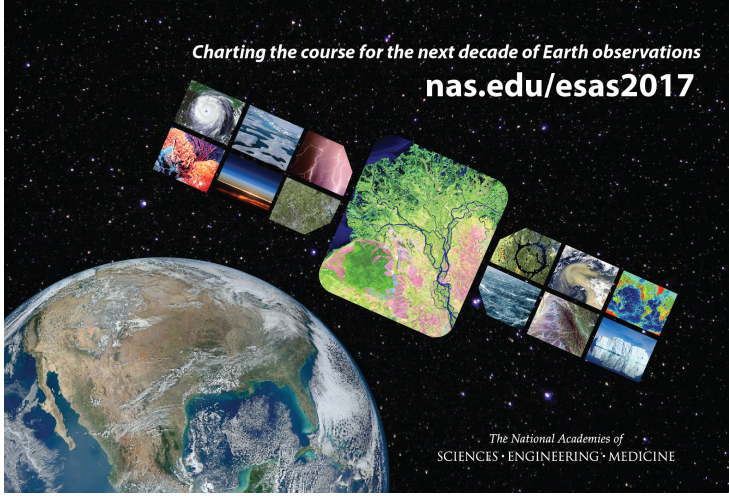
Planning for the next generation of satellite missions in the United States.

- Earth Science and Applications from Space – ESAS
- Space Platform Requirements Working Group - SPRWG

Christian Kummerow
Colorado State University
8th IPWG and 5th IWSSM Joint Workshop
Bologna, 3-7 October, 2016

ESAS 2017



- Sponsors:
  - NASA—Earth Science Division
  - NOAA—NESDIS
  - USGS—Climate & Land Use Change (land imaging)
- The survey will also have close connections with the agencies carrying out in situ and other relevant programs

- Within the Academy:
  - Collaboration (including staff) of the Space Studies Board (lead) with the Board on Atmospheric Sciences and Climate, Board on Earth Sciences and Resources, Ocean Studies Board, Polar Research Board, and Water Sciences and Technology Board.

Setting for ESAS 2017

- **NASA**: Has a backlog of missions recommended in the inaugural survey and increased responsibility—without commensurate budget increases— starting after the JPSS-1 era for vertical profiles of stratospheric and upper tropospheric ozone, solar irradiance, Earth radiation budget measurements, and altimetry (beyond Jason-3).

- **NOAA**: Stabilizing the weather satellite portfolio and avoiding a potential gap between the NPP spacecraft and the first of the next-generation POES systems, JPSS-1, is a top priority. "Climate"-related instruments moving to NASA.

- **USGS**: Landsat-8 launched Feb. 2013. USGS interested in future capabilities for a sustained land-imaging imaging program. However, Landsat-9 is projected to be a near-rebuild of L-8 for launch in in 2023, possibly accelerated to 2021 to account for 3-year design life of the thermal infrared sensor, TIRS.

ESAS 2017—Overarching Tasks

- Assess progress in addressing the major scientific and application challenges outlined in the 2007 Earth Science Decadal Survey.
- 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).
- 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.
- Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space. 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.
- Findings due by July 2017

ESAS 2017 vs. ESAS 2007

- No longer appropriate to base recommendations on an aspirational budget
- Science-based vs. Mission-based
- Congressionally-mandated independent cost appraisal and technical evaluation (CATE) for big ticket items
- Likely that the science will be "valued" to avoid having one recommended activity grow at expense of all others
- Increased opportunities to consider "new space" ideas—new players, smaller and less costly platforms, constellations, hosted payloads

  -- Challenge: developing *credible* evaluations of their potential
- Improved consideration of international partners

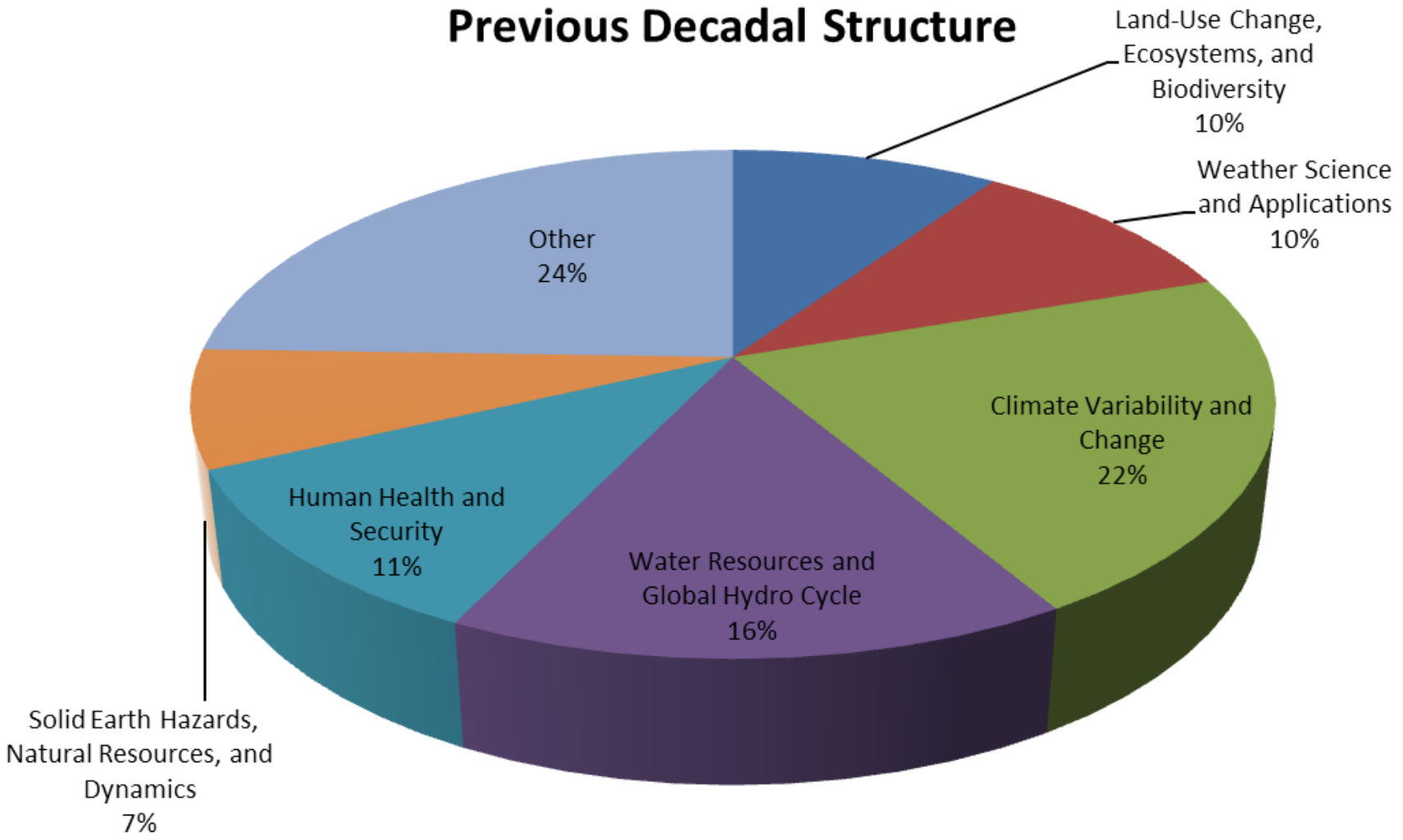
Survey Initial RFI

Issued in late September 2015 to inform the steering committee and the organization of the panels:

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?

- > 200 responses at: www.nas.edu/esas2017

RFI Categories: Previous Decadal Structure



ESAS 2017 Study Panels

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

ESAS 2017 Panels

WORKING GROUPS*

Carbon Cycle Integrating Theme	Global Hydrological Cycles	Weather: Minutes to	Marine & Terrestrial	Climate Variability and Change	Earth Surface & Interior
Water Cycle Integrating Theme	& Water Resources	Sub-seasonal	Eco-systems		
Extreme Events Integrating Theme					
Technology & Innovations Cross-Cut					
Applications' Science Cross-Cut					

*Tentative

ESAS 2017 Steering Committee

Dr. Waleed Abdalati, Co-Chair
University of Colorado Boulder

Mr. Steven J. Battel
Battel Engineering

Dr. Stacey W. Boland
Jet Propulsion Laboratory

Dr. Robert D. Braun
Georgia Institute of Technology

Dr. Shuyi S. Chen
University of Miami

Dr. William E. Dietrich
University of California, Berkeley

Dr. Scott C. Doney
Woods Hole Oceanographic Inst.

Dr. Christopher B. Field
Carnegie Institution for Science

Dr. Helen A. Fricker
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Dr. Anthony C. Janetos
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Mr. Charles Harris, Research Associate

Dr. Michael Moloney, Director, Space Studies Board

NOAA Space Platform Requirements Working Group (SPRWG) Terms of Reference

BACKGOUND

- The current US weather satellite program of record (POR) provides for continuous and evolving essential satellite services to weather and space weather missions to the 2020s and beyond.

- The services provided in the POR will fall below desired assurance levels at various dates (depending on the service) from approximately 2024 to 2032.

- The current constellation carries high budget requirements and leaves significant unmet needs behind.

- The US Government intends to continue weather satellite services for the indefinite future and to continuously bring new capabilities into operation that promise to save lives in dangerous weather incidents, improve on warnings of environmental events, and contribute to economic growth.

- Given the long timelines required for satellite acquisition, it is necessary to make major decisions about next generation systems to follow the POR beginning in FY 2017.

The Office of Space Architecture and Advanced Planning (OSAAP) within the National Environmental Satellite Data and Information Service (NESDIS) is conducting an architecture study in FY16 and FY17 to determine the most cost effective space segment architectures for performing NOAA weather, space weather, and environmental remote sensing (excluding land mapping) missions. The objectives, scope, and products of this NOAA Satellite Observing System Architecture (NSOSA) study are summarized in the NSOSA study Terms of Reference (TOR).

The Space Platform Requirements Working Group (SPRWG)

The Space Platform Requirements Working Group (SPRWG) will determine needs and relative priorities for weather, space weather and environmental remote sensing (excluding land mapping) space-based observations in the epoch of 2030 in support of the NSOSA study Architecture Development Team (ADT). The priorities, as specified in the NSOSA TOR, will be NOAA operational functions first, followed by NOAA non-operational functions. The SPRWG has no decision authority beyond the deliverables defined within this TOR.

SPRWG Functions: The SPRWG will work in close coordination with the ADT lead, and ADT members identified by the ADT lead, in development of the following products.

Value Model: The SPRWG will participate in developing the user value model and will participate in developing and reviewing study products as discussed below.

The Goals

To have an agile system, NOAA needs a model that trades “value” of an operational mission, or improvements to a mission, against the projected cost.

Assuming that some minimum capacity must exist for today’s operational functions, the SPRWG is charged with developing the value model that ranks todays as well as potential new measurements as well as the value of improving them from a “minimum acceptable” level to “expected (today’s capabilities)” to the “maximum effective” level for each set of observations – i.e. the “value model” such that the optimal design can always be found given a realistic “cost” model and an available budget.

The SPRWG will do this in three iterations to allow for feedback between the “value” model and the “cost” model. Currently on second iteration.

I. Global Hydrological Cycles and Water Resources

The movement, distribution, and availability of water and how these are changing over time

1. ANA P. BARROS, Duke University, Co-Chair
2. JEFF DOZIER, University of California, Co-Chair
3. EFI FOUFOULA, University of Minnesota
4. ANDREA RINALDO, Ecole Polytechnique Federale de Lausanne
5. ERIC F. WOOD, Princeton University
6. DARA ENTEKHABI, Massachusetts Institute of Technology
7. GRAHAM E. FOGG, University of California, Davis
8. JOHN D. BOLTEN, NASA Goddard Space Flight Center
9. VENKAT LAKSHMI, University of South Carolina
10. NEWSHA AJAMI, Stanford University
11. TERRI HOGUE, Colorado School of Mines
12. DAVID C. GOODRICH, USDA-ARS
13. EDWIN WELLES, Deltares USA Inc.
14. JEFFREY S. KARGEL, University of Arizona
15. CHRISTIAN KUMMEROW, Colorado State University

II. Weather and Air Quality: Minutes to Subseasonal

Atmospheric Dynamics, Thermodynamics, Chemistry, and their interactions at land and ocean interfaces

1. Steve Ackerman (Co-chair), University of Wisconsin
2. Nancy Baker, Naval Research Laboratory (Co-Chair)
3. Stanley Benjamin, NOAA-Earth Systems Research Laboratory
4. Maria Pirone, Harris Corp.
5. Elizabeth Barnes, Colorado State University
6. Xubin Zeng, University of Arizona
7. Mark Bourassa, Florida State University
8. Julie Thomas, Scripps Institution of Oceanography
9. Duane Waliser, Jet Propulsion Laboratory
10. Bryan Duncan, NASA Goddard Space Flight Center
11. Charles Kolb, Aerodyne Research Corp.
12. Armistead Russell, Georgia Institute of Technology
13. Philip Ardanuy, INNOVIM Corp.
14. Ying-Hwa Kuo, University Corporation for Atmospheric Research
15. Paul Menzel, University of Wisconsin

IV. Climate Variability and Change: Seasonal to Centennial

Forcings and Feedbacks of the Ocean, Atmosphere, Land, and Cryosphere within the Coupled Climate System

1. CAROL ANNE CLAYSON, Woods Hole Oceanographic Institution, Co-Chair
2. VENKATACHALAM RAMASWAMY, NOAA Geophysical Fluid Dynamics Laboratory, Co-Chair
3. ARLYN E. ANDREWS, NOAA Earth System Research Laboratory
4. ENRIQUE CURCHITSER, Rutgers University
5. LEE-LUENG FU, Jet Propulsion Laboratory
6. GUIDO GROSSE, Alfred Wegener Institute
7. RANDAL D. KOSTER, NASA Goddard Space Flight Center
8. SONIA M. KREIDENWEIS, Colorado State University
9. EMILIO F. MORAN, Michigan State University
10. CORA E. RANDALL, University of Colorado, Boulder
11. PHILIP J. RASCH, Pacific Northwest National Laboratory
12. ERIC J. RIGNOT, University of California, Irvine
13. CHRISTOPHER S. RUF, University of Michigan
14. ROSS J. SALAWITCH, University of Maryland, College Park
15. AMY K. SNOVER, University of Washington
16. JULIENNE C. STROEVE, National Snow and Ice Data Center
17. BRUCE A. WIELICKI, NASA Langley Research Center
18. GARY W. YOHE, Wesleyan University

SPRWG Subgroups

- Oceans (NOS, NMFS, OAR)
  - Rich Edwing, Michael Ford (Chair), Bob Atlas, Pam Emch, Jim Yoe
- Weather/climate (NWS, OAR)
  - Short term (nowcasting, GOES type of product, etc.)
    - Gerry Dittberner, Chris Velden (Chair), Kevin Schrab, Steve Goodman, Steve Ackerman
  - NWP and longer scales (few hours to two weeks and beyond)
    - Jim Yoe (Chair), Bob Atlas, Mitch Goldberg, Lisa Callahan, Tom VonderHaar., Chris Kummerow.
- Space weather (NWS)
  - Tom Berger (Chair), Dan Baker, Lisa Callahan
- Anthes and Gail (overviews, context setting, international, commercial, communications)