Advancing QuikSCAT Wind and Rain Retrieval

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Abstract

Rain can adversely affect the accuracy of scatterometer-retrieved winds. This is true for both Ku- and C-bands. Rain introduces several effects on the sigma-0 measurements used to retrieve the wind: attenuation of the scatterometer signal falling through the rain, backscatter from falling rain, and modification of the wind-induced surface backscatter caused by rain modifying the surface situations. Under low wind conditions, rain tends to increase the observed backscatter while at high wind speeds rain tends to attenuate the observed backscatter. Rain also reduces the directional accuracy. Based on the rain and wind backscatter, three regimes have been proposed: when rain has minimal effect on the backscatter, when rain backscatter dominates the observed backscatter (thereby precluding wind retrieval), and the intermediate regime.

Simultaneous wind and rain estimation has been proposed as a method for (1) detecting the presence of rain, (2) determining of the rain effect is significant enough to contaminate the wind retrieval, (3) correcting the rain-contaminated sigma-0 measurements to enable accurate wind retrieval and (4) estimating the rain rate and thereby providing additional information from the measurements. Simultaneous wind/rain retrieval works well in the intermediate backscatter regime, but in cases where radar backscatter is dominated by wind however, simultaneous wind and rain estimation can have higher error levels than the wind-only estimates. Similarly, rain-dominated backscatter leads to poor simultaneous wind and rain estimates and improved rain estimates can be obtained using rain-only retrieval.

To improve the reliability of QuikSCAT wind and rain estimates a method of estimator selection is proposed whereby the rain-only, wind-only and simultaneous wind and rain estimates are compared. Using a Bayes decision rule formulation an estimator is selected by choosing the estimator with the minimum posterior expected squared error. The Bayes decision rule technique requires that a prior distribution be determined for the wind and rain in addition to a distribution reflecting estimator performance for a specific wind and rain value. The wind and rain prior is calculated empirically whereas the estimator performance distribution is estimated from the wind and rain model function for QuikSCAT. Initial results indicate that Bayes estimator selection can be an effective and powerful technique for improving wind and rain estimation performance without sacrificing performance in non-raining and high-rain cases. The Bayes selection is thus a type of rain-impact flag. The theory and performance of the Bayes estimator selection and the accuracy of the various retrieval schemes are described for both conventional and enhanced resolution wind-only, simultaneous wind/rain, and rain-only retrieval.