1 Overview

Chuter et al. (2021) use a joint Bayesian inversion technique and remote sensing datasets to separate the variations of ice sheet processes on an annual scale for the Antarctic Peninsula. This is an advancement of prior work using similar methods for analyzing the surface and mass change of the Antarctic ice sheet as a whole. The authors use higher resolution and more localized datasets to solve for this complex region of ice sheet mass change. The work presented by the authors falls within the scope of *The Cryosphere* and could make an interesting contribution to mass change estimates for the Antarctic Peninsula. Overall, this is a good study with established techniques to analyze a difficult region of Antarctica.

2 Broad comments

- The authors note a paucity of altimetry available for the Antarctic peninsula. Could surface elevation measurements data from Operation IceBridge help here?
- What impact does using interpolated gridded products for altimetry have here versus using an along-track product?
- Should use "ICESat" for the original mission rather than "ICESat-1"
- The ENVISAT section (2.2.1) should be after the ICESat section since ENVISAT is "providing complementary coverage to ICESat"
- The MEaSUREs ice velocity and RACMO2.3p2 5.5km descriptions should be in their own subsections.
- Could note that all datasets were converted to a common reference frame and projection versus repeating.
- En dashes should be used for date ranges rather than hyphens
- Colors on the plots could be changed to be able to be discernible when printed

3 Line-by-line comments

Page 1, Lines 11–12: This makes it seem like it was continual and accelerating losses. However, as noted later in the abstract there were a couple of years of mass gains late in the study period.

Page 1, Lines 21–22: Are there any times when surface mass balance and ice dynamics are not happening simultaneously?

Page 1, Line 28: Partial or near-full collapse of Larsen-B

Page 1, Line 32: I would just say "Continuous long-term monitoring of the AP is important as..."

Page 2, Line 36: Remove "Therefore"

Page 2, Lines 37–38: I would break this into pieces to be similar to the following: "The Antarctic Peninsula is difficult to monitor using conventional mass balance approaches. The high relief of the peninsula make it a particularly poor region to monitor with satellite altimetry, Interferometric SAR-derived (InSAR) velocities and ice thickness data. In addition, the sharp topography and large climatic gradient across the AP provides significant challenges for predictions from regional climate models. Finally, the more northerly latitude increases the across-track spacing between orbits for satellite altimetry, which decreases the available measurements in the region."

Page 5, Line 93: Should note here that these are "a $0.5^\circ \times 0.5^\circ$ global grid interpolated from equal area 3° diameter spherical caps."

Page 5, Line 104: the mascon delineations are available from JPL

Page 5, Lines 108–110: There are larger uncertainties in the GRACE products starting October 2016 due to efforts to extend the mission lifetime and preserve battery life. GRACE-FO also has larger uncertainties due to accelerometer issues on GF2.

Page 6, Line 144: averaged and interpolated using a hypsometric approach

Page 7, Line 171: is 5km grid spacing be too large for a planar assumption in the AP?

Page 7, Line 173: would the 15 m/yr cutoff eliminate some valid points near the grounding line? The near ground-line thinning on Page 15 was 10.1 m/yr.

Pages 7–8, Lines 179–181: This is an important piece of the paper and should probably be in the abstract or conclusion.

Page 8, Line 194: should be "photogrammetric" acquisitions correct?

Page 8, Lines 208–211: A difficulty here would be the sensitivity of GRACE/GRACE-FO to near-grounding line change. If these values are masked in the DEM fields but of a large enough magnitude to be detectable by GRACE/GRACE-FO, then there has to be some sort of bias being introduced. Would be good to have some clarifying text in the discussion.

Page 9, Line 216: GIA is "quasi-invariant" over short time scales (years to decades). It would have been interesting to see the results if GIA wasn't fixed as the uncertainty is a limiting factor in GRACE/GRACE-FO studies ($\sim$4–5 Gt/yr difference between Ivins et al. (2013) and Whitehouse et al. (2012) in the AP)

Page 11, Line 265: Is this 99.6% of the AP or ice sheet wide?

Page 11, Lines 274–276: For overlapping grid cells in the 27km and 5.5km models, are the average spectral properties the same?

Page 11, Line 277: Use something besides "per se"?

Page 11, Lines 287–289: The near collapse of Larsen-B resulted in rapid sub-annual responses in ice velocity (Rignot et al., 2004). Would this still be over-smoothing potential discharge contributions?

Page 14, Line 324: Figure 4 instead of "Fig. Figure 4"

Page 16, Line 367: "Changes in surface processes are the major drivers"

Page 16, Line 380: Could other altimetry datasets (OIB/IS2) help with the "paucity" of data?

Page 16, Line 382: If it is a large enough signal in magnitude, GRACE/GRACE-FO should be able to observe it. However, it would be a smoothed representation of that mass change and difficult to localize due to the non-uniqueness of the solutions.

Page 19, Lines 413–415: What about comparing to the individual components of IMBIE?

Page 21, Lines 467: "cannot be resolved with gravimetry alone."

Page 23, Lines 486: Is there a space missing between "2011" and "to"?

Page 23, Lines 498–499: Would the deficiencies in calculating ice discharge in the Martín Español et al. (2016) solutions affect the GIA solution used here?

References

S. J. Chuter, A. Zammit-Mangion, J. Rougier, G. Dawson, and J. L. Bamber. Mass evolution of the Antarctic Peninsula over the last two decades from a joint Bayesian inversion. *The Cryosphere Discussions*, 2021:1–32, 2021. doi: 10.5194/tc-2021-178.

E. R. Ivins, T. S. James, J. Wahr, E. J. O Schrama, F. W. Landerer, and K. M. Simon. Antarctic contribution to sea level rise observed by GRACE with improved GIA correction. *Journal of Geophysical Research: Solid Earth*, 118(6):3126–3141, June 2013. ISSN 2169-9356. doi: 10.1002/jgrb.50208.

A. Martín Español, A. Zammit Mangion, P. J. Clarke, T. Flament, V. Helm, M. A. King, S. B. Luthcke, E. Petrie, F. Rémy, N. Schön, B. Wouters, and J. L. Bamber. Spatial and temporal Antarctic Ice Sheet mass trends, glacio-isostatic adjustment, and surface processes from a joint inversion of satellite altimeter, gravity, and GPS data. *Journal of Geophysical Research: Earth Surface*, 121(2):182–200, Feb. 2016. ISSN 2169-9011. doi: 10.1002/2015JF003550. 2015JF003550.

E. J. Rignot, G. Casassa, S. P. Gogineni, W. B. Krabill, A. Rivera, and R. H. Thomas. Accelerated ice discharge from the Antarctic Peninsula following the collapse of Larsen B ice shelf. *Geophysical Research Letters*, 31 (L18401):1–4, 2004. doi: 10.1029/2004GL020697.

P. L. Whitehouse, M. J. Bentley, G. A. Milne, M. A. King, and I. D. Thomas. A new glacial isostatic adjustment model for Antarctica: calibrated and tested using observations of relative sea-level change and present-day uplift rates. *Geophysical Journal International*, 190(3):1464–1482, 2012. doi: 10.1111/j.1365-246X.2012.05557.x.