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Modulation of regional precipitation and groundwater level variability by large-scale oceanic/atmospheric circulation over interannual and interdecadal scales

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Hydrological processes vary over long time-scales, which are originating from large-scale climate. It is not always straightforward, however, to identify how large-scale climate variability can affect regional or local-scale hydrological processes, as such relationships are not linear. Taking the example of the Seine river watershed (northern France), we study the modalities of precipitation and chalk aquifer groundwater level (GWL) variability, focusing on interannual (4-12 years) and interdecadal (12-23 years) scales. We propose a methodological approach for analysing and discussing potential large-scale relationships and forcings on hydrological systems.

163 GWL and 13 precipitation monthly time series, covering the northern half of metropolitan France between 1964 and 2015, were analysed using continuous and discrete multiresolution wavelet transforms. GWL time series all revealed statistically significant oscillating components on interannual and interdecadal scales, but with different amplitudes in space. All precipitation time series displayed the same oscillating components across the watershed with rather constant amplitudes spatially, contrary to GWL time series, which suggest an impact of local physical watershed properties to filter some parts of the climate signal. Using precipitation and GWL time series available over one century, as well as the NOAA 20CR reanalysis, we then analysed the relationship with the North Atlantic atmospheric circulation at both the interannual and interdecadal scales. On interannual scale, using sea-level pressure and geopotential height at 200 hPa, we found that precipitation and GWL variability would be linked to pronounced Rossby wave-like patterns. On interdecadal scale, the patterns obtained correspond to clear west-circulation patterns, which are very similar to the patterns associated with Atlantic Multidecadal Oscillation (AMO). Interdecadal precipitation variability are indeed also found to be consistent with the positive and negative phases of the AMO, suggesting potential impacts on hydrological variability. Examining both precipitation and GWL, major droughts occurred during low levels of interannual and interdecadal components. This study therefore demonstrates that such extreme events would then be: i) linked to a weakened western circulation with strong North-South jet stream oscillations on interannual scale; ii) modulated by western circulation associated with the AMO on

interdecadal scale.