Stable climate and surface mass balance in Svalbard over 1979–2013 despite the Arctic warming

Author answer to the review of anonymous referee #2

Thank you very much for your comments and suggestions that will improve our paper. We will include your comments in the revised version of the manuscript.

Are you familiar with any WRF/PolarWRF simulations over the Svalbard area that can be used for estimations of the SMB, other than ASR? I see that you have compared MAR and WRF in EGU in 2012. Can you briefly mention the reasons why you use MAR instead of WRF in this investigation?

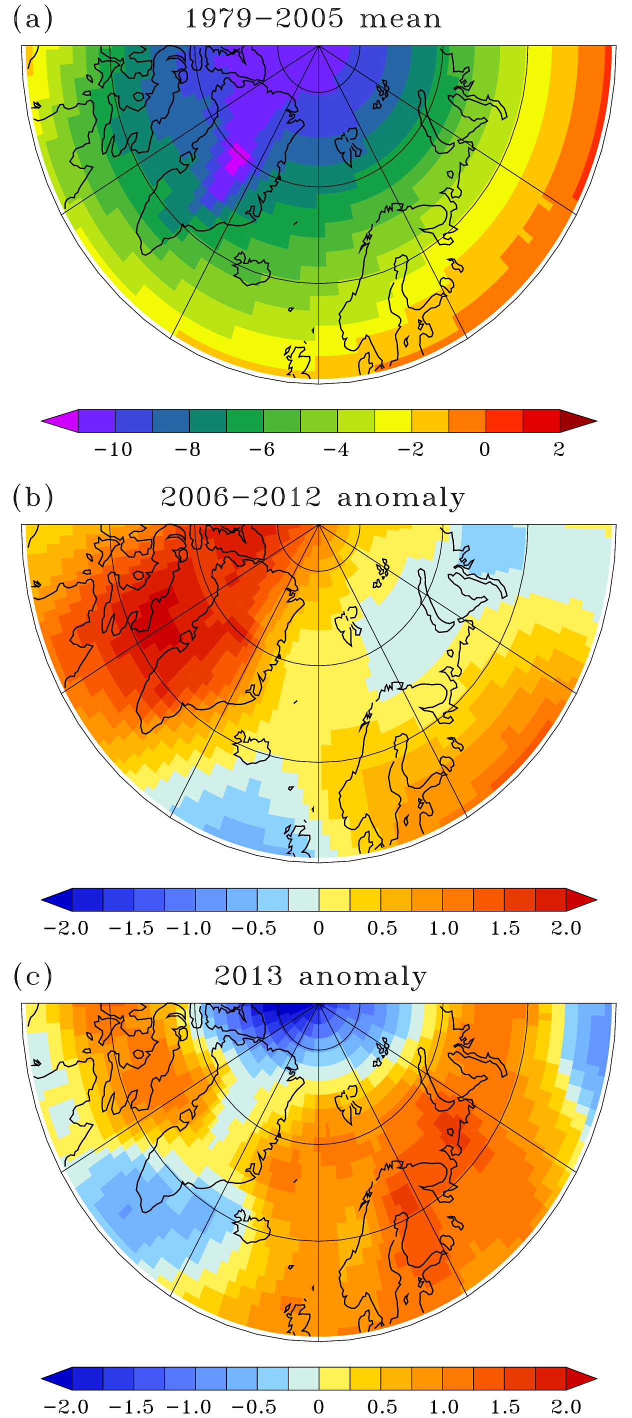
C. Lang's initial PhD project was to couple the SISVAT module from MAR to WRF, as the MAR code was not parallelised at that time and was too slow at very high resolution. But we gave up our coupling project when the parallel version of MAR became available, given the very good ability of MAR to simulate the Svalbard climate. In addition, we have decided in our laboratory to use only MAR as RCM for all of our studies (over polar regions and Belgium). That is why this paper and the companion one focusing on the future projections only deal with MAR.

At the time of EGU 2012, we had not found any published papers about modelling the climate or SMB of Svalbard with WRF/Polar WRF. After a quick search, apart from Claremar et al. (2012) that you also mentioned, we found that Sauter et al. (2013) used the outputs of WRF to force a snowdrift model over Vestfonna. We will add these references in the revised version of our manuscript.

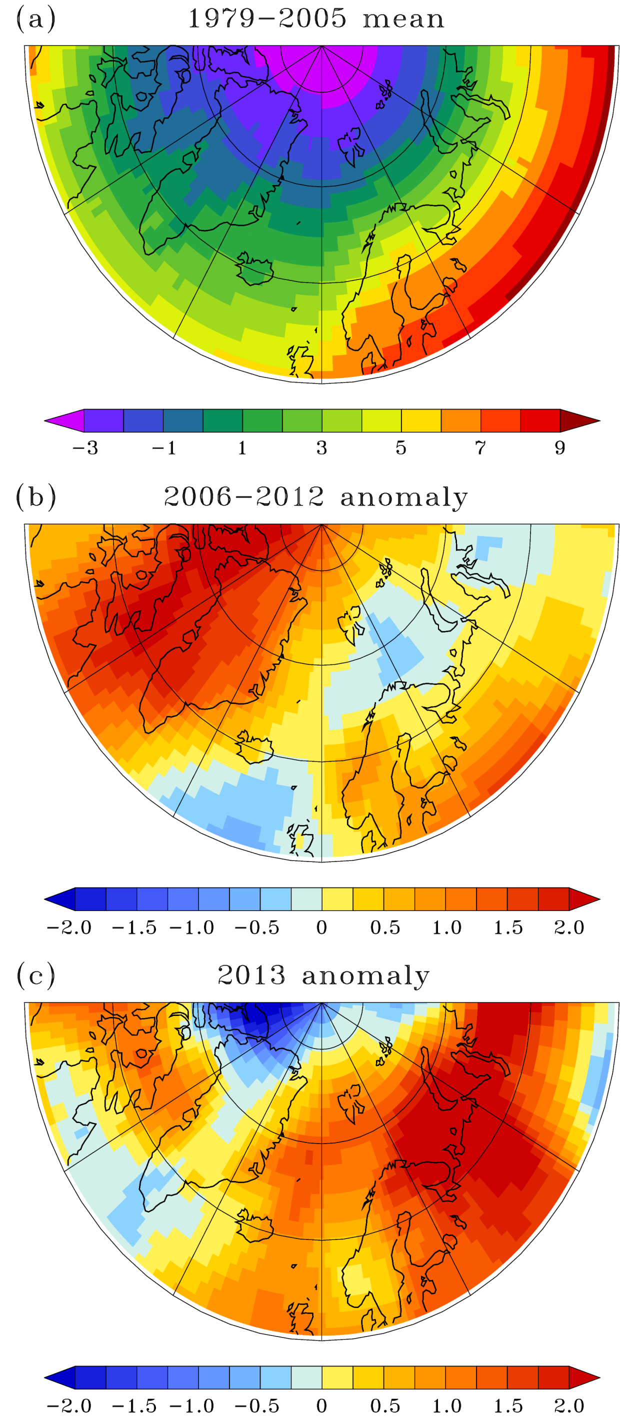
Why do you use both T700 and T850 in the analysis? Is the reason that T700 is more related to the precipitation amount and T850 to TAS? Please make this clear in the text.

T850 should be used rather than T700. On one hand, the variability of T850, representing the free atmosphere, is more representative of the melt variability than T700. On the other hand, the 850 hPa level is high enough to still be above the highest mountains of Svalbard, knowing that they barely exceed 1200 m in our 10km topography.

To be consistent, we will replace T700 with T850 in figure 6. The anomalies are a bit larger at 850 hPa than at 700 but our comments about T700 in figure 6 are also valid at 850 hPa (see figure below).



1979–2005 T700$_{JJA}$ mean (°C) from ERA-Interim and 2006–2012 and 2013 anomalies, fig. 6 from TCD manuscript.



Same as fig. 6 but for T850$_{JJA}$.

TAS is underestimated by MAR but snowfall amount should be determined by the temperature in the clouds or at least above the surface layer. The humid air does not originate at the local surface. It is not necessarily a negative bias above the surface layer since it is probably the surface energy balance that leads to the negative T2-bias. You also state in P4505, L6, that the lateral forcing from ERA-Interim is warmer and therefore also the free atmosphere temperature over Svalbard is affected by this.

Yes, even if a colder temperature means less/fewer precipitation, the cold near-surface temperature bias detected in MAR does not necessarily mean that the temperature bias above the surface layer will also be cold. Moreover, the sea-ice cover largely influence the temperature at the coast, where all our stations are located and we can not be sure that this apparent cold bias is also present further inland. As suggested by Jan Lenaerts in review #1, it is likely that a SIC overestimation in the fjords near the coastal weather stations explains these biases in MAR where no data is assimilated into.

Regarding your last sentence about ERA-Interim being warmer, we are not sure to understand what you mean. We just said that, given the opposite signs of the ERA and MAR_{ERA} biases at some coastal stations, we can expect that these biases are not due to ERA-Interim. In addition, a bias in the free atmosphere of ERA-Interim should induce a bias in the MAR free atmosphere but we have no observations in the free atmosphere to compare to our model and therefore can not say anything about the sign and magnitude of a temperature bias in the free atmosphere.

Comments about T2/T3/TAS

Finally, you made several comments about the use of TAS, T2 and T3. In MAR, the vertical coordinate system is in sigma coordinates. The near-surface level we refer to is the levels that is found at approximately 2 or 3 m, hence the "2m temperature" or "3m temperature" you can find in the text. For consistency, we will use the term near-surface temperature and the abbreviation TAS instead of T2/T3 in the revised version of the paper.

Vertical resolution in the lowest km

Here is a table with the altitude (in metres) of the vertical levels in the lowest km with their respective sigma coordinate.

Level	Sigma coordinate	Altitude (m)
1	0.99962	3
2	0.99924	6
3	0.99849	12
4	0.99773	18
5	0.99611	31
6	0.99309	55
7	0.98780	97
8	0.97871	170
9	0.96349	293
10	0.93897	494
11	0.90155	808
10	0.84852	1270

Set ups section. What are the resolution of the forcing data from MIROC and ERA-Interim (in this case). Are they the same, 1.5◦ , and did you use the same resolution just to have similar forcing? ERA-Interim is available down to 0.75◦, what I know.

We used the 1.5° ERA-Interim and the MIROC5 resolution is 1.4°.

In a sensitivity study with the WRF model by Claremar et al. (2012, Advances of Meteorology, ID 321649) the effect of resolution was investigated but for the parameters of wind and temperature. As here, one of the conclusions were that you really need high resolution to model wind speed and direction which is related to the precipitation pattern.

Thank you, the reference will be added in the revised version.