Review of: "The effect of changing sea ice on the vulnerability of Arctic coasts." By K. R. Barnhart, I. Overeem, and R. S. Anderson. Submitted for publication in The Cryosphere

General comments:

The paper presents useful pan-arctic data on the growing open-water period in the Arctic Coastal Zone and on the growing fetch at a particular site (Drew Point, Alaska, USA) on the Beaufort Sea. It argues that vulnerability to coastal erosion is most directly related to open water period. The data presented on ice condition and bluff height was also nice. There is undoubtedly a lot of good information in the manuscript.

Specific comments:

Section 5.3.1.

Work done by Chapman et al. (2004, US Army Corps of Engineers) suggests that, when calculating storm surge height, the drag coefficient increases due to the presence of sea ice. This would appear to be inconsistent with some of the work cited in the manuscript.

Section 5.3.2.

The comparison of Drew Point wave measurements and calculations presented in the manuscript (Fig 10) would suggest that the fetch-limited equation for wave height (developed by the Coastal Engineering Research Center, CERC) is actually not very accurate in this situation. I am led to wonder which wave processes, neglected by the CERC formula, might be responsible for the disagreement: wave refraction, wave breaking, wave setup, wave shoaling, duration of wind condition, etc. Alternatively, could it be that incorrect assumptions are responsible for the disagreement such as: the assumption of quasi-static conditions, the use of the Drew Point wind data to represent the ocean wind condition, the use of the 0.15 ice concentration contour to designate the sea ice edge, etc. Some discussion of the limitation of the equation for wave height should be presented. Also, it would be useful to include the equation in the manuscript.

Section 5.3.3.

It is certain that coupling the surge and wave height calculation would in principle lead to improved calculations since that is what happens in nature. Hence, the discussion around this point could be made more concise. Given the weakness in the wave modeling with the CERC equation, the effort to determine whether wave height is "saturated" or not does not seem to be appropriate (if this wave equation is used).

Section 5.3.5.

The first two sentences in paragraph 2 (lines 23-25, p. 2298) are confusing.

“Over the 1979–2012 period we find 799 storms, only 28 of which set water levels up. Over this same time, we find 306 positive set up events.”

The first sentence implies/states that there were 28 water level setup events. The second sentence implies/states that there were positive setup 306 events. It is not clear from the text how you get two different numbers for the same phenomena.

Figure 13.

The plot of the distribution of directional fetch and modeled positive set up is compelling.

Section 6.1.

It is uncertain how you determined that the increase in the open water season is the main driver for increasing coastal erosion rates. You note in various locations that there are multiple additional phenomena contributing to increased erosion rates including: increase in size of large setup events, increase in the frequency of positive set up events, and increased water temperatures. Is it the case that the increase in the open water season is relatively large (i.e., the open water period has basically doubled in length whereas the other phenomena have not changes quite so much)?

p. 2287, line 20. Beaufort Sea is repeated twice.