

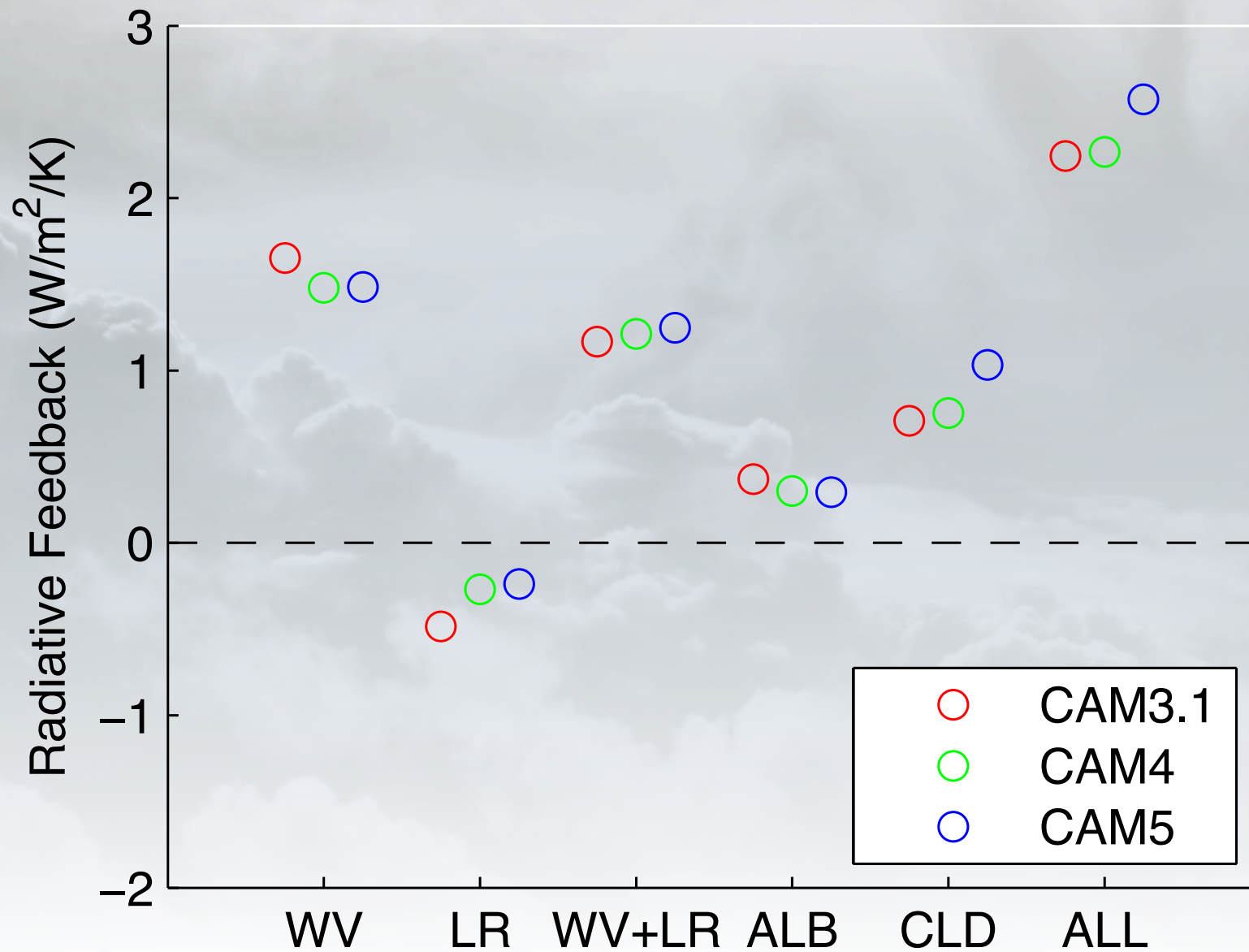
Diagnosing Cloud Feedbacks
using Nonlinear
Radiative Kernels
B. Sanderson



Outline

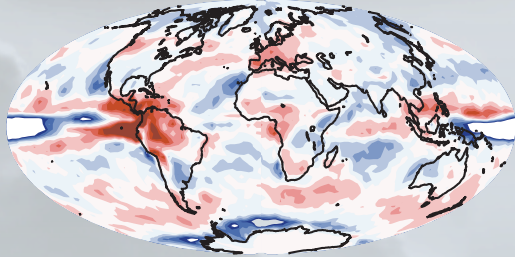
- Linear Kernels in CAM
- Cluster analysis
- Nonlinear kernel analysis

Linear Kernels in CAM

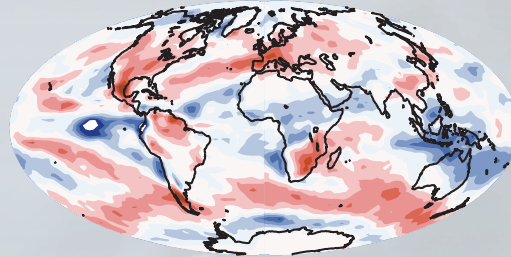


Adjusted Cloud Feedback

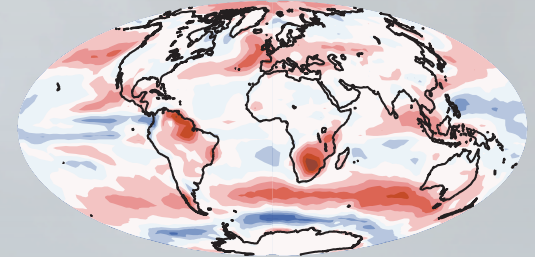
CAM 3.1 SW



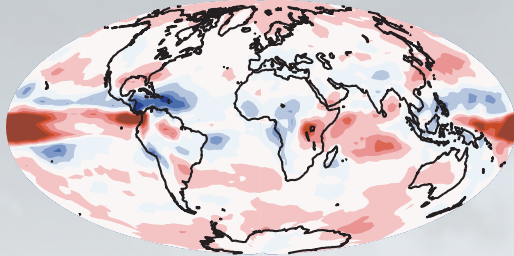
CAM 4.0 SW



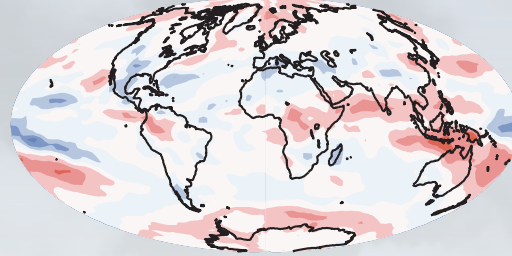
CAM 5.0 SW



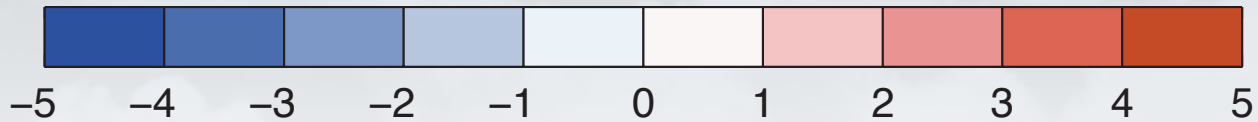
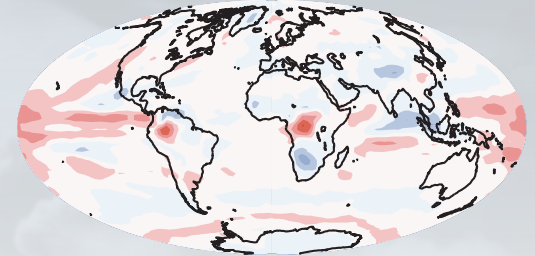
CAM 3.1 LW



CAM 4.0 LW



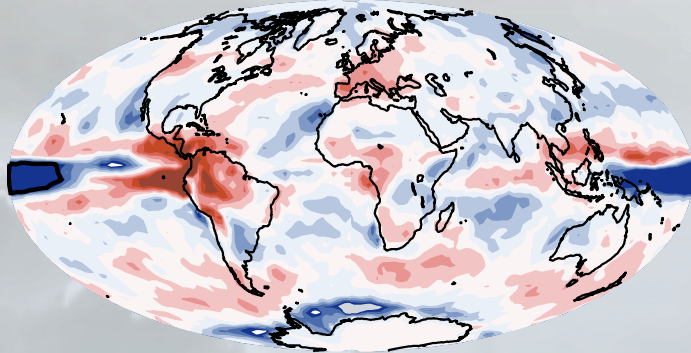
CAM 5.0 LW



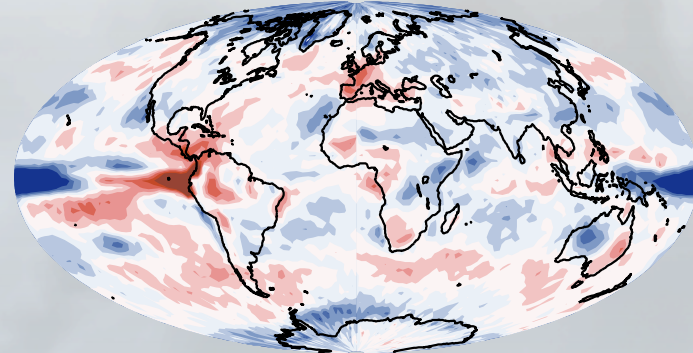
Adjusted Cloud Feedback ($\text{Wm}^{-2}\text{K}^{-1}$)

Non-linear estimator

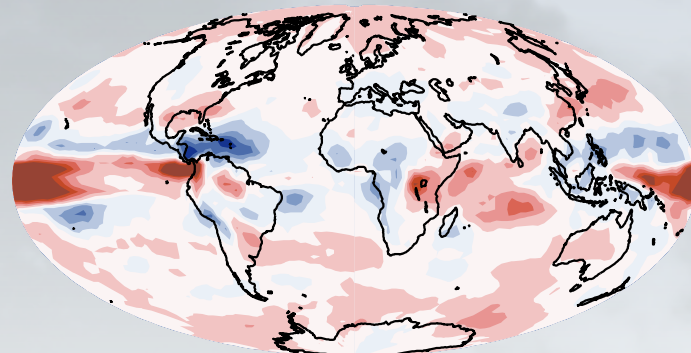
Shortwave dACRF (2X-1X CO₂)



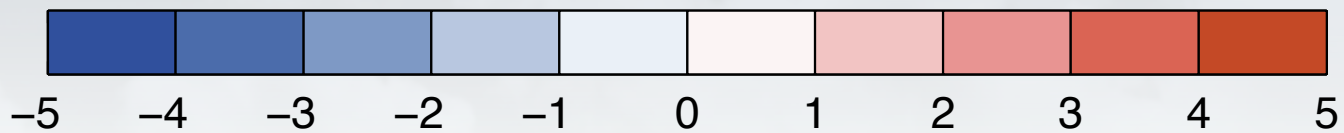
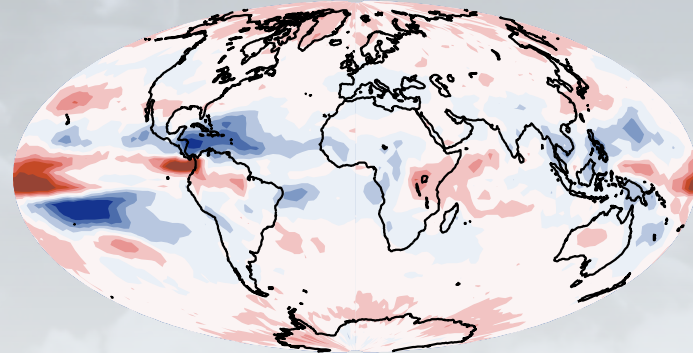
NN. estimate for SW (2X-1X CO₂)



Longwave dACRF (2X-1X CO₂)

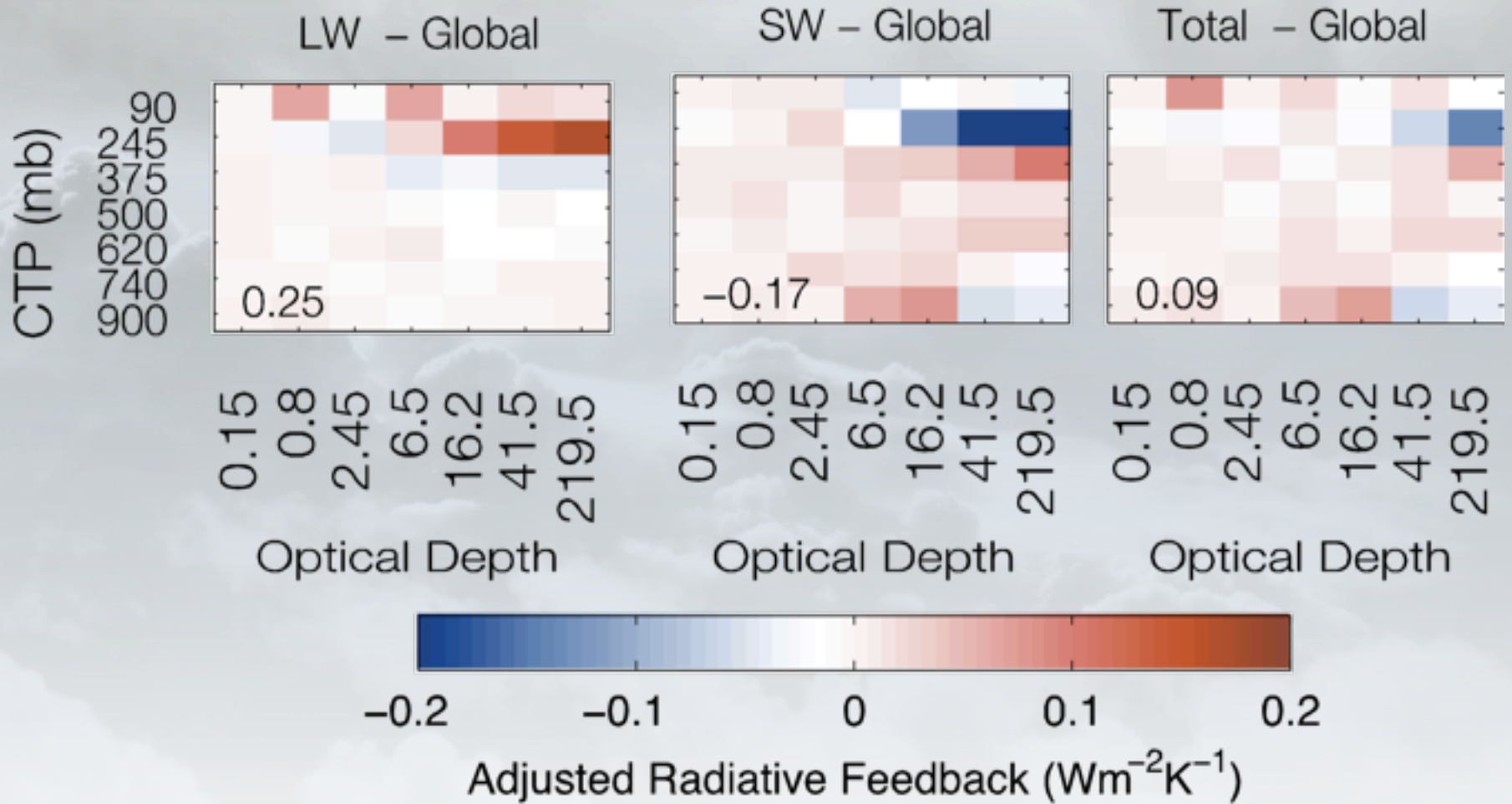


NN. estimate for LW (2X-1X CO₂)



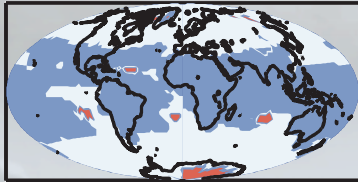
Adjusted Cloud Feedback ($\text{Wm}^{-2}\text{K}^{-1}$)

Non-linear estimator

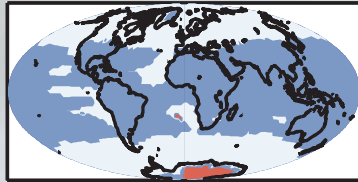


Clustering

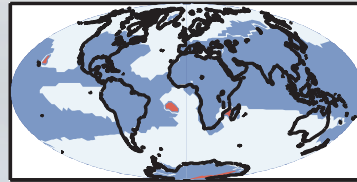
Jan cam3.1



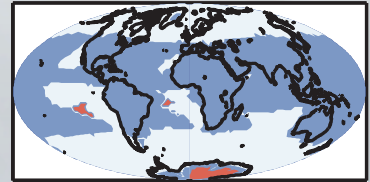
Apr cam3.1



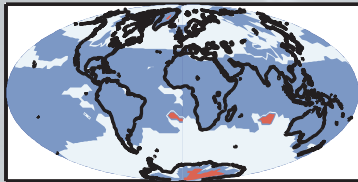
Jul cam3.1



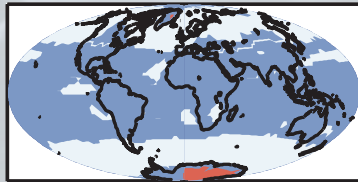
Oct cam3.1



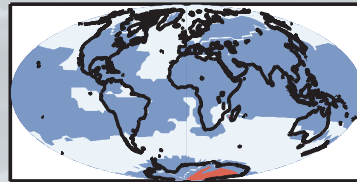
Jan cam4.0



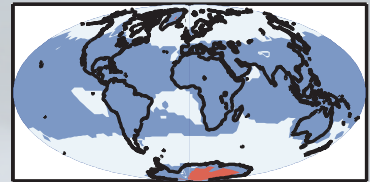
Apr cam4.0



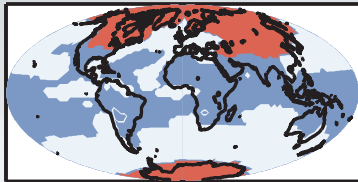
Jul cam4.0



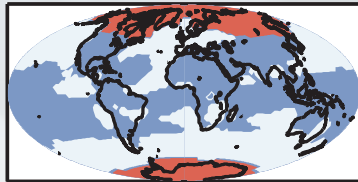
Oct cam4.0



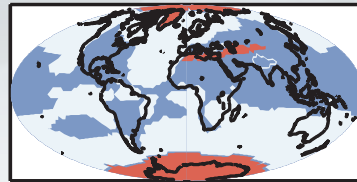
Jan cam5.0



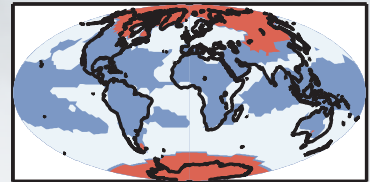
Apr cam5.0



Jul cam5.0



Oct cam5.0

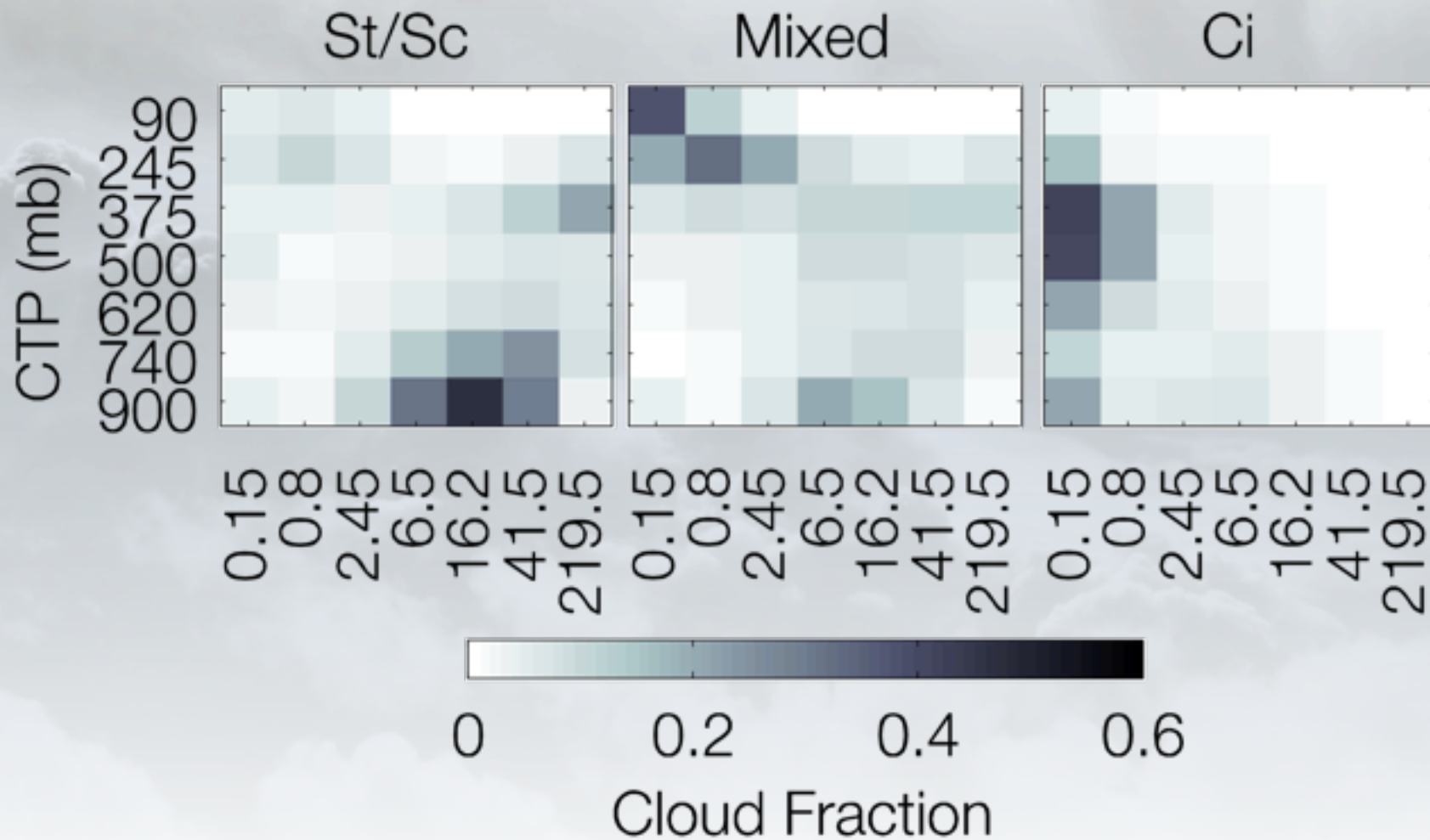


St/Sc

Mixed

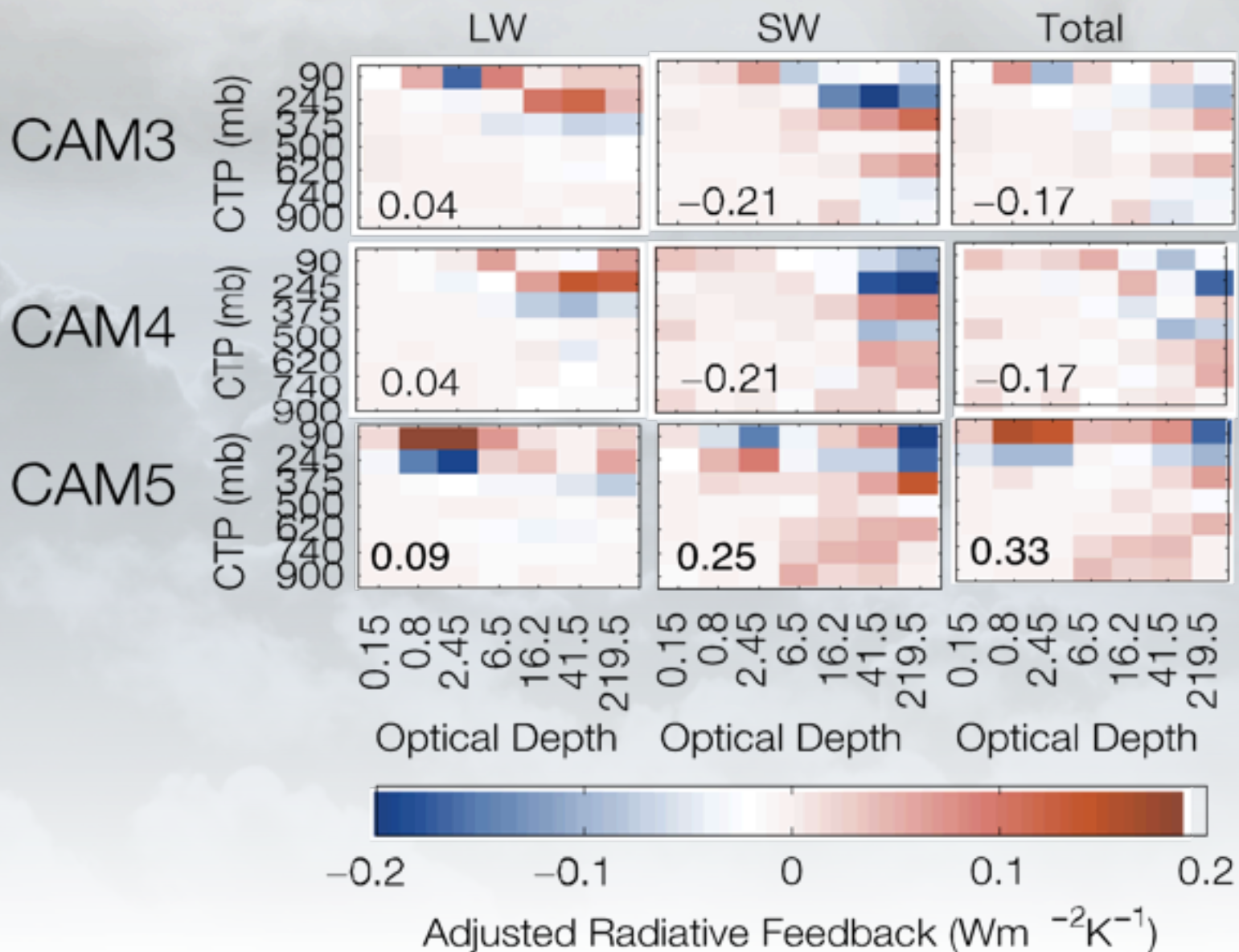
Ci

Clustering



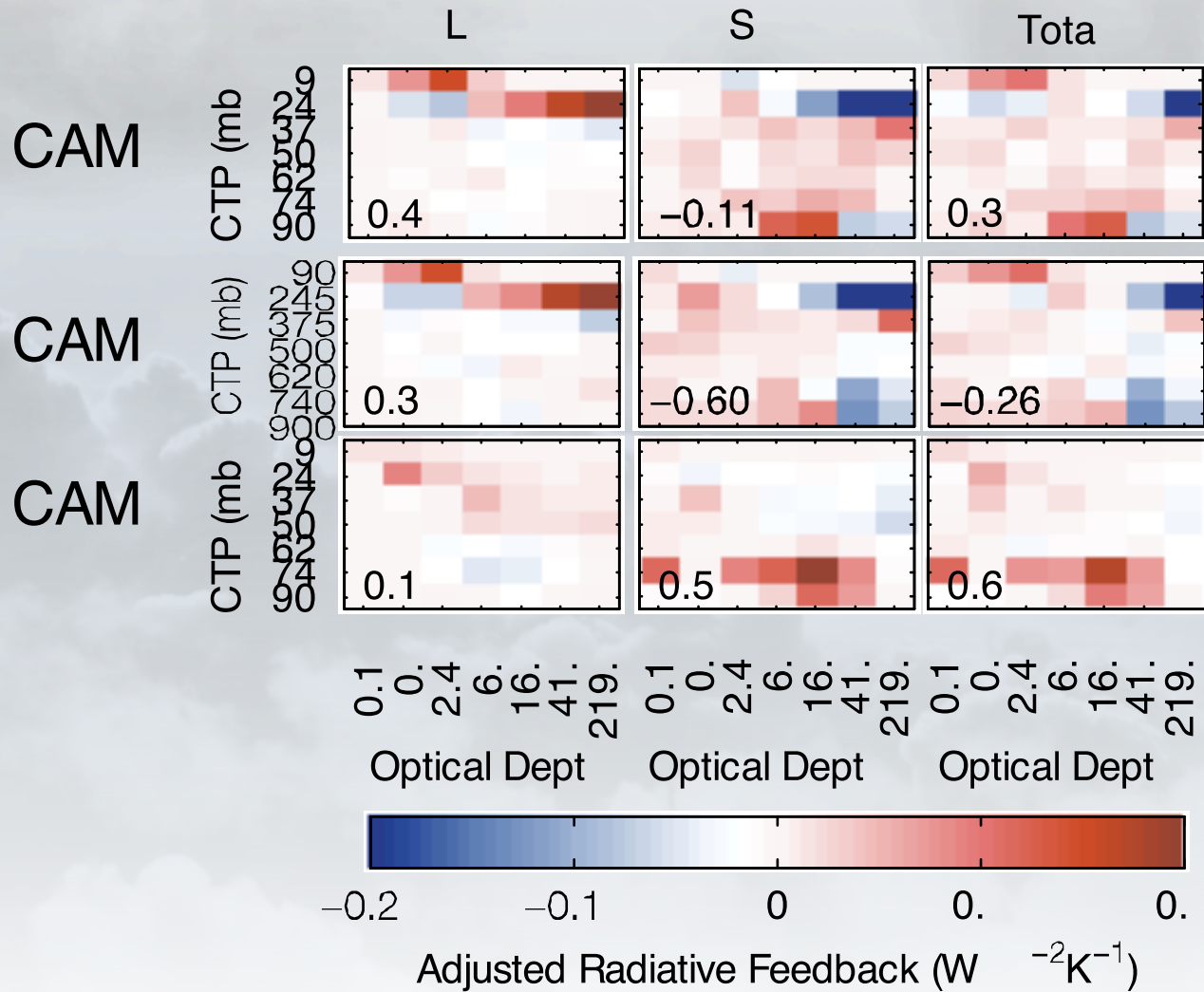
Clustering

St/Sc Regions



Clustering

Mixed Cloud Regio



Summary

- New non-linear kernel technique allows direct estimate of cloud forcing changes from P/Tau diagram output
- Increased CAM5 sensitivity has two main causes: low cloud, shortwave feedback outside Sc regions and absence of deep convective negative feedback
- To Do: COSP input, Uncertainty Analysis and Multi-model ensemble