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## **Efficacies, pattern effects & radiative feedback in a large ensemble of HadGEM3-GC3.1-LL historical simulations**

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Climate feedbacks over the historical period have been investigated in a 47 member ensemble of atmosphere-ocean general circulation model (AOGCM) simulations. Here, the model response to historical forcing, as well as individual forcing constituents such as aerosol and greenhouse gases separately, has been analysed. The analysis addresses the cause of differing feedbacks across the ensemble, the disparity between feedbacks seen in these AOGCM simulations and atmosphere-only GCM (AGCM) experiments prescribed with observed SSTs, and the different forcing efficacies of the respective forcing agents. It is found that much of the spread in feedbacks across ensemble members and different experiments can be explained through varying SST patterns. The level of polar amplification is shown to strongly control the amount of sea ice melt per degree of global warming, a mechanism responsible for the spread in shortwave clear sky feedback and a large contributor to the different forcing efficacies seen across the different forcing agents. The spread in feedbacks across the historical ensemble is also shown to be caused by both the level of tropical surface temperature warming, due to its influence on longwave clear sky feedback, and the response of cloud feedbacks to local surface temperatures and large scale changes in tropospheric temperature. It is also shown that each of these processes discussed are partly responsible for the disparity in feedbacks seen between AOGCM simulations and AGCM experiments prescribed with observed SSTs.