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Small Differences, Big Impacts

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acknowledgements

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There remains a significant portion of model–
observational data difference that may be considered
“irreducible” without fundamental improvements in
the parameterizations of subgrid-scale processes.

(McWilliams 2007).

“Irreducible errors”

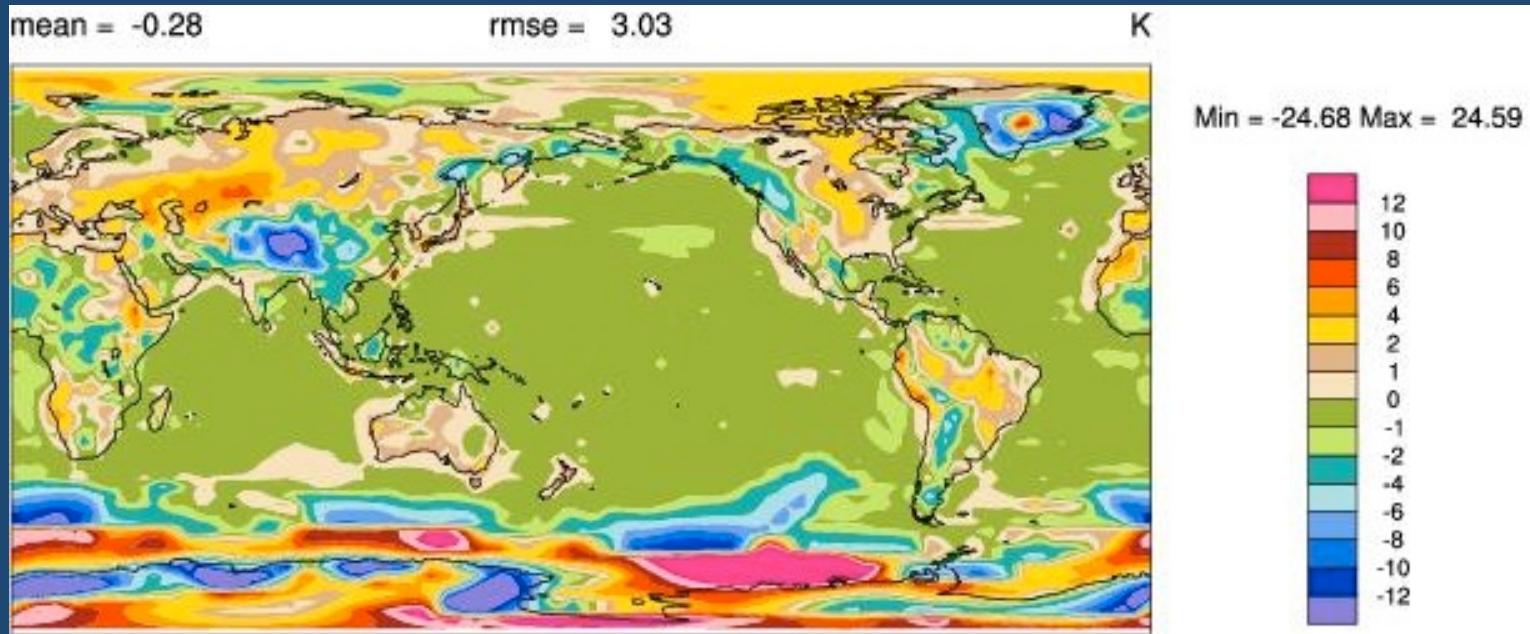
- Search over 6 parameters within HadAM3
 - 10% reduction in errors (Stainforth et al., 2005)
- Search over 6 parameters within CAM3.1
 - 10% reduction in errors (Jackson et al., 2008)
- Search over 15 parameters within CAM3.1
 - 10% reduction in errors (recent result)

These errors do not necessarily imply that climate models provide poor predictions of forced change if the errors do not affect feedbacks.

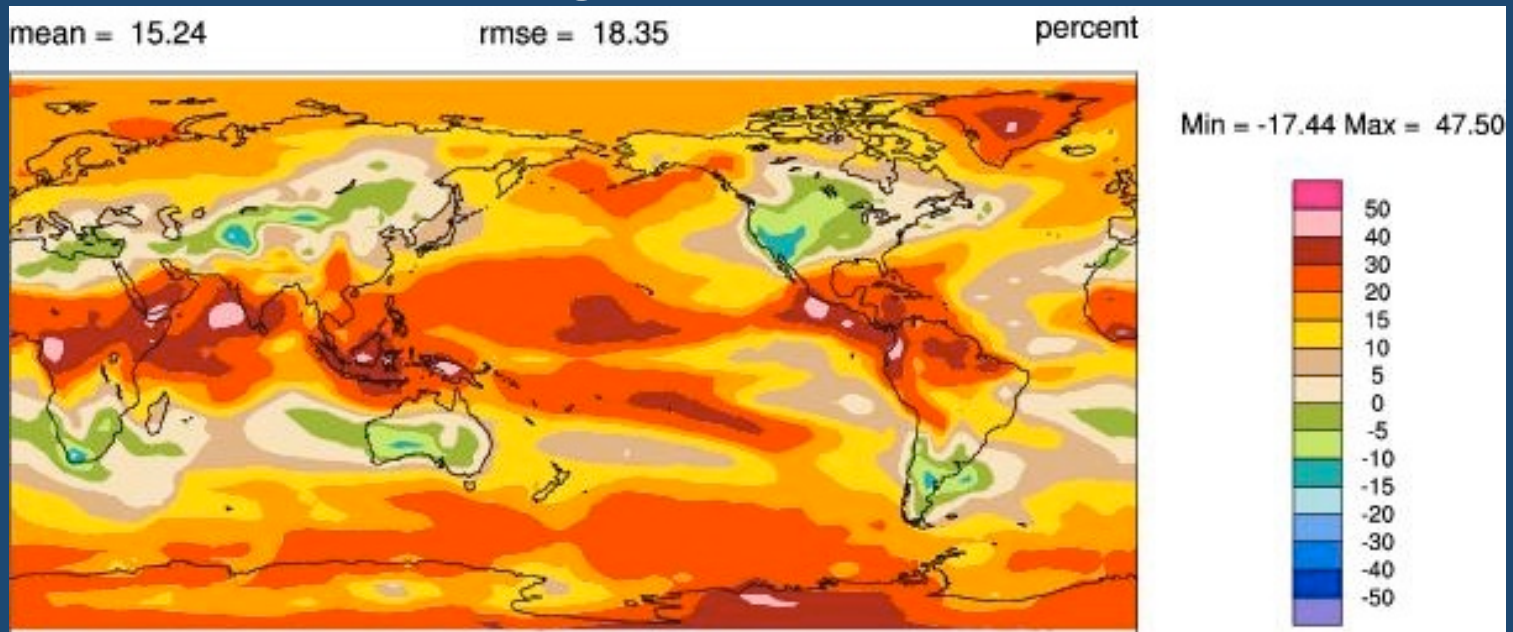
Statistical models of uncertainty assume prediction/projection errors scale with the size of errors in the control. Likelihood function accepts or rejects models in proportion to

$$\exp\left[-\Delta \frac{1}{2} (g(m) - d_{obs})^T C_{error}^{-1} (g(m) - d_{obs})\right]$$

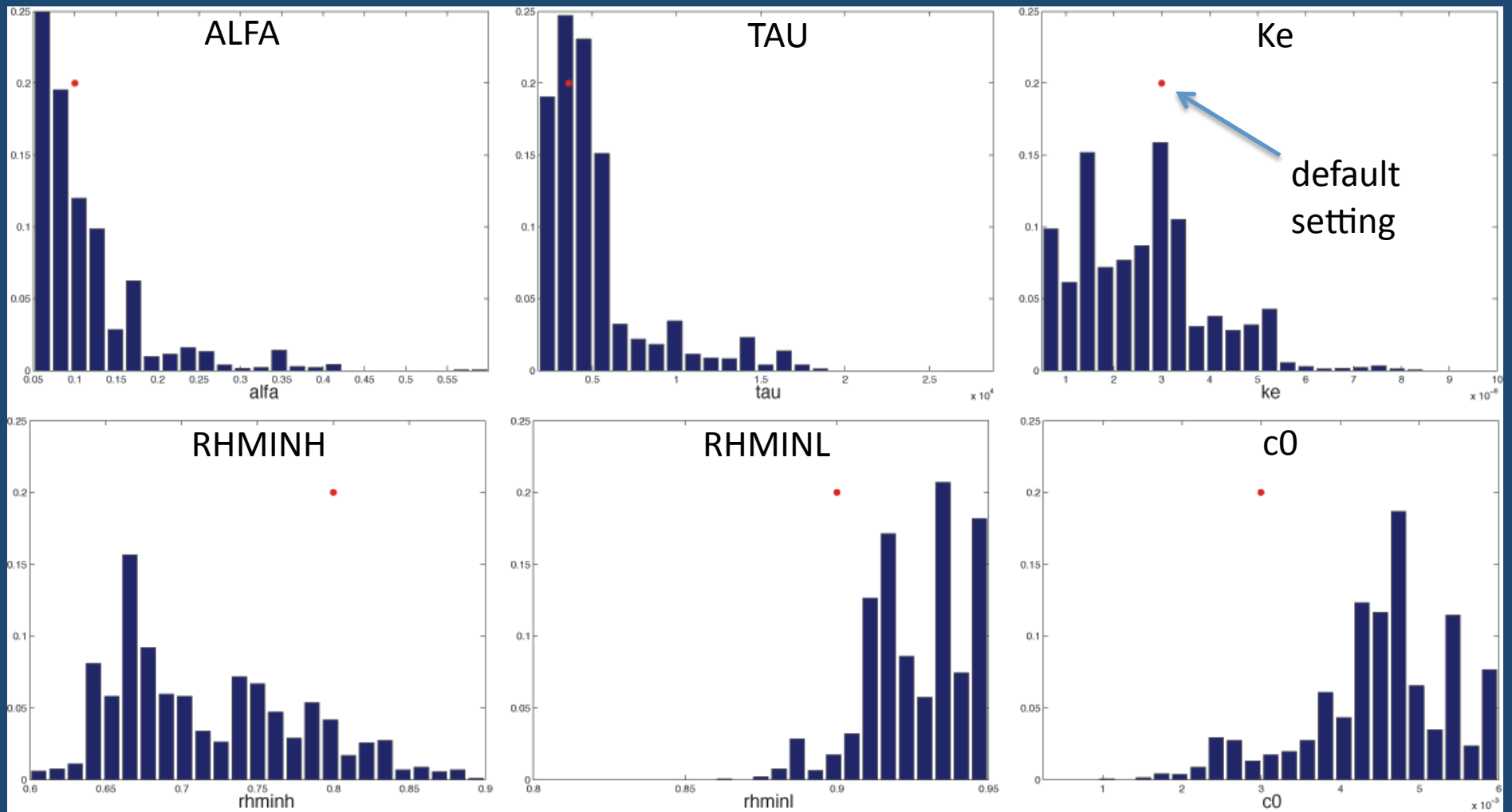
CAM3 2m air temperature bias

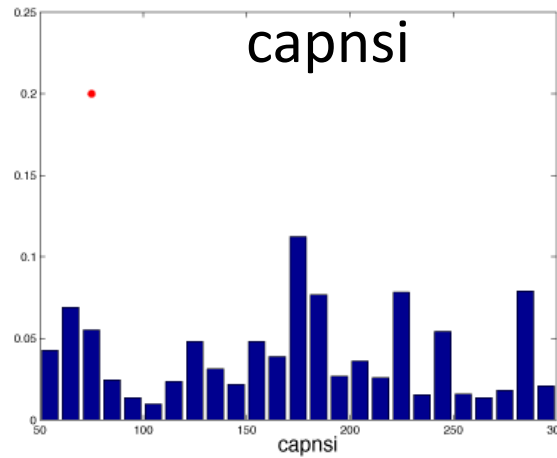
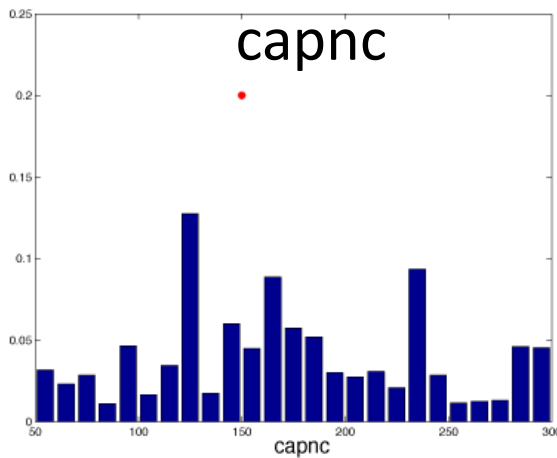
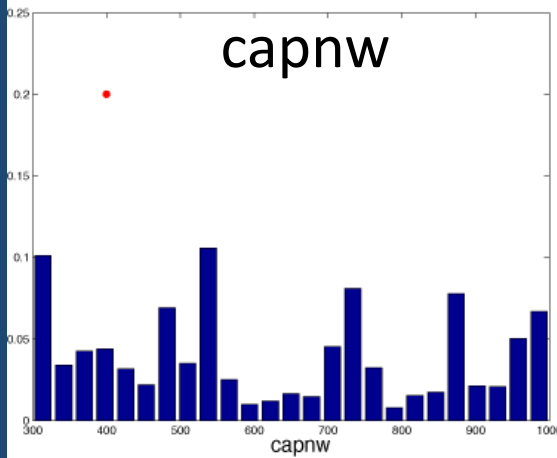
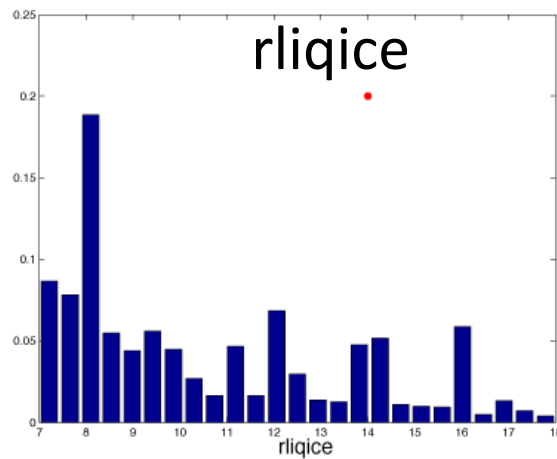
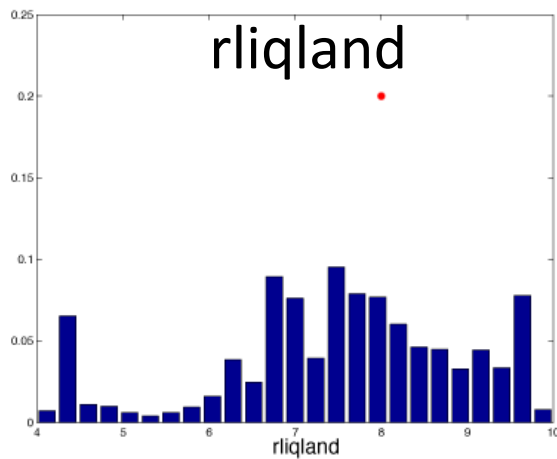
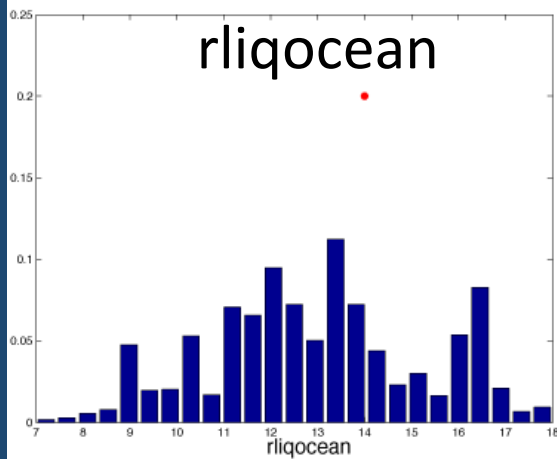
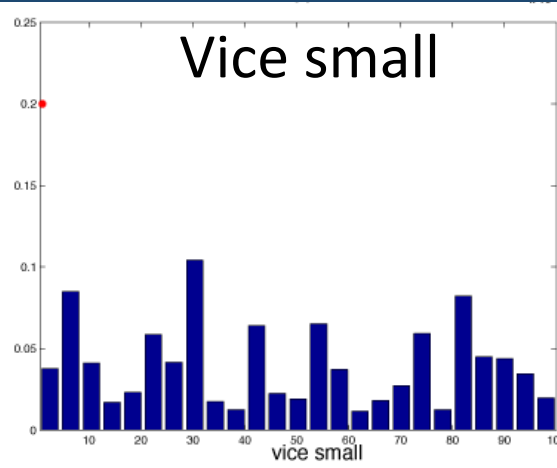
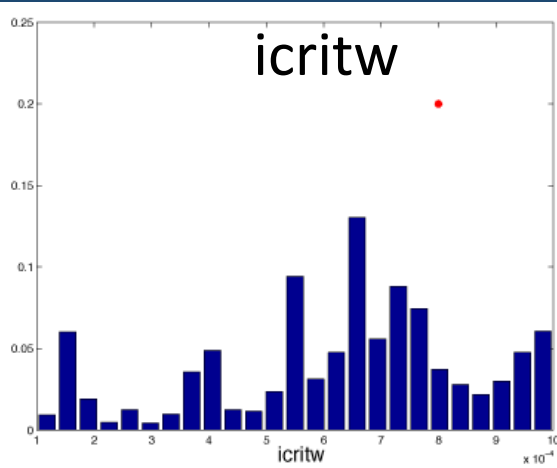
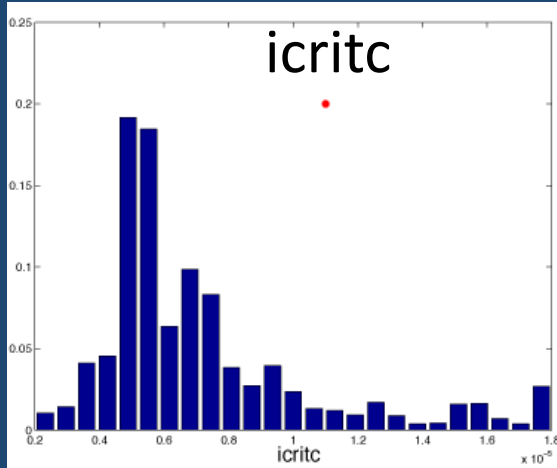


CAM3 high cloud bias

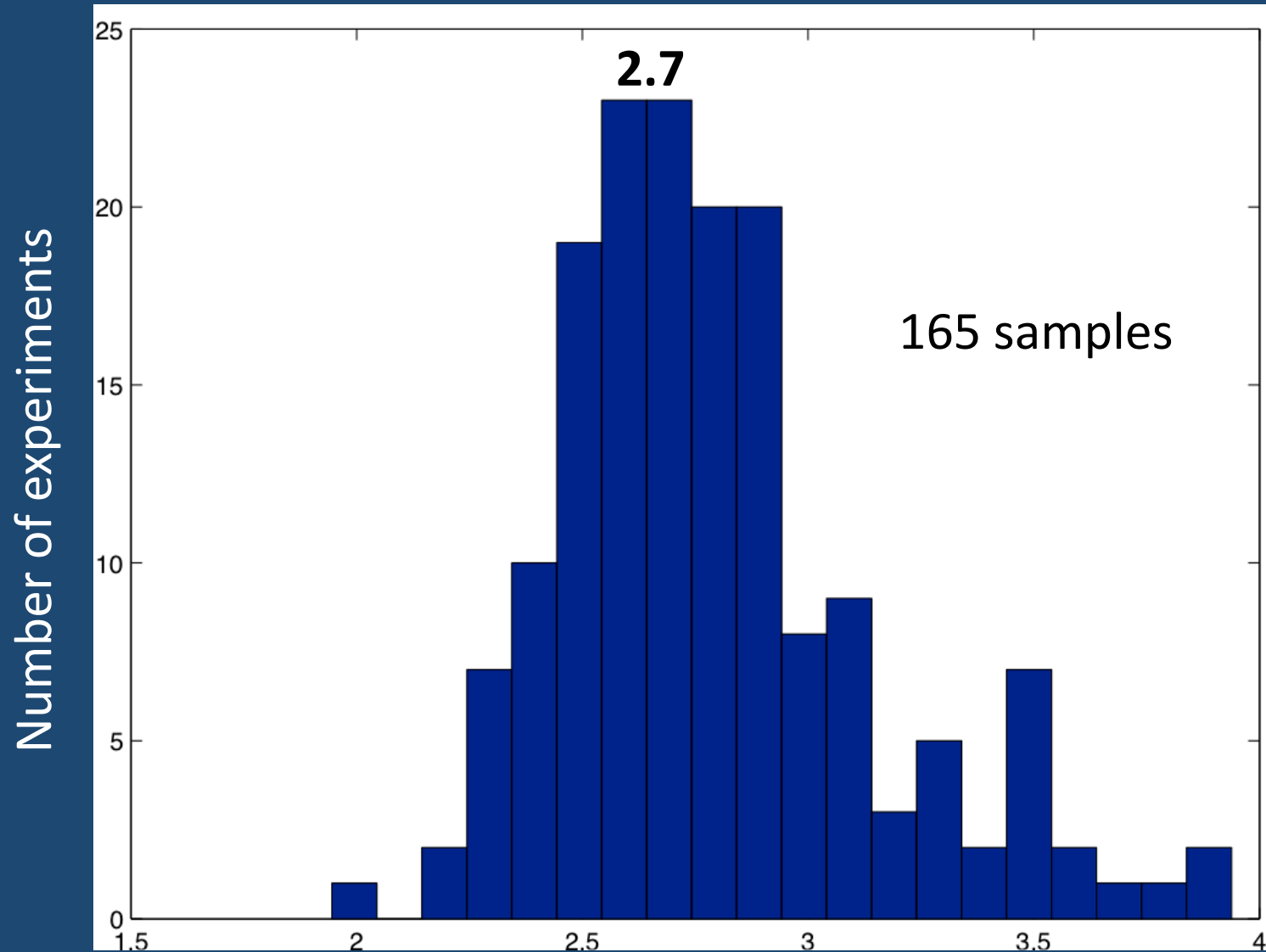


Distribution of accepted model configurations (1886 samples)





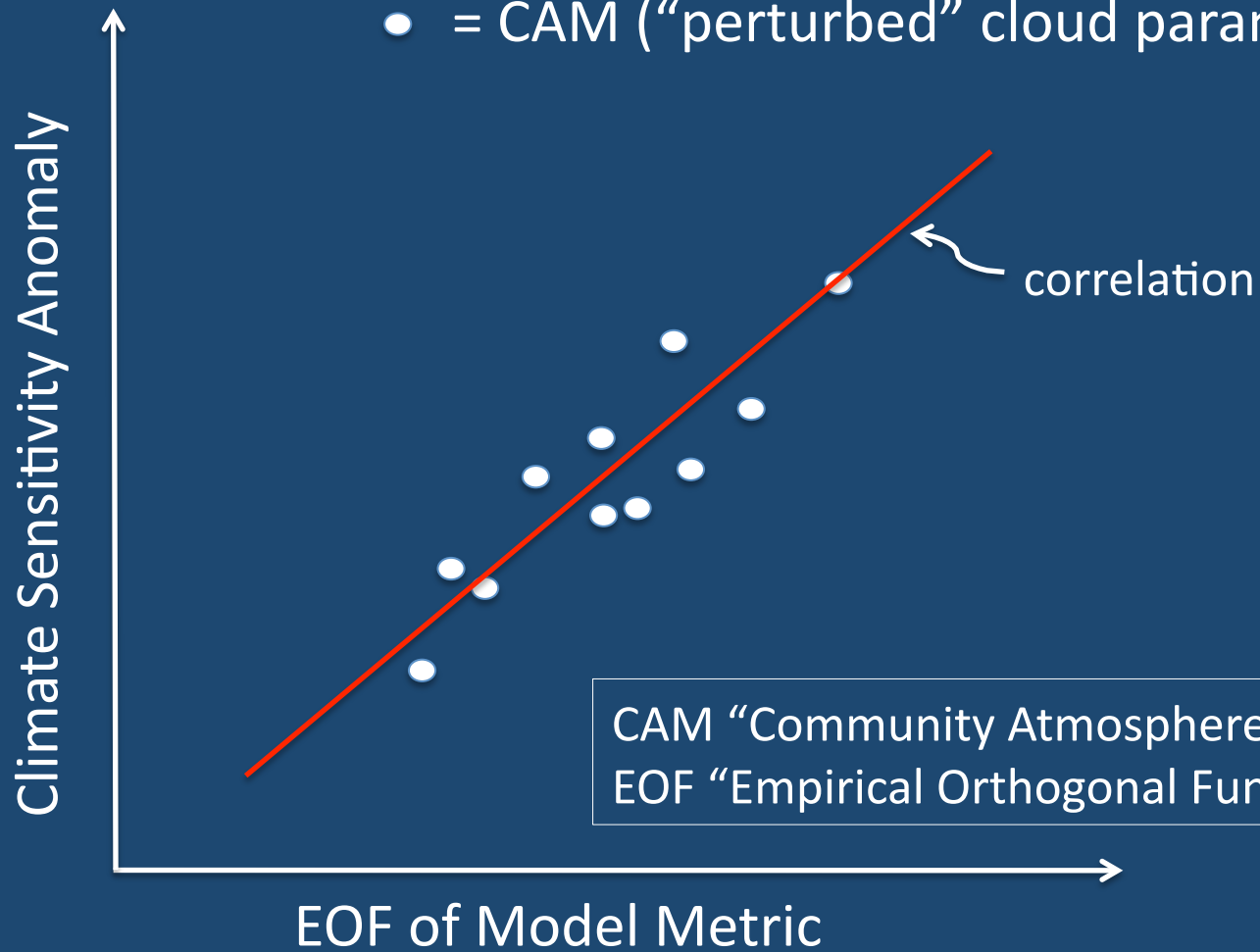
Equilibrium Climate Sensitivity

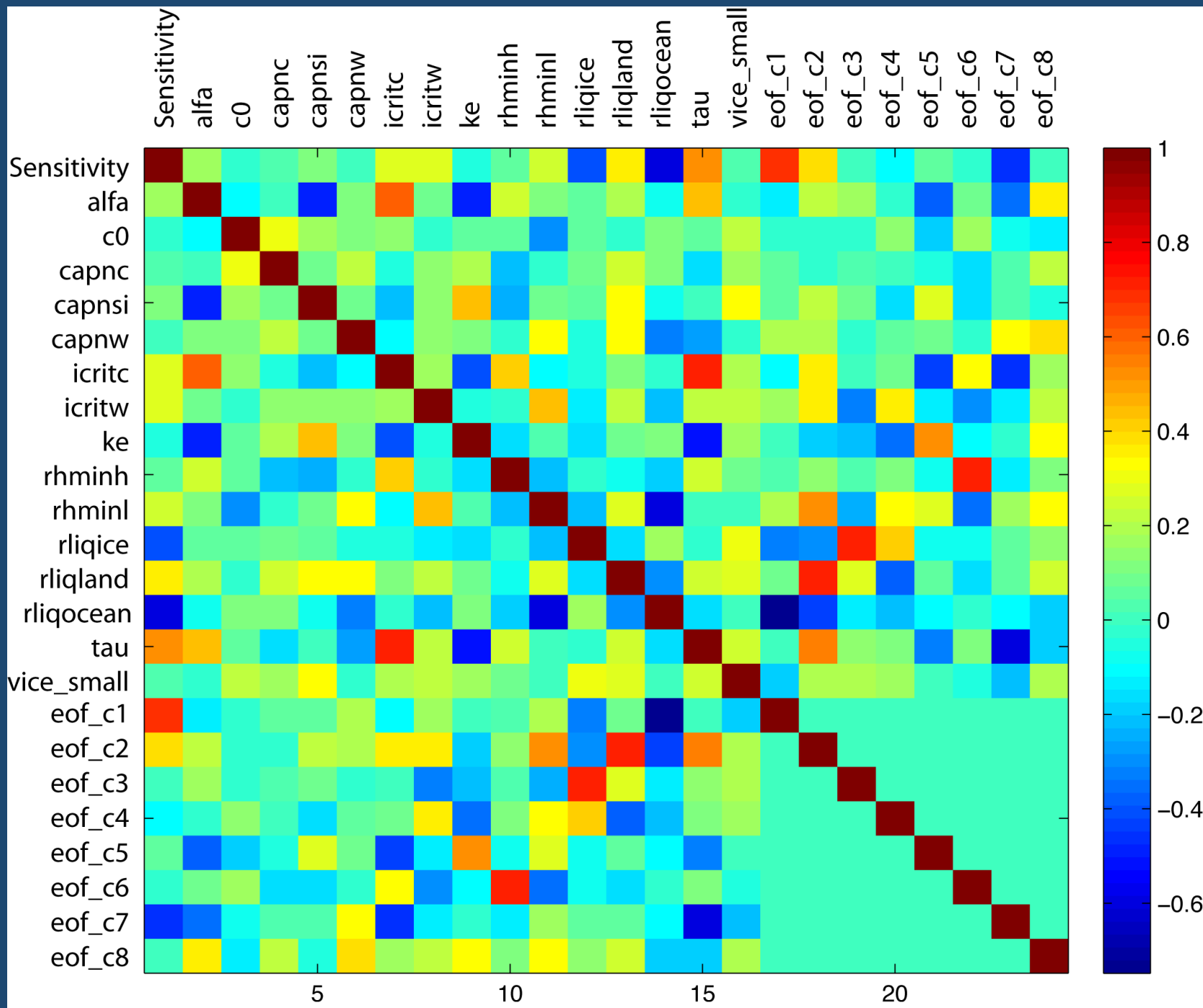


Global Mean Temperature after doubling CO2

Which errors matter to predictions?

• = CAM (“perturbed” cloud parameters)

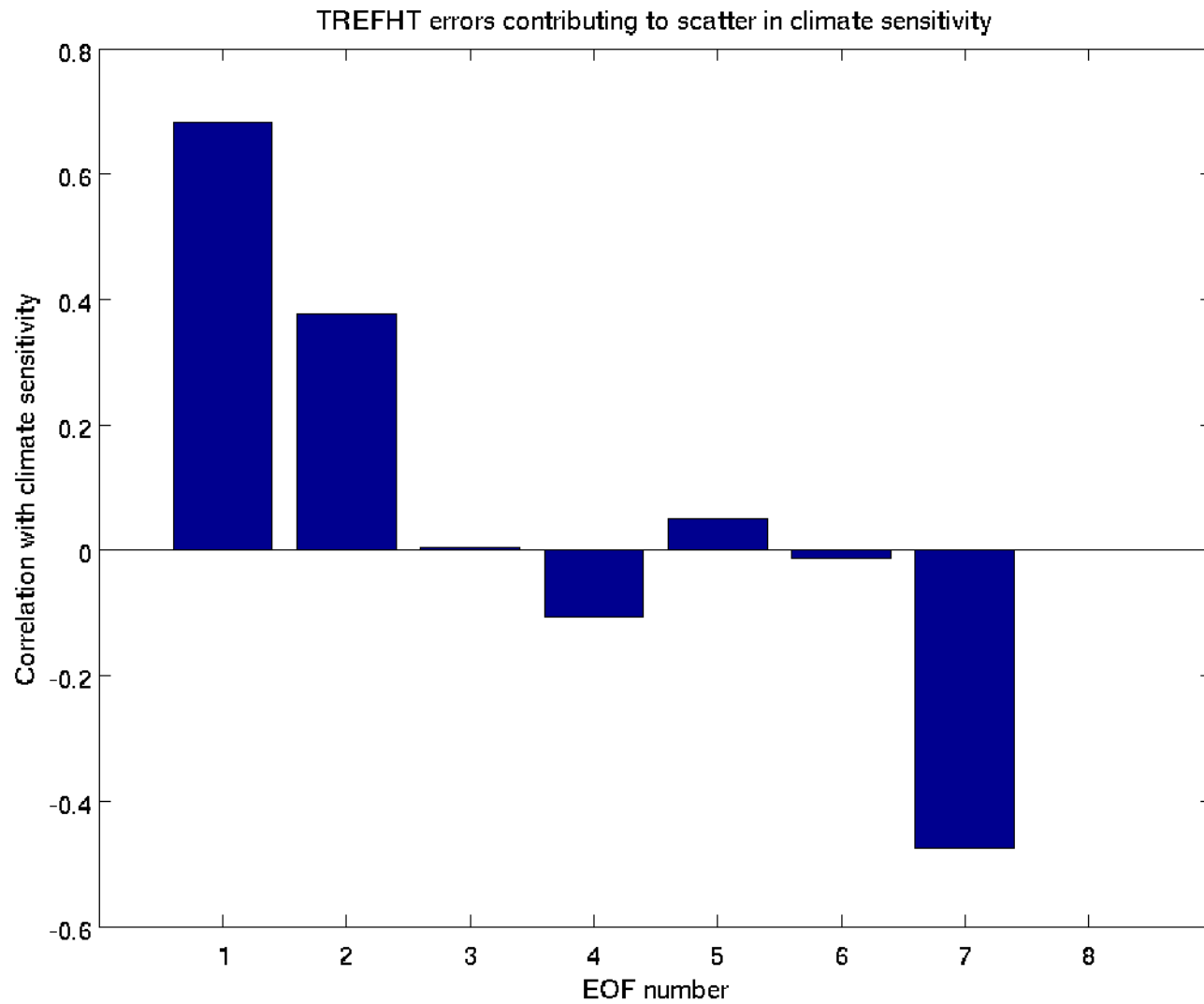




Correlation

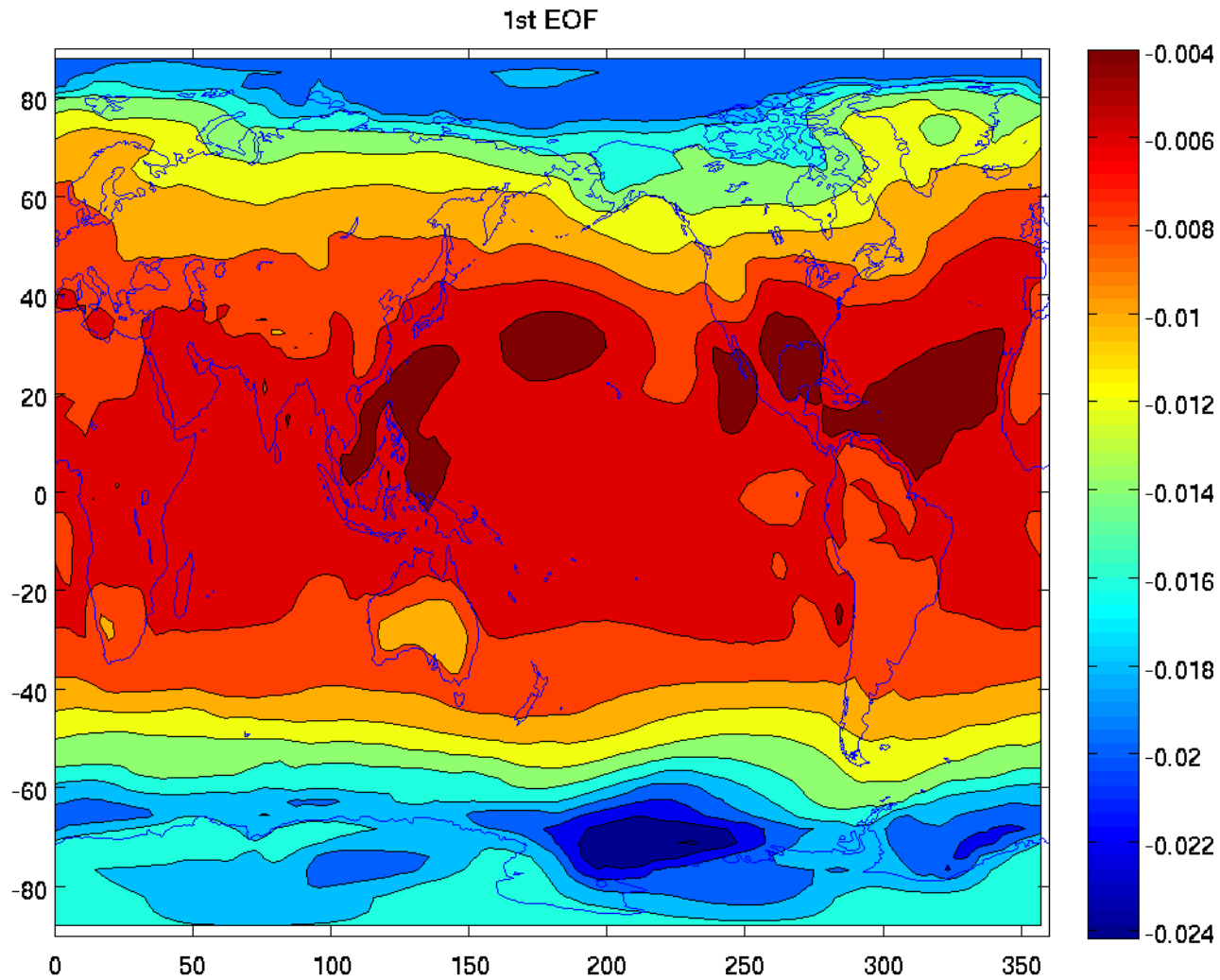
2m air temperature biases affecting climate sensitivity

Correlation with climate sensitivity



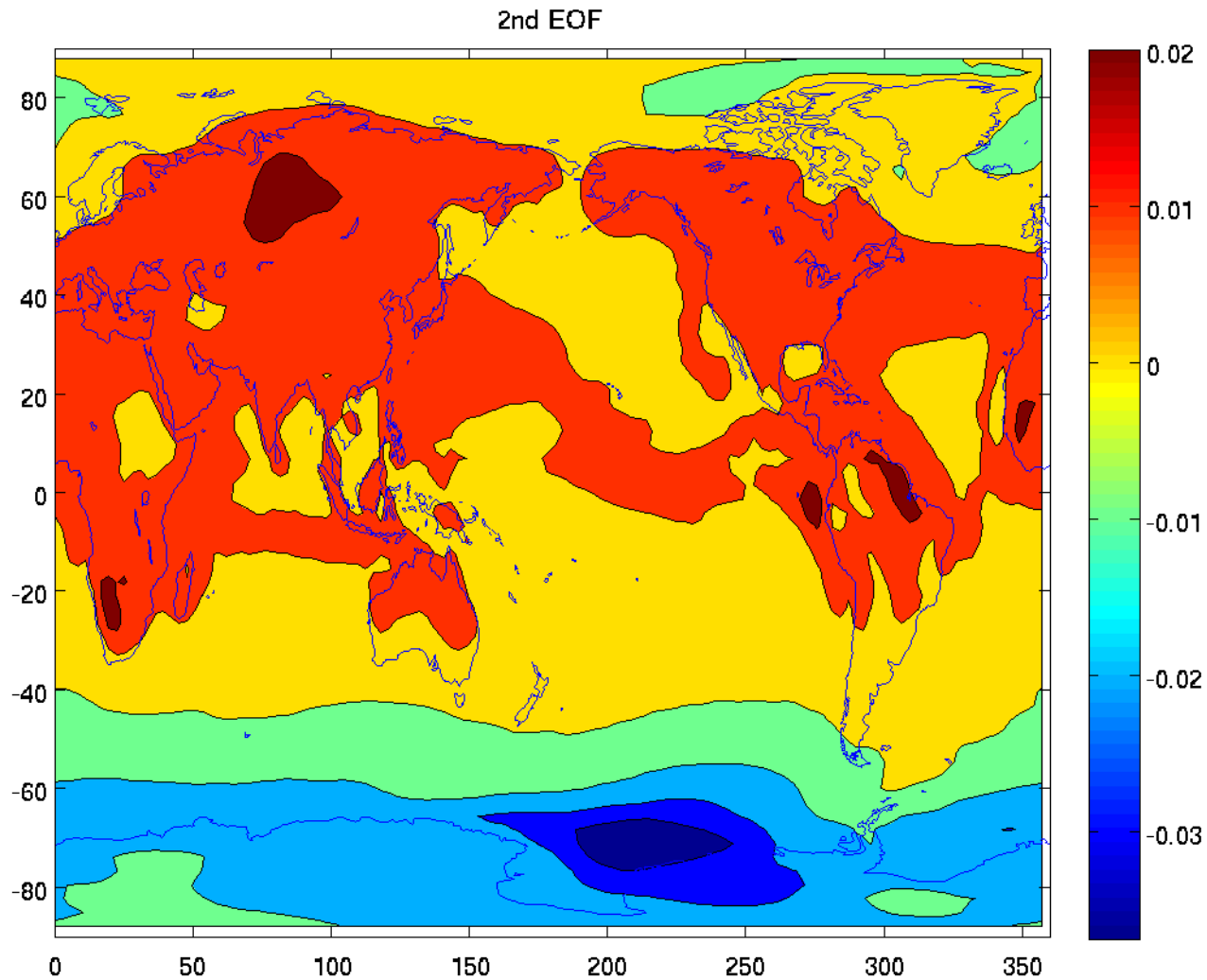
EOF number

1st EOF of 2m air temperature



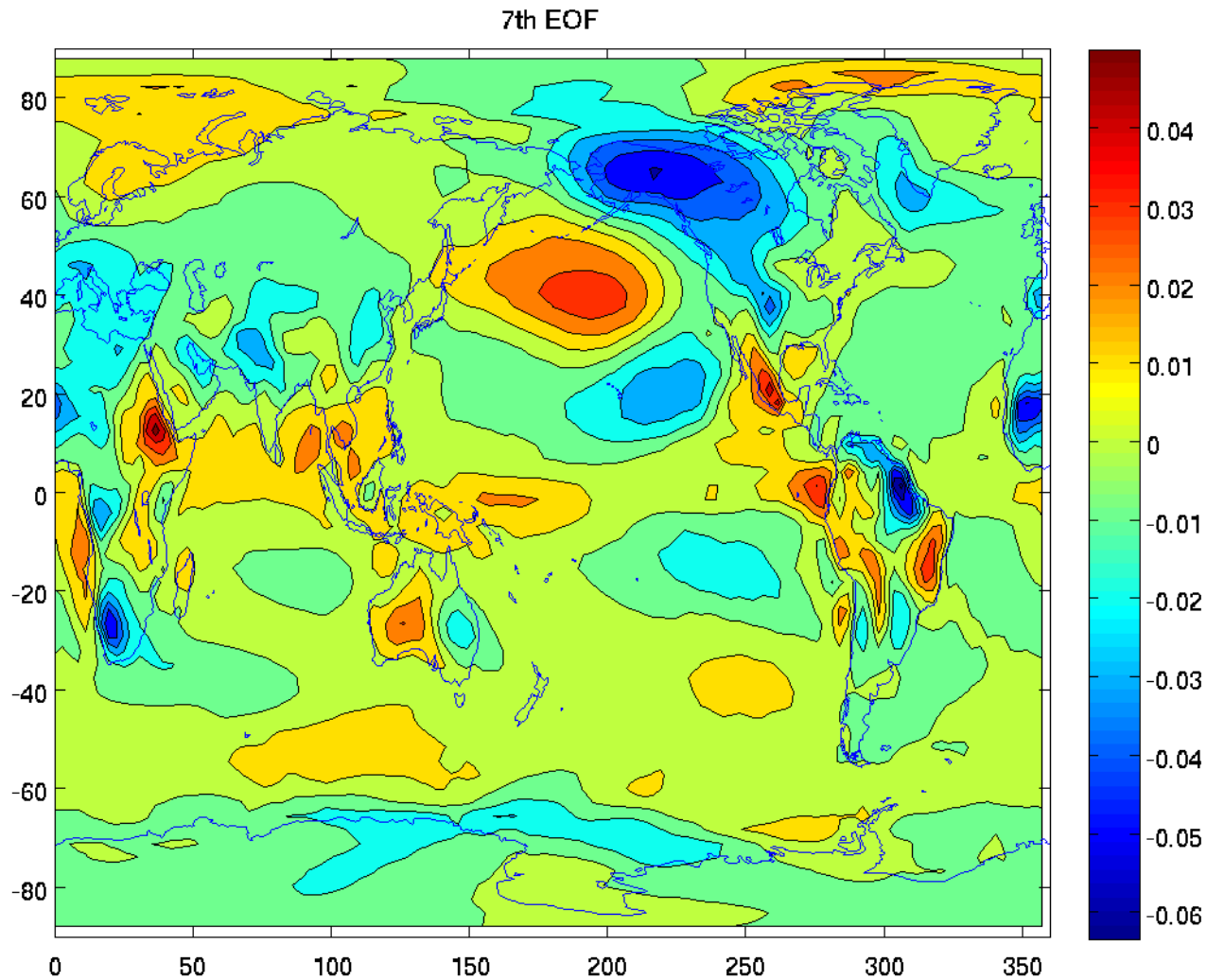
important parameters (correlation):
rliqocean (-0.73); rliqice(-0.32)

2nd EOF of 2m air temperature



important parameters (correlation):
rliqland (0.71); rhminl (0.52); tau (0.56);

7th EOF of 2m air temperature



**important parameters (correlation):
tau (-0.59); icritc (-0.46); capnw (0.33);**

So, unfortunately,

- Relatively small errors can lead to large scatter in predictions.
- However, choice of parameter values may give us some control over feedbacks. If you have live with errors, minimize those that affect scatter in predictions of quantities of interest.