ON-FIELD DILUTION OF AIRBORNE FLUX: IMPORTANCE FOR MODELING EXPOSURES

David A. Sullivan*, Sullivan Environmental

Ryan D. Sullivan, Sullivan Environmental

An important assumption for dispersion models, whether using the ISCST3 model or its replacement the model AERMOD, is atmospheric stability. Stability defines the rate of dilution, i.e. how quickly emitted flux mixes with the ambient air and dilutes as it travels downwind.

The dispersion models in use for buffer zones determine the amount of dilution based on hour of day, time of year, cloud cover, and wind speed. Although AERMOD allows for more potential flexibility in defining the inputs to stability, there remains an important limitation. The standard application of a dispersion model does not specifically consider the special conditions associated with the heat retention properties of tarped or recently irrigated fields.

For example, according to past research involving fine wire thermocouples positioned at levels between 0.3 m and 3.0 m above applied fields, a broadcast or bedded tarped application does not cool during nocturnal periods the same way a natural surface would cool. Similarly, it could be argued that a chemigation application that has its peak flux rate while the soil surface has a relatively high amount of moisture does not cool in the same manner as a typical, dry natural surface.

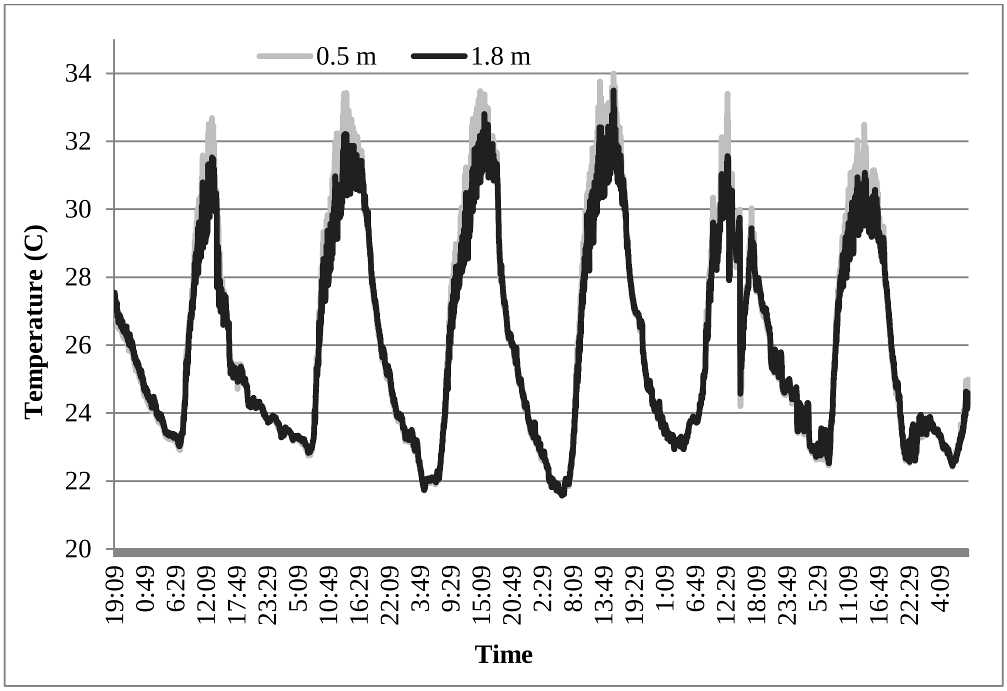
Why is this important to growers? Current modeling of buffer zones does not account for the above facts. A broadcast bedded / tarped field, for example, will not be considered by the model. The modeling will proceed as though the tarp was not there. During conditions conducive to worst-case buffer zone periods, i.e. nocturnal periods with relatively clear skies and light winds, standard modeling methods allow for minimal dilution as the flux is emitted and flows towards the downwind edge of the treated field. In other words, the plume will be substantially more concentrated than it should at the point it leaves the treated field and moves on downwind. A companion paper: "*Modeling of Nocturnal Periods Over Treated Fields: Influence* *on Buffer Zones*" provides examples of the relative importance of on-field dispersion in terms of defining buffer zones. This paper presents representative field data that shows typical nocturnal stability on tarped and untarped agricultural applications.

Figure 1 shows the 0.5 m and 1.8 m air temperature data for a bedded tarped application in sandy soil in Florida. As shown, during daytime periods the 0.5 m level temperature is significantly higher than the 1.8 m level. During nocturnal periods, however, the two levels are approximately the same. This would not be the case if a typical inversion were in place over dry, non-tarped and non-irrigated, bare ground with conditions conducive to nocturnal, which would be expected to show a significant increase in ambient temperature from 0.3 to 3 m, e.g. up to 5C or higher.

Figure 2 provides an alternative example for an untarped chemigation application in the Pacific Northwest. During the first two full evenings there is a minimal inversion shown. During these evenings wind speeds were averaging approximately 5 m/sec, which is not conducive to the formation of inversions. By the third evening the wind speeds were averaging approximately 1 m/sec and sky conditions were clear. A modest inversion is shown with approximately a 3C difference between the 0.5 m and 3.1 m levels. Initial soil moisture was approximate 15 percent by weight at the time of application, with a relative drop of approximately 20 percent by the third evening. The residual moisture likely reduced the severity of the inversion.

The consequence of these findings is that near-field concentrations, in particular, for tarped applications are being overstated by the modeling because when the stability is neutral or near-neutral on the treated field (moderate dilution conditions) the model is proceding as though it is extremely stable (minimal dilution). As travel time further and further downwind occurs, this factor becomes of lesser significance. For pesticides that have flux managed such that standard modeling methods show less than ~ 100 m buffer zone, initial testing has shown that buffer zones can be overstated by a substantial margin. Further work is needed on evaluating heat flux and stability for both tarped and untarped (but irrigated) fields to compare the dilution potential for these surfaces with unirrigated, untarped ground. While untarped fields are shown to have inversions, such as the example in Figure 2, 2.5 days after the application, it appears that especially during the first 24-36 hours after untarped applications that the severity of inversion conditions is reduced relative to non-agricultural land. If that were shown to be the case, then there would be potential benefits in terms of refining the near-field modeling to produce more accurate, and smaller buffer zones for tarped and untarped applications.

Figure 1: Air Temperature at the 0.5 and 3.1 m Levels for a Shank Injection / Compaction Application with a Water Seal in the Pacific Northwest



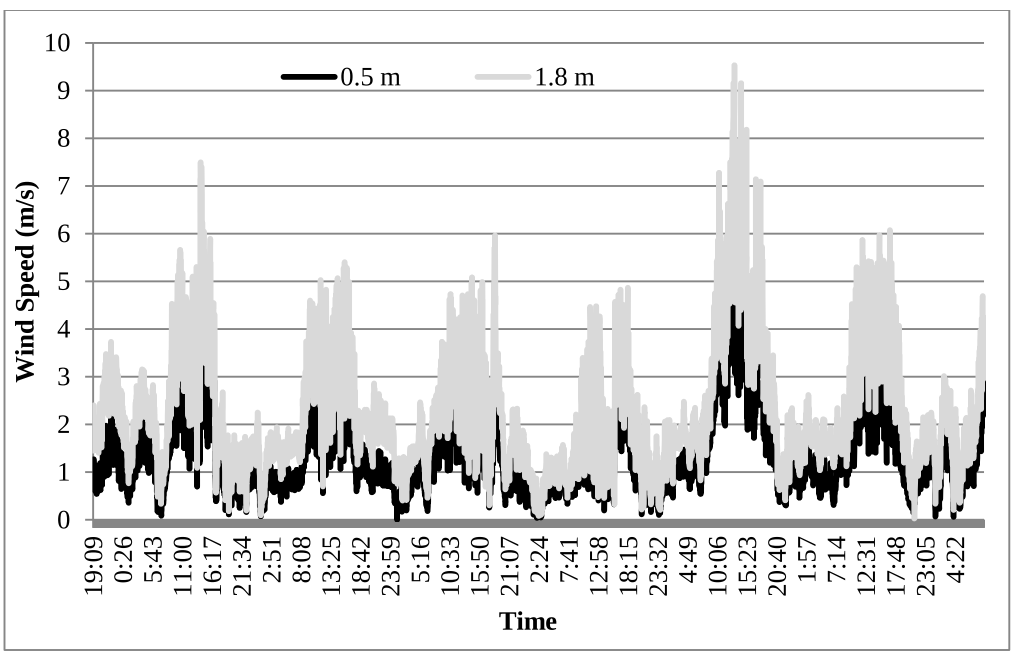


Figure 2: Temperature Profile Data for a Shank Injection Compaction Study in the Pacific Northwest