Lagrangian diffusivities in the ACC of 1/10°POP

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Questions

- Horizontal and Vertical patterns of Taylor diffusivity
- Detectable given number of floats?
- Where to deploy?

★New★

- 4 patches
- put two deployments together (→ 160 floats)
- projection along/across streamlines
- streamline bins instead of latitude bins
Parallel Ocean Program Model

- 1/10° horizontal resolution, 2-9 km grid spacing between 79°S - 34°S
- 40 depth levels (10 m - 250 m cell thicknesses)
- Subgridscale mixing: horizontal: biharmonic diffusion for tracers and momentum. Vertical: KPP
- NCEP/NCAR 6 h air-sea heat fluxes and evaporation, monthly ISCCP (shortwave and cloud fraction), MMS (Spencer, 1993) and Xie, Arkin 1997 precipitation
- Restoring to SSS, SST climatology (Steele et al. 2001) under ice, open ocean SSS restoring with timescale of 6 months

(Maltrud and McClean, 2005)
Trajectories from all deployments

- release in 4 patches
- 300 m, 800 m and 1500 m
- two groups per patch and depth
- 60 days apart, 80 floats each
- initial deployment grid: 1/4° spacing
- floats are advected by model flow
\begin{align*}
\left\langle u'_i(x, t) \Theta'(x, t) \right\rangle &= - \int_0^t d\tau \partial_\tau \kappa_{ij}(x, \tau) \partial_{x_j} \Theta(x, t - \tau) \\
\kappa_{ij}(x, \tau) &= \int_{-\tau}^0 d\tilde{\tau} \left\langle u'_i(t_0 \mid x, t_0) \ u'_j(t_0 + \tilde{\tau} \mid x, t_0) \right\rangle_L \\
\tau \to \infty : \\
\left\langle u'_i(x, t) \Theta'(x, t) \right\rangle &= - \kappa_{ij}^\infty(x) \partial_{x_j} \Theta(x, t)
\end{align*}

1 Defining Means

\[ v'_E = v_f(x, t) - V_E(x, t) \]
\[ v'_L = v_f(x, t) - V_L(t) \]

1/10° 1998-1999 mean meridional velocity in one bin [\( cm/s \)]

\[ \bar{v}_E = (-2.26 \pm 4.04) cm/s \quad \bar{v}_L = (-1.73 \pm 3.23) cm/s \]
Method

- eliminate points in mixed layer
- subtract $u_E(x)$ from each float velocity
- project each residual float velocity along/across local streamline
- Bin: 10° in longitude, streamlines
- compute diffusivities, 100 times subsampling bin
- $\kappa_{inf} = \kappa(\pm 75)$, statistically different from zero
- average over 100 times bootstrapping and $\kappa(\pm 75)$
Across-stream diffusivity $[m^2 \text{s}^{-1}]$
All bins: $\kappa_\perp$: Depth dependence
All bins, $\kappa_\perp$: North and South of SAF
All bins, $\kappa_\perp$: Depth, streamline dependence
DIMES: P3, DD300/1500 m, 160 floats each
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Depth [m] vs. $\kappa_\perp$ [m$^2$/s] with data points indicating depth and $\kappa_\perp$ values for South and North of SAF.
DIMES: P3, DD300/1500 m, 80 floats each
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\[ \kappa_\perp \text{ [m}^2/\text{s]} \]

Streamline

- DD300
- DD1500

\[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \]

\[ 0 \quad 500 \quad 1000 \quad 1500 \quad 2000 \quad 2500 \quad 3000 \quad 3500 \]
Summary

- \( \kappa_\perp \): highly inhomogeneous horizontal patterns \( \approx \) eddy intensity

- streamwise average: masking high longitudinal variability. North of SAF: 2000 m\(^2\) s\(^{-1}\), decrease with depth South of SAF: 1000 m\(^2\) s\(^{-1}\), no maximum at depth detectable

DIMES Region:

- latitudinal dependence: high at core of jet with decrease northward

- no depth dependence detected

- from P3 DD300,1500: changes \( \pm 500 \) for upper 1000 m, \( \pm 1000 \) detectable
\( \kappa || : P3, \text{ DD300/1500 m, 80 floats each} \)
**P3: \( \kappa_\perp \) as a function of timelag**
P3: $\kappa_{||}$ as a function of timelag
All bins, $\kappa_\parallel$: Depth, streamline dependence

![Graph showing depth and streamline dependence with data points and lines indicating trends.](image)

- Depth [m]
- $\kappa_\perp$ [m$^2$/s]

- South of SAF
- North of SAF

- Streamlines with data points indicating $\kappa_\perp$ values for different depth ranges.