ISCE

The Institute of Sound and Communications Engineers

Engineering Note 31.1

Where did the wind blow my sound?

or 'Anomalous propagation of acoustic waves due to meteorological influences'

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Where did the wind blow my sound?

These relatively uncommon effects due to the weather often come as a nasty surprise, especially if you don't operate outdoor systems very often. They range from problems of people not hearing on the site to problems of people 10 miles away hearing much more than they want. In the worst case, both at once!

Sound radiation over distance

An omnidirectional source outdoors would obviously radiate into part of a sphere, depending on its height above ground level. But most sources (loudspeakers) used outdoors are directional, so we may consider radiation along the principal axis, where the radiation is strongest, without too much risk of error.

At a distance above ground, in good weather the radiation is predictable. Near the ground, the radiation tends to be effectively delayed by interaction with the ground covering, especially long, sparse grass. Dense grass tends to appear like a smooth surface, however. This delay causes the direction of maximum radiation to bend down towards the ground, which may be an advantage in reducing sound spill outside the venue. The same effect occurs if the temperature of the air just above ground is much lower than the air temperature at a height; the speed of sound is lower at low temperatures. The effect can actually be 'encouraged', if necessary, by deliberately aiming the loudspeakers at points on the ground near the site boundary.

Effects of wind

Headwind (blowing towards the source), being stronger at height, tends to refract the sound upwards, away from the ground, while a tail wind refracts it downwards. These effects are quite noticeable; the 'wavefront' only needs a small push at the top to deflect it significantly. On the other hand, a cross wind tends to deflect the sound sideways, but not much. A 60 mph cross wind deflects by about 4.5 °, or 8 m at 100 m distance.

Humidity

For humidity values over 50%, the effects of humidity are fairly well-behaved. But at low humidities and especially at low temperatures, the attenuation of high frequencies can be large. For example, at 10 °C and 20% RH, the attenuation at 4 kHz is over 9 dB/100 m, and far more at 10 kHz.

Conversely, the attenuation at high humidities may be unexpectedly low.

Temperature inversion

This is often the most traumatic situation. If a layer of warm air is trapped below a layer of cold air, often resulting in fog or mist, sound can 'tunnel' through the warm layer with very low attenuation with distance. Effectively the atmosphere is making the loudspeakers have the same fan-shaped directional response as a line source, and quite a tall one. The result can be that disturbing sound levels occur at considerable distances, leading to complaints and possible official retribution. This is probably what happened at Glastonbury in 2007, if you can remember that far back.