Geophysical Research Abstracts
Vol. 20, EGU2018-2070, 2018
EGU General Assembly 2018

The impact of polar amplification on mid-latitude Rossby waves and persistent circulation patterns using idealized numerical modeling

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Climate change warms the polar latitudes twice as much as the mid-latitudes. This polar amplification leads to a decrease in mid-latitude horizontal temperature gradients whose effects on mid-latitude atmospheric circulation and on the high-impact weather events frequency of occurrence are still debated. Different mechanisms have been discussed in the recent literature on the effect of a decreased horizontal temperature gradient on Rossby waves properties and blocking events but no consensus was found. Here, a three-level quasi-geostrophic model on the globe forced by a relaxation in temperature is employed to assess the relevance of these mechanisms. Two long-term runs are compared, the first, called the control run, corresponding to the present wintertime climate and the other, the modified run, including a climate warming pattern. The control-run restoration temperature is optimized to get a model climatology close to the observed wintertime present-day climatology. The modified-run includes a stronger warming at the northern pole compared to the control run. The focus is made on the Northern Hemisphere mid-latitude atmospheric variability. Spectral properties of the waves in the two runs are compared. The modified run is characterized by a decrease in the eastward phase speed of Rossby waves, consistent with the changes in the background flow and dispersion relation of Rossby waves. In particular, the eastward displacement of synoptic Rossby waves (zonal wave numbers between 6 and 8) slows down and its consequence in terms of changes in persistent circulation patterns like blocking events is analyzed. Finally, these differences between the two runs are compared to differences between two successive periods (1979-1995 and 1996-2013) using reanalysis datasets.