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Ice-mass and sea-level variations from GRACE

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Recent ice-mass loss in the Earth's polar regions has a major impact on global sea-level change, being spatially variable. Analyzing five whole years of time-variable gravity field observations (April 2002 to March 2007, inclusive) provided by the GRACE (Gravity Recovery and Climate Experiment) satellite mission, we present ice-mass loss estimates over Greenland, Alaska and Antarctica that are considerably larger than given by previous studies. Taking the effect of spectral leakage in the GRACE data into account, we estimate the total cryospheric volume change to $-749\,\mathrm{km}^3\,\mathrm{yr}^{-1}$ with the separation among Greenland, Alaska and Antarctica being $-308\,\mathrm{km}^3\,\mathrm{yr}^{-1}$, $-127\,\mathrm{km}^3\,\mathrm{yr}^{-1}$ and $-314\,\mathrm{km}^3\,\mathrm{yr}^{-1}$, respectively. The total ice-mass change corresponds to an eustatic (or globally uniform) sea-level rise of $1.90\,\mathrm{mm\,yr}^{-1}$, suggesting that ice-mass loss is the largest contribution to recently observed eustatic sea-level rise. However, we prove that simplistic uniform modeling of sea-level variations is insufficient as it does not represent spatially variable features, especially in high-latitude regions. As such, gravitational and elastic feedback effects due to global mass redistribution should always be considered.