Estimating the ASCAT spatial response function for enhanced resolution processing

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Introduction

The Advanced Scatterometer (ASCAT) is a scatterometer orbiting the Earth. A scatterometer is a type of radar that measures the normalized radar cross-section, $\sigma^\circ$. ASCAT measures $\sigma^\circ$ of the Earth surface on a global scale.

Each ground measurement has an associated spatial response function (SRF):

$$\sigma^\circ_{\text{meas}} = \int \sigma^\circ(x, y) h(x, y) \, dx \, dy,$$

where $h(x, y)$ is the SRF and $\sigma^\circ(x, y)$ is the radar backscatter from the Earth surface.

Enhanced resolution processing effectively inverts this equation using the $\sigma^\circ$ measurements in conjunction with their associated SRFs to produce a high resolution image of $\sigma^\circ(x,y)$. Lacking enough information to accurately represent the ASCAT SRF, we estimate the ASCAT SRF in order to produce enhanced resolution $\sigma^\circ$ data.

Estimating the SRF

Each ASCAT antenna beam is subdivided into adjacent measurements. Each measurement SRF is dominated by the antenna beam response in the cross-beam direction, and the response imposed by range-Doppler processing in the along-beam direction. The cross-beam antenna response is known, but the along-beam equivalent response is estimated from ASCAT data. ASCAT beams that overlap a land/ocean transition are used to estimate the along-beam response. A noncausal FIR filter is used to model the equivalent along-beam processing:

$$t[n] \rightarrow [g[n] \ast x[n]] \rightarrow \eta[n]$$

The land/ocean transition measurement model. The transition is $t[n]$, the along-beam response is $g[n]$, noise is $\eta[n]$, and the measured ASCAT beam is $x[n]$. $n$ indexes along the beam.

The filter $\hat{g}[n]$ is estimated using least squares estimation. Multiple land/ocean transitions are used to jointly estimate the filter coefficients.

$$g[n] \rightarrow \hat{g}[n] \rightarrow x[n] \rightarrow [\hat{g}[n] \ast x[n]] \rightarrow \hat{\eta}[n]$$

Estimating the along-beam filter $\hat{g}[n]$. From the ASCAT data $x[n]$ the transition $t[n]$ is created (this is not a linear operation). The data $x[n]$ is expressed as the convolution of $t[n]$ with the unknown system $g[n]$ with $\eta[n]$ representing remaining additive noise. $\hat{g}[n]$ is found such that the error $\hat{\eta}[n]$ is minimized.

Estimation Results

30 days of ASCAT data are used to find over 110 000 land/ocean transitions.

Enhanced Resolution Results

The estimated SRF is used for enhanced resolution processing.

Conclusion

The SRF is estimated from ASCAT data using transitions between land and ocean. The estimated SRF is used for enhanced resolution $\sigma^\circ$ data. Work is ongoing to determine the sensitivity of the high resolution processing to approximations made to the SRF. The ASCAT dataset has been processed and is available at http://scp.byu.edu.

References