EPSC Abstracts
Vol. 10, EPSC2015-873, 2015
European Planetary Science Congress 2015

Venus Atmospheric Maneuverable Platform Science Mission

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Abstract

In terms of its size and distance from the Sun, Venus is the most Earth-like planet in our solar system. However, it has evolved very differently and its atmosphere is now dominated by carbon dioxide and thick layers of sulfuric acid clouds. The resulting greenhouse warming heats the surface to over 450°C. Over the past years we have explored a possible new approach to Venus upper atmosphere exploration by applying recent Northrop Grumman (non-NASA) development programs to the challenges associated with Venus upper atmosphere science missions. We will discuss the suite of instruments and measurements to study the current climate through detailed characterization of cloud level atmosphere and to understand the processes that control climate on Earth-like planets.

1. Introduction

To understand the current greenhouse warming and general circulation on Venus, one must measure the radiative, dynamical and chemical processes in the atmosphere and in the cloud layers. To determine the climate evolution, measurements of the atmosphere-surface interactions are also necessary. An *in-situ* mission to Venus for i) detailed measurement of atmospheric gas abundances and their isotopic ratio and ii) measurement of radiative, dynamical and chemical processes in the cloud layer is therefore needed. We describe a low ballistic coefficient (<50 Pa), semi-buoyant aircraft that deploys prior to entering the Venus atmosphere, enters the Venus atmosphere without an aeroshell, and provides a maneuverable vehicle capable of carrying science payloads to explore the Venus upper atmosphere. VAMP (Venus Atmospheric Maneuverable Platform) targets the global Venus atmosphere between 52 – 68 km altitude and would be an ideal, stable platform to make these science measurements.

2. VAMP Science Concept

We will present a straw man concept of VAMP, including platform area, mass, power, propulsion and science payloads. We will discuss the various science instrument options and their vehicle levels impacts, such as comprehensive chemistry and isotopic analyzers, including gas-chromatograph mass-spectrometer, optical sensors for aerosol analysis (composition, microphysics), meteorological and electric field sensors and filter radiometer. VAMP subsonic flight starts at ∼94 km and after less than an hour, the vehicle will reach its cruise altitude of 68 km. During this phase of flight, the VAMP sensor suite will acquire a pre-defined set of upper atmosphere measurements. The nominal VAMP lifetime at cruise altitude is ∼150 days, over 20 circumnavigation cycles of Venus at mid-latitude. The stability of the air vehicle and its long residence time will provide for the very long integration times required for isotopic mass analysis. VAMP will communicate with the orbiter vehicle, which will both provide for data relay and additional science measurements complementing the *in-situ* measurements from the air vehicle.

In this context, we will specifically focus upon key factors impacting the design and performance of VAMP science:

1. Science payload accommodation, constraints and opportunities

2. Characteristics of measurement CONOPS in the Venus atmosphere, including altitude range, latitude and longitude access, day and night performance, sampling strategy, state vector determination

We will show how the these factors provide constraints as well as enable opportunities for novel long duration scientific studies of the Venus upper atmosphere.