CMUG Work Packages

Task 4: CCI contributions to ESMValTool

Earth System Model Evaluation Tool

① Update/extend existing CCIs Implement new CCIs

- aerosol cci
- biomass cci
- cloud cci
- land cover cci
- land surface temperature cci
- permafrost cci
- snow cci
- soil moisture cci
- sst cci
- water vapour cci

② Implementation of uncertainty information

- Implement available **uncertainty information** into the ESMValTool (technical)
- Investigate possibilities to **propagate uncertainty information** to the spatial and temporal scales used by global models
- **Starting point:** work done on implementing uncertainty information for the CCI LAND SURFACE TEMPERATURE (Mittaz et al., 2019)

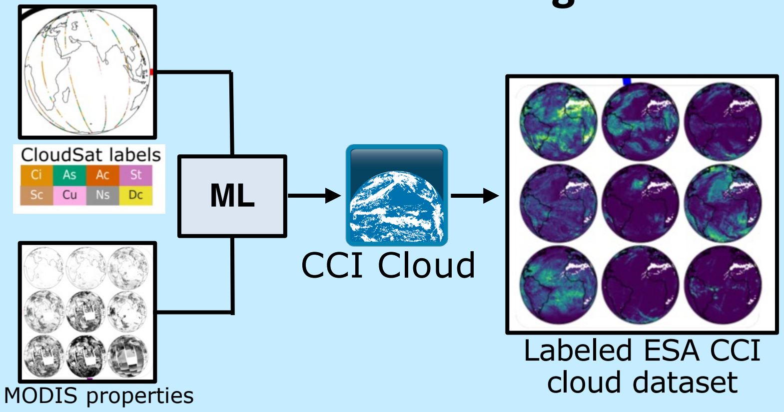
Key personell

- **DLR**
  Axel Lauer
- **Met Office**
  Rob King
- **Univ. Reading**
  Claire Bulgin

WP5.1 Machine learning to advance climate model evaluation and process understanding

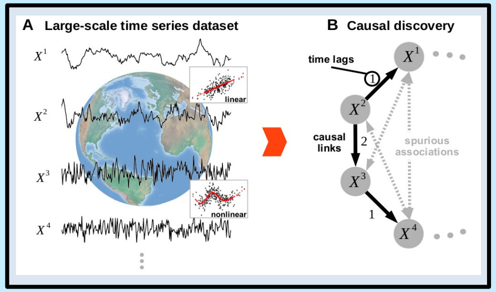
Lisa Bock, Axel Lauer and Veronika Eyring

WP5.1.1
Enhancing observational products for climate model evaluation with machine learning



- → Developing ML-based approach to derive cloud classes from coarse-scale datasets
- → Application of NN: timeseries of labelled ESA CCI Cloud data
- → Evaluation of climate models

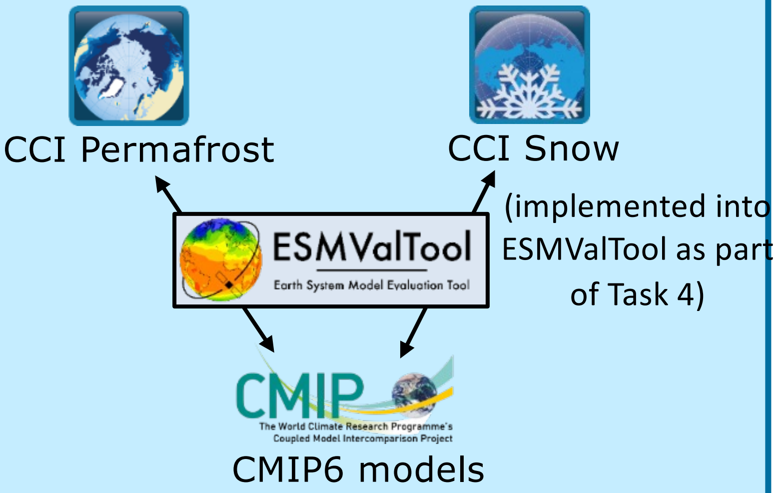
WP5.1.2
Causal model evaluation for cloud regimes and land cover types



Causal inference (Runge et al., 2019)

- → Investigate the causal connections among the cloud properties and their controlling factors (in ESA CCI data)
- → Evaluation of global climate models

WP5.1.3
Evaluation of CMIP6 models with the ESMValTool



- → Evaluation of CMIP6 models
- → Investigate use of uncertainty information

CMUG Phase 2 – WP5.2: Impacts and evaluation of vegetation phenology changes on observed and modelled land-atmosphere processes.

Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)

Task 5.2.1

Testing and feedback on preliminary LAI datasets

Vegetation CCI LAI and FAPAR

CMUG team

In the development phase of the CCI Vegetation and **interaction** with the CMUG team will provide **testing** and **feedback** on preliminary LAI and FAPAR data.

Task 5.2.2

Analyses of relationships between phenology and land-atmosphere processes

Snow

LAI and FAPAR

Land cover

Water vapour

biomass

soil moisture

Land surface temperature

ERA5
FluxNet
CMIP6

In this tasks, the **CMUG team** will:

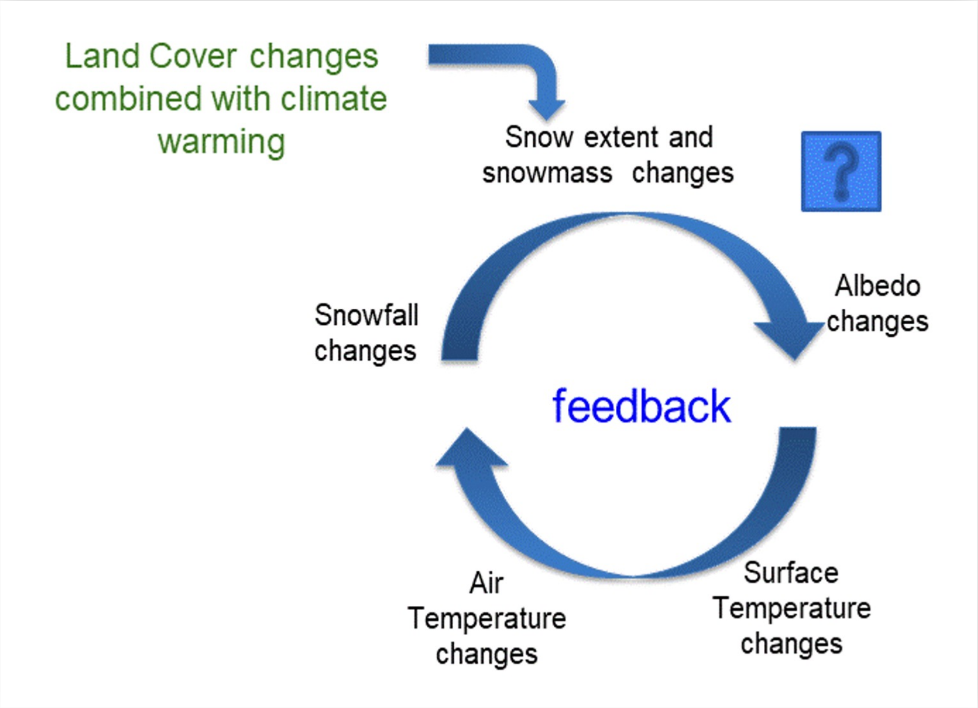
- ➢ define a core set of **phenology indicators** at global and habitat scale;
- ➢ Quantify the influence of phenology on **land-atmosphere** interactions;
- ➢ **Compare** with model and observed values.

Snow dynamics impacts on temperate / high latitude climate

Objective: Improve our understanding and modelling of snow-vegetation-atmosphere feedback, with the IPSL climate model and CCI products (i.e. Snow, LC,..)

IPSL (P. Peylin, C. Ottlé, F. Chéruy)

Potential feedback loop induced by land cover and albedo changes



Planned work

1. **Data Analysis**

   Consistency analysis btw Snow Cover (mass & extent) and LC dynamics & other products (LST, Fire, Biomass, Albedo)

2. **ORCHIDEE model evaluation**
3. **Model developments**

   Shrubs – Snow interactions (parallel developments)

4. **Snow parameters calibration**

   Multi-site Bayesian calibration

5. **Coupled model simulations**

   LMDZ-ORC historical simulations (prescribed SST)

ESA CCI data assimilation impact on seasonal predictability of ocean biogeochemistry

- WP1: Assimilation of ESA CCI variables (SST, Sea Ice, SSS, Sea Level, Ocean Color) to produce reconstructions
  - Subtask 1.1: assimilate only physical CCI variables
  - Subtask 1.2: assimilate physical and biogeochemical CCI variables

- WP2: Impact of assimilation choices of these reconstructions on physical and biogeochemical properties
  - Subtask 2.1: evaluate physical properties of reconstructions
  - Subtask 2.2: identify best strategy to reconstruct ocean biogeochemistry

- [Option, unfunded] WP3: Impact of assimilation choices of these reconstructions on seasonal predictions
  - Subtask 3.1: production of seasonal predictions
  - Subtask 3.2: evaluation of seasonal predictions (e.g., ACC, RMS Skill Score)

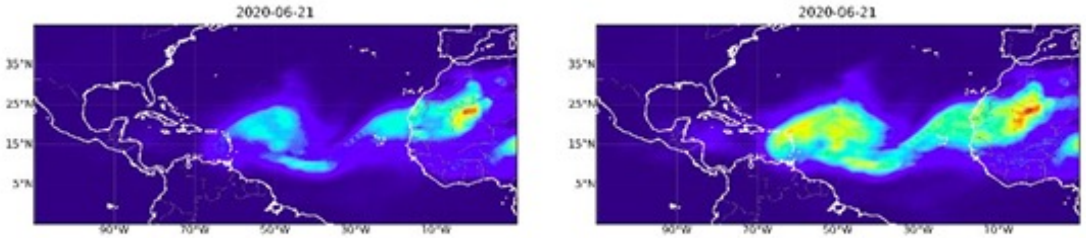
With thanks to David Ford

WP5.5 Cloud and Aerosol Analysis Study

Aerosol ECVs : Aerosol Optical Depth (Dust AOD, FM AOD, AOD)
Cloud ECVs : Cloud Optical Depth (Cloud Top Height, Cloud Fraction, Ice Water Path, Liquid Water Path)

WP5.5.1 Dust aerosol analysis with the BSC system

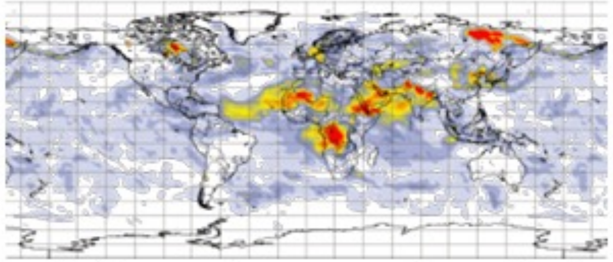
Jeronimo Escribano (**BSC**)



Constrain global **dust** aerosol simulations from the BSC MONARCH model with CCI data to produce dust analyses during the extraordinary event of June 2020.
→ Explore pixel-level uncertainties, Coarse AOD vs DOD, Comparison with DOMOS results.

WP5.5.2 Cloud/Aerosol analysis with the ECMWF system.

Angela Benedetti and Kirsti Salonen (**ECMWF**)



Joint assimilation of **aeroso**l and **cloud** ECVs in the ECMWF IFS during June 2020 and September 2021 with the IFS 4DVar scheme in CAMS configuration.
→ Impact of COD and AOD level 2 data on the 4D-Var analysis

OWP5.5 Cloud and Aerosol Analysis Validation Study:
Evaluation using the ESMValTool and internal tools at BSC/ECMWF
Soil Moisture, Water Vapour ECVs.
A. Benedetti and K. Salonen (ECMWF), Axel Lauer (**DLR**), J. Escribano (BSC)

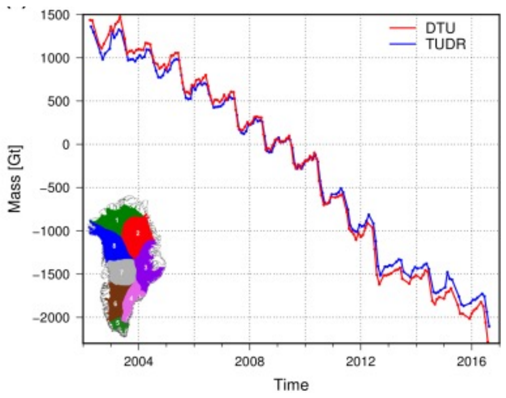
CMUG: Ice sheets and atmospheric drivers

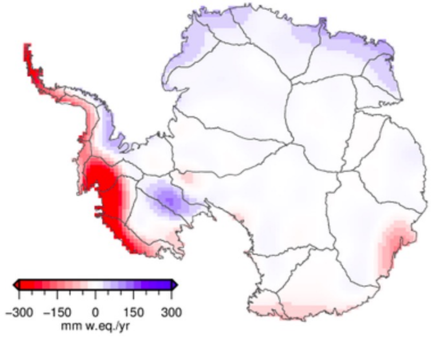
Scientific questions to be addressed:

- Can regional (global) climate models represent accurately the atmospheric and surface processes affecting the Greenland and Antarctic ice-sheets?
- Where, when and why do the surface mass (energy) balance of the models processes perform least & most well?

CCI ECV’s:

- Gravimetric Mass balance and Surface Elevation Change
- Land Surface Temperature
- Total Column Water vapour
- Cloud (fraction, ice/water path) and radiation fluxes (surface and TOA)
- *Snow on Greenland ice-free margins*





GMB_figure.png

Partners:

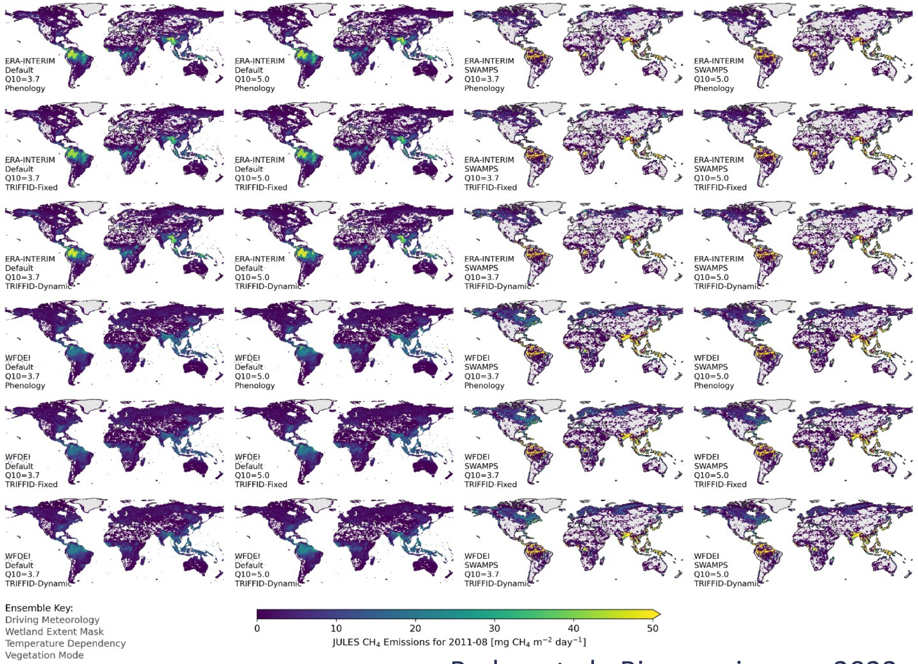
SMHI (Swedish Meteorological, Hydrological Institute) Ulrika Willén, Klaus Wyser
DMI (Danish Meteorological, Hydrological Institute) Ruth Mottram, Shuting Yang

Rob Parker | rjp23@le.ac.uk

Using Machine-Learning to Evaluate and Understand our Capability to Model Tropical Wetland Methane Emissions

- ❑ Team: Rob Parker and Cristina Ruiz Villena (NCEO-Leicester), Nic Gedney (Met Office), Paul Palmer (NCEO-Edinburgh)
- ❑ In short: We'd develop an emulator for JULES wetland methane, use it's explainability to show which factors matter in the model, drive the emulator with CCI EO data to generate wetland fluxes and compare those to a CH_4 inversions performed on GOSAT/TROPOMI ESA-CCI data.

Figure: Ensemble of JULES simulations with different driving data, temperature dependency, vegetation and wetland mask show massively different methane fluxes!



Parker et al., Biogeosciences, 2022

CCI Datasets

- ❑ GHG (methane)
- ❑ Land Surface Temperature
- ❑ Soil Moisture
- ❑ Land Cover
- ❑ + Vegetation (?)

Models

- ❑ JULES (land surface)
- ❑ GEOS-Chem (atmospheric)

National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

UKRI Natural Environment Research Council

Break out rooms

10-11am First Session:

- Room 1 = WP5.1 Machine learning for process understanding (moon room)

Cloud, SST, WV, LST, SM, LC, Snow, Permafrost

- Room 2 = WP5.8 Machine learning for wetland methane emissions (mars room)

GHG, SM, LST, LC

11:00 Coffee break 30'

11:30-12:30 Second Session:

- Room 1 = WP5.3 Land cover (moon room)

LC, Snow, SM, LST

- Room 2 = WP5.6 Snow dynamics (mars room)

Snow, LC, Fire, AGB

- Room 3 = WP5.7 Ice sheets (ECSAT 243)

AIS, GIS, LST, WV, cloud

- Room 4 = Drop in for ESMValTool demo (ECSAT A013)

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- Room 4 = Drop in for ESMValTool demo (ECSAT A013)