Snowhow
-the project

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SnowHow philosophy- what is the problem?

- For the current and future climate, accurate snowmodelling is needed for:

- Flood forecasting
- Avalance forecasting
- Hydropower planning
- Biological systems
- Water resources monitoring
- Prediction in ungauged basins
- Transport, roads and railways
- Tourism- outdoor activities

Demands are for nationwide (everywhere) and for all temporal and spatial resolutions

SnowHow philosophy- what is the problem?

- Summarized:

- We need better simulations of snowparameters such as: snowdepth, snow water equivalent, snowcovered area, snowpack layering, -temperature regime etc..for areal and point values, and different temporal resolutions 1-24h

- Robust simulations – the models need to simulate snow for the variability of **current climate everywhere (PUB)** and that of a **changed climate**

- Because models are (often) wrong ,they need the possibility to be updated (with internal consitency) based upon observed deviation between observed and simulated variables

SnowHow philosophy- solutions
(-or steps in the right direction)

- Reduce the number of **calibrated** parameters in snowmodels by parameterising the models from observed information such as:
  - Spatial variability of precipitation,
  - GIS data (topography)
  - Where and when
  - Scale (point vs catchment scale approach)

- Model parameters should either be independent of the climate or estimated from observations (not calibrated against runoff).

- The models should be validated against several observed hydrological parameters (snow depth, snow water equivalent, snow covered area and runoff). The models need simulate **all** elements well («right for the right reasons»).

SnowHow philosophy- solutions
(-or steps in the right direction)

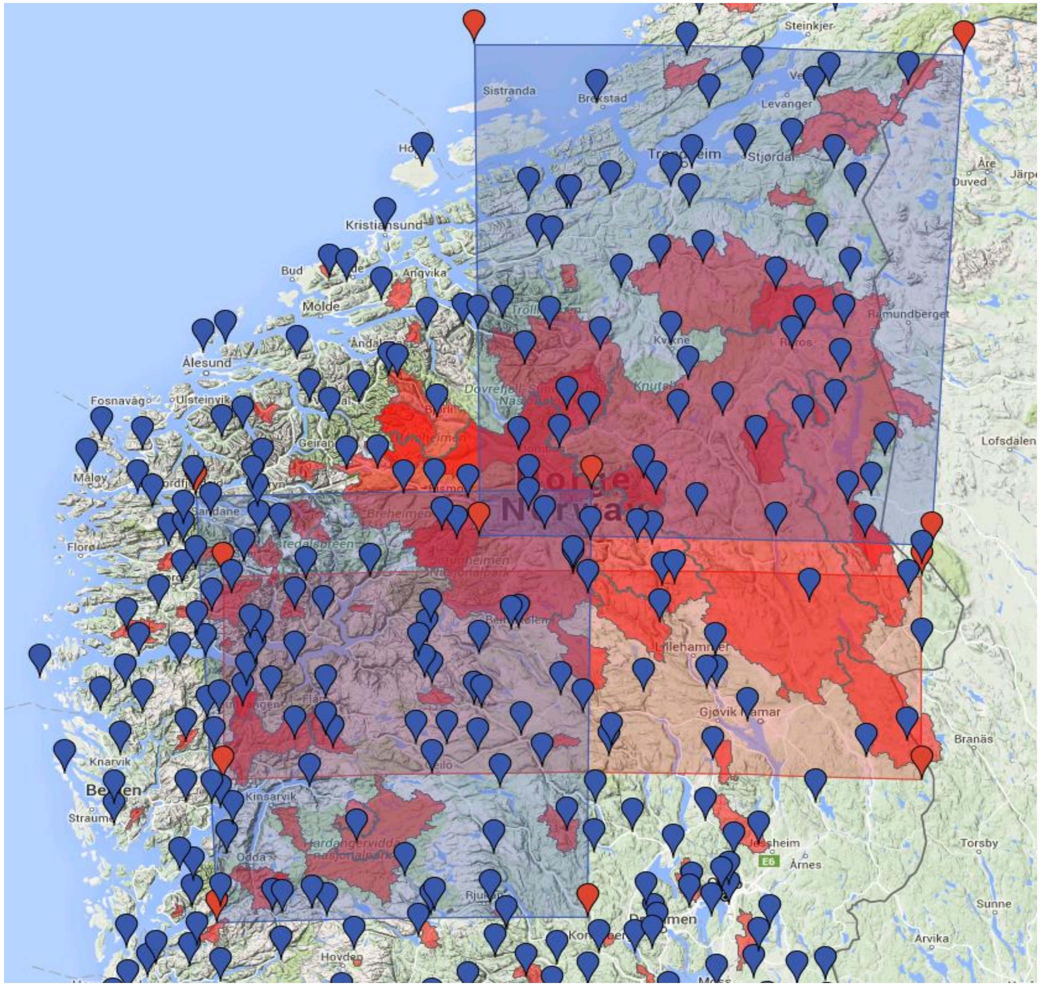
- Updating plans for: SCA, SD and runoff

- DATA:

- New meteorological grid (precipitation and temperature):
  1X1 km², 24h, 1957-dd
  1X1 km², 3h, 1985-dd
  1X1 km², 1h 2013-dd
- Lidar derived snowdepth of Hardangervidda 2008-2009 (400 000 000 SD measurements).
- Snowdepth and SWE observations at points
- Timeseries of SCA (MODIS): 2001-2015
  ~1500 scenes (used for validation and updating)

SnowHow philosophy- solutions
(-or steps in the right direction)

- Common study area even if the partners work with different models and on different spatial and temporal scales.



SnowHow plan

- Research task 1:
- Proxy models (for energy balance elements)
- Spatial predictability (i.e interpolation) of forcing data such as radiation, humidity, clouds.
- Satellite derived variables, clouds, SCA, albedo, Tss

- The motivation for this task is the sad fract that we really only have precipitation and temperature to use as forcing data on a nationwide scale

SnowHow plan

- Research task 2:
- Model intercomparison

Compare the following models:

- DDD (catchment/empirical)
- DDD_EB (catchment/pseudo physical)
- SeNorge (distributed/empirical)
- SURFEX/Crocus (distributed/physical)
- Gamsnow (distributed/pseudo physical

For these variables:

- Snow-covered area
- Snow depth
- Snow water equivalent
- Melt rate
- Energy balance components
- Runoff

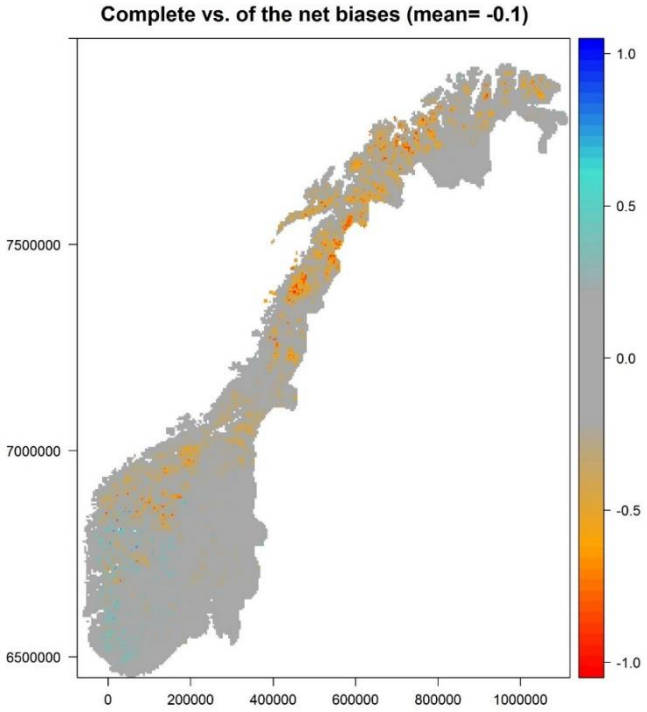
❖Synthesis of models, «optimal blend-the supermodel»
❖Snowdistribution and scales
❖Future projections: new model run on climate projections

SnowHow plan

- Research task 3:
- Assimilation of satellite data and grids
  - Bayesian method
- Assimilation of point observations
  - Bayesian method

Results so far:

- Through heroic efforts of colleagues at NVE, about 1500 MODIS satellite scenes (2001-2015) are dowloaded and classified.
- Many are rubbish, but about 150 scenes pr. catchment can be used.
- Invaluable (actually the only!) validation of snowmodelling at the catchment scale
- For example used for validating the seNorge snow model



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Operational snow mapping with simplified data assimilation using the seNorge snow model

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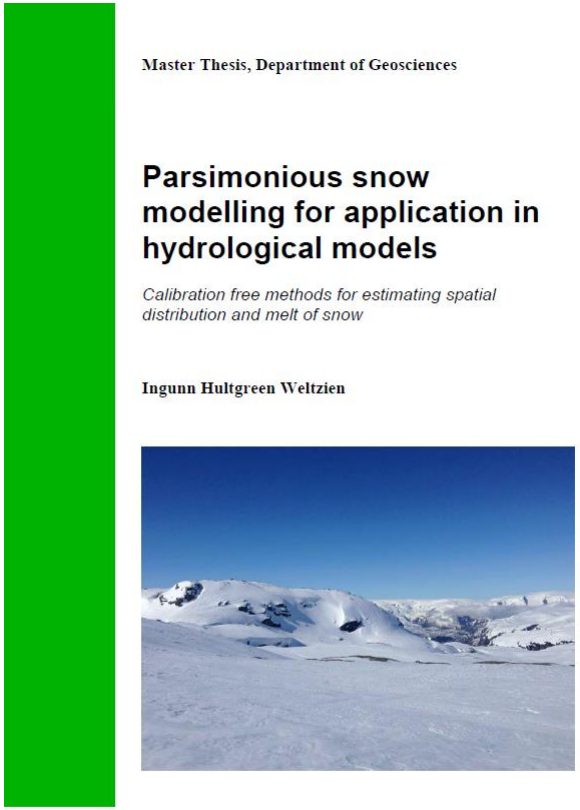
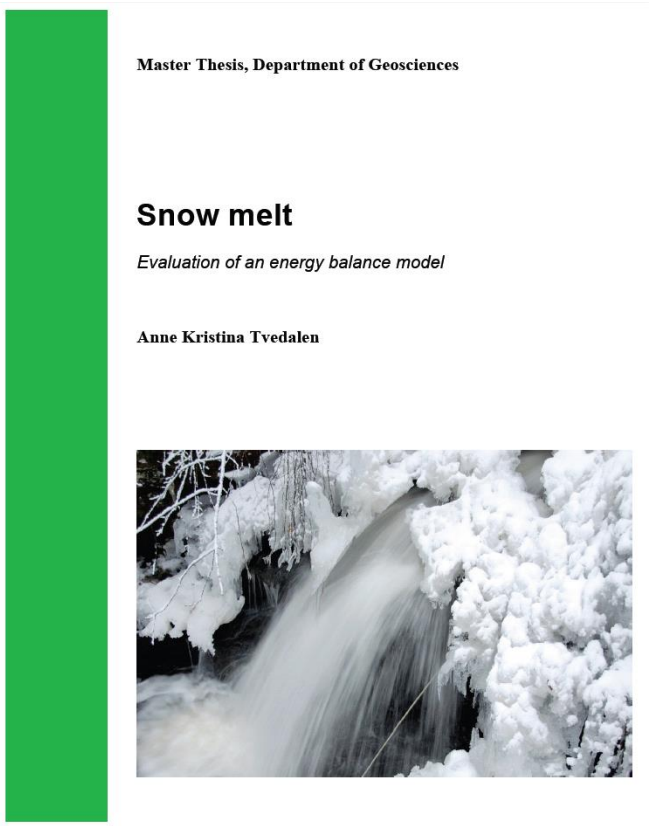
Results cont'd:

- Two master students on snowmodelling have finished (supervised by SnowHow people)





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- The thesis of I.H. Weltzien work was further developed into a paper:

The Cryosphere, 10, 1947–1963, 2016
www.the-cryosphere.net/10/1947/2016/
doi:10.5194/tc-10-1947-2016

The Cryosphere Open Access EGU

A model for the spatial distribution of snow water equivalent parameterized from the spatial variability of precipitation

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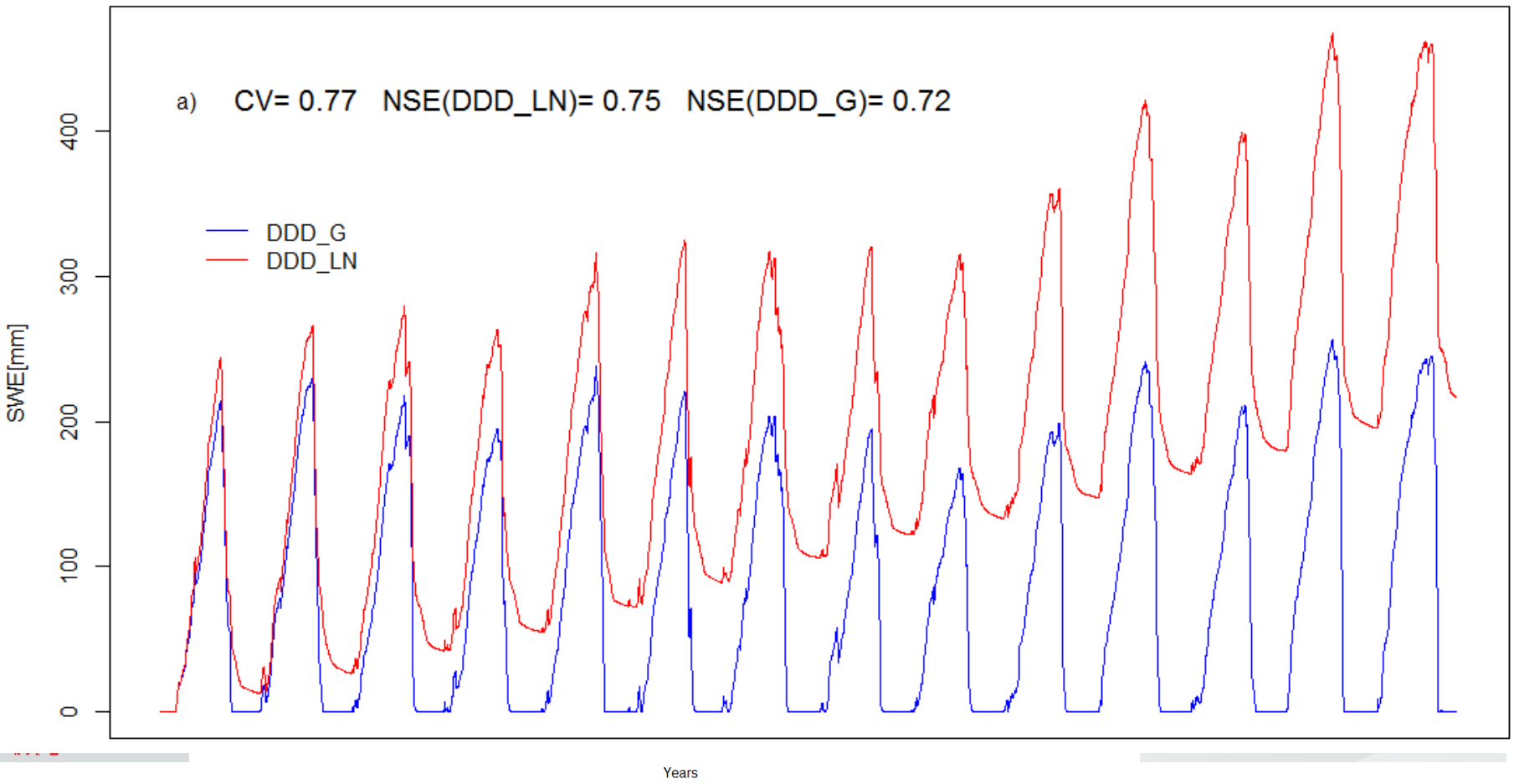
Compared to the previous calibrated model for spatial distribution of SWE used in operational hydrological models, the new method:

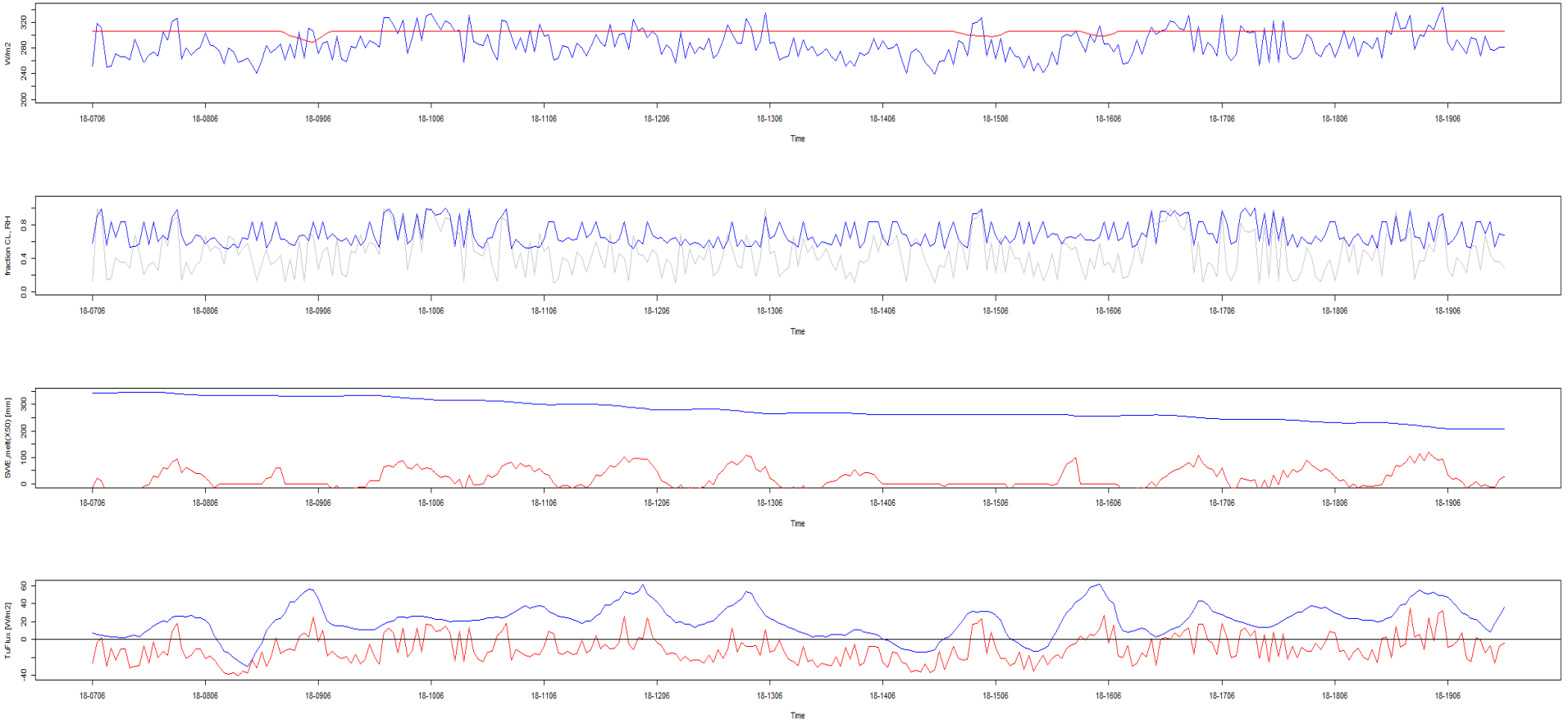
-Removes one calibration parameter in the DDD model

-SCA appears to be better simulated.

-The presence of «snow towers» is no longer a problem



- The thesis of K. Tvedalen is part of the the basis for developing an energybalance apporach to snowmelt with only precipitation and temperature as forcing data (no calibration against runoff).



Thank you for your attention!