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Quasi-3D Statistical Inversion of Oceanographic Tracer Data

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The application we are presenting involves estimating water velocities and diffusion coefficients in a 2 km deep region in the South Atlantic Ocean. Partial and sparse measurements of tracer concentrations (salinity, oxygen, etc.) are available. The data are filtered to eliminate outliers, then interpolated to the nearest point on a regular lattice and restricted to thin neutral density layers. The connection between velocities, diffusion coefficients, boundary conditions and tracer concentrations is made via a 3D advection-diffusion equation and a geostrophic flow model. A robust solution to this inverse problem can be obtained by introducing prior information on the parameters (velocities, diffusion coefficients, boundary values) and modeling the measurement error. The (un-normalized) posterior density of the parameters conditionally on the data is summarized using Markov chain Monte Carlo techniques. We reconstruct the tracer fields as well, thus, for regions where no data was available, concentrations are now estimated in a manner that is consistent with physical principles. This approach is extended to a model with multiple active layers interconnected via thermal wind equations.

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