Response

We want to thank W. Bleuten for the valuable comments on the manuscript. The comments are a great help to improve the manuscript. Below you can find our detailed responses (bold) to the comments:

W. Bleuten (Referee)

General comments

The article present an interesting attempt to define decomposition of peat in three different land unit types by radio isotopes of N and C and classical methods (ash content, C/N, Bulk Density, 14C). The results of the different methods have been compared and combined in order to find clues for determination of peat decomposition rates related to land use. The "semi-natural" type (NW), according to the vegetation composition obviously has been degraded. The question rise if the top "soil" of this NW type can be compared to the grassland types, which both are drained heavily. There is no information about the application level of manure, fertilizer and or lime, nothing mentioned about cattle grazing (and dropping) yes or no. Liming, if occurred, will strongly influence the Carbon and ash content of the top layers and therefore effect the conclusions from the analyses. The location of the cores and the surrounding drainage system development over time could be found in Leifeld et al. (BGD-11-12341-2014 Supplement: Fig S1). It should have been much better if this Figure was included in this paper (I could not find/open any supplement of the article).

Reply: We used stable isotope ratios of carbon and nitrogen as well as ash content, C/N ratio, bulk density and 14-C to indicate peatland degradation. We give an overview of the application of fertilizer and mowing (Page 16830; line 21). For detailed description see Beetz et al. (2013) and Frank et al. (2014). Our sites were neither limed nor grazed. We will add a sentence to this aspect to the study site description. The study sites from Leifeld et al. (BGD-11-12341-2014) are not the same as studied here. Study sites from Leifeld et al. (2014) are situated in Paulinenaue, Brandenburg, Germany whereas our study sites are placed near Cuxhaven, Lower Saxony, Germany. We will add a figure with the study sites in the revised manuscript. There is a supplement to this article available online at the Biogeosciences homepage (http://www.biogeosciences-discuss.net/11/16825/2014/bgd-11-16825-2014-supplement.pdf).

Specific comments Definition of catotelm as used in this paper is missing. What is the top of the soil: top moss heads, top of acrotelm? That is important for interpretation of decomposition: in acrotelm always rather high.

Reply: We will delete the term catotelm in the revised manuscript, because it is only usable in pristine peatlands. For C loss calculations by the combined method we used the data from depth below the lowest water table throughout the year (Frank et al., 2014) in the profiles as reference layer for the C loss calculation. This was done in a similar way in the paper by Leifeld et al. (2014). The top of the soil is the vegetation of the site.

No C-concentration data are presented, only ash content

Reply: C concentrations for each sample are presented in the supplementary table (http://www.biogeosciences-discuss.net/11/16825/2014/bgd-11-16825-2014-supplement.pdf).

Depth in Table 1 is missing: regressions refer to different depths?

Reply: We will add the depths to which the regression analyses were done to table 1.

It is not clear which peat layer(s) of the NW cores are used as reference peat

Reply: We used the samples from the lowest 30 cm of our profiles (i.e. 70-100 cm depth) of the NW cores as references. These samples show no enrichment of ash content. We will add a sentence in the revised manuscript.

Technical corrections

P3: 6-7 Alternatively, under anaerobic conditions with anaerobic decomposition the depth profile may show a slight decrease with depth because of an relative enrichment of 13C depleted lignin Not clear what is meant here. Maybe better use instead of “alternatively”: “However,” And what is “13C depleted lignin” ?

Reply: We will use however instead of alternatively. It should be … because of a relative enrichment of ^{13}C depleted substances like lignin.

12-13 Together, peatland drainage induces a change from a uniform δ13C depth profile to increasing δ13C values with depth. That is valid for catotelm layers, not for acrotelm.

Reply: This is the description of our theoretical concept about the effect of drainage on $\delta^{13}C$ depth profile. We used the depth patterns of $\delta^{13}C$ profiles from the literature and from our own investigations for our theoretical concepts. A water saturated peat soil has a uniform depth profile of $\delta^{13}C$ values (Clymo and Bryant, 2008;Alewell et al., 2011;Krüger et al., 2014) throughout the whole profile and in oxic soils the $\delta^{13}C$ values increase with depth (Nadelhoffer and Fry, 1988). Please see additionally our response to reviewer 1.

25-27 In intensively managed ecosystems, the application of mineral and/or organic fertilizer, with their different isotopic signals, could additionally alter the stable nitrogen isotope signature in soil Also by droppings from cattle and by atmospheric deposition N balance will be influenced, the latter not only in intensively used peatland.

Reply: Our sites were not grazed (we will add this information in the revised manuscript). Yes, not only the intensively used grassland site is influenced by atmospheric N deposition. We discussed the influence of atmospheric N deposition on the $\delta^{15}N$ values in the soil as well as peat vegetation in chapter 3.2 (Page 16835; line 21) in our manuscript.

29-31 Little decomposed peat has wider C/N ratios, reflecting the former plant material, whereas the ratio becomes narrower in strongly decomposed peat owing to a preferential loss of C over N during microbial decomposition. “wider” and “narrower”: low and high? Expected is depletion of N by microbial decomposition and therefore increase of C/N ratio.

Reply: changed to: Little decomposed peat has larger C/N ratios, reflecting the former plant material, whereas the ratio becomes lower in strongly decomposed peat owing to a preferential loss of C over N during microbial decomposition. Please see also our reply to reviewer 6.

P 5 11-12 .. vegetation is dominated by cross-leaved heath (Erica tetralix L.), flat-topped bog moss 11 (Sphagnum fallax Klinggr.), and common cotton grass (Eriophorum angustifolium Honck.). On p10:1 Calluna vulgaris is mentioned to be one of the dominant species. Typically, the presence of heather points at some drainage.

Reply: The vegetation of the near-natural site indicates a mild degradation of this peatland (please see page 16839; line 2).

Where were the cores taken? 16 (GI type)

Reply: Cores were taken close to the former study sites (see study site location in Beetz et al. 2013 and Frank et al. 2014).

..fertilized with mineral fertilizer and manure. What about cattles droppings, liming?

Reply: Liming and cattle grazing was not performed on these sites. We will add a sentence to this aspect in the revised manuscript.

16-17 GI is drained with pipes as well as drainage ditches whereas GE is only drained by ditches Depth of drainage?, depths of ditches? Distances of drains and ditches to the core sites?

Reply: A detailed description of drainage ditch depth and drainage pipes can be found in Frank et al. (2014).

18 At the NW site, the water table was around the soil surface What is meant with "around"? Needs specification.

Reply: The water table was close to the soil surface with a variation of -10 cm to 5 cm during the sampling period by Frank et al. (2014). We will change this in the revised manuscript.

28-29 . . .three peat cores per site were collected in the Ahlen-Falkenberger peatland at NW, GE and GI (n=3). No details of the core sites location properties. Is it expected that the 3 land unit types are homogenous spatially?

Reply: We took three cores per site. The cores of each site show a similar stratigraphy, consequently we expect some spatially homogeneity between the three land unit types. The management of the grassland sites has not changed for more than 20 years (Frank et al. 2014).

P6 13-14 The material remaining after heating is defined as the ash content of the sample. The presence of lime (naturally and or applied for agriculture) is included in Carbon content? Results of Organic Matter or Carbon content and of Bulk Density are not presented in this article which is an omission.

Reply: The sites were never limed. Results of all biogeochemical parameters for every single soil sample are presented in a table in the supplementary material of the manuscript. The results represent the organic carbon content of the peat samples. Additionally, the results of bulk density

as well as C/N ratio are presented in figures in the supplementary material (http://www.biogeosciences-discuss.net/11/16825/2014/bgd-11-16825-2014-supplement.pdf).

P7 5-7 we assume that the ash content in the catotelm is not affected by drainage and ash from the oxidized peat remains at the site and accumulates in the upper layer. The ash content of the catotelm of each individual core is taken as a reference value Not clear what is meant here with “catotelm”. Usually it is dedicated to the permanently saturated peatlayers of pristine bogs. In the bogs described here the lower water table is -40 to -80 cm below the “soil”surface, which means that at least part of the original catotelm fall dry as a result of artificial drainage. What is meant with the “upper layer”? Is that catotelm? Or top of catotelm? It is advisable to avoid the usage of the term catotelm for this study.

Reply: We used the deepest samples of our cores as references. All samples we used as reference are deeper than 80 cm below the soil surface. That’s right the term catotelm in case of degraded peatlands is not usable. We will revise the ash content part and replace the word catotelm. The term “upper layer” will be defined in more detail.

P8: 20-25, p9: 4-5 The interesting differences in d13C increase with depth between the grasslands and the NW type is related to drainage even in the NW site. However, in the (limited) description of the site the water level is said to be “near the surface”. The top layers of the NW site differ substantially to the grassland sites, but this cannot be verified as the article does not give details of the core. Most probably, the top layers of the NW site consists of fresh organic material (acrotelm thickness can be up to 40 cm). In contrary, the top layers of the grasslands consists of already partly decomposed peat (see 14C ages in Fig 2).

Reply: Today the water table at NW is high, but could have been lower in the past due to a stronger influence of drainage activities of the surrounding area. Since the 1990s the NW site is a nature reserve (page 16830; line 13) and may thus be more protected against drainage influence. Yes, the top layers of the NW site differ to the top layers of the grassland sites. The NW site consist of fresh organic material and the grassland site are already more stronger decomposed due to aerobic decomposition. Furthermore, the grassland sites have lost peat deposits from almost 1000 years, which is indicated by the radiocarbon ages at the grassland sites.

In Table 1 the regressions coefficients and slopes between the core sites are compared but for the NW site to a depth of ca. -0.5 m and for the GE and GI sites ca. -0.3 m (depth of -25 0/oo, deducted from fig 1).

Reply: We will add the depth used for regression analyses to every single core in table 1. As we described in section 2.5 (page 16834; line 11) the regression analyses were done until the $\delta^{13}C$ value of -25.0 ‰ was reached.

P9: 20 – p10:20 (3.2 Stable nitrogen isotopes) Here, also the differences between NM and grassland sites are described solely from the analyses. The peat material, in particular of the upper layers are different between NW and grassland sites, which influence the value of the conclusions.

Reply: The results of the stable nitrogen isotope values are presented and discussed in the chapter 3.2 for each land use type. In this part we discuss the influence of the present vegetation types on the stable nitrogen isotope signal (Page 16835; line 23). The material in the upper layers is certainly different between the near-natural and both grassland sites. We found stronger decomposed peat

material in the upper layers at the grassland sites (indicated by low C/N ratios (Fig. S1), higher bulk densities (Fig. S2), high ash content (Fig. 4)) compared to the near-natural site. Furthermore, we could show with the radiocarbon ages that the grassland sites have lost a substantial amount of peat and that the near-natural site has organic matter fixed during the second half of the last century.

P11 (3.5 Ash content and bulk density) 15-16 (Fig. 4). Bulk density increases at this depth and is higher compared to deeper parts of the profiles and 18-19 We interpret this accumulation as being the result of drainage activities in the vicinity of NW during formation of these peat layers There is no information about the presence of charcoal within the peat as indicators of fires at or near the core sites. Fires may explain the peaks in ash content about ca 1880 and ca 1780 (estimated from Fig 4). Also by deposition of mineral soil material spread from arable land by wind may explain the peaks. The conclusion that any increase in ash content result from drainage can be doubtful. 20-21 At both grassland sites, ash content (Fig. 4) and bulk density (Fig. S1) increase strongly in the upper centimeters Could not find Fig S1

Reply: We found no charcoal layer in the peat profiles. The history of the peatland is well documented and there is no mention of fires. While it is true that we have no proof that there were no fires, we are quite confident that we would know if there had been fires. It is, however possible that ash particles from other burning peatlands in the vicinity may have been deposited. In the late 19th century, peat burning was quite common. If mineral soil material would have been deposited on top of the organic soils, we would expect a stronger ash signal also for the natural site, which we didn't find. Hence, it is reasonable to assume that the ash accumulation stems primarily from a preferential loss of organic matter via oxidation although atmospheric deposition cannot be fully excluded as a contributing process. At both grassland sites, ash content (Fig. 4) and bulk density (Fig. S1) are very high in the upper centimetres compared to the lower parts of the profiles. Figure S1 is in the supplementary material of the manuscript (http://www.biogeosciences-discuss.net/11/16825/2014/bgd-11-16825-2014-supplement.pdf).

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