

# Overview of HIRLAM surface activities

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

**with contributions as acknowledged**



## General surface comments

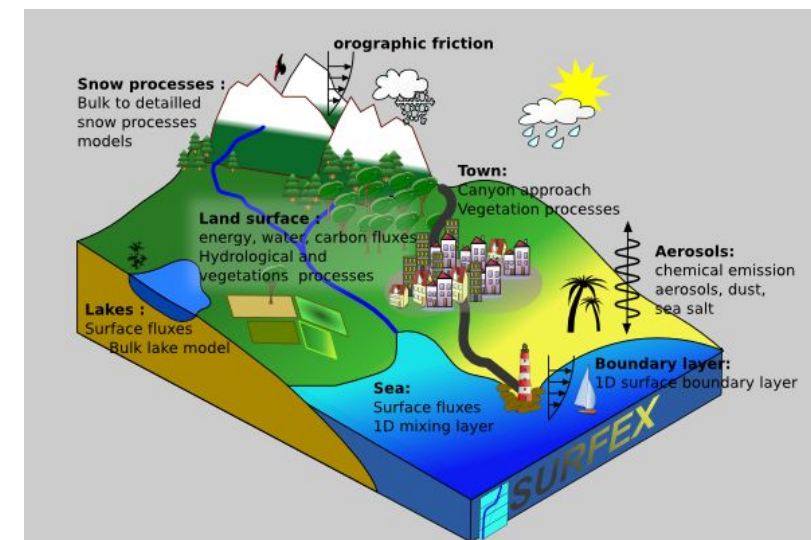
**cy43h2.1** is our latest release of the ACCORD NWP system with the HARMONIE-AROME model configuration, including **SURFEXv8.1** compared to the corresponding t-release which includes SURFEXv8.0.

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

|                 | <b>cy43h2.1(SFX8.1) – latest release</b>                   | <b>cy46h(SFX8.1) - development</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  | titanlib/gridPP-SEKF                                       |
| Orog rough      | OROTUR   | OROTUR   |
| <b>Sea</b>      | SICE   | SICE   |
| <b>Lake</b>     | FLake  | FLake  |
| <b>Town</b>     | TEB  | TEB  |
| <b>Physiog.</b> | ECOCLIMAP 2 <sup>nd</sup> generation<br>ESA CCI land cover | ECOCLIMAP 2 <sup>nd</sup> generation<br>ESA CCI land cover |

# Why SURFEX v8.1 instead of SURFEXv8.0...

|  | v8.0   | v8.1                                  | comments  |
|--|--|---------------------------------------|---|
| <b>Diffusion soil (14 layers)</b><br><b>Explicit snow (12 layers)</b><br><b>Multi-Energy Balance</b> | not totally mature<br>not mature<br>does not exist | mature<br>mature<br>mature for forest | 8.0 has problem with thin snow layers<br>MEB for open land is under testing |
| <b>ECOCLIMAP 2<sup>nd</sup> generation</b>   | does not exist                                     | available                             | needs adjustment, see next slide  |
| <b>t-cycles</b><br><b>h-cycles</b>   | 43t, 46t   | 48t<br>43h, 46h (v9 for 48h?)         | the version mess will be discussed in the surface side meeting              |



## Difference between ECOCLIMAP 1<sup>st</sup> and 2<sup>nd</sup> generations

ECOCLIMAP 1<sup>st</sup> generation has 1 km resolution (ECOCLIMAP v1.1-8 v2.0-6)

Each 1 km pixel has its original land-cover type (e.g. C3 crops) but

**in SURFEX it is assumed that these pixels are seldom homogeneous but only dominated by this original land cover and then also mixed with other land-cover types** (e.g. C3 crops mixed with some lake, forest and urban areas).

This creates a non-homogeneous land-cover input to e.g. the roughness estimation. Not bad idea :-)

But maintenance... big ASCII-files with parameters for LAI, albedo, tree height per cover.

ECOCLIMAP 2<sup>nd</sup> generation has 300 m resolution

Based on ESA-CCI land cover and can be updated whenever new versions appear.

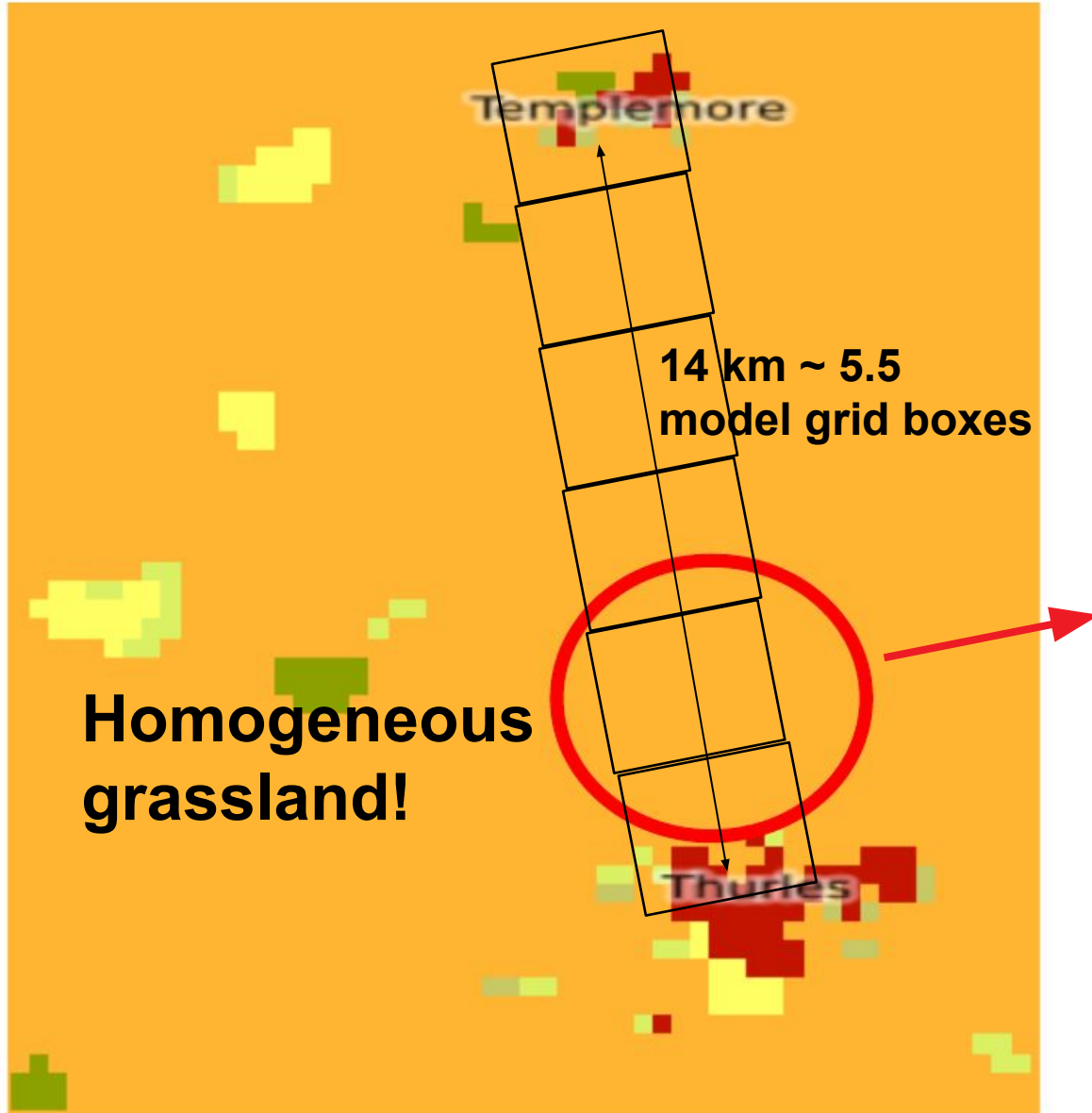
**Each 300 m pixel is assumed to be homogeneous** given its original land-cover type.

Separate binary input files for LAI, albedo, tree height.

**A quite serious problem** for us with ECOCLIMAP 2<sup>nd</sup> generation has been...

# A ECOCLIMAP 2<sup>nd</sup> generation problem example from the interior of southern Ireland

ESA-CCI land cover with 300 m pixels



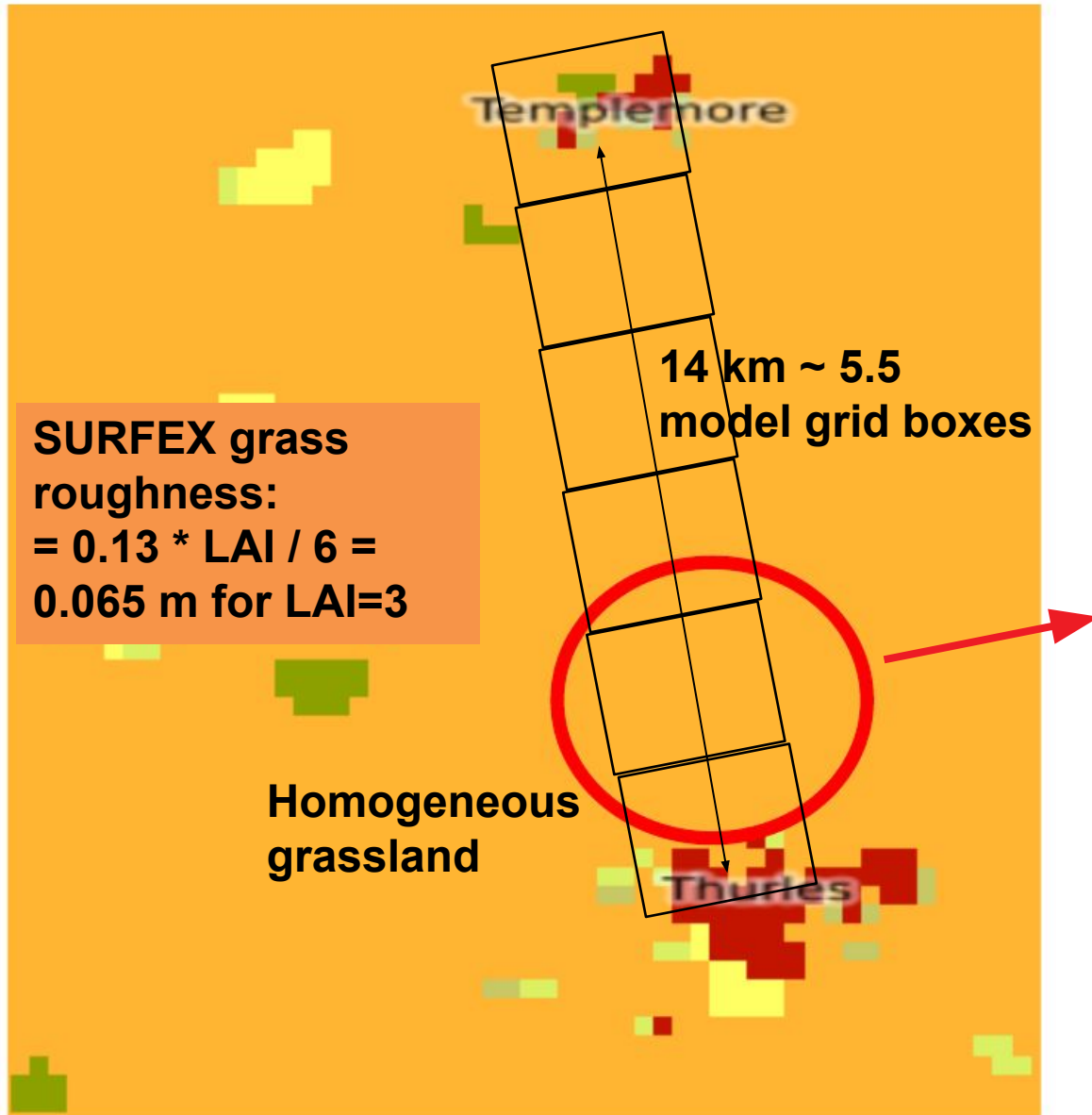
This area in reality (Google maps)!



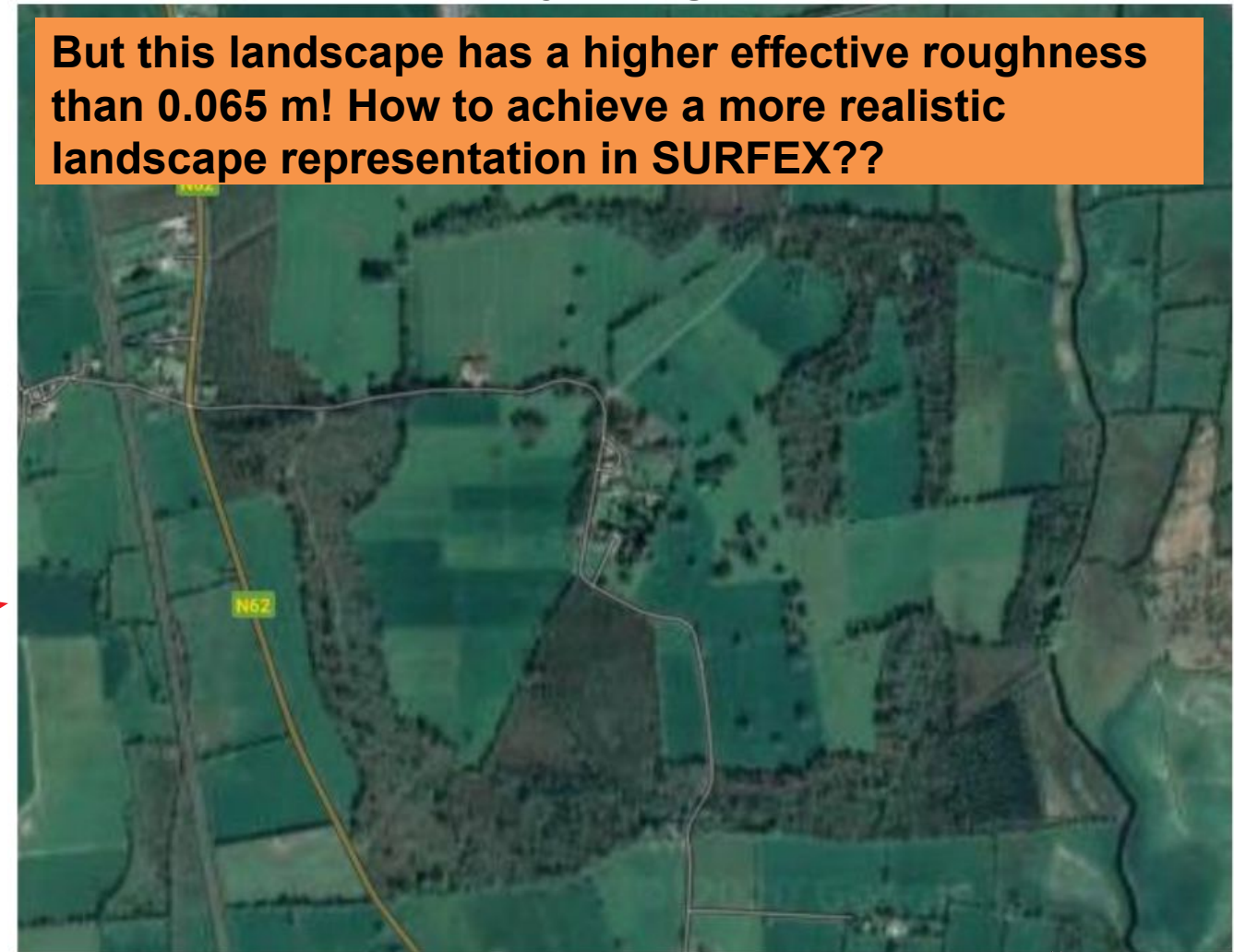
Figures from Emily Gleeson and  
Geoffrey Bessardon (Met Éireann)

# A ECOCLIMAP 2<sup>nd</sup> generation problem example from the interior of southern Ireland

ESA-CCI land cover with 300 m pixels



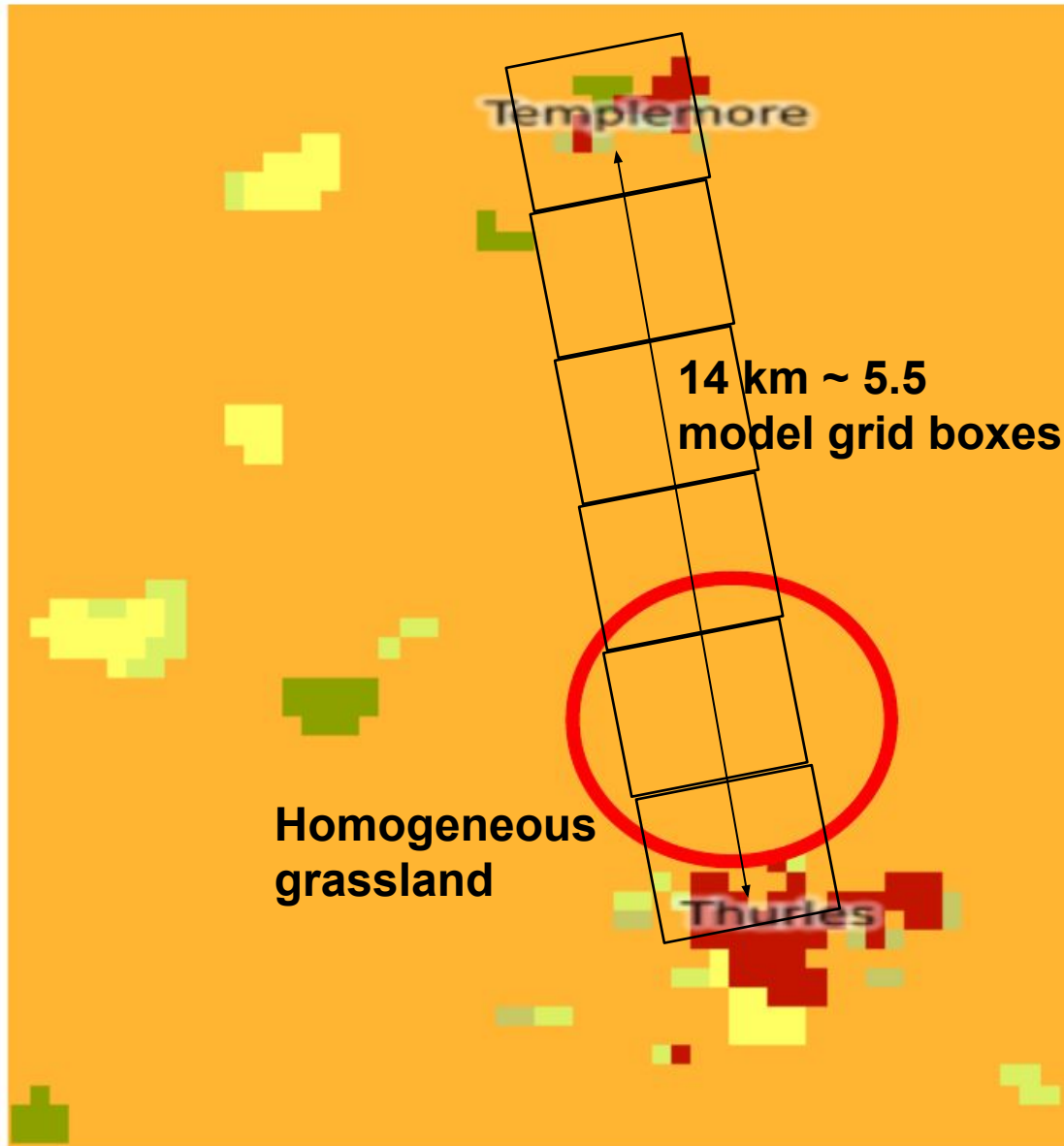
This area in reality (Google maps)!



Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)

# We attack the problem by introducing extra trees

ESA-CCI land cover with 300 m pixels



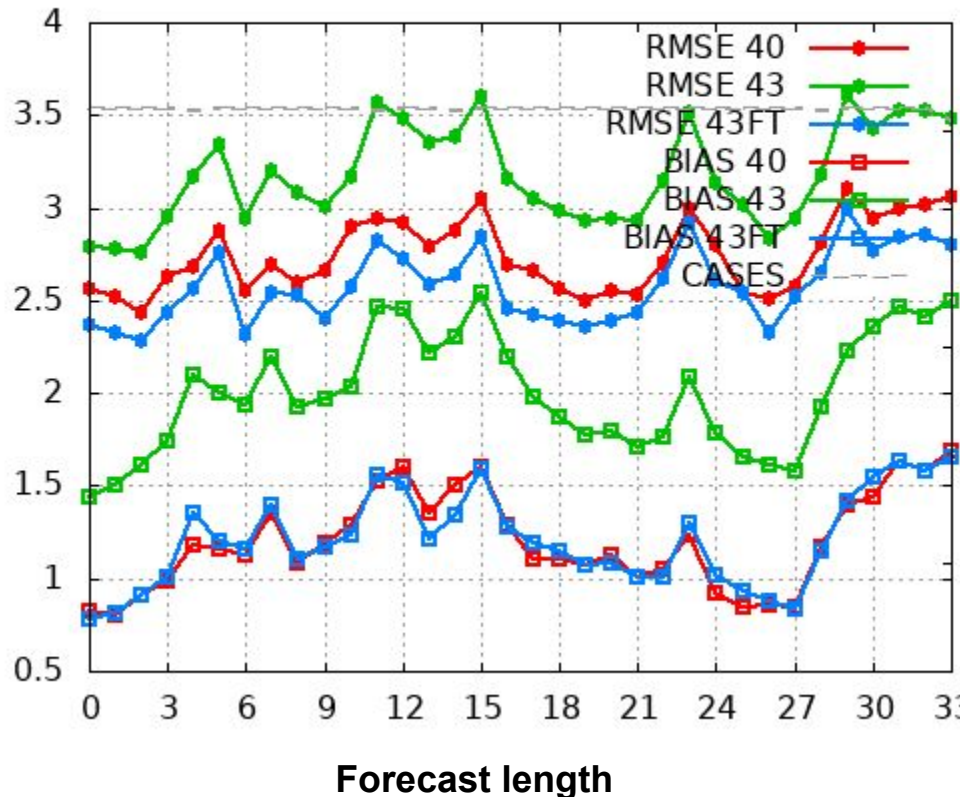
Samuel Viana (AEMET) came up with the suggestion to mimic the true landscape and increase the roughness by **introducing extra trees in each vegetation type represented by any grass or crop type.**

The idea is similar to the principal behind the ECOCLIMAP 1<sup>st</sup> generation land cover where the original covers are modified,

but here we do not change LAI, evapotranspiration, albedo... but the extra trees only affect the roughness length over these open-land vegtypes.

# U10m model wind statistics for Ireland shows how it works

U10m statistics over Ireland February 2020.  
Bias (lower lines) and RMSE (upper lines)



cy43h with default SURFEX PGD and ECOCLIMAP 2<sup>nd</sup> generation shows in general a positive, and higher, U10m wind bias than the operational model using ECOCLIMAP 1<sup>st</sup> generation (v2.5).

However, cy43h with extra trees in PGD for open-land vegtypes shows less and better bias for U10m.

This solution is now default in the HIRLAM release of cy43h based on ECOCLIMAP 2<sup>nd</sup> generation.

Figures from Emily Gleeson and  
Geoffrey Bessardon (Met Éireann)

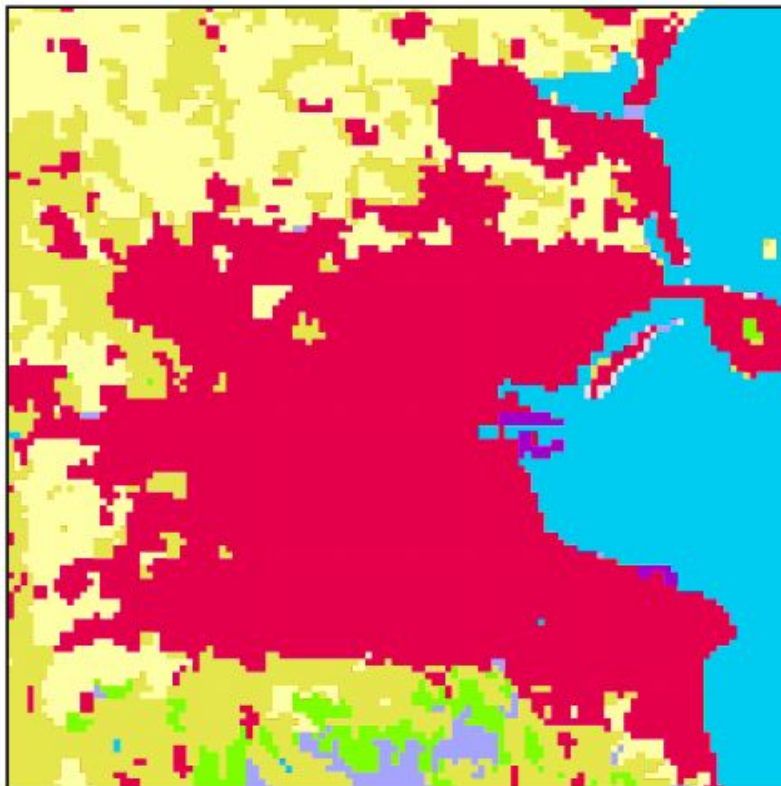


# Machine learning applied on satellite land information gives new land cover

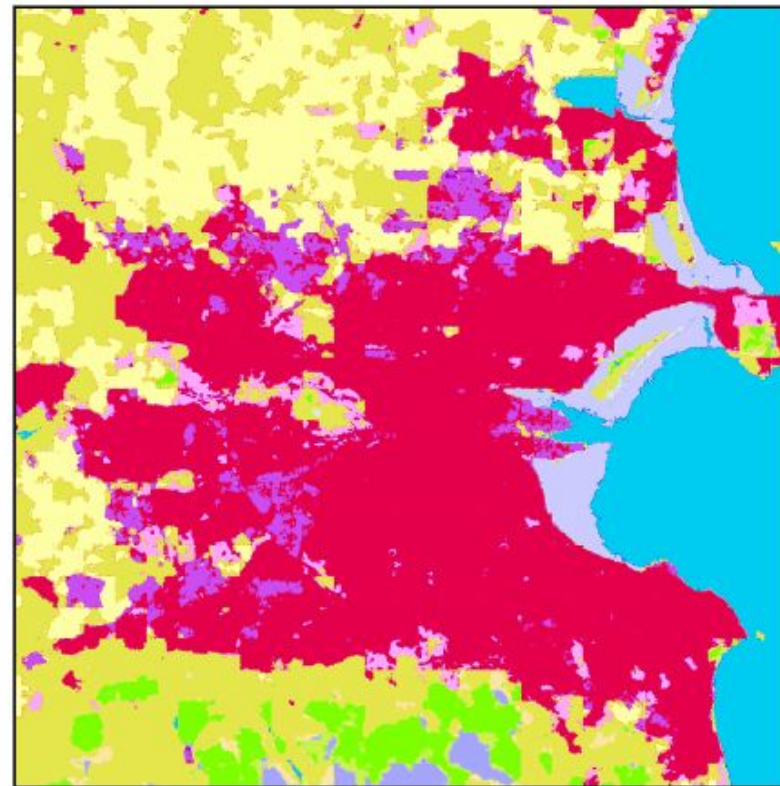
Eoin Walsh (University of Limerick, Ireland) has together with Met Éireann colleagues and Estonian collaborator Priit Ulmas applied **Machine Learning on a combination of Corine land cover and Sentinel-2 satellite images to process new 10 m resolution land cover over Ireland**. See more information in this presentation given by Eoin at last EWGLAM/C-SRNWP meeting:

[http://srnwp.met.hu/Annual\\_Meetings/2020/download/thursday/AM/EWGLAM%20Talk-Eoin%20Walsh.pdf](http://srnwp.met.hu/Annual_Meetings/2020/download/thursday/AM/EWGLAM%20Talk-Eoin%20Walsh.pdf)

Dublin area according to  
ECOCLIMAP Second Generation



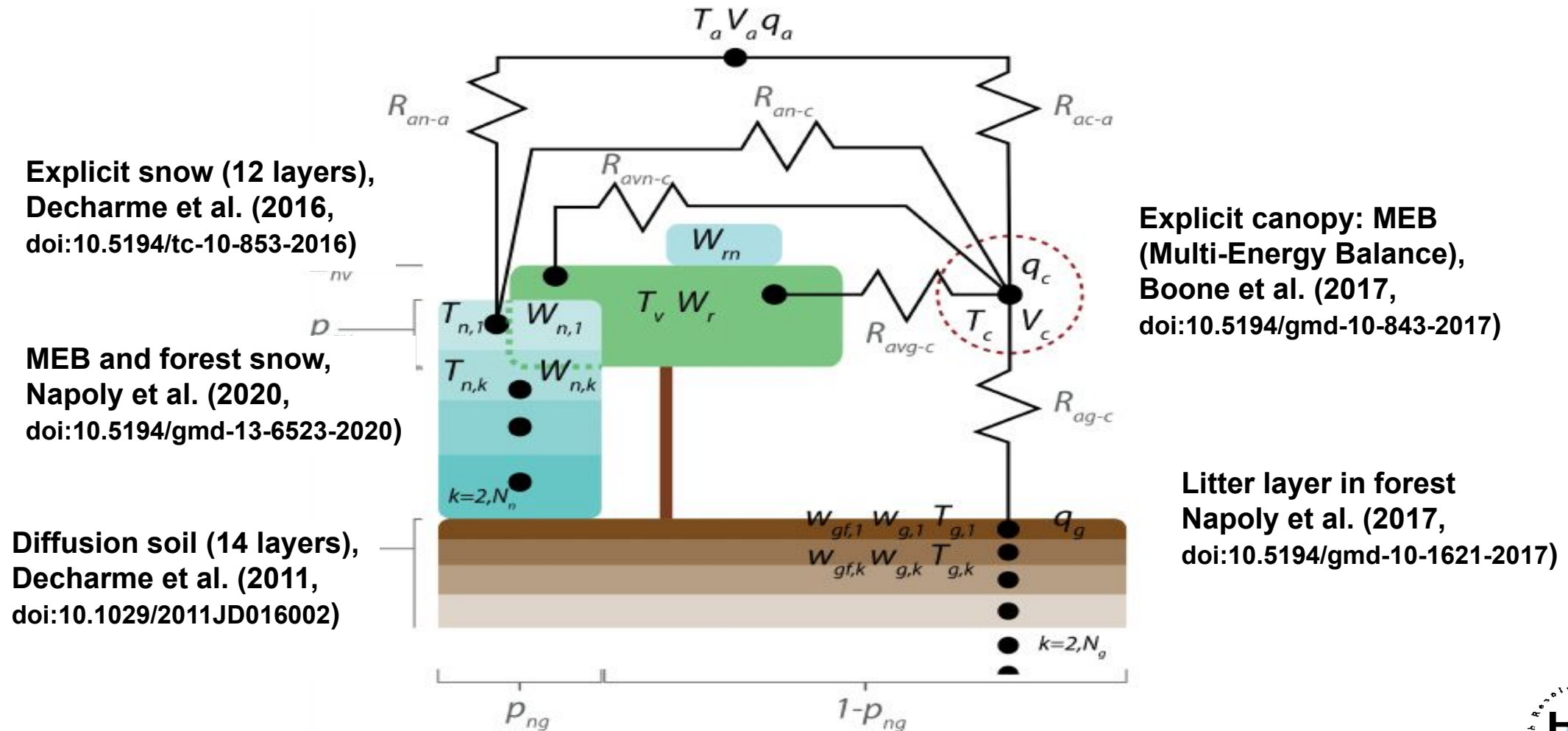
Dublin area according to  
New high resolution land cover



- Marine Waters
- Continental Waters
- Coastal Wetlands
- Inland Wetlands
- Open Space No Vegetation
- Scrub
- Forest
- Hetero-Agri Areas
- Pastures
- Permanent Crops
- Arable Land
- Urban Green Areas
- Construction
- Industry
- urban fabric

cy46h, based on SFXv8.1, can now run with DIF/ExplSnow/MEB in combination with SEKF

see more information and results in next presentation by Åsmund.



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

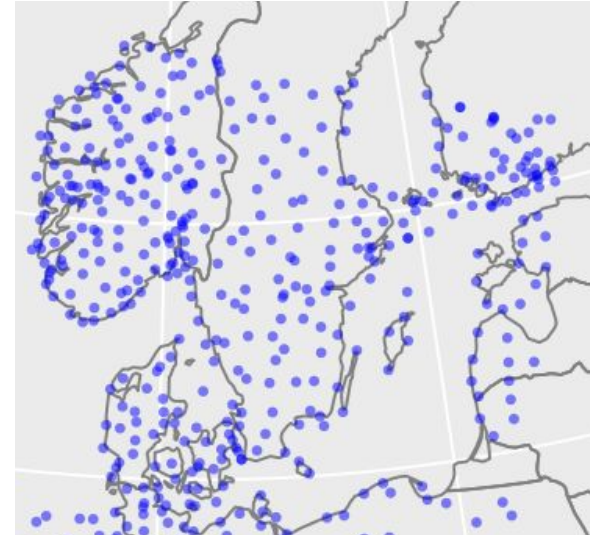
# cy46h, based on pySURFEX, can now assimilate Netatmo crowd-source observations

pySURFEX is a **stand-alone** python(3) **open-source** (<https://github.com/metno/pysurfex>) **interface to SURFEX/SODA**, developed by Trygve Aspelien (MetNorway), which enables e.g.

- Forcing file creation from AROME output (GRIB2NetCDF, FA2NetCDF if Epygram is available)  
Used in cy46h with SEKF for SURFEX offline perturbation runs needed by SODA
- GRIB, BUFR reading via Eccodes
- Observation quality control by open-source titanlib (<https://github.com/metno/titanlib>)  
Applied in cy46h on SYNOP and Netatmo observations
- Surface analysis by open-source gridpp (<https://github.com/metno/gridpp>)  
Used in cy46h for the OI surface analysis of T2m, Rh2m, snow depth needed by SODA

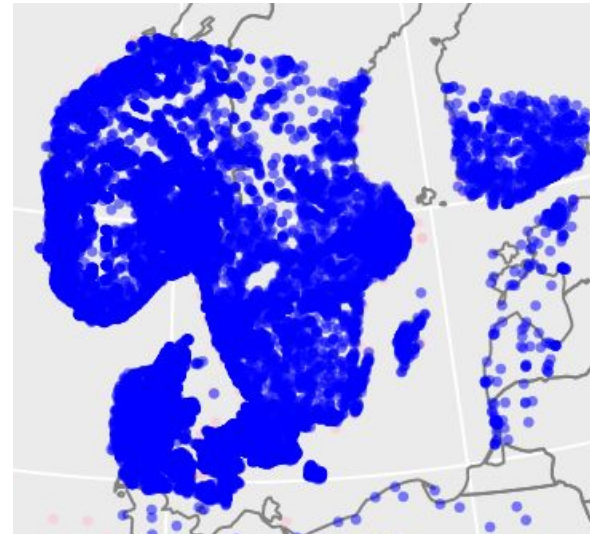
pySURFEX (and Netatmo) is currently used in MetCoOp HARMONIE-AROME nowcasting setup

SYNOP  
observation  
density



compared to

SYNOP+Netatmo  
observation  
density



# Assimilation of satellite based snow extent information

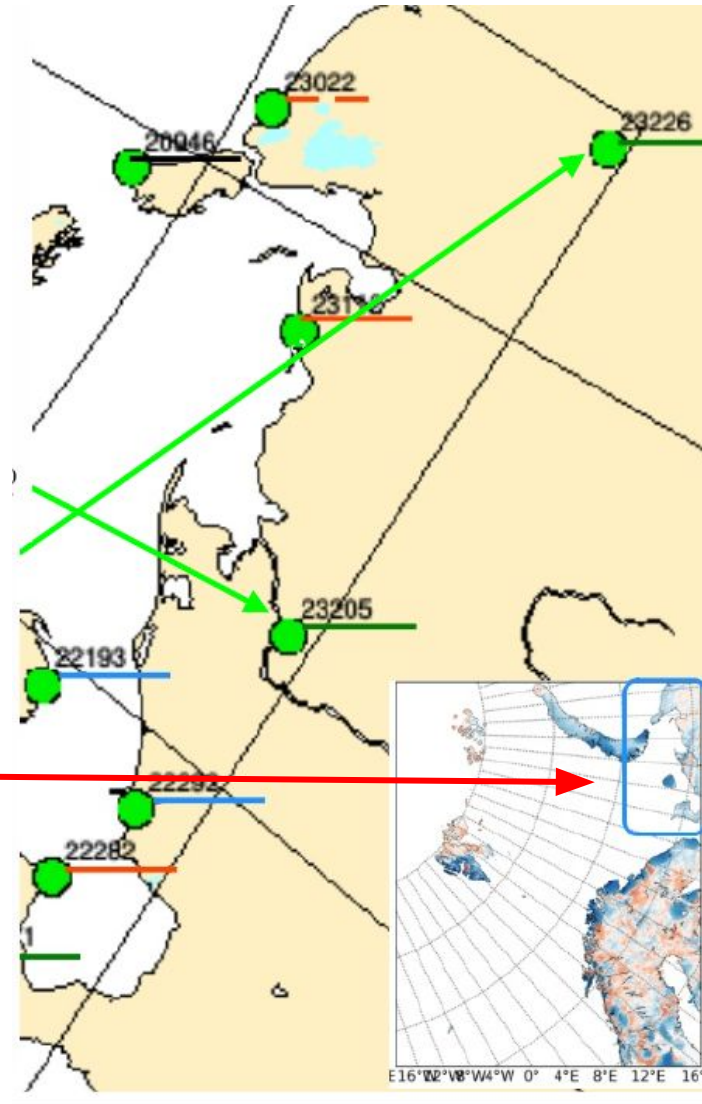
Laura Rontu, Mariken Homleid, Ekaterina Kurzeneva, Niilo Siljamo et al. have continued the work on assimilation of satellite based snow extent (SE) in HARMONIE-AROME.

SE plays an important role especially in areas where SYNOP snow observations are sparse or are missing.

The satellite SE barrel method has been developed which eliminates the need for interpolation of raw satellite data or screening/thinning. Many tests are done and evaluations exist over e.g. northern Russia.

Steps are now taken to solve the data flow of satellite data within the HARMONIE-AROME system.

See also Katy's suggested ACCORD snow plans in surface side meeting.



Arild Midthun, 2019  
Aku Anka 49/2020

# Introduction of roughness sublayer in SURFEX

Currently in SURFEX the roughness length over forest is simply

$$Z0_{for} = 0.13 * h_c,$$

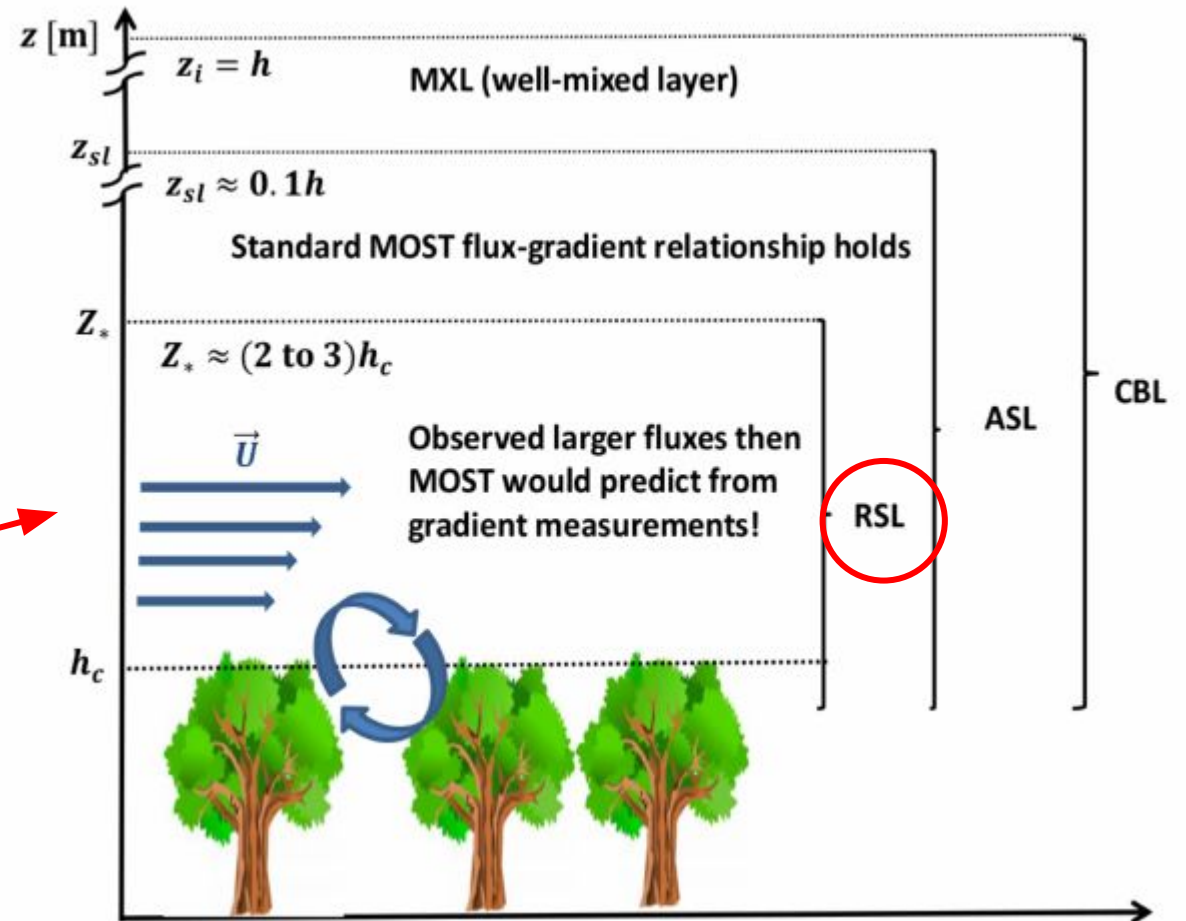
where  $h_c$  is height of trees. This gives e.g.  $z_0=3$  m for  $h_c=23$  which **underestimates U10m over forest areas!**

Currently in HARMONIE-AROME we tune tree height and limit  $z_0$  do deal with this situation.

So, there is **no dependence of  $Z_0$  on e.g. displacement height, LAI or stability...**

The characters of energy exchange above tall vegetation, in the **roughness sublayer (RSL)**, are extensively investigated and better formulations for roughness length and energy exchange do exist.

Currently Meto (SMHI) and Samuel (AEMET) are **implementing and testing the Harman & Finnigan (2007) RSL model in SURFEX**. More realistic roughness and energy exchange are expected.



## Some other surface related activities...

...were reported at last HIRLAM Surface Working week available via this wiki:

<https://hirlam.org/trac/wiki/Meetings/Surface/Surface202101>

For example (search wiki for corresponding first name):

- **Bias-aware EKF** is used and developed by Yurii in SODA for assimilation of **satellite based surface temperature for sea ice** in the Simple Sea-ice model.
- The project Hydrometeorology to Operations (H2O) at MetNorway includes work related to **EnKF assimilation of satellite products** for the surface (Jostein) and **coupled atmosphere-surface assimilation** (Roel). See presentation by Roel in afternoon surface side meeting.
- **HARMONIE-AROME is now running coupled (via OASIS) to sea-wave model WW3**. Erin reported results from extensive testing over the AROME-Arctic domain and Basanta about the setup over the Irish domain.

# THANKS!!



**HIRLAM virtual Surface working week,  
June 2020**



**HIRLAM virtual Surface working week,  
February 2021**

## **Welcome to join Tuesday afternoon Surface side meeting starting at 14:35**

- **ACCORD Surface plans (Patrick Samuelsson, SMHI Sweden)**
- **Discussion, thoughts and ideas related to ACCORD surface activities**
- **Status of the SURFEX implementation work in ALARO CSC (Bogdan Bochenek, IMGW-PIB Poland)**
- **ACCORD snow plans (Ekaterina Kurzeneva, FMI Finland)**
- **Long term atmosphere-surface coupling strategy (Roel Stappers, Met Norway)**
- **Recent results about Ecoclimap-SG and DIF in AROME (Yann Seity, Adrien Napoly, Camille Birman, Météo-France)**
- **SEKF issues in the Alps (Helga Toth, OMSZ Hungary)**