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The effect of spatial filters on infrasound array responses

David Brown (1), David McCormack (2), and Pierrick Mialle (1)
(1) CTBTO, IDC, Vienna, Austria (david.brown@ctbto.org), (2) Natural Resources Canada, Ottawa, Canada (David.McCormack@NRCan-RNCan.gc.ca)

When connected to a low-frequency microphone or microbarometer, a spatial filter, which consists of an arrangement of connecting pipes with ports placed at regular intervals that are open to the atmosphere, is used to reduce the acoustic noise due to atmospheric turbulence. This filtering technique is based on the assumption that the coherence length of the turbulence is smaller than the spatial extent of the filter and so contributions from turbulence recorded at widely separated ports will tend to sum out while those of the signal of interest, which will have coherence length larger than the spatial dimensions of the filter, will be reinforced. In this paper, the plane wave response for a spatial filter with an arbitrary arrangement of open ports is determined. It is found that differing propagation distances due to different port-to-sensor lengths causes out-of-phase sinusoids to be summed at the central manifold and can lead to significant amplitude decay and phase delays as a function of frequency. This plane wave response is then superimposed on an array response typical of infrasound arrays that constitute the International Monitoring System (IMS) infrasound network, which is used for nuclear monitoring purposes. It is found that phase delays are not significant when the same spatial filter is used at each sensor provided the filter is rotationally symmetric, because the same phase delay is observed at each sensor. However the amplitude attenuation can be significant at certain frequencies, reducing signal detection capability in terms of the Fisher Statistic. When differing spatial filters are used at the same infrasound array, as well as reducing the amplitude of the main-lobe, the differing phase-delays at each sensor can cause changes in the observed signal backazimuth because the shape of the main lobe is changed.