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"Measuring Flows in the Ocean: A Case for Further Sensor Development and Testing"

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The acquisition of both spatially and temporally resolved experimental data is one of the greatest challenges in solving real-world fluids engineering problems. Experimental observation and analysis methods have the potential to unlock many secrets of fluid flow in the complex marine environment, for a wide range of Naval, environmental, biological and engineering applications. The development of sensors capable of being deployed in the deep ocean to assess flows, such as oil spill plumes, gives rise to critical challenges that must be addressed so that scientists have an array of well-characterized flow sensors at-the-ready. Accurate experimental data is vital in order to develop robust hydrodynamics models for, and assess the accuracy of, numerical simulations and design tools, which can enhance the utility of the next generation of oceanographic exploration vehicles.

Typical flow sensors rely on optical access, using lasers and digital cameras, and few sensors are capable of measuring non-transparent flows. Image based sensors, using light-field imaging methods, have great potential for *in situ* measurement in turbid and multiphase flow conditions. As the cost of high quality imaging sensors comes down, arrays of multiple cameras become economically viable options for gathering three-dimensional, time resolved flow data. However, these techniques still cannot succeed in measuring inside opaque flows. Acoustic techniques are widely used in ocean flow sensing and have been proven successful where imaging techniques have not proven useful, for example both at hydrothermal vents as well as in the 2010 Deepwater Horizon oil spill.

Time-resolved, volumetric observational techniques can deliver highly accurate experimental data for unsteady hydrodynamic flows and provide critical insights for the design and understanding of many systems that operate in the marine environment, including surface ships, submarines, undersea projectiles, offshore oil platforms, and ocean energy systems, and to evaluate potential environmental impacts in the case of oil or chemical spills. Examples from both field and laboratory experiments will be discussed, which highlight the power of experimental observation and the need for further sensor development.