

Greater rate of climate zone change in CMIP6 Earth System Models due to stronger warming rates

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Motivation

- Understanding the distribution of the climate zones for future climate conditions is important to attribute the effects of climate change on land ecosystems.
- Some CMIP6 models with high equilibrium climate sensitivities (ECS) simulate too **strong warming rates** that are inconsistent with the historical observations.
- Nevertheless, state-dependent cloud feedbacks might increase the likelihood of facing a **high sensitivity** climate state.
- Therefore, we analyze both the plausible and less-plausible ensemble subsets of CMIP6 for the future climate zone distributions and compare them with the expectations based on the models in CMIP5.

Methods

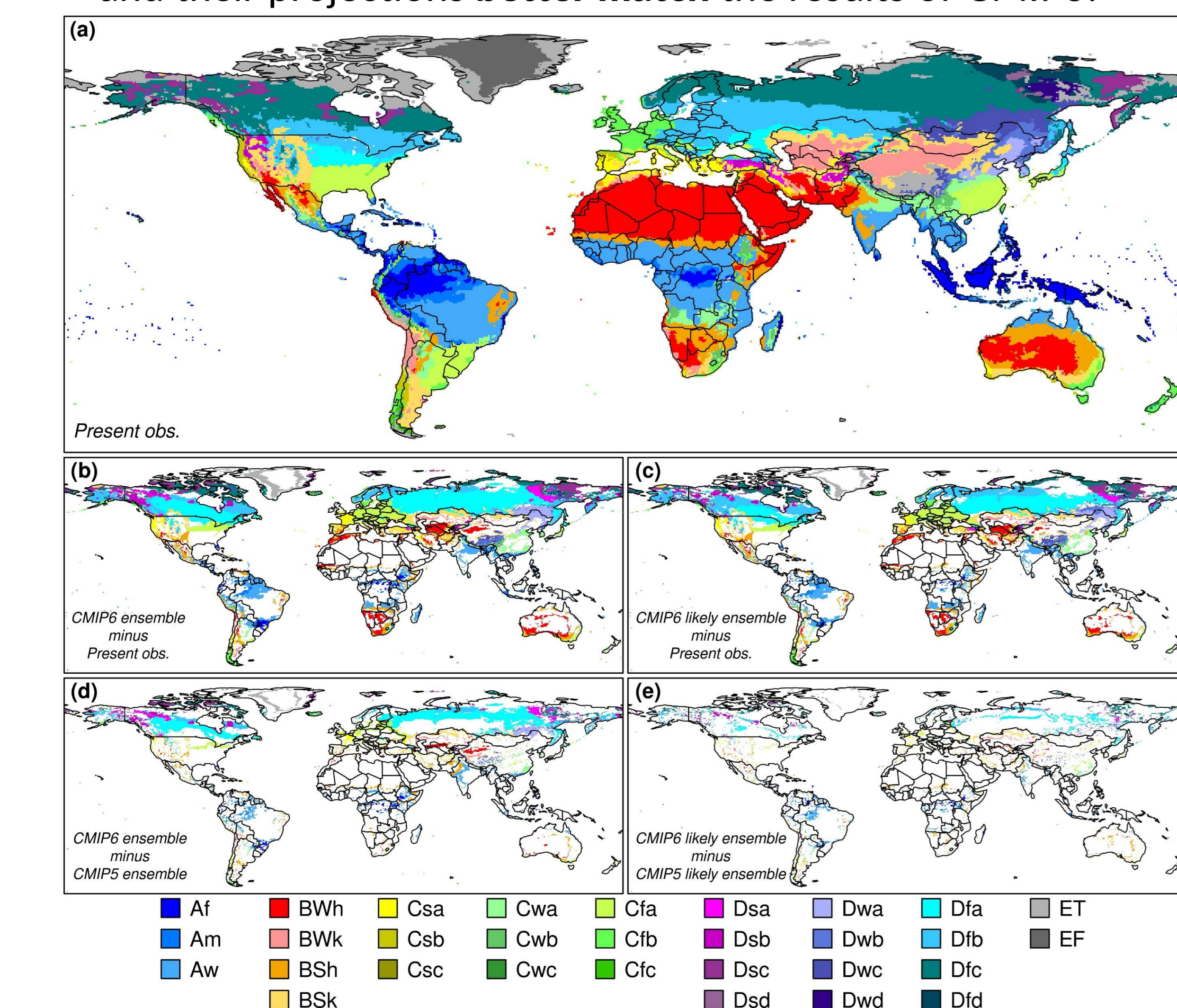
- Köppen-Geiger climate classification has been used as a tool to obtain the climate zone distributions.
- CRU temperature and GPCP precipitation data sets have been used as observational references.
- Two different climate model ensemble subsets have been created for CMIP5 (RCP 8.5) and CMIP6 (SSP 5-8.5).

Ensemble Name	Number of Models Included	Method
CMIP5 ensemble	25	Based on historical performance
CMIP6 ensemble	25	Based on historical performance
CMIP5 likely ensemble	16	Based on ECS (models whose ECS lie in the likely range of 2.5-4 °C)
CMIP6 likely ensemble	11	Based on ECS (models whose ECS lie in the likely range of 2.5-4 °C)

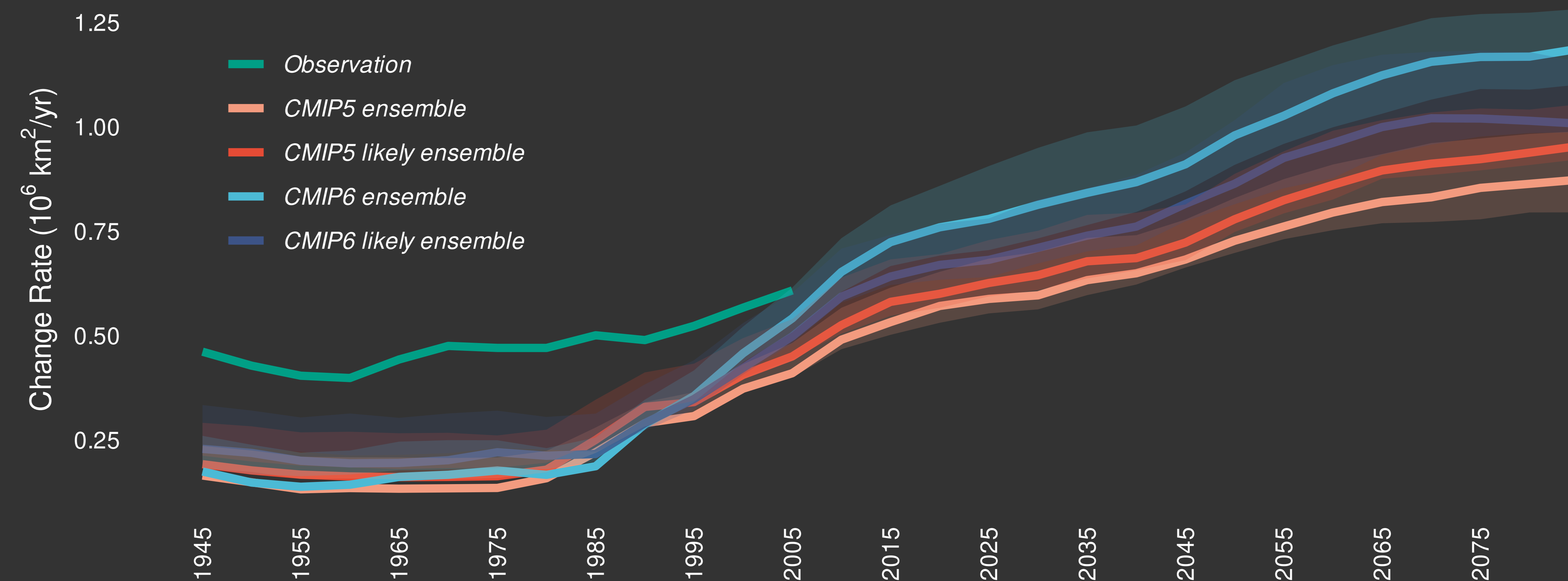
- Change rate** is the total land area undergoing climate zone change per year, between two consecutive 30-year time periods.

Results

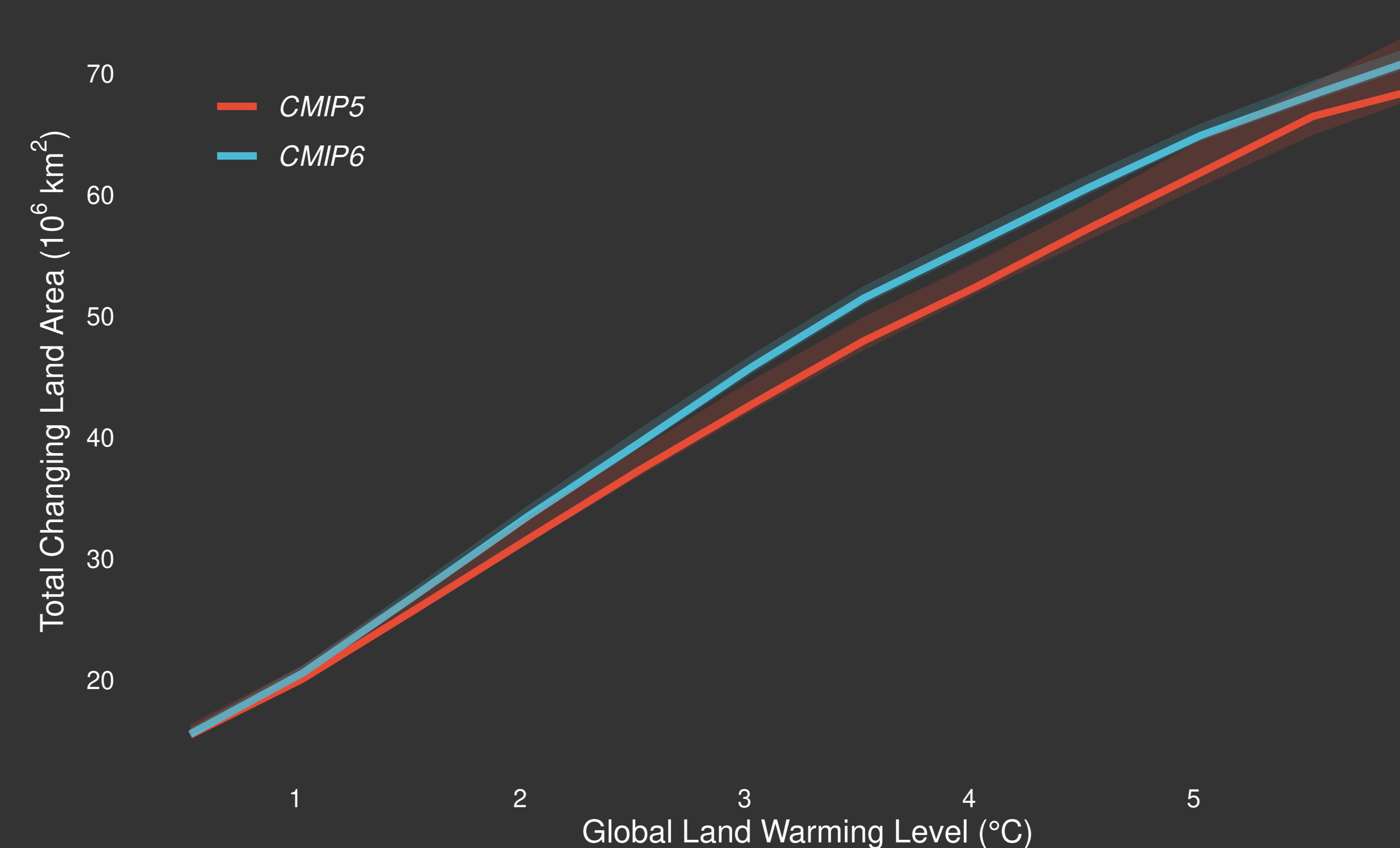
- Using a **likely ECS subset** of CMIP6 models that is consistent with the latest evidence **constrains** the shifts in climate zones, and their projections **better match** the results of CMIP5.



CMIP6 models project greater acceleration of climate zone change than CMIP5 during the 21st century...

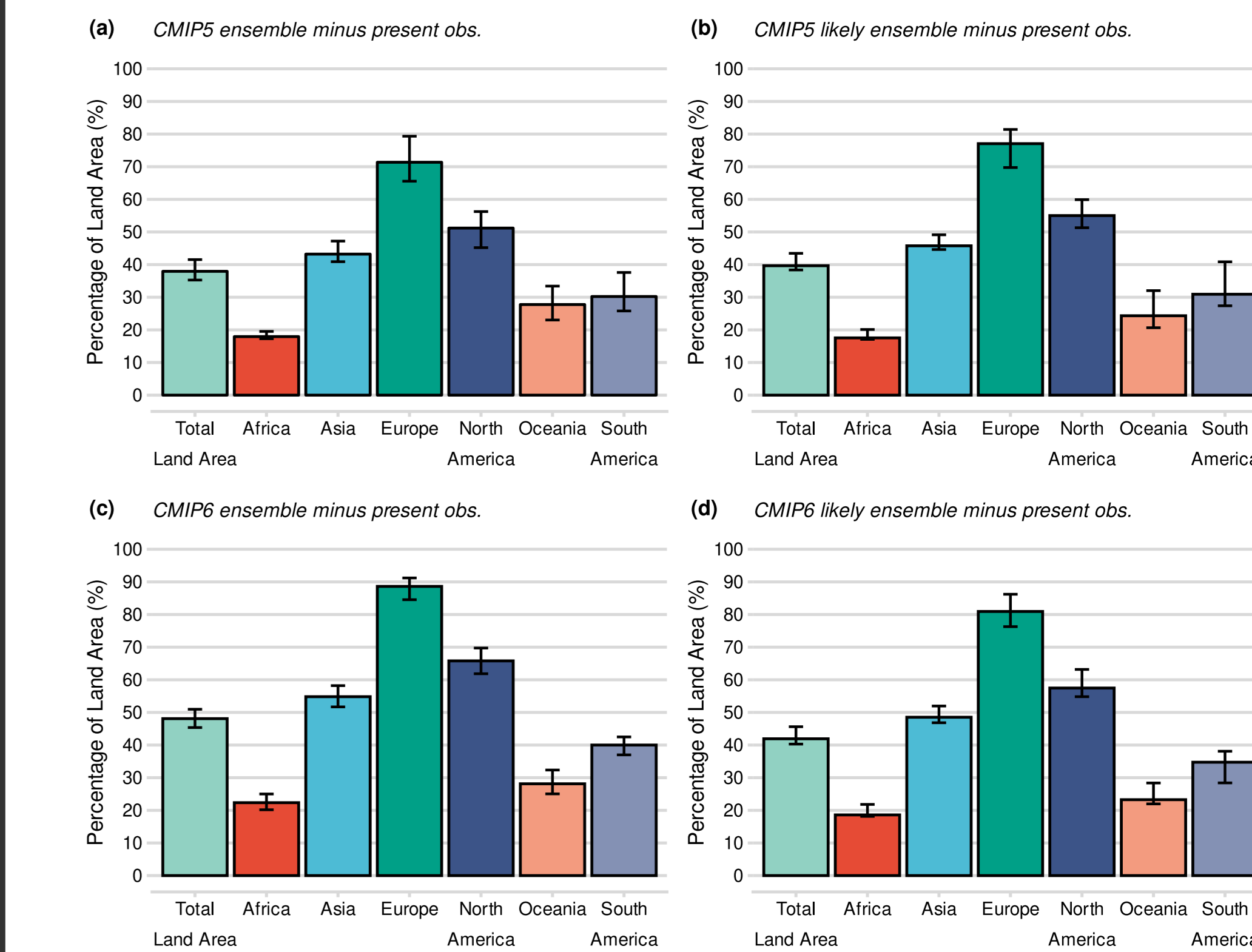


... but that is mainly attributable to their stronger warming rates, whose plausibilities are a matter of debate



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- 38-48%** of the **global** land area is projected to be in a **different** climate zone by the end of the century. **Europe** and **North America** are projected to have changes **above** the global average.



- Independent of the ensemble subset that is used, **tropical (A)** and **arid (B)** climate zones are projected to **expand**, while **cold (D)** and **polar (E)** climate zones are projected to **shrink**.

