Reply

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I would like to thank Dr. Leahey for his question about the CTDMPLUS dispersion model (Perry 1992). He correctly points out that the model does not account for the effects of downslope flow on plume material that is approaching a terrain feature. In fact, there are many complex-terrain-related flow phenomena (e.g., leeside distortion, valley circulations, upslope–downslope flows) that are not specifically simulated by this model except as these phenomena are represented by the wind and turbulence data provided as input to CTDMPLUS.

To review briefly, CTDMPLUS was developed primarily to estimate windward-side concentrations on terrain, with particular emphasis on stable plume impaction. The model is based on the assumption that meteorological conditions are steady over each simulation period (typically 1 h or less). The meteorological data are provided as vertical profiles of winds, turbulence, and temperature from an on-site location expected to be representative of flow near the release point (the ambient flow encountering the source plume). The model simulates the distortion of this ambient flow around terrain features downwind of the release. CTDMPLUS considers the effects from upwind terrain only to the extent that the measured ambient flow represents the influence of these upwind features. Once the model digests the vertical wind profile for a given simulation, it selects the wind direction and other wind variables that are representative of those at the estimated plume height. It is not designed to simulate a reverse flow that may be occurring near the surface (as with drainage flows). Instead, it simulates the flow distortion by the downwind terrain on the ambient flow and the plume embedded in that flow.

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Dr. Leahey raises a good question about the physical reasonableness of CTDMPLUS estimates in situations where downslope winds exist on the "windward" side of terrain. This is a difficult question to address definitively as I am unaware of any investigation of this specific issue. So I will simply offer the following brief thoughts. The influence of a windward-side downslope flow will certainly depend greatly on the strength (depth and speed) of the katabatic wind relative to the speed of the "ambient" flow that is bringing the plume toward the terrain. Entrainment in this counterdirection downslope flow would, intuitively, have the effect of spreading the plume footprint more widely across the face of the obstacle and may bring material toward the windward base. If the entrainment is significant, it is difficult to predict the effect on maximum ground-level concentrations at plume elevation since concentration may decrease due to shear-induced mixing but may also increase locally if the plume material is brought rapidly to the terrain surface.

Comparisons of CTDMPLUS predictions against field measurements at a number of study sites ranging from small isolated hills to full-scale, mountain–valley situations (Paumier et al. 1992; Strimaitis et al. 1987) suggest that CTDMPLUS is simulating the maximum concentrations related to plume impaction quite well. Drainage flows of varying degrees existed during these studies; in particular, at the Tracy Power Plant Study in Nevada (DiCristofaro et al. 1986), drainage into and down the valley was commonly the primary mechanism for plume transport during stable conditions. Anecdotal evidence from the study investigators implies that windward-side drainage on the target terrain features was weak and intermittent when noticeable at all. However, the effects of these weak drainage winds on maximum plume impacts were not specifically addressed. The implication is that, during conditions that transport plumes to a terrain feature, the dynamic interaction of the transport flow with the terrain feature is dominant and CTDMPLUS yields physically reasonable estimates of maximum plume impacts even in the presence of weak downslope flows.

REFERENCES

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