CAM^3

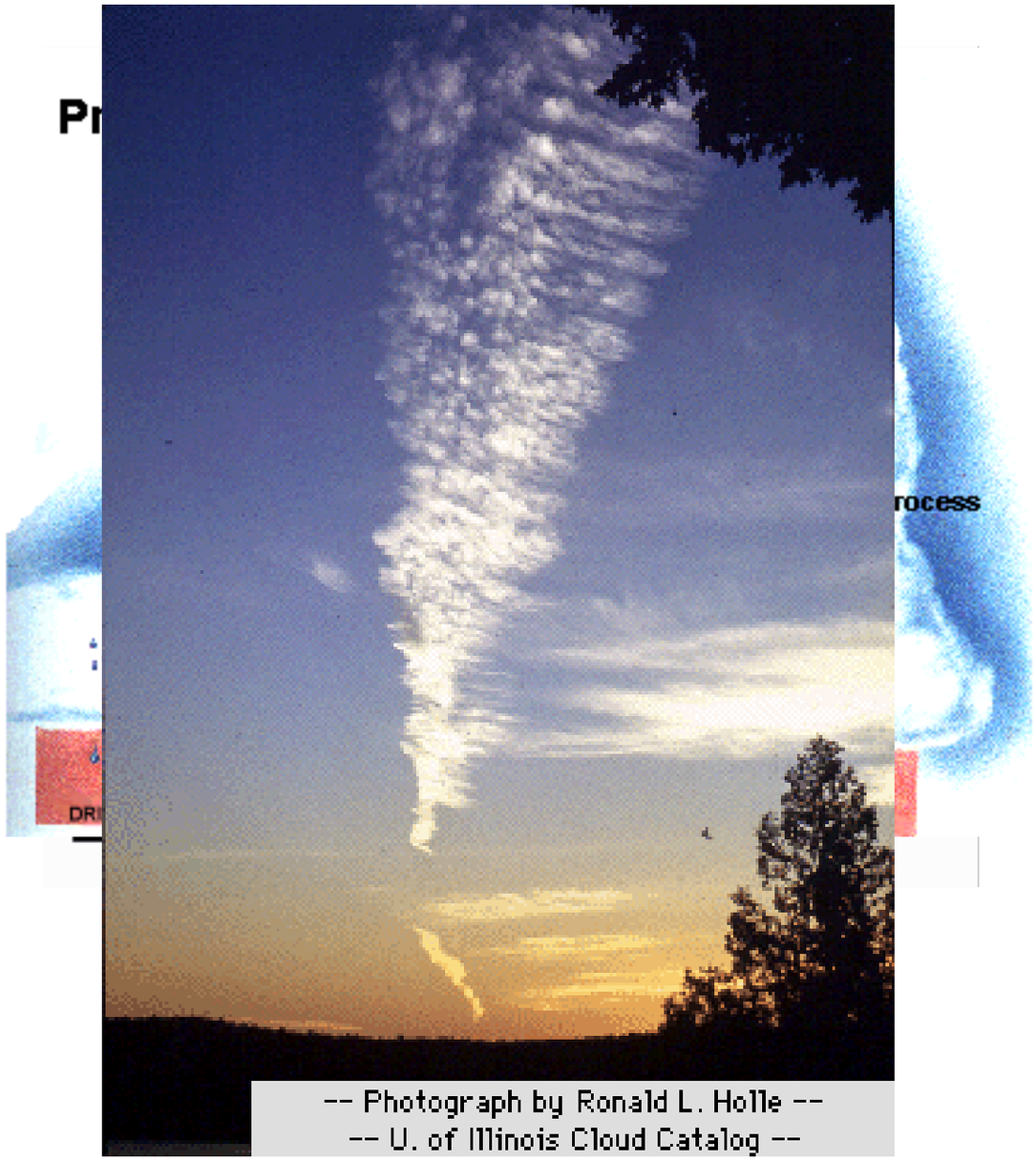
A multi-model study of parameterization and Climate Sensitivity

Ben Sanderson

QuickTime™ and a
decompressor
are needed to see this picture.

Ensemble Design

Parameters

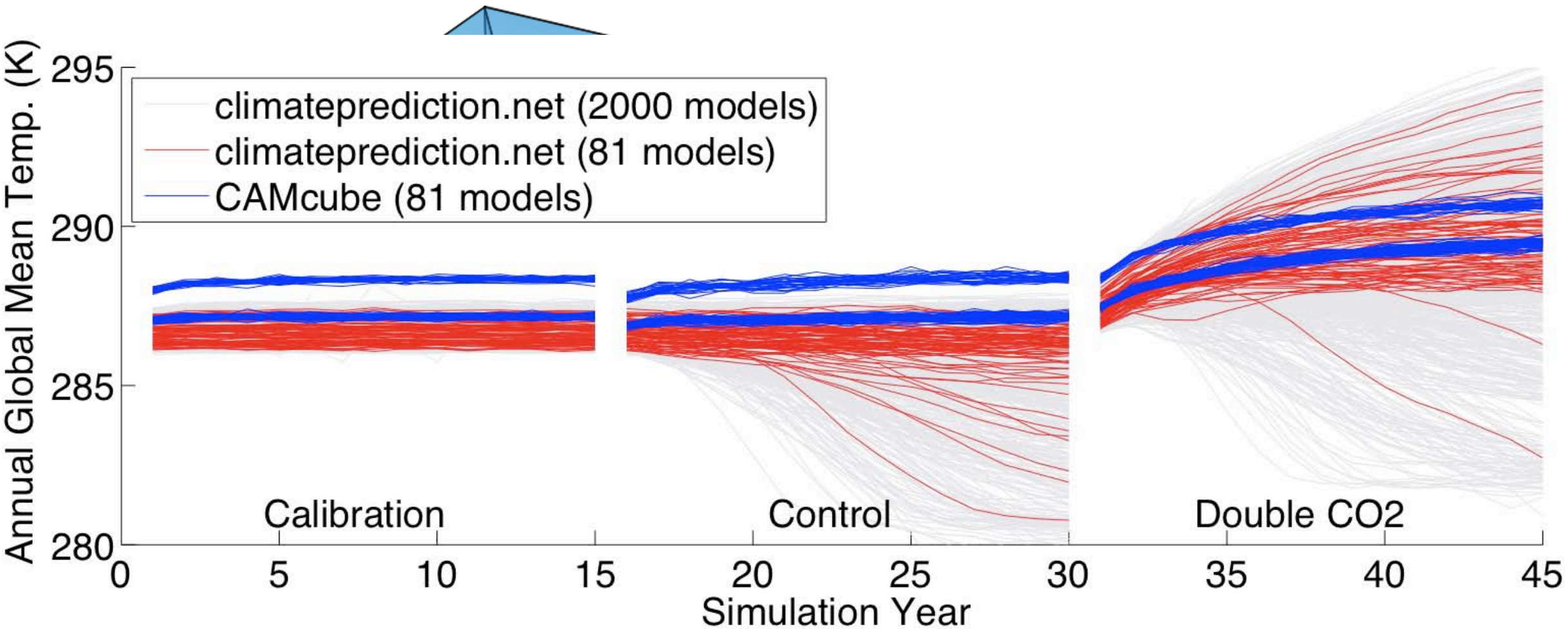


- fractional mass entrainment rate
- threshold for ice conversion
- ice fall velocity scaling
- minimum RH for stable cloud

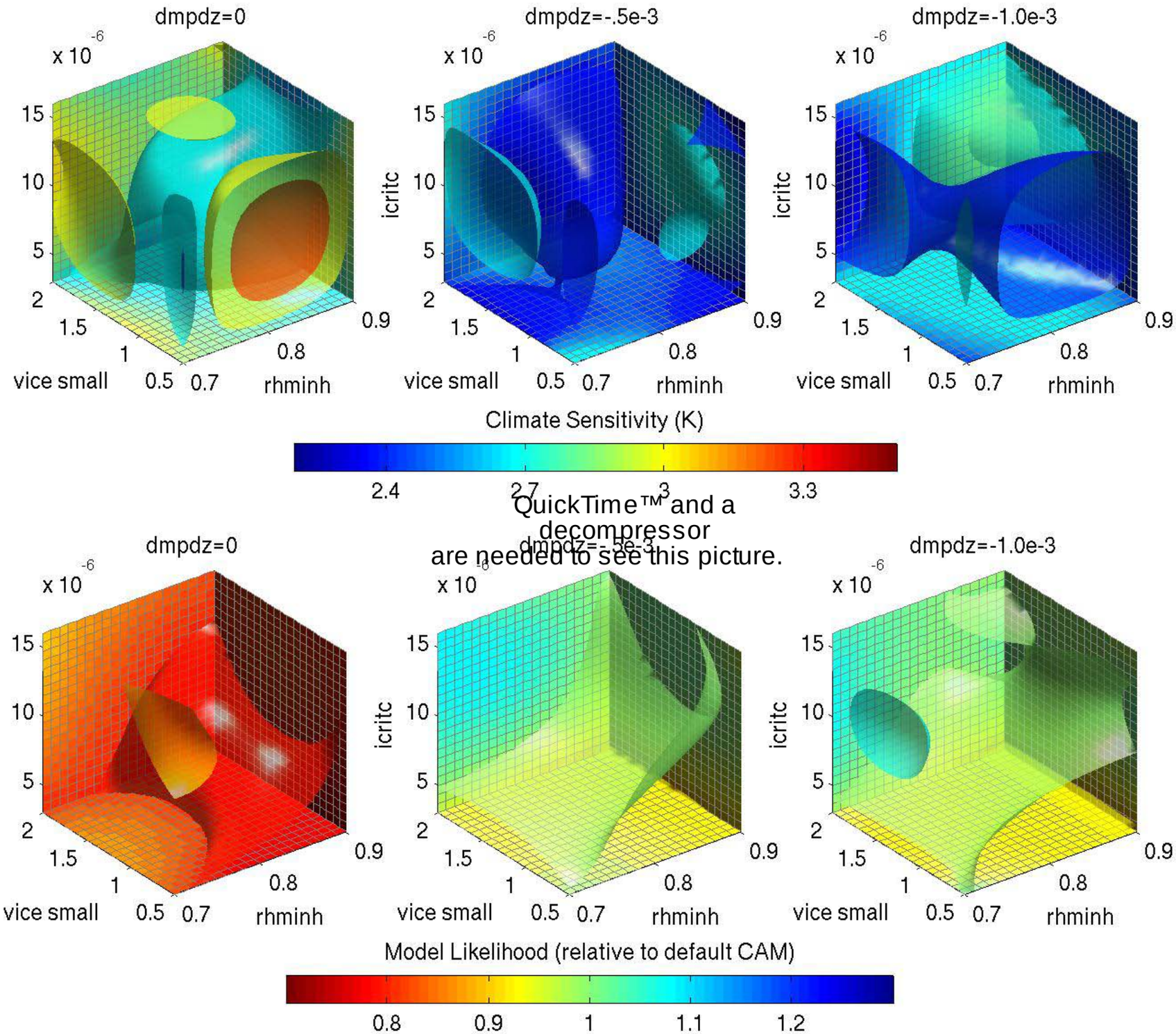
Ensemble Design

Stage 1

- Hypercube parameter sampling
- Slab sensitivity experiments

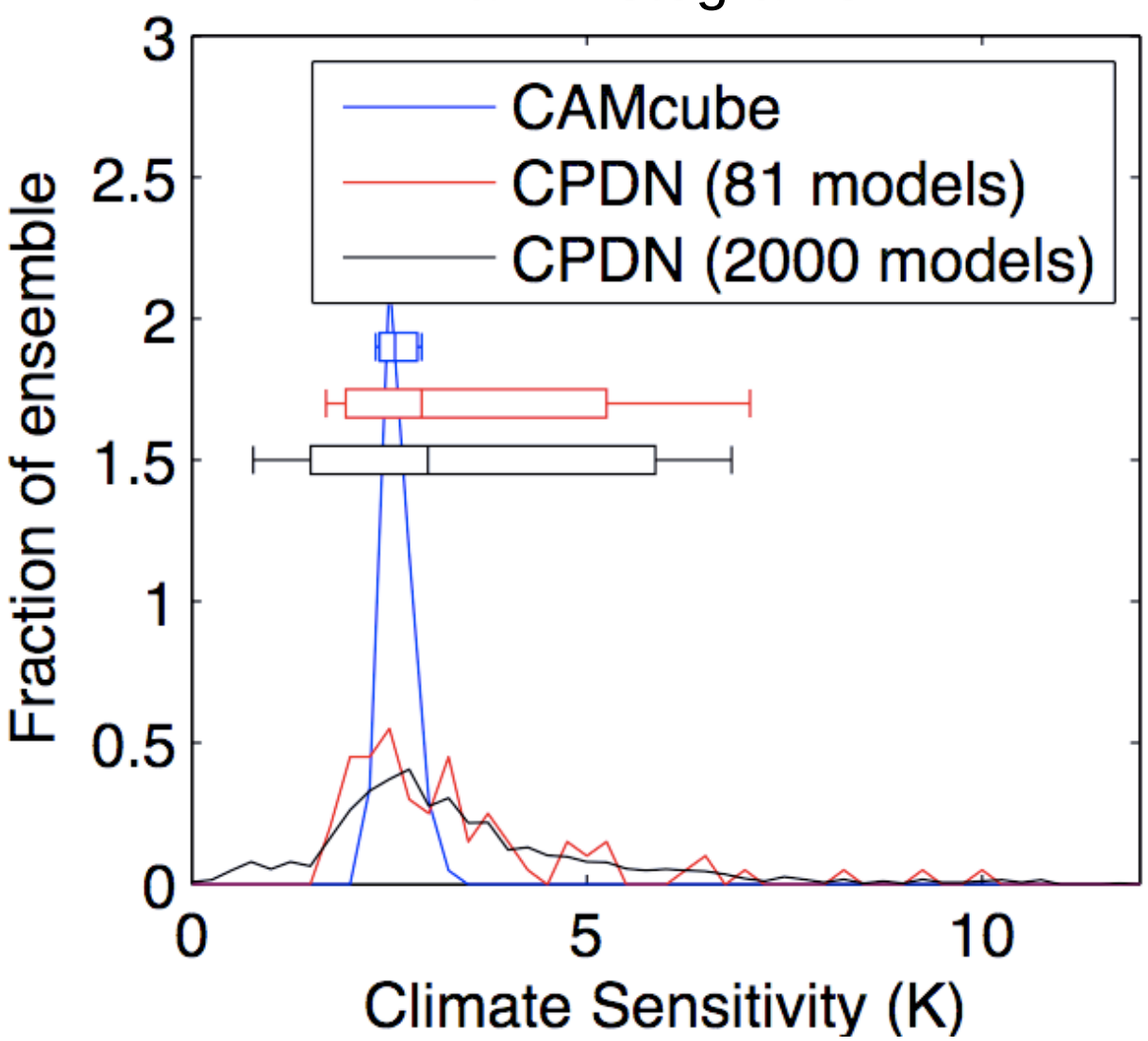


Interpolated Parameter Space

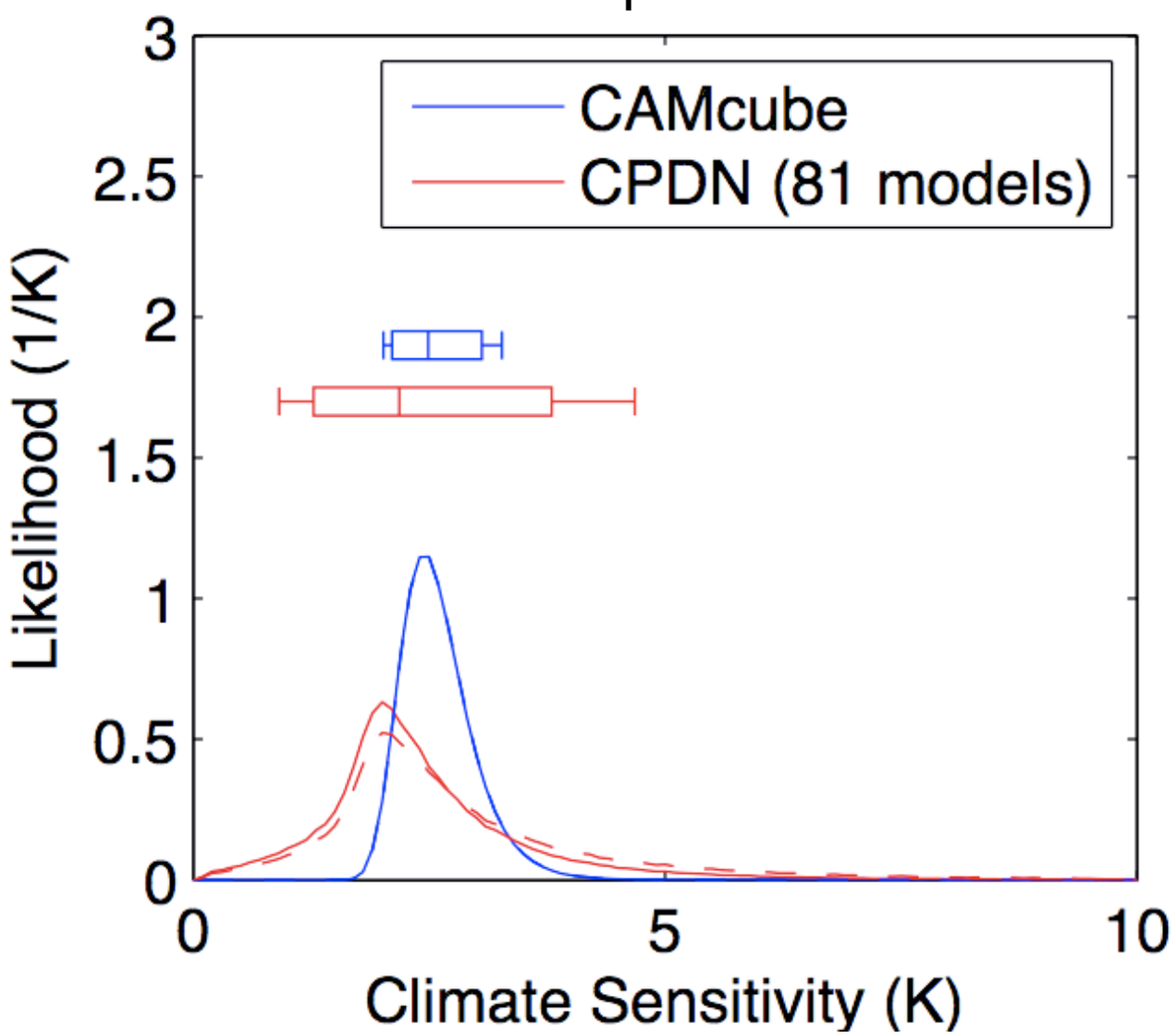


Climate Sensitivity Distributions

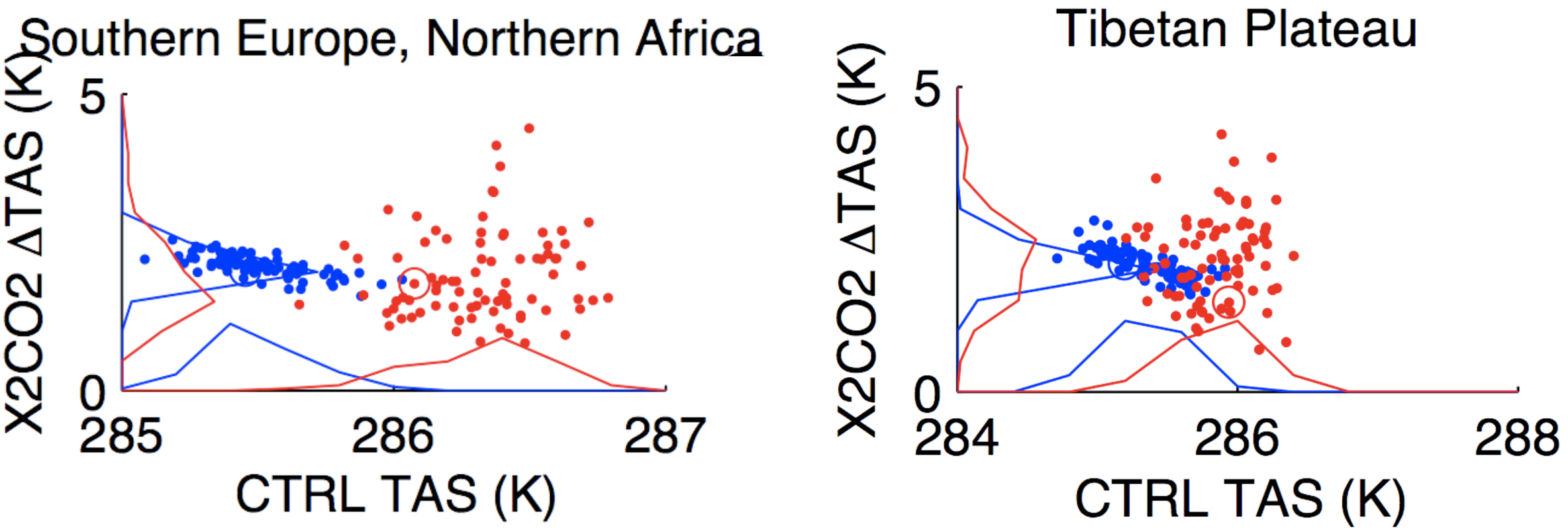
Raw Histograms



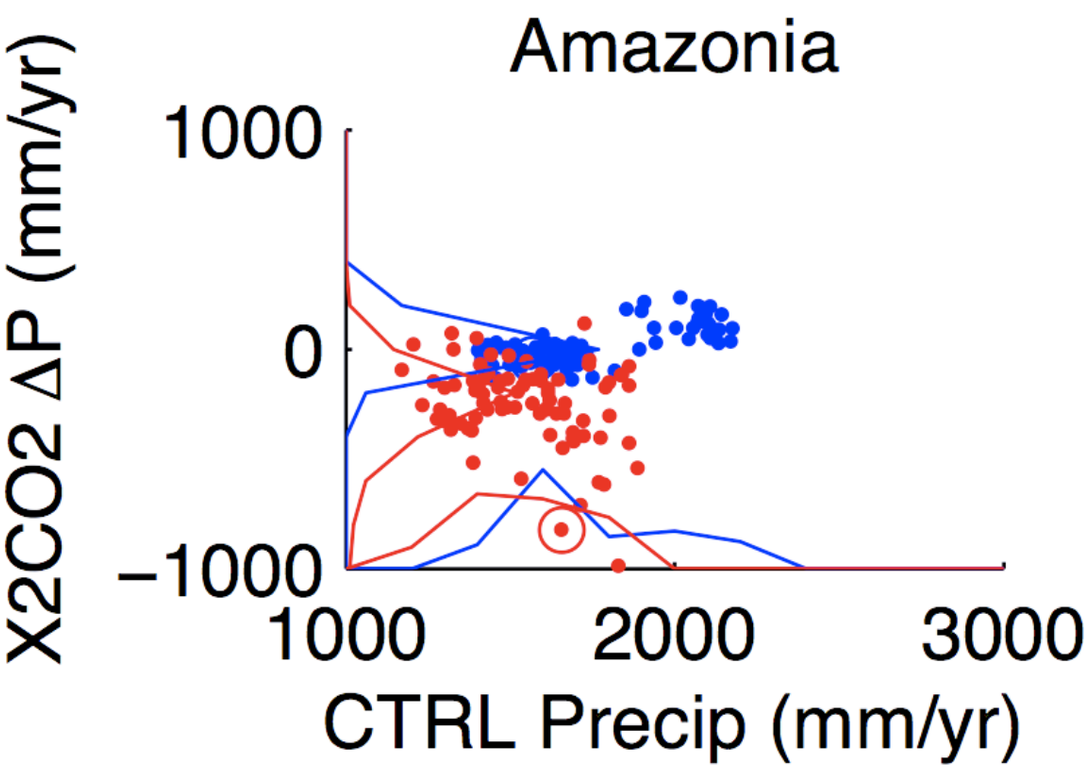
Interpolated

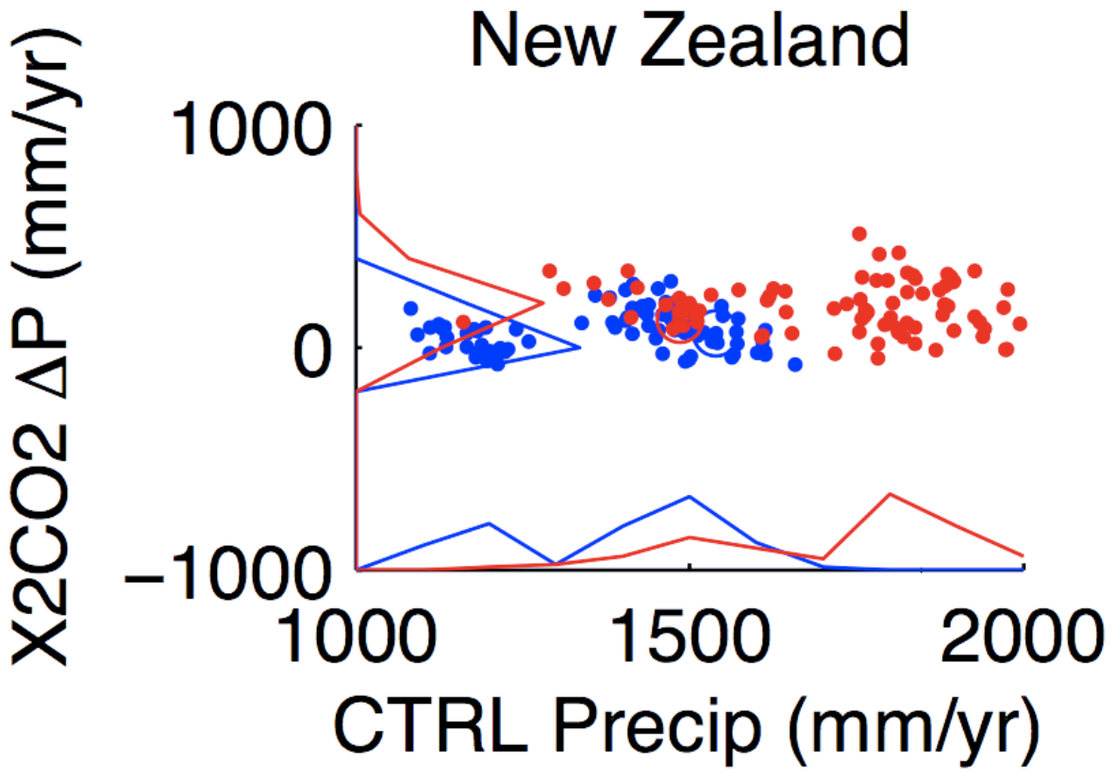


Regional Temperature Response



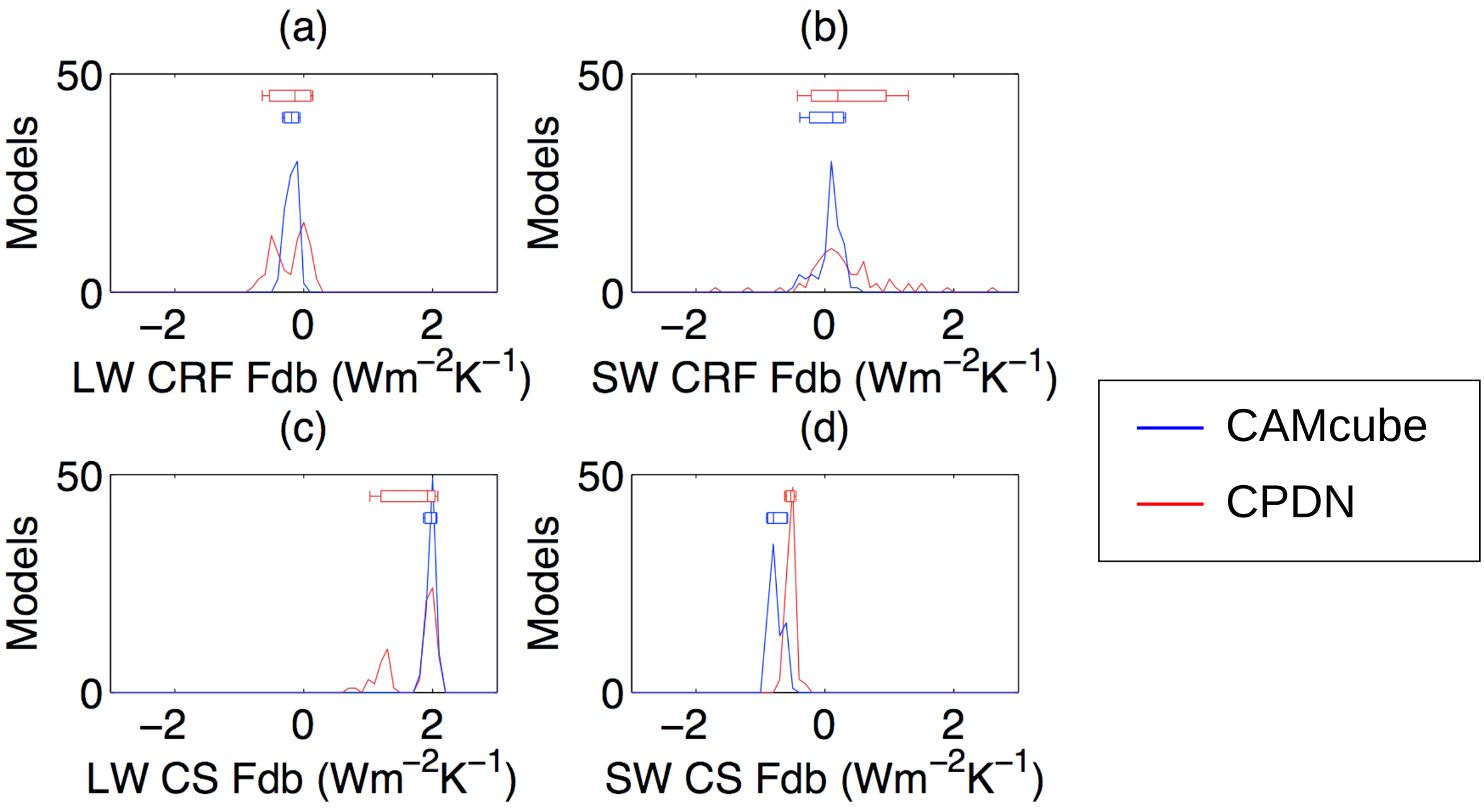
Regional Precipitation Response



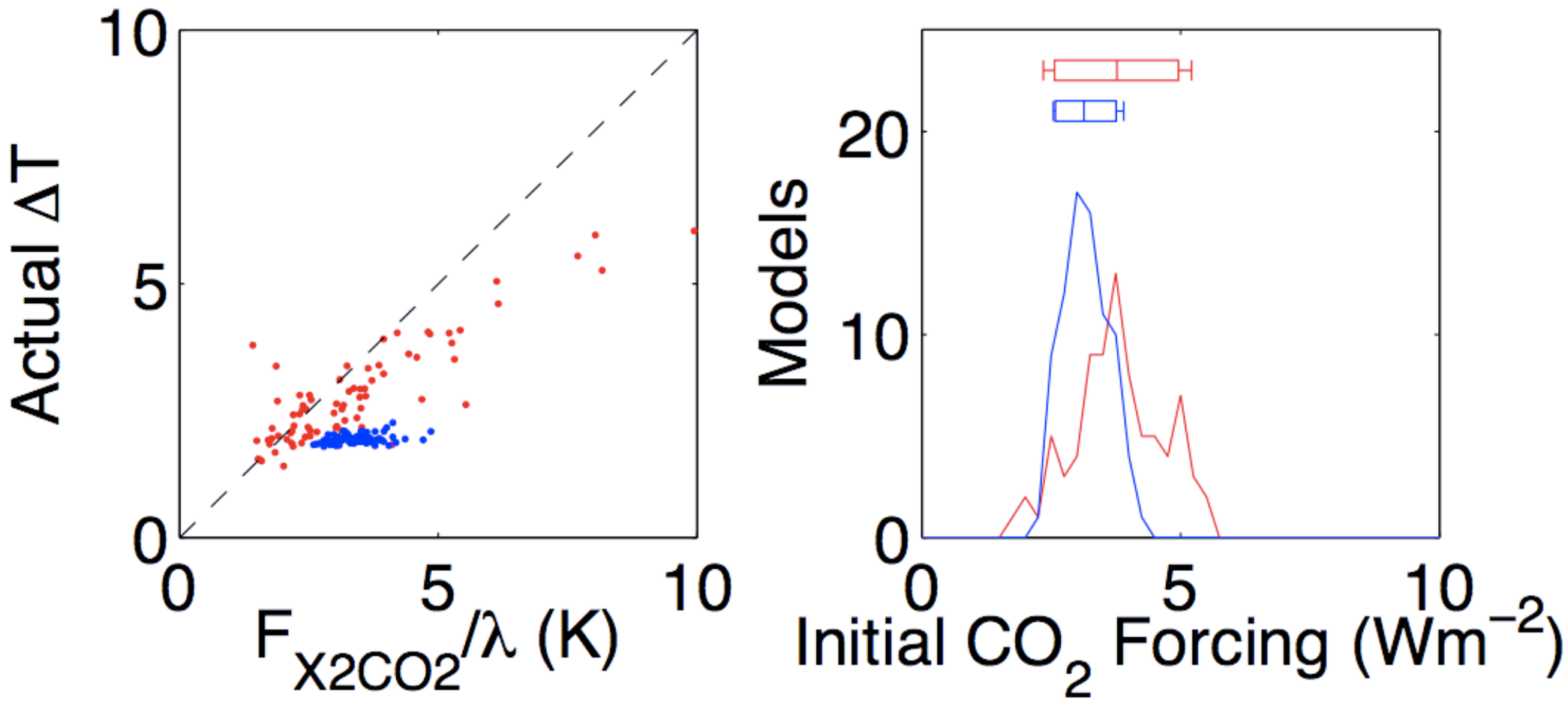


- CAMcube
- CPDN

Top of Atmosphere Global Feedbacks



Top of Atmosphere Global Feedbacks



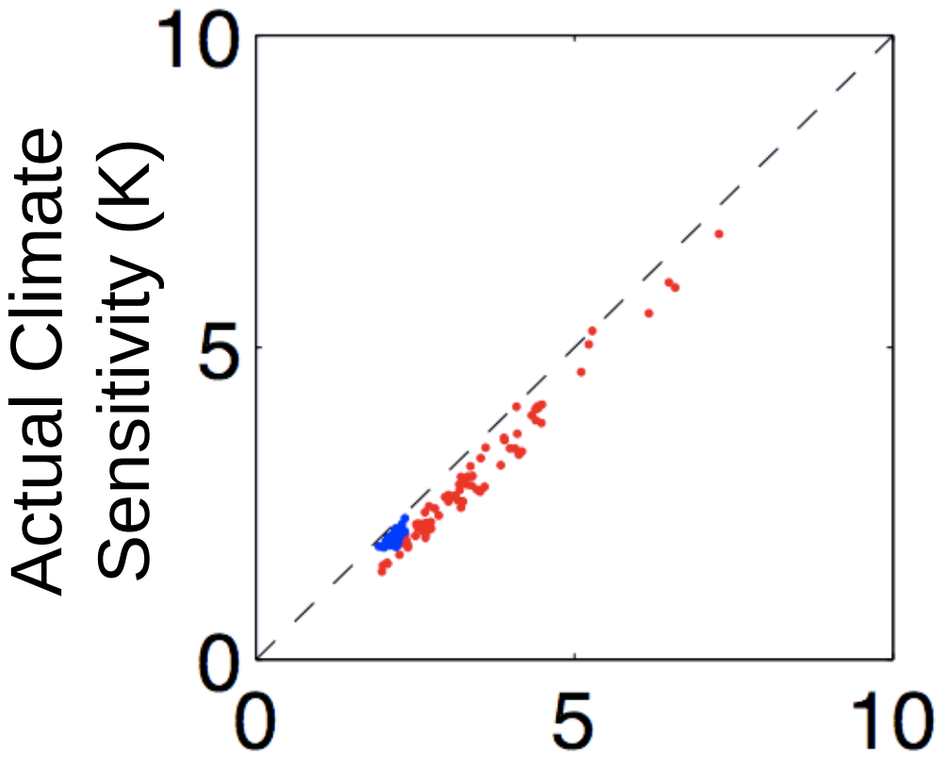
$$\Delta T_g = \frac{F_{X2CO_2}}{\lambda_{LWCS} + \lambda_{LWCLD} + \lambda_{SWCS} + \lambda_{SWCLD}}$$

Partial Surface Temperature Response

$$\sigma T_g^4 = \frac{S_o(1-\alpha)}{\gamma}.$$

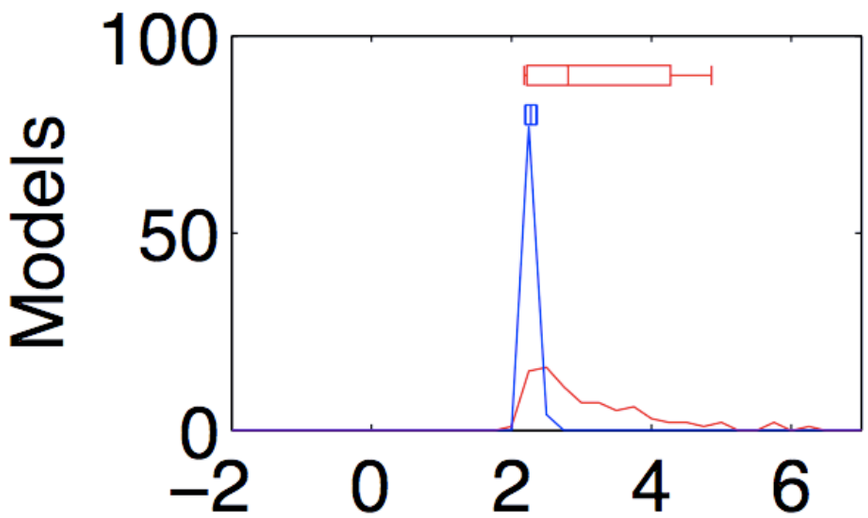
$$\gamma = \gamma_{cs} + \gamma_{cld}$$

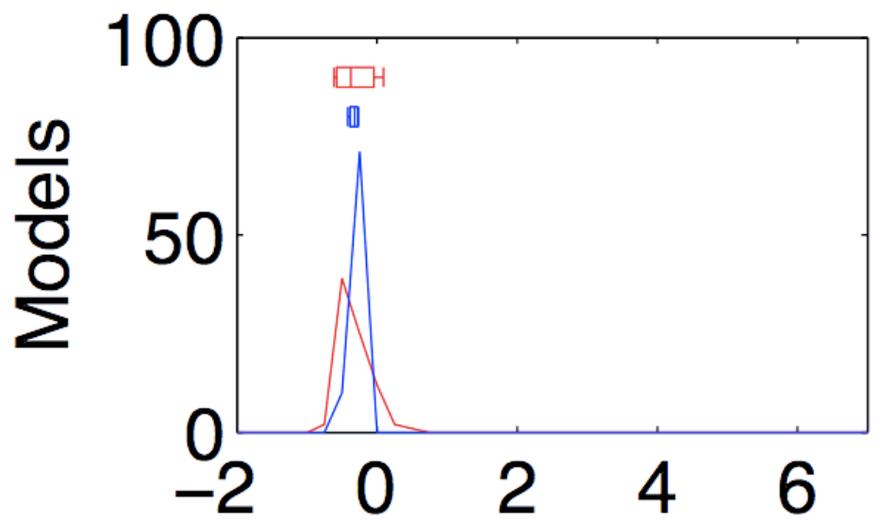
$$(1-\alpha) = (1-\alpha_{cs})(1-\alpha_{cld})$$

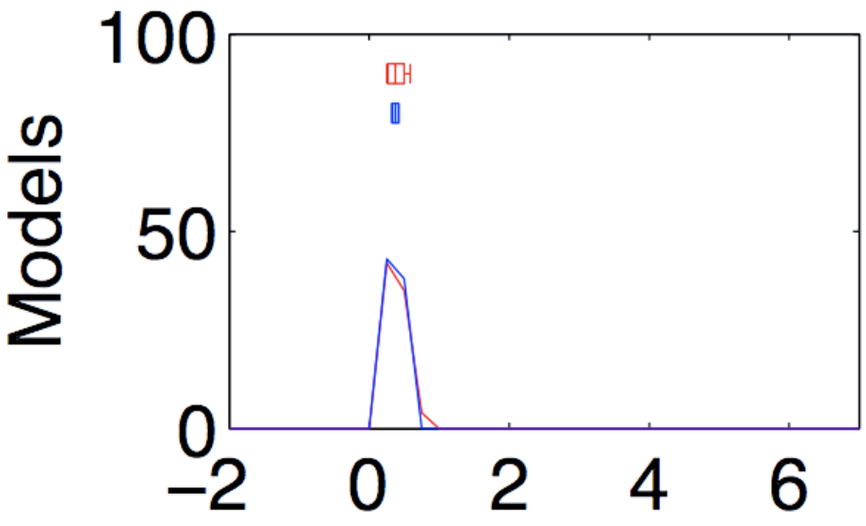


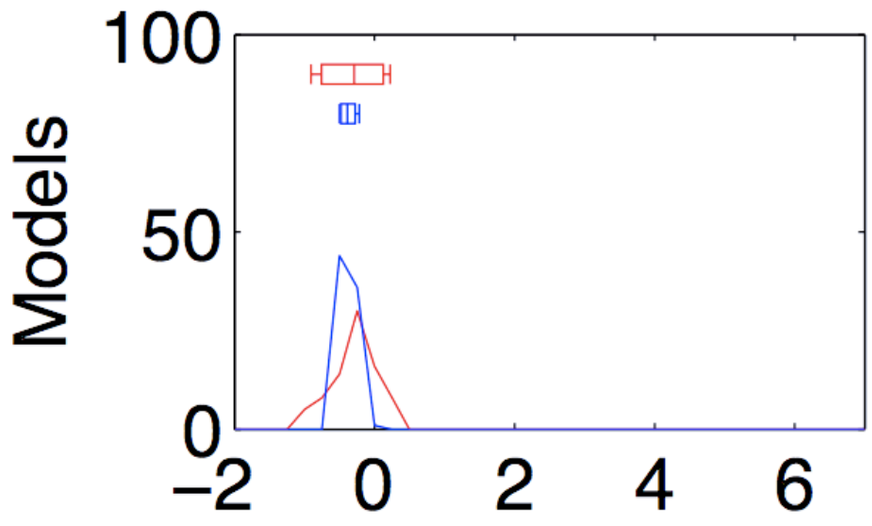
$$\Delta T_g \approx \frac{T_g}{4}\left(\underbrace{\frac{\Delta\gamma_{cs}}{\gamma_{cs}+\gamma_{cld}}}_{\text{Longwave Clear-Sky}} + \underbrace{\frac{\Delta\gamma_{cld}}{\gamma_{cs}+\gamma_{cld}}}_{\text{Longwave Cloud}} + \underbrace{\frac{\Delta\alpha_{cs}}{(1-\alpha_{cs})}}_{\text{Shortwave Clear-Sky}} + \underbrace{\frac{\Delta\alpha_{cld}}{(1-\alpha_{cld})}}_{\text{Shortwave Cloud}}\right)$$

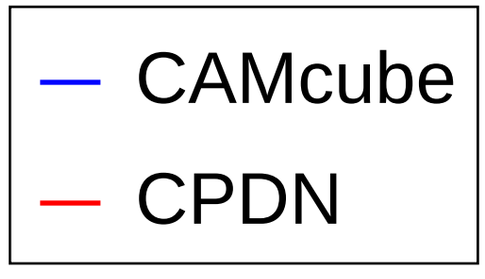
Partial Surface Temperature Response



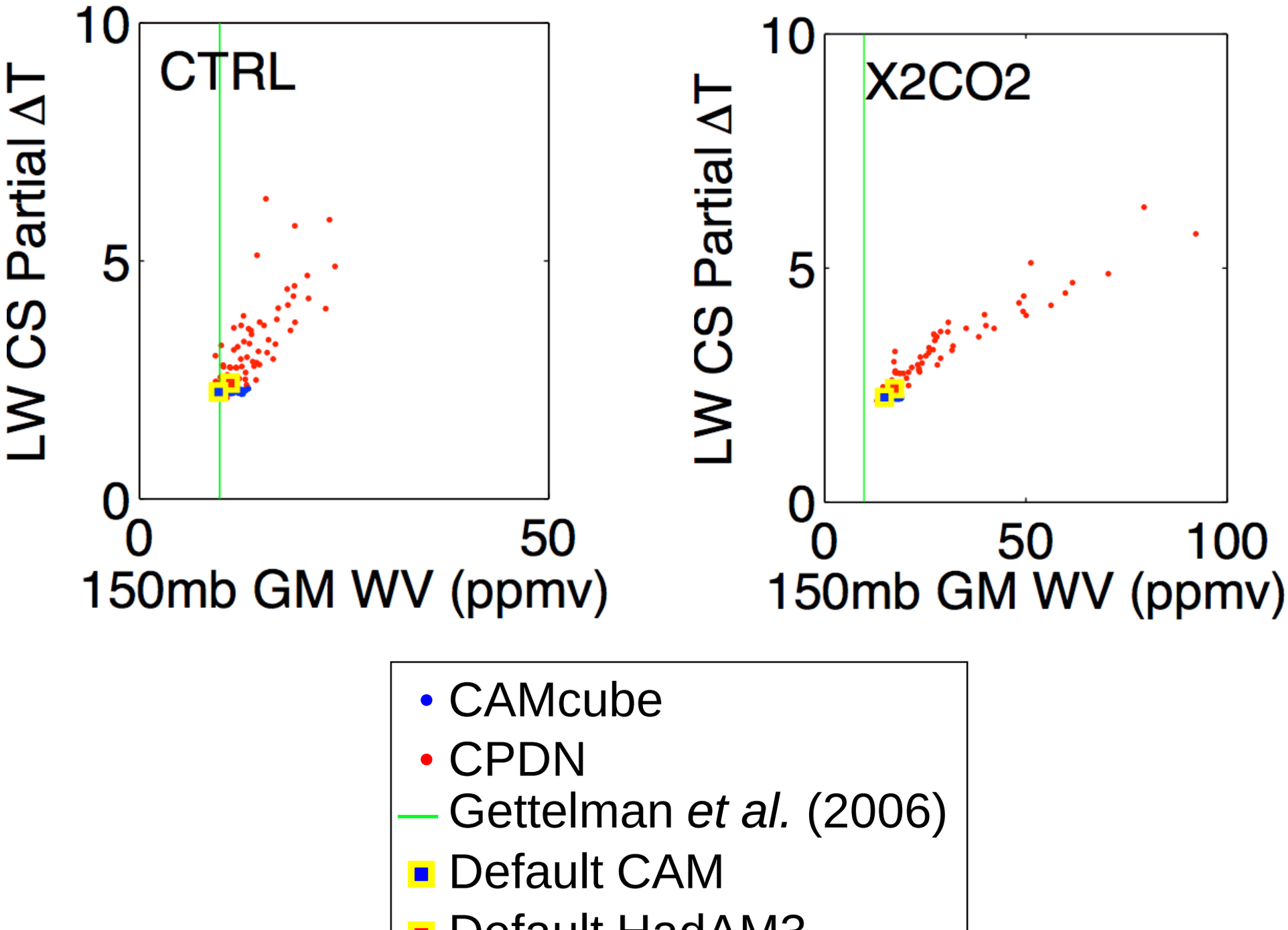








Upper Tropospheric Humidity

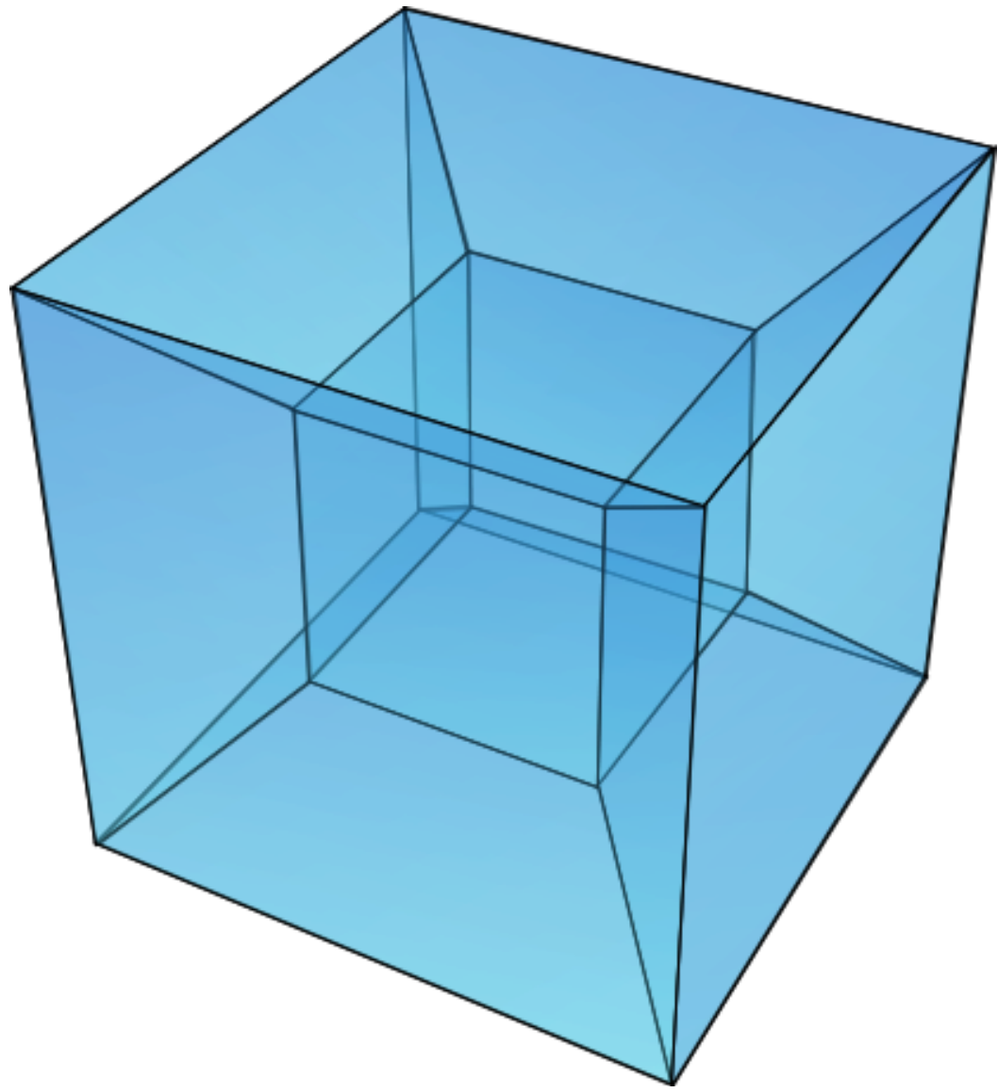


Conclusions

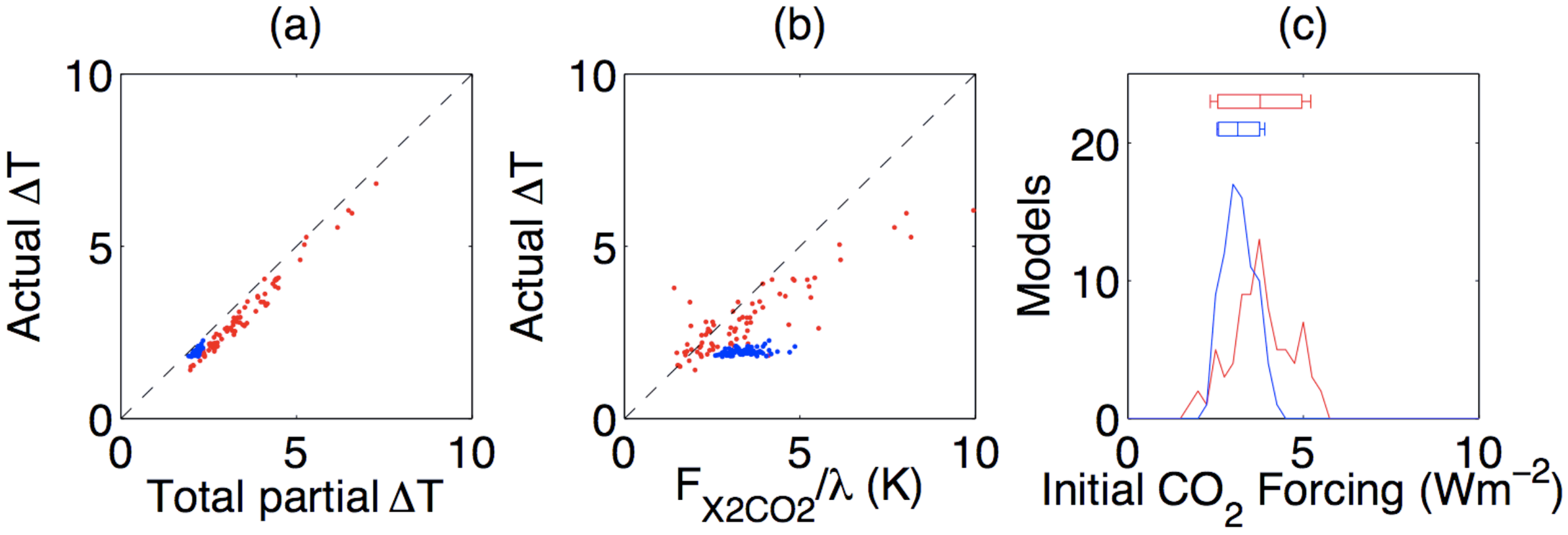
- Climate Sensitivity in CAM 3.5 is relatively insensitive to commonly used tuning parameters as compared with HadAM3

- Upper tropospheric humidity is robust to parameter changes in CAM, but not in HadAM3 where high UT humidity in some models may to very strong clear-sky feedbacks.

- Single column simulations will verify efficacy of high UT water vapor as a mechanism for high Climate Sensitivity



Partial Surface Temperature Response



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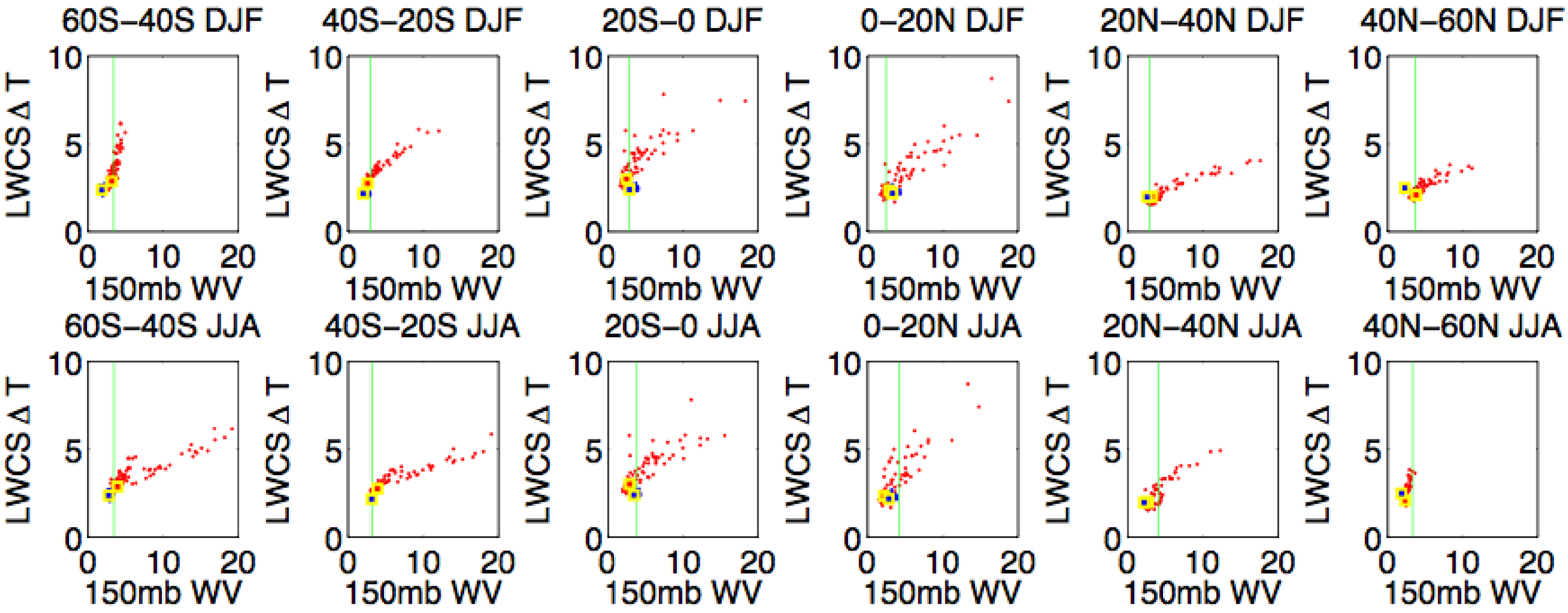
Partial Surface Temperature Response

$$CRF_{LW} = \gamma_{CLD}\sigma T_g^4$$

$$\frac{dCRF_{LW}}{dT} = \Delta\gamma_{CLD}\sigma T_g^4 + 4\gamma_{CLD}T_g^3\Delta T$$

Partial Surface Temperature Response



Partial Surface Temperature Response