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Astronomically forcing hydrological controls on salinity variations during the Late Ordovician-Early Silurian in the Upper Yangtze area: Responses to the monsoon climate and HICE

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Salinity, a key indicator of watermass conditions, is crucial for understanding the interactions between watermass conditions and climate change. This study presents novel insights into the paleosalinity variations with astronomically forced hydrological changes in Late Ordovician - Early Silurian marine shales of the Upper Yangtze area, based on high-resolution cyclostratigraphic analysis of the gamma-ray (GR) series. Watermass conditions proxies and organic carbon isotope ($\delta^{13}C_{org}$) are significantly in-phase variations with ~405 kyr long eccentricity cycles. The astronomically forced climate controls the hydrological conditions by modulating the expansion and shrinkage of ice sheet, resulting in lower paleosalinity in interglacial interval than glacial interval. Specifically, during the eccentricity maxima, increased monsoon precipitation established a positive feedback mechanism between continental runoff and marine water, significantly decreasing salinity. The Kwangsian Orogeny induced tectonic-sedimentary patterns created substantial spatial heterogeneity in salinity distribution across different sedimentary centers. Furthermore, we focused on the Hirnantian Isotopic Curve Excursion (HICE) event during the Ordovician – Silurian (O-S) transition, identified by minimum GR, TOC values, positive excursions in $\delta^{13}C_{org}$ with organic–lean shales. Due to the impact of the Hirnantian glaciation, both WF4 and LM1 were characterized by highly restricted, fostering anoxic and euxinic conditions, while the Rhuddanian stage manifested weakly to moderately restricted conditions. Paleosalinity variations were primarily influenced by astronomically forced sea-level fluctuations that modulated watermass dynamics, sedimentation processes, and biological activities, these fluctuations affected the hydrochemistry of the basin, modulating the relative placements of pycnoclines and redoxclines. Hence, under the regional tectonic-sedimentary setting, the astronomically forcing monsoon system, sea level fluctuations and the dynamic changes in glacier have been the decisive factors for the salinity variations. This study advances our understanding of orbital-scale climate forcing influences salinity dynamics in a restricted marine basin, providing new insights for paleoenvironmental reconstruction in deep-time sedimentary systems.







