Characterizing Large-Scale Circulations Driving Extreme Precipitation in the Northern French Alps

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Extreme precipitation in the Northern French Alps are mainly associated with large-scale circulations (LSCs) bringing moist air from the Atlantic Ocean and the Mediterranean Sea - two atmospheric influences that are very frequent in the climatology. In this work, we investigate what characterizes the Atlantic/Mediterranean circulations driving extreme precipitation in the Northern French Alps in comparison to “random” Atlantic/Mediterranean circulations. We focus on extreme 3-day precipitation over two medium size neighboring catchments from 1950 to 2017. Atlantic and Mediterranean circulations are identified using an existing weather pattern classification established for Southern France. Every single LSC is characterized using three atmospheric descriptors based on analogy in geopotential shapes at 500hPa over Western Europe that were introduced in previous works. They are i) the celerity, characterizing the stationary nature of a geopotential shape, and ii) the singularity and relative singularity, characterizing the resemblance of a geopotential shape to its analogs, in other words the way this geopotential shape is closely reproduced in the climatology. We add to these analogy-based descriptors a new (non analogy) descriptor accounting for the strength of the low and high pressure systems. We show that Atlantic/Mediterranean circulations driving extreme 3-day precipitation in the Northern French Alps are the Atlantic/Mediterranean circulations featuring the strongest centers of action as well as the most stationary and the most reproducible geopotential shapes - characteristics that are rare for both atmospheric influences. In the Atlantic case, these characteristics appear to be even more pronounced and rare with regard to the whole climatology, pointing LSC as an important driver of extreme precipitation. In the Mediterranean case, these characteristics appear to be more random with regard to the whole climatology, pointing a more balanced contribution between specific LSC and humidity in driving extreme precipitation.