Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of July 9-10, 2024

Findings

1. Program Funding Concerns and Requested Feedback

Summary

The Sounding Rocket Working Group has profound concern regarding the funding reductions for Sounding Rockets and Research Range activities as expressed in (A) below. We very reluctantly provide feedback on how best to accommodate the proposed cuts in (B).

(A) The proposed funding reductions for Sounding Rockets and Research Range activities would have significant, negative impacts on NASA's sounding rocket program which supports Heliophysics (Solar and Geospace) and Astrophysics science missions. Given the proven, long-term value of the program to the agency and the scientific community, the Sounding Rocket Working Group urges that the proposed cuts to the program *not* be enacted and that funding be maintained to continue NASA's robust and highly successful scientific sounding rocket program.

(B) The Working Group was asked to provide feedback regarding how such cuts might be accommodated while maintaining a basic research program. In response to a suggestion that launches take place every other year at the Poker Flat Research Range in Alaska and interleaved with international campaigns, we strongly urge that during lean times, emphasis be maintained at all three domestic ranges: Wallops, White Sands, and Poker Flat, with campaigns in Norway and other foreign sites continued, but perhaps not as frequently. We also suggest that surplus vehicles be used to a greater extent, insofar as possible, for appropriate investigations. We also note that both of these cost saving measures would have significant impact to the science output of the program.

Background and Suggestions:

(A) Information presented to the SRWG during the July 2024 meeting included a prospectus for the Sounding Rocket and Research Range budget allocations at Wallops for the coming few years which indicated that significant reductions were expected. Although the SRWG understands that the NASA budget is being constrained for all programs within SMD and HPD, we respectfully offer that the Sounding Rocket program is already a very efficient program with regards to science return, technology maturation, and development of early career investigators per dollar invested. Accordingly, reductions to the budget for an already lean program such as this tend to have a disproportionate effect and we urge that the current allocations for Sounding Rockets and Research Range not be reduced. Furthermore, budget reductions that significantly affect the number of experiments, launches, or campaigns could easily result in the loss of entire sounding rocket programs, given that many university groups do not have resources to maintain heritage and personnel through long gaps between launch opportunities.

The Working Group is further concerned that the budget outlook did not indicate any restoration of funding in the outyears. In essence, the sharp delta proposed in the near-term was not shown to be offset by subsequent increases to return the funding to present-day levels. This permanency is especially alarming – it constitutes a threat to the pipeline of new missions, large and small, required to answer the recommendations of the Heliophysics and Astrophysics Decadal Surveys. To maintain a viable Sounding Rocket program that continues to support multiple SMD Divisions, matures technology for flight missions, and provides an indispensable, irreplaceable, and unique training ground for the next generation of Principal Investigators and technologists, we urge that Heliophysics Division and SMD seek restoration of funding.

The Sounding Rocket Working Group is painfully aware of budgetary limitations imposed on the Agency. However, as the rocket program embraces a wide community in Astrophysics, Solar, and Geospace including new researchers, providing one of the few means to reliably access space at low cost, we believe that we should judiciously invest in future generations of research and researchers. Along these lines, the 2013 Heliophysics Decadal Survey provided clear, resounding support for the program, and we are confident that the 2024 Heliophysics Decadal Survey, expected to be released in September, will as well. Similarly, the latest Astrophysics Decadal Survey in 2021 concluded that the rocket program provides unique, irreplaceable opportunities for accessing space which are important to maintain. Although such enthusiastic support from the community and the National Research Council does not alleviate the current budget challenges, we hope it will nonetheless underscore the importance of maintaining a robust, vibrant sounding program for the research community and for the nation.

(B) While the dollar amount or the percentage of the proposed cuts was not explicitly provided to the Working Group, we were nevertheless asked to comment on how reductions might be accommodated while still maintaining a basic research program. In particular, it was suggested that reductions to the program might include such measures as limiting the overall number of launches per year, and a suggestion that the program alternate between campaigns at Poker Flat Research Range and international launch sites, every other year.

In the Working Group's discussions, we are particularly concerned that yearly alternation between Poker Flat and international opportunities would introduce significant complications. We note that this has been tried before, unsuccessfully. For example, unexpected problems encountered in fielding a given experiment due to weather or unforeseen technical difficulties (either due Wallops/NSROC, the range, or the experimenter) would then result in 2-year launch delay, with particularly detrimental impacts to graduate students relying on launches as part of their dissertation. Furthermore, Geospace mission teams would have to know 3 years in advance (or more) whether PFRR will be on/off when submitting proposals. This specific complication becomes increasingly significant in the near-term phase of the solar activity cycle. The "next few years" of on/off cycle of PFRR, Norway, Kwajalein, etc. would have to be announced in each ROSES call, and maintained, to allow proposers to plan accordingly. For these reasons, as well as the fact that Wallops is under contract to pay essentially a flat fee annually to Poker Flat regardless of whether any launches take place, alternating launches from Poker Flat is not the best mechanism to save funding dollars while keeping the program vibrant. It should also be noted that previous attempts to switch launches at Poker Flat to every other year did not fare well (see SRWG Finding 1 of June 2005) and this approach was eventually abandoned.

Recognizing that efficiencies must be sought, as requested, we offer our initial suggestions to preserve/safeguard key aspects of the Sounding Rocket program within constrained budget years:

- We suggest that during lean times, the program condenses operations and maintains priority for the three domestic ranges (WFF, WSMR, PFRR), while acknowledging that among these three, PFRR is a significant driver of logistical (and budgetary) complications.

- We suggest that launches be bundled at foreign sites, such as Norway and Kwajalein, and when those campaigns occur, consider an occasional down year for launches at Poker Flat that could be planned together with the foreign campaign. This might require that when a mission at a foreign site is selected, the P.I. would be asked to delay its start by one or two years, a situation which has taken place previously. Similarly, for the very rare campaigns at the magnetic equator (e.g., Peru) and southern hemisphere (e.g. Australia) which occur at most once every few decades (although we hope more frequently), those would also be years to consider limiting launches from Poker Flat.

- Explore ways to encourage increasing the number of simpler payloads for Geospace missions, such as those that are described as Category 2 & 3 missions (e.g., without ACS systems or complex, intricate sub-payloads), as well as the use of military surplus rockets, insofar as possible. The idea is to help promote and demonstrate the excellent science that can be carried out with payloads that are somewhat simpler while using motors that are less expensive than those obtained commercially. We note that re-flights for Solar and Astro payloads are already recognized as lower cost missions.

- Wallops currently conducts two educational launches each year: RockOn/RockSat-C, and RockSat-X. These launches serve a critical service to the program by involving newer institutions and younger students in the sounding rocket program and serving as training ground for new hires at NSROC. Nevertheless, during lean times, either pausing one of the two or offering it every other year might be considered.

2. Real-time Access to Payload Data with non-NASA Computers

Summary

The considerable difficulty of non-NASA experiment teams connecting their Ground Support Equipment (GSE) computers to their payload and acquiring critical real-time data during recent operations at the Poker Flat Research Range has alarmed the SRWG. Real-time access to experiment data is required to monitor the health of the experiment both prior to launch and during launch. Unfortunately, NASA's IT security rules greatly hindered the access of this payload data to PI teams that have non-NASA computers, impacting checkout and slowing operations. While acknowledging that NASA IT security rules are important and must be respected, a workable solution across all ranges and payloads must nevertheless be implemented for non-NASA computers.

Background

Recently, an experiment team at PFRR led by a non-NASA P.I. was told that their GSE computers could not be connected to the launch site network to monitor and conduct pre-flight operations with their payload on the launcher. The payload was designed using TM via Ethernet (EVTM), a relatively new and user-friendly method of interfacing GSE to the payload. EVTM significantly

simplifies payload interfacing, especially for new PI teams. The SRWG applauds the sounding rocket program for implementing this system! The experiment team in question successfully conducted I&T and payload checkout at PFRR using a private network with no issues. However, on the launcher at Poker Flat, they were required to use a much more restrictive NASA network and were initially not allowed to connect their GSE computers and their custom checkout and visualization software to the payload. This had the potential to scrub this mission from a ground-breaking science campaign, which is clearly not acceptable. While a work-around was eventually found, albeit with considerable effort and anxiety, time was lost in the field and a large amount of unnecessary stress was levied on the experiment team as well as the rest of the campaign team.

Real time access to experiment data using experiment team computers is a baseline capability of the SR program and generally is a requirement for all science payloads at every stage of payload operations, including on the launcher pre-flight, as well as during the flight itself. Thus, nearly all science payloads require access to payload data during pre-launch and inflight activities, including while on the launcher. The experiment team GSE computers generally contain custom visualization and analysis tools that monitor payload health and conduct pre-flight operations, pre-flight calibration, and monitoring and uplink feedback during flight. If these tools cannot access the data, generally all the way up to launch, most payloads simply cannot fly. At a minimum, the experiment team must be able to assess the payload Go/No-Go criteria during the count. The SRWG urges the SRPO to investigate such network access issues at all ranges and to develop a workable solution for experiment-team GSE computer access for all payloads, with both NASA and non-NASA computers. If there are restrictions, these must be discussed with the experiment team prior to instrument design. Given that GSE software is often developed by students, it is important that solutions to this network access difficulty do not add significant burden for experimenters in developing their software. We note that this may be a problem even for re-flights. A workable solution must be found.

3. Maintaining Adequate Technical Expertise Depth at NSROC

Summary

The SRWG continues to be concerned about the depth and resiliency of engineering expertise at NSROC in critical areas where the "bench" appears to be a single string or, at best, only 1 or 2 persons deep. We learned at the SRWG meeting that a suggestion to save funds proposed by the SRPO involves evaluating backfills after personnel departures in SRPO and NSROC resulting in possibly delaying (or eliminating) hiring replacements. As many key engineering areas are already thin with respect to NSROC staffing, we do not think that further reductions in technical expertise are sustainable or healthy for the program. Although fully aware that budget cuts may ultimately impact the vibrancy of the program, we urge the SRPO and NSROC not to restrict key engineering hirings as a means to save resources, as this places the program's unique and required technical expertise at risk.

Background

Long-term (and short-term) depth in technical expertise at NSROC is critical to the sustainability of the sounding rocket program. It is important to retain critical engineering expertise and institutional memory, even when the budget is tight.

At the recent SRWG meeting in July 2024, NASA presented information indicating that budget cuts are pending for which one possible mitigation approach suggested by the SRPO (slide 9) refers to evaluating backfills after personnel departures in SRPO and NSROC, implying that replacements could be delayed or eliminated. The PI community and SRWG have already noted considerable thinness in NSROC engineering staffing. Many telemetry engineers have recently left NSROC, resulting in the few remaining telemetry engineers having to work simultaneously on multiple missions, some involving multiple payloads. This is acutely applicable to the newly developed Swarm technology. We believe it is essential that the engineers who left be replaced and trained as this type of specialty engineering unique to the rocket program is acquired via experience and sustained investment in key, long-term personnel. Furthermore, whereas retirements are often announced in advance and appropriate planning can make sure the expertise is transitioned, a larger concern is when people leave on very short notice (e.g., for family or a new job, including transfer to the civil service!) Thus, a deeper bench enables the program to be resilient to sudden departures.

In summary, the SRWG reinforces the widely held belief that in order for the sounding rocket program to remain viable, it must maintain its critical and unique engineering expertise, even during tough budget times. In our view, saving resources at the expense of restricting key technical expertise puts the program at considerable risk.

4. Interference of PFISR with Uplink Command Frequencies

Summary

The recent Solar Flare campaign required that the Poker Flat Incoherent Scatter Radar (PFISR) be turned off for extended periods (> 8 hours per day) due to interference of the radar frequency and that of the uplink command frequency on one of the payloads. Although the interference of PFISR with standard rocket telemetry frequencies is a known problem that had been mitigated in the past, this was a complete surprise to the PFISR operators, impacting the long-term operational mandate of that facility. The SRWG recommends that the communications between the management teams at Wallops and PFISR be greatly improved to include discussions between possible interference issues at mission initiation and also that a wider set of frequencies be made available for uplink command operations.

Background

Since its initial operations in 2006, interference between the Poker Flat Incoherent Scatter Radar (PFISR) and the frequency of the rocket telemetry has been jointly resolved by engineers at the NASA/Wallops Flight Facility and the Stanford Research Institute (SRI), which operates PFISR for NSF. By judicious selection of telemetry channels, most of the problems have been resolved and the strong desire (in some cases, requirement) by Geospace PIs to have simultaneous PFISR data in conjunction with their sounding rocket flights has been accommodated. This includes rocket missions with multiple payloads in flight at the same time. We note that in resolving this problem, the interference issue between PFISR and the telemetry had been discussed previously by the SRWG (see Finding 4 from July 2008 and Finding 6 from June 2010.) We note that this is a different issue from the need to turn off PFISR due to interference with digital sondes for wind-weighting operations, which is the subject of Finding #5.

What appears to be new is that the Solar Flare campaign missions in April 2024 included uplink commanding, which is not typical for geophysical rockets launched from Poker, and furthermore, that multiple solar flare rockets were designed to be in space at the same time and thus required simultaneous uplink commanding. Our understanding is that there is only one uplink telemetry frequency with harmonics that will not conflict with PFISR, so including a second simultaneous rocket with different uplink frequencies resulted in interference from PFISR operations. As such, unfortunately, during the daily countdown, PFISR was switched off for 6 to 10 hours per day from March 25th to April 17th. While the science teams for FOXSI-4 and Hi-C Flare did not require PFISR data for their mission success, the daily disruptions had a significant impact on the PFISR mandate for long-term monitoring of the ionosphere in the auroral zone, especially during an active period near solar maximum.

PFISR operators brought up these concerns with NASA engineers on site while testing the command uplink frequencies in 2023, yet a path for a successful course correction was not identified. While this may have been unavoidable due to insufficient time to approve new frequencies, the PFISR operators were nevertheless surprised by the lengthy required outage time. PFISR operators are justifiably concerned with regards to future missions which might result in such extended outages.

Although the SRWG is fully supportive of the Solar Flare campaign and any mission that might require an uplink command, it is clear that the frequency interference problem needs to be resolved. Furthermore, despite the technical challenges of avoiding interference, the SRWG believes that communications between NASA/Wallops and the PFISR operators and management must be improved. Accordingly, the SRWG recommends three possible actions to alleviate this problem in the future: (1) Include a clear discussion of required frequencies to implement a rocket mission at Poker Flat as soon as possible in the mission lifecycle (e.g. at the Mission Initiation Conference); (2) Communicate with the PFISR operations team before mission designs are finalized, so the possible impacts to their operations can be discussed, and (3) SRPO and NSROC should examine implementing a wider set of frequencies so missions which require multiple simultaneous command uplink operations have more than one frequency to alleviate interference with PFISR.

5. Evaluating Wind Weighting Solutions at Poker Flat Research Range

Summary:

Wind weighting is required to provide an assessment of the trajectory of sounding rockets prior to launch for safety reasons and to enable adjustments of the rocket launch azimuth and elevation, if feasible, to optimize the desired trajectory prior to launch. Gathering the necessary wind information at Poker Flat has proven to require additional procedures and time that can preclude launches in acceptable scientific conditions as experienced in the past few years. Upgrading the wind weighting data collection procedure at Poker Flat has proved elusive, and the SRWG remains concerned that an acceptable resolution to wind-weighting at Poker Flat may not be feasible for a number of years. We request that the various proposed solutions be re-evaluated and a plan to obtain accurate, timely wind information during future countdowns be adopted as soon as possible.

Background:

This finding is a follow-on to a similar one from January 2024, "Wind Weighting Challenges and Impacts to Science at Poker Flat". That finding described the issues during the 2021/2022 season and the Fall 2023 season at Poker Flat, noting that the timing and procedures for confirming wind-weighting status potentially impacted the science return of at least three missions – LAMP, Dissipation, and Beam-PIE. While the SRWG appreciates the efforts on the part of NASA, Poker Flat and NSROC personnel to resolve these issues, we remain concerned that an acceptable resolution to this important problem may not be feasible for a number of years.

Of course, wind-weighting solutions must be current and valid, sometimes requiring the launch of additional balloons during the final minutes in a countdown. Because launch calls can be very challenging, science teams generally prefer to *not* stop the count any more than necessary, depending on the mission objectives. Thus, having an acceptable wind profile within 10 minutes before launch is very important to help ensure that science objectives are achieved.

The wind-weighting background at Poker Flat may be summarized as follows:

Inputs for wind weighting at Poker Flat were historically gathered with a 300-foot meteorological tower for surface and low altitude winds with a sequence of balloons tracked by either radar reflector or GPS-sondes for medium and high-altitude winds. After an assessment of the 300-foot tower at Poker Flat (first installed in the 1970's) in 2019, it was deemed unfit to climb by the WFF safety group and its anemometers have not been serviced since that time.

For the 2021/2022 season and the Fall 2023 launch window, a portable 150-foot tower was provided by NASA and located at PFRR. The shorter tower reduces the number of altitude levels which in turn increases the uncertainty in the wind-weighting solution, negatively constraining launch conditions and requiring more balloon launches to confirm that wind variations are within limits and the wind requirements are met. This resulted in delays for the desired launch times for both missions during the Fall 2023 launch season (Dissipation and Beam-PIE). It also provided serious, observational gaps in the night long associated PFISR data record for the LAMP mission night, including much of the downleg portion of the flight itself.

In 2019, the NASA tracking radar at PFRR was moved to WFF resulting in only balloon-based wind weighting from GPS sonde payloads to determine winds aloft. There have been several incidents where a GPS sonde has failed when near the beam pattern of the Poker Flat Incoherent Scatter Radar (PFISR) and it has now been determined that the PFISR beam is directly responsible for the failures of the GPS sondes. Because of this, the current procedure is to turn off PFISR when local winds might direct the balloon sondes near the PFISR field of view, negatively impacting the science outcome of the mission, particularly as they typically occur near the time of the launch. Indeed, the time histories of the aurora and the state of the ionosphere are very important in the data analysis work because this information establishes the prelaunch conditions (the "initial conditions"), carrying over to the launch and post-launch conditions of the experiment.

Possible resolution(s) of the wind weighting problems at Poker, as identified to the SRWG, include:

1) Re-furbish or replace the 300-foot met tower, which would require fewer balloon launches than with the 150-foot tower

2) Implement new technology using sonar and/or lidar systems

3) Re-install the radar system and return to using retro-reflective balloon payloads in conjunction with the wind observations from the tower

At the summer 2024 SRWG meeting, we were informed that options (1) and (3) are non-starters, at least at the present time, because of cost concerns. The remaining option (2) could possibly take advantage of a lidar system used by NASA and tested at the range during the solar campaign, though it is believed to have an upper limit of 300 m. In addition, concerns about the challenges due to cloud cover were noted, such that local clouds overhead could prevent a launch. Nevertheless, this option is of interest to the SRWG and should be explored, particularly as it raised numerous questions for which answers were not readily available at the meeting.

To summarize, the current solution of using the 150-foot tower in conjunction with balloons that require PFISR to be turned off is sub-optimal due to the negative impact of having to turn PFISR off while numerous balloon(s) are launched (Are there balloon sondes that are more robust that will not be fried by PFISR?) as well as the fact that the count must be held for extended periods because balloons are still in the air. We believe that a better solution must be found, possible using the lidar. The SRWG requests that the various proposed solutions be re-evaluated and a plan to obtain accurate, timely wind information without requiring that PFISR be turned off or the count be held except for only very briefest periods be adopted as soon as possible.

6. Appreciation for the Success of the Eclipse and Solar Flare Campaigns

Summary

The NASA Sounding Rocket program has always taken pride in its flexibility and dedication to performing experiments that "go where the science is". Significant efforts have been taken by NASA HQ, SRPO, and NSROC to accommodate justified requests from science PIs to carry out new and innovative campaigns focused on science targets organized in special campaigns. Three of these special campaigns were held over the past year: The solar flare campaign was conducted after years of planning and preparation, and the Solar Eclipse campaign of triple launches from two distinct ranges was rapidly conceived and executed. Additional launchers were added at White Sands to accomplish the triple launches for the eclipse campaign, and a later-than-usual launch window was accommodated from Poker Flat to enable the Solar Flare campaign. Each campaign was highly successful scientifically and technically, achieving new firsts for the sounding rocket program. These campaigns also garnered a great deal of positive publicity for the program. The Sounding Rocket Working Group expresses its commendation and deep gratitude for the extra effort, dedication, and enthusiasm by the PIs as well as NASA HQ, the SRPO, and NSROC that collectively contributed to the enormous success of these campaigns which included the launch of 8 rockets in a period of 6 months from three different launch sites.

Background

The timing and paths of solar eclipses are known well in advance, but only cover a small fraction of the surface of the Earth. The paths of two of these eclipses, an annular eclipse on 14 October 2023 and a total eclipse on 8 April 2024, were close to standard launch sites: the White Sands Missile Range and the Wallops Flight Facility. This provided a unique opportunity to observe *in*

situ the lower ionospheric and upper atmospheric response to the eclipse using sounding rockets launched prior, during, and after the maximum of totality. The investigation of these altitudes with small-scale sampling is only possible via sounding rockets! The 6 total launches at the exact times during the eclipse within two campaigns occurring only 6 months apart at two different locations presented a challenge to the team that NSROC valiantly undertook. This included addition of extra launchers to enable triple launches from WSMR, a program first! All six launches took place at their prescribed times and returned excellent data, meeting their success criteria. This achievement is especially notable considering the Mission Initiation Conference (MIC) for this campaign only happened approximately 16 months before the first eclipse. Additionally, to then refurbish and refly the same rockets within 6 months during the total solar eclipse from a different launch range is an incredible feat!

A white paper by Winebarger, Glesener, and Reeves was submitted to NASA HQ and the SRPO in 2019 suggesting a sounding rocket campaign be initiated and executed during the upcoming solar maximum from 2023-2026. Missions were proposed in 2019, and two missions flew in April 2024, Hi-C Flare (Savage) and FOXSI-4 (Glesener), from Poker Flat Research Range. Both payloads observed an M-class flare together, gathering an unprecedented data set using cutting edge imaging and spectroscopic technology to observe a flare from extreme ultraviolet to hard X-rays. Many firsts were achieved from this highly successful campaign, including the use of the SPARCS system from a range other than WSMR, real-time sounding rocket launch decisions based on the appearance of solar flares during a dedicated two-week window, extension of the launch window at PFRR into Spring, and solar rockets launched from PFRR.

Making the campaign such a huge success required an unequivocal amount of support from multiple integrated teams working in lock step but with measured flexibility -- from the campaign manager and mission managers for logistics and oversight, to the field engineers accommodating new methods of handling the cryogenics and telemetry systems, to the command uplink personnel who made every effort to ensure a maximally efficient environment for monitoring the science and payload conditions as well as for communicating with and between the payloads and flare prediction teams. This effort has proven the feasibility and utility of Sounding Rocket Flare Campaign and provides endorsement for future such campaigns to be supported from PFRR or other appropriate NASA sounding rocket launch facility. Additionally, the successful recovery of telescope payloads from Poker Flat helps promote the continued use of this range for both Solar and Astrophysics rockets.

The Sounding Rocket Working Group expresses its commendation and deep gratitude for the extra effort, dedication, and enthusiasm by the PIs as well as NASA HQ, the SRPO, and NSROC that collectively contributed to the enormous success of these campaigns which included the launch of 8 rockets in a period of 6 months from three different launch sites. All campaigns were met with excitement and dedication from all team members, reflecting well on the Sounding Rocket program commitment to “go where the science is”.

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. Jason Corliss
University of Arizona

Dr. Brian Fleming
University of Colorado, Boulder

Dr. Phil Chamberlin
University of Colorado, Boulder

Dr. Don Hampton
University of Alaska, Fairbanks

Dr. Allison Jaynes
University of Iowa

Dr. Marc Lessard
University of New Hampshire

Dr. Kristina Lynch
Dartmouth College

Dr. David McKenzie
NASA/Marshall Space Flight Center

Dr. Robert Michell
NASA/Goddard Space Flight Center

Dr. Charles Kankelborg
Montana State University

Dr. Aroh Barjatya (substitute for Robert Michell, this meeting only)
Embry-Riddle Aeronautical University

Dr. Emily Witt (substitute for Brian Fleming, this meeting only)
University of Colorado, Boulder