Studies of the Atmosphere and Seismo-acoustic Events Using the USArray

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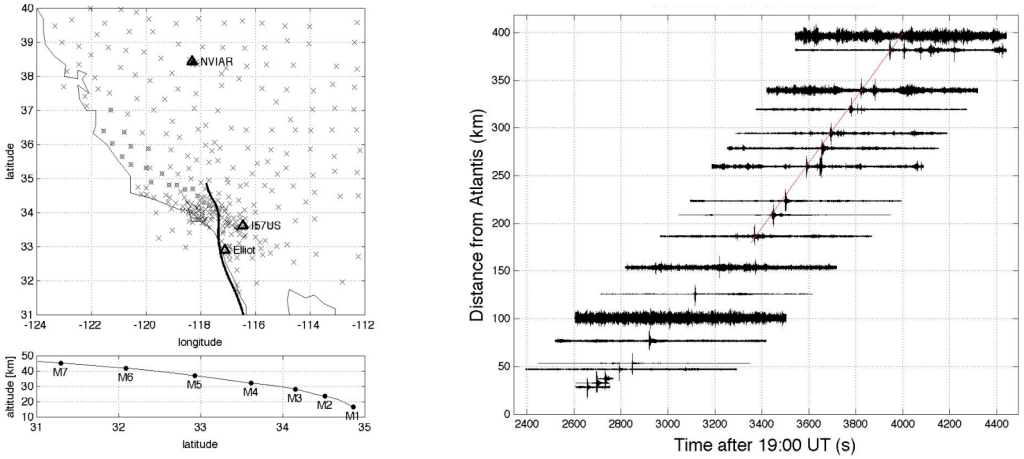
Although intended for study of the Earth's interior, the USArray is also shedding light on atmospheric phenomena and the structure of the atmosphere. Acoustic-seismic coupled signals are often observed from a broad suite of atmospheric sources. Dense seismic networks provide far more propagation paths for study of the source and the intervening atmosphere than are offered by infrasound stations, of which there are several dozen operating worldwide at any given moment. Numerous closely spaced recordings of accurately located atmospheric sources are particularly useful for testing atmospheric velocity models as these models are not grounded in travel time data, as in seismology, but are inferred from other sources, such as weather and climate data. In one recent example, the shuttle Atlantis passed over the USArray in southern California (see the figures). Although signals registered clearly on three infrasound stations, over 100 seismic stations also recorded the event. These recordings provided accurate travel times and also revealed the increasing complexity of infrasound propagation with increasing range.

High-altitude sources can be detected and studied by infrasound and seismic stations. Sources at, or just below, the free surface lie at the interface between the infrasound and seismic realms and can be rich sources of both upgoing acoustic and downgoing seismic energy. In a new program, the Acoustic Surveillance of Hazardous Eruptions (ASHE), researchers have examined the utility of infrasound arrays to fill gaps in existing monitoring systems – e.g. detecting eruptions that are aseismic but large acoustic sources, detecting eruptions that are obscured from satellites by cloud cover. Recent experiments conducted as part of the ASHE program, and outside of ASHE by other researchers, have served as a reminder that volcanoes are rich 3-D sources of energy and it is important to capture both acoustic and seismic wavefields for a fuller understanding of their internal dynamics.

The USArray has proven very useful for atmospheric studies but the coupled recordings are just a proxy for true atmospheric pressure. Some day, if we can collect atmospheric pressure and seismic data together on a large scale we will be able to study weaker atmospheric sources from a greater range with more stations and further our understanding of the 3-D seismo-acoustic sources at or near the free surface.



The path of the shuttle Atlantis over the USArray (x's) and three infrasound stations as it decelerated from Mach 7+ to Mach 1 just south of Edwards AFB. Filtered vertical component seismic recordings of the shuttle, shown on the right provide accurate travel times to a large number of stations and reveal increasing complexity of the waveform with increasing range.