Climate Model Code Genealogy and Its Relation to Climate Feedbacks and Sensitivity

Peter Kuma, Frida A.-M. Bender and Aiden R. Jönsson

Department of Meteorology (MISU) and Bolin Centre for Climate Research,
Stockholm University, Stockholm, Sweden

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Aims

1. Determine code genealogy of CMIP3, CMIP5 and CMIP6 models with a focus on the atmospheric component and atmospheric physics.

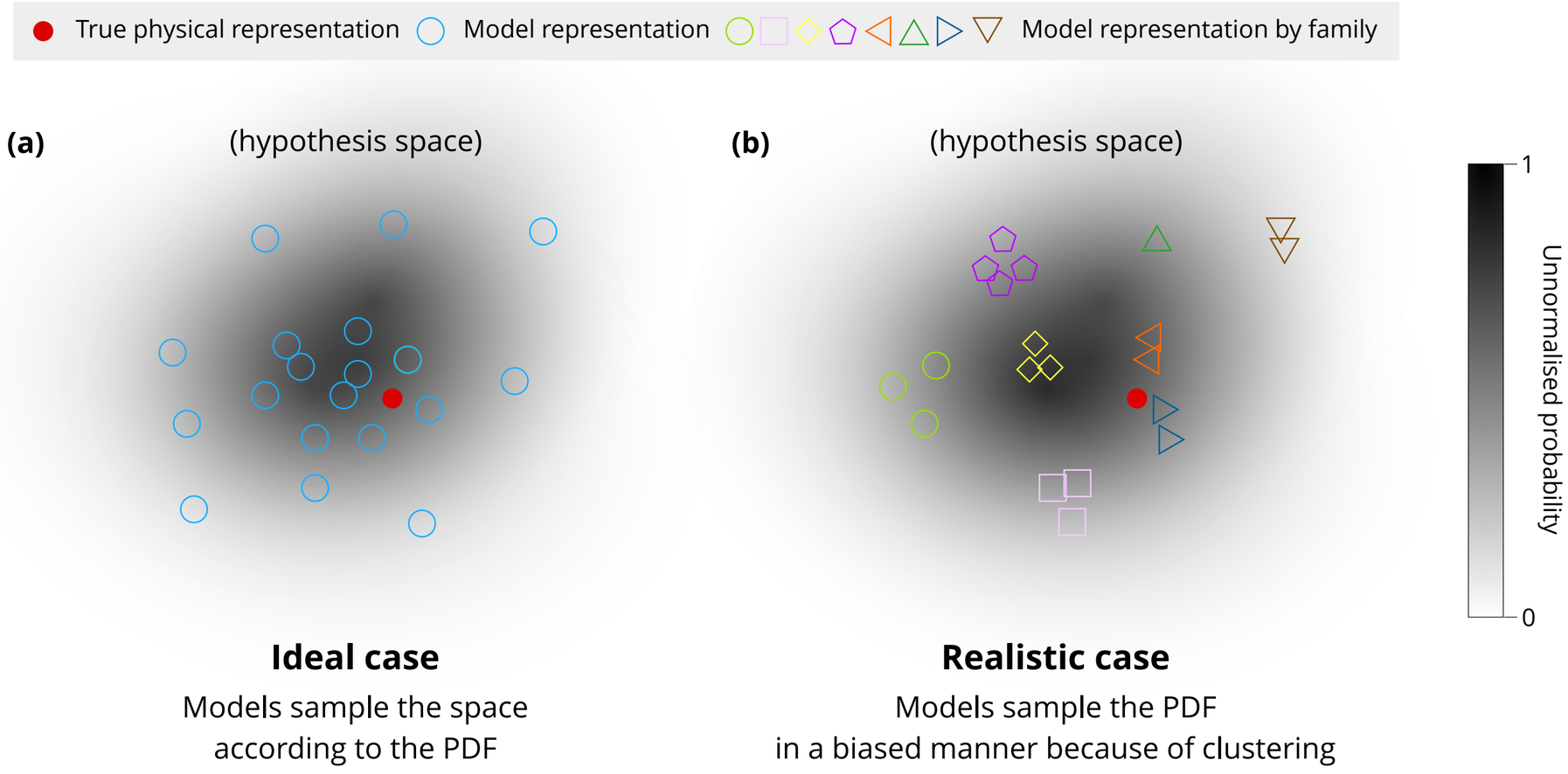
2. Create a weighting method which takes into account code dependence between the models.

3. Evaluate climate feedbacks, sensitivity, forcing, historical and projected time series of global mean near-surface temperature under different weighting methods.

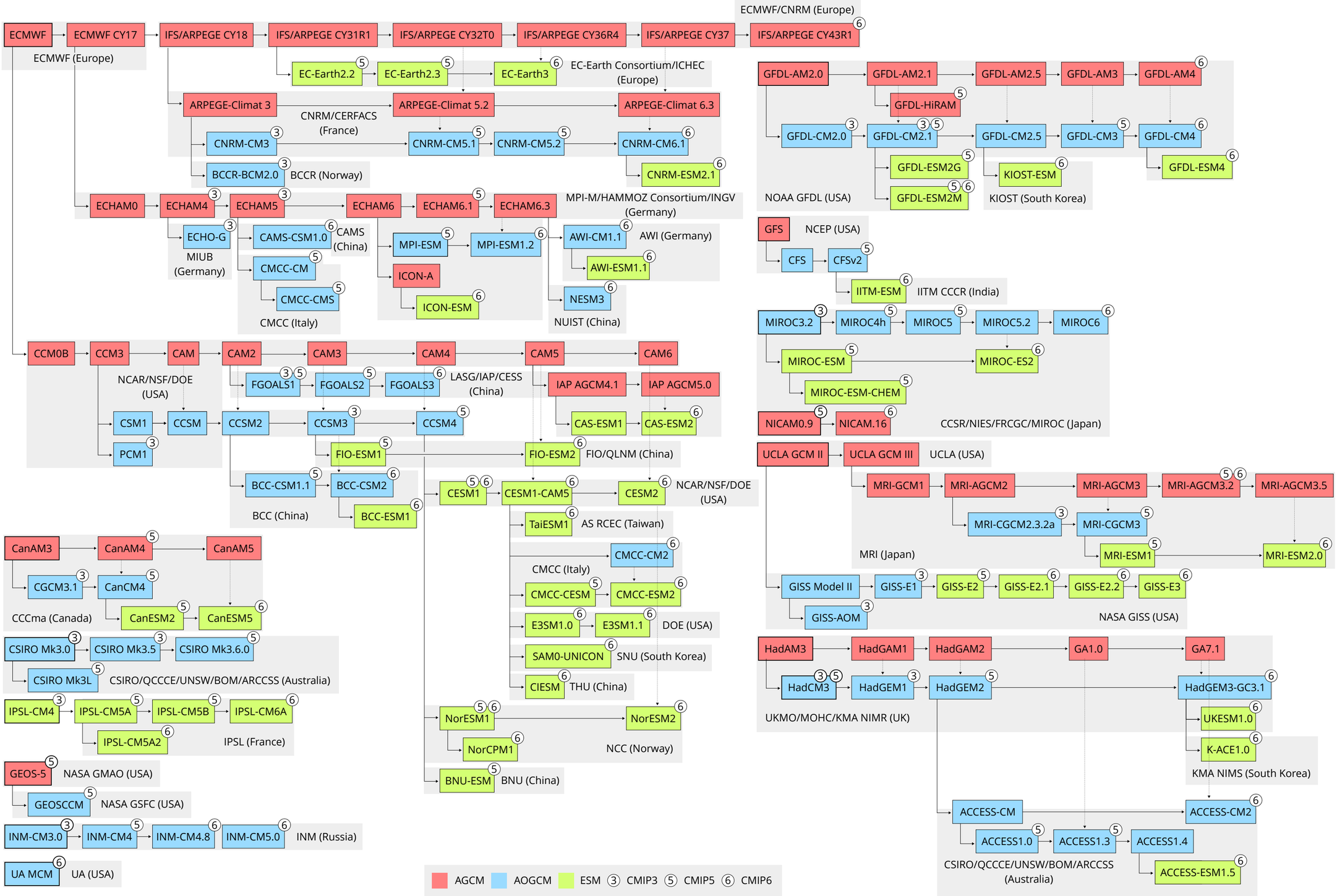
Model evolution

– In an ideal case, models sample the hypothesis space of the climate system (model structural uncertainty) independently.

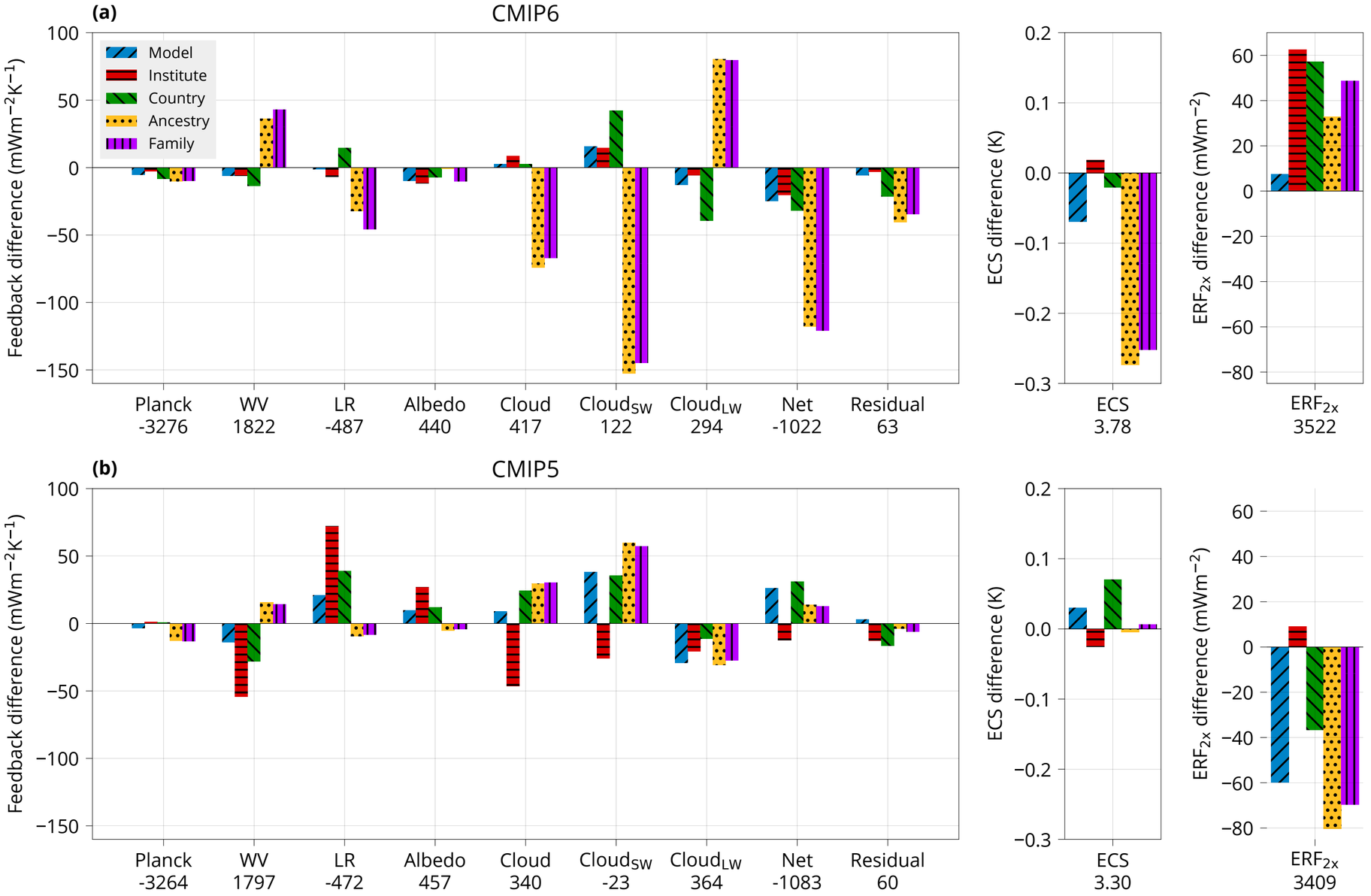
– In practice, they form culsters due to structural model dependence (code sharing).



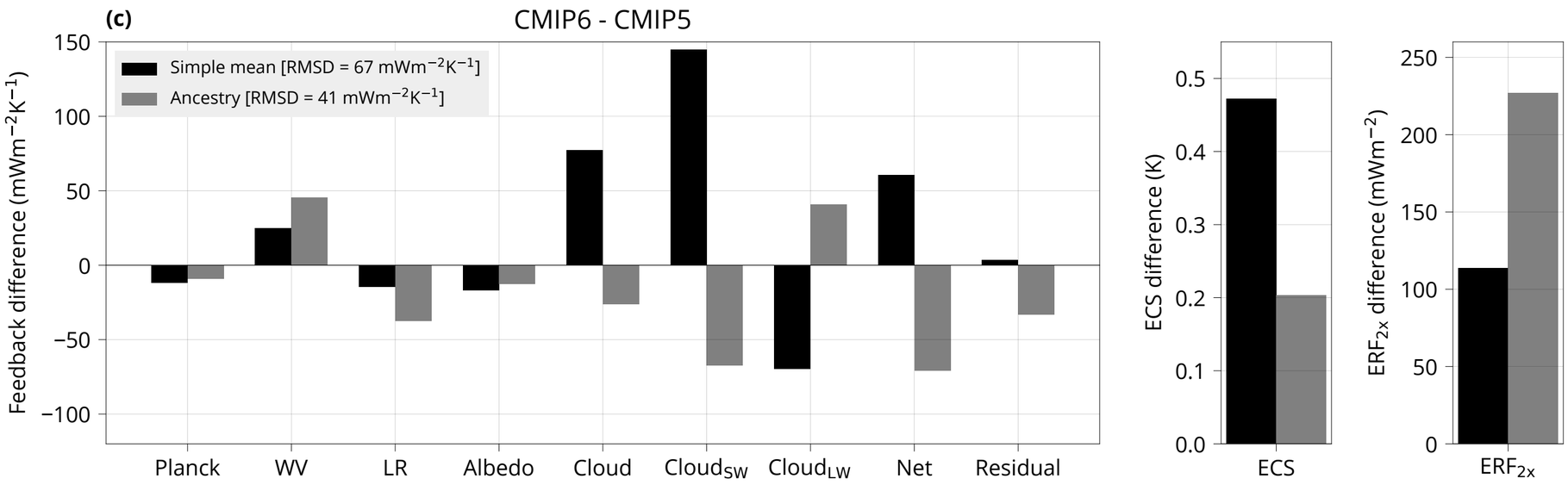
Code genealogy



Weighting climate feedbacks and sensitivity

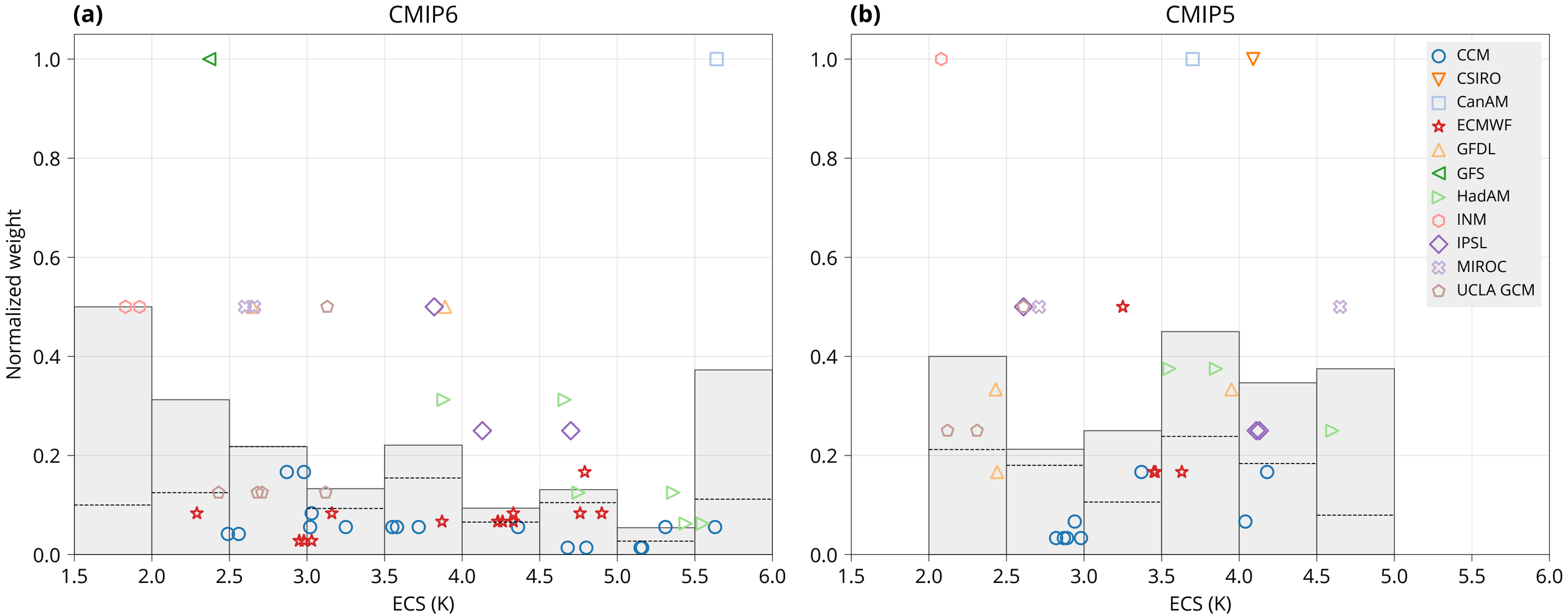


Weighting climate feedbacks and sensitivity

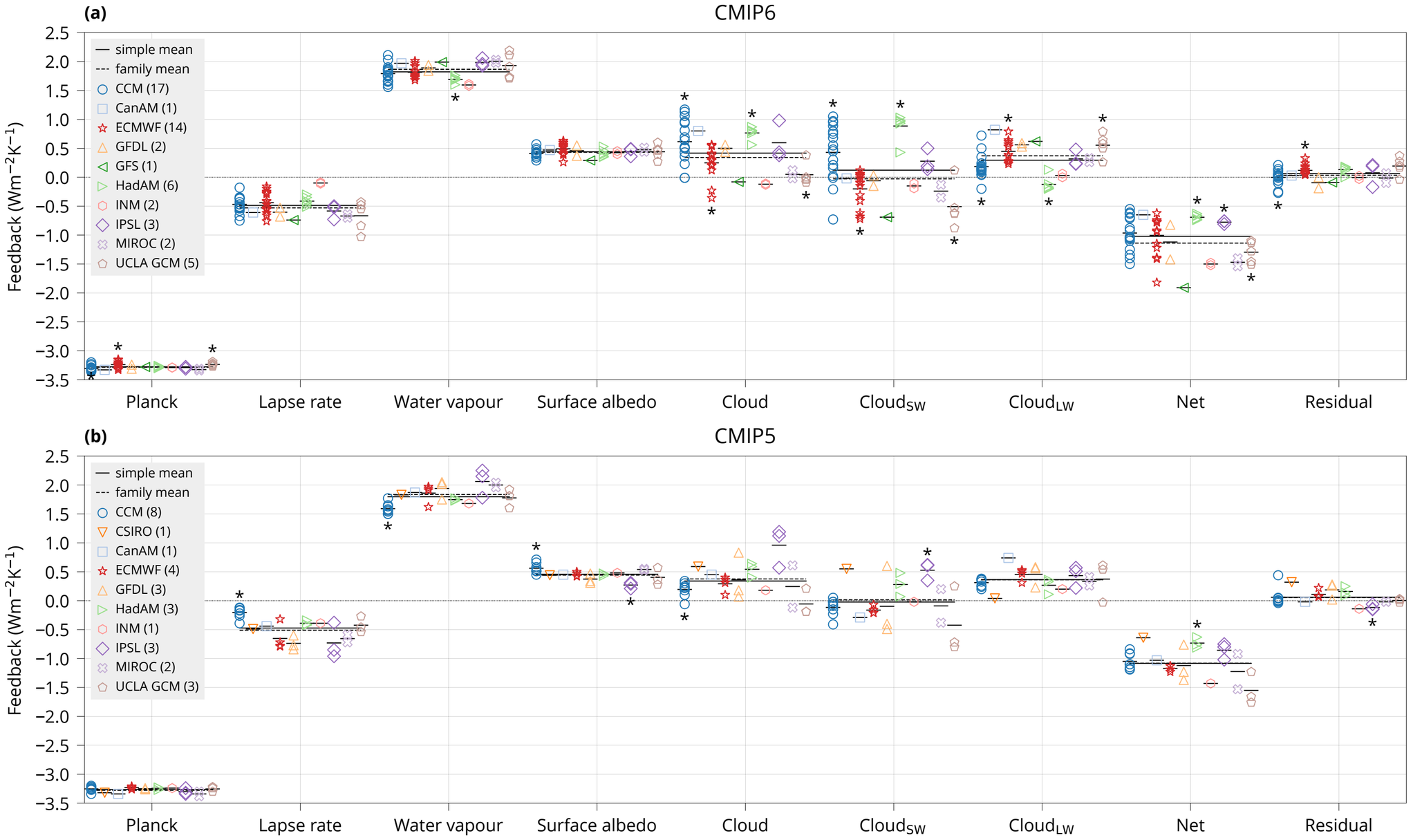


ECS weighting

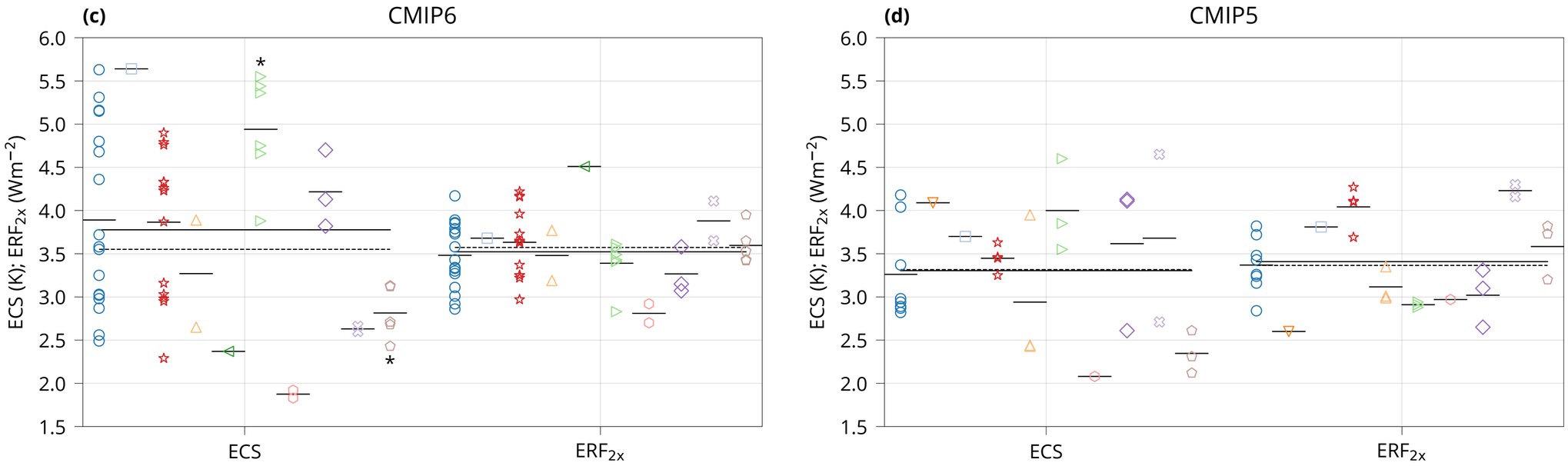
– Ancestry weighting in CMIP6 results in greater weights for low- to mid-ECS models, while in CMIP5 the weights are more evenly distributed.



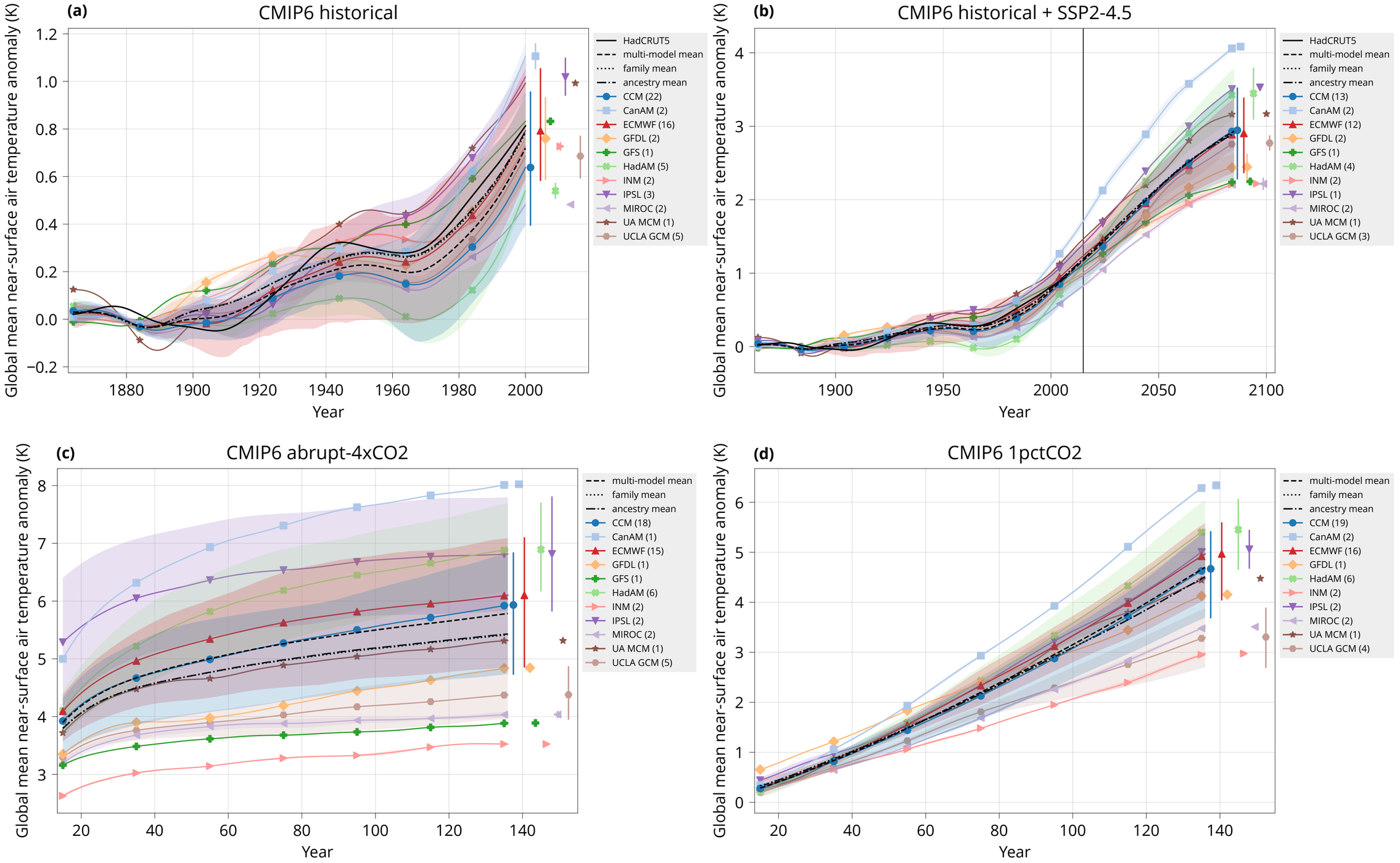
Climate feedbacks and sensitivity



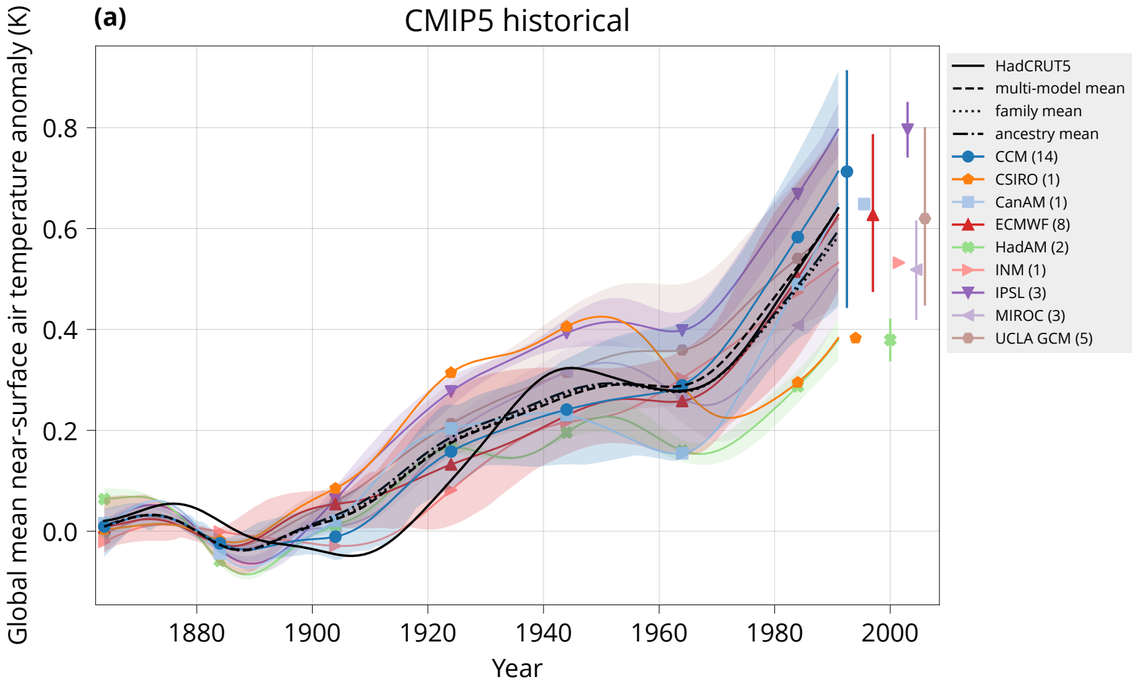
Climate feedbacks and sensitivity

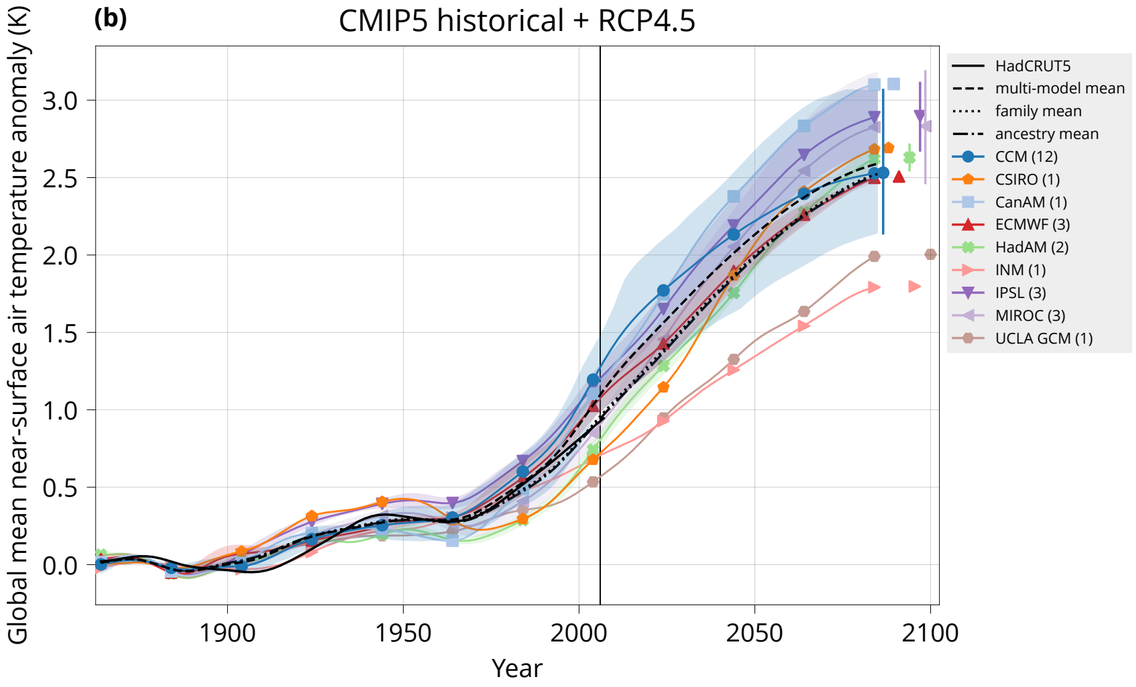


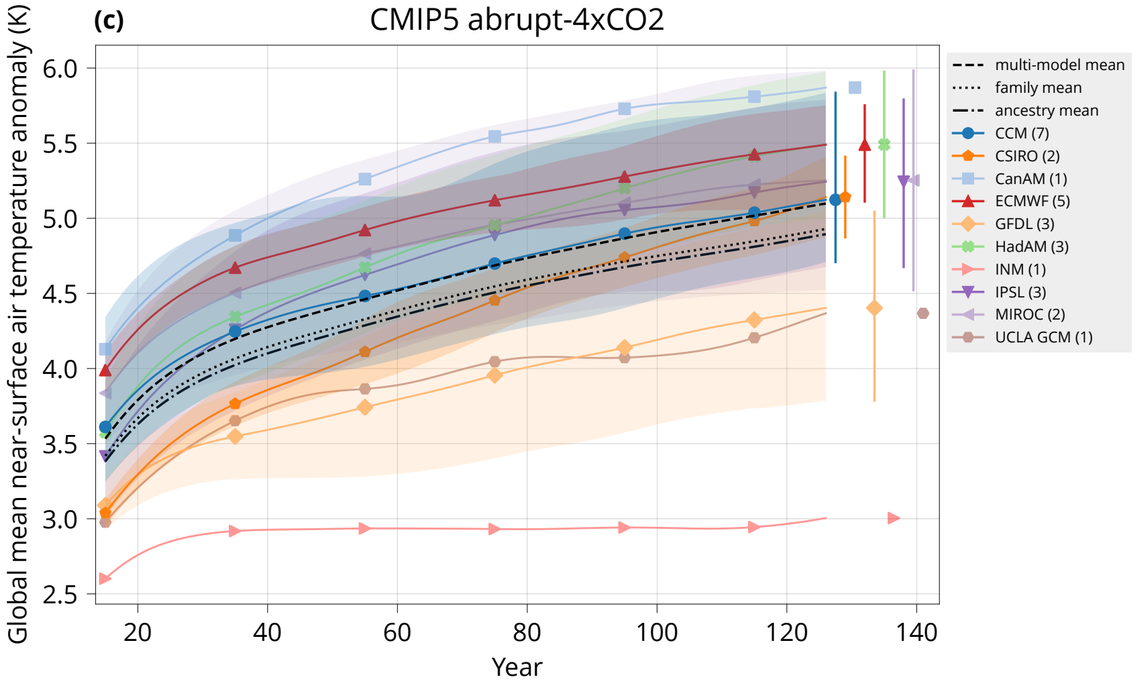
Temperature projections

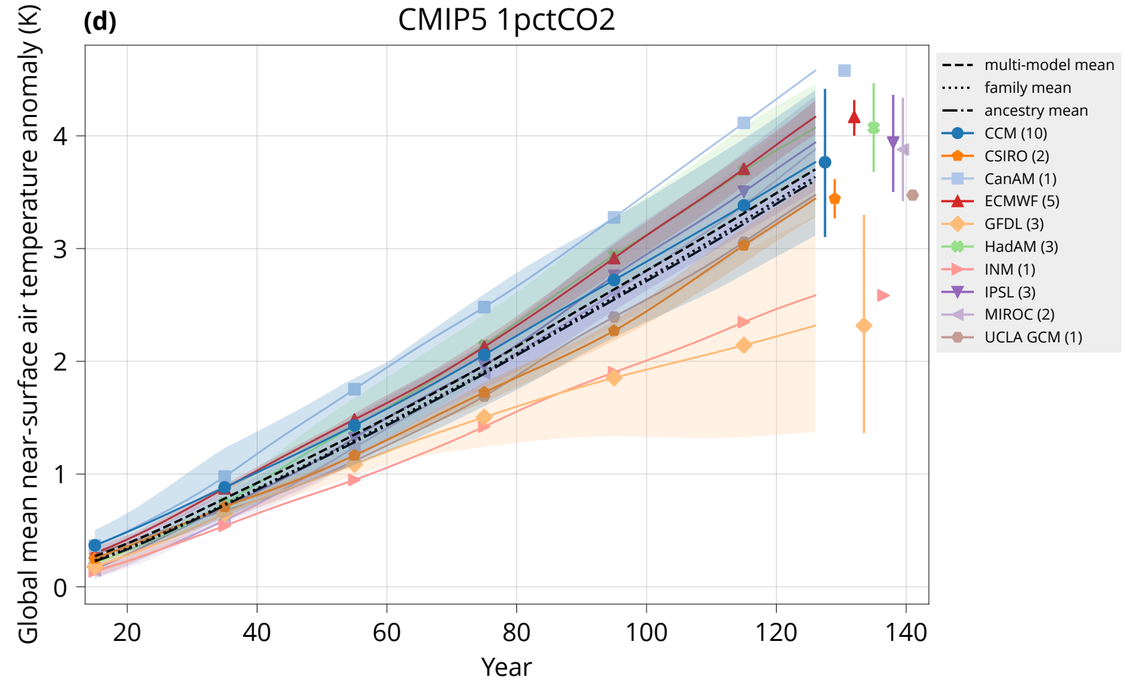


Temperature projections









Conclusions

– Large code dependence exists between most CMIP models.
– CMIP models can be grouped into about 12 families by code heritage.
– Ancestry and family weighting can partly reconcile differences between CMIP5 and CMIP6 climate sensitivity.
– Model families tended to exhibit warm/cold tendencies across CMIP generations.
– We propose ancestry and family weighting methods as a fairer weighting for multi-model ensemble studies and an alternative to no weighting and model output similarity and performance weighting.