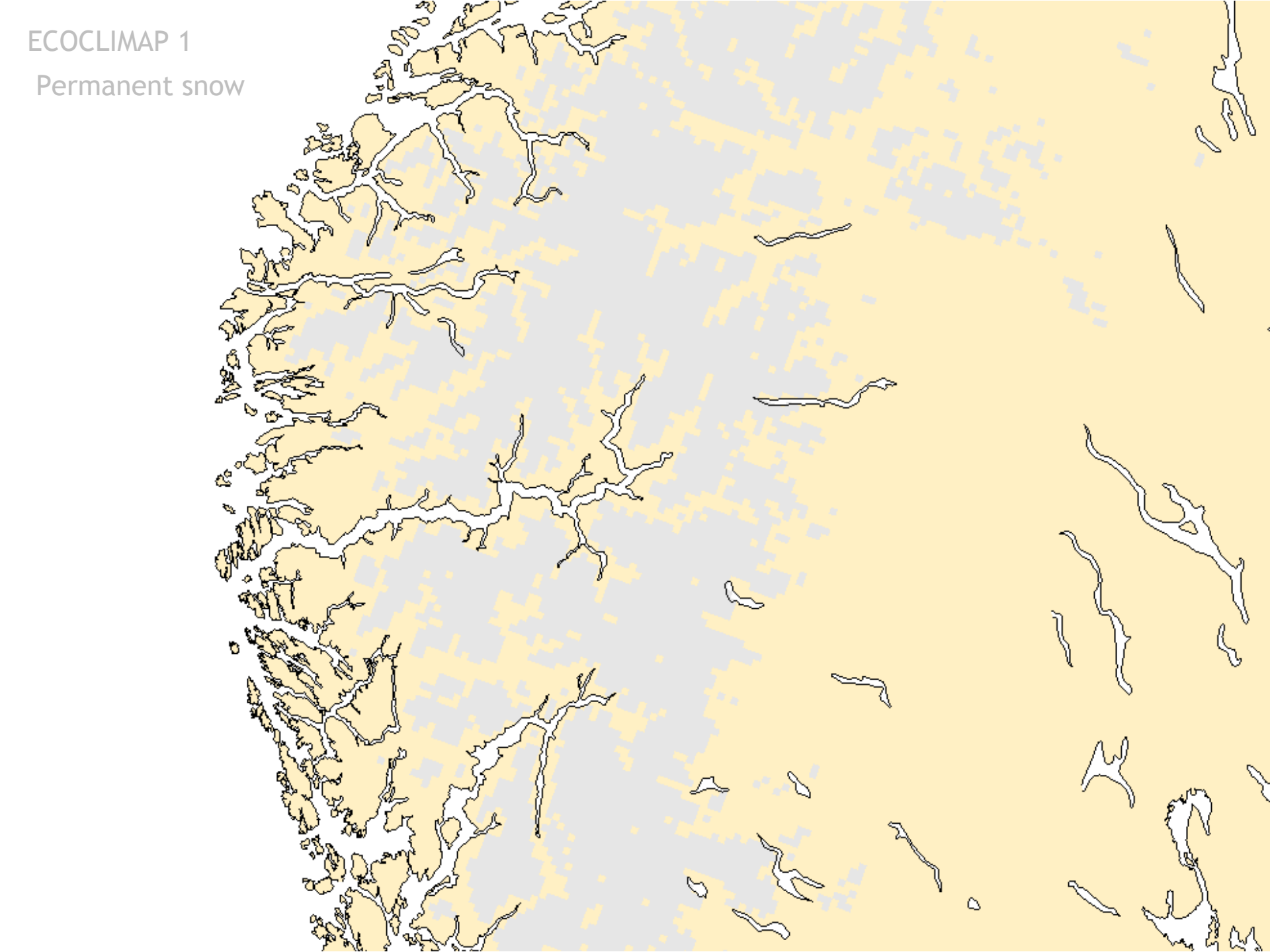
AROME-Norway snow albedo 11 April 2013 06 UTC

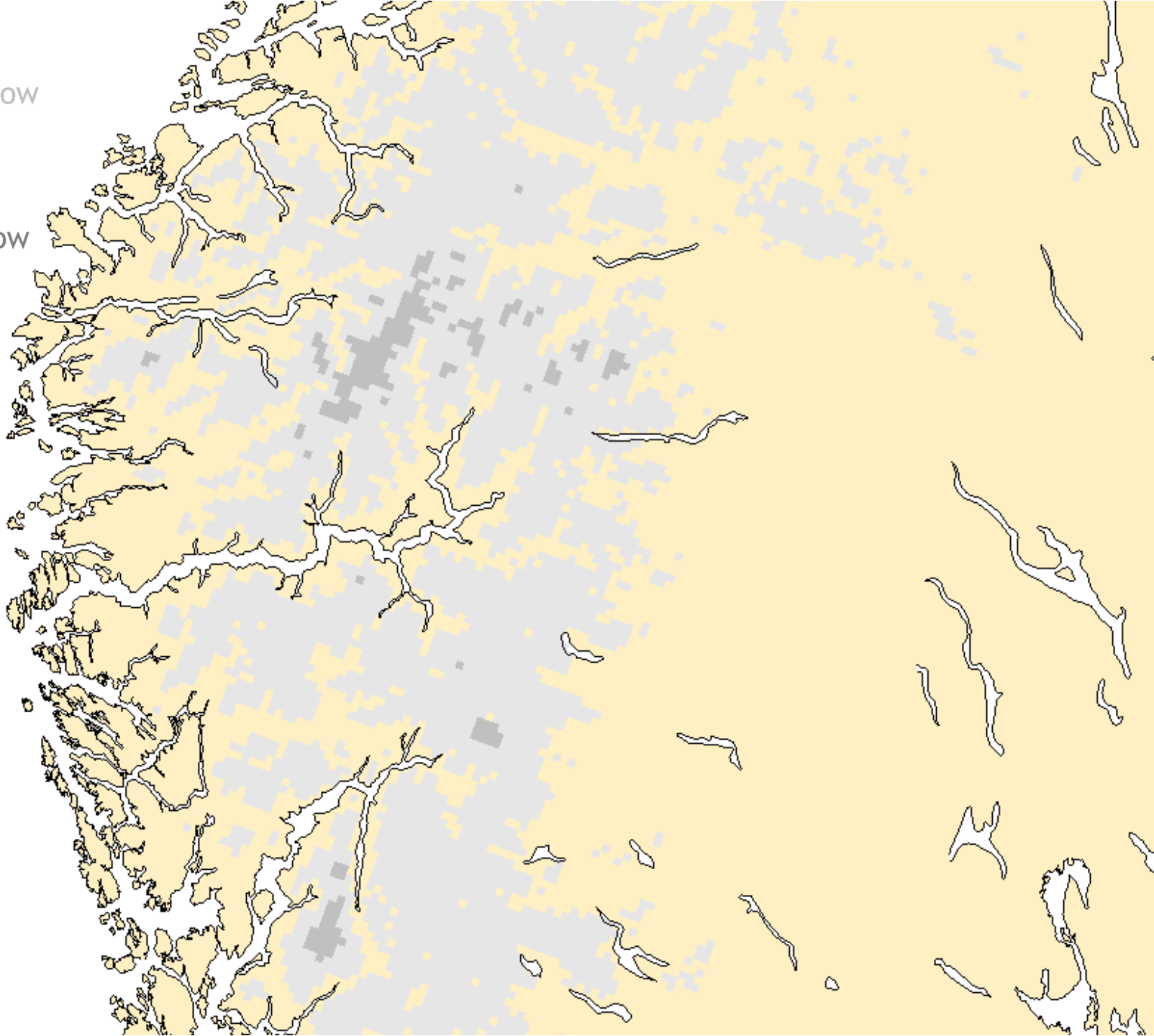

ECOCLIMAP 1
Permanent snow

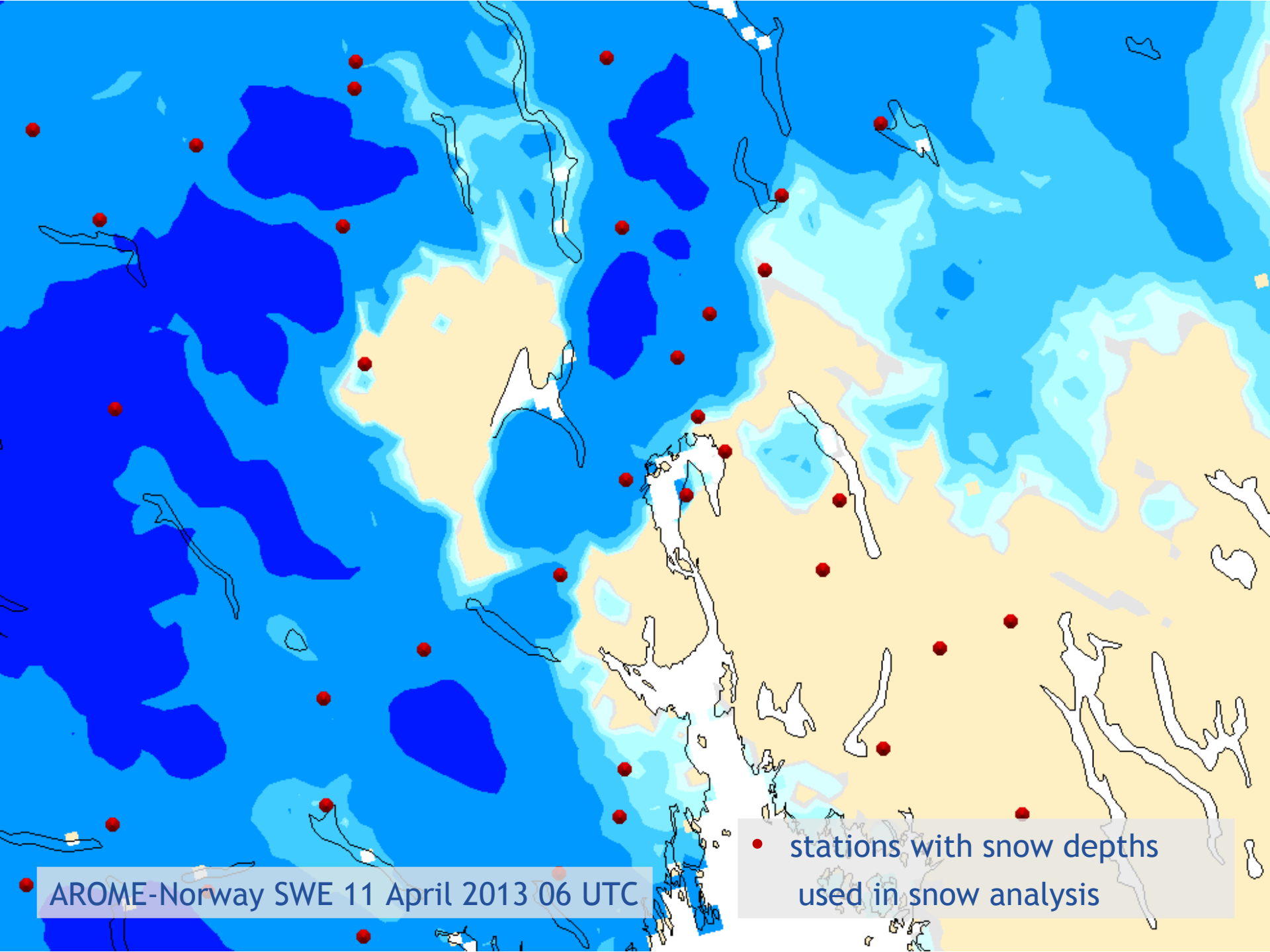
ECOCLIMAP 1

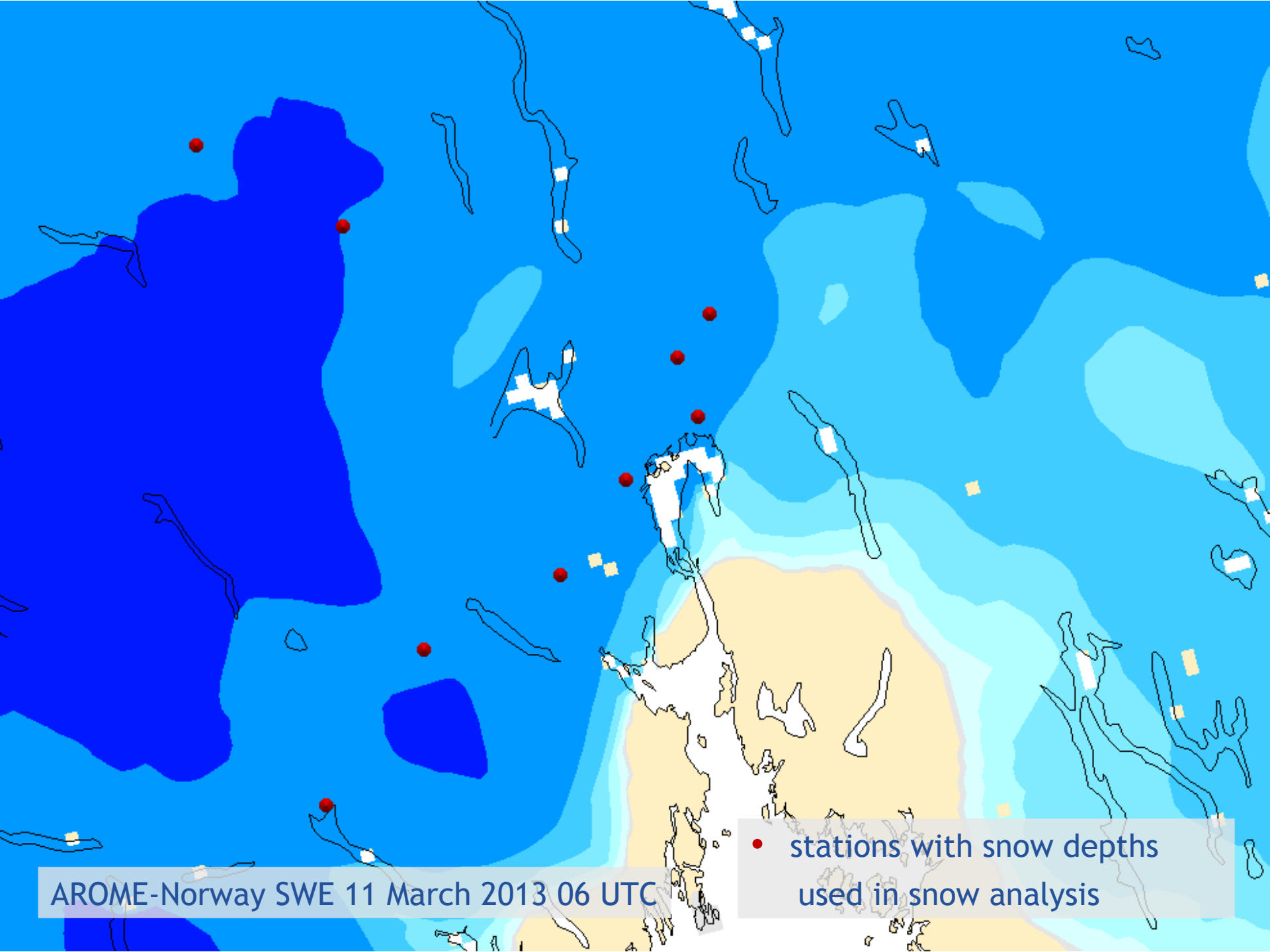
Permanent snow

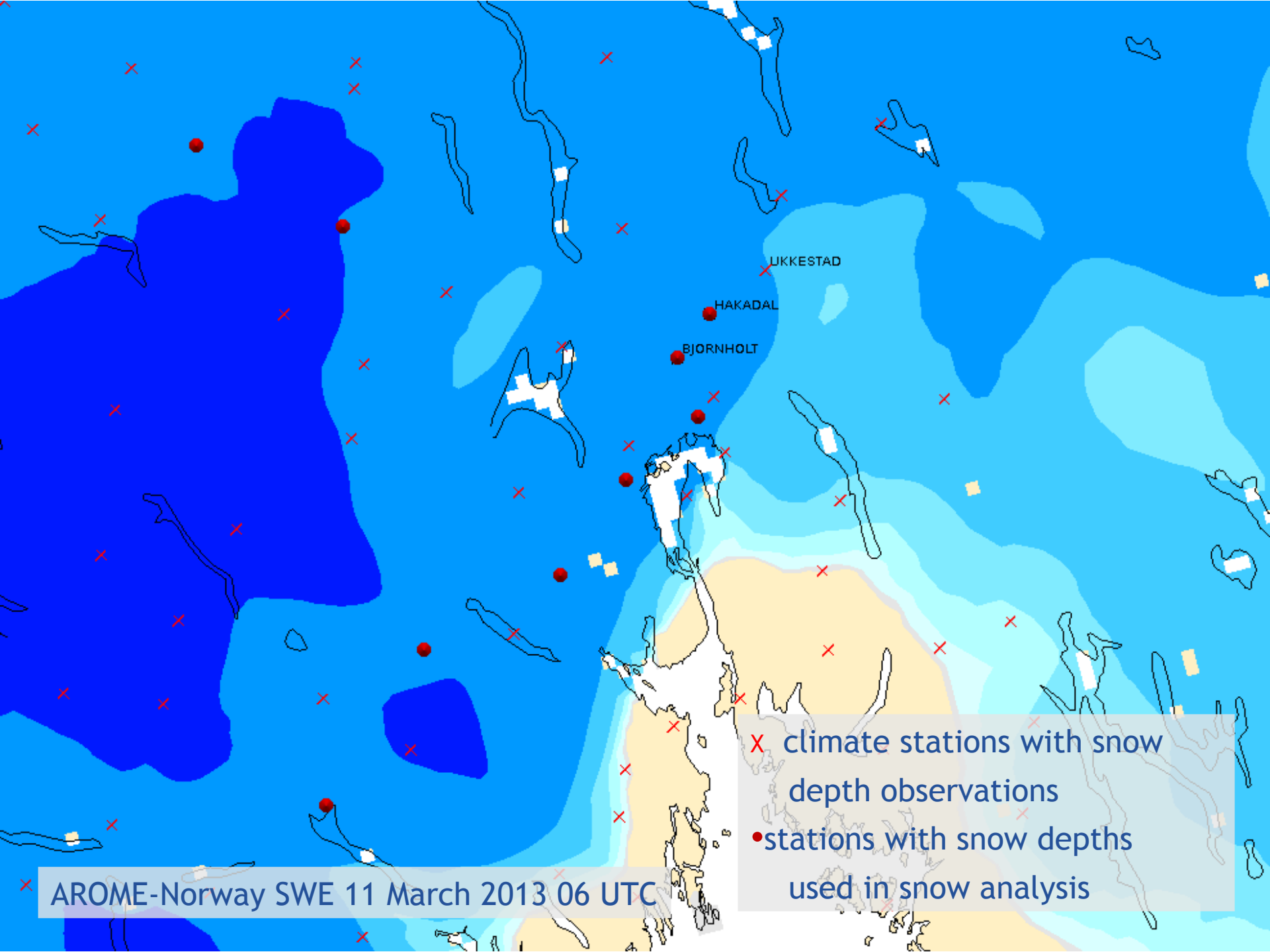
ECOCLIMAP 2

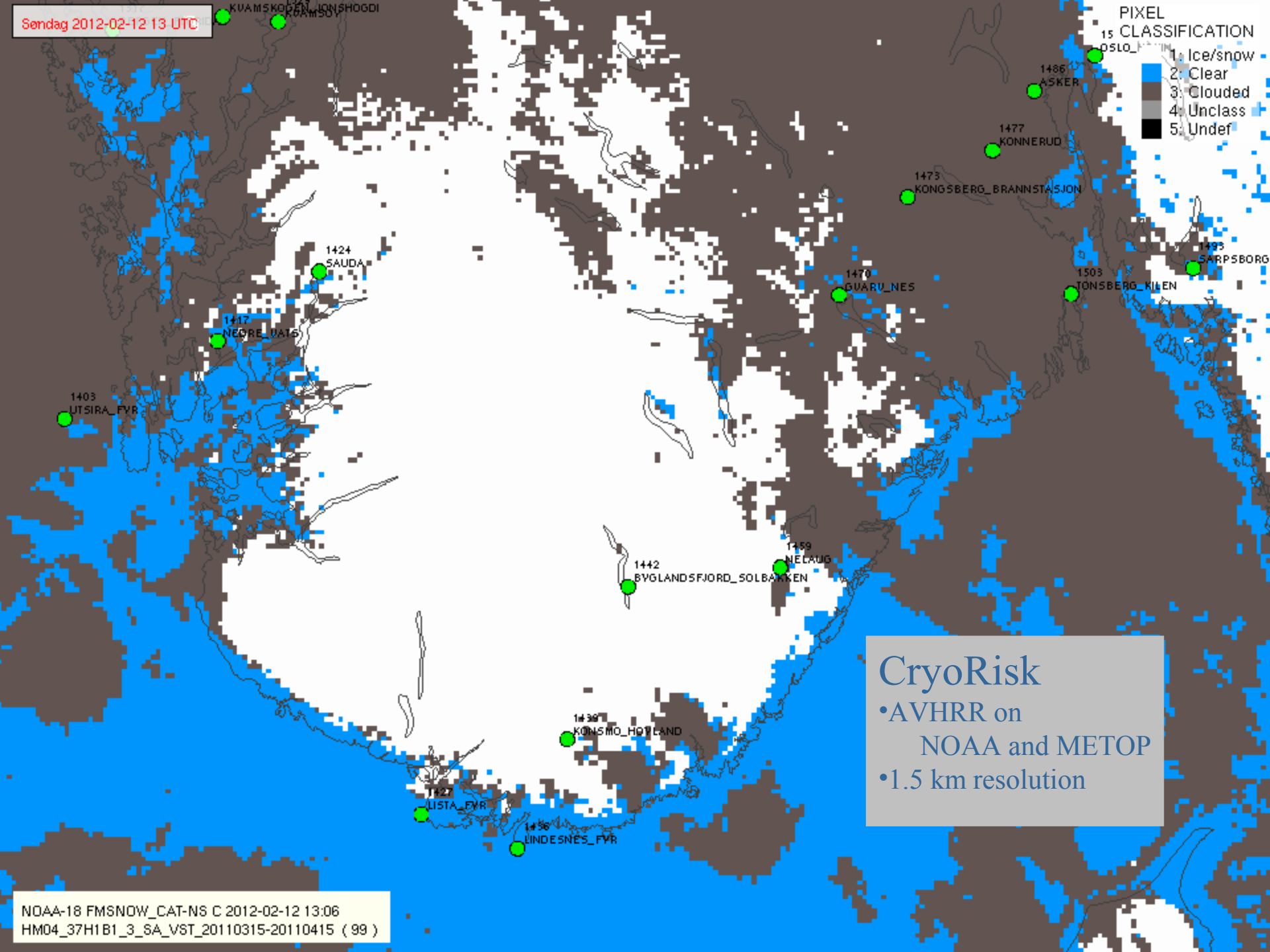
Permanent snow




AROME-Norway SWE 11 April 2013 06 UTC
stations with snow depths
used in snow analysis


AROME-Norway SWE 11 March 2013 06 UTC
stations with snow depths used in snow analysis


UKKESTAD
HAKADAL
BJORNHOLT
X climate stations with snow depth observations
•stations with snow depths used in snow analysis
AROME-Norway SWE 11 March 2013 06 UTC


Søndag 2012-02-12 13 UTC
PIXEL
15 CLASSIFICATION
1: Ice/snow
2: Clear
3: Clouded
4: Unclass
5: Undef
1486
ASKER
1477
KONNERUD
1473
KONGSBERG_BRANNSTASJON
1424
SAUDA
1417
1403
UTSIRA_FVR
1442
BYGLANDSFJORD_SOLBAKKEN
1459
1427
LISTA_FVR
1456
LINDESNES_FVR
CryoRisk
•AVHRR on
NOAA and METOP
•1.5 km resolution
NOAA-18 FMSNOW_CAT-NS C 2012-02-12 13:06
HM04_37H1B1_3_SA_VST_20110315-20110415 (99)

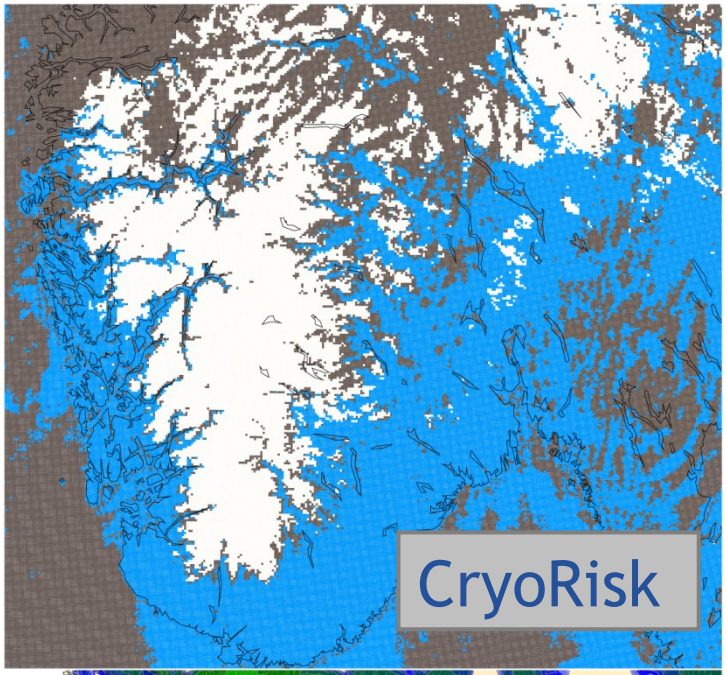
Snow analysis experiments

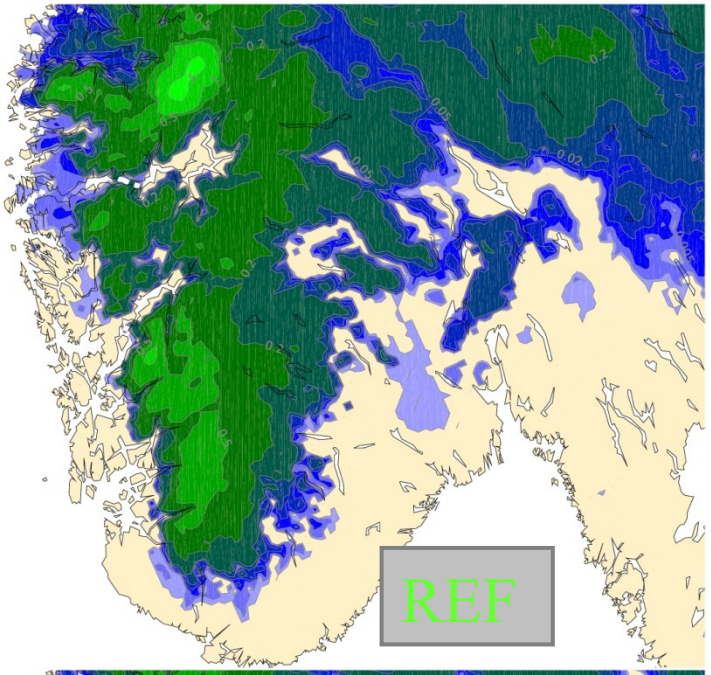
- 15 February – 31 May 2012

- REF: 37h1.beta.2 with minor changes (bug-fixes)

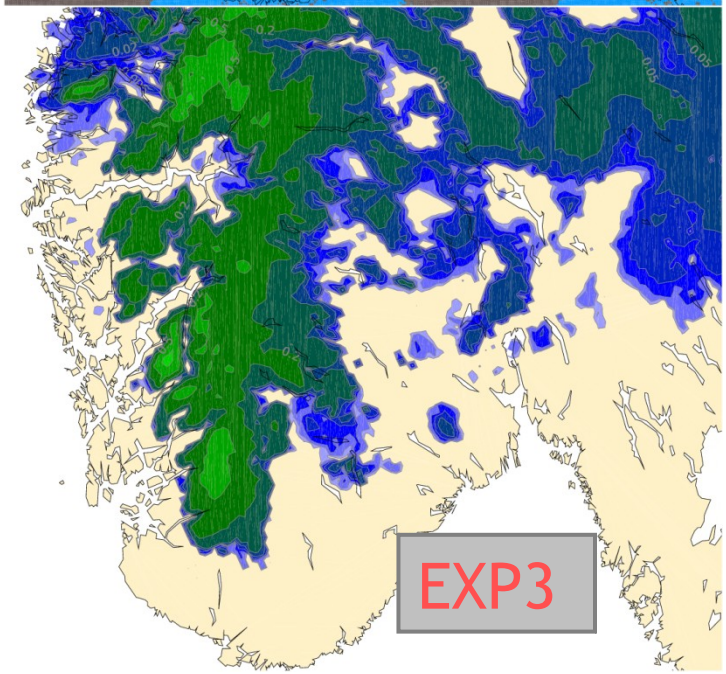
- EXP2: REF + snow depths from climate stations
- **EXP3**: REF + snow depths from climate stations,
  reduced influence radius of background error

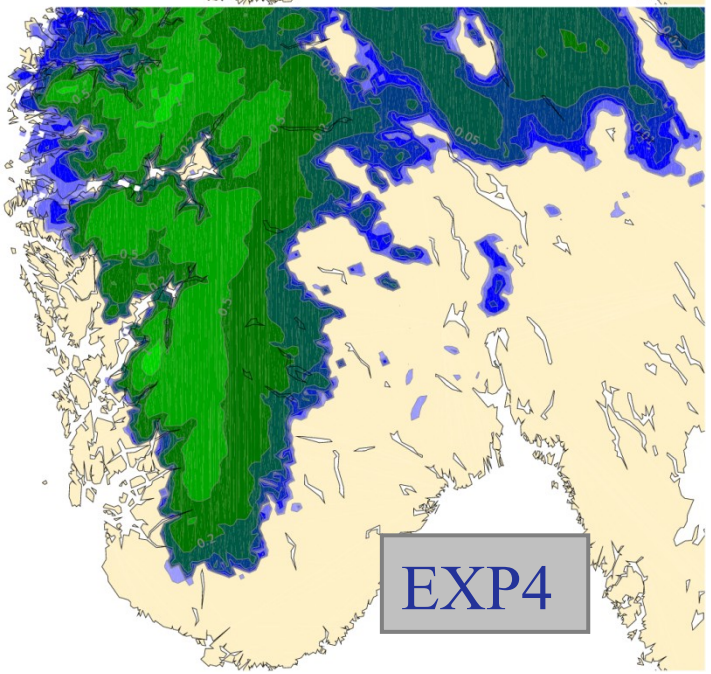
- **EXP4**: REF + CryoRisk satellite data with 15 km resolution, error statistics as EXP3, use of satellite data only **when 1. guess <25 kg/m2 (10 cm)**
- EXP5: REF + CryoRisk satellite data with 15 km resolution, error statistics as EXP3, use of satellite data **when 1. guess <100 kg/m2 (40 cm)**

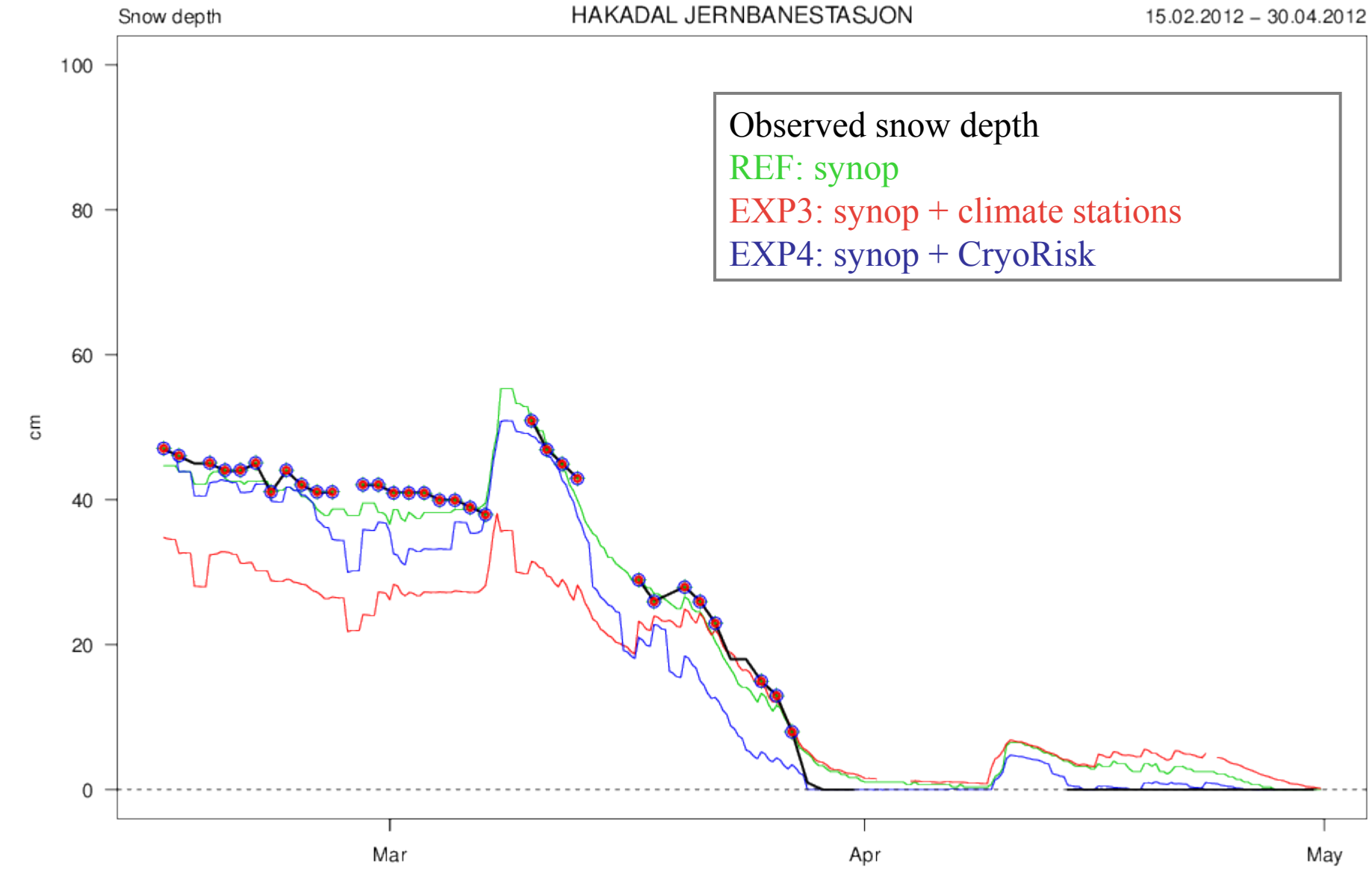


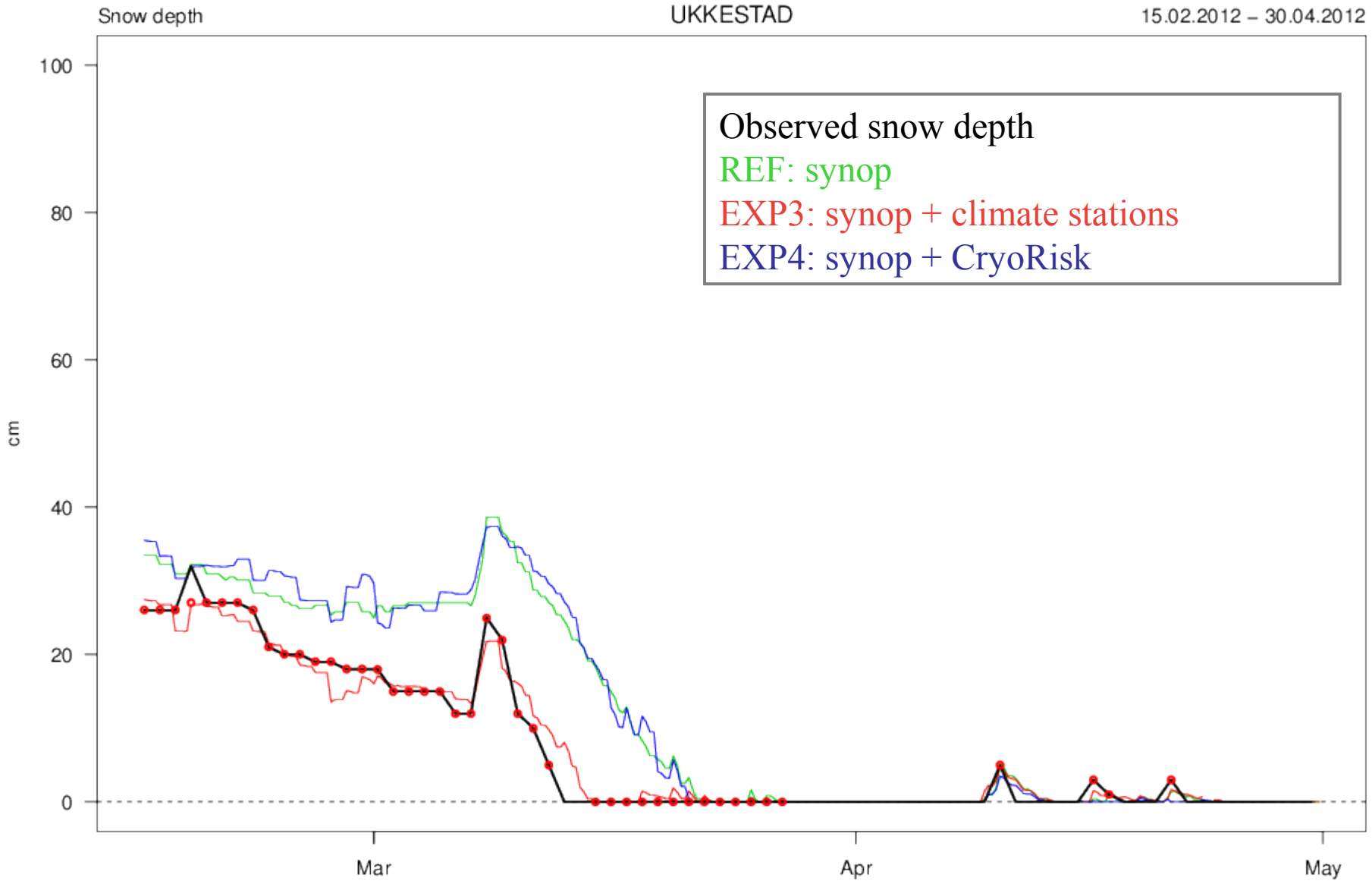


31 March 2012






Snow depth
HAKADAL JERNBANESTASJON
15.02.2012 – 30.04.2012
Observed snow depth
REF: synop
EXP3: synop + climate stations
EXP4: synop + CryoRisk
cm
100
80
60
40
20
0
Mar
Apr
May


Snow depth
UKKESTAD
15.02.2012 – 30.04.2012
Observed snow depth
REF: synop
EXP3: synop + climate stations
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cm
100
80
60
40
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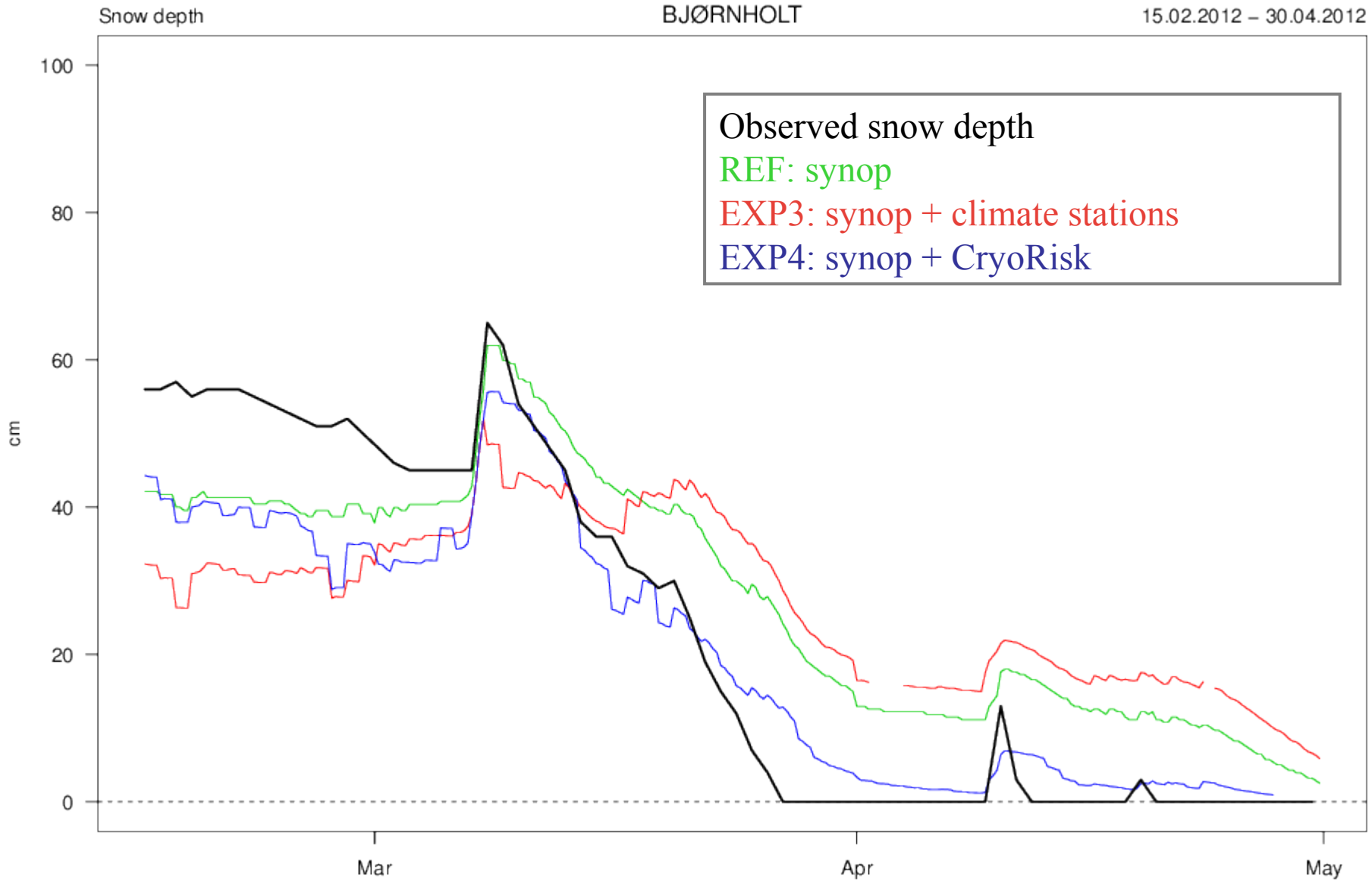
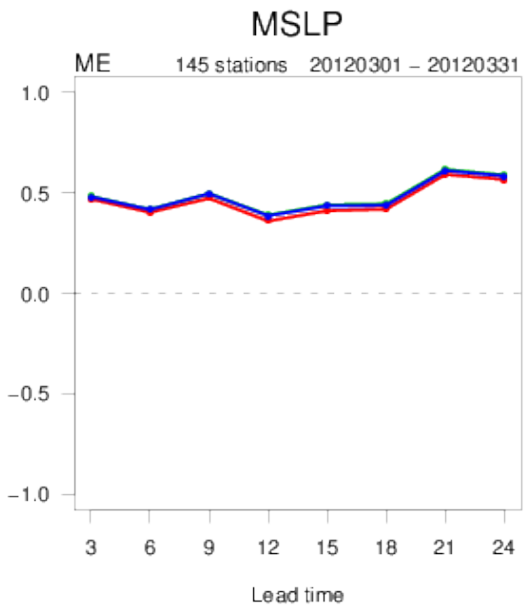
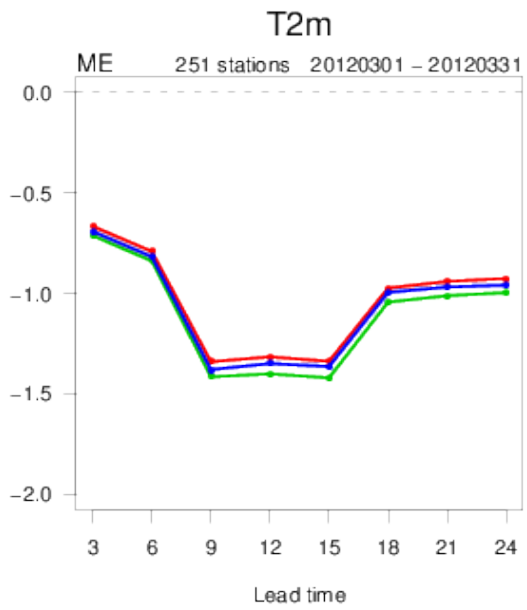
Mar
Apr
May

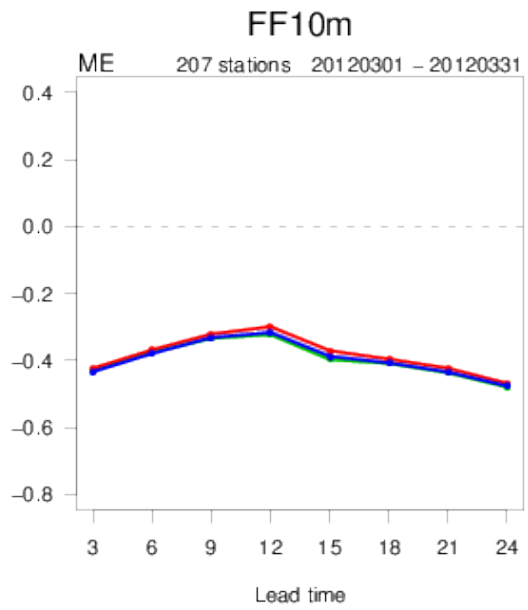

Snow depth
BJØRNHOLT
15.02.2012 – 30.04.2012
Observed snow depth
REF: synop
EXP3: synop + climate stations
EXP4: synop + CryoRisk
cm
100
80
60
40
20
0
Mar
Apr
May

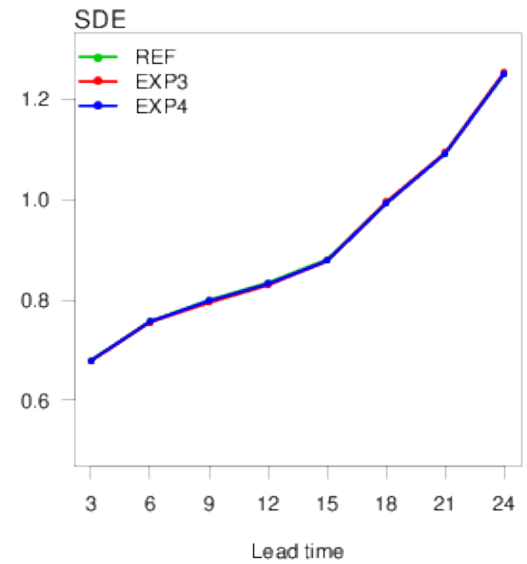
Summary results March 2012

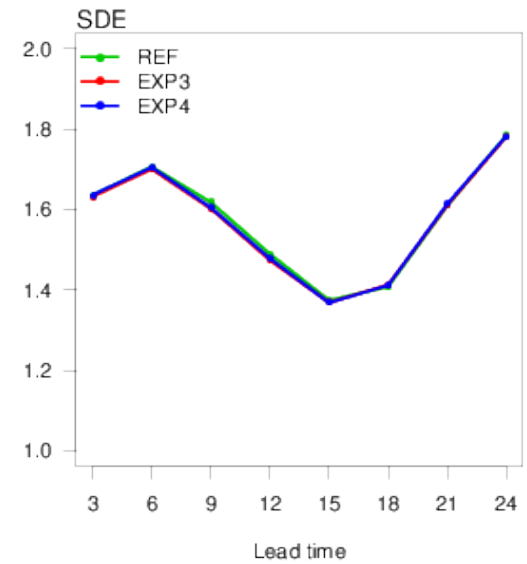
REF EXP3 (+ climate) EXP4 (+ CryoRisk)

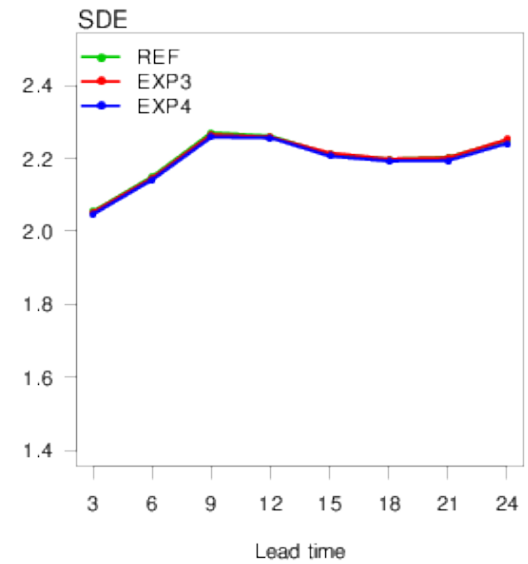






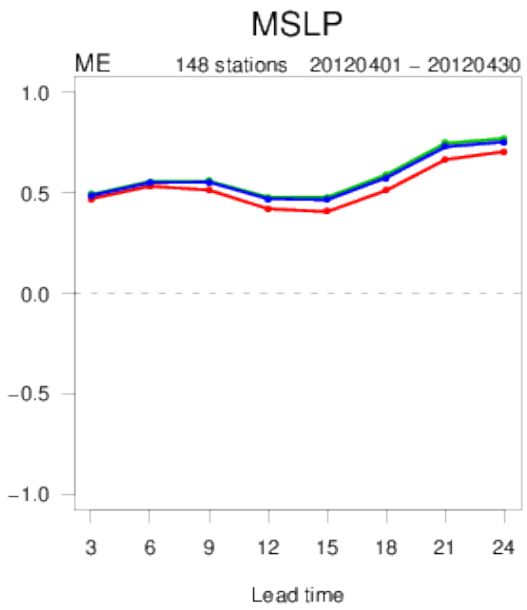


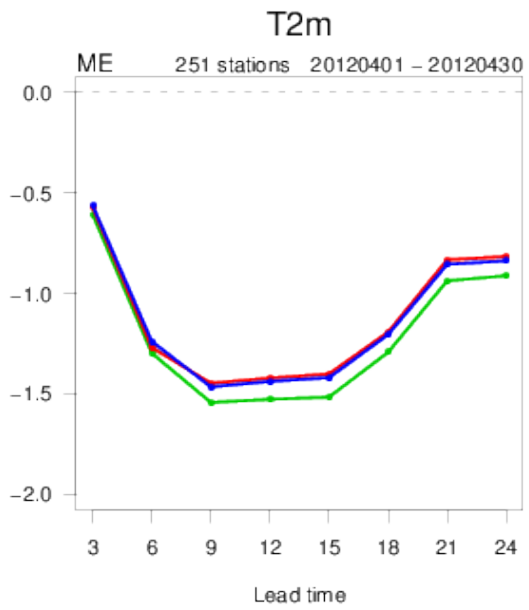


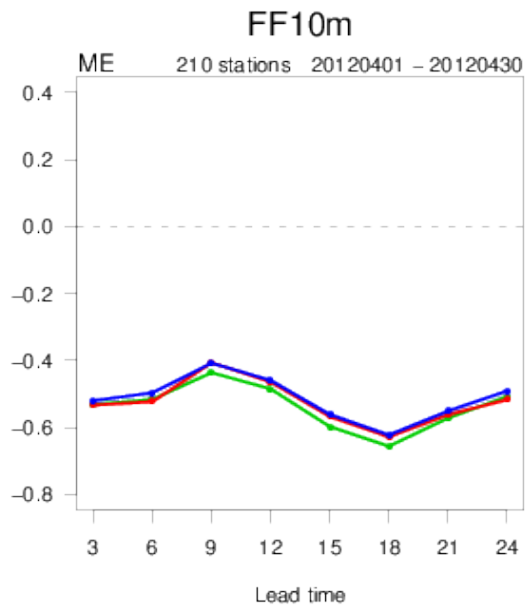


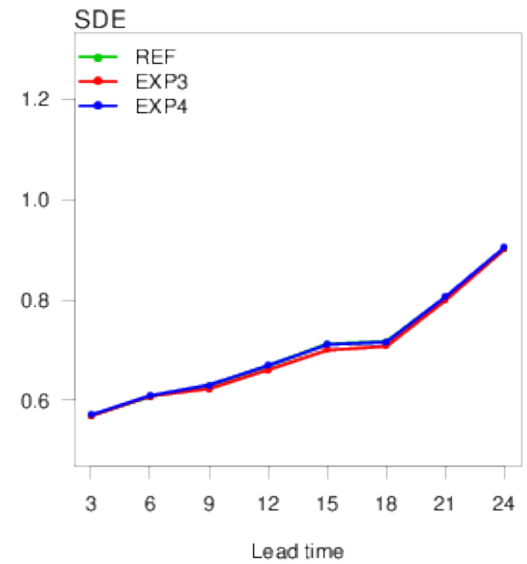
Summary results April 2012

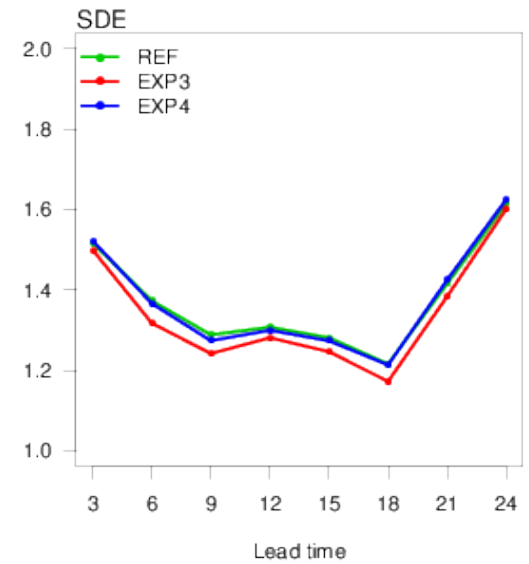
REF **EXP3** (+ climate) EXP4 (+ CryoRisk)

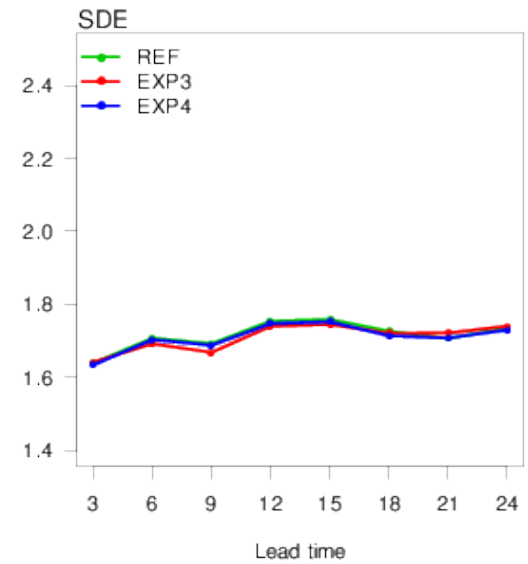












Summary results May 2012

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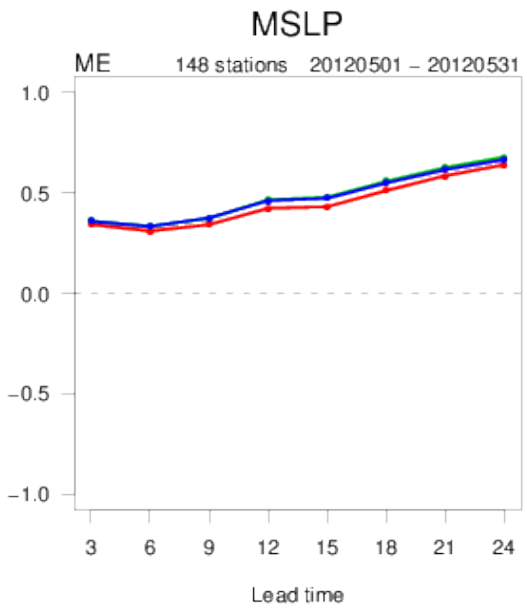

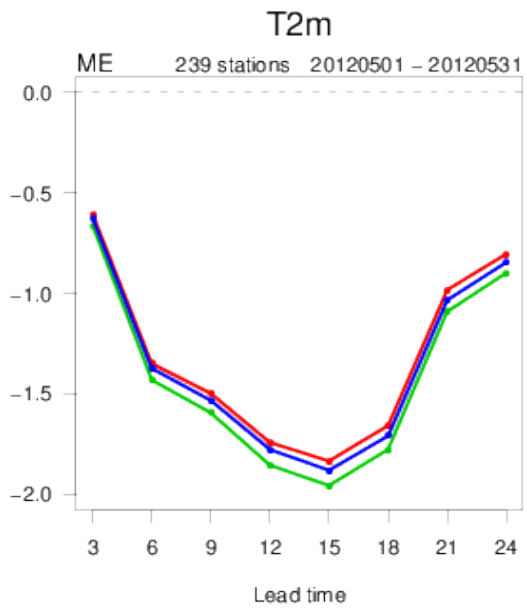

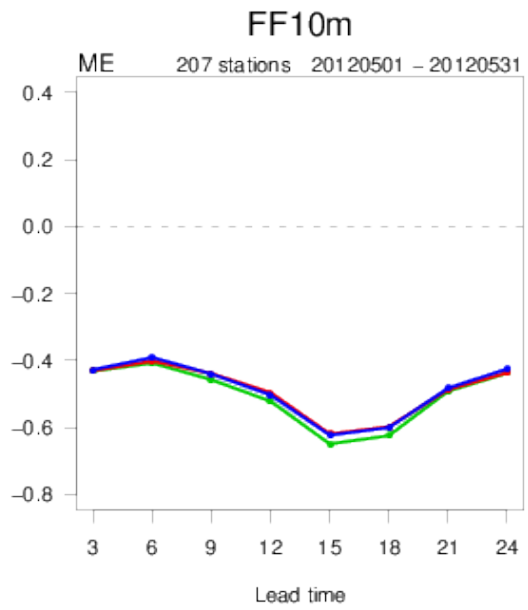

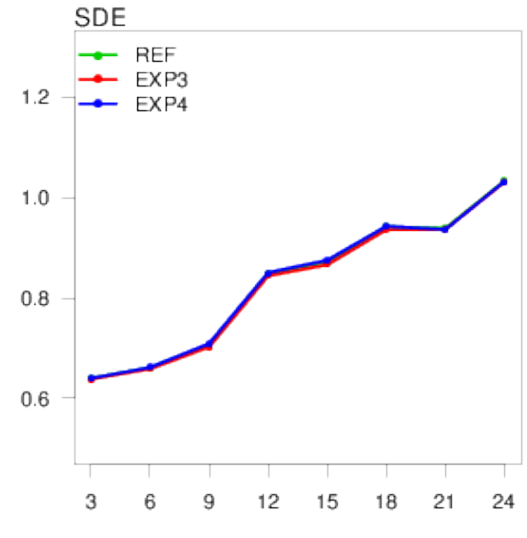

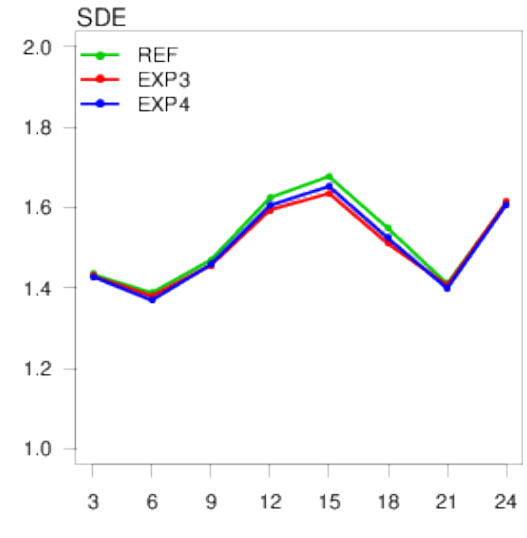

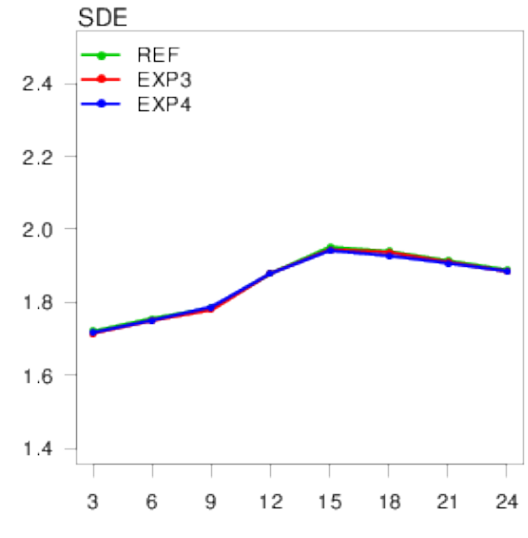

Summary

- the snow analysis within HARMONIE cycle 27h1.2 shows good performance in domains with representative observations

- snow analysis experiments March-May 2012 show
  - snow depth observations from Norwegian climate stations available in real time from 12 March 2013 will give significant improvements of
    - snow cover
    - surface temperatures, particularly in the melting season
  - CryoRisk satellite data shows potential to discriminate between snow free/covered ground

- next steps (HIRLAM/ALADIN work plan):
  - experiments with other sources of satellite data, e.g. Globsnow and MODIS
  - 3-layers snow scheme instead of 1-layer to have more realistic modeling of snow properties and surface temperatures

Thank you !!!