1. Introduction
Vertical exchanges in the ocean supply nutrients to the euphotic zone, subsidize matter in the deep ocean and can be strong when driven by meso and submesoscale dynamics. Vertical velocity \( w \) is driven by different sources: deformation of the main flow at different vertical and horizontal scales, surface forcing, inertia-gravity waves, ...

\( \text{However } w \text{ is difficult to observe because it's localized, has a small spatial scale, low intensity and a rapid variability. Thus, it is usually diagnosed from other data, most often using the } Q\text{-equation.} \)

Here we compare and contrast the results from the \( Q\text{-equation} (\omega) \) in different flow regimes using different data sets.

\[
Q = Q_{TW} + Q_{DAG} + Q_{TD} + Q_{FL}
\]

2. The Omega Equation

\[
\frac{\partial \Omega}{\partial t} + \nabla \cdot (\vec{V} \cdot \nabla \Omega) = \nabla \cdot \mathbf{Q}
\]

Different forcings can drive vertical velocity:

\[
\Omega = \text{fromogenesys + Deformation of the thermal wind imbalance + Turbulent fluxes of momentum and buoyancy + Trend of the thermal wind imbalance)
\]

3. Boundary conditions

The impact of the boundary conditions was studied by comparing different versions of the \( \Omega \) vector. In particular div(\( \Omega \)) and the boundary conditions were derived directly from \( \omega \) to get an information on the accuracy of the solution.

4. Vertical velocity

The data from four contrasted regions in the NATL60 simulation is used to calculate \( w \) and compare the results to \( \omega \).

- numerical code : NEMO v3.5
- horizontal grid : 1.60°
- vertical grid : 300 levels
- realistic boundary conditions and atmospheric forcing
- 4 series of 10 consecutive daily averaged outputs in March-June-September-December

MDV: TW + DAG + FL:

\[
\text{Vertical velocity from the quasi geostrophic } \Omega \text{-equation including the ageostrophic field and the windstress}
\]

5. Dynamical regimes - regionality

The selected regions have very contrasted dynamics that affects the reconstruction of the vertical circulation by the \( \Omega \)-equation.

- LMX : in this region energetic mesoscale is well represented but the coherence decreases rapidly towards the small scales.
- OSM : the region where the small scales are reproduced best by \( \omega \) but only when the ageostrophic velocity is also included.
- A2O : in general \( \omega \) doesn't represent well the vertical circulation in this region, although \( \omega \) is generally weak everywhere.
- REK : here, including higher order dynamics doesn't substantially improve the solution.

6. Summary and ongoing work

- The vertical velocity inferred from the \( \Omega \)-equation represent well the mesoscale energetic patterns.
- It doesn't give good results at submesoscale (below few tens of kilometers) in any dynamical regime.
- the reconstruction from deformation has different skills depending on the region (and season)
- improvement due to the inclusion of the others terms is also region (and season) dependent

7. SWOT

- Lower the resolution of the subsurface data
- how is the solution impacted by a reduced resolution in subsurface coupled with a high resolution surface information?
- what kind of in situ information would be needed to resolve \( \omega \) depending on the regime?
- \( Q\) variable fidelity
- how to propagate the information on the subsurface ?
- can vertical modes of variability be identified ?