Shortwave flux trends in the UKESM1 historical ensemble are too strong with implications for climate sensitivity.

Dr Daniel Grosvenor

NCAS, Leeds

Daniel Grosvenor, Kenneth Carslaw

Changes in how clouds respond to temperature and atmospheric changes have been identified as the main cause of an increase in climate sensitivity between CMIP5 and CMIP6. Uncertainty in the radiative forcing (RF) from aerosols also leads to large uncertainties in model predictions of future climate change with aerosol RF being the largest of the climate RF uncertainties over the industrial period. Recently the DEEP-C long timeseries (1985-2019) dataset of shortwave (SW) top of the atmosphere (TOA) fluxes and surface fluxes based on satellite data and atmospheric reanalysis data has become available. This long observational record provides opportunities for evaluating the performance of models in terms of long-term trends in SW fluxes. Significant trends in SSTs and aerosols have occurred over the period of the Deep-C record and hence the evaluation of the model SW TOA trends and timeseries provides insight into the realism of the model SW TOA response to these changes.

Here we examine changes in SW TOA fluxes over recent years for the UKESM1 historical coupled ocean ensemble and find that observed and modelled SWTOA trends are negative due to a combination of increasing SSTs and decreasing aerosol emissions. However, all of the members produce negative SWTOA trends that are too strong compared to observations in almost all regions of the globe. This suggests that either the ensemble is not representing a realistic spread of real-world variability, or that there are errors in the model physics. Either would be cause for concern in terms of using that model to make predictions about the future. The AMIP model (where the observed SSTs and sea-ice concentrations are prescribed) does a better job showing generally less negative trends than the ensemble. The better agreement here compared to the coupled model might suggest issues with the ocean component of the model. Many regions still show discrepancies, though, particularly in the Atlantic Ocean region where the trends are too negative in the northern hemisphere, but too positive in the southern hemisphere. The lack of agreement indicates issues with the atmospheric components of the model too giving insights into the representation of cloud feedbacks and ACIs, which are currently being explored.