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Solar influences on flood frequency in a 450-year time series of detrital layers in annually laminated sediments from pre-alpine Lake Ammersee (Southern Germany)

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Forecasting of extreme events and their impacts on the human habitat requires profound understanding of the triggering mechanisms and recurrence intervals. Since instrumental time series rarely exceed a century, geo-archives are adequate tools to examine such events on longer time scales and under different climate boundary conditions. Annually laminated (varved) lake sediments are continuous high-resolution archives of climate and environmental variability. Flood-triggered sediment fluxes of detrital catchment material into these lakes allow establishing an event stratigraphy with seasonal resolution. Precise time control of these events can be obtained by varve counting.

Lake Ammersee in the alpine foreland is an ideal site for the reconstruction of long time series of flood frequencies. The annually laminated sediments enable precise dating and reliable detection of even microscopic flood layers by their sedimentological and geochemical characteristics. The seasonality of each layer can be determined by the micro-stratigraphic position within a varve. Instrumental and historical flood data of the main tributary River Ammer can be used for calibrating the palaeoflood-record. The existing high-resolution Holocene palaeotemperature reconstruction derived from ostracods in Lake Ammersee sediments (von Grafenstein et al., 1999) facilitates the discussion of changes in flood frequency patterns in relation to changes in climate boundary conditions.

A combination of micro-facies analyses and high-resolution element scanning (μ-XRF) allowed reconstructing a seasonal 450-year time series of flood layers in two varved sediment cores from Lake Ammersee. A comparison between instrumental River Ammer runoff and weather regimes (Großwetterlagen) data distinguished five main flood-prone weather regimes triggering 71% of extreme Ammer flood events. The agreement of the flood layer record with flood-prone weather regimes and the correlation of flood layer frequency with solar activity suggest changes in mid-latitude atmospheric dynamics related to solar variability.

Reference:
von Grafenstein U., H. Erlenkeuser, A. Brauer, J. Jouzel, and S.J. Johnson (1999), A Mid-European Decadal Isotope-Climate Record from 15,000 to 5000 Years B.P., Science, 284(5420), 1654-1657, doi:10.1126/science.284.5420.1654.