ARM MEASUREMENTS OF VERTICAL VELOCITY IN BOUNDARY LAYER CLOUDS

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ARM Atmospheric Radiation Measurement

Vertical Velocity Measurements in ARM

Vertical velocity measurements have been at the top of the priority list of the cloud modeling community for some time.

Using ARM datasets for evaluating and improving cloud parameterization in global climate models (GCMs) is not straightforward, due to gigantic scale mismatches.

Most ARM instruments are suitable for cloud observations and have limited capabilities in precipitation

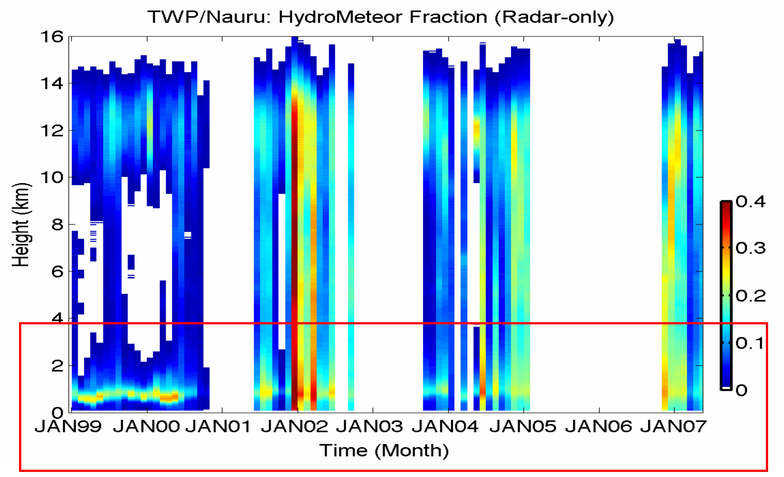

Fig. 1 Monthly-averaged hydrometeor (cloud+precipitation) fraction using MMCR-only observations at the Nauru (C2) ARM Tropical Western Pacific site

Progress has been made in our ability to observe the vertical velocity in clouds using the ARM MMCR's (Kollias et al., 2007; Kollias and Albrecht, 2000; Kollias et al., 2001).

Periods with small particles (clouds) are identified using **Z-V** (reflectivity-Doppler) correlations and a dynamic radar reflectivity threshold.

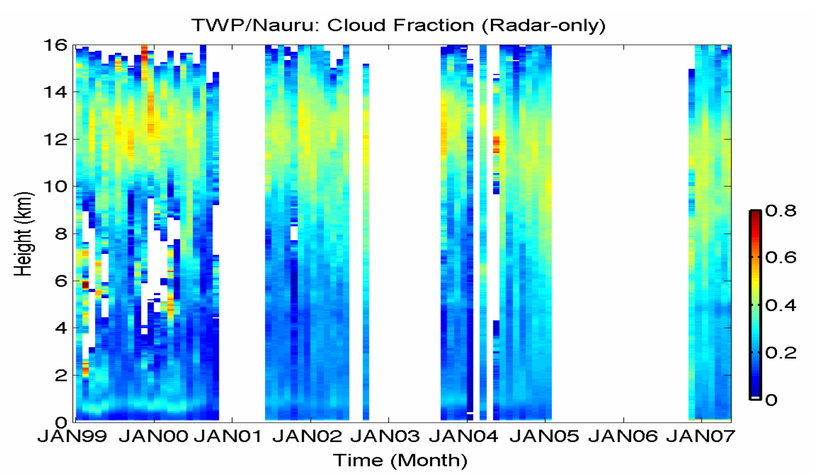

Fig. 2 Monthly-averaged cloud fraction (portion of the hydrometeor fraction) reported in Fig.1 using MMCR-only observations at the Nauru (C2) ARM TWP site

VERTICAL VELOCITY STATISTICS OF BOUNDARY LAYER CLOUDS

Cloud Base

Cloud Top

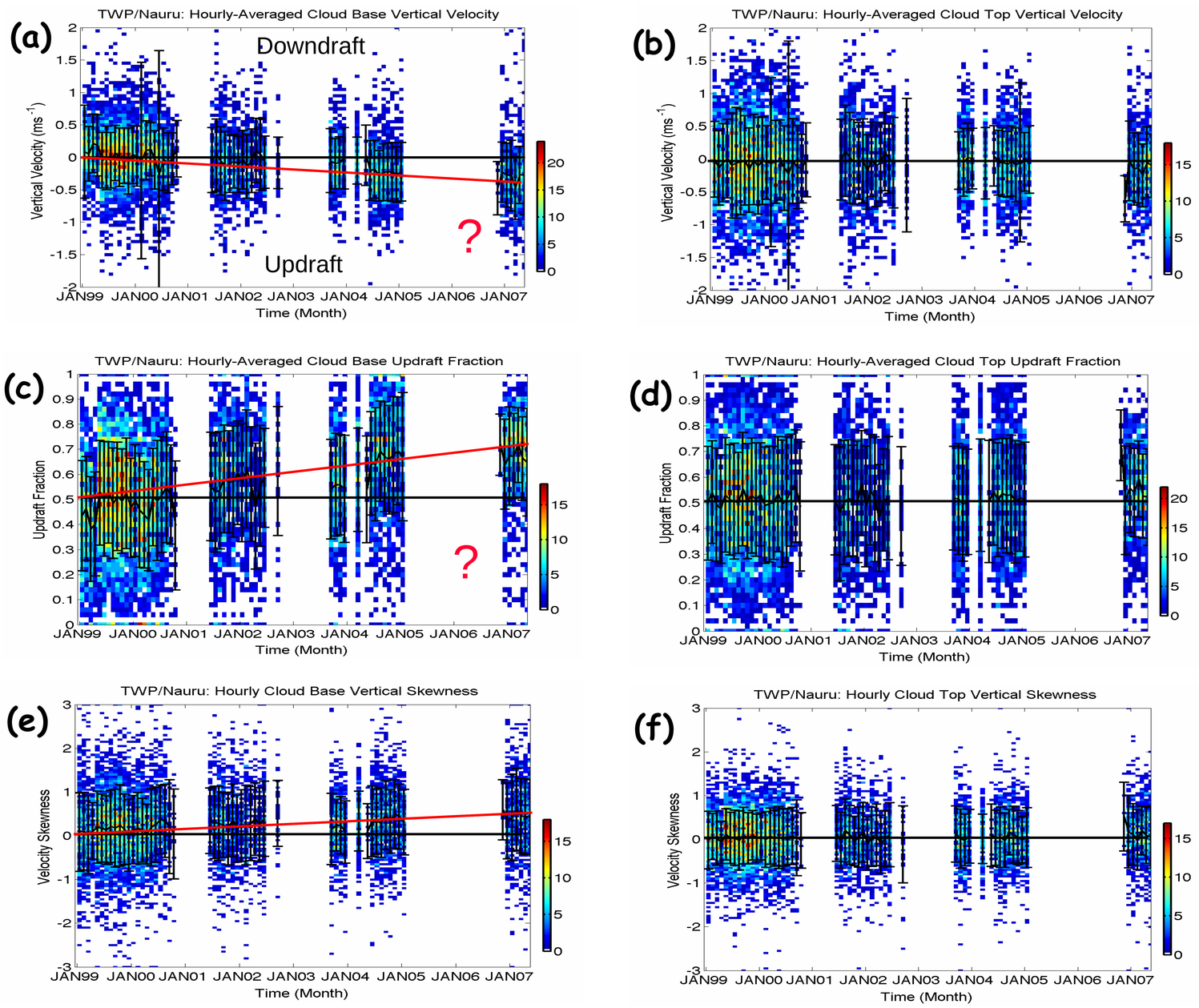

Fig. 3: (a,b): Monthly PDF's of hourly-averaged observed cloud vertical velocity at the hourly-averaged cloud base (left) and cloud top (right) height, (c,d): monthly PDF's of hourly observed updraft fraction at the hourly-averaged cloud base (left) and cloud top (right) height, (e,f): monthly PDF's of hourly estimated cloud vertical velocity skewness at the hourly-averaged cloud base (left) and cloud top (right) height.

Key Points

Doppler velocity measurements from ARM profiling radars operating at 915-MHz, 35-GHz and 94-GHz have been largely **unexploited**.

The cloud-sensitive ARM radars provide **unique** Doppler measurements of non-precipitating clouds.

ARM observations need to evolve beyond the 1D "soda straw" view of clouds and precipitation. **Looking only vertically drastically limits opportunities for observing the vertical velocities in precipitation.**

References

Kollias, P, and B Albrecht. 2000. "The turbulence structure in a continental stratocumulus cloud from millimeter-wavelength radar observations." Journal of Atmospheric Sciences 57: 2417-2434.

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Kollias, P, EE Clothiaux, MA Miller, EP Luke, KL Johnson, KP Moran, KB Widener, and BA Albrecht. 2007. "The Atmospheric Radiation Measurement Program Cloud Profiling Radars: Second-Generation Sampling Strategies, Processing, and Cloud Data Products." Journal of Atmospheric Sciences 24: 1199-1214.