Preliminary Modelling and Observational Studies of the Juan de Fuca Eddy

Michael Foreman¹, Barbara Hickey², Scott Tinis¹, Amy MacFadyen², Vera Trainer³, Cliff Mass⁴, Rick Thomson¹

¹ Institute of Ocean Sciences, Sidney, Canada
 ² School of Oceanography, University of Washington, Seattle, USA
 ³ Northwest Fisheries Science Center, NOAA, Seattle, USA
 Department of Atmospheric Sciences, University of Washington, Seattle, USA

Project Background & Objectives



AVHRR (18 July 1997)



- Juan de Fuca Eddy is a summer upwelling feature off the entrance of Juan de Fuca Strait
 - may be the initiation site for toxic pseudonitzschia (PN) that cause harmful algal blooms impacting clams & crabs along the Washington coast
- ECOHAB PNW: project to study ecology & oceanography of this toxic PN
- Objectives:
 - determine factors making eddy more viable for toxic PN
 - **O** determine factors regulating toxin production
 - O determine pathways to shellfish beds

Physical Oceanography Questions

- ☆ What causes the eddy generation & collapse?
- ② What role does the circulation play in toxic PN growth and domoic acid production/release & accumulation?
- ③ Is there transport to the coast under storm conditions?



Persistent Upwelling



Storm

Summer Circulation Features

- ☆ Juan de Fuca Eddy
- a Shelf Break Current generated by upwelling winds from NW
- estuarine flow in Juan de Fuca Strait with bottom, nutrientrich flow up the canyon
- B a coastal current toward NW along Vancouver Island
- S a California Undercurrent along the continental slope toward NW
- strong tidal currents in Juan de Fuca Strait
- diurnal shelf waves on Vancouver Island shelf





2003 ECOHAB Field Studies

- June 2-23 & Sep 2-19
- CTD surveys
- Physiological and grazing studies
- Drifter deployments
- Moored arrays for physics & biology
- ship-board ADCP
- atmospheric conditions from buoys & UW MM5 model





Fluorescence (chlorophyll) from MERIS Satellite

June 3





June 15

June 6





June 28

Salinity & Temperature at 5m



Salinity & Temperature at 100m



Atmospheric Forcing

- Observations from offshore buoys
- MM5 regional model:
 - Cliff Mass & colleagues at University of Washington
 - http://www.atmos.washington.edu/mm5rt/
 - o 36km, 12km, 4km resolutions
 - initial & boundary conditions from NCEP GFS
 - **0** 48 hr forecasts
 - archived initial conditions & forecasts during cruises
 - animation if time permits



Ocean Circulation Models

• under development/validation:

- ☆ POM
- ⑦ ROMS
- B ELCIRC
 - **O** 3D finite volume, Lagrangian time-stepping, MY 2.5 turbulence, level surfaces
 - **O** Baptista & Zhang, Oregon Graduate Institute
 - **U** http://www.ccalmr.ogi.edu/



ELCIRC Run

average summer sea surface elevations (cm) elcirc, run 7





- average summer circulation:
 - o initial TS from CTD climatology
 - M₂, S₂, K₁, O₁ tidal forcing on outer boundaries
 - **o** winds from buoy climatology
 - along-shore pressure gradient to get California Undercurrent
 - run for 15 days with nudging back to climatology

ELCIRC Tides





• Speeds are approx 10% too large

Future Work



- ☆ Circulation simulations during June cruise (ROMS, POM)
- ③ annual cycle runs (ROMS)
- Process studies to understand eddy generation mechanism (ROMS)
- coupling to biological model
- assimilating observations (CTD, ship ADCP, moorings)



Summary



- **☆** Lots of interesting physical (& biological) oceanography in **ECOHAB PNW** ⑦ model development progressing
- Update next year



MM5 Winds





MM5 Winds



