NEAR-NADIR KA-BAND RADAR BACKSCATTERING STATISTICS FOR SURFACE WATER INTERFEROMETRIC ALTIMETRY

Delwyn Moller[1] and Ernesto Rodriguez[2]

Remote Sensing Solutions (1)
Jet Propulsion Laboratory, California Institute of Technology (2)

1. ABSTRACT

The National Research Council Decadal Survey [1] has recommended the Surface Water Ocean Topography satellite mission (SWOT) to address terrestrial fresh water hydrology and physical oceanography science questions. To satisfy the needs of these science communities, the primary SWOT instrument is a Ka-band Radar Interferometer (KaRIN). This height measurement sensor is capable of simultaneously meeting coverage, accuracy and resolution requirements of both the surface water and ocean topography communities, and enhances greatly the science achievable from a traditional profiling altimeter. In particular, by looking at a range of near-nadir incidence angles (from θ_i~1° to 5°), the measurement coverage of KaRIN is substantially greater than that of conventional altimetry. For hydrology, the KaRIN swath capability will enable measurements of the spatial extent of water and its height, enabling derivation of freshwater storage, storage change and discharge. A Ka-Band center frequency provides a high level of accuracy from a technologically feasible baseline, while still penetrating clouds and light rain. However the uniqueness of this solution, and application, means there remain some specific questions for which there currently exists little or no supporting data.

In particular, radar observations of freshwater bodies are very limited both at Ka-band frequencies and for near-nadir incidence angles. Specifically, Vandemark et.al [2] presented limited nadir σ_0-derived surface slope observations of a single inland water body as a point of comparison for their more substantial ocean observations. We present data obtained by deploying a bridge-based Ka-band radar at several diverse river and reservoir locations in Ohio and California. These observations deliver formative data that demonstrates a great degree of sensitivity of the radar backscatter to the local meteorological and surface conditions. Specifically:

1) The angular characteristic of the backscatter ($\sigma_0(\theta_i)$) decay can vary greatly from a very strong specular return and sharp decay, to a more moderate nadir-return with a slow decay as θ_i increases to 5-6°.
2) The surface temporal decorrelation ranged from just a few milliseconds to tens of milliseconds.

An implication from the $\sigma_0(\theta_i)$ measurements is that, for very low wind-speed conditions and little turbulence-induced roughness there may be narrowing of the achievable swath for SWOT due to σ_0 decay. Furthermore, and importantly, rapid temporal decorrelation may limit the azimuth resolution of SWOT which in turn limits the ability of KaRIN to specify accurately the spatial extent of the water body: a key variable in storage and discharge calculations. For this reason understanding the dynamics of the temporal decorrelation for different surface (current induced turbulence) and meteorological

(primarily wind) conditions is key for predicting storage change and discharge accuracies in a manner which is scalable to the global coverage of SWOT.

2. REFERENCES

[1] Anthes, R.A. and B. Moore (eds.), "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond, Committee on Earth Science and Applications from Space: A Community Assessment and Strategy for the Future", National Research Council, ISBN: 0-309-66714-3, 456 pages, http://www.nap.edu/ catalog/11820.html, 2007.

[2] Vandemark, D., B. Chapron, J. Sun, G.H. Crescenti and H.C. Graber, "Ocean Wave Slope Observations Using Radar Backscatter And Laser Altimeters", *J. Physical Oceanography*, vol. 34, 2825-2842, Dec. 2004.