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Locally optimized passive microwave detection of precipitation over heterogenous surfaces

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Land surfaces pose a challenge for the satellite passive microwave detection and estimation of precipitation, not only because of their generally high emissivity but especially because the emissivity may be highly variable in both time and space in response to changing wetness, vegetation, and other properties. Standard global retrieval algorithms that work well over reasonably uniform surfaces perform poorly near coastlines and wetlands and over "problem" surface types such as rocky or sandy deserts and frozen or snow-covered ground,

We demonstrate a technique for greatly reducing artifacts and improving the precipitation detection threshold in the presence of spatially and temporally heterogeneous surface properties. First, we empirically determine the multichannel mean $\langle \mathbf{T}_\mathrm{B} \rangle$ and covariance $\mathbf{\Sigma}_\mathrm{TB}$ of the background brightness temperature within each geographic grid box. The covariance quantifies the geophysical noise (both spatial and temporal) within that grid box against which the precipitation signature must be detected. Second, we model the desired multichannel precipitation signature $\mathbf{a} \equiv \partial \mathbf{T}_\mathrm{B}/\partial R$ as a function of $\langle \mathbf{T}_\mathrm{B} \rangle$. Finally, we use constrained optimal estimation (COE) to define a locally optimized linear estimator $\mathbf{d}$ which, when applied to the local multichannel brightness anomaly, yields an estimate $\hat{R} = \mathbf{d} \cdot \Delta \mathbf{T}_\mathrm{B}$ that minimizes the sensitivity to $\mathbf{\Sigma}_\mathrm{TB}$ while preserving the correct scaling of the desired signature R.

The advantages of the above method are demonstrated in the context of a simple prototype precipitation algorithm applied to data from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI), but it is currently being adapted to more sophisticated Bayesian retrieval methods under development for the Precipitation Measuring Mission (PMM).