NASA SBIR 2015 Phase I Solicitation

S3.06 Terrestrial and Planetary Balloons

Lead Center: GSFC

Participating Center(s): JPL

Terrestrial BalloonsÂ

NASAs 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 two key areas:Â

Power StorageÂ

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.Â

Satellite CommunicationsÂ

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.Â

Planetary BalloonsÂ

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 Titan and Venus that will perform in situ investigations of their atmospheres and near surface environments. Both Titan and Venus feature extreme environments that significantly impact the design of balloons for those two worlds. Proposals are sought in the following areas:Â

Power Systems for Titan BalloonsÂ

NASA is interested in Titan balloons that can fly at an altitude range of 5 to 10 km above the surface for at least 30 days. Innovative concepts are sought for power systems capable of providing 100 Watts of electric power continuously at 28 Volts for a 30 day mission for a total electrical energy output of 72 kW-hrs. The system must be capable of operating within the Titan environment at 85 to 95 K. The Titan atmosphere at this altitude range contains approximately 95% nitrogen and 5% methane gas which may be harvested as an in situ fuel source. Waste heat from the power source can be used to keep the balloon payload at a warm operating temperature to reduce electrical heating requirements. Consideration should also be given to define requirements (e.g., power needs) placed on the host spacecraft during the transit to Titan from Earth, which could be as long as 8 years, for storage and retention of the fuel and oxidizer components. 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. Proposers should include estimates of the mass and volume of their power system concept.

Steerable Antenna for Titan and Venus TelecommunicationsÂ

Many concepts for Titan and Venus balloons require high gain antennas mounted on the balloon gondola to transmit data directly back to Earth. This approach requires that the antenna remain mechanically or electronically pointed at the Earth despite the motions experienced during balloon flight. A beacon signal from the Earth will be available to facilitate pointing. Innovative concepts are sought for such an antenna and pointing system with the following characteristics: dish antenna diameter of 0.8 m (or equivalent non-dish gain), total mass of antenna and pointing system of d 10 kg, power consumption for the steering system d 5 W (avg.), pointing accuracy d 0.5 deg (continuous), hemispheric pointing coverage (2 pi steradians), azimuthal and rotational slew rates Â³ 30 deg/sec. It is expected that a Phase I effort will involve a proof-of-concept experiment leading to a plan for full scale prototype fabrication and testing in Phase II. Phase II testing will need to include an Earth atmosphere balloon flight in the troposphere to evaluate the proposed design under real flight conditions.