We thank Baines and Hughes for their interest in our work (Pedlosky and Spall 2015) and their comment (Baines and Hughes 2016), but we respectfully disagree with their contention that our theory is in error. We do agree that the group velocity for Rossby waves in the steady state for an eastward-flowing current is positive, but we do not believe that that fact is as determining of the form of the solution as they maintain for the finite domain considered in our problem. Our reasoning was sketched out in our paper, but this exchange gives us an opportunity to expand on our reasoning.

The first point that needs emphasizing is that in the regime of interest, namely, where the parameter $\beta L^2/\bar{U}$ is greater than unity, one anticipates from Sverdrup theory that it is precisely on the eastern boundary that an arbitrary flow condition can be imposed. If, for example, the eastern boundary is an impenetrable wall, the solution they allude to satisfying the traditional radiation condition will not, in general, satisfy the no normal flow condition on the eastern boundary. Since no eastern boundary layer is possible, that, in our opinion, rules out the legitimacy of their proposed alternative solution.

The experiment of White that they reference does not discuss any eastern boundary, nor does White’s paper describe the degree of frictional damping in the experiment. However, it is clear that the effect of friction is substantial in the experiment or else the downstream wave would have wrapped around the experimental annulus to become an upstream forcing. As a consequence, the experimental region is equivalent to an infinite domain, which is not the problem we considered. Thus, we find the proposed solution and the referenced experimental support inadequate.

We would like to propose a thought experiment, which will lead to a clarifying calculation. Imagine a basin without an island. The basin is bounded solidly on the north and south. On the western edge of the domain a uniform inflow with no relative vorticity is specified. This is always possible. On the eastern boundary defined by $0 \leq y \leq 1$, we suppose that boundary is closed except for a narrow gap on the interval $y_n \leq y \leq 1$ (in nondimensional units). The gap is narrow, and, in conformance with Sverdrup theory, we assume the flow exiting the gap has the same flux as the entering flow, although it may have relative vorticity.

If the flow is otherwise unforced, pure Sverdrup theory would suggest that the exiting zonal flow would extend westward to the western boundary. If there was sufficient friction, that eastward zonal flow could be fed by a viscous western boundary layer. However, in the absence of friction a western boundary layer is impossible by Greenspan’s (1962) theorem. See also Pedlosky (1965). The mismatch between the inflow condition and the putative Sverdrup solution becomes the source of the steady wave response. Figure 1 of this reply shows the solution in that case. The wave solution fills the domain. The flow enters from the western boundary and navigates to the exit on the eastern boundary through a steady Rossby wave-type solution containing both long and short waves in the zonal direction.

Now imagine that the solution in Fig. 1 is reflected about the x axis. The solution so obtained represents a flow past an island barrier with small gaps to the north and south of the barrier, each of width $1 - y_n$. This, in our opinion, is exactly the upstream solution of the island problem forced by the continued mismatch between the
Sverdrup solution, were it valid, and the inflow on the
western boundary.

We agree that if there were sufficient friction to damp
the short Rossby waves one might be able to idealize the
domain as infinite and use the radiation condition as
Baines and Hughes (2016) suggest, but in the absence of
sufficient friction, we believe our solution is correct.

Baines and Hughes (2016) also question the applica-
bility of the numerical model calculations in Pedlosky
and Spall (2015) and assert that because the model al-
lows for time-dependent solutions that the analysis
should be time dependent. They then demonstrate that
the upstream waves are not consistent with linear time-
dependent waves. This is true, but the solutions under
question are steady, so the low-frequency dispersion

\[ K^2v^2 = 3 \eta \pi = 2 \]

relation they present in Fig. 2 of Baines and Hughes
(2016) is not relevant.

REFERENCES

Baines, P. G., and R. L. Hughes, 2016: Comments on “The in-
teraction of an eastward-flowing current and an island: Sub-
and supercritical flow,” J. Phys. Oceanogr., 46, 2263–2265,
doi:10.1175/JPO-D-16-0016.1.

Greenspan, H. P., 1962: A criterion for the existence on an inertial

Pedlosky, J., 1965: A note on the western intensification of the

——, and M. A. Spall, 2015: The interaction of an eastward-flowing
current and an island: Sub- and supercritical flow. J. Phys.