Ocean Modeling:
Using the Cloud to Connect Science & the Public
LiveOcean: Daily Forecast Model of Regional Ocean Circulation and Chemistry

Funded by Washington State
Earlier model development funded by NSF, NOAA, DOE

Focused on Ocean Acidification
When CO$_2$ from the atmosphere dissolves into seawater it makes it more acidic. Harder for larval oysters to grow shells $\Rightarrow$ no natural set of oysters in Willapa Bay in 8 of last 10 years!

Who will use it? Oyster Growers
Did you know 7 out of every 10 oysters consumed in US are grown in Willapa Bay? By changing hatchery operation in response to forecasts they may be able to continue operation.
LiveOcean: System Architecture

Use Azure for post-processing and web-delivery

- **LiveOcean Server**
  - Post Processing
  - Pre-make .png "views"
  - **Archive NetCDF files**
  - API for web sites
    - Admin.js
    - Client.js

- **LiveOcean Forecast Driver**
  - cron, shellscripts, python, matlab

- **HPC**
  - linux 150 cores

- **Blob Storage**
  - Forecast Copy

- **Science User python**
  - Admin Website

- **Client Website**
  - http://mappable.azurewebsites.net/liveocean/

- **Rivers USGS**
- **Atmosphere UW WRF**
- **Ocean HYCOM**
Realistic Regional Ocean Modeling

Predicts 3-D Ocean currents and water properties (salinity, temperature, biogeochemistry) by numerical integration of Partial Differential Equations.

Relies on external data sources:

- Bathymetry
- Wind and heating
- Open Ocean BC's
- Tides
- Rivers
Model Movie

CMG
UW Coastal Modeling Group
Interactive 3-D Model Visualization using WorldWide Telescope and Narwhal
Modeling Workflow

- Raw Forcing Data
- Forced Data Processed into Standard Format
- Model-specific Forcing Files
- MODEL
- RAW OBSERVATIONAL DATA
- Observations Processed into Standard Format
- SKILL TEST
- Standard Post Processing 1 week
- Skill Result
- Output
- ROMS
- Cluster 200 cores 1 week/year
- 2 TB per model year

ROMS Cluster 200 cores 1 week/year

Raw Forcing Data
Forcing Data Processed into Standard Format
Model-specific Forcing Files
MODEL

Raw Observational Data
Observations Processed into Standard Format
SKILL TEST

Standard Post Processing 1 week
Skill Result

2 TB per model year
Comparisons are done to an extensive suite of in-situ observations

- sea surface height
  12 NOAA tide gauges

- salinity and temperature
  over 2000 CTD casts from ECOHAB, RISE, DOE, NANOOS, Hood Canal, IOS, King County, and NOAA

- velocity and moored S,T
  7 coastal ADCP / CTD moorings from the ECOHAB and RISE projects, 2 moorings from IOS
Validation: Dissolved Oxygen & Temperature

Figure from SA Siedlecki, UW/JISAO; Observations from Connolly et al., 2010
LiveOcean: System Architecture

Use Azure for post-processing and web-delivery

- LiveOcean Forecast Driver: cron, shellscripts, python, matlab
- HPC: linux 150 cores
- Forecast NetCDF files
- Azure Table: Log Info
- Blob Storage: Forecast Copy
- LiveOcean Server:
  - Post Processing
  - Pre-make .png “views”
  - Archive NetCDF files
  - API for web sites
    - Admin.js
    - Client.js
- Science User python
- Admin Website
- Client Website: http://mappable.azurewebsites.net/liveocean/
Conclusions

What are advantages of using the cloud?

Reliable and scalable

Simplifies: Collaboration with others who work on content delivery (e.g. Client Website)
Enables: Nesting On-Demand
Enables: Particle Tracking On-Demand
Enables: Comparison with Real-Time Observational Data (OOI, IOOS)
Enables: Comparison with Data from Other Models

What are the drawbacks?

Have to learn how to talk to Azure (but python azure module helps!)
Azure currently not good for HPC beyond ~16 cores
Save the planet and return your name badge before you leave (on Tuesday)