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Design and Operation of Infrasound Stations for Hazardous Weather Detection

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Each year tornadoes cause property damage and death, some of which could be avoided with increased warning lead time. The year 2011 was particularly severe, with more than 1600 tornadoes causing in excess of 500 deaths in the U.S. It is known that tornadoes and their precursors generate infrasound in the 0.5Hz to 10Hz frequency band, with precursors occurring some 30-60 minutes prior to tornado touch down, which is some 15-45 minutes earlier than the average tornado warning lead time in the U.S. Given the potential of infrasound to improve tornado early warning and emergency response, the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), in conjunction with its research on small, boundary-layer observing X-band weather radars, has begun a research project whose goal is to combine the passive detection of tornado infrasound with active tracking of the parent storms that carry the tornadoes with its weather radars. In the spring of 2011 CASA conducted an infrasound field-test in Oklahoma, in the heart of the so-called "tornado-alley" where statistically the majority of springtime tornadoes in the U.S. occur. This being CASA's first infrasound experiment, the goal of the field-test was to gain an understanding of the issues involved in the design and operation of infrasound stations for severe weather monitoring and early warning. In this application, it is not so much the ability of infrasound to travel long distances that is of importance, but rather the fact that there can be precursor signals that unlike radar do not require line-of-sight to detect. In fact, for early warning, detection distance would generally need to be less than 100 km, since a propagation delay of much more than 5 minutes would be too late. Challenges encountered included persistent infrasound "clutter" from a nearby large windfarm, accurate bearing detection over a wide bandwidth with a fixed four sensor aperture, and the need to operate in the the high winds that surround the supercell storms that spawn tornadoes. This paper details our solutions to these signal processing and wind noise reduction challenges and how they will be applied to a redesign of the CASA infrasound monitoring stations for a 2012 re-deployment.