Divergent Pathways of anticyclonic and cyclonic ocean eddies
Rosemary Morrow, Florence Birol, Joel Sudre, LEGOS, France, and David Griffin, CSIRO, Australia.

The Study
5 years of satellite altimetry data are used to study the propagation pathways of warm and cold ocean eddies in different ocean basins. We track eddies with a life span longer than 3 months, and we present three regional studies: in the southeast Indian, the southeast Atlantic, and the northeast Pacific Oceans. Under certain conditions, anticyclonic eddies propagate westward and equatorward; cyclonic eddies propagate eastward and poleward.

Defining cyclones and anticyclones
We track the A/C and C eddy cores using the 10-day T/P-ERS gridded data (DUACS). Following Isern-Fontanet et al. [2003], we define the eddy cores as regions in which the second invariant of the velocity gradient tensor is positive. We can express this in terms of a parameter, Q:

\[ Q = \frac{(\partial u/\partial y)^2 - (\partial v/\partial x)^2}{(\partial u/\partial y)^2 + (\partial v/\partial x)^2} > 0 \]

which is based on the 2D velocity field, \((u, v)\) derived from the satellite SLA maps assuming the geostrophic approximation. A vortex exists in regions where Q is positive and large, \(Q > Q_0\).\(Q_0\) is set at 2.5 x 10^{-11} in the Agulhas region where the eddy energy is highest, and 1 x 10^{-11} elsewhere.

Tracking the eddies in each basin
We developed an automatic tracking technique to monitor the eddy propagation. All eddies with \(Q > Q_0\) and (SLA) > H_2 are identified in the initial map at time, t_0. We then search for the same eddy structure within a spatial radius, R, around our initial eddy position in the next map at time, t_1 to t_10 days. The final values for \(Q_0\) and H_2 are summarized in Table 1 for our three case studies. The minimum eddy lifetime is > 90 days and > 120 days in the Agulhas. Sometimes eddies “disappear” in the gaps between groundtracks. To minimize this problem we keep searching for each eddy for 20 days after it disappears.

Table 1: Selection criteria applied in the 3 study regions
<table>
<thead>
<tr>
<th>Region</th>
<th>SE Indian</th>
<th>SE Atlantic</th>
<th>NE Pacific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation</td>
<td>A/C Cyc</td>
<td>A/C Cyc</td>
<td>A/C Cyc</td>
</tr>
<tr>
<td>Q_0 (10^{-11})</td>
<td>1</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>H_2 (cm)</td>
<td>20-20</td>
<td>30-25</td>
<td>8-8</td>
</tr>
</tbody>
</table>

What causes this divergence in the eddy pathways?
- Eddies have relatively large diameters > 100 km
- The \(\partial\) effect influences their rotation.

Conclusions
- Favourable conditions for observing these divergent eddy pathways are: strong eddies (tracked over long periods), weak background flow and no bathymetric steering.
- The reason why the SE Indian eddies have such a strong divergence is not clear.
- These divergent pathways of warm and cold ocean eddies may have repercussions on the global heat, salt and tracer budgets.
- Further studies are required to quantify whether divergent eddy transport in this eastern boundary region provides a counter-balance to the poleward heat transport of the western boundary currents.

References
- Isern-Fontanet et al. (2003), Divergent pathways of cyclonic and anti-cyclonic ocean eddies, Geophysical Research Letters, 28, 5, 975-978.