Earth Science and Applications from Space

National Imperatives for the Next Decade and Beyond

Lessons Learned from 2007 Survey

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CESAS Meeting

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ESAS Charge

- Recommend a prioritized list of flight missions and supporting activities to support national needs for research and monitoring of the dynamic Earth system during the next decade.

- Identify important directions that should influence planning for the decade beyond.

Sponsors: NASA SMD, NOAA NESDIS, USGS Geography

CHALLENGES

- Community Buy-in
  - First decadal survey in Earth Sciences
  - Breadth of interests
    - An organizational challenge was how to cover science/application themes as well as scientific disciplines. in retrospect, having additional discipline-focused subgroups would have been useful
- Multi-Agency Issues
  - Transition to Operations
  - Sustained Research Operations
- Important changes during the study at NASA and NOAA
  - Budgets
  - NPOESS
  - GOES

Earth Sciences Community

Community Organizational Meeting

Organization of Study

- Executive Committee (18 members)
- Seven Thematically-Organized Panels
  1. Earth Science Applications and Societal Needs
  2. Land-use Change, Ecosystem Dynamics and Biodiversity
  3. Weather (incl. space weather and chemical weather)
  4. Climate Variability and Change
  5. Water Resources and the Global Hydrologic Cycle
  6. Human Health and Security
  7. Solid-Earth Hazards, Resources and Dynamics

Charge to Panels

1. Identify needs and opportunities for observations from space to advance Earth science and applications for the next decade and beyond;
2. Propose programs or missions to meet these needs and opportunities, in priority order;
3. Describe each proposed mission in terms of
   - Contributions to science and applications
   - How it meets prioritization criteria
   - Benefits to society
   - Technical aspects
   - Schedule
   - Costs
4. Briefly identify needs for obs that are needed to complement space-based obs
5. Identify essential other components (telemetry, data processing, management and stewardship)

Comment

- An Executive Committee and seven panels worked well
- Involved broader and larger community
- Panel reports were good, stand-alone reports of opportunities and priorities in those areas
- Executive Committee found Panel Reports useful

Process

1. Organizational meeting at Woods Hole (Aug. 2004)
2. Appointment of Executive Committee and Panels
3. Request for Information (RFI)
   - Widely advertised
   - Papers submitted
   - Reviewed by Panels and Executive Committee
4. Panels meet, establish priorities, write reports
5. Ex Com considers Panel recommendations and selects highest priority missions
6. Play money used to encourage missions serving multiple purposes (Gave each of 5 Panels $500M and urged them to 'make a deal' with other Panels.)
7. Rollout January 2007

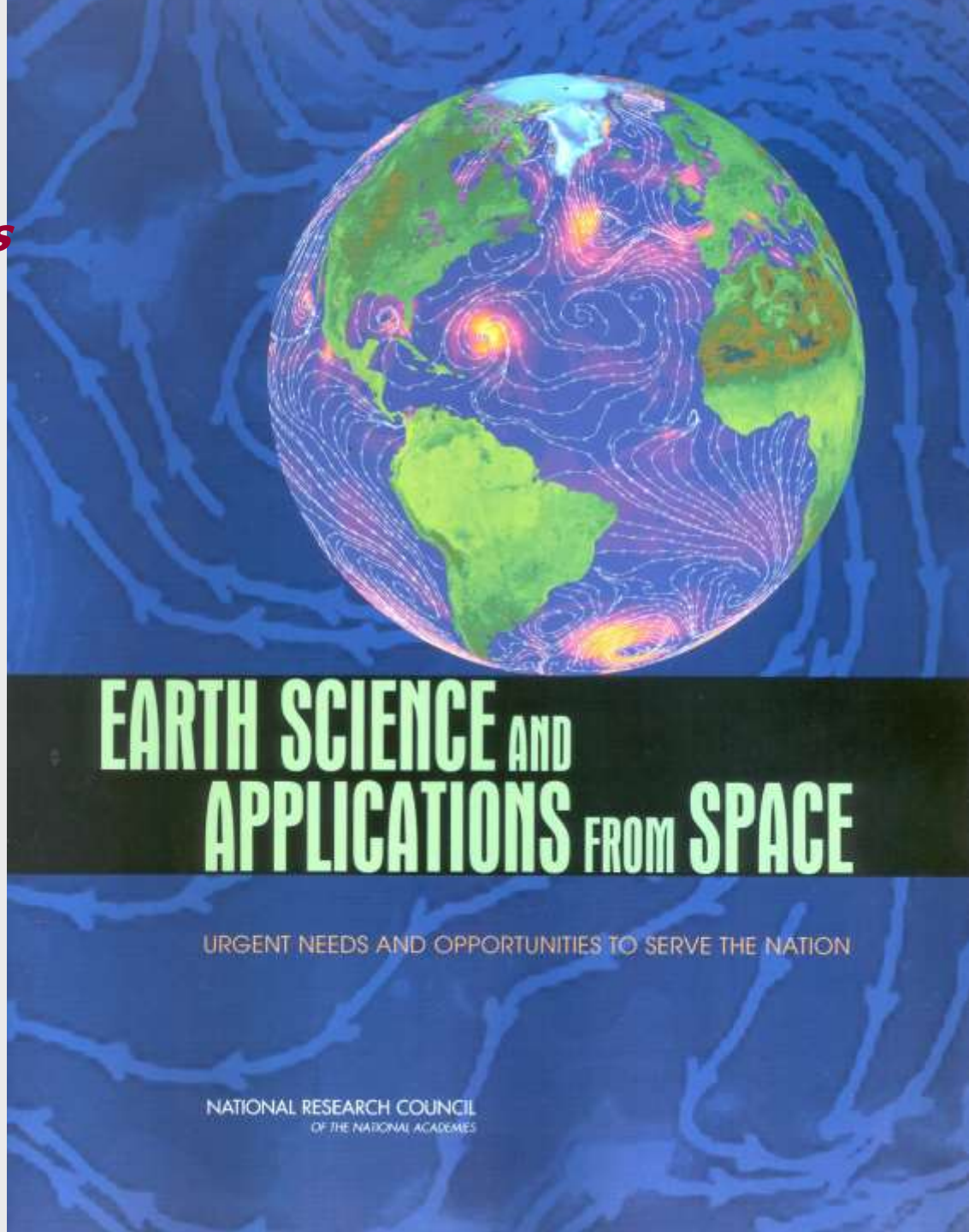
Comment: Use of Executive Committee and Panels And Process similar to other recent decadal surveys

VISION

A healthy, secure, prosperous and sustainable society for all people on Earth

"Understanding the complex, changing planet on which we live, how it supports life, and how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity. It is also one of the most important for society as it seeks to achieve prosperity and sustainability."

NRC (April 2005)



Scientific and Societal Imperatives

Climate change and impacts

Ice sheets and sea level

Shifts in precipitation and water availability

Transcontinental Air Pollution

Shifts in ecosystems response to climate change

Human health and climate change

Extreme events, including severe storms, heat waves, earthquakes and volcanoes

Comment

- Vision was good, but not sure anyone really paid attention to it.
- In vision, societal benefits played equal role with science in establishing importance and priorities.
- However, it was not clear to me that in the end societal applications really did play an equal role.

Criteria for Prioritization

- Contributes to the most important scientific questions facing Earth sciences today (scientific merit-discovery, exploration);
- Contributes to applications and policy making (societal benefits);
- Contributes to long-term observational record of Earth;
- Complements other observational systems, including national and international plans;
- Affordable (cost considerations, either total costs for mission or costs per year);
- Degree of readiness (technical, resources, people);
- Risk mitigation and strategic redundancy (backup of other critical systems);
- Makes a significant contribution to more than one thematic application or scientific discipline.

Above not in priority order

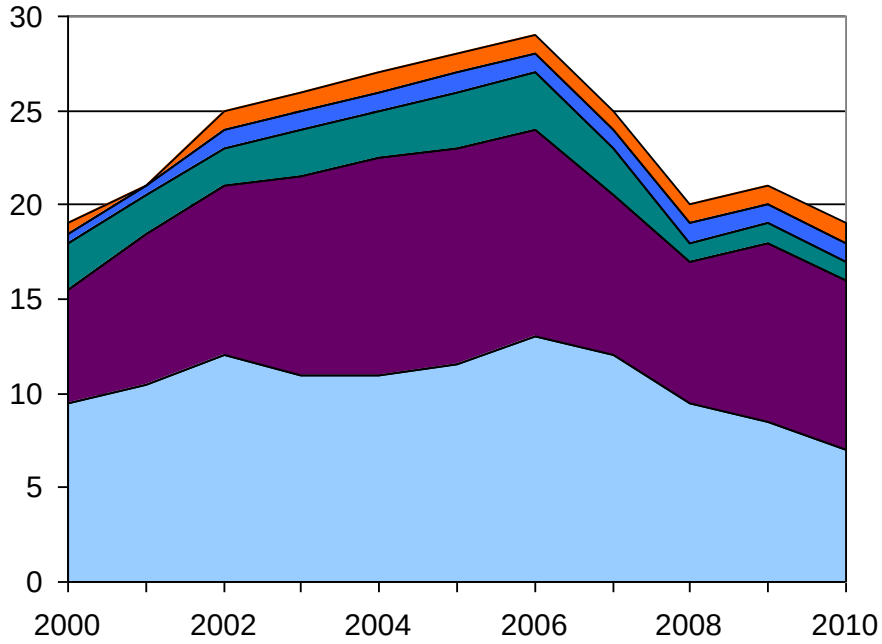
Comment

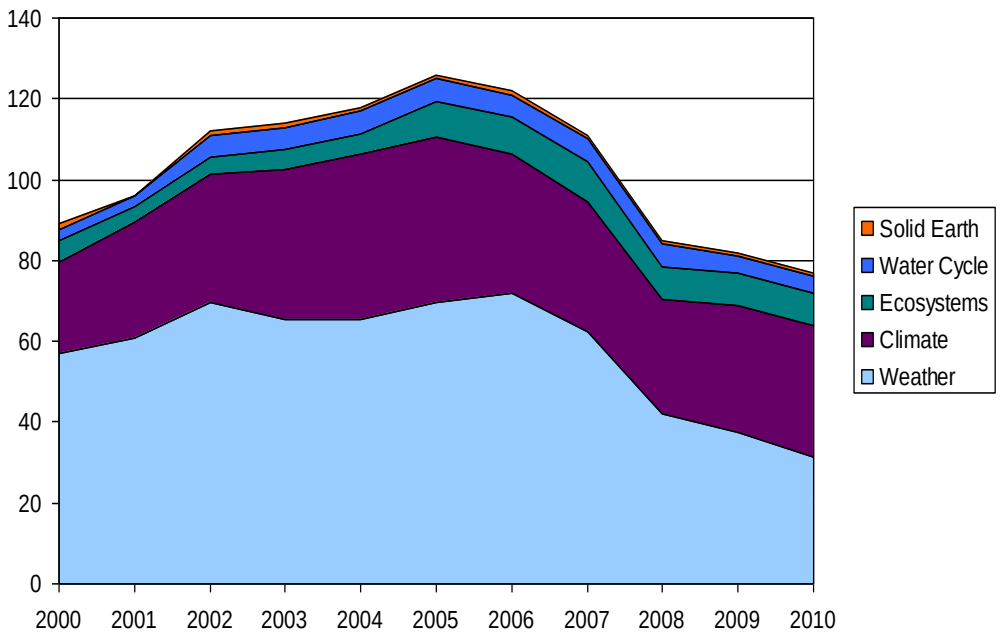
- Criteria for prioritization were good and useful
- Prioritization
  - Started with 135 ideas from RFI
  - Panels recommended 3-6 missions in priority order, total of 35 missions
  - Ex Com selected highest priorities from panels
  - Report recommended 17 missions, in a priority order of implementation

Interim Report
April 2005

"Today, this system of environmental satellites is at risk of collapse."

Trends In Earth Observations Missions From Space



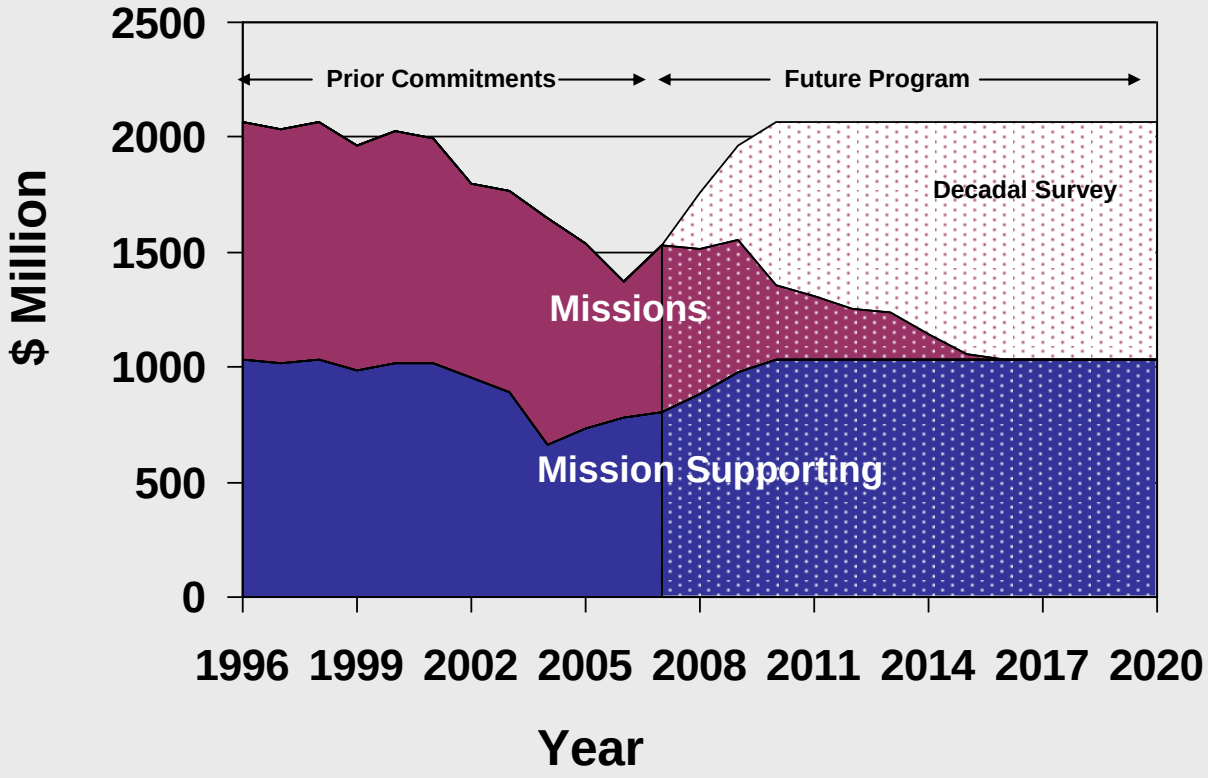


Number of Missions **Number of Instruments**

FINAL REPORT

- Recommends a Path Forward that Restores US Leadership in Earth Science and Applications and averts the Potential Collapse of the System of Environmental Satellites
- Presents an Integrated Suite of Missions
  - Panel recommendations rolled-up
  - Missions sequenced
  - Overall cost matched to anticipated resources plus reasonable growth
- Highest Priorities of Each Panel Preserved
- Some Guidance on How To Handle Budget or Technology Development Problems

Implementing the Decadal Survey (NASA Budget)



Comment

- Recommending aggressive (optimistic) but still realistic budget was important
  - Showed opportunities with modest increase in resources
  - No enthusiasm for recommending a minimal program that fits within flat or declining budgets

RECOMMENDATIONS

- Technology development in support of missions
- 12 additional recommendations related to turning observations into information
- OSTP develop and implement a plan for achieving and sustaining global Earth observations.
- Leverage International Efforts

PROGRAMMATIC DECISION STRATEGIES AND RULES

- **Manage Technology Risk**
  - Sequence missions according to technological readiness and budget risk factors… technological investments should be made across all recommended missions.
  - Establish technological readiness through documented technology demonstrations before mission development phase...
- **Respond to budget shortfalls**
  - Protect the overarching observational program by canceling missions that substantially overrun…
  - Maintain broad research program

What worked well

- Request to community for ideas (RFI) and involvement of community throughout process
- Executive Committee and Panels
  - Good ideas
  - People on both EC and Panels worked hard
- Vision and principles for prioritization
- Sand charts showing trends in budgets, missions, and instruments
- NRC staff support

What worked less well

- Panels on Human Health and Security and Earth Science Applications and Societal Benefits-seemed lost at times
- Budget estimates of missions (no independent cost assessment and technical evaluation (NO CATE)
- Limited consideration of international missions

What worked less well

- Could have used more resource people
  - Budget analysis
  - International missions
  - Help with cost estimates

Impacts/Outcomes

- Good response from media and Congress
- Budget declines in NASA and NOAA were reversed
- NASA response-strong
- NOAA response-weak

Impacts/Outcomes

- Response to recommendations other than missions weak
- Did not focus on overall, balanced program rather than separate missions (stovepiping)
- NASA did not receive the recommended budget increases
- Administration priorities added to NASA's "to do" list without additional resources
- Mission creep alleged

10 Years Later

- Need for Earth observations greater than ever
- Earth Sciences changing
  - Less exploratory
  - Need for sustained observations rather than one offs
  - Societal applications more important
  - Advances in technologies can make observations cheaper
- Commercial ‘data buy’ opportunities (or threats)

Implications

- More emphasis on technology advancement and sustained observations-observe Earth variables cheaper so can do more and longer, e.g.
  - Sea level
  - Atmospheric composition
  - Temperature, water vapor, winds
  - Gravity
  - Land surface characteristics
- But still leave room for exploratory or revolutionary proposals (e.g. Venture class)