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Dynamics of Gravity Waves observed at the USArray Transportable Array

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Although gravity waves are a common feature of the atmosphere, many of their characteristics – their geographic distribution, and the temporal variability in their amplitudes and occurrence – are poorly known. Very long-period pressure waves, with periods and phase velocities consistent with gravity waves, have been observed to move slowly across the seismo-acoustic USArray Transportable Array (TA), which is a portable array of approximately 400 sites deployed on a nearly Cartesian grid spanning nearly 2 million square kilometres, with an average inter-station spacing of approximately 70 km. Both seismometers and barometers are deployed at each site. The TA is sufficiently dense that the wavefronts of the gravity waves are coherent between neighboring stations, but is too large for coherence across the entire network. We have developed a method to examine the characteristics of gravity waves propagating across the network using pressure sensor data at all sites within it; the TA is divided into a large number of elemental, triangular, sub-arrays consisting of three neighboring stations. Coherent analysis of the data at each triad provides a robust estimate of the signal's direction and speed. The results from all triads are combined to follow the progress of a gravity wave as it propagates across the TA. This method allows for observation of fine-scale variations in the speed, direction and amplitude of long period signals across the TA.

Application of the technique to pressure data recorded over a full year show several interesting correlations between our results and those made by satellite detections of convective gravity waves. Gravity waves occur most frequently in regions near the Great Lakes and are less frequent during local daytime hours than nighttime hours. However, we also frequently observe gravity waves that probably originate in airflow over the Rocky Mountains to the west of the array: gravity waves are more frequent in winter, when stratospheric winds are to the east toward the TA, than in the summer when the stratospheric winds reverse direction. Furthermore, the dominant propagation direction of the gravity waves is to the east, away from the mountains, further suggesting their origin in the mountains.