Greenland mass changes from 1960 to 2100

Hindcasting and forecasting with PISM and RACMO2/GR

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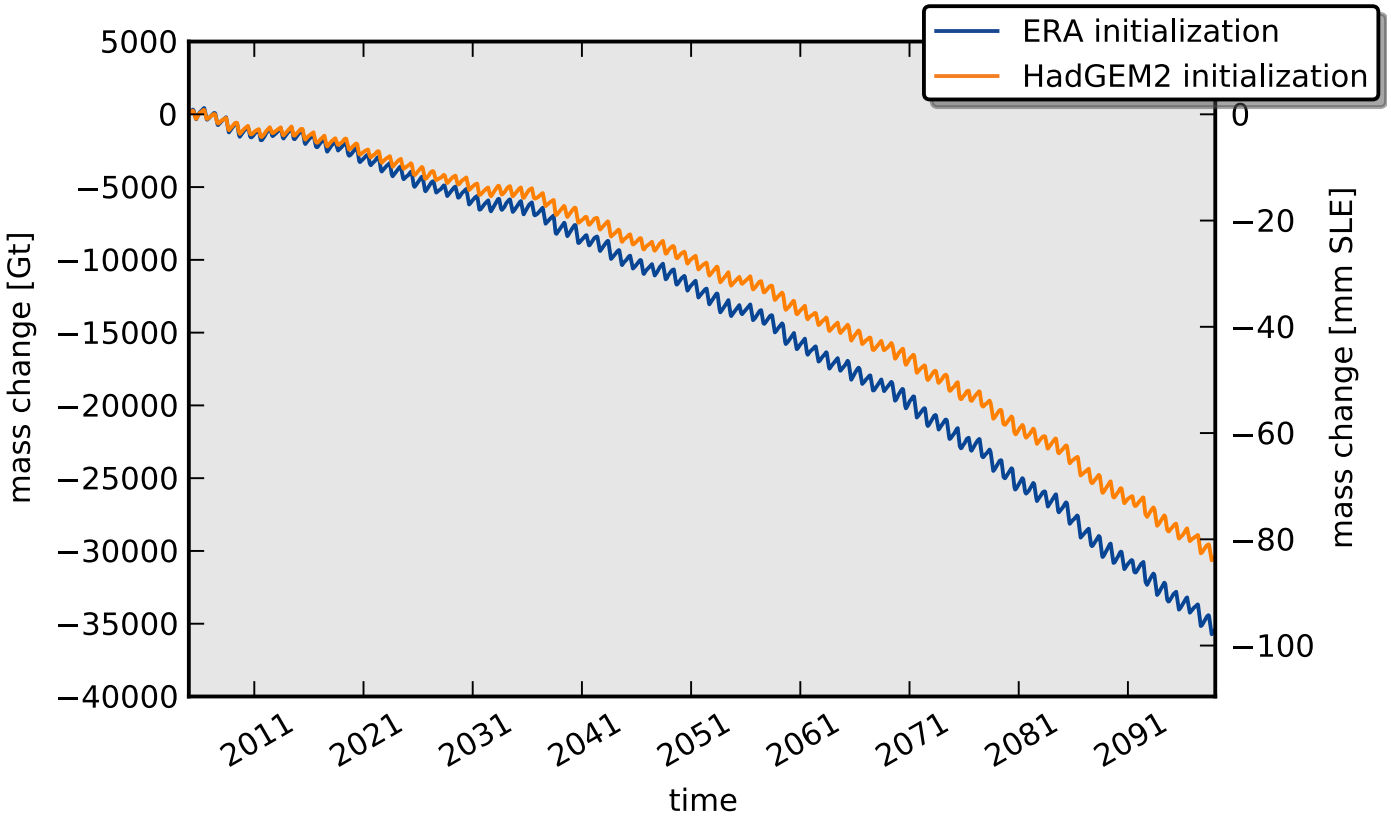
Greenland's future contribution the global sea-level



- produced with the Parallel Ice Sheet Model PISM
- climate forcing from RACMO2/GR using RCP4.5 emission scenario
- what is the difference between the two simulations?

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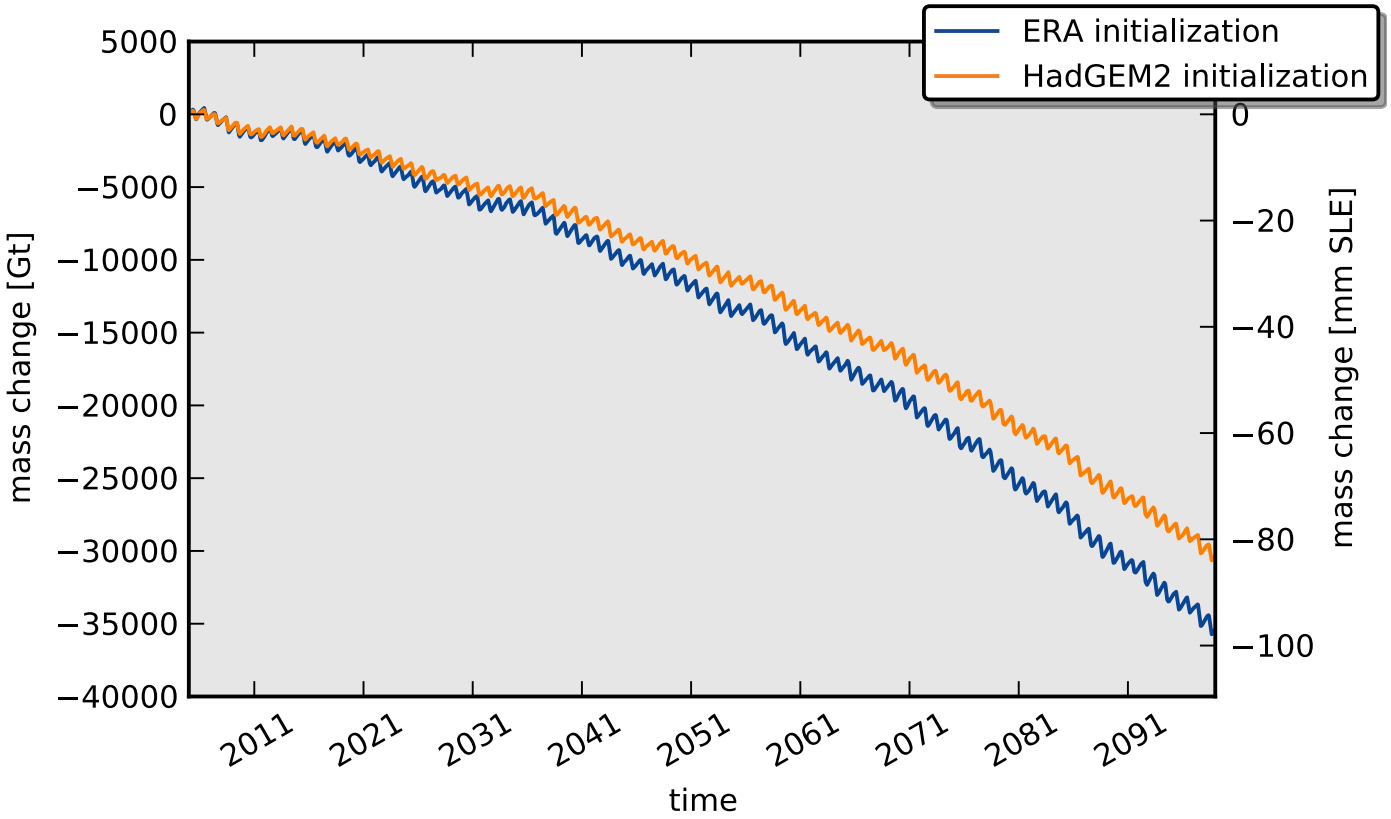

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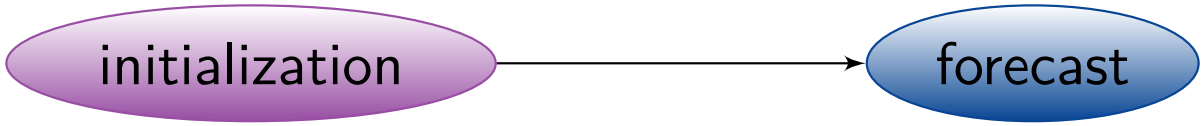
Initialization, hindcast, forecast

"Traditional"



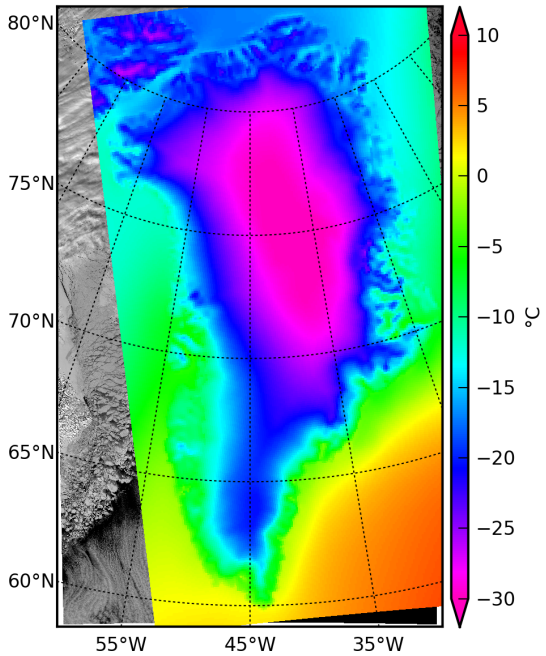
This study

A hindcast is a way of testing a mathematical model. Known or closely estimated inputs for past events are entered into the model to see how well the output matches the known results.

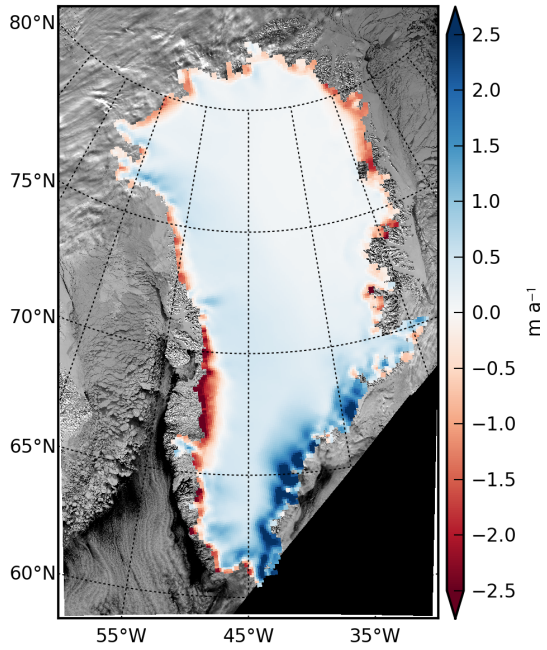
Initialization

- RACMO2/GR driven by
  - ERA-reanalysis from 1961-2004
  - HadGEM2 from 1971-2004
- PISM driven by mean values of:

2 m air temperature



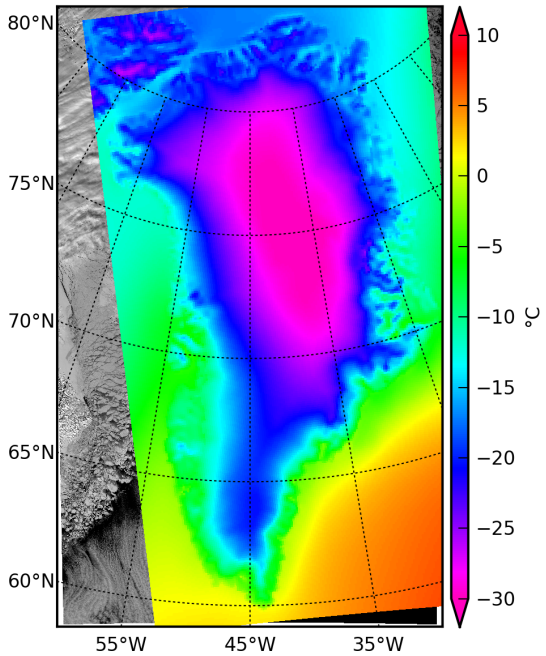
climatic mass balance



Hindcast

- RACMO2/GR driven by
  - ERA-reanalysis from 1961-2004
  - HadGEM2 from 1971-2004
- PISM driven by monthly time-series of:

2 m air temperature



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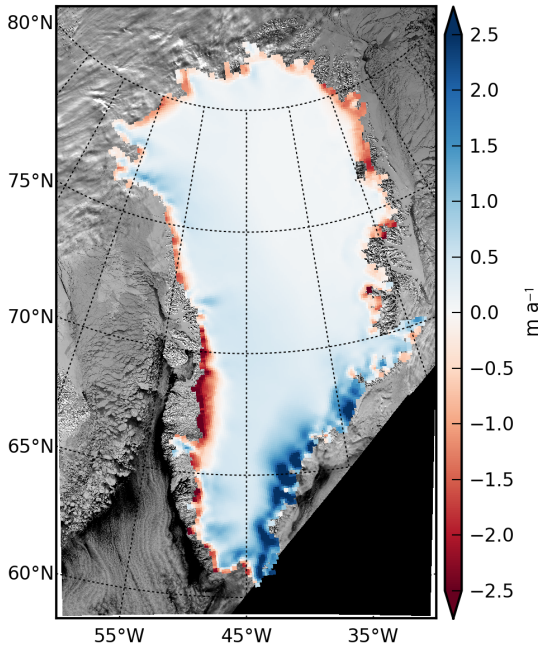
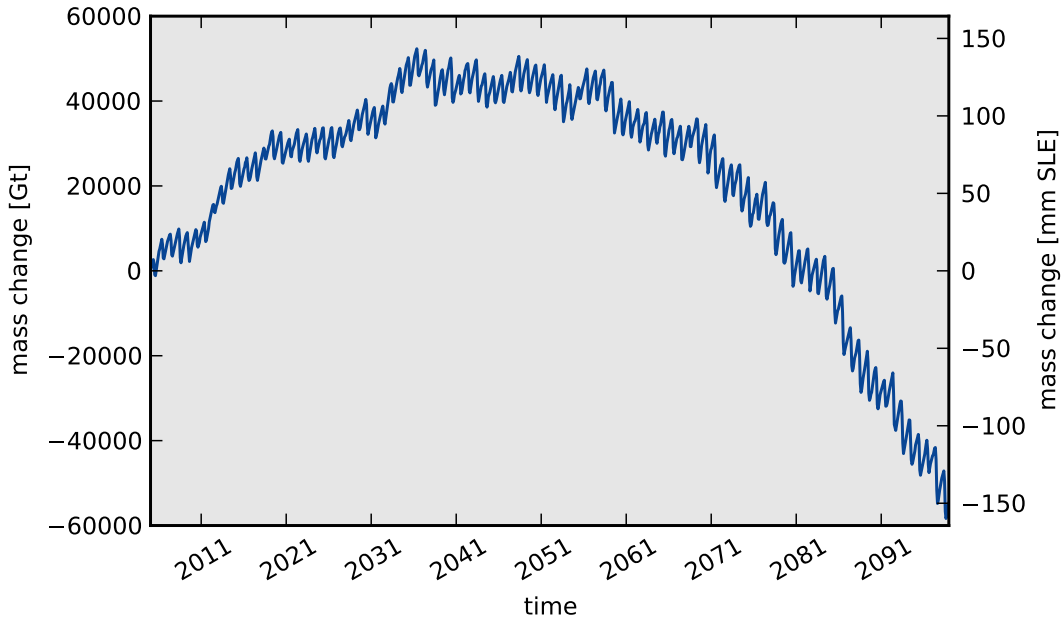


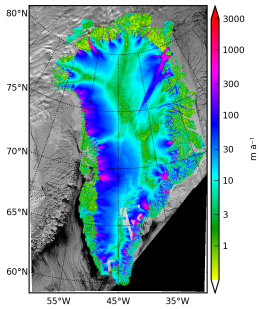
Forecast

- RACMO2/GR driven by HadGEM2 RCP 4.5 forcing
- PISM driven by RACMO climate:
  - RACMO - HadGEM2 directly
  - RACMO - ERA/HadGEM2 anomalies

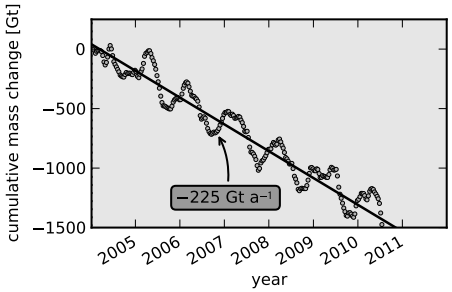


Let's look at the recent history: model validation

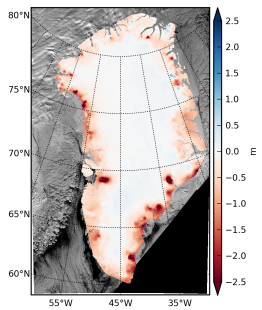
The hindcasts covers an era where we have a variety of in-situ and remotely-sensed observations such as:



- mean flow speed from 2000,2006–2008 (SAR) from *Joughin et al.* (2010)



- cumulative mass change from 2003–2011 (GRACE) from *Luthcke et al.* (under review)



- elevation change from 2003–200 (ICESat) from *Sørensen et al.* (2011)

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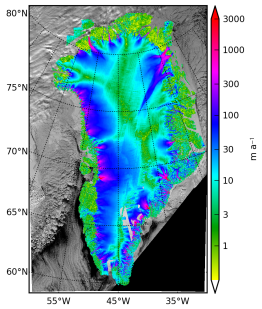

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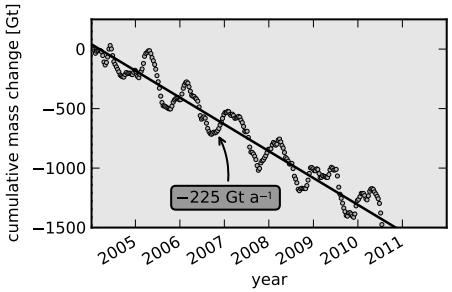

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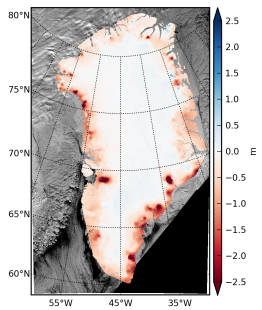

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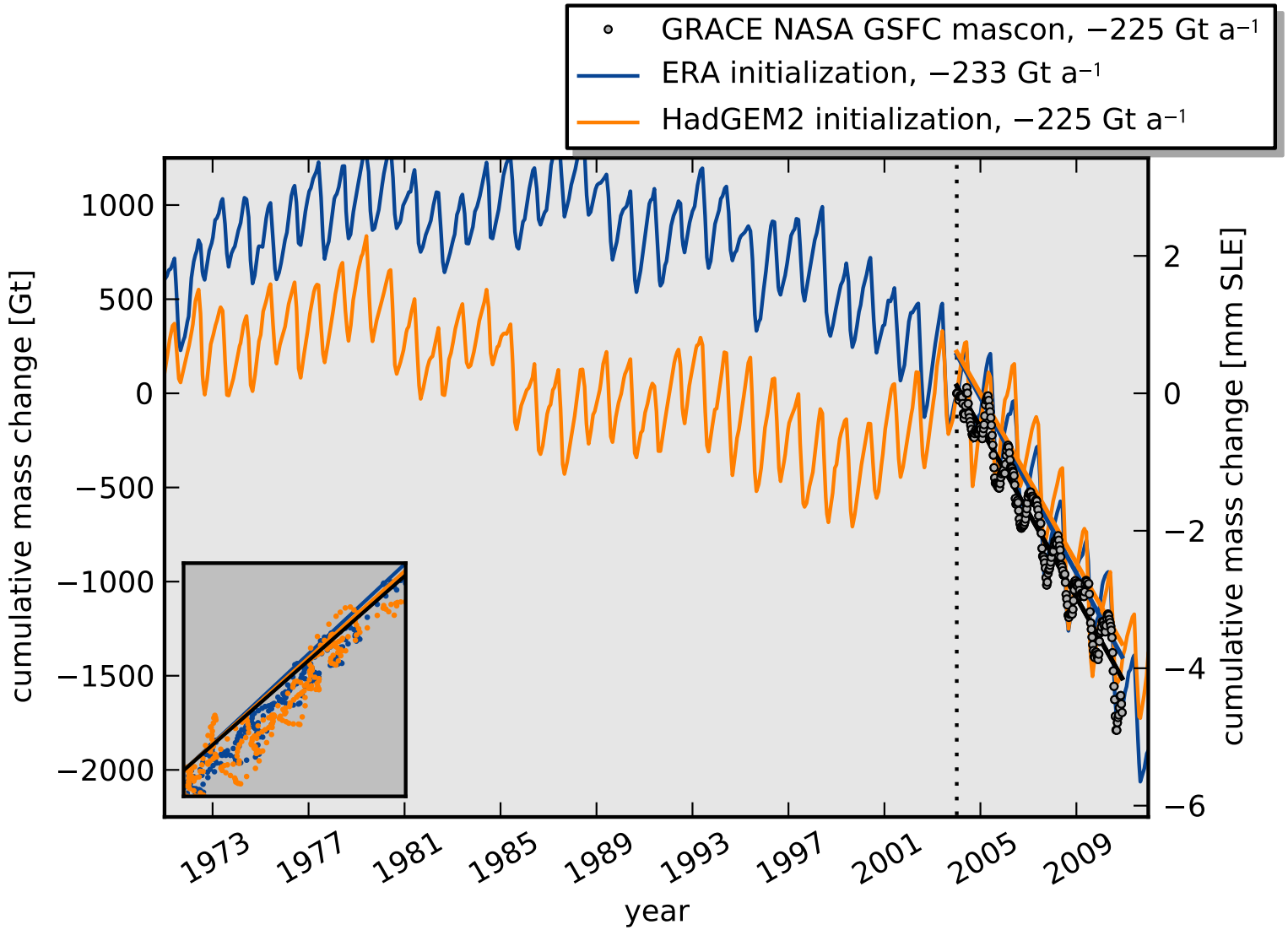
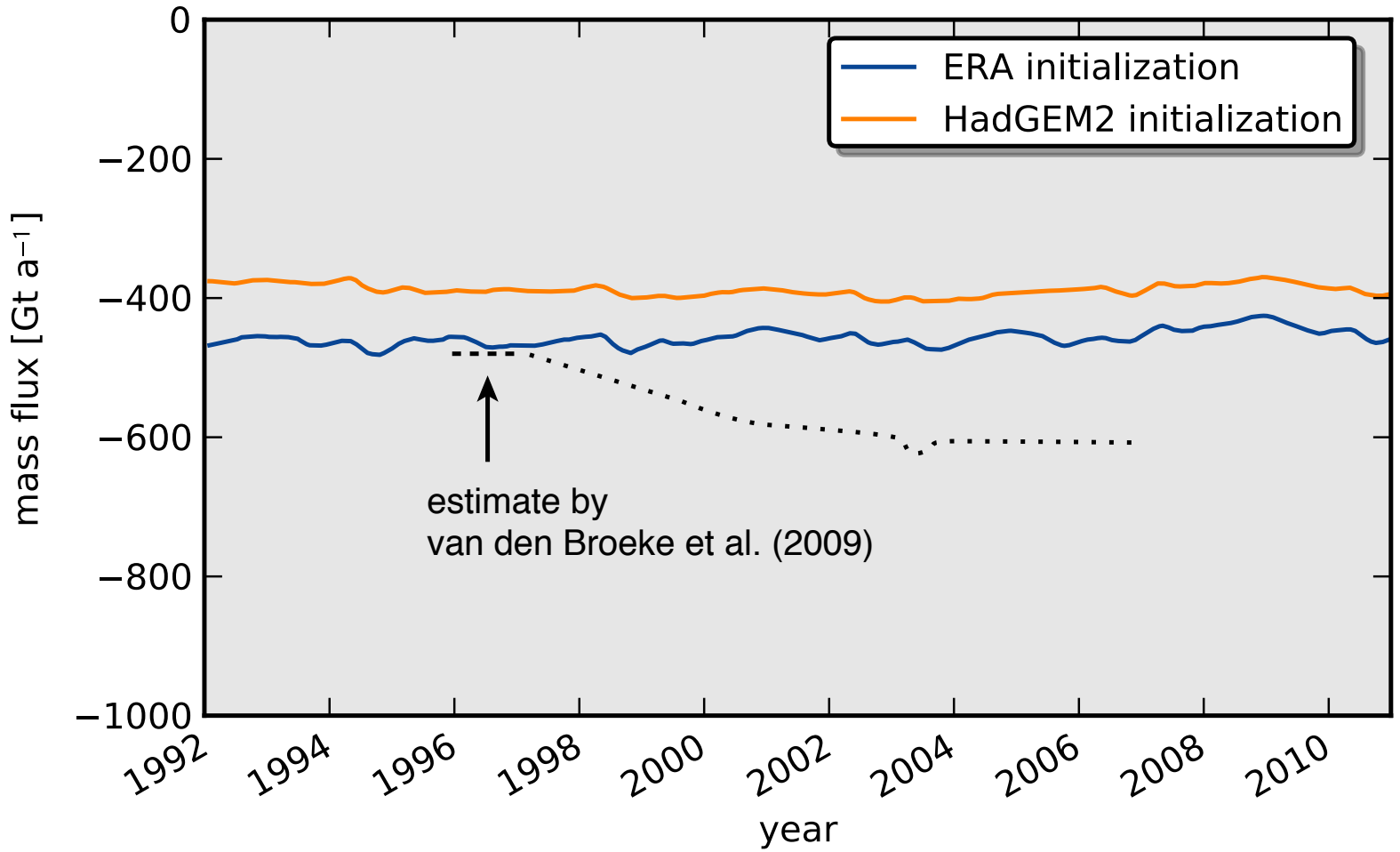
Validation: mass changes



- an almost perfect fit (?)

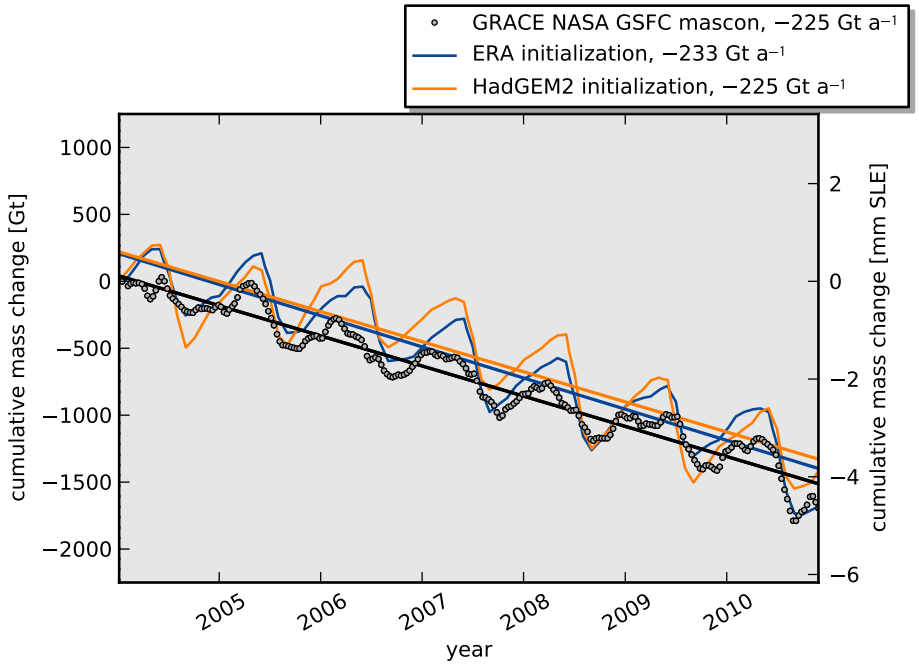
Validation: ice discharge at ice/ocean interface



- observed increase not simulated
- simulated ice discharge remains nearly constant

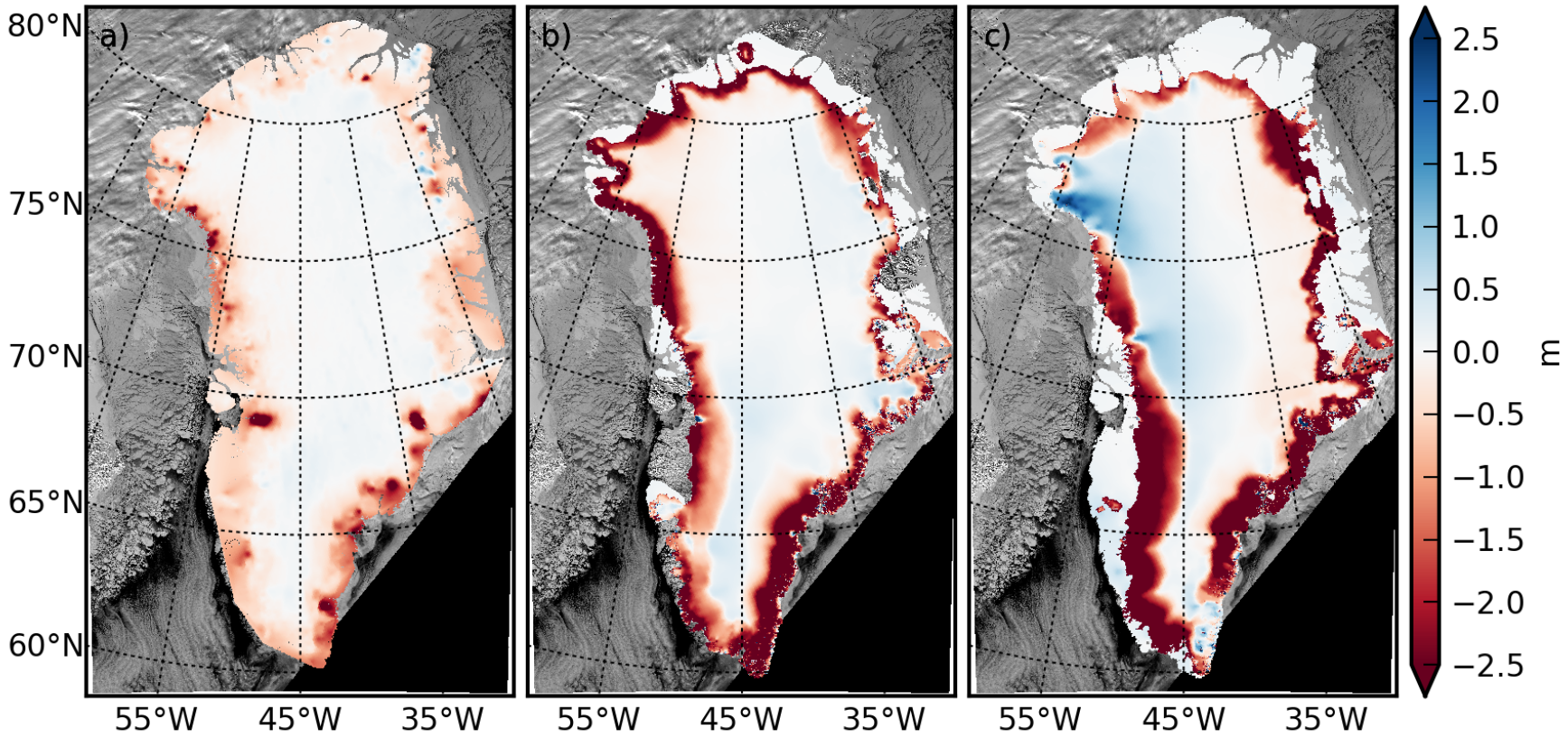
Wait a minute. . .

- 2000–2008 mass changes equally split between changes in surface mass balance and ice discharge (van den Broeke et al, 2009)
- but simulated ice discharge is nearly constant
- why do we get such a good agreement with observed mass loss?



bottom line: careful validation is crucial!

Validation: surface elevation changes 2003–2009



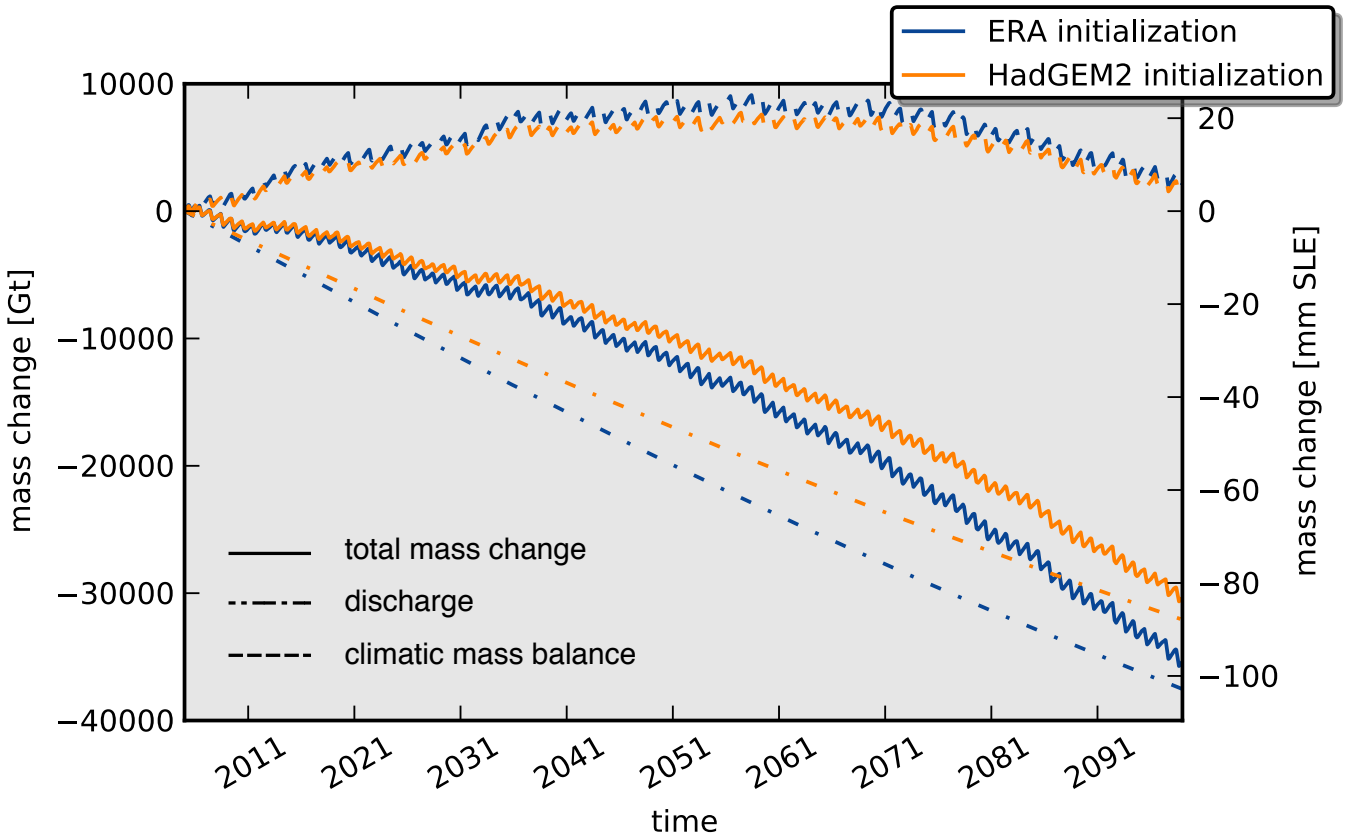
(a) ICESat (Sørensen et al, 2011)

(b) ERA init.

(c) HadGEM2 init.

too much mass loss around the perimeter

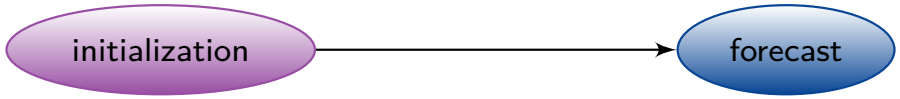
Conclusions I



- despite ERA and HadGEM2 initializations showing very similar mass loss trends between 2004 and 2010, they differ by 2 cm SLE by 2100
- as a result of having different initial states

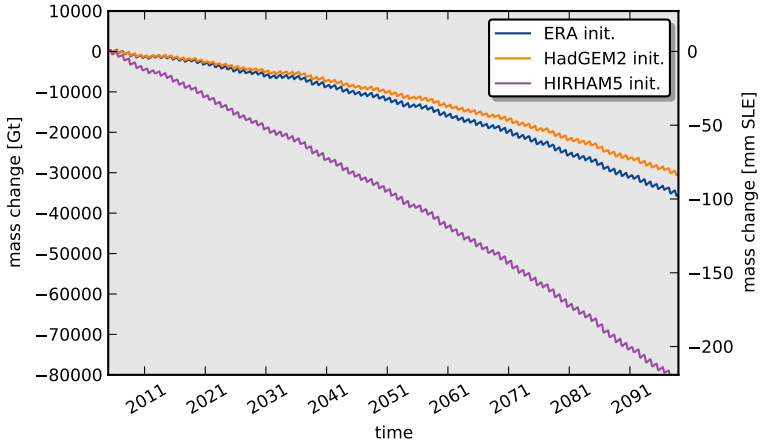
Conclusions II

Switching from



to

facilitates careful and thorough validation of initial states



and allows measuring the sensitivity to initial states