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Ice sheet elevation and volume change from Sentinel-3 SAR altimetry

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The launch of the first Sentinel-3 satellite in February 2016 represented the beginning of a new long-term series of operational radar altimeters, which will provide Synthetic Aperture Radar (SAR) altimetry measurements over ice sheets for decades to come. With these satellites reaching a latitude of ∼81.5 degrees and operating with a repeat period of 27 days, they offer the opportunity to provide continuous measurements of surface topography and volume change across most of the Antarctic and Greenland Ice Sheets, thereby extending the existing 25 year altimeter record. The global operation of Sentinel-3 in SAR mode differs from all past Ku-band instruments; for the first time SAR measurements are routinely acquired across the interiors of the ice sheets; however unlike CryoSat-2 there is no interferometer to aid signal retrieval in regions of complex coastal terrain. In view of these differences and the novel characteristics of the Sentinel-3 system, early assessments of the performance of the instrument are required, to evaluate the satellite's utility for monitoring Earth's Polar regions.

Here, we present analysis of data acquired during the two years of routine operations, which builds upon pre-launch activities undertaken as part of SPICE (Sentinel-3 Performance Improvement for Ice Sheets), a 2 year study that was funded by ESA's SEOM (Scientific Exploitation of Operational Missions) programme. We focus both on inland ice sheet regions, where Sentinel-3 provides the first operational SAR altimeter measurements, and also on coastal areas with more complex topography. We investigate SAR waveforms and retrieved elevations, evaluating instrument shot-to-shot precision over the Lake Vostok validation site in Antarctica, and absolute accuracy through comparisons with airborne reference data. We conclude by assessing the capability of Sentinel-3, after its first two years of routine operations, to measure ice sheet elevation and volume change, and to resolve signals of glaciological imbalance and subglacial lake activity.