2009 IPY Polar Field School Oceanography Project: An Investigation of the Impacts of Polynyas in Storfjorden, Svalbard

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Abstract

During this investigation students participating in the 2009 IPY Polar Field School used buoy data to study the water mass properties as well as the local tides and currents impacting deep water formation in the basin. The research questions addressed during this study include:

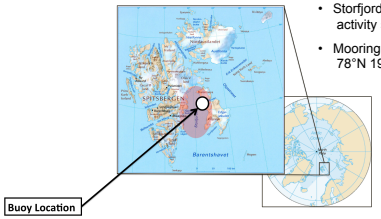
Temperature and Salinity

- How do temperature and salinity values vary seasonally in Storfjorden?
- What impact does local polynya activity have on ocean temperatures and salinity?

Local Tides and Currents

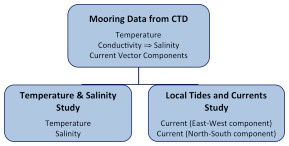
- What is the dominant current direction in Storfjorden?
- Could local currents impact polynya activity and sea ice production?

Region of Interest

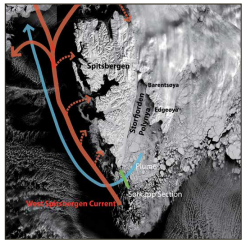


- Storfjorden, Svalbard (polynya activity site)
- Mooring located at approximately 78°N 19°W

Methods



What is a Polynya?



What are they?

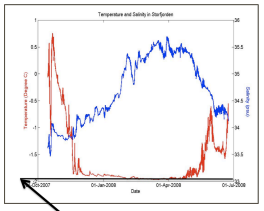
- Open ocean area in sea ice that is influenced by strong winds
- Referred to as "Sea ice factory" due to the amount of sea ice produced
- Locations are determined by ocean currents and the polar jet stream

How are they formed?

- Wind and ocean currents push sea ice leaving an open water surface
- This surface freezes, producing more sea ice and increasing ocean salinity
- Process repeats

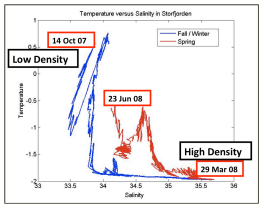
Results: Temperature and Salinity

Temperature and Salinity Timeseries
Temperature (Red) Salinity (Blue)



- From late Oct to early Dec temperatures decrease steadily while salinity remains fairly constant
- From late Dec through early May tempeatures remain constant around -1.9 °C, while salinity increases
- Temperatures steadily increase from late May through July while salinity decreases

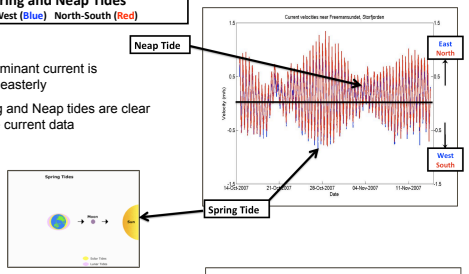
Temperature versus Salinity
Fall/Wintere (Blue) Spring (Red)



- Ocean waters start relatively warm with a low salinity, resulting in a low density water mass
- Through winter months, temperatures hold steady while salinity increases, increasing density
- During spring water starts return to a lower density water mass

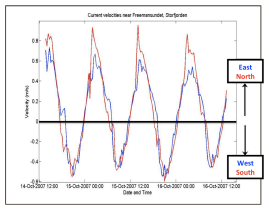
Results: Local Tides and Currents

Spring and Neap Tides
East-West (Blue) North-South (Red)



- Predominant current is Northeasterly
- Spring and Neap tides are clear in the current data

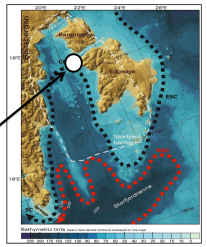
Diurnal Tidal Cycle
East-West (Blue) North-South (Red)



- Currents show daily tides
- Dominant current is Northeast

Importance of Storfjorden

- Research shows that the Storfjorden Basin is responsible for 5-10% of the worldwide deep water
- This deep water is critical to overall global thermohaline circulation and heat transport by the oceans



Norwegian Atlantic Current (red)
Carries warm, saline water from North Atlantic
East Spitsbergen Current (black)
Carries cold, less saline water from Arctic

Conclusions

Temperature and Salinity

- Water temperature drops in fall months approaching winter, while salinity holds steady
- As temperature reaches critical point of -1.9 C° (freezing temperature of seawater) salinity begins to increase, owing to polynya activity and sea ice formation
- Water temperature stabilizes at -1.9 C° in winter months as expected
- Salinity increases steadily throughout winter months with local peaks that support polynya formation and sea ice production in Storfjorden
- As temperatures increase in spring, salinity values decrease, owing to melting sea ice, reintroducing freshwater to the system
- It may be concluded that the formation of deep water would be largest in winter months during peak polynya activity and sea ice production

Local Tides and Currents

- Spring and Neap tides, as well as Diurnal tidal cycle are clearly displayed as expected
- Northeast direction is the overall dominating current, which pushes ice out, reinforcing polynya activty

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