Past Evolution of Western Europe Large-scale Circulation and Link to Extreme Precipitation Trend in the Northern French Alps

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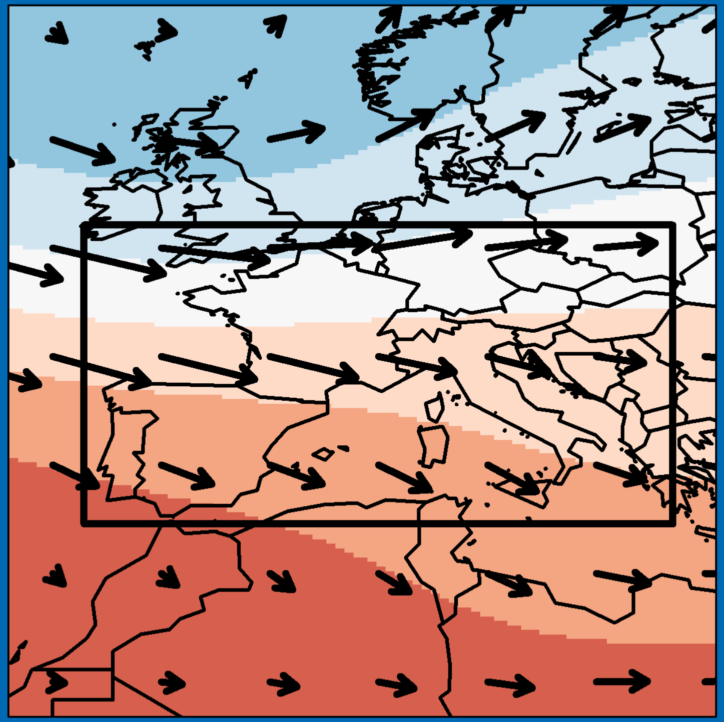

EGU General Assembly 2022

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How to study past evolution of large-scale circulation?

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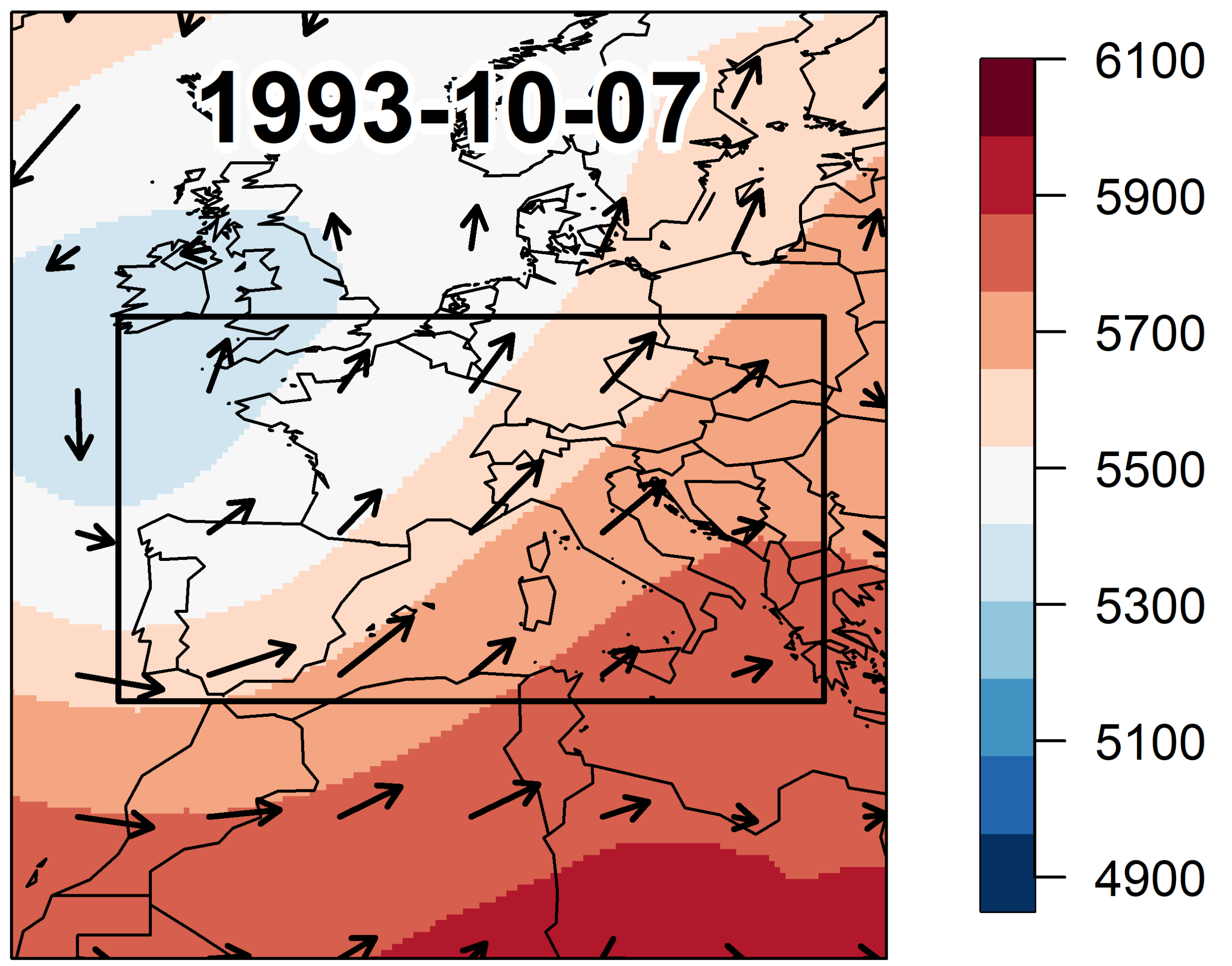
Daily **500 hPa geopotential height** over Western Europe

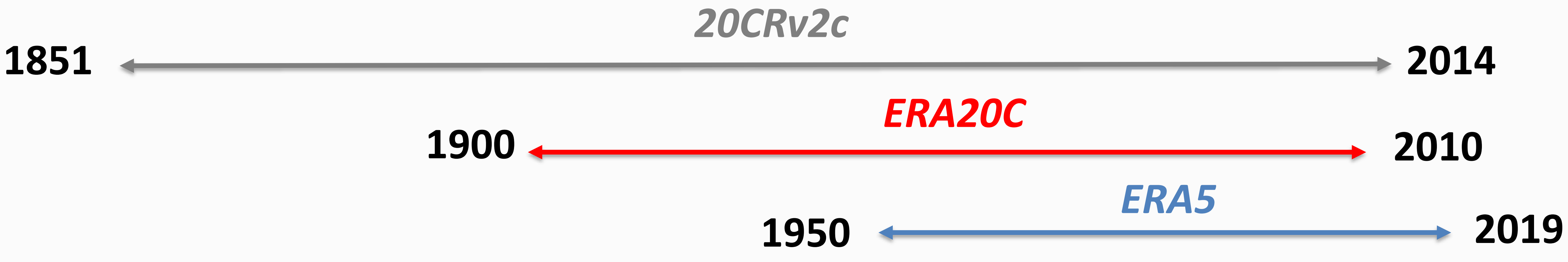


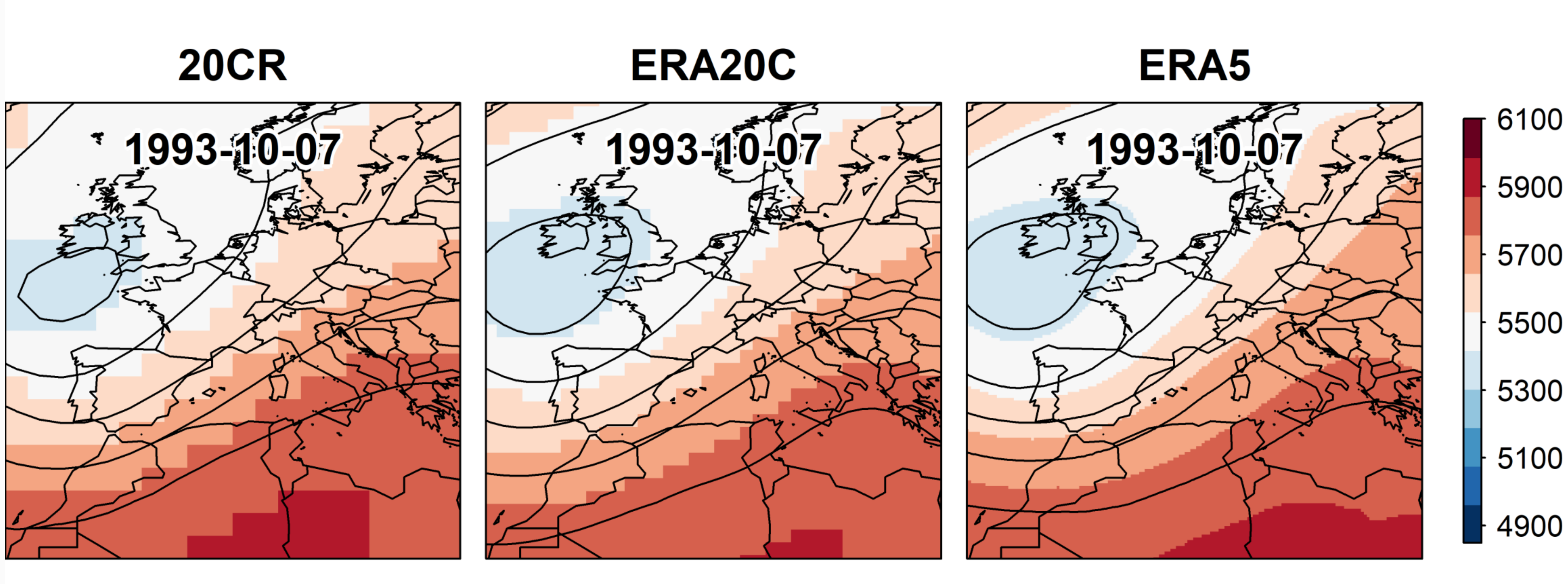
- **3 atmospheric descriptors**
- 2 based on **analogy in geopotential shapes** using the Teweles-Wobus Score (TWS)

Descriptor	Interpretation
Celerity	**Stationarity** in flow direction
Singularity	**Reproducibility** in flow direction
Maximum Pressure Difference: **MPD**	Flow **intensity**

How to study past evolution of large-scale circulation?

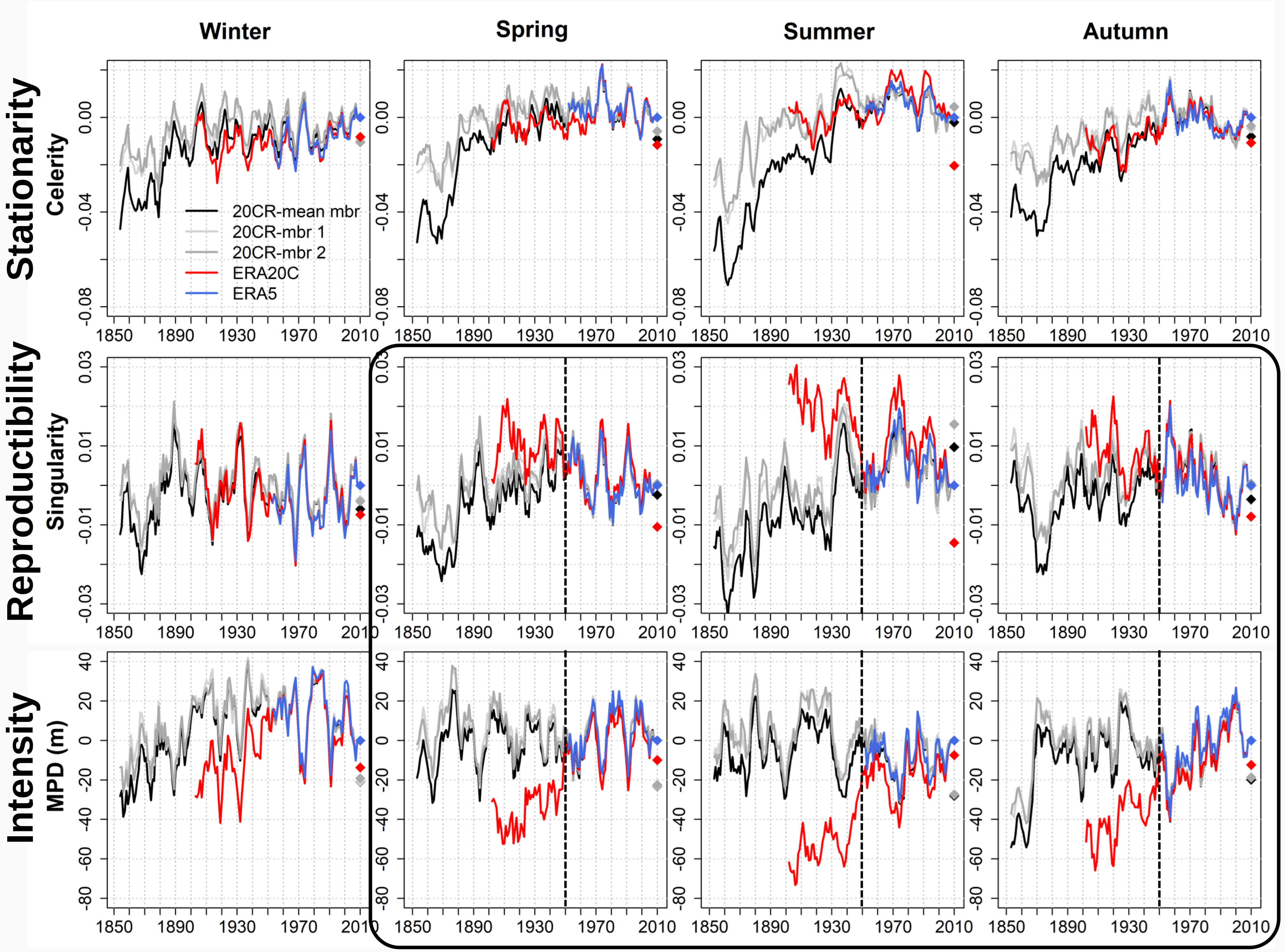
3 atmospheric reanalyses covering different periods…





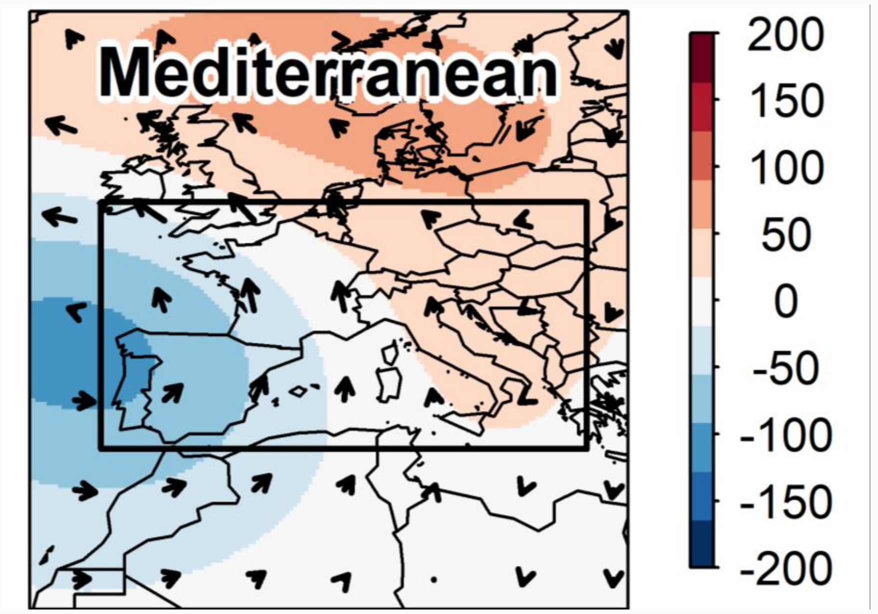
… with **different data assimilated** and **different spatial resolution**

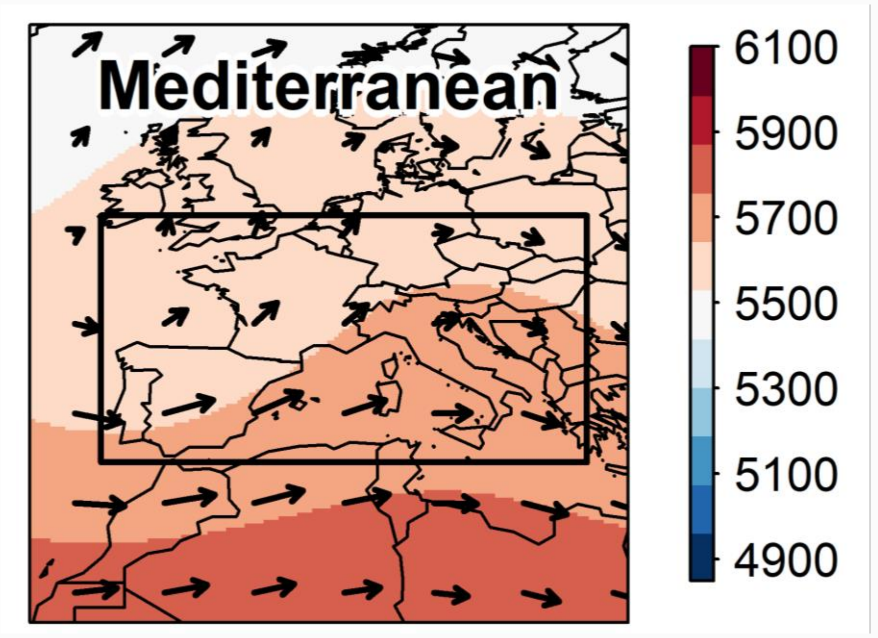
Before 1950: different trends between reanalyses



- Different trends **from spring to autumn**
- **ERA20C:** increasing reproductibility of flow directions and increasing flow intensity (MPD) **from 1900 to 1950**
- **20CRv2c:** no particular trend **from 1900 to 1950**
- **Agreement** between reanalyses **after 1950**

From 1950 to 2019: marked changes in Mediterranean circulations



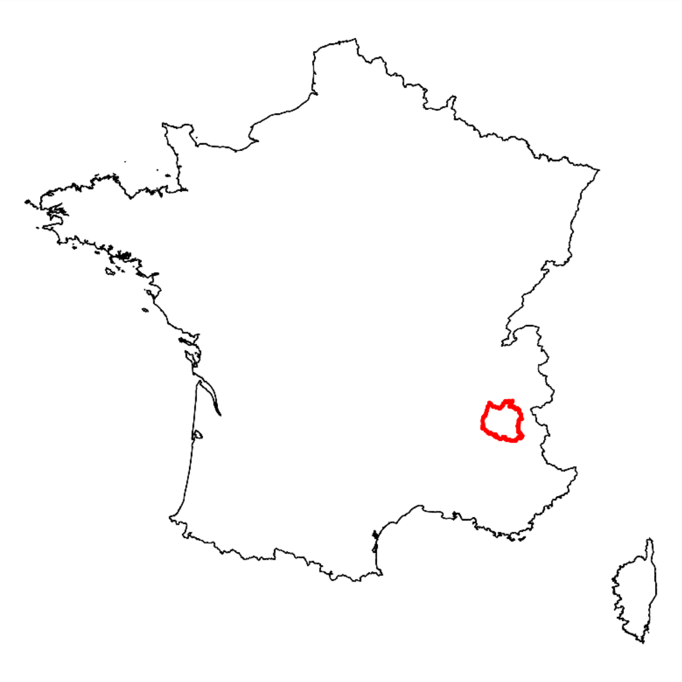


Season	Stationarity	Reproducibility	Intensity
Winter		↘	↘
Spring	↘	↘	↘
Summer	↗	↗	↗
Autumn	↗	↗	↗

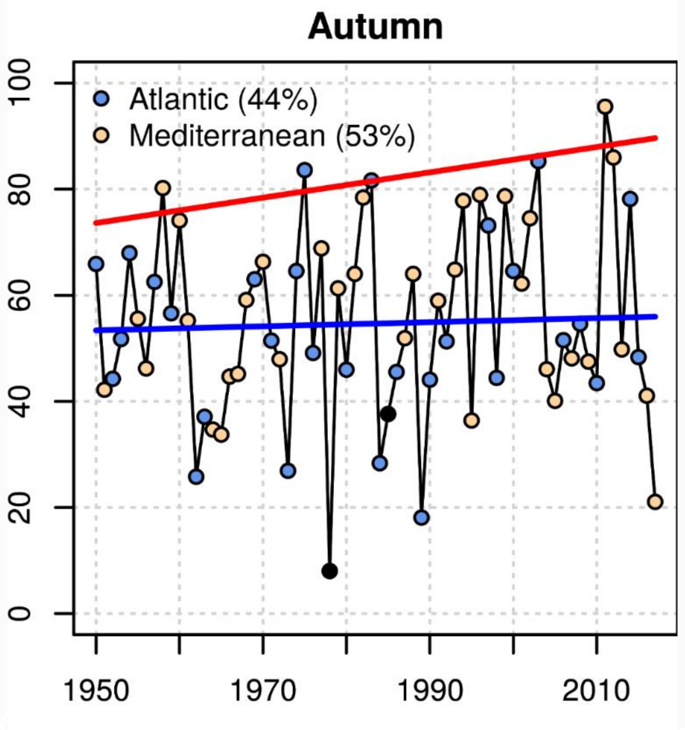
Winter and spring: decreasing reproductibility and decreasing intensity of Mediterranean flows

Summer and autumn: increasing stationarity, increasing reproductibility and increasing intensity of Mediterranean flows

Link with extreme precipitation trends in the Northern French Alps



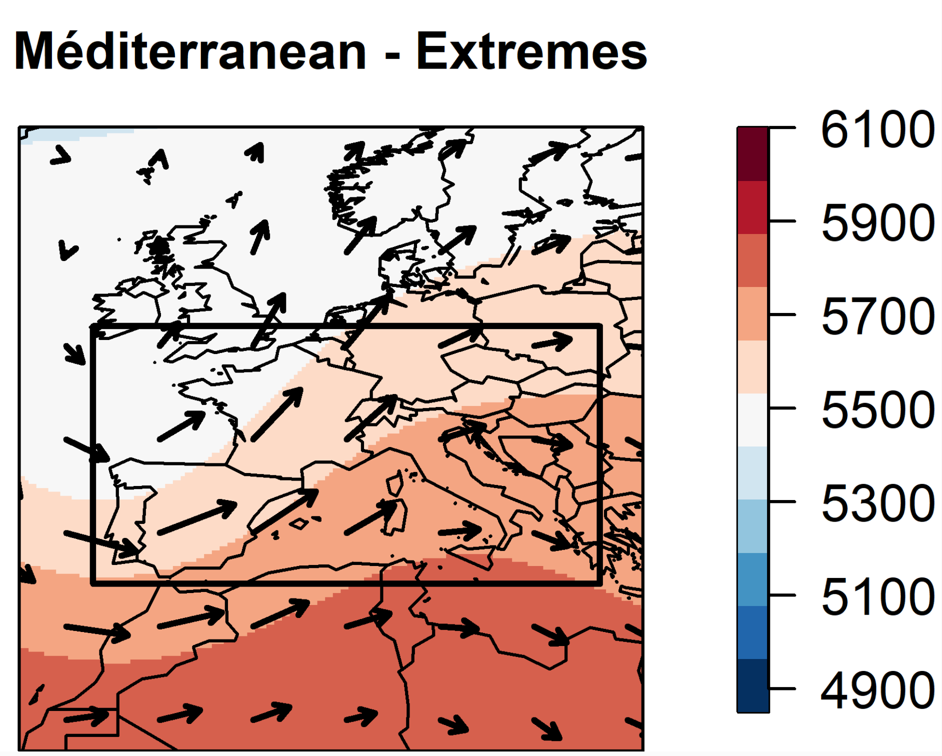
- **The Drac** catchment at Grenoble
- Observed **increase in autumn extreme precipitation** from 1950 to 2017



- More than half of the extremes: **stationary, reproductible and intense Mediterranean circulations** *Blanc et al., 2022*

Season	Stationarity	Reproducibility	Intensity
Autumn	↗	↗	↗

⇒ **The increasing occurrence of such circulations from 1950 to 2019** could partly explain the increase in autumn extreme precipitation



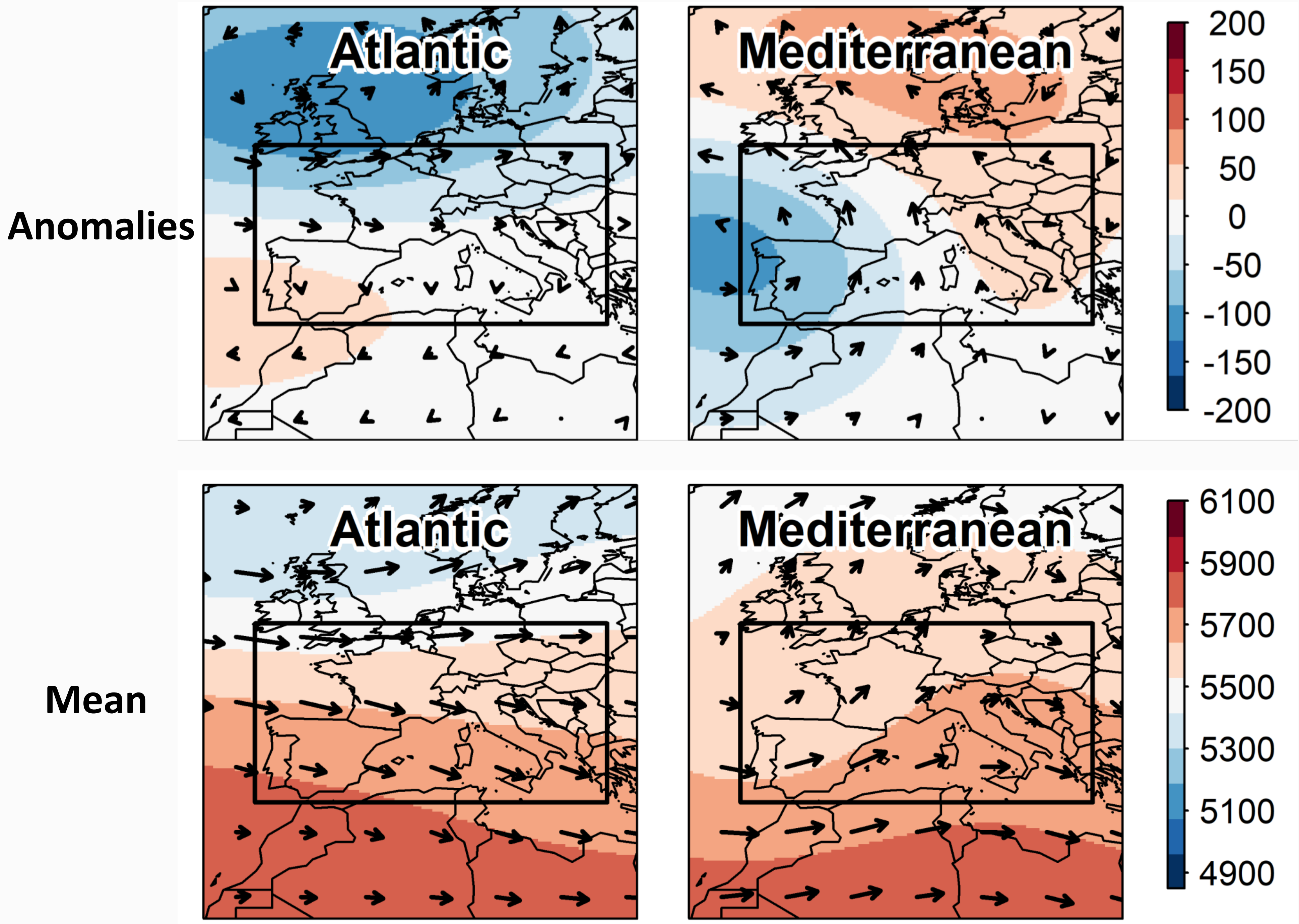
To go further…

Blanc, A., Blanchet, J., and Creutin, J.-D. (2022). Past evolution of western Europe large-scale circulation and link to precipitation trend in the northern French Alps. *Weather and Climate Dynamics,* 3(1) :231-250. https://doi.org/10.5194/wcd-3-231-2022.

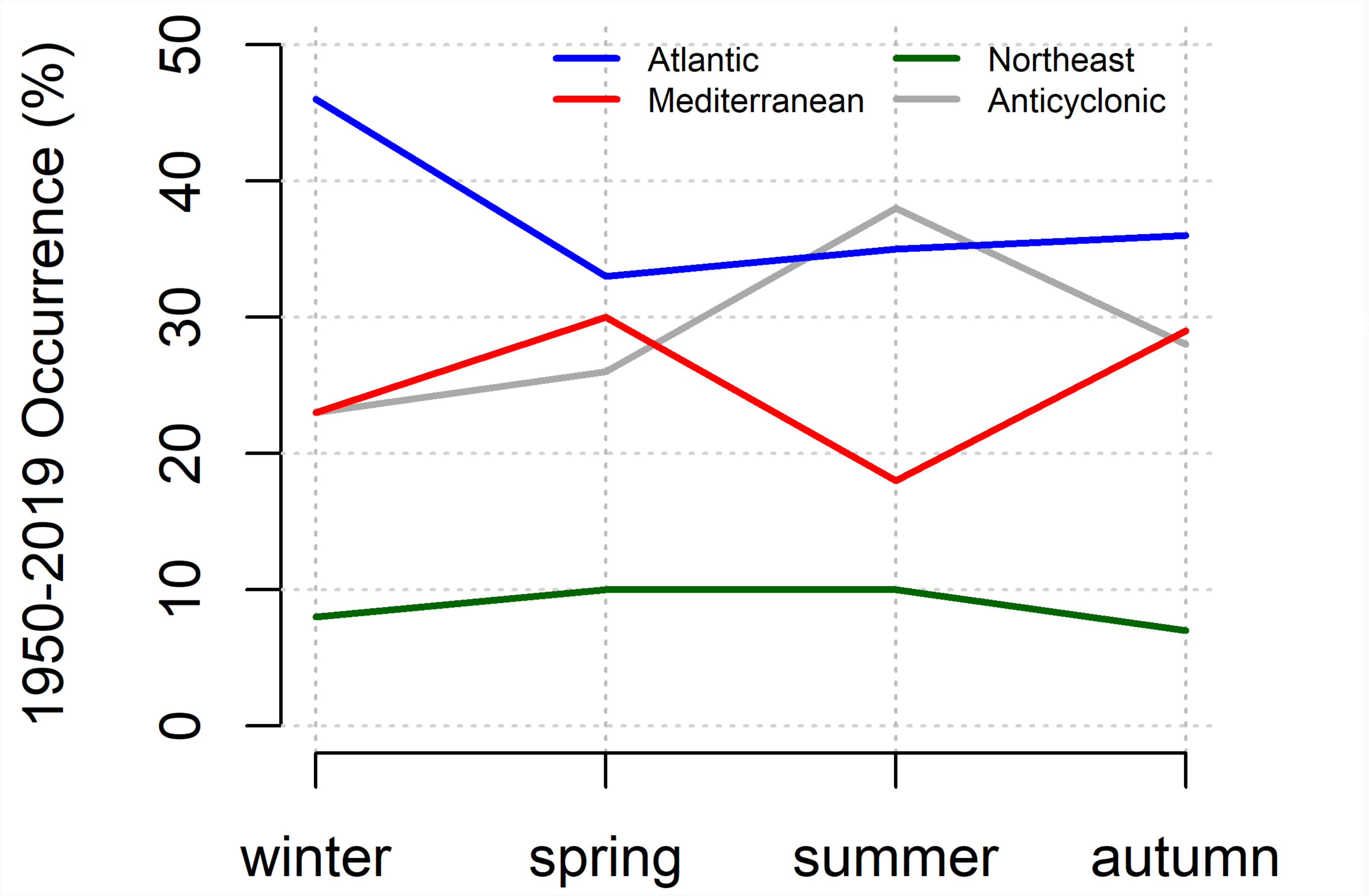
… and the following slides

The Isère River downstream Grenoble, Northern French Alps

Methodology: the main atmospheric influences



Derived from the classification of Garavaglia et al. (2010), from 1950 to 2019

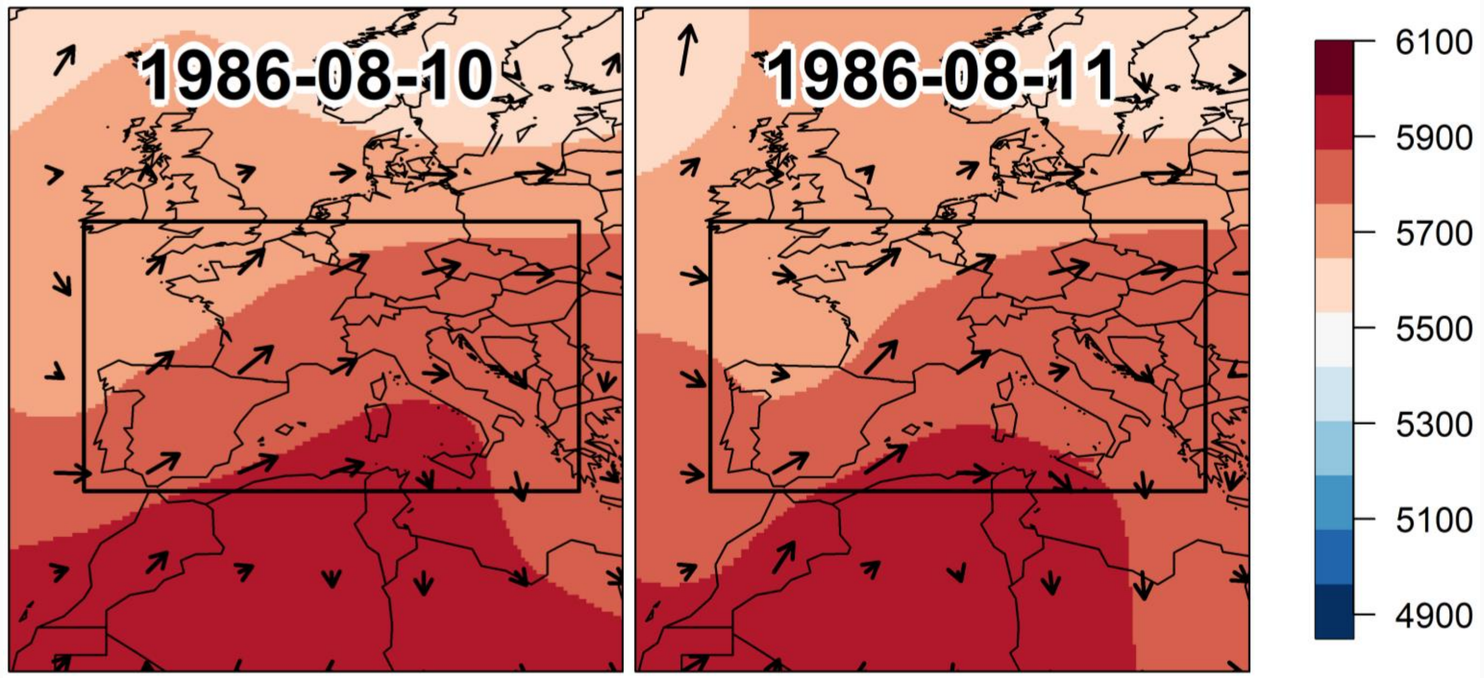


Methodology: the atmospheric descriptors

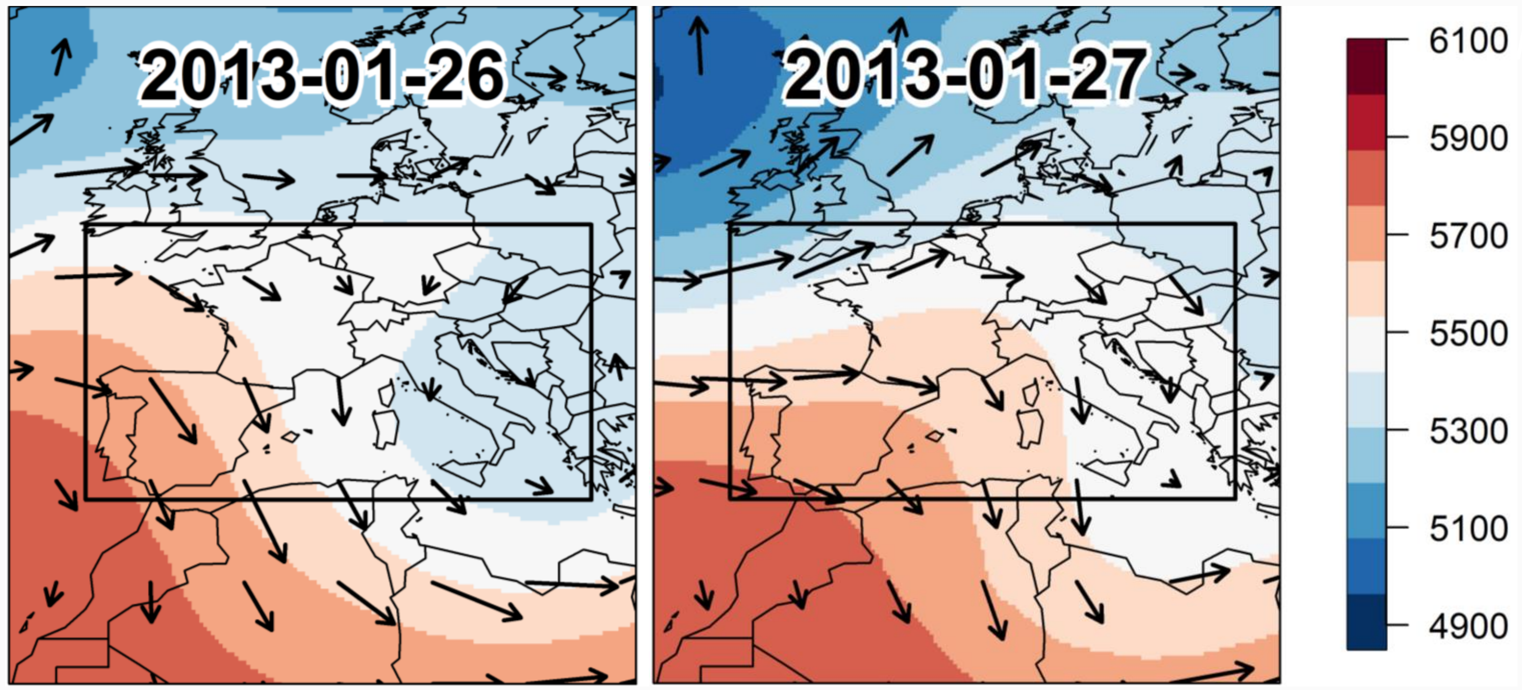
The celerity

Ressemblance in geopotential shapes between day D and day D-1 (TWS between two consecutive days).

Low celerity



Large celerity



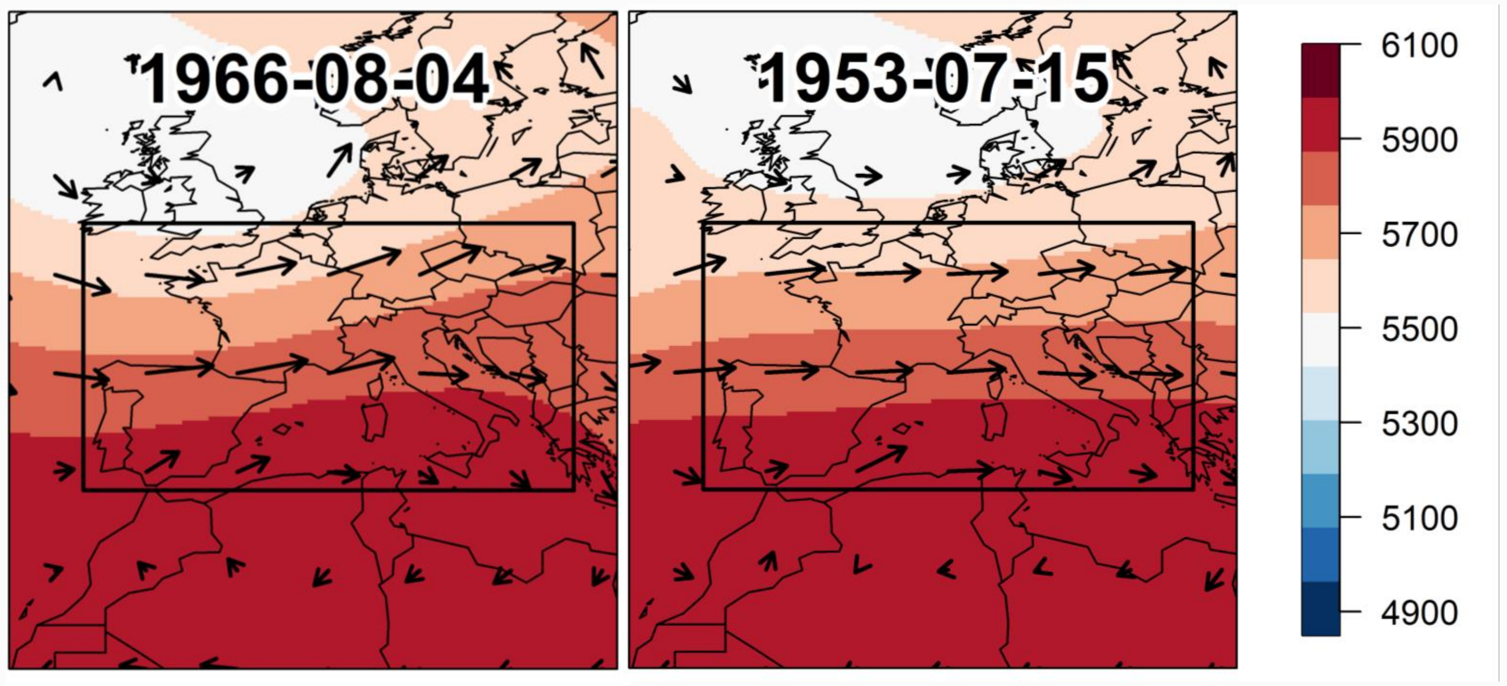
Methodology: the atmospheric descriptors

The singularity

Ressemblance of geopotential shapes between day D and its closest geopotential shapes in the climatology (0.5%).

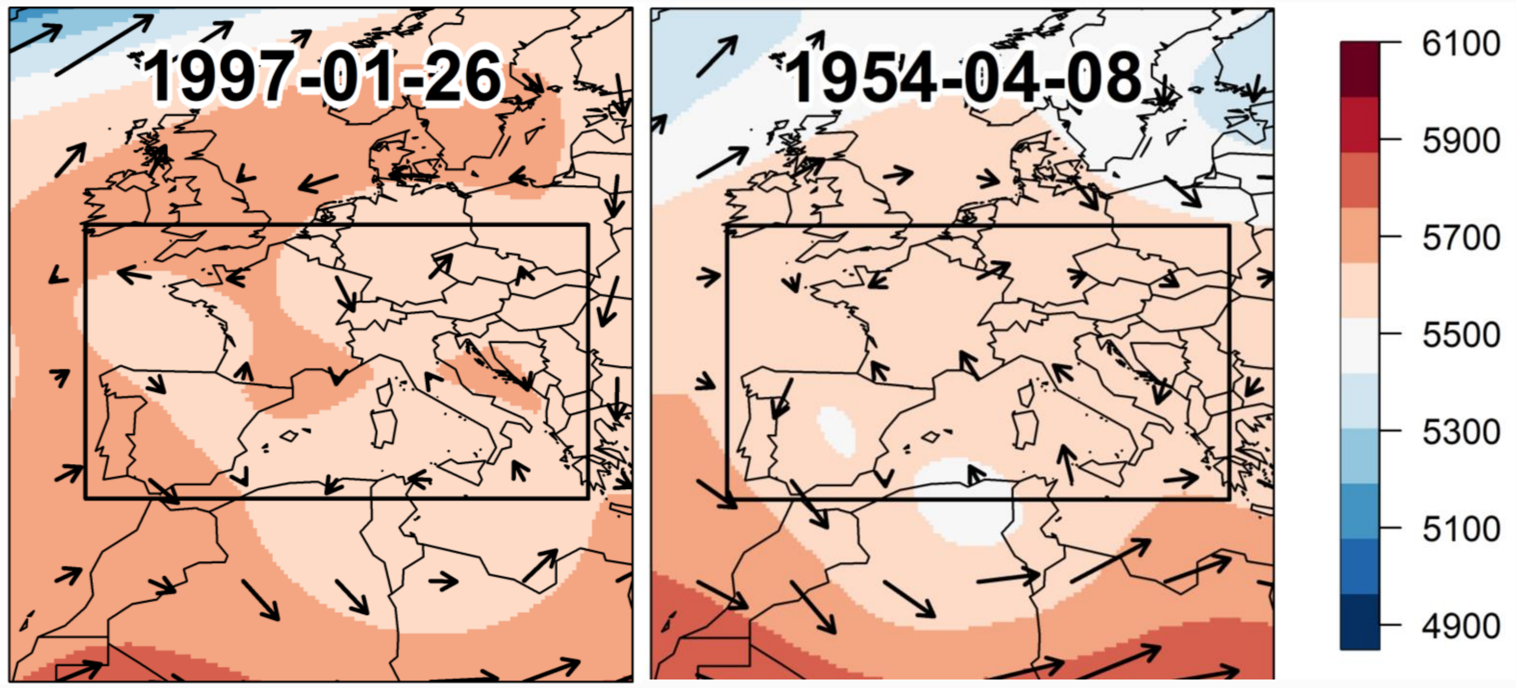
Singularity: mean TWS between a day and its analogs (0.5% closest).

Low singularity



Day D *50th analog*

Large singularity



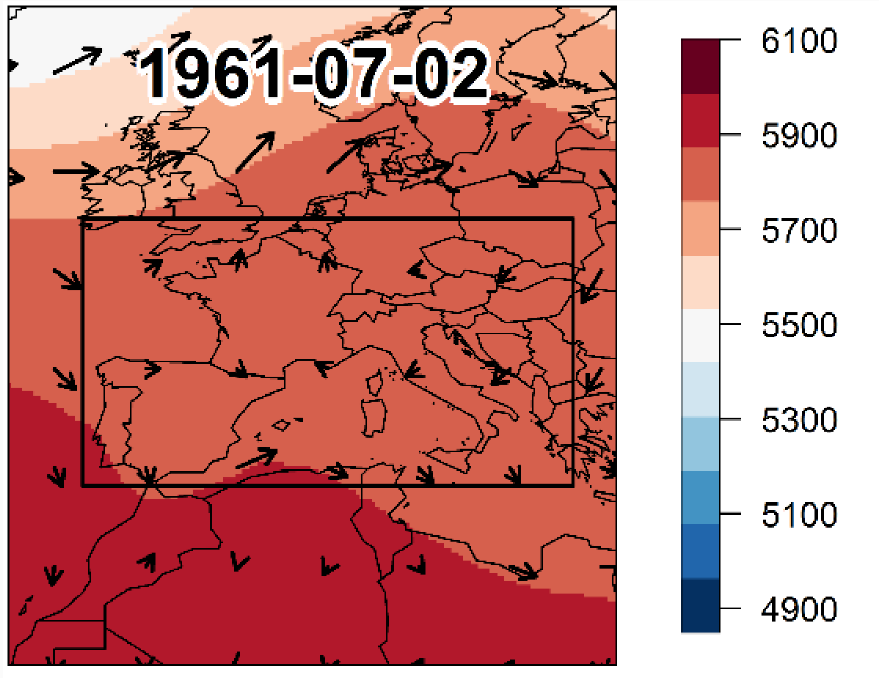
Day D *50th analog*

Methodology: the atmospheric descriptors

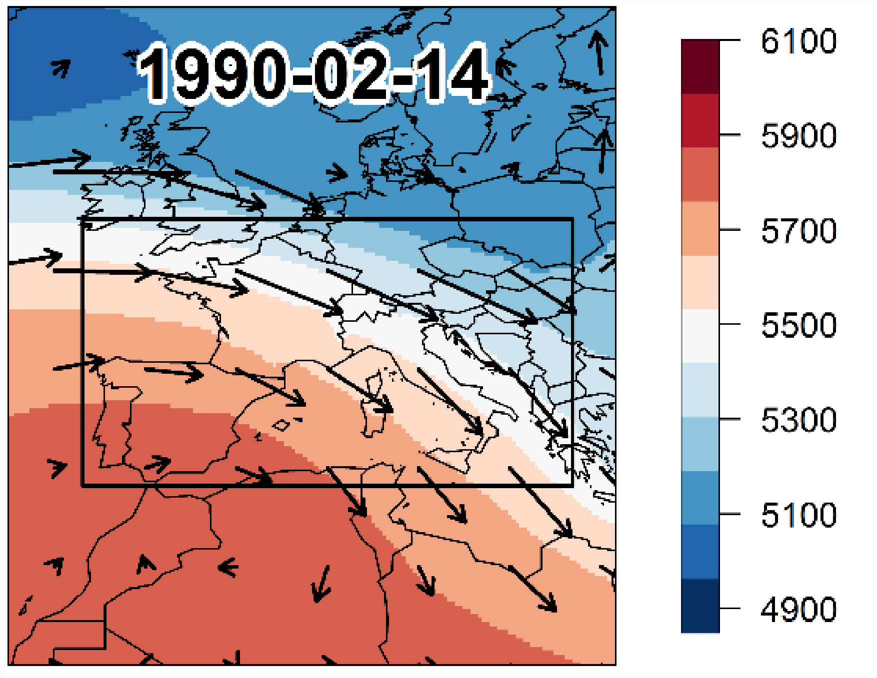
The Maximum Pressure Difference (MPD)

Range of geopotential heights for day D (not based on analogy)

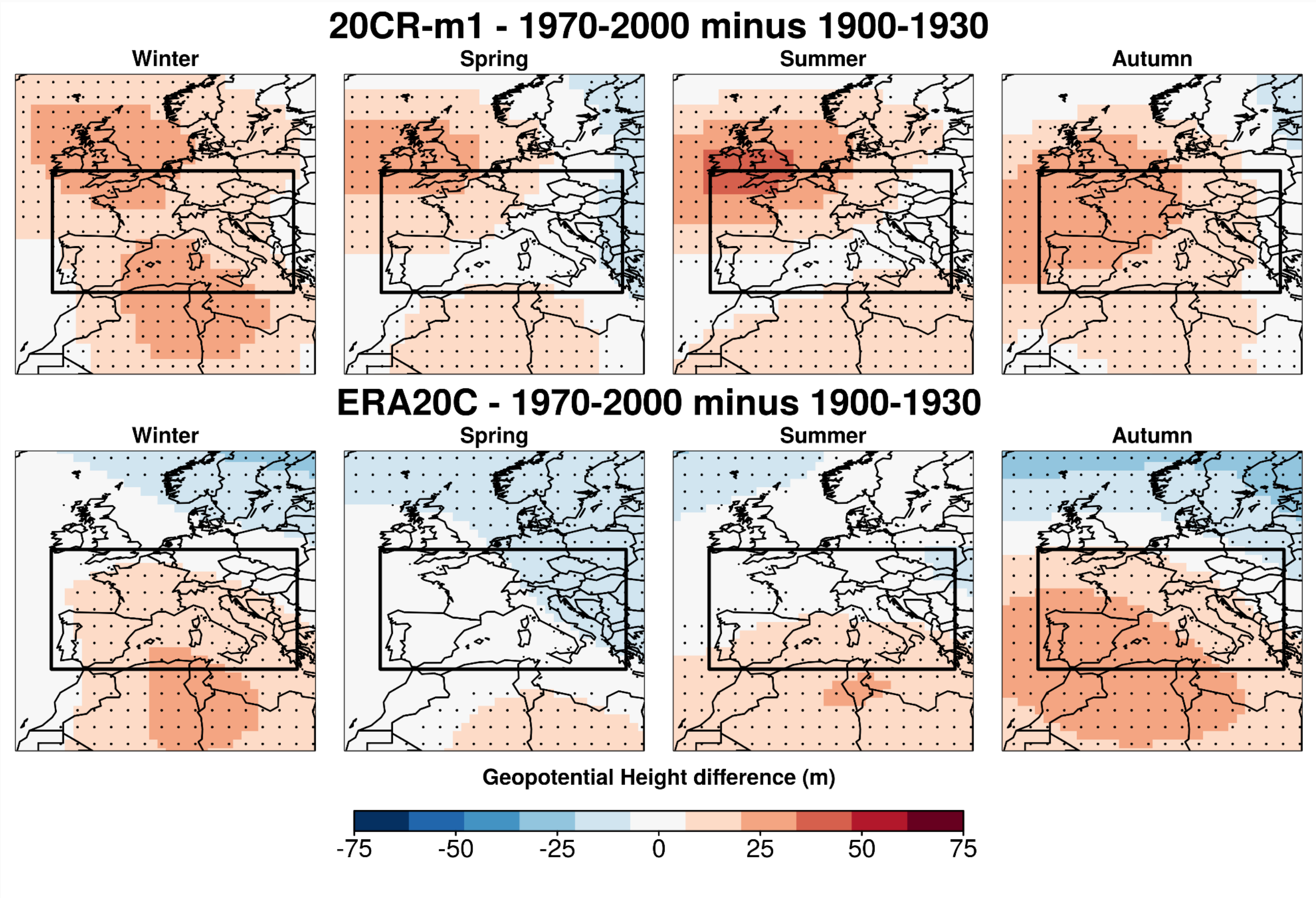
Low MPD



Large MPD



Results: differences between 20CRv2c and ERA20C



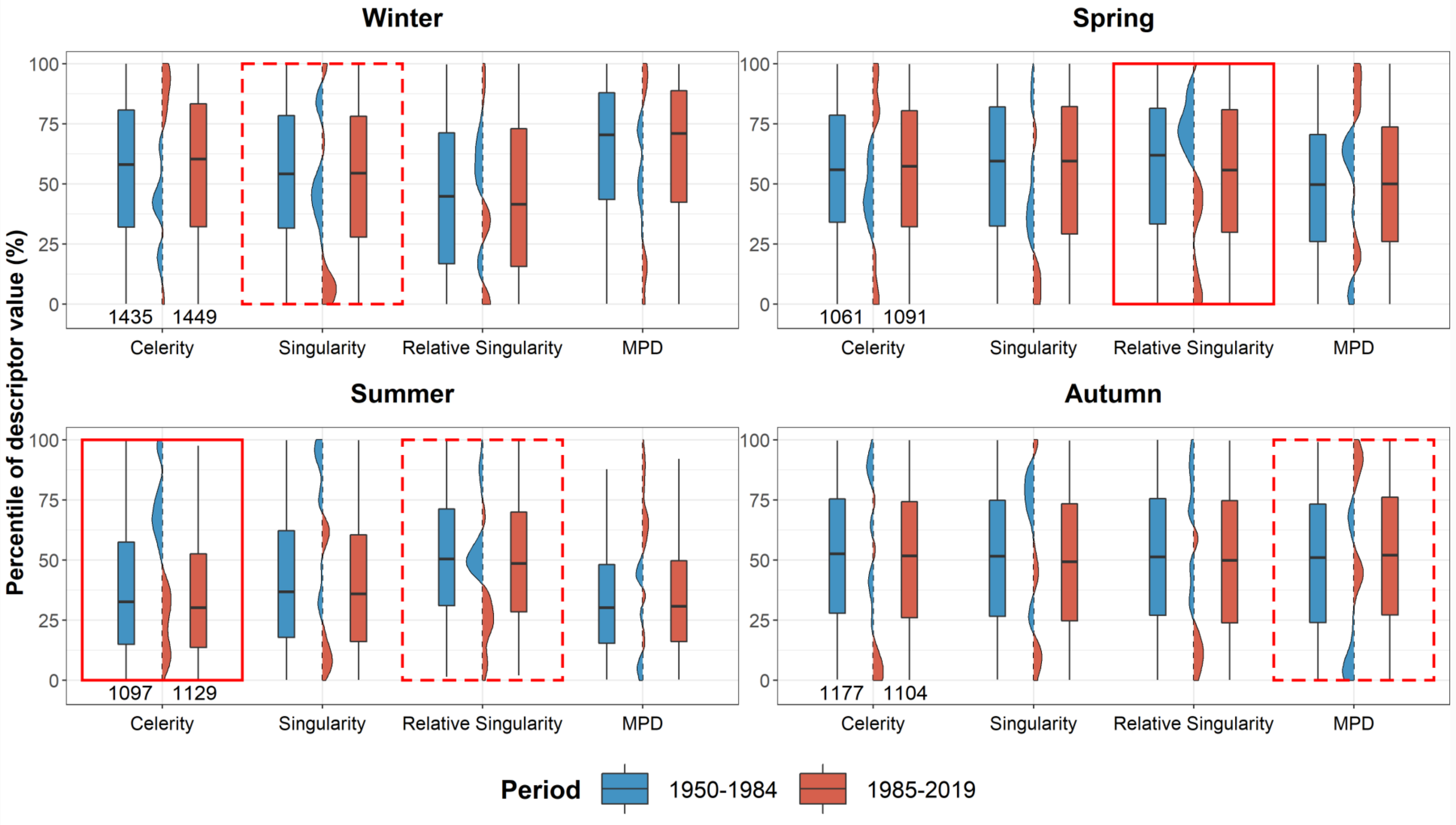
20CRv2c

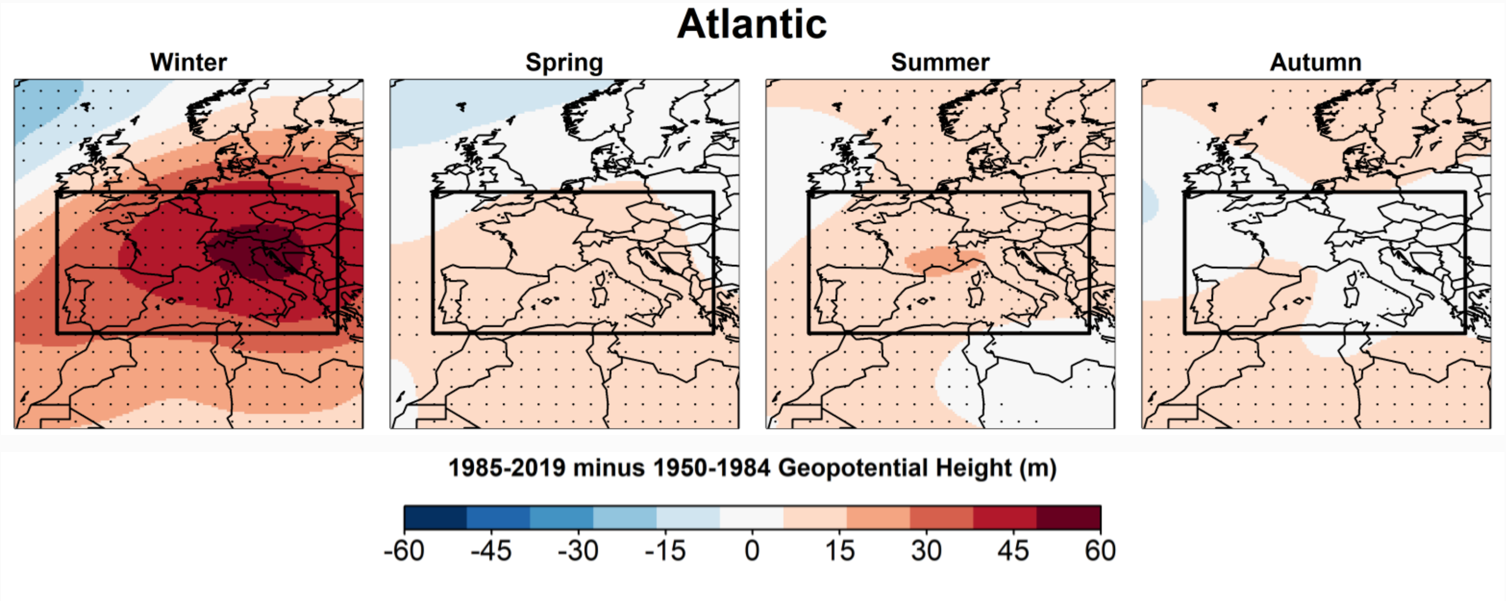
Mainly increase in 500 hPa geopotential height

ERA20C

Increasing geopotential height gradient between Southern and Northern Europe

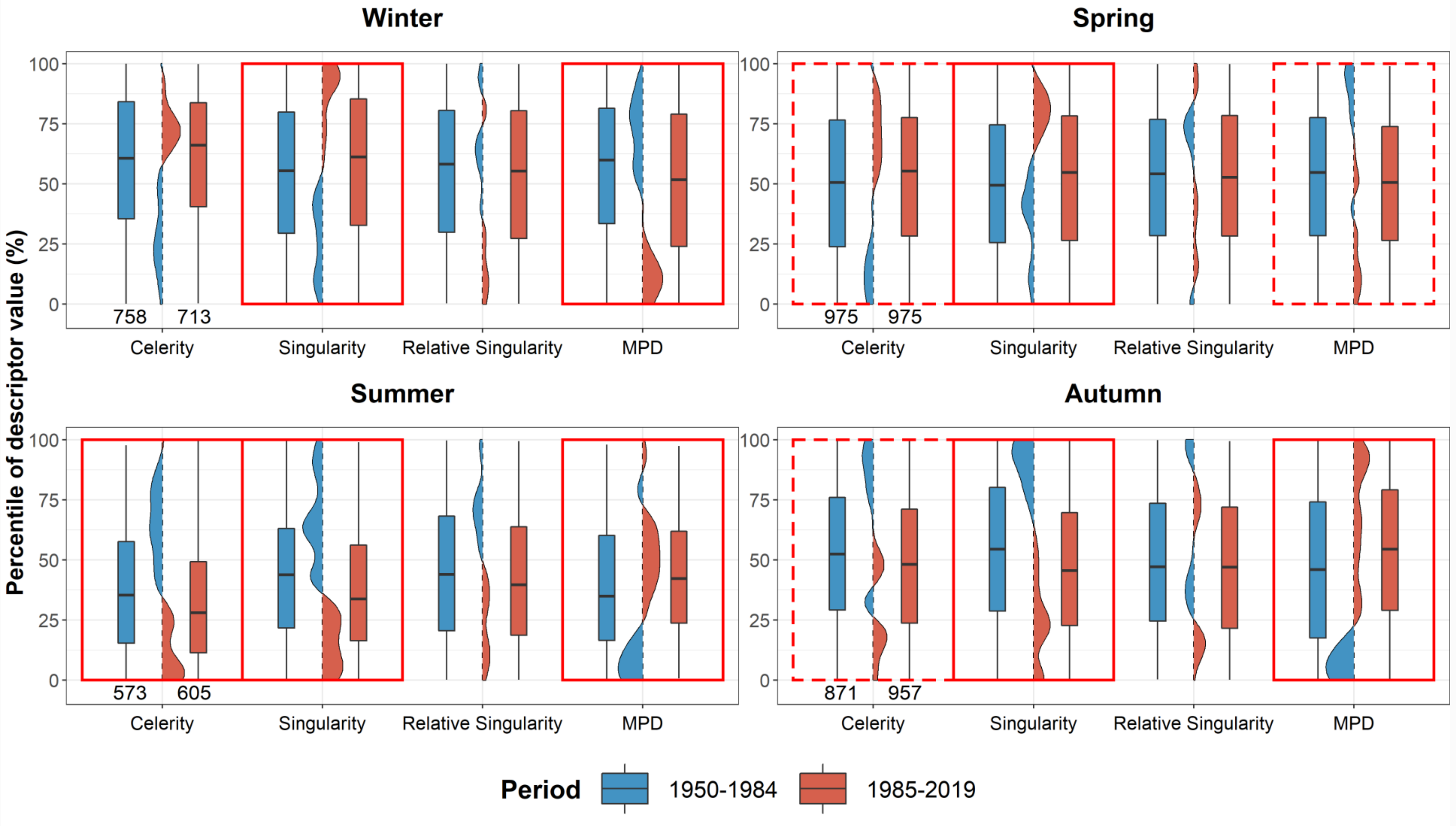
Results: Atlantic circulations from 1950 to 2019





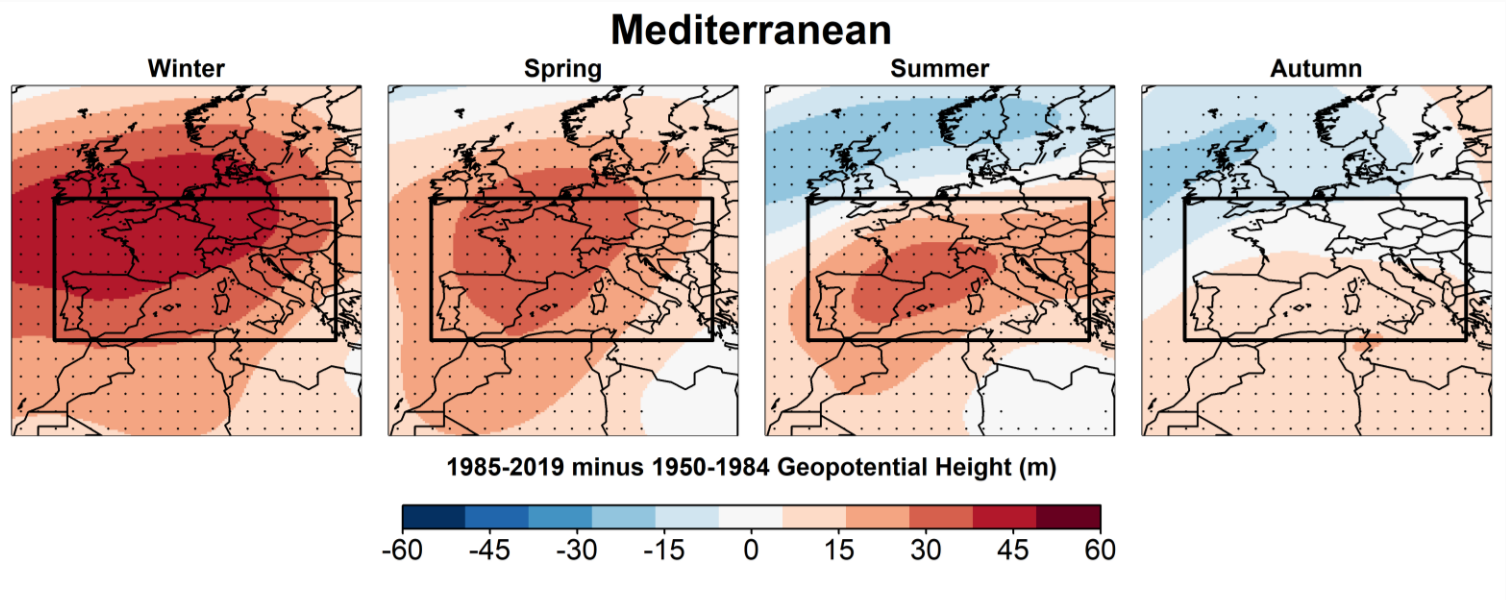
- ERA5 reanalysis
- **Few changes** in circulation characteristics according to the four descriptors
- Increasing southwest component of the flow **in winter**

Results: Mediterranean circulations from 1950 to 2019



- **Opposite changes** between summer/autumn and winter/pring

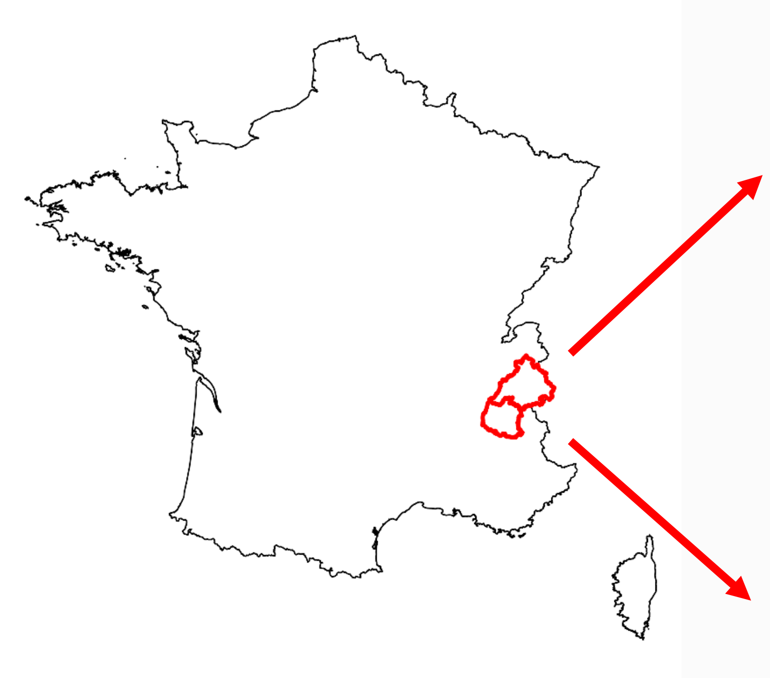
- **Increasing occurrence of circulations characteristics driving extreme precipitation in autumn**

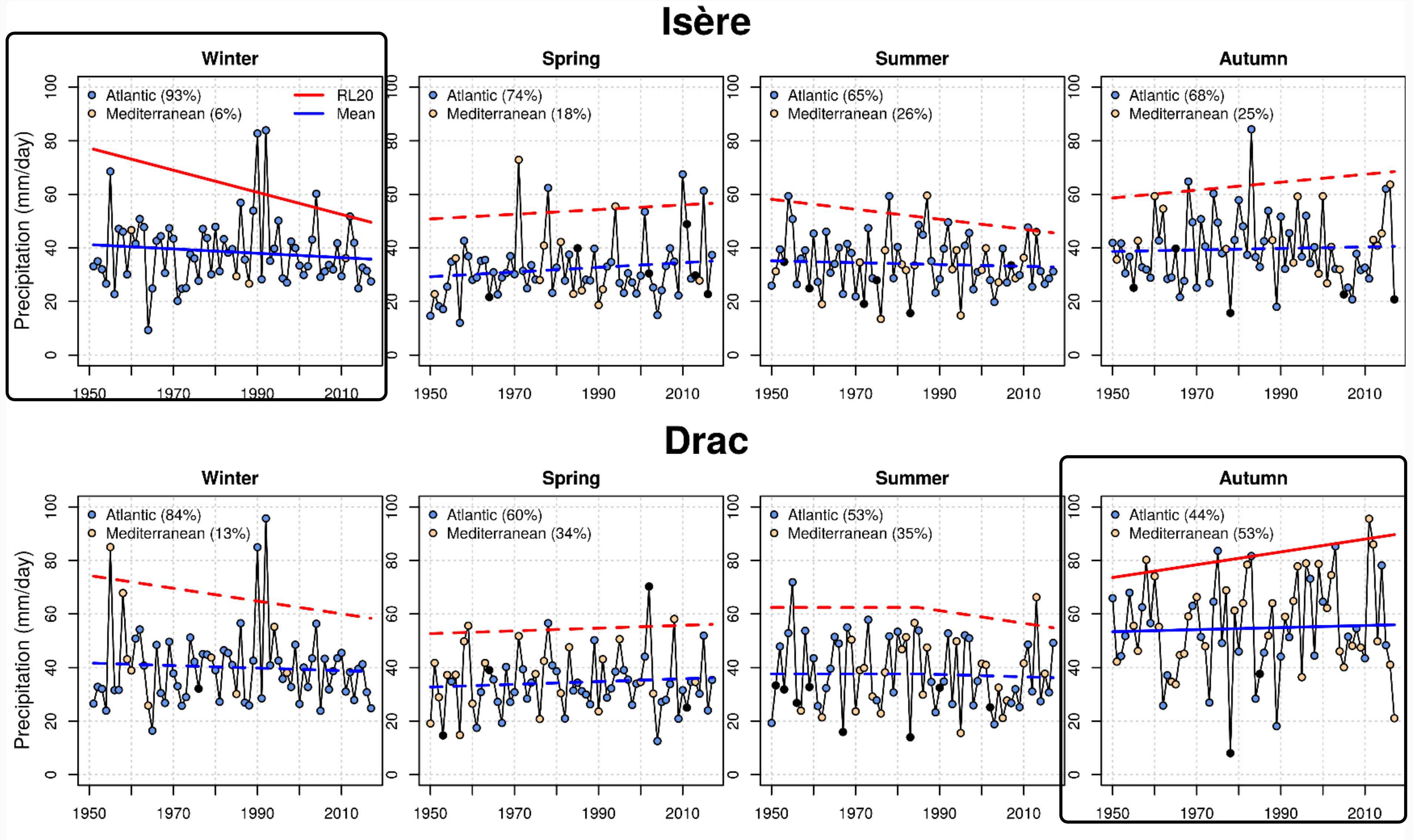


- **Weakening** of Mediterranean circulation in winter, and to a lesser extent in spring

- **Increasing zonality** of Mediterranean circulation in autumn

Results: extreme precipitation trends in the Northern French Alps



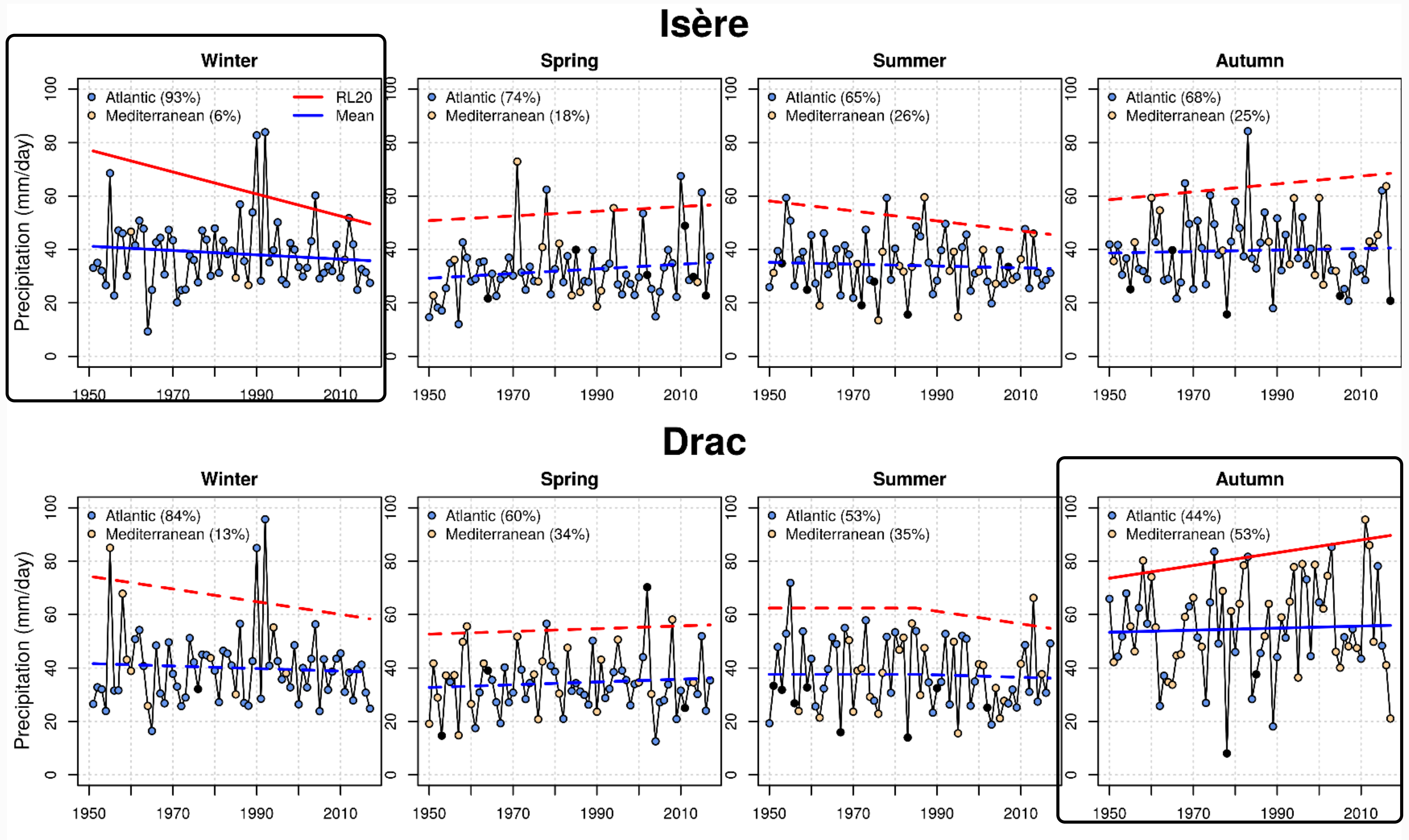


- **Decrease in winter extreme precipitation** in the Isère catchment
- **Atlantic** extremes

- **Increase in autumn extreme precipitation** in the Drac catchment
- **Mainly Mediterrenaean** extremes

Results: extreme precipitation trends in the Northern French Alps

Increasing southwest component of Atlantic flows
⇒ May play a role



Increasing occurrence of Mediterranean circulation characteristics driving extreme precipitation
⇒ May partly explain the trend

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