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Twenty-two years of radar-derived height changes over Antarctic ice shelves

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Surface height observations over the last two decades have shown significant and complex spatial and temporal variability in the elevations of ice shelves. This variability is especially pronounced in the Amundsen Sea sector of Antarctica, where processes controlling rapid ice-shelf thinning remain unclear. Such changes, which occur over seasonal to decadal timescales, can potentially impact the dynamics of the grounded ice sheet behind the floating ice shelves. Therefore, it is vital to continue the long-term monitoring of ice shelves through the modern satellite altimetry missions, and lengthen our existing time series to investigate the climate forcings driving observed changes. Here, we use Cryosat-2 (CS-2) radar altimetry (2010-present) to extend the currently available 18-year observational record (1994-2012) of ice-shelf height from the ERS-1/2 and Envisat missions. The SARin-mode data from the CS-2 mission requires a different processing technique due to the differences in orbit configuration and instrumentation between CS-2 (which carries a Delay/Doppler altimeter) and ERS-1/ERS-2/Envisat (which carried conventional altimeters). We use the $\sim$2-year overlap period between the Envisat and CS-2 records to validate the independently-derived height change records. We also investigate the limitations/capability of the CS-2 system (compared to conventional altimetry) for the long-term monitoring of ice shelves. Finally, we merge the two time series, present our new, 22-year estimate for ice-shelf height change across Antarctica, and demonstrate the value of this extended record with case studies of the Larsen C and Getz ice shelves, each of which shows substantial multi-year variability.