

**Environmental Engineering**

**and Earth Sciences**

**EEES Department Seminar**

**Structure and Mixing of a Turbulent Meandering Chemical Plume**

**Dr. Don Webster**

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Turbulent mixing in a meandering non-buoyant chemical plume is far less understood than in a straight plume – partially due to difficulty separating the plume meander from the turbulent fluctuations. This study presents simultaneous particle image/tracking velocimetry (PIV/PTV) and laser-induced fluorescence (LIF) measurements of a phase-locked meandering chemical 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-Reynolds-number open channel flow. For the meandering plume, the centerline phase-averaged concentration decreases more rapidly with downstream distance and the plume width increases more rapidly with downstream distance (as ) compared to the straight plume (as ). Furthermore, the concentration fields and transverse profiles are asymmetric about the plume centerline in the meandering plume. Nevertheless, the transverse profiles can be modeled by a Gaussian shape in a segmented manner. The velocity fields indicate that the large-scale alternating-sign vortices induced by the diverting plate are the dominant feature of the flow. The vortices induce the plume to meander and govern the spatial distribution of the phase-averaged concentration. Further, a phenomenological model of chemical filament transport by the vortical motion explains local peaks in the phase-averaged concentration along the plume centerline. Analysis of the covariance of the turbulent fluctuations of velocity and concentration, i.e. the turbulent flux, reveals that the spatial distribution of the turbulent quantities is governed by the large-scale alternating-sign vortices that induce the plume meander. The spatial variation of turbulent flux agrees well with the spatial variation of the phase-averaged concentration gradient. As a result, the eddy diffusivity framework effectively models the turbulent flux. As expected from turbulent mixing theory, the eddy diffusivity coefficient plateaus at a constant value once the plume width reaches the size of the largest eddies. However, when the plume width is less than the size of the largest eddies, the eddy-diffusivity coefficient scales with the plume width to the  = 1 power.

**About Dr. Webster:**

Dr. Don Webster earned his Ph.D. in mechanical engineering from the University of California at Berkeley. His primary research interests lie in environmental fluid mechanics, with an emphasis on the influence of fluid motion and turbulence on biological systems. His work has been featured in the New York Times and dozens of other news outlets. He is a fellow of the Association for the Sciences of Limnology and Oceanography and has served on the editorial board of the journal Experiments in Fluids for more than a decade.

Dr. Webster has won a number of awards, including the Class of 1934 Outstanding Innovative Use of Education Technology Award, the Eichholz Faculty Teaching Award, and the British Petroleum Junior Faculty Teaching Excellence Award. He has been a member of Georgia Tech’s Commission on Creating the Next in Education, including chairing a discovery group and co-chairing an ideation group.

**2:30 PM**

**Friday, September 2, 2022**

**Watt Family Innovation Center – Auditorium (1st floor)**

Buses will be available to transport from Rich Lab (departing at 2:00 pm) to the Watt Center

and from the Watt Center back to Rich Lab (departing at 4:00 pm).

***Attendance is mandatory for graduate students enrolled in EES 8610, EES 9610, and GEOL 8510***

***This seminar is sponsored by the School of Civil and Environmental Engineering and Earth Sciences***

***Reception to follow in the Watt Center Lobby***