

Introduction

- It is important to understand how the emissions of different regions, sectors, or climate forcers play a role on pathways toward the Paris Agreement temperature targets.
- There are however **methodological challenges** for attributing individual contributions due to **complexities associated with a variety of climate forcers** affecting the climate system on different spatial and temporal scales.
- We use the **latest historical and future emissions data** for a comprehensive set of climate forcers as well as land-use datasets and apply the **normalized marginal approach** to quantify the forcing contributions of regions, sectors and forcing agents toward the 2 °C and 1.5 °C targets.

Method

- Normalized marginal method** (Li et al., 2016)

$$F_{f,r,s,e} = \frac{F_{f,r,s,e}^{all} - F_{f,r,s,e}^{\epsilon}}{\sum_{r,s,e} (F_{f,r,s,e}^{all} - F_{f,r,s,e}^{\epsilon})} F_{f,r,s,e}^{all}$$

- The subscripts denote scenario (*f*)-, region (*r*)-, sector (*s*)- and emission (*e*)-specific forcing agent.
- $F_{f,r,s,e}$ indicates the marginal effect of the forcing agent, $F_{f,r,s,e}^{all}$ shows the forcing agent with global emissions as input while $F_{f,r,s,e}^{\epsilon}$ means the forcing agent with the global emissions after subtracting $E_{f,r,s,e} \cdot \epsilon$, $\epsilon=0.001$, as input.

- Climate-related uncertainties:**

Results

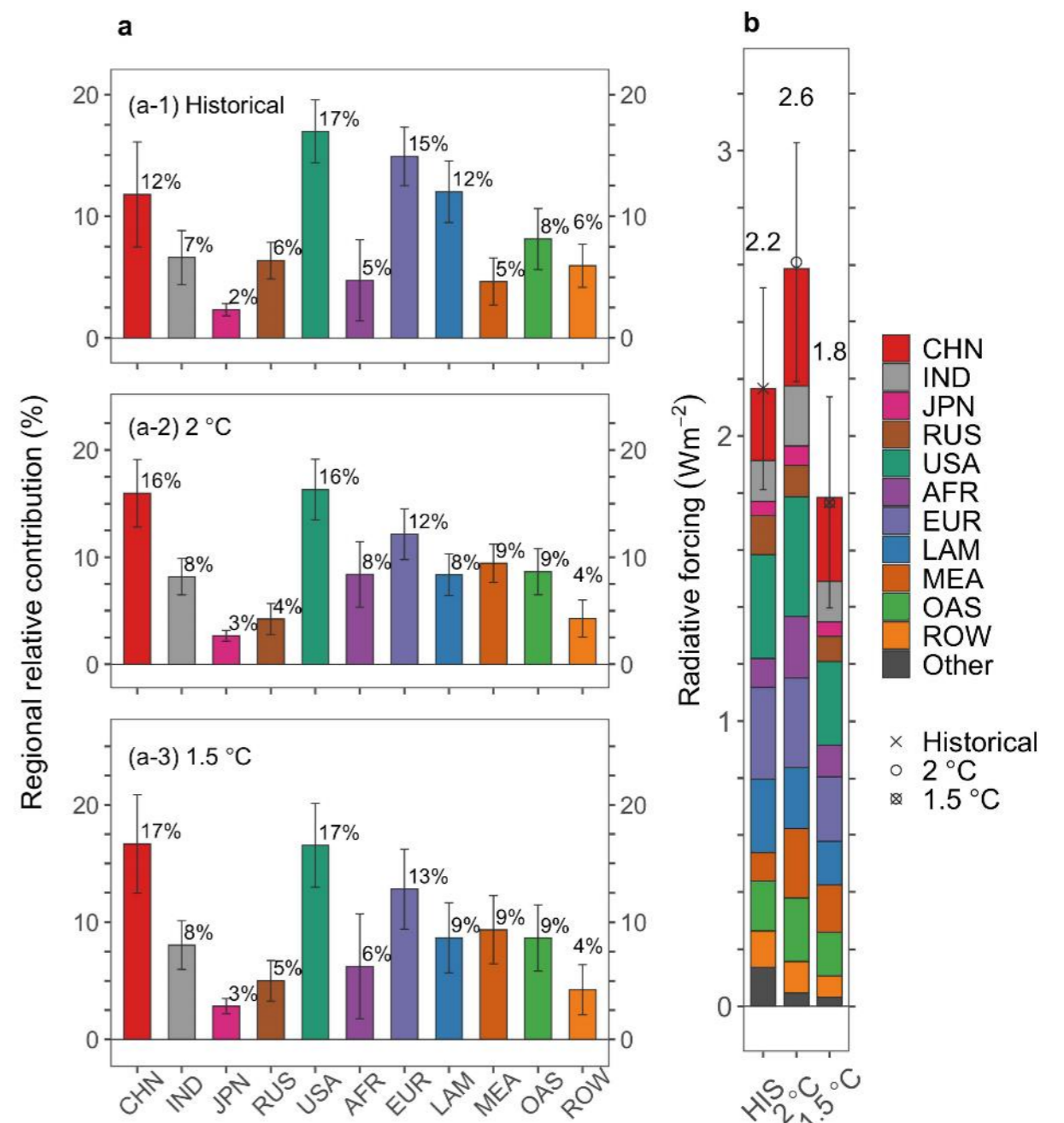


Figure 2: Regional forcing contributions to climate change.

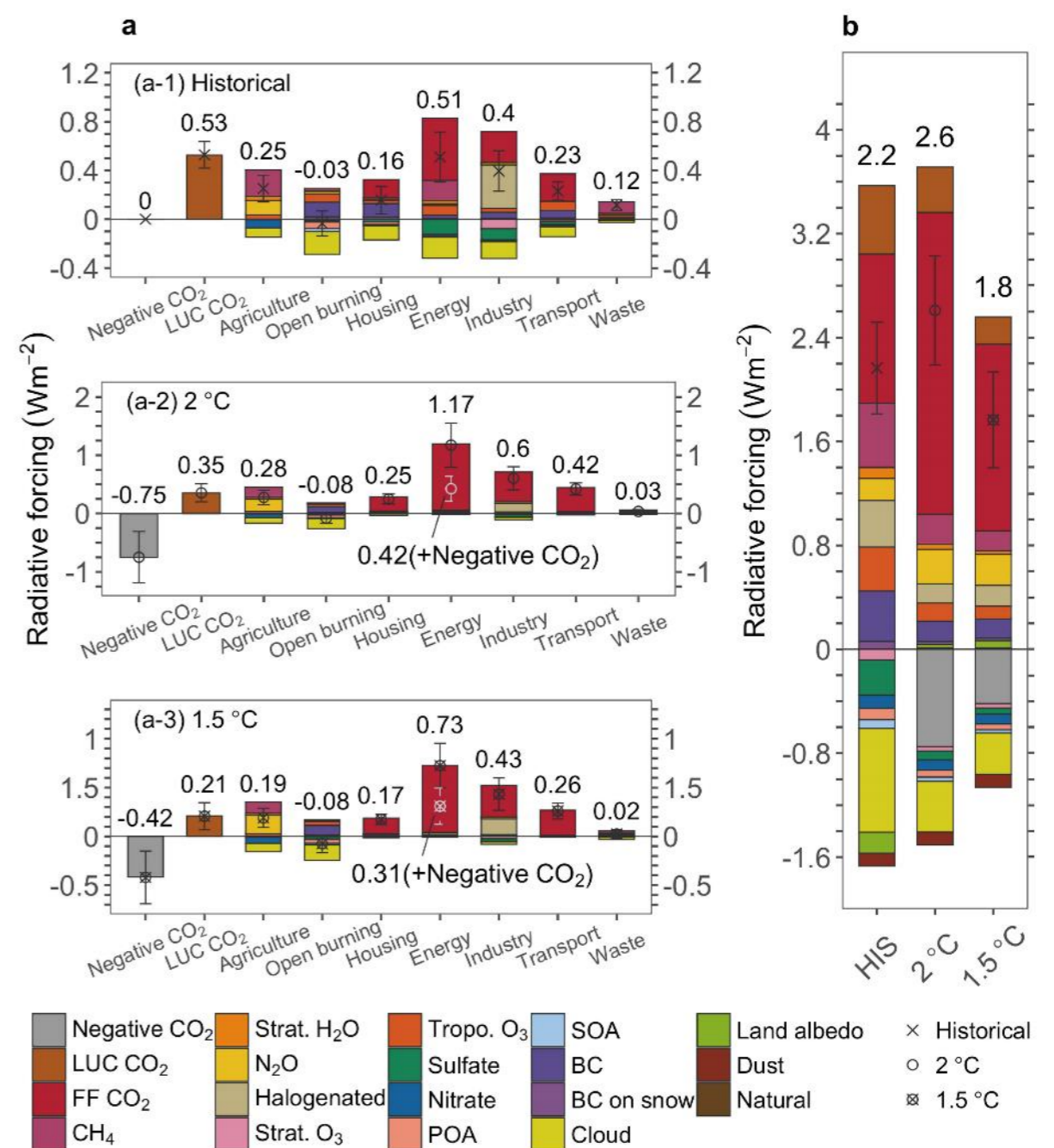


Figure 3: Sectoral contributions by individual forcing agents.

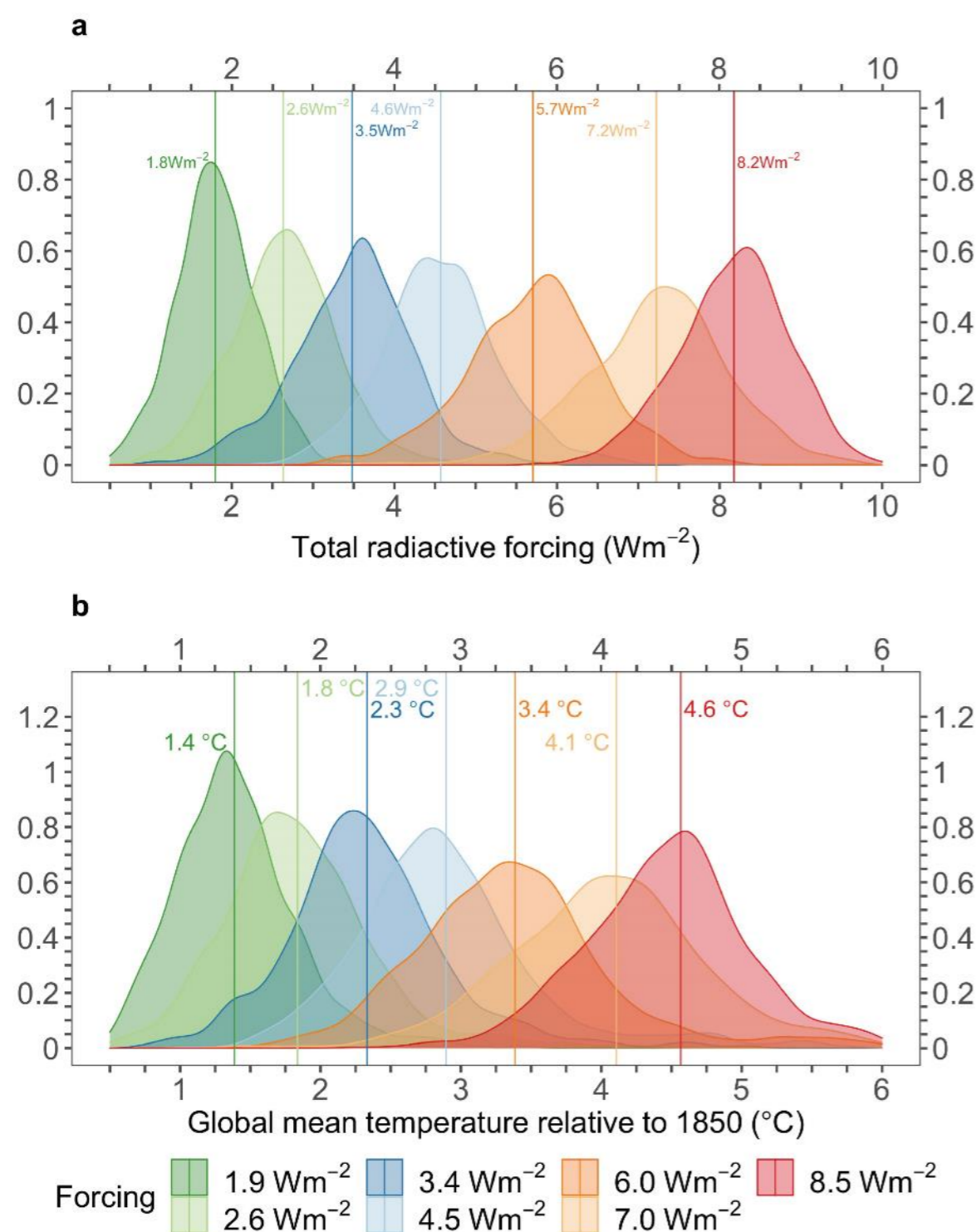


Figure 1: Probability distributions of the total radiative forcing and global mean temperature, generated by SCM4OPT v2.0.

Conclusions

- We show that most of the worldwide regions and sectors need to maintain forcing levels not higher than present levels to attain the 1.5 °C target of the Paris Agreement, while slightly higher future forcing levels than present levels are allowed for the 2 °C target.
- Our results also illustrate the importance of negative CO₂ emissions, which contribute -0.75 ± 0.44 Wm⁻² and -0.42 ± 0.27 Wm⁻² to the 2 °C and 1.5 °C targets.