**Ocean Science
Discussions**

Interactive comment on "Retroflection from slanted coastlines – circumventing the "vorticity paradox"" *by* V. Zharkov and D. Nof

V. Zharkov and D. Nof

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Dear reviewer,

Thanks for taking the time to review the document. Please see our response embedded in your review below (in italics).

Report on "Retroflection from slanted coastlines – circumventing the vorticity paradox" by Zharkov and Nof.

This paper is an interesting attempt to investigate the shedding of rings by currents that retroflect and in particular the effect of the orientation of the coast line on the number of rings formed. The main results are applied to the Agulhas rings. The problem of circumventing the vorticity paradox is tackled in different ways. Most of the paper is about a nonlinear analytical model. This is followed by a numerical solution of the

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derived equations, which suffers from stability problems that require rather high eddy viscosities.

We are not sure but think that there might be some confusion here. The numerical solution of the derived ordinary differential equation is obtained by using the Runge-Kutta method. Unlike the numerical simulations of a reduced gravity model, it does not involve any viscosity.

Finally the results are compared with a numerical simulation using a reduced gravity model. The comparison is not as good as the authors claim.

We agree. In our revised version, we wrote that the agreement is "satisfactory", not "very good".

In general the paper is well written with clear descriptions of the physical processes involved, good figures and referencing. The mathematically development suffers from a number of inconsistencies (which may be misprints) but certainly need to be sorted out before the paper can be published in Ocean Science.

Specific comments on the mathematics:

P 7, equations (2) and (3). It would be useful if the equations numbers in NP could be quoted.

OK. We added the quotations to (3.2b) in NP before (2) and to (3.3b) in NP before (3).

P7/8, equations (2) and (4). From these two equations it follows that $2(Q + q) = Q - q$ and so $Q = $ -3q and therefore $\Phi = (Q - q)/Q = 4/3$. But should Φ be less than unity?

Sure, but this is the main idea of the paper. As stated, Φ is a ratio of the mass flux going into eddies and the total incoming mass flux, so it cannot exceed unity. In the cases of some particular vorticities, this condition is incompatible with the momentum flux balance. This introduces what we call the "vorticity paradox". We now note that just after (5).

P 13, equations (16), (17) and (18a). Differentiating (18a) gives $u = (\alpha f/2)\,(R+y)$ which not the same as (16). Similarly differentiating (18b) on P14 does not lead to (16).

You are right. Our original equations (16) and (18b) were misprinted. We corrected these mistakes, introducing f_0 instead of f.

P15, equations (25) and (26). Using (1) in (25) and integrating and then using the boundary condition at $r = R$ does not give (26). In (26) (2-α) is replaced by (-2-α).

You are right again. This was a result of a misprint in (1). We corrected this.

P15, equation (28) requires C_η =dR/dt. Probably worth stating here.

We agree. It is now stated prior to (28).

P16, equation (29). Should the 24 actually be 12? Note also that $H^\star$ is not defined in the text, only in the appendix.

We understand what brought this question about. The coefficient 12 in (29) is obtained when we integrate ψ from 0 to r. But what one should really do is use,

$$\psi = \int\limits_{R}^{r} \overline{v_\theta} h\, dr = \frac{\alpha f_0}{2} \int\limits_{R}^{r} \left[\frac{\alpha(2-\alpha)f_0^2\left(R^2 r - r^3\right)}{8g'} + rH \right] dr,$$

because we should satisfy the boundary condition of zero stream function at the edge of the BE (r =R). After integrating, we obtain,

$\psi = \frac{\alpha f_0 \left(R^2 - r^2\right)}{4} \left[\frac{\alpha(2-\alpha)f_0^2\left(R^2-r^2\right)}{16g'} + H \right]$ *, from which it follows that (29) indeed has the coefficient 24, not 12. We have corrected all related aspects in the new version.*

Regarding H^*, this was our misprint, and we changed it to H.

P17, equation (33). Not obvious how this comes from (20) and (21).

When R_i (i.e. initial value of R) coincides with d_1, it follows from (20) that $\delta_1 = 0$.

Equating (21) to zero, we obtain (33). This was added to the revised version.

P18 line 9. The RHS of (36) does not have α maximum. The result only follows if state that α cannot exceed unity. α is ring intensity. Why is it less than unity?

$\alpha = 1$ means zero PV of the BE. The parameter α cannot exceed unity because the eddy's PV cannot be negative. We now note this in the text.

The inconsistencies on pages 13, 15 and 16 do not make one confident that the more complicated algebra following these errors is accurate.

We re-checked (21)-(24). They are correct but f_0 is now used instead of f.

Overall the paper is an interesting and novel contribution that is worthy of publication in Ocean Science but only after the mathematics is sorted out.

We hope that you will find the new version satisfactory.

Interactive comment on Ocean Sci. Discuss., 5, 1, 2008.

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