

Design of a high-resolution land cover database for numerical modelling applications

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Outline

- ❑ Context and motivation
- ❑ Principle of ECOCLIMAP Second Generation
- ❑ Impact on applications
- ❑ Summary

Context and motivation

- ❑ NWP and climate models relying on land surface modelling need a realistic representation of surfaces to derive models' parameters

- ❑ At Meteo-France the land cover description relies on ECOCLIMAP, a 1km global database that describes the ecosystems fractions all over the globe (Masson et al., 2003)
 - Interfaced to the land modelling platform SURFEX to define model parameters
 - The current version based on data from 1999 to 2005 (Faroux et al., 2013) is operational in AROME applications

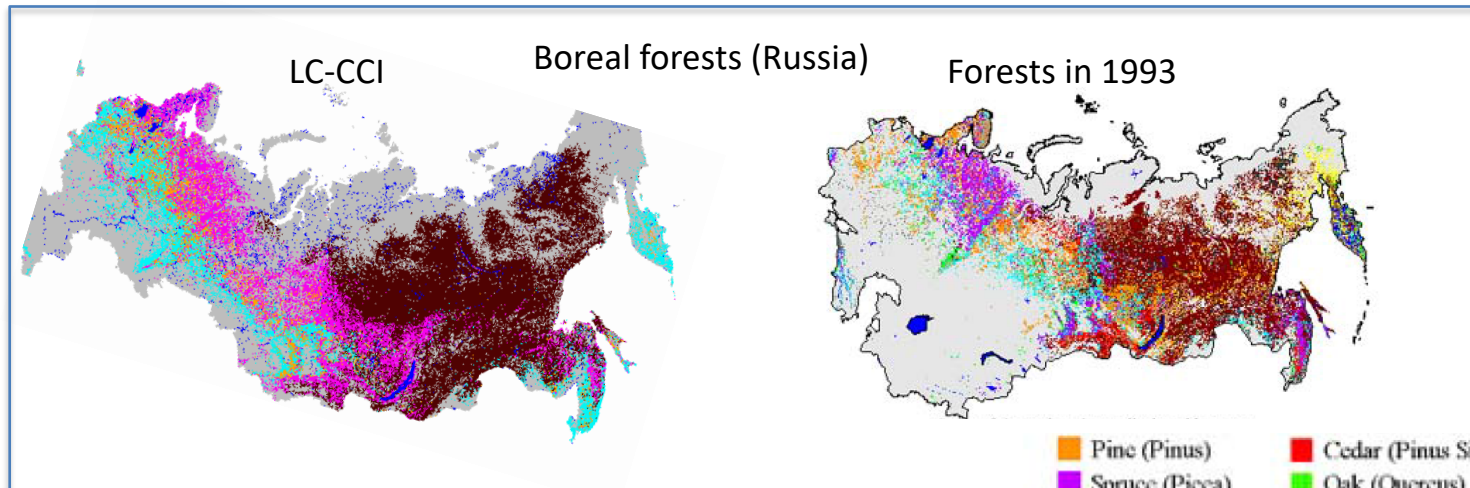
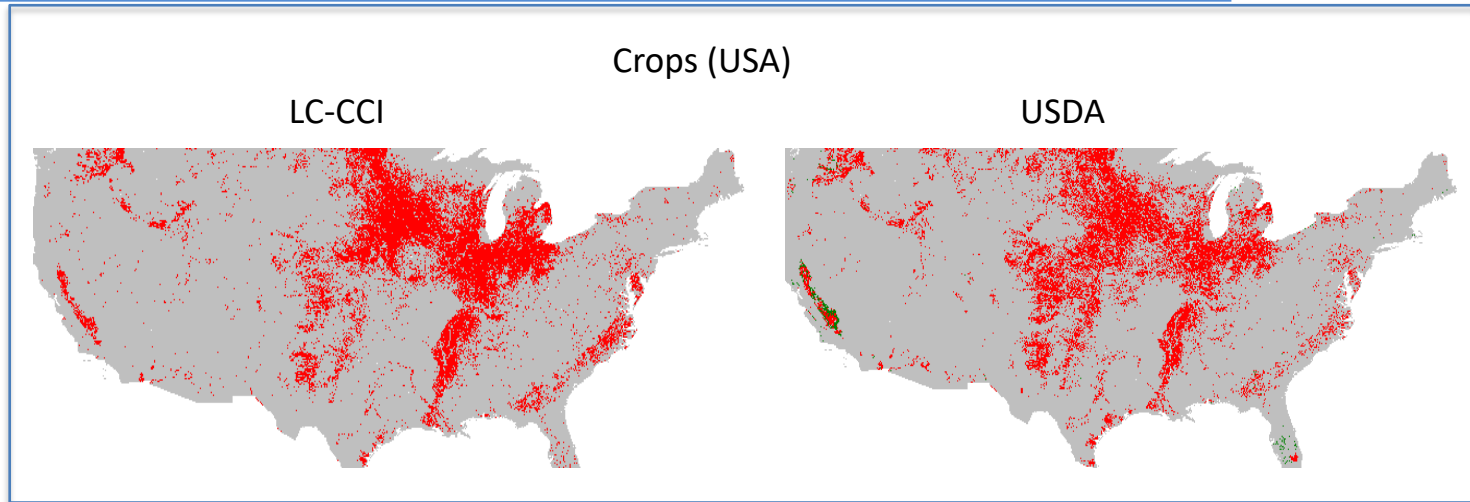
- ❑ A need to improve the resolution and the realism (more frequent updates) of land cover representation and simplify the computation of parameters was expressed

Principle of ECOSG (ECOCLIMAP Second Generation)

- ❑ **ECOSG** specifications were defined in 2015
 - A global land cover map at 300m (1/360) resolution
 - Each grid point stands for **one single** surface type
 - The principle of covers (several surface / vegetation types in a homogeneous ecosystem) of the former ECOCLIMAP disappears
 - Algorithms have to be (mainly) automatic for regular updates

- ❑ **ESA-CCI Land Cover** product was chosen as basemap to build ECOSG new land cover map
 - Version 1.6.1 (28/01/2016)
 - Spatial resolution of 300m
 - Epoch 2010 (from 2008 to 2012)
 - Coming from satellite data MERIS FR & RR and SPOT-VGT

ESA-CCI land cover maps



- in **brown**, needleleaf deciduous
- In **pink**, **yellow** and **red**, needleleaf evergreen
- In **light blue** and **green**, broadleaf deciduous
- In **orange**, needleleaf evergreen on the left, mixed forest on the right

Forest Cover Map of the Former Soviet Union (January 1993)
 (http://www.borealforest.org/world/rus_mgmt.htm)

Principle of ECOSG

- ❑ Global maps of primary parameters associated to this land cover map
 - 10-day LAI
 - Root, soil and ice depths
 - Height of trees
 - Soil and 10-day vegetation albedos
 - Primary parameters for towns

- ❑ The difficulty to build the map lies in:
 - Converting the ESA-CCI LC original cover types into the new ECOSG land cover types
 - Design as automatic as possible algorithms to be usable when new ESA-CCI LC release is published.

- ❑ The algorithms to combine the ESA-CCI LC data and the other input data sources rely on the GRASS GIS software.

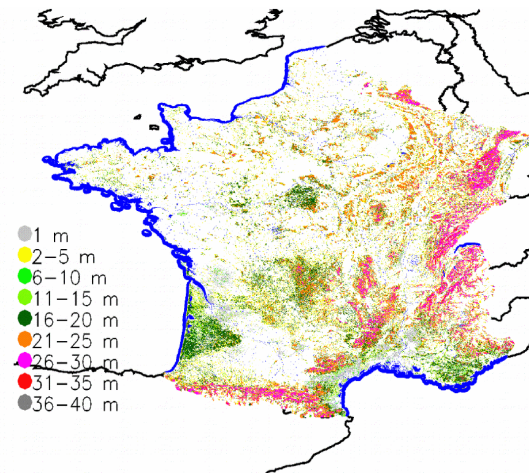
Data sources in ECOSG

	<i>Difficulty</i>	<i>Data sources used</i>
<i>Sea, lakes and rivers</i>	To separate them	<ul style="list-style-type: none"> - personal try to manually separate them - SRTM Water Body Data from USGS - GSHHC and WDBII from NOAA
<i>Bare soil and bare rock</i>	To separate them	<ul style="list-style-type: none"> - GLC2000 regional tiles
<i>Forests / grassland</i>	To distinguish the boreal / temperate / tropical climatic areas	<ul style="list-style-type: none"> - The bioclim_LPJ.nc map (already used to move from 12 to 19 vegtypes)
<i>Crops</i>	To distinguish winter C3 / summer C3 / C4 crops	<ul style="list-style-type: none"> - FAO crops statistics by country for the whole world, year 2014 - USDA map of crops for the USA at 30m resolution, year 2015 - AGRESTE statistics by French departement, year 2015
<i>Urban areas</i>	To separate them into the 10 urban LCZs	<ul style="list-style-type: none"> - CLC2012 - GHSL_LABEL pre-release data

Principle of ECOSG

33 surface types

1. Sea and oceans (cov. 1)
2. Lakes (cov. 2)
3. Rivers (cov. 3)
4. Bare soil (veg. 1)
5. Bare rock (veg. 2)
6. Permanent snow (veg. 3)
7. boreal broadleaf deciduous (veg. 16)
8. temperate broadleaf deciduous (veg. 4)
9. tropical broadleaf deciduous (veg. 13)
10. temperate broadleaf evergreen (veg. 14)
11. tropical broadleaf evergreen (veg. 6)
12. boreal needleleaf evergreen (veg. 5)
13. temperate needleleaf evergreen (veg. 15)
14. boreal needleleaf deciduous (veg. 17)
15. shrubs (veg. 19)
16. boreal grassland (veg. 18)
17. temperate grassland (veg. 10)
18. tropical grassland (veg. 11)
19. Winter C3 crops (veg. 7)
20. Summer C3 crops (new)
21. C4 crops (veg. 8)
22. Tree cover, flooded (new)
23. Shrub or herbaceous cover, flooded (new)
24. urban LCZ1: compact high-rise (new)
25. urban LCZ2: compact midrise (new)
26. urban LCZ3: compact low-rise (new)
27. urban LCZ4: open high-rise (new)
28. urban LCZ5: open midrise (new)
29. urban LCZ6: open low-rise (new)
30. urban LCZ7: lightweight low-rise (new)
31. urban LCZ8: large low-rise (new)
32. urban LCZ9: sparsely built (new)
33. urban LCZ10: heavy industry (new)



Primary parameter maps

- LAI (Copernicus Global Land, 2014-2016, PROBA-V, 300 m)
- Tree height (NASA IceSat 1km)
- Rooting depth (from ECOCLIMAP-2)
- Soil, vegetation, VIS, NIR, albedo (Copernicus Global Land, 1998-2014, SPOT-VGT, 1km)

Surface parameters depending on primary parameters

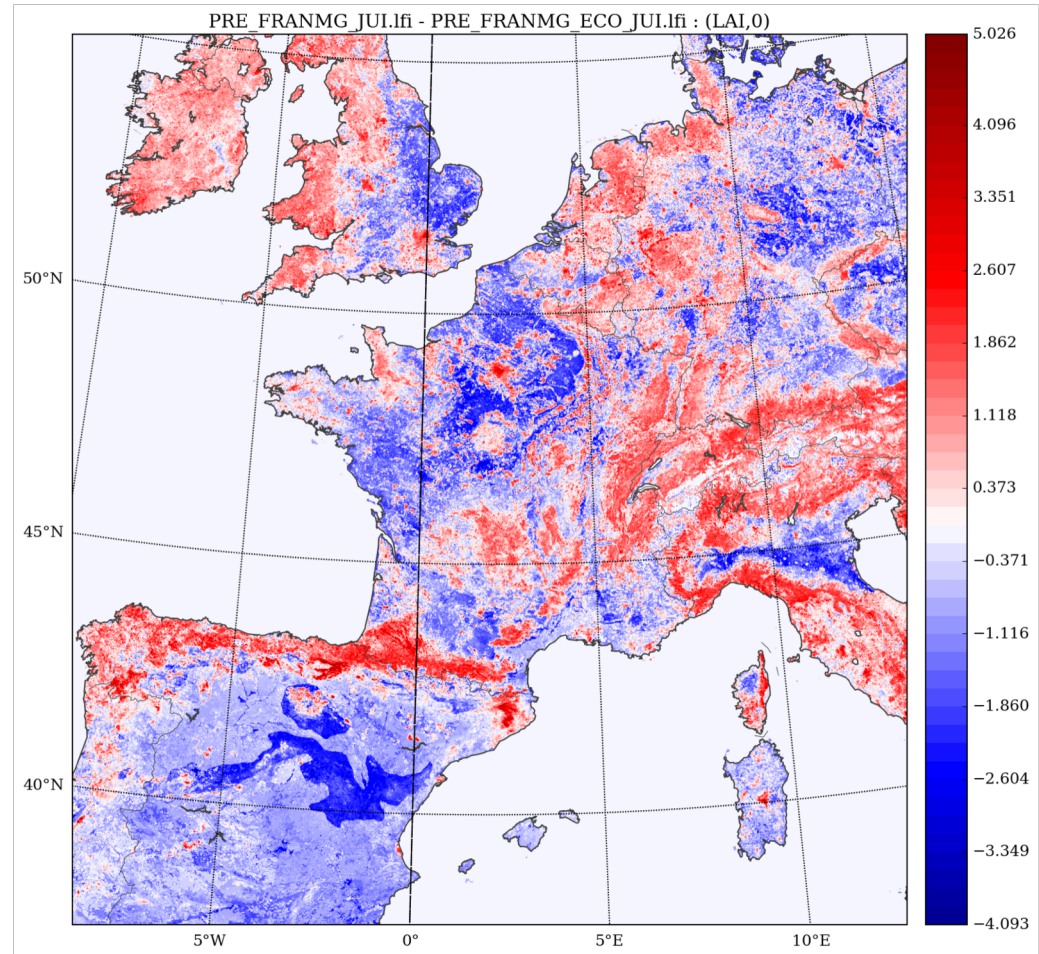
- Fraction of vegetation
- Roughness length
- Emissivity
- Total albedo

Surface parameters depending only on surface type

(e.g. photosynthesis parameters)

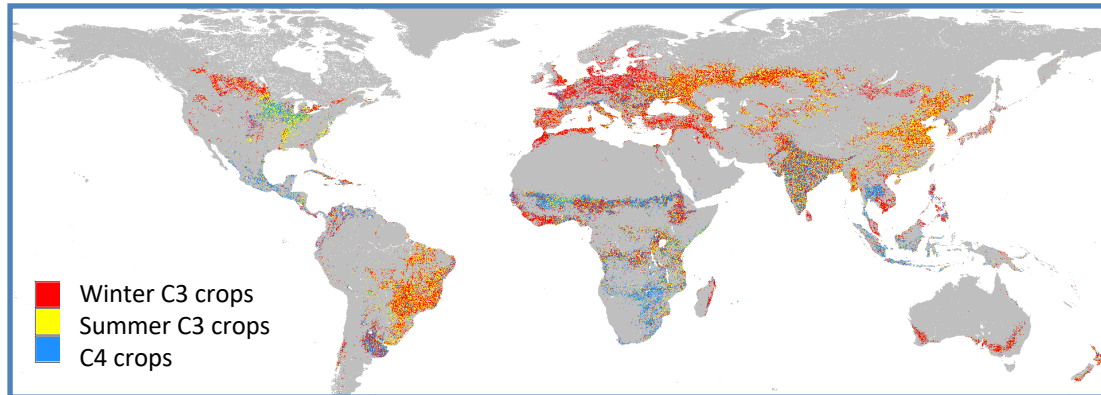
Leaf Area Index in ECOSG and ECOCLIMAP

- ❑ LAI in July can vary by $\pm 5 \text{ m}^2/\text{m}^2$
- ❑ Potential high impact on evaporation

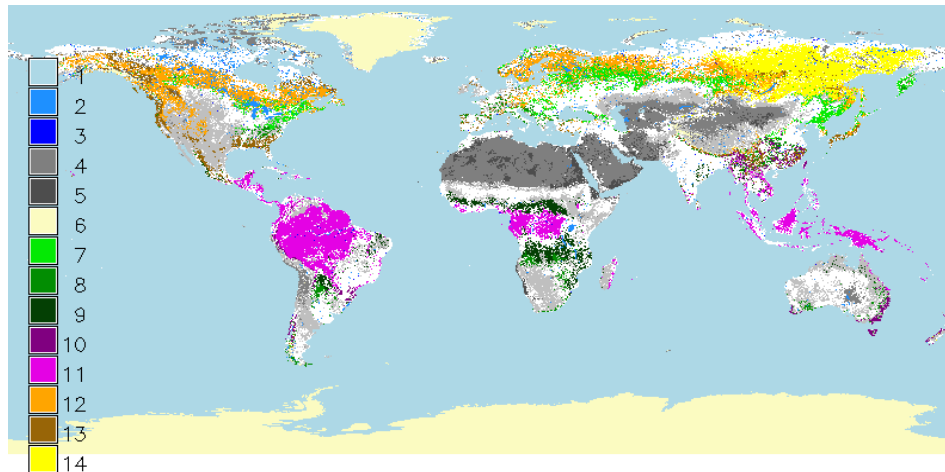


Crops and Forests in ECOSG

- ❑ Crops: using AGRESTE 2015 for France, 2015 USDA 30m data over USA, FAO statistics 2014 elsewhere



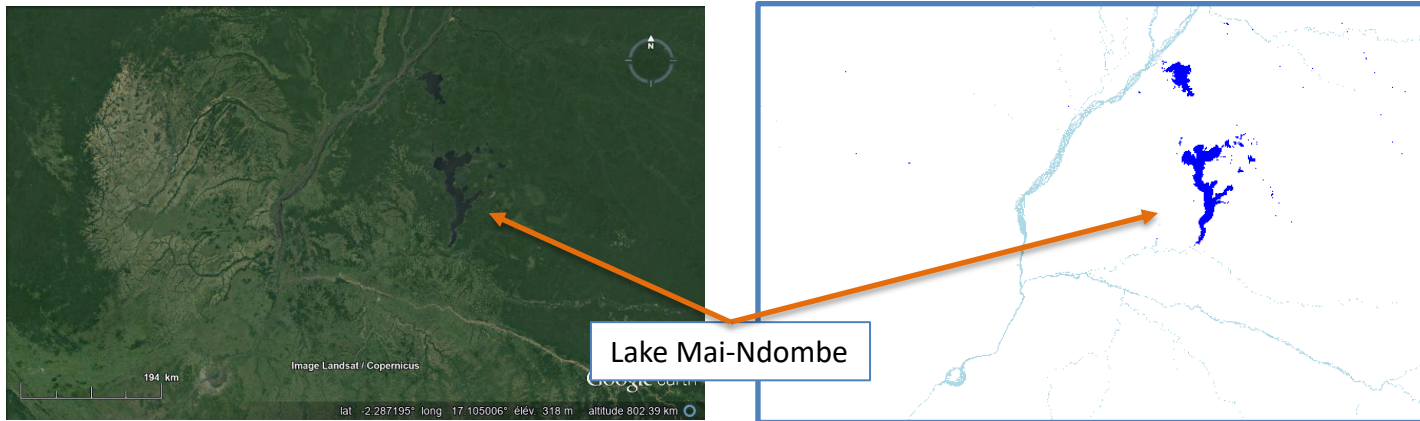
- ❑ Forest: using a climate map to distinguish boreal, temperate and tropical forests



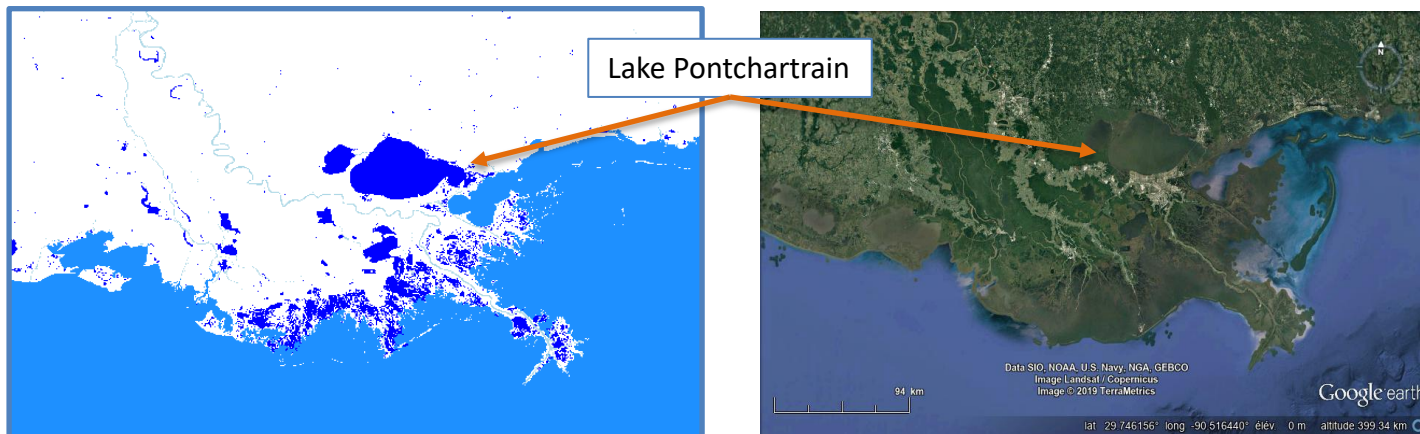
7-8-9 : broadleaf deciduous resp. boreal, temperate, tropical
10-11 : broadleaf evergreen resp. temperate, tropical
12-13 : needleleaf evergreen resp. boreal, temperate
14 : needleleaf deciduous, boreal

Water bodies in ECOSG

- ❑ SRTM water bodies plus GSHHC and WDBII from NOAA
- ❑ Congo river

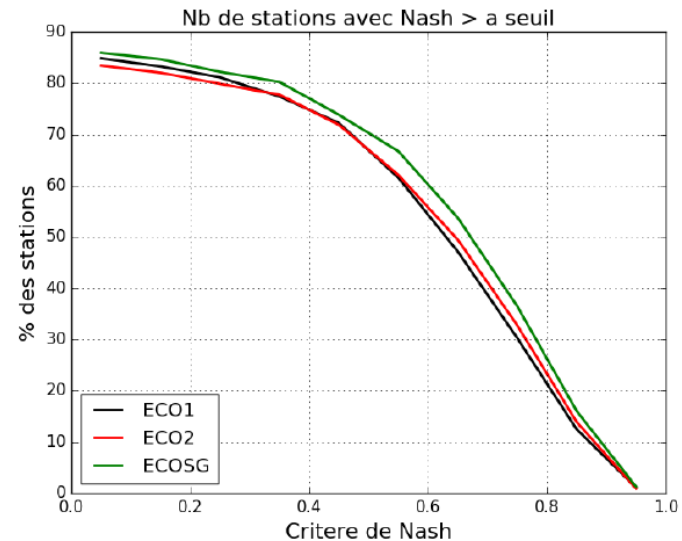
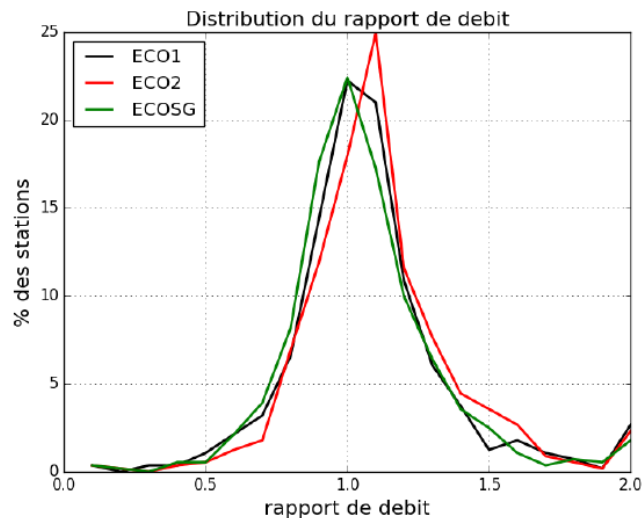


- ❑ Mississippi river



Impact on applications

- River discharges over France using SIM hydrological simulations for 1995-2015
 - Discharge ratio very sensitive to height of trees
 - ECOSG improves Nash criterion



- Tests in AROME France for 1 month

- LAI and tree height differ a lot from previous ECOCLIMAP versions
- Scores are degraded in relation to outdated/calibrated parameterizations in AROME
- Model physics need to be revised to integrate new land surface description

Summary

- ❑ ECOSG new land cover map @300m resolution is available and already used by several centres for testing
- ❑ It aims at better representing land surfaces at the global scale
- ❑ Using satellite data information from ESA-CCI and other high resolution data
- ❑ Surfaces are represented by 33 generic surface types
- ❑ Maps of parameters for land cover type, albedo, height of trees, etc. are prepared at decadal time resolution
- ❑ Firsts tests have shown a positive impact using ECOSG in discharge simulations but negative impact with NWP simulations with AROME, and also a high sensitivity of the model results to the height of trees
- ❑ ECOCLIMAP and ECOSG are very different and require tuning of both surface and atmospheric models for NWP apps.
- ❑ Further efforts are needed to integrate local data in the algorithms