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Linking paleofloods to precipitation extremes at Lake Mondsee (NE Alps)

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The summer floods of 1997, 2002 and 2013 rank among the most severe events in Austria according to the damage losses. Long and reliable records help to better understand the link between distinguished weather patterns and flood extremes, and to further improve the estimation of flood damage potential in the future. Robust and well-calibrated paleoflood records, e.g. flood records preserved in lake sediment records, are ideal natural records to investigate flood variability of the past and to use the data for further modelling.

Here we present an in-depth analysis of the Lake Mondsee sediments, which present a seasonal summer flood record (April-August) of the last 7000 years. By applying a change point analysis, the paleoflood record exhibits four points of changing flood occurrence: 3532 BP (1582 BC), 3258 BP (1308 BC) und 2031 BP (81 BC) and 461 BP (1489 AD). To better understand the paleoflood record, we analysed the meteorological conditions of the floods as recorded in Lake Mondsee sediments for the instrumental time period. A new classification scheme of atmospheric cyclone tracks (Hofstätter et al., 2016) is used to identify specific precipitation events and related cyclone track types as meteorological drivers. This approach allows to establish a direct link between long term paleo records and daily weather extremes at lake Mondsee for the instrumental period. Almost all of the TOP 20 daily precipitation extremes in summer (1976-2013) are related to type Vb cyclones which develop around Northern Italy south of the Alps. Those top precipitation events correspond very well with the Lake Mondsee flood record (up to 80%). As another main feature, a major Cut Off Low could be identified at upper atmospheric levels directly located across the Alpine Range. In consequence a strong pressure gradient at the surface level leads to an enhanced northerly flow at deep atmospheric layers, favouring extreme precipitation amounts by orographic lifting in this region. The resulting floods, which also trigger sediment deposition in Lake Mondsee, are high intensity floods (e.g. 12.08.2002, 16.08.2015, 02.06.2013), presenting highest hourly discharges (> 85 m3/s) and highest discharges lasting at least 1-3 hours. In contrast, antecedent soil moisture and long-rain floods (e.g. 31.07.1977) seem to be not the main factor characterising the sediment flood record of Lake Mondsee. We encourage further analysis of the floods as recorded in natural archives to better define the meteorology of flood proxy records.

This study is part of the FloodRisk-7000 project (https://floodrisk.joanneum.at/), funded by ACRP 2015, 8th Call. We aim at providing improved estimations on flood damage potential in Northern Austria for past, current and future climatic conditions by making use of and merging different kinds of data sets. These data sets include, damage data from municipalities, a 7000 year paleoflood record derived from Lake Mondsee sediments (Upper Austria), and triggering cyclone tracks with their related daily precipitation totals.