

Climate Predictions and Projections

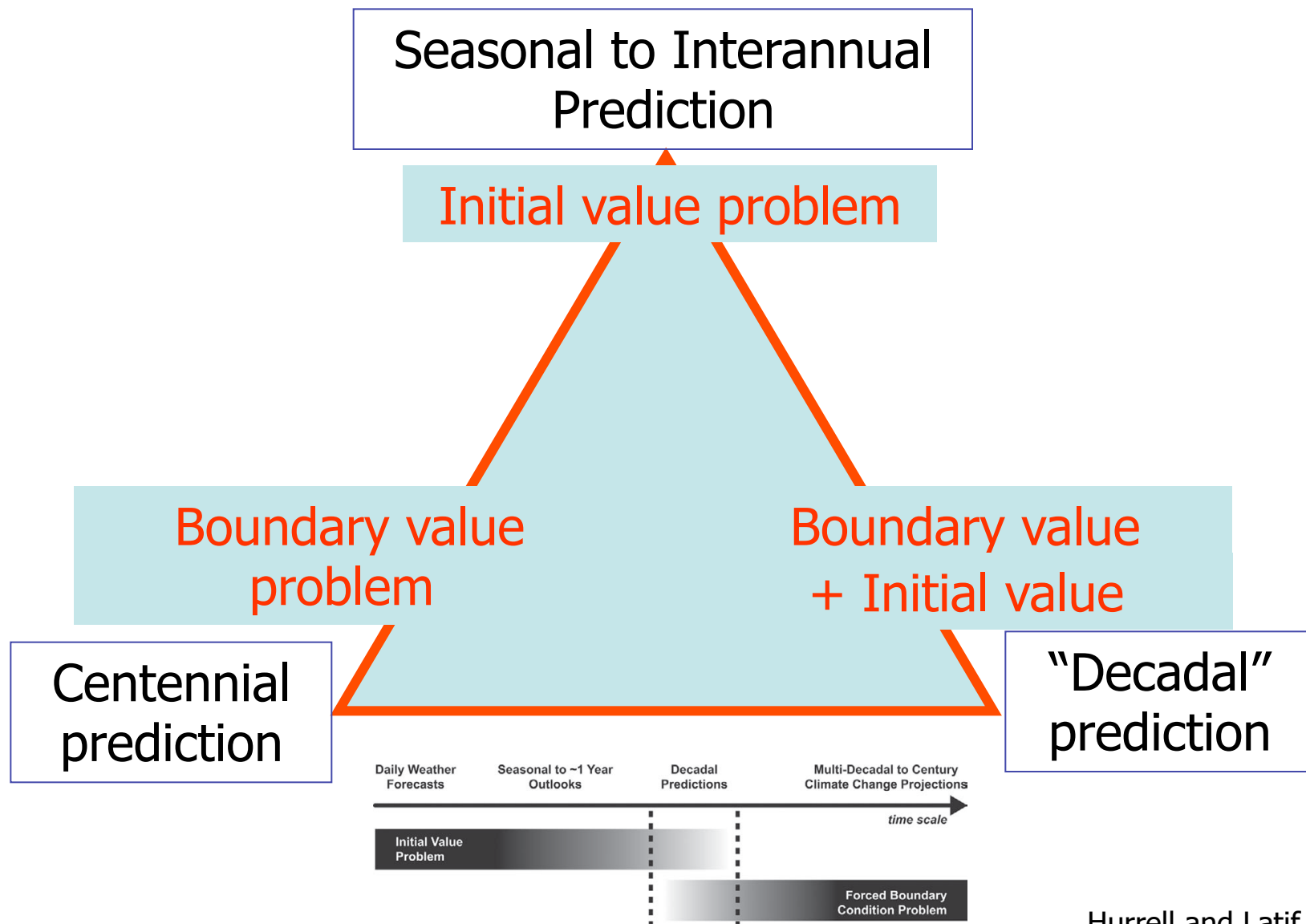
Sources of Uncertainty

James W. Hurrell

Director, NCAR Earth System Laboratory



Climate Prediction



Hurrell and Latif (2012)

Climate Prediction: Sources of Uncertainty

Forcing (or Scenario Uncertainty)

- GHG emissions scenarios (e.g., B1, A1B, A2, RCPs)
ozone, sulfate aerosols, land use, black carbon ...

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- Model sensitivity
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- 20+ different climate models in both IPCC AR4 and AR5

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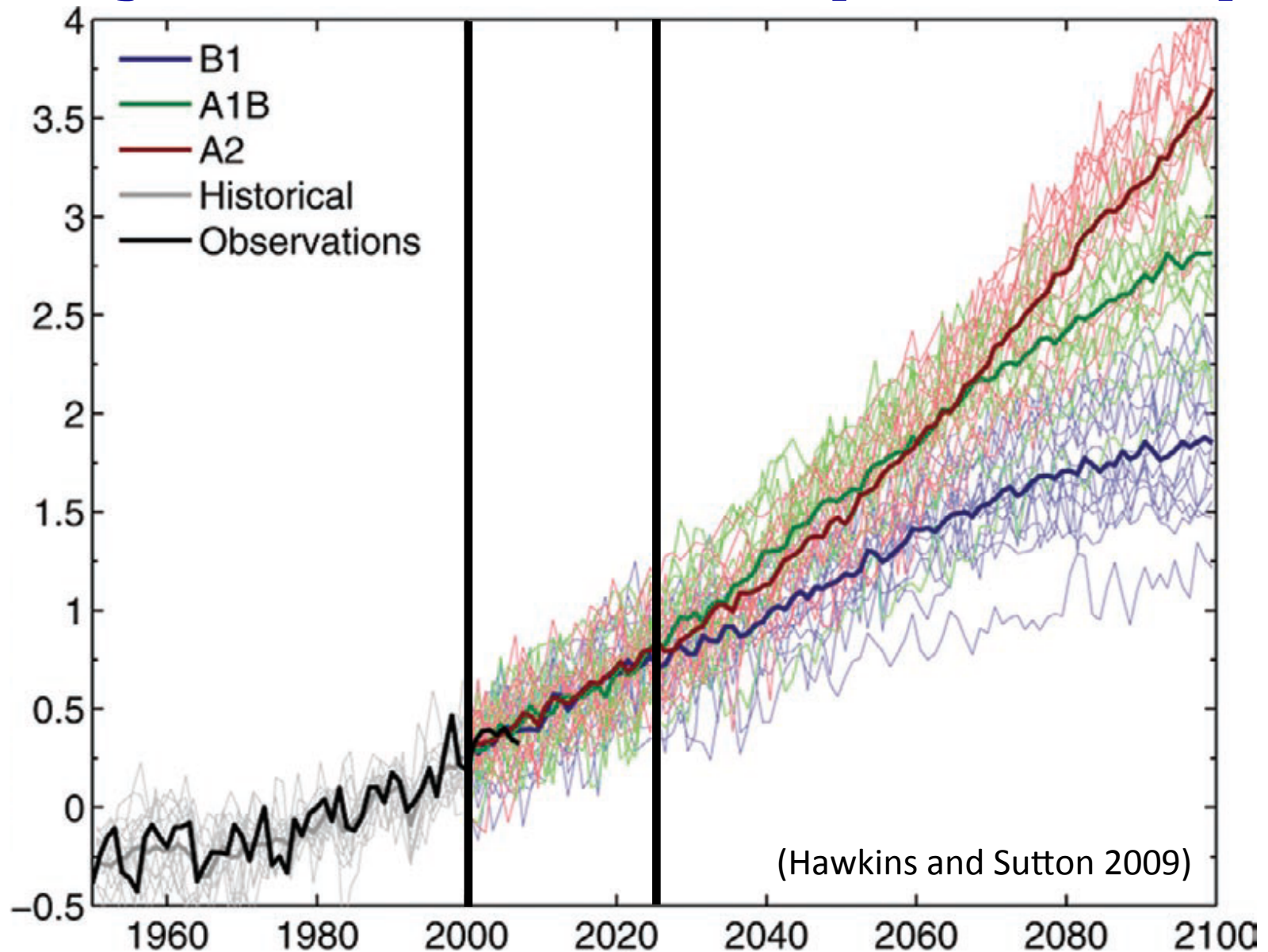
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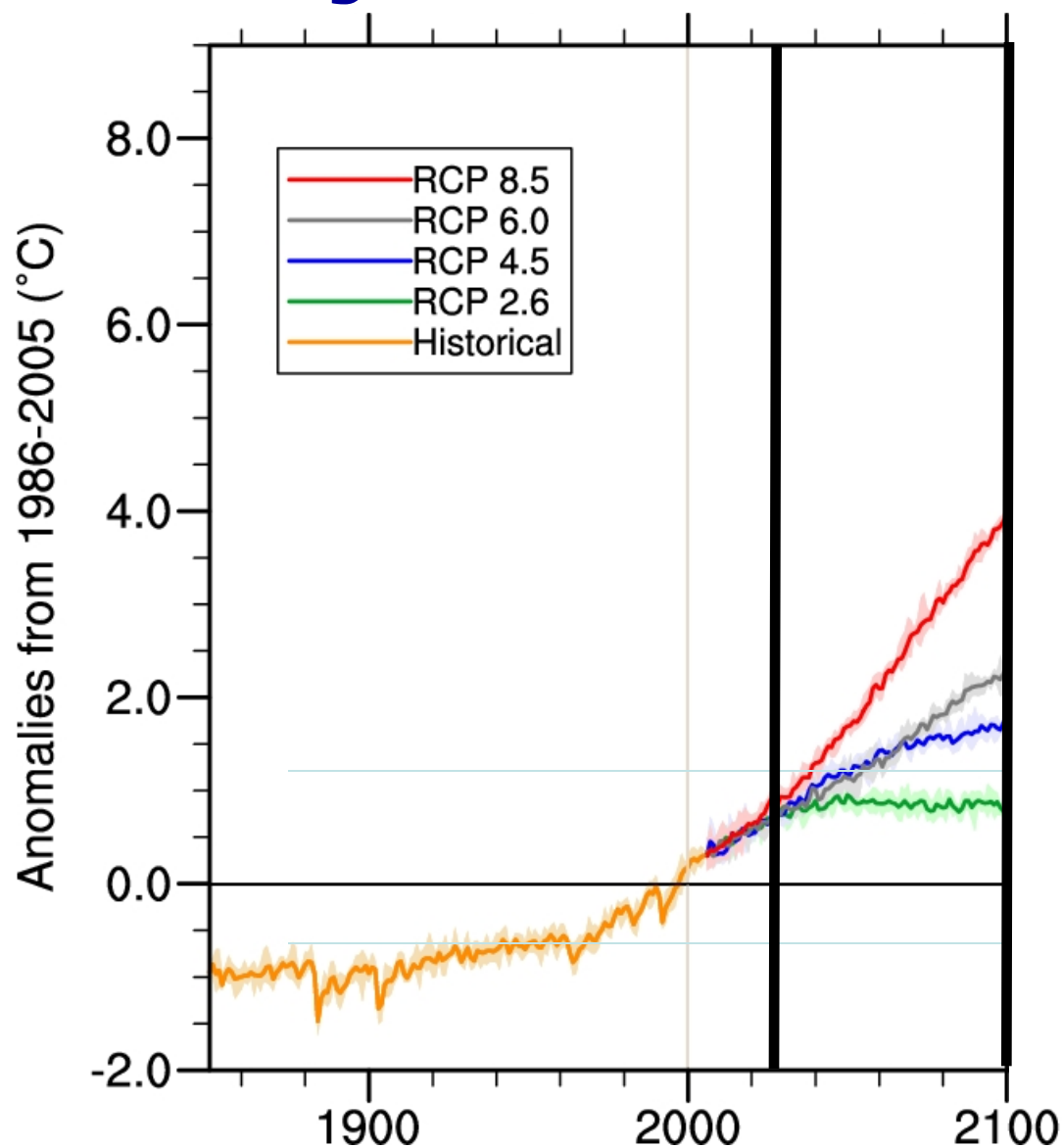
Internal (Natural) Variability

- Atmosphere and Ocean
- Coupled atmosphere-ocean interactions
- Multiple simulations

Projected Global SAT (IPCC AR4)

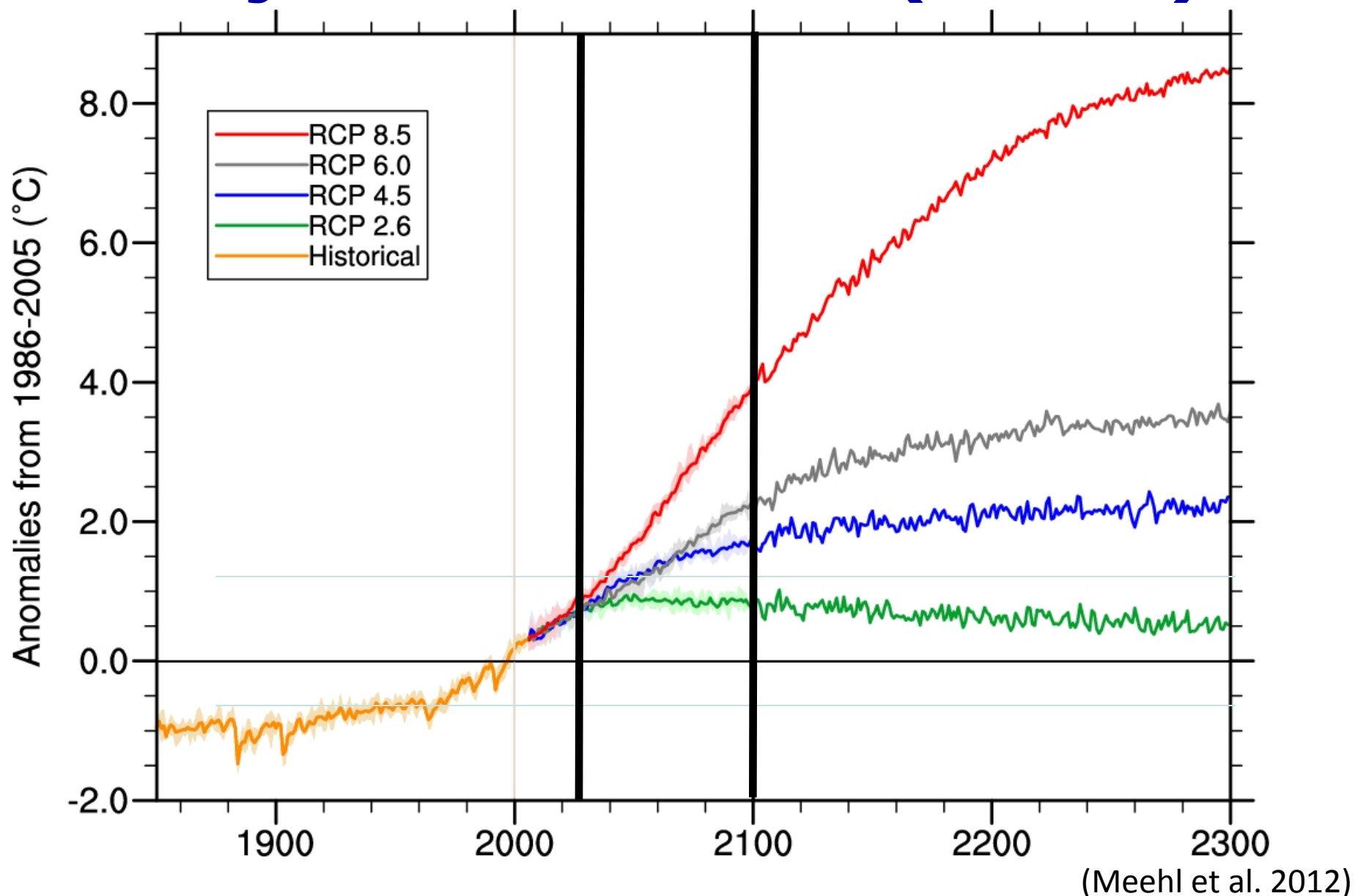


Projected Global SAT (CCSM4)



(Meehl et al. 2012)

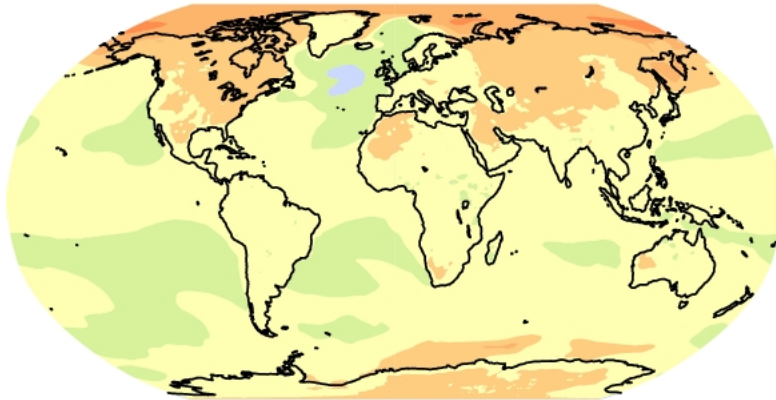
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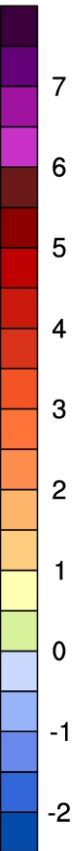
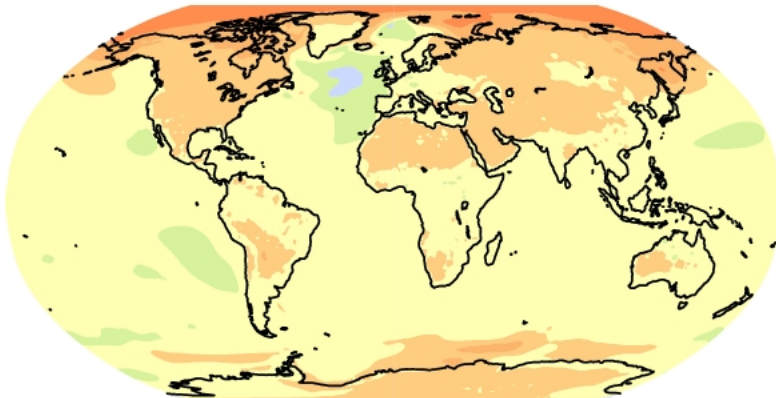
Scenario Uncertainty

Projected Global SAT (CCSM4)

c) RCP 4.5 2016-2035 minus 1986-2005



g) RCP 8.5 2016-2035 minus 1986-2005



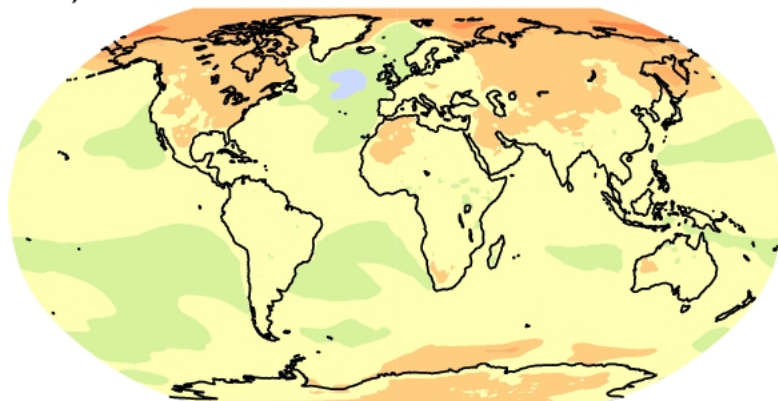
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(°C)

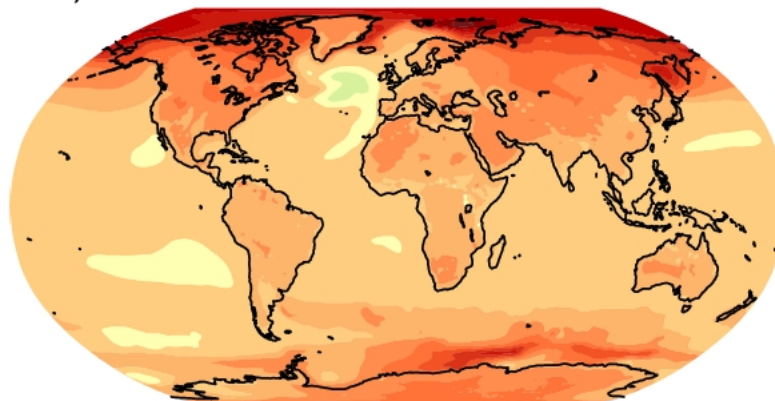
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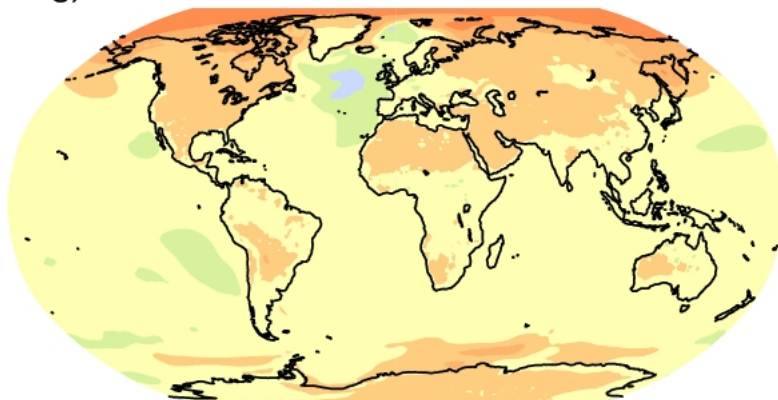
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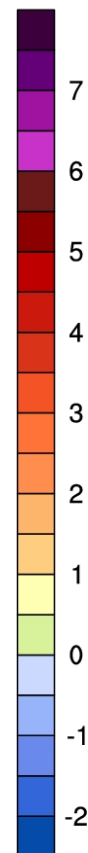
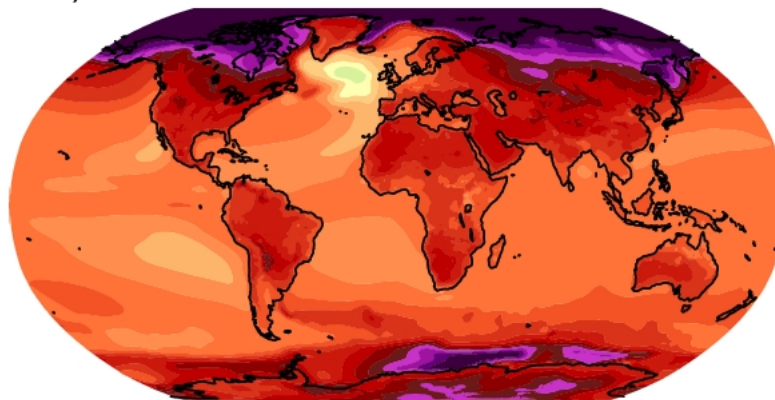
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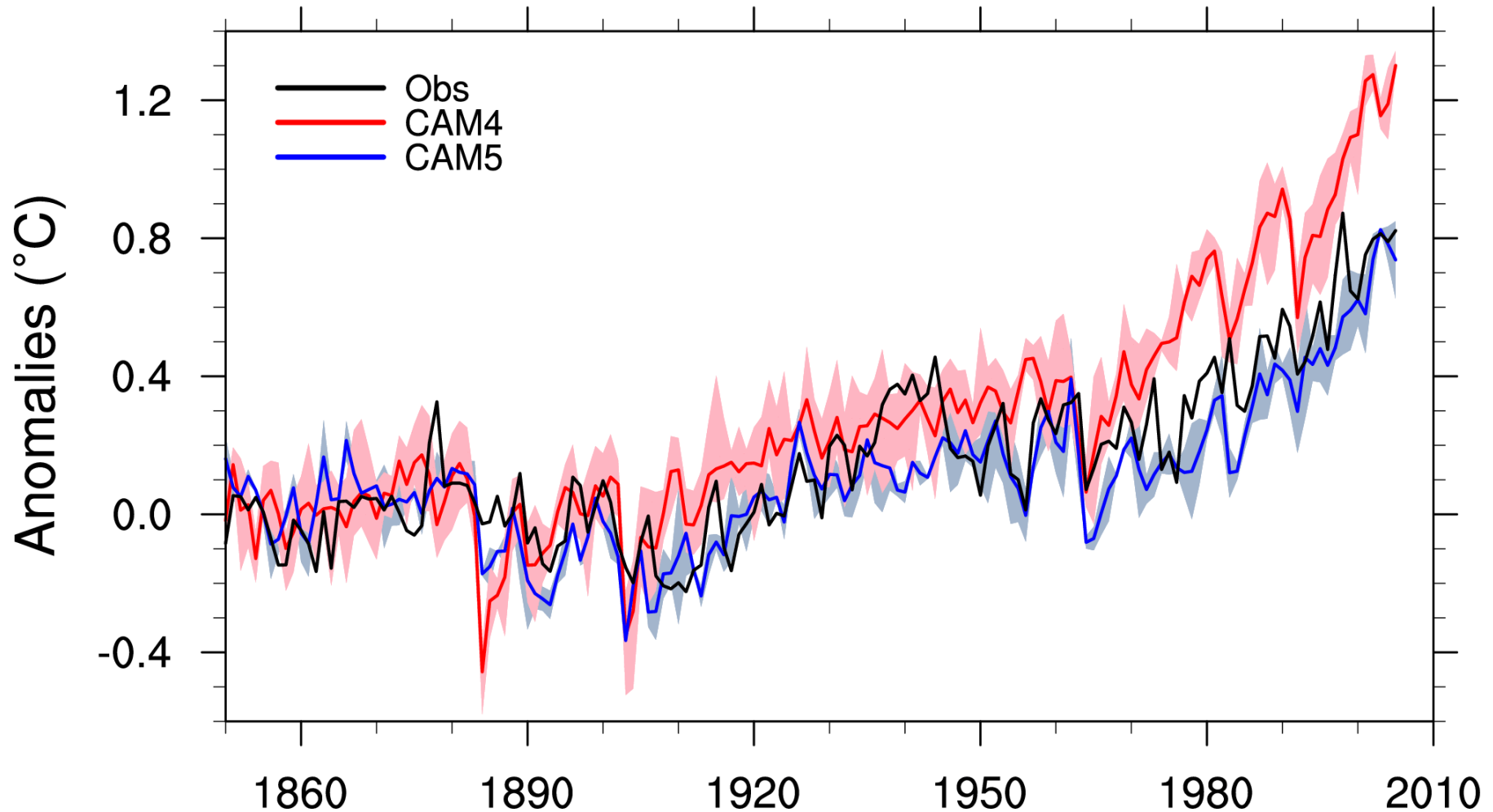


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Model Uncertainty

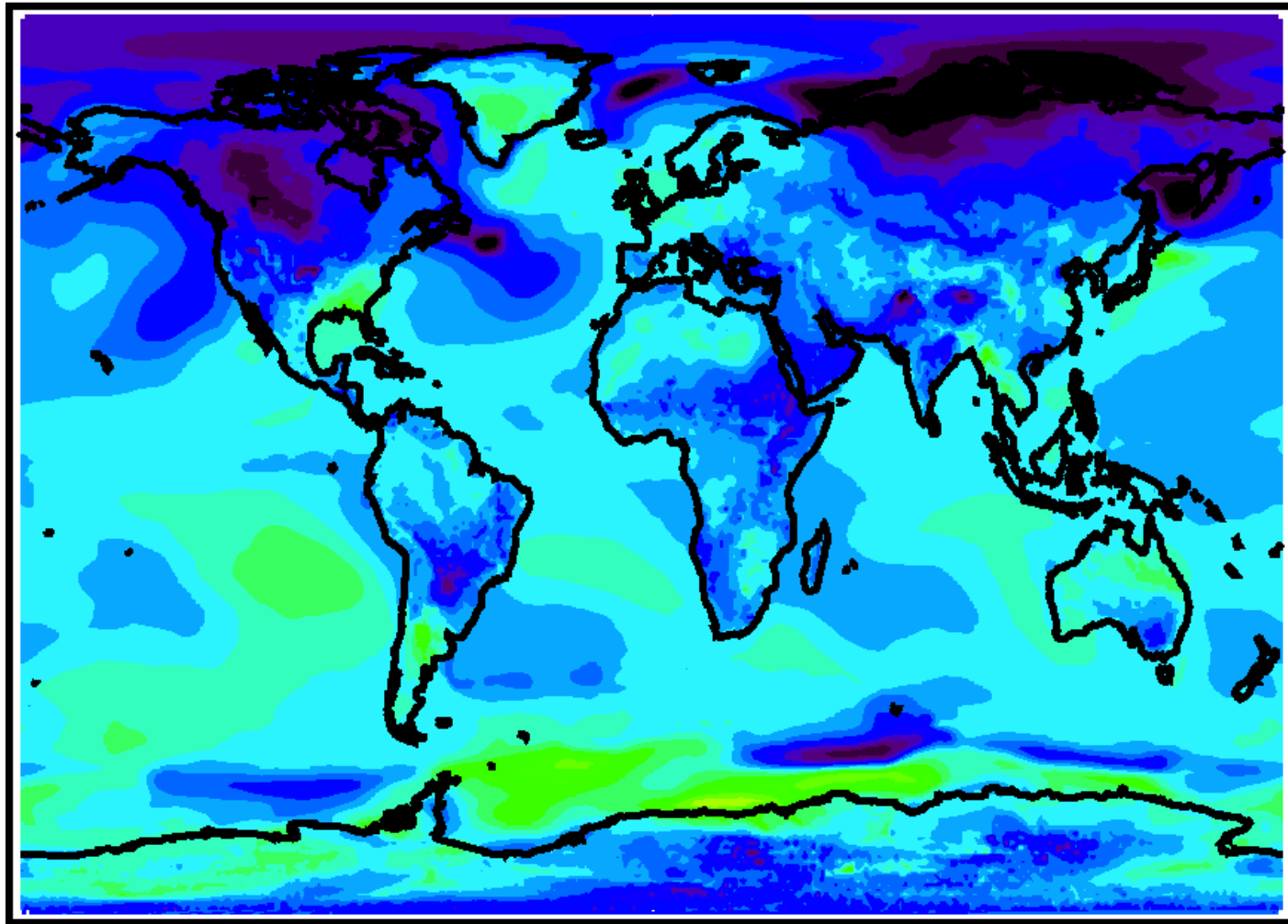
Projected Global SAT (CAM4 vs CAM5)



(Hurrell et al. 2012; Neale et al. 2012)

Model Uncertainty

20th Century SAT Response (CAM5 – CAM4)

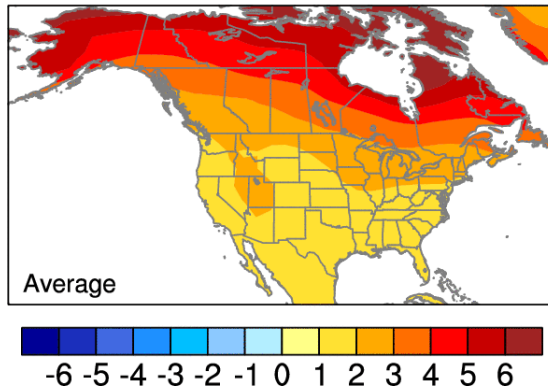


Uncertainty due to Natural Variability

Projected N.A. SAT (CCSM3 – 40 A1B simulations)

DJF

2005-2060

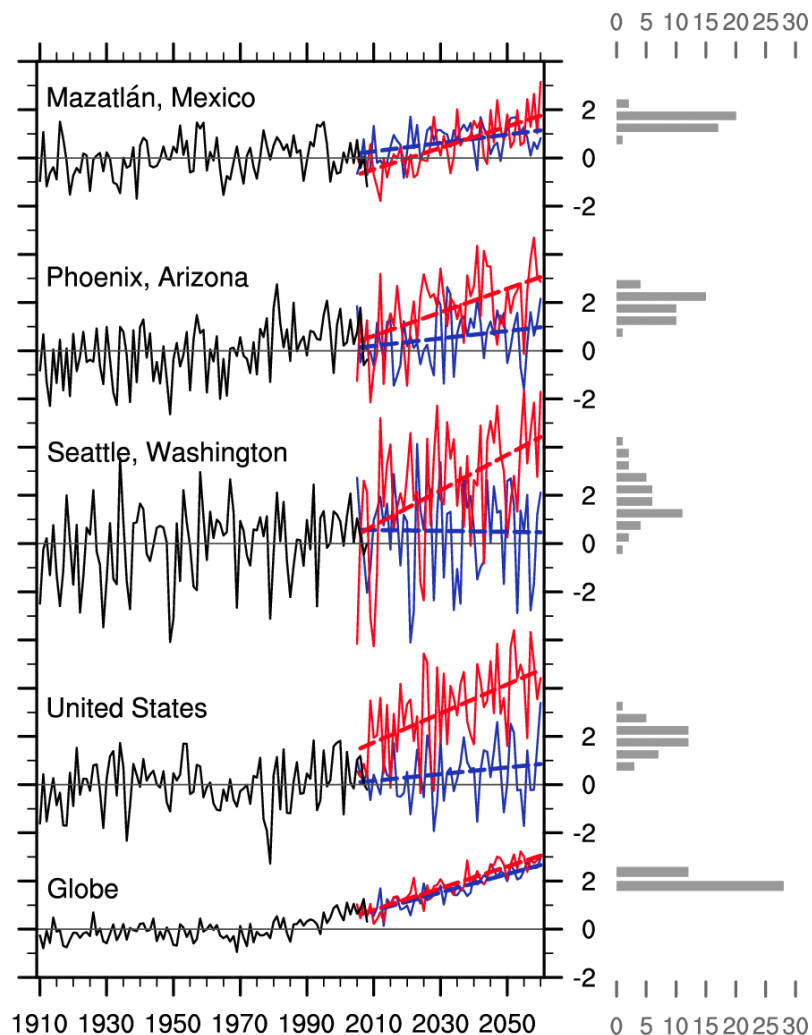
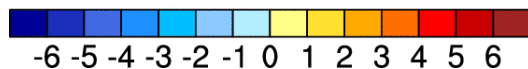
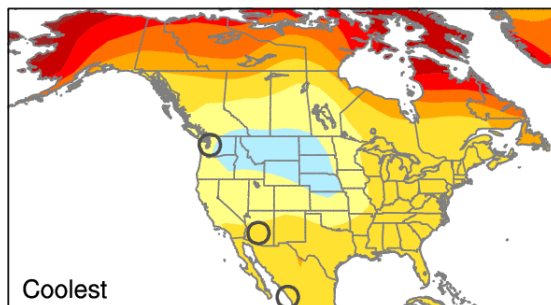
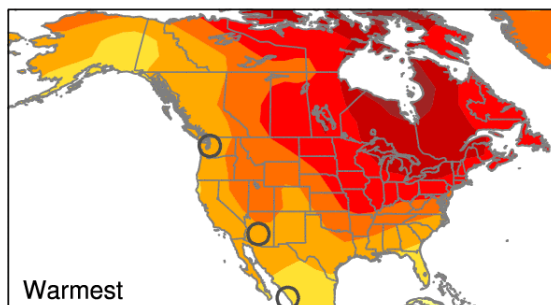
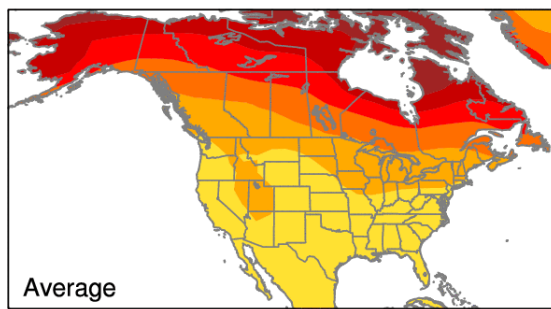


(Deser et al. 2012)

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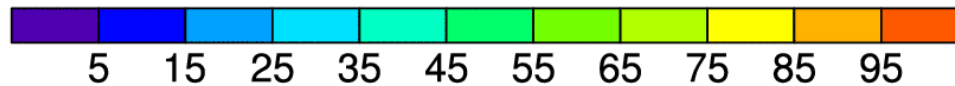
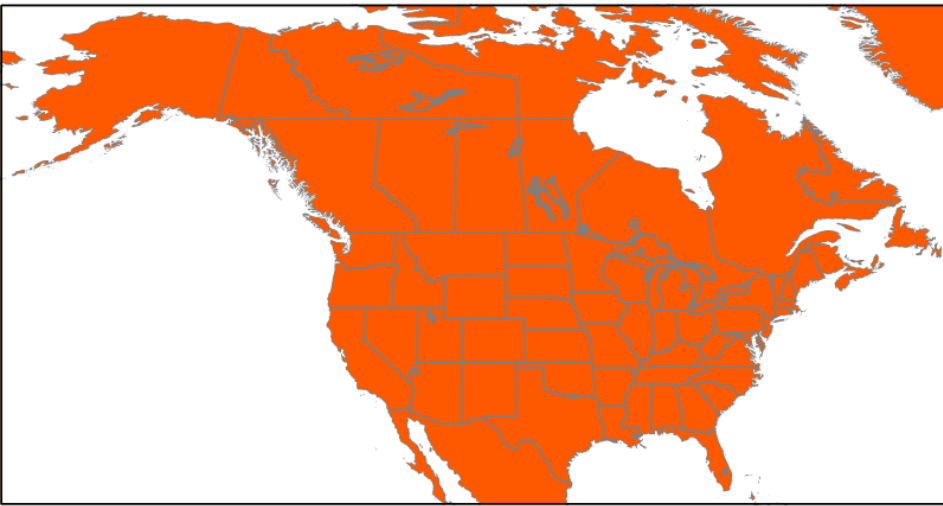


(Deser et al. 2012)

Uncertainty due to Natural Variability

Projected N.A. SAT (CCSM3 – 40 simulations)

2005-2060



% chance warming

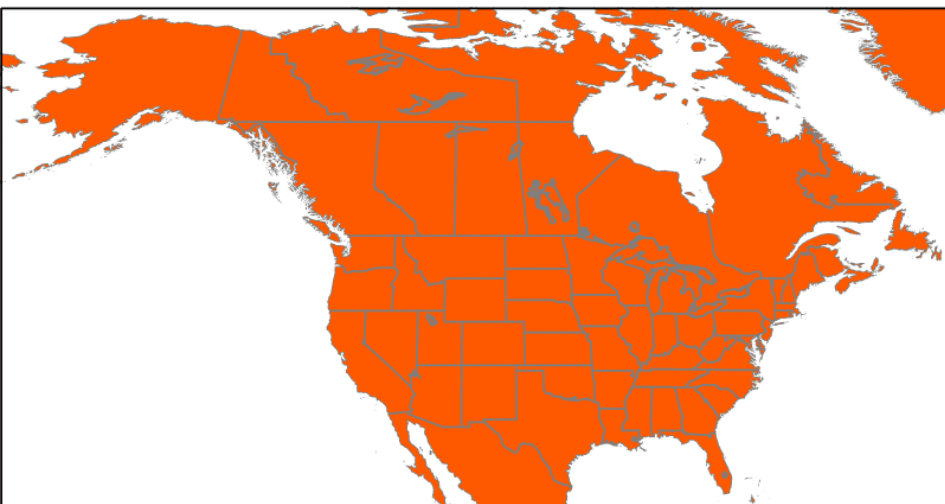
$$\frac{\text{\# of ensemble members with trend} > 0}{\text{total \# of ensemble members}}$$

(Deser et al. 2012)

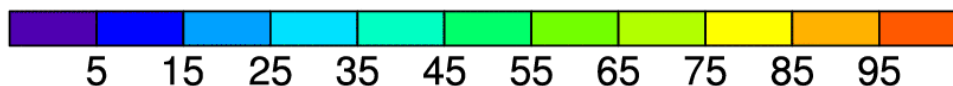
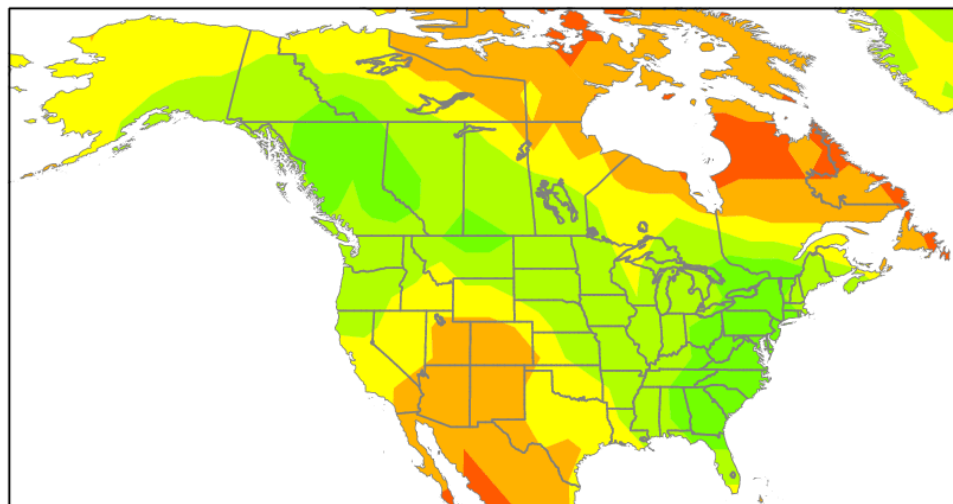
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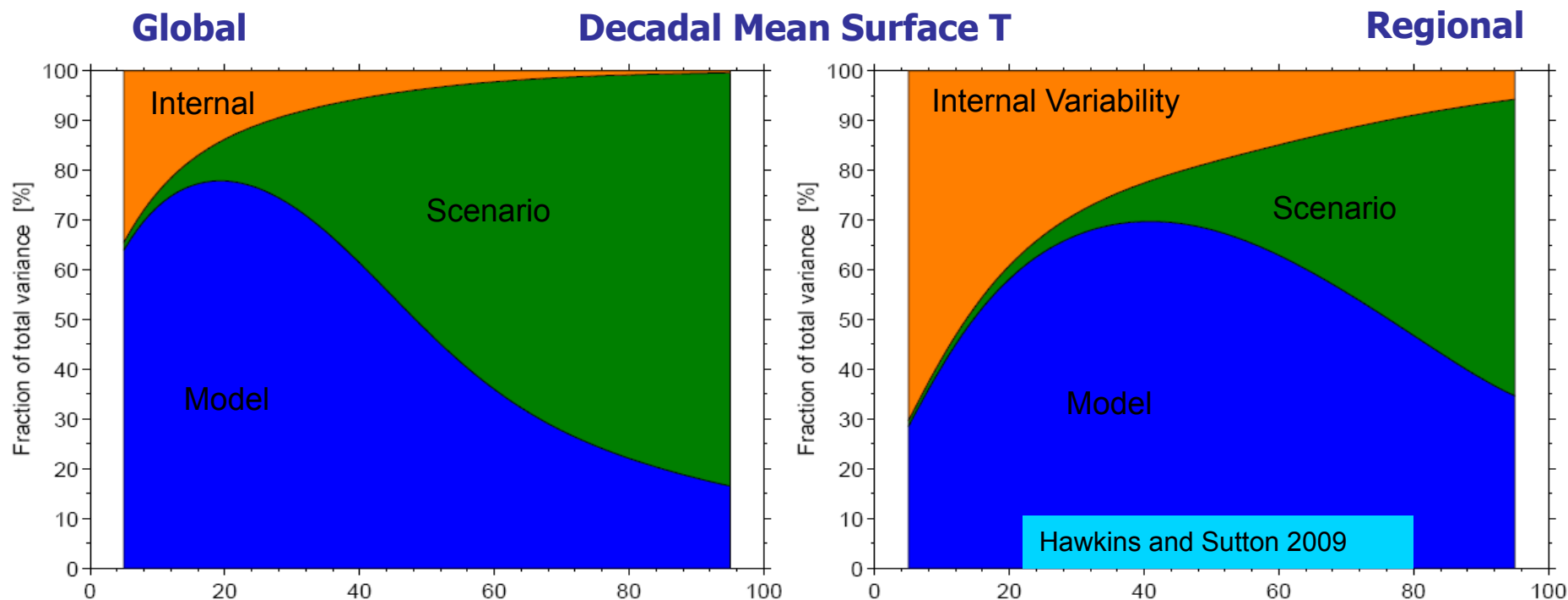


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Climate Prediction: Sources of Uncertainty



- Importance of *Model Uncertainty* is evident on all policy-relevant scales
- *Scenario Uncertainty* only becomes important for multi-decadal lead times
- Uncertainty due to *Internal Variability* becomes more important on regional scales

Summary and Outlook

Toward Reducing Uncertainty

- 1) Expect a range of climate change outcomes due to natural variability of the atmospheric circulation, especially over the next several decades
- 2) Initialized “decadal” predictions have the *potential* to reduce uncertainty due to natural variability.
- 3) Larger ensembles of model projections are needed to better constrain the timing and magnitude of forced climate change.
- 4) Models will continue to improve with continued investments in climate science, in addition to new observations and advances in understanding.

Thank You!

