



## **Dynamics of $\sim$ 100-kyr glacial cycles during the early Miocene**

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Here, we present high-resolution stable isotope records from ODP Site 1264 in the south-eastern Atlantic Ocean, which resolve the late Oligocene to early Miocene (23.7-18.9 Ma) climate changes. Using an inverse modeling technique, we decomposed the oxygen isotope record into temperature and ice volume and found that the Antarctic ice sheet expanded during distinct episodes (e.g. Mi zones) of low short-term ( $\sim$ 100-kyr) eccentricity forcing, which occur two to four long-term (400-kyr) eccentricity cycles apart. We argue that a non-linear mechanism, such as the merging of (several) large East Antarctic ice sheets, caused the build-up of a larger ice sheet. During the termination phases of these larger ice sheets, on the contrary, we find a more linear response of ice-sheet variability to orbital forcing and climate became highly sensitive to the  $\sim$ 100-kyr eccentricity cycle. At the Oligocene – Miocene transition the model output indicates a decrease in Northern Hemisphere temperatures such that a small ice cap could develop on Greenland. This Supports the hypothesis of a threshold response for the development of Northern Hemisphere land ice to decreasing pCO<sub>2</sub>. Furthermore an independent orbital tuning of the latest Oligocene and early Miocene is explored.