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Title: Improvement and Further Development of SSM/I Overland  
Parameter Algorithms Using the WetNet Workstation

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#### Background of the Investigation:

Since the launch of the DMSP Special Sensor Microwave/Imager (SSM/I), several algorithms have been developed to retrieve overland parameters. These include the present operational algorithms resulting from the Navy calibration/validation effort such as land surface type (Neale et al. 1990), land surface temperature (McFarland et al. 1990), surface moisture (McFarland and Neale, 1991) and snow parameters (McFarland and Neale, 1991). In addition, other work has been done including the classification of snow cover and precipitation using the SSM/I (Grody, 1991).

Due to the empirical nature of most of the above mentioned algorithms, further research is warranted and improvements can probably be obtained through a combination of radiative transfer modelling to study the physical processes governing the microwave emissions at the SSM/I frequencies, and the incorporation of additional ground truth data and special cases into the regression data sets.

We have proposed specifically to improve the retrieval of surface moisture and snow parameters using the WetNet SSM/I data sets along with ground truth information namely climatic variables from the NOAA cooperative network of weather stations as well as imagery from other satellite sensors such as the AVHRR and Thematic Mapper. In the case of surface moisture retrievals, the characterization of vegetation density is of primary concern. The higher spatial resolution satellite imagery collected at concurrent periods will be used to characterize vegetation types and amounts which, along with radiative transfer modelling should lead to more physically based retrievals. Snow parameter retrieval algorithm improvement will initially concentrate on the classification of snowpacks (dry snow, wet snow, refrozen snow) and later on specific products such as snow water equivalent.

#### Significant Accomplishments in the Past Year:

The project initiated mid-November 1991. The following tasks have been accomplished since that date:

- 1) Inventory of all SSM/I and climatological ground truth data presently available in-house. Identification of additional SSM/I data needs covering precipitation and snow accumulation events of interest (in progress).

- 2) Development and programming of a radiative transfer model (RTM): A working model has been coded in Quickbasic for the PC

and is presently being tested against actual SSM/I brightness temperatures for different uniform surface types i.e. dense vegetation, deserts, water bodies. The model is a non-coherent, first order RTM. The complex dielectric constants of the soil matrix, the canopy and the leaves are calculated using de Loor's mixing formula (de Loor, 1968). The model allows for the simulation of SSM/I footprints with different proportions of surfaces (soils at different moisture content, water bodies, snow and vegetation cover at different densities). Several simulation options are possible by varying incidence angle, frequency, vegetation density, surface soil moisture or the proportions of different surface types. The output is presently in graphical form on-screen. The model has been able to reproduce brightness temperatures at different frequencies, under different surface emissivity conditions described in several papers in the literature. We will further test the model with more complex scenes as our research progresses.

3. Establishment of a link to the Soil Conservation Service SNOTEL network. We have obtained a two year data set from more than 80 stations in the Great Basin area to compare with SSM/I brightness temperatures. Though we realize the complications that large footprints entail over the mountains, we are looking to monitor the onset of snow melt, an important hydrological parameter.

4. In cooperation with the Central Sierra Snow Laboratory, U.S. Forest Service, we are examining the possibility of using time domain reflectometry (TDR) to obtain snow liquid water content for future field studies on this project. An experiment was conducted by comparing capacitance meter measurements with TDR measurements in snow pits during a week in February, 1992. The data has been analyzed and a report is presently being written.

#### Focus of Current Research and Plans for Next Year:

We see the development of the above mentioned RTM as being crucial for the proper understanding of the processes governing the overland microwave emissions at the SSM/I frequencies. In this way, we plan to develop more physically based algorithms for some of the overland parameters which are complicated by the large footprint size of the SSM/I and the heterogenous nature of the earth's surface.

During the next year we will concentrate on further building our database of SSM/I and ground truth climatic data to support algorithm development. We plan to conduct several comparisons of actual SSM/I and simulated SSM/I brightness temperatures under different surface moisture conditions resulting from large precipitation events over the central plains of the United States. The effect of vegetation density on the microwave emissions will be studied. We plan to conduct similar comparative studies with snow covered surfaces using surface climatic and snowpack information as ground truth.

## Publications:

We plan to publish a paper on the RTM in the near future after further testing has been completed. A paper on the use of TDR for monitoring snow wetness is forthcoming.

## References:

de Loor, G.P. 1968. Dielectric properties of heterogenous mixtures containing water. *J. Microwave Power*, Vol. 3, pp. 67-73.

Grody, N.C. 1991. Classification of snow cover and precipitation using the special sensor microwave imager. *J. of Geophysical Research*, Vol. 96, No. D4, pp 7423-7435.

Hollinger et al. 1991. DMSF Special Sensor Microwave/Imager Calibration/Validation, Final Report, Volume II. Naval Research Laboratory, Washington, D.C.

McFarland, M.J. and C.M.U. Neale. 1991. Surface Moisture Retrieval Algorithms for the SSM/I. Section 9.3, and Snow retrieval algorithms, section 9.4, DMSF Special Sensor Microwave/Imager Calibration/Validation, Final Report, Volume II. James Hollinger, editor. Naval Research Laboratory, Washington, D.C.

McFarland, M.J., R.L. Miller and C.M.U. Neale. 1990. Land surface temperature derived from SSM/I passive microwave brightness temperatures. *IEEE Transactions on Geoscience and Remote Sensing*, Vol 28, No.5, pp 839-845.

Neale, C.M.U., M.J. McFarland and K. Chang. 1990. Land-surface-type classification using microwave brightness temperatures from the Special Sensor Microwave/Imager (SSM/I). *IEEE Transactions on Geoscience and Remote Sensing*, Vol 28, No.5, pp 829-838.

