EGU21-10036
https://doi.org/10.5194/egusphere-egu21-10036
EGU General Assembly 2021

AtmoFlow - Investigating planetary fluid flow on the International Space Station

Peter Haun[1], Florian Zaussinger[2], Peter Szabo[1], and Christoph Egbers[1]
[1]Department of Aerodynamics and Fluid Mechanics, BTU Cottbus-Senftenberg, Cottbus, Germany, (peter.haun@b-tu.de)
[2]Faculty Applied Computer Sciences and Biosciences, Mittweida University of Applied Sciences, Mittweida, Germany, (Zaussing@hs-mittweida.de)

AtmoFlow is the third spherical shell experiment designed to investigate planetary flow structures under microgravity conditions. It is in fact the subsequent investigation of a series of experiments on the ISS namely GeoFlow I and GeoFlow II which investigated mantle convection with and without volumetric heating. As the name already indicated the AtmoFlow experiment is designed for the purpose to investigate atmospheric flow structures and their sensibility of changes in the thermal boundary conditions. The experiment is designed to reveal the influence of melting polar ice caps, the role of the baroclinic jet stream and thus on global climate change.

In general, there are three main challenges in constructing such an experiment. First, a radial force field is required which surrogates the buoyancy force under micro gravity conditions. Second, the thermal boundary conditions are non-uniform accordingly to the temperature distribution on earth's surface, with features as cold North and South Pole as well as a hot equatorial zone. The third challenge considers the measurement technique and the restriction to the flow visualisation which has to rely on non-invasive methods, without particles.

A radial force field, similar to the earth gravity is established between both spherical boundaries by applying an alternating electric potential. Thus, the experiment can be considered as a spherical capacitor. Buoyancy may than be expressed via an electric force term, the dielectrophoretic force and is in fact an equivalent term to the Archimedean buoyancy for thermo-electrohydrodynamic convection. An electric Rayleigh number may than be formulated which is comparable to the well-known Rayleigh number formulated by Lord Rayleigh.

In order to fulfil the requirements of the thermal boundary conditions, the experiment is thermalised by a heating circuit for the inner sphere and a cooling circuit for each pole, respectively.

The visualization of the thermal flow between both spherical shells is achieved by a Wollaston shearing interferometry (WSI) unit. This method is able to provide high resolved information of the

temperature difference between both shells. However, the system is difficult to align and adjust. Results may also be difficult to interpret as reference cases are missing. For this purpose, we are conducting complementary numerical investigations and ground experiments to fully resolve the recorded images of the AtmoFlow project.

In combining experimental and numerical investigations one will obtain a better understanding of the physical process in thermo-electric convection. When the experiment is sent to the ISS, we expect to observe various flow structures with temporal evolution to investigate zonal flow fields, their implication on global weather formation and climate.