On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf

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1) Introduction

The 40-year temperature (T) and salinity (S) time series from the coastal hydrographic station GAK 1 on the northern Gulf of Alaska (GOA) shelf, NCEP meteorological data, and moored T/S records from GAK 1 are used to describe the anomalous cooling that began in the winter of 2006-07 and continued through winter 2008-09. The recent cooling halted a ~1ºC/30 yr increase in deep (>150 m) temperatures on the shelf and recent spring temperature anomalies were ~1ºC over much of the water column. Key variables that regulate the late winter temperature distribution are winter air-sea heat fluxes AND runoff, which sets the vertical stratification (Janout et al., accepted). Hence fluxes of salt or freshwater have a profound influence on mixing and the temperature distribution on this shelf. The winter of 2008-09 appears unusual in that the shelf developed anomalously strong stratification below 150 m due to high salinity, which prevented the deeper waters from cooling substantially. The source of the high salinity was enhanced upwelling (western Gulf) and reduced downwelling (eastern Gulf), which forced saline slope water onto the shelf.

Multiple regression results indicate that 81% of the deep temperature variance is accounted for by:
- air-sea heat fluxes and winter discharge!
- while other variables are less important

Above normal air temperatures occur with strong Aleutian Lows (centered over the Aleutians) that transport warm and moist oceanic air from southern latitudes to the northern GOA.

Below normal air temperatures occur with a less pronounced low pressure system at the head of the Gulf, that causes advection of cold and dry continental air over the northern GOA.

Winter Air-sea heat fluxes are greatest in Shelikof Strait and Prince William Sound and smaller over the basin, SE Alaska and the outer shelf.

Summary:
1. The winters of 2006-07, 2007-08, and 2008-09 were unusually cold and comparable to the early 1970s.
2. Deep (>100 m) cold temperature anomalies depend upon strong air-sea heat fluxes that cool the ocean and low winter runoff, that permits deep mixing.
3. However, deep cooling in 2009 was inhibited by deep stratification established by the intrusion of saline slope onto the shelf due to weak downwelling winds in the eastern Gulf and upwelling winds in western Gulf.
4. Surface temperature anomalies are not a good index of deep temperature anomalies on this shelf.
5. Cold winters (high heat loss and low runoff) are characterized by a weak low in the northern Gulf. Warm winters (low heat loss and high runoff) are characterized by a strong low centered over the Aleutians.
6. There are large spatial gradients in winter air-sea heat loss.

Heat fluxes in Shelikof Strait are 1.5-2.5 times greater than elsewhere on the shelf and basin!!

References:


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