# Spurious Signal in Measurement of the Third Stokes Parameter from Space at L-Band

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The third Stokes parameter will soon be observed from space for the first time at L-band by SMOS and Aquarius [Martin-Neira et al, 2002; Le Vine et al, 2007]. The correlation between polarizations (i.e. third Stokes parameter) is of interest at L-band to measure Faraday rotation (Yueh, 2000) and also to indicate novel features of the surface. However, in studies of the time series of the third Stokes parameter expected from space at L-band, spurious spikes in the signal have been seen when the radiometer crosses regions such as land-water boundaries associated with a large change in brightness temperature. In this presentation, simulations of the Aquarius radiometer response in space will be used to illustrate this phenomenon. Analysis will be presented to show that these signals are due to cross-polarization coupling and the large beam width associated with realistic L-band antennas in space. Both the inhomogeneous scene and the antenna characteristics are necessary to produce the spurious signal.

This is illustrated in Figures 1 and 2. Figure 1 shows the ground track of the Aquarius satellite (solid line) and the boresight for the three radiometer antenna beams (broken line) during one representative orbit. The orbit begins in North America and proceeds westward. Figure 2 shows the radiometer response for vertical polarization (top), the third Stokes parameter (middle) and the derived Faraday rotation angle (bottom). The computations are done using a "forward algorithm" that computes the signal radiated from the surface and propagates it to the spacecraft where it is convolved with the radiometer antenna pattern. The computations are done every 6 seconds around the orbit and the results in Figure 2 are plotted as a function of time step (e.g. index 1 = 6 sec). Step 300 (arrow in Figure 2) corresponds roughly to crossing from land to ocean in the vicinity of India. The simulation includes upwelling and downwelling radiation from the atmosphere, direct and reflected signals from the Sun, and direct and reflected signals from the galaxy and the cosmic microwave background; however, only the contribution from the signal radiated from the surface is included in this example to avoid any possible confusion as to the source of the spurious signal. The Faraday rotation angle (bottom, solid line) is

computed from the third Stokes parameter (Yueh, 2000) and the actual angle at boresight (bottom panel, broken line) is also plotted. The retrieved angle should follow the value at boresight perhaps with a bias due to the antenna (Le Vine et al, 2008). This is approximately true as is evident in the bottom two traces in Figure 2. However, the third Stokes parameter (middle panel) and the retrieved angle (bottom panel, solid line) have features not present in the Faraday rotation angle at boresight (e.g. the spikey behavior at steps 300, 500 and 600). The source of these spikes is the subject of this talk. It will be shown that they occur at transitions in surface brightness such as occur at land-water boundaries and are due the imperfections of realistic antennas (cross polarization coupling and finite beam width). Both the inhomogeneous scene and the antenna characteristics are necessary to produce the spurious signal. It will be necessary to take these signals into account in using data obtained from the third Stokes parameter.

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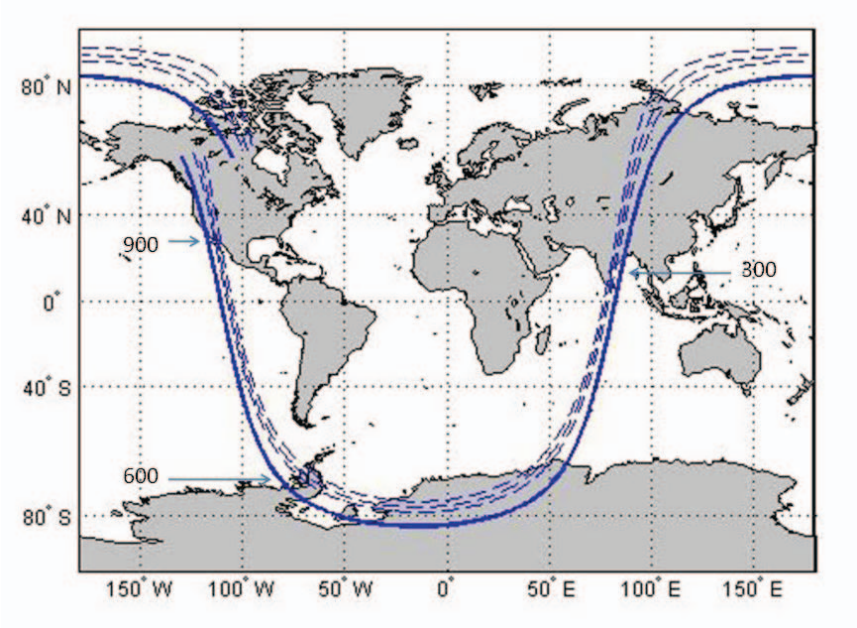


Figure 1. Spacecraft ground track (solid) and the boresight of the three Aquarius radiometer antenna beam (broken) during one orbit. The orbit starts in North America and advances westward.

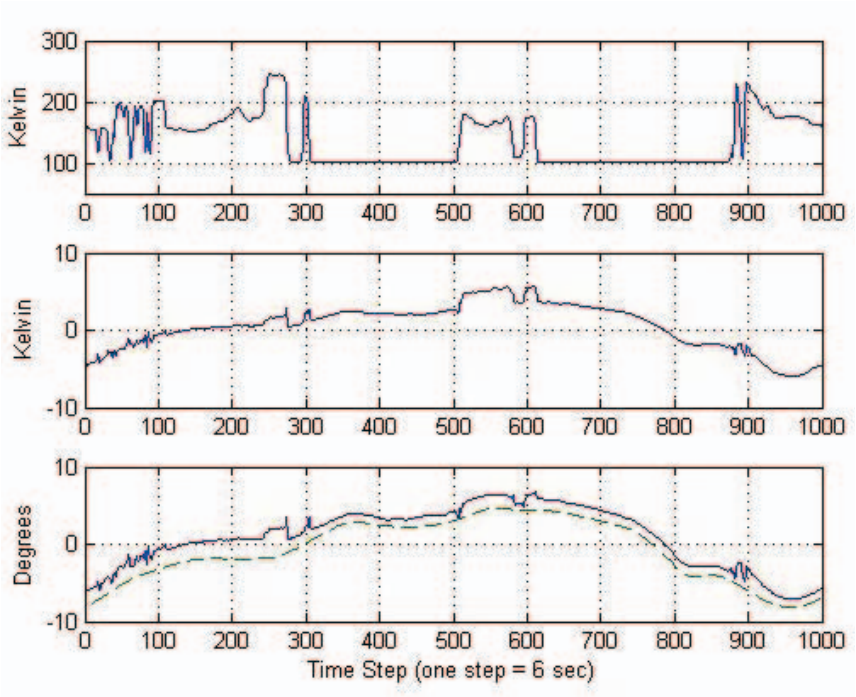


Figure 2. Results of the numerical simulation for the Aquarius inner beam. (Top) Antenna output at vertical polarization; (Middle) Third Stokes parameter; (Bottom) The retrieved Faraday rotation angle (solid) and value at boresight (broken).