IMPROVING ACCURACY OF BUFFER ZONE MODELING: INITIAL CONDITIONS

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This paper builds on the companion paper: *"On-Field Dilution of Airborne Flux: Importance for Modeling Exposures."* The companion paper demonstrates that for tarped fields, and likely for recently irrigated untarped fields, that standard model treatments substantially underestimate the amount of atmospheric dilution that takes place while gaseous emissions are travelling over a treated field. This paper describes the significance of this issue relative to the establishment of buffer zones. This discussion is relevant to buffer zones for agricultural fumigants, and also may be more broadly relevant to other pesticides, including semi-volatile pesticides applied to irrigated bare ground and/or crop canopies.

To avoid biasing the modeling to overstate near-field concentrations, it is necessary to account for the differences in dispersion conditions between two zones: (1) during the over-field transport, and (2) during the off-field transport. Standard dispersison modeling approaches in ISCT3 (as used in PERFUM) or AERMOD assume that dispersion is the same in both zones, and are equal to off-field conditions. These assumptions are conservative, but inaccurate. There is a great difference in terms of dilution rates between very stable conditions (modeled when nocturnal periods have clear skies and light winds) and neutral or near-neutral, which generally occurs over treated fields.

The modeling approach in the AERFUM prototype model identifies what initial dispersion conditions are needed for a particular field size when modeling as stable conditions (standard model treatment) to match near-field concentrations modeled as neutral stability as typically observed over tarped fields during nocturnal periods. This approach results in an accurate treatment of initial conditions. In the near-field, concentrations will be substantially lower when modeled to realistically match on-field dispersion rates.

These initial conditions are then modeled in a standard fashion out to the full extent of the modeling domain. As travel distance increases further downwind, the modified and standard approaches will tend to converge. The significance of this factor is as follows. If a pesticide and a specific application method can provide effective flux management, such that computed buffer zones for typical commercial fields (20-40 acres) are less than 100 m, the more accurate treatment of initial conditions can result in significantly lowered buffer zones.[1] On the other hand, if the buffer zones by standard methods are large, i.e. >> 100 m, this modified method will not make a substantial difference in buffer zone results. First, however, flux needs to be managed to relatively low levels for this approach to make significant reductions in modeled buffer zones.

Figure 1 shows isopleth examples of the differences between the standard model treatment and the adjusted procedure that more accurately accounts for initial dispersion over the field for hypothetical hour with stable off-field conditions. Figure 2 shows four plots of 95th percentile concentrations for perspective based on an example 20 acre application of metam sodium by shank injection / compaction and five years of hour-by-hour meteorological data. The direct comparison of the standard treatment with the adjusted treated to more accurately represent initial conditions is shown on the left side of Figure 2, which bases distributions on the worst-case day (top-left is the standard treatment; bottom-left is adjusted for initial conditions). For comparison, the right side of Figure 2 provides Monte Carlo-based comparisons where distributions are conservatively based on the first four-day period (top-right is the standard treatment; bottom-right is adjusted for initial conditions).

The interpretation of Figure 2 is as follows. There is a significant reduction in near-field concentrations caused by increasing the accuracy of initial conditions. Especially for Monte Carlo based modeling, where applications are triggered on a Monte Carlo basis and distributions are based on the first-four days (e.g. when the highest flux generally occurs), the benefits of the more refined dispersion treatment are more evident as the percentile increases. The following table summarizes the results:

			2010C #1			
PERCENTILE	66 μg/m^3 CUTPOINT					
	PERFUM2		AERMOD (SUMMER ONLY)			
	WHOLE FIELD	MAX	BASE-RUN	BASE-RUN (ADJ)	BASE (MC)	BASE (ADJ -MC)
90TH	65	220	101	65	0	0
95TH	110	265	161	127	24	0
99TH	195	350	308	275	108	87

[1] If daytime emissions are highly dominant (e.g. 10 times higher than nighttime emissions) , the modified treatment would not be likely to produce significant reductions in buffer zones.

Figure 1: Comparison of Standard Model Treatment with More Refined Treatment of Initial Conditions

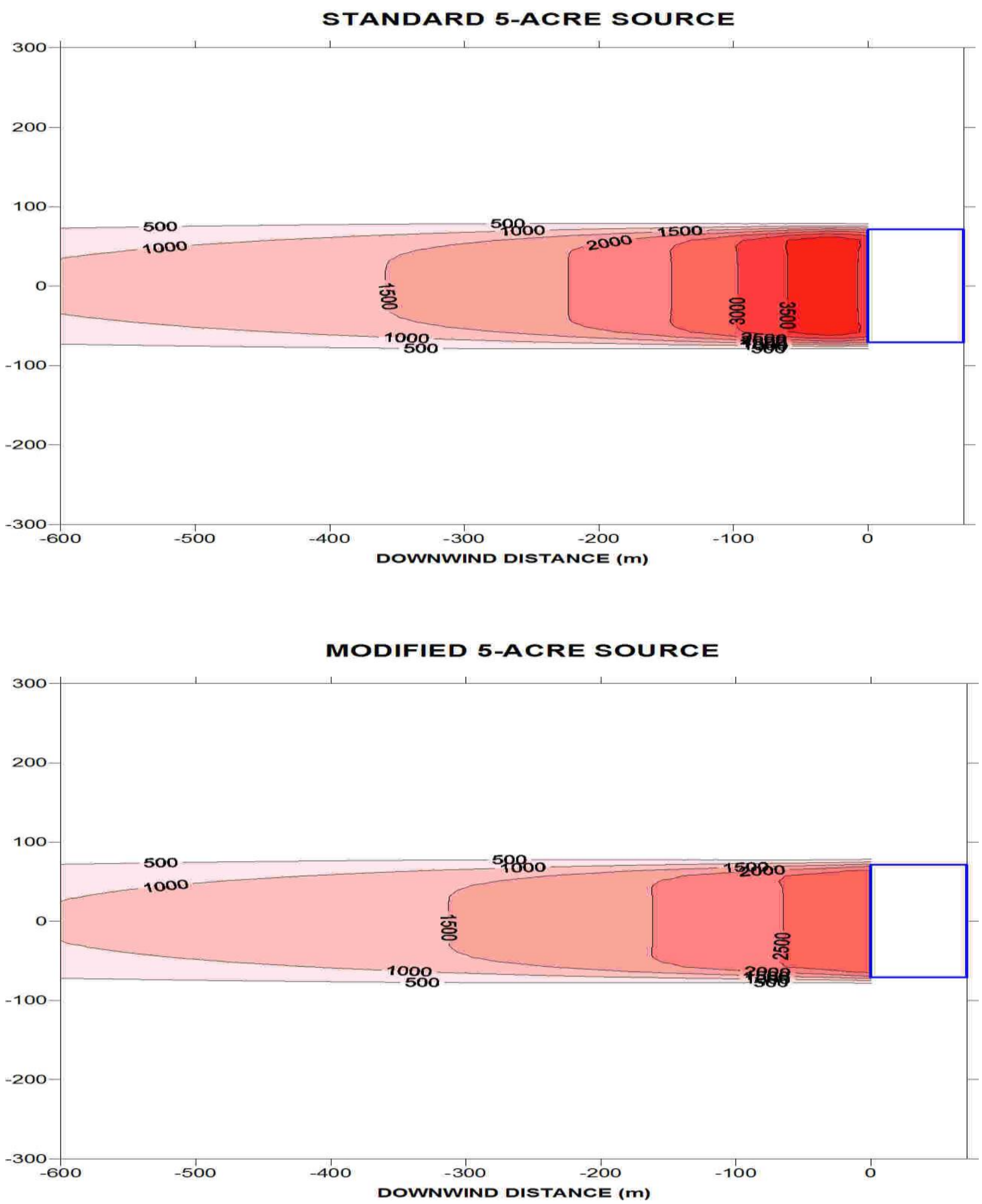

Figure 2: Comparison of Standard Model Treatment with More Refined Treatment Based on the AERFUM Pilot Model and Shank Compaction 20 Acre Example (95th Percentile Results Based on Five Years of Meteorological Data)

Meteorological Data Set: Bakersfield, California

95TH Percentile