

New Earth Science Opportunities for Small Orbital Instruments and Missions

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Abstract - A key element of the National Academy of Science's Earth Science and Applications Decadal Survey called for the creation of the Venture Class line of low-cost research and application missions. The vision for these missions relied on the promotion of revolutionary scientific innovation while nurturing the next generation of future Earth science project leadership. The architecture that the National Aeronautics and Space Administration (NASA) has chosen for implementation of the Earth Venture portfolio is based on an optimal mix of suborbital investigations, full orbital missions, and orbital instruments opportunities that are released on a regular basis. The first of the EV missions, a collection of 5 suborbital missions, was selected in May 2010. There are two space-based solicitations planned for release in 2011, a complete mission designated Earth Venture-2 followed by an orbital instrument designated Earth Venture-Instrument1. This paper provides salient characteristics of the upcoming Earth Venture program opportunities.

Keywords: Earth Venture, Earth Science, ESSP, EV-2, EV-1.

1.0 INTRODUCTION

One of the outcomes of the National Academy of Science's Earth Science and Applications Decadal Survey conducted in 2007 was the recommendation to establish Venture Class missions in order to "...restore more frequent launch opportunities and to facilitate the demonstration of innovative ideas and higher-risk technologies..." The aim of these missions should be to focus on "fostering revolutionary innovation and on training future leaders of space-based Earth science and applications." The survey further suggested "priority would be given to cost-effective, innovative missions rather than those with excessive scientific and technological requirements. These missions could focus on establishing new research avenues or on demonstrating key application-oriented measurements." The recommendation, also suggested that the Venture class could cover a range of possible missions including "stand-alone missions that use simple, small instruments, spacecraft, and launch vehicles; more complex instruments of opportunity flown on partner spacecraft and launch vehicles; or complex sets of instruments flown on suitable suborbital platforms to address focused sets of scientific questions." The Decadal Survey noted that the 'key to the success of such a program will be maintaining a steady stream of opportunities for community participation in the development of innovative ideas, which requires that strict schedule and cost guidelines be enforced for the program participants."

In response to the recommendation made in the Decadal Survey for the Venture class of missions, in 2009 the Earth Venture (EV) Program was established as a component of the Earth System Science Pathfinder (ESSP) Program within the NASA Earth Science Division of the Science Mission Directorate. The Earth System Science Pathfinder (ESSP) Program is a science-driven Program designed to provide an innovative approach to

Earth science research by providing periodic, competitively selected opportunities to accommodate new and emergent scientific priorities. ESSP Projects are developmental, high-return Earth Science missions that allow for higher risk than decadal survey flagship missions and include advanced remote sensing instrument approaches to achieve these priorities. ESSP Projects often involve partnerships with other U.S. agencies and/or with international science and space organizations. These Projects are capable of supporting a variety of scientific objectives related to Earth science, including the atmosphere, oceans, land surface, polar ice regions and solid earth. Projects include development and operation of space missions, space-based remote sensing instruments for missions of opportunity, as well as airborne science missions, and the conduct of science research utilizing data from these missions. ESSP missions encompass the entire Project life-cycle from definition, through design, development, integration and test, launch, operations, science data analysis, distribution and archival. The ESSP Program Office is located at the Langley Research Center in Hampton, Virginia.

2.0 IMPLEMENTATION OF EARTH VENTURE

This paper provides an overview of the Earth Venture Program including full orbital missions, referred to as Earth Venture-Orbital, orbital instruments of opportunity, designated Earth Venture-Instrument, and suborbital investigations, called Earth Venture-Suborbital. An overview of the common attributes will be discussed, followed by the unique features for each, and the schedule for upcoming opportunities for all three elements.

2.1 Common Features of Earth Venture Program

The goal of NASA's Earth Venture mission portfolio is to provide frequent flight opportunities for high quality, high value, focused Earth science investigations that can be accomplished under a not-to-exceed cost cap and that can be developed and flown relatively quickly. Open competitions will be used to select the investigations to ensure broad community involvement and to encourage innovative scientific measurement approaches. The Announcement of Opportunities (AO) for the mix of Earth Venture projects (suborbital, orbital instrument, and orbital) will be released on an annual basis. The Science Mission Directorate at NASA Headquarters will lead the announcement and selection process while the ESSP Program Office will manage the implementation effort after the missions are selected.

The competitive solicitations will seek small-to-moderate size orbital missions and instruments while the suborbital solicitations will accommodate larger investigations. These missions/investigations will focus on exploratory science that is open to all six Earth science themes. These Earth Science themes include atmospheric composition, weather, carbon cycle and ecosystems, water and energy cycle, climate variability and change, and earth surface and interior. The solicitations will stipulate that the proposed missions/investigations be principal investigator led, cost capped projects with schedule completion

required within 5 years from award. The solicitations budget caps vary for each of the Earth Venture lines and will be discussed in the following sections. The Earth Venture-Orbital missions and Earth Venture-Instrument development could potentially overlap with the Decadal Survey strategic missions but are not a mechanism for replacing or accelerating the implementation of the Decadal Survey missions. As part of the selection process, all AO-proposed Earth Venture projects will be evaluated relative to the criteria of science measurement innovation, cost, schedule and science relevance.

A key to the success of Earth Venture is to maintain a steady stream of opportunities for community participation with innovative scientific investigations. This requires strict enforcement of schedule and cost guidelines on the selected Earth Venture missions and mission teams.

2.2 Unique Features of Earth Venture-Orbital Missions

The solicitation for Earth Venture-Orbital missions is an Announcement of Opportunity open to the broad Earth science community including academia, Government, and commercial providers. The solicitation will request proposals for a complete, principal investigator-led mission to conduct innovative, integrated, hypothesis or scientific question-driven approach to pressing Earth system science issues. For any Earth Venture-Orbital mission, a complete proposal will include all phases, from development thru implementation, for all aspects of the hardware/software required to obtain the specified sustained measurements from space as well as the process necessary to make that science available to the general public. Each principal investigator will propose their scientific instruments of choice as well as the necessary spacecraft bus, launch vehicle, and ground systems in the proposed cost capped mission. The principal investigator must propose all phases of instrument development and integration; integration onto the spacecraft bus and launch vehicle; mission operations; data analysis, archiving, and distribution; publication of science results; project management; logistics; travel; shipping; any proposed partnering arrangements including both domestic or international; and science team. All proposed investigations must use mature system technology, requiring at a minimum Technology Readiness Level (TRL) of 6 or greater (system/sub-system model or prototype demonstration in a relevant environment) no later than the Preliminary Design Review. The proposals will be evaluated on the basis of cost, schedule, technical, and risk using a "single step" evaluation process. The successful proposal must launch within 5 years from award and have a total life cycle cost not to exceed \$150 million, including reserves. Partnerships are encouraged and will be evaluated as a risk element in the proposal, considering the stability and the reliability of the partnership. In addition, hosting an instrument on the International Space Station or on a partner-provided satellite is acceptable, and the partnership must be established in the proposal.

2.3 Unique Features of Earth Venture-Instrument

NASA anticipates that the Earth Venture-Instrument (EV-I) solicitations will utilize the Stand Alone Mission of Opportunity NASA (SALMON) Research Opportunity. Similar to Earth Venture-Orbital, the competition solicits broad Earth science community involvement and encourages innovative science measurement approaches. The opportunity solicits proposals for a complete, principal investigator-led instrument development to conduct innovative, integrated, hypothesis or scientific question-driven approach to pressing Earth system

science issues. For EV-I, a complete instrument includes all phases of development: design, fabrication, and qualification testing. The completion of development should result in a fully qualified space instrument that is ready for integration on a spacecraft. The schedule for instrument development is not to exceed 5 years from award to flight-qualified instrument completion. For EV-I, the total value of the selections is 90 million dollars, however there may be more than one instrument selected per solicitation depending on the availability of proposals of appropriate merit and the ability to stay within the total budget profile of the solicitation. The cost associated with the instrument integration, spacecraft and launch vehicles are outside of the instrument development cost cap. The developed instruments may fly on either domestic or international flights of opportunity. The proposal is not required to include a confirmed host mission, however proposed manifests are encouraged. The Earth Science Division at NASA Headquarters is responsible for negotiating the flight opportunities. At the time the instrument is manifested and flown, the principal investigator will retain a central role on the instrument. The science and instrument technical feasibility are both critical components of the proposal evaluation criteria. For EV-I, technology development is allowable, however, the overall integrated instrument development risk must remain within the schedule and cost-cap.

2.4 Unique Features of Earth Venture-Suborbital

The first Earth Venture-Suborbital missions were selected in May 2010. The next solicitation for suborbital investigations, designated EV-3, is currently planned for release in fiscal year 2013. This solicitation will request proposals for complete suborbital, principal investigator-led investigations to conduct innovative, integrated, hypothesis or scientific question driven approaches to pressing Earth system science issues. These new investigations will be competitively selected to create an opportunity for investment in innovative Earth system science to that enhances our capability to better understand the current state of the Earth and to predict future change.

These investigations will support sustained, science-based data acquisition, advancing Earth system science objectives through temporally sustained regional- or larger-scale measurements sufficient and necessary to prove/disprove a scientific hypothesis or address scientific questions. For Earth Venture-Suborbital a complete investigation includes: access to proposed observation platforms, all phases of any required instrument development and integration of instrument(s) onto the observation platforms, investigation operations, data analysis, data distribution, and data archiving, publication of science results, project management, logistics, travel, shipping, any proposed partnering arrangements, either domestic or international, and science team. Similar to Earth Venture-Orbital, the investigations must use mature system technology where, at a minimum, there has been a system/subsystem model or prototype demonstration in a relevant environment (Technology Readiness Level (TRL) of 6 or greater) no later than the Preliminary Design Review. To ensure broad Earth science community involvement, open competitions will select investigations from proposals from academia, government, and commercial entities. Finally, each suborbital Venture-class investigation must have a life cycle of less than or equal to 5 years and a total investigation cost not to exceed \$30 million.

2.5 Earth Venture Schedule of Opportunities

The release of the first Earth Venture-Orbital, designated as Earth Venture-2 (EV-2), announcement of opportunity is anticipated in the third quarter of fiscal year 2011, with selection in early fiscal year 2012. Thereafter, the calls for these complete orbital missions will be conducted every 4 years.

The release of the first of the Earth Venture – Instrument line, Earth Venture – Instrument1 (EV-I1) is anticipated in the fourth quarter of fiscal year 2011 and selection in fiscal year 2012, with annual opportunities thereafter.

The next Earth Venture-Suborbital opportunity is currently planned for fiscal year 2013. Thereafter, the calls for these suborbital missions will be conducted every 4 years.

Table 1 depicts the overall Earth Venture portfolio schedule including suborbital, orbital and instrument projects as currently planned. Earth Venture-1 (EV-1), the initial suborbital offering, is included in the table for completeness.

Table 1. Earth Venture Mission Schedule

EV-#	Mission	Solicitation/Selection	Launch or Delivery
EV-1	Suborbital	2009/2010	Various
EV-2	Orbital	2011/2012	LRD ~ 2017
EV-I1	Instrument	2011/2012	Del ~ 2016
EV-I2	Instrument	2012/2013	Del ~ 2017
EV-3	Suborbital	2013/2014	Various
EV-I3	Instrument	2013/2014	Del ~ 2018
EV-I4	Instrument	2014/2015	Del ~ 2019
EV-4	Orbital	2015/2016	LRD ~ 2021
EV-I5	Instrument	2015/2016	Del ~ 2020
EV-I6	Instrument	2016/2017	Del ~ 2021

3.0 CONCLUSIONS

The portfolio of Earth Venture projects is a mix of suborbital investigations, orbital missions, and instruments of opportunity. These new science-driven, competitively selected, low cost missions provide an opportunity for investment in innovative Earth science to enhance understanding of the current state of the Earth system and to enable continual improvement in the prediction of future changes. These opportunities represent investments in the development of future Earth science project leaders and at the same time, provide a format for more frequent opportunities for scientific missions and investigations. The NASA community looks forward to the innovative science produced as a result of the new and robust Earth Venture Program.

For more information on ESSP and Earth Venture, please visit <http://science.nasa.gov/about-us/smd-programs/earth-system-science-pathfinder/>. For further information regarding the upcoming solicitations, please see <http://soma.larc.nasa.gov/>. For further detailed information about the EV-2, please go to <http://essp.larc.nasa.gov/EV-2>.

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