

## **Finding the Reference Velocity from Hydrographic Data: The Box Inverse**

This project addresses one of the oldest problems in oceanography: the determination of a reference for the geostrophic shear calculated from hydrographic data. It is a relatively straightforward matter to calculate the geostrophic shear given measurements of temperature, salinity and pressure along a section. The absolute velocity is made up of the sum of the vertically integrated shear and a reference velocity, which may be horizontally variable. All methods of determining the reference velocity depend to some extent on the conservation of such properties as mass, heat, salt, and other tracers. In doing this project, you will examine some of the assumptions (and their consequences) that go into the estimation of the reference velocity.

I have supplied some data from a section across the mouth of the Labrador Sea. Here are some of the steps you may have to take:

1. The first step is the calculation of the geostrophic shear, which involves the calculation of horizontal derivatives of density. In doing this, you will have to address the issue of the “bottom triangle.” The bottom triangle is the region defined by the lowest common depth of two adjacent stations and the bottom of the deeper station. If you were to use some sort of finite difference estimate to calculate horizontal derivatives, you would face a problem in the bottom triangle. There are a variety of approaches to this problem in the literature. One sensible approach is to make an objective map of the section before calculating derivatives.
2. The next step is to determine some constraints that the absolute velocity must satisfy. The conservation of mass over the entire depth of the ocean is an obvious constraint. Other possible constraints are conservation of mass over layers, and conservation of temperature, salinity, and other tracers over the ocean depth or defined layers. My advice is to try few constraints at first, and then to evaluate what additional constraints teach you.
3. What makes a good reference velocity? You will have to decide upon and initial reference level. You will also have to decide whether your solution should be best in the sense that it is small, or smooth, or confined to a certain location, or whatever.
4. You may wish to examine the uncertainty in your estimated reference velocity. This will involve determining the error in your constraints. Another source of uncertainty is the estimation of the geostrophic shear.
5. The resolution of your solution is an interesting issue. How well can you resolve the reference velocity? Given your constraints, you can probably estimate only certain scales in the reference velocity.