TIME EVOLUTION AND SPATIAL DISTRIBUTION OF OCEAN-REFLECTED RADIO-FREQUENCY INTERFERENCE DURING THE WINDSAT ERA

Ian S. Adams, Michael H. Bettenhausen, Peter W. Gaiser
Naval Research Laboratory
Washington, DC 20375

William Johnston
Computational Physics, Inc.
Springfield, VA

The demand for satellite communications has led to large-scale deployments of fixed-satellite service (FSS) systems. Some of the bands allocated for such systems in the X- and K-band regions of the spectrum are either adjacent to, or shared with, those allocated for passive Earth exploration-satellite service (EESS) [1]. While FSS systems are designed such that maximum power is directed towards terrestrial users, the concentration of populations in coastal regions coupled with the finite characteristics of downlink antenna patterns results in considerable amounts of radiation being directed towards coastal oceans. This radiation reflects off the ocean surface into the fields-of-view of spaceborne microwave radiometers. The sensitivity of radiometers, particularly those with polarimetric capabilities, means that even small levels of radio-frequency interference (RFI) can corrupt geophysical retrievals. RFI is not just a concern for shared FSS-EESS bands. Even when a radiometer receiver is designed to operate adjacent to an FSS allocated band, receiver characteristics are such that the sensor bandwidth can overlap the FSS allocation.

Due to the high radiometric accuracy required for passive wind vector retrievals, the WindSat polarimetric radiometer, and the accompanying inversion algorithms, are especially suceptible to RFI. The large bandwidths implemented to reduce NEDT overlap FSS allocated bands, and retrievals utilizing the polarimetic measurements (3rd and 4th Stokes), are more sensitive to RFI. In some cases RFI can be directly observed in 4th Stokes measurements.

This work will present a survey of ocean-reflected RFI over the life of the WindSat mission–early 2003 to present–for 10.7 and 18.7 GHz. A brief explaination of the method for identifying ocean RFI using retrieval chi-square probability, $P(\chi^2)$, as detailed in [2, 3], will be provided. Receiver center frequency and passband considerations will be mentioned to show the relevance of this work to instruments with bandwidths constrained to EESS bands, such as AMSR-E and GMI. Maps will be presented to show the geometry dependence, spatial distribution, and time evolution of ocean-reflected RFI from geostationary

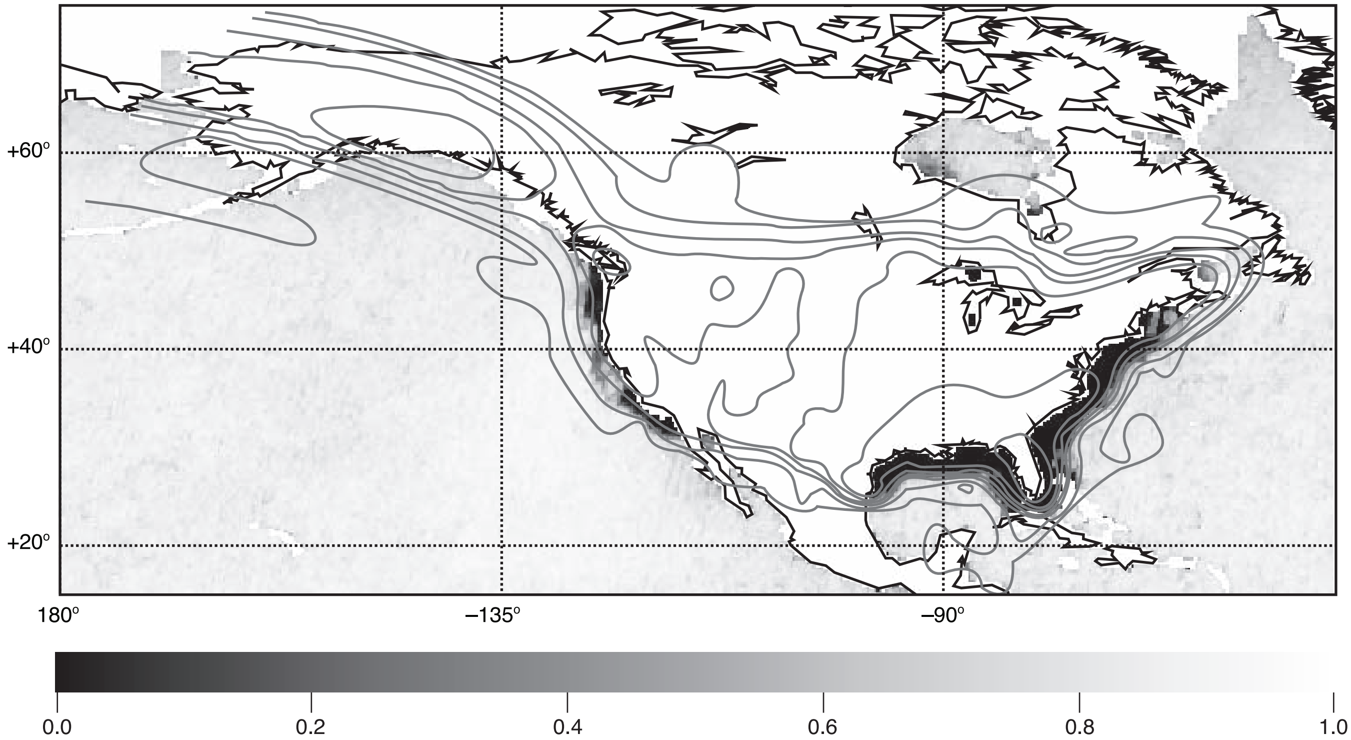

Fig. 1. Three-month average of $P(\chi^2)^{0.3}$ for North America. All descending portions of orbits from August 1 through October 31, 2008 are included. Low $P(\chi^2)$ is denoted by solid black. The contours show the approximate national downlink coverage for DirecTV 10.

satellite sources. Figure 1 shows the spatial distribution of 18.7-GHz ocean-reflected RFI surrounding the coastal United States. The region of low retrieval $P(\chi^2)$ corresponds closely to the downlink pattern of DirecTV 10, demonstrating that $P(\chi^2)$ is a suitable indicator of ocean-reflected RFI.

1. REFERENCES

[1] “Manual of regulations and procedures for federal radio frequency management,” National Telecommunications and Information Administration, Tech. Rep., 2008.

[2] M. H. Bettenhausen, C. K. Smith, R. M. Bevilacqua, N.-Y. Wang, P. W. Gaiser, and S. Cox, “A nonlinear optimization algorithm for WindSat wind vector retrievals,” *IEEE Trans. Geosci. Remote Sens.*, vol. 44, no. 3, pp. 597–609, Mar 2006.

[3] I. S. Adams, M. H. Bettenhausen, P. W. Gaiser, and W. Johnston, “Identification of ocean-reflected radio-frequency interference using WindSat retrieval chi-square probability,” *IEEE Trans. Geosci. Remote Sens.*, In press.