Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of July 1, 2008

1. Review of the Sounding Rocket Technology Roadmap

Summary.

At the request of the Sounding Rocket Program Office (SRPO), the Sounding Rocket Working Group (SRWG) reconsidered which future technology developments promise the most significant scientific advances within the sounding rocket program. Rather than add new ideas to the existing SRPO Technology Roadmap, the SRWG reaffirms that the new technology ideas previously suggested remain highly relevant and scientifically promising. Our four highest priorities for new technology development are: (1) high altitude sounding rocket, (2) new mesosphere miniaturized rocket, (3) water recovery for astrophysics and solar payloads, and (4) significantly higher telemetry rates. Features of these new technology ideas are discussed below.

Background.

At the July 1, 2008 meeting, the Sounding Rocket Working Group (SRWG) was asked by the Sounding Rocket Program Office (SRPO) to reassess their priorities regarding new technology within the program from the standpoint of those developments which would enable significant, new scientific advances. The SRWG was also asked if there were new ideas which should be added to the SRPO "Technology Roadmap". The SRWG has reviewed the ideas previously discussed over the past several years and which were outlined in previous SRWG Findings, particularly those of the December, 2001 and June 2002 SRWG meetings.

The SRWG has reaffirmed that the new technology ideas suggested previously by the sounding rocket research community remain highly relevant and promise the significant advances in scientific research. Our four highest priority new technology advances are provided below:

High Altitude Sounding Rocket (HASR). The nominal performance requirements for the High Altitude Sounding Rocket (HASR) are that it achieve an altitude of at least 3000 km, provide ~40 minutes of observing time above 100 km, include a ~1 meter diameter experiment section, and provide an option to be recoverable, although this could be developed later. When implemented, the HASR would profoundly advance future rocket-based investigations across all scientific disciplines supported by NASA, including X-ray and UV astronomy, planetary science, space physics, earth sciences, and micro-gravity. Furthermore, this new vehicle presents a unique and inexpensive engineering test bed for high velocity landing and aerobraking systems, such as currently being considered for probes that will impact other planets and return samples to the earth.

The SRWG is mindful that that the HASR would not be inexpensive. Indeed, we do not advocate the implementation of this vehicle at the exclusion of the traditional, less expensive rocket systems, particularly those that uniquely address low altitude

geophysics research (e.g., < 150 km) and the general rockets which permit frequent access to space for technology development and graduate student "hands on" experience. However, as the scientific reward in all disciplines of the HASR promises to be particularly significant, we urge that this new vehicle be developed as soon as possible and integrated as an option within the existing program.

New Mesosphere "Miniaturized" Rocket. Sounding rockets present the only means to gather *in situ* sampling of the many phenomena and critical processes in the earth's upper atmosphere between 40 and 120 km. Further, there is a demonstrated need for multiple (5-10) launches in a given experiment, either in a relatively rapid sequence or as simultaneous launches along different azimuths. Such multiple launches of standard, (larger) sounding rockets are either impractical and/or too expensive. Clearly, the development of a very small, low-cost vehicle and payload system would provide the necessary platform to achieve these measurement goals.

Consequently, the SRWG strongly supports the development of a low-cost, miniaturized (e.g., 4 inch diameter) sounding rocket system for sampling the 40 to 120 km region of the earth's upper atmosphere. We are pleased that such a new vehicle/payload development is currently underway at Wallops via the "Mosquito" program. Indeed, the SRWG has followed the development of this vehicle from its onset and we look forward to seeing it implemented for routine use within the program.

Water Recovery for Astrophysics and Solar Payloads. The SRWG believes that the development of a water recovery system for high flying payloads with as much as 1000 lbs of reentry mass should be a priority. Such a system would enable the recovery of heavy, high altitude payloads launched from the Wallops Flight Facility and Kwajalein Atoll, and would be particularly beneficial for astrophysics and solar payloads that desire to recover the telescope and fine-pointing attitude systems. In the near term, recovery of heavy payloads launched over water would enable the use of BBX, BBXI, and BBXII delivery systems, with high flying performance envelopes that preclude their use at WSMR. This would allow an immediate factor of two increase in observing time over that of payloads currently launched on BBIX's. In the long term, such systems could then serve as a model for development of a recovery technology for the High Altitude Sounding Rocket (HASR) payloads.

Significantly Higher Telemetry Rates. Increased telemetry rates will enable significant advances in a number of experiment areas, including the detection of multiple component HF plasma waves, high speed auroral imaging, and high resolution spectrometry. Higher data acquisition rates of (say) 10-100 times greater than the 10 Mbps rates currently available would provide an immediate increase in the quality and quantity of science experiments performed within the rocket program and we urge Wallops to pursue the technology development needed to provide such higher telemetry rates on a routine basis.

2. Southern Hemisphere Launch Sites

Summary.

The SRWG has expressed concern that a southern hemisphere launch site be available for astrophysics sounding rockets and is seeking information from the SRPO regarding the status of Woomera and Kwajalein as viable alternatives. The issue of non-recovery and water recovery of payloads at Kwajalein continues to command much interest and we seek to learn if these ranges might enable higher apogees for astrophysics payloads with recovery without the need for significant new technology development.

Background.

The Sounding Rocket Working Group is concerned that launch sites suitable for southern hemisphere astrophysics launches no longer appear to be in serious consideration as launch range alternatives. It has been more than 20 years since the last southern hemisphere sounding rocket campaign for astrophysics payloads. This took place at Woomera, Australia, involved land recovery on parachutes of all payloads, and was quite successful. An informal polling of the astrophysics community indicates a strong interest in conducting future flights from the southern hemisphere. Given such interest, the SRWG requests that the following questions be considered by the Sounding Rocket Program Office:

-- What is the status of the Woomera site? How soon could astrophysics flights be supported from Woomera? Would a "campaign mode" flight manifest be essential or could launches be conducted on an individual P.I. basis? Could higher altitude rockets be flown here (compared to White Sands) and still be recovered on land? If so, what are the highest apogees that the rockets might achieve and still be recovered on land, using existing parachute technology?

-- Is Kwajalein a possible site for astrophysics payloads? Given the lack of an alternate, there may be demand for a non-recoverable astrophysics flight opportunity if that could be accommodated at Kwajalein. For example, this might be the last flight of a multi-flight astrophysics program for a given payload. Would the SRPO be agreeable to such a non-recoverable flight of the fine pointing ACS and associated hardware?

-- What is the status of water-recovery analysis for high altitude astrophysics payloads? Kwajalein might become a particularly favorable astrophysics site if this were to become feasible. Astrophysics payloads may also be considered from Wallops if recovery were feasible and the apogees were significantly higher than those permitted at White Sands.

3. Ground-Based Science Instrument Support Within Poker Flat Contract

Summary.

The SRWG appreciates the detailed response of the SRPO to our finding of the January, 2008 meeting regarding support of ground-based science instruments within the Poker Flat Contract. To follow up to this response and the suggestions of the SRPO, the SRWG proposes to form a sub-committee to interact with both Poker and the SRPO to better understand specifics regarding the instruments supported by the range contract and how they will be supported.

Background.

The SRWG appreciates the detailed response of the SRPO to our finding of the January, 2008 meeting regarding support of ground-based science instruments (both at Poker and downrange) within the Poker Flat Contract. The SRWG proposes to form a sub-committee to interact with both Poker and the SRPO to better understand specifics regarding the instruments supported by the range contract and how they will be supported. We propose that this sub-committee would interact directly with the Poker Flat range representative and, if needed, the contract technical representative at Wallops. This appears to us to be the most expedient means to exchange information regarding the

ground-based science instruments, their nominal operation, and the expected data flow within the confines of the existing contract. We are particularly interested in specifics on which instruments are supported and their specifications (beyond the Table listed in the range contract). We also request a status report on the instruments at Fort Yukon and Kaktovic that will be used in the winter campaign in 2009.

4. Mitigating PFISR Interference at Poker Flat

Summary.

The SRWG reiterates the urgent need to solve the problem of RF interference between the rockets and the Poker Flat Incoherent Scatter Radar and to develop workable guidelines regarding PFISR operation before, during, and after the sounding rocket launch.

Background.

The SRWG recognizes that the National Science Foundation (NSF) Poker Flat Incoherent Scatter Radar (PFISR) is a critical instrument that brings much needed context to auroral rockets launched from Poker Flat. Indeed, this radar was placed at Poker Flat expressly so that rocket and radar measurements of the high latitude upper atmosphere might be gathered simultaneously.

Recent Poker Flat campaigns (Joule-2, ROPA, CHARM) experienced significant interference on the launch pad between a harmonic of the PFISR operating frequency and the rocket telemetry links. This is especially problematic with payloads whose telemetry essentially fills the entire S-band, making PFISR interference difficult to avoid. The SRWG would like to reiterate its desire for NSROC to work with NSF, PFRR, and SRI to find ways to mitigate this interference, and to develop guidelines as to PFISR operation before, during, and after the moment of rocket launch. Especially critical are simultaneous measurements from PFISR while the rocket measurements are being made. If possible, SRWG would like to see operational modes and plans in place so that PFISR use before, during, and after rocket launches would be routine. This may require a combination of field testing, reduction in strength of harmonics while the rockets are on the pad, and a more realistic assessment of the impact of the interference on the pad.

5. Restoring Wallops Ionosonde Capability

Summary.

The SRWG recognizes the importance of having a local, ground-based ionosonde at the Wallops Island rocket range that provides both background and specific real-time information essential for many geophysical rocket launches as well as synoptic, statistical ionospheric data placed in a worldwide archive to be used for planning new missions as well as for research by the international scientific community. Despite being an integral part of the Wallops range, neither the normal Wallops digisonde nor the new, "enhanced" ionosonde at Wallops are currently working. The SRWG urges Wallops Range Operations management to help facilitate the restoration of these ionosondes to their routine, operational status, thus continuing their important role for the Wallops rocket range.

Background.

For almost 80 years an ionosonde has provided measurements of the mid-latitude ionosphere in the Washington, D.C. region. For over four decades, the "home" of such an ionosonde as been at the NASA/Wallops Flight Facility. Although two very capable ionosondes are set up and available at WFF, neither ionosonde is currently operational.

Ionosondes are ground based instruments that provide both practical (space weather) information (e.g., maximum useable frequency for navigation/communication purposes) as well as important geophysical data in their own right (e.g., ionospheric density motions, and irregularities versus altitude). Ionosondes at Wallops have provided a treasure trove of synoptic, statistical data regarding the ionosphere and are typically relied upon by geophysics sounding rockets for either background or specific real-time information regarding the local ionospheric conditions during launch operations at Wallops. They are also provide essential data for planning the season and local times of future ionospheric missions.

At Wallops, there is currently a traditional ionosonde, represented by the Air Force "digisonde" that has been in service for several decades and is currently linked to the worldwide digisonde network and data archiving facility. This instrument is currently not working, although may only be in need of a minor repair. Unrelated to the fact that this instrument is currently not operational, the Air Force has decided to discontinue its support of this instrument. The SRWG urges that Wallops assume responsibility for maintaining this instrument as part of its normal home base range operations. We note that in this manner, the support of this instrument would be similar to that of the nominal ground-based instrument support provided at Poker Flat as part of that range operations contract.

Wallops also recently helped install a state-of-the-art ionosonde, referred to as the Vertical Incidence Pulsed Ionospheric Radar (VIPIR) in support of the recent Earle rockets. This ionosonde was provided with funds from NASA HQ in support of the Earle mission, although continued maintenance support was not provided. Although successfully operated during the Earle rocket campaign, the VIPIR ionosonde currently needs additional work in order to operate autonomously and routinely as well as to provide daily ionospheric measurements available for archiving and web access. The SRWG requests that routine maintenance of the VIPIR ionosonde also be supported at some reasonable level by the Wallops Range Operations, with specific support and data analysis for concentrated data gathering during rocket campaigns to be borne by the individual rocket Principal Investigator.

The SRWG suggests that they designate a user who is knowledgeable of ionosonde operations and data usage to be an interface with the Wallops range management to help evaluate and facilitate the restoration of this essential ionospheric tool at the Wallops rocket range.

6. Praise for Wallops Sounding Rocket Annual Report

The SRWG is delighted with the annual report that was presented at the SRWG meeting and which comes on the heels of the very successful quarterly "Rocket Reports" that were presented at the previous SRWG meeting. To this end, the SRWG again salutes the work of Ms. Berit Bland and Mr. Charles Brodell for this welcomed accomplishment.

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