Puget Sound
Dissolved Oxygen Model

Agenda:

- **Introductions**
- **Review of the project**
- **Circulation Model Calibration Update**
- **Next meeting**

Puget Sound Dissolved Oxygen Model

Circulation Model Calibration Update

Mindy Roberts

July 2009

Project questions

1. Are human sources of nutrients in and around Puget Sound significantly impacting water quality?
2. How much do we need to reduce human sources of nutrients to protect water quality in Puget Sound?

Project components

- QAPP (Publication No. 09-03-110, April 2009)
- Circulation model and report (PNNL)
  - Focus: water movement
- Water quality model and report (PNNL)
  - Focus: loads and effects
- Final project report (Ecology)
  - Focus: Puget Sound-wide scenarios

Model domain

Coordination

- Project web page: www.ecy.wa.gov/programs/wq/PugetSound/DOModel.html
- Quarterly reports
  - Through December 2008
  - January through March 2009
    - www.ecy.wa.gov/programs/wq/PugetSound/PS-DOModelingQrtlyRpt2/psdom-qr2.html
    - Interactive graphics for exploring model input
    - River inflows for first example
    - Expand to other parameters and model output

PSDOM Quarterly Progress Report #2 (Jan-Mar 2009) - Microsoft Internet Explorer provided by Dept of Ecology

File Edit View Favorites Tools Help

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Address http://www.ecy.wa.gov/programs/wq/PugetSound/PS-DOModelingQrtlyRpt2/psdom-qr2.html Go

Ecology is currently exploring ways to incorporate interactive data visualizations into project web pages and reports to make large datasets more readily accessible. The example that follows gives users the opportunity to perform more in-depth and self-guided explorations of flow data for rivers that discharge into Puget Sound and Canadian waters by allowing them to vary the range of the x-axis and by providing real-time readouts of data values at each point in time.

River Flows ($m^3 s^{-1}$)

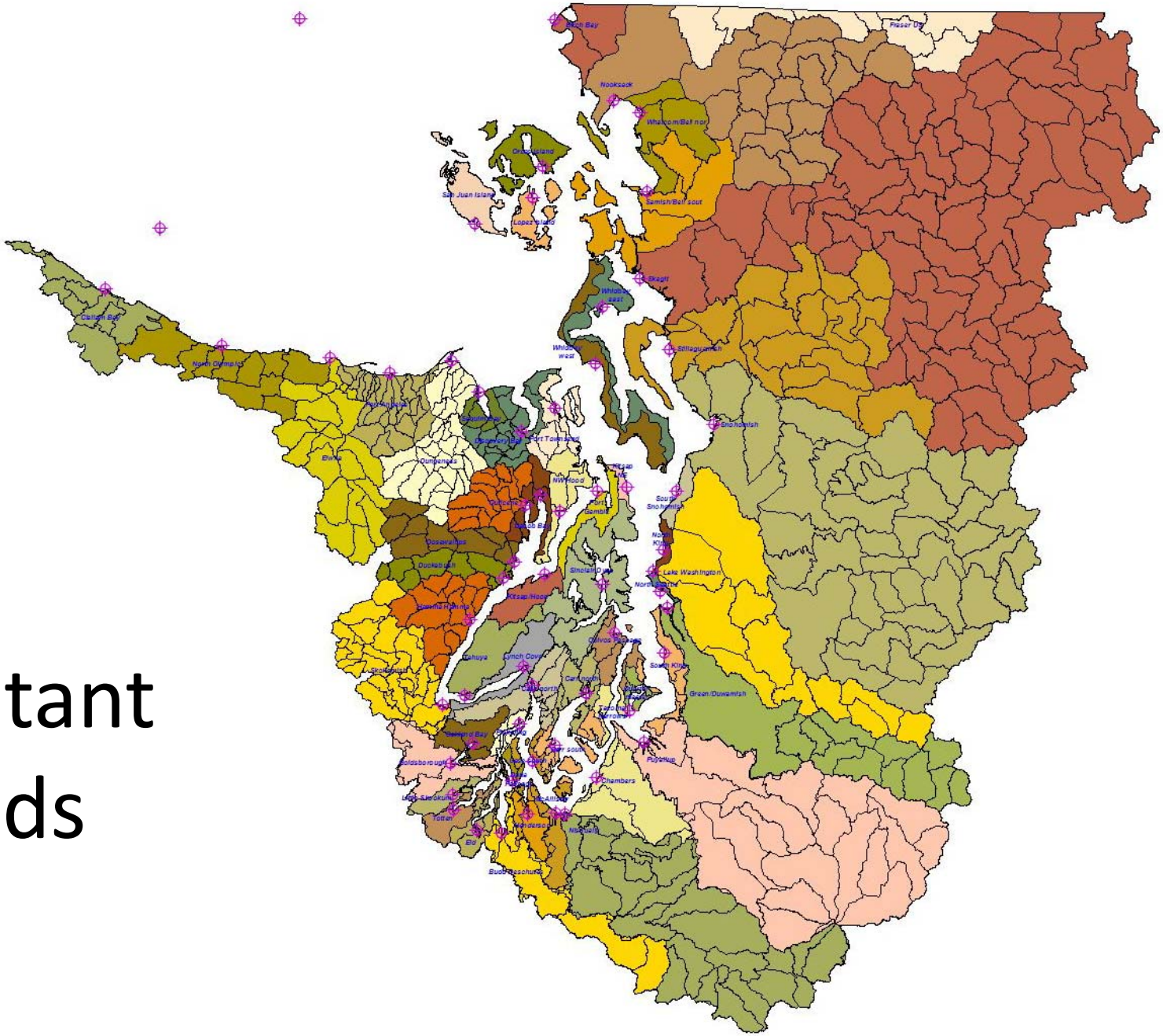
(be patient as the data are retrieved and the visualization is loaded...)

Ctrl-Click (or Cmd-Click on Mac)

Birch Bay
Budd/Deschutes
Carr north
Carr south
Case north
Case south
Chambers

Done Internet

Pollutant loads



WWTP loads

- In development…
- Will send time series to each plant
- Use South Sound DO Study results for South and Central Puget Sound
- Extrapolate SPS DO Study to fill in missing information for North Puget Sound
- Search for Canadian WWTP data
  - Victoria has agreed to build wastewater treatment plant (June 2009)

First step: Circulation model report

<u>Outline</u>:

- Introduction
- Model setup
  - Model grid
  - Information sources for tides, open boundaries, rivers, meteorology, initial conditions
- Model calibration
- Summary and next steps

Calibration steps

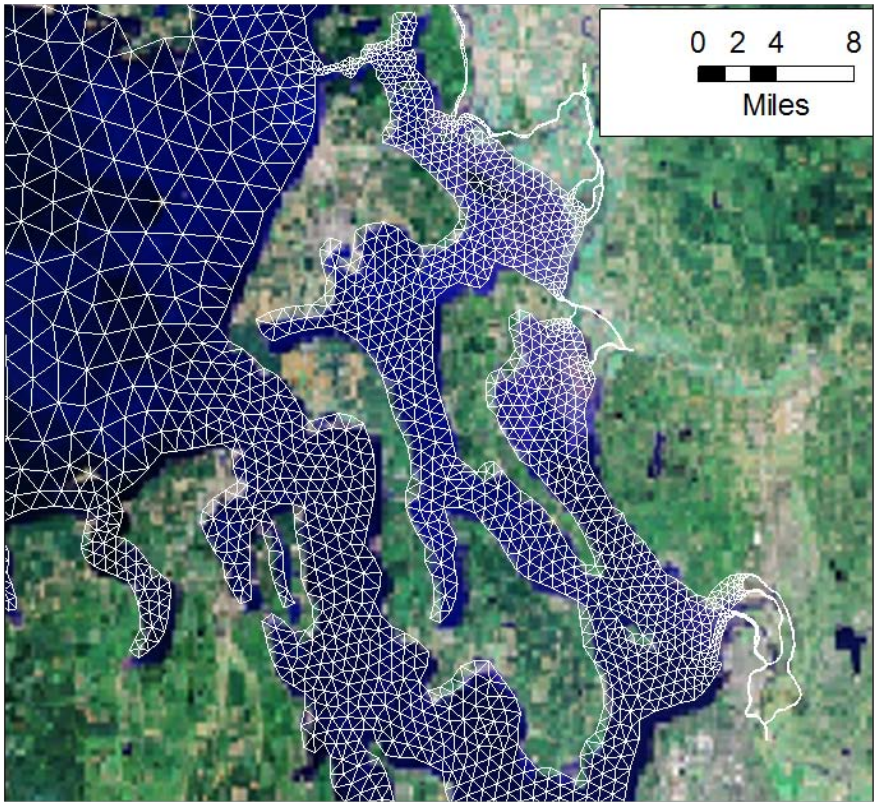
- Water surface elevations
- Surface and near bottom temperature and salinity
  - Spatial patterns
  - Temporal patterns (seasons to diel as appropriate)
- Profiles of temperature and salinity
- Acoustic Doppler current profiles (ADCPs)

Tarang Khangaonkar
PNNL

Model grid development

- Data sources
  - PSDEM
  - DFO (Canada)
- NAVD 88
- Tide Flats
  - 4 m depth
  - Nodes = 9,052
  - Elements = 13,976
  - Layers = 30

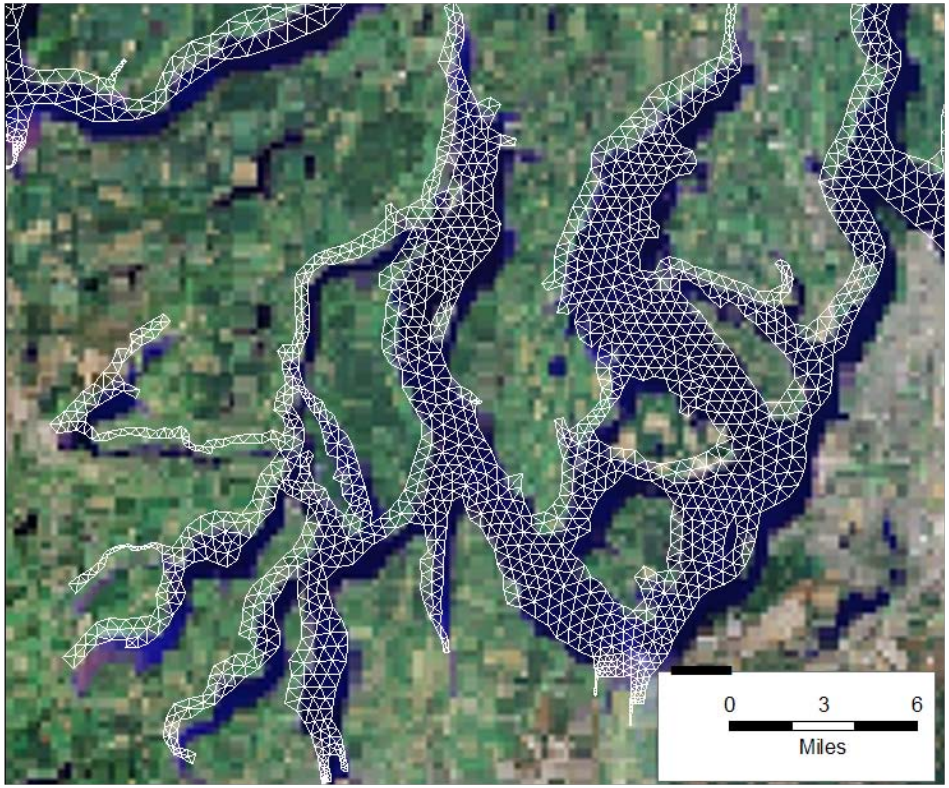
Model grid, close-up



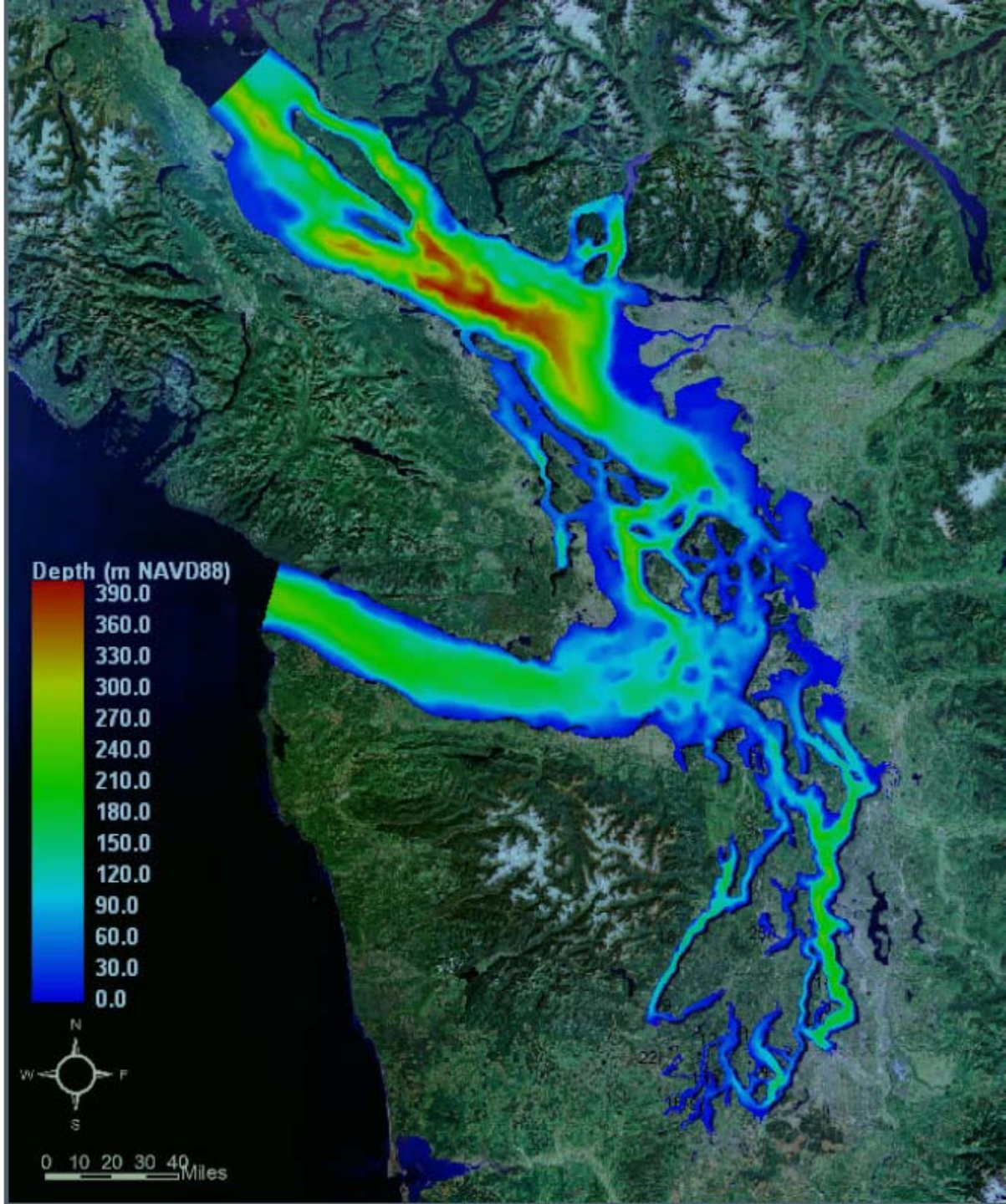
Cell size variation

350 m to 3,000m

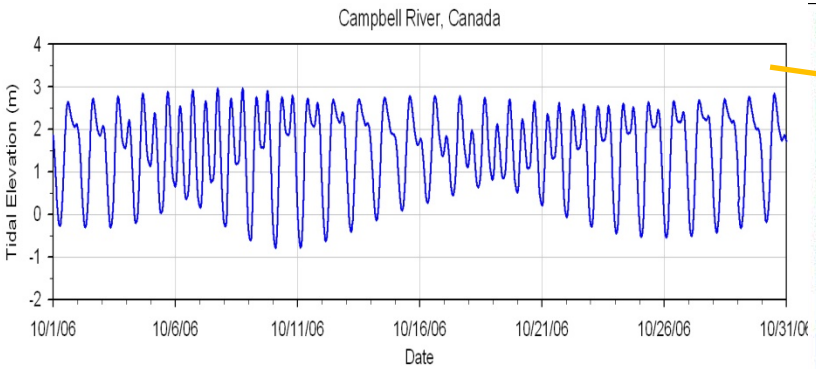
≈ 880 m



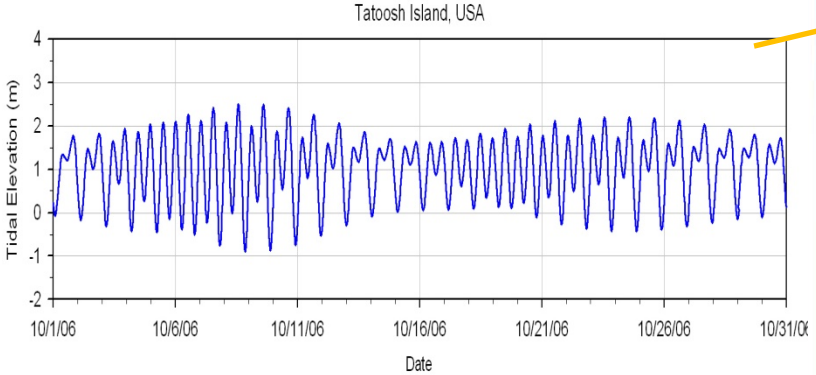
Model Bathymetry

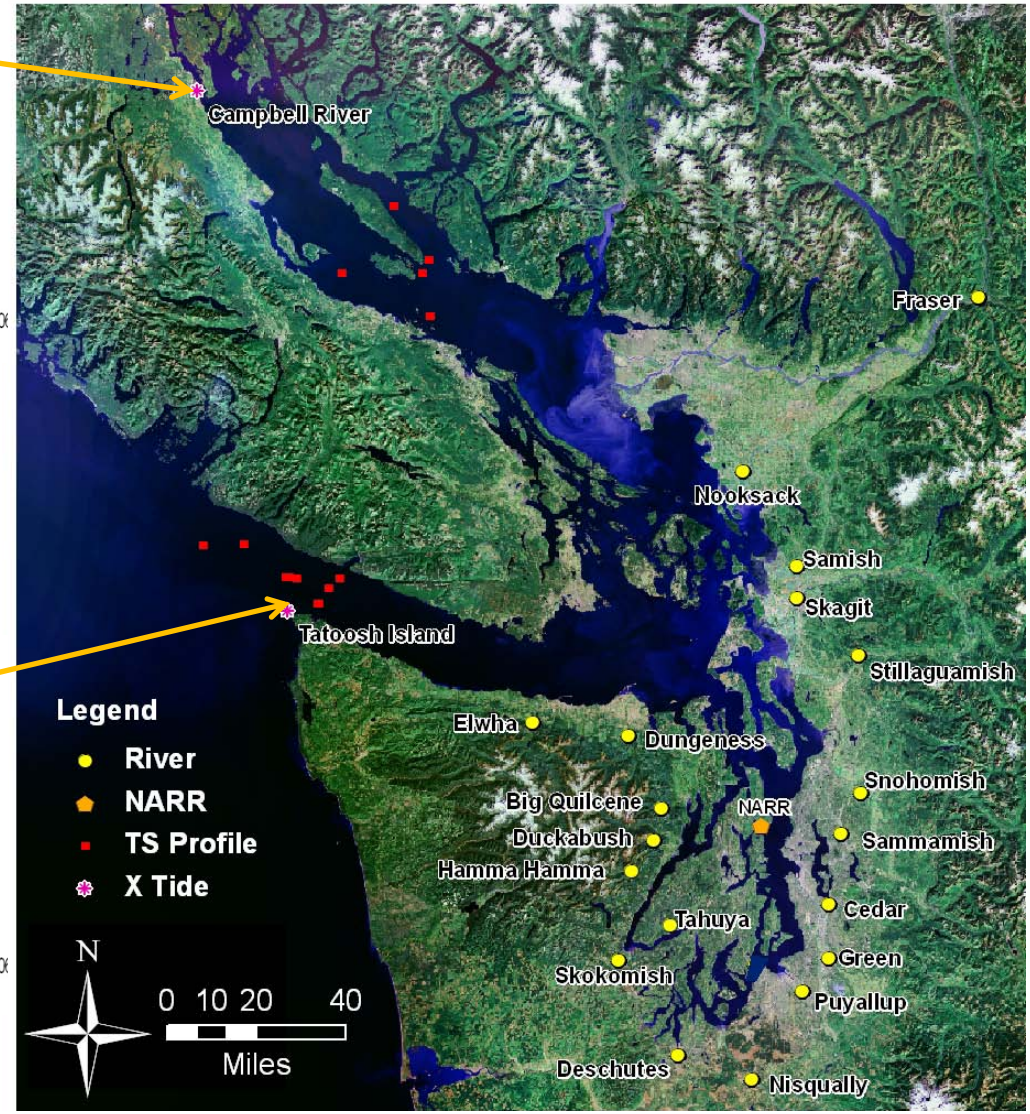


Marine boundaries – Tides Year 2006



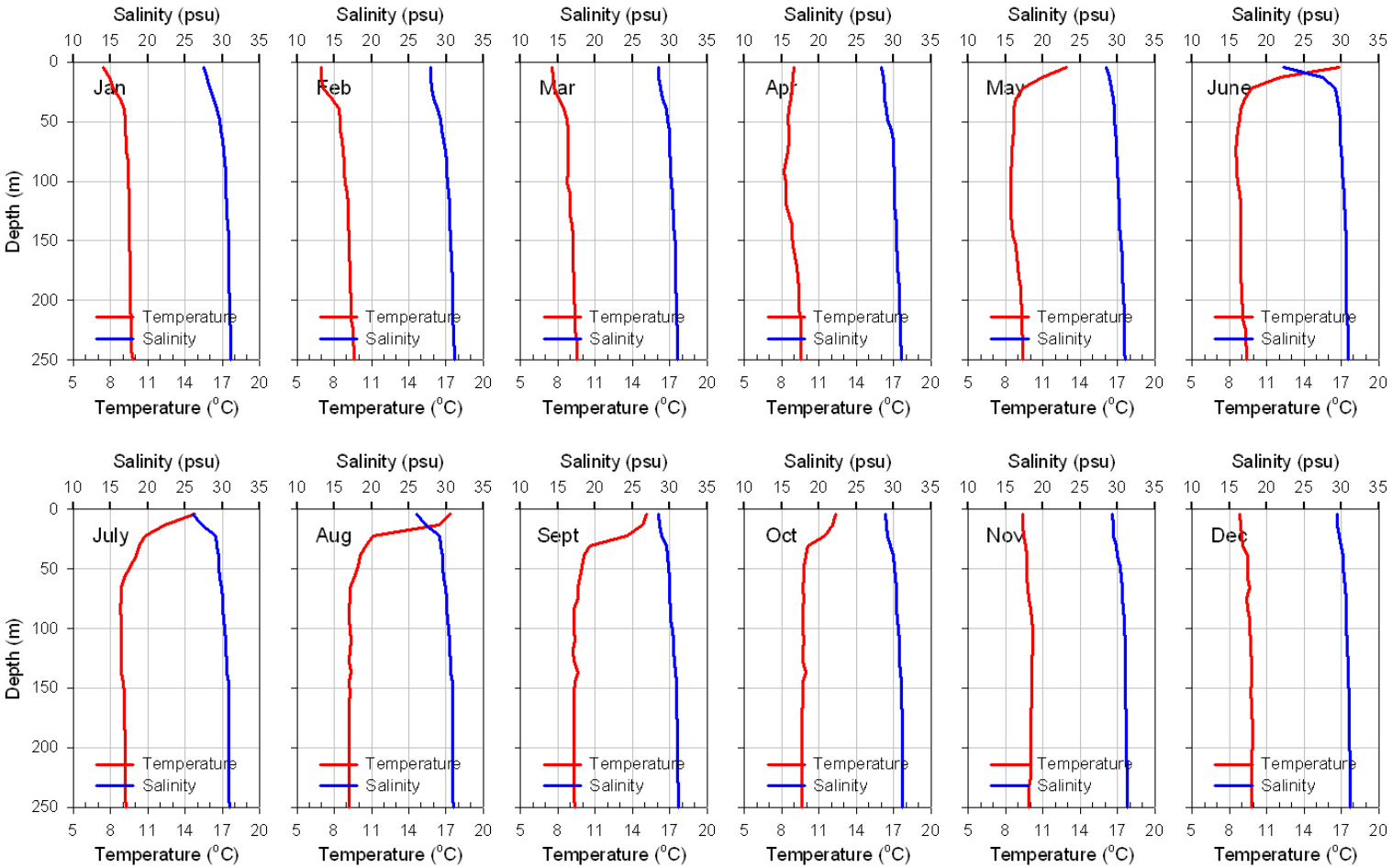
Tidal Elevations – Xtide
Harmonic tide predictor
(Flater 1996)





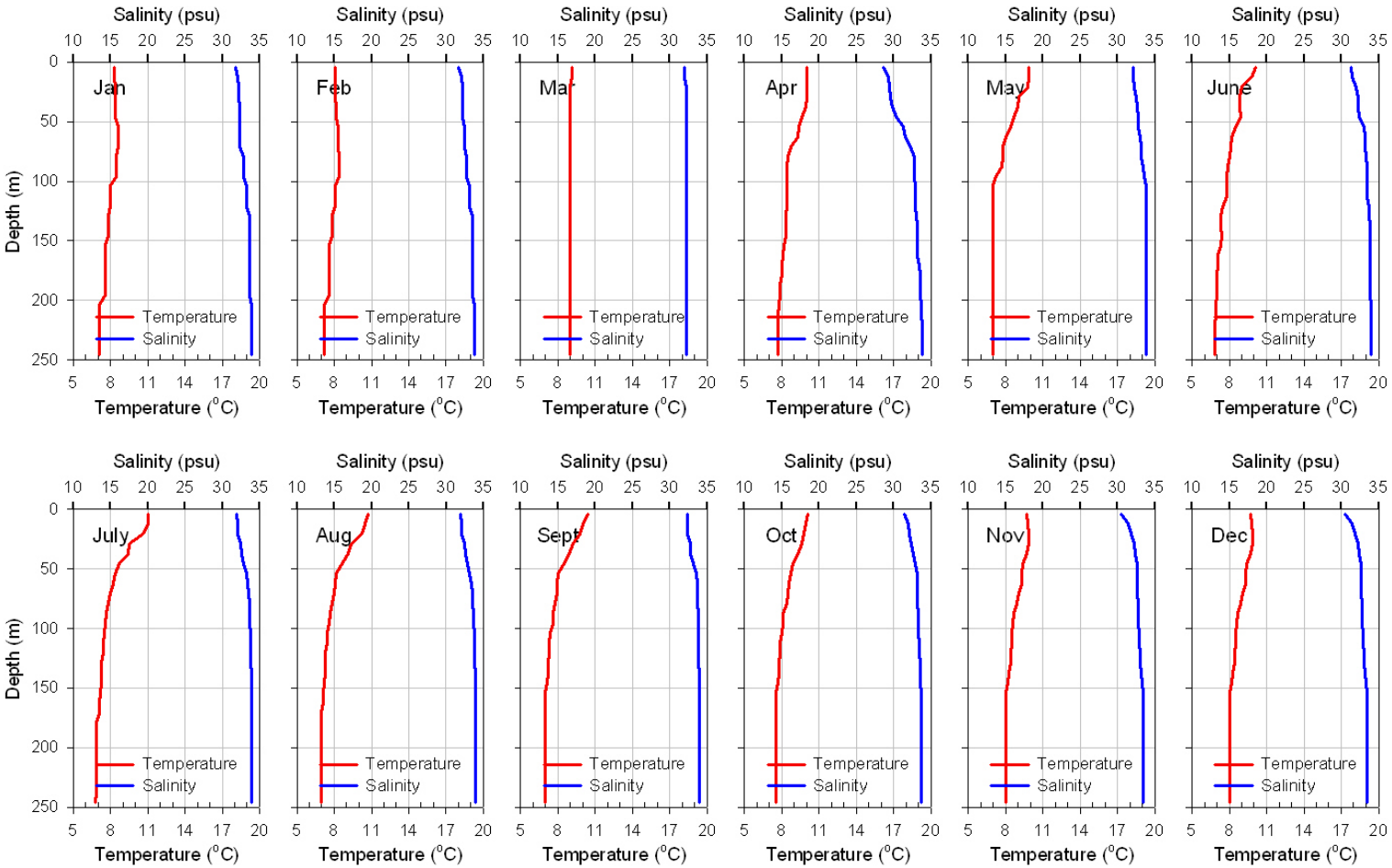
Temperature and Salinity Profiles

Georgia Strait Open Boundary

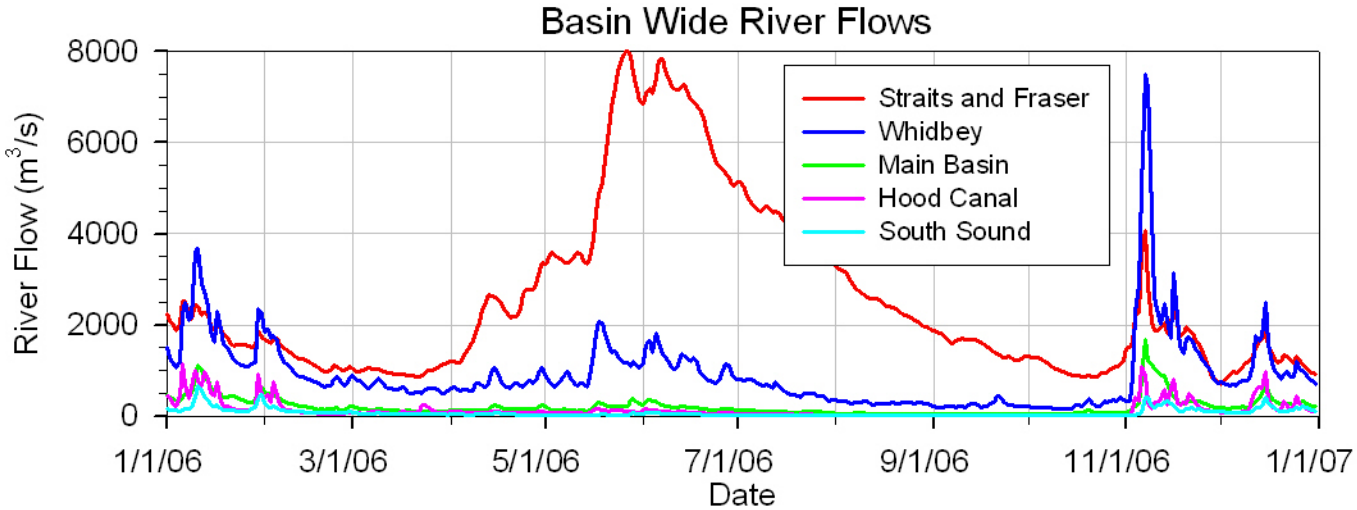


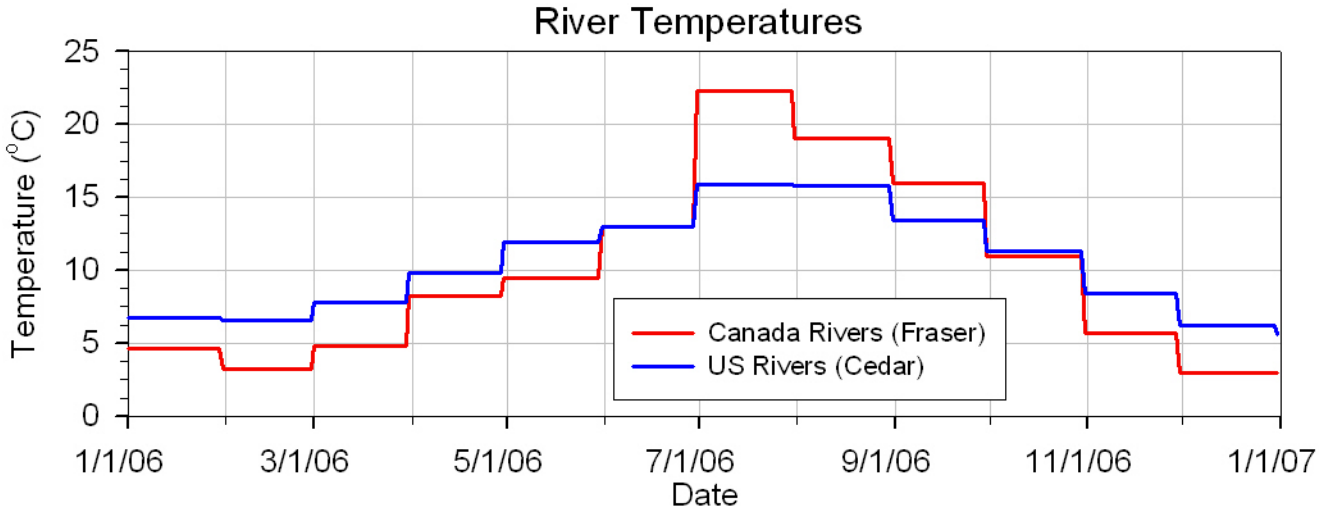
Temperature and Salinity Profiles

Strait of Juan de Fuca Open Boundary



River flow and Temperature



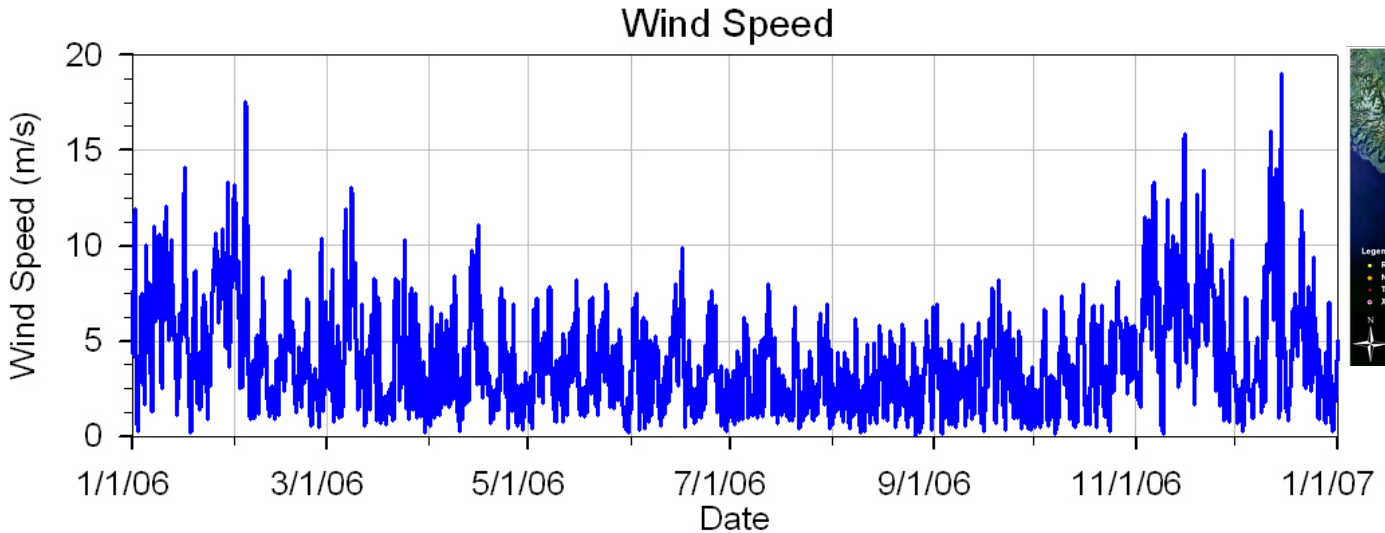


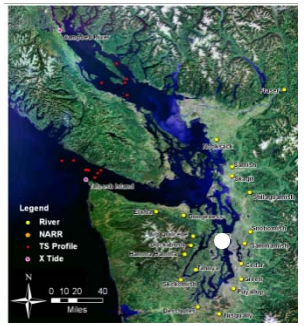
Meteorological forcing

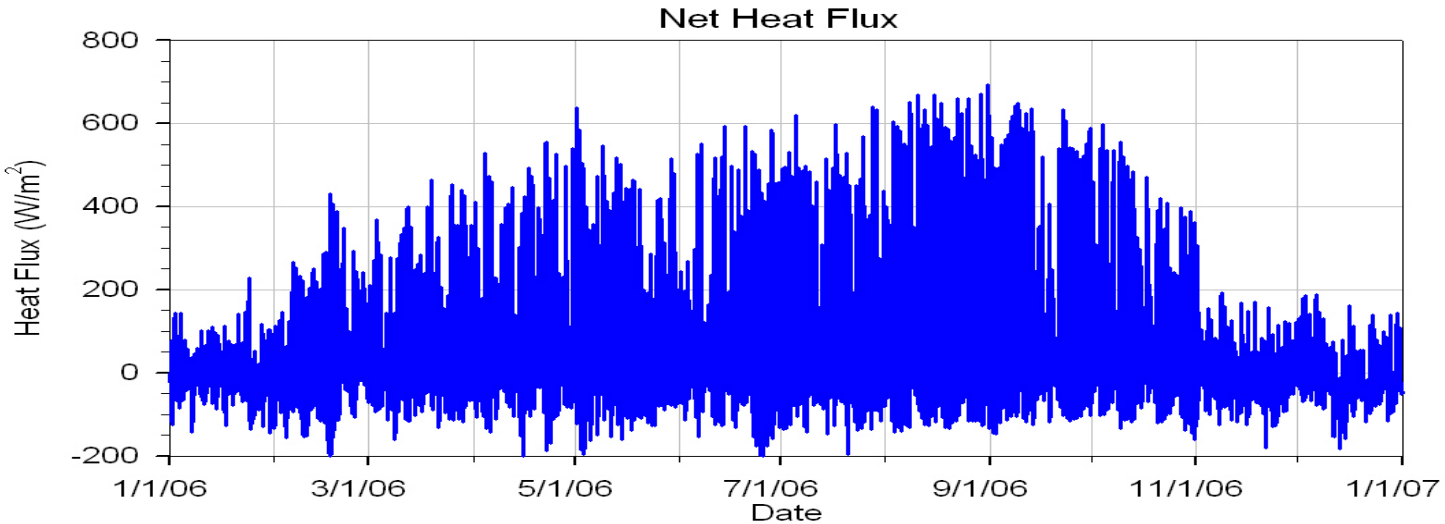
North American Regional Analysis (NARR) Data

NOAA National Center for Environmental Protection (NCEP) Model (32 Km resolution – 3hr)

(Wind, short and long wave solar radiation, latent heat flux and sensible heat flux)



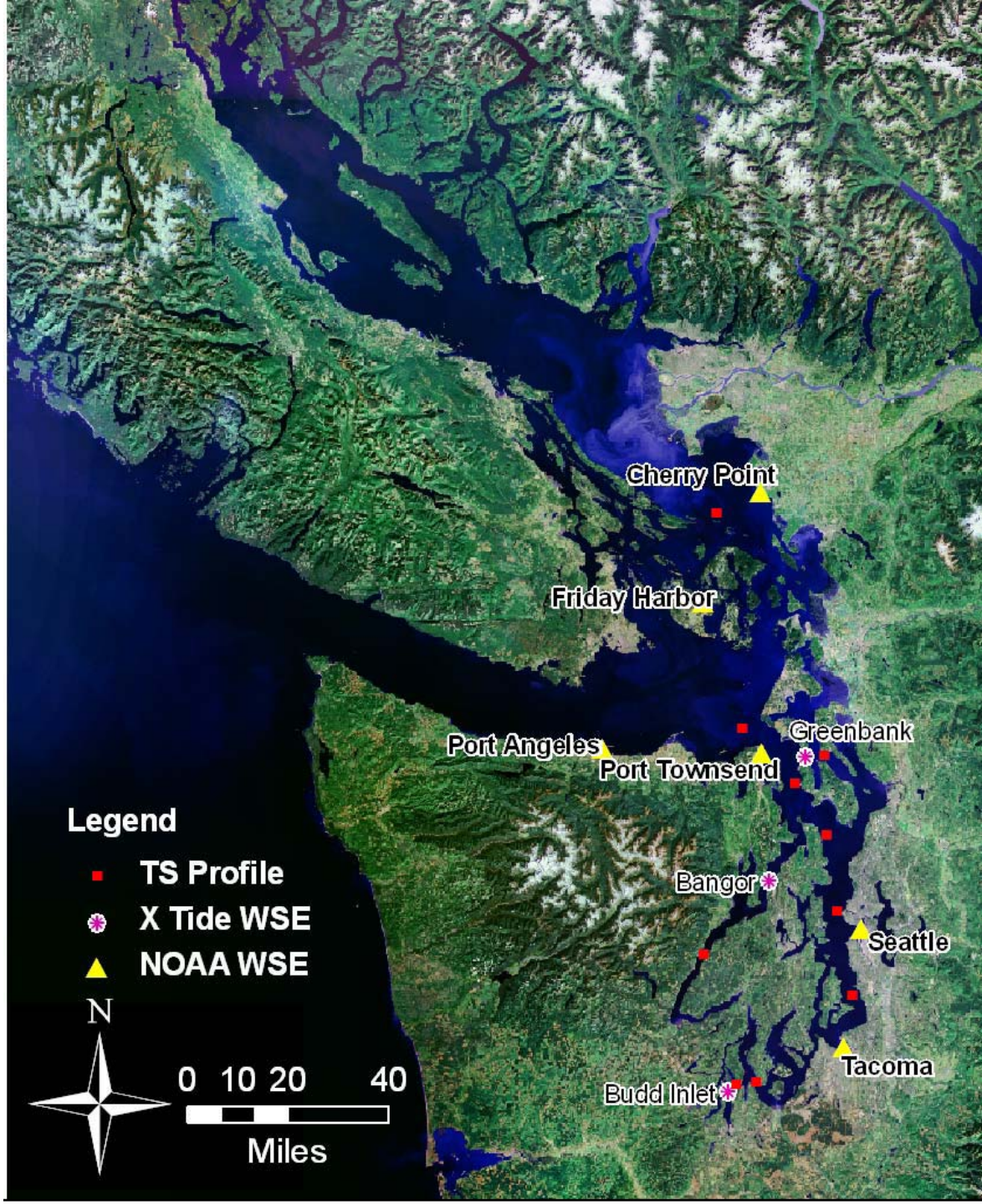




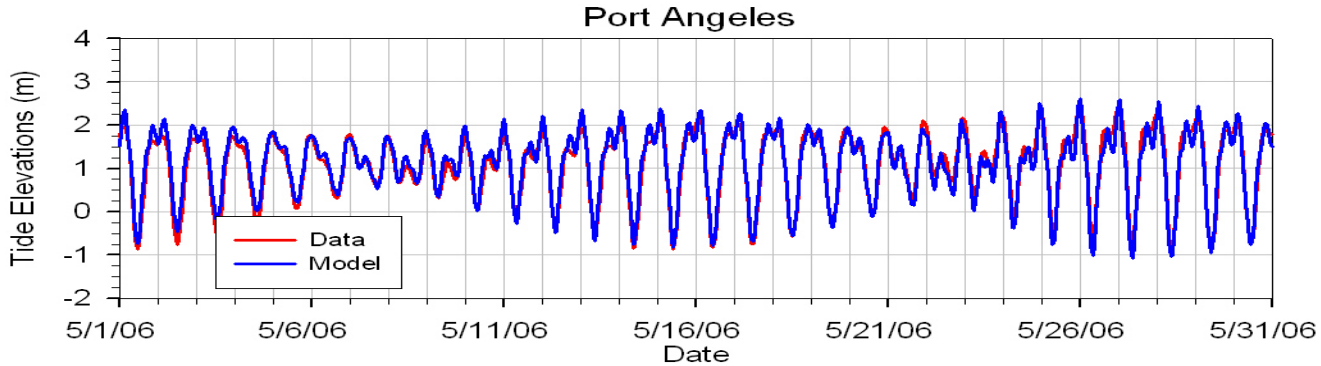
Stations for comparisons

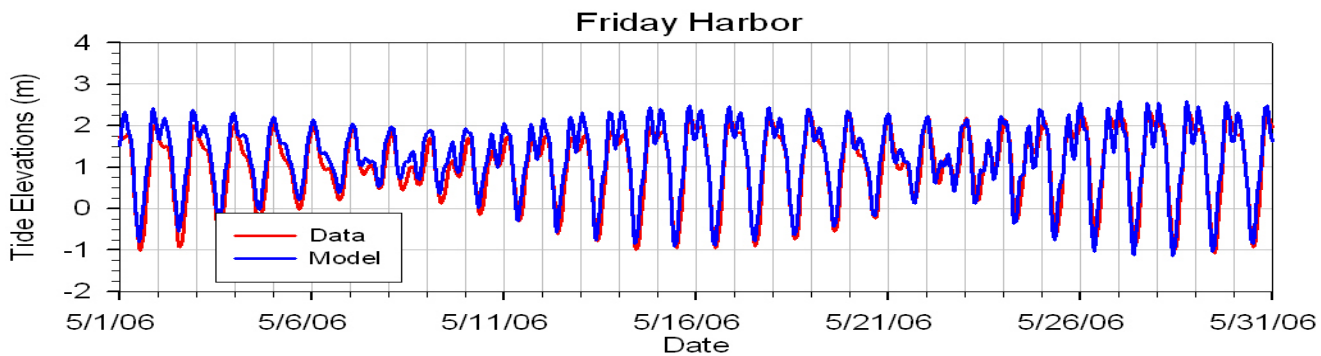
Initial conditions

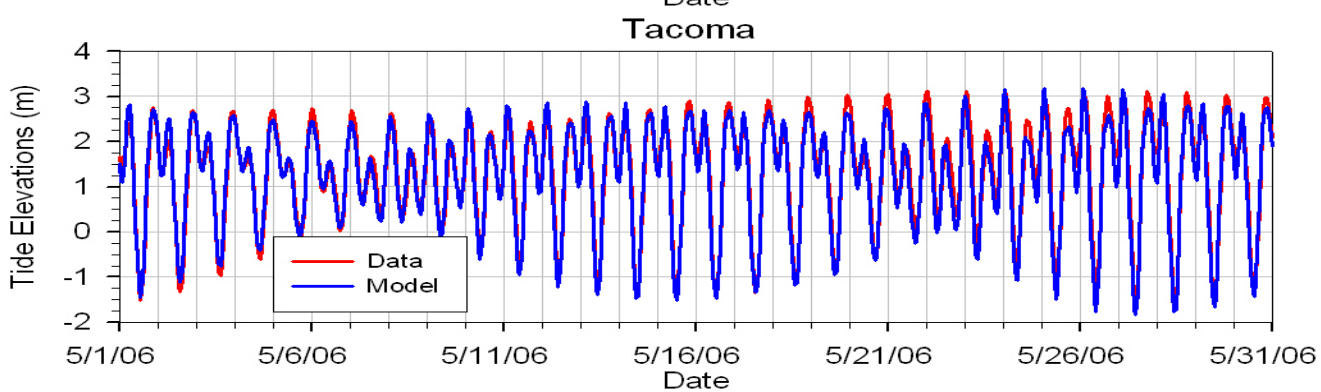
- Year 2005 model run
- Hot start for January of 2006



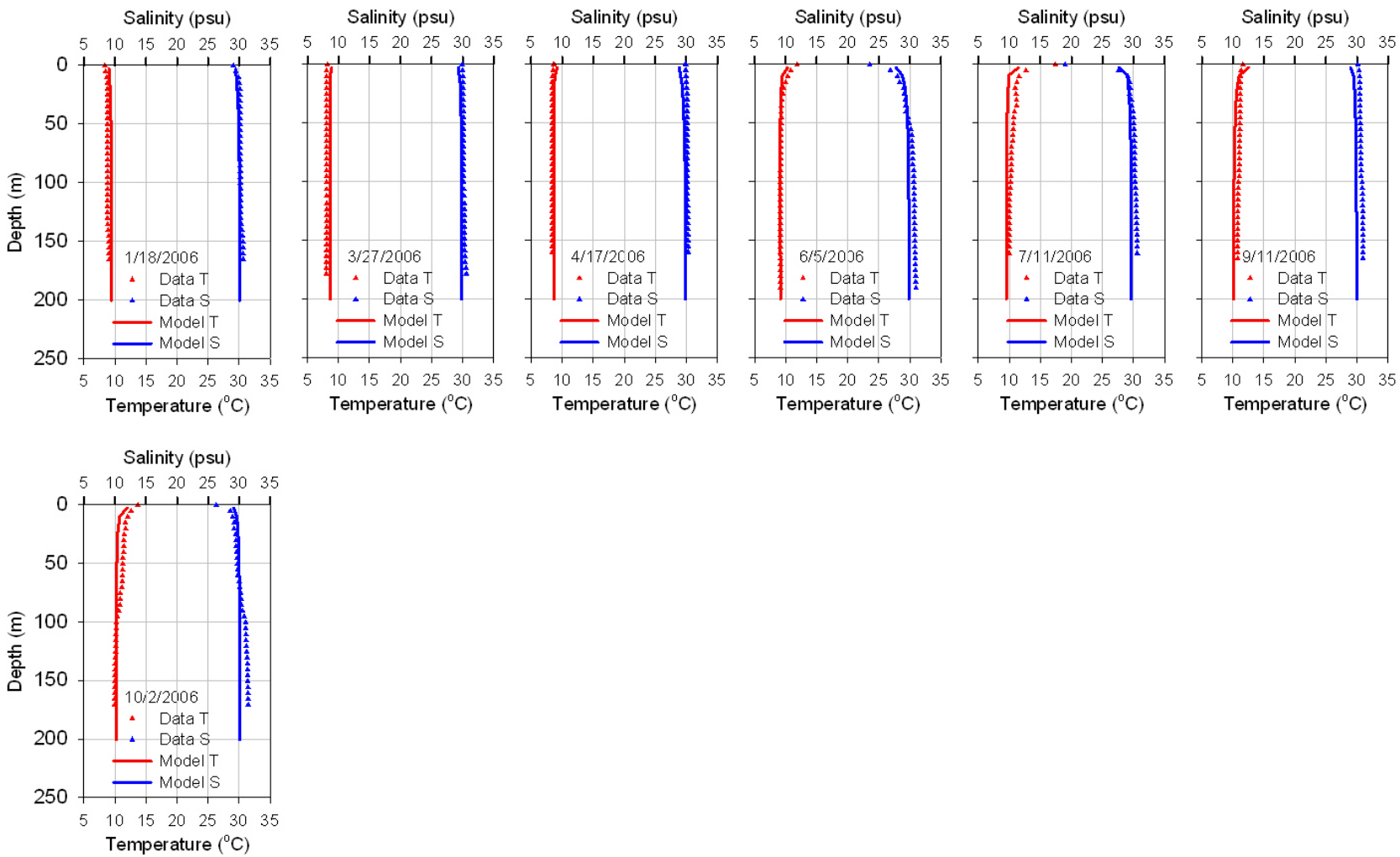
Calibration: water surface elevations



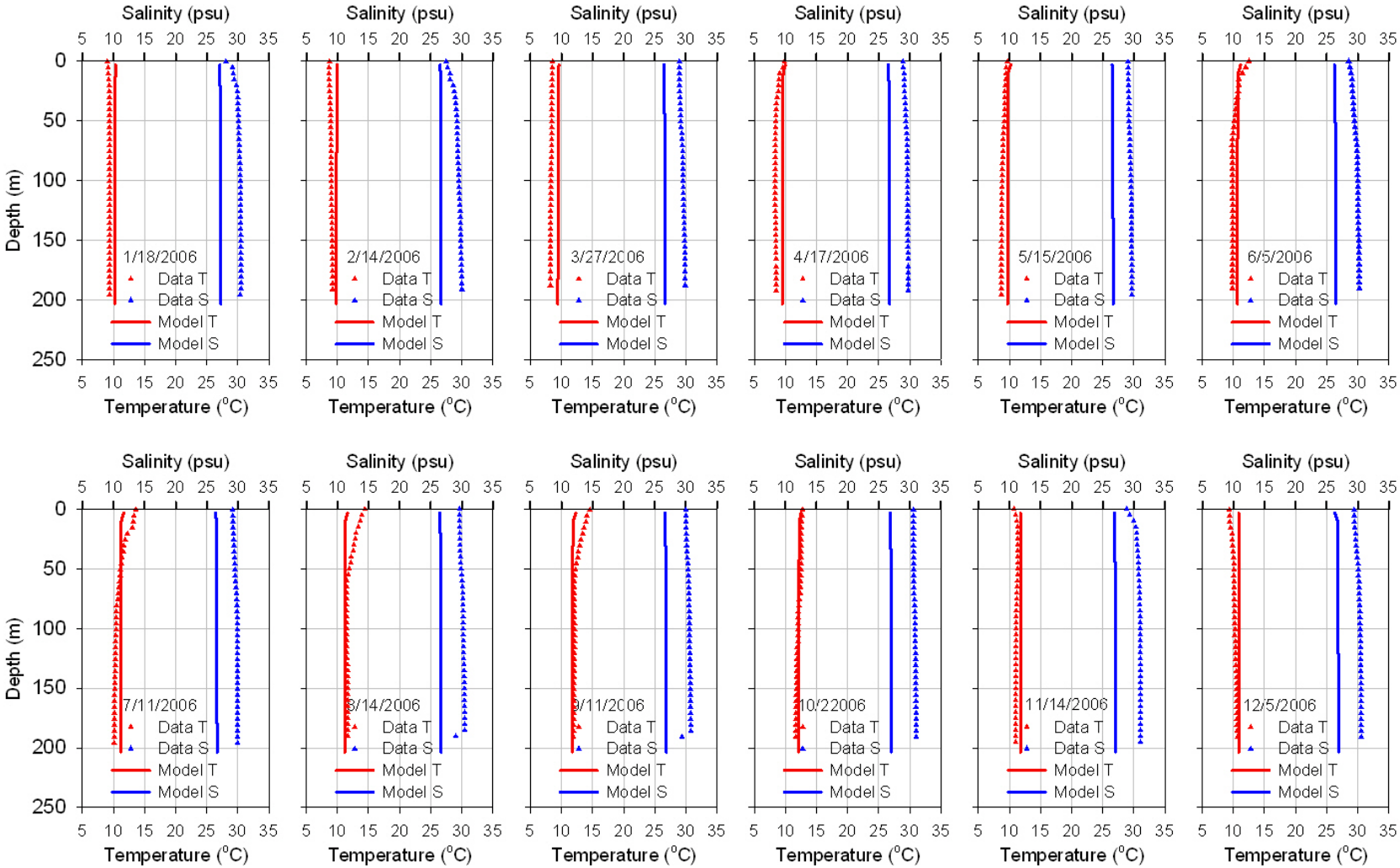




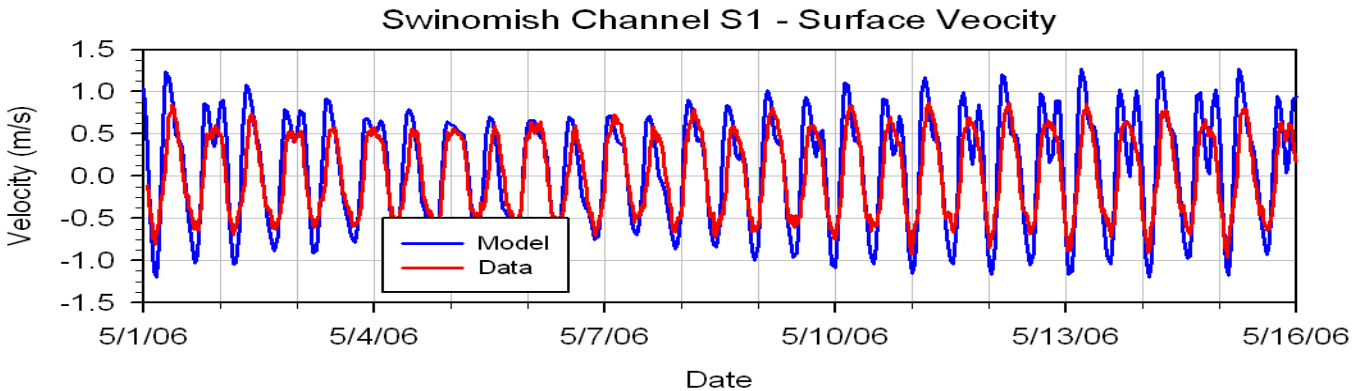
Calibration: Temperature and salinity profiles GRG002 (Georgia Strait)

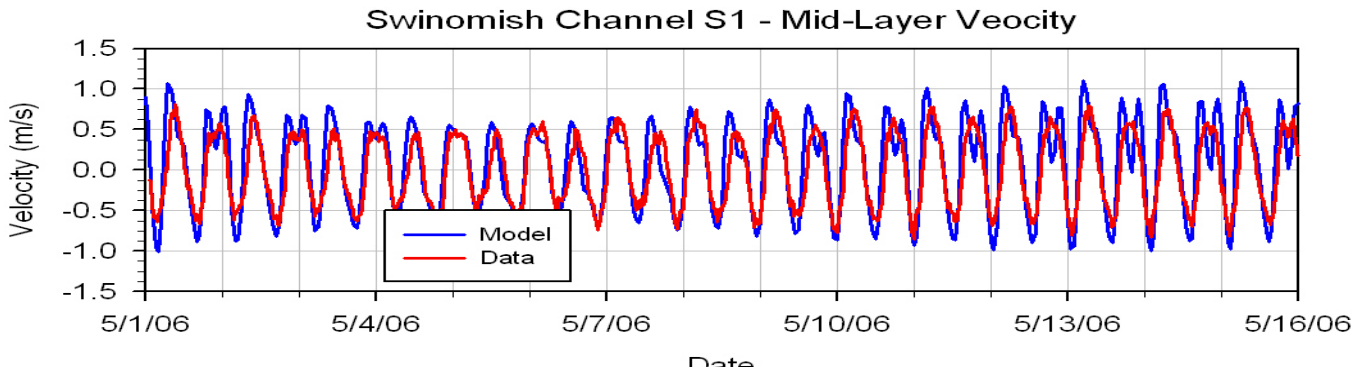


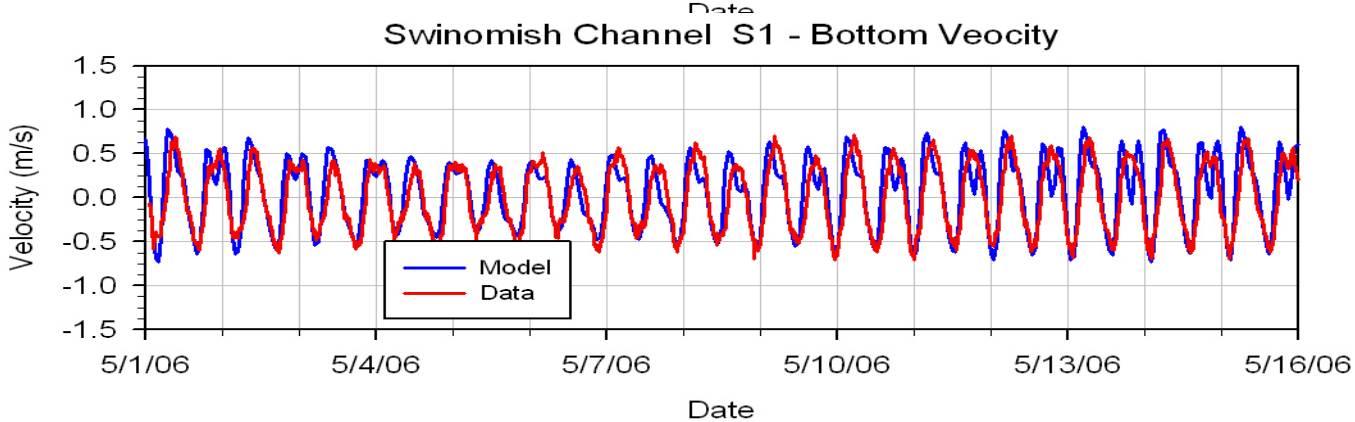
Calibration: Temperature and salinity profiles East Passage (Vashon Island)



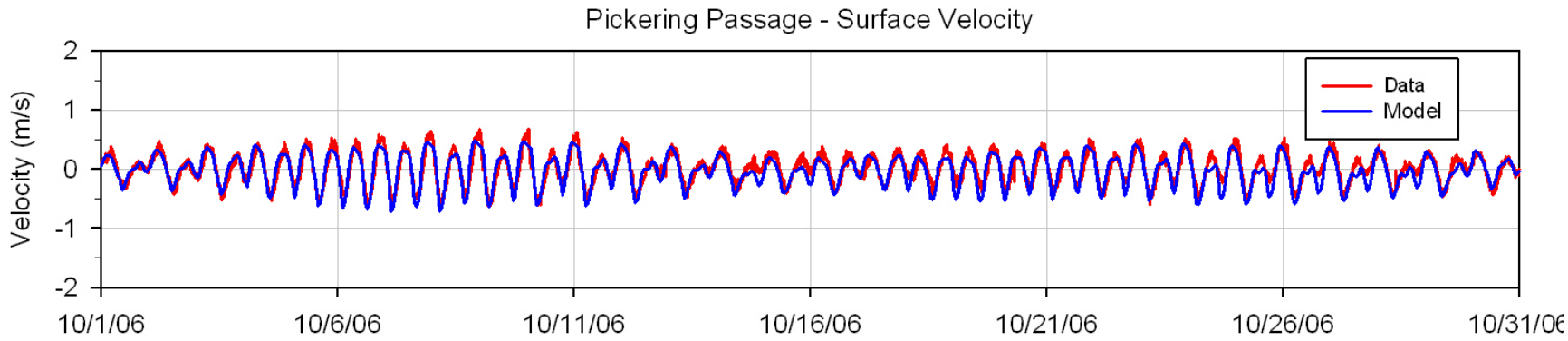
Calibration: Velocity

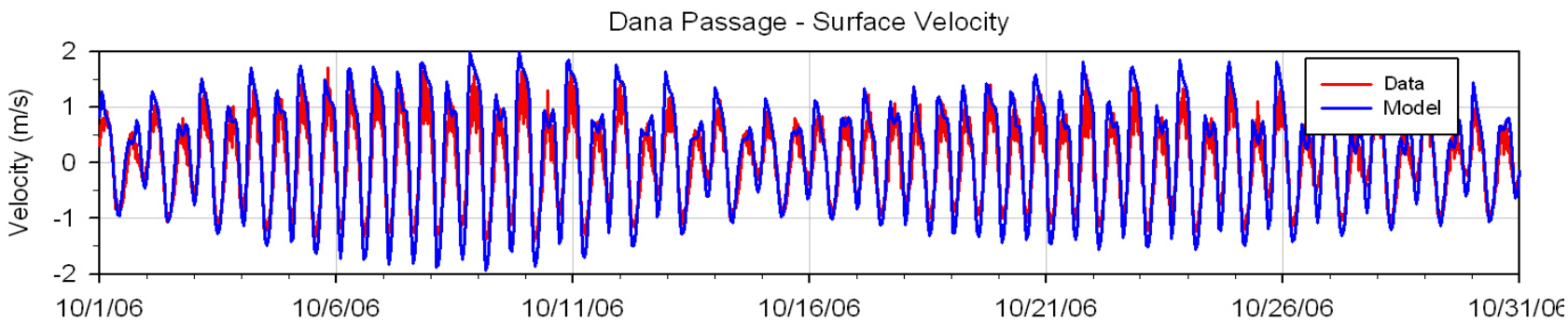






Calibration: Velocity
(Hartstene Island)





Model Operation and Computational Resources

- Model Run Time
  - 1 year simulation in 37hours
  - 80 cores used in parallel mode
- Ecology Cluster Computer
  - 184 cores, 2.0 GHz (24 dual quad cores)
  - Linux, Intel Fortran Compilers
- Remote access for external users through VPN
  - pending approval from PNNL IT/security 2010

Water quality model development

- Model selection – CE-QUAL-ICM
- Linkage of FVCOM & CE-QUAL-ICM - *Complete*
  - Test 1 – Propagation of Unit Pulse
  - Test 2 – Plume Dispersion (Brooks 4/3rd Law)
  - Test 3 – DO-BOD Sag (Streeter Phelps)
  - Test 4 – Phytoplankton Growth and Nutrients Consumption
- Setup of Puget Sound input files and task of initiating model run *in progress*

Andrew Kolosseus
Ecology

Next Meeting

- Mid Oct-Nov
  - Review circulation report
  - Introduce water quality modeling work (with sensitivity analyses)
  - Develop / prioritize “what-if” management scenarios

What-if Scenarios

- Ecology will develop an initial list before next meeting
- If you have ideas now for scenarios, e-mail them to Andrew
- Ecology will send list to everyone
- We will discuss scenarios, add more where needed, prioritize if possible