Flow through a rotating, tilted rectangular box

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Abstract

Laboratory and numerical experiments describe the flow of a homogeneous fluid through a fully-enclosed rectangular box. The flow is driven by an imposed longitudinal pressure gradient of variable strength. The question is raised whether rotation of the system leads to an increase or a decrease of the throughflow. Due to the abrupt way the flow enters and exits the tank, turbulence is created, which, in the rotating case, may manifest itself partly in the form of inertial waves. The energy stored in the inertial wave field is at the expense of that available for the throughflow, especially as the waves will scatter throughout the box and be lost to heat. Hence we expect a decrease of the throughput. However, tilting the box leads to geometric focusing of these inertial waves, that may locally drive a mean flow, amplifying the throughflow. Tilting also allows the presence of topographic Rossby waves, as the fluid column height will then vary. The efficiency of the throughflow will be discussed in relation to the geostrophic balance, obeyed by the mean flow.

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