Antarctic ice mass fluxes from satellite observations and a regional climate model

Jonathan Bamber (1), Willem van de Berg (2), Michiel van den Broeke (2), Curt Davis (3), Yonghong Li (3), Erik van Meijgaard (4), Eric Rignot (5)

1 University of Bristol
2 Utrecht University
3 University of Missouri-Columbia
4 KNMI, Netherlands
5 JPL, Caltech

Estimates of the mass imbalance of the WAIS derived from satellite radar altimetry and GRACE differ by more than a factor three, ranging from, for example, -47 ± 4 Gt a-1 for ~1992-2002 to -148 ± 21 Gt a-1 for 2002-2005, respectively. Some of the difference may be due to changes in ice dynamics during the measurement periods. Some is also due, however, to issues related to spatial sampling and assumptions made and methods used during data analysis. Different GRACE estimates of WAIS imbalance are not consistent, for example, within their combined error budget. To improve our understanding of both the spatial and temporal pattern of mass balance changes at the basin scale, we have begun refining mass flux calculations for the whole of the Antarctic ice sheet, incorporating ~90% of the grounding line discharge. We aim to reduce the uncertainty in all components of the mass flux calculation by incorporating i) improved mapping of grounding line locations and thickness using combined GLAS/ERS-1 altimeter data and MODIS imagery, ii) velocity time series from 1996-2005 for glaciers with a significant imbalance, iii) improved and extended drainage basin delineation and iv) estimates of the mean and time-varying accumulation rate from a regional climate model driven by re-analysis data. Here we present the methodology and first results of this analysis for the WAIS along with an overview of the improved data sets being used and developed within the project. Our results indicate a mass loss for the WAIS that falls between the SRA and GRACE estimates quoted above between 1996 and 2006. The results to date do not show an acceleration in mass loss during this time interval. The error in our estimate is currently dominated by uncertainties in accumulation rate, followed by the combined uncertainty in grounding line location and thickness. How we will reduce these errors further is discussed.