Supporting Information for

"Vertical motions in a fine-scale cyclonic structure observed in the Ligurian Sea and their effects on a biogeochemical tracer"

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Details on objective mapping analysis

In this study we use the method of Le Traon (1990) to access 3-D fields of density and horizontal velocities from 2-D observations. The method consists in an optimal interpolation, correcting a background mean value through a weighted average of the anomalies with respect to the mean background. It is a useful technique because neither the mean nor the fluctuations need to be known *a priori*, but it does need a functional form to be prescribed for the mean along with the statistics of the fluctuating anomalies and error variance. In our case study, the functional form for density is an ellipse, so we have the following matrix of size N × M, for N data points and M functions, F_{NM}
where $F_{N1} = 1$, $F_{N2} = x_N^2$ and $F_{N3} = y_N^2$.
The linear relations for u and v follow from the assumption of geostrophic balance and the density field's contribution to vertical velocity shear:

$$\frac{\partial \rho}{\partial x} = -\frac{\partial v}{\partial z} \quad \text{and} \quad \frac{\partial \rho}{\partial y} = \frac{\partial u}{\partial z}$$

For u, we thus have:
$F_{N1} = 1$ and $F_{N2} = y_N$.
For v, we have:
$F_{N1} = 1$ and $F_{N2} = x_N$.
where x and y are the distances of each observation point from the center of the eddy.

The fluctuating part of the field's statistics are assumed to be anisotropic, with a gaussian auto-covariance C that is scaled by the observed de-correlation scales (L_a, L_b) and structure orientation (θ):

$$C(a,b) = e^{\left(-\frac{(a\cos\theta - b\sin\theta)^2}{L_a^2} - \frac{(a\sin\theta + b\cos\theta)^2}{L_b^2}\right)}$$

where a and b are the distances (in x and y directions respectively) either between data points for the data-data covariance matrix, or between data and grid points for the data-grid covariance matrix.

Figure S1.

Sections of density (top), cross-track velocity (m s^{-1}, center) and particle abundances (log scale) from 3-D reconstruction co-localised on the AB transect. Contours of corresponding *in situ* data from MVP and ADCP are superimposed with respect to the colorbar scale. The small inset on the bottom-left side of each figure represents the Lagrangian SST map (Fig. 2) and the location of the AB transect.

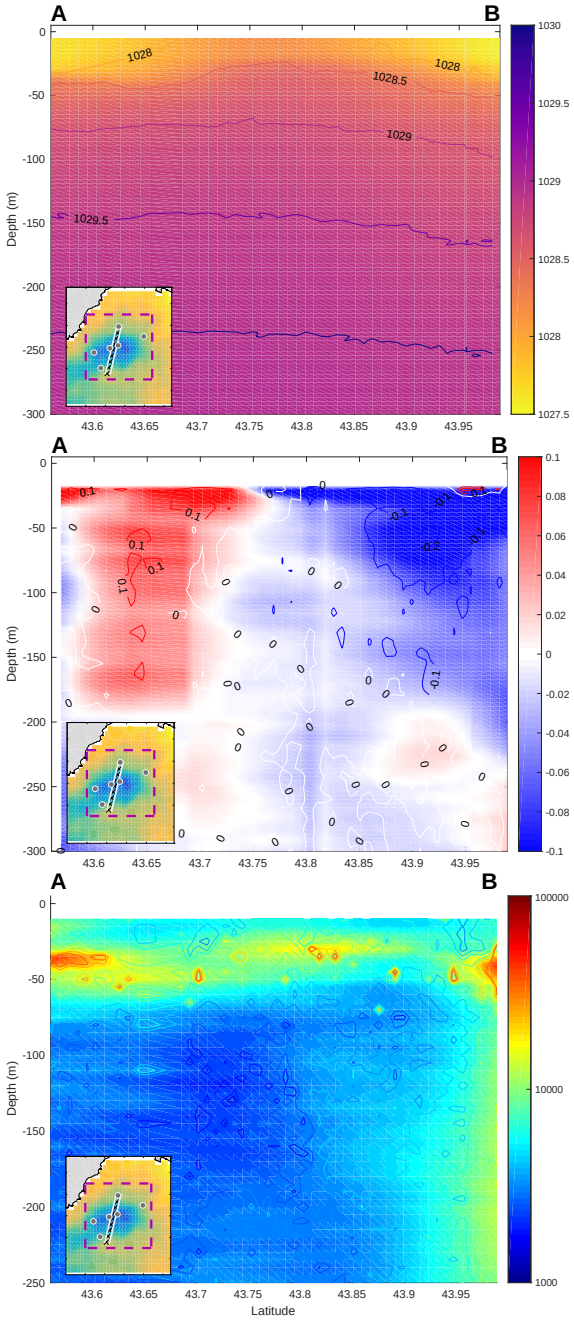

Figure S2.

Top: Seasonal (autumn) mean of absolute salinity (colorbar) and horizontal velocities (m s^{-1}, black arrows) from NEMO-OPA model for the period 1991 to 2016. Bottom-left: Meridional section of autumnal mean of absolute salinity (section location on top). Bottom-right: Zonal section of autumnal mean of absolute salinity (section location on top). On both bottom figures, the isopycnals are displayed with solid black lines.