climate change initiative

→ CLIMATE MODELLING USER GROUP

WP5.3 - **Impact of integrating CCI LC data in the ISBA land surface model**

16 October 2024

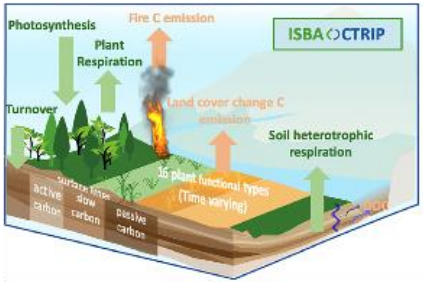
J.-C. Calvet, O. Rojas-Munoz, B. Bonan, P. Vanderbecken, J. Vural
CNRM, Meteo-France, Toulouse

cmug cci

The SURFEX modelling platform

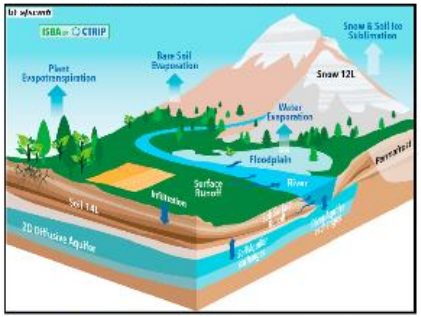
ACCORD
A Consortium for COnvection-scale modelling Research and Development

CARBON CYCLE



Delire et al. 2020

WATER CYCLE

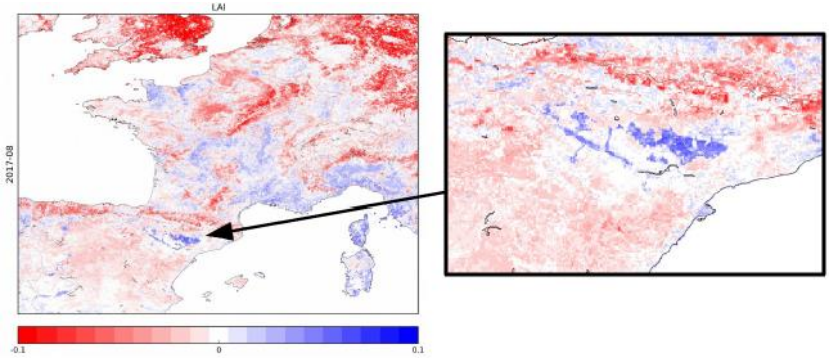


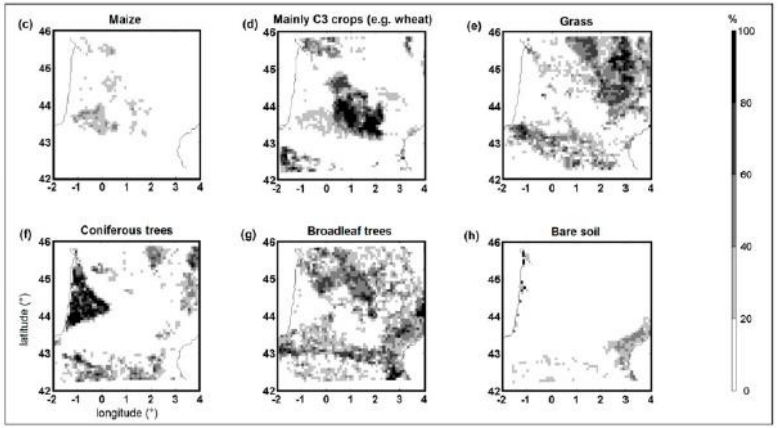
Decharme et al. 2019

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

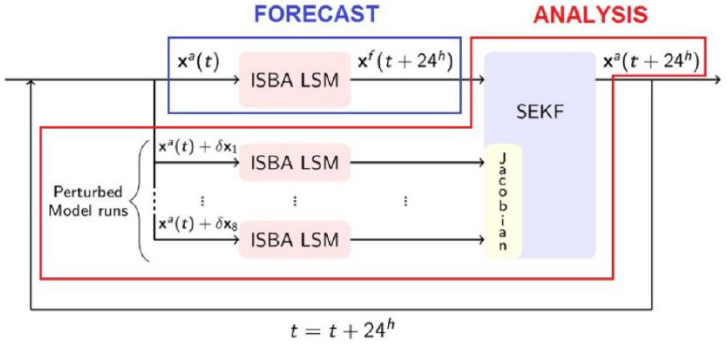




Land Data Assimilation within SURFEX

- **LDAS-Monde**

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

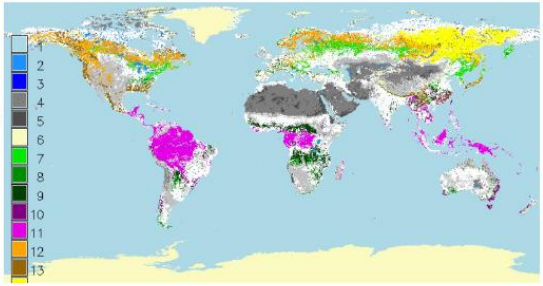


  - Integration of satellite observations into the ISBA land surface model
  - Involves the CTRIP river discharge model
  - Sequential assimilation of LAI
    - Flexible LAI thanks to photosynthesis-driven phenology
    - Root-zone soil moisture can be analysed assimilating LAI
    - Joint LAI and SM assimilation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

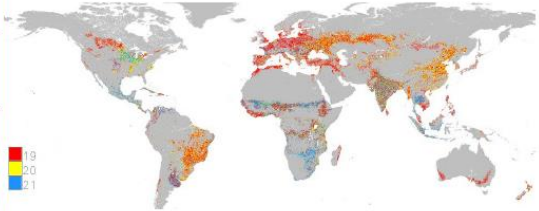
From ECOCLIMAP to ECOCLIMAP-SG

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)	
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



How do LC and SNOW uncertainties propagate?

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

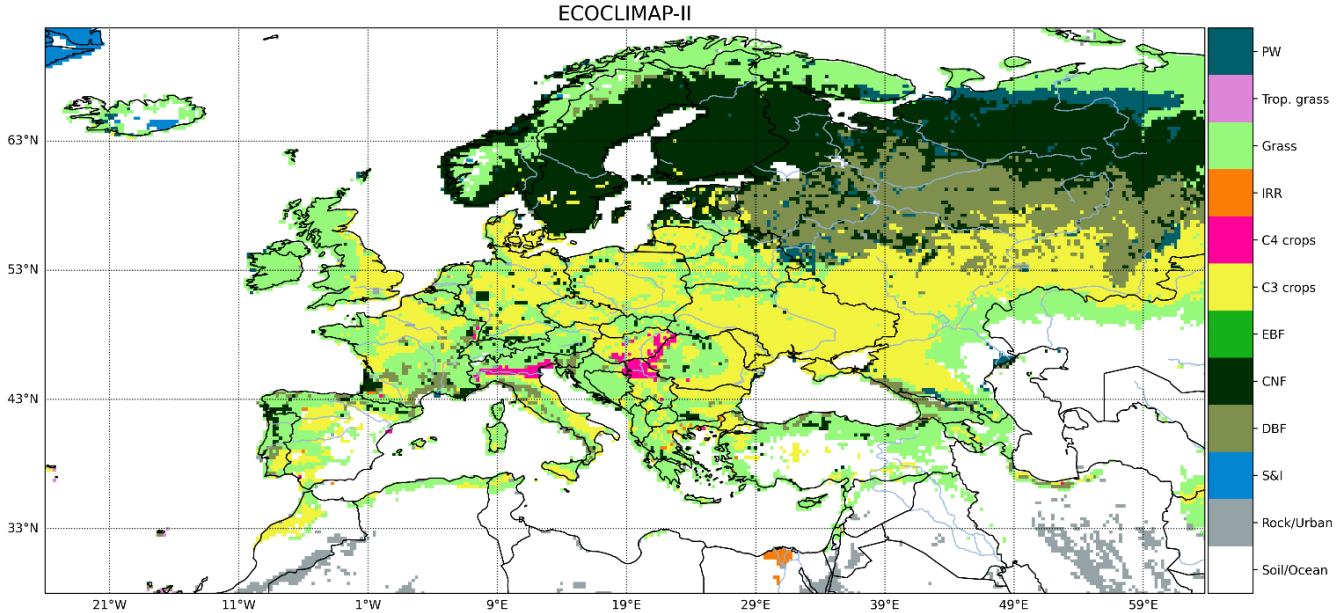
  - Eurasia 2010-2022, 0.25 x 0.25 km, ERA5 forcing
  - Experimental design
    - Open-loop with pre-existing LC
    - Open-loop with CCI LC
    - SWE assimilation with pre-existing LC
    - SWE assimilation with CCI LC.
  - Comparison of simulated LST and SM with corresponding CCI variables.
  - Products to be used
    - LC: v.1.6.1 **-> obsolete, need to switch to a newer version**
    - SNOW: SWE L3c v3.0
    - SM: COMBINED v8.1
    - LST: v2.23 AQUA_MODIS_L3C_0.05, TERRA_MODIS_L3C_0.05

Plans

- **WP5.3**
  - Open-loop with pre-existing LC and with LC-CCI
    … **done but needs to be updated with new LC data**
  - SWE assimilation experiments and SM and LST benchmarking
    … **SWE DA is being reactivated**
    … **all should be ready before March 2025**

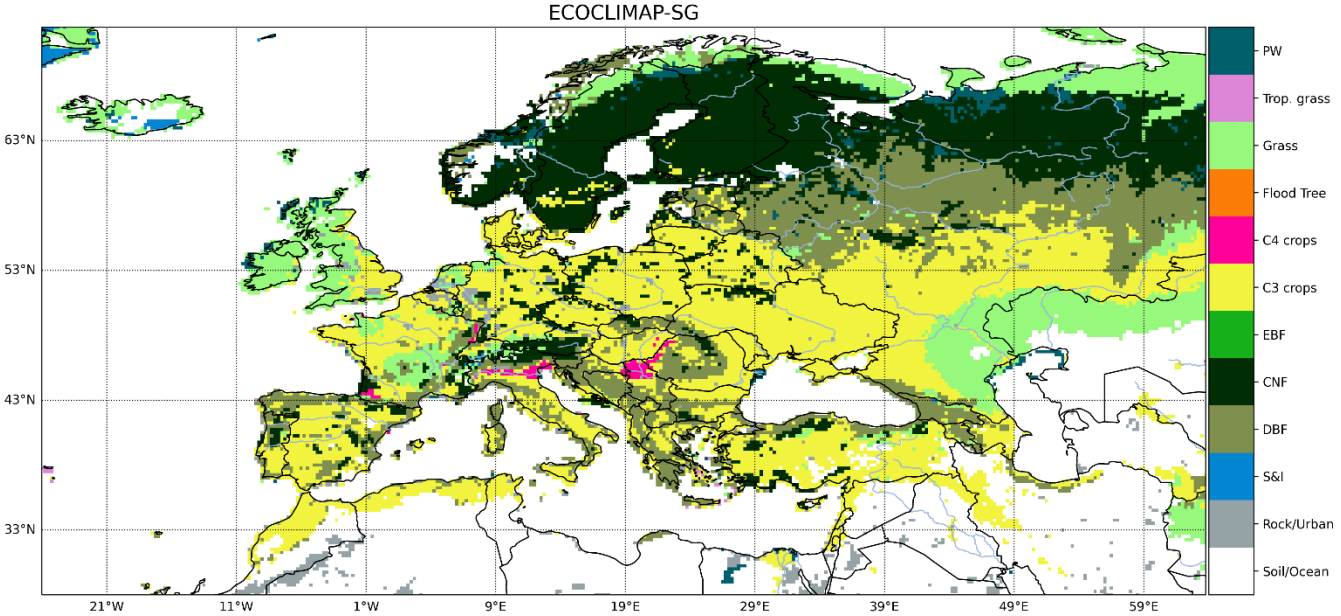
ECOCLIMAP-SG vs. ECOCLIMAP-II

- **ECOCLIMAP-II (without LC-CCI)**



ECOCLIMAP-SG vs. ECOCLIMAP-II

- **ECOCLIMAP-SG (with LC-CCI v1)**



Less bare soil

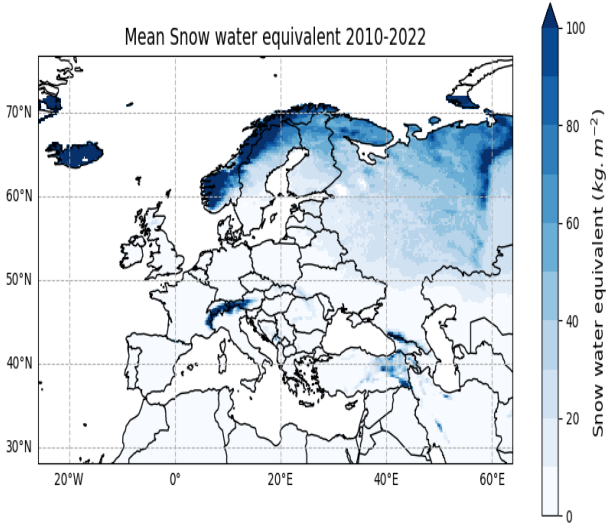
Less grasslands

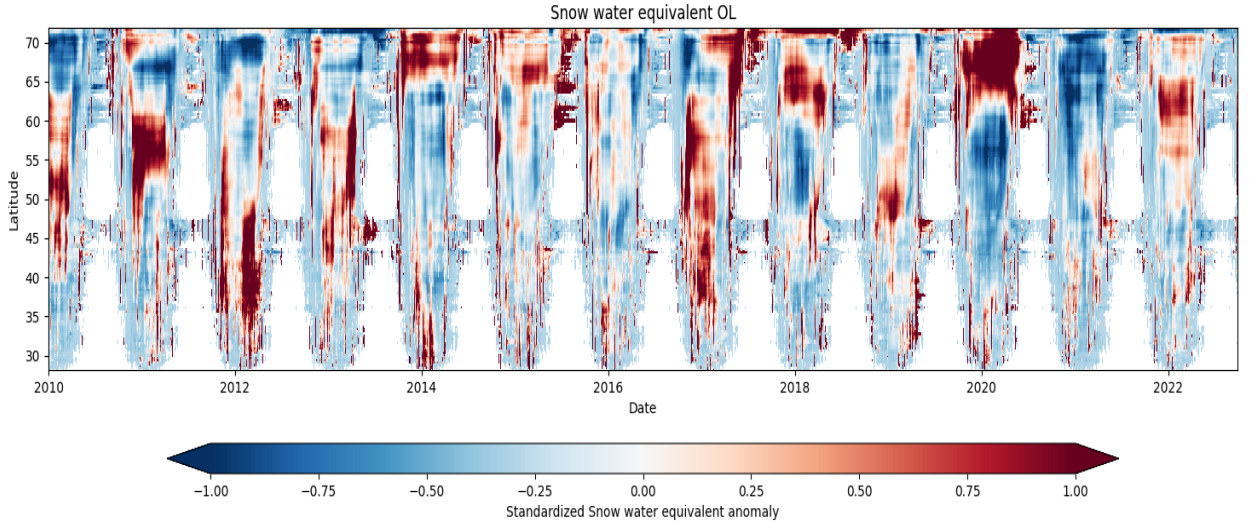
More crops

More forests

ECOCLIMAP-II OL results

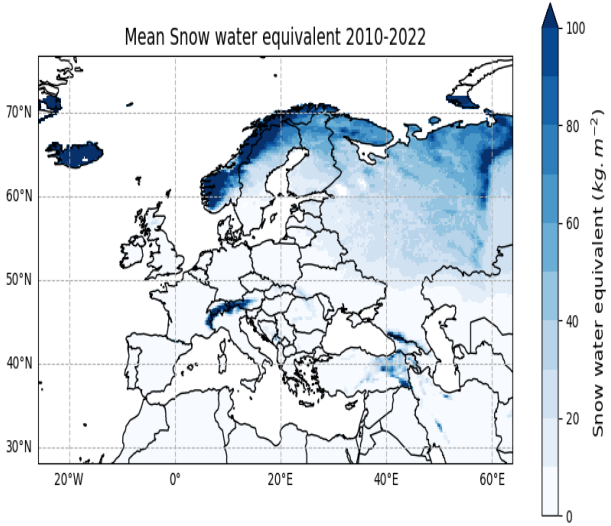
- **SWE**

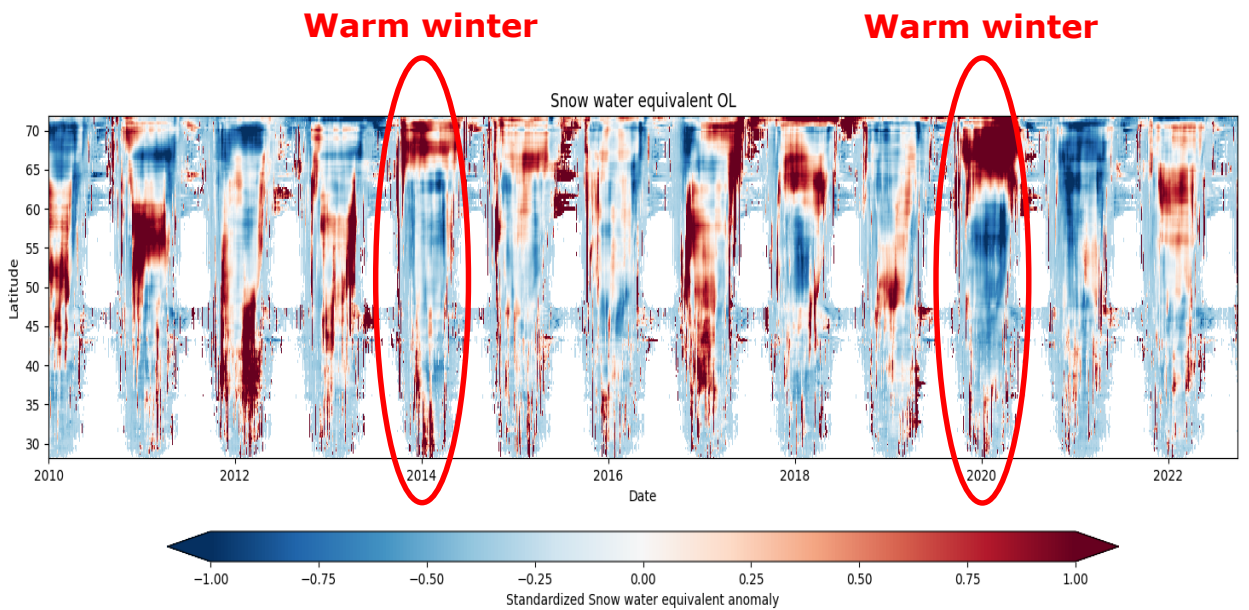




ECOCLIMAP-II OL results

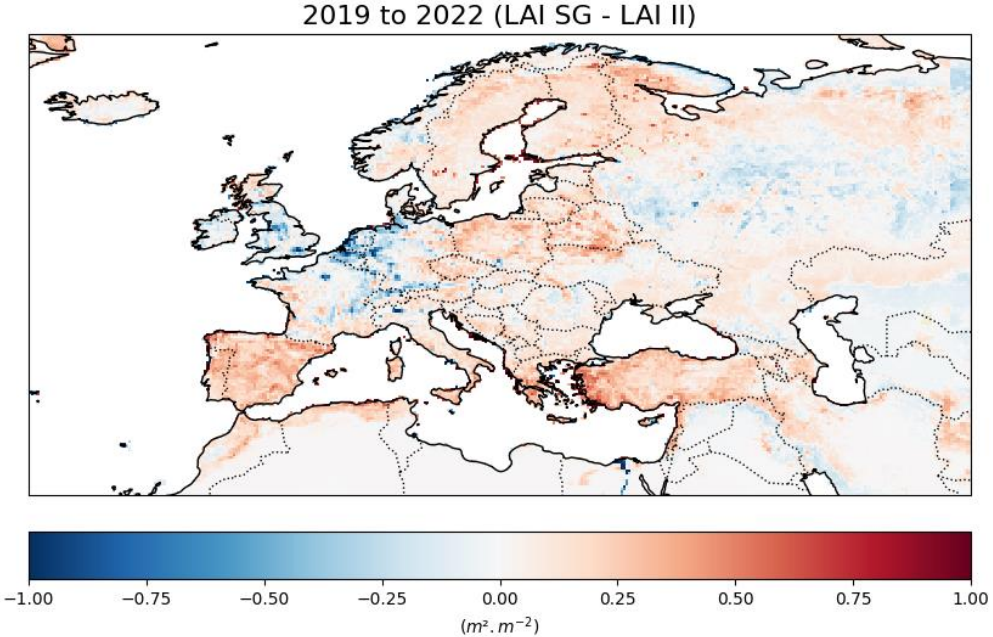
- **SWE**





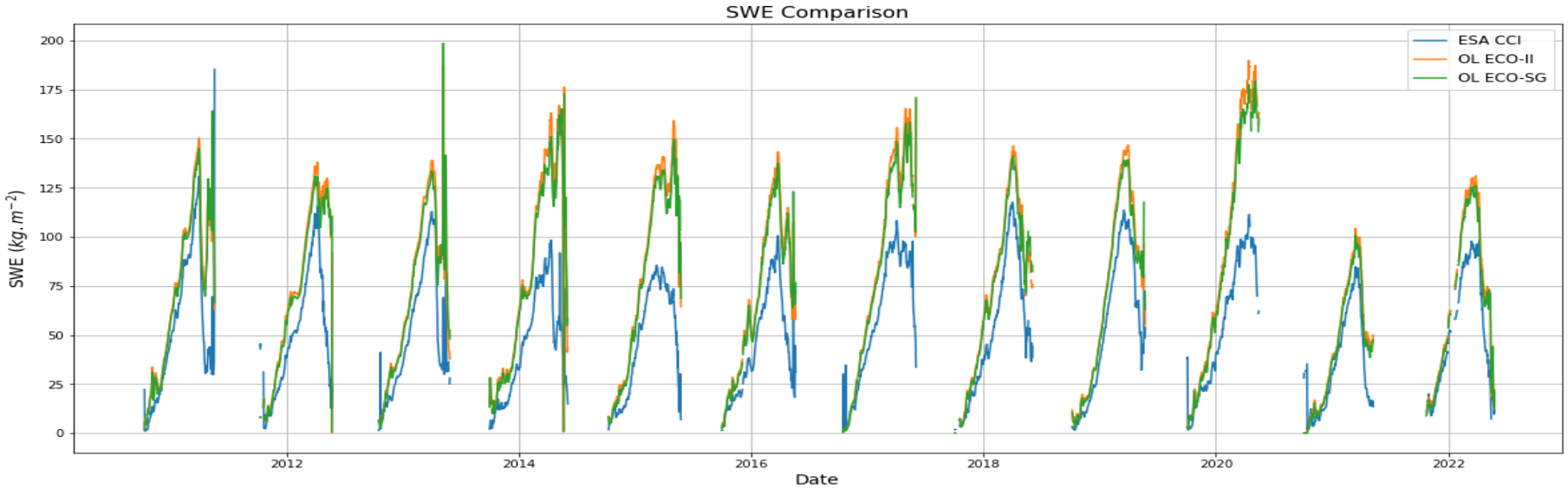
ECOCLIMAP-SG vs. ECOCLIMAP-II

- **Effect of LC-CCI on vegetation (simulated LAI)**



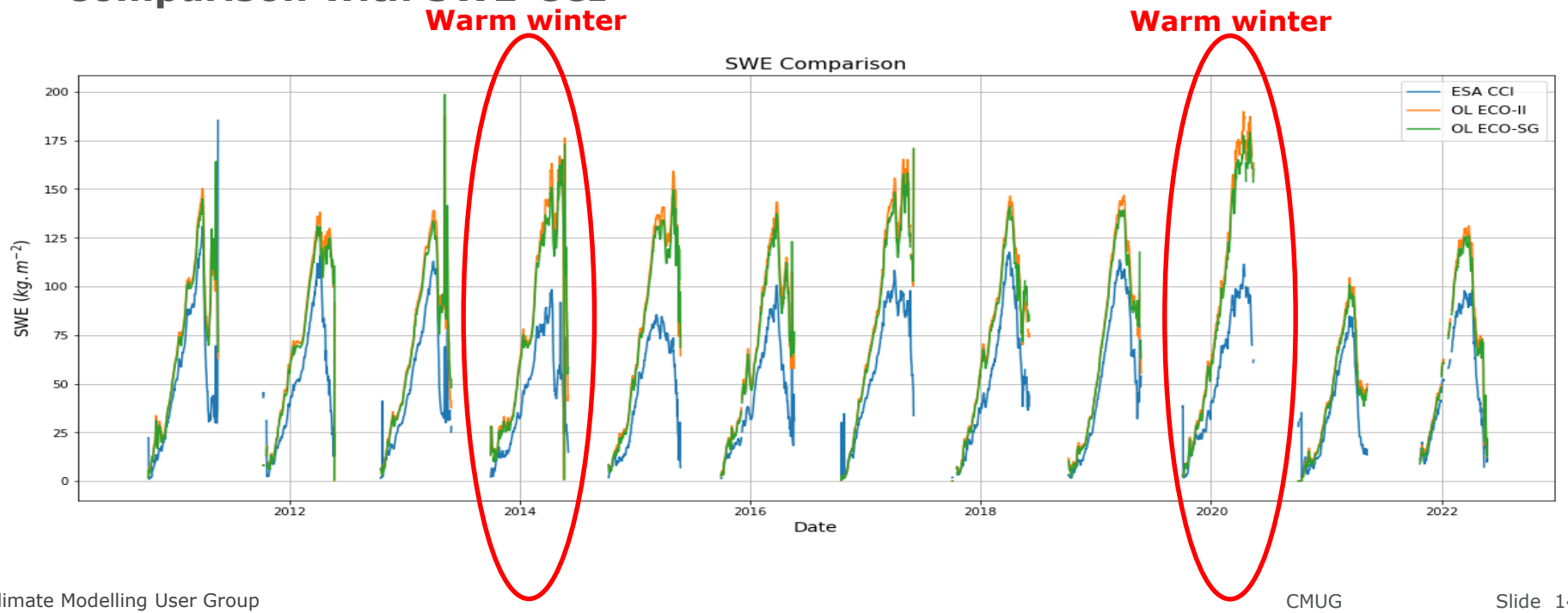
ECOCLIMAP-SG vs. ECOCLIMAP-II

- **Comparison with SWE-CCI**



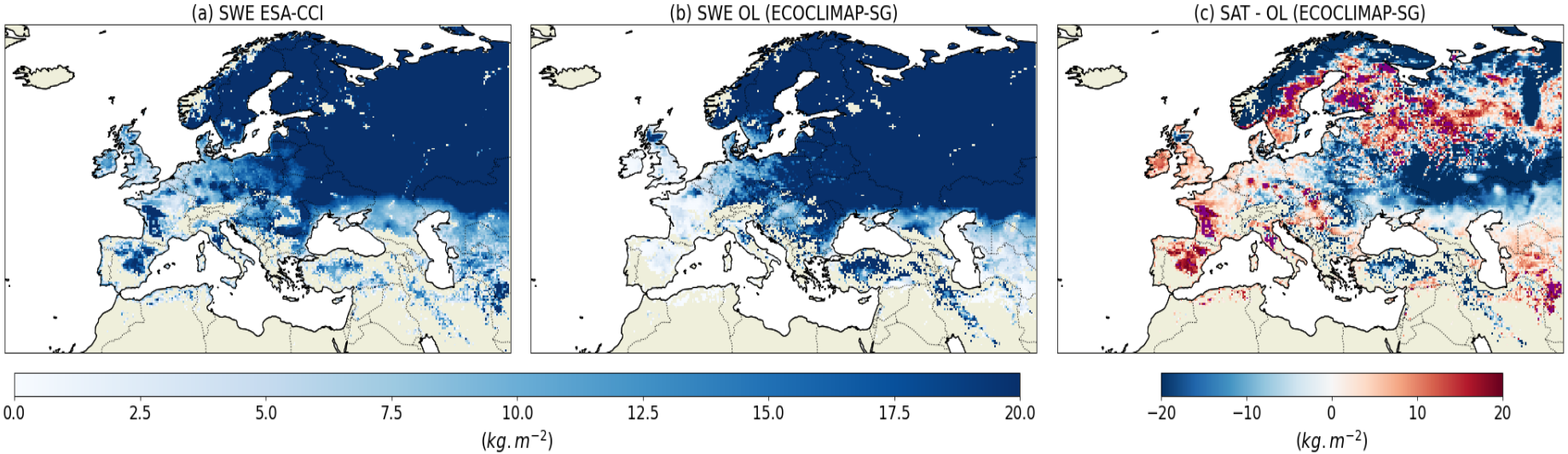
ECOCLIMAP-SG vs. ECOCLIMAP-II

- **Comparison with SWE-CCI**



ECOCLIMAP-SG vs. ECOCLIMAP-II

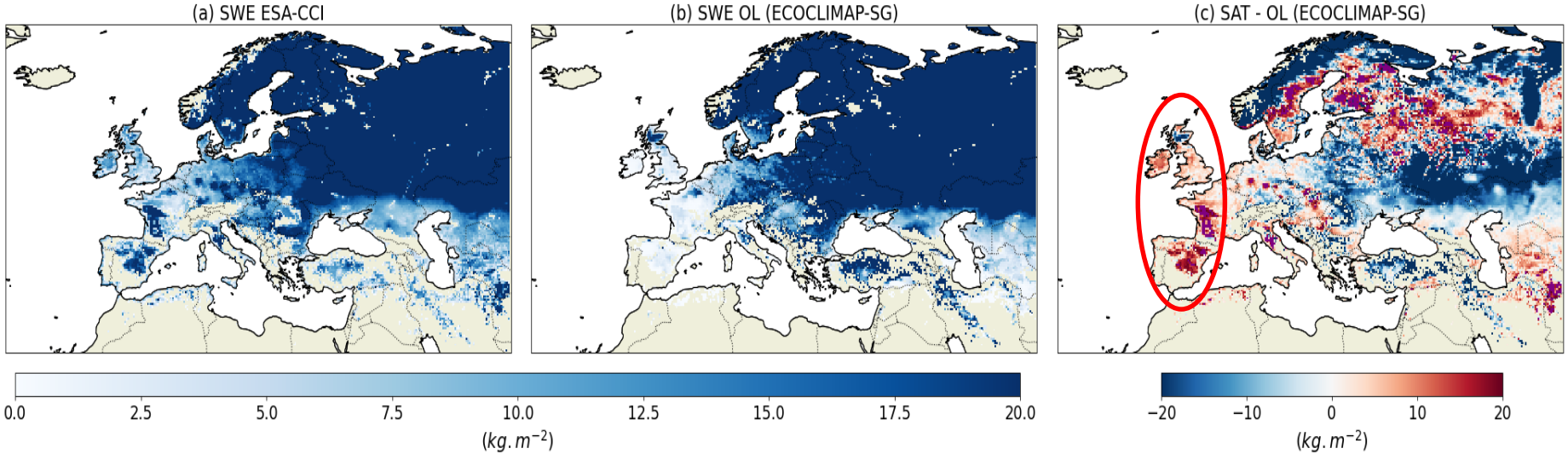
- **Comparison with SWE-CCI**



ECOCLIMAP-SG vs. ECOCLIMAP-II

- **Comparison with SWE-CCI**

SWE-CCI too large over western Europe?



Conclusions

- The inclusion of LC-CCI in SURFEX has a major impact on SWE simulations by the ISBA model
  - More crops and forests, less grasslands

- OL simulations were made and comparison with SWE-CCI initiated
  - Marked model-CCI SWE difference
    - during 2013-2014 and 2019-2020 « warm winters » at mid-latitudes
    - over Ukraine and southern Russia
    - over western Europe (overestimation of SWE by CCI?)
  - Reduced model-CCI SWE difference by LC update over Scandinavia and the Oural

- Work in progress:
  - Use of LC-CCI v2 (simulation is running)
  - Assimilation of SWE-CCI
  - Comparison with LST-CCI, SM-CCI

Prospects

- Assimilation of LAI using LST diurnal cycle as a benchmark
  - A region TbD in Eurasia 2010-2019, 0.25 x 0.25 km
  - Experimental design
    - LAI assimilation with CCI LC.
  - Comparison of simulated LAI with corresponding CCI LAI.
  - Products to be used
    - LAI: should be available in 2024
    - LST GEO product: should be available in 2024

Prospects

- Assimilation of BIOMASS-CCI data

CORSO
CO2MVS Research on Supplementary Observations

Co-funded by the European Union

Thank you for your attention