NASA SBIR 2009 Phase I Solicitation

S3.10 Terrestrial Balloon Technologies

Lead Center: GSFC

Currently, NASA is developing a Super Pressure terrestrial vehicle targeting 100 day duration missions in mid-latitude. This added capability will greatly enable new science investigations. The design of the current pumpkin shape vehicle utilizes light weight polyethylene film and high strength tendons made of twisted ZylonÂ® yarn. The in-flight performance and health of the vehicle relies on accurate information on a number of environmental, design, and operational parameters. Therefore, NASA is seeking innovations in the following specific areas:

Balloon Instrumentation

Devices or methods to accurately and continuously measure ambient air, helium gas, balloon film temperatures, and film strain. These measurements are needed to accurately model the balloon performance during a typical flight at altitudes of approximately 120,000 feet. The measurements must compensate for the effects of direct solar radiation through shielding or calculation. Minimal mass and volume are highly desired. For film measurements, a non-invasive and non-contact approach is highly desired for the thin polyethylene film used as the balloon envelope, with film thickness ranging from 0.8 to 1.5 mil. The devices of interest must be compatible with existing NASA balloon packaging, inflation, and launch methods. These instruments must also be able to interface with existing NASA balloon flight support systems or alternatively, a definition of a telemetry solution be provided.

Device and method to recover a scientific balloon from Antarctica

Scientific balloons are recovered after flight from the interior of Antarctica. These balloons are either loaded onto aircraft used for remote field operation support, or are loaded upon passing overland traverse vehicles to carry back to McMurdo Station for later disposal. Better methods and/or equipment are needed to expedite the operation and reduce the burden on resources used for recovery of scientific balloons in Antarctica. Current methods to recover balloons are resource and time intensive. In these remote locations, resources and available time are limited. Balloons must be cut up into bundles of manageable size and weight in order to fit inside aircraft that are currently used in support of the United States Antarctic Program (USAP). Scientific balloons weigh up to approximately 2000 kg. The balloon is made up of layers of polyethylene film that are 0.8 to 1.5 mil thick. Each balloon is made up of approximately 200 gores that are heat-sealed together. Each gore seal incorporates load tendons that are made of either polyester load tapes or woven ZylonÂ® fibers. Each balloon incorporates metal end-fittings that can be cut out by hand. Folds, twists and binding of material are characteristics of balloons being recovered. The Antarctic operating environment can be -50 degrees Celsius. Environmental sensitivity is also an issue in Antarctica. Existing aircraft recovery assets include ski-equipped Twin Otters and a DC-3 Basler.

Devices or methods to accurately and continuously measure individual axial loading on an array of ~50 or up to 300 separate tendons during a Super Pressure balloon mission

Tendons are the load carrying member in the pumpkin design. During a typical mission, loading on individual tendons should not exceed a critical design limit to ensure structural integrity and survival. Tendons are typically captured at the fitting via individual pins. Loading levels on the tendons can range from ~20 N to ~8,000 N and temperature can vary from room temperature to the troposphere temperatures of -90 degrees Celsius or colder. The devices of interest shall be easily integrated with the tendons or fittings during balloon fabrication and shall have minimal impact on the overall mass of the balloon system. Support telemetry and instrumentation is not part of the this initiative; however, data from any sensors (devices) that are selected from this initiative must be able to be stored on board and/or telemetered in-flight using single-channel (two-wire) interface into existing NASA balloon flight support systems.

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.