### Introduction

Zonal jets might play an important role in the ocean circulation and their effects on tracer transport should be included in ocean climate models. These models do not resolve mesoscale and eddy processes. However, PV is an active tracer and its fluxes can be expressed in terms of potential vorticity and buoyancy fluxes.

### The Numerical Model and Eulerian Analysis

**Zonal Flow in a Channel**
- Heating (cooling) at equatorward (poleward) boundary, no surface forcing
- Rossby Radius: $\text{Width} = 4500 \text{km}, \text{Depth} = 2000 \text{m}$

**Eulerian Diffusivity Estimates**
Dissipation estimates for PV and buoyancy are shown in Figure 1. The black lines indicate the zonal mean zonal flow, whereas the white line indicates the difference between the zonal mean and the instantaneous flow.

**Lagrangian Diffusers and Mean Particle Velocity**
We partition the meridional plane in a grid of bins of 200 km x 200 m. We use a pseudo-trajectory to a bin if its central point is located in the bin. The mean particle velocity calculated from 200 day trajectories shows the expected meridional overturning circulation caused by the diabatic forcing in the restoring zones. Black lines indicate Lagrangian zonal mean flow.

**Single Particle Diffusivity**

- Taylor (1921): $K = \frac{2}{\Delta t} \left( \frac{\Delta x}{\Delta y} \right)$
- Davis (1991): $K = \left( \frac{\Delta x}{\Delta y} \right) \left( \frac{\Delta y}{\Delta x} \right)$
- Bratseth (1998): $K = \frac{1}{\Delta t} \left( \frac{\Delta x}{\Delta y} \right) \left( \frac{\Delta y}{\Delta x} \right)$

**Different Estimates for meridional diffusivity $K_y$**

- At the 50 day lag the diffusivities defined by Davis (1991) and Bratseth (1998) show minima within the jets. While the difference between values inside and outside the jet is on the order of 1-2 magnitudes for the Davis-diffusivity, the difference of Bratseth-diffusivity is about 1 order of magnitude.

**Objective**
Can we find Lagrangian float statistics which resemble the distribution of PV diffusivity obtained from Eulerian estimates?

**References**
- Davis, R. E., 1991: Observing the general circulation with floats.
- Davis-diffusivity tensor was very noisy in the baseline experiment. Presumably, this noise is caused by the strong shear of the zonal mean flow. We use a different set of particles, integrated with the velocity $u = \frac{v}{\Delta x}$, where $\Delta x$ is the zonal mean velocity.

**Comparing Estimates of Isopycnal Diffusivities in Zonal Jets Obtained from Eulerian Analysis and Lagrangian Particle Statistics**

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<tr>
<th>Parameter</th>
<th>Eulerian Estimates</th>
<th>Lagrangian Estimates</th>
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<td>$K_y$</td>
<td>$\frac{2}{\Delta t} \left( \frac{\Delta x}{\Delta y} \right)$</td>
<td>$\frac{1}{\Delta t} \left( \frac{\Delta x}{\Delta y} \right) \left( \frac{\Delta y}{\Delta x} \right)$</td>
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### Discussion

In our study we find similarities in the meridional distribution of Lagrangian estimates of isopycnal diffusivity and Eulerian estimates of potential vorticity and buoyancy. It remains to be seen whether or not there exist any similarities in the zonal direction.

**Theoretically**, single-particle estimates of diffusivity rely on the assumption of a random-walk behaviour of individual particles. The presence of a coherent, mean-flow pattern which is larger than the mixing-barrier, cannot lead to random-walk behaviour. Nevertheless, diffusivity estimates using single-particle statistics yield a physically reasonable distribution in the vicinity of the jets and in the jet cores.

**Previous studies** suggest that unresolved tracer transport in the ocean can generally not be modelled with an isopycnal diffusivity. Diffusivity transport parametrizations are adequate for flows in which there is no mixing and therefore no mixing-barrier. This is the case for the transport of passive tracers in a well-mixed layer. The time-series of $K_y$ in our model suggests that meridional particle displacements can be viewed as statistically independent between intervals of 50 days.