A Framework for Analyzing the Needs for Continuity of NASA-Sustained Remote Sensing Observations of the Earth from Space

Mark Abbott, Oregon State University

Space Studies Board

November 7, 2013

Disclaimer: These slides represent a personal assessment of the issues discussed by the CESAS. This document should not be cited or quoted because the views expressed do not necessarily reflect those of CESAS, SSB, or the NRC.

Background to NASA ESD Study Request

- Instruments on NASA research and NOAA "operational" spacecraft measure numerous variables relevant to Earth's biosphere, hydrosphere, atmosphere, and oceans —and their interactions on various spatial and temporal scales. Such data streams are critical components of Earth Science research programs
- Diminished fiscal resources, the coming loss of heritage assets, and increasing societal needs for information products derived from Earth observations create a growing tension between the need for measurement "continuity" and the development of new measurement capabilities.

A Framework for Analyzing the Needs for Continuity of NASA-Sustained Remote Sensing Observations of the Earth from Space

- An *ad hoc* committee will develop a framework to assist NASA's Earth Science Division (ESD) in their determination of when a measurement(s) or dataset(s) should be collected for extended periods. Although focused on the particular needs of the ESD, the committee will consider the relevant current and planned Earth observation programs of NOAA and the USGS.
- Take into account policy guidance ("Climate-centric architecture," ESAS decadal survey) and budgetary realities
- Will not prioritize—will provide a framework to support survey prioritization

1. Byron Tapley (NAE), UT Austin, *Chair*
2. Michael King* (NAE), Univ. of Colorado, *Vice Chair*
3. Robert Dickinson (NAS and NAE), UT Austin
4. Judith Lean (NAS), Naval Research Laboratory
5. Randall Friedl, Jet Propulsion Laboratory
6. Michael Prather, UC Irvine
7. Joyce Penner*, Univ. of Michigan
8. John Bates, NOAA-National Climatic Data Center
9. Chelle Gentemann*, Remote Sensing Systems
10. William Smith, Hampton University
11. Steven Ackerman*, Univ. of Wisconsin-Madison
12. Bruce Wielicki, NASA Langley Research Center
13. Mark Abbott*, Oregon State University
14. Lee-Lueng Fu* (NAE), Jet Propulsion Laboratory
15. Kathryn Kelly, Univ. of Washington
16. Eric Rignot, UC Irvine
17. Jim Tucker, NASA Goddard Space Flight Center
18. Rafael Bras (NAE), Georgia Institute of Technology

* Member of the Committee on Earth Science and Applications from Space

Recent Activity

- Committee approval August 21, 2013
- Two teleconferences to date
  - Review of task statement—is it tractable
  - Approach to the study
  - Preliminary work on tasks and consideration of committee member thinkpieces
    - The committee has tremendous depth of knowledge and we anticipate relying to an unusually large extent on their deliberations to inform this study.
  - Developing the agenda for the November 12-14, 2013 kick-off meeting in Washington, DC
    - We want to leave the meeting with a consensus detailed outline for the report and a consensus methodology
      - Committee is considering in-depth case studies; e.g., MODIS, altimetry, ice sheet mass and dynamics and ICESat-I→IceBridge→ICESat-II

Challenges

- Defining continuity for data products that require measurements of several variables, some with different temporal, spatial, and radiometric resolution requirements.
- Working within the boundaries set by NASA ESD, which does Earth System Science, but within the confines of a “climate-centric architecture”
- Developing a framework that can be backtested to demonstrate its utility going forward

Opportunities

- Develop a “systems engineering capacity” in both the science and engineering communities
  - How to think quantitatively about continuity in the context of specific science questions and issues
  - How to evaluate missions, sensors, and strategies to sustain “dynamic” continuity
- Critical component of a long-term observing strategy
- Will inform the next decadal survey

Continuity Study Timeline

- Committee Appointed, Aug 21, 2013
  - Telecon on September 30, 2013
  - Telecon on October 22, 2013
- First Meeting, November 12-14, 2013 in DC
- Second Meeting, late January, 2014, location TBD
- Final Meeting, Mid-April, 2014, UC Irvine
- Draft Report for Review, May 31, 2014
- Report Submission , July 31, 2014*

*God willing and the creek don't rise

Task Statement-next 2 slides (backup)

The committee will seek to provide guidance to NASA that will be broadly applicable under a variety of scenarios that might unfold over decadal timeframes. In particular, and within the constraints of expected budgets for the NASA earth science program, the committee will:

1. Provide working definitions of, and describe the roles for "continuity" for the measurements and datasets ESD initiates to accomplish Earth system science objectives;
2. Establish methodologies and/or metrics that can be used to:
    1. Determine whether a measurement(s) should be collected for extended periods;
    2. Prioritize the relative importance of measurements that are to be collected for extended periods;
    3. Identify the characteristics of and extent to which data gaps and/or performance degradation are acceptable for given measurement(s);
3. Considering the program plan as defined in the NASA-ESD Climate-Centric Architecture:
    1. Identify and prioritize opportunities to improve alignment with the existing program and continuity needs identified above; and,
    2. For selected examples chosen from the Climate-Centric Architecture, evaluate the robustness of continuity plans, including consideration of contributions from NASA surface and airborne assets, as well as contributions from other U.S. and foreign agencies. In considering the robustness of these plans the committee will:
        a. Determine the robustness of the combined programs for providing the needed data over continuous periods with acceptable data gaps, coverage, and resolution;
        b. Determine the capabilities of these programs to provide calibrated and consistently processed data records that are both made publicly available and archived;

Task Statement Continued

4. Assess the feasibility to achieve continuity, or near-continuity, to previously determined acceptable levels (see items 1-2) of data products that are derived from instruments on space platforms by means other than the re-flight of such instruments. In addition to examining alternative, non space-based instrument platforms, the committee will consider the potential role of enhancements in data sampling and/or data reprocessing. The committee will also consider steps that might improve the scientific utility of data streams composed of multiple measurements sources;
5. In the context of limited resources, provide guidance concerning methods to determine the appropriate balance between cost, risk, and performance when addressing continuity needs for specific measurements; and
6. With the upcoming decadal survey in Earth science and applications from space in mind, provide an illustration of how the proposed framework might be applied to determine the relative importance of continuity versus new or improved measurements, including the contributions of each towards the advancement of scientific objectives.