Assessing prior emergent constraints on surface albedo feedback in CMIP6

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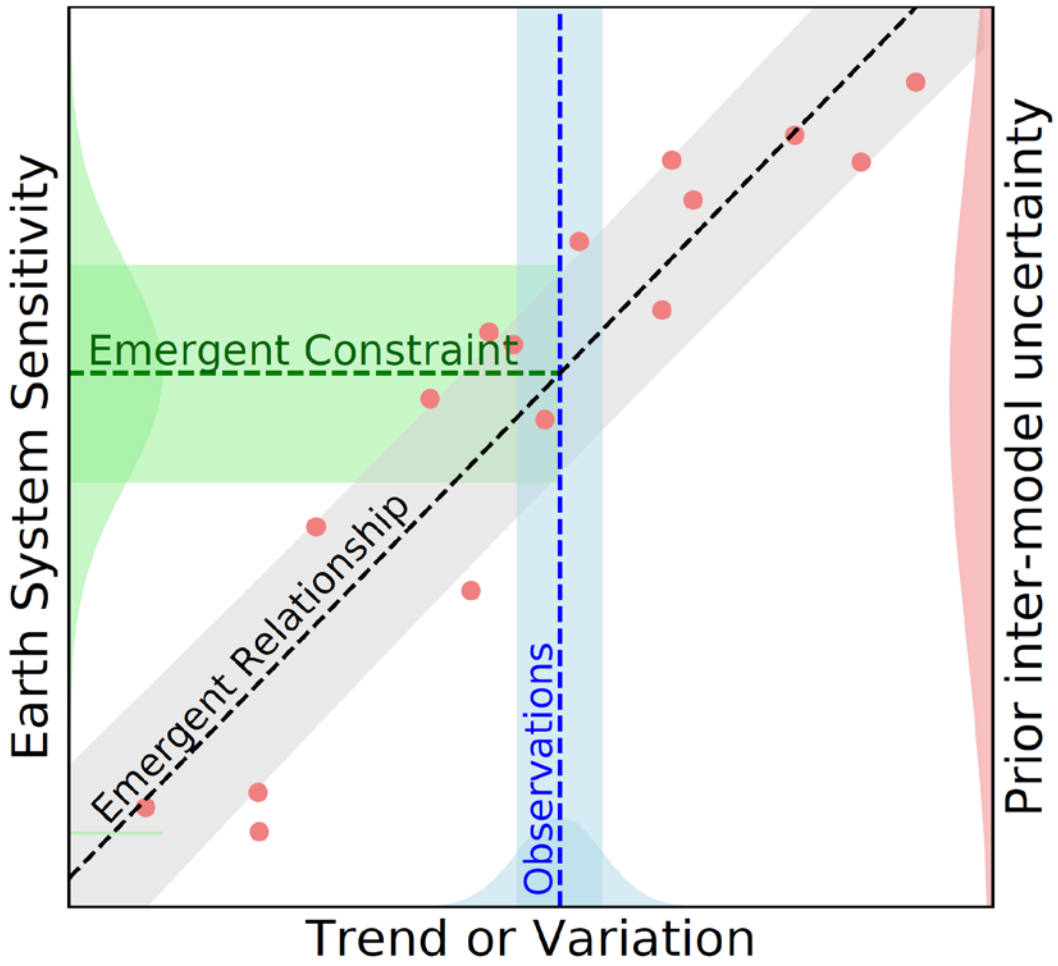
MOTIVATION

- Large intermodel spread in climate feedbacks drives uncertainty in projections of Arctic climate change.

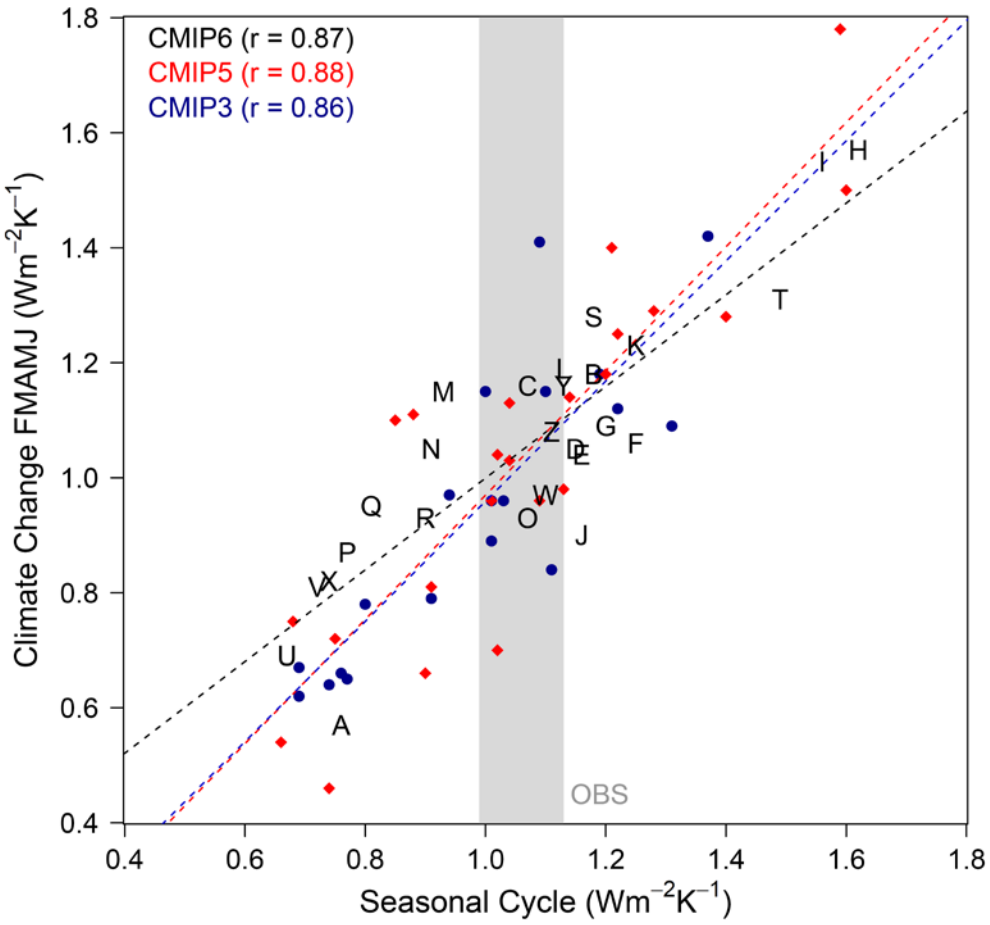
- Prior research identified two separate emergent constraints (ECs) tied to future surface albedo feedbacks (SAF) stemming from loss of Northern Hemisphere snow cover (SAF_{snow}) and sea ice (SAF_{ice}).
  - A strong statistical relationship between metrics describing aspects of current *(X)* and future *(Y)* climate across a GCM ensemble.
  - Because of the tight relationship, taking steps to reduce intermodel spread in the *(X)* should be reflected in *(Y)*.

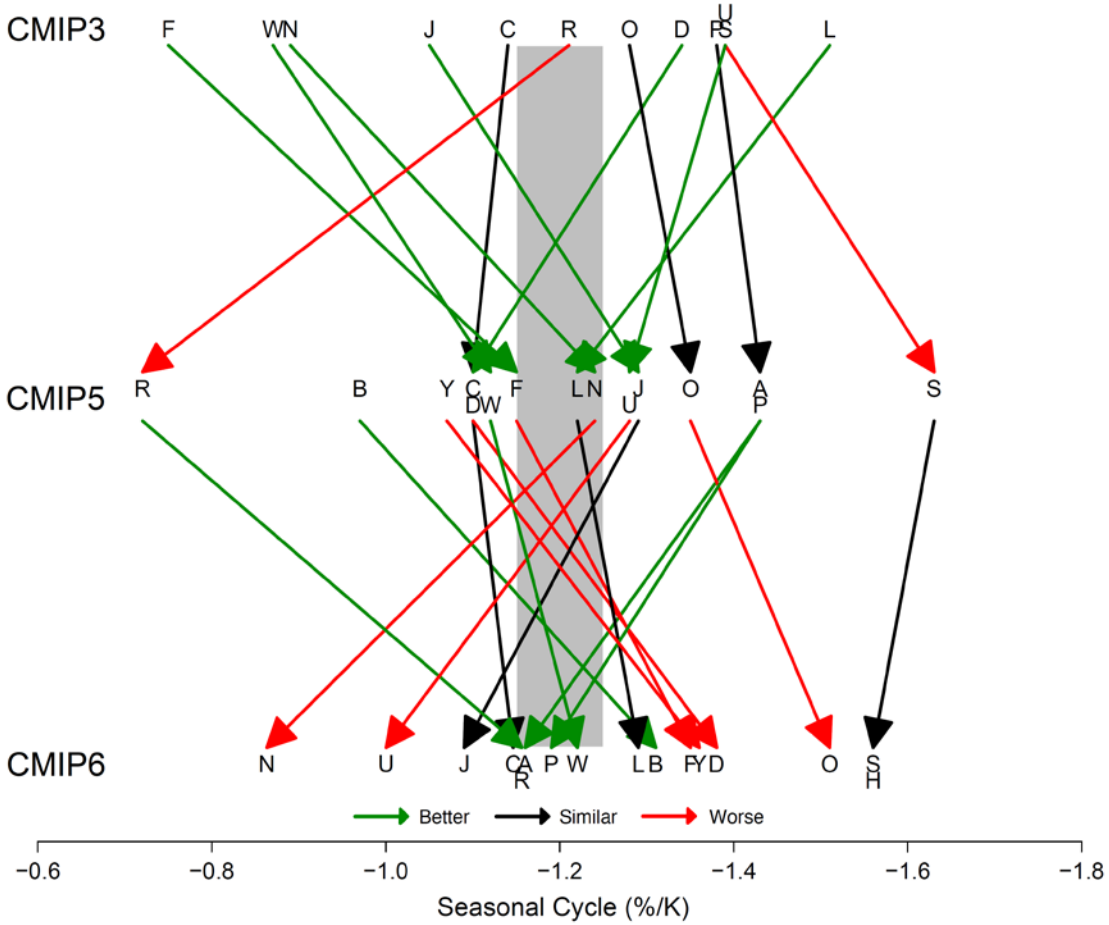
- **In this study, we use the CMIP6 ensemble to test prior ECs, through out-of-sample verification, an important examination of EC robustness.**



Williamson et al. in review

SAF_{SNOW} EC IS VERY ROBUST, MODEL SPREAD REMAINS LARGE

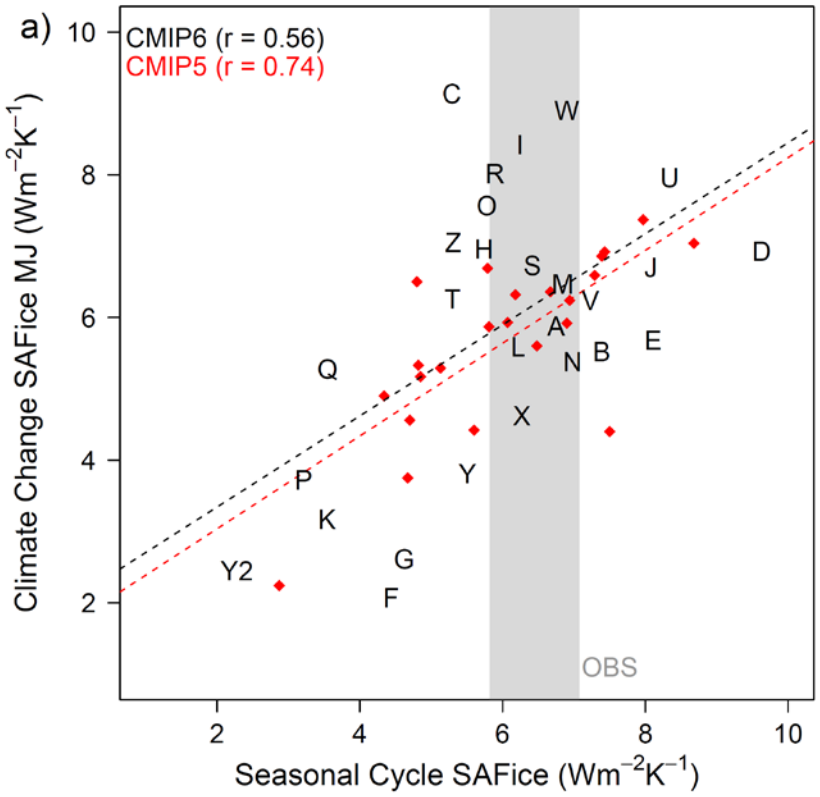


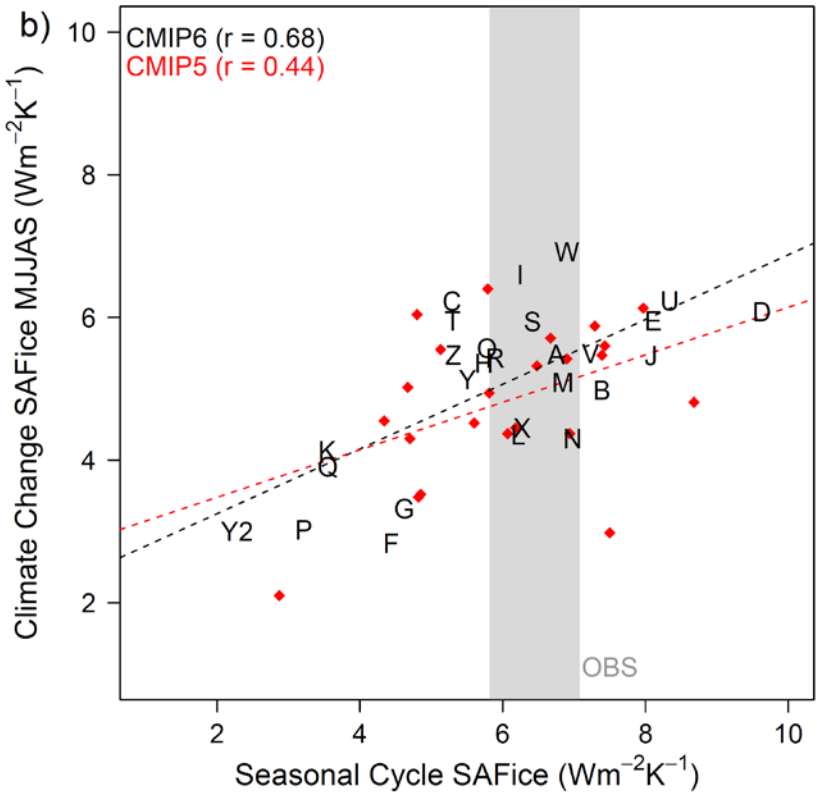


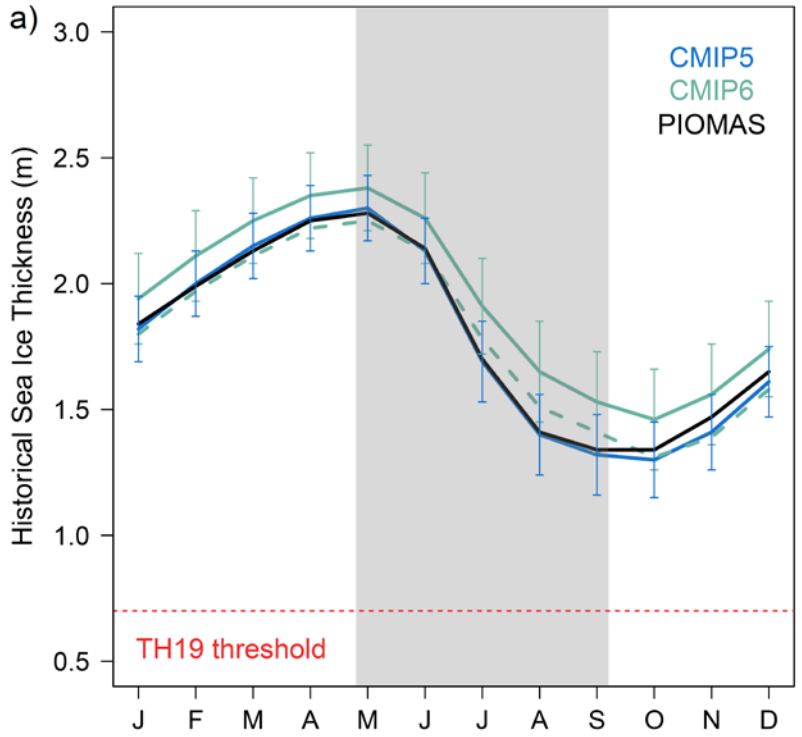
- Two main things we are interested in: is the emergent relationship still present (yes) and has the intermodel spread been reduced through model development? (no)

Thackeray et al. submitted

SAF_{ICE} EC WEAKENS SLIGHTLY, MODEL SPREAD REMAINS LARGE







- The SAFice EC also exists in CMIP6, but with different, slightly weaker characteristics and slightly larger model spread. Changing characteristics tied to larger biases in historical sea ice thickness in CMIP6.

Thackeray et al. submitted

SUMMARY

- We find that ECs on future snow and sea ice albedo feedbacks exist in the new CMIP6 ensemble, despite substantial changes to climate sensitivity. This increases our confidence that the relationships have physically meaningful drivers.

- Outlier models with biased simulations of snow cover extent, sea ice thickness and surface albedo prevent the reduction of intermodel spread in these feedbacks.

- This research uncovers the model development steps taken between generations that have improved/worsened simulations of surface albedo feedback.

- This research aligns with RGMA goals of better understanding feedbacks and reducing biases in ESMs.