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Current Research

Lateral stirring by internal waves

- Using a combination of surface drifters, gliders, and other observations from the ONR Lateral Mixing (LatMix) experiments of 2011, my collaborators and I have shown that Stokes drift from internal waves may be responsible for the ubiquitous $O(1) \text{ m}^2/\text{s}$ submesoscale diffusivity. My work has focused on analyzing the observational data, writing and analyzing the supporting numerical models, and advancing the theoretical foundations. This work is supported by ONR.

Lagrangian dynamics of mesoscale eddies

- This research has focused on unraveling the dynamical underpinnings of mesoscale eddies through Lagrangian methods. Guided by observations from subsurface floats, surface drifters, satellite altimetry, and satellite color data, this work focuses on identifying eddy characteristics from the transport of Lagrangian, semi-Lagrangian, and passive tracers. I use numerical models, including quasigeostrophic simulations, to test our analysis techniques and compare with observations. This is supported by NSF.

Numerical modeling methods and interactive simulations

- In support of my primary research I have been working to lower the barrier to entry for numerical modeling, with the hope of engaging new audiences from students to researchers. Modern programming techniques allow a significant level of abstraction that solve many of the issues that have troubled programmers in the past. As a byproduct of this work, I will also create interactive fluid simulations on handheld devices usable by an even wider audience.

Education

Doctor of Philosophy in Physical Oceanography
Oregon State University, Corvallis, OR; 2004–2009

Master of Science in Physics
University of Oregon, Eugene, OR; 2002–2004

Bachelor of Science in Mathematics and Physics
University of Puget Sound, Tacoma, WA; 1998–2002

Full immersion exchange studying Informatik (Computer Science) and Mathematik
Universität Passau, Passau, Germany; 2000–2001

Professional Experience

Research Scientist at NorthWest Research Associates, 2012–Present
Postdoctoral Researcher at Northwest Research Associates, 2011–2012
Graduate Research Assistant at Oregon State University, 2004–2009
Graduate Research Assistant at University of Oregon, 2003–2004
Graduate Teaching Assistant at University of Oregon, 2002–2003
Summer Research Experience at Medical College of Wisconsin, 2000
Murdock Summer Research Grant at University of Puget Sound, 1999
Teaching Assistant at University of Puget Sound, 1998–2000

PI Level Funding

Satellite-derived global wind-driven ocean surface currents: incorporating local and fast-timescale dynamics into the wind-driven component of the ocean surface analyses real-time product (OSCAR). PI: K. Dohan. Subaward to PI **J. Early**. NASA: NNX10AO89G.

Studies of stirring and mixing at the submesoscale in the ocean. PI: R. Ferrari & K. S. Smith. Subaward to PI **J. Early**. ONR: N-00014-09-1-0633.

Lateral stirring by internal waves. PI: **J. Early** & M. P. Lelong. ONR: N-00014-15-1-2465.

Dynamics and transport of mesoscale eddies. **J. Early**, J. Lilly & P. Gaube. NASA.

Publications

J. Early, M. P. Lelong, K. S. Smith, M. A. Sundermeyer, A. Sykulski. Submesoscale diffusivity inferred from surface drifters.

J. M. Lilly, A. Sykulski, **J. Early**, S. Olhede. Fractional Brownian Motion, the Matérn Process, and Stochastic Modeling of Turbulent Dispersion. In prep.

J. Early, R. Samelson. Near-geostrophic approximations of the spherical shallow-water equations. Draft available at jeffreyearly.com.

Sykulski, S. Olhede, J. M. Lilly, **J. Early**. The de-biased Whittle likelihood for inference of second-order stationary stochastic processes. Submitted to *Biometrika*.

Sykulski, S. Olhede, J. M. Lilly, **J. Early**. Frequency-domain stochastic modeling of stationary bivariate or complex-valued signals. Under revision at *IEEE Transactions on Signal Processing*.

A. Guillaumin, A. M. Sykulski, S. C. Olhede, J. J. **Early**, and J. M. Lilly (2016). Analysis of nonstationary modulated time series with applications to oceanographic surface flow measurements. Under revision at *Journal of Time Series Analysis*. arXiv preprint: 1605.09107.

Elipot, S., R. Lumpkin, R. C. Perez, J. M. Lilly, J. J. **Early**, and A. M. Sykulski (2016). A global surface drifter data set at hourly resolution. *Journal of Geophysical Research: Oceans*. May 2016

T. Bartlett, A. Sykulski, S. Olhede, J. M. Lilly, **J. Early**. A power variance test for nonstationarity in complex-valued signals. *Proceedings of the 14th International Conference on Machine Learning and Applications*. December 2015.

A. Shcherbina, et al. The LatMix Summer Campaign: Submesoscale Stirring in the upper ocean. *Bulletin of the American Meteorological Society*. August 2015.

J. Early. The forces of inertial oscillations. *Quarterly Journal of the Royal Meteorological Society*. October 2012.

D. Chelton, P. Gaube, M. Schlax, **J. Early**, R. Samelson. The influence of nonlinear mesoscale eddies on near-surface oceanic chlorophyll. *Science*. October 2011.

J. Early, R. Samelson, D. Chelton. Evolution and propagation of geostrophic ocean eddies. *Journal of Physical Oceanography*. August 2011.

J. Early, J. Pohjanpelto, R. Samelson. Group foliation of equations in geophysical fluid dynamics. *Discrete and Continuous Dynamical Systems, Series A*. March 2010.

J. Early. Mathematical approaches to the physics of mesoscale oceanography. Oregon State University dissertation. Oct. 2009. <http://hdl.handle.net/1957/13656>

J.E. Brau, C. Potter, **J. Early**, J. Strube. Flavor tagging and the Higgs branching ratio measurement at the Linear Collider. *International Workshop on Linear Colliders (LCWS 2002), Seogwipo 2002, Linear colliders*. August 2002.

Products

GLNumericalModelingKit; 2012 – Present

A numerical modeling framework in Objective-C that allows rapid implementation and numerical solutions of differential equations with minimal overhead. Models include:

- Kelvin-Helmoltz instability
- Rossby waves, linear quasigeostrophic equations
- Quasigeostrophic turbulence
- Anisotropic turbulence

- Linear internal waves
- Shoaling surface gravity waves
- Surface quasigeostrophy
- Coupled inertial oscillation-quasigeostrophy

Examples can be found at <http://jeffreyearly.com/numerical-models/>

Image2Movie; 2011 – Present

A simple utility designed to make high quality movies from a series of still images. Available for download from jeffreyearly.com.

PhotoLinker; 2009 – Present

A professional level annotation and geotagging tool that provides an unprecedented level of map, GPS track and photo tag interactivity. PhotoLinker is sold by Early Innovations, LLC on the Mac App Store.

GPSPhotoLinker; 2004 – Present

The first geotagging tool for Mac OS X, GPSPhotoLinker also introduced the world to the concept of reverse geocoding. GPSPhotoLinker is still available for free download.

Presentations

AGU Ocean Sciences Meeting, New Orleans, Louisiana, February 2016. “Disentangling mesoscale strain and internal waves using surface drifters.”

Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics (LAPCOD), Winter Harbor, Maine, July 2015. “Diffusivity and the internal wave spectrum from Lagrangian drifters.”

Conference on Atmospheric and Oceanic Fluid Dynamics (AOFD), Minneapolis, Minnesota, June 2015. “Diffusivity and dynamics of linear internal waves: a Lagrangian perspective.”

Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, April 2015. “Diffusivity of surface drifters from internal waves.”

DigiPen Institute of Technology, Redmond, Washington, March 2015. Guest lecture on numerical methods and geophysical fluid dynamics.

Ocean Sciences, Honolulu, Hawaii, February 2014. “Submesoscale diffusivity inferred from surface drifters.”

New York University, New York, New York, September 2012. “Scaling & near geostrophic approximations to the spherical shallow water equations.”

University of Washington, Seattle, Washington, February 2012. “Rossby waves or eddies: comparing quasigeostrophic theory with satellite altimetry observations.”

Ocean Sciences, Salt Lake City, Utah, February 2012. “Rossby waves or eddies: comparing quasigeostrophic theory with satellite altimetry observations.”

Conference on Atmospheric and Oceanic Fluid Dynamics (AOFD), Spokane, Washington, June 2011. “The evolution and propagation quasigeostrophic eddies.”

New York University, New York, New York, November 2009. “Theoretical approaches to understanding satellite altimetry tracked eddies.”

American Mathematical Society, Sectional Meeting, Bloomington, Indiana. April 2008. “Group foliation and the Korteweg de-Vries equation.”

Reviews

Bulletin of the American Meteorological Society

Geophysical Research Letters

Journal Geophysical Research – Oceans

Journal of Marine Science and Technology

Journal of Physical Oceanography

National Science Foundation – Physical Oceanography

National Science Foundation – Physical Oceanography Review Panel

Nature

Quarterly Journal of the Royal Meteorological Society