Lessons from the Trenches of an Operational Ocean Modeling Production Center

Frank L. Bub

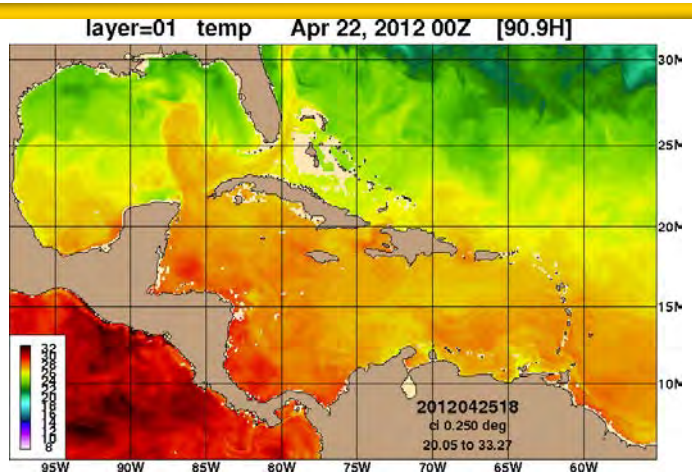
Naval Oceanographic Office

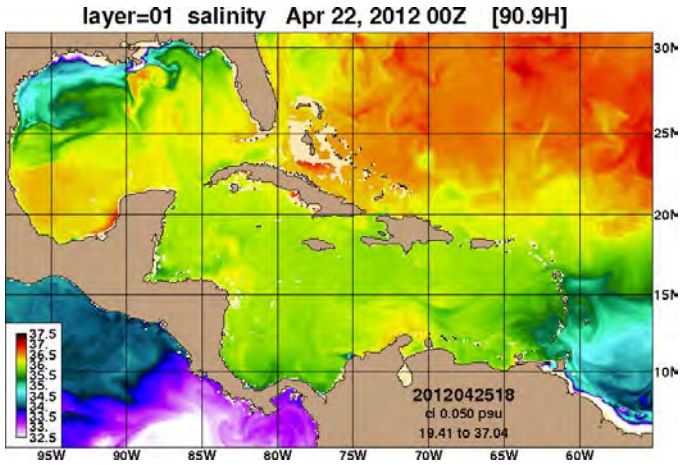
Code NP3M

Frank.Bub@Navy.mil / 228-688-4758

Global Hybrid Coordinate Ocean Model (G-HYCOM)

- POM-based / variable vertical coordinates
- NOPP Consortium
  - NRL lead,
  - U Miami, Los Alamos, French, NOAA/AOML, etc.
- Forecasts 3D Temperature, Salinity, Currents, Elevation
  - To 168 hours (7 days)
  - ESMF backbone
- Initial global resolution 1/12 deg (2012)
  - Model 40+ vertical layers
  - Pressure, depth, sigma coordinates as needed
- FNMOC NOGAPS→NAVGEM atmospheric forcing
- Assimilates SST / SSH / surface obs / profile data – using NCODA
- **Operational March 2013**
- Global service to Navy, NOAA, others





365-day

Temperature

Elevation

Salinity

NRL Stennis graphics

NAVOCEANO Model

1/12 (9 km / 5 nm) → **1/25 deg** (3.8 km / 1.8 nm) in 2014

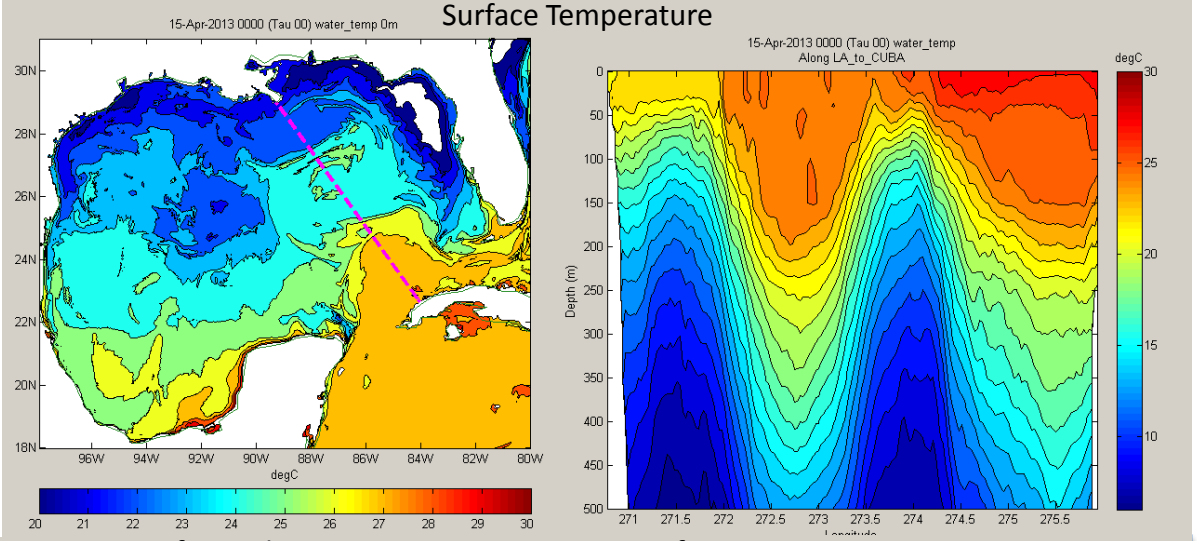
Regional Navy Coastal Ocean Models (R-NCOM)

AMSEAS R-NCOM 96-Hr Series

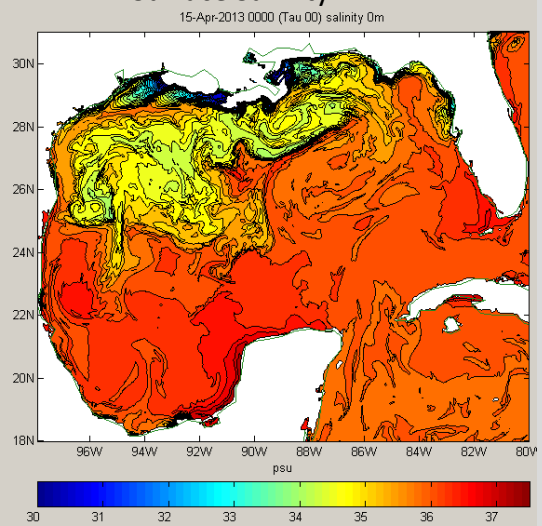
- Boundary Conditions provided by HYCOM
- FNMOC COAMPS forcing
- 3D Forecasts
  - T, S, Currents, Elevation
  - Resolution1 / 30 deg
  - 55 vertical layers
- Forecast to 72/96 hr @ 3hr increments
- Assimilates data from
  - Satellites (SST, SSH)
  - *insitu* obs (XBTs, CTDs, floats, buoys)
- First - East China Sea (ECS) NCOM operational MAR08
  - Implement 3 - 4 regions/year
- Eventual transition to COAMPS-5 (coupled atmosphere—ocean—waves)

1/30 deg (3.7 km / 2.0 nm)

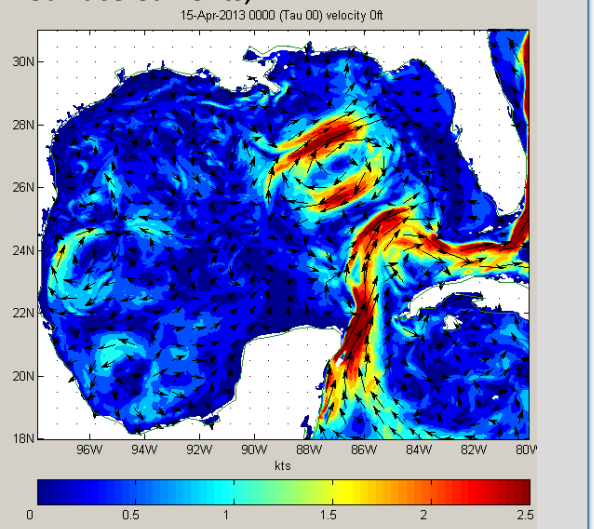
Surface Temperature



Surface Salinity



Surface Currents,



4/19/2013

Agenda
Key Concept – Operational Modeling

- Plan Ahead
  - Customers
  - Support
  - Interactions
- Determine your Capacities
  - Computers
  - People
  - Software
- Automate the Process
  - Be efficient
- Delivery the Products

Plan Ahead

- Establish your customer base(s)
  - Set their and your objectives early
    - Determine requirements
    - Talk their language
  - Get adequate funding
    - Make sure it will be for the long term
    - Research $$ expire
    - Plus-ups will do you in!

- Consider your approach carefully
  - Set up the model to meet customer applications
  - Link in development team
  - Create a transition plan

- Communicate!
  - Be interactive – keep channels open
  - Relate customer needs → development plans → production → customer
  - Objective is to get R&D to operations, results to users

Establish & Evaluate Your Capacities – 1

Available Computer Power

- Computer processing
  - Double or triple what you think you need
  - Each operating system has different requirements
- Communications
  - Can you get your data in or out?
    - Forcing fields (atmosphere, boundary conditions)
    - Observations for assimilation / assessment
    - Products
  - Don't stretch it (i.e., clog network)
  - Ensure you will be meeting customer needs
- Storage
  - Only keep what you need
  - Consider compression
  - Establish purge process (don't need old forecasts)
  - Set up easy access via data mining and extraction

Establish & Evaluate Your Capacities – 2

Have the Right People

- Good people are key
  - Knowledgeable
  - Dedicated
  - Have enough
    - Two-person rule
- Establish development team early (Ops plus R&D)
  - Open and constant communications
  - Common language
  - Proper skills
    - Training
    - Documentation
    - Communication
- Operations Team
  - Implementation group (R2O)
  - Monitoring (Model OPS)
    - Part of process
    - Notification when a problem
  - Trouble-shooting and repair
- Forecasting and Analysis Team
  - Use and interpret
    - Interactive with the customer
    - Ocean forecaster
  - Know how customers use the products

Establish & Evaluate Your Capacities – 3

Manage the Software

- Start to finish
  - Pre-processing, main production, post-processing
    - Scripts
    - Main algorithms
  - Accessible (readable) by others
  - Development uses or knows operational environment
- Include monitoring links (event-based)
  - Data base
  - Constant update
- Portable
  - Success will lead to upgrades
  - Computers change
  - Do you plan to share with others?
- Robust
  - Minimize human interactions
  - Multiple fallbacks
    - Automated repairs when possible
  - Troubleshooting guidance
- Configuration managed (CM)
  - Tested changes
  - Easy reversion
  - Offsite backup
- External validation & certification

Automate the Production Process

- Minimize manual intervention
  - Script control from start to finish
  - No 24/7 needed for ocean modeling
- Monitor production
  - Use a check list (web / wiki)
  - Automatic alerts for major events
  - Automatic alerts for problems
  - Keep timelines - schedule versus actual
- Build an operations manual
  - What does each script do?
  - Follow checklists
  - Tell how to restart
  - Log issues & fixes (trouble tickets)
  - Record lessons learned
  - Provide feedback to R&D
- Efficiency, efficiency, efficiency

Concentrate on Product Delivery

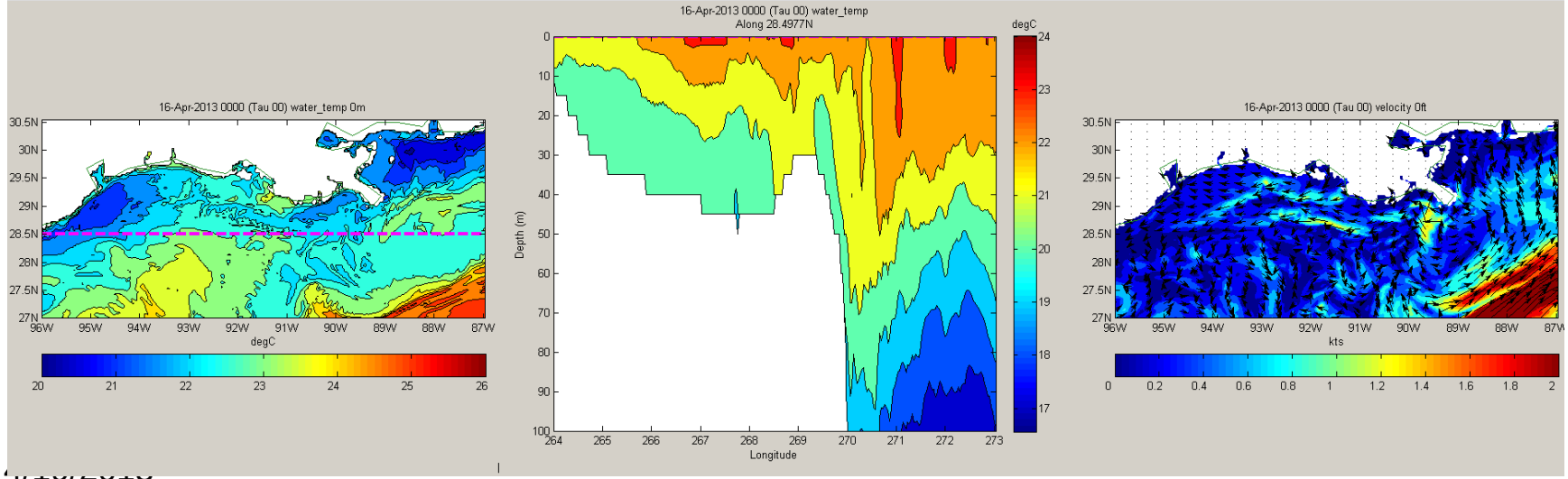
- Use standard and acceptable formats
  - NetCDF, JPEG, GIS
  - Ensure customer has easy access
- Have products arrive "on time"
  - Rule: timeliness more important than better accuracy
  - If not on time, know and convey forecast skill decay
- Produce levels of content
  - Quick and easy (image)
  - Full package (data files)
  - Interpolated products
- Include metadata!
- Ensure customer access
  - At various levels of requirement / interest / knowledge
  - From browsing to downloading
  - Ensure ease of use
  - Limit the spinning wheels
  - Subset just what needed
  - Subscription service (when product is there, start download)
  - Download in background

Summary

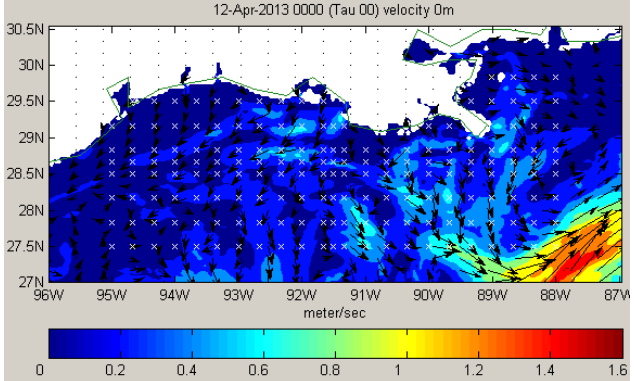
Keys to a Successful Operational Modeling System

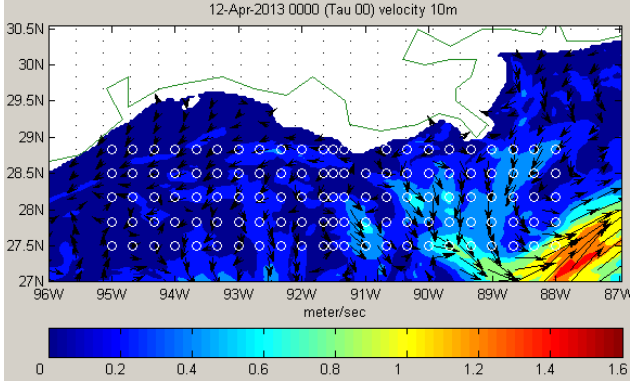
- Make a Plan, Stick to It
  - Customers
  - Support
  - Interactions
- Live within your Capacities
  - Computers
  - People
  - Software
- Automate the Process
  - Be efficient
- Deliver the Products

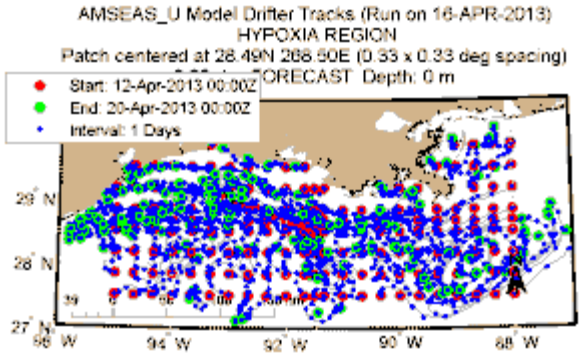
AMSEAS RNCOM 96-hour animations of surface temperature and currents starting 00Z 16APR13

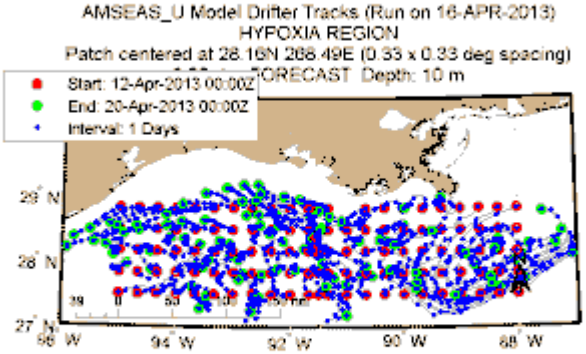


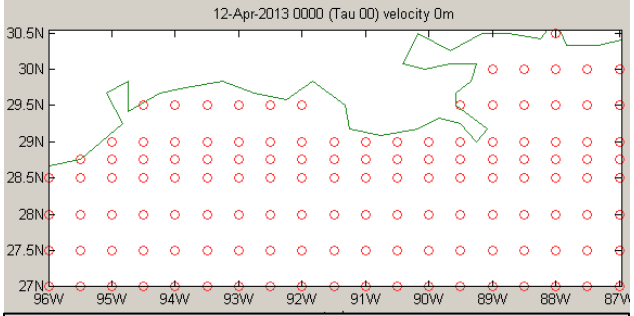
Hypoxia Region 8-Day Currents and Drift Plots











- 8-day surface currents at 6-hour times steps
- Surface and 10m (33ft)
- 00Z 12APR13 to 24Z 20APR13
-
- Drifters seeded 0.5 degrees apart

NAVOCEANO Model Data Sources

- NRL Stennis Website
  - HYCOM: http://www7320.nrlssc.navy.mil/GLBhycom1-12/skill.html
  - Graphics (tau 00 daily analyses, 30-day, 365-day animations)

- NOAA Ocean Prediction Center (OPC) Website
  - RNCOM: http://www.opc.ncep.noaa.gov/Current_fcasts.shtml
  - RTOFS (NCEP HYCOM)
  - Graphics, access to NetCDF files

- NOAA OceanNOMADS Website
  - http://ecowatch.ncddc.noaa.gov/
  - AMSEAS: http://ecowatch.ncddc.noaa.gov/amseas/
  - Graphics, access to NetCDF archives

- NOAA ERDDAP Website (Northern Gulf Institute)
  - http://coastwatch.pfeg.noaa.gov/erddap/index.html
  - Graphics and data – subsetting and manipulation available