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University of Wisconsin, Madison  
Space Science and Engineering Center  
Madison, WI 53706

Contract N00014-86-K-2001

(2)

## SSM/I Rainfall Rate Algorithm Validation Summary 2/15/89

### Program Status:

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**ELECTE**  
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#### 1. Validation Data Base

##### 1.1 Midlatitudes

The precipitation rate retrieval validation data base for midlatitudes consists of collocated SSM/I all-channel scene measurements and radar-derived rainfall rates obtained from 9 SSM/I overpasses of the Patrick Air Force Base (PAFB) radar at Cape Canaveral, Florida and 23 overpasses of the seven radars in the United Kingdom (UK) operational network. Upon screening of all collocated measurements within 69 km (one 19.35 GHz footprint) of all coastal boundaries, a total of 2660 collocated observations over land and 924 collocated observations over ocean during summer, spring-fall, and winter seasons were obtained.

##### 1.2 Tropics

Radar and raingage data from the tropical sites at Darwin, Australia and Kwajalein (Marshall Islands) are being received from David Short and David Wolff at the Severe Storms Laboratory at NASA/Goddard Space Flight Center.

Weather information at the Darwin radar site is recorded during special observing periods which extend through the Darwin wet season (December through March). Radar and raingage data are available for the first special observing period, which ran from December of 1987 to March of 1988.

Access to Kwajalein radar and raingage data was established through our discussions with the personnel of Aeromet, Inc., who are in charge of collecting these data under NASA contract. We have received tropical radar and raingage data from Kwajalein, covering portions of August, September, and October of 1988.

In addition to the radar/gage data collection, Brian Morrison of Aeromet has been sending us brief weather summaries corresponding to SSM/I overpass times in order to help us better specify SSM/I data orders. The weather summaries are especially important during the Kwajalein dry season (December through June), since significant rainfall events are very infrequent during that time.

#### 2. Processing of Validation Data

##### 2.1 Midlatitudes

The processing of all midlatitude validation data was completed as of December, 1988. SSM/I data and radar data were geolocated and then collocated in space and time to create higher-order data sets for statistical analyses.

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Approved for public release  
Distribution Unlimited

## 2.2 Tropics

We are currently in the process of assembling the tropical data from Darwin, Australia and Kwajalein for validation analysis. Brightness temperature data from SSM/I overpasses of Darwin and Kwajalein have been unloaded in anticipation of merging with forthcoming radar data from both installations. Images of the sensor data record brightness temperatures are presently being produced and reviewed.

## 3. Summary of Validation Results

Details of the validation analyses are included in the DMSP SSM/I CAL/VAL Team Final Report (1989). It was determined that the Hughes D-Matrix rain rate retrieval algorithms did not perform within specifications ( $\pm 5$  mm/hr) over the ocean at midlatitudes. Over land surfaces, the D-Matrix summer algorithm yielded reasonable estimates, but the performance of the spring-fall and winter algorithms was only marginal.

Validation of tropical rainfall rate estimates will be performed in 1989.

## 4. Alternate Algorithm Development

Multiple linear and logarithmic regressions of SSM/I brightness temperatures versus collocated radar rainfall rates at midlatitudes over land and ocean have yielded candidate alternate rain rate retrieval formulae. The regression formulae, in combination with the original Hughes algorithm screening logic produced more accurate rain rate estimates than the original D-Matrix formulae, especially over ocean regions. SSM/I regression estimates of rainfall rate over an "all-season" data base at midlatitudes yielded maximum correlations with radar of .70 over land and .74 over ocean.

## 5. Budget (see attached Financial Progress Report).

### Recent Developments:

We are continuing to collect SSM/I and radar data corresponding to DMSP overpasses of the Darwin and Kwajalein sites in anticipation of rain retrieval validations in the tropics. In the meantime we are experimenting with improved statistical retrieval algorithms which are based upon our midlatitude validation data, although funds are very limited for this work.

Preliminary results of our recent investigations are summarized in the attached conference abstract. The recent studies suggest that logarithmic regression formulae provide better rain rate estimates than linear formulae over both land and ocean surfaces when pre-screening of the SSM/I data is eliminated. Maximum correlations between SSM/I estimates and radar rain rates of .78 over land and .85 over ocean were achieved.

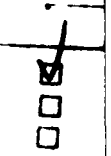
Model simulations were utilized to quantify the impact of the phase and spatial distribution of precipitation on observed brightness temperatures. Since the footprint-relative location of rainfall was shown to have a significant bearing on the modeled brightness temperatures at 85.5 GHz, regressions were performed which included a 3x3 neighborhood of 85.5 GHz measurements as predictors. The neighborhood of measurements would provide information on the low-resolution structure of the rainfall distribution. Indeed, correlations between regression estimates and radar rainfall rates over the ocean increased significantly with the added 85.5 GHz data.

We are currently regridding neighboring 85.5 GHz observations to compensate for the varying spatial relationship between neighboring footprints across the swath. We are also acquiring more ground truth data from PAFB to help constrain the new regressions which involve greater numbers of predictors.



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FINANCIAL PROGRESS REPORT

Nov. - Dec., 1988

Progress Period

CONTRACT NUMBER : N00014-86-K-2001

DESCRIPTION OF EFFORT : Validate Algorithms for Determination of  
Rainfall Rates from SSM/I Microwave  
Satellite Imagery

PROGRAM MANAGER : William S. Olson PHONE NUMBER : (608)263-4085

FUNDS ALLOCATED : 443,272.00

FUNDS ON CONTRACT : 360,643.00

\$ AMOUNT THIS VOUCHER : 0

CUMULATIVE \$ AMT VOUCHERS SUBMITTED : 391,322.20

BALANCE : 51,949.80

COST THRU TECHNICAL REPORT PERIOD NOT VOUCHERED : 43,849.12

William S. Olson / 2/17/89  
Signature/Date