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14. ABSTRACT
Collaborative with the PHILEX team in two separate areas is described. One involves stirring, mixing and Lagrangian predictability at the surface of the Phillipine Archipelago. This work uses dynamical system theory in combination with model and observations by other investigators in the PHILEX program. The second area concerns the deep circulation and, in particular, the overflow over the Panay Sill and its consequences for ventilation of the deep Sulu Sea.

15. SUBJECT TERMS
Physical Oceanography, separation phenomena, Philippine Archipelago, wind-generated dipoles, horizontal filamentation, Langrangian

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The Physics and Forecasting of Separation Phenomena in the Philippine Archipelago

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LONG TERM GOALS

To better understand stirring, mixing and transport processes in the Philippine Archipelago.

OBJECTIVES

Use models and data from PHILEX program to map out and quantify stirring and mixing processes at the sea surface. Also, to locate and quantify deep mixing processes associated with overflows.

APPROACH

Apply dynamical systems analysis and hydraulic theory to models and observations.

TASKS COMPLETED

We (Rypina, et al. 2010) have completed a comprehensive analysis of stirring and mixing at the surface of the Philippine Seas through the use of various numerical models, satellite observations and underway temperature observations.
Another study (Tessler, et al. 2010) has described and quantified a region of deep, basin-to-basin mixing and transport associated with the Panay Sill overflow.

RESULTS

In Rypina et al. (2010) we establish chaotic advection as a reasonable model for understanding stirring processes at the sea surface. By plotting the stable and unstable manifolds of the surface flow field, we identify regions of rapid and limited stirring and the barriers that separate them. We also have performed more detailed analysis of mesoscale features, including wind-generated dipoles, and mapped out pathways of chaotic transport indicated by turnstile lobes. We have used this pathway to describe the transport of biological properties from nearby coastlines. From the characteristic lobe stretching rates we have attempted to identify the 'arrest' scale: the minimum filament width that can exist before sub-mesoscale diffusive processes intervene.

The Panay Sill project has made use of hydraulic theory to estimate the deep transport into the Sulu Basin and has identified hydraulic control as a process that limits this transport. Estimates of downstream mixing rates and penetration depths have also been made.

IMPACT FOR SCIENCE

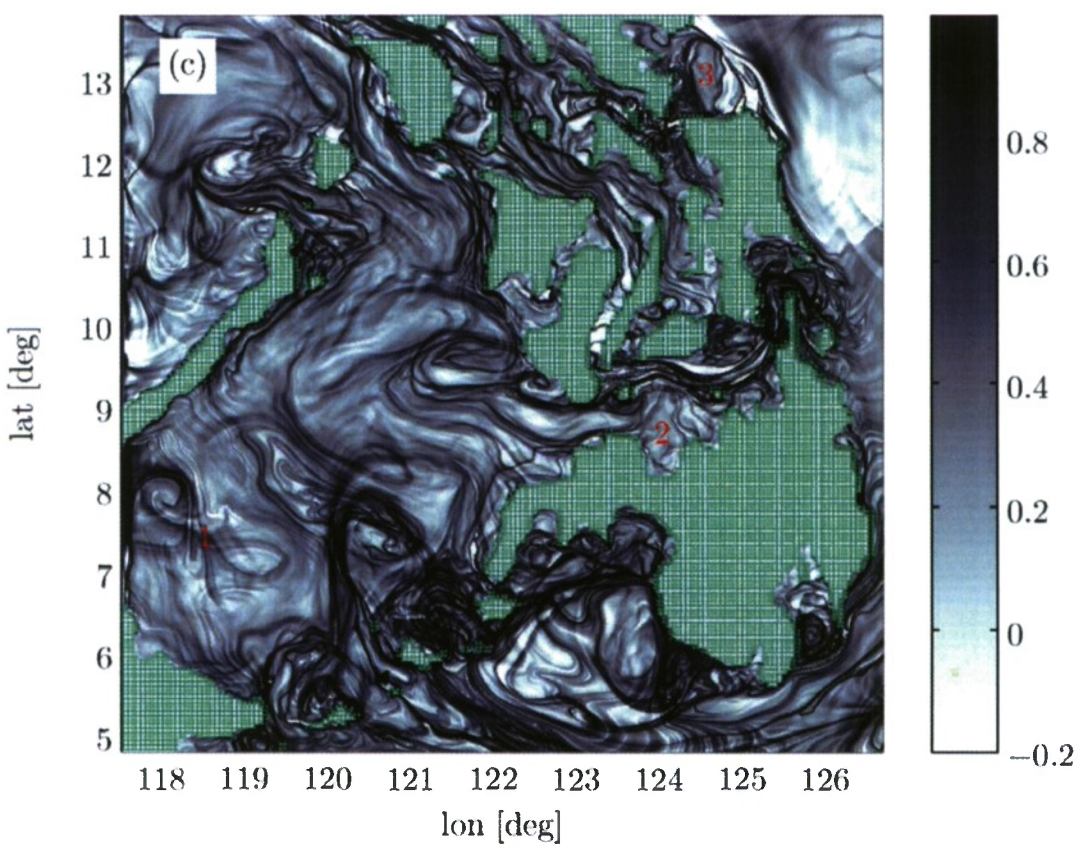
The insights in to surface stirring, mixing, and transport have clarified a process by which nutrient rich water from Manila Bay can be stripped away, carried offshore, and entrained into a dipole. This process should be useful in understanding the dispersal of pollutants and the offshore distribution of biological fields. Our study also sheds light on the horizontal filamentation and mixing of physical and biological tracers and the surface of the Archipelago in general. These processes are important for an overall understanding of the distribution of these properties. The Panay Sill project gives insights into how the deep circulation in the archipelago is controlled and how the deep Sulu Sea is ventilated.

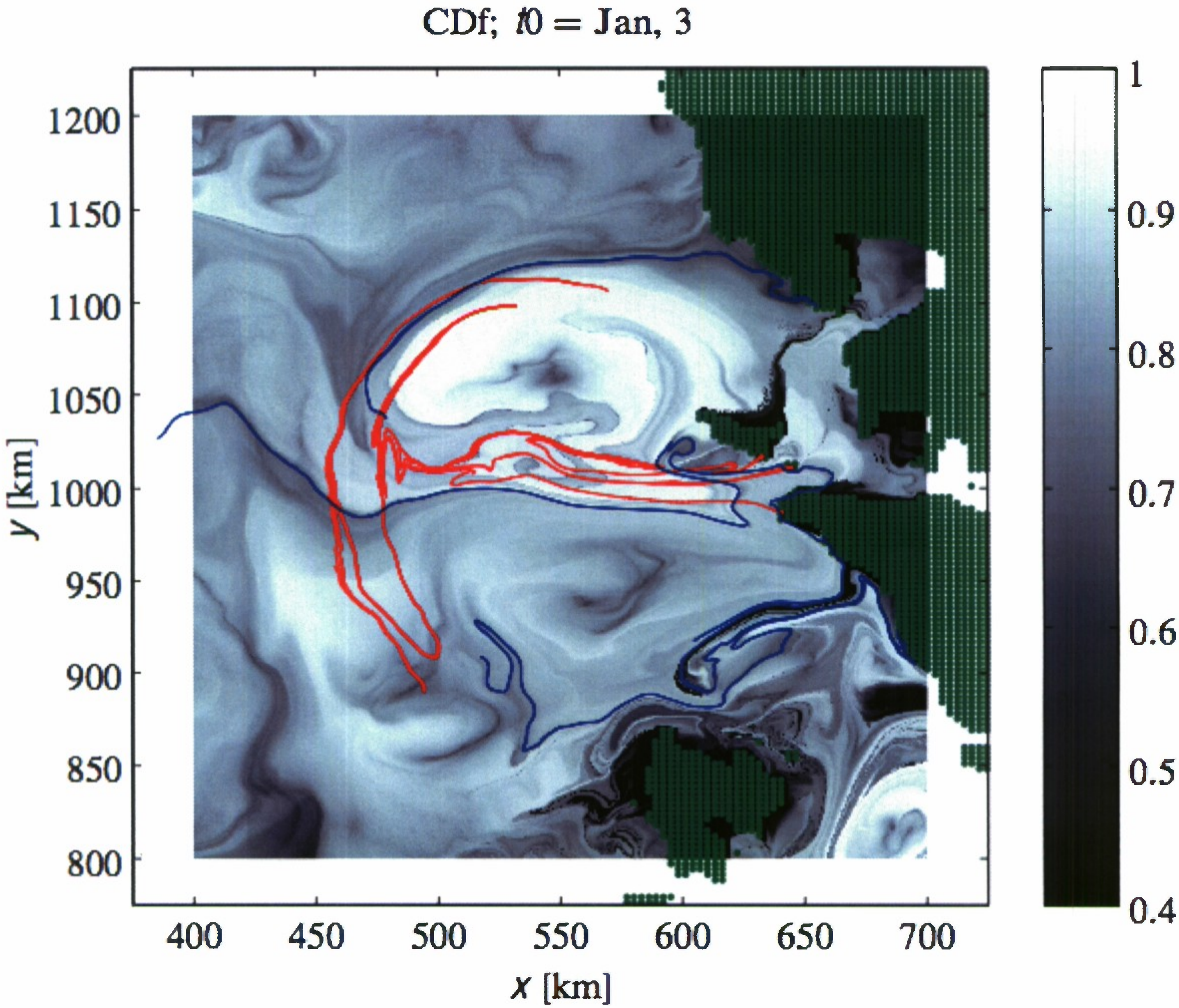
RELATIONSHIPS TO OTHER PROGRAMS

Our maps of stable and unstable manifolds at the surface of the Archipelago would be extremely useful for any operation that involves Lagrangian predictability. This would include search and rescue operations.

FIGURES/PICTURES

Stable and Unstable Manifolds for a dipole structure west of Manila Bay.





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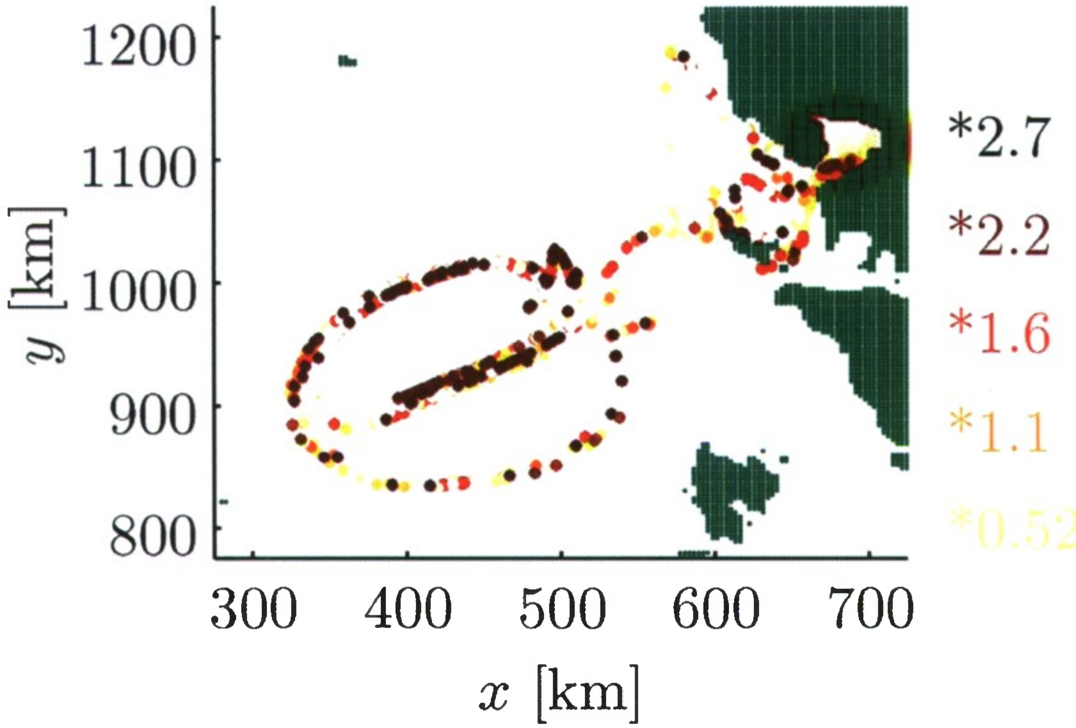

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Rypina, I. I., L. J. Pratt, J. Pullen, J. Levin, and A. Gordon, 2010. Chaotic Advection in an Archipelago. Submitted to the *Journal of Physical Oceanography*.

Tessler, Z., A. Gordon, L. J. Pratt, and J. Sprintall (2010). Transport and Dynamics of Panay Sill Overflows in the Philippine Seas. Submitted to the *Journal of Physical Oceanography.*