The Polar Amplification Asymmetry: Role of Antarctic Surface Height

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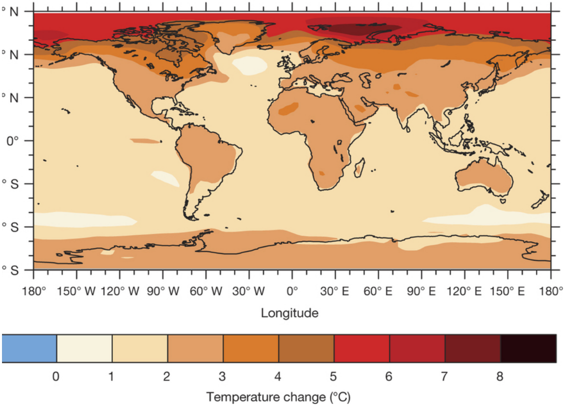
Polar Amplification Asymmetry

Local temperature change when $\Delta T_{glob} = 2°C$ from the CMIP5 RCP8.5 experiment



Seneviratne et al., Nature 529, 477-483 (2016)

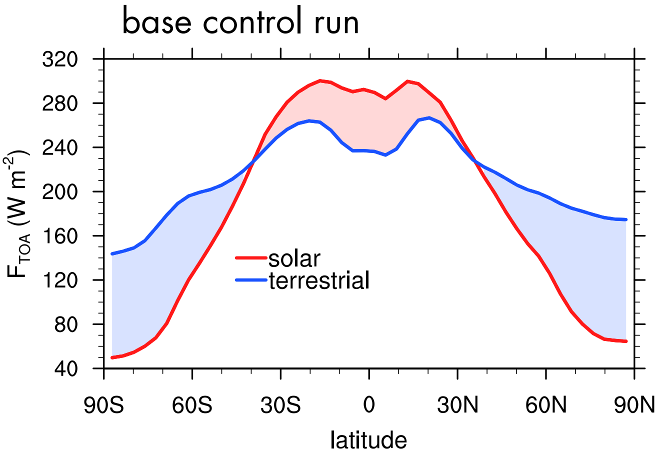
Role of antarctic land height

- use Community Earth System Model (CESM) v1.0.6, at low resolution (T31, gx3v7)
  1. base control run
  2. base 2xCO_2 run
  3. flat Antarctica control run
  4. flat Antarctica 2xCO_2 run

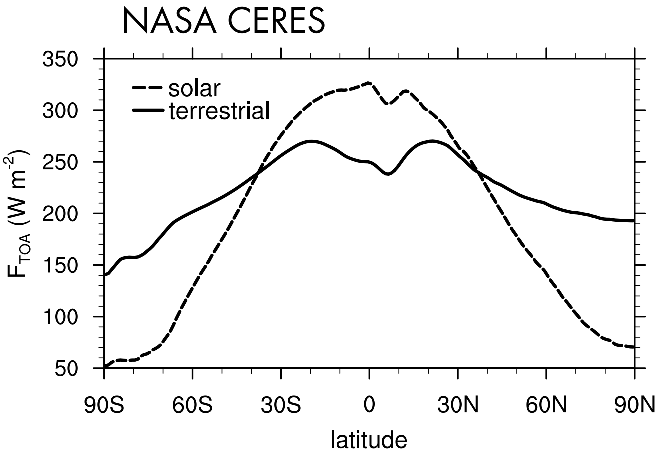
Role of antarctic land height

- mainly analyze years 80 to 109
- use partial radiative perturbation (PRP) method to compute forcing and feedbacks
  - lapse rate (LR)
  - Planck (PL)
  - surface albedo (ALB)
  - water vapor (WV)
  - cloud (CL)
- regions defined by polar circles

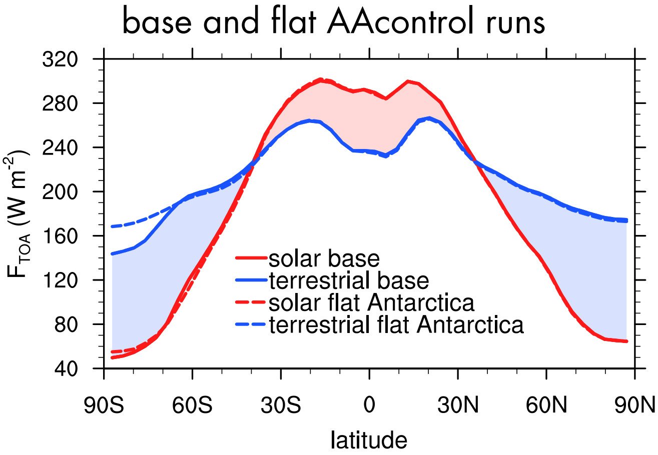
Top of atmosphere radiation budget



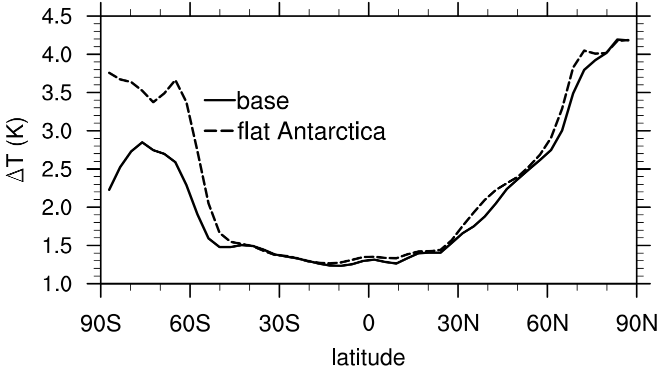
Top of atmosphere radiation budget



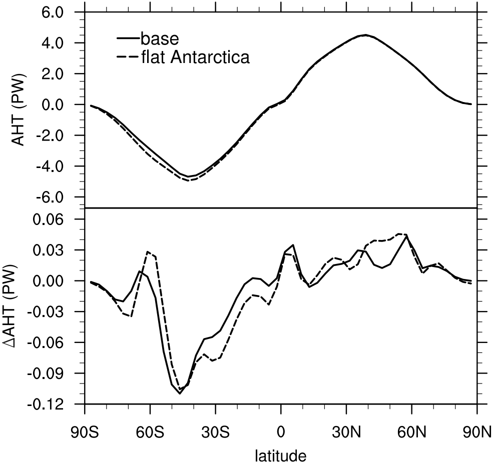
Top of atmosphere radiation budget



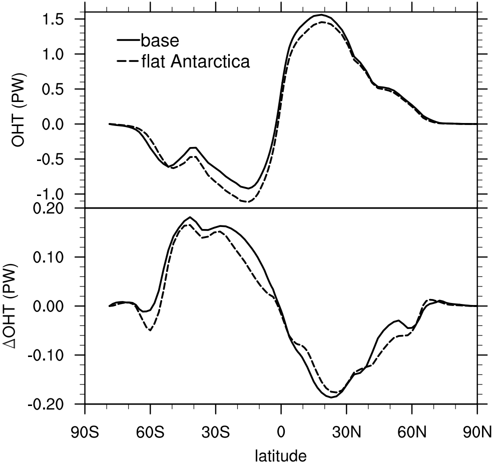
Surface air temperature increase due to CO_2 doubling



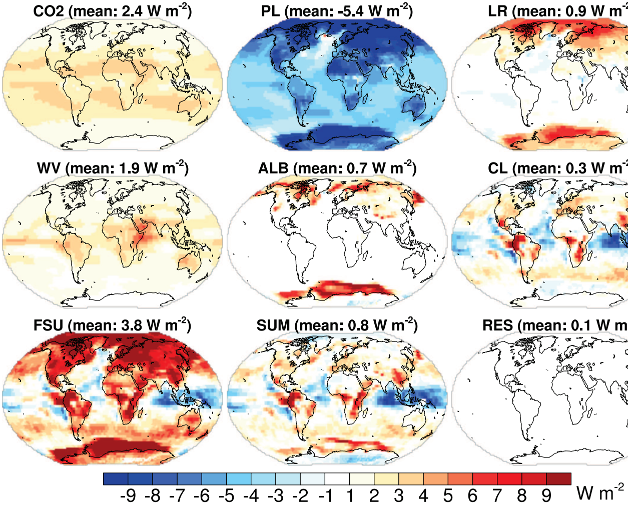
Northward atmospheric heat transport



Northward oceanic heat transport

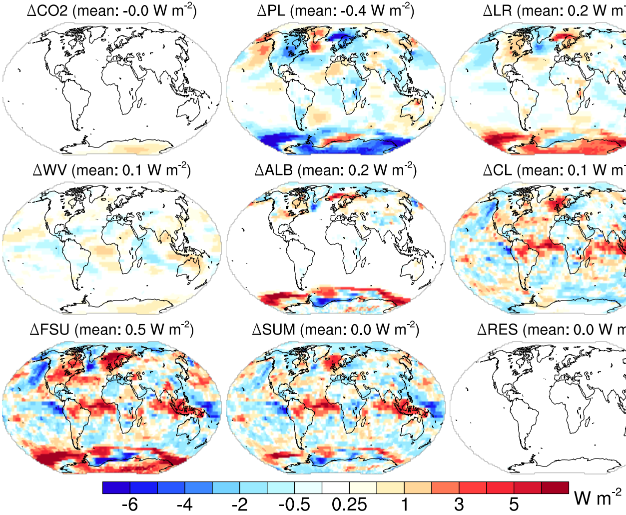


Radiative forcing and feedbacks

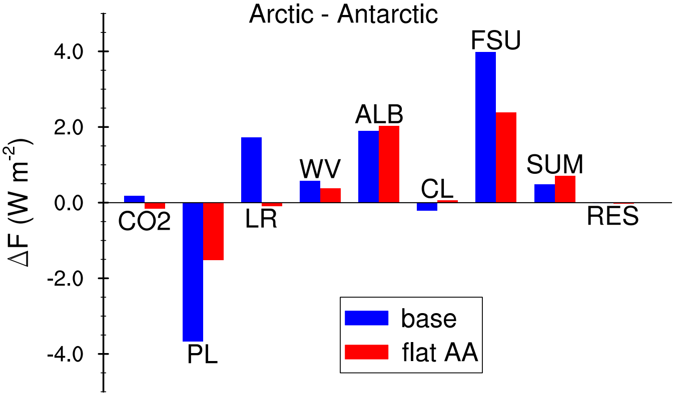


FSU=LR+WV
+ALB+CL

Difference (base - flat AA)



Compare local feedbacks



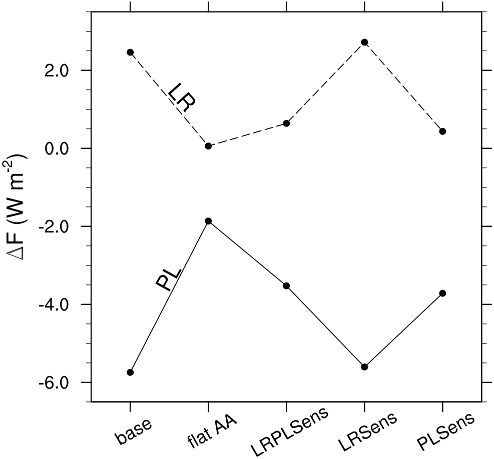
Why this LR feedback difference?

Additional PRP sensitivity runs ...

label	variable(s) from flat AA model setup in base model setup
LRPLSens	surface air (T_s) and atmospheric (T_a) temperature
LRsens	atmospheric temperature T_a
PLSens	T_s and control T_a with added ΔT_s as in PL

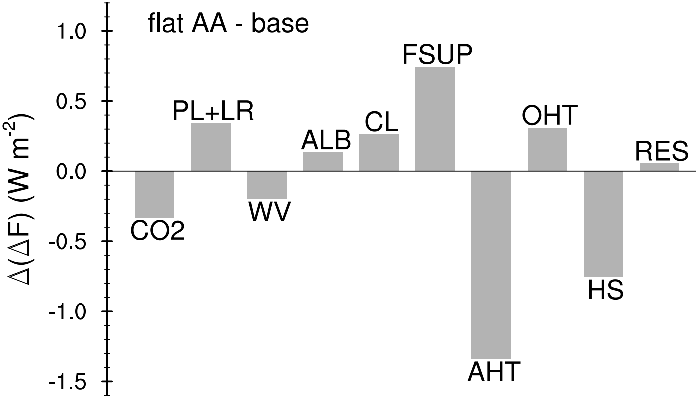
Why this LR feedback difference?

... suggest that LR feedback mainly depends on surface



Attempt to analyze budgets

Arctic - Antarctic



HS:heat storage; FSUP=FSU+PL

Summary/Conclusions

- antarctic surface height plays an important role for polar amplification asymmetry
- flat Antarctica allows for warm air advection from lower latitudes
  - once the ice shield is lost warm air advection might make restoration of ice shield more difficult
- local feedbacks and ocean heat transport play important roles as well
- other important factors investigated elsewhere

- thank you!

Manuscript in review: Salzmann, M.: The polar amplification asymmetry: Role of antarctic surface height, Earth Syst. Dynam. Discuss., doi:10.5194/esd-2016-74, in review, 2017.

U.S. contributions:

- satellite data product: NASA CERES (EOS, Langley)
- model: CESM (CGD/NCAR, sponsored by NSF and DOE)
- analysis software: NCL (UCAR/NCAR/CISL/TDD)

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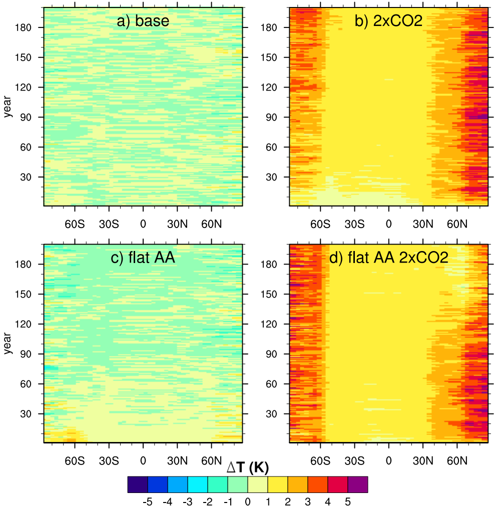
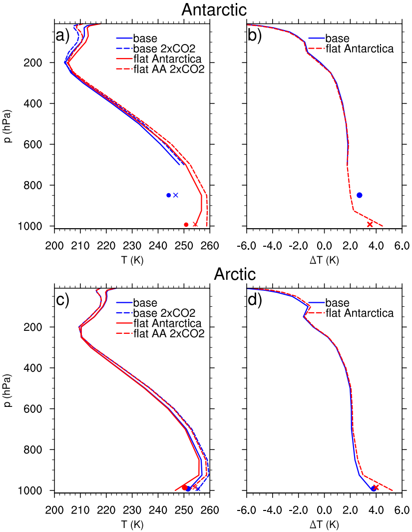
Temporal evolution



Air temperature profiles



Regional Feedbacks