



EGUsphere, referee comment RC2  
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## **Comment on egusphere-2022-148**

Anonymous Referee #2

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Referee comment on "Jet stream variability in a polar warming scenario – a laboratory perspective" by Costanza Rodda et al., EGU sphere,  
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The impact of Arctic amplification resulting from climate change on the atmospheric circulation is an important and topical problem in climate dynamics. This manuscript provides an interesting and unusual approach in exploring the statistics of variability in a plausible laboratory analog of mid-latitude baroclinic circulations, albeit on an f-plane (or at least on a weak topographic beta plane due to free surface curvature). Laboratory studies of fluid dynamical analogs of atmospheric circulation and other phenomena have played an important historical role in helping to validate other approaches to model such phenomena e.g. using numerical tools. It is intriguing, therefore, to see this brave attempt to examine possible insights relevant to climate trends in the Earth's atmosphere.

The article itself seems generally well written and the experiments described build on a body of previous work by the Brandenburg/Budapest group. This is clearly just a first step in such studies in that the authors focus on relatively simple statistical measures of changing variability as a function of thermal contrast and "latitude" (i.e. radius). The results are presented well and discussed realistically, and seem to suggest that the experiments are broadly consistent with recent observations and (at least some) models. I have just a few points of clarification that I would encourage the authors to take into account.

- The authors make reference in several places to the "equator" in their experiment though such experiments cannot represent realistic equatorial dynamics. I would suggest they replace the term "equator" with something like "subtropics", which is perhaps more accurate dynamically.

- Section 2 notes that the temperature of the outer cylinder is maintained by an electric heater operated at a fixed power input, which one would have thought really corresponds to a fixed heat flux boundary condition rather than a fixed temperature if the same power input is used for all experiments - is that the case? If so, it is surprising from Fig. 2 that merely increasing the temperature of the inner cylinder would lead to a smaller

temperature difference across the annulus unless either the power input to the outer bath was reduced or more heat was being lost to the environment instead of being transported by motions in the annulus. This is because a lower temperature difference with fixed heat flux would imply a larger Nusselt number. This deserves a little more discussion and clarification, since it bears on the degree to which the forcing in the experiment is analogous to Arctic amplification (cf the statement in Lines 127-8).

- Section 3 describes changes in flow regime with varying thermal contrast at fixed Taylor number (rotation rate), which seems to suggest an increase in dominant wavenumber with thermal Rossby number. This is a little surprising given comparisons with comparable experimental studies by other groups (e.g. see the reviews by Hide & Mason (1975), Read et al. (2014) etc.) where an increase in thermal Rossby number generally leads to lower wavenumber flows. But the Taylor number used here is quite large, placing the flow close to an irregular flow transition which may account for the different behaviour - a point worth mentioning/discussing. Are the results presented here dependent on operating in this high  $Ta$  regime?

Minor points:

- Line 40 "is" rather than "are"

- Line 41 Isn't the key point here that "cause and effect are difficult to distinguish...." ?

- Line 118 The depth of the fluid layer here is fairly shallow, indicating that, although  $Ta$  is large the Ekman number (representing the effect of bottom drag) may be relatively large - comment?

- Line 153 The waves in the experiment are not strictly "Eady waves" even though the Eady model may have some quantitative comparisons with the experiment. Eady waves are fundamentally baroclinic "edge waves" associated with thermal gradients along horizontal boundaries (and with weak PV gradients in the interior).

- Line 171 Rossby waves are only slower than the background flow for  $\beta > 0$ . Sloping topography can produce a  $\beta < 0$  which would lead to faster propagation than the background flow.

- Line 205-6 "the temperature distribution skewness has a positive value at the cold (top) boundary and becomes more and more negative close to the warm (bottom) boundary" Is there a physical interpretation for this?

- Line 262-4 If the outer region between e and the outer cylinder have "no baroclinic activity", how is heat being transported into the interior?

Line 298 and ff "not significant" perhaps should be stated as "not formally significant" since its sign may still be physically significant?