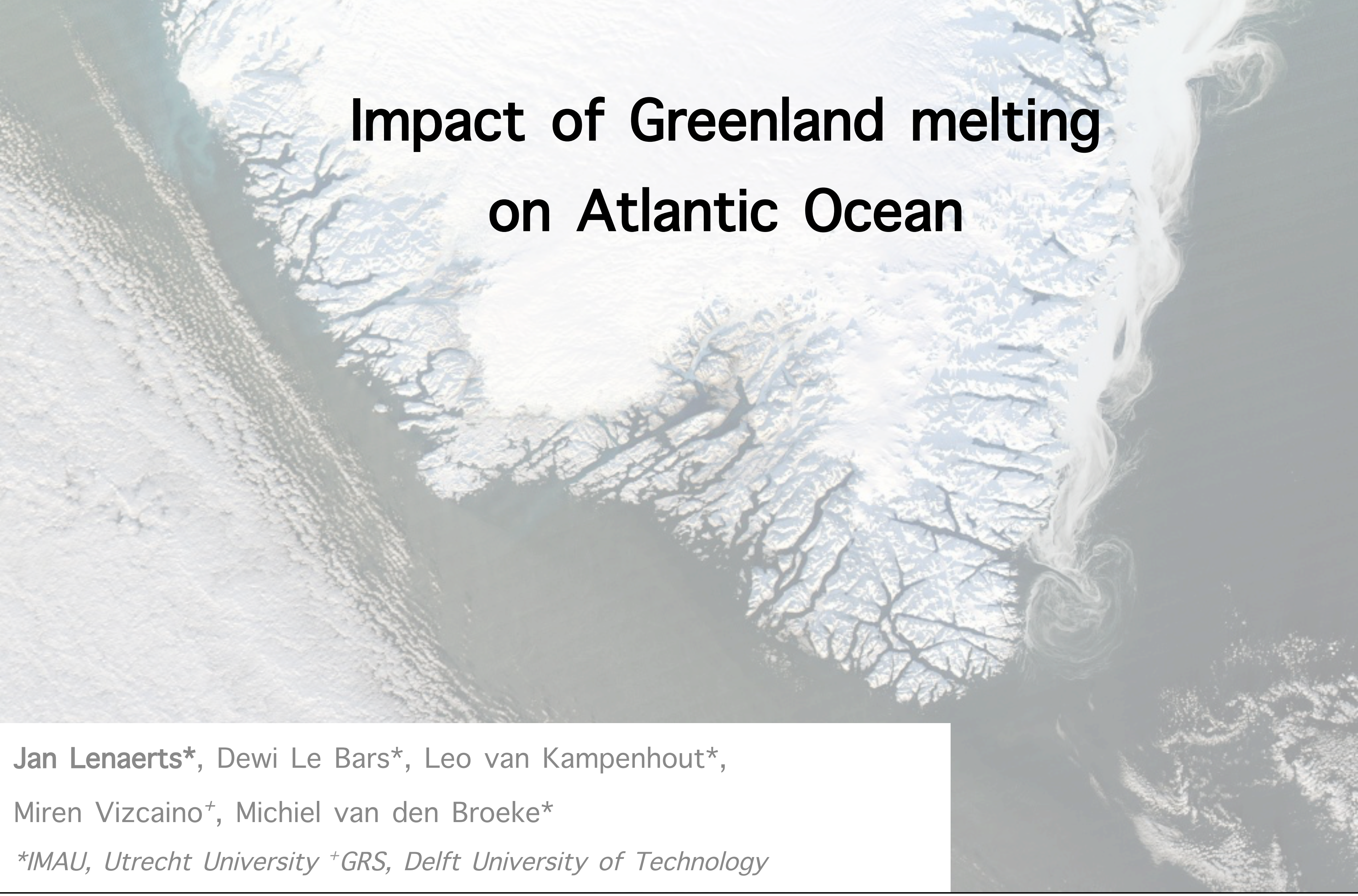

Impact of Greenland melting on Atlantic Ocean

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Miren Vizcaino+, Michiel van den Broeke*

**IMAU, Utrecht University +GRS, Delft University of Technology*

EGU Vienna – 16 April 2015

Utrecht University

Greenland freshwater (FW) forcing

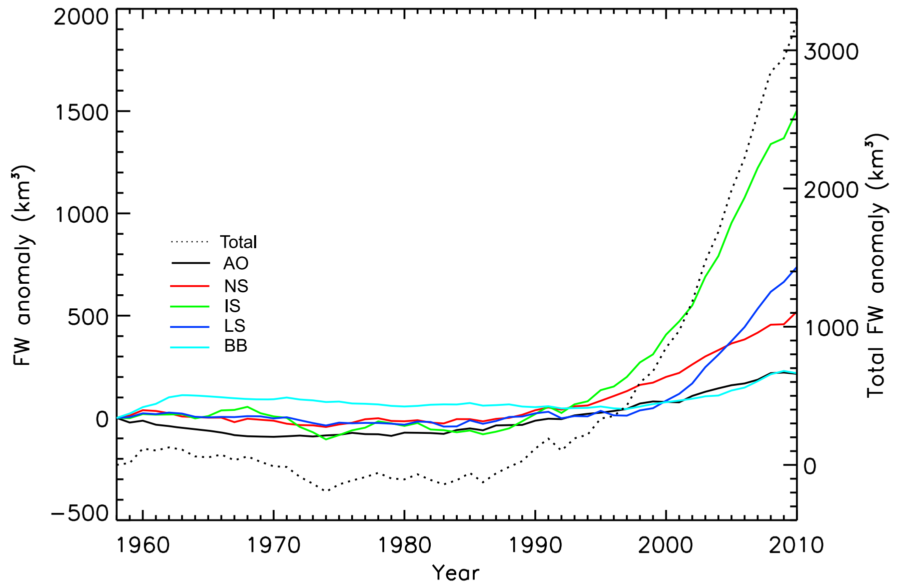
GrIS FW: CALVING + RUNOFF ≈ 1000 km^3 yr^{-1}

Impact on MOC and global climate

(Rahmstorf et al., 2015)

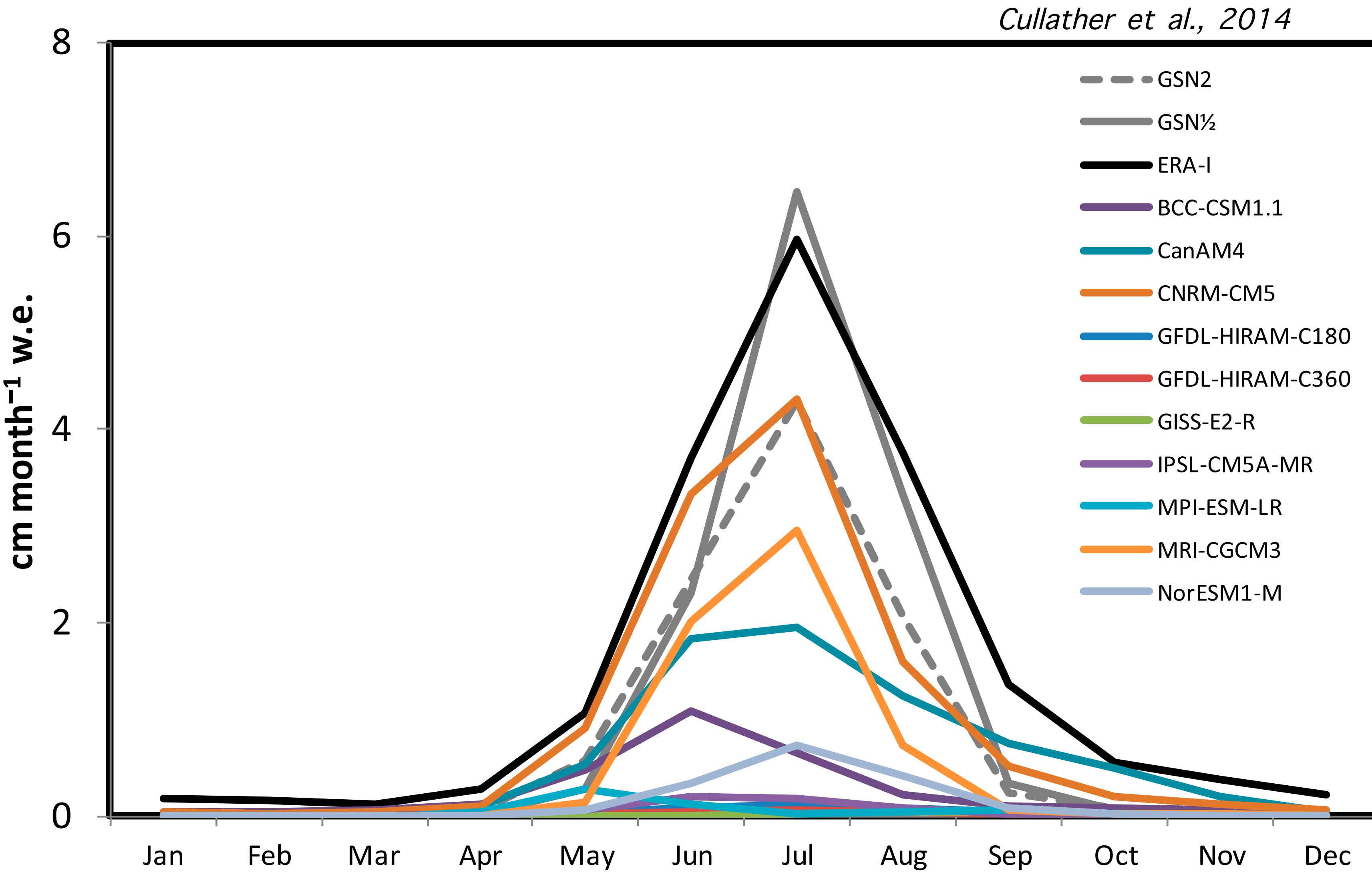
Requires land (ice)-atmosphere-ocean, global modeling framework

- Unrealistic(ally high) hosing
- CMIP5: poor representation of GrIS
  no ice dynamics
  no ice sheet mass loss



Bamber et al., 2012

And no snow scheme…



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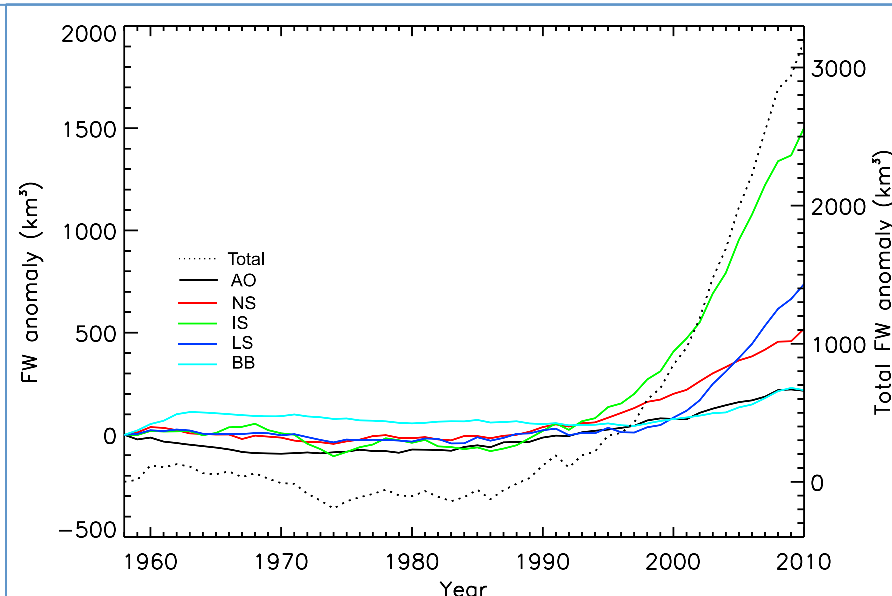


Bamber et al., 2012

This study:

(Re)construct past and future GrIS FW

Analyze impact in coupled climate model

Calving rates

(Enderlyn et al., 2014)

From remote sensing observations 2000-2012

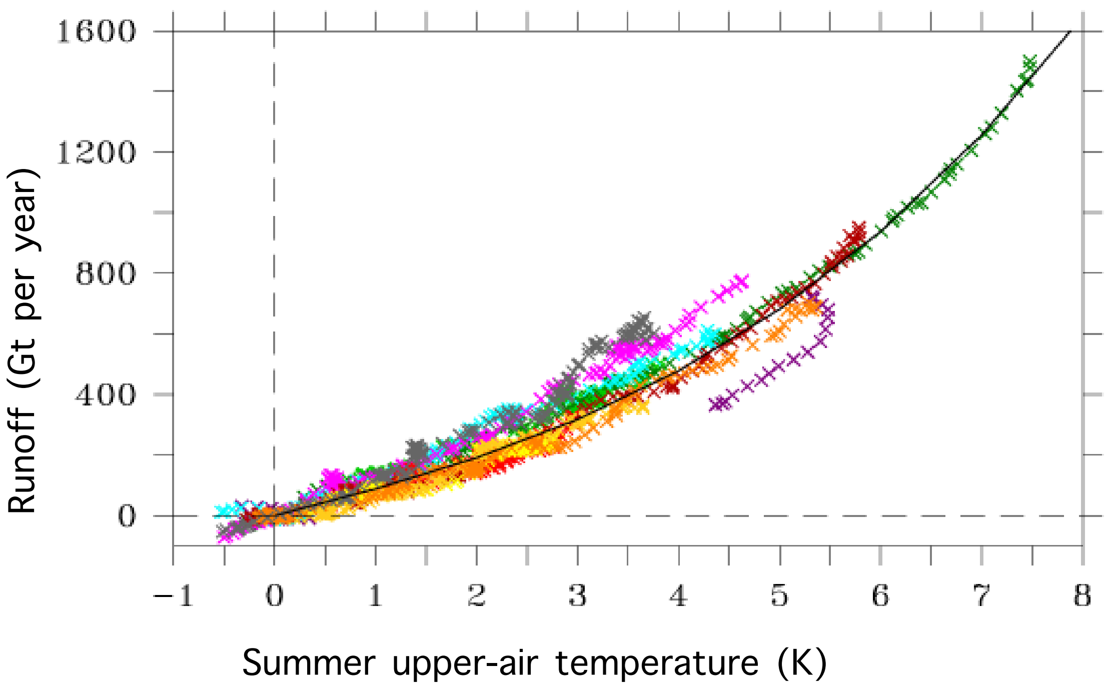
178 glaciers, total calving 520 Gt yr^{-1}

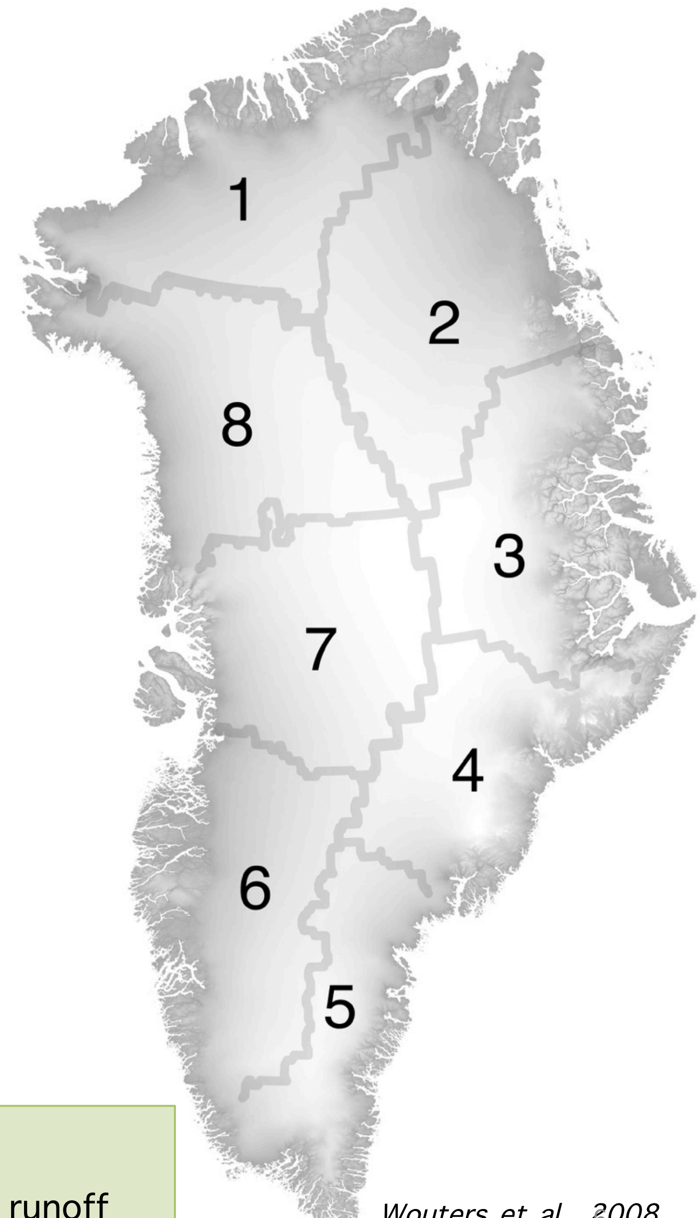
No temporal change: mass loss dominated by enhanced runoff

Assigned to nearest ocean grid point

GrIS runoff (I)

Fettweis et al., 2013





Wouters et al., 2008

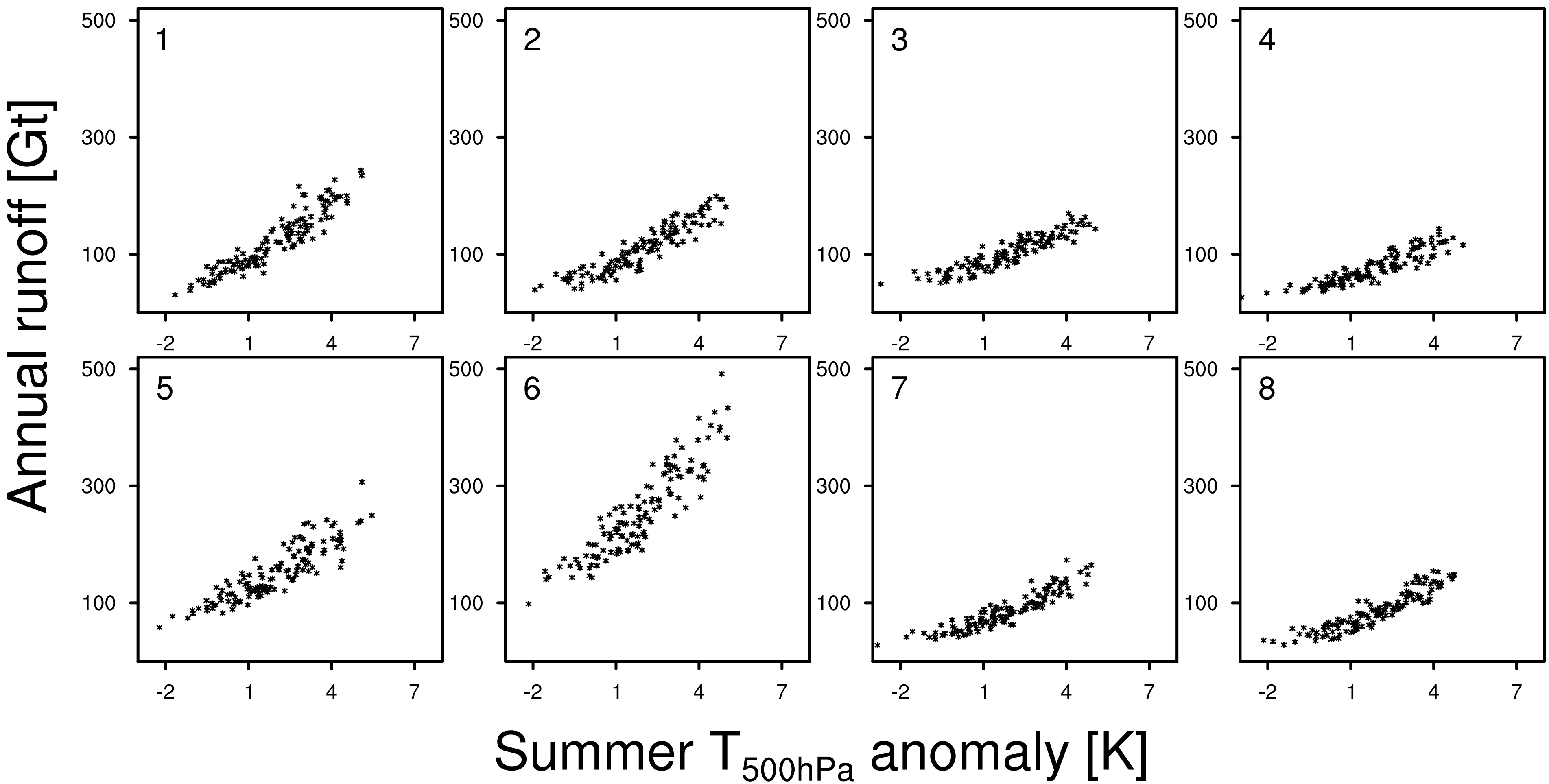
RCM
Runoff vs. T 500hPa

polynomial fit

apply to basins

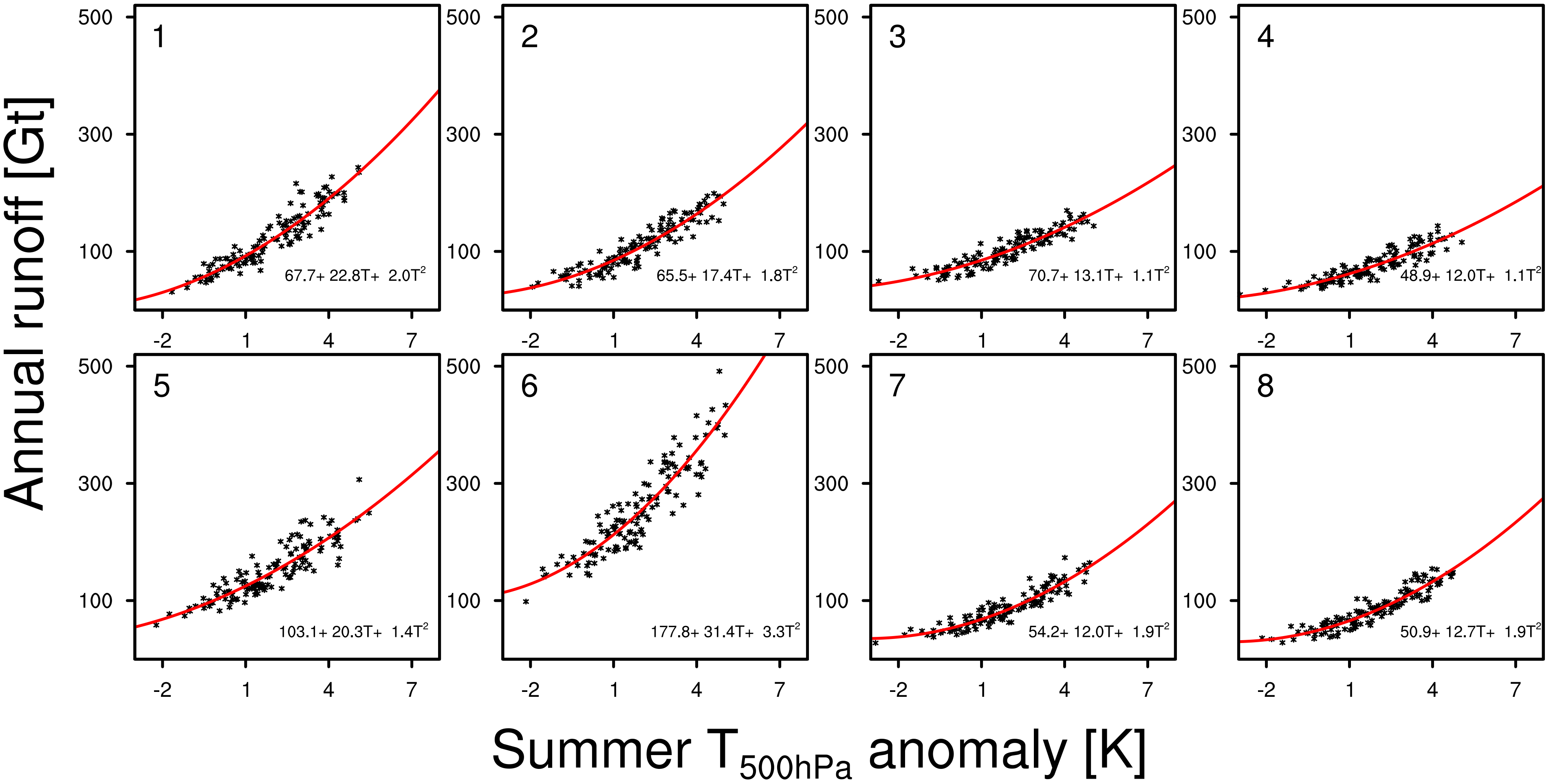
GCM
T 500hPa ➔ runoff

GrIS runoff (II)



Source: RACMO2 forced by HadGEM2-ES RCP4.5 (1971-2100) *(Van Angelen et al., 2013)*

GrIS runoff (II)



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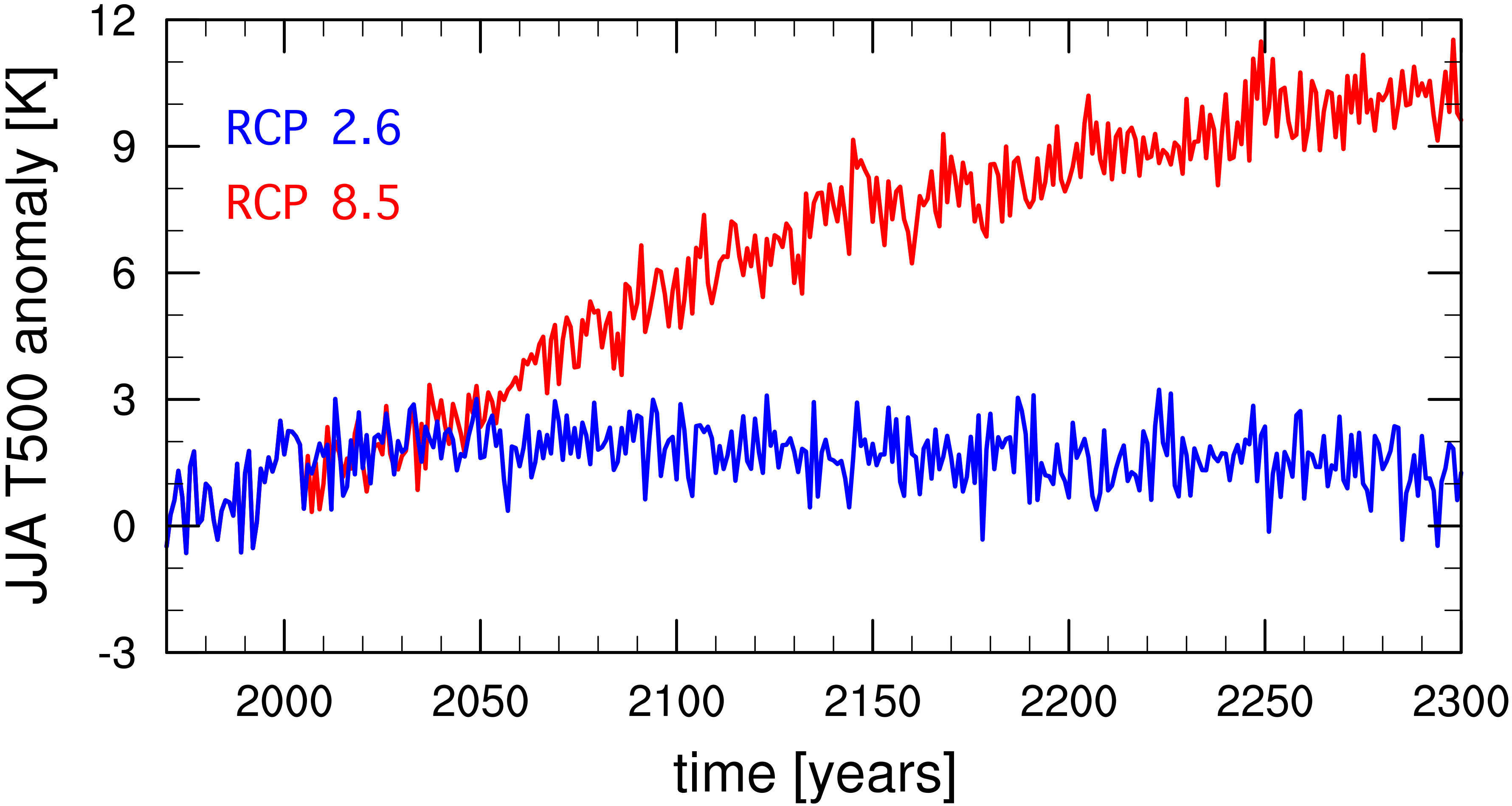
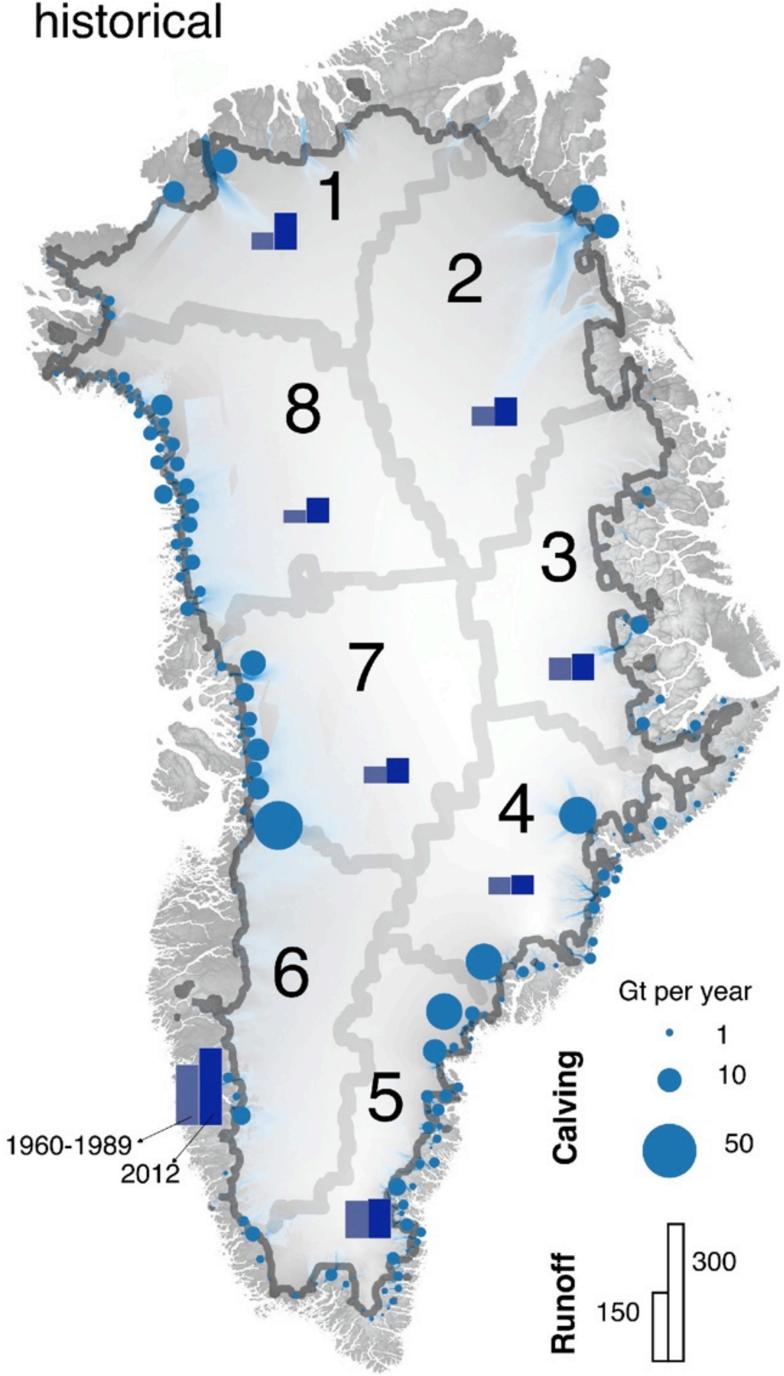
Forcing

CCSM4 T500 evolution until 2300 (Meehl et al., 2012)



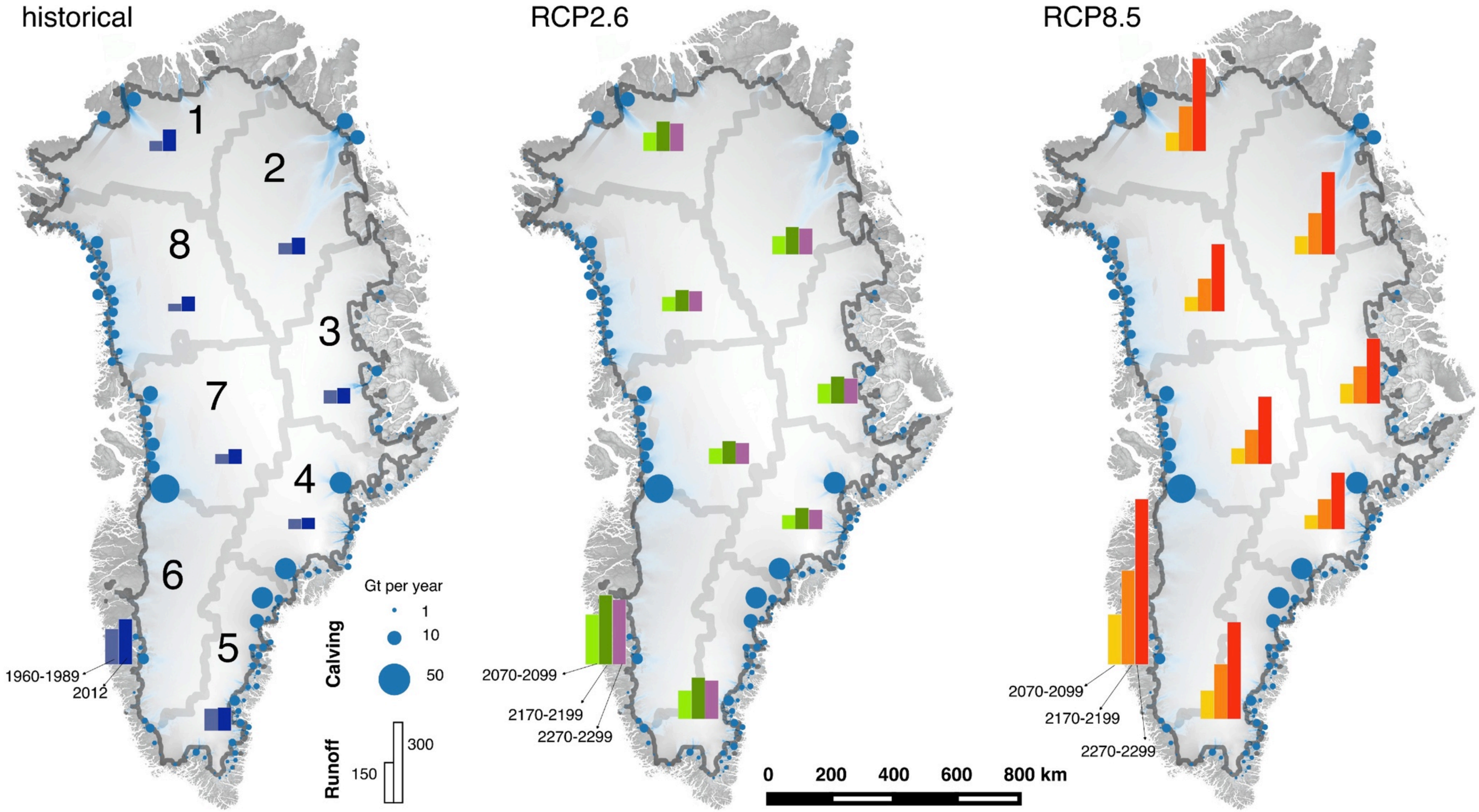


Runoff results (I)

Runoff highest in SW

2012: runoff in Northern Greenland

Runoff results (II)



1960-1989: ~400 Gt yr^{-1} ~1000 Gt yr-1 ~2600 Gt yr^{-1}

2012: ~700 Gt yr^{-1}, most in N (0.06 Sv)

Model setup

Global, land-ocean-atmosphere coupled CESM

Snow model, realistic SMB & runoff (*Vizcaino et al., 2013*)

~1 degree resolution

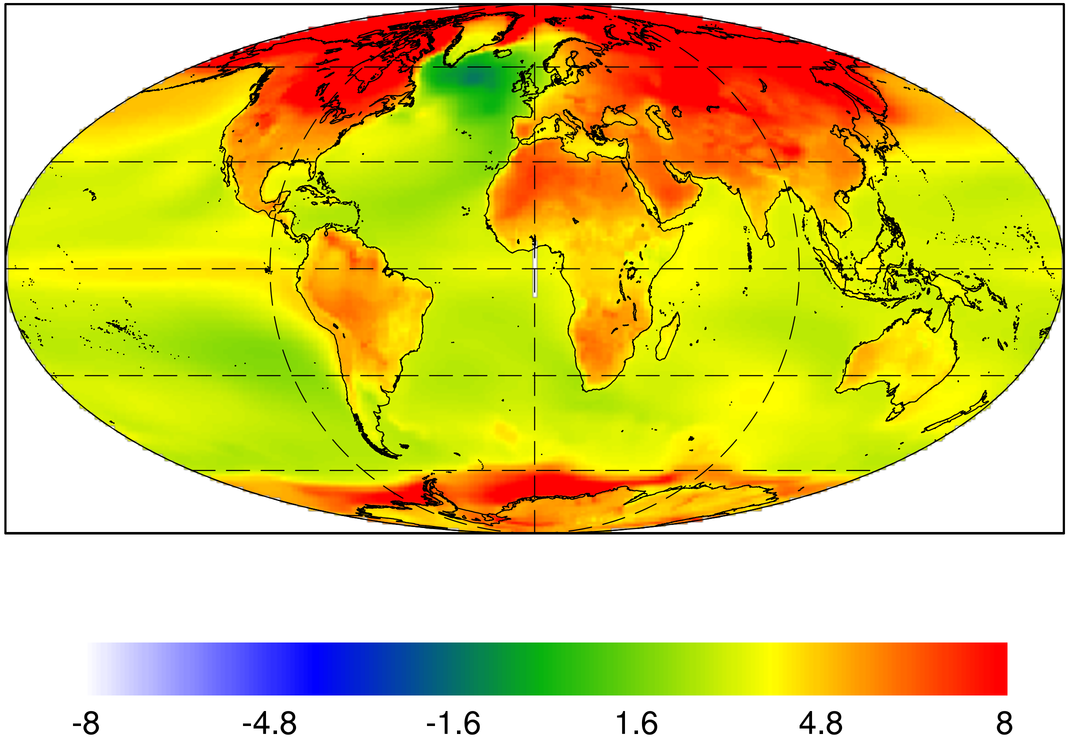
Two **forcings**

(RCP 2.6, RCP 8.5 capped)

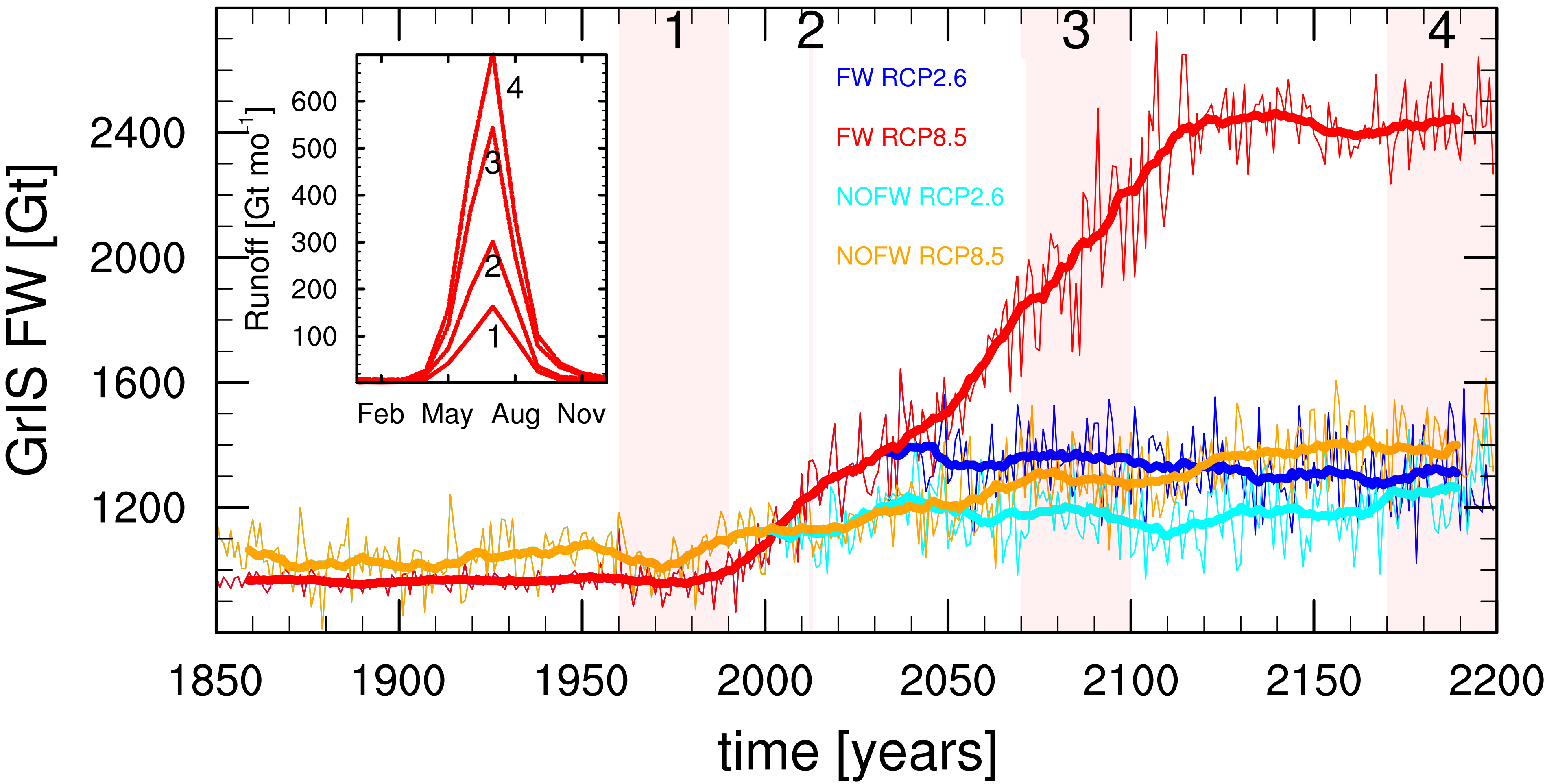
Two **experiments**

(FW, NO FW)

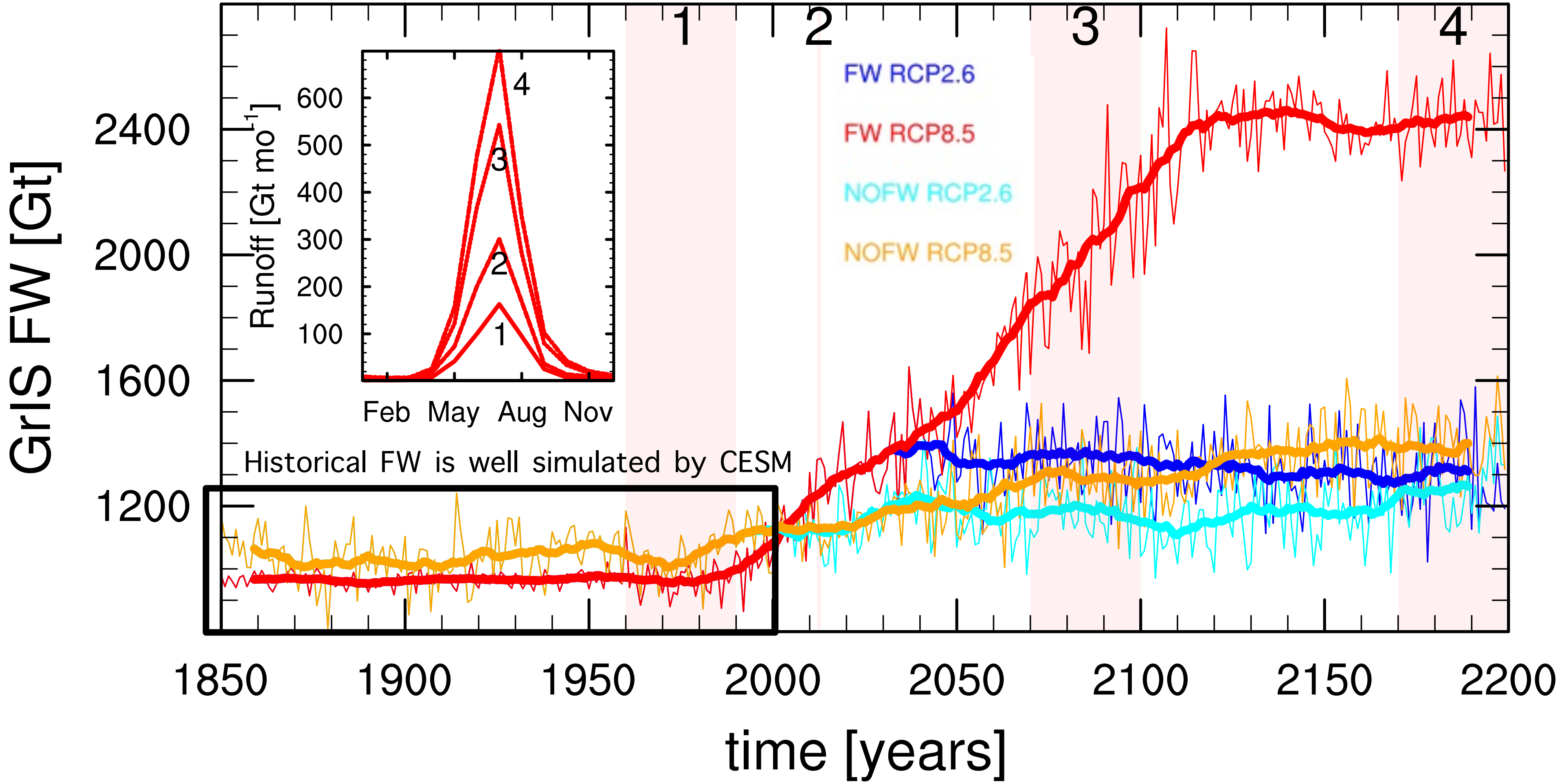
1850-2200



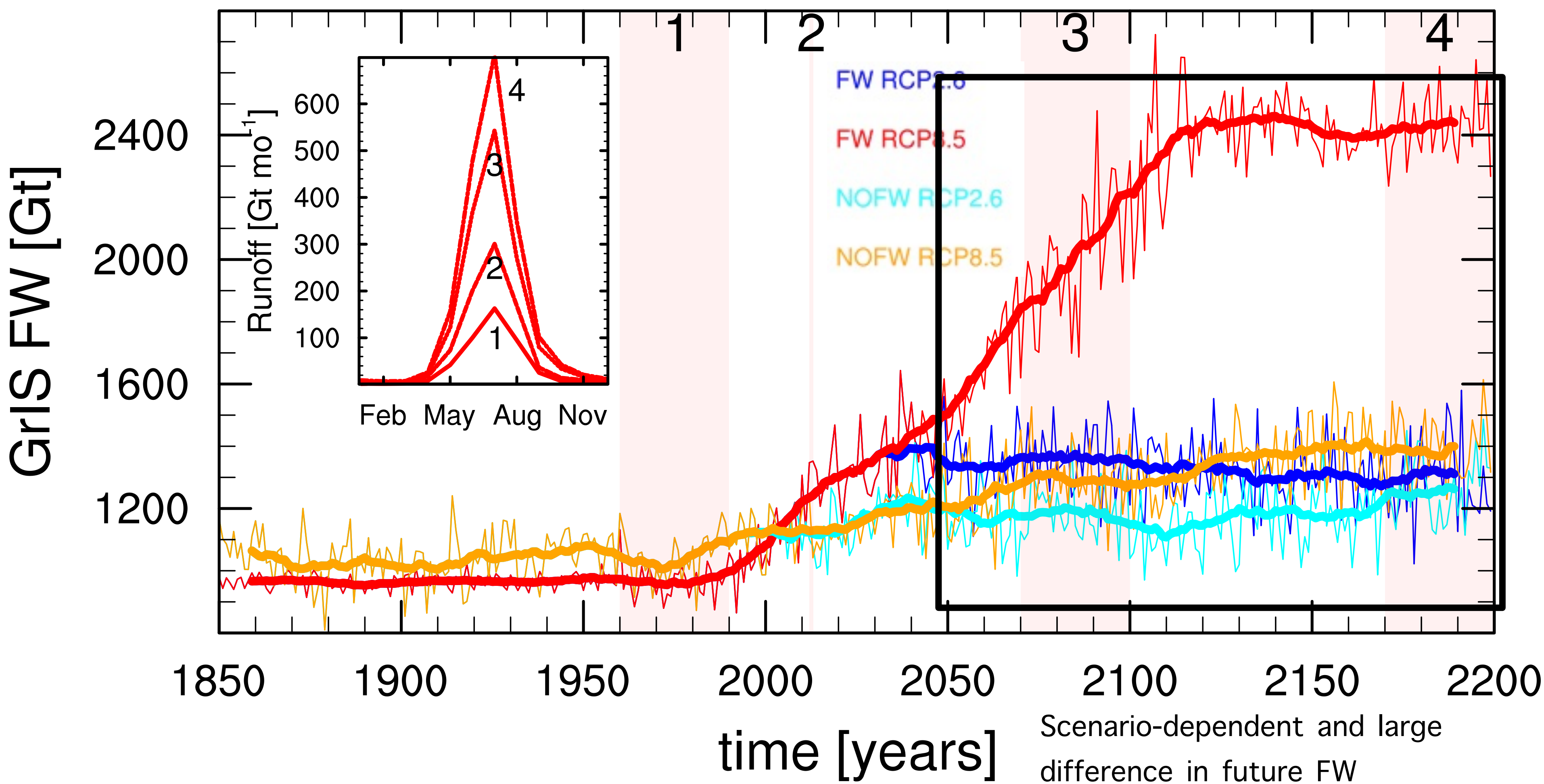
Simulated GrIS FW



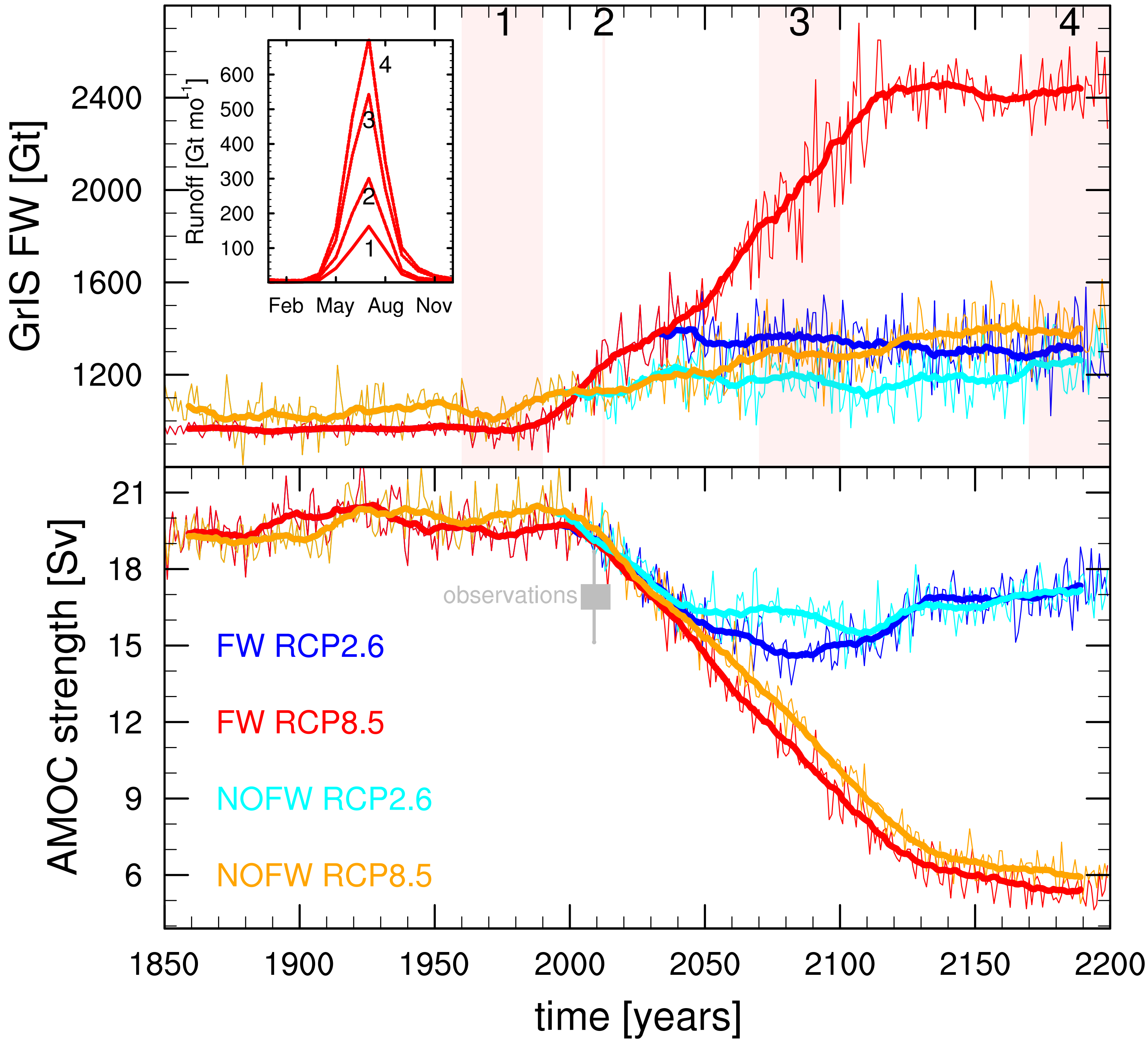
Simulated GrIS FW

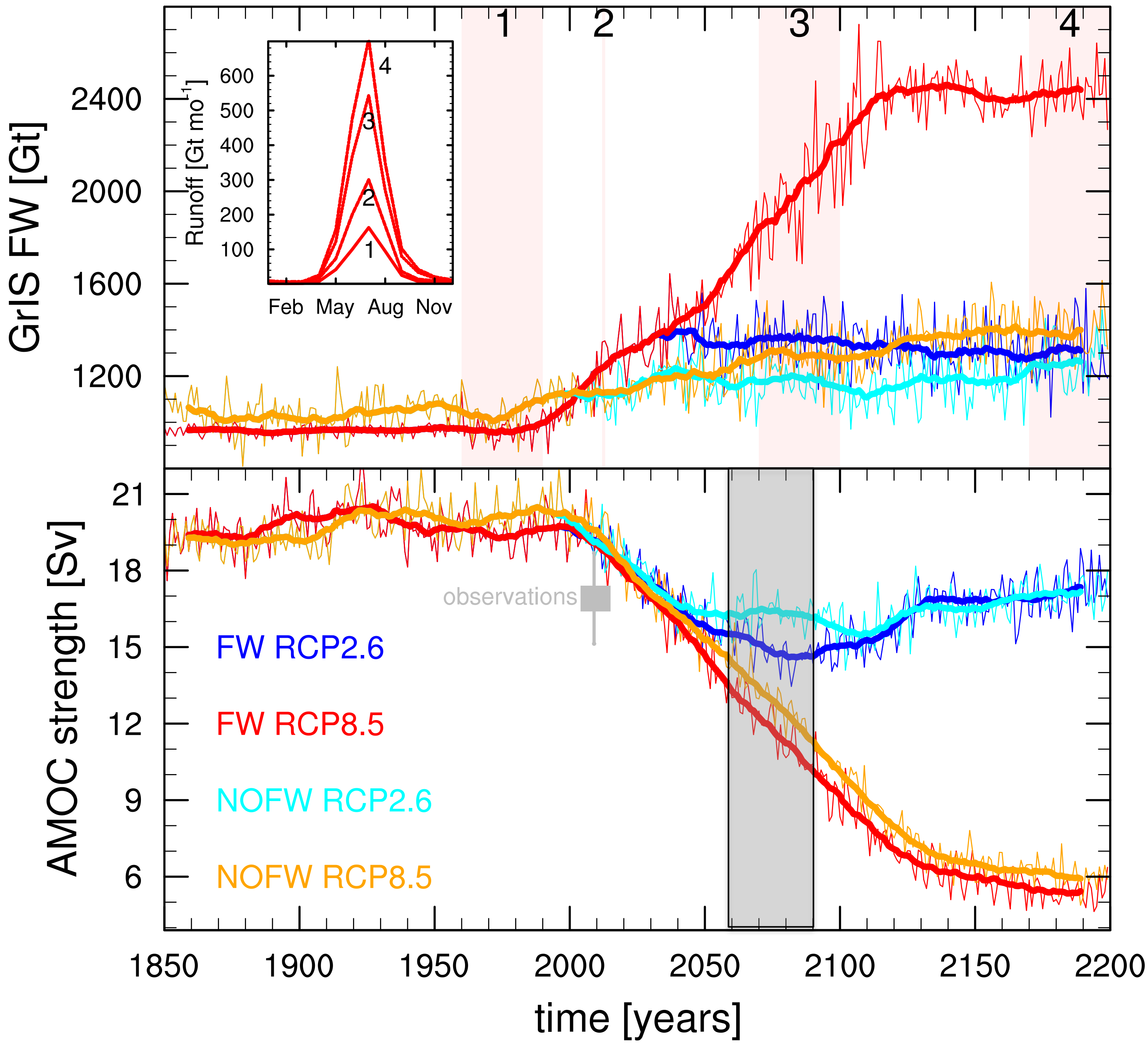


Simulated GrIS FW



Scenario-dependent and large difference in future FW


GrIS FW [Gt]
2400
2000
1600
1200
1
2
3
4
Runoff [Gt mo-1]
600
500
400
300
200
100
Feb
May
Aug
Nov
AMOC strength [Sv]
21
18
15
12
9
6
observations
FW RCP2.6
FW RCP8.5
NOFW RCP2.6
NOFW RCP8.5
1850
1900
1950
2000
2050
2100
2150
2200
time [years]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time [years]

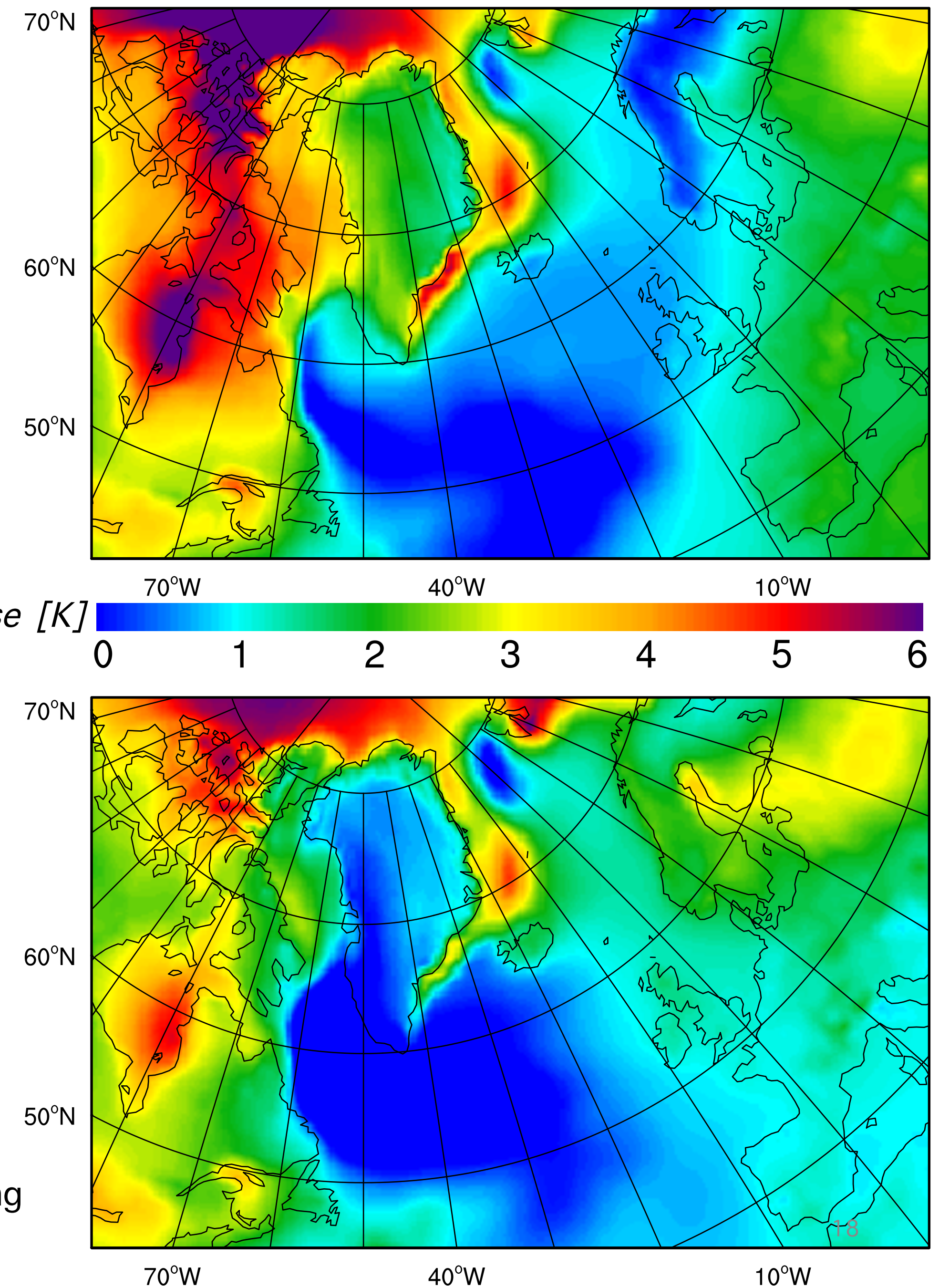
Impact on climate
(RCP 8.5, 2060-2090)

Without freshwater forcing

“CMIP5 style”

Near-surface temperature increase [K]

With freshwater forcing



Conclusions

- "Best estimate" of past, present and future GrIS FW forcing with dominant runoff forcing
  - Southwest GrIS most sensitive to warming
- Limited sensitivity of GrIS melting to ocean and climate dynamics, with temporary effects on climate
  - MOC slowdown occurs ~10-20 years earlier
- Climate models should improve snow physics for reliable SMB and runoff (->ISMIP6)