The Cryosphere Discuss., 5, C75–C78, 2011
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The Cryosphere Discussions

Interactive comment on "Variability and changes of Arctic sea ice thickness distribution under different AO/DA states" *by* A. Oikkonen and J. Haapala

Anonymous Referee #1

Received and published: 22 February 2011

This paper presents data about changes in the ice draft measured by submarines in the Arctic Ocean over a 26-year period divided in two 13-year periods. The paper is generally well presented and references much of the relevant literature. The evidence for a significant shift in the distributions of ice draft is strongly presented. However the links made to the Arctic Oscillation and the Dipole Anomaly are not strong, beyond the simple observation that these indexes have changed over the two periods. While this observation is perhaps warranted, the mention of the AO/DA in the title is probably not.

While much of the relevant literature is cited there are a few publications that I am aware of that should be mentioned as they are highly relevant to the discussion (of

course there may be others I am forgetting). Some of them are quite recent.

Rothrock, D. A., D. B. Percival, and M. Wensnahan, "The decline in arctic sea-ice thickness: Separating the spatial, annual, and interannual variability in a quarter century of submarine data", J. Geophys. Res., 113, C05003, doi:10.1029/2007JC004252, 2008. They give a polynomial regression analysis of the same data set to determine the spatial, seasonal, and secular variability of the mean ice draft.

Kwok, R., and D. A. Rothrock (2009), Decline in Arctic sea ice thickness from submarine and ICESat records: 1958 2008, Geophys. Res. Lett., 36, L15501, doi:10.1029/2009GL039035. They extend the Rothrock eat al 2008 analysis with icesat data.

Overland et al. 2008 The recent Arctic wram period. Tellus, Ser A. 60, 589-597. For a different and more recent take on meridional winds and the Dipole Anomaly.

Lindsay, R. W., J. Zhang, A. J. Schweiger, and M. A. Steele, and H. Stern, 2009: Arctic sea ice retreat in 2007 follows thinning trend. J. Clim., 22, 165-176, doi: 10.1175/2008JCLI2521. They analyze changes in the ice thickness distribution for the Arctic Ocean for 1979-2007.

Lindsay, R. W. and J. Zhang, 2005: The thinning of arctic sea ice, 1988-2003: have we passed a tipping point?. J. Climate, 18, 4879–4894. They point to 1988 as the beginning of the current decline in ice thickness, a decline that began with the big change in the AO but continued after the AO returned to normal.

J. Rodrigues, Beamwidth effects on sea ice draft measurements from U.K. submarines, Cold Regions Science and Technology, Volume 65, Issue 2, February 2011, Pages 160-171, ISSN 0165-232X, DOI: 10.1016/j.coldregions.2010.09.005. They show a much more detailed analysis of the bias in draft measurements due to beam width effects than in Rothrock and Wensnehan (2007).

Lindsay, R. W., 2010: A new sea ice thickness climate data record, Eos, 44, 405–

406. Describes a new data set of all available ice thickness distribution measurements. Means, standard deviations and the full distribution of the ice draft are given for 50-km regions for all submarine cruises, including now a cruise from 2005. Mooring and airborne EM measurements, and ICESat measurements are also included.

Some other minor comments:

Pg 132, Line 5 and in the title: define AO/DA

Pg 135, Line 16: A 2005 US submarine cruise is now available at NSIDC.

Pg 135, Line 23: While there is some link between the AO, the DA, and the ice thickness distribution, it must be remembered that the AO and the DA are statistical constructs and not physical modes, so while they are useful descriptors of the atmospheric circulation they can't really be said to cause anything. While you have showed a loose relationship between the DA and the thickness distribution there is also a general trend in mean ice thickness that continues regardless of the phase of the AO and DA. This fact should be discussed. It is also difficult to make sense of connections between the atmospheric forcing from one year and the ice thickness since the thickness represents the integral of the dynamic and thermodynamic forcing over several years.

Pg 136, Line 22: Mention Rodreguez 2011 and say what the implications are for your analysis.

Pg 137, Line 6: I am concerned that there could be large regional variations in the ice draft, particularly in regions 2 and 4, that might be sampled differently if the cruises covered different areas within the region in the two time periods. Is there a way to show this hasn't happened? Maybe by showing maps of the sample locations for the two time periods and the two seasons would help.

Pg 137, Line 22: You might change the name of the third ice category to "heavily deformed" or "thick deformed" as deformed ice can be found for any thickness.

Pg 140, Line 23: Here and throughout the rest of the paper you have confused ice

volume with mean ice draft. Volume has dimensions of m3, never of m. Please change all the references to ice volume to ice draft.

Pg 141, Line 9: Please define the cumulative mean ice draft more clearly.

Pg 140, Line 10: Percentual → percentage

Pg 148, Line 25: What are the intervals for these trends?

Pg 151, Line 10: I think you may be overstating the differences in the AO and DA

Table 1. I think km of track sampled would be more informative.

Interactive comment on The Cryosphere Discuss., 5, 131, 2011.