Effects of Anthropogenic European SO_2 Emissions on North Atlantic Tropical Cyclone Behavior

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Historical records show a notable decrease in the frequency of severe hurricanes in the North Atlantic basin between 1960 and 1990. Previous work attributed this trend to the Atlantic Multidecadal Oscillation, but more recent studies have suggested that the radiative forcing effects of anthropogenic aerosols – in particular, the increase and subsequent curbing of European SO_2 emissions – may have also impacted the decadal variability of North Atlantic tropical cyclone behavior. As reliable North Atlantic tropical cyclone data is only available after 1950, showing only one cycle of decadal variability, our ability to resolve this debate with historical data is limited. We will analyze the output of three coupled climate-chemistry global models – GFDL-CM3, CESM1 and NASA GISS-E2 – run for two different simulations: the first with perpetual year 2000 or 2005 anthropogenic aerosol emissions, the second with European SO_2 emissions cut by 80%, but other forcing identical to the first. We analyze climatology of environmental proxies for Tropical Cyclone activity – Potential Intensity, multiple Tropical Cyclone Genesis Indices, sea surface temperature (SST), Relative Humidity – in these two simulations for the peak North Atlantic hurricane season August to October (ASO), compare with the ERA5 reanalysis climatology in order to determine model biases, and calculate the difference between the climatologies in both simulations. We attribute the difference between these two simulations to the response of the environmental proxies to a reduction in EU SO_2 levels. We will also show results obtained when downscaling ERA5 and these model simulations with the Columbia Hazard model (CHAZ). CHAZ downscaling simulations produce synthetic tropical cyclones using environmental fields from climate models or reanalysis. We will analyze the differences in tropical cyclone activity between the control and the reduced European SO_2 simulations, as well as the climatological biases in TC activity in the control simulations, when compared with the ERA5 downscaling.