Community Plan for NASA Ocean Biology & Biogeochemistry Program

- A plan for the NASA OBB program
- **Science to Requirements to Strategies to Missions**
- Community plan
- Intended as a “living document”
- Will be reviewed by NRC
The Four OBB Scientific Questions

- Ecosystems & Diversity
- Carbon & Biogeochemistry
- Habitats
- Hazards
Emerging Scientific Questions in Ocean Biology and Biogeochemistry Research

• How are ocean ecosystems and the biodiversity they support influenced by climate or environmental variability and change, and how will these changes occur over time?

• How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do these biogeochemical fluxes impact the ocean and Earth’s climate over time?

• How (and why) is the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?

• How do hazards impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?
Ecosystems & Diversity, Carbon & Biogeochemistry, Habitats, Hazards

• Relevance:
  • changing ecosystem structure, function, distribution on synoptic to climatic time scales
  • impact on higher trophic levels (e.g., fish, reptiles, birds, mammals)

• Science:
  • Assessing biogeography in a multidisciplinary manner
  • Quantifying ocean productivity
  • Identifying plankton functional groups

• Benefits to society:
  • Assessing ecosystem health, services
  • Understanding nutrient and carbon sinks/sources
  • Improving human welfare
• Relevance:
  • Impacts & feedbacks of climate change on global biogeochemistry
  • Impacts of humans

• Science:
  • Assessing primary producer biomass
  • Estimating carbon fluxes
  • Understanding climate controls

• Benefits to society:
  • Assessing/verifying ocean carbon credit trading & mitigation strategies
  • Helping manage human services in a changing climate
• Relevance:
  • Growing human population density & dependence on ocean resources
  • Changing coastal environments

• Science:
  • Classification of regional marine habitats & coastal landscapes
  • Measuring impacts of land use
  • Understanding climate control
  • Assessing fisheries & shelf ecosystem resilience
  • Assessing red tides and coral reef health

• Benefits to society:
  • Basis for ecosystem-based management
  • Improving human health, recreation, & commerce
Ecosystems & Diversity, Carbon & Biogeochemistry, Habitats, Hazards

- Relevance:
  - Significant risk to human life and property
  - Protection of natural environments

- Science:
  - Acute hazards:
    - Tsunamis & Hurricanes
    - Pollution
    - Harmful Algal Blooms
  - Chronic Hazards:
    - Ocean warming and sea level rise
    - Ocean acidification
    - Eutrophication

- Benefits to society:
  - Forecasting of hazards
  - Disaster preparedness/security
  - Mitigation tools
Science Requirements & Mission Themes

- Global separation of in-water constituents & advanced atmospheric correction
- High temporal & spatial resolution coastal measurements
- Active assessments of plant physiology & functional composition
- Mixed layer depth
Science Requirements Lead to Observational Strategies

- Global Hyperspectral Imaging Radiometer
- Geostationary Hyperspectral Imaging Radiometer(s)
- Multi-Spectral High Spatial Resolution Imager
- Portable Sensors from Suborbital Platforms
- Variable Fluorescence Lidar
- Mixed Layer Depth & Illumination Sensor
- Ocean Particle Profiler & Aerosol Column Distributions
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GEO partnership
Earth Science & Applications from Space Decadal Survey (2007)

NRC's response to NASA, NOAA & USGS to generate consensus recommendations regarding …

1. high-priority missions & activities to support needs for research & monitoring of the Earth during the next decade, and

2. important directions that should influence planning for the decade beyond.

Prepublication copy available at http://www.nap.edu/catalog/11820.html
17 Recommended New Missions: “Minimal Yet Robust”

- NOAA & NASA missions launched from 2010-2020:
  - Seven “small” ($65M to $300 million, ~50% “error bar”)
  - Eight “medium” ($350M to $600M)
  - Two “large” ($700M & $800M, ~30% “error bar”)

- NOAA: Transition 3 LEO “research” to “operational”
  - Extended vector winds, GPS radio-occultation, total solar irradiance

- NASA: Implement 14 other missions
  - 2 GEO & 12 LEO
  - Four 2010-2013, Five 2013-2016 & Six 2016-2020 launches
OBB Plan Mission Prioritization

Global Hyperspectral Imaging Radiometer

Geostationary Hyperspectral Imaging Radiometer

Multi-Spectral High Spatial Resolution Imager
Community Plan for NASA Ocean Biology & Biogeochemistry Program

- Provide a plan for future of the NASA OBB program
- Science to Requirements to Strategies to Missions
- Community plan - intended as “living document”
- Rec’s consistent with the NRC Decadal Survey
Plans are worthless, but planning is everything.

Dwight David Eisenhower
### 2013-2016 NASA Missions

<table>
<thead>
<tr>
<th>Mission</th>
<th>(#) Measurement Types (Panel Themes)</th>
<th>Orbit</th>
<th>Instruments</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperspectral/IR Imagery (HyspiRI)</td>
<td>(4) Land surface composition for agriculture &amp; mineral characterization, vegetation types for ecosystem health (Ecosystem, health, solid earth)</td>
<td>LEO, SSO</td>
<td>Hyperspectral spectrometer</td>
<td>$300M</td>
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<td><strong>Active Emissions</strong>: Days, and Seasons (ASCENDS)</td>
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<tr>
<td>Surface Water/Ocean Topography (SWOT)</td>
<td>(4) Ocean Circulation, Heat Storage, &amp; Climate Forcing. Algal Blooms &amp; Water-Borne Infectious Disease, Global Ecosystem Dynamics, Heat Stress &amp; Drought, Inland &amp; Coastal Water Quality (Climate, health, water)</td>
<td>LEO, SSO</td>
<td>Ka-band wide swath radar</td>
<td>$450M</td>
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<tr>
<td><strong>OBB #2 Geostationary Hyperspectral Radiometer</strong></td>
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<td>Geostationary Coastal &amp; Air Pollution Events (Geo-CAPE)</td>
<td>(9) Air Pollution, Acute Toxic Pollution Releases, Algal Blooms &amp; Water-Borne Infectious Disease, Global Ecosystem Dynamics, Heat Stress &amp; Drought, Inland &amp; Coastal Water Quality (Climate, health, water)</td>
<td>GEO</td>
<td>High &amp; low spatial resolution hyperspectral</td>
<td>$550M</td>
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<tr>
<td><strong>OBB #1 Global Hyperspectral Imaging Radiometer</strong></td>
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Decadal Survey Q’s Driven by Societal Needs*

**Air Quality**: More reliable forecasts for effective urban pollution management

**Climate Prediction**: Robust estimates of climate forcings for better forecasts, including local predictions of climate change effects

**Earthquake Warning**: Identify active faults & predict likelihood of earthquakes for effective structural improvements & informed land-use decisions

**Ecosystem Services**: Improved agricultural land-use & ocean productivity forecasts to improve planting & harvesting schedules & fisheries management

**Extreme Event Warnings**: Better storm track forecasts & intensification predictions, volcanic eruption & landslide warnings for effective evacuation planning

**Freshwater Availability**: Improved precipitation & drought forecasts for better management

**Human Health**: Better infectious & vector-borne disease forecasts for control & response

**Improved Weather Prediction**: Longer-term, more reliable forecasts

**Sea-level Rise**: Better ocean temperature & ice-sheet volume change forecasts & feedback for effective coastal community planning
Next Decade Mission Prioritization

Selection Process
- Panels reviewed >100 candidates, 35 recommended to Executive committee
- Range & synergy of measurements critical, not individual missions
- Robustness of mission synergies ensures measurements

Prioritization Criteria (Not in order of importance)
- Ability to complement other systems, US & international plans
- Contribution to:
  - Applications & policy (societal needs)
  - Long-term observational record
  - Multiple applications or science disciplines
  - Top scientific questions
- Cost (mission total or per year)
- Readiness (technical, resources, people)
- Risk & strategic redundancy (backup other critical systems)
Setting NOAA’s Foundation: Recommended Current Decade

- Restore NPOESS canceled capabilities:
  - Total solar irradiation (TSI) & Earth radiation budget (ERB) to avoid 2008-2012 gap
  - Passive ocean vector winds & all-weather sea surface temperature Conical Microwave Imager/Sounder (CMIS)
  - Limb sounding by Ozone Monitoring & Profiling Suite (OMPS)

- Restore GOES-R canceled capabilities:
  - GEO temperature & water vapor vertical sounding via canceled Hyperspectral Environmental Suite (HES)
  - Recognizing technology challenges & potential HES cost growth:
    - Complete & launch Geostationary Imaging Fourier Transform Spectrometer (GIFTS), & evaluate as HES prototype; and/or
    - Restore HES study contracts to focus on cost-effective, essential GOES-R sounding
  - Will strengthen GEO sounding technology & provide experience for efficient operational implementation
Setting NASA’s Foundation: Recommended Current Decade

- Near-term NASA concerns:
  - Understand changing precipitation patterns due to climate change
  - Understand land-use effects of growing population, changing economies, & agriculture intensification

Therefore: Maintain Global Precipitation Measurement (GPM) mission & continue to document biosphere changes provided by Landsat
  1. Launch GPM by 2012
  2. Replace Landsat 7 data before 2012

Sustained measurements of key climate & weather variables are part of committee’s strategy to achieve vision for Earth information in next decade
Relevance to Science Questions
GEO partnership