# NASA Earth Science Enterprise

## Earth Science Applications Program & Coastal Management Application

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*Expanding the realization of economic and societal benefits from Earth science, information, and technology …*

# Earth Science Applications: Summary

Purpose of Earth Science Applications Program:

> Understand priority issues facing public & private decision makers and determine if & how NASA Earth science research results can serve their management and policy responsibilities

Pursue opportunities to contribute products derived from NASA's Earth science activities *(measurements, models, assimilation methods, visualizations, etc.)* to help Partners with policy & management responsibilities serve their mandates.

- evaluate products ability to serve operational requirements
- verify and validate products (I.e. application verification)
- develop prototypes/guidelines to assist partners' use in their operations

Extend Earth science results to partners' *Decision Support Systems* (DSS)

- National/regional level
- DSSs: Owned and operated by partners. NASA *not* creating new ones for partners
- Funds to develop prototype products (observations, model outputs) to enable integration in DSSs
- Applied science or research to investigate possible applications is beyond scope

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<u>Coastal Management Application</u>

FY04: - Finalizing Evaluation Reports of Coral Reef and Oil Spill Decision Tools
- Pursuing Earth science inputs to HAB Forecast/Mapping System with NOAA, NRL, & Applied Coherent Technology through Coop. Agreement
- Issuing NRA for application project proposals

FY05: - Develop prototype products with partners (Coral Reef, Oil Spill, HAB, Fisheries)
- Select projects in FY04 NRA; Issue another NRA (annual)

# Applications of National Priority

Energy Management

Aviation

Disaster Management

Invasive Species

Agricultural Efficiency

Homeland Security

Public Health

Water Management

Carbon Management

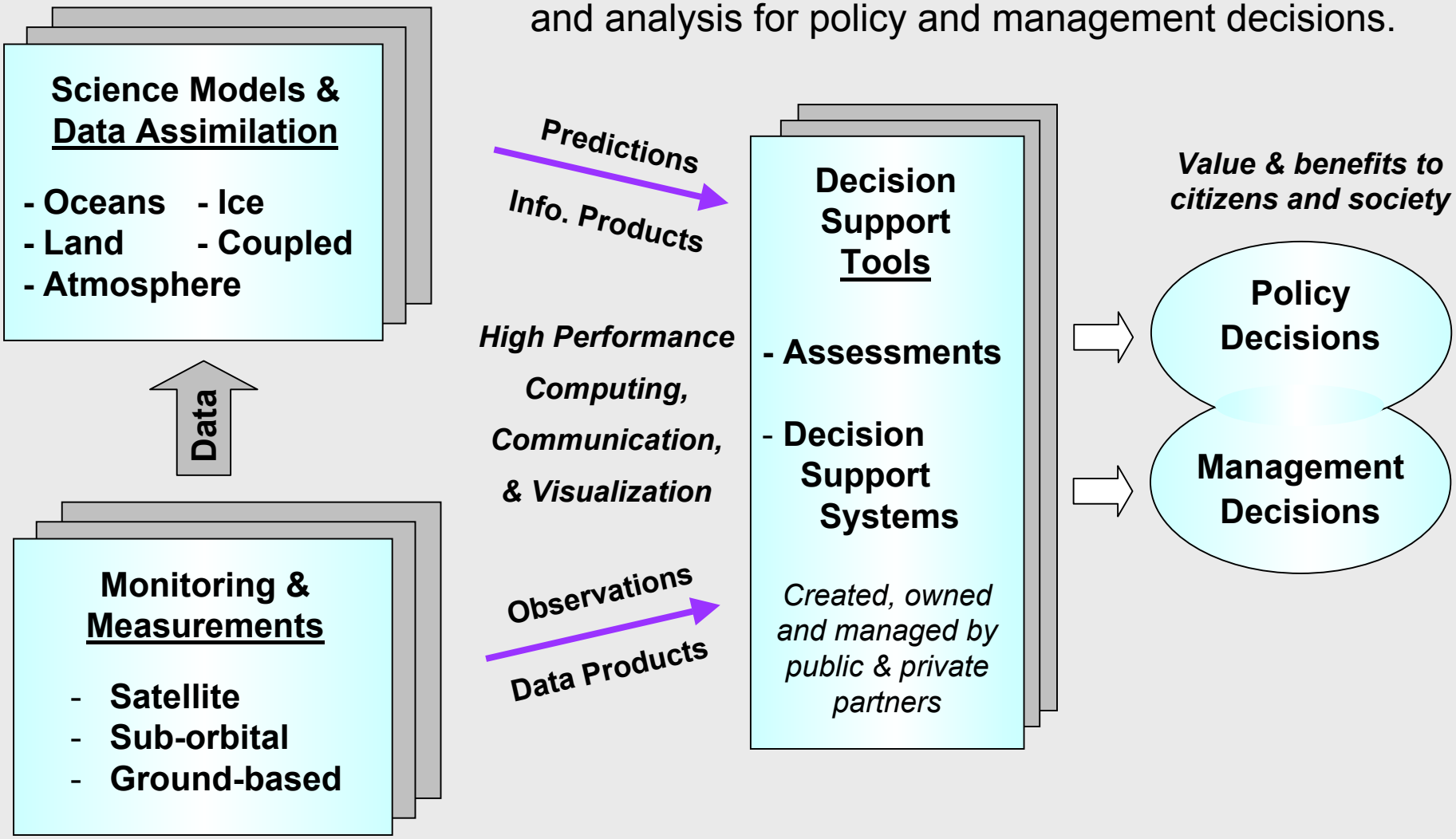
Ecological Forecasting

Coastal Management

Air Quality

# Solutions: Science to Decision Support

Applying a systems engineering approach and ESE results to support decision-making tools, predictions, and analysis for policy and management decisions.



# Coastal Management

## Integrated System Solution

### EARTH SYSTEM MODELS

- **Global Ocean Circulation Models:** *LANL POP, LANL HYPOP*
- **Coastal Ocean Circulation Models:** *MITgcm, GFDL MOM4, ADCIRC, SHORECIRC*
- **Wind & Wave Models:** *COAMPS, SWAN*
- **Ocean Pattern Models:** *MITgcm, GFDL, HIM*
- **Chlorophyll Models (*regional)***
- **Sea Surface Temperature:** *NSIPP Ocean, ECCO OSE*

Data

### EARTH OBSERVATIONS

- **SST & Salinity:** *Terra, Aqua, Aquarius, GOES, NPP, NPOESS*
- **Ocean Winds:** *QuikScat, ADEOS-II, GCOM*
- **Coastal/Land Use:** *Terra, Aqua*
- **Ocean Color:** *Terra, Aqua, NPP, NPOESS, SeaWifFS*
- **Ocean Topography:** *Topex, Jason 1, OSTM*
- **Precipitation:** *TRMM, Aqua*
- **Ocean Circulation:** *Jason, Aqua*

Predictions

- Nearshore upwelling
- Speed and direction of ocean currents
- Ecological Forecasts
- Runoff Change
- Seasonal Forecasts
- Aerosol Properties
- Salinity predictions
- Ocean Surface Currents/ Winds/ Topography
- Sea Surface Salinity/Temperature
- Land Use
- Phytoplankton concentrations

Observations

### DECISION SUPPORT TOOLS

**HAB (Harmful Algal Bloom) Bulletin & Mapping System**

**Analysis:** Predict landfall, track transport-speed- direction, forecast duration/demise, assess severity

**Management:** Warning time to fisheries managers, beach closures, shellfish quotas, finfish limits, aquaculture flushing and recirculation, mitigation response

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**Coral Reef Early Warning System (CREWS)**

**Analysis:** Assess potential bleaching conditions from wind, temperature, primary productivity

**Management:** Warning time and automated alerts to managers, mitigation activities

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**GNOME - Oil Spill Modeling**

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**Fisheries - Drift Nets**

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**Stormwater Runoff**

### VALUE & BENEFITS

- Reduce public health risks, hospital admissions, lost work-school days
- Reduce impacts to regional coastal economies & tourism
- Raise quotas for shellfish harvesting prior to HABs; improve siting and design of shellfish beds
- Preserve ecological diversity and tourism economies
- Reduced threats to human and natural environments
- Rapid response to emergencies to reduce effects on human safety and economies
- Public health and reduce preventable costs

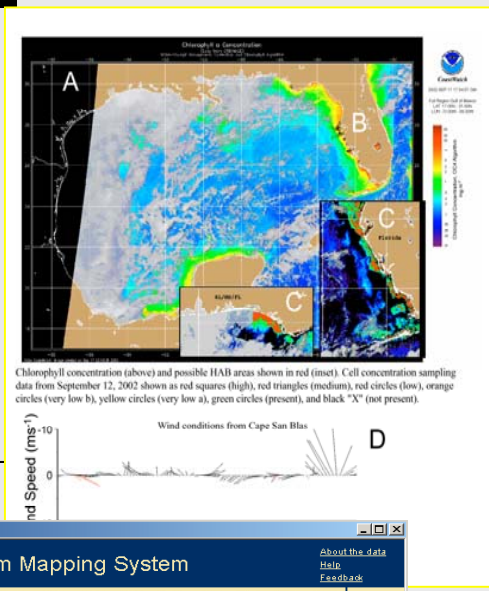
# Operational HAB Forecasts

## HAB Bulletin and HAB Mapping System

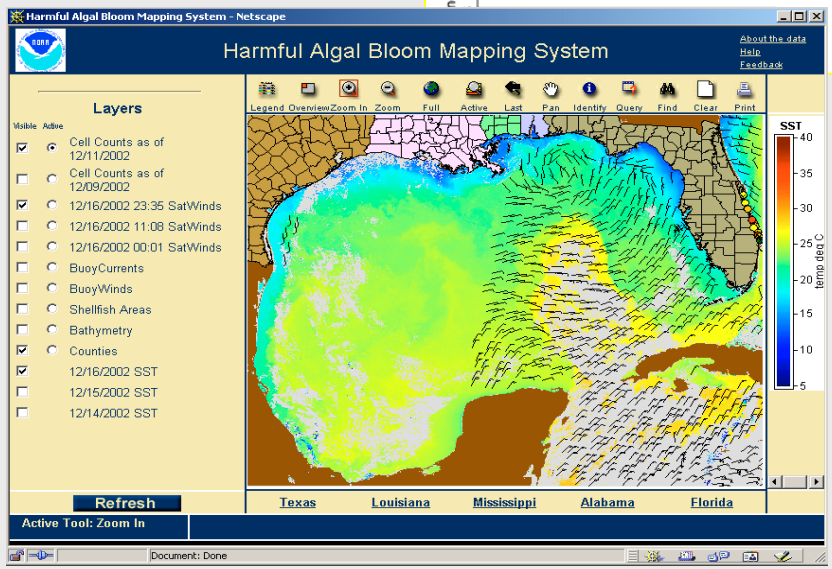
- NOAA developed and operated
- HAB Bulletin: Notification of change in conditions via e-mail
- HAB Mapping System: Constant supply of information. Internet-based mapping.
- Provide real-time data for event response and analyzed data with interpretation
- Primary audience: Fisheries managers, public health officials, local governments
- NOAA utilizes products derived from NASA QuikScat & SeaWiFS; data from MODIS (Terra & Aqua) pending.
  - ocean color
  - chlorophyll
  - primary productivity
  - ocean winds

| Warning Time | Management Options |
|---|---|
| seasonal | re-allocate resources<br>alter monitoring schedules<br>change harvesting policy |
| week – 3 days | alter monitoring schedules change harvesting policy<br>alert businesses<br>prepare for clean-up |
| 24 hours | alter monitoring schedules<br>alert businesses<br>prepare for clean-up |
| none | extensive testing of harvested products<br>initiate public health warnings<br>divert resources to monitoring and clean-up |

NOAA HAB Bulletin



Chlorophyll concentration (above) and possible HAB areas shown in red (inset). Cell concentration sampling data from September 12, 2002 shown as red squares (high), red triangles (medium), red circles (low), orange circles (very low b), yellow circles (very low a), green circles (present), and black "X" (not present).




*www.csc.noaa.gov/crs/habf/habmaps.html*

# Coral Reef Early Warning System

## CREWS

CREWS is designed to collect real time environmental data from prime coral reef sites throughout the world

- analyze patterns and trends via expert systems
- predict the effects of environmental events on coral reefs

(bleaching, fish and invertebrate spawning and migration)

Owner Agency: NOAA Coral Reef Watch
OAR AOML; NOAA/NESDIS (Hotspots)

POC: Jim Hendee, NOAA/AOML, Coral Health and Monitoring Program

Website: http://www.coral.noaa.gov/

Potential Earth science inputs:

– Missions (in evaluation): QuikSCAT, Terra/Aqua MODIS, TRMM, Landsat 7 ETM+, Terra ASTER

# General NOAA Oil Modeling Environment

## GNOME

GNOME is a publicly available oil spill trajectory modeling software

- Use by oil spill response and mitigation planners, researchers, and the educational community
- Estimates oil spill movement
- Uses information on ocean winds, currents, tides, and oil characteristics

Owner Agency: NOAA, Hazardous Materials Response Division (HAZMAT)

POC: NOAA HAZMAT -or- ORR.GNOME@noaa.gov -or- 206-526-6317

Website: http://response.restoration.noaa.gov/software/gnome/gnome.html

Potential Earth science inputs:

- Missions / sensors (in evaluation): Landsat 7 ETM+, QuikSCAT, Terra/Aqua MODIS, Jason-1, TOPEX/Poseidon
- Models (in evaluation): ADCIRC, OGCM, MITgcm, ROMS, SCRUM, WW3

# Coastal Management

**Coastal - State 2 (c. 2015)**
- Routine prediction of HAB events.
- Increased response time for oil spills
- Mitigation of coral bleaching events.
- Improved management decisions for sediment transport near coasts.

Socioeconomic Impact

— $1 Billion / 10 years

*Primary Partners:*

ATMS– global temperature and moisture profiles. VIIRS –SST, ocean color/chlorophyll measurements, turbidity, suspended matter concentrations, littoral sediment transport at < 1km resolution.

Increased spatial/temporal coverage of coastal remote sensing & modeling for reduced impact of pollution, spills to protected & commercially important coastal resources (reefs, fisheries). Routine forecasting of HAB events, climate-induced coastal change, other natural phenomena impacting coastal environments and property.

Aquarius LBR/LBS monthly, global sea surface salinity mapping (within 0.2 psu). DPR/GMI 3-hr global precipitation data & 4-D structure of rainfall rates. GCOM ocean vector wind mission – improvements to coastal OGCM.

More accurate prediction of sediment & freshwater input to coastal waters, improvements in coastal circulation modeling for HAB prediction & tracking, fisheries management. Prediction of conservative mixing region for point source pollution into coastal waters – improved forecasting abilities for resource managers, public health officials, and hazard response teams. Improved measurements of storm surge and coastal inundation for emergency response planning.

Improved 3Dvar ocean circulation models with Grace KBR geoid estimates. OSTM DORIS/TRSR sea surface state & ocean tides – short-range circulation products. Input to GODAE operational demonstration products.

Higher spatial/temporal resolution of coastal models for improved fisheries management, HAB tracking. Better projections of shoreline erosion for flood and coastal storm damage reduction. Chlorophyll advection product for improved HAB forecasting. Coastal dispersion models for oil spill tracking – improved mitigation strategies for hazard response teams. Bleaching indices for coral reef health estimation – advanced warning to sanctuary managers.

MODIS phytoplankton, DOM, & SST. SeaWiFS ocean color. AIRS & AMSR-E SST. SeaWinds & AMSR-E surface wind fields. JMR/Poseidon2/DORIS SSH, waves, sea level. Correlation with GOOS data.

Chlorophyll products for HAB detection – increased lead time for shellfish managers and public health officials. Identification of coastal sediment flux around coral reefs & depth-classification algorithms for coral reefs – accurate reef mapping for sanctuary managers and warnings of environmental conditions detrimental to reef health. Synoptic spatial/temporal coverage of coast – large oil spill & hurricane tracking for damage analyses.

***Current trajectory:***
***Steady improvement in coastal-ocean measurements and circulation models.***

**Coastal - State 1 (c. 2003)**
**HAB Bulletin, CREWS, GNOME.**

| SeaWiFS | Terra | Jason-1 | Aqua | QuikSCAT | GRACE | OSTM | GPM | Aquarius | NPP/NPOESS | OVW * | * Pre-formulation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | | 2005 | | 2007 | | 2009 | | 2011 | 2013 | | 2015 |

Improved capabilities to coastal resource managers for prediction and analysis of impacts to environmental and economic resources.

# Coastal Management Application

## Project Solicitation Across Earth Science Applications Program

- Announcement expected Spring/Summer 2004
- Extend Earth science results to existing or evolving decision support tools
- Considering use of Pre-Proposals
- Website: www.earth.nasa.gov/working/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