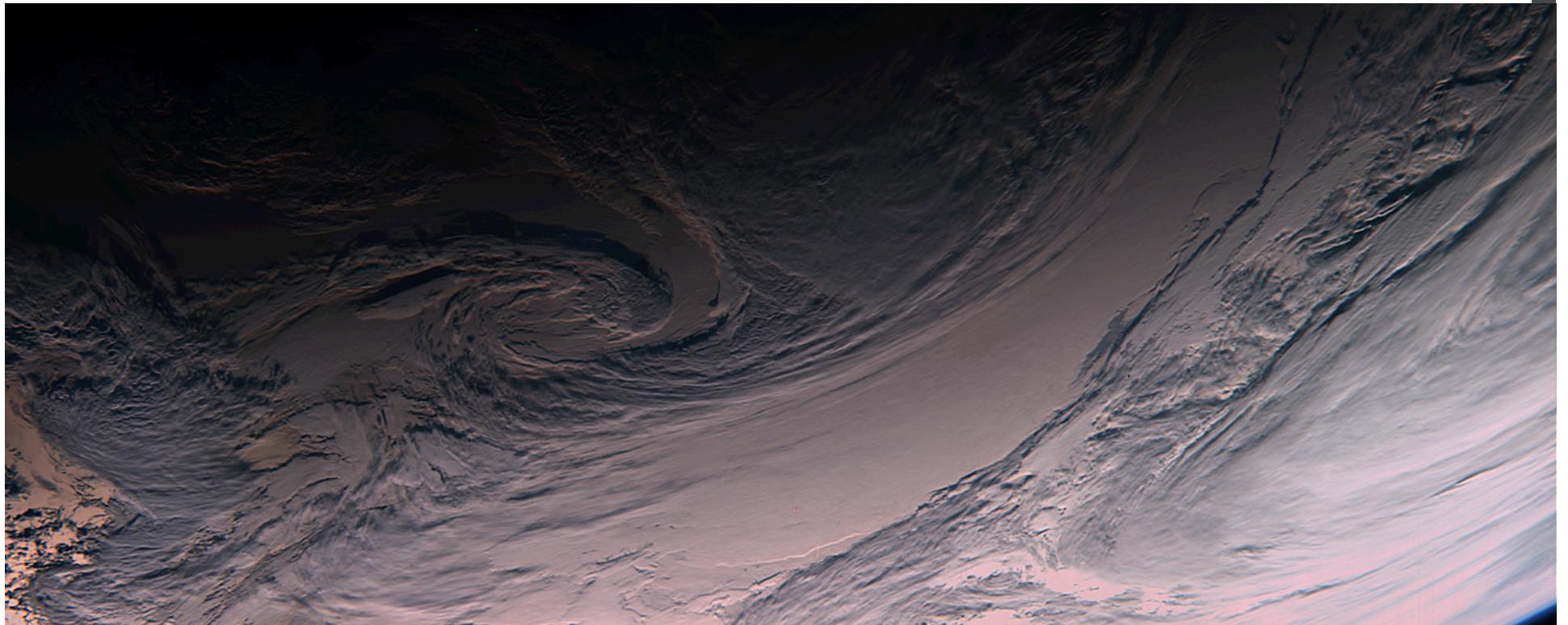
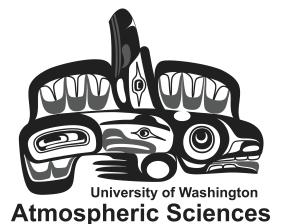


# MIXED-PHASE CLOUD PHYSICS AND MID-LATITUDE CLOUD FEEDBACK IN CLIMATE MODELS

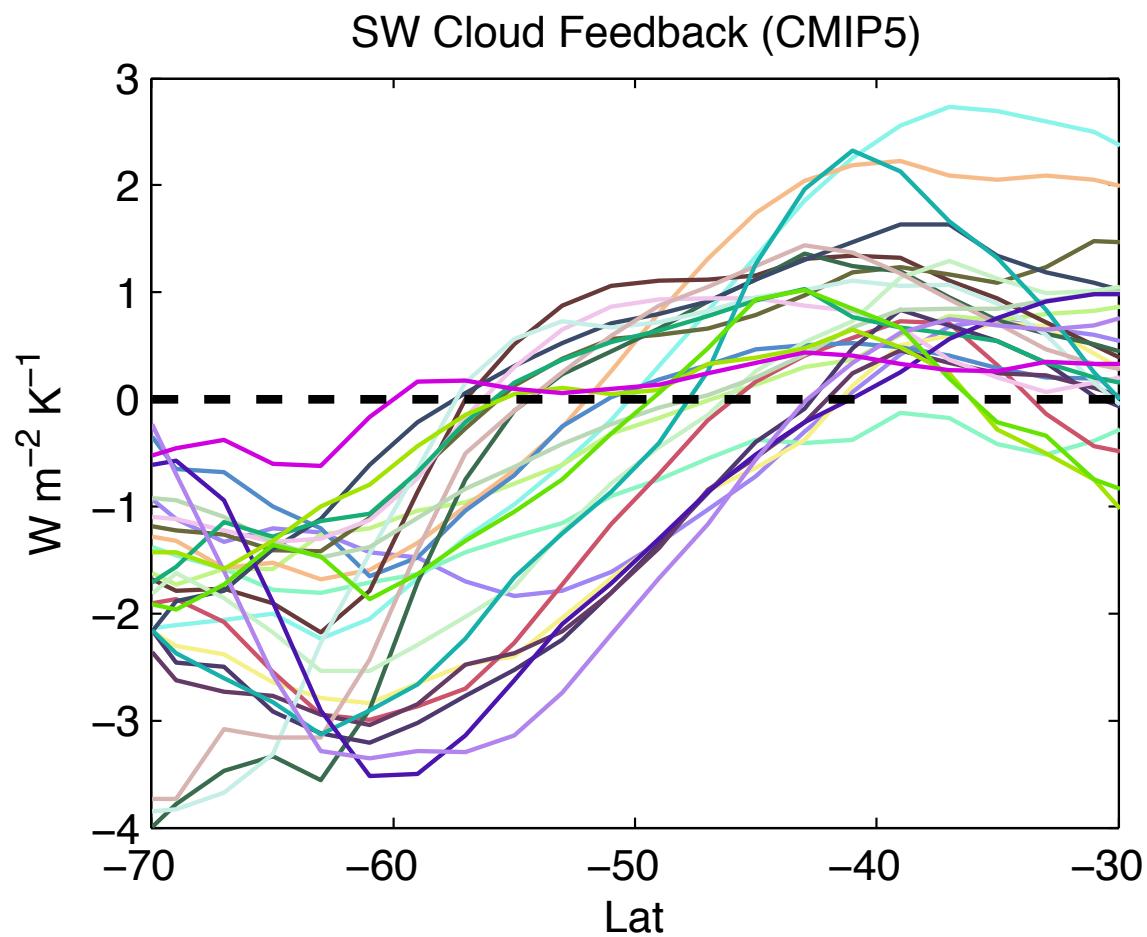


**DANIEL MCCOY<sup>1</sup>, DENNIS HARTMANN<sup>1</sup>, MARK  
ZELINKA<sup>2</sup>, PAULO CEPPI<sup>1</sup>, DANIEL GROSVENOR<sup>3</sup>**

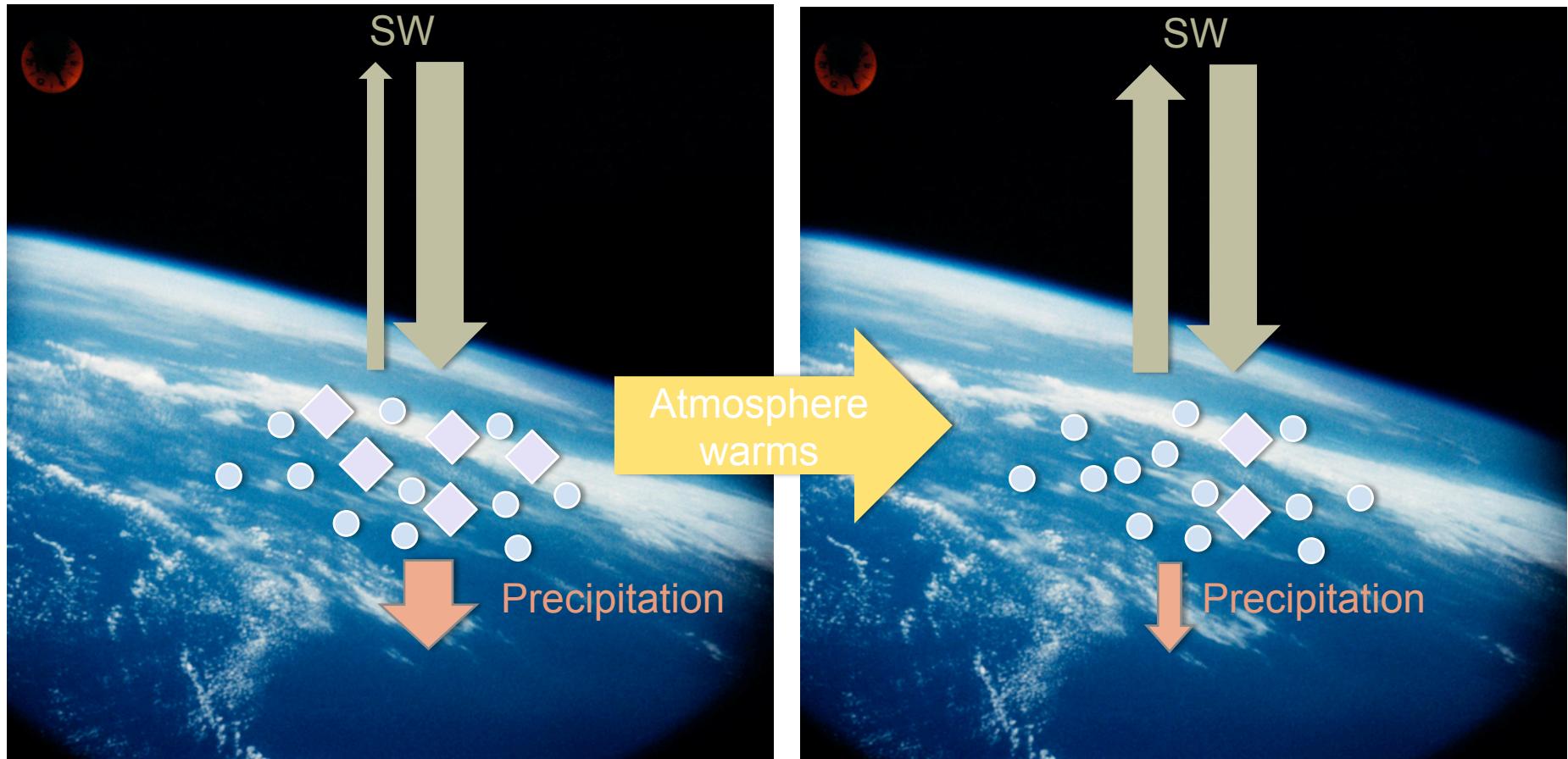
**1-UNIVERSITY OF WASHINGTON, 2-LLNL, 3-LEEDS**



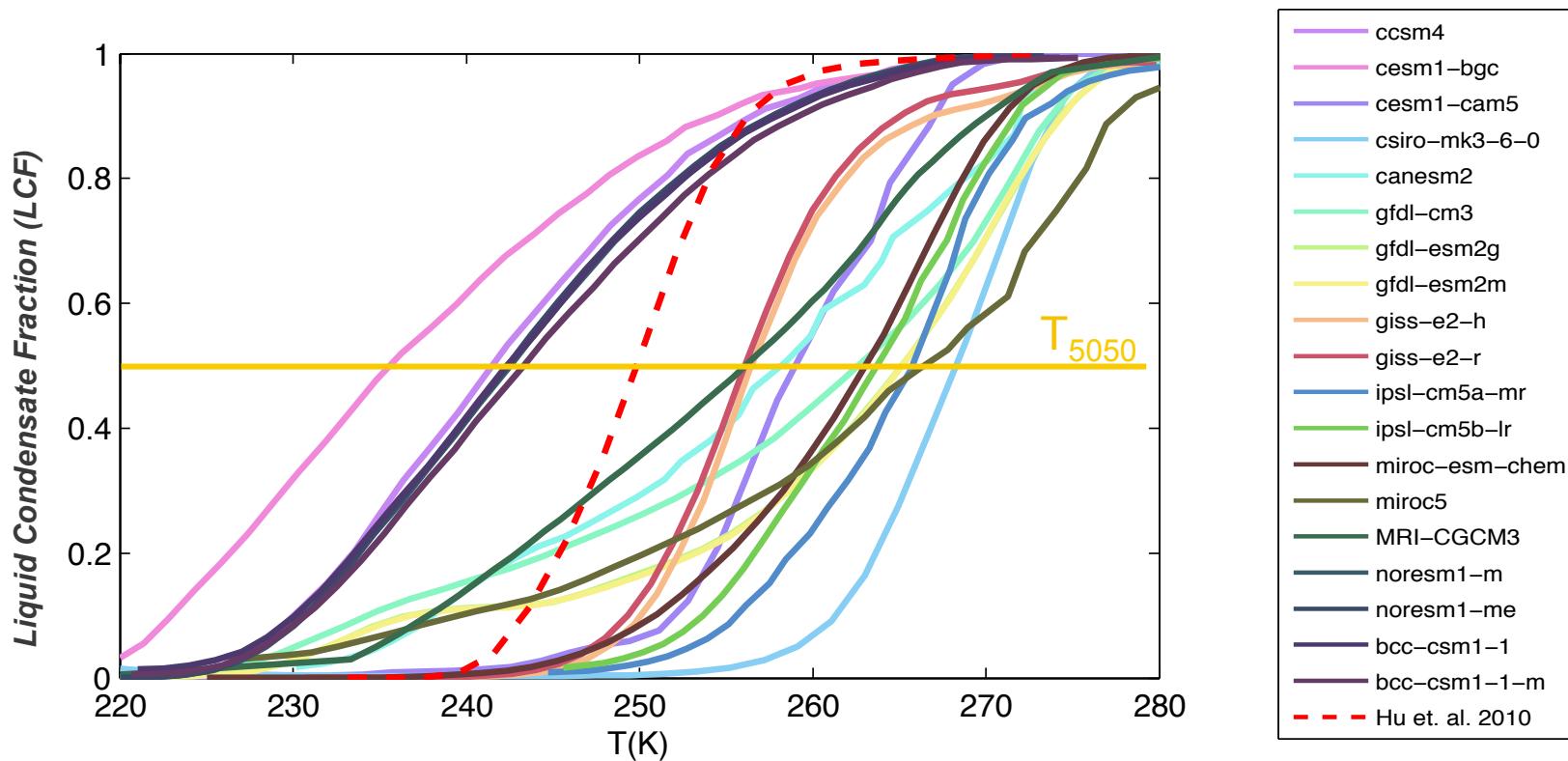
# SW CLOUD FEEDBACK



# ORIGINS OF THE NEGATIVE SW CLOUD FEEDBACK



# PARTITIONING

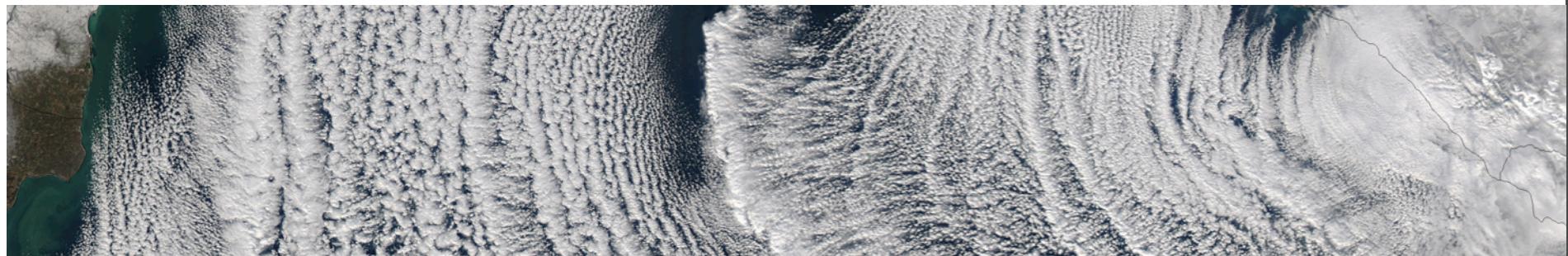


# DATA USED IN THIS STUDY

19 GCMs from CMIP5

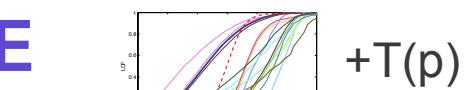
Historical data 1850-1900

RCP8.5 data 2050-2100



# THE INCREASE IN LWP IN GCMS BETWEEN HISTORICAL AND WARMED CLIMATE

$$\Delta LWP = \sum_p \underbrace{\Delta CWP(p) \cdot LCF_0(p)}_{\text{Changes in LWP due to changes in total mass of condensate}} + \underbrace{\Delta LCF(p) \cdot CWP_0(p)}_{\text{Changes due to repartitioning}} + \underbrace{\Delta LCF(p) \cdot \Delta CWP(p)}_{\text{Covariance term}}$$



Changes in LWP due to changes in total mass of condensate

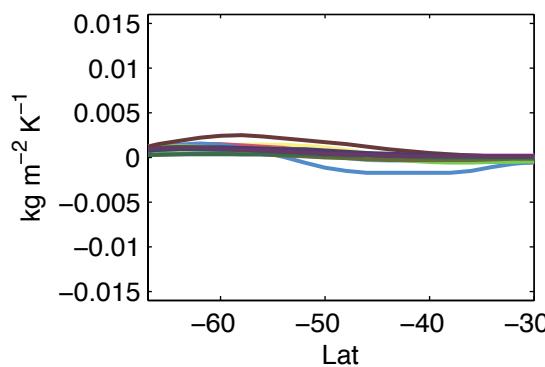
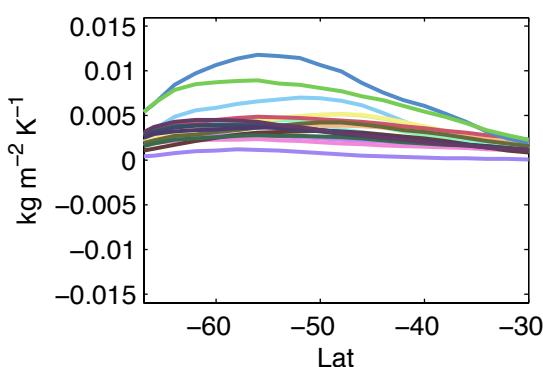
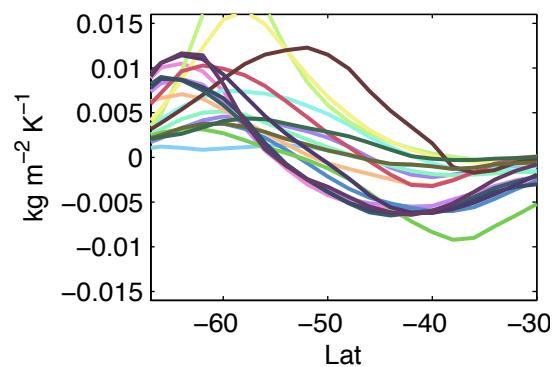
**Condensate Mass Term**

Changes due to repartitioning

**Condensate Partitioning Term**

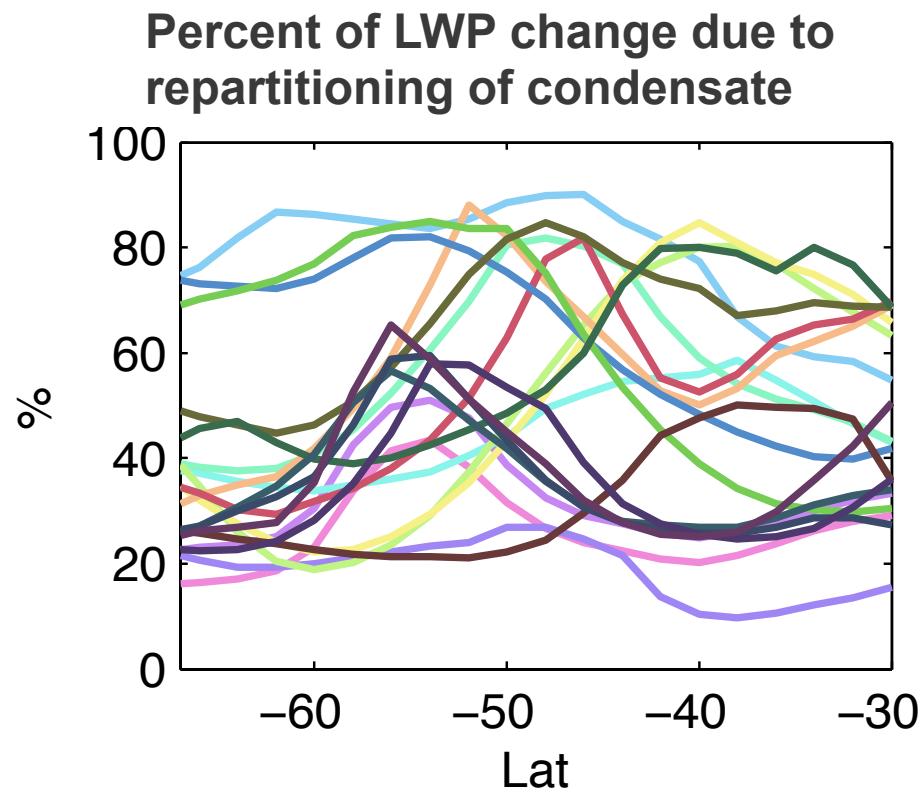
Covariance term

**Covariance Term**



# PARTITIONING EFFECT ON LWP CHANGE

- This assumes that changes in condensate mass and partitioning are not related.



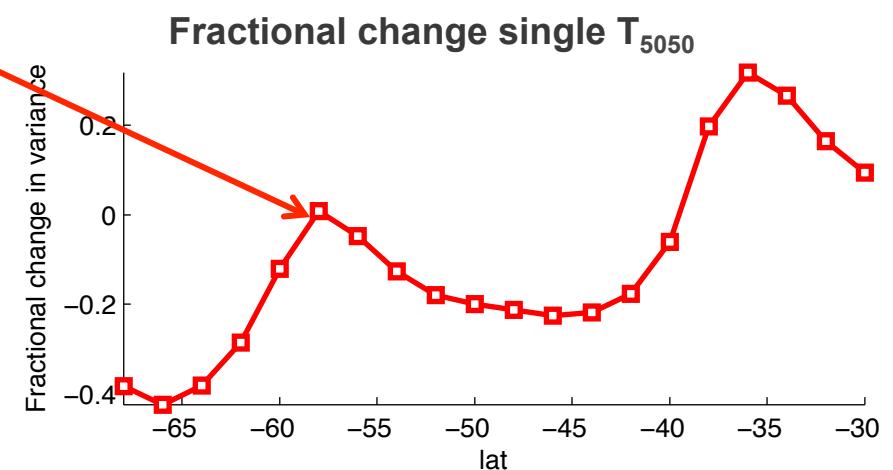
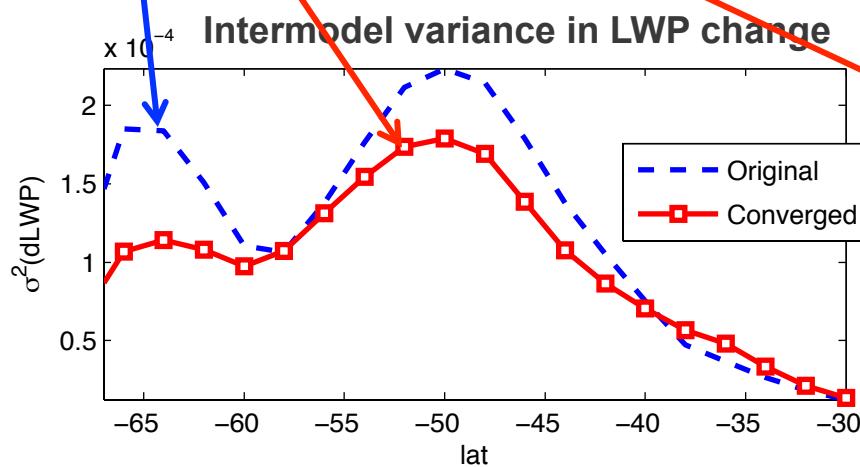
# HOW IMPORTANT IS SPREAD IN PARTITIONING TO SPREAD IN LWP CHANGE?

$$\Delta LWP = \sum_p \Delta CWP(p) \cdot LCF_0(p) + \Delta LCF(p) \cdot CWP_0(p) + \Delta LCF(p) \cdot \Delta CWP(p)$$

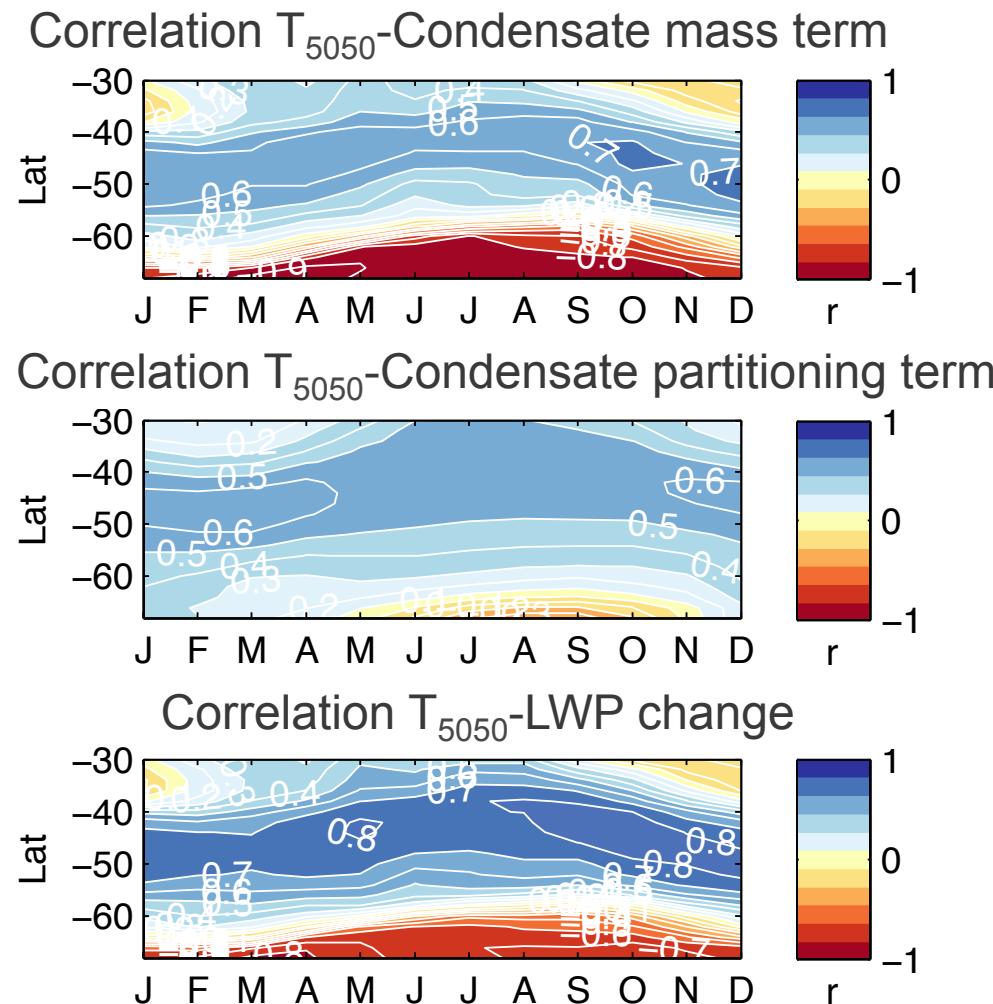
Intermodel spread in LWP changes under warming

Reduced intermodel spread in LWP changes under warming

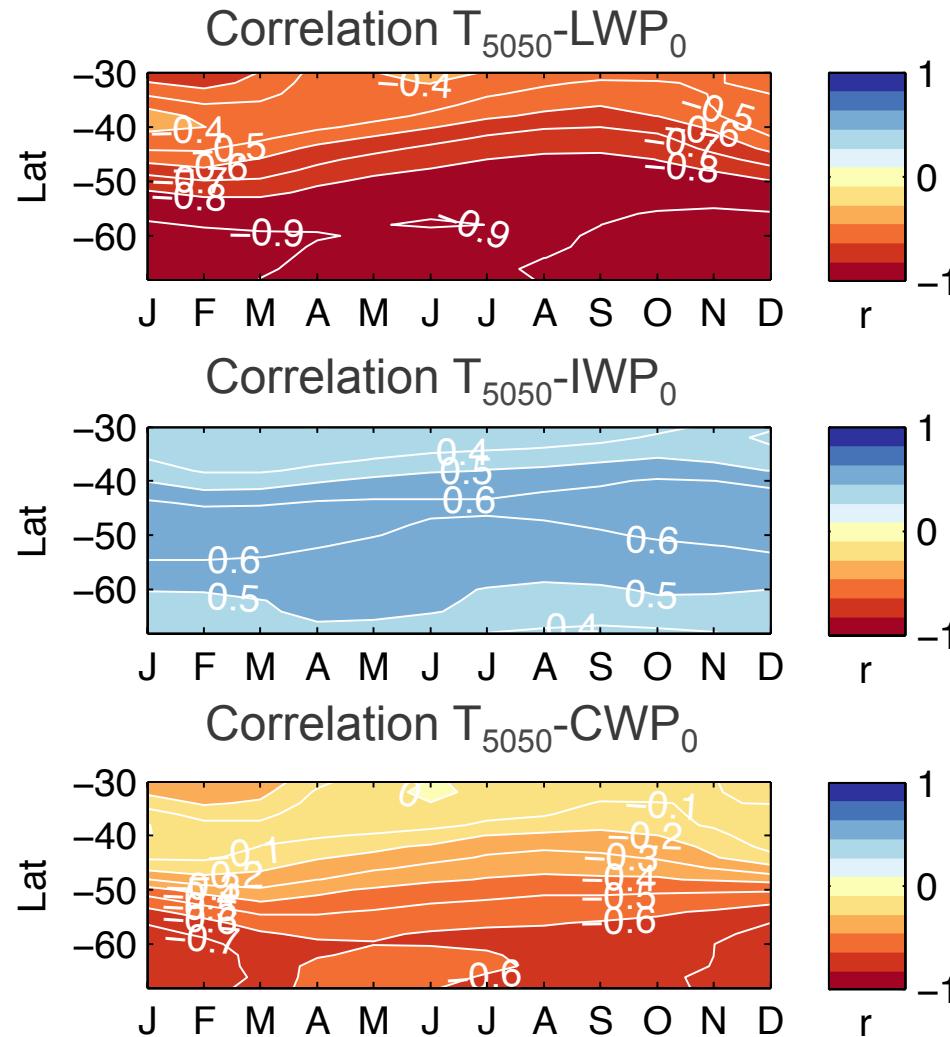
Converge  $T_{5050}$



# CORRELATION BETWEEN INTERMODEL SPREAD IN LWP CHANGE AND $T_{5050}$

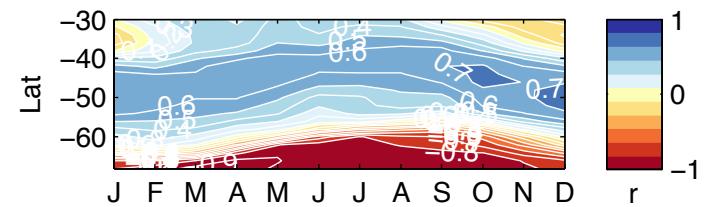
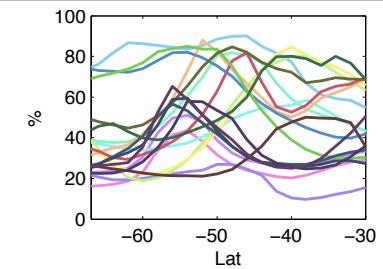
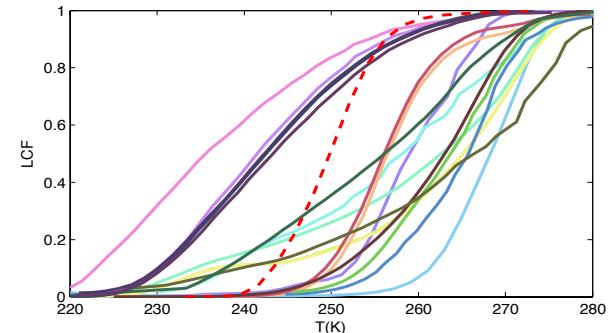


# CORRELATION BETWEEN INTERMODEL SPREAD IN CLIMATE MEAN STATE AND $T_{5050}$



# SUMMARY

- GCMs partition condensate monotonically as a function of temperature, but the 50-50 ice-liquid point varies by as much as 40K
- Change in SO LWP explained by repartitioning is between 20% and 80% of overall LWP change, depending on model.
- A considerable amount of the inter-model spread in the climate mean state, and change in LWP with warming is explained by the partitioning of condensate in each model.



# QUESTIONS