SELECT THE ENVIRONMENTALLY CORRECT STATEMENT ABOUT THE EARTH'S ATMOSPHERE——

a) greenhouse gases from automobiles are causing global warming.

b) airborne dust from volcanic explosions is causing global cooling.

c) the contradiction of "a" and "b" is causing global confusion.
Does this mean it’s going to be windy?

**Navier-Stokes Equations**

*3-dimensional – unsteady*

Coordinates: \((x, y, z)\)

<table>
<thead>
<tr>
<th>Time: (t)</th>
<th>Pressure: (p)</th>
<th>Heat Flux: (q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density: (\rho)</td>
<td>Stress: (\tau)</td>
<td>Reynolds Number: (Re)</td>
</tr>
<tr>
<td>Velocity Components: ((u, v, w))</td>
<td>Total Energy: (E_t)</td>
<td>Prandtl Number: (Pr)</td>
</tr>
</tbody>
</table>

**Continuity:**

\[
\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u)}{\partial x} + \frac{\partial (\rho v)}{\partial y} + \frac{\partial (\rho w)}{\partial z} = 0
\]

**X – Momentum:**

\[
\frac{\partial (\rho u)}{\partial t} + \frac{\partial (\rho u^2)}{\partial x} + \frac{\partial (\rho uv)}{\partial y} + \frac{\partial (\rho uw)}{\partial z} = -\frac{\partial p}{\partial x} + \frac{1}{Re} \left[ \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} \right]
\]

**Y – Momentum:**

\[
\frac{\partial (\rho v)}{\partial t} + \frac{\partial (\rho uv)}{\partial x} + \frac{\partial (\rho v^2)}{\partial y} + \frac{\partial (\rho vw)}{\partial z} = -\frac{\partial p}{\partial y} + \frac{1}{Re} \left[ \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} \right]
\]

**Z – Momentum:**

\[
\frac{\partial (\rho w)}{\partial t} + \frac{\partial (\rho vw)}{\partial x} + \frac{\partial (\rho w^2)}{\partial y} + \frac{\partial (\rho wz)}{\partial z} = -\frac{\partial p}{\partial z} + \frac{1}{Re} \left[ \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} \right]
\]

**Energy:**

\[
\frac{\partial (E_t)}{\partial t} + \frac{\partial (u E_t)}{\partial x} + \frac{\partial (v E_t)}{\partial y} + \frac{\partial (w E_t)}{\partial z} = -\frac{\partial (u p)}{\partial x} - \frac{\partial (v p)}{\partial y} - \frac{\partial (w p)}{\partial z} - \frac{1}{Re \cdot Pr} \left[ \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z} \right]
\]

\[
+ \frac{1}{Re} \left[ \frac{\partial}{\partial x} \left( u \tau_{xx} + v \tau_{xy} + w \tau_{xz} \right) + \frac{\partial}{\partial y} \left( u \tau_{xy} + v \tau_{yy} + w \tau_{yz} \right) + \frac{\partial}{\partial z} \left( u \tau_{xz} + v \tau_{yz} + w \tau_{zz} \right) \right]
\]

On this slide we show the three-dimensional unsteady form of the Navier-Stokes Equations. These equations describe how the velocity, pressure, temperature, and density of a moving fluid are related.
Simplify Information

...we appreciate your metadata, but don't need to see it!
Outreach model

- DMAC/IT SUPPORT
- Role and Funds need to be included in needs assessments
- Common look & feel to information?
  - Web template?
  - Who should coordinate?
    - RAs? U.S. IOOS office?

Expand audiences-opportunities to include underserved groups, “upstream” citizens disconnected from the coast.

Link technology with real-word applications

For example…
Good Information…

How do I evacuate?

Properly forecasting and displaying storm surge information makes it “easier” to decide when to evacuate and by which route evacuation is safest.

…but not as meaningful as local references
The Future – Coupling Forecast Model Output with Visualization

Should I evacuate?

Biloxi storm surge forecast depiction

Gulfport storm surge forecast depiction

Advanced Circulation Model Surge Forecast Hurricane Katrina

People need to identify and find relevance in the information
Recreational Boater Priorities
February 2009

“IT’s a GPS, fish finder, weather station and a translator that converts X size tippet material into a pound rating.”

We want it all…and in one place
High Priority Items

• High resolution wave heights (1 ft increments) and current information - passes & out to ~20 nm. WH should include max height-not just significant WH

• Real-time, accurate weather data and forecasts at more localized resolution, including environmental alerts and FOG.

• Internet-synoptic mapping tool “one stop shop” for observations and forecasts.

• Improvements in the delivery of information - using a combination of low and high tech options (e.g., at the ramp with visual/flag signal, VHF, local radio transmission, GIS on GPS units, iPhone). NOTE: for-hire fishermen didn’t think a flag/warning system at the dock is a good idea- liability issues.

• Education, emphasizing common and understood terminologies and verbiage.

• Near-term hazardous weather development - at least 30 min advanced warning - use of advanced weather radar (e.g. like Doppler used by meteorologists)

• More buoys through private sector sponsorship - esp. near artificial reefs and major diving spots. Sensors should include aids to navigation.

• Bathymetry of coastal shorelines, inlets and passes.
2009 GCOOS Recreational Boater Workshop
Lower Priority Items

• Targeted dissemination by audience (e.g., small boats, near-shore vs. larger boats, off-shore.

• Local area pilot charts made available.

• Integrated web data portal (e.g. inter-agency), “tagging” data that are not currently available.

• Higher resolution remote sensing products (e.g., weed line, temperature).

• VHF Distress call relay via buoys (“repeater” system to extend range of VHF offshore).

• Better tools and distribution for subsurface currents.

• Water quality products (salinity, turbidity, chlorophyll, dissolved oxygen, bacteriological) surface and bottom measurements.
A few other requests…

- Wave and wind data at each major pass in Florida at a 1-5 mile range.
- Separate channel linking all biological hazards, i.e., discharges, bypasses, blooms, animals
- Real time water depth information (impact of winds that overwhelm tides)
- More coastal wave buoys (Big Bend – Panhandle)
- Archival data-for planning open ocean cruises-seasonal/historical trends
- Display of products via GIS on similar scale
Display of products via GIS on similar scale—with labels!

Pretty, but not very informative.  A little better, but units would be nice.

Can we get organizations to present information using the same scales of reference?
Bathymetry maps like this, with lat/long are desired by many!
Welcome Seafarers!

How do you use the ocean?

**Fishermen**
Find out where the fish may be hiding

**Boaters and Sailors**
Discover where ocean currents are going

**Swimmers, Surfers and Divers**
Check out ocean temperatures and wave heights before you drive

Simply click on what you’re interested in to begin your underwater voyage.

Looking for more than just New Jersey?

What's a COOLroom?
In the COOLroom, scientists from Rutgers University pull together data from satellites, coastal radars and underwater weather stations. TheCOOLroom.org is the place where this information is processed and posted on the web for you to use to make the most of New Jersey's Coastal resources.

Where you can find the Underwater Weather for the New Jersey Coast.

**c.o.o.l. classroom**
A new web site featuring the latest ocean science and instrumentation just for cool students!

**Learn More!**
Check out our Education Center for valuable ocean science knowledge.

**See the Shore**
Check out some nifty COOLcams around the state.

**What Does an Oceanographer Look Like?**
A new one minute downloadable film by Randy Olson
**Tidal Links**

In the COOLroom, we are currently developing methods to calculate tidal predictions for New Jersey from our web site.

**NOAA's National Ocean Service** makes available their real-time tidal observations for thousands of locations across the country. On their site you can find real-time two-day tide graphs including tide predictions for the next day. They even post their raw data. Check out NOAA's Tides Online site at: `tidesonline.nos.noaa.gov`

Or go directly to your local Tide Station:

```
8510560 Montauk, NY
8516945 Kings Point, NY
8516990 Willets Point, NY
8518750 The Battery, NY
8519483 Bergen Point West Reach, NY
8531680 Sandy Hook, NJ
8534720 Atlantic City, NJ
8536110 Cape May, NJ
8545240 Philadelphia, PA
8551910 Reedy Point, DE
```

**Commercial Sites** - Many sites will sell you tide charts, almanacs and other products catered just for you. We have found two sites that freely display general tide predictions including full month forecasts for several months in the future. Incidentally, almost all commercial tide products are calculated from the measurements made by NOAA's National Ocean Service (see their links above).

Check out `tidesonline.com` or `harbortides.com`

*Note: recurring theme: Forecasts that include wind component*
2005 GCOOS Oil & Gas Workshop


35 Products identified (by 45 people)
  - Length/time scales
  - Key components/measurements needed
  - Priority ranking (High, Medium or Low)
<table>
<thead>
<tr>
<th>Products</th>
<th>Length/time scales</th>
<th>Key Components/Measurements</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane severity forecasts</td>
<td>Accuracy of 20% CPI at 5 days</td>
<td>Models, Upper-level circulation, BL, ocean mixed-layer temp., offshore Doppler radar</td>
<td>H</td>
</tr>
<tr>
<td>Surface current forecast maps</td>
<td>0-15 days, 10 km horiz. D/W, 1 km shelf</td>
<td>Models, wind, HF radar, density profiles, SST, river inflow, air-sea flux, bathymetry, front locations, tomography</td>
<td>H</td>
</tr>
<tr>
<td>Measurement &amp; product archive</td>
<td>N. A.</td>
<td>List of all ongoing measurements, periodically updated. Archive of data collected after initiation of GCOOS</td>
<td>H</td>
</tr>
<tr>
<td>Operational maps of SST</td>
<td>Existing. Higher resolution TRMM</td>
<td>AVHRR, GOES, TRMM</td>
<td>H</td>
</tr>
<tr>
<td>Forecast maps of 3-D deepwater currents</td>
<td>0-30 days, 10 km horiz, 50 m vert.</td>
<td>Models, density profiles, SSH, SST, winds, air-sea flux, ADCP, Caribbean current inflow</td>
<td>H</td>
</tr>
<tr>
<td>Forecast maps of winds and waves (&amp; crests)</td>
<td>0-15 days, 10 km horiz. D/W, 2 km shelf</td>
<td>BL, offshore surface met. (V, T, P, H) sensors, atmospheric profiles, QuikSat, TRMM, Doppler Radar, currents (for waves). Store waves at 2Hz</td>
<td>H</td>
</tr>
<tr>
<td>3-D current forecasts on shelf</td>
<td>0-10 days, 1 km horiz, 2 m vert.</td>
<td>Modeling, density profiles, SST, Winds, river inflow, air-sea flux, bathymetry (in some small areas), ADCP</td>
<td>H-</td>
</tr>
<tr>
<td>Probability maps of bottom hazards</td>
<td></td>
<td>Turbidity current measurements &amp; modeling, hydrate locations, soil type, bottom currents, high-resolution bathymetry, waves</td>
<td>H-</td>
</tr>
<tr>
<td>Products</td>
<td>Length/time scales</td>
<td>Key Components/Measurements</td>
<td>Priority</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Marine mammal &amp; turtle maps</td>
<td>Monthly</td>
<td>Physical sightings, tagging, currents (as a proxy)</td>
<td>M</td>
</tr>
<tr>
<td>Legacy measurement &amp; product archive</td>
<td>N. A.</td>
<td>Inventory and archive of QA/QC’d data</td>
<td>M</td>
</tr>
<tr>
<td>Improved storm surge probability maps (not real-time)</td>
<td>0.5 km horiz.</td>
<td>High resolution model, hi resolution bathymetry &amp; ref. water level, wind stress, bottom roughness, atm. pressure</td>
<td>M</td>
</tr>
<tr>
<td>Severe weather monitoring</td>
<td></td>
<td>Offshore Doppler radar, lightening strikes</td>
<td>M</td>
</tr>
<tr>
<td>Maps of water quality (DO, PH, etc.)</td>
<td></td>
<td>DO, PH, Nutrients, Hydrocarbons, salinity, temperature, river inputs, models, currents, winds, hyperspectral (satellite)</td>
<td>M</td>
</tr>
<tr>
<td>Maps of hydrocarbon seeps</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Maps of chemosynthetics &amp; arch. sites</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Maps of SSH, Color Imagery</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Bathymetry, topography, soil maps</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Temperature/Salinity profiles</td>
<td></td>
<td></td>
<td>L</td>
</tr>
</tbody>
</table>
2006 Sentinel HABs Station Transects
A Recommended GCOOS Regional Enhancement

Project: The specification, acquisition, placement, operational integration and data management/archive of sentinel monitoring stations in the Coastal zone of the GOM

At least three stations per transect (eventually >3 transects per U.S. Gulf Coast State and one along Veracruz.)
Capabilities Users Would Like

• Advance notice of a HAB event (e.g. 2 weeks)
• Species/toxins present
• Risks (animal mortality)
• Ability to forecast trajectory in time/space
• Data and information for control and mitigation
• Adaptive sampling and rapid response
• Relational databases

• Timely availability of synthesized data & maps
• Standards & protocols for:
  – Sampling and laboratory analysis
  – Data management
What the people want?

• There is much overlap in the type of information desired by different audiences.

• HOWEVER, the level of complexity desired in the delivery varies greatly.
How can we harness the power of nature to change people's minds about polluting?

Is hitting them with rocks outta the question?