IPY, COLLABORATIVE RESEARCH: Constraining the Mass-Balance Deficit of the Amundsen Coast's glaciers

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Relevance to IPY: The West Antarctic Ice Sheet is losing mass, in large part because of rapid thinning of the Amundsen Coast glaciers. Estimates of Amundsen Coast thinning range from 46 to 86 Gtons/yr, with the 40-Gton/yr difference being nearly equivalent to the combined outflow of Mercer, Whillans, Kamb, and Bindschadler ice streams (46 Gtons/yr). While warmer ocean temperatures may drive this thinning, the large uncertainties in the current mass balance estimates largely arise from poor knowledge of the snowfall accumulation over Pine Island, Thwaites, Smith, Pope and Kohler glaciers. This international project will determine accumulation rates in this vastly under-sampled region to remove the large uncertainties in current mass balance estimates and, in doing so, it will directly address the NSF IPY emphasis on "*ice sheet history and dynamics*."
Intellectual Merit: The field effort consists of a series of airborne accumulation radar profiles to map internal layers and ice thickness. Near-surface radar layers will be dated using age-depth profiles derived from shallow ice cores. The combination of these data will yield multiple transects of decadal-scale average accumulation extending back through the last century. Spatially complete, annually-resolved maps of accumulation will be obtained from these data using EOF-based interpolation schemes guided by weather hindcast results (i.e. NCEP, ECMWF, Polar MM5 output). Comparison of the basin-averaged accumulation with ice discharge determined using Interferometric Synthetic Aperture Radar (InSAR) velocity data will provide improved mass-balance estimates. Study of changes in flow speed will produce a record of mass balance over the last three decades. Analysis of the satellite altimeter record in conjunction with annual accumulation estimates also will provide estimates of changes and variability in mass balance. Finally, these data will constrain a modeling effort to determine how coastal changes propagate inland, to allow better prediction of future change.
Broader Impacts: During the period while the next IPCC assessment was being prepared, new credible estimates of Antarctic mass balance were published that range from thickening by 45 Gtons/yr to thinning by 152 Gtons/yr. The difference in these estimates represents nearly one third of the ~1.5 mm/yr 20th Century sea level rise. By removing uncertainty in the region where imbalances are the largest, this project will make a significant contribution to subsequent IPCC estimates of sea level, which are important for projection of the impacts of increased sea level on coastal communities. The research will contribute to the graduate education of students at the Universities of Washington and Kansas and will enrich K-12 education through the direct participation of the PIs in classroom activities. Informal science education includes 4-day glacier flow demonstrations at the Polar Science Weekend held annually at the Pacific Science Center in Seattle. The project also will communicate results through Center for the Remote Sensing of Ice Sheets (CRESIS) outreach effort. All field and remotely-sensed data sets will be archived and distributed by the National Snow and Ice Data Center.