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Complementary numerical and experimental study in the baroclinic annulus for the microgravity experiment AtmoFlow

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The experimental investigation of large-scale flows on atmospheric circulation and climate such as Earth, Mars or even distant exoplanets are of great interest in geophysics. Gaining the fundamental knowledge of the origin of planetary waves or global cell formation is interesting from a meteorological point of view but up till now difficult to reproduce in laboratory scale. The limitation is based on the central force field which may be induced by the dielectrophoretic effect. However, the established radial force field is overpowered by the gravitational field unless experiments are conducted in a microgravity environment. The AtmoFlow project provides the possibility to study convective flow patterns in a spherical shell under microgravity conditions, planned after 2022, on the International Space Station (ISS) and is in fact the follow-up experiment of the GeoFlow project which served between 2008 and 2016 on the ISS.

Without losing the overall focus of complex planetary atmospheres, the AtmoFlow experiment is able to model the intake and outtake of energy (e.g. radiation) and the rotational forcing via rotating or co-rotating boundaries. The gap is filled with a Fluor-based fluid with physical properties sensitive to temperature and electric fields. With an electric potential applied between the spherical shells a central force field is established that is based on the above mentioned dielectrophoretic effect. By adjusting rotation, thermal forcing and strength of the applied electric potential the AtmoFlow experiment can simulate different planetary atmospheres to investigate local pattern formation or global planetary cells. An interferometry system similar to the one used in the GeoFlow experiment uses the Wollaston shearing technique (WSI) to record the evolving temperature fields.

To provide a benchmark solution for the experimentally recorded WSI interferograms a ground experiment is used to develop a validation method and to find the best postprocessing method for the AtmoFlow experiment. The ground experiment consists of a thermally forced baroclinic wave tank with a corresponding WSI setup and an infrared (IR) camera that are used to record the evolving temperature field. Here, we present first numerical simulations of the ground experiment that include the formation of the convective wave patterns and the numerical evaluated

interferograms and IR pictures. The numerical calculated data will then be compared to the experimental recorded data to find a technique to best process the recorded WSI interferograms of the AtmoFlow project.

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