

# Effect of the Greenland Ice Sheet on the MOC and Future Climate: Preliminary Results

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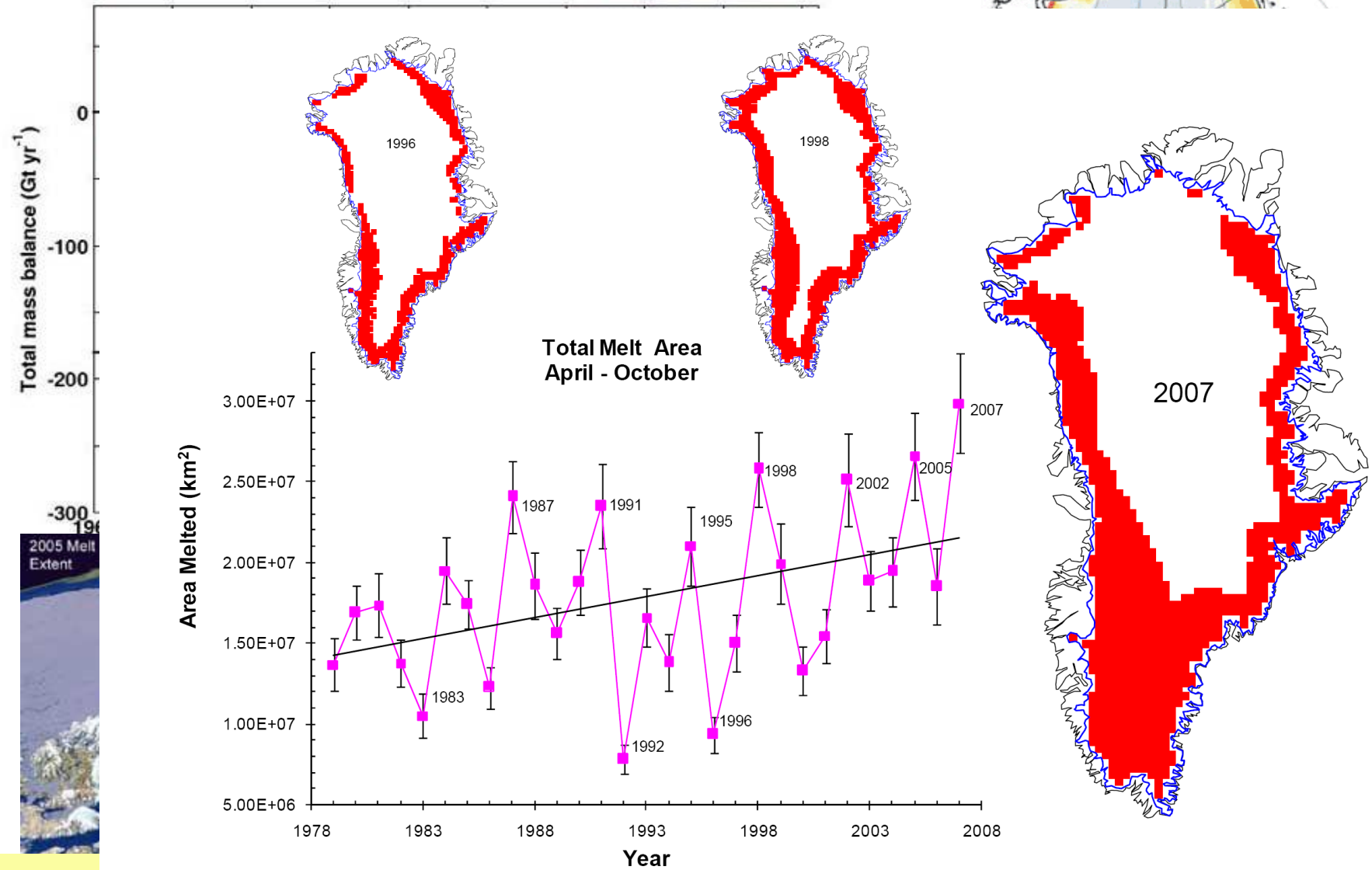
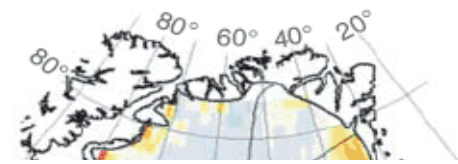


**NCAR**



# Introduction:

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Konrad Steffen and Russell Huff, 2005

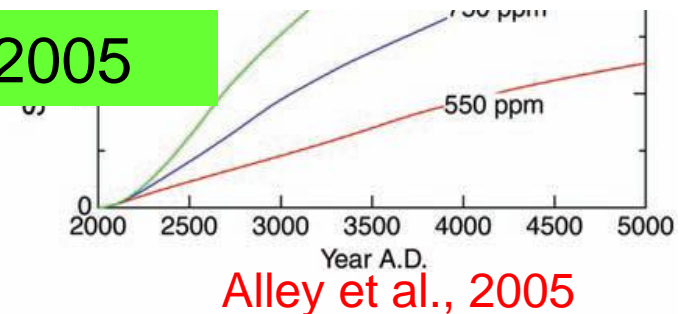
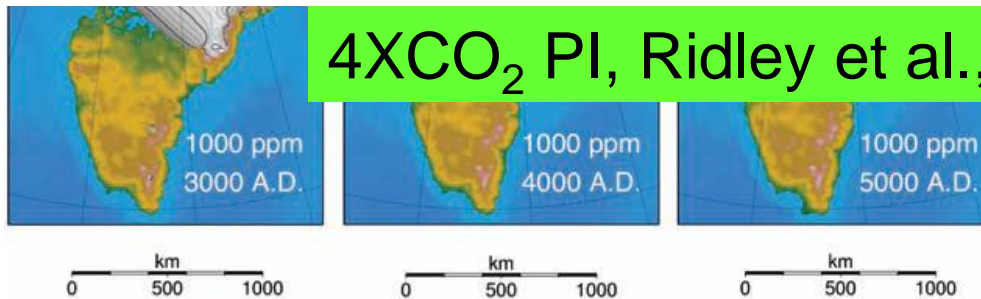
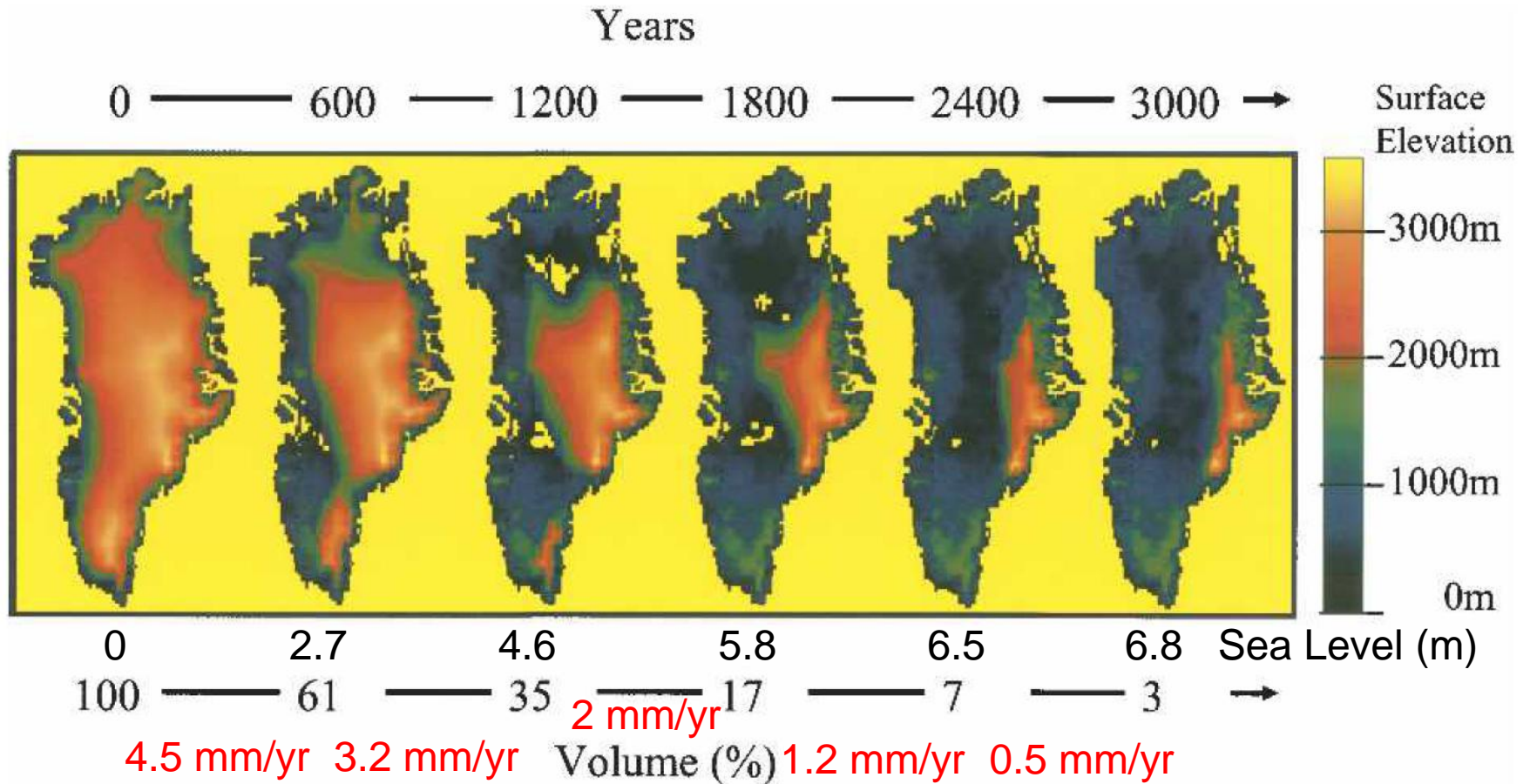
Konrad Steffen and Russell Huff, CIRES, University of Colorado at Boulder

Luthcke et al., 2006

Year

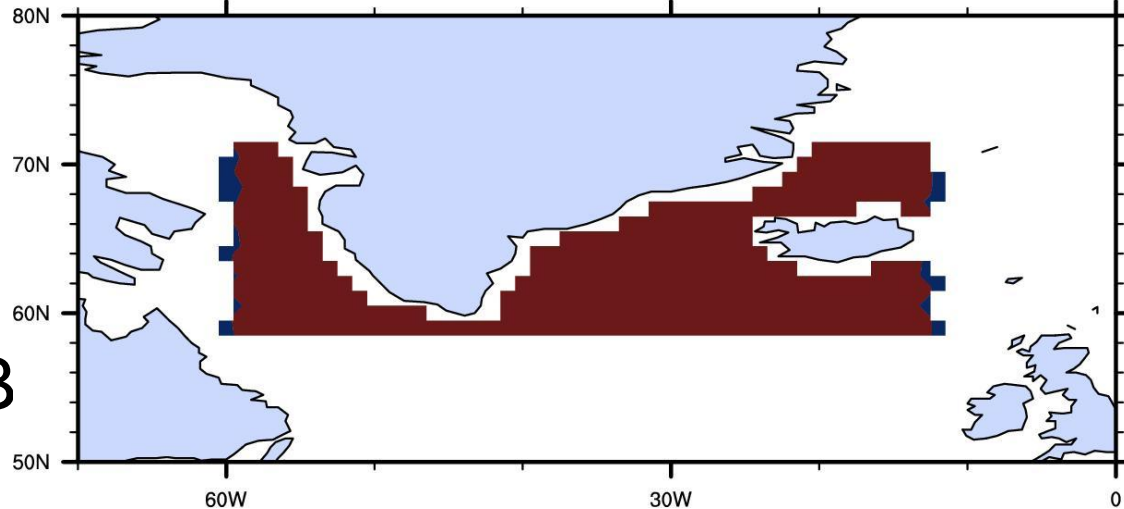


# How fast can Greenland Icesheet melt away?



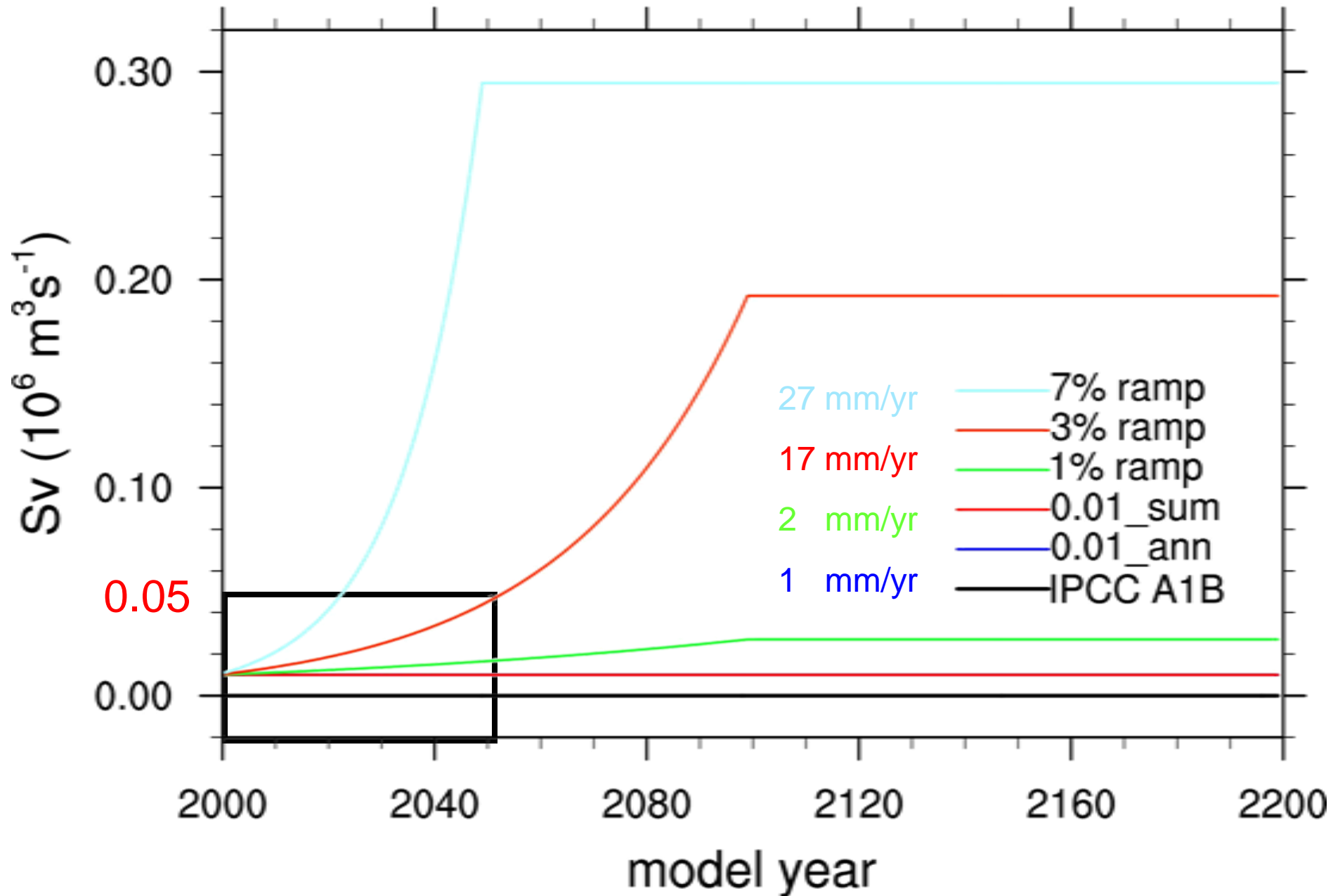
# Model and Experiments

- CAM3 with T42 horizontally and 26 levels vertically
- POP with 1 degree horizontally and 40 levels vertically
- CSIM5
- CLM3
- Climate forcing: A1B



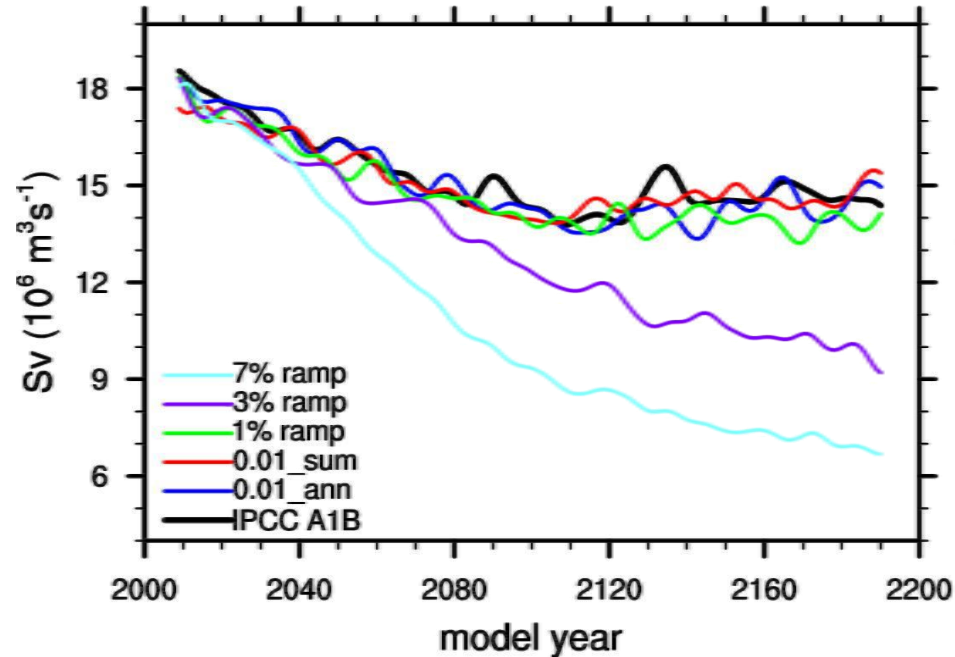
**Experiments:** Six simulations: 1, standard A1B; 2. A1B with 0.01 Sv Greenland melting flux; 3. A1B with Greenland melting flux only added in summer months (May-Oct.); 4. A1B with 0.01 Sv Greenland Melting flux increasing 1% per year till 2100; 5. same as 4, but 3% per year; 6. same as 4, but 7% per year till 2050.

# Rates of the Greenland Ice-sheet Melting

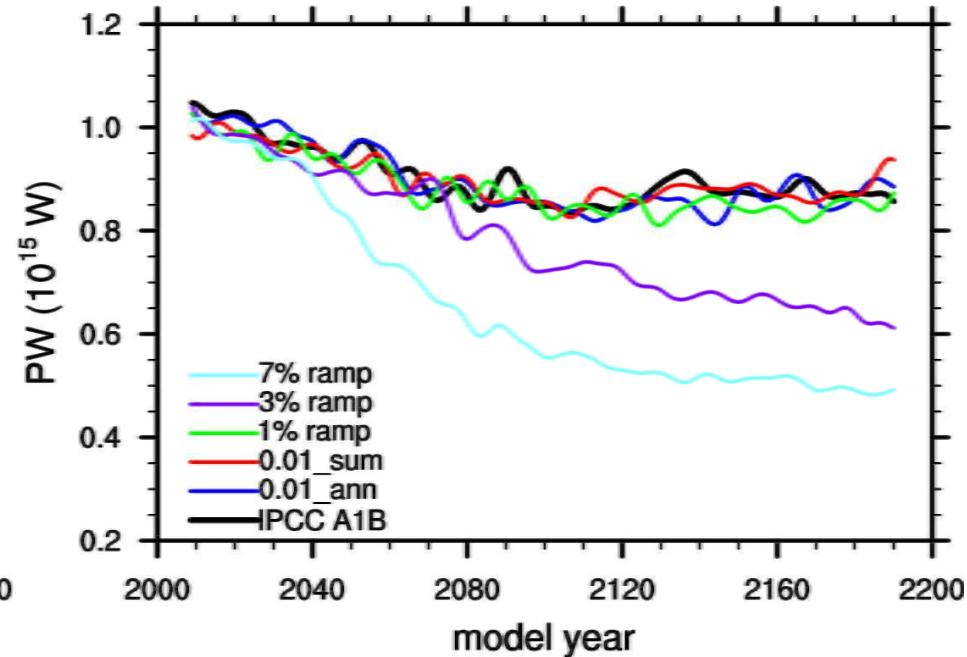


# Changes of the MOC and MHT

## Atlantic Meridional Overturning



## Atlantic MHT at 24°N



A rate of the Greenland Ice Sheet melting up to 0.02 Sv would not alter the MOC significantly in the next two centuries in comparison to the changes of the MOC due to greenhouse gas induced warming. However, if the rate of the Greenland Ice Sheet melting is 0.05 Sv or greater, the weakening of the MOC is significantly larger than that induced by greenhouse gas warming only. The change of the MHT is proportion to the MOC.

# 20 yr mean surface temperature anomaly to the end of the 20th century

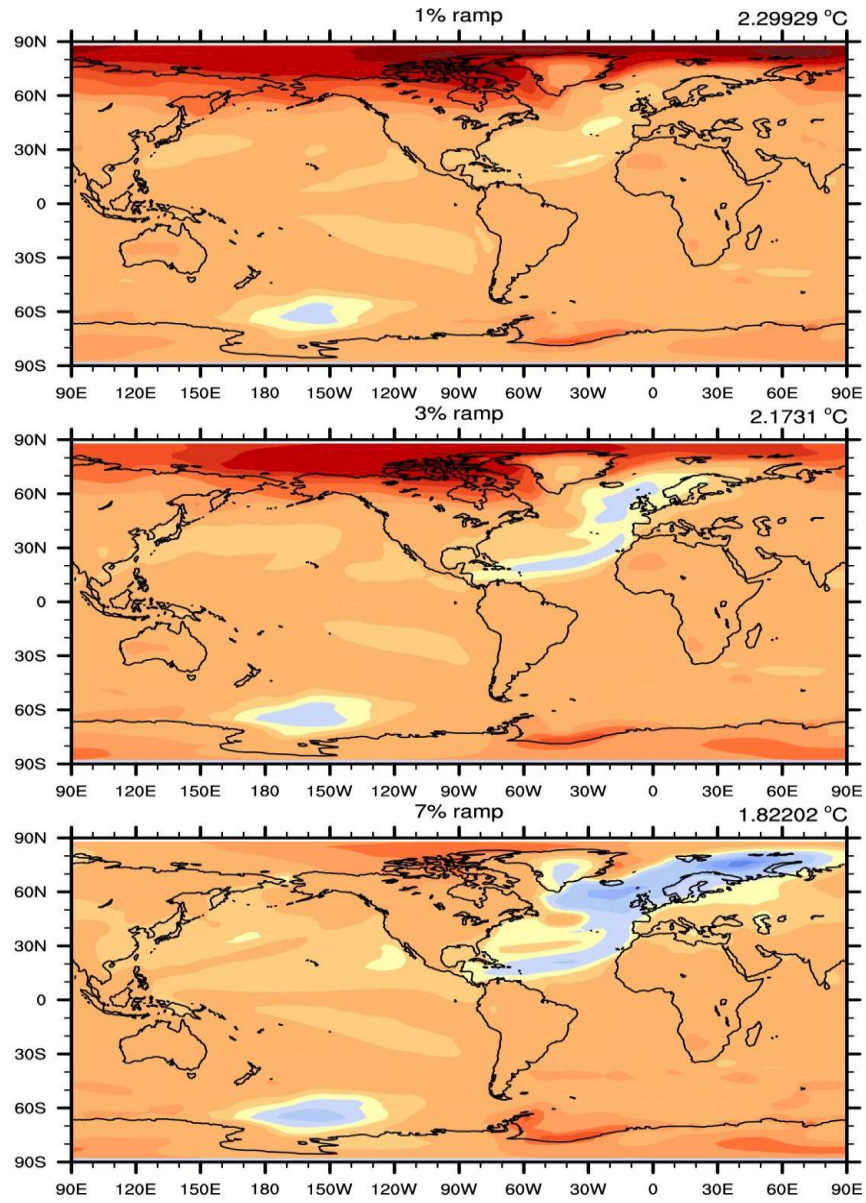
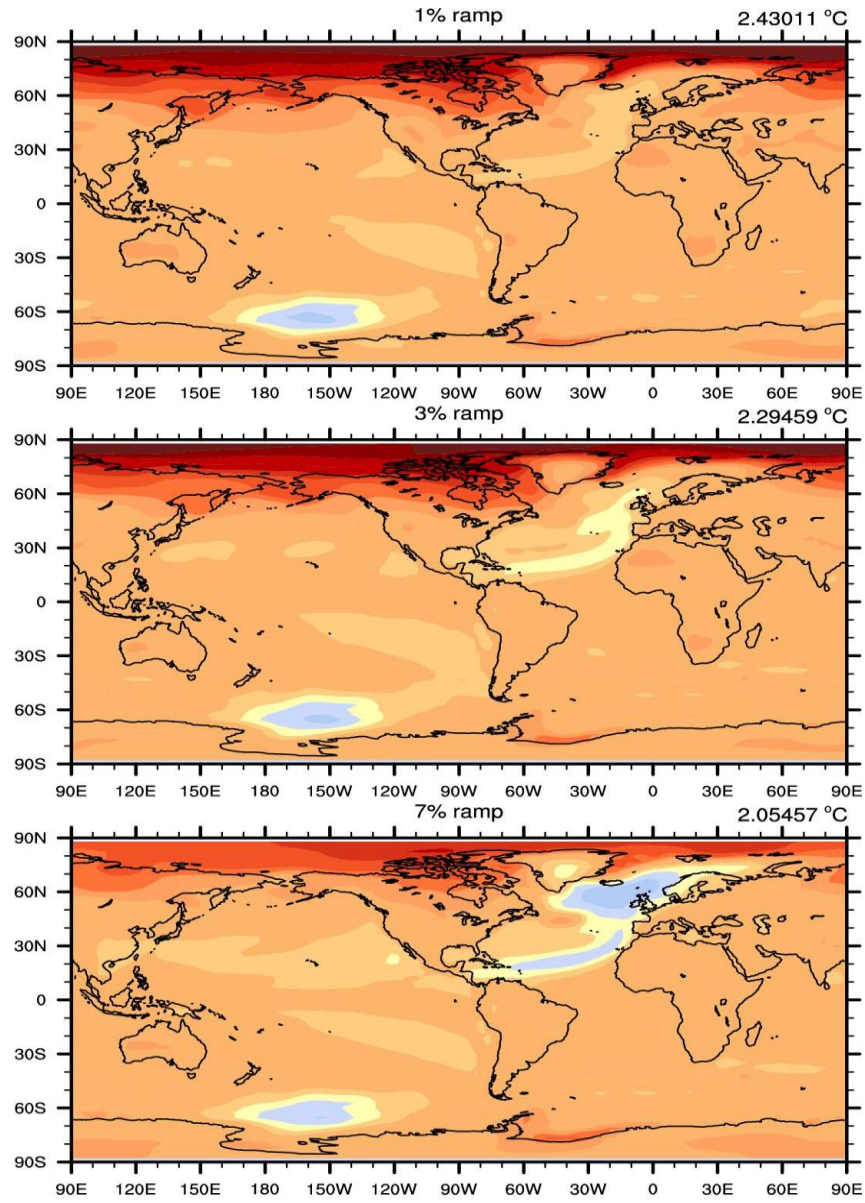
(2090-2109) – (1980-1999)

(2180-2199) – (1980-1999)

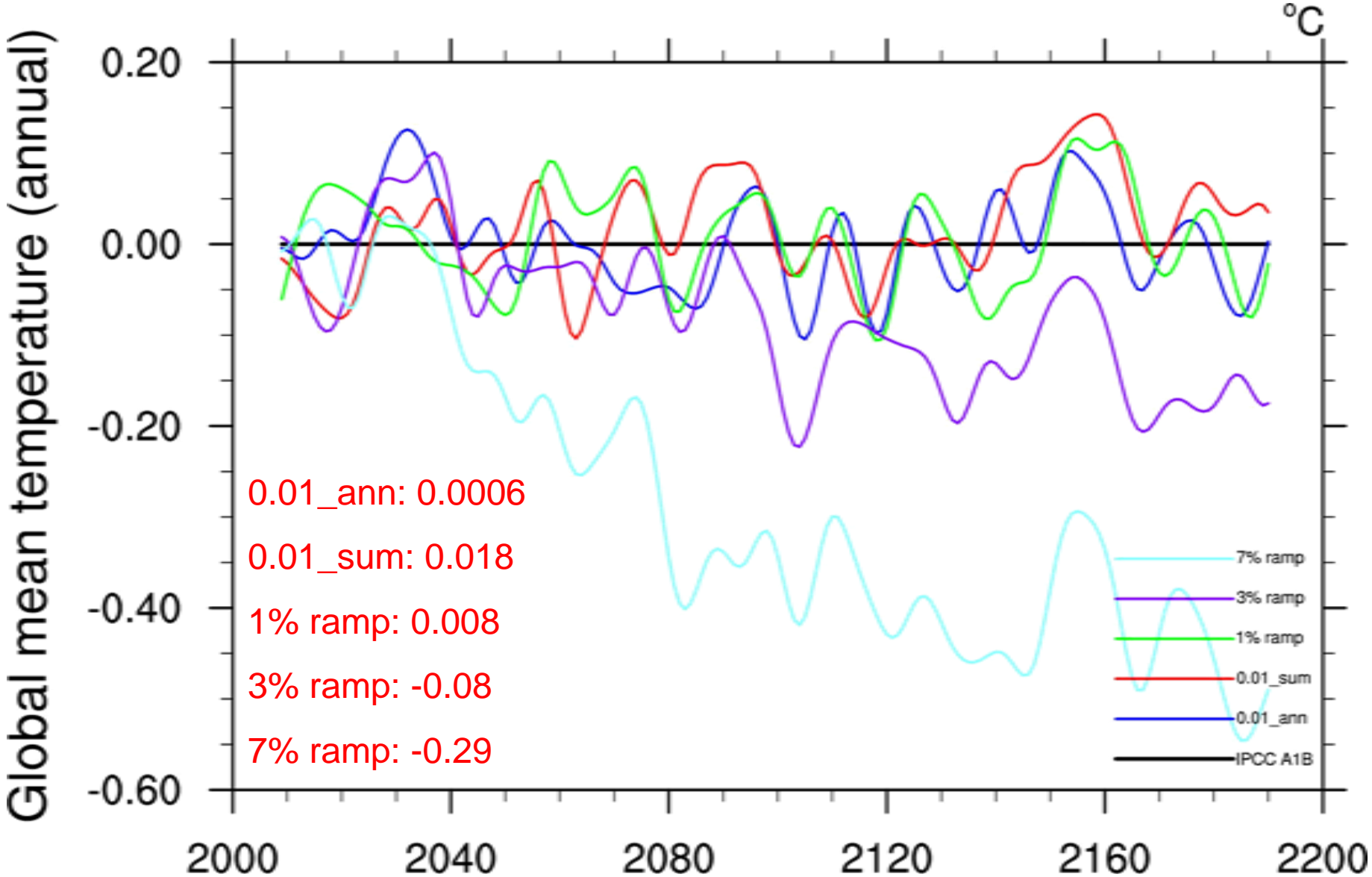
1% ramp

3% ramp

7% ramp



# Global mean surface temperature anomaly





# Surface temperature anomaly relative to the same period of standard A1B run

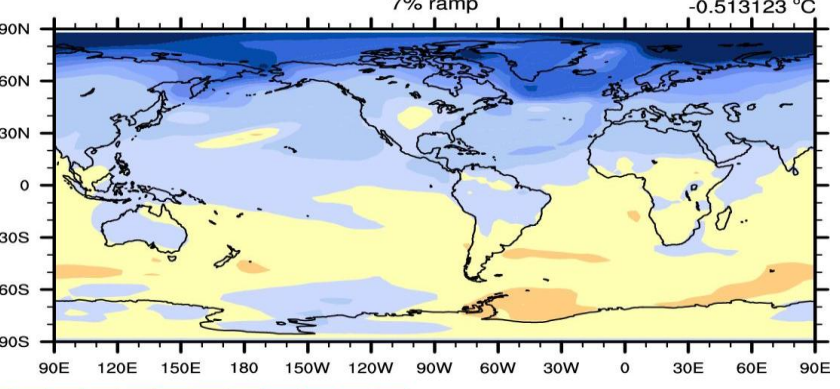
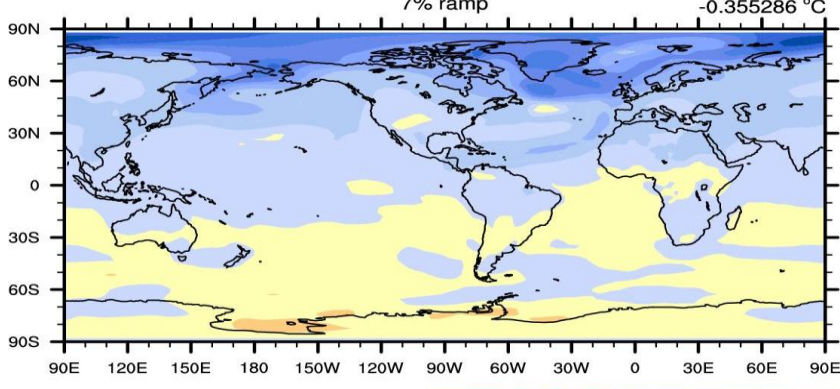
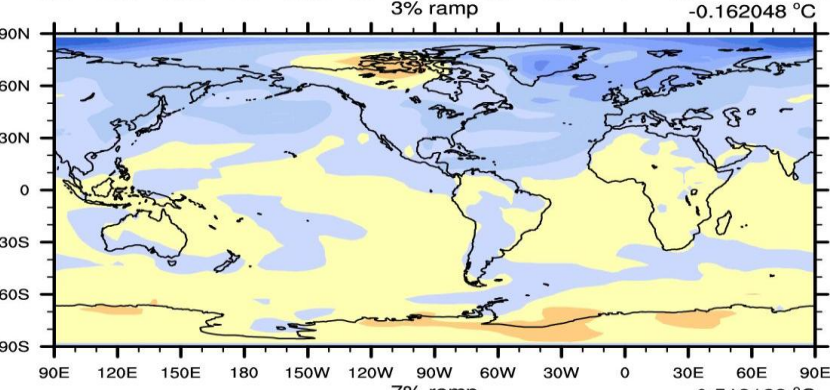
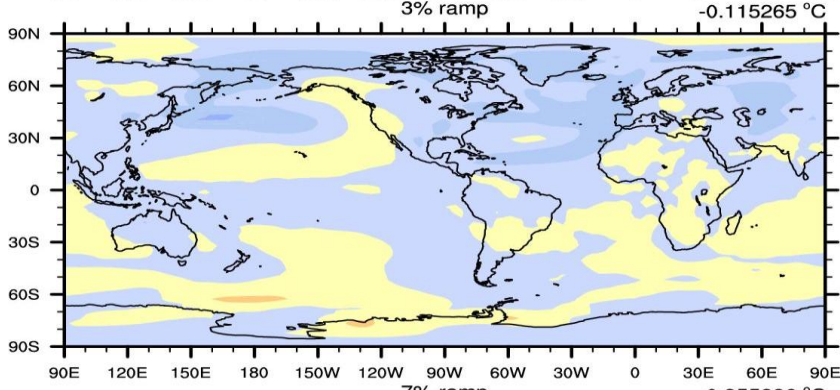
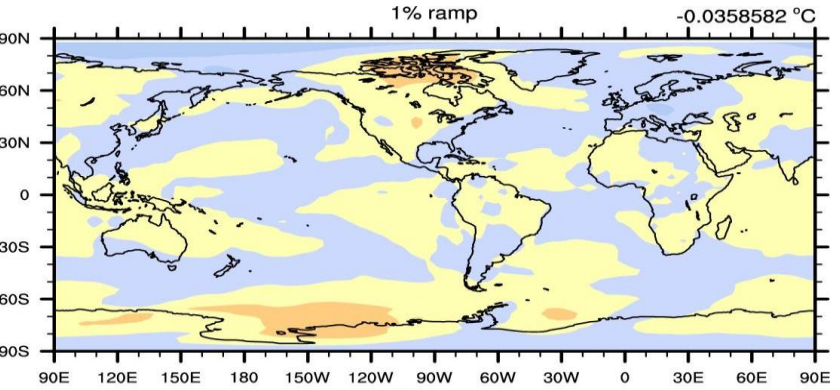
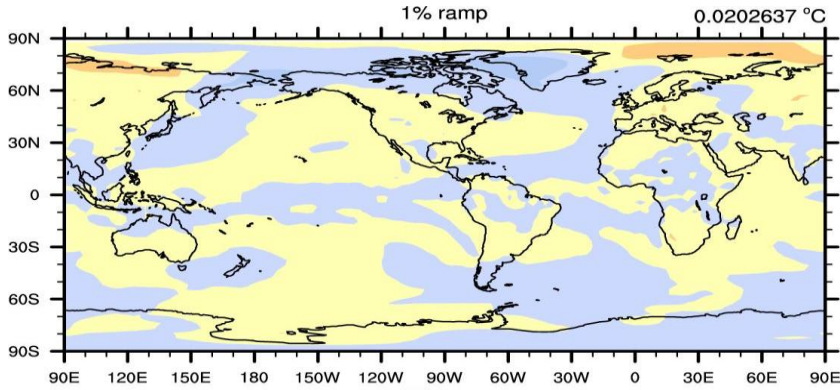
2090-2109

2180-2199

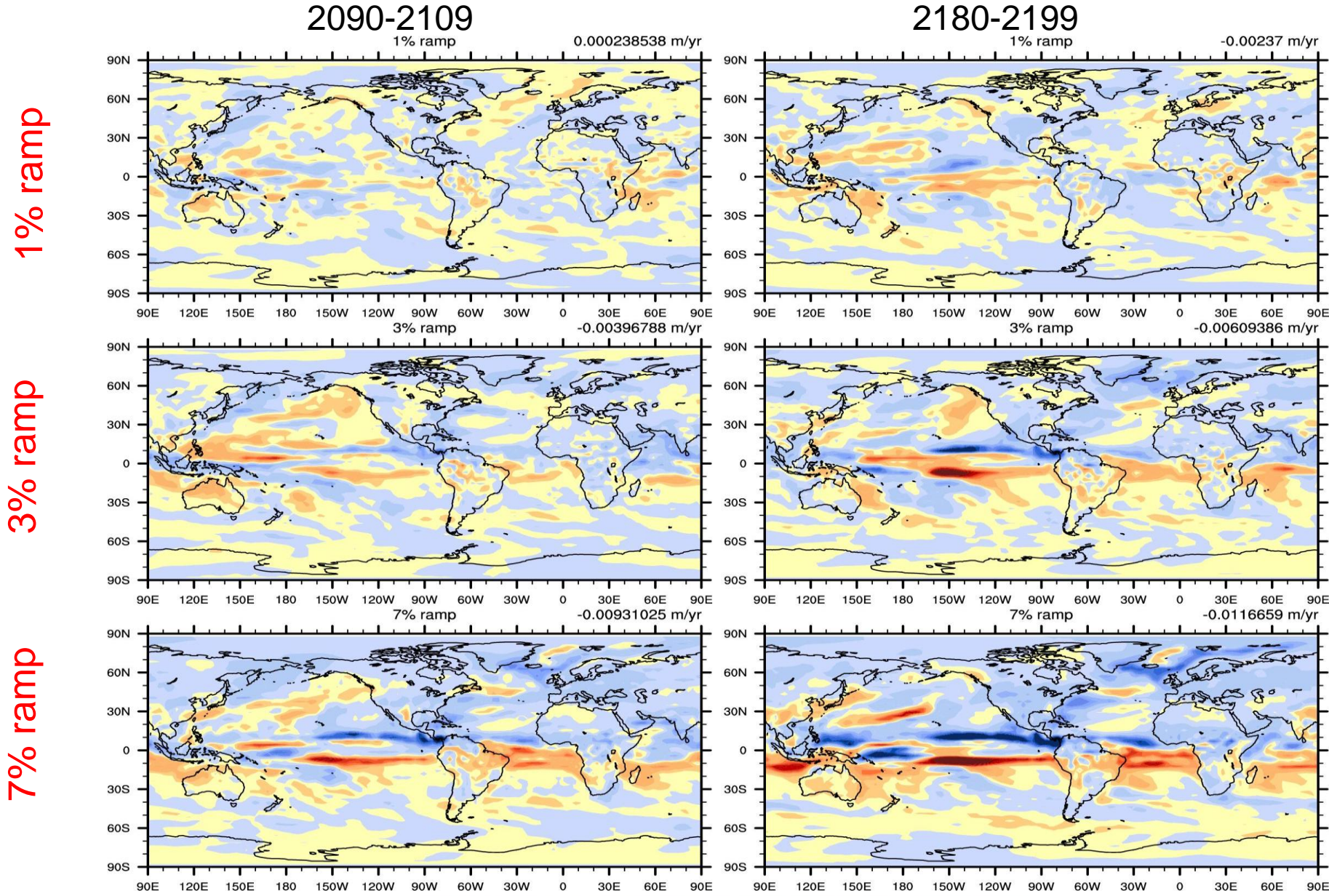
1% ramp

3% ramp

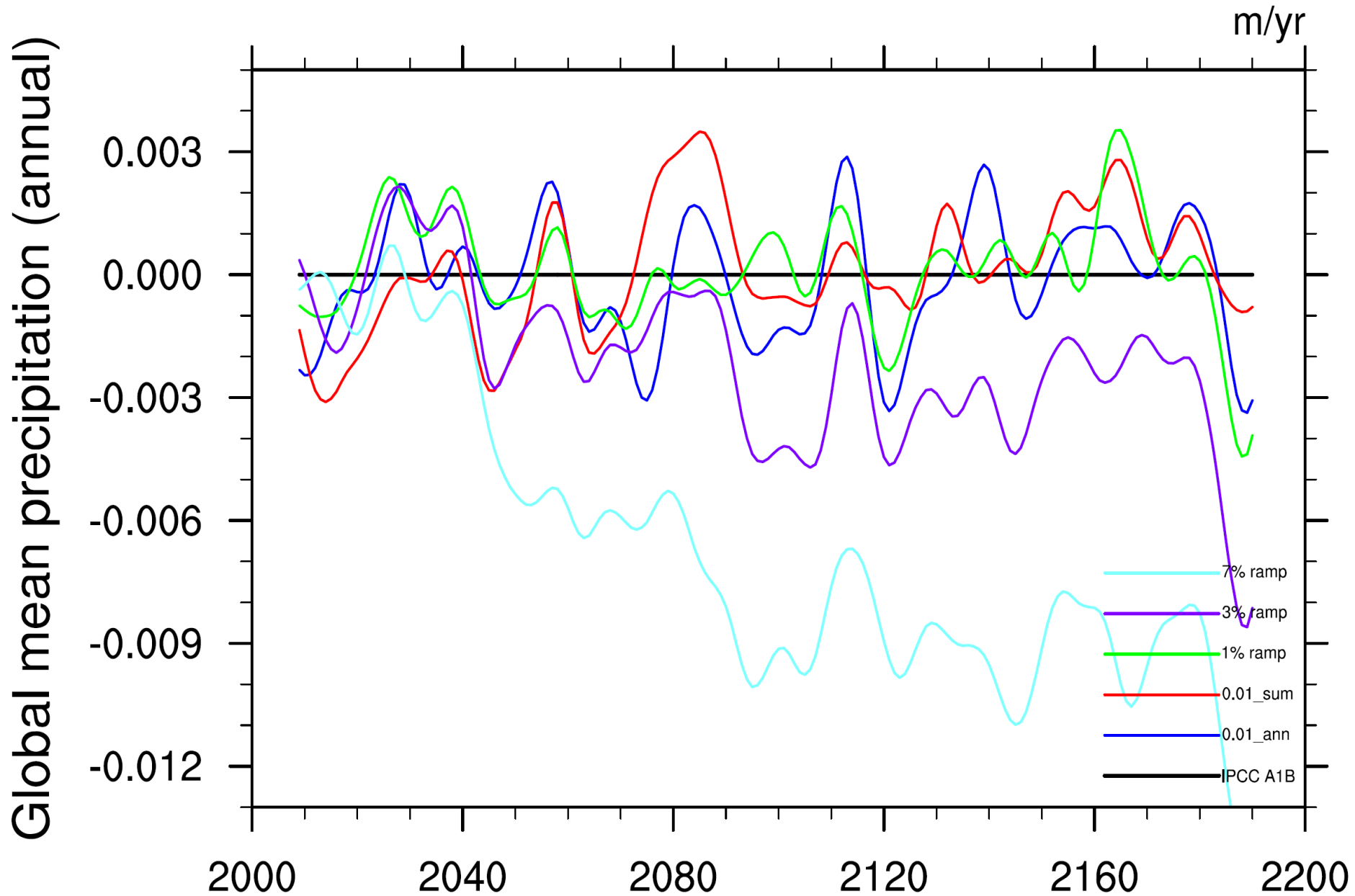
7% ramp



# Precipitation anomaly relative to the same period of standard A1B run



# Precipitation anomaly relative to standard A1B run



# Summary

- ➔ A rate of Greenland ice sheet melting less than 0.05 Sv may not significantly alter the strength of the MOC, however, a melting rate above 0.05 Sv could change the MOC significantly.
- ➔ With a high rate of Greenland Ice sheet melting, the dramatically weakened MOC would not reverse the trend of the surface temperature increase due to greenhouse gas effect in comparison to late 20<sup>th</sup> century, except in the subpolar North Atlantic region.
- ➔ Compare to the standard A1B simulation, simulations with a stronger rate of ice sheet melting reduce the warming in the Northern Hemisphere, this reduction is up to a few degrees in the Pan-Arctic region.