3.2.2 GRAVITY WAVES IN SEVERE WEATHER

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During 1983, the Urbana radar operated essentially every day gathering stratospheric and mesospheric gravity-wave data, for two hours centered around local noon. This paper presents some preliminary analyses of those data.

Figure 1 shows plots of the noon gravity-wave amplitude for April - December 1983, derived by subtracting the hourly mean for each day and averaging the residual minute-by-minute data. Considerable variability is seen from day to day and with season in both the stratosphere and mesosphere. Stratospheric data have been revised using the Tukey algorithm (BOWHILL and GNANALINGAM, 1986).

Annual average climatology is shown in Figure 2 between the stratosphere and mesosphere. On average, the rms gravity-wave velocity is about 15x larger in the mesosphere than in the stratosphere.

Figure 3 shows the relationship between the stratospheric and mesospheric gravity-wave amplitudes on a daily basis. Correlation between them is fairly strong, indicating that much of the variation in mesospheric wave amplitude is produced by gravity waves propagating from the stratosphere.

With a view to determining the role of severe weather in producing gravity waves, two tests were made. In the first, the wind speed measured at two nearby radiosonde stations, Peoria and Salem, was correlated with the stratosphere gravity-wave intensity at Urbana. Figures 4 and 5 show the results for May and August 1983. Although the gravity-wave intensity fluctuated greatly from day to day, there is little if any correlation with the stratospheric wind speed. This suggests that orographic forcing is not a factor in generating gravity waves in Urbana.

On the other hand, Figure 6 shows a scatter plot of gravity-wave intensity vs the heights of the highest cloud tops associated with precipitation within 100 miles of Urbana. A clear correlation is found between cloud top heights exceeding 20,000 ft and an increased gravity-wave amplitude in the stratosphere.

Two examples are now shown of the correlation of gravity-wave intensity with radar summary charts. Figure 7 shows a set of summary charts for May 7, 1983, with strong convective activity centered over Urbana starting at 1235 CST. Figure 8 shows an explosive growth of stratospheric gravity waves shortly following 1230 CST, suggesting that convective activity was the cause of the gravity waves seen.

On the other hand, Figure 9 shows summary charts for September 9, 1983, with no convective activity within about 1000 km of Urbana, but Figure 10 shows strong wave activity in the upper stratosphere. It is noticeable that there is a strong wind shear between 12 and 13.5 km, evidenced by the change in mean level of the line-of-sight velocity measurements. The fact that the Urbana antenna is tilted at an angle of 1.6 deg to the southeast suggests the existence of a strong shear in the southeasterly velocity just above 12 km, and this is probably responsible for the generation of the gravity waves seen at altitudes up to 22.5 km.

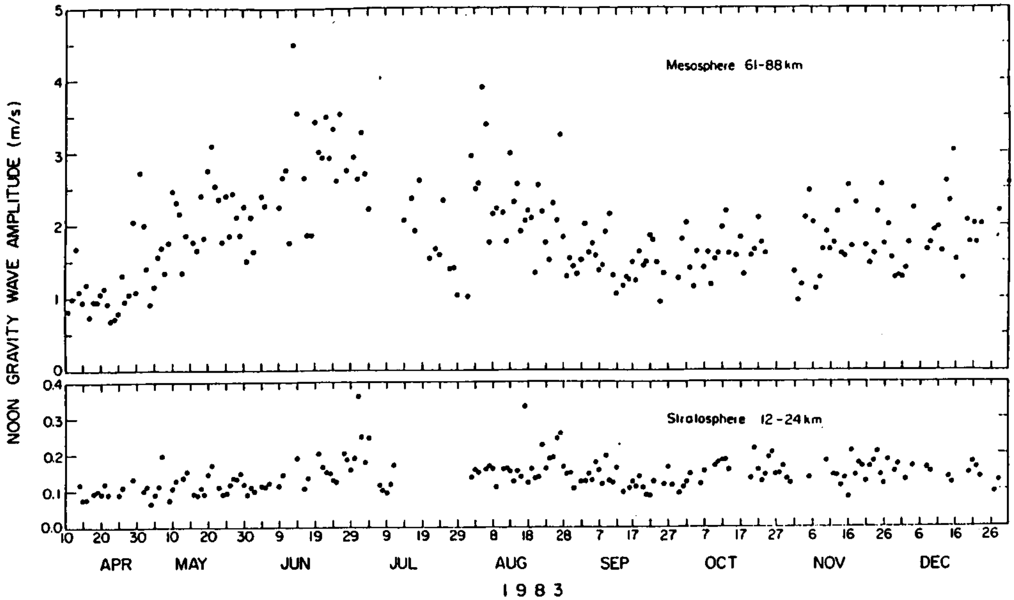

Figure 1. Daily variation of noon gravity-wave amplitude in the mesosphere and stratosphere.

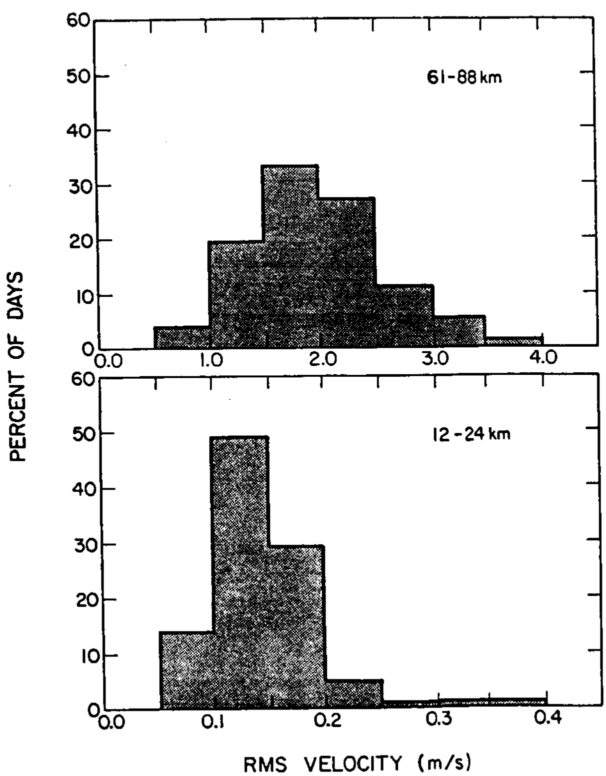

Figure 2. Annual average climatology for the the stratospheric and mesospheric vertical gravity-wave velocity, periods less than 1 hour.

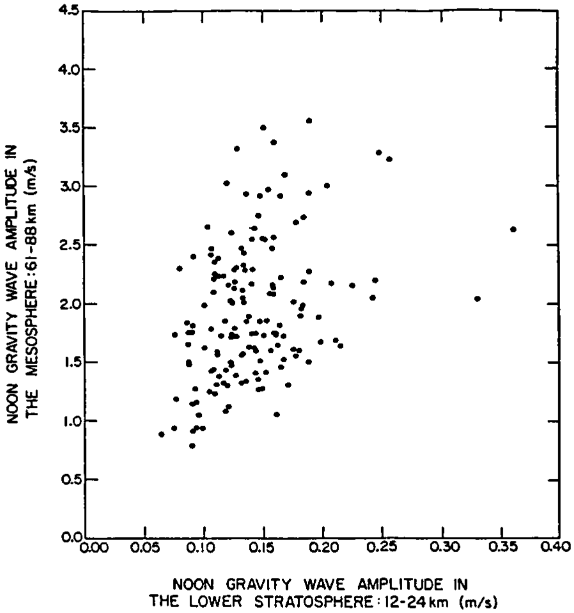

Figure 3. Scatter diagram illustrating the correlation between gravity-wave activity in the lower stratosphere and mesosphere.

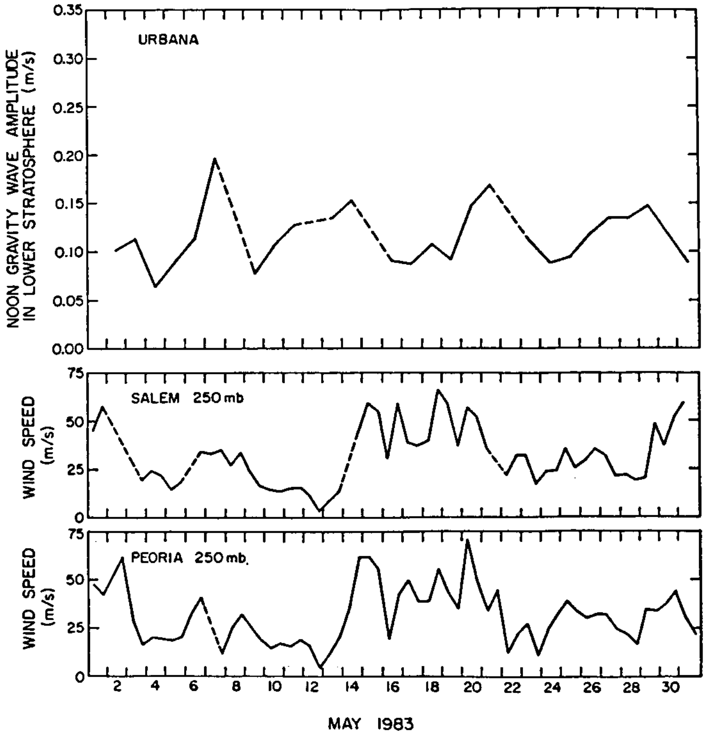

Figure 4. Relationship between stratospheric gravity-wave amplitude and wind speed: May, 1983.

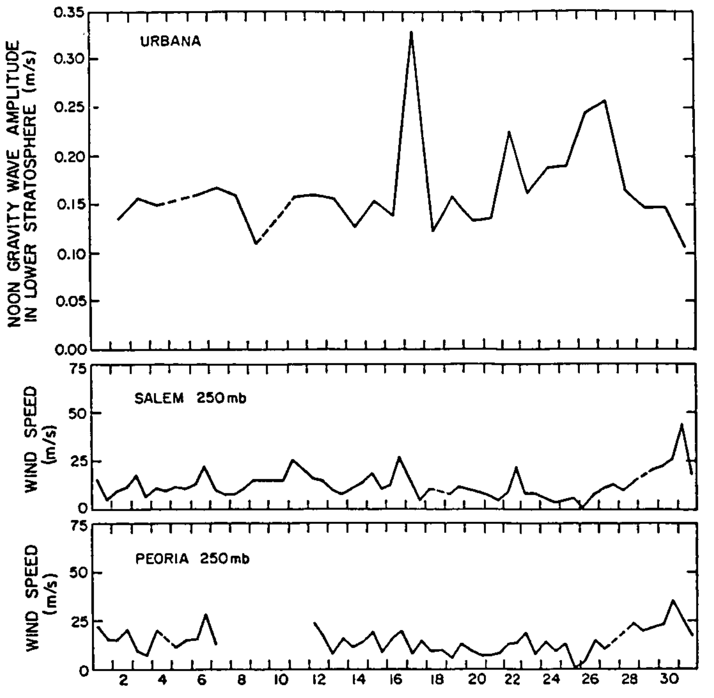

Figure 5. Relationship between stratospheric gravity-wave amplitude and wind speed: August 1983.

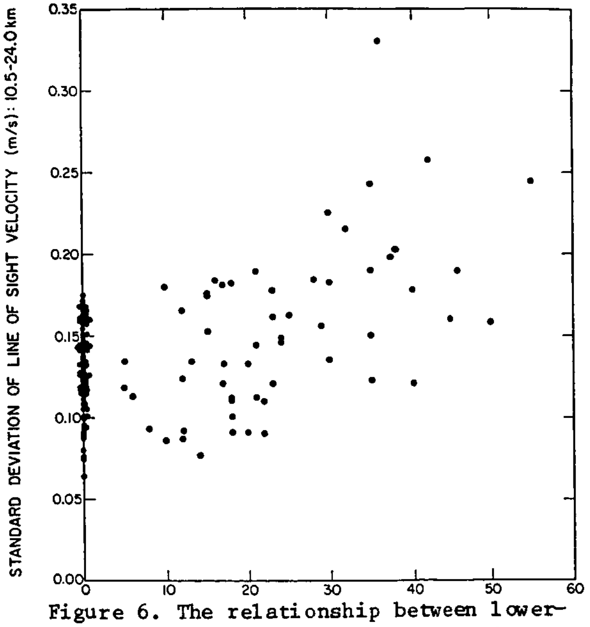

Figure 6. The relationship between lower-stratospheric gravity-wave velocity and highest cloud-top height within 100 miles of Urbana (thousands of feet).

MAY 07, 1983

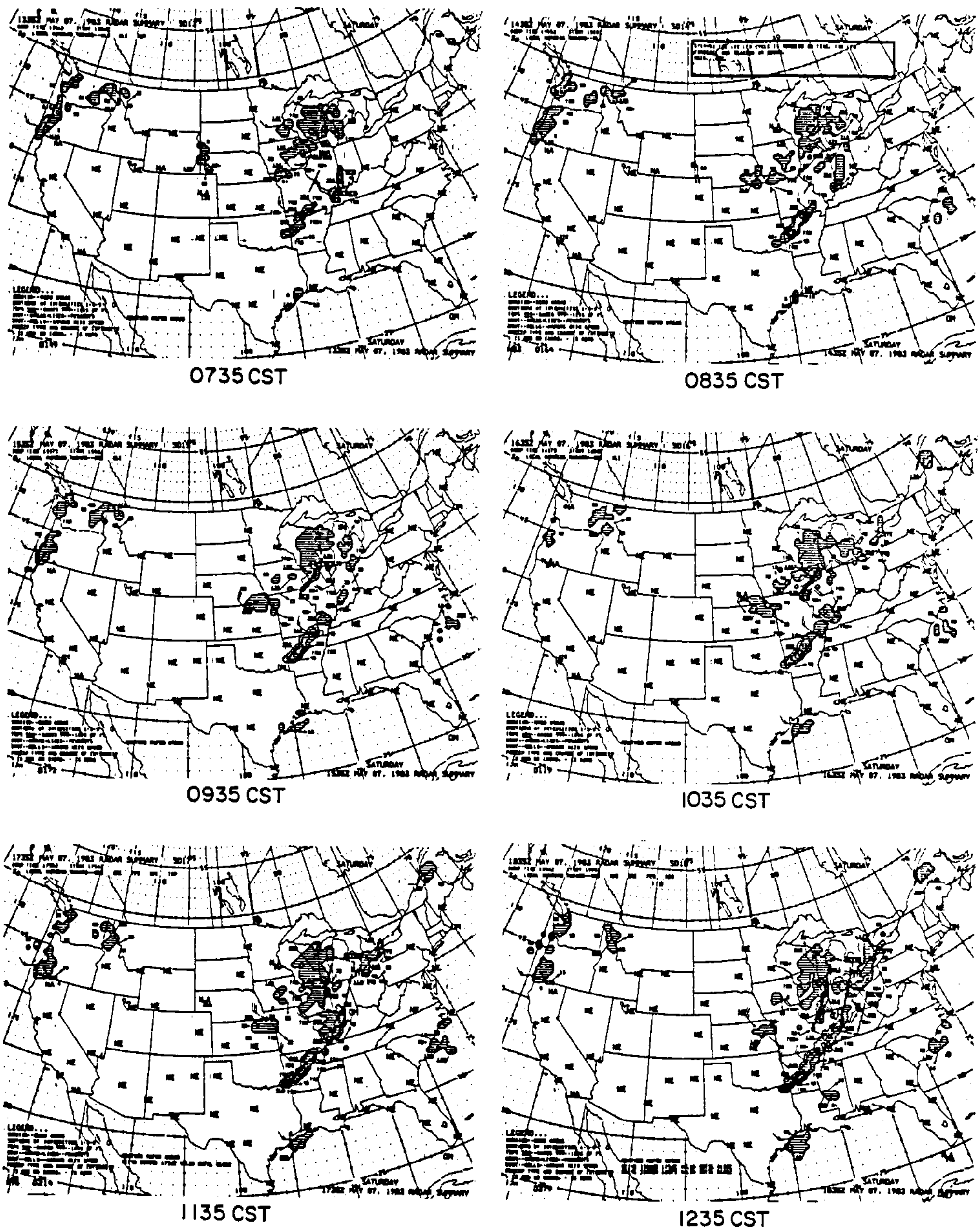

Figure 7. Radar summary chart showing strong convective activity over Urbana at 1235 CST on May 7, 1983.

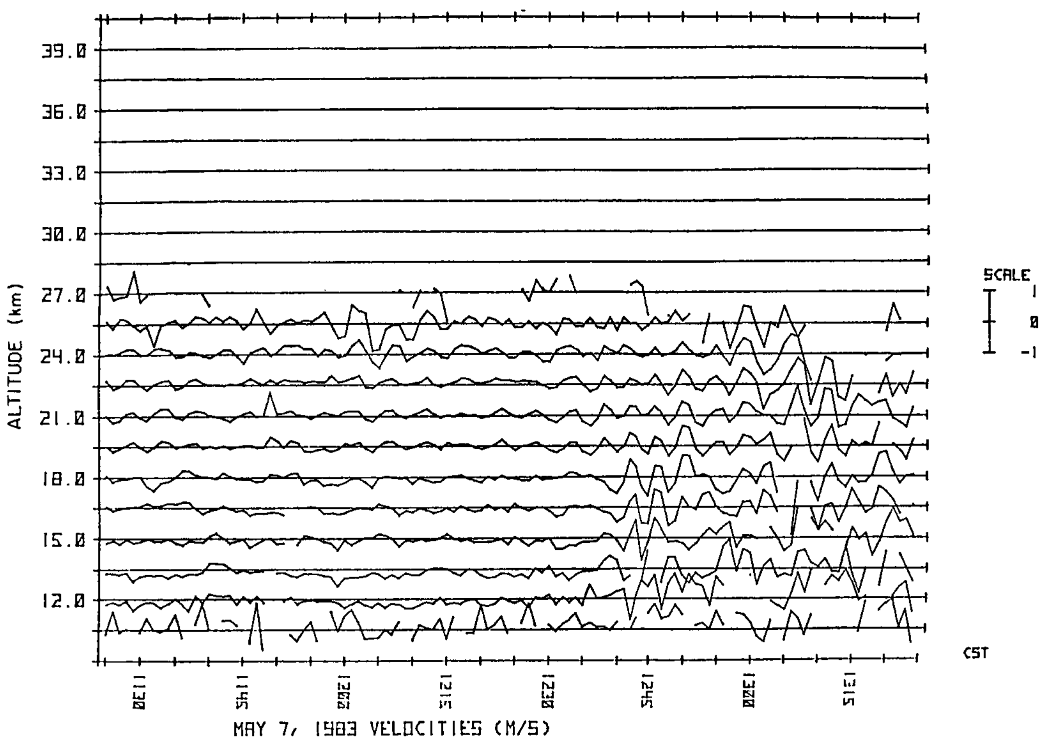

Figure 8. Vertical velocity plot over Urbana on May 7, 1983, showing an explosive growth of gravity waves at 1235 CST.

SEPTEMBER 09, 1983

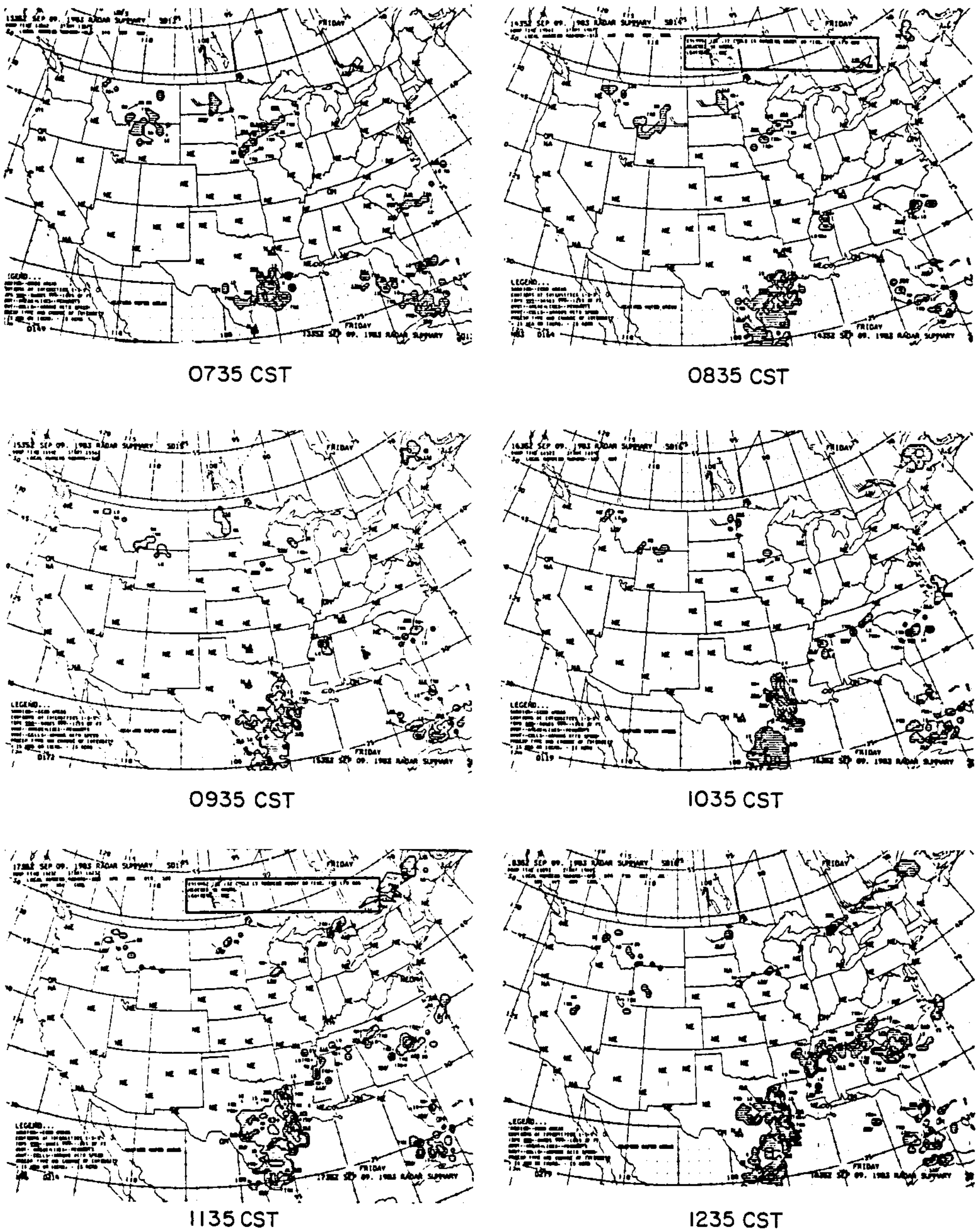

Figure 9. Radar summary charts showing lack of convective activity over Urbana on September 9, 1983.

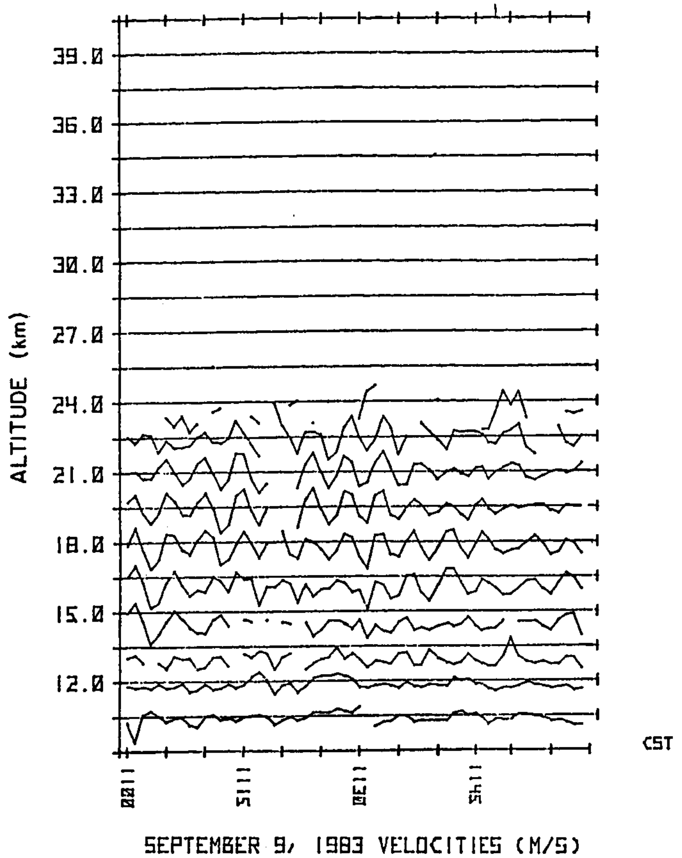

Figure 10. Strong gravity-wave activity over Urbana on September 9, 1983.

Reference

S. A. Bowhill, and S. Gnanalingam (1986), The Tukey algorithm for enhancing MST radar data, this volume.