Neural Network Retrievals of Atmospheric Temperature and Moisture Profiles from High-resolution Infrared and Microwave Sounding Data

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A novel statistical method for the retrieval of atmospheric temperature and moisture (relative humidity) profiles has been developed and evaluated with sounding data from the Atmospheric InfraRed Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU). The algorithm is implemented in three stages. First, the infrared radiance perturbations due to clouds are estimated and corrected by combined processing of the infrared and microwave data. Second, a Projected Principal Components (PPC) transform is used to reduce the dimensionality of and optimally extract geophysical profile information from the cloud-cleared infrared radiance data. Third, an artificial feedforward neural network is used to estimate the desired geophysical parameters from the projected principal components.

The cloud-clearing of the infrared radiances was performed by the AIRS Science Team using infrared brightness temperature contrasts in adjacent fields of view and microwave-derived estimates of the infrared clear-column radiances to estimate and correct the radiance contamination introduced by clouds. The PPC compression technique was used to reduce the infrared radiance dimensionality by a factor of 100, while retaining over 99.99% of the radiance variance that is correlated to the geophysical profiles. This compression allows the use of smaller, faster, and more robust estimators. A single-layer feedforward neural network with approximately 3000 degrees of freedom was then used to estimate the geophysical profiles at approximately 60 levels from the surface to 20 km.

The performance of this method (henceforth referred to as the PPC/NN method) was evaluated using global (ascending and descending) EOS-Aqua orbits co-located with ECMWF fields for a variety of days throughout 2003 and 2004. Over 350,000 fields of regard (3×3 arrays of footprints) over ocean and land were used in the study. Retrieval performance compares favorably with that obtained with simulated observations from the NOAA88b radiosonde set of approximately 7500 profiles. The PPC/NN method requires significantly less computation than traditional variational retrieval methods, while achieving comparable performance.

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