

Overview of HIRLAM surface activities

Patrick Samuelsson
SMHI

with contributions as acknowledged



General surface comments

cy40h1.1.1 is our latest release of the ALADIN-HIRLAM NWP system, **including SURFEX**, with the HARMONIE-AROME model configuration.

cy43h2.1 is our current development cycle (including SURFEXv8.1) where new options will be activated (e.g. convection updates, surface updates).

cy43hxx represents our next big step with respect to land processes.

	cy40h1.1.1	cy43h2.1	cy43hxx	cyxx
Land				
Patches	1 or 2 (no SBL model) 2	2 (separated forest and open land)		
Vegetation	Bulk soil/veg/snow	Bulk soil/veg/snow	Explicit canopy (MEB)	
Soil	Force-restore	Force-restore	Diffusion (14 layers)	
Snow	D95 (bulk)	D95 (bulk)	Explicit snow (12 layers)	
Glacier	-	-	Explicit snow as glacier	
Assimilation	CANARI-OI	CANARI-OI	TITAN/gridPP(?)-SEKF	Coupled DA for atmosphere and surface based on 4D EnKF
Sea	SICE	SICE	SICE	
Lake	FLake (optional)	FLake	FLake (later with EKF)	
Town	TEB	TEB	TEB (more options)	
Physiog.	ECOCLIMAP (modified)	ECOCLIMAP II or 2nd generation	ECOCLIMAP 2 nd generation	

New potential surface options in combination with Force-restore and bulk snow in cy43h2.1

Land use physiography: Evaluate ECOCLIMAP-SG (Second Generation) (ECOSG) as based upon ESA-CCI global land cover map at 300-m resolution

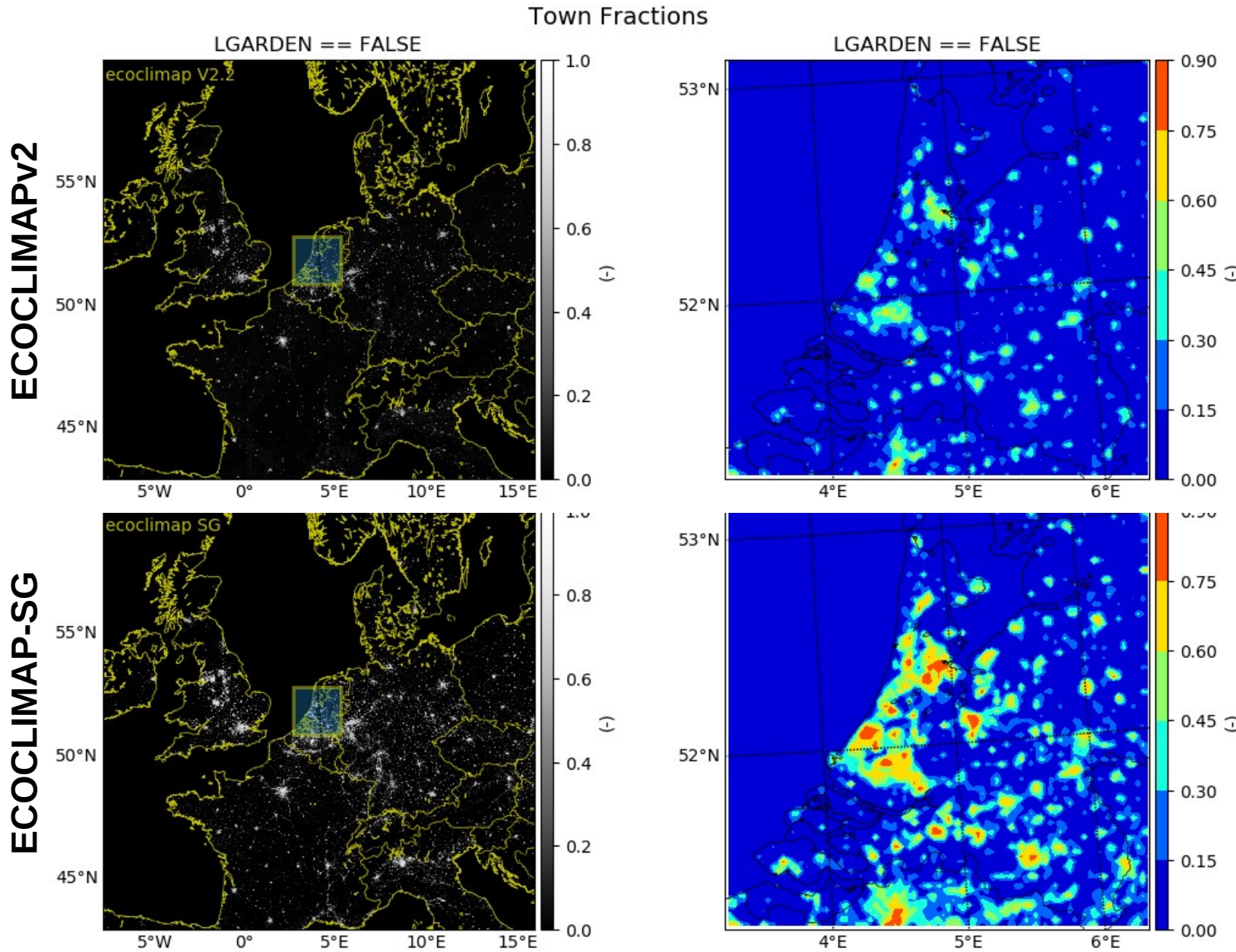
Why? We have a few identified problems with current physiography (ECOCLIMAP II):

- (i) Annual cycle of LAI is not realistic, especially in spring when LAI increases too early, which induces excess transpiration. ECOSG looks more realistic...
- (ii) The urban area seems not to be dense enough in some areas (e.g. the Netherlands). ECOSG looks more realistic...

For more info on ECOCLIMAP-SG please visit:

<https://opensource.umr-cnrm.fr/projects/ecoclimap-sg/wiki>

How does ECOCLIMAP-SG compare with ECOCLIMAPv2 – Urban fraction



Considerable larger fraction of urban areas in ECOSG.

Evaluations have shown that ECOSG urban properties are quite realistic (personal communication with e.g. Margarita Choulga (ECMWF), Carl Fortelius (FMI)).

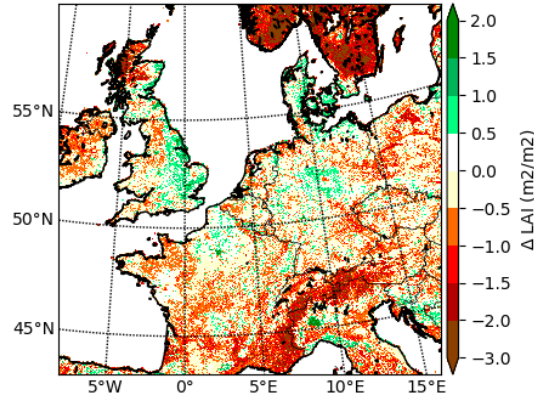
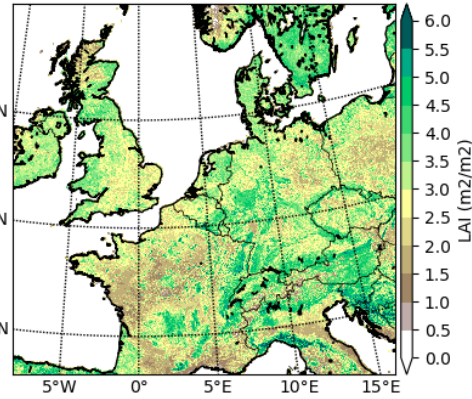
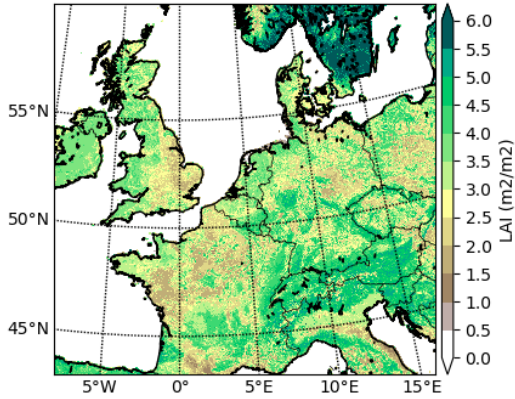
How does ECOCLIMAP-SG compare with ECOCLIMAPv2 – Leaf Area Index (LAI)

ECOCLIMAPv2

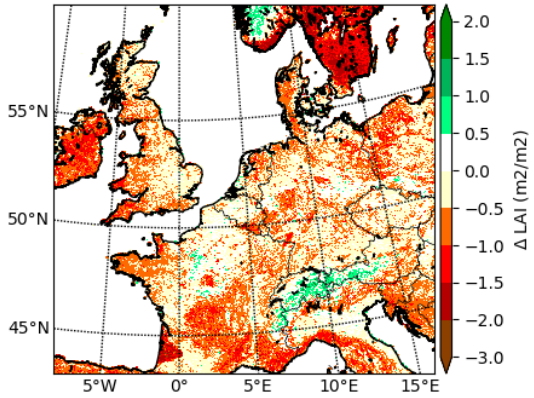
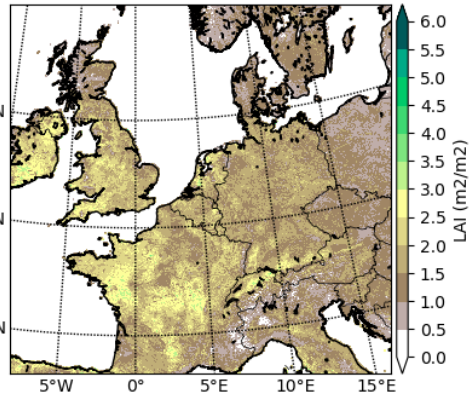
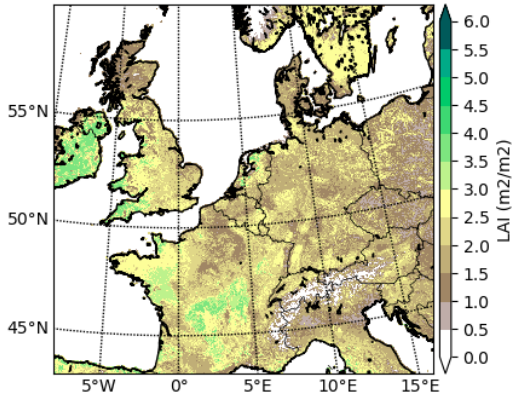
ECOSG

ECOSG - ECOCLIMAPv2

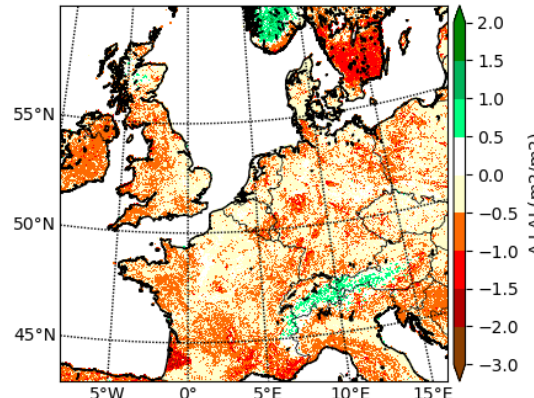
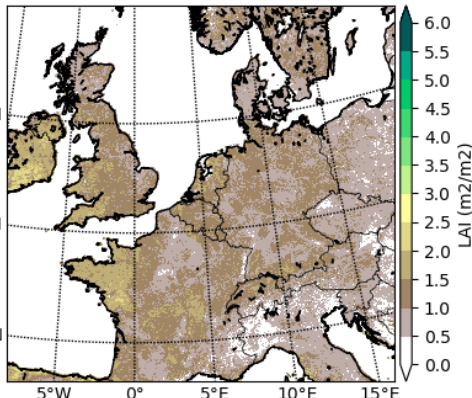
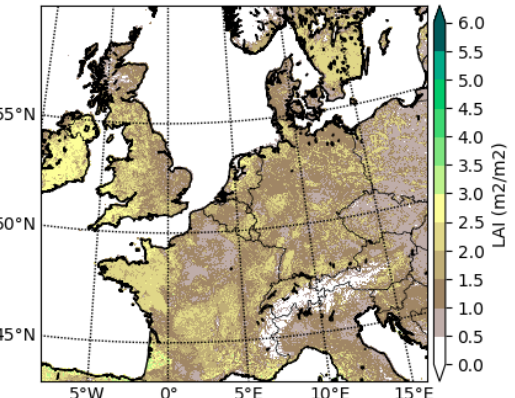
July 15th



April 5th



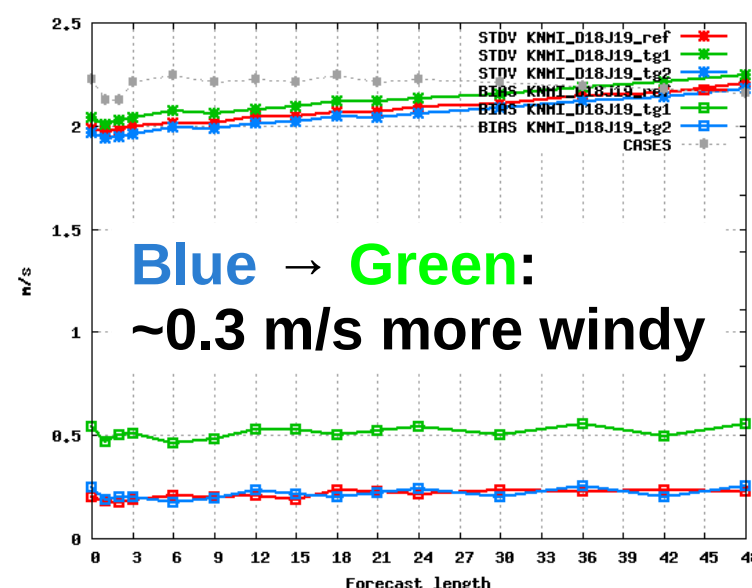
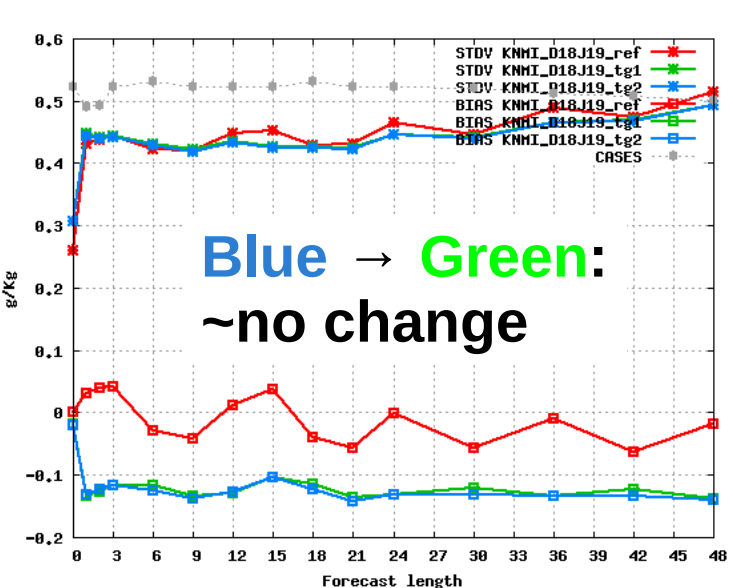
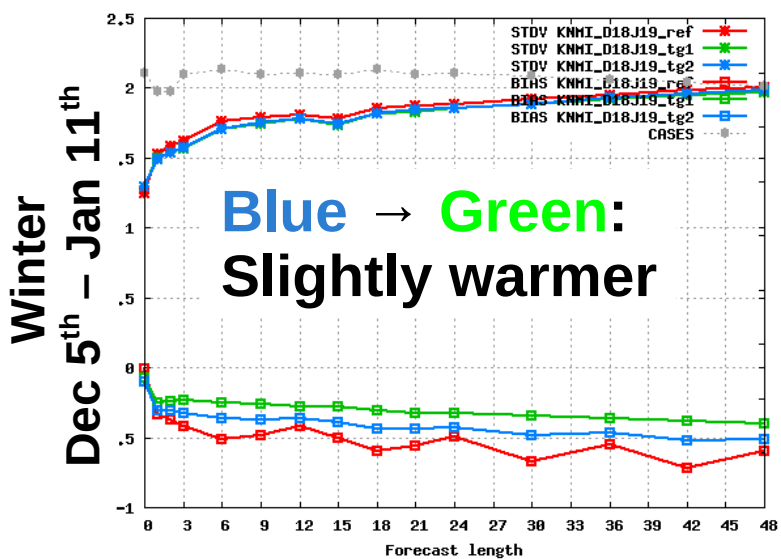
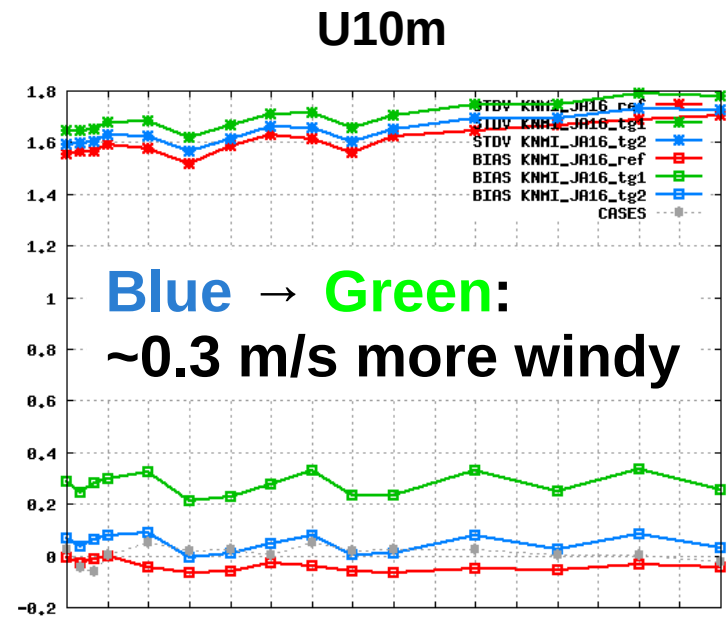
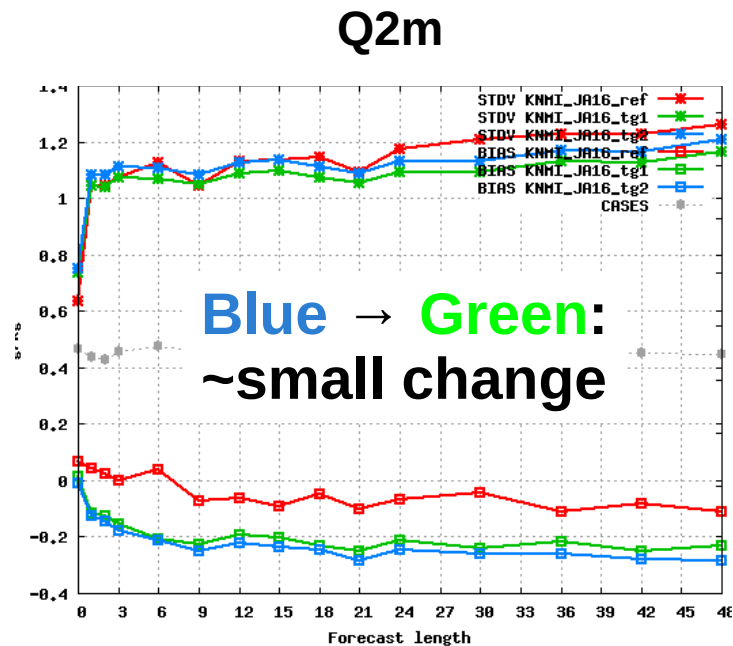
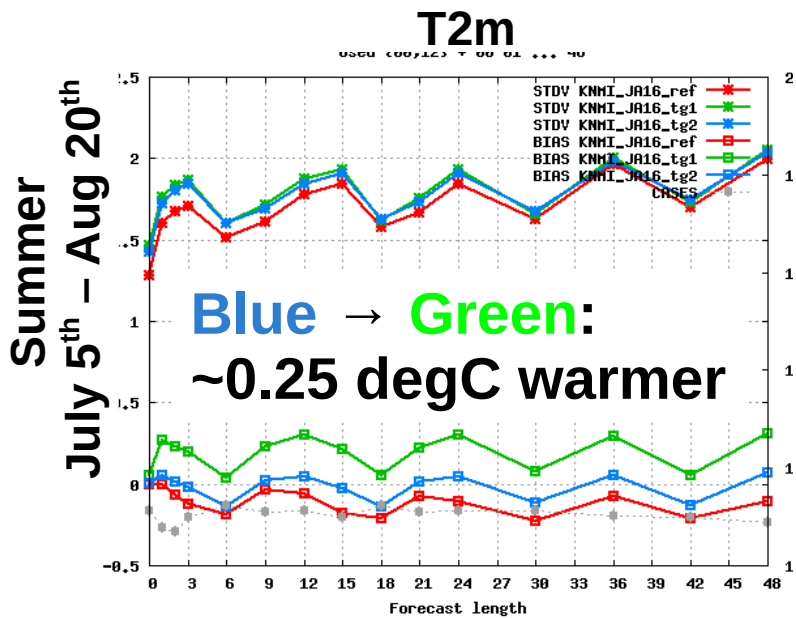
February 5th



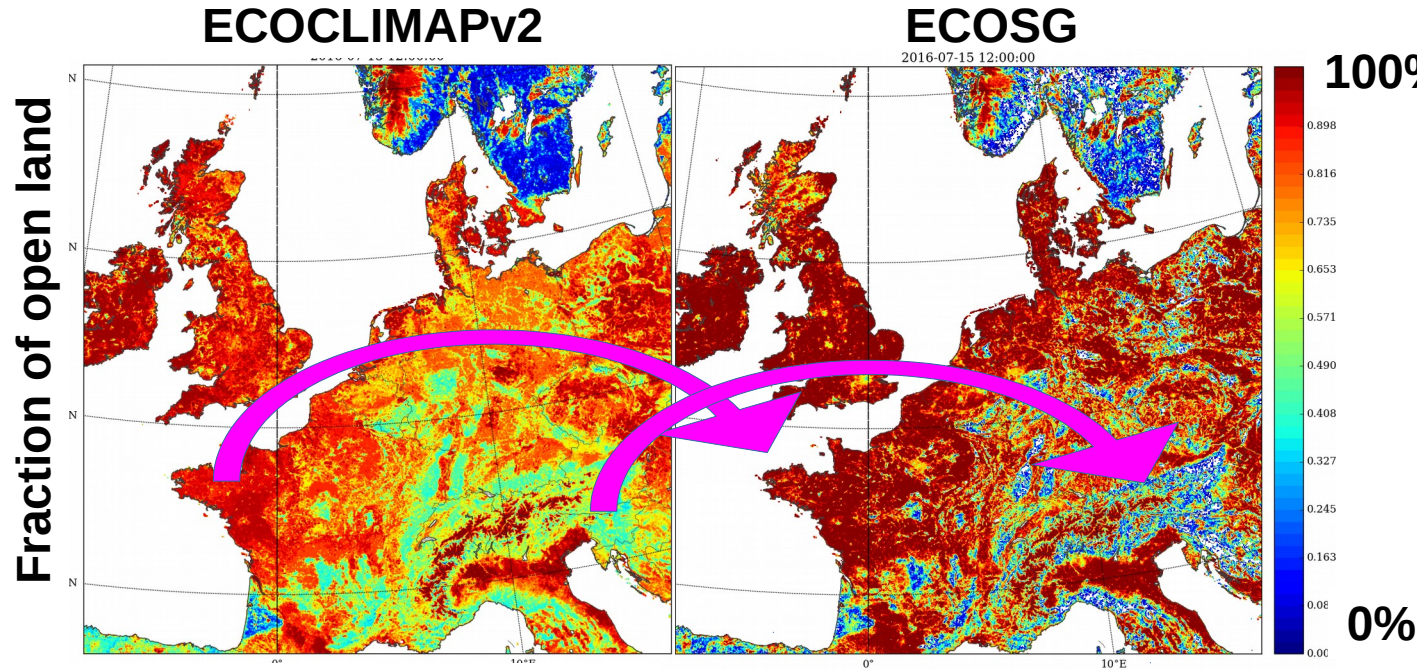
In general less LAI in ECOSG (often half of ECOCLIMAPv2).

ECOSG in general compares better with other estimates of LAI.

How does ECOCLIMAP-SG compare with ECOCLIMAPv2 – Meteorological impact (KNMI domain)



How does ECOCLIMAP-SG compare with ECOCLIMAPv2 – Surface characteristics



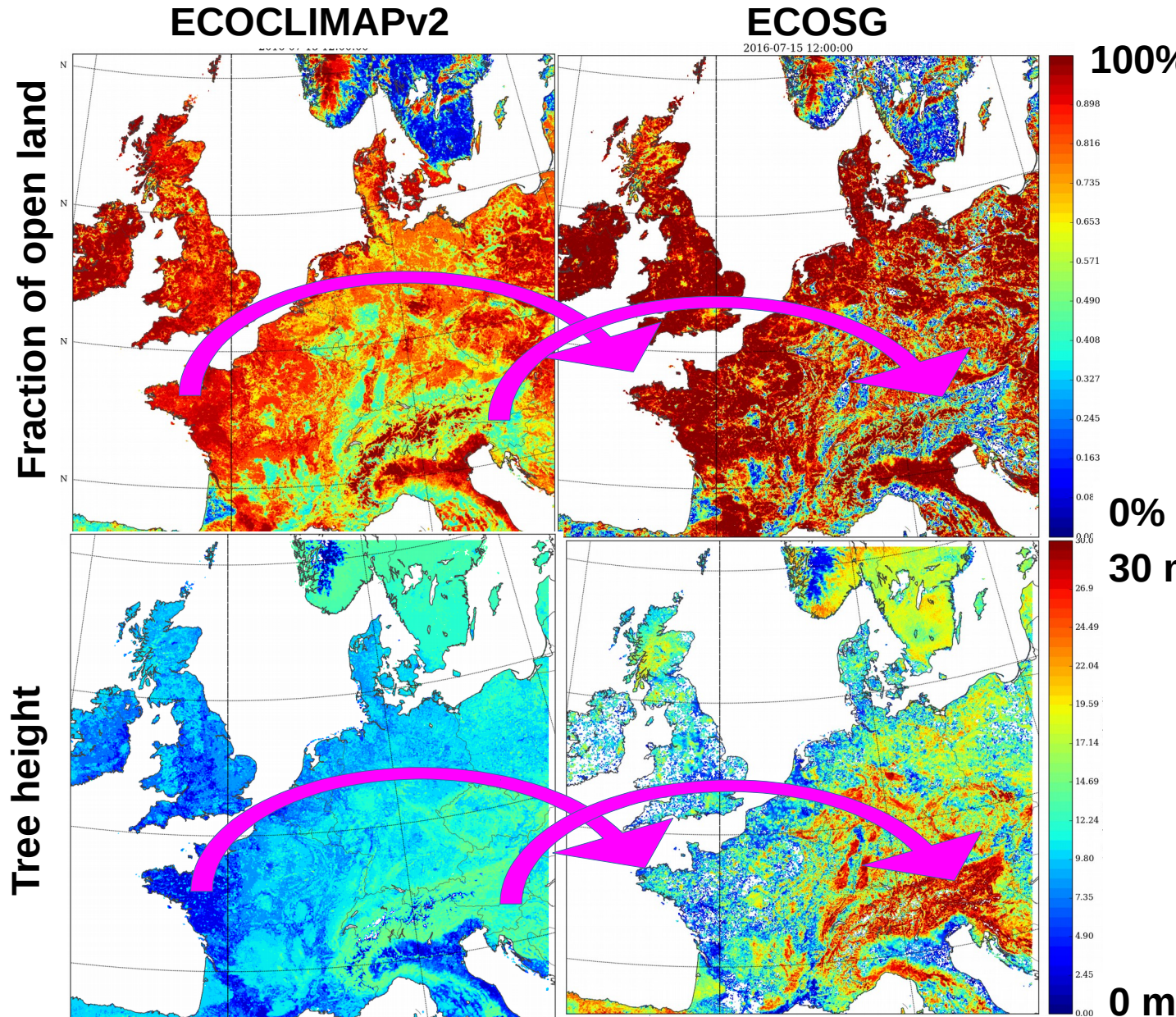
Wind (too high) is the main issue. Why?

Okay, LAI is less which decreases roughness:

$$z0_grass = 0.13 * LAI / 6$$

But also, over continental Europe, open land areas seem to become more open in ECOSG while forested areas become more dense, thus contrasts increase.

How does ECOCLIMAP-SG compare with ECOCLIMAPv2 – Surface characteristics



100% Wind (too high) is the main issue. Why?

Okay, LAI is less which decreases roughness:

$$z0_grass = 0.13 * LAI / 6$$

But also, over continental Europe, open land areas seem to become more open in ECOSG while forested areas become more dense, thus contrasts increase.

0%

30 m

ECOSG tree height is taller.

$$z0_forest = 0.13 * \text{tree_height}$$

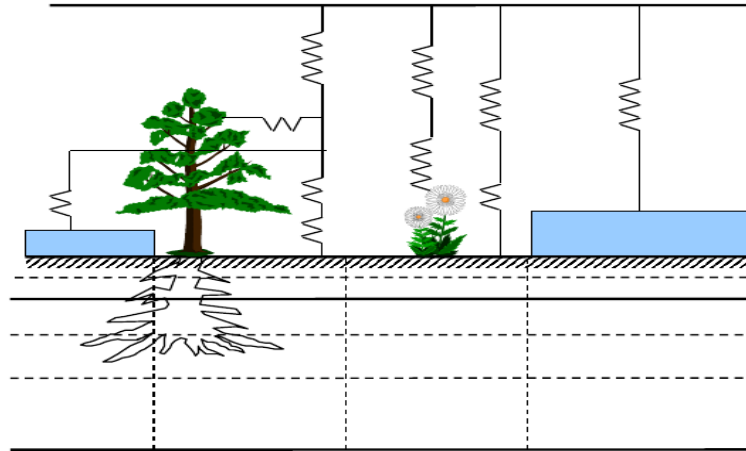
So, for experiments in previous slide $0.7 * \text{ECOSG_tree_height}$ was used to reduce roughness. Too much?

Yes, Dmitrii, this is tuning... or actually retuning... Unavoidable!?

HIRLAM - cy40h SURFEXv7.3 - cy43h SURFEXv8.1

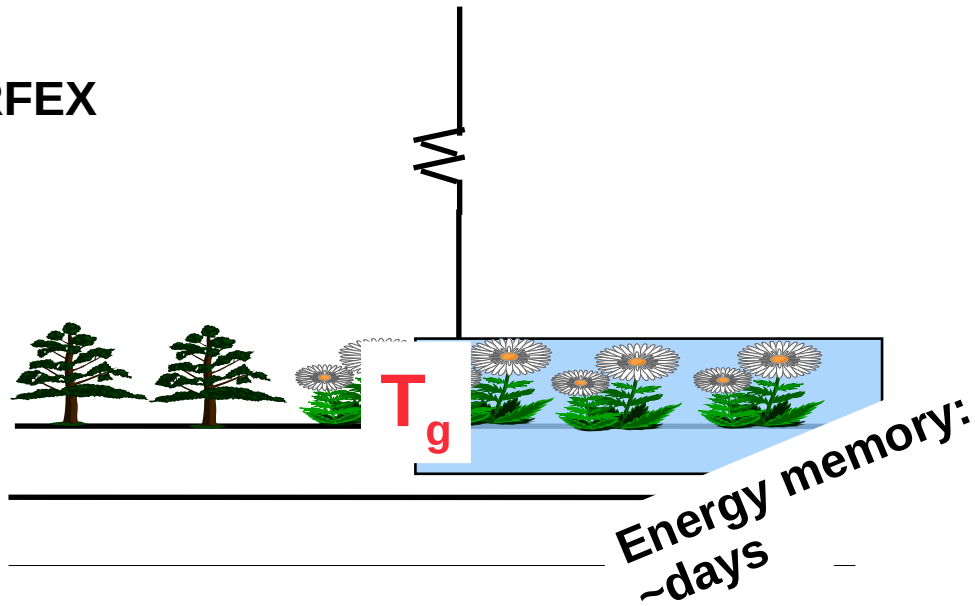
HIRLAM

Multi level/energy with OI

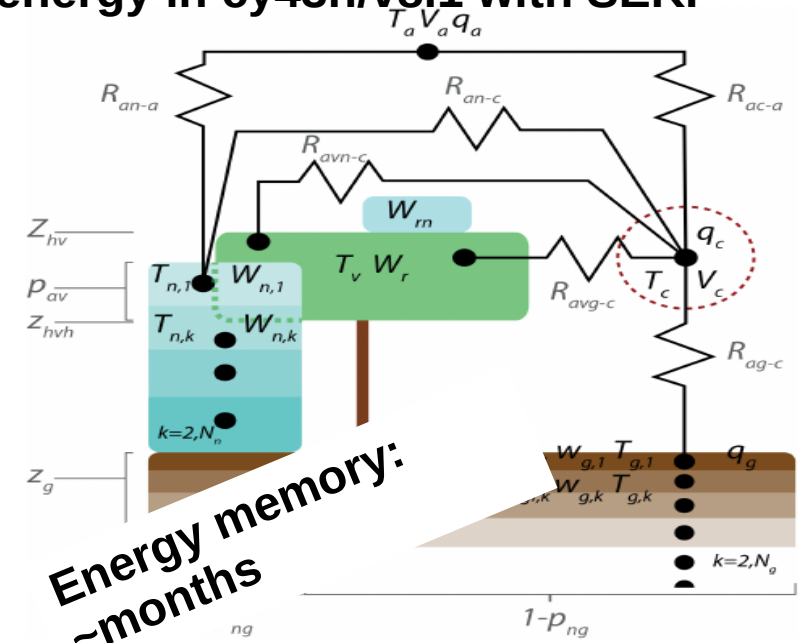


Force-restore in cy40h/v7.3 with OI

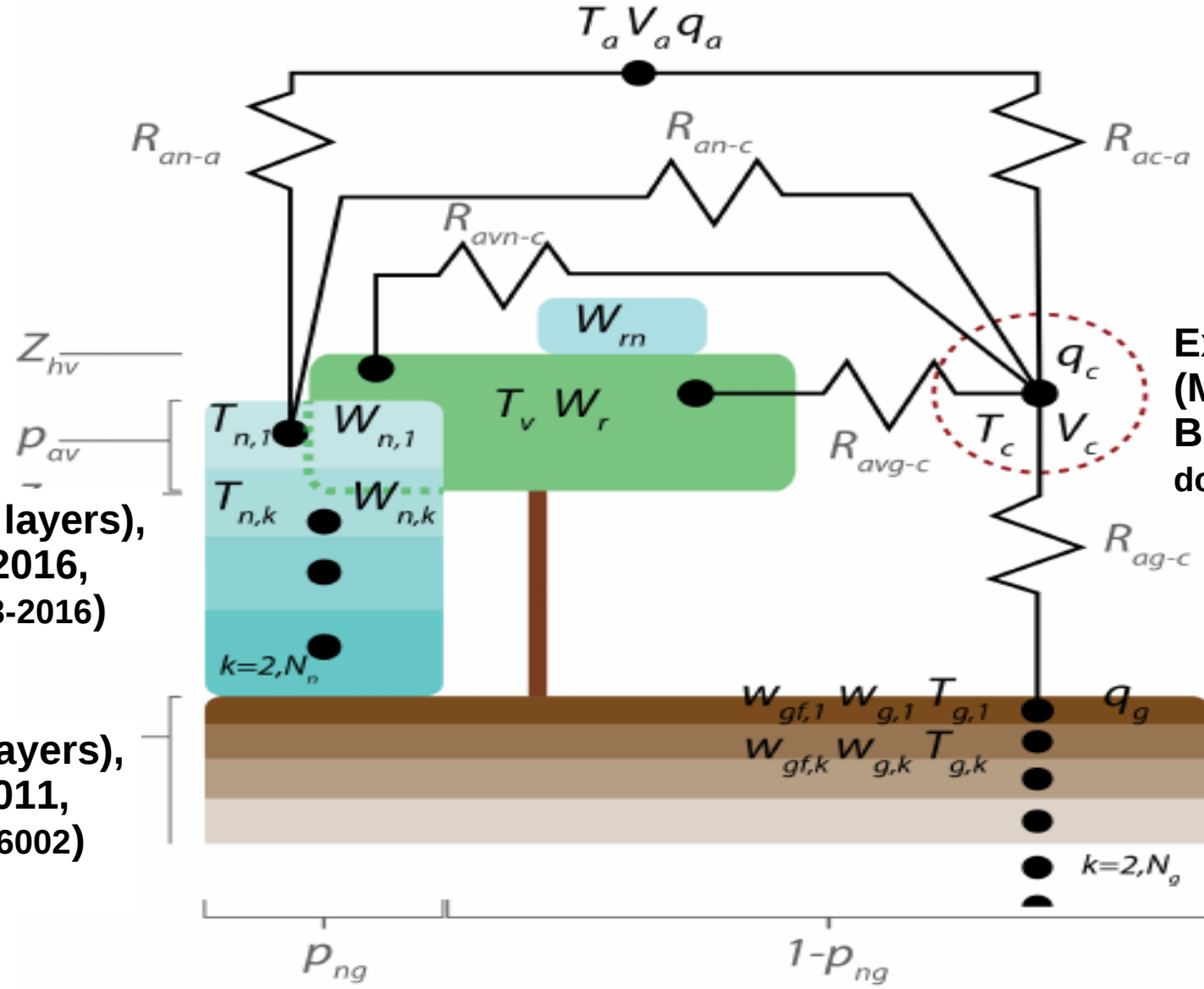
SURFEX



Multi level/energy in cy43h/v8.1 with SEKF



Diffusion soil and explicit snow and canopy in cy43h/SURFEXv8.1



Explicit snow (12 layers),
Decharme et al. (2016,
doi:10.5194/tc-10-853-2016)

Diffusion soil (14 layers),
Decharme et al. (2011,
doi:10.1029/2011JD016002)

Explicit canopy: MEB
(Multi-Energy Balance),
Boone et al. (2017,
doi:10.5194/gmd-10-843-2017)

Litter layer
Napoly et al. (2017,
doi:10.5194/gmd-10-1621-2017)
Low heat capacity.
Stores energy and
water/ice.

Main development by the SURFEX team at Météo-France and their collaborators.

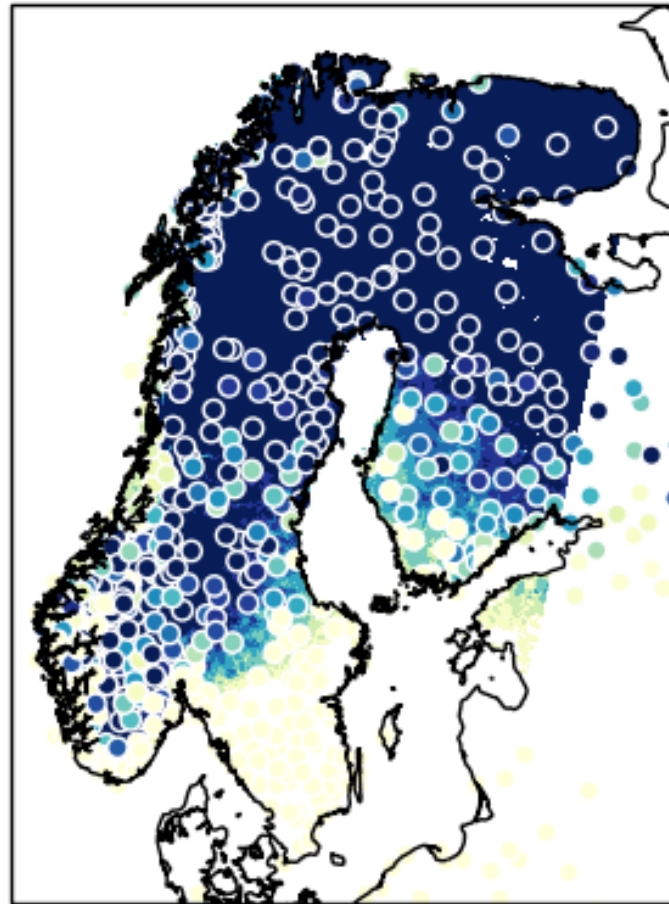
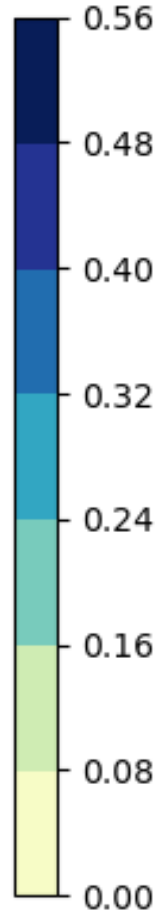
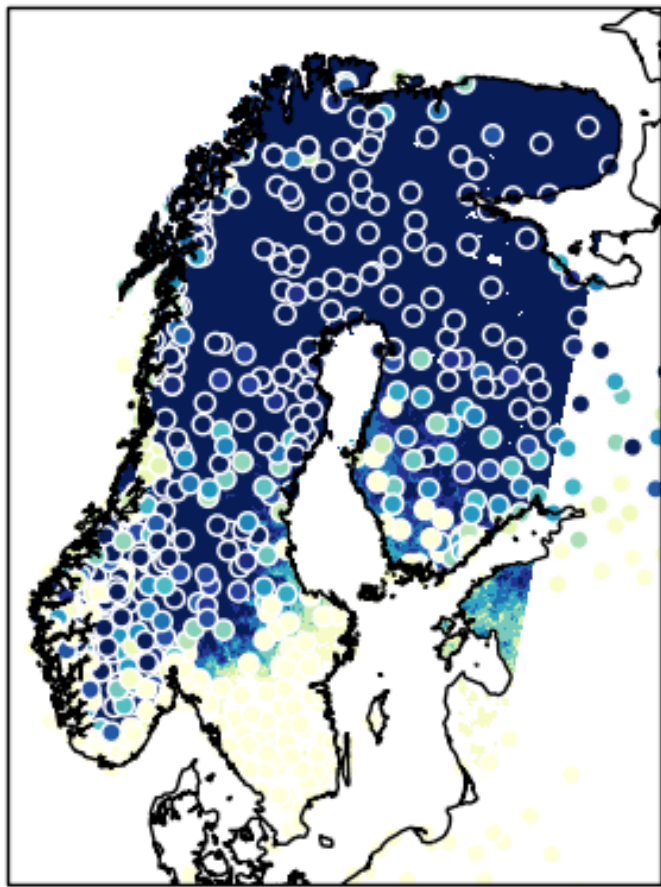
Diffusion soil and explicit snow and canopy in (SURFEX+SODA)v8.1 offline setup - snow

Open loop simulations September – June, 2018 - 2019.
Forcing from MetCoOp EPS (MEPS) control run.

Snow depth (m) at **April 1st** 2019

Force-restore + bulk layer snow (D95)

New physics



Model snow is a bit overestimated in southern Finland, but less so with new physics...

Maps: SURFEX snow
Circles: Observed snow

Based on development and simulations by Trygve Aspelien (MetNorway)

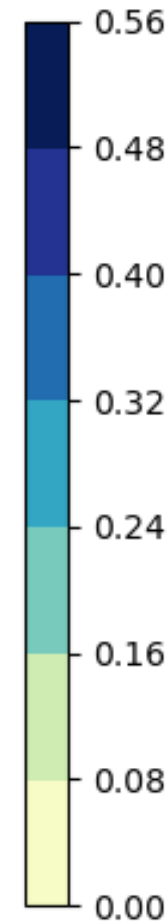
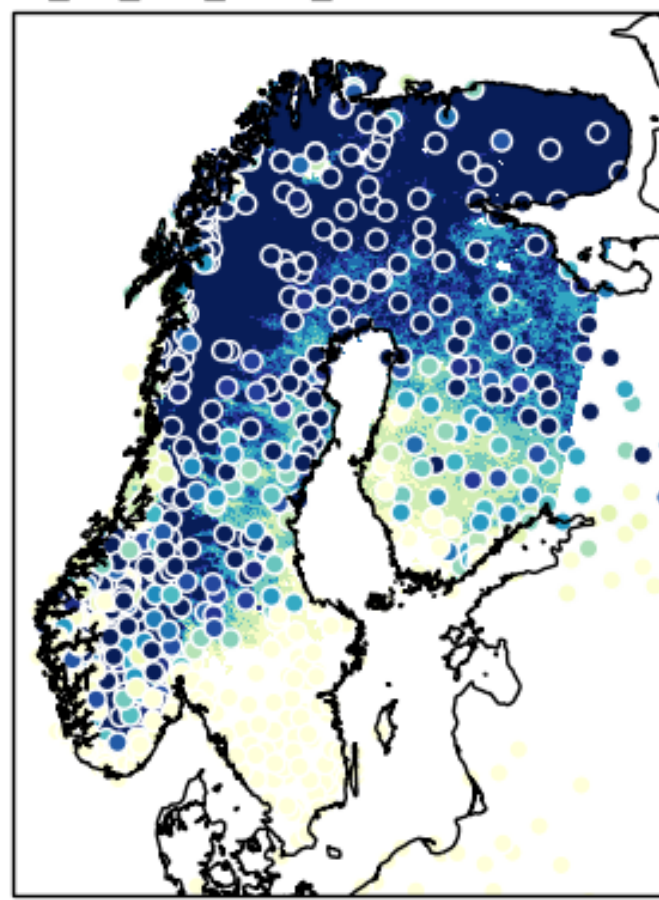
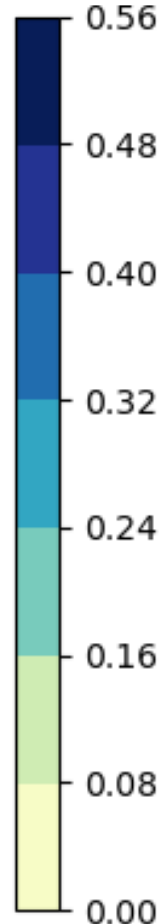
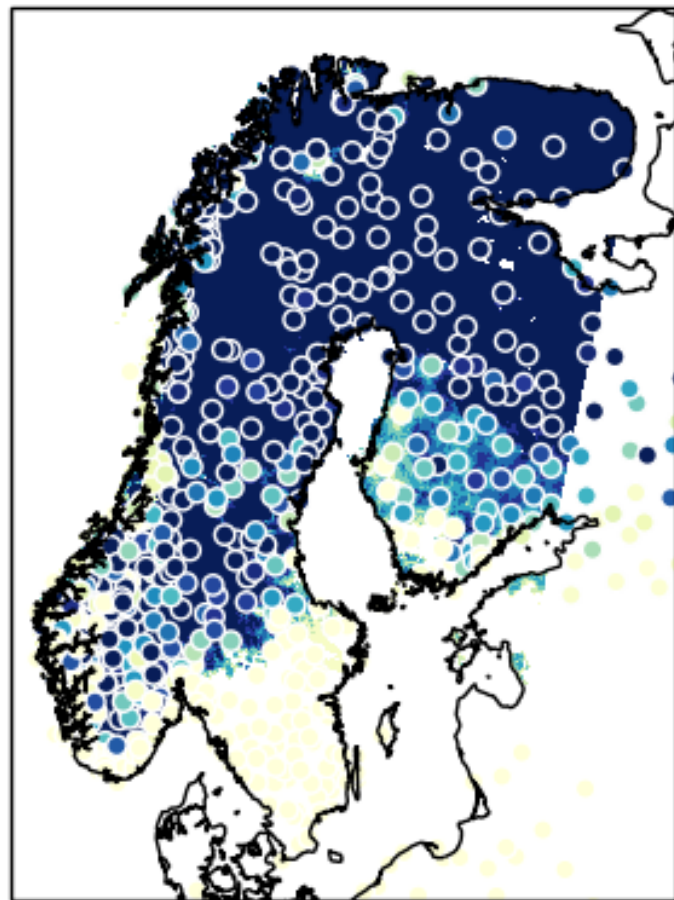
Diffusion soil and explicit snow and canopy in (SURFEX+SODA)v8.1 offline setup - snow

Data assimilation simulations (**analysis with TITAN/gridPP**) September – June, 2018 - 2019.
Forcing from MetCoOp EPS (MEPS) control run.

Snow depth (m) at **April 1st** 2019

Force-restore + bulk layer snow (D95)

New physics



More similarity between model and observations when data assimilation is applied.

Trivial result you can say, but how to assimilate the snow depth is far from trivial...

Snow depth is observed over open land (SYNOP) but we also need to correct snow depth in forest...

Maps: SURFEX snow
Circles: Observed snow

Based on development and simulations by Trygve Aspelien (MetNorway)

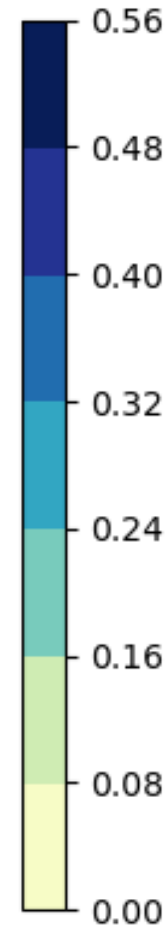
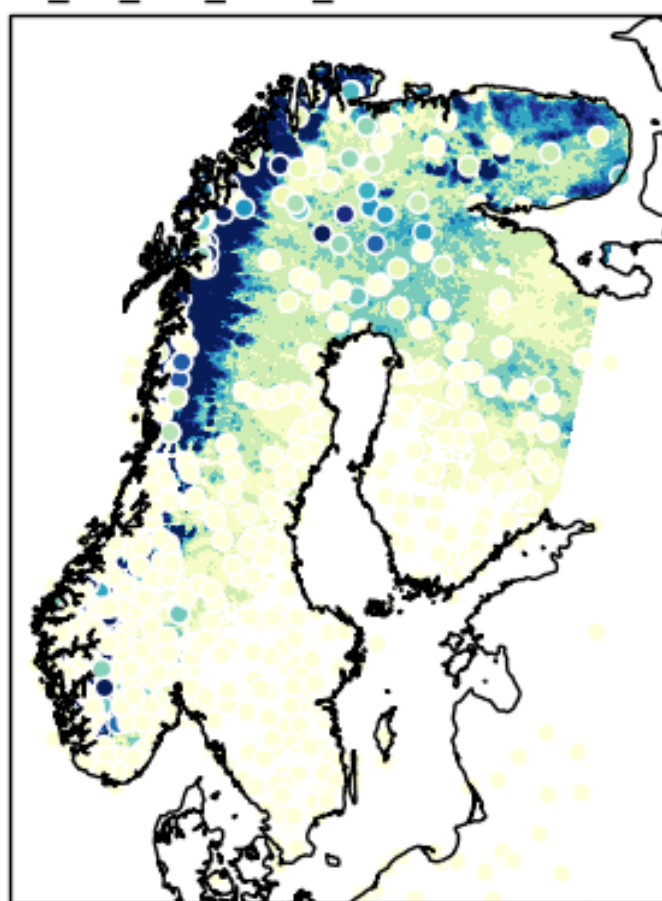
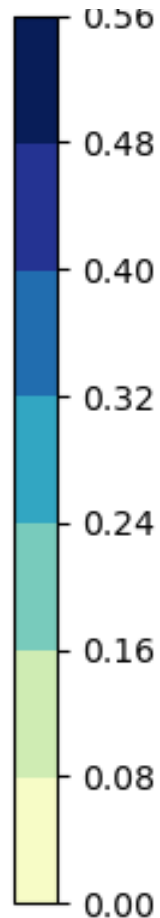
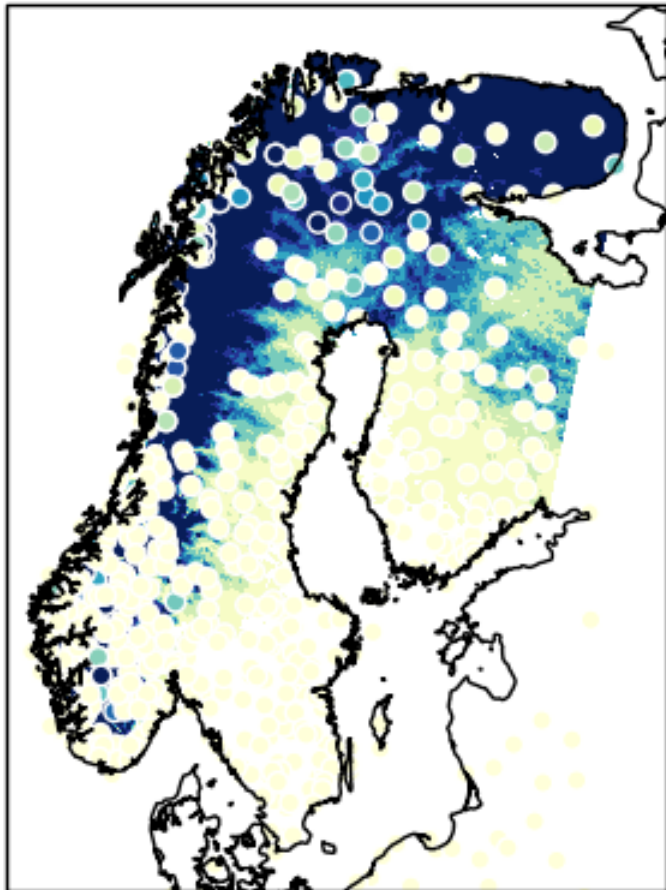
Diffusion soil and explicit snow and canopy in (SURFEX+SODA)v8.1 offline setup - snow

Open loop simulations September – June, 2018 - 2019.
Forcing from MetCoOp EPS (MEPS) control run.

Snow depth (m) at **May 1st** 2019

Force-restore + bulk layer snow (D95)

New physics



**Open loop again:
Less difference between
model and observations
for new physics.**

**Thus, new physics is able
to capture the snow-
melt period better
also without data
assimilation.**

Maps: SURFEX snow
Circles: Observed snow

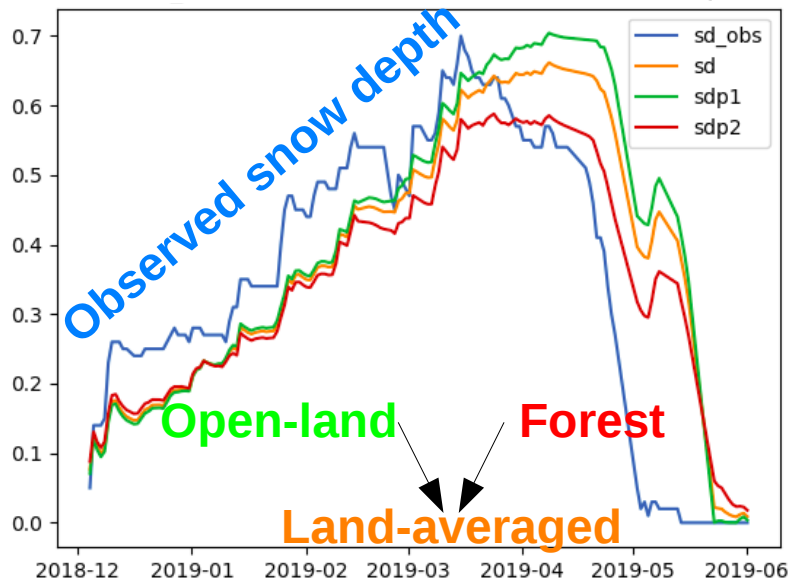
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Diffusion soil and explicit snow and canopy in (SURFEX+SODA)v8.1 offline setup - snow

Open loop simulations September – June, 2018 - 2019.
Forcing from MetCoOp EPS (MEPS) control run.

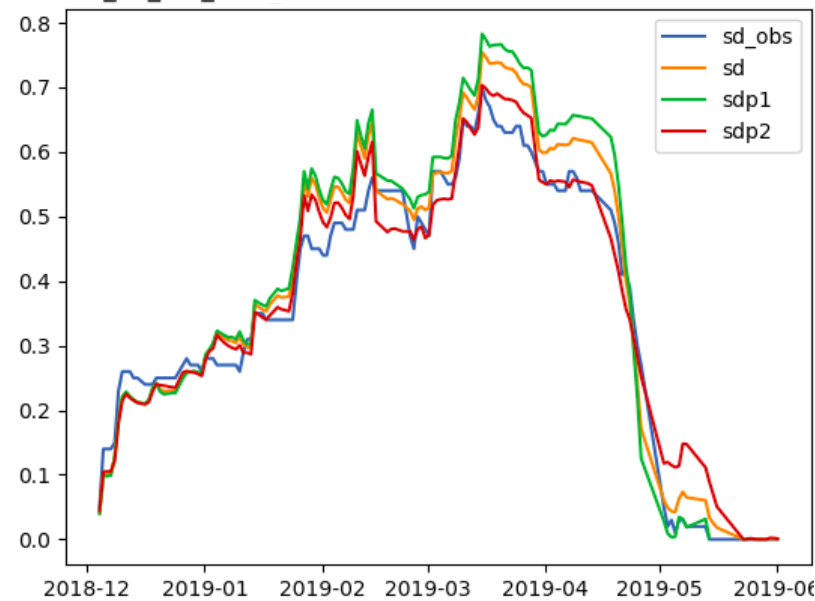
Svartberget SYNOP station, northern Sweden. Results Dec - June, 2018 - 2019:

D9 Force-restore and D95



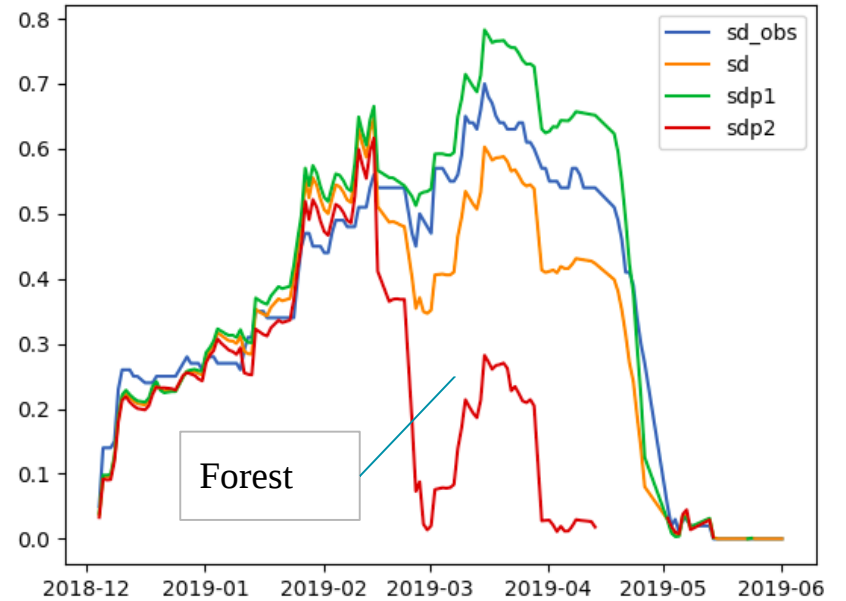
D95 underestimates accumulation and melts snow too late.

ISBA_ES_DIF_1 Full new physics



Full new physics does well.

Full new physics but without explicit canopy (MEB)

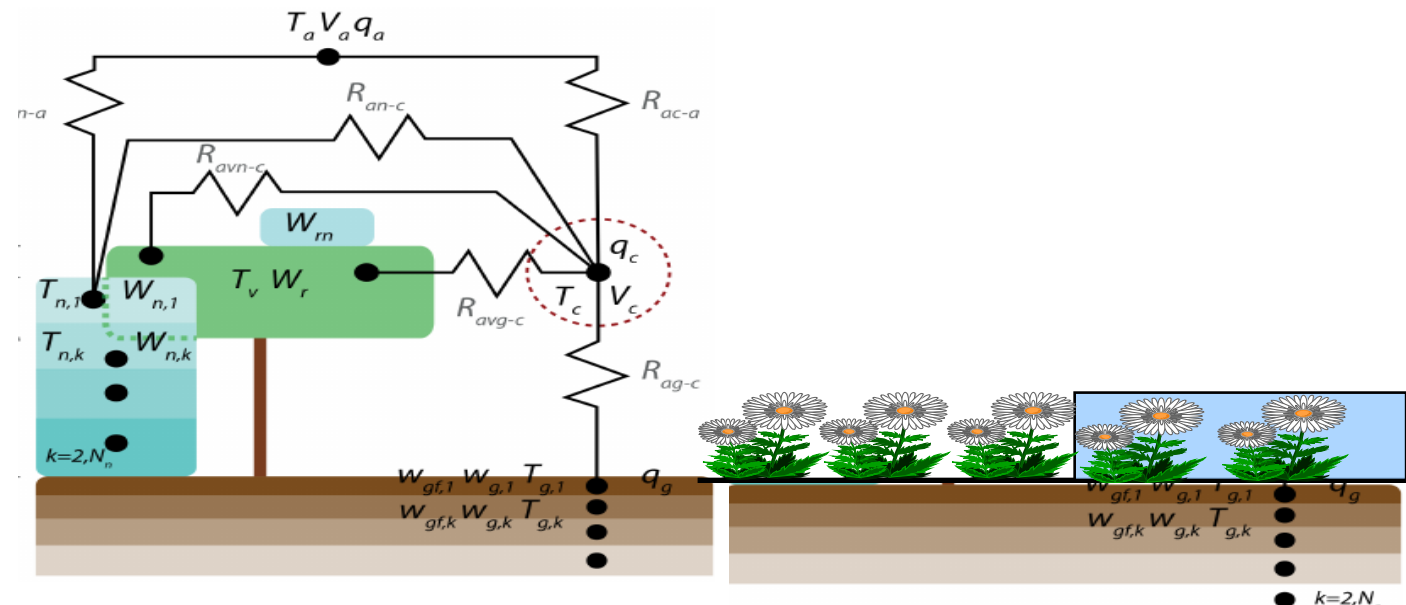


But, don't try to use multi-layer snow in forest without proper canopy!

Other activities connected to new surface physics

A development version of cy43h is currently used with new surface physics in combination with SEKF surface data assimilation. What are the proper control variables to use? (among ~70 prognostic ones).
Åsmund Bakketun (MetNorway) et al.

A development version of cy43h is currently used for climate simulations (HCLIM43).
Now a 3-year test run (+ spinup) is running over the Iberian domain using ERA5 as BC and ECOCLIMAP Second Generation as physiography.
Samuel Viana (AEMET), Emily Gleeson (Met Eireen) et al.



Wednesday 14:30-16:00: Parallel session on surface aspects

Additional presentations:

- **Jan-Peter Schulz and Gerd Vogel (Deutscher Wetterdienst):**
Improved processes in the land surface model TERRA: Bare soil evaporation and skin temperature
- **Goran Pejanovic (NHMS of Serbia):**
Recent developments addressed to integrated atmospheric and hydrology modelling
- **Jürgen Helmert (DWD):**
Results of COSMO-D2 experiments with the peatland/mire parameterization.
- **Patrick Le Moigne (Météo-France):**
ECOCLIMAP Second generation – new land use for SURFEX and the ALADIN-HIRLAM NWP system.
- **Massimo Milelli (Arpa Piemonte):**
Urban modelling in COSMO
- **And a discussion on how to possibly proceed with cross-consortia efforts in handling of physiography information.**
- **New effort to document our surface work (COMSO and HIRLAM currently there...):**
https://docs.google.com/document/d/17x7ysyoOI280fzQMYmD94N7GGfORiPHkrTWECIPc_H0/edit?usp=sharing

THANKS!!

Very low LAI →



HIRLAM Surface working week in Norrköping, February 2019

