Analysis for identification of variables for which downscaling is needed

ETH partner report for deliverable D11 — 28 Oct 2003

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Introduction

The purpose of deliverable D11 is to illustrate and quantify the limitations/accuracy of GCM grid-box values in representing regional features of extremes. Here, the NCEP reanalysis serves as an optimistic surrogate for GCM output.

Data and method

In this study we evaluate the skill of the NCEP output in reproducing *interannual variations* of precipitation extremes in the Alpine region for the HadAM grid points shown in Fig. 1. The evaluation is based on the following three datasets:

Figure 1: The twelve HadAM grid points and the four stations (La Cure, Zürich, Arosa and Locarno-Monti) analyzed in this study.

- NCEP: NCEP precipitation interpolated onto the HadAM grid (daily data available from 1958–2001)
- UOBS: upscaled observations based on over 6000 rain-gauge stations (daily data available for all grid points from 1971–1992)
- STA: rain-gauge observations at the four stations La Cure, Zürich, Arosa and Locarno-Monti (daily data available form 1901–2000)

Seasonal values of all precipitation related STARDEX Diagnostic Extreme Indices were calculated for every year in the period 1971–1990 for the three datasets. The following analysis, however, is restricted to the indices listed in Table 1.

In this study the NCEP-skill for a given grid point, diagnostic extreme index and season is measured by the anomaly correlation, the standard deviation ratio, and the debiased root mean square error. The skills are calculated from the appropriate seasonal time series in the period 1971–1990.

Table 1: STARDEX Diagnostic Extreme Indices considered in the present analysis.

name	STARDEX name	description
mea	601R	mean climatological precipitation
fre		precipitation frequency
int	646SDII	simple daily intensity
q90	prec90p	90th percentile of rainday amounts
mx5d	643R5d	greatest 5-day total rainfall
mxncdd	641CDD	max no consecutive dry days
nl90	691R90T	No events > long-term 90th percentile

Results

Regional variations of NCEP-skill

The variations of the NCEP-skill between different (climatic) regions for different indices is summarized in Fig. 2, detailed results in form of Taylor diagrams for each grid point and for all indices listed in Table 1 can be found in Fig. 4–7.

Correlation

The variation of the correlation skill from one region to another is moderate for mea and fre, but large to very large for q90 and mxncdd. On average the skill is higher for winter and autumn than for spring and summer. The skill is also higher for the frequency-related indices mea, fre, mxncdd, than for the intensity-related indices int, q90, mx5d, nl90 (see also Fig. 4–7).

In winter, the highest skill is obtained for grid point 03 (Po Valley) with correlations of 0.8 and higher for all indices. The lowest skill is obtained for grid point 10 (an Alpine grid point) where the highest correlation is 0.7 (for fre and mxncdd), but correlation values drop to below 0.0 for mx5d (see Fig. 4). In autumn, the highest skills are agained found for grid point 03 with values between 0.55 and 0.85, and the lowest skills are obtained for grid point 11, again an Alpine grid point. In spring, the highest skill is obtained for grid point 06 (central France). Thus, on average, the skill is signficantly higher for grid boxes in flat regions, than for grid boxes in mountainous regions.

Standard deviation ratio

The regional variations of the standard deviation ratio are quite large for all indices, especially for mxncdd. The standard deviation, that is the interannual variability, is on average too low for mea and q90, too high for mxncdd, but about correct for fre (this is valid for all seasons except summer).

Scale dependance of NCEP-skill

The scale dependance of the NCEP-skill for four climatic regions, characterized by the stations La Cure, Zürich, Arosa, and Locarno Monti, is summarized in Fig. 3. Detailed results in form of Taylor diagrams for each station and for all indices listed in Table 1 can be found in Fig. 8–11.

As expected, the NCEP-skill is on average higher on the scale of the GCM grid box (NCEP versus UOBS) than at the station scale (NCEP versus STA). Looking at the Taylor diagrams, it can be seen that the blue symbols which represent the station scale are typically further to the left (lower correlations) and further away from the unit circle (too low or too high interannual variability) than the red symbols. Sometimes, however, the skill at the station scale is higher than the skill at the grid box scale (see Fig. 8–11). It should be mentioned, that for some indices and some seasons the NCEP-skill is heigher for a neighbouring grid box (not shown).

Conclusion

It has been shown, that the NCEP-skill varies significantly from region to region, from season to season, and from index to index. While for some grid points and for some seasons (winter and autumn) the NCEP-skill might be acceptable for a particular application, there are grid points where the performance, even for the diagnostic index with the highest skill, is very low in all

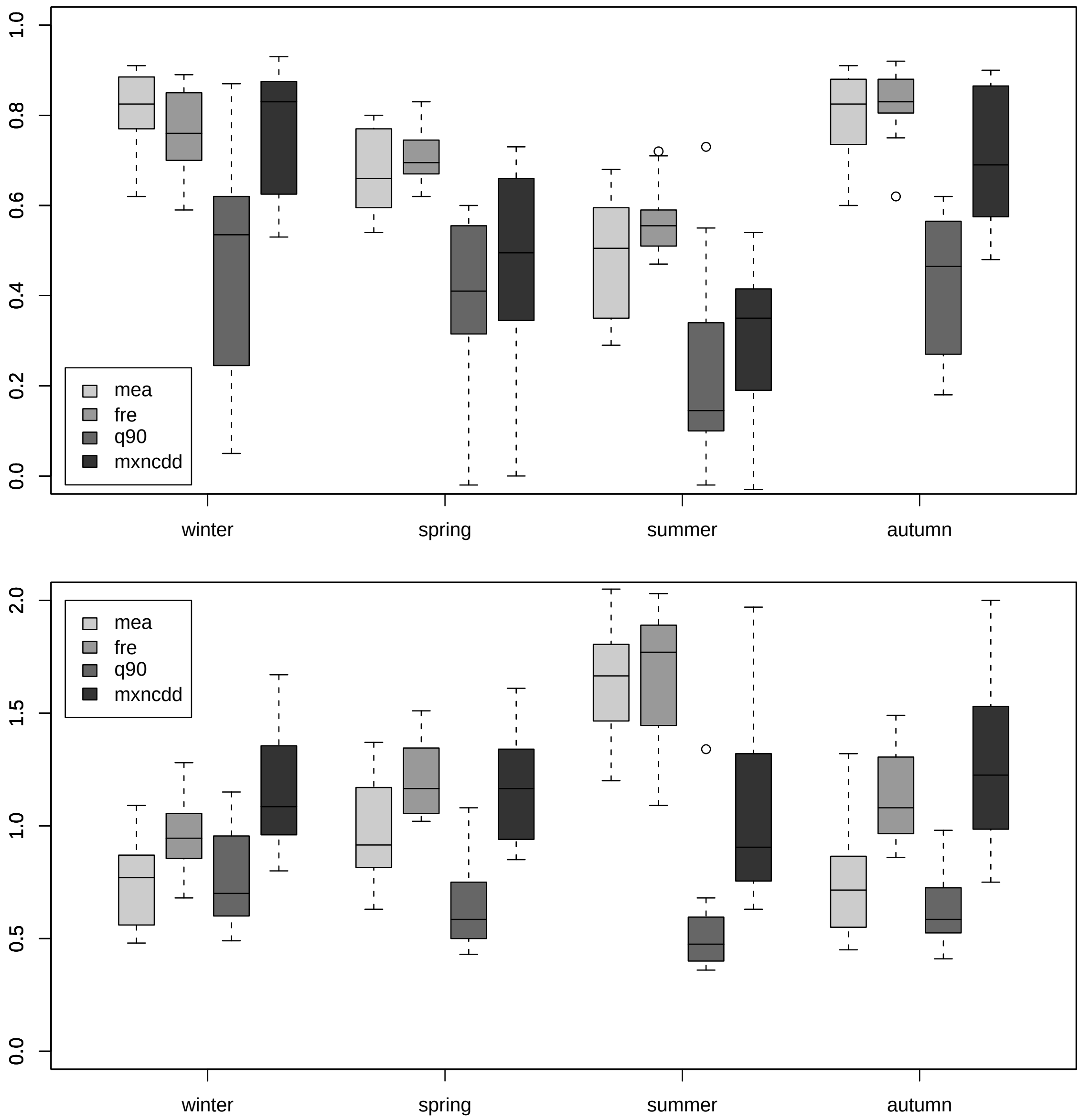
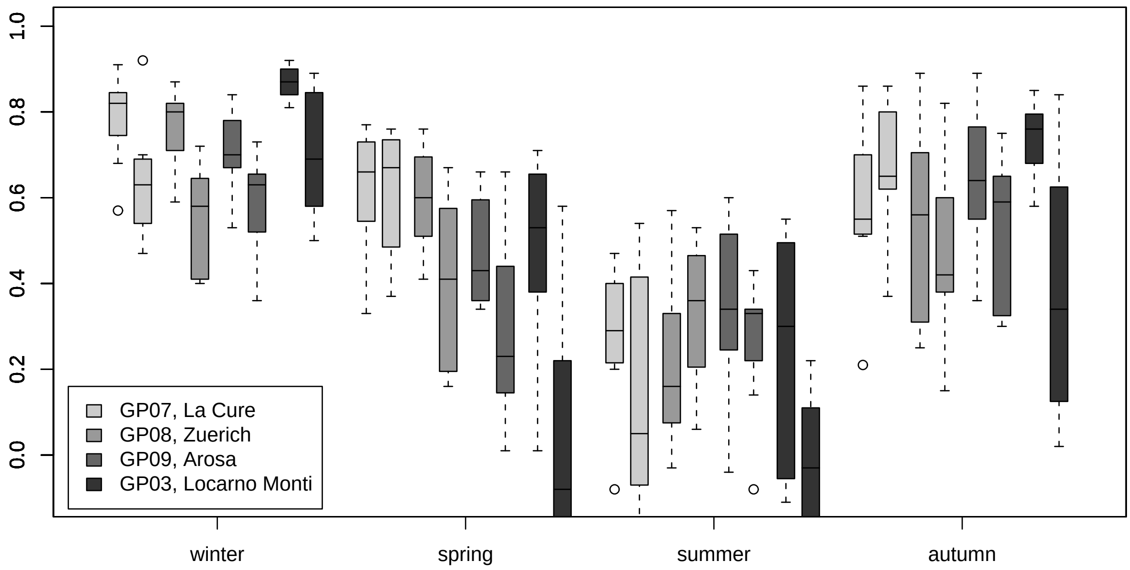


Figure 2: Box plot of correlations (top) and standard deviation ratios (bottom) between NCEP and UOBS for the twelve Alpine grid points.



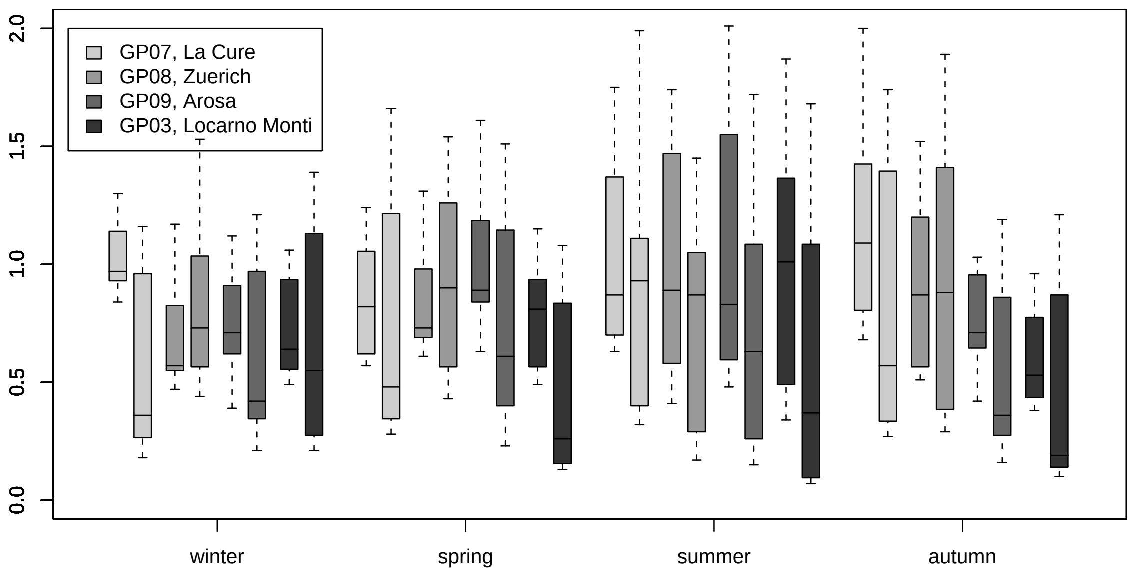


Figure 3: Box plot of the correlations (top) and standard-deviation ratios (bottom) for the indices in Table 1 for four grid points (NCEP versus UOBS, boxes to the left), and for four stations (NCEP versus STA, boxes to the right).

seasons. Generally, the indices related to precipitation intensity such as q90, mx5d, or nl90 achieve lower skills. Also, the skill for the different indices usually decreases with decreasing spatial scale, and more rapidly so for the intensity related indices such as q90 and mx5d. Thus, for a region with average skill, downscaling is most likely required for the indices related to precipitation intensity such as q90 or mx5d.

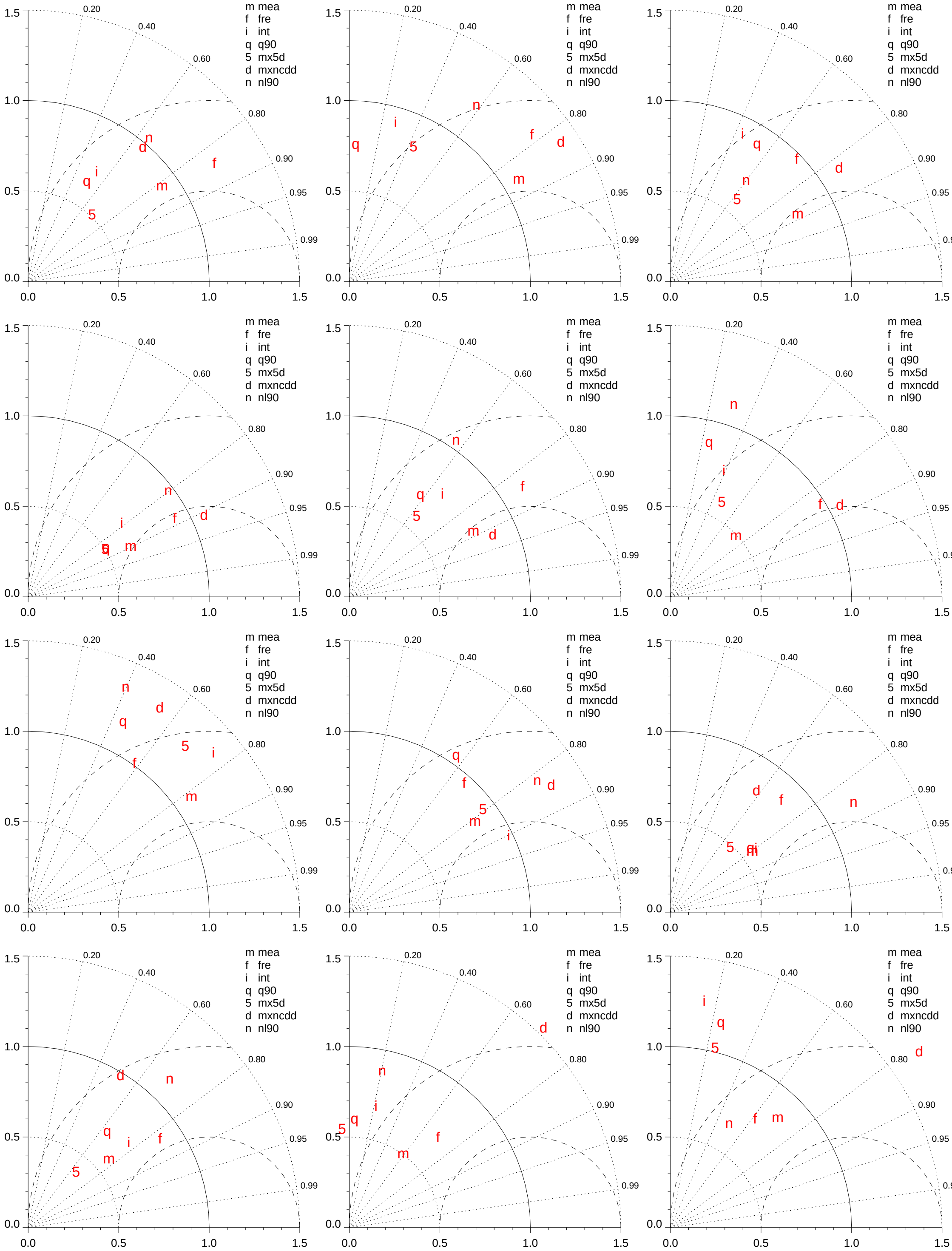


Figure 4: Taylor diagrams for winter, for NCEP versus UOBS for the 12 Alpine grid points.

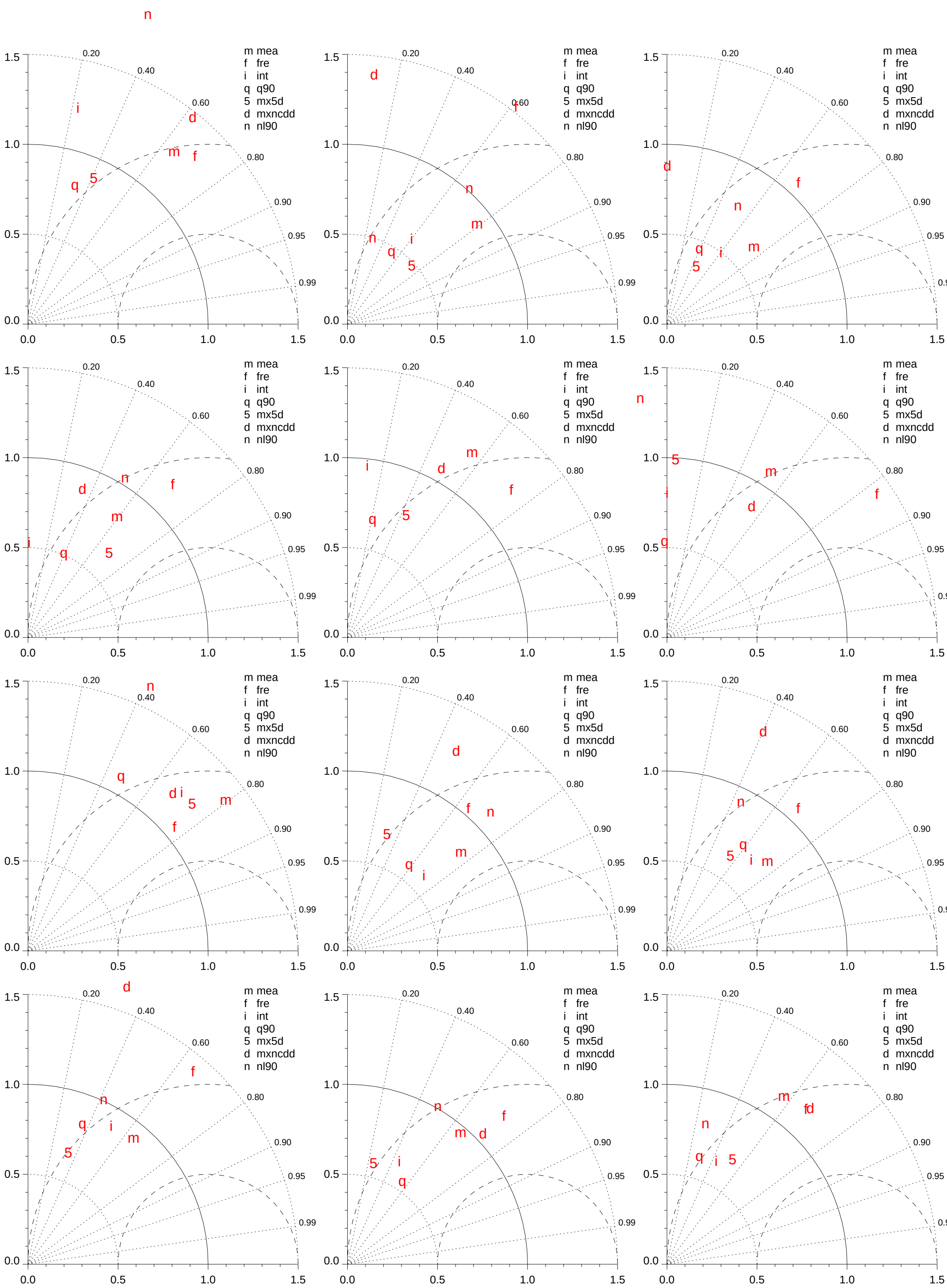


Figure 5: As Fig. 4, but for spring.

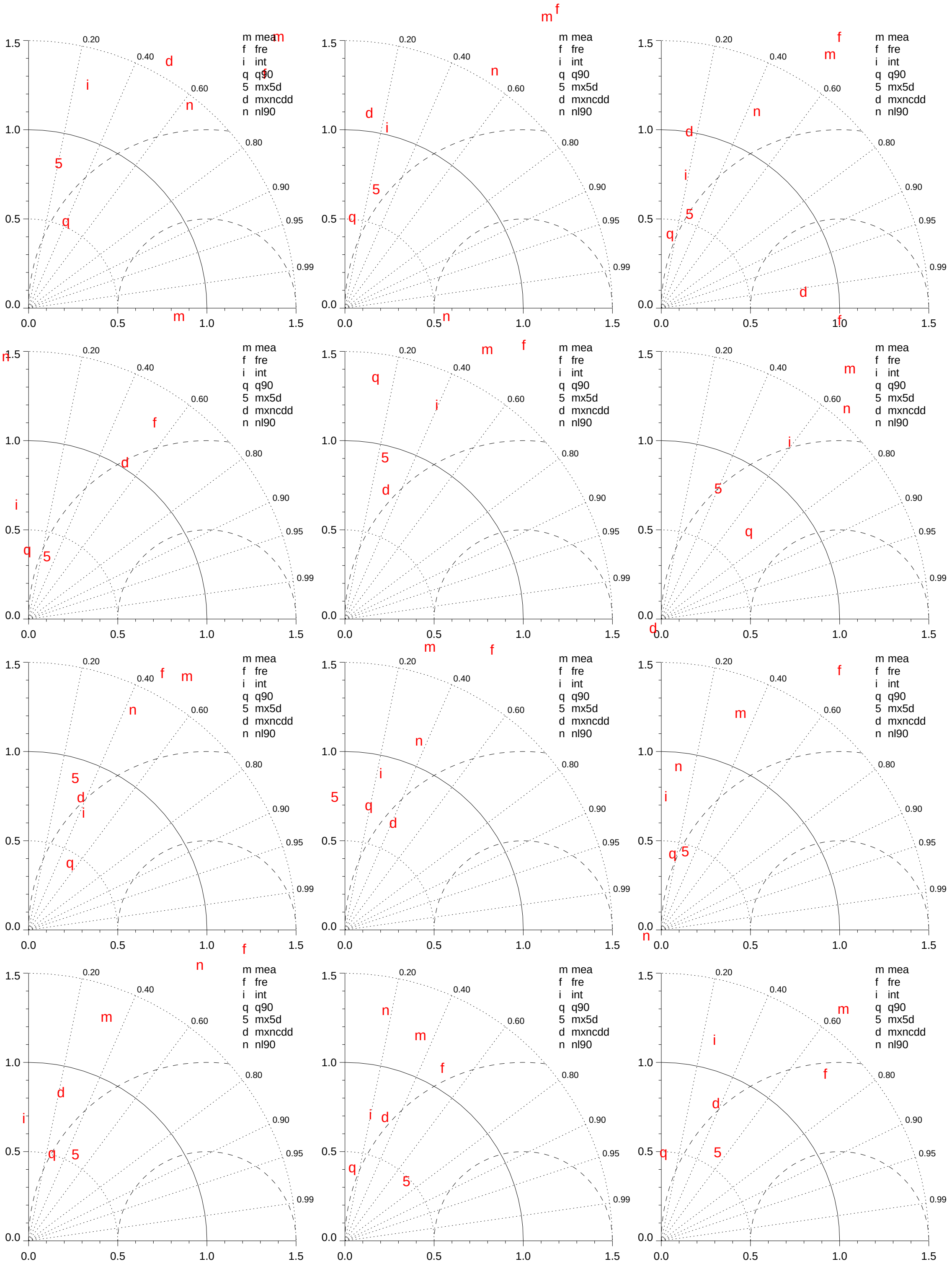


Figure 6: As Fig. 4, but for summer.

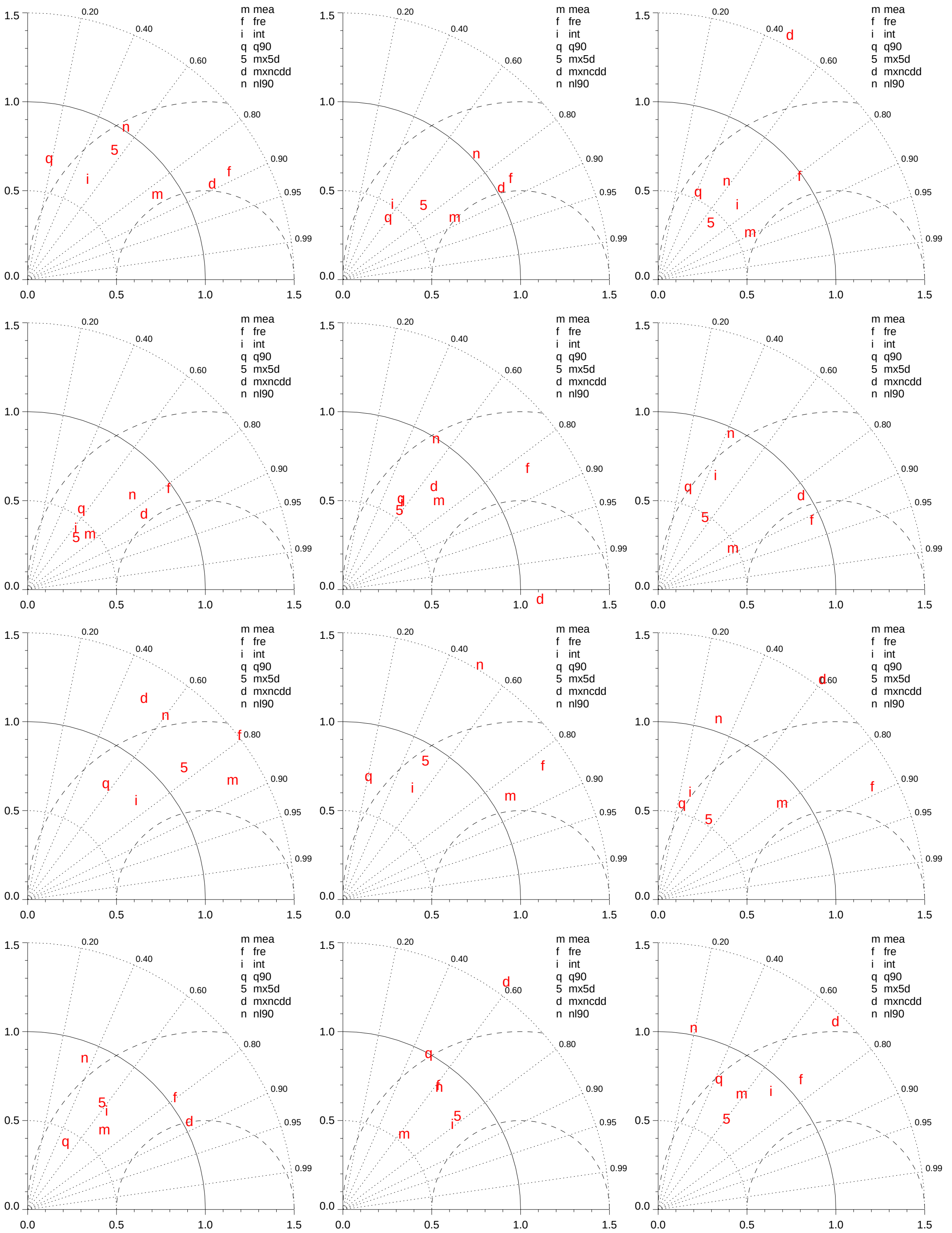


Figure 7: As Fig. 4, but for autumn.

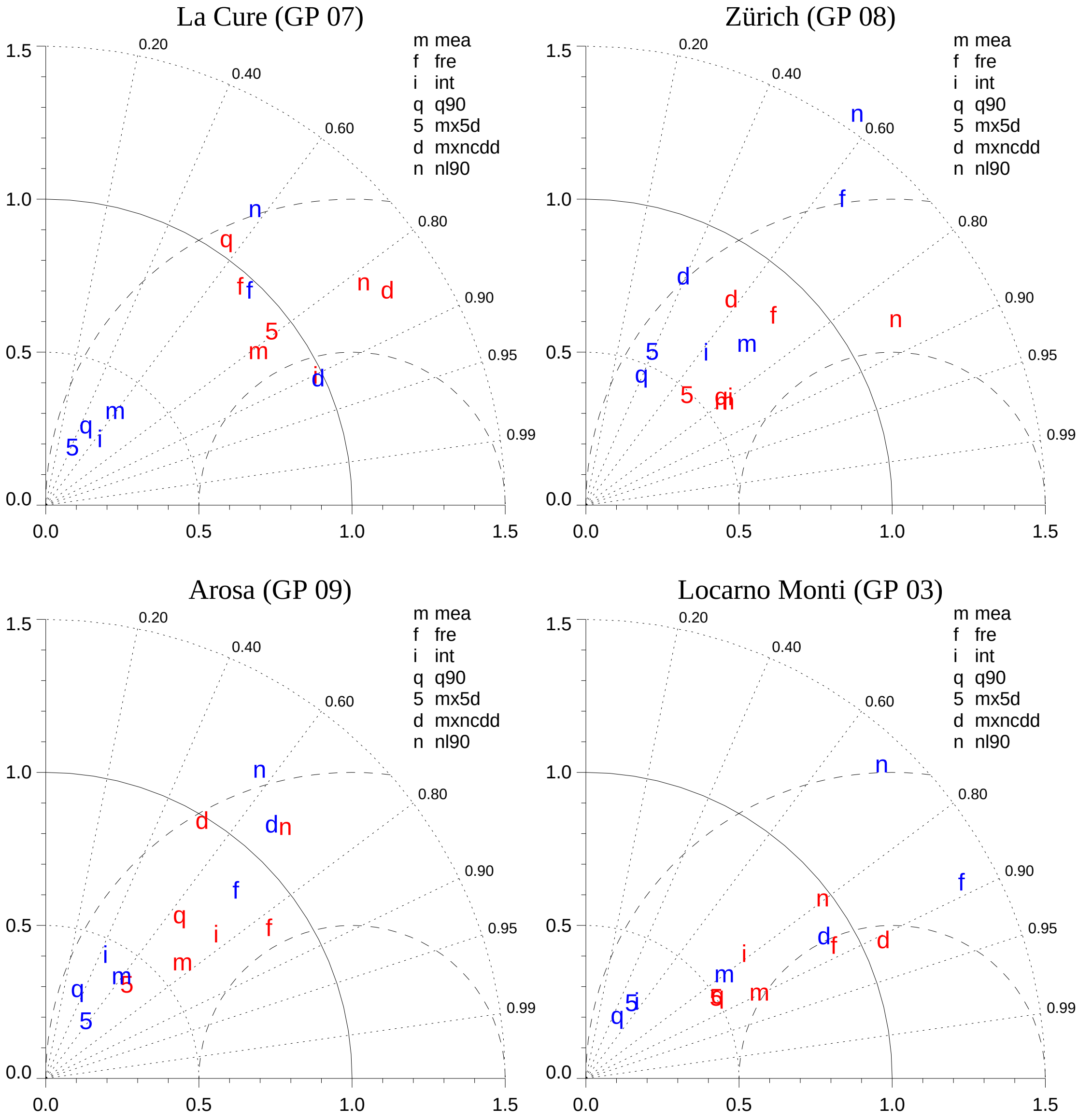


Figure 8: Taylor diagrams for winter, for NCEP versus UOBS (red) and NCEP versus STA (blue).

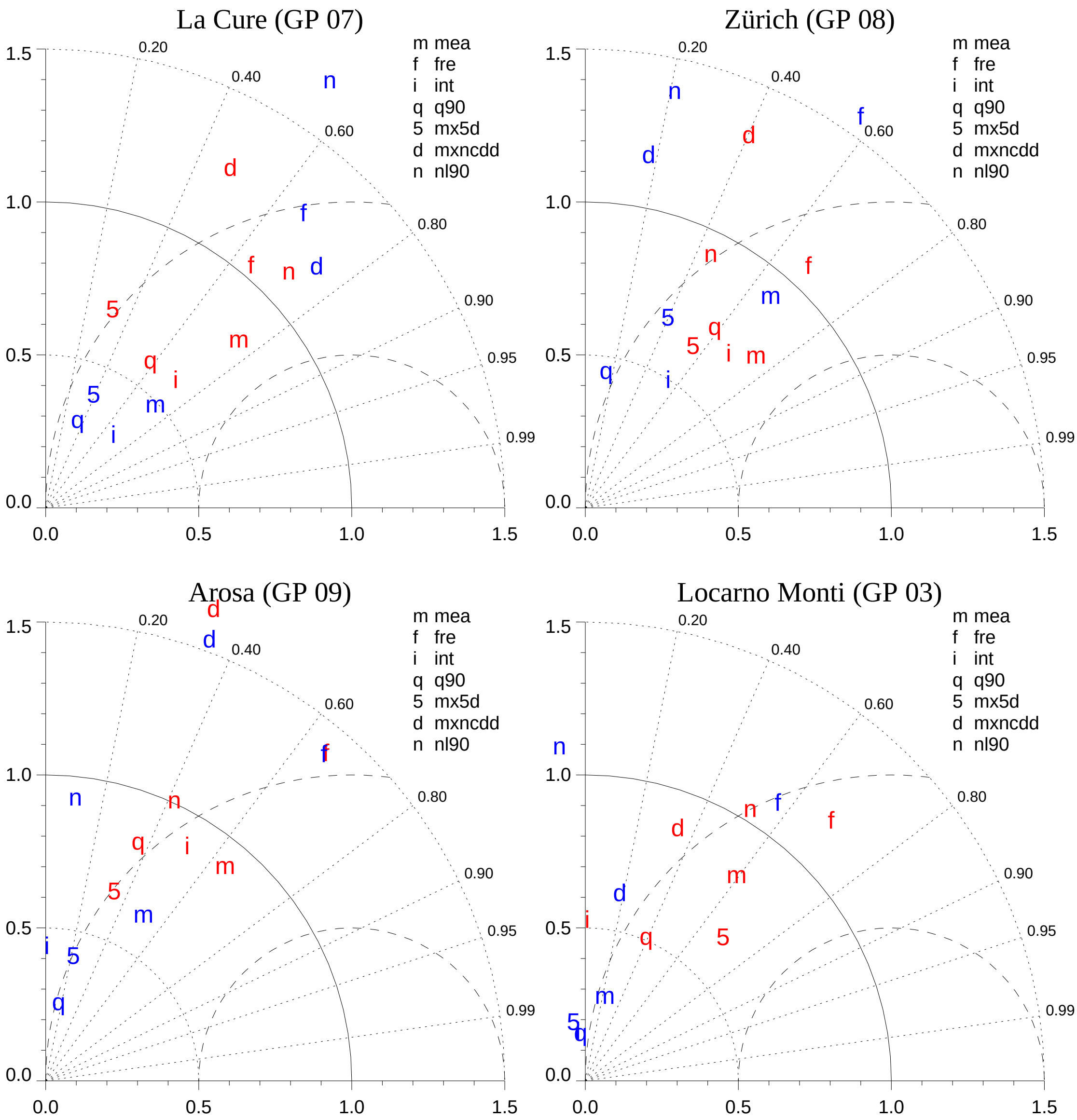


Figure 9: As Fig. 8, but for spring.

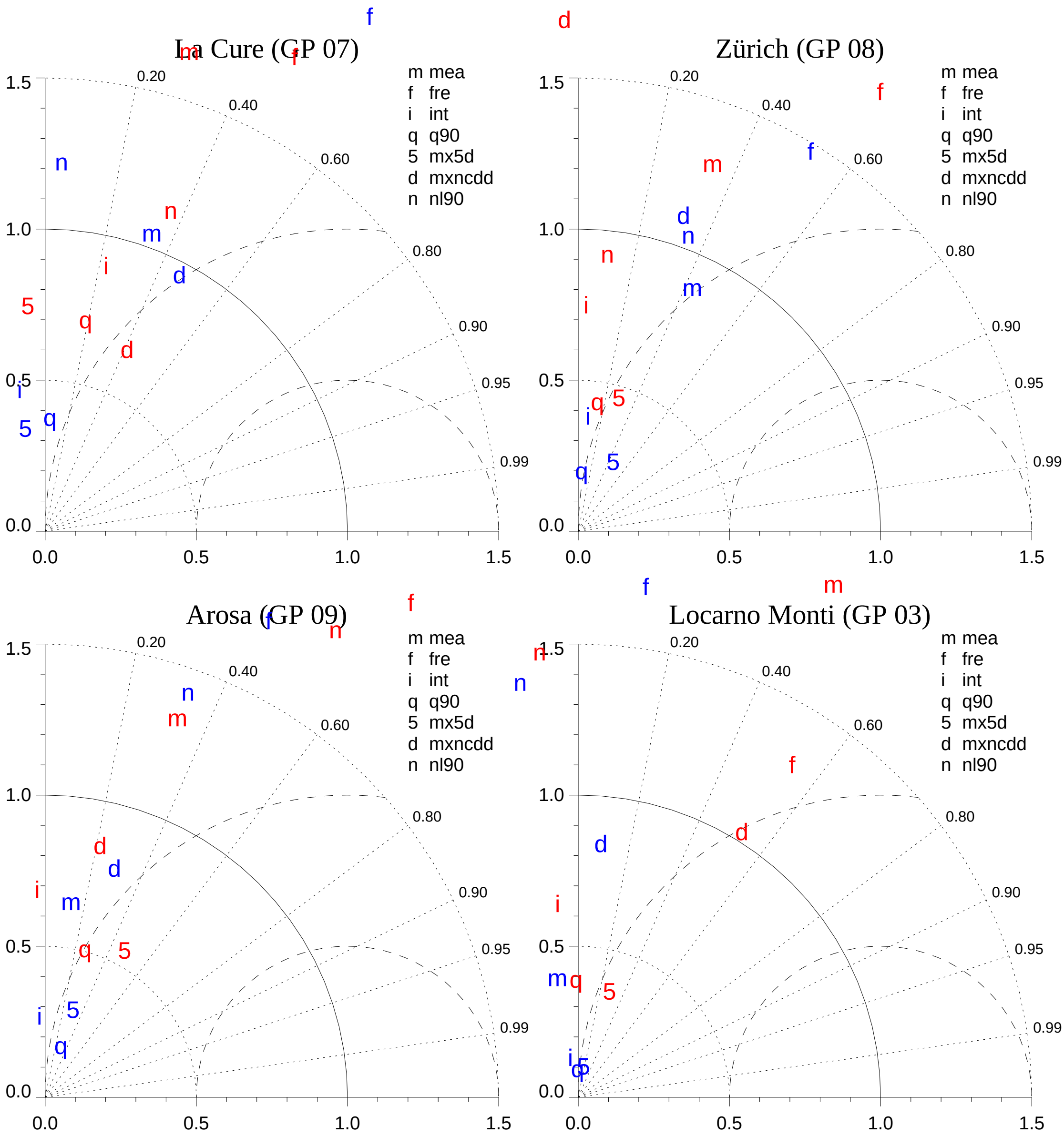


Figure 10: As Fig. 8, but for summer.

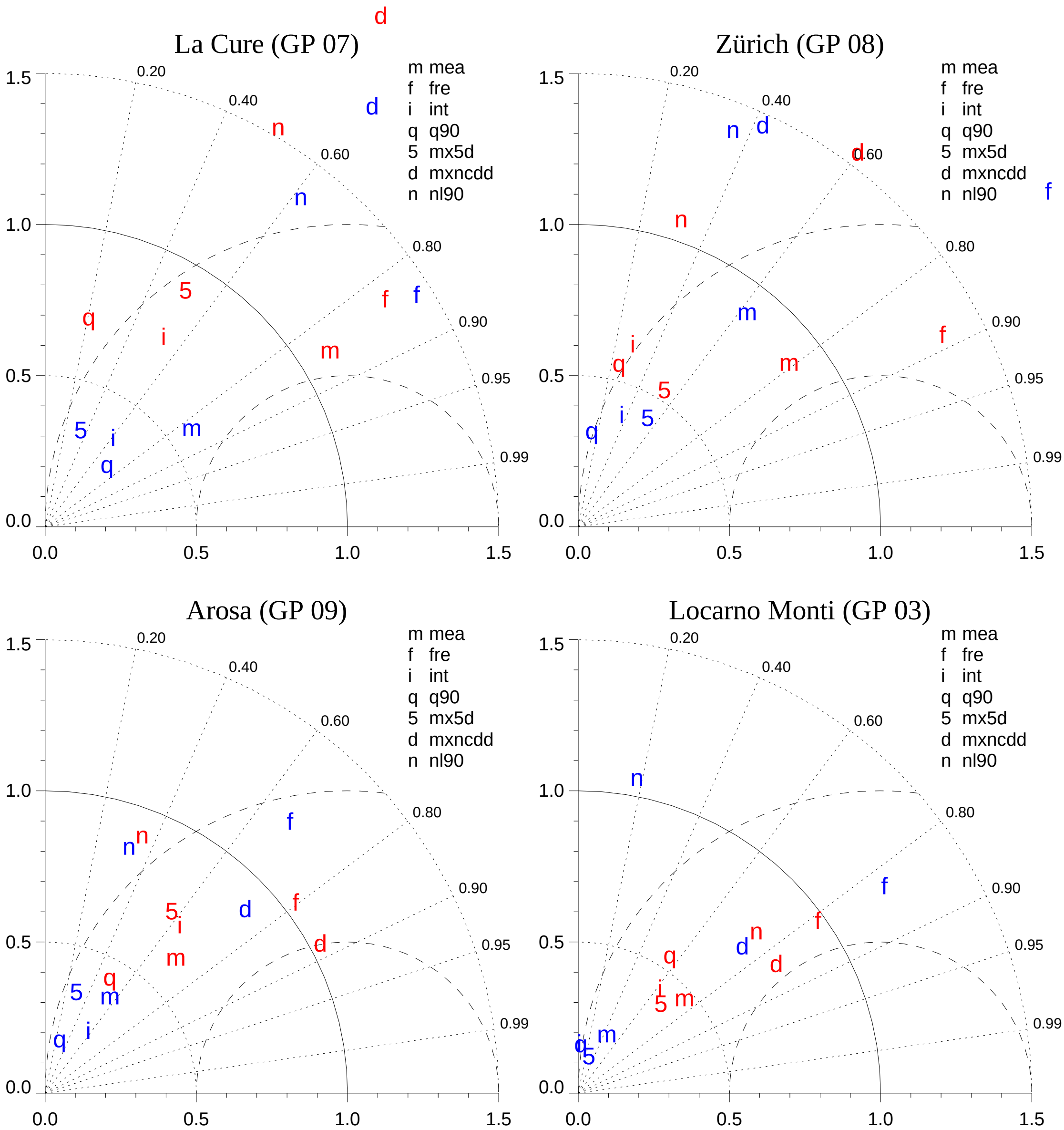


Figure 11: As Fig. 8, but for autumn.