Referee # 2
Interactive comment on "Deglacial sea-level history of the East Siberian Sea Margin" by Thomas M. Cronin et al. E. Taldenkova (Referee) etaldenkova@mail.ru Received and published: 29 April 2017 - Interactive comment on Clim. Past Discuss., doi:10.5194/cp-2017-19, 2017.

This interesting paper addresses an important question about the last postglacial sealevel variability in the eastern Eurasian Arctic seas in relation to the recently obtained new evidence on glacial ice influence in this part of the Arctic Ocean and its margins. It is clearly written and well-structured, the discussion and conclusions are conceivable.

Response. We appreciate the positive comments and we appreciate the constructive questions about the chronology and micropaleontology addressed in the following sections.

However, I have several concerns about the interpretation of the data presented. 1. My first concern is the dating of sediment sequences. - The authors refer to Bauch et al., 2001 when they explain the application of ΔR=50±100 years for the oldest section in core 4-PC1 from the Herald Canyon that was not affected by Pacific waters. However, in the paper of Bauch et al., 2001 the C1 average ΔR for the Laptev Sea based on the measurements of live molluscs collected prior to 1950 and stored in the Zoological museum was estimated as 370 yrs (see their Table 1).

Response: The average value of 370 years reported in Bauch et al 2001 is the reservoir age, R(t), which is the difference between the tree-ring age of a marine sample and its measured radiocarbon age. This is not the same as ΔR, the regional variation of the marine reservoir age, which is calculated as the difference between the measured radiocarbon age and the marine calibration dataset for the calendar age of sample correction. The mean ΔR value for the samples in Bauch et al 2001 is 53 ± 67 years. We rounded this value and included a larger uncertainty, ending up with ΔR = 50 ± 100 years.
More background information regarding these concepts can be found in the following publication: Reimer PJ, and Reimer RW. "A Marine Reservoir Correction Database and On-Line Interface." Radiocarbon 43, no. 2A (2001): 461–63. doi:10.2458/azu_js_rc.43.3986.
The use of a particular reservoir correction in the Arctic has been contentious for years and we do not deny there may be several choices both for calibration [see Hanslik et al. 2013 QSR] and choice of material dated. For our particular Siberian and Chukchi margin cores, we refer to the papers of Pearce et al. and Jakobsson et al., both in this CP volume, for our rationale in using a lower delta R number (50 yrs) for the pre-Holocene/Deglacial than for the Holocene (200 yrs). In our own text, this is made clear on page 4. In Jakobsson et al. Supplement Fig 1, using 3 different delta R values (50, 300, 500 yrs) for NOSAMS date 131218 results in about 118 year range in calibrated ages

(11,065, 10,788, 10,547 years) at the time the Bering Sea was flooded, roughly 11,000 years ago. The ages on the dated sections of the SWERUS cores may or may not be equivalent to those from the Laptev Sea.

- When estimating the age of the section in core 20-GC from the East Siberian Sea margin I would rather rely on the dating obtained on mixed benthic foraminifers from 56 cm. The whole sediment section is bioturbated, and infaunal molluscs like Macoma could have burrowed into older sediments, like in the case with the datings at 72, 74 and 76 cm. I would suggest for the age model to take the dating on forams at 56 cm (10725 14C), the dating at 72 cm (11050 14C), and then the old dating at 81 cm (11785 14C). Thus, the time span for sediment accumulation would be rather of 12-13 cal.ka, i.e. the YD.

Response: There is only 1 date on benthic foraminifera while all the others are on mollusks, so it is not possible to choose only foram dates. The scenario proposed by the reviewer is highly selective and would exclude mollusk samples at 74 and 76 cm, while including the one at 72 cm simply because it fits better. If the mollusk at 76 cm was burrowed in older sediments, it would have to be >25 cm deep in the sediments. In the case of reworking, it is more likely for too old samples to be included in the section rather than young samples due to deep burrowing. We acknowledge it is not possible to be certain, but we are convinced that the scenario of reworked samples is much more plausible than the scenario that requires deep burrowing for selected mollusk samples.

2. My major concern is the interpretation of the species composition of benthic foraminifers and ostracods in terms of reconstructing past water depths. - First of all, from the point of view of statistically correct interpretation, I wouldn't calculate percentages of species in the samples that contain less than 100 foram tests, but rather present their abundance in the form of tests/g dry weight. In fact, almost all samples from the sediment section of core 4-PC1 below 504 cm contain less than 100 tests (see Supplementary material). The same is true for several samples from the upper sediment units. Ostracods are usually rather rare in sediments from Arctic shelf seas and slope. This is also the case with the samples from the current study. Most of them from both localities contain less than 10 valves. There is a slightly more abundant interval in core 4-PC1 between 504 and 427 for which the authors calculated relative abundances of species, but actually only 4 samples from this interval contain more than 20 valves, whereas 4 samples are barren of ostracods. –

Response. In micropaleontology, more specimens are usually better – standard rarefaction curves show that the number of species recovered varies with different samples sizes (total specimens) picked randomly. But there is a law of diminishing returns on finding more species as you pick more specimens and you can also have too many. In fact, the paradigmatic must-pick "300 specimens" standard for micropaleontology goes back to Imbrie and

Kipp's classic 1971 for CLIMAP and pertained to statistical analyses of what Imbrie thought was needed for adequate SST reconstruction. Of course, Imbrie's deep sea material consisted of nearly solid planktic forams in coretop residues, he had far too many to count and needed a minimal # of planktics to develop and carry out the first transfer functions using factor analyses and multiple regressions.
But getting 300 specimens does not necessarily have bearing on determining whether <u>a stratigraphic [temporal] change in micropaleontological assemblages</u> in a core is significant or not in terms of environmental change. That determination depends on the proportions of any two species changing upcore, better determined by computing binomial confidence limits. This method is well outlined theoretically by a foram expert, Buzas (1990 J. Paleo) and applied to the Arctic (Cronin et al. 2013 QSR). Consider, a change in species proportion from 1 % to 2 % over a 10cm core interval is hardly significant, but if that change were from 10 % to 90 % few would call this insignificant, even if let's say only 100 specimens were picked (randomly). Binomial confidence limits can easily be calculated to see if a change is significant (further reading in Buzas 1990).

All samples from core 20-GC that contain river-proximal foraminifers and euryhaline ostracods Paracyprideis pseudopuctillata and Heterocyprideis sorbyana do also contain abundant river-intermediate species and some relatively deep-water species like C2 Islandiella (Cassidulina) teretis among forams which is an indicator of transformed Atlantic waters in the Arctic (Lubinski et al., 2001),

Response. Yes, *I. teretis (C. neoteretis* of some authors) has been known as an inhabitant of the Atlantic Layer in the Arctic since at least as far back as Green 1960 and Marty Lagoe's papers in the 1970s and maybe Loeblich and Tappan before that. But it is a highly eurytopic species living in a wide variety of habitats: in inland seas (see Cronin's papers in the 1970s & 80s), in various water masses off the Canadian Arctic (see Dave Scott's and Gus Vilk's papers), and in fjords and slopes (see Alve's papers), to mention a few. It is useful as an indicator as general inhabitant of Atlantic Water at 200-1000 mwd, but this is only a limited part of its modern distribution and its stratigraphic distribution is extremely complicated and not clearly linked to oceanographic changes (see Ishman, Poore, Polyak 1996; Cronin et al. 2014).

or ostracods Bythocythere constricta., Cytheropteron arcuatum, C. champlainum, C. porterae, C. paralatissium, C. tumefactum, Krithe hunti (see Supplementary material). Similar assemblage occurs in unit B1 of core 4-PC1. How to explain the co-existence of these ecologically different species? I would rather assign these assemblages to the environments on a relatively steep slope of the East Siberian Sea or Herald Canyon with paleodepths of 50-60 m, but in close proximity to the paleocoast from where the shallow-water species were either transported downslope with slides or ice-rafted.

Response: The reviewer is correct: Multiple factors affect species' distribution in the highly dynamic environments with strong gradients [in light, oxygen, salinity and temperature] as found along the upper continental slopes in the Arctic. While acknowledging possible changes in water depth/environment might be recorded in the ~80-cm of core 20-GC1, and we'd prefer that there were more specimens, the occurrences of *Sarsicytheridea* spp, *Paracyprideis pseudopunctillata*, *H. sorbyana*, *Rabilimis mirabilis*, and *Acanthocythereis dunelmensis* would be interpreted as shelf assemblages by most workers (See Stepanova 2006, Gemery et al. 2015).

A "slide event" assemblage was recorded in core PS51/154-11 from the Laptev Sea slope (Taldenkova et al., 2013) at around 15 cal.ka which contained deep-water foraminifers and ostracods along with river-proximal foraminifers, C. macchesneyi and even freshwater ostracod Iliocypris bradii. According to such an assumption, around 12-12.5 cal.ka the sea-level position in both localities was close to -60 m. –

Response. Downslope transport of microfossils is always a concern especially on the upper slope. We found no evidence [such as fresh water ostracodes] in the 4PC-1 core as Taldenkova did for events like this. In fact the ostracode and foram assemblages in our study are pretty well preserved and standard fare for an Arctic shelf.

The only "true" shallow-water assemblage dominated by river-proximal species is the one in unit B2 of core 4-PC1, but its age is determined by extrapolation and not supported by any AMS14C dating.

Response: We noted the age uncertainty in the revision; calcareous fossils were not abundant enough below this level to obtain an AMS data. The text reads "possibly" in regard to marking the onset of the YD. Core 20-GC1, however, provides a minimum date supported the extrapolation.

In the Laptev Sea, similar fossil assemblages with river-proximal species and Elphidium clavatum among foraminifers, C. macchesneyi, P. pseudopunctillata, H. sorbyana among ostracods and brackishwater molluscs Portlandia aestuariorum and Cyrtodaria kurriana were found in basal sediment units of cores from the outer and middle shelf retrieved from river paleovalleys (Taldenkova et al., 2005, 2008; Stepanova et al., 2012). These assemblages likely dwelled at water depths not exceeding 10 m in former river estuaries during their initial flooding by the transgressing sea. Depending on water depth of these cores that ranges between 60 and 45 m, the ages of these assemblages vary between 12.3 and 10.2 cal.ka. Particularly, in core PS51/159-10 from the Khatanga paleovalley (water depth 60 m) the estuarine assemblage occurs below 400 cm and dates back to 12-12.3 cal.ka.

Response: First PS51/154-11 has a different water depth from our cores (258 vs ~115-120m) and this is crucial for oceanography, proximity to fresh water influx, and sensitivity to rapid SL rise. Our text emphasized this by pointing

out Taldenkova's excellent work on Laptev paleoceanography in the upper Arctic Ocean water masses during deglacial changes related to Atlantic water, the halocline, and stratification.
But it's not directly related to sea –level rise as the PS51/154core site is too deep. Tin contrast, the shift in 4-PC1 within Unit B from 80 to 40 % river proximal is significant and its age is based on dates the upper part of the unit. But the reviewer is correct; we cannot exclude the possibility that "true" shallow water biofacies are not age-equivalent to similar assemblages in other Laptev Sea cores from shallower water depths, as pointed out by the reviewer and we added a sentence to this effect. However, we do not wish to split hairs on river proximal versus river intermediate species; clearly as seen in the original Polyak paper, they are gradational in terms of dominant species, and all live in shallow shelf environments. Upper unit B in our core still has up to 40-50% river proximal species and we doubt experts would disagree with us the assemblage changes at 540-500 cm core depth are real but subtle. We inserted new text on pages 4 & 5 urging caution interpreting faunal changes and emphasizing the qualitative nature of the inferred transgression.

However, the main transition in the 4PC-1 core, which we focused on, is ~ 412-400 cm core depth [Unit B/A boundary] and is dated near 11 ka cal as discussed in detail in the companion paper Jakobsson et al. (Climate of the Past, same volume). The sharp break is not only obvious in the micropaleontology but in magnetic susceptibility, bulk density and proxies like biogenic silica and $\delta^{13}C$ of organic material.

This allows assuming the sea level to be positioned at about -55 m around 12 cal.ka which is consistent with the model estimations and many other lines of evidence from different C3 Arctic regions including the Hope Valley on the Chukchi Sea (Keigwin et al., 2006).

Response: We are not sure where the reviewer's -55 meters level comes from and refer to the Jakobsson et al paper (same CP volume) for a discussion of Keigwin's and other papers on the Bering Strait opening. Importantly, Keigwin's Hope Valley core at 53 mwd only had two C14 ages ~10.9 and 6.9 ka and minimal foram data, and regardless of which reservoir correction is used, the paper says the first marine evidence for transgression at Hope Valley was "as early as" 12 ka. In contrast, our new Siberian margin cores contain much more detail, i.e., physical properties, age control and paleodepth information from two microfossil groups. In contrast, most of the arguments about sea level in Keigwin et al were based on much deeper water Chukchi slope cores. These cores do have excellent paleoceanographic information but they are only indirectly linked to sea level.

Some minor corrections and typos: - The title might include not only the East Siberian, but also Chukchi Sea margin, as the Herald Canyon formally belongs to the Chukchi Sea. –

Response: Done

In Fig. 5, the plot of E. incertum percentage should be shown against X-axis range 0-40%, otherwise the visual impression is that H. orbiculare is more abundant than E. incertum, which is not the case. –

Response: the % axes should be obvious

In the abstract, 6th sentence from below – the word "during" should be shifted to the right position. - P. 6, 6th line from top – "East Siberian Sea margin" should be changed to "Chukchi Sea margin". The same correction should be made for Fig. 7 caption.

Response: Corrected