

Interest of a Regional Climate Model for doing future projections over the Greenland Ice Sheet

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Talk #1528

Plan

Advantages of RCM vs GCM:

1. physics tuned and developed for a specific area.
2. spatial resolution.

Drawbacks of RCM vs GCM:

1. add an additional uncertainty.
2. dependent of the forcing fields.



Ref: Fettweis et al., TC, 2017.

Plan

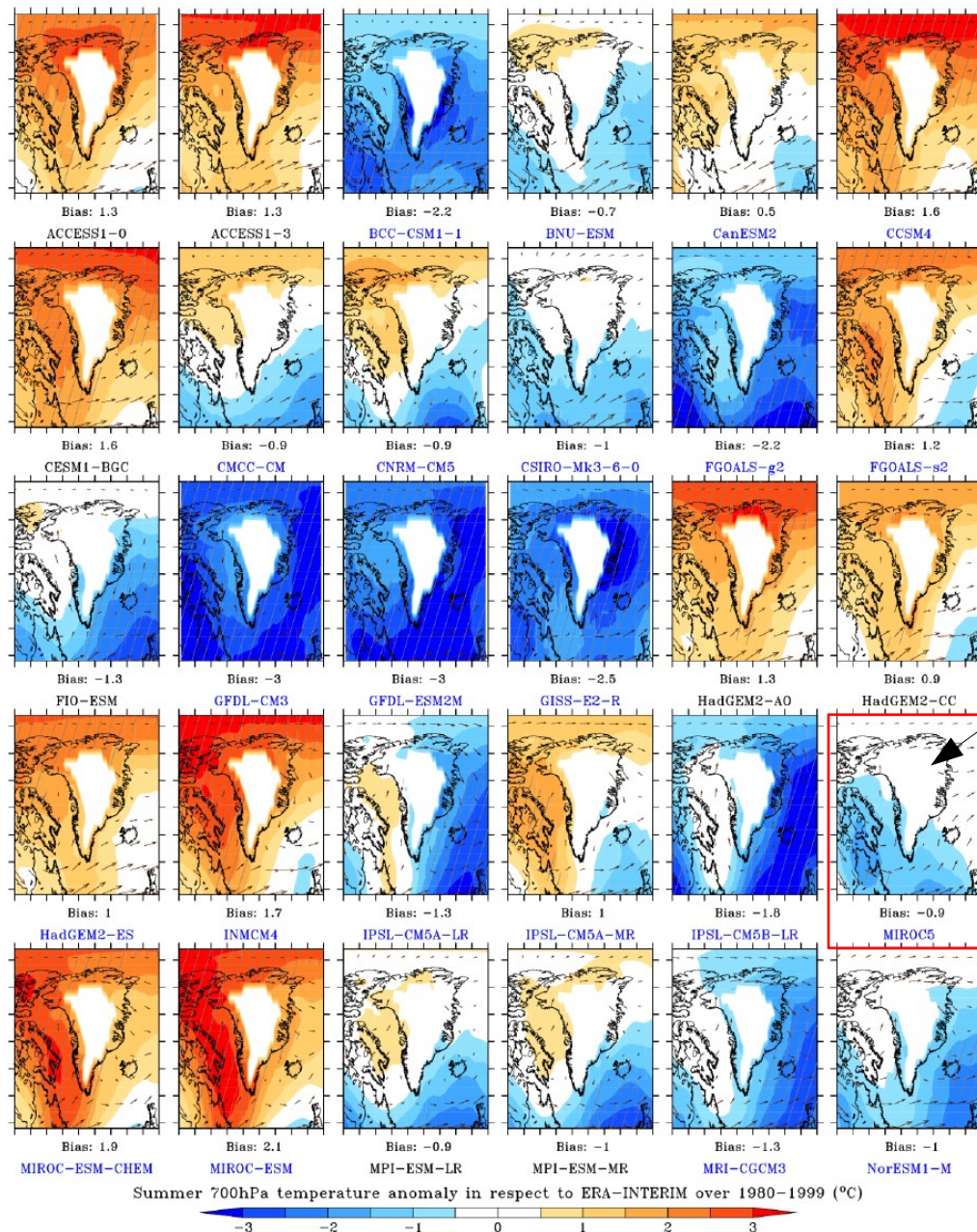
Interest of the use of the **regional model MAR** to

- ➔ compute future anomalies of temperature and precipitation over Greenland (at low resolution).
- ➔ estimate the impact of potential circulation changes to future GrIS SMB projections.

1. future anomalies over Greenland

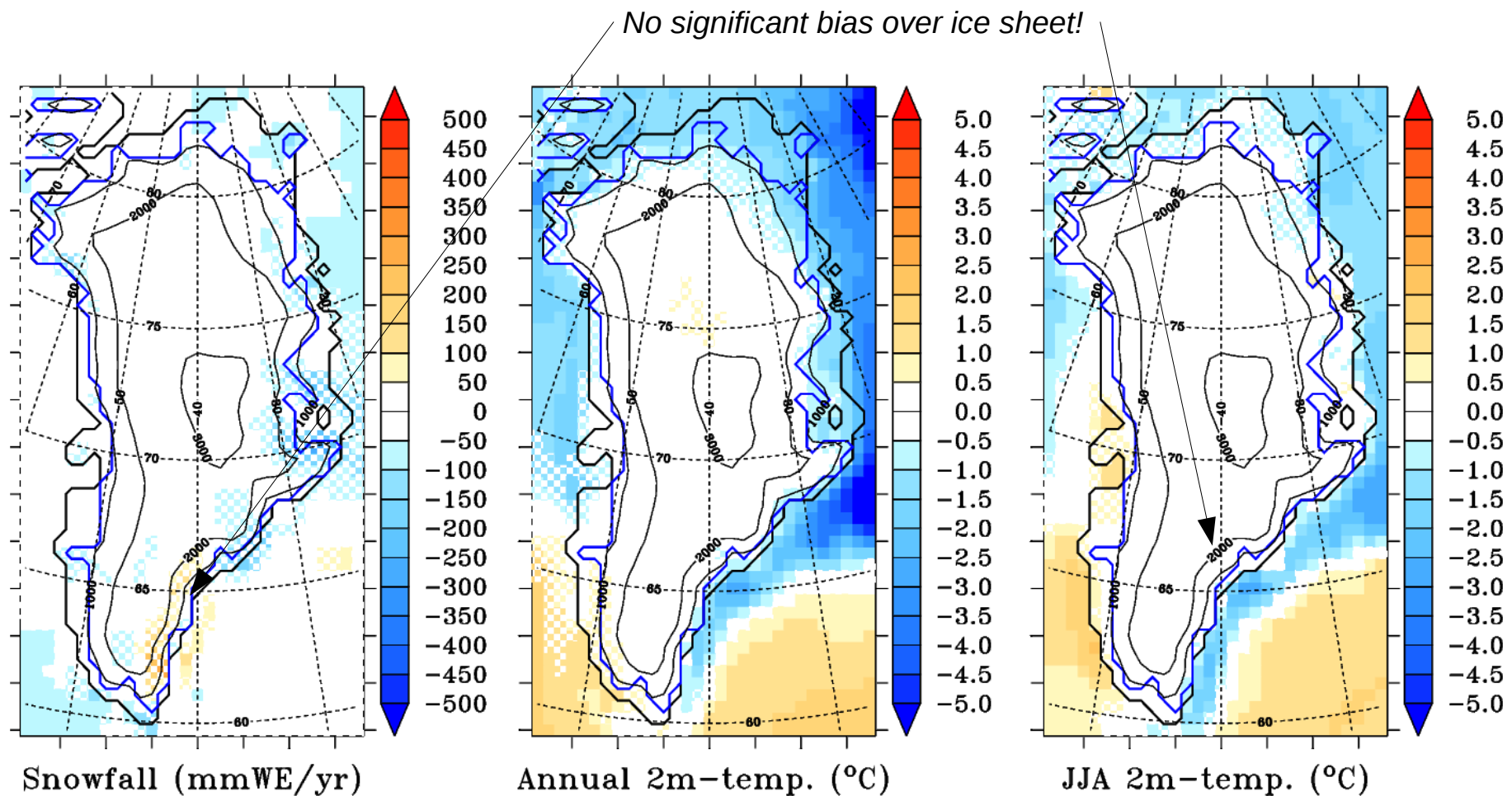
The best GCM from CMIP5 over Greenland:
MIROC5

*Anomaly of JJA T700 in respect to
ERA-Interim over 1980-1999.*



Ref: Fettweis et al., TC, 2013.

1. future anomalies over Greenland

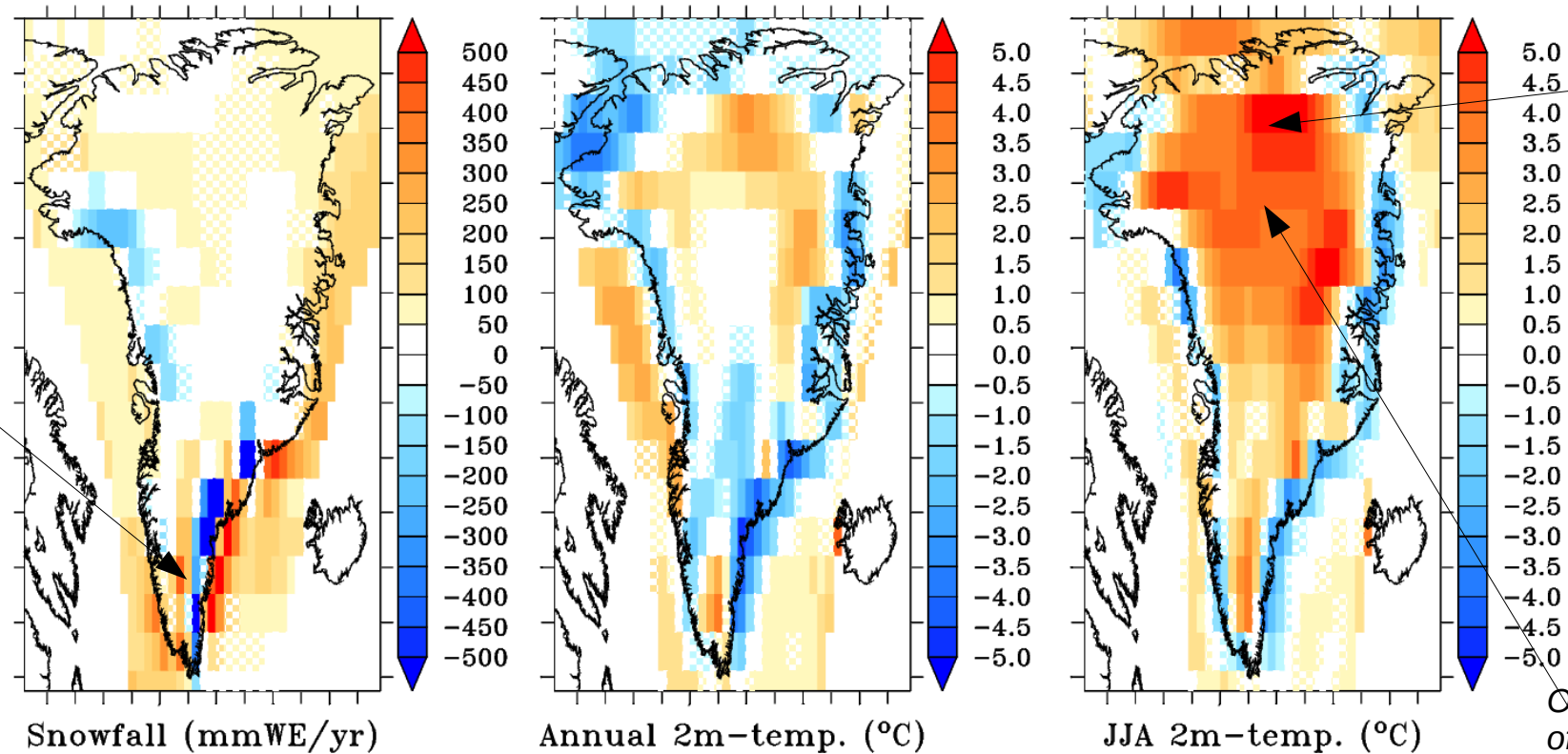


**MAR forced by MIROC5 vs
MAR forced by ERA-Interim over 1980-1999.**



MAR has been run at **50km** to remove the added value of the resolution in MAR.

1. future anomalies over Greenland



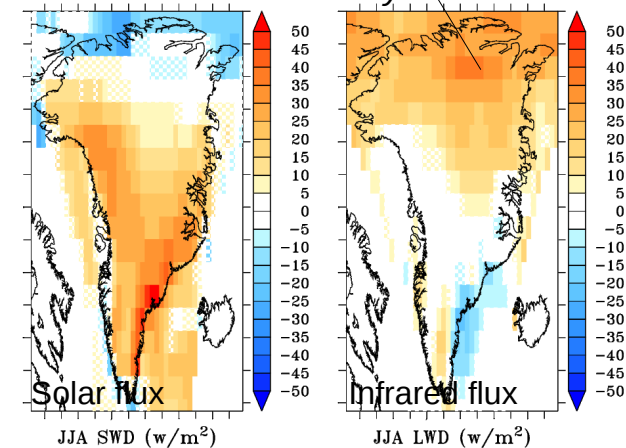
MIROC5 is too warm in summer vs MAR

Overestimation of energy fluxes by MIROC5

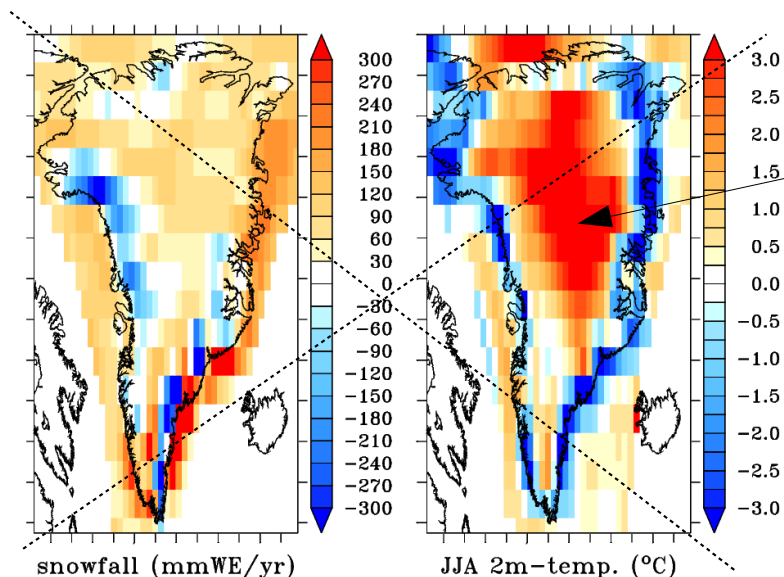
**MIROC5 vs
MAR forced by MIROC5
over 1976-2005.**



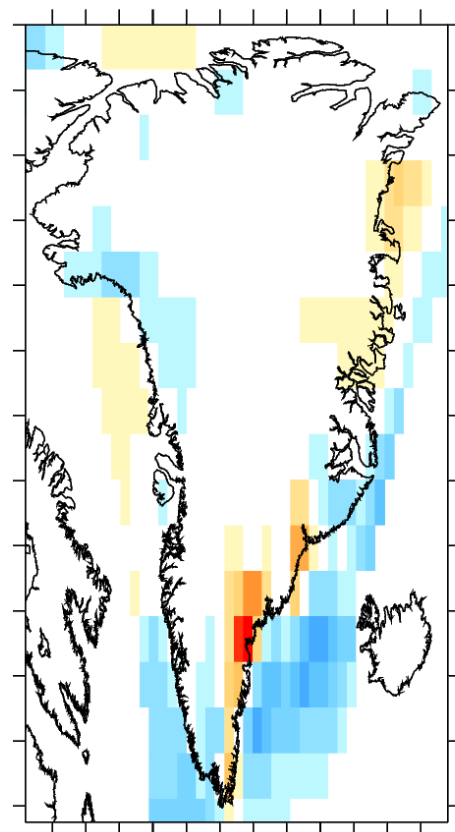
The MAR 50km outputs have been interpolated on the MIROC5 1.4° x 1.4° grid



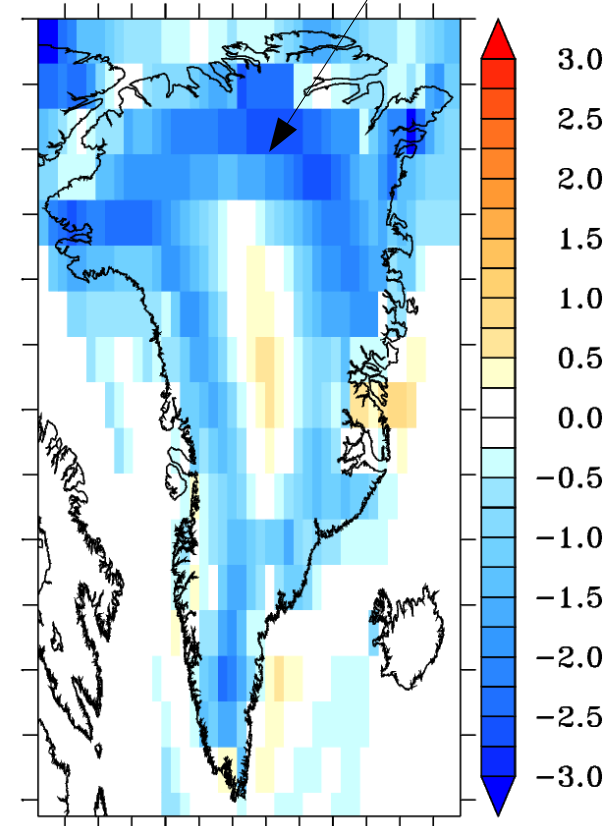
1. future anomalies over Greenland



Future projected anomalies from MIROC5 vs future anomalies from MAR over 2070-2100 (RCP85).



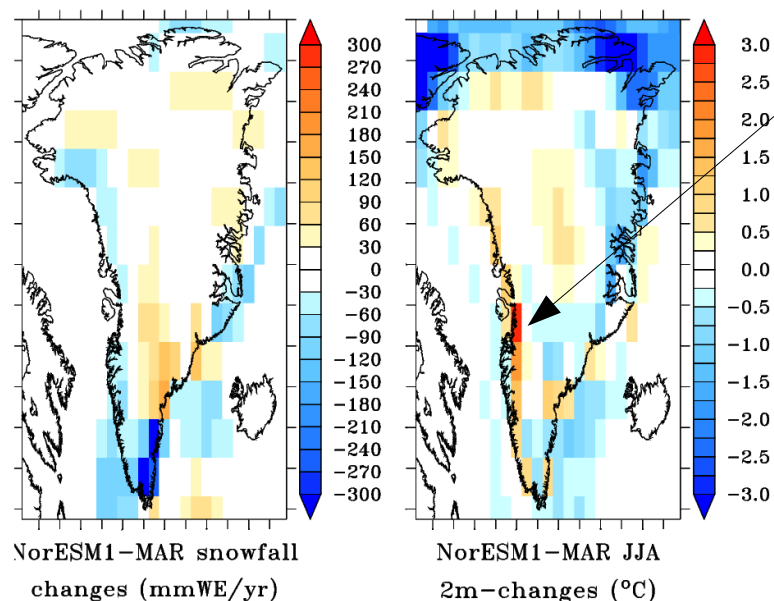
MIROC5-MAR snowfall changes (mmWE/yr)



MIROC5-MAR JJA 2m-temp. changes (°C)

The MIROC5 JJA 2m-temp future anomalies are 2°C colder than MAR

1. future anomalies over Greenland



*The NorESM1 JJA
2m-temp future
anomalies are 3°C
warmer than MAR*

**Future projected anomalies
from NorESM1
vs future anomalies from MAR
forced by NorESM1
over 2070-2100 (RCP85).**

Conclusion: The projected anomalies from GCM over Greenland are significantly different than the ones simulated by MAR forced by the same GCM, **even at low resolution.**



Can we reasonably use GCM-based anomalies applied to reference fields for forcing ice sheet models ?

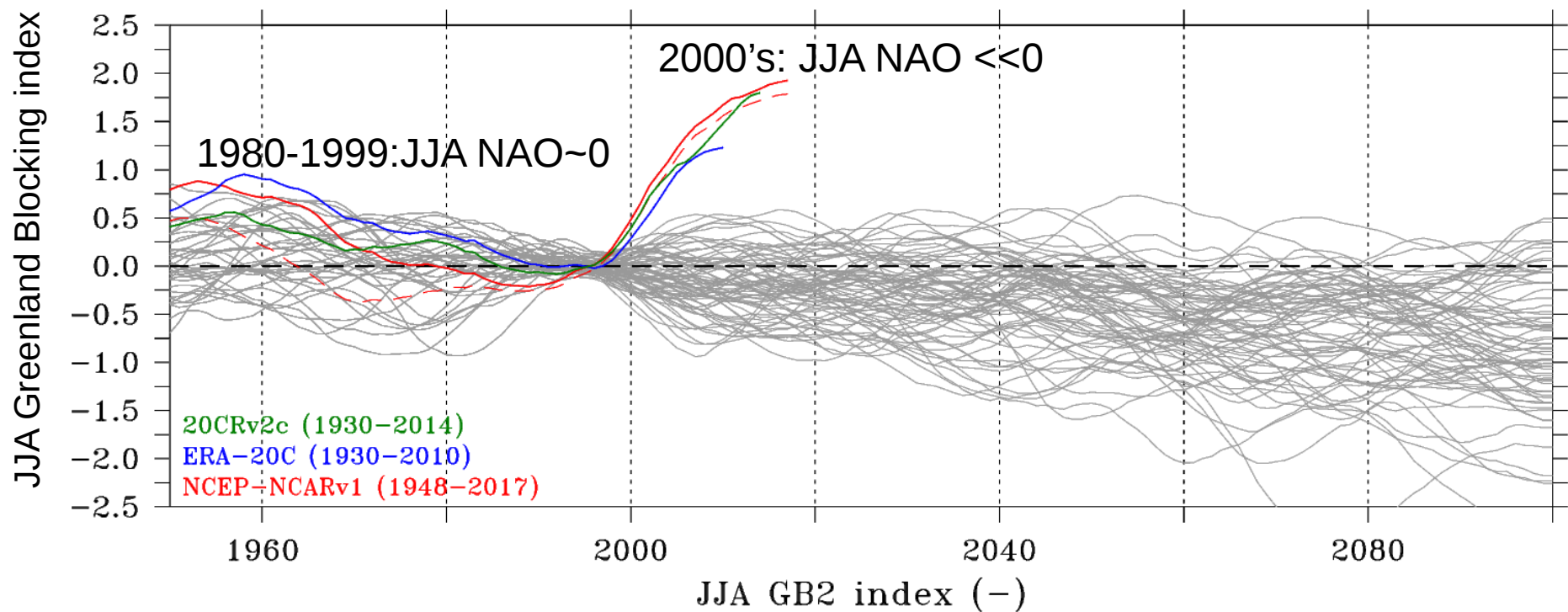


2. Impact of circulation change



None of the CMIP5 models simulates the recent changes in summer Greenland blocking!

(while the change in JJA NAO explains ~70% of the observed recent melt increase)



Ref: Hanna, E., Fettweis, X., and Hall, R. J.: Recent changes in summer Greenland blocking captured by none of the CMIP5 models, *The Cryosphere Discuss.*, <https://doi.org/10.5194/tc-2018-91>, in review, 2018.

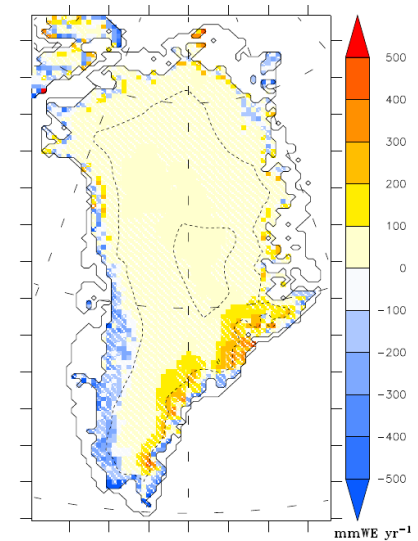
2. Impact of circulation change

+2°C at the MAR
lateral boundaries

MAR forced by ERA-Interim **1980-1999** +2 °C
≈ MAR forced by GCMs

RCP45	MIROC5	2029 – 2049
	CanESM2	2016 – 2036
	NorESM1	2033 – 2053

as GCM's do not project any circulation changes!

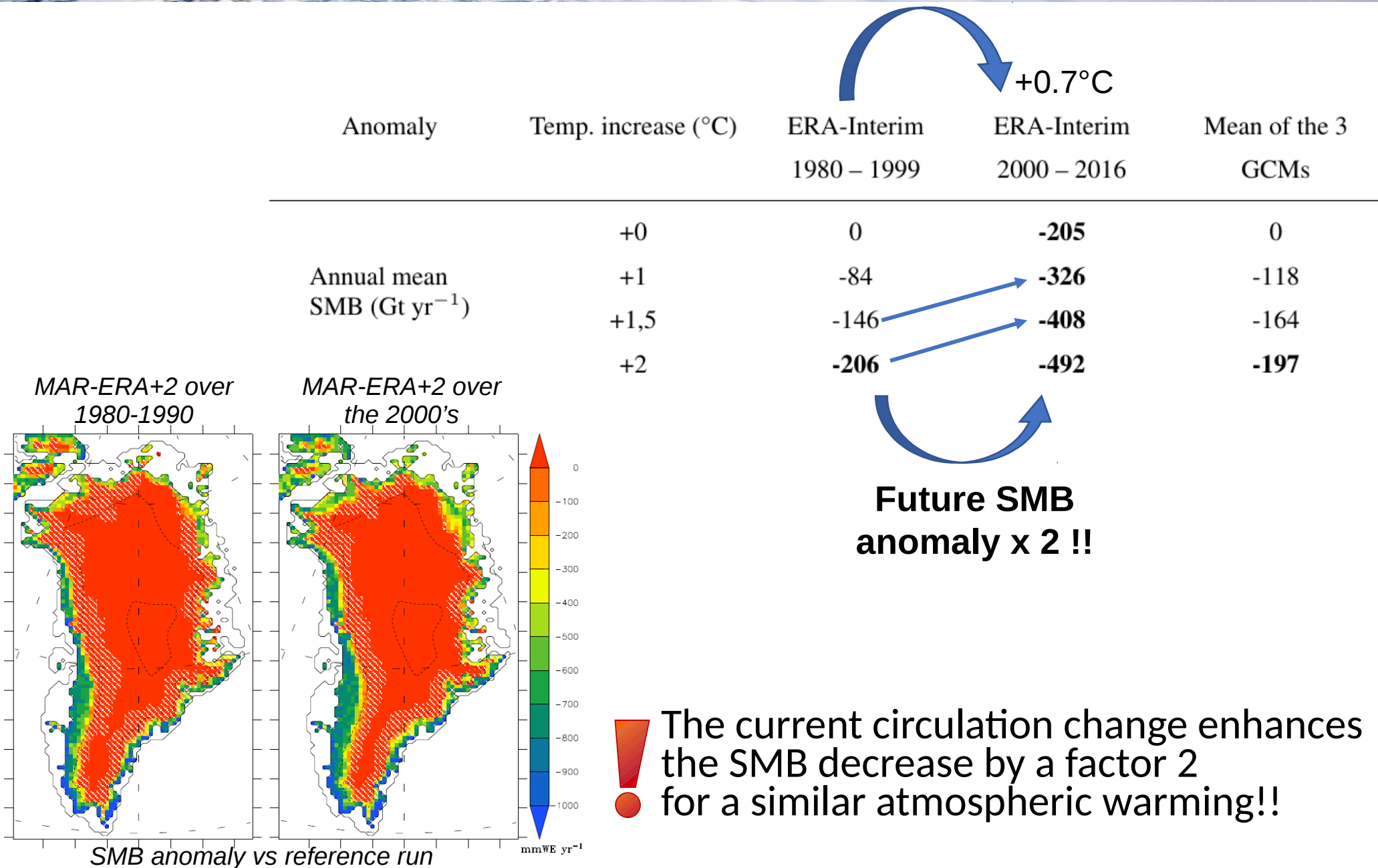


Mean SMB anomalies
(mmWE/yr)

💡 MAR forced by ERA-Interim **2000-2016** +2 °C
≈ impact of JJA NAO<0 in a warmer climate!

Ref: Delhasse, A., Fettweis, X., Kittel, C., Amory, C., and Agosta, C.: Brief communication: Impact of the recent atmospheric circulation change in summer on the future surface mass balance of the Greenland ice sheet, *The Cryosphere Discuss.*, <https://doi.org/10.5194/tc-2018-65>, in review, 2018.

2. Impact of circulation change




Conclusion:

- Future anomalies of temperature and precipitation simulated by a GCM are significantly different than the ones from MAR forced by the same GCM.



Are reliable the future anomalies of surface fields coming from GCMs in polar regions?

- CMIP5 do not project any circulation change over North-Atlantic. Is it reliable?
- With the circulation change (JJA NAO<0) as we currently observe, the projected SMB decrease will be enhanced by a factor 2 as suggested by MAR forced by warmer reanalysis.
- What about CMIP6 vs CMIP5?

 <http://climato.be/melt:>
7-day forecast by MAR
over Greenland