

Profiling atmospheric graupel, snow and ice using TRMM's PR and TMI

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Of TRMM's three instantaneous algorithms, the radar-only and combined radar-radiometer algorithms currently produce profiles of liquid rain only. The radiometer algorithm produces estimates of liquid rain and undifferentiated solid ice at a coarser resolution than the other two and using a fraction of the available data. We have recently refined the combined algorithm to expand its scope and estimate graupel, snow and ice profiles along with the current rain-only estimates. The associated uncertainties can also be quantified and will allow TRMM to produce robust latent heating estimates with unprecedented accuracy. The main problem in trying to estimate frozen hydrometeor profiles along with the rain is the large number of unknown variables to be determined. Indeed, given one radar reflectivity profile and a few co-located radiances, it seems a priori possible to estimate no more than one rain profile and a few additional variables (rather than three additional profiles of variables). Fortunately, our principal component analysis revealed that the frozen hydrometeor profiles can be quite adequately approximated by one or two eigenvariables each. We then developed a straightforward Bayesian method to estimate these additional variables and will include them in the output structure of the next version of the combined algorithm. Simple piecewise-linear formulas will enable users to reconstruct the corresponding graupel/snow/ice profiles which can then be used to calculate the associated latent heating.