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Impacts of the Atlantic Multidecadal Variability on the tropical climate and tropical cyclone activity

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The Atlantic Multidecadal Variability (AMV) is associated with marked modulations of climate anomalies over many areas of the globe. This includes droughts in Africa and North America, decline in sea ice, changes of tropical cyclone activity in the Atlantic, and changes in the atmospheric large-scale circulation. However, the shortness of the historical observations compared to the AMV period (∼60-80yr) makes it difficult to show that the AMV is a direct driver of these variations. To isolate the AMV climate response, we use a suite of global coupled models from GFDL and NCAR, in which the North Atlantic sea surface temperatures are restored to the observed AMV pattern, while the other oceanic basins are left fully coupled. To explore and robustly isolate the AMV impacts on weather extremes (e.g., heat waves, tropical cyclones), we perform large ensemble simulations (between 30 and 100 members) that are integrated for 10 years.

During boreal summer, in all models the AMV warming alters the Walker Circulation and modifies the surface winds over the tropical Pacific Ocean. During boreal winter, the AMV warming is associated with large anomalies over the Pacific that project onto a negative phase of the Interdecadal Pacific Oscillation (IPO). This IPO response comes from a lagged adjustment of the tropical Pacific to the summer AMV forcing, highlighting the necessity of using a global coupled framework to fully capture the AMV climate impacts. Finally, it is shown that the AMV warming leads to changes in the tropical cyclone activity over the entire tropical belt, with more tropical cyclones over the Atlantic and less tropical cyclones over the Pacific. These changes are very similar to the fluctuations of the tropical cyclone activity observed over the last 40 years. It hence suggests that the 1995/96 phase shift of the AMV has partly driven these variations.