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Climate of the Past Discussions

Interactive comment on "Long-term variations in Iceland–Scotland overflow strength during the Holocene" *by* D. J. R. Thornalley et al.

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General comment

The ms presents the Holocene evolution of a major deep water overflow in Northern North Atlantic (ISOW). The grain size distribution of 11 sediment cores collected in Iceland basin was analysed to determine the *sortable silt*, i.e. a proxy for current strength. The database is complete with previous measurements on two cores. The full dataset is used to produced a stacked Holocene record of the ISOW strength. The reconstruction is further compared with climate model simulations in order to evidence the main forcing factors. The topic and approach of the ms are interesting. However for my point of view the interpretation is too rapid and does not give sufficient credit to the numerous previous studies dedicated to the similar problematic, i.e reconstruction of deep

circulation changes over the Holocene in North Atlantic. Basic but important sedimentological information must be present in order to attest the continuous sedimentation deposition in area often characterised by strong deep current. I have also many comment on the figures 1 and 5. Finally I'm not shure that CP is the most suitable journal to publish such dataset since most of the interpretations are related to paleoceanography. Based on my expertise, it is difficult to estimate if the results derived from the climate model simulations are sufficient new to be published in CP. I leave this question open. . . Wathever my feeling is that the ms requests a stronger discussion before any publication in CP.

Here are below specific comments :

Title – OK

Abstract – OK

Introduction – OK but I would not say that " we have limited knowledge of the long term behaviour of the overflows " (see line 16). Indeed many publications concern the Holocene evolution of deep circulation, Even quantitative reconstructions of overflow strength are limited, previous studies give some clues on North Atlantic overflows (DSOW, ISOW, NSOW, DSO). I would suggest to enlarge the state of the art in the next section and the discussion in order to better integrate relevant publications (see some suggestions below).

Previous studies

This section is too short. Taking into account the problematic, I suggest to expand it in order to present a more exhaustive state of the art. Here are some suggestions of publications with relevant results for the ISOW behavior.

Line 19 - Fagel and Mattielli (2011) have combined mineralogy with radiogenic isotopes (Nd & Pb) to trace sediment provenance. Event indirect, such approach has allowed to evidence significant reorganization of paleocirculation of the deep North Atlantic

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components in the eastern Atlantic basins: mainly the reorganizations for the Iceland-Scotland Overflow Water (ISOW) and the Norwegian Sea Overflow Water (NSOW). For instance they evidenced that the Late Holocene Optimum period was characterised by enhanced particles driven by ISOW. At 6 kyr BP a pronounced shift in the geochemical isotopic ratio evidence a major change in particle supplies driven by the deep current. This period coincides in Nordic Seas with the end of the Holocene Climate Optimum [e.g., Rousse et al., 2006]. After a period characterized by minor variation, Rousse et al. [2006] emphasized increased oceanic instability linked to climate variations, from 6 kyr in core MD99 – 2275, North Iceland (water depth 440 m). The variability, deduced from magnetic mineral properties, was mainly associated with the renewed activity of the paleo-Irminger Current in relation with periods of enhanced NADW [Knudsen and Eirıksson, 2002]. Mayewski et al. [2004] also evidenced in cores from Iceland Shelf strong fluctuations in grain size parameters after 6 kyr. In Iceland Basin (ODP980, Feni drift, 2179 m), Oppo et al. [2003] reported a long-term reduction in NADW contribution beginning at 6.5 kyr. Those long-term records all demonstrated that a major change in the regional oceanography took place at 6 kyr, most likely in relation with, as suggested by Rousse et al. [2006], the neoglacial cooling of the surface waters observed in the Denmark Strait [see also Bond et al.,1997].

Line 15 – In their paper Kissel et al. [2009] interpreted the decreasing trend of the mineral magnetic content in 6 cores from Iceland Basin as a decrease of the ISOW strength over the Holocene. However, they already noticed that their hypothesis was inconsistent with the short-term variations derived from deep-sea proxies [Bianchi and McCave, 1999; Oppo et al., 2003; Hall et al., 2004; Praetorius et al., 2008]. The geochemical observations in Fagel and Mattielli (2011) in cores from Iceland Basin are rather in favor of a continuous depletion of the detrital supply after the Holocene optimum. It is important to to present in this ms the earlier discussions and contradictions.

Some additional references :

Bilodeau et al. (1994), Benthic foraminiferal assemblages in Labrador Sea sediments:

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Relations with deep-water mass changes since the deglaciation, Can. J. Earth Sci., 31, 128– 138.

Fagel, N., C. Hillaire-Marcel, M. Humblet, R. Brasseur, D. Weis, and R. Stevenson (2004), Nd and Pb isotope signatures of the clay-size fraction of Labrador Sea sediments during the Holocene: Implications for the inception of the modern deep circulation pattern, Paleoceanography, 19, PA3002, doi:10.1029/2003PA000993.

Giraudeau et al (2004), Timing and mechanisms of surface and intermediate water circulation changes in the Nordic Seas over the last 10,000 cal years: A view from the North Iceland shelf, Quat. Sci. Rev., 23(20 – 22), 2127 – 2139, doi:10.1016/j.quascirev.2004.08.011.

Giraudeau et al. (2010), Millennial-scale variability in Atlantic water advection to the Nordic Seas derived from Holocene coccolith concentration records,Quat. Sci. Rev., 29(9 – 10), 1276 – 1287, doi:10.1016/j.quascirev.2010.02.014.

Hillaire-Marcel et al. (2001), Absence of deep water formation in the Labrador Sea during

the last interglacial period, Nature, 410,1073–1077.

Knudsen and J. Eirıksson (2002), Application of tephrochronology to the timing and correlation of palaeoceanographic events recorded in Holocene and late Glacial shelf sediments off north Iceland, Mar. Geol.,191, 165 – 188, doi:10.1016/S0025-3227(02)00530-3.

Kuijpers et al., (2003), Late Quaternary sedimentary processes and ocean circulation changes at the southeast Greenland margin, Mar. Geol.,195, 109– 129.

Mayewski, P. A., et al. (2004), Holocene climate variability, Quat. Res.,62(3), 243 – 255, doi:10.1016/j.yqres.2004.07.001.

Rousse et al. (2006), Holocene centennial to millennial-scale climatic variabil-

ity: Evidence from high-resolution magnetic analyses of the last 10 cal kyrs off North Iceland (core MD99 – 2275), Earth Planet. Sci. Lett., 242, 390 – 405, doi:10.1016/j.epsl.2005.07.030.

Solignac et al. (2004), Holocene sea-surface conditions in the North Atlantic - Contrasted trends and regimes between the eastern and western sectors (Labrador Sea vs. Iceland Basin), Quat.Sci. Rev., 23, 319–334.

Method

Lines 19-25 – The text is not clear. The proposed 1000-yr smoothing method must also be discussed according to the temporal resolution in the different proxy records. You should indicate what is the sampling resolution before you propose temporal average. The ^{14}C ages are reported as supplement data but I think it is crucial to present the age models and their uncertainties. What about the sediment model deposition ? is there any hiatus in the record ? Remobilization of glacial sediments by the renewed ISOW at the end of the deglaciation was for instance observed by Kissel et al.(2009) in the same marine sector.

Sensitivity test – ok

Calibration

As it is stated in the ms, a calibration with only 5 points is not very robust, it just gives a trend. Some additional information must be give about the sediment model deposition for those 5 locations (winnowing ? focusing ?). I'm surprised that they are so few available data. Using cruise report I would suggest to compile a regional map of bottom current strength to give a spatial representation of modern current strength in the study area. In parallel I assume they are more available grain size data on surface sediments from the Iceland basin ? Even the measurements were not performed using the same Sedigraph method, an estimation of sortable silt values may be calculated from raw grain size data. Even the current strength and the SS proxy is not measured

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at the same location, it could give some indication to support the calibration.

Result and Discussion

4.1 proxy

Fig. 1 – Since modern ISOW only influences the sites deeper than 1300 m I would suggest to adapt the depth intervals (1200 to <1300 for the first group). For 1375-1575m how do you explain the important error bars on the average profile? Some error bars are as important as the total range of variation for sortable silt proxy. Do the two records give unconsistent results ? Between 1575 and 1750m the individual trends do not record many fluctuations over the Holocene. What's your interpretation ? Between 1750-2250m the trends are different from one core to another. The figure needs to be deeper discussed in the text. Indeed the stacked curve mainly mimicts the average trend for the cores collected around 1.5 km. The other records are more variable. with a max. Does this depth corespond to the main axis of influence of ISOW ? The stacked curve is characterise by a maximum during the climate Holocene optimum and a progressive decline but a plateau is observed between 5 and 3 kyr BP, an interval consistent with deep current reorganisation (see Fagel and Mattielli, 2011 ; Fagel et al., 2004 and reference therein)

Figure 5 – Why do you not report the curves from Kissel et al (2009), Rasmussen et al .2002) and Hoogakker et al. (2011)? Those papers are cited in the text but it could be useful for the discussion to compare the Holocene record of ISOW strength, even some contradictions have been evidenced. The neoglacial trend is not obvious from the benthic 13C profile (5f). We rather observe a sharp decrease than a stabilization.

4.2 model

Figure 6 – The changes during the climate holocene optimum and the neoglacial have been already suggested in several papers (see suggested additional references). I would suggest to discuss deeper the discrepancies between the model and the proxy

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data (see the end of the section). Are the model trends consistent with other publications ?

Conclusion – OK

References – OK, all citations are listed.

Hoping this review will help to improve the ms,

Your sincerely,

Nathalie Fagel

Interactive comment on Clim. Past Discuss., 9, 1627, 2013.