

Background: Dronning Maud Land coast, sea-ice free in Austral summer

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# **Intensifying Antarctic hydrological cycle in a warming climate**

*a study with CESM*

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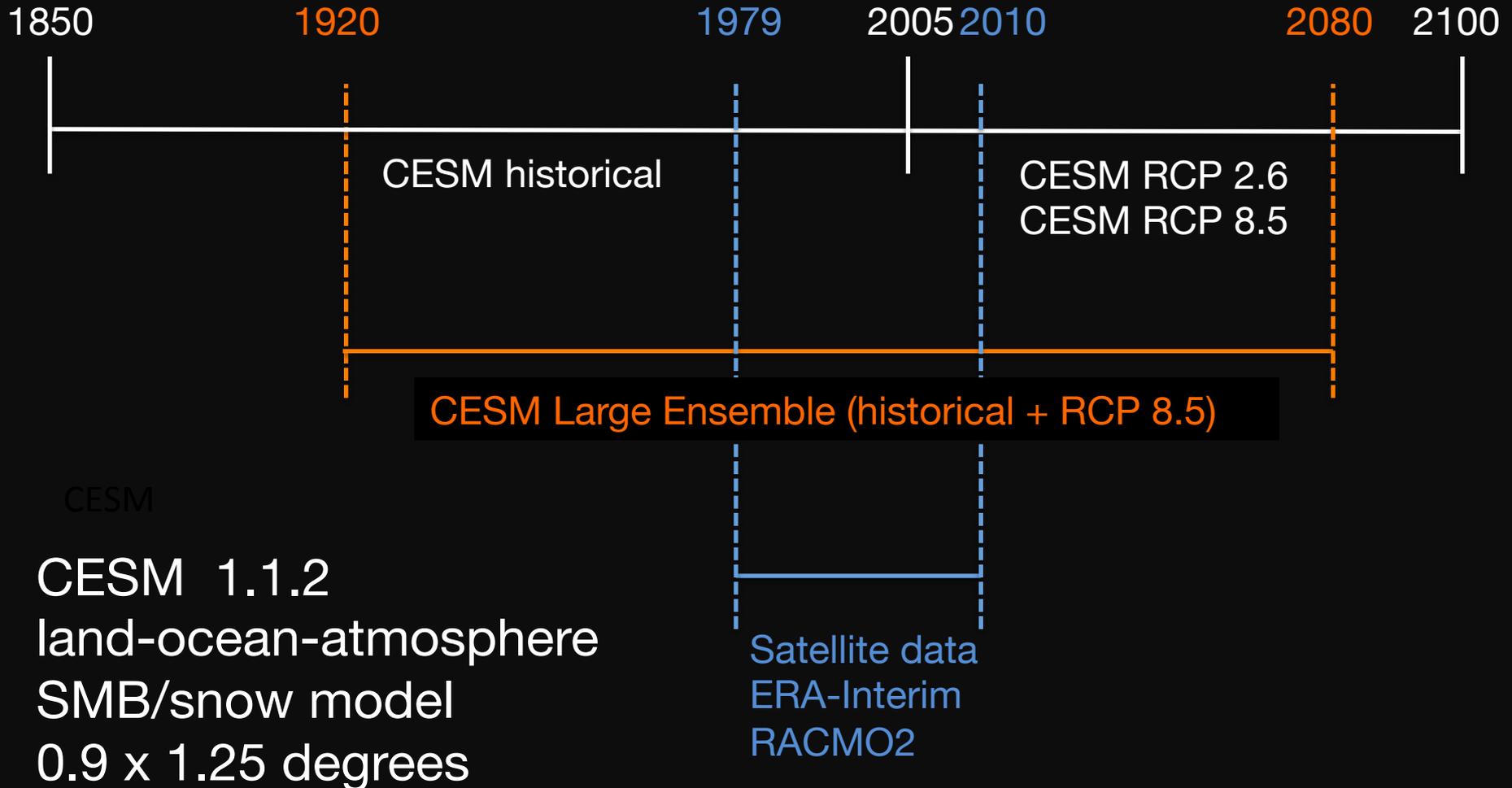
Universiteit Utrecht



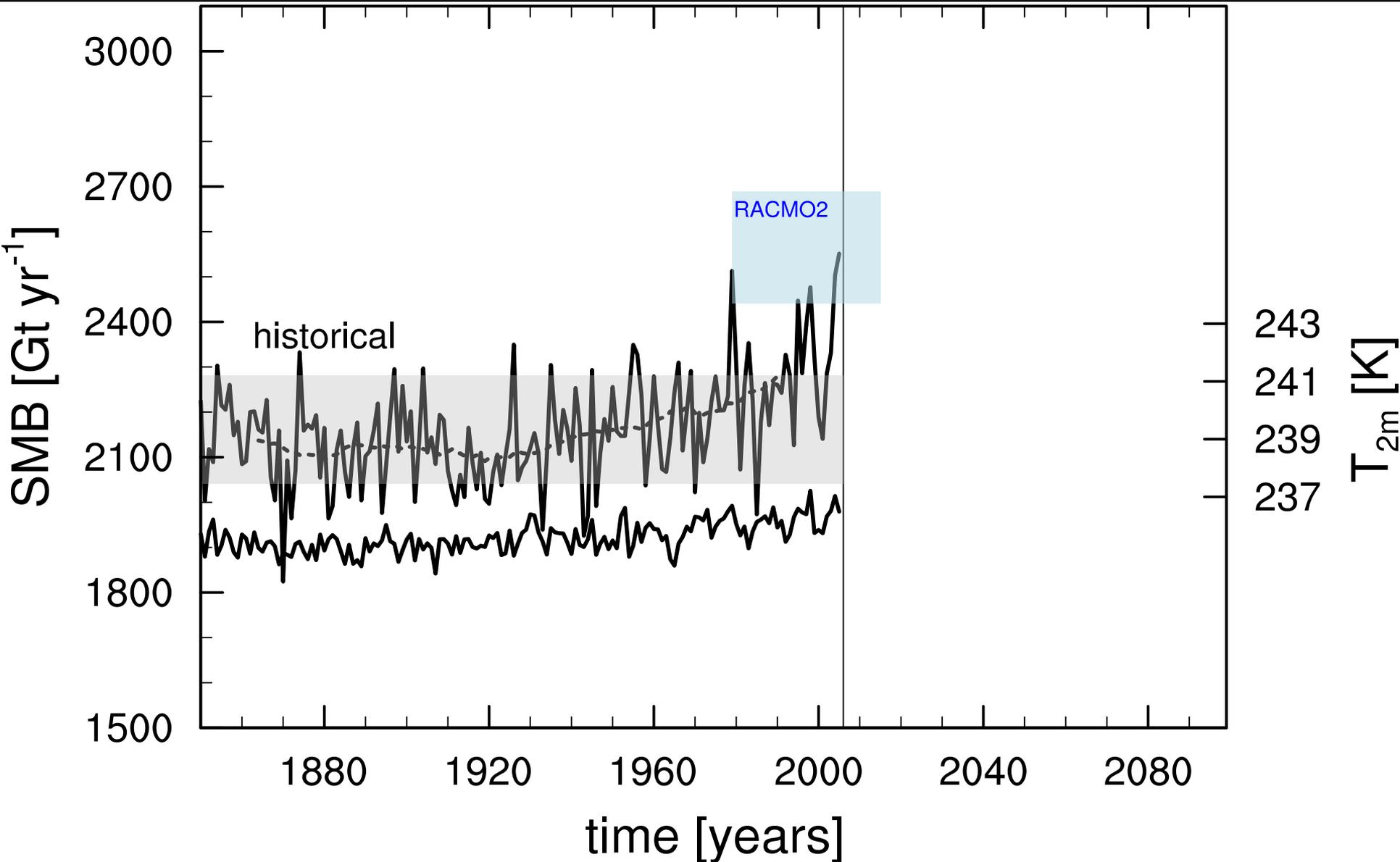
# Introduction

- CESM is ESM with multi-layered snow model, vital for ice sheet SMB studies (Vizcaino et al., 2013)
- Enable studies of interaction of ice sheets with other components of climate system
- Antarctica is relatively poorly studied compared to Arctic/Greenland
- Challenging for models: ice shelves (ice – ocean), recent sea-ice trends, very few observations

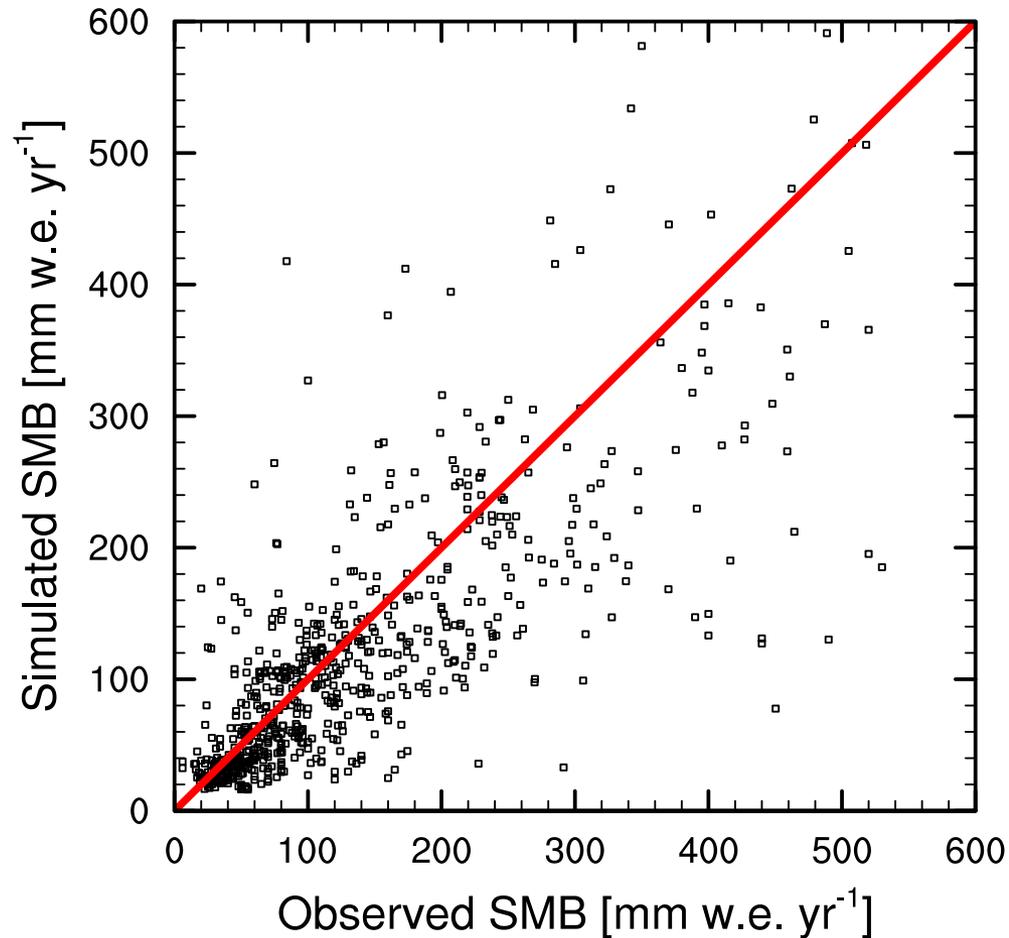
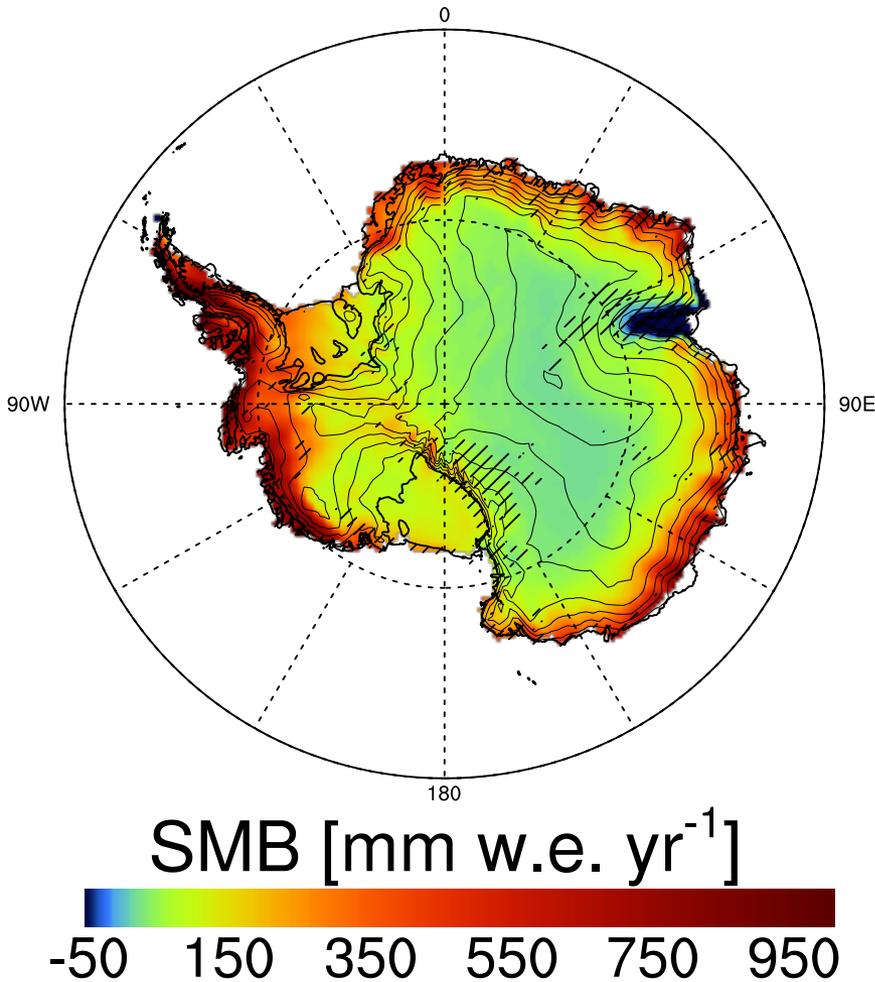
# Tools



# SMB – time evolution



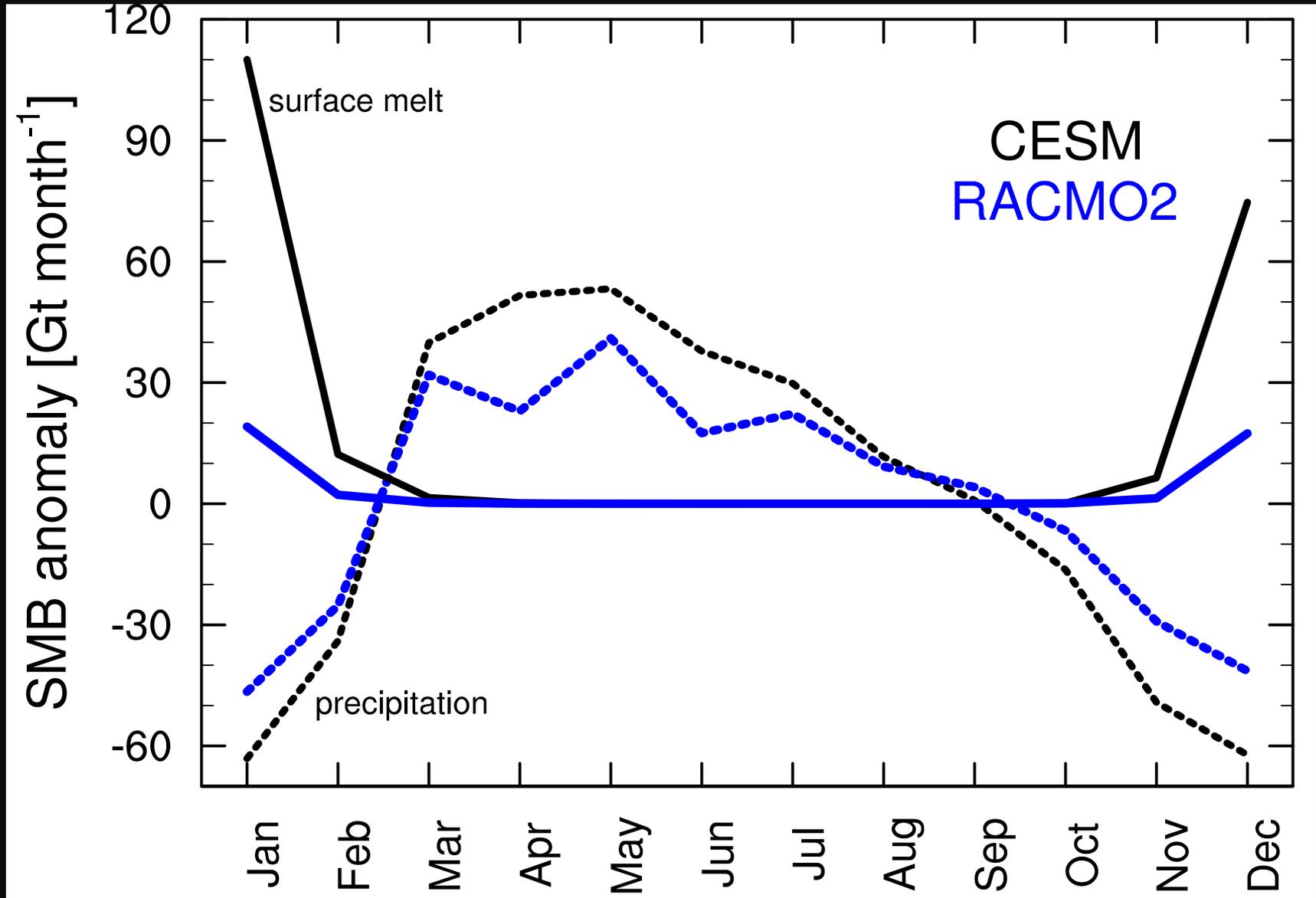
# SMB – spatial field



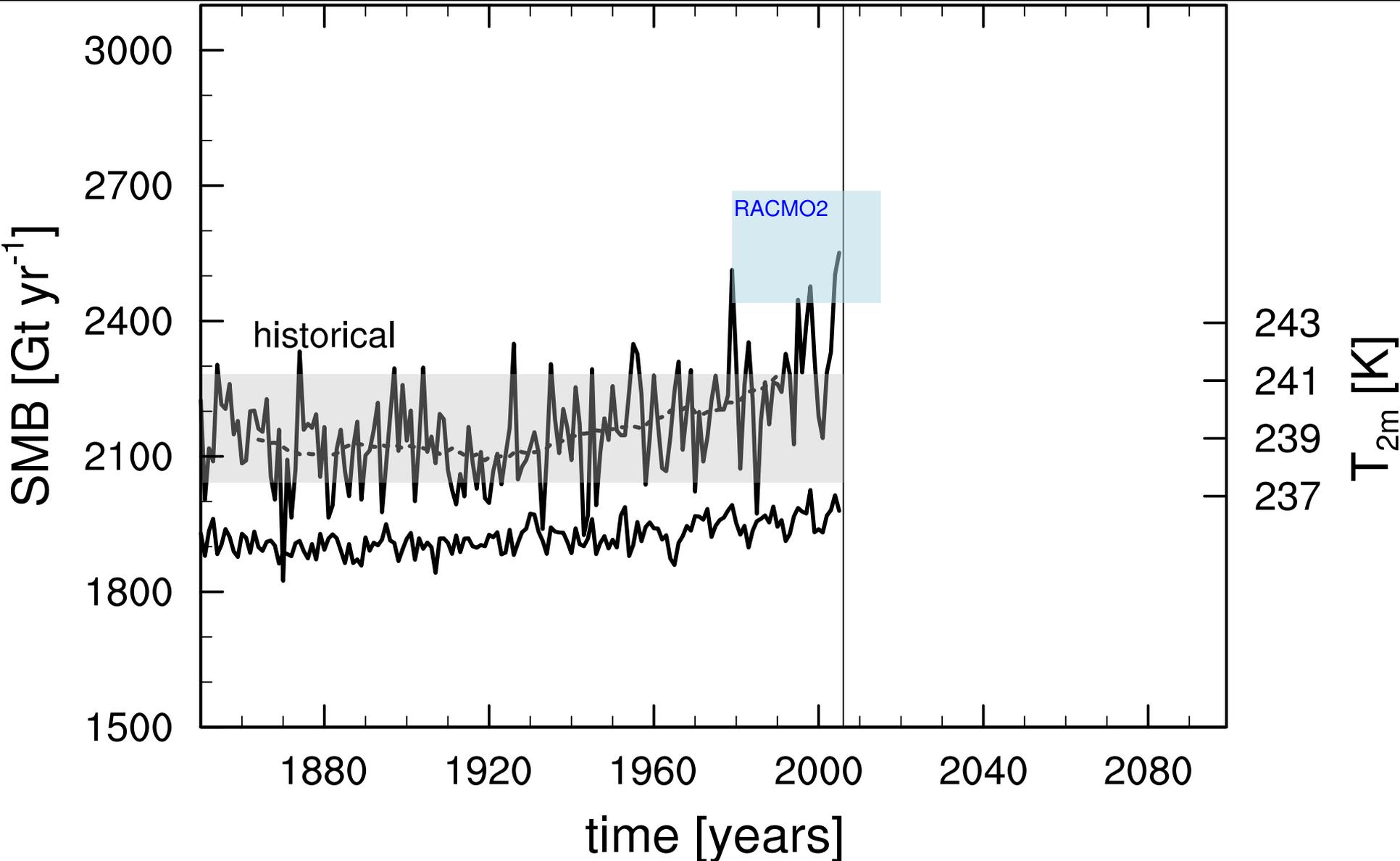
*Dashed: >50% different from RACMO2*

*Observations: Favier et al. (2013, updated)*

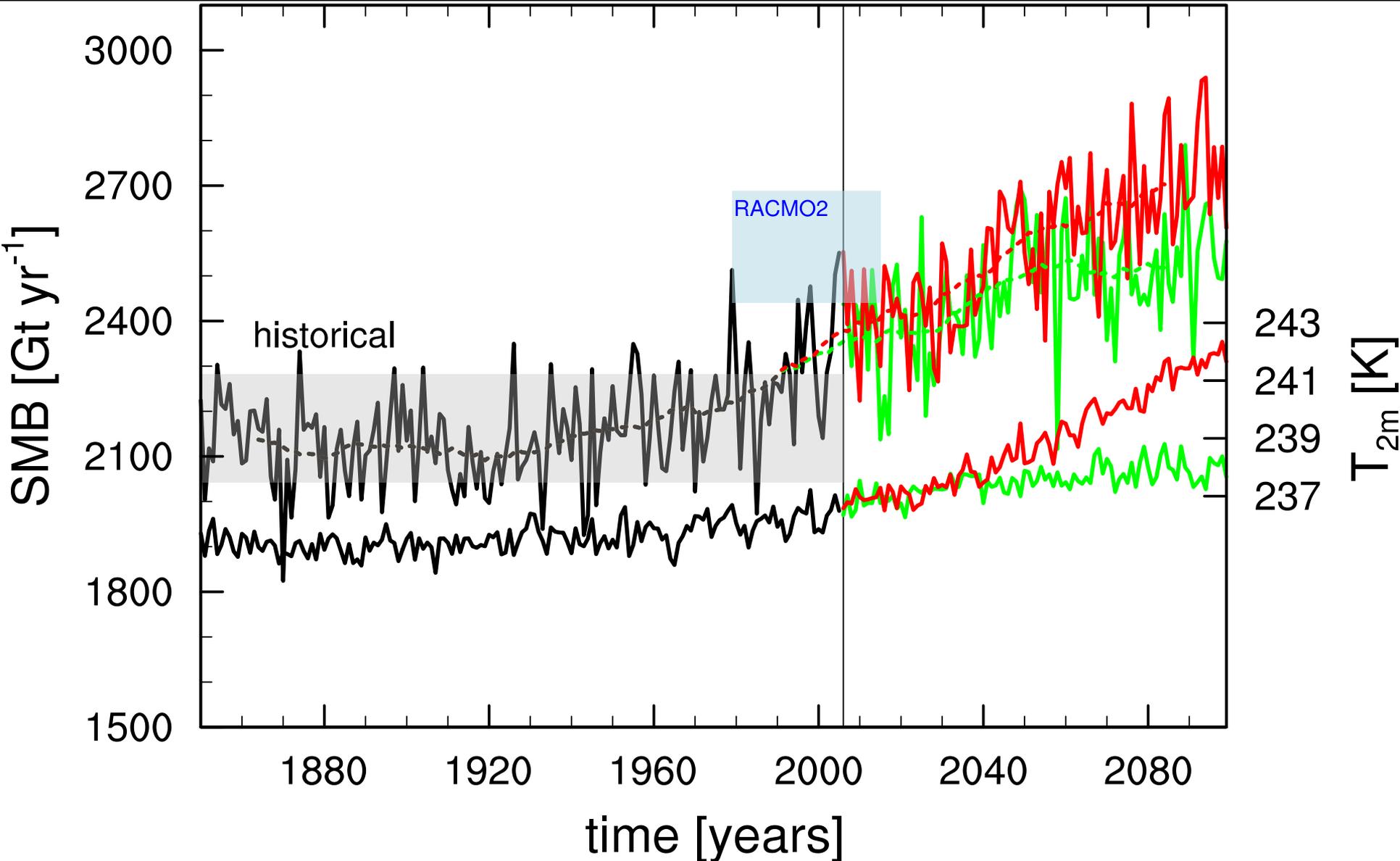
# SMB – seasonal cycle



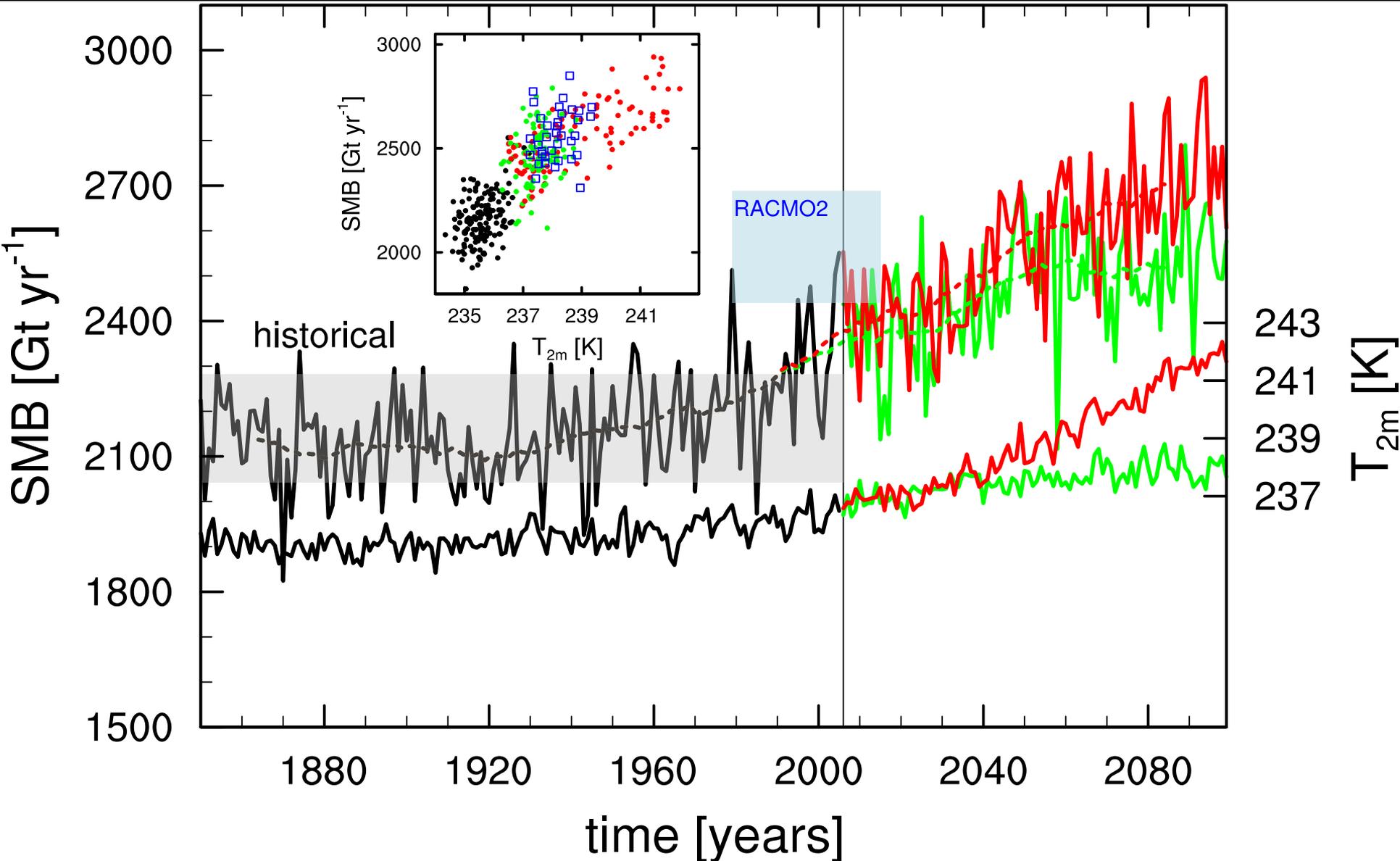
# Future SMB (I)



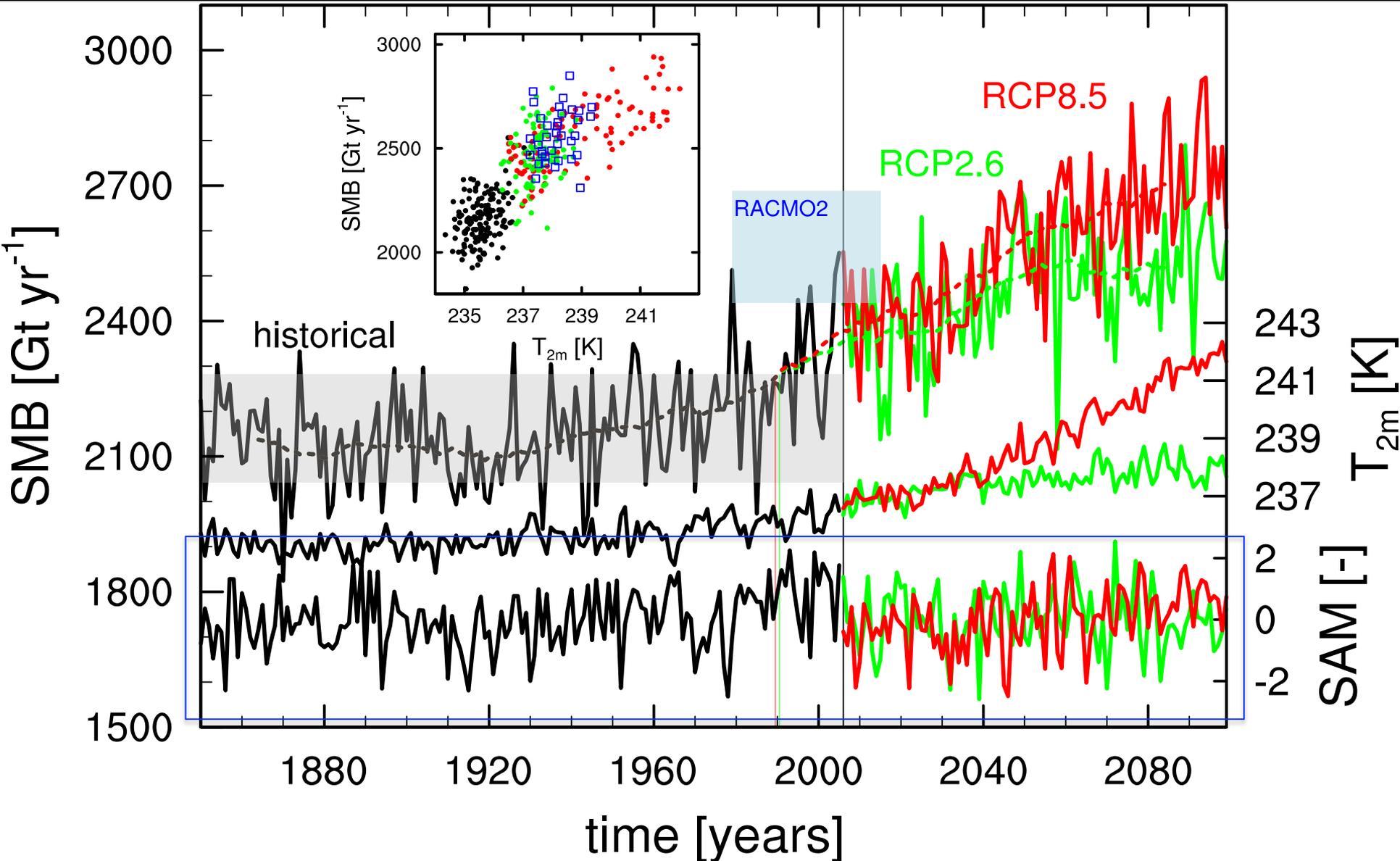
# Future SMB (II)



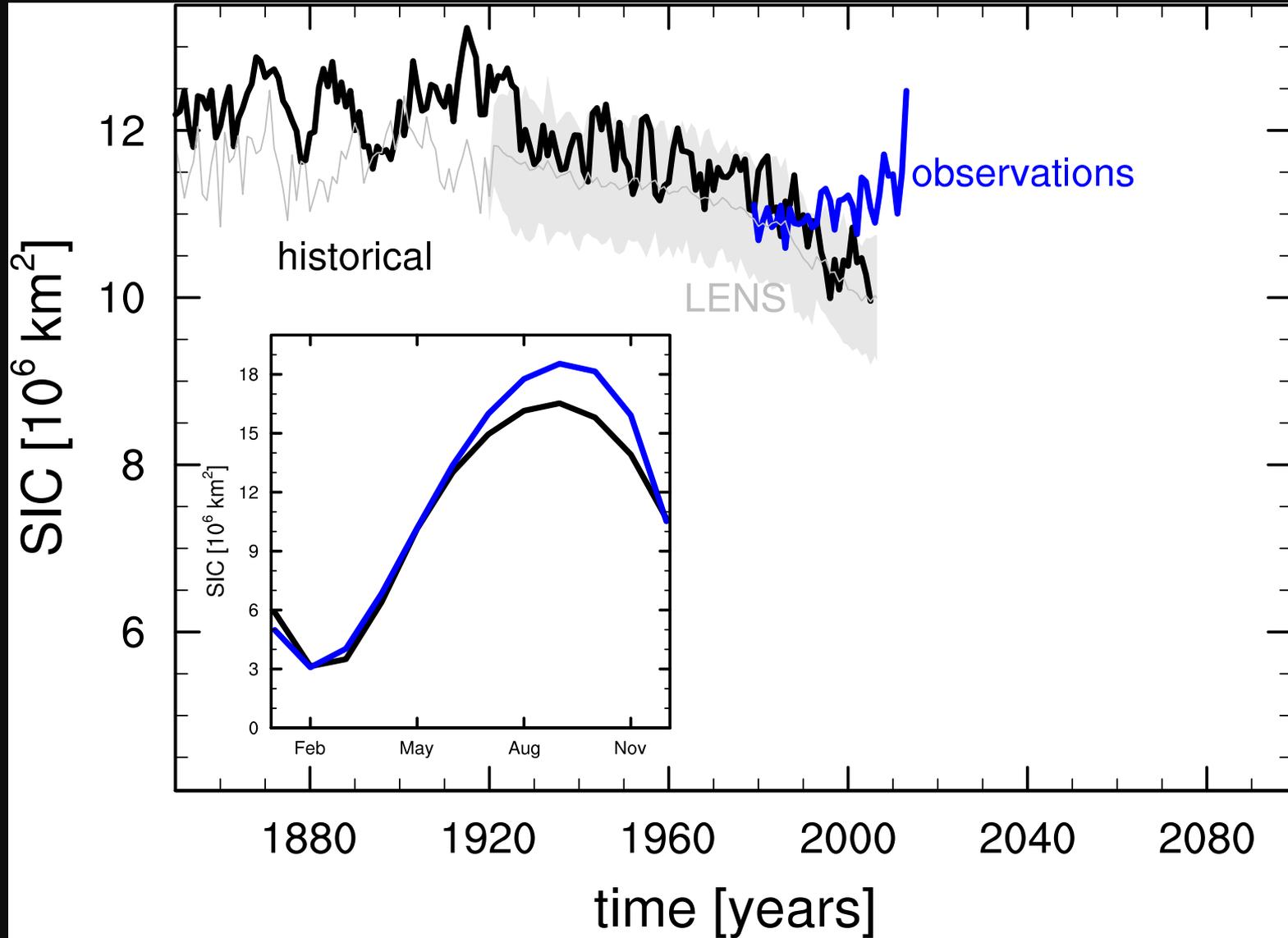
# Future SMB (III)



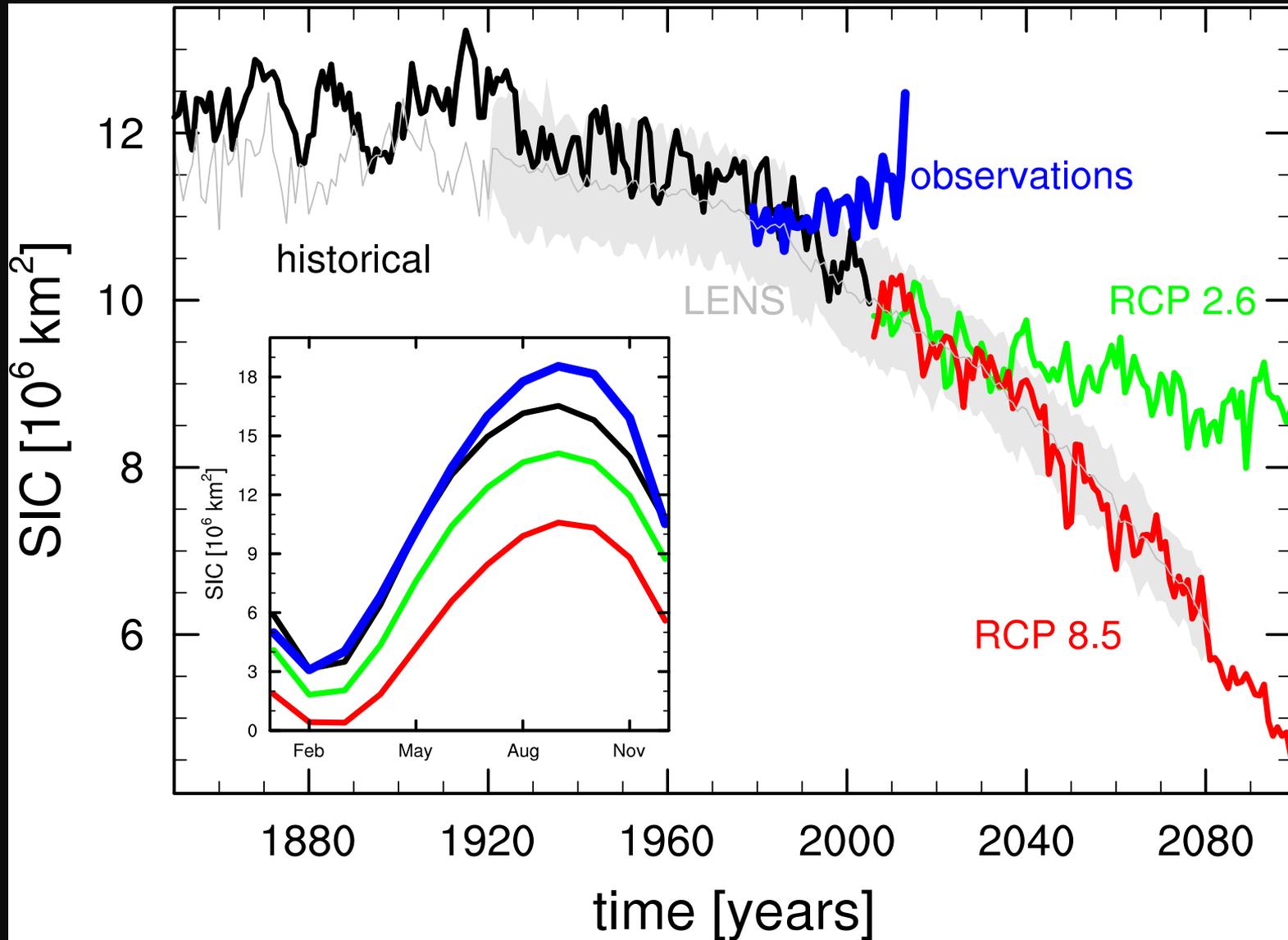
# What drives SMB increase?



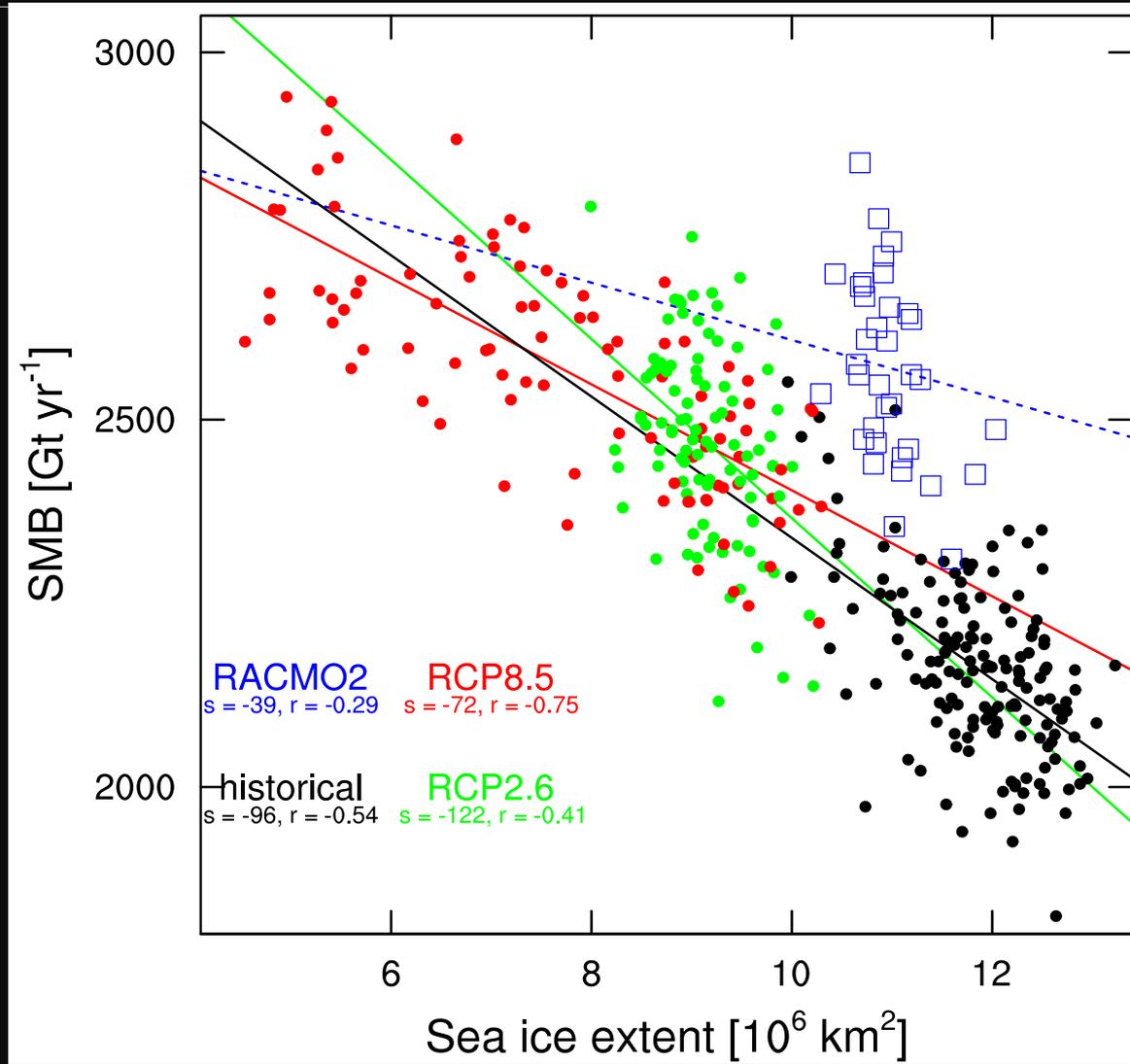
# Future sea ice (I)



# Future sea ice (II)

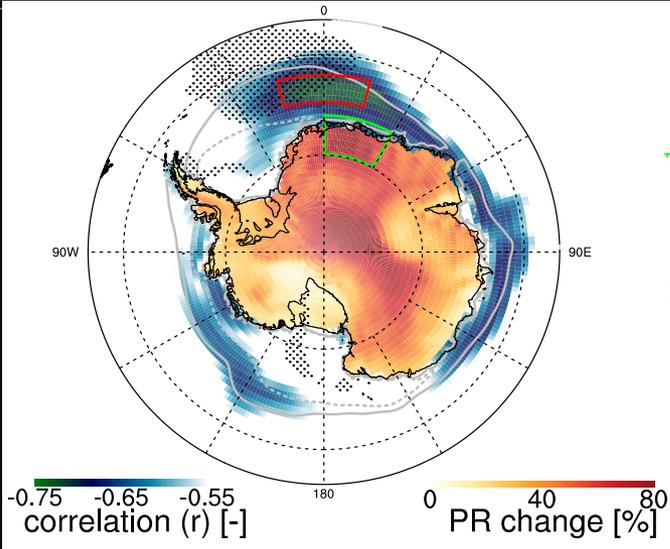


# Sea ice vs. SMB (I)

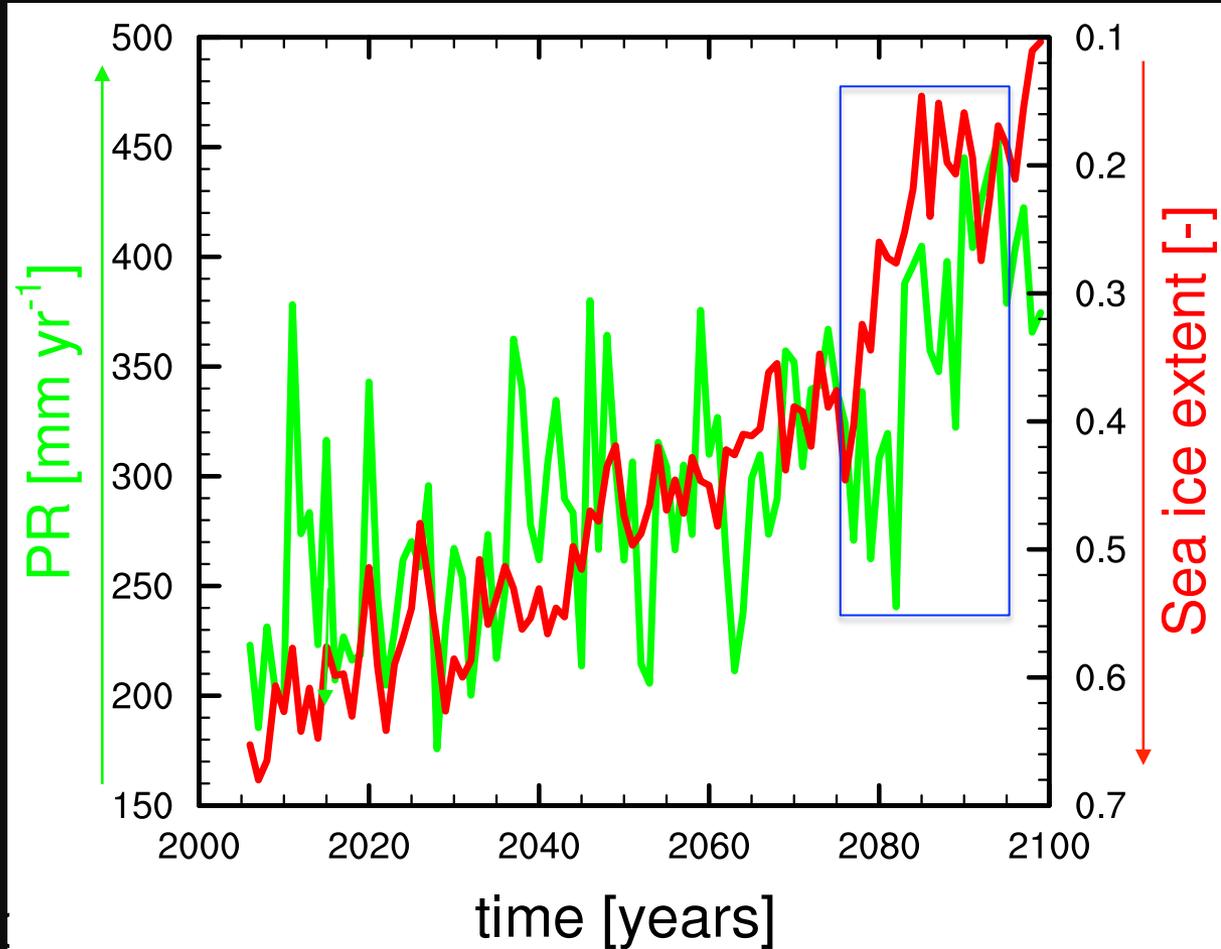


Highly correlated, on continental scale...

# Sea ice vs. SMB (II)

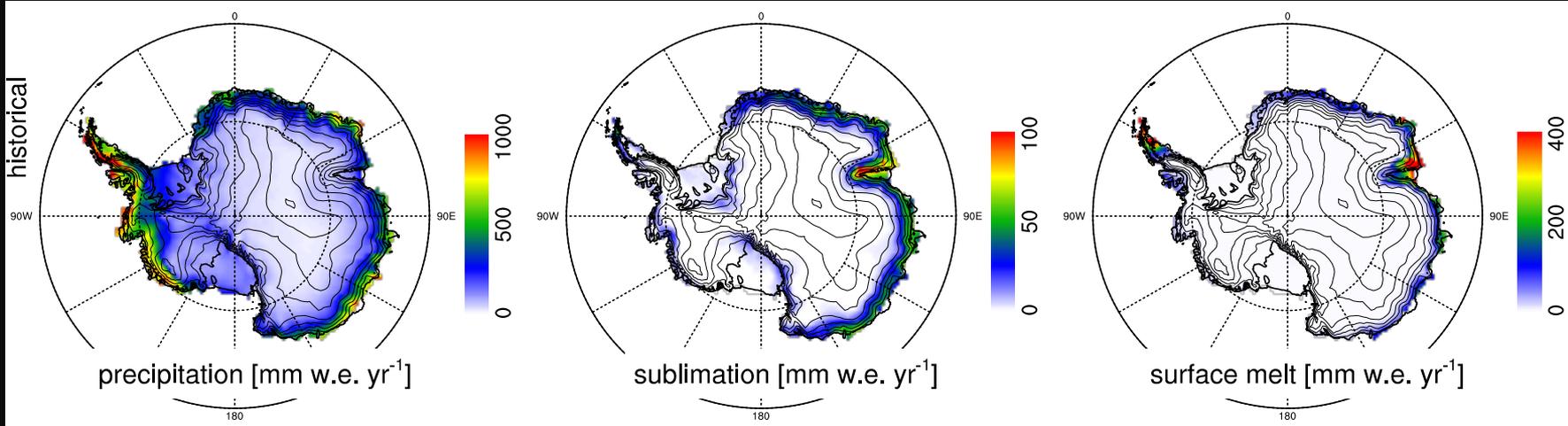


...as well  
as on  
regional  
scale.



# SMB components (I)

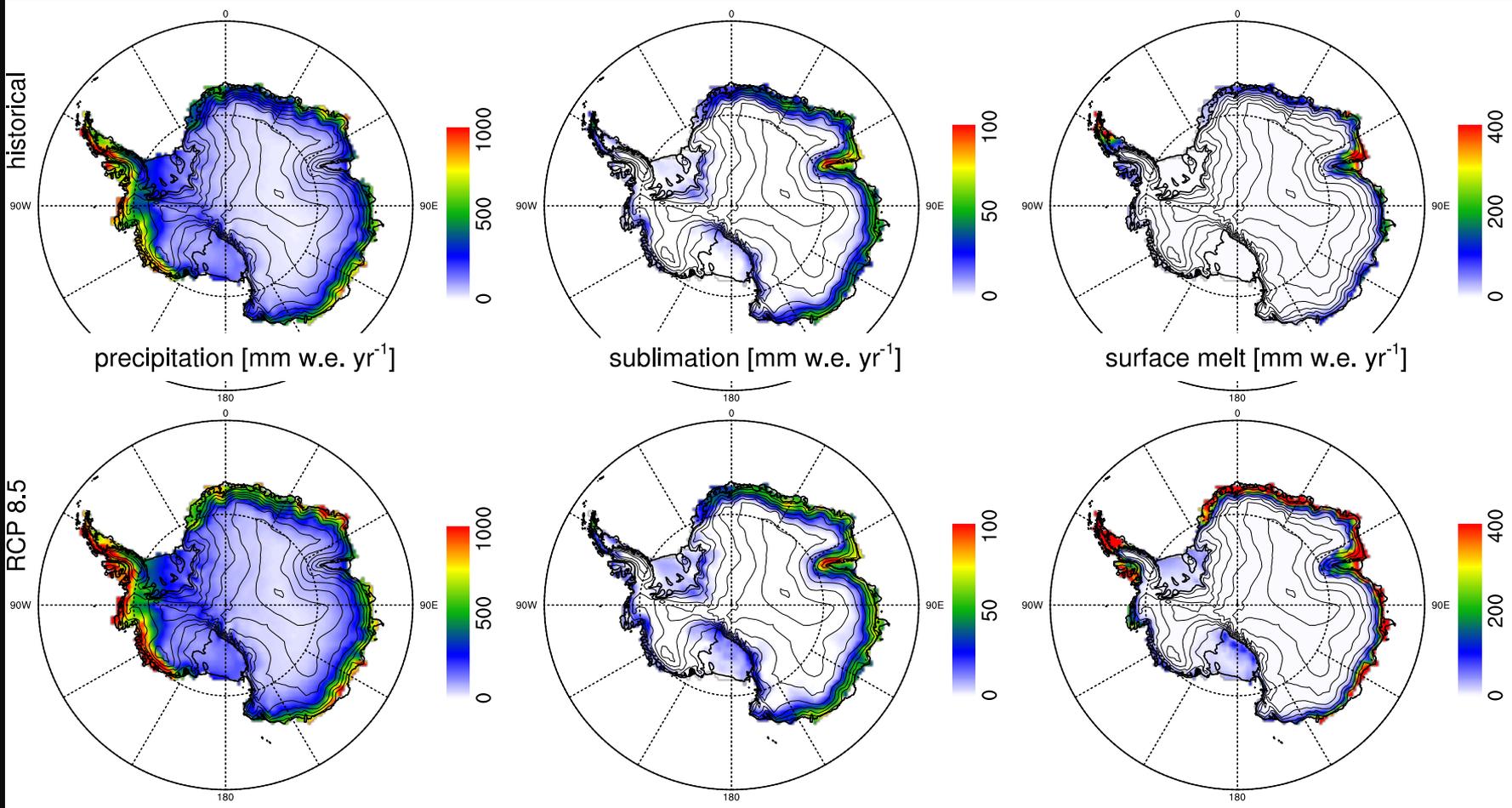
historical



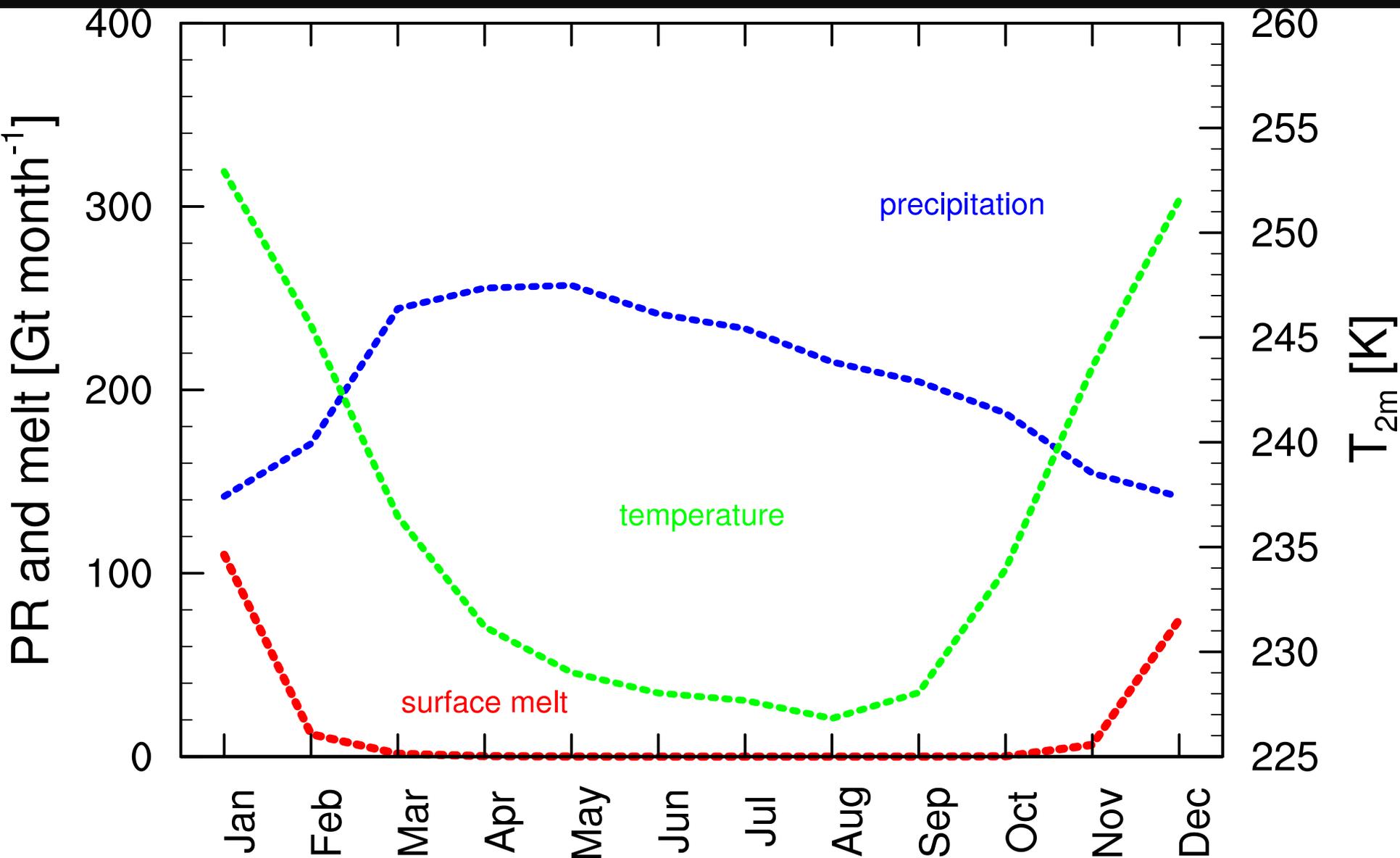
RCP 8.5

# SMB components (II)

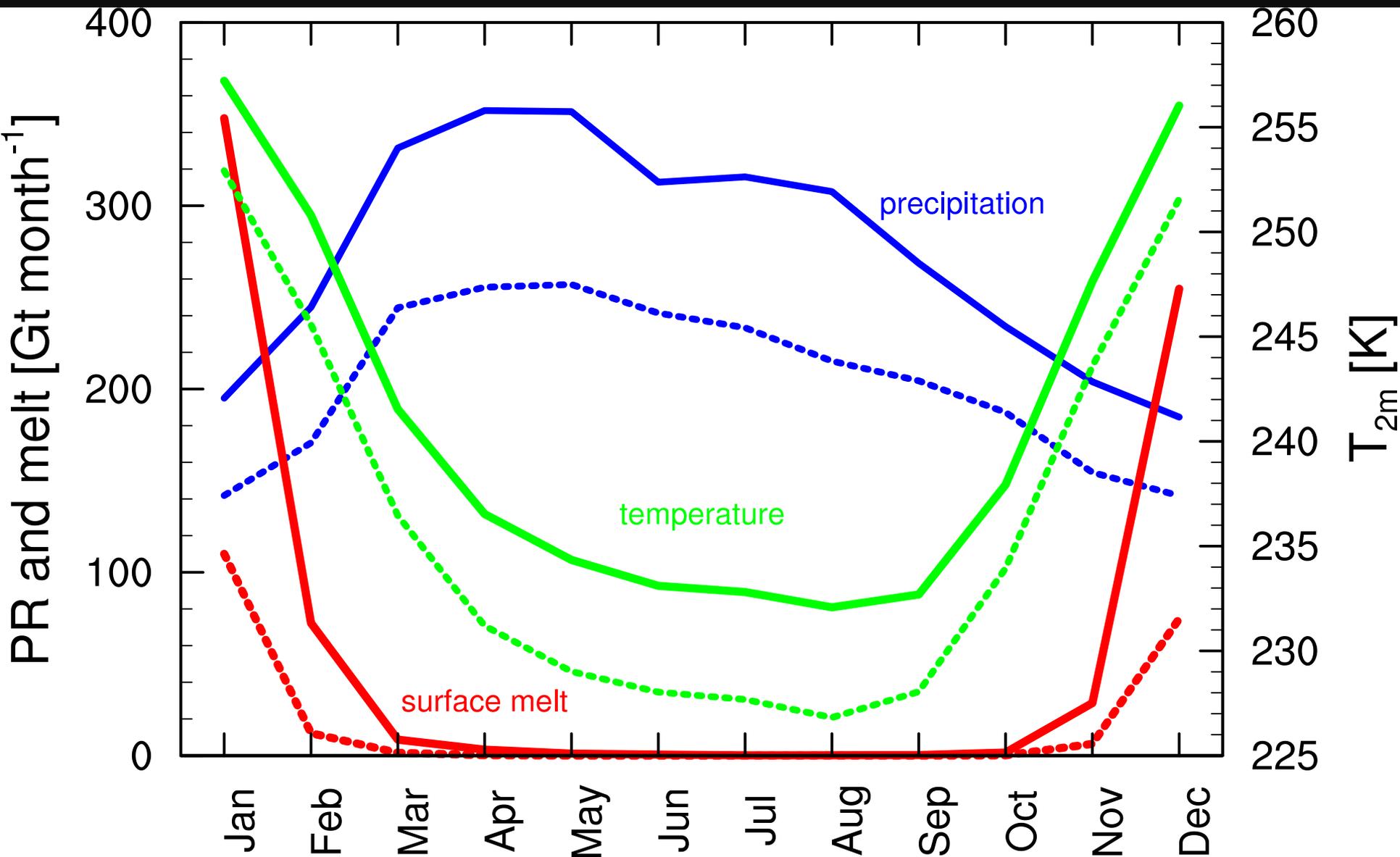
historical



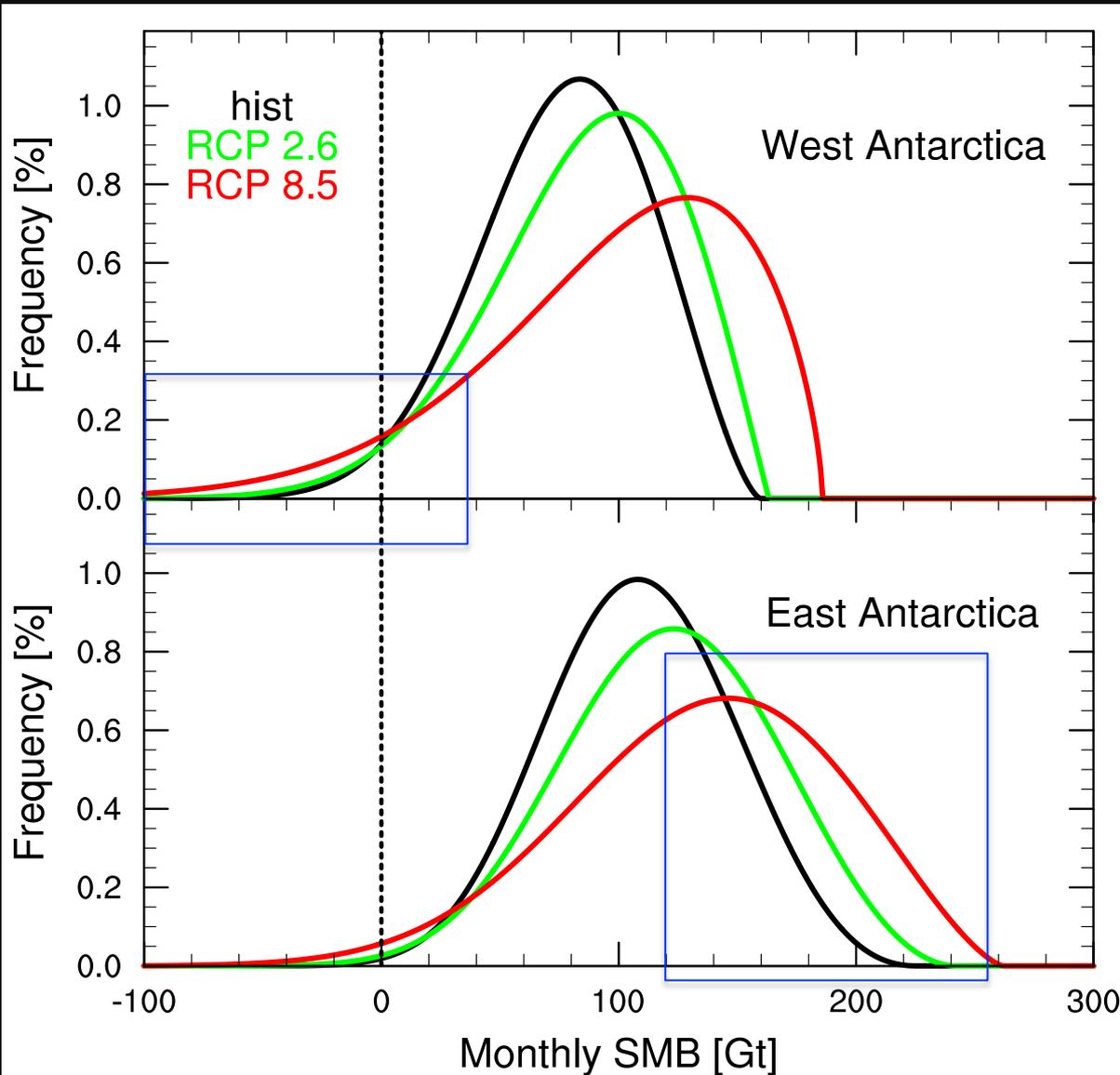
# Hydrological cycle (I)



# Hydrological cycle (II)



# Extreme value analysis



**Heavy left tail**

**Warming -> melt & runoff**

**Heavy right tail**

**Warming -> snowfall**

# Conclusions

- CESM is well able to represent large-scale atmospheric circulation, near-surface climate and SMB of Antarctica
- Sea-ice trends problematic, especially because sea ice and SMB are tightly coupled
- Higher SMB in future ( $\sim 70$  Gt/K), and enhanced seasonal variability – more runoff & snowfall (*disclaimer: snow model*)
- Equivalent sea level fall: 50-75 mm in 2100