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Structure and Mixing of a Turbulent Meandering Plume Part 1: Concentration and Velocity Structure D.L. YOUNG, Georgia Tech, A.I. LARSSON, University of Gothenburg, D.R. WEBSTER, Georgia Tech — While much is known about the dynamics and mixing of straight non-buoyant plumes of chemical tracer, comparatively little is understood about the dynamics of meandering plumes, where meander is defined as large scale movement of the plume centerline. Meandering chemical plumes occur in atmospheric and other environmental flows, such as the flow past natural obstacles. In this study, we present simultaneous PIV, PTV, and LIF measurements of a phase-locked meandering plume, the motion of which is forced by the periodic oscillation of a diverting plate. The plume evolves in a turbulent boundary layer in a moderate-Re open channel flow. Similar measurements are made for a straight plume for comparison. Analysis of the LIF data reveals that, for the meandering plume compared to the straight plume, the centerline phase-averaged concentration decreases more rapidly with distance downstream and the plume width increases more rapidly with distance downstream. This indicates a more rapid dilution of tracer. Furthermore, the concentration profiles, along transects perpendicular to the plume centerline, are not symmetric about the meandering plume centerline. Analysis of the velocity data indicates that the large-scale alternating-sign vortices induced by the diverting plate are the dominant feature of the flow. The vortices force the plume to meander and govern the spatial distribution of the phase-averaged concentration, phase-averaged vorticity, Reynolds stress, and TKE.

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