Paper ID: 3186
student

SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Small Satellites Potential for Future Integrated Applications and Services (4)

Author: Mr. Guy de Carufel
University of Toronto Institute for Aerospace Studies, Canada, gdecarufel@gmail.com

Prof. Georgia Fotopoulos
University of Toronto, Canada, georgia.fotopoulos@utoronto.ca

ASSESSMENT OF MULTISTATIC SCATTEROMETRY MISSION PARAMETERS FOR OCEAN MONITORING VIA GNSS-REFLECTOMETRY

Abstract

It has been demonstrated from the recent success onboard the UK-DMC satellite that multistatic oceanic scatterometry can be performed with Global Navigation Satellite System – Reflectometry (GNSS-R). UK-DMC detected L1 signals emitted by GPS satellites reflected off the ocean surface using a single moderate gain antenna and correlated these signals with ocean surface wind speeds. The premise of this paper is to find the best parameters to enable a nanosatellite in Low Earth Orbit to conduct GNSS-R for ocean scatterometry. An operational satellite system of this sort would greatly augment the current availability of sea state information from existing traditional monostatic scatterometry satellites, which would be extremely valuable for storm warnings, among other applications. The first objective was to analyze a link budget related to a bistatic equation based on current known error budgets associated with GNSS-R and results obtained from the UK-DMC experiment. The link budget produced a signal strength expected before subtracting the scattering coefficient, equal to 10.7dB. Subtracting this result by the Signal-to-Noise (SNR) values obtained from the UK-DMC produced a theoretical scattering coefficient which agrees with results derived from an independent study based on the CALIPSO space-based Lidar experiment. Making use of this link budget, maximum wind speed measurement requirements and orbital parameters were translated into necessary antenna gains. An oceanic coverage study is also presented to determine the ideal orbital and antenna parameters for which the greatest Earth coverage can be achieved. It was found that a GNSS access cone should be used to provide temporal coverage information. The results show that a polynomial function best fits the coverage time with respect to varying the orbital inclination angle for particular altitudes. For an orbit of 500km, an ideal inclination was demonstrated to be approximately 60 degree in order to achieve maximum signal acquisition time. This study also considers the potential use of off-nadir pointing to increase the access to reflected signals, both statically and dynamically. Static along track elevations have slight improvements in coverage time, at the expense of lowering the SNR. The dynamic study indicates that continuously varying the antenna boresight direction would also improve coverage. Combining the coverage analysis with the link budget analysis, specific parameters were derived for this conceptual GNSS-R mission including; orbit altitude, orbit inclination, antenna gain, antenna pointing strategy and sea state knowledge requirements such as maximum detectable wind speeds.