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The Cryosphere Discussions

Interactive comment on "Spatial and temporal variations of glacier extent across the Southern Patagonian Icefield since the 1970s" *by* A. White and L. Copland

Anonymous Referee #2

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General comments

The paper is a welcome effort at updating changes in the areal extent of the outlet glaciers at the Southern Patagonian Icefield. The text is clear and well structured and the statistical detail provided for each of the glaciers considered is admirable. Unfortunately the work is superseded by another recently published inventory [Davies and Glasser, 2012] and therefore only provides a small amount of new information. The light level of analysis does not adequately address the wide variety of factors that can influence the evolving geometry of the glaciers at the Icefield. Overall I cannot recommend the paper for publication in its current state, but I would happily take a look at a

revised version.

Specific Comments

The introduction section needs to reason much more strongly why the authors believe area changes are important, especially when the dominant causes for length and area change may be only indirectly linked to climate. The work needs to more fully investigate and cite the increased number of recent relevant studies that concern the various mass loss estimates from the icefield over more recent timescales e.g. [Dietrich et al., 2010; Ivins et al., 2011; Jacob et al., 2012; Willis et al., 2012]. These would help put the behavior of any individual glacier in to context. Area and glacier length changes are relatively easy to measure, but thickness and mass changes are a better estimate of the health of the glacier system as a whole.

The rationale for simply splitting the icefield in to four quarters is somewhat arbitrary and probably not useful – are the four segments expected to act differently? A more elegant classification method could be based upon terminus type - lacustrine vs tidewater calving vs ending on land. Geographic position could be used - on the maritime west side vs on the drier east side; latitude based, or geometry based - AAR ratio, or aspect, for example. The paper could provide new insight if the area changes were examined in such a context and ideally resubmission would include an even more nuanced classification scheme, mixing the above suggestions.

The GLIMS catalogue, which should be cited fully, is used to delineate basins. These outlines are then "verified and updated" using ArcMap routines applied to the SRTM – but SRTM is a lower resolution raster than either the vector polygons from GLIMS or the higher resolution orthorectified images that GLIMS uses to derive basins. This seems like a path to degrading the original basins.

Absolute rates of area change are of dubious value, normalizing to the total area of the glacier at a set point in time would provide more insight into which glaciers are changing most.

It is not clear in the methodology whether the authors are truly measuring area changes, or are inferring them from length changes. The small section on debris-covered ice is confusing. It notes that if flow features are not observed on the debris covered part of the ice, then the glacier ice limit is taken to the boundary between ice and debris – It is not clear how changes in this boundary equate with changes in the area of the glacier.

The spatial coarseness of the climate data (2.5 degrees by 2.5 degrees) included in the paper preclude their use for this type of analysis. Relying on two cells from the NCEP reanalysis that provide air temperatures at 2m above surface level means little in this region of high relief, as the relief that is not reflected in the NCEP resolution.

The passive microwave analysis of Monahan and Ramage [2010] provides an idea of the real spatial scales involved when considering the seasonal and annual effects of changing atmospheric variables on the icefield. They show surface melting and refreezing through time that is distinctly related to local climatology (maritime versus in the rain shadow etc). They indicate a lengthening of the melt season over a short timescale - 2002 to 2008.

Koppes et al., [2011] provide a good example of refining the NCEP reanalysis for a local region at the Northern Icefields. We acknowledge that the region is data sparse and more intense investigation in to the local climate is a major undertaking.

We note that the changing ratio of snow to rain at the more meaningful 850 hPa height has been previously investigated in Patagonia [Rasmussen et al., 2007] and should be cited.

Some suggested references to consider further.

Davies, B., and N. F. Glasser (2012), Accelerating shrinkage of Patagonian glaciers from the Little Ice Age (∼AD 1870) to 2011, Annal. Glac., 58(212).

Dietrich, R., E. R. Ivins, G. Casassa, H. Lange, J. Wendt, and M. Fritsche (2010), Rapid

crustal uplift in Patagonia due to enhanced ice loss, Earth. Plan. Scie. Lett., 289(1-2), 22-29.

Heid, T., and A. Kääb (2012), Repeat optical satellite images reveal widespread and long term decrease in land-terminating glacier speeds, The Cryosphere, 6(2), 467-478.

Ivins, E. R., M. M. Watkins, D.-N. Yuan, R. Dietrich, G. Casassa, and A. Rülke (2011), On-land ice loss and glacial isostatic adjustment at the Drake Passage: 2003 - 2009, J. Geophys. Res., 116(B2), B02403.

Jacob, T., J. Wahr, W. T. Pfeffer, and S. Swenson (2012), Recent contributions of glaciers and ice caps to sea level rise, Nature, advance online publication.

Koppes, M., H. Conway, L. A. Rasmussen, and M. Chernos (2011), Deriving mass balance and calving variations from reanalysis data and sparse observations, Glaciar San Rafael, northern Patagonia, 1950-2000, The Cryosphere, 5, 1123-1166.

Monahan, P. A., and J. M. Ramage (2010), AMSR-E Melt Patterns on the Southern Patagonian Icefield, J. Glacio., 56(198), 699-708.

Willis, M. J., A. K. Melkonian, M. E. Pritchard, and A. Rivera (2012), Ice Loss from the Southern Patagonian Icefield, South America, between 2000 and 2012., Geophys. Res. Lett., 39(L17501).

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