Review of HIRLAM/HARMONIE SURFEX activities

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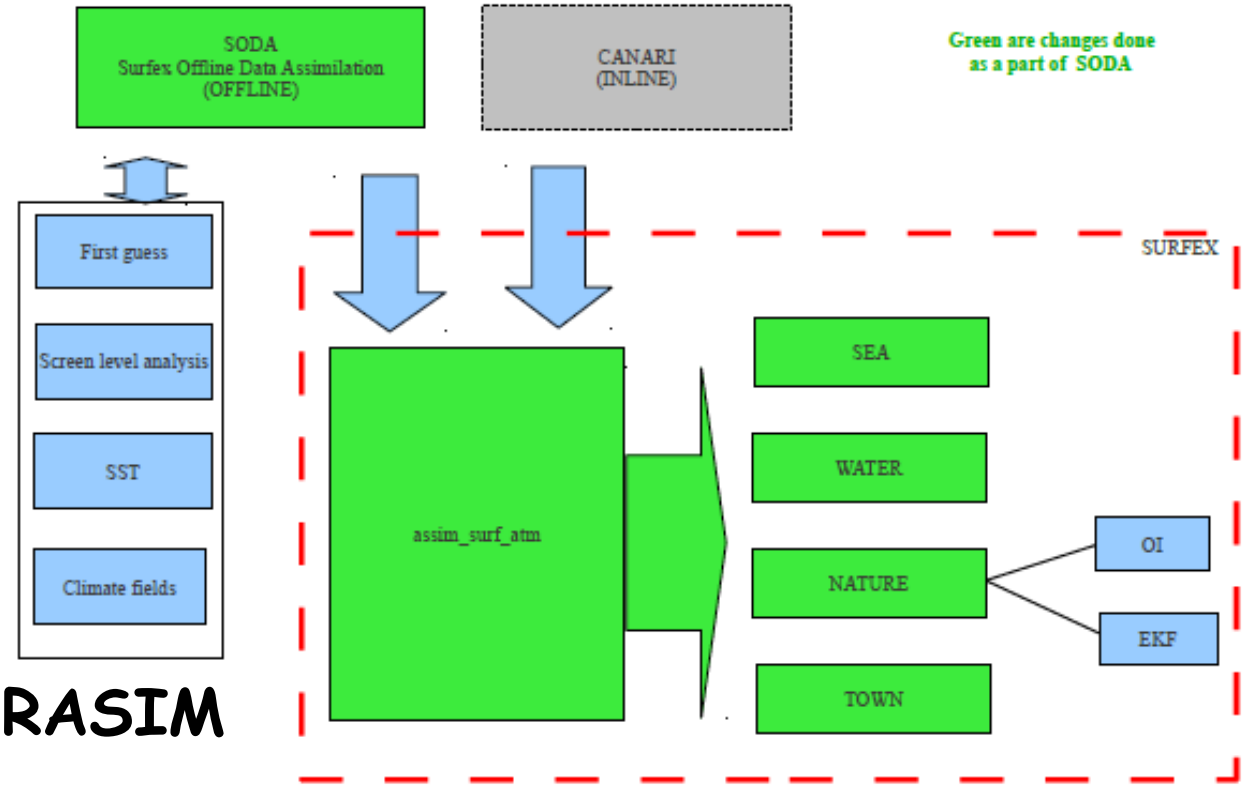
SURFEX SC meeting
28 Mar. 2012

Contents

- Status of ongoing R&D, planned R&D:
  - DA: SODA, Euro4M
  - Snow: MEB, snow DA
  - Sea ice: simple ice scheme
  - Lakes: climatology, DA
  - TEB: sensitivity tests
  - Orography: new datasets, modeling
  - Physiography: lake database, evaluation of the new soil dataset
  - Interactions between tiles
- Proposals for the SURFEX team

DA: SODA

SURFEX
Offline
Data
Assimilation
parallel system
with CANARI
and SURFEX/VARASIM
Ready

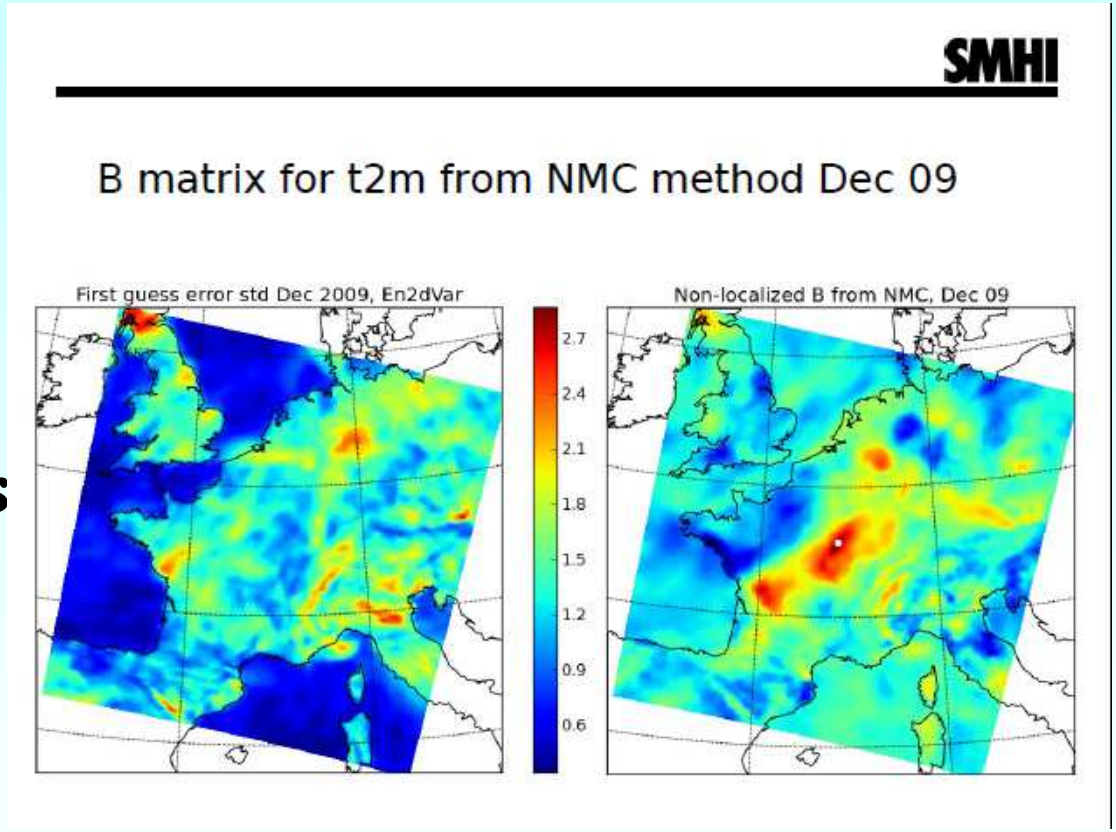


… to be continued with some options in parallelization …

DA: Euro4M

- Forcing from HIRLAM
- Anisotropic structure functions in CANARI vs wavelets vs Ens2DVar

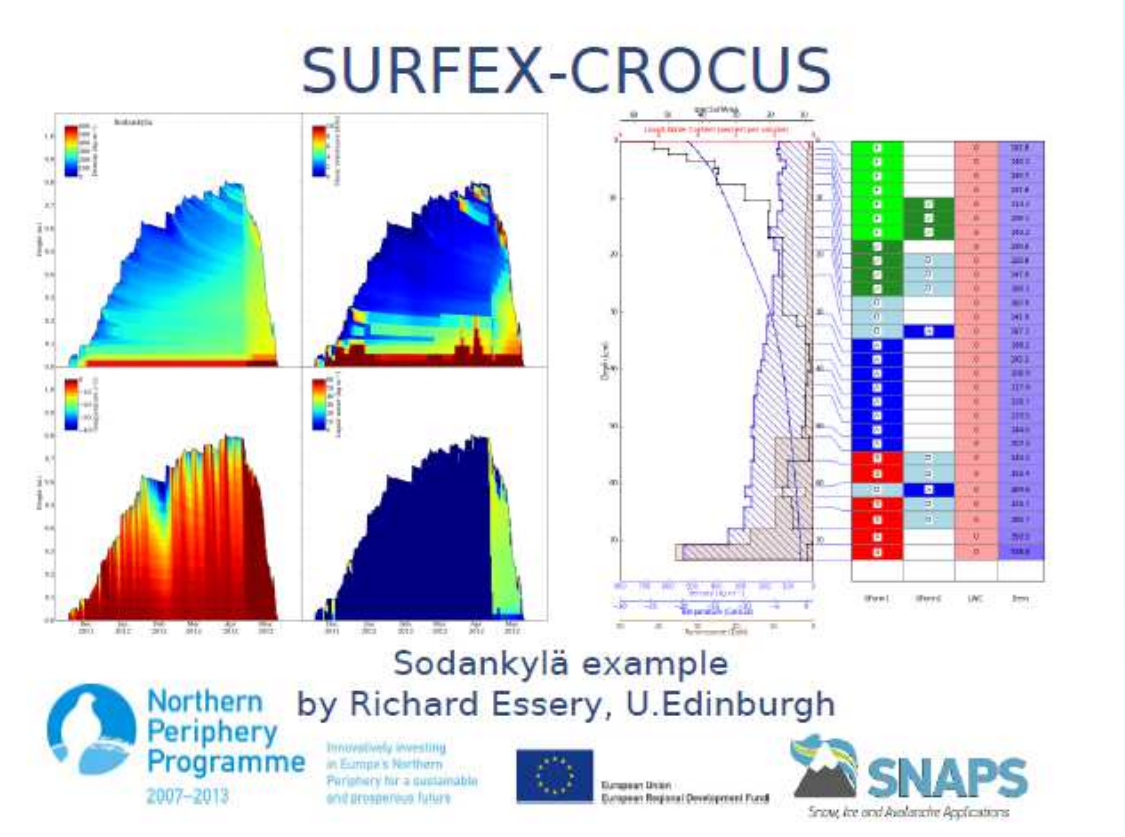
To be continued …



Snow: modelling

MEB:

→ SURFEX 7.0
technically ready
Planned: testing



CROCUS
in EU Northern Periphery SNAPS project
for avalanches and snow drift on roads in Iceland

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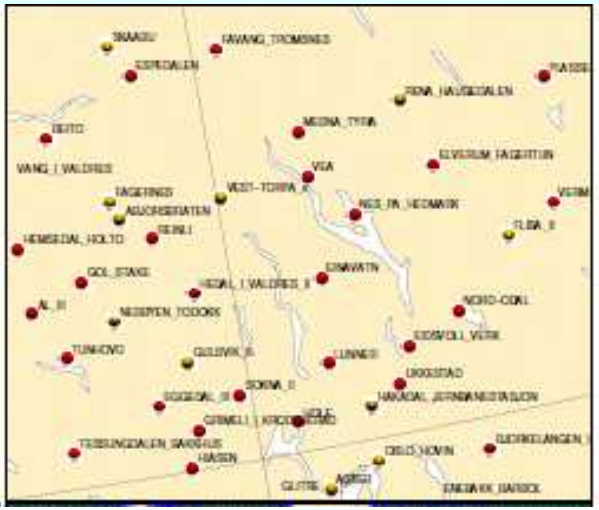
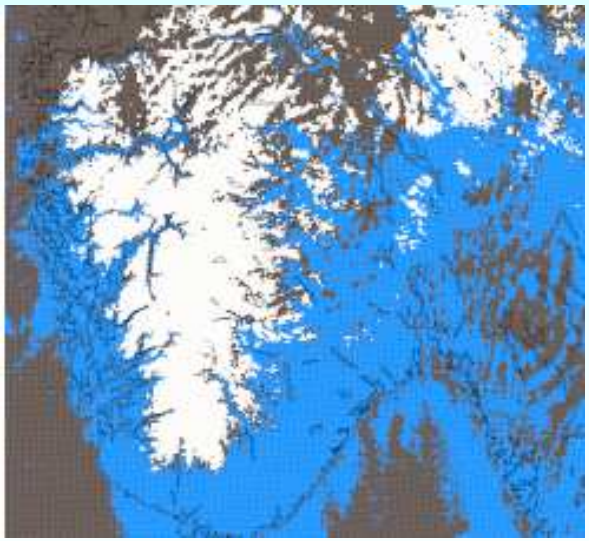
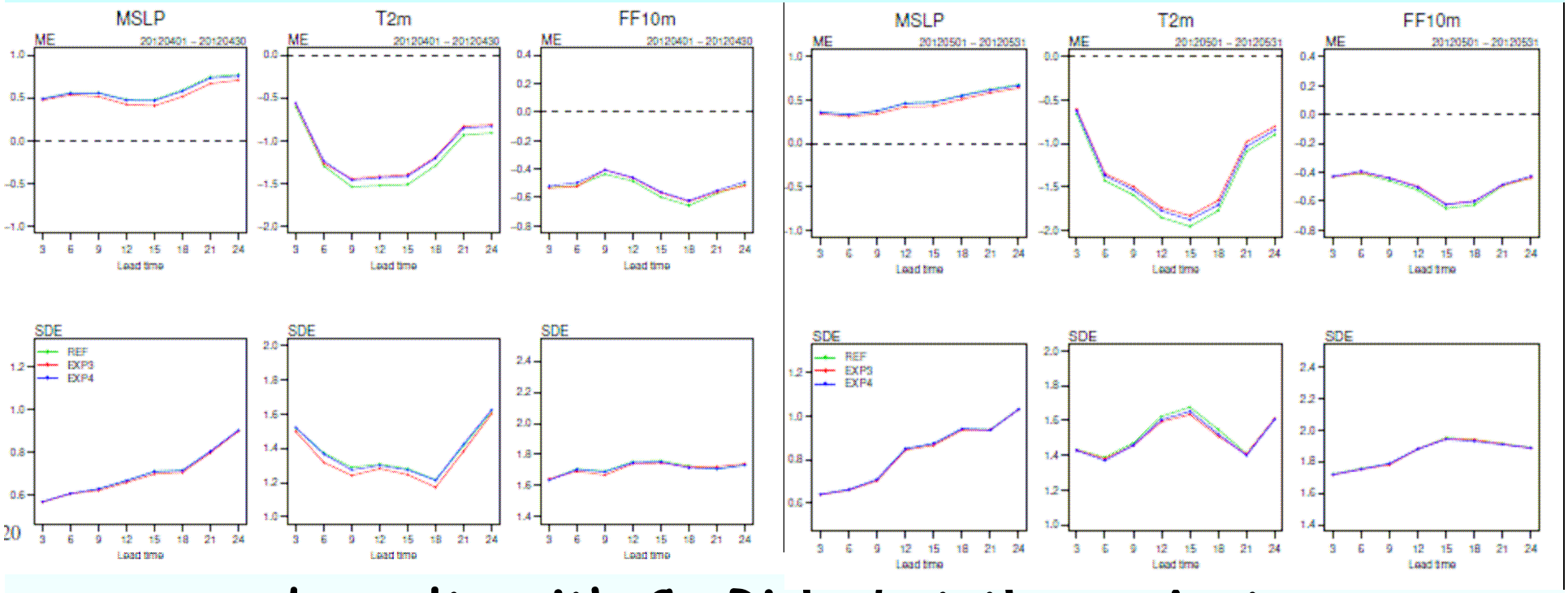
Snow: DA

- **Snow depth** from precipitation stations (Norway) slightly modified structure functions
- **Snow extend** data from CryoRisk project (Norway)





Snow: DA

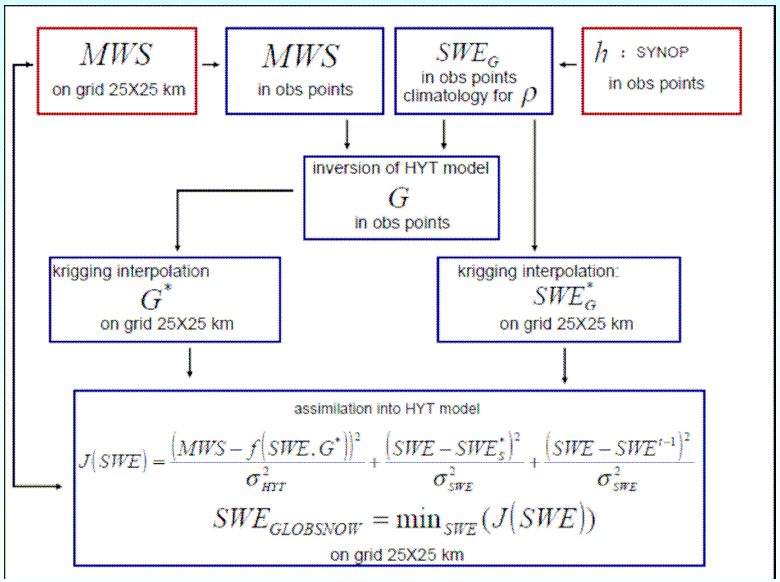


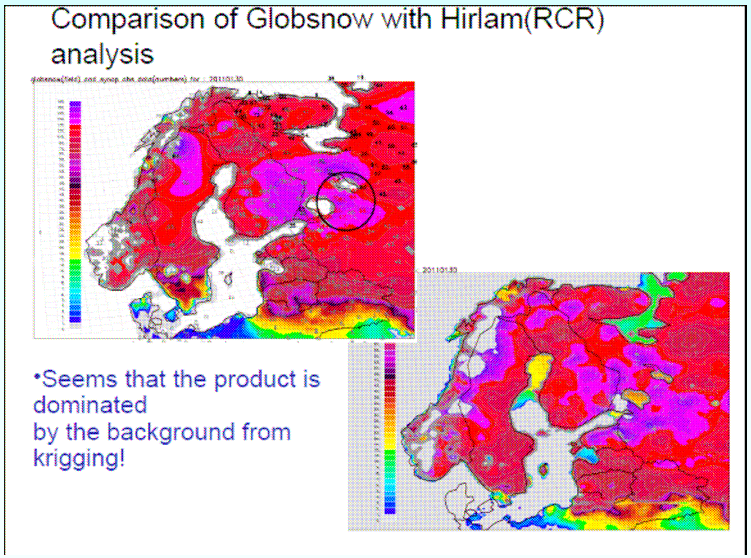
=> good results with CryRisk, but the project finished; we have a framework but should look for new data

- Planned: use of NESDID data or Land-SAF SE EUMETSAT, second generation SE from Globsnow, Icelandic MODIS-based SE

Snow: DA

Snow water equivalent (SWE): feasibility of GLOBSNOW data: comparison with independent obs, HIRLAM analysis, study of algorithm





Problems: artifacts, small variability in meso-scale

Possible reasons: weak points in algorithm.

Planned: try with modified algorithm … EKF for SWE!

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Sea ice: simple scheme

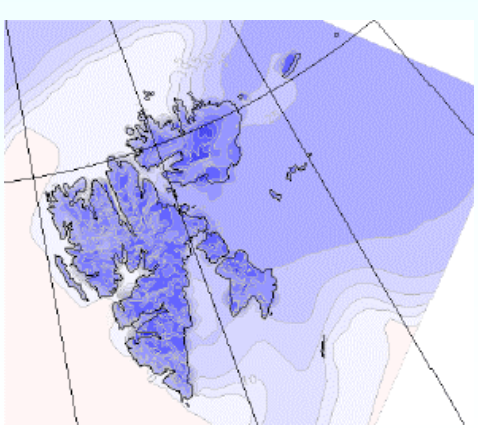
By now:

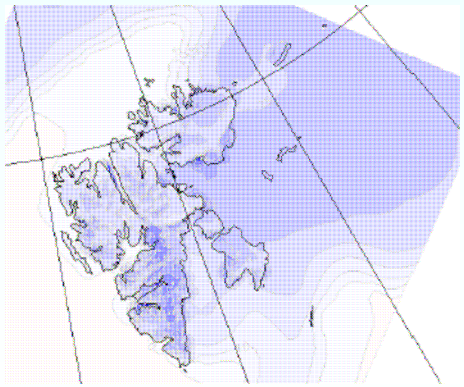
Sea Ice Temperature (SIT) is taken from boundaries (ECMWF) and kept constant during a forecast, no diurnal cycle of SIT, impossible to apply for for e.g. Arctic

Idea:

Simple ice scheme (as in ECMWF or HIRLAM)
H=1m, several (3?) layers in ice,
Heat diffusion scheme with ice parameters.
Snow on ice?

Swalbard area,
March 8, 2012,
00 UTC+03 and
00 UTC+48





Sea ice: simple scheme

Implementation of a sea ice model in SURFEX

Status

- follow Stefans suggestion of using the SURFEX-routine SOIL_HEATDIF by Aron Boone

- SURFEX 7.2

- has taken the first steps to run SURFEX offline experiments, e.g. at Hopen:
  1) read SST from namelist
  2) TICE Sea/Water ice temperature defined on NICE_LAYER (not only one)
  3) write TICE to output file
  4) introduce a call to SOIL_HEATDIF in the subroutine ICE_SEA_FLUX to update TICE

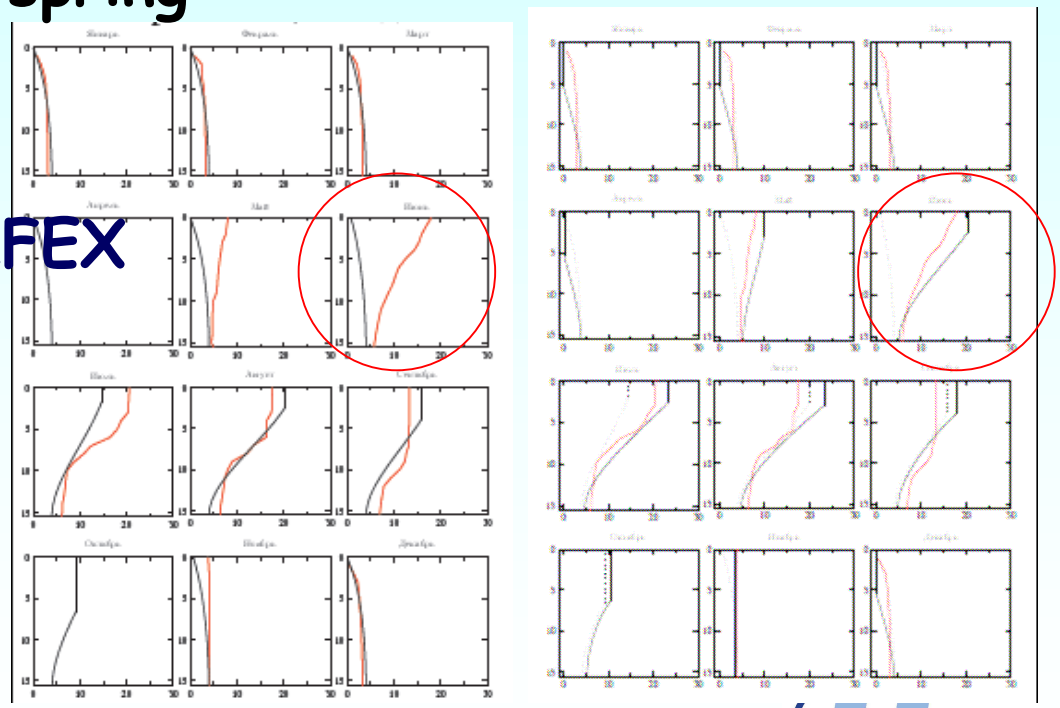
NEXT: nead to understand all input variables to SOIL_HEATDIF,
e.g 'coefficients of linearization of surface energy budget'

HIGHTSI is still planned …

Lakes: climatology

- Improved lake climatology:
  forcing from NCEP, albedo after Mironov-Ritter,
  numerical scheme, snow on lake ice
  => reduced errors in spring

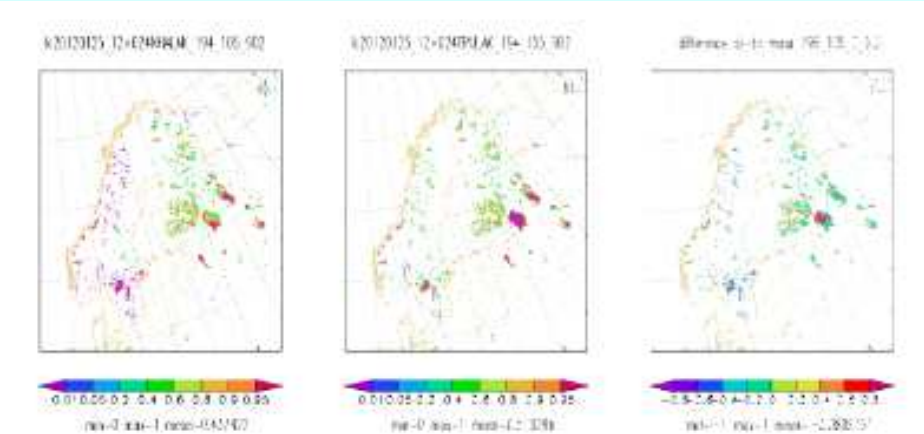
- Planned:
  - to include into SURFEX
  - more tests with FLake in SURFEX
  - to test FLake in HARMONIE !!!

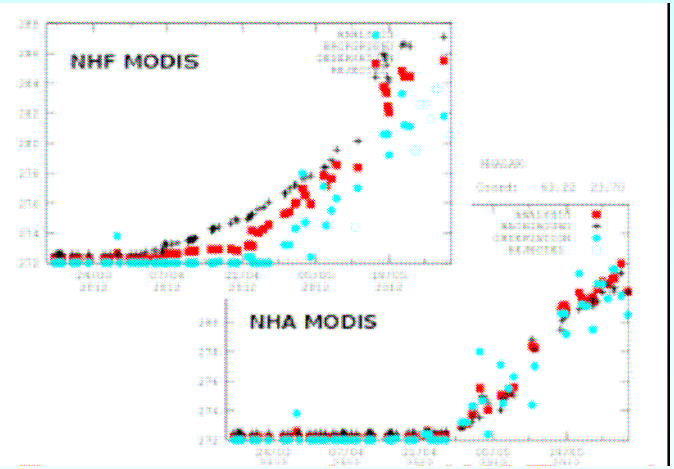


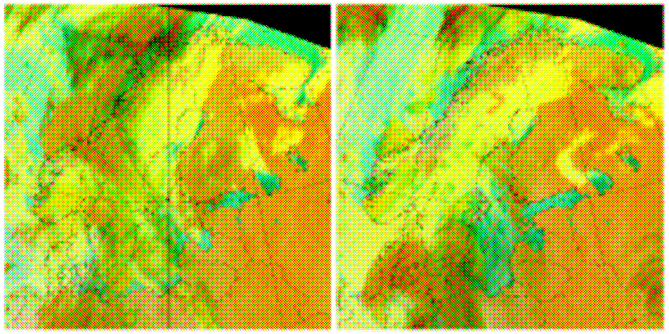
Lake Amisk, Canada

Lakes: DA

Analysis of LST in horizontal using in-situ and MODIS data by OI: NH project



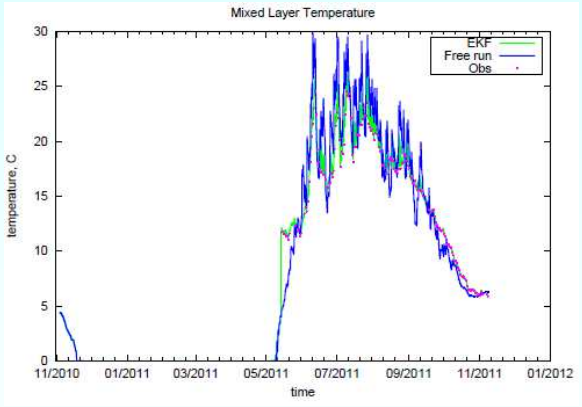


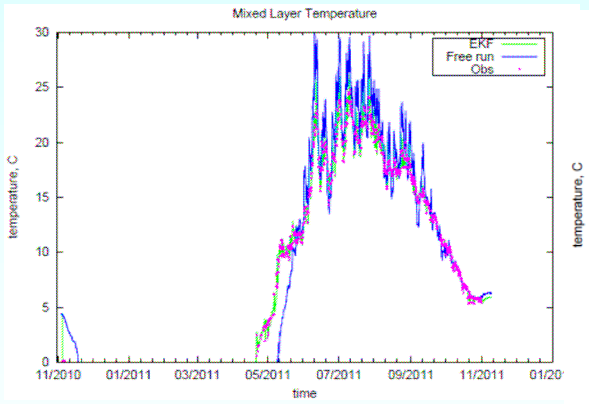


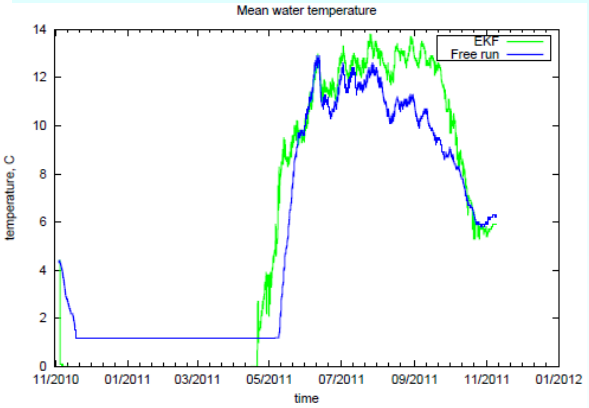
Planned: quality control of satellite data, new structure functions, etc.

Lakes: DA

- Assimilation of LSWT in vertical: EKF for FLake:
  - for mixed/non-mixed regime
  - for ice/non-ice period
  - use in-situ or synthetic (incl. MODIS) obs
  - extensively tested, for 71 lake points





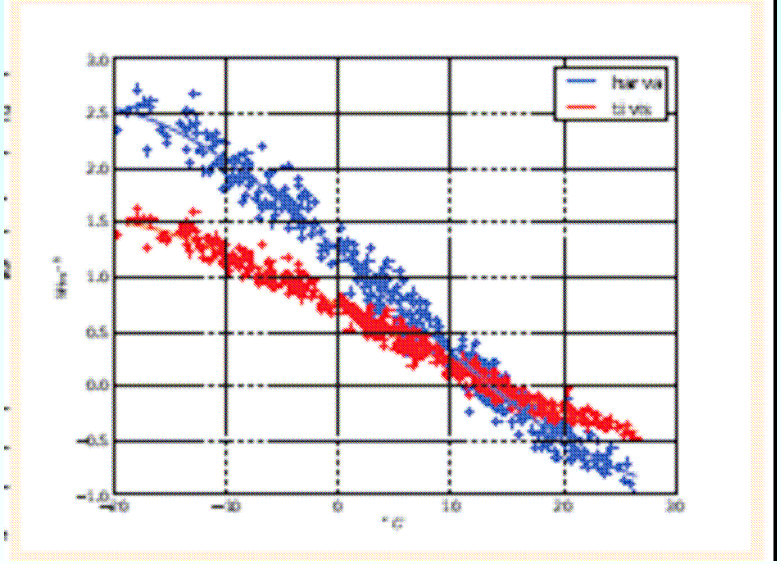


Lake Lappa: in-situ, synthetic

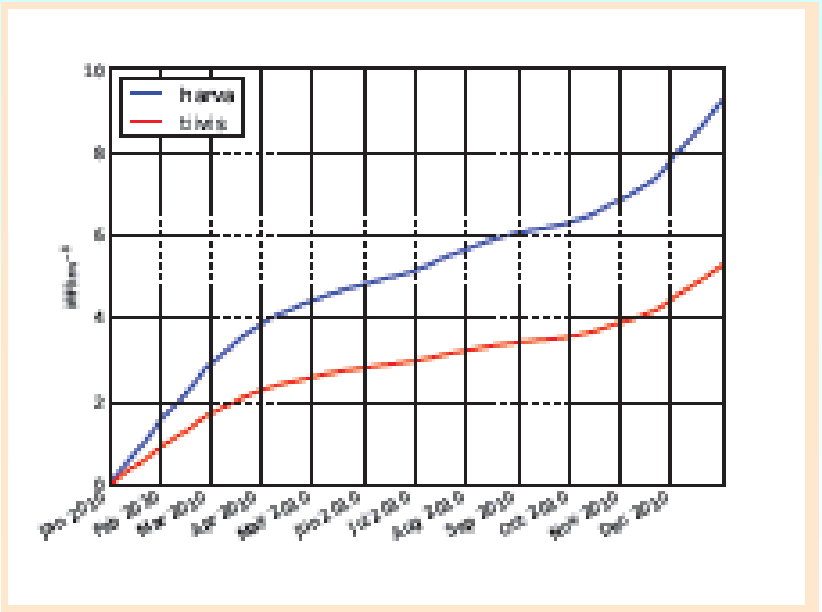
Planned: to include into SURFEX

TEB: sensitivity tests

kaavoitus	korkeus	peittävyys	seinäpintasuhde
harva	10 m	28 %	28 %
tiivis	30 m	45 %	90 %



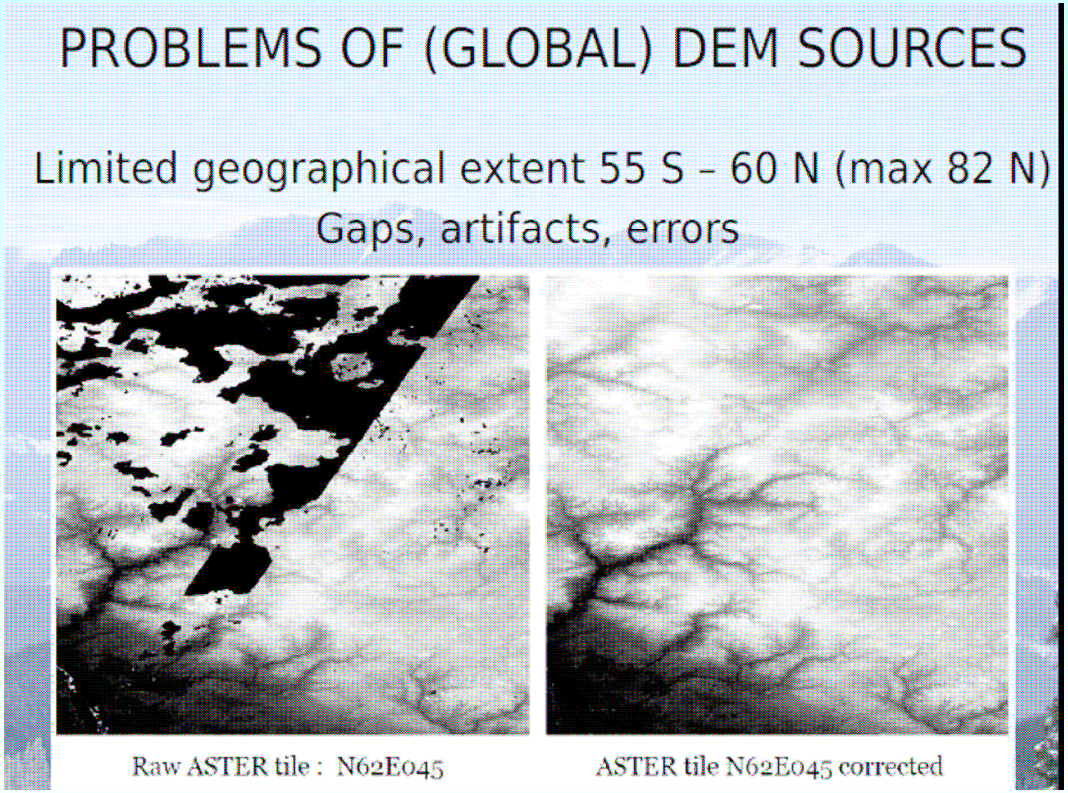
Helsinki, 2010



To be continued …

Orography: new datasets, modeling

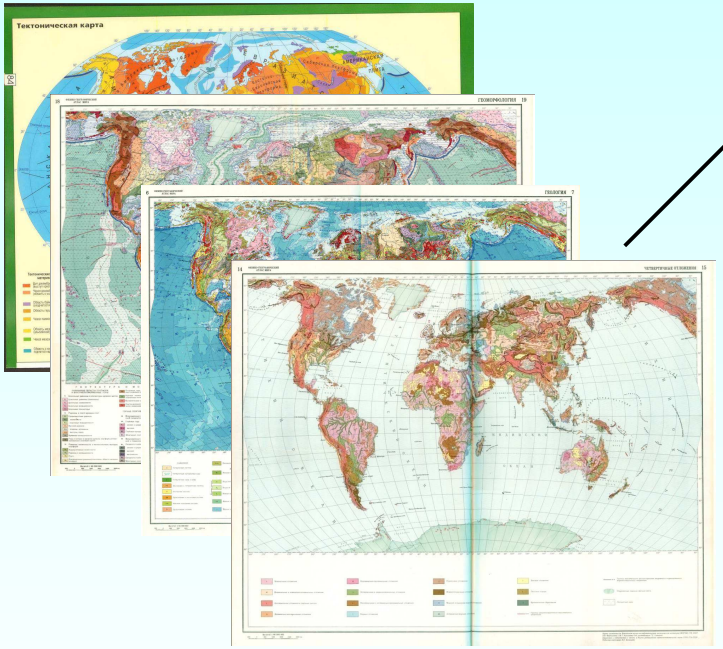
Example of ASTER data evaluation and improving

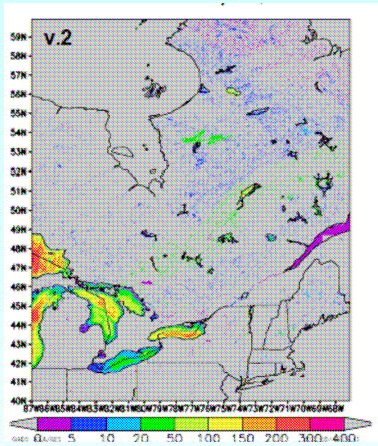


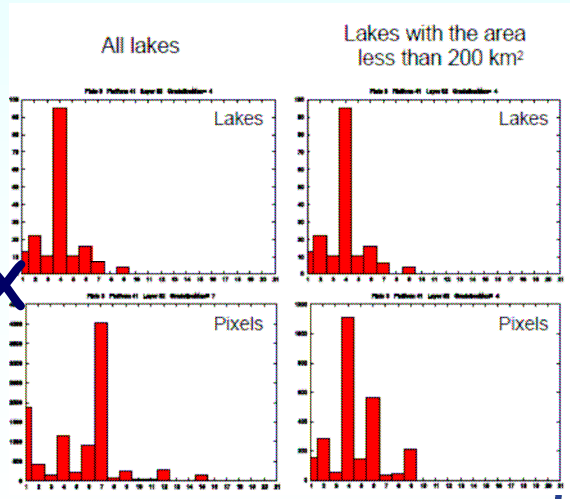
Planned: to include SRTM (+ASTER, …) into SURFEX
- radiation over sloping surfaces

Physiography: Global Lake Database

New version of GLDB, with estimates of the lake depth from geological information for boreal zone







Planned: to include into SURFEX
to continue for tropics
and Southern hemisphere

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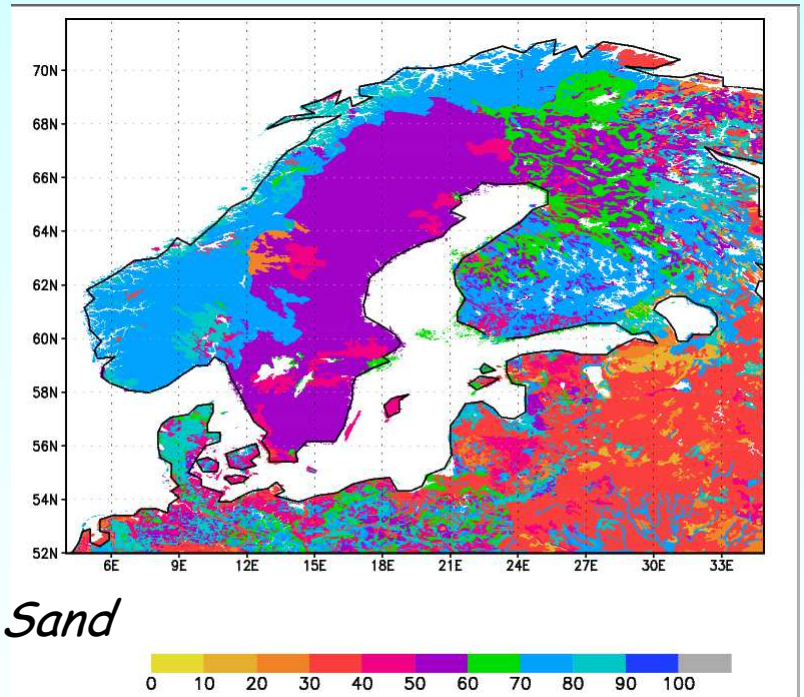
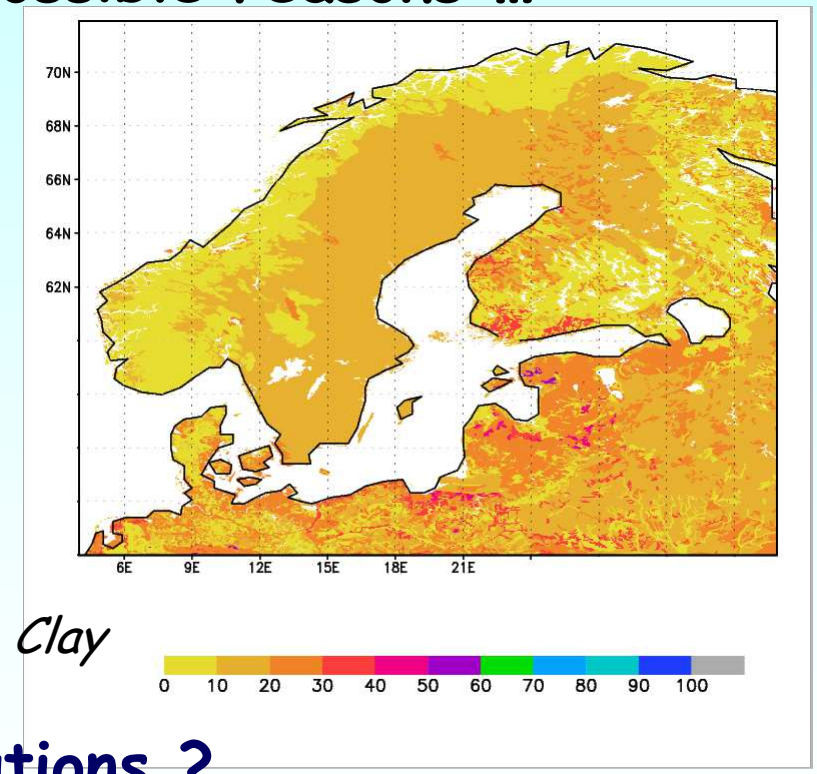
Physiography: evaluation of new soil data for Nordic region

Problems in Scandinavia … possible reasons …





To contact appr. institutions ?

Planned: evaluation of GLOBCOVER

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Interaction between tiles (planned)

An idea, for expanding the tile-approach in surface schemes

The problem:

An example from the lake discussions in Helsinki.

A model simulation over a lake with a narrow cross section confined in a forested area, gets much smaller fluxes, than observed by measurements.

The reason is that the exchange coefficient (K-lake) , produced in the model (in a tiled scheme) becomes too small, since:

K-lake= F(roughness(lake), windspeed, stability)

In reality the turbulence is mainly generated by the nearby forest.

In a tiled scheme the total flux from a gridsquare is a weighted sum of each tile:

$$\Phi = \sum_{i=1}^{n} Fr_i \Phi_i$$

Where for e.g. temperature:

$$\Phi_i = K_i \frac{\partial T_i}{\partial z} \approx K_i \frac{(T_{nlev} - T_{si})}{z_{nlev}}$$

This is a reasonable assumption, when the physiographic situation is such, where we can assume:

- The turbulence is generated by the local roughness
- The turbulence has reached an equilibrium (quasi steady state)

In other words, when we assume that Monin-Obhukov's theory is valid

This assumption becomes less and less valid when the wind flows between tiles, (or even gridsquares in a very high resolution model) on a short time scale.

We have (at present) no information how "patchy" a gridsquare is, but only on the fractions.

The idea is that we should (to a varying degree) let the different fractions have some kind of turbulent interactions:

$$\Phi_i = \alpha K_j \frac{(T_{nlev} - T_{si})}{z_{nlev}} + (1-\alpha) K_i \frac{(T_{nlev} - T_{si})}{z_{nlev}}$$

or

$$\Phi_i = [\alpha K_j + (1-\alpha) K_i] \frac{(T_{nlev} - T_{si})}{z_{nlev}}$$

This is important only if the tile j has a larger exchange coefficient than the current tile i. Physically this happends when the air is blowing from a rougher surface towardes a smoother, or more exact, when we have larger turbulence over the upstream tile (or grid).

So the idea is to let the size of α be a function of the upstream turbulence.

This information could be estimated by the TKE of the lowest model layer. If the TKE is less than the potential energy of the present tile (bouyancy B), we should use a small value of α

$$\alpha = f(TKE/B)$$

where

$$B \approx 2g z_{nlev} \frac{(T_{nlev} - T_{si})}{(T_{nlev} + T_{si})}$$

Practically it could be a rather messy job to code in the present SURFEX structure?
Question: Is it meaningful to test this idea?

Technical aspects, questions, proposals

- Status of GELATO – branch in svn …
  To share some common part. Which?
- Rotated lon-lat grid in SURFEX7.3
- Use FORTRAN structures, to include new variables easier
- Snow COST initiative

Summary

- Continuation with some option in parallelization with SODA
- Continuation of anisotrophy in CANARI experiments
- Testing MEB in SURFEX7.0
- Assimilation of SE data (NESDIS or …), futher investigation of GLOBSNOW SWE obs, EKF for SWE
- Implementation of simple ice model, HIGHTSI
- Implementation of improved lake climatology into SURFEX, more tests with FLake in SURFEX and in HARMONIE
- Using of satellite lake obs: quality control of satellite data, new structure functions, etc. Implement EKF for lakes into SURFEX
- Testing of TEB
- Implementation of high resolution orography in SURFEX, radiation over sloping surfaces, implementation of new version of lake database into SURFEX, continuation of lake database (Southern hemisphere), evaluation of GLOBCOVER data
- Feasibility study: interactions between tiles
- Evaluation of EKF vs OI-MAIN, assimilation of ASCAT soil moisture data
- To be solved: problems in soil maps for Scandinavia
- Technical aspects: rotated lon-lat, FORTRAN structures
- To avoid double-work in development of ice scheme
- SNAPS: using of CROCUS
- COST proposal for snow obs and DA

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Thank you for attention!

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