

KINEMATICAL CHARACTERISTICS OF THE TROPICAL STORM JULIETTE

Carlos López Carrillo*, Dave Raymond
New Mexico Tech

* clopez@kestrel.nmt.edu

<http://www.physics.nmt.edu/~clopez/>

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Abstract

Tropical storm Juliette was observed by the NOAA WP3-43 research aircraft on September 21, 2001 in the east Pacific. In the following days it spun up to become a category 4 hurricane. As such, it posed a significant threat to the Mexican west coast. In this work, we document the characteristics of the vertical profiles of divergence and circulation observed during the tropical storm phase of hurricane Juliette. The winds were synthesized from radial velocities taken by the x-band Doppler radar mounted on board the WP3-43.

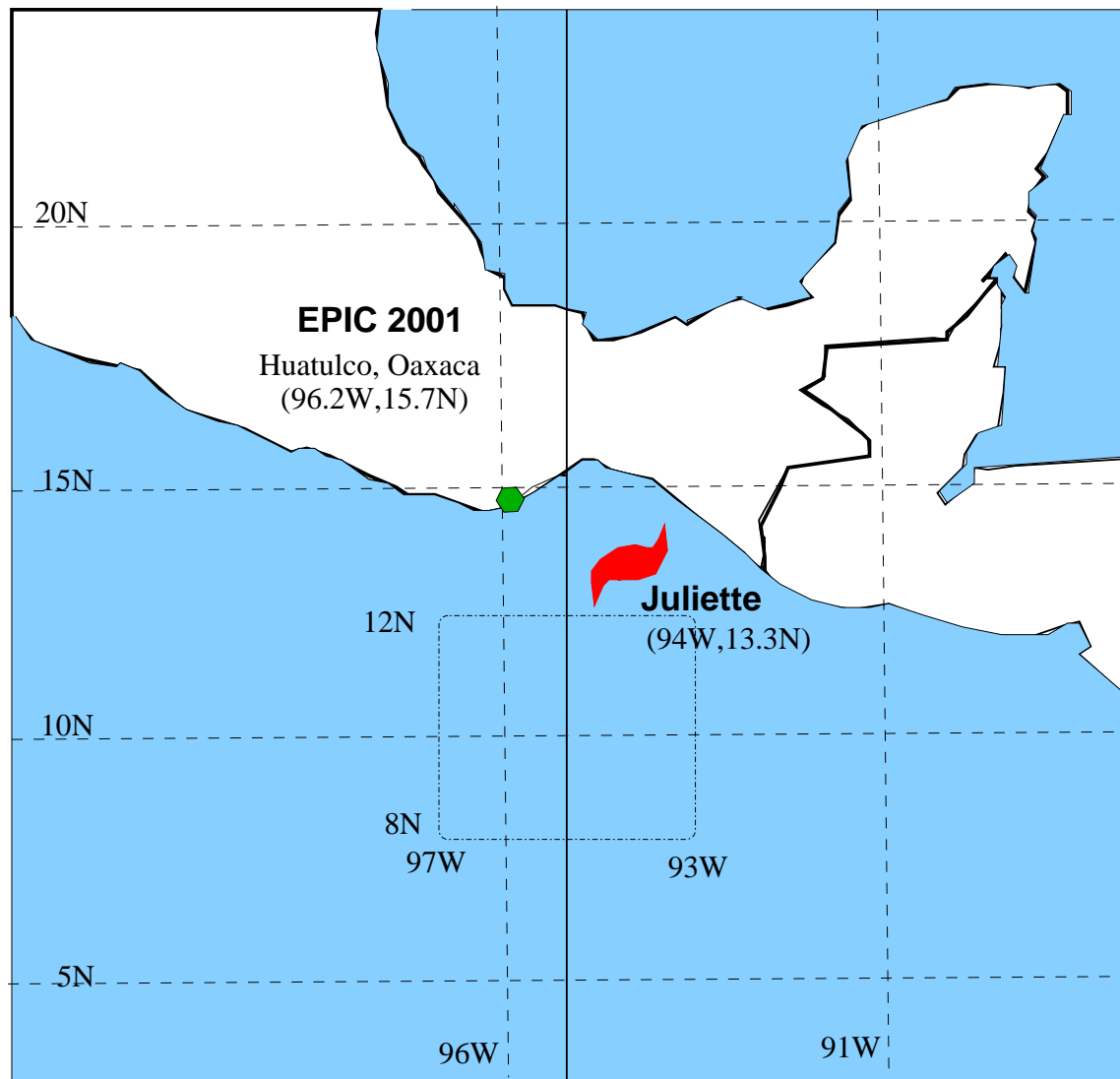


Figure 1.

Figure 1. Location of Juliette with respect to the EPIC-ITCZ box.

AirCraft Track

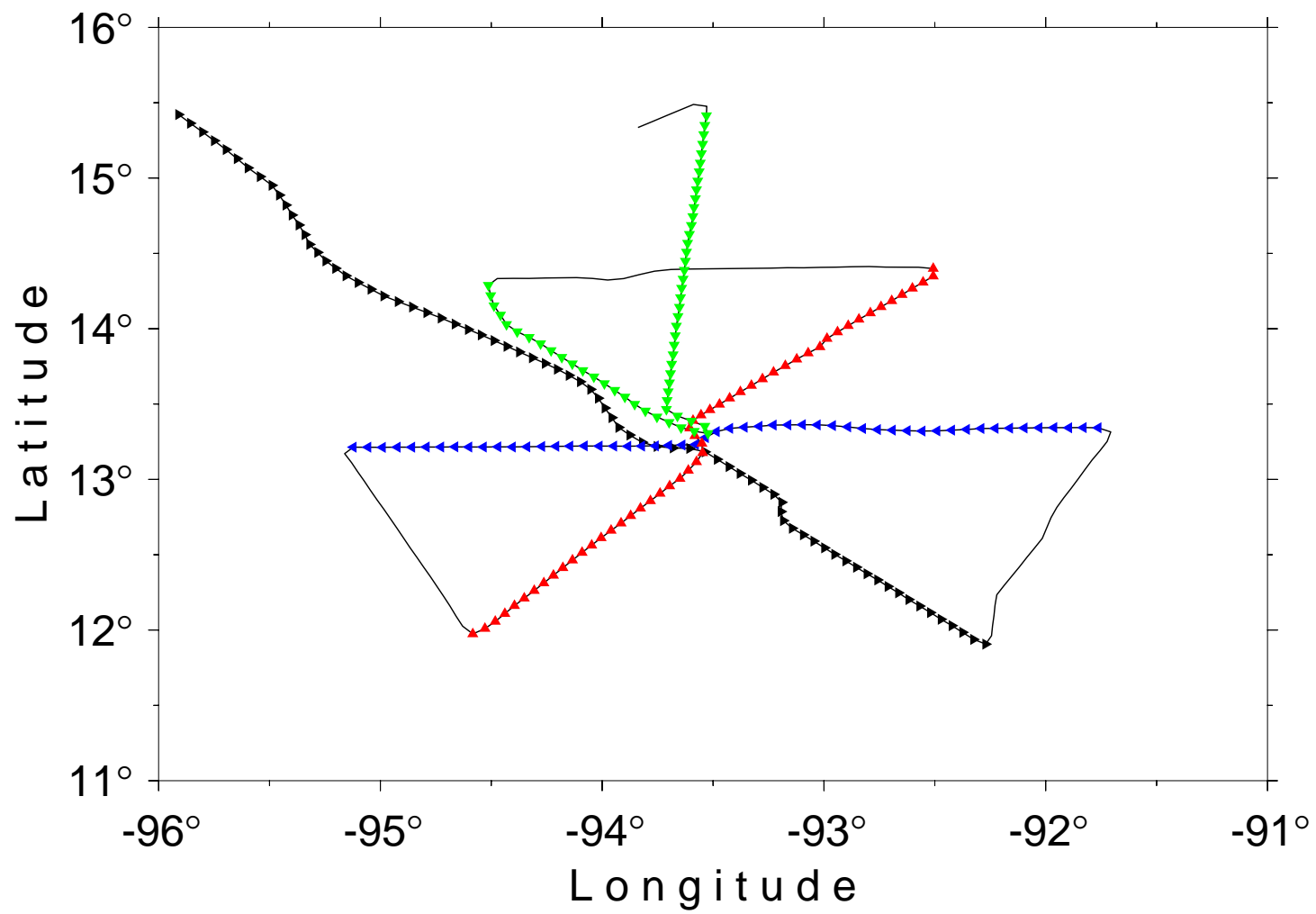


Figure 2.

Figure 2. Aircraft Track in the reference frame of the storm – a translation velocity of $(-8.44, 2.26)$ has been assumed.

Insitu Measurements

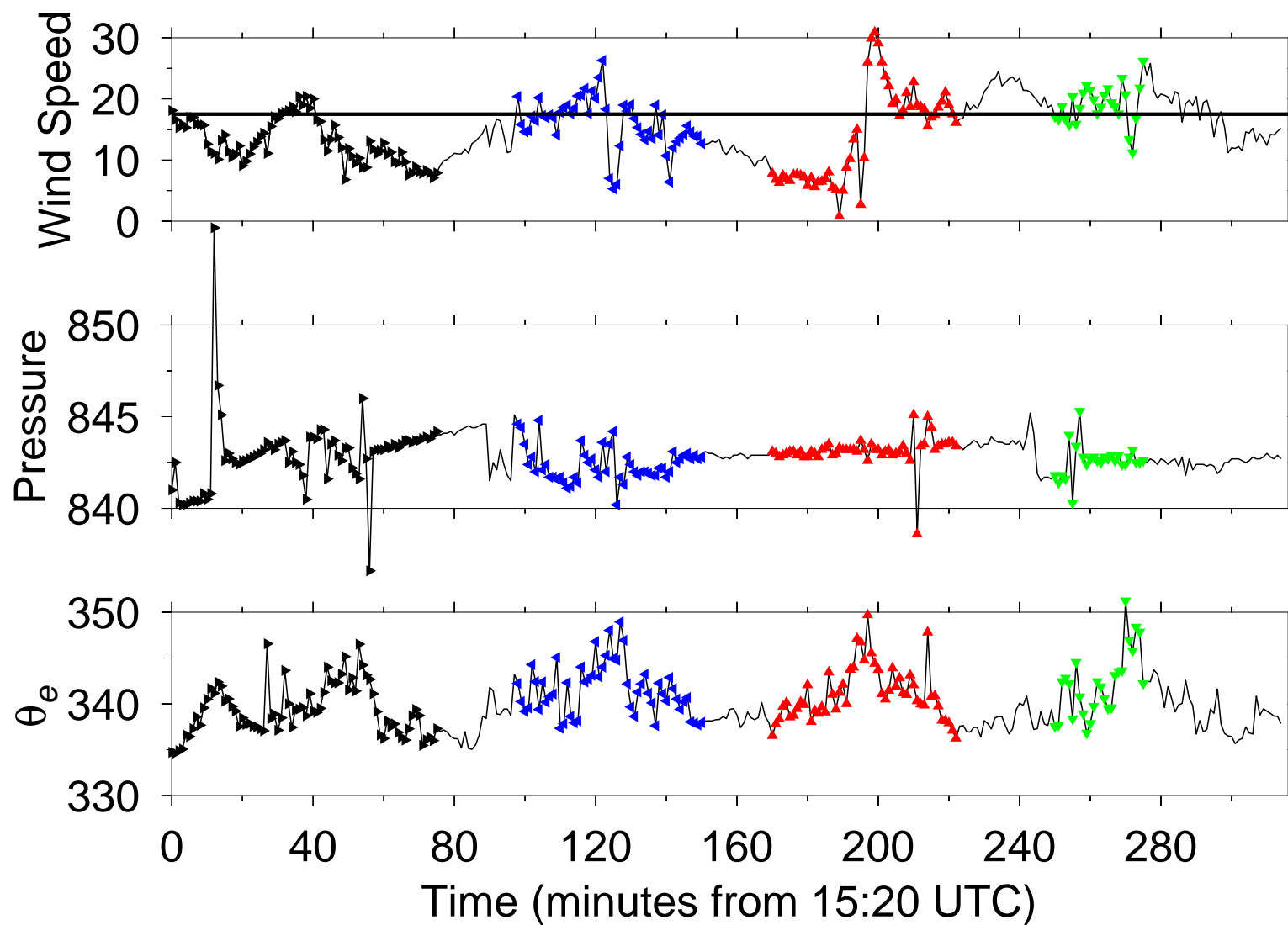


Figure 3.

Figure 3. Aircraft Insitu measurements. Panels show one-minute averages of Markings show measurements taken during the segments of the aircraft track shown in figure 2 – storm traverses.

M e s o S c a l e F i e l d s

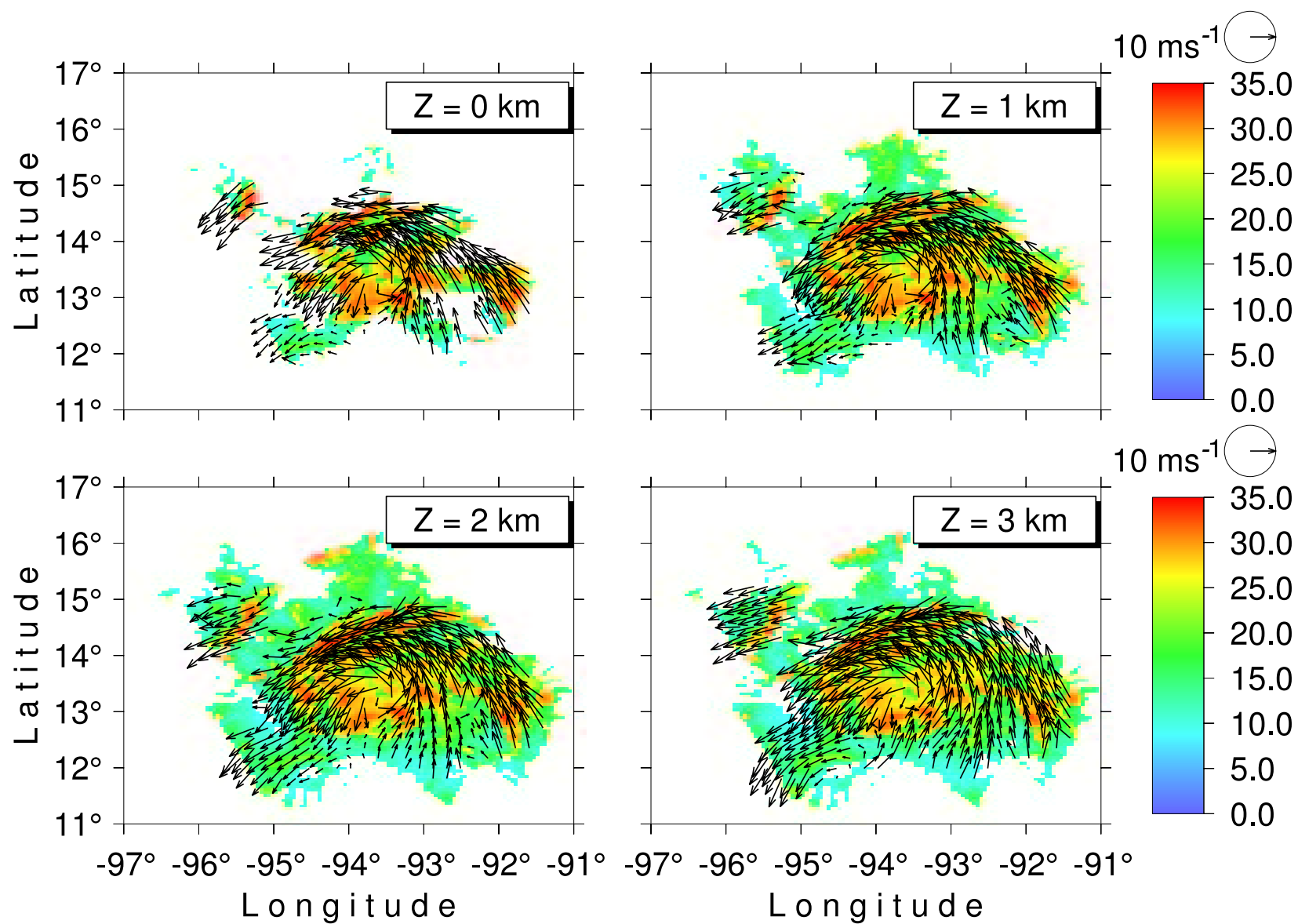


Figure 4a.

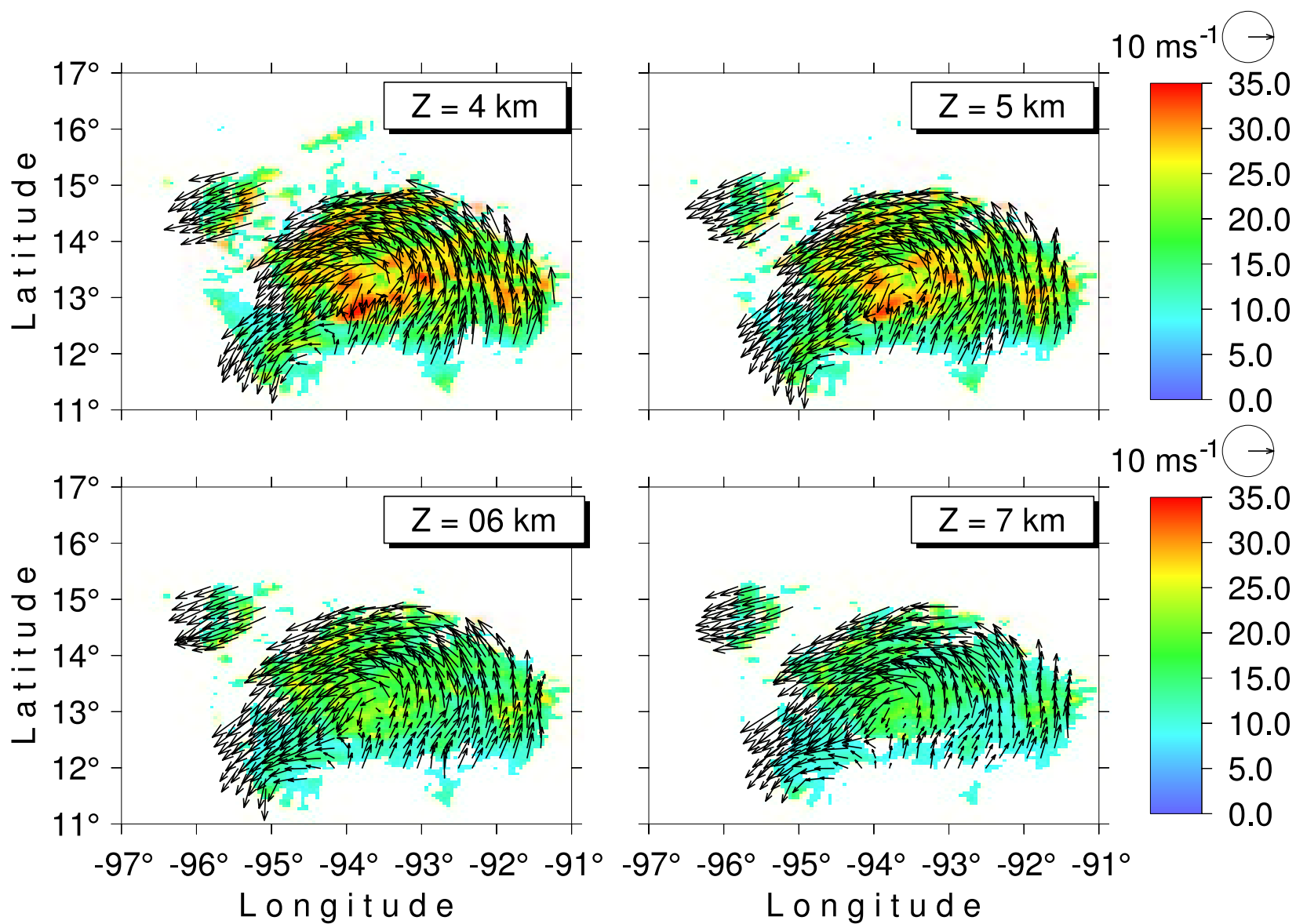


Figure 4b.

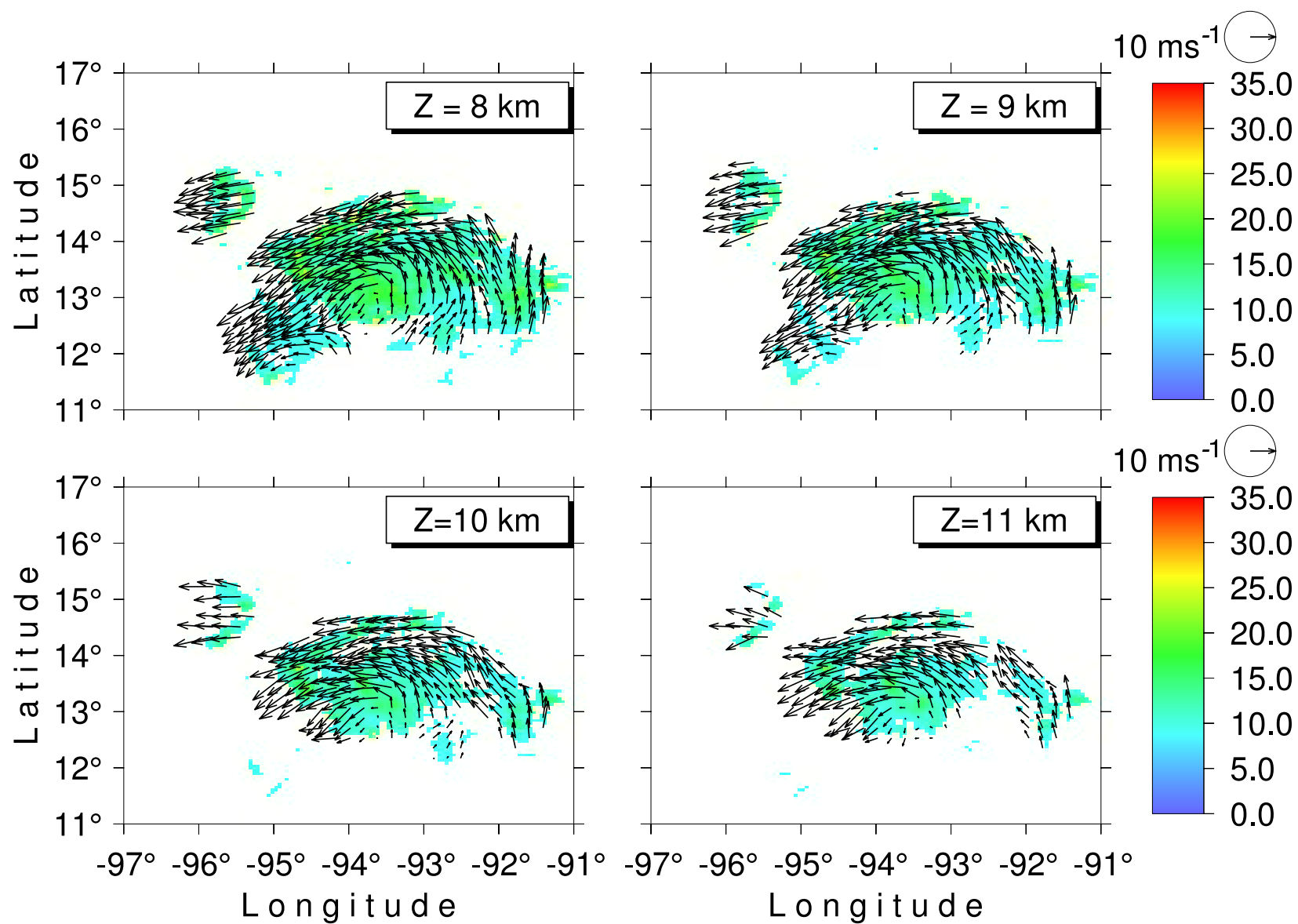


Figure 4c.

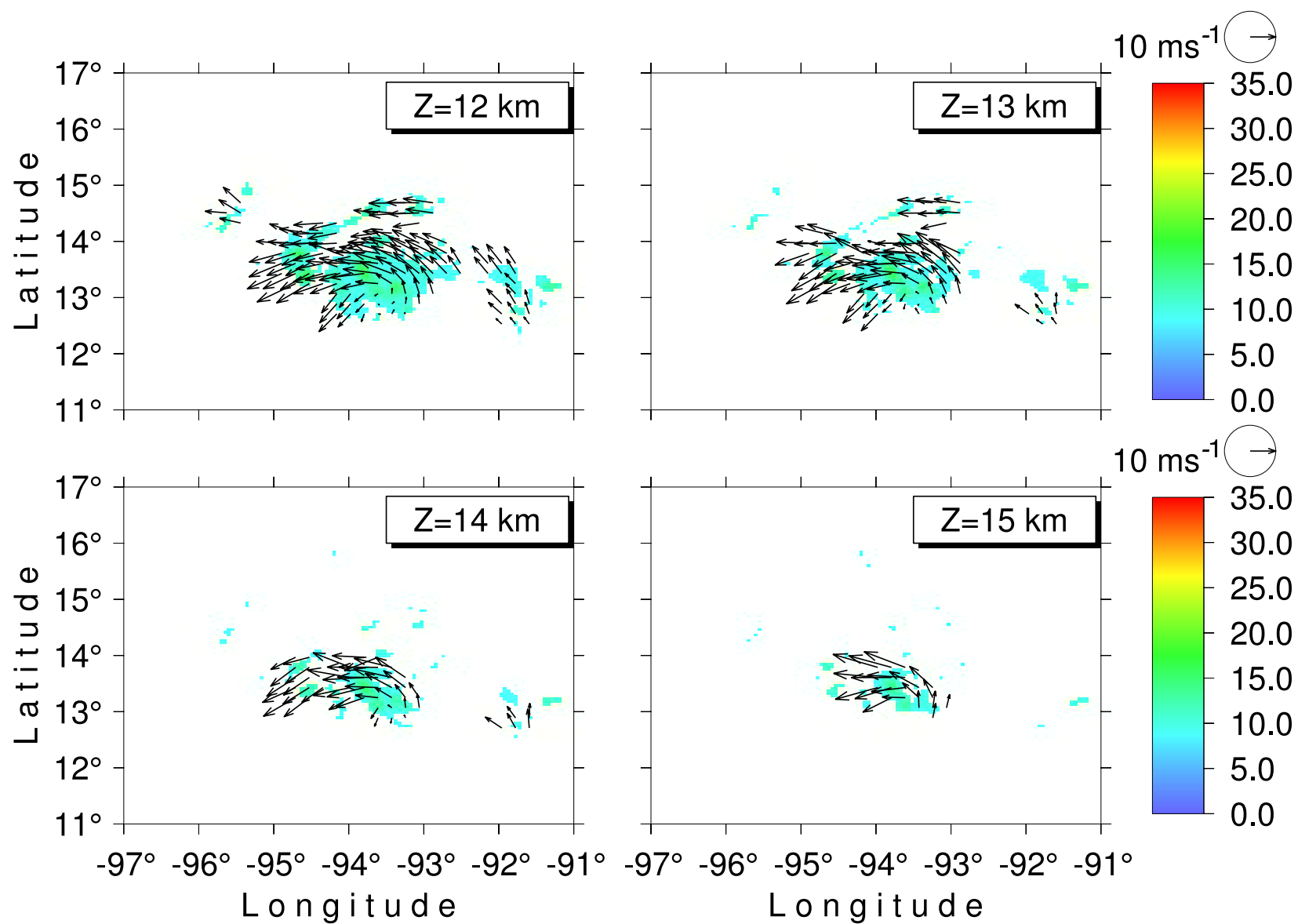


Figure 4d.

Figure 4. Horizontal slices of reflectivity (dbz) and mesoscale velocity fields (ms^{-1}) synthesized from Doppler radar measurements taken by the NOAA-WP3-43.

V e r t i c a l P r o f i l e s

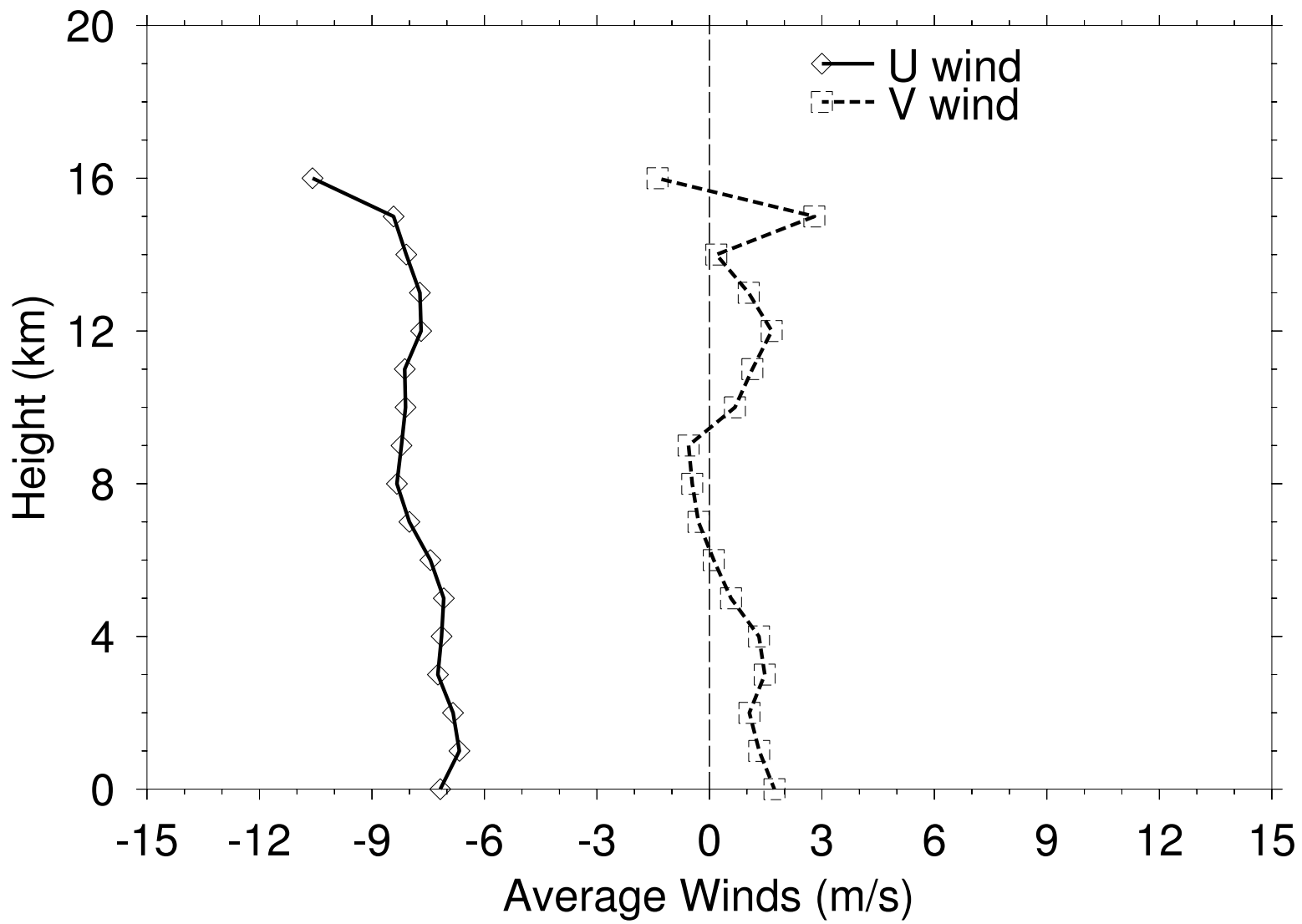


Figure 5a.

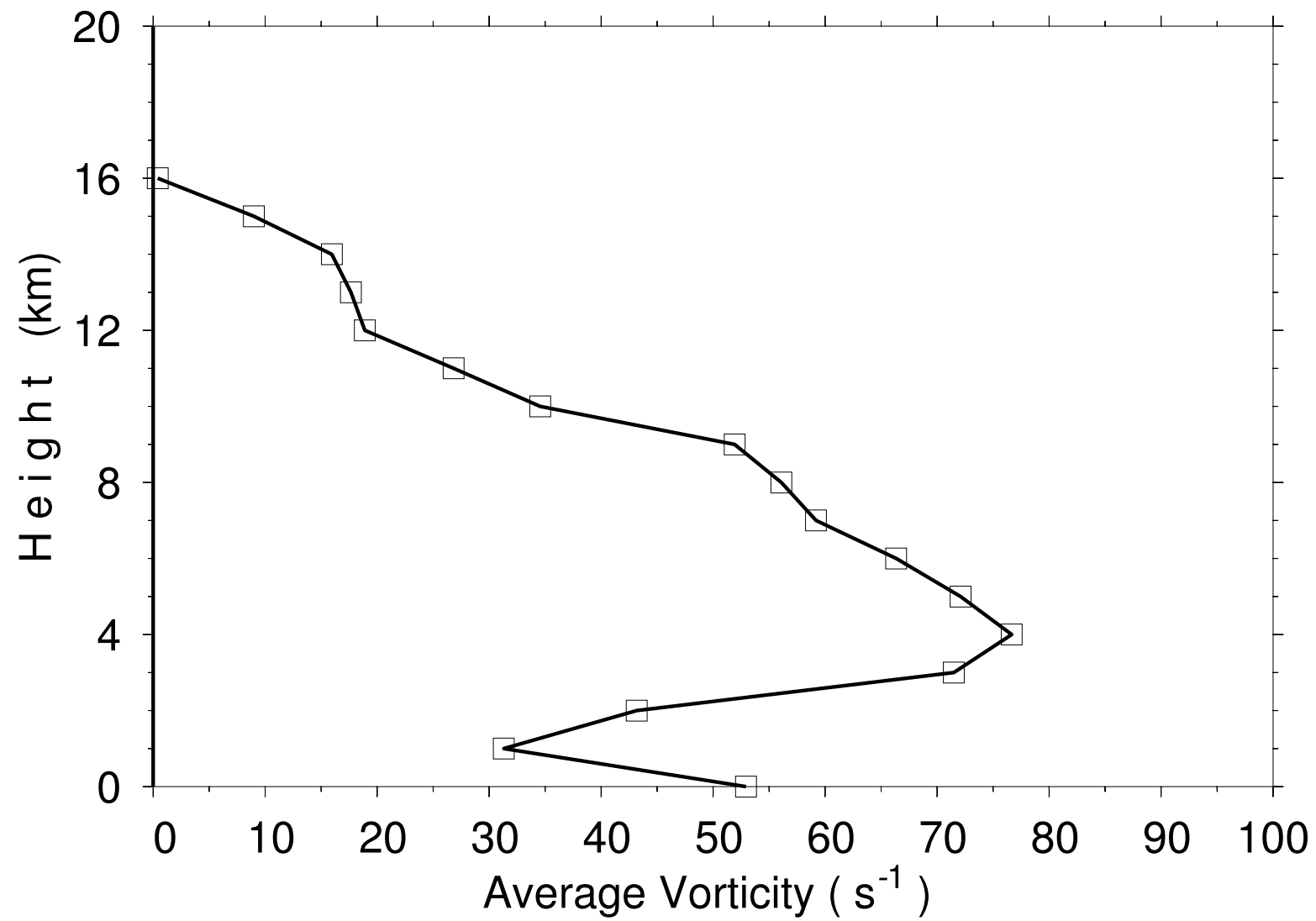


Figure 5b.

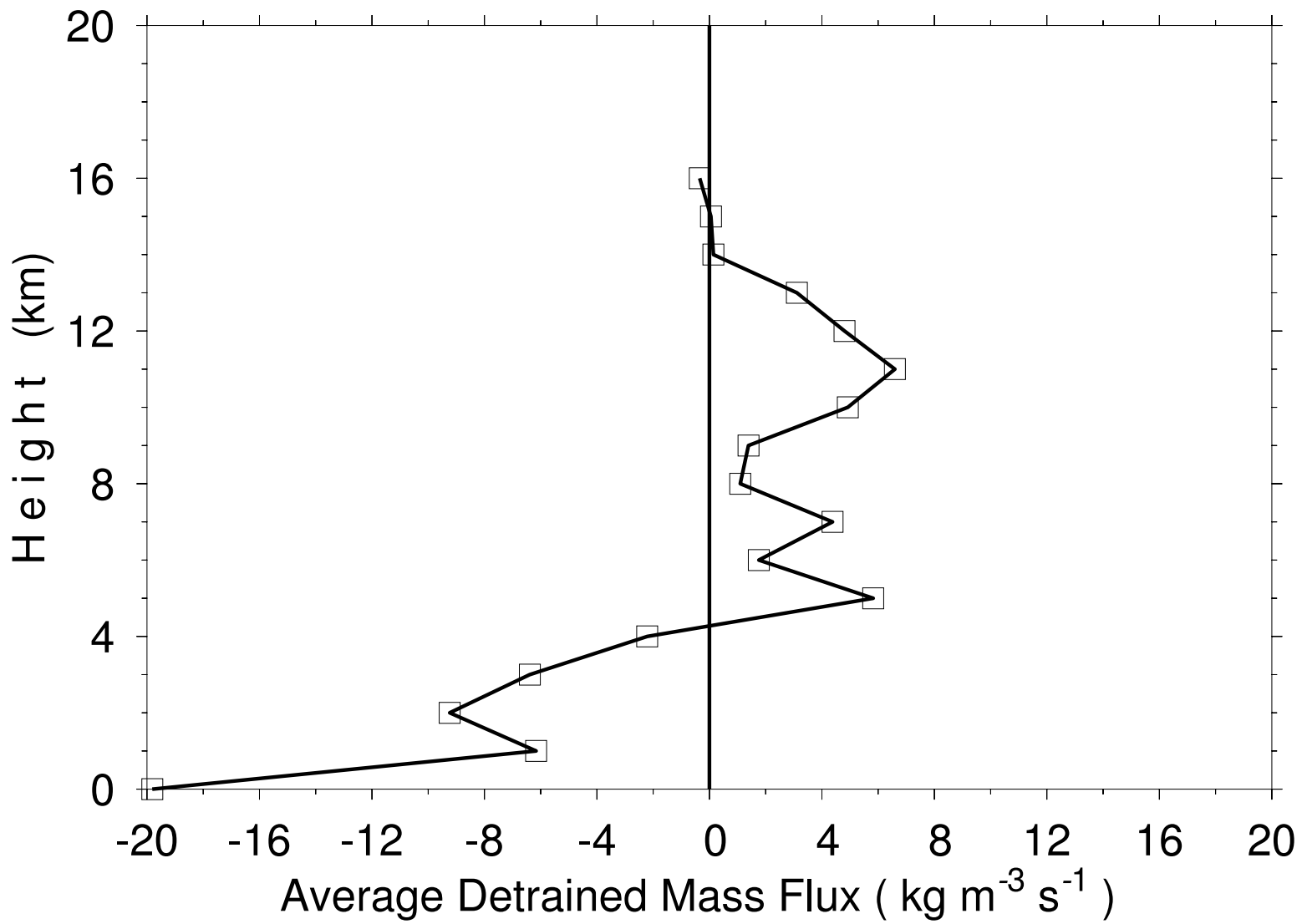


Figure 5c.

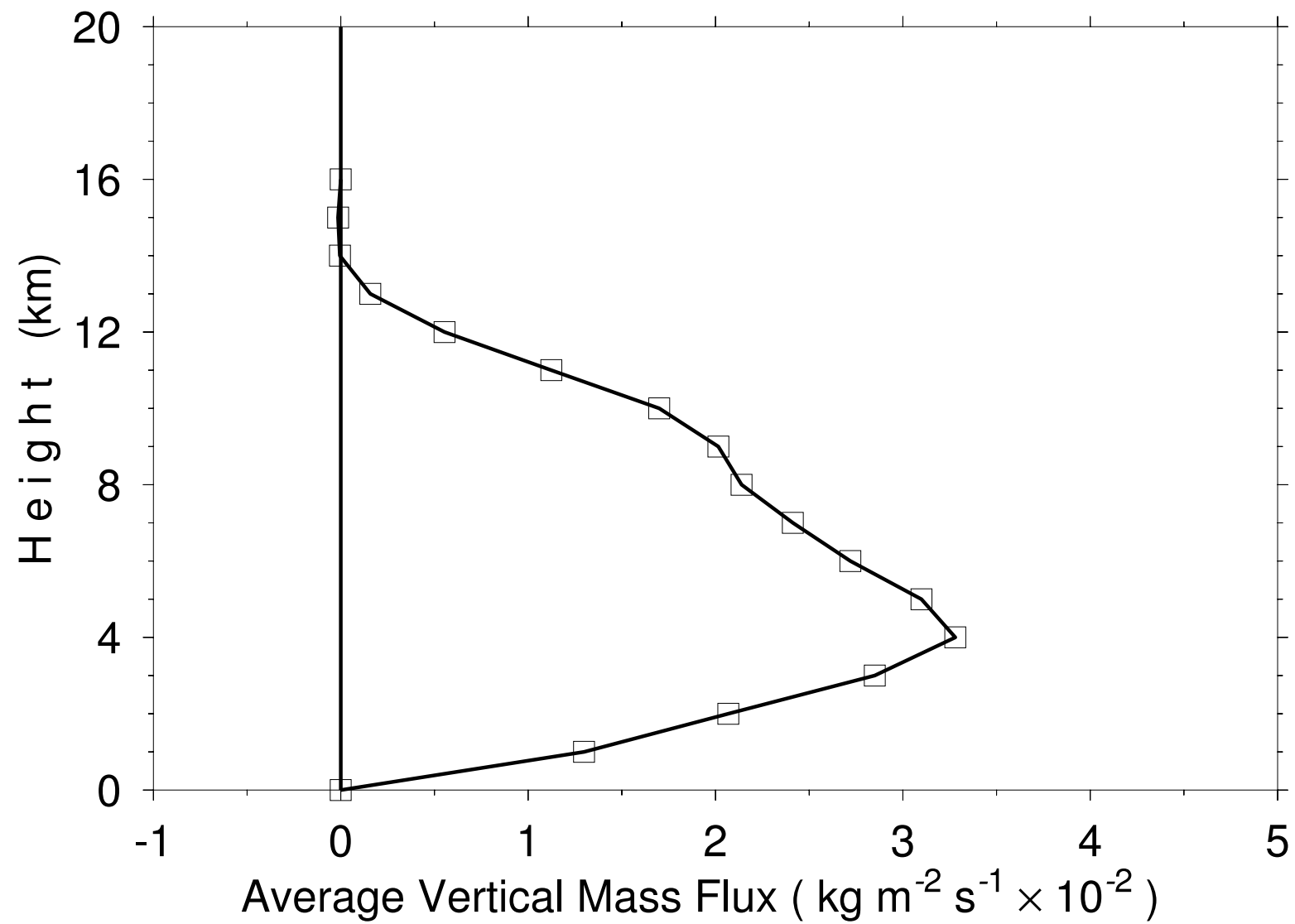


Figure 5d.

Figure 5. Radar-Derived Vertical profiles

(a) Average Wind Velocity. (b) Average Vorticity. (c) Average Horizontal Mass Divergence. (d) Average Vertical mass Flux

S p i n T e n d e n c y

Vertical component of the Vorticity equation (Haynes and McIntyre, 1987)

$$\frac{\partial \zeta_a}{\partial t} + \vec{\nabla} \cdot \vec{Z} = 0 \quad (1)$$

where

$$\vec{Z} = \zeta_a \vec{v}_h + \partial \vec{v}_h / \partial P \times \hat{k} w + \hat{k} \times \vec{F} \quad (2)$$

The circulation tendency is obtained integrating over the area of the system, (Raymond, Lopez and Lopez, 1997)

$$\frac{d \Gamma_a}{d t} = \Delta - \tau \quad (3)$$

where

$$\Delta = - \int_A \vec{\nabla} \cdot (\zeta_a \vec{v}_h) ds \quad (4)$$

$$\tau = \int_A \vec{\nabla} \cdot (\hat{k} \times \vec{F}) ds \quad (5)$$

From Radar measurements, ζ_a and \vec{v}_h are readily available. An estimate of the vertically averaged drag force at the surface is

$$\vec{F} = -C_d |\vec{v}_h| \vec{v}_h / D \quad (6)$$

where $C_d \approx 1.5 \times 10^{-3}$, and D is the depth of the inflow layer.

Δ	τ	$d\Gamma_a/dt$

References

- Haynes, P.H. and McIntyre, M.E. On the evolution of vorticity and potential vorticity in the presence of diabatic heating and frictional or other forces. *J. Atmos Sci.*, **44**:828-841, 1987.
- D.J Raymond, C. López-Carrillo, and L. López Cavazos. Case Studies of Developing east Pacific easterly waves. *Quart. J. Roy. Meteor. Soc.*, **124**:2005-2034, 1998.
- 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.