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A new elevation change time series of the Antarctic Ice Sheet from Envisat and CryoSat-2 radar altimetry

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Satellite altimetry is an important data source for ice sheet change observation. The long-term time series of ice sheet changes can be obtained by combining satellite altimetry missions with similar sensor characteristics. Then, how to correct the inter-mission offsets becomes an important scientific issue. Review of previous studies, we found that the observations of satellite ascending and descending orbits also have an important influence on the estimation of inter-mission offsets. On this basis, have created a new least-square fitting mathematical model to estimate and correct the errors of ascending and descending orbits and inter-mission offsets by introducing the inter-mission offsets terms related to the observations of ascending and descending orbits. Utilizing this model, we developed a time series of monthly Antarctic ice sheet elevation changes of 5 km grid from May 2002 to April 2019. A validation with surface elevation from airborne observations and a comparison with surface elevation changes from ICESat proved that the proposed model can successfully estimate and correct the errors and be used to construct multi-mission surface elevation time series. Without a doubt, the temporal and spatial changes of Antarctic ice sheet elevation can be obtained from our monthly grid time series. From the time series, we find that over the period May 2002 to April 2019 the loss of ice and snow in the Antarctic ice sheet mainly occurred in the glaciers along the Amundsen coast in the West Antarctic and the Totten glacier in the East Antarctic, while the accumulation took place in Queen Maud of the East Antarctic. In May 2002, the Antarctic ice sheet experienced a volume loss of -71.4 ± 11.7 km^3/yr, with an acceleration of –5.8 ± 1.2 km^3/yr^2 over the period May 2002 to April 2019, including 45.0 ± 9.6 km^3/yr and 0.1 ±1.0 km^3/yr^2 for the East Antarctic ice sheet, -97.0 ± 4.4 km^3/yr and -7.6 ±0.5 km^3/yr^2 for the West Antarctic ice sheet and -19.5 ± 5.3 km^3/yr and 1.7 ±0.5 km^3/yr^2 for the Antarctic Peninsula ice sheet.