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Life and Microgravity Sciences on board ISS and beyond (Part I) (6)

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ATMOFLOW – SIMULATING ATMOSPHERIC FLOWS ON THE INTERNATIONAL SPACE STATION. PART I: EXPERIMENT AND ISS-IMPLEMENTATION CONCEPT

Abstract

Atmospheric flows are observable on Earth and on most planets of the solar system. Large scale circulations and pattern formations are inherent features of such flows. Fundamental knowledge on the origin and behaviour of flow phenomena such as the formation and evolution of global cells, planetary waves, and baroclinic instabilities, is interesting from a meteorological perspective on Earth. In addition, understanding the interaction between atmospheric circulation and a planet's climate, be it Earth, Mars, Jupiter, or a distant exoplanet, contributes to various fields of research such as astrophysics, geophysics, fluid physics, and climatology to name a few.

The International Space Station provides a unique platform for an experiment on atmospheric flow that simulates planetary rotation, a planet's gravity field, and temperature conditions in a way that is not possible on Earth. In a faithful three-dimensional representation of planetary atmospheric flow, Earth's gravity field always influences the accuracy of the scientific data due to its dominance compared to the experiment's simulated gravity field.

In 2017, the AtmoFlow study was funded by DLR and carried out by Airbus Defence and Space to determine the feasibility of developing and performing such an experiment on the International Space Station. Within this framework, a preliminary concept has been defined for developing a payload that could be integrated in European Drawer Rack 2 and provide the services required for performing atmospheric flow experiments. AtmoFlow's experiment concept is based on the successful GEOFLOW experiment, which modelled the flow in Earth's liquid core and mantle, and provides differential rotation of two concentric shells that confine a test liquid, a radial high-voltage field to simulate planetary gravity based on dielectrophoretic interaction with the test liquid, and local temperature control at poles and equator of the shells. Besides a number of temperature sensors, the main diagnostic element consists of a Wollaston shearing interferometer with two optical paths for acquiring data on the distribution of temperature gradients in test liquid. As has been demonstrated with the results from the GEOFLOW experiment, these images can be utilized in conjunction with data from numerical simulations to determine the underlying velocity field.

This talk focuses on the experiment setup and the proposed concept for a possible implementation of AtmoFlow on the ISS.