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Intrinsic predictability measures of baroclinic chaos and quasi-periodic flow in the rotating annulus

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We present some initial results obtained in a study of predictability in fully-developed baroclinically unstable flows in the laboratory. This behaviour is studied in a numerical simulation of the classic rotating annulus experiment with differentially heated cylindrical sidewalls. A framework has been developed to generate ensemble forecasts of annulus flows in a way similar to operational weather forecasting, using bred vectors to initialize the ensemble. During this work so far the perfect model approximation has been used, where one simulation is defined to be the true flow state and all forecasts are measured against it. We describe the construction of this framework, and present results from forecasts over a range of quasi-periodic and chaotic annulus regimes. We quantify the predictability of these regimes under the perfect model approximation using a number of techniques.

It is proposed that a data assimilation scheme will be coupled to this framework, using the sequential Analysis Correction method. This will allow our forecasts to be extended to predicting actual laboratory flows. Similar predictability measures computed for forecasts using assimilated data will enable the predictability of the real annulus to be found. The annulus is firmly established as a good testbed for atmospheric methods and dynamics, and the laboratory setting allows baroclinic flow to be studied in a controlled and reproducible manner. However, few attempts have been made to use laboratory systems to test data assimilation techniques; it is hoped that the results from this work will generate useful insights for operational forecasting.