NASA Coastal Zone Research Initiative

Workshop Proceedings

NASA GSFC
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Executive Summary

During two days in October of 2002, representatives from within NASA participated in an Earth Science Enterprise Coastal Zone Research workshop. The aim of the workshop was to overview the present capabilities and requirements and outline the future needs for carrying out NASA-relevant Coastal Zone Research. The workshop was precipitated from interest in further developing NASA's coastal zone research in order to support the efforts of the National Ocean Partnerships Program (NOPP). The NOPP, an interagency program established by the legislative branch and endorsed by the administration, formed a federal interagency office, Ocean. US (http://www.ocean.us), to guide the development on an Integrated and Sustained Ocean Observing System (IOOS). The workshop was initiated at the request of Dr. Franco Einaudi, Director of the Earth Science Directorate (Code 900) at GSFC.

The focus of the workshop was to define what present capabilities and requirements existed within the NASA-wide science community and characterize the future needs for supporting a National Coastal Zone Research effort. The goals were to develop a synthesis that could then be presented to Code Y program managers from HQ in order to support development of a NASA Coastal Zone Science Initiative.

Presently, developments of NASA remote sensor applications have centered on specific global Earth features such as land, ocean, atmosphere and ice. In addition, science products have generally been focused on specific disciplinary topics such as sea surface temperature, sea surface height, relative humidity, wind speeds, terrestrial vegetative indexes, surface ocean chlorophyll concentrations, etc. Many of the sensors have difficulties measuring at the boundaries of the features that they are attempting to observe. For example, sea surface height, sea surface winds and ocean color sensors all have difficulties resolving near the ocean-land boundary.

In the near future, NASA will be tasked to develop sensors and platforms to observe coastal zone processes that exist at shorter time and smaller space scales. Some of the immediate, high priority actions detailed within the IOOS design and implementation plan include: Deployment of new satellite sensors to improve resolution of ocean features down to a 300 m resolution; Develop enhanced sub-orbital remote sensing capabilities for rapid detection of coastal erosion, changes in coastal bathymetry, and coastal ocean biogeochemistry, and ecosystem assessment, and; development of regional data management capabilities/infrastructure. In addition to coastal ocean processes, product enhancement in coastal atmospheric and terrestrial sensors in also needed.

This report presents an overview of the workshop proceedings. Two sets of working groups were formed to facilitate attaining the workshops goals. In the first set, discipline specific working groups for Terrestrial Science, Biological Oceanography, Physical Oceanography and Atmospheric Science met to focus on discipline-driven issues. Workshop participants were then regrouped into interdisciplinary working groups (4

total) to focus on characterizing interdisciplinary science issues associated with coastal zone research.

A Coastal Zone Drafting Committee was formed at the conclusion of the workshop and tasked with development of a white paper that will elucidate the Science Capabilities, Needs and Requirements for Coastal Zone Research.

Introduction and Background

The coastal oceans and estuaries bordering the United States provide tremendous living and non-living resources to our society, they modify our weather and climate, function as buffer-zones for national security, have exceptional recreational and commercial value, and are ecologically rich environments supporting a diversity of scientific, medical, and educational pursuits. Our coastal oceans and estuaries are undergoing profound alterations due to changes in climate and a rapidly expanding human population. Roughly half of the U.S. population resides within 150 km of the coast, and these communities are growing three times faster than communities elsewhere in the nation. Consequently, the coastal zone is experiencing increased commercial, recreational, and domestic (e.g., living space and effluent load) pressures in parallel with decreased capacities to meet these demands.

Our growing dependence on coastal and estuarine resources and increased susceptibility to the health and safety hazards of the coastal zone (e.g., floods, severe weather, chemical and biological toxins) impart a great urgency to developing a comprehensive observational program and coastal information distribution system. In response to this need, the National Oceanographic Partnership Program (NOPP) (NOPP is an innovative program made up of fourteen collaborating Federal agencies that provides leadership and coordination of national oceanographic research and education programs and was established by Congress in Fiscal Year 1997 and has been endorsed by the Executive Branch) has developed the Integrated and Sustained Ocean Observing System (ISOOS) as a framework through which federal, state, and locally supported programs can contribute to a unified effort at improving observing and predictions of critical processes in the coastal zone. The central function of the ISOOS is to acquire and disseminate data and data-products on marine and estuarine environments in response to the needs of the government, industry, science, education, and the public. The ISOOS will thus function in a manner similar to the National Weather Service, which provides meteorological data and data products for weather now casts and forecasts. An important difference, however, is that issues relevant to meteorological observations and prediction are nowhere near as multidimensional as those involved in coastal zone processes.

Of relevance to NASA's role in obtaining coastal land and ocean observations from space, is that many of the national needs for satellite-based observations will require a significant level of effort to obtain the required observations necessary for Calibration/Validation, algorithm development, and development of future coastal, space-

based sensors. Satellite data from coastal regions have land-ocean transition issues. Additionally, the short space-time scales of the relevant coastal processes require more frequent and higher resolution data sets. Also, in contrast to open ocean region—where NASA has historically excelled—where optical properties are dominated by known optical properties of water and the well-resolved optical properties of living particulates, the bio-optics of the coastal zone are exceedingly complex due to the myriad of additional non-living optically-active components contributed by river input, sediment resuspension, and atmospheric deposition. This is further complicated by aerosols from air sheds influenced by terrestrial influx from agricultural, industrial and urban sources.

Due to the profound complexity of coastal systems, the ISOOS is envisioned as a joint federation of regional observational programs unified through a single, national infrastructure. Requirements for implementing and designing this observational network are presently being developed through the National Office for Integrated and Sustained Ocean Observing and Predicting through a congressional mandate (ISOOS, 2002). The network is envisioned to consist of overlapping regional components supported through state and national partnerships involving a variety of Federal agencies. The National Aeronautics and Space Administration (NASA) developed a scientific and technological capacity to observe coastal ocean processes in a unique and integrated manner. These established and developing capabilities offer NASA an opportunity to contribute a critical, core component to the ISOOS network in.

This NASA Coastal Research Initiative unifies the diverse research activities presently developed at NASA through their complementary relevance to critical, national coastal zone issues and seeks to outline the steps required to further develop NASA as a center of excellence in supporting collaborative research on and observations of the coastal zone.

Terrestrial Science Working Group

Outstanding Research Objectives

Ecological

- Characterize the influence of land cover/land use change on the coastal environment and associated agricultural, recreational, and fisheries resources.
    - Do existing remote sensing techniques capable making the observations required to support such research?
    - Can the present remote sensing data sets be capitalized upon by coupling them with coastal *in situ* observations and water quality modeling?
    - How can watershed and terrestrial modeling activities support land use/land change investigations? Do the present NASA's nutrient flow and freshwater runoff models possess the required skills?
- Periodically (semi-decadal?) produce remote sensing products of coastal habitats and provide data sets to facilitate their assessment.
    - Detailed maps of coastal habitat are required to monitor the state of coastal regions. Coastal areas are more dynamic areas, subject to larger natural and anthropogenic scales of variability. In addition, landscape patterns are more varied and fragmented due to the highly fractal nature of the coastal land-ocean boundary. This requirement is one of the immediate needs of the U.S. effort to develop an Integrated and Sustained Ocean Observation System.
    - What types of sensors and platforms should NASA develop in order to acquire the level of data needed to produce such products?
- Monitor coastal species diversity and monitor progress of invasive species.
    - To what taxonomic level are present remote sensing instruments able to characterize?
    - What taxonomic level needs to be resolved in order to achieve adequate monitoring skills?
    - What are the unique problems associated with monitoring vegetation condition and in directing land management (such as recreations, agricultural and forestry) in coastal regions?

Geophysical

- Quantitatively monitor suspended sediment loads.
    - Do existing or will planned sensors have the spatial resolution required to resolve watershed features (rivers, streams)?
    - Can sensors discriminate between sediments and other optical signatures such as from colored dissolved material and algae?
- Measure coastal topography at higher spatial resolution.
    - Can these data be used to support studies on coastal erosion?
    - Can these data provide for an absolute reference elevation data set?

- Develop sub-canopy topographic methods to provide improved topographic data sets and an estimate of biomass.
    - Can such an observing system support the needs for the U.S. Climate Change program?
- Develop methods to obtain water flux estimates, such as those from the GRACE mission, to monitor aquifer levels and model ground water processes and flow.
- Develop remote sensing data sets to characterize coastal water and energy balances.
    - What is the role of these budgets in coastal regions?
    - How do various coastal watersheds influence these budgets?
    - Can such information be useful for water management or agricultural management efforts?

<u>Natural Resources</u>

- Develop sensors to improve flood and storm surge management efforts.
    - What level of resolution is required to develop improved storm surge risk assessments?
    - Can NASA support this capability though development of new sensors?
- Develop improved flood plane mapping capabilities.
    - Can topographic mapping techniques be improved to provide more precise topographic maps for flood plane and storm surge prediction efforts?
    - How can NASA develop techniques to improve coastal bathymetry mapping for support of coastal navigation applications, coastal erosion monitoring and ocean modeling efforts?
    - Can NASA quantitatively characterize beach erosion processes through the use of airborne topographic mapping techniques?
    - Can these observations be used to help estimate the risk and impact of coastal storms and floods?
    - Can NASA use improved coastal plane topography data sets with numerical analysis techniques to provide enhanced evacuation routes for coastal areas?
- Improve NASA interactions with agencies such as NOAA to improve storm and hurricane forecasts in coastal areas.

Relevant (NASA's Role) Strategies and Methods Required to Address the Science Questions

- Multidisciplinary field campaigns
    - Joint planning and participation within multidisciplinary NASA-led intensive field campaigns
- Collaborations with outside researchers
    - Collaborative efforts with universities, government agencies, NGOs involved in coastal science research
- RADAR/LIDAR Instrumentation

    - Use and R&D advancement of LIDAR/RADAR technologies to support research in sea level change, surface topography, sub-canopy topography, soil moisture, photosynthetic indexes, etc
    - Sensor miniaturization efforts as a means to achieve cost reductions and increase the potential to use alternative sub-orbital platforms.
- Increase synoptic capabilities of remote sensing platforms
    - Develop higher temporal resolution (geostationary) and finer spatial (<50 – 250 m) resolution sensors.
    - Develop increased throughput capability of remotely sensed data to coastal science applications.
    - Increase data to sensor comparison (Cal/Val) efforts.
    - Develop real-time feedback between remotely sensed observations and timing and location of *in situ* measurements. Foster development of in situ sensor web technology to support group-based in situ observations.
    - Enhance timeliness of space-based products to improve real-time data assimilation modeling efforts. This requires improvement in computational infrastructure-see below.
- Develop computational technologies.
    - Increase resolution capability of coastal terrestrial modeling efforts.
    - Increase turn around time between data acquisition and user availability.
- Develop various modeling capabilities
    - These efforts support development of real-time forecasts.
- Facilitate involvement of terrestrial scientists to define instrumentation and techniques required to carrying out science investigation in coastal regions.
- Continue development and support of visible and infrared passive satellite and sub-orbital sensors.
- Continue develop capabilities and applications for space-based and sub-orbital hyperspectral imagery technology.
- Develop methods for fusion of data from multiple sources.
    - Pathfinder and data assimilation applications.
- Extensive *in situ* instrumentation and science networks (Fiducial GPS, seismic, tide gauge, AERONET, etc.)

Research Planning

- Develop an interdisciplinary infrastructure/forum to discuss issues and develop partnerships and proposals.
- Characterize the relevant extend of the watershed influence for the various coastal phenomenon.
- Characterize the various levels of spatial, temporal, and spectral resolution that will be required for each research topic.
- Focus on regional science studies to develop and characterize the global consequences.
    - NOAA's designated coastal zone regions (13, regional in Chesapeake)
    - Potential NASA Coastal Zone Research Nodes:
        - Florida Coastal Preserve (Kennedy Space Center)

        - Chesapeake Bay, Mid-Atlantic Bight and U.S. East Coast (GSFC Wallops Flight Facility)
        - Mississippi River Delta, Gulf of Mexico (Stennis Space Center)
        - California Current Region, U.S. West Coast (Jet Propulsion Lab.)

Biological Oceanography Working Group

Outstanding Research Objectives

- Coastal carbon cycle
- Coastal nutrient cycles (N, P, SiO4, Fe)
- Coastal eutrophication
    - Point source versus non-point source issues
    - urban versus industrial versus agricultural sources
    - deposition method issues
        - fluvial
        - groundwater
        - surface overflow
        - atmospheric wet/dry deposition
- Fisheries
    - Monitoring individual stock habitats over large spatial scales
    - Effects of climate change and eutrophication
    - Links between fisheries and ecosystem changes
- Pathogens/biohazards
    - Harmful algal bloom detection
    - Monitoring of oil spills and other contaminants
    - Human pathogen detection/monitoring
        - Coastal Cholera monitoring
- Fresh water budgets
    - Development of a coastal hydrological budget
        - Required to force biogeochemical and physical coastal models
        - Useful for estimation of nutrient loads
        - Groundwater budgets are unknown
- Biodiversity
    - Monitoring of long term changes in coastal ecosystems
    - Specific species may be useful for climate change markers
- Invasive species
    -
- Airborne pollution

Relevant (NASA's Role) Strategies and Methods Required to Address the Science Questions

- Passive e.g. MODIS
- bandwidth=0.4-2 nm (→ bigger),
- resolution=1 km (→ 0.1 km)
- Ocean color, florescence efficiency
- Color dissolved organics
- Salinity, need airborne resolution
- Improved, Geostationary measurements (high space and time resolution)

Improved algorithms needed
Not blue water algorithms
Collect new data --. New algorithms

Research Planning

Biological issues:

- Why here?
  - Chesapeake good, but other sys different – unique ecological systems
  -
- NASA as a whole
- Prediction in space and time → coupled models needed

Physical Oceanography Working Group

Outstanding Research Objectives

- Understand the small temporal/spatial scale processes in CZ
  - Significant fetch and topography issues in CZ
  - Coastal currents and eddies
  - Surface water and fresh water mixing & air-sea interface
  - Bottom complications: dissipation
- How can we develop an improved measure of sea level change and avoid the issues of local reference levels?

- How can tide predictions in coastal areas be improved?

- To what level does sea ice influence processes in the coastal zone?
  - Not all coastal areas are ice-free.

Relevant (NASA's Role) Strategies and Methods Required to Address the Science Questions

- Develop and improve satellite and suborbital sensors to enable processes
- Enhance observations to meet the requirements for increased spatial and temporal resolution and increased observation type (increase spectral resolution, different sensors, etc).

Research Planning

- Scales for Coastal Zone processes are much smaller than present day satellite observation scales
    - Aircraft sensors have poor temporal domain and small aerial coverage
    - Balloons, UAVs, High Altitude (Stratospheric) Dirigibles
- Techniques are required to remotely sense water column vertical distributions
- Support efforts to ascertain coupling mechanisms between various processes
- Small scale structure and variability are major issues
    - Coastal Zone is highly heterogeneous. As a result, fluxes of heat, mass, nutrients and other material is highly variable.
- Sensors need to be developed that are able to measure the complete range of hydrological processes.
- NASA should support the development of the capability to integrate all the observations into a prognostic modeling effort aimed at prediction and sensitivity studies.
    - The scope of the modeling studies should encompass climatological, retrospective and real-time data assimilative efforts.

Atmospheric Science Working Group

Outstanding Research Objectives

- Climate Change and Urbanization Effects
    - Observe and monitor aerosol levels in highly populated coastal regions
- Coastal Carbon Budget & CO_2 Gas Transport and Flux Processes
    - Observe and monitor sources and sinks of Atmospheric CO_2
        - Flooding, fresh water invasion
- Coastal Water Cycle and Budget
    - Observe and monitor effect of coastal flooding events on coastal flood plane
    - Characterize the variability in atmospheric moisture associated with land sea interface

    - How do changes in the water cycle impact land surface changes, i.e. surface soil moisture, runoff, etc.
- Aerosols, Ozone, Other Atmospheric Constituents
    - Assess the impact of human activity in coastal regions on aerosols (type, amount, distribution)
    - Determine the relative roles of local vs. remote sources
    - Characterize the roles and predictability of natural vs. anthropogenic sources
- Heat Budget and Solar Radiation
    - Characterize the differences in solar radiation absorbers inland vs. Coastal Terrestrial vs. Coastal Ocean vs. Open Ocean
    - Characterize the differences in albedo and other reflectance properties
    - How do these differences affect radiation budget?
        - e.g. How and why do heat budgets differ in urban and rural or agricultural regions?
- Weather prediction
    - Develop an accurate representation of Coastal Zone processes
    - Resolve (increase resolution) variability across Coastal Zone
        - e.g. Improved wind products are required to improve coastal ocean circulation models
    - Understand the physical processes associated with hurricanes impacting upon the Coastal Zones
    - Investigate physics of extra-tropical weather systems in relation to Coastal Zones

Relevant (NASA's role) Strategies and Methods Required to Address the Science Questions

- Elucidate relationships between local and global processes with respect to coastal processes
- Characterize global teleconnections and their effects on local coastal processes, i.e. how do global teleconnections affect the magnitude and timing of coastal upwelling events?
- Develop continuous coastal weather observation capability
- Encourage support and development of an interdisciplinary approach
- Develop new satellites and sensors
- Improve numerical weather forecasting capability—with increased resolution at coastal zones. Support development of regional coupled modeling efforts.
- Develop small, low cost robotic capabilities for autonomous sensors
- Maintain expertise at the nine NASA centers—foster cross-center collaborations.

Application of research objectives to national needs

- Management of Coastal Zone Resources
    - Fisheries
    - Recreational areas

    - Agricultural and forestry resources
    - Wildlife habitat
    - Urban development
- Monitoring and management of ecosystem health
- Regulation and policy setting
- Development of coastal navigation infrastructure/data sets
- Development and management of agricultural and fisheries resources
- Assessment and management of risk for real estate resources (Flood, Hurricane risk assessment)
- Monitoring of coastal commercial facilities
    - Waterways
    - Piers, docking and mooring areas, ...
    - Aquaculture beds, processing facilities
    - Effluent monitoring—both point and non-point source.

Interdisciplinary Working Group I

What are interdisciplinary goals?

- Focus scientific effort on chronic problems related to specific coastal regions
    - Chesapeake and Delaware Bays
        - Harmful algal blooms
        - Eutrophication from urban and agricultural sources
        - Coastal subsidence through erosion and sea level rise
    - Lower Mississippi Delta
        - Anoxia and Dead-Zone from mid-continental eutrophication
    - Long Island Sound and New Jersey Coastal Region
        - Suboxic conditions from eutrophication
    - U.S. West Coast Issues
        - Harmful Algal Blooms (HABs)
        - Influence of El Nino
        - Watershed pollution from urban regions
        - Effect of coastal storms
        - Orographic influence on wind field—strongly influences coastal upwelling and circulation patterns
    - Alaskan Region
        - Chronic HABs
        - Climate changes
        - Monitoring of long term changes over large regions
            - Ice extent and thickness
            - Tundra health
            - Methane clathrate stability
    - Hawaiian Islands and other U.S. tropical territories

        - Monitoring of coral reef health—indicators of climate change
        - Tectonic effects on weather—dust and gas injection (also important in Alaskan and U.S. west coast areas)
- Development of improved remote sensing methods to improve information yield capability
    - Can hyperspectral sensors be developed that be used with some level of on-board data reduction or pre-processing to yield a manageable data stream? One thought is to develop a dynamic sensor that collects specific waveband information only when required.
- Coastal Beach Erosion
    - Develop next generation of topographic mapping technology
    - Support transition to NOAA of technology
    - Develop more outreach efforts for local studies/research efforts
    - Support long term monitoring for science studies
    - Develop methods to use remote sensing to obtain absolute estimates of sea level change—perhaps with new platforms such as ICESat
- Invasion of marine, lacustrian and fluvial regions by non-indigenous species
    - Develop remote sensing techniques to identify target species in both terrestrial and marine environments
- Assessment of epidemiology of air-born and water-born diseases
    - West Nile Virus
    - Cholera in coastal river plumes
    - Malaria
- Diffusion of coastal pollutants and pathogens
    - point source vs non-point source
    - urban, industrial and agricultural issues
    - dissolved, particulate, waterborne, airborne
    - specific need to develop techniques for obtaining better estimates for wet/dry atmospheric deposition

What would be the best team?

- Composed of a variety of remote sensing groups
    - Satellite
        - Hyperion, metsats
        - Use of hyperspectral, meteorological, topographic data sets
    - Aircraft
        - LIDAR, RADAR, Hyperspectral
    - Ground-based Measurements
        - Flux Towers, profiling LIDAR, RADAR, CODAR, moorings, autonomous platforms (OASIS, etc) and sensors, ship-board LASER Fluorometry, LASER pigment analysis, precipitation, and wind.

How should the NASA Coastal Zone Research Program be structured?

- Formed with strong partnerships with other federal agencies as well as local, state, and NGO agencies
    - NOAA, ONR, DoD, NFS, DOE, DOH, Coast Guard
    - State environmental monitoring, management and planning agencies
    - Local municipal agencies
    - Environmental organizations (e.g. The Nature Conservancy)
- Coordinate efforts with existing national and international organizations
    - Global Ocean Observing System (GOOS), Coastal Ocean Program (CoOP), Integrated and sustained Ocean Observing System (IOOS), etc
- Coordinate efforts with other NASA programs
    - NASA Climate Change Initiative
    - NASA Carbon Cycle Initiative
    - NASA Hydrological Cycle Program
- Develop Regional Coastal Zone Research Centers
    - Establish local Coastal Ocean DAAC (CO-DAAC)
    - Develop GIS data bases
- Improve public and scientific outreach activities
- Develop educational and outreach activities at local and national levels
- Include Alaska, Great Lakes, Hawaii and island territories into activities.

What is the role of the different centers, other agencies, state and local agencies?

- NASA
    - Participate in characterization of the science requirements and goals
    - Decide upon NASA's role in achieving the stated goals
    - Coordinate with other agencies the NASA's tasks and level of involvement
    - Develop new orbital, sub-orbital and earth-based, miniaturized sensors
    - Coordinate transfer of satellite research efforts to NOAA applications
        - coastal ocean color, coastal SST, wind, etc.
    - Develop new data assimilation, data analysis, numerical modeling techniques and capabilities.
    - Develop cutting-edge Earth sensors and platforms for *in situ* environmental monitoring
        - Increases skill-set for NASA technology
        - Provides training and experience for development of planetary *in situ* sensor platforms and sensors
        - Allows NASA to participate in real-time Coastal Ocean monitoring
            - Useful for Real-Time Pathfinder Efforts
            - Useful for development of Real-Time Data Assimilation
- NOAA
    - Facilitate operational activities
    - Serve as partners with NASA in development of new sensor capabilities
    - Provide support for Cal/Val activities

    - Partner with NASA to develop GIS and outreach education centers at several key U.S. coastal regions
- NSF, DoD, ONR, etc
    - Work with NASA through the National Ocean Partnerships Program to develop and coordinate future efforts

Why NASA?

- Perspective from space—remote sensing observations
- Ability to integrate and analyze large (TB) data sets
- Space-based, space-time measurement span
- Extensive global Earth data time series
- Capability of quick remote sensing response using both airborne and space-based sensors

Why now?

- Present development of Global Ocean Observing System (GOOS) and a U.S. Sustained Coastal Ocean Observing System (IOOS)
- Human population continues to move towards coastal region—increasing the concern for the health and welfare of the coastal regions
- Fish stocks continue to plummet and climate change will impact coastal regions even more

With whom?

- NOAA, NSF, ONR, DoD, USGS, NIH, FEMA, state & local, EPA, NGOs, Army Corps of Engineers

So what?

- NASA remote sensing capabilities have always had issues with sensor data collected near boundary regions, such as the coastal region. Developing a coastal zone initiative will allow NASA to focus its efforts on a region that has always been difficult—thus allowing NASA to improve its remote sensing skills.
- Coastal regions are highly multi- and inter-disciplinary. A Coastal Zone Research Initiative would serve as a model program to develop stronger ties within and across agency centers. Several NASA facilities presently carry out research related to coastal zone issues: i.e. Goddard, JPL, Stennis, Kennedy and AMES.

Interdisciplinary Working Group II

What are interdisciplinary goals?

- Understand budgets within Coastal Zone
    - Carbon Cycle
        - What is the role of the carbon budget
        - What are land-ocean-atmosphere exchanges
    - Nutrient Cycle
        - Impact of urban, industrial, and agricultural influenced runoff
        - Issues concerning changes in wetlands altering historical regions for denitrification
        - Issues concerning the cycling and interactions of multiple nutrients—There is still considerable debate as to which nutrient controls carbon cycle dynamics in the coastal zone, Nitrogen, Phosphate or Iron?
    - Hydrological Cycle
        -
    - Light
- Improvement of remote sensing
    - Algorithms
    - Accuracy
- Storm development and prediction
    - Multi-regional
    - Impact of climate change

What would be the best team?

How should the NASA Coastal Zone Research Program be structured?

- Multiple coastal nodes (start small and tractable):
    - East Coast—GSFC
    - West Coast—JPL/AMES
    - Gulf of Mexico—Stennis Space Center
- Coastal center at Wallops

What is the role of the different centers, other agencies, state and local agencies?

Why NASA?

- Technology
    - Satellites
    - Data handing & computing
    - Data assimilation model development
    - Sub-orbital

        - Sensor development
    - Comprehensive program that can integrate & synthesize data and concepts

Why now?

- Global change impacts
- Population growth in Coastal Zone
- Growth of measurement technology

With whom?

- Dependent on research topic
    - Federal, state and local agencies
    - Universities
    - Non-Governmental Organizations (NGOs)
- Outreach to users

So what?

- Important contributions to
- Socio-economic models
- Global change
- Natural hazards
- Ecosystem models
- Homeland security

Interdisciplinary Working Group III

What are interdisciplinary goals?

- Coastal hazards
- Monitoring and outreach to facilitate mitigation
- Coastal health assessment

What would be the best team?

- Interdisciplinary
- Highly complex
- Dynamic and changeable

How should the NASA Coastal Zone Research Program be structured?

- Instrument development
    - In-situ
    - Communication (two-way, real-time) with users
    - Platforms (satellite, aircraft, autonomous platforms (OASIS/high altitude dirigibles)
    - Sensor development focusing on improved spatial, temporal and spectral resolution
- Science observations questions
    - What are remote sensors measuring
    - Algorithm development
    - End-to-end ==> Theory to applications
    - Integration of measurements in data assimilation models
    - Science program support/Monitoring and mitigation/Storm prediction

What is the role of the different centers, other agencies, state and local agencies?

- All NASA Centers
    - in-situ observations and developments
- Stennis Space Center
    - inter-agency facilitator
- GSFC
    - central coastal zone center
    - expand DAAC to include CO.DAAC (Coastal DAAC)
    - continue developing models with focus of developing a Regional Earth Modeling System (REMS)
- JPL
    - expand PO.DAAC to include a west coast CO.DAAC
    - develop merged data products from multiple sensor observations and distribute through DAAC
- NOAA
    - use NASA data and models for now cast/prediction efforts
    - collaborate with NASA to develop new instruments
        - satellite and in situ
- ONR
    - use of models for coastal applications
- MMS (Minerals Management Service)
    - share of data sets
- EPA
    - collaborate with coastal modeling community at NASA and NOAA to develop pollution transport and coastal health modules for coastal modeling efforts and real-time applications
- DOE
    - develop CO_2 sequestration estimates and air-sea gas flux estimates using in situ observations and satellite data
- NIH

    - use observations/simulations concerning transport of harmful algal blooms, pollution, disease
    - develop techniques to apply model results to prediction-level risk assessments to coastal health status, i.e. toxic blooms or cholera outbreaks
- Army Core of Engineers
    - use remotely sensed data to monitor coastal erosion

Why NASA?

- NASA is the integrator of global Earth observations and observing/ data/ modeling systems.
- NASA provides space-based and aircraft sensor development.
- Program intersects Coastal Zone needs.

Why now?

- Sensors are maturing and some are merging into new operational sensors
- Climate change issues are daily current events
- Coastal stress is presently serious and continues to increase

With whom?

- See earlier agency descriptions

So what?

- In order to address global climate problems, including Coastal Zone health, science requires the long-term vision that is provided by global observations that are calibrated over long periods, including across evolving sensors, and also including re-calibration of historic datasets to maintain continuity of measurements.
- Coastal regions are dynamic and increasingly stressed.
- Coastal zones are where majority of primary customers (U.S. Citizens) reside.

Interdisciplinary Working Group IV

What are interdisciplinary goals?

- Regional uncertainty in the budgets for carbon, nitrogen, CO_2, H_2O, solar radiation in Coastal Zone and associated watersheds.
- Develop skill in predicting impact of human population doubling in coastal zone.
- Establish measurement capability and supporting information infrastructure.
- Develop techniques for high spatial, temporal, spectral observations using satellite and airborne sensors to resolve dynamics and structures of exchange mechanisms in Coastal Zone.

What would be the best team?

- Center teams around well defined process study or science problem as a way to define teams and participants.
- Use a hierarchical, inter-disciplinary, interagency approach
- Develop high-performance teams that work effectively and cooperatively.
- Limit teams to a manageable size.
- Interface process study teams or science problem teams with 'science theme teams.'

How should the NASA Coastal Zone Research Program be structured?

- Develop cross-cutting communication and interactions between flight projects, data systems, laboratories within NASA.
- Partner with other agencies: NOAA, USGS, DoD, EPA, NIH, NSF, etc.
- Create regionally focused NASA Center "nodes."
- Discuss serial vs. parallel studies.

What is the role of the different centers, other agencies, state and local agencies?

- Active partner with other agencies.
- NASA is responsible for technology development.
- Observations of Coastal Zone thermal structures (use IR measurements with ~10s of m spatial resolution) in collaboration with NOAA.
- Remote sensing of ocean surface winds and topography.
- Develop increased temporal and spatial resolution in coastal regions.
- Improve algorithm for all sensors to effectively improve resolution of coastal regions.
- Improve algorithms for ocean color and net primary production estimates in case II waters.

- Continue support to develop active optical sensors, such as LIDAR, for obtaining new ocean remote sensing capabilities.
- Develop information infrastructure.
- Develop data assimilation methods for terrestrial, hydrological, atmospheric and ocean modeling efforts.
- Satellite calibration sites (e.g., ARM, MOBY, Coastal MOBY "COBY").
- NASA contributes to scientific objectives, formulation, process studies, models for data assimilation, merger, and synthesis.
- Emphasize transfer of remote sensing to applications.
    - NOAA operational efforts
    - Regional ocean observations
    - State and local environmental monitoring efforts

Appendix A: NASA Coastal Zone Drafting Committee

At the request of the workshop organizing committee members, a NASA Coastal Zone Drafting Committee was created and tasked with development of a white paper that will elucidate the Science Capabilities, Needs and Requirements for Coastal Zone Research. The members of this committee were chosen so as to represent a wide range of coastal zone research areas as well as to represent the various NASA centers that are presently involved in carrying out coastal zone research. The committee members include:

Name	**NASA Center Affiliation**	**Committee Function**	**Research Focus**
John R. Moisan	GSFC WFF	Co-Chair	Ocean observations, coupled models, & data assimilation
Mike Behrenfeld	GSFC WFF	Co-Chair	Ocean biology observations
Rick Miller	Stennis Space Center	Member	Ocean biology, phytoplankton
Mary-Elena Carr	JPL	Member	Ocean biology
Antonio Mannino	GSFC	Member	Ocean chemistry
Carlos Del Castillo	Stennis Space Center	Member	Ocean chemistry
Grant Gilmore	Kennedy Space Center	Member	Coastal zone ecology
Betsy Middleton	GSFC	Member	Coastal zone ecology
Wayne Wright	GSFC WFF	Member	Coastal morphology
Randy Kawa	GSFC	Member	Coastal CO_2 fluxes
TBD*		Member	Sea Ice
TBD*		Member	Hydrology
TBD*		Member	Atmospheric processes

*Some of the areas that the committee would like to find a representation for have yet To Be Determined (TBD).

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