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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?

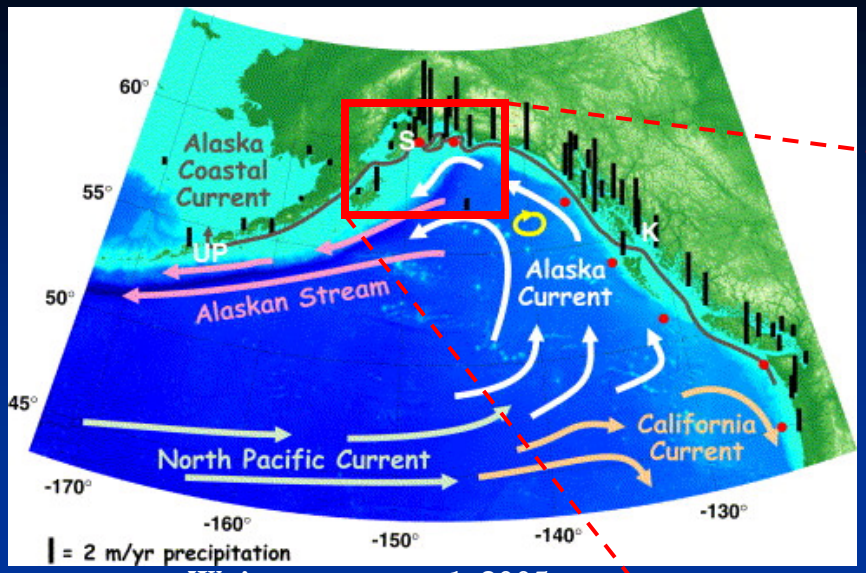
Data Sets:

NCEP

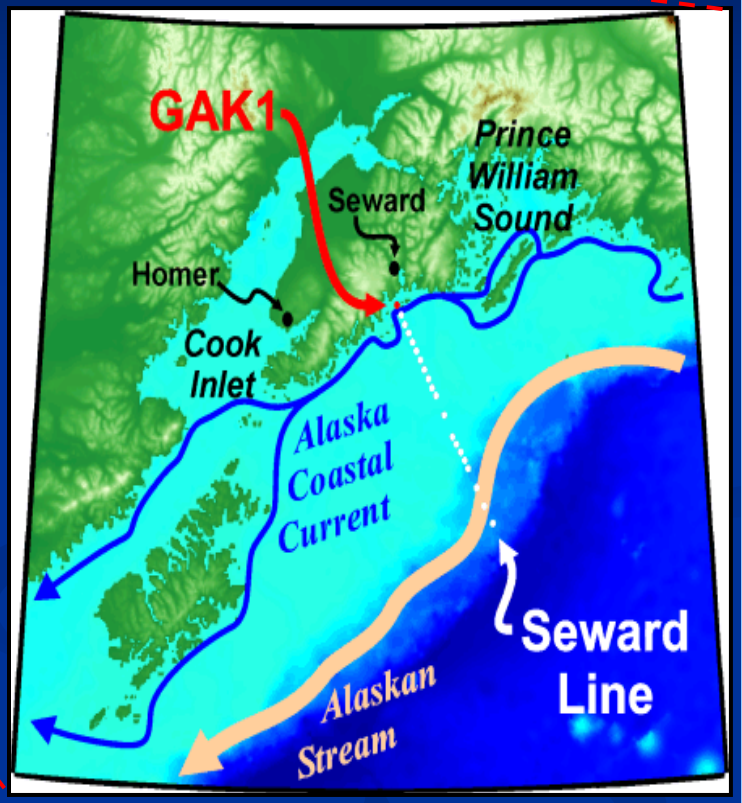
NDBC meteorological buoys

38-year GAK1 hydrographic record

Northern Gulf of Alaska (GOA) circulation



Weingartner et al. 2005



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

The trend has been:

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

Consequences on:

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

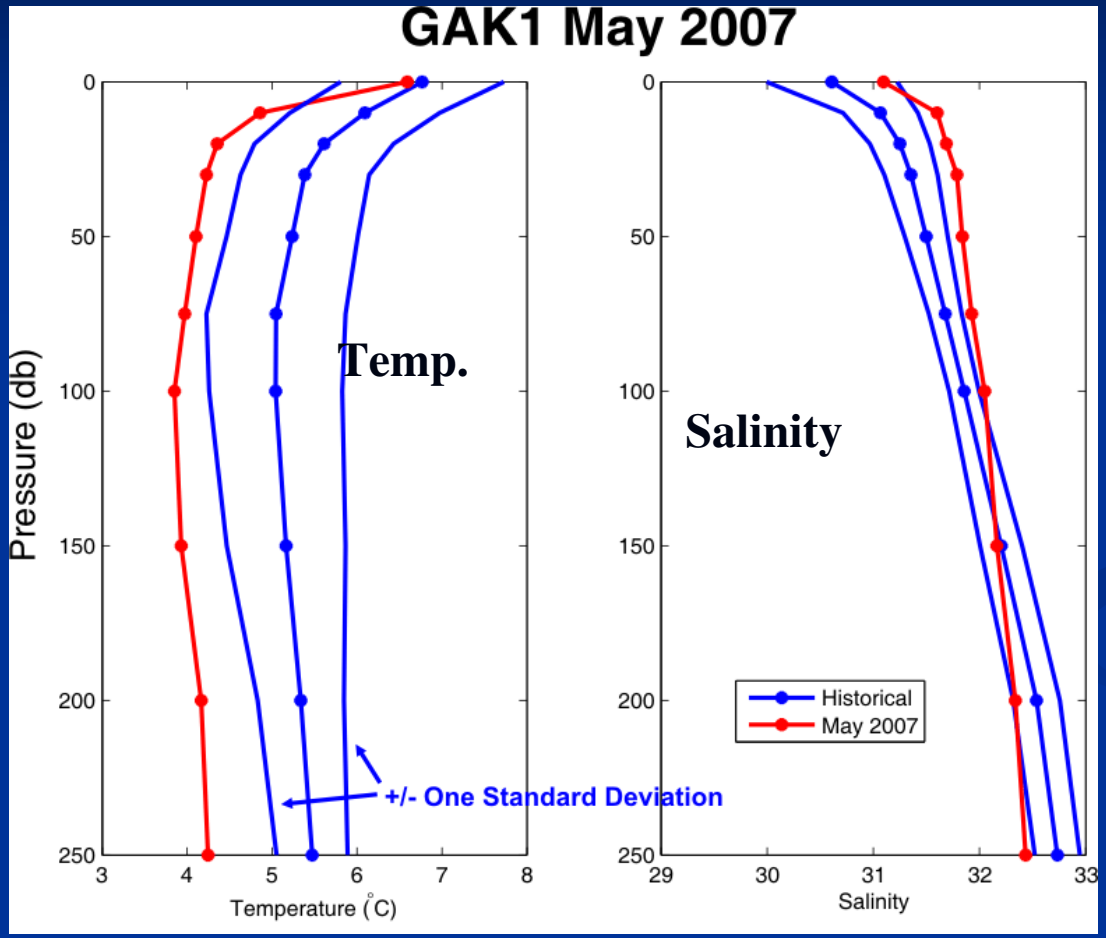
Transition in ecosystem:

early 1970's → **present**



Anderson et al. 1997

Spring 2007: Lowest temperatures at GAK1 since the early 1970's



We ask:

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

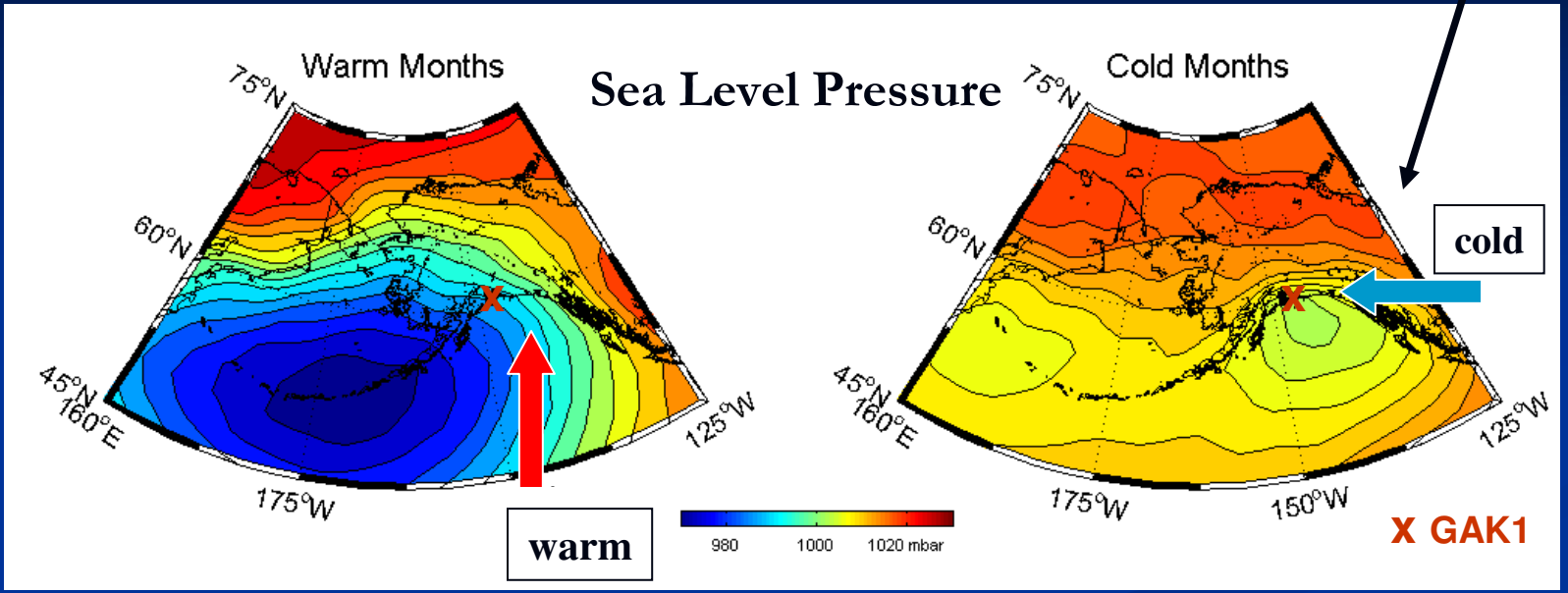
2) When and why did the cooling begin?

3) What were the main forcing mechanisms?

4) Interannual variability or will it persist?

General (NCEP) SLP distribution during warm and cold winter months

Winter 2006/07 dominated by cold pattern



(Similar figures found in Rodionov et al. 2008)

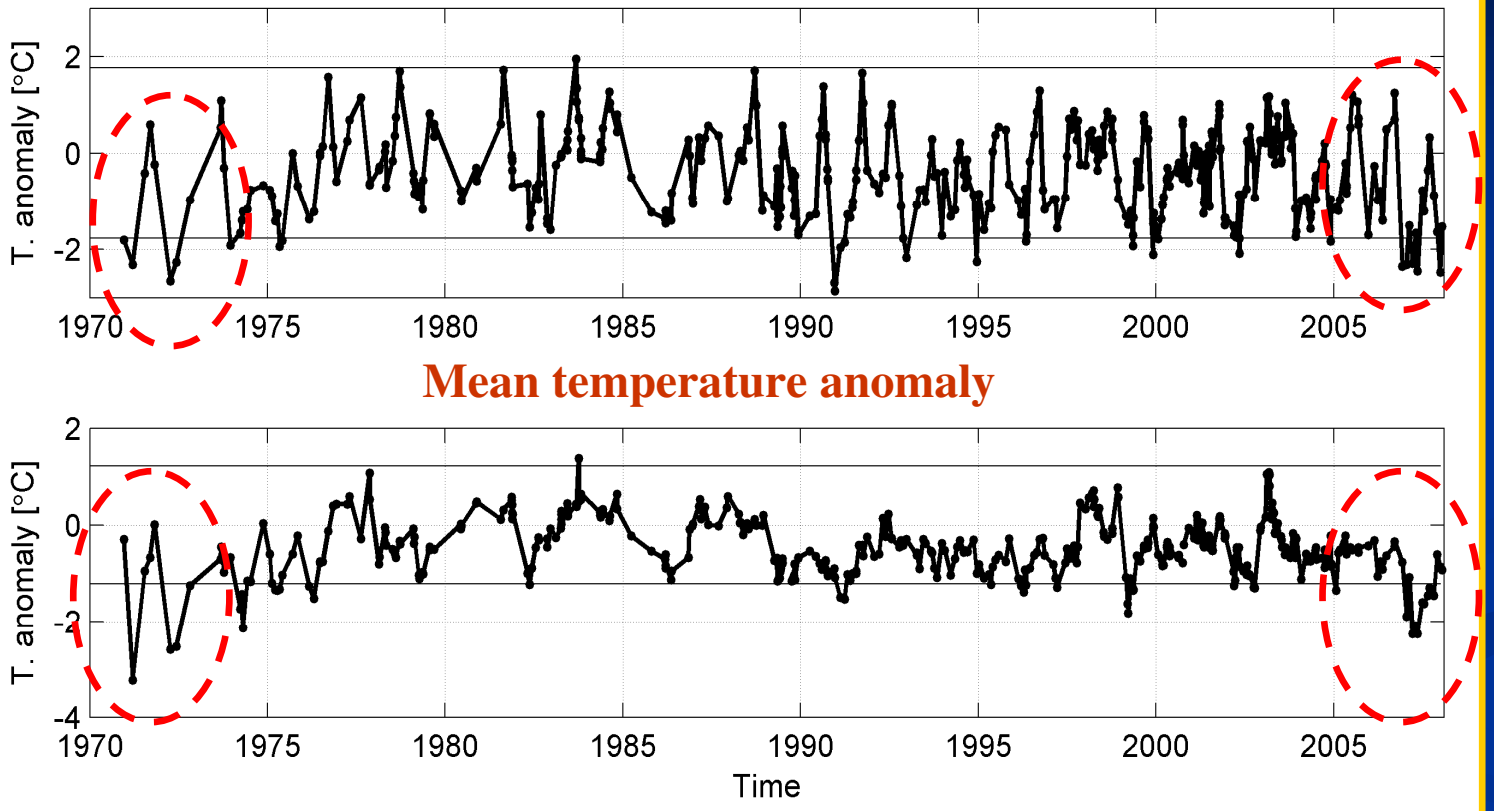
Warm periods:

- Strong Aleutian Low
- Northward advection of warm oceanic air ("Pineapple Express")

Cold periods:

- Two weak low pressure cells
- Advection of cold continental air

How do the 2007 ocean temperatures compare with previous years?

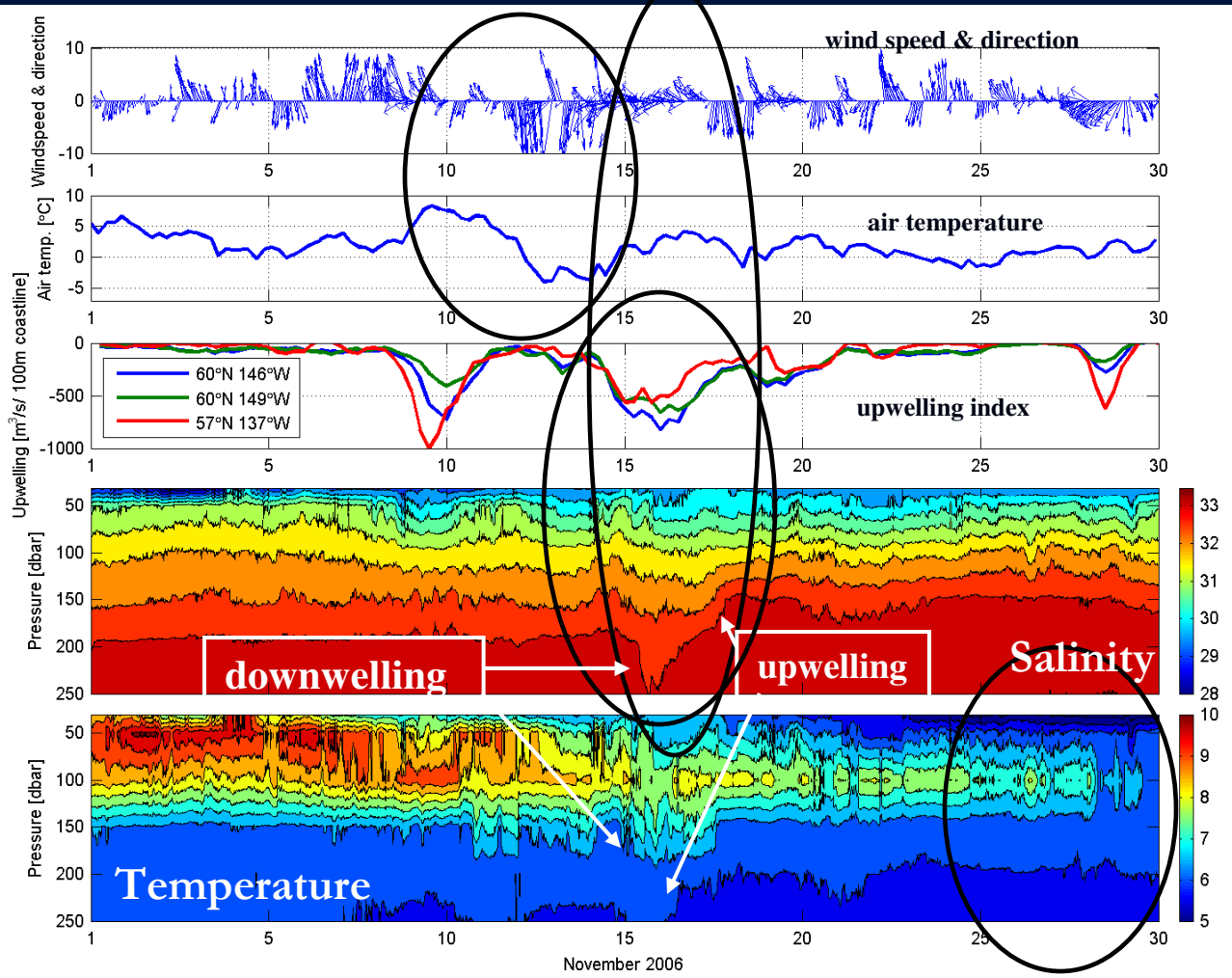


Upper layer (0-100 m)

Lower layer (100-250 m)

Early 1970's and 2007: cold upper *and* lower layers

November 2006: The beginning of the cooling



-Cold north winds

-Downwelling winds

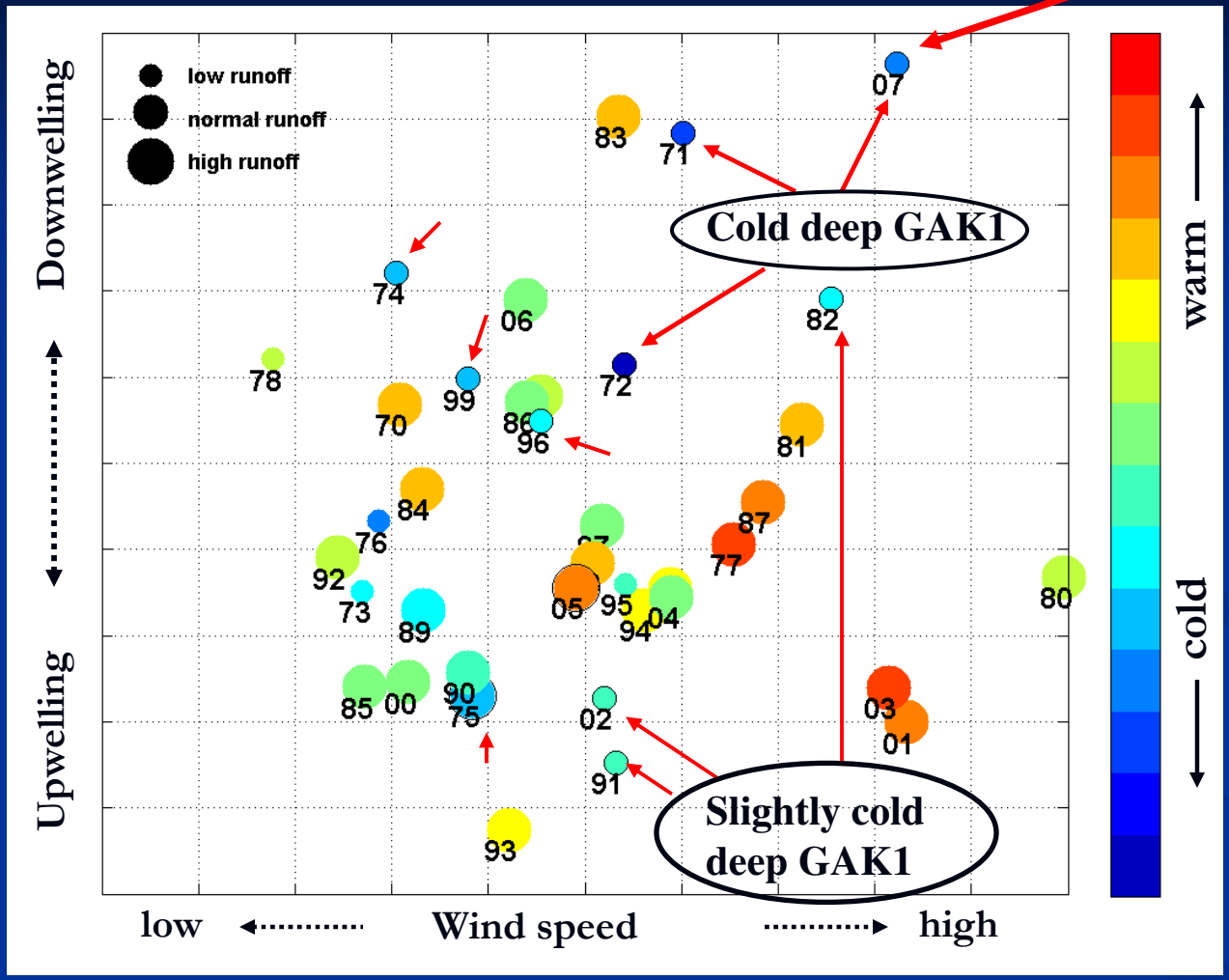
-Downwelling lowers deep salinity

-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)

Mean winter (Nov-Mar) conditions 1970-2007



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

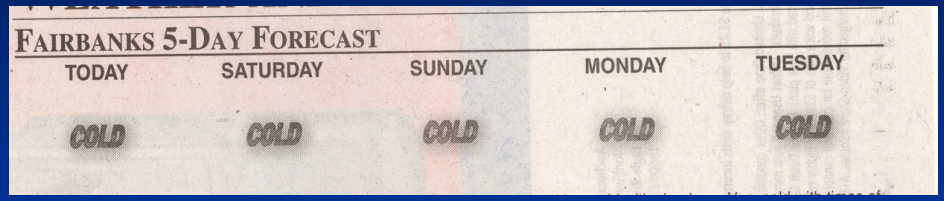
-Extreme *and* late events important for spring cooling (November '06 and March '07)

Will the cooling persist? ---
What should we expect for GAK1 in spring 2008 ?

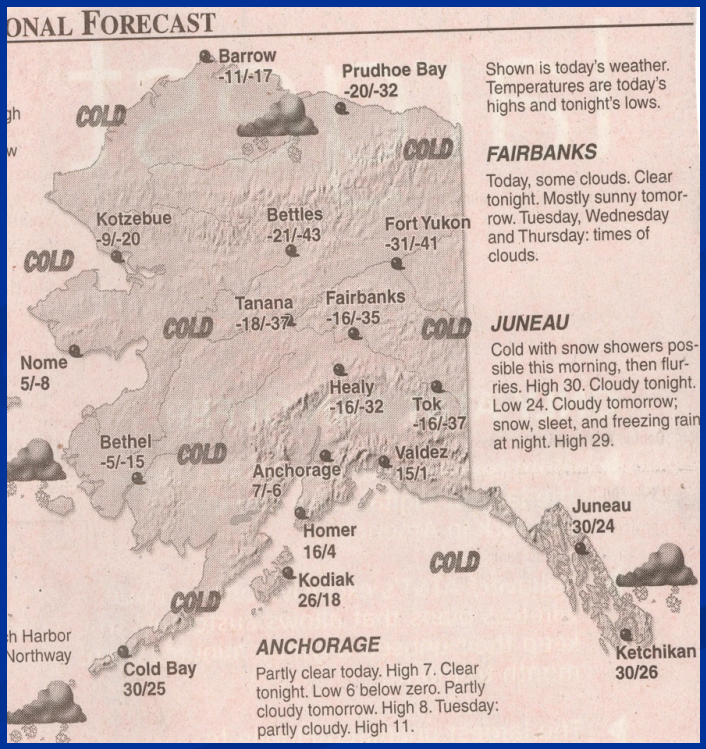
Present conditions this winter …

… suggest another cold spring in 2008

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



Fairbanks Daily News Miner, 1 February 2008



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-NCEP data (NOAA-CIRES Climate Diagnostics Center, http://www.cdc.noaa.gov/)

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For info and data on GAK1:
http://www.ims.uaf.edu/gak1/