New, High-Resolution Spatio-Temporal Accumulation Rate Measurements and Their Validation of Climate Models and Implication for the Recent Sea-Level Contribution from West Antarctica

Medley, B.[1,2], I. Joughin[2], S. B. Das[3], E. J. Steig[1,4], P. S. Gogineni[5], A. S. Criscitiello[3,6], M. R. van den Broeke[7], J. T. M. Lenaerts[7], D. H. Bromwich[8], J. R. McConnell[9]

[1]Earth and Space Sciences, University of Washington, Seattle, WA, USA.
[2]Polar Science Center, Applied Physics Lab, University of Washington, Seattle, WA, USA.
[3]Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA, USA.
[4]Quaternary Research Center, University of Washington, Seattle, WA, USA.
[5]Center for Remote Sensing of Ice Sheets, University of Kansas, Lawrence, Kansas, USA.
[6]MIT/WHOI Joint Program in Oceanography/Applied Ocean Sciences and Engineering, Woods Hole Oceanographic Institution, Woods Hole, MA, USA.
[7]Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Utrecht, Netherlands.
[8]Polar Meteorology Group, Byrd Polar Research Center, and Atmospheric Sciences Program, Department of Geography, The Ohio State University, Columbus, Ohio, USA.
[9]Desert Research Institute, Nevada System of Higher Education, Reno, NV, USA.

Under a warming planet scenario, enhanced accumulation could potentially counteract the recent and future sea-level rise caused by increased ice discharge over the Antarctic continent. Several individual core accumulation histories show temporal trends, but their spatial significance is limited due to the small-scale variability in accumulation. Climate model and global reanalyses of the accumulation rate (i.e., surface mass balance) show insignificant temporal trends in accumulation over recent decades, yet the skill of these models has yet to be rigorously determined. This work presents a new, high-resolution spatio-temporal accumulation rate data derived from airborne CReSIS snow radar surveys flown between 2009 and 2011 as part of NASA's Operation IceBridge. The snow radar horizons are confirmed as annually repeating through comparison with several new and existing intermediate-depth ice core accumulation records, which allows us to date each horizon by manual count rather than core glaciochemistry. This discovery will expand use of the snow radar to more remote and inaccessible areas of the ice sheet, as little to no fieldwork is necessary to generate accumulation rate estimates. We find the radar is most capable of resolving an annual signal in areas that receive 0.3-0.6 m we yr^{-1} accumulation on average.

Based on model comparison with our spatio-temporal accumulation measurements, we find that the RACMO2 regional climate model is very capable (r = 0.88) of generating the spatial pattern of the 30-year average accumulation rates. The reanalyses have weaker spatial correlation, but more highly correlate (r > 0.90) with the annual variation in accumulation yet underestimate the overall *magnitude* of accumulation. Our accumulation results from Thwaites Glacier, West Antarctica, indicate that between 1980 and 2009 no significant trend in accumulation exists and is thus not counteracting the increasing trend in local ice discharge. Additional flight surveys are necessary before basin-wide annual net accumulation is estimated.