Change of midlatitude winter cyclones and Nortes over Mexico in Global Warming Projections

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Abstract

Global warming projection experiments over Mexico during the winter season have been analyzed. The high resolution Japanese TL959L60-AGC model was used. Under the present climate conditions, the model reproduces a realistic winter cyclone evolution in terms of the onset of the high pressure system, its geographical distribution and its southeastward seasonal march. The future winter climate simulation, at the end of the 21st century, projects a shifting of the zonal flow normal modes toward higher wave-numbers. This is manifested in an increasing cold front and Nortes activity and in a rate of growth of the most unstable baroclinic mode, which becomes stronger in future than in present climate conditions.

The physical and dynamical properties of the increasing number of Nortes, however, are qualitatively different from those observed in present climate conditions. In a warmer climate, since the wave-length of the zonal flow would decrease, Nortes would have shorter time-scales, a diminished strength and colder temperature drops during the life time of the system (i.e., lower temperatures during shorter periods of time). The induced amounts of precipitation over the Gulf of Mexico states, however, it is not clear whether would encounter any substantial change. Further analysis should be undertaken to elucidate a clear tendency.

Most of these features seem to be in disagreement with the alterations to the winter local circulations, temperatures and rainfall distributions normally observed during the El Niño events, when the frequency of Nortes is also increased. That is, the dynamical factors underlying an increasing frequency of Nortes in a global warming scenario are different from those underpinning its increment during the El Niño episodes.

Despite a decreasing local meridional gradient of temperature in a global warming scenario, the increase in the mid-latitude winter cyclone activity and in the amplification rate of the most unstable baroclinic mode suggests an increase in the baroclinicity of the lower troposphere. Effectively, since the static stability of the atmosphere

modulates the baroclinic response of the atmosphere, we found that a future weaker local meridional gradient of temperature and lower static stability of the lower troposphere, promotes a more intensive mid-latitude winter cyclone activity.