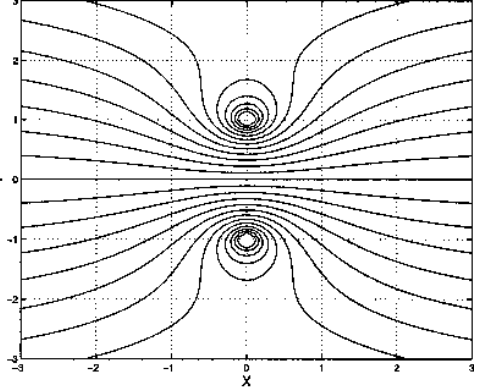
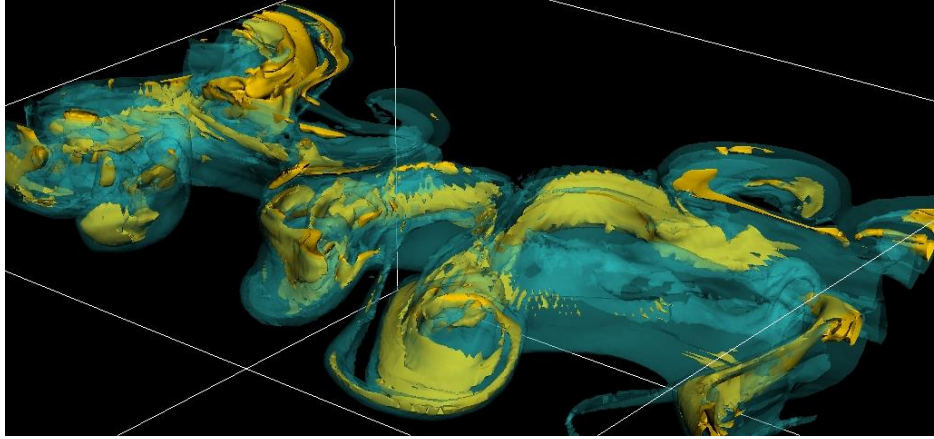


2D+1: existing theory

Dynamically weakly 3D: theory lacking

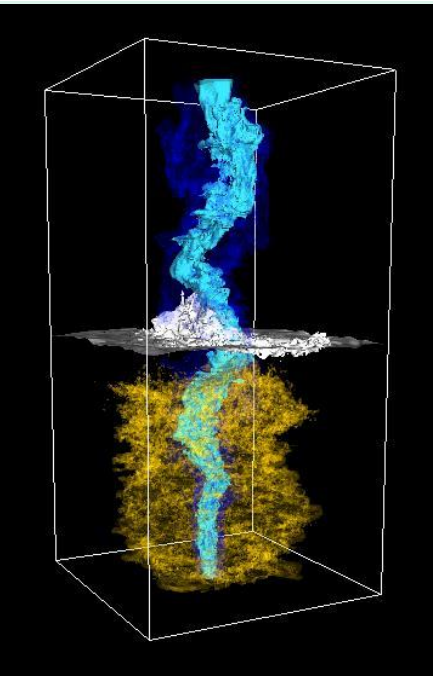


Theory and simple models

Ocean 3D+1

Llewellyn Smith, Chabreyrie, Keppel, Mezić, Budisic, Pratt, Rypina, Scott

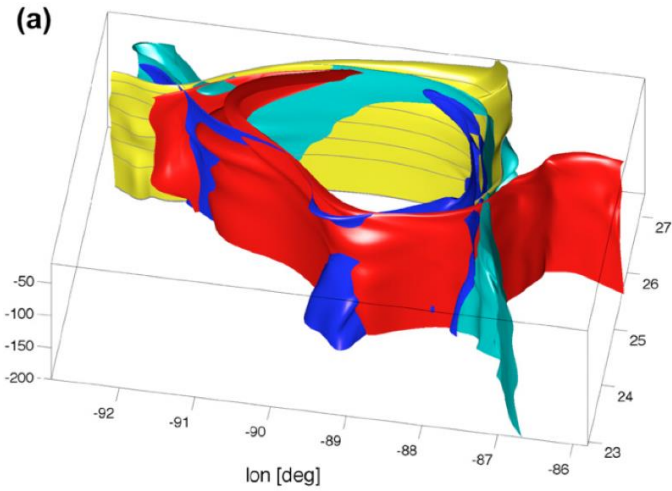
Ocean 3D+1 MURI review
May 1, 2013, Washington DC

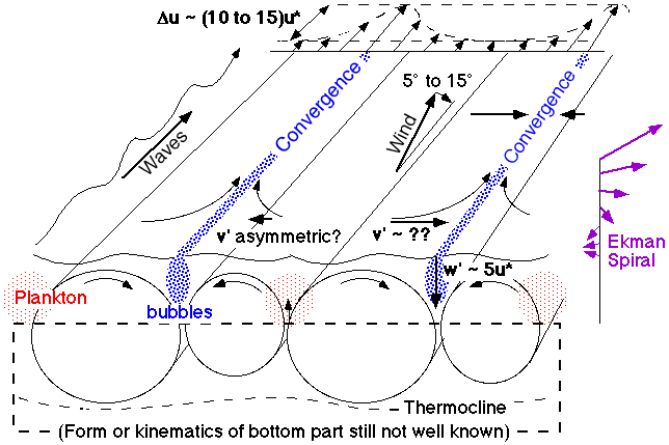


3D unsteady: beyond scope

Questions

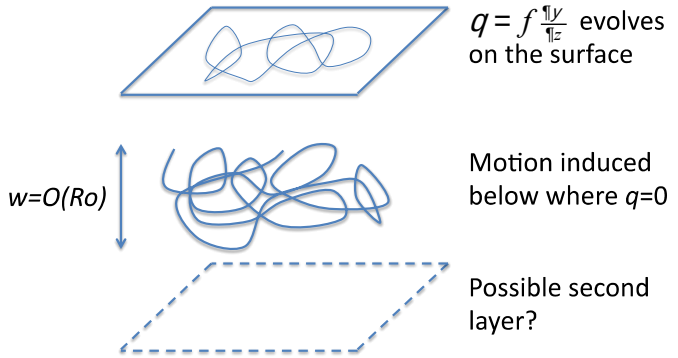
- What underlying structures exist in 3D? How can we find them?
- When is a 2D or quasi-2D approach enough to compute and understand mixing and pathways?
- What are the essential differences between 2D and 3D?
- Does aperiodic time dependence play a new role here?
- 2D on large scales vs. 3D on small scales in same flow? Large Reynolds number/turbulence effects?

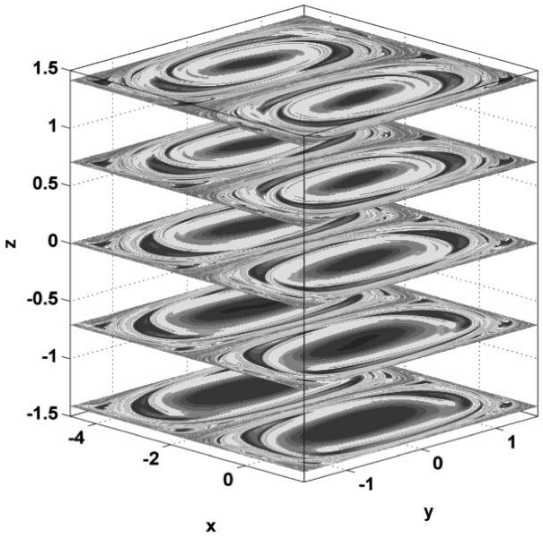




UCSD (Llewellyn Smith)

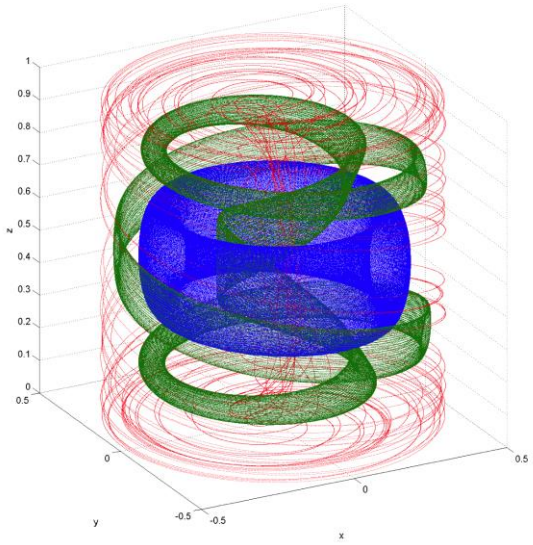
- Solomon/Mezić eddy-chain model (Chabreyrie).
- SQG model (Keppel): 2D dynamics with 3D transport.
- Look at limitations of 2D analysis and long-time behavior.
- Start with vortex flows, moving to moment models and beyond.
- Two boundaries (~mixed layer).

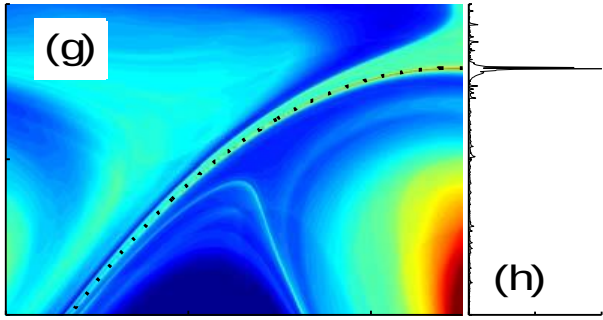




WHOI (Pratt, Rypina)

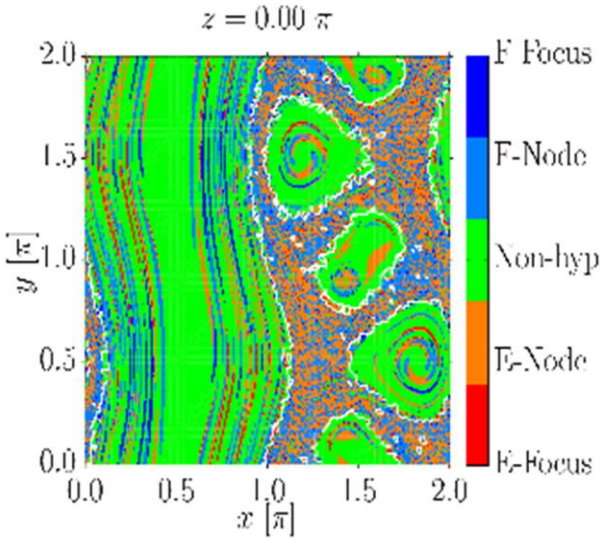
- Working on “rotating can” experiment. Both kinematic flow and full numerical solution in collaboration with RSMAS.
- Developing measures of complexity (alternatives to FTLEs) to map out Lagrangian structures.

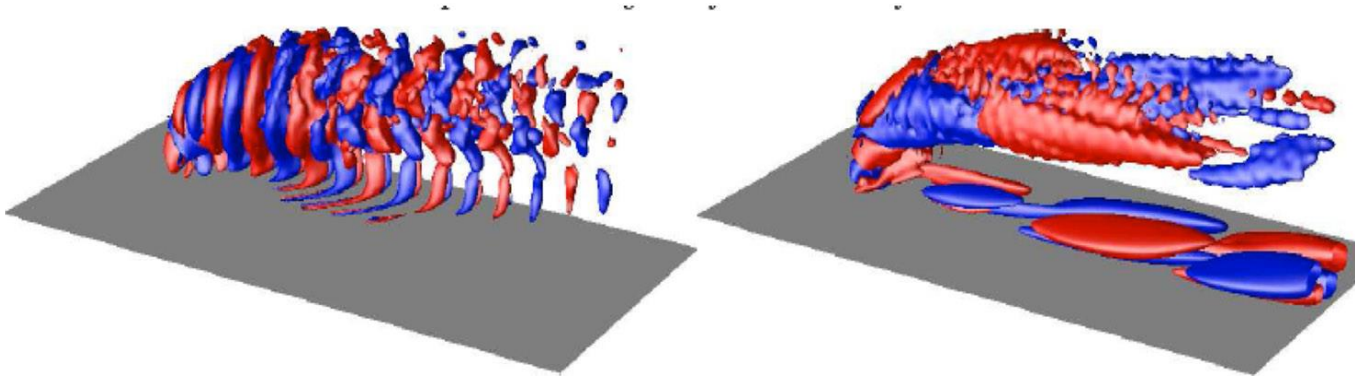


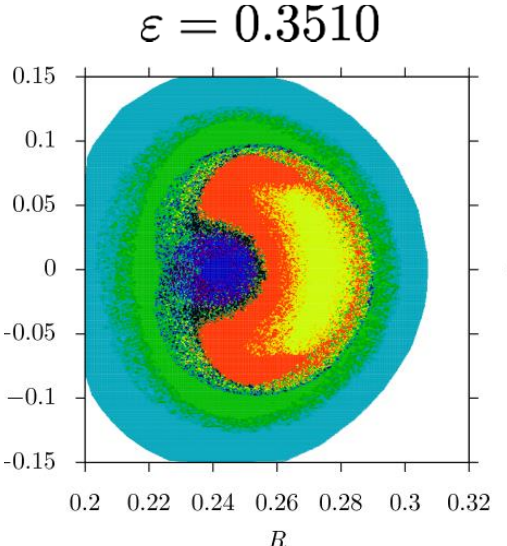


UCSB (Mezić, Budisic)

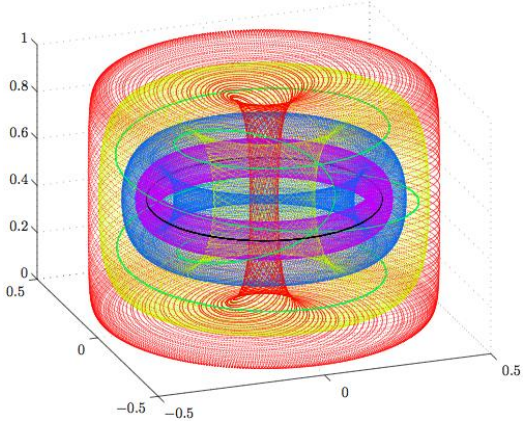
- Developing new measures and techniques to map out Lagrangian structures in 3D+1.
- Mesohyperbolicity.
- Ergodic quotient and partition.



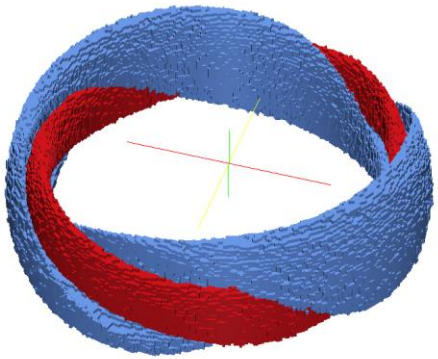


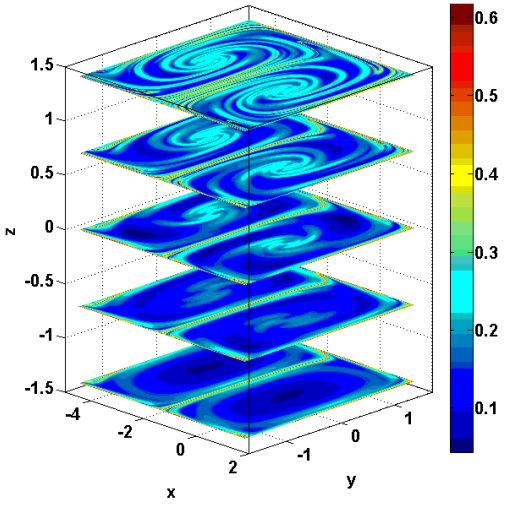


New advances



- Development of dynamically consistent models. Simple enough to know “truth”: testbeds.
- New theory: ergodicity defect, resonance criteria, complexity measures, etc…
- Identification of new structures and phenomena using these methods: SN bifurcations, separated tori, slow-fast dynamics, etc…





Potential breakthroughs

- Advances in efficient methods for identifying and decoding LCS.
- Finding 3D structures in both model and realistic flow fields, eventually in turbulent flows.
- Leap forward in understanding mixing.
- Use of dynamics to constrain and understand 3D kinematics
- How does knowledge of organizing Lagrangian structures inform LDA?

Connections with other groups

- OM: analysis of quasi-2D methods and measures
- OM: benchmarking of different measures in model flows
- OM: comparisons between realistic and idealized flow models
- OM: QG ellipsoid vertical velocities
- LDA: dynamic velocity fields to develop assimilation techniques