Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Relating 2D and 3D Lagrangian coherent structures in oceanic flows[1] H M ARAVIND, G. SALVADOR-VIEIRA , Northeastern University, VICKY VERMA, SUTANU SARKAR, University of California San Diego, MICHAEL ALLSHOUSE, Northeastern University — Lagrangian coherent structures (LCS) techniques reveal elliptic structures that partition the domain into minimally- and well-mixed regions (Jupiter's Great Red Spot, Polar Vortex), and hyperbolic structures that are highly attracting/repelling material surfaces (long filaments of the Deepwater Horizon oil spill). These techniques can be applied to 3D ocean flows; however, the high computational cost of calculating 3D LCS or the lack of an accurate vertical velocity model often prove to be prohibitive. Hence, identifying when a 2D calculation captures the 3D LCS is beneficial. Sulman et al. (2013) introduced two diagnostic metrics – the maximum vertical shear magnitude in horizontal velocities and the vertical velocity gradient – to identify when 2D calculations of the finite-time Lyapunov exponent (FTLE) field are insufficient to capture the 3D hyperbolic LCS in steady, analytic flows. In our study, we investigate how well Lagrangian extensions of these metrics identify regions where 2D approximations for hyperbolic and elliptic LCS sufficiently represent the full structure. For this, we compare 2D FTLE and trajectory-clustering structures with 3D results for a high-fidelity, submesoscale simulation of an oceanic density front.

[1]Support provided by ONR N00014-18-1-2790

H M Aravind
Northeastern University

Date submitted: 01 Aug 2019 Electronic form version 1.4