Deliverable D12
Regional Analysis of Downscaling Methods

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Introduction

The purpose of deliverable D12 is to compare different downscaling methods based on the NCEP reanalysis. This report compares the downscaling results for four different models from three partners for the ten stations in the Alpine region from the FIC station data set.

Data

This evaluation is based on ten stations in the Alpine region from the FIC station data set:

Station	lon	lat	height
Innsbruck	11.38	47.25	578
Montelimar	4.73	44.58	74
Nice	7.20	43.65	10
München	11.50	48.16	515
Bologna	11.25	44.48	60
Lazzaro Albernoi	9.71	45.03	50
Bobbio	9.36	44.76	270
Arosa	9.68	46.78	1840
Zürich	8.56	47.38	556
Locarno-Monti	8.78	46.16	379

see also Fig. 1.

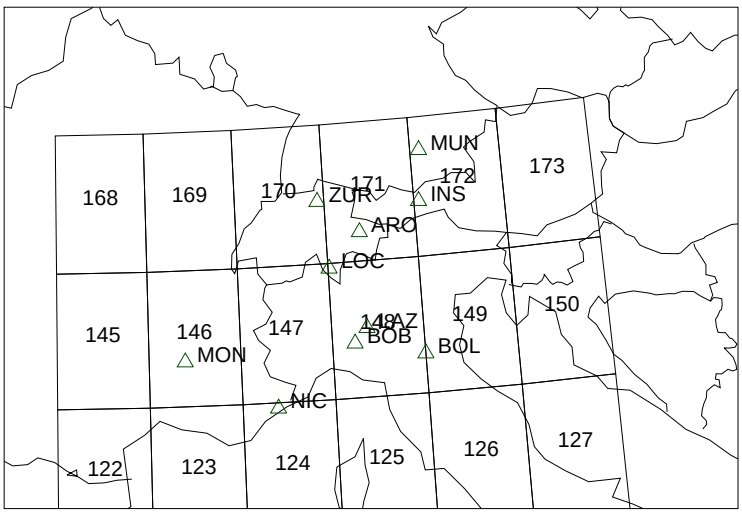

Figure 1: The 10 Alpine stations from the FIC station data set together with the cooresponding HadAM grid points.

The downscaling methods are calibrated using the data from 1958–1978 and 1994–2000 and validated for the ERA-15 period 1979–1993. The seasonal verification statistics used for the present comparison are:

name	description
PAV	mean daily precipitation
PINT	precipitation intensity
PQ90	90th percentile of precipitation amounts (mm/day)
PX5D	Maximum 5-day total precipitation
PNL90	No. of events $>$ long-term 90th percentile of raindays
PXCDD	Max no. consecutive dry days

The following four downscaling methods (models) were compared:

model	description	downscaled variable
loci-eth	local rescaling of GCM precipitation intensity	daily precipitation
mar-ustutt	multivariate auto-regressive model	daily precipitation
mlr-ustutt	multiple linear regression	seasonal indices
anal2-fic	two-step analogue method	daily precipitation

Results

Figure 2 summarizes the correlation skill of the four downscaling methods for the six precipitation indices for the four seasons of the year. It can be seen that the skill varies from index to index, from method to method, and from season to season. The strongest variation of the skill, however, is the variation from station to station. For the remaining discussion we shall focus on the median and interquartile range, which indicate the typical value and range of skills obtained for an average station in the Alpine region.

At first glance, none of the downsclaing methods is generally superior to all of the others. In terms of the correlation skill, the methods achieve quite similar results. Most methods obtain acceptable skill for most stations (i.e. correlations large than 0.5) in winter for PAV and PXCDD, in spring for PAV, and in autumn for PAV and PXCDD. Also relatively high values are obtained for PX5D in winter for three of the four methods and for PNL90 in autumn for two of the four methods.

In terms of the standard deviation ratio shown in Figure 3 the differences between the methods are larger for some of the indices (e.g. PNL90 and PXCDD). For example, anal2-fic tends to largely overestimate the variability of PNL90, while loci-eth tends to overestimate the variability of PXCDD in spring and summer. In general, however, all methods have the tendency to underestimate the interannual variability of the indices. Yet, loci-eth tends to be closer to the correct variability than the other methods, especially in winter and autumn.

In terms of the scaled bias shown in Figure 4 the differences between the methods are also larger than for the correlation skill. Again anal2-fic is the method with the largest biases for some of the indices, especially PNL90. In terms of the biases, mlr-ustutt seems to be the method with the highest skill, that is the smallest biases.

Figures 5-7 illustrate the spatial variability, that is the variability from station to station, for PAV, the index which is generally downscaled with the highest skill. Again no generally superior downscaling method can be identified. The difference in skill between the stations is large as is the difference from season to season. In winter, for example, loci-eth has the highest skill for 2 stations, mar-ustutt for 4 stations, and anal2-fic for 4 stations, while at the same time loci-eth has the lowest skill for 1 station, mar-ustutt for 2 stations, mlr-ustutt for 6 stations, and anal2-fic for 1 station.

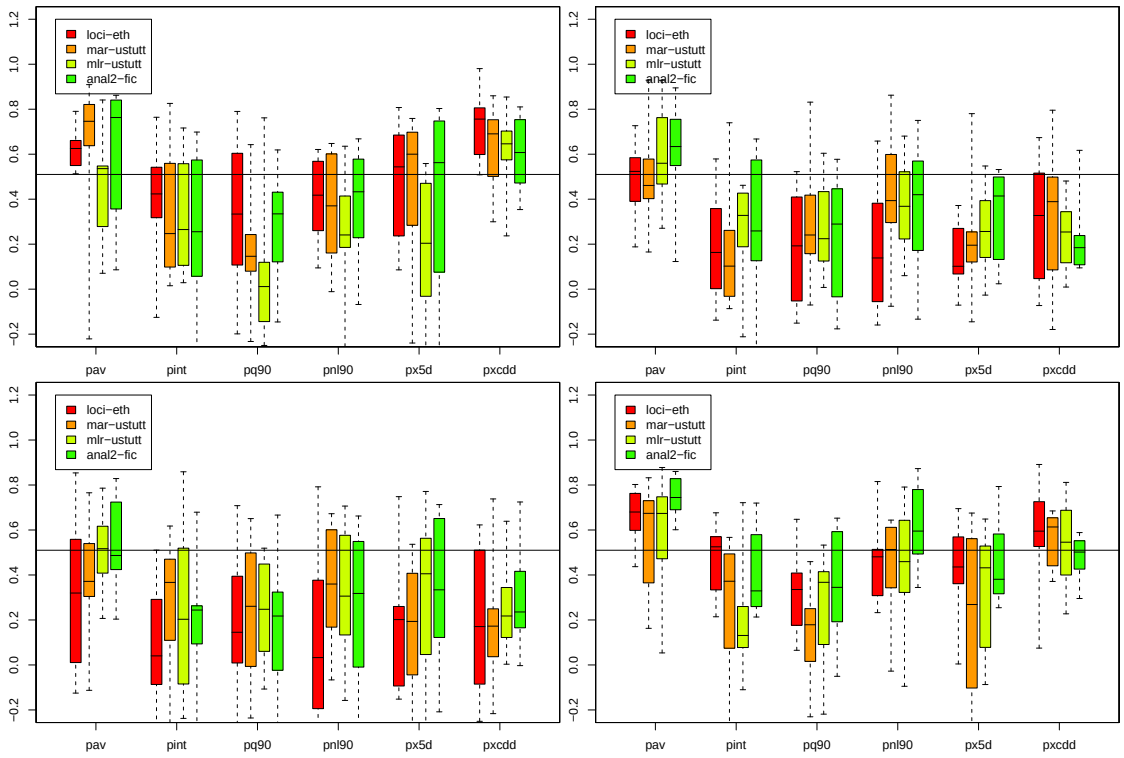

Figure 2: Box-and-whisker plots of the correlation skill for the four different downscaling methods for the six precipitation indices.

Again more consistent differences between the methods can be found with respect to the standard deviation ratio. For this skill, loci-eth tends to be closest to the correct interannual variability, at least in winter and autumn. With respect to the bias, however, the methods achieve similar skills. There is no clear superior method.

Conclusion

From the present evaluation, it can be concluded that none of the downscaling methods is generally superior. Generally reasonable skills are obtained only for PAV in winter, spring, and autumn, and for PXCDD in winter and autumn. For a specific station, some of the methods might also achieve reasonable skills for further indices and seasons.

While no consistent differences between the methods can be found for the correlation skill, loci-eth is often the best method with respect to the standard deviation ratio in winter and autumn, and mlr-ustutt is often the best method with respect to the biases. While anal2-fic scores well with respect to the correlation skill, it is often the method with the largest biases.

For most indices, the downscaling skills are rather disappointing. This is probably due to the low predictability of the interannual variations of these indices at the station scale. Downscaling precipitation at the grid point or regional scale might lead to higher skills and more conclusive comparisons of the different downscaling methods.

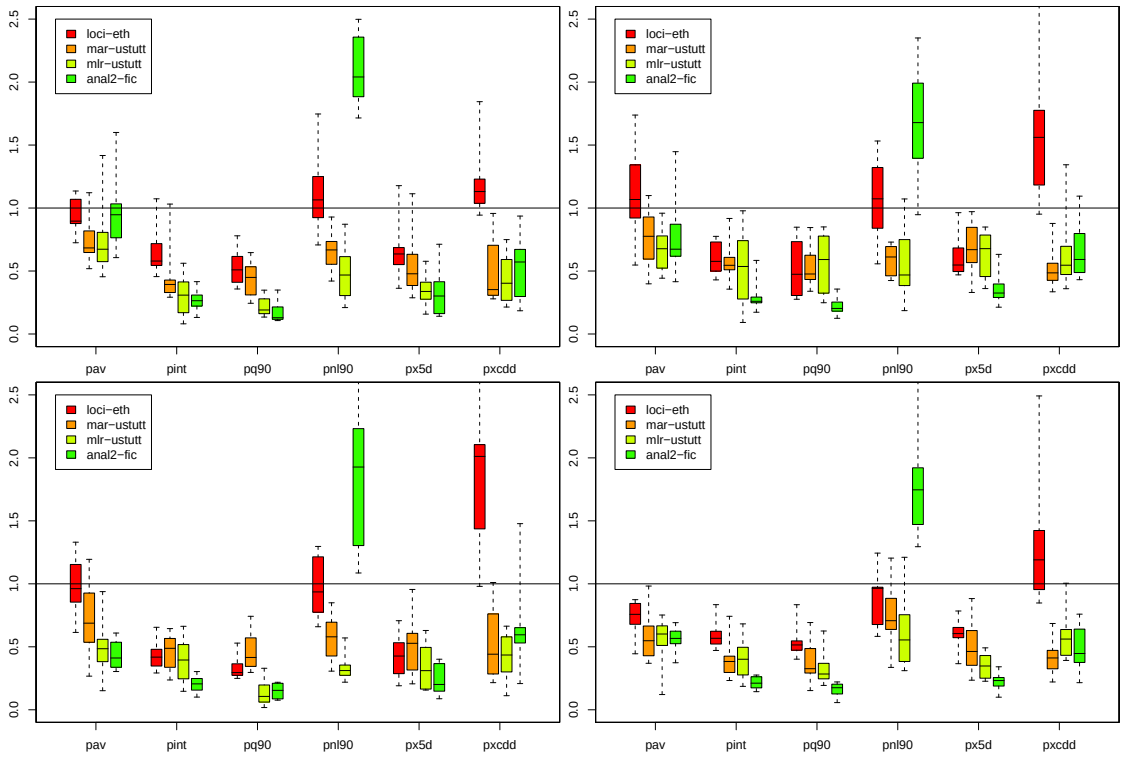

Figure 3: Same as Fig. 2, but for the ratio of downscaled standard deviation over observed standard deviation.

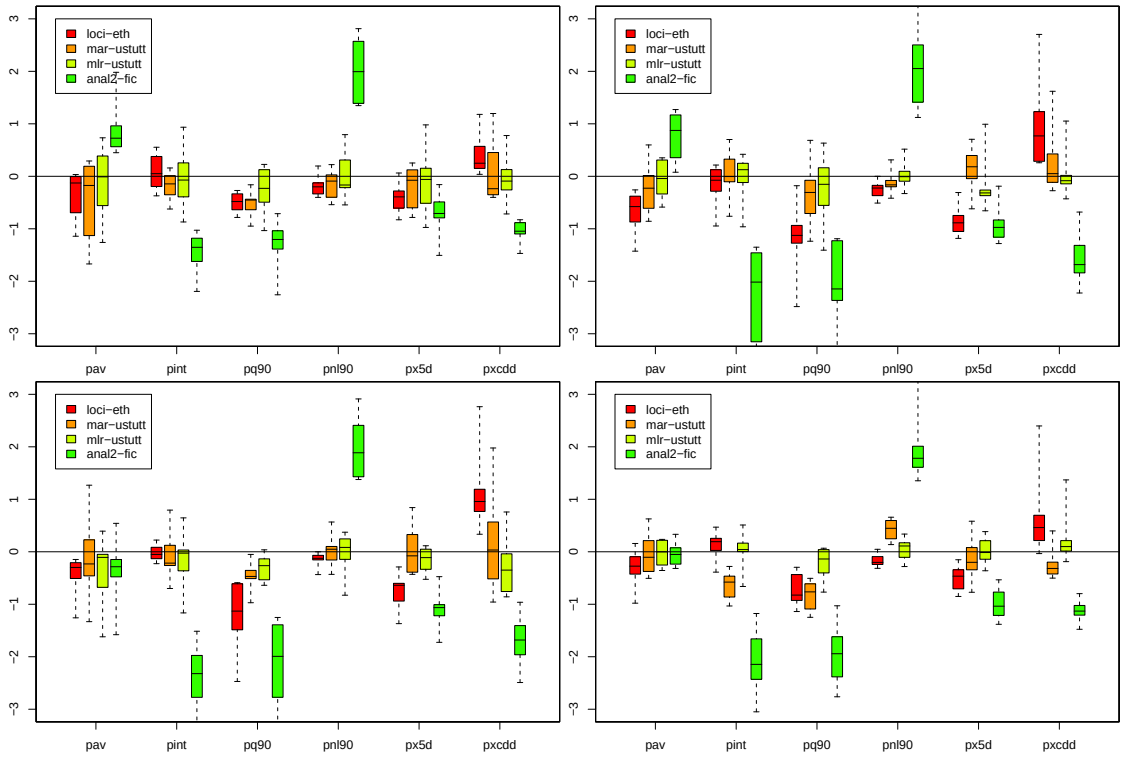

Figure 4: Same as Fig. 2, but for the bias scaled with the observed standard deviation.

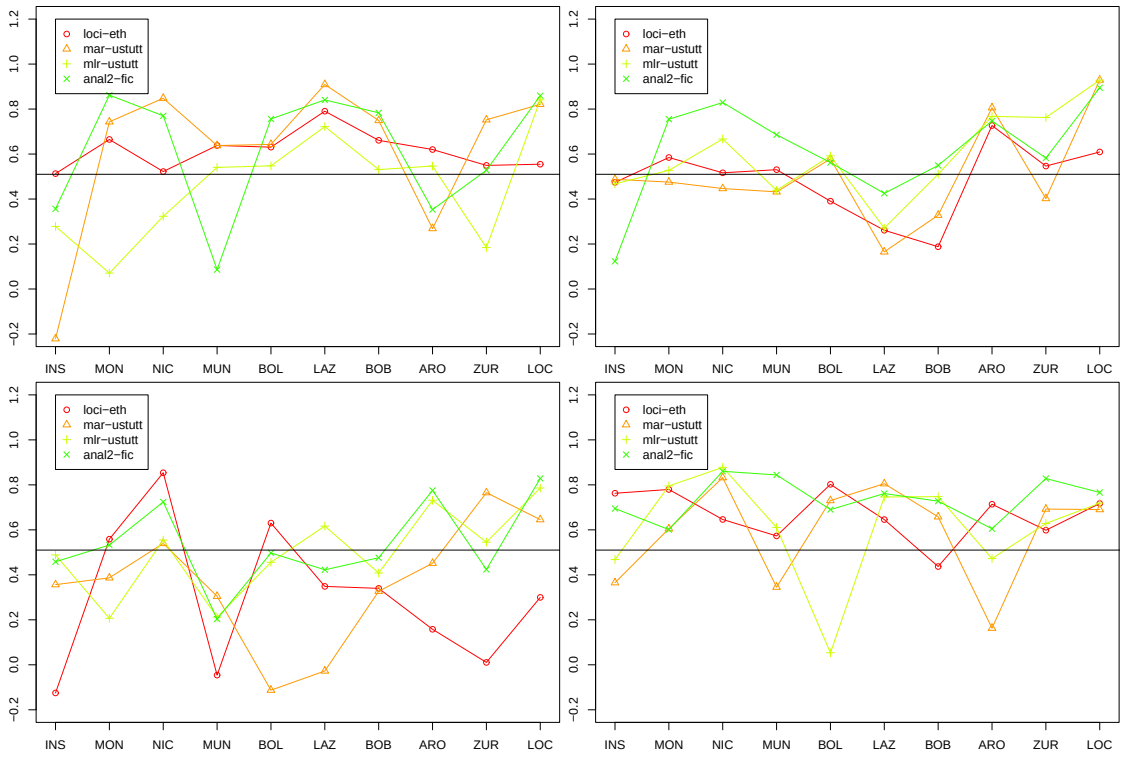

Figure 5: Correlation skill for the 10 FIC stations for PAV for the four downscaling methods.

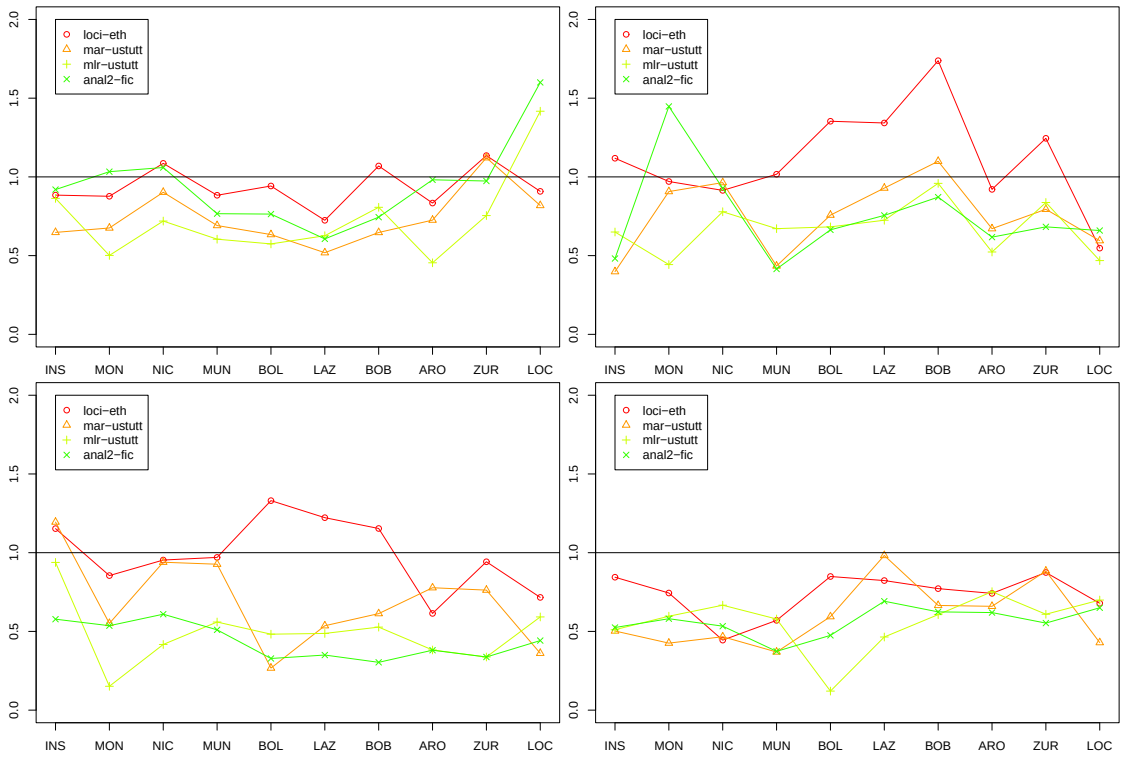

Figure 6: As Fig. 5, but for the ratio of downscaled standard deviation over observed standard deviation.

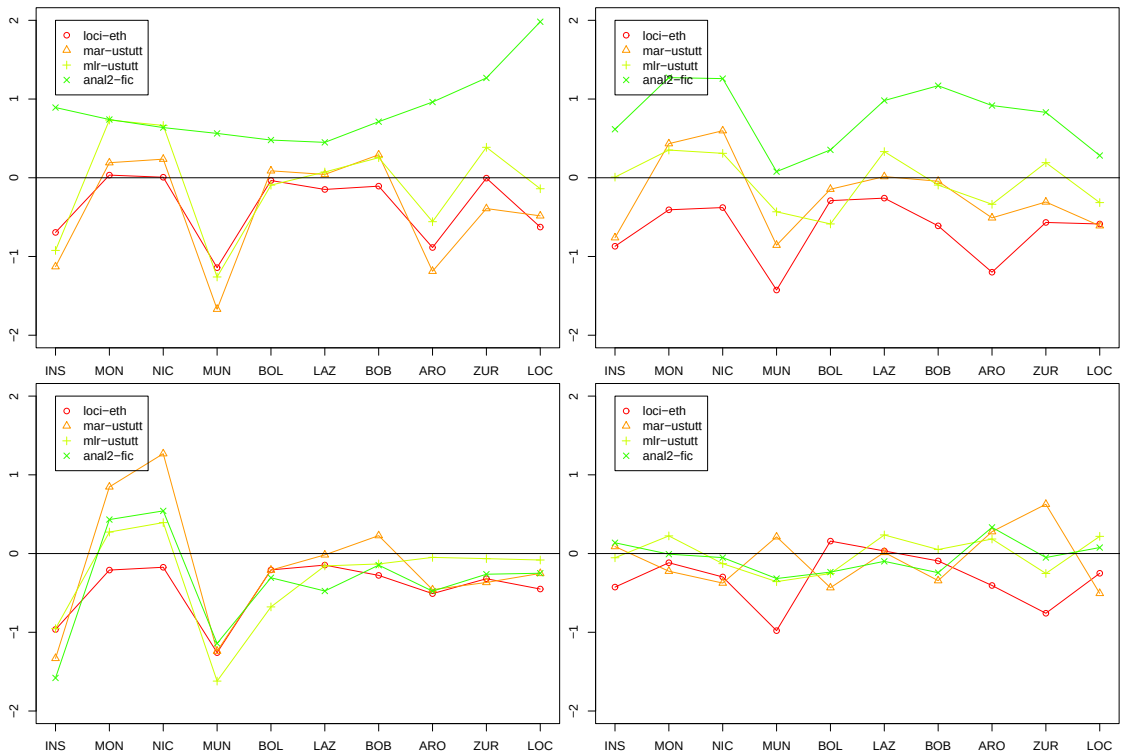

Figure 7: As Fig. 5, but for the bias scaled with the observed standard deviation.