Clim. Past, 5, 721–722, 2009
www.clim-past.net/5/721/2009/

Climate of the Past

Corrigendum to

"The importance of Northern Peatlands in global carbon systems during the Holocene" published in Clim. Past, 5, 683–693, 2009

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In the manuscript "The importance of Northern Peatlands in global carbon systems during the Holocene" by Y. Wang et al., an error has occurred in the final published manuscript. The section "Results" on page 689 appears at a wrong text passage; the correct text passage is on page 687.

4 Results

The simulated global NPP (Fig. 5) increases slightly from 60.5 to 61.2 PgC/yr from 8 to 6 ka BP in response to a retreating LIS. The simulated boreal forest also expands in association with a retreating LIS and higher summer insolation in the mid-Holocene (figure not shown, see Wang et al., 2005b and WMR for more details). The subsequent global NPP decrease (Fig. 5) is caused primarily by the desertification in North Africa where the green Sahara/Sahel gradually becomes a semi-dry desert (figure not shown, see Wang et al., 2005b and WMR for more details). Because of the NP development, the global NPP has been compensated (reduced) slightly in $AOVI_b$ and $AOVI_g$ simulations. However, the overall trends are similar as compared with AOVI run. Notice that we only plot the simulations with a prescribed high present-day NP C value (450 PgC) in Fig. 4, which provides the most significant impact of the NP development on the vegetation module (VECODE) in the "Green" MPM. For the mid- and low-values (360 and 270 PgC) of the present-day NP, the simulated global NPP curves are similar to those in Fig. 5.

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As occurs with the global NPP evolution, the simulated global terrestrial C (Fig. 6), including global biomass and soil C, increases from 2132 to 2158 PgC from 8 to 6 ka BP due to a retreating LIS and an expanded boreal forest under higher summer insolation. Subsequently, the global terrestrial C (Fig. 6) decreases from the peak in mid-Holocene (6 ka BP) to a minimum value of about 2090 PgC at the end of the pre-industrial period (hereafter, 0 ka BP). The mid-Holocene climatic optimum is well simulated in the model. As shown in WMR, the desertification of North Africa decreases terrestrial C there by about 50 PgC, which explains around 75% of the total peak-peak terrestrial C changes from 6 to 0 ka BP (figure not shown, see WMR for more details). In addition, we have simulated a slight terrestrial C increase in the Southern Hemisphere throughout the Holocene from 8 to 0 ka BP, which is attributed to the increasing summer insolation over the same period (WMR). Again, we only plot the simulations for a prescribed high present-day NP C value as in Fig. 5, which provides the most significant influence of the NP development in simulated global terrestrial C in the $AOVI_b$ and $AOVI_g$ transient simulations. For the mid and low values, the simulated global terrestrial C curves are similar to those in Fig. 6.

Overall, gradual development of the NP, as prescribed in the model, has only negligible influences on the simulated NPP and terrestrial C cycles. This is primarily due to the slow build-up of the NP as prescribed in the model (∼0.03 PgC/yr). We expect that any abruptness in the NP development would have a substantiative impact on the terrestrial C cycle dynamics over a short period. However, over millennial timescales, we do not expect a significant impact of the NP on terrestrial C cycle dynamics, which are

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controlled presumably by the simulated climate conditions, atmospheric CO_2 concentration, and anthropogenic land-use and/or land-cover changes (Ruddiman's hypothesis) during the Holocene. The global SST (Fig. 7) increases slowly under the retreating LIS, which overrides the orbital-induced cooling, and the radiative forcing of atmospheric CO_2 until about 1 ka BP. After that, a strong SST cooling is caused presumably by the drop in atmospheric CO_2 concentration. The global peak-to-peak increase of SST is about 0.2°C in the three types of transient simulations (AOVI, $AOVI_b$, and $AOVI_g$). Because these three SST curves are almost identical, we have shifted upward the curves for the $AOVI_b$ and $AOVI_g$ simulations by 0.1°C and 0.2°C, respectively. Because of the similarity, we do not show the SST plots for the mid and low prescribed present-day peat C values. Overall, we find the prescribed NP development has negligible impact on the evolution of the SST during the Holocene period from 8 to 0 ka BP. With such a small magnitude of SST increase, we do not expect a substantiative CO_2 outgassing from the sea surface during the Holocene (Brovkin et al., 2002, 2008).

Based on our three NP development trajectories and three types of model simulations, we have estimated the relative C storage changes in land (VECODE plus prescribed NP trajectories, green curves), atmosphere (ice core data, blue curves), and ocean (red curves, assuming a global C conservation during the Holocene) (Fig. 8). It is clear that, without considering the human land-use/land-cover changes (Ruddiman, 2008), the inclusion of the NP has sequestered a large amount of C from both the atmosphere and ocean (presumably deep ocean), which significantly changes the conclusions of WMR. Because of the NP C sequestration, small variations of terrestrial C in VECODE are fading out. The only remaining detectable signal is the oceanic C source during the Holocene from 8 to 0 ka BP. We note, however, that if the anthropogenic land-use and/or land-cover changes are considered together with the NP development during the Holocene, Fig. 8 would be changed. We also note that for a specific NP accumulation scenario, there are very little differences among three types of model simulations. This is because that VECODE model is confined to simulate the evolution of carbon storage on land by climatic forcings.