Near-future changes in Greenland climate in the CESM Large Ensemble

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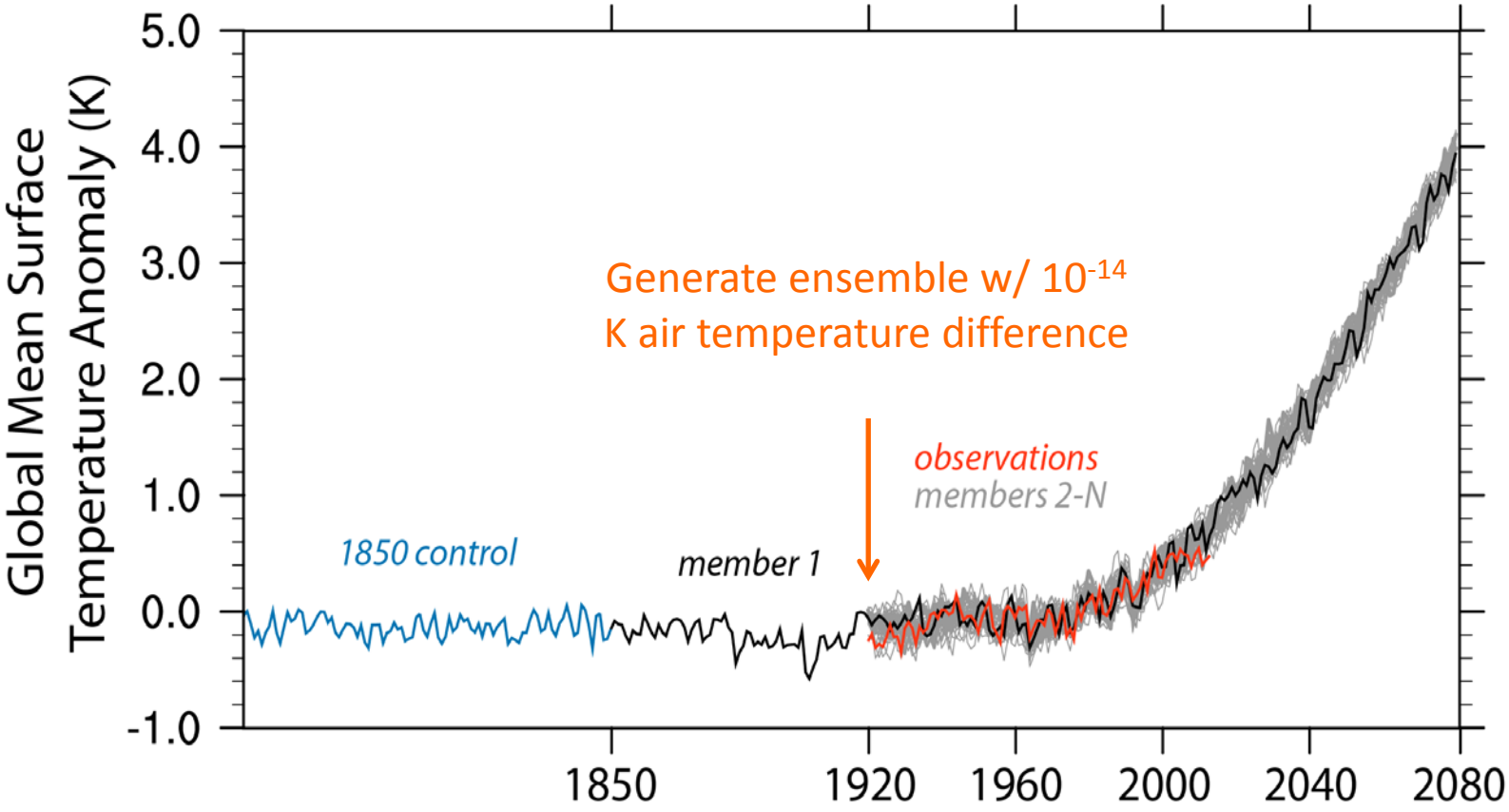
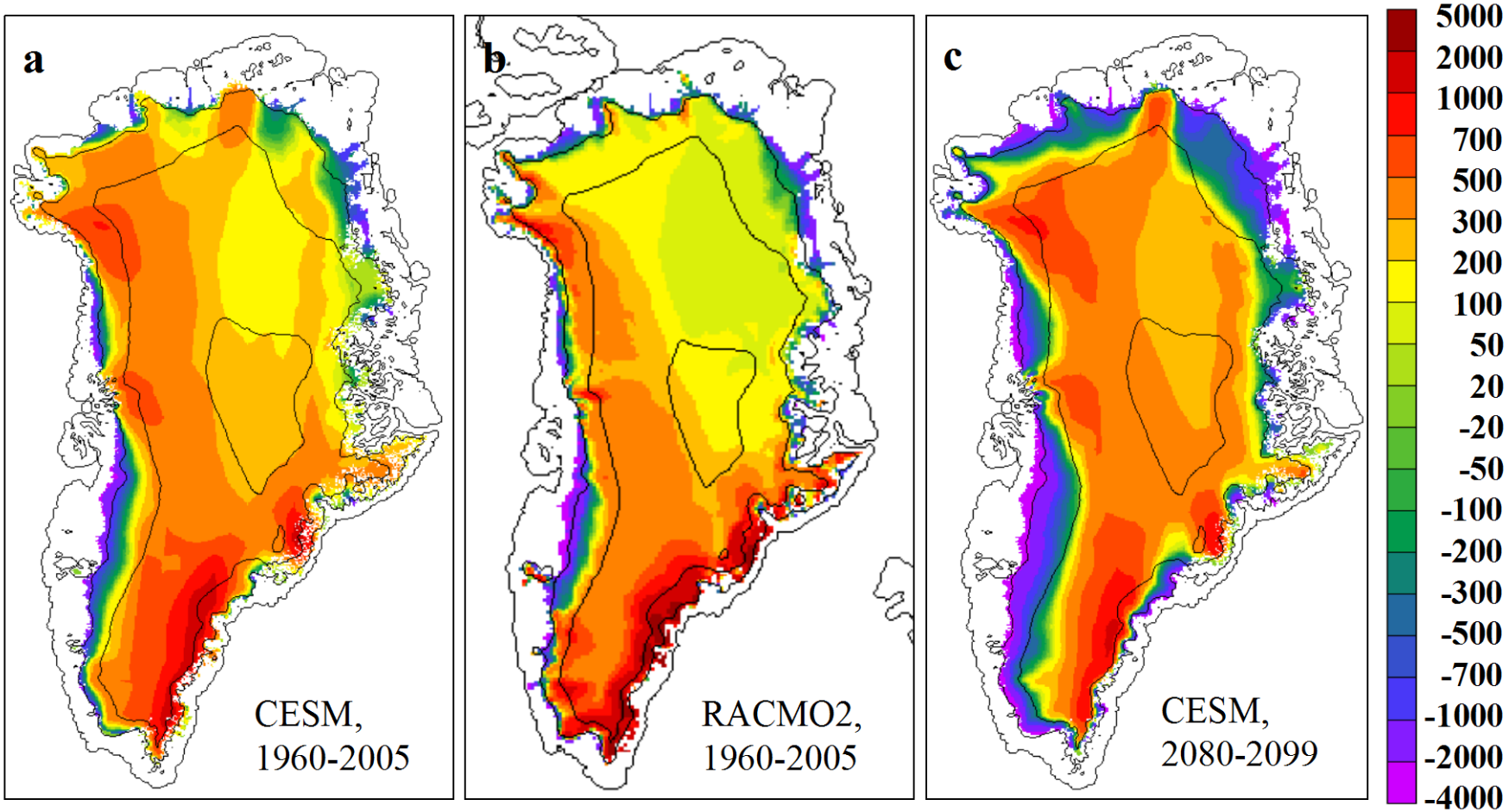
CESM-CAM5 Large Ensemble

Data at www.earthsystemgrid.org



CESM-LE Experimental Design (Kay et al. submitted).
Historical and RCP8.5 forcing, 1920-2080

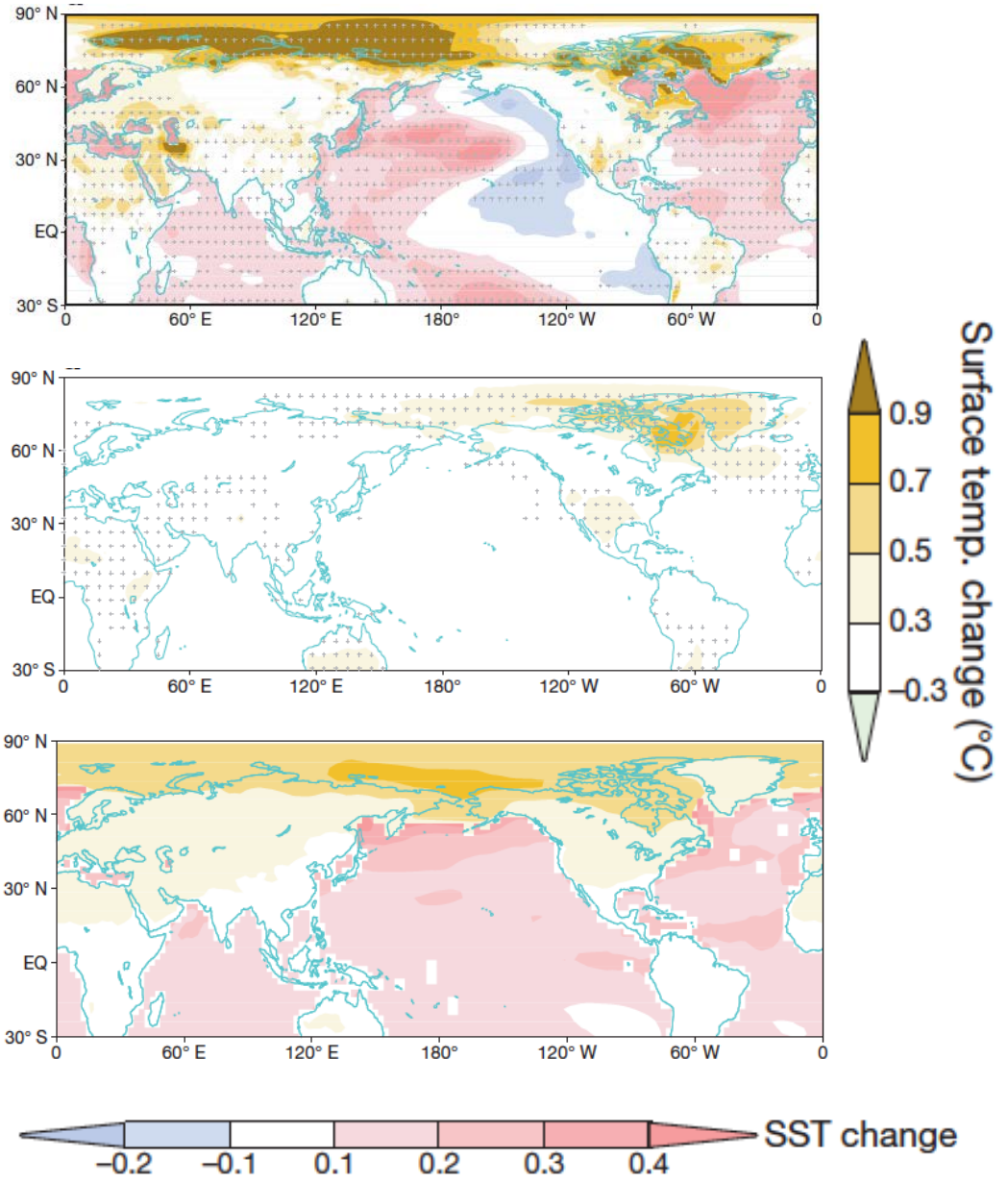
Why Greenland?



Present-day and end-of-the-century simulations of the Greenland Ice Sheet Surface Mass Balance (kg m^{-2} yr^{-1}) from CESM, and comparison with a high-resolution regional climate model RACMO2 (Vizcaino et al., 2013, 2014).

Why Greenland?

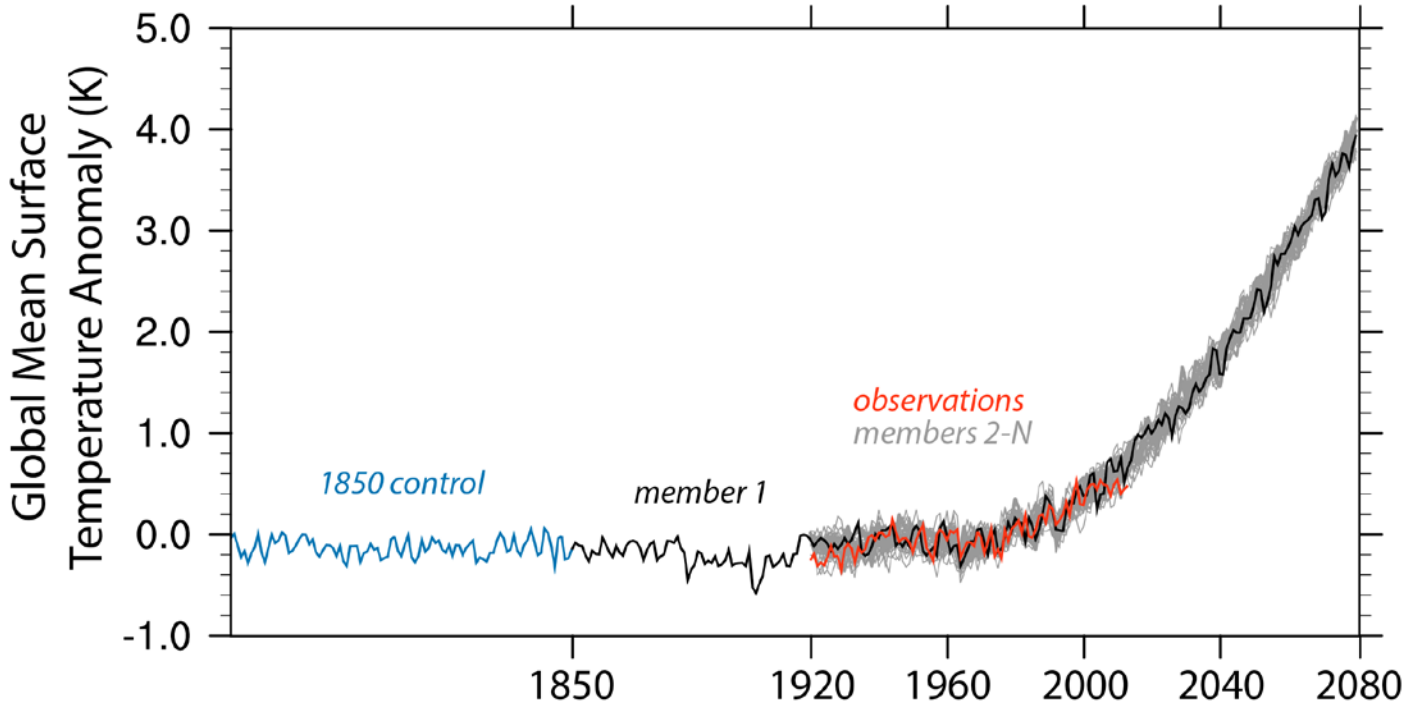
e.g., Ding et al. 2014: >50% of 1979-2012 Greenland warming arose from unforced natural variability



Annual mean trends: Observed 1979-2012 (top), ECHAM forced by observed Tropical SST 1979-2012 (middle), CMIP5 mean response to historical forcing 1979-2004 (bottom)

Today:

- Greenland in the CESM Large Ensemble (CESM-LE)
- Focus on ice sheet surface mass balance (summer surface temperature, annual precipitation)



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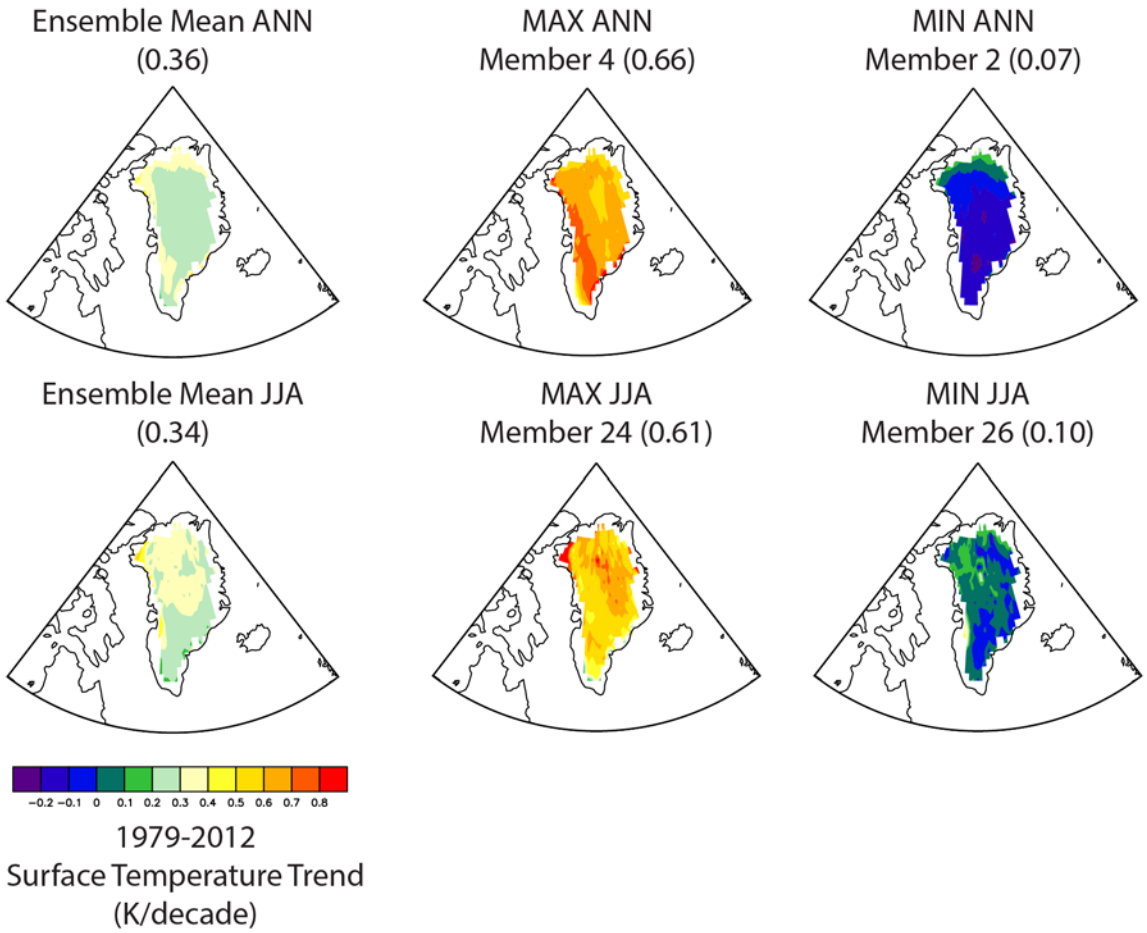
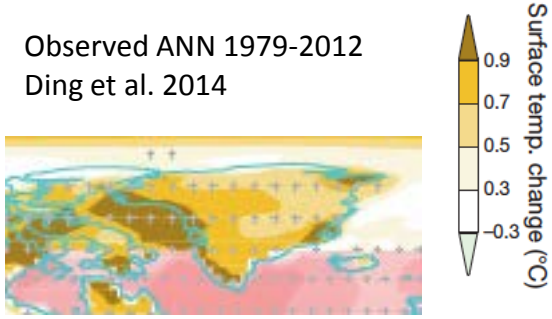
Historic surface temperature changes

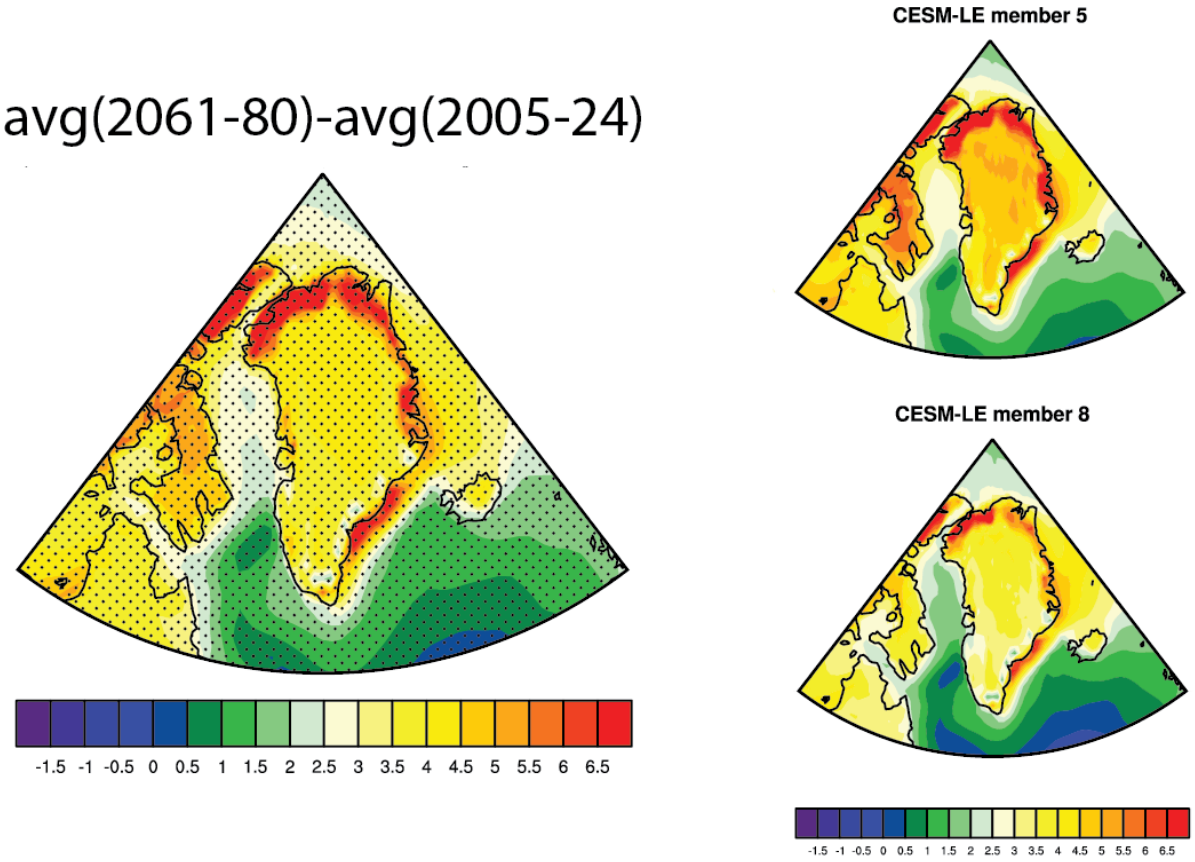


Observed ANN 1979-2012
Ding et al. 2014



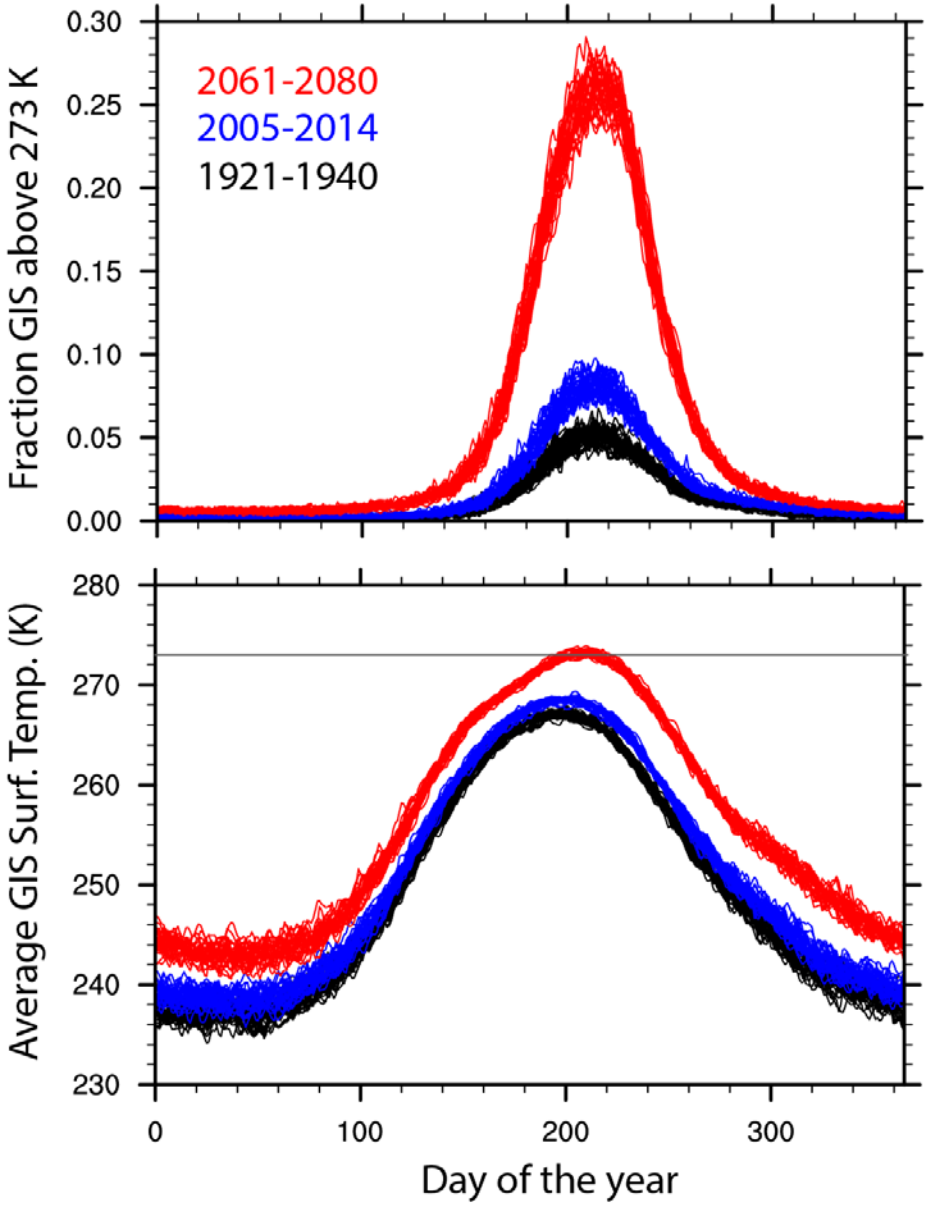
CESM-LE suggests observed Greenland 1979-2012 surface warming enhanced by internal variability, consistent with Ding et al. 2014.

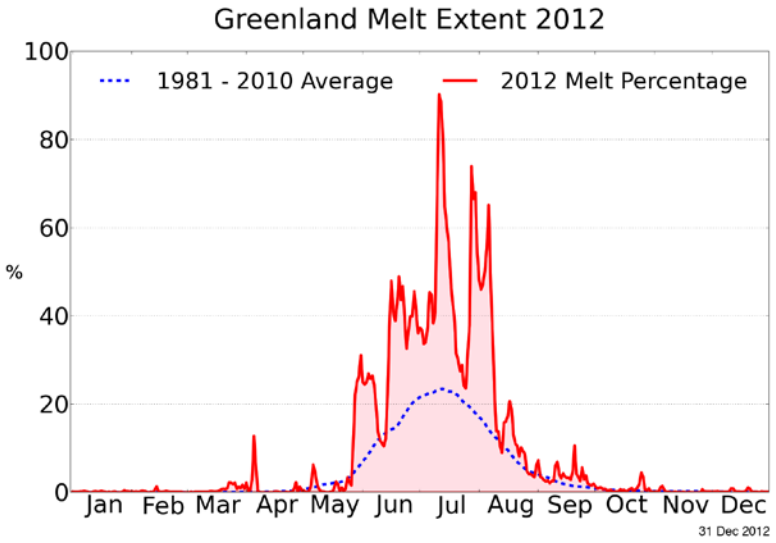
Robust future summer surface warming



Inescapable Greenland Ice Sheet Warming: AVG: +4.5 K, MAX: +5.1 K, MIN: +4.5 K

Increasing Greenland melt extent

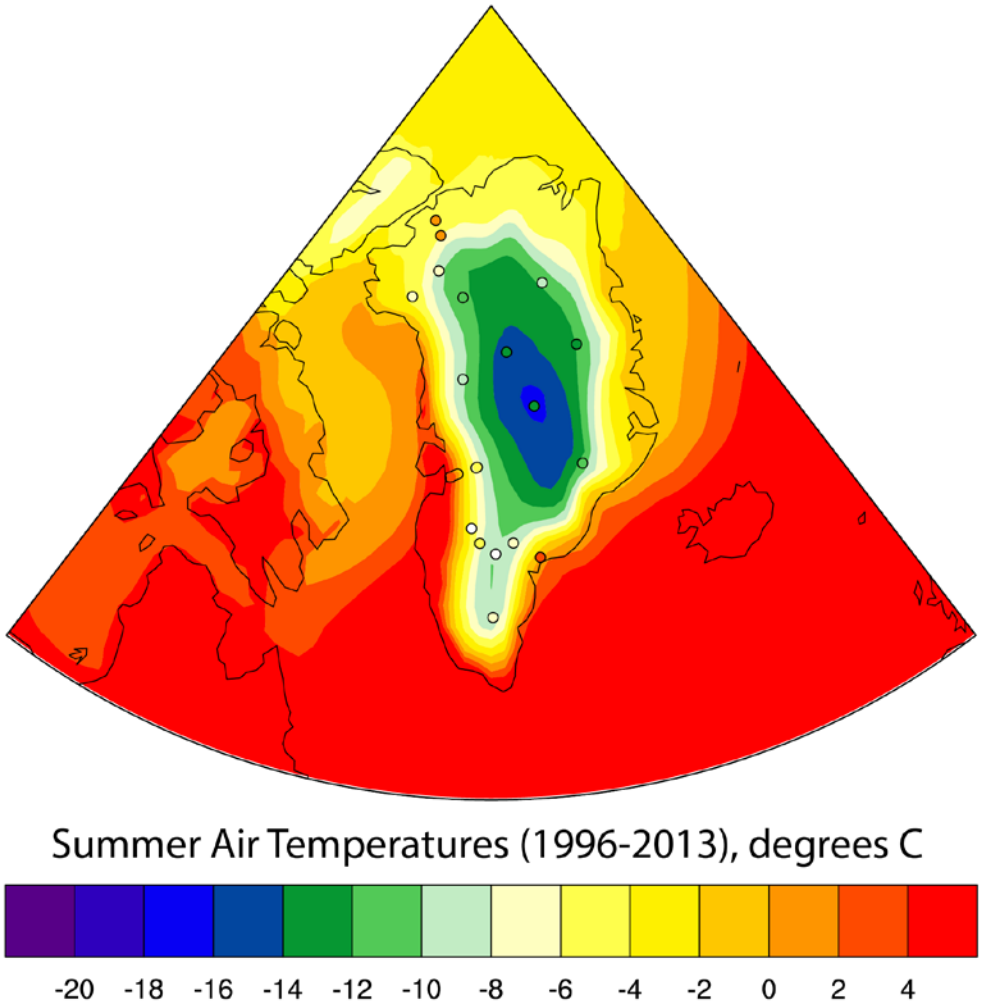




NSIDC / Thomas Mote, University of Georgia

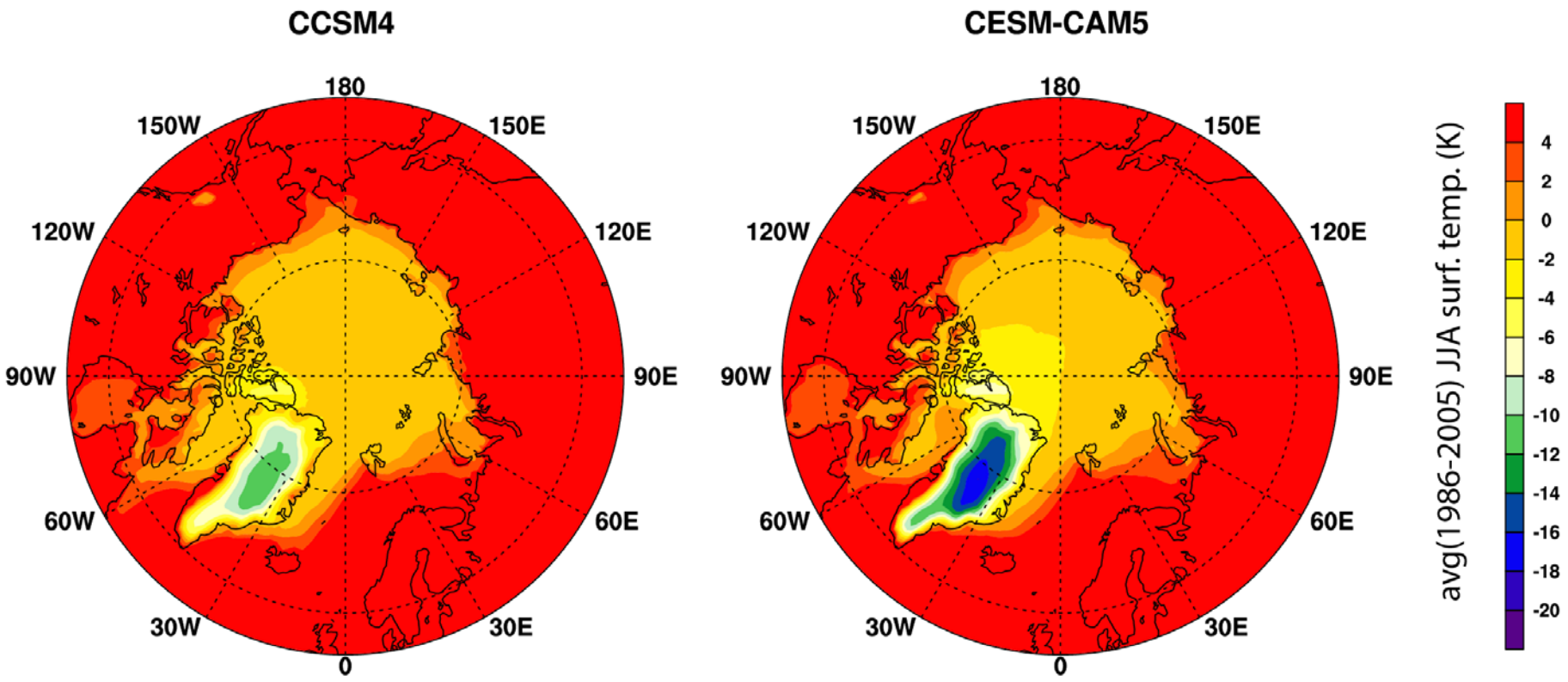
But present-day melt fraction
in CESM-LE less than observed (?)

CESM-LE Greenland too cold

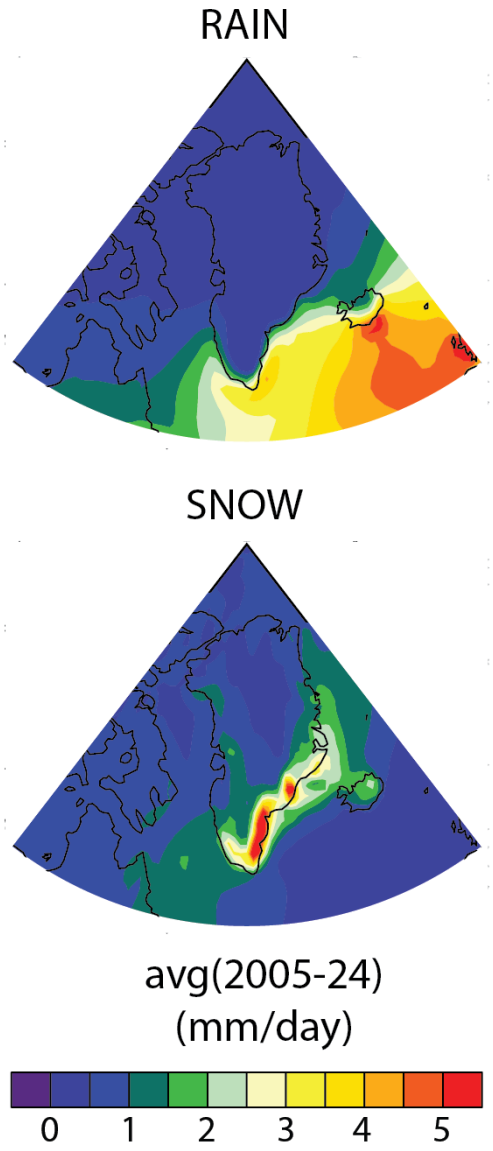


GC-Net Observations: Steffen, K., and J.E. Box, Surface climatology of the Greenland ice sheet: Greenland climate network 1995-1999, *J. Geophys. Res*., *106*(D24), 33,951-33,964, 2001. (Thanks Anne-Katrine Faber!).

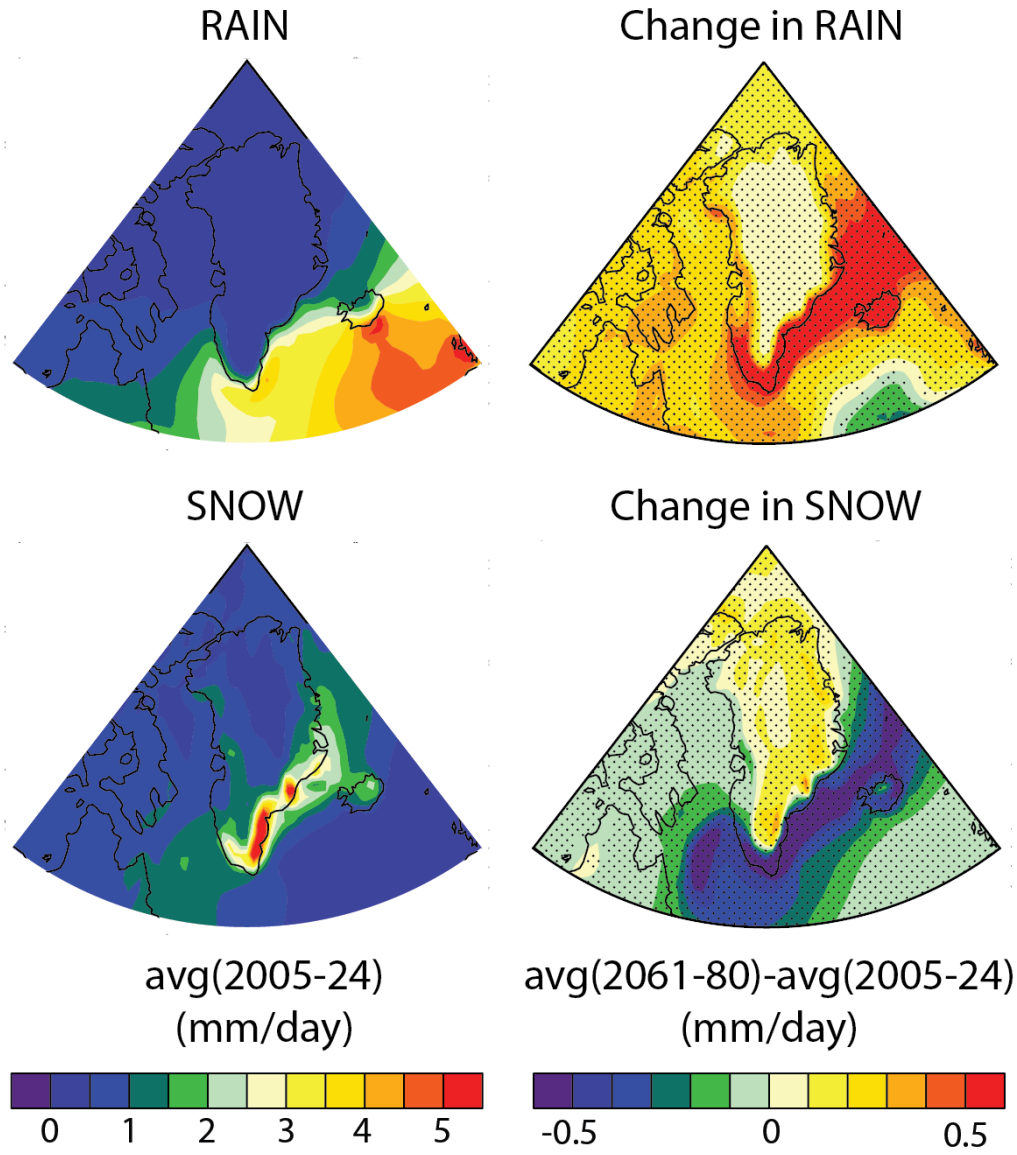
CESM-LE (CAM5) colder than CCSM4 (CAM4)



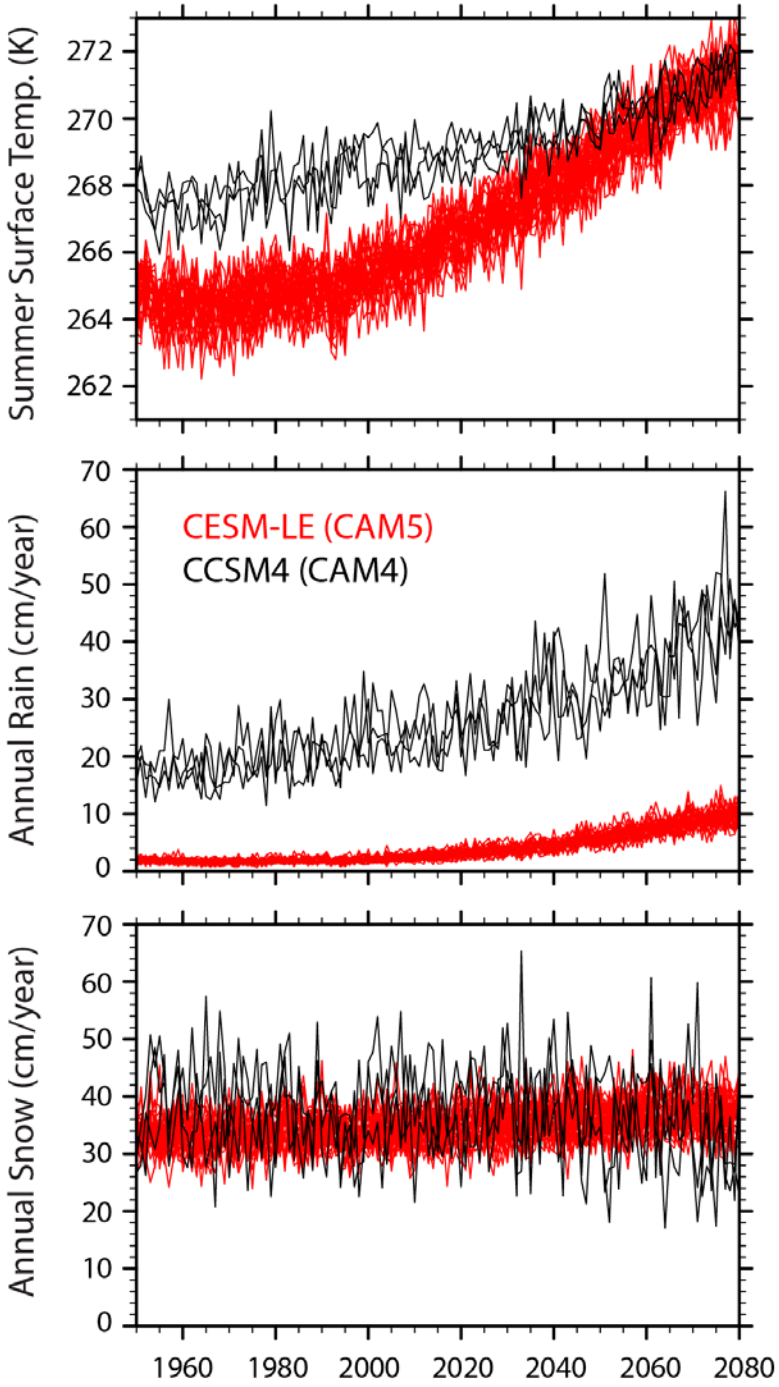
Greenland Precipitation in CESM-LE



Future precipitation changes



Greenland climate different with CAM5 than with CAM4 – implications for ice sheet modeling?



Summary:

1. 1979-2012 Greenland surface warming enhanced by internal climate variability (Ding et al. 2014, CESM-LE)

2. Warmer and wetter late 21st century for Greenland in CESM-LE

3. Greenland climate differences between CAM4 and CAM5 (CAM5 too cold now) -- implications for ice sheet modeling?