A Regional Climate Model for the British Columbia Continental Shelf

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Acknowledgements

- Fisheries and Ocean Canada:
  - Climate Change Science Initiative
  - Ecosystem Research Initiative
  - Centre for Ocean Model Development for Application
- Environment Canada
- North American Regional Climate Change Assessment Program (NARCCAP)

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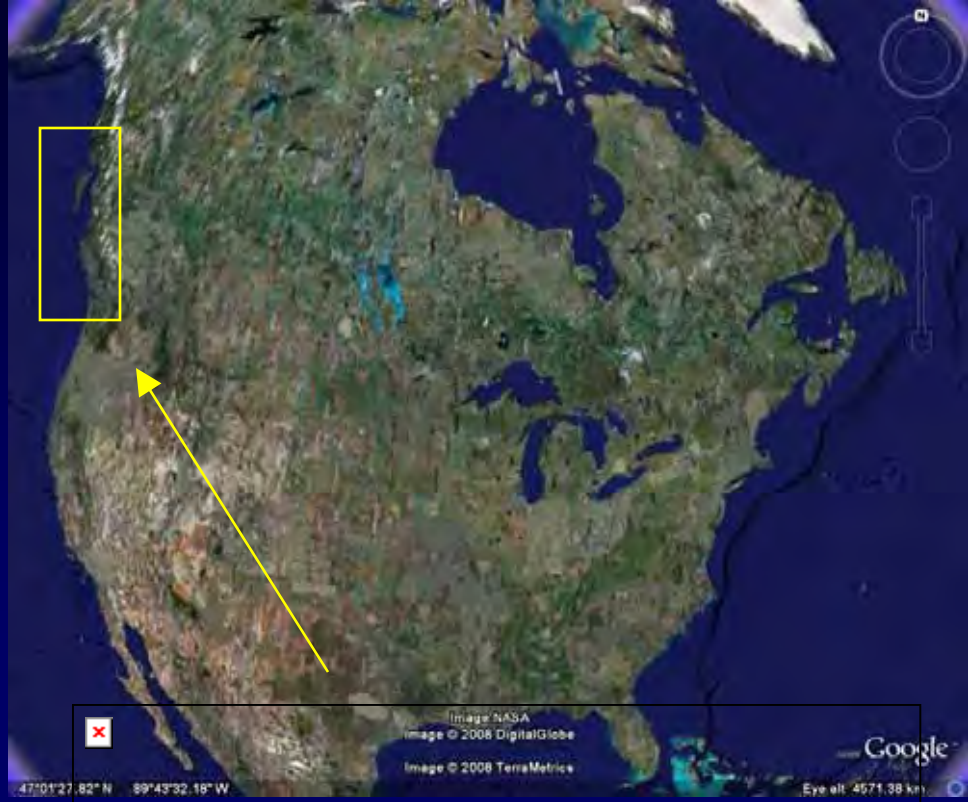
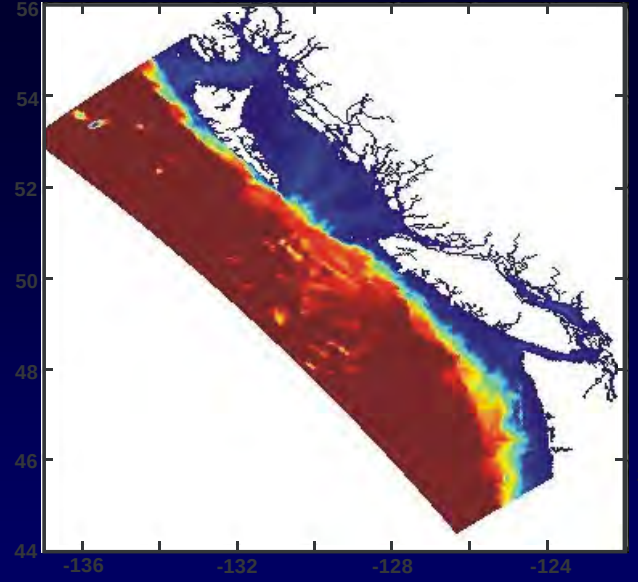
Outline

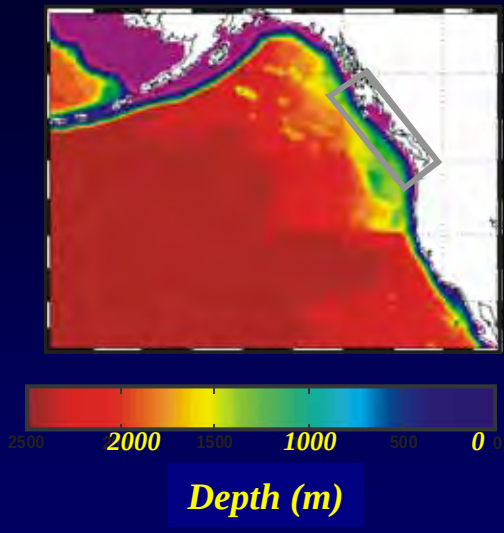
- RCM details
  - Historical evaluation
- Forcing fields
- Results to-date
- Summary & future work



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

BC Shelf Model





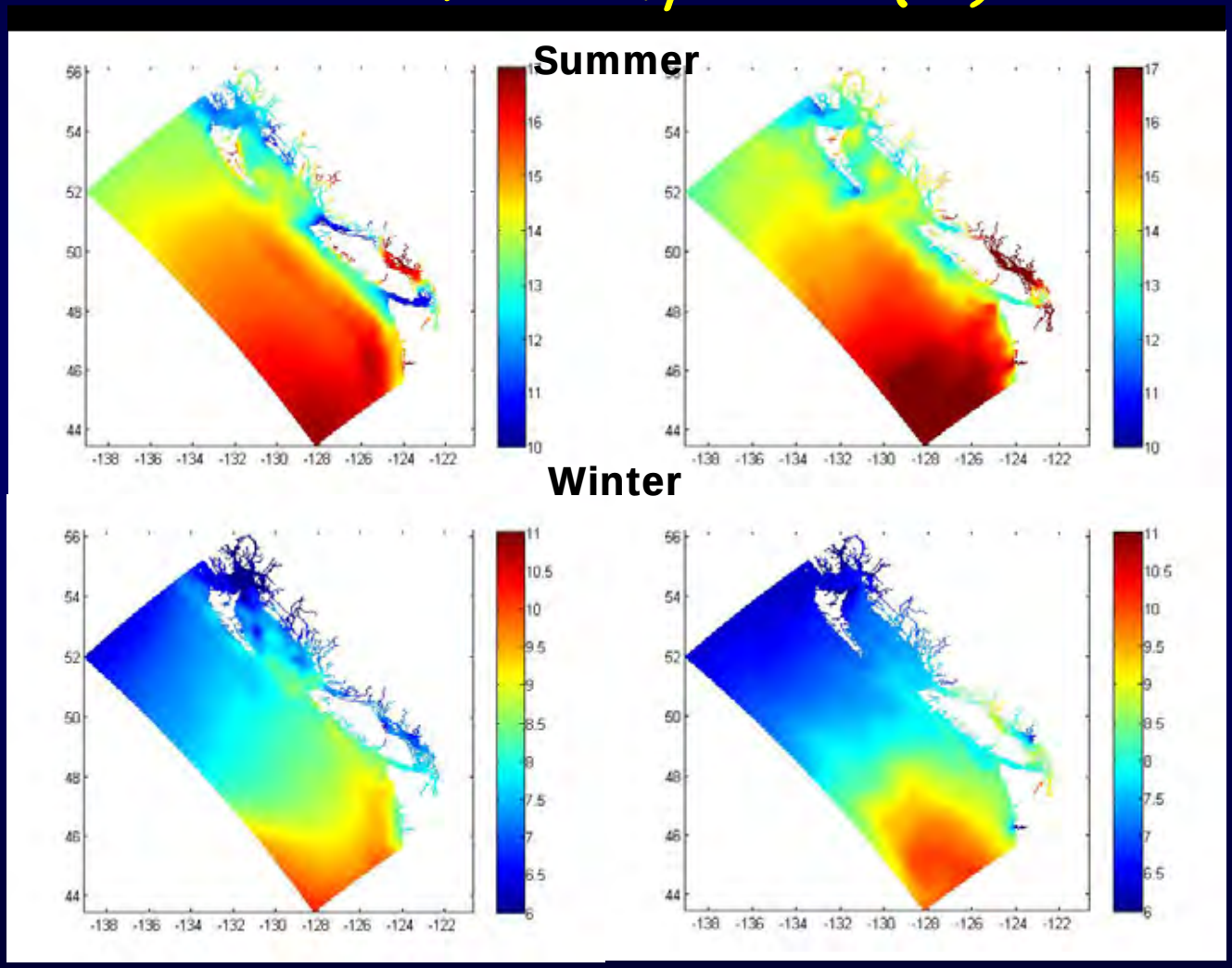
Regional Ocean Modeling System (ROMS): Masson & Fain

- Model domain: south of Columbia River to the Alaska border
- 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

Over an annual cycle, the model behaves realistically:

1. SSTs show seasonal upwelling & downwelling

Sea Surface Temperature (°C)

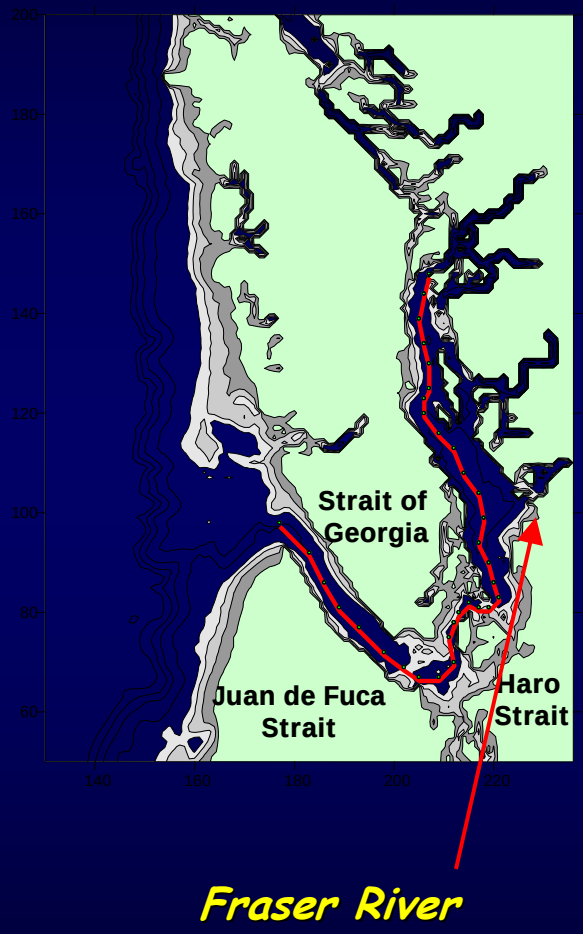


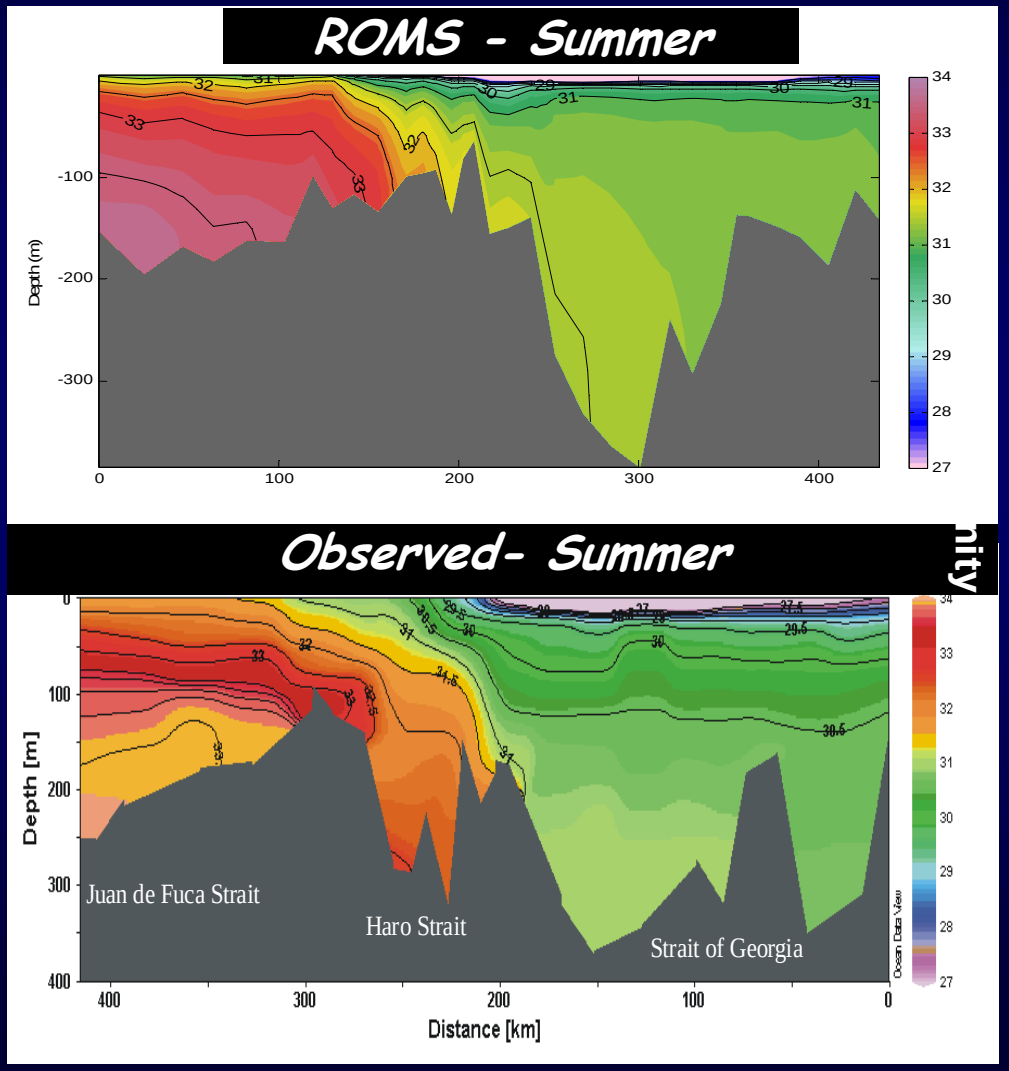
Climatology

ROMS (1997-2006)

2. Annual cycle

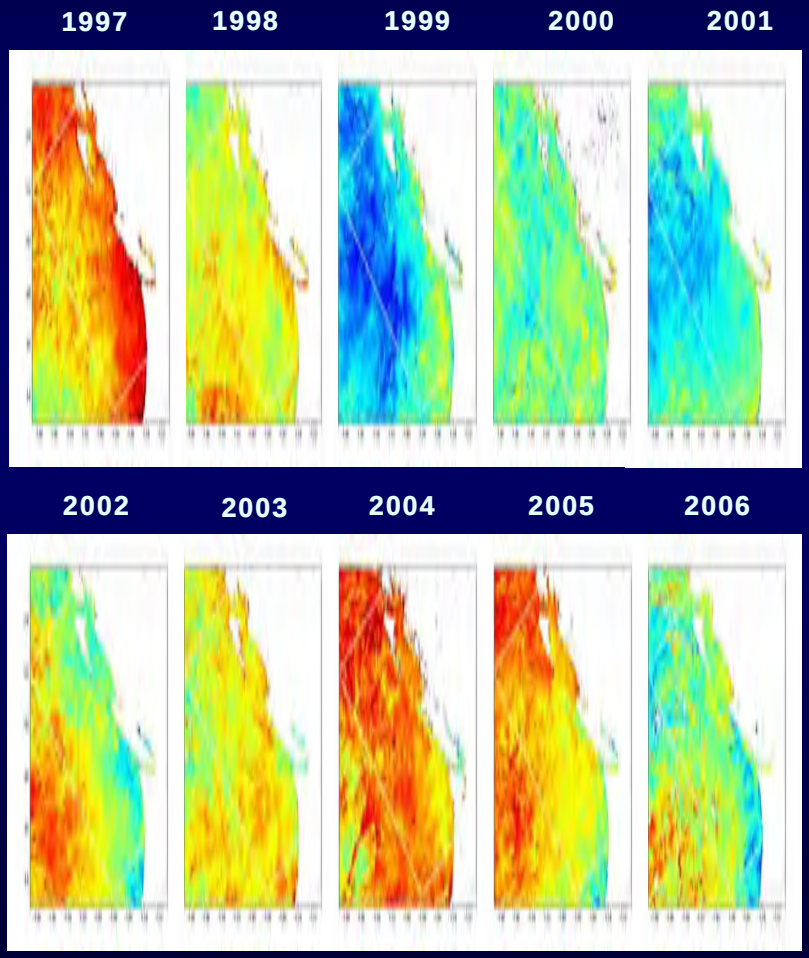
Summer estuarine circulation in Salish Sea



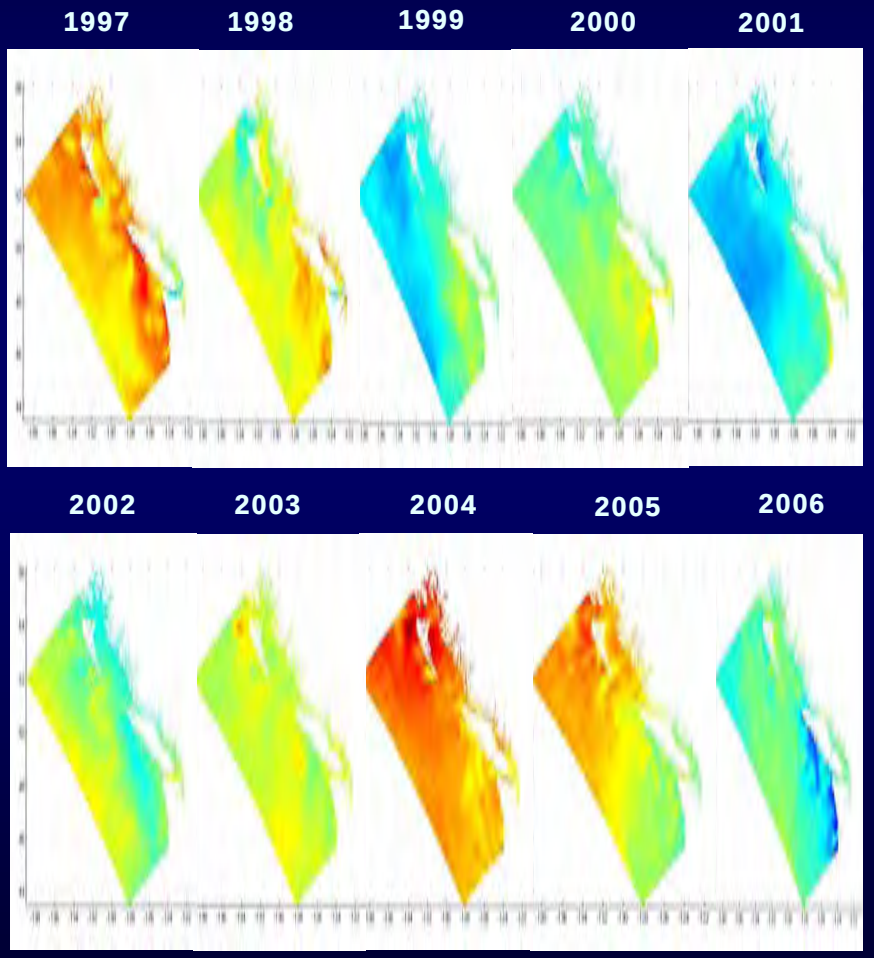


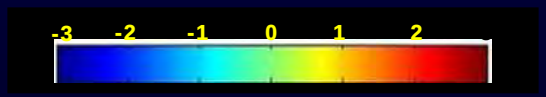
3. Interannual variability:
(annual summer SST anomalies)

AVHRR Pathfinder v5



ROMS

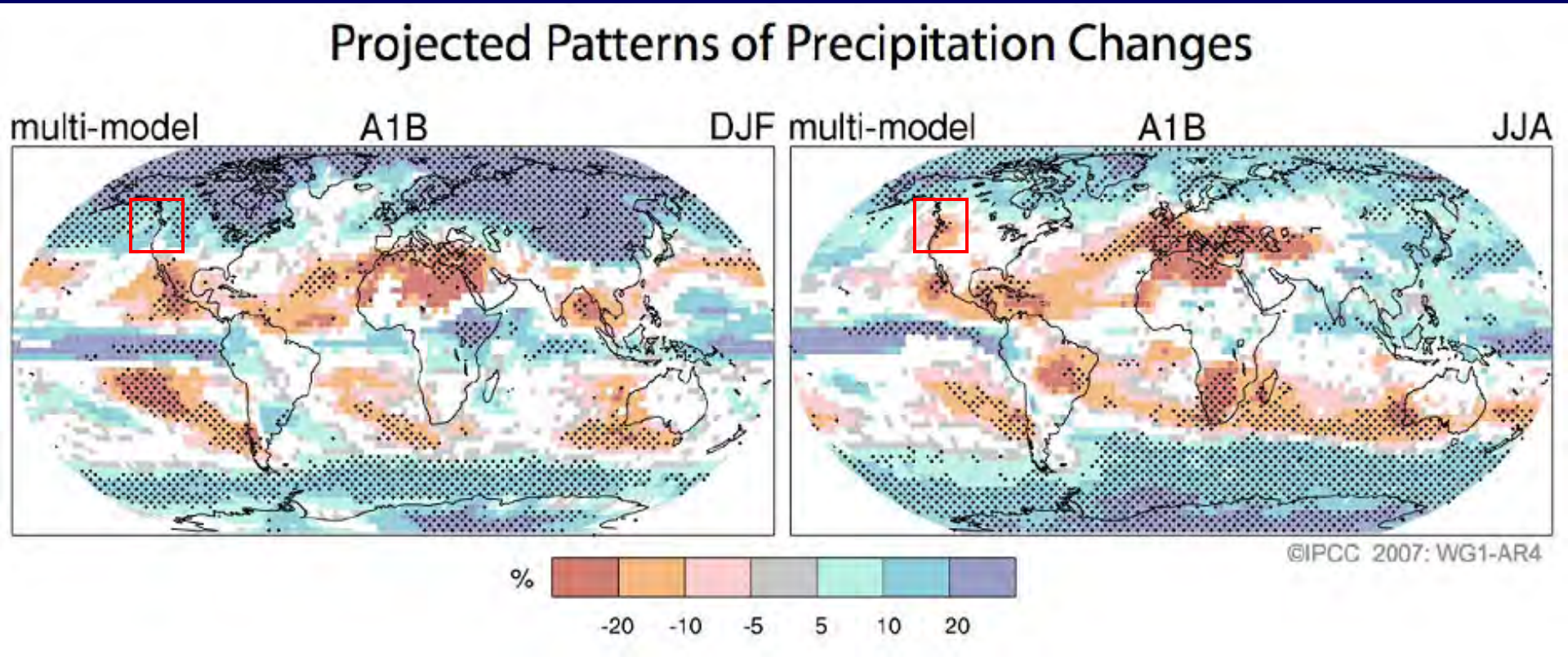




(ºC)

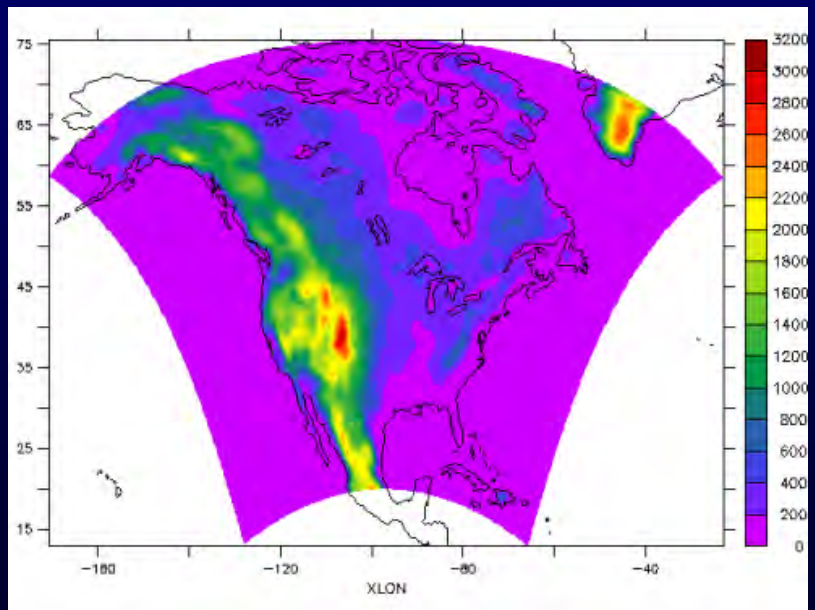
Future Forcing for the RCM

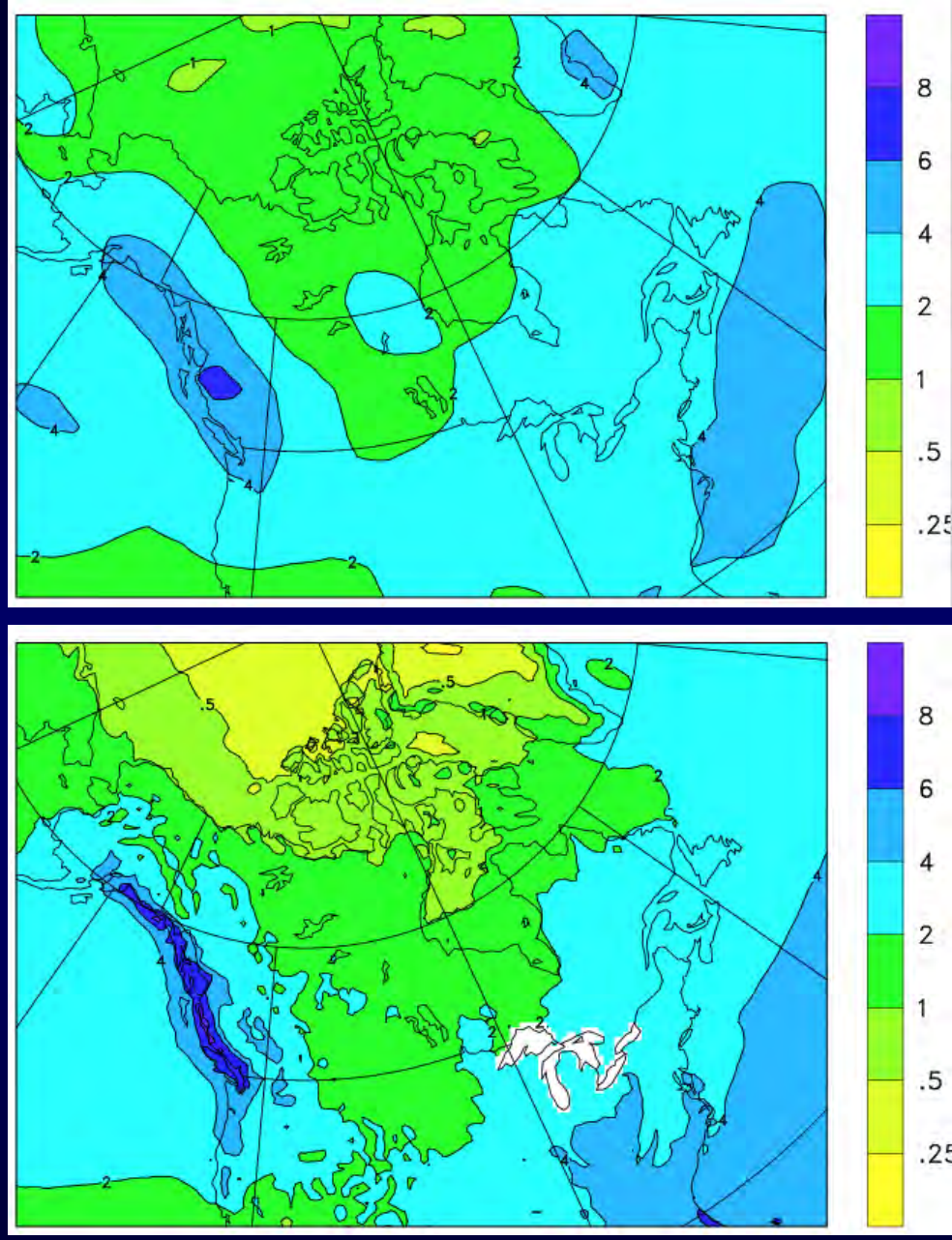
- *Anomalies to 1995-2009 forcing & initial fields*
  - *Tides unchanged*
  - *Wind & heat flux thru interpolation from GCMs and/or RCMs*
  - *Oceanic initial conditions & boundary forcing from GCMs*
  - *Freshwater runoff by downscaling precipitation & temperature from RCMs*



North American Regional Climate Models

- 6 RCMs in North American Regional Climate Change Assessment Program (NARCCAP)
- 50 km resolution vs >1° for GCMs
- 1971-2000 & 2041-2070
- IPCC AR4 A2 scenario (business as usual)
- http://www.narccap.ucar.edu

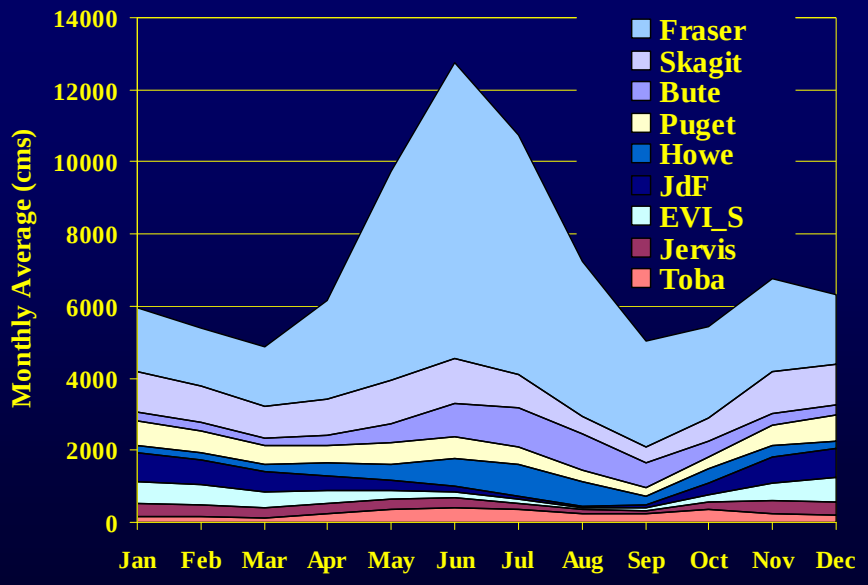




Mean (1971-90) daily precipitation (mm) as computed by top): the CCCma GCM, bottom): the CRCM.

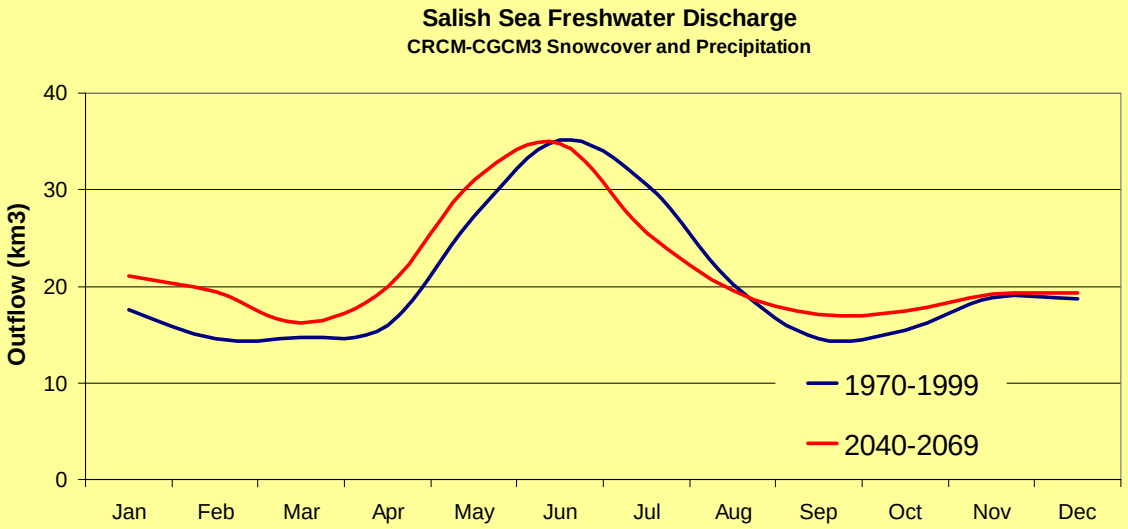
Freshwater Discharges affecting the BC Coast

- Freshwater discharges generate coastal currents which are important to marine ecosystems
- Total drainage basins ≈ 1,315,000 km² but ≈ 20% is ungauged
- Morrison et al (2011) developed technique to estimate ungauged runoff using precipitation, terrain, storage capacity etc. within 22 watersheds
  - Verified vs observations
  - Re-constructed total discharge time series back to 1970 (no trends)
  - Applied to future discharges using RCM precipitation & temperatures

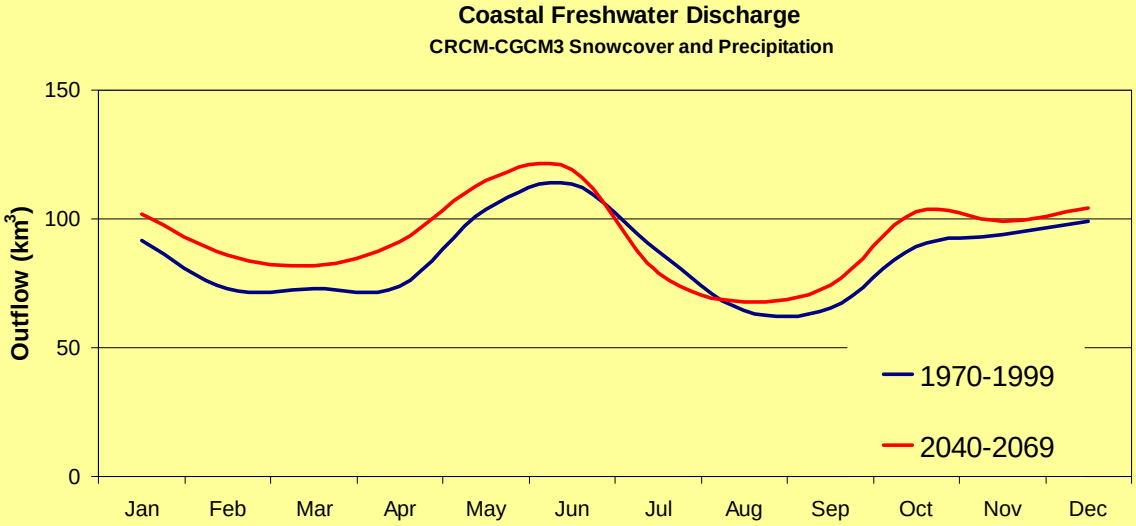


Salish Sea Runoff

Contemporary & Future Freshwater Discharges

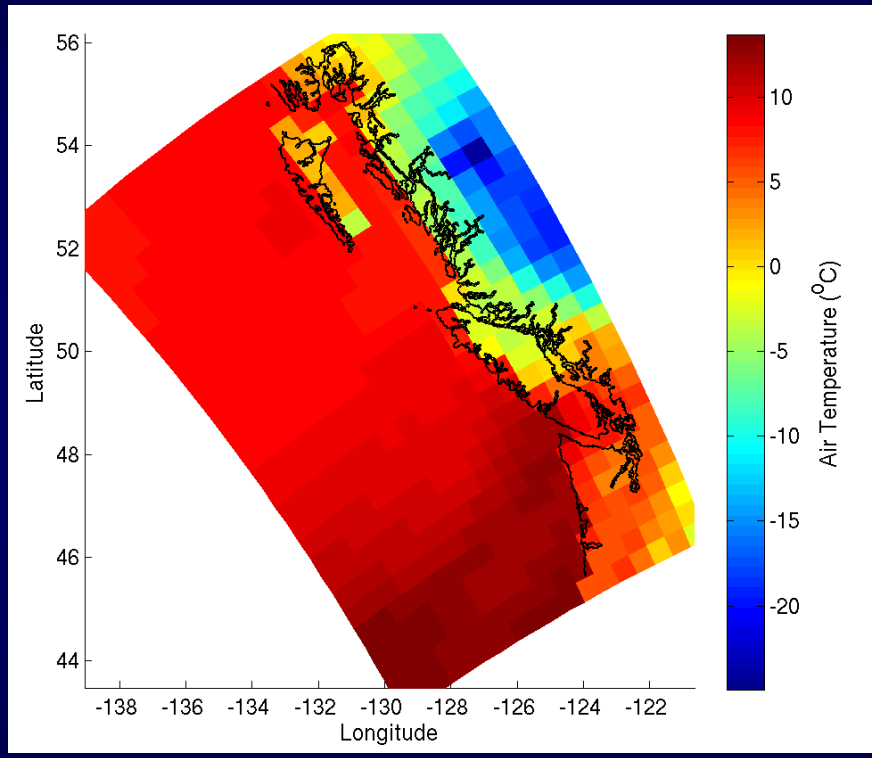


- *Estimated from NARCCAP CRCM/CGCM3 precipitation & snowcover output*
- *Except for June-Aug, more runoff in future*



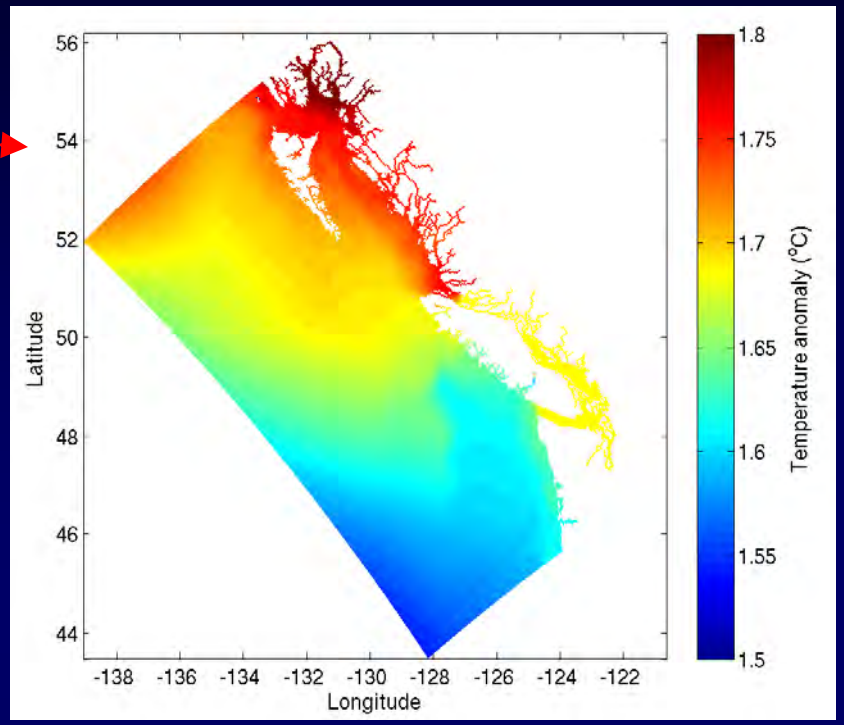
Heat Flux Forcing

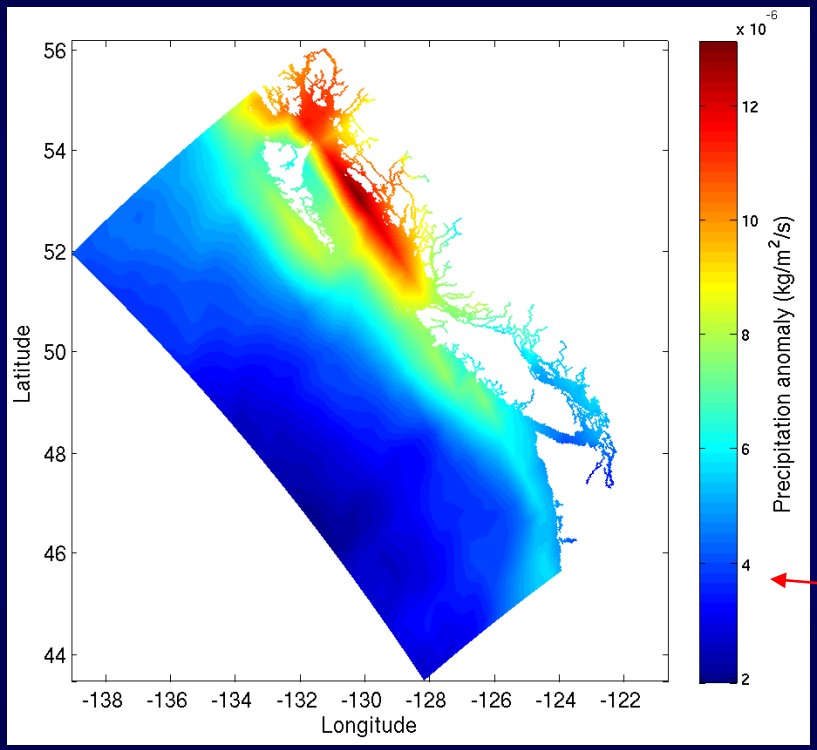
- CRCM grid is too coarse
  - coastal regions defined as land
  - affects heat flux variables
- CRCM data was downscaled into coastal regions using EOFs
  - patterns generated from SODA re-analysis output
  - Special treatment in Salish Sea
    - coastal data could not be reliably predicted from offshore data
    - assigned average of the values at either end of the straits



For now, just spatially varying anomaly fields; seasonally next

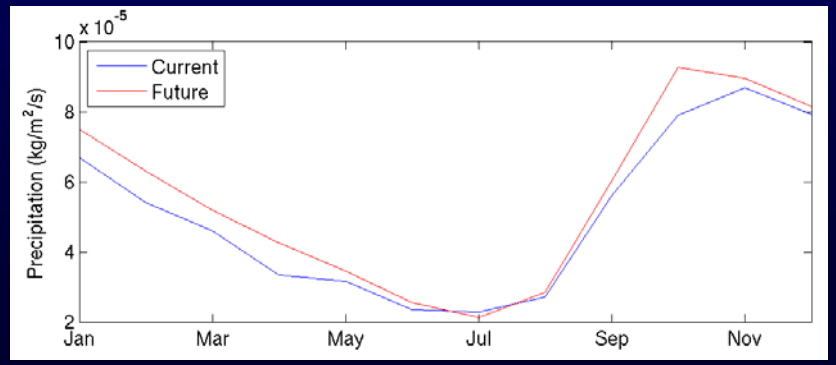
- Air temperature anomaly is ~1.5-2°, increasing with latitude





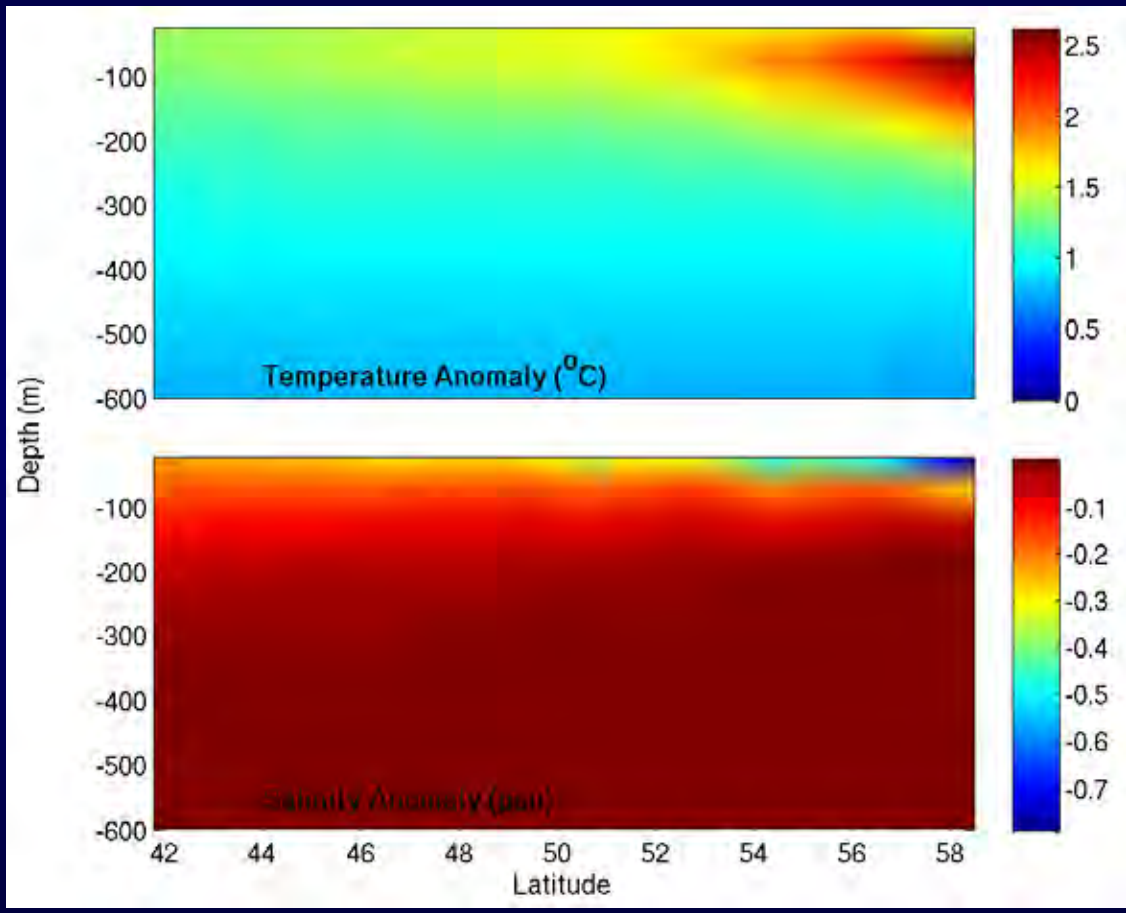
- Precipitation anomaly > 0 (6×10^{-6} ~0.5mm/day)

- Precipitation anomaly is greatest in winter, almost non-existent in summer.
- Seasonal cycle dominates anomaly



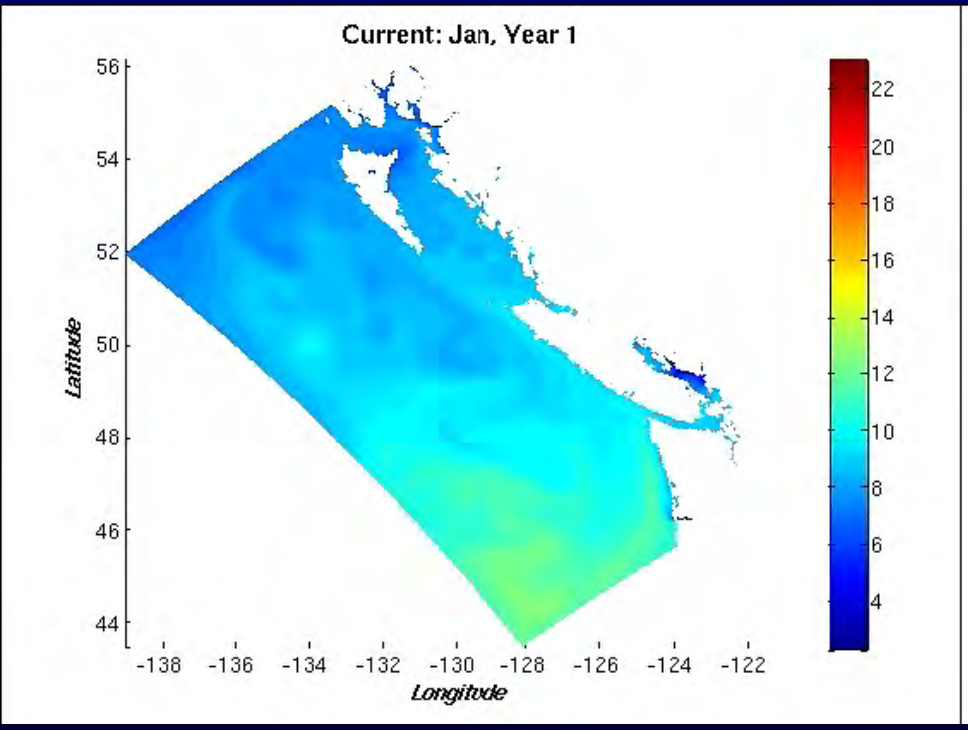
Initial and Boundary Conditions

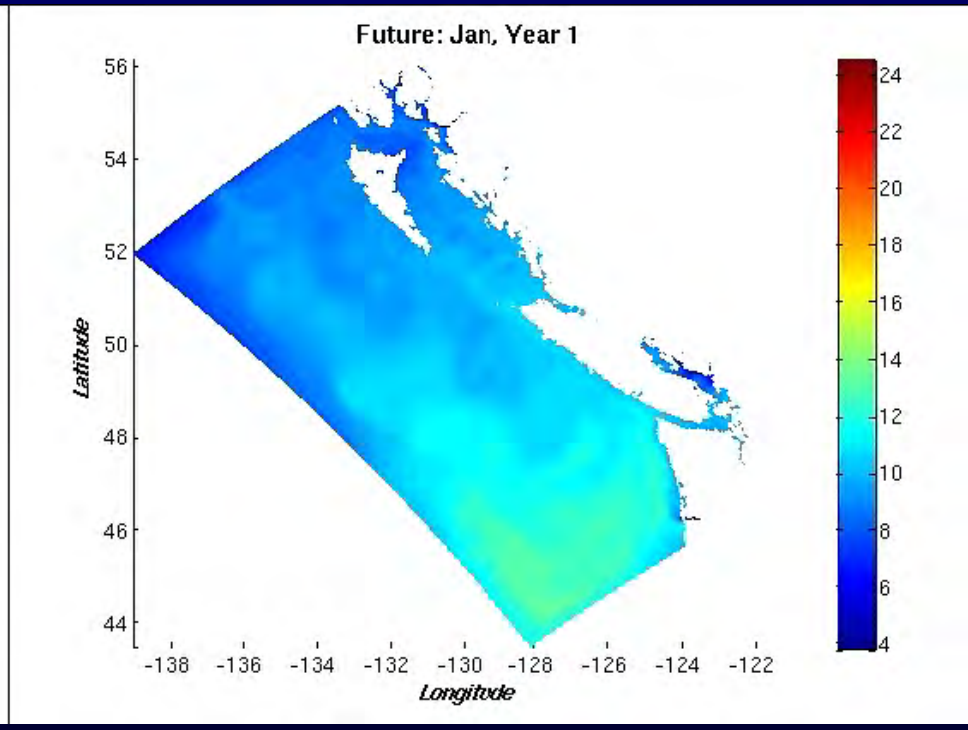
- 3D TS anomalies from CGCM3 (no active ocean in CRCM)
  - Future will be warmer and fresher
- anomaly was averaged over constant latitude and then applied to the current initial and boundary conditions
- Greatest anomaly at the surface & at high latitudes
- Max temp anomaly not at surface – deepening of the thermocline



14 year simulation: SSTs

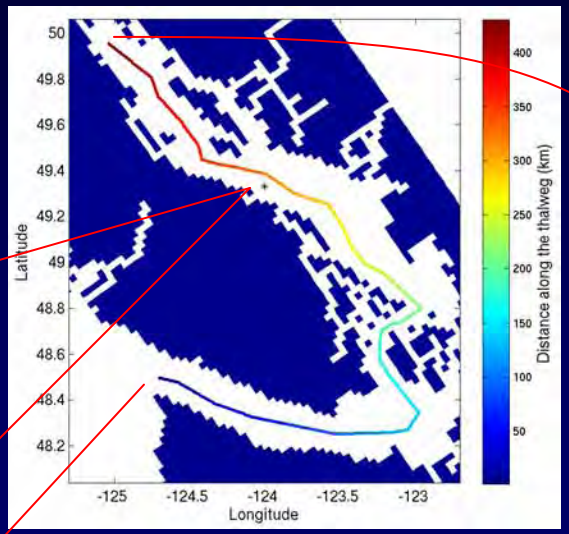
- *Future forcing has only heat flux & initial/boundary anomalies*
  - *Winds & freshwater discharges unchanged*

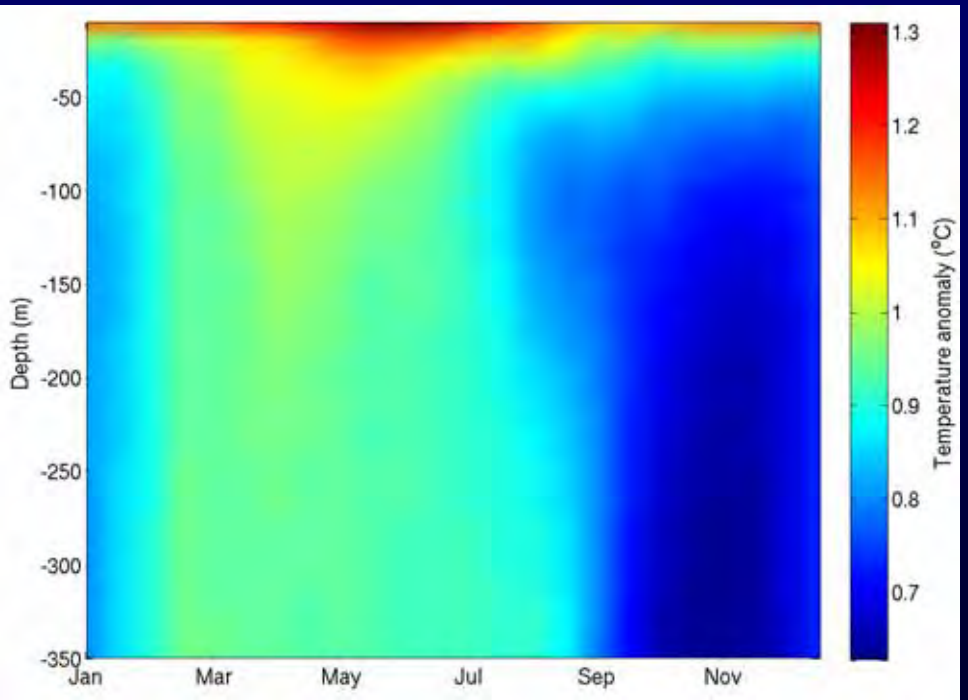


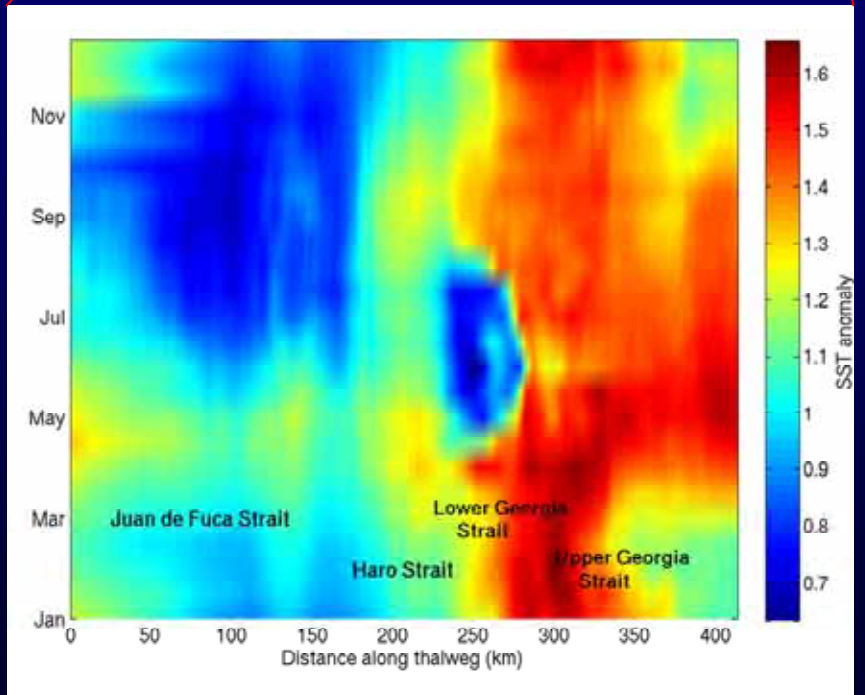


Temperatures in the Salish Sea

SST anomaly greatest in Georgia Strait, least in areas and times of greatest mixing and times of river influence. Normal seasonal variability is between 8 and 12 degrees at the surface.







Summary

- development & preliminary results from BC shelf, ocean-only, RCM
  - ROMS with 3km resolution
  - Future forcing & initial field anomalies computed from NARCCAP CRCM/CGCM fields
  - Incremental build-up of future forcing
    - Results so far with only future initial TS & heat flux fields

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

Future Work

- Future winds & freshwater discharge runs soon
- Ensemble with other NARCCAP RCM output
- Couple to NPZD & geochemical ecosystem models

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