Poster Session

Tuesday, 17 May 2016, 2:00 PM to 5:30 PM

Short Poster Introductions

5 minutes, maximum 2 slides

From	To	Name		Affiliation	Title
2:00 PM	2:05 PM	Rodrigo	Duran	NETL-DOE / CEOAS-OSU	Transport in the Gulf of Mexico
2:05 PM	2:10 PM	G. Jay	Brett	WHOI	Chaotic Advection and Mixing in an Idealized 3D Eddy Model
2:10 PM	2:15 PM	Peng	Wang	University of Miami	Spiral inertial waves emitted from geophysical vortices
2:15 PM	2:20 PM	Mattia	Serra	ETH Zürich	The Objective Eulerian Skeleton of Fluid Flows
2:20 PM	2:25 PM	David	Oettinger	ETH Zurich	An Autonomous Dynamical System Captures all Lagrangian Coherent Structures in Three Dimensions
2:25 PM	2:30 PM	Sebastian	Essink	WHOI	Observations of Vorticity and Strain from Drifters in the Ocean
2:30 PM	2:35 PM	Margaux	Filippi	MIT/WHOI	NA
2:35 PM	2:40 PM	Sachiko	Yoshida	WHOI	Fukushima Cs pathway in the western North Pacific
2:40 PM	2:45 PM	Viviane V.	Menezes	WHOI	Multiple quasi-zonal jets in the South Indian Ocean
2:45 PM	2:50 PM	Phillip	Walker	Arizona State University	Scalar Moments of 2D Nonlinear Flows

Afterwards: Time to view the posters until 5:30 PM

Poster Abstracts

Transport in the Gulf of Mexico

Rodrigo Duran (NETL-DOE / CEOAS-OSU)

Aided by Lagrangian coherent structure theory techniques we separate the surface-ocean flow in the Gulf of Mexico into regions with distinct transport characteristics, using the output from a 12-year-long data-assimilative simulation produced by the HYbrid-Coordinate Ocean Model (HYCOM).

Chaotic Advection and Mixing in an Idealized 3D Eddy Model

G. Jay Brett (Woods Hole Oceanographic Institution)

Typically, oceanic fluid flows are well-approximated by a restriction to two dimensions; however, this approximation breaks down in the submesoscale. A laminar kinematic model for the flow within a rotating Ekman-driven cylinder is used to approximate a fully three-dimensional submesoscale eddy. Patterns of chaotic advection and stirring rates under a steady symmetry-breaking perturbation are described and matched to those of a dynamic rotating cylinder simulation from prior work. The possibility of observing such chaotic patterns in the ocean is then examined. Four methods are used to determine the importance of chaotic advection's effect on mixing with respect to smaller-scale turbulent diffusion: scaling arguments including a Lagrangian Batchelor scale, the spread of ensembles of trajectories, numerical simulations of dye release, and the calculation of a Nakamura effective diffusivity. We find that chaotic advection will dominate turbulent diffusion in the widest chaotic regions.

Spiral inertial waves emitted from geophysical vortices

Peng Wang (University of Miami)

By numerically simulating an initially unstable geophysical vortex, we discover for the first time a special kind of inertial waves, which are emitted in a spiral manner from the vortices; we refer to these waves as spiral inertial waves (SIWs). SIWs appear at small Rossby numbers ($0.01 < Ro < 1$) according to our parameter sweep experiments; the amplitude, wavelength and frequency of SIWs are sensitive to Rossby numbers. We extend the Lighthill-Ford radiation into inertial waves, and propose an indicator for the emission of inertial waves; this indicator may be adopted into general circulation models to parameterize inertial waves. Additionally, in our tracer releasing experiments, SIWs organize tracers into spirals, and modify the tracer's local rate of change by advecting tracers vertically. Further, the spirals of SIWs resembles some spiral features observed in the ocean and atmosphere, such as spiral ocean eddies and spiral hurricane rainbands; thus, SIWs may offer another mechanism to form spiral eddies and rainbands. Since no density anomaly is required to generate the spirals of SIWs, we infer that the density anomaly, hence the baroclinic or frontal instability, is unlikely to be the key factor in the formation of these spiral features.

The Objective Eulerian Skeleton of Fluid Flows

Mattia Serra (ETH Zürich)

We discuss a new objective (frame-invariant) theory for Eulerian Coherent Structure identification in two-dimensional unsteady flows. Objective Eulerian Coherent Structures (OECS) reveal the time-varying skeleton of fluid flows that instantaneously approximates the most influential material surfaces in transport and mixing. We also describe an objective non-dimensional metric that quantifies the persistence of vortex-type OECSs. In an application to persistent eddy detection in satellite-derived ocean velocity data, we find that our OECS persistence metric significantly outperforms vortex predictions from other customary Eulerian diagnostics, such as the potential vorticity gradient and the Okubo-Weiss criterion.

An Autonomous Dynamical System Captures all LCSs in Three-Dimensional Unsteady Flows

David Oettinger (ETH Zürich)

Lagrangian coherent structures (LCSs) are material surfaces that shape finite-time tracer patterns in flows with arbitrary time dependence. Depending on their deformation properties, elliptic and hyperbolic LCSs have been identified from different variational principles, solving different equations. Here we observe that, in three dimensions, initial positions of all variational LCSs are invariant manifolds of the same autonomous dynamical system, generated by the intermediate eigenvector field, $\xi 2(x0)$, of the Cauchy-Green strain tensor. This ξ2-system allows for the detection of LCSs in any unsteady flow by classic methods, such as Poincaré maps, developed for autonomous dynamical systems. As examples, we consider both steady and time-aperiodic flows, and use their dual ξ2-system to uncover both hyperbolic and elliptic LCSs from a single computation. (Based on joint work with George Haller, available under http://arxiv.org/abs/1604.05071 .)

Observations of Vorticity and Strain from Drifters in the Ocean

Sebastian Essink (WHOI/MIT)

Lagrangian velocity estimates from a large, but closely-spaced, drifter array in the Bay of Bengal are used to calculate vorticity and strain. The along-trajectory vorticity signal reveals complex patterns, supposedly generated by tides, inertial oscillations, and mesoscale and submesoscale flow. In particular, banded structures of alternating positive and negative vorticity are observed, where trajectories are parallel to the coastline. This work aims at a mechanistic understanding of the contributing factors that generate the observed vorticity patterns. By understanding the role of tides and the mesoscale circulation, estimates for the vorticity generating effect of submesoscale flows will be retrieved. The footprint of submesoscale dynamics is evidenced from a) positively-skewed distributions of vorticity, b) regions, in which high strain and high vorticity co-occur and c) a correlation between vorticity and lateral density gradients or fronts.

Title TBA

Margaux Filippi (MIT/WHOI)

(Abstract not available.)

Fukushima Cs pathway in the western North Pacific

Sachiko Yoshida (WHOI)

Radionuclide samples collected as part of the spring 2013 CLIVAR P02 at 30N revealed that the Fukushima-derived 134Cs had reached a depth of 600 m west of dateline with distinct zonal extent. Physical processes responsible for the deep 134Cs penetration in the western Pacific appear to be related to specific water mass subduction pathways, such as Subtropical Mode Water (NPSTMW) and Intermediate Water (NPIW). The Fukushima ocean discharge was deposited in the Oyashio-Kuroshio mixed region and the CLIVAR P02 observations suggest a rapid deep penetration of Cs at 30N. This short subduction time scale is key to understanding the Cs pathway spreading into the mid-depth western North Pacific Ocean. Here, a detailed

analysis of water mass property characteristics is presented. The study is based on a number of hydrographic dataset collected from the coastal survey near Japan between 2011 to 2015. Mixed layer depth is calculated from Argo float profiles in western North Pacific to examine the interannual changes in the distinct water mass production rates.

Multiple quasi-zonal jets in the South Indian Ocean

Vivian V. Menezes (WHOI)

The large-scale current systems of the world ocean is now considered as a well-known subject, mostly based on ocean circulation of the Northern Hemisphere. One distinctly different large-scale circulation system and whose dynamics is still not understood is observed in the subtropical South Indian Ocean (SIO). The SIO is dominated by a system of multiple eastward quasi-zonal jets extending from Madagascar to Western Australia, which are collectively known as the South Indian Countercurrent (SICC). These jets flow in a direction opposite to that predicted by classical theories of wind-driven circulation. Further, the subtropical countercurrent theory (also known as mode-water-induced subsurface frontogenesis) was found to be unsatisfactory to explain the observed multiple jet structure. Here, we conjecture that this persistent multiple zonal jet structure may be explained as a result of frontal perturbations associated to meridional discontinuities in the PV distribution (PV staircase-like), formed by interactions between turbulence, waves and eddies.

This is joint work with Marcio Vianna (VM Oceanica).

Scalar Moments of 2D Nonlinear Flows

Phillip Walker (Arizona State University)

Nonlinear flows are essential templates for investigating chaotic transport and mixing processes. In the autonomous and time-periodic case many tools can be used to analyze these flows- yet an analytic representation for the scalar moments caused by these flows is still missing. With the first and second order moment information known the evolution of a scalar density can be obtained without having to solve the Fokker-Planck equation associated with the flow. In this work we show the effectiveness of using a local linear-flow approximation to obtain the desired moments. The local linear-flow approximation has an analytic expression for the moments that can be used for finite-times to approximate the evolution of the scalar density. Two approximation techniques are investigated: the analytic approach, and an approach based on ensembles of tracers.