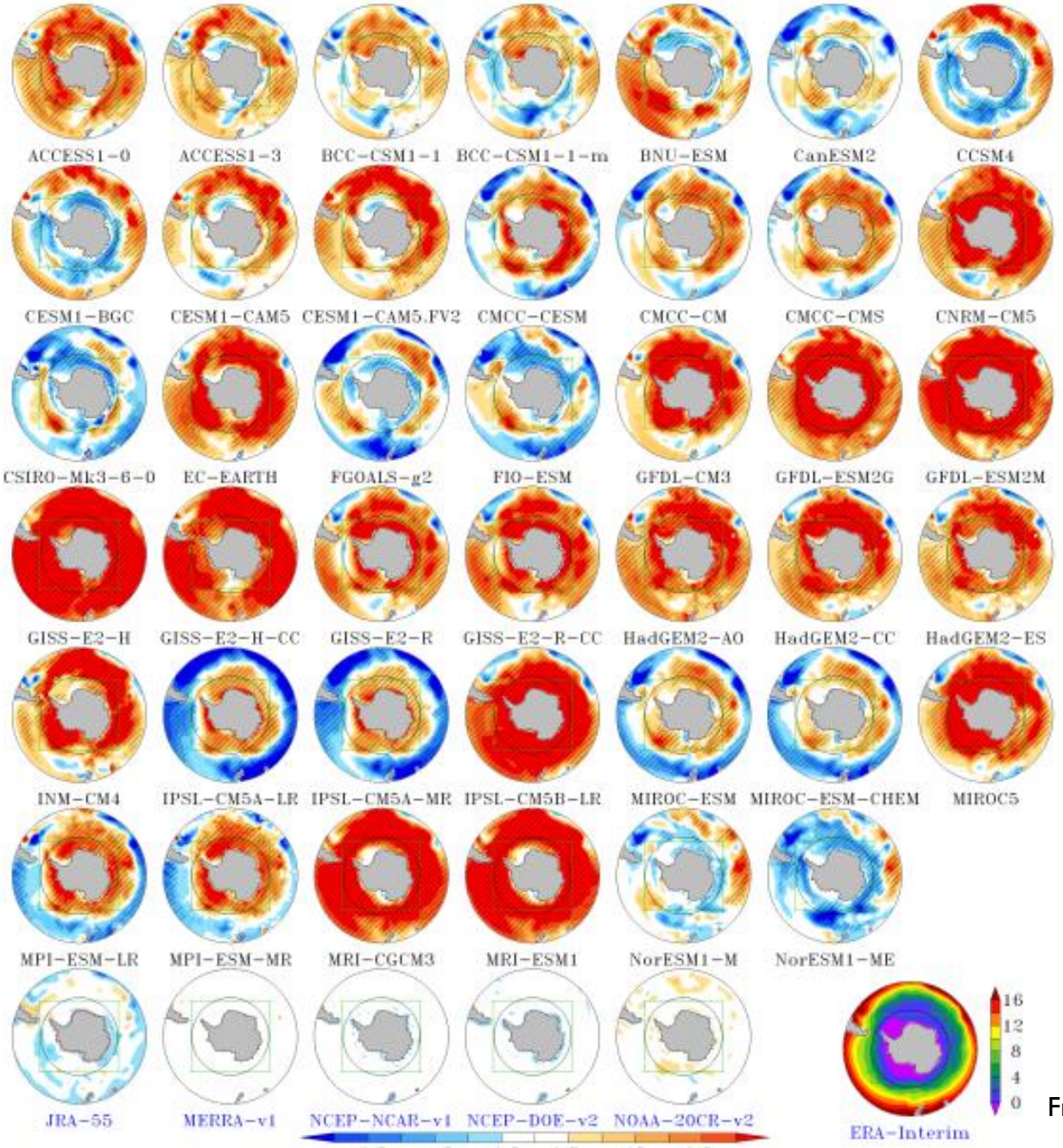
Sensitivity of the Antarctic surface mass balance to oceanic perturbations

MAR 2nd Workshop (13 – 15 Sept 2017)

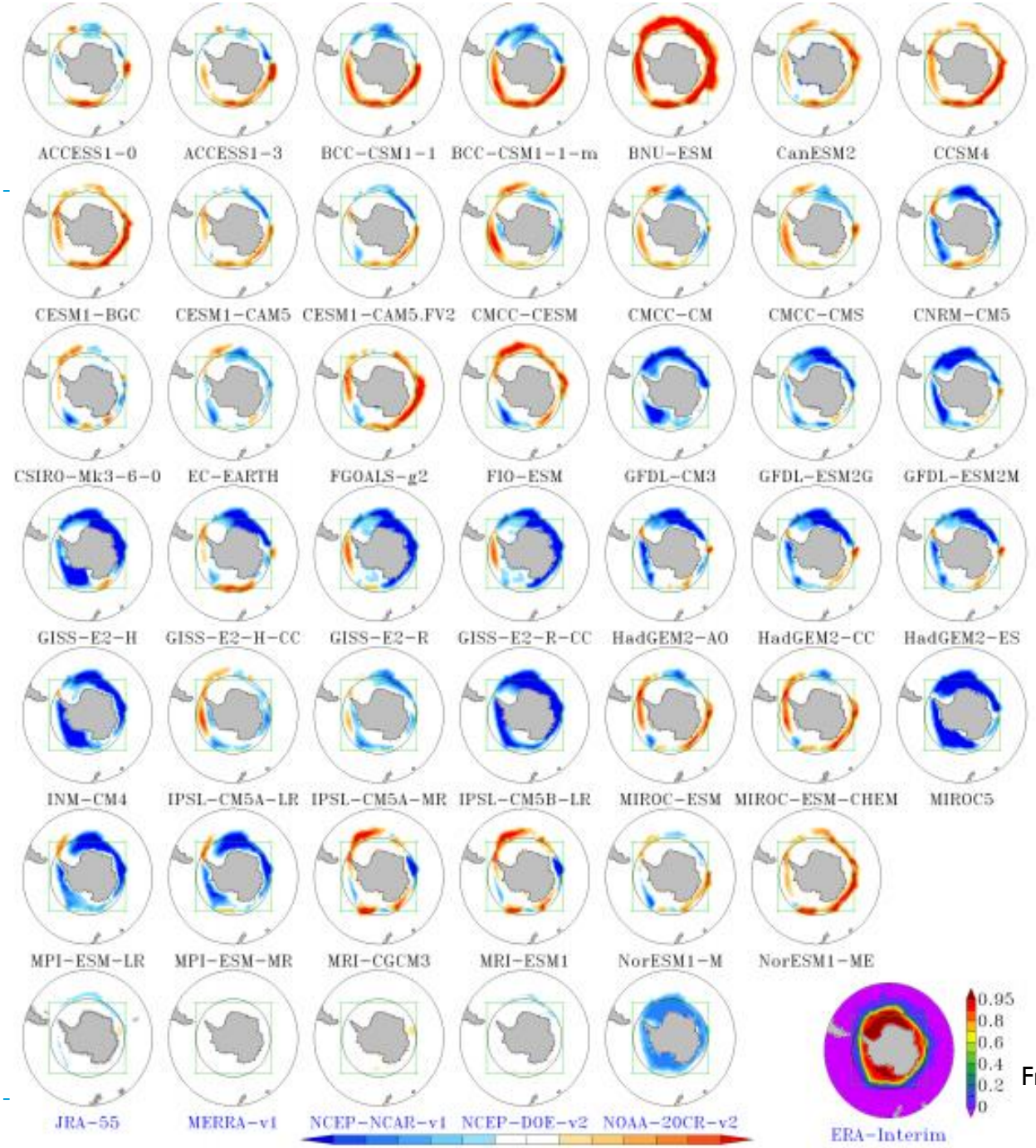
SMB sensitivity to sea surface conditions

- Link between SSC and the Antarctic climate
  - Already mentioned by Hubert Gallée in the first studies with MAR over the Ross Sea Sector (Gallée 1995 and 1996)

- CMIP5 models are unable to correctly simulate the Antarctic climate (Agosta *et al.*, 2014)
  - Particularly true for SST and SIC



From Agosta *et al.* (2014)



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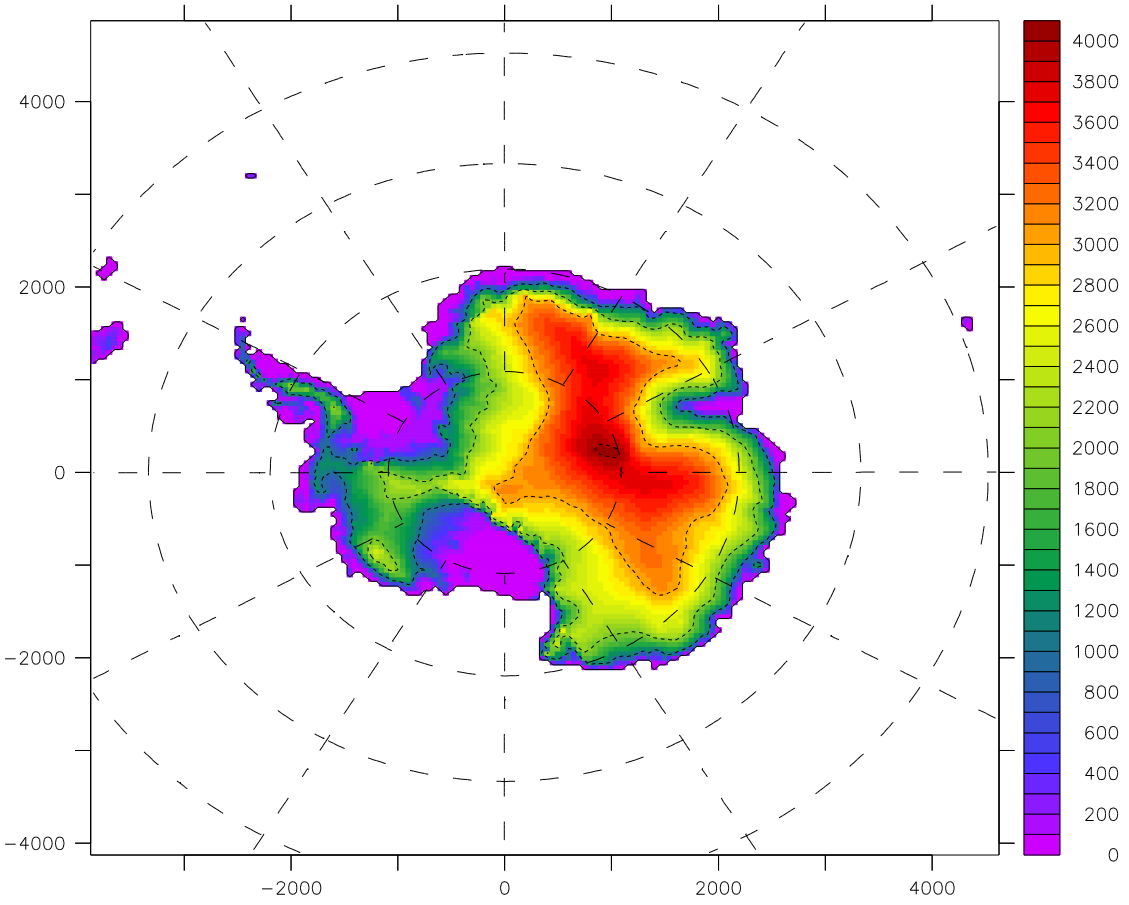
- CMIP5 models are unable to correctly simulate the Antarctic climate (Agosta *et al.*, 2014)
  - Particularly true for SST and SIC
- Importance of the large-scale forcing at boundaries
  - Even if SSC anomalies do not considerably impact Greenland Ice Sheet SMB (Noël *et al.*, 2014)

The MAR model

- MAR v3.6.4
  - Same set-up as C. Agosta
    - Density of fresh snow derived from observation
    - $Z_{0\ \text{snow-covered surface}}$ (T)
    - No drifting snow

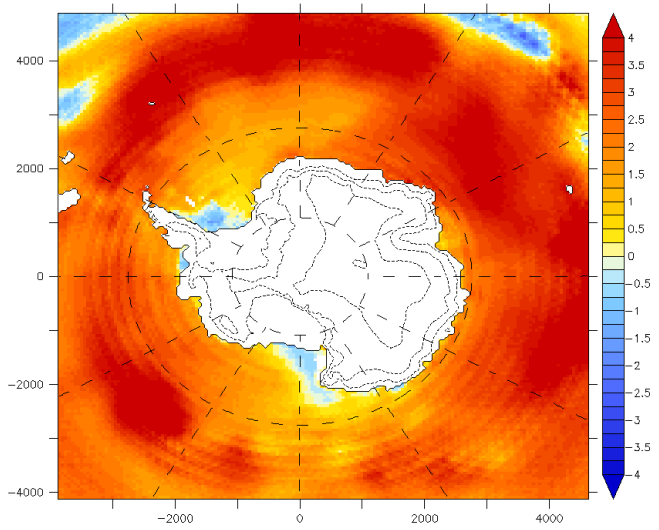
Domain

- Dimensions
  - 170x180 (dx=50km)
  - 24 vertical levels
    - Zmin=2m
    - Mzabso=7
    - UAR ~6000m
  - 30 snow layers

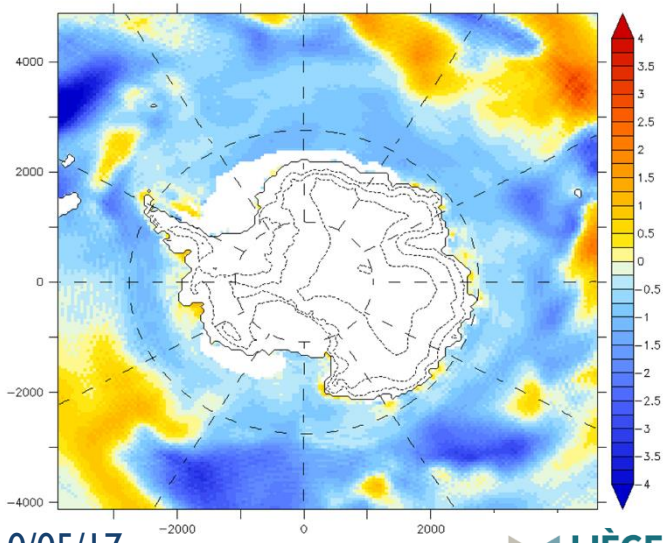


Reference run and sensitivity experiments

- Reference run
  - Forcing by ERA-Interim (1979-2015)
- Sensitivity experiments
  - SST anomalies
    - ± 2°C, ± 4°C and CMIP5 SST
  - SIC anomalies
    - ± 3, ± 6 and CMIP5 SIC
  - Combined anomalies
  - SIT anomalies
    - 1m and 2m (rather than 0.5m)



$SST_{GISS\text{-}E2\text{-}H} - SST_{ERA\text{-}Int}$



$SST_{NorESM1\text{-}ME} - SST_{ERA}$

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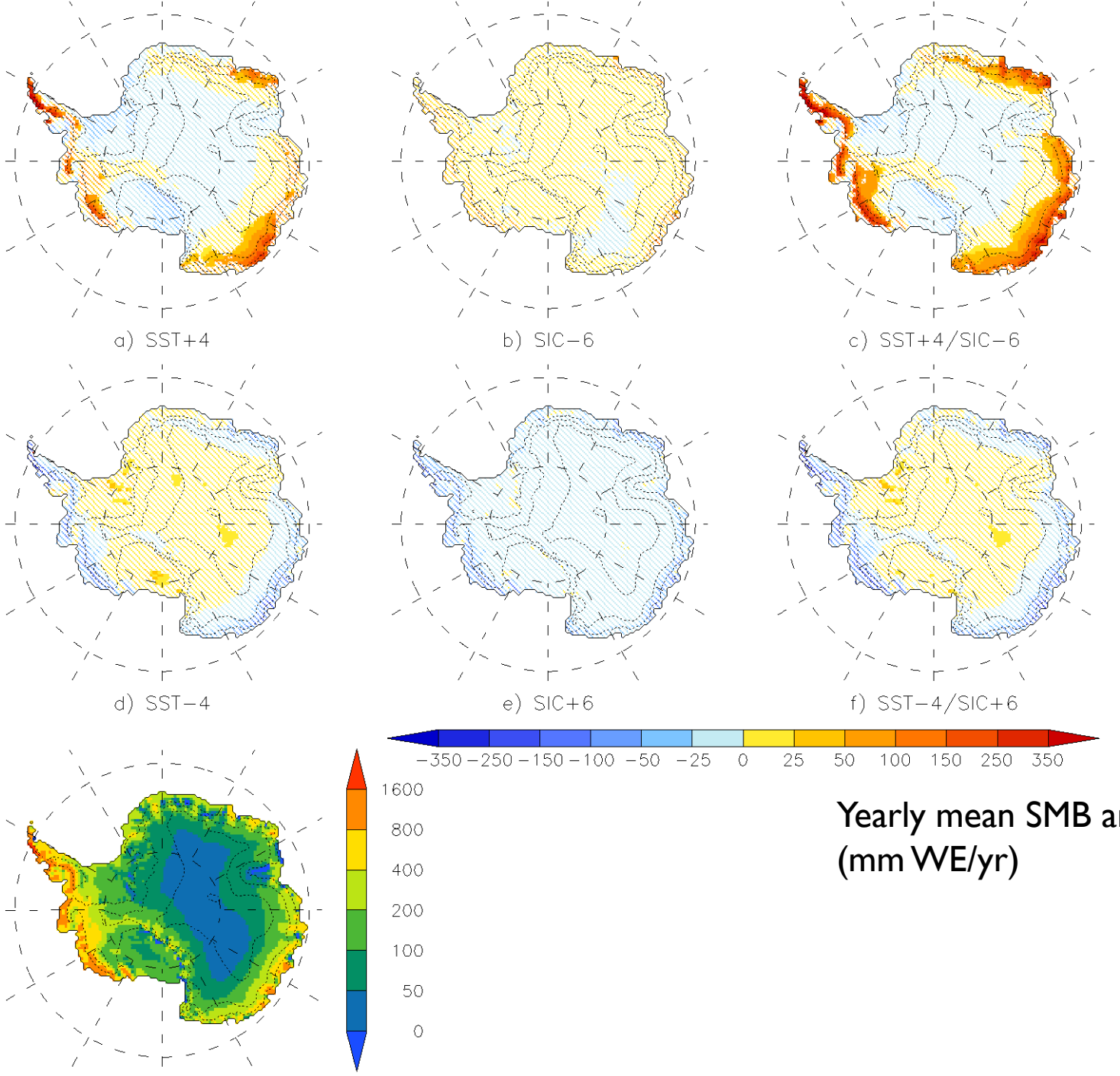
SMB sensitivity to sea surface conditions

- Résults (units= $Gt.yr^{-1}$)

Des	SMB	RU	ME	RF	SF	SU
Ref	2565.5 (std 114.8)	0.9 (std 0.8)	97.0 (std 28.6)	20.0 (std 3.4)	2658.3 (std 110.)	108.9 (std 10.414)
Sic+3 T-2	**2439.6**	0.5	85.7	**15.9**	**2533.4**	101.4
Sic+6 T-4	**2444.6**	0.5	97.8	17.0	**2525.0**	**93.7**
Sic-3 T+2	**2688.4**	**2.2**	**150.7**	**26.6**	**2784.5**	118.3
SIC-6 T+4	**2891.5**	**7.0**	**315.1**	**60.5**	**2962.8**	**122.3**
ST-2	2483.7	0.5	76.3	**15.6**	2573.1	101.9
ST-4	2515.9	0.3	76.0	**16.5**	2597.2	**94.4**
ST+2	2606.3	**1.8**	**136.4**	**24.8**	**2704.1**	118.7
ST+4	**2708.6**	**3.7**	**214.1**	**45.2**	**2795.3**	**125.8**
SIC+3	2457.3	0.9	96.4	16.7	2554.2	110.5
SIC+6	**2396.5**	0.8	95.9	**16.1**	**2492.6**	109.0
SIC-3	2590.1	0.9	92.3	17.3	2686.5	110.5
SIC-6	2655.9	0.9	91.7	17.5	2751.9	110.2
dzSIce2	2563.2	0.9	96.8	20.1	2655.9	108.8
dzsice1	2565.3	0.9	96.8	20.0	2658.0	108.8



Yearly mean SMB anomaly (mm WE/yr)

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Conclusion and perspectives

- Sensitivity to large SST and SIC biases
  - But still in GCM biases range (!)
- No sensitivity to sea ice thickness

- Importance of coupling MAR and NEMO-LIM
  - Feedbacks
  - Expecting more accurate SSC
    - Diurnal evolution
    - Higher resolution