Anomalously cold conditions on the northern Gulf of Alaska shelf in spring 2007

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1) Introduction
The 37-year temperature and salinity time series from the coastal hydrographic station GAK1 on the northern Gulf of Alaska (GOA) shelf and NCEP meteorological data are used to describe the anomalous cooling of the winter 2006-07. That cooling interrupted a ~1°C/30 yr increase in deep (>150 m) temperatures on the shelf and resulted in spring 2007 temperatures being >1°C lower than normal throughout the water column. The deep temperatures were the lowest observed since 1973. Spring salinities were also anomalously, being fresher at depth and saltier at the surface, and consistent with abnormally strong winter mixing and decreased coastal freshwater discharge. While anomalies in winter heat fluxes, wind mixing, and downwelling in the winter 2006-07 contributed to the cooling, it also appears that low winter runoff reduced shelf stratification and enhanced deep mixing. Our results underscore the sensitive dependence of temperature distributions on salinity for this shelf. Anomalously low temperatures persisted through fall and finally increased in December 2007.

2) Cold GAK1 waters in May 2007
- While May profiles in recent years were warmer than the historical mean, May 2007 was...
  - anomalously cold throughout the water column (below 10 m) (Fig.2)
  - saltier than normal above 150 m
  - fresher than normal below 150 m
  - less stratified than normal

3) Summary and Conclusion:
Spring 2007 conditions on the northern GOA shelf included: 1) anomalously weak stratification, 2) the coldest temperatures in ~35 years, 3) anomalously high salinities in the upper 100 meters and 4) anomalously low salinities at depths >150 m.

Responsible mechanisms include:
- A weakening of shelf stratification (by downwelling and wind mixing) early in winter, e.g., November 2006;
- Low air temperatures and strong winds that induced vigorous cooling and implied reduced coastal runoff;
- Mean monthly runoff between November 2006 and March 2007 was 12000 m³/s; only 60% of the normal winter runoff;
- Low runoff increased upper ocean salinities, weakened along-shelf flow and thus northward heat transport by the Alaska Coastal Current (Weingartner et al. 2005), and reduced stratification over the inner shelf;
- anomalously strong March downwelling-favorable winds that enhanced mixing and cooling at depth

Potential ecosystem consequences are:
- Nutrients were likely more abundant in the spring euphotic zone due to weak stratification; metabolic rates affected by low temperatures

The Cold Temperature Anomaly may strengthen this winter
- La Niña is expected to continue into spring 2008 and the Arctic Oscillation has been trending toward negative values. Both indices tend to result in cooler and saltier conditions on the GOA shelf;
- Anomalously low temperatures were observed through fall 2007 at depths below 100 m on the shelf. Thus we are entering the cooling season with temperatures below normal.

References: Royer, T. C. and C. E. Grosch, 2006, Ocean warming and freshening in the northern Gulf of Alaska, Geophysical Research Letters, 33 (16)

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2a) Cold GAK1 waters in May 2007
2b) November 2006: The start of the cooling!
3) Summary and Conclusion: