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Subtropical forest expansion in the middle Miocene Europe: pCO_2, Antarctic ice volume and oceanic changes

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The middle Miocene is a crucial period for ape's evolution and corresponds to their appearance in Europe. The dispersion of apes was made possible by tectonic changes and the expansion of their habitat, which is tropical to subtropical forest, in Europe. The context in which the Middle Miocene Climatic Optimum occurred still lacks constraints in terms of atmospheric pCO_2 and Antarctic ice sheet volume and extent.
Using the coupled atmosphere – ocean GCM FOAM and the dynamic vegetation model CARAIB, we investigate the sensitivity of Miocene climate and vegetation to pCO_2 levels and Antarctic ice sheet configurations. We performed sensitivity experiments to test the impact of varying pCO_2 (280 ppmv, 560 ppmv and 700 ppmv) and Antarctic albedo (ice and tundra) on the European vegetation during the Middle Miocene Climatic Optimum.
Our results indicate that higher than present pCO_2 is necessary to simulate subtropical forest in Western and Central Europe during the middle Miocene. However, a threshold between 560 and 700 ppmv makes subtropical forest partly collapse, which is due to colder and slightly dryer conditions in Europe. This can be explained by the fact that CO_2-induced warming of the high latitudes strongly reduces North Atlantic Deep Water formation, therefore reducing the heat transport in this region.
Moreover, the albedo change over Antarctica, which is directly linked to the ice surface, leads to further warming in Europe, and the expansion of subtropical forest. These results suggest that a small East Antarctic Ice Sheet (25% of present-day ice volume) together with higher than present pCO_2 are in better agreement with available European middle Miocene data.