Temperature controlling processes and the recent cooling in the northern Gulf of Alaska

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Alaska Marine Science Symposium
Anchorage, 19 January 2009
Coastal oceanography in the northern GOA dominated by wind- and freshwater-driven ACC

Surface waters in the northern GOA warmed and freshened throughout the last 3 decades (Royer and Grosch, 2006) ...

Temperature

Salinity

Janout et al., in prep.
The cooling extended across the inner and middle shelf in springs of 2007 and 2008

Seward Line Temperature anomalies

Janout et al., in prep.
Recent northern GOA temperatures are the lowest since the early 1970's

GAK1 temperature anomalies 1970-2008

Regime shift 1976/77
Temperature variability impacts all members of the GOA ecosystem ... 

... therefore, we need to understand relevant processes and parameters, such as

a) Air-sea heat flux
b) Salinity stratification
c) Advective heat flux

Anderson et al. 1997

See R. Hopcroft tomorrow morning on recent biological conditions along the Seward Line
Mean winter (Nov-Mar) anomalies 1970-2008

100-250m GAK1 spring temperatures

Air Temperatures

Coastal runoff

Heat fluxes and runoff cooperate to promote deep cooling
The role of Runoff and Salinity stratification

Janout et al., in prep.

- low runoff in early winter
- weak salinity stratification
- deep oceanic cooling after atmospheric cooling events

Salinity is a critical parameter on temperature variability...

- large runoff in early winter
- stronger salinity stratification
- oceanic cooling not as deep
We discussed:
- Air-sea fluxes (atmosphere)
- Freshwater runoff/salinity (atmosphere/ocean) 
  (explain 81% of variance (stepwise regression) in GAK1 spring temperatures)

Next:
- Advective (oceanic) heat contribution
Positive feedback mechanism (reduced heat advection likely contributed to recent cooling)

Estimated contribution of alongshore heat advection to the northern GOA heat budget: ~10-30% (*preliminary*)

**Alongshore heat advection (in the ACC)**

cold conditions = low runoff = reduced alongshore flow = reduced heat transport
Conclusions:

1) Salinity stratification/freshwater runoff is a regulator on deep GAK1 temperatures

2) Early and late cooling events most effective to cause cold spring conditions

3) 2007 cooling amplified by reduced alongshore heat transport (to be continued...)
Outlook for spring 2009:

- GOA is currently entering its 3rd consecutive cold winter

Prerequisites for deep cold spring 2009 are met (i.e. cold fall/early winter, strong cooling events in mid-winter)
Near-future studies...

**Improve understanding and quantification of heat flux variability in the northern GOA**

- using met-buoys to compute air-sea fluxes to determine cross-shelf gradients in heat fluxes

- with that knowledge, use Middleton Island met record (1948-present) to hindcast GAK1 ocean temperature record to 1948
Thank you!

Funding was provided by:
- North Pacific Research Board
- Center for Global Change, IARC
- Exxon Valdez Oil Spill Trustee Council

Dave Leech for braving wind & weather at GAK1 for a monthly CTD cast

Questions?

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