Multi-Scale Flow in a heated rotating annulus

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In the fifties, Fultz and Hide designed an elegant laboratory experiment to study baroclinic waves. It consists of a cooled inner and heated outer cylinder mounted on a rotating platform, mimicking the heated tropical and cooled polar regions of the earth's atmosphere. The gap between the two cylinders is filled with water. Depending on the strength of the heating and the rate of rotation, different flow regimes can be identified: wave-regimes that can be classified by prograde propagating waves of different wavenumbers, and quasi-chaotic regimes where waves and small scale vortices coexist. The former regimes are well studied, the latter, however, still raise fundamental questions.

More recently, these classical experiments have been reconsidered. The reason for this revival is manifold. First, the experiments observed by modern laser techniques and analyzed by modern statistical methods give reliable quantitative information on the flow field. Such data can thus be used to verify numerical models of turbulent flows. In fact, this is the main motivation for our experiment that is part of the priority program of German Science Foundation (DFG) 'MetStröm', an initiative to link numerical techniques of engineering computational fluid dynamics with methods of numerical weather prediction. Second, like numerical models, the experiments can be seen as data generators that produce data ensembles appropriate to investigate flow features statistically.

Goal of our study is to provide a velocity and temperature data base to numerical modelers (e.g. from the EULAG community) for comparative numerical simulations of complex multi-scale flow.