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DERIVING EARTH SCIENCE PRODUCTS FROM SSM/I

Principal Investigator:
Frank J. Wentz
Remote Sensing Systems
Santa Rosa, CA

SIGNIFICANT ACCOMPLISHMENTS

There are three components to this project. The first is the production of a quality-controlled Level-1 data product for the SSM/I. Second is the generation of research-quality ocean products. The third component is studying the feasibility of obtaining both wind speed and direction from satellite microwave radiometers. The following paragraphs discuss the status of these three investigations.

Currently, four years of SSM/I sensor data have been produced. Time series of the SSM/I physical temperatures, receiver gains, and noise figures have been studied in order to access the stability and integrity of the sensor data. Algorithms for precise geolocation have been implemented to satisfy the requirements for ice edge location. Quality-control and editing routines have been developed to ensure an error-free Level-1 SSM/I product.

A physically-based retrieval algorithm is used to compute ocean products from the SSM/I Level-1 data. It simultaneously finds the near-surface wind speed, the columnar water vapor, and the columnar liquid water. These parameters are found by matching the SSM/I observations to a radiative transfer model of the ocean and atmosphere. The wind speeds have been compared to 3321 buoy reports, and the water vapor contents have been compared to 575 radiosonde flights. The rms differences for these *in situ* comparisons are 1.6 m/s and 0.31 cm, respectively. The algorithm has the ability to detect both light rain and a sea ice concentration of 5%. The ocean products are being used at approximately 30 institutions to study air-sea interaction, global change, moisture and heat fluxes, storms, and altimeter tropospheric correction.

A wind direction signal has been found in the SSM/I brightness temperatures (T_B). For moderate wind speeds, the v-pol upwind T_B is about 2 K higher than the downwind T_B. For h-pol observations, the T_B peak occurs at crosswind rather than upwind and is approximately 3.5 K higher than the downwind value. When this wind direction signal is removed, the rms difference between the SSM/I and buoy winds reduces to 1.3 m/s. The wind direction signal has been used to make global, low-resolution maps of the monthly mean oceanic wind vector. We have also begun a feasibility study on using a two-look satellite radiometer to measure the oceanic wind vector. Preliminary computer simulations indicate a wind direction accuracy of 15°.

CURRENT AND FUTURE RESEARCH

We are proposing to continue the production the Level-1 and Level-2 SSM/I products for another three years. This will result in a 7-year data set from which interannual variations can be studied. Water vapor, by itself, is an important Greenhouse gas, and the combination of water vapor and wind speed is a critical parameter in the estimation of latent heat flux and evaporation. A 7-year time series of these parameters in conjunction with the Microwave Sounding Unit (MSU) air-temperature time series being produced by *Spencer and Christy* [1990] will be of considerable value to global change studies.

A second SSM/I was launched in December 1990. We plan to cross-calibrate the second SSM/I with the first SSM/I. The cross-calibration must be done with extreme care to an accuracy better than 0.1 K in order to ensure that no artificial discontinuities are introduced into the ocean products time series. With proper cross-calibration, the seven SSM/I's to be launched during this decade should provide a time series of microwave radiances at the same accuracy as obtained for the MSU's (i.e., better than 0.1 K).

In addition to continuing the production of SSM/I ocean data, we will also continue our *in situ* comparisons. Thus far, only the first nine months of SSM/I products have been compared to *in situ*. We plan to extend the buoy and radiosonde comparisons to cover the entire 7 years of SSM/I data. This will give about 50,000 buoy comparisons and 6,000 radiosonde comparisons. This very large *in-situ* data set should provide a definitive statement on the capabilities of microwave radiometers to measure wind speed and water vapor.

We also plan to extend the SSM/I wind direction study. The two objectives of this extended study are:

1. Determine if a scientifically useful wind vector product can be obtained from the SSM/I's. If so, we would provide this product to the community.

2. Determine if a two-look radiometer can accurately measure the oceanic wind vector. If so, we would propose a design (i.e., noise figures, channel selection, scan geometry, etc.) for a radiometer wind-vector sensor that could be flown on future NASA spacecrafts.

To accomplish these objectives, we will first better determine the wind direction signal. The current results are based on 3321 buoy comparisons during the first nine months of SSM/I observations. To better characterize the signal, more buoy observations are required. As mentioned above, it will be possible to obtain about 50,000 collocated buoy-SSM/I observations for the 7-year SSM/I data set. Given this many comparisons, we should be able to well determine the wind direction signal and its associated variability.

Monthly global wind vector maps will be generated from the 7 years of SSM/I data. We will experiment with different methods for constructing these maps. One approach is to bin the SSM/I observations into monthly 5° latitude by 10° longitude cells. Possibly, better results on a shorter time scale can be obtained in areas where ascending and descending orbits crossover within 12 hours or less of each other. These wind fields will then be compared to fields coming from numerical models and from the ERS-1 Scatterometer (E-Scat). In addition, the SSM/I wind speeds can be used to validate the E-Scat wind speeds.

Finally, the simulations of the two-look radiometer need to be expanded. Thus far, we have done only a few simulations using smoothly varying wind fields. Realistic wind fields for a variety of mesoscale features should be considered, and various radiometer configurations should be tested. These simulations will determine the feasibility of obtaining mesoscale wind fields from a satellite microwave radiometer.

PUBLICATIONS

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