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The influence of the stratosphere on the North Atlantic storm track predictability in subseasonal-to-seasonal reforecasts

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Extreme stratospheric polar vortex events, such as sudden stratospheric warmings (SSW) or extremely strong polar vortex (SPV) states, can have a prolonged downward impact, influencing surface weather for several weeks to months. These events often lead to changes in the midlatitude storm track position and associated cyclone frequency over the North Atlantic and Europe. Such changes can result in infrastructure damage and health impacts due to cyclone-associated extreme winds and the risk of flooding or heavy snowfall. However, there exists a strong inter-event variability in these downward impacts on the tropospheric storm track, leading to opposite predictions of the storm track response. Therefore, identifying the biases in the forecast of the downward impact of stratospheric polar vortex extremes can improve the predictability of extratropical winter storms on subseasonal-to-seasonal timescales, and has the potential to benefit society and stakeholders.

Using ECMWF reanalysis data and ECMWF reforecasts from the Subseasonal to Seasonal (S2S) Prediction Project database, we investigate the stratospheric influence on extratropical cyclones, identified with a cyclone detection algorithm. Following SSWs, there is an equatorward shift in cyclone frequency over the North Atlantic in reforecasts, and a poleward shift is observed after SPV events, consistent with the response in reanalysis. However, less than 70% of the reforecasts capture the sign of the cyclone frequency response over the North Atlantic during weeks 1-2 after SSWs, and less than 50% of the reforecasts capture the response during weeks 3-4. The cyclone forecasts following SPV events are generally more successful. We further discuss the differences in predictability of extratropical cyclones between the two types of stratospheric extremes.

The results provide new insights on the role of the stratosphere in subseasonal variability and predictability of extratropical cyclones during winter that can be used for forecasting their frequency and surface impacts.