

D. Petrova¹, P. Tarin-Carrasco¹, A. Sekulic², J. Lukovic³, M. Gali Reniu⁴, X. Rodó^{1,5},
I. Cvijanovic¹

(1) Climate and Health Programme, Barcelona Institute for Global Health (ISGlobal), Catalonia, Spain, (2) University of Belgrade, Faculty of Civil Engineering, Belgrade, Serbia, (3) University of Belgrade, Faculty of Geography, Belgrade, Serbia, (4) University of Barcelona, Faculty of Physics, Barcelona, Catalonia, Spain, (5) Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Catalonia, Spain.

Contact: desislava.petrova@isglobal.org

Introduction

- California is a major climate change hotspot, as models have been split between projecting wetter or drier future conditions.
- This future precipitation uncertainty may pose major problems for the water management and economy of the state, and impede adaptation measures.
- We compare California’s precipitation changes from the latest Coupled Model Intercomparison Project Phases 6 (CMIP6) and 5 (CMIP5) over the wet season (December-January-February, DJF), in order to identify if the improvements in the new generation of CMIP6 models have resulted in the elimination or decrease of the uncertainty.
- ENSO is a leading modulator of winter precipitation in California, and the frequency and intensity of rainfall are related to ENSO extremes. Therefore, we also study future changes in the ENSO cycle and their potential impacts on California’s precipitation changes.

Methods

- We use historical and future scenario simulations from CMIP5 (RCP5.8) and CMIP6 (SSP5-8.5) obtained with 30 different models from each.
- We downloaded monthly precipitation, surface temperature, 200 hPa geopotential height and OLR from the Copernicus Climate Data Store.
- We analysed the precipitation changes in mid-century (2040 - 2059) and end-century (2080 - 2099) future periods relative to a historical baseline (1980 - 1999) period. We consider model means, as well as model agreement, percent of models that agree on either positive or negative future changes in a given variable.
- We calculated ENSO precipitation composites separately for every model in CMIP5 and CMIP6, by summing the precipitation anomalies occurring during each El Niño or La Niña event in the considered period.

Future Precipitation Changes

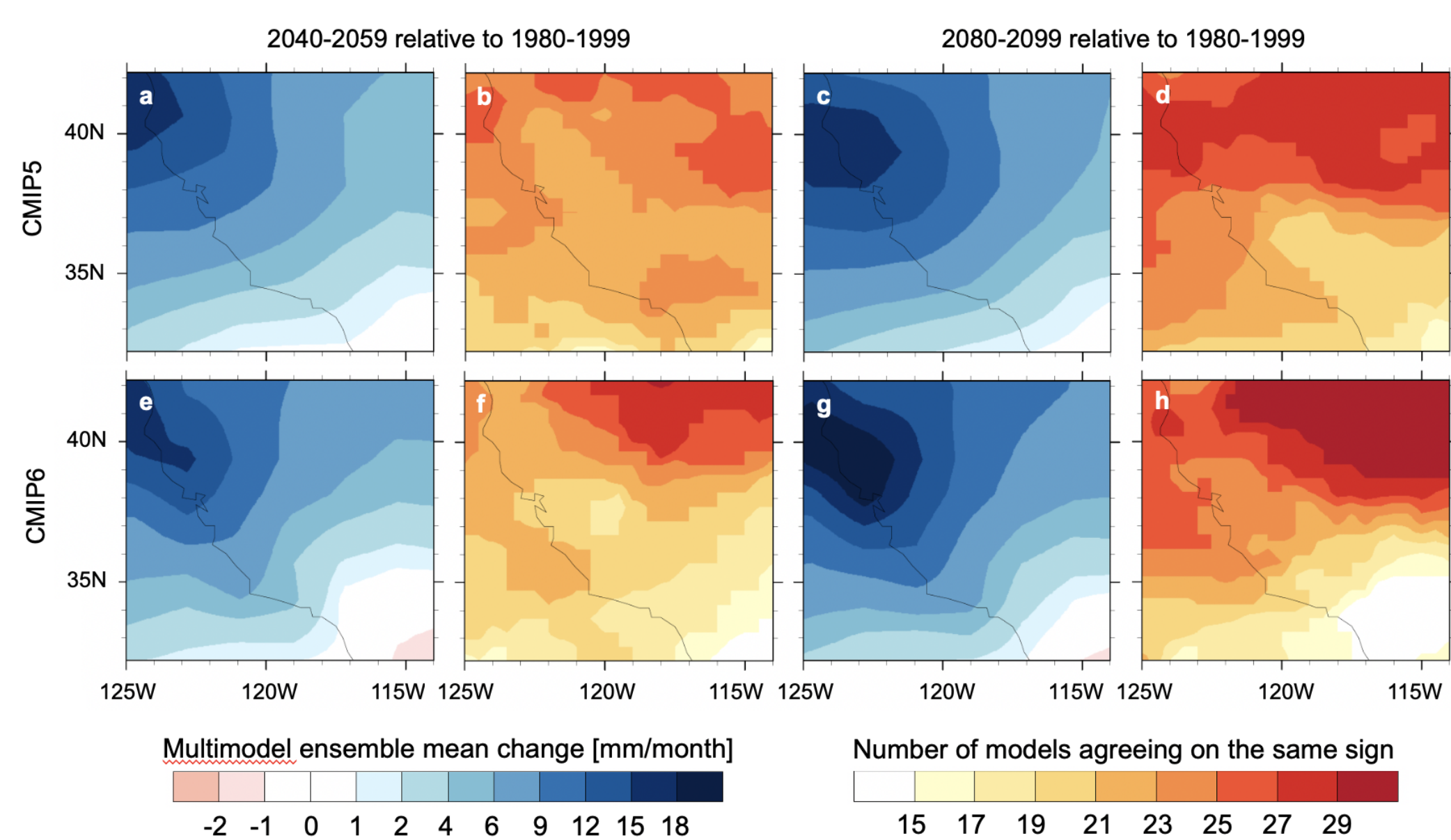
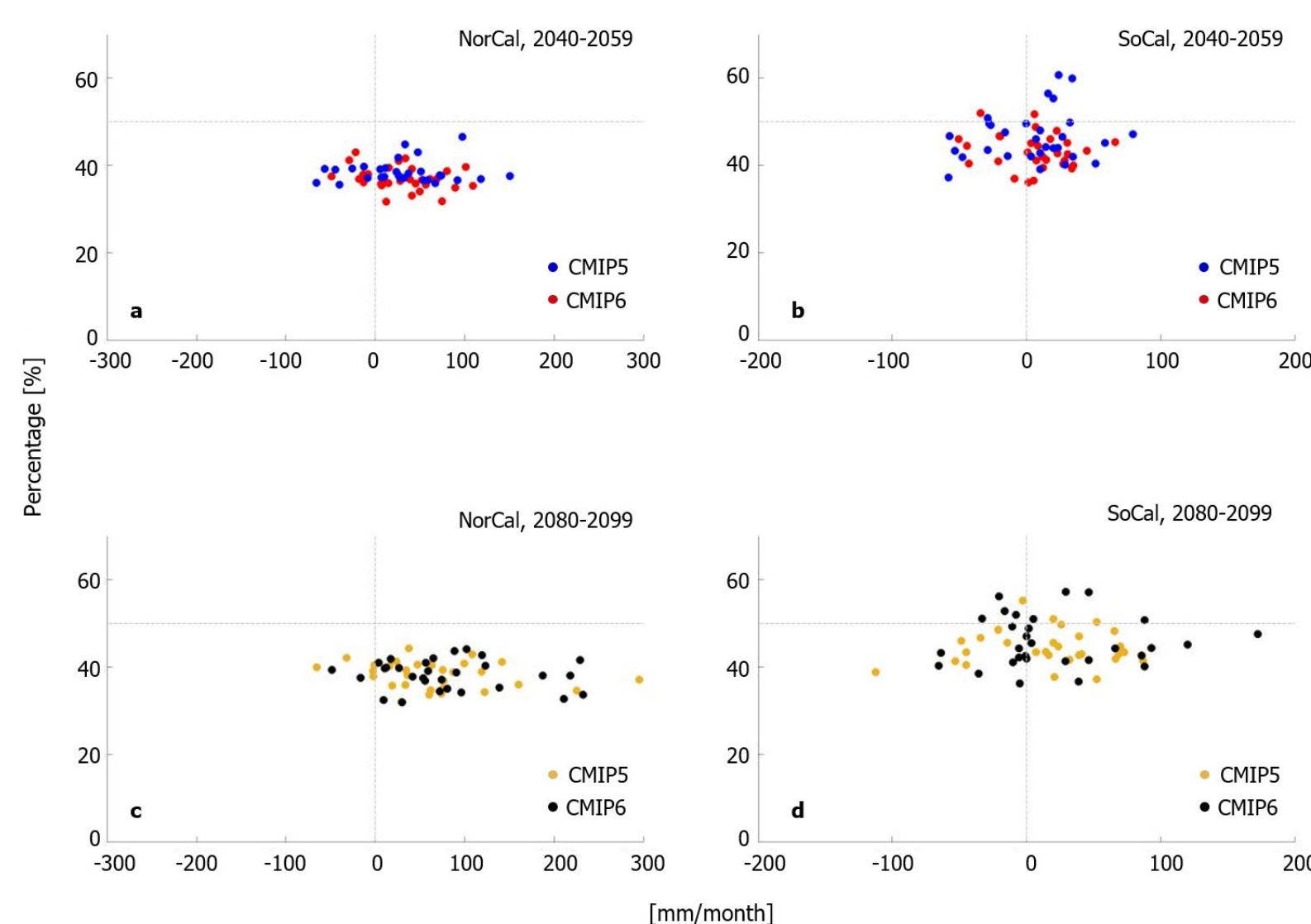


Figure 1: California wet season (DJF) precipitation anomalies (a, e, c, g), and model agreement (b, f, d, h) on mean precipitation changes for mid-century (2040-2059) and end-century (2080-2099) in the CMIP5 (a - d) and CMIP6 (e - h) ensembles.

Wettest Winters



Figures 2: Y-axis: relative contribution from the five wettest winters in the mid-century (a - b) and end-century (c - d) periods; X-axis: mean cumulative precipitation change from the historical period in northern California (a, c) and southern California (b, d).

Dynamical Changes

Figure 3: DJF ensemble mean changes in Outgoing Longwave Radiation (a - d) and model agreement on the sign of changes (e - h) in CMIP5 and CMIP6 for mid-century (2040-2059) and end-century (2080-2099) relative to the historical (1980-1999) period.

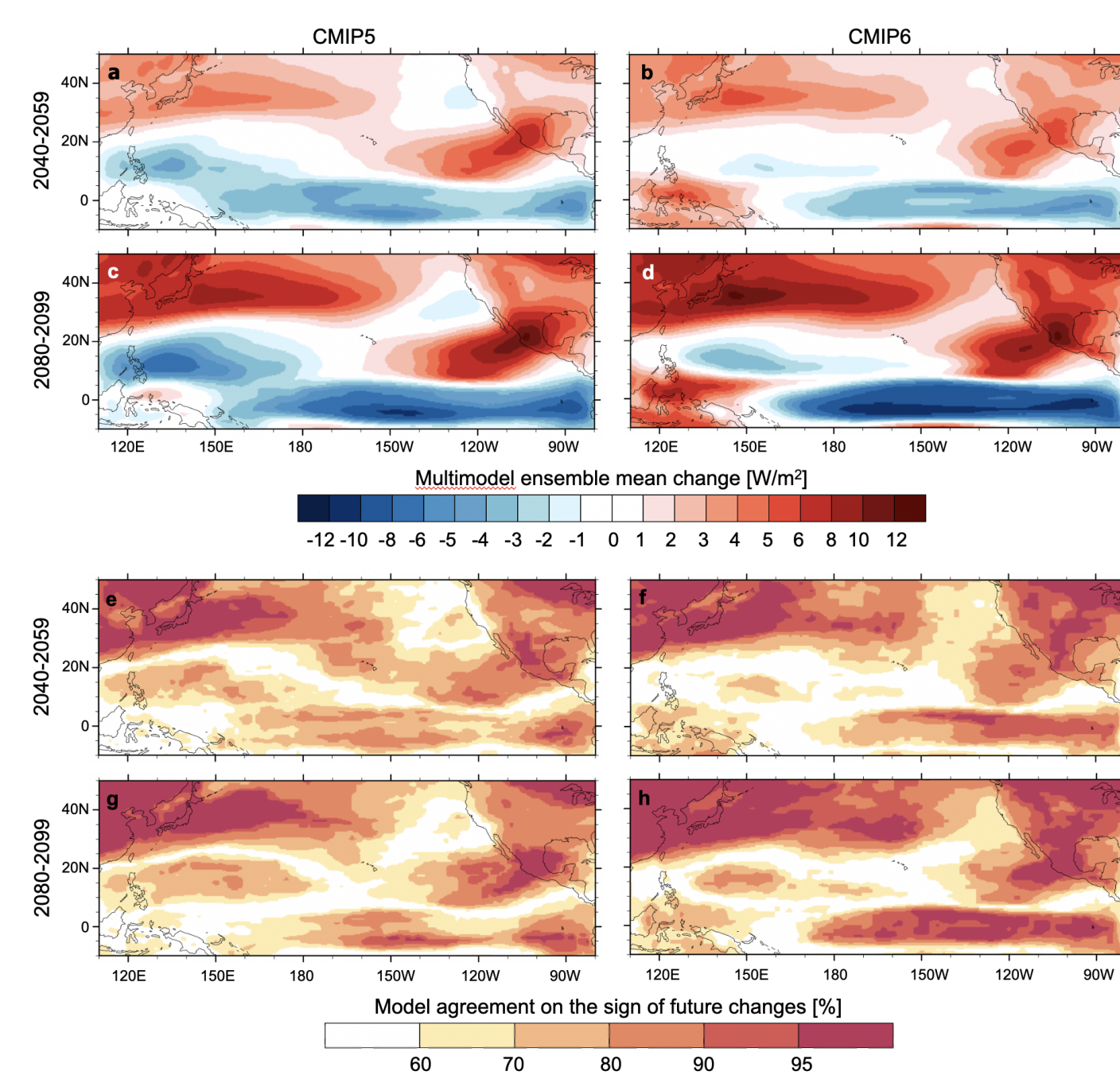
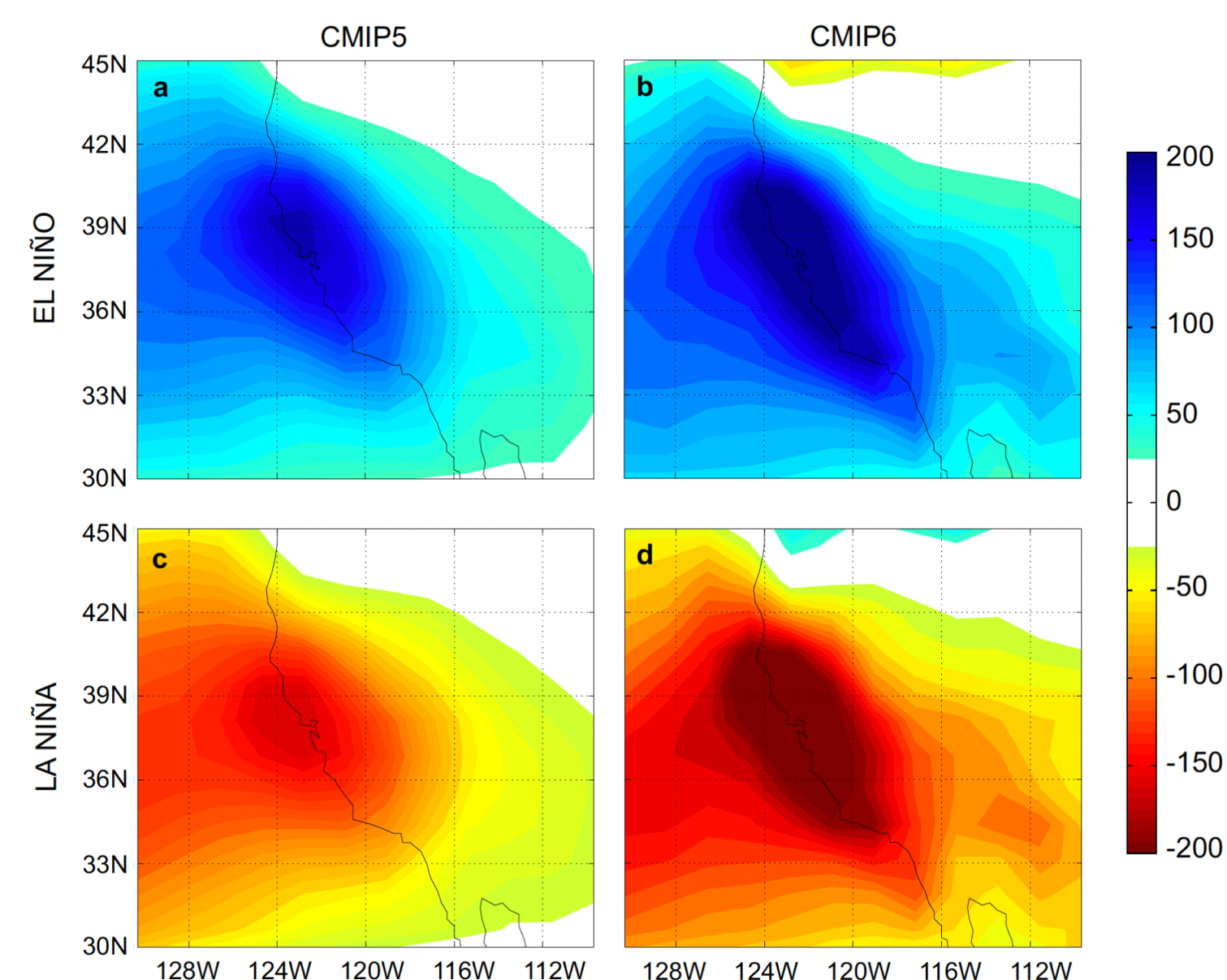


Figure 4: ENSO precipitation teleconnection for California for the end-century (2080-2099) period in CMIP5 (left) and CMIP6 (right). El Niño (a - b) and La Niña (c - d) DJF precipitation anomaly composites (the sum of all events) are calculated separately for every model and the ensemble means are shown here.



Conclusions

- The new generation of CMIP6 model simulations does not show a better agreement on the sign of future precipitation changes in California than CMIP5. In fact, the model agreement over southern California decreases as compared to CMIP5.
- The CMIP6 projections, however, suggest wetter future conditions over central and northern California, and more extreme wet and dry years in southern California.
- We find a stronger impact of ENSO on southern California precipitation in CMIP6 at the end of the century, in line with results for more extreme wet and dry winters.
- Our results have important implications for water planning and infrastructure protection in the state, as there will be a need to deal with prolonged periods of dry conditions, intercepted by some very wet seasons. In fact, this year is a prime example, when record precipitation occurred in California over the winter season, after a few years of drought conditions.

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Reference

1. Petrova, D., Tarin-Carrasco, P., Sekulic, A., Lukovic, J., Gali Reniu, M., Rodó, X., Cvijanovic, I., Future precipitation changes in California: comparison of CMIP5 and CMIP6 intermodel spread and its drivers, *under revision in Climatic Change*.