Geophysical Research Abstracts,
Vol. 11, EGU2009-13558, 2009
EGU General Assembly 2009

Greenhouse atmospheric hydrology and polar warmth during the mid-Cretaceous and PETM

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The δ^{18}O composition of wetland paleosol siderite spherules is a reliable proxy for paleoprecipitation δ^{18}O values, a method so far applied to understanding atmospheric hydrologic conditions during the Albian-Cenomanian (mid-Cretaceous) greenhouse episode. A new and evolving data set from transects of PETM paleosol locales in North America, with spot locales from Europe, displays a strong paleolatitudinal gradient. Comparison of the PETM results to published and new values for the Albian- Cenomanian boundary suggests that paleoclimatic conditions were very similar during these two greenhouse episodes. Using the paleosol siderite data as a proxy for paleoprecipitation chemistry, we benchmark model hindcasts of the Albian-Cenomanian boundary and PETM episodes using an isotopic tracer model linked to the GENESIS GCM. Model-data comparisons indicate that our results are robust through the high midlatitudes. Model results for the high latitudes are sensitive to paleotopographic constraints – only with geologically realistic paleotopography are we able to adequately model the paleosol siderite δ^{18}O values in the high latitudes. Suppression of cloud condensation nuclei, controlled by biological productivity and hypothesized to have occurred during past episodes of warmth-induced stress on ecosystems, substantially alters the paleotemperature reconstructions and our modeled paleoprecipitation δ^{18}O values.

Unpublished δ^{18}O data from siderite concretions obtained from very early Eocene strata, ODP Leg 189, Site 1171, lie along the paleolatitudinal gradient established from the North American paleosols. The data, combined with petrographic and major oxide analysis of the siderite, are suggestive of an episode of enhanced freshwater recharge to the offshore shelf setting of the Paleogene Tasman Gulf, probably related to elevated precipitation rates under conditions of an accelerated hydrologic cycle. An anomalous data point in the PETM paleosol δ^{18}O data from the Yakutat Terrane, southern Alaska, is used to evaluate potential migration pathways for the terrane – the evaluation suggests that the Yakutat Terrane is a far-traveled rather than nearby terrane, probably having originated from near the present Washington-Oregon border, northwestern U.S.