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SPICE: Sentinel-3 Performance Improvement for Ice Sheets

Malcolm McMillan (1), Roger Escola (2), Monica Roca (2), Pierre Thibaut (3), Jeremie Aublanc (3), Clemente Lacrouts (3), Andrew Shepherd (1), Frederique Remy (4), Jerome Benveniste (5), Americo Ambrozio (5), and Marco Restano (5)

(1) University of Leeds, Leeds, United Kingdom (m.mcmillan@leeds.ac.uk), (2) isardSAT Ltd, Guildford, United Kingdom, (3) CLS, Ramonville Saint-Agne, France, (4) LEGOS, Toulouse, France, (5) ESA ESRIN, Frascati, Italy

For the past 25 years, polar-orbiting satellite radar altimeters have provided a valuable record of ice sheet elevation change and mass balance. One of the principle challenges associated with radar altimetry comes from the relatively large ground footprint of conventional pulse-limited radars, which reduces their capacity to make 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 Interferometric (SARIn) altimetry. However, because the satellite operated in SARIn and LRM mode over the ice sheets, many of the non-interferometric SAR altimeter processing techniques have been optimized for water and sea ice surfaces only. The launch of Sentinel-3, which provides full non-interferometric SAR coverage of the ice sheets, therefore presents the opportunity to further develop these SAR processing methodologies over ice sheets, for the purpose of scientific exploitation of this operational mission.

Here we present results from SPICE (Sentinel-3 Performance Improvement for Ice Sheets), a 2 year study that focuses on (1) developing and evaluating Sentinel-3 SAR altimetry processing methodologies over the Polar ice sheets, and (2) investigating radar wave penetration through comparisons of Ku- and Ka-band satellite measurements. The project, which is funded by ESA's SEOM (Scientific Exploitation of Operational Missions) programme, has worked in advance of the operational phase of Sentinel-3, to emulate Sentinel-3 SAR and pseudo-LRM data from dedicated CryoSat-2 SAR acquisitions made at the Lake Vostok, Dome C and Spirit sites in East Antarctica, and from reprocessed SARIn data in Greenland. In Phase 1 of the project we have evaluated existing processing methodologies, and in Phase 2 we have investigated new evolutions to the L1b Delay-Doppler Processing and L2 retracking chains. In this presentation we focus on (1) the novel L2 processing developments used to improve retracking over complex topographic surfaces, such as those found across the margins of the Antarctic Ice Sheet, and (2) the impact of volume scattering on SAR retrievals, through a comparison of SAR waveforms to equivalent Ku- and Ka-band LRM acquisitions.