Contribution to prospective workshop on
"Earth and Space Sciences in Europe using CNES balloons"

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Eric Chassefière, Service d'Aéronomie - LATMOS

Super-pressure and Phase Change Fluid balloon studies to be undertaken to prepare Venus balloon exploration

Executive summary

Recently, it was proposed by a group of scientists under European leadership to use a balloon to characterize by in-situ measurements the evolution, composition and dynamics of the Venus atmosphere. This balloon is part of a mission called EVE (European Venus Explorer) proposed in response to the ESA AO for the first slice of the Cosmic Vision program by a wide international consortium including Europe, Russia, Japan and USA.

The foreseen mission will consist of one (or several) balloon(s) platforms floating at an altitude of 50-60 km and an orbiter with a polar orbit which will relay data from the balloon(s) and perform science observations, with the possible addition of other probes (like a descent probe, as proposed by Russia for EVE). The nominal balloon lifetime is 7 days – enough for one full circumnavigation of the planet.

The balloon is delivered to Venus from transfer orbit, and the spacecraft then is itself inserted into orbit around Venus. It carries comprehensive chemistry and isotopic analysers, focusing on cloud-level processes. The key instrument is a state of the art GCMS (Gas Chromatograph/ Mass Spectrometer) system to analyse cloud and gas composition. Other instruments provide optical investigations of aerosol composition, microphysical properties, and radiative balance. In particular, the balloon provides a stable platform for the long integration times (~ hours) required for isotopic mass spectrometry.

We propose a feasibility / demonstration phase of both super-pressure and PCF balloons in Venus middle atmosphere.

The balloon system by itself is composed of:

- balloon envelop
- balloon deployment systems
- balloon inflation systems
- He (and PCF) reservoir

A full Feasibility/demonstration Phase 1 (2 years), as detailed in the EVE proposal to ESA, should consist of:

- development of the balloon fabrication technique (material, assembly technique and tools),
- fabrication of prototypes of balloon systems,

- engineering for the flight physics analysis and on Earth similarity determination as applicable,
- for the super pressure balloon, it will include a qualification on ground of the mechanical behaviour,
- for the PCF (oscillating) balloon, it will include on Earth flight tests and flight physics model calibration,

Such a full Feasibility/demonstration study is probably not realistic, due to limited available money, and it will be necessary to identify actions to be led in priority, depending on the exact amount of money put by CNES in the study.