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

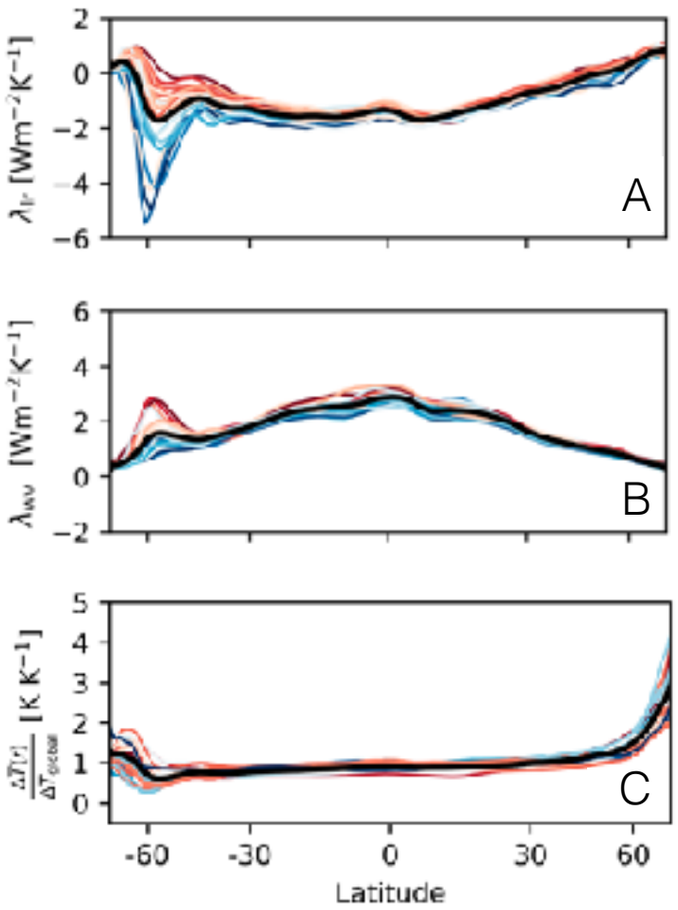
NASA MAP NNX13AN49G (PI: Q. Fu)

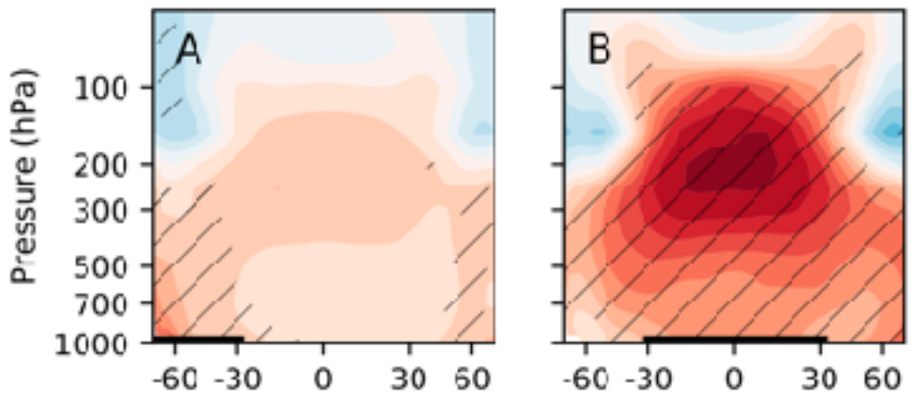
Introduction

This study seeks to understand intermodel differences in the lapse rate (LR) and water vapor (WV) feedbacks across 28 GCMs from the CMIP5 archive.

Region of importance

In terms of local feedbacks, most of the model spread in LR and WV feedbacks is in the subantarctic [A and B below]. This spread corresponds to a region in which there is a minimum in surface warming [C]. The variability in local feedbacks causes uncertainty in the global feedbacks.



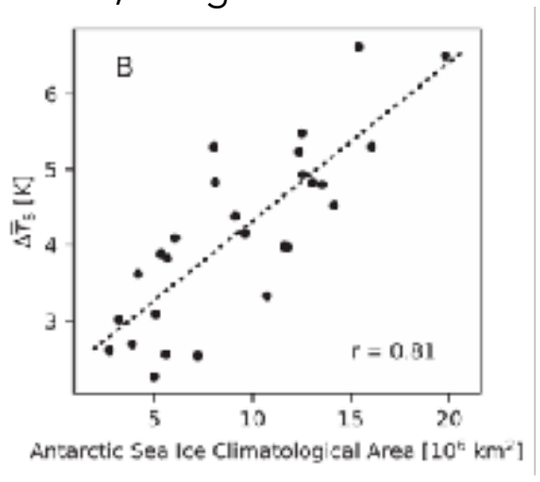


A linear decomposition

Across models, the pattern of atmospheric warming can be related to the magnitude of surface warming in the extratropics [A above] and the tropics [B]. The radiative change due to LR and WV changes (ΔR) can then be expressed using the magnitude of surface warming in the tropics (ΔT_T) and extratropics (ΔT_{ET}) [A and B below]. It can be shown that the extratropical feedback scales with the ratio of tropical and extratropical surface warming.

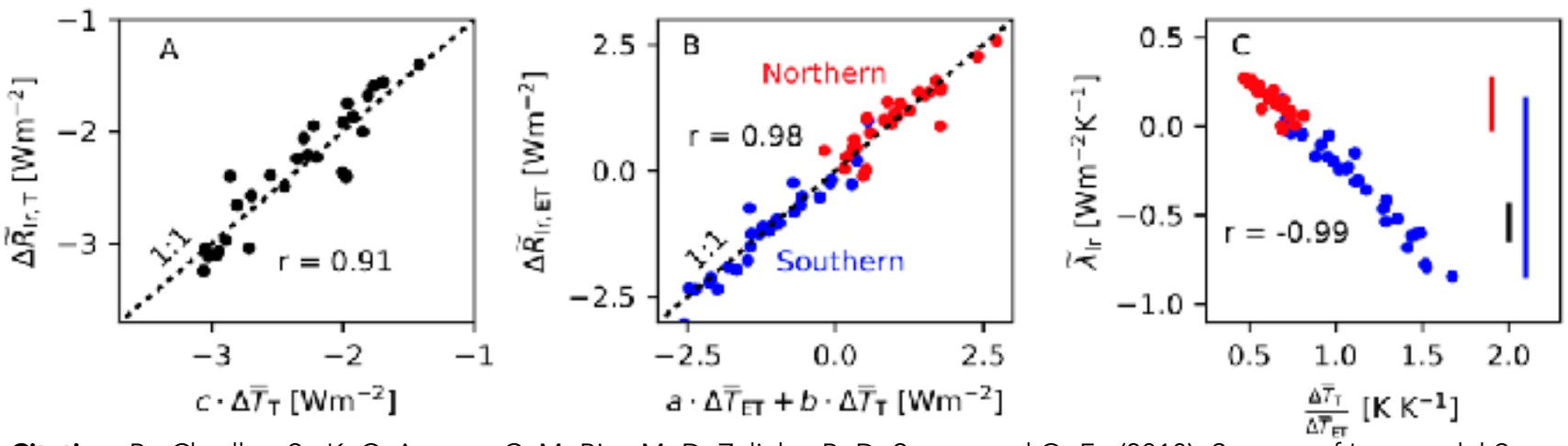
A role for sea ice climatology

Surface warming in the southern extratropics is strongly related to the loss of sea ice and the sea ice climatology [below]. As a result, model sea ice climatology influences the LR and WV feedbacks in the southern hemisphere and, in turn, the global feedbacks.



Significance

This work shows a simple linear framework for expressing the LR and WV feedbacks, which may also relate to other feedbacks. Surprisingly, much of the spread in these feedbacks arises in the extratropics.



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