The ESA CCI Climate Modelling User Group

Met Office, Exeter, U.K.: Barcelona Supercomputing Centre (BSC), Barcelona, Spain: Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany: European Centre for Medium-range WeatherForecsting (ECMWF), Reading, U.K.: Institut Pierre Simon Laplace (IPSL), Paris, France: Max-Planck Institute für Meteorologie (MPI-M), Hamburg, Germany: MétéoFrance, Toulouse, France: Swedish Meteorological and Hydrological Institute (SMHI), Norköpping, Sweden

Overview

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 modeling, 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.

Figure 1 shows the CMUG structure. Some of the results from CMUG research are shown below.

Sea Ice Concentration ECV

Barcelona Supercomputer Centre have performed two sets of 30-member ensemble seasonal predictions, covering the period 1992-2018 and initialised on the first May, with and without assimilation of Sea Ice Concentrations (SIC) (from OSISAFv2) for ocean and sea ice initial conditions generation.

Figure 2 represents the reduction in the Root Mean Square Error of surface mean temperature (evaluated against ERA5) averaged across three different latitudinal bands, with positive values indicating an improvement when SIC assimilation is performed. It can be seen that assimilation leads to reduced forecast biases in all the three regions at least up to 7 forecast months.

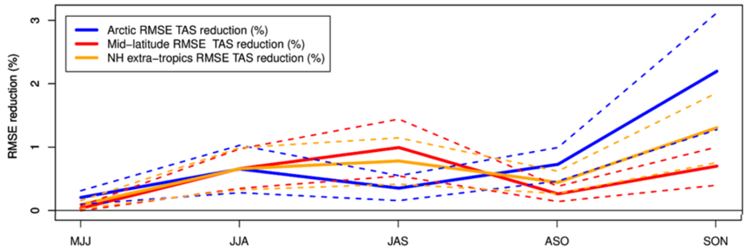
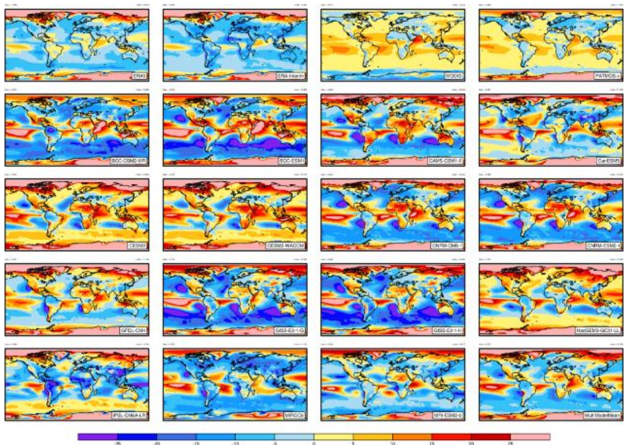


Figure 2: Reduction in RMSE of surface temperature due to assimilation of Sea Ice.

Cloud ECV

DLR compared the CCI Cloud ECV dataset with the bias in total cloud cover from a number of CMIP6 GCMs models as shown in Figures 4 and 5.



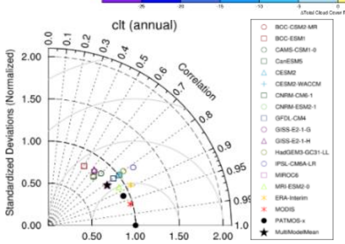


Figure 4 (top): bias in multi-year annual mean (1988-2014) total cloud cover from 15 CMIP6 models, ERA5 and ERA-Interim reanalyses and MODIS and PATMOS-x satellite observations in comparison with ESACCI-CLOUD data.

Figure 5 (bottom): Taylor diagram showing normalized standard deviation (radial distance) and linear pattern correlation (azimuthal angle) for total cloud cover compared with ESACCI-CLOUD data.

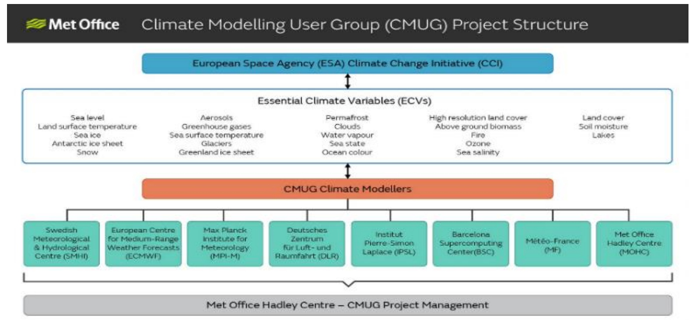


Figure 1: CMUG organisational

Ocean ECVs

The Met Office carried out research assimilating SST, sea level, ocean colour, and sea ice in reanalysis and found improvement in the representation of spatial features and variability in both physical and biogeochemical systems.

Figure 3 shows horizontal gradients in the Gulf Stream region during December 2010, for SST (left column), sea level anomaly (middle column), and surface $\log_{10}$(chlorophyll) (right column). Calculated from satellite observations (a-c), a model with no data assimilation (d-f), and assimilating SST, sea level, ocean colour, and sea ice (g-l). Reproduced from Ford (2020).

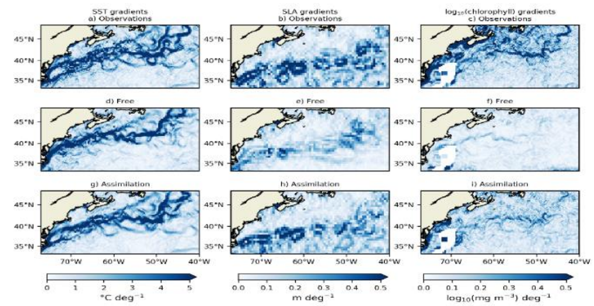
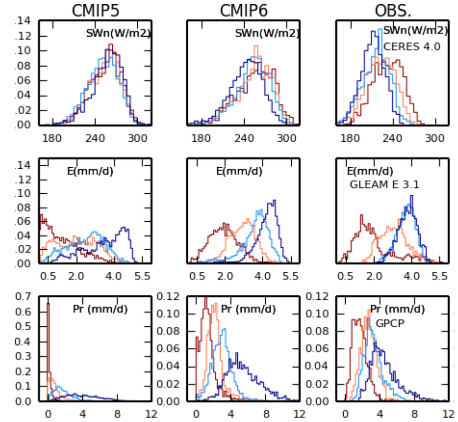


Figure 3: Impact on simulating Gulf Stream features from the assimilation of 4 ECV datasets.

Soil Moisture ECV

IPSL evaluated regional scale soil moisture/atmosphere couplings in AMIP simulations of the CMIP5 and CMIP 6 versions of its GCM using the Surface Soil Moisture (SSM) ECV.



To analyze model simulated evaporation, precipitation and solar flux (via clouds) coupled with surface moisture, we classify these fluxes for the four quartiles of monthly SSM at regional scale.

Figure 6 shows a significant improvement in the evaporation and in the precipitation from CMIP5 to CMIP6 (IPSL-CM), compared to the observations. This is due to improvements in the atmospheric and land surface (hydrology) physics implemented in IPSL-CM6 (Cheruy et al.,2020, JAMES)

Figure 6: Results for Central North America in JJA for 10 years. The colors depict the PDF from the minimum to first quartile of SSM (dark red) from first quartile to the median (pale orange), from median to third quartile (cyan line) and from the third quartile to the maximum (blue line).

Recent CMUG Publications

Cheruy et al. (2020). Improved near surface continental climate in IPSL-CM6A-LR by combined evolutions of atmospheric and land surface physics. Journal of Advances in Modeling Earth Systems. doi: 10.1029/2019MS002005

Eyring et al. (2019) Taking climate model evaluation to the next level. Nature Climate Change. doi:10.1038/s41558-018-0355-y.

Ford (2020), Assessing the role and consistency of satellite observation products in global physical-biogeochemical ocean reanalysis. https://os.copernicus.org/articles/16/875/2020/.

Popp et al. (2020) Consistency of satellite climate data records for Earth system monitoring. Bull. Amer. Meteor. Soc., doi: https://doi.org/10.1175/BAMS-D-19-0127.1

Aerosol ECV

ECMWF carried out comparisons for the month of December 2019 between the CAMS reanalysis output of the mean 550 nm Aerosol Optical Depth (AOD) and the product of the same parameter provided by Swansea University (SU) from the Sea and Land Surface Temperature Radiometer (SLSTR) instrument on Sentinel 3A and Sentinel 3B. Figure 6 shows CAMS reanalysis (top panel), SLSTR SU product from Sentinel 3A (bottom left) and SLSTR SU product from Sentinel 3B (bottom right). The signal from the Australian bush fires is well captured in the CAMS reanalysis as compared to the SLSTR datasets. However, discrepancies are observed in Central Africa and South America with a smaller biomass burning signal in the CAMS reanalysis (constrained by MODIS AOD data) and the CCI+ observational datasets. These are initial qualitative comparisons and further research is required before drawing any conclusions.

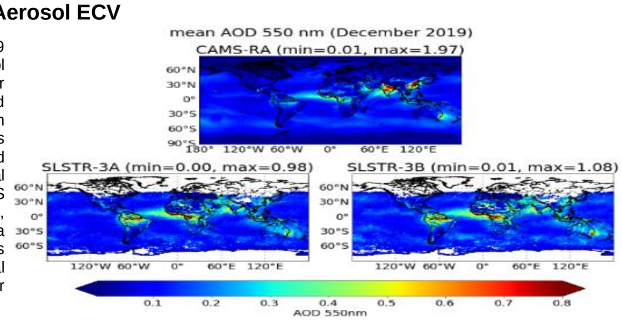


Figure 6: AOD model and observation comparisons.

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