Geophysical Research Abstracts,
Vol. 11, EGU2009-10100, 2009
EGU General Assembly 2009
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A possible role of the Panamanian gateway closure in Pliocene Antarctic ice-sheet development

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Simulations with the Community Climate System Model CCSM2 in combination with an off-line axially symmetric Antarctic ice-sheet model are performed in order to study the effect of the Panamanian gateway closure on Antarctic ice volume. The gateway closure induces an intensification of the meridional overturning circulation which, in turn, causes a cooling of Antarctica and an expansion of the Antarctic cryosphere. The model results suggest that the corresponding Antarctic ice-volume increase may explain a substantial portion (maybe up to 60%) of the 40-50 m long-term (3.6-2.4 Ma) mid-Pliocene global sea-level lowering that has been calculated by Mudelsee and Raymo (2005). The remaining part of the long-term sea-level change is attributable to the growth of ice sheets in the northern hemisphere. We propose that the first phase (3.6-3.0 Ma) of the mid-Pliocene sea-level decrease was largely caused by Antarctic ice-sheet growth (induced by the Panamanian gateway closure) rather than northern hemisphere glaciation. It is further speculated that the mid-Pliocene Antarctic ice-sheet growth might have had an impact on the global climate system through a possible influence on sea-ice formation, ocean circulation and the carbon cycle.