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The poleward shift of storm tracks under climate change: tracking cyclones in CMIP5

T. Tamarin and Y. Kaspi
Weizmann Institute of Science, Israel (talia.tamarin@weizmann.ac.il)

Extratropical cyclones dominate the distribution of precipitation and wind in the midlatitudes, and therefore their frequency, intensity, and paths have a significant effect on weather and climate. Comprehensive climate models forced by enhanced greenhouse gas emissions suggest that under a climate change scenario, the latitudinal band of storm tracks would shift poleward. While the poleward shift is a robust response across most models, there is currently no consensus on what is the dominant dynamical mechanism. Here we use a Lagrangian approach to study the poleward shift, by employing a storm-tracking algorithm on an ensemble of CMIP5 models forced by increased CO_2 emissions. We demonstrate that in addition to a poleward shift in the latitude of storm genesis, associated with the expansion of the Hadley cell, the averaged cyclonic storm also propagates more poleward until it reaches its maximum intensity. A mechanism for enhanced poleward motion of cyclones in a warmer climate is proposed, which relates the shift to changes in upper level jet and atmospheric water vapour content. The mechanism is demonstrated on one CMIP5 model member, MPI-ESM-LR, where a full PV tendency budget is performed. Our results imply that under the RCP8.5 climate change scenario, the averaged latitude of peak cyclone intensity shifts poleward by about 1.2° (1.0°) in the Atlantic (Pacific) storm track in the Northern Hemisphere (NH), and by about 1.6° in the Southern Hemisphere (SH) storm track. These changes in cyclone tracks can have a significant impact on midlatitude climate.