

EVOSTC ANNUAL PROJECT REPORT

Project Number: 040699

Project Title: Biophysical Observations aboard Alaska Marine Highway System Ferries

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Time Period Covered by Report: 1 October 2005-30 September 2006

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Project Website: http://www.pmel.noaa.gov/foci/GEM/alaska_ferry

Work Performed:

The Alaska Coastal Current (ACC) is important because it flows along the continental shelf of the Gulf of Alaska carrying the river runoff, nutrients and plankton that fuel this rich ecosystem. In addition, it transported the *Exxon Valdez* oil spill onto Kenai Peninsula, Cook Inlet and Kodiak archipelago beaches. The goal of this project is to design, build, install, operate and maintain an oceanographic observation system aboard the Alaska state ferry *Tustumena* to measure the near-surface water properties of the ACC. System design, construction and installation were completed in FY04. Oceanographic monitoring began in FY05. The second monitoring year, FY06, shows some marked climatic differences from the previous year.

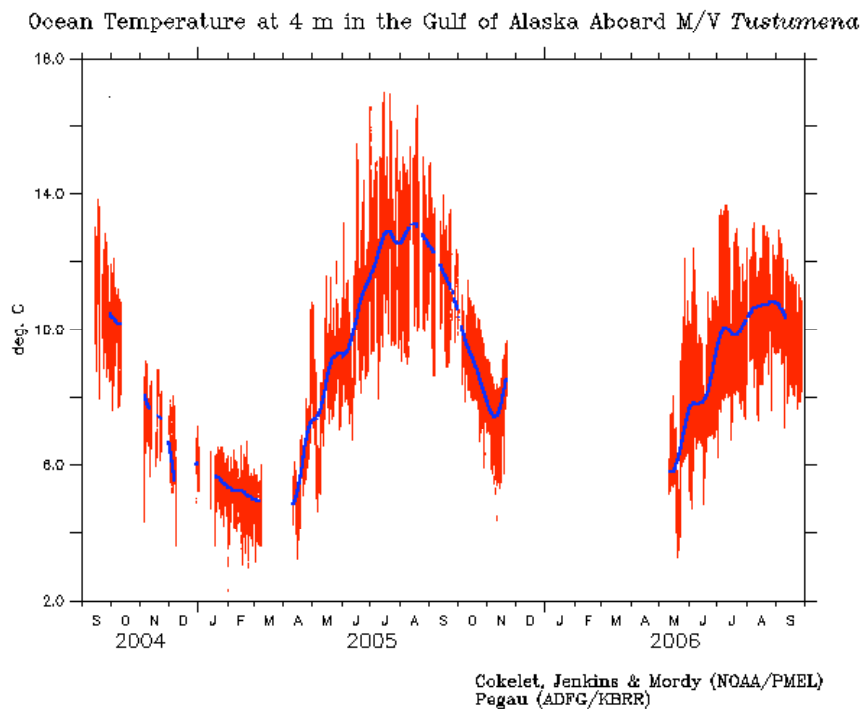


Figure 1. Time series of ocean temperature along *Tustumena*'s route in the Gulf of Alaska. The red line represents the measurements every 30 seconds, and the blue line is the 30-day-average.

The ferrybox system began operation on 15 September 2004. Figure 1 shows the time series of near-surface ocean temperature from 15 September 2004 to 28 September 2006 as measured along *Tustumena's* route. The high-frequency variations (red line) come from spatial differences along the track as the ship moves between confined and open waters. Local temperature extremes occur in bays such as Kachemak Bay (near Homer), Resurrection Bay (near Seward) and Prince William Sound. Sheltered from winds and subject to freshwater inflow and ice from rivers and glaciers, the confined surface waters cool in winter to form ice and warm in summer in thin, stratified layers. The 30-day-averaged (blue line) annual cycle of cooling and warming is shown over two years. With more than one year of data, it is possible to compare years and detect interannual differences. The observations show that 2005 was a warm year compared to 2006 (Figure 1). At its peak, the 30-day-averaged temperature in August was 2.3 °C warmer in 2005. Recent work by W. Crawford (Recent trends in waters of the subarctic NE Pacific, *PICES Press*, vol. 14, no. 2, 24-25, July 2006) using Argo profiling floats shows that 2005 was an anomalously warm year in the central Gulf of Alaska as well. This warming began in 2002 as observed in the Pacific Decadal Oscillation (PDO) climate index. The PDO entered its cold phase in late 2005, and the cooling we observe between 2005 and 2006 is consistent with that. Figures 2a and 2b show the near-surface temperature along *Tustumena's* route for a few days in August 2005 and 2006. 2005 is clearly warmer than 2006. This pattern persists over the two summers along the ACC's axis from the Kenai Peninsula ports of Seward and Homer to Dutch Harbor. These results show that we can detect a climate signal in our near-surface monitoring from an Alaskan ferry. The ferry has the advantage of covering a large area; therefore the results are truly regional and applicable to the ACC in general, not just to some local site.

Figure 3 shows the time series of near-surface ocean salinity measured along *Tustumena's* track. High-frequency variations (blue line) are due to spatial differences as the ship moves between bays and the open ocean. Fresher surface water occurs near river mouths and glaciers when temperatures are warm enough for melting. During winter, salinity variability is reduced because freezing binds the fresh water into ice. The 30-day-average observations (red line) show that summer 2005 was fresher than summer 2006. This is consistent with warming and more ice melt in 2005.

Figure 4 shows the time series of dissolved nitrate concentration, an essential nutrient for phytoplankton growth. Water samples have been collected to calibrate these measurements, but they await laboratory analysis. The preliminary results of Figure 4 show high nutrients in winter and nutrient depletion in summer. Consistent with ecosystem understanding, the depletion likely is due to phytoplankton uptake.

More results including movies of oceanographic measurements along the ship track are available at our website: http://www.pmel.noaa.gov/foci/GEM/alaska_ferry.

We also measured chlorophyll and colored-dissolved-organic-matter fluorescence, and optical transmittance. These optical sensors have the disadvantage of biological fouling between weekly cleaning cycles. We are working on ways to resolve the data. In May 2006 we changed the fluorometers to a type with an automatic wiping system that is less susceptible to fouling.

Data gaps before mid-January 2005 are due to start-up problems with the new instrument system. They were resolved, and only short gaps due to instrument or maintenance problems occur in the remaining time series. Long data gaps in March-April 2005 and November 2005-May 2006 are due to shipyard periods when the vessel was laid up.

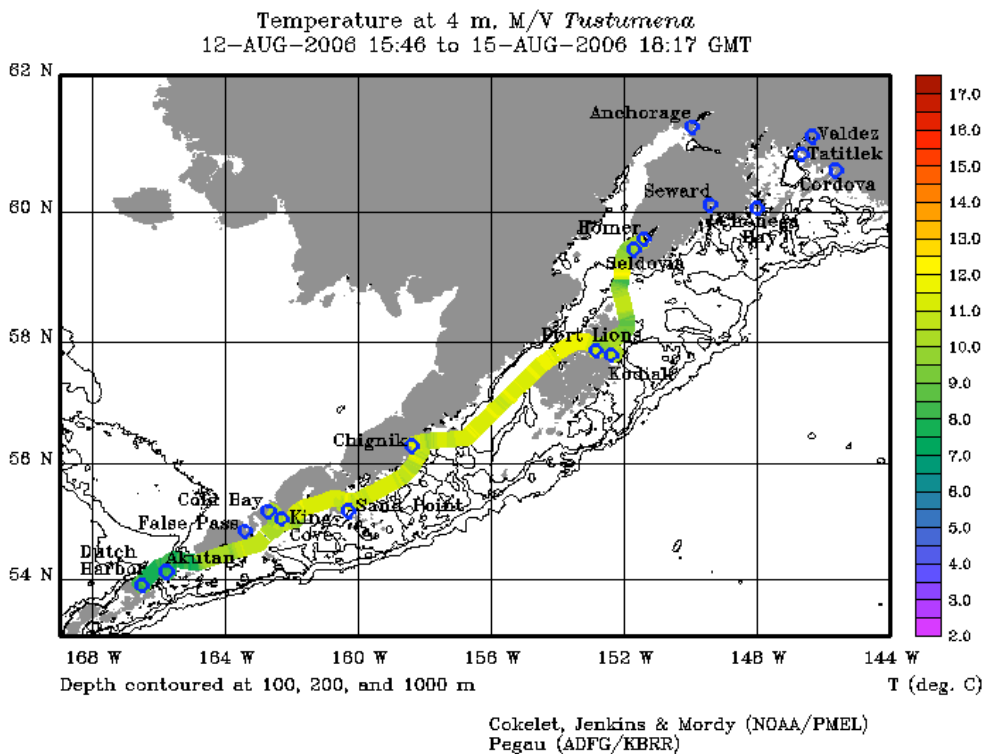
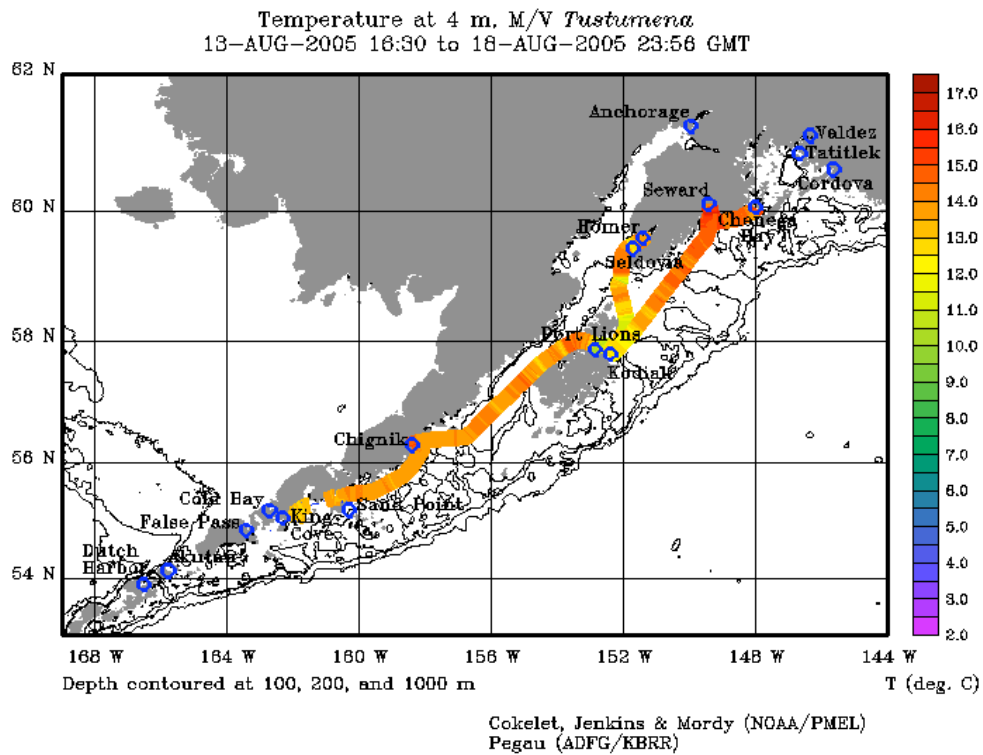
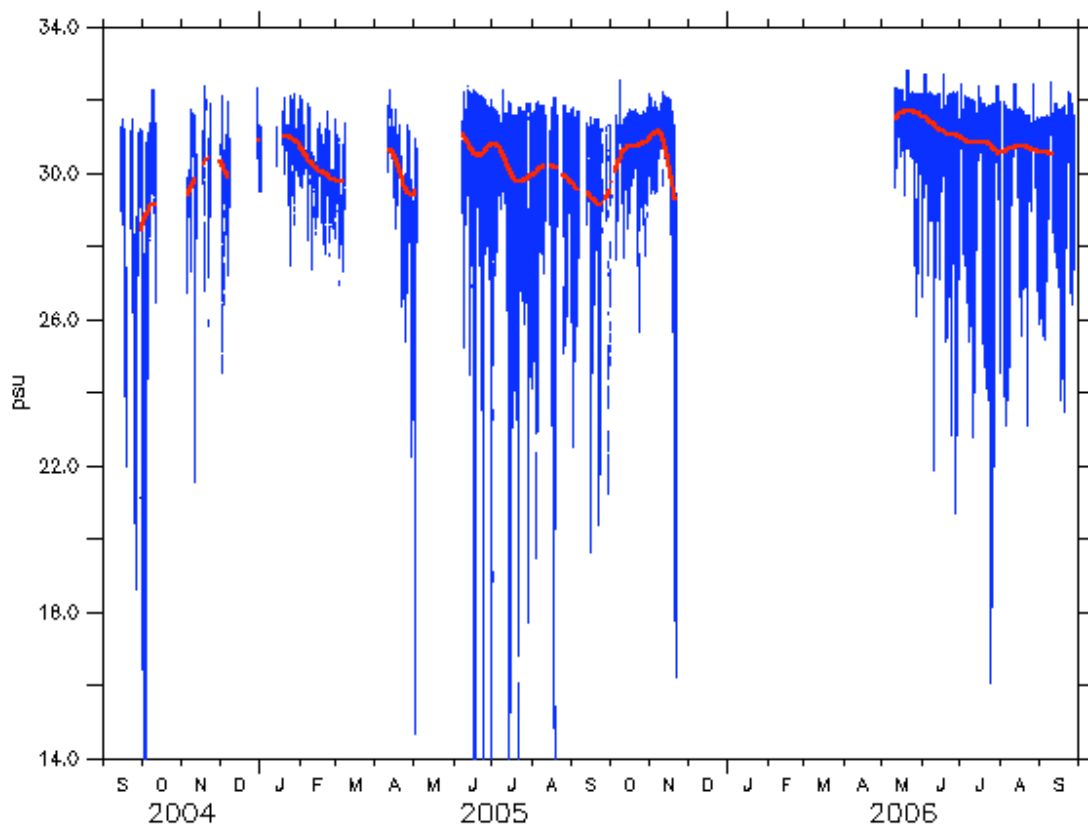


Figure 2. Ocean temperature along *Tustumena's* route, (a) 13-18 August 2005, (b) 12-15 August 2006.

Ocean Salinity at 4 m in the Gulf of Alaska Aboard M/V *Tustumena*



Cokelet, Jenkins & Mordy (NOAA/PMEL)
Pegau (ADFG/KBRR)



Figure 3. Time series of ocean salinity along *Tustumena*'s route in the Gulf of Alaska. The blue line represents the measurements every 30 seconds, and the red line is the 30-day-average.

Nitrate Concentration at 4 m in the Gulf of Alaska Aboard M/V *Tustumena*

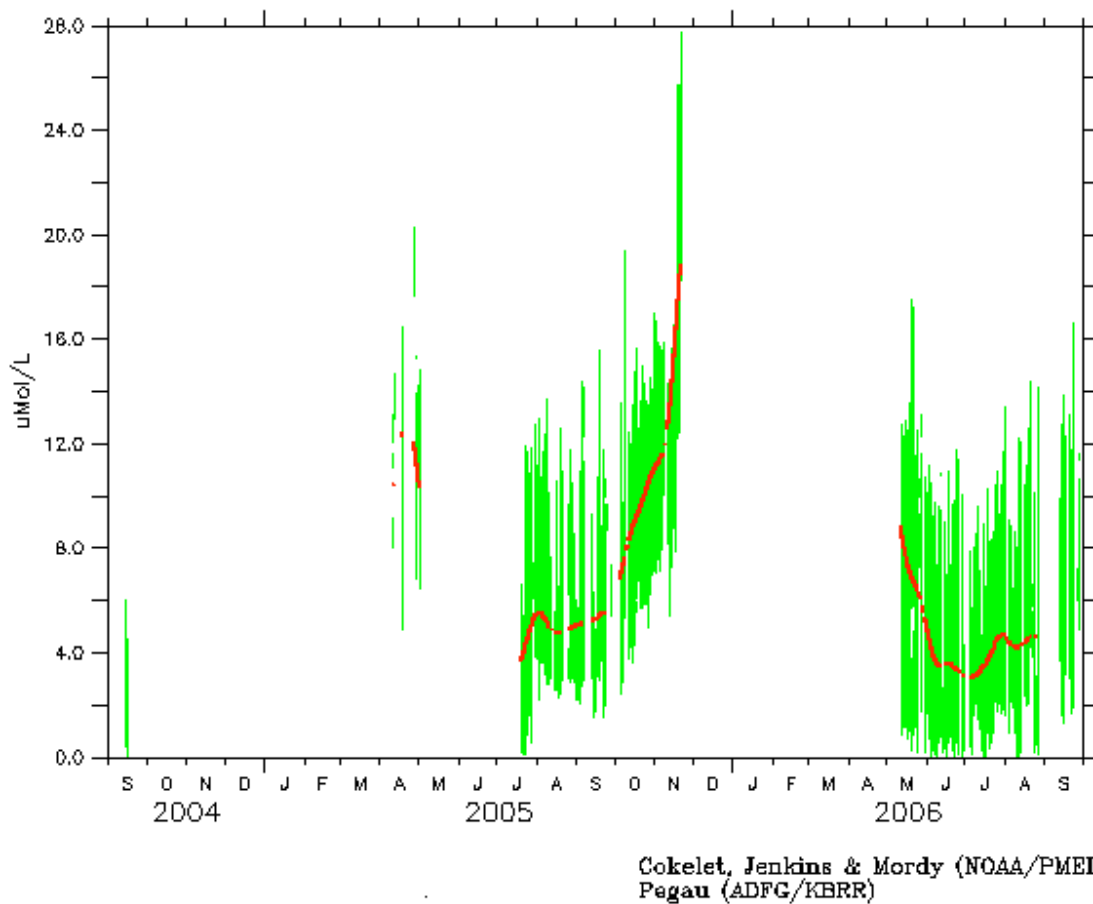


Figure 4. Time series of oceanic dissolved nitrate concentration along *Tustumena*'s route in the Gulf of Alaska. The green line represents the measurements every 10 minutes, and the red line is the 30-day-average.

Future Work:

The initial three-year EVOS/GEM grant ends 30 September 2006. We have proposed to the EVOSTC to continue *Tustumena* observations for three more years and to add a similar sampling system to the Alaskan state ferry *Aurora* in Prince William Sound. We propose to add oxygen sensors to both systems indicators of phytoplankton productivity.

Coordination/Collaboration:

No specific coordination/collaboration provisions were mentioned in the proposal other than that amongst the Principal Investigators at NOAA/PMEL, Kachemak Bay Research Reserve and the University of Washington/JISAO. However, one justification of this research, as cited in the original EVOS request for proposals, is to provide measurements to which numerical model results can be compared. Comparison has been made with the GLOBEC Northeast Pacific Regional Ocean Model System (ROMS). We have also subsampled our data for times when the ferry passes the GAK1 long-term oceanographic measurement site on the Seward Line. The two sets of measurements agree well in both temperature and salinity.

Community Involvement/TEK & Resource Management Applications:

The Alaska Marine Highway System (AMHS) has cooperated with the project by granting permission to install instruments on the ferry *Tustumena*. AMHS Port Engineering staff and the ship's captains and crew assisted in various ways and have hosted us during system maintenance. A computer display in *Tustumena*'s passenger lounge gives project background, acknowledges EVOS/GEM and shows maps of the ship's position and oceanographic variables measured underway. A US Forest Service naturalist utilizes our computer display in interpretive lectures.

Information Transfer:

(a) Publications – none to date

(b) Conference and workshop presentations:

E. D. Cokelet, A. J. Jenkins, W. S. Pegau, C. W. Mordy and M. E. Sullivan "Biophysical Observations Aboard an Alaskan State Ferry", presentation at NOAA/NMFS/Auke Bay Lab., 16 Nov. 2005, Juneau, AK.

E.D. Cokelet, A.J. Jenkins, W.S. Pegau, C.W. Mordy and M. Sullivan, "GEM Biophysical Observations Aboard the Alaskan State Ferry *Tustumena*", poster presented at Alaska Marine Science Symposium, 23-25 Jan. 2006, Anchorage, AK.

(c) Data and/or information products – see website: http://www.pmel.noaa.gov/foci/GEM/alaska_ferry

Budget:

Expenditures were in line with the projected budget. NOAA provides matching funds for one Principal Investigator's salary as mentioned in the original proposal.

