Eighteen years of height and mass changes in West Antarctic Ice Shelves

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Recent mass losses from the grounded Antarctic Ice Sheet have been associated with changes in its floating ice shelves, but the duration and variability of these changes is so far undocumented. Using data from three overlapping satellite radar altimetry missions (ERS-1, ERS-2 and Envisat) we construct a record, at high spatial and temporal resolution, of ice-shelf height changes for the 18-year period 1994-2012. The record reveals a complex pattern of ice-shelf height change resulting from the varying impacts of the Antarctic oceans and atmosphere on the ice sheet. We show that Antarctica-wide average ice-shelf height increased moderately up until ~2003 and then declined rapidly after ~2006. The Amundsen Sea ice shelves have experienced persistent surface lowering since the beginning of the record, with mean values ranging from ~-5 cm/year (Cosgrove) to ~-30 cm/year (Dotson). We observe more rapid lowering at the deep grounding lines than at the shallower ice shelf fronts, consistent with thermal erosion driven by warm Circumpolar Deep Water flowing under the ice shelves. On the eastern Antarctic Peninsula, the rate of thinning starts much larger at the northernmost portion and develops southwards, consistent with a response to the observed trend of atmospheric warming. Although relatively stable with average rates of -1.6 to +0.5 cm/year, the two largest ice shelves (Ross and Filchner-Ronne) show large interannual and spatial variability. Our 18-year-long dataset demonstrates that results from single satellite missions, with typical duration of a few years, are insufficient to draw conclusions about long-term response of ice shelves to changes in oceanic and atmospheric conditions.

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