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Co-validation of Jason-1 and QuikSCAT Wind Speeds Within the Context of TRMM Rain Data

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SeaWinds on QuikSCAT is a satellite-based scatterometer designed to measure near-surface winds over the earth's oceans. Ocean surface wind speed is an important parameter in many short-term and long-term climate and weather analyses. QuikSCAT is a rapidly developed replacement for the successful, although prematurely terminated, NSCAT mission of similar objectives. Spaceborne scatterometers find *raison d'etre* in their facilitation of near-global daily coverage. Planetary scale wind vector measurement has proven impractical using only *in situ* methods.

The Jason-1 altimeter is a follow-on to the highly successful TOPEX/Poseidon mission. It is designed to measure ocean surface topography to an accuracy of 4.2 cm. Space-borne altimeters allow scientists to study ocean circulation and its effect on the global climate. Ocean surface topography measurements have already proven effective at predicting *El Nino* and *La Nina* events. Wind speed estimates are a secondary product calculated from Jason-1 data.

Highly accurate precipitation data is available from the Tropical Rainfall Measuring Mission (TRMM) and its precipitation radar. The precipitation radar is designed to provide three-dimensional maps of storm structure. It is able to detect rain rates down to about 0.027 inches (0.7 millimeters) per hour. TRMM's rainfall data is important in global warming and water cycle studies.

Calibration and validation analyses ensure sensor quality and consistency. An important method of validation is the comparison of measurements from one sensor with those of another. Under optimal circumstances, two sensors providing estimates of the same geophysical parameter report identical values when temporal and spatial conditions are similar. Ideally, the estimated parameter echoes the actual state. Disagreements in observed parameters enable us to understand, and possibly ameliorate, detrimental factors.

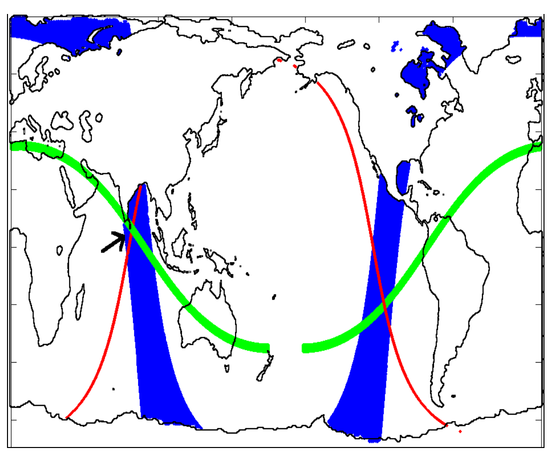

Figure 1. Sensor Orbits

QuikSCAT is known to suffer from rain effects. It is likely that Jason-1 experiences similar difficulties. The addition of TRMM rain data provides reliable precipitation context for tri-sensor co-located measurements. QuikSCAT supplies wide area context for Jason-1 winds. Such information offers insight into possible factors adversely affecting parameter estimates. Relative orbit geometries lead to frequent and long series of Jason-1 / QuikSCAT co-locations. Within a given Jason-1 pass (half a revolution), there are, on average, about 400 Jason-1 measurement cells out of about 2000 that co-locate both temporally and spatially with QuikSCAT measurement cells. Figure 1 demonstrates the relative orbit geometries of Jason-1 (red), QuikSCAT (blue), and TRMM (green). Since Jason-1 and QuikSCAT carry primarily ocean surface sensors, their data points occurring over land are masked. The black arrow indicates one tri-sensor co-location to be further explored in this report. Although this figure contains two, tri-sensor co-locations do not occur within every data set. Tri-sensor co-locations are relatively rare, and, as indicated in this figure, spatially short. For a given co-location, less than 40 Jason-1 cells co-locate spatially with TRMM. Data points used herein are co-located temporally to within 30 minutes.

In the context of TRMM rain data, four classifications of co-located data are noteworthy: those *without* significant rain and with wind speed *agreement* (Jason-1 / QuikSCAT), those *without* rain but with wind speed *disagreement*, those *with* rain but with wind speed *agreement*, those *with* rain and with wind speed *disagreement*. Each of these classifications yields information applicable to sensor validation. We focus on the last case.

Rain affecting Jason-1 and QuikSCAT wind speed agreement is suggested in many co-located data points. A particularly good case of this is depicted in Figure 2 which shows a close up of the tri-sensor co-location indicated by the arrow in Figure 1. The red line represents a small segment of the Jason-1 measurement path. The blue dots represent QuikSCAT measurement points. The final swath is the green TRMM path with its rain estimates overlaid onto a portion of the segment. From the rain overlay, it is apparent that heavy rainfall is present along the Jason-1 measurement path where co-locations occur.

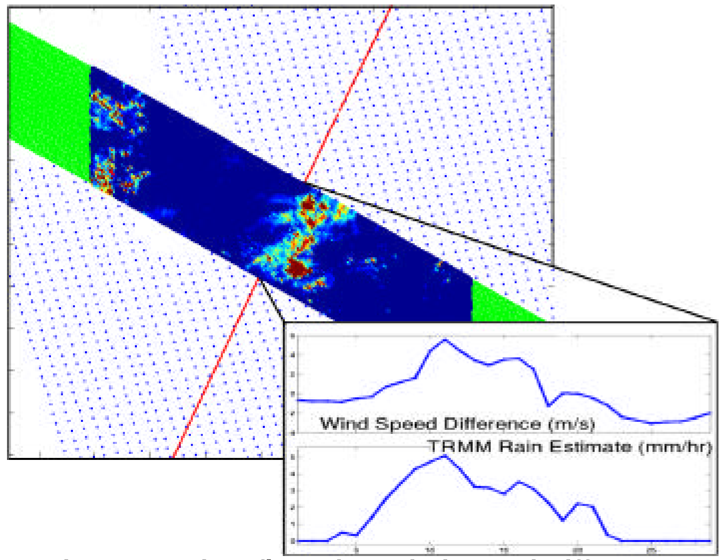

Figure 2. Rain Influencing Wind Speed Difference

Within this co-location there are 29 Jason-1 measurement points that co-locate with both QuikSCAT and TRMM. The wind speed difference and TRMM rain estimates for these points are sequentially plotted and inset within Figure 2. An important observation is that wind speed disagreement closely mirrors rain rate. Further study reveals that the wind speed difference is primarily influenced by fluctuations in Jason-1 wind estimates. QuikSCAT winds remain fairly constant across this co-location set. It appears that, at least in this case, Jason-1 is more affected by rain than is QuikSCAT.

Analysis of additional cases within each of the aforementioned classifications will permit more rigorous validation of Jason-1 and QuikSCAT operation. From this and other cases, the methodology seems promising. Further research is ongoing to explore other troublesome wind speed estimates.