# Overview of HIRLAM surface progress and plans

**Patrick Samuelsson**
**SMHI**

**with contributions as acknowledged**

Helsinki, April 5, 2017

# SURFEX Users Workshop in Toulouse, Feb-March 2017 - SUW2017


**61 participants**

**See Workshop website here:**
**http://www.umr-cnrm.fr/surfex/spip.php?article426**

**Session 1: SURFEX in an NWP environment for short term to seasonal forecasting**
**Session 2: Snow modelling**
**Session 3: Poster session**
**Session 4: Land surface modelling: water, energy and carbon cycles**
**Session 5: Urban surface processes and climate**
**Session 6: Water surfaces**
**Session 7: Hydrology**
**Session 8: Satellite data applications with SURFEX**

# Summary of Monday side meeting on Surface processes and data assimilation

- **Message from SURFEX Steering Committee, March 1st:**
  - **Release of SURFEXv8.1 during spring (technical)**
  - **Deadline for contributions to SURFEXv9 at the end of 2017.**

- **A HIRLAM/ALADIN/LACE/SURFEX Surface Working week coordinated with the LACE Data Assimilation Working Days (DAWD) will be arranged in Ljubljana September 18-20.**

- **Discussions on how to limit problems related to phasing with respect to SURFEX development. Proposed way forward exist...**

- **Sander Tijm gave a report on assimilation/ soil/ evapotranspiration issues (same as yesterday).**

**See here for details, agenda and memory notes:**
https://hirlam.org/trac/wiki/Surface_physis_assimilation/Surface_side_meeting_Helsinki_201704

# Surface related presentations at the Workshop from HIRLAM institutes

**Oral**

- Sander Tijm (KNMI): Operational HARMONIE-AROME issues (clouds and precipitation)
- Ekaterina Kurzeneva (FMI): FLake in HARMONIE-AROME
- Laura Tuomi (FMI): Using wave forecast model to estimate the accuracy of surface wind fields in the Baltic Sea

**Posters:**

- Markku Kangas (FMI): Mast Verification
- Yurii Batrak (MetNorway) and Bin Cheng (FMI): Sea ice mass balance in the Arctic Ocean

# General surface comments

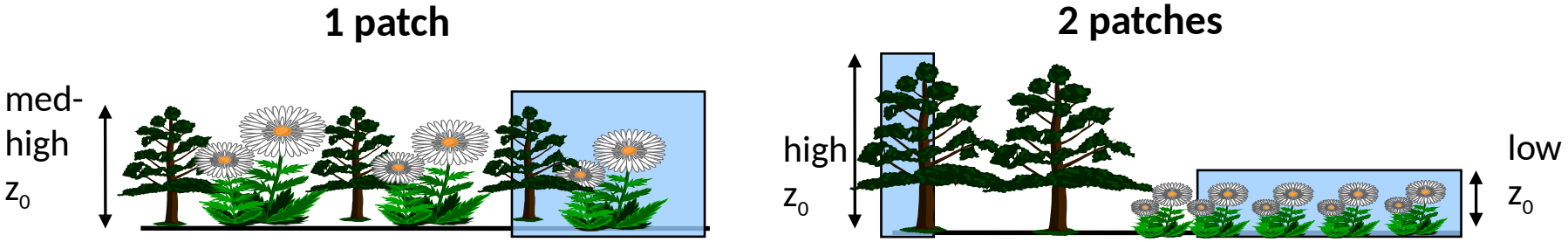
Our latest operational version is cy40h1.1, of the ALADIN-HIRLAM NWP system (HARMONIE-AROME model configuration). Next release, cy40h1.2, is currently under testing. cyxxh represents a future ambition:

| | c**y40h1.1** | **cy40h1.2** | **cyxxh** |
|---|---|---|---|
| **Land** | | | |
| Patches | 1 | **1 or 2 (no SBL model)** | 3 patches with excl. canopy |
| Soil | Force-restore | Force-restore | Diffusion (14 layers) |
| Snow | D95 | D95 | Explicit snow (12 layers) |
| Glacier | - | - | Explicit snow as glacier |
| Assimilation | CANARI-OI | 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 |

# Problem with too cold/moist spring conditions in cy38h1.2

Over Scandinavia HARMONIE-AROME (cy38h1.2) and HIRLAM (E05 at SMHI) differ in dividing available net radiation at surface into sensible and latent heat fluxes during spring situations leading to too cold/moist near-surface conditions in cy38h1.2.
Similar problem is reported over the Netherlands...

**One hypothesis is that using 2 patches in SURFEX instead of 1 can help this problem (similar to HIRLAM 7.4). A test branch of cy40h has been setup by MetCoOp with modified OI for 2 patches:**




Note: The atmospheric surface-boundary layer (SBL) (also known as the Canopy model) needs to be switched off when 2 patches are used.

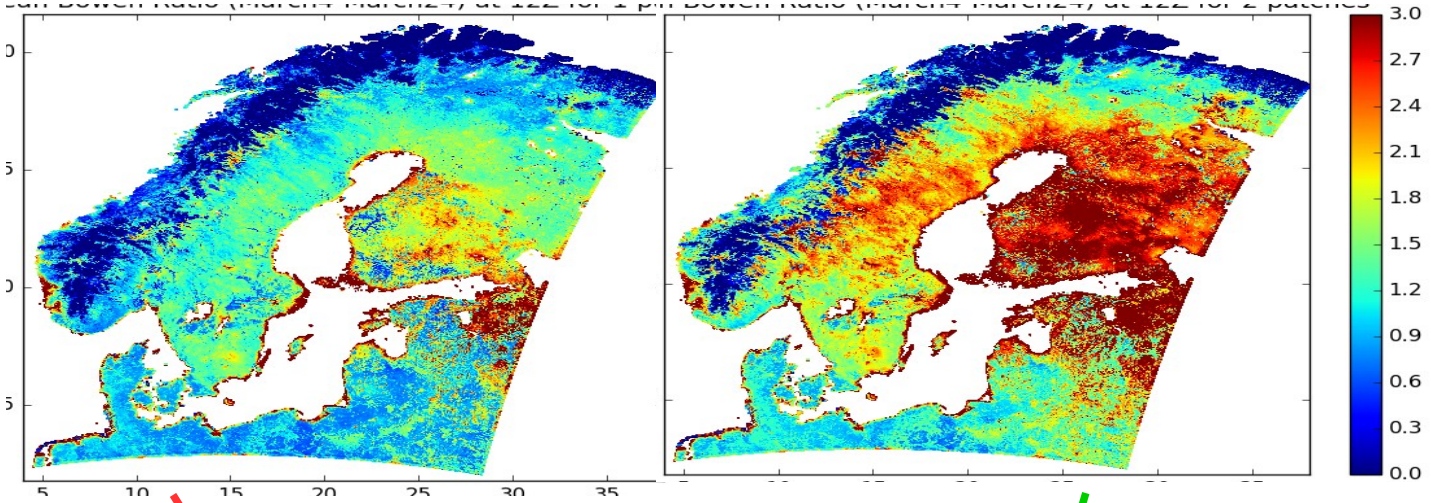
People involved: Trygve Aspelien, Patrick Samuelsson, Mariken Homleid, Karl-Ivar Ivarsson, Javier Calvo Sanchez

# Problem with too cold/moist spring conditions in cy40h1.1

March 2016

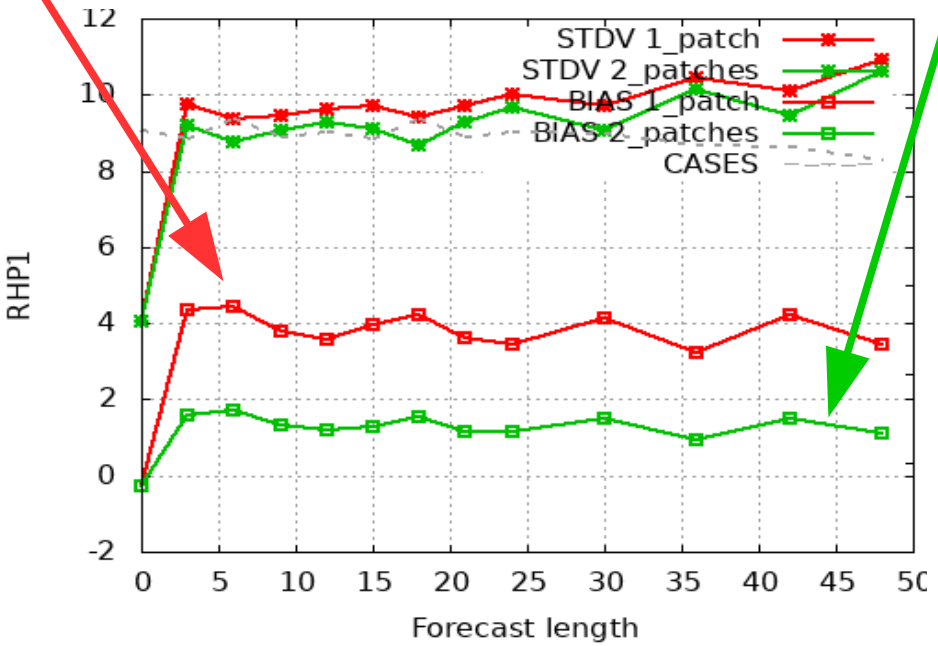
1 patch

2 patches




Bowen ratio = H/LE

Rh2m

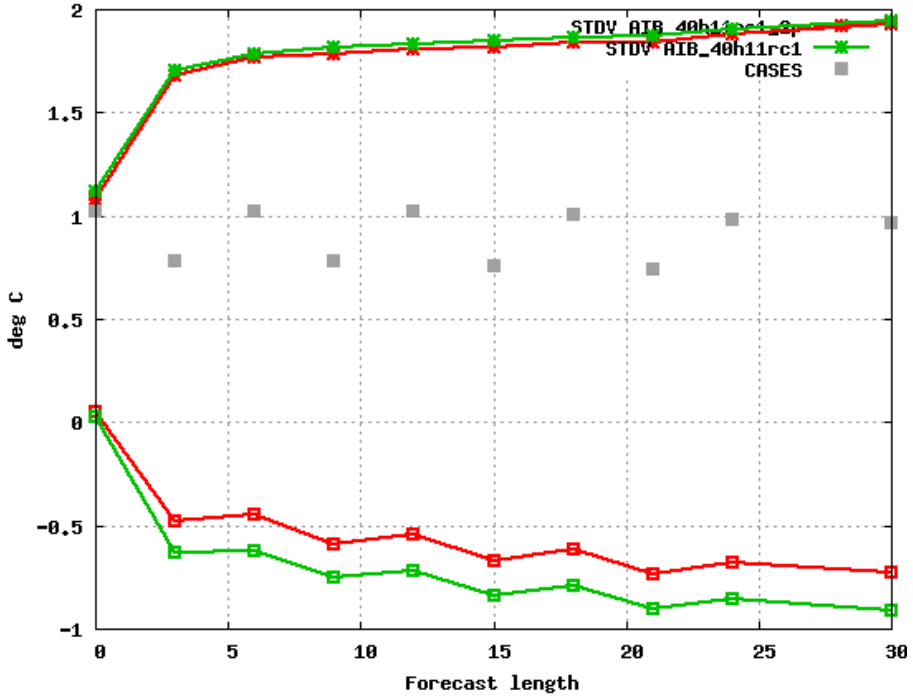



**Promising results:**
2 patches will be available in cy40h1.2.
**But**, still considerable bias in late spring.
**Hypothesis**: transpiration starts in the model while in reality it does not, due to still cold/frozen ground.
**Solution**: diffusion soil scheme!

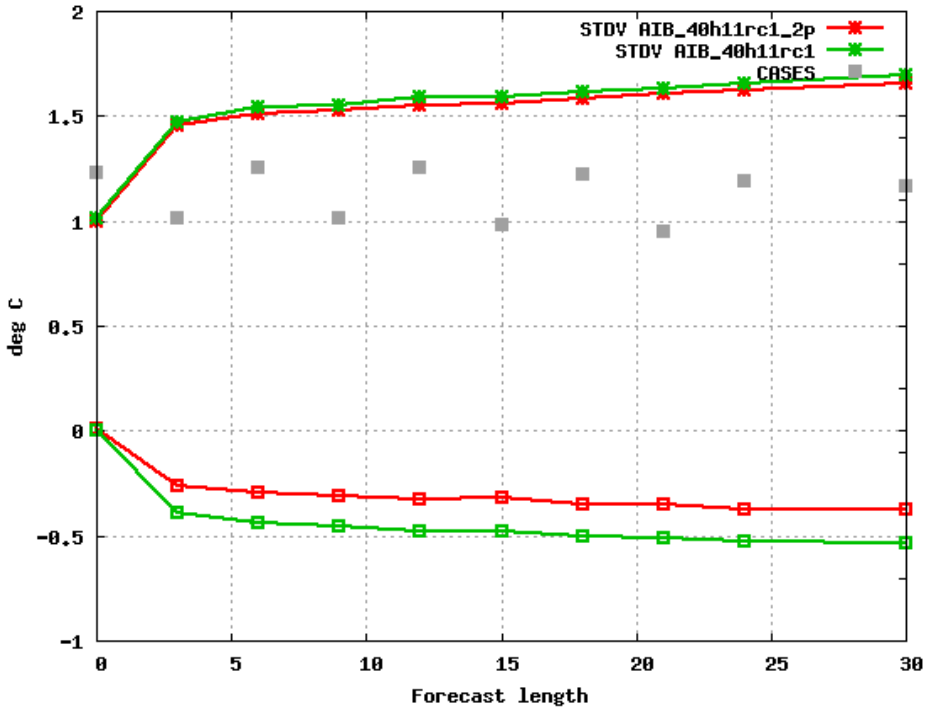
# 2 patches help also over Spain

## T2m verification for cy40h1.1 and cy40h1.1 + 2 patches

### January 2015




### April-May 2016



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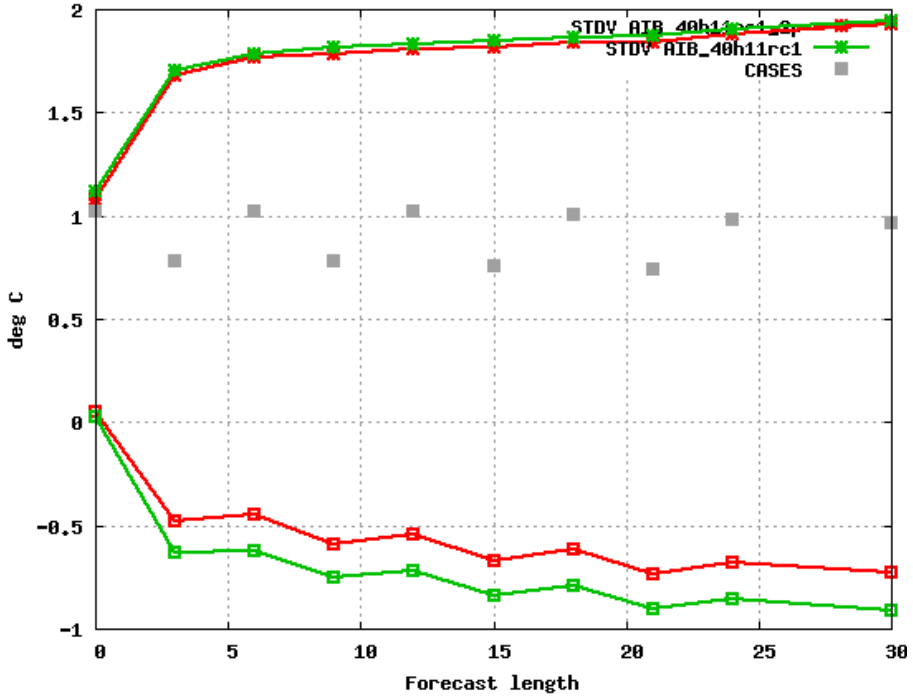


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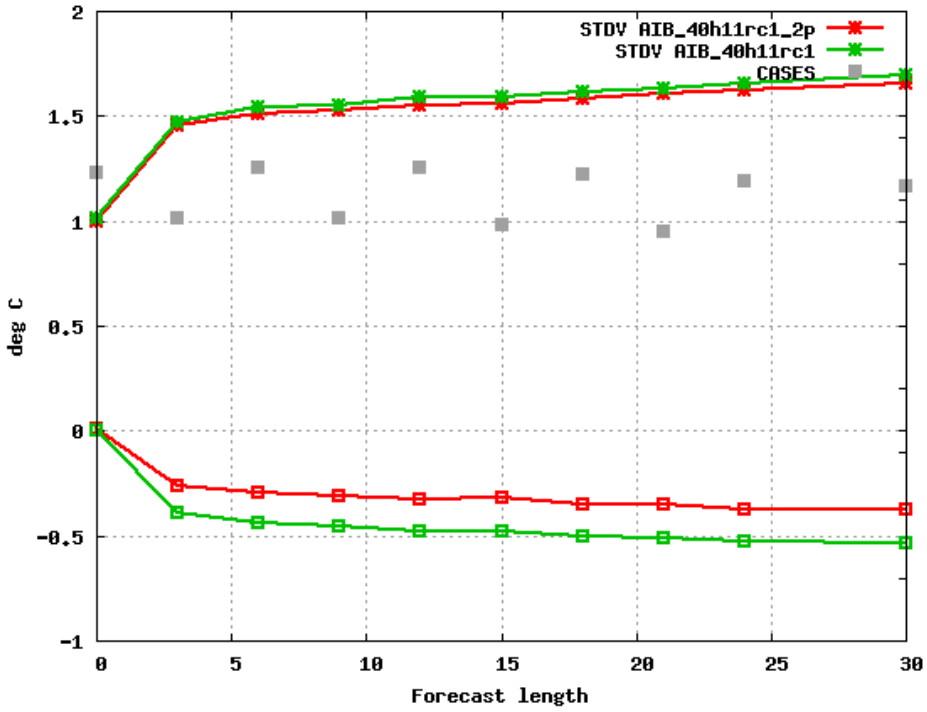
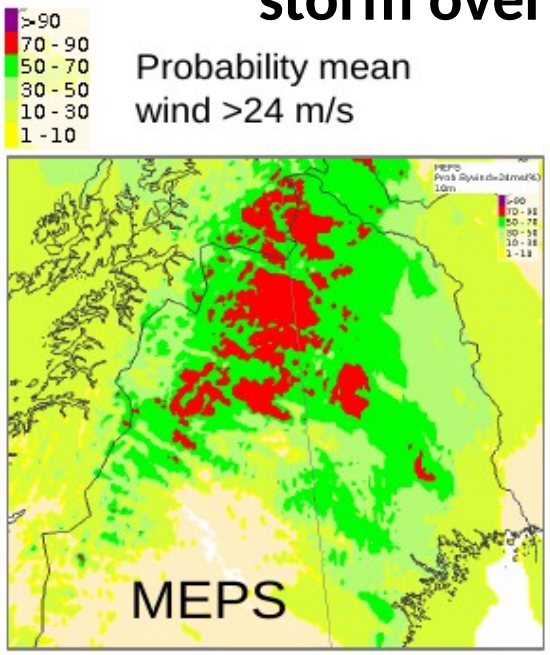
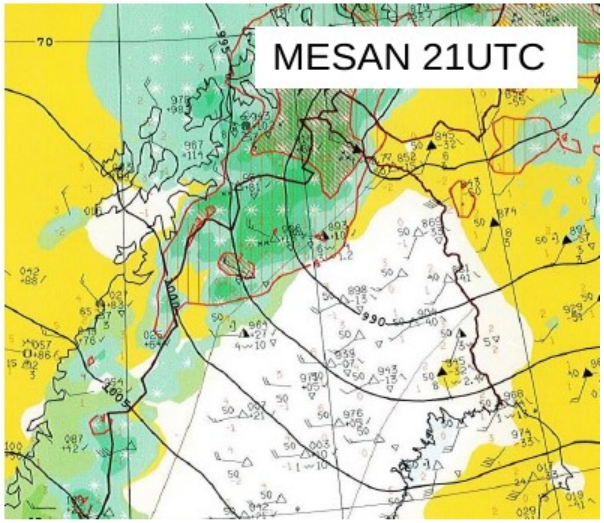



**2 patches (incl. SBL off) give lower wind speed than 1 patch due to higher effective surface roughness (forest). Hmhm, some tuning of e.g. forest roughness may be needed...**

# Talking about wind… biases in U10m and gusts for a storm over Northern Scandinavia, January 18, 2017

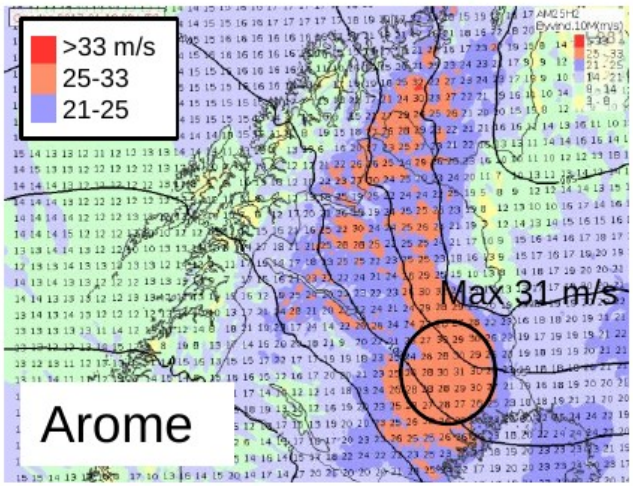
Analysis by Anders Wettergren (SMHI)

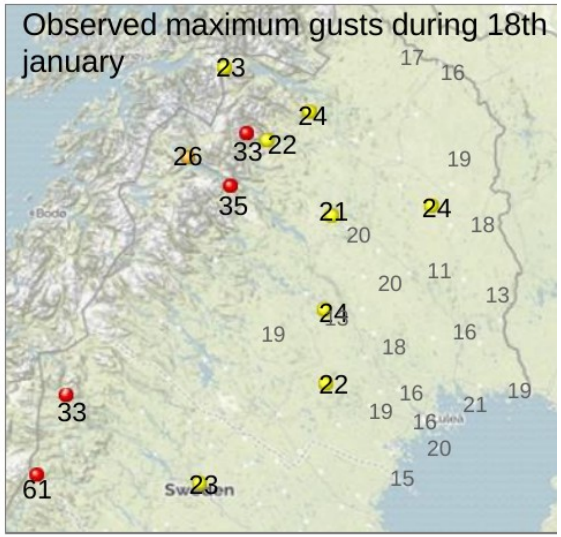



**70-90% EPS probability for mean wind > 24 m/s in red areas.**

**Observed mean wind ≤20 m/s in most areas**



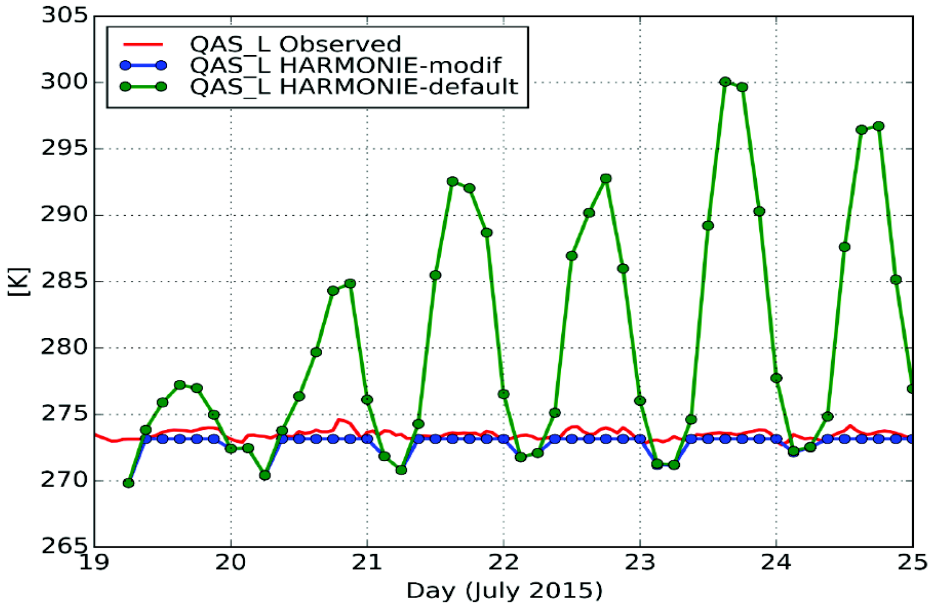




**AROME gust at 31 m/s in areas where <22 m/s was observed.**

**Problem is related to snow covered areas!**

# Glaciers in SURFEX

Current HARMONIE-AROME Ts over a snow-free part of a Greenland glacier

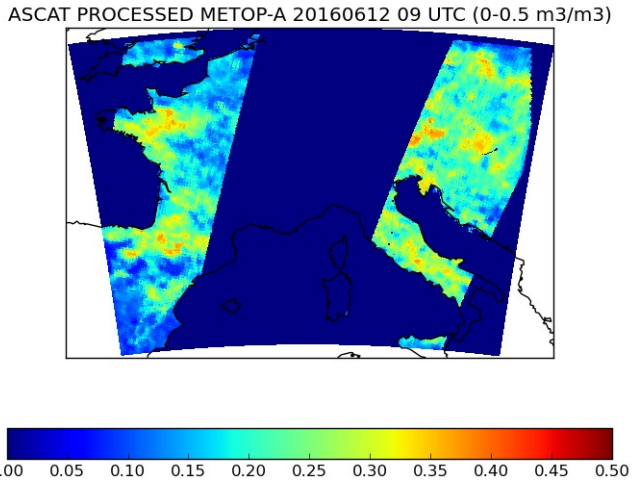



SURFEX currently does not include any glacier ice processes. Thus, when snow disappears a soil surface appears.

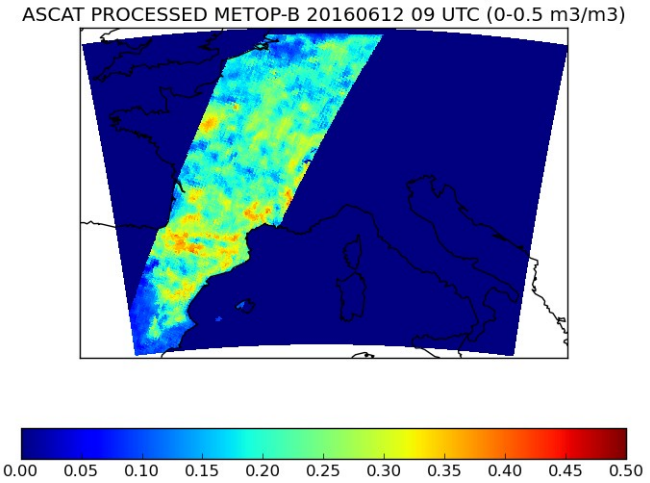
In collaboration with the SURFEX team at Météo-France a few HIRLAM colleagues (Ruth Mottram, Emily Gleeson, Kristian Pagh Nielsen, Bolli Palmason) are currently involved in work where the Explicit snow scheme of SURFEXv8 will used as glacier model.

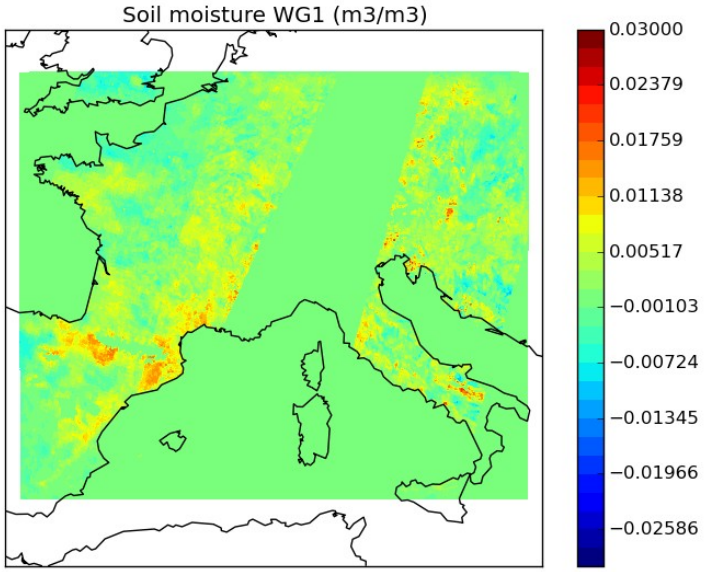
Latest status and plans are reported here:
https://hirlam.org/trac/wiki/HarmonieWorkingWeek/Surface201604/Glacier_plans

# Surface Data Assimilation of ASCAT data using EKF in cy38h




**ASCAT A & B**
**2016-06-12**
**09 UTC**

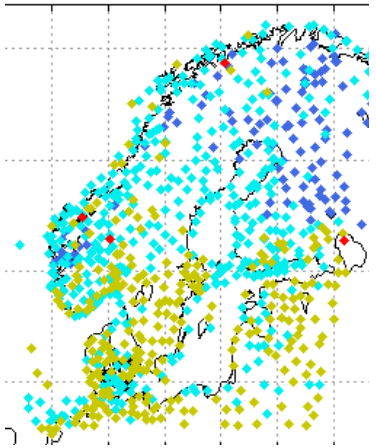



**EKF based surface data assimilation WG1 increments 2016-06-12 09 UTC**

EU-IMPREX work by Magnus Lindskog (SMHI)

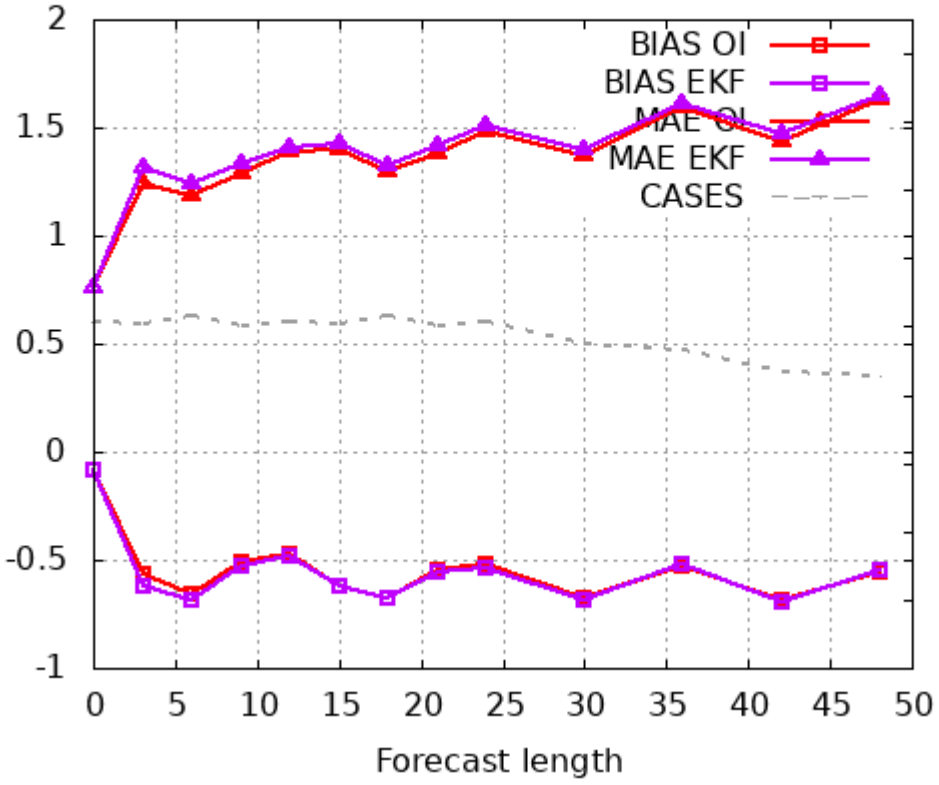
# Surface Data Assimilation of SYNOP data using SEKF in cy40h



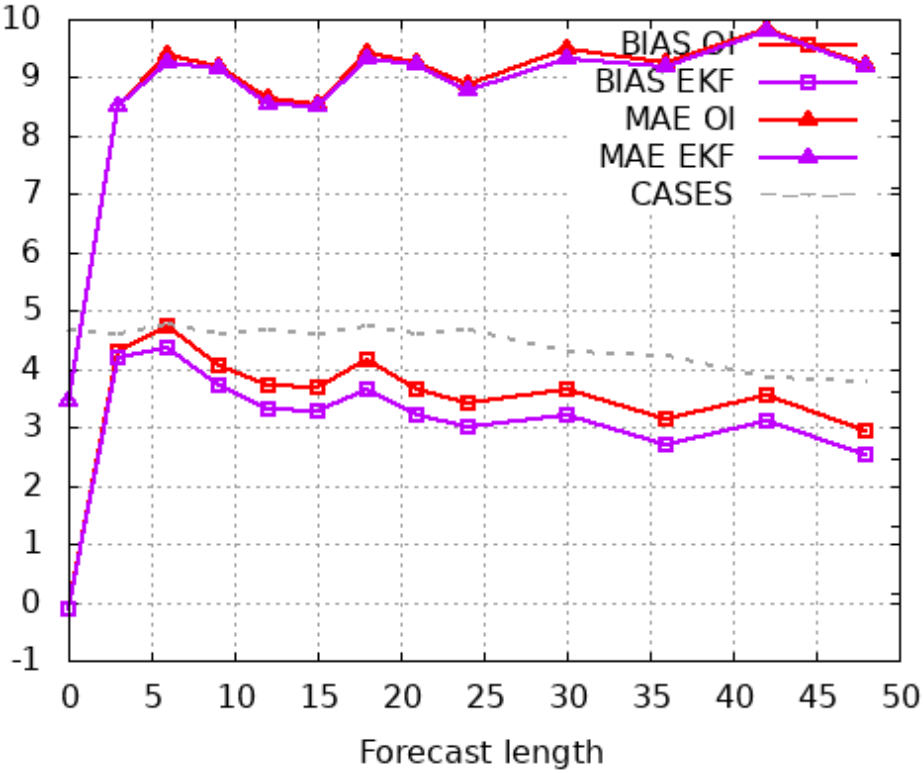
**HARMONIE-AROME with surface OI replaced by EKF**

**Validation period: Tricky period from near-surface humidity point of view, May 13-19, 2016, with 12 days spinup.**

**T2m (degC)**




**Rh2m (%)**



# Snow analysis

A visiting student at FMI, Maxime Quenon, has published a report on “Visual and Statistical Analysis of Snow Cover” where snow extent (SE) and Snow-Water Equivalent (SWE) simulated by cy38h1.2 HARMONIE-AROME-SURFEX has been compared with SYNOP snow depth, MetOp and MSG SE and Globsnow SWE.

A summary of the report was presented by Ekaterina Kourzeneva at a COST Action ES1404 workshop on snow data assimilation, March, 8-9, 2017, Offenbach, Germany:
https://agora.fmi.fi/download/attachments/21991738/SEANA_for_Offenbach.pdf?version=1&modificationDate=1489504265723&api=v2

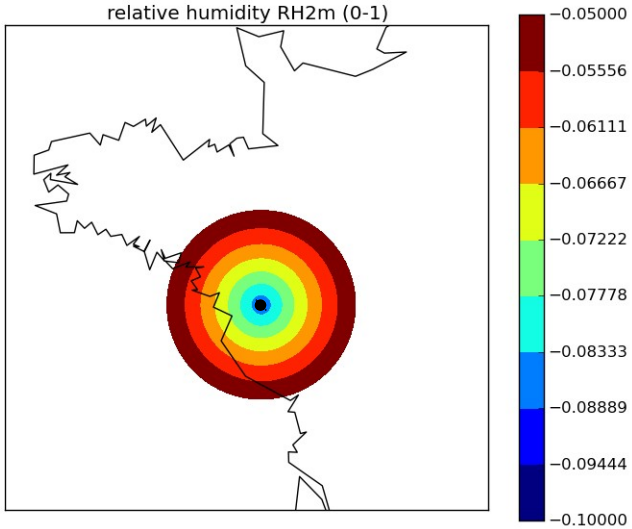
Next step is to utilize the satellite SE product H-SAF. Other possible sources of satellite snow-related information are H-SAF SWE, based on microwave data (similar to Globsnow), and L-SAF albedo. How about IMS (Interactive Multisensor Snow product)?

Please talk to Ekaterina Kourzeneva (FMI) if you are interested in details and plans.

# Move from CANARI to MESCAN

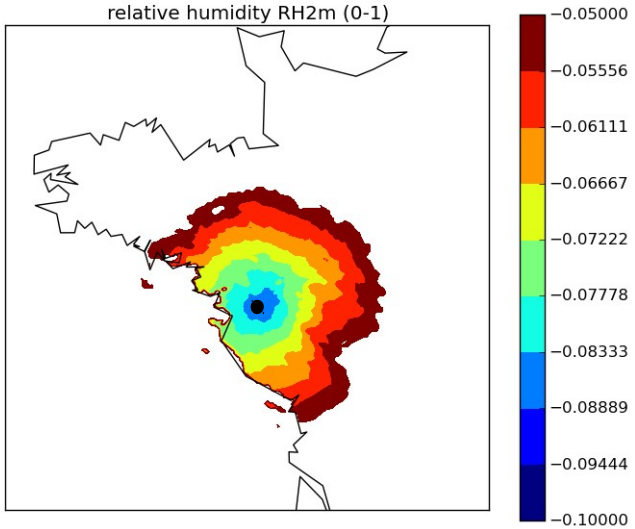
Horizontally varying background error statistics in MESCAN.

Rh2m, current Method in CANARI




```
ro12=exp(-r/2a)
```

Rh2m improved Method in MESCAN




$$Corr(r_{ij}, d_p, d_z) = 0.5\left[e^{-\frac{r_{ij}}{L}} + \left(1 + \frac{2r_{ij}}{L}\right)e^{-\frac{2r_{ij}}{L}}\right] \cdot F_p(d_p)F_z(d_z)$$

---

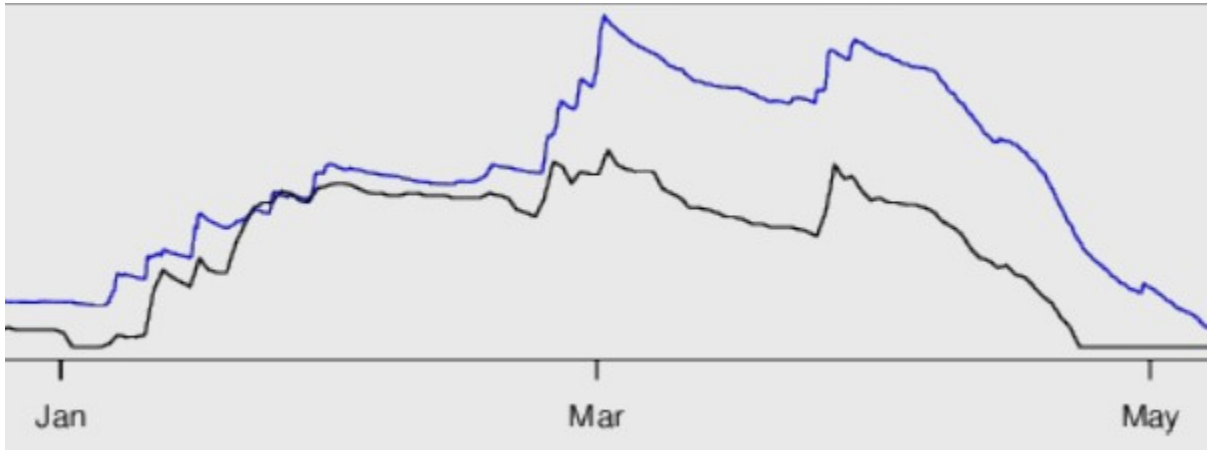
**Work is ongoing to make SURFEX tile/patch information available for CANARI/MESCAN to allow for a more realistic first guess for T2m and Rh2m analysis. Currently, only grid-averaged values are available.**

Magnus Lindskog, Tomas Landelius, Mariken Homleid, Trygve Aspelien

# Towards new SURFEX physics in cy43h/SURFEXv8

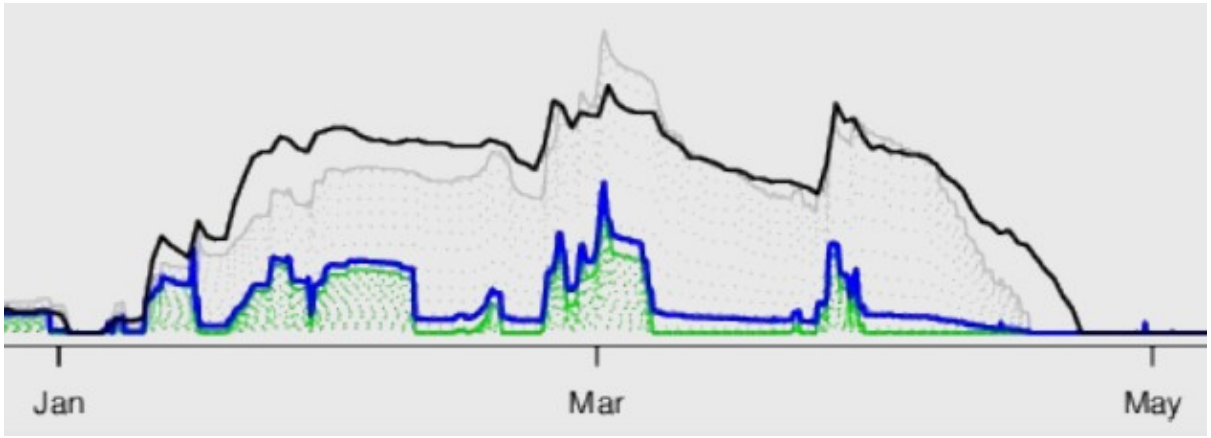
**Mariken Homleid et al. have been testing Explicit snow scheme (12 layers) in SURFEXv8 offline simulations for NPATCH=1 & 2 versus operational setting (1 patch & D95 snow). Forcing from HARMONIE-AROME.**

**Snow Water Eq for Bjørnholt (90% forest), north of Oslo, winter 2014-2015.**




**Observation**
**D95 snow & 1 patch**

**Forcing?**




**Observation**
**ES snow & 2 patches grid average**
**ES snow & 2 patches forest**
**ES snow & 2 patches open land**

**ES snow & 1 patch not good!**

# Towards new SURFEX physics in cy43h/SURFEXv8

**Once we are able to run cy43h in climate mode Samuel Viana (AEMET) et al. will start to look into how cy43h performs when activating a wish-list of SURFEX namelist settings for new physics. The list is currently under discussion:**

https://hirlam.org/trac/wiki/Surface_physis_assimilation/New_SURFEX_options_cy43h

```
&NAM_ISBA
 CISBA = 'DIF'    ! Activate diffusion soil heat transfer
 YSOC_TOP   = 'soc_top'  ! Read top Soil organic carbon field
 YSOC_SUB = 'soc_sub' ! Read deep Soil organic carbon field
 CPHOTO = 'NON'  ! J                                    plant transpiration (nothing else is available for
 LTR_ML = .FALSE.  !                                    etation (but see LMEB option below).
 NPATCH = 2-4      ! Number of patches. 2 means separate forest and open land. 3 would mean an ad
 LMEB = .TRUE.    ! Use Multi-Energy Balance (explicit canopy). Automatically sets LTR_ML = .TRUE.
 CPEDO_FUNCTION =  'CH78' ! Pedo-transfert function for DIF. Clapp and Hornberger 1978 for BC. Al
 XUNIF_RUNOFFB = 0.5 or 0.2? ! Uniform prescribed value of subgrid runoff coefficient. 0.5 sis th
/
&NAM_MEB_ISBA
 LMEB_PATCH    = .F., .T.,  ! Use MEB for forest but not for open land (with NPATCH=2)
 LMEB_LITTER   = .TRUE.     ! Use litter on ground in forest.
/
&NAM_ISBAn
 CSCOND = 'PL98'  ! Type of soil thermal conductivity
 CSOILFRZ = 'LWT' or 'DEF'? ! LWT means activate unfrozen water in frozen soil. Hmhm, what to use
 CSNOWRES = 'RIL' ! Maximum Richardson number limit for stable conditions ISBA-SNOW3L turbulent e
 CALBEDO = 'CM13' ! Albedo by cover and vegetation type processed from satellite data. Recommende
 CC1DRY = 'DEF'   ! Giard-Bazile formulation. Type of C1 formulation for dry soils. Available als
/
&NAM_SGH_ISBAn
 CRUNOFF   = 'DT92' or 'SGH'?  ! DT92 means Dumenill and Todini (1992) subgrid runoff. SGH means
 CRAIN    = 'SGH ' ! Activate spatial distribution of rainfall.
 CHORT    = 'SGH' or 'DEF'?   ! SGH activates the Horton surface runoff for intense rain on dry s
```

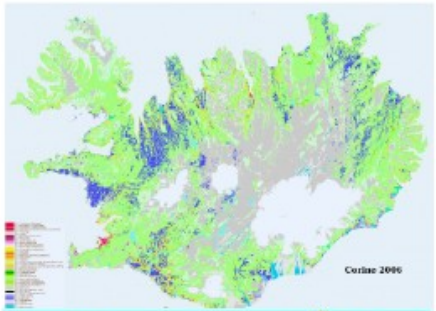
HIRLAM newsnow

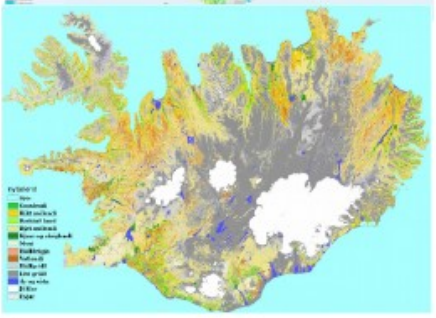
# Towards new SURFEX physics in cy43h/SURFEXv8

**John de Vries (KNMI) is developing methods for optimizing SURFEX options and parameter values. It includes also evaluation tool for comparing model SSM-ET feedback strength with observations.**

# Improvements over Iceland with new physiography

Bolli Palmason et al (IMO, Icelandic Met Office)



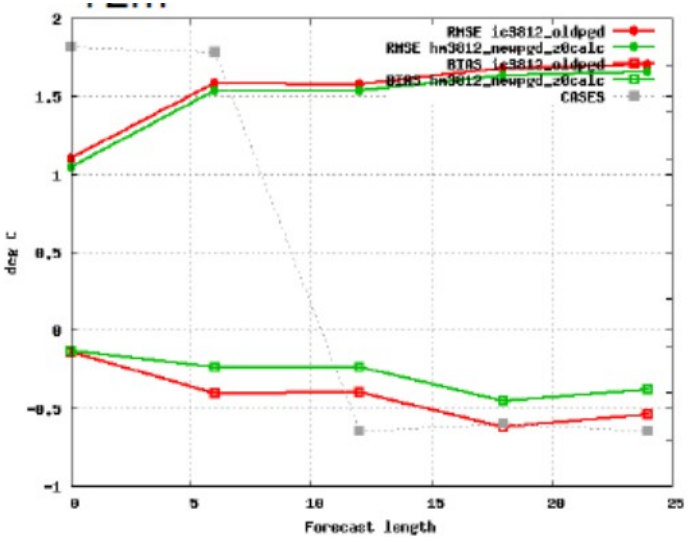




**Modified ECOCLIMAP for Iceland based on four databases:**

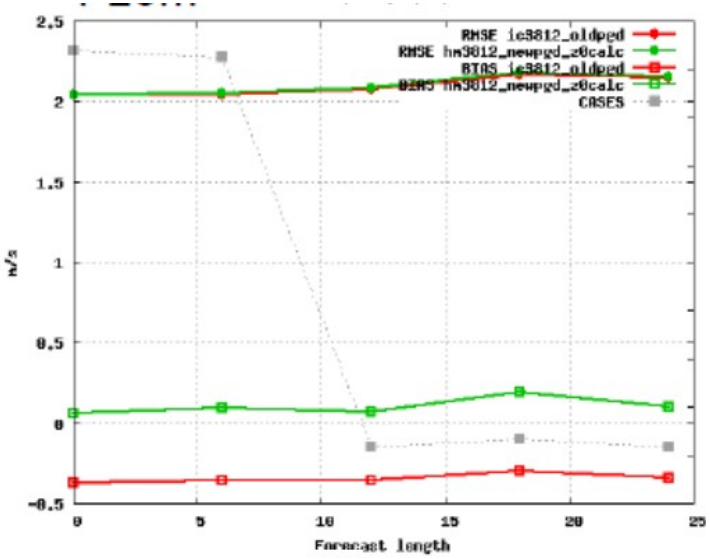
- Corine 2006
- Agricultural Univ. of Iceland (AUI) soil map
- AUI vegetation map
- MODIS LAI

Experiments for July 2012 with **OLD PGD** and **NEW PGD**
Biases decrease for

T2m




U10m



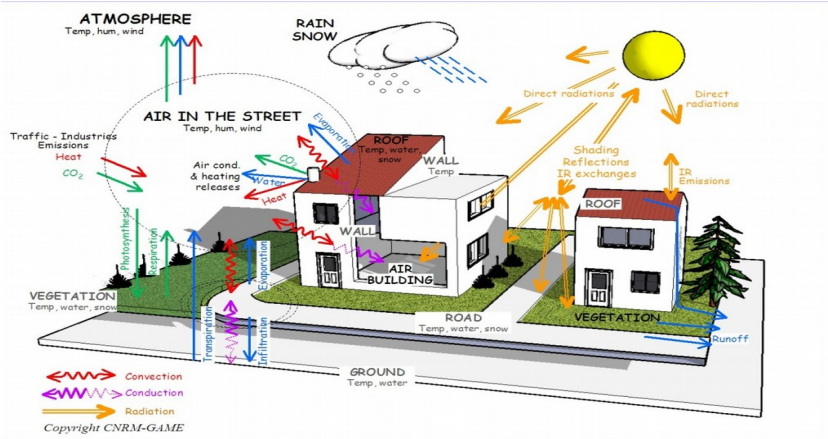



2006-2007
2012-2014

# Urban SIS:

# high resolution climate data for cities

A database for end-users working with infrastructure & health in the urban environment




**David Segersson & Jorge H. Amorim**

On behalf of ECMWF for the European Commission

SMHI

Copernicus
Europe's eyes on Earth

# Two papers published related to Multi-Energy Balance in SURFEXv8

## The interactions between soil–biosphere–atmosphere land surface model with a multi-energy balance (ISBA-MEB) option in SURFEXv8 – Part 1: Model description

Aaron Boone[1], Patrick Samuelsson[2], Stefan Gollvik[2], Adrien Napoly[1], Lionel Jarlan[3], Eric Brun[1], and Bertrand Decharme[1]

doi:10.5194/gmd-10-843-2017

## The Interactions between Soil-Biosphere-Atmosphere (ISBA) land surface model Multi-Energy Balance (MEB) option in SURFEX - Part 2: Model evaluation for local scale forest sites

Adrien Napoly[1], Aaron Boone[1], Patrick Samuelsson[2], Stefan Gollvik[2], Eric Martin[3], Roland Seferian[1], Dominique Carrer[1], Bertrand Decharme[1], and Lionel Jarlan[4]

doi:10.5194/gmd-2016-270

**Preparation work is ongoing for a third paper devoted to snow conditions...**

# For more information and work

**Most HIRLAM activities related to development in surface physics and assimilation are documented at the HIRLAM wiki site:**
**https://hirlam.org/trac/wiki/Surface_physis_assimilation**

**Next HIRLAM surface meeting will take place in Norrköping in May:**
**https://hirlam.org/trac/wiki/HarmonieWorkingWeek/Surface201705**

**Next joint HIRLAM/ALADIN/LACE/SURFEX Surface Working week will be arranged in Ljubljana September 18-20.**


THANKS!