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Introduction / Background

The existence of weekly cycles in varying meteorological surface parameters (mainly temperature and precipitation) has been analysed in numerous studies. However there is no generally accepted proof of the existence or the lack of weekly cycles in surface variables.

The issue of weekly cycles in atmospheric circulation dynamics has only rarely been raised: Sanchez-Lorenzo et al. (2007) and Laux and Kunstmann (2008) analysed occurrence frequencies of objectively derived circulation types and found evidence for significant weekly cycles for some types.

In this contribution the existence of weekly cycles in occurrence frequencies of large-scale atmospheric circulation types is analysed on the basis of a comprehensive set of circulation type classifications that is available from the EU COST action 733 “Harmonisation and Applications of Weather Type Classifications for European regions”.

Data

The COST733CAT data base of circulation type classifications (Philipp et al. 2010) comprises 423 variants of objectively derived circulation type classifications (threshold based, leader algorithms, PCA based, optimization algorithms).

These 423 classifications are all available for 12 spatial domains embedded into the greater North Atlantic European region (Fig. 1) resulting in a total of 5076 classifications.

All classifications are determined for the period 1957 to 2002 on the basis of gridded daily (12 UTC) data from the ERA40 reanalysis data set.

The classifications mainly use solely MSLP data and are derived for the whole year.

The number of circulation types varies among classifications. Most frequent numbers are 9, 18 and 27. All in all around 7700 circulation types are available for each spatial domain.

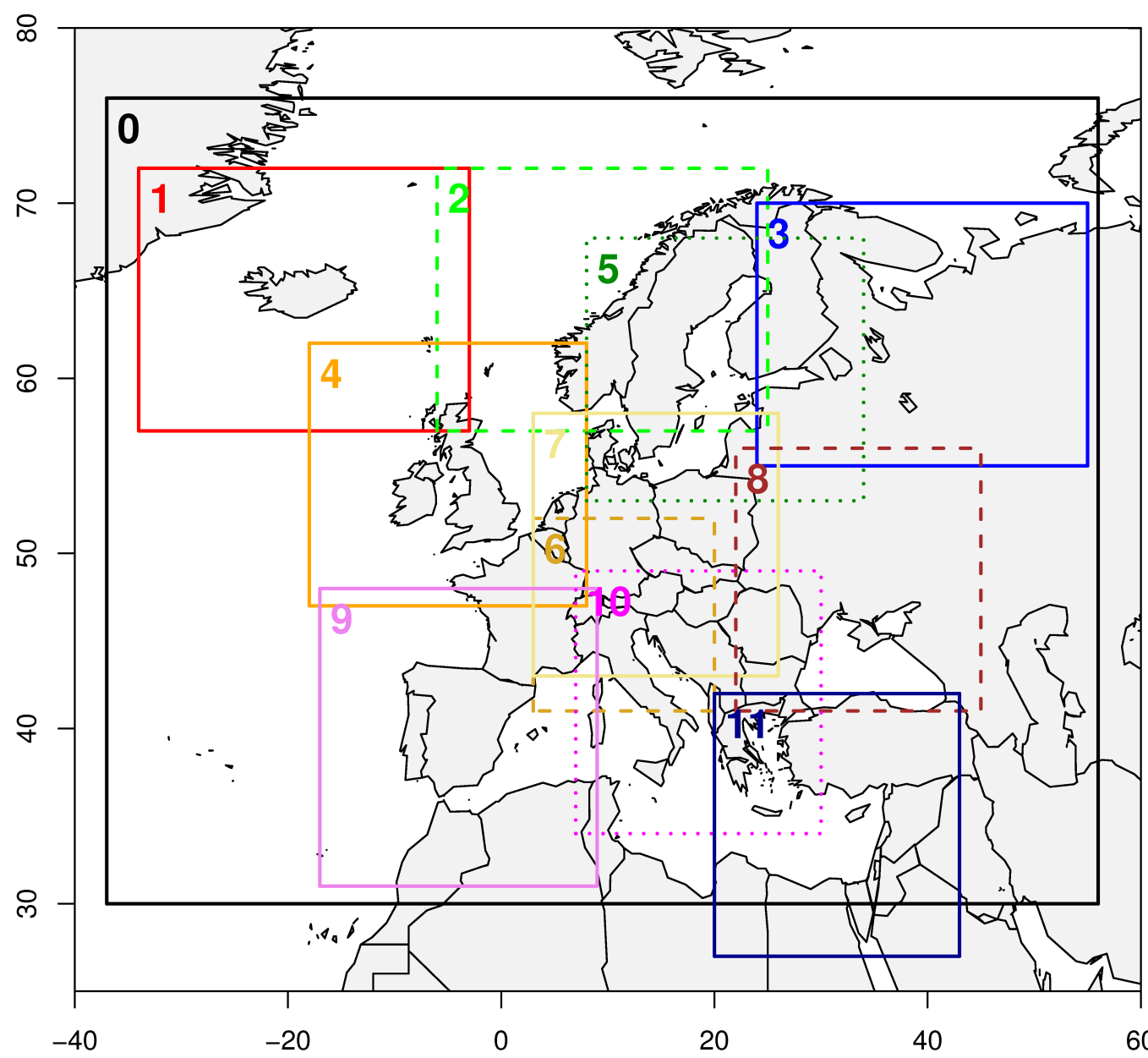


Figure 1: 12 spatial domains for which circulation type classifications from the COST 733 action „Harmonisation and Applications of Weather Type Classifications for European Regions“ are available.

Approach

To find out whether there are significant differences in occurrence frequencies of circulation types among days of the week

- for each circulation type occurrence frequencies for any day of the week have been computed and
- Chi²-tests have been applied to each set of seven weekday frequency values to check for significant deviations (at the 95% confidence level) from the ideal uniform distribution.

Circulation types exhibiting significant weekly cycles have been compared with respect to

- Similarity of MSLP composite patterns and
- Distribution of Frequency maxima and minima over weekdays.

To check for the robustness of results tests have been applied to the whole sample (all days from 01/09/1957 to 31/08/2002), to two samples covering the first and second half of the period respectively and to two subsamples each of them comprising 22 randomly picked years).

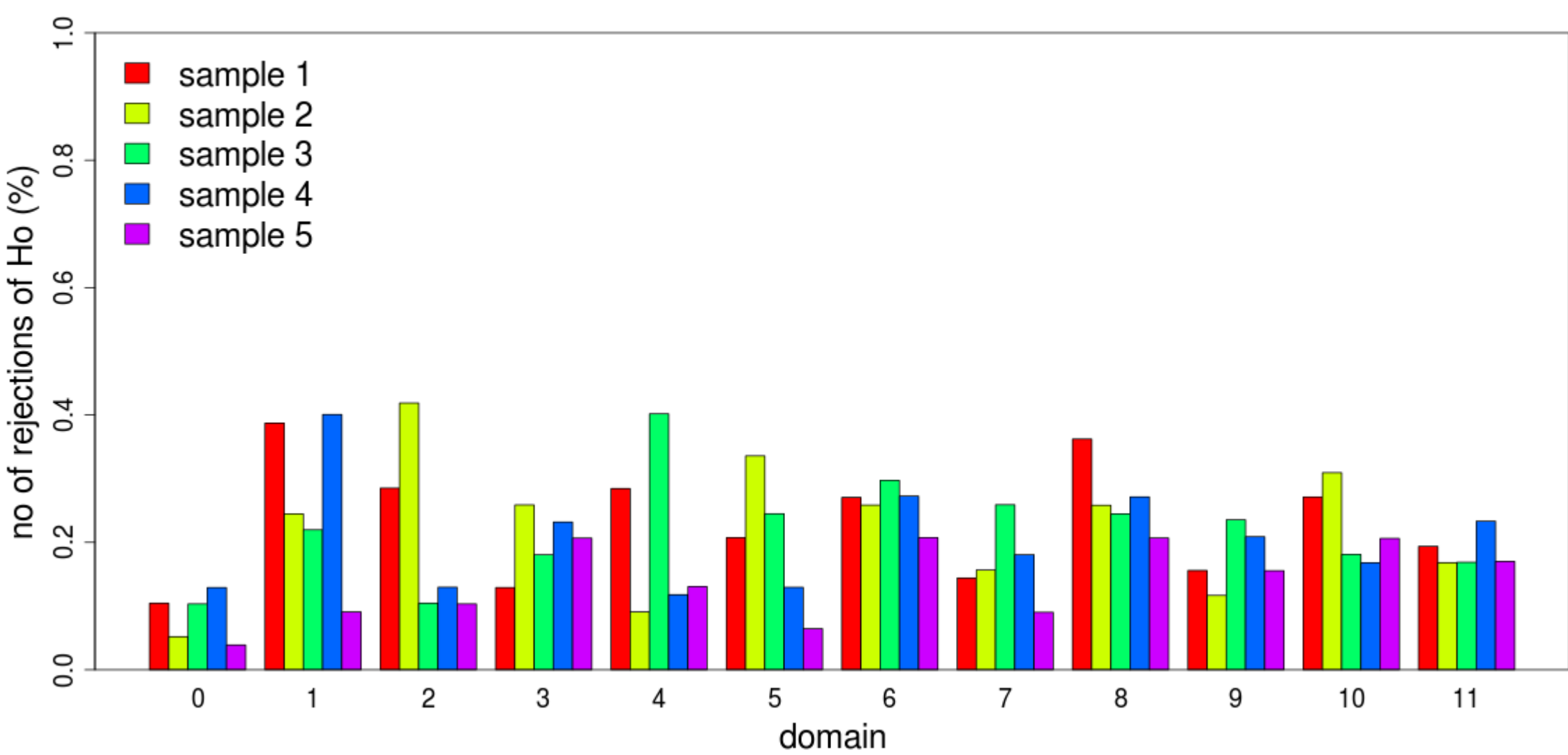


Figure 2: Percentages of circulation types for which the null hypothesis of uniform distribution of occurrence frequencies over weekdays is rejected, according to chi-square tests (95% confidence level). Applied to varying temporal subsamples (sample 1 to 5) of circulation types from spatial domains 0 to 11.

		Day of maximum/minimum frequency						
Day of maximum/minimum frequency		Mon	Tue	Wed	Thu	Fri	Sat	Sun
	Mon							
	Tue	23						
	Wed	57	22		31	52	59	71
	Thu	69	55	31		20	39	63
	Fri	62	61	52	20		18	52
	Sat	45	68	59	39	18		13
	Sun	13	53	71	63	52	13	

Table 1: Number of circulation types with significant deviations from the ideal uniform weekly frequency distribution - for specific combinations of days with minimum/maximum or maximum/minimum type frequencies.

Results

- Significant weekly cycles in occurrence frequencies are evident only for a minor fraction (0.4% at a maximum) of circulation types (Fig. 2).
- The number of circulation types showing significant weekly cycles varies distinctly among spatial domains (lowest number for largest domain 0) and temporal subsamples.
- Looking at combinations of weekdays with maximum/minimum frequencies of circulation types with significant weekly cycles, for a majority of types differences of 3 to 4 days between maximum and minimum occurrence frequencies appear (Tab. 1).
- Circulation types exhibiting their frequency maxima and minima on corresponding days of the week show varying degrees of similarity between circulation patterns:
- Example 1 - Domain 8, frequency maximum on wednesday, frequency minimum on sunday (Fig. 3) → circulation patterns representing 4 different basic SLP configurations.
- Example 2 - Domain 7, frequency maximum on monday, frequency minimum on wednesday (Fig. 4) → patterns showing comparable basic circulation structures.
- Circulation types with very similar SLP patterns partly exhibit distinctly varying frequency distributions over the days of the week (Fig. 5).

References

- Laux, P. and H. Kunstmann (2008): Detection of regional weekly weather cycles across Europe. Environ. Res. Lett. 3: doi:10.1088/1748-9326/3/4/044005
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- Sanchez-Lorenzo, A., J. Calbo, J. Martin-Vide, A. Garcia-Manuel, G. Garcia-Soriano and C. Beck (2008): Winter 'weekend effect' in Southern Europe and its connections with periodicities in atmospheric dynamics. Geophysical Research Letters 35, L15711, doi:10.1029/2008GL034160

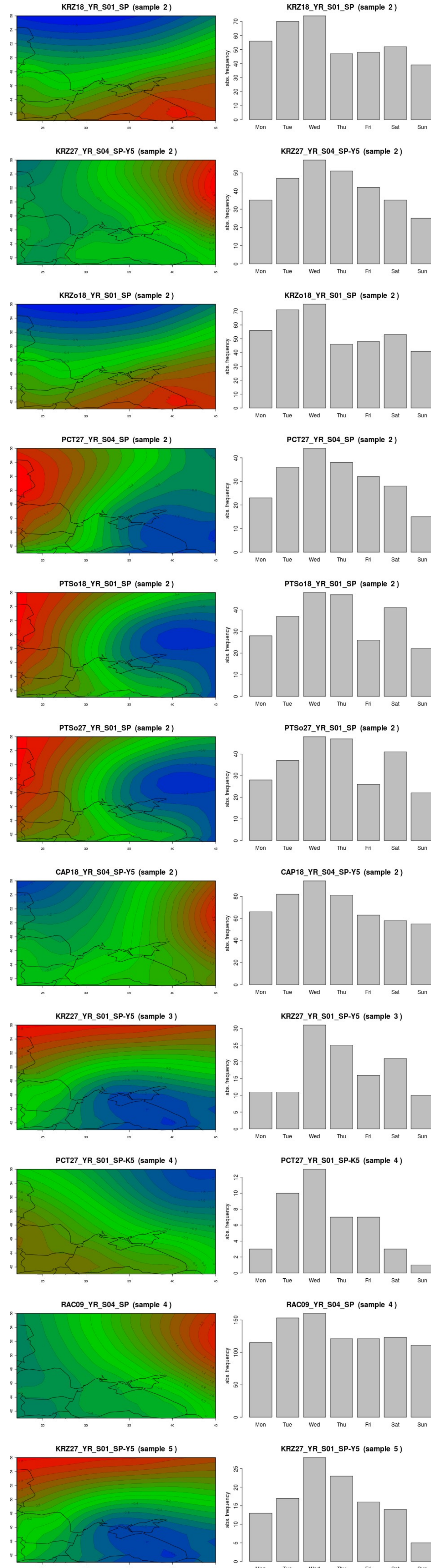


Figure 3: SLP composite maps (left column) and absolute occurrence frequencies for each weekday (right column) of domain 8 - circulation types for which significant deviations (95% confidence level) from the ideal uniform distribution of frequencies have been detected. Only types with their frequency maximum/minimum on wednesday/sunday resp. are shown.

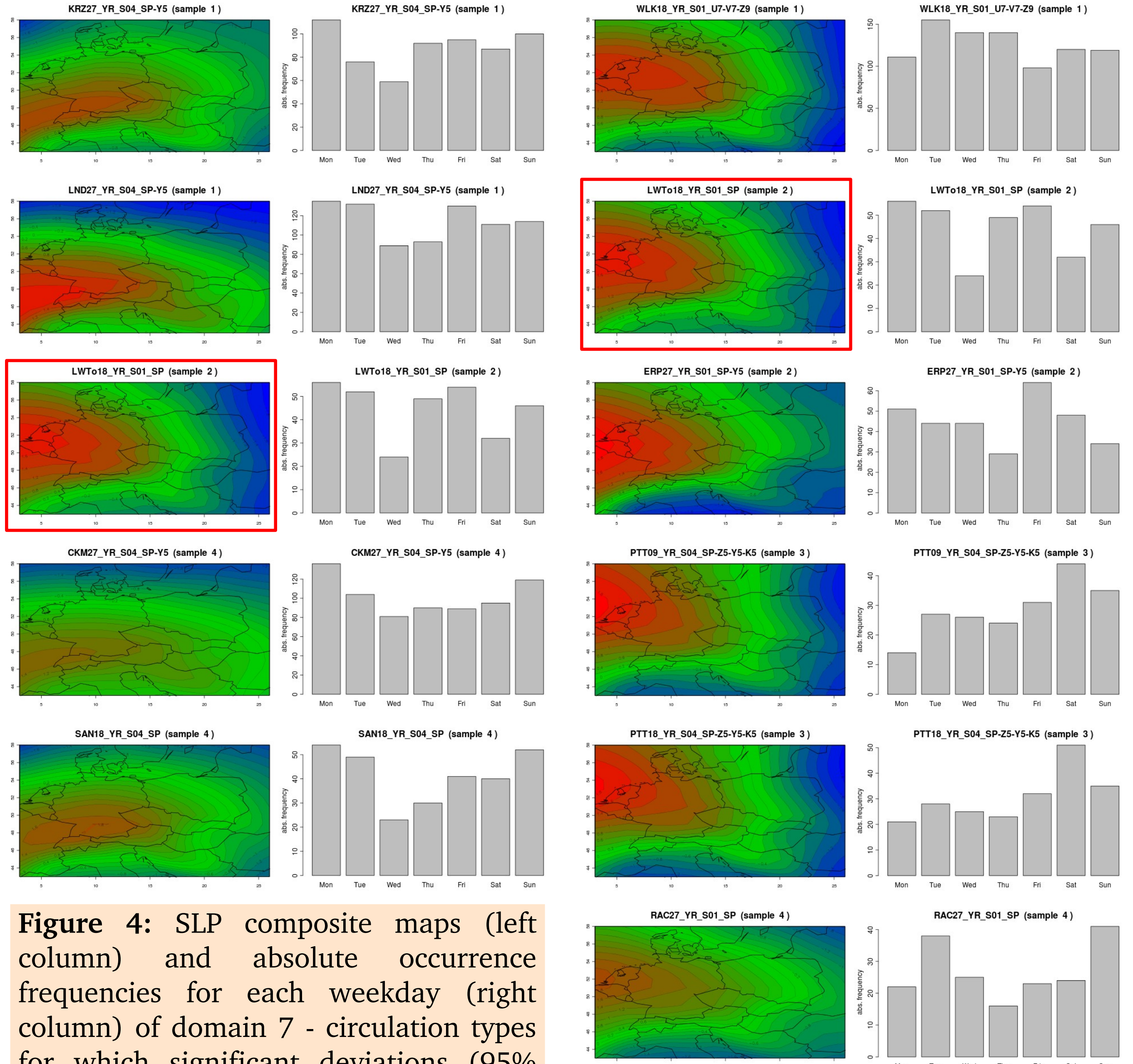


Figure 4: SLP composite maps (left column) and absolute occurrence frequencies for each weekday (right column) of domain 7 - circulation types for which significant deviations (95% confidence level) from the ideal uniform distribution of frequencies have been detected. Only types with their frequency maximum/minimum on monday/wednesday resp. are shown.

Figure 5: SLP composite maps (left column) and absolute occurrence frequencies for each weekday (right column) of domain 7 - circulation types for which significant deviations (95% confidence level) from the ideal uniform distribution of frequencies have been detected. Only types with a pattern correlation >0.9 to the circulation type marked with a red rectangle in Fig. 4 and Fig. 5 are shown.

Summary and Conclusions

- Chi²-tests have been applied to more than 90.000 circulation types, available for 5 different temporal samples in order to test the null hypothesis of uniform distribution of occurrence frequencies of circulation types over the days of the week.

- For 946 circulation types a significant deviation (95% confidence level) from the uniform distribution of occurrence frequencies can be detected.

- Taking into account that – given the confidence level of 95% - one would expect a rejection of the null hypothesis by chance for around 23.000 circulation types, it can be stated that the results provide no evidence for the existence of weekly cycles in large-scale circulation dynamics.

- This conclusion is supported by preliminary analyses of the spatio-temporal characteristics of circulation types with significant weekly cycles in occurrence frequencies revealing that:
 - very different circulation patterns show similar frequency distributions over the days of the week while
 - highly similar circulation patterns show distinctly varying frequency distributions over the weekdays.