

Overview of Ice-Sheet Mass Balance and Dynamics from ICESat Measurements

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The primary purpose of the ICESat mission was to determine the present-day mass balance of the Greenland and Antarctic ice sheets, identify changes that may be occurring in the surface-mass flux and ice dynamics, and estimate their contributions to global sea-level rise. Although ICESat's three lasers were planned to make continuous measurements for 3 to 5 years, the mission was re-planned to operate in 33-day campaigns 2 to 3 times each year following failure of the first laser after 36 days. Seventeen campaigns were conducted with the last one in the Fall of 2009. Mass balance maps derived from measured ice-sheet elevation changes show that the mass loss from Greenland has increased significantly to about 170 Gt/yr for 2003 to 2007 from a state of near balance in the 1990's. Increased losses (189 Gt/yr) from melting and dynamic thinning are over seven times larger than increased gains (25 Gt/yr) from precipitation. Parts of the West Antarctic ice sheet and the Antarctic Peninsula are losing mass at an increasing rate, but other parts of West Antarctica and the East Antarctic ice sheet are gaining mass at an increasing rate. Increased losses of 35 Gt/yr in Pine Island, Thwaites-Smith, and Marie-Bryd Coast are more than balanced by gains in base of Peninsula and ice stream C, D, & E systems. From the 1992-2002 to 2003-2007 period, the overall mass balance for Antarctica changed from a loss of about 60 Gt/yr to near balance or slightly positive.