Modeling of the present surface mass balance over the Ellesmere Island using the regional climate model MAR

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Master thesis in Climatology

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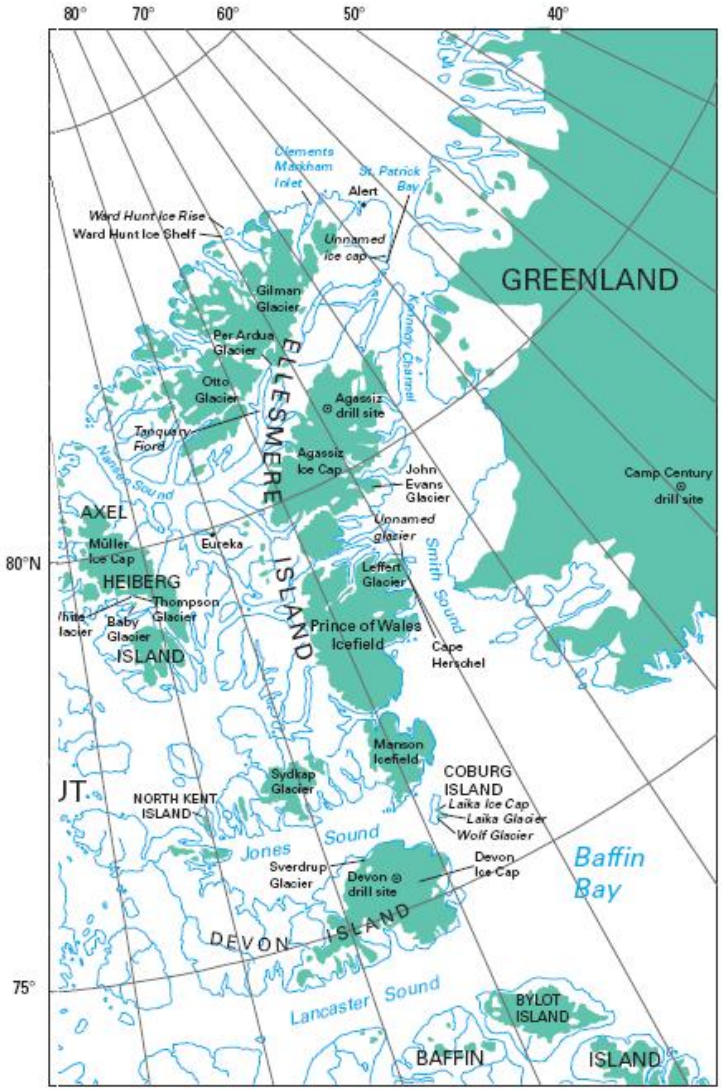
Region of interest



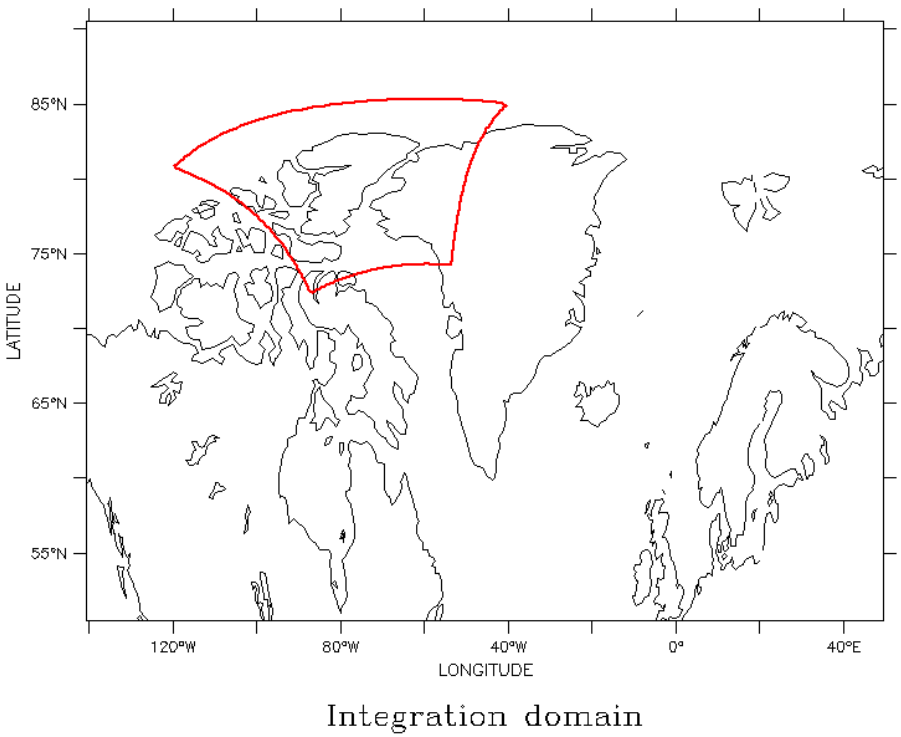


Figure 1: Adapted from Koerner et al. (2002)

Motivation and purpose

- Ellesmere + Baffin : $\frac{1}{3}$ world's land ice (except Grls & Als)
- GRACE (2003-2010) : Highest melting rate for Ellesmere, after Alaska (except Grls & Als) [Jacob et al., 2012]

BUT

- Few observation stations, showing a increasing loss of mass
- Satellite time series too short

What about the models ?

- The PDD models :
  - Gardner et al. (2011) ; Hirabayashi et al. (2010)
  - Statistical downscaling $\Rightarrow$ no future projections

Motivation and purpose

- The RCM, coupled with EBM :
  - Physical downscalling : interactions ice $\Leftrightarrow$ atmosphere
  - Only one study using RACMO2 over Ellesmere [Lenaerts et al., 2013] !

Purpose :
Reconstruction of the present SMB over the Ellesmere Island

Tools :

- The model MAR running at 15 km resolution coupled with a snow module
- The ERA-Interim reanalysis

Results - MAR,ASR,ERA against observations

Comparison valid for 1986, 2006 and 2010 :

- PP :

ME = -18 $\pm$ 23 mm ($\Leftrightarrow$ -15%)

- T2m :

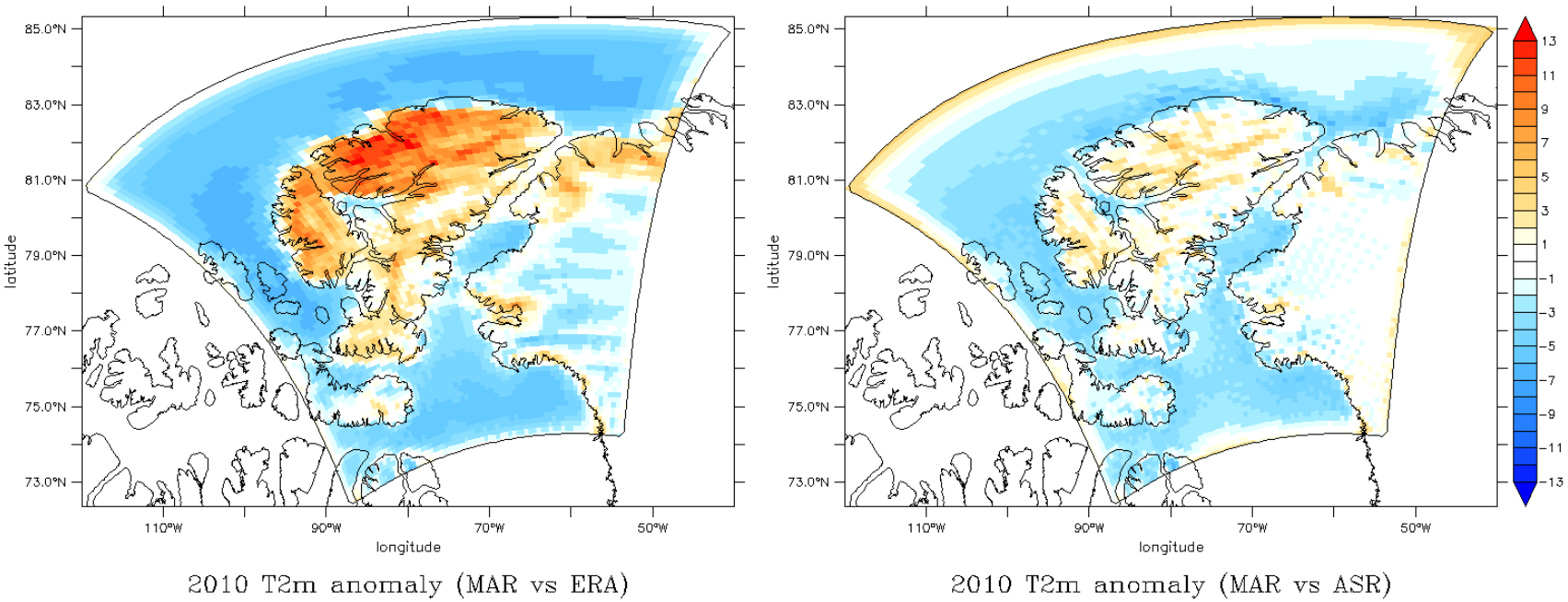
Figure 2: EC weather stations

2010	ERA-Int vs obs	ASR vs obs	MAR vs obs
Correlation	0.96 $\pm$ 0.02	0.97 $\pm$ 0.01	0.96 $\pm$ 0.01
ME	-1.5 $\pm$ 2.0	0.2 $\pm$ 1.7	-0.4 $\pm$ 1.1
MAE	3.9 $\pm$ 0.5	3.0 $\pm$ 0.2	3.2 $\pm$ 0.6

where ME (mean error) = $\frac{\sum(X_i - X_{obs})}{n_{obs}}$ and

MAE (mean absolute error) = $\frac{\sum(|X_i - X_{obs}|)}{n_{obs}}$

Results - MAR against ERA-Interim and ASR

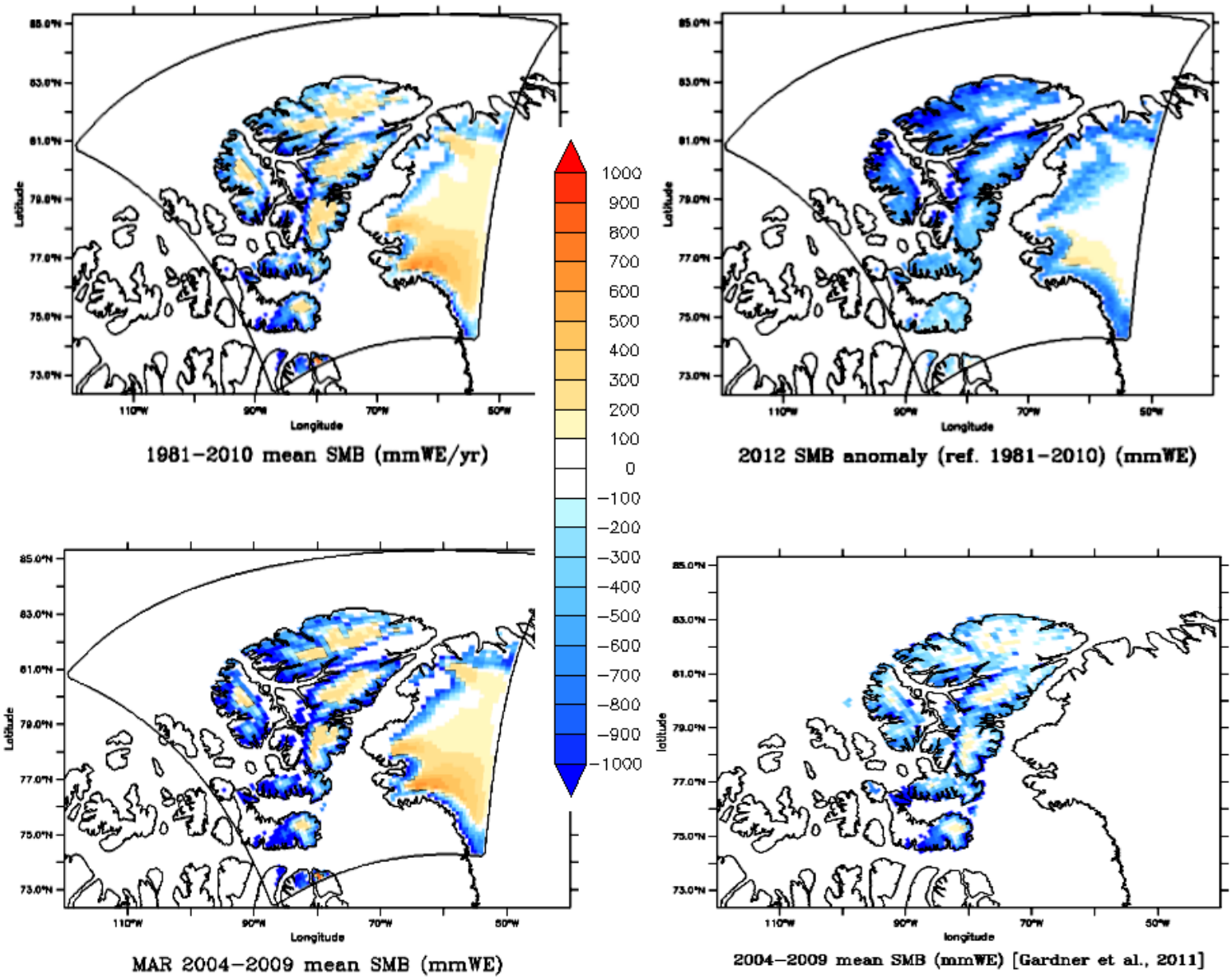


2010 T2m anomaly (MAR vs ERA)

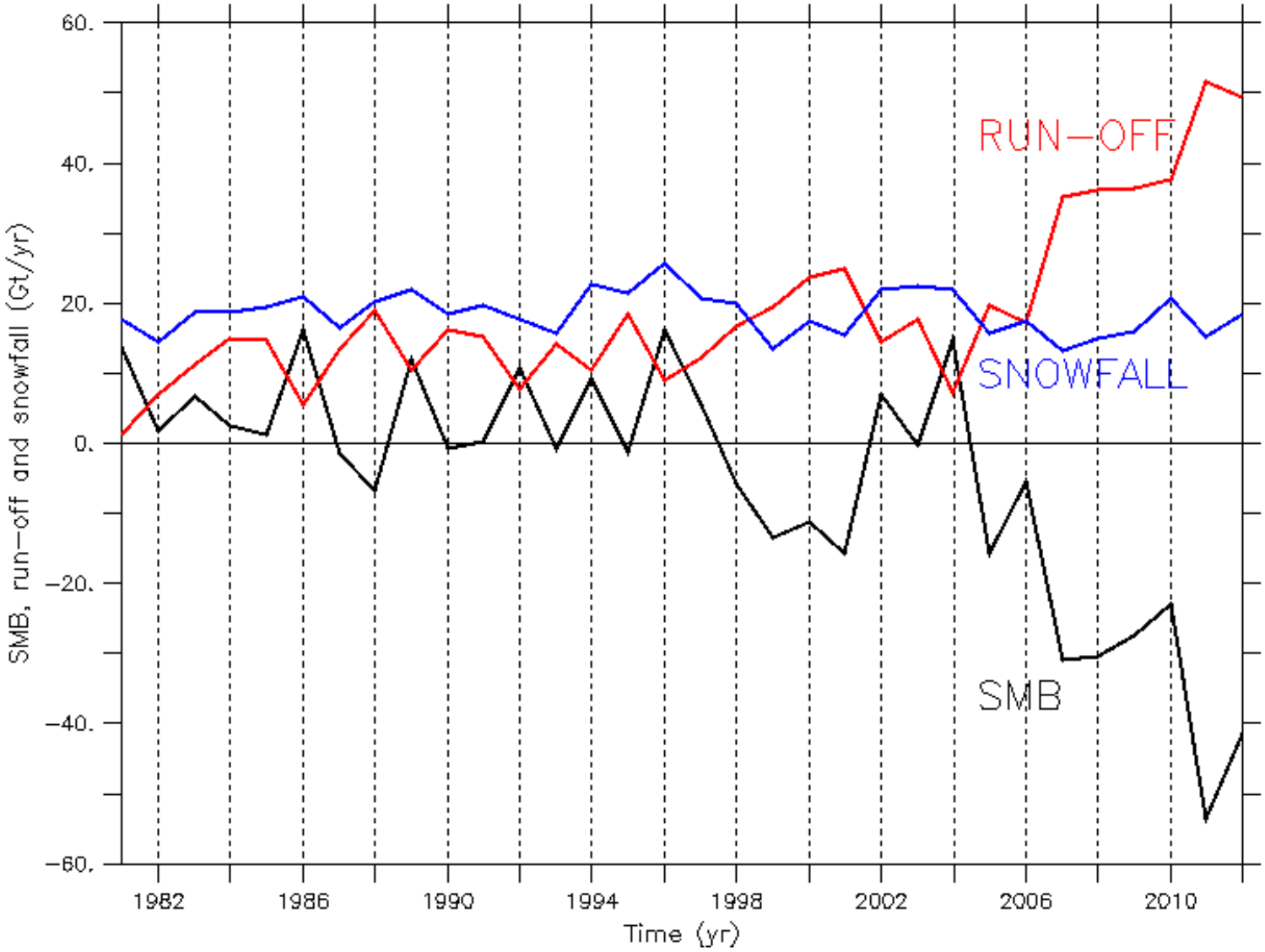
2010 T2m anomaly (MAR vs ASR)

Figure 3: Influence of the resolution on the near-surface temperature

Results - SMB

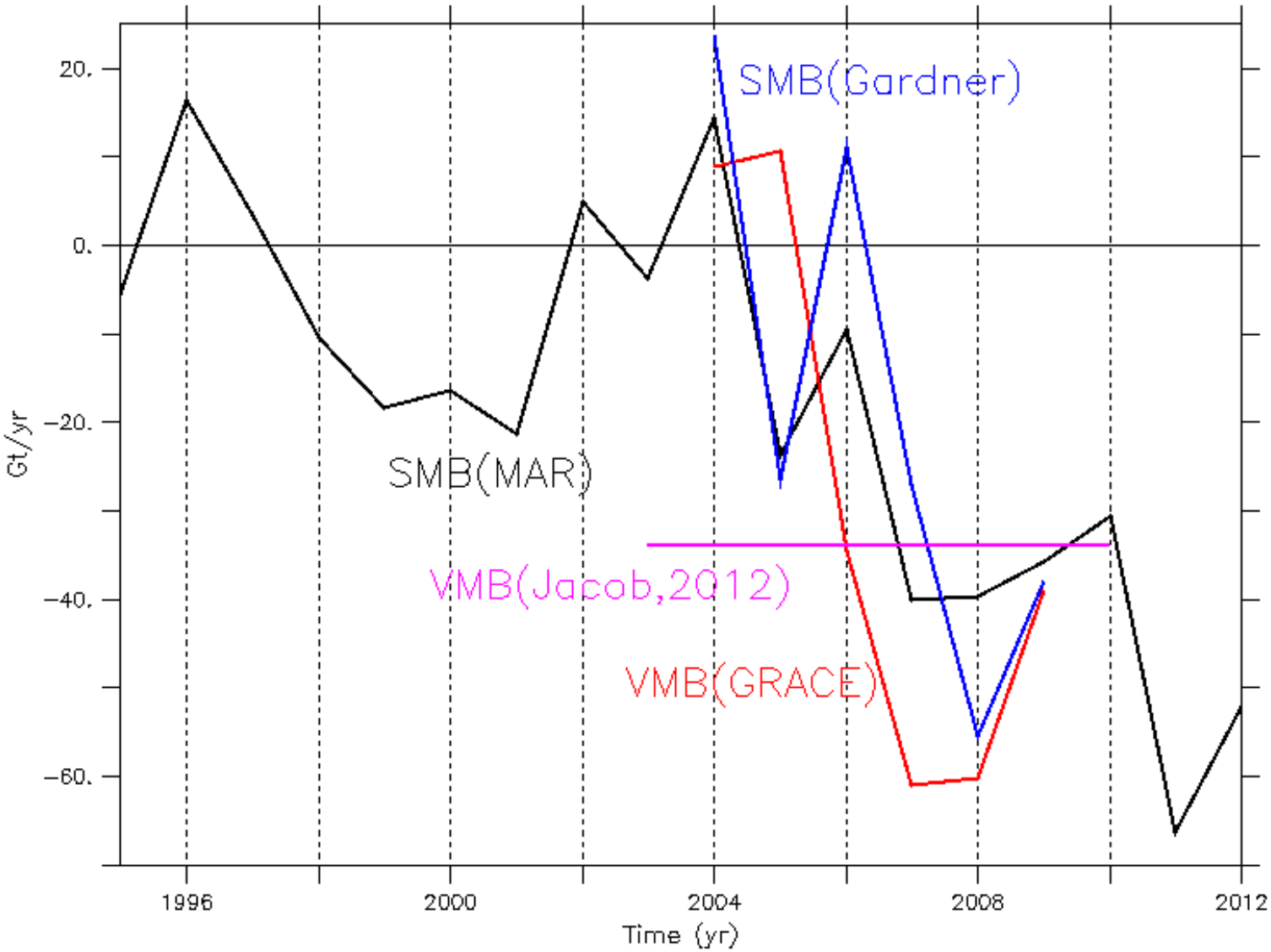


Results - SMB



Evolution of the SMB and its main components

Results - SMB



MAR,GRACE and Gardner loss of mass

Conclusion and Perspectives

The MAR shows an acceleration of the mass loss over 1981-2012, due to the increasing run-off. The SMB, becoming more and more negative since 2005, reaches records in 2011 and 2012.

My plan :

- 1958-1979 + future projections
- Increasing the spatial resolution to 5$\sim$10 km
- Coupling with the Elmer ice sheet model
- ...

Thank you for your attention !

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