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Solar modulation of Mid- to Late Holocene flood frequency in detrital layers from varved sediments of Lake Ammersee (southern Germany)

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Climate is the principal driving force of hydrological extremes like floods and attributing generating mechanisms is an essential prerequisite for predicting future flood risk. Instrumental flood records, however, rarely exceed more than the last century and are too short for satisfactory assessing flood responses to changing climate boundary conditions. Intercalated into annually laminated (varved) lake sediments, flood triggered layers of detrital catchment material provide a natural archive of flood frequency with the potential to extend instrumental runoff data for millennia even down to seasonal precision.

Lake Ammersee in the pre-alpine region of southern Germany is an ideal site to build up a long time series of flood triggered sedimentation because the varved sedimentary record enables both accurate detection and precise dating of detrital flood layers. Extensive late moraine formations in the lake catchment provide abundant easy erodible detrital material transported downstream into the gully shaped lake by only one main tributary, River Ammer.

A 5500-year flood layer time series was established at seasonal resolution back to 400 yr BP and at annual resolution from 400 yr BP to 5500 yr BP conducting high-precision sediment microfacies analyses and geochemical X-ray fluorescence scanning (μ-XRF). Flood layer frequency is in agreement with reconstructed total solar irradiance back to 5500 yr BP, indicating more frequent flood layers during periods of reduced solar irradiance. Further, comparison of the seasonal flood layer time series with instrumental data reveals that most spring and summer flood layers are triggered by cyclonic weather regimes from the North Atlantic. Since spring and summer flood layers comprise 89 % of all flood layers in the seasonally resolved part of the record, we assume for the complete 5500 years an intensified cyclonic activity in spring and summer for the Ammersee region during intervals of reduced solar irradiance.