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The role of a delay time on the spatial structure of chaotically advected reactive scalars

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This talk concerns the spatial structure of reactive scalar fields in two-dimensional, incompressible chaotic advection flows. Considerations of such fields arise naturally when studying interacting chemical or biological species, such as ozone in the atmosphere and plankton populations in the ocean, where the dominant flow is large-scale and quasi-horizontal. In a regime where diffusion can be neglected (large Péclet number), the scalar concentration in any fluid parcel is determined by the time history of that parcel. The emerging spatial structures are filamental and characterised by a single scaling regime with a Hölder exponent that depends on the rate of convergence of the reactive processes involved and the stirring induced by the flow, measured by the average rate of divergence of the distance of neighbouring fluid parcels.

Motivated by the models of evolution of complex organisms such as oceanic zooplankton, we here examine the role of delay times introduced into the reaction term. For sufficiently small scales all interacting fields share the same spatial structure, as found in the absence of a delay time. For larger scales, depending on the strength of the stirring and the magnitude of the delay time, two scaling regimes that are unique to the delay system, may appear.