Recent trends in waters of the subarctic NE Pacific: Cooler and fresher in summer of 2006

By William Crawford and Peter Chandler

Shore station temperatures

Ocean waters cooled through the late summer and autumn of 2006 at almost all shore stations in western Canada. **Figure 1** presents a time series of temperature at Amphitrite Point on the west coast of Vancouver Island. Temperatures fell below normal at several periods in the first half of 2006, and remained below normal after mid-August.

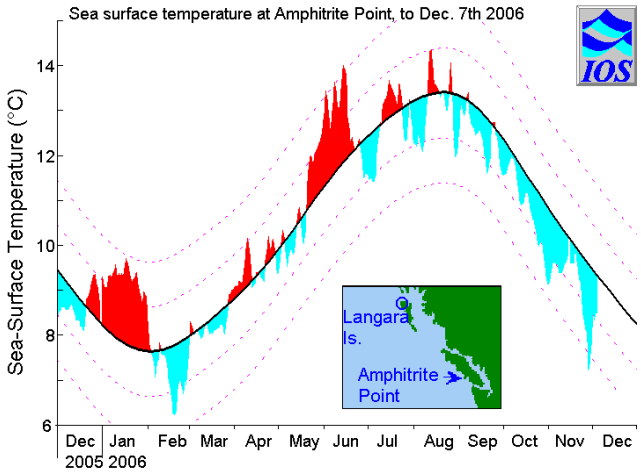


Fig. 1 Daily temperature at Amphitrite Point on the west coast of Vancouver Island. Black curve denotes the average annual cycle of temperature for the past 65 years; red and blue show measured temperatures above and below the annual cycle. (Figure provided by H. Freeland; updates are available at: http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/sst/default_e.htm#)

The steepest declines in temperature were along the west coast of Vancouver Island and at stations on the inshore waters to the north. Declines were less significant in the Strait of Georgia, and at Langara Island at the northwest point of the Queen Charlotte Islands (see inset to **Fig. 1** for location).

Amphitrite Point and Langara Island are two of fourteen Canadian shore stations with daily samples of temperature and salinity. The longest time series began at the Pacific Biological Station in Nanaimo in 1912, with additional stations added in the 1930s and 1960s. Details and data can be found at http://www-sci.pac.dfo-mpo.gc.ca/osap/data/Search Tools/Searchlighthouse_e.htm.

Mid-ocean temperatures

Surface waters of the Gulf of Alaska turned cooler in the summer of 2006, following the very warm summers of 2004 and 2005. **Figure 2** reveals this return to normal through a sequence of plots of temperature anomalies at 10 metres depth for the summers of 2005 and 2006, plus the winter of 2006. Temperatures at 10-m depth were selected to enable a better comparison between ship-based and Argo measurements, and to avoid waters stirred at depths above 10 metres by vessels while on station.

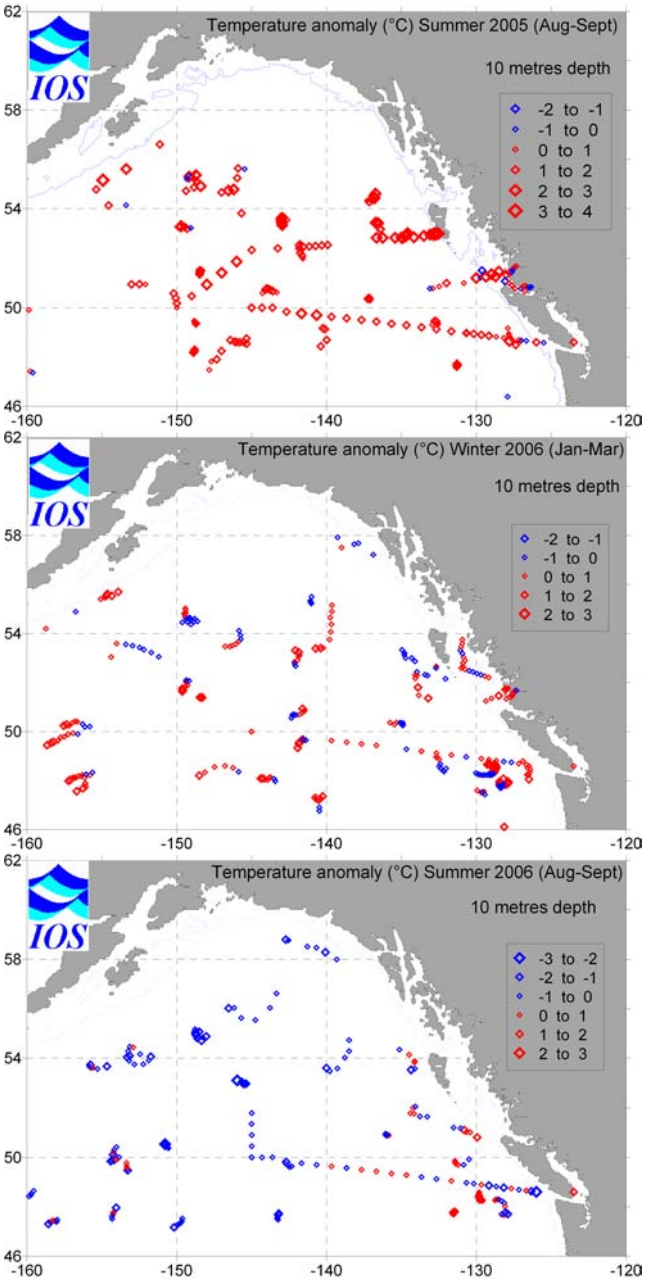


Fig. 2 Anomalies of temperature at 10 metres depth in the Gulf of Alaska from summer 2005 to the summer of 2006. Symbols denote negative (blue) or positive (red) anomalies in degrees Celsius. Each symbol represents a single profile from a research vessel, or by an Argo profiler.

Anomalies are computed relative to climatology of all observations in the U.S. and Canadian data archives. This climatology covers shelf, inshore and deep-sea regions of the Gulf of Alaska east of 160°W. Summer includes the two-month interval of August 1 to September 30, avoiding the month of July when surface temperatures are still warming through most of these regions. Winter extends through the three months of January 1 to March 31. Plots of temperature and salinity climatology are available on-line at http://www-sci.pac.dfo-mpo.gc.ca/osap/data/alaska/default_e.htm.

This decline in the warm anomalies began after the record-high temperatures observed in the gulf in previous summers. For example, temperatures measured between 10 and 50 m below surface along Line-P in the summers of 2004 and 2005 were two of the four warmest in almost 50 years of sampling along this line. (Line-P extends from the coast to Ocean Station Papa at 50°N, 145°W. It is evident in all three panels of **Figure 2**).

Salinity

Near-surface salinity in the summer of 2006 remained slightly below the long-term average through the Gulf of Alaska, as noted in **Figure 3**. Lowest salinities in the 10 to 50 m layer along Line-P were observed in both 1992 and 2003; highest salinity in the nearly 50-year-long record occurred in 1999. Between 1999 and 2003, salinity along Line-P declined by 0.4 psu, the steepest decline over the entire half-century record. A preliminary analysis of this decline attributes it to an increase in westerly winds from 1999 to 2002 that deflected the low salinity water of the Alaska Current toward the North American coast.

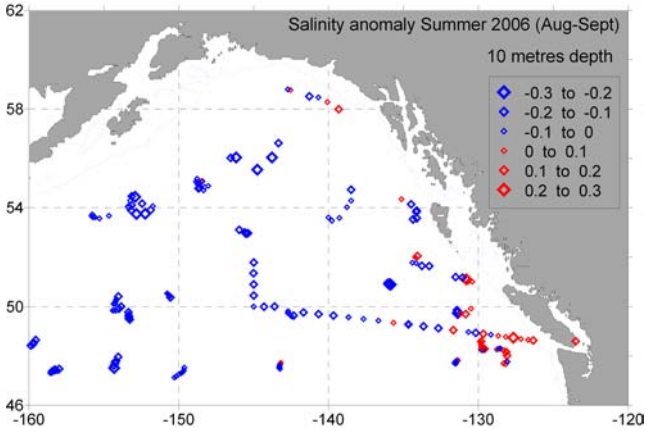
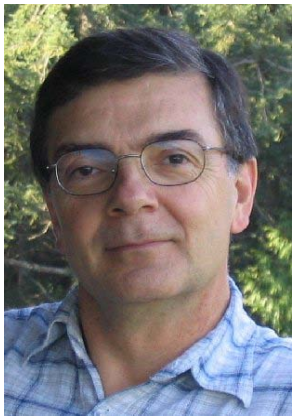


Fig. 3 Anomalies of salinity at 10 metres depth in the Gulf of Alaska for the summer of 2006. Symbols denote fresher (blue) or saltier (red) anomalies. Each symbol represents a single profile from a research vessel, or by an Argo profiler.

Salinity anomalies were slightly lower in offshore regions of the Gulf of Alaska than in waters near Vancouver Island in the summer of 2006, as can be seen in the distribution of positive and negative anomalies in **Figure 3**.

Salinities at shore stations along the west coast of Vancouver Island and to the north increased slightly through 2006. Three stations in the Strait of Georgia measured salinities well above normal in the summer, with anomalies of +3 to +4 psu from July to October. We expect these high values are due to the very low runoff of the Fraser River through these months, combined with a dry summer and early autumn.



Dr. William (Bill) Crawford (crawfordb@pac.dfo-mpo.gc.ca) works as a research scientist for Fisheries and Oceans Canada at the Institute of Ocean Sciences (IOS). Bill leads the State of the Ocean Section of IOS, researching the movement and impacts of moving water masses in the Gulf of Alaska and Canadian coastal waters. He co-chairs the Fisheries and Oceanography Working Group that prepares the annual "State of the Ocean Report" for Canada's Pacific Region. Bill is a member of the PICES CFAME Task Team, serves as the Canadian member of the Pacific Panel of CLIVAR, and is one of two Canadian representatives on the International Association of Physical Oceanography.

Peter Chandler (chandlerp@pac.dfo-mpo.gc.ca) is a physical oceanographer with Fisheries and Oceans Canada, also at IOS. Peter manages the shore station program that records daily temperature and salinity at fourteen locations along the western coast of Canada.