General comments:

The manuscript by Goelzer et al. investigates the impact of ice sheet changes (and resulting freshwater fluxes (FWF)) during the period of 135ka – 120 ka, which includes Termination II and most of the last interglacial (LIG). The analysis is based on a set of transient simulations with the EMIC LOVECLIM1.3 which are forced with somewhat realistic boundary conditions with respect to ice sheet geography and freshwater fluxes. More precisely, they force LOVECLIM1.3 with a reconstruction of the Northern Hemisphere (NH) ice sheets as well as with output of ice sheet models for Greenland and Antarctica. The latter distinguishes the paper from the relatively closely related work the authors published as Loutre et al. 2014. The main result of the paper is that the climate in the Southern Ocean area is crucially affected by the ice sheet changes and associated FWF in the NH through the so-called seesaw effect as well as by direct FWF from melting of the Antarctic ice sheet.

The paper takes up relevant scientific questions regarding the temporal evolution of the LIG climate and elaborates on to which extent FWF (and from which ice sheets) are shaping this climate evolution. The chosen setup and the set of simulations are novel although somewhat rather similar than Loutre et al. 2014. Unfortunately, the present manuscript lacks a thorough analysis and the number of novel results, figures and conclusions is rather limited. The simulated seesaw effect can somehow be anticipated from previous freshwater experiments (e.g., Menviel et al. 2011) and the main conclusion that NH freshwater fluxes crucially affect the evolution of the NH climate including AMOC has already been reached in Loutre et al. 2014. In order to make full use of the simulations and to increase the relevance of the paper, I expect, a more detailed analysis, particularly for the Southern Ocean/Antarctic region. I would prefer to see more results illustrated with figures as the paper in its present form discusses many features in text-form only.

Concerning the formal aspects, I rate the manuscript to be of good quality as it is well-structured and mostly clearly written. In my view, Sections 2 and 5 are sometimes hard to follow and consequently need a revision (see specific comments below). I am very optimistic that a revised version of the manuscript will be a valuable contribution to its research field and should be fit for publication in Climate of the Past.

Specific comments:

A: Similarities with Loutre et al. 2014
As already mentioned in the general section this work seems closely related to Loutre et al. 2014. Consequently, this should be clearly stated in the manuscript and the authors should clarify how the setup and the results advance from the previous work.

It seems that the biggest plus of this study is the inclusion of Antarctic ice sheet changes and FWF. Consequently, it would be very valuable to determine the benefit of this inclusion and therefore provide a detailed analysis of the Southern Ocean and Antarctic surface climate including a comparison with proxies (analogue to Fig. 7 in Loutre et al. 2014). One interesting question is if the agreement with the EPICA Dome C temperature record (Fig. 7h in Loutre et al. 2014) and other proxy records can be improved when implementing the temporal evolution of the Antarctic ice sheet?

B: Additional information regarding the NH ice sheet reconstruction/ ice sheet model simulations needed
Sects 2.1 and 2.2. have the difficult task to describe the rather complex origin of the ice sheet boundary conditions. In its present form it is quite hard to read as it includes many technical details but at the same time lacks crucial information. In my view an additional introductory paragraph in Section 2 which describes the “three ice sheet components approach” (complementing Fig. 1) might help the reader to get a quick impression of your setup without

going through all the details of Sects. 2.1 and 2.2. It would also be valuable to elaborate on the advantages/problems of your approach. Do you think it is a problem that the three ice sheet components (NH, Greenland, Antarctica) are based on different technical approaches and therefore do not necessarily combine to a globally consistent ice sheet/sea level realization?

Section 2.1: Has this NH ice sheet reconstruction been newly created for this study and Loutre et al. 2014? Or is there a reference for this approach/reconstruction which apparently combines geomorphological data with the ice sheet modeling effort published by Zweck and Huybrechts, 2005? More details are needed.

Similarly, it is not completely clear to me if the Greenland and Antarctic ice sheet simulations have been produced specifically for this paper or if they stem from previous publications which can be referenced.

On page 4396, lines 26ff you mention that the Greenland and Antarctic ice sheet models use different sea level information as forcing data. As shown in Fig. 4c, the two sea level curves differ quite remarkably. Why haven't you used the Grant et al. 2012 curve, which you judge to be more accurate, for both ice sheet models? Do you know about the consequences of using two different sea level curves?

C: Ice volume/sea level curve which corresponds to implemented ice sheets
Relating to the previous comment **B** I am missing a figure with the 135ka-120ka ice volume/sea level equivalent for Greenland, Antarctica, the NH ice sheets, and their sum to complement Fig. 3. As the authors claim to force LOVECLIM with realistic ice sheet boundary conditions (e.g., stated on page 4406, line 14) this ice sheet volume/ sea level curve used for the “Reference” experiment should be validated with an observational reference (e.g., Kopp et al., 2009). A respective figure would be very helpful for the reader and illustrate the descriptions on page 4397, lines 16-27.

I am curious if the Antarctic ice volume is growing from 125ka to 120ka as implied by Fig. 2. This seems to be in contrast with the ongoing Antarctic FWF throughout the LIG (Fig. 3b) which I connect with a retreating ice sheet.

D: Questions regarding FWF (Fig. 3)
Moreover, I feel I have to question the massive Antarctic FWF between 128ka and 120ka. A rough calculation for 8000 years of 0.1Sv is equal to a global sea-level rise of ~70m - is this totally balanced by evaporation from the oceans or any other process?

Do the substantial Antarctic FWF truly have no effect on the SH temperature between 128ka - 120ka as implied by the comparison of noAG,noIS in Fig. 5?

Why is the Antarctic FWF so peaked whereas the Greenland FWF is so steady throughout 135 – 120 ka?

Do the implemented FWF (as shown in Fig. 3) completely exclude surface runoff from deglaciated areas (i.e. simulated by the land model) and is this justified? How does surface runoff from land masses compare to ice sheet melting?

E: Extended analysis on the Greenland and Antarctic climate response
A fair part of Section 4 describes temperature responses in Greenland and Antarctica which could be extended by map plots at selected times to provide more details regarding how the temperature evolution differs regionally and to which extent this relates to the FWF.

As mentioned in comment **A** an additional comparison with proxies could clarify whether your “Reference” simulation improves upon the simulations in Loutre et al. 2014. One possibility

would be to evaluate the “Reference” simulation against proxies at first and secondly compare the different model simulations with each other. An extended comparison (e.g., also for the AMOC) of the “Reference” simulation with proxies would also better support the findings in the discussion (page 4404, lines 8-19).

F: Please revise the text of Section 5
Section 5 describes the interesting and information-loaded Figure 6. However, as a reader I feel poorly guided through the figure so I kindly ask the authors to revise this Section in order to increase its comprehensibility.

For example, the statements regarding the sensitivity of the AMOC seem to jump around and the reader hardly knows which curves of Fig.6b he should study to comprehend the findings of the text.

Furthermore, this Section might benefit from a short notion that the effect of the Antarctic ice sheet FWF is the difference between noAGfwf and noGfwf whereas the effect of the Greenland ice sheet is noGfwf vs. Reference.

G: Extend final paragraph of Section 6
The final paragraph of Section 6 (page 4403, lines 26ff.) is another example where the reader is left with sparse information, no figures or references to any figures. In its present form I fear this paragraph is hardly an asset. Nevertheless, I think the mechanism of a freshwater induced cooling and possible analogies/differences to the Antarctic cold reversal during the last deglaciation might be very interesting and I encourage the authors to deepen the analysis of there simulations in this respect.

Technical corrections:

1. page 4393, line 3: Define the abbreviation of 'LGM' here at its first occasion rather than on page 4395, line 13.

2. page 4394, lines 23-25: The numbering of the sections in this list does not correspond to the actual section's numbers (e.g., model and experimental setup actually are Sects. 2 and 3).

3. page 4395, line 3: remove the term 'and the ice sheets' here, as it implies that the ice sheet model is used as an interactive model component of LOVECLIM which is not the case.

4. page 4395, line 21: If I understand it correctly the NH reconstruction is largely based on the model presented in Zweck and Huybrechts, 2005? If so this should be referenced here.

5. page 4400, line 6: “Greenland experiences maximum summer warming in the “Reference” experiment around 125 kyr BP of less than 3 C over ...”
3 C warming compared to pre-industrial? Please clarify.

6. page 4400, line 22: Add reference to Fig. 5 after “NH temperature evolution”

7. page 4402, lines 21-26: Please add a figure to complement these statements or at least finish the paragraph with a “(not shown)”.

8. page 4403, lines 14-25: Please include more references to Fig. 8 in this paragraph.

9. Fig. 1: The references of ECBilt, VECODE and CLIO only appear in this figure but not in the reference list.

10. Fig. 5: Please add a,b,c, labels to the panels and adapt the references to this figure in the text, respectively.

11. Fig. 6: Please add the definitions/calculations of AMOC and AABW in the figure caption or somewhere else in the manuscript.

12. Fig. 4c: I assume the LR04 curve should be named LR05 as it relates to Lisiecki and Raymo, 2005.

13. Fig. 7: As an alternative, complementary illustration to Fig. 7a,b the authors could plot the noAGfwf minus Reference ocean temperature anomalies as a time-depth section (Hovmoeller diagram) for the South Ocean.

14. Fig. 8: Add circles of latitudes (e.g., 75S, 60S, 45S etc) to Fig. 8 to better illustrate the statements in the text.