The Atlantic jet response to forcing: a regime perspective

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The winter jet stream in the North Atlantic has been shown to preferentially occur at three distinct latitudes [Woolings et al., 2010; Woolings et al., 2018], which we will call the three Atlantic “jet regimes.” Distinct physical mechanisms may be responsible for each of the three jet regimes—for example, the northernmost jet regime is strongly linked to the Greenland tip jet [White et al., 2019]. We seek to investigate the role of stratospheric and CO2 forcing, such as from sudden stratospheric warmings (SSWs), strong polar vortex events (SPVs), and anthropogenic global warming, on the Atlantic jet in the context of these jet regimes.

To do so, we use a “jet latitude index” (JLI), which is determined by finding the latitude of the peak zonal winds over some latitude range, averaged over some longitude range, to show that sudden stratospheric warmings (SSWs) impact the likelihood that the Atlantic jet will be in any particular jet regime. These calculations are performed in the ECMWF Interim Reanalysis (ERAI) data set, an in-house 200-year Whole Atmosphere Community Climate Model (WACCM) run, and in a subset of CMIP6 models. We seek to investigate how changes in the composite response of the jet over the Atlantic associated with SSWs, SPVs, and greenhouse gas forcing, are borne out in the context of the three Atlantic jet regimes. We find that, following SSWs, the northern regime becomes less frequent, and the southern regime becomes more frequent, while the jet latitude peaks of the regimes do not notably shift. Following SPVs, the northern regime becomes more frequent, the southern regime becomes less frequent, and again, the peak latitudes do not shift. Under CO2 forcing, we do not find a consistent signal from model to model, and we test whether these differences may be related to model differences in local meridional temperature gradients over the Atlantic.