# Geostationary Coastal and Air Pollution Events (GEO-CAPE) Mission
# &
# Korea's GOCI Mission

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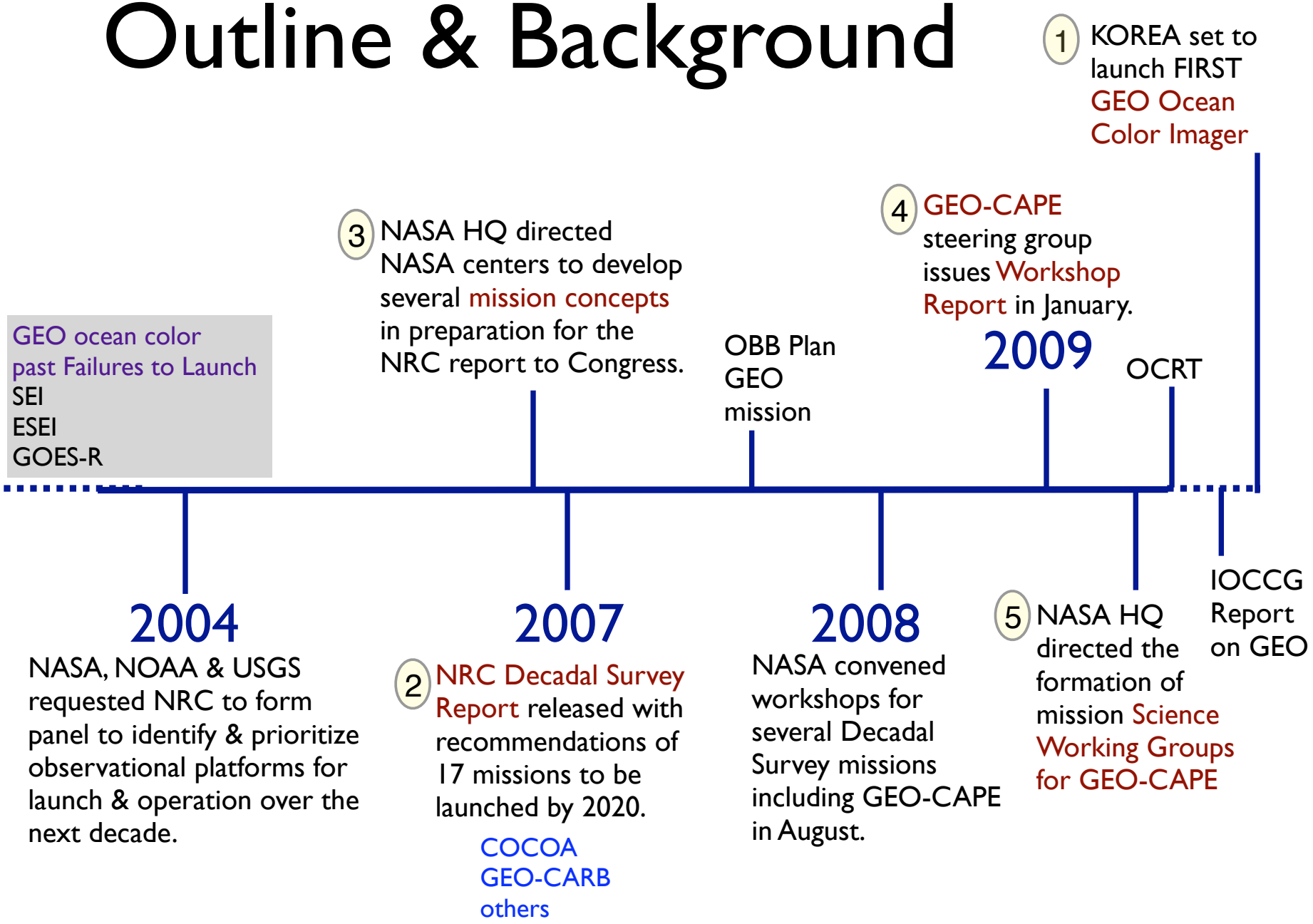
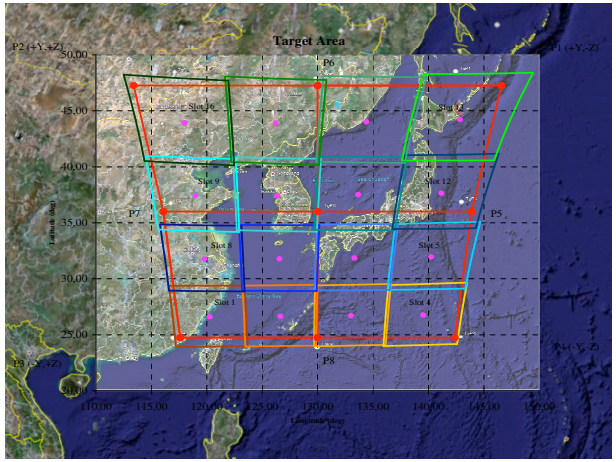
http://geo-cape.larc.nasa.gov/

# Outline & Background



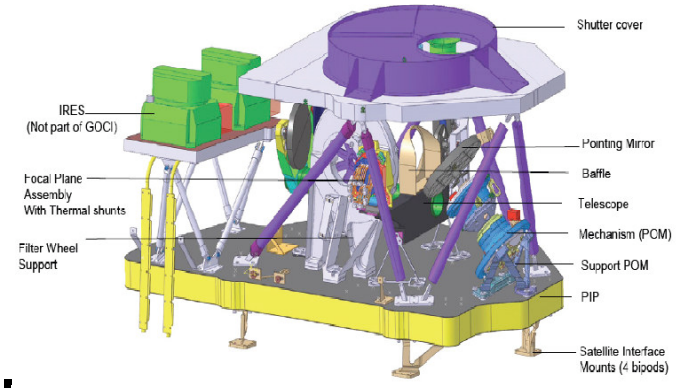
# Korean Geostationary Ocean Color Imager (GOCI)




Local area coverage: 2500km x 2500 km
Center Position: 130°E Longitude, 36°N Latitude

| | SeaWiFS | GOCI |
|---|---|---|
| Altitude | 700-800 km | 36,000 km |
| Scanning type | 1-axis scanning | Staring-frame capture |
| Spatial resolution | 1000 m | 500 m |
| Spectral range | 400-900 nm | 400-900 nm |
| Temporal resolution | 1 day | 1 hour |
| Sun-Satellite position | stable | variable |
| Coverage | global | Local |
| Previous algorithms | Case-1 (Case-2) | No previous result |

from Yu-Hwan Ahn (KORDI)




# GOCI Spectral bands

| Central wavelength (nm) | SeaWiFS (bandwidth, nm) | GOCI (bandwidth, nm) | Primary Use |
|---|---|---|---|
| 412 | 1(20) | 1(20) | Yellow substance and turbidity |
| 443 | 2(20) | 2(20) | Chlorophyll absorption maximum |
| 490 | 3(20) | 3(20) | Chlorophyll and other pigments absorption, K(490) |
| 510 | 4(20) | | Chlorophyll absorption |
| 555 | 5(20) | 4(20) | Suspended sediment |
| 660 | | 5(20) | Fluorescence base 1, chlorophyll, suspended sediment |
| 670 | 6(20) | | Atmospheric correction |
| 680 | | 6(10) | Fluorescence signal, atmospheric correction |
| 745 | | 7(20) | Atmospheric correction, Fluorescence base 2 |
| 765 | 7(40) | | Atmospheric correction, aerosol radiance |
| 865 | 8(40) | 8(40) | Aerosol optical thickness, vegetation, Water vapor reference over the ocean |

from Yu-Hwan Ahn (KORDI)

# GOCI-2 planned for 2015 launch

Full Disk capability
250 m local resolution
300 km FOV
13 bands

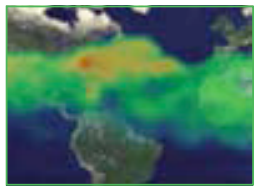
Radiance : W/m²/um/sr

| Band | Heritage | Band Center | Band width | Nominal Radiance | Maximum Ocean Radiance | Saturation Radiance | Maximum Cloud Radiance | NEdL | SNR | Primary use |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GOCI-B1 | 412nm | 20nm | 100.0 | 150.0 | 152.0 | 601.6 | 0.100 | 1000 | Yellow substance and turbidity |
| 2 | GOCI-B2 | 443nm | 20nm | 92.5 | 145.8 | 148.0 | 679.1 | 0.085 | 1090 | Chlorophyll absorption maximum |
| 3 | GOCI-B3 | 490nm | 20nm | 72.2 | 115.5 | 116.0 | 682.1 | 0.067 | 1170 | Chlorophyll and other pigments |
| 4 | (KGOCI) | 520nm | 20nm | | | | | | | Red Tide |
| 5 | GOCI-B4 | 555nm | 20nm | 55.3 | 85.2 | 87.0 | 649.7 | 0.056 | 1070 | Turbidity, suspended sediment |
| 6 | (KGOCI) | 625nm | 20nm | | | | | | | SS & Red Tide |
| 7 | GOCI-B5 | 660nm | 10nm | 32.0 | 58.3 | 61.0 | 589.0 | 0.032 | 1010 | Baseline of fluorescence signal, Chlorophyll, suspended sediment |
| 8 | GOCI-B6 | 685nm | 10nm | 27.1 | 46.2 | 47.0 | 549.3 | 0.031 | 870 | Atmospheric correction and fluorescence signal |
| 9 | GOCI-B7 | 745nm | 20nm | 17.7 | 33.0 | 33.0 | 429.8 | 0.020 | 860 | Atmospheric correction and baseline of fluorescence signal |
| 10 | (KGOCI) | 765nm | 20nm | | | | | | | Aerosol Properties, Atmospheric Properties |
| 11 | GOCI-B8 | 865nm | 40nm | 12.0 | 23.4 | 24.0 | 343.8 | 0.016 | 750 | Aerosol optical thickness, vegetation, water vapor reference over the ocean |
| 12 | | 905nm | 40nm | | | | | | | Atmospheric Properties, Cloud Properties |
| 13 | | 650nm | 500nm | 6.5E-6 | | | | | | Night Band (Night time fishing boat activities) |

from Yu-Hwan Ahn (KORDI)

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

**Launch: 2013-2016 Mission Size: Medium**

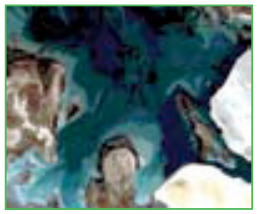


**Identification of human versus natural sources of aerosols and ozone precursors**

**Dynamics of coastal ecosystems, river plumes, and tidal fronts**

**Observation of air pollution transport in North, Central, and South America**

**Prediction of track of oil spills, fires, and releases from natural disasters**



**Detection and tracking of waterborne hazardous materials**

**Coastal health**

**Forecasts of air quality**

credit: NRC 2007

# Decadal Survey Summary

**GEO-CAPE Coastal Waters Science Objectives from NRC Decadal Survey:**

- To quantify the **response of marine ecosystems to short-term physical events**, such as passage of storms and tidal mixing.
- To assess the **importance of high temporal variability in coastal-ecosystem models**.
  - Both short-term and long-term forecasts of the coastal ocean require better understanding of critical processes and sustained observing systems.
- 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.
- To **detect floods** from various sources, including river overflows.

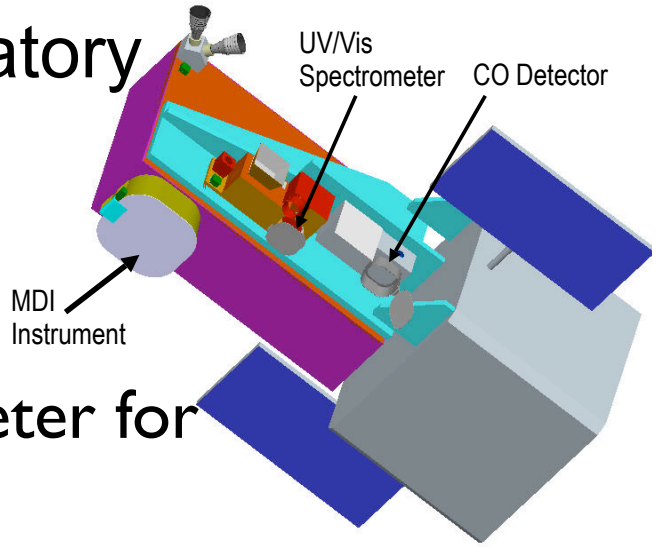
**Societal benefits from GEO-CAPE oceans mission**

- Prediction of fisheries yield through improvement of models and model forecasting.
- Detection and tracking of hazards that relate to human health.
- Link data to models and decision-support tools and processes.
  e.g., to predict the occurrence and extent of hypoxic regions (“dead zones”)

# Geostationary Multidiscipline Observatory

## GSFC ISAL & IMDC - Engineering Study

- 4-6 weeks



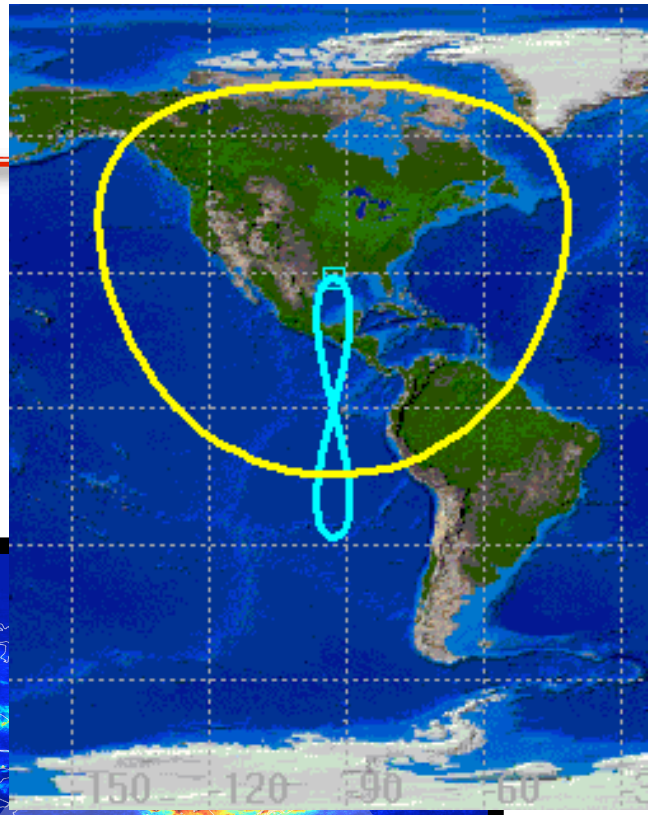

- Payload of 3 instruments
  - Medium-resolution (5km) spectrometer for atmospheric chemistry
  - MDI - High-resolution (300m) regional scanning spectrometer for coastal & atmospheric research

    UV-VIS-NIR 300-1139 nm + SWIR bands
  - CO detector
- Geo-stationary orbit - 100°W

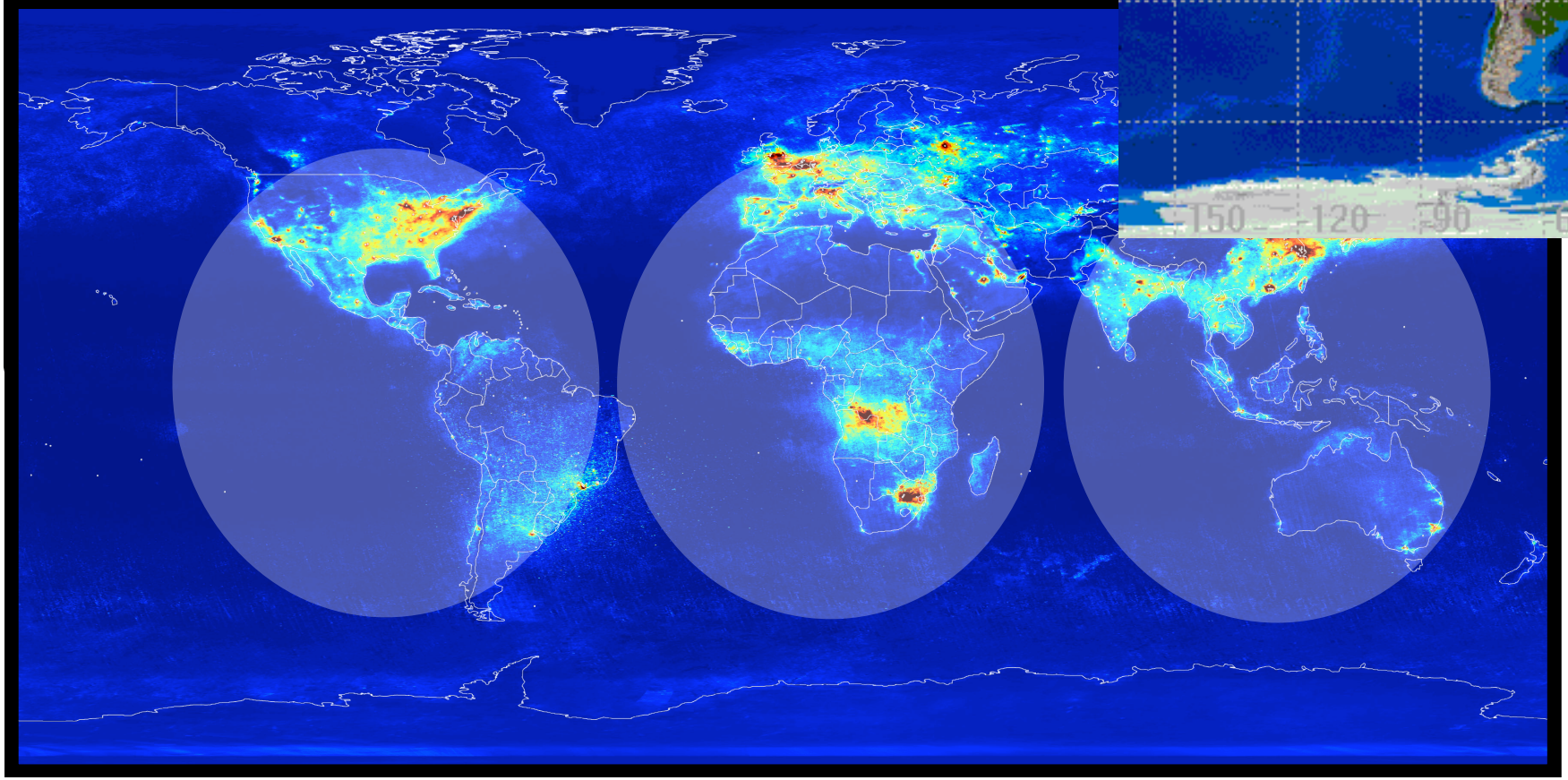

**Study Team:**

**S. R. Kawa, A. Mannino, E. Middleton (GSFC, science leads)**
**M. Carr, C. Bruce (JPL)**
**S. Janz, R. Knox (GSFC)**
**J. Fishman, D. Neal (LaRC)**

# Option to Reposition Geo Longitude and Latitude




- Engineering studies needed to determine drift rates, fuel load, ground communication requirements.




# NASA GEO-CAPE

## Geostationary Coastal and Air Pollution Events

# Workshop Report

**August 18-20, 2008**
**Chapel Hill, North Carolina**

Report released January 2009

http://geo-cape.larc.nasa.gov/

# Workshop Report Science Questions

Table 1. Overarching Science Question: What natural and anthropogenic processes affect and control atmospheric composition, air quality, water quality, and coastal ecosystems, and how will they respond to climate change?

| Science Questions | Mission Objectives |
|---|---|
| What are the emission patterns of the precursor chemicals for tropospheric ozone, aerosols, and air quality pollutants? | Quantify the diurnal emission patterns of ozone and aerosol precursors, and air quality pollutants over North America and distinguish natural and anthropogenic contributions. |
| How do the distributions of gaseous pollutants and particulate matter evolve throughout the course of the day and what are the chemical, transport, mixing, and deposition mechanisms that determine these distributions? | Measure the diurnal evolution of atmospheric constituents as they are transformed and transported throughout the day over the continent and the surrounding ocean. |
| What processes affect and control the biology and biogeochemistry of aquatic coastal zones, and how are they modulated by natural and anthropogenic forcing? | Characterize variability in primary productivity, phytoplankton biomass, and carbon pools in the coastal ocean in conjunction with measurements of natural and anthropogenic forcing. |
| How do weather and the episodic releases from fires, dust storms and volcanoes affect air quality, river discharge, water quality, and the ecology and biogeochemistry of coastal ecosystems and what are the feedbacks? | Characterize changes in the atmospheric chemistry, hydrology, and coastal ocean biogeochemistry in response to weather events and episodic input. |

# Ocean Science Questions

1. How are **coastal algal blooms** impacted by climate or environmental variability and change? What are the consequences of these impacts for fisheries, biodiversity, the ocean's biological pump, carbon fluxes, the extent of oxygen minimum zones, and for ecosystem health?

2. How and how fast do (harmful) algal blooms, oil spills, pollutants and other elements that could be detrimental to ecosystems disperse in the coastal ocean? **Hazards**

3. What is the role of continental margins in the global cycles of **carbon and nitrogen** (including global primary productivity)? What are the sources/pathways, forms, and fates of carbon and nitrogen to rivers, estuaries, and continental shelves? What is the contribution of terrigenous organic matter exported to the coastal ocean and to the open ocean?

# Workshop Report
## Recommendations for Near-Term Studies

- Generation of datasets for analysis
- Measurement strategies and algorithm development
- Observing strategy
- Mission Requirements
- Access to space

# Workshop Report
# DRAFT Science Traceability Matrix (STM)

| Science Questions | Mission Objectives | Measurement Requirements | Mission Requirements | Instrument Requirements | Mission Concept |
|---|---|---|---|---|---|
| What are the emission patterns of the precursor chemicals for tropospheric ozone, aerosols, and air quality pollutants? | Quantify the diurnal emission patterns of ozone and aerosol precursors, and air quality pollutants over North America and distinguish natural and anthropogenic contributions. | $O_3$, $NO_2$, HCHO, CO partial columns; $O_3$ and CO with sensitivity in the planetary boundary layer (PBL); aerosol optical depth | Coverage of North and South America and adjacent ocean at spatial scales of 10 km or better.<br><br>Simultaneous constituent measurements<br><br>Hourly or more frequent daytime coverage; nighttime sampling for CO | High-precision radiometer/spectrometer with sufficient SNR.<br><br>0.5 nm spectral resolution in the UV-VIS-NIR<br><br>Thermal IR radiometer for CO and $O_3$ measurements (is this redundant with first requirement?) | Instruments in geostationary orbit continuously observe populous N & S America coast-to-coast; and upwind and downwind of continent.<br><br>UV/Visible spectrometer measures $O_3$, $NO_2$, HCHO, $SO_2$, and aerosol column density; plus CO, $O_3$ detectors for BL and free troposphere |
| How do the distribu-tions of pollutants and particulates evolve throughout the course of the day and what are the chemi-cal, transport, mixing, and deposition mechanisms that determine these distributions? | Measure the diurnal evolution of atmospheric constituents as they are transformed and transported throughout the day over the continent and the surrounding ocean | | | | |
| What processes affect and control the biology and biogeochemistry of aquatic coastal zones, and how are they modulated by natural and anthropogenic forcing? | Characterize variability in primary productivity, phytoplankton biomass, and carbon pools in the coastal ocean in conjunction with measurements of natural and anthropogenic forcing. | Multi-spectral UV-VIS water leaving radiances; column $O_3$, $NO_2$ and other absorbing trace gases and NIR-SWIR radiances for atmospheric corrections. | Observe dynamic coastal regions during cloud-free viewing opportunities.<br><br>Measure variability at hourly temporal resolution and spatial scales of ~ 250-500m.<br><br>Monitor instrument stability and adjust calibration with solar, lunar, and surface observations. | High-precision radiometer with SNR>1000:1 (340-1000nm)<br><br>~1 nm resolution in the UV-VIS-NIR; SWIR bands: 1240, 1640 and 2130 nm for atmos. corrections<br><br>Radiometric stability of <0.1% band-to-band, polarization of <1% below 700nm; | Advanced ocean color remote sensing from geostationary orbit provides the temporal resolution needed to resolve variability in biology and biogeochemistry driven by multiple processes in coastal ocean (tides, winds, upwellings, and input from rivers and atmosphere). |
| How do weather, and the episodic releases from fires, dust storms, and volcanoes affect air quality, river discharge, water quality, and the ecology and biogeochemistry of coastal ecosystems, and what are the feedbacks? | Characterize changes in the atmospheric chemistry, hydrology, and coastal ocean biogeochemistry in response to weather events, and episodic input. | All of above atmospheric and oceanic measurements | Continuous daytime coverage; ability to focus on regions affected by episodic weather events or input from fires or volcanoes. | Same as above plus the ability to point or stare at focus areas of interest for extended periods of time. | Atmosphere and ocean observations from geostationary orbit provide the temporal resolution needed to capture responses to storms and other episodic events. |

# GEO-CAPE Oceans Science Working Group (SWG)

**NASA HQ Managers:** Ken Jucks, Paula Bontempi, Jassim Al-Saadi & Fred Lipschultz

**Coordinator:** Laura Iraci (NASA ARC)

**Science Working Group:**

Bob Arnone
Janet Campbell (co-lead)
Francisco Chavez
Paula Coble
Curt Davis
Carlos del Castillo
Paul DiGiacomo
Jay Herman
Zhongping Lee
Carolyn Jordan
Steve Lohrenz
Antonio Mannino (co-lead)
Paty Matrai
Ru Morrison
Joe Salisbury
Heide Sosik
Rick Stumpf
Omar Torres

**Objectives**

Develop mission Science Traceability Matrix (STM) for Coastal Oceans

- Define ocean science questions for GEO-CAPE mission
- Establish measurement requirements
- Advise HQ on required scientific studies

We need input from this community.

What science questions should we tackle with GEO-CAPE?