Sounding rockets as platforms for instrument and spacecraft technology development

How sounding rockets provide an effective testbed for technology development

Sounding rockets have long been the traditional development platform for space instrumentation. Many of the reliable and effective instruments currently in operation on various satellites have been developed, in part, on sounding rockets.

The rocket program, through the LCAS portion of the ROSS announcement, provides annual opportunities for science-driven missions. While these missions are often used for instrument development, sounding rockets can also be used to develop spacecraft technology.

About sounding rockets

The various sounding rockets currently available through the LCAS program provide

- Altitudes from a few hundred kms to 1000+ kms.
- Telemetry at bandwidths that greatly exceed what is typically available on a satellite.
- Launches into high or low latitude regions (Poker Flat in Alaska, White Sands in New Mexico and Wallops Island in Virginia are routine; other locations possible on a campaign basis).
- A high degree of flexibility with regard to mission concepts.
- Flight times lasting ~15 minutes or more.

Types of missions

The objectives of any particular mission are driven by science. At the same time, the flexibility provided by a rocket is well-suited to unique tasks. For example:

- The Enstrophy mission, designed jointly by the University of New Hampshire and JPL, was both an auroral science mission and a feasibility test for ultra-low-resource “sensorcraft”. Each of 4 hockey-puck sized free-flyers carried a power and telemetry system, a magnetometer and sun sensors.These tiny spacecraft provided the opportunity to design within very low resource boundaries and to test the outcome in a realistic environment, while also providing new observations of spatial and temporal structure of auroral currents.
- In conjunction with the Johns Hopkins Astro-2 rocket, GSFC developed a SiC coating procedure for large mirrors. This technique was then applied to the Hopkins Ultraviolet Telescope, increasing the sensitivity by a factor of 3. The same technique was also used on the Far Ultraviolet Spectroscopic Explorer (FUSE), and enabled the mission to remain successful in spite of a descope of the project from $300M to $100M.

Combining research in ionospheric physics, aeronomy and astronomy with technology development

New missions consistently point to the need for increasing complexity, which typically implies multiple (i.e., smaller) and more efficient payloads, precision formations, etc. The need for multi-point measurements is clear.

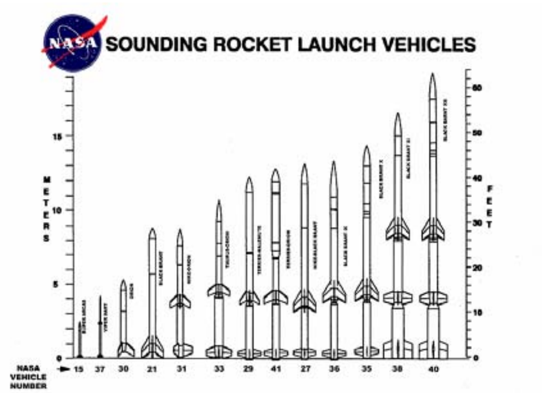
Many of the same techniques that require development for advanced satellite missions can also be used to provide useful data on sounding rockets. Certainly, multiple payloads (with the associated requirements of payload stability, positioning, attitude knowledge and control, stability, etc.,) are often used with sounding rocket missions. These same missions have also provided a steady stream of excellent science.

A wide range of possibilities, thirsty for new ideas...

Aside from providing a platform for addressing targeted science objectives, sounding rockets traditionally provide a test and development platform for instrument development and validation. Historically, this has always been an important role for sounding rockets and many different types of instruments have benefited from this situation

However, sounding rockets can also provide a testbed for technology development. Only on a sounding rocket can techniques and devices be tested in free-fall and under vacuum for a relatively low-cost in terms of time and money. Testing and integration very similar to what is required for satellites.

Possible examples include precision formation flying concepts, nano-satellites tests (i.e., telemetry, deployment and stability issues), deployment/release mechanisms, laser-based communications (both between spacecraft and from ground to spacecraft), attitude determination and control of small spacecraft, etc.



Note that with regard to precision formation flying, sounding rocket platforms include the possibility of acquiring GPS measurements of the locations of the various spacecraft with high precision, providing an easy means of evaluating the results of the test.

From the classroom to the launchpad....

The sounding rocket program is very well-suited to student participation. For example, students at Dartmouth College (funded by the New Hampshire Space Grant) are developing aspects of small-satellites in support of the upcoming MagCon mission. The goal has been narrowed to developing aspects of a small satellite that includes a magnetometer, telemetry and power. The students are not planning on actually building a working satellite, but are focusing their efforts on resolving payload separation and stability issues. The first step (in progress) is to build a simple model that includes a spin-up and separation system and to test this on the KC-135 Vomit Comet. Afterwards, the goal is to carry out more extensive tests onboard a sounding rocket, in a “real” space environment, including powered flight, telemetry issues, etc. These types of experiences provide excellent teaching opportunities, with possibly significant contributions to actual missions.

Where will the future lead?

Rockets will continue to be a mainstay of space exploration because of their usefulness as a development tool. The future is bright, with exciting opportunities limited only by imagination. Possible examples for the future include:

• The use of hybrid fuels, allowing rocket motors to be throttled to provide variable thrust.
• Tests involving atmospheric effects on laser-based ground-to-spacecraft communications.
• The incorporation of MEM-manufactured components, such as gyros.

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