Overview of HIRLAM surface activities

Patrick Samuelsson
SMHI

with contributions as acknowledged

but special thanks to HIRLAM system colleagues who are always involved!

General surface comments

cy40h1.1 is our latest operational version of the ALADIN-HIRLAM NWP system with the HARMONIE-AROME model configuration.
cy40h1.2 has been under development for a while but suffers from convective precipitation problems as already reported.
cyxxh represents our future ambitions.

	c**y40h1.1**	**cy40h1.2**	**cyxxh**
Land			
Patches	1	**1 or 2 (no SBL model)**	3 patches with expl. canopy
Soil	Force-restore	Force-restore	Diffusion (14 layers)
Snow	D95	D95	Explicit snow (12 layers)
Glacier	-	-	Explicit snow as glacier
Assimilation	CANARI-OI	CANARI-OI	MESCAN-EKF/EnKF
Sea	SICE	SICE	Sea ice
Lake	Deep soil temp	**FLake (optional)**	FLake (later with EKF)
Town	TEB	TEB	TEB (more options)
Physiog.	ECOCLIMAP	**ECOCLIMAP (modified)**	Utilize high res. data

Now we head for cy43h including SURFEXv8

Great! SURFEXv8 opens up the possibility to utilize more physically based processes for vegetation, snow, soil, hydrology.

Testing of more physically based snow scheme in SURFEX

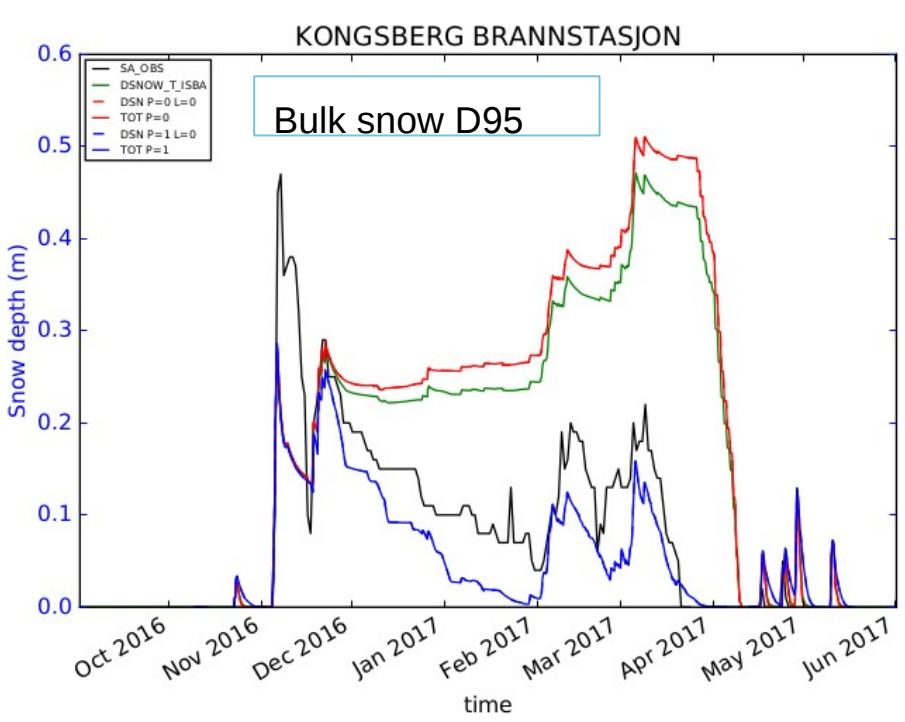
Typical South-Norway site with bulk snow model (D95) vs multi-layer snow model (ES):

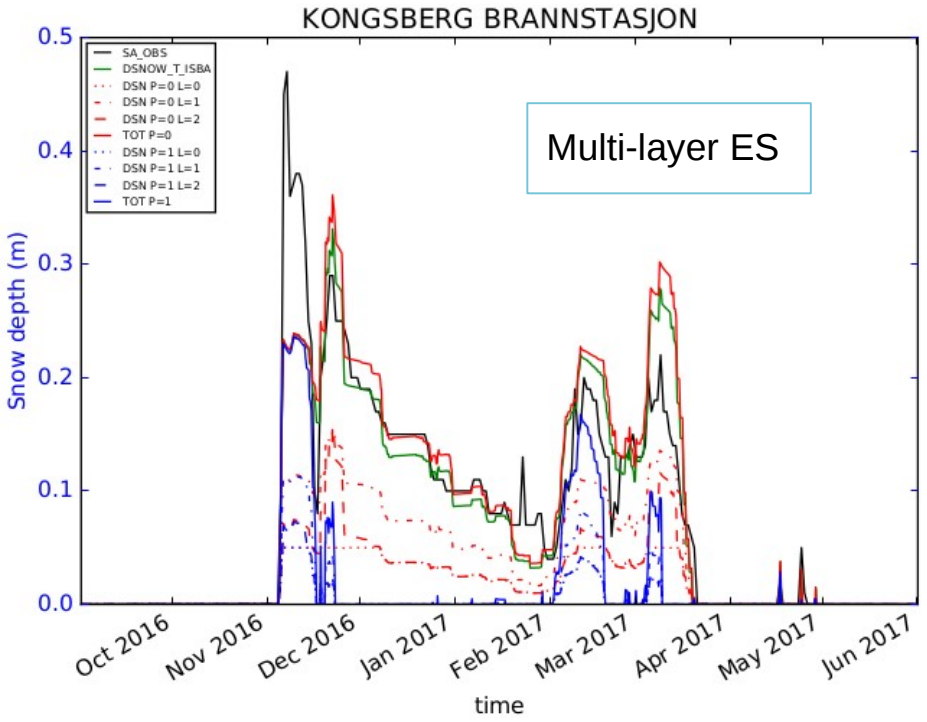
- **ES gives an improvement compared to D95**
- **Not shown, but good performance by ES requires good representation of physiography (separation between forest and open land).**

"Open land" and "forest"
Grid average

Observations in black

"Open land" and "forest"
Grid average





People involved: Trygve Aspelien and Mariken Homleid (MetNorway)

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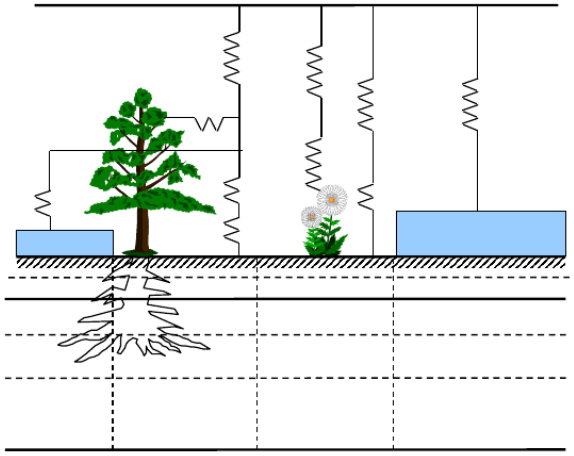
HIRLAM – cy40 SURFEXv7.3 – cy43 SURFEXv8

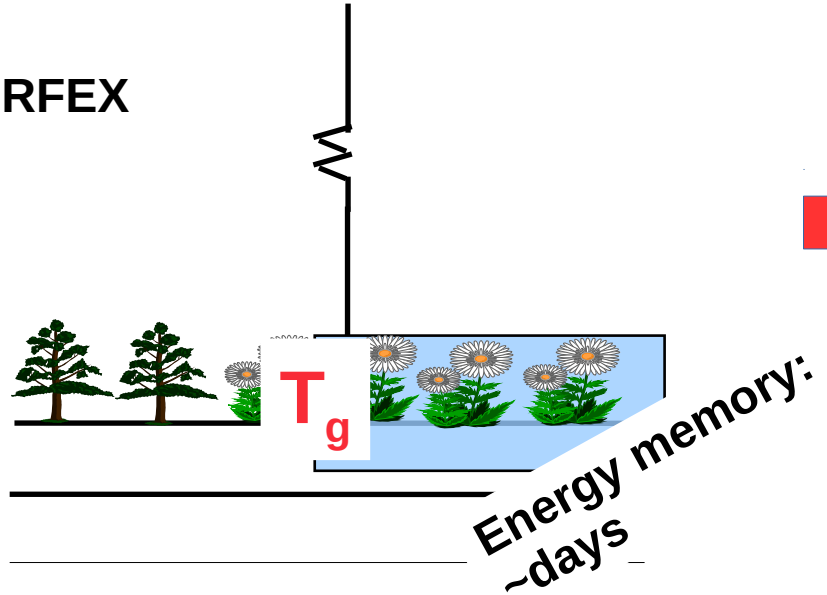
Multi level/energy with OI

HIRLAM

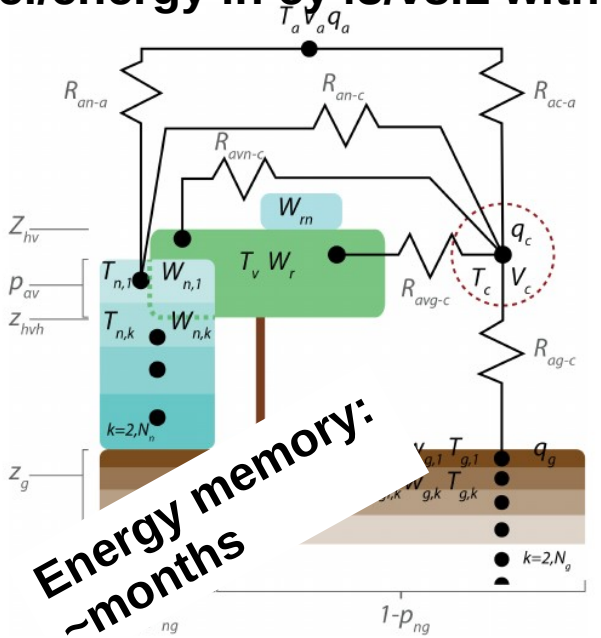


Force-restore in cy40/v7.3 with OI

SURFEX

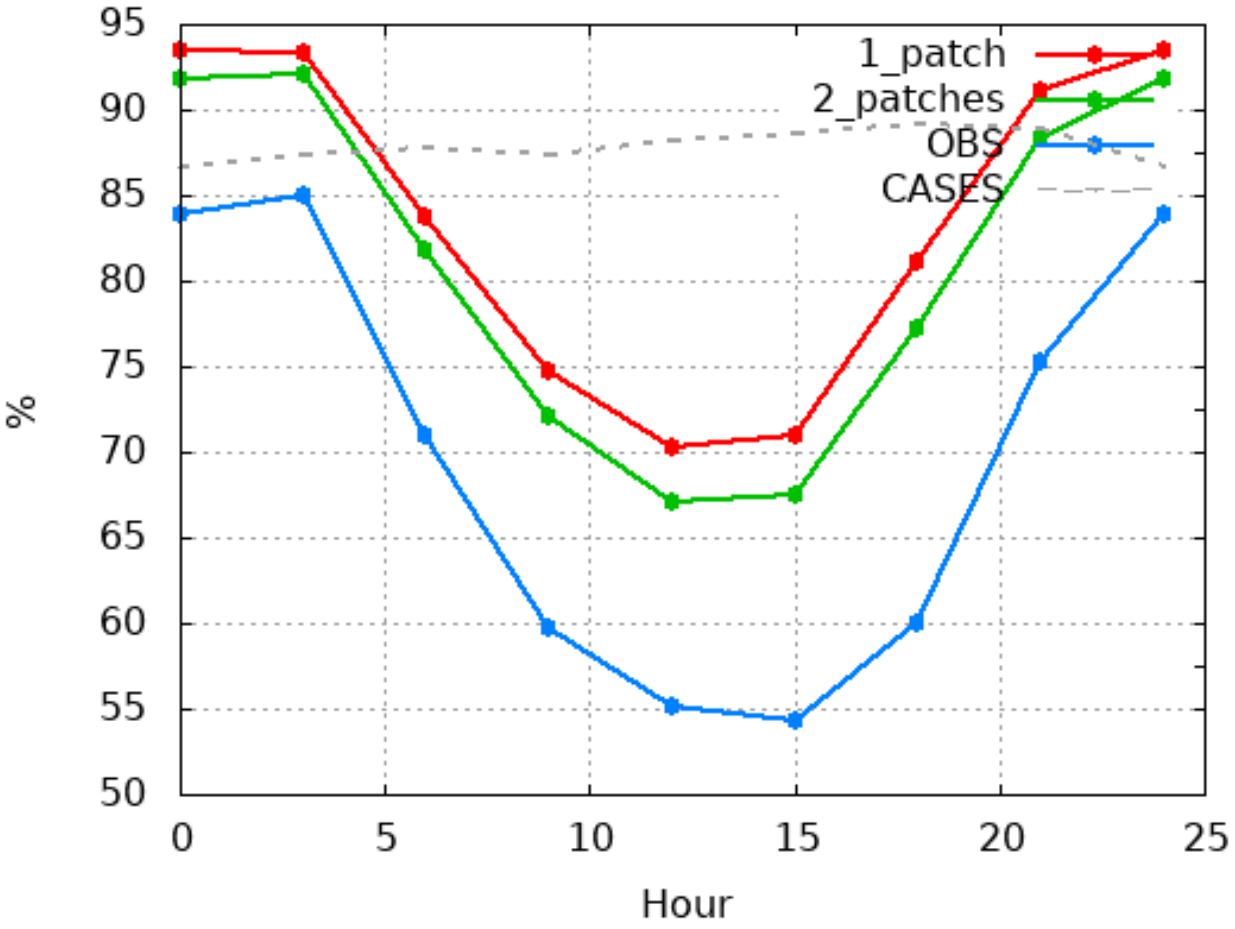


Multi level/energy in cy43/v8.1 with EKF



Current near-surface forecasting problems

Rh2m diurnal cycle for Northern Sweden in May



Positive bias in daytime Rh2m in northern Scandinavia during spring time.

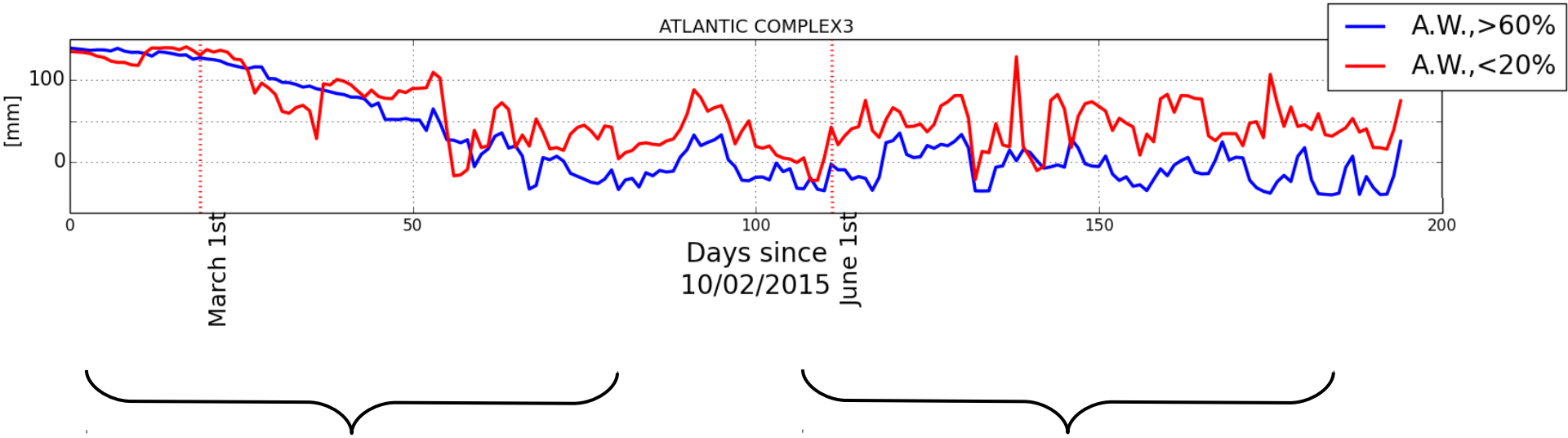
Consequence, e.g., HARMONIE-AROME cannot be used for fire risk assessment.

Hypothesis: need longer soil memory to hinder too quick thawing of soil in spring time.

Observations
cy40h1.1 (operational)
1 average land → separate forest and open land

Current near-surface forecasting problems.

Drying out of soil over the Netherlands



Springtime:
Excess LAI forcing too high evaporation in combination with negative increments in data assimilation.

Summertime:
Inaccurate process descriptions forcing too high evaporation

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With a longer soil memory we can run the system in climate mode (down-scaling, say ~5 years without data assimilation) to identify systematic biases and hopefully reduce them before we activate data assimilation. By including "large-scale mixing" the time may be reduced to let's say 3 years….

Activities in cy43 climate mode

An Ecflow set up is now available to run HARMONIE-AROME in climate mode:

- Restart normally once per month
- SST and Sea-ice concentration read continuously (e.g. each 6th hour)
- Output option: NetCDF in CORDEX style.

The climate mode functionality has been developed by the RCM colleagues, mainly by Rossby Centre at SMHI. Now the climate branch of the HARMONIE configuration is maintained by Bert van Ulft (KNMI).

A wish-list of new SURFEXv8 potential options (new physics) will be tested once we have cy43h running…

The aim is to identify and reduce systematic biases.

People involved: Samuel Viana (AEMET), Patrick Samuelsson (SMHI), ….

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Problem?

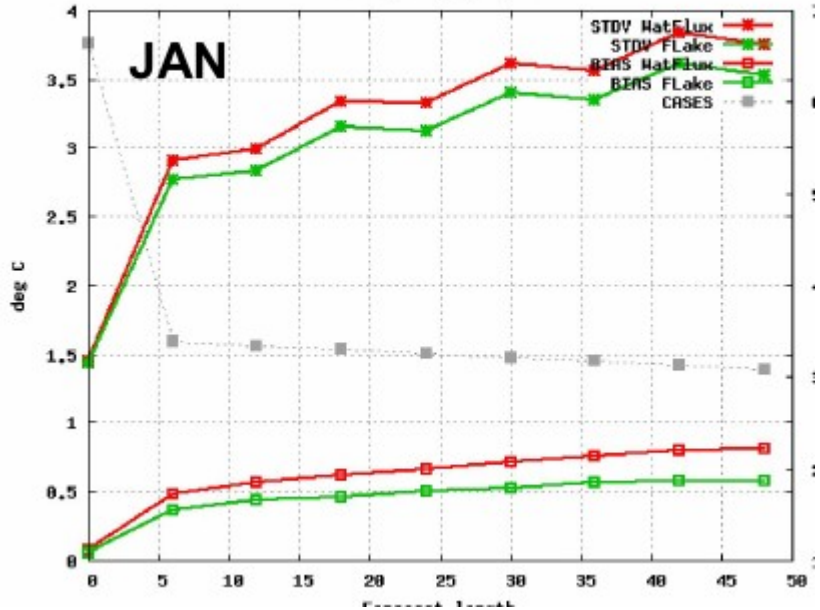
Yes, the "required" spin up period will be longer (for cold start). Maybe 6-12 months…. Lakes, modelled by lake model FLake, introduce a similar need of spinup. But, at least, lakes represent a smaller area.

Talking about lakes… FLake can soon be operational

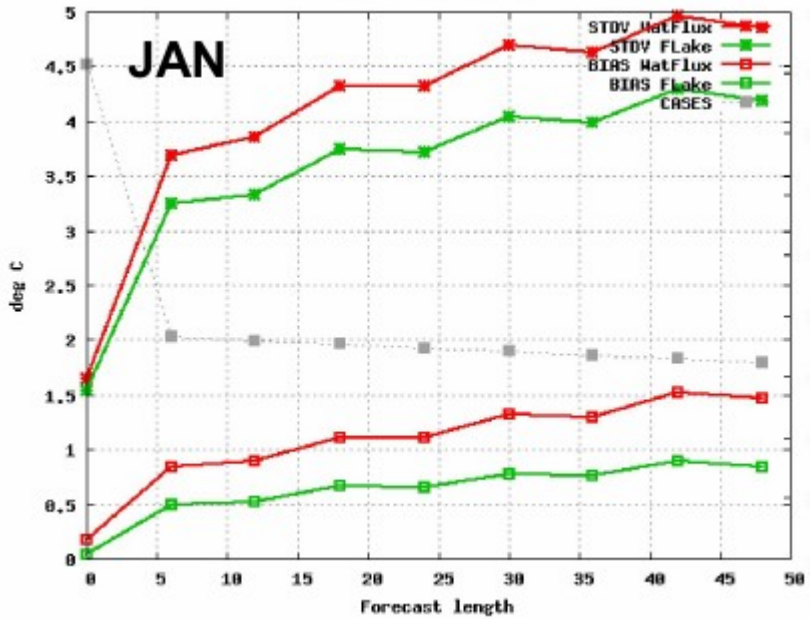
- Experiments with **FLake** versus **Deep-soil-proxy**
- Domain: MetCoOp
- Time period: two weeks spinup + November 16 2015 – January 20 2016.
- Result: FLake gives significant improvement in both bias and standard deviation for T2m.

T2m scores for January 2016

All domain



124 lake stations



People involved: Ekaterina Kourzeneva (FMI),

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Also, we need to replace surface assimilation OI with En/S/EKF.

But, great again, with En/S/EKF we can start to utilize e.g. satellite products/radiances.

Surface assimilation activities

Current activities:

- **Using ASCAT satellite soil-moisture product in combination with Simplified EKF to look for improvements in forecasting of convective events** (Magnus Lindskog, SMHI, within IMPREX).
- **Using Short-Time Augmented Simplified EKF (STA(S)EKF) to improve forecast by adjusting LAI** (what Belgian colleagues have done already). (Jelena Bojarova, SMHI, within UERRA)
- **Utilizing satellite radiances in combination with EnKF to improve near-surface diagnostics** (Tomas Landelius, SMHI, within RSLand)
- **Using SYNOP in combination with SEKF to improve near-surface diagnostics** (Patrick Samuelsson, SMHI)

Near-future plan:

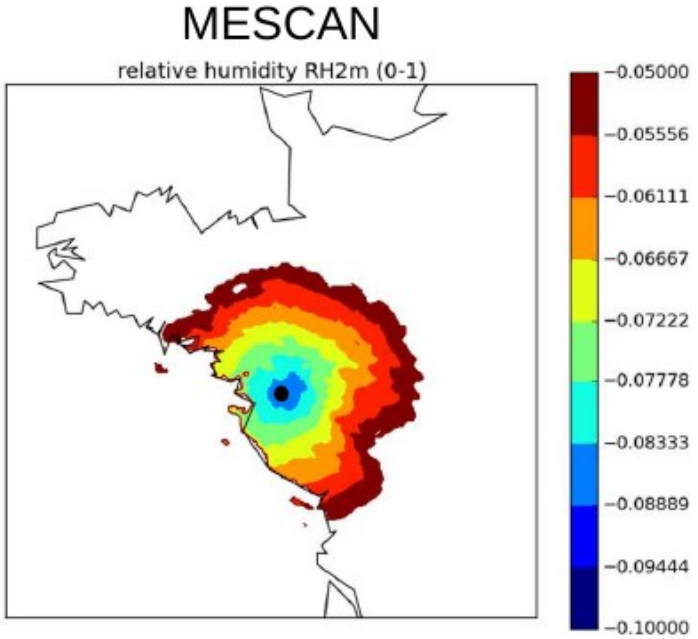
- Replace OI with SEKF (nothing else).
- Sensitivity studies with more advanced snow and soil physics in combination with (S)EKF.

Common problem: In some situations we experience problems with “crazy” Jacobian values in (S)EKF (the linear assumption of EKF is violated for different reasons). We need one or more systematic solutions to tackle this...

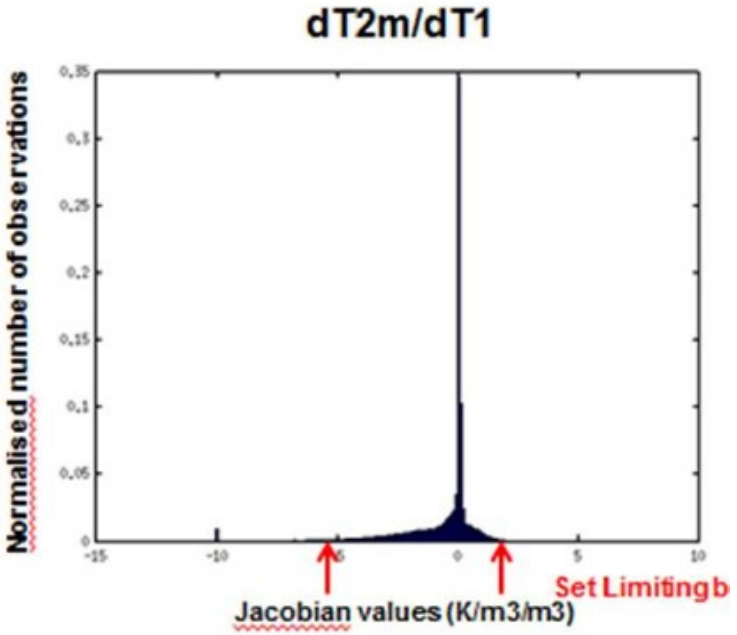
SMHI IMPREX NWP contributions by Magnus L and Tomas L

Improvement of short-term prediction of extreme precipitation events by:

- Assimilating surface remote sensing data (snow and soil moisture, derived products) and in-situ observations. (use SEKF in SURFEX/SODA)
- Include new horizontal background error variation to better derive small scale variations in surface conditions (activate MESCAN in CANARI)



Mariken Homleid (MetNorway) is testing different structure functions in MESCAN.



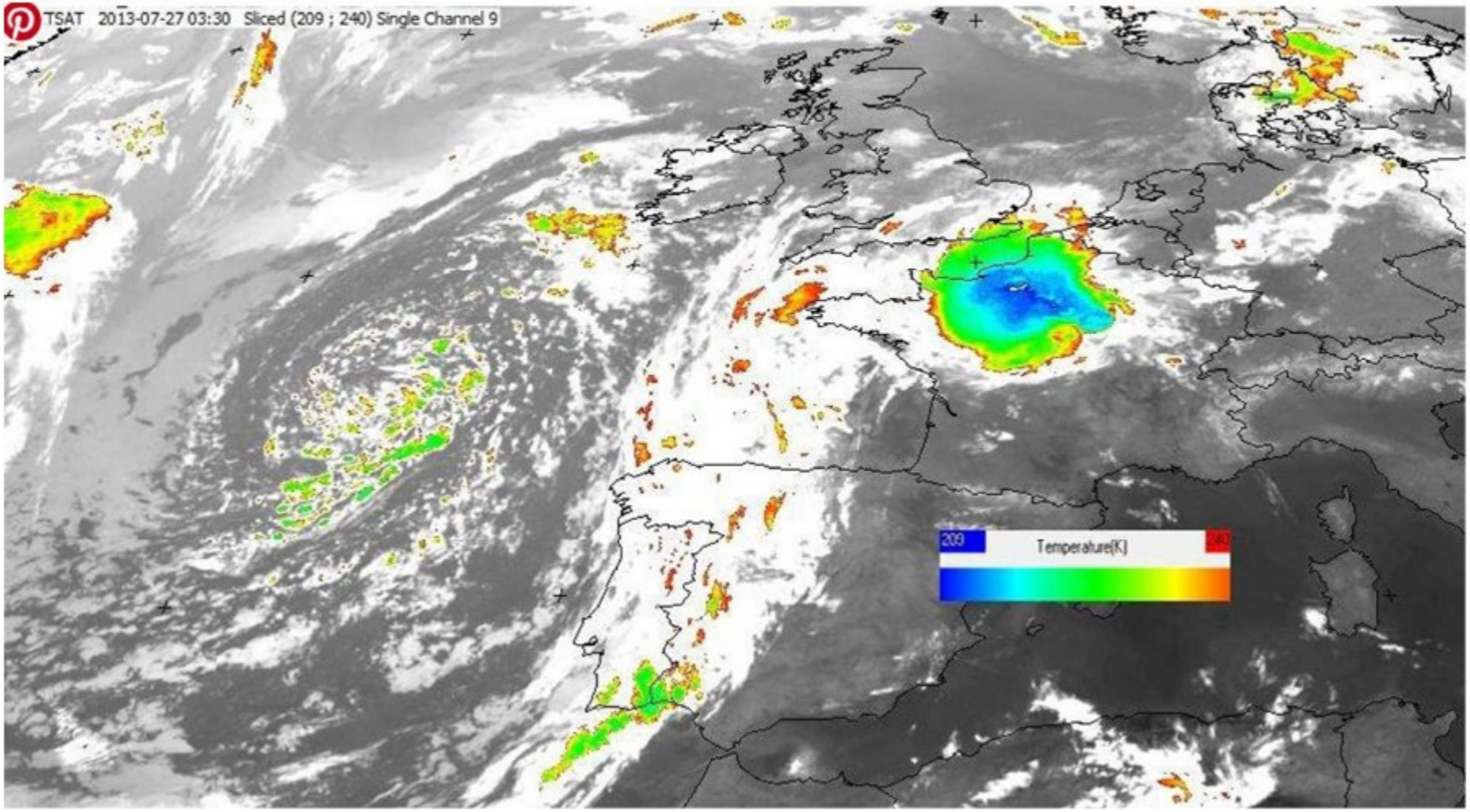
Magnus has limited the Jacobian values in SEKF to avoid problems with non-linear behaviour

SMHI IMPREX NWP contributions by Magnus L and Tomas L

Preliminary results...

CASE 2 large convective system over Northern France

26-27 July 2013



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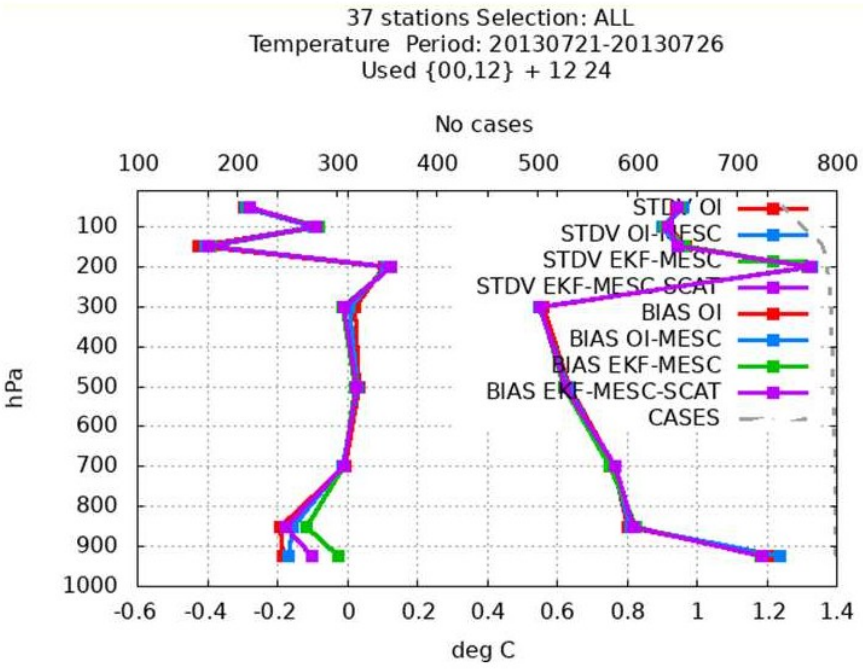
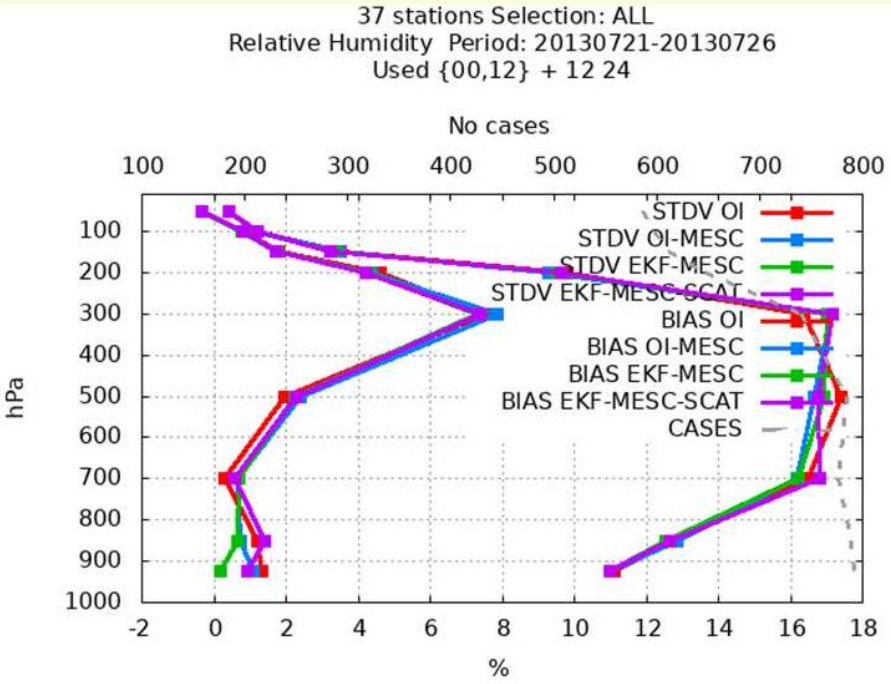




Temperature and relative humidity profiles: improves OI → OI-MESC → EKF-MESC. But degrade again with EKF-MESC-SCAT

Sensitivity in upper-air forecasts T,RH to surface modifications, needs to be looked at in more detail

Physiography issues

In SURFEXv8.1 the new ECOCLIMAP Second Generation physiography is available (is based on ESA CCI Land Cover product at 300 m resolution)

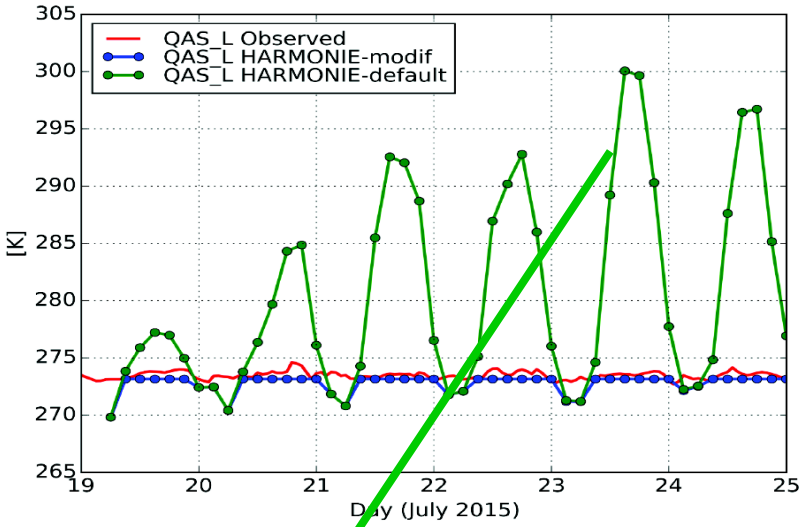
But before we can activate that we struggle/solve problems with current physiography, e.g.

- Albedo over Iceland
- Inland water areas
- Characteristics of urban areas
- Tree height / roughness length

People involved: Bolli Palmasson (IMO), Ekaterina Kourzenea (FMI), John de Vries (KNMI), Patrick Samuelsson (SMHI), Samuel Viana (AEMET)

Parametrisation of glaciers in SURFEX

Iceland from MODIS August 11, 2004



Currently, when snow disappears from the glacier surface a soil surface appears

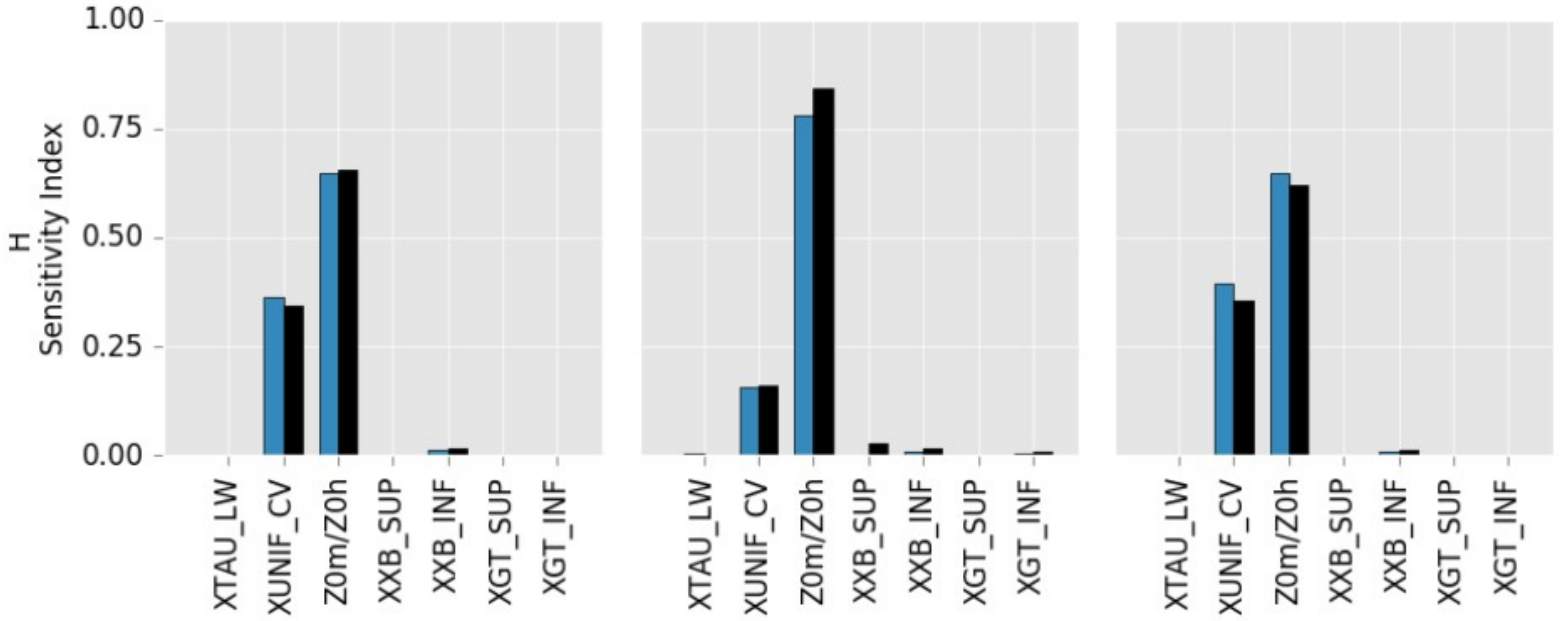
Solution: utilize the Explicit Snow scheme in SURFEX as glacier model (with relevant albedo).

People involved: Bolli Palmasson (IMO), Emily Gleeson (Met Éireann), Kristian Pagh Nielsen (DMI) and SURFEX Team colleagues at Météo-France.

Identification and calibration of sensitive parameters in SURFEX

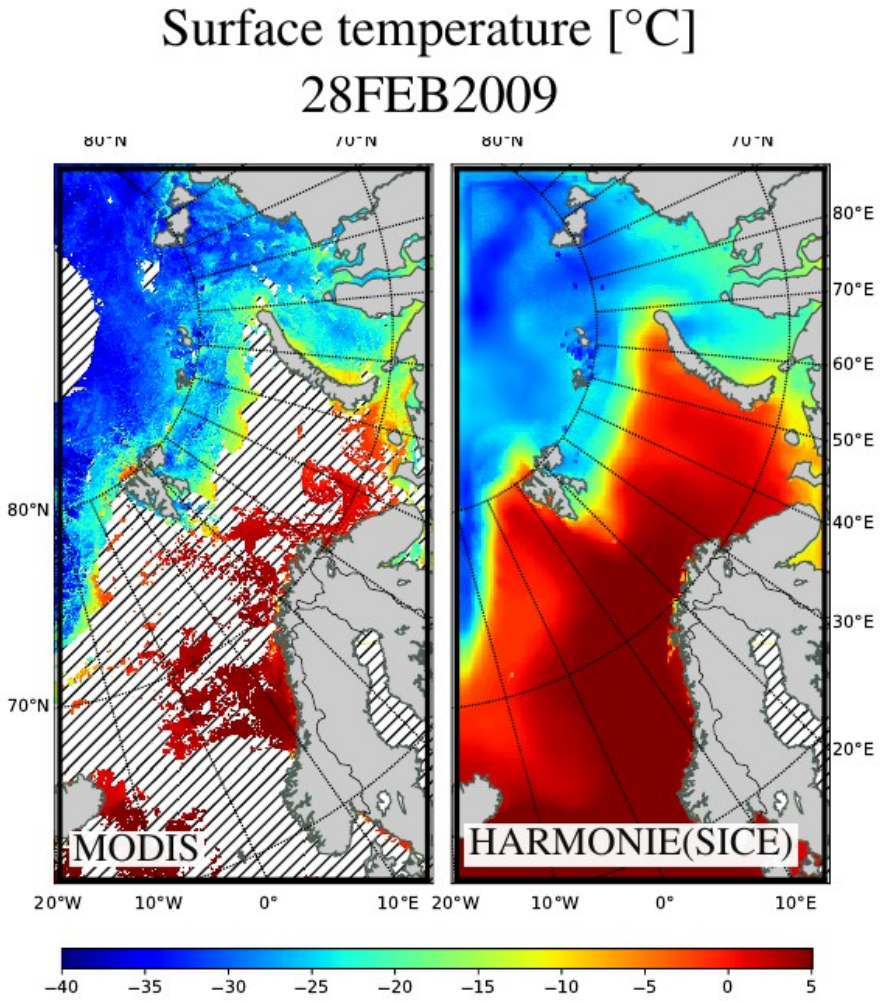
Currently, given a new release of a HARMONIE-AROME cycle there are still a number of parameters in SURFEX which, if they are tuned, may give yet a bit better performance of a certain setup (domain).
How to develop a methodology for this?

Identify the sensitive parameters by Variance-based methods (Sobel Sequences)



People involved: John de Vries (KNMI), Kim Friberg (SMHI)

Continues development of SimpleICE scheme for sea areas



- updated SICE configuration
  - snow on top of the ice
  - prognostic ice thickness
  - run starts form the uniform 1 m thick ice field
- SIC over open sea areas is set to $1 \cdot 10^{-6}$ to preserve the ice state
- SICE can be adjusted by
  - value of the oceanic heat flux
  - ice albedo parametrisation
  - fresh snow density

Data by Oskar Landgren

People involved: Yurii Batrak (MetNorway), Bin Chen (FMI)

New efforts into sea/ocean wave modelling

The HIRLAM strategy says:
... making the interaction between atmosphere and sea more realistic through coupling of the atmosphere with an ocean or sea surface model.
A good starting point would be to couple the model to a model representing the sea surface, like the wave model WAM,... Preliminary studies of coupling the HARMONIE-AROME configuration with WAM have indicated possible benefits for the description of surface drag and winds over sea.

Now this work will continue within HIRLAM but in tight collaboration with colleagues already experienced in e.g. France and Slovenia.

People involved: Lichuan Wu (SMHI),...

SRNWP Surface side meeting

Margarita Choulga (currently at ECMWF) gave us an update on her work on the Global Lake Data Base (GLDB).

We shared information on status and plans for surface in our NWP systems. Conclusion was that it is valuable to update the existing tables on this on the ALADIN web site:
http://www.cnrm-game-meteo.fr/aladin/spip.php?rubrique42

We had some more philosophical discussions on long term plands for surface-atmosphere coupling