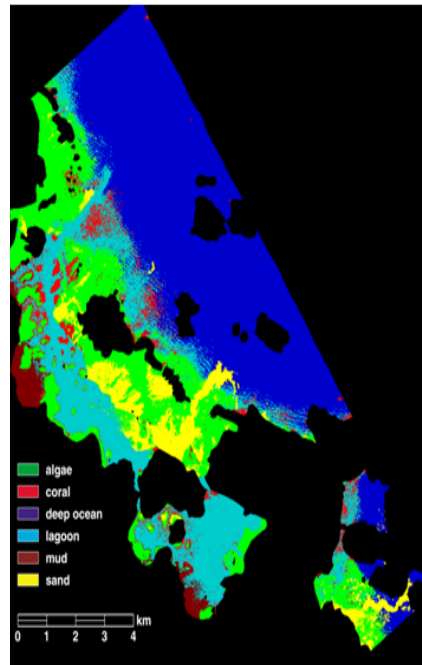
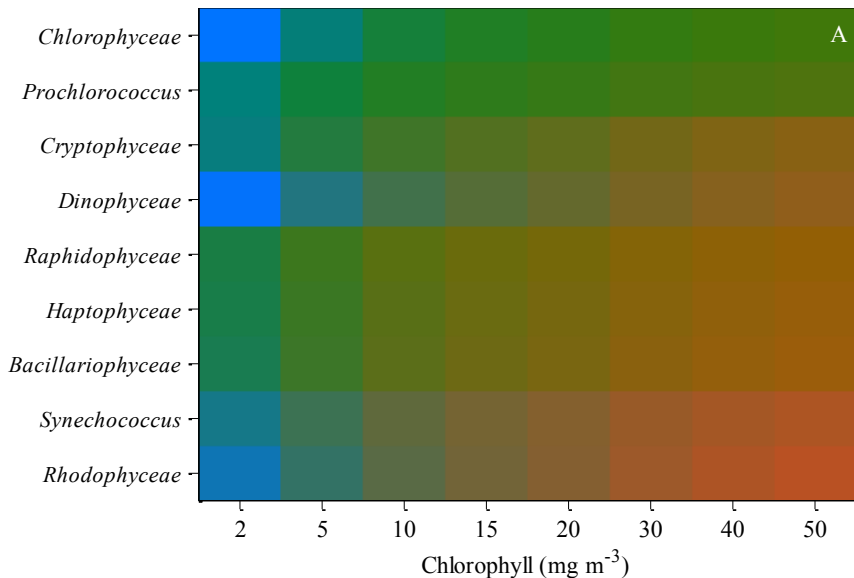


CQ1. Aquatic Ecosystems

How do inland, coastal, and open ocean aquatic ecosystems change due to local and regional thermal climate, land-use change, and other factors?

CQ1: How do Inland, Coastal, And Open Ocean Aquatic Ecosystems Change Due To Local and Regional Thermal Climate, Land-Use Change, And Other Factors?



TOP- Color of the sea surface as a function of surface biomass concentration (Chlorophyll-a used as a proxy for different phytoplankton taxa. Color was modeled from water-leaving radiance using the CIE color matching functions and mean absorption and backscattering properties for each taxa (Courtesy H. Dierssen)

LEFT-Fractional cover of bottom types derived from AVIRIS imagery of Kaneohe bay, Hawaii. (Courtesy: Eric Hochberg)

Science Issue:

Aquatic areas of the globe include inland and coastal waters, open oceans, and ice-covered zones. Coastal zones include coastal watersheds, dunes and wooded coastal areas, beaches and cliffs, wetlands, estuaries, barrier islands, and shallow submerged lands like seagrass beds, kelp beds, coral reefs, and many ice covered areas. Combined, these areas provide critical ecosystem and cultural services, supporting abundant, productive and diverse biological communities that play important roles in local and global biogeochemical cycles. Knowledge of thermal microclimates and their relation to habitat and community structure, biodiversity, the occurrence of harmful algal blooms, the distribution and effects of vector-borne diseases, and ecosystem productivity of these systems with regard to local and global climate change, the effects of various forms of disturbance, is of critical importance to define management scenarios that help sustain human life on Earth [DS 201/Table 7.1; DS 208; GEO 2007; USCOP 2004]. This knowledge needs to include how small-scale processes in the water column, shallow benthic, and ice-covered habitats are related to land-use and land-cover changes. It is also critical to understand how these ecosystems interact with the atmosphere, the hydrologic cycle (storage, precipitation, evaporation), aerosol deposition, and cloud radiative forcing.

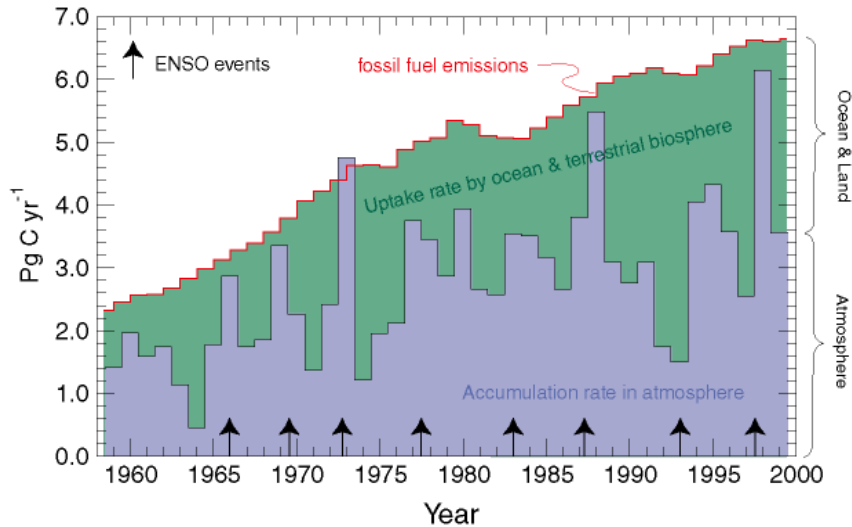
Tools:

- High- to medium spatial resolution hyperspectral HypsIRI observations.
- In situ* measurements for validation and complementing satellite observations in high and low latitude coastal and inland aquatic regions.
- Published scientific literature, observing technology, and software tools.
- Decision-Support Systems

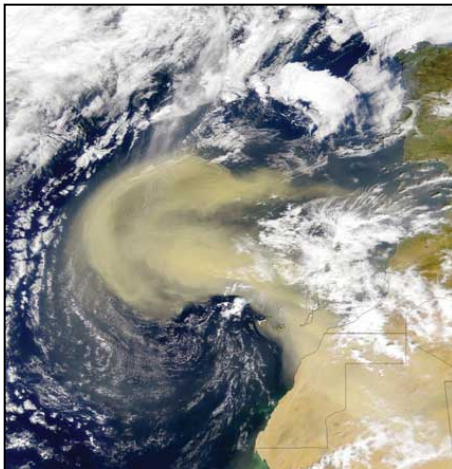
Approach:

- Develop accurate algorithms to assess small-scale surface temperature variability, phytoplankton pigment, major aquatic functional groups, and habitat geomorphology. Improve the accuracy in retrievals of absorption and backscattering coefficients and of other environmental properties
- Study interactions between small-scale physical variability and biological / biogeochemical variability

CQ1-a: What are the feedbacks between climate and change in habitat structure, biogeochemical cycling, biodiversity, and ecosystem productivity of aquatic habitats, including ice-covered habitats? What are the ecological linkages of landscape-scale ocean-atmosphere interactions including the hydrologic cycle, aerosol production and transport, and cloud radiative forcing?



Interannual variability in the global Carbon cycle, showing the growing role of uptake by terrestrial and aquatic biota (Sarmiento and Gruber, 2002)



SeaWiFS image of a plume of Saharan dust blown over the Atlantic Ocean. Such events have significant impacts on aerosol processes and on biogeochemical cycles and functional group composition in inland, coastal, and open ocean waters.
(Image courtesy of GeoEye)

Science Issue:

Aquatic ecosystems are affected by climate change and by other natural or human-caused disturbances. For example, processes as varied as changes in storm frequency and intensity, air temperature, acidification of waters due to higher carbon dioxide concentration, deforestation and desertification, mining or fishing activities, or the application of fertilizers within a watershed can lead to significant changes in coastal physical and biogeochemical processes that can have profound effects on biology. In turn, these communities, habitats, and their biogeochemical processes have feedbacks on larger ecosystems and climate. Some of these changes affect community structure, production of beneficial or harmful biological or chemical compounds, changes in cloud, aerosol cover, or temperature, and they impact ecosystem services. Understanding these changes and feedbacks at small scales is required to define management scenarios [DS 201/Table 7.1; DS 208; GEO 2007; USCOP 2004].

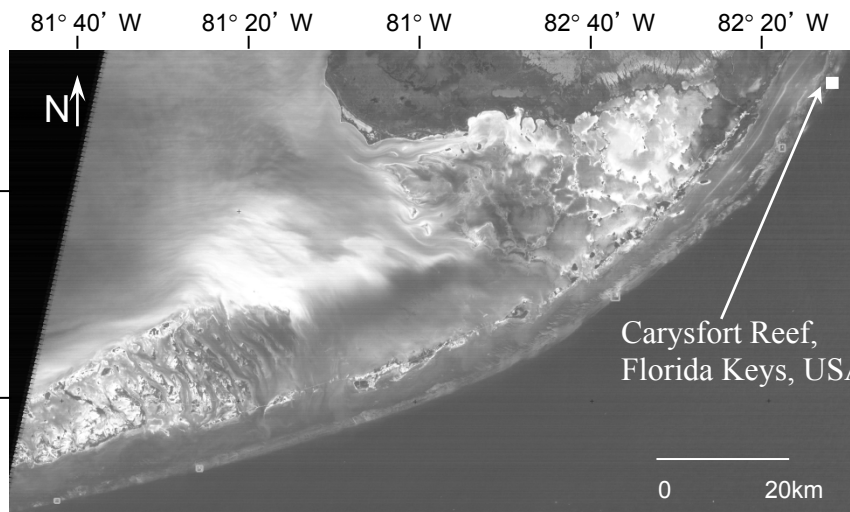
Tools:

- High- to medium spatial resolution hyperspectral HypsIRI observations.
- *In situ* measurements for validation and complementing satellite observations in high and low latitude coastal and inland aquatic regions.
- Published analyses of linkages between community structure, biogeochemical processes, human-caused disturbance, and climate.
- Decision-Support Systems

Approach:

- Use systematically acquired day and night VSWIR and TIR observations for watersheds, inland and coastal water bodies including ice-covered environments, including areas near urban and
- Field campaigns to quantify community structure, bio-optical properties of the physical environment and of different biological functional groups
- Develop a long-term vicarious calibration process.
- Establish close links between the operational and science communities.

CQ1-b: How are small-scale processes in water column, shallow benthic, and ice-covered habitats related to changes in functional community types (including harmful algal blooms and vector-borne diseases), productivity, and biogeochemical cycling including material fluxes and water quality, at local scales?



Science Issue:

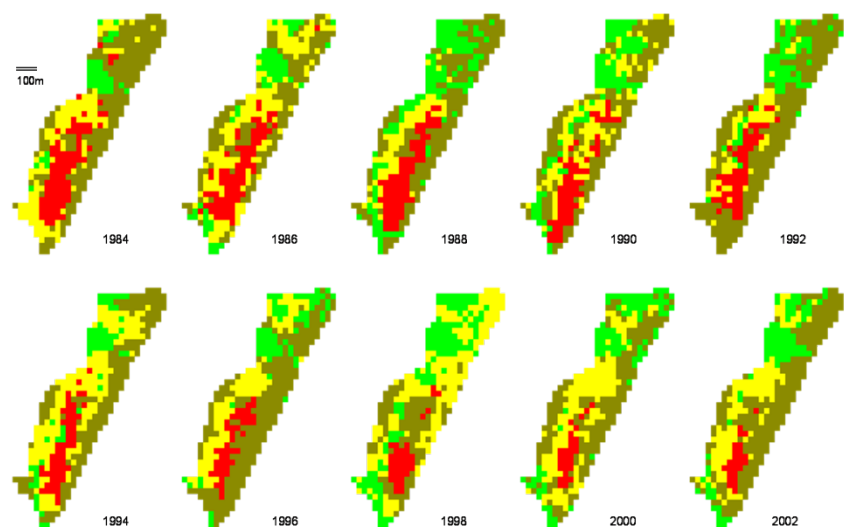
Aquatic ecosystems in inland, open ocean, and coastal settings, including shallow benthic areas and ice-covered zones host a large array of biological communities whose functioning is tightly linked to physical and biogeochemical properties of the ecosystem. Community types and processes, including changes in land use and many disturbances on land also affect processes in adjacent aquatic ecosystems. Changes in any of these communities often leads to significant changes in ecosystem properties over short and long time scales. To properly understand these linkages and changes, and variability at large spatial and temporal scales, it is necessary to quantify variability at small temporal and spatial scales.

Tools:

- High- to medium spatial resolution hyperspectral HypsIRI observations
- In situ* measurements for validation and complementing satellite observations in high and low latitude coastal and inland aquatic regions.
- Decision-Support Systems

Approach:

- Develop accurate algorithm to assess small-scale surface temperature variability, phytoplankton pigment, major functional groups, and habitat geomorphology. Improve the accuracy in retrievals of absorption and backscattering coefficients and of other environmental properties
- Study interactions between small-scale physical variability and biological / biogeochemical variability
- Develop Decision-Support Systems

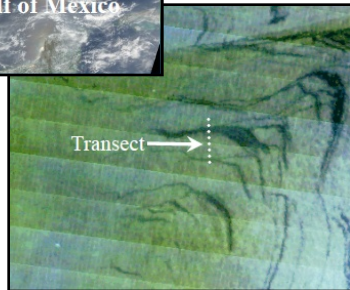


Carysfort

KEY: coral habitat sand covered hardbottom bare hardbottom

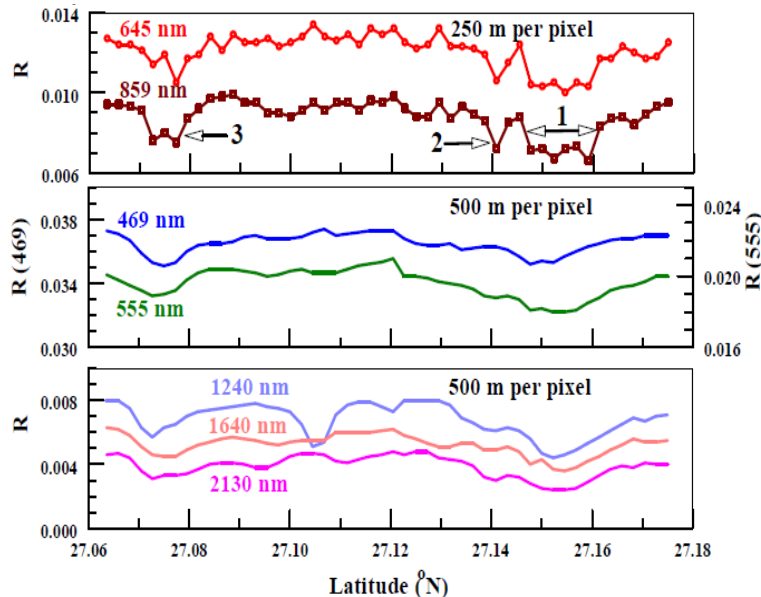
TOP FIGURE: Landsat image of the Florida Keys reef tract, showing the location of Carysfort Reef. BOTTOM: Change in the fractional cover of live coral and other bottom types in Carysfort Reef between 1984 and 2002, derived from Landsat imagery (Courtesy: David Palandro)

CQ1-c: How can these observations be used to guide the wise management of living marine and other aquatic resources?



LEFT – Surface oil slicks from natural seeps are seen in sunglint, captured in a MODIS/Terra RGB image of 13 May 2006 (16:45 GMT) of the Gulf of Mexico.

BOTTOM - SAR and MODIS data along the transect shown in the image above. MODIS data are the Rayleigh-corrected reflectance (R). Three surface slicks are annotated (1, 2, and 3). (Courtesy: Chuanmin Hu).



Science Issue:

Aquatic areas of the globe, including inland and coastal waters, open oceans, and ice-covered zones provide critical ecosystem and cultural services. Many coastal zones, rivers and lakes are under chronic stress due to exposure to high sediment or nutrient load, or sewage discharges from cities or towns. Resource use such as sand mining or beach renourishment programs alter coastal habitats. In some cases such stresses impact coral reef ecosystems, or lead to the occurrence of harmful algal blooms, the dispersal of vector-borne diseases, and changes in ecosystem productivity. [DS 201/Table 7.1; DS 208; GEO 2007; USCOP 2004]. It is important to develop the knowledge about how small-scale processes in the water column, shallow benthic, and ice-covered habitats are related to land-use and land-cover changes.

Tools:

- High- to medium spatial resolution hyperspectral HypsIRI observations.
- *In situ* measurements for validation and complementing satellite observations in high and low latitude coastal and inland aquatic regions.
- Decision-Support Systems.

Approach:

- Develop accurate assessment algorithms that help to assess various environmental properties critical to resource management
- It will be critical to engage government agencies and the private sector engaged in operational, management, and regulatory processes to understand their requirements for products and to train practitioners in the application of HypsIRI data.
- Development and testing of Decision-Support Systems.