

## What is CMUG?

CMUG is the Climate Modelling User Group, set up by ESA to facilitate communication between the providers of the CCI ECV datasets and the climate modelling, research and service communities. CMUG provides feedback in the form of user requirements and assessments of the ECV datasets to ESA's CCI projects and carries out research on the effectiveness of the ECVs when used in climate modelling. The diagram to the top right shows CMUG's objectives, to the middle right CMUG's project structure, and to the bottom right CMUG's partner institutes.

## Evolution of Obs4MIPs



Obs4MIPs for Model Intercomparisons Project refers to a limited collection of documented datasets that have been formatted according to the Coupled Model Intercomparison Project (CMIP) model output requirements and made available on the Earth System Grid Federation (ESGF). This effort was initiated with support

from NASA and the U.S. Department of Energy (DOE) and has now expanded to include contributions from a broader community including ESA. Obs4MIPs underpins model evaluation in CMIP (and beyond) and thus makes a significant contribution to the assessment of and sustained improvement in model quality, e.g., as reported by IPCC.

## ESMValTool

The Earth System Model Evaluation Tool (ESMValTool) is an open-source community-developed diagnostics and performance metrics tool for the evaluation and analysis of Earth System Models (ESMs). ESMValTool allows for a comparison of

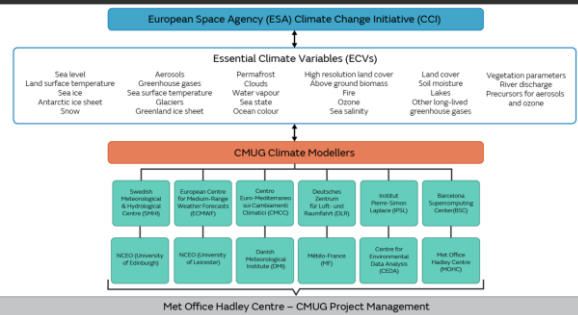
single or multiple models against predecessor versions and observations. The aim of the ESMValTool is to take model evaluation to the next level by facilitating analysis of many different ESM components, providing well-documented source code and scientific background of implemented diagnostics.



## CMUG Objectives

1. Support integration within the CCI programme
  - Through requirements and user assessment from data users
  - Through feedback from a "climate system" perspective
2. Foster the exploitation of satellite-derived Essential Climate Variables (ECVs)
  - By promoting the use of CCI datasets to climate modellers
  - By building partnership and links with the climate modelling community
  - By working to include CCI data in standard databases and tools
3. Assess quality and impact of individual/combined CCI ECVs in climate research and data assimilation contexts
  - By assessing suitability of products for climate applications (e.g. climate modelling, decadal prediction, reanalysis, etc)
  - By quantifying their added value on model performance in an objective manner

## Climate Modelling User Group (CMUG) Project Structure



## Scientific Studies



### WP5.1 Machine Learning

This study focuses on 1) enhancing observational products for climate model evaluation with machine learning, 2) causal model evaluation for cloud regimes and land cover types by calculating causal networks from timeseries of several cloud variables, and 3) evaluation of CMIP6 models with ESMValTool.



### WP5.3 CCI Land Cover

This study will assimilate CCI Snow Water Equivalent (SWE) in the ISBA land surface model. CCI Soil Moisture and LST products will be used as benchmarks to compare simulations.



### WP5.5 Cloud and Aerosol Analysis

This study will undertake 1) dust aerosol analysis with the BSC system, and 2) Cloud / Aerosol analysis with the ECMWF system.



### WP5.7 Ice Sheets

This study aims to address these scientific questions: 1) can regional/global climate models accurately represent the atmospheric and surface processes affecting ice-sheets? 2) do models capture variability of ECVs, and albedo and emissivity feedbacks over ice sheets? 3) where, when and why do surface mass balance of models' processes perform least and most well? 4) which ECVs show the most important biases affecting surface mass budget estimates from climate models? and 5) can metrics be used for obs-based model selection to reduce spread of ice sheet contributions to future sea level rise?



### WP5.2 Vegetation Phenology

This study will 1) provide testing and feedback on preliminary LAI and FAPAR data, and 2) analyse relationships between phenology and land-atmosphere processes.



### WP5.4 Ocean Biogeochemistry

This study will assimilate ESA CCI variables to produce forced ocean/sea-ice reconstructions. Then the impact of assimilation choices of these reconstructions on physical and biogeochemical properties will be explored.



### WP5.6 Snow Dynamics

This study aims to improve our understanding and modelling of snow-vegetation-atmosphere feedbacks, with the IPSL climate model and various CCI products (especially snow products).



### WP5.8 Tropical Wetland Methane Emissions

This study aims to develop an emulator for JULES wetland methane, use its explainability to show which factors matter in the model, drive the emulator with CCI Earth Observation data to generate wetland fluxes, and compare those to methane inversions performed on GOSAT/TROPOMI ESA CCI data.

