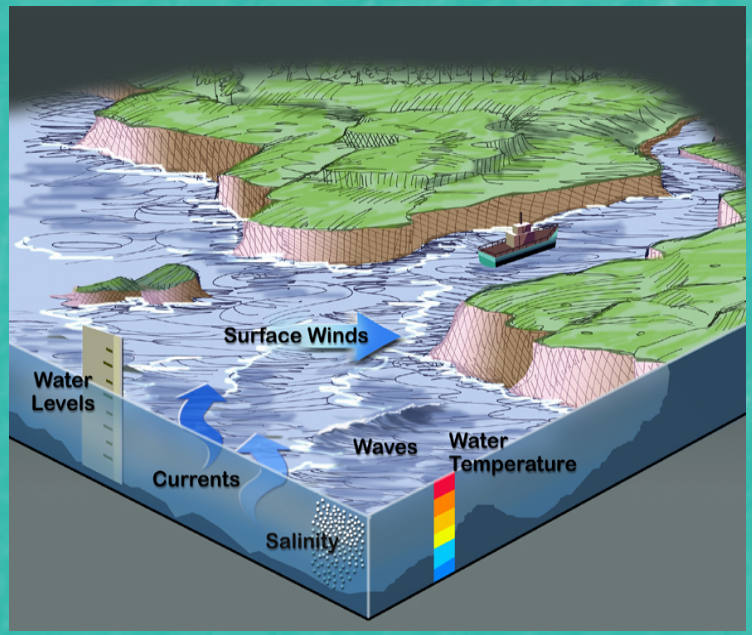
NCEP-NOS COLLABORATIONS:
NOS Coastal Operational Forecast Systems and . NOAA Strategies & Challenges



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National Ocean Service

NCEP Review
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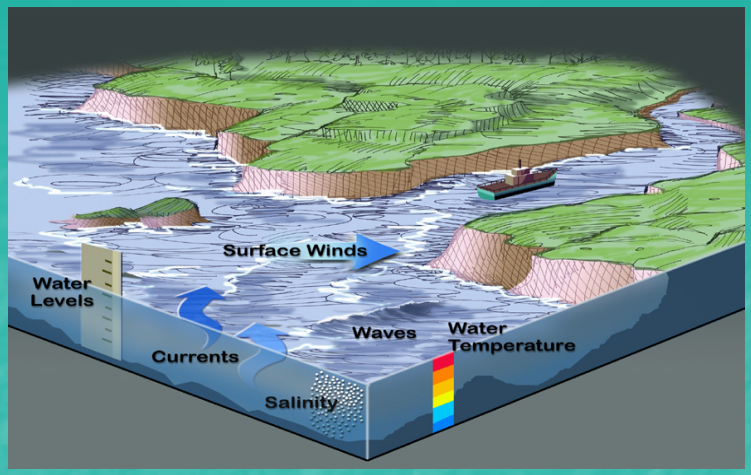
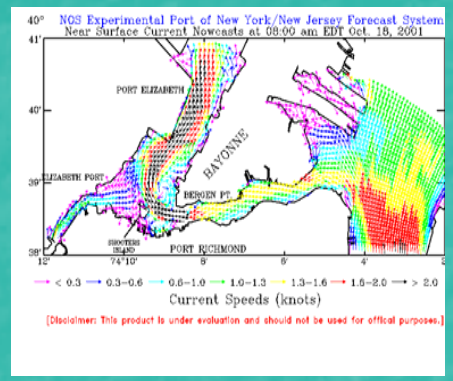


Outline

- The State of NOS's Operational Forecast Systems
- The Coastal Ocean Modeling Framework
- NOAA Strategies & Challenges
- Example Ecosystem Applications
- Some On-going Technical Issues

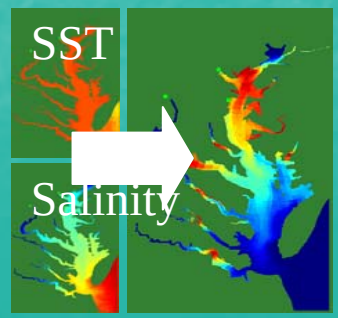
NOS Marine Modeling Requirements

- Support of safe & efficient navigation
  - Water levels for under-keel clearance
  - Currents for right-of-way, maneuverability



- Emergency preparedness & response
  - HAZMAT; Search & Rescue: Homeland Security
  - Storm surge & coastal inundation

- For environmentally sound management of the coastal zone
  - Ecosystem applications
  - Marine geospatial applications



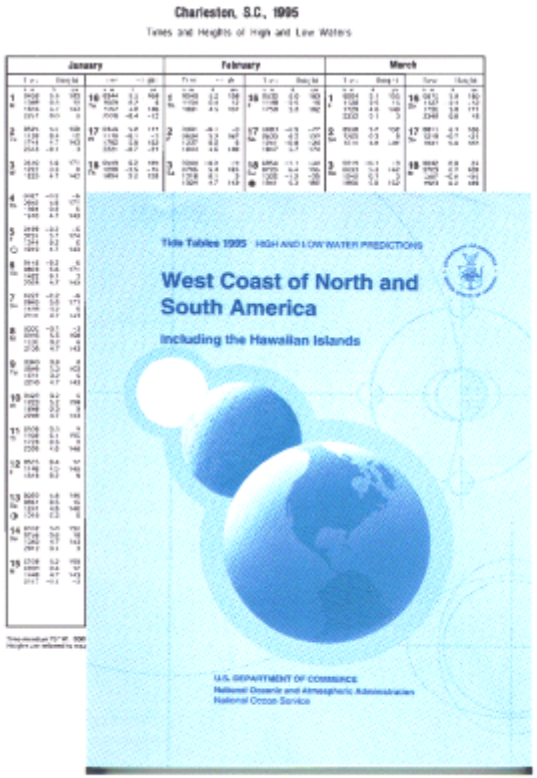
In the beginning .....

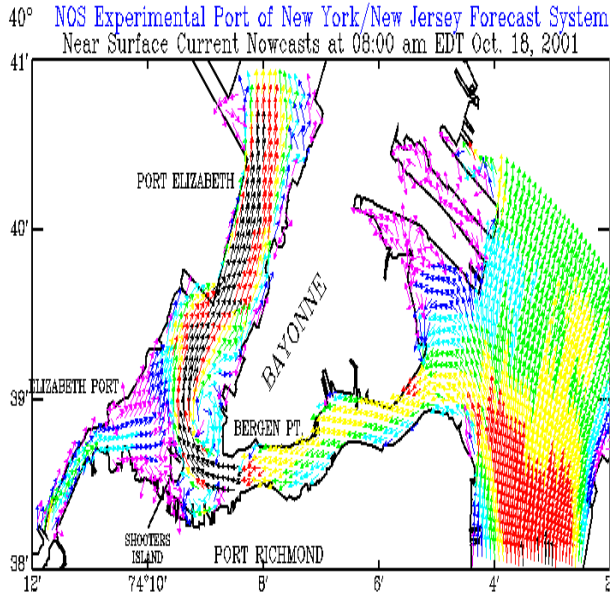
Tidal Prediction → Real-Time Data → Forecasting

(Tables provide only *astronomical* tide and tidal current predictions; no wind or river effects included)

(Wind and river effects included in the data, but information is only for the time of measurement)

(Pilots and other users need water levels and currents up to 24 hours into the future; use numerical models)

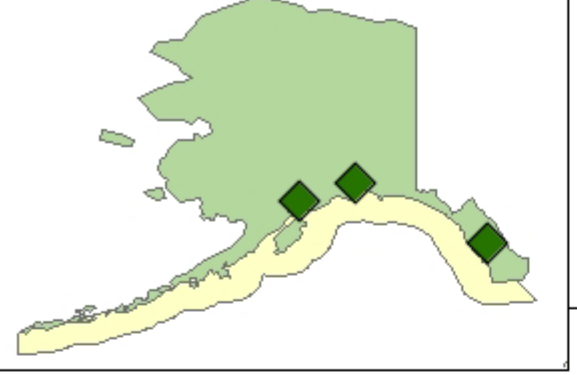


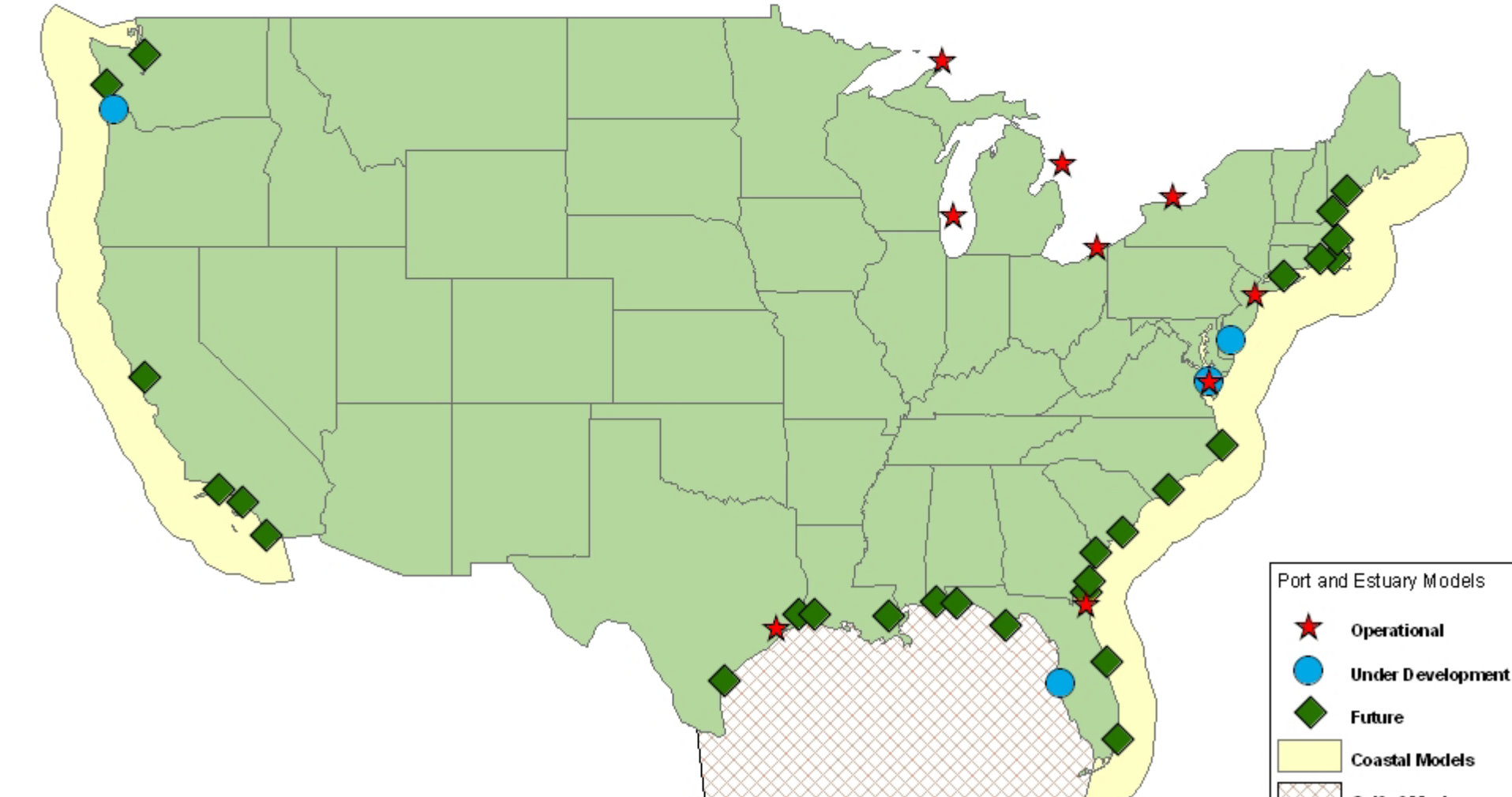


Nowcasting – providing real-time information at locations other than sensors

Implementation Strategy Map
NOS Operational Coastal Modeling

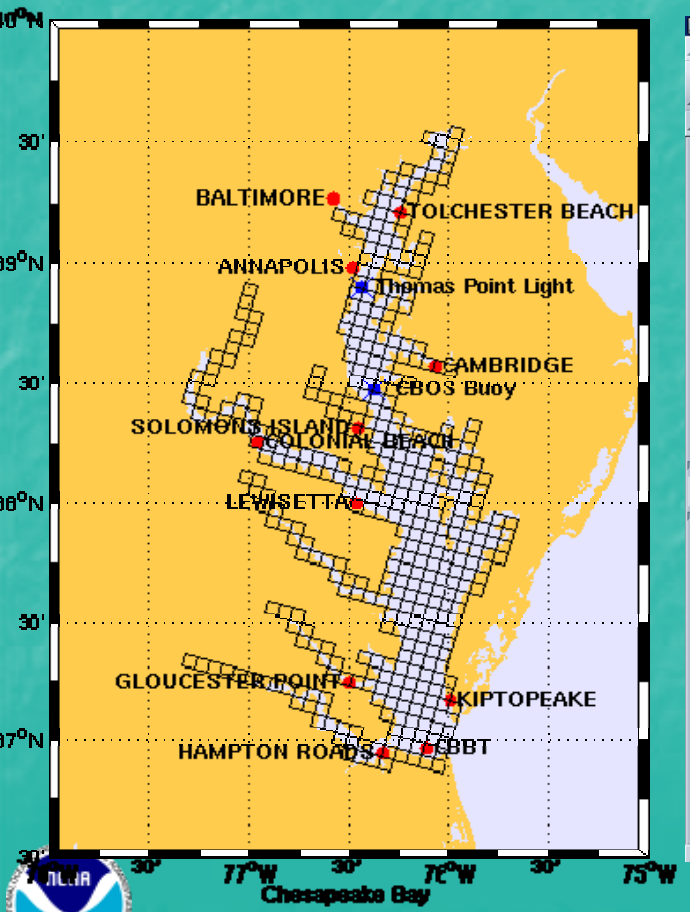
Dynamic strategy subject to revision by NOAA management based upon stakeholder needs and budget opportunities.

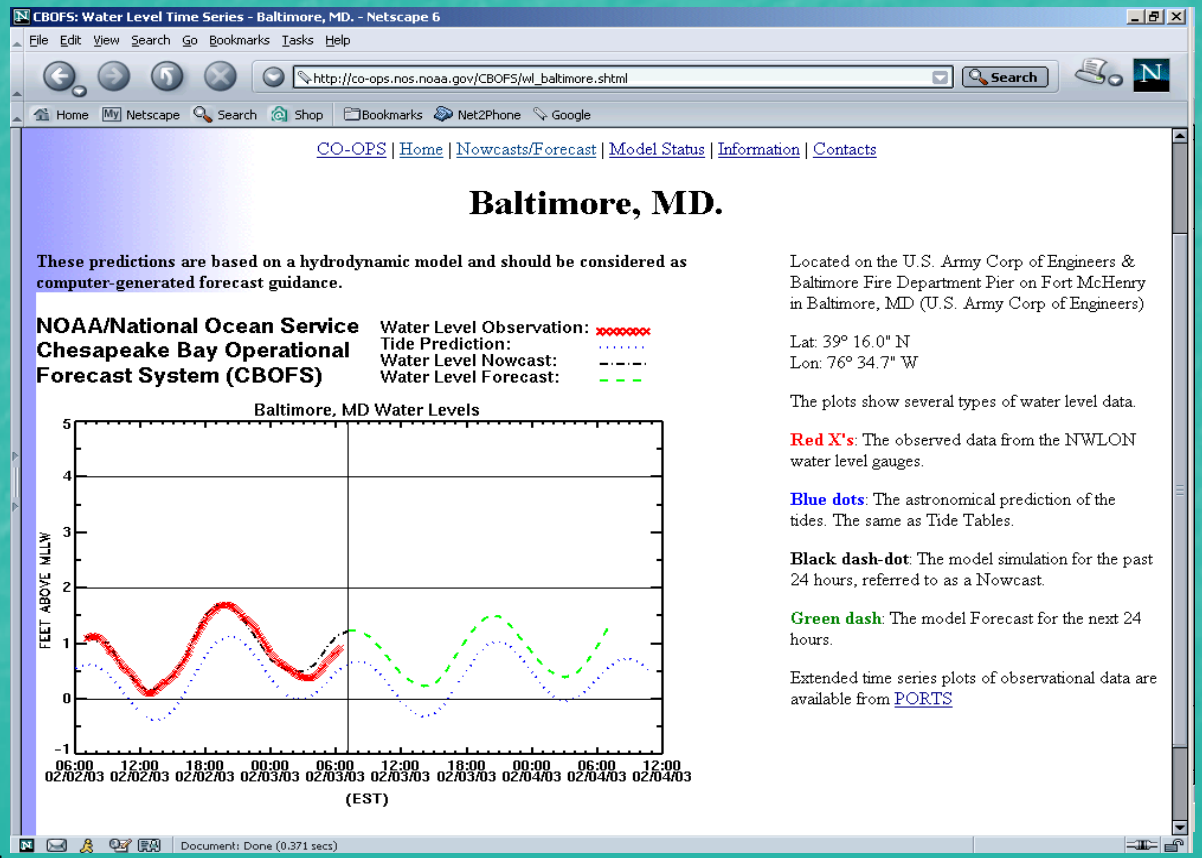




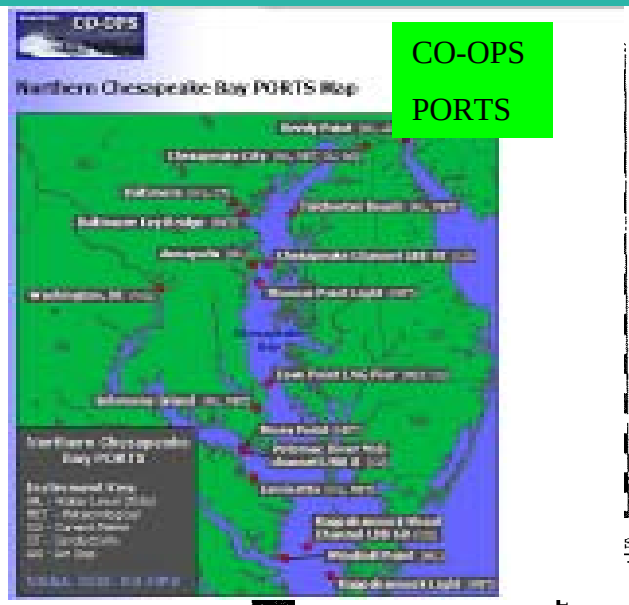
Chesapeake Bay Operational Forecast System (CBOFS)

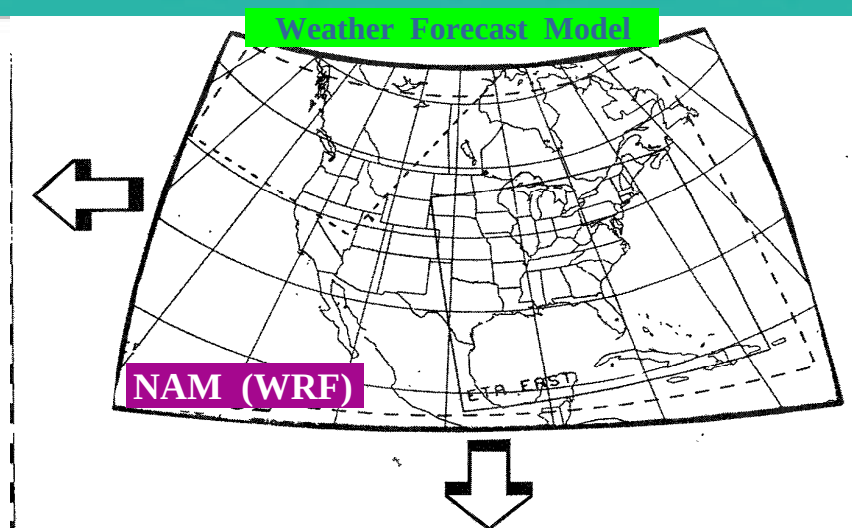
Operational since August 2001

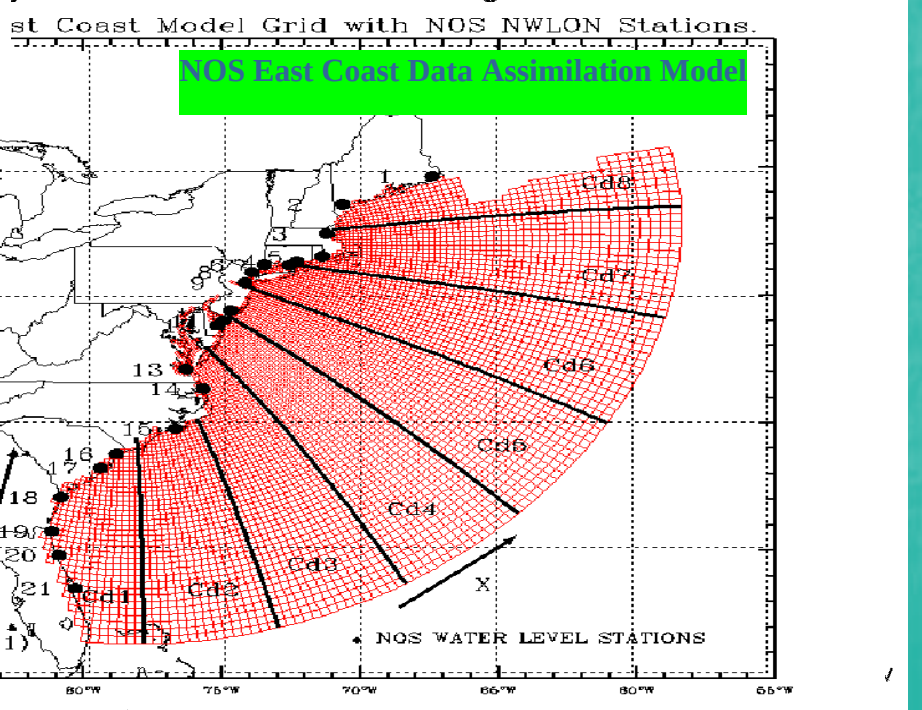


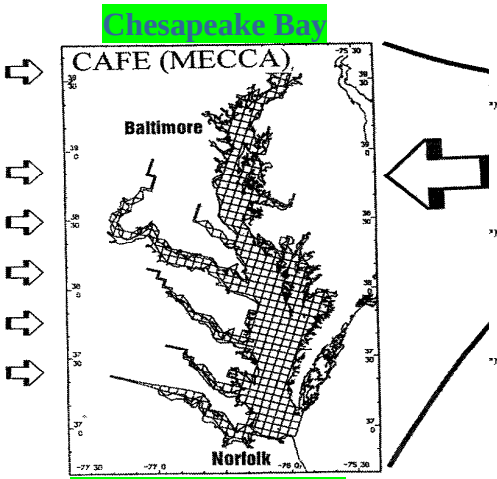


Inputs to Chesapeake Bay Operational Forecast System









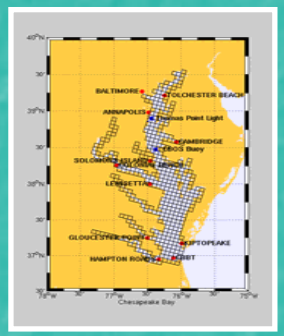
RIVER INPUTS

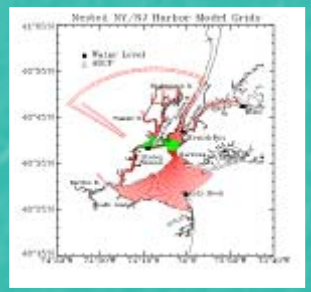
Coastal Ocean Modeling Framework

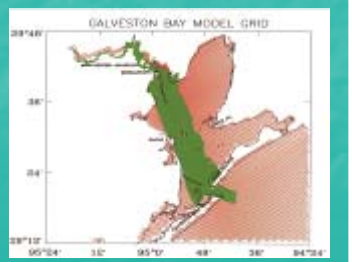
- Instead of one-of-a-kind creations
  - A Babel of
    - Data grabbers
    - Data base translators
    - Tools, etc.

- Define & develop a single standard system
  - The Rosetta Stone
    - Frameworks
    - Formats
    - Methodologies
    - Access methods

Individual Model Systems







NOAA/NOS Coastal Ocean Modeling Framework*

Standardized for any model at any location

REAL-TIME DATA INGEST → QA/QC (CORMS) 24 x 7 → NOS OPERATIONAL MODELS → QA/QC (CORMS) 24 x 7 → FORECAST MODEL GUIDANCE (water level, water temp, currents, & salinity) PRODUCTS (web pages and digital pt. & gridded data) FOR USERS

***Consistent with IOOS (DMAC); the Earth System Modeling Framework (ESMF); and COARDS/CF Conventions**

COMF:
Operational System Management

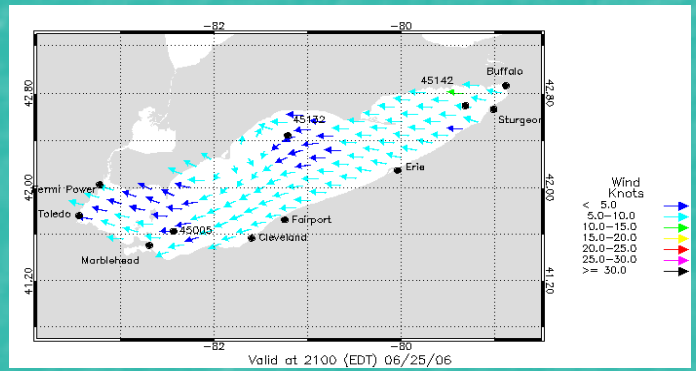
- Operational Estuarine Models Require Real-Time Observations and Forecasts of:
  - Atmospheric Forcing
  - Coastal Boundary Conditions
  - Riverine Fresh Water Inputs

- ODAAS: Operational Data Acquisition and Archive System

Atmospheric Forcing

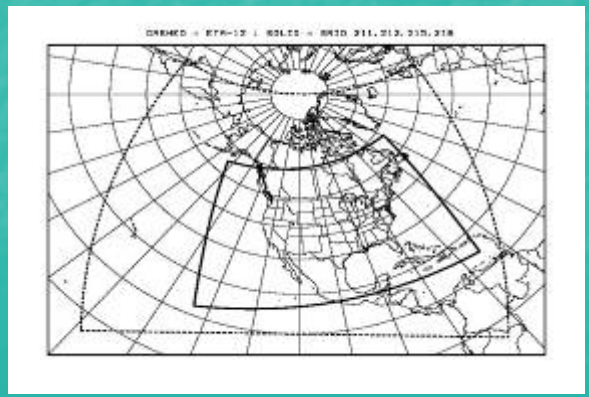
Nowcasts: Local Analysis & Interpolation

Lake Erie Surface Wind Analysis



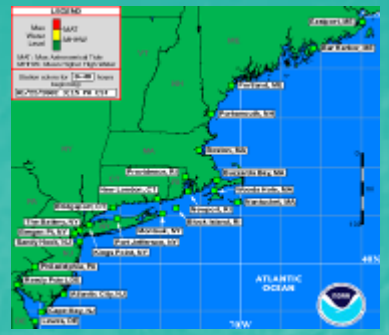
Forecasts: NWS/NCEP operational models

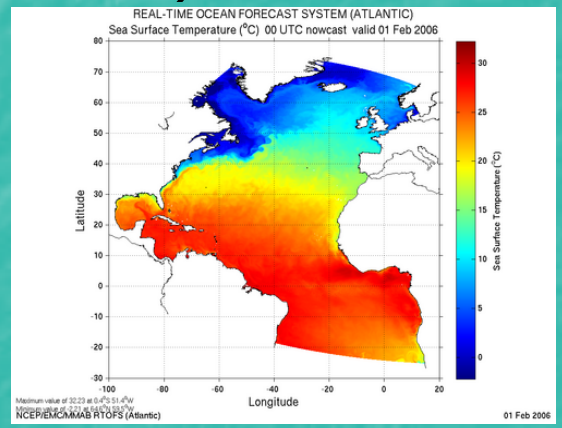
- NAM (WRF)
- Global Forecast System (GFS)
- RUC
- NDFD next



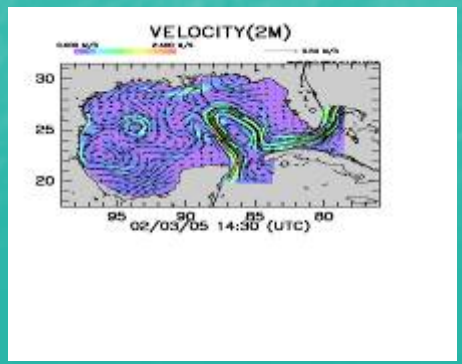
Coastal Boundary Conditions

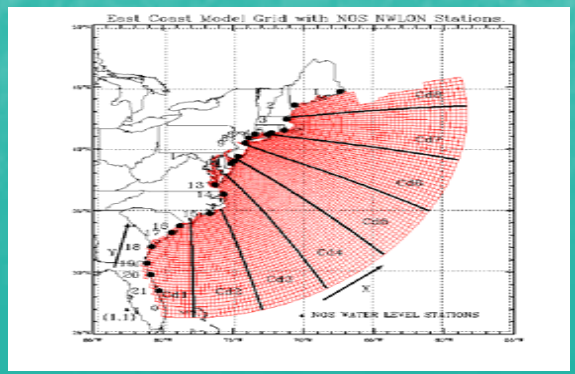
- NWS Operational
  - Extra-Tropical Storm Surge (ETSS)
  - Real-Time Ocean Forecast System (RTOFS)





- NOS Experimental
  - East Coast Data Assimilation (ECDA)
  - NOS Gulf of Mexico (NGOM)





Estuarine Fresh Water Inputs

- Riverine fresh water inputs are important:
  - Affects the estuarine stratification
  - Produces the density-driven circulation
  - Buoyancy effects on ship UKC
  - Salinity determination
- NWS River Forecast Centers:
  - Forecast guidance at points
  - Hourly USGS observed transport
  - 6 hourly forecasts of discharge

NWS Mid-Atlantic RFC Inputs

Strategies & Challenges for NOAA Coastal Ocean Modeling

- Transition to the NOAA High Performance Computing Environment (e.g. NCEP/CCS)
- Evolving Concept of Operations
- Storm Surge & Community Modeling
- Coupled Systems
- Ecosystem Forecasting

NOS Transition of Operational Forecast Systems to NCEP

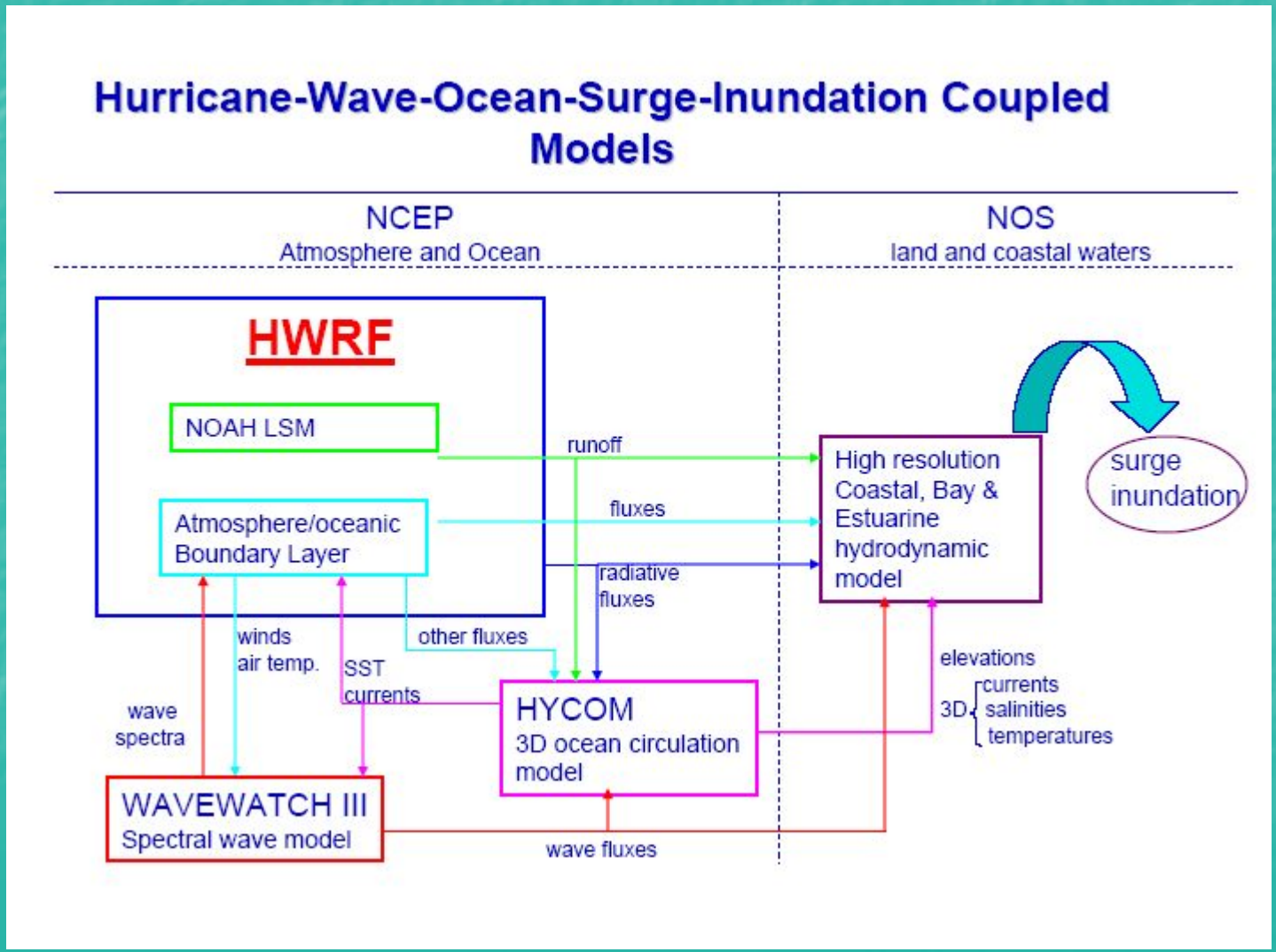
OBJECTIVE: More efficient R&D, O&M

PROCESS (FY08-09):

- Establish a version of *COMF at NCEP
- Transition 5 Great Lake Models (GLOFS)
- Set up Ches. Bay (CBOFSv2) at NCEP (ROMS)
- Test/evaluate Del. and Tampa Bay OFS at NCEP (ROMS)

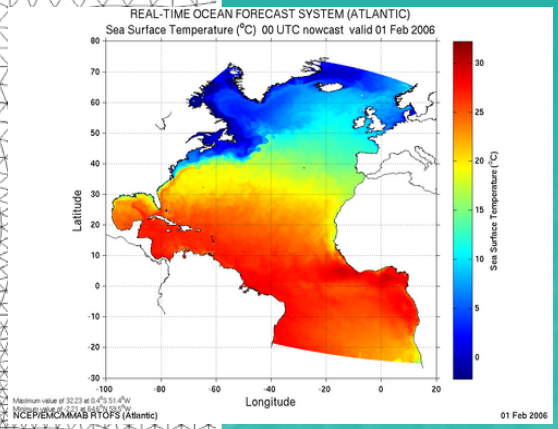
*Consistent with IOOS (DMAC); the Earth System Modeling Framework (ESMF); and COARDS/CF Conventions

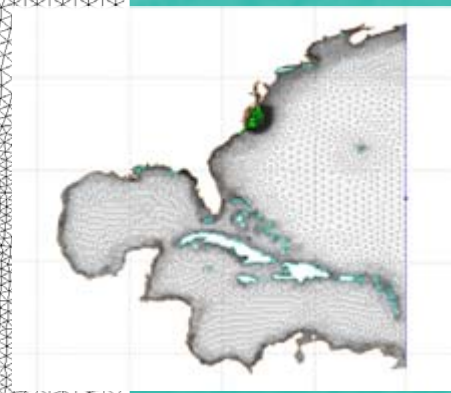
NCEP/CSDL Coupled Storm Surge Project

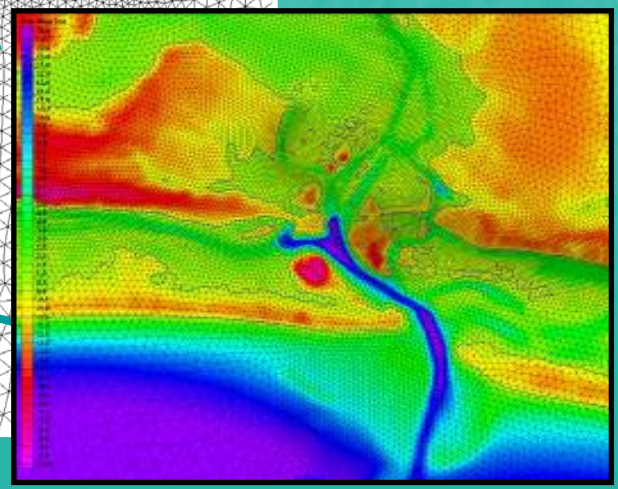


15 m Topographic Contour

200K node high resolution unstructured triangular mesh with elevation relative to NAVD 88







MHW Shoreline

Beaufort Inlet

Key Issues in Inundation & Storm Surge Modeling

- Advancements to surge predictions are very dependent on storm track, intensity, and structure
- Model enhancement and coupling – tides, waves, coupling to ocean and atmospheric models.
- Cost vs Benefit
  - Computationally simple surge models for time-constrained operations and to run numerous scenarios
  - High resolution, physically complex models
- Enhanced observations are widely available to the modeling community for evaluation; data assimilation
- Standards and protocols are necessary to allow grid sharing

Plan for Inundation & Storm Surge Modeling

- **NOAA Transition Team - Next Generation Storm Surge System**

- **Establish Clear Goals and Shared Practices Through a Community Modeling Approach**
  - Vetted requirements for NOAA inundation information across all decision time-scales
  - Established methods, standards and criteria for evaluating inundation modeling systems
  - Exchangeable modeling inputs, outputs, and software components.
  - Identify transition and decision making path from Community to NOAA (and back!)

Community Modeling Approach

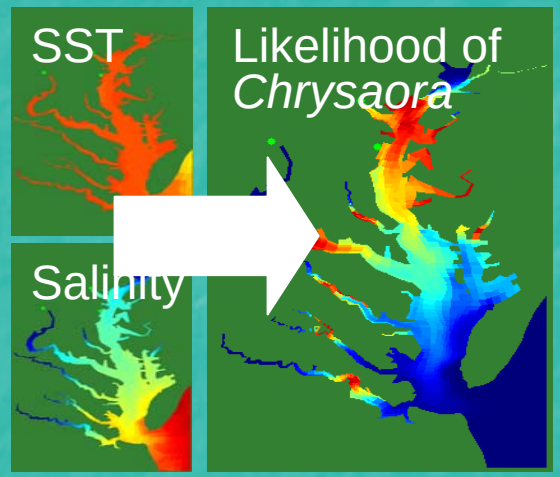
- A community approach...
  - Allows for open discussion of strengths and weaknesses of different models
  - Elucidates the requirements of a common shared infrastructure
  - Allows model improvements to be shared effectively
  - Advances the science (research and operations)
  - Leverages resources and amplify the voice of the community

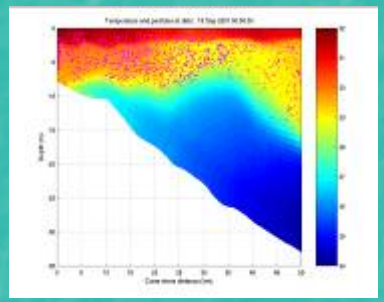
Community Modeling: Barriers, Benefits and Priority Needs

- Barriers
  - Formats of data and model files
  - Data and model availability
  - Lack of documentation
  - Lack of coordination
  - Lack of resources
- Benefits
  - Expanded resources
  - Credibility
  - Data exchange
  - Streamlining research to operations and model coupling
  - Education of user community (risk)
- Priorities
  - Error metrics and reference datasets
  - Standards and infrastructure
  - Engagement and support

Ecosystem Applications of Hydrodynamic Models

- Noxious biota
  - Sea nettle probabilities





- Harmful Algal Blooms (HABs)
  - Red tide in Gulf of Mexico

- Hazardous materials dispersion (HAZMAT)

- Future: **Model Coupling**
  - **Riverine-estuarine-coastal-basin;**
  - **Hydrodynamic-wave; hydrodynamic-sediment transport;**
  - **Physical-biogeochemical coupling (ecosystem; ecological; water quality; habitat; fish recruitment; etc.).**

Strategies & Challenges for NOAA Coastal Ocean Modeling

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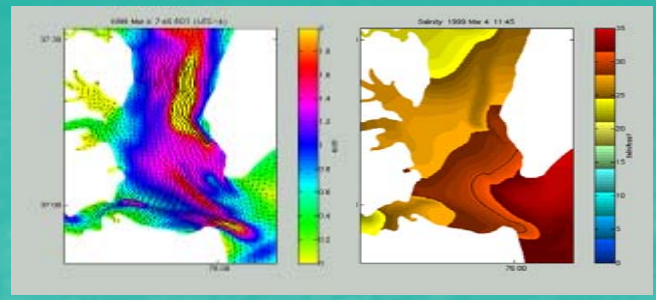
On-going Issues



- Forecast *uncertainty* estimation
  - Probabilistic approach
  - Ensemble averaging
- Data assimilation techniques
  - HF Radar; coastal altimetry; IOOS data; etc.
- Higher spatial resolution in key areas (e.g. in navigation channels; for storm surge and inundation modeling)
  - Nesting vs. unstructured grids;
  - Finite difference, finite element and finite volume approaches
- Model coupling
  - Riverine-estuarine-coastal-basin;
  - Hydrodynamic-wave; hydrodynamic-sediment transport
  - Physical-biogeochemical coupling (ecological; water quality; habitat)
- Strategy of moving from individual port & estuarine models to a regional modeling approach
  - Transitioning NOS OFS to the NOAA HPC facility maintained by NCEP