

WINDSAT OCEAN RETRIEVALS AT MULTIPLE RESOLUTIONS

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WindSat [1] was launched in January 2003 with the primary mission to evaluate the use of a polarimetric radiometer to provide measurements of the ocean surface wind vector. Several algorithms have been developed which demonstrate this capability including our own which uses a physically based model for the WindSat brightness temperatures and an optimal estimation inversion method [2]. All of the initial algorithms used brightness temperatures resampled to a resolution of about 50 km. This choice was made because all of the WindSat channels can be used at this resolution. The resolution is similar to the resolution of SSM/I wind speed retrievals. The full WindSat channel set enables the retrieval of sea surface temperature, ocean surface wind speed and direction, columnar water vapor and columnar cloud liquid water.

There are three primary factors that limit the accuracy of the retrievals at higher resolution. One is that it becomes more difficult to obtain accurate footprint matching of the WindSat channels. WindSat has 22 channels at five different frequencies: 6.8 GHz, 10.7 GHz, 18.7 GHz, 23.8 GHz and 37.0 GHz. The native resolution varies with frequency from 39 km by 71 km at 6.8 GHz to 8 km by 13 km at 37.0 GHz. The measurements must be resampled to a common footprint for accurate retrievals in regions where the geophysical parameters exhibit significant spatial variability. It is more difficult to obtain accurate footprint matching at higher resolution because fewer native resolution measurements are used for individual pixels. This is a limiting factor near storms and other features with high spatial variability.

The second factor that limits retrieval accuracy at higher resolutions is that the noise reduction from resampling and averaging decreases with increasing resolution. The additional noise in the resampled WindSat brightness temperatures limits wind direction retrieval performance and to a lesser extent wind speed retrieval performance.

Finally, the channel set at a given resolution is limited to those channels that have smaller native footprints than the target resolution. This is because resampling the measurements to improve the resolution significantly increases measurement noise. For WindSat the 6.8 GHz channels are not used at resolutions higher than about 50 km. This effectively means that global sea surface temperature retrieval is not possible at the higher resolutions.

We have made numerous recent improvements to our WindSat data processing including refinements to instrument calibration, quality control and resampling algorithms as well as retrieval algorithm and forward model improvements. These changes have made it possible to accurately retrieve the ocean surface wind vector, water vapor and cloud liquid water at resolutions that are better than the initial 50 km resolution. The higher resolution makes it possible obtain retrievals closer to land and to resolve higher wind speeds near storms.

The relevant methods used in the WindSat data processing and retrieval algorithms will be presented.

We will discuss extension of the forward model for the WindSat brightness temperatures to higher wind speeds. We will also present analyses of current WindSat ocean vector wind retrieval performance at three different resolutions and discuss the relative merits and limitations of retrievals at the different resolutions. This analysis will consider the tradeoff between footprint matching and noise reduction during resampling of the brightness temperatures. Case studies of retrievals will also be presented.

1. REFERENCES

- [1] Peter W. Gaiser, Karen M. St. Germain, Elizabeth M. Twarog, Gene A. Poe, William Purdy, Donald Richardson, Walter Grossman, W. Linwood Jones, David Spencer, Gerald Golba, Jeffrey Cleveland, Larry Choy, Richard M. Bevilacqua, and Paul S. Chang, "The WindSat spaceborne polarimetric microwave radiometer: Sensor description and early orbit performance," *IEEE Trans. Geosci. Remote Sensing*, vol. 42, no. 11, pp. 2347–2361, Nov. 2004.
- [2] Michael H. Bettenhausen, Craig K. Smith, Richard M. Bevilacqua, Nai-Yu Wang, Peter W. Gaiser, and Stephen Cox, "A nonlinear optimization algorithm for WindSat wind vector retrievals," *IEEE Trans. Geosci. Remote Sensing*, vol. 44, no. 3, pp. 597–610, Mar. 2006.