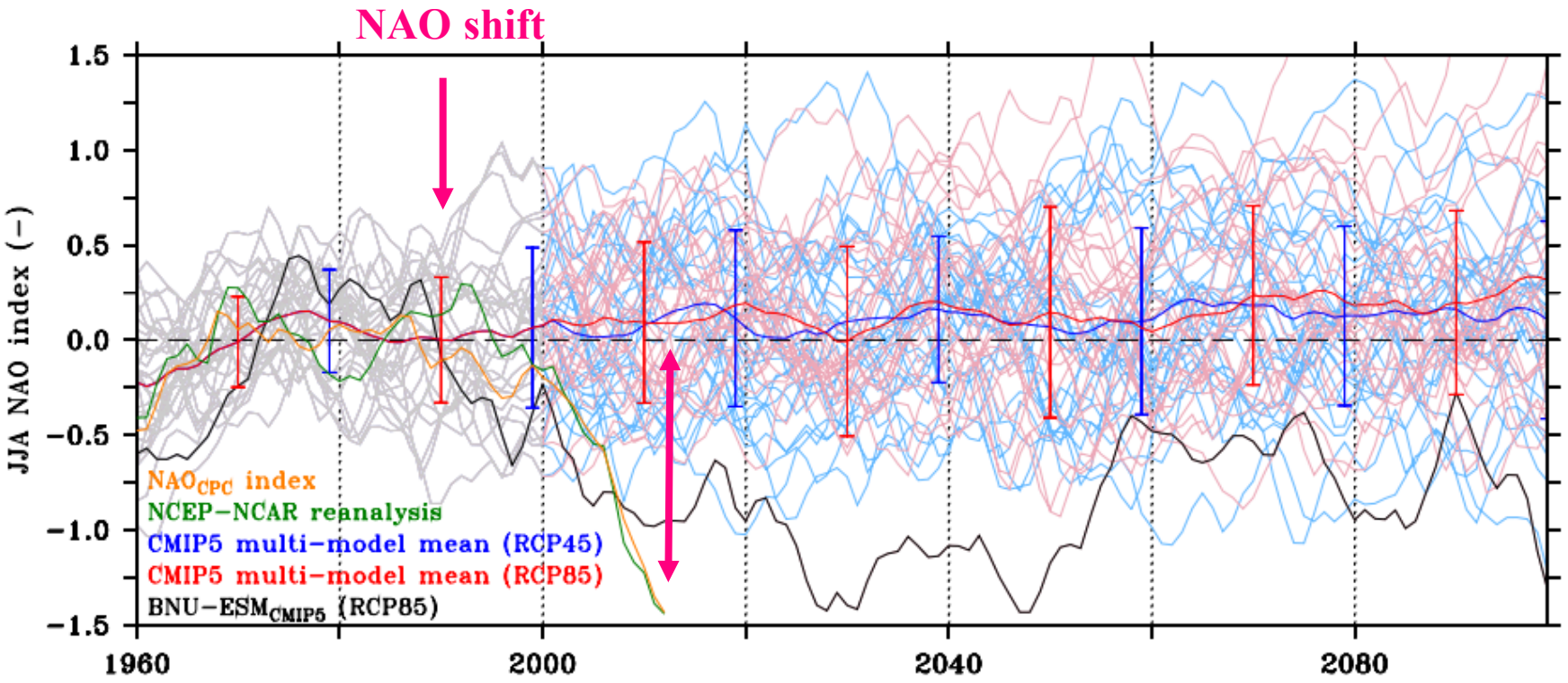
Interests of using RCMs (MAR..) to downscale CMIP6 outputs

ISMIP6 Pre-AGU workshop

MAR Team

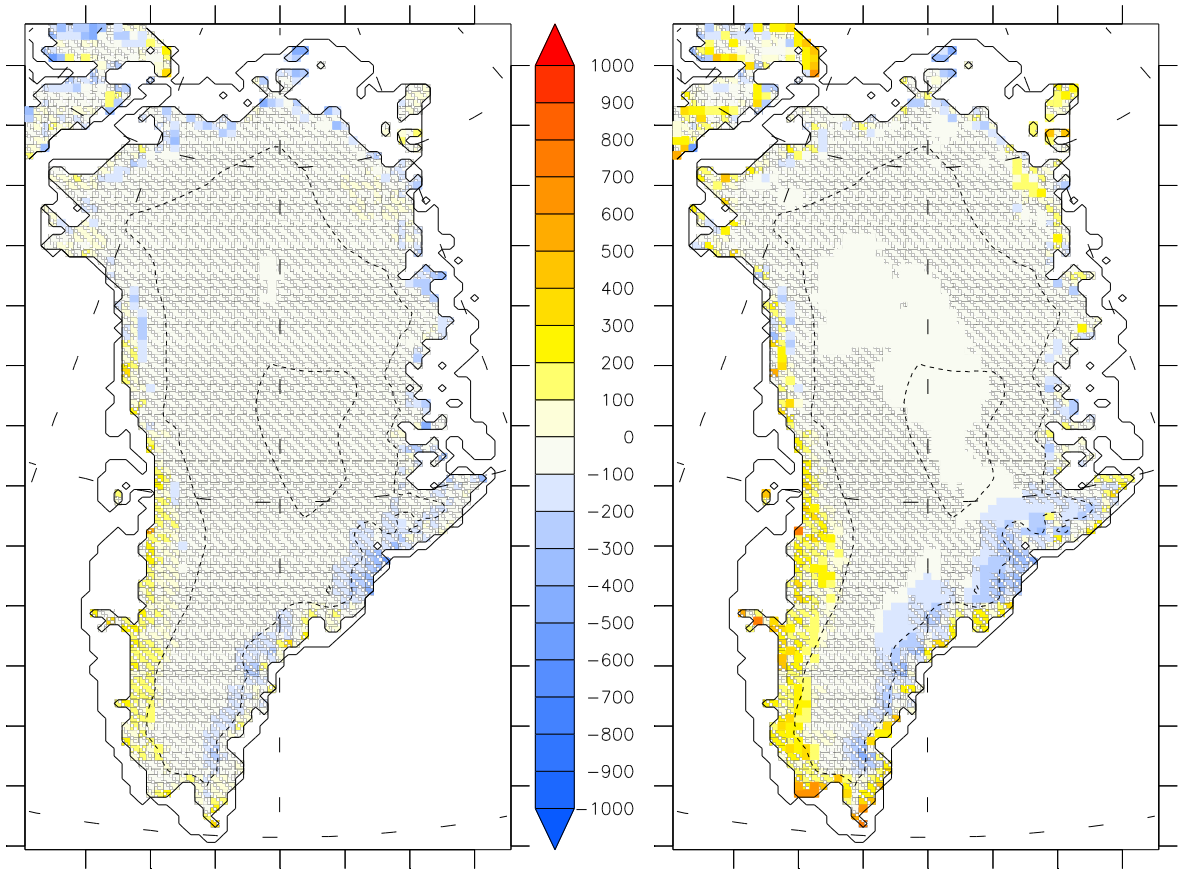
Why should GCM results be used with caution? (1)



Time series (10-yr running mean) of the JJA NAO index over 1960–2100 (Fettweis *et al.*, 2013)

- GCMs do not represent the circulation change observed since the end of 1990's.

Why should GCM results be used with caution? (2)



SMB anomalies (mm we yr-1) differences between MAR forced with MIROC5 and MAR forced with ERA Interim +1°C (+2°C) during 1980-1999

- No significant differences
- Possibility to use MAR with ERA Interim +1°C (in place of GCM)

Why should GCM results be used with caution? (3)

NorESM1
CanESM2
MIROC5

+ 0,65°C

Mean SMB anomalie (Gt)	ERA 1980-1999	ERA 2000-2016	Mean 3 GCMs	SD moy
+1°C (2006-2026)	-84	-326	-118	132
+1,5°C (2016-2036)	-146	-408	-164	134
+2°C (2026-2046)	-206	-492	-197	137

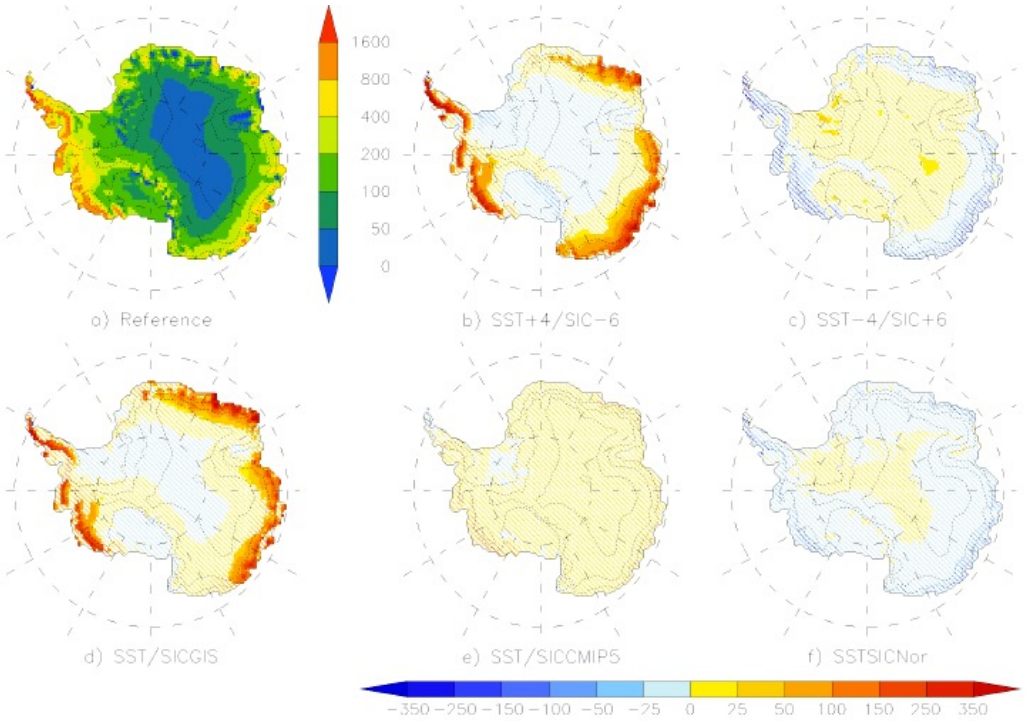
!!

X 2

- MAR ERA Interim +1°C (until 2°C) is the only way to take into account circulation changes

(See Delhasse *et al.* 2018, in preparation)

Why should GCM results be used with caution? (4)

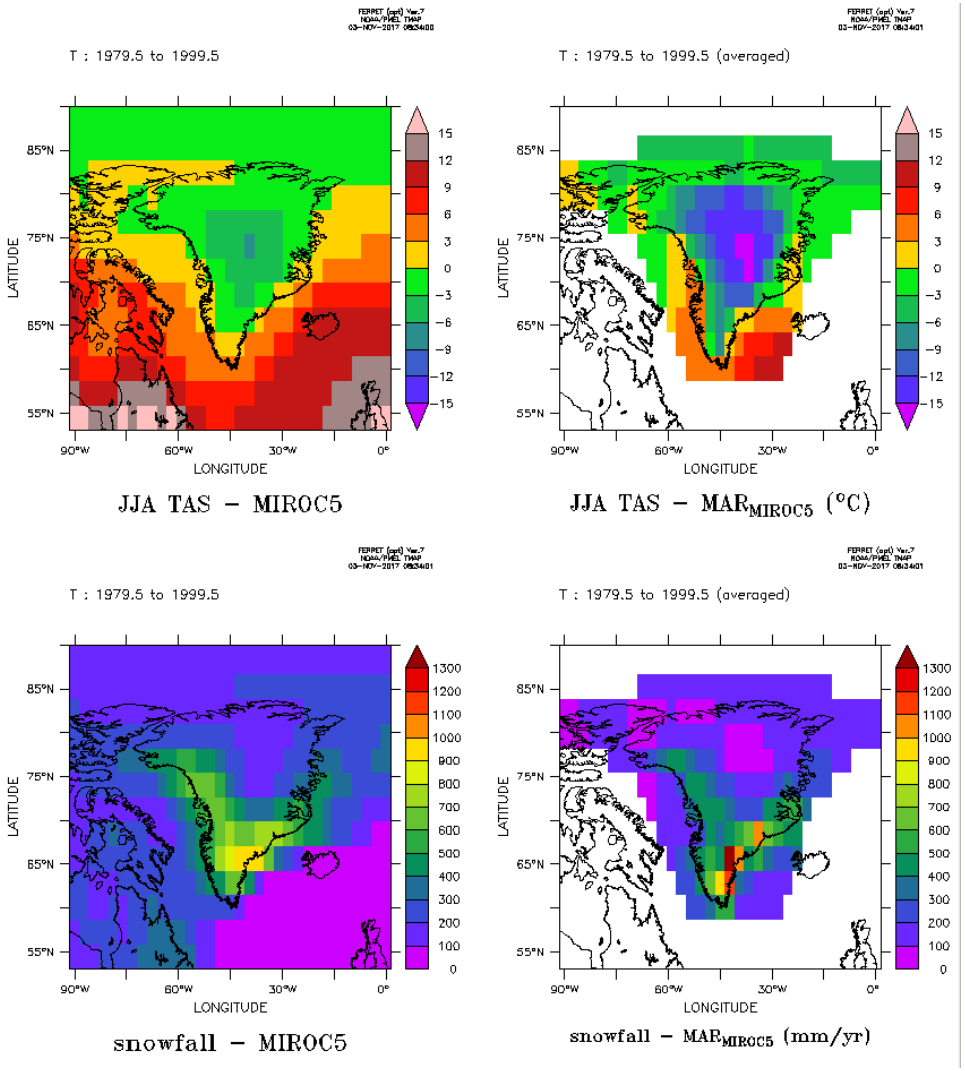


Units= Gt.yr^{-1}	SMB	SMB%
Ref	2565 ± 115	
SST+4/SIC-6	+325	+12.7
SST-4/SIC+6	-121	-4.5
SST/SICGIS	+357	+13.9
SST/SICCMIP5	+103	+4.0
SST/SICNor	-104	-4.0

(See Kittel *et al.* 2018, in preparation and AGU poster session A51E-2104)

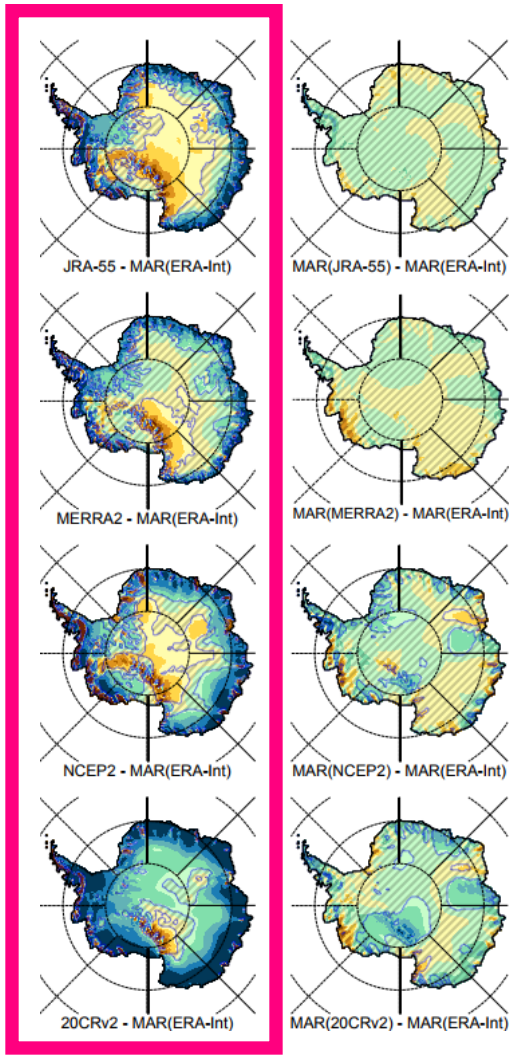
Correction of large scale biases by RCM (1)

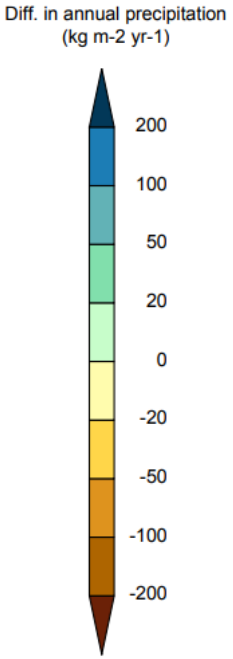
- Correct climate at 500 and 700 hPa ≠ Correct surface climate

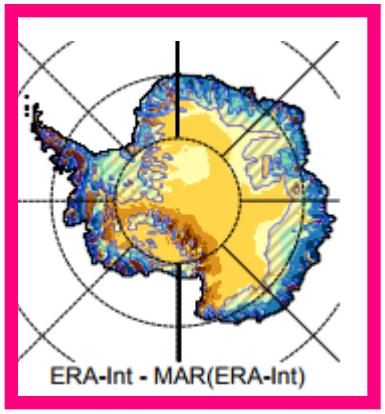


Correction of large-scale biases by RCM (2)

Annual precipitation (kg m^{-2} yr^{-1})

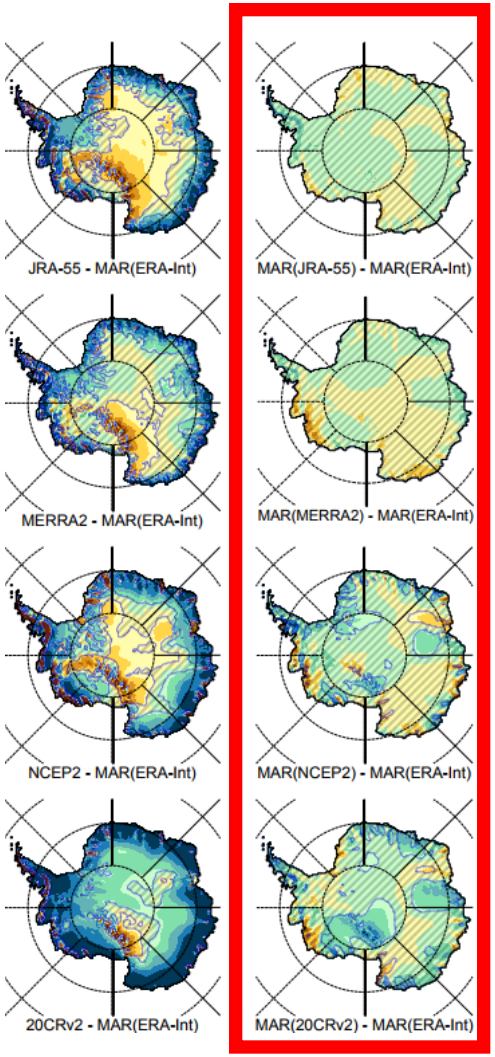




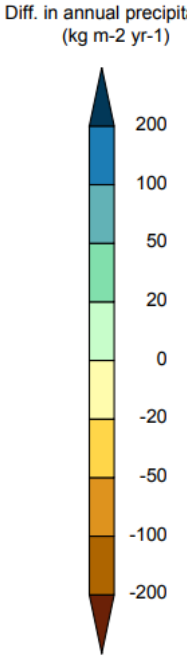


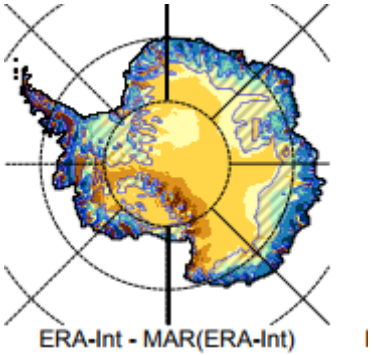
Reanalysis - MAR(ERA-Interim)

Correction of large-scale biases by RCM (2)



Annual precipitation (kg m^{-2} yr^{-1})



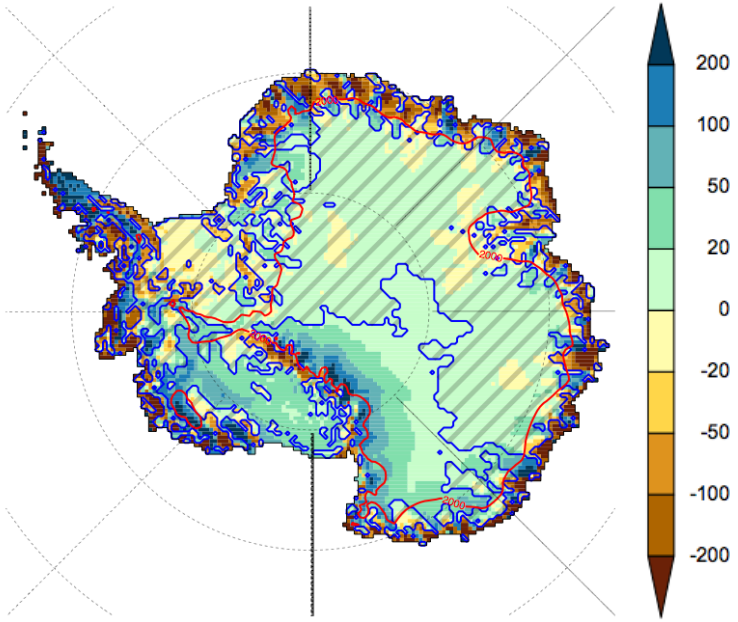


MAR(Reanalysis) - MAR(ERA-Interim)

- The RCM is able to minimize initial forcing errors on the representation of surface climate for both GCMs and reanalyses for both GIS and AIS.
  - And thus does not introduce supplementary errors

Added value of a RCM

- Choosing a RCM is not a determining factor
  - Which should not further complicate the design of the ISM ensemble



MAR - RACMO2
SMB (kg m-2 yr-1)

- **MAR vs. RACMO2:**
  - **Resolution:** 35 km vs. 27 km
  - **Topography:** bedmap2 (2013) vs. Bamber (2009)
  - **Physics**

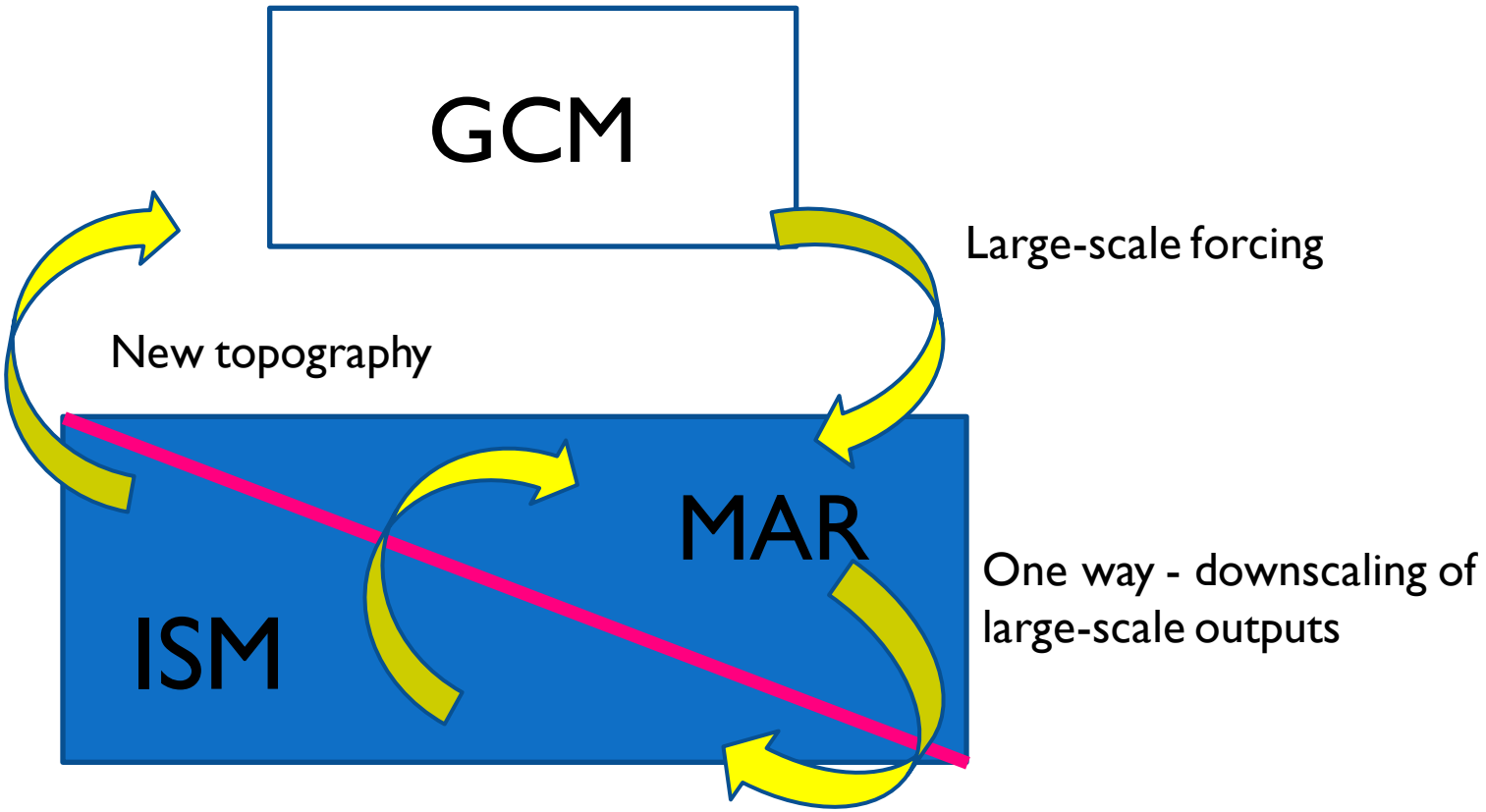
(See Agosta *et al.* 2018, in preparation)

MAR and ISM (1)

- Coupling between MAR and GRISLI over the GIS
  (see Leclec'h *et al.*, 2017in disc.)
  - One-way coupling method by correcting offline the MAR outputs to account for topography changes computed by GRISLI is sufficient until 2100
  - Beyond 2100, topography-induced precipitation pattern changes prevent the use of off-line corrections
- Sensitivity tests of the MAR resolution on fETISh outputs
  (see Delhasse, 2017 and Verjans, 2017)
  - Optimal resolution <30km for both SMB (MAR) and MB (fETISh) outputs

MAR and ISM (2)

- Project coupling MAR-ISM-GCM



The RCM MAR

- Fully operational over the Greenland (25 km) and Antarctic (35 km) ice sheets for future projections
  - Operational from a technical point of view
    - Downloading CMIP6 data is the most time-consuming factor (!)
  - Operational from a modelling point of view
    - Physics and improvement in the drifting snow routine
      - validated for both the frequency of occurrence and surface mass transport in Adelie Land – currently running over Antarctica

Distribution of MAR outputs (1)

- Annual/monthly outputs of SMB and climate variables
  - Free downloads from ftp://ftp.climato.be/
  - No co-authorship requested if used "as is"
  - ULg can provide MAR outputs interpolated on a given grid with correction of surface fields according to topography anomalies

Distribution of MAR outputs (2)

- Downscaling of CMIP6 outputs from the "good" GCMs (correct summer free air temperature AND correct atmospheric circulation) already planned

- ULg can also lead sensitivity studies to topography over the next century with MAR over modified grids according to topography anomalies

We're ready to give you high resolution projection outputs that you need!