An Update on the IOS Regional Climate Model for the British Columbia Continental Shelf

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Outline

- model details
- strategy & forcing fields
- preliminary results
- summary & future work
BC Shelf Model

- Developed by Diane Masson & Isaac Fine
- Regional Ocean Modeling System (ROMS) with resolution
  - Horizontal: 3km (236 X 410),
  - Vertical: 30 sigma levels
- Forcing:
  - tides
  - 3 hourly wind and daily atmospheric forcing (NARR)
  - monthly discharge from 21 main rivers
  - monthly open boundary forcing (SODA)
- Hindcast:
  - 1995-2008
  - JGR, in press

ROMS & AVISO SSH EOFs
Strategy for Future Climate Simulations

- Add anomalies to the Masson & Fine forcing & initial fields
  - Wind & heat flux from NARCCAP, IPCC AR4, A2 scenario
    - [http://www.narccap.ucar.edu](http://www.narccap.ucar.edu)
    - 2041-2070 minus 1971-2000
    - So far only CRCM+ CGCM3 combination
  - Oceanic initial conditions & boundary forcing from CGCM3
  - Freshwater runoff from Morrison et al. (2011) hydrology model that uses NARCCAP precipitation & temperature
- Future 14-year run
Why Anomalies?

- CRCM/CGCM3 doesn’t capture 1971-2000 offshore winds accurately
  - May/Sept differences between observed (black) & CRCM (green) monthly average winds
  - Timing of spring/fall transitions critical for marine ecosystems
## Atmospheric Forcing

- **Average annual anomaly ~ +0.5mm/day**
- **Seasonal & regional variations**

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation anomaly (mm/day)</th>
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Contemporary & Future Freshwater Discharges

- 21 sub-basins
- Except for June-August, more discharge
- Warmer river temperatures
Atmospheric Forcing

- Slightly different patterns for day and night

- Note land/sea differences
Less in April – June (%) because more cloud cover

Could be important for marine photo-synthesis
Average cloud cover anomaly (fraction)

January  
February  
March  
April  
May  
June  
July  
August  
September  
October  
November  
December

NB: Slightly different patterns for day vs night
Initial and Lateral Boundary Ocean Conditions

- 3D temperature/salinity initial anomalies from CGCM3
  - no active ocean in CRCM
  - Only latitudinal anomalies
  - future will be warmer and fresher

- Seasonal anomalies in temperature, salinity, normal velocity forcing along northern, western, southern boundaries
Results: Eddy Kinetic Energy

*Runs with different combinations of contemporary & future forcing show these differences mainly arise from wind*
Hecate Current Intensification Producing stronger Haida Eddies

- Stronger counter-clockwise gyre & flows past Cape St James
Results: July Alongshore Current, Temperature & Salinity

- Black lines = temperature, grey lines = salinity
- Future has stronger Vancouver Island Coastal Current and Shelf Break Current
- Possibly stronger upwelling & California Undercurrent?
Salish Sea Summer Surface Currents

Future

Contemporary

• Not much difference
Salish Sea Salinity Anomalies

Salinity Anomaly Along the Salish Sea Thalweg

Depth [m]

Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Distance Along Transect [km]

Latitude

Longitude

Distance Along Transect [km]
Summary

- described development & preliminary results from BC shelf, ocean-only, RCM
  - Future forcing & initial field anomalies computed from NARCCAP CRCM/CGCM fields
  - Run with combinations of future & contemporary forcings to understand changes
Future Work

• More analyses of results

• Other NARCCAP AR4 RCM combinations
  • AR5 RCM anomalies

• Couple to NPZD & marine geochemical ecosystem model
  (Angelica Peña)

Meris chlorophyll, Sept 11, 2011, courtesy Jim Gower & Erika Young
Objectives:

- To detect, understand and predict climate change impacts on:
  - Plankton productivity
  - Nutrient supply, oxygen and carbon content
- Evaluate the potential risk (likelihood) for the development of hypoxia events and corrosive conditions
Biogeochemical / ecosystem model

- Cycle of several biogeochemical elements (N, C, Si(OH)₄ and O₂)
- Two-types of phytoplankton and of zooplankton
- Multiple nutrient limitation of phytoplankton growth
- Dynamic chlorophyll compartments
- Temperature dependence of physiological rates
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