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Author: Mr. Ilham Mammadov
Zentrum für Telematik, Germany

Mr. Maximilian von Arnim
Zentrum für Telematik, Germany
Prof. Ilan Koren
Weizmann Institute of Science, Israel
Dr. Orit Altaratz
Weizmann Institute of Science, Israel
Prof. Klaus Schilling
Zentrum für Telematik, Germany

CLOUD CHARACTERIZATION FOR IMPROVED CLIMATE PREDICTIONS BY THE SATELLITE FORMATION CLOUDCT

Abstract

Clouds contribute via Earth albedo and water transport through the air significantly to atmospheric properties impacting climate. They are a mayor uncertainty factor in climate predictions. The CloudCT mission coordinates ten small satellites appropriately in a formation to acquire backscatter data of Sun light from different perspectives. These observation data are fused by computed tomography methods to characterize the composition of the clouds' interior. Identical cameras on all ten satellites detect magnitude and polarization of backscattered Sun light. Challenges in satellite system design concern realization of all necessary functionalities in just a 3U-CubeSat of 4 kg mass, as well as provision of optimal formation topologies for joint observations by coordinating all ten individual attitude and orbit control systems by networked control approaches.

In-orbit analyses of 3-dimensional formation topologies were objective of ZfT's NetSat mission, a satellite formation composed of four 3U-Cubesats, launched 2020. Based on that experience, the more complex CloudCT using computed tomography methods (as applied in medicine) in an innovative way to generate slice by slice a 3D-characterisation of the cloud's interior. Self-organization capabilities of the CloudCT formation will allow to analyze contrails from aircrafts in new detail, as all satellites can after detection by one camera autonomously orient towards the identified target area. This contribution provides a survey on the CubeSat design, in particular on the attitude determination and control system based on miniature reaction wheels, as well as on the chemical propulsion system for orbit control. Position data from GNSS, timing information, attitude data, networked control intentions and payload data are exchanged between the ten satellites via inter-satellite links.

Results from current ground tests will be summarized, including camera payload performance characterizations, as well as attitude coordination properties based on hardware-in-the-loop simulations with high precision turntables.

A precursor satellite will be launched 2023, in order to test in-orbit performance of the chemical thruster used for orbit control, as well as the camera payload hardware and software. After successful precursor tests, the complete ten satellite formation will follow 2024.