Have Aerosols Caused the Observed Atlantic Multidecadal Variability?

Rong Zhang[1], Thomas L. Delworth[1], Rowan Sutton[2], Daniel L. R. Hodson[2], Keith W. Dixon[1], Isaac M. Held[1], Yochanan Kushnir[3], John Marshall[4], Yi Ming[1],Rym Msadek[1], Jon Robson[2], Anthony J. Rosati[1], MingFang Ting[3], Gabriel A. Vecchi[1]

[1]GFDL, NOAA, Princeton, NJ, USA

[2]NCAS-Climate, Dept. of Meteorology, University of Reading, Reading, UK

[3]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA

[4]Dept. of Earth, Atmospheric and Planetary Sciences, MIT, Cambridge, MA, USA

Identifying the prime drivers of the twentieth-century multidecadal variability in the Atlantic Ocean is crucial for predicting how the Atlantic will evolve in the coming decades and the resulting broad impacts on weather and precipitation patterns around the globe. Recently Booth et al (2012) showed that the HadGEM2-ES climate model closely reproduces the observed multidecadal variations of area-averaged North Atlantic sea surface temperature in the 20th century. The multidecadal variations simulated in HadGEM2-ES are primarily driven by aerosol indirect effects that modify net surface shortwave radiation. On the basis of these results, Booth et al (2012) concluded that aerosols are a prime driver of twentieth-century North Atlantic climate variability. However, here it is shown that there are major discrepancies between the HadGEM2-ES simulations and observations in the North Atlantic upper ocean heat content, in the spatial pattern of multidecadal SST changes within and outside the North Atlantic, and in the subpolar North Atlantic sea surface salinity. These discrepancies may be strongly influenced by, and indeed in large part caused by, aerosol effects. It has been suggested previously that the anticorrelated multidecadal variations between surface and subsurface ocean temperature in the Tropical North Atlantic is a distinctive fingerprint of AMOC variations. Here we show that the aerosol effects simulated in HadGEM2-ES cannot account for the observed anti-correlation between detrended multidecadal surface and subsurface temperature variations in the tropical North Atlantic. These discrepancies cast considerable doubt on the claim that aerosol forcing drives the bulk of this multidecadal variability.