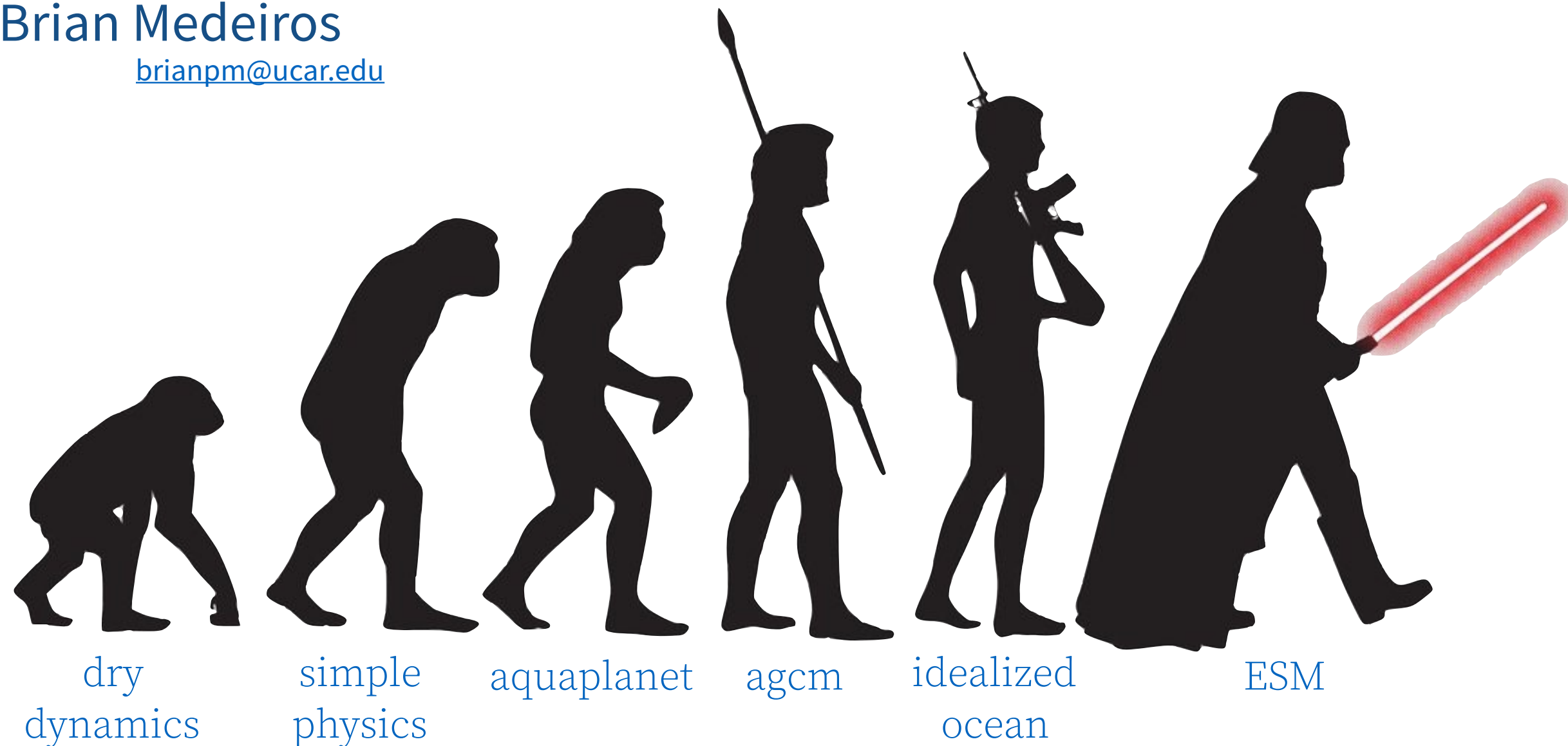


Investigating the role of clouds in the climate system through the CESM modeling hierarchy

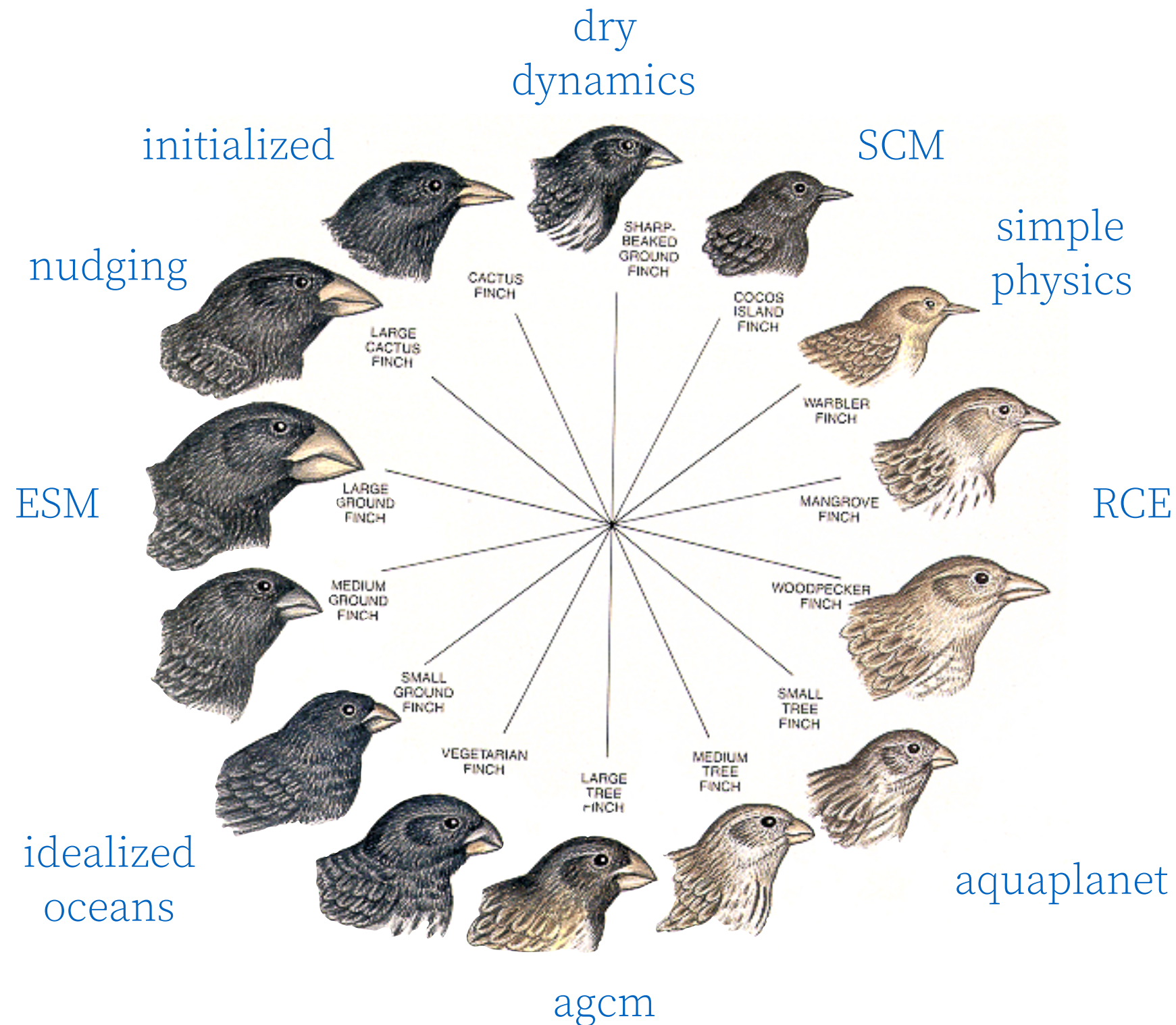
Brian Medeiros

brianpm@ucar.edu



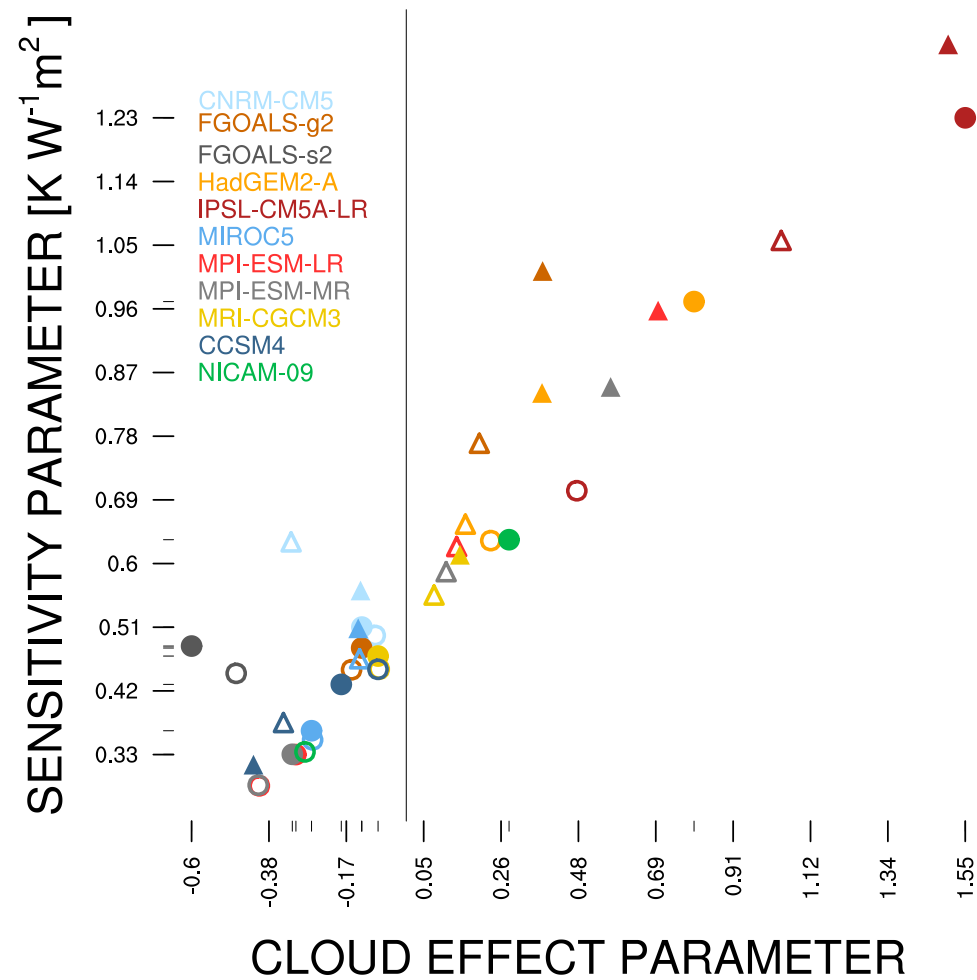
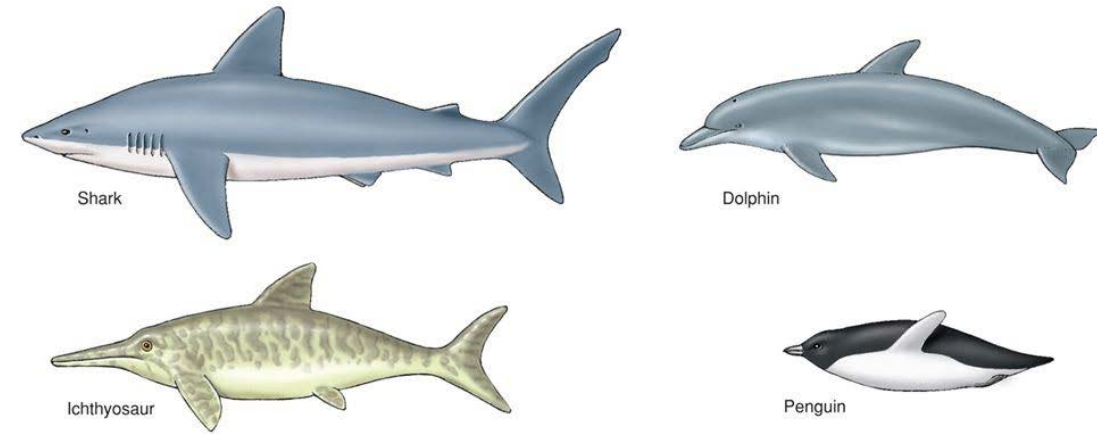
Divergent Evolution

Different tools for different jobs

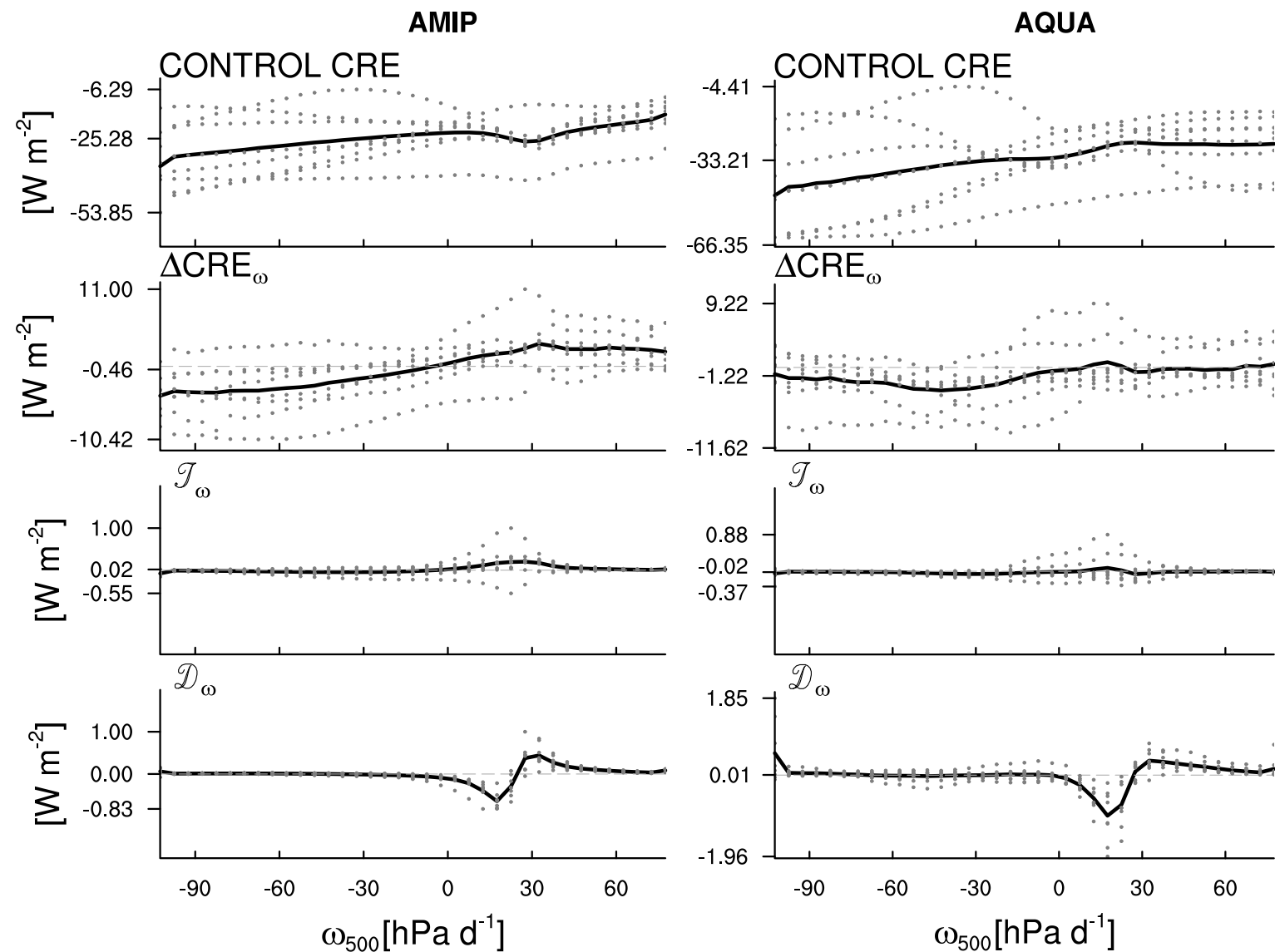


Convergent Evolution

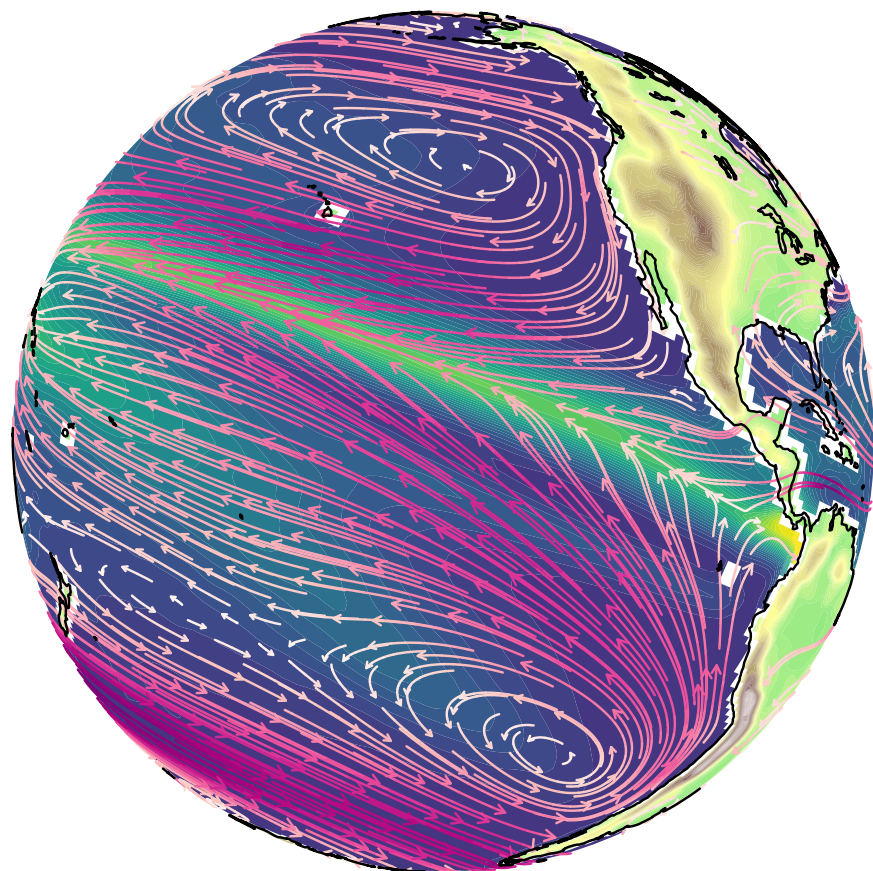
... without convergent solutions



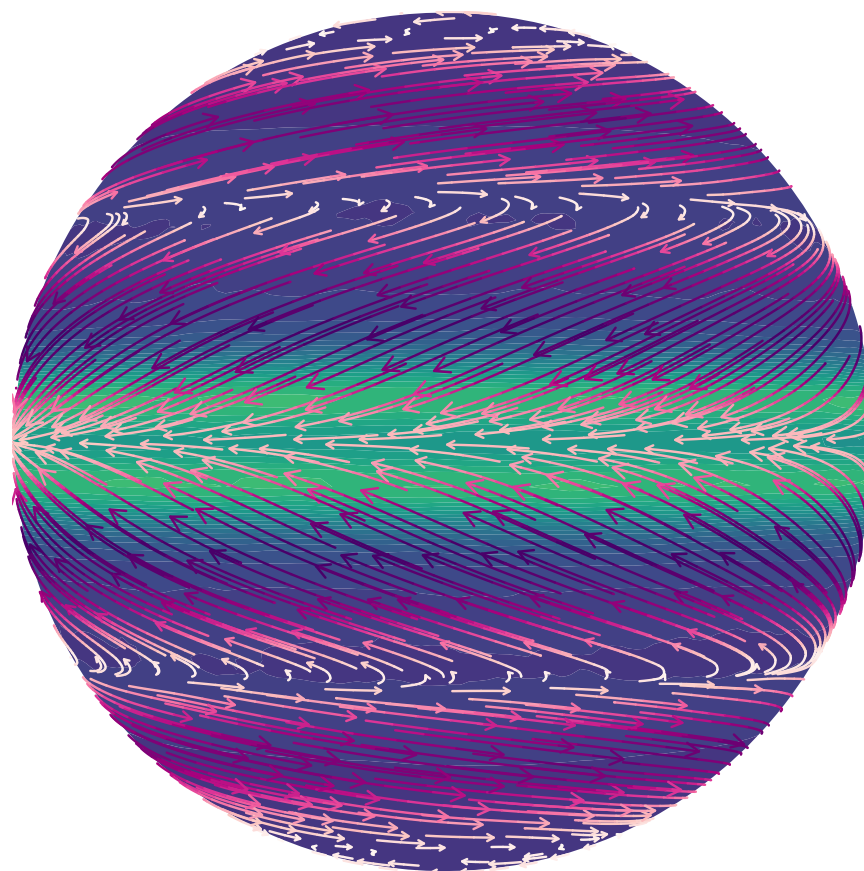
Earth & Aquaplanet configurations have similar climate sensitivity and cloud feedback ...



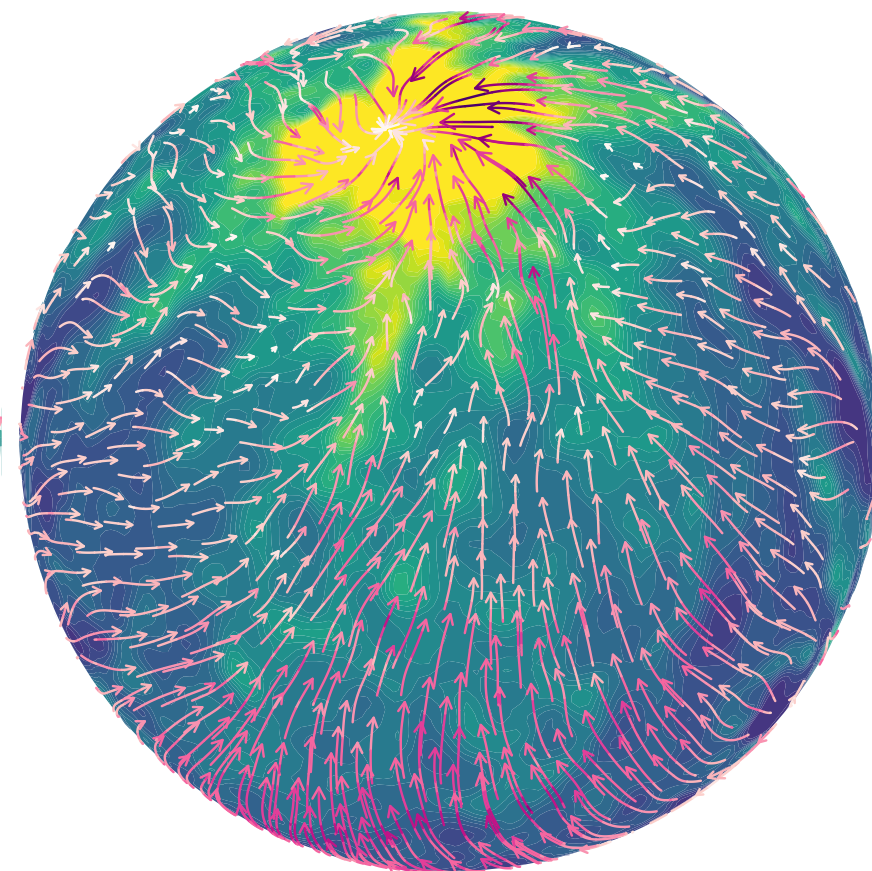
... because similar physical responses.



Earth



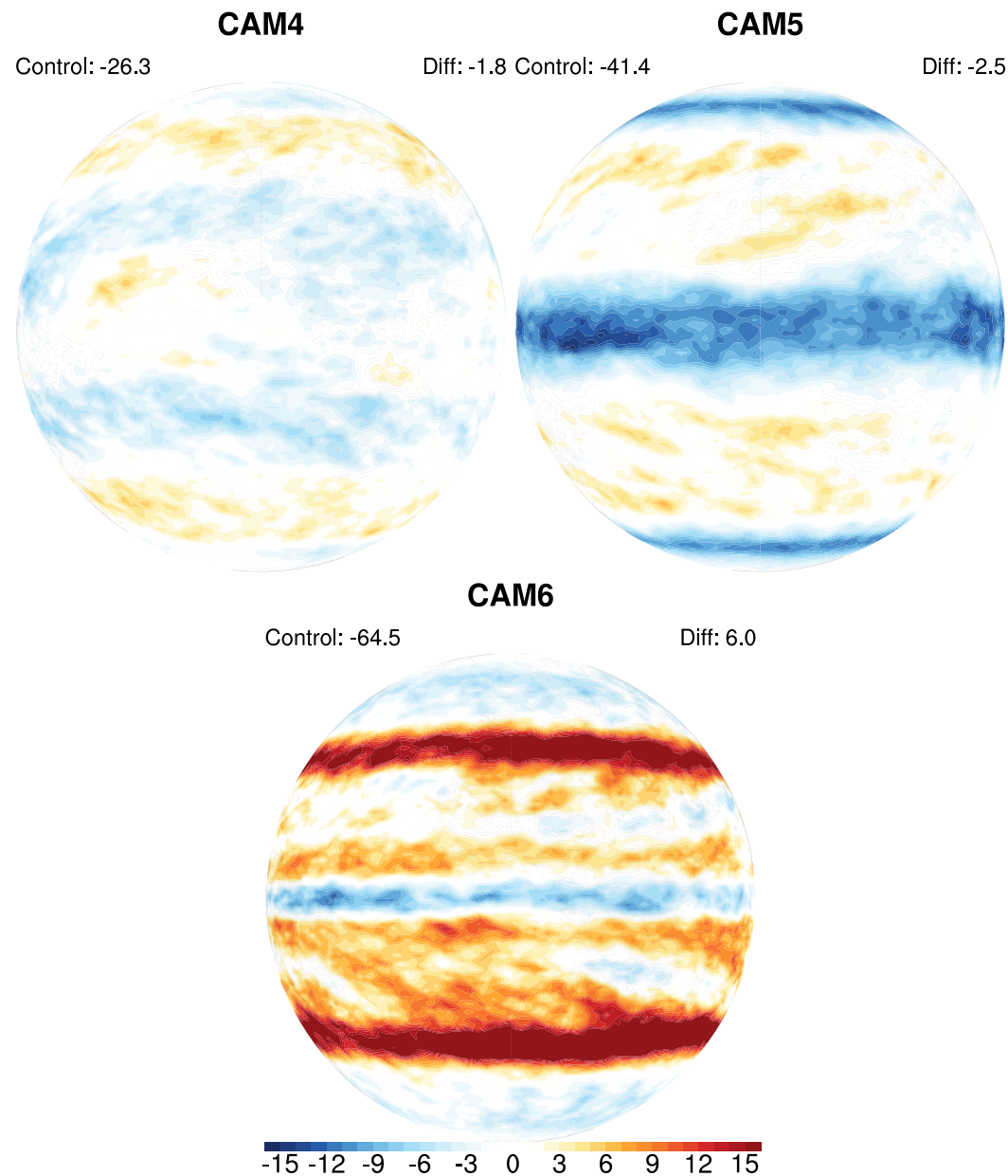
Aquaplanet



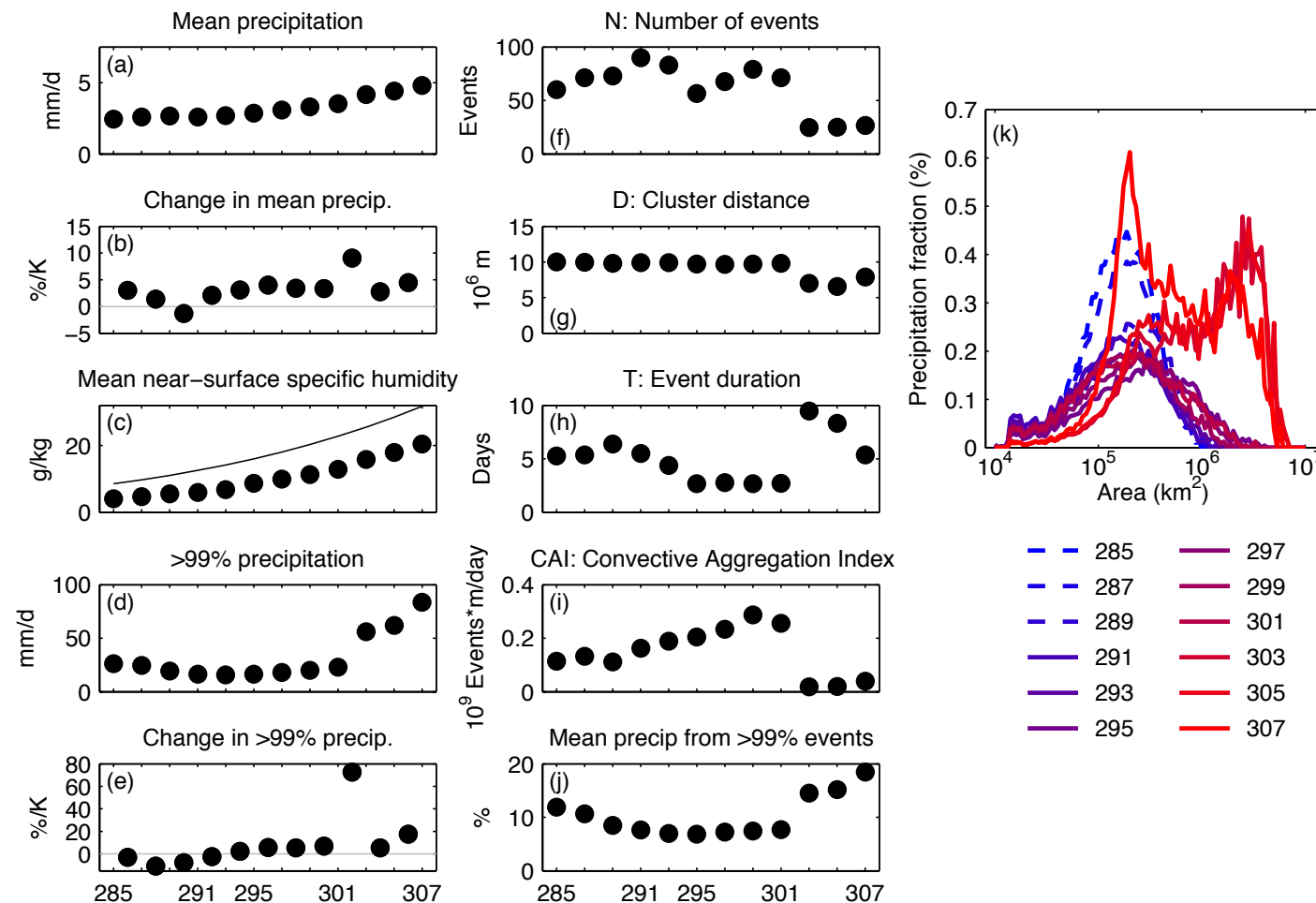
RCE

See Kevin Reed's talk.

Response to external forcing (warming)



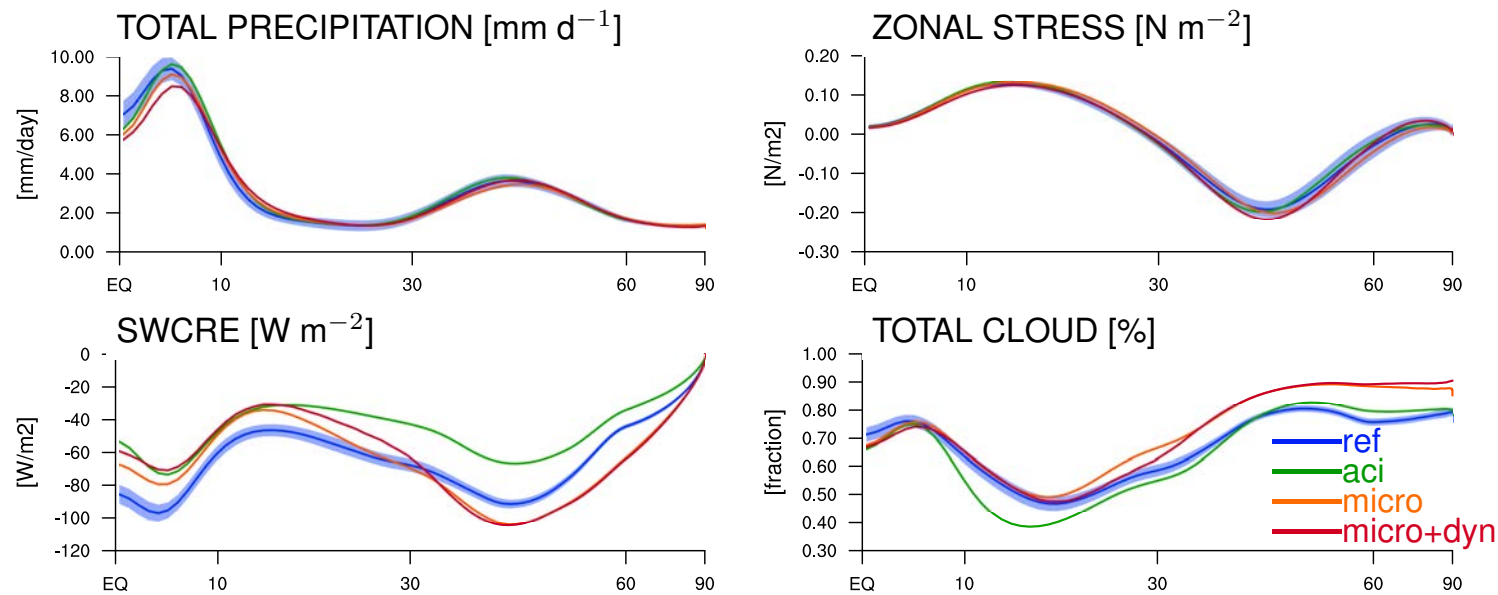
Change in CRE for CAM aquaplanets under SST+4K.



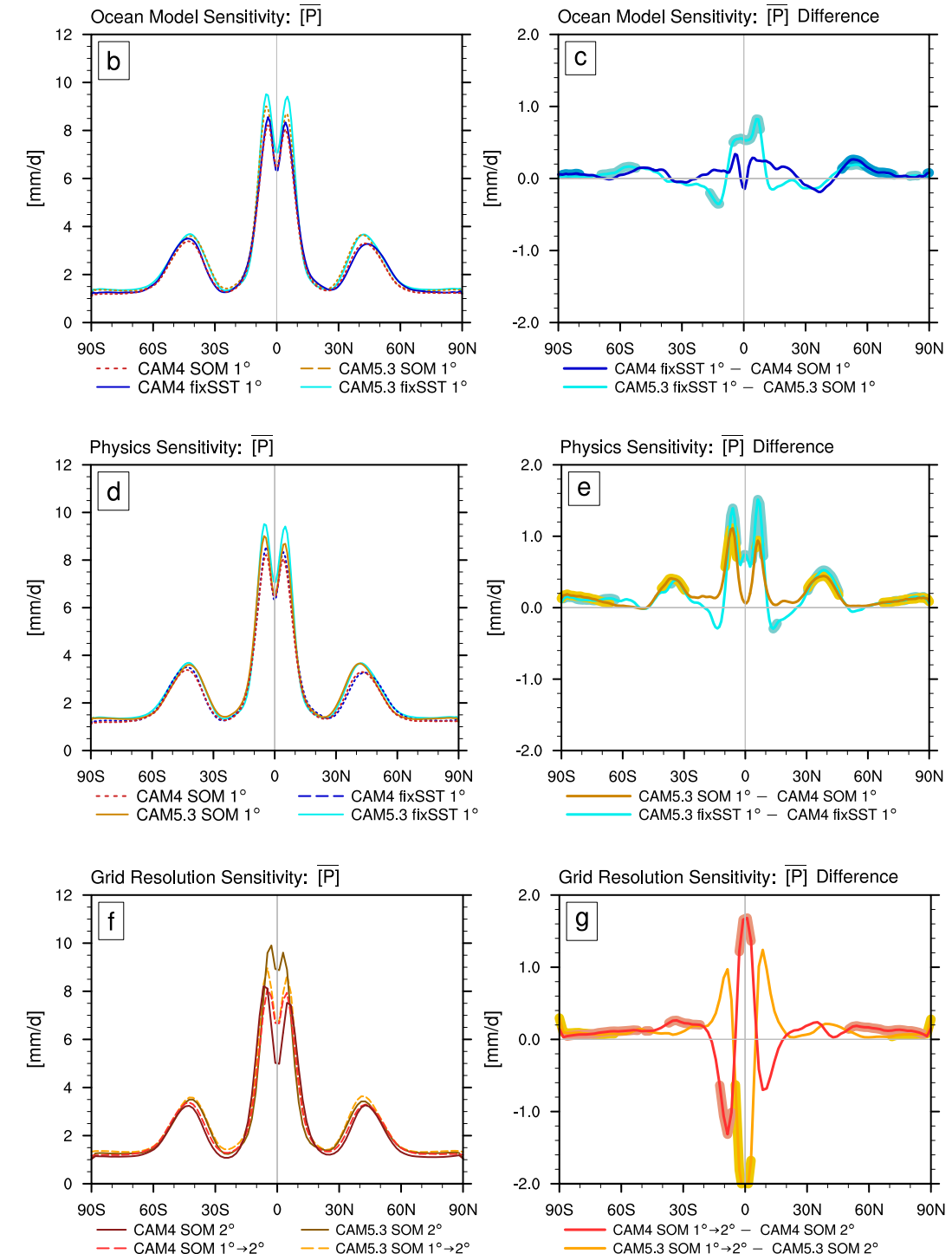
Relating extreme precipitation and convective aggregation in RCE ([Pendergrass et al. GRL 2016](#)).

(See also [Bony et al. PNAS 2016](#).)

Sensitivity to model structure



Changes with aerosol assumptions, microphysics, and dynamical core ([Medeiros et al. JAMES 2016](#)).

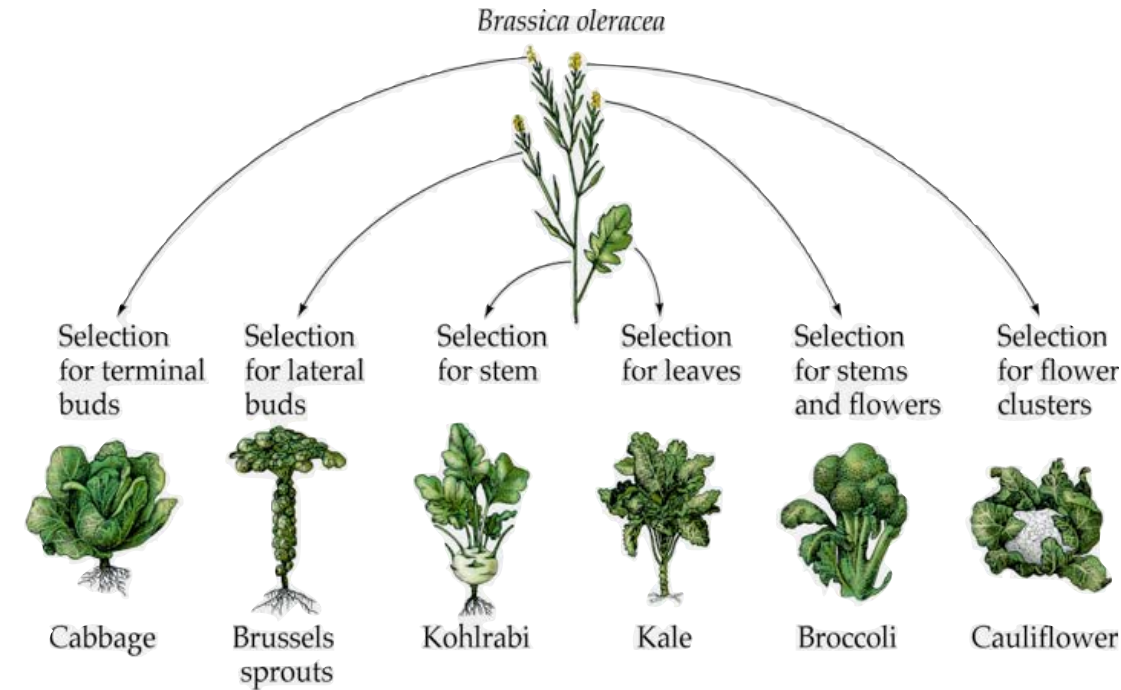


Precipitation sensitivity to physics package, air-sea coupling, and resolution (Benedict et al. in prep.)

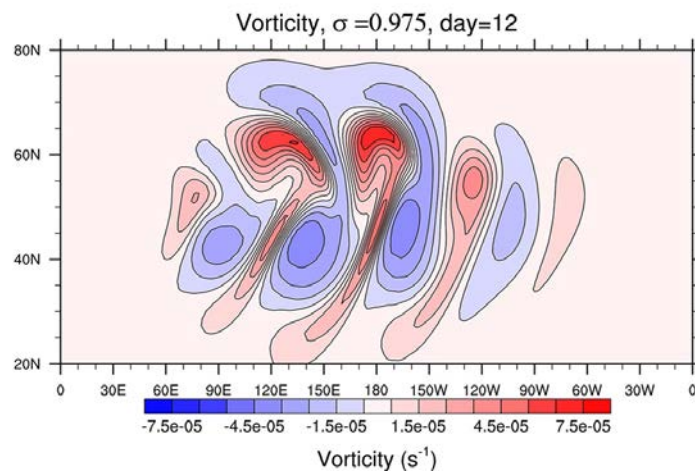
artificial selection

Cultivating an ecosystem of model complexity

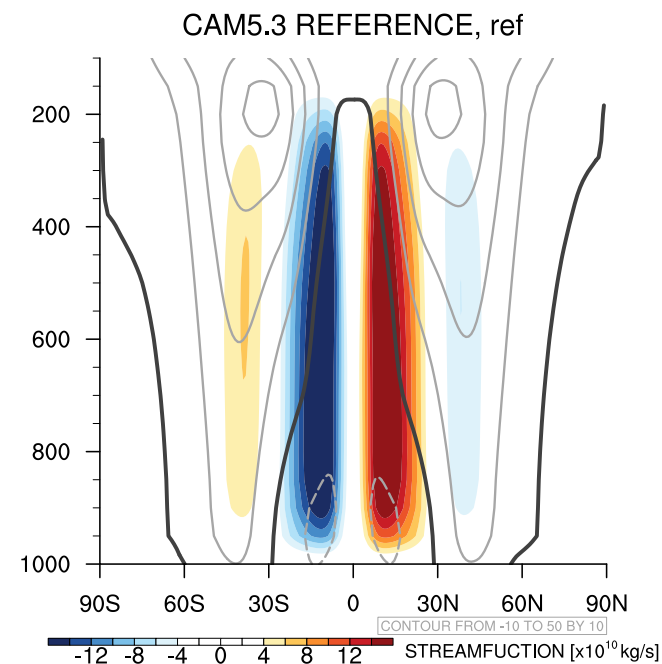
- ▶ Eos Article (Polvani et al., submitted)
- ▶ <http://www.cesm.ucar.edu/models/simpler-models/>



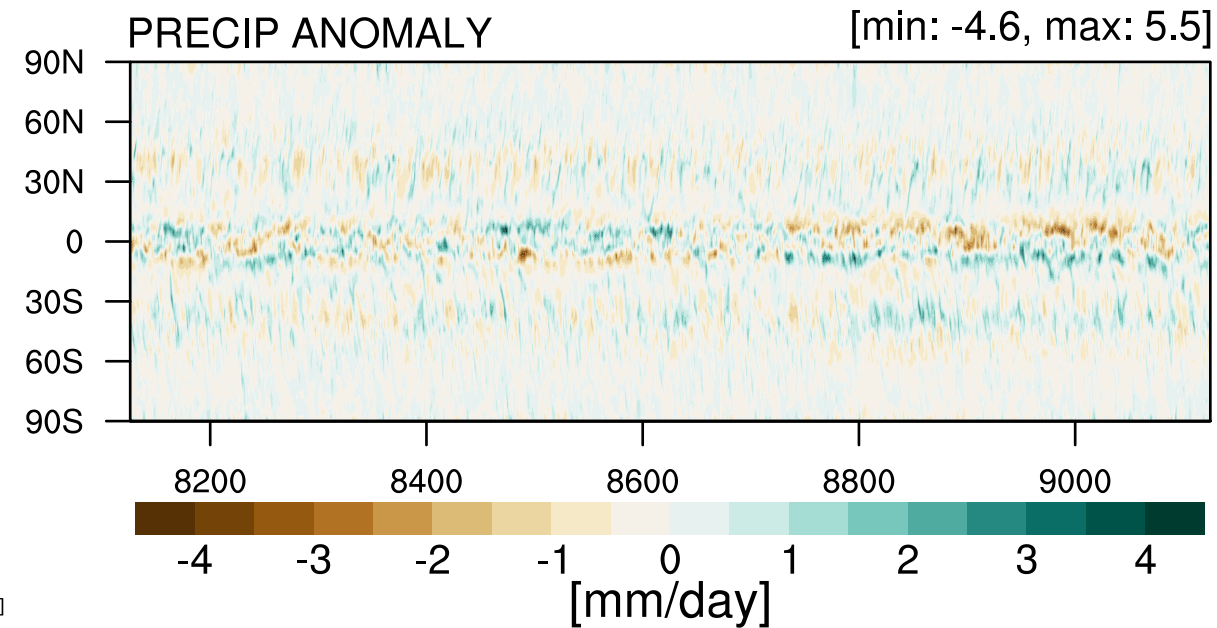
Adiabatic & Held-Suarez



Fixed SST Aquaplanet



Slab-Ocean Aquaplanet

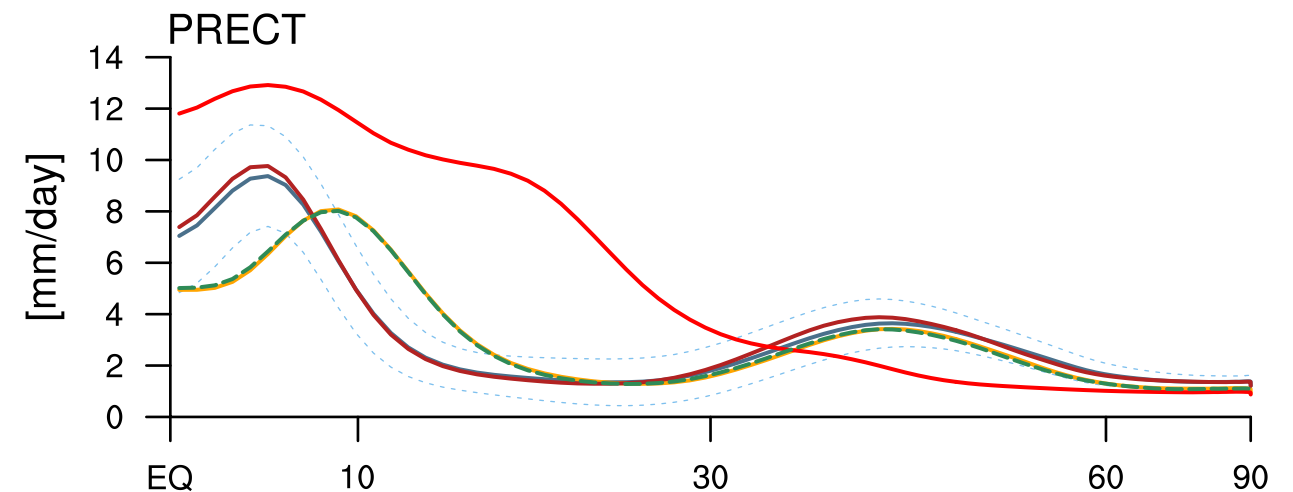
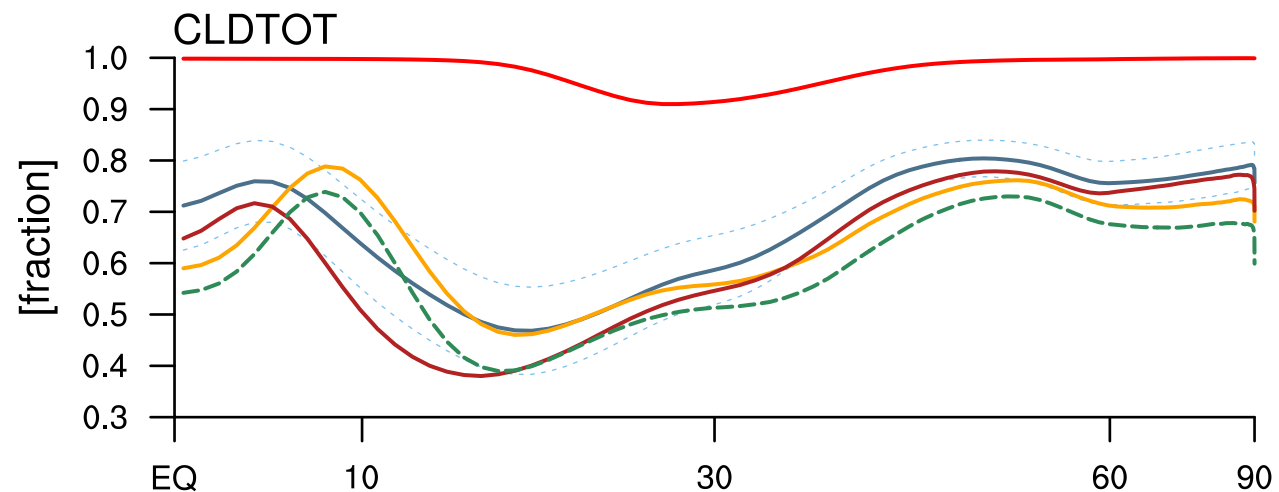
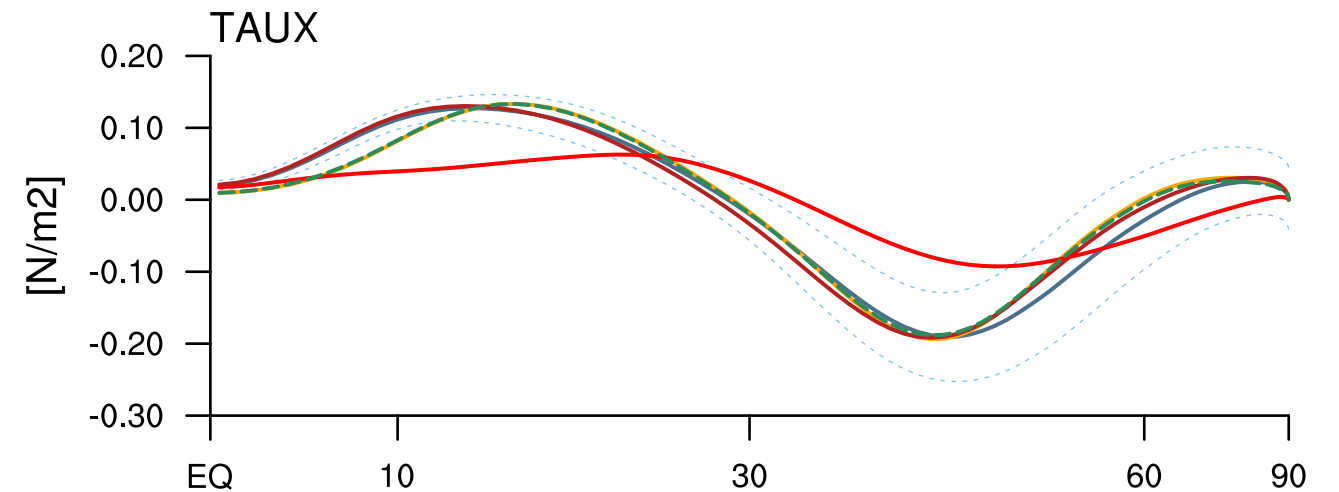
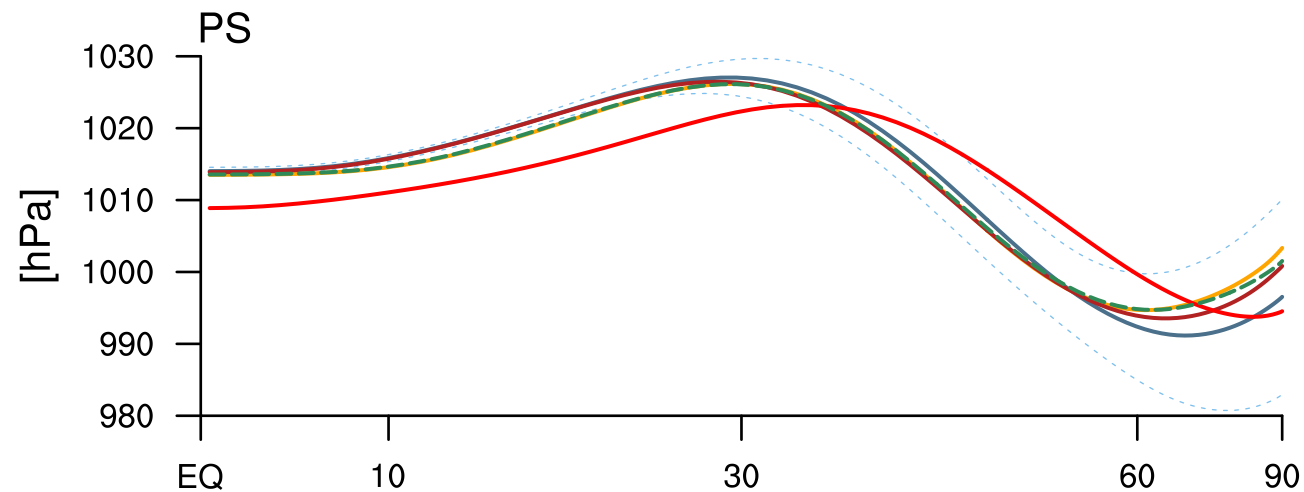
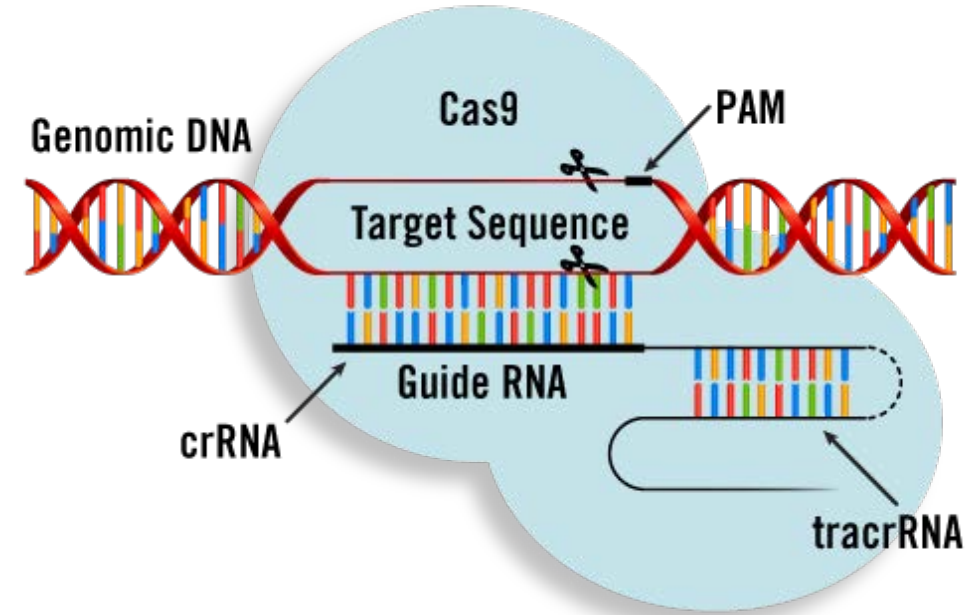


Genetic Manipulation

designer models?

EXAMPLE: Within [aquaplanet](#) framework,
remove effects of clouds:

- ▶ **Cloud radiative effect**
- ▶ **Condensate transport**
- ▶ **Latent heating effects***



Summary

- ▶ CESM as a platform allows a deep and broad hierarchy of model configurations
- ▶ Aquaplanets and dry dynamics soon to be supported “out of the box”
- ▶ Hierarchy allows simplified views into complex processes, including
 - ▶ convection aggregation
 - ▶ cloud-circulation interaction
 - ▶ structural sensitivities
- ▶ Bonus: useful approach for inter-model comparison