Optimal Passive Microwave Detection and Estimation of Precipitation over Land Surfaces and Coastlines

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Year One Progress Report

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Overview

This progress report outlines progress during the first year of a three-year grant.

The grant covers the following research objectives relevant to the optimal detection and estimation of precipitation over land surfaces by passive microwave radiometers:

1. Characterization of Land Surfaces: We will characterize the statistics of background variability in brightness temperatures (e.g., annual and monthly means and covariances) in a form that can be utilized to (a) validate current and future emissivity models, and (b) directly aid in optimal retrievals of radiometric signatures related to precipitation (see next objective).
2. Precipitation Retrieval Over Land: We will refine and demonstrate a new conceptual basis for optimally detecting and quantifying precipitation-related radiometric sig- natures over almost any surface type, including coastlines, deserts, and frozen ground.

Objective 1: Characterization of Land Surfaces

We have completed the first phase of a cluster analysis of 6-channel passive microwave emissivities provided by C. Prigent and F. Aires. The technique involves a novel similarity test that takes into account not only the mean emissivity vector at each grid point but also its covariance. The analysis was computationally time-consuming (months of continuous computation) and involved terabytes of intermediate data.

The initial results reveal hundreds of spectrally distinct surface types and their seasonal variation. Because we are tasked with providing a much smaller number (10-20) of land surface classes to the passive microwave algorithm team, we will apply an additional clustering analysis to group numerous smaller classes into a few larger ones.

Both the method and the results of our cluster analysis are sufficiently novel that we expect to prepare at least two journal papers during the coming months. In addition, we are collaborating with Karen Mohr (NASA-GSFC) to provide geophysical interpretations of various classes, particularly in terms of vegetation types.

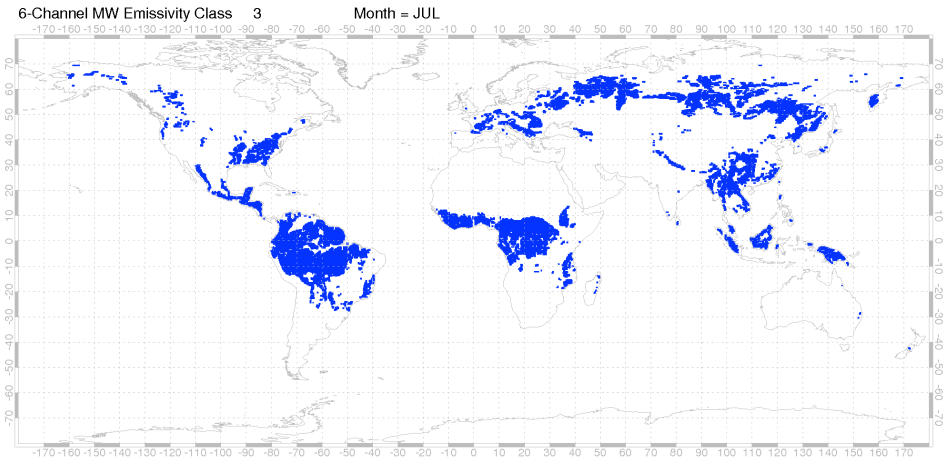

Fig. 1: Example of land surface class map derived from Prigent/Aires microwave emissivity climatology.

Objective 2: Precipitation Retrieval Over Land

In our proposal, we had demonstrated the use of a constrained optimal estimation technique to detect precipitation signatures against highly inhomogeneous surface types, including coastlines. The basic principle is now established, but the quality of the result depends crucially on the quality of the background means and covariances of brightness temperatures. The primary technical challenge is to include all background variations in the climatological covariances that are not associated with falling precipitation but to exclude falling precipitation. We have a TRMM PR-TMI matchup data set from C. Kummerow that in principle can allow this separation to be made, but the sample size is not large enough to generate robust statistics at each grid point. We will therefore rely on the surface classification described under the previous objective to group PR-TMI matchups by background type so that robust statistics can be determined for each class and applied to larger regions than just single gridpoints.

We have also hired an talented undergraduate student, Ryan Harp, as an hourly project assistant to examine the statistics of brightness temperature variations in snowpack vs. the signatures of falling precipitation. Our hope is that by using a more sophisticated analysis than has previously been undertaken, we can identify spectral differences that can be exploited to optimally separate the two signatures.

Publications Relevant to this Grant

We anticipate the following publications during the coming year:

Petty, G.W. , 2011: Unsupervised classification of multi-dimensional data based on both means and covariances. (manuscript in preparation, journal TBD)

Petty, G.W. , 2011: Unsupervised classification of land surface types and temporal variability based on multichannel passive microwave emissivities. (manuscript in preparation, journal TBD)

Petty, G.W., 2011: Optimal detection and estimation of precipitation from passive microwave data over heterogeneous surfaces, including coastlines. (manuscript in preparation for submission to *J. Appl. Meteor.*)