Mean baroclinic structure of the Polar Front in stream coordinates near the Shackleton Fracture Zone

Annie Foppert (annie_foppert@my.uri.edu), Kathleen A. Donohue, D. Randolph Watts
University of Rhode Island, Graduate School of Oceanography

1. Introduction

cPIES recorded acoustic travel time, \(\tau\), 2x-daily during the cDrake experiment (11/2007 – 11/2011)

Shackleton Fracture Zone (SFZ): predominant bathymetric ridge in Drake Passage

Examine sub-surface structure of Polar Front (PF) as it navigates the SFZ by projecting acoustic travel time, \(\tau\), from C-line into stream coordinates

2. Methodology

From AVISO/CLS09:
- Local maximum of \(\nabla\text{SSH}\) along C-line at SFZ (58.5°S)
- SSH contour associated with this maximum quasi-perpendicular to C-line nearly 60% of the time coincident with cDrake

Refine PF definition with cPIES data:
- Strongest \(\tau\) gradient located either north or south of, not above, the SFZ
- Median difference: 3.3 ms \(\pm 20\) cm of geopotential height

Define core \(\tau\) values based on location relative to SFZ:
\[ \tau_{\text{north}} = 2.6794 \text{ s (N=719)} \]
\[ \tau_{\text{south}} = 2.6827 \text{ s (N=326)} \]

Stream coordinate system:
- A line of measurements will smear the gradient, if not projected onto the frontal (PF) axis
- Stream coordinates move with the core of the jet

3. Baroclinic velocity and relative (shear) vorticity

Baroclinic (BC) velocity is referenced to zero at the bottom:

One set of times (\(|\theta|<20°\))

4. Potential vorticity, \(Q\)

\[ Q = \frac{1}{\rho} \frac{\partial \rho}{\partial z} U + \frac{1}{\rho} \frac{\partial \rho}{\partial z} f + \frac{\partial U}{\partial Y} + kU \]

\(Q\) in density layers

Neutral density \(>28.1\) kg/m

Refined \(Q\) in density layers

5. Conclusions

- The structure of the Polar Front, in both baroclinic velocity and potential vorticity, remains remarkably similar, regardless of location relative to the Shackleton Fracture Zone
- When the PF is downstream (north) of the SFZ, it centers on a higher geopotential by approximately 20 cm.
- PF satisfies the necessary condition for baroclinic instability whether it is upstream or downstream of the SFZ

6. Future Work

- Inclusion of barotropic component of the velocity and PV fields with bottom pressure and current measured by cPIES
- Mixed barotropic-baroclinic instability model

References


For more information on cDrake, see the following posters:
- #950

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