Trajectory Optimization for Underwater Vehicles in Time-Varying Ocean Flows

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Motivation

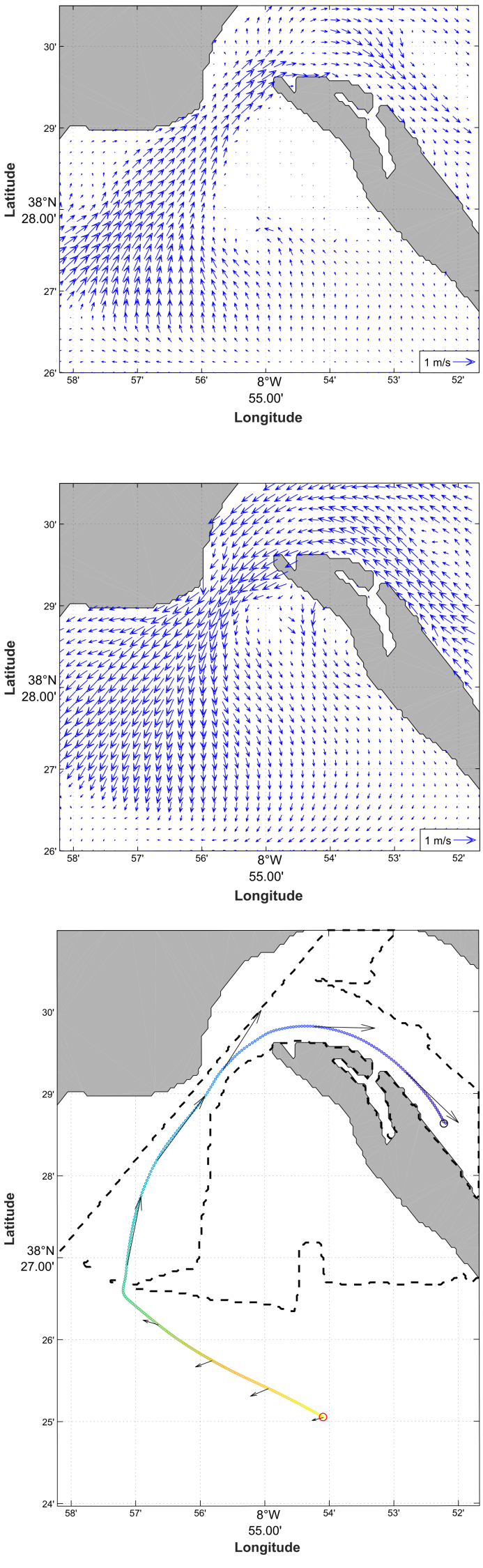
- Path planning for missions in spatially constrained areas with strong currents that can temporarily overcome the vehicle's maximum velocity
- The initial position and deployment time may not be known in advance
- Optimize the initial position and deployment time

Approach

- Simple (planar) motion model:
  $\dot{\mathbf{x}}(t) = \mathbf{u}(t) + \mathbf{v}(t, \mathbf{x}(t)) \quad |\mathbf{u}(t)| \leq \mathbf{u}_{\max}$
- Objective: reach a target set minimizing the performance index
  $$\int_{t_{\text{init}}}^{t_{\text{arrival}}} g\left(\mathbf{x}(t)\right) \mathrm{d}t$$
- Value function for this problem satisfies a Hamilton-Jacobi PDE, solvable using level set methods

Results

- Hydrodynamical model of the Sado estuarine region in Portugal
- Goal: enter the inner region of the estuary in minimum time avoiding low-depth regions
- Observed a 50% velocity gain in some trajectories
- Generated trajectories are feasible
- Future work: experimental tests and 3d problems



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