Characterizing large-scale circulation triggering heavy precipitation in the northern French Alps

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Context / Objectives

- Large-scale circulation (LSC) explain a significant part of Alpine precipitation.
- Heavy precipitation LSCs are usually characterized using weather-type classifications, providing useful information on the different weather patterns. However, the discrete nature of weather-types leads to a loss of information.

This work proposes a continuous characterization of heavy precipitation LSC using atmospheric descriptors based on analogy. The atmospheric descriptors describe both the stationarity of LSCs and their relative position in the atmospheric space.

Region of study / Data

- The Isère River catchment at Grenoble (5800 km²). Main influence: Atlantic circulations (zonal flows).
- The Drac River catchment at Grenoble (3600 km²). Main influences: Atlantic and Mediterranean circulations (zonal and meridional flows).
- 3-day catchment precipitation
- Daily 500 hPa geopotential height fields from the 20CR-V2c reanalysis
- 1950-2011 period

The atmospheric descriptors

- Based on analogy in geopotential shape using the Teweles Wobus Score (TWS).

Celerity

TWS between one day and its previous day.

Singularity

Mean TWS between one day and its 112 (0.5%) closest days.

Relative singularity

Singularity normalized by the TWS with the 112th closest day.

Stationarity

- For both catchments, heavy precipitation LSCs feature among the most stationary geopotential shapes (low celerity values) => slow-moving geostrophic wind direction
- Heavy precipitation LSCs associated with zonal flows (Isère catchment) show among the strongest centers of action (high MPD) => strong geostrophic wind

Singularity

- Heavy precipitation LSCs associated with zonal flows (Isère catchment) show among the most twinlike circulation patterns (low singularity)
- Heavy precipitation LSCs associated to meridional flows (Drac catchment) feature less twinlike circulation patterns

Clustering

- Heavy precipitation LSCs associated with zonal flows (Isère catchment) show among the highest degree of clustering (low relative singularity)
- Heavy precipitation LSCs associated to meridional flows (Drac catchment) feature a lower degree of clustering

Conclusions

- Whatever the circulation patterns, heavy precipitation LSCs feature among the most constant geostrophic wind direction, corresponding to quasi stationary situation in altitude.
- Heavy precipitation LSCs associated with zonal flows feature more twinlike circulation patterns than other LSCs. They show among the strongest geostrophic wind and among the highest degree of clustering in the atmospheric space.

References:

- Blanchet et al., 2018, doi: 10.1002/asl.809
- Blanchet and Creutin., 2020, doi: 10.1175/JAMC-D-19-0112.1
- Faranda et al., 2016, doi: 10.1038/srep41278