What controls the historical timeseries of shortwave fluxes in the North Atlantic?

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Abstract

Using radiative flux calculations and the DAMIP experiments we determine what causes the long-term trends in the shortwave (SW) top-of-the-atmosphere (TOA) fluxes in the UKESM1 and HADGEM coupled climate models for the North Atlantic region and the implications for the evaluation (using observations) of aerosol-cloud interactions (ACIs) and cloud feedbacks to circulation and temperature changes. We find that there is a positive SWTOA trend between 1850 and 1970 and then a negative trend between then and 2014. The early period trend is mainly driven by an increase in cloud droplet concentrations (Nd) due to aerosol increases, whereas the trend in the later period is mainly driven by a decrease in cloud fraction caused by greenhouse gas increases. This suggests that it is unfeasible to use the later period (during which there are useful satellite observations) to evaluate and constrain ACIs, but that cloud feedbacks might be evaluated. Using nudged simulations where the meteorology can be controlled, we also determine the aerosol effects without any atmospheric circulation feedbacks, thus allowing a partitioning between feedback and non-feedback aerosol effects. In the coupled DAMIP run in which only aerosol forcing is applied we find that feedbacks cause over 50% of the overall SWTOA change implying that ocean response and its uncertainty, as well as the atmospheric response and cloud feedbacks, is very important in determining the overall response to aerosol.

Keywords: shortwave, climate, aerosols, greenhouse, Atlantic, cmip6, damip, ukesm, hadgem, cloud feedback, ocean

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