On the spread of changes in marine low cloud cover in climate model simulations of the 21st century

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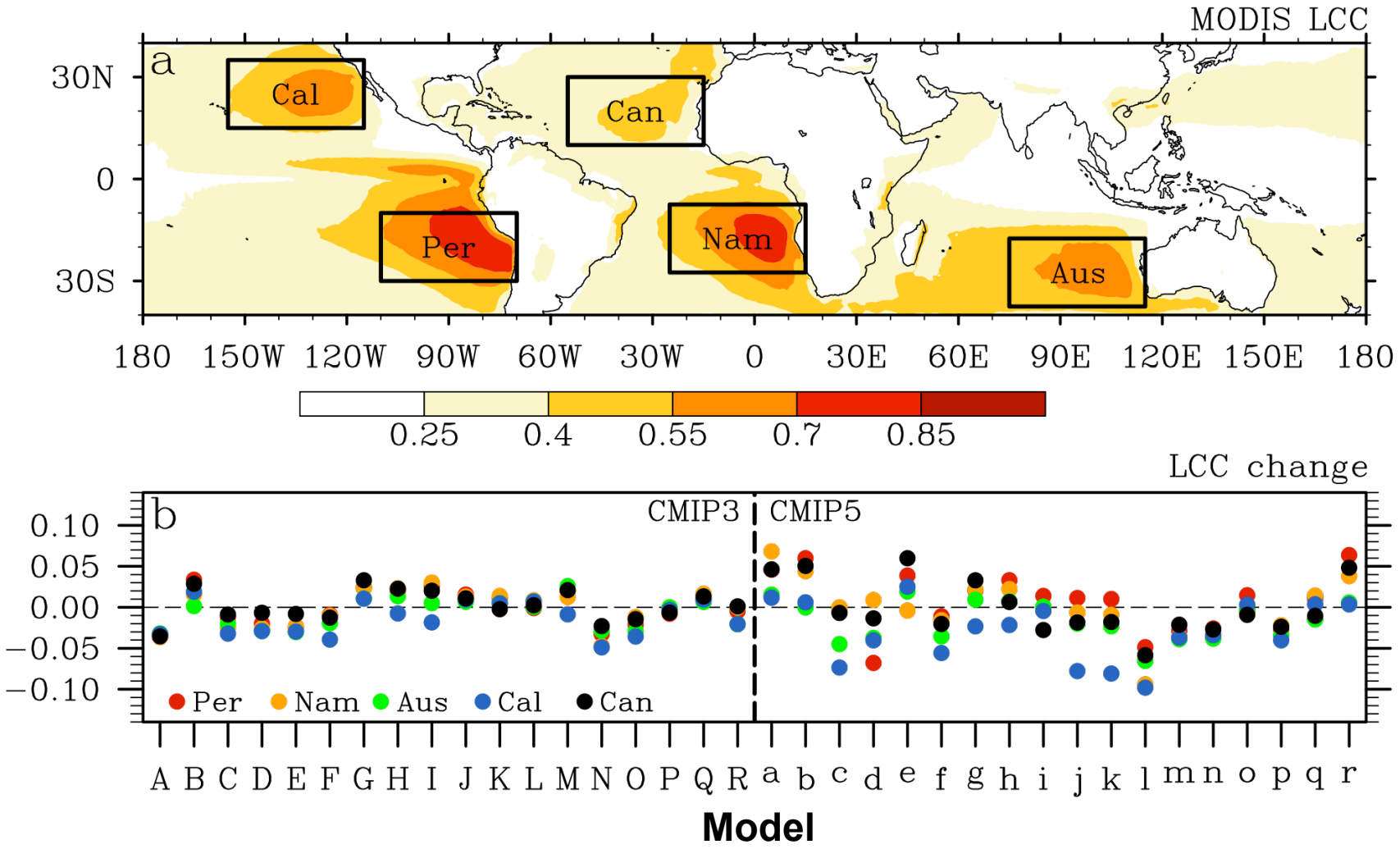
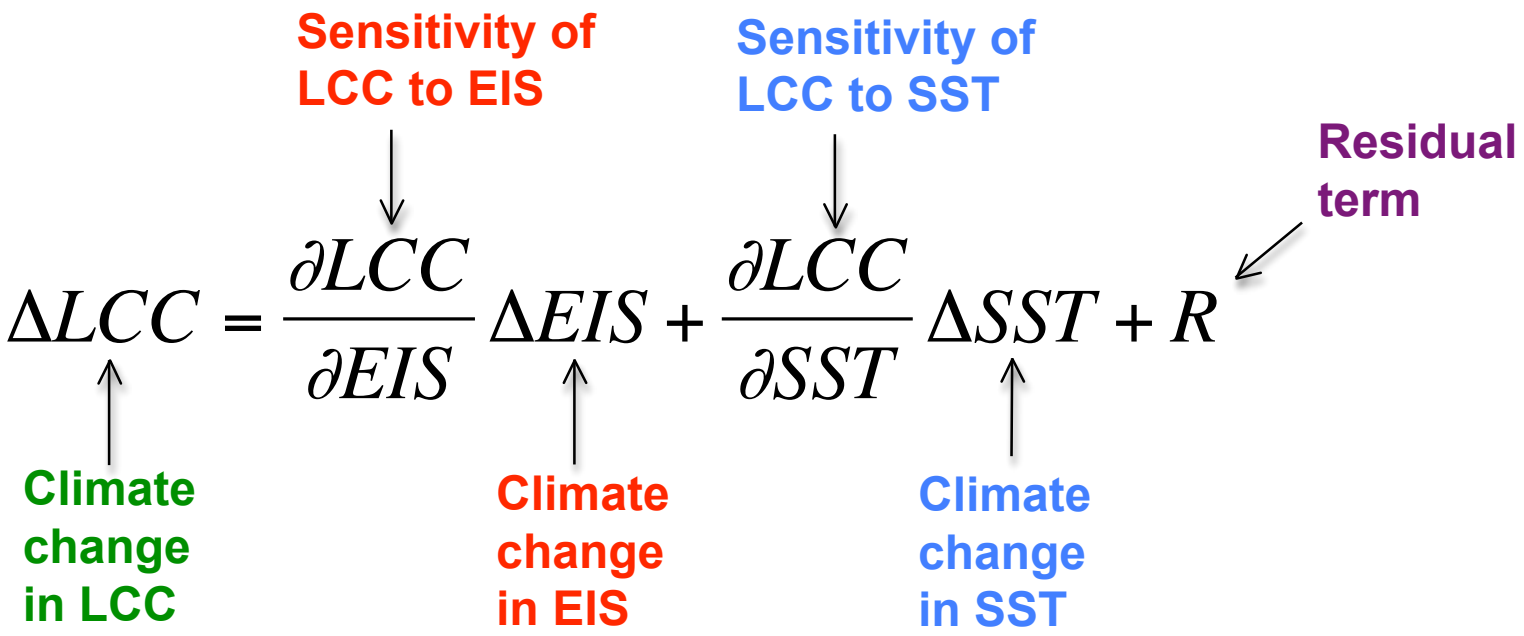
Goal 1: Understand the persistent spread in simulated changes in low cloud cover

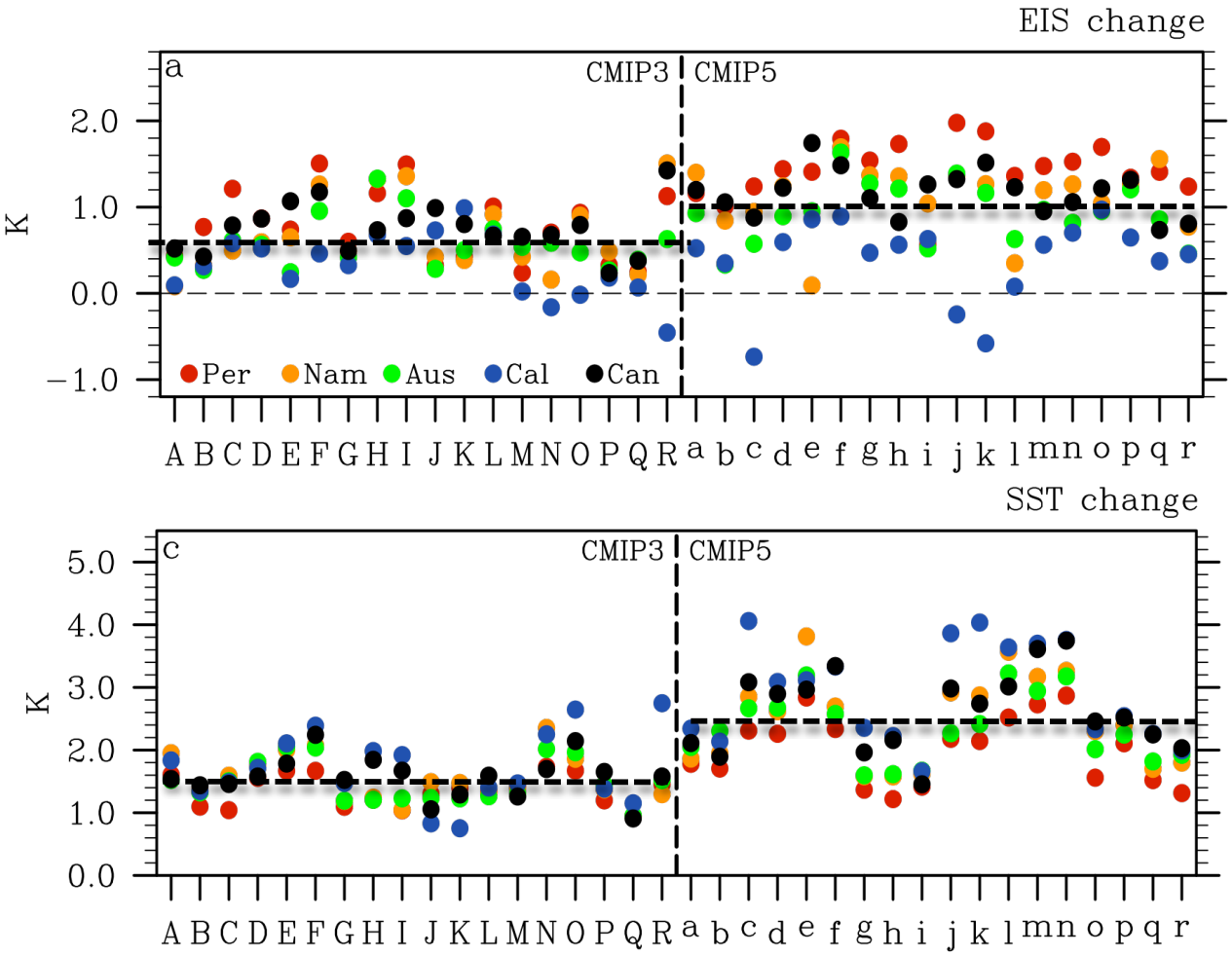


Heuristic model



Sensitivities of LCC to EIS and SST are estimated based on simulated 20th century climate variability.

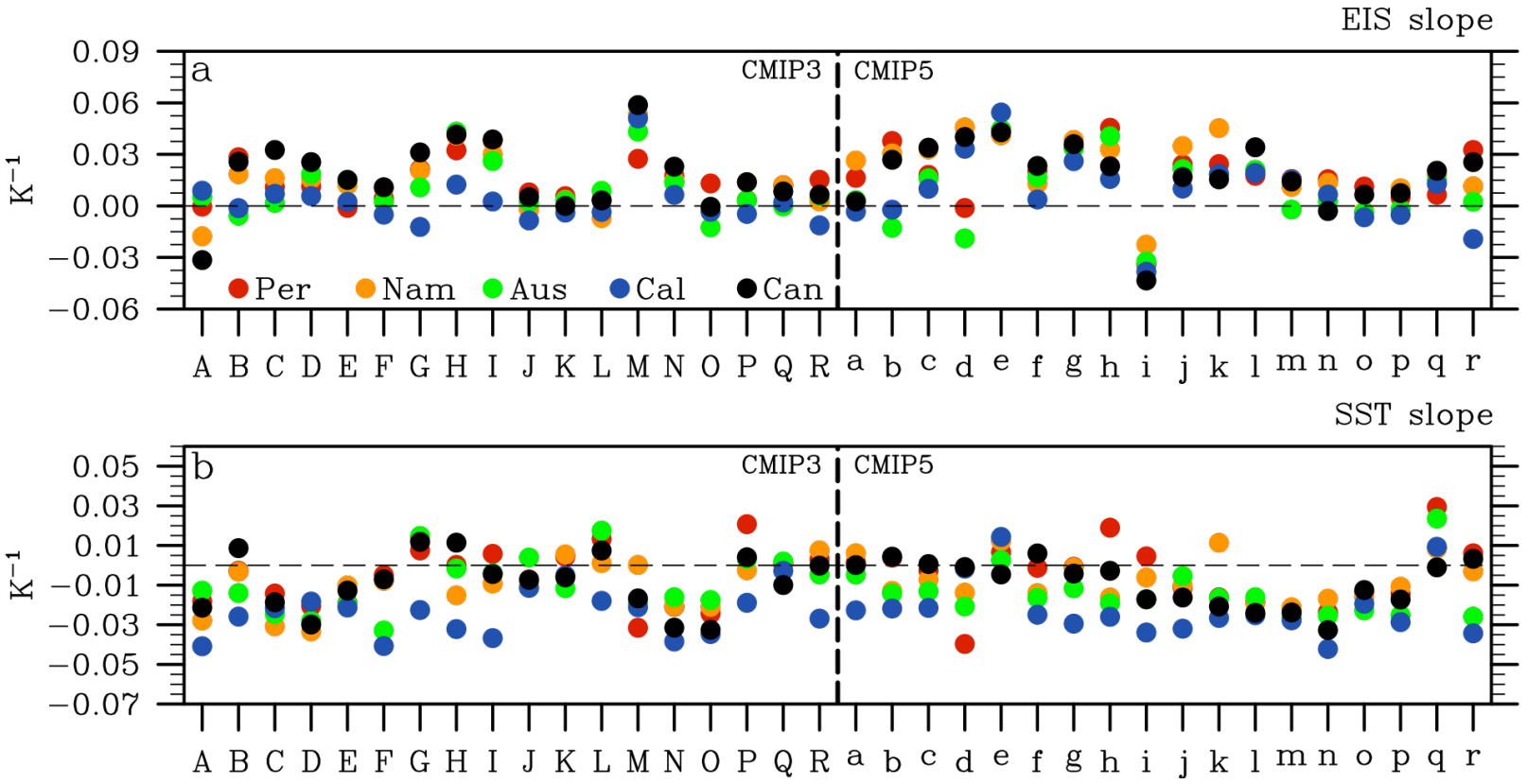
Simulated changes in EIS and SST



There is a systematic increase in EIS in a warming climate.

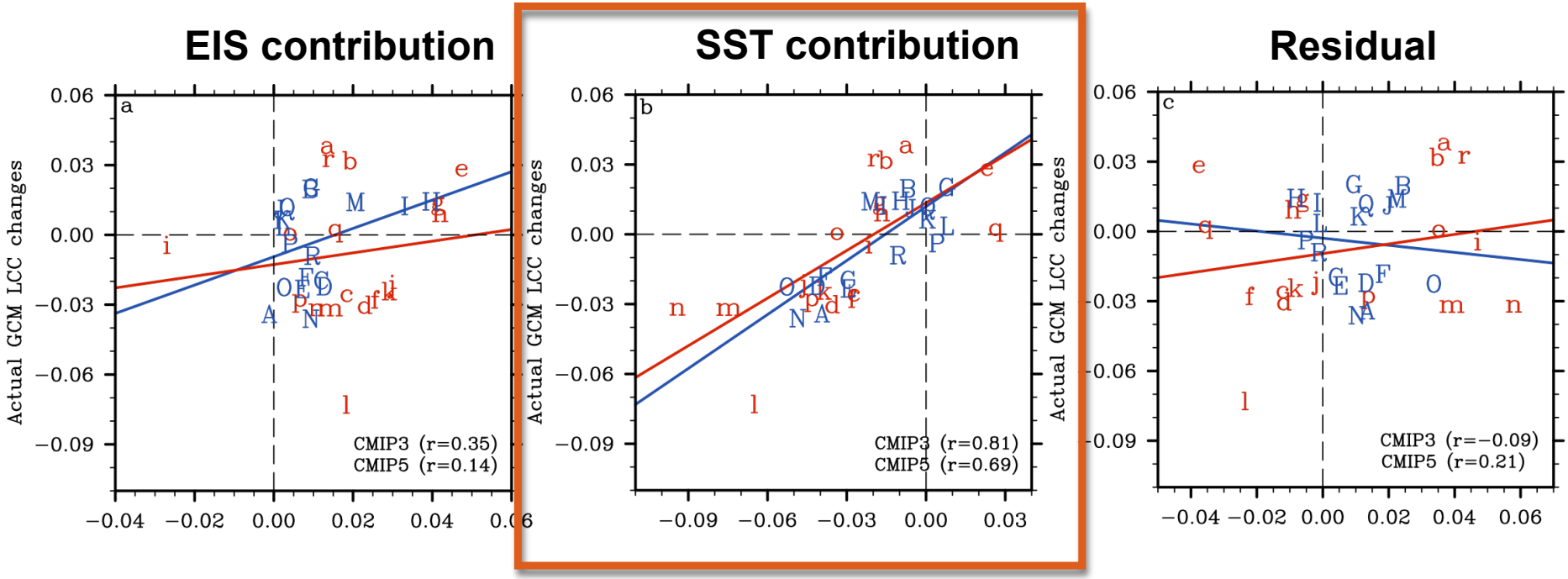
SST increase is much larger in magnitude than EIS increase.

EIS and SST slopes



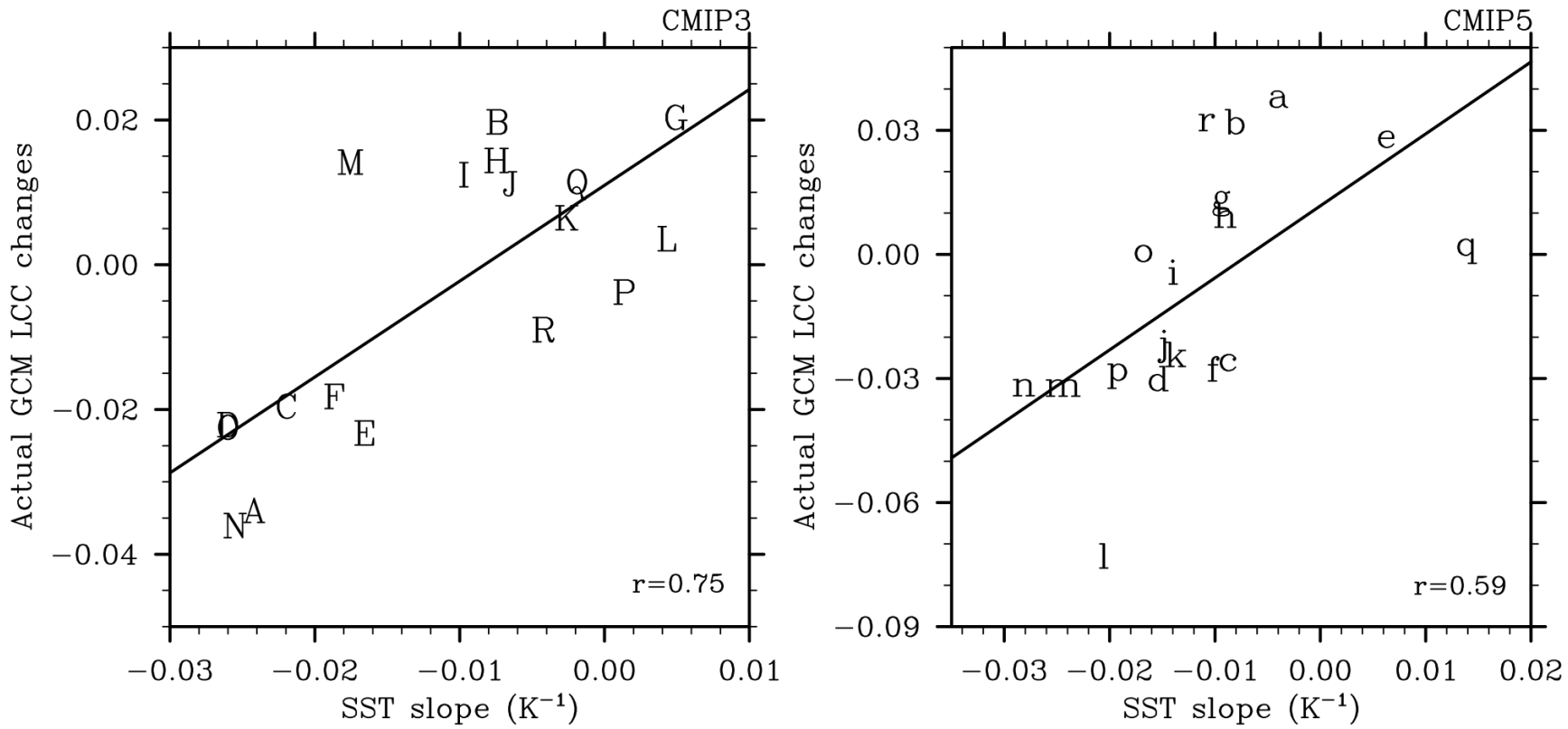
- **EIS slope is generally positive, while SST slope is generally negative.**
- **The magnitudes of EIS and SST slopes vary significantly from model to model.**

SST contribution is the major source of the spread



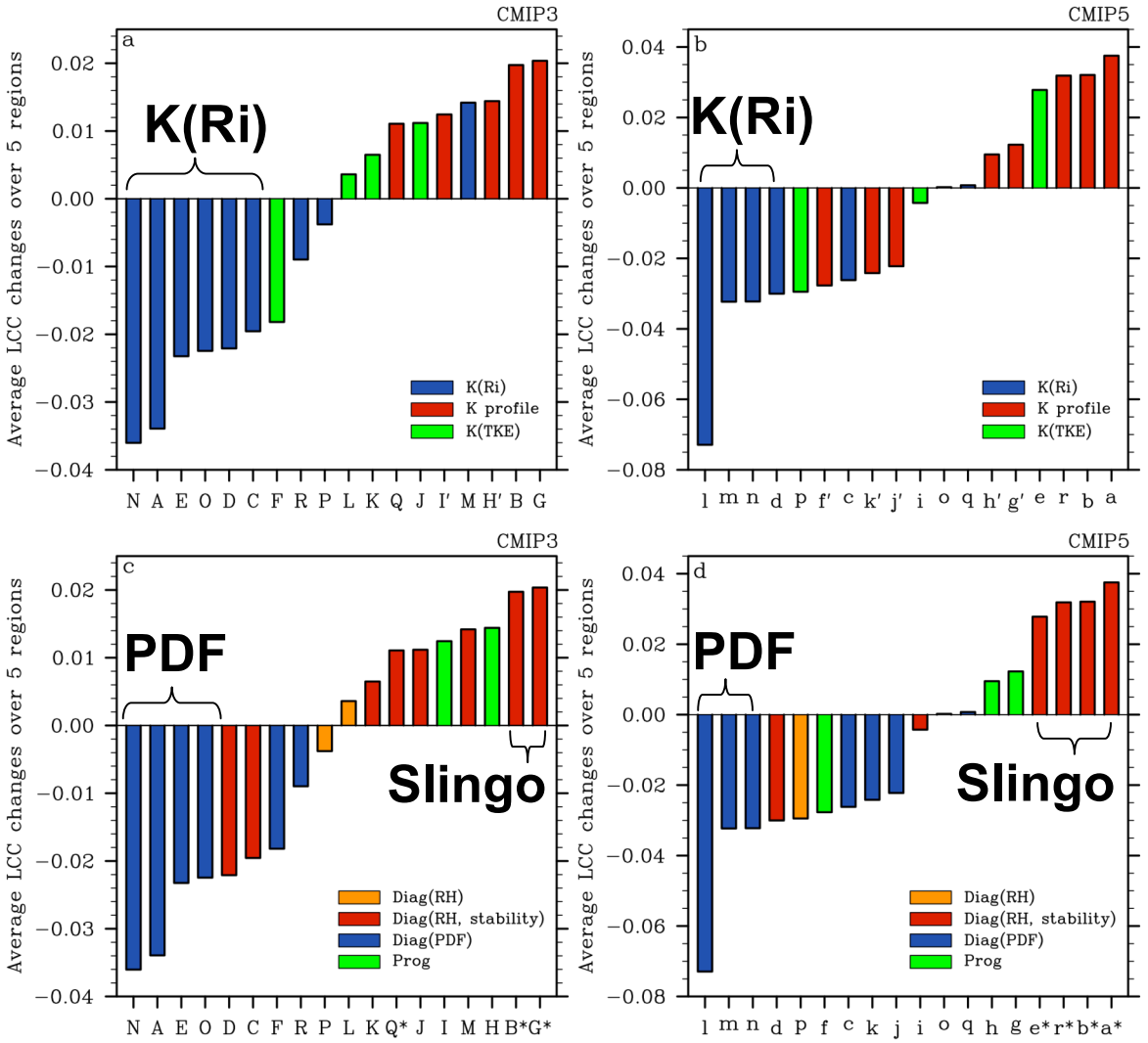
- **The SST contribution accounts for nearly two-thirds of the intermodel spread variance of LCC and about half of it in CMIP5 models.**
- **Either EIS contribution or the residual is not significantly correlated with LCC changes.**

Role of SST slope to the spread



LCC changes are positively correlated with the SST slope.

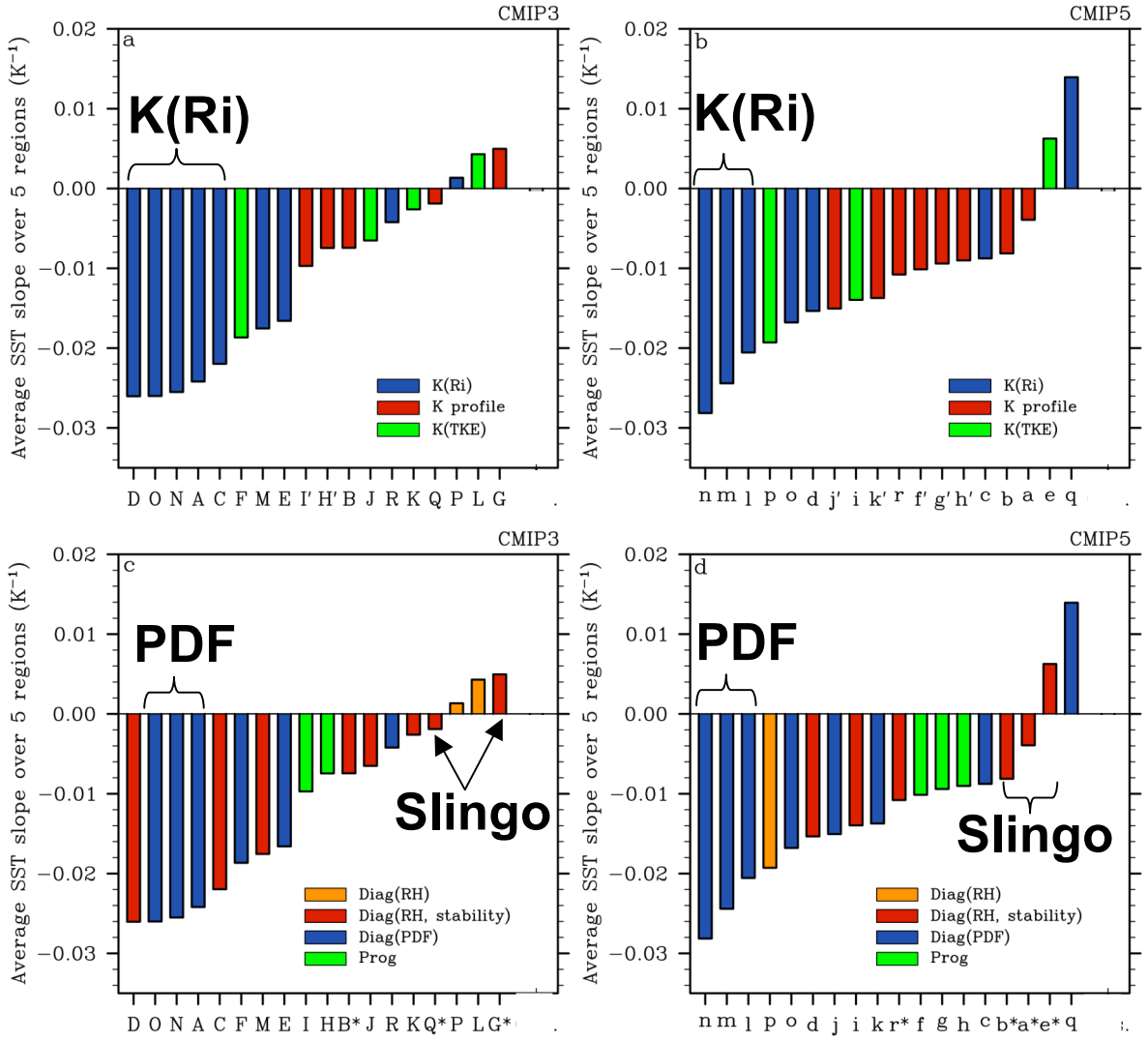
Goal 2: Link LCC changes to PBL and cloud parameterizations



- **Models with a large LCC decreases are mostly those with the "K(Ri)" PBL scheme and "Diag(PDF)" cloud scheme.**

- **Models with a large LCC increase are mostly those with the "Diag(Slingo)" cloud scheme (denoted by stars).**

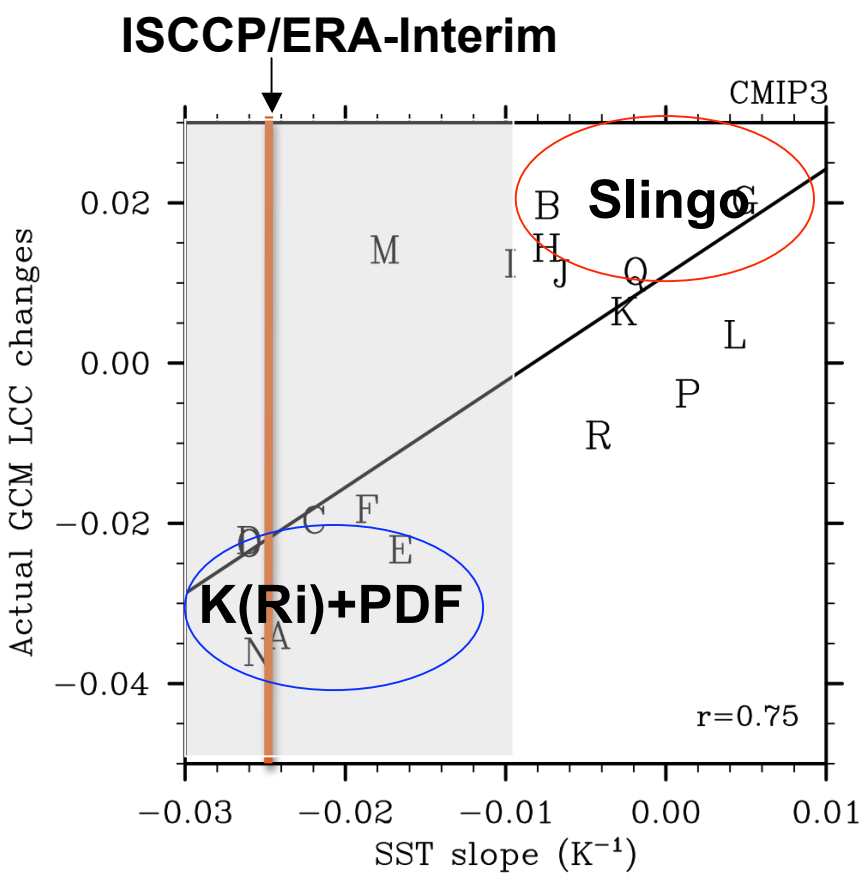
Link SST slope to PBL and cloud parameterizations

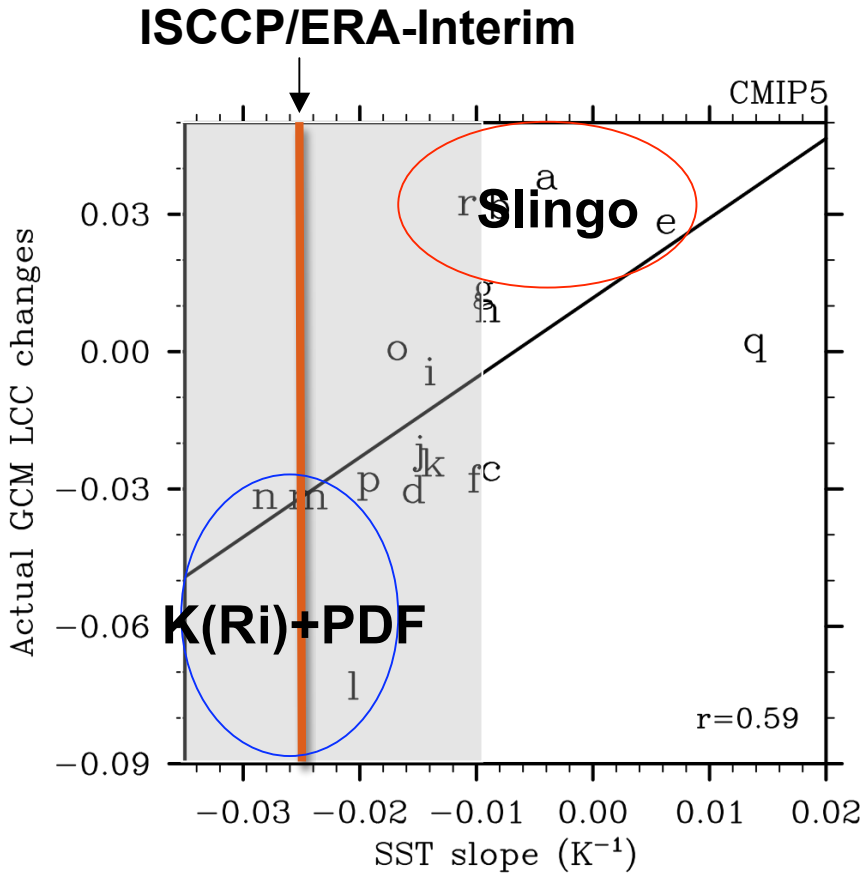


- **Models with a large SST slope are mostly those with the "K(Ri)" PBL scheme and "Diag(PDF)" cloud scheme.**

- **Models with a small or even a positive SST are mostly those with the "Diag(Slingo)" cloud scheme.**

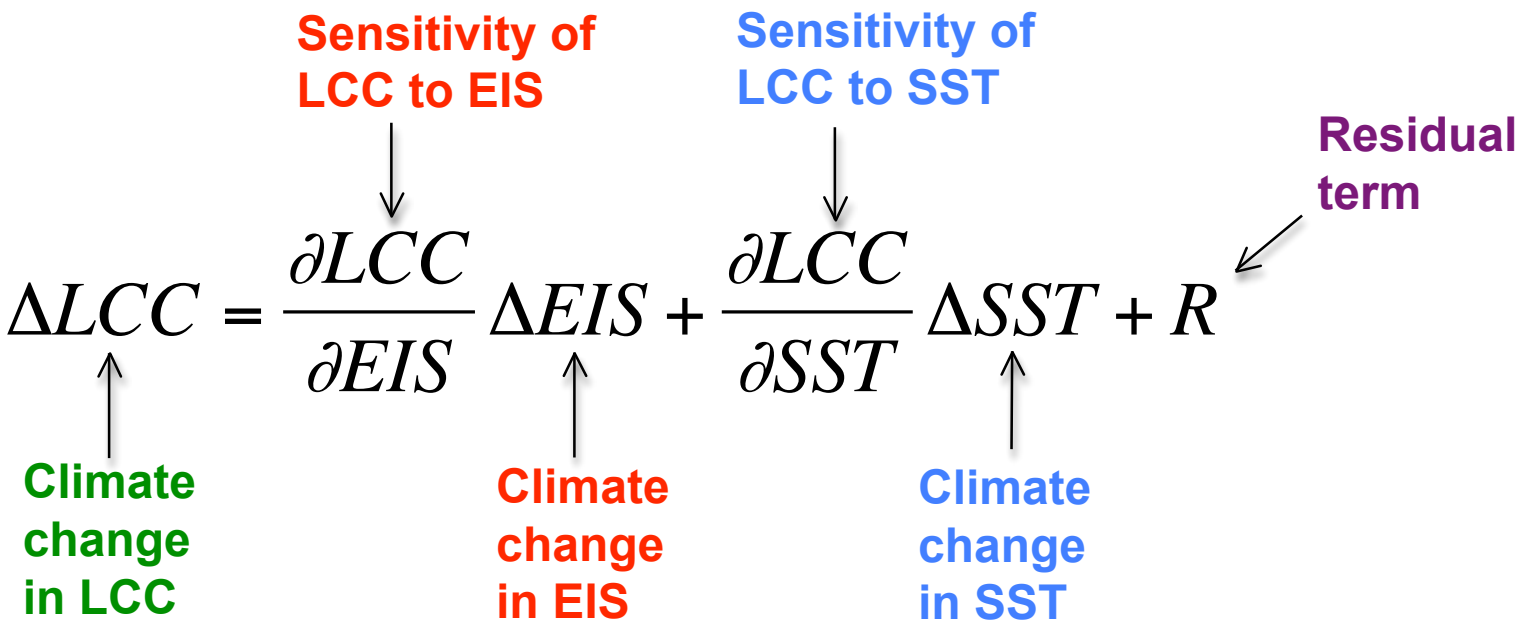
Goal 3: An observed constrain on SST slope





Observed constrain on SST slope suggests LCC will likely decrease.

An argument for a future decrease in LCC



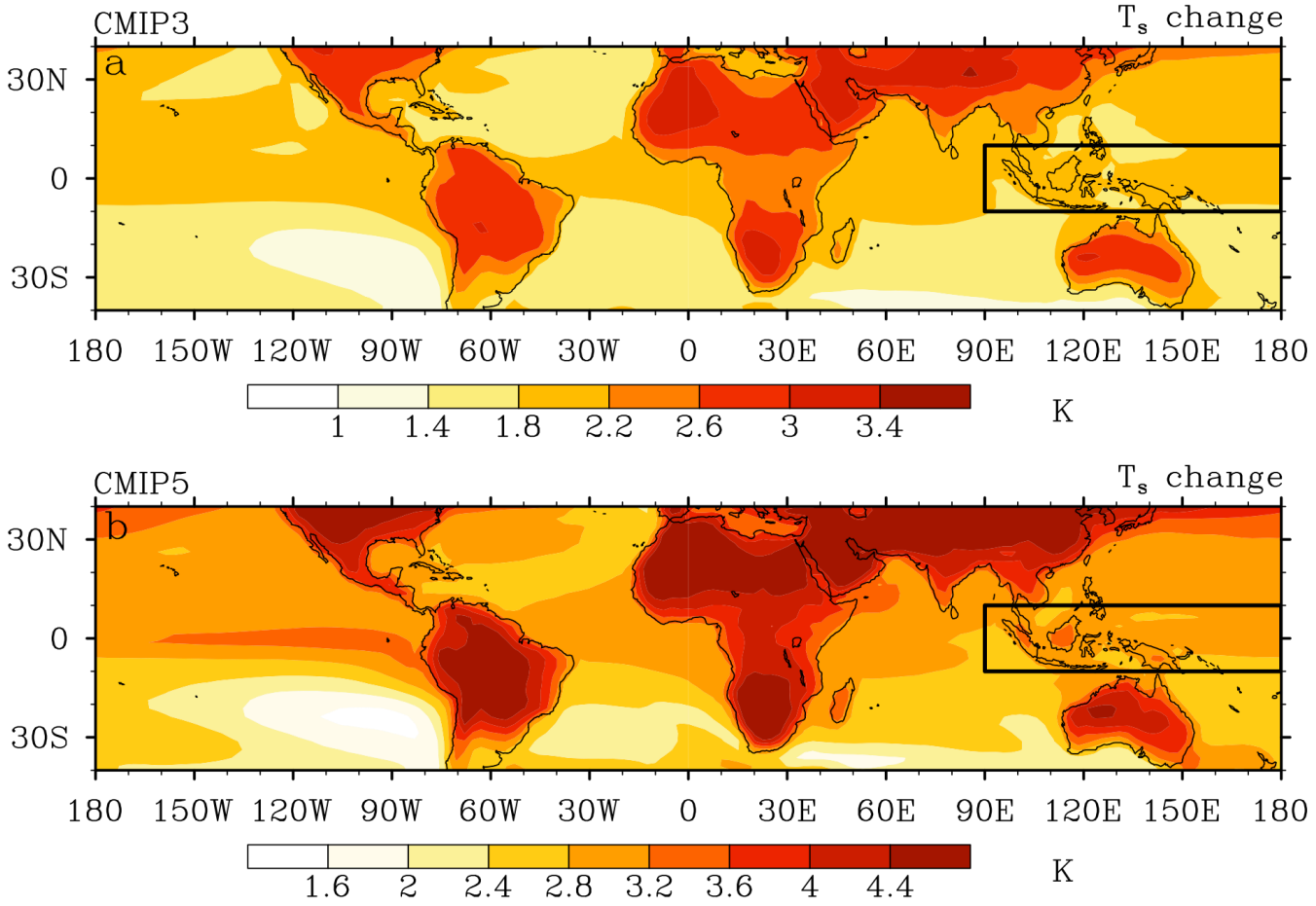
(1) SST change is much larger than EIS change
(2) SST and EIS slopes are similar in magnitude.

Summary

1. **The linear contributions of the estimated inversion strength (EIS) and sea surface temperature (SST) to simulated changes in low-cloud cover (LCC) are quantified.**
2. **The SST contribution accounts for a big portion of the intermodel spread in LCC changes.**
3. **The sensitivity of LCC to SST perturbations drives the spread in LCC changes. This sensitivity is strongly influenced by cloud and boundary layer parameterizations in the global models.**
4. **Observed constrain on the sensitivity suggests LCC will likely decrease.**

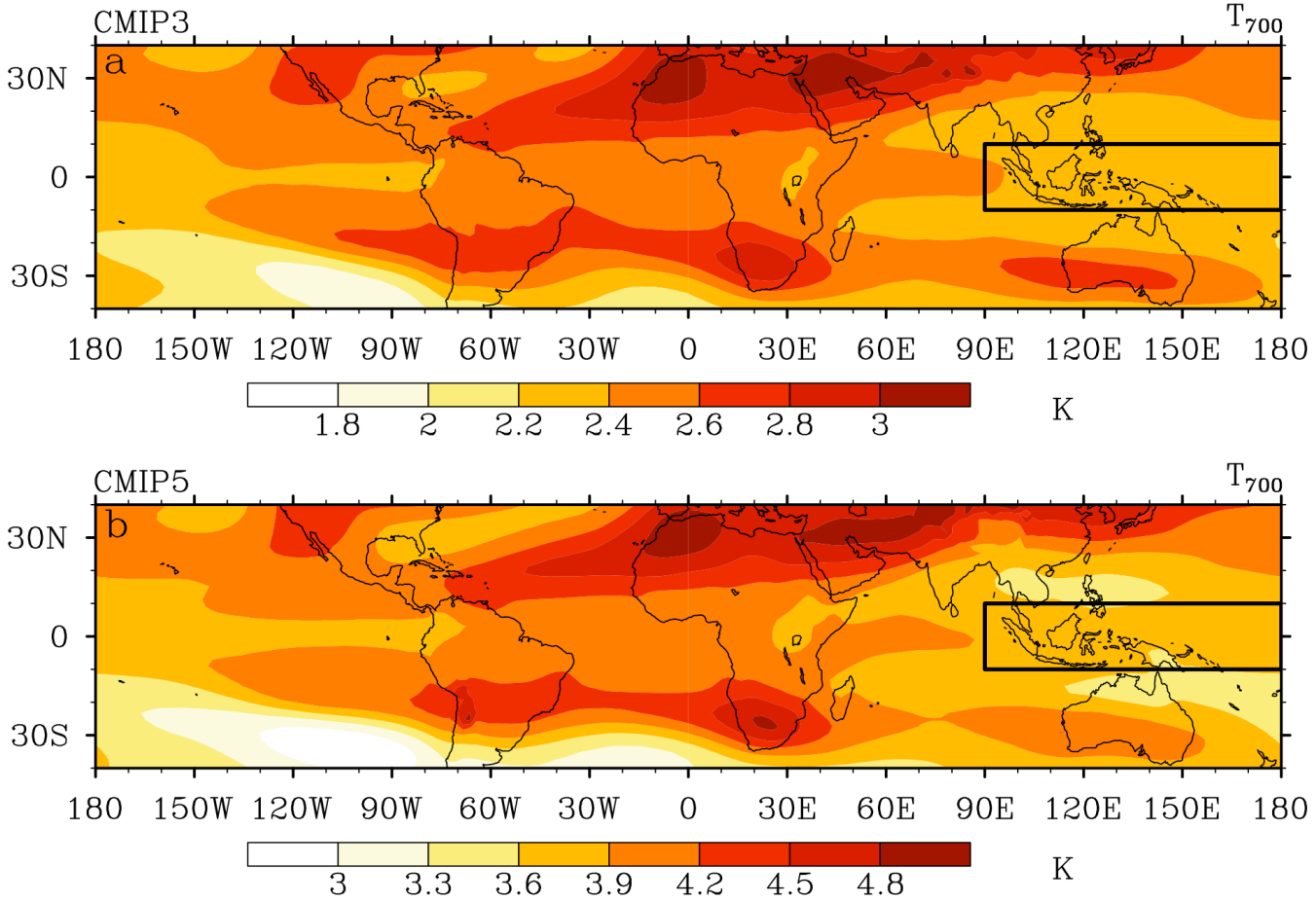
Extra slides

Simulated changes in EIS and SST



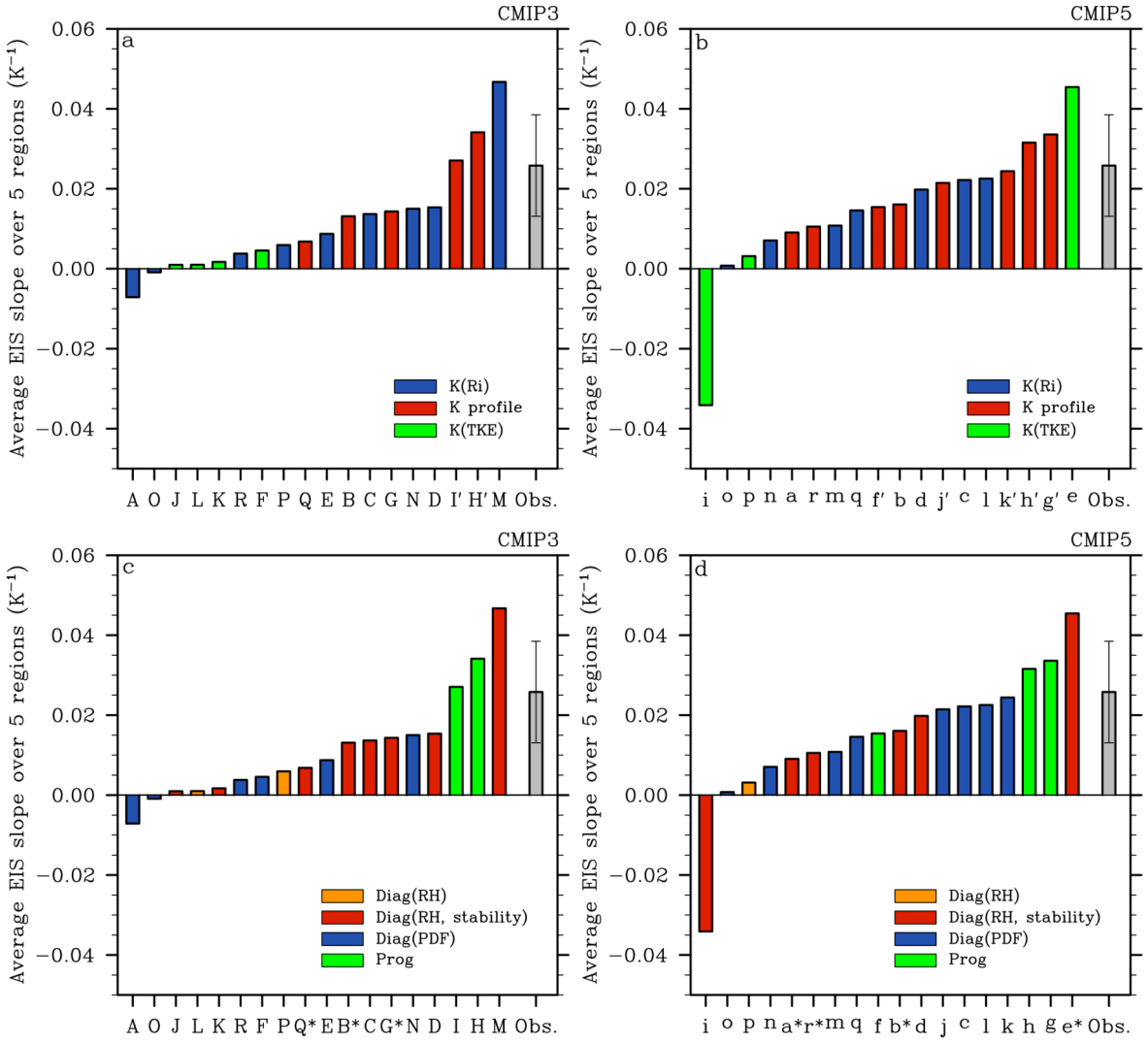
Warming in tropical warming pools is greater than warming in low cloud regions.

Simulated changes in EIS and SST



Warming over nearby land is generally greater than warming in the low cloud regions.

EIS slope is NOT linked to PBL and cloud parameterizations



There is no systematic relationship between the EIS slope and parameterizations.