ACCORD

A Consortium for COnvection-scale modelling Research and Development

SMHI

Swedish Meteorological & Hydrological Institute

ACCORD experience with ESA-CCI land cover and new efforts with ML-based physiography

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[1]SMHI, [2]FMI, [3]AEMET, [4]Met Éireann

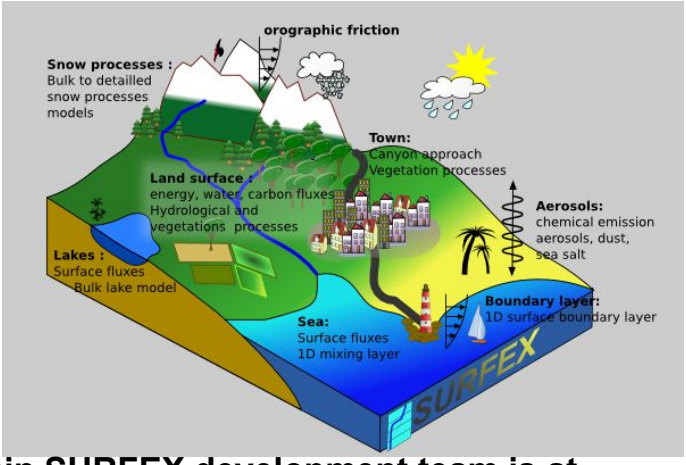
Workshop on ancillary data for land surface and Earth system modelling Bonn, Germany, April 2025

ACCORD - an NWP development collaboration including 26 countries

… for an even higher number of operational setups.

https://www.accord-nwp.org/

We all share the common model SURFEX for surface processes:



Main SURFEX development team is at Météo-France in Toulouse
https://www.umr-cnrm.fr/surfex/

I'm currently acting as Area Leader of the surface science area in ACCORD.

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Physiography used by ACCORD-related NWP setups

We use a subset of the databases presented by Patrick Le Moigne two talks ago:

Topography (ground altitude above sea level):

- GTOPO30 at ~1 km
- USGS GMTED2010 at ~250 m

Land cover by ECOCLIMAP (land cover types):

- First Generation: v1 Global (Masson et al. 2003) and v2 European (Faroux et al. 2013), both at ~1 km
- **Second Generation: based on ESA CCI land cover at ~300 m + separation of waters + LCZ urban classes**

Soil texture (percentage of clay and sand, and soil organic carbon):

- FAO clay and sand at ~10 km
- HWSD clay and and at ~1 km
- SOILGRIDS clay and sand at ~300 m
- Soil Organic Carbon at ~1 km and ~300 m

Lake depth:

- Global Lake DataBase at ~1 km

Link to SURFEX physiography

Physiography used by ACCORD-related NWP setups

And, in addition, specifically for ECOCLIMAP 2nd generation

Leaf Area Index (LAI):

- Copernicus satellite LAI data at 300 m-resolution for the period 2014-2016.

Albedo:

- Copernicus satellite albedo data at 1 km-resolution.

Tree height:

- NASA, Jet Propulsion Laboratory, 1 km-resolution.

Link to SURFEX physiography

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Experience with ESA-CCI land cover

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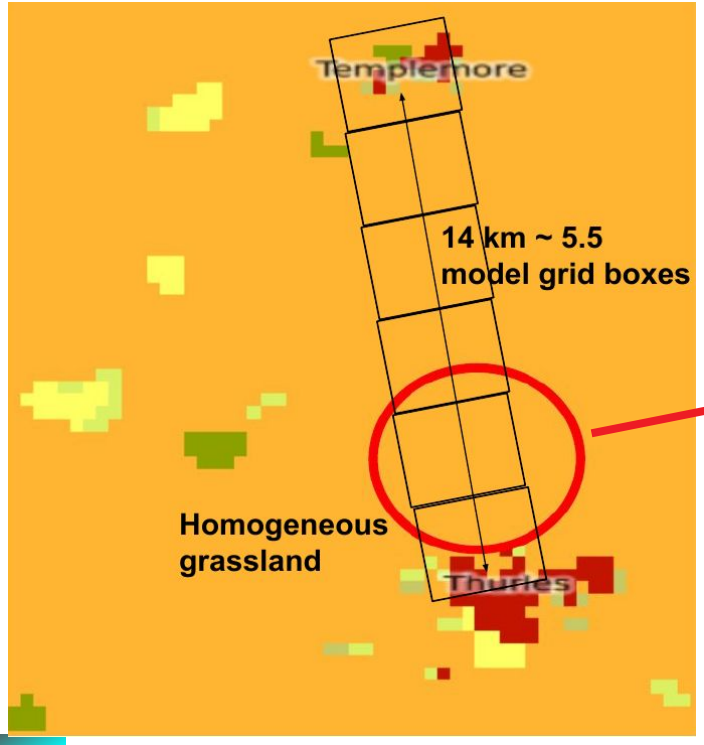
A few years ago, the HIRLAM countries (the green countries) identified a need to go for an updated physiography, and choosed the ECOCLIMAP Second Generation (ECOSG) product.

ECOSG is based on ESA CCI land cover at ~300 m, where in addition, the SURFEX team has introduced a separation of waters (sea and lakes) and complemented with urban Local Climate Zones (LCZs) classes.

Quite a few aspects of ECOSG looked good (e.g. land-water mask and copernicus satellite LAI data). But we identified a problem with too homogeneous grass/crop landscapes…

The ESA-CCI covers over a part of Ireland

ESA-CCI land cover with 300 m pixels



This area in reality (Google maps):

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)

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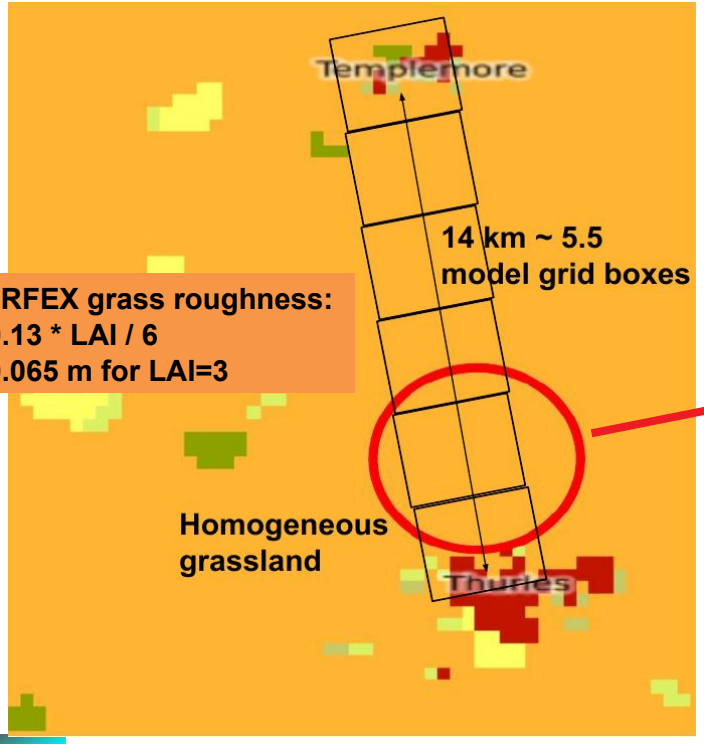
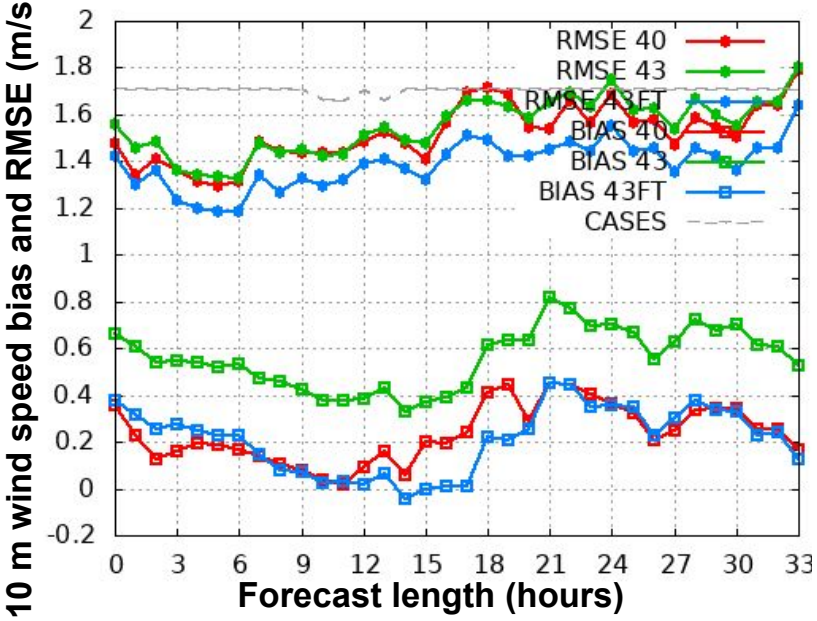


This area in reality (Google maps):

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)

Roughness effect on 10 m wind speed

A 14 days period in May 2020 showing Forecast validation of 10m wind speed representing 24 SYNOP stations over Ireland.



Reference experiment with ECOCLIMAP First Generation

Experiment based on ECOCLIMAP Second Generation

ECOSG, as is, gives a clear overestimation of 10 m wind speed over Ireland.

What to do?

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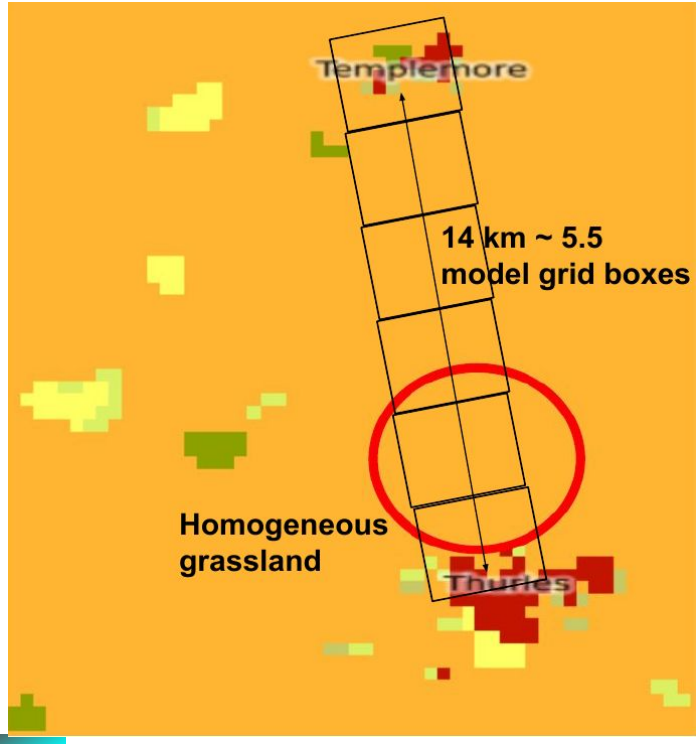
Experience with ESA-CCI land cover

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.

So, we introduced 10% trees, 10 m tall, over all open-land VEGTYPES. This fix has become to be named the FakeTree correction in the ACCORD context.

Maybe one can claim that this is a SURFEX problem… meaning, the way SURFEX interprets and use the land cover information creates a problem for us.

Is this done in other ways in other surface models?

Figures from Emily Gleeson and Geoffrey Bessardon (Met Éireann)

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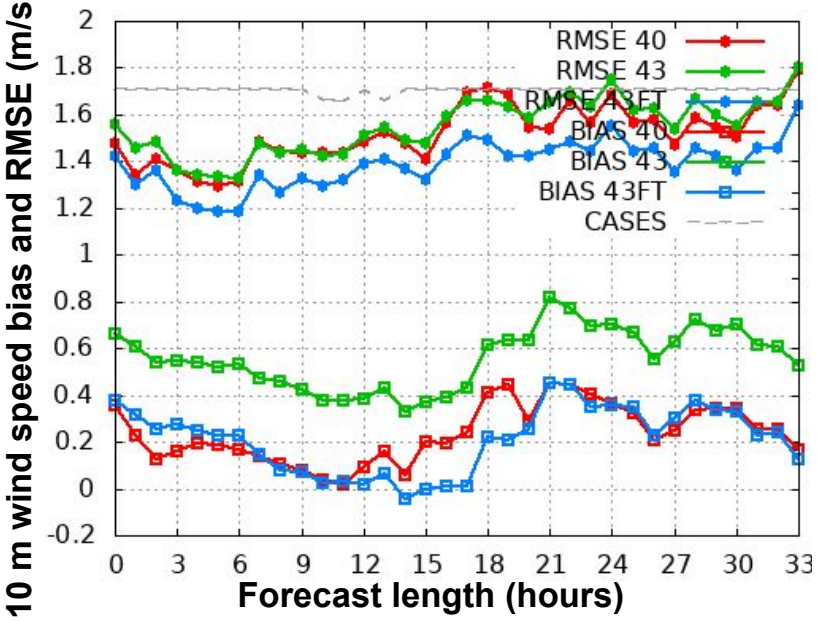

Reference experiment with ECOCLIMAP First Generation

Experiment based on ECOCLIMAP Second Generation

As ECOSG experiment but with FakeTree added

The introduction of FakeTree reduces the bias and even improves the statistics with respect to the reference experiment.

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Satellite physiography and NWP model

To represent the satellite-estimated physiography using the dominating character over each pixel, as in this case for ESA CCI land-cover types with 300x300 m2 pixels, is a totally reasonable method. I guess….

But the way the surface model, in this case the SURFEX, interprets these data can lead to problems if nothing else than the dominating type is considered.

Is the presented "method" to solve the problem reasonable or should we recommend other methods?

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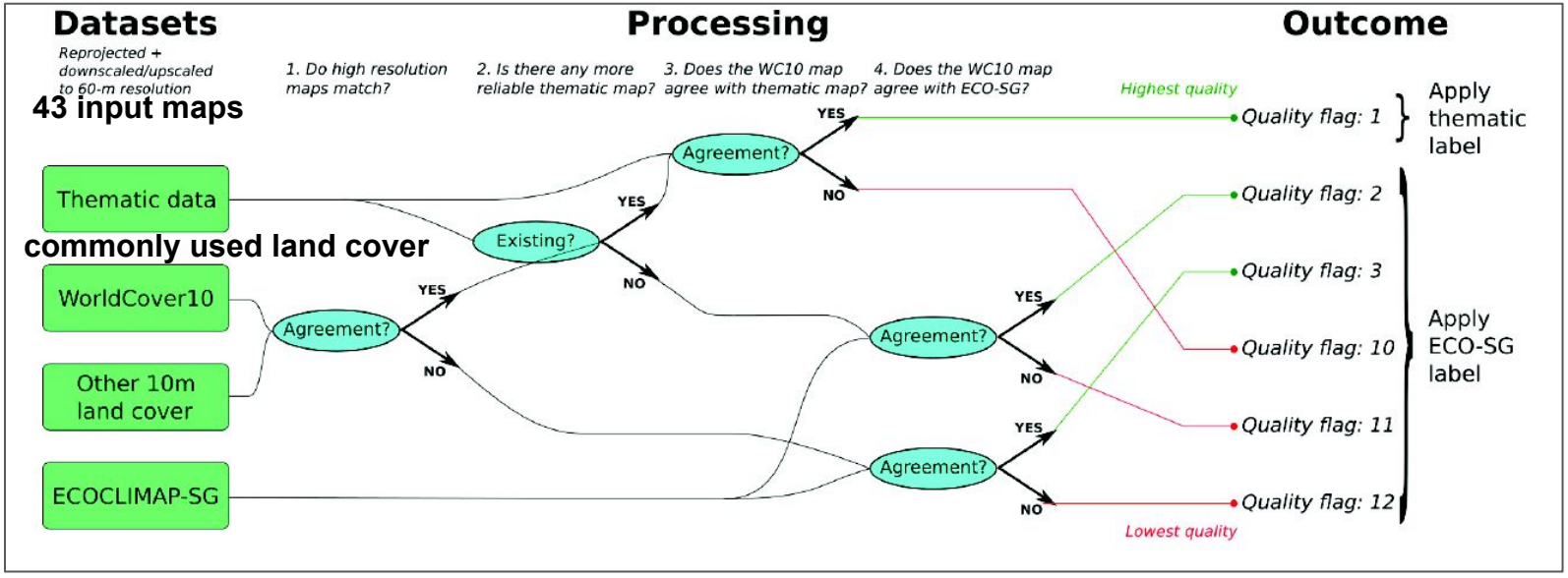
Motivation and purpose

- 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.

Step 1 of 2: the decision tree and ECOSG+

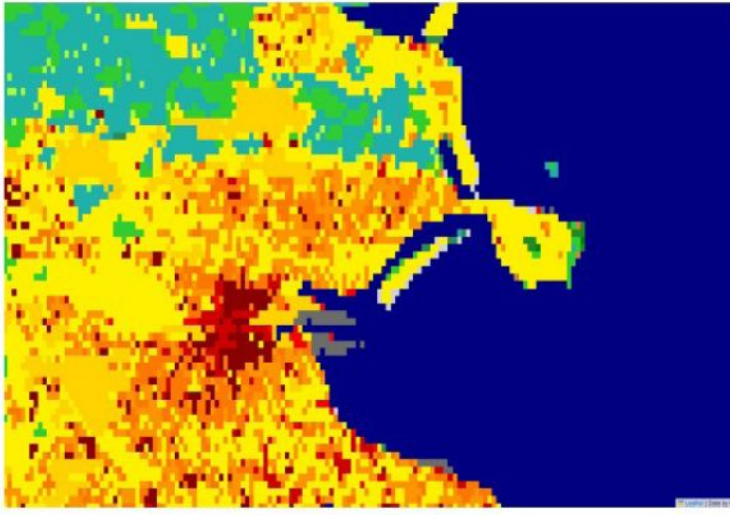


Through this decision tree a number of input maps are translated to ECOSG physiography covers along with a quality flag, resulting in what is labeled the ECOSG+ map at 60 m resolution.
See Geoffrey Bessardon et al. (2024) for details.

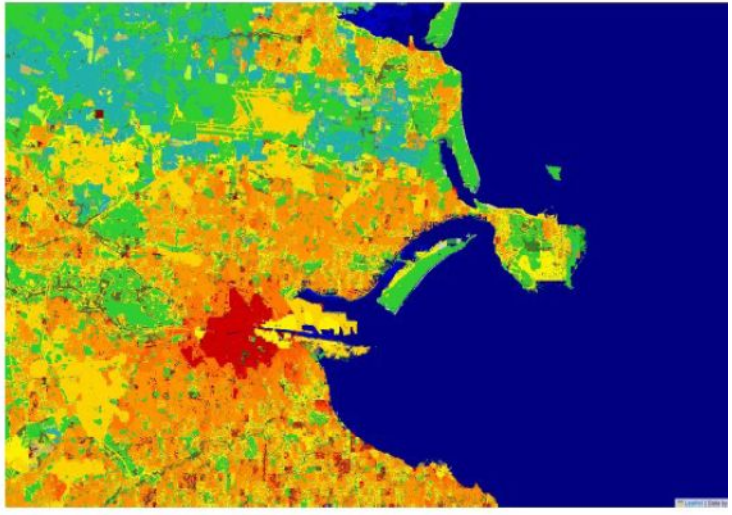
Step 1 of 2: the decision tree and ECOSG+

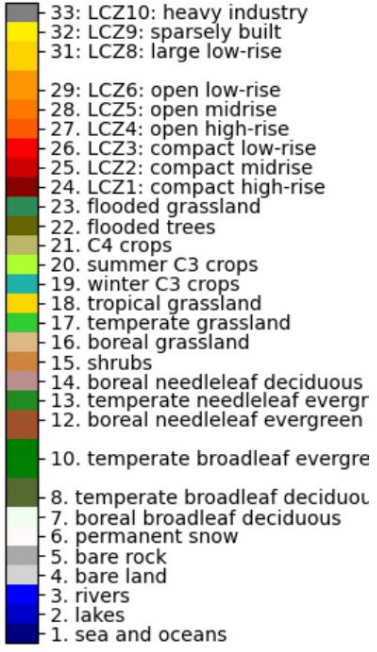
Around Dublin

ECOSG (300 m resolution)



ECOSG+ (60 m resolution)





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

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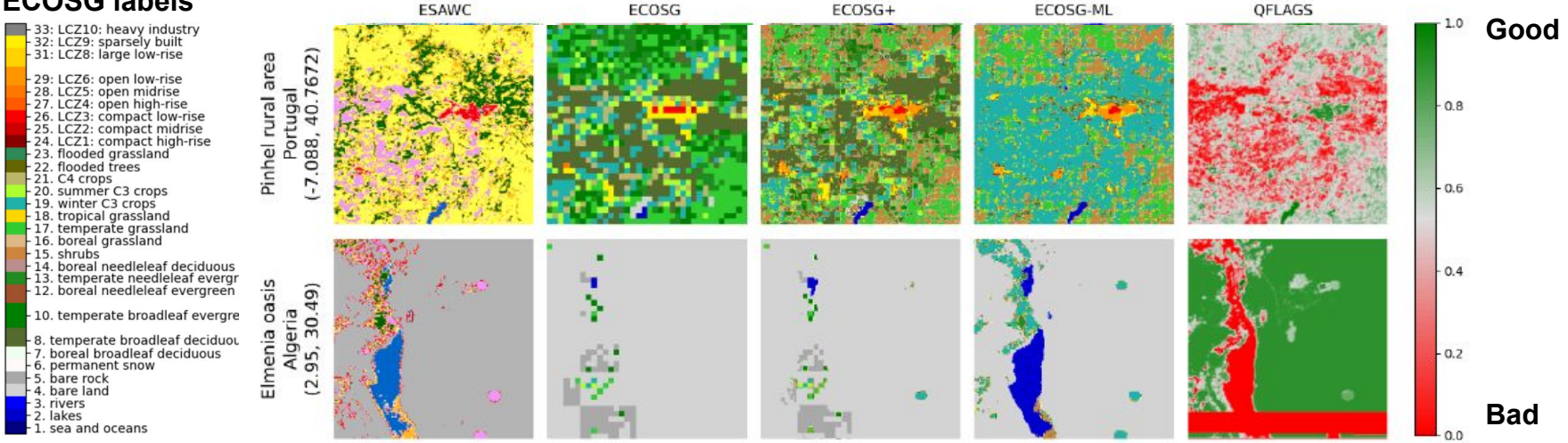
Step 2 of 2: correct the areas with low quality

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).



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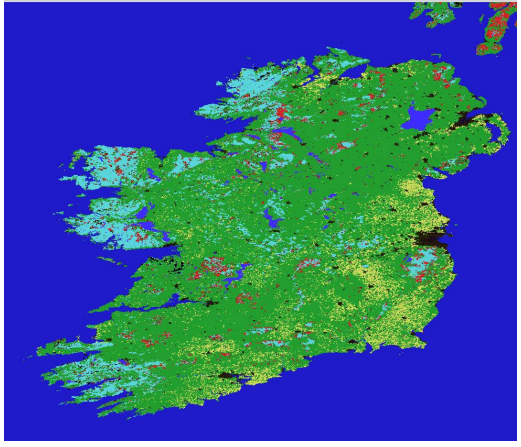
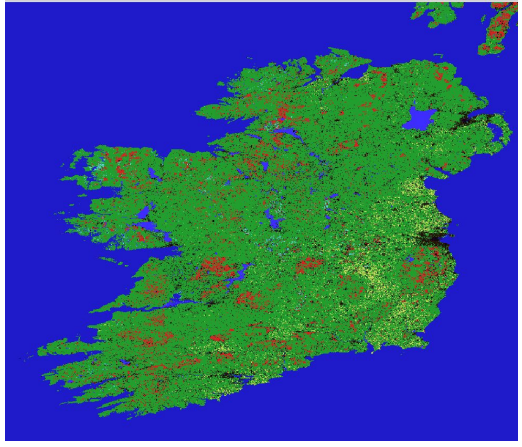
Step 2 of 2: correct the areas with low quality

Another, kind of tricky example:

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)

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.

Please contact my co-authors for more info!

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