

CAM³

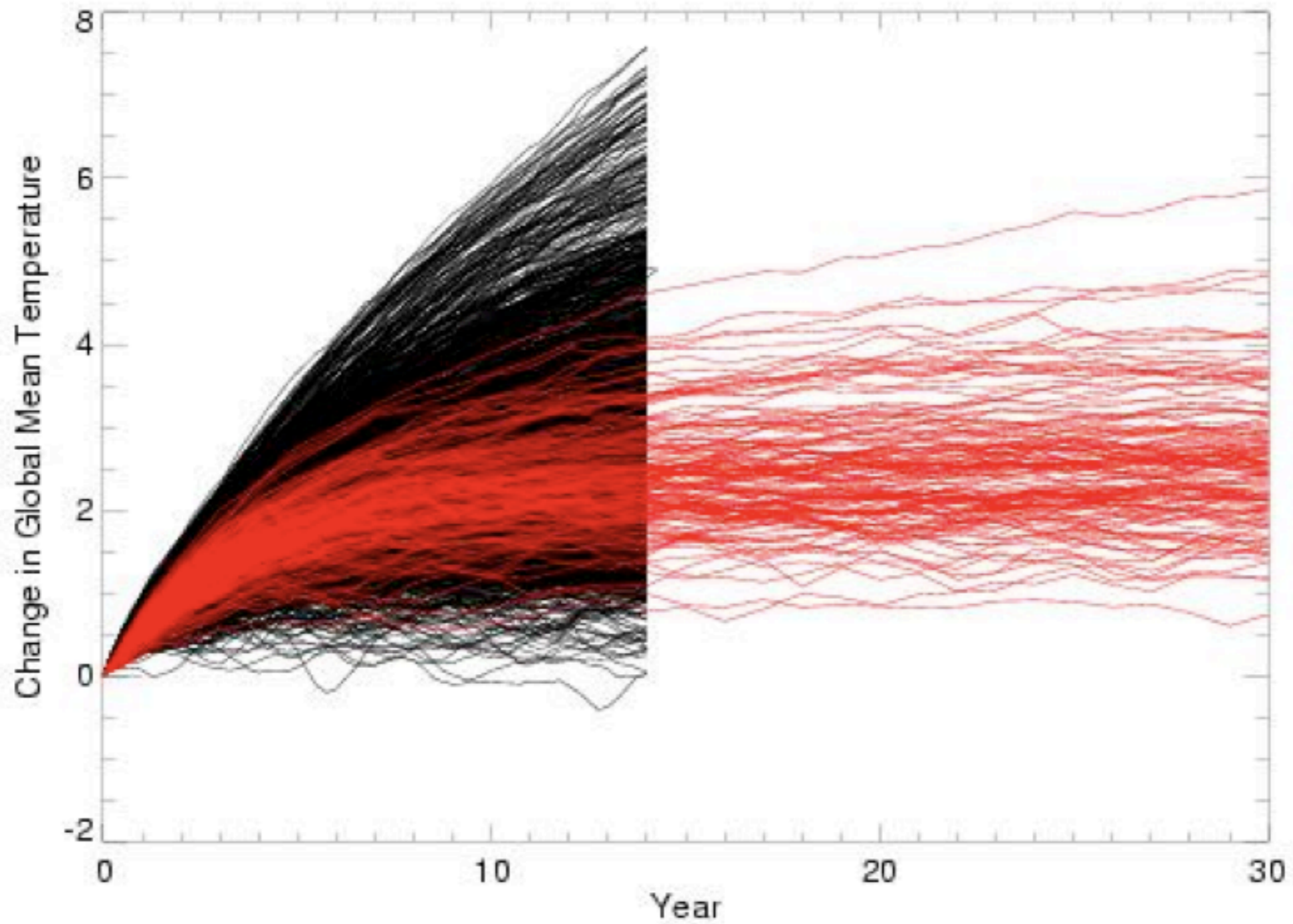
Exploring the parameter space of the
Community Atmosphere Model

Ben Sanderson



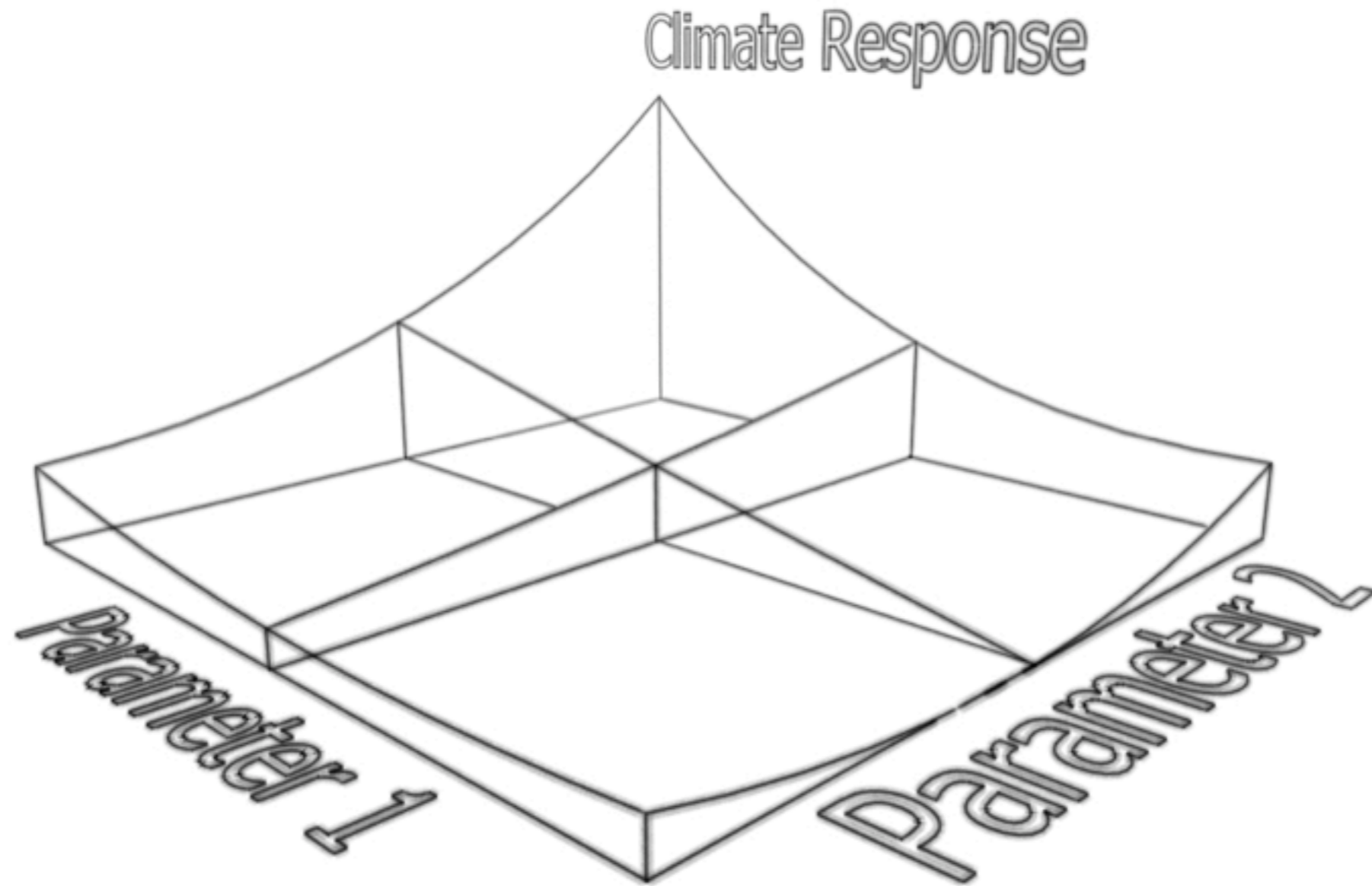
NCAR

Perturbed Physics



Perturbed Physics

● range of climate response



Perturbed Physics

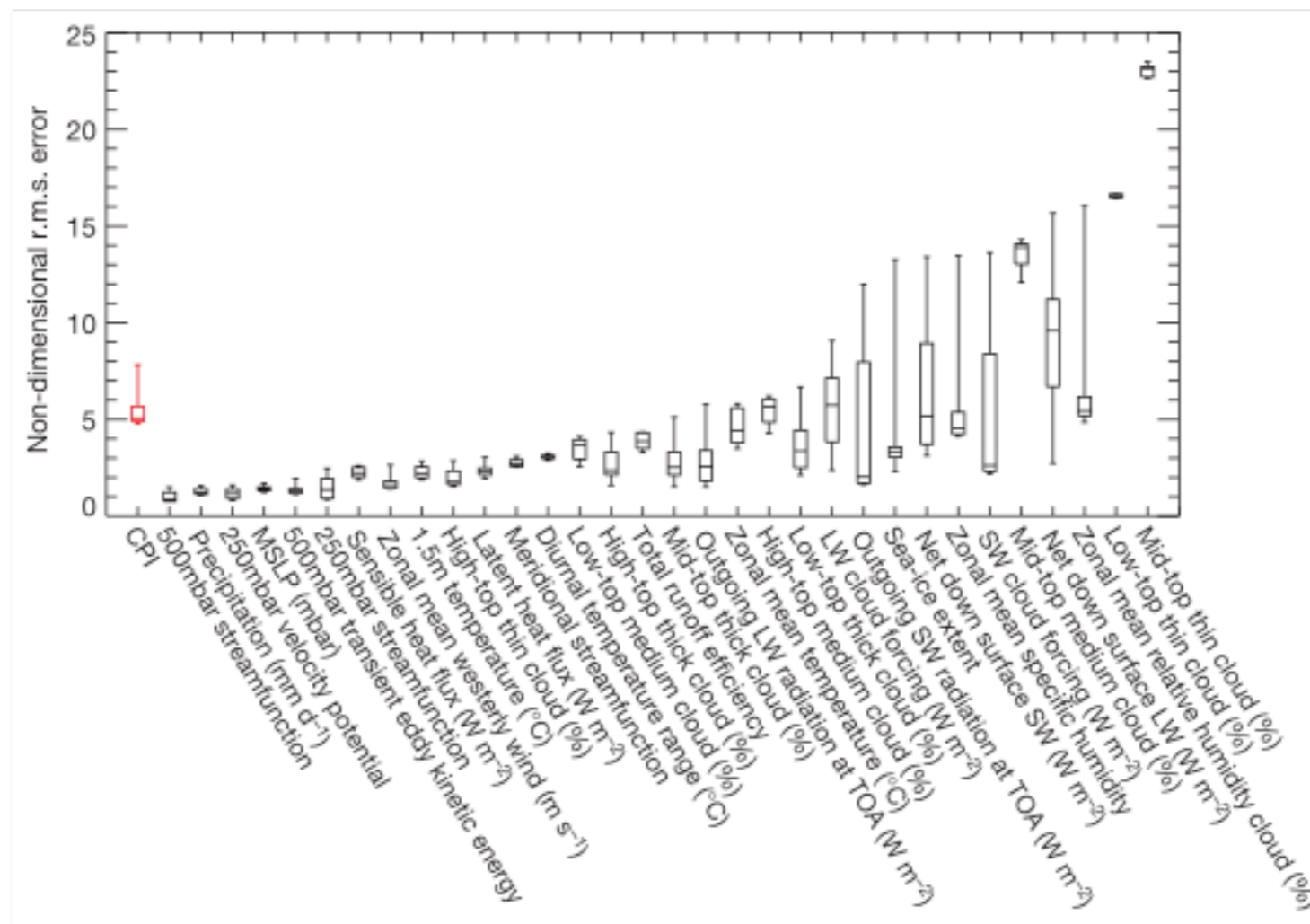
- range of climate response
- explore model parameter space

What's been done before?

What's been done before?

Estimating Climate Sensitivity

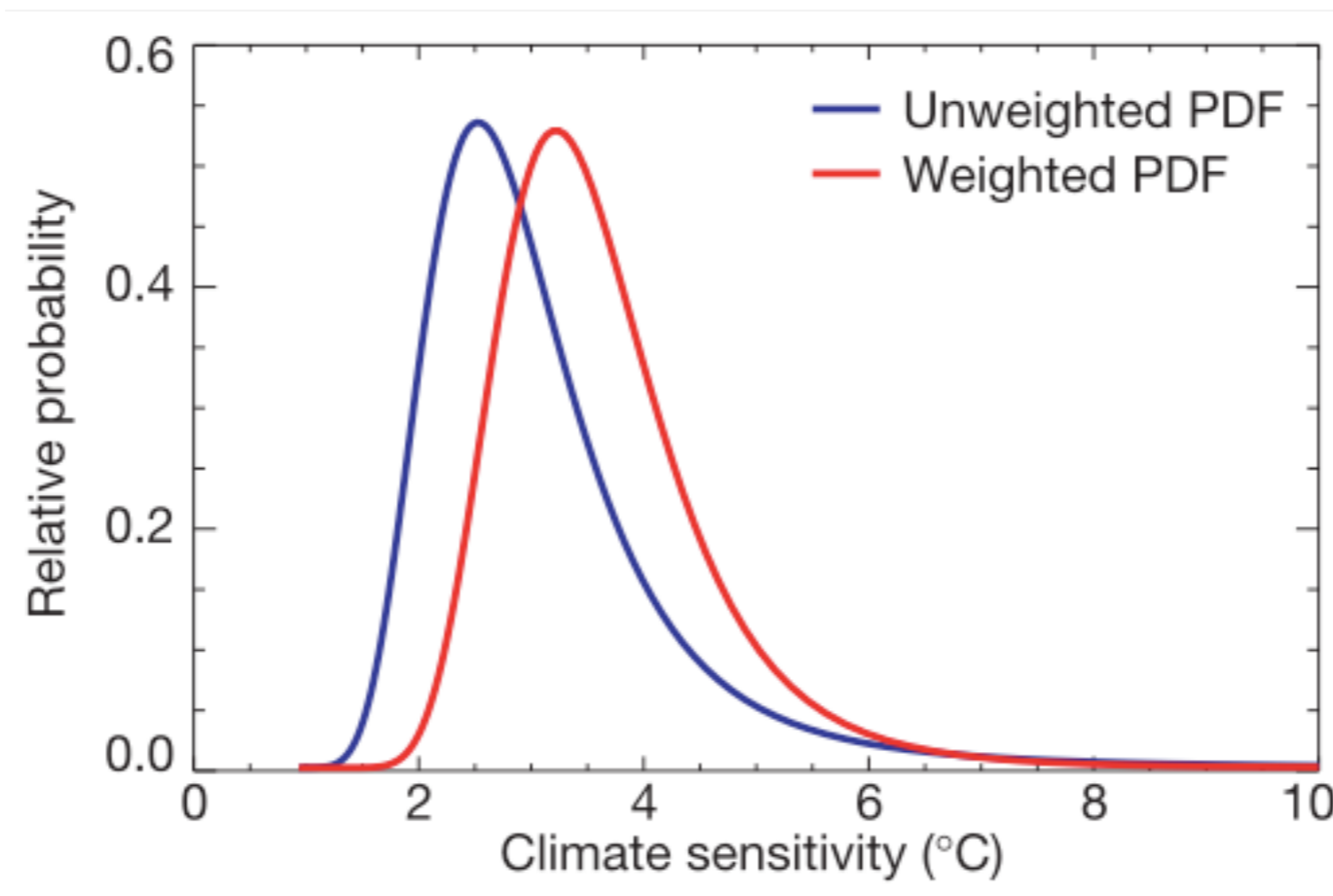
- Murphy et al. (2004)



What's been done before?

Estimating Climate Sensitivity

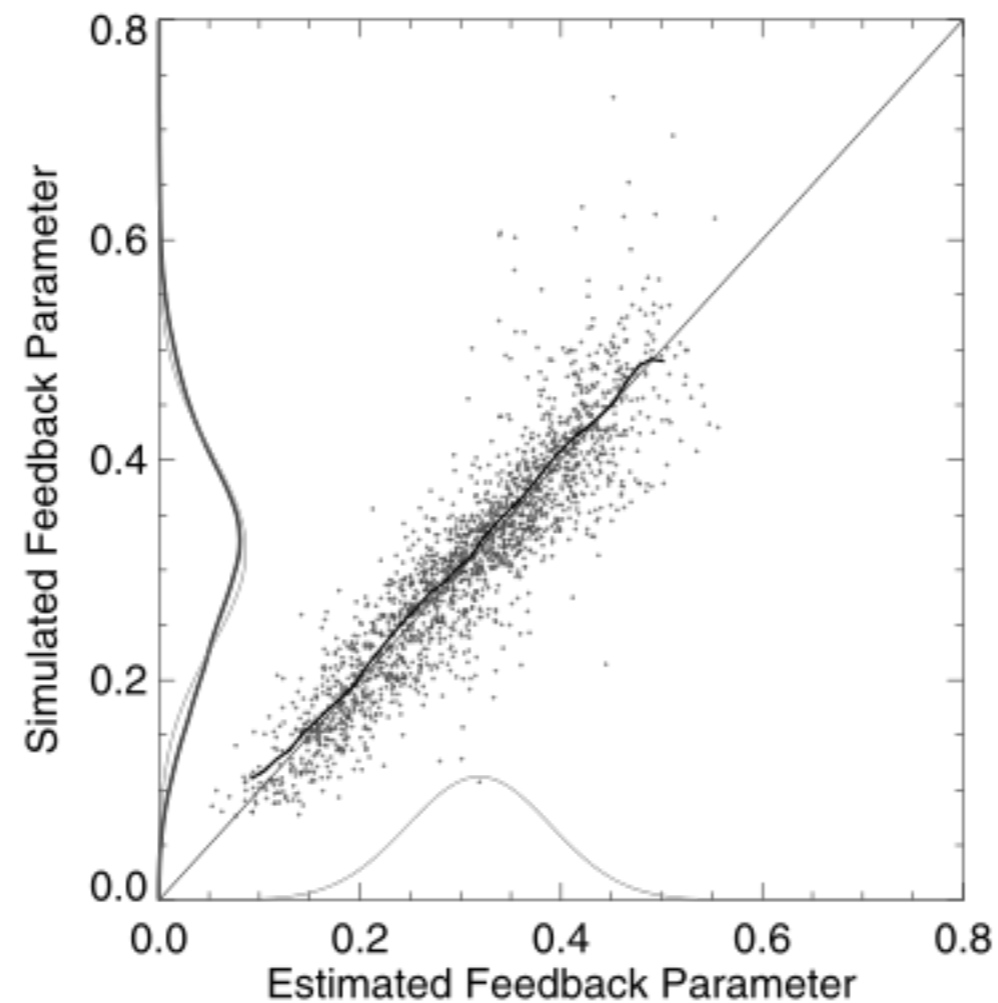
- Murphy et al. (2004)
- Piani et al. (2005)
- Knutti et al (2006)



What's been done before?

Estimating Climate Sensitivity

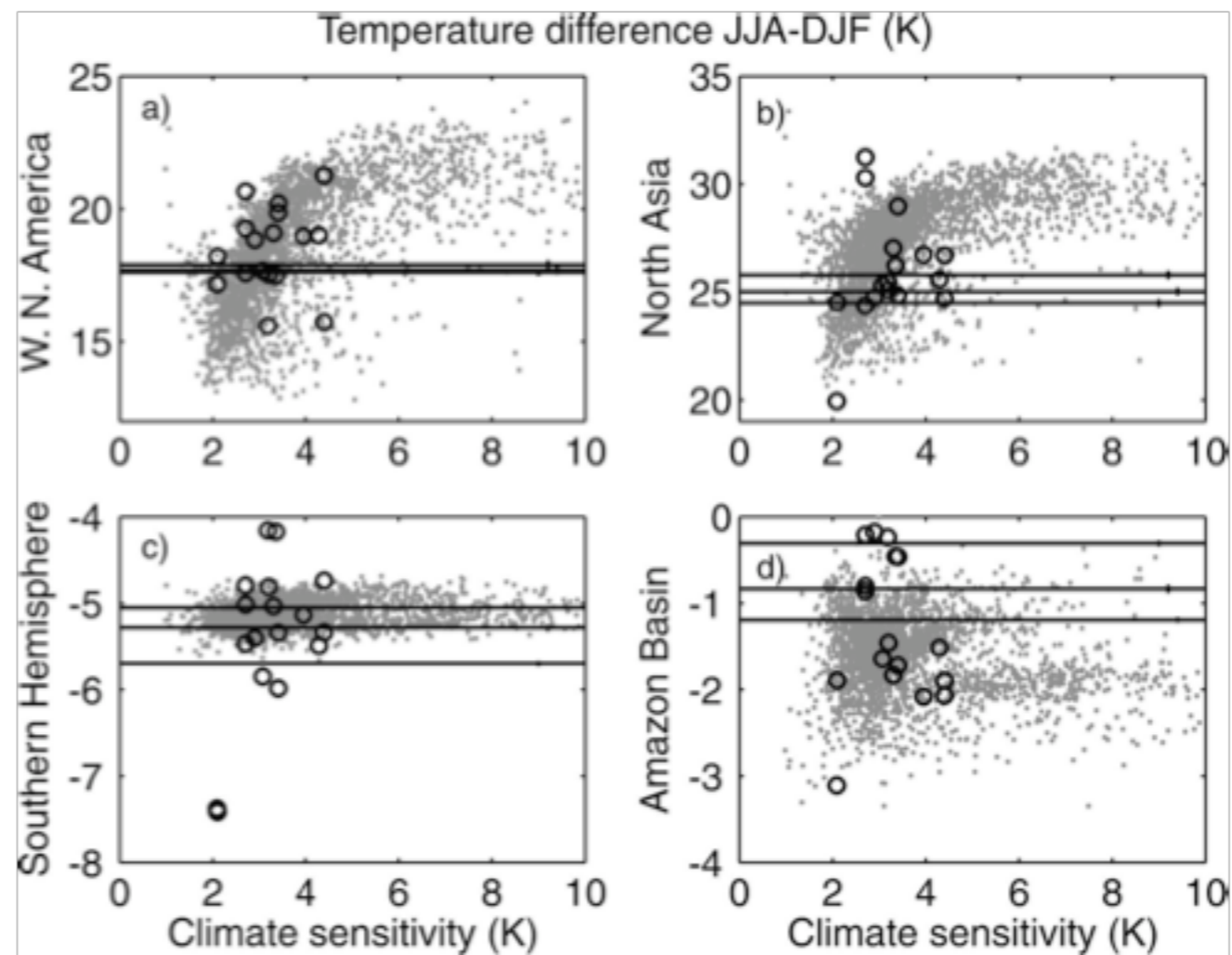
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What's been done before?

Estimating Climate Sensitivity

- Murphy et al. (2004)
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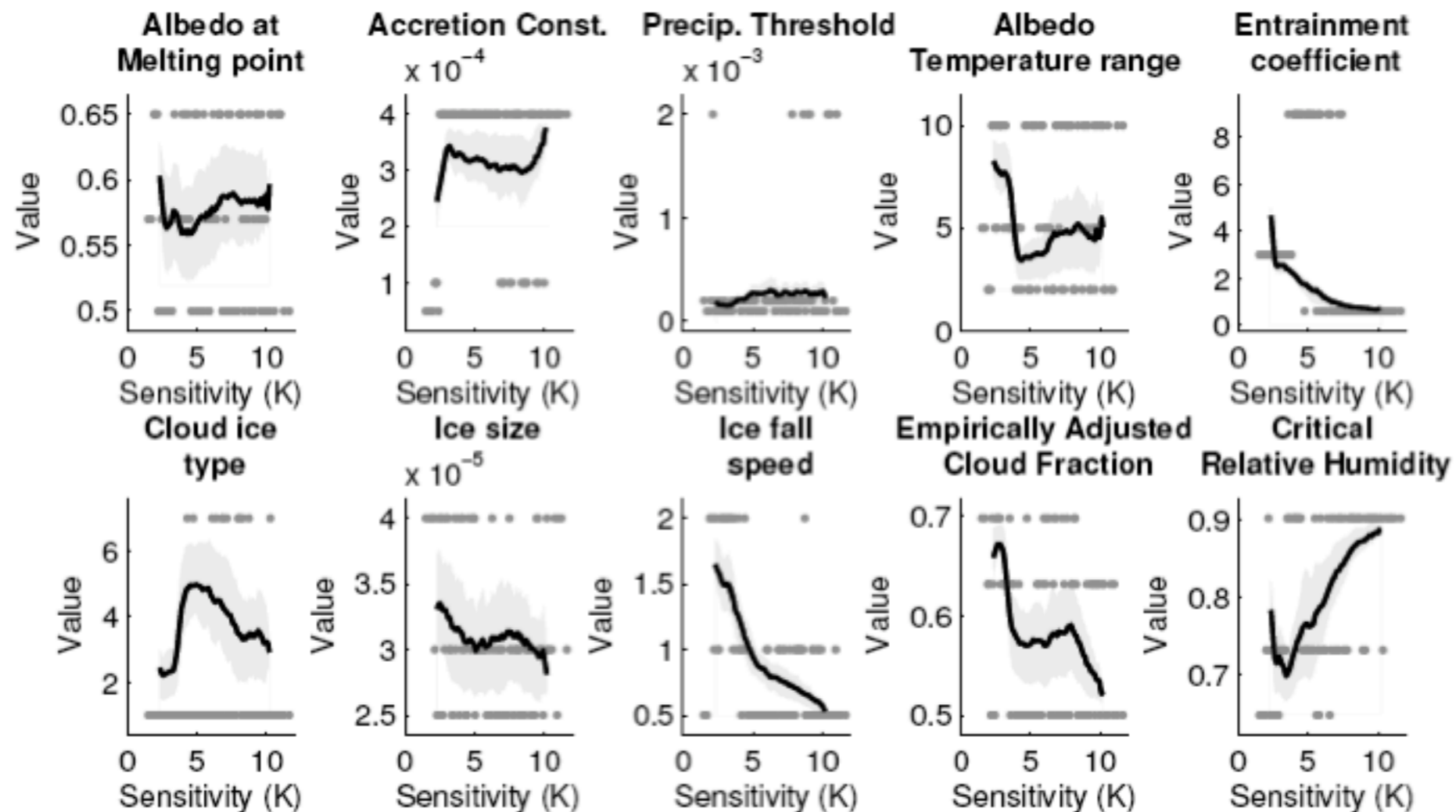


What's been done before?

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Optimising model parameters

- Sanderson et al. (2008b)



What's been done before?

Optimising model parameters

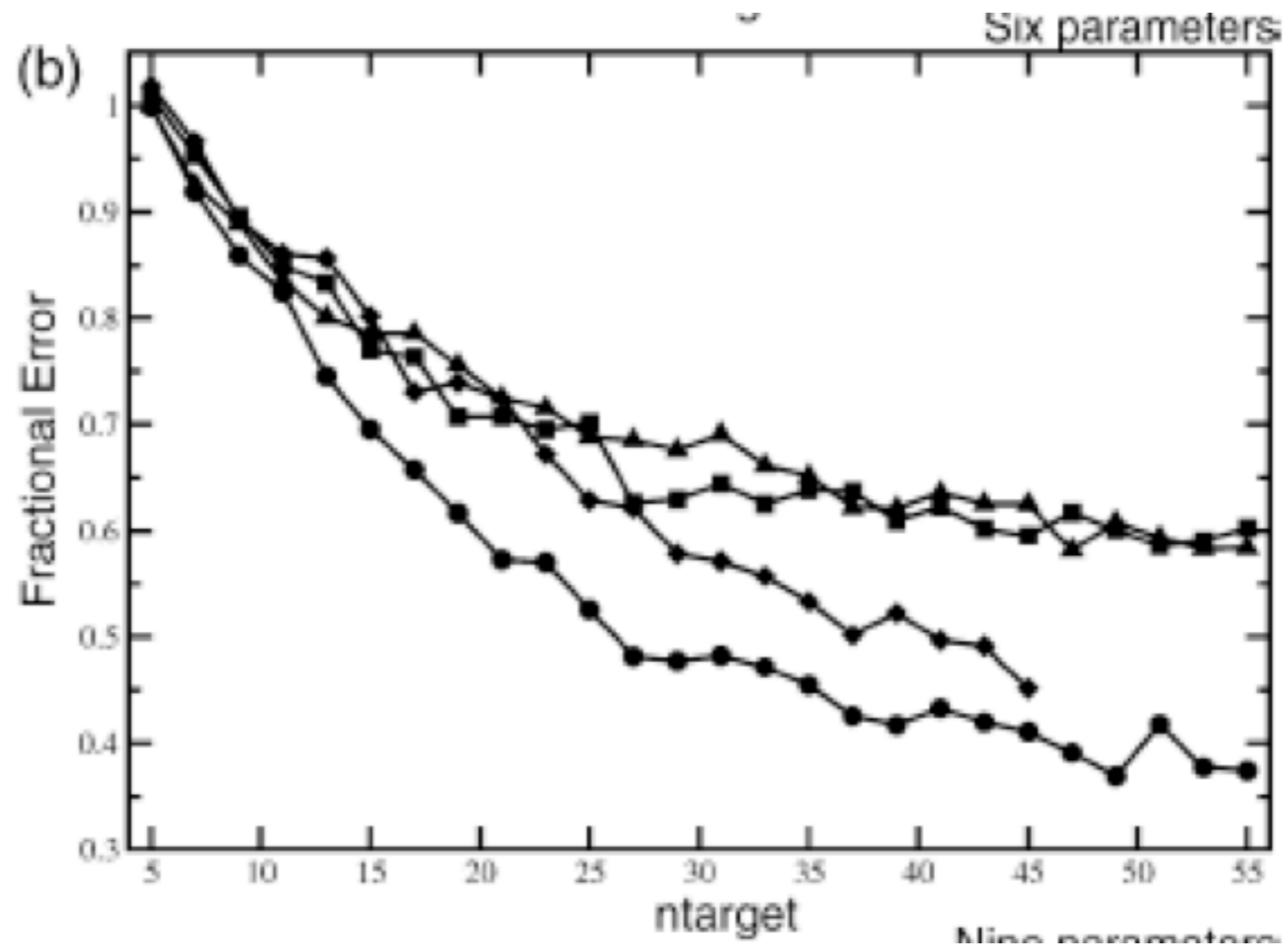
- Sanderson et al. (2008b)
- Jackson et al. (submitted)

Parameter	Definition	Value Ranges
RHMINL [%/100]	Low cloud critical relative humidity	0.80 -----*----- 0.95 654 3
RHMINH [%/100]	High cloud critical relative humidity	0.60 -----2 5 3 * 6 1----- 0.90
ALFA [fraction]	Initial cloud downdraft mass flux	0.05 -----6 4 * 3 1 3----- 0.60
TAU [hours]	Consumption rate of CAPE	0.5 -----* 3 5 6 2 4----- 8.0
ke [(kg m ⁻² s ⁻¹) ^{-1/2} s ⁻¹]	Environmental air entrainment rate	3.0e-6 -----2 3 * 6 5----- 10.0e-6
c0 [m ⁻¹]	Precipitation efficiency	3.0e-3 -----*-----5 6 3 2 4 1----- 6.0e-3

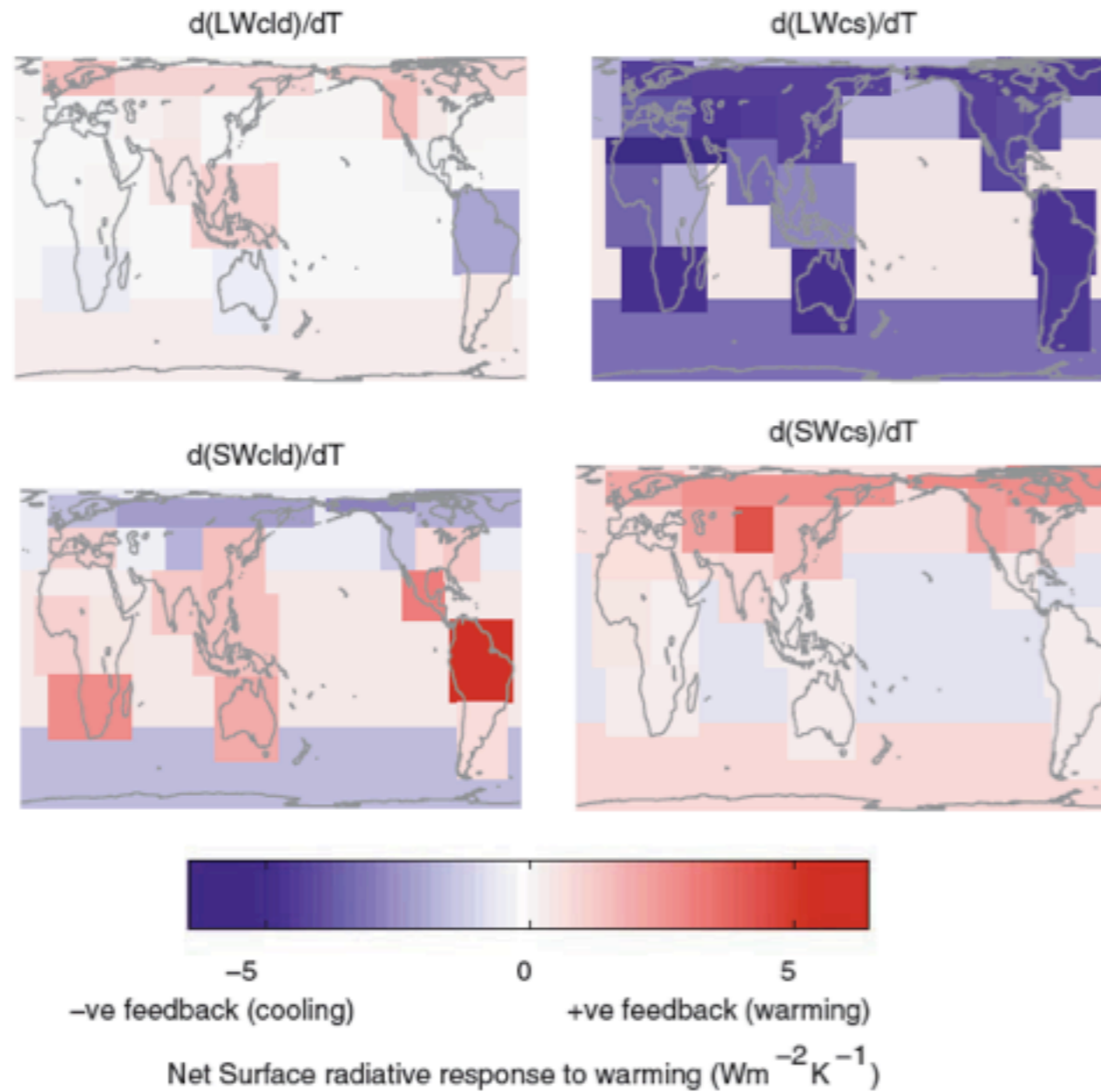
What's been done before?

Optimising model parameters

- Sanderson et al. (2008b)
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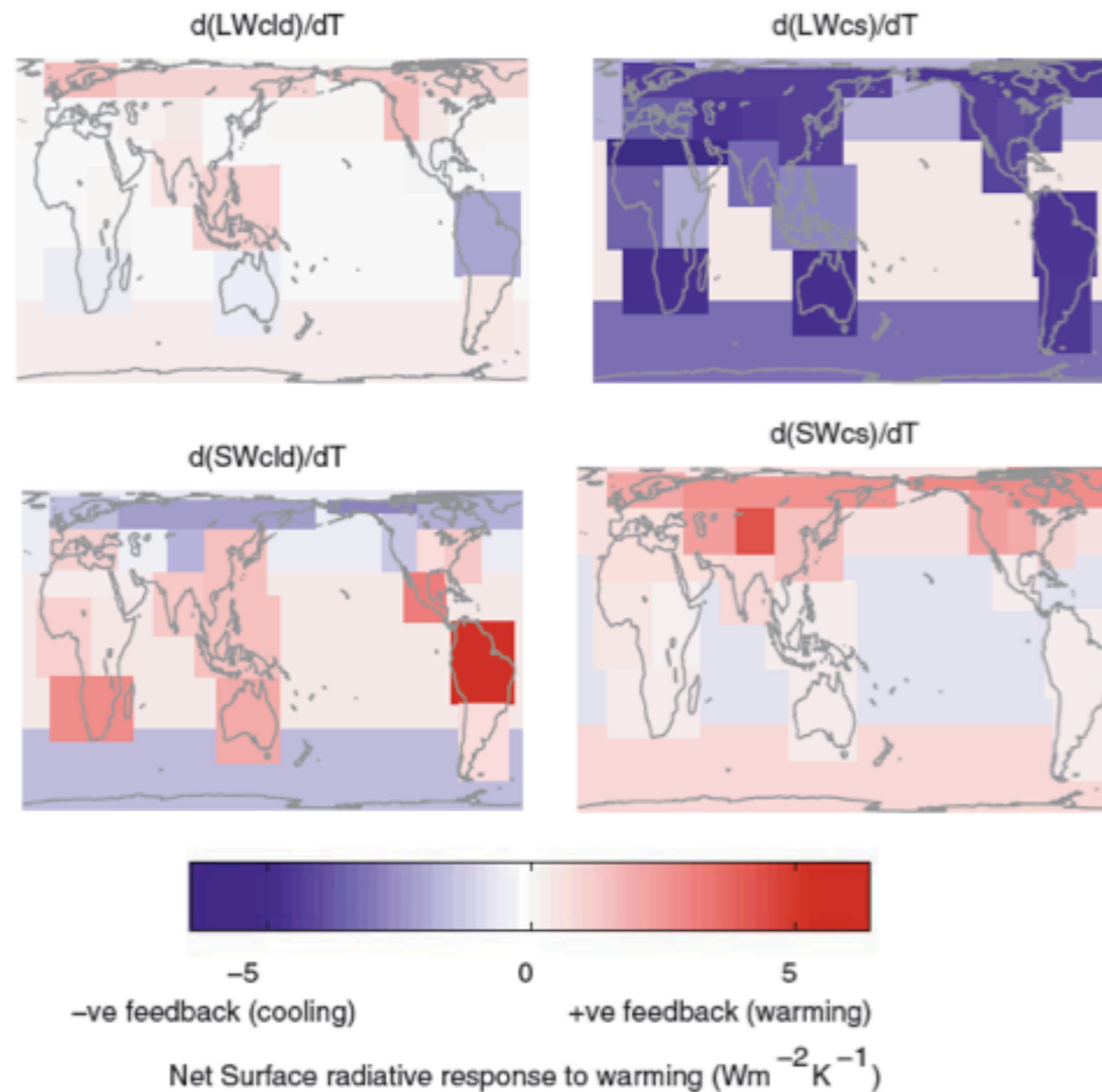
What's been done before?



What's been done before?

Understanding Feedbacks

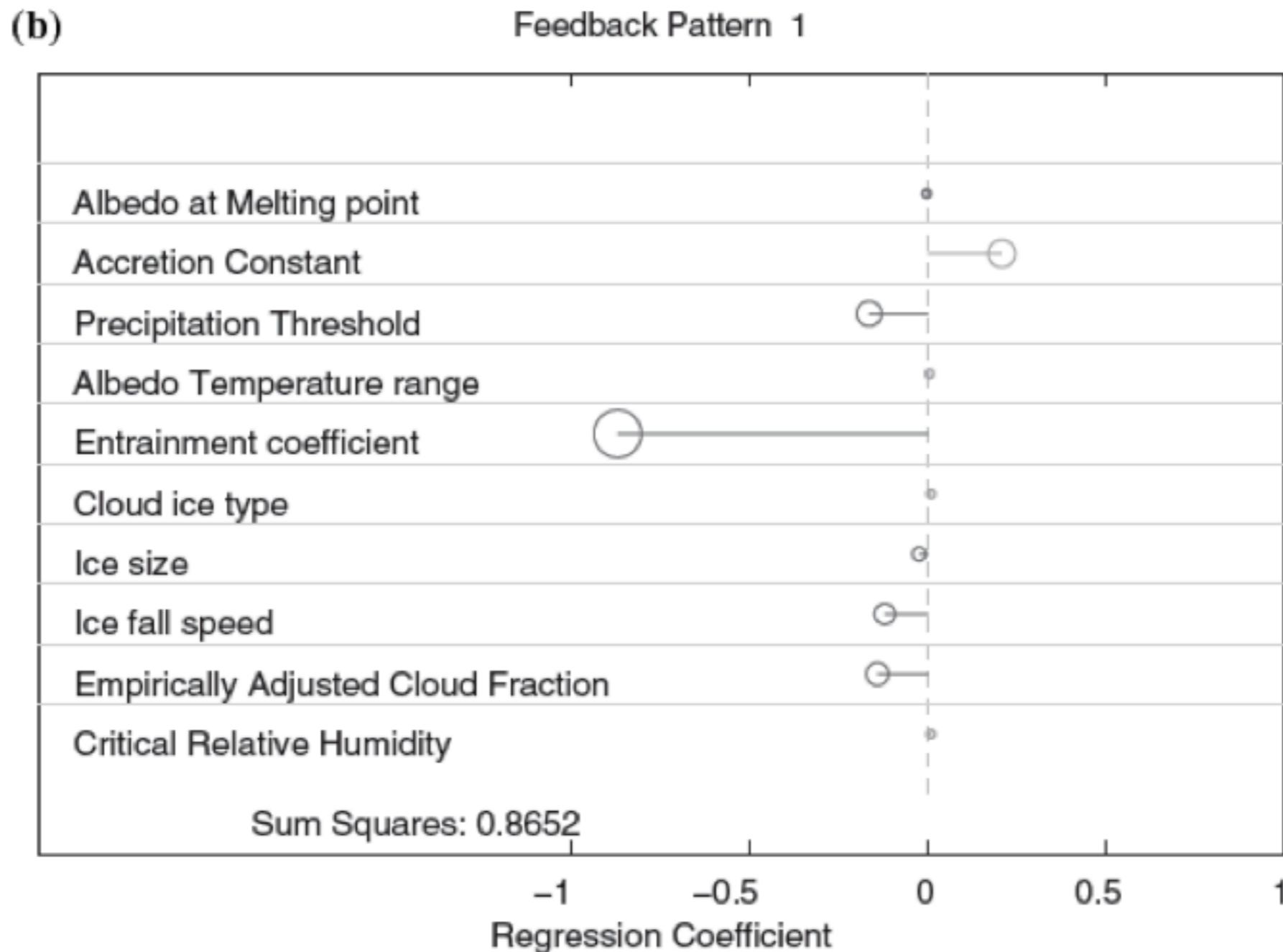
- Sanderson et al. (2008a)



What's been done before?

Understanding Feedbacks

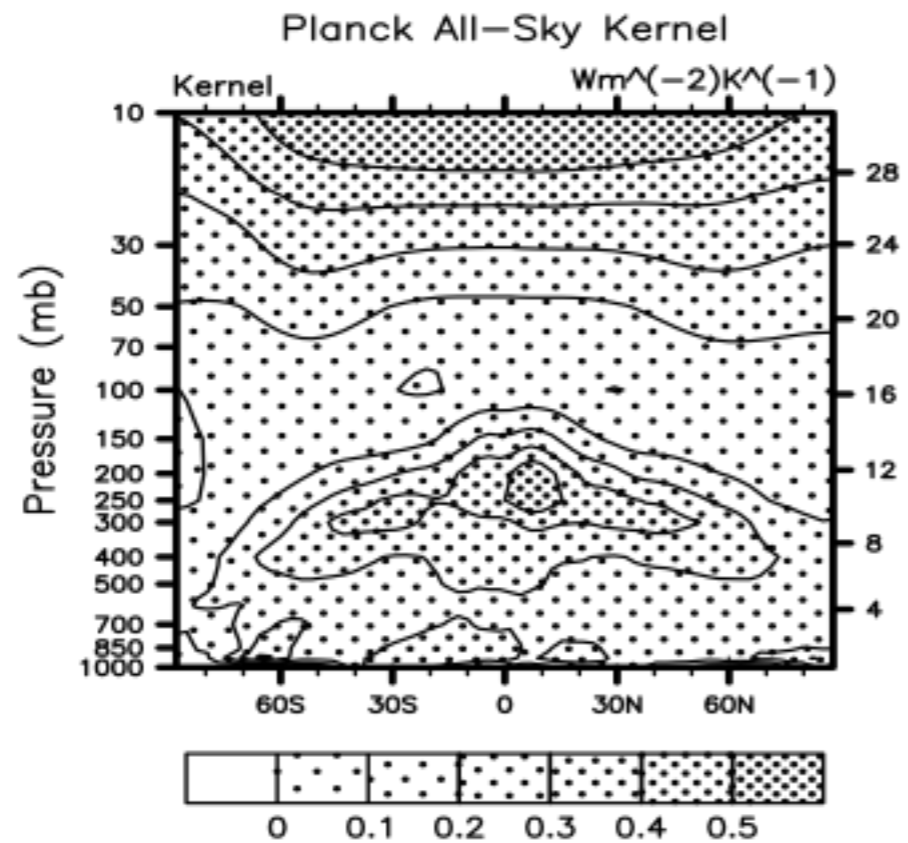
- Sanderson et al. (2008a)
- Sanderson et al. (in preparation)



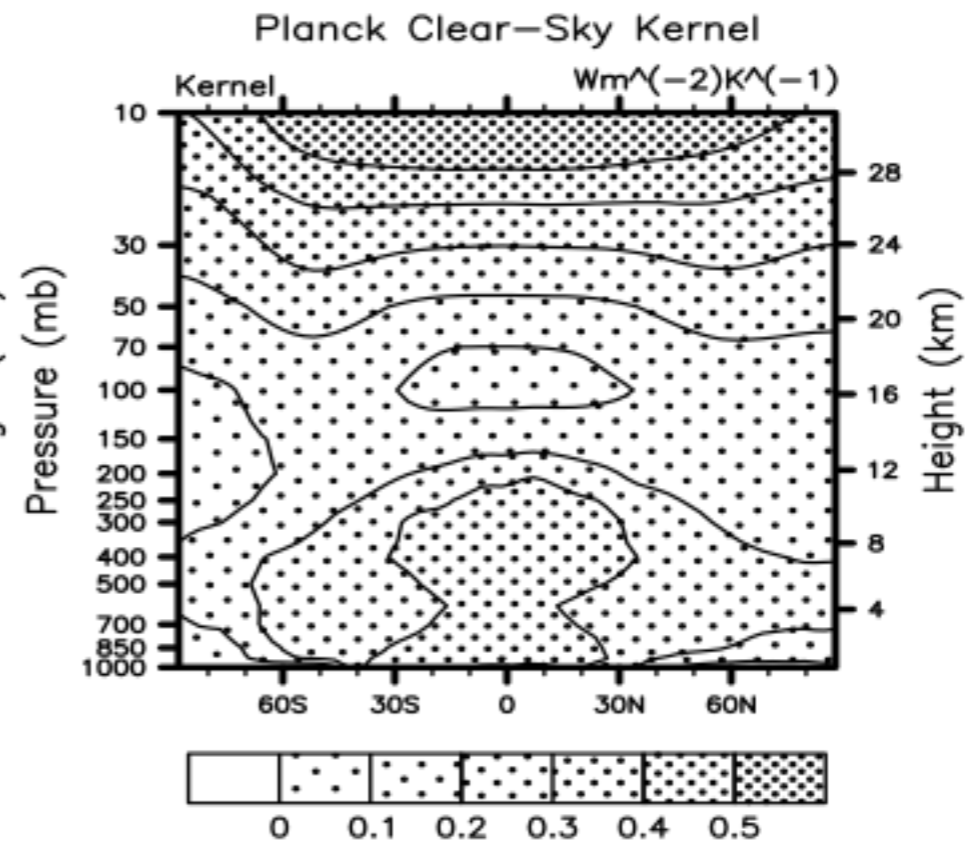
What's been done before?

Understanding Feedbacks

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- Sanderson et al. (in preparation)



Water Vapor All-Sky Kernel (longwave)

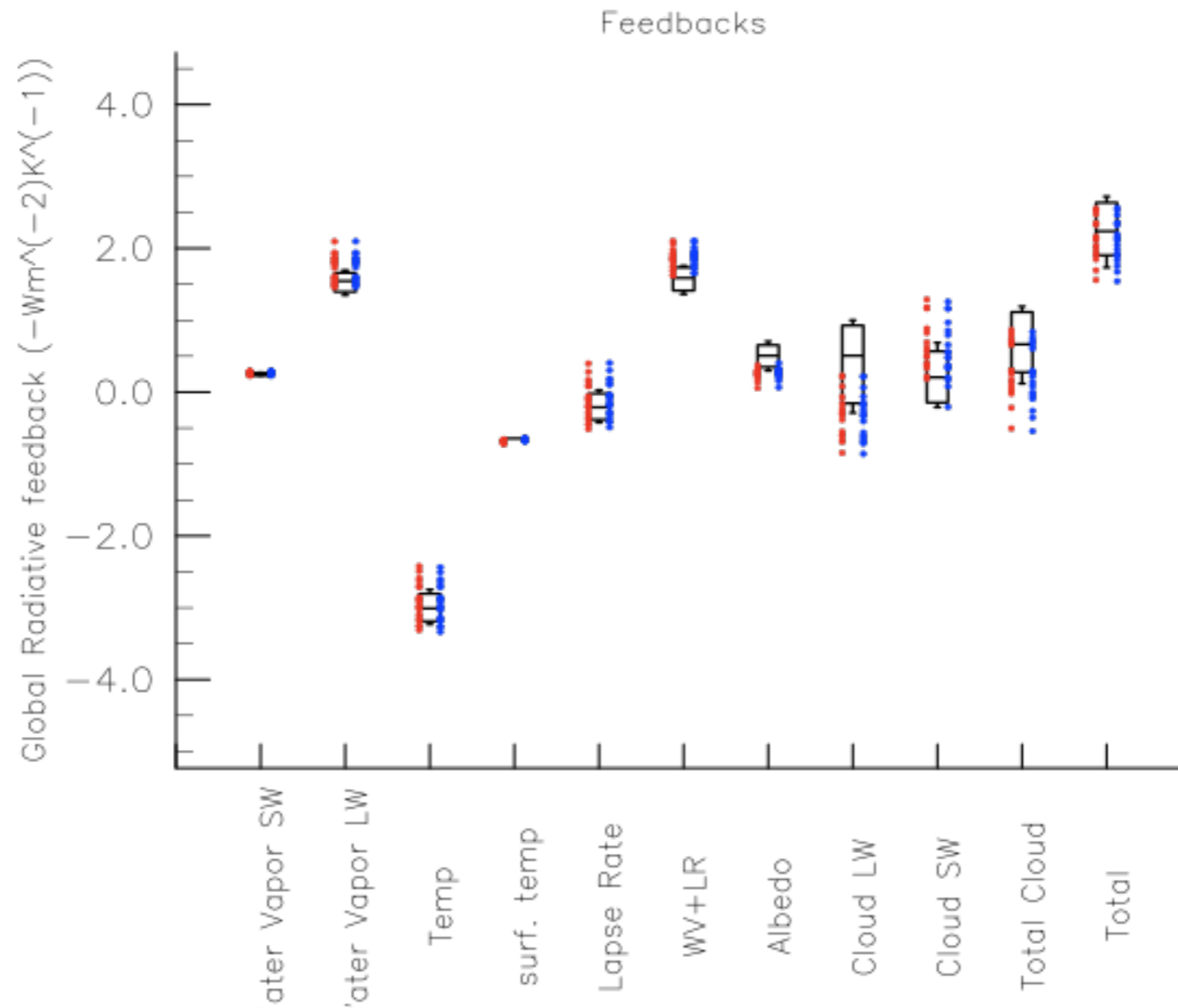


Water Vapor Clear-Sky Kernel (longwave)

What's been done before?

Understanding Feedbacks

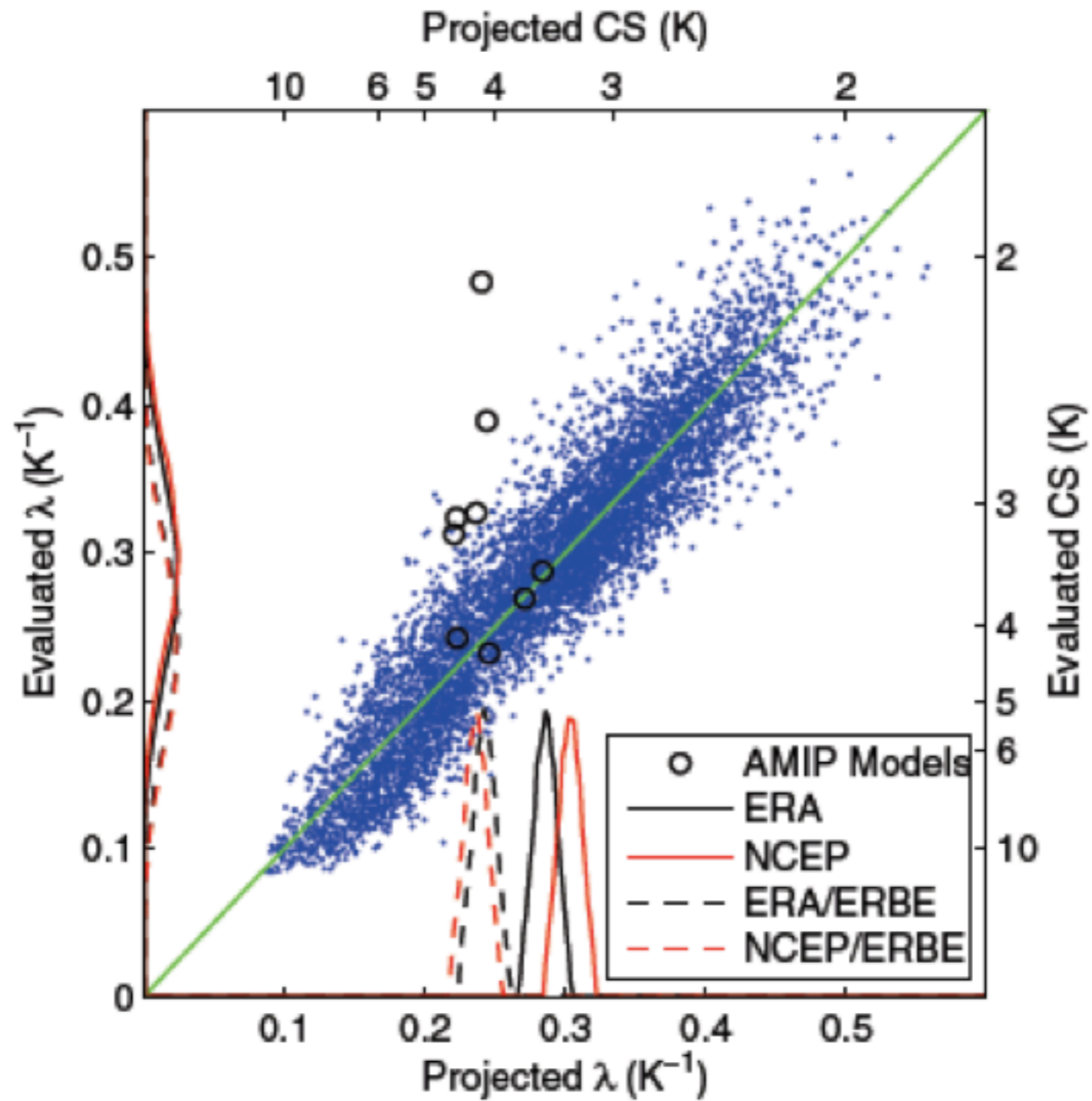
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So why do we need another ensemble?

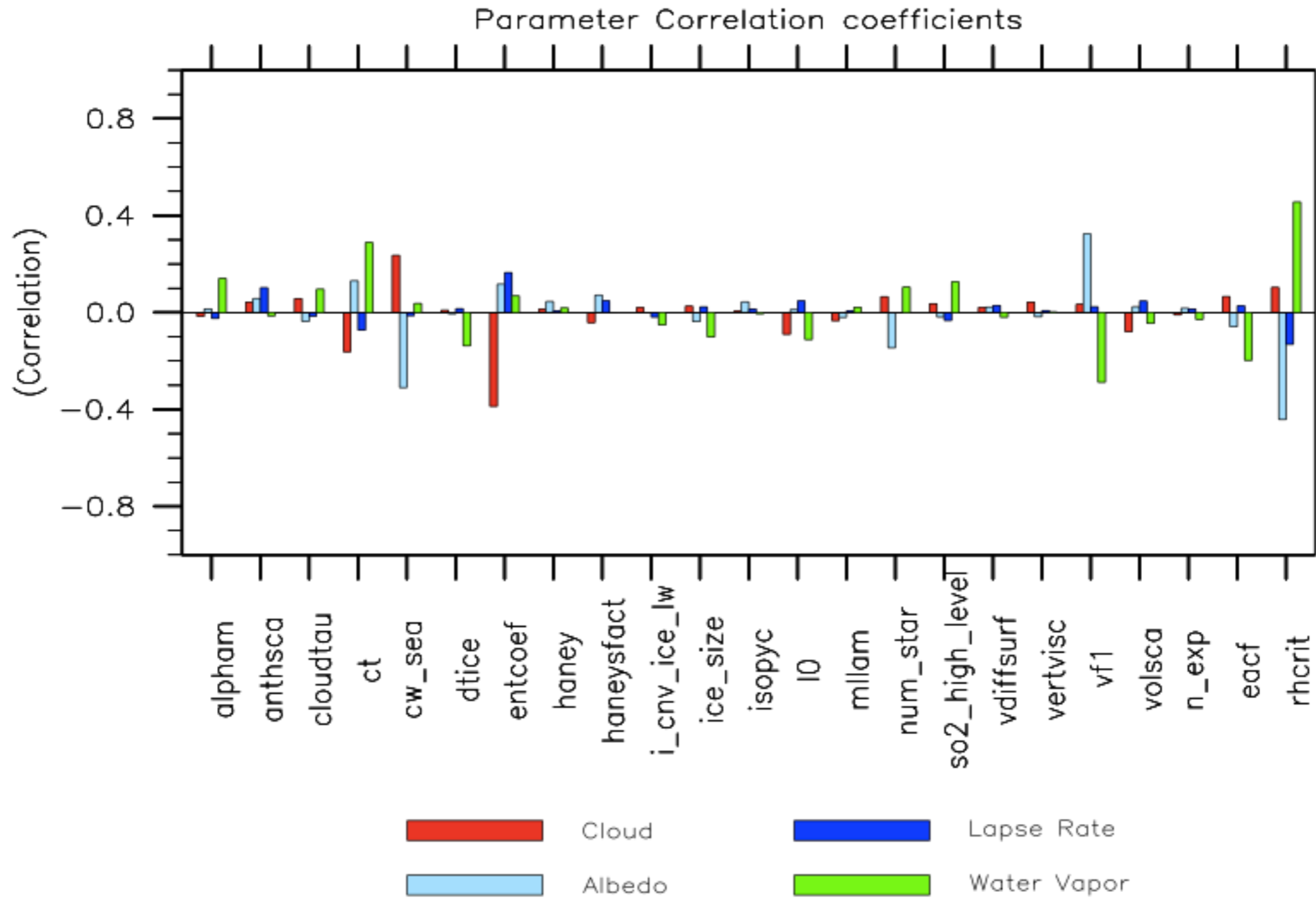
So why do we need another ensemble?

Why we need CAM³



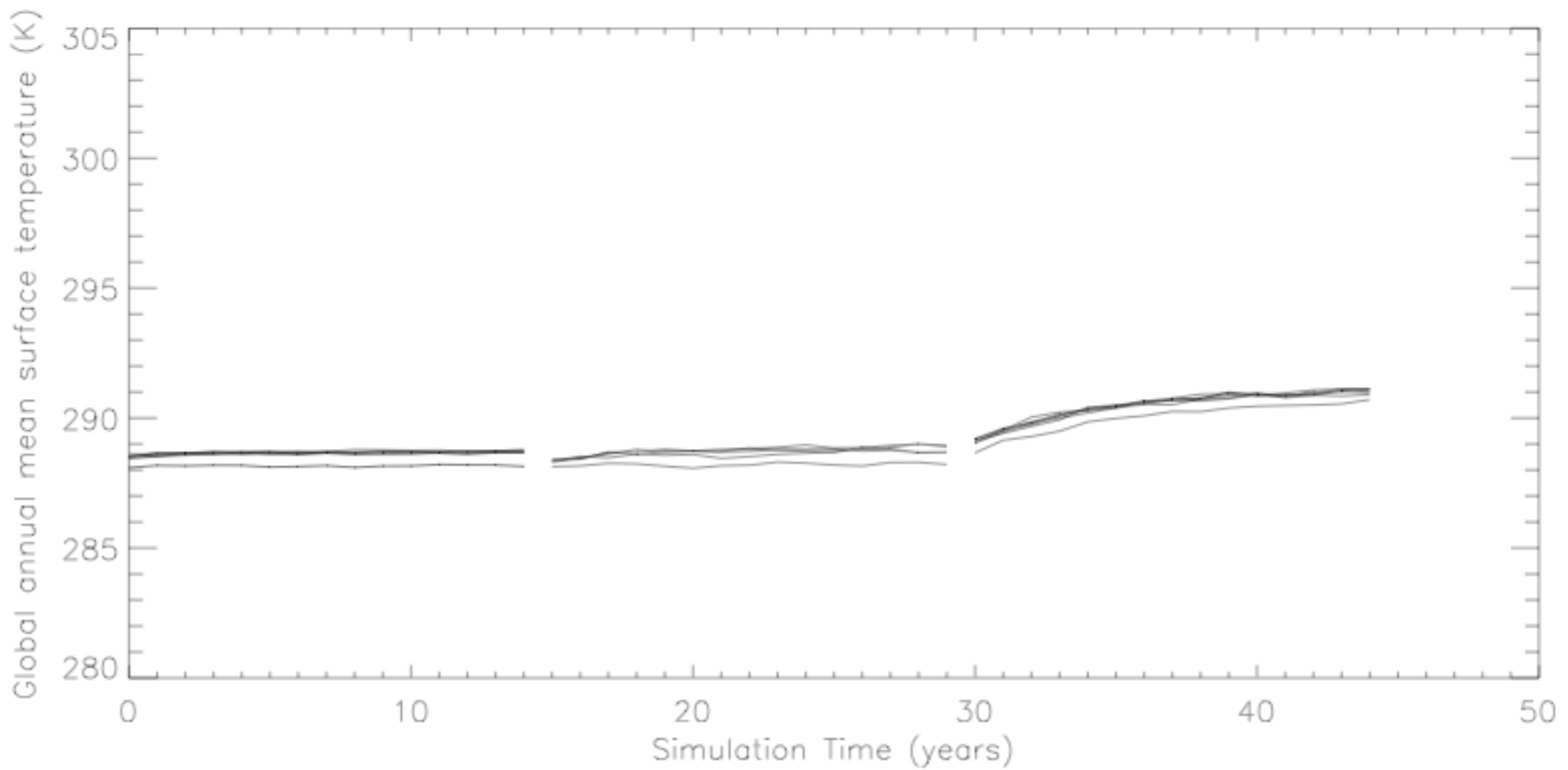
Why we need CAM³

- Estimate systematic model error



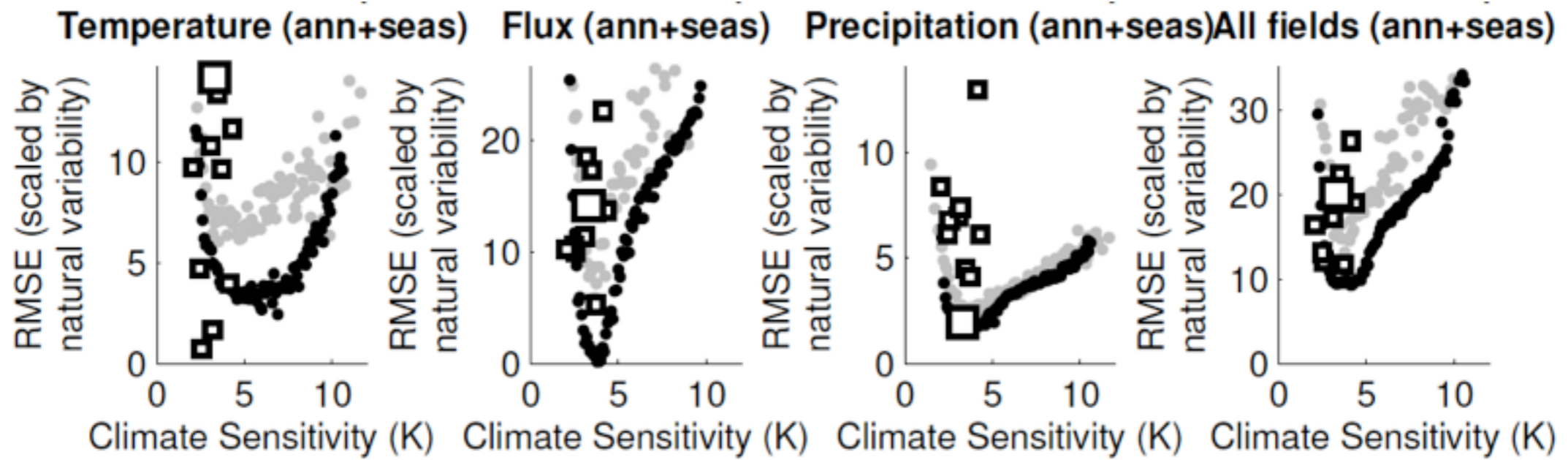
Why we need CAM³

- Estimate systematic model error
- Understand parameter-feedback relationships



Why we need CAM³

- Estimate systematic model error
- Understand parameter-feedback relationships
- Internal variability and parameter uncertainty



Why we need CAM³

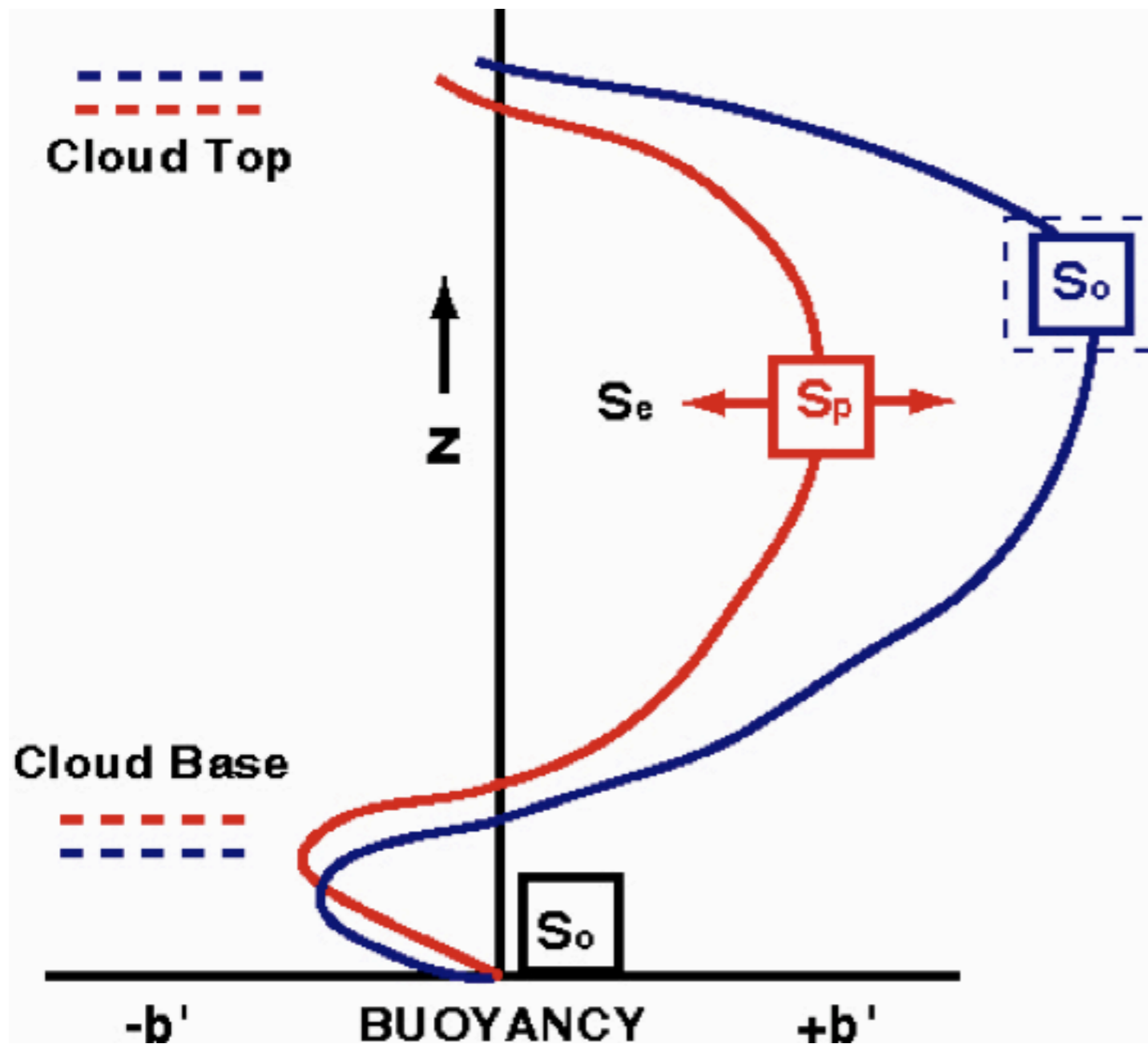
- Estimate systematic model error
- Understand parameter-feedback relationships
- Internal variability and parameter uncertainty
- Find optimal model configurations

Ensemble Design

Ensemble Design

Parameters

- fractional mass entrainment rate

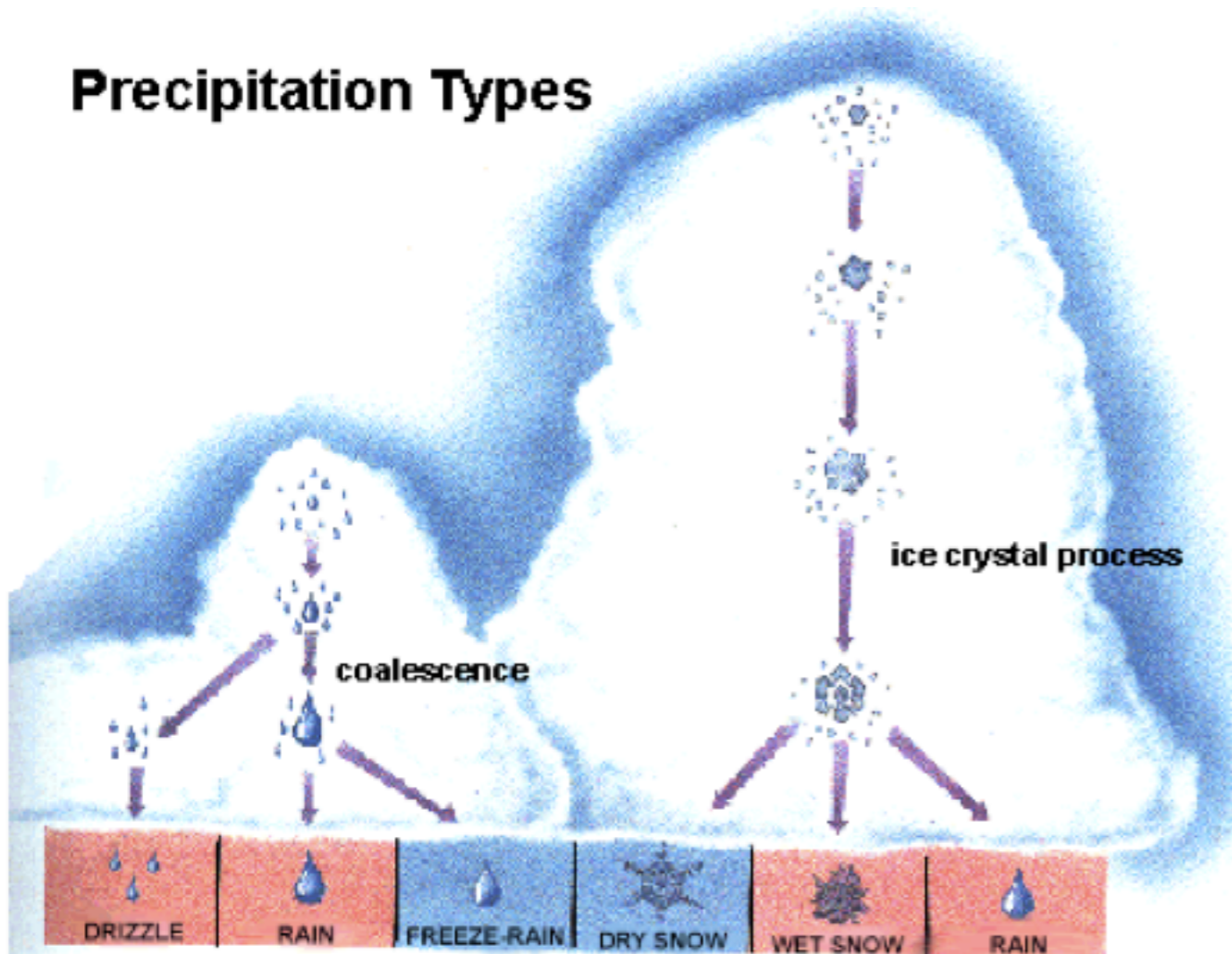


Ensemble Design

Parameters

- fractional mass entrainment rate
- threshold for ice conversion

Precipitation Types

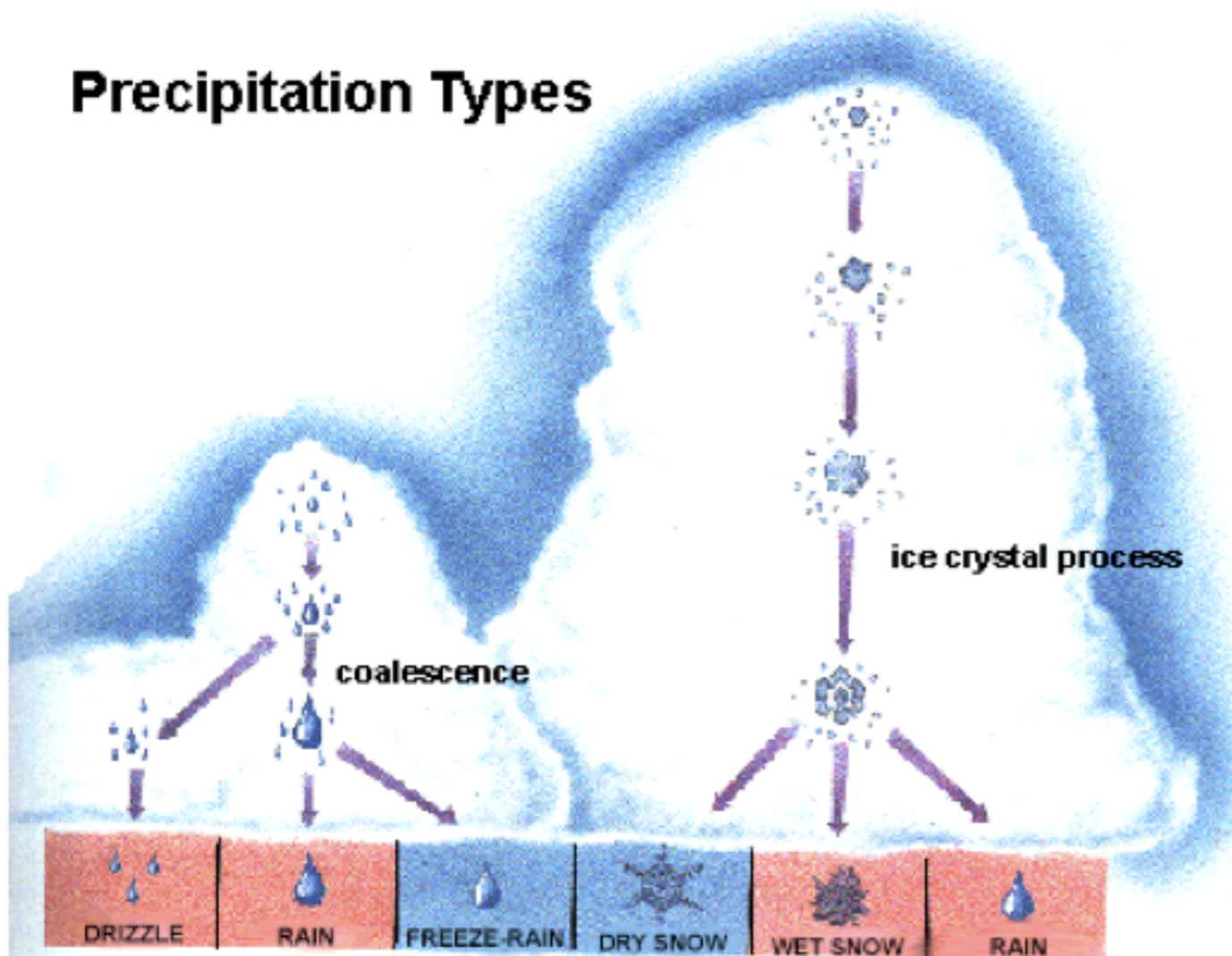


Ensemble Design

Parameters

- fractional mass entrainment rate
- threshold for ice conversion
- ice fall velocity scaling

Precipitation Types



Ensemble Design

Parameters

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



-- Photograph by Ronald L. Holle --

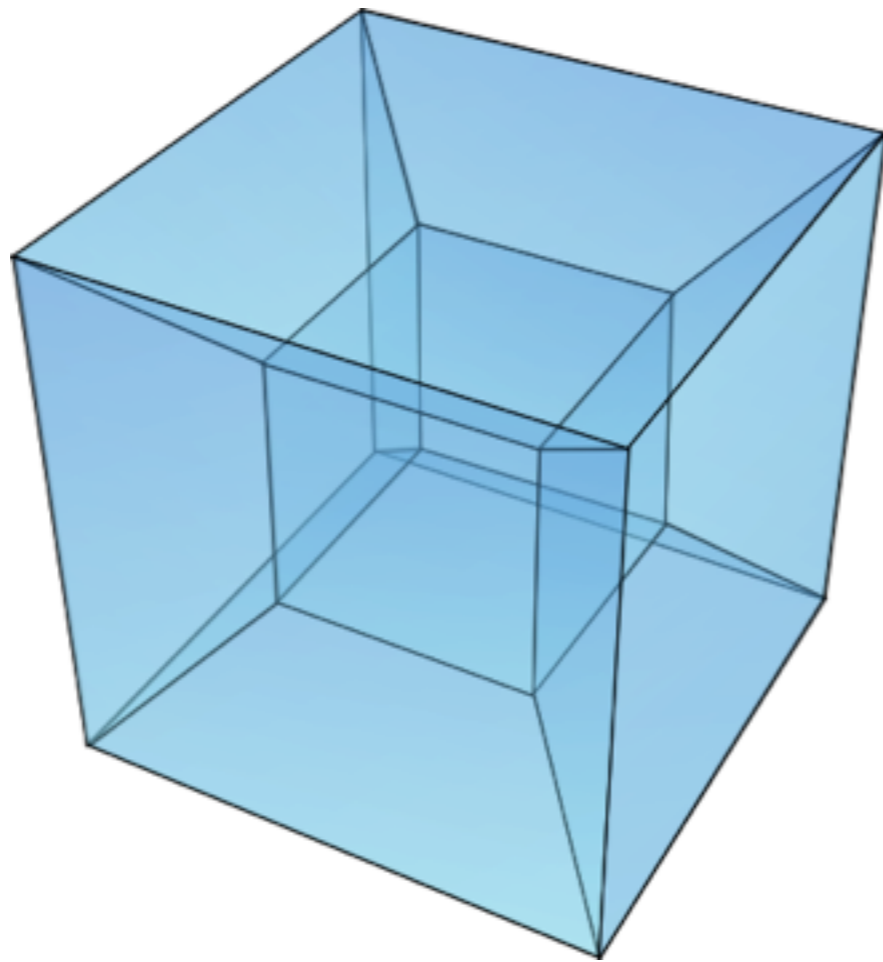
-- U. of Illinois Cloud Catalog --

Ensemble Design

Ensemble Design

Stage 1

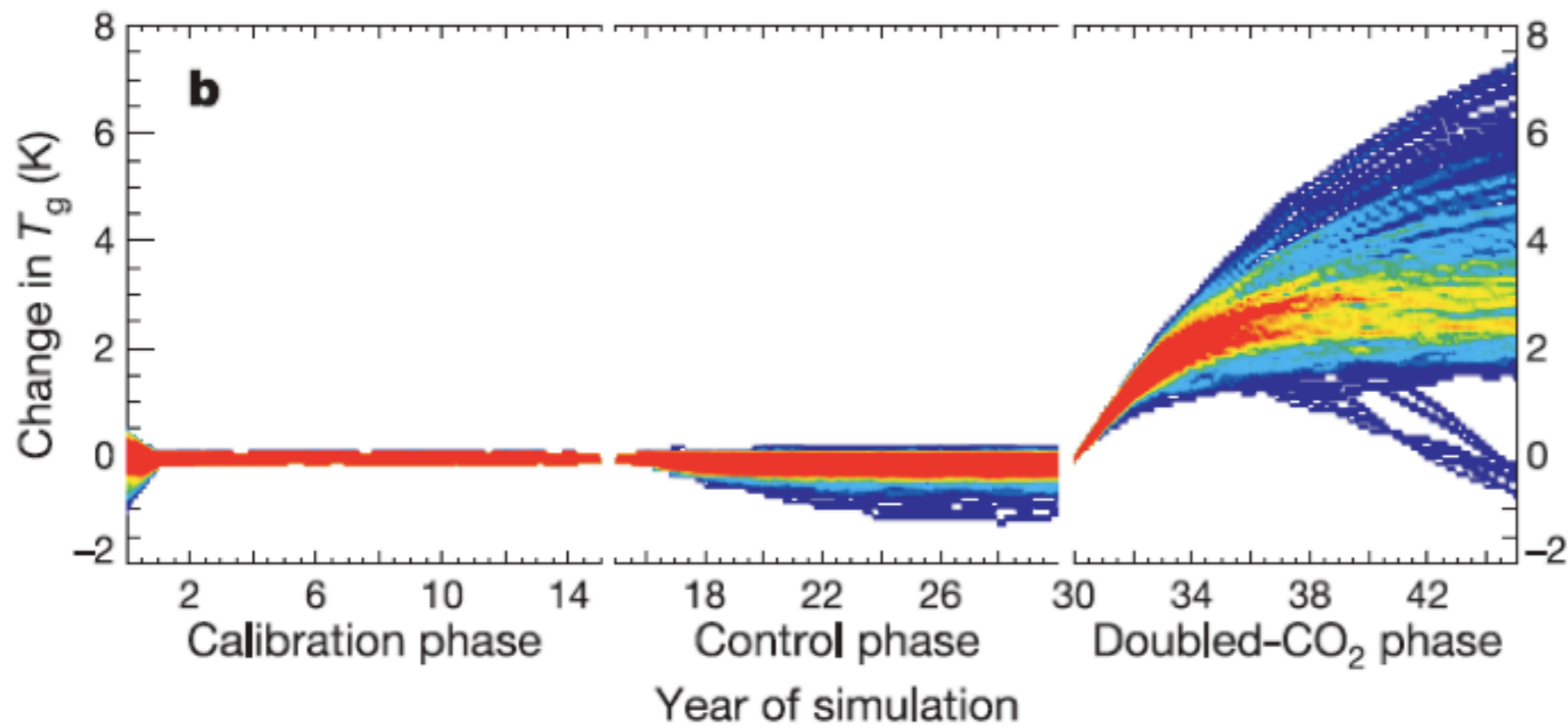
- Hypercube parameter sampling



Ensemble Design

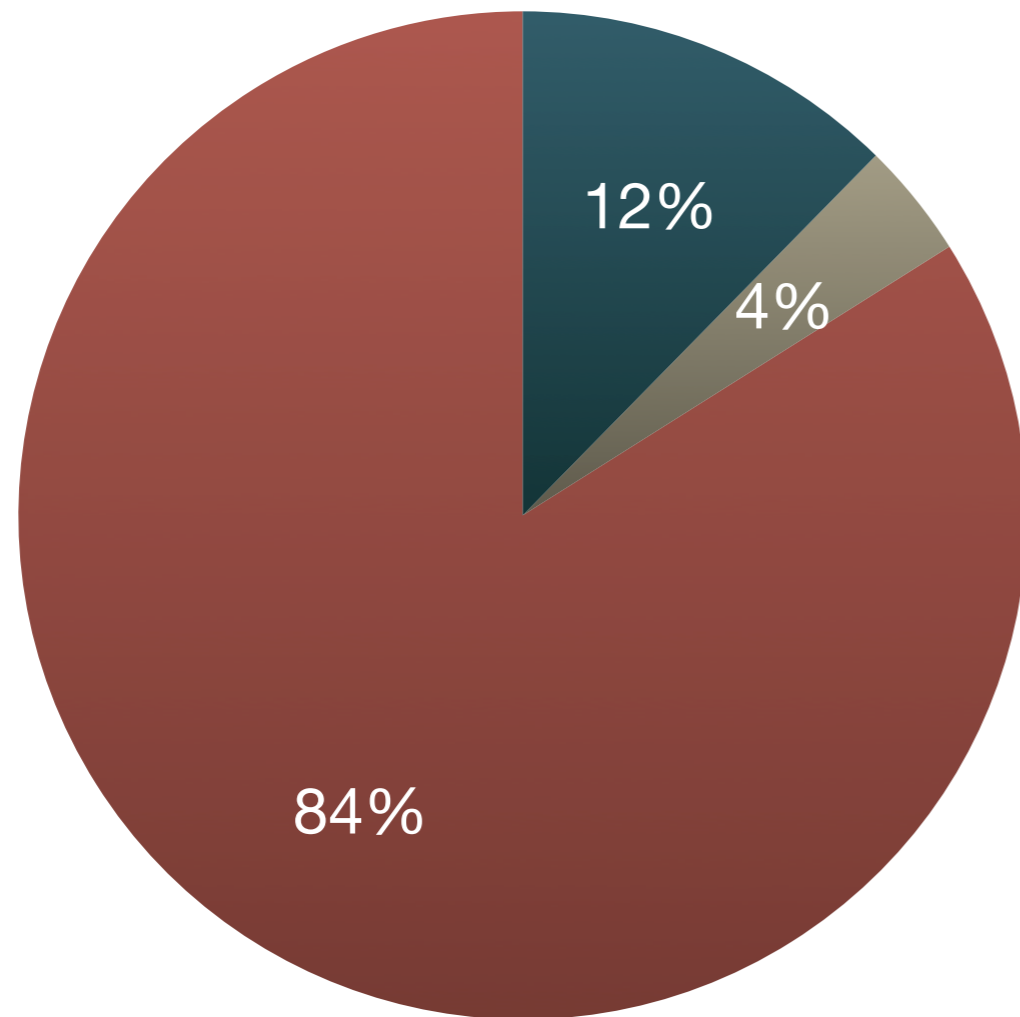
Stage 1

- Hypercube parameter sampling
- Slab sensitivity experiments

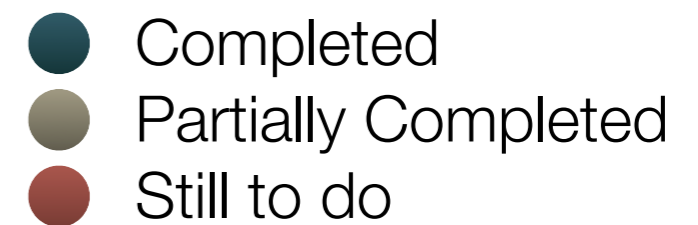


Ensemble Design

Stage 1



- Hypercube parameter sampling
- Slab sensitivity experiments
- Simulations in progress

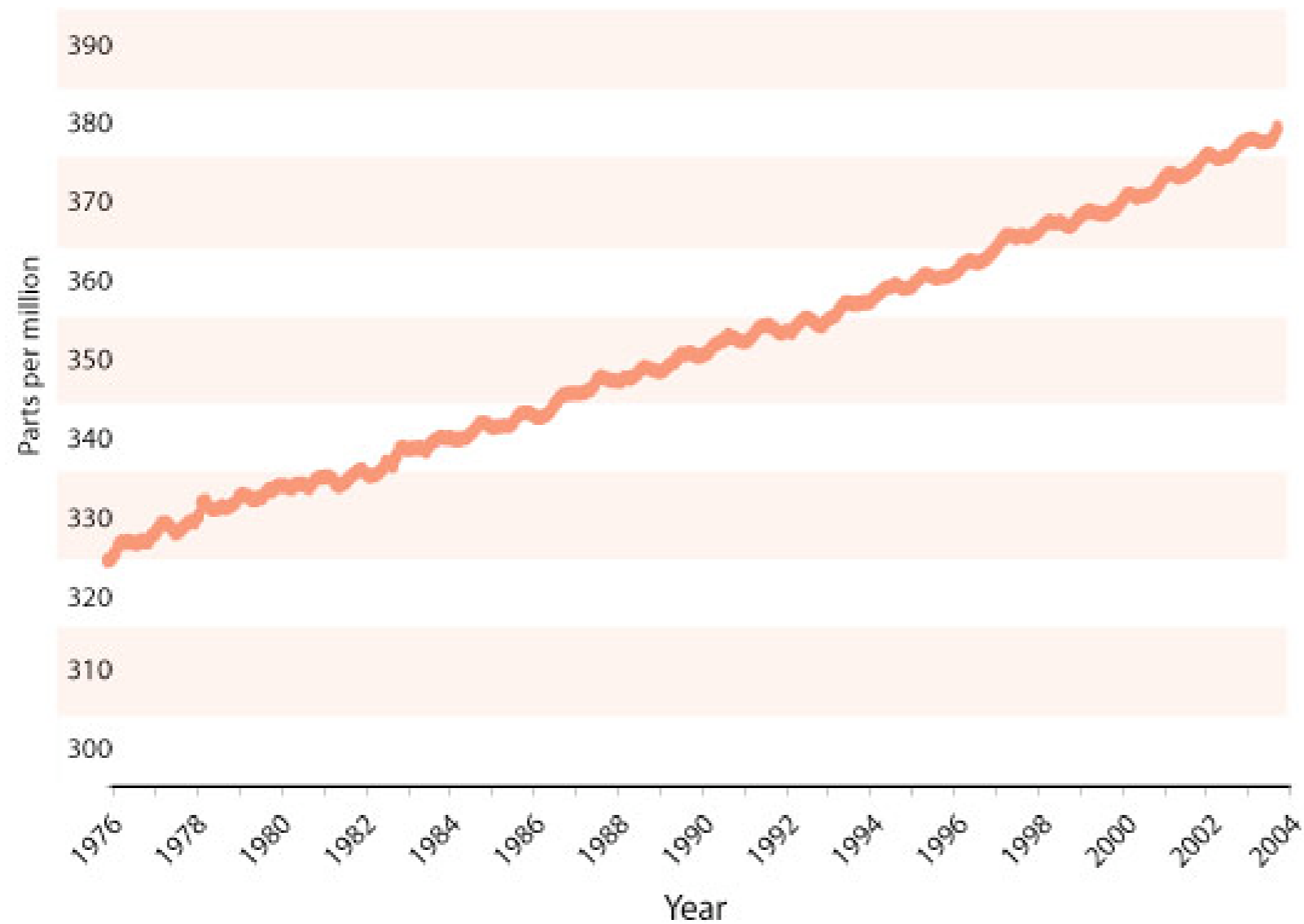


Ensemble Design

Ensemble Design

Stage 2

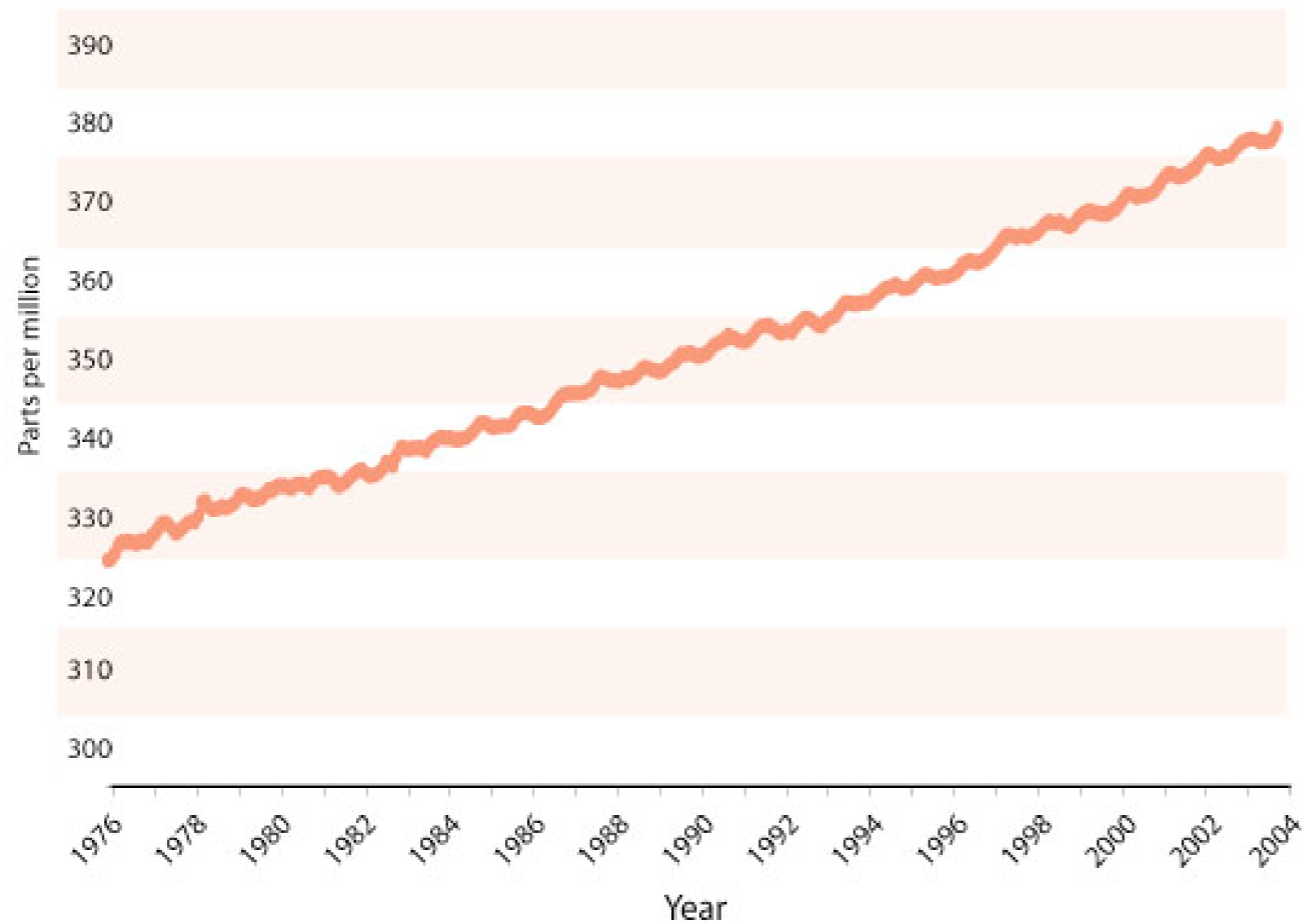
- Hindcast simulations 1960-2000



Ensemble Design

Stage 2

- Hindcast simulations 1960-2000
- Compare transient vs. base state predictors of climate response

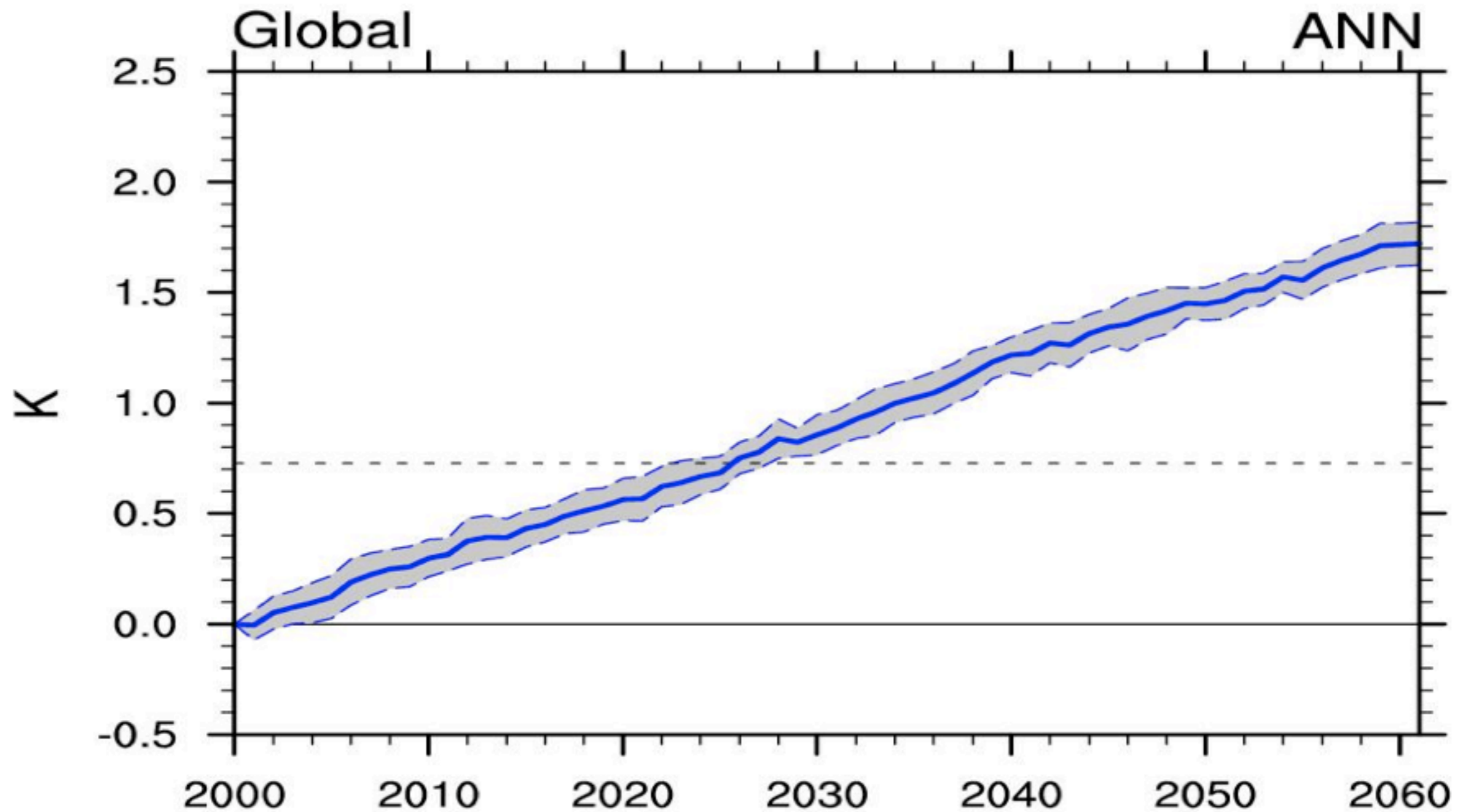


Ensemble Design

Ensemble Design

Stage 3+

- Integration with the CCSM3 Large Ensemble Experiment

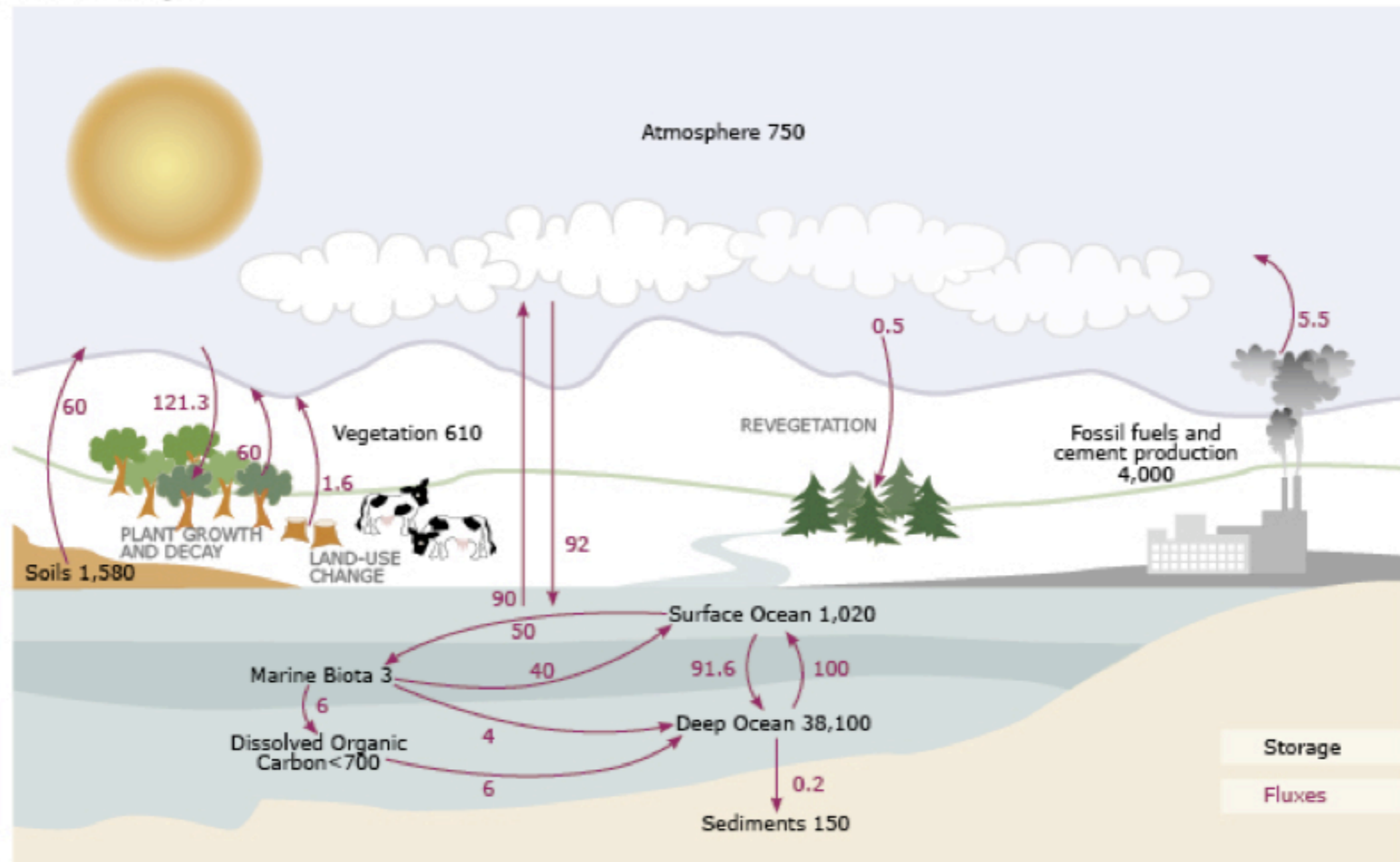


Ensemble Design

Stage 3+

- Integration with the CCSM3 Large Ensemble Experiment
- Add Carbon cycle to perturbed models

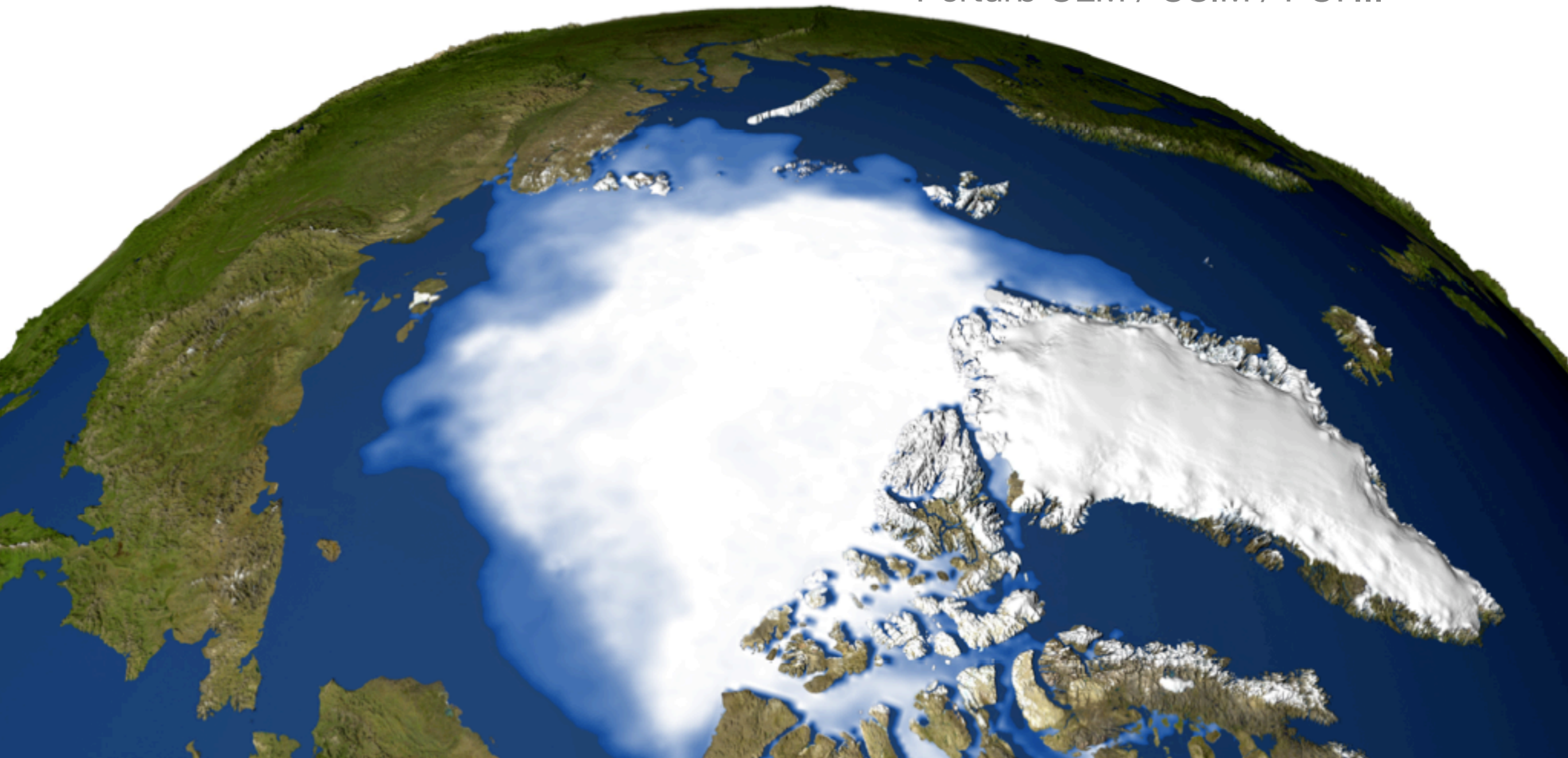
Carbon cycle



Ensemble Design

Stage 3+

- Integration with the CCSM3 Large Ensemble Experiment
- Add Carbon cycle to perturbed models
- Perturb CLM / CSIM / POP...



Thank you

Thank you

