

Ocean Sci. Discuss., author comment AC2
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Reply on RC3

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Author comment on "Analytical solution of the ray equations of Hamilton for Rossby waves on stationary shear flows" by Vladimir Gnevyshev and Tatyana Belonenko, Ocean Sci. Discuss., <https://doi.org/10.5194/os-2022-5-AC2>, 2022

Dear reviewer,

We are very grateful to you for the review. We really appreciate that you are able to understand the results presented in the article.

Our results have two aspects. The first is that asymptotic analysis works even where it doesn't seem to work. They are extremely simple to analyze so they can be tested in different ways. That's why we submitted the paper to OS. However, there is a second aspect: the conclusions are extremely unpleasant for the applied analysis. And this is very clearly seen in our solution which show the extreme sensitivity of the results for non-trivial solutions.

There are not any appropriate in situ observations that would allow us to verify the conclusions. Altimetric observations characterize the sea surface and have insufficient spatial resolution of 0.25° . Buoys and gliders describing the variability of oceanological parameters at different horizons are also not suitable for describing the asymptotic behavior of Rossby waves. Nowadays the only method for describing the time-spatial variability of Rossby waves in the ocean is the construction of Hovmöller diagrams. However, this simple method cannot describe the asymptotic behavior of Rossby waves on non-zonal flows, in particular the situations with adhering and overshooting of the waves (see please

Gnevyshev, V.G., Badulin, S.I., Belonenko, T.V., 2020. Rossby waves on non-zonal currents: structural stability of critical layer effects. *Pure Appl. Geophys.*, 177: 5585–5598. <https://doi.org/10.1007/s00024-020-02567-0>;

Gnevyshev V.G., Badulin S.I., Koldunov A.V., and Belonenko T.V. 2020. Rossby Waves on Non-zonal Flows: Vertical Focusing and Effect of the Current Stratification. *Pure Appl. Geophys.* 178(8), 3247 – 3261. <https://doi.org/10.1007/s00024-021-02799-8>).

Going further, we have come to the conclusion, that the concept of searching for continuously differentiable solutions for the World Ocean is suitable more or less for the open ocean, and here we agree with the results of Kilworth with his students. However, we have taken a step to expand this approach. We assumed that it is necessary to expand the class of solutions in the analysis of interaction of the Rossby waves with an inhomogeneous flow. We added the reflected from the zonal or non-zonal flow waves to

the analysis. Thus, we have moved from the class of continuously differentiable, to simply continuous solutions. Moreover, we used the so-called crosslinking conditions in the Miles-Ribner problem:

see please Gnevyshev, V.G. and Belonenko, T.V., 2021. Vortex Layer on the β -Plane in the Miles – Ribner Formulation. Pole on the Real Axis. *Physical Oceanography*, [e-journal] 28(5), pp. 486-498. doi:10.22449/1573-160X-2021-5-486-498.

Here we considered the solution for the vortex layer and established that the previous researchers who tried to solved this problem made a silly mistake. They missed an extremely important solution, which may be useful for interpreting and analyzing the role of non-zonality in the interaction of the Rossby waves with the flow. And we could see such examples in altimetry (DOI: 10.21046/2070-7401-2021-18-5-242-251).

These results are extremely revolutionary and have no analogues.