ANALYSIS OF PRECIPITATION PATTERNS AND EXTREMES IN EUROPEAN LOWLANDS

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1. Abstract

It is well-known that climate change affects large scale weather patterns and local extremes all over the world as well as in Europe. These changes include the changes of precipitation occurrences, amounts, and spatial patterns, which may require appropriate risk management actions. For this purpose, the first step is a thorough analysis of possible hazards associated to specific precipitation-related weather phenomena.
The primary goals of this study are (i) to examine the changes in precipitation patterns and extremes, and (ii) to explore the possible connections between changes in different lowlands across Europe. Altogether 14 plain regions are selected in this study to represent different parts within Europe. Daily precipitation times series are analyzed and compared for these plain regions using various statistical tools. The results represent annual and seasonal changes in average and extreme precipitation amount as well as in the frequency of precipitation occurrences. Climate indices and the occurrence of extreme weather conditions including wet and dry spells are also analyzed.

2. Database

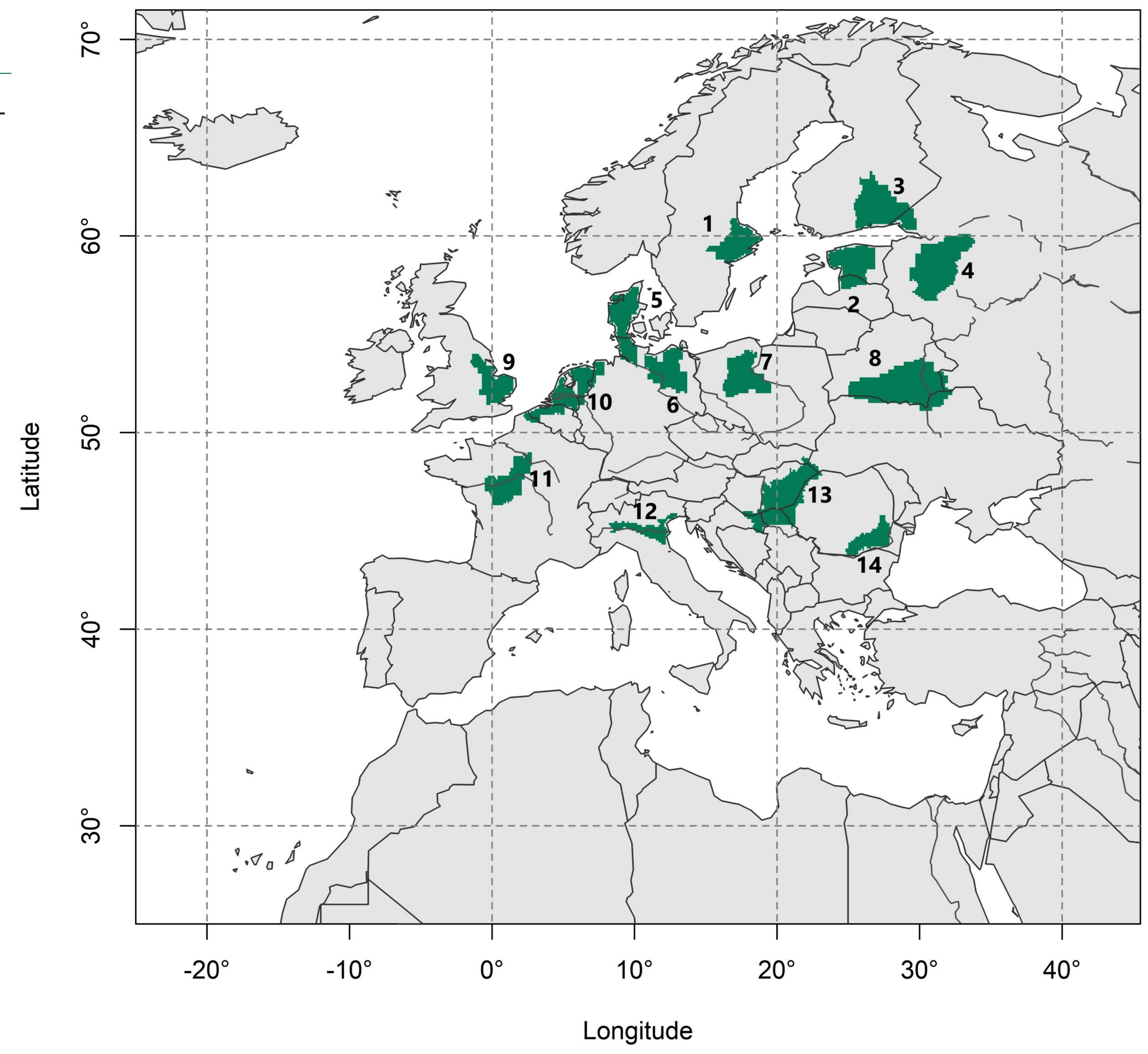
Precipitation time series are used from the E-OBS v.20[1] datasets on a 0.1° regular grid. Datasets are based on station measurements from Europe and are available from 1950 onward with daily temporal resolution, and updated regularly.

3. Selected regions

For choosing the plains and their spatial representations we used an objective method. The pre-selected regions have to fulfill two criteria, namely:

- Elevation remains under 200 m throughout the entire defined area
- Difference between the neighboring gridpoints within the plain region does not exceed 40 m

No.	Name	Countries	Total number of gridpoints	Avg. elevation (max. deviation) [m]
1	Svealand	SE	408	35 (55)
2	Estonian Lowlands	EE	501	61 (70)
3	Finnish Lakeland	FI, RU	745	87 (85)
4	Izhora Plateau	RU	907	55 (54)
5	Jylland	DK,DE	523	29 (70)
6	Mecklenburg Lakeland	DE	465	42 (64)
7	Polish Plain	PL	496	101 (94)
8	Polesia	UA, RU, BY	1186	131 (36)
9	Fenland	UK	369	44 (79)
10	Low Lands	FR, NL, BE, DE	575	11 (36)
11	Paris Basin	FR	453	107 (84)
12	Po Valley	IT	265	31 (133)
13	Pannonian Plain	HU, RO, RS, HR, SK	897	97 (66)
14	Romanian Plain	RO	308	52 (106)



Locations of the selected plains within the E-OBS domains.

Detailed information about the selected regions. The table contains the covered countries, the number of gridpoints in the domain and the average elevation with the maximum deviation.

4. Results

Index	Definition	Unit	Median
Precipitation indices			
RR1	Number of wet days, i.e. daily precipitation exceeding 1 mm ($R_{day} > 1$ mm)	day	124.3
RR5	Number of days with precipitation exceeding 5 mm ($R_{day} > 5$ mm)	day	40.6
RR10	Number of heavy precipitation days ($R_{day} > 10$ mm)	day	11.4
RR20	Number of extremely heavy precipitation days ($R_{day} > 20$ mm)	day	1.8
RRX1	Maximum 1-day precipitation ($\max(R_{day})$)	mm	49.6
RRX5	Maximum consecutive 5-days precipitation ($\max(\sum_{i=1}^{5} R_{day})$)	mm	86.1
R90p	The 90th percentile of daily precipitation amount	mm	10.1
R95p	The 95th percentile of daily precipitation amount	mm	13.2
R95N	Number of days exceeding the 95th percentile of daily precipitation amount	day	6.1
Drought indices			
CDD	Maximum number of consecutive dry days $\max(R_{day} < 1$ mm)	day	22.0
DD	Number of dry days ($R_{day} < 1$ mm)	day	241.0
DS5	Number of dry spells with length above 5 consecutive days	-	17.5
DS10	Number of dry spells with length above 10 consecutive days	-	6.2
DS95p	The 95th percentile of the length of DS5	day	17.8
DS5N	Number of dry days in DS5	day	166.6

The list of the indices used in this study with their definitions.

The median values in the table were calculated with multiple statistical tools. First, yearly time series were determined with spatial averaging for each region. Then medians were calculated, finally we also calculated the median values for the indices.

1 *Relationship of **RR5, RR10, RR20** vs. **RR1**.*

Minimum, mean and maximum values were calculated from gridded data with yearly temporal resolution. The absolute maximum is the highest value of the 69-year time series.

The decreasing number of days in the minimums and means from the RR5 to the RR20 indicates that extreme events occur mostly in small areas within the region (i.e. in a few number of gridpoints). In general, relatively high variability can be seen among the different regions. Extreme preicipitation events are more frequent in the regions at lower latitude.

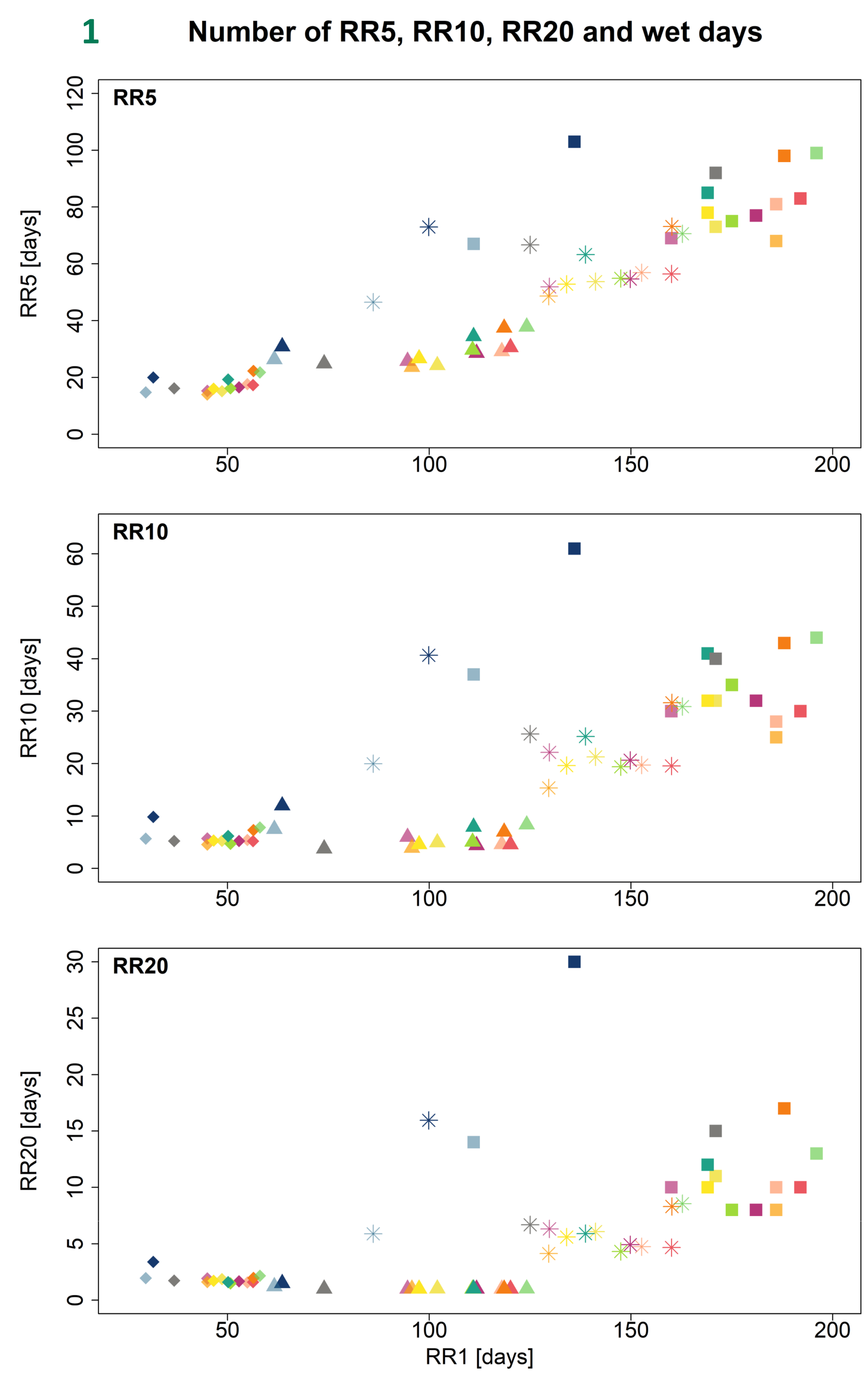
2 *Mean monthly precipitation and monthly time series presented on Taylor diagrams[2]. For the reference region, we chose the Pannonian Plain.*

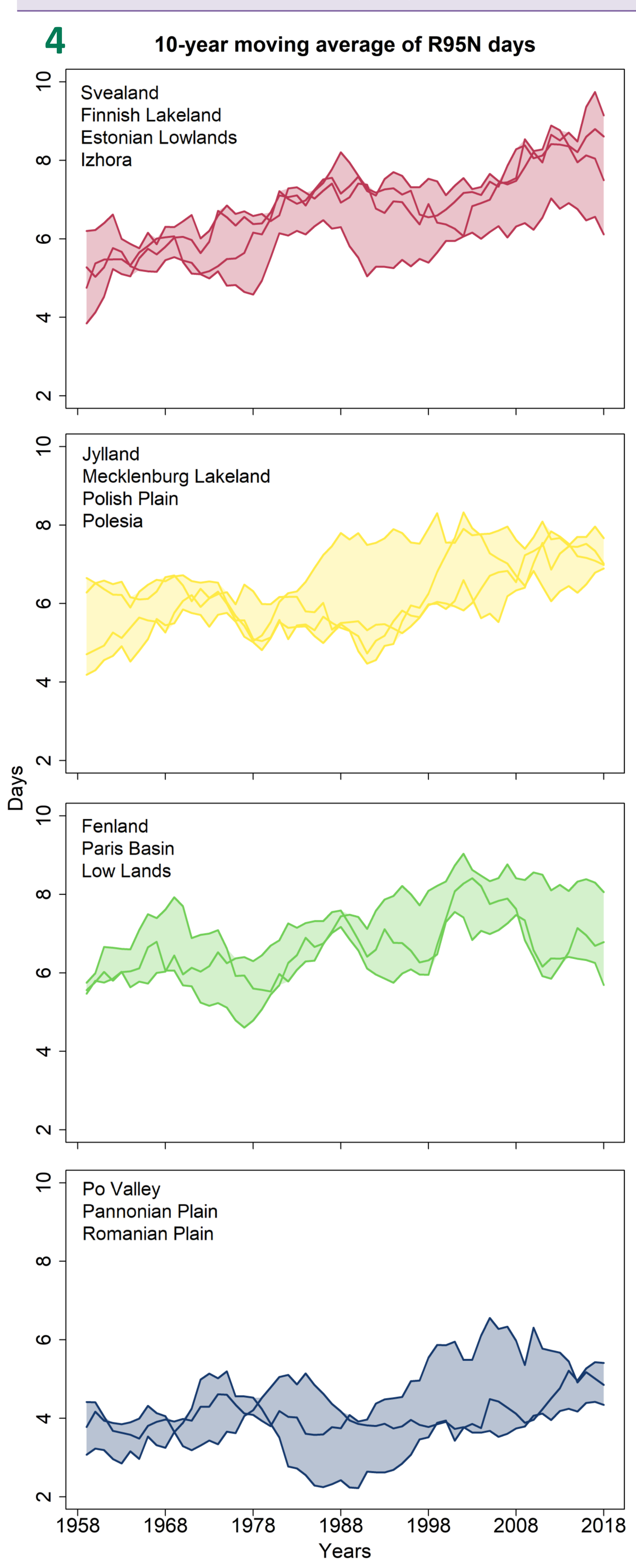
Based on these results, four groups of regions can be identified representing different geographical proximities and different lattitudes.

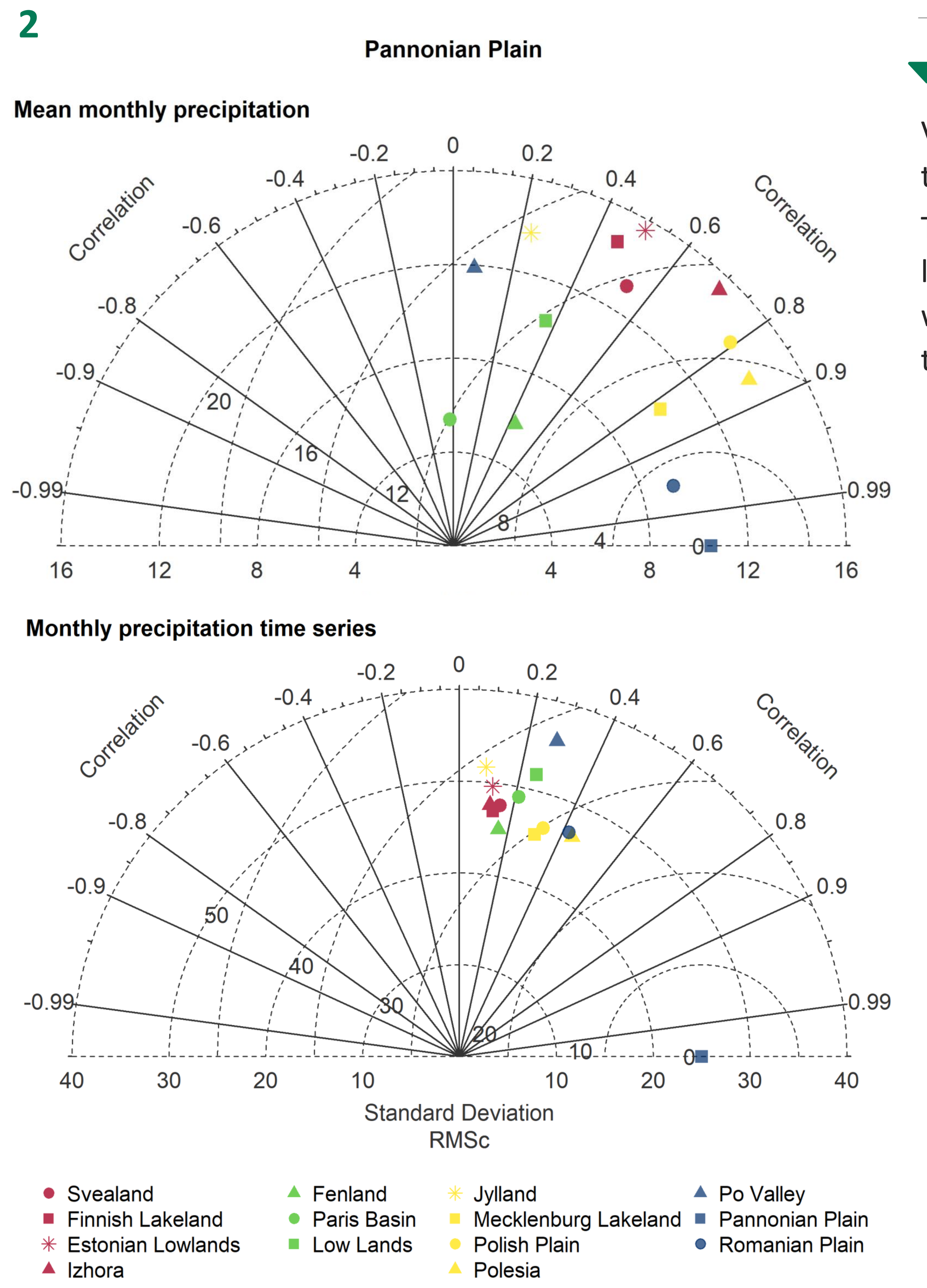
3 *Frequency **(DS5)** average length of dry spells **(DS5N)**.*

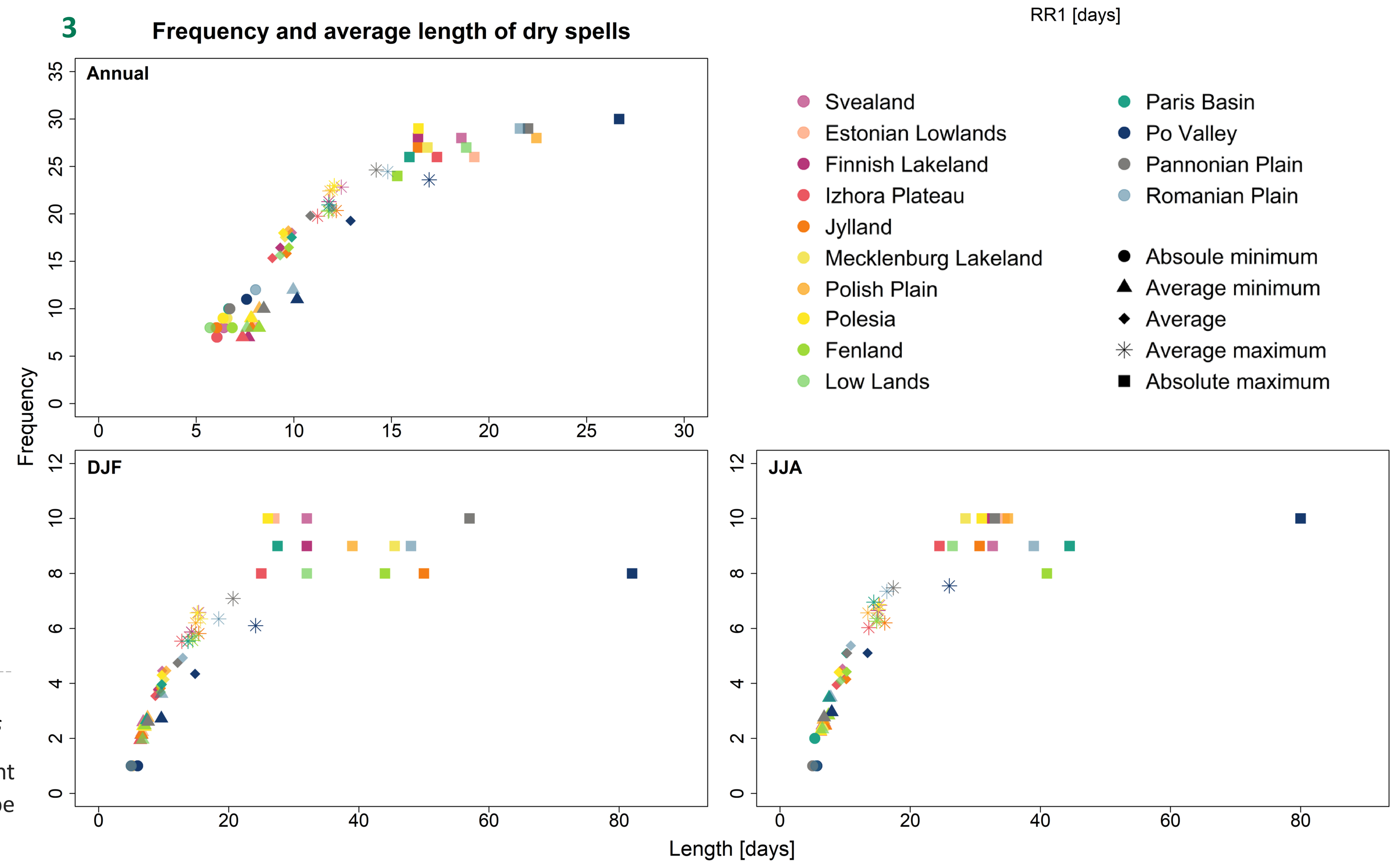
Values of minimum, mean and maximum were calculated as in the case of precipitation days above.

There is no linear connection between the frequency and the length of dry spells. The absolute maximum of length occur in a wide range, while the absolute maximums of frequency seems to show less differences amoung the regions.









4 *10-year moving average of extreme precipitation **(R95N)** days*

The yearly numbers of extreme precipitation days show significant increase in most of the regions. The highest increasing trend can be detected at Estonian Lowlands , Finnish Lakeland and Polish Plain.

5. Summary

Altogether 14 regions were selected all across Europe for analysis of precipitation patterns and extremes. In most of the regions, significant changes in drought indices can not be detected. In the cases of precipitation indices, several regions show significant increases. We identified four group of regions where similar precipitation trends can be seen, however they also include differences in wet days and dry spells .

6. References and acknowledgement

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