

STUDIES OF MIDLATITUDE CYCLONE STRUCTURE  
WITH SEASAT SCANNING MULTICHANNEL MICROWAVE RADIOMETER

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In this project we use the new tools provided by the atmospheric water channels of Seasat's Scanning Multichannel Microwave Radiometer (SMMR) to investigate mesoscale structure at various stages of the development of a midlatitude cyclone. Seasonal and graphic differences in the storms are also studied.

Significant Accomplishments

This is a new grant, only in effect for six months. However, the work follows our previous studies of North Pacific Cyclones which occurred during September 1978 and benefits from our available software and experience with the SMMR data.

There have been two significant accomplishments to date:

1) We have begun to analyze several cyclones as they cross the Gulf Stream during September 1978. We have paid special attention to the infamous "QEII" storm, which caused trouble for the ocean liner Queen Elizabeth II. We note that substantial amounts of water vapor are present in the warm air over the Gulf Stream. Cold fronts are well defined by the gradients in integrated atmospheric water vapor, and interesting differences in the water vapor content exist between regions which have the same rain rates.

2) We have combined SMMR and SASS (Seasat A Satellite Scatterometer) data at its highest resolution, 50 km, to study mesoscale regions of convergence and divergence, and waves on frontal boundaries between the cold and warm air.

Focus of Current Research

We are currently doing the following:

1) We are looking for differences between the late summer cyclones in the North Pacific and North Atlantic.

2) We are beginning to analyze the relationship between low level convergence, available from SASS, and total atmospheric water vapor, liquid water and rain rate, available from SMMR, trying to determine what it can tell us about the dynamics of the storm. For this we are considering the severity of assumptions one must make about steady state, horizontal and vertical advection and continuity or discontinuity in the vertical.

3) We are evaluating the forecasting value of the detection of waves on the cold front of a mature cyclone with SMMR data.

#### Plans for FY 85

1) As we amass more case studies we look for statistically valid evidence of differences in cyclone moisture content between the North Pacific east coast and the Western Atlantic.

2) Next we plan to analyze cyclones in the Southern Hemisphere during Seasat's time, especially to see whether the moisture in the winter storms show the same clear relationship to the surface cold front as we have seen for the late summer storms in the Northern Hemisphere.

3) We are generally aiming to be more sophisticated in the use of combined Seasat SASS and SMMR data.

4) Together with our colleague Frank Wentz of Remote Sensing Systems, we plan to analyze the rain rate information from SMMR on the smallest pixel scale, 0 (12 km), rather than the 50 km now provided. This is important since rain occurs on this scale or smaller and rain drop effects on microwave brightness temperatures are highly non-linear.

#### Recommendations for New Research

Further work demonstrating the diagnostic value of the atmospheric water parameters: integrated water vapor, total cloud liquid water and rain rate for midlatitude cyclones should be carried out. I feel that these kinds of data can have important operational applications, especially in view of the next microwave radiometer's much larger swath width. (The next microwave radiometer scheduled for launch is the Special Sensor Microwave Imager, SSM/I, which will be on a Defense Department satellite in 1986. It will have 1300 km swath width compared to Seasat SMMR's 600 km.) It is also my opinion that the total cloud liquid water and rainrate information should be used in prognostic models. We have previously not had such data available, and its kind does not, therefore, have immediate use. However, we know that clouds and rain are related to latent heat release and heating and cooling of atmospheric layers by visible and infrared radiation. After further verification of the algorithms for these parameters, we should be able to use them to initialize and update numerical models. Better verification can only come with new instruments. In the meantime we can study the consequences of such information with the present data from SMMR.

List of Publications Prepared Since June 1983:

- Katsaros, K. B. and L. A. McMurdie, 1983: Atmospheric moisture as vapor and liquid in storms seen with microwave radiometry. Presentation at 18th General Assembly of IUGG, Aug., 1983, Hamburg, W. Germany.
- Katsaros, K. B. and L. A. McMurdie, 1983: Atmospheric water distribution in cyclones as seen with Scanning Multichannel Microwave Radiometers (SMMR). Presentation at IGARSS'83, Sept., 1983, San Francisco, Calif.
- McMurdie, L. A., 1983: Seasat Scanning Multichannel Microwave Radiometer (SMMR) Observation of North Pacific Cyclones. M.S. Thesis, Dept. of Atmospheric Sciences, Univ. of Washington, Seattle, Wa, 205 pp.
- McMurdie, L. A. and K. B. Katsaros, 1984: Atmospheric water distribution in a midlatitude cyclone observed by the Seasat Scanning Multichannel Microwave Radiometer. Mon. Wea. Rev. (submitted).