Title:
Motion Tomography and Collective Mobile Sensing in the Ocean

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Abstract:
Modeling and predicting ocean currents are great challenges for physical oceanography due to the lack of direct measurements. Mobile sensor networks have been proven to be an effective tool to answer this challenge, providing estimated flow information along the Lagrangian trajectories. To incorporate these flow estimates into ocean models, existing approaches based on Lagrangian data assimilation usually require significant amount of computing power. We develop generic environmental models (GEMs) to combine computational ocean models with real-time data streams collected by mobile sensing platforms to provide high-resolution predictions of ocean current in a small spatial area around the mobile platforms. Motion tomography (MT) can be viewed as a novel way to construct GEMs. The method fuses the data collected by multiple mobile platforms along their paths to formulate an "inverse problem" that has been the core problem underlying medical CT imaging. By solving this inverse problem, a high-resolution spatial map of ocean flow in the volume traversed by the mobile platforms can be reconstructed. While a similar inverse problem has been formulated and solved in ocean acoustic tomography to reconstruct spatial maps of sound speed, motion tomography provides a "directly measured" Eulerian map of ocean current, which has never been achieved by other means before. MT may significantly increase the spatial accuracy of GEMs. More accurate GEMs also feed high quality data to data assimilation algorithms, hence eventually improve ocean circulation models.