Extreme rainfall events in Morocco: Spatial dependence and climate drivers

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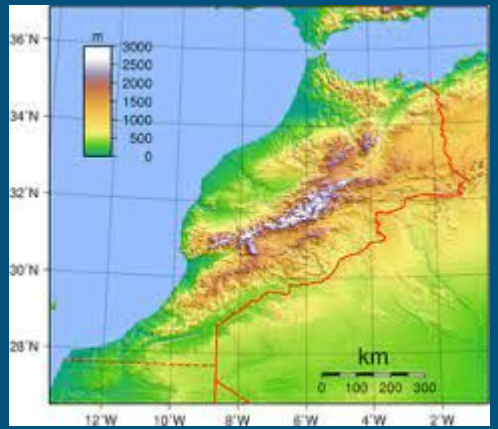
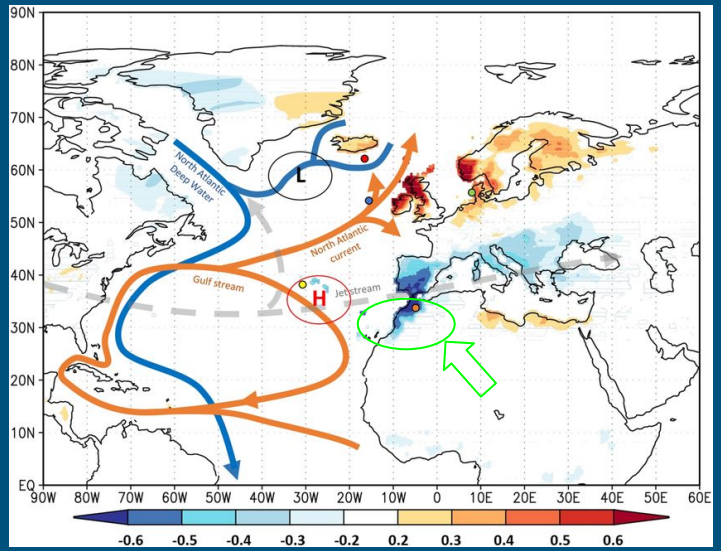
Morocco Location Information

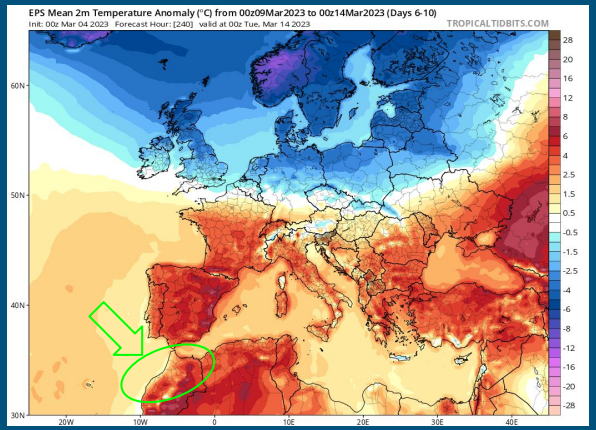
Many different types of landforms



North Atlantic Oscillation (NAO) and other teleconnection patterns



Other Events: Rossby Wave-Breaking (RWB), Greenland blocking, Atmospheric Rivers, extratropical cyclones, etc.



Research Question:

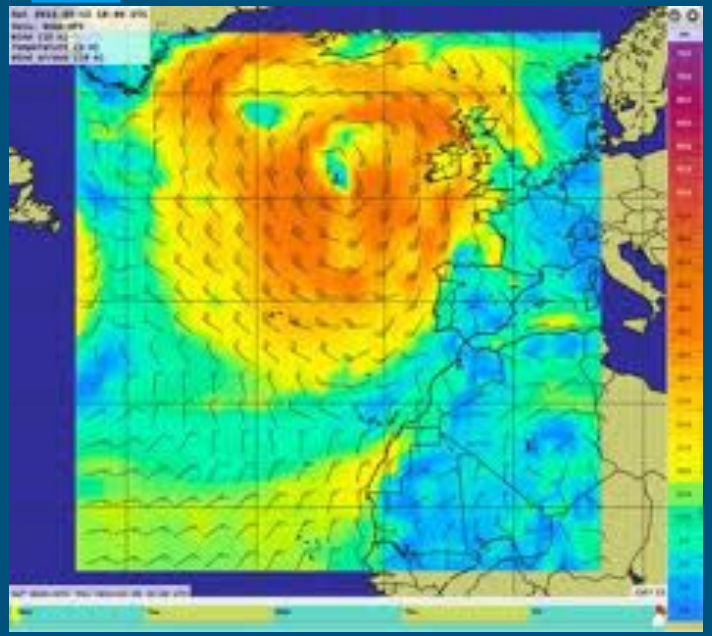
What are the physical drivers of Extreme Precipitation Events in Morocco, and how do they differ regionally?

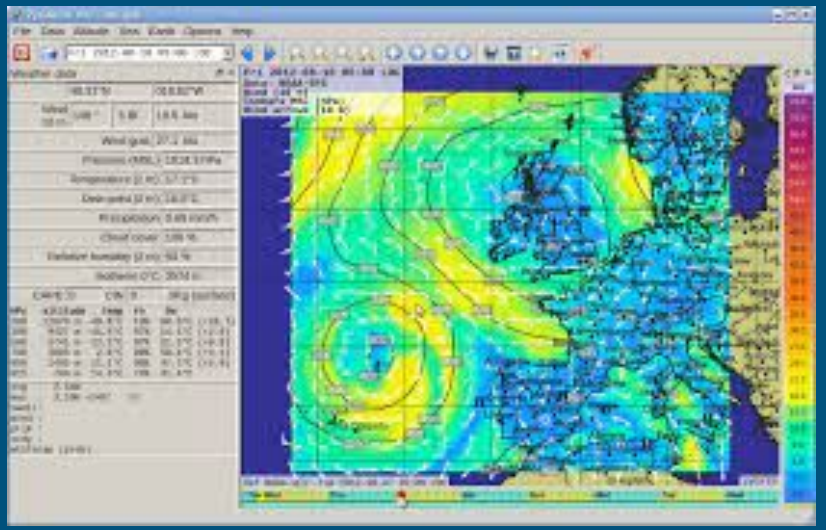
Datasets Used:

1. NAO Teleconnection Index Data (link)
   - US government data - Climate Prediction Center
2. MJO Teleconnection Index Data (link)
3. ERA5 Data (link)
   - Files are in .grib or .nc format
   - Considered the years 1979-2020
   - 7 Variables: precipitation, sea surface temperature, wind speed, geopotential height, total column water, integrated water vapor transport, and daily Ertel potential velocity.

(Both contain simple time series information including variables of time with corresponding NAO and MJO Indexes)

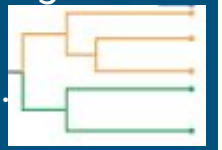
Some EDA (Examples)





Methods

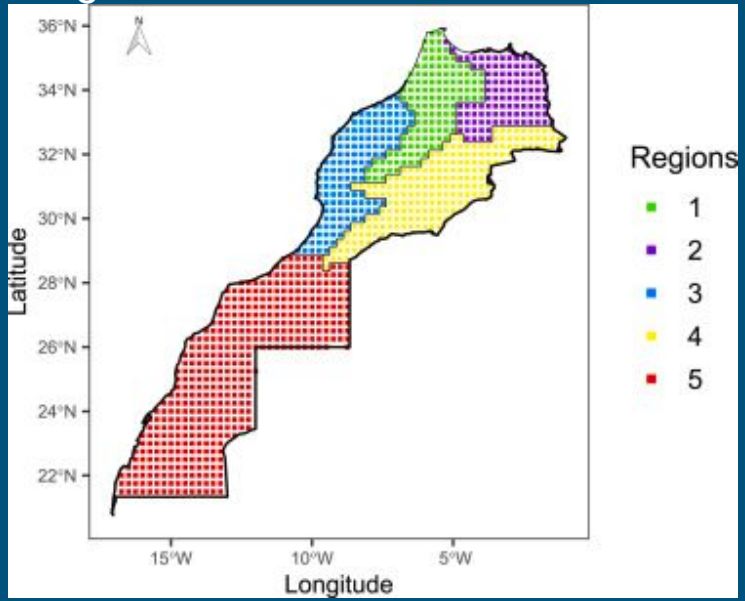
1. Use an algorithm to partition Morocco into regions
   - Used a Hierarchical Clustering (HC) Algorithm from Saunders et al. (2021).



2. Check the spatial coherence of the regions
   - Using co-occurrence probability
   - Changed cluster amount from 6 to 5 (pg. 10-11)
   - Algorithm listed on pg. 13

3. Define EPEs for each region and compute circulation anomalies (with significance)

Regionalization Results for Morocco



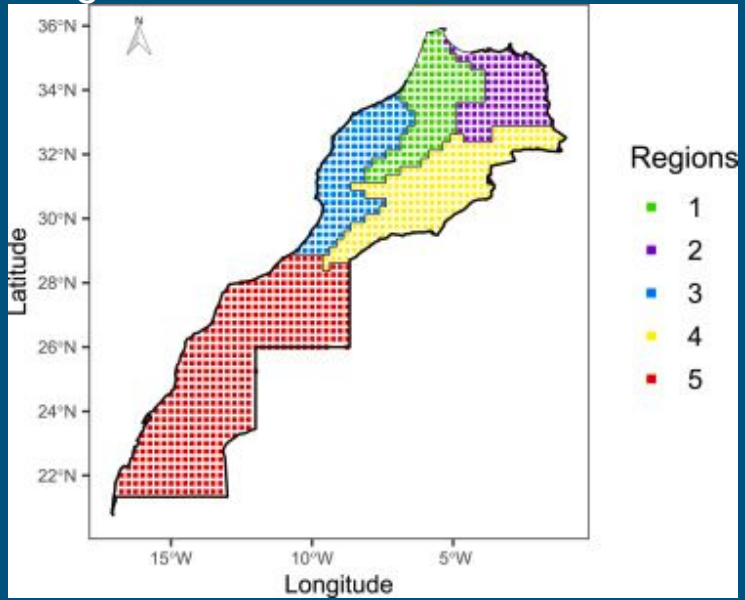
Results

Defining EPEs for each region (Hydrology year)

Table 1. Seasonal frequency (%) of EPEs in each region.

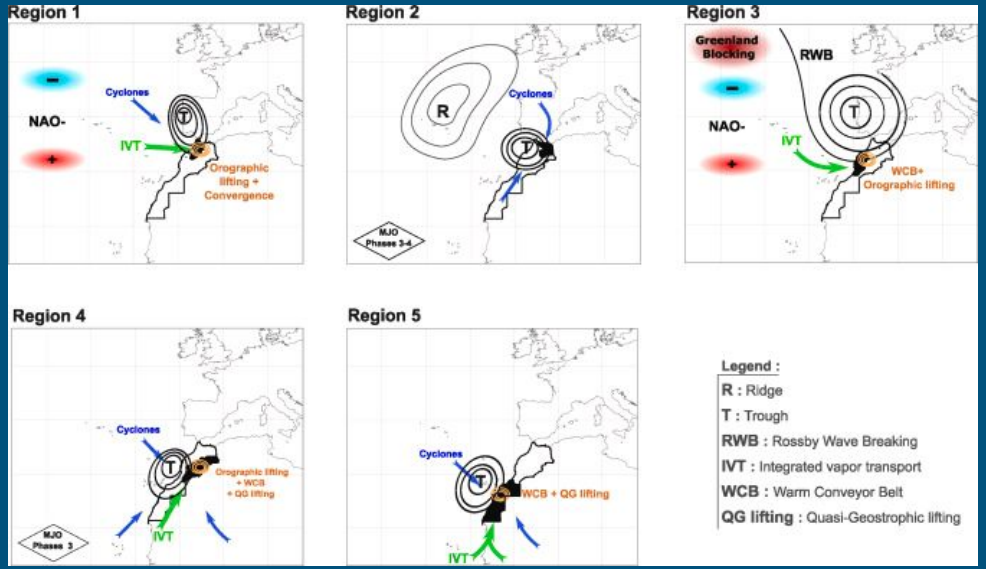
	Winter			Autumn
	DJF	MAM	JJA	SON
Region 1	55★	0	0	45★
Region 2	25★	25	10	40★
Region 3	40	15	0	45
Region 4	15	20	10	55★
Region 5	25	10	5	60★

Regionalization Results for Morocco

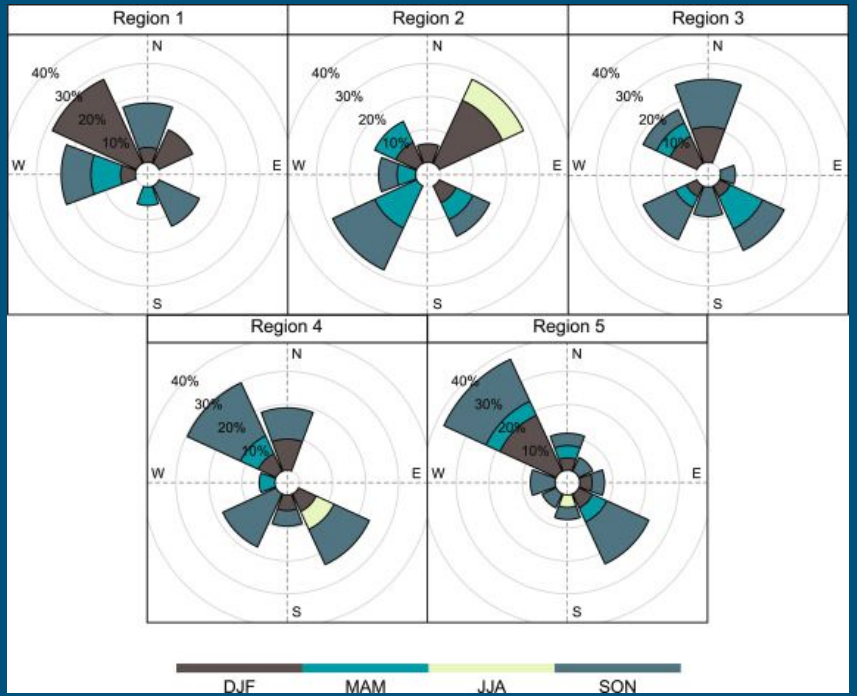


Overall Results

Circulation Anomalies with Significance (Summary)

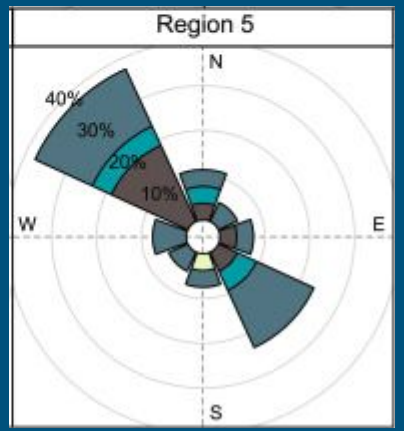


Wind Rose Plots

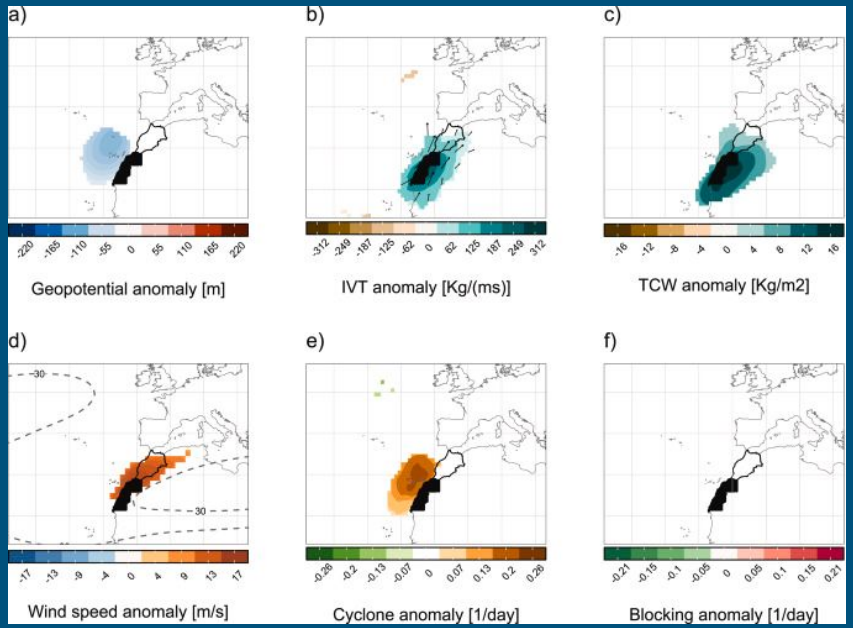


Results For Region 5

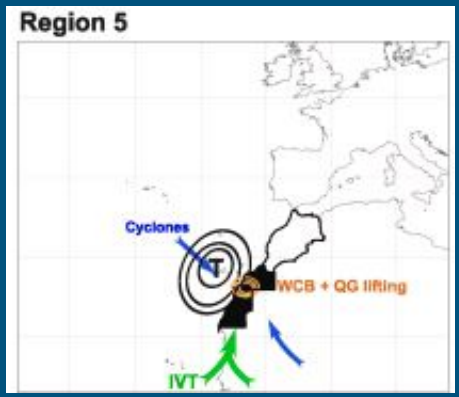
Wind Rose Plot



Average Anomalies of large-scale conditions associated with EPEs



Climate/Weather factors identified



Legend :

R : Ridge
T : Trough
RWB : Rossby Wave Breaking
IVT : Integrated vapor transport
WCB : Warm Conveyor Belt
QG lifting : Quasi-Geostrophic lifting

3 Ideas of Future Applications

1. Flooding Forecasting
    - Can use this knowledge with other factors that affect flooding, such as river flow data, knowledge of dykes, and snow melt (near mountain ranges).

2. Defining EPEs for other countries, such as Canada.
    - Look at Basins in Squamish area- using co-occurrence probabilities

3. Assess if regions and their EPE physical drivers are useful for OTHER weather extremes such as cold and heat waves in Morocco.