climate change initiative

CLIMATE MODELLING USER GROUP

CMUG CCI+ WP5.3
Meteo-France contribution

Impact of integrating CCI LC data in the ISBA land surface model

18 September 2023

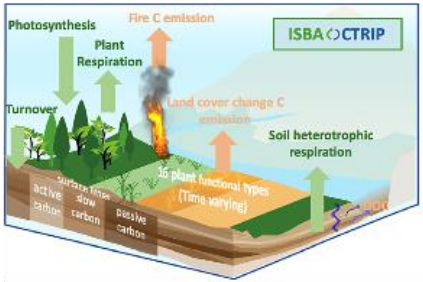
J.-C. Calvet

cmug cci

The SURFEX modelling platform

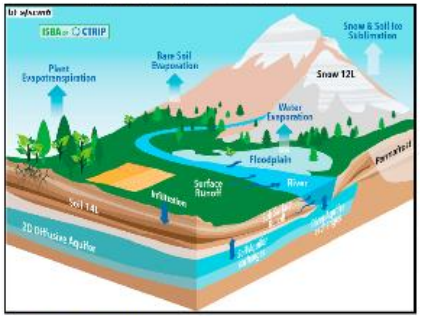
ACCORD
A Consortium for COnvection-scale modelling Research and Development

CARBON CYCLE



Delire et al. 2020

WATER CYCLE

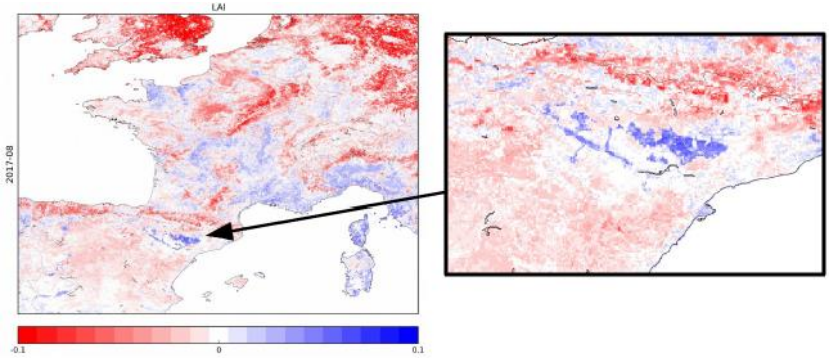


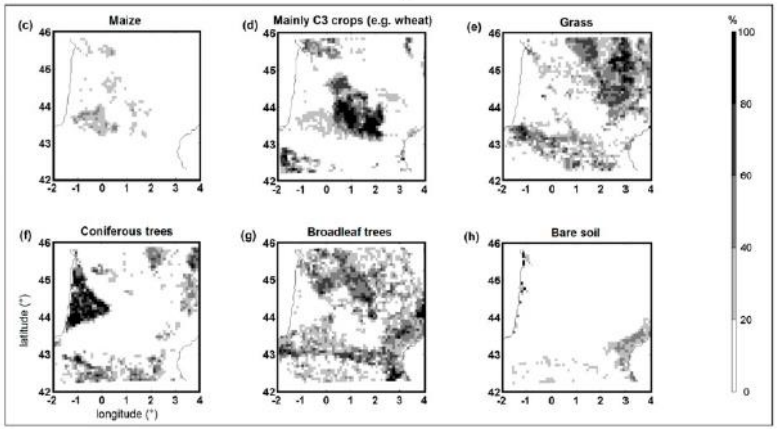
Decharme et al. 2019

ISBA	Soil	Force restore : 2 temperature, 2 or 3 layers for water, icing Diffusion : multilayer (temperature, water, icing)
	Vegetation	Noilhan et Planton 89 (~Jarvis) A-gs (photosynthesis and CO2 fluxes) A-gs and interactive vegetation Slow carbon processes (wood and roots)
	Hydrology	No subgrid process Subgrid surface runoff Subgrid drainage Flooding and coupling with TRIP
	Snow	1 layer, albedo, density variable (ARP/Climat, Douville 95) 1 layer, albedo, density variable (ARP/ALD, Bazile) Multilayer (3, or...) albedo, density, liquid water content (Boone and Etchevers 2000)

Integration of geographical info in SURFEX

- **Sequential assimilation of satellite-derived LAI**
  - LDAS-Monde
    - e.g. LAI increments highlighting irrigated areas in Spain (August 2017)
- **Land cover and model parameter mapping**
  - ECOCLIMAP
    - e.g. surface types in southwestern France

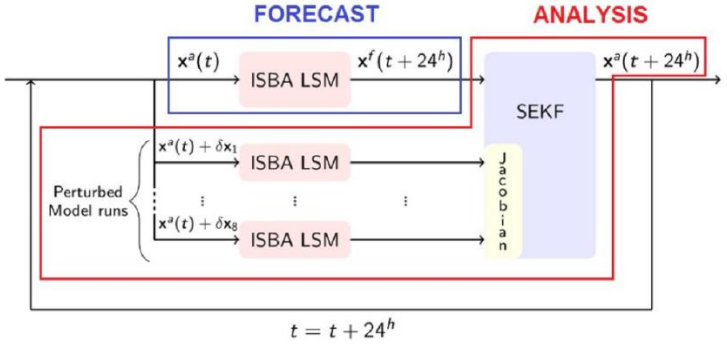




Land Data Assimilation within SURFEX

- **LDAS-Monde**

$$x^a = x^f + K(y^o - H(x^f))$$

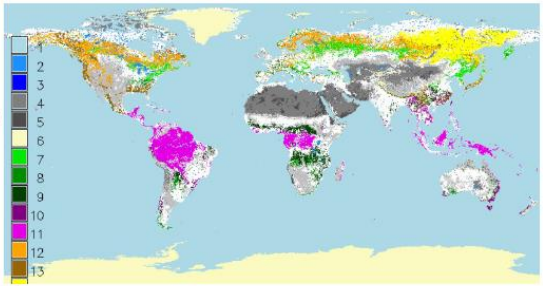


  - Integration of satellite observations into the ISBA land surface model
  - Involves the CTRIP river discharge model
  - Sequential assimilation of LAI
    - Flexible LAI thanks to photosynthesis-driven phenology
    - Root-zone soil moisture can be analysed assimilating LAI
    - Joint LAI and SM assimilation is possible
  - Sequential assimilation of Snow Water Equivalent (SWE)

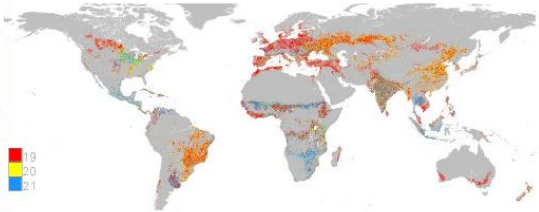
From ECOCLIMAP to ECOCLIMAP-SG

Geographical information	Years 2000 Ecoclimap-I	Years 2010 Ecoclimap-II	Years 2020 Ecoclimap-SG
LAI	NDVI AVHRR (1992-1993)	LAI MODIS (2000-2005)	LAI Copernicus (2014-2016)
Land cover (LC)	IGBP Corine 1990 (Europe)	IGBP Corine 2000 and GLC2000 (Europe)	ESA-CCI (2008-2012) Corine 2012 (Europe)
Plant functional types (PFTs)	10	12	33
LC classes (« ecosystems »)	125 (outside Europe) 90 (Europe)	125 (outside Europe) 273 (Europe)	33
Spatial resolution	1 km	1 km	300 m
Primary parameters (LAI, rooting depth, tree height, etc.)	Look up tables based on LC classes		Existing freely available databases
Secondary parameters - Biological (e.g. photosynthesis)	Look up tables based on PFTs		
Secondary parameters - Physical (e.g. bare soil fraction, roughness, IR emissivity, albedo, etc.)	Look up tables based on PFTs and primary parameters		

Forest cover types



Crop cover types



From ECOCLIMAP to ECOCLIMAP-SG

Covers = 33 generic 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)

How do LC and SNOW uncertainties propagate?

- Assimilation of SWE with and without LC-CCI using LST and SM as a benchmark

  - Eurasia 2010-2019, 0.25 x 0.25 km
  - Experimental design
    - Open-loop with pre-existing LC
    - Open-loop with CCI LC
    - SWE assimilation with pre-existing LC
    - SWE assimilation with CCI LC.
  - Comparison of simulated LST and SM with corresponding CCI variables.
  - Products to be used
    - LC: v.1.6.1, already available
    - SNOW: SWE L3c v2.0, already available
    - SM: COMBINED v6.1, already available
    - LST: AQUA_MODIS_L3C_0.05, TERRA_MODIS_L3C_0.05, already available

Land surface analysis

Thank you for your attention