P1.8 MICROWAVE RADIOMETER OBSERVATIONS OF INTEGRATED ATMOSPHERIC WATER VAPOR AND CLOUD LIQUID WATER AT SHEBA AND ARM'S NSA SITE USING NEW ABSORPTION MODELS

Brad W. Orr* and Taneil Uttal
[1]NOAA Environmental Technology Laboratory, Boulder, Colorado

1. INTRODUCTION

Radiometric retrievals of precipitable water vapor and integrated cloud liquid water have been made for the Surface Heat Budget of the Arctic Ocean (SHEBA). Potential problems were noticed during comparison with *in situ* aircraft data over SHEBA which suggested that retrieved values were too high (J.A Curry, personal communication).

The 2-channel microwave radiometer (MWR) (Liljegren and Lesht, 1996) at SHEBA was operated and processed using the same algorithms employed at NSA. Results from Han et al. (2001) suggest the absorption models currently being used to generate retrieval coefficients for the MWR were developed for lower latitudes and produce an overestimate in the integrated cloud liquid water (L) from the MWR in the Arctic. Integrated atmospheric water vapor (V) measurements are also effected but to a much lesser degree. The implications are significant for remote sensor cloud microphysical retrievals and for cloud and atmospheric modeling studies for which L and V are fundamental inputs.

This study compares data using the original ARM processing methods to those obtained using a new set of radiative transfer absorption models as suggested in Han et al. (2001). Data from the full SHEBA year and two years of data from NSA are examined.

2. METHODOLOGY

The original ARM analysis used radiometer retrieval coefficients derived using oxygen and water vapor absorption algorithms from Leibe and Layton (1987) and liquid water absorption from Grant et al. (1957). Han et al. (2001) suggest using the model of Rosenkranz (1998) for atmospheric molecular absorption and Leibe et al. (1991) for the dielectric constant equations for liquid water. These models are more appropriate for super cooled liquid water which is prevalent in the Arctic.

Using these models we derived a new set of monthly statistical MWR retrieval coefficients and atmospheric mean radiating temperatures (Tmr) from *a priori* sounding data taken from 1986-1996 at Barrow, AK. These data are used to derive new estimates of V and L from the MWR brightness temperature data. These new data are compared to the original data to assess the magnitude of the correction.

3. ANALYSIS AND DISCUSSION

Figure 1 is an example of the monthly regression analysis for NSA for the year 2000. The figure shows individual plots for each month of new versus original estimates of L. Similar analysis were done for NSA 1999 and the SHEBA year. In Fig. 2 the slope of the regression analysis is plotted for each month of the three years of data. The dashed lines in Fig. 2 are the monthly regression slopes for new versus original V and the solid lines are the regression slopes for the new versus original L.

The new absorption models only indicate small corrections in V which are generally positive, the largest values only being a few percent. Corrections for L are much larger. The new estimates for L show a decrease of around 10 percent from the original estimates in summer and near 15 percent much of the rest of the year.

There are some obvious annual trends in Fig. 2, in particular in the L data. The peak in summer, where the new data are closer to the original, is expected because of the warmer temperatures. The main improvement in the Liebe et al. (1991) model over the Grant et al. (1957) is

**Corresponding author address*:
Brad W. Orr, NOAA/ETL, 325 Broadway,
Boulder, CO, 80305. brad.w.orr@noaa.gov

the incorporation of data on the dielectric constant of water for temperatures below 0 ^{o}C. Intrieri et al. (2001) indicate a significant frequency of liquid in clouds, even in the winter, making the accuracy of retrieving L at cold temperatures important.

The largest departures of the new L from the original appear in the late Fall and early Spring months. There are secondary peaks where the models start to converge in winter (January and November, the behavior in December is less clear). This is consistent with an error analysis in Fig. 5 of Han et al. (2001) where the complex behavior of the two liquid water absorption models is shown. The difference between the Liebe et al. (1991) and Grant et al. (1957) models maximizes near -9 ^{o}C. At temperatures above and below -9 ^{o}C the difference between the two models is less. This may partially explain the maximum difference in L during the Spring and Fall.

Data calibration has not been considered in this study but it is an acknowledge problem during some periods of the data selected for this study. However, since both the original and the new estimates of L and V use the same initial data the results should not be significantly effected. Some data thresholding was done before the new estimates of L and V were computed. This mainly included placing reasonable limits on measured brightness temperatures and eliminating periods when the wet window sensor was set.

4. CONCLUSION

New estimates of L and V have been computed for three years of MWR in the Arctic region using radiative transfer models which more accurately account for molecular absorption and the behavior of the dielectric constant of liquid water at cold temperatures. The new data have been compared to the original estimates of L and V from SHEBA and NSA. It is found that the new retrievals of L and V are in better agreement with *in situ* measurements.

5. *References*

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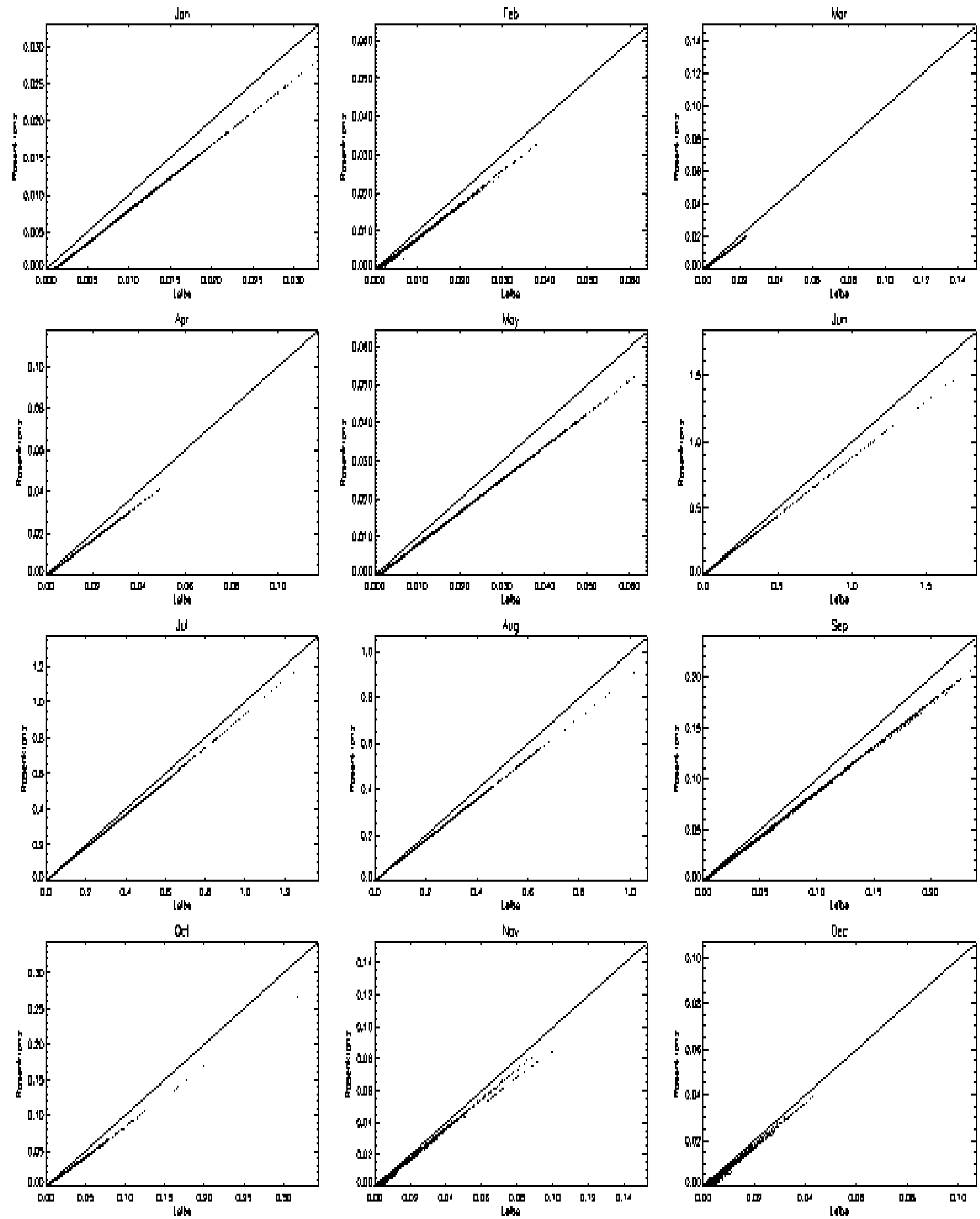

Figure 1. Monthly regression plots of original estimate (x-axis) versus new (y-axis) of integrated cloud liquid water (L) from NSA for the year 2000.

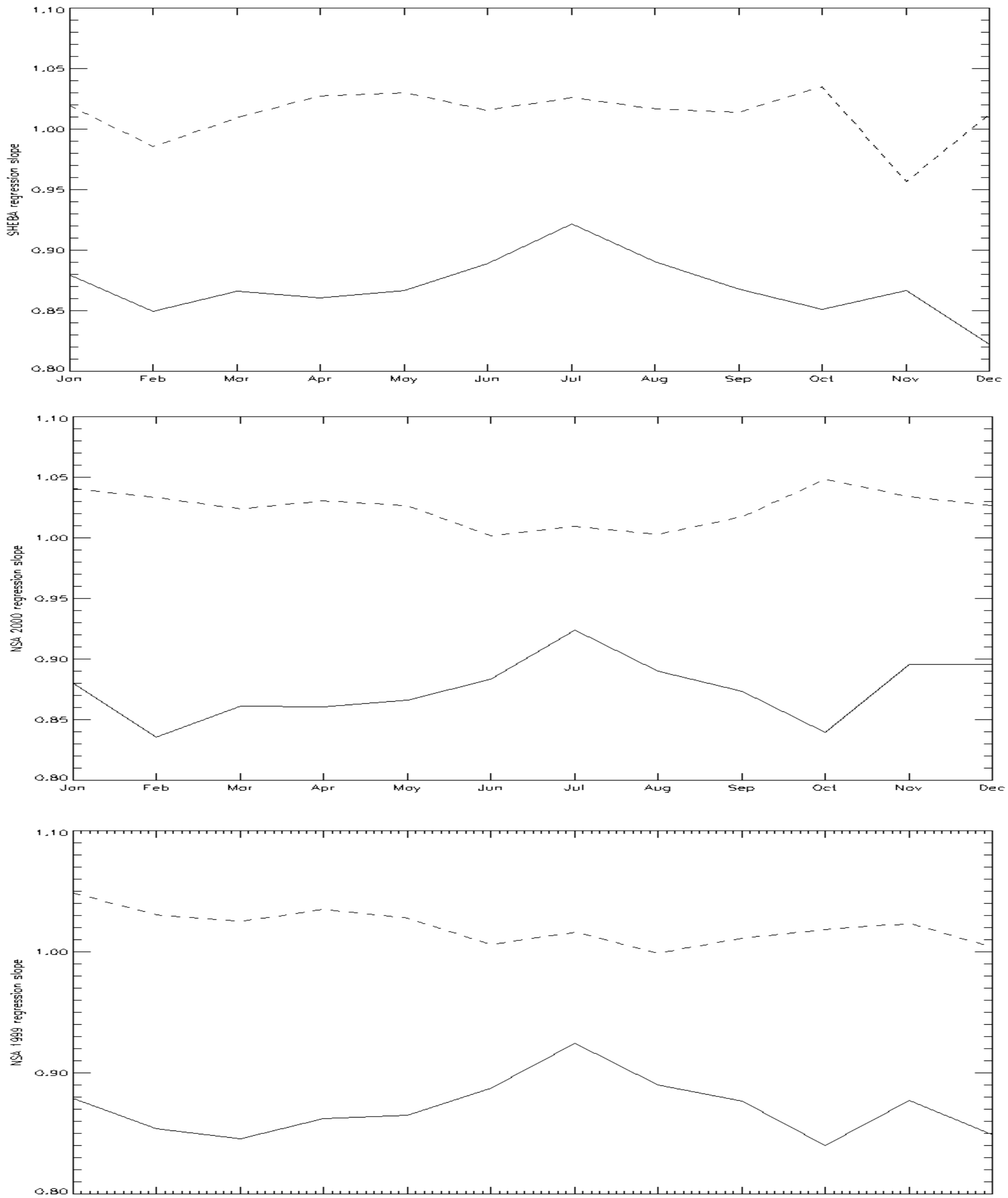

Figure 2. Plot of regression slope for each month for the new versus original MWR L (solid line) and V (dashed line). SHEBA (top), NSA 2000 (middle), and NSA (1999).