Meso- and submesoscale mechanisms of vertical exchange of fluid associated with mesoscale eddies around Hawaii

Meso- and submesoscale surface temperature fronts are ubiquitous in the surface ocean around the Hawaiian Islands and tend to be regions where the surface chlorophyll concentration is larger. These surface fronts are shown to be coincident with regions of large straining by calculating the Finite-Size Lyapunov Exponents. Elongated submesoscale filaments, generated by the straining of the eddying flow are associated with large vertical velocities and can act as an important pathway for the vertical exchange of fluid between the nutrient-rich waters below the euphotic zone and the sun-lit upper ocean. Using high-resolution model simulations we focus on surface frontogenesis and nonlinear Ekman pumping as the main mechanisms in generating submesoscale vertical velocities of the order of 70m/day around Hawaii. Such velocities are likely to have a significant impact on primary productivity and export productions in the oligotrophic ocean by allowing episodic nutrient injections and organic material export.

Quantification and comparison of patch, class, and seascape scale metrics for the shallow coral reefs of the Northwestern Hawaiian Islands

The science of Landscape Ecology (LE) seeks to describe the influence of spatial patterning on the dynamics of ecological processes. Within this scientific paradigm, the research quantifies and compares the patch, class and seascape scale metrics that depict the spatial patterns of the shallow coral reef habitats of the Northwestern Hawaiian Islands. The research describes the distribution and complexity of reef habitats with LE metrics and explores the influence that habitat heterogeneity at various maps scales has on within- and among-habitat connectivity for mobile reef organisms with different movement ranges.

Finding seamounts in the satellite-derived gravity field

Seamounts are ubiquitous volcanic features on the ocean floor and they occur in a variety of tectonic settings. Understanding their spatial distribution, volumes, and summit depths is important for both practical and scientific endeavors. From a practical perspective, seamounts can pose obstacles to navigation and cause focusing or shadowing of acoustic and tsunami waves. From a scientific perspective, they sustain important ecological communities, determine habitats for fish, and act as obstacles to water currents, thus enhancing tidal energy dissipation and ocean mixing. Furthermore, both geographical-and size-distributions of seamounts give key insight into the variations of underwater volcanism through time and space and hence the plate tectonic processes that formed them. For all these reasons, it is important to locate and characterize seamounts globally.
Elastin is the principal protein component of the elastic fiber, a structure that is found in vertebrate tissue. Elasticity of blood vessels and skin, among other structures in the human body, is thought to originate from the eponymous protein elastin. Although clearly an essential element, very little is known about the molecular-scale organization of elastin. I.e., is it much like rubber or does it form discrete conformations that are key to understanding its structure-function relationships? How do molecular dynamics figure into the picture?

Elastin is unique in its largely hydrophobic composition, thought to be a mass of possibly-structured long, floppy chains interspersed with covalent crosslinks. The now-classic description of elastin and its soluble precursor tropoelastin identifies two domain types, crosslinking and hydrophobic. The former are typically polyalanine stretches interspersed with lysines (tropoelastin) and/or heteroaromatic crosslinks (mature elastin), and the latter are characterized by unique, repeating polypeptide sequences. For many years, it was believed that the hydrophobic regions held the key to understanding elasticity. More recently, however, our group and others have provided experimental evidence that the crosslinking region plays a more critical role than previously believed. Furthermore, our initial computations of the crosslinking domain encoded by spliced exons 21 and 23, as expressed in humans, show that water plays a pivotal role in the folding and unfolding of the protein.

The primary goal of this project was to gain, through fundamental research using LES, a deep understanding of the physical mechanisms underlying the fluid-structure interaction in tsunami or hurricane waves impacting over coastal structures. Success in the planned work will leverage the experimental resources and findings in another NSF project by providing novel and vital insight into this complex and critical phenomenon, and by developing modeling and simulation capabilities to the development of PBTE.