SNAPSHOTS on HIRLAM work on SURFACE DATA ASSIMILATION and MODELLING

Laura Rontu
FMI, Meteorological Research, International HIRLAM-B programme,
Physical parametrisations

With contributions by
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Mariken Homleid, Ekaterina Kurzeneva,
Suleiman Mostamandy, Jouni Pulliainen, Patrick Samuelsson

SRNWP Expert Group on Surface
ECMWF the 5th of September 2011

In this presentation

From HIRLAM to HARMONIE
Snow and vegetation
Lakes
Sea surface
Orography
Soil & Urban

SRNWP Expert Group on Surface
ECMWF the 5th of September 2011

HIRLAM-B programme and HARMONIE

HIRLAM as operational limited area MODEL: 1985 – 2015

International HIRLAM PROGRAMME
HIRLAM 1 – 6 1985-2005
HIRLAM-A 2006-2010
HIRLAM-B 2011-2015
… HIRLAM-Z ...

HIRLAM-B programme and HARMONIE

HIRLAM – ALADIN Research for Meso-scale Operational NWP In Europe
- HARMONIE cooperation 2005 -

HARMONIE as pre-operational local NWP model system
based on ALADIN-AROME from Meteo France
used and developed within HIRLAM consortium since 2005

HIRLAM-B programme focuses in the operational kilometer-scale NWP development, application and maintenance in the HARMONIE framework

How to transfer experience from the HIRLAM model to HARMONIE?

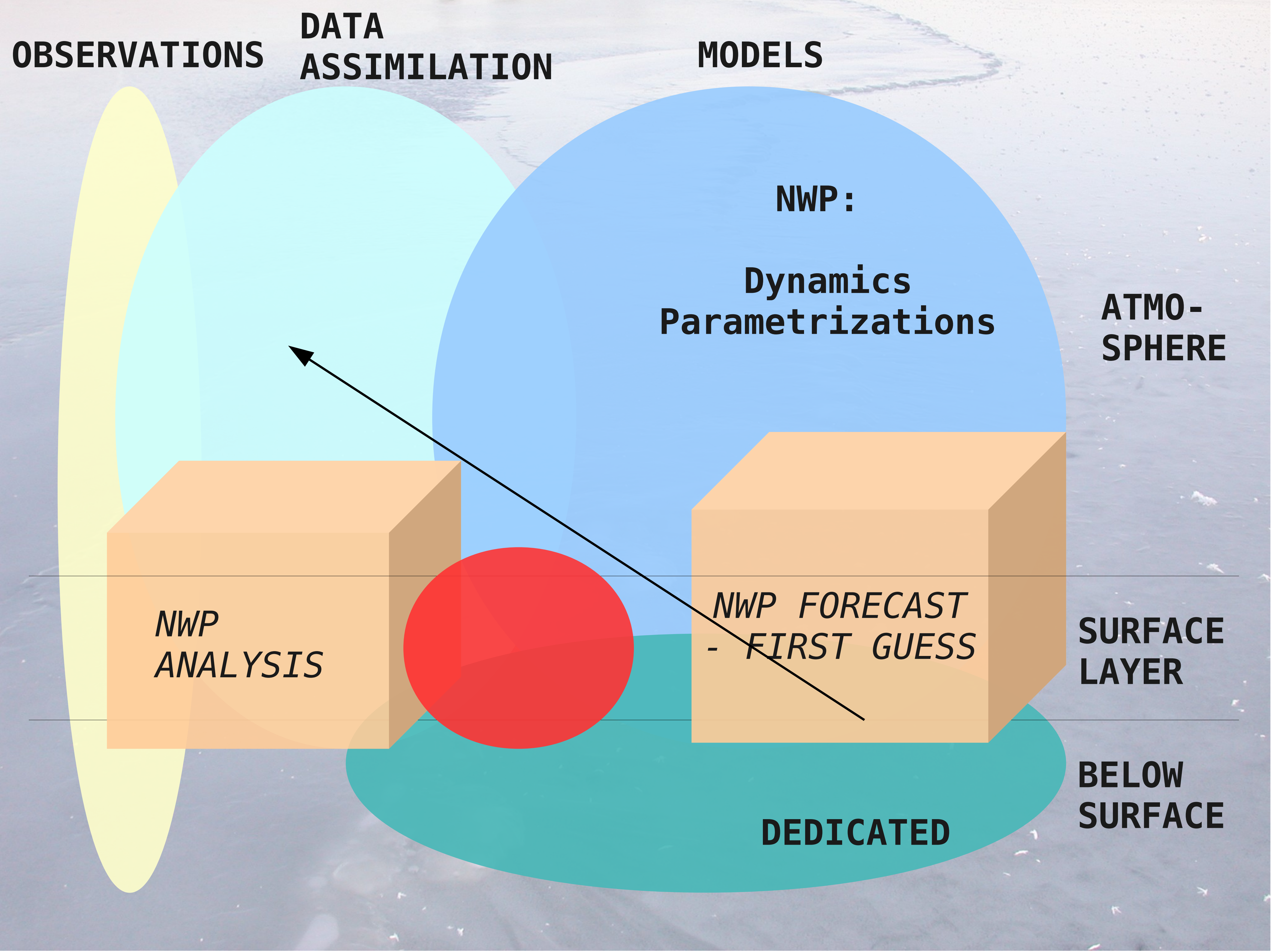
Convergence between the plans of ALADIN and HIRLAM programmes

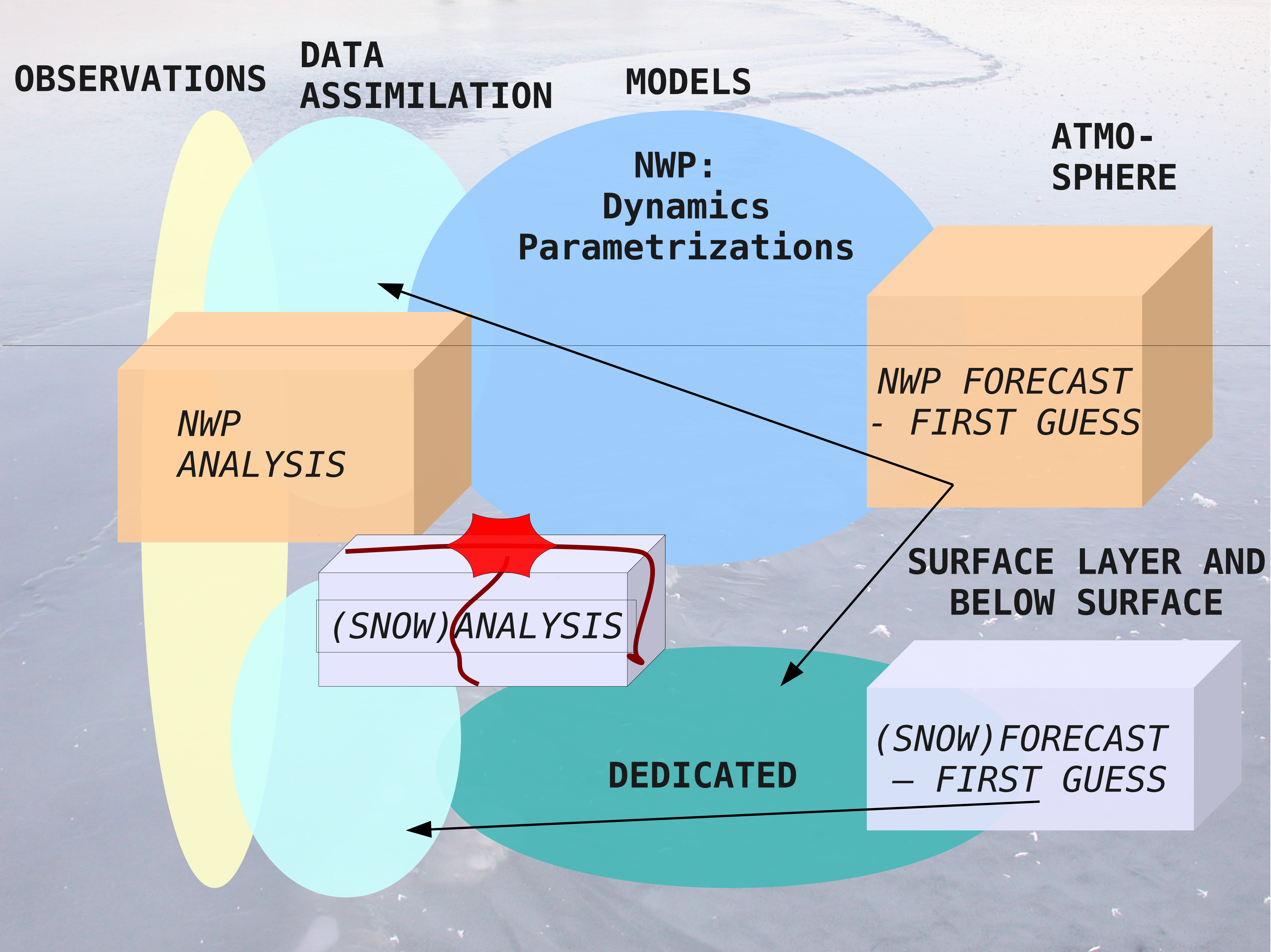
HIRLAM APPROACH on SURFACE

Focus on Northern aspects

Integration of surface data assimilation, surface description and prognostic parametrisations for the operational NWP application

Work within SURFEX framework


OBSERVATIONS
DATA ASSIMILATION
MODELS
NWP:
Dynamics
Parametrizations
ATMO-SPHERE
NWP ANALYSIS
NWP FORECAST - FIRST GUESS
SURFACE LAYER
BELOW SURFACE
DEDICATED


OBSERVATIONS
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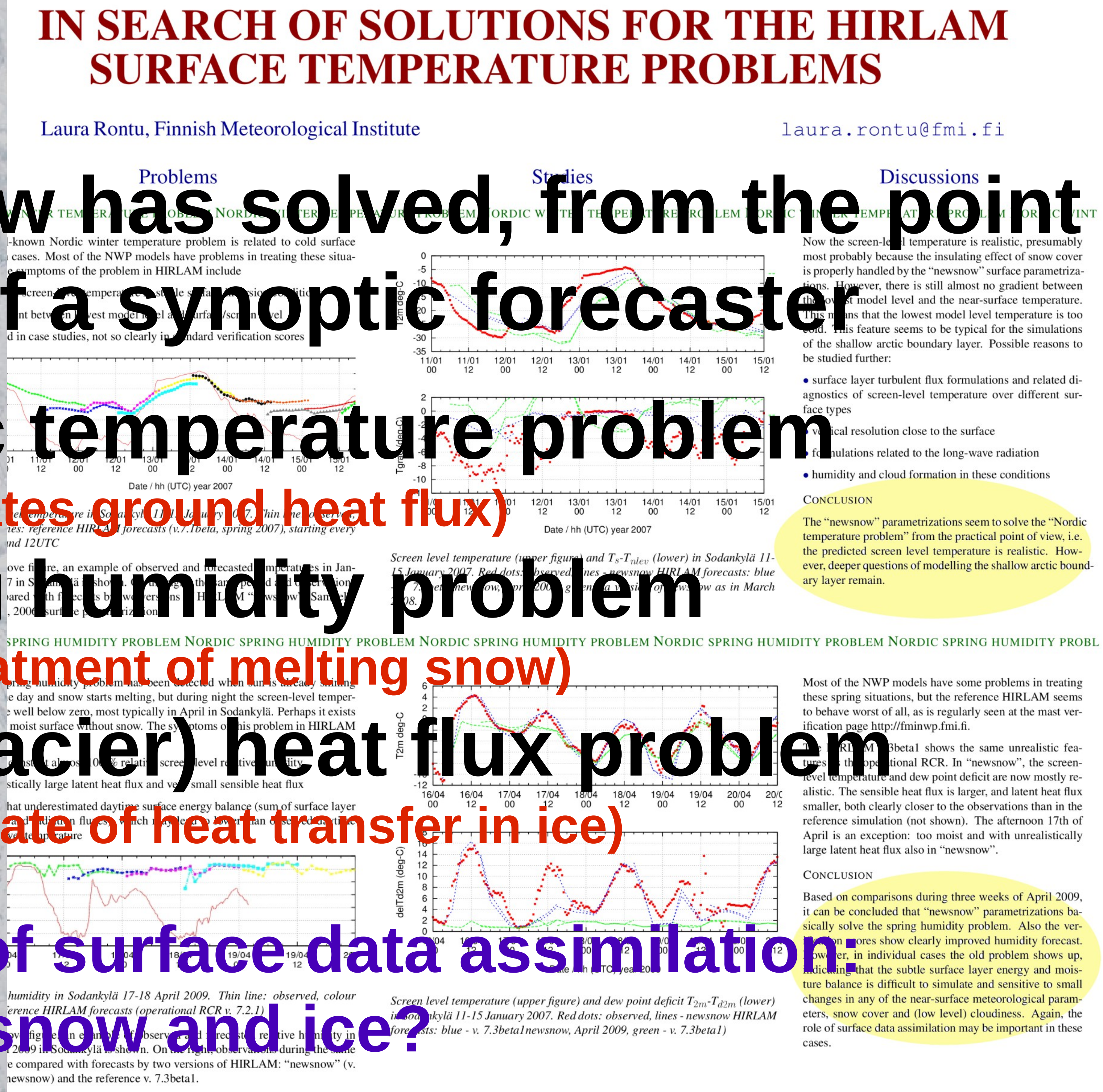
NWP: Dynamics Parametrizations
NWP ANALYSIS
NWP FORECAST - FIRST GUESS
(SNOW)ANALYSIS
SURFACE LAYER AND BELOW SURFACE
DEDICATED
(SNOW)FORECAST – FIRST GUESS

SNOW AND VEGETATION

From HIRLAM ”newsnow” to HARMONIE MEB

Snow data assimilation

ASM09 poster/LR:



Newsnow has solved, from the point of view of a synoptic forecaster

- Nordic temperature problem

(snow insulates ground heat flux)

- Spring humidity problem

(realistic treatment of melting snow)

- Ice (glacier) heat flux problem

(better estimate of heat transfer in ice)

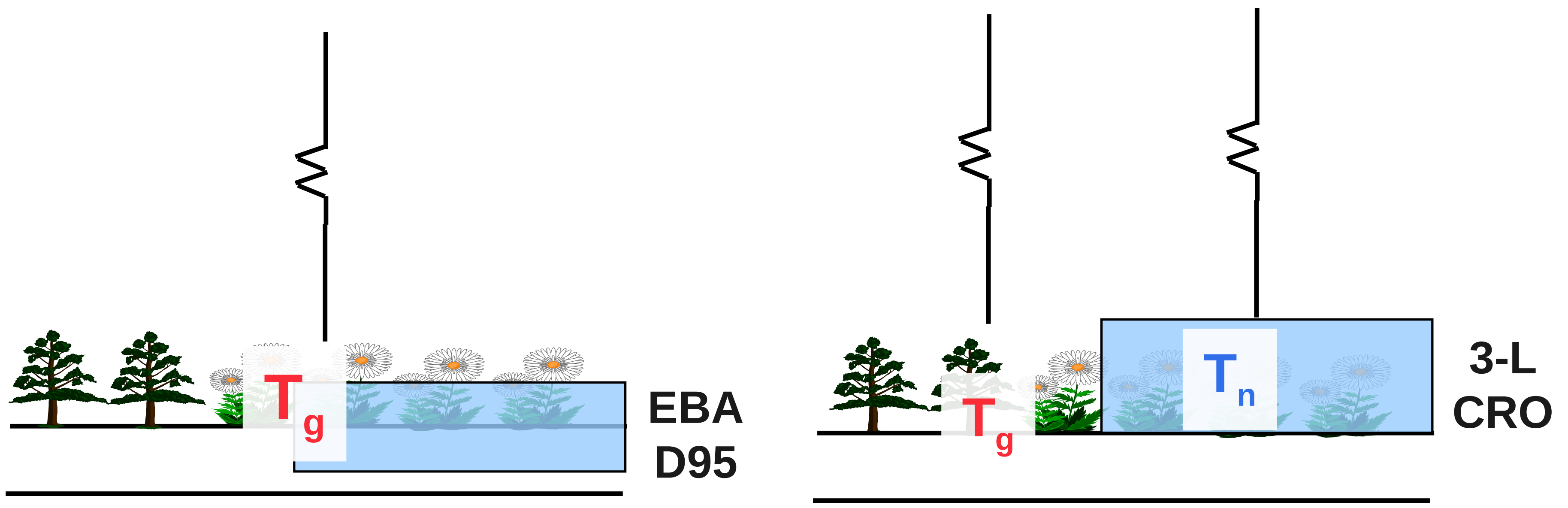
The role of surface data assimilation: where is snow and ice?

Implementation of multi-energy balance (MEB) into SURFEX

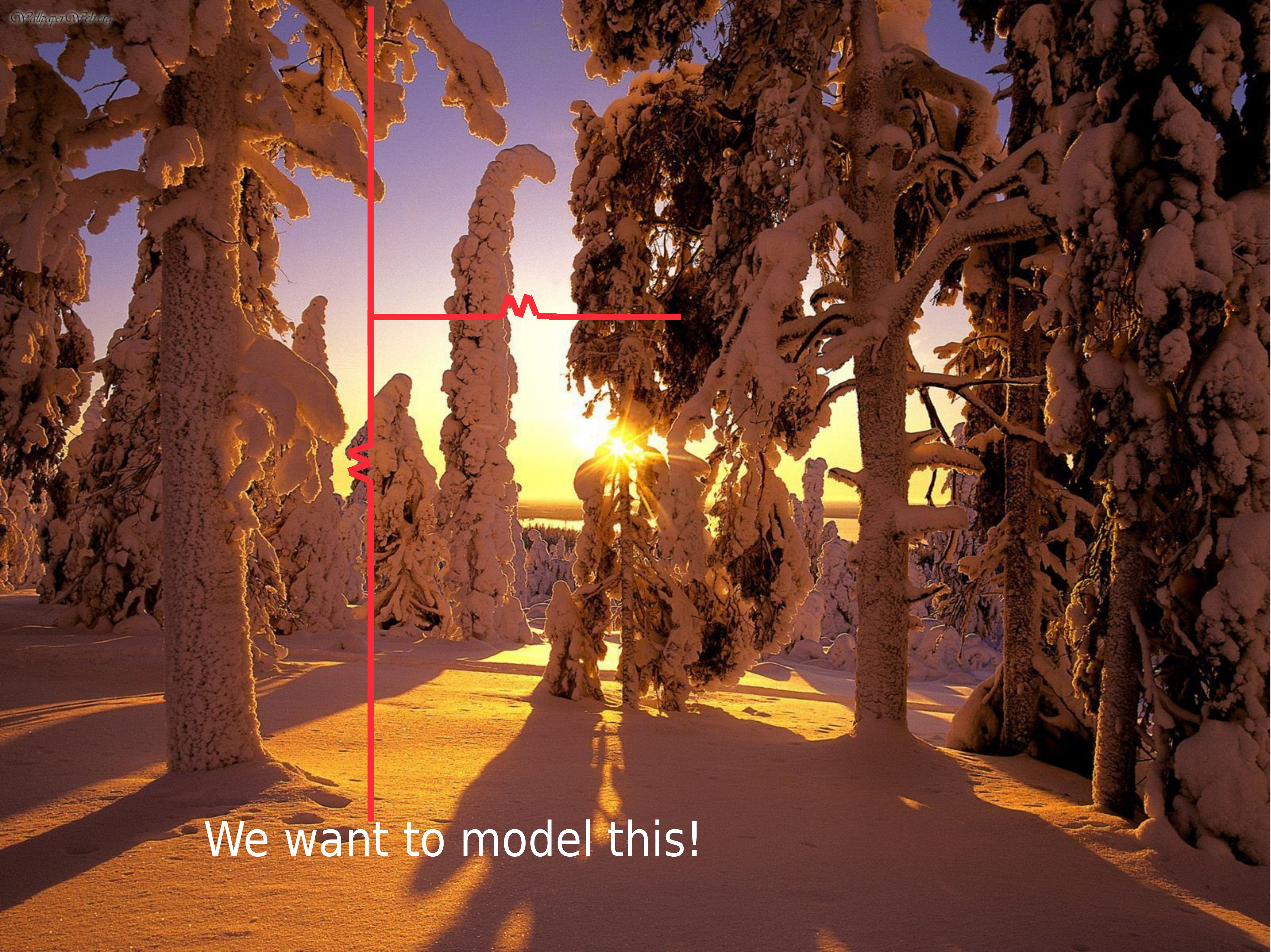
Patrick Samuelsson **Stefan Gollvik**
SMHI

Aaron Boone **Christophe Canac**
Meteo France

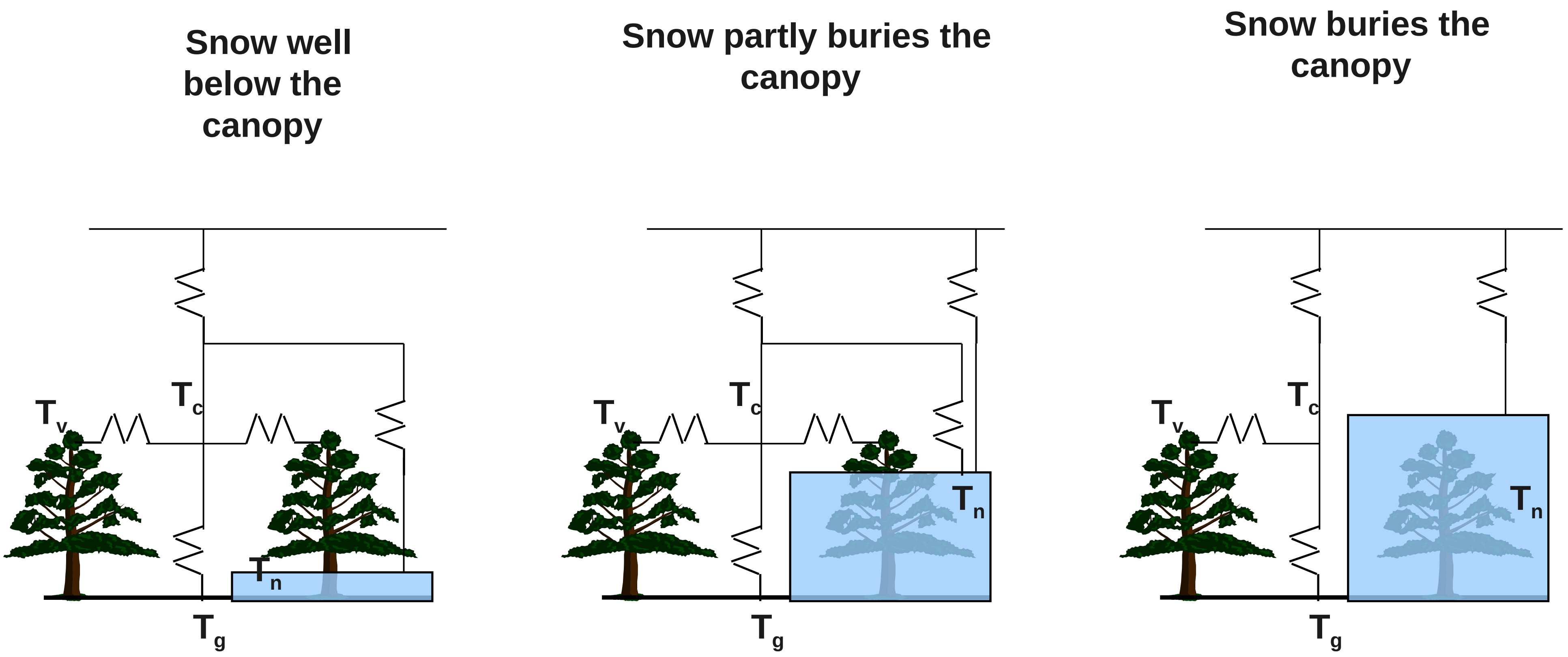
Current SURFEX 6.1 ISBA



No explicit canopy vegetation energy balance (temperature)!


We want to model this!

Multi-Energy Balance (MEB)



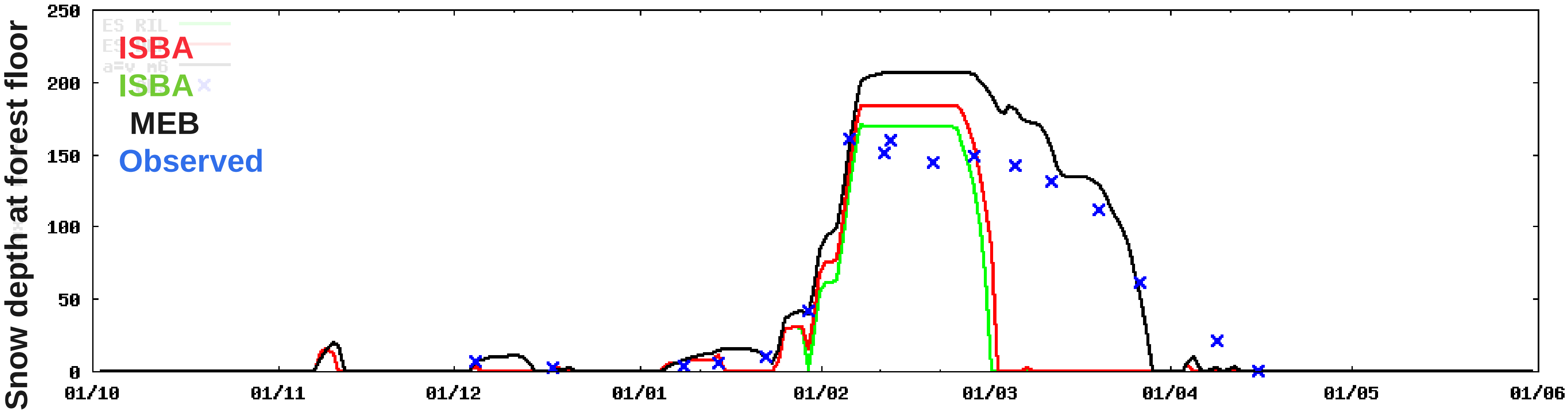
MEB is designed to work with

- snow schemes 3-L and CRO (requires separate snow energy balance)
- soil schemes 2-L & 3-L (force restore) and DIF (diffusion)

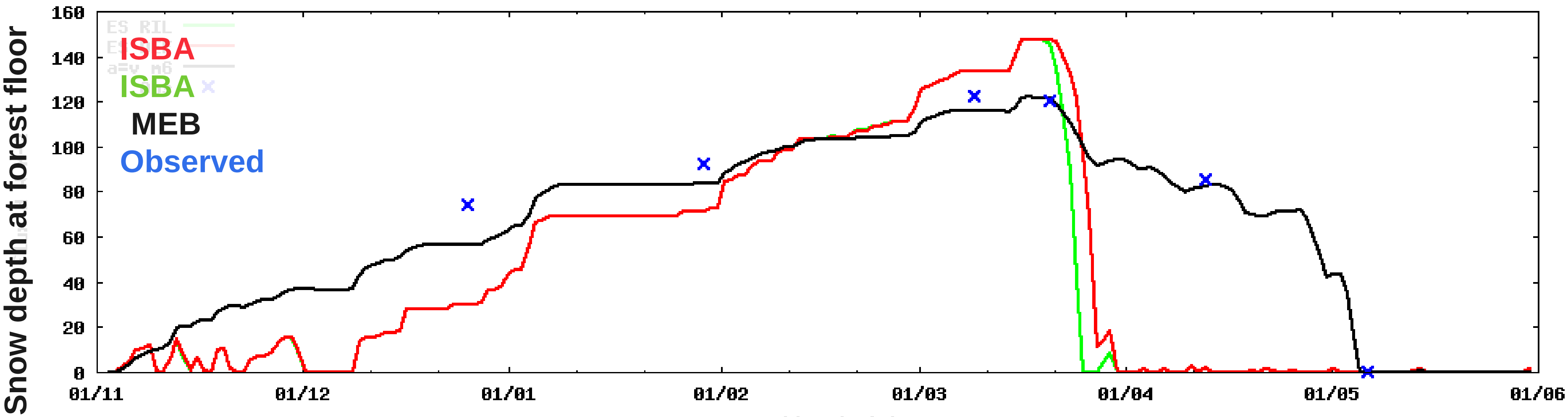
Evaluation of MEB

Two SnowMIP2 forest sites where snow interception matters

Alptal (Switzerland), 1185 masl, trees: 25 m, LAI 4.2



Fraser (US Rockies), 2820 masl, trees: 27 m, LAI 5

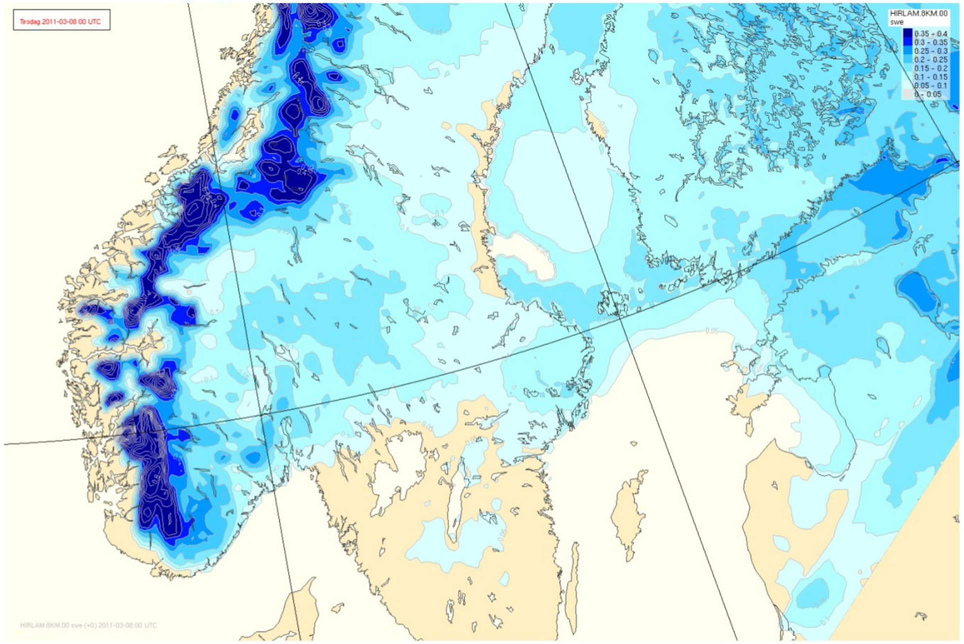


Time over snow season

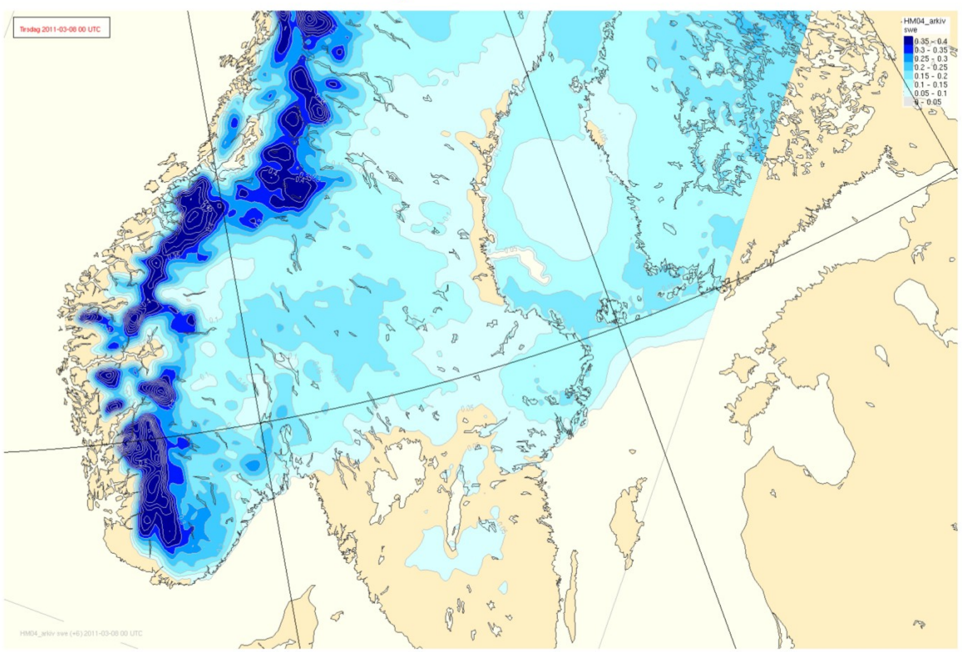
By Mariken Homleid, 2011

Status of snow analysis in HARMONIE

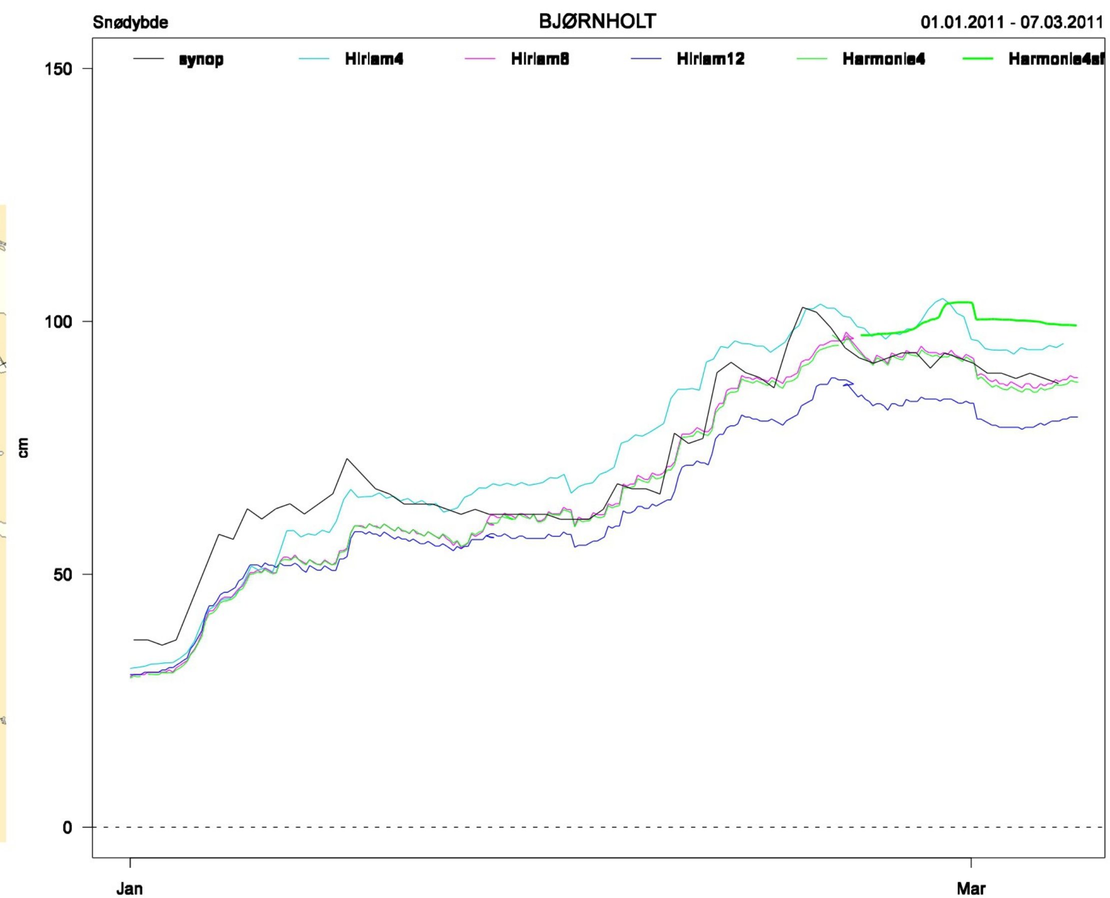
- in analogy with HIRLAM’s snow analysis
- in HARMONIE at met.no since 18 February 2010
- HARMONIE and HIRLAM are very close
- good results at stations with representative observations, e.g. Bjørnholt:



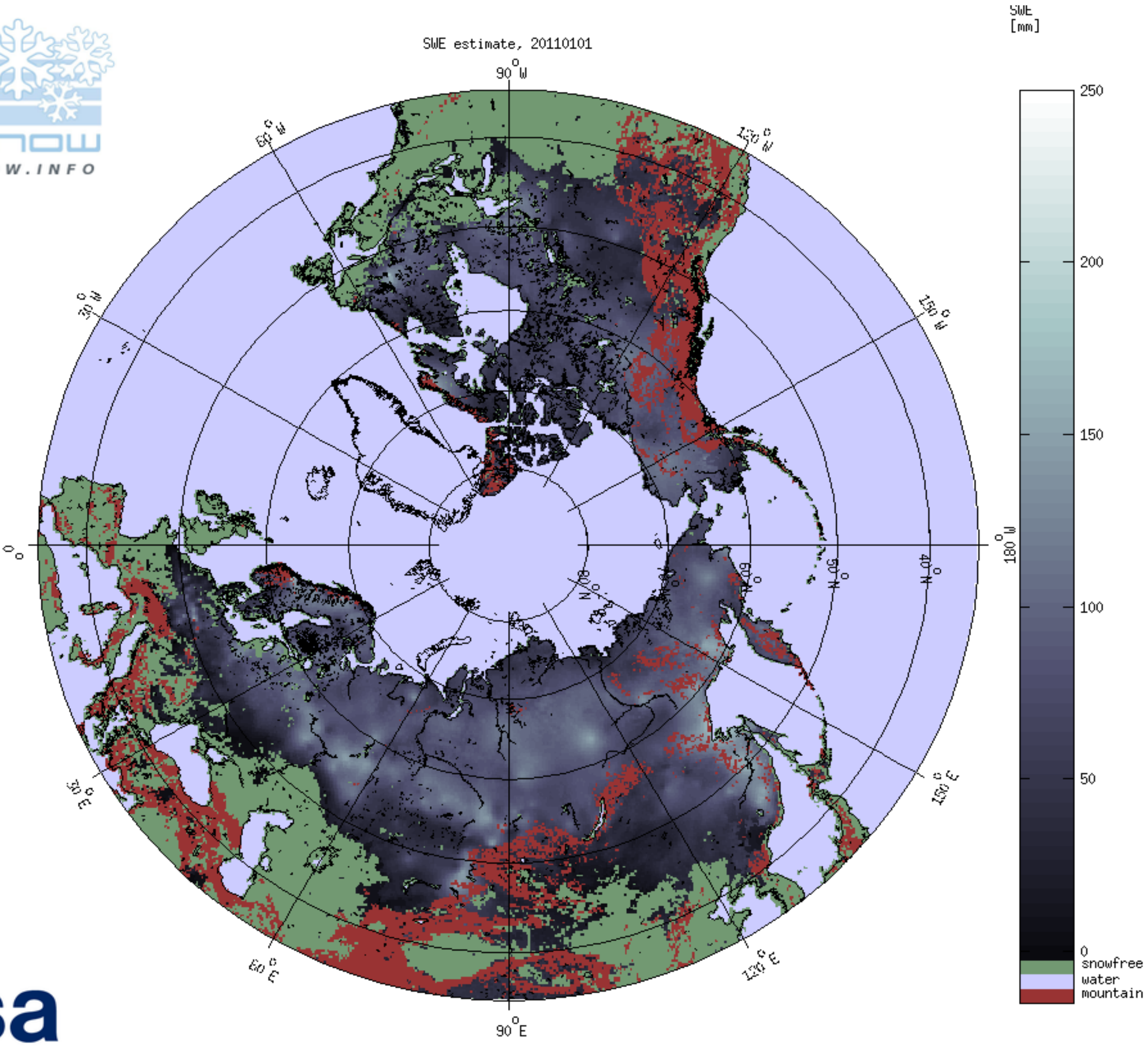
Hirlam8 snow water equivalent 8 March 2011



Harmonie4 snow water equivalent 8 March 2011

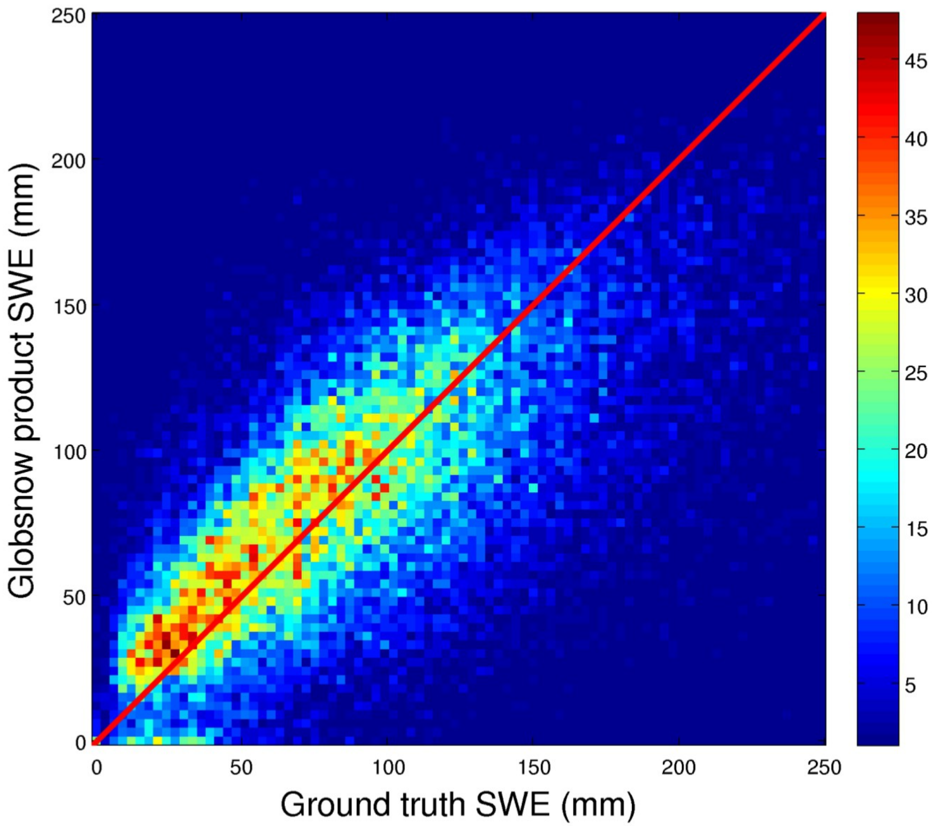


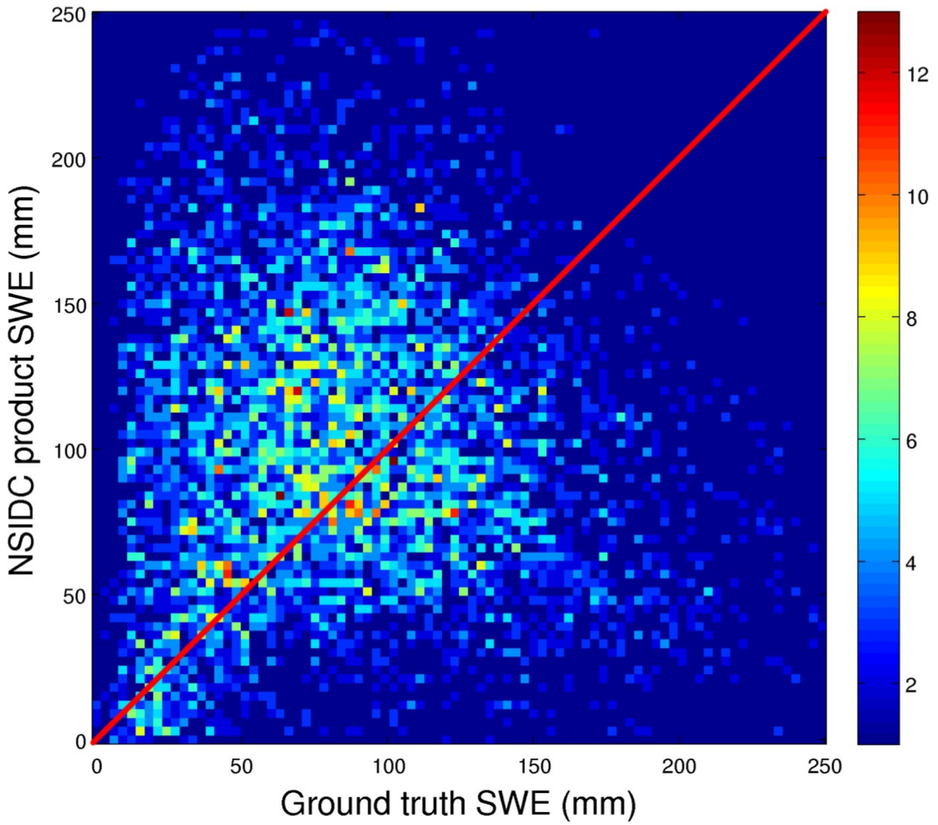
Globsnow
www.globsnow.info



SWE retrieval accuracy (I)

- **Density scatterplot**
- **Ground truth data is INTAS SCCONE SWE path data**

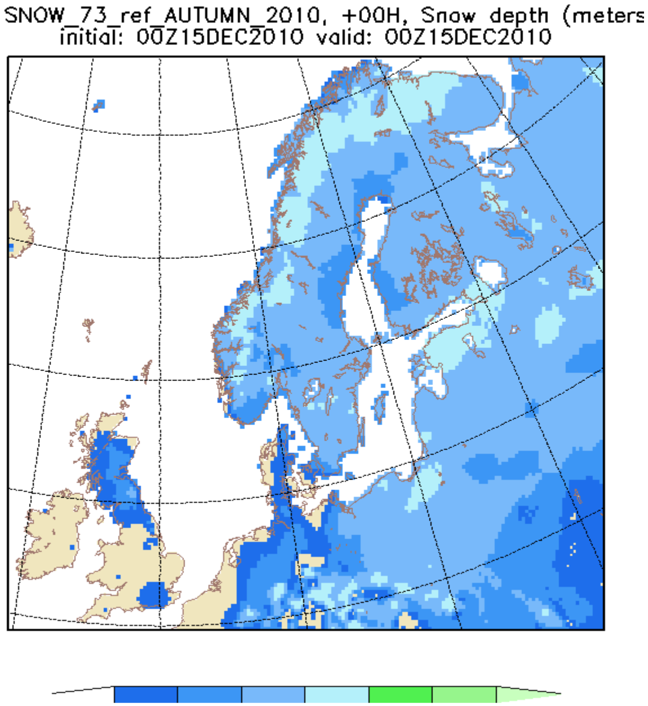


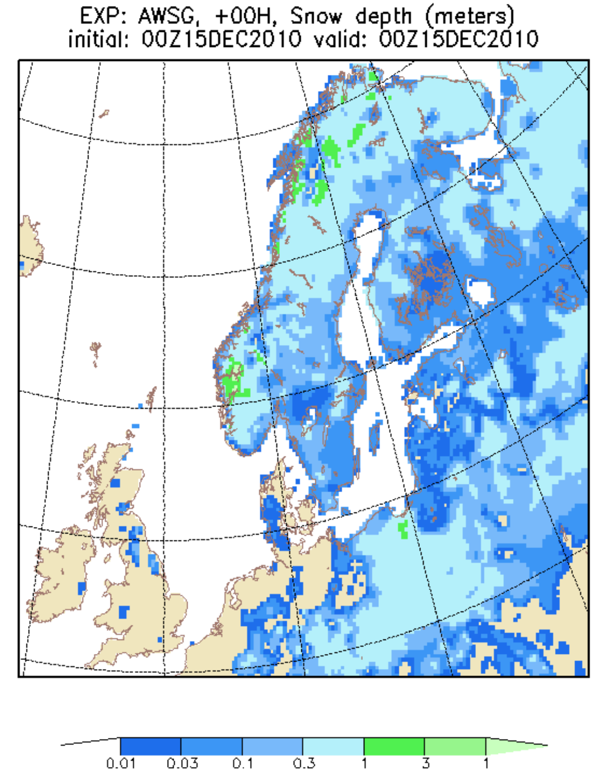


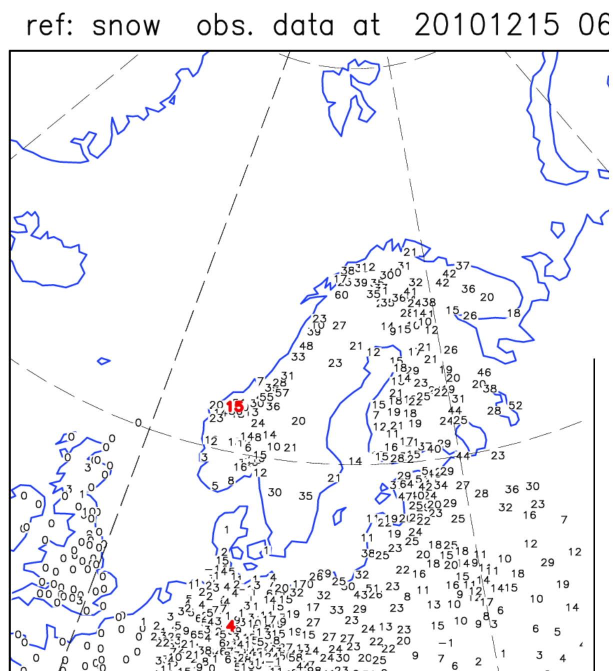
By Jouni Pulliainen, 2011

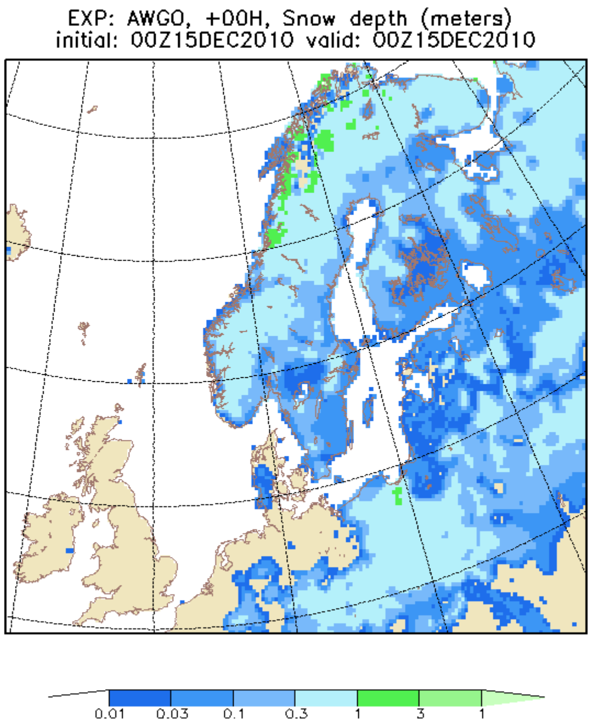
HIRLAM + Globsnow

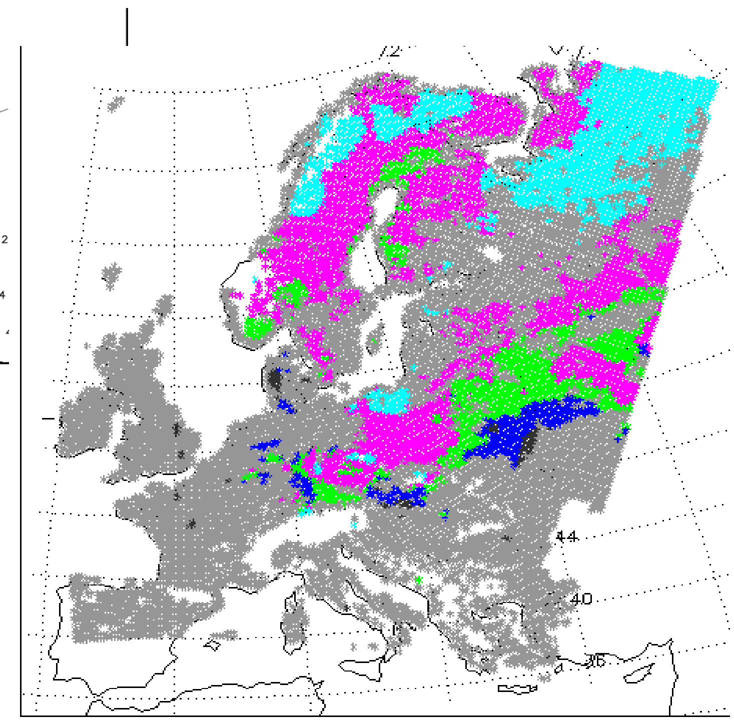
15 December 2010





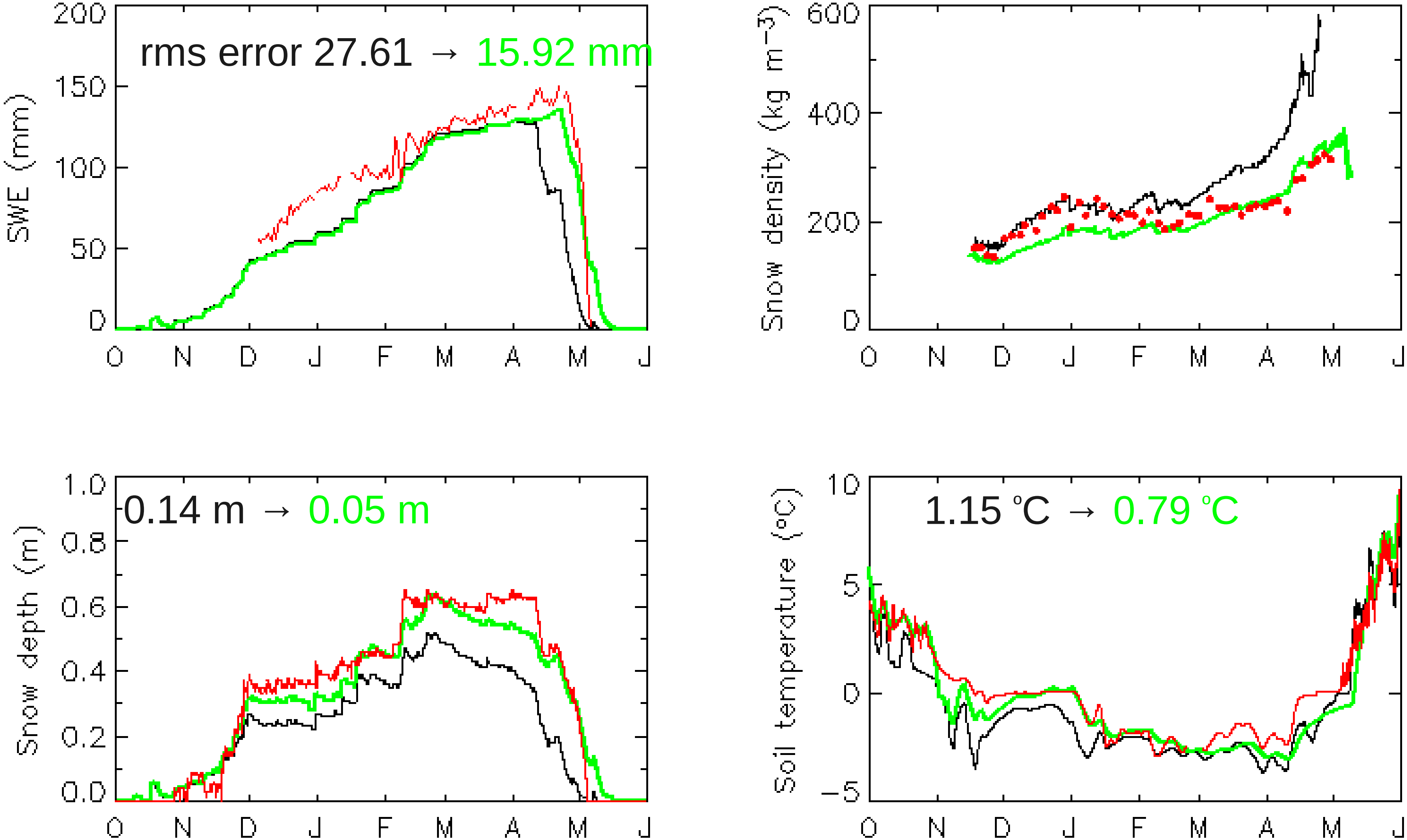






By Suleiman Mostamandy

Sodankylä 2008-2009:
CoSDAS snow model + data assimilation



By Richard Essery ESA COREH2O Snow Data Assimilation Study

SNAPS

Snow, Ice and Avalanche Applications

Northern Periphery Programme

2007–2013

HARMONIE CONTRIBUTION TO SNAPS

How to profice useful information for avalanche forecasters and model by using HARMONIE with SURFEX

- **Atmospheric conditions:**
  near surface wind, temperature, humidity, radiation, precititipitation
- Kilometre-scale **snow maps** over complex orography
  from SYNOP and satellite input
- **Advanced snow properties** like
  snow depth, density, water content, layers
- **High-resolution orography** available in HARMONIE

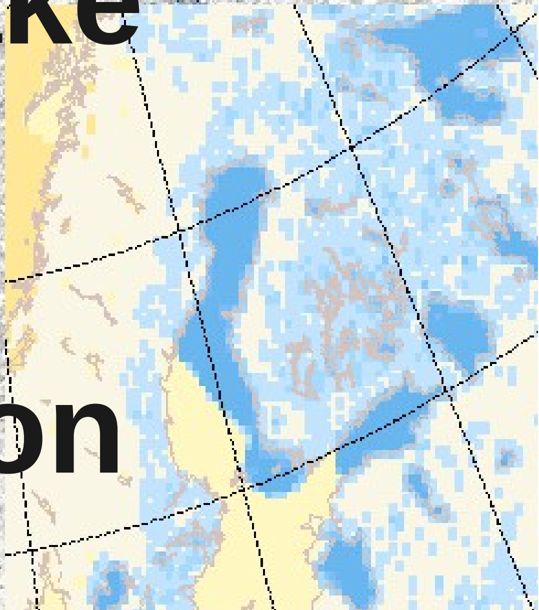
- run HARMONIE experiments
  over Iceland and Northern Scandiavia and verify
- improve snow data assimilation
- define and validate snow variables

LAKES

Lake depth and climatology data

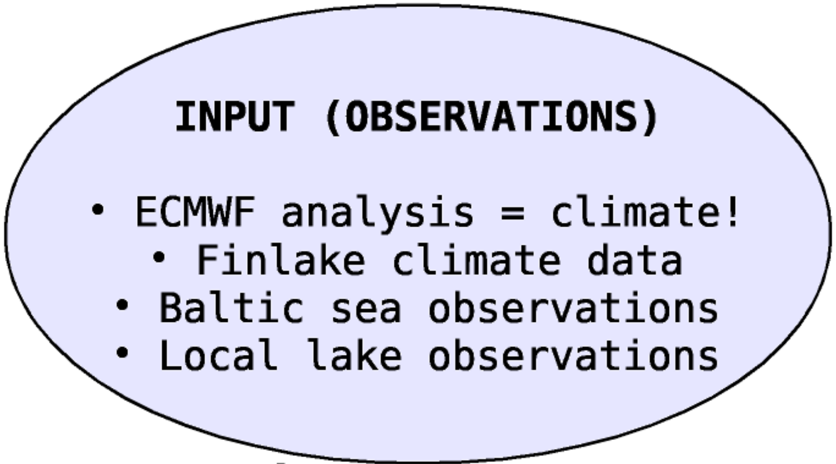
Lake modelling – Flake

Lake data assimilation

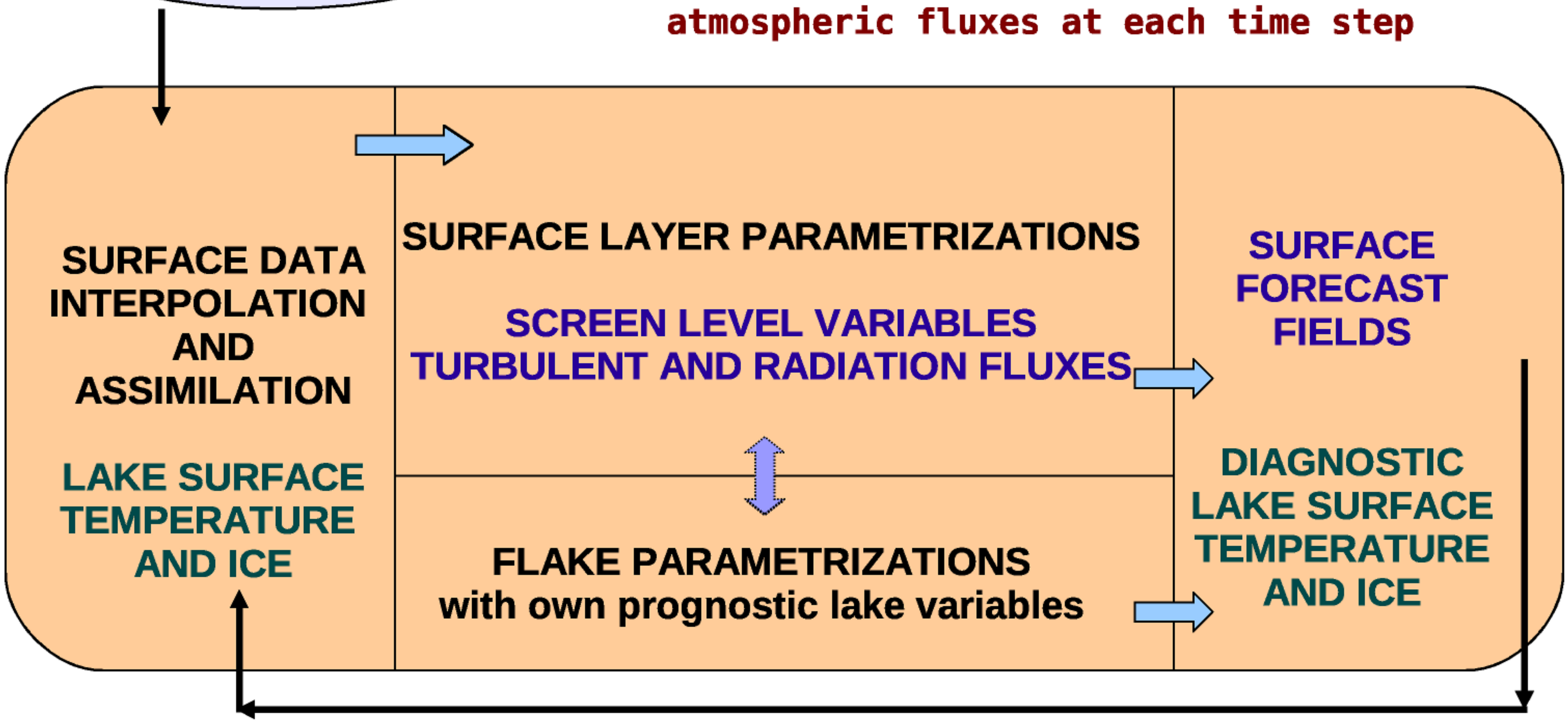


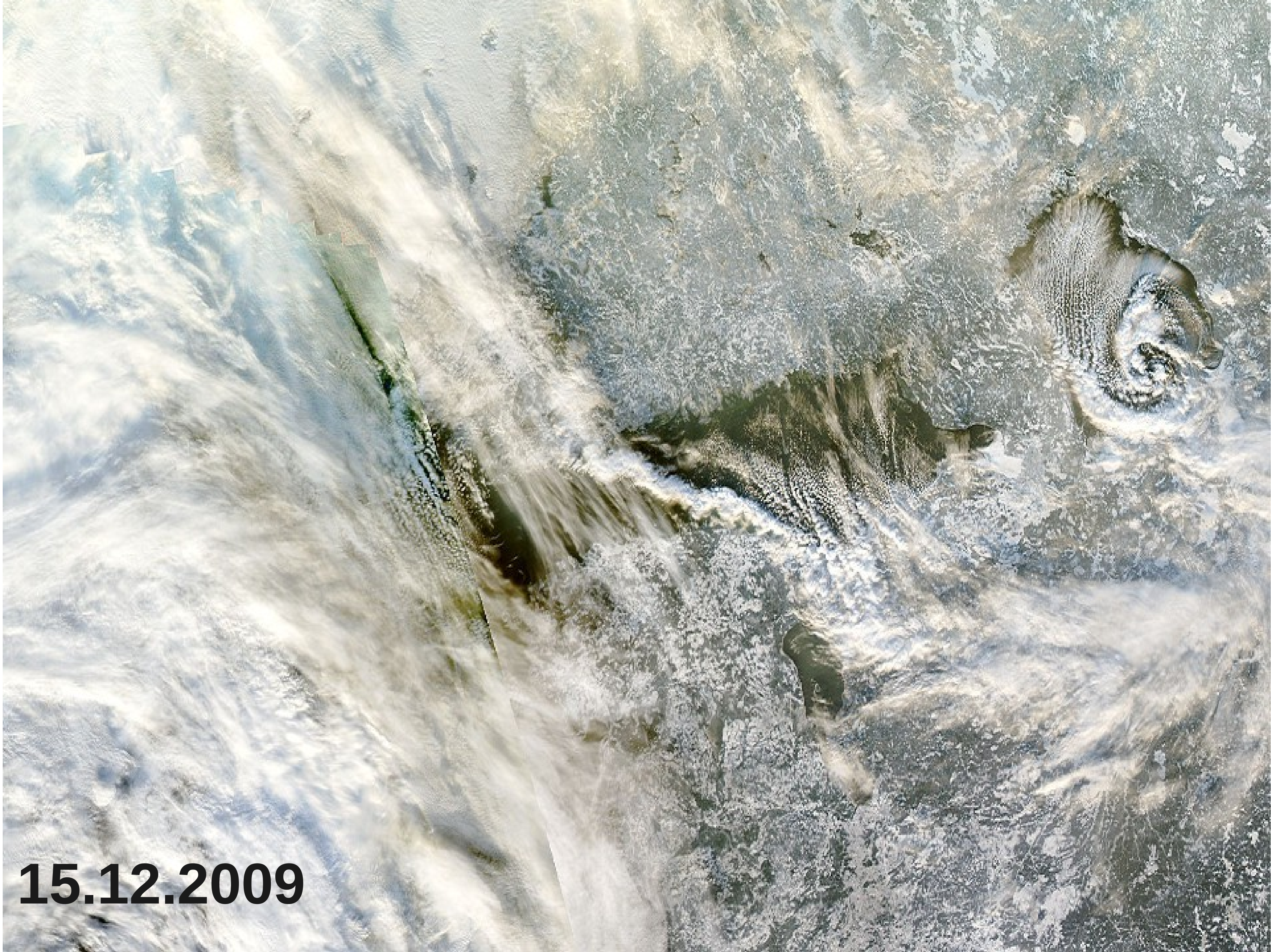
STATUS OF FLAKE IN OPERATIONAL HIRLAM AND IN SURFEX	Depth and fraction of lakes	Cold start climate data	Data assimilation	Prognostic model
HIRLAM	Implemented in climate generation	Implemented in climate generation	Peaceful coexistence LST, ice	Integrated to ISBA + all over HIRLAM switchable
SURFEX	Stand-alone only	Stand-alone only	Not implemented	Module for water tile

PEACEFUL COEXISTENCE OF SURFACE DATA ASSIMILATION AND FLAKE



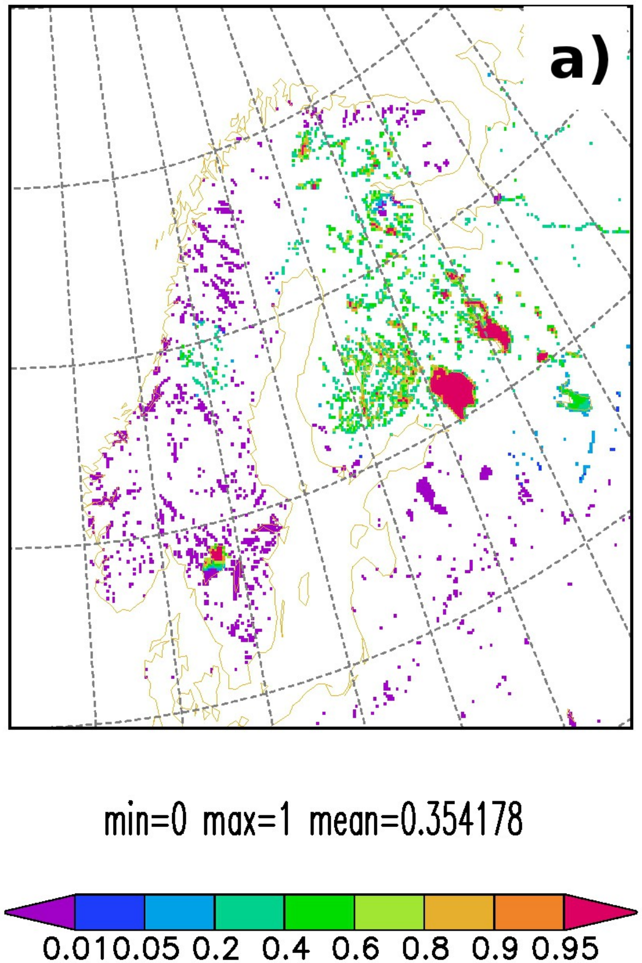
- FLake provides background for the LST analysis
- FLake prognostic lake variables are not influenced by the data assimilation
- During the forecast, the HIRLAM surface layer parametrizations see the assimilated SST and ice/water fraction and evolving lowest model level variables
- FLake parametrizations know the evolving atmospheric fluxes at each time step



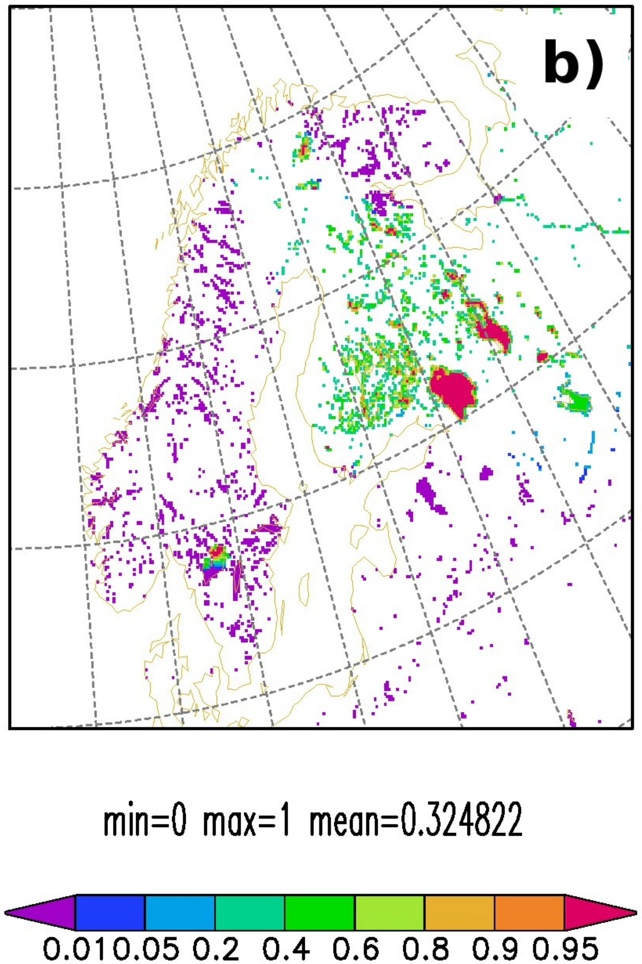

15.12.2009

Fraction of ice over lakes

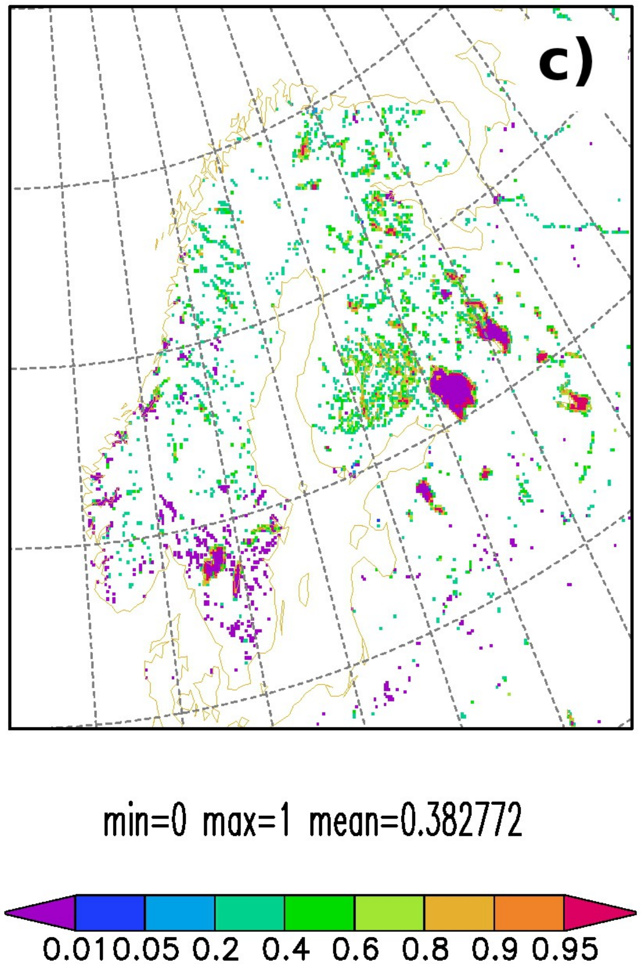
Climatological



Analysed

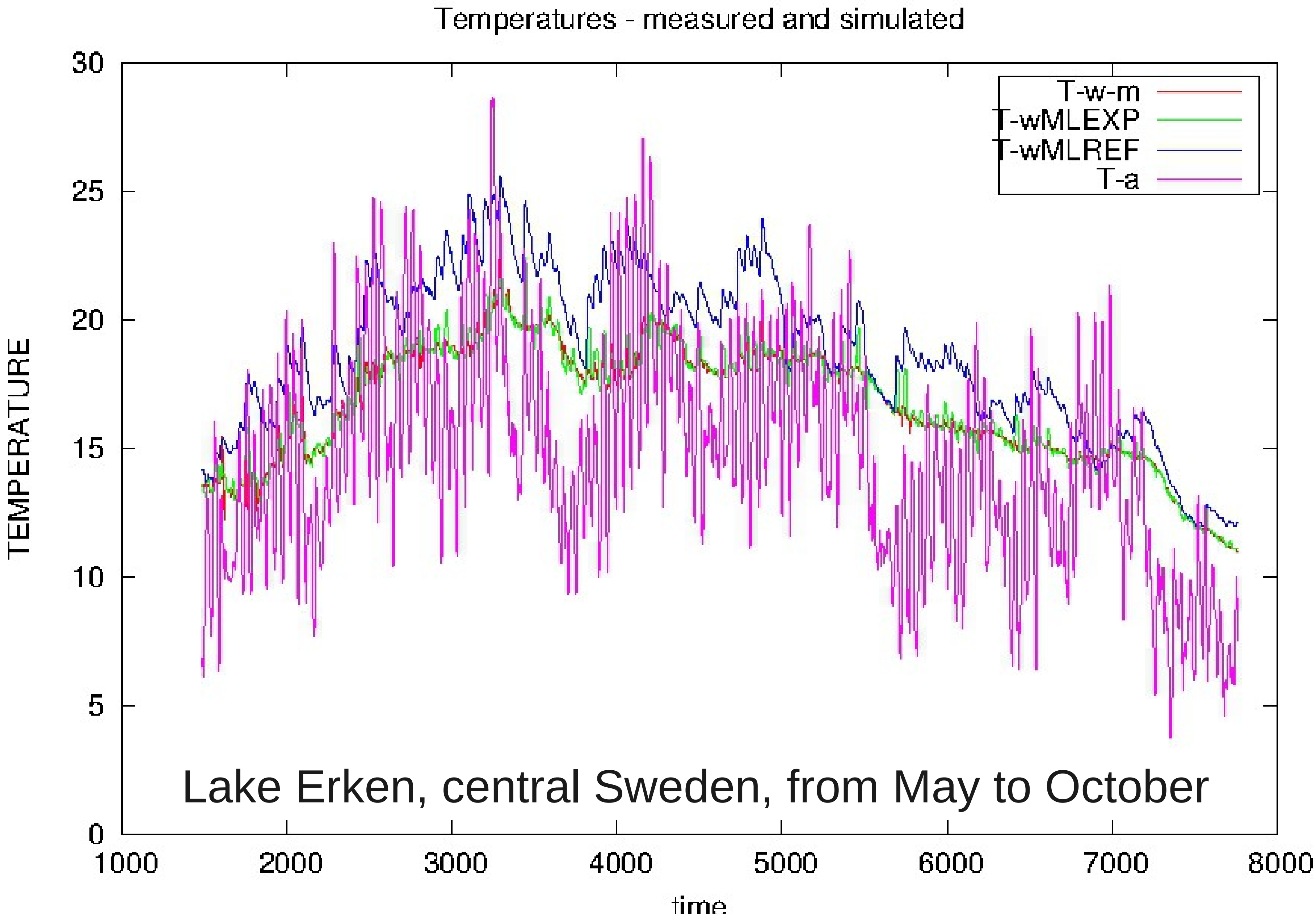


FLake



15.12.2009

A FIRST ATTEMPT TO ASSIMILATE LAKE SURFACE TEMPERATURE FOR FLAKE

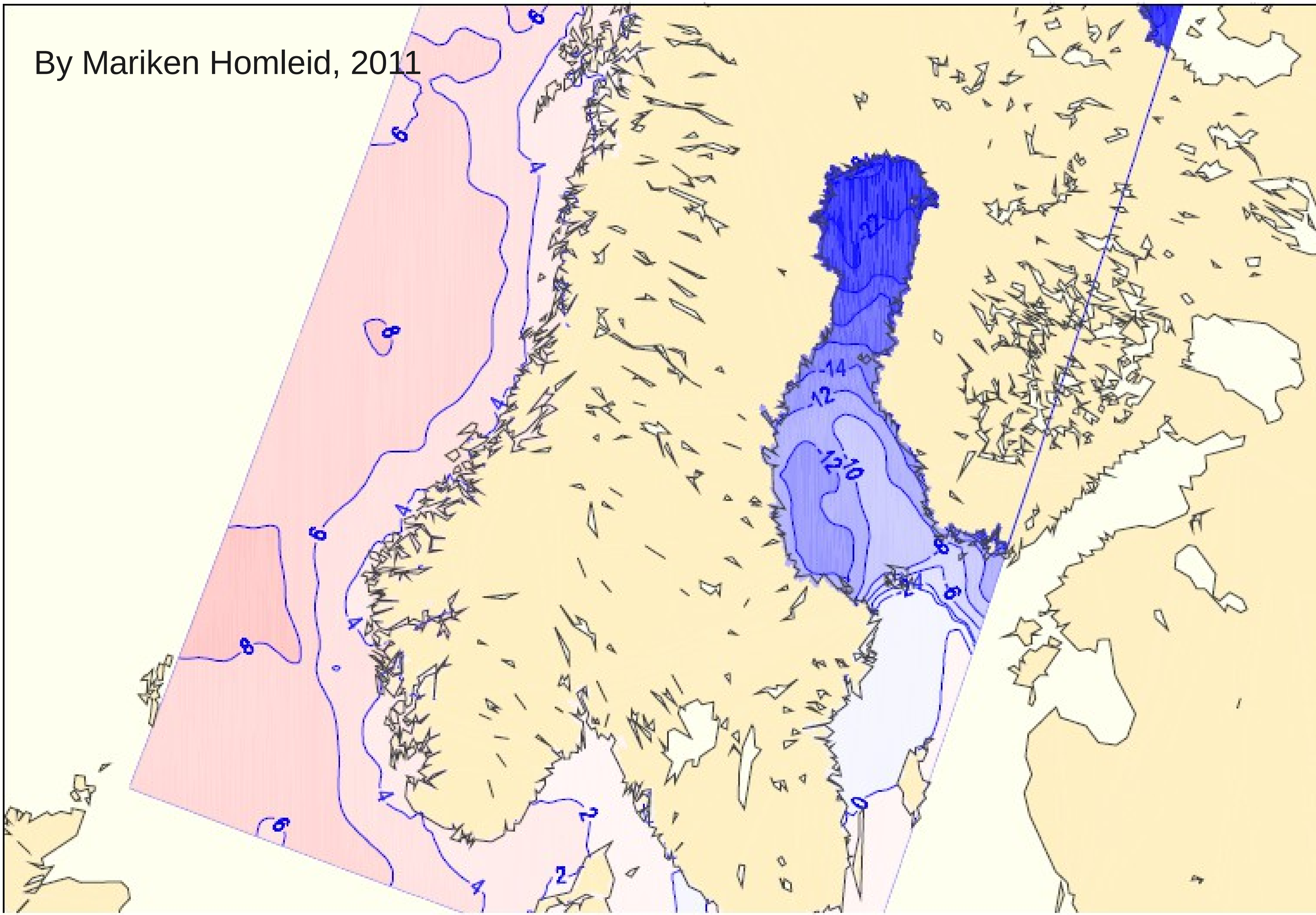


by E.Kurzeneva, 2011

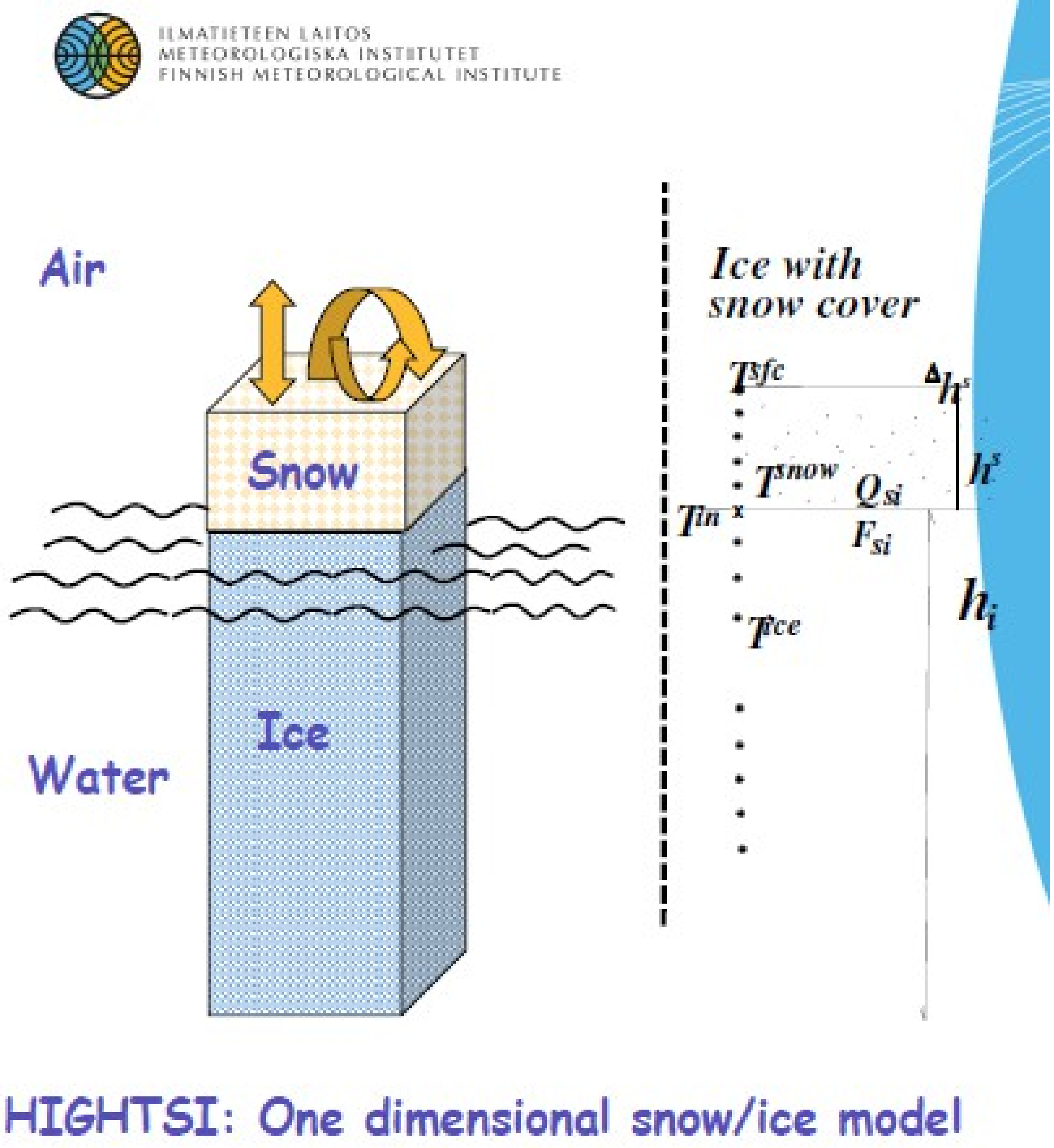
SEA SURFACE TEMPERATURE AND SEA ICE

SST AND ICE DATA ASSIMILATION

SEA ICE AND SNOW THERMODYNAMIC MODELLING



Example of OSTIA SST from ECMWF boundaries optimally interpolated to HARMONIE. If SST < 271.2 K, ice can be diagnosed



HIGHTSI

HIGH RESOLUTION THERMODYNAMIC ICE AND SNOW MODEL

by Bin Cheng et al., FMI 1998 -

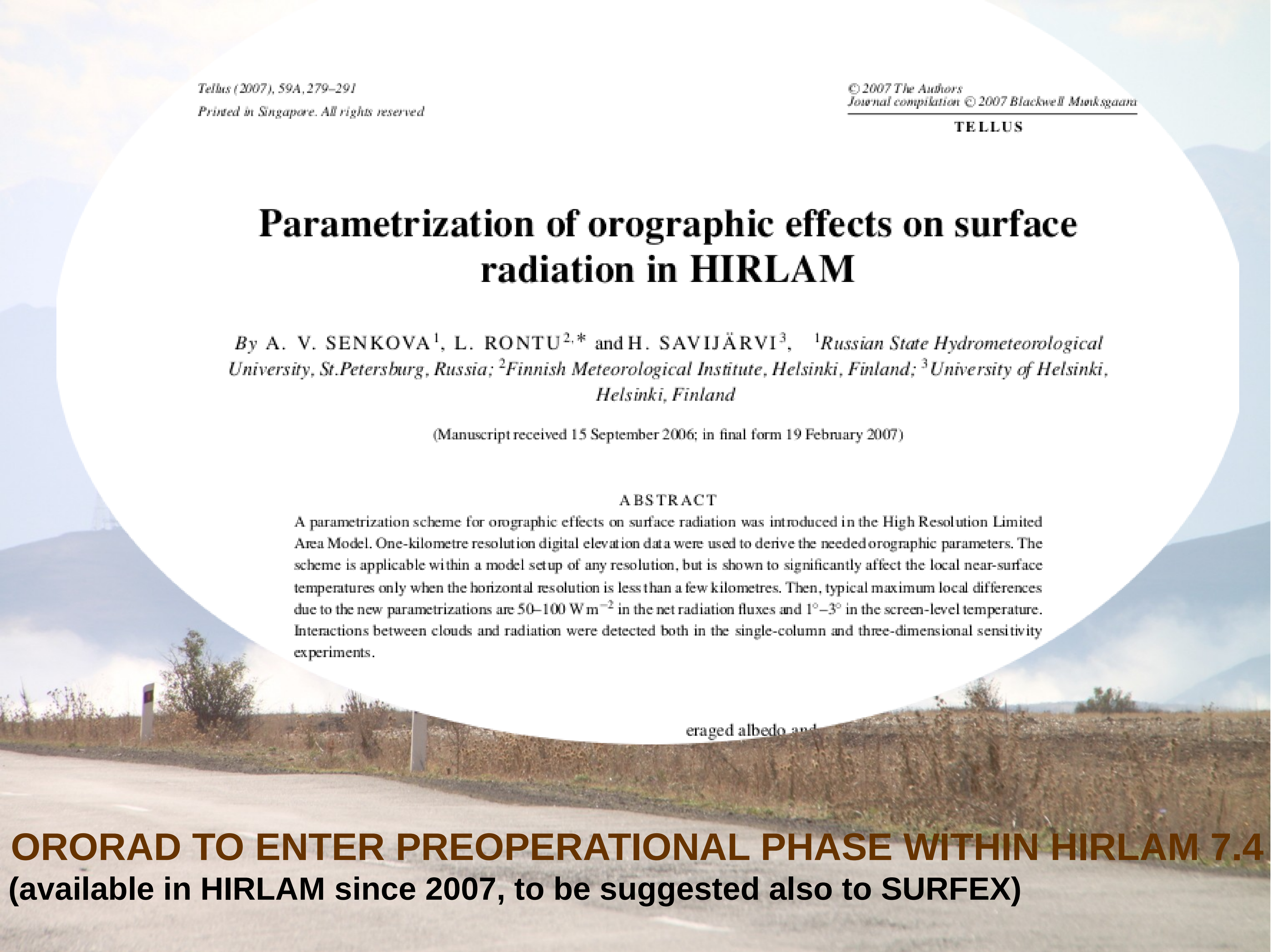
Implementation to SURFEX prognostic model and coupling to SST/sea ice analysis, started recently

HIGHTSI Documentation found best via
http://www.atm.helsinki.fi/~jaraisan/numlab2011/NumLab11.html

OROGRAPHY

Parametrisation of orographic radiation effects

Consistent usage of digital elevation data in NWP



Tellus (2007), 59A, 279–291
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TELLUS

Parametrization of orographic effects on surface radiation in HIRLAM

By A. V. SENKOVA[1], L. RONTU[2,*] and H. SAVIJÄRVI[3], [1]Russian State Hydrometeorological University, St.Petersburg, Russia; [2]Finnish Meteorological Institute, Helsinki, Finland; [3]University of Helsinki, Helsinki, Finland

(Manuscript received 15 September 2006; in final form 19 February 2007)

ABSTRACT

A parametrization scheme for orographic effects on surface radiation was introduced in the High Resolution Limited Area Model. One-kilometre resolution digital elevation data were used to derive the needed orographic parameters. The scheme is applicable within a model setup of any resolution, but is shown to significantly affect the local near-surface temperatures only when the horizontal resolution is less than a few kilometres. Then, typical maximum local differences due to the new parametrizations are 50–100 W m^{-2} in the net radiation fluxes and 1°–3° in the screen-level temperature. Interactions between clouds and radiation were detected both in the single-column and three-dimensional sensitivity experiments.

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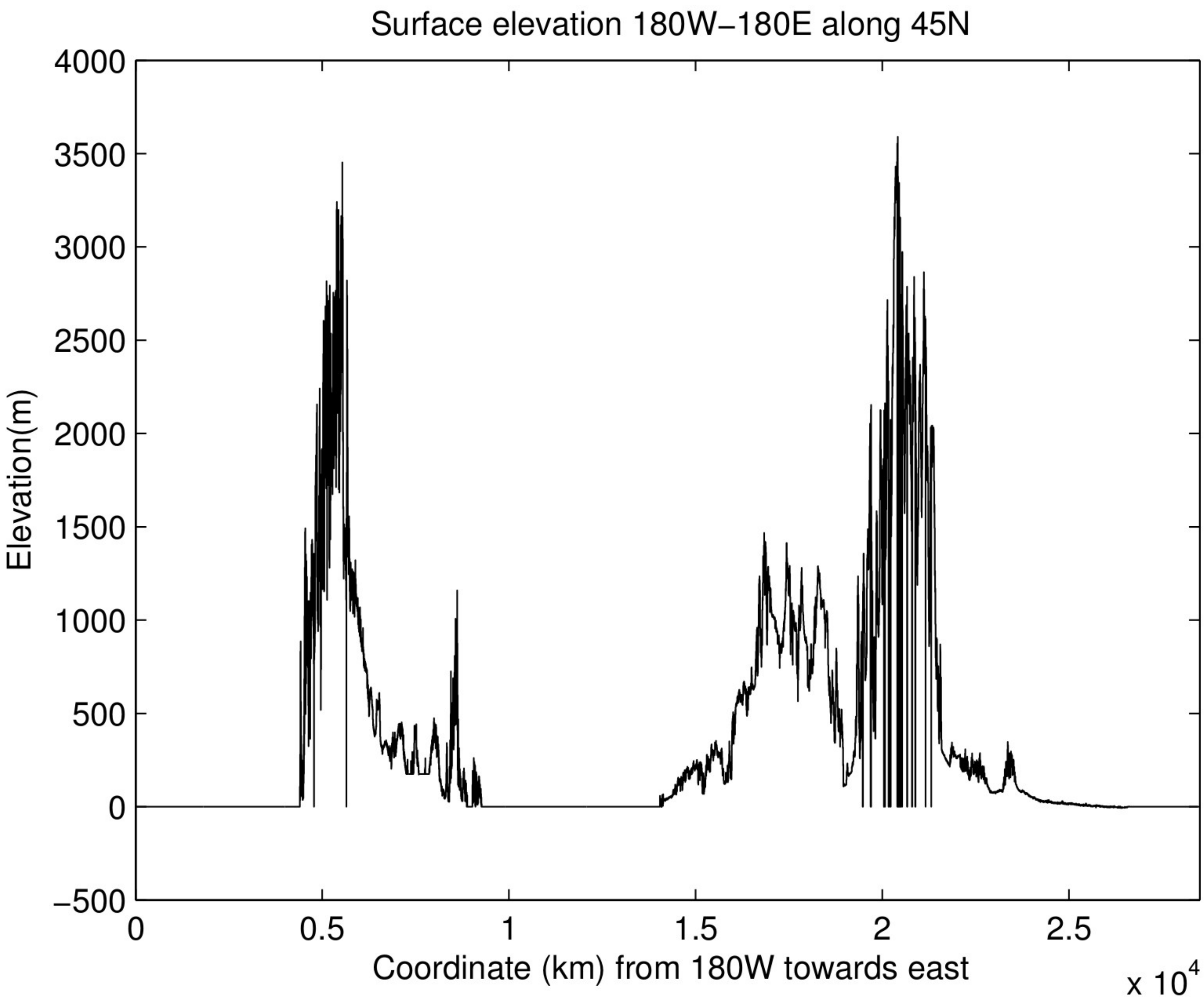
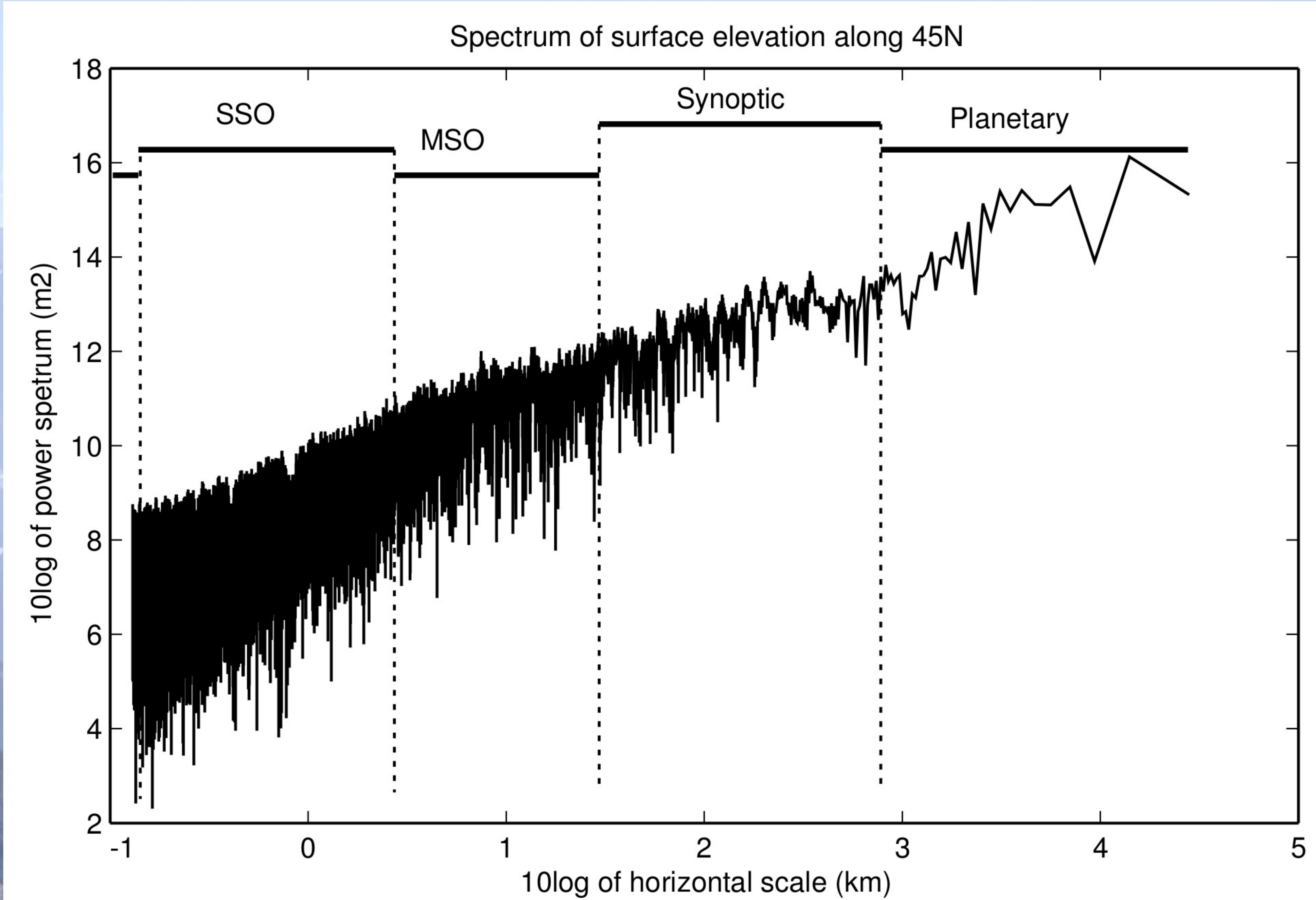
ORORAD TO ENTER PREOPERATIONAL PHASE WITHIN HIRLAM 7.4

(available in HIRLAM since 2007, to be suggested also to SURFEX)


Surface elevation 180W−180E along 45N
Elevation(m)
4000
3500
3000
2500
2000
1500
1000
500
0
−500
0
0.5
1
1.5
2
2.5
Coordinate (km) from 180W towards east
x 10^4



Spectrum of surface elevation along 45N
SSO
MSO
Synoptic
Planetary
18
16
14
12
10
8
6
4
2
-1
0
1
2
3
4
5
10log of power spetrum (m2)
10log of horizontal scale (km)

OROGRAPHIC PLAN

Take the most detailed global digital elevation data (ASTER?)
Do (spectral) filtering to separate scales for derivation of variables for

- **Model dynamics**
- **Orographic buoyancy wave parmetrisations**
- **Smallest scale orographic effects on momentum fluxes**
- **Orographic radiation parametrisations**

SOIL

Testing soil moisture and temperature

analysis by variational methods

within SURFEX

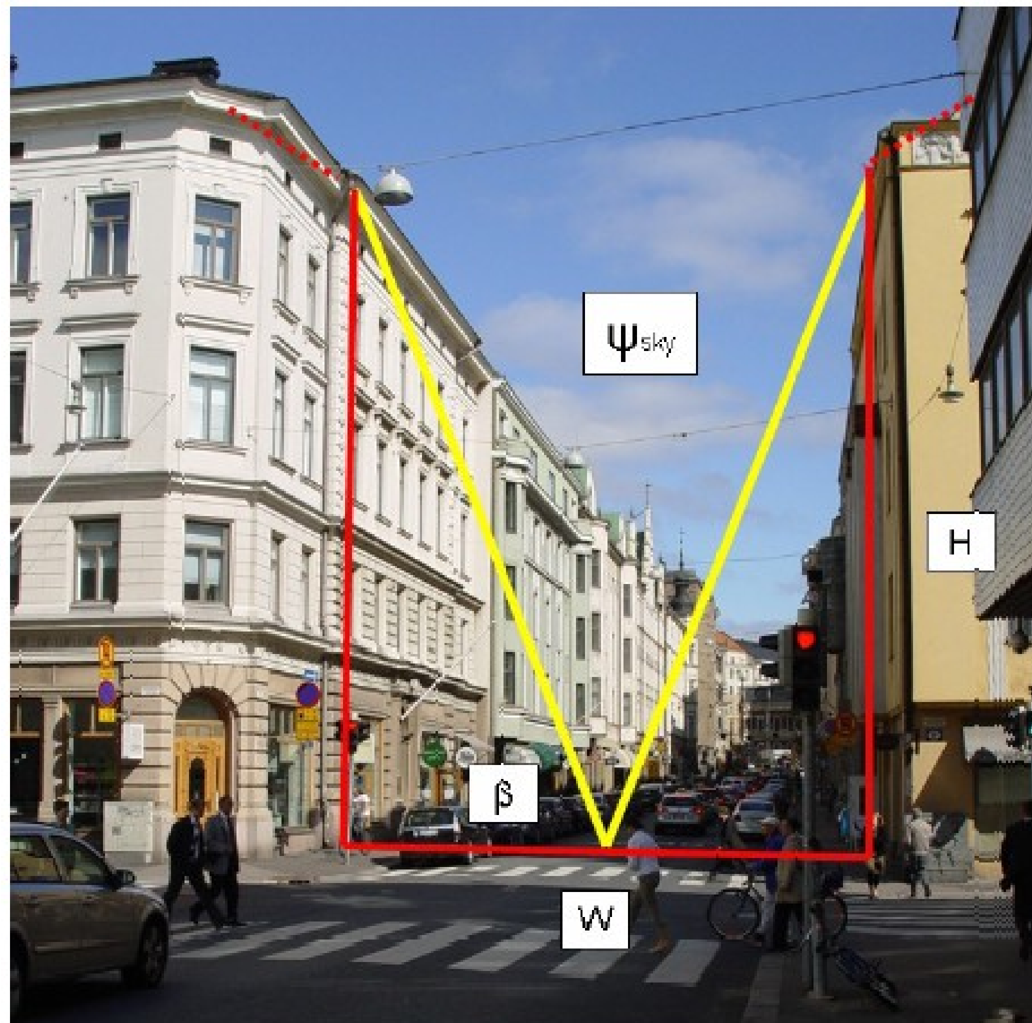
URBAN

High resolution town descriptions

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Central Helsinki in a nutshell

- **On the coast, 60.2 N, 25.9 E**
- **Minor orographic variations**
- **Population: 600 000, 1 M in Helsinki metropolitan area**
- **Fairly closed streets**
- **Building height 20-30 m**
- **Mostly built in the early 20th century**
- **brick, concrete, steel frame**
- **street surfaces mostly asphalt and granite setts**
- **Photo: Uudenmaankatu, Achim Drebs**



EURO4M

EUROPEAN REANALYSIS AND OBSERVATIONS FOR MONITORING

Tracking changes in European climate

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Specifically, the objectives of EURO4M are to:

- Generate datasets consisting of time series of observations and reanalyses of past observational data;
- Produce innovative and integrated high-quality data products for research and practical applications;
- Out reach to the user community, stakeholders, policy-makers and the general public with data products and climate services;
- Evolve into a future GMES service on climate change monitoring that is fully complimentary and supportive of the existing core services.

SEVENTH FRAMEWORK PROGRAMME

HARMONIE surface data assimilation

Mariken Homleid

August 24, 2011

http://netfam.fmi.fi/sfcda11/

http://hirlam.org

Gollvik & Samuelsson


THANK YOU!