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ICE-SHEET ELEVATION CHANGE

(Abstract)

by

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Over century time scales, the primary effect of ice-sheet/climate-change interactions is vertical growth or shrinkage of the ice in response to changes in precipitation and surface heat flux. Because the dynamic response of large ice masses is generally slower than climate variations experienced during the last few centuries, the ice sheets are unlikely to be in equilibrium with today's climate. Uncertainty in the current mass balance has been large, at least ±30% or ±2 mm yr^{-1} in sea-level equivalent. Estimates of annual snow accumulation, iceberg discharge, and peripheral melting of the Antarctic ice sheet (personal communication from S. Jacobs) would suggest a negative mass-balance equivalent to +2 mm yr^{-1} of sea-level rise, in contrast to other estimates of a small positive balance for both Antarctica (−0.6 ±0.6 mm yr^{-1} sea level) and Greenland (−0.1 ±0.4 mm yr^{-1} sea level) (Meier and others, 1985). For some years, measurement of changes in ice-sheet surface elevation by satellite altimetry has been noted as a potential means of determining the overall ice-sheet mass balance and investigating regional variations. Difficulties in deriving elevation change from a set of sequential measurements from several satellites have been primarily a result of the limited precision (about 1–2 m) of satellite radar altimetry, residual orbit errors, and relative uncertainties in the gravity fields and geoid reference levels used for different satellites. However, recent radar altimeter measurements by the U.S. Navy Geosat to 72°N and 72°S provide a sufficient density of repeated measurements of ice elevation for analysis of elevation change during the life of the satellite. The average elevation change at 224 267 orbital crossovers over southern Greenland is +28.3 ±0.4 cm yr^{-1}. The largest values are observed near the summit and over the southern dome, with smaller values in the saddle region and toward the margins. Local gridded values of thickening and thinning rates agree with estimates from surface studies in the vicinity of the EGIG traverse (Steckel, 1977), Dye 3 (Reeh, 1985), and the OSU survey (Kostecka and Whillans, 1988) within the error limits of the respective measurements. Comparisons with elevations measured by the Seasat altimeter in 1978 and continuing Geosat measurements provide information on the temporal continuity of the thickening. The spatial distribution of the elevation changes is used to estimate an average thickening rate and the current rate of oceanic depletion.

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