Earth Science Research Program: Structure and Recent Evolution

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Summary of Discussion

- Structure and Overall Content of Research Program
- Research Management
- Evolution of Research Lines
- Future Outlook

Structure and Overall Content of Research Program

- Historically, Earth Science Research is broken up into five budget lines:
  - Research and Analysis (R&A)
  - Mission Science Teams
  - EOS Science
  - Suborbital Science
  - High End Computing
- Evolution in budget structure complicates tracking evolution of research program
- Research program is mostly competed, but includes some elements of infrastructure (esp. high end computing, suborbital science) for which much of implementation is competed

Research Program Structure

- **Research and Analysis -** mainly individual investigator competed activities, organized predominantly around scientific disciplines
- **Mission Science Teams -** support for investigators affiliated with individual satellite missions or groups of closely related missions
- **EOS Science -** includes calibration/validation for EOS and interdisciplinary science
- **Suborbital Science -** includes operation of aircraft platforms and investments to support bringing new capability into NASA airborne science programs
- **High End Computing -** includes investment in supercomputing capability (esp. at GSFC) to support community and infrastructure needed for its use

Research Management

- Development of solicitations and review process is led by HQ program managers/program scientists
- Solicitation now carried out through series of ROSES elements (beginning 2005) - previously through series of separate research announcements
- Most programs are on 3 year cycle
- Most programs have multiple entry points, but some get largely determined by a single competition (e.g., “EOS recompetiton” for Terra/Aqua)
- Some competitions cover multiple programs to facilitate scientific connections and enhance efficiency of solicitation process

Research Disciplines (R&A)

- Atmospheric Composition
  - Upper Atmosphere Research Program
  - Tropospheric Chemistry Program
  - Atmospheric Chemistry Modeling and Analysis Program
- Climate Variability and Change
  - Physical Oceanography Program
  - Cryospheric Science Program
  - Modeling and Analysis Program
- Carbon Cycle and Ecosystems
  - Terrestrial Ecology Program
  - Land Cover/Land Use Change Program[1]
  - Ocean Biology and Biogeochemistry Program
- Global Water and Energy Cycle
  - Atmospheric Radiation Program[2]
  - Atmospheric Dynamics Program[3]
  - Terrestrial Hydrology Program
- Weather
- Earth Surface and Interior
  - Solid Earth and Natural Hazards Program

[1] Also Supports GWEC FA

[2] Also Supports Atmos. Comp. and CVC FA

[3] Also Supports Weather FA

Historical Mission Science Team Lines

- Terra
- Aqua
- Aura
- Precipitation
- Ocean Surface Topography
- Ocean Surface Vector Winds
- SeaStar
- ICESat
- TOMS
- SBUV/2
- NIST Calibration
- UARS
- SAGE (II/III)
- NPP
- Glory
- Earth System Science Pathfinder (GRACE)
- Carbon Cycle Science
- Land Cover Project Science Office
- Radarsat
- Satellite Laser Ranging
- AVIRIS/AirSAR
- Global Modeling and Assimilation

MO&DA Competition History

Mission	Comp. Element	Due Date	Sel Date
OVWST	ROSES 05 A.8		4/4/06
OSTST	NRA-03-OES-05		9/28/04
Precipitation	ROSES 06 A.8	4/28/06	
ICESat	ROSES 05 A.9		4/17/06
GRACE	ROSES 06 A.12	9/25/06	
GPS/GNSS	ROSES 06 A.13	8/28/06	
Cloudsat/CALIPSO	ROSES 05 A.10	*7/1/05*	
Terra/Aqua/ ACRIMSAT	ROSES 06 A.15	7/18/06	
SOSST	NRA-02-OES-02	5/30/02	
Aura - OMI	ROSES 05 A.14 (part)		3/31/06
Aura - other	ROSES 07 (plan)	2007?	
SORCE	TBD- ROSES 07?	2007?	
Carbon Cycle Sci.	NRA-04-OES-01		7/12/04

EOS Science Contents

- Calibration/Validation Prog.
  - **EOS Project Science Office**
  - **Calibration Labs**
    - GSFC
    - ARC
  - **Ground Networks**
    - Aeronet
    - MPLNet
    - MOBY
  - **Facility Instruments**
    - MAS
    - MASTER
    - NAST-I
  - **Augmented Campaigns (ex.)**
    - Aura
    - NAMMA
    - Crystal Face
    - Sea Ice
    - SOLVE
    - SAFARI 2000
- Interdisciplinary Science
  - **2002 RSP NRA**
    - Coupled Modeling
  - **2003 NRA Topics**
    - Changing Global Ecosystems
    - Methane Trends
    - Sea Level and Climate
    - Land Cover and Climate
    - Climate Change and Coastal Regions
    - Polar Feedbacks
    - Global Carbon Modeling
  - **ROSES 2006 Element Topics (abbrev. Titles)**
    - Landscapes to Coasts
    - Global Sea Level
    - Biodiversity and Disturbance
    - Coupled Carbon Cycle Modeling
    - Aerosol Impacts

Research Management, Cont.

- 2003 Research NRAs
  - NPP Science Team
  - Earth System Science Research using Data and Products from TERRA, AQUA and ACRIM Satellites
  - Interdisciplinary Science in the NASA Earth Science Enterprise
  - The Ocean Surface Topography Science Team (OST/ST)

- 2004 Research NRAs
  - Carbon Cycle Science
  - Oceans and Ice
  - Tropical Cloud Systems and Processes (TCSP)
  - Measurements, Modeling, and Analyses in Support of AURA and Other NASA Satellite Observations …
  - Modeling, Analysis and Prediction Climate Variability and Change
  - NASA Energy and Water Cycle NRA (NEWS)

Primary Funding Lines:

R&A

Mission Science Team

EOS Science

Research Management, cont.

ROSES 2005 Elements and Due Dates

A.2 Land Cover/Land Use Change - 8/1

A.3 LBA in Amazonia - 4/26

A.4 Terrestrial Ecology and Biodiversity - 9/12

A.5 Ocean Biology and Biogeochemistry - 7/1

A.6 North American Carbon Program - 12/15

A.7 Remote Sensing Science for Carbon and Climate - 8/3

A.8 Ocean Vector Winds Science Team - 6/1

A.9 Ice Cloud and Land Elevation Satellite and Cryosat - 5/25

A.10 CloudSat and CALIPSO Science Team and Modeling/Analysis of A-Train Related Data - 7/1

A.11 NASA Energy and Water Cycle Study - 8/16

A.12 Terrestrial Hydrology - 9/1

A.14 Atmospheric Composition - 6/15

A.15 Earth Surface and Interior - 7/27

A.31 NAMMA - 11/21

Primary Funding Lines:

R&A

Mission Science Team

EOS Science

ROSES 2006 Elements and Due Dates

A.8 Precipitation Science - 4/28

A.9 Atmospheric Composition: Tropical Composition, Cloud, and Climate Coupling Experiment - 8/1

A.10 Atmospheric Composition: Research and Modeling - 6/15

A.12 Recompetition of the GRACE Science Team - 9/25

A.13 GNSS Remote Sensing Science Team - 8/28

A.14 Interdisciplinary Research in Earth Science - 4/17

A.15 Earth System Science Research using Data and Products from the Terra, Aqua, and ACRIMSAT Satellites - 7/18

A.16 International Polar Year - 5/1

A.23 Atmospheric Composition: Modeling and Analysis - 9/1

Research Management, cont.

- Suggested Organization of Proposals in EOS (Terra/Aqua) Recompetition
  - Instrument-specific Algorithm Refinement and Cal/Val Activities
  - EOS Algorithm Refinement and Cal/Val for Earth System Data Records
    - Atmospheric Profiles for Meteorological Variables
    - Atmospheric Particulates - Aerosols and Clouds
    - Ocean Biological and Biogeochemical Properties and Related Variables
    - Vegetation Productivity and Related Properties
    - Land Cover
    - Land Surface Temperature and Fires
    - Snow Cover
    - Sea Ice
    - Trace Gases
    - Solar and Infrared Radiative Fluxes at the Surface and the Top of the Atmosphere
  - Integrated Science Data Analysis

Selection Statistics for From FY04 NRAs

NRA Title	# Rec	# Sel.	NASA	Univ.	OG	P/NP
Carbon Cycle Science	301	59	8	37	5	2
Oceans and Ice	293	53	23	18	3	8
Tropical Cloud Systems and Processes	105*	25	9	11	5	0
NASA Energy and Water Cycle	101	33	9	19	1	4
Modeling, Analysis and Prediction - Climate Variability and Change	225	65	27	31	5	2

* Does not include proposals submitted to radiation science part that was not carried out

Selection Statistics for From FY05 ROSES Elements

ROSES Element	# Rec	# Sel.	NASA	Univ.	OG	P/NP
Atmospheric Composition						
OMI	12	8	4	3	1	0
Kinetics	23	16	5	5	5	1
ICESat/Cryosat	71	19	11	7	0	1
Land Cover/Land Use Change	83*	14	1	12	0	1
LBA	37	22	1	16	0	5
NAMMA	N/A	23	10	10	2	1
Ocean Biology and Biogeochm.	22	7	2	1	2	2
Ocean Vector Winds Sci Team	57	22	4	12	1	5
Remote Sensing Science	44	10	4	5	0	1
Terr. Ecol. & Biodiversity	34	7	1	5	0	1

* Step 2 Proposals (173 Step 1 Proposals were submitted)

Review Process

- Changes to SMD Peer Review Process in 2006
  - Salary Information will be withheld from reviewers
  - Intent is to help reviewers avoid focusing on cost structure of proposer's institution ("sticker shock")
    - It's possible that proposals from high cost institutions will be helped by this policy, but that is not known
  - Program officer is expected to figure out how to best accommodate highest ranked proposals within budget

Research Funding*

Budget Line	FY03	FY04	FY05	FY06	FY07 (note)
Research and Analysis	160.2	191.2	201.5	162.1	133.8 (158.7)
Mission Science Teams	102.6	193.0	177.8	264.3	226.0 (247.0)
EOS Science	53.6	58.3	63.4	56.4	57.0 (61.8)
Suborbital Science	25.0	31.0	43.1	35.0	26.7 (35.3)
Scientific Computing	10.5	15.9	25.7	26.9	19.0 (21.8)
HECC					37.3 (21.8)
Total Research	353.9	489.4	511.4	544.7	499.8

Major year-to-year changes:

FY04 - merge former EOS algorithms line into mission science teams, change to full cost - note in R&A estimate increase in requirements was significantly greater (~$55M), removed $8M from EOS science

FY05 - carry out ~$44M reduction and then restore but make adjustments in restoration

FY06 - add mission ops into mission science teams, reduce R&A by ~ 17.5%, EOS science by ~ 20% from planned amount; earmarks hit multiple lines

FY07 - had planned $9M reduction to R&A and EOS science; Remove CM&O money, assign HECC to research, make minor puts/takes across lines; numbers in parentheses reflect numbers from FY06 President's Budget for FY07; note begin to look at Education/Public Outreach as research funds, although carried as separate line

* Archaeology done by JAK with best effort - undoubtedly not fully consistent (esp. w/r taxes, earmarks) - some numbers are approximate and may not reflect everything within a budget line (esp. scientific computing, suborbital science)

Future Evolution of Research Funding

- R&A Reduction in FY06 initiated in FY06 operating plan announced along with FY07 budget submission is continued in FY07 (indeed, FY07 had been planned to be $9M below FY06) with slow rebuilding beginning in FY08
  - By FY11, R&A budget would be almost up to FY05 amount (before CM&O reduction) but with no inflation adjustment
  - Earth Science R&A was treated differently from others in SMD for which R&A did not recover in out years (they "flat-lined" with 15% cut
- Note Increased Pressure on Mission Science Line due to Potentially Large Number of Extended Missions and need to have competed science teams for increasing set of ESSP missions
  - FY07 Senior Review will provide priorities
  - Note all missions except Aura will be reviewed
  - Operations costs are large and if they cannot be reduced in out years, our ability to sustain and utilize multiple missions will be challenged
- CM&O reductions are increasing in out years, suggesting further pressure on funding for civil servant salaries and extramural grants
- Earth Science budget structure differs from that of other SMD divisions given mission science showing explicitly as a research line - together with R&A makes research very large (and a target), so restructuring of budget is being considered