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# Variability of Annual Advance and Retreat of Chukchi Sea Ice

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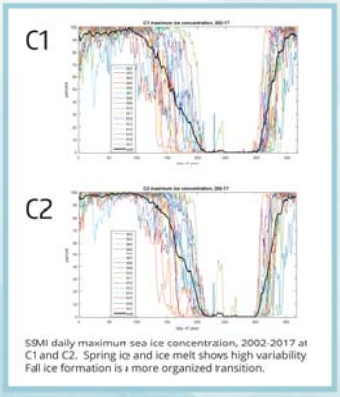
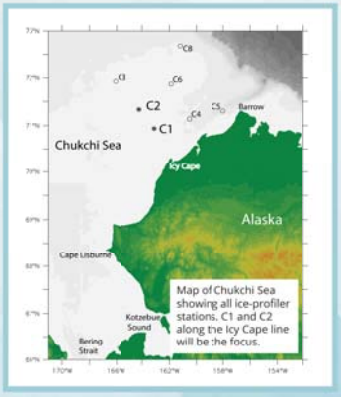
**ABSTRACT**

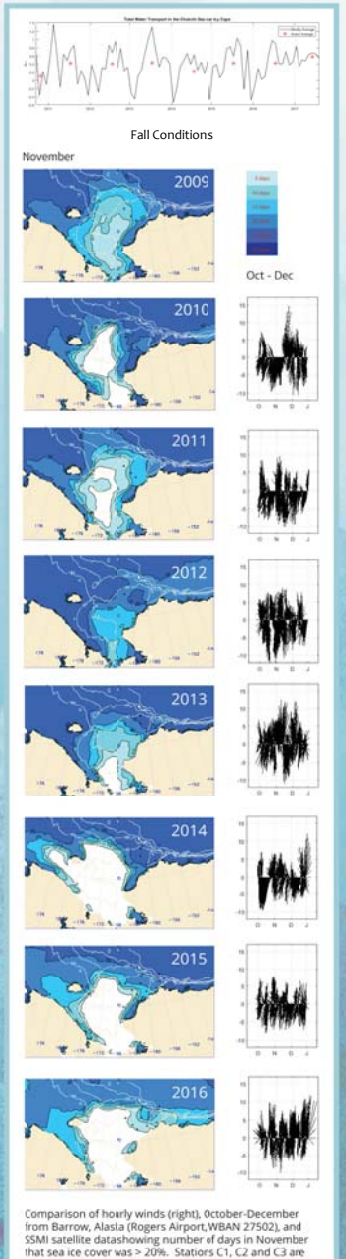
The Chukchi Sea marginal sea-ice zone serves as a conduit between the North Pacific and the Arctic Ocean. On the shallow (~50m), extensive Chukchi Sea shelf, predominantly northward currents, strong winds, and the interplay between various water masses (Bering Sea, locally-formed, upwelled warm Atlantic water) contribute to the annual advance and retreat of sea ice. Year-to-year ice conditions are rapidly changing in this region, influenced by changing atmospheric and oceanographic conditions, and in turn, influencing the ecosystem characteristic of the Chukchi Sea.

Ice draft data have been collected at several locations on the eastern Chukchi Sea shelf from 2010 to the present, using ASL IPS-5 sonar ice profiler instruments. We focus on two stations, C1 and C2, on the Icy Cape mooring line (C1,C2C3). Multiple years of data allow an examination of ice-wave transition patterns critical to annual ice and ecosystem processes. Some deep ice keel observations, up to 30 meters, are noted. We show satellite data, winds, and transport to examine the timing and variability of the ice advance and retreat seasons.

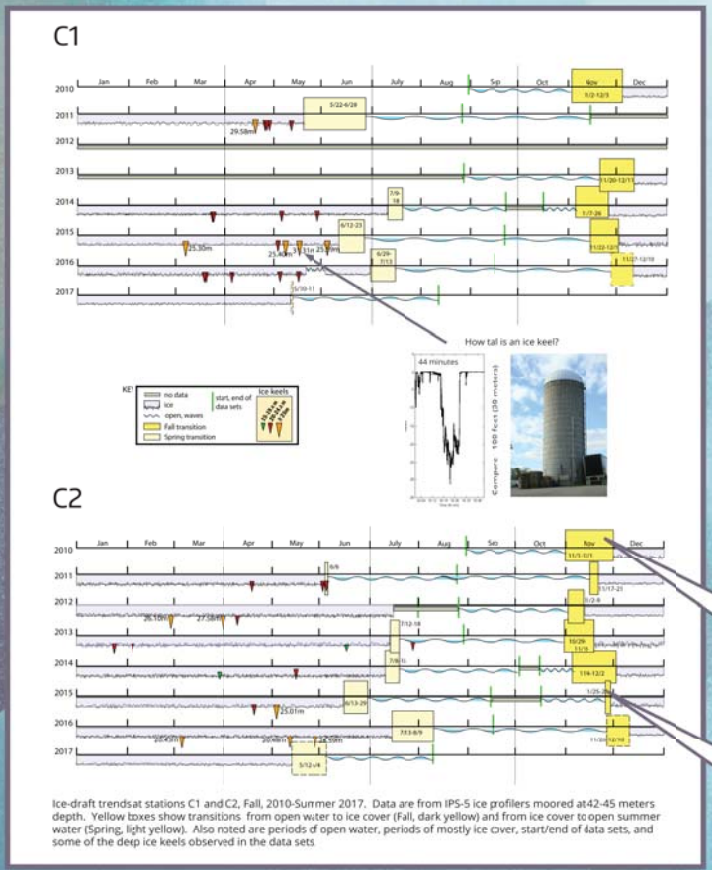



SSMI daily maximum sea ice concentration, 2002-2017 at C1 and C2. Spring ice and ice melt shows high variability. Fall ice formation is more organized transition.



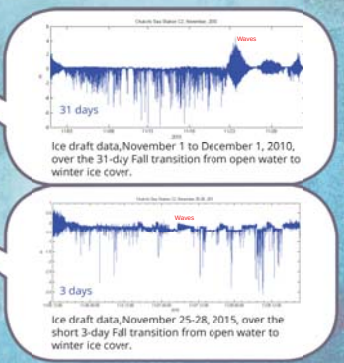

Comparison of hourly winds (right), October-December from Barrow, Alasla (Rogers Airport,WBAN 27502), and SSMI satellite datashowing number of days in November that sea ice cover was > 20%. Stations C1, C2 and C3 are marked with astersks.




Ice-draft trendsat stations C1 and C2, Fall, 2010-Summer 2017. Data are from IPS-5 ice profilers moored at42-45 meters depth. Yellow boxes show transitions from open water to ice cover (Fall, dark yellow) and from ice cover to open summer water (Spring, light yellow). Also noted are periods of open water, periods of mostly ice over, start/end of data sets, and some of the deep ice keels observed in the data sets

## CONCLUSIONS

- Deep ice keels within the sea ice cover occur regularly in the spring to early summer. Ice keels > 25 m were observed in most years. The deepest observed ice keel was 31.3 m (69% of water-column depth) in May, 2015. Moorings were < 10 m tall and deployed belowkeel depth in 40-45 m water.
- Seasonal Transitions are defined by changing wind waves, currentsand ice: the break-up and melting of *spring* ice to *summer* waves; and the formation of *winter* ice cover in late *fall*. These processes are chaotic, involving ice freeze/melt cycles, and cycles of wind variability that move ice and slow currents.
- *Spring* Transition to *summer* waves is variable in time and duration, and occurs mid May to mid July. Ice melts at days lengthen and air and water temperatures increase. It is broken up by winds pushing waves. Larger ice masses and ice keels can pass through the newly opened water.
- *Fall* Transition often occurs in November to early December, and s a more organized process compared to the *spring* transition. Ice can be advected from the north, facilitating cooling of the water-column. As the water cools ice forms in situ. Ice forms and breaks up until enough ice is formed to dampens waves. This process can occur in a few days, or can take a month
- Open water duration and *summer* waves last from 3.5 to 5.5 months. Maximum observed wave heights were ~4 m.




Ice draft data,November 1 to December 1, 2010, over the 31-day Fall transition from open water to winter ice cover.

Ice draft data,November 25-28, 2015, over the short 3-day Fall transition from open water to winter ice cover.

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