

Review on the paper

Comparative Mesoscale Eddy Dynamics under Geostrophic versus Cyclogeostrophic Balance from Satellite Altimetry

by Zhu, X., Cao, Y., Liu, L., Deng, Y., Liu, R. and You, Z.

The paper presents a comparisons of an eddy census and subsequent analysis using the same eddy identification tool but using either a velocity obtained by geostrophic balance or cyclogeostrophic balance from SSA. The latter being slightly more accurate.

The paper has merits and is of interest to physical oceanographers. It would nonetheless benefit from some revisions.

- Eddy census/analysis strongly depend on the criteria used to define/detect eddies: the method used and field used as well as the value of any threshold used.
 - The identification tool used is not sufficiently described in the text, leaving ‘the fourth constraint’ a mystery.
 - Are the differences observed using the two different balances larger than differences that would be obtained using the same balance but different eddy detection tool?
 - The inclusion of the centripetal acceleration (which has the same sign regardless of the orientation of the eddy rotation) induces an asymmetry between cyclones and anticyclones which is not present in the geostrophic balance. Can the authors explain some of the differences observed by this?
- Section 3 organises the discussion by physical quantities and analyses there each region while the discussion (section 4) organises the discussion by region. This change in organisation somehow breaks the flow of reading. Is it necessary?
- Parts of the text can be improved. Please see below some specific points
 1. Throughout the paper ‘curvature effect’ is ambiguous and too vague. I suggest the authors use ‘centrifugal force’ or ‘centripetal acceleration’. Curvature effects could refer to the Earth’s curvature. i.e. the latitudinal variation of the Coriolis parameter.
 2. 1 27: ‘... vorticity is more stable’ vorticity is a quantity. It cannot be stable or unstable. An eddy can.
 3. 1 30: The statement ‘translate faster’ is more than surprising. I understand eddies can have slightly different characteristics if analysed using two different balances but the statement suggests they are not even at the same location... Surely the two analysis analyse the same SSA and the latter itself would give the location of eddies.
 4. 1 44: The authors mention the 3D structure of eddies, but only analyse SSA so do not have access to the 3D structure (unless they make further assumptions).
 5. 146-49: It would be much simpler (and clearer and shorter) to state that cyclones rotate in the same direction as the Earth and anticyclones in the opposite direction.
 6. 1 78: what is meant by ‘significant periods’
 7. 1 89-90: the statement ‘These biases... wind stress’ must be further explained.
 8. 1 91-92: is somehow a trivial statement as cyclogeostrophic balance is more accurate. Is it needed (at least in this form)?
 9. 1 95-96: what is meant by ‘theoretical’?
 10. 1 120: velocity anomalies: these have not been defined. Why ‘anomalies’? Also EKE is not an energy (only its volume integral - including multiplying by density - is). It is an EKE density (assuming it is measured on a isopycnal and the density is ignored for simplicity)
 11. Equation (2) does not define a percentage (unless it is multiplied by 100).
 12. 1 123-125: The authors can simplify by simply stating that the index i refers to quantities obtained through cyclogeostrophic balance and g by geostrophic balance.

13. 1 127-128 Explain the statement ‘Entrophy...’ and how it ‘account for dissipative effets’. This seems incorrec
14. 1 169: I assume the authors mean geostrophic velocities not satellite altimetry data (same 184 etc...).
15. 175-176 ‘due to wind stress and current shear’: what is the link with cyclogeostrophic balance?
16. 1 330-333: There are many mechanisms which can lead to the destruction of an eddy: instability, interaction with nathymetry, coast, other eddies and currents. Why is (turbulent) dissipation the only mechanism singled out?
17. Fig 8 and text: explain how the age is normalised
18. 1 537: include ‘local’ before ‘rotation’ otherwise the statement is incorrect. Does the eddy description that follows agree with the criteria used to detect eddies (I don’t think so). Moreover, it is questionable. For example. one would most likely to identify eddies using potential vorticity, not (the vertical component of) the (relative) vorticity.

Minor points

- 1 11: ‘among’ → between
- 1 12: ‘induced owing to’ → ’induced by’
- 1 15: remove ‘their’ before ‘cyclogeostrophic’
- 1 19: ‘cyclogeostrophic correction’ → ‘cyclogeostrophic balance’ (as cyclogeostrophic includes both the ‘correction (centripetal acceleration) and the leading order geostrophic balance)
- 1 24: ‘exhibiting opposite biases’ is too vague to be informative
- 1 44: ‘evolutionary behavior’ → ‘evolution’
- 1 58-59: ‘a region of highly active mesoscale eddy activity’ deos not read well (and acticity is unexplained/undefined - same 1 70)
- 1 84: remove ‘assumption’
- 1 86: ‘classical’ is unnecessary
- Eq (5) Ro is undefined. Is f constant or measured locally?
- 1 190: ‘pronounced’ → ‘larger’
- 1 191: remove ‘percentage’ (unnecessary)
- 1 198: ‘pronounced divergence’ → ‘larger difference’ (divergence should be reserved for the mathematical oerator in an oceanogrphic paper)
- 1 224: ‘evolutionary pattern’ → ‘evolution’
- 1 237: What is the ‘mature phase’. ‘close’ → ‘close to each other’
- 1 238: ‘decline’ → decrease
- 1 241: ‘lower than’ → less than