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Rossby wave breaking through the 21st century in a global climate model

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Rossby wave breaking on the dynamic tropopause (DT) occurs when synoptic-scale Rossby waves become highly amplified and undergo a breaking process. This process can result in significant meridional transport of air masses resulting and intrusions of low latitude air poleward, high latitude air equatorward, or a combination of the two. The ensuing modification of the troposphere and lower stratosphere in response to such events have been areas of considerable research due to their potential impacts on both high- and low-frequency mid- and high-latitude variability. Furthermore, the processes and feedbacks associated with these events can result in notable changes to the jet structure and are frequently associated with atmospheric river events amongst other phenomena. As such, the potential impacts of future changes in these events make them of considerable interest for identifying and studying in global climate model (GCM) simulations.

Here, we apply a Rossby wave breaking identification scheme to three sets of 25-member Community Earth System Model simulations with prescribed sea surface temperature and sea ice conditions over the historical period (2010-2019), mid-Century (2050-2059) and late-Century (2090-2099). This dataset represents a unique opportunity to study Rossby wave breaking processes in future climate simulations on a dynamically evolving surface rather than the more common pressure levels or isentropic levels as the DT is calculated for each of the CESM members. Both anticyclonic and cyclonic Rossby wave breaking events are identified and tracked. Events modeled in the historical period are compared to existing reanalysis data for the same period to explore the ability of the CESM model in this configuration to reproduce these events accurately. Furthermore, the three periods of interest are examined to determine changes in the locations of Rossby wave breaking as well as the dynamic and thermodynamic characteristics of composited events.