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Interactive comment on "Quantifying mass balance processes on the Southern Patagonia Icefield" *by* M. Schaefer et al.

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Schaefer et al. (2014) present results of mass balance simulations for the Southern Patagonia Icefield (SPI) for 1975 to 2011, applying a distributed surface mass balance (SMB) model driven by downscaled reanalysis data. Differences between simulated SMB and geodetic mass balance values (obtained by differencing DEMs derived from satellite data) are used to infer calving fluxes. Considering that knowledge on the individual components of SPI mass balance has been rather uncertain by now, this is an important effort for advancing the knowledge on climatic sensitivity of the SPI ice masses.

Main issues:

At first, I should mention that I am aware of Mauri Pelto's comments (dated 26 June 2014) and agree with his well-founded concerns and suggestions. My main concerns refer also to the limited verification, in particular regarding the following points:

Verification of precipitation and accumulation on the ice field is largely missing due to the lack of data. In particular accumulation is a main source of uncertainty in the mass balance computations. The three mass balance point values in accumulation areas in Fig. 3 underline this problem. There is no 1:1 correspondence (indicated by the line) in the accumulation area. Point 6 (ice core on Tyndall Glacier, Shiraiwa et al. 2002) covers only two years of accumulation, with annual accumulation in the two years differing by as much as 7 m w.e. This is not even adequate for verifying multi-annual mean accumulation at this single point, not to mention accumulation over the whole ice field. For the SMB simulations a large error should be assigned to the accumulation component of the simulations, in particular when stepping down to the scale of individual glaciers.

Lacking details on simulation results for individual SMB components impairs comparisons with field measurements and with studies in other glacier regions. Mass balance profiles (specific MB in dependence of altitude) should be provided, e.g. for comparison with balance profiles by De Angelis (2014) and Stuefer et al. (2007). For the glaciers in Table 2 it would be useful adding the net balance values for ablation and accumulation areas. Stuefer et al. (2007) specify for Moreno Glacier numbers on net balance for accumulation area and ablation area, based on ice flux through at a gate below the equilibrium line and ablation measurements 1995 to 2003. Late summer snow line (e.g. De Angelis, 2014, Section 2.5) would be useful for checking the SMB model performance near the equilibrium line.

There is an obvious mismatch between observed retreat of non-calving glaciers and multi-year trends in modelled SMB. Non-calving glaciers (in particular if small) are more directly linked to climate trends than calving glaciers. According to the increasing positive SMB trend in Fig. 4, the retreat of small glaciers should have stopped (or even turned over to advance) during recent years. Davies and Glasser (2012), however, show ongoing retreat of non-calving glaciers. Although the mass turnover of these glaciers is small compared to the calving glaciers of SPI, this seems to indicate some bias (overestimation of accumulation?) in the SMB model. Besides, one would expect that increase in accumulation is reflected in increase of surface height in level parts of the ice sheet (in areas with little motion). This has not been reported by geodetic data.

The relevance of computing calving fluxes using velocities of a single date for comparison with fluxes over multi-year periods (Table 1) is doubtful. The lack of information on calving cross sections further increases the uncertainty. Several of the main calving glaciers show strong temporal variations of calving velocity (e.g. Muto et al., 2013; Sakakibara et al., 2013). Comparisons of SMB inferred and velocity-based calving fluxes should better focus at a few glaciers where information on calving cross section is available (e.g. from bathymetric data, ice thickness, height above floating) and should account for multi-annual variations in velocity. Accurate data on retrieved calving fluxes would be important for checking the performance of inferred calving fluxes (and SMB).

Further issues:

Information should be provided on the data base and performance of statistical downscaling (mentioned on page 3120, line 13 ff). Statistical downscaling requires a representative observational data base. The only station data shown are precipitation data of three stations (not very close to SPI), each of which covers only a subset of the 35 years (Fig. 4).

The error estimate for the inferred calving fluxes (Table 1) should be revisited. At least for Moreno Glacier there is a consolidated number for 1995 – 2003 (0.36 Gt/yr, Stuefer et al.), whereas the SMB inferred calving flux for 2000-2011 is 4 times higher.

The performance of the geodetic balances, based on differencing of DEMs retrieved from spaceborne sensors, is critical for estimating calving fluxes from SMB data. The

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authors use data published by now (only option anyway). Nevertheless, I want to bring forward some points that might be relevant for future work. Regarding the 1975-2000 Volume change, Rignot at al. (2003; Notes 15. and 16) explain that the 1975 DEM did not cover areas at elevations above 1200 m, whereas the SMB simulations extend over the whole ice field. For recent years, new evaluations of volume change based on single pass interferometry data of 2001 and 2012 (Abdel Jaber et al., 2013) indicate less mass depletion than data based on SRTM/optical DEM differencing (for which earlier versions agree better with SRTM-TanDEM-X differencing, both for NPI and SPI).

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