Role of three major climate modes on decadal climate variability and change

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Abstract

We investigate the role of the North Atlantic Oscillation, El-Niño Southern Oscillation and Southern Annular Mode as pacemakers of climate variability since 1780, evaluating where their evolution masks or enhances forced climate trends. We use a particle filter data assimilation technique that constrains the observed variability in a global climate model without the use of nudging, producing a near free running model simulation with modes of variability similar to those observed. Since the climate model also contains external forcings these simulations can be used to compare the forced response to the effect of the three modes assimilated. As expected, the assimilated model is closer than free-running model simulations (without any assimilation) to annual temperature and precipitation observations over many regions, in particular the tropics, the north Atlantic and Europe. The talk will focus on areas of the globe where the assimilation model shows a clear increase in explained decadal variance. The NAO plays a leading role in north Atlantic ocean sea surface temperature with a link to the overturning circulation. The observed evolution of the NAO shows larger long-term trends in the NAO than occurring in all CMIP6 models, and this leads to large multi-decadal trends in temperature and precipitation over Northern Hemisphere land, which dominate over externally forced trends. Assimilating these three modes reconciles simulated global cooling with that observed following volcanic eruptions but cannot explain the large discrepancy previously found between observed and modelled variability in the Southern extra-tropics. The results suggest where skilful predictions of these modes may lead to potential skill in decadal predictions.

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