On the nature of the 2006-07 cooling on the northern Gulf of Alaska shelf

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Observation: Coldest ocean temperatures in 35 years on northern Gulf of Alaska (GOA) shelf in winter 2006/2007

Question: How did it happen?

Data Sets:
NCEP
NDBC meteorological buoys
38-year GAK1 hydrographic record
Northern Gulf of Alaska (GOA) circulation

Weingartner et al. 2005

Shelf dominated by:
- Alaska Coastal Current
- Coastal freshwater runoff

GAK1
- 1970-present
- 38 years of CTD casts (~monthly)
- 9 years of moored T & S data

Weingartner et al. 2005
The trend has been:

Warming (0.8 °C) and freshening (0.1) of northern GOA during last 3 decades (Royer and Grosch 2005)

Consequences on:

Stratification, nutrients, timing of bloom, metabolism, etc.

Transition in ecosystem:

early 1970’s  present

Anderson et al. 1997
We ask:

1) How does this cooling compare with other years in the GAK1 record?

2) When and why did the cooling begin?

3) What were the main forcing mechanisms?

4) Interannual variability or will it persist?
Warm periods:
- Strong Aleutian Low
- Northward advection of warm oceanic air ("Pineapple Express")

Cold periods:
- Two weak low pressure cells
- Advection of cold continental air

(Similar figures found in Rodionov et al. 2008)
How do the 2007 ocean temperatures compare with previous years?

Early 1970’s and 2007: cold upper and lower layers

Mean temperature anomaly

Upper layer (0-100 m)

Lower layer (100-250 m)
November 2006: The beginning of the cooling

- Cold north winds
- Downwelling winds
- Downwelling lowers deep salinity
- After downwelling stops, inflow (upwelling) of cold, saline water
- GAK1 cooled from top and bottom by end of November

1.) Nov: Preconditioning
2.) Dec-Feb: “normal” winter cooling
3.) March: renewed strong cooling (3rd coldest March on record)
Common features for cold water winters (1970’s & 2007):

- Strong heat loss
- Strong downwelling
- Strong wind mixing
- Low coastal runoff

Combination of several forcing variables important

Coastal runoff regulator for deep water temperatures
What did we learn?

- Coastal runoff impacts GOA’s T and S
- Deep mixing of cold signal combined effort of downwelling and weak stratification
- Extreme and late events important for spring cooling (November ‘06 and March ‘07)
Will the cooling persist? --- What should we expect for GAK1 in spring 2008?

Present conditions this winter ...
... suggest another cold spring in 2008

- GAK1 already cooler at beginning of winter
- Moderate/strong downwelling
- Developing La Nina
- Extreme cooling events in January/February

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Questions?

More questions or comments:
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For info and data on GAK1:
http://www.ims.uaf.edu/gak1/