We thank the reviewer for the valuable comments on our manuscript and the suggestions for improvements.

In the following, we comment point by point on the referee's suggestions and highlight our efforts to address the parts that needed clarification.

Comment:

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.

Reply:

*We agree that the experiment does not capture the equatorial dynamics, although the term is often used in the literature. We have replaced the term `equator' with `subtropics' in the text when referring to the dynamics.*
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).

Reply:

The cold inner and hot outer baths are obtained differently in our experimental set-up. The water is circulated in the inner cylinder by pipes connecting it to an external device where the water is cooled to a set temperature and then pumped back. The temperature is, therefore, regulated by the thermostat. The outer ring hosts heating wires and water that heat the water. For all experimental runs, we kept the power supplied to the wires in the outer cylinder fixed and changed the temperature in the cooling thermostat. The system is then let reach the thermal equilibrium before rotation is started. Increasing the temperature in the inner cylinder increases the equilibrium temperature of the working fluid in the middle gap and consequently the equilibrium temperature for the hot bath.

The figure added as a supplement shows the time series of the temperature measured in the inner (in blue) and outer (in red) rings for the experiments C11 (a) and C18 (b). It can be noticed that when rotation is started (marked by the grey vertical line), the temperatures in both baths have reached an equilibrium and remain stable for the entire duration of the experiment. From these considerations, we can conclude that the boundary conditions at the two conductive walls are constant temperature.

We have added an appendix with the figure shown here and clarified the matter of the boundary conditions.

Comment:

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?

Reply:

In the regime identified as 'regular wave' by Hide & Mason (1975) it is indeed the case that an increase in thermal Rossby number leads to lower wavenumber flows. Our experiments have Taylor numbers higher than $10^8$, which is found to be the threshold to irregular baroclinic waves/ geostrophic turbulent regimes for experimental apparatus with similar dimensions to the one used here. In this regime, the flow becomes much more complicated, with irregular structural variation and nonlinear interactions between the dominant mode and sidebands (as discussed in detail by Früh and Read 1997). These complex interactions result in wider spectra spanning several wavenumbers for smaller Ro, as can be seen in figure 4. Although a complete study of the regime transitions and waves interactions is beyond the scope of our paper, it seems that the experiment with the highest ΔT (C9) is in a regular wave regime, then there is a transition to a structural vacillation with loss of regularity of the waves to finally enter the geostrophic turbulent regime for the smallest ΔT investigated. We have extended the discussion on the wave regimes, comparing our experiments with other studies in the new manuscript.

Comment:

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

Reply:

Yes, thanks for the correction. We updated the text.

Comment:

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?

Reply:
This is indeed an interesting point. We dedicated a section in our previous publication (see Rodda et al ‘A new atmospheric-like differentially heated rotating annulus configuration to study gravity wave emission from jets and fronts’, Experiments in Fluids 2020) to discuss the viscous effects in shallow water configurations. Our previous study reveals that the bottom drag hinders the formation of baroclinic waves for total fluid depth lower than 3 cm (for the same experimental set-up used in the current study). The fluid depth was carefully chosen to avoid the bottom drag affecting the dynamics. We added a paragraph in the manuscript to address this point.

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).

Reply:

Yes, the baroclinic waves observed in the experiment differ from the highly idealised Eady model. We have modified the text to make this point more clear.

Comment:

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.

Reply:

Yes, we have added a note to distinguish the two cases in the new text.

Comment:

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?
The negative skewness is attributed to the passing of a cold thermal front. We added this interpretation to our text.

Comment:

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?

Reply:

The heat transport in the baroclinic wave regime is a combination of the transport from the baroclinic eddies and the axisymmetric meridional circulation. In the outer region, which is not reached by the baroclinic eddies, heat transport is mainly due to this meridional circulation. Some minor transport might come from boundary layer instabilities (Th. v. Larcher, S. Viazzo, U. Harlander, M. Vincze, and A. Randriamampianina. "Instabilities and small-scale waves within the Stewartson layers of a thermally driven rotating annulus." J. Fluid Mech., 841, 380-407, 2018) and turbulent diffusion.

Comment:

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

Reply:

We agree that the trend might be physically significant. We specified it in the manuscript.

Please also note the supplement to this comment: https://egusphere.copernicus.org/preprints/egusphere-2022-148/egusphere-2022-148-AC
