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Clouds and the extratropical circulation response to global warming in a hierarchy of global atmosphere models

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Climate models project that global warming will lead to substantial changes in the position of the extratropical jet streams. Yet, many quantitative aspects of such jet stream changes remain uncertain among models, and recent work has indicated a potentially important role of cloud radiative interactions. Here, I will investigate how cloud-radiative changes impact the extratropical circulation response using a hierarchy of global atmosphere models. I will first focus on aquaplanet setups with prescribed sea-surface temperatures (SSTs), which reproduce the model spread found in realistic simulations with interactive SSTs. Simulations with two CMIP5 models MPI-ESM and IPSL-CM5A and prescribed clouds show that half of the circulation response can be attributed to cloud changes. The rise of tropical high-level clouds and the upward and poleward movement of midlatitude high-level clouds lead to poleward jet shifts. High-latitude low-level cloud changes shift the jet poleward in one model but not in the other. The impact of clouds on the jet operates via the atmospheric radiative forcing that is created by the cloud changes and is qualitatively reproduced in a dry Held-Suarez model, although the latter is too sensitive because of its simplified treatment of diabatic processes. I will then show that the aquaplanet results also hold when the models are used in a realistic setup that includes continents and seasonality. Finally, I will juxtapose these prescribed-SST simulations with interactive-SST simulations. This will allow for a comparison of the circulation impacts of atmospheric and surface cloud-radiative changes.