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Interactive comment on "Systematic study of the fresh water fluxes impact on the carbon cycle" *by* N. Bouttes et al.

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Some parts of the manuscript entitled "Fresh water fluxes impact on the carbon cycle" by Bouttes et al., are factually incorrect, specifically the discussion of the Menviel et al. 2008 results.

It looks like instead of discussing the LOVECLIM results presented in Menviel et al. 2008 the authors are referring to the LOVECLIM results presented in Kageyama et al. 2010. These simulations differ in terms of their forcings and model versions employed. The authors should carefully read both papers and reference them in the right context.

For example, p1371 L10, it is stated: "the AMOC in LOVECLIM recovers in 200yrs" As seen on figure 1 (left) of Menviel et al. 2008 , the AMOC recovers ∼400 years after the

end of the freshwater perturbation.

P1373: Bouttes et al. state that there is no seesaw in LOVECLIM L7. "With the LOVECLIM model the warming in the Southern Hemisphere is comparatively very small or not seen." This is obviously wrong. In figure 7 of Menviel et al. 2008, you can see that under both pre-industrial and LGM conditions, the North Atlantic cools drastically, while a considerable warming is seen in the Southern Ocean. This warming is up to 3degC in some areas of the Southern Ocean. Other studies with the non-carbon cycle version of LOVECLIM (Knutti et al. 2004, Stocker et al. 2007 and Krebs and Timmermann 2007) also demonstrate a seesaw response.

P1373, L10. Bouttes et al. say: "it globally becomes dryer everywhere in the LOVECLIM model." If you read Menviel et al. 2008, even just the abstract: "A shutdown of the AMOC leads to substantial cooling of the North Atlantic, a weak warming of the Southern Hemisphere, intensification of the northeasterly trade winds, and a southward shift of the Intertropical Convergence Zone (ITCZ)." Menviel et al. 2008 base most of their analysis on the fact that during an AMOC shut down, the Northern Hemisphere gets colder and drier while the Southern Hemisphere gets warmer and wetter. Figure 9 of Menviel et al. 2008, shows the precipitation anomalies obtained during an AMOC shut down under pre-industrial and LGM conditions. You can see that, in nice agreement with paleoproxies, the Northern Hemisphere gets generally drier, while the Southern Hemisphere gets wetter. This is particularly true in the Tropics.

It might also be worth mentioning that the climate module of LOVECLIM is much more complex than CLIMBER-2 and that the atmospheric module of LOVECLIM is more complex than the one used in UVIC.

The carbon cycle response to an AMOC shut down obtained with LOVECLIM in Menviel et al. 2008 is actually in agreement with the one obtained with full CGCMs (Obata 2007, Journal of Climate and Bozbiyik et al. 2011, CP).

This being said, it is worthwhile figuring out why the carbon cycle response to an AMOC shut down is so model dependent and particularly why the ocean acts as a source in some models and as a sink in others.

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