The modulation of stationary waves, and their response to climate change, by parameterized orographic drag

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The parameterization of orographic drag processes in atmospheric models remains uncertain because of a lack of observational and theoretical constraints on their formulation and free parameters. While previous studies have demonstrated that parameterized orographic drag acting near the surface has a significant impact on the atmospheric circulation, this work follows a more systematic approach to investigate its impacts on the large-scale circulation and the circulation response to climate change. A set of experiments with a comprehensive atmospheric general circulation model is used to ascertain the range of climatological circulations that may arise from parameter uncertainty. It is found that the Northern Hemisphere (NH) wintertime stationary wave field is strongly damped over the North Pacific (NP) and amplified over the North Atlantic (NA) as a result of increased low-level parameterized orographic drag, both of which are shown to be conducive to higher-latitude westerlies. A comparison with the stationary wave field presented in other studies suggests that the too-zonal NA jet and equatorward NP jet biases that are prevalent in climate models may be at least partly due to their representation of orographic drag. The amplitude of the stationary wave response to climate change across the experiments is shown to scale with the magnitude of low-level parameterized orographic drag through its influence on the present-day climatological stationary wave amplitudes over different sectors of the NH, which is consistent with linear stationary wave theory. This work highlights the importance of fidelity in a model's basic state for regional climate change projections.

Key words: orographic drag, stationary waves, climate change

References

van Niekerk, A., J.F. Scinocca, and T.G. Shepherd, 2017: The modulation of stationary waves, and their response to climate change, by parameterized orographic drag. *J. Atmos. Sci.,* 74, 2557–2574, https://doi.org/10.1175/JAS-D-17-0085.1