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Deciphering dynamical proxy responses from lake sediments

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Lakes form a reliable archive of paleoenvironmental change in the terrestrial realm. Non-destructive XRF scans provide high-resolution records of element concentrations that are commonly related to past environmental change. However, XRF records of lake sediments enclose paleoenvironmental information that originates from multiple lake external and internal forcing. The variety of environmental forcing factors can complicate a direct identification of single mechanisms like climatic change from XRF or other proxy records.
Here we present XRF records from several Asian lake archives, which indicate asynchronous variations of similar geochemical records since the late glacial/early Holocene. All XRF time series are characterized by damped harmonic oscillations of relative element concentrations through time. The asynchronous variations can be expressed by the frequency and the rate of damping of theses oscillations that differ between the lakes. We argue that the oscillatory behavior is a result of a feedback between the physical removal and dissolution of mineral phases in catchment soils and their subsequent enrichment and deposition within the lake. We present a numerical model, which accurately simulates major Holocene variations in the element concentration of lake records and discuss implications for the reconstruction of environmental signals from lake sediments.