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Bent-over plume models for large-area highly-buoyant turbulent plumes NIGEL KAYE, ALI TOHIDI, Clemson University — The problem of large-area turbulent plumes driven laterally by wind has numerous applications in environmental fluid mechanics. For example, one of the primary mechanisms of wildfire spread is through the creation of spot fires that result from embers being lofted into the atmosphere by a fire plume and then transported ahead of the fire by wind. We review existing entrainment models for bent over plumes and investigate the modeling approach most appropriate for large-area highly-buoyant plumes. We present analytic solutions for the far-field behavior of a bent-over plume in the presence of both a uniform and power-law velocity profile. The plume trajectory in a power-law velocity profile is flatter and the volume and momentum fluxes are larger compared to a plume in a uniform velocity field. Comparison with experimental measurements shows that modeling the boundary layer velocity profile is important to accurate prediction of plume trajectory. The results of a sensitivity analysis show that the choice of entrainment model has little influence on plumes with flatter trajectories but has a large effect on more vertical trajectories that are typical of large-area highly-buoyant plumes under low wind conditions. Further, the choice of boundary layer velocity profile function influences the trajectory of more vertical plumes. However, model predictions are insensitive to any eccentricity in the plume cross-section.

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