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ACCORD Overview of Surface activities

Patrick Samuelsson, 2025-09-24,
47th EWGLAM and 32nd SRNWP Meeting at SMHI

Overview outline

ACCORD surface overview covers activities at ACCORD level and in sub-organisations Météo-France, HIRLAM, LACE and individual Met services.

This year the LACE surface activities will be presented separately by the LACE project manager Martina Tudor in the surface parallel session later this morning.

Examples of activities are given for

- **Surface physiography**
- **Surface processes**
- **Surface Data Assimilation**

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Status of our efforts with ML-based physiography

- **Moving towards High Resolution needs physiography with even higher resolution. Thus, current activities in ACCORD, and for DEODE Destination Earth on-demand Extremes, on hectometric resolution for the model asks for decametric resolution for physiography.**

- **Physiographic maps exists (e.g. ESA WorldCover), but with their specific cover types. For the ACCORD NWP system, based on SURFEX and ECOCLIMAP physiography, we need our specific cover types. However, no individual map at decametric resolution can provide us a complete solution.**

So, the purpose is to create a land cover map for Europe with 60 m resolution and with cover types of ECOCLIMAP Second Generation (ECOSG). For that, we combine information from available thematic maps and apply ML methods.
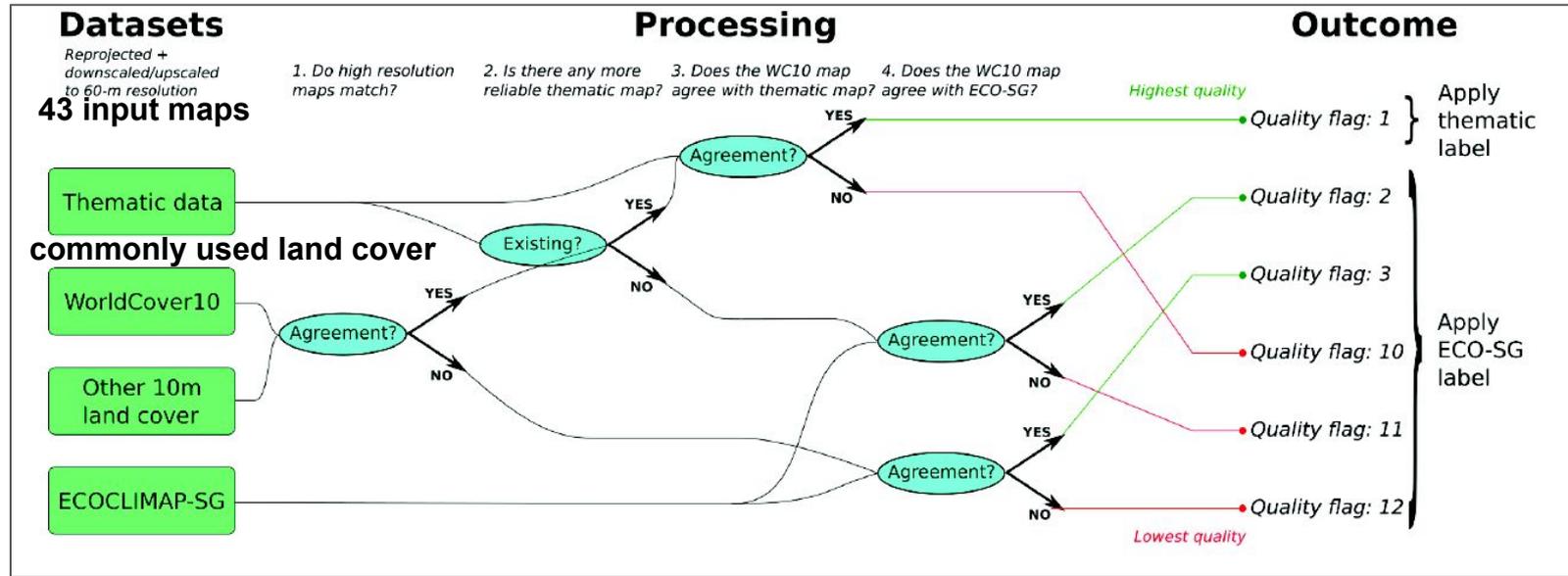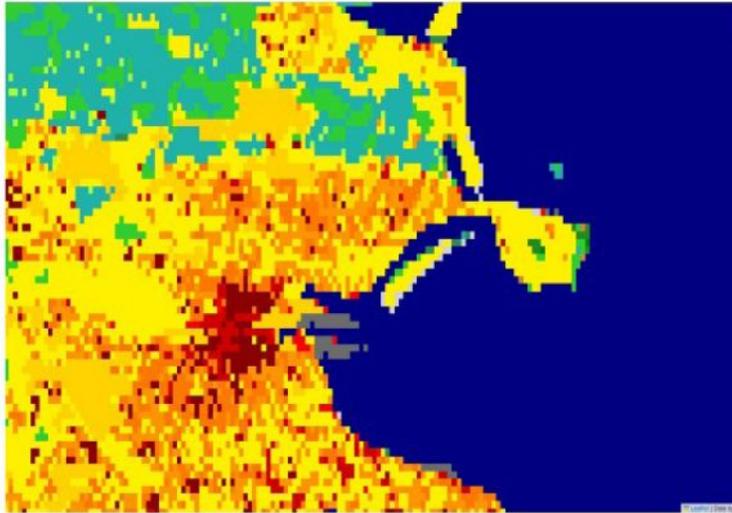
Through this decision tree a number of input maps are translated to ECOSG physiography covers along with a quality flag, **resulting in what is labeled the ECOSG+ map at 60 m resolution**.
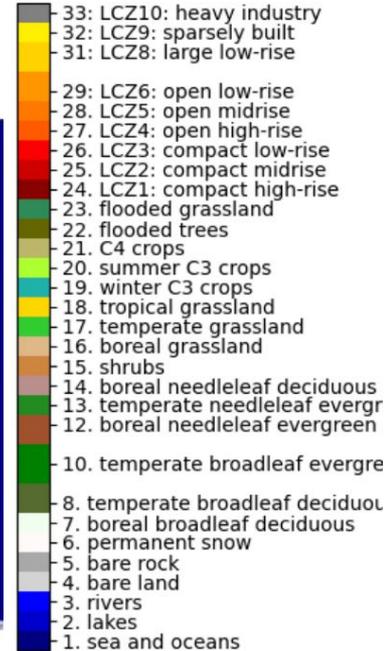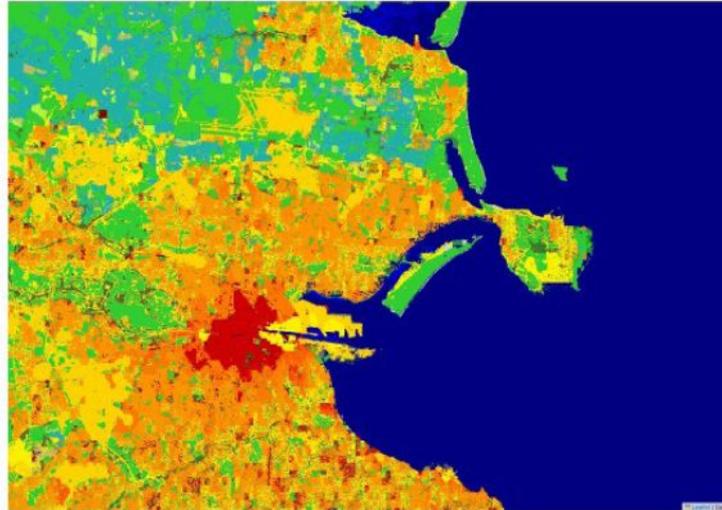See [Geoffrey Bessardon et al. (2024)](#) for details.

Around Dublin

ECOSG (300 m resolution)　　　　**ECOSG+ (60 m resolution)**

Legend:
- 33: LCZ10: heavy industry
- 32: LCZ9: sparsely built
- 31: LCZ8: large low-rise
- 29: LCZ6: open low-rise
- 28: LCZ5: open midrise
- 27: LCZ4: open high-rise
- 26: LCZ3: compact low-rise
- 25: LCZ2: compact midrise
- 24: LCZ1: compact high-rise
- 23: flooded grassland
- 22: flooded trees
- 21: C4 crops
- 20: summer C3 crops
- 19: winter C3 crops
- 18: tropical grassland
- 17: temperate grassland
- 16: boreal grassland
- 15: shrubs
- 14: boreal needleleaf deciduous
- 13: temperate needleleaf evergr
- 12: boreal needleleaf evergreen
- 10: temperate broadleaf evergre
- 8. temperate broadleaf deciduou
- 7. boreal broadleaf deciduous
- 6. permanent snow
- 5. bare rock
- 4. bare land
- 3. rivers
- 2. lakes
- 1. sea and oceans

This step is published in Geoffrey Bessardon et al. (2024, 10.20944/preprints202409.0953.v1)

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Apply convolutional ML model: Train the model over the areas with high quality and apply it to correct areas with low quality. **The result is a ECOSG-ML at 60 m resolution.**
In the figure, ECOSG+ and ECOSG-ML are compared to ESA CCI landcover Word Cover map (ESAWC) and ECOSG, accompanied by a quality flag (QFLAGS).


ECOSG labels

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Some peculiar behaviour…

Some regions of Ireland are characterized by **flooded grassland** in EGOSG…
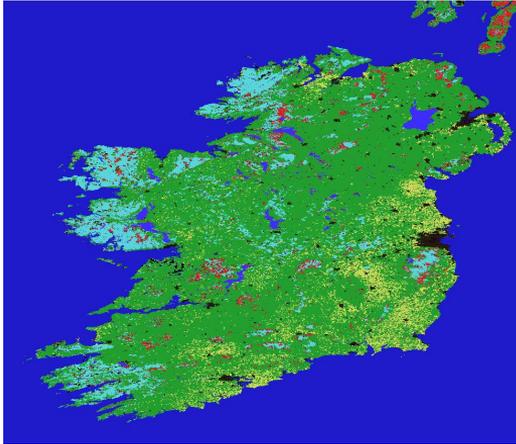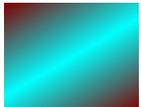
… but in ECOSG-ML they become **temperate grassland.**

However, in reality it is actually flooded part of the year, but really dry at the surface during other part of the year.

This second step, the ECOSG-ML step, is documented by Thomas Rieutord et al. (2024, 10.20944/preprints202409.0942.v1)

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Next steps in ML-based physiography for ACCORD

The next steps towards the creation of **an ECOSG-ML land cover map for Europe with 60 m resolution** includes the connection to parameters, Leaf-Area Index (LAI), albedo and tree height. How these parameters connect to ECOSG-ML through the SURFEX processing is currently under investigation.

Also, recently, the training has been optimized by GPU-parallelisation of the code.

Can this development be useful for non-SURFEX/ECOCLIMAP users…?

Please contact the ML-physiography team for more info and questions:
Ekaterina Kurzeneva[2], Emily Gleeson[4], Geoffrey Bessardon[4], Thomas Rieutord[4], Eoin Walsh[4], Panu Maalampi[2], Olli Saranko[2], Rudolf Mård[2]
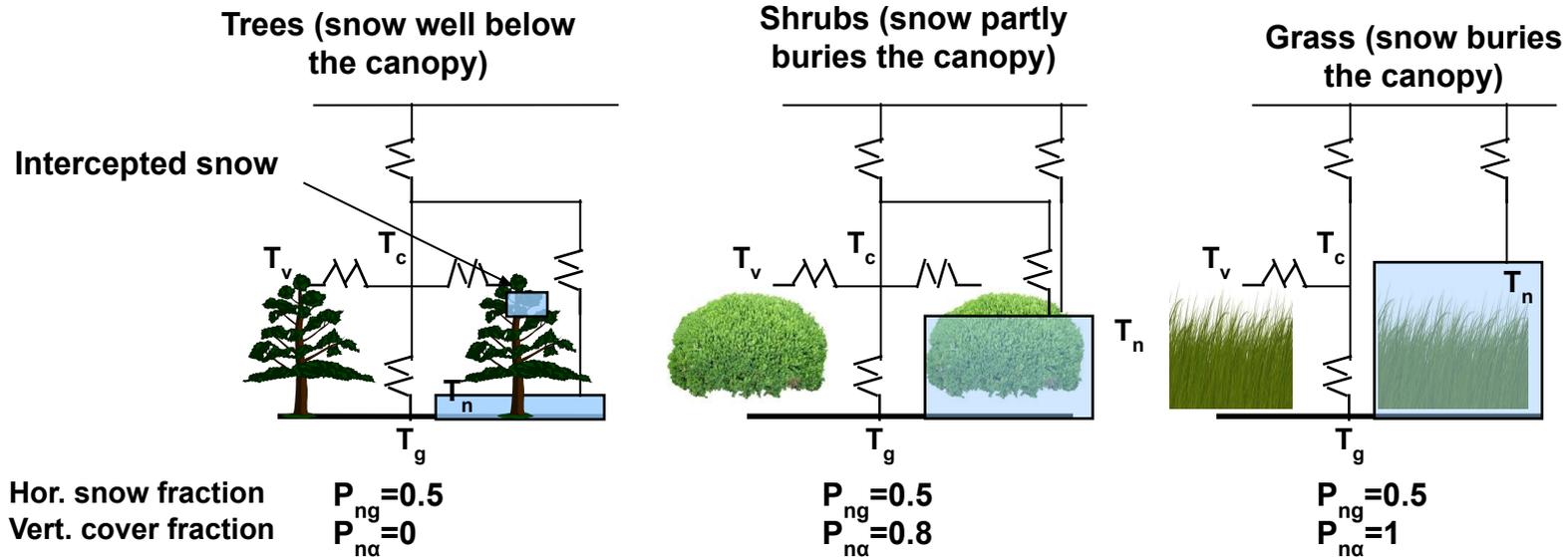[2]FMI, [4]Met Éireann

SURFEX multi-layer land processes for NWP

- ❏ **I have reported a few times now how we make efforts towards our multi-layer surface physics including the 14-layer diffusion soil scheme, the 12-layer explicit snow scheme and the explicit canopy (Multi-Energy Balance).**

- ❏ **I'm happy to forward news from Met-Norway. This setup has now, this week, for the first time been launched for operational use in ACCORD, for their AROME-Arctic system.**

- ❏ **In our continued development of this physics we separate the open land patch into low vegetation and a bare soil part, i.e. now three patches: 1) forest 2) low veg 3) bare soil.**

- ❏ **And we also apply the Multi-Energy Balance for low vegetation…**

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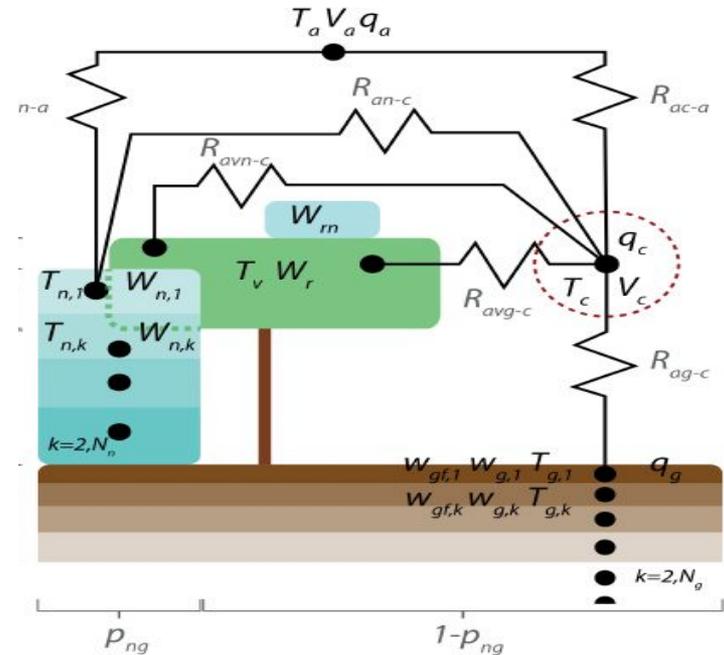
The Multi-Energy Balance (MEB), or explicit canopy, is designed to handle growth of snow which can gradually cover any present vegetation with time depending on the height of the vegetation:

Trees (snow well below the canopy)	Shrubs (snow partly buries the canopy)	Grass (snow buries the canopy)

Intercepted snow

T_c T_v T_n T_g

Hor. snow fraction	$P_{ng}=0.5$	$P_{ng}=0.5$	$P_{ng}=0.5$
Vert. cover fraction	$P_{n\alpha}=0$	$P_{n\alpha}=0.8$	$P_{n\alpha}=1$

In fact, P_{ng} grows very quickly to near 100% coverage due to the smooth surface floor.

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SURFEX multi-layer land processes for NWP

Why go for Multi-Energy Balance (MEB) for low vegetation?

- **Offline SURFEX evaluations by Aaron Boone (SURFEX team at Météo-France), one of the Multi-Energy Balance (MEB) developers, have shown that simulated energy fluxes over low vegetation compare better with corresponding observations when MEB is activated.**

- **Our SURFEX-team vegetation colleagues argue that our currently applied surface resistance in NWP by Jarvis (1976) would be good to replace by the A-gs option including offensive/defensive stress. This should go along better with an explicit vegetation.**

- **Experience from Météo-France snow colleagues in Grenoble is that MEB applied for low vegetation improves the ability to describe soil evolution of temperature (with time and with depth).**

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However, with this setup we still notice excess ground heat flux for a low-vegetation surface and consequently biases in soil temperatures.

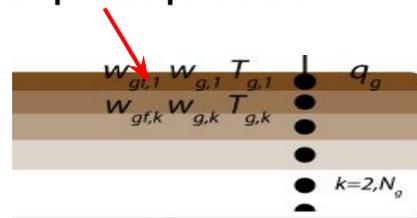**Spring - early summer warm bias**

Winter cold bias event connected to frozen soil

The figure shows bias in soil temperature (SURFEX - observations) at three different depths (30, 50, 90 cm) over a two year period 2011-2012 for a grass site at the Lindenberg observatory, Germany.

A modification of temperature and moisture characteristics of the top two soil layers (make them more fluffy) helps this problem!

More info about this at the surface parallel session later 😊

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Winter cold [...] oil
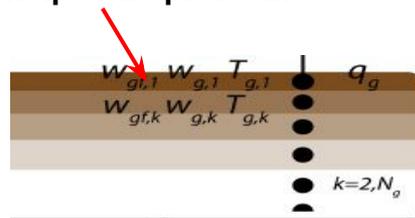
These activities contribute to the ACCORD efforts towards increased process-based validation.

For the surface area this is now being concretasied in the development of the Offline Surfex Validation System (OSVAS) being led by Samuel Viana (AEMET).

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ACCORD has a variety in surface data assimilation

Operationally, OI surface assimilation is still our working horse in most setups with assimilation.

Circumstances decide how short-medium term solutions beyond OI look in our consortia:

Ensemble NWP system: OI for soil with EPS-coeff.	Ensemble NWP system: EnKF-based solution	Deterministic and Ensemble NWP system: (S)EKF-based solution	Crowd-sourced focus: TITAN/gridPP spatialisation	Less weakly coupled atm-surface assimilation

Two flavours of **EnKF**:
- the Ensemble Square Root Filter (EnSRF)
- the Local Ensemble Transform Kalman Filter (LETKF)

Both in connection to multi-layer surface physics.

MetHungary CARRA2

Create a good initial state for the surface (before any additional surface DA) by forcing SURFEX by optimized/analysed forcing variables.

2D-Var
2D-EnVar

Météo-France

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ACCORD has a variety in surface data assimilation

How can we make joint efforts forward together?

During this autumn we will investigate if we possibly can combine e.g.

- the ECMWF's Object-Oriented Prediction System (OOPS)

- the Local Ensemble Transform Kalman Filter (LETKF) implemented in OOPS by Benjamin Menetrier (MET-Norway)

- the Variational system Var + dynamical B-matrix En to surface 2D analysis = 2DEnVar system developed by Météo-France (Sophie Marimbordes et al.)

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Agenda of Parallel session on surface aspects

When: Just after the coming coffee break
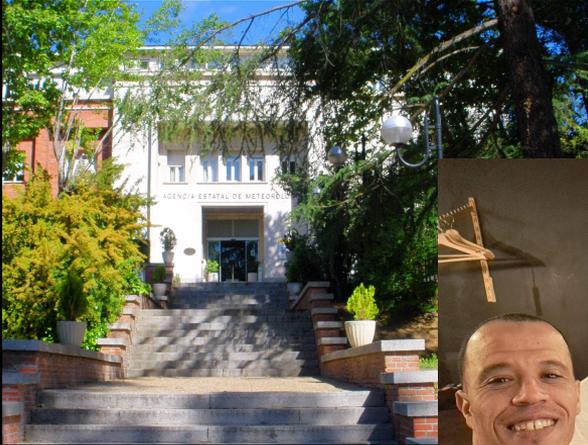**Where:** In the other room "Vadstena".
Direction: on the other side of the locked door, turn right.

- Martina Tudor: "Coupling ALARO physics with SURFEX"

- Jan-Peter Schulz: "Land surface atmosphere interactions simulated by the ICON atmospheric model"

- Abhishek Lodh: "Recent advancements in EnKF based LDAS methods for the soil diffusion based ISBA model at SMHI"

- Patrick Samuelsson: "Sensitivity studies for characterisation of thermal and moisture properties of the uppermost soil layers"

THANKS!

ACCORD Surface Working weeks

Madrid, May 2025

Prague, spring 2026