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Assessment of ESA CryoSat-2 radar altimetry data using GNSSdata at three sites on the Greenland Ice Sheet

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Ten-year records of ice surface elevation changes derived from three GNSS stations placed on the interior of the Greenland ice sheet are used to assess the ability of CryoSat-2 radar altimetry to capture surface elevation changes during 2010-2021. We use GNSS interferometric reflectometry (GNSS-IR) to derive time series of continuous daily surface elevations. The footprint of GNSS-IR is about 1000 m2 and the accuracy is ±2cm, making it an excellent tool to validate ice surface height from satellite altimetry. We compare GNSS-IR derived ice surface elevations with CryoSat-2 derived surface elevations and find Cryosat-2 performs best at the GNSS site furthest north (GLS3) with a maximum difference of 12cm. The other GNSS sites have a higher residual range because of poorer data availability and local surface variations. The number of Cryosat-2 data points are roughly doubled from GLS1 and GLS2 to GLS3. GLS3 Is located in a very flat area of the ice sheet only moving 55m during 2011-2020. In contrast GLS1 moved 292m in the same period, clearly indicating a steeper slope to the ice sheet at this location, which we have difficulty correcting for because digital elevation models are associated with high uncertainty on the interior of the ice sheet. The strength of this assessment method lies in the continuous daily time series of surface elevation change derived from GNSS, as they clearly capture extreme short-term changes, which otherwise might have been perceived as errors in the radar altimetry measurements.