The impact of the AMOC and Andes topography on the location of tropical precipitation

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More precipitation falls in the northern hemisphere tropics than in the southern hemisphere tropics in the annual mean, and the literature contains many theories that seek to explain this climate asymmetry. One theory that has gotten more attention in recent literature attributes this asymmetry to the energy transport of the Atlantic Meridional Overturning Circulation (AMOC) (Fučkar et al, 2013). Here, the impact of ocean energy transport and Andes topography on the location of tropical precipitation is tested in an aquaplanet configuration of the GFDL AM2.1 GCM with a slab ocean. Adding realistic Andes topography regionally displaces tropical rainfall from the equator into the northern hemisphere. The relative importance of the Andes as compared to a hemispherically asymmetric heating of the atmosphere by ocean transport is examined by including idealized and realistic zonally-averaged surface heat fluxes (q-fluxes) in the slab ocean. A hemispherically asymmetric q-flux displaces the tropical rainfall toward the hemisphere receiving the greatest heating by the ocean. The zonal mean displacement of rainfall is greater in simulations with a realistic q-flux than with realistic Andes topography.

We also examine the location of zonally averaged precipitation in coupled GCM simulations with the ICCMp1 model which is a climate model that contains the MOM4 ocean model coupled to an atmospheric model using a gray radiation scheme (GRaM). In these simulations, a meridional overturning circulation develops in the ocean choosing its direction either spontaneously (in a symmetric basin) or from boundary conditions. In either case, the hemisphere with the greatest deep water production is also the hemisphere with the greater net ocean to atmosphere energy flux. As a result, the hemisphere with deep water production is also the hemisphere with greater tropical precipitation. These model studies collectively point to the importance of the AMOC on the location of tropical precipitation.

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