ACCORD

A Consortium for COnvection-scale modelling Research and Development

ACCORD Overview of Land Physics and Physiography

ACCORD Surface Data Assimilation in next talk by Ekaterina Kurzeneva

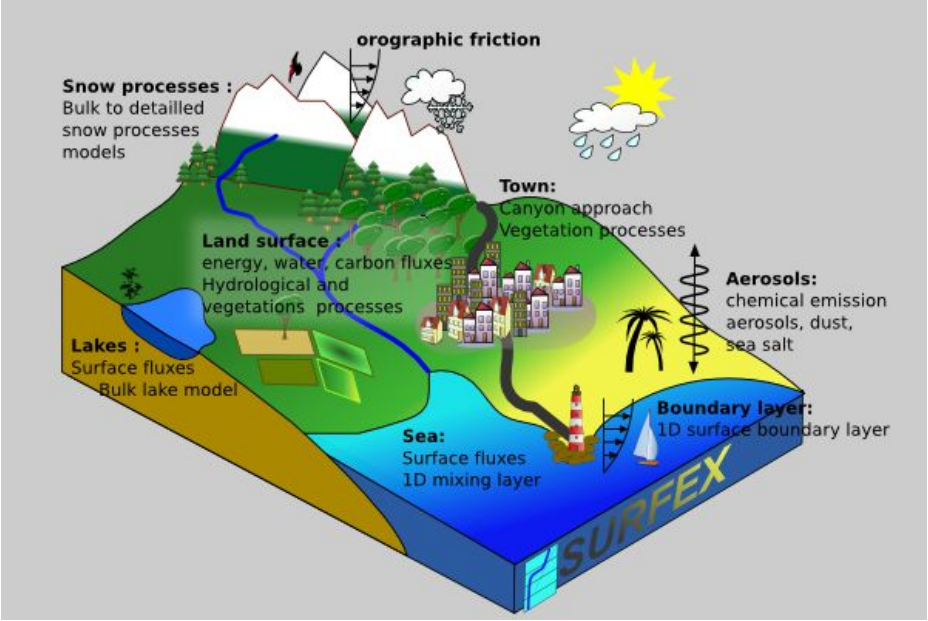
Patrick Samuelsson, 2021-09-28, 43rd EWGLAM and 28th SRNWP Meeting

SURFEX - the ACCORD surface processes

Snow:
- D95 bulk 1-layer snow
- 12-layer Explicit Snow
- Crocus multi-layer

Soil and vegetation:
- ISBA ForceRestore (3 lay)
- Diffusion soil (14 lay)
- Explicit canopy (MEB)
- A-gs progn. vegetation

Lake and river:
- FLake
- Proxy based on deep soil



Link to SURFEX home page

Orography:
- Orographic drag
- Orographic radiation

Urban:
- Town Energy Balance
- A rocky surface

Surface layer:
- Monin–Obukhov
- Multi-layer prognostic
- Roughness sublayer

Sea:
- SST from boundary with a few flux options
- GELATO and SICE ice models
- OASIS coupler to 3D ocean models and wave models

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SURFEX - the ACCORD surface processes

The development of SURFEX is moving forward based on needs in a few science areas like e.g. climate modelling, agricultural aspects, urban aspects, detailed snow aspects, NWP....
A few examples on recent contributions are:

- **Crocus multi-layer snow model:** SYTRON blowing snow transport, prognostic impurities, Crocus-RESORT for snow in ski resort areas, formation of a ice crust by freezing rain.
- **Irrigation:** 3 types considered: sprinkler, flood, drip. External mapped info on type of irrigation, date of irrigation, duration, intervals, water quantities.
- **Vegetation:** NIT A-gs prognostic LAI option coupled to MEB, wildfires, improved carbon cycle, representation of photosynthesis, respiration and plant functional types.
- **Radiation:** Orographic effects of radiation
- **Urban TEB scheme:** Road characteristics, radiative exchange, street and wall vegetation, CO_2 fluxes, improved Building Energy Model

List by Marie Minvielle, Météo-France SURFEX team

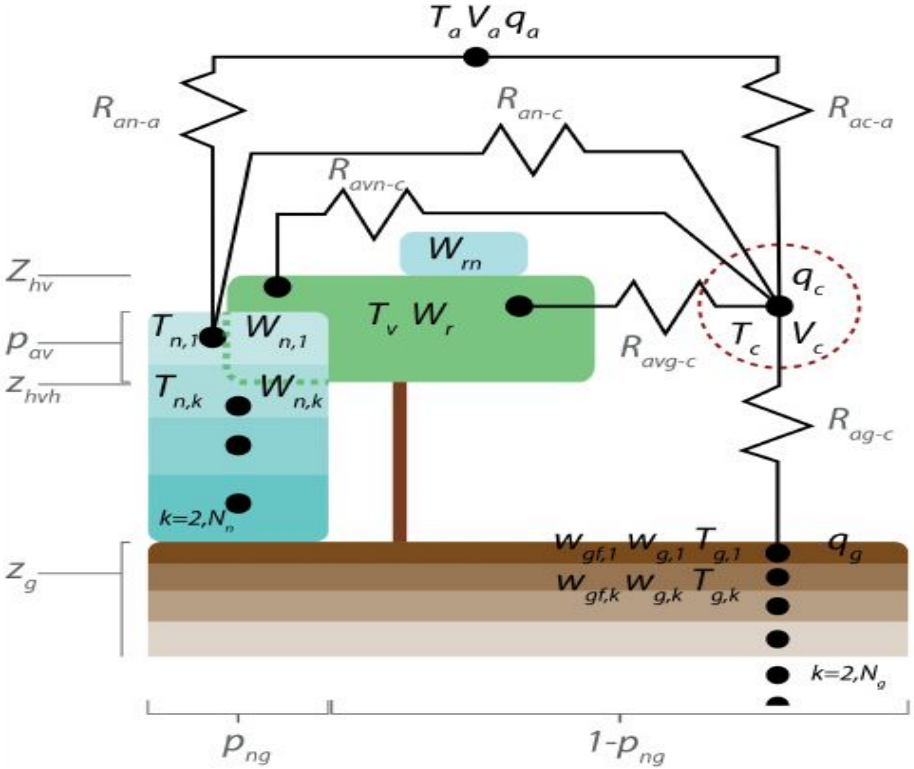
Link to SURFEX home page

SURFEX Land - Towards multi-layer physics in NWP

MEB and forest snow, Napoly et al. (2020, doi:10.5194/gmd-13-6523-2020)

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)
Currently under testing for open grass surfaces by Aaron Boone et al. Indicates need for inactive LAI!

Litter layer in forest Napoly et al. (2017, doi:10.5194/gmd-10-1621-2017)

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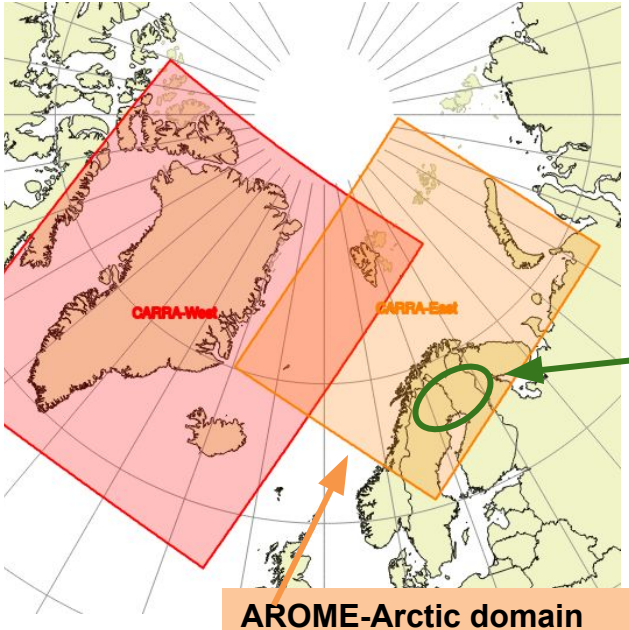
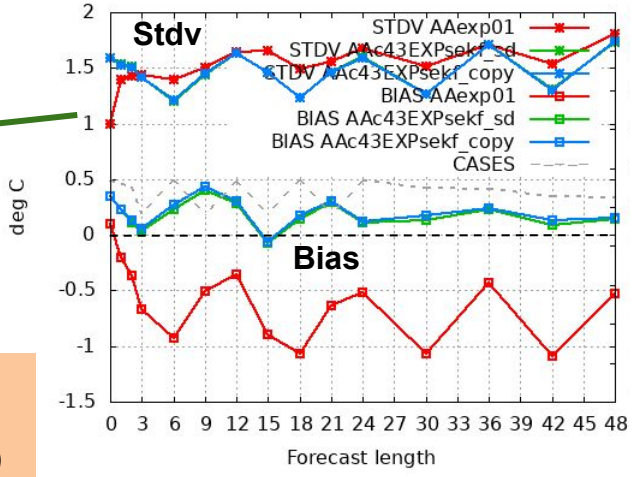
SURFEX Land - Towards multi-layer physics in NWP



AROME-Arctic domain (same as the Eastern CARRA reanalysis domain)

This multi-layer physics, with SEKF surface assimilation, has now been running over the AROME-Arctic domain for more than two years (since September 1st 2019) with 3 hours cycling. Soon goes pre-operational...

T2m validation (45 stations) for the north-Scandinavia forest region for May 2020



The multi-layer physics, both with SEKF and without SEKF, outperforms the currently operational Force-Restore/OI combination.

This setup is now under testing for other domains...

By Åsmund Bakketun, Trygve Aspelien, Patrick Samuelsson

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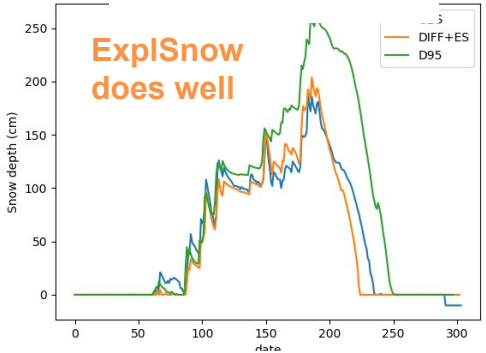
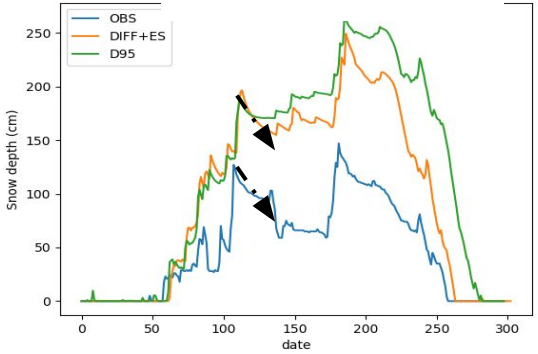
SURFEX Land - Explicit snow scheme (12 layers)

AROME-France, French Alps, 2019-2020:
D95 bulk 1-layer snow
DIFF soil + ExplSnow
Observed snow depth

Col des Saisies, 1614m



Restefond Nivose, 2550m

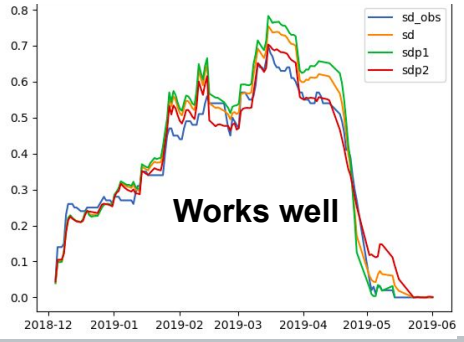


ExplSnow (and D95) overestimates snow but melt rate is good (better than D95)

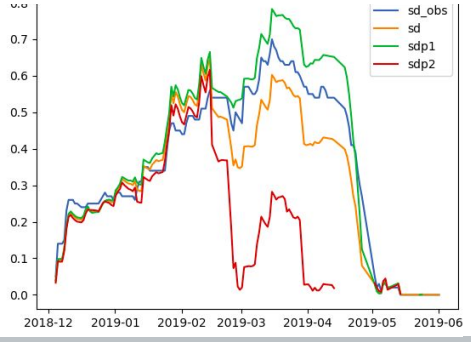
By Yann Seity

SURFEX offline, north Sweden forest area, 2018-2019:
ExplSnow open land, forest and land average
Observed snow depth

DIFF soil + ExplSnow + ExplVeg (MEB)



DIFF soil + ExplSnow, but no ExplVeg (MEB)



Without ExplVeg (MEB), ExplSnow overestimates snow melt in forest area.

By Trygve Aspelien

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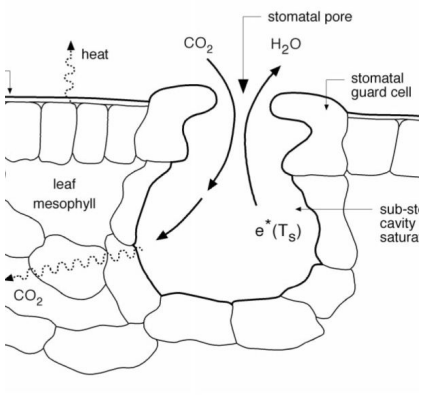
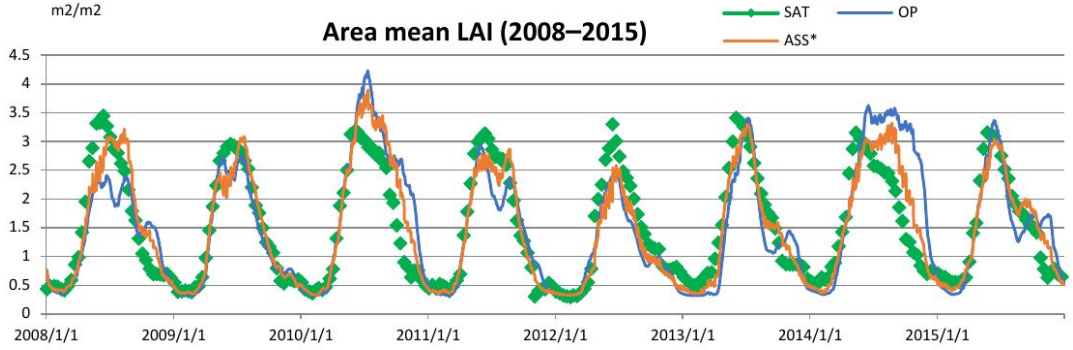
SURFEX Land - prognostic LAI by A-gs

Currently all ACCORD operational NWP setups use prescribed ECOCLIMAP annual cycle of LAI. However, we see many examples where prognostic LAI gives better results in e.g. simulated soil moisture and energy fluxes (see e.g. Mucia et al., 20201, doi: 10.5194/bg-2021-248)



Recently ACCORD colleagues Helga Tóth and Balázs Szintai have shown how satellite observations in combination with the SURFEX A-gs prognostic LAI can simulate LAI over the Carpathian Basin (doi: 2073-4433/12/8/944)**:**



A-gs LAI open loop
A-gs LAI EKF
Satellite LAI

We'll see more ACCORD NWP activities towards operational A-gs LAI in combination with satellite observations.

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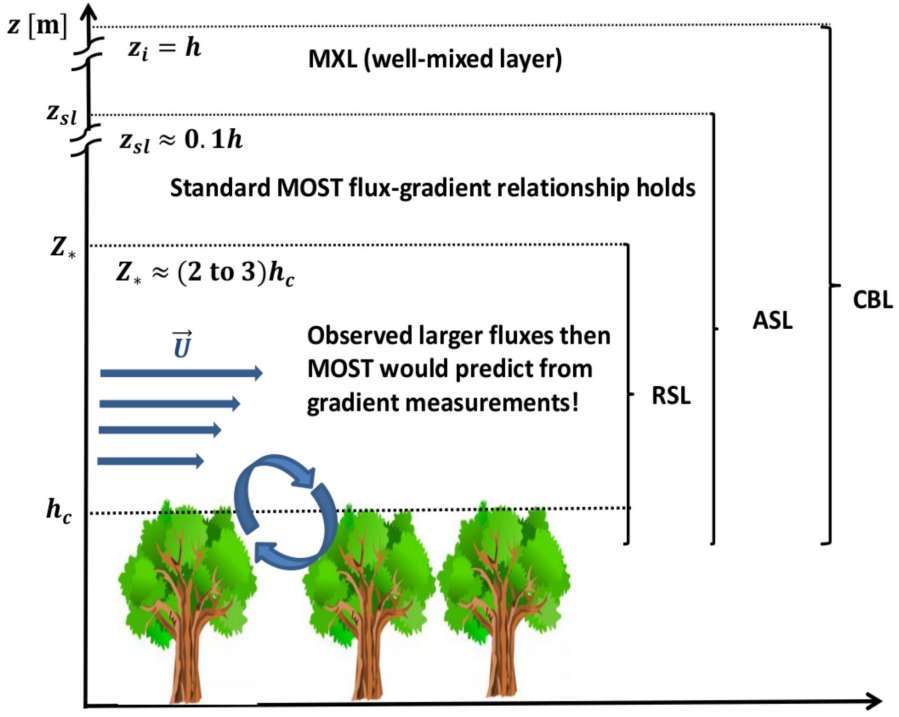
SURFEX Land - Development of Roughness Sublayer



Currently in SURFEX there is no dependence of roughness length on e.g. displacement height, LAI or stability...

However, 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 compared to Monin–Obukhov Similarity Theory (MOST).

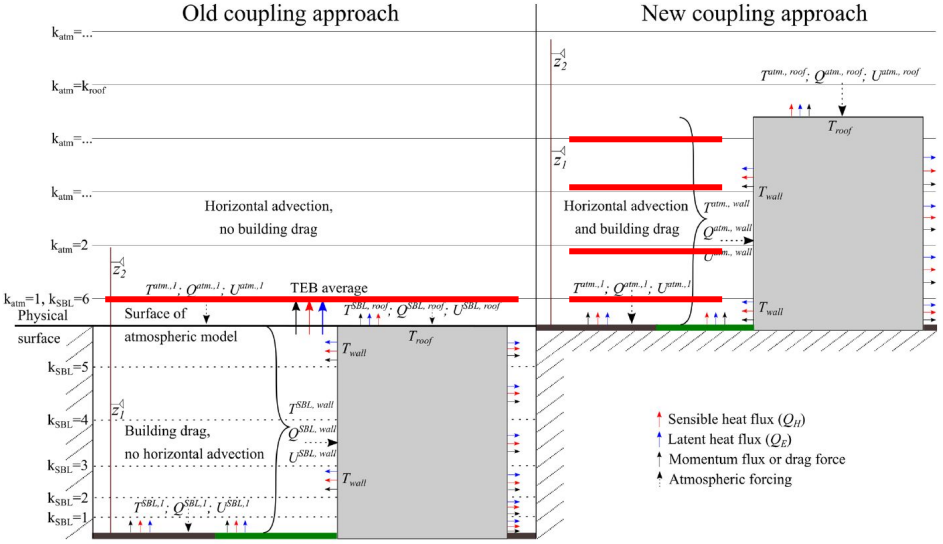
Now ACCORD colleagues Metodija Shapkalijevski (SMHI) and Samuel Viana (AEMET) are implementing and testing the Harman & Finnigan (2007) RSL model in SURFEX.

More results on this on Friday this week!

SURFEX Town-Energy Balance

Multi-layer coupling between SURFEX-TEB and Meso-NH atmospheric model for urban high-rise cities (Schoetter et al. 2020, doi: 10.5194/gmd-13-5609-2020)

Today the ACCORD NWP atmosphere and surface (SURFEX) have a strict interface at the lowest atmospheric model level where state variables and fluxes are interchanged.



In the new coupling approach urban buildings interact with a number of the lowest atmospheric model levels depending on their height.

Météo-France currently considers this coupling approach for AROME… Okay, on the ACCORD activation list is also TEB in all ACCORD NWP setups, vegetation within the urban area, ...

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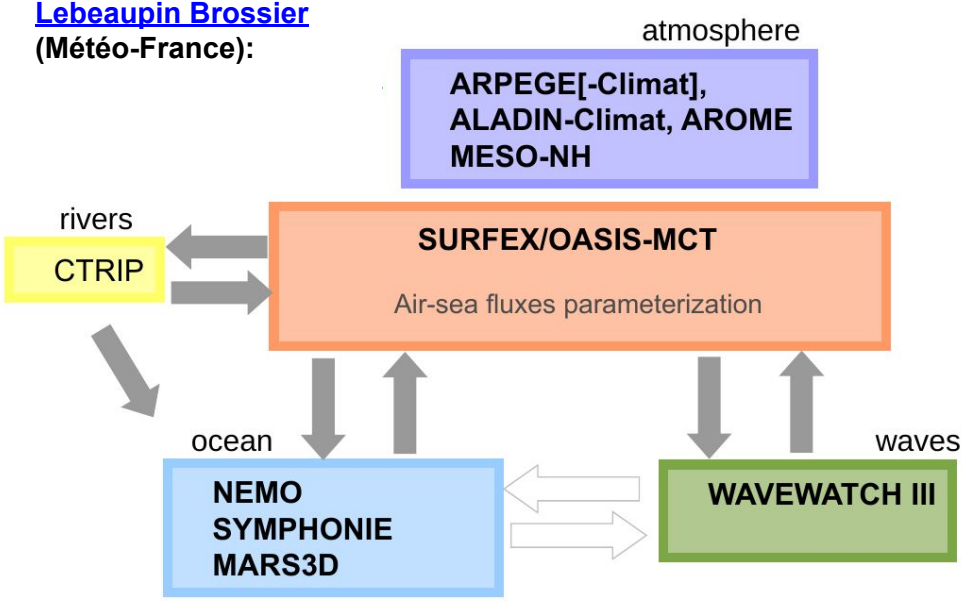
Coupling to ocean and wave models

Figure from Cindy Lebeaupin Brossier (Météo-France):



At Météo-France there are activities on AROME-WW3-NEMO coupling, see e.g. presentations by Cindy Lebeaupin Brossier and Sylvie Malardel.

At ARSO, Slovenia, there are activities on ALARO-WAM-NEMO coupling, see e.g. poster by the ARSO team.

At MetNorway there are activities on HARMONIE-AROME-WW3-ROMS-SICE coupling, see e.g. presentation by Erin Thomas.

In Ireland there are activities on HARMONIE-AROME-WW3 coupling, see e.g. presentation by Basanta Kumar Samal.

For operational NWP maybe we need something in between prescribed SST and coupling to ocean models...

Physiography for SURFEX

Topography:

- GTOPO30 at ~1 km
- USGS GMTED2010 at ~250 m
- CGIAR SRTM at ~90 m

Land cover by ECOCLIMAP:

- 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:

- 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

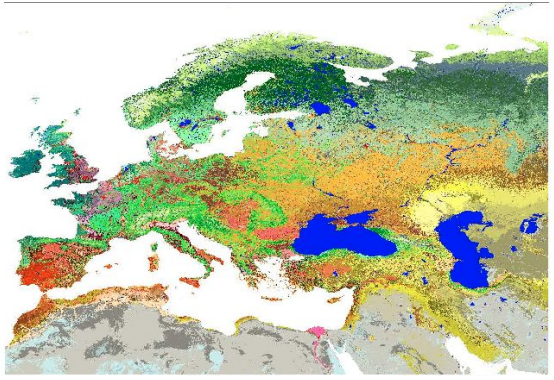
Lake depth:

- Global Lake DataBase at ~1 km

Info on C-SRNWP project on ESA-CCI land cover in Surface break-out session on Friday.

Link to SURFEX physiography

Land cover in ACCORD



- Operationally based on ECOCLIMAP 1st (1 km) and 2nd (ESA-CCI land cover 300 m) generations.
- The ESA-CCI land cover have issues as reported last year:
  - too homogeneous which is corrected for by modified roughness.
  - misses urban and water info. Solved by complementing with urban Local Climate Zones and add division between sea, lake, rivers.

  Changing physiography requires tidy work on tuning! See that e.g. COSMO has interesting tools here...
- Ways forward: Adjust current global databases, leave the ambition to stick to global data bases and look for European alternatives, go for new combinations of satellite and machine learning products, high-resolution setups asks for more specific physiography (e.g. urban)

Lake Ågelsjön, Norrköping, Sweden

Breakout Session on Surface Aspects on Friday morning

- **Patrick Samuelsson: “The C-SRNWP project on ESA-CCI land cover”**
- **Daniel Regenass: “Numerics of the 1d Richards Equation and implications for land surface modelling on the kilometer-scale”**
- **Geoffrey Bessardon: “An update on physiography activities at (Met Éireann) including some work on machine learning”**
- **Eoghan Keany: “Mapping of building heights for Ireland using Sentinel-1 and Sentinel-2 time series”**
- **Samuel Viana: “Implementation of Roughness Sublayer in SURFEX”**
- **Discussions… please bring items and questions!**

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