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Investigating Spatial Patterns And Characteristics Of Preconditioned Compound Flooding Over Europe

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Preconditioned compound events are defined as events in which an underlying weather-driven or climate-driven precondition causes an increase in the impacts of a hazard. In state-of-the-art risk assessment studies, the dependencies and cross-correlations between multiple variables/processes are usually difficult to account for. However, previous studies have shown that some of the most devastating extreme events in the past years occurred within a cascade of interdependent and interrelated hazards. This is particularly true in the case of initial hydrologic conditions for large scale pluvial events (Eg: European Floods – 2021). The lack of proper characterisation of the spatiotemporal patterns and impacts of antecedent soil moisture conditions on extreme precipitation events hinder our understanding of such high impact flooding events and subsequently the early warning and mitigation or reduction of severe impacts for the society. Hence with this critical research gap in mind, in the present work, we employ Event Coincidence Analysis (ECA) to identify and characterise the regions over which Precipitation extremes (P) occur over Soil Moisture extreme states (SM). Precursor coincidence rate calculates the fraction of such preconditioned SM-P events out of total P extremes. The datasets used include the E-OBS v24.0 gridded product for precipitation and GLEAM v3.5a for soil moisture modelled product. Our results indicate strong seasonal variations in such SM-P preconditioning over Europe. A significant shift in the magnitude and spatial extent of SM-P coupling is seen within the seasons for the various regions. Strong coincidence is seen for western and central Europe in winter, and the coincidence weakens in summer. For eastern Europe, stronger preconditioning is seen in the summer compared to the winter season. The observed trends over the study duration of 1980 to 2020 are in line with the historical climatological and meteorological patterns of the regions. We further made use of the timings of annual maximum discharge (Peak flood values) at a catchment scale from a European flood database to investigate how the seasonal and spatial variations in the timings of floods could be interpreted from the SM-P preconditioning perspective. Our results will aid in strengthening existing flood risk assessment initiatives while providing new avenues and implications for a better understanding and proper representation of preconditioned

compound flooding events over Europe.