Effects of thermal gradients on the intensity of vortices generated in a cylindrical annulus

It is widely recognized the importance of convective phenomena in the formation and evolution of some meteorological events. Thermal convection has been shown to be determinant, for instance, in the formation and intensity of dust devils and cyclones: dust devils are more likely to form in the presence of large horizontal temperature gradients [1], and the evolution of hurricane intensity depends, among other factors, on the heat exchange with the upper layer of the ocean under the core of the hurricane [2, 3].

In Ref. [4] authors show the relevance of convective mechanisms in the generation of vertical vortices in a cylindrical annulus and prove that under certain thermal conditions (vertical and horizontal temperature gradients) and conditions on the annular geometry, a stable vortical structure, very similar to a dust devil, can be generated from a convective instability.

We have extended the results reported in Ref. [4] and analyze the influence of the thermal parameters on the structure and intensity of the vortex developed. We prove that the horizontal temperature gradient considered at the bottom of the cylindrical annulus and the vertical temperature gradient, determine the intensity of the vortex so its behavior can be changed and controlled by thermal mechanisms [5]. We report strategies to thermally control the vortical structures: make them stronger, weaker, or make them disappear.

The results found are remarkable as they qualitatively agree with those observed for the evolution of the intensity of vortices appearing in some atmospheric phenomena such as dust devils or cyclones.

References

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