

# Overview of HIRLAM surface activities

**Patrick Samuelsson**

**SMHI**

**HIRLAM project leader for surface model and assimilation**

**with contributions as acknowledged**



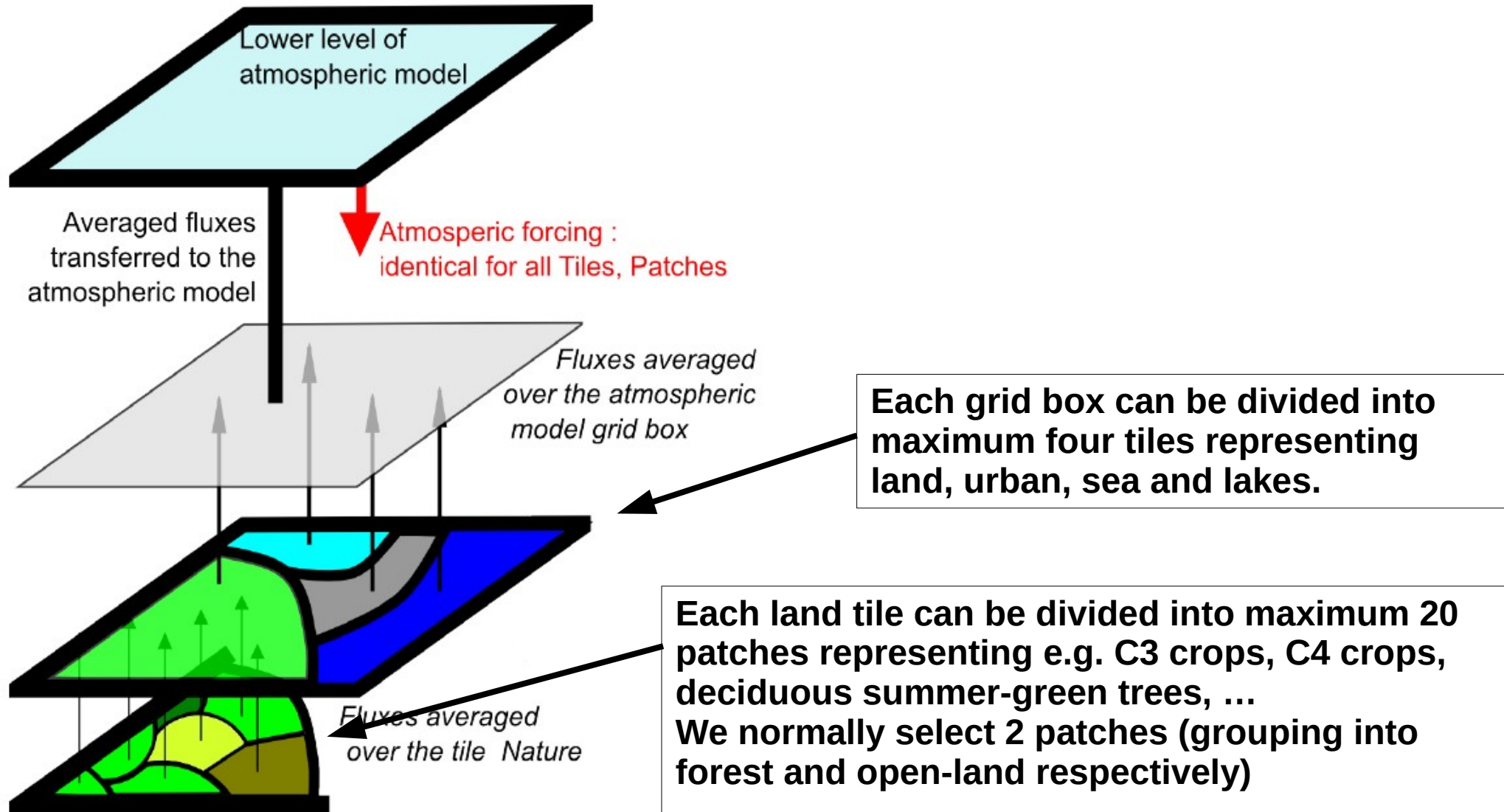
# General surface comments

**cy43h2.1** is our latest release of the ALADIN-HIRLAM NWP system, including **SURFEX**, with the HARMONIE-AROME model configuration.

**cy46h** is a development cycle which represents our next big step with respect to land processes.

	<b>cy43h2.1 – latest release</b>	<b>cy46h - development</b>	<b>cyxx</b>
<b>Land</b>			
Patches	2 (separated forest and open land)	2	
Vegetation	Bulk soil/veg/snow	Explicit canopy (MEB)	
Soil	Force-restore	Diffusion (14 layers)	
Snow	D95 (bulk)	Explicit snow (12 layers)	
Assimilation	CANARI-OI	TITAN/gridPP-SEKF	
			Coupled DA for atmosphere and surface based on 4D EnKF
<b>Sea</b>	SICE	SICE	
<b>Lake</b>	Flake	FLake (later with EKF)	
<b>Town</b>	TEB	TEB (more options)	
<b>Physiog.</b>	ECOCLIMAP 2 <sup>nd</sup> generation ESA CCI land cover	ECOCLIMAP 2 <sup>nd</sup> generation ESA CCI land cover	

# SURFEX tiles and patches

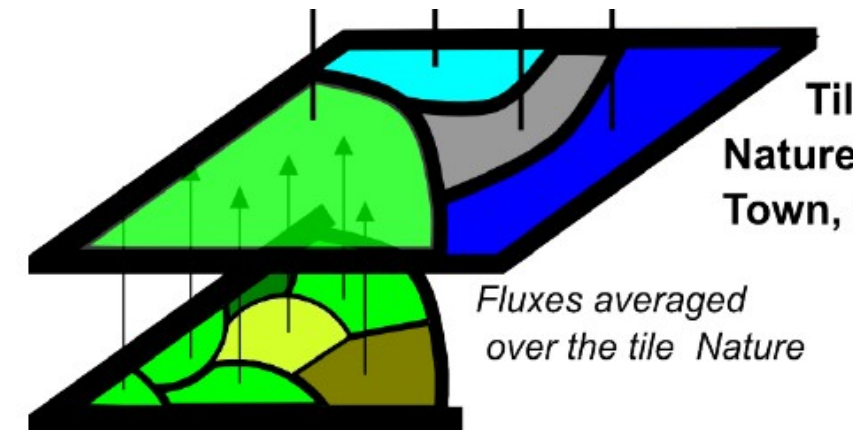


# Land use

Earlier HARMONIE-AROME releases used ECOCLIMAP 1<sup>st</sup> generation as land use which has 1 km resolution. Each 1 km pixel has its original land-use type (e.g. C3 crops) but **in SURFEX it is assumed that these pixels are seldom homogeneous but only dominated by this original land use and then also mixed with other land-use types** (e.g. C3 crops mixed with some lake, forest and urban areas). This creates a non-homogeneous land-use input to e.g. the roughness estimation.

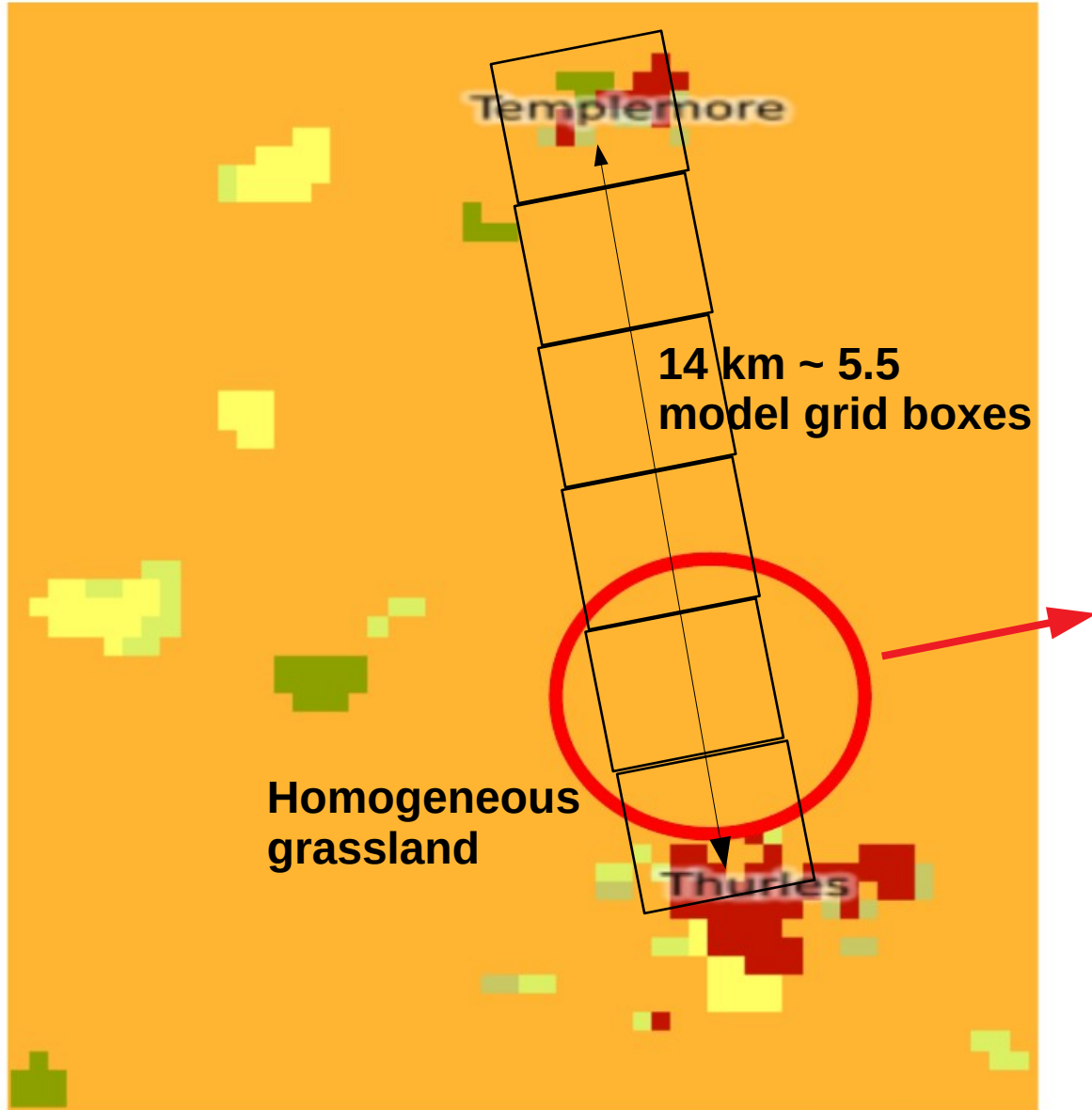
However, ECOCLIMAP 2<sup>nd</sup> generation (ESA CCI) land use has 300 m resolution and **each 300 m pixel is assumed to be homogeneous** given its original land-use type.

The problem is that with ECOCLIMAP 2<sup>nd</sup> generation we find areas in our HARMONIE-AROME domains (2.5 km resolution) that are homogeneous with one dominating patch (e.g. open-land) given properties from one dominating land use type e.g. C3 crop. **But in reality this is not how the landscape always looks!**



# Example from the interior of southern Ireland

ESA-CCI land cover with 300 m pixels



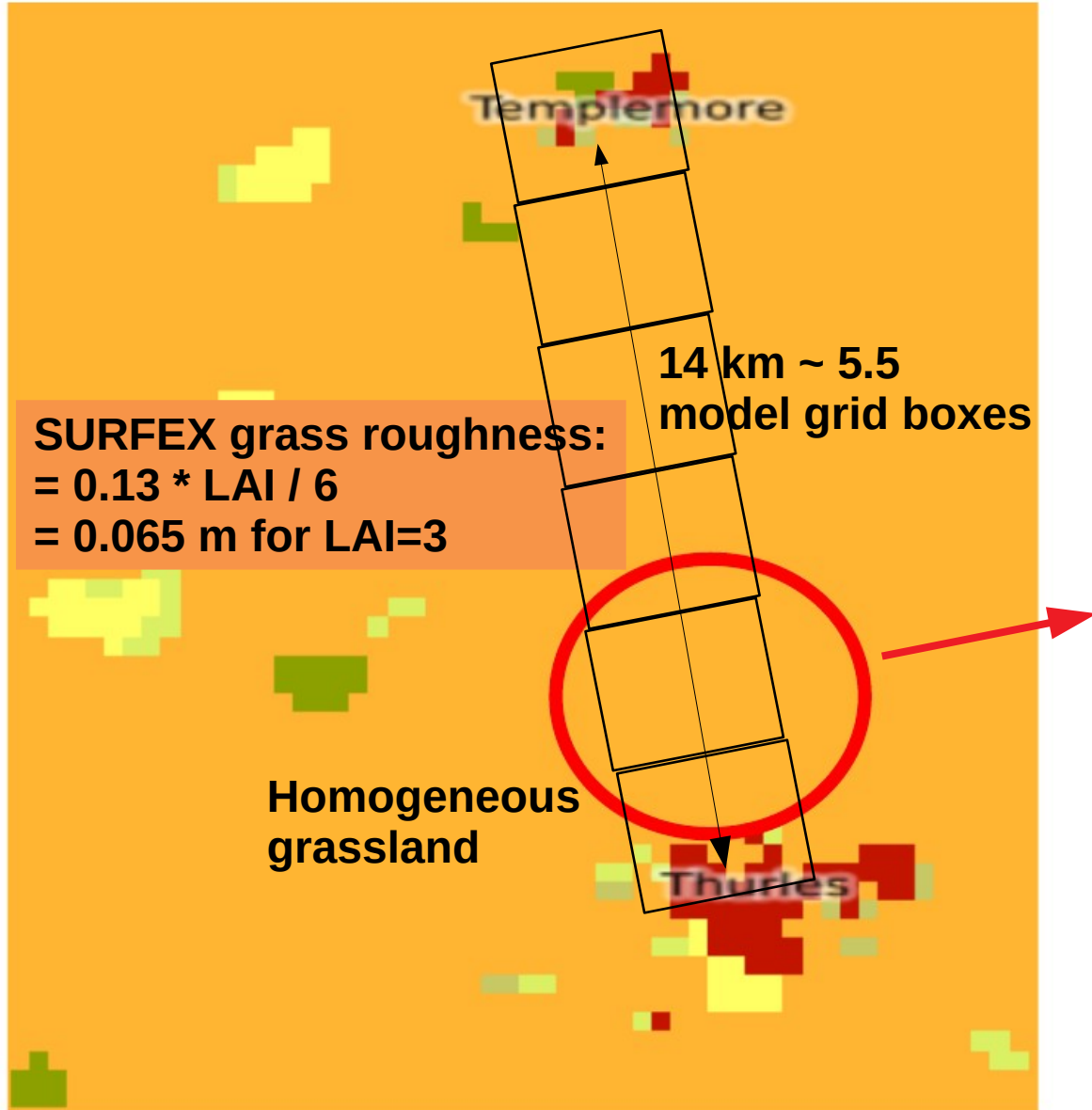
This area in reality (Google maps)!



Figures from Emily Gleeson and  
Geoffrey Bessardon (Met Éireann)

# Example from the interior of southern Ireland

ESA-CCI land cover with 300 m pixels

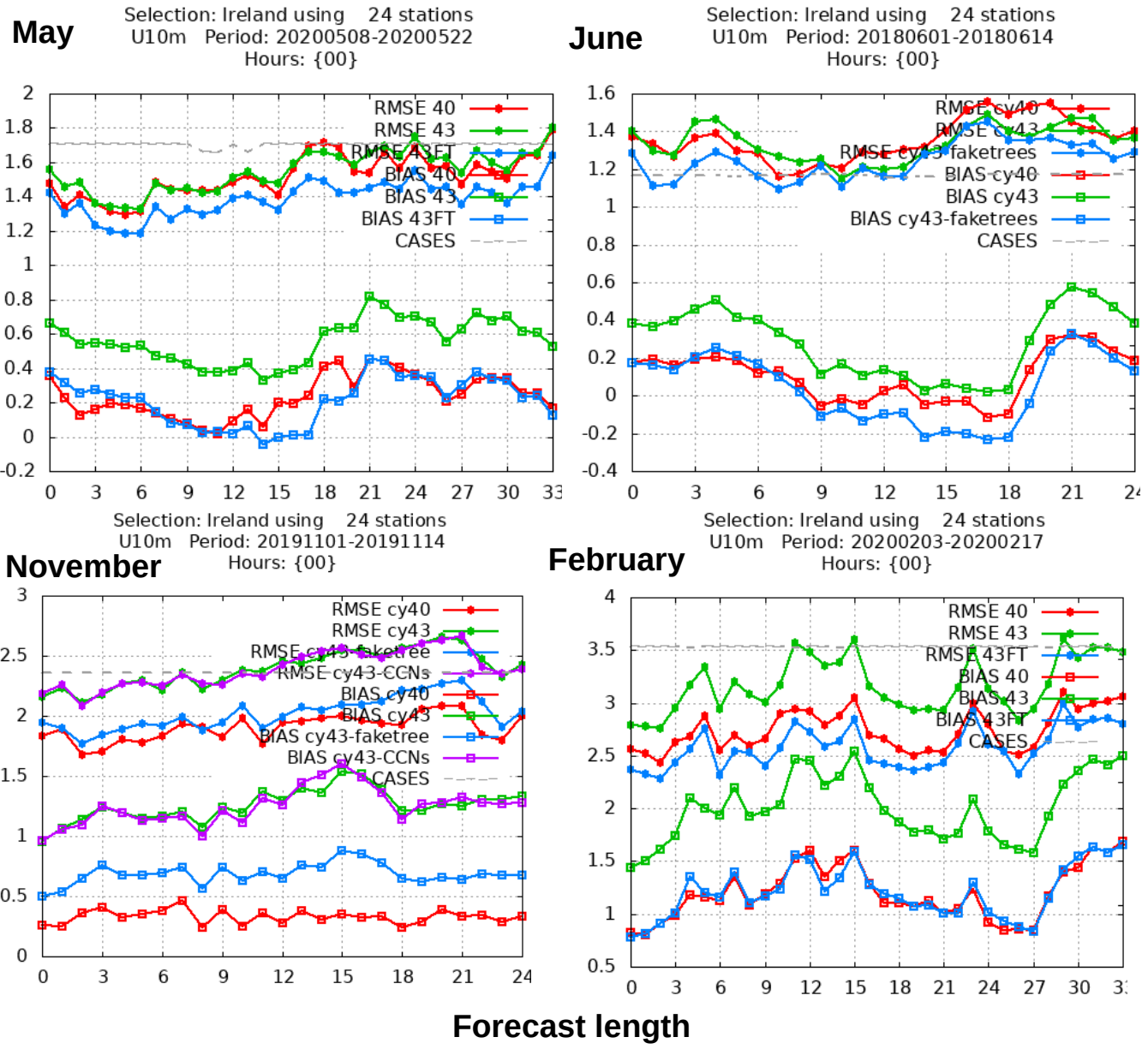


This area in reality (Google maps)!



Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)

# U10m model wind statistics for Ireland



Bias (lower lines) and RMSE (upper lines) for Operational model (red) and cy43h with ESA-CCI (green).

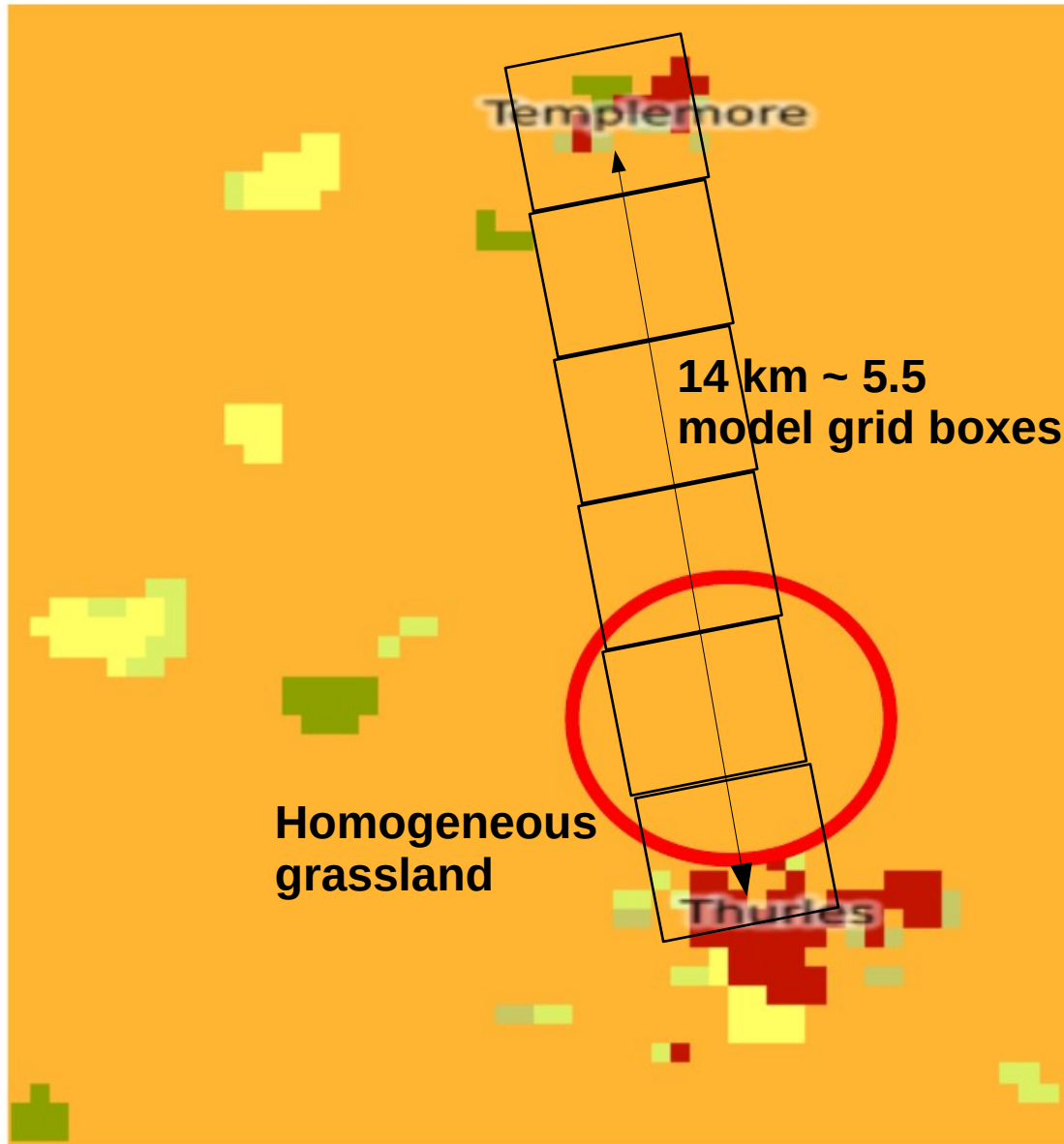
The cy43h model version with ESA CCI land use shows in general a positive, and higher, U10m wind bias than the operational model using ECOCLIMAP 1<sup>st</sup> generation land use.

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)



# We attack the problem by introducing extra trees

ESA-CCI land cover with 300 m pixels



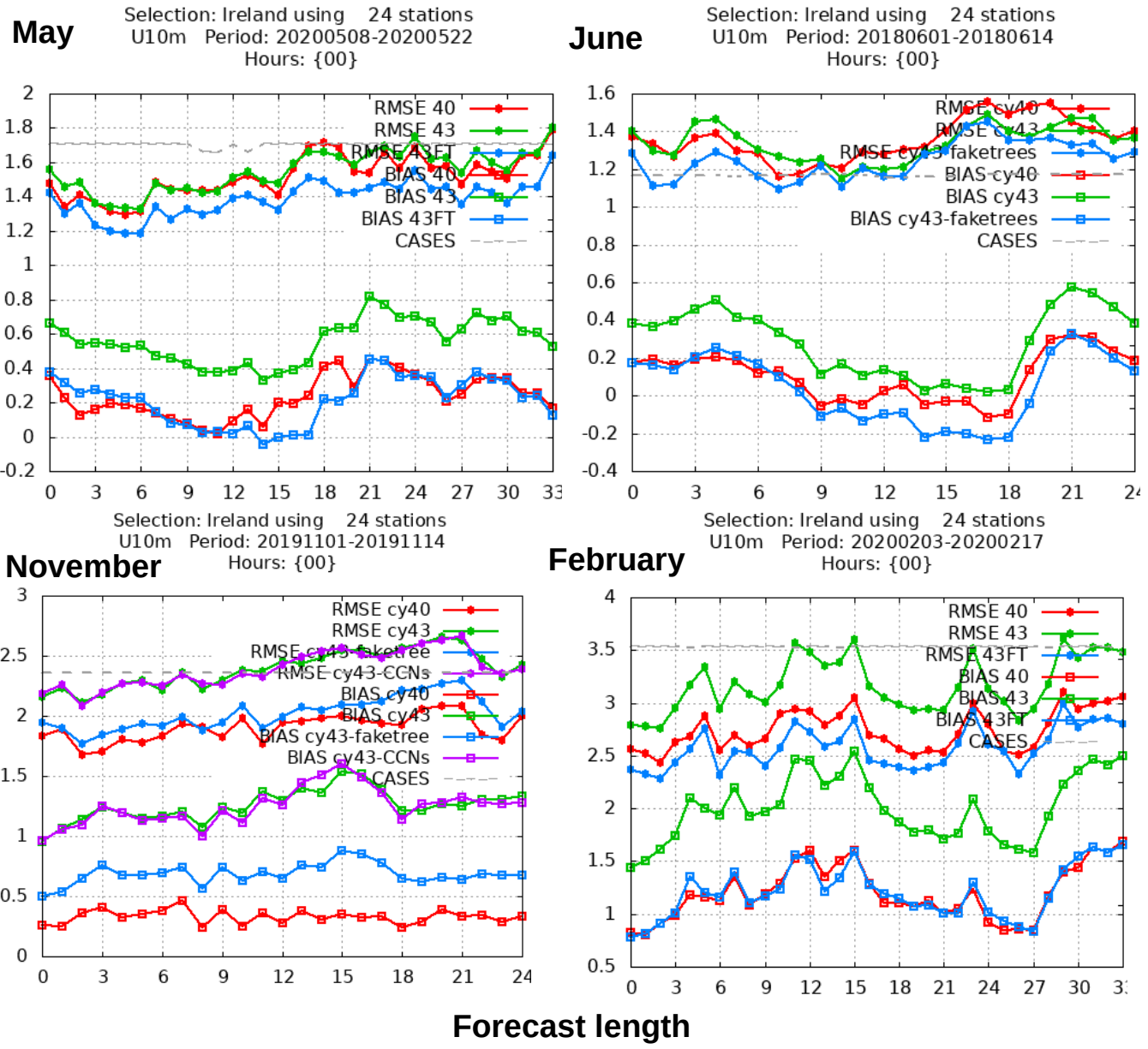
Samuel Viana (AEMET) came up with the suggestion to mimic the true landscape and increase the roughness by introducing extra trees in each vegetation patch represented by any grass or crop type.

The idea is similar to the principal behind the ECOCLIMAP 1<sup>st</sup> generation land use but here we do not change LAI, evapotranspiration, albedo... but the extra trees only affect the roughness length over these open-land patches.

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)



# U10m model wind statistics for Ireland



Bias (lower lines) and RMSE (upper lines) for  
**Operational model**  
 cy43h with **ESA-CCI**  
 cy43h with extra trees

The cy43h model version with extra trees shows less and better bias for U10m.

This is now the recommended solution for HIRLAM countries to attack excess U10m wind bias for their open-land dominated areas.

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)



## How to use ESA CCI land cover

Overall we are more happy with ESA-CCI land use than with earlier ECOCLIMAP 1<sup>st</sup> generation land use:

- Better representation of coast line and land/sea/water mask.
- Better representation of urban areas.

Please refer to this report for details:

Samuelsson P., Kourzeneva E., de Vries J. and Viana S., 2020: HIRLAM experience with ECOCLIMAP Second Generation. ALADIN-HIRLAM Newsletter no 14, 154-188.

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But, as you have seen, we also have issues.

With the 1 km pixels in ECOCLIMAP 1<sup>st</sup> generation it was obvious that we can not simply assume that these homogeneous pixels are representative for the landscape description needed by the land-surface model to do a good job.

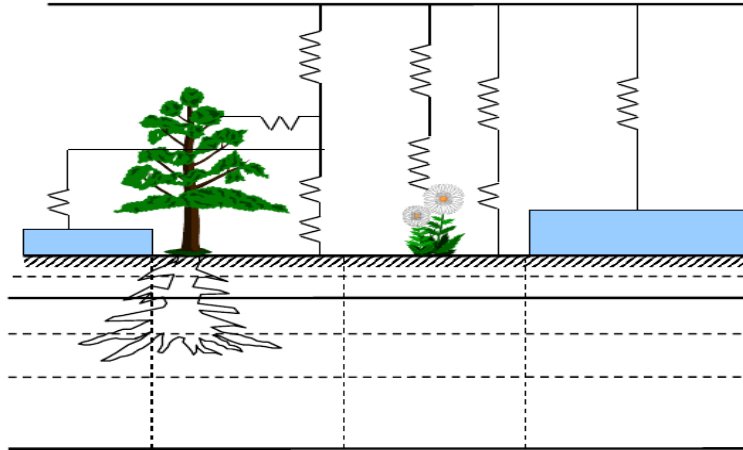
**But, which higher resolution (pixel size) is required for this assumption to be a valid and good enough one? 100 m? 50 m?...**

At least, our experience now is that the assumption is not good enough for 300 m pixels. How is this issue approached by other centres? Let's discuss this Thursday morning in the Surface breakout session...

# HIRLAM - Force restore - Multi-level physics

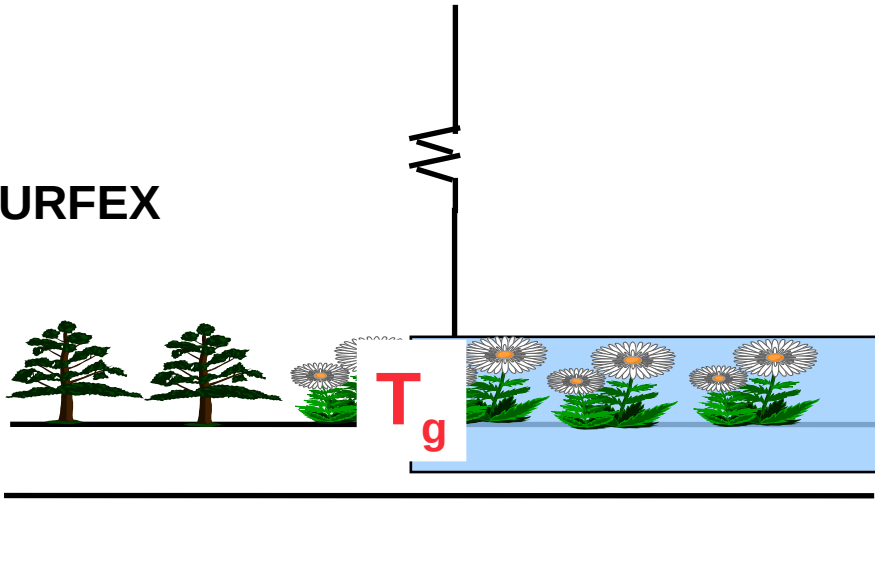
Multi level/energy with OI

HIRLAM  
model  
system



Force-restore in cy43h with OI

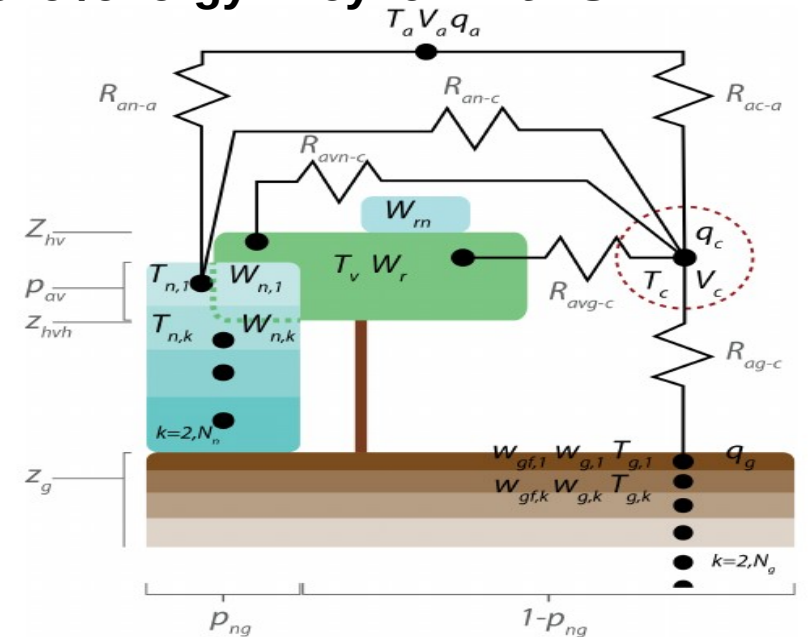
SURFEX



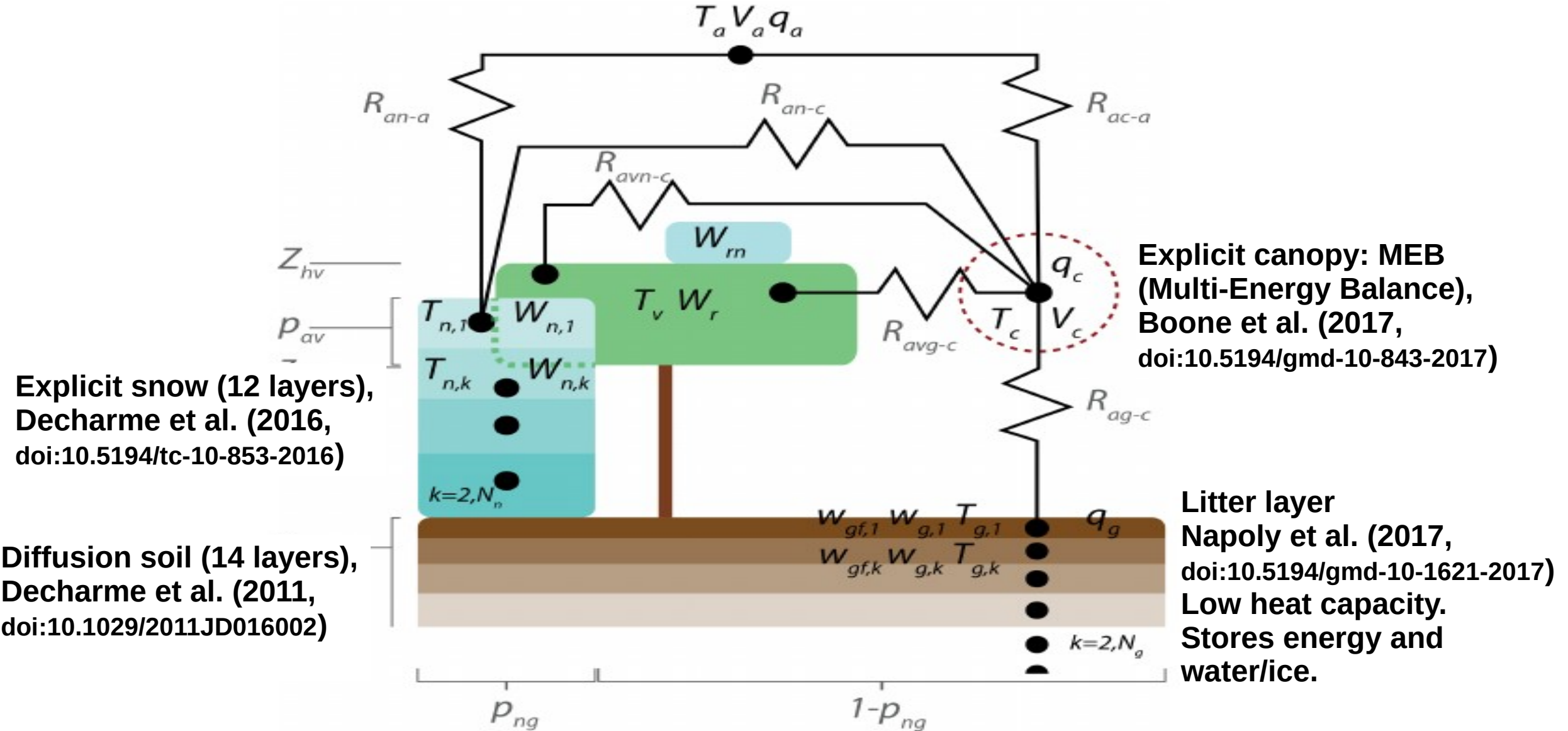
Multi level/energy in cy46h with SEKF



Our experience with the HIRLAM model shows us that we need to go in this direction



# All physics components we need are available for us in cy43h/SURFEXv8.1



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

## This setup is now running over the AROME-Arctic domain by MetNorway

Pre-operational setup  
(currently in a development branch of cy43h)

HARMONIE-AROME Atmosphere with 3D-VAR

SURFEXv8.1 for the surface with

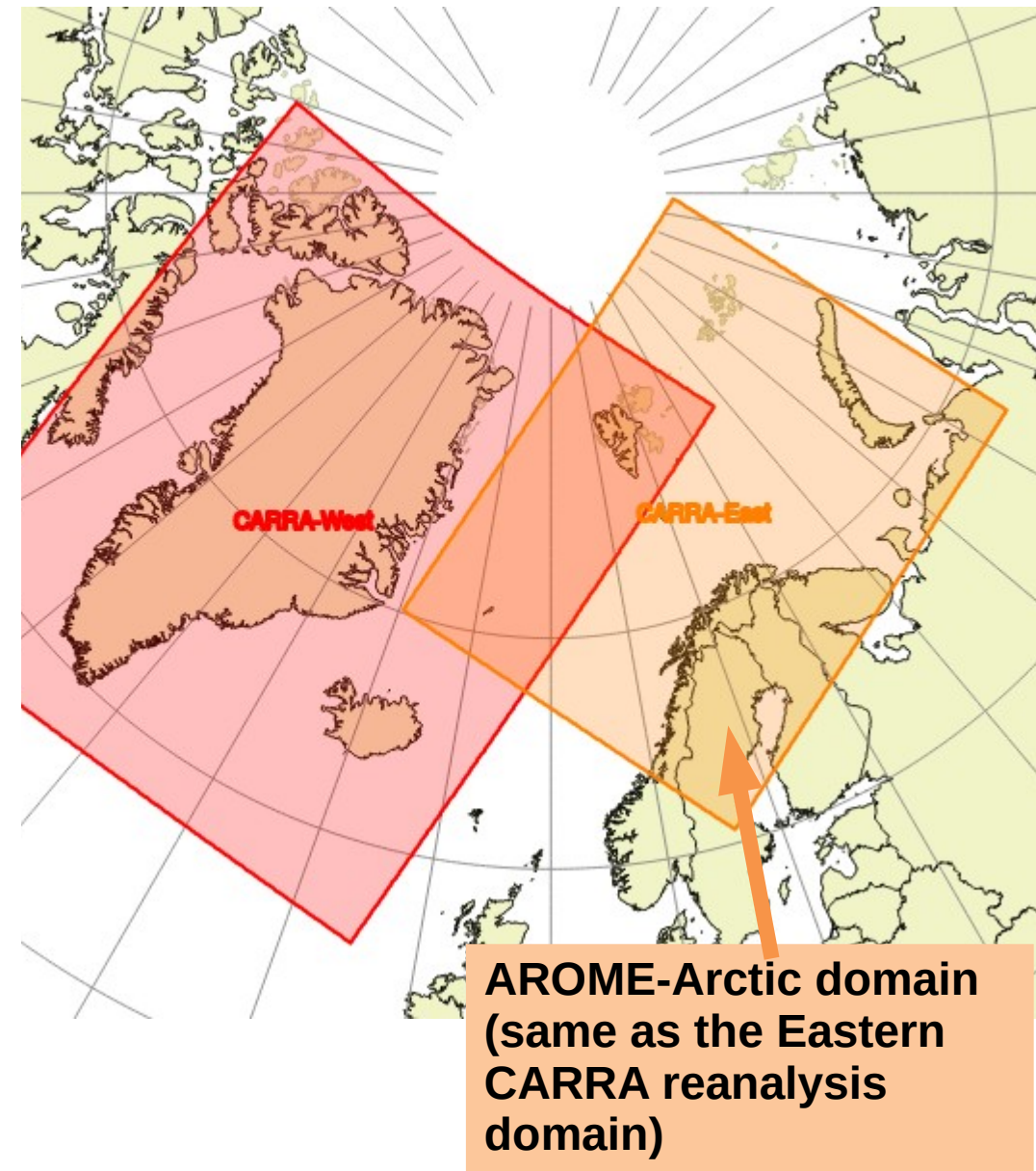
- 2 patches (forest and open land)
- Diffusion soil scheme (14 layers)
- Explicit snow scheme (12 layers)
- Explicit canopy (MEB)
- Simplified EKF surface assimilation for the soil temperature and moisture from SYNOP T2m, Rh2m
- Snow update from SYNOP snow depth.

TITAN and gridPP are used for SYNOP quality control and surface analysis:

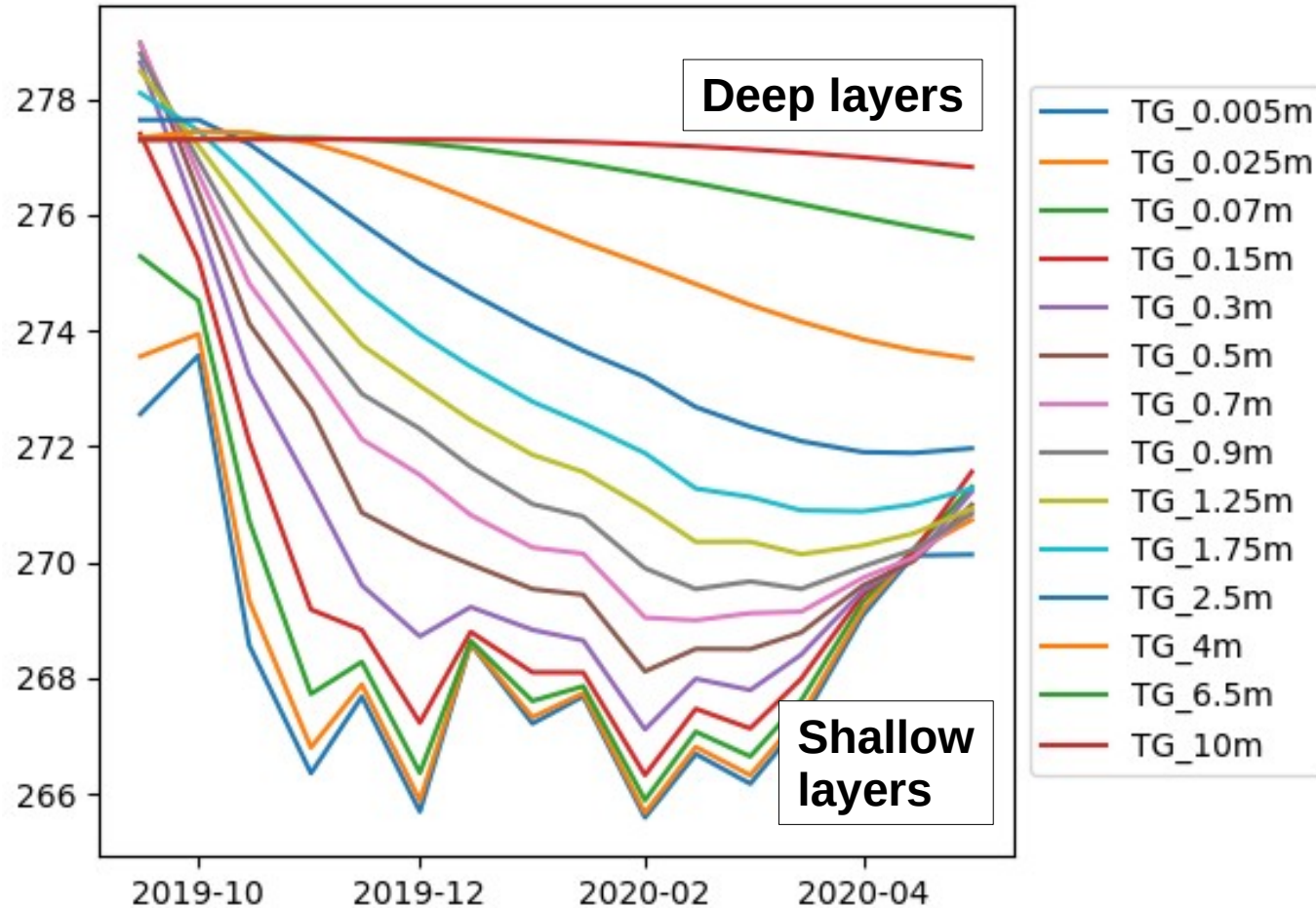
[see presentation by Roger Randriamampianina at last year's EWGLAM](#)

This setup is now running as spinup since September 1<sup>st</sup> 2019 with 3 hours cycling.

Work by Åsmund Bakketun, Trygve Aspelien and Jostein Blyverket (MetNorway)



**This setup is now running over the AROME-Arctic domain by MetNorway**

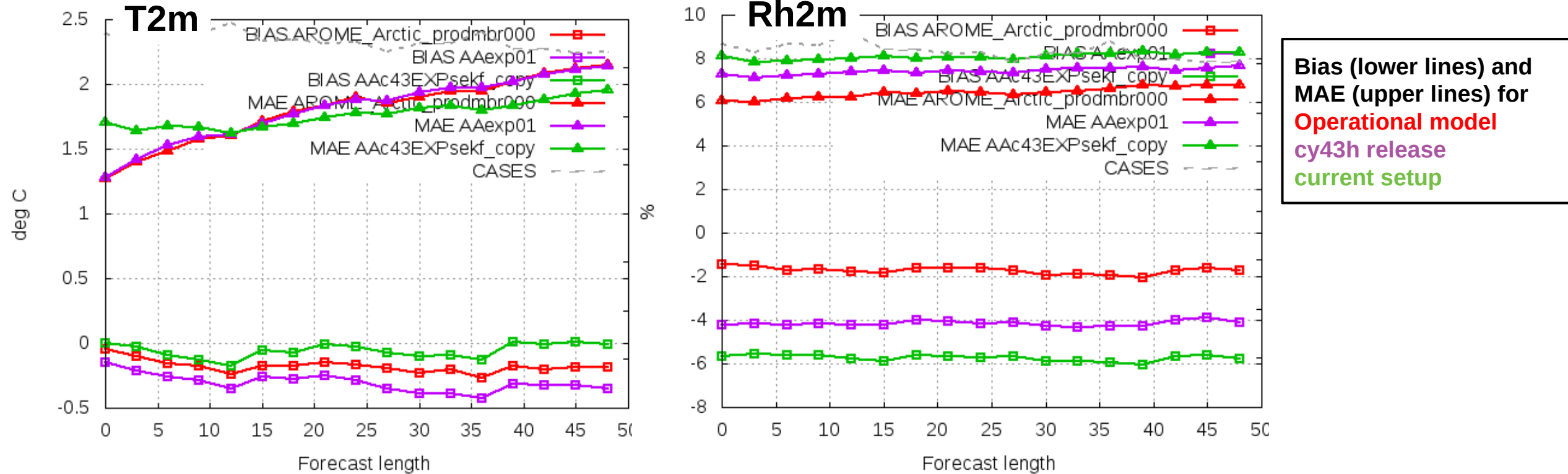


**Soil temperature evolution for each 14 layers of the ISBA-DIF model (domain average).**

**Period September 2019 – May 2020.**

**Work by Åsmund Bakketun, Trygve Aspelien and Jostein Blyverket (MetNorway)**

# This setup is now running over the AROME-Arctic domain by MetNorway



Verification of T2m and Rh2m for the period Nov 14<sup>th</sup> – Dec 31<sup>st</sup> for all SYNOP stations in the domain (~200).

Note that for **current setup** the surface temperature of snow is not assimilated while it is so for **operational model** and for **cy43h release**. And note that no surface/soil moisture is assimilated during snow/frozen-soil conditions in any of the models. The reason for the more dry bias in **current setup** is not yet understood...

Work by Åsmund Bakketun, Trygve Aspelien and Jostein Blyverket (MetNorway)



## Some other HIRLAM activities – links to ALADIN-HIRLAM annual meeting last spring

Assimilation of satellite snow extent is used in the CARRA (Arctic) reanalysis project and is also on its way into the HARMONIE-AROME NWP system. See presentations by respectively [Laura Rontu](#) (FMI) and [Mariken Homleid](#) (MetNorway)

The Simple Sea-ice model by Yurii Batrak (MetNorway) has been running operationally in HARMONIE-AROME for many years. New development is e.g. related to drifting of sea ice. See presentation by [Yurii](#).

[Kristian Pagh Nielsen](#) (DMI) presented work he has done together with Niels Woetmann Nielsen on “Calculation of turbulent surface fluxes and wind, temperature and specific humidity over land in the stably stratified surface layer, based on a cubic relation between the Monin-Obukhov stability parameter and a bulk Richardson number.”

# THANKS!!



HIRLAM virtual Surface working week, June 2020



## **Thursday 11:10-13:10: Parallel session on surface aspects**

- **11:10-11:20 Patrick Samuelsson (SMHI): Welcome and purpose of this breakout session.**
- **11:20-11:40 Eoin Walsh (University of Limerick): “Improving ECOCLIMAP Physiography map using Machine Learning Techniques and Satellite Image data”**
- **11:40-12:00 Dáire Healy (Maynooth University): “Estimating Roughness Lengths with Machine Learning”**
- **12:00-12:20 Paola Mercogliano (CMCC): “Treatment of new external parameters in COSMO urban modelling”**
- **12:20-12:35 Jürgen Helmert (DWD): “Global ICON experiments with ESA CCI land-use data”**
- **12:35-13:10 Open discussion e.g. on external databases, ESA-CCI land cover etc.**