An axisymmetric flow in a cylindrical tank with a rotating bottom: comparison with experimental data in preceding studies and corrections around sidewall

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Non-axisymmetric flows are often realized in the terrestrial and planetary atmospheres even when their environments are axisymmetric. Such non-axisymmetric flows are observed in a very simple laboratory experiment using a cylindrical container filled with water by rotating a disk at the bottom rapidly. In order to investigate the mechanism of such symmetric breaking, we need to know axisymmetric flow as the basic state. We obtained the parameter of the basic axisymmetric flow by solving analytically the boundary layers, and showed that we can predict the basic state theoretically.
In order to verify the theory, we compared the theoretical prediction with the results which appeared in preceding researches on similar laboratory experiments. Although most preceding studies focus on non-axisymmetric phenomena, some data on axisymmetric regime are documented. Through this comparison with experimental data, the validity of the theory is confirmed. However, it is also found that the water surface around sidewall tends to be raised higher than theoretical prediction. The behaviour of the sidewall boundary layer is re-examined. We found that it has an effect to raise the water surface, whose specific value we estimated. The theory including this correction gives a good prediction including the region close to the sidewall.

Keywords: rotating flow, boundary layer, axisymmetric flow, laboratory experiment

