Sources of Intermodel Spread in the Lapse Rate and Water Vapor Feedbacks

PCMDI Program for Climate Model Diagnosis and Intercomparison

Objective

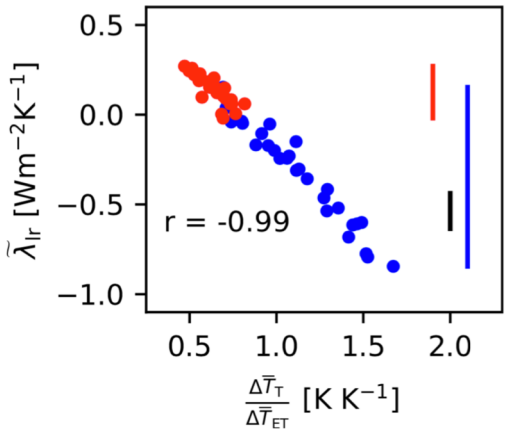
- The most fundamental climate feedbacks, the lapse rate (LR) and water vapor (WV) feedback, also exhibit substantial spread across climate models. This study seeks to understand controls on these related feedbacks

Research

- In this study, the LR and WV feedbacks are decomposed into local feedbacks to determine regions that contribute to intermodel feedback differences
- The feedbacks are then related to the meridional pattern of surface warming, which controls the structure of atmospheric warming and moistening
- Substantial feedback spread is related to the rate of warming in the southern hemisphere and, in turn, Antarctic sea ice extent

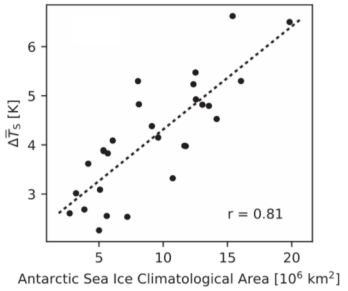
Impact

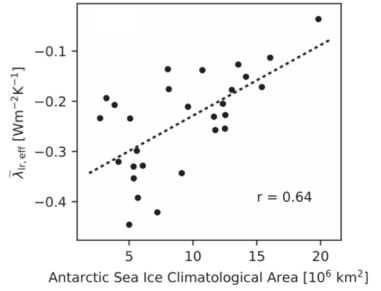
- LR and WV feedbacks can be accurately predicted using metrics of surface warming alone
- This study demonstrates that model sea-ice climatology has a significant impact on global LR and WV feedbacks



Above: The lapse rate and water vapor feedback at constant relative humidity versus the ratio of tropical and extratropical surface warming in the northern (red) and southern (blue) hemisphere. The vertical lines represent the total feedback spread across CMIP5 models, demonstrating that model differences are largest in the southern hemisphere.

Bottom panel: Southern hemisphere surface temperature warming is closely related to the model's climatological sea ice area (left panel). Because of climatological sea ice's influence on southern hemispheric warming and the importance of the southern hemispheric warming in controlling the lapse rate and water vapor feedback spread, Antarctic sea ice is a significant predictor of the global lapse rate and water vapor feedbacks (right).





Reference: Po-Chedley, S., K. C. Armour, C. M. Bitz, **M. D. Zelinka**, **B. D. Santer**, and Q. Fu, 2018: Sources of Intermodel Spread in the Lapse Rate and Water Vapor Feedbacks. *J. Clim.*, **31**, 3187 - 3206, doi: 10.1175/JCLI-D-17-0674.1.