Kumo mission to Venus - DSE group 18

Despite being our inner neighbour planet, Venus still harbours many secrets. Previous missions such as Venus Express, Akatsuki, Vega and Pioneer have studied the planet and its atmosphere. However, few probes have actually descended into the Venusian atmosphere. Recent studies have revitalised speculations about life in the atmosphere of the planet.

Kumo (Japanese for *cloud*) is a planetary exploration mission designed to perform in-situ measurements in the Venusian atmosphere for 60 days, with a focus on investigating the planetary fingerprint written in the abundance of noble gas isotopes, the abundance of important biomarkers, and the yet unknown UV-absorbers in the cloud tops. The probe shall perform ten revolutions around the planet at altitudes between 55 km and 65 km, covering latitudes from the equator up to 30 degrees north.

The atmospheric explorer Tori (Japanese for *bird*) is a hybrid airship shaped like a flying wing. Tori is inflatable such that it can make use of the dense Venusian atmosphere to generate lift from buoyancy. When flying on the night side of the planet, Tori will float in the Venusian clouds and get carried with the zonal winds until reaching the day side. When sunlit, Tori will maneuver and fly with electrical propellers running on solar power. Tori will carry a mass spectrometer, a UV-imager spectrograph, and a nephelometer to measure biomarkers, noble gas isotopes, UV-absorption values, and cloud particle sizes.

The relay satellite Tsubuyaki (Japanese for *tweet*) is designed to communicate between Tori and Earth. Additionally, Tsubuyaki will carry remote sensing scientific instruments. The orbiter will take a global picture of the UV-absorbers from orbit to enable correlation of the UV-measurements from within the atmosphere with the position of the probe. A hyperspectral imager will measure night glow and temperature distributions in the atmosphere.

The mission is divided into three phases. The first phase includes Tori flying five revolutions around Venus in an equatorial band, making use of the super rotating atmosphere. Concurrently, Tsubuyaki will fly a circular orbit of 95,000 km radius to always stay overhead of the probe. In this phase, Tori will measure continuously during day time only and Tsubuyaki will not perform scientific measurements at all. In the second phase, Tory will fly another five revolutions where it will collect repeat observations at five specific locations of interest. Tsubuyaki will transfer from a probe synchronous orbit, to an elliptical scientific orbit with the pericenter at 300 km and the apocenter at 66,000 km and will start collecting its own data. Finally, the third phase starts after 60 days, when Tori's nominal mission is complete. Tsubuyaki will stay in its scientific orbit to perform measurements until becoming inoperative. Once inoperative, Tsubuyaki will burn in the atmosphere, where final additional measurements of the upper cloud deck will be carried out.

Since this mission is the first of its kind, significant research and development is to be expected. One aspect to be studied is the use of novel materials resistant to the high acidic concentration within the Venusian atmosphere for a significant duration. So not only will this mission give new insights into a relatively unexplored planet, it will also use innovative technology to do so. Therefore, Kumo is ready to take off and float through the Venusian clouds.

We hope to see you at the presentation, where you can be part of our journey to our sister planet.