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SPICE: Sentinel-3 Performance Improvement for Ice Sheets

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For the past 25 years, polar-orbiting satellite radar altimeters have provided a valuable record of ice sheet elevation change, yielding estimates of ice sheet mass imbalance at the scale of individual ice sheet basins. One of the principle challenges associated with radar altimetry comes from the relatively large ground footprint of conventional pulse-limited radars, which limits their capacity to make reliable measurements in areas of complex topographic terrain. In recent years, progress has been made towards improving ground resolution, through the implementation of Synthetic Aperture Radar (SAR), or Delay-Doppler, techniques. In 2010, the launch of CryoSat-2 heralded the start of a new era of SAR altimetry, although full SAR coverage of the polar ice sheets has only been achieved with the launch of the first Sentinel-3 satellite in February 2016. Because of the heritage of SAR altimetry provided by CryoSat-2, many SAR altimeter processing techniques have been optimized and evaluated for water and sea ice surfaces only. This leaves several outstanding issues related to the development and evaluation of SAR altimetry for ice sheets, including improvements to Delay-Doppler processing algorithms and SAR altimetry waveform retracking procedures.

Here we present results from SPICE (Sentinel-3 Performance Improvement for Ice Sheets), a 2 year project that focuses on the expected performance of Sentinel-3 SAR altimetry over the Polar ice sheets. The project, which began in September 2015 and is funded by ESA's SEOM (Scientific Exploitation of Operational Missions) programme, aims to contribute to the development and understanding of ice sheet SAR altimetry through the emulation of Sentinel-3 data from dedicated CryoSat SAR acquisitions made at the Lake Vostok, Dome C and Spirit sites in East Antarctica, and from reprocessed interferometric SAR data in Greenland. More specifically, we will evaluate SAR elevation retrievals using different processing methodologies and develop pseudo Low Resolution Mode (pLRM) measurements from SAR Full Bit Rate (FBR) data, to investigate the ability to generate a low resolution product from a closed burst SAR system. For all processing scenarios, we will evaluate the ice sheet elevation measurement using reference airborne and satellite datasets. Finally, we will describe future SPICE activities, which will focus on algorithm developments to existing Delay-Doppler processing schemes, implementation of new SAR retrackers designed for ice sheets, and comparison to AltiKa Ka-band altimetry to study radar wave penetration into the snowpack.