Request for Information

To: Members of the Earth and Environmental Science and Applications Community

From: Waleed Abdalati and Antonio Busalacchi, co-chairs of the 2017-2027 Decadal Survey for Earth Science and Applications from Space ("ESAS 2017")

Date: February 18, 2016

Dear Colleagues:

As you likely know, the Space Studies Board, in collaboration with other units[1] of the National Academies of Sciences, Engineering, and Medicine has begun ESAS 2017, the 2017-2027 Decadal Survey for Earth Science and Applications from Space. This community-based effort will develop a comprehensive strategy that updates and extends the inaugural decadal survey, which was released in January 2007. Sponsored by NASA (Earth Science Division); NOAA (NESDIS), and USGS (Climate & Land Use Change), the study will generate prioritized recommendations regarding an integrated and sustainable systems approach to the space-based and ancillary observations that are central to the research and operational programs of the study's sponsors. A website has been created to describe the survey and to provide an opportunity for community input throughout the study process: www.nas.edu/esas2017.

The statement of task, which is posted on the website, directs the survey committee to:

1. Assess progress in addressing the major scientific and application challenges outlined in the 2007 Earth Science Decadal Survey.

2. Develop a prioritized list of top-level science and application objectives to guide space-based Earth observations over a 10-year period commencing approximately at the start of fiscal year 2018 (October 1, 2017).

3. Identify gaps and opportunities in the programs of record at NASA, NOAA, and USGS in pursuit of the top-level science and application challenges—including space-based opportunities that provide both sustained and experimental observations.

[1] Within the Academy, the decadal survey is being led by the Space Studies Board (SSB), which is working in close collaboration—including the sharing of staff—with the Board on Atmospheric Sciences and Climate (BASC), the Board on Earth Sciences and Resources (BESR), the Ocean Studies Board (OSB), the Polar Research Board (PRB), and the Water Science and Technology Board (WSTB). Information about SSB is available at: http://sites.nationalacademies.org/SSB; information about the other Boards is available via links at: http://dels.nas.edu/.

4. Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space. In doing so, consider: Science priorities, implementation costs, new technologies and platforms, interagency partnerships, international partners, and the in situ and other complementary programs carried out at NSF, DoE, DoA, DoD..

The present decadal survey's task statement also asks the survey committee to, "include reconsideration of the scientific priorities associated with the named missions from the 2007 decadal survey." Accordingly, the *geophysical variables* associated with the measurement objectives of missions prescribed in the 2007 survey (Earth Science and Applications from Space) that have not yet been formally confirmed for implementation will be considered as part of the 2017 survey's prioritization effort.

The scope of the study and the "deliverables" expected by the sponsors are described in the full task statement that is posted on the survey's website. Working with five study panels (described below), the survey committee will establish science and application priorities and measurement needs. The previous decadal survey wrapped its science and application objectives around detailed mission concepts. *In a change from the previous survey, recommendations in the 2017 decadal survey will generally refer to Earth science and applications targets (i.e., an objective or a set of objectives that could be pursued and significantly advanced by means of a space-based observation) and the required measurements to address those targets rather than specific mission implementations*. However, for recommendations involving potentially large investments, notional mission concepts may be generated for the purposes of independent analysis of cost and risk.

An initial RFI, issued by the standing Committee on Earth Science and Applications from Space in late September 2015, asked for community input on the following questions:

1. What are the key challenges or questions for Earth System Science across the spectrum of basic research, applied research, applications, and/or operations in the coming decade?

2. Why are these challenge/questions timely to address now especially with respect to readiness?

3. Why are space-based observations fundamental to addressing these challenges/questions?

The more than 200 responses to this RFI are available at the survey website. The responses guided the steering committee's initial discussions on survey organization; in particular, regarding the structure of its supporting study panels. The responses will also continue to inform the work of the committee and will be made available to the soon to be formed

study panels. However, by design, the initial RFI did not ask the community for ideas on how to address an identified challenge/question in Earth System Science.

We now invite you to submit ideas for specific science and applications targets (i.e., objectives) that promise to substantially advance understanding in one or more of the following Earth System Science themes:

I. **Global Hydrological Cycles and Water Resources**
The movement, distribution, and availability of water and how these are changing over time

II. **Weather and Air Quality: Minutes to Subseasonal**
Atmospheric Dynamics, Thermodynamics, Chemistry, and their interactions at land and ocean interfaces

III. Marine and Terrestrial Ecosystems and Natural Resource Management
Biogeochemical Cycles, Ecosystem Functioning, Biodiversity, and factors that influence health and ecosystem services

IV. Climate Variability and Change: Seasonal to Centennial
Forcings and Feedbacks of the Ocean, Atmosphere, Land, and Cryosphere within the Coupled Climate System

V. Earth Surface and Interior: Dynamics and Hazards
Core, mantle, lithosphere, and surface processes, system interactions, and the hazards they generate

Submitted ideas will be reviewed by one or more of the survey's study panels, which are organized to address the above-mentioned themes. Suggested targets that are cross-cutting among these themes are particularly encouraged. ***Submissions should also identify the key geophysical variables/measurements, and the observational requirements, needed to address the science and application targets.***

We anticipate that some of the targets, and their associated measurements, recommended by the Panels will be selected by the Steering Committee for detailed technical and cost analysis of potential implementation architectures. ***To assist those efforts, you are encouraged to provide information on measurement approaches, including technical, performance and maturity/heritage specifications, for relevant current and near-future instrumentation.***

All responses will be considered non-proprietary public information for distribution with attribution. Submitted papers should be no longer than <u>five</u> single-spaced pages in length, excluding figures and tables, and should provide the following information, if possible:

1. A clear description of the Science and Application target, its importance to the Theme as evidenced in previous reports or community roadmaps, and how, by addressing it, understanding in one or more of the above-mentioned Decadal Survey Themes is advanced.

2. An explanation of the utility of the measured geophysical variable(s) to achieving the science and application target.

3. The key requirements on the quality (i.e. the performance and coverage specifications) of the measurement(s) needed for achieving the science and application target.

4. The likelihood of affordably achieving the required measurement(s) in the decadal timeframe given the heritage and maturity of current and near-future instruments and data algorithms, and the potential for leveraging similar or complementary measurements, especially from international partners.

In reviewing ideas for science and applications targets, the survey panels and steering committee may use an evaluation methodology similar to that outlined in the recent NRC report Continuity of NASA Earth Observations from Space: A Value Framework (2015). Accordingly, we encourage you to submit your ideas for science and application targets in the context of a potential contribution to a "Quantified Earth Science Objective" (QESO).[2]

For full consideration, please submit the concept paper by April 30, 2016 via the "RFI #2" submission link that will be posted by March 1, 2016 to the survey website (www.nas.edu/esas2017). Questions about the RFI may be directed to the study director, Art Charo (acharo@nas.edu), or to us: Waleed Abdalati (waleed.abdalati@colorado.edu) and Tony Busalacchi tonyb@essic.umd.edu). You can also contact Dr. Charo by telephone at 202 334-3477, or by fax at 202 334-3701.

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[2] As discussed in Continuity of NASA Earth Observations from Space, examples of QESOs —provided by the authoring committee solely to illustrate the methodology—include *Narrow the Intergovernmental Panel on Climate Change Fifth Assessment (IPCC AR5) uncertainty in equilibrium climate sensitivity (ECS) (1.5 to 6°C at 90% confidence) by a factor of 2; and Determine the change in ocean heat storage within 0.1 W m^{-2} per decade (1σ).* Additional examples and the motivation for this methodology are presented in the report; see especially Box 3.2 on page 33.