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Decoupling of Late Paleozoic epicontinental sea and ocean δ18O in an isotope-enabled Earth system model

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Reconstructions of paleo-seawater conditions during the Late Paleozoic Ice Age (LPIA) are predominantly inferred from epicontinental sea records due to the subduction of virtually all pre-Mesozoic oceanic crust. Mounting geologic evidence suggests that localized environmental dynamics of semi-restricted, shallow seas lead to a decoupling of epicontinental-based isotope records from those of the open ocean. We employ the fully coupled isotope-enabled Community Earth System Model 1.2 to investigate how environmental conditions vary between shallow seas and the open ocean during both glacial and interglacial states of the LPIA. All simulations include a late Pennsylvanian (c. 300 Ma) paleogeography and reduced solar luminosity (97.5% of modern). Mean glacial (interglacial) conditions are simulated with prescribed atmospheric CO_2 concentrations of 280 ppm (560 ppm) and extensive (reduced) Gondwanan ice centers. Preliminary data from our simulations suggest that lower sea surface salinities of 18 to 30 psu (relative to $\sim$35 psu in the near-shore open ocean) from excess freshwater input to the Midcontinent sea contribute to depleted δ18O values of -1 to -10‰ during interglacial sea-level high stands. High salinities in shallow regions of the Uralian seaway due to net evaporative conditions lead to enriched δ18O values of 0.5 to 1.5‰ . Shallow water depths of <100 m and restricted movement in epicontinental seas limit communication with the open ocean, whereas on unobstructed continental shelves, such as in South China, mean δ18O values closely reflect that of the open ocean. The simulated variability of marine conditions has implications for the use of biogenic δ18O from epicontinental seas as a proxy for glacioeustasy and paleotemperature. High spatial variability in δ18O from epicontinental seas due to variable local environmental conditions indicate that these environments do not represent global conditions and should be expected to have disparate signals.