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Progress Report

ATMOSPHERIC INFRARED SOUNDER

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The microwave "first-guess" algorithm was run on the cloudy test simulations. Eight datasets were considered in the cloudy test, comprising ~360 retrievals, of which one failed to converge. Retrievals were done on the AMSU-A grid. Examination of the true profiles (provided for the A, C and D tracks) showed numerous cases of very pronounced temperature inversion layers in the troposphere which the retrieval does not have enough vertical resolution to reproduce. A typical example with an inversion layer near 700 mbar is shown in Figure 1. The inversion layers also exhibit strong vertical gradients of water vapor which are not resolved in the retrieval. (Water vapor volume density is given in g/cm^2 per layer. Layer thickness is 20 mb from 200 to 400 mb, and 25 mb from 400 to 1,000 mb.) The retrievals do reproduce the overall smoothed shape of the profiles, and therefore as a first guess should be within the range of linear methods for IR retrievals using AIRS. The updated microwave first-guess algorithm was delivered to JPL in December. The algorithm description document is being revised, and will be delivered when ready.

Figure 2 shows the temperature and water vapor from the one profile that did not converge (the retrieved profile results from the last iteration). Figure 3 is the corresponding cloud liquid water profile, showing the presence of a cloud with 0.4 g/cm^2 total liquid in the true profile. The retrieved liquid water was arbitrarily limited to 0.02 g/cm^2 in each layer. (A retrieval without this limit was also done, but it did not converge either.) It should be pointed out that this case is somewhat unrealistic, in the sense that the simulation did not include precipitation, yet previous experience indicates that clouds begin to rain well before this value of liquid water is reached.

Retrieval of precipitation-cell-top altitude by means of a neural network was investigated. 118-GHz brightness temperature perturbations (ΔT_B cell-top minus clear-air) observed with MTS were used as inputs to the network. It was trained to reproduce cell-top altitudes determined by optical stereoscopy with the video camera. The optimal network was found to have one hidden layer and five nodes (Spina, et al, 1994). Table 1 compares this technique with a simple linear regression estimator and with the nonlinear statistical method described by Gasiewski and Staelin (1989). The four rows of the table correspond to trials in which the cloud types were restricted, or in which the input brightness temperature perturbations were supplemented by the clear-air absolute brightnesses, and by the logarithm of the cell size. For comparison, the *a priori* variability of cell-top altitude was 3.85 km rms. It should be noted that the altitude errors introduced by the stereoscopy were estimated to be ~1 km rms, which is a non-negligible component of the errors in Table 1.

Table 1. Comparisons of rms errors (km) for cell-top altitude estimators.

Data set used	Linear regression	Nonlinear statistical	Neural networks
All cloud types; ΔT_B	2.03	1.97	1.76
Cumulus only; ΔT_B	1.82	1.63	1.44
Cumulus only; ΔT_B & T_B	1.66	1.53	1.41
Cumulus only; ΔT_B & T_B & ln (size)	1.58	1.50	1.36

Papers describing the rapid microwave transmittance algorithm, the neural-network relative humidity retrievals, and the precipitation cell-top retrieval were presented at the IGARSS'94 Conference in Pasadena, CA., and manuscripts have been submitted to the *IEEE Transactions on Geoscience and Remote Sensing.*

Retrieval of temperature profiles from AIRS data is being investigated by William Blackwell. Noise-free clear-air radiances simulated from the TIGR global ensemble of 1761 profiles were divided into a training set (2/3) and a validation set (1/3). As an initial experiment, a linear retrieval technique was applied to 390 selected channels. The technique is a combination of Karhunen-Loeve transformation and linear regression. Retrieval errors for the validation set are generally less than 0.8K. This noise-free simulation will provide a "best-case" baseline for further studies.

References

Spina, M.S., Schwartz, M.J., Staelin, D.H., Gasiewski, A.J., "Application of Multilayer Feedforward Neural Networks to Precipitation Cell-Top Altitude Estimation," IGARSS '94 Conference, Pasadena, CA, Aug. 8-12, 1994.

Gasiewski, A.J. and Staelin, D.H., "Statistical Precipitation Cell Parameter Estimation Using Passive 118-GHz 0_2 Obervations," J. of Geophys. Res., **94** (D15), 18,367-18,378, (1989).

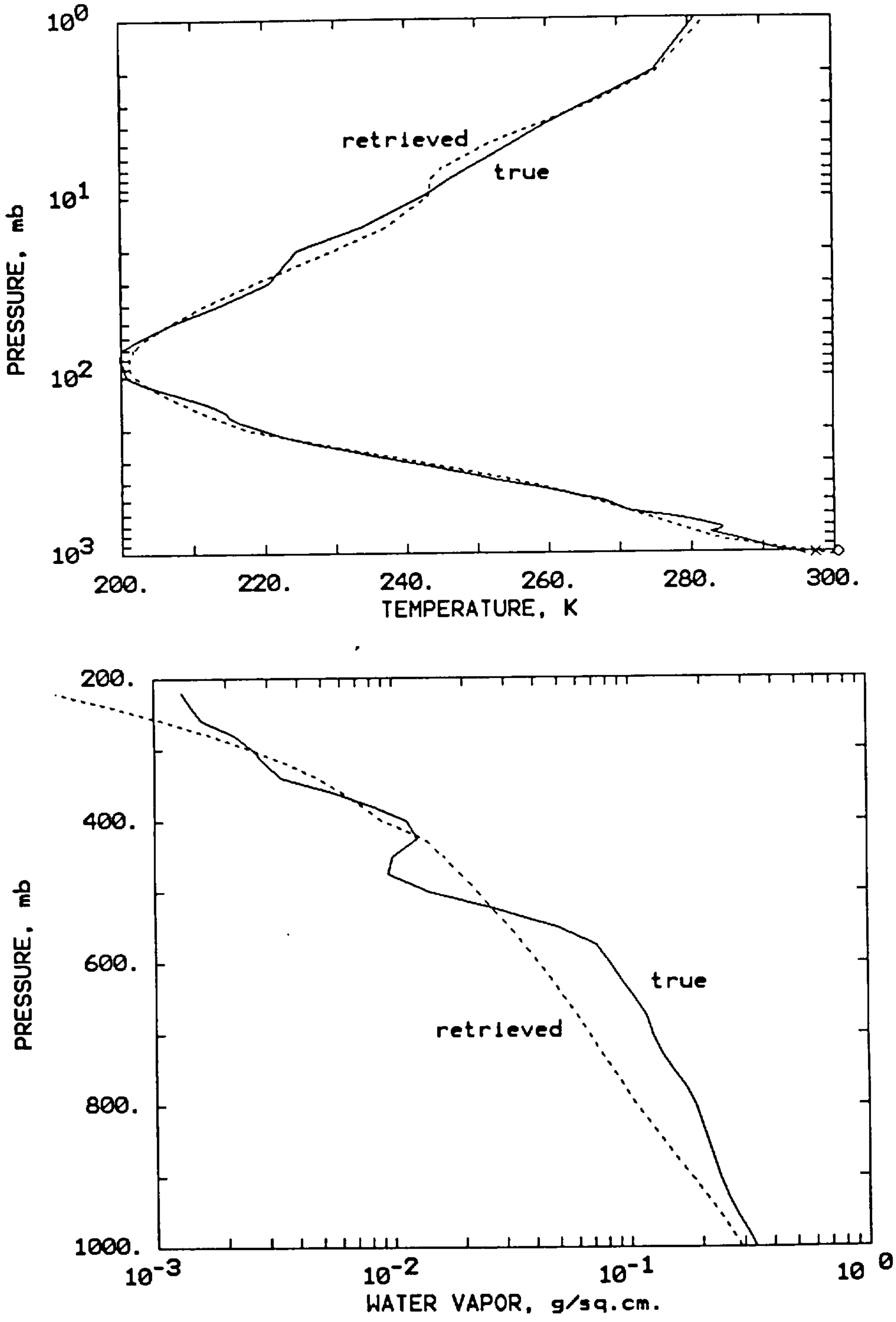

Figure 1. Temperature and water vapor profiles from track A, nightime, spot 86.

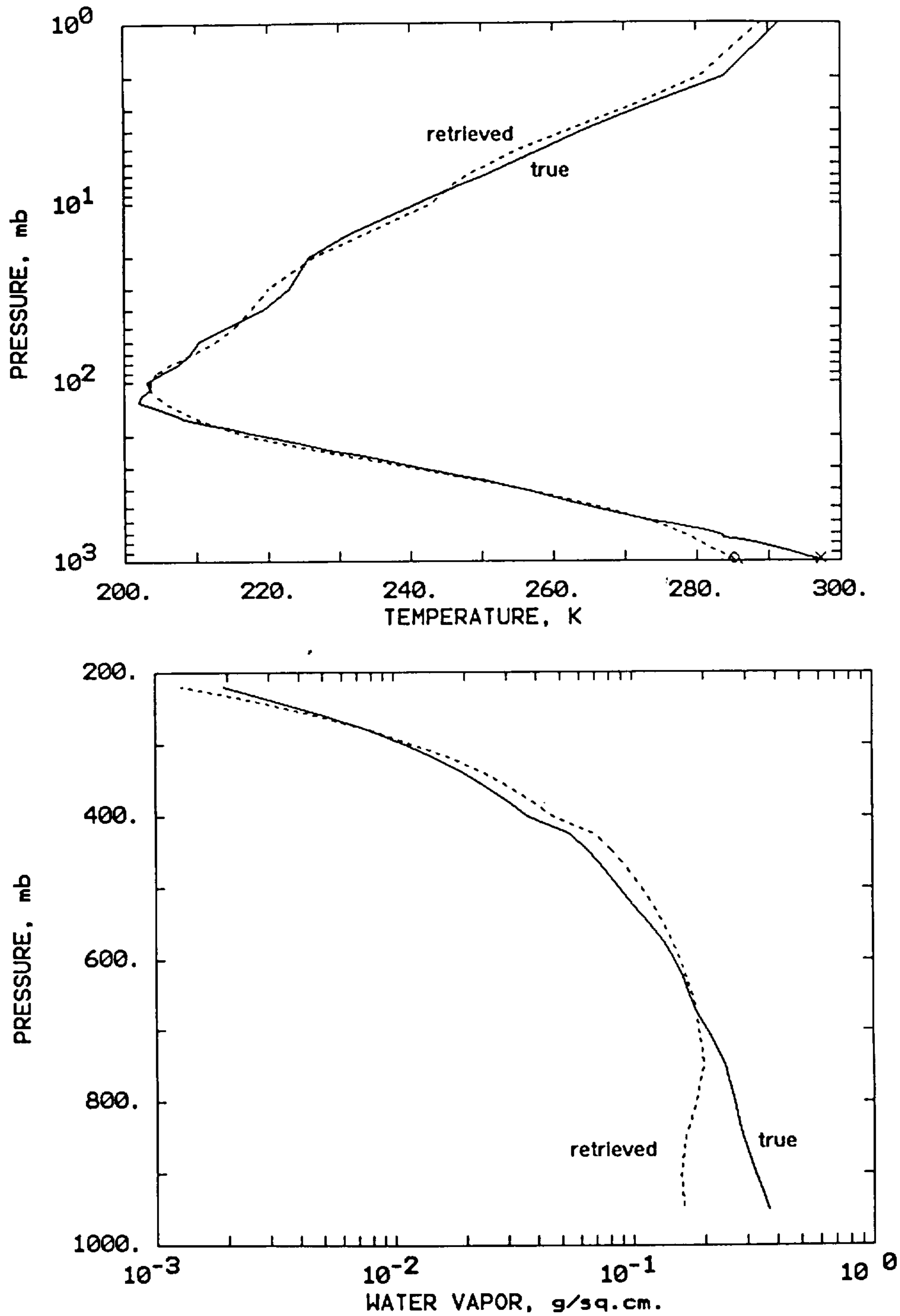

Figure 2. Temperature and water vapor profiles from track C nighttime, spot 275.

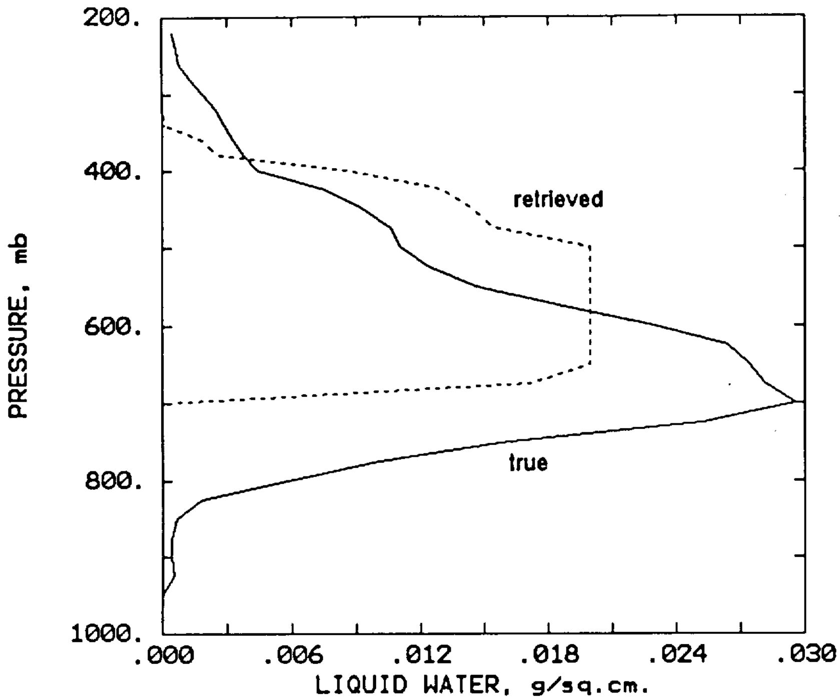

Figure 3. Liquid water profiles from track C nighttime, spot 275.

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15. Supplementary Notes

This report summarizes the activities of AIRS Team Members P.W. Rosenkranz and D.H. Staelin during the second half of 1994.

16. Abstract

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