Increased poleward flux of atmospheric moisture during the PETM as deduced from paired in situ d18O:Mg/Ca measurements in planktic foraminifera

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Much of the ambiguity in future climate projections derives from uncertainties regarding atmospheric water vapor transport, as robust data from past greenhouse climate events, such as the Paleocene-Eocene thermal maximum (PETM), are sparse. Results from previous studies suggest that the poleward flux of atmospheric moisture may have increased during the PETM. Such changes in atmospheric water transport can be inferred from meridional surface-ocean d18Osw gradients, typically reconstructed by pairing "bulk-shell" d18O:Mg/Ca ratios obtained from fossil planktic foraminifers. However, reconstructing d18Osw using Early Paleogene foraminifera shells is hampered by generally poor preservation of available material. Here, this problem is addressed by combining secondary ion mass spectrometry and electron probe microanalyzer to measure d18O:Mg/Ca ratios in minute (<10 micrometers) domains of individual planktic foraminifer shells from tropical (Site 865) and austral (Site 690) deep-sea records of the PETM. Conversion of these paired d18O:Mg/Ca data to sea-surface salinities (SSS) reveals that the poleward flux of atmospheric water vapor increased markedly during the PETM. This transient perturbation to the hydrologic cycle is signaled by a ~5‰ decrease in local SSS at austral Site 690 ~50 ka after the onset of PETM warming. Reduced SSS at Site 690 is mirrored by a weaker SSS increase at tropical Site 865. The evidence at hand indicates that the PETM greenhouse climate state fostered an accelerated global hydrologic cycle typified by decreased net precipitation in the tropics and the opposite scenario for the high latitude Southern Ocean.