

# Mesoscale Mass Fluxes in the Eastern Pacific

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# Abstract

In this paper, mesoscale characteristics of convective mass fluxes observed during EPIC-2001 are presented. The fluxes are synthesized from radial velocities collected with the Doppler radar mounted on the tail of the NOAA WP3-43 aircraft. Nine of the ten ITCZ-missions in which this aircraft participated were analyzed. The target area for all these missions is a rectangular box extending from 8N to 12N and from 93W to 97W. The aircraft observed this area roughly from 10:30 am to 3:30 pm local time while flying a lawn-mower pattern.

# Epic 2001

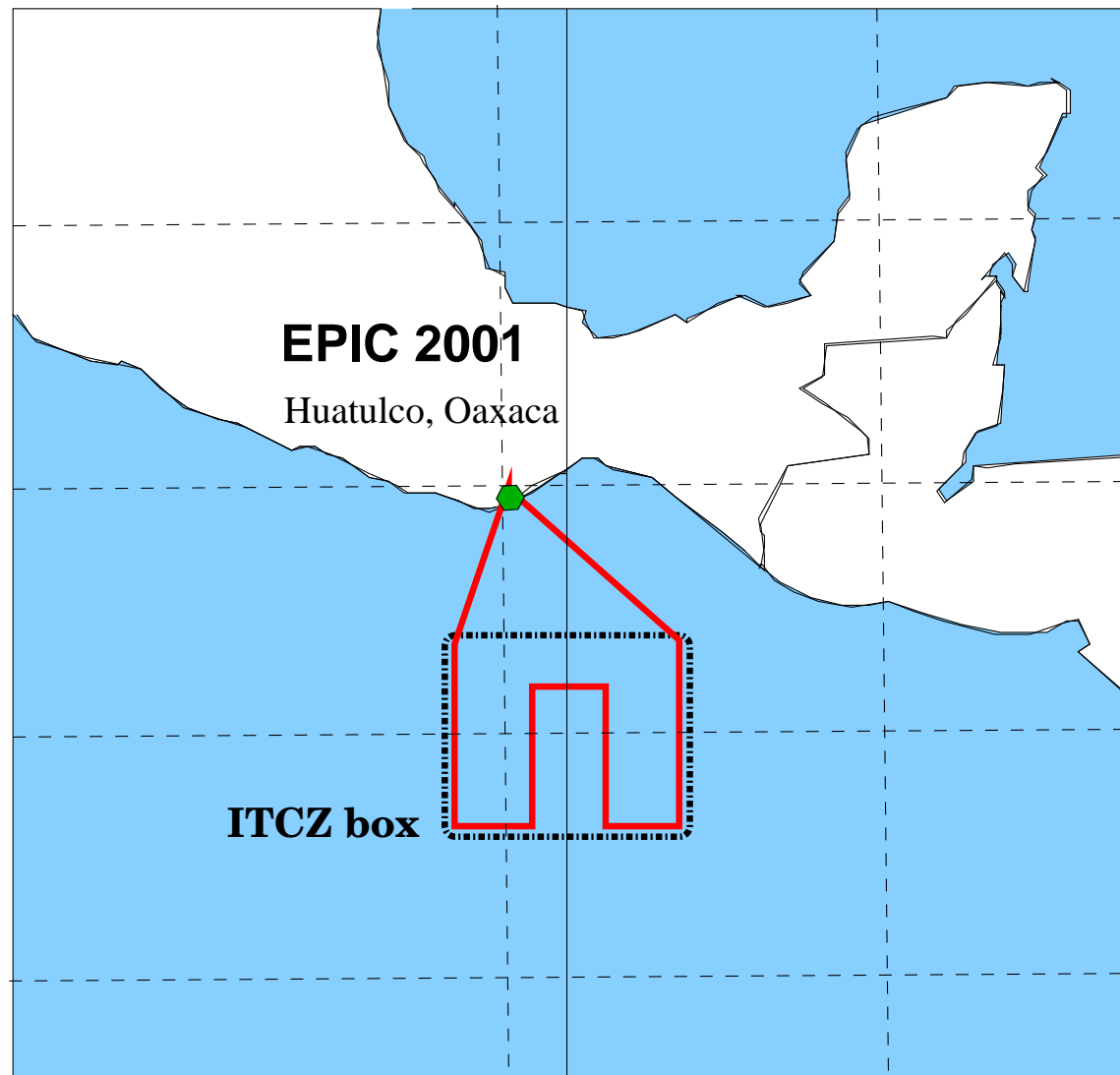


Figure 1.

**Figure 1.** This map shows the location of the ITCZ box. The red line is the WP3-43 track. The aircraft completed this pattern in 10 missions at a nominal altitude of 2 km. On September 28, engine number 4 broke down at the end of the first leg of the pattern and the mission was canceled. The WP3-43 came back to action on October 3 –thanks to a well coordinated effort and the tenacity of its crew.

# Satellite Infrared Temperature

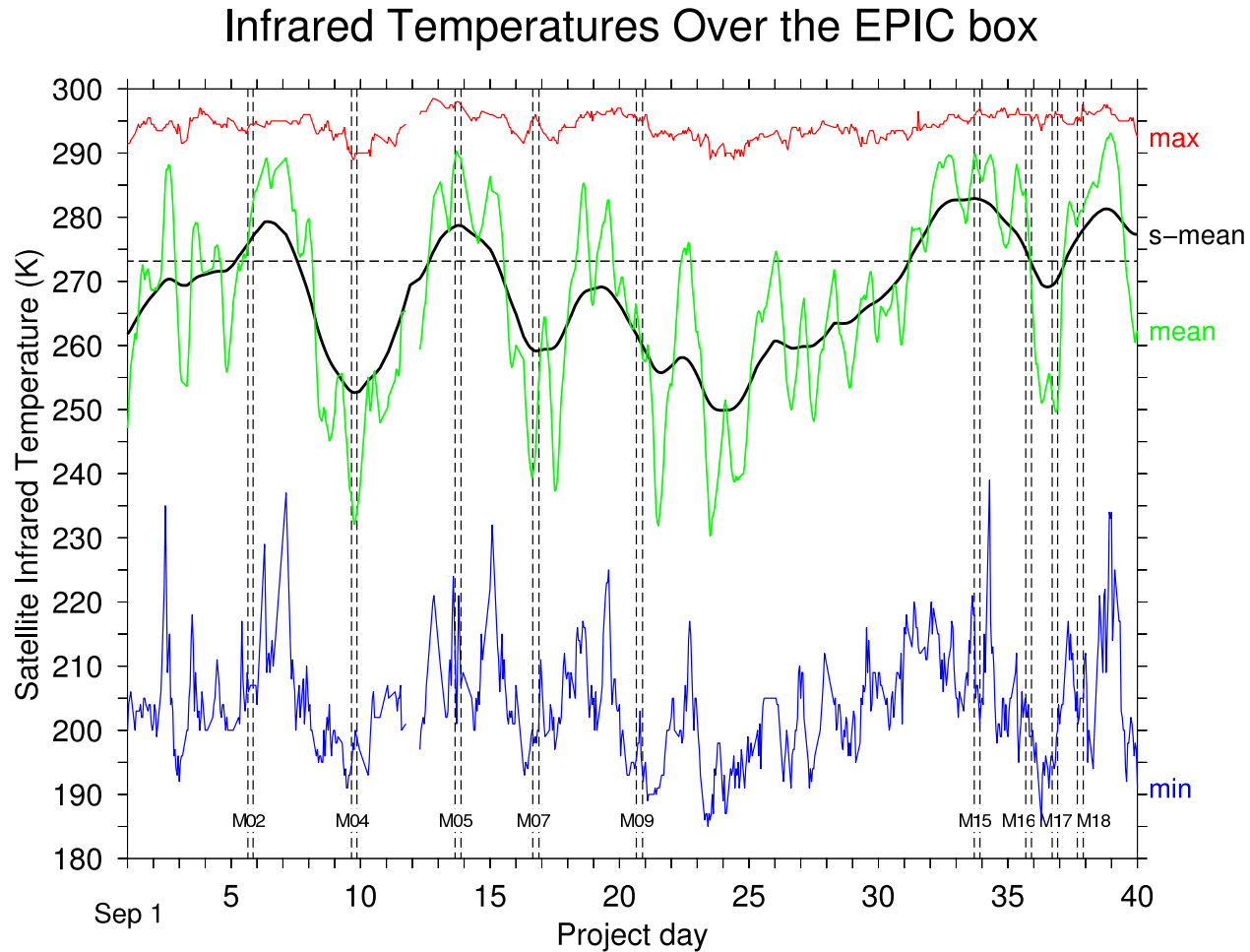


Figure 2.

**Figure 2.** The green line shows the time series of the areal mean of the infrared temperature over the EPIC box. The red and blue lines show the time series of the minimum and maximum infrared temperatures inside this box. The solid black line shows a smoothed version of mean with smoothing length of one day. The diurnal cycle and a seven day cycle are clearly visible in these plots. The vertical dashed lines indicate the time interval for each of the WP3-43 ITCZ-missions. The freezing level is shown by the horizontal dashed line.

# R E S U L T S

# Vertical Mass Flux Profiles

## Decaying Convective Systems

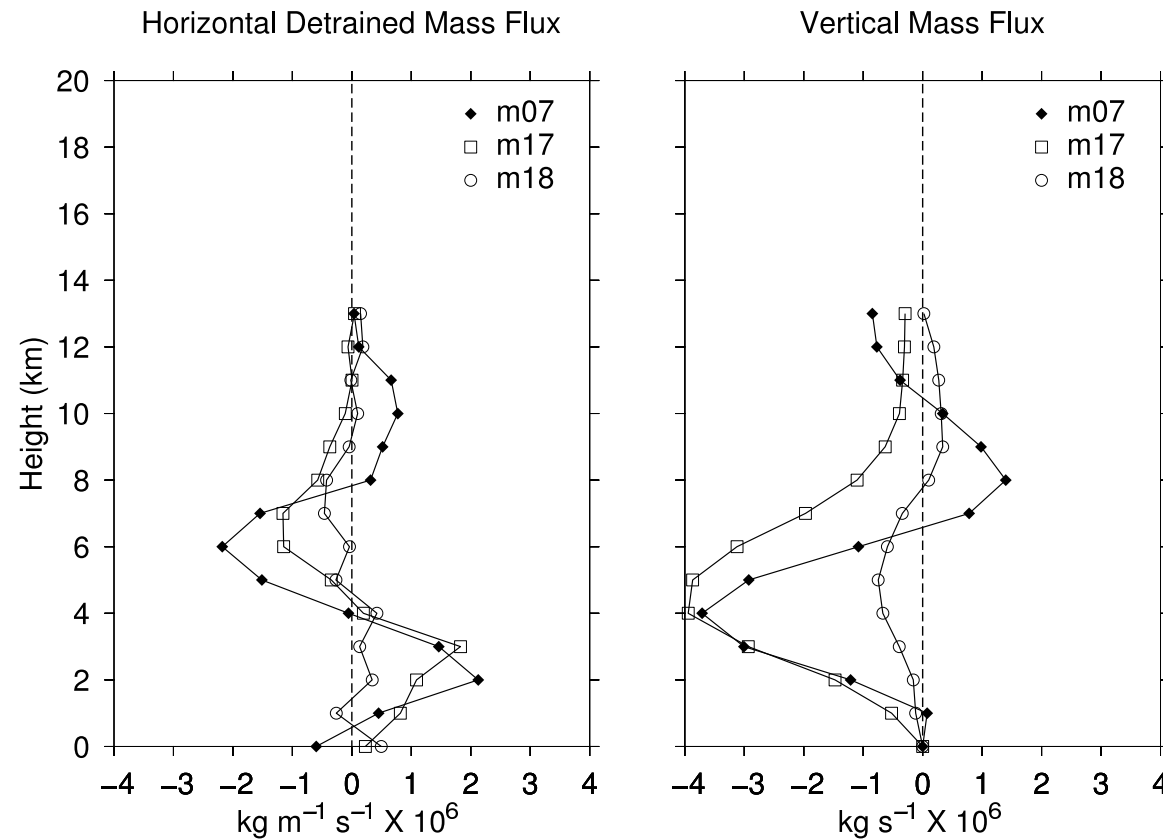


Figure 3a.

# Vertical Mass Flux Profiles Strong Convective Systems.

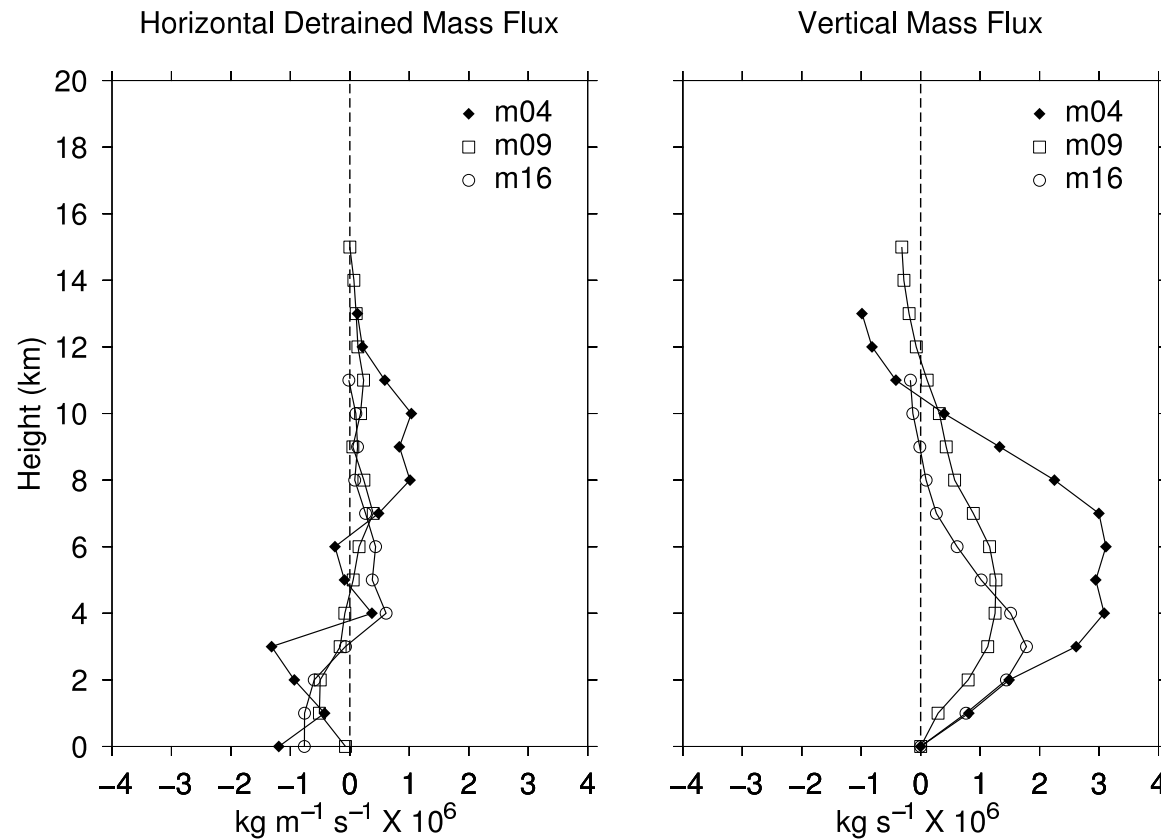


Figure 3b.

# Vertical Mass Flux Profiles

## Weak Convective Systems.

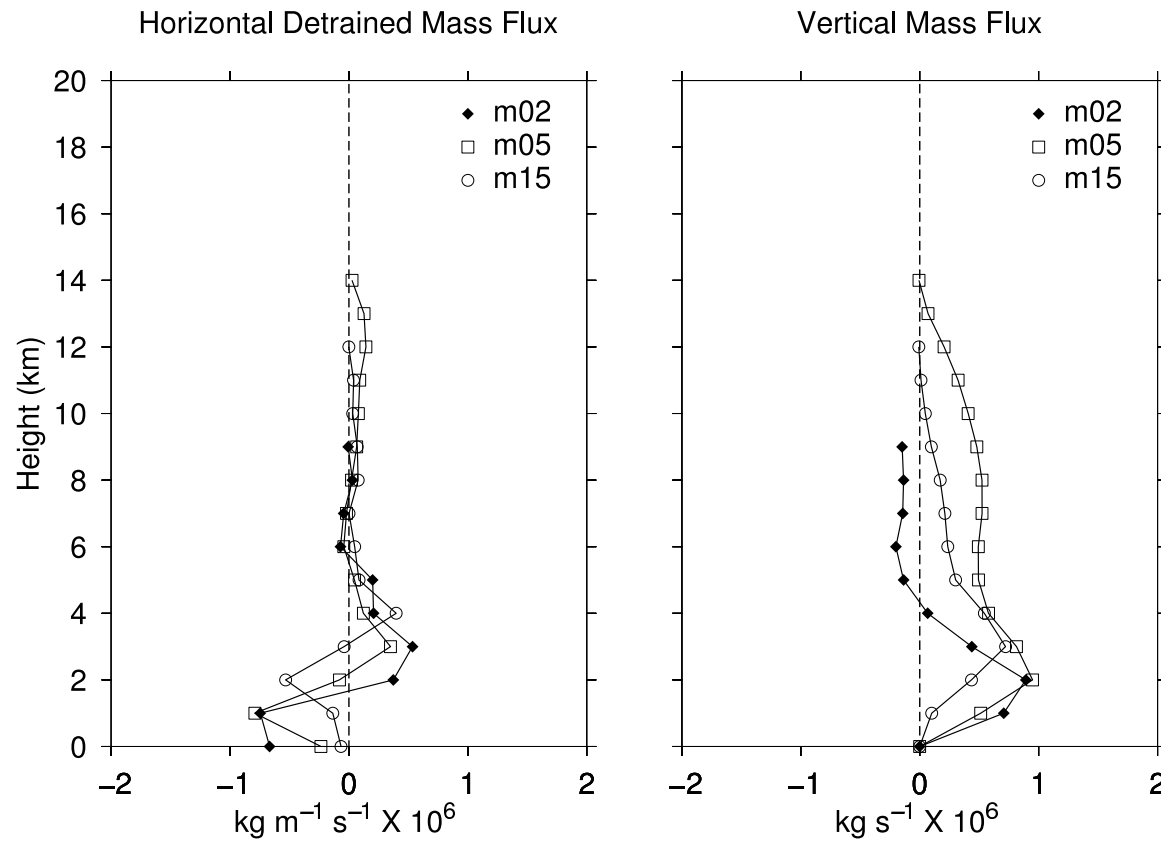


Figure 3c.

### **Figure 3. Vertical Wind Shear Profiles**

Vertical Mass Flux Profiles.

(a) Decaying Convective Systems.

(b) Strong Convective Systems.

(c) Weak Convective Systems.

The left sub-panels show horizontal detrainment mass fluxes, which have been mass balanced. The right hand side sub-panels show the corresponding vertical mass flux profiles.

# Average Vertical Wind Velocity Decaying Convective Systems

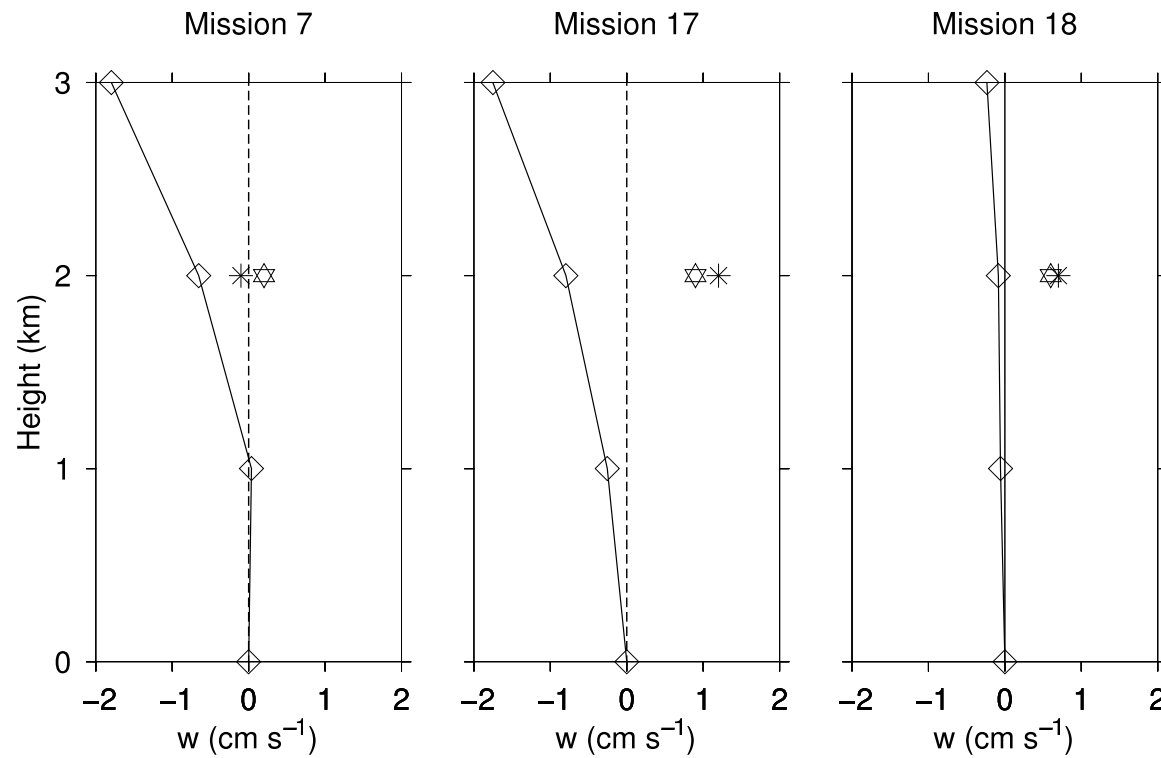


Figure 4a.

# Average Vertical Wind Velocity Strong Convective Systems

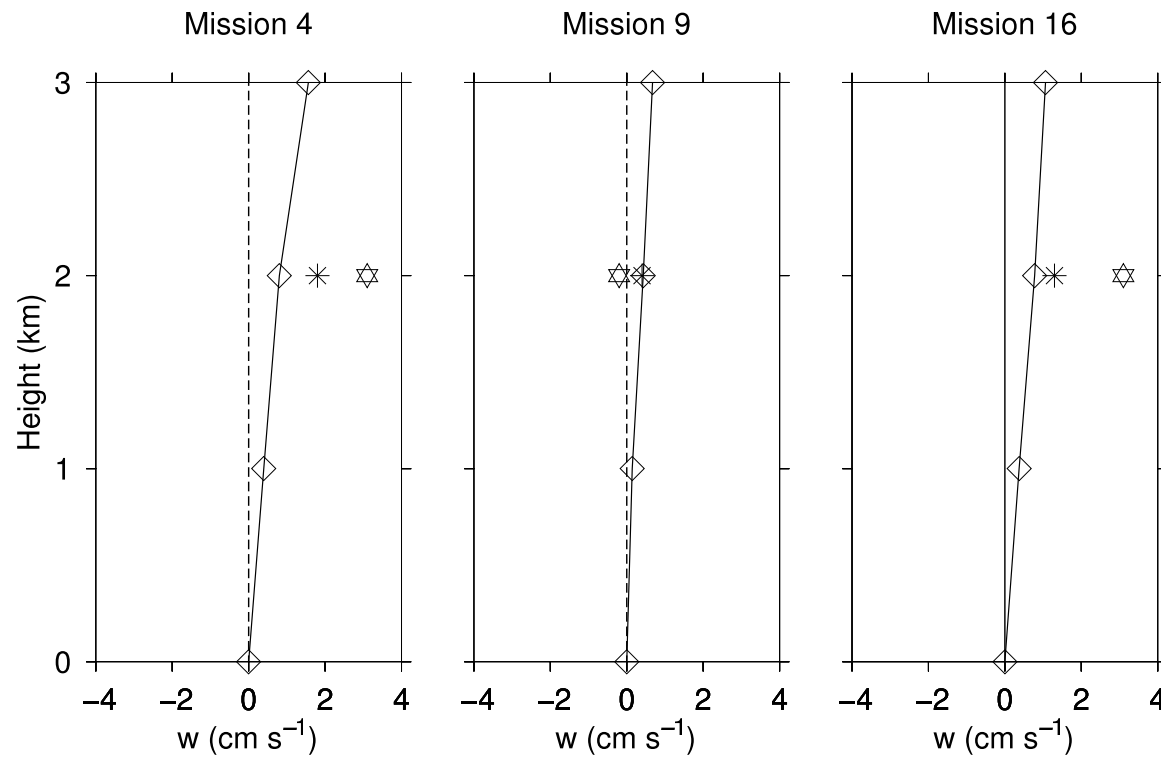


Figure 4b.

# Average Vertical Wind Velocity Weak Convective Systems.

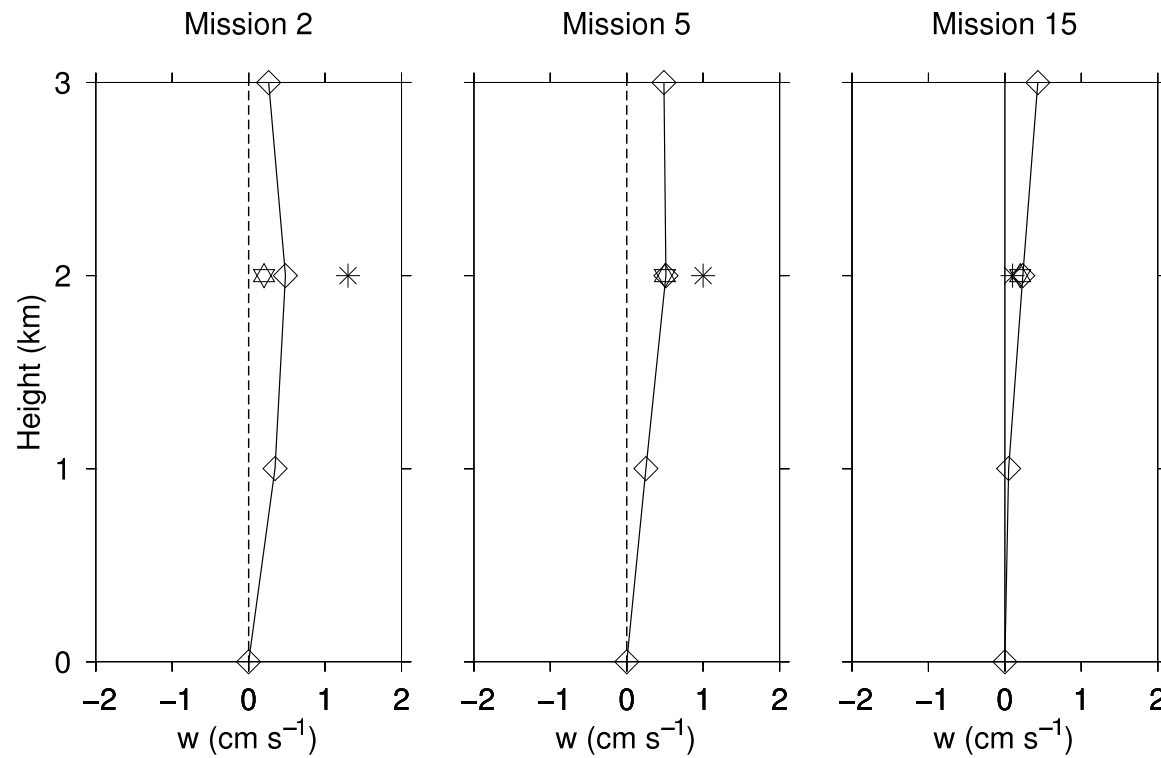


Figure 4c.

## **Figure 4.** Average Vertical Wind Velocity

- (a) Decaying Convective Systems.
- (b) Strong Convective Systems.
- (c) Weak Convective Systems.

These plots show three estimations for the average vertical wind velocity in the ITCZ box: Doppler radar (empty diamonds), dropsondes (starts), and aircraft in-situ (asterisks).

# Vertical Wind Shear Profiles Decaying Convective Systems

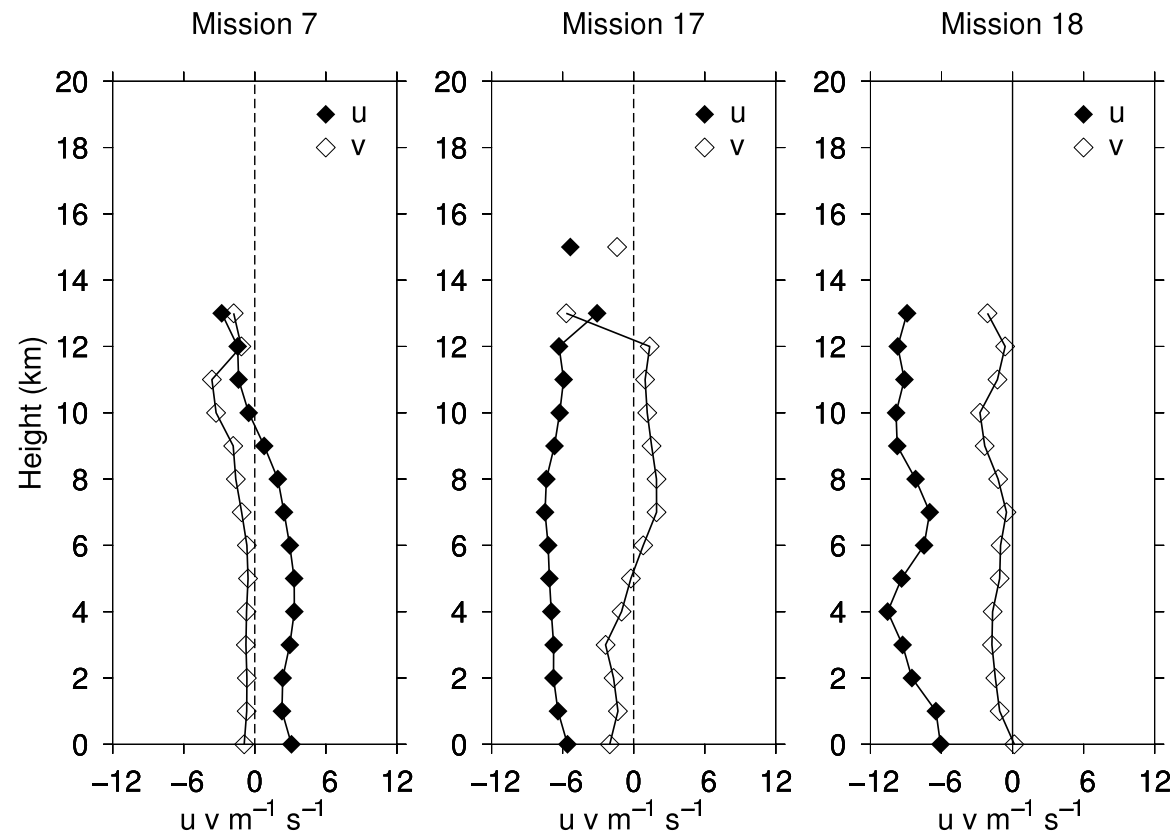


Figure 5a.

# Vertical Wind Shear Profiles

## Strong Convective Systems

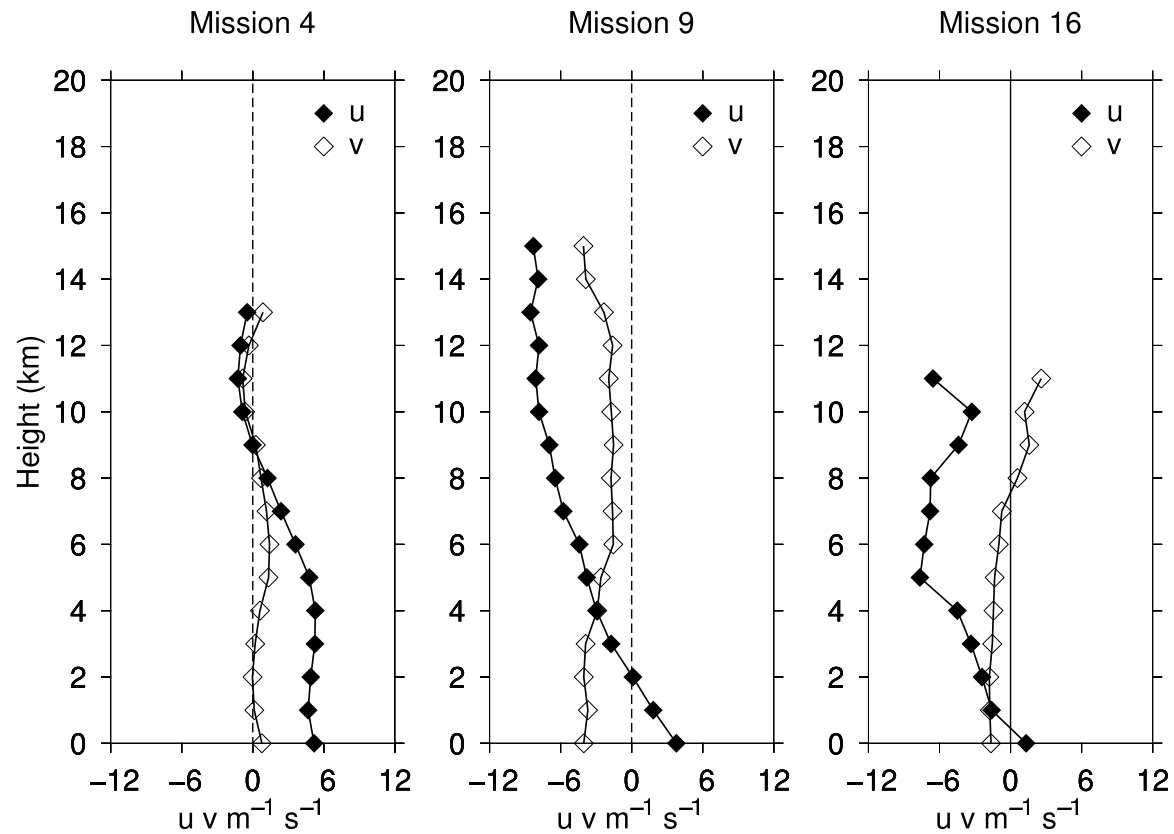


Figure 5b.

# Vertical Wind Shear Profiles

## Weak Convective Systems

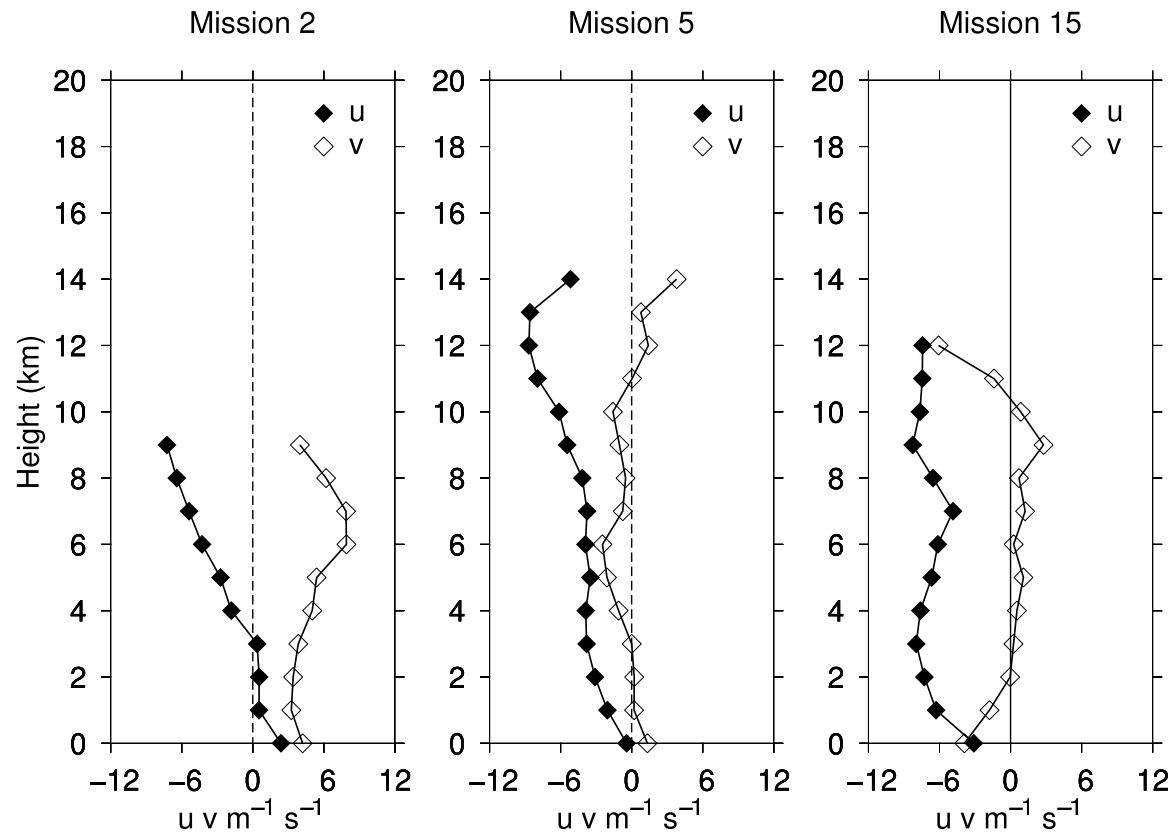


Figure 5c.

## **Figure 5.** Vertical Wind Shear Profiles

- (a) Decaying Convective Systems.
- (b) Strong Convective Systems.
- (c) Weak Convective Systems.

In these plots, filled diamonds show the east-west component of the average horizontal velocity (positive to the east), while empty diamonds show the north-south component (positive to the north).

# Cloud Top Distributions

## Decaying Convective Systems

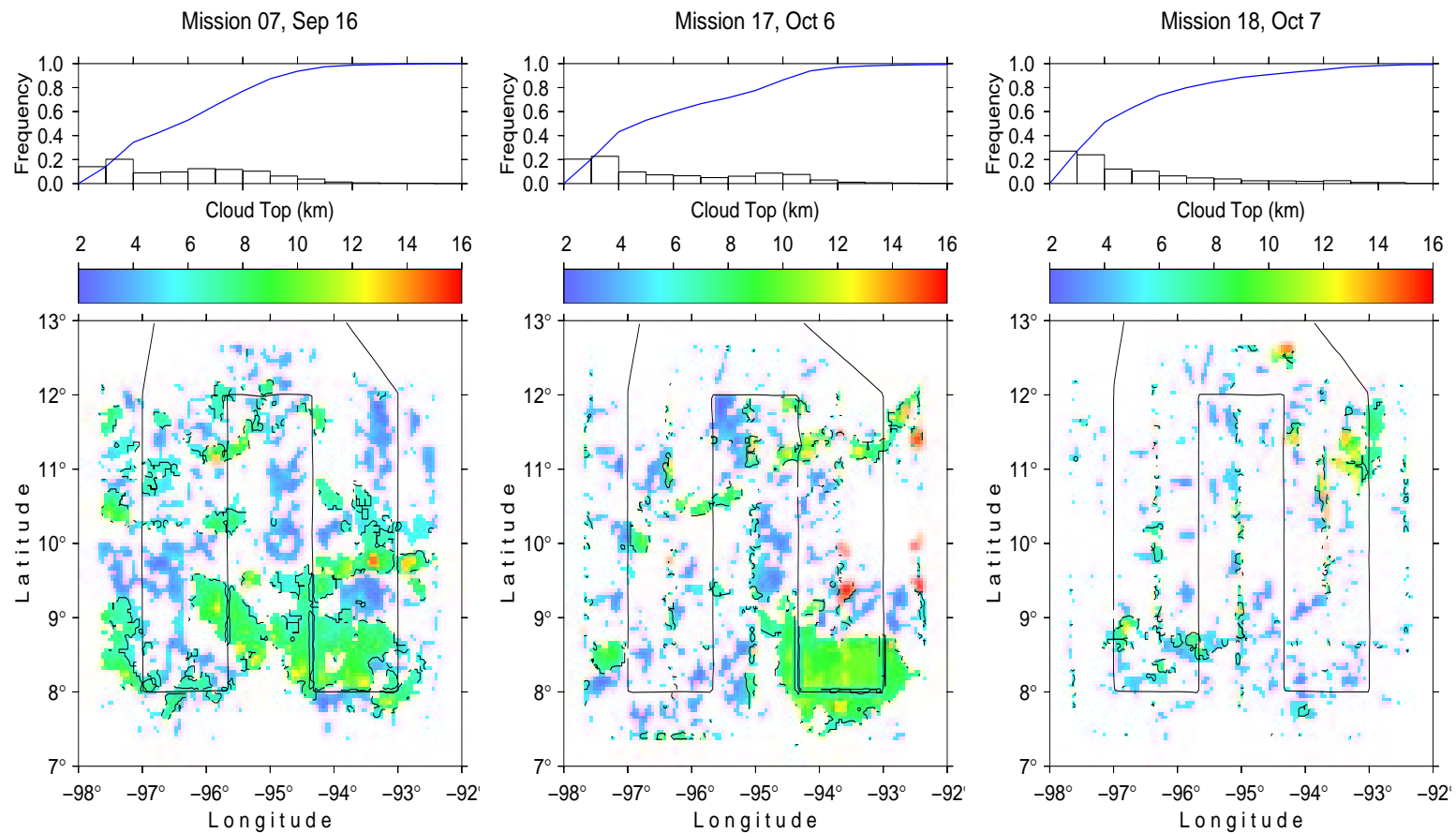


Figure 6a.

# Cloud Top Distributions

## Strong Convective Systems

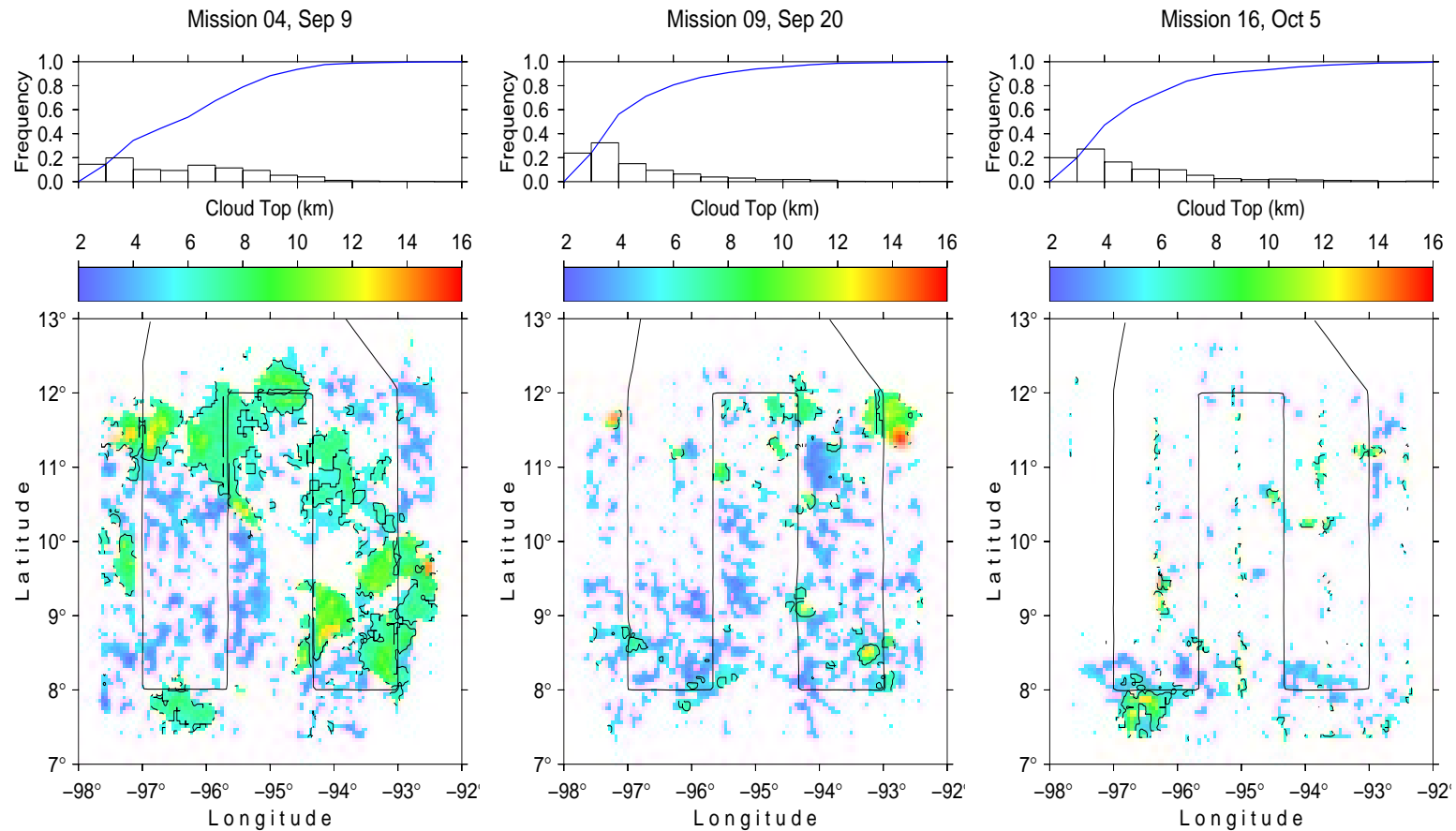


Figure 6b.

# Cloud Top Distributions

## Weak Convective Systems

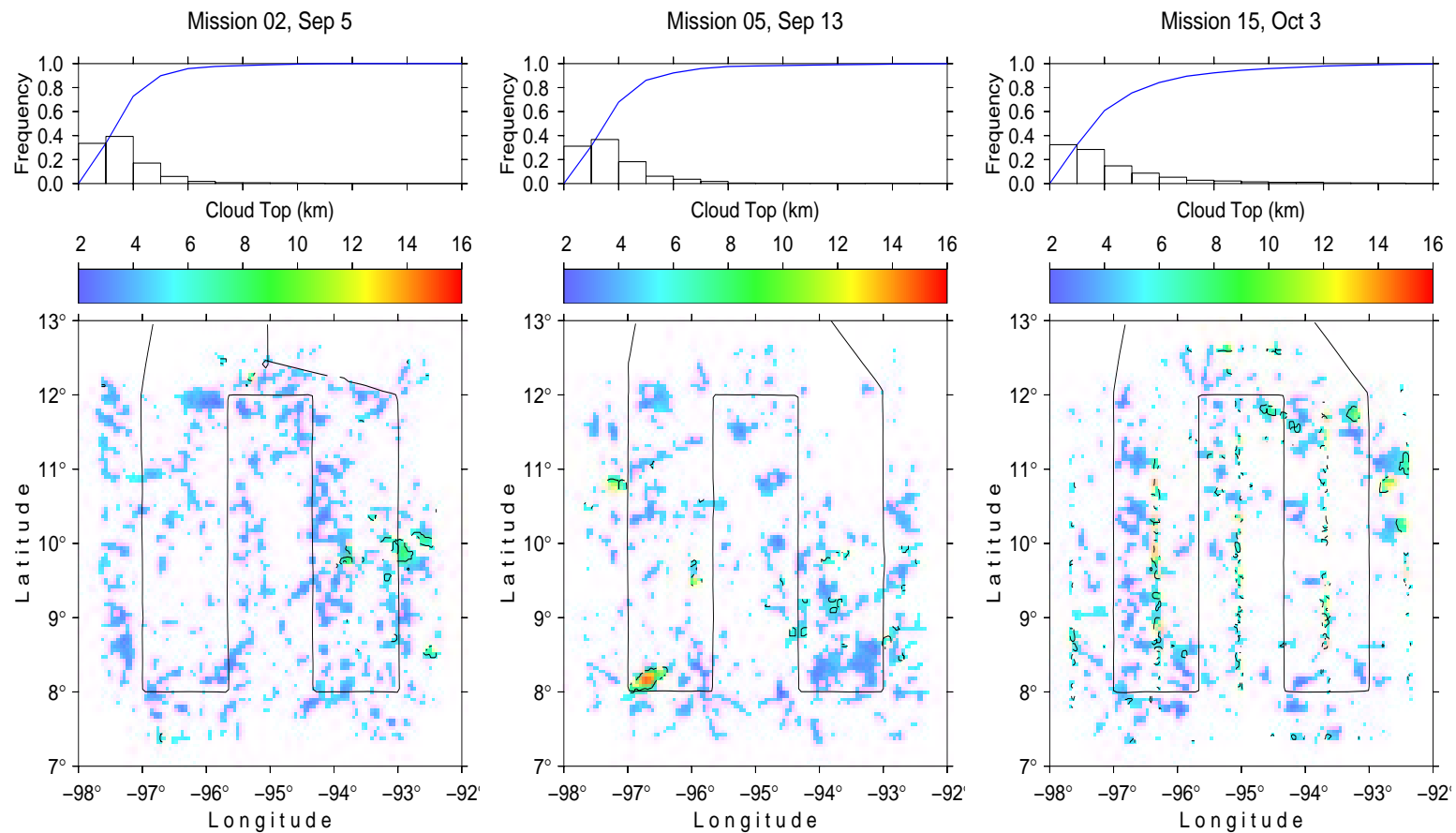


Figure 6c.

## **Figure 6.** Cloud Top Distributions

- (a) Decaying Convective Systems.
- (b) Strong Convective Systems.
- (c) Weak Convective Systems.

The upper sub-panels show the overall cloud top distribution observed during the mission, while lower sub-panels show how those cloud tops are spatially distributed over the ITCZ box. Cloud tops were determined based on reflectivity measurements as follows: at each grid point, continuity in the vertical was sought starting at two km height.

# Summary of Results

- Out of the nine missions analyzed, only three (Fig. 3b) exhibit strong mesoscale convective updrafts. Three more (Fig. 3a) also have mesoscale updrafts but smaller by a factor of two. The rest (Fig. 3c) exhibit mesoscale downdraft fluxes in the middle troposphere (4-8 km) – decaying convection.
- The strong convective cases and the two strong, but decaying cases (missions 7 and 17), are well correlated with the minimum of the 7-day oscillation seen by the satellite Fig. 2.
- The average horizontal winds computed from the Doppler radar, show that the strong convective cases have preferentially north-westerlies at low levels (Fig. 5b).
- Some indication of the spatial distribution of the clouds, as observed by the radar, is offered in the lower sub-panels of figure 6. The overall cloud-top distributions are shown in the upper sub-panels. They show that the majority of the clouds with cloud-top heights between 3 and 4 km. A broader peak, between 6-10 km, is also apparent in missions 4, 7, and 17.

# References

The essence of the technique used here to analyze Doppler radar data can be found in:

- D.J Raymond, C. López-Carrillo, and L. López Cavazos. Case Studies of Developing east Pacific easterly waves. *Quart. J. Roy. Meteor. Soc.*, **124**:2005-20034, 1998.

More extensive treatises are reported in:

- López Cavazos L. *Precipitation development in convective systems over the west Pacific warm pool*. PhD thesis, New Mexico Institute of Mining and Technology, Socorro, NM, 1995.
- López-Carrillo C. *Moisture interchange between clouds and environment in a tropical atmosphere*. PhD thesis, New Mexico Institute of Mining and Technology, Socorro, NM, 2001.
  - available on line <http://www.physics.nmt.edu/~clopez/>

Some of the recently added features are based on:

- David P. Jorgensen and Tom R. Shepherd. A Dual-Pulse Repetition Frequency Scheme for mitigating Velocity Ambiguities of NOAA P-3 Airborne Doppler Radar. *Journal of Atmospheric and Oceanic Technology.*, **17**:585-594, 2000.