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Interactive comment on "Observing Muostakh Island disappear: erosion of a ground-ice-rich coast in response to summer warming and sea ice reduction on the East Siberian shelf" *by* F. Günther et al.

Anonymous Referee #1

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Summary This paper analyzes seasonal thermo-erosion dynamics for a permafrost coast in the central Laptev Sea, Russian Federation. It documents the evolution of the small Muostakh Island, which is characterized by ice-rich permafrost and has spectacular erosional features; icy cones, called baydzharakh fields. Analysis uses high-resolution satellite imagery (2010-2012), geodetic field surveys and historical aerial photographs (1951) to quantify longterm coastal change. Thorough comparison of aerial photos of the 1950's and satellite imagery in the period 2010-2012 shows longterm land loss of 0.9 km2 (24% of the island disappeared in the 60 years). In

addition, analysis of stereo-reconstructions show the island subsided ∼1.2m due to melt of excess ice and subsequent drainage of meltwater over this period. The reconstructed rates of thermo-abrasion and thermo-denudation for the warm recent period of 2010-2012 were much faster: average coastal erosion from 1951 to 2012 was 1.8 m/a; recent rates were 1.7 times more rapid at 3.1 m/a. Using time series of local sea ice concentration and air temperatures at nearby Tiksi, the authors apply normalization to coastal retreat observations over seasonal and inter-annual periods to identify their seasonal intensity and to discuss environmental controls on processes involved in coastal thermo-erosion development.

Main Comments Arctic coastal erosion is one of the effects of a rapidly warming Arctic climate. This study provides a well-documented example of Arctic coastal erosion on a small island in Laptev Sea, Russian Federation. The study use particularly thorough reconstruction techniques for assessment of erosion rates and, even more novel, subsidence. Erosion rates were much faster over the last 3 years, as compared to the 60-year background rates. These important results corroborate other studies in the Arctic region, particularly the Beaufort Sea, along similarly ice-rich coasts. It is important to assess and quantify the geomorphic changes in different regions and this paper is a great contribution towards our mapping of the changing Arctic coast.

To then relate the erosion rates to controlling factors is a logical next step; but this paper lacks sophistication in quantifying the controls on erosional processes. The environmental parameters that control erosion are much simplified and the analysis weakens the strong reconstructions of observed erosion rates. I also think that not much new insights are provided by the analysis f the controls. I suggest that this section needs either major strengthening, or needs to be shortened considerably, with a focus on the reconstructions and erosion rate data.

A few suggestions to strengthen the analysis of the controls: 1) To use 'positive degree days' as the control on thermo-denudation is a (likely justified) oversimplification. However, it neglects the variability of temperature, T-air, over the season, and furthermore

neglects the influence of clouds on the actual incoming heat. Since the daily T data is available, I suggest that an improved metric can be formulated that uses all sea-ice free season daily temperatures more specifically. Even a simple integration under the daily temperature curve would already be a more powerful simple metric. A more sophisticated direct melt model for TD with the actual observed T-air for the period 2010-2012 could be formulated potentially. Make sure to show how far is Tisksi from Muostakh Island? Can you justify that this meteorological station is representative for Muostakh Island

2) Probably the major missing process is that thermo-abrasion and cliff-niching only happens when the ocean water is set up against the shoreface by wind-driven waves. Thermo-abrasion will not be a direct function of just the wind-speed, but it needs to include the wind-direction, and is further controlled by fetch and local bathymetry. At least a directional analysis needs to be added that shows what wind directions are important and then the Implicitly the authors assume that wind climate has not changed over the last 5 decades. Is this a reasonable assumption? Are there any trends in the wind data from 1999 - 2012?

3) Why start the sea-ice SSMI-analysis in 1992? Daily or two-daily data is available from 1979 onwards from the National Snow and Ice Data Center (NSIDC). This longert-erm dataset seems much more appropriate considering the long comparison of the aerial photos and satellite imagery? To start the analysis in 1992 seems completely arbitrary considering the time-span of the imagery.

Detailed Edits Abstract: Line 7: What is Ice Complex type? Use Pleistoce Ice Rich Deposits to keep it more general. Line 12: State what length of coastal stretch has been studied in the abstract Line 19: Use ‘positive degree days’ instaed of ‘thawing degree days’ Line 22: Not sure what vertical hourglass distribution means. Maybe use ‘non-uniform’ or anisotropic to keep the statement more general. Line 28: Specify quantitatively what is meant by ‘cyclicity’.

Nice distinction. . .Thermo-denudation TD, thermo-abrasion TA.

Introduction Line 7: add Lantuit et al to the references. Line 14: Interesting, Laptev coast has doubled, just like the Beaufort Coast (e.g. Marsh & Houseknecht, 2007). Line 26: This is all fairly speculative; the discharge of the Lena has increased, but freshening (and decreasing salinity) has a positive feedback on sea ice stability.

Study area: Line 20: sea level regressed Line 17/Fig3: caption. Use ‘dominating’ instead of surpassing.

Data and Methods set-up 3.4 Caption; typo in analyzing 3.4. Please list the available imagery with source, date and resolution in a table, and make clear how long the time-series is and at what intervals you have data coverage. This information now comes relatively late in the paper and is not very organized. 4.3.Line 15. Typo in ‘distribution’.

“As a result, we found that a continuous increase of mean daily Tair by 1 C throughout the TD active period is responsible for an acceleration of coastal erosion by 1.2 ± 0.55 m/a.”

Discussion The comparison discussion with the reported Sea Ice Free days of Markus et al. is not necessary; you do not compare apples to apples. Markus et al. use the entire Laptev Sea as their reference region, you are ‘zoomed in’ to the section around Muostakh Island. Omit this section.

P4129. Overeem shows. . .. Omit the part of the statement ‘over a century’. That paper uses 1979-2009 as their reference time for analysis (SSMI goes back to 1979).

P4131. Please include wind-driven setup into your discussion about storms and wind direction. What wind direction sets up the water highest around Muostakh? That maybe even more relevant than the fetch!

Interactive comment on The Cryosphere Discuss., 7, 4101, 2013.