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Summer heat waves over Europe since 1880, their changes and relationship to atmospheric circulation

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Using a Sea Level Pressure data that extends back to 1880 the relationship between large–scale circulation patterns and the occurrence of summer heat waves over (northern) Europe is shown to be related to anomalous high pressure over Scandinavia and central western Europe. The relationships were determined using Canonical Correlation Analysis and the simultaneous predictive skill of the seasonally averaged SLP is a modest 35% showing that factors other than large–scale circulation are contributing to the occurrence of heat waves over Europe. Given the constraints on the use of more sophisticated measurements of the atmospheric and ground state due to the period under investigation, alternative data sources have been investigated as potential contributing factors of heat wave events. These include using lagged station rainfall as an indicator of potential soil moisture, a known factor in exasibating the continuity of a heat wave event and lagged and simultaneous Sea Surface Temperature. This investigation uses 21 station time series of daily maximum and minimum temperature, as well as daily precipitation from western Europe that have been homogenised at the daily timescale to ensure that the presence of inhomogeneities has been minimised. The daily station data has been used to create seasonal based indices of the number of heat waves, hot days, hot nights and consecutive dry days. Results show that the frequency of heat waves has increased from 1880, however the this is embedded in periods of large interannual and interdecadal variability. There are two primary modes of atmospheric circulation related to heat waves, both are anomalous high pressure regions, one over central western Europe and the other over northern Europe. The seasonal average position of these anticyclonic anomalies are crucial to the spatial distribution of heat wave occurrence. Experiments with multiple predictors including SLP and both global and North Atlantic Sea Surface Temperature (SST) show that SSTs have a small but

noticeable effect on the occurrence of summer (JJA) heat waves over Europe. Simultaneous and lagged seasonal precipitation anomalies are also found to have a small but non-negligible effect on exasibating the occurrence of heat waves pointing to the importance of soil moisture feedback processes. Summers with a high frequency of heat waves were investigated more throughly at the synoptic, daily timescale to see if more could be learned about the variability of these events.