Karlsruhe Institute of Technology

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3rd August 2023

Master thesis – numerical

Dynamics of mineral dust in the inlet of an aerosol spectrometer

Background

Mineral dust is a dominant type of atmospheric aerosol with impacts on, e.g. climate, air quality and solar power generation. It is formed from the suspension of minerals that make up the soil. While the Sahara desert is the main source of mineral dust, human activities, e.g. agriculture, also contribute to dust in the atmosphere. The diameter of mineral dust particles suspended in the atmosphere spans more than three orders of magnitude, from $< 0.1\,\mu$m to $> 100\,\mu$m. The amount of large mineral dust particles and their influence on the Earth's energy balance is a subject of current research and not yet considered in weather and climate models. In this context, the Institute of Meteorology and Climate Research - Department Troposphere Research (IMK-TRO) at KIT investigates the emission of large mineral dust particles using aerosol spectrometers. Some of these devices aspirate a particle-laden air flow through an inlet and a pipe into the actual measuring chamber. Due to varying flow conditions outside the inlet and due to different inertia and particle dynamics, particles of different sizes show different measurement efficiencies. Especially large particles ($> 10\,\mu$m) tend to sediment in the pipes or do not even reach the inlet. This has a strong impact on the measured particle size distribution.

Content of the Thesis

The aim of the work is the numerical investigation of the particle movement in the inlet and the feeding pipe of an aerosol spectrometer. In particular, the focus is on the dynamics of larger mineral dust particles, which may not enter the measurement chamber. The work thus contributes to the quantification of this shape-induced filtering effect.
Specifically, the feasibility of numerically representing correct particle dynamics in the presented scenario by means of the flow solver OpenFOAM will be investigated. A numerical pipeline will be set up to evaluate different inlet geometries in terms of their ability to capture larger mineral dust particles.

Starting date:

Submission date:

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