AQUARIUS SCATTEROEMTER CALIBRATION AND ROUGHNESS CORRECTION ALGORITHM

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1. INTRODUCTION

Aquarius is a combined passive/active L-band microwave instrument developed to map the salinity field at the surface of the ocean from space. The data will support studies of the coupling between ocean circulation, the global water cycle, and climate. The primary science objective of this mission is to monitor the seasonal and interannual variation of the large scale features of the surface salinity field in the open ocean with a spatial resolution of 150 km and a retrieval accuracy of 0.2 psu globally on a monthly basis [1]. The measurement principle is based on the response of the L-band (1.413 GHz) sea surface brightness temperatures (T_B) to sea surface salinity. To achieve the required 0.2 psu accuracy, the impact of sea surface roughness (e.g. waves) along with several factors on the observed brightness temperature has to be corrected to better than a few tenths of a degree Kelvin. To this end, Aquarius includes a scatterometer to help correct for this surface roughness effect.

2. AQUARIUS SCATTEROMETER CALIBRATION

The Aquarius scatterometer is an L-band radar system for estimating ocean surface roughness [2]. Its measurements will enable the removal of roughness effects from the Aquarius radiometer ocean-surface brightness temperature measurements being used to retrieve ocean salinity. To meet its science requirement, the scatterometer must be very stable, with repeatability on the order of 0.1 dB over several days, and retain calibration accuracy to this level over several months.

The scatterometer front end includes a calibration loop which is an essential part of the design to enable accurate on-orbit calibration of transmit power and receiver gain. In addition to the use of the calibration loop, high accuracy (0.1 deg C) temperature sensors will be deployed on temperature-sensitive components. The goal is to achieve better than 0.1 dB calibration stability after corrections for changes in temperature. Pre-launch instrument calibration tests have been conducted to characterize the loss of the calibration loop and other critical elements as a function of temperature. The test results illustrated in Fig. 1 indicate that the scatterometer calibration loop power was very stable during thermal vacuum test, and was also highly repeatable with the simulated changes of orbital temperature variations with 0.3 to 0.4 deg C for scatterometer electronics boxes and 1 deg C for the transmit power amplifier:

- The variations are 0.02 dB peak-to-peak over the 100-minute orbit period
- There is another higher-frequency 0.02 dB peak-to-peak fluctuation due to the Solid State Power Amplifier (SSPA) heater cycling with a roughly 7 minute period.

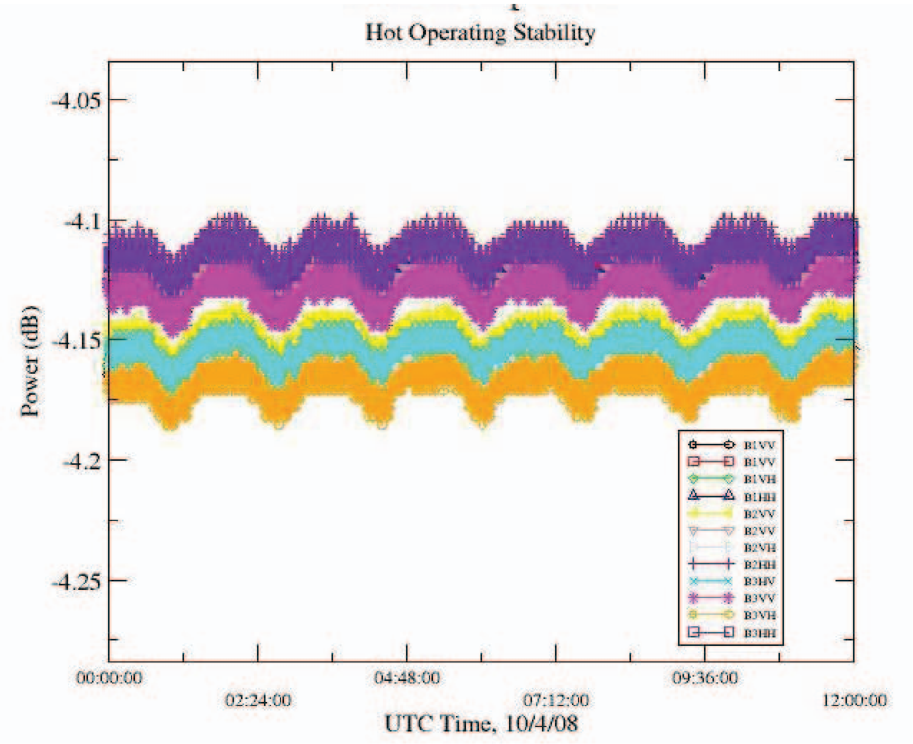

Figure 1. The scatterometer loop-back power measurements obtained from the thermal vacuum tests with simulated orbital temperature variations. Each curve indicates the data for various beam and polarization combinations.

3. SCATTEROEMTER WIND AND BRIGHTNESS TEMPERATURE CORRECTION ALGORITHM

To quantify the benefits of combining passive and active microwave sensors for ocean salinity and soil moisture remote sensing, the Jet Propulsion Laboratory (JPL) designed, built and tested a precision Passive/Active L-band System (PALS) instrument to support soil moisture and ocean salinity field campaigns [3, 4]. For sea surface salinity sensing, there are a number of key algorithm issues. These include (1) What is the sensitivity of L-band radar backscatter and radiometer brightness temperatures to ocean wind under high wind conditions (>10 m/s), (2) What is the wind direction dependence of radar backscatter and brightness temperature, and (3) How to model and correct the sea surface roughness effects on the reflection of Sun and Galactic radiation?

Given the need for further L-band microwave measurements, we performed the PALS High Ocean Wind (HOW) Campaign to acquire data over a wide range of ocean surface wind conditions. Four NASA P-3 flights were conducted out of Goose Bay, Canada. For each flight, we selected one way point in the North Atlantic, where high ocean winds were expected according to the daily weather

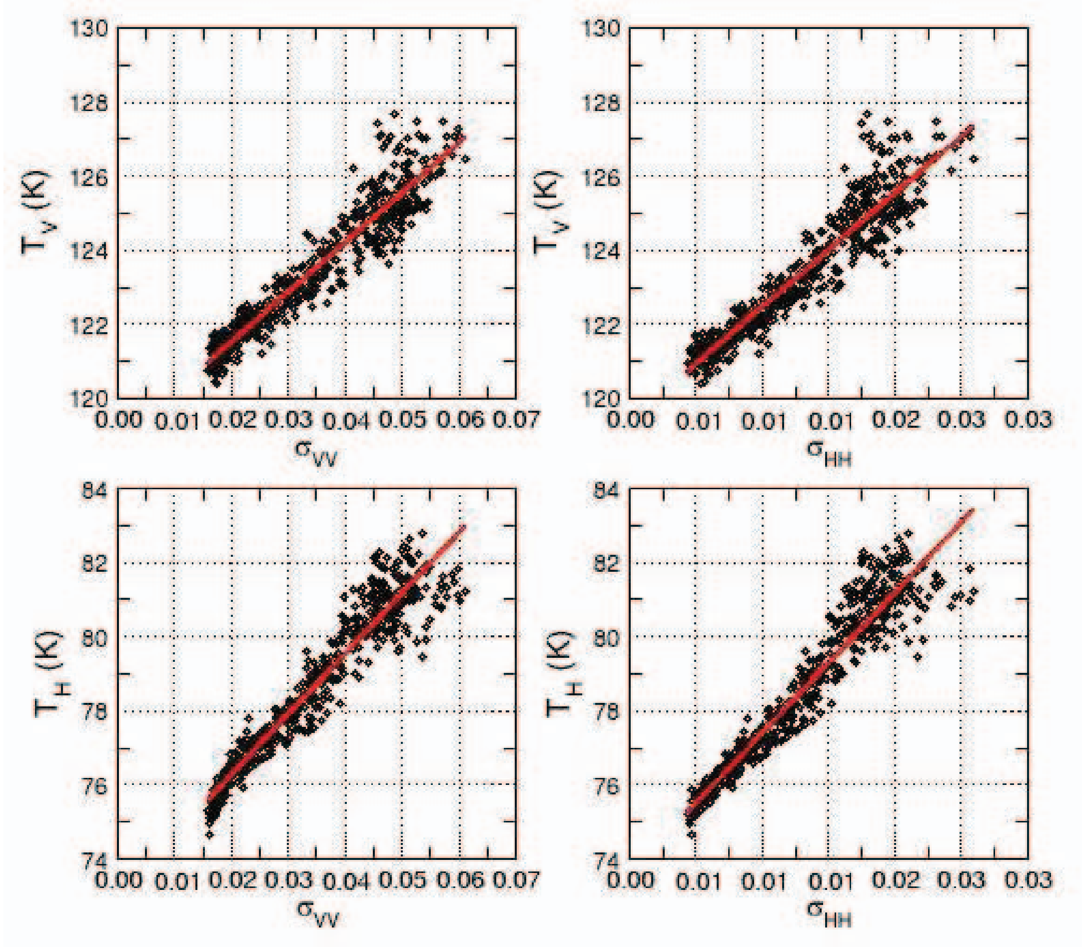

Figure 2. The brightness temperatures versus radar A0 for four polarization combinations are illustrated for data at 45 degree incidence angle.

forecast and QuikSCAT near real time winds at twelve hours before the flight.

We correlated the PALS brightness temperatures with the radar A_0 to illustrate their relationship at 45 degree incidence angle (Fig. 2). Note that the radar A_0s are in real number, not in dB. This figure also included a linear regression line. The correlation coefficients are quite high (0.95) although slightly less than the correlation between the brightness temperature and wind speed (0.96). The results suggest that the brightness temperatures can be linearly related to the radar backscatter A_0. Also the mean square errors of the T_B-A_0 regression are comparable to the T_B-Wind regression. This suggests that the L-band radar measurements are very good indicators of the excess brightness temperatures due to wind forcing.

4. ACKNOWLEDGMENT

The work described in this paper was performed by the Jet Propulsion Laboratory, California Institute of Technology, was carried out under a contract with the National Aeronautics and Space Administration.

5. REFERENCES

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