Measurements of the Effect of Rain on the L-Band Sea Surface Brightness Temperature for the Aquarius Instrument

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MOTIVATION:

Does the sea surface rainrate affect the measured brightness temperatures and surface radar cross section?

DATA SOURCES:

AQUARIUS Radiometers and Scatterometers and National Weather Service coastal NEXRAD S-band radar reflectivity of rain events, with 3 minutes of overpass located around the Gulf of Mexico.

In accordance with the pursuit of the principal scientific objectives of the Aquarius mission , [1] the effects of a variety of ocean and atmospheric phenomena on the active and passive measurements need to be explored and better understood in order to achieve the desired accuracy and quantity of data for observing the global sea surface salinity (SSS). It is a high priority to understand and model the effect of surface wind speed on both the microwave scatterometer and radiometer data that lead to the final mission data products. Aircraft missions [2] have produced considerable new quantitative information and general knowledge about the effects of wind speed on both the active and passive measurements. However there is little high resolution quantitative information about the effect of rain on both the active and passive Aquarius sensors across a range of wind speed and rain intensities. This project is organized to provide quantitative comparisons with collocated rain measurements across wide ocean areas, using the high-resolution NWS NEXRAD ground-based radar stations on coastal positions around the Gulf of Mexico.

An optimum location for combining satellite and collocated surface based rain measurements is the section of the Gulf of Mexico ranging from Corpus Christi, TX to Tallahassee, FL. NEXRAD stations are at numerous cities and there are multiple NOAA-NDBC buoys, from which continuous wind data is available, in the region between them. The NEXRAD system features an S-band radar whose beam extends out to 450 km, then it scans the atmosphere azimuthally, and at stepped elevations. This radar has high spatial resolution; 1 km in range and 1° azimuth. These scans are then used to model the 3-dimensional reflectivity of the volume of precipitation. Surface rainrate calculations are then straightforward.

An analysis and comparison for a notable event, on April 21, 2012 has been initiated. Figure 1 illustrates the measurement region just south of Mobile, AL, where the NEXRAD station (designate KMOB) is located. The rain intensity (in logarithmic reflectivity units, dBZ) is color coded and its spatial distribution is apparent. An "X" is placed in the rain area to indicate the intersection of longitude = 88° and latitude = 29°. Buoy estimates of the winds in this region are in the range of 7-8 m/s, at the time of this overpass, both in areas with and without rain.

Data used here are from Beam #2, incidence angle = 38°, with a swath width of 84 by 120 km.

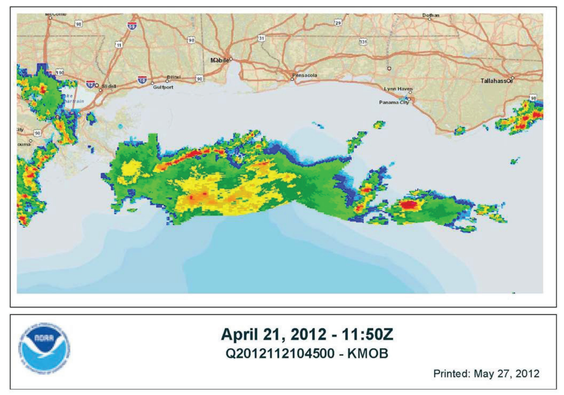
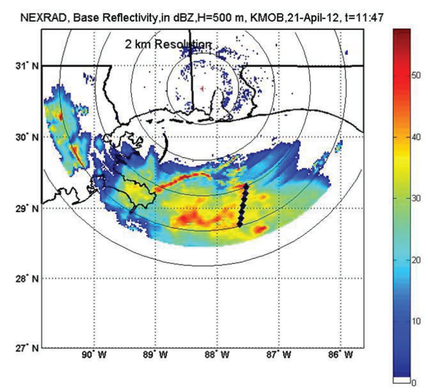
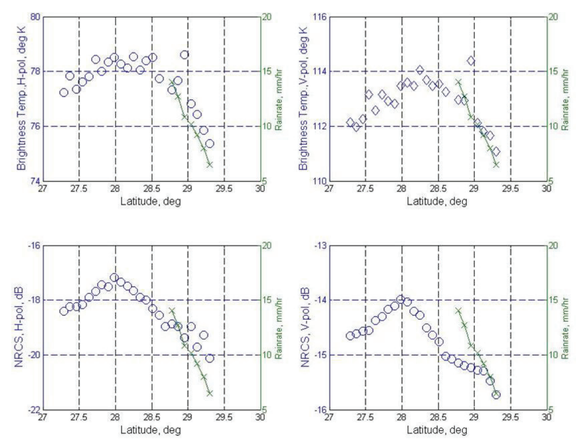


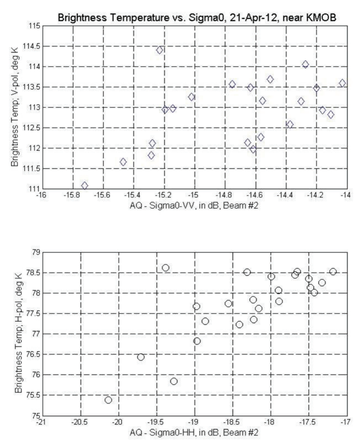
Image from the National Weather Service MOSAIC Webstite, coincident with an overpass by Aquarius, data collected from KMOB, Mobile, AL and KVPS, Eglin AFB.



Gridded NEXRAD Rain Reflectivity Data from NCDC Level 2 archives, within 5 minutes of Aquarius Measurements; Color code is in dBZ, Diamond symbols are locations of Aquarius Beam #2 Measurement Cells.



Variations of Brightness Temperature, NRCS and Rain Intensity Across Rain Event 21-April-2012, t=11:50Z.

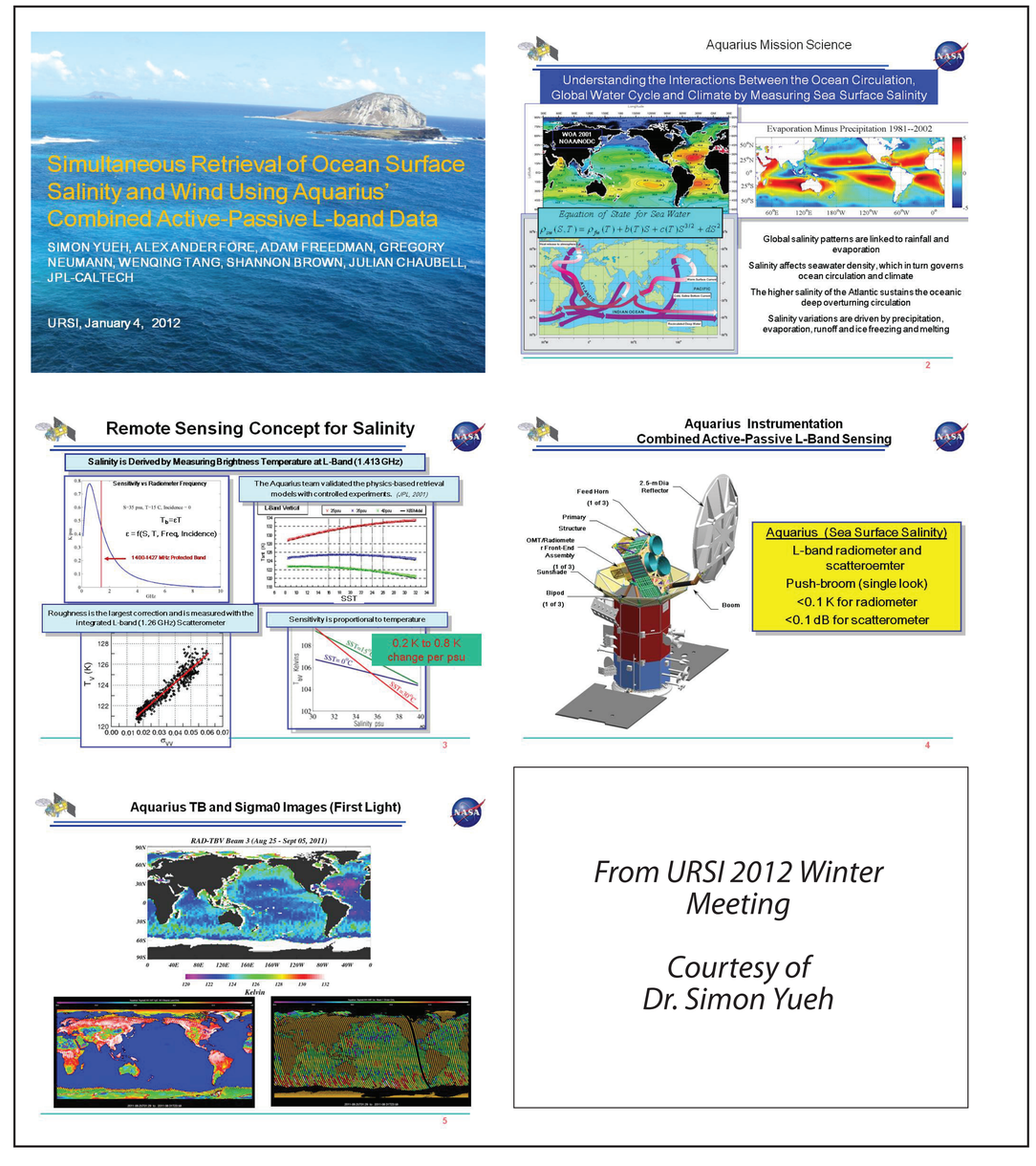


Plotting Coincident NRCS and Brightness Temperature across rain event; 21-April-2012.

PRELIMINARY FINDINGS:

Both the Aquarius radiometer and scatterometer for Beam #2 respond to the additional sea surface roughness produced by rain in a manner similar to their response to increases in wind speed.

The rain induced increases in brightness temperature are approximately the same for both H-pol and V-pol. With respect to the normalized radar cross section, the H-pol changes are slightly larger than for V-pol.



[1] D.M. Le Vine, G. Lagerloef, F. Colomb, S. Yueh and F. Pellerano, "Aquarius: An Instrument to Monitor Sea Surface Salinity from Space", IEEE Trans. *Geosci. Remote Sens.*, Vol. 45, No. 7, July 2007

[2] S. Yueh, S. Dinardo, A. Fore and F. Li, "Passive and Active L-band Microwave Observations and Modeling of Ocean Surface Winds", IEEE Trans. *Geosci. Remote Sens.*, Vol. 48, No. 8, August 2010

[3] Aquarius User Guide, Revision [1.0], August 11, 2011, Document # JPL D-70012, PODAAC, Jet Propulsion Laboratory, Pasadena, CA 91109-8099