Surface modelling - some Nordic challenges

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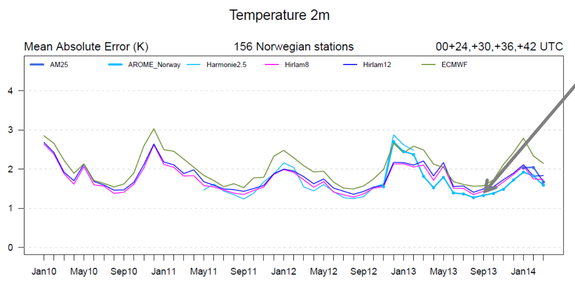
How to improve winter temperatures in HARMONIE?

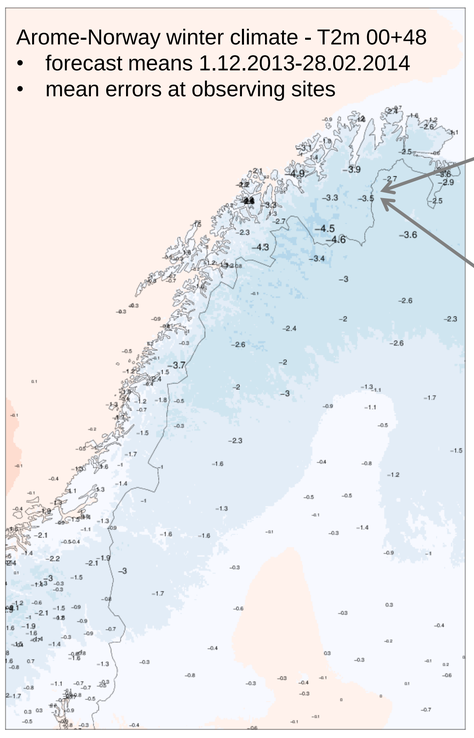


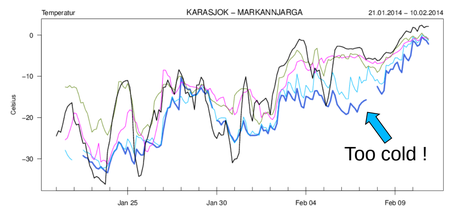
Temperature 2m

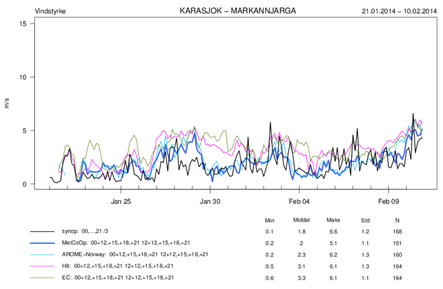
- Good quality in summer
- Relatively good in mild winters (e.g winter 2013/14).
- Much too cold in specific winter situations
- The largest errors
  - occur in weak wind (2-6 m/s) situations when the modelled near surface temperatures are more influenced by the surface than in reality (see below)
  - larger with cycle 38 (SURFEX 7.2) than with cycle 37 (SURFEX 6.1)
  - the negative bias increases with lead time

Arome-Norway winter climate - T2m 00+48

- forecast means 1.12.2013-28.02.2014
- mean errors at observing sites



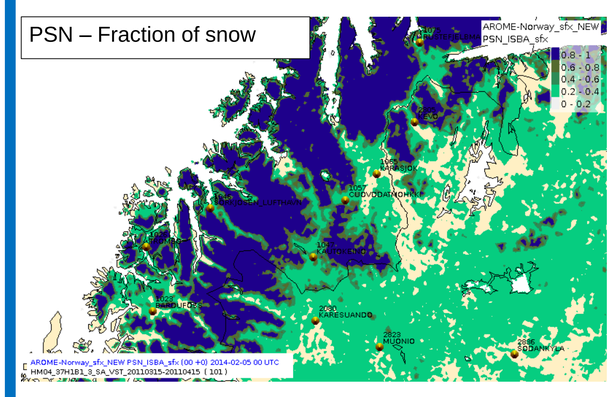




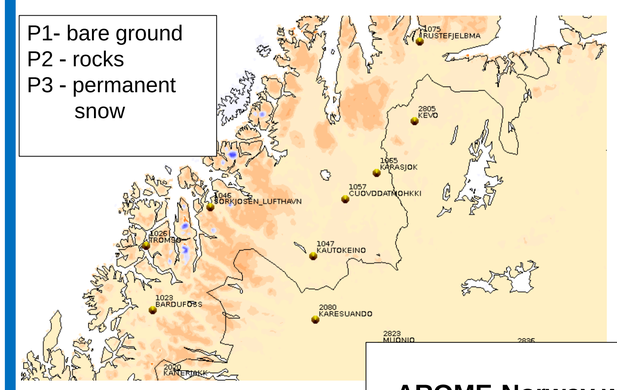
Key parameters for exchange between surface and atmosphere – questions for discussion

- Roughness for moment, heat and evaporation
  - cycle 38 has higher roughness than cycle 37, leading to less wind and larger underestimation of Tm2…
- The wind speed in 10m seems to be realistic, but the wind speed in the lowest canopy layer might be too low?
- Snow fractions
  - a function of SWE and surface type
    - values close to 1 in domains with bare ground/rocks/grass etc
    - too low values in wood lands?
  - effect the update of soil temperatures with CSNOW=3-L, but not with CSNOW=D95 ?
- Snow emissivity = 1; could be reduced?
- What about LISBA_CANOPY=F?

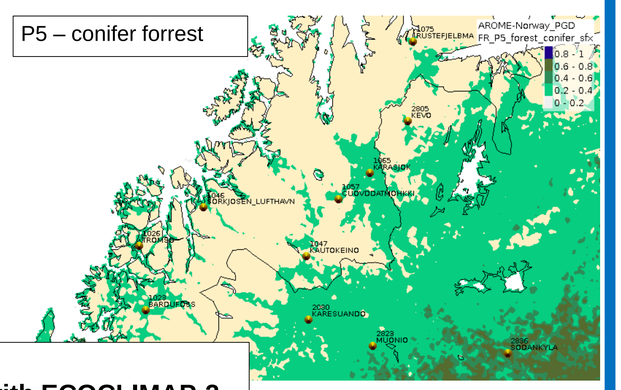
PSN – Fraction of snow



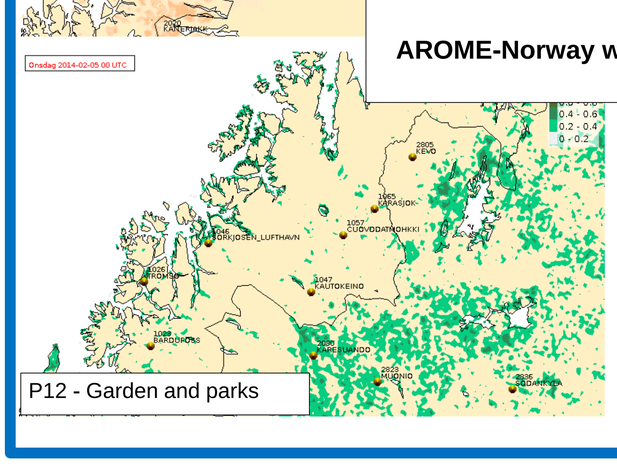
P1- bare ground
P2 - rocks
P3 - permanent snow



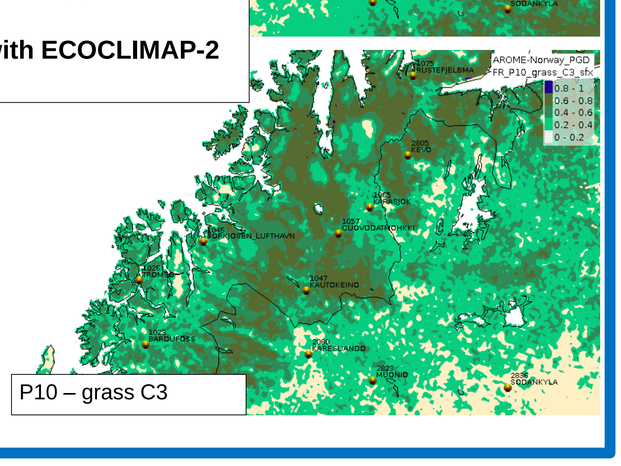
P5 – conifer forrest



AROME-Norway with ECOCLIMAP-2



P12 - Garden and parks



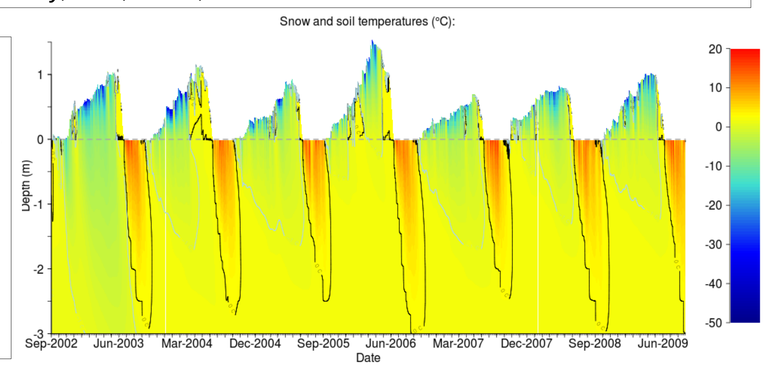
P10 – grass C3

SURFEX offline (ISBA-DIF/CROCUS) for climate analysis: Examples

Case 1: Permafrost modeling in Ny Ålesund

CryoMet project: Bridging models for the terrestrial cryosphere and the atmosphere
Institutes: Univ. Oslo, MET Norway, AWI, UNIS, NP

- Modeling the depth of the active layer: 2002-2009
- Forcing data: Weather station observations (MET Norway and AWI).
- Validation data from Bayelva: 2008-2009.
  - Snow depth good
  - Too warm soil temperatures.



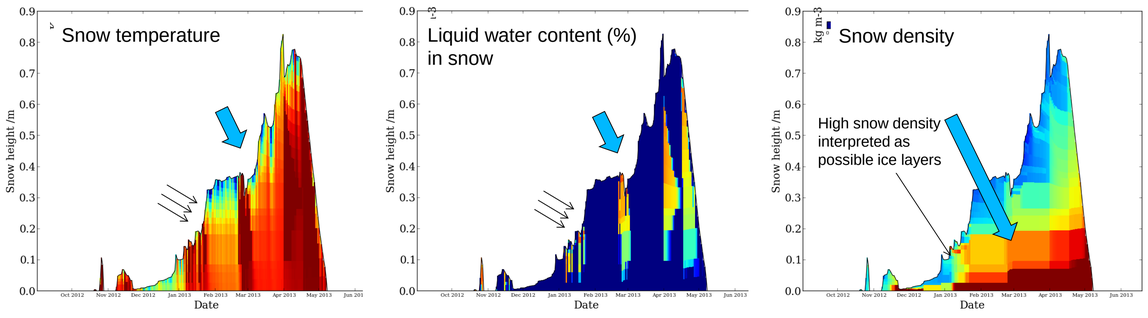
Case 2: Warm winter spells affect snow conditions - Modeling of ice layers in the snow

EWWA project: Extreme winter warming in the High North
Institutes: NINA, MET Norway, NORUT, Bioforsk et al.

- Warm spells succeeded by freezing temperatures create ice layers at the bottom snow layers.
- Vegetation get stressed: browning
- Reindeer trouble to access the pasture below the snow.

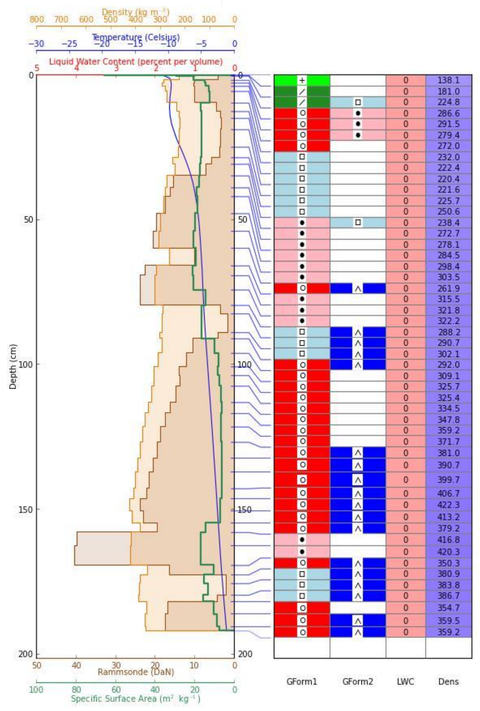
- Forcing data:
  - Hourly observations from weather station.
  - Forecasts from Arome Norway

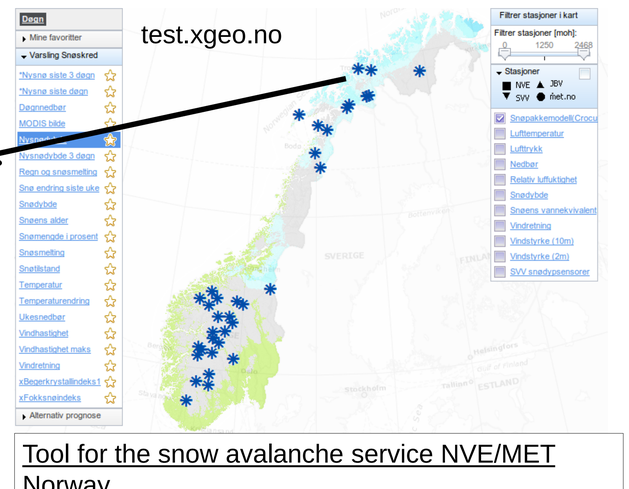
Rain-on-snow events, Tromsø, Norway: 22–28 February 2013 (smaller events end of January 2013).



Case 3: Using SURFEX/ISBA-CROCUS to support regional snow avalanche warning service

Vertical profile showing snow properties from Lyngen station 1 April 2014 at 14h





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Tool for the snow avalanche service NVE/MET Norway

- We demonstrate the benefit of offline SURFEX model runs. Implement the snow avalanche model SURFEX/Crocus developed at MeteoFrance.
- Great potential for snow models in areas lacking observations, particularily high mountains.
- Forcing data: Combination of observations from weather stations and AROME Norway forecasts.

Future plans:

- Offline 2D runs for a warning region
- Assimilation of observed snow depths.

AROME-Norway and MetCoOp common features

- AROME physical parameterization
- 2.5 km/65 levels
- Domain with 750x960 gridpoints.
- Hourly boundaries from ECMWF.
- Surface assimilation
- Forecast length 66 hours.
- Identical SURFEX namelist settings, e.g ECOCLIMAP-2

AROME-Norway and MetCoOp differences

AROME-Norway

- Blending of ECMWF UA
- 6-hourly cycling
- Harmonie cycle ~37h1.2, with SURFEX 6

AROME-MetCoOp

- 3DVAR
- 3-hourly cycling
- Harmonie cycle 38h1.1, with SURFEX 7.2

Potential improvements of surface temperatures

- With cycle 38, SURFEX 7.2 and current SURFEX settings; CISBA=3-L, CSNOW=D95; try to reduce the exchange with the surface in weak wind situations without reducing the exhange in stable situations
- 3-layers snow scheme
- Mulitple Energy Balance – under implementation