Observation-driven Spaceborne GNSS-R Altimetry Model for Slope Surface

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Abstract

The geometry computation, as a foundation of the spaceborne Global Navigation Satellite Systems Reflectometry (GNSS-R) technique, faces the challenge of complicated Earth's surface topography. Due to the different bistatic observation models from the traditional active along-track implementation, the surface slope including its aspect will result in intensified errors in the measurements location and vertical determination. In this study, a new geometry computation strategy for carrying out forward and inverse path geometries calculations of reflected signals. In addition, the local Earth's topography can be introduced to take the large-scale surface slope and aspects into account. From the simulation with respect to different slope and elevation angles, it can be found that tens of kilometers and hundreds of meter errors in geolocation and surface height estimations respectively can potentially occur for the grazing observation condition over slopes. To validate the proposed method, a ground track crossing the Greenland ice surface from the crest to the edge received by the TDS-1satellite with a slope range from 0% to 1% was investigated. The results demonstrated that a slope of 1% at an elevation angle of 54 degrees can result in a 16km geolocation inaccuracy and 90m height error when the TanDEM-X 90m Digital Elevation Model was taken as a reference. After employing the proposed method, the standard deviation of geolocations of specular points and height retrievals were greatly reduced from 4758m to 367m, from 28m to 5.8m, respectively. Applications related to topography slopes, e.g. ice surface in polar regions could benefit from this method.