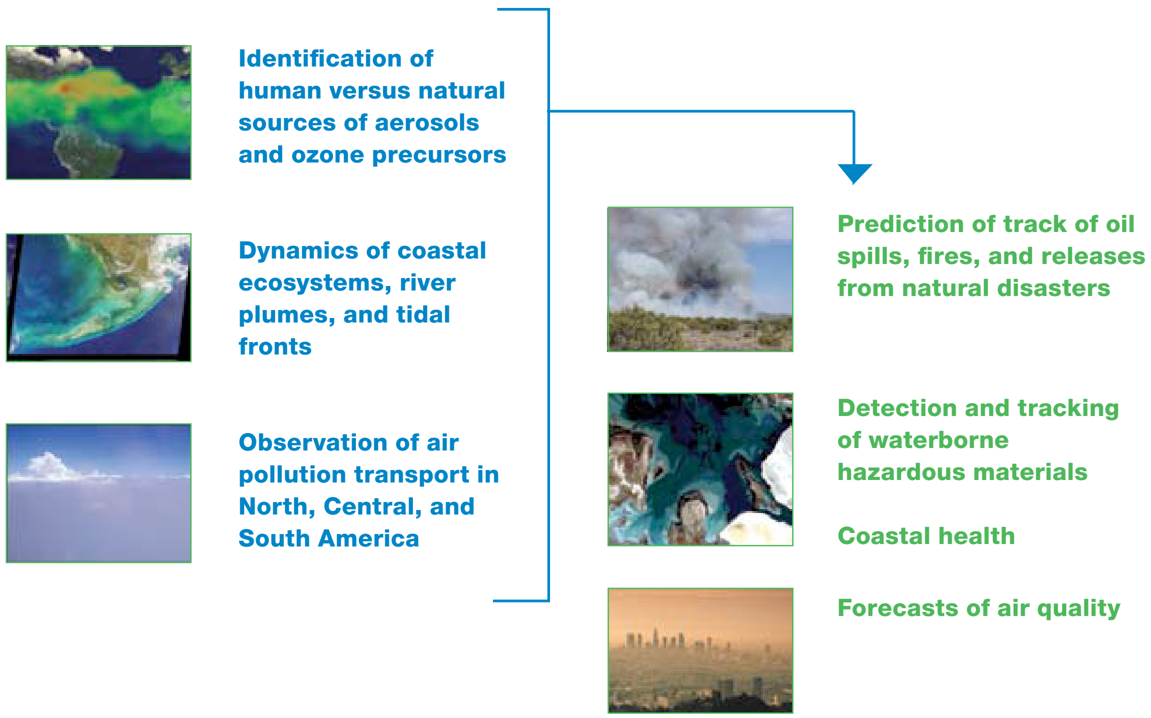
GEOSTATIONARY COASTAL AND AIR POLLUTION EVENTS (GEO-CAPE)

Launch: 2013-2016 Mission Size: Medium



GEOSTATIONARY COASTAL AND AIR POLLUTION EVENTS (GEO-CAPE) MISSION

The concentration of people living near coasts is causing enormous pressure on coastal ecosystems. The effects are visible in declining fisheries, harmful algal blooms, and eutrophication such as the "dead zone" in the Mississippi delta and more than 20 other persistent dead zones around the world. Climate change combined with the continuing growth of populations in coastal areas creates an imperative to monitor changes in coastal oceans. Key needs include the ability to forecast combined effects of harvesting, coastal land management, climate change, and extreme weather events on economically important seafood species. The GEO-CAPE mission would provide observations of aerosols, organic matter, phytoplankton, and other constituents of the upper coastal ocean at multiple times in the day to develop capabilities for modeling ecological and biogeochemical processes in coastal ecosystems.

The mission would be of considerable value in improving the ability to observe and understand air quality on continental scales and thus in guiding the design of air-quality policy. Air pollutants (O_3 and aerosols) are increasingly recognized as major causes of cardiovascular and respiratory diseases. Based on networks of surface sites, the current system for observation of air quality is patently inadequate to monitor population exposure and to relate pollutant concentrations to their sources or transport. Continuous observation from a geostationary platform will provide the necessary data for improving air-quality forecasts through assimilation of chemical data, monitoring pollutant emissions and accidental releases, and understanding pollution transport on regional to intercontinental scales.

Background: The GEO-CAPE mission advances science in relation to coastal ecosystems and air quality. If both types of measurements are made from the same platform, aerosol information derived from the air-quality measurements can be used to improve the ocean ecosystem measurements.

Coastal ocean ecosystems are under enormous pressure from human activities, both from harvesting and from materials entering the coastal ocean from the land and the atmosphere. Compared with the open ocean, these regions contain greatly enhanced amounts of chlorophyll and dissolved organic matter, but the coastal ocean is not simply a region of enhanced primary productivity; it also plays an important role in mediating the land-ocean interface and global biogeochemistry. The high productivity of the coastal ocean supports a complex food web and leads to a disproportionate harvesting of the world's seafood from the coastal ocean regions. Persistent hypoxic events or regions associated with riverine discharge of nutrients in the Gulf of Mexico, the increasing frequency of harmful algal blooms in the coastal waters of the United States, and extensive closures of coastal fisheries are just a few of the issues confronting the coastal areas. Both short-term and long-term forecasts of the coastal ocean require better understanding of critical processes and sustained observing systems. Characterizing and understanding the short-term dynamics of coastal ecosystems are essential for the development of robust, predictive models of the effects of climate change and human activity on coastal ocean ecosystem structure and function. The scales of variability in the coastal region require measurements at high temporal and spatial resolution that can be obtained only from continuous observation, such as is possible from geosynchronous Earth orbit.

Air-quality measurements are urgently needed to understand the complex consequences of increasing anthropogenic pollutant emissions both regionally and globally. The current observation system for air quality is inadequate to monitor population exposure and develop effective emission-control strategies. O_3 and aerosol formation depends in complex and nonlinear ways on the concentrations of precursors, for which few data are available. Management decisions for air quality require emission inventories for precursors, which are often uncertain by a factor of two or more. The emissions and chemical transformations interact strongly with weather and sunlight, including the rapidly varying planetary boundary layer and continental-scale transport of pollution. Again, the scales of variability of these processes require continuous, high-spatial-resolution and high-temporal-resolution measurements possible only from geosynchronous Earth orbit.

Science Objectives: The GEO-CAPE mission satisfies science objectives for studies of both coastal ocean biophysics and atmospheric-pollution chemistry. It also has important direct societal applications in each domain. Compatibility with objectives of the terrestrial biophysical sciences should also be explored.

The ocean objectives are to quantify the response of marine ecosystems to short-term physical events, such as the passage of storms and tidal mixing; to assess the importance of high temporal variability in coupled biological-physical coastal-ecosystem models; to monitor biotic and abiotic material in transient surface features, such as river plumes and tidal fronts; to detect, track, and predict the location of sources of hazardous materials, such as oil spills, waste disposal, and harmful algal blooms; and to detect floods from various sources, including river overflows.

The air-quality objective is to satisfy basic research and operational needs related to air-quality assessment and forecasting to support air-program management and public health; emission of O_3 and aerosol precursors, including human and natural sources; pollutant transport into, across, and out of North, Central, and South America; and large puff releases from environmental disasters. Measurements of aerosols from the air-quality instrument can be used to correct aerosol contamination of the high-resolution coastal-ocean imager.

Mission and Payload: GEO-CAPE consists of three instruments in geosynchronous Earth orbit near 80°W longitude: a UV-visible-near-IR wide-area imaging spectrometer (7-km nadir pixel) capable of mapping North and South America from 45°S to 50°N at about hourly intervals, a steerable high-spatial-resolution (250 m) event-imaging spectrometer with a 300-km field of view, and an IR correlation radiometer for CO mapping over a field consistent with the wide-area spectrometer. The solar backscatter data from the UV to the near-IR will provide aerosol optical depth information for assimilation into aerosol models and downscaling to surface concentrations. The same data will provide high-quality information on NO_2 and formaldehyde tropospheric columns from which emissions of NO_x and volatile organic compounds, precursors of both O_3 and aerosols, can be characterized. Combination of the near-IR and thermal-IR data will describe vertical CO, an excellent tracer of long-range transport of pollution. The high-resolution event imager would serve as a multidisciplinary programmable scientific observatory and an immediate-response sensor for possible disaster mitigation. The data from the high-resolution event-imaging spectrometer would be coupled to the data generated by the wide-area spectrometer through on-board processing to target specific events (such as forest fires, releases of pollutants, and industrial accidents) where high-spatial-resolution analysis would provide benefits. A substantial fraction of its time would be made available for direct support of selected aircraft and ground-based campaigns or special observing opportunities.

Mission Cost: About $550 million.

Schedule: All the instruments have a low-Earth-orbit space heritage and are at a high level of technology readiness, and so launch would be feasible by 2015.

Further Discussion: See in Chapter 10 the section "A Cross-disciplinary Aerosol-Cloud Discovery Mission," and in Chapter 7 the section "Coastal Ecosystem Dynamics Mission."

Related Responses to Committee's RFI: 21, 30, 52, 60, and 105.