



**EARTH SCIENCE AND
APPLICATIONS FROM SPACE**

NATIONAL IMPERATIVES FOR THE NEXT DECADE AND BEYOND

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Putting together the next OBB Advance Plan & NASA PreDec Survey reports

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OCB Pre-Decadal Survey/OBB Advanced Plan
meeting, WHOI, July 2015

Earth's Living Ocean: 'The Unseen World'

An advanced plan for
NASA's Ocean Biology
and Biogeochemistry
Research

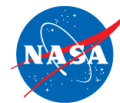




Broader goals for the Advanced Plan & the pre-Decadal Survey report

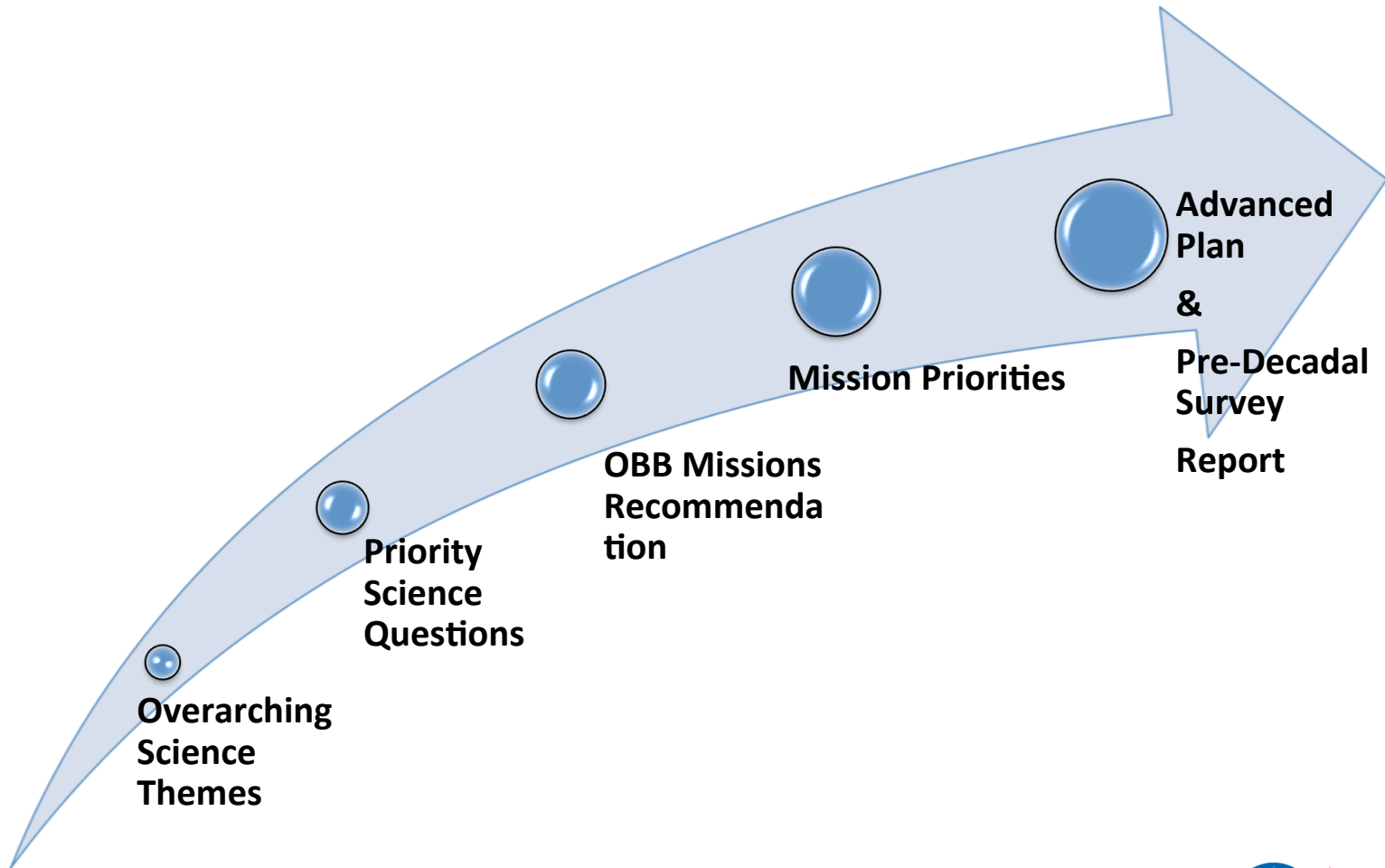
- Key questions in OBB science
(science themes -> overarching questions (to be prioritized) -> integrated mission themes -> mission priorities)
- Needs for sustained measurements
(process studies, field campaigns, international collaboration, technology development)

Science Traceability Matrix





Roadmap for the Advanced Plan

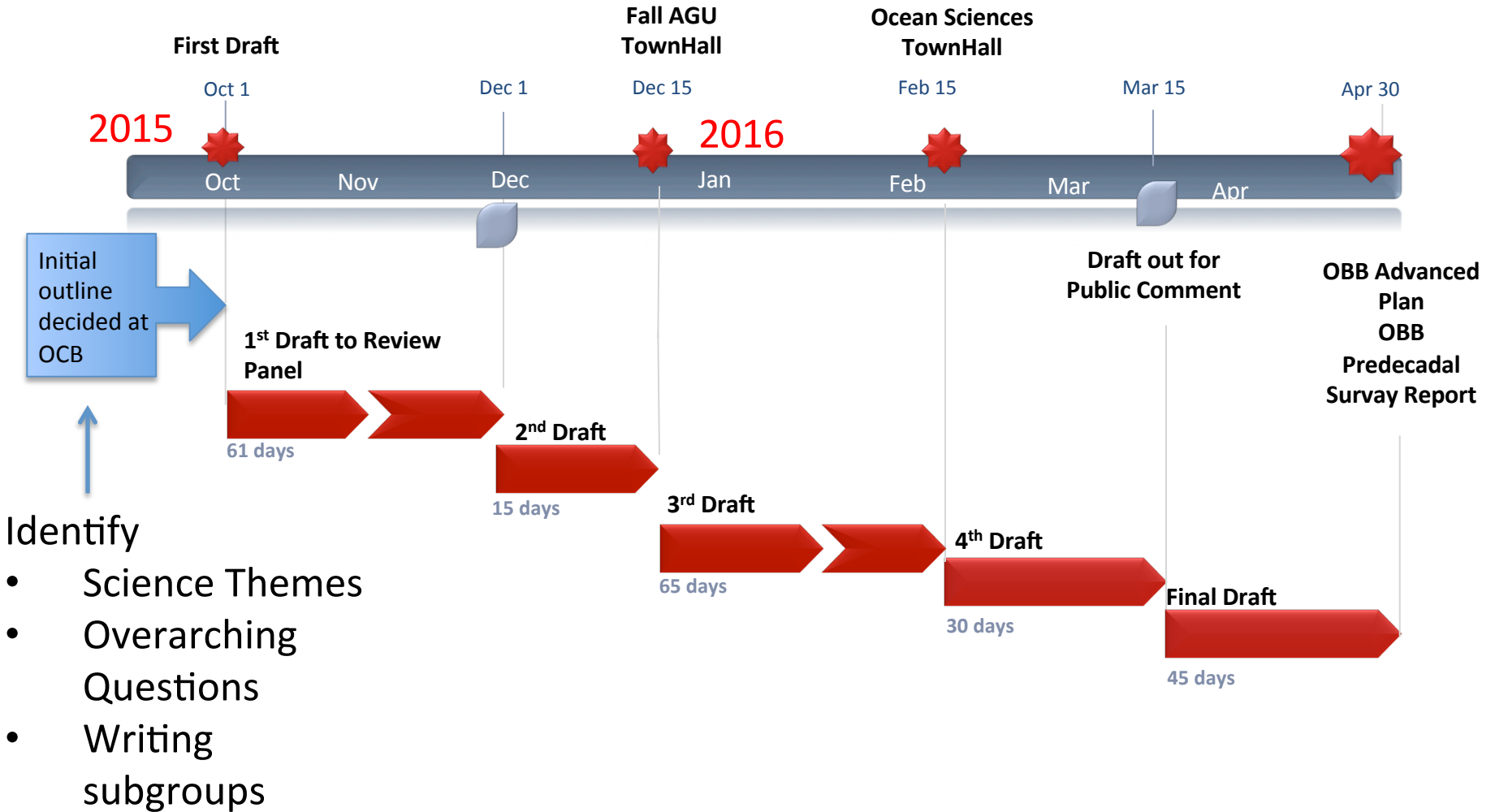




Science Traceability matrix

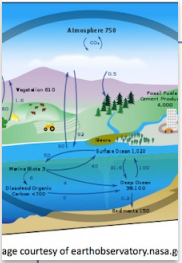
science themes	overarching questions (prioritized)	Integrated mission themes	Mission priorities



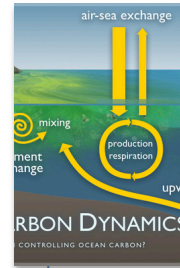




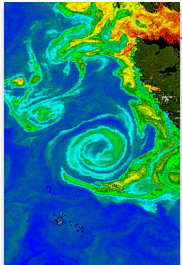
Overarching Science Themes



carbon-climate-ecosystem interactions and feedbacks



coastal processes and ecosystems



the meso- & submeso-scale



acidification



fisheries and interactions of at the higher trophic levels



High latitude oceanography & biogeochemistry



Carbon-Climate-Ecosystem

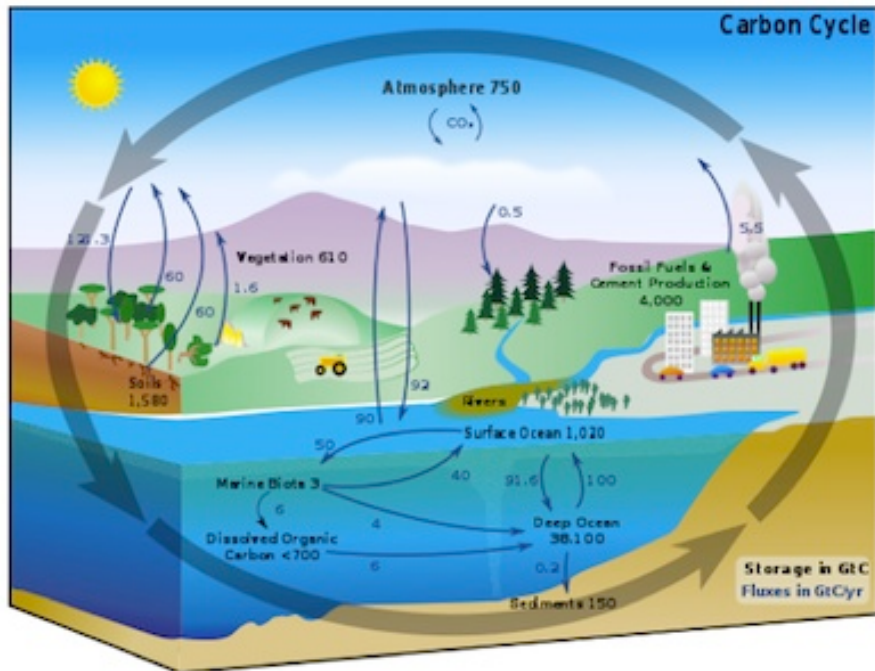
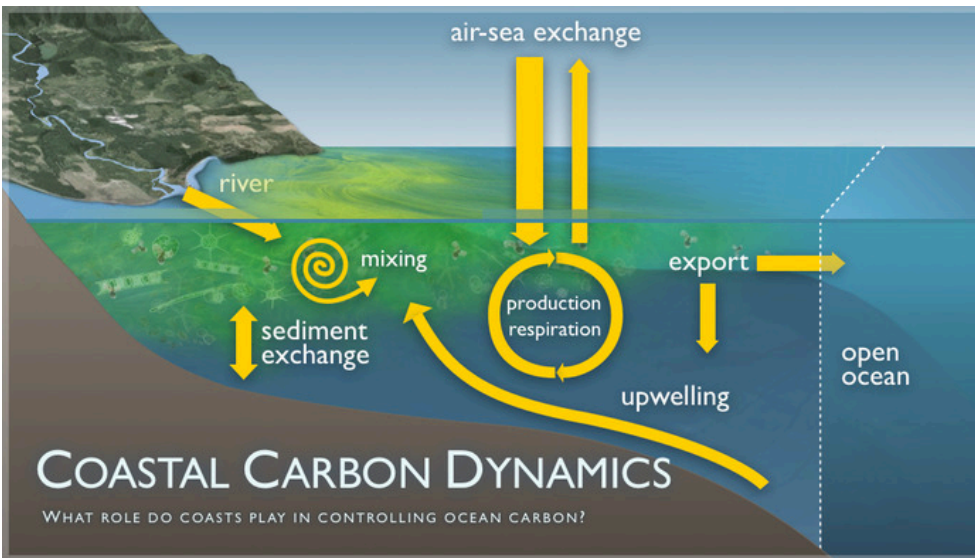


Image courtesy of earthobservatory.nasa.gov

- Quantification of ocean biogeochemical cycles; stock sizes, transformation rates;
- Partitioning in the different pumps of CO_2 ;
- Land-atmosphere-ocean-ice interactions
 - high frequency variability forcing (storms, hurricanes, floods)
 - Boundary fluxes: continental runoff, seafloor inputs (hydrothermal & volcanic, hydrates, permafrost), atmospheric deposition
 - Exchanges with land-atmos-ice system DMS, biogenic aerosols, oxygen, nitrogen, phosphorus
 - Light availability at surface; absorption in the water column; ocean albedo
- Identify Regimes of variability under different climates
 - Upwelling regime, marginal ice zones, extreme events, blooms, HNLC, etc (eg fluorescence can detect iron-limited zones), acute local events (landslides, contaminations, oil spills)
 - Stressors under climate or environmental variability
- Separation of multiple in-water constituents: NOT EVERYTHING COVARIES WITH CHL!!! Through light retrievals, physiological variability through C:CHL ratios from passive remote sensing obs

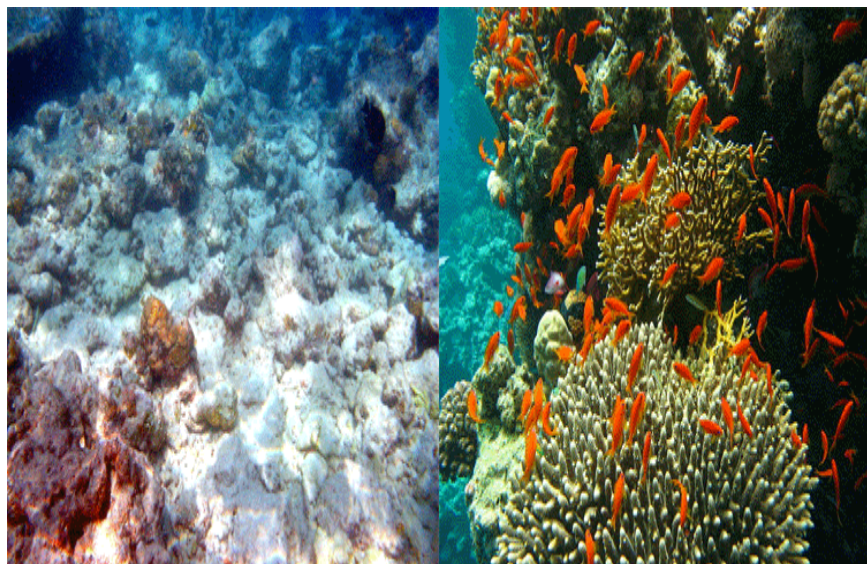
Coastal Processes and Ecosystems



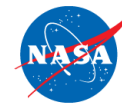
- Links to the global hydrologic cycle
- Land use and urban waste inputs
 - Sediments, nutrient, pollutant fluxes
 - Trophic structure; Habitat loss
- Hot spots of productivity
- Connections to the open ocean
 - Export of pollutants, organic carbon to open ocean & sea floor
 - Open ocean vs coastal ocean: eg. deoxygenation in coastal & open ocean
 - Upwelling from the deep ocean
- Soil carbon export to coastal regions (SMAP mission)



Acidification

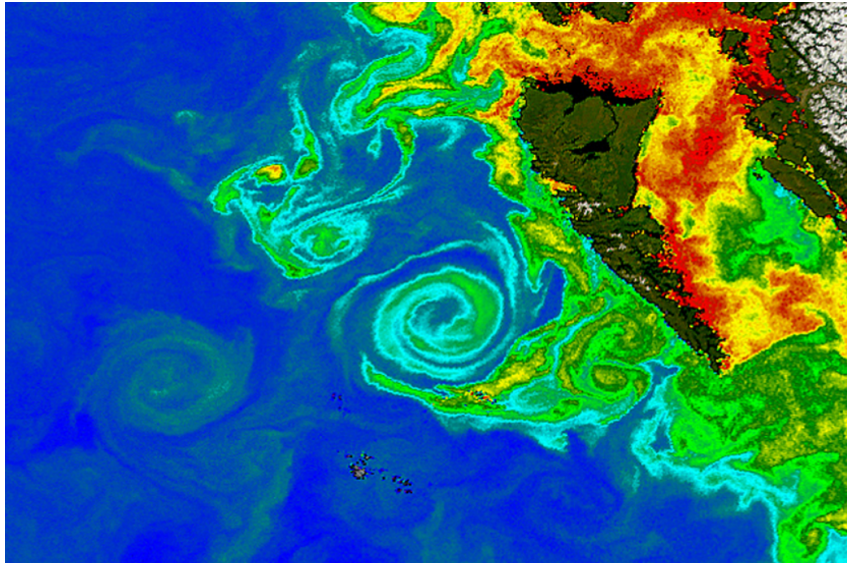


- Rate of change of pH/alk
- Consequences to marine biology (species all the way to ecological communities) and geochemistry
- Altering species interactions and community structure
- Natural variability impacts on carbonate ion concentrations
- Acidification in coastal environments; particularly in combination with other stressors, eg warming, eutrophication, deoxygenation
- Coincident measurements of SST and SSS, or SST, chl-a and PIC





Meso- and Submeso- scale



- Spatial & temporal distribution of mixing, turbulence, eddy stirring; fronts, narrow currents, eddies; vertical velocities
- Role in the biological pump (e.g. onset of blooms)
- Role in primary productivity
- Observing System Simulation Experiments (OSSE's) to downscale satellite measurements (SST, SSS, SSH,color, etc) to resolving scales; validated with in situ measurements
- detailed processes models will be developed and employed to understand many factors that are beyond present observational capabilities.
- High spatial resolution SSH, can we do better than SWOT?



Fisheries and interactions at Higher Trophic Levels

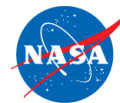


- Extractive activities (fishing) monitoring
- Sequential depletion of productivity
- Devaluation of fish stocks
- Changes in species composition of ecosystem
- cascading effects through trophic levels due to removal of top predators



Recommended Mission Themes

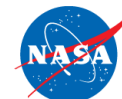
- Continuation of existing missions
- All physical measurements (SST,SSS,SSH, mixex layer depth?,waves, winds, currents, topography,precipitation,sea ice changes, land ice...)
- Broader spectrum; higher spectral resolution 350-3000n; higher spatial resolution; global and regional;
- Frequent and synoptic scale obs for small-scale phenomena in coastal environments
- Global separation of optically active and ecosystem components (advance radiometry and aerosol characterization)
- High spatial and temporal resolution coastal
- Active Assessment of Plant Physiology and Composition
- Not a mission per se: supporting other obs and modeling





Observational Strategies (previous plan)

- Global Sun-synchronous Hyperspectral Imaging Radiometer
- Global Geostationary Hyperspectral Imaging Radiometers
- Multi-spectral High Spatial Resolution Imager
- Portable Sensors from Suborbital Platforms
- Variable Fluorescence Lidar
- Mixed Layer Depth and Illumination Sensor
- Ocean Particle Profiler and Aerosol Column Distributions





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Goddard Institute for Space Studies

Goddard Space Flight Center
Sciences and Exploration Directorate
Earth Sciences Division

Cool title about Living Ocean

An advanced plan for NASA's Ocean
Biology and Biogeochemistry
Research



Goddard Institute for
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