

Satellite snow in flood forecasting

*Experience on Cryoland products in WSFS
User Dissemination Workshop*

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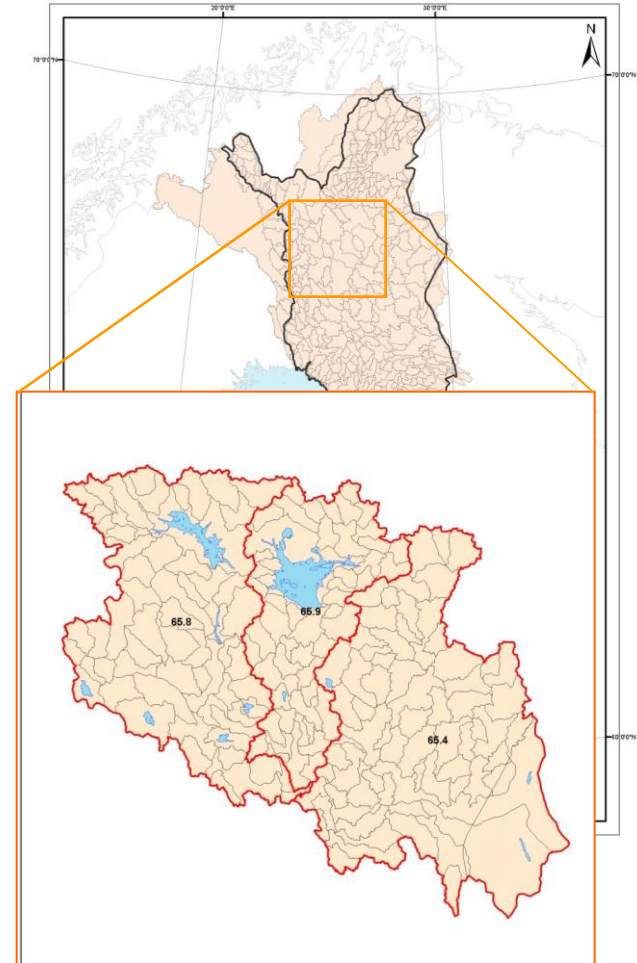
Finnish Environment Institute
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Hydrological forecasts in Finnish Environment Institute (SYKE)

- Modelling and Forecasting (WSFS)
 - Watershed simulations and forecasts
 - Water levels and discharges
 - Areal precipitation, runoff, snow, evaporation, soil moisture, groundwater, lake and river ice
 - Warning system
 - Flood warnings by email, SMS, on www-pages
 - Snow loads on roofs
 - Aerial precipitation based on weather radars
 - Water quality modelling
 - Nutrient load simulations and forecasts (P, N, C, sediments)
 - Climate change studies

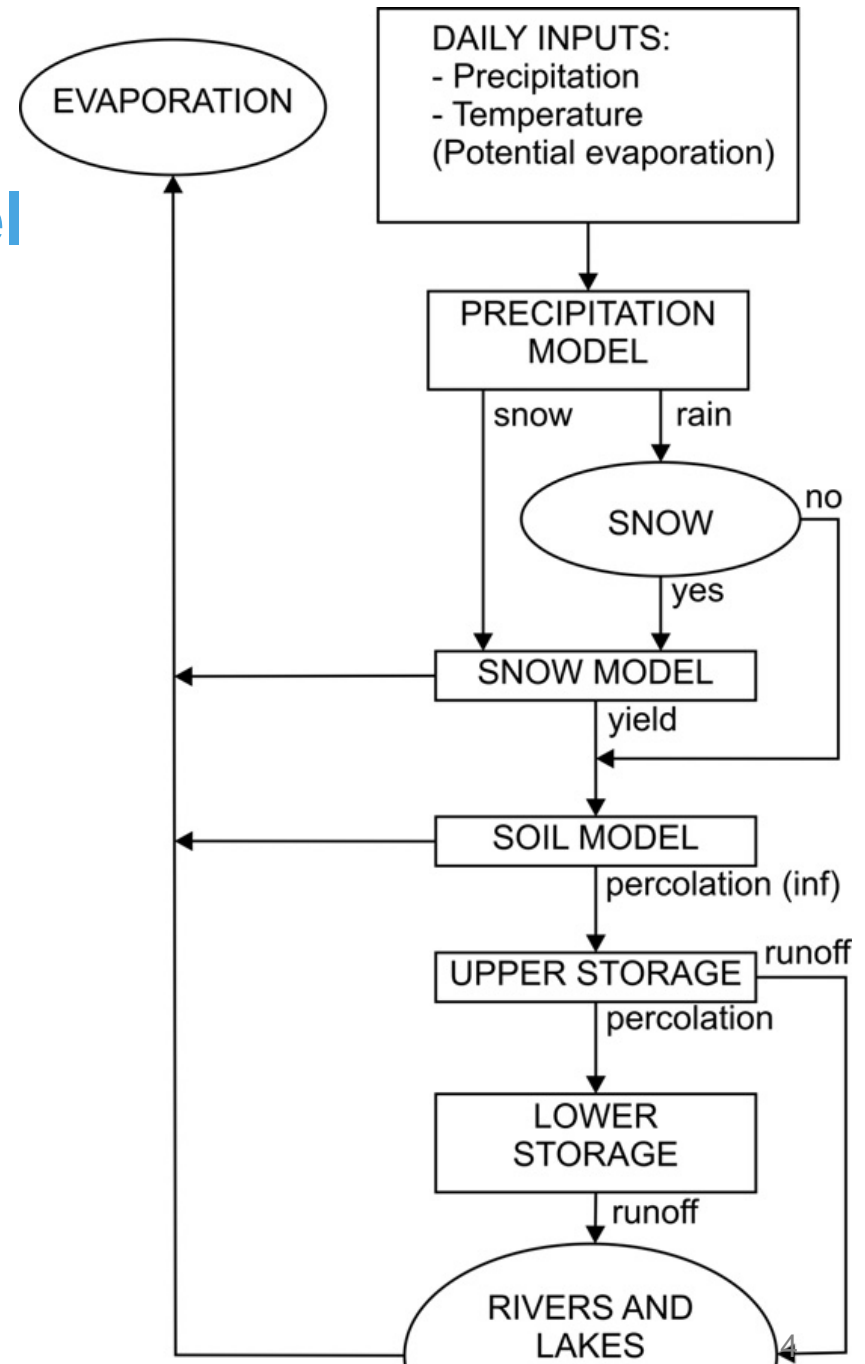
Watershed simulation and forecasting system (WSFS)

- A conceptual hydrological model for runoff simulations
- Includes models for: precipitation, snow, soil moisture, subsurface and ground water
- Simulates
 - Water levels and discharges in 1300 points
 - Water balance in 6200 drainage basins
 - covers 390 000 km² and 2400 lakes (>1 km²)
- Separate model version for water quality simulation (VEMALA)
 - Total phosphorus, total nitrogen, suspended solids, organic carbon (TOC)
 - Diffuse loading (fields and other land area)
 - Point load, settlements, fallout
 - Simulates transport in rivers and lakes
 - 58 000 lakes (>1 ha), 1 100 000 fields (2 400 000 hectares)



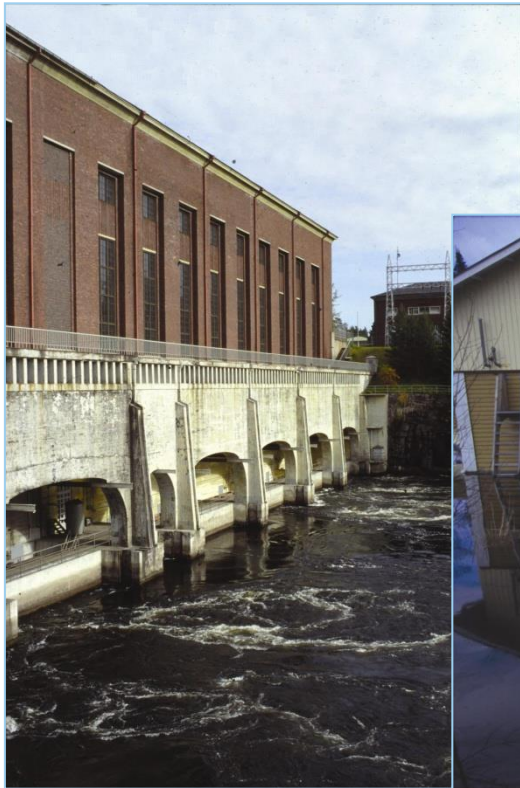
Based on conceptual HBV-model

- Input variables
 - Temperature
 - Precipitation
 - (Potential evaporation)
 - (Wind speed)
 - (Relative humidity)
 - (Radiation/cloudiness)
- Sub-models
 - Precipitation
 - Snow
 - Soil moisture
 - Subsurface and ground water
 - Surface water temperature
 - Lake and river ice



Forecasts provide predictions on hydrological phenomena for the needs of

hydropower industry



flood forecasts



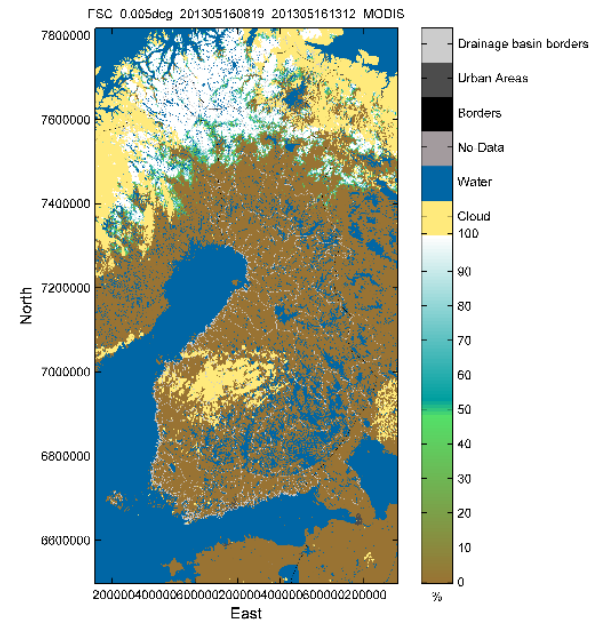
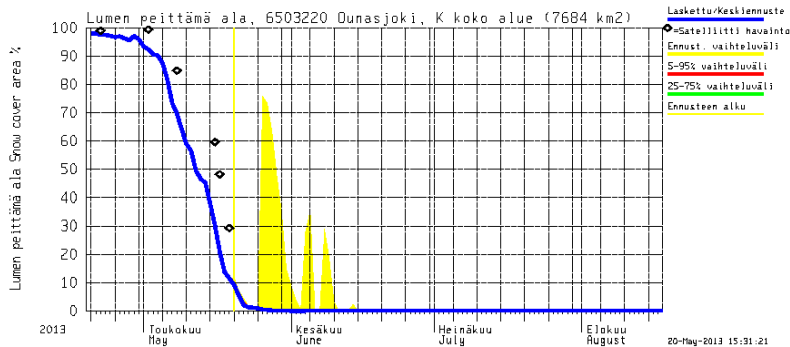
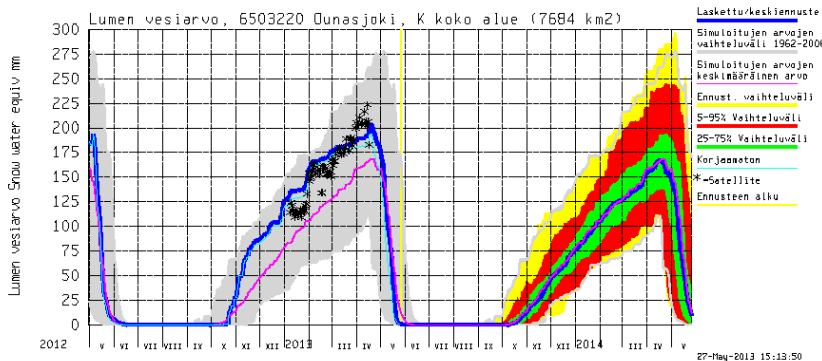
tourism



www.environment.fi/waterforecast

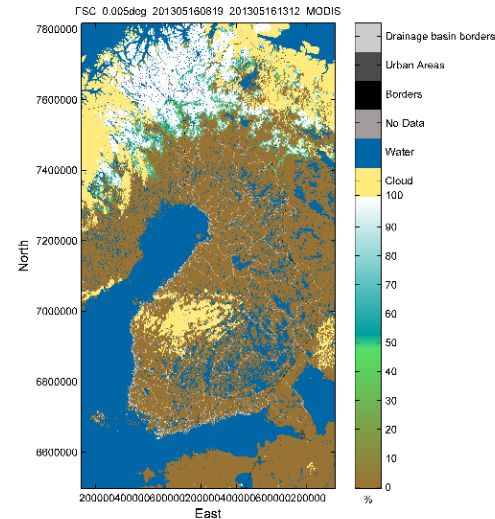
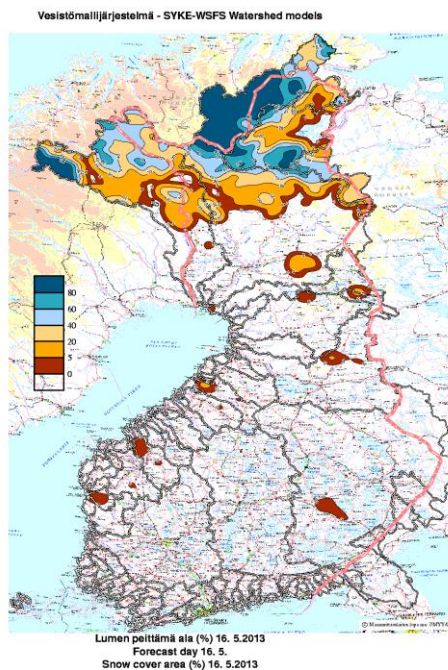
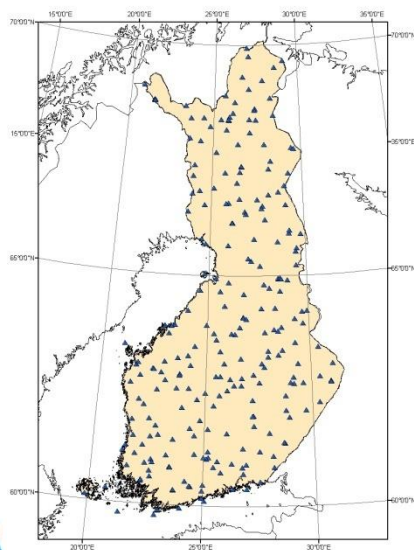
CryoLand products in WSFS

- Snow products in operational hydrological forecasts
 - Fractional Snow
 - Snow Water Equivalent Cover
- Products are not in the assimilation at the moment
- Products are used manually to change the state of the model



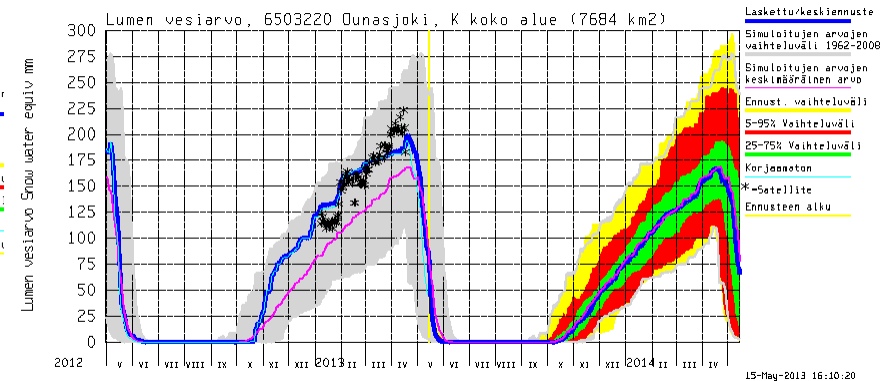
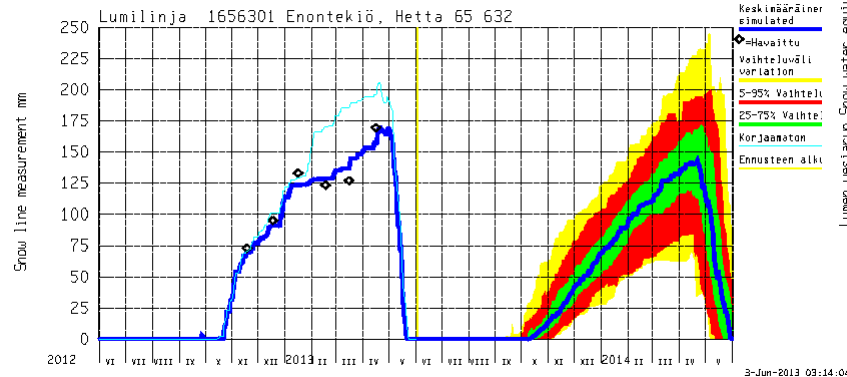
Estimating snow water equivalent and fractional snow cover

- One of the most difficult components to determine in WSFS
- Observation network is neither accurate nor dense enough
- Obs not useful in melting phase
- Snow covered area in the final stage of melting helps to estimate remaining snow



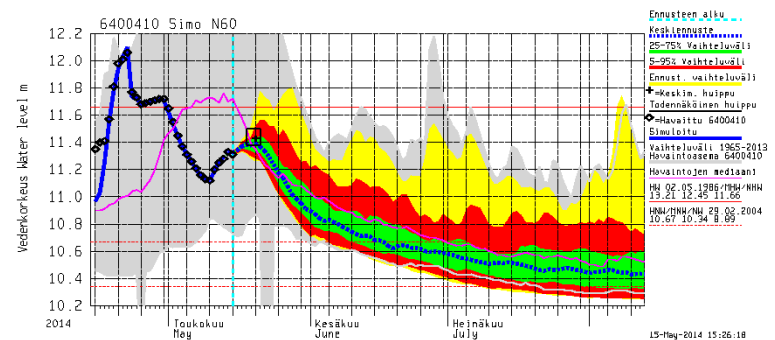
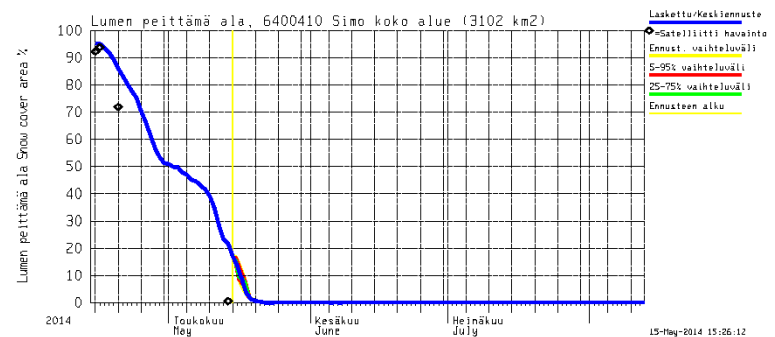
Snow assimilation

- Simulation is updated against observed Q & W
 - By changing temperature and precipitation
 - Snow is updated against snow obs.
- Fractional snow cover area is not used in assimilation. (Was tested several years ago before Cryoland)



Areal Snow – Simojoki basin

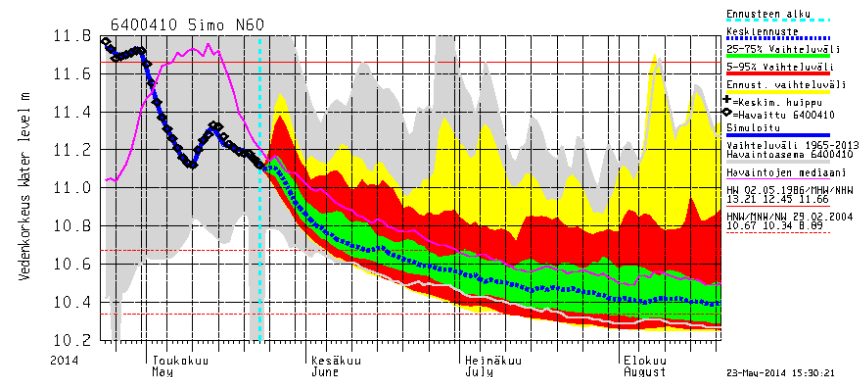
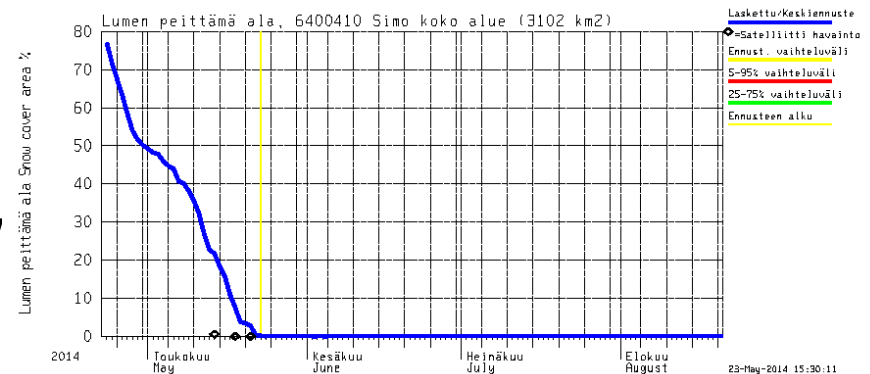
- Will there be second peak?
- FSC suggests snow has already melted
- Model has still some snow left



Areal Snow – Simojoki basin

Accurate

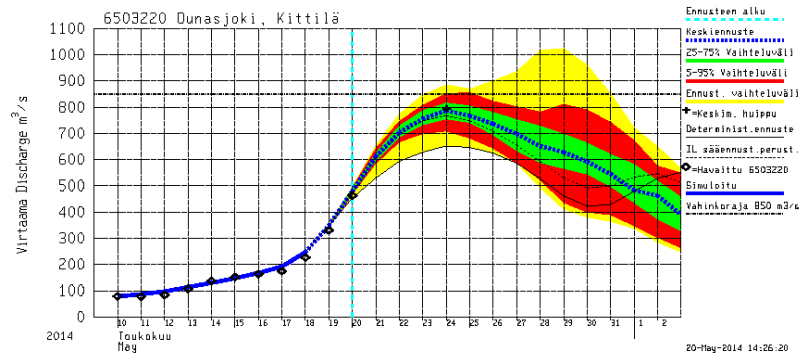
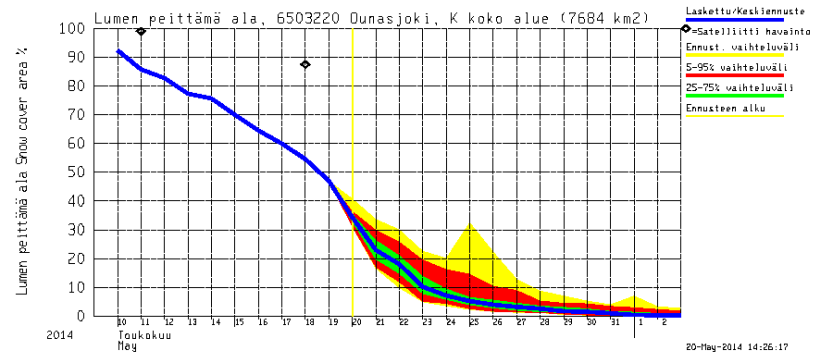
- Areal snow was quite accurate in Simojoki basin
- There was too much snow in the model
- Should have trusted the FSC more



Areal Snow – Kemijoki basin

In Kemijoki estimating the snow has been challenging

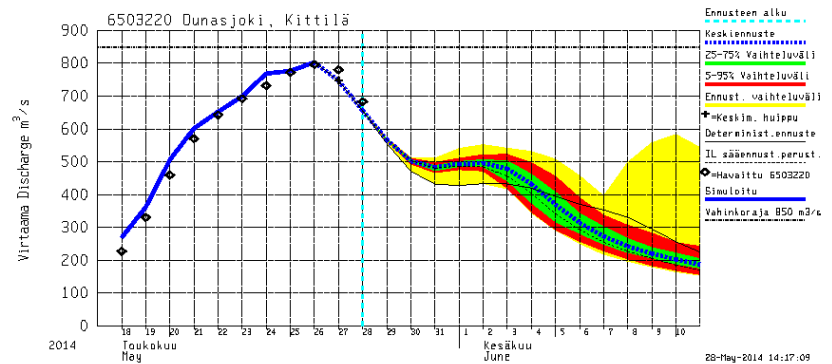
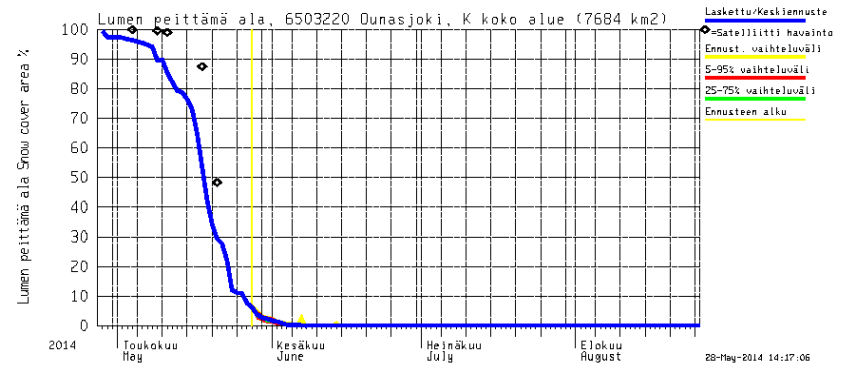
- Again cloudy most of the melting season
- Satellite data hints there is not enough snow in the model
- Is the flood going to rise?



Areal Snow – Kemijoki basin

Snow ok, but difference in sca

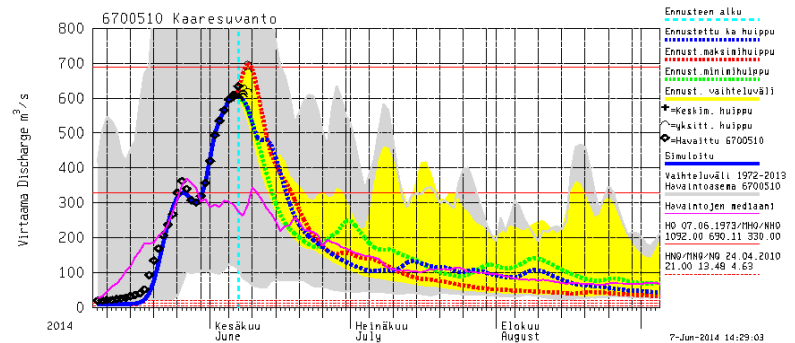
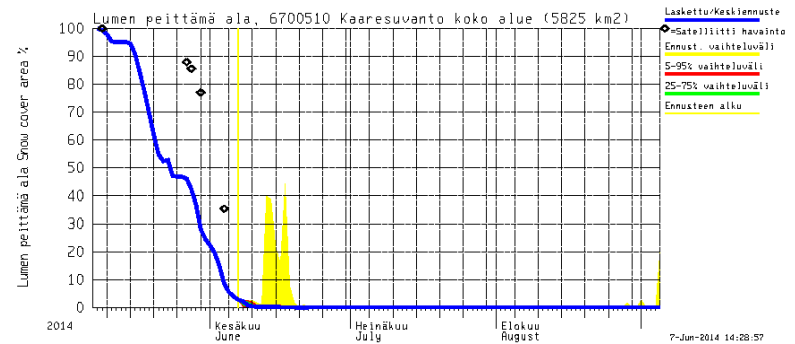
- Satellite data showed larger sca
- Snow in the model was adequate
- Model didn't adjust the snow but added precipitation



Areal Snow – Tornionjoki basin

In Lapland estimating the snow has been challenging

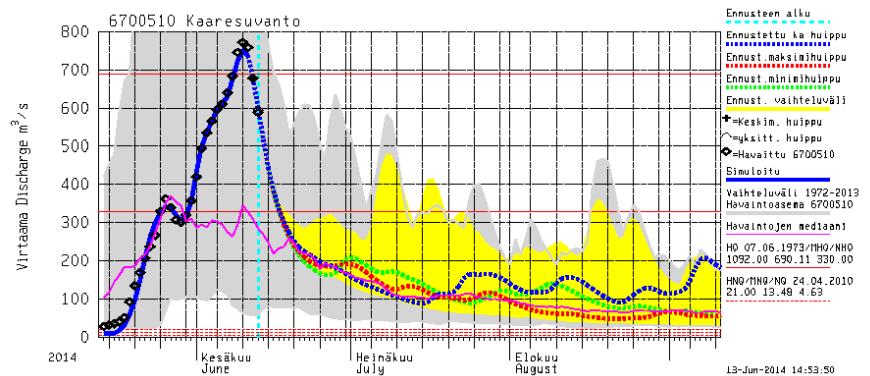
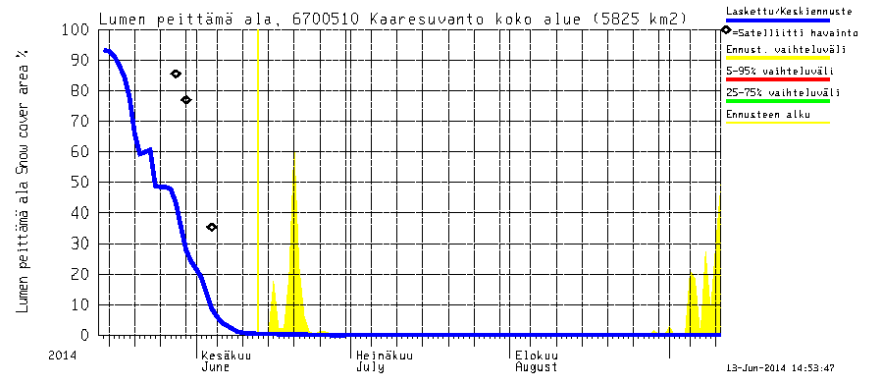
- Sky is clearer -> more obs
- Satellite data hints there is not enough snow in the model
- Is the flood going to rise?



Areal Snow – Tornionjoki basin

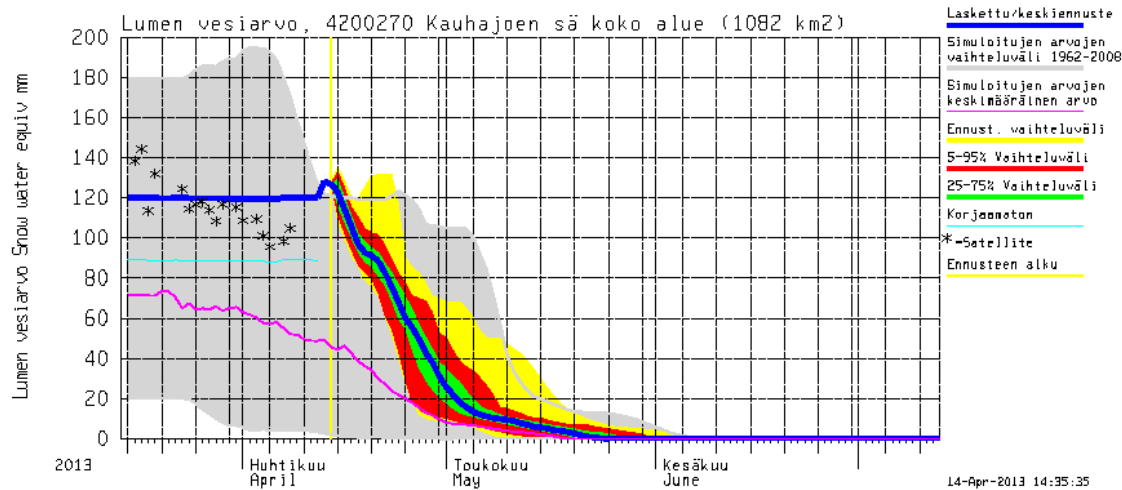
Not enough snow

- Model underestimated snow
- River peaked higher than forecasted
- Should have believed SCA
- Model did not add snow but updated with precipitation



Snow water equivalent

- If modelled snow differs from prec.sum SWE helps
- In spring 2014 not in use
- Has not yet been as helpful as areal snow
- Provides a guideline
- More accurate product in development



Conclusions

- Areal snow water eq. is one of the most difficult component in WSFS
- In the final stages of snow melt Fractional Snow Cover helps to estimate amount of remaining snow
 - Is the peak reached or will the flood rise again
- On some basins difference between Snow Cover and WSFS-model was around 20%
- Unfortunately cloudy weather in the final stage on melting prevented most of the sat.observations
- Cloud detection is essential
- SWE could use density and depth observations from snow lines (more representative than meteorological obs)

...Conclusions

- Satellite observation would be more useful if the snow model was also calibrated against sca.
- 2014 most of the sca-obs (in Lapland melting season) were discarded because of the clouds. If the cloud cover is not complete, maybe some of the information could be used
- Data is needed within few hours.
- We need sca with max 20% error (fsc-unit)

Thank You!