

# Surface mass balance of the Greenland ice sheet in the new CESM model

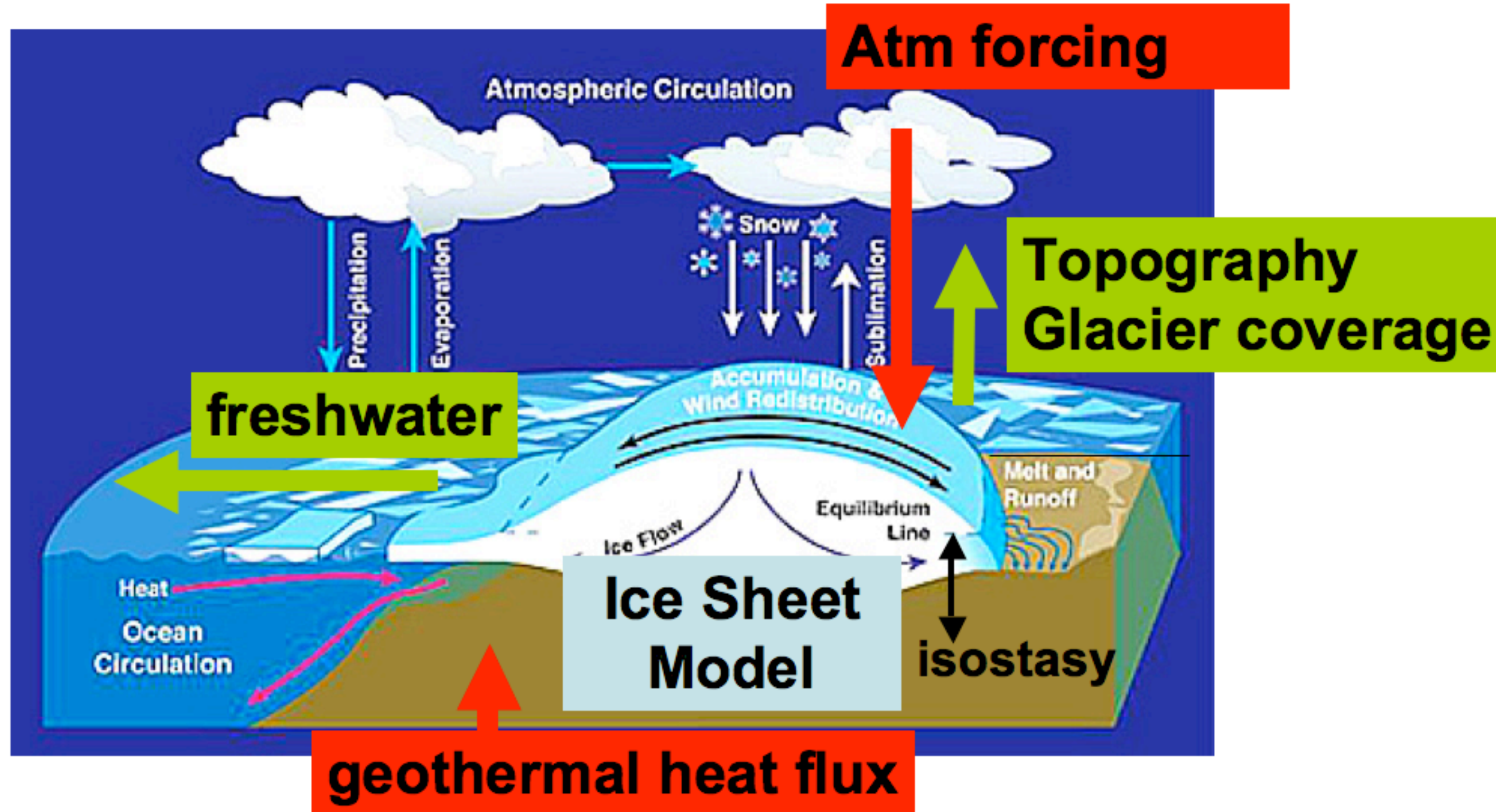
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## 1. Motivation

In development: ice sheet bi-directionally coupled to the Community Earth System Model (CESM)



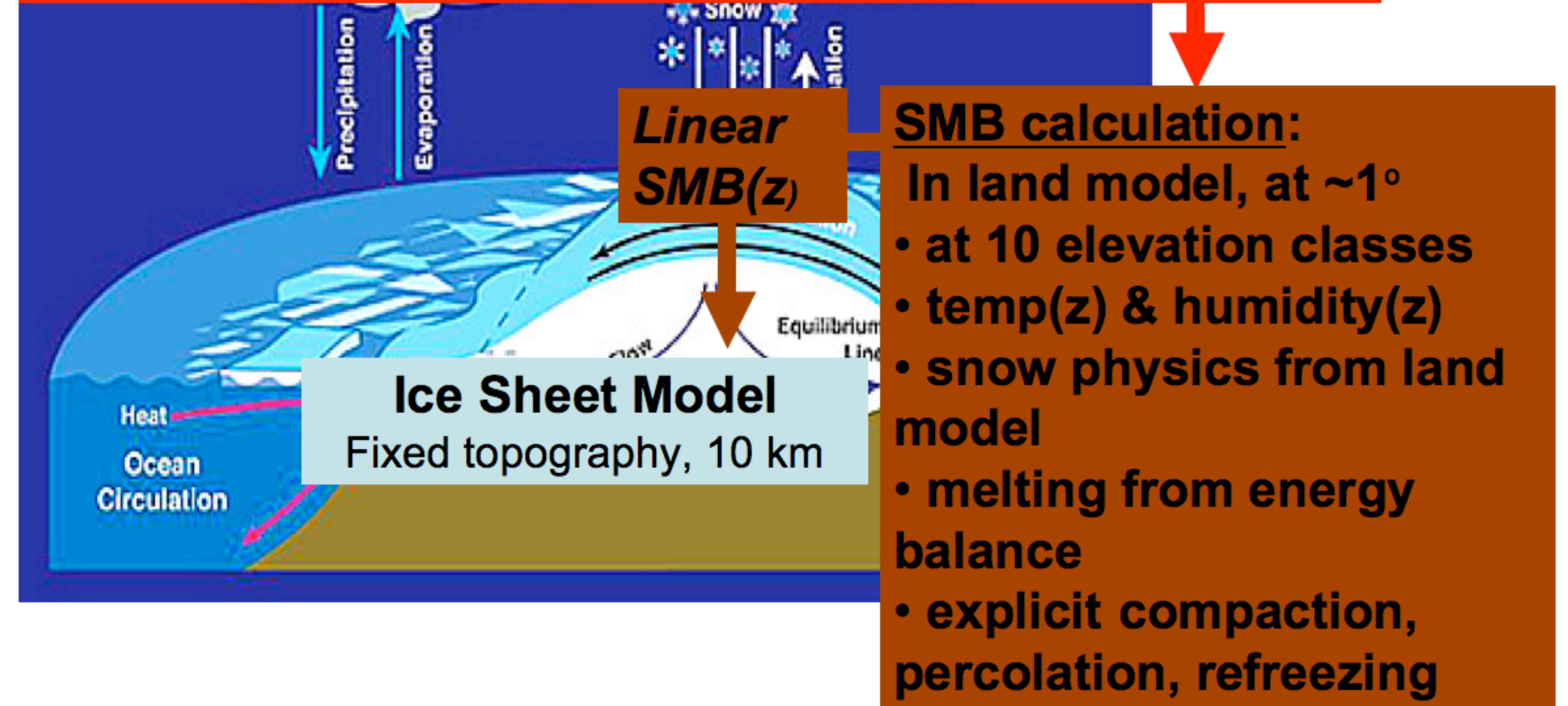
To investigate:

- mass balance response to climate forcing
- climatic impact of ice sheet change (e.g. thermohaline circulation, local climate)
- ice sheet-climate feedbacks (e.g. height change, albedo)

## 2. Model & Set-up

**Precipitation, temperature, radiation, wind, humidity**

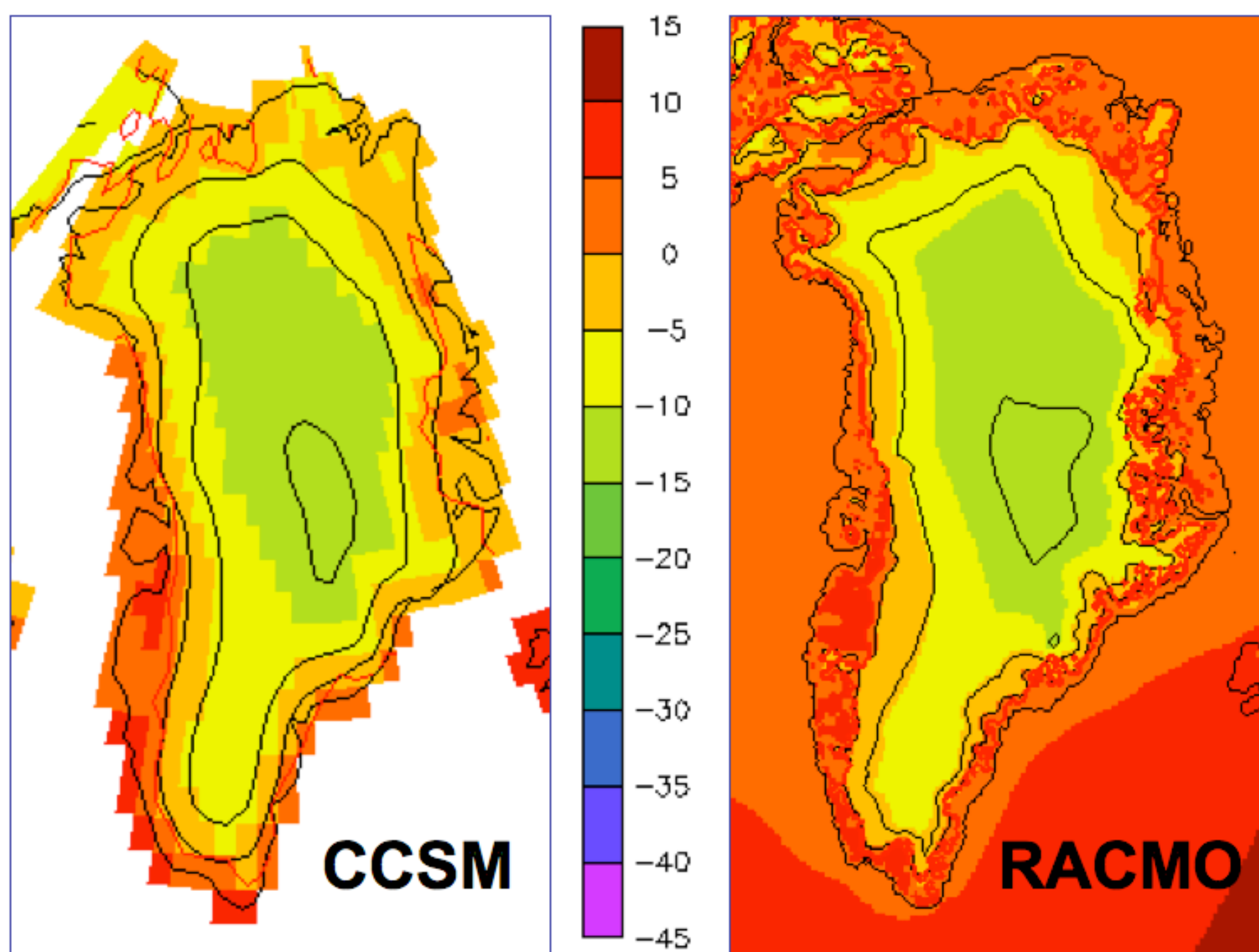
- *Reanalysis* (modified from NCEP/NCAR 1948-1998, Qian et al. *J Hydrom*, 2006),  $\sim 1.875^\circ$
- *Model* (CCSM4.0), pre-industrial,  $\sim 1^\circ$



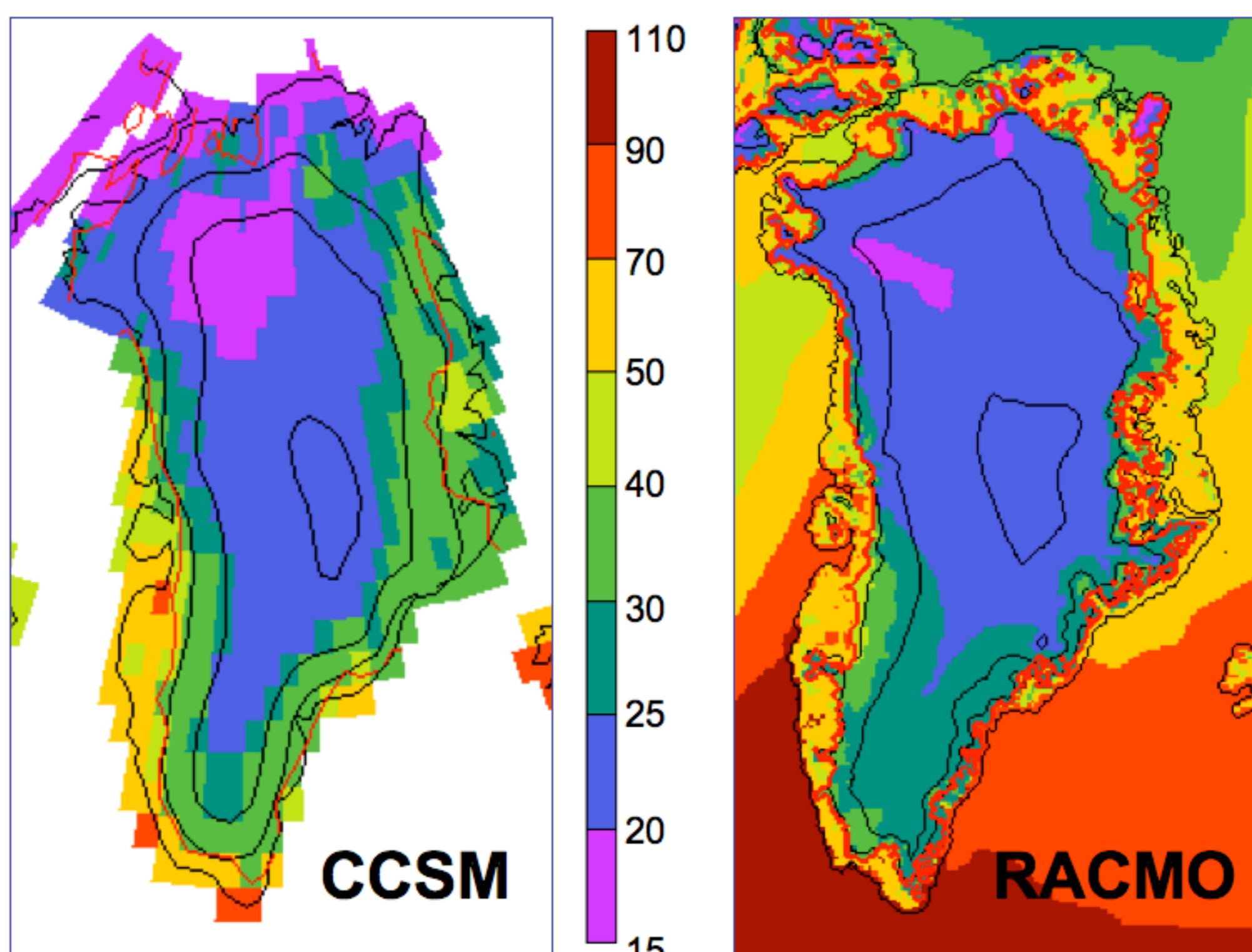
Set-up: land model is run at  $1^\circ$  with reanalysis and CCSM4.0 forcing. SMB is downscaled to 10 km.

Validation: with regional model RACMO (forced by ERA-40/ECMWF reanalysis 1958-2008; Ettema et al. *GRL*, 2008)

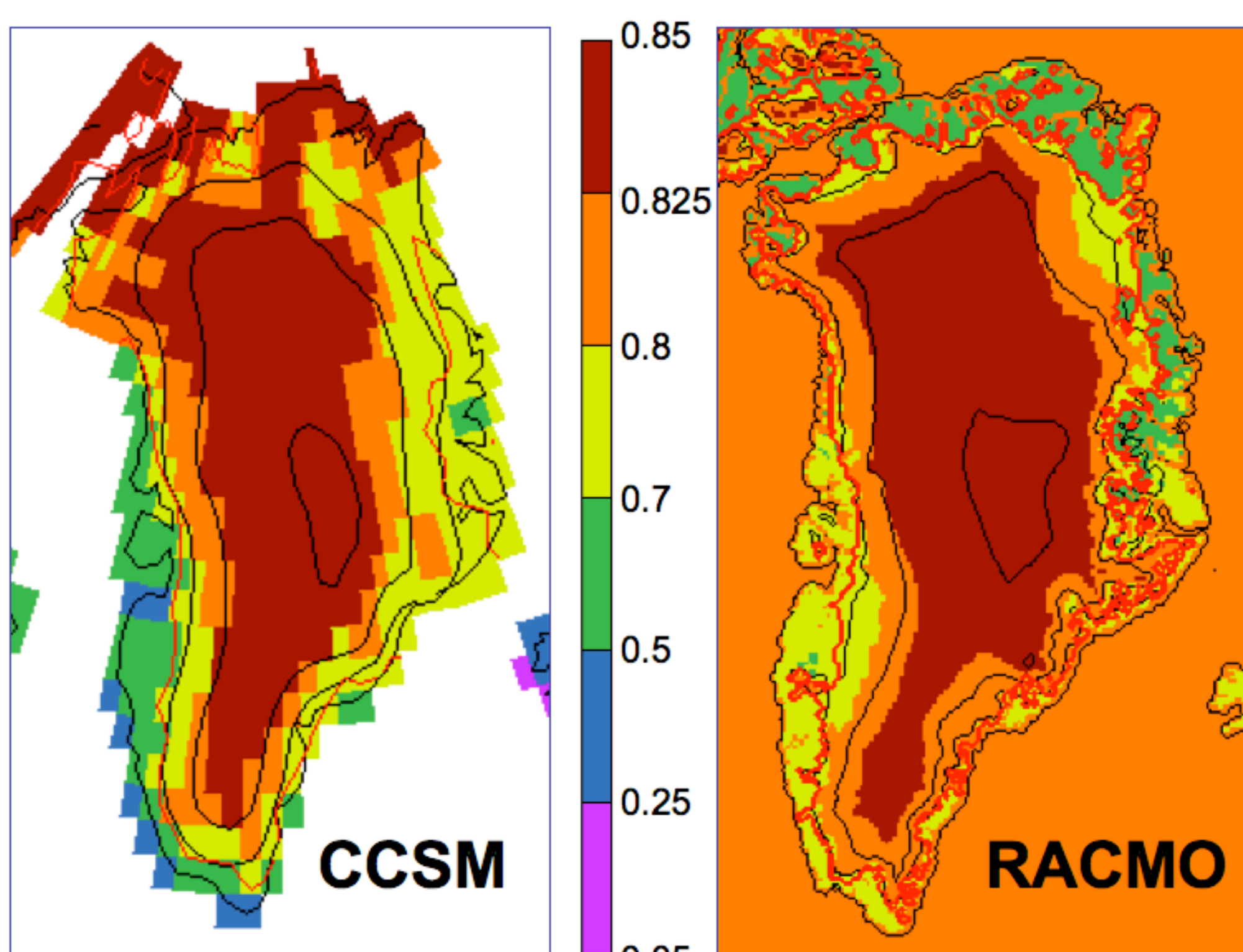
## 3. Simulated climate



Summer near-surface temperature [ $^\circ\text{C}$ ]

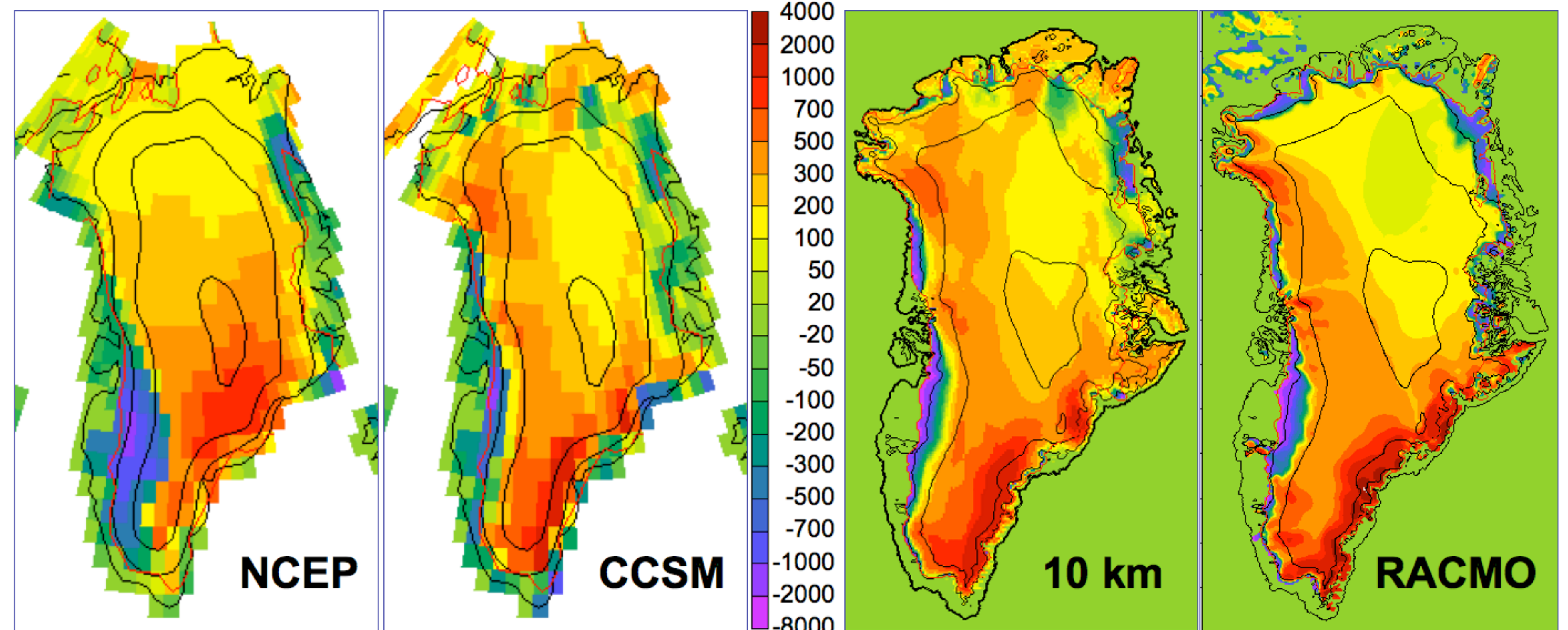


Annual net LW radiation [ $\text{Wm}^{-2}$ ]



Annual albedo

## 4. Simulated surface mass balance



*Contours: ice sheet margin, 1000, 2000, 3000 m height*

**Annual mean values** [mm/yr] for NCEP forcing, pre-industrial CCSM4.0 forcing, previous downscaled to 10 km resolution, and RACMO at 11 km

**Surface mass balance terms integrated over ice sheet** [ $\text{Gt yr}^{-1}$ ]

(\*) MAR (Fettweis, 2007)/PMM5 (Box et al., 2006)/ERA-40 based (Hanna et al., 2008)

Variable	CCSM4 $\sim 1^\circ$	Downscaled at 10 km	NCEP $\sim 1^\circ$	RACMO	Other reg models (*)
Precip	1019 (75)		721 (61)	743 (78)	600/696/610
Rain & rain frac	139 (17) 0.14		115 (6) 0.16	46 0.06	22/18/28
Sublim	66 (4)		-81 (6)	26 (3)	5/108/38
SMB	429 (121)	438 (97)	348 (99)	469 (107)	288/356/287
Abl/precip	0.58		0.52	0.37	0.52/0.49/0.53
Area	2.019	1.685	2.019		

## 5. Conclusions

Good agreement with regional model RACMO. Main discrepancies:

- overestimation of precipitation in the N interior
- underestimation of ablation at N & E

**Acknowledgements**- Miren Vizcaíno is funded by NSF via SGER grant.

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## 6. Outlook

- Comparison to other GCMs
- IPCC type simulations (RCP4.5 & 8.5)
- Eemian (last interglacial): for model validation & investigation of ice sheet response to high summer insolation forcing
- Long-term response (multi-century runs)