climate change initiative

→ HIGH RESOLUTION LAND COVER

CCI+ High Resolution Land Cover ECV

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high resolution land cover cci

Objectives

- ✓ Large amount of activity developed in CCI Medium Resolution Land Cover (MRLC) project with **products at 300m resolution.**

- ✓ CCI+ HRLC aims at improving the understanding of the interaction between climate and land cover **increasing the spatial resolution of 1 order of magnitude (from 300m to 10-30m).**

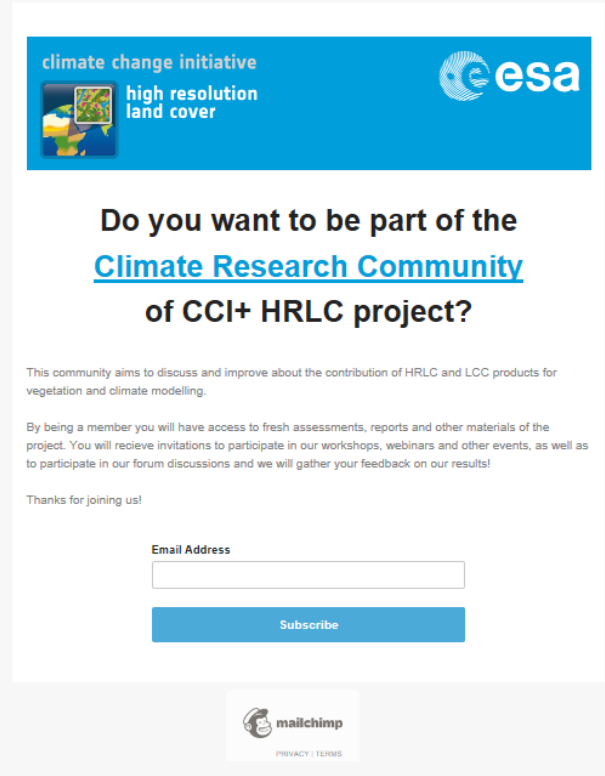
- ✓ The primary objectives are:
  - Examining the **role of the spatial resolution** to support climate research;
  - Studying LCC in key regions exposed to **extreme climate conditions** or characterized by **significant climate changes** over the last decades;
  - Understanding **classification variability across spatio-temporal scales**.

User Requirements Collection

- ✓ The involvement of Climate Research Community in the definition of the user requirements is crucial.

- ✓ The first planned activities are:
  - List potential users (climate/vegetation modellers + end users, including CMUG group);
  - Personal letter of contact with short project presentation and proposal to registration to this community:

    https://mailchi.mp/76bf36dea1a2/esaccihrlc_signup



User Requirements Collection

- ✓ Survey to registered members for collecting specific user needs and generating the user requirements:
  - Questionnaire on line to present project & preliminary UR, to collect feedbacks and potential interest to participate to product assessment;
  - Analysis of answers.
- ✓ Organization of a virtual meeting to discuss and converge on the UR (KO+4)
- ✓ Preparation of the URD (KO +6)

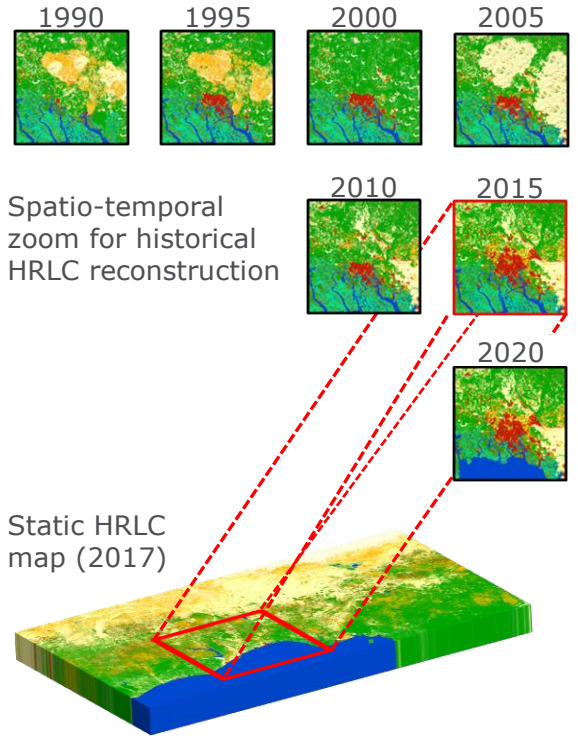
Preliminary Requirements

	GCOS	CCI+ HRLC	CLIMATE MODELLING	MITIGATION/ADAPTATION
COVERAGE AND SAMPLING				
GEOGRAPHIC COVERAGE	Key regions (w/ IPCC AFOLU)	Sub-continental and key regions	Large regional areas	Regional to local Specific products
TEMPORAL SAMPLING	5 years	5 year LC, plus annual change	5-year or higher	5-year satisfactory
TEMPORAL EXTENT	1990 - present	1990 - present	1990 (or earlier) - present	Last decade to present
RESOLUTION				
GEOMETRICAL RESOLUTION	10/30 m	10/30 m	30 m sufficient	30 m sufficient
ERROR/UNCERTAINTY				
ACCURACY-UNCERTAINTY	5% (individual classes) Location accuracy better than 1/3 IFOV	Higher accuracy than existing datasets	Sufficient to resolve mix vegetation classes at MR	Thematic LC details to distinguish land use effect

Data Products

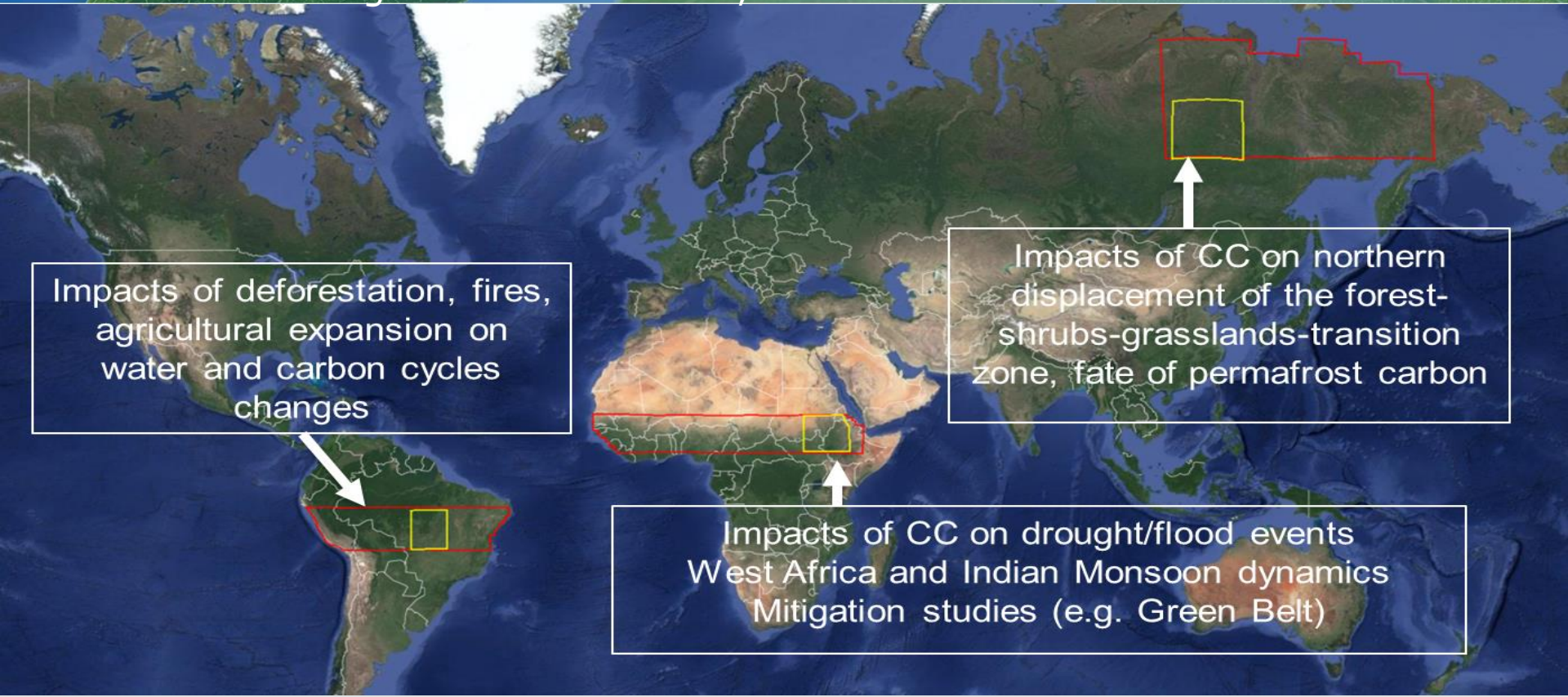
Different EO products will be generated:

- ✓ A **static HRLC** at subcontinental scale at **10m** as reference static input to the climate models.
- ✓ The **long-term record** of regional HRLC maps at **30m** in the regions identified for the historical analysis every 5 years.
- ✓ The **change** information at **30m** and **yearly scale** for supporting the updates of the HRLC maps.
- ✓ The **rescaled maps** at **intermediate** multiple **spatial resolutions**.



Challenges and model improvements

3 studied regions: African Sahel, North-Eastern Siberia and Amazon



Uncertainty

Uncertainty component	Source
Spatial Resolution Of the LC map	Effective spatial resolution
Time span of the LC map and LCC detection	Observation duration
Information Gap	Quantity of valid observations
Minimum Mapping Unit	Map specification
Precision of the LC type	Legend quality
Thematic resolution	Legend quality and algorithm discrimination capabilities
Geolocation accuracy	Image processing algorithms and EO geometric correction
LC classification accuracy	Image processing algorithms and cartographic standards

Scientific questions

- ✓ How can we **better characterize ecosystems** from LC classes ?
- ✓ How can we **better describe** and then **model subgrid variability** of surface properties? (mixed canopies, vegetation and soil spatial organisation, various plant species, land management, etc…)
- ✓ **Impacts** of sub-grid variability on **surface processes**?
- ✓ **Impacts** of LC and LCC on **atmospheric dynamics**, climate simulations and predictions?
- ✓ **Adaptation / Mitigation** strategies?

IPSL Earth System Model: LMDZ + ORCHIDEE

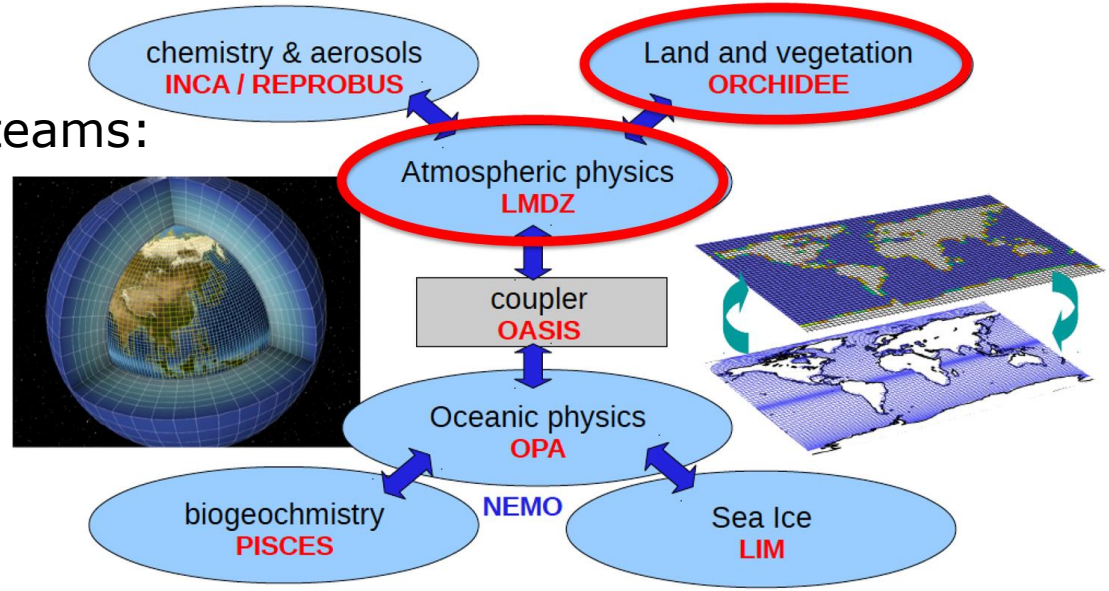
Used for CMIPs Climate simulations

Developed at IPSL by various teams:

LMD, LSCE, LOCEAN, LATMOS,

METIS, etc…

since more than 30 years



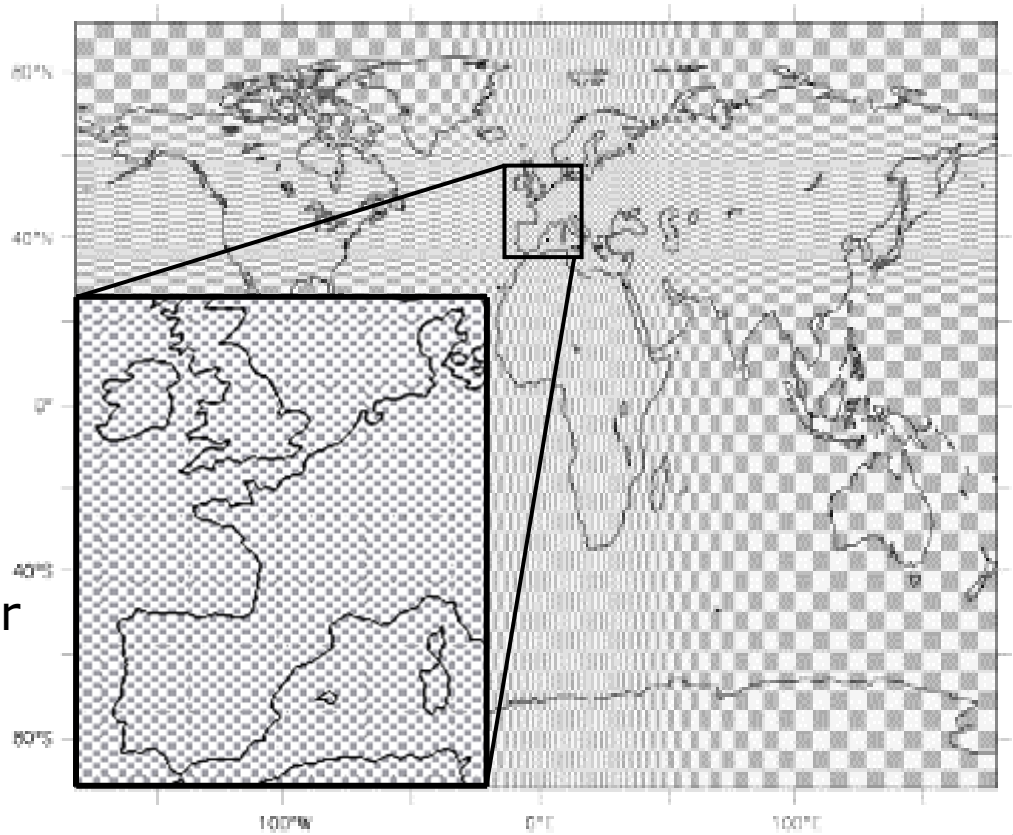
LMDZ Atmospheric Model

Zoomed and **nudged** capacities:

Up to **20km** in the zoomed area

Wind nudged to observations or reanalysis products:

→ allow to simulate **short term periods** and represent real atmospheric situations as particular heat waves



ORCHIDEE Land Surface Model

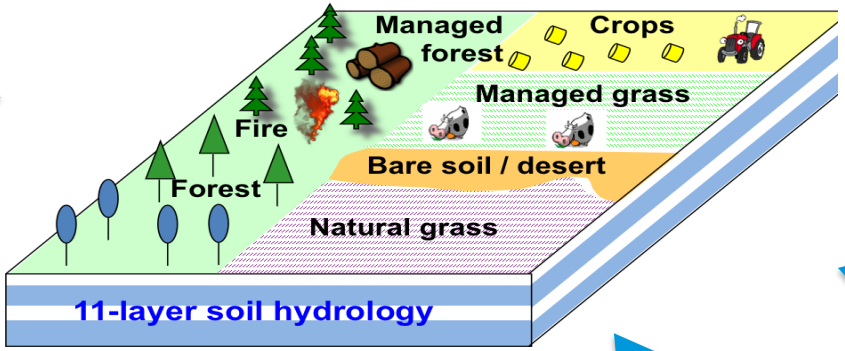
Nitrogen cycle

Forest Management

Fires

Temperate Crops

Arctic processes (permafrosts, methane emissions)



PASIM

grassland

Arctic PFTs (mosses, lichens)

Natural & anthropogenic vegetation to study climate adaptation/mitigation

ORCHIDEE Model Planned Improvements

Surface processes representation:

- ✓ Improve radiative transfer for forests (**gap fraction**)
- ✓ Improve **surface roughness** characterization according to vegetation height and spatial organisation (image processing via textural indices)
- ✓ Calibrate **phenological parameters** with Vegetation Indices
- ✓ Combine **Vegetation – Topography – Albedo and Snow** extent data to improve snow modelling
- ✓ Improve the **coherence of soil and vegetation** properties inside a grid
- ✓ Improve **shrubs** representation

Land cover description

- ✓ Translation of LC classes into PFT, **refining the Cross Walking Table** thanks to the better classification of mixed and mosaic classes and better estimation of bare soil fractions, split the PFT classes regionnally

- ✓ Move to the **concept of Ecosystem Functional Types** (EFT) to better characterize ORCHIDEE:
  - Groups ecosystems that share functional characteristics in relation with the amount and timing of the exchanges of matter and energy between the biota and the physical environment, with a specific and coordinated response to environmental factors and global changes.
  - EFT description based on C gain dynamics (primary production, seasonality and phenology) -> satellite-derived variables

Product assessment

- ✓ Protocol of experiments based on the **comparison of MRLC and HRLC** inputs.
- ✓ **Different types of experiments**:
  - forced mode
  - coupled with the atmosphere
  - with static LC map
  - with updated yearly maps
  - with standard (based on MRLC) and refined parameterizations (based on HRLC)
- ✓ **Objectives:**
  - to assess the contribution of HR+MR/MR products
  - to assess the contribution of LCC products
  - to better understand the climate/surface interactions

ECMWF Reanalysis Data Needs

The data needs of Climate Research Group of HR_LCC for ECMWF reanalysis data are basically:

- Higher spatial resolution.

  In situ observations of climate variables, topograhic variables and remote sensing products are increasing their spatial resolution.

  The increase of spatial resolution of data reanalysis will improve the local understanding of climate and land cover interconnections.

- Spatialized uncertainty on the outcomes standards, OGC compliance.

  Example: QualityML (+ info: OGC Testbed-13: Data Quality Specification Engineering Report http://docs.opengeospatial.org/per/17-018.html)

- Bias corrected (precipitation / radiation) reanalysis products

CCI-relevant meetings

- CCI Co-location

  Oxford, 2019

- ESA Living Planet

  Milan, 13-17 May 2019

- EGU General Assembly

  Vienna 7-12 April 2019

- SPIE Remote Sensing

  Strasbourg 9-12 September 2019

Needs for ECMWF Reanalysis Data

Meteorological reanalysis can not be used directly to force climate models, because of precipitation/radiation biases. Necessary to correct them with climatological data.

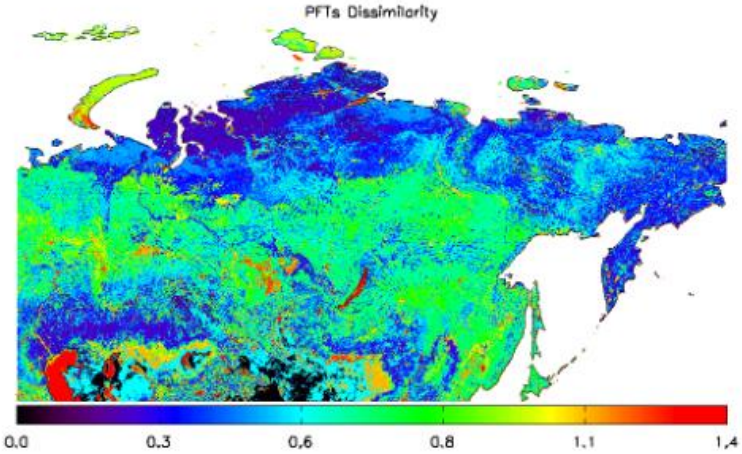
- Various Reanalysis products: ERA, , NCEP, JRA, MERRA
- Various climatological products (at different temporal and spatial scales): CRU, GPCP, TRMM,

→ Various climate forcing data: WATCH, WFDEI, NCEP-CRU, JRA-CRU, GSWP, Princeton, etc..

Maps of PFT and EFTs

Plant Functional Types (PFTs) summarise the complexity of individual species and populations in recurrent patterns of plants that exhibit similar responses to biophysical environmental conditions.

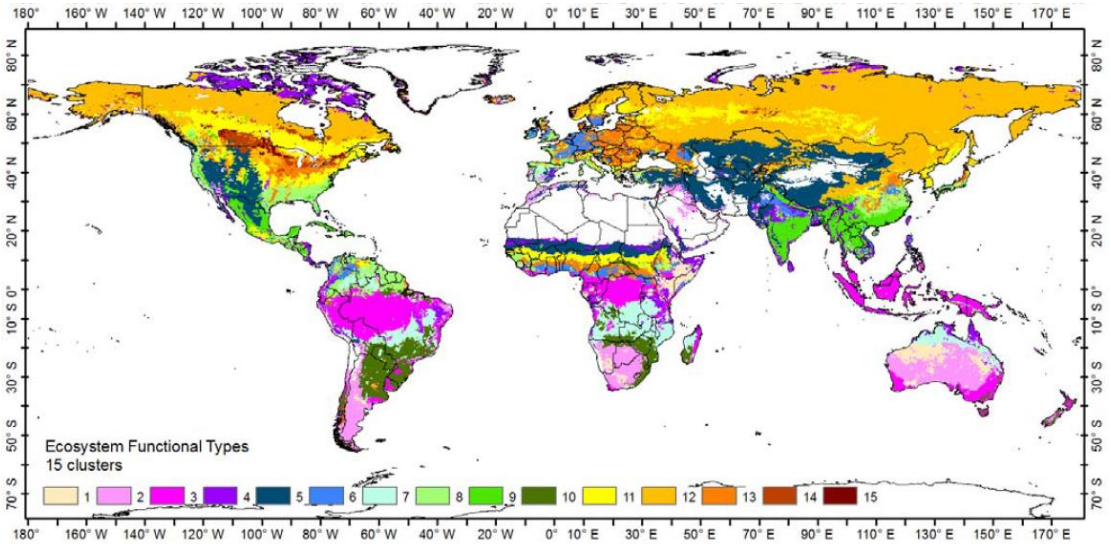
Ecosystem Functional Types (EFTs) are defined as groups of ecosystems or patches of the land surface that share similar dynamics of matter and energy exchanges between the biota and the physical environment



Ottlé, C. *et al.* (2013). Use of various remote sensing land cover products for plant functional type mapping over Siberia. Earth System Science Data. 5. 331-348.

Data Production

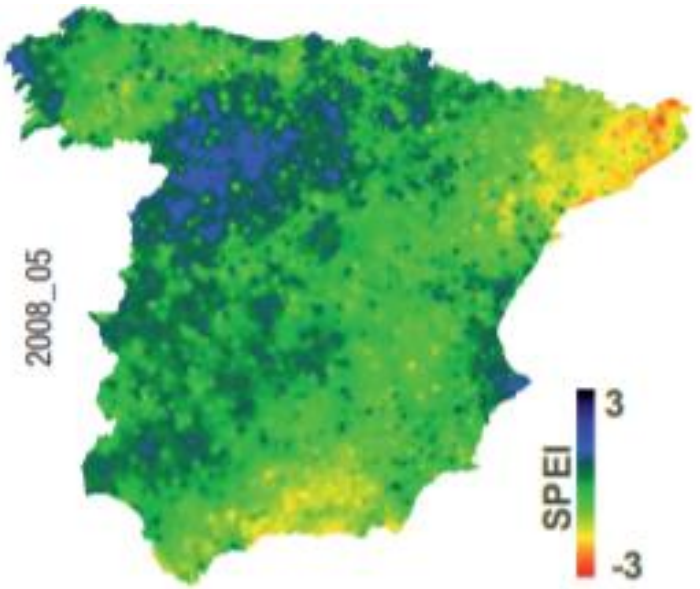
EFTs categories identification, directly generated from remote sensing products (vegetation indices, surface reflectance classification, etc. depending on the method) will improve by HR products.



Ivits *et al*.(2013) Global Biogeographical Pattern of Ecosystem Functional Types Derived From Earth Observation Data

Data Production

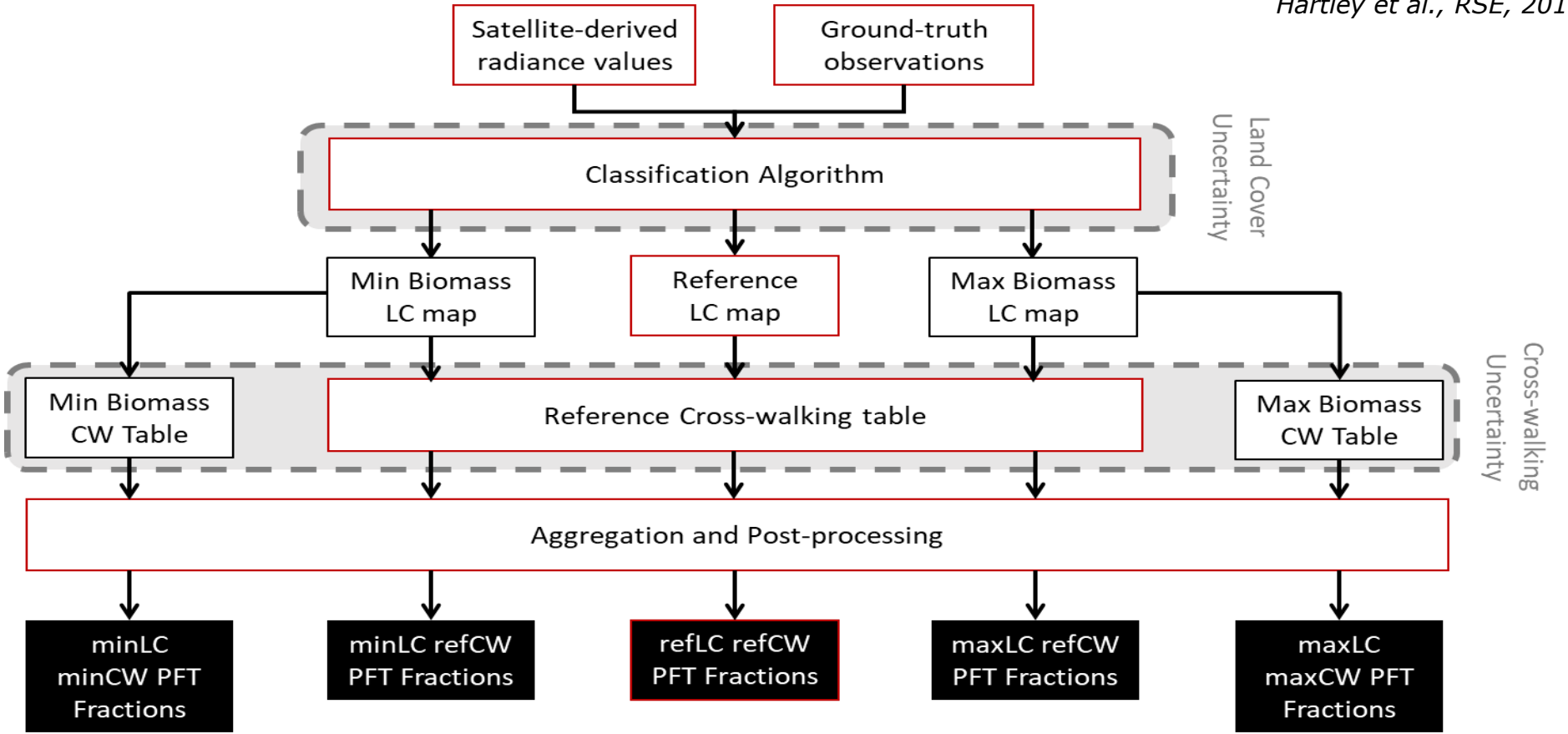
Drought indices: generation of Standardized Precipitation Index (SPI) and SPEI (+Evapotranspiration) indices in a simulation experiment for an additional validation of LMDZ outputs.



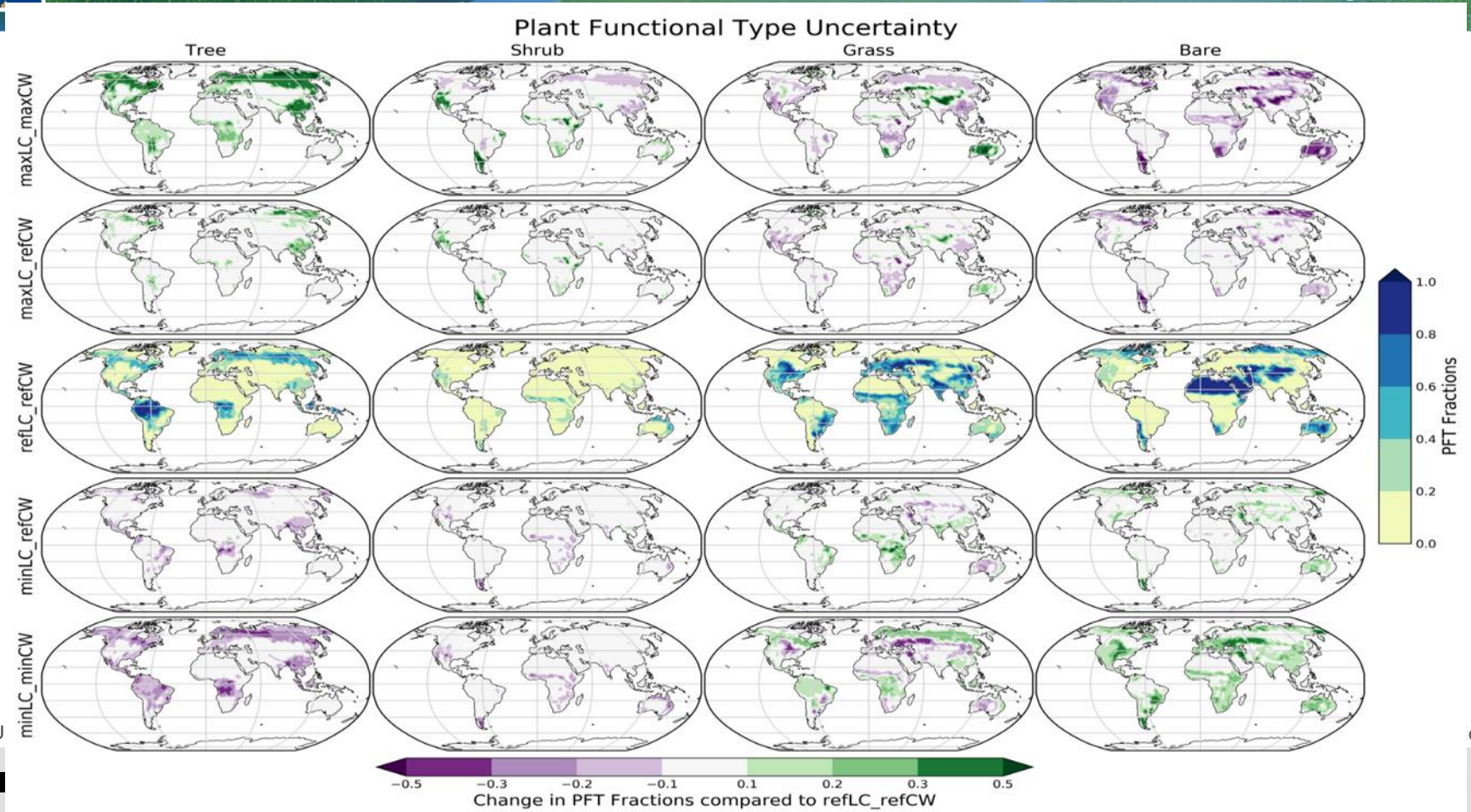
Landscape pattern metrics, forests gap spatial distribution and entropy analysis. Maps for a spatial representation of disturbance regimes (fragmentation, forest recovery and forest expansion).

Land Cover to PFT Uncertainties (MRLC Approach)

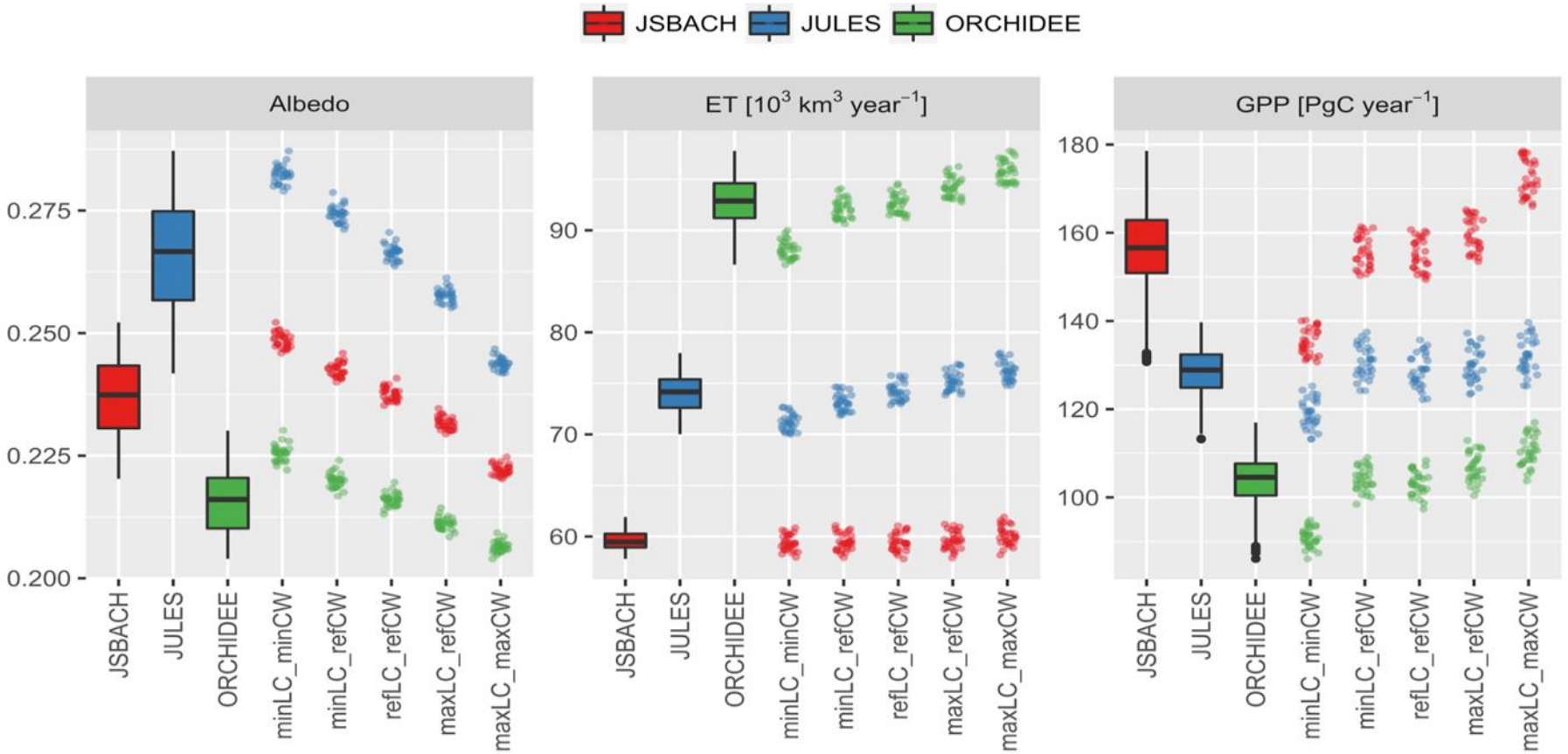
Hartley et al., RSE, 2017



PFT Uncertainty Maps



Impacts on LSM State Variables: Inter-annual and Model Variability

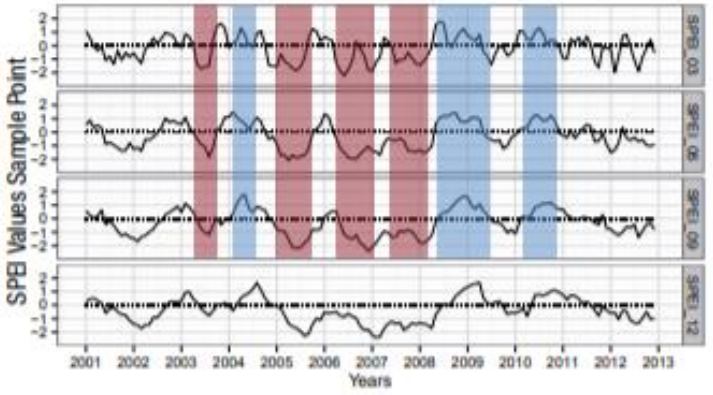


Simulation experiments

- ✓ **Zoomed-Nudged** configurations for the 3 regions (20 km resolution in the center)
  - 3 decades **(1990-2017)**
  - Starting from Africa, Amazonia and Siberia

- ✓ **Validation with local and satellite observations** (fluxes stations, soil moisture, evapotranspiration, LST products, stream flows …)

- ✓ **Validation via drought indices** from:
  - outputs of LMDZ model
  - reanalysis by ECMWF
  - focused in African Sahel



Overall Climate Science Assessment

- ✓ **Strategy:**
  - communication to the climate modeling community
  - motivate other teams to use the HRLC products
  - share tools / data to facilitate their involvement
  - intercompare results
  - links to the other CCI teams (Biomass, LST, Fire, Permafrost, Glaciers…)
- ✓ **Workshops:**
  - 1st Users virtual meeting (T0+3): refining URD
  - 2d Users virtual meeting (T0+18): organize the intercomparison
  - Final Climate users meeting (T0+33): results presentation and recommandations
- ✓ **Outcomes:** Production of the Climate Assessment Report and a white paper summarizing the climate community view