NASA SBIR 2017 Phase I Solicitation

S3.05 Terrestrial and Planetary Balloons

Lead Center: GSFC

Participating Center(s): JPL

Technology Area: TA5 Communication and Navigation

Terrestrial Balloons

NASA's Scientific Balloons provide practical and cost effective platforms for conducting discovery science, development and testing for future space instruments, as well as training opportunities for future scientists and engineers. Balloons can reach altitudes above 36 kilometers, with suspended masses up to 3600 kilograms, and can stay afloat for several weeks. Currently, the Balloon Program is on the verge of introducing an advanced balloon system that will enable 100 day missions at mid-latitudes and thus resemble the performance of a small spacecraft at a fraction of the cost. In support of this development, NASA is seeking innovative technologies in power storage and satellite communications bitrates as described below:

- *Power Storage* - Improved and innovative devices to store electrical energy onboard balloon payloads are needed. Long duration balloon flights can experience 12 hours or more of darkness, and excess electrical power generated during the day from solar panels needs to be stored and used. Improvements are needed over the current state of the art in power density, energy density, overall size, overall mass and/or cost. Typical parameters for balloon are 28 VDC and 100 to 1000 watts power consumption. Rechargeable batteries are presently used for balloon payload applications. Lithium Ion rechargeable batteries with energy densities of 60 watt-hours per kilogram are the current state of the art. Higher power storage energy densities, and power generation capabilities of up to 2000 watts are needed for future support.

- *Satellite Communications* - Improved and innovative downlink bitrates using satellite relay communications from balloon payloads are needed. Long duration balloon flights currently utilize satellite communication systems to relay science and operations data from the balloon to ground based control centers. The current maximum downlink bit rate is 150 kilobits per second operating continuously during the balloon flight. Future requirements are for bit rates of 1 megabit per second or more. Improvements in bit rate performance, reduction in size and mass of existing systems, or reductions in cost of high bit rate systems are needed. TDRSS and Iridium satellite communications are currently used for balloon payload applications. A commercial S-band TDRSS transceiver and mechanically steered 18 dBi gain antenna provide 150 kbps continuous downlink. TDRSS K-band transceivers are available but are currently cost prohibitive. Open port Iridium service is under development, but the operational cost is prohibitive.

Planetary Balloons

Innovations in materials, structures, and systems concepts have enabled buoyant vehicles to play an expanding role in planning NASA's future Solar System Exploration Program. Balloons are expected to carry scientific payloads at Venus that will perform in-situ investigations of the atmosphere. Venus features extreme environments that significantly impact the design of balloons. Proposals are sought in the following areas:

- *Floating Platforms for Venus -* NASA is interested in conducting long term monitoring of the Venus atmosphere and the signatures of seismic and volcanic events from the planetary surface using floating platforms at altitudes of between 50 and 60 km for periods in excess of 100 days. The temperature at 50 km is roughly 75°C; at 60 km it is about -10°C. Sulfuric acid aerosols are known to exist in this altitude range on Venus. A target payload mass of 100 kg shall be used for system sizing purposes. The primary focus should be on the design of the floating platform system and the materials for achieving long duration operation. Concepts may include fixed altitude and/or variable altitude (controlled) floating vehicles. Systems that use alternative lift gases such as ammonia, or phase change fluids should be considered. Traditional lift gases such as helium or hydrogen are acceptable. Additional areas of interest for developing floating platforms include:
    - Analytical tools for predicting vehicle dynamic behavior in the atmosphere.
    - Packaging and storage methods for inflatable components.
    - Methods for deployment, inflation, and component separation during descent in the atmosphere.

It is expected that a Phase I effort will consist of a system-level design and a proof-of-concept experiment on one or more key components.