The Deep Arctic Ocean as an Indicator of Climatic Shifts

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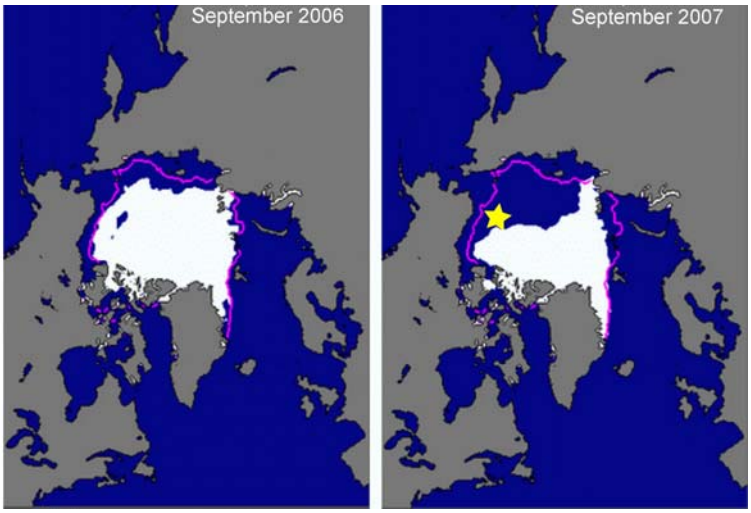
Significant climate changes are presently occurring in the Arctic, evidenced by the recent dramatic decline of Arctic sea ice, warming atmosphere, sea-level rise, and increasing northward ocean heat transport. The most striking changes are associated with sea-ice disappearance in the Canada Basin of the Arctic Ocean. The deepest waters of this basin, which likely originated from dense salty brine expelled during sea-ice formation, have been isolated from shallower waters for at least the past 500 years. I am investigating deep-water dynamics and properties with the goal of understanding what changes in past climate led to isolation of the deep Canada Basin, and what future climate conditions may re-start deep-water renewal.



Sea-ice extent in September 2006 (left) and 2007 (right) when the ice cover was near its minimum extent (figure from nsidc.org/data/seaiceindex). The magenta line indicates the median minimum extent of the ice cover, for the period 1979-2000. The September 2007 minimum extent established new records as the lowest for the period 1979-2007. The star indicates the Canada Basin region.

Through theory-guided analysis, I have shown how large volumes of dense salty brine, formed under conditions of extensive new sea-ice growth, could sink to great depths in the Arctic Ocean. Given sufficient new ice growth, it is possible that the resulting dense flows could ventilate the deep Canada Basin. This result is particularly relevant in today's Arctic where there is less permanent ice cover, and a larger capacity for substantial new sea-ice growth each winter. My preliminary analysis was the basis for a project (with funding from the National Science Foundation) to measure and monitor changes in the deep Canada Basin. To this end, we deployed two deep moored instrument arrays there in summer 2007. These instruments will be re-deployed for an additional year in summer 2008.

Another aspect of my research involves computer climate model simulations. I have examined model output from the Community Climate System Model under characteristic global warming scenarios to ascertain changes to the Arctic Ocean deep water over the next century. My numerical climate model investigations have provided the foundation for future work adjusting input parameters so that models may be used to understand how deep-water renewal events are indicators of a shifting Arctic climate.

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