ANALYSES OF SURFACE PRESSURE PERTURBATIONS DURING VTMX.

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During the VTMX field campaign, the NOAA's Air Resources Laboratory Atmospheric Turbulence and Diffusion Division (ATDD) measured surface pressure perturbations on a six sensor array depicted in Figure 1. The array was located at the PNL site in Midvale. Sampling frequency was 1 Hz. Data were

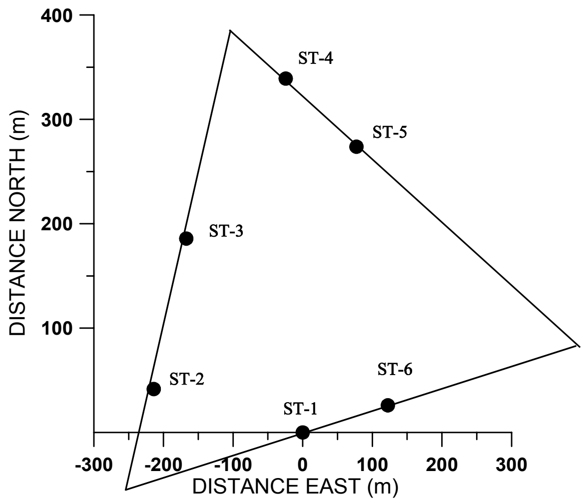

Figure 1 VTMX microbarograph array.

collected from 4 to 31 October, 2000. The primary purpose for the pressure measurements is the analysis of gravity waves and their interactions with turbulence.

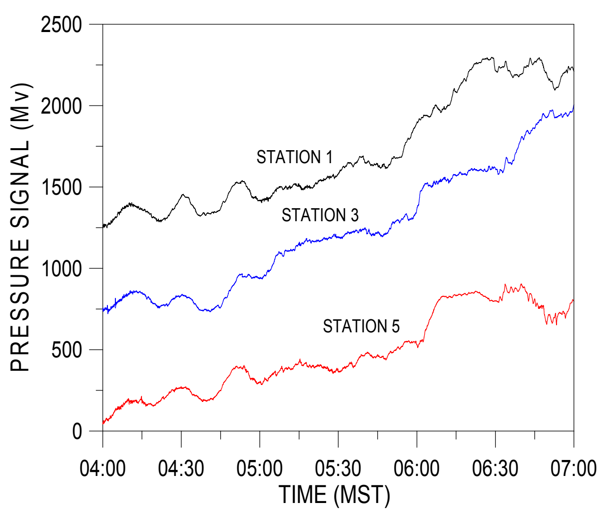

Figure 2 Raw data on 25 October 2000.

This extended abstract describes the analysis techniques and presents some initial results. These analyses are illustrated using data for the period 04:00 to 07:00 MST on 25 October, 2000. Figure 2 plots the raw data recorded at stations 1, 3, and 5. Between 04:00 and 05:00, large amplitude pressure perturbations with periods of about 20 minutes are seen. Between 05:00 and 06:00, these wave-like disturbances give way to

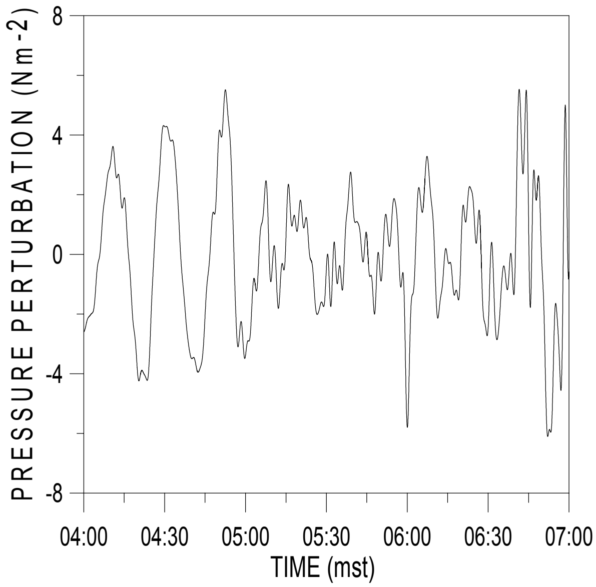

Figure 3 Band-passed (2-30 minute) pressure data for station 3 on 25 October 2000.

high-frequency perturbations which may be due to turbulence. These fluctuations are superimposed on an approximately linear trend of increasing pressure. A clearer picture of the disturbances is obtained by band-pass filtering the signals. Figure 3 plots the 2 to 30 minute band-passed filtered and calibrated data taken at station 3. The wave-like oscillations between 04:00 and 05:00 appear to grow in amplitude, but after 05:00

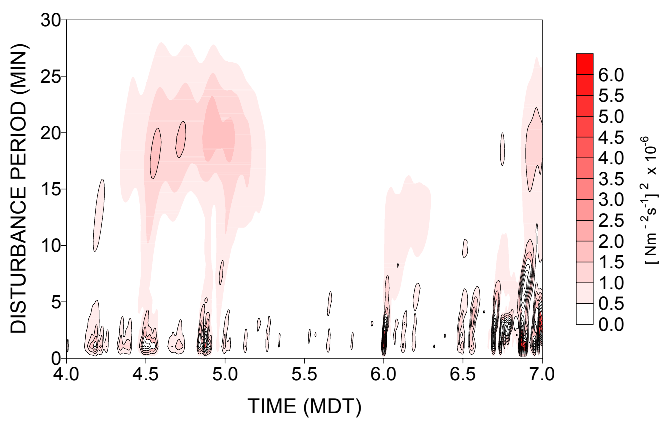

Figure 4 Wavelet analysis for station 3.

the amplitude is reduced, and higher-frequency signals appear. This behavior may be an example of wave growth and subsequent breakdown into turbulence.

A wavelet analysis reveals the energy content (wavelet energy density) of the pressure signals as functions of frequency and time. Figure 4 shows the wavelet analysis diagram for the period 04:00 to 07:00 25 October for station 3. High-frequency, *i.e.*, fluctuations with periods less than five minutes exist throughout the observation period. These high-frequency signals contain most of the disturbance energy density. They appear intermittently, and may be associated with turbulence events. The wave-like signal with period of about 20 minutes has noticeable energy density between 04:30 and 05:00. Wavelet analysis is a robust tool for identifying wave-like disturbances. However, aside from frequency the analysis gives no further information on the characteristics of the disturbances, *i.e.* propagation speed, direction, and

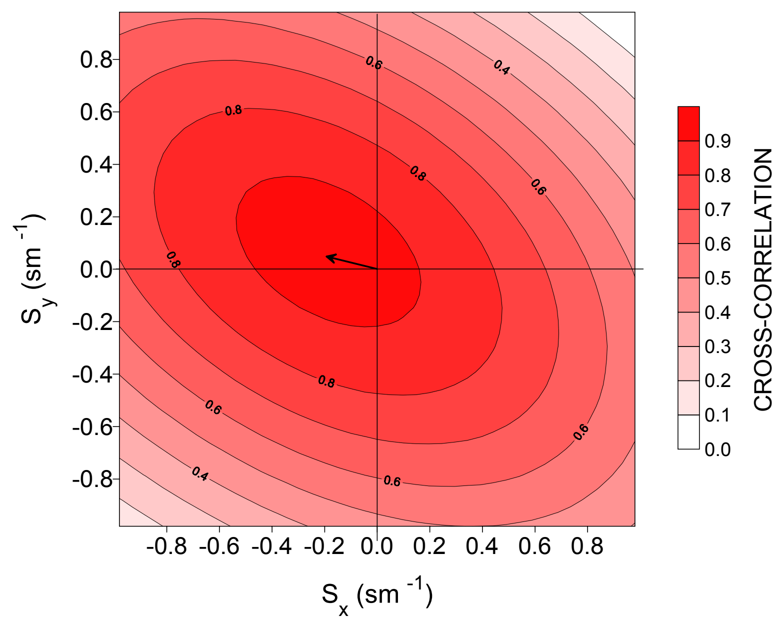

Figure 5 Beamsteering for disturbances with periods between 15 and 25 minutes between 04:00 and 05:00 MDT.

wavelength. These wave characteristics can be obtained from a beamsteering analysis.

Beamsteering refers to any process that uses a spatial array of sensors to determine the direction and speed from which a disturbance is propagating. This is done by varying the signal phases at the various stations (beamsteering) until maximum cross-correlation is achieved between all pairs of stations. The phase lags between stations are used to estimate disturbance speed and direction. Figure 5 shows the results of the beamsteering calculation. The arrow indicates the direction from which the wave-like disturbances is propagating. The axis S_x and S_y represent the "slowness" in the x and y-directions respectively. The slowness is the reciprocal of the wave speed. For the case shown in Figure 5, the disturbance has a speed of about 6.5 ms^{-1}, is coming from about 288^{o}, and has a wavelength of about 6 km.

The analyses described above are typical of those to be done on the VTMX data. Each experimental period, which is usually about 90 minutes long, must be analyzed by hand. This is because wave signals must be separated from turbulence or other intermittent disturbances. Computer screening codes are not capable differentiating between these various signal forms. In many cases, a trial-and-error approach must be used, and even then uncertainty exists in the final results. This is because gravity waves in the lower troposphere seldom resemble the waves imagined in the linear theory. An objective of ATDD's participation in VTMX is the continued study of the nature of gravity wave disturbances in the boundary layer.