Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 19-20, 2022

Findings

1. Water Recovery Logistics

Summary

The SRWG applauds the sounding rocket program's efforts to make water recovery of high-altitude (> 250 km apogee) payloads a routine operation. This important feature allows re-useable payloads to be flown to high altitudes at ranges that do not have extensive unoccupied land downrange such as Wallops and Kwajalein. Such a capability relieves pressure on operations at WSMR and enables new science investigations not possible at WSMR. Because it was located and photographed floating in the ocean, the recent loss of the DXL4 payload at sea is surprising. In addition to the actual parachute and recovery hardware on the payload, the SRWG urges that the logistics for water recovery be reviewed. Ultimately, lessons learned from this recovery attempt can be applied to future flights. The logistical challenges associated with water recovery may necessitate detailed rehearsals or recovery of tech development flights to fully appreciate the range of scenarios associated with water recovery while developing contingency plans to enhance the probability of success.

Background

Many sounding rocket payloads, including most astrophysics and solar physics payloads, are re-useable and can be flown many times if they can be successfully recovered. Traditionally, recovery of such high-altitude telescope payloads is carried out at ranges with extensive unoccupied downrange land such as WSMR, Poker, Woomera, and hopefully the new Australian launch range. Ranges that launch recovered payloads over water, including WFF and Kwajalein, require technology including buoyancy systems, water seals, and a system for locating the payload. Although water recovery of low apogee payloads whose impact at sea are relatively close to the launch location are more commonplace, higher altitude rockets that impact considerably farther downrange pose new challenges with respect to recovery logistics. The sounding rocket program has invested significant resources in developing the water recovery technologies with respect to the necessary payload hardware and design. Recovery logistics, on the other hand, appear deserving of additional attention.

At its recent meeting, the SRWG learned of the recent loss of the DXL4 payload at sea, even though it was located and photographed floating in the ocean. All indications are that the recovery systems worked well on the DXL4 payload. Post-flight aircraft reconnaissance shows the payload fully buoyant indicating that even the large side-looking experiment doors remained substantially sealed after landing. In addition, the location system successfully tracked the payload in the gulf stream for several days after impact in the water, well beyond the predicted battery lifetime. However, the payload was not recovered due to logistical constraints. The SRWG believes that

there may be important logistical lessons to be learned from this flight. We encourage the sounding rocket program to review the planning and operations pertinent to the DXL4 recovery, and develop lessons learned that could be applied to future water recovery payloads. The SRWG looks forward to learning the results of this review at a future meeting.

2. Implementation of Momentum Wheels for Continuous Pointing of Payloads along the Ram Direction

Summary

Attitude control remains a critical capability for high-performance Geospace missions, enabling cutting edge science that cannot be obtained in any other way. Recent advances in commercial reaction wheel technologies provide new opportunities to develop cost-effective reaction wheel-based ACS solutions for sounding rockets. The SRWG urges that the "new technology" arm of the SR program continue to pursue including reaction wheels (or momentum wheels) as a standard option for Geospace payloads.

Background

Attitude control remains a critical capability for high-performance Geospace missions, enabling cutting edge science that cannot be obtained in any other way. As experimental instrumentation advances to meet science requirements, ACS performance must keep pace to keep scientific value high. A reaction-wheel based (or reaction-wheel enhanced) ACS can provide an important intermediate performance step between the current cold gas systems and fine-pointing systems. Features of such a system include: (1) near-zero deadband allowing narrow-to-moderate field of view instruments to perform well; (2) Elimination of ejected gas along with smaller, smoother motion which minimizes the disturbance of measurements; and (3) ACS operations which are simplified due to: fewer controls (deadband and/or programmed activation intervals), fewer or eliminated pneumatics (including Safety requirements), and reduced or eliminated need for compressed gas and boost pumps in the field. Drawbacks of such a system may include their mass, power, and possible electromagnetic interference.

Recent advances in commercial reaction wheel technologies provide new opportunities to develop cost-effective reaction wheel-based ACS solutions for sounding rockets. Reaction-wheel based ACS solutions also provide a more direct path for development of scientific instruments for the orbital environment. The SRWG also notes that commercial reactions wheels developed in recent years for small satellite applications are available at modest costs, particularly in comparison to fine-pointing systems.

The SRWG urges that the "new technology" arm of the SR program continue to pursue including reaction wheels (or momentum wheels) as a standard option for Geospace missions that include instruments that require continuous pointing along the ram direction. In particular, given the significant strides forward of the SR program in the last 10 years in developing sub-payloads and their associated sub-systems, momentum wheels that could be used for such smaller payloads may provide a straightforward means for those payloads to point continuously along the ram direction, without requiring the large torques associated with more massive payloads.

3. Maintenance of the Sounding Rocket Handbook and its Expansion to Modern Media

Summary

In order to enhance communications between the Sounding Rocket program and the Principal Investigators (PIs), particularly new PIs, the SRWG re-iterates its past recommendations that the sounding rocket program enhance and modernize the user's handbook and associated documents. The main suggestions which we believe would be particularly helpful include:

1) Create a Welcome Package with Guidelines for New PIs
2) Update the NASA Sounding Rockets User Handbook (SRHB)
3) Consider creating a "living" version of the SRHB that would include the latest material available.

Background

The document entitled "NASA Sounding Rockets User Handbook" (aka SRHB), which can be found at the SRPO website, is a valuable and useful tool for new and veteran investigators in the sounding rocket program. Since it describes a complex set of instructions and technologies, it is a lengthy document (180 pages in its current version), and is therefore burdensome to maintain with updates to processes, regulations, and most importantly the new technologies available to potential investigators that might enable new and innovative experiments.

We note that two similar findings were put forward by the SRWG in July, 2020 (see Findings 3 and 4), but it is likely that the added work required to manage the SR program during the COVID-19 pandemic might have shifted attention away from those recommendations. We nevertheless encourage that those two previous findings be pursued and incorporate them into this updated finding. There are three main areas to consider

(1) Create a Welcome Package with Guidelines for New PIs

In the July 2020 SRWG document, Item 3 indicates that there were plans for an Orientation Package for new PI's that would concisely list what is required for the successful completion of a sounding rocket project. A review of the SRPO website did not reveal such a document. While it would not be a replacement for the SRHB, such a document would assist the novice PI (and perhaps remind veteran PI's) to understand the roles and responsibilities of the three major teams (SRPO, NSROC and the PI science teams), indicate the key program milestones, and assist in defining mission success and how to manage acceptable risks. These definitions would help a new PI understand the scope of the project and produce appropriate schedules and budgets. Therefore, we suggest the following: A) produce such a document, ,B) have it linked to forthcoming LCAS and APRA announcements, and C) make sure it references the full SRHB.

(2) Update the NASA Sounding Rockets User Handbook

The current version of the SRHB available online (as of January 19, 2022) is listed with a 2015 creation date. Since 2015, several innovative and enabling technologies have become available (e.g. sub-payloads and their subsystems), and continue to be developed, as seen during the presentation at the most recent SRWG meeting. We therefore suggest it is timely for the SRHB to

update its technology and process changes. We also suggest that the SRHB be mentioned in all announcements of opportunity germane to the rocket program.

(3) Consider creating a "living" version of the SRHB

As technologies are enhanced in the SRPO and NSROC and validated with test flights and/or other mission successes, adding descriptions to the SRHB may enable or enhance innovative experiments. Similarly, changes in procedures or management of a sounding rocket mission should be available for those seeking to propose a new mission. Having a document format that enables quick review and additions to an individual section, without having to review and revise the entire document, could significantly reduce the burden on the SRPO to maintain the document, while enabling the adoption of new technologies in a timely manner.

NASA Sounding Rocket Working Group

Dr. Robert Pfaff, Jr. (Chair and Project Scientist)
NASA/Goddard Space Flight Center

Dr. Scott Porter (Deputy Project Scientist)
NASA/Goddard Space Flight Center

Committee Members:

Dr. Aroh Barjatya (substitute)
Embry Riddle Aeronautical University

Dr. Scott Bounds
University of Iowa

Dr. Phil Chamberlin
University of Colorado, Boulder

Dr. Don Hampton
University of Alaska, Fairbanks

Dr. Steven Kaeppler
Clemson University

Dr. Marc Lessard
University of New Hampshire

Dr. Dan McCammon
University of Wisconsin

Dr. Sabrina Savage
NASA/Marshall Space Flight Center

Dr. Sam Tun
Naval Research Laboratory

Dr. Michael Zemcov
Rochester Institute of Technology