

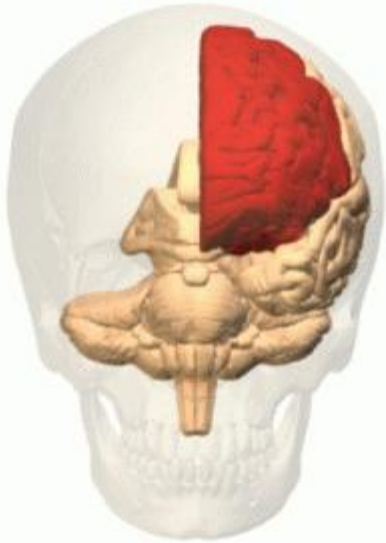


De-Evolving Climate Models

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Understanding the Human Brain



http://en.wikipedia.org/wiki/File:Frontal_lobe_animation.gif

- Much work on understanding the human brain has revolved around the study of cognitive impairments in people who have suffered disease or injury to specific areas.
- Famous cases include that of Phineas Gage, a railway worker who suffered personality changes following accidental damage to his prefrontal cortex.
- Can we better understand the physical mechanisms of cloud feedbacks by removing or simplifying different components of climate models?



Selected Process On/Off Climate Intercomparison Experiment (SPOOKIE)

Aims

- Establish the relative contributions of different areas of model physics to inter-model spread in cloud feedback
- Understand the roles of different areas of model physics in mechanisms of robustly simulated cloud feedbacks

Approach

- Repeat CFMIP-2 AMIP/AMIP Uniform +4K experiments, switching off or simplifying different model schemes in turn

Pilot Experiments

- Start by switching off convective parametrization



Convection off (convoff) Experiments

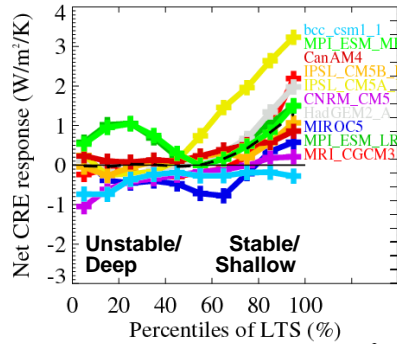
What do we expect to see?

Hypotheses

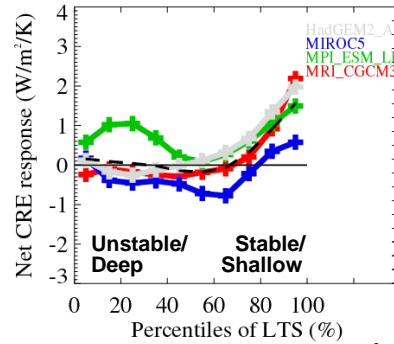
- Zhang et al. (2013) argue that positive subtropical feedback is caused by enhanced entrainment of dry air into the boundary layer from the free troposphere in models with active shallow convection.
 - If this is the sole cause of positive subtropical feedback, then convoff feedbacks will be neutral or negative.
- Sherwood et al (2014) argue that positive shallow cloud feedback (and much of its spread) is related to the strength of lower tropospheric mixing by convective parametrizations and shallow large scale circulations.
 - Hence some reduction in magnitude and spread would be expected in the absence of convective parametrization.

amip4K Cloud feedbacks over tropical oceans [30°N/S]

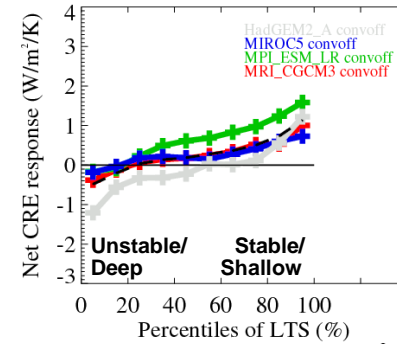
All Standard Models



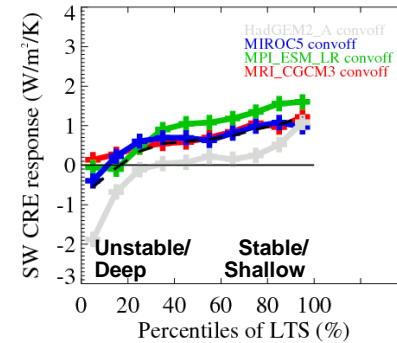
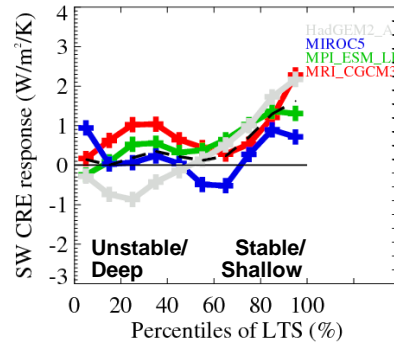
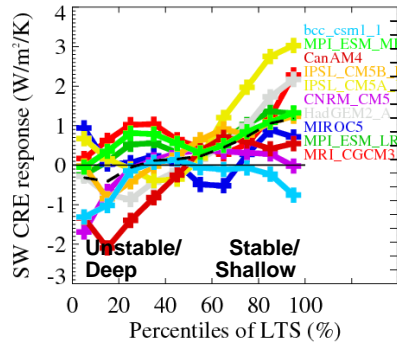
SPOOKIE Standard models



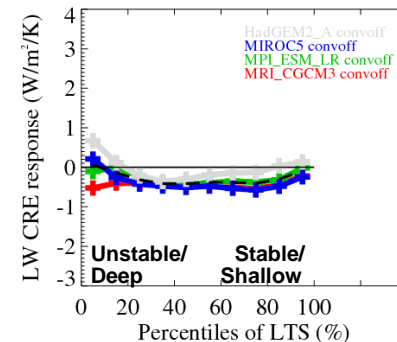
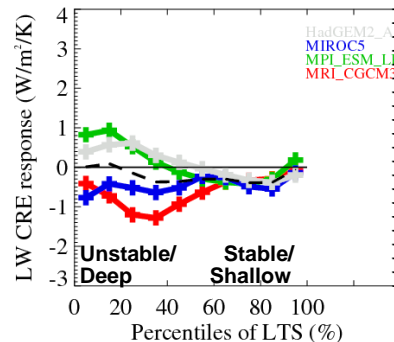
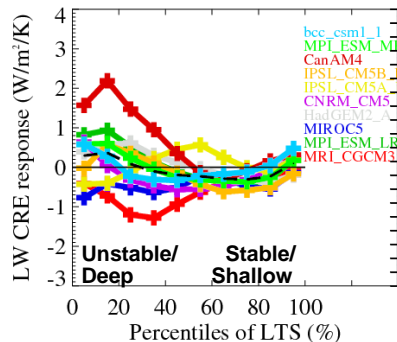
SPOOKIE ConvOff models



**Net
Cloud
Feedback***



**Shortwave
Cloud
Feedback***

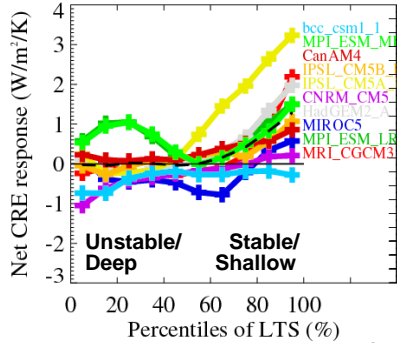


**Longwave
Cloud
Feedback***

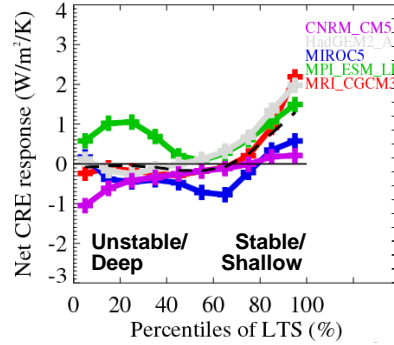
*Includes cloud masking

amip4K Cloud feedbacks over tropical oceans [30°N/S]

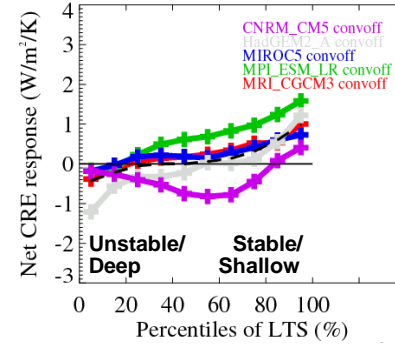
All Standard Models



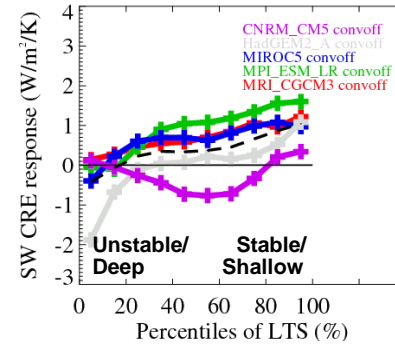
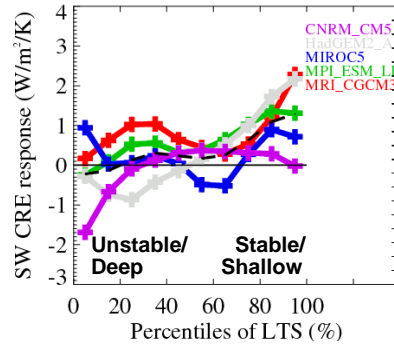
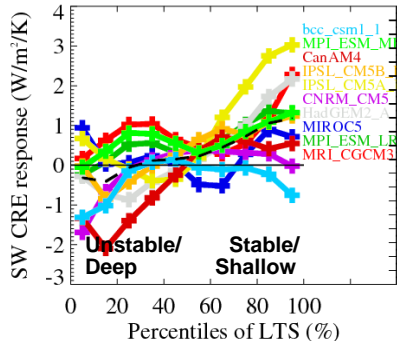
SPOOKIE Standard models



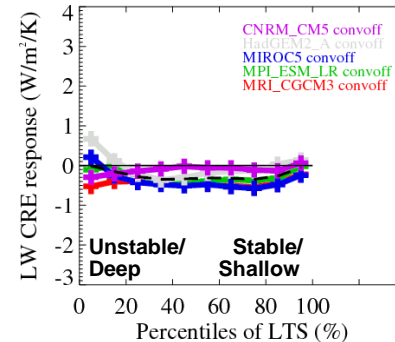
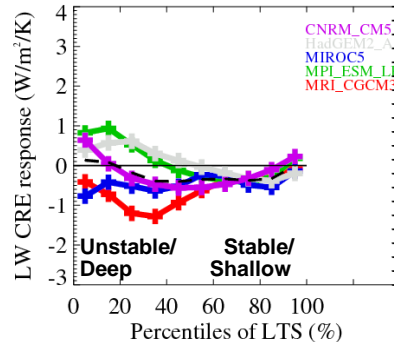
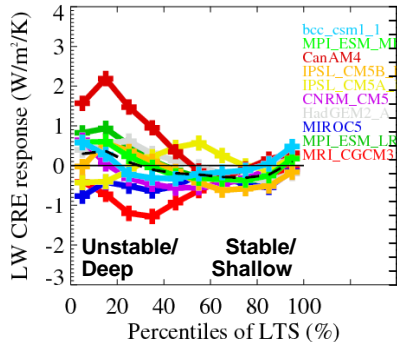
SPOOKIE ConvOff models



**Net
Cloud
Feedback***



**Shortwave
Cloud
Feedback***

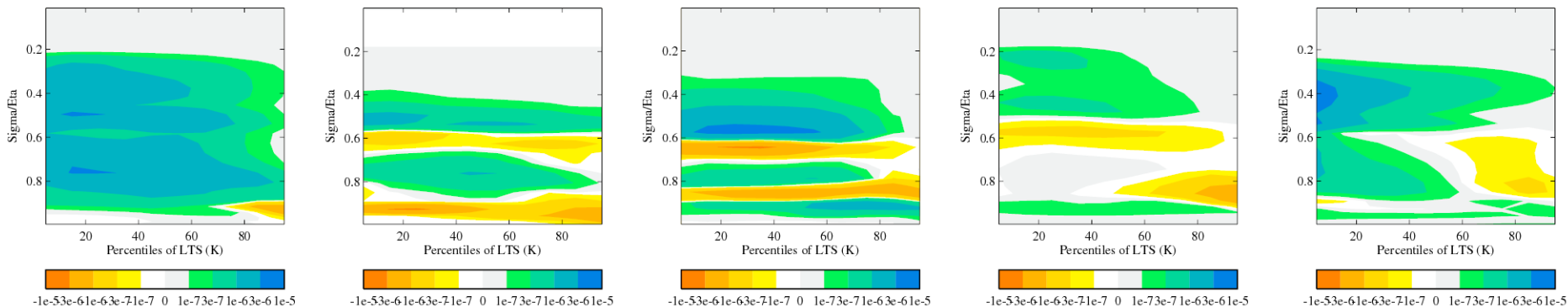


**Longwave
Cloud
Feedback***

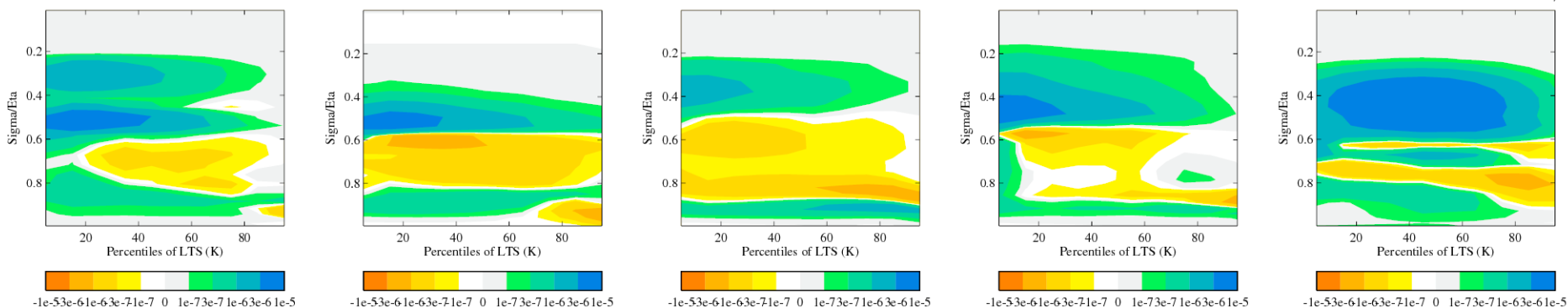
*Includes cloud masking

AMIP +4K Response of Cloud Liquid Water (g/g/K)

Standard models



Conv Off models



MRI-CGCM3

MPI-ESM-LR

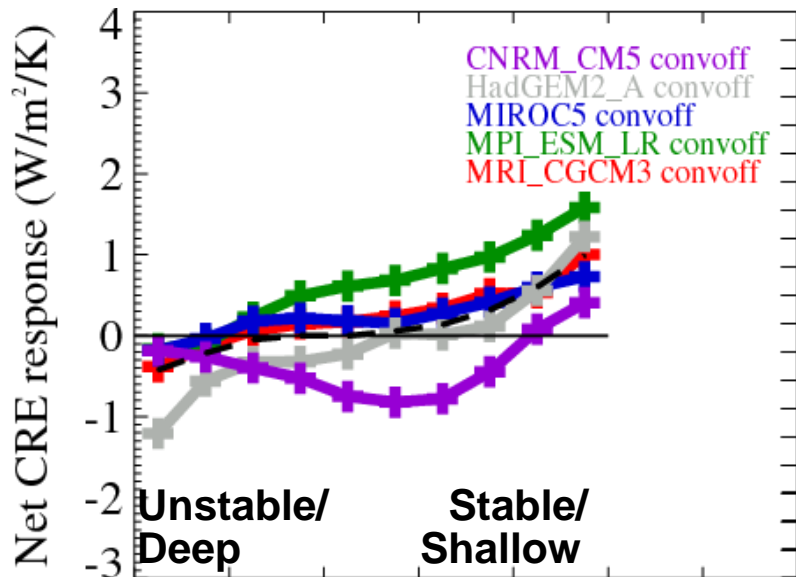
MIROC5

HadGEM2

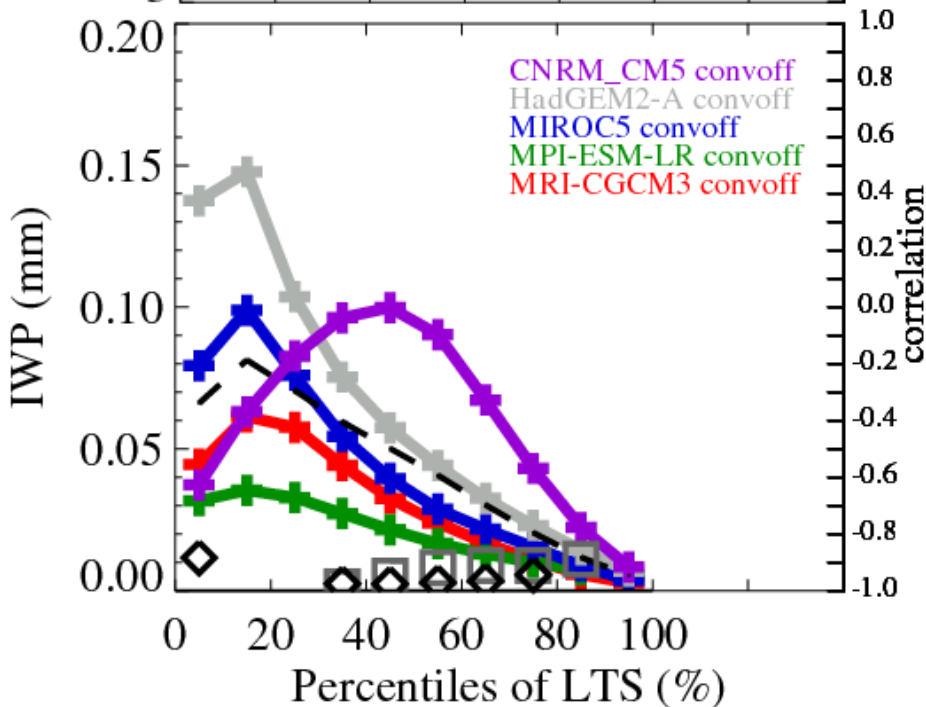
CNRM-CM5

SPOOKIE ConvOff models

Net
Cloud
Feedback



AMIP
Control
Ice Water
Path (mm)



Black diamonds indicate significant correlations with cloud feedbacks in same regime

Grey squares indicate a significant correlation with cloud feedback area average over tropical oceans



Preliminary Conclusions

- Models are viable without parameterized convection at present resolutions
- Models are able to reproduce positive subtropical cloud feedback without parametrized convection
- Four models show convergence on deep and shallow tropical cloud feedbacks without parametrized convection
- Phase change feedback looks to be more important in CNRM-CM5
- The CFMIP experiments provide an efficient platform for such sensitivity experiments
- Such sensitivity experiments provide an opportunity to advance our understanding of cloud feedback mechanisms and also to test the physical credibility of 'emergent constraints'