MAST 4667/667: Introduction to Arctic Oceanography (Fall 2014)

Oct.-16, 2014

Workshop/Homework-7: Thermal Wind (PhD-students only)

Data: Ice-Tethered Profiler (ITP) at http://www.whoi.edu/website/itp/overview

Introduction.* Observed vertical and horizontal density gradient relate to a geostrophic flow field via the thermal wind relation

$$\partial V/\partial z = -g/(\rho f)\ \partial \rho/\partial x$$

where V is the velocity component perpendicular to the two stations at x1 and x2 from which to estimate $\partial\rho/\partial x \approx (\rho 2-\rho 1)/(x2-x1)$. The constants g=9.81 m/s^2 and f=1.4×10^{-4} s^{-1} are gravity and Coriolis parameters. The vertical co-ordinate z increases towards the sea surface and x is an along-track distance.

Estimating V, you must perform a vertical integral of the right-hand side of the thermal wind equation. Start this integration with V(z=-700)=0 m/s.

Goal. Estimate geostrophic flows using ITP buoy data.

Assignment.

1. Generate a clean, averaged time series of density profiles 5 days apart.

2. Estimate the vertical current shear $\partial V/\partial z$ as a function of time t, depth z, and along-track distance x from your observations of $\rho=\rho(t,x(t),z)$.

3. For successive locations 10 days apart, estimate the velocity V(t,x(t),z) relative to zero flow at 700-m depth that serves as the assumed level of no motion.

4. Show the geostrophic velocity both as a section, e.g., V(x,z) and as a map, e.g., V(lat,lon, z=-10 m). Recall that V is perpendicular to a line connecting the two profile locations x1 and x2 that in your data may change with time also.

5. What is the difference between the geostrophic velocity near the surface V(t,x(t),z=-10 m) and the observed buoy drift (or ice) velocity?

6. Post graphics and data on your web-pages along with an interpretation as a separate text file not to exceed 500 words.

(*) This way to estimate thermal wind shear is for instructional purposes only. Alternative approaches involve production of a grid $\rho_{ij}=\rho(x_i,z_j)$ which is then shifted in "i" and summed in "j." There are many ways to generate and manipulate grids.