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# Snow modelling using the Surfex-Crocus snow scheme

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❑ R&D project on SNOW AVALANCHES

　➢ to test and develop methods for avalanche forecasting on a regional scale in Norway.

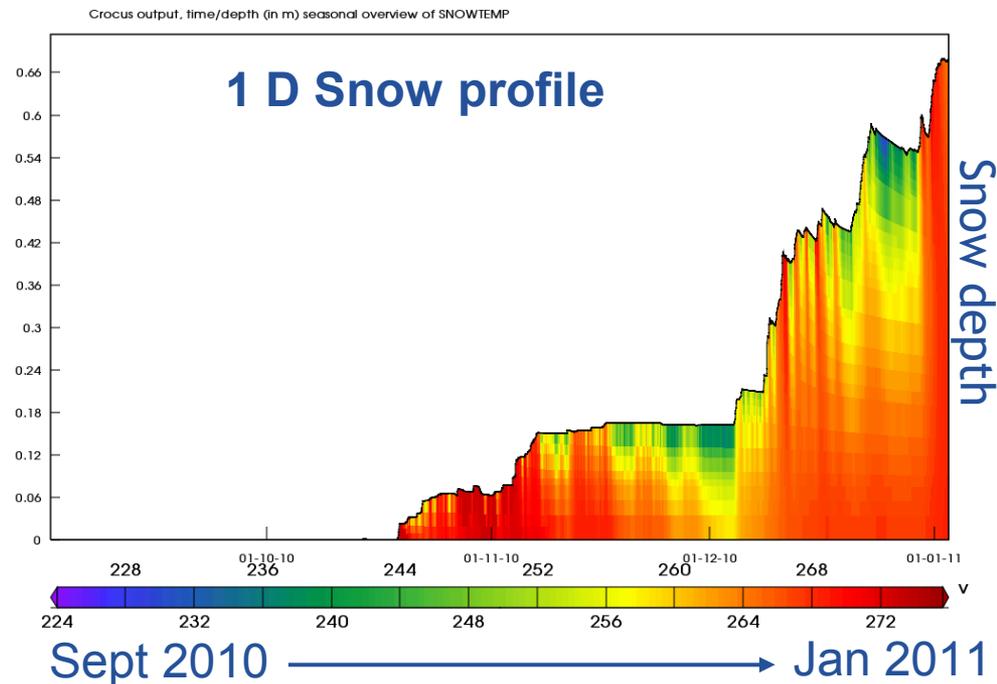❑ Partners: NVE, Norwegian Public Roads Administration, Norwegian National Rail Administration, NGI, met.no
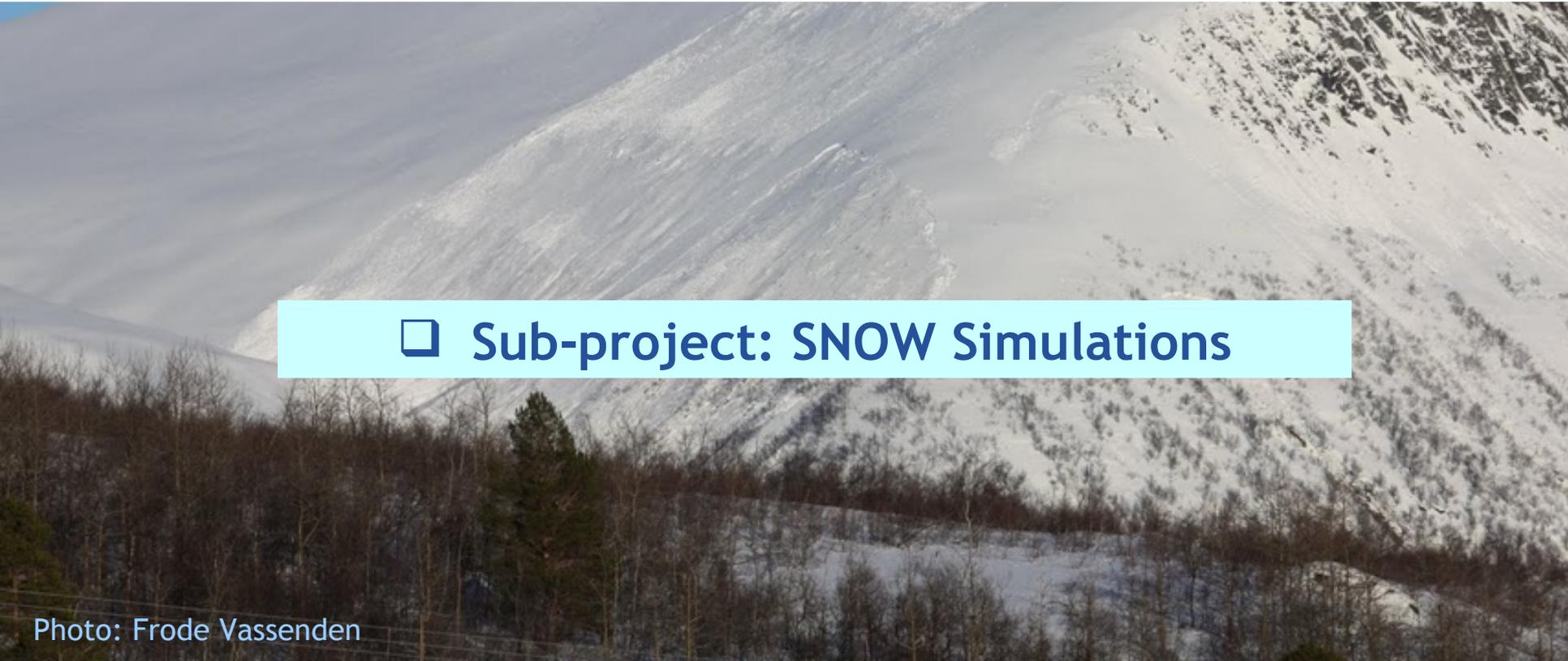
❑ **Sub-project: SNOW Simulations**

Photo: Frode Vassenden

SNOW AVALANCHES

Photo: Frode Vassenden

AIM: Model snow profiles

Additional TOOL for an expert group for determining avalanche danger level

Crocus output, time/depth (in m) seasonal overview of SNOWTEMP

1 D Snow profile

Snow depth

228   01-10-10 236   244   01-11-10 252   01-12-10 260   268   01-01-11

224   232   240   248   256   264   272   v
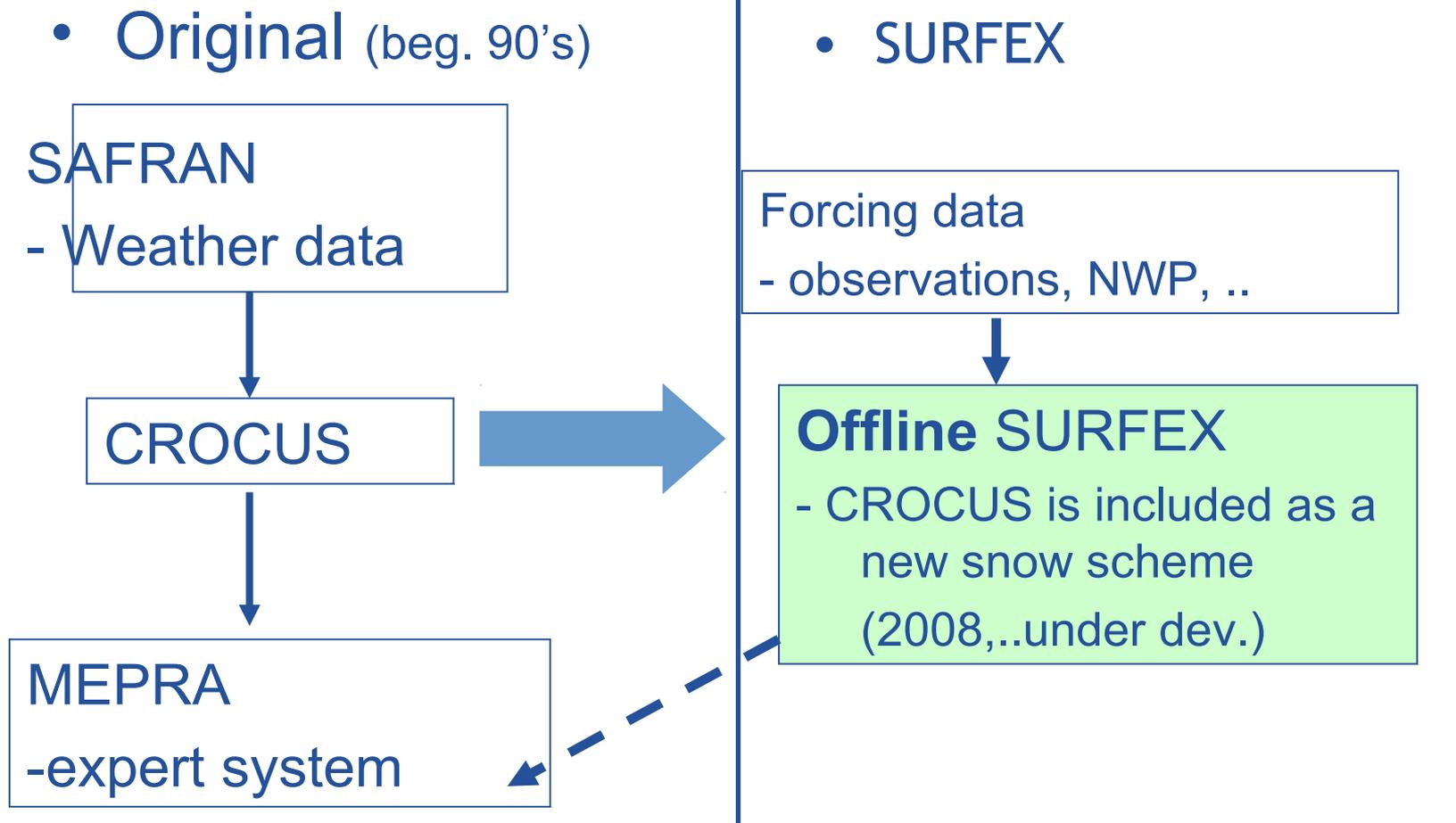
Sept 2010 ——————————→ Jan 2011

1 D Snow Profiles

- Seasonal development of the snowpack

- For every layer, snow properties are computed:
  - Density, grain type, temperature, water content, hardness

- Possibility to derive info about unstable layers
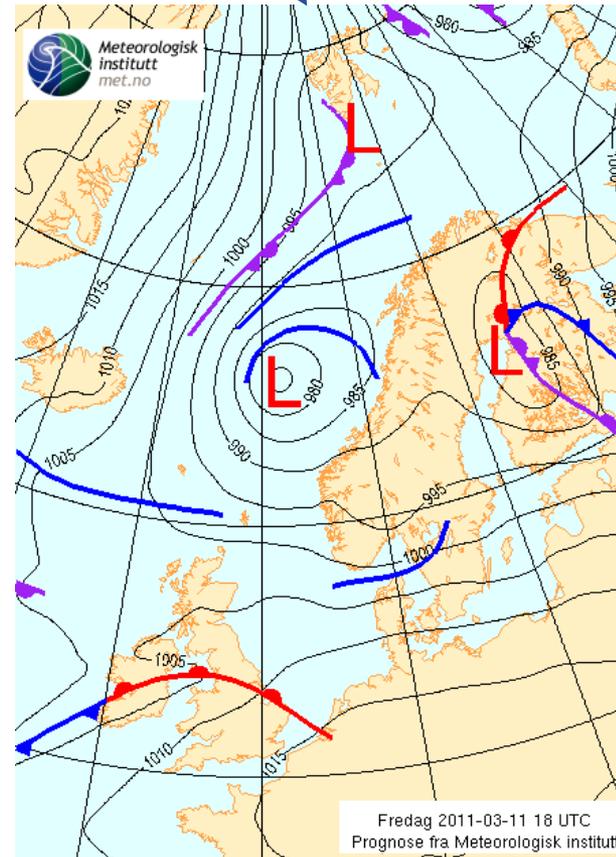
How?

Snow model developed for avalanche warning

- **CROCUS** from MeteoFrance/CEN, France
  - Contact persons:
    - Eric Brun (CNRM/GMGEC, MeteoFrance, Toulouse)
    - Samuel Morin (CNRM/CEN, MeteoFrance, Grenoble)

- Original (beg. 90's)

SAFRAN

- Weather data

CROCUS

MEPRA

-expert system

- SURFEX

Forcing data

- observations, NWP, ..

Offline SURFEX

- CROCUS is included as a new snow scheme

(2008,..under dev.)

SENSITIVITY study of FORCING data
- replace Observations with Prognoses (NWP)

Fredag 2011-03-11 18 UTC
Prognose fra Meteorologisk institutt

SENSITIVITY study of FORCING data
- replace Observations with Prognoses (NWP)

| WEATHER station: Observations | ○ NWP: UM prognoses |

EXPERIMENT	A	B	C	D	E	F
Short- and longwave radiation	○	○	○	○	○	○
Precipitation		○				
Air temperature			○			
Wind dir. + speed				○		
Surface pressure					○	
Air humidity						○

18 Weather Stations in Norway

Norwegian Meteorological Institute *met.no*

Grotli (872 masl): 2009-2010
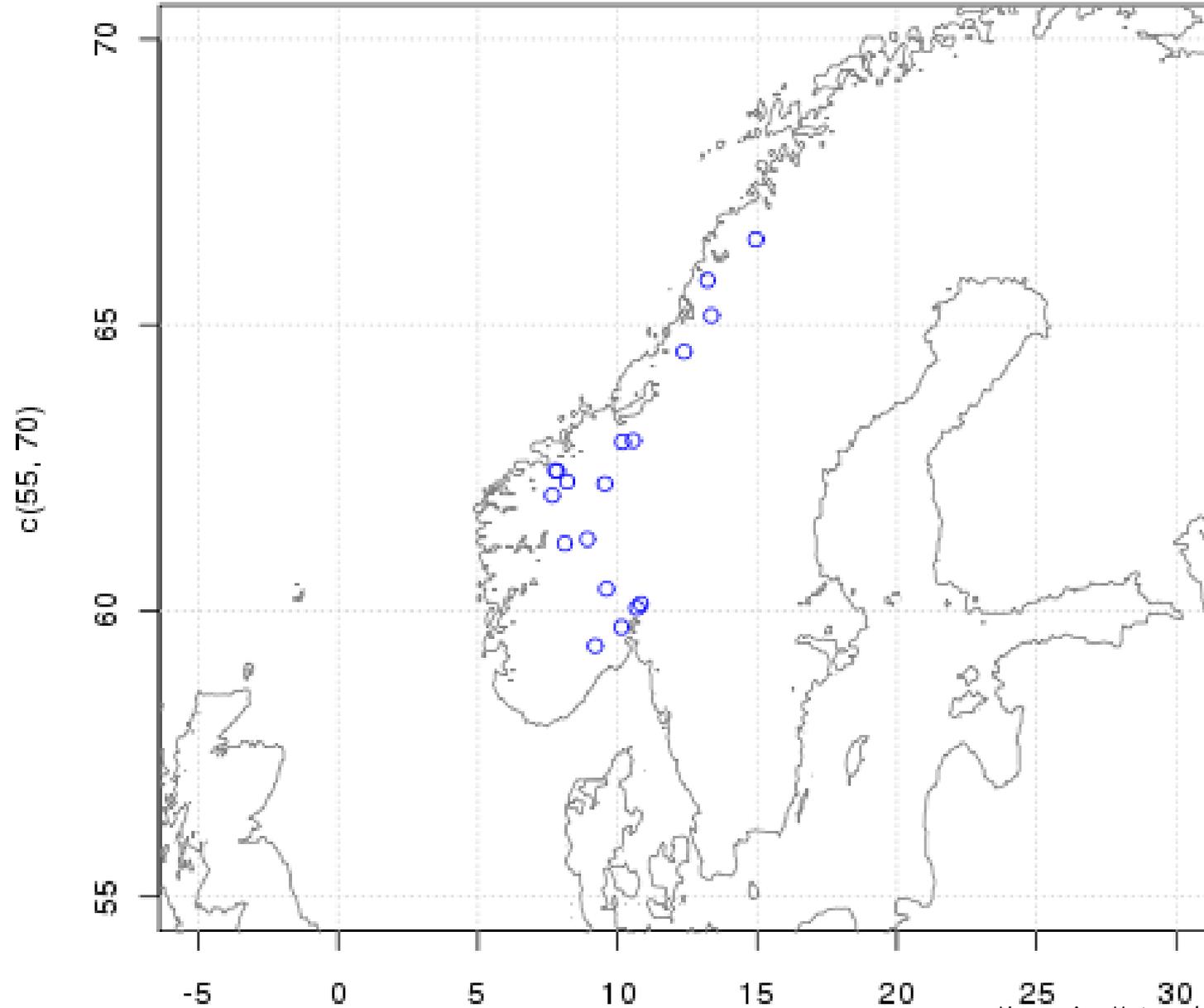
— Observed Snow Depth
— Modelled Snow Depth

- forcing data: observations except …:

Replaced RAD with UM data.

UM: Radiation

UM: Radiation, Surface pressure

UM: Radiation, Wind

UM: Radiation, Air humidity

Replaced TA with UM data.

UM: Radiation, Temperature

Replaced RR with UM data.

UM: Radiation, Precipitation
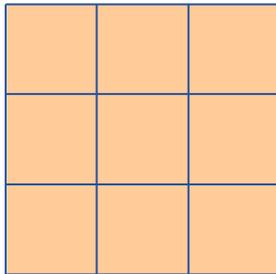
Norwegian Meteorological Institute *met.no*
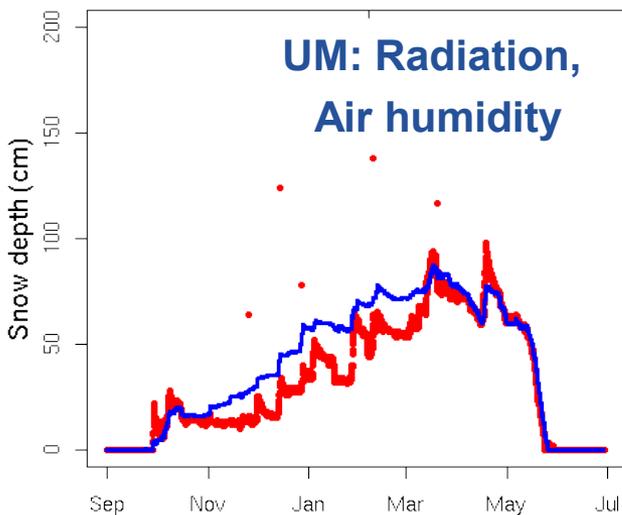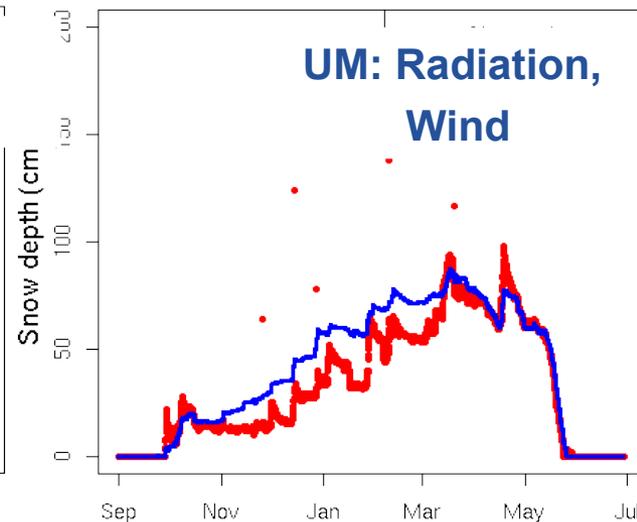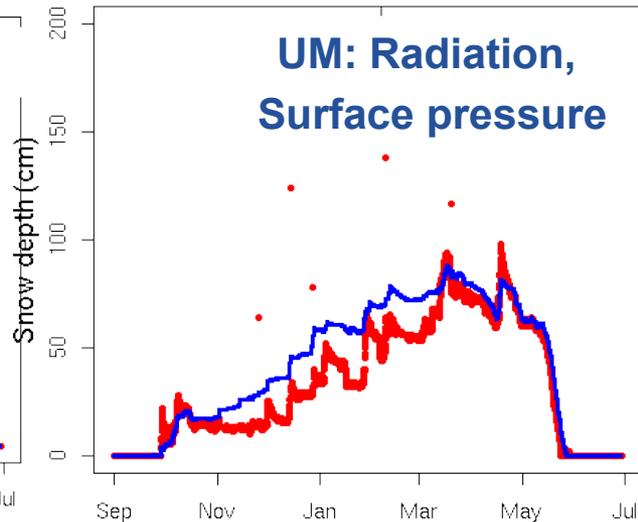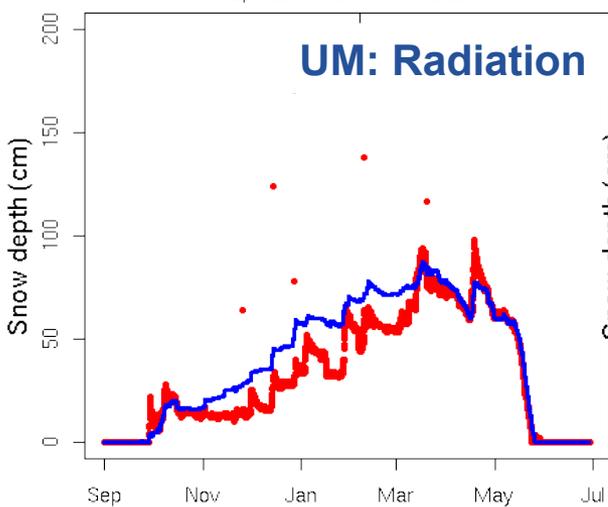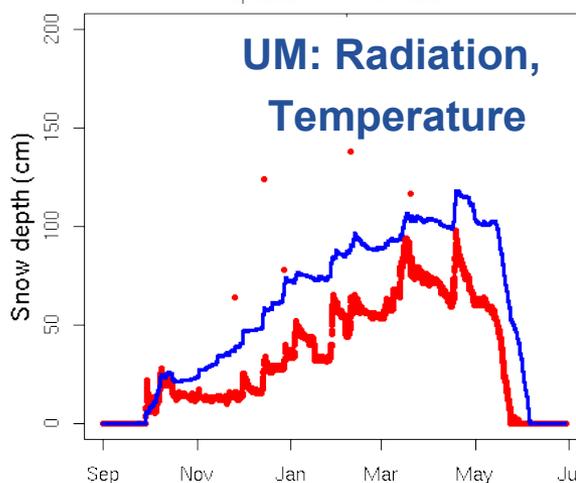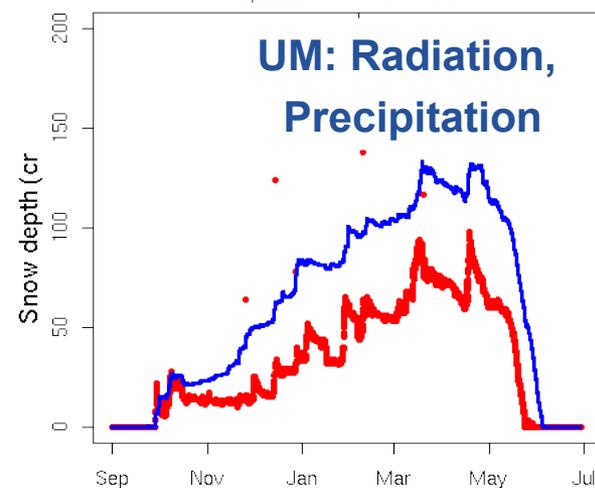
For all Stations:

- BEST results using OBSERVATIONS of precipitation (and temp).

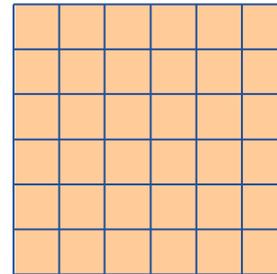- Other parameters seems ok to derive from UM (NWP) data
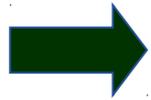
Improvement test:

- Use postprocessed Hirlam8 temperatures (yr.no)

UM: 4 km grid

YR: 0.5 km grid

- Improved modelling of topography
- Elevational temperature gradient -0.6°C/100m

MARSTEIN, 67 masl., located in a narrow valley:
Temperatures from UM or YR(Hirlam8)
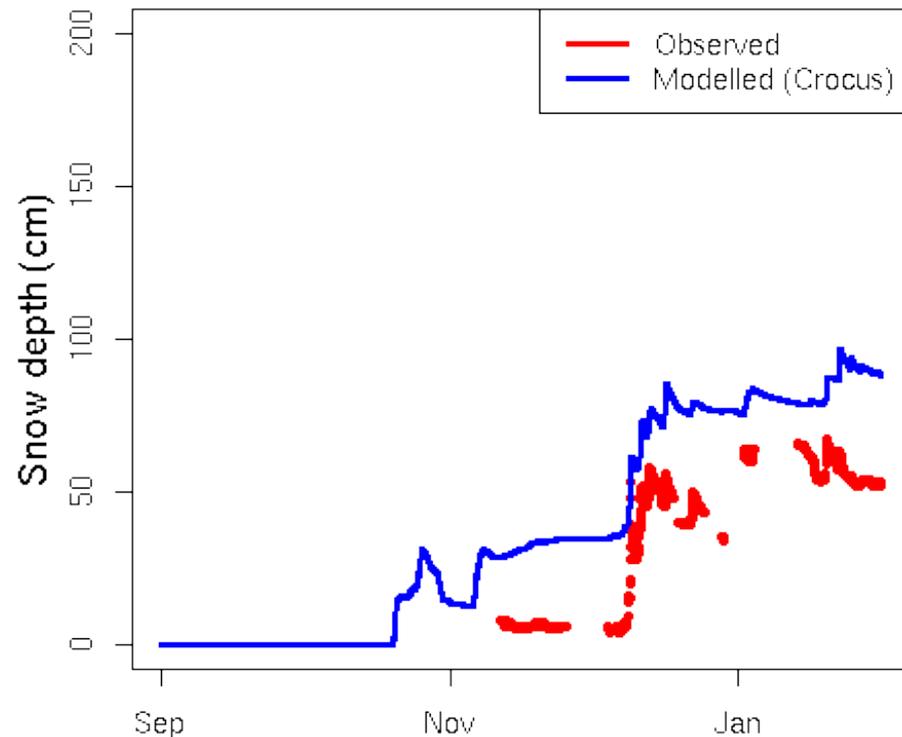
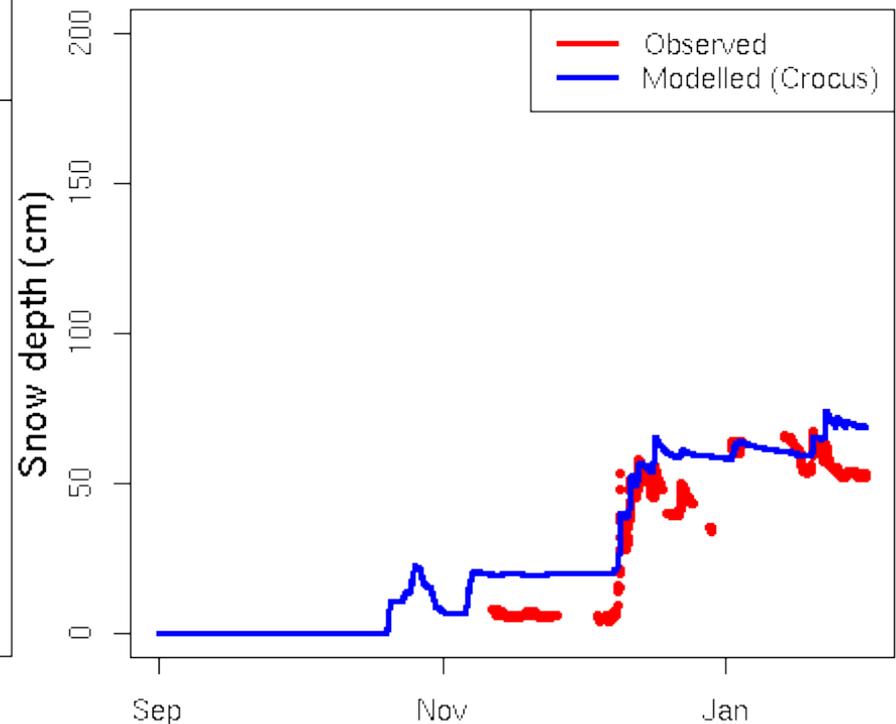| masl.	UM	YR
67	952	244

MARSTEIN: 1.9.2010-31.1.2011
Replaced QE, QL, TA, with UM data.

MARSTEIN: 1.9.2010-31.1.2011
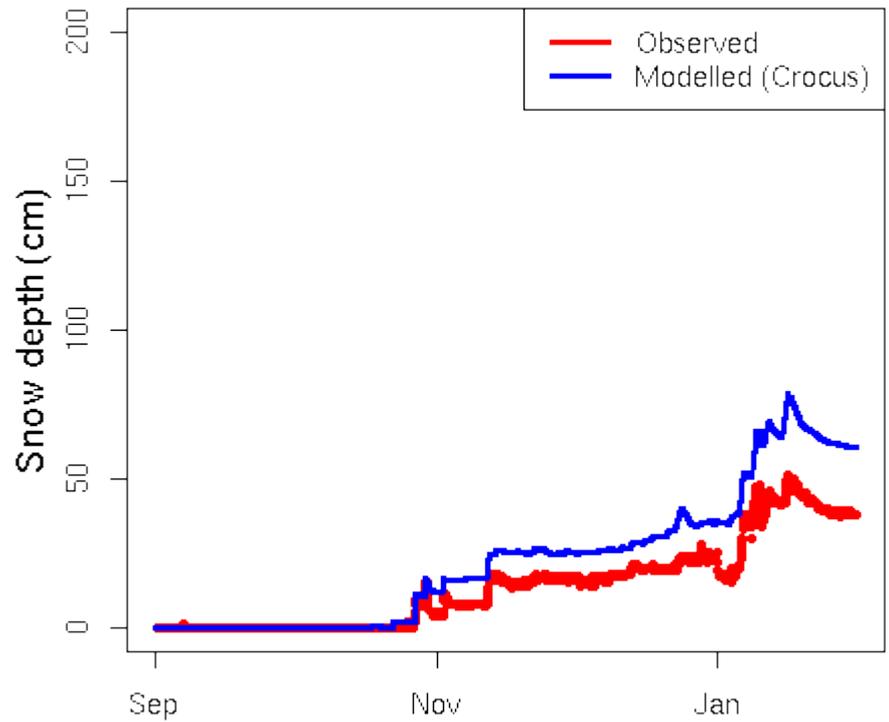Replaced QE, QL, TA, with UM data. Replaced TA with YR data

BEITOSTØLEN, 965 masl:
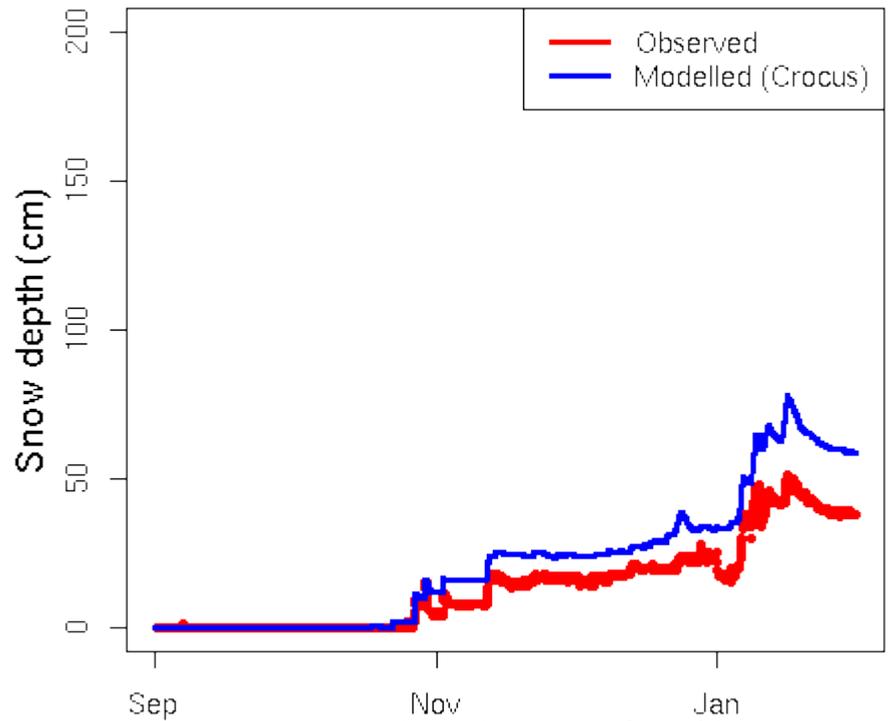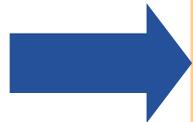## Temperatures from UM or YR(Hirlam8)

masl.	UM	YR
965	912	952

BEITOSTØLEN: 1.9.2010-31.1.2011
Replaced QE, QL, TA, with UM data.

Observed
Modelled (Crocus)

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Replaced QE, QL, TA, with UM data. Replaced TA with YR data

Observed
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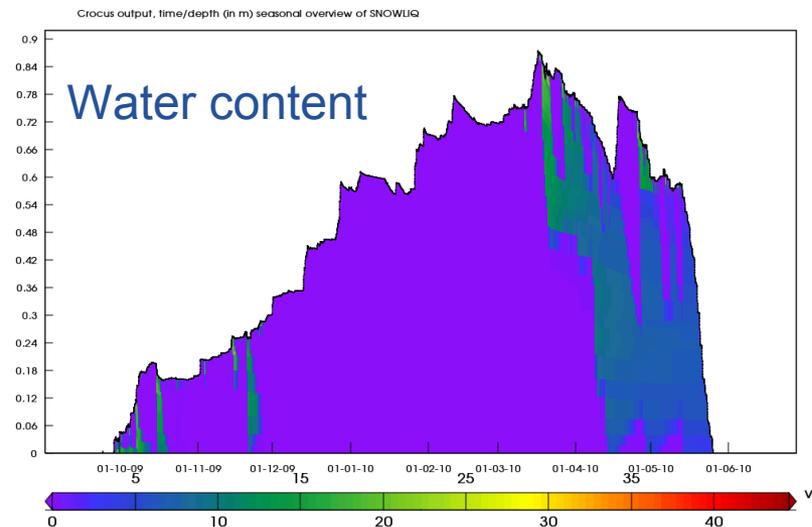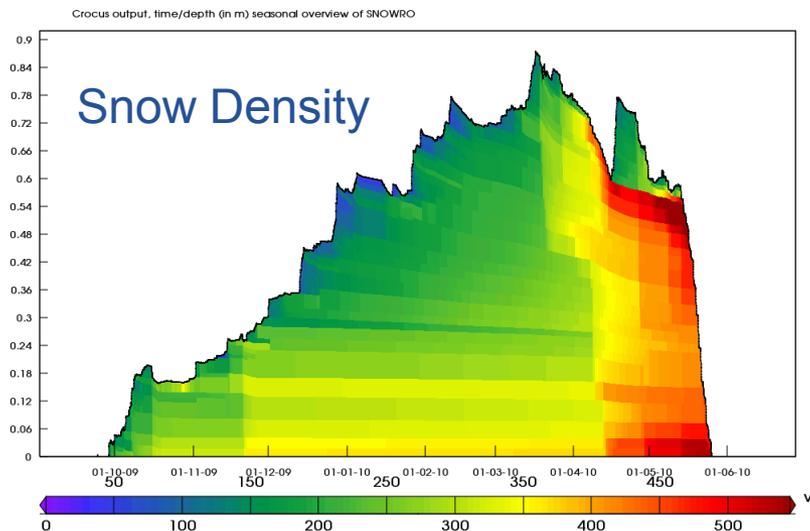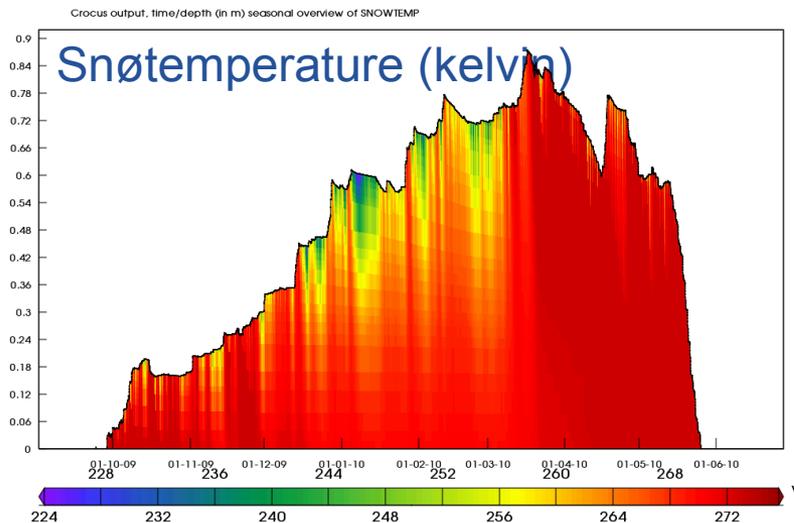*Norwegian Meteorological Institute met.no*

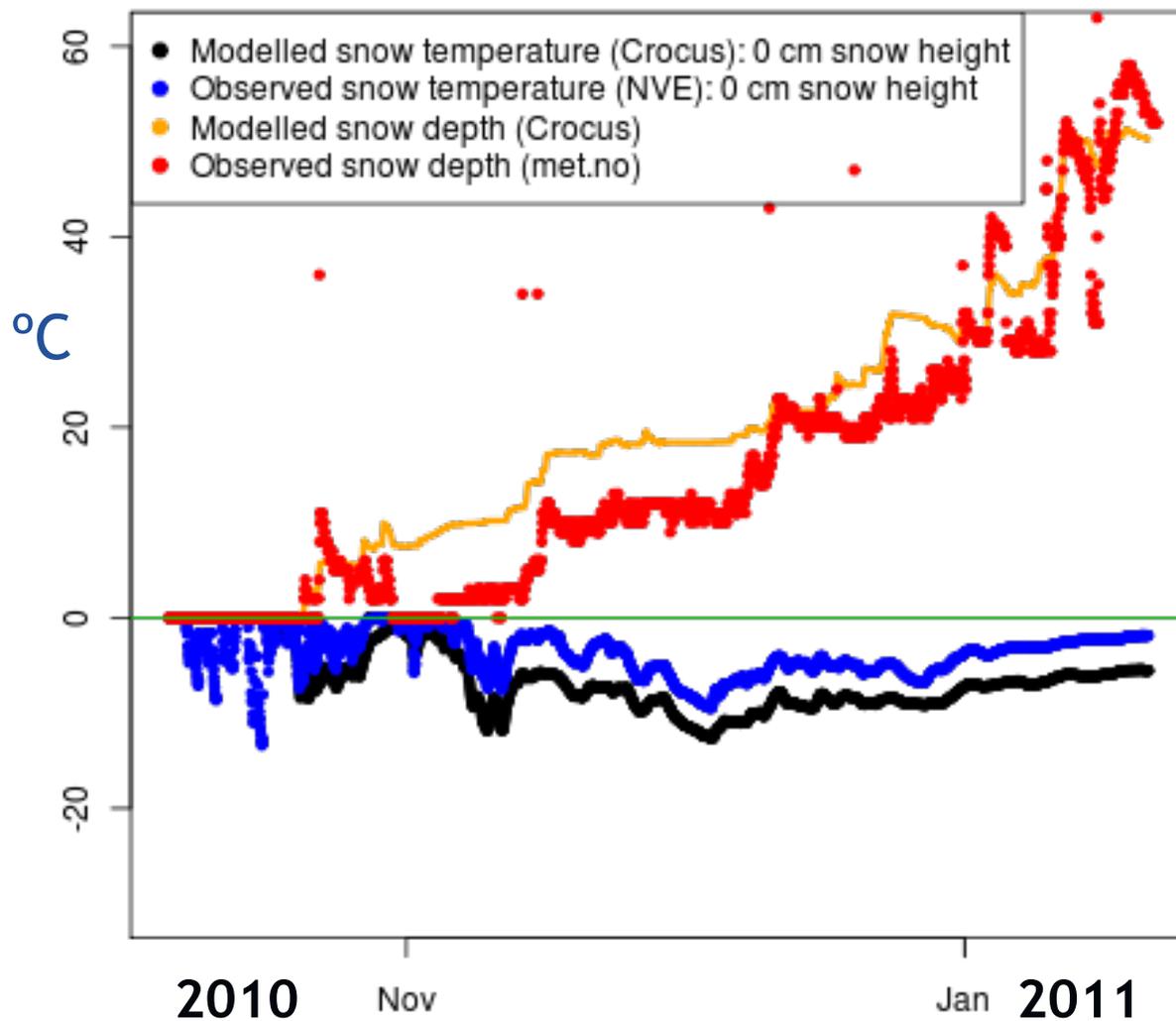We have evaluated the snow depth.

What about the snow pack layers?

EVALUATION of
Physical Snow Properties

Grotli (872 masl), 2009-2010:
- modelled snow profile

Snøtemperature (kelvin)

Snow Density

Water content

Ref: Samuel Morin, MeteoFrance

Snow Temperatures

FILEFJELL
Weather Station

- Snow temperatures are measured hourly
- 0, 5, 15, 30 og 55 cm snow height

Ground surface temperature

SUMMARY

- CROCUS reproduces well the observed snow depth

- Results are most sensitive to precipitation and temperature
  - Other parameters ok to derive from NWP data
  - Postprocessed Hirlam8 temperature data improves the results (0.5 km vs. 4 km)

- Planning of sensors at new weather stations

- Future work:
  - More evaluations of snow profiles
  - Include terrain aspects and slopes