



Supplement of

The SPARC water vapour assessment II: profile-to-profile comparisons of stratospheric and lower mesospheric water vapour data sets obtained from satellites

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In the Supplement we show additional figures that complement those in the main manuscript.

Figure S1 shows the standard deviations of the percentiles presented in Fig. 5 of the main manuscript. These standard deviations were calculated with a jackknife approach (Efron, 1979). Figures S2 to S4 relate to the bias percentiles shown in Fig. 6 in the main manuscript. Figure S2 also shows the 50% percentile but without the aggregation of the MIPAS results. The other two figures consider this aggregation, but focus on the 80% and 95% percentiles, respectively.

In Figs. S5 to S8 bias histograms are shown. Figure S5 is based on comparisons at all altitudes as Fig. 7 in the main manuscript, but without the aggregation of the MIPAS results. In contrast to Fig. 7 and Fig. S6, Figs. S7 to S8 present the histograms for certain altitude ranges, i.e. 100 hPa – 10 hPa, 10 hPa – 1 hPa and 1 hPa – 0.1 hPa, respectively. The results shown in these three figures consider again the aggregation of the MIPAS results.

Figure S9 summarises the bias results for all data sets, completing the ACE-FTS v3.5 example shown in the main manuscript (Fig. 9). This figure extends over multiple pages, which is indicated at the page header. This header also provides information on which data set is considered. These summary results consider the aggregation of the MIPAS results, as described in Sect. 3.5 of the main manuscript.

Drift histograms considering comparison results at all altitudes are shown in Fig. S10. This figure corresponds to Fig. 12 in the main manuscript, but again omits the aggregation of the MIPAS results.

In Fig. S11 the data set specific drift results are presented. This completes the examples for the MIPAS-ESA v7 and MLS data sets shown in the main manuscript (Figs. 13 and 14). No results are available for the ILAS-II, MIPAS V5H and SMILES-NICT data sets, which are too short for such an analysis according to our criteria (see Sect. 3.4 in the main manuscript). As Fig. S9 this figure again extends over multiple pages. Also here, the page header serves as a guide to which data set actually is shown.

Finally, Figs. S12 and S14, respectively, show the drift results between the different data sets for the latitude bands from 15°S to 15°N and 50°N to 60°N at four altitudes. Both figures are a complement to Fig. 15 in the main manuscript that considers results in the latitude band between 80°S and 70°S. In combination, these three figures allow for a direct comparison to the drift results presented in the work by Khosrawi et al. (2018), which however are based on comparisons of zonal mean time series. For a more convenient and straightforward comparison we provide the differences between the drift estimates derived from the profile-to-profile and zonal mean time series comparisons for the latitude band between 80°S and 70°S in Fig. 16 of the main manuscript. Figures S13 and S15 do the same for the two latitude bands only presented here in the Supplement.

standard deviation of percentiles

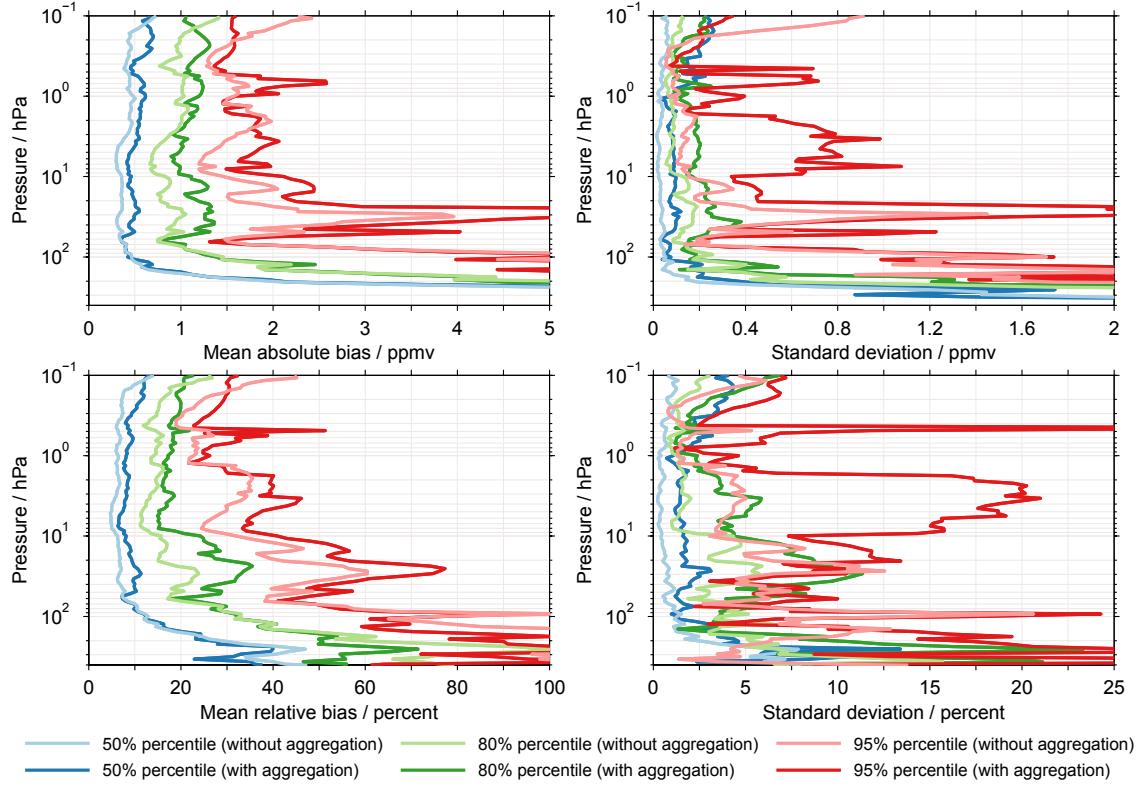


Figure S1: The left panels show the 50% (blue), 80% (green) and 95% (red) bias percentiles that were derived from the full matrix of comparisons using coincidences during all seasons and at all latitudes. In the upper row the results for absolute biases are shown, in lower those for the relative biases. As such, these results have already been shown in Fig. 5 of the main manuscript. In addition, the right panels show an estimation of the standard deviations that are associated with the percentiles. The standard deviations have been calculated with a random jackknife approach (see main manuscript). They represent one of many possible realisations, however they exhibit a characteristic behaviour.

50% percentile biases - no aggregation of MIPAS results

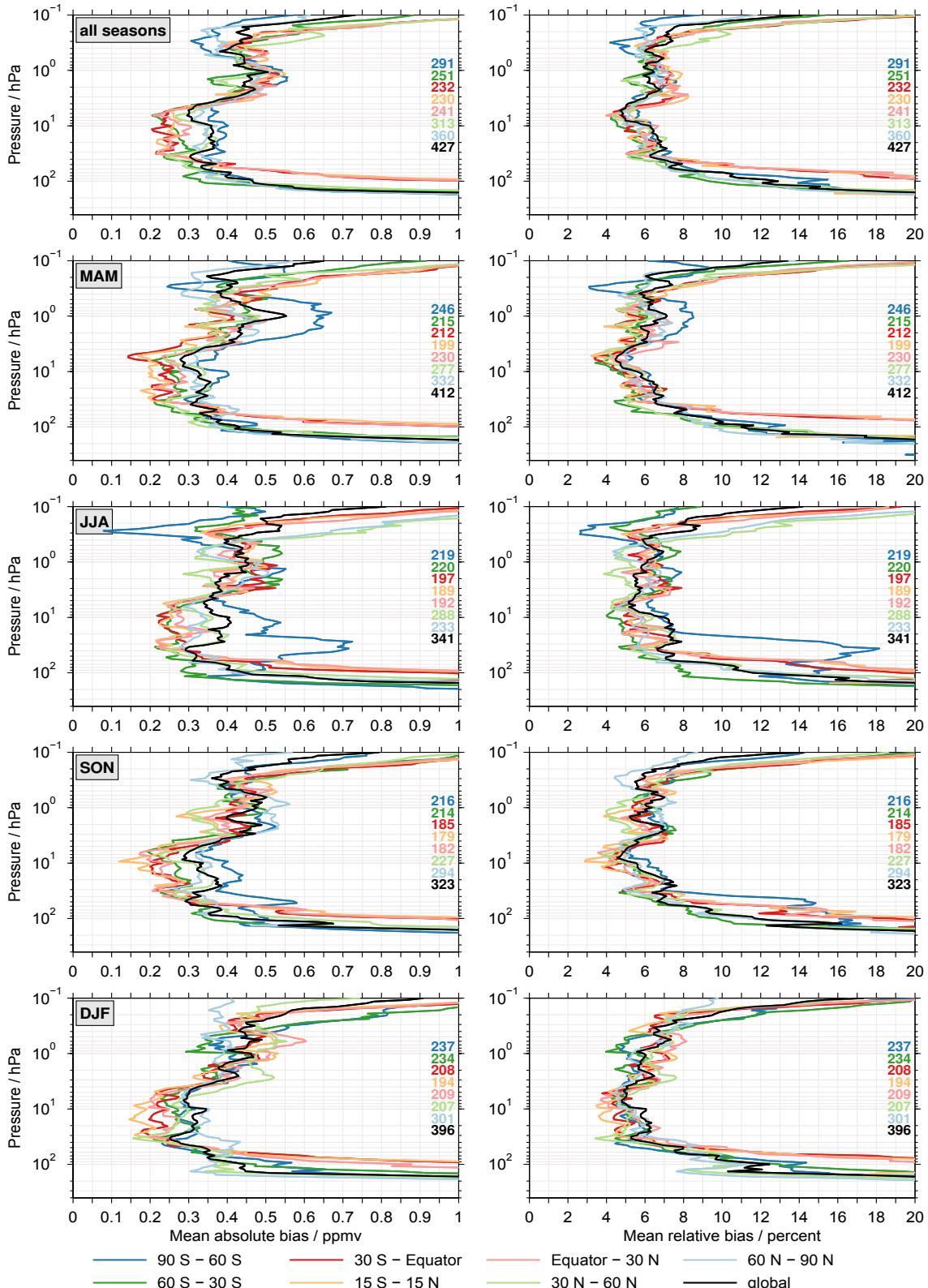


Figure S2: The 50% percentile of the biases from all available comparisons. The left column shows the results for the absolute bias, the right column presents the results for the relative bias. The different rows consider different seasons or their combination. For the results derived for the different latitude bands different colours as indicated in the figure legend are used. On the right-hand side of the individual panels the number of comparisons contributing to the results are given. In contrast to Fig. 6 in the main manuscript the results presented here do not consider the aggregation of the MIPAS results.

80% percentile biases

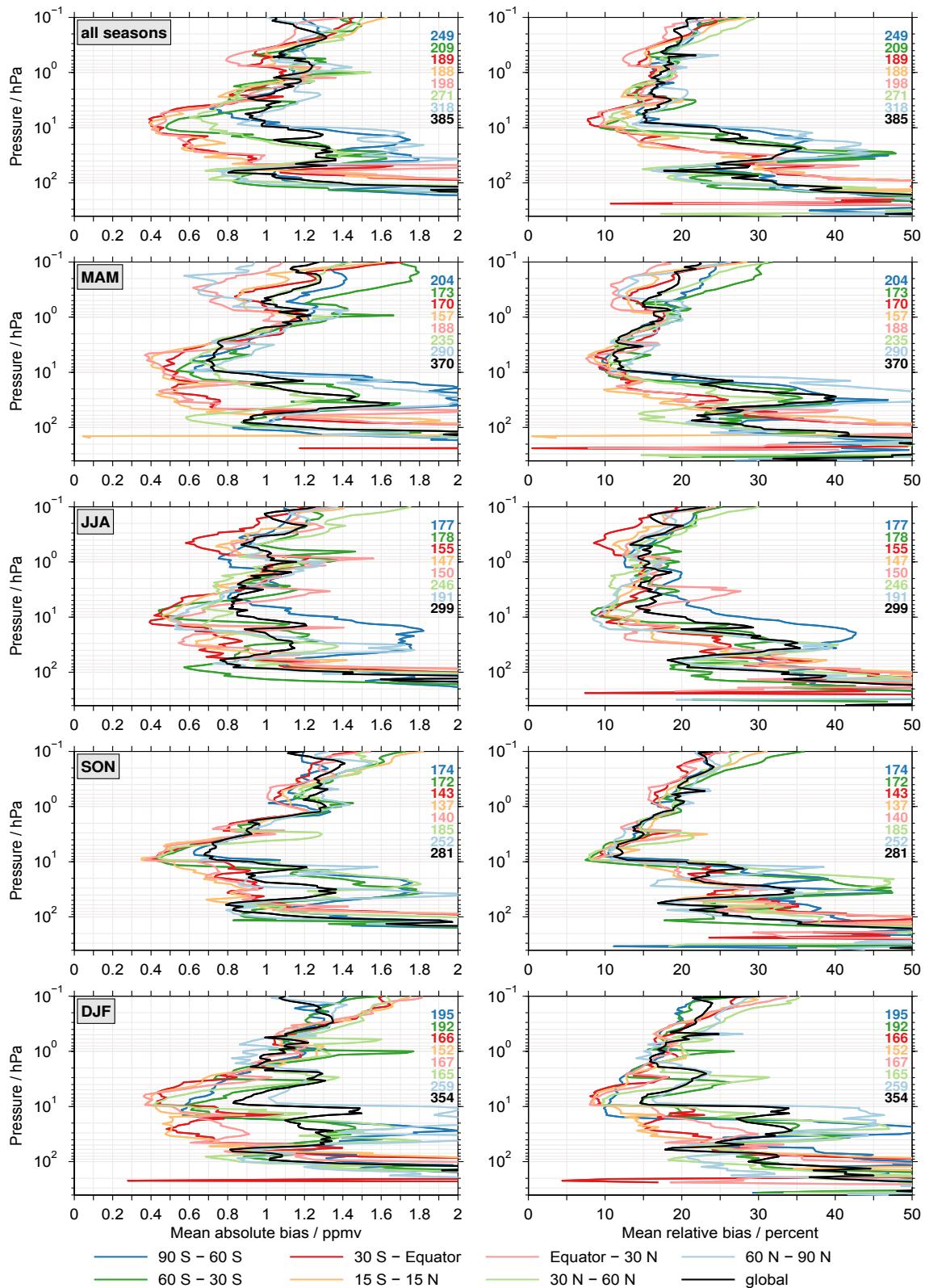


Figure S3: As Fig. S2, but like in the main manuscript the results shown here take into account the aggregation of the MIPAS results. Further, here the results for the 80% percentiles of the biases are presented.

95% percentile biases

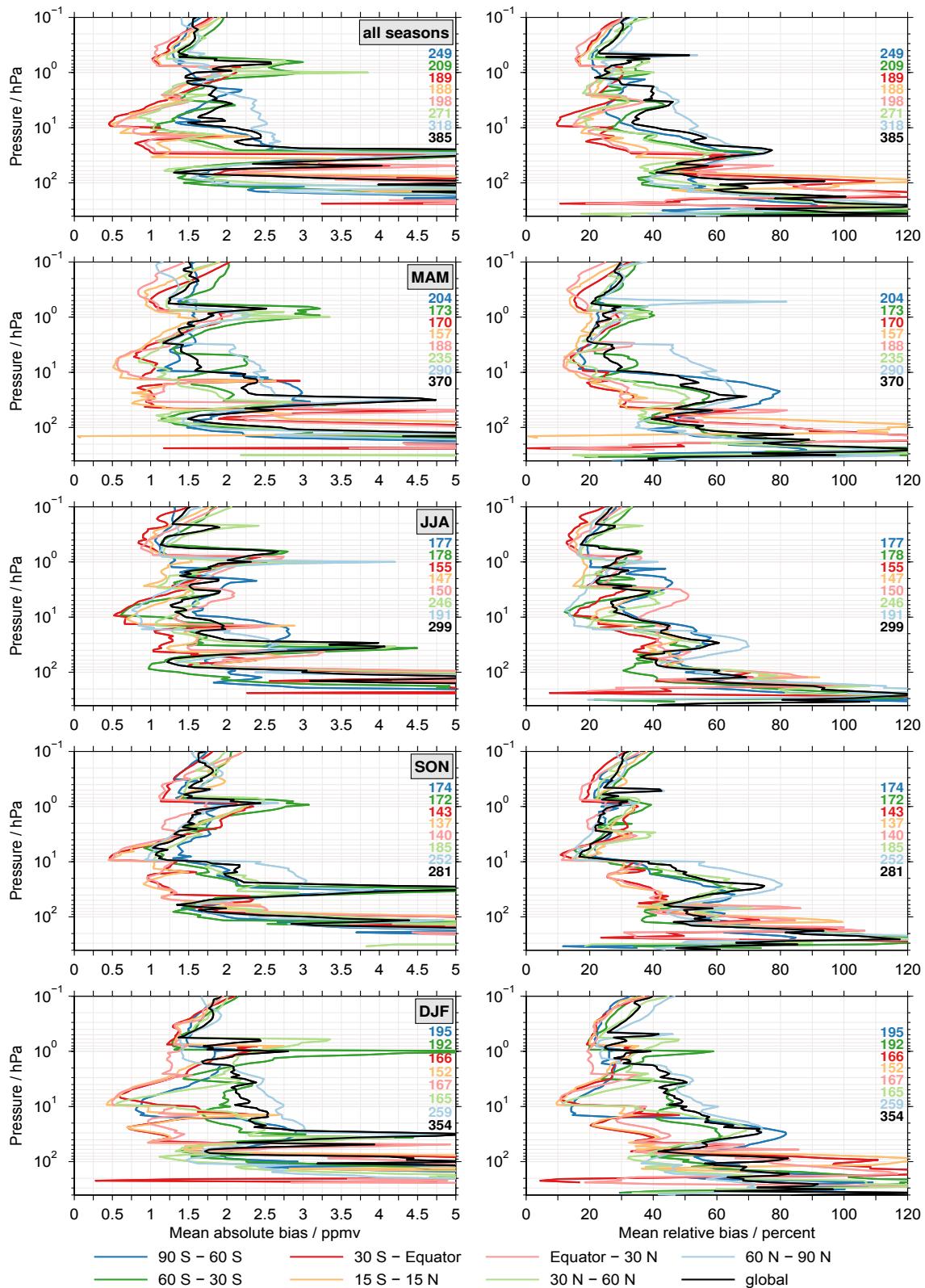


Figure S4: As Fig. S3, but here the 95% percentile of the biases is considered.

bias histograms all altitudes - no aggregation of MIPAS results

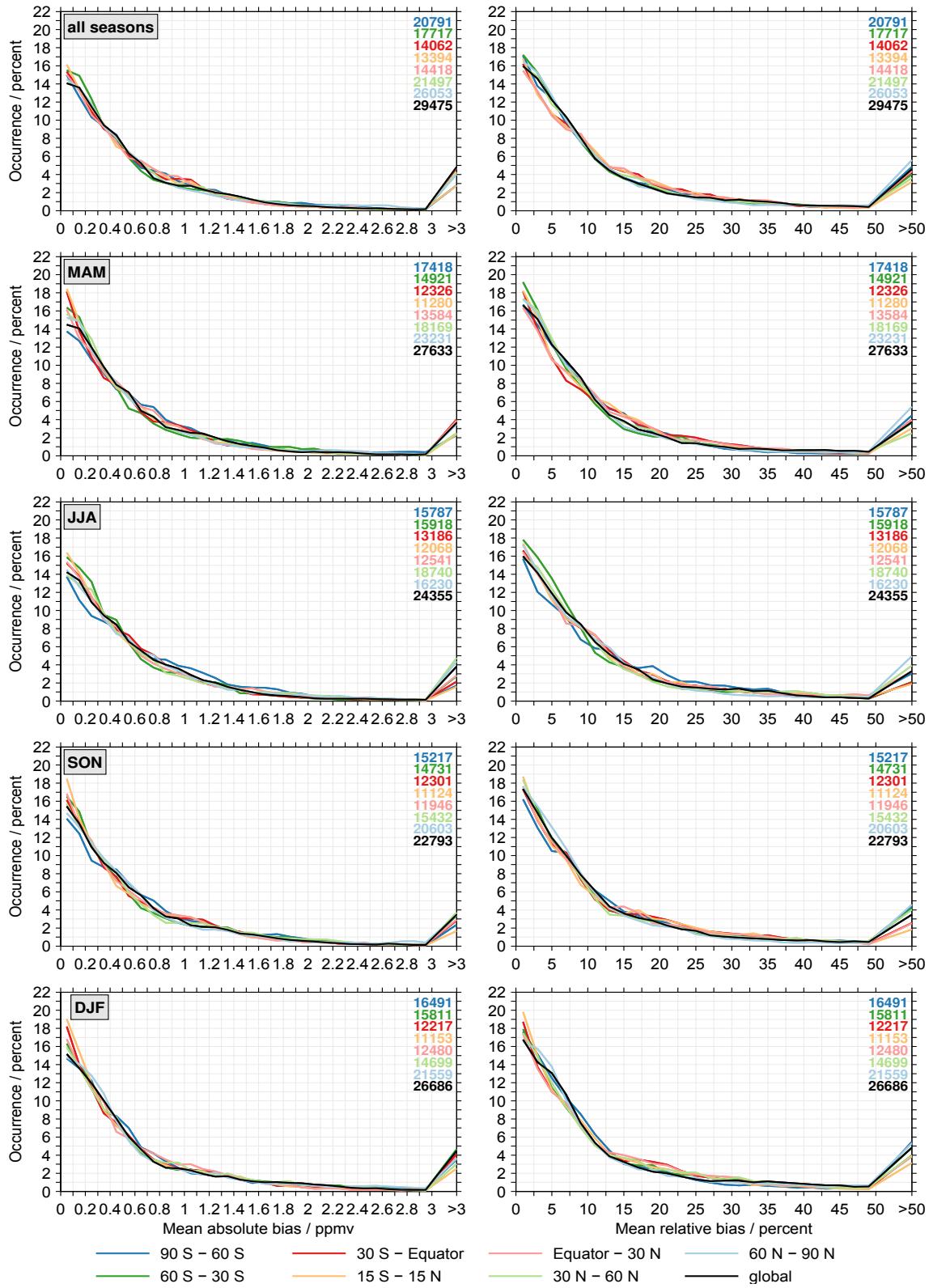


Figure S5: Histograms of the absolute (left column) and relative biases (right column) considering data at all altitudes. The results for different seasons are shown in different rows. For the different latitude bands a colour-coding is used. In the upper right corner of the individual panels the number of data points contributing to the results are shown. As Fig. S2 the results shown here do not consider the aggregation of the MIPAS results.

bias histograms 100 hPa – 10 hPa

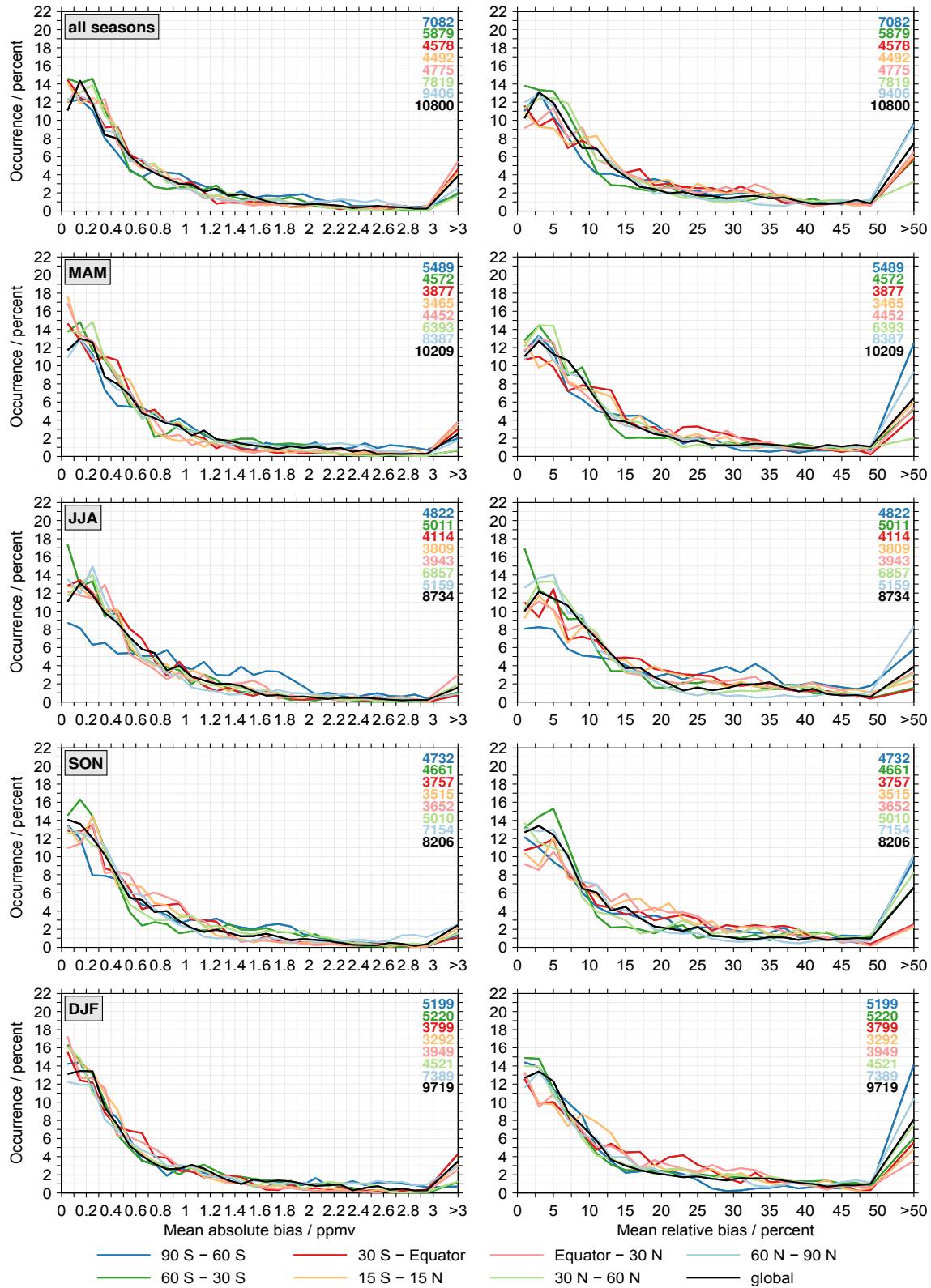


Figure S6: As Fig. S5, but here the aggregation of the MIPAS results is taken into account and the results consider only biases in the altitude range between 100 hPa and 10 hPa.

bias histograms 10 hPa – 1 hPa

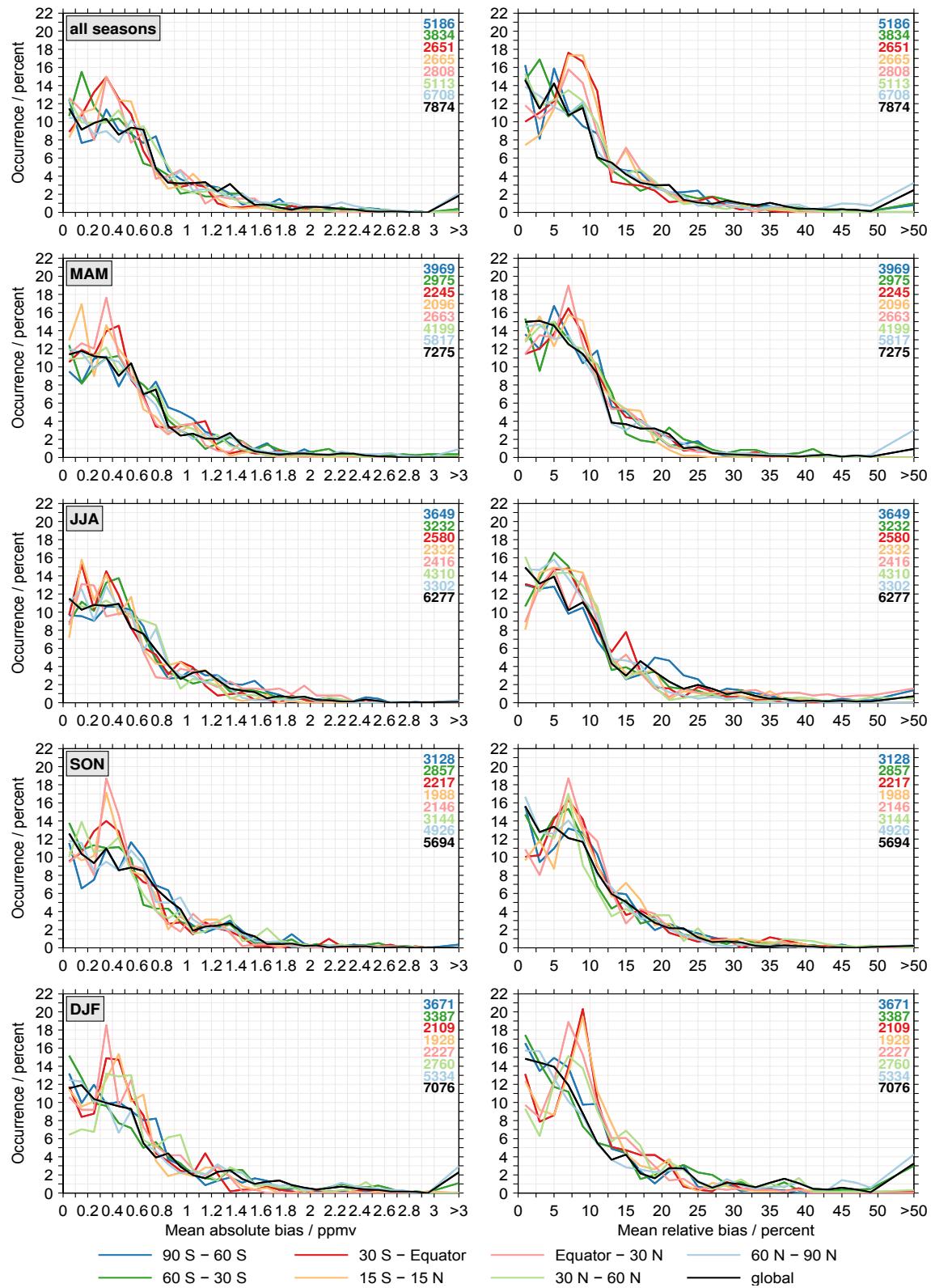


Figure S7: As Fig. S6, but here biases in the altitude range between 10 hPa and 1 hPa are considered.

bias histograms 1 hPa – 0.1 hPa

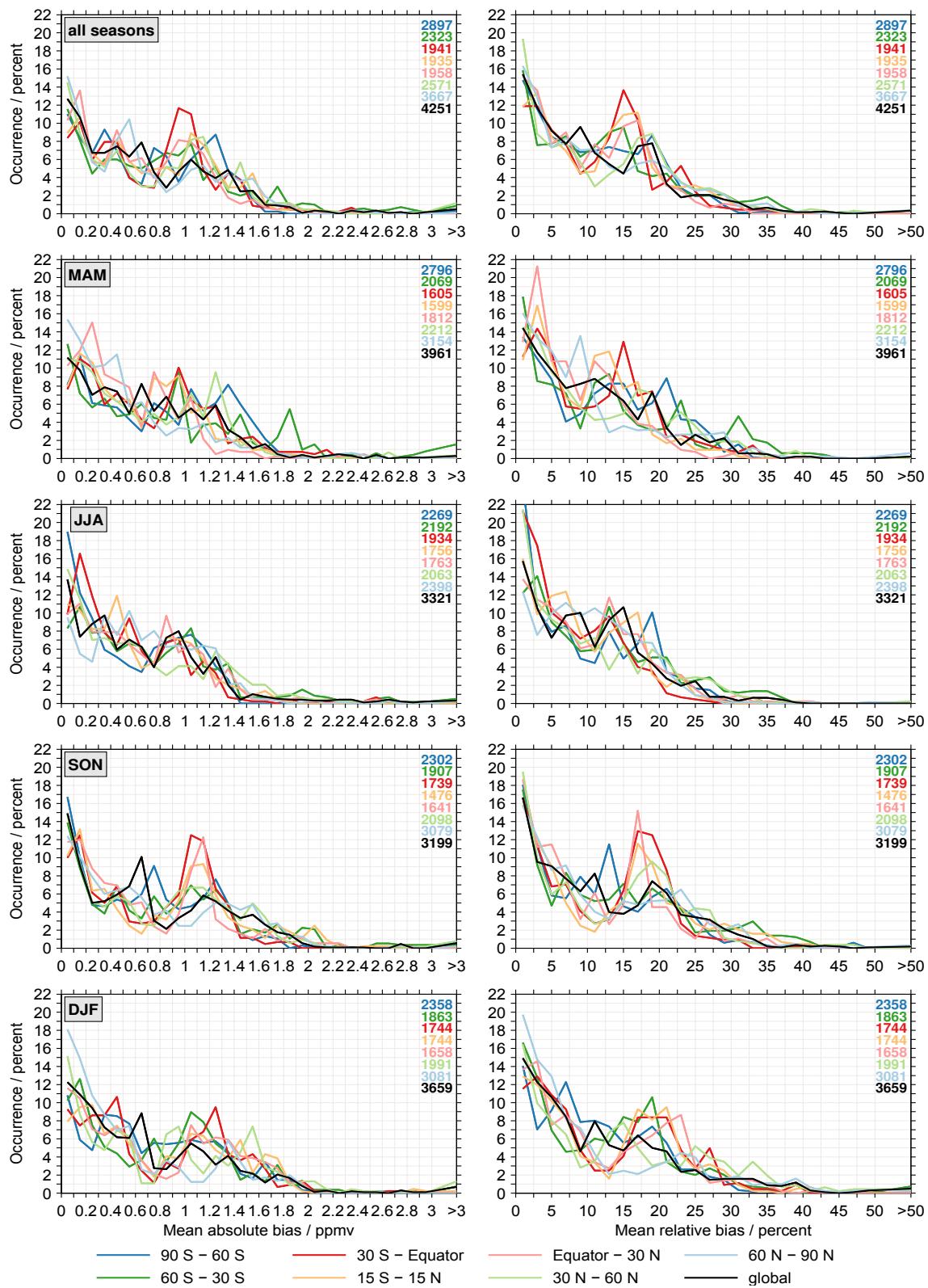
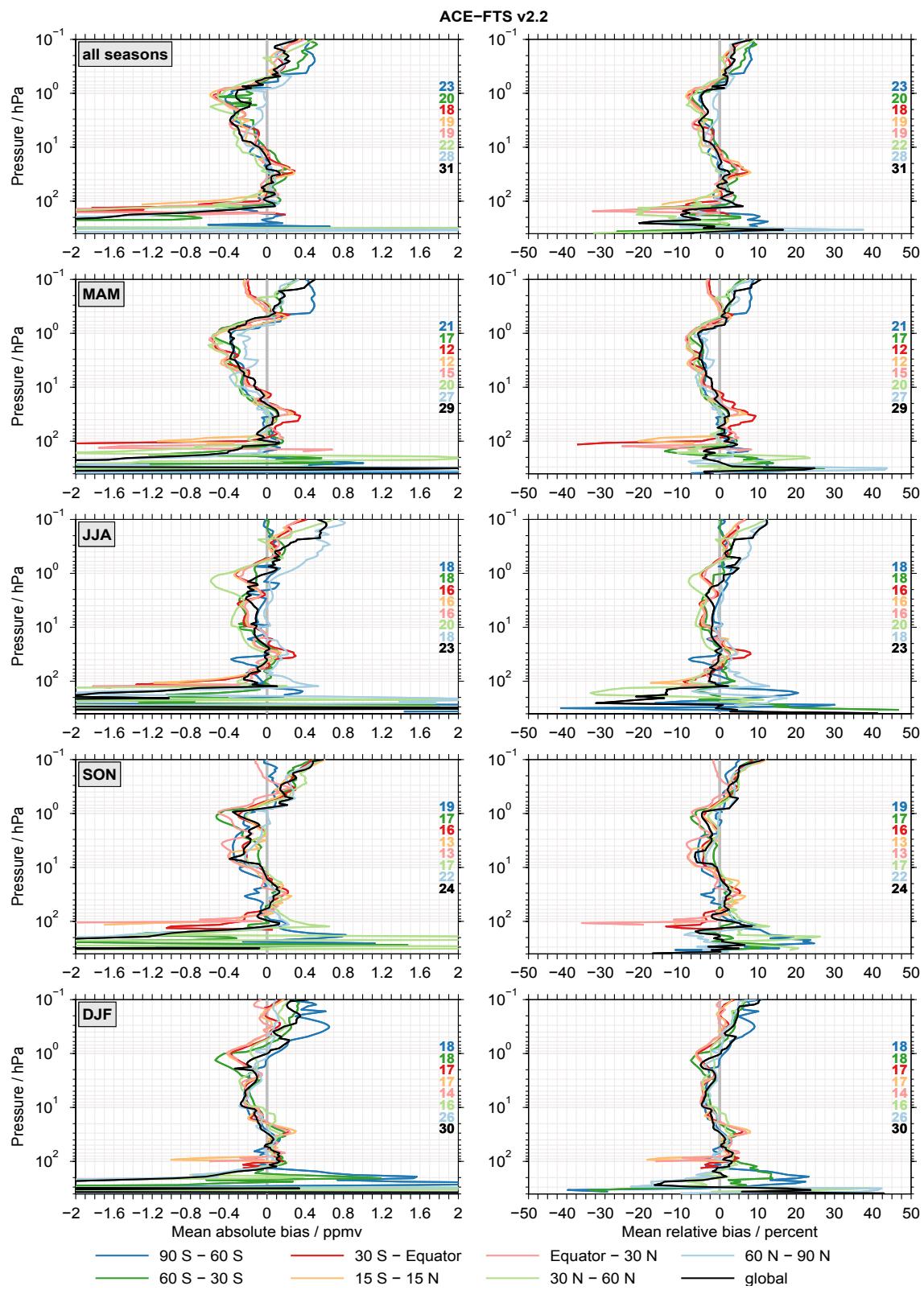


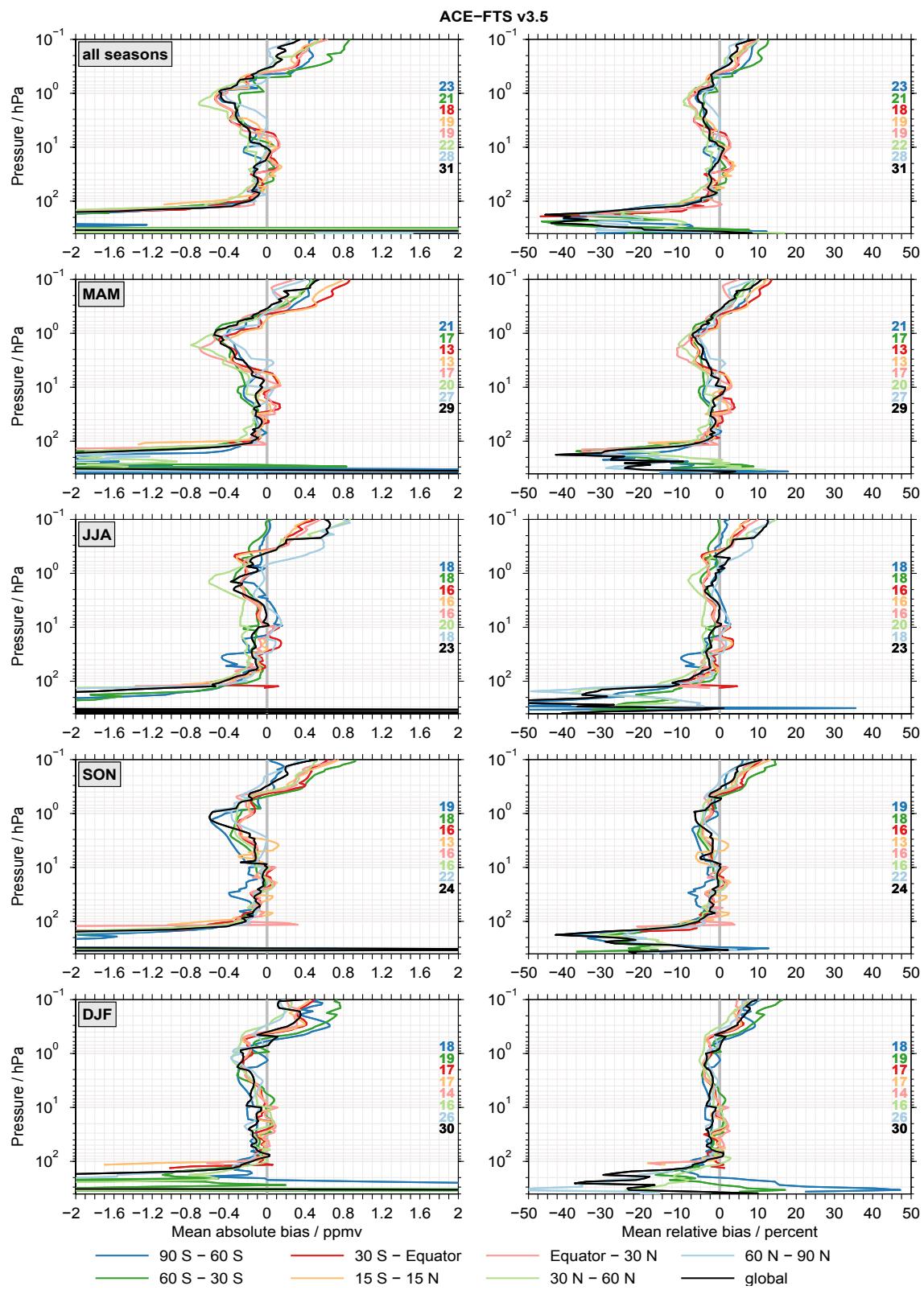
Figure S8: As the two previous figures, but here biases in the altitude range from 1 hPa to 0.1 hPa are taken into account.

bias summary for ACE-FTS v2.2 (1 of 33)

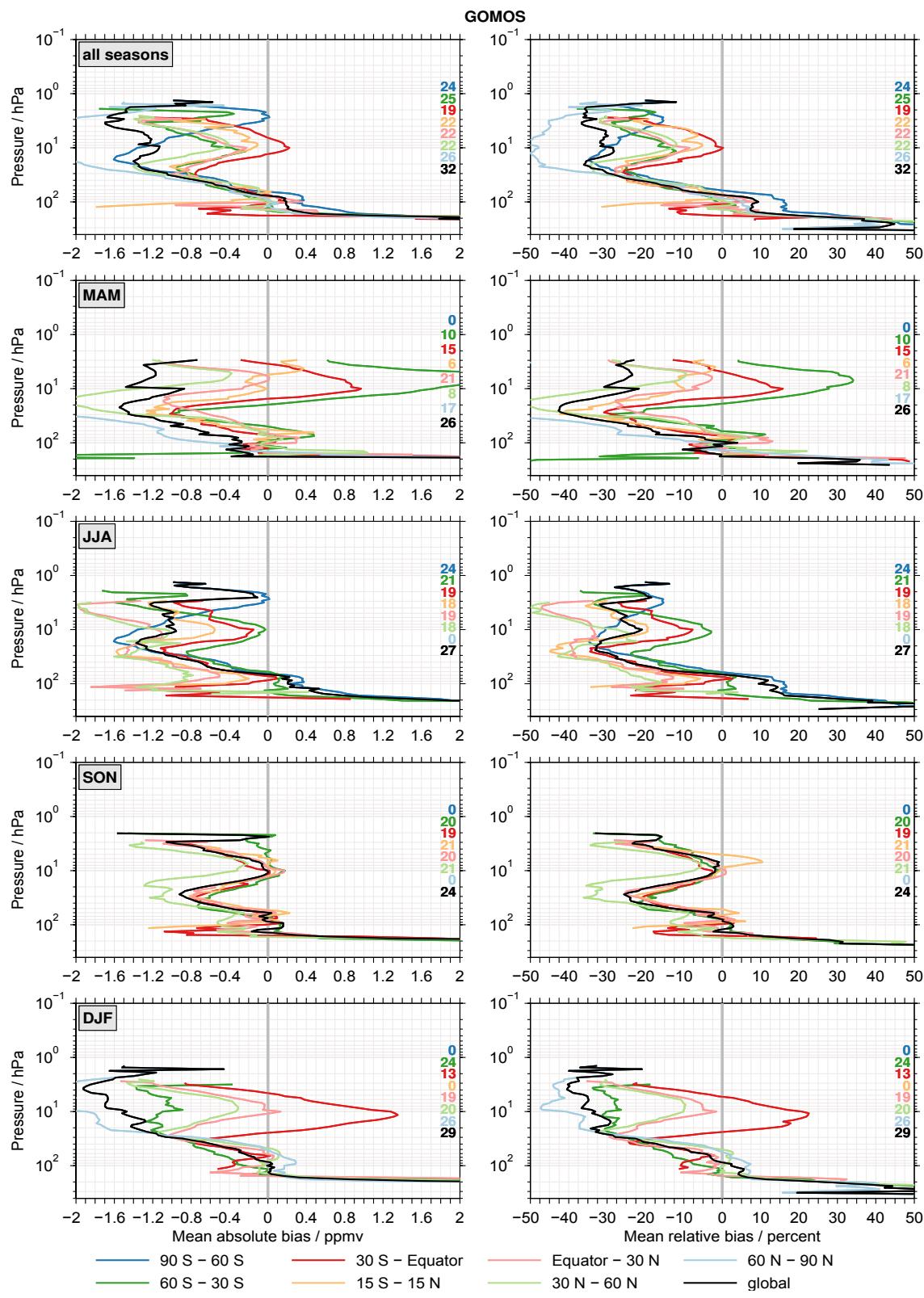


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bias summary for ACE-FTS v3.5 (2 of 33)

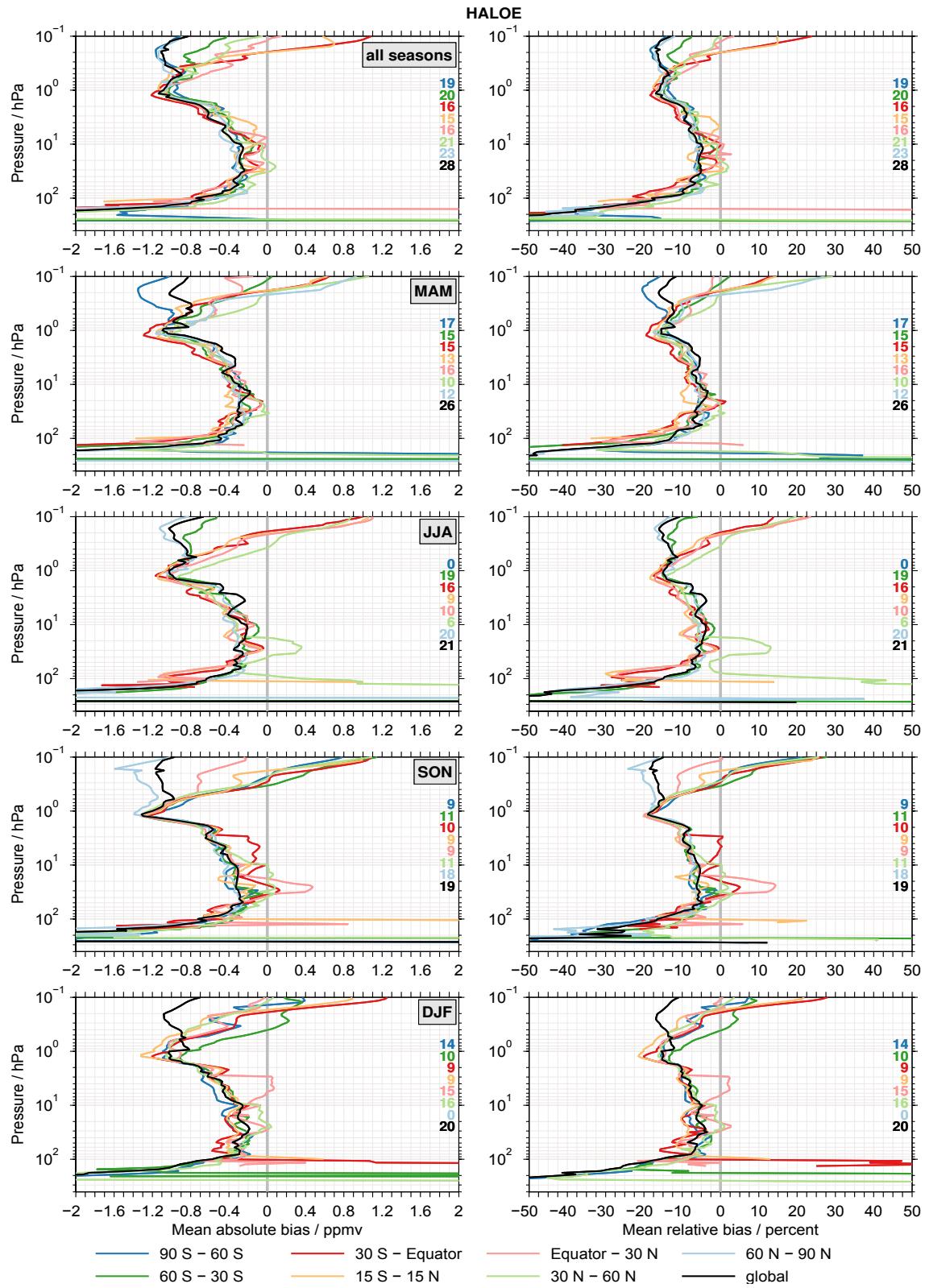


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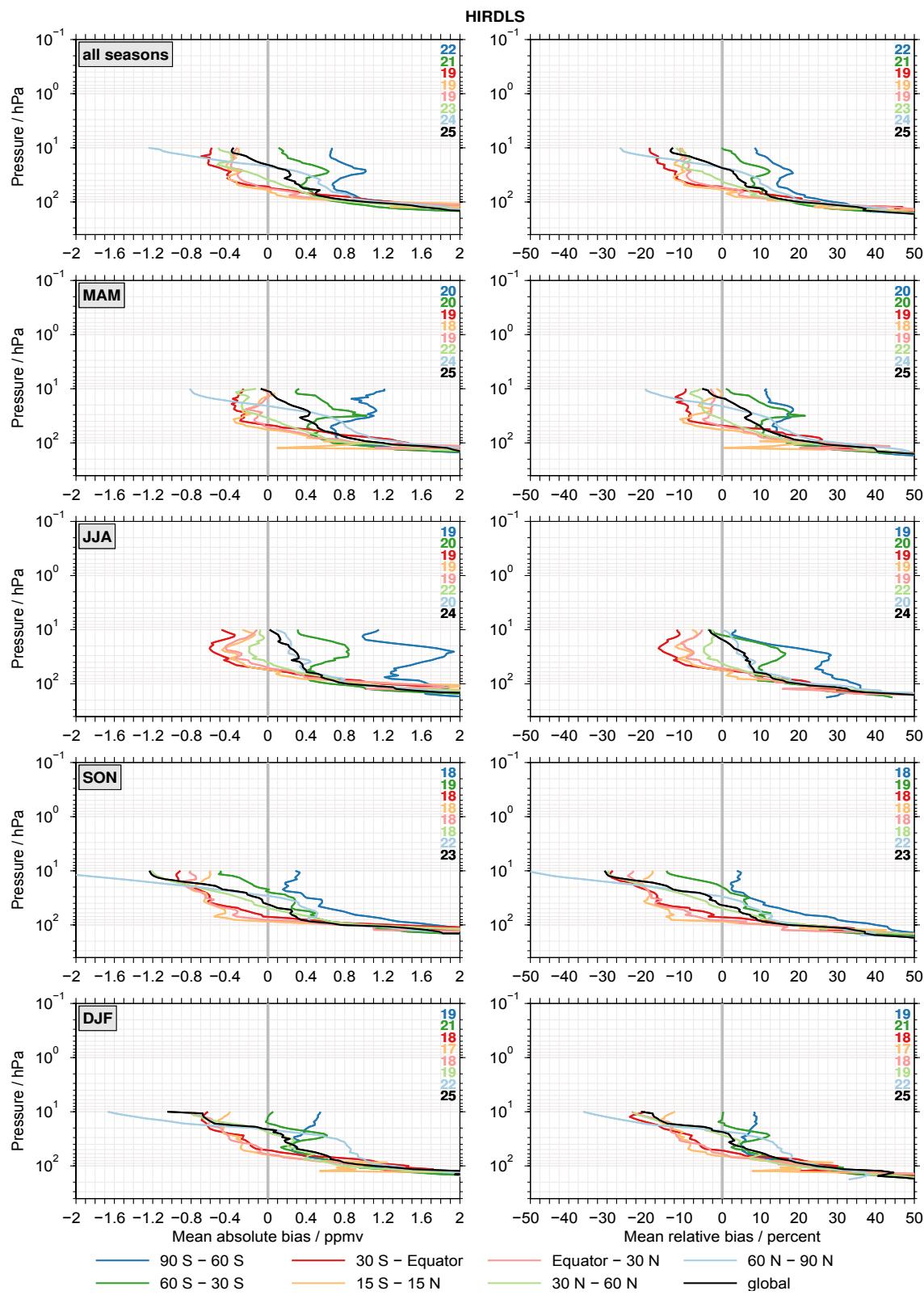


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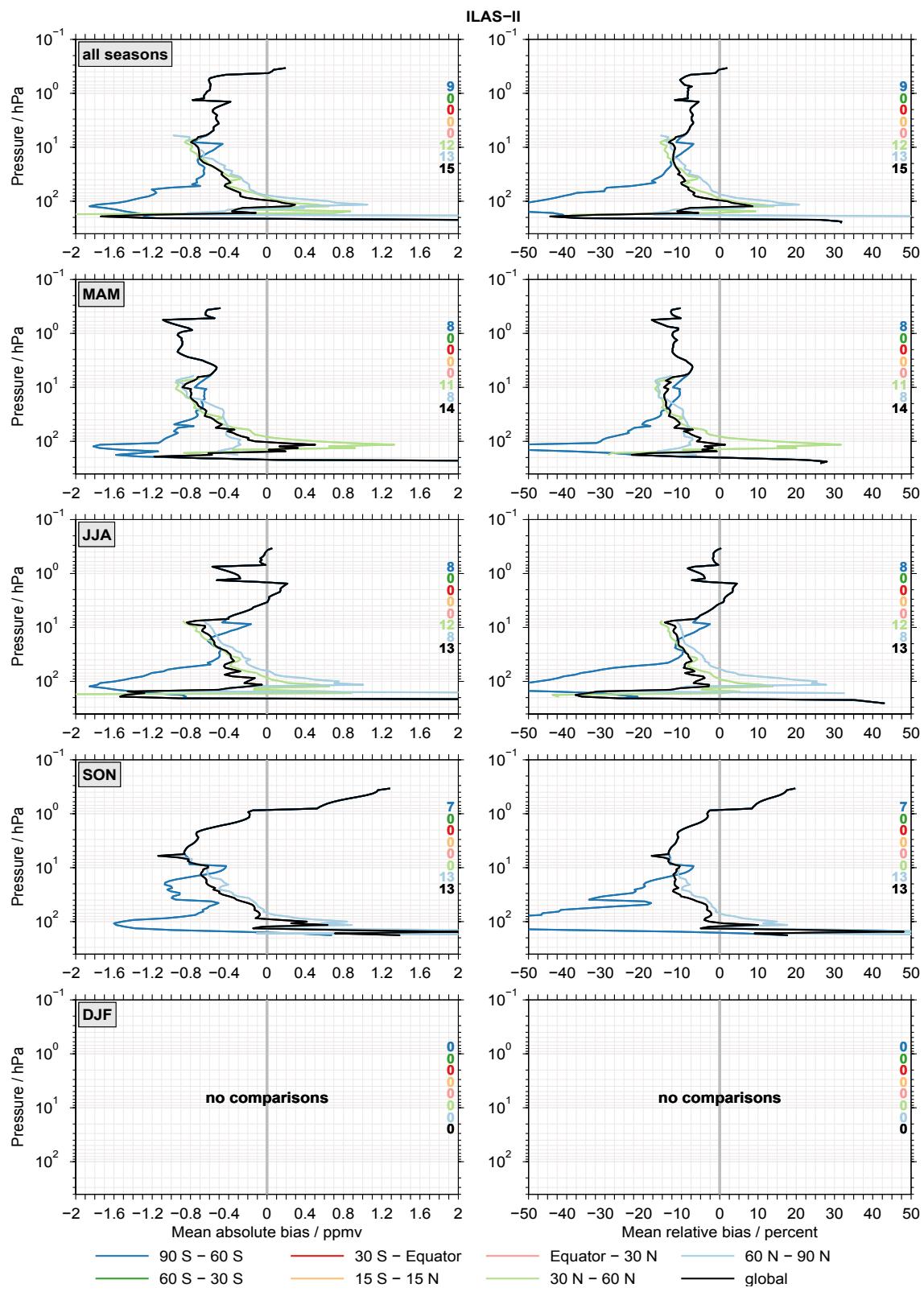
bias summary for HALOE (4 of 33)



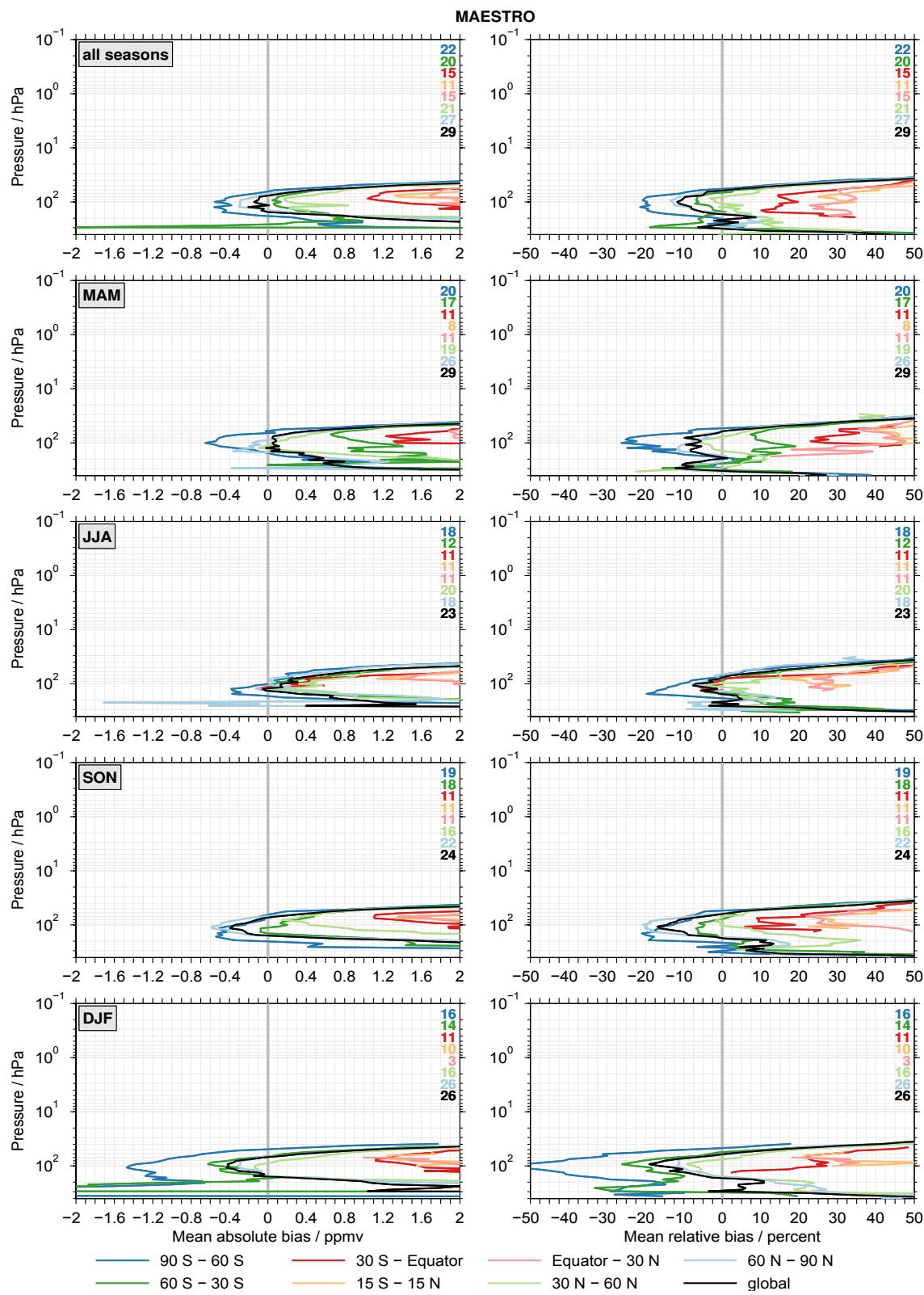
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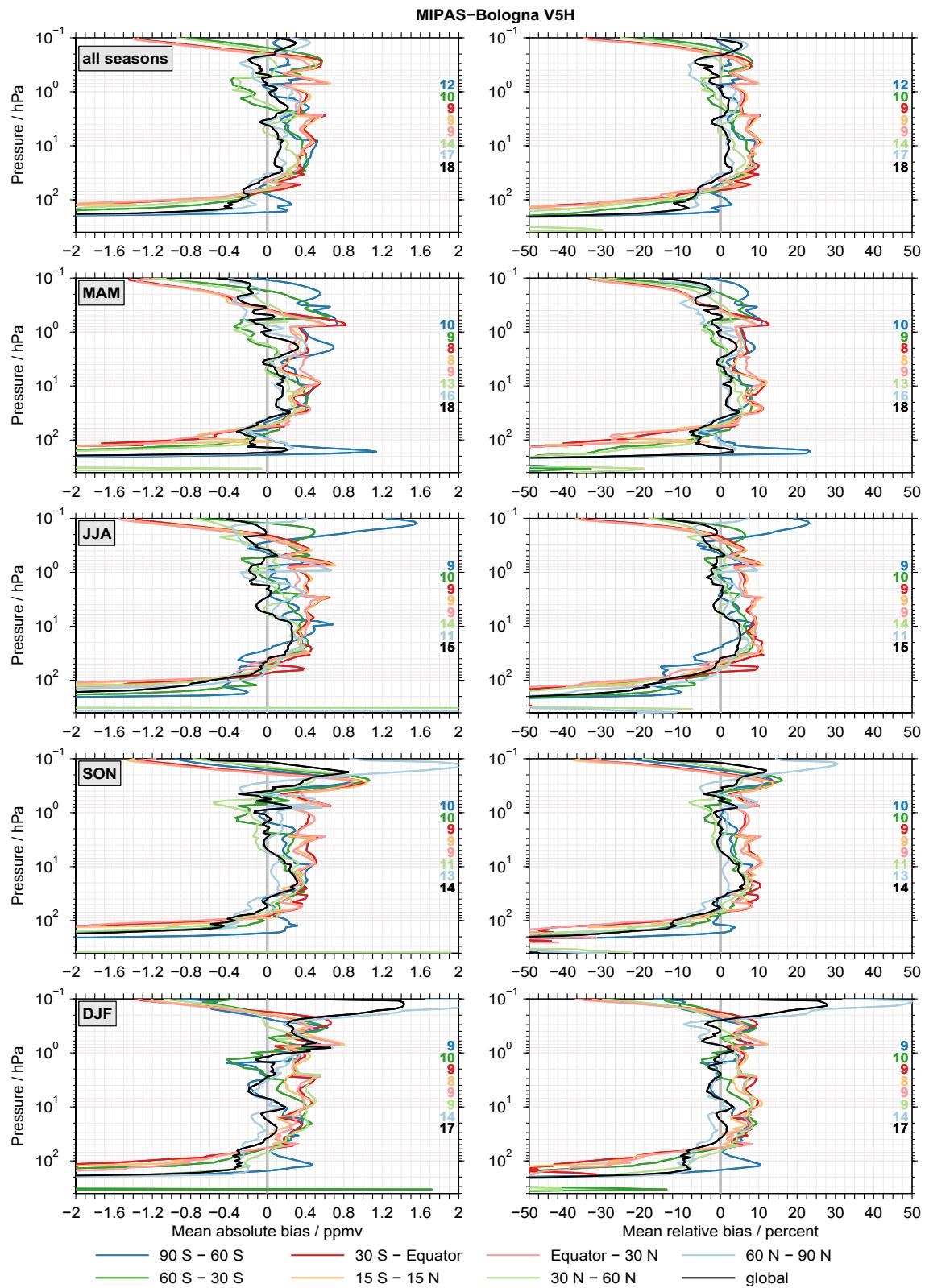


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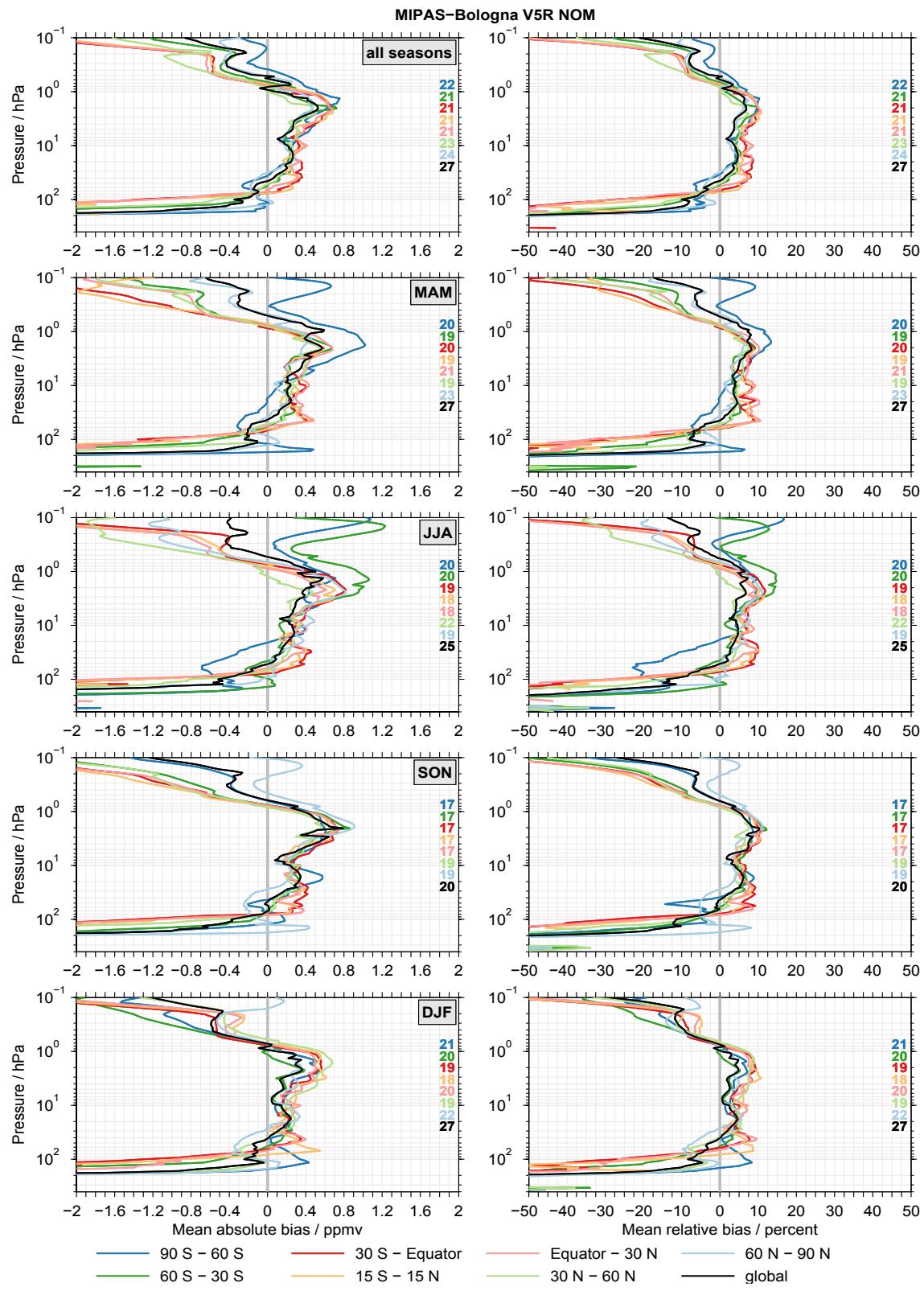


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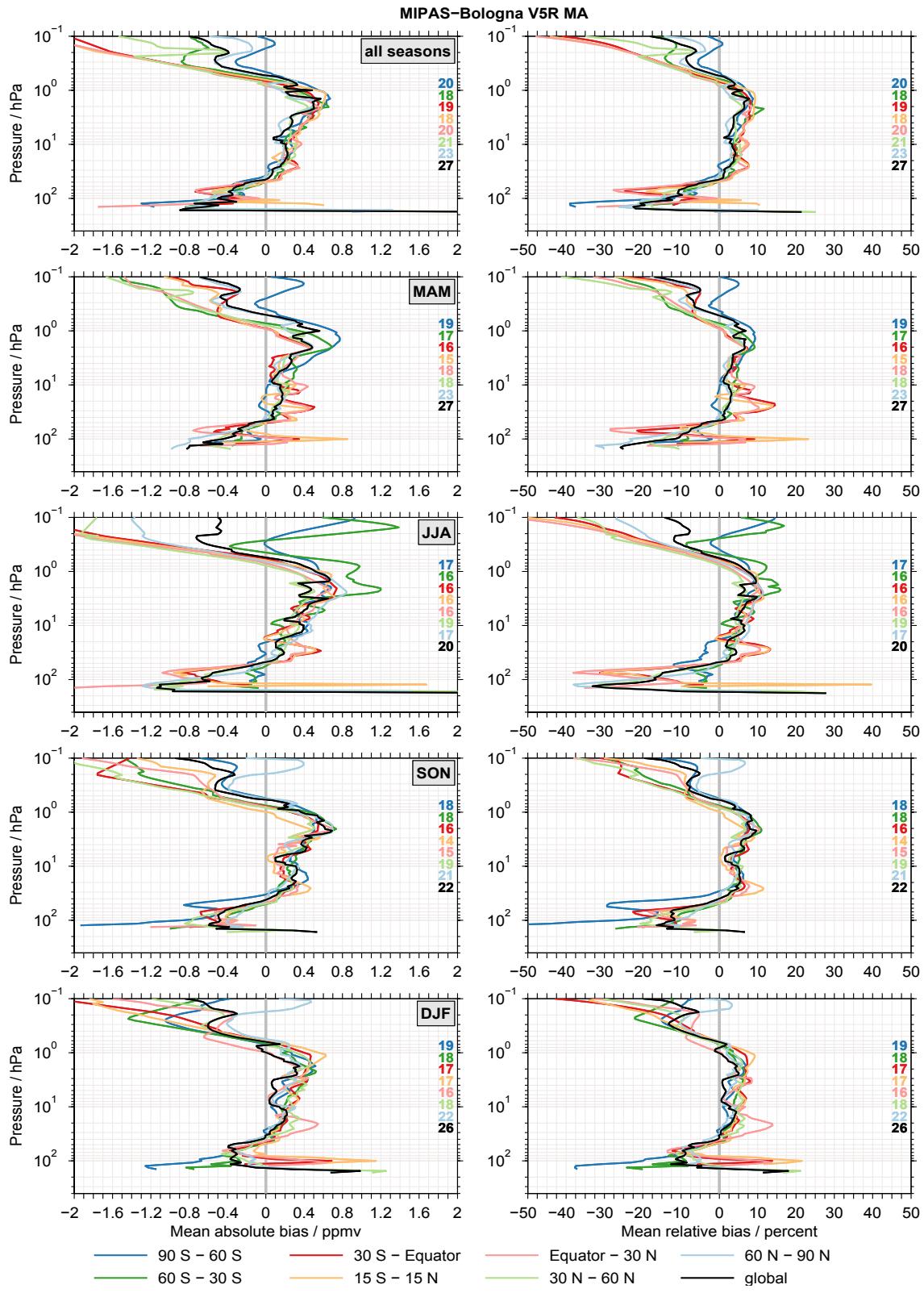
bias summary for MIPAS-Bologna V5H (8 of 33)



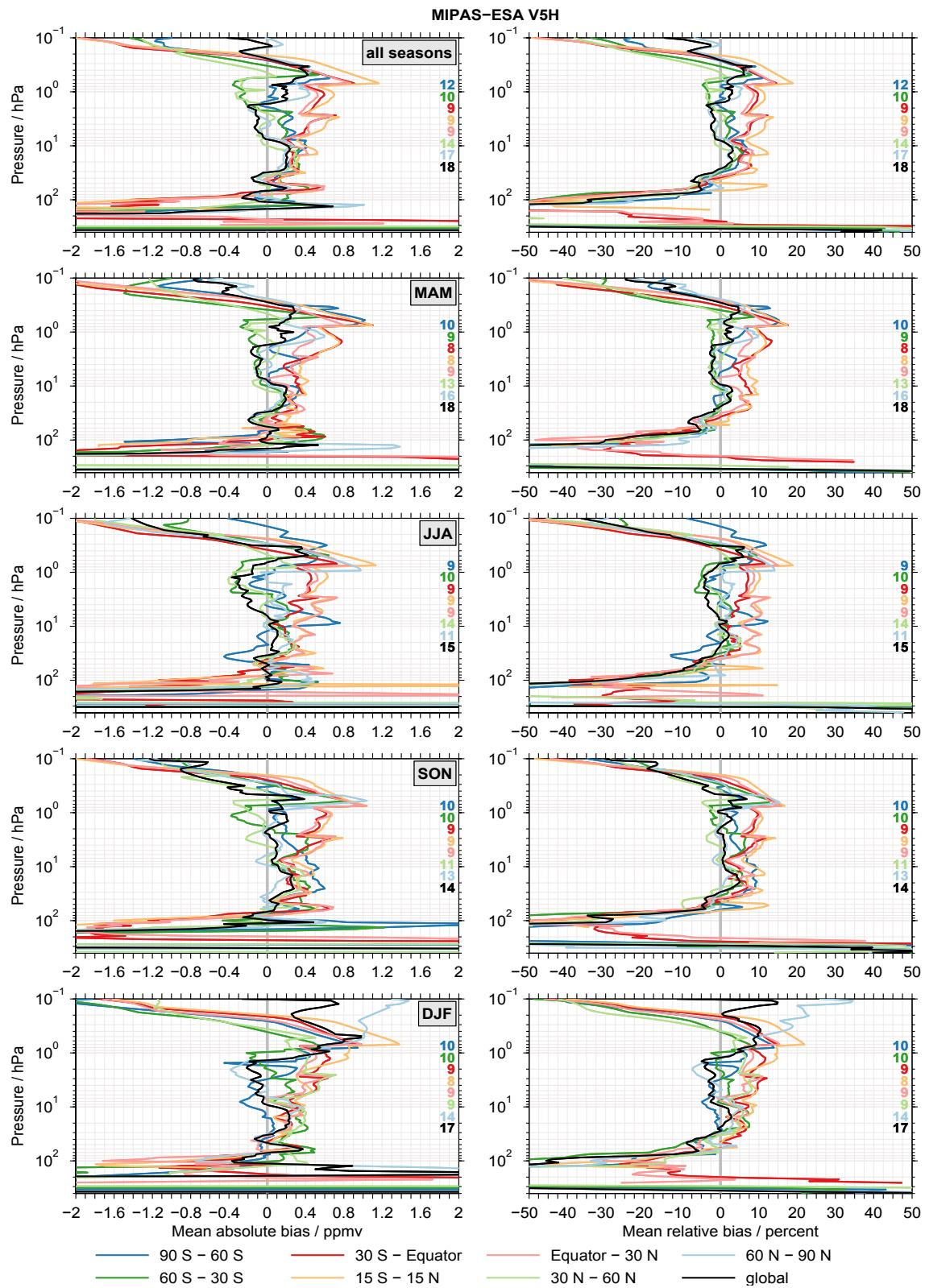
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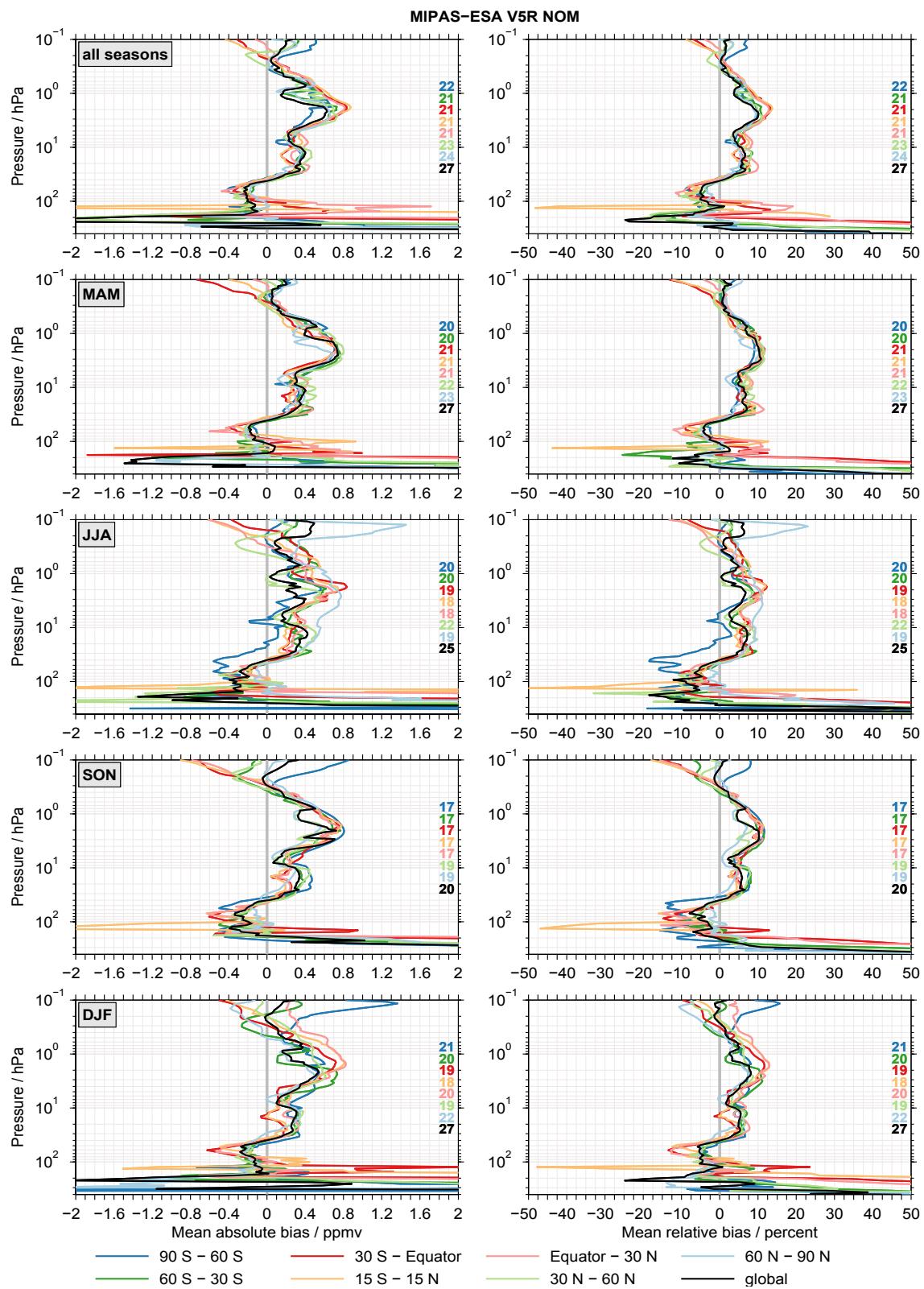
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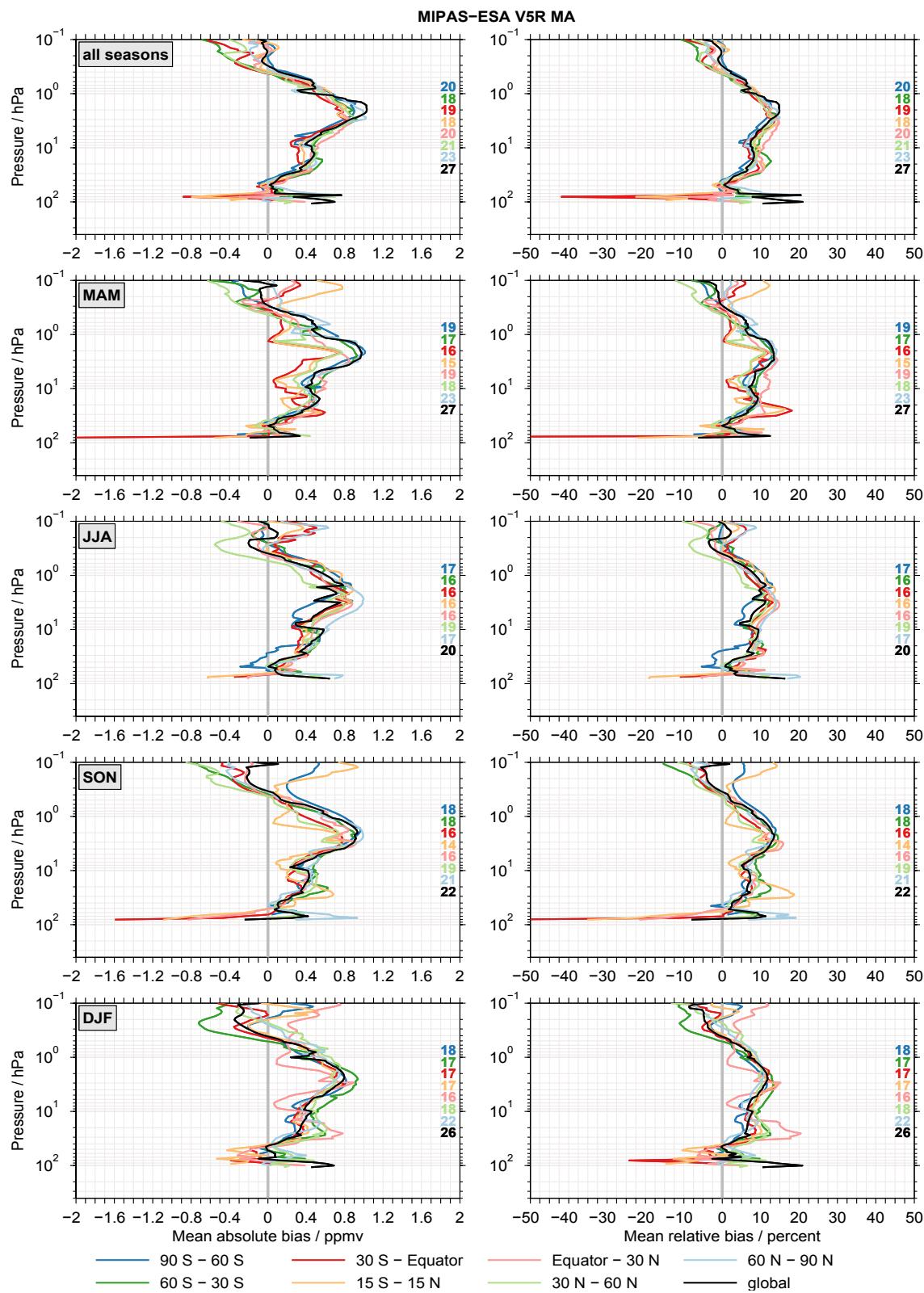
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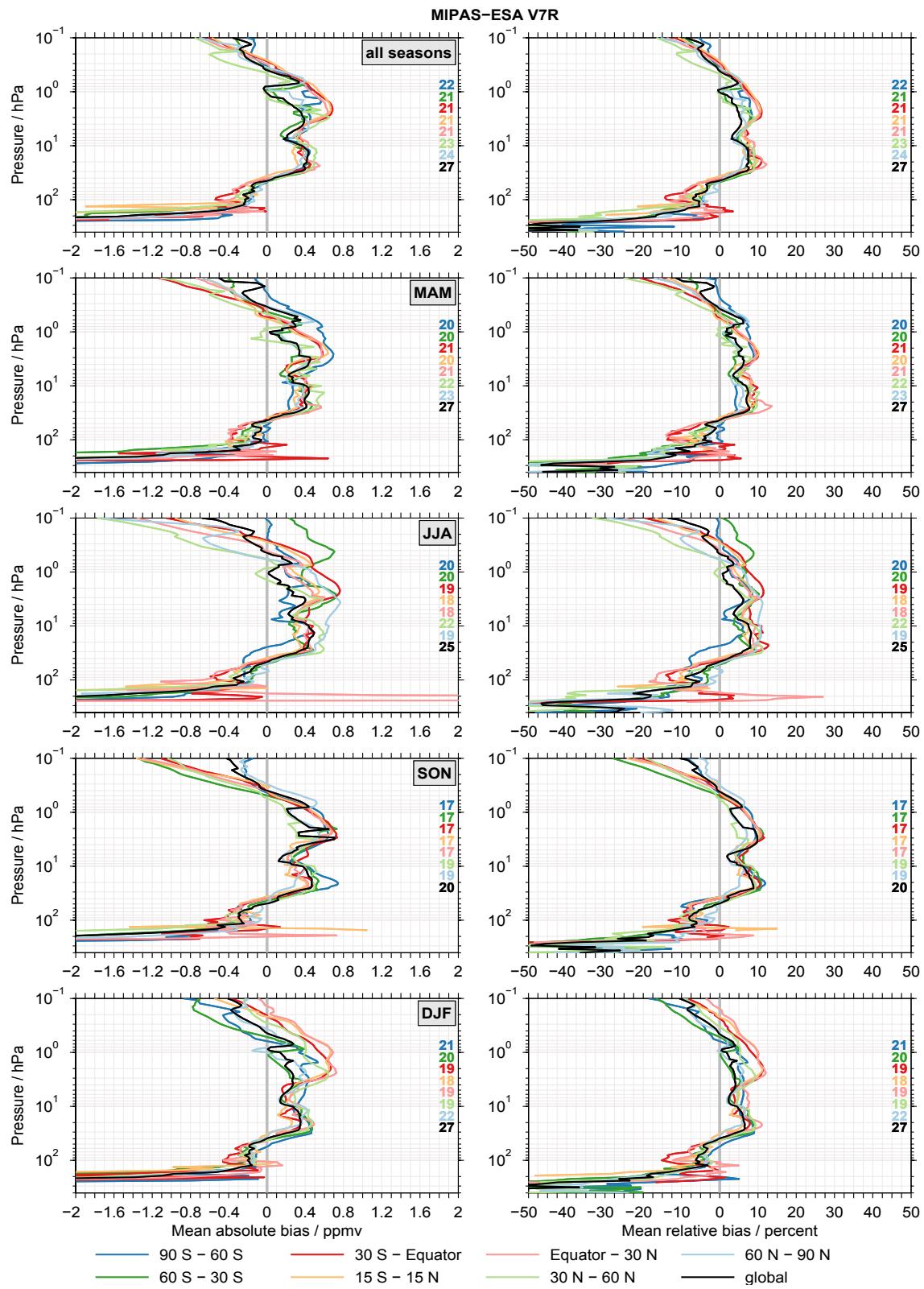
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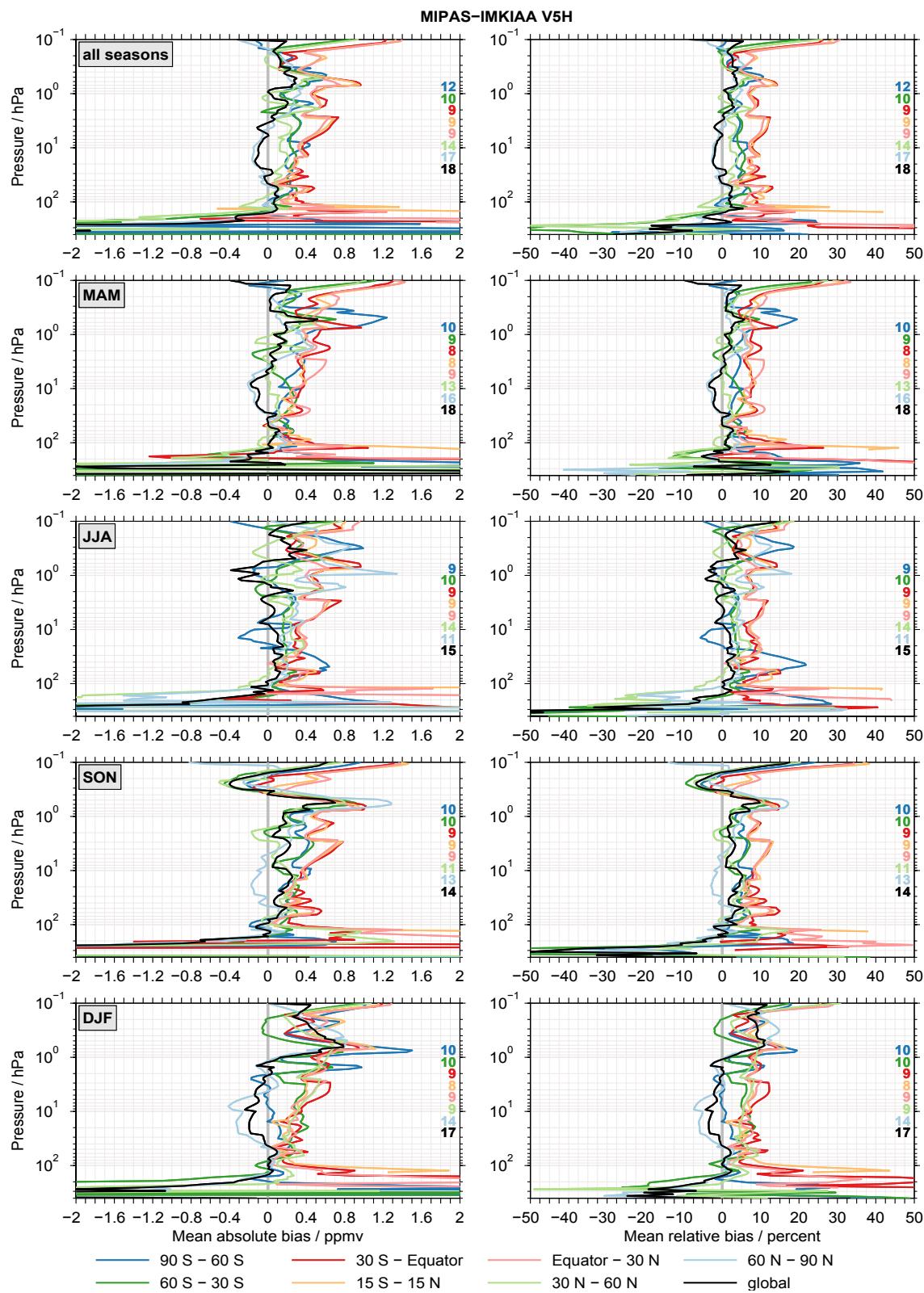
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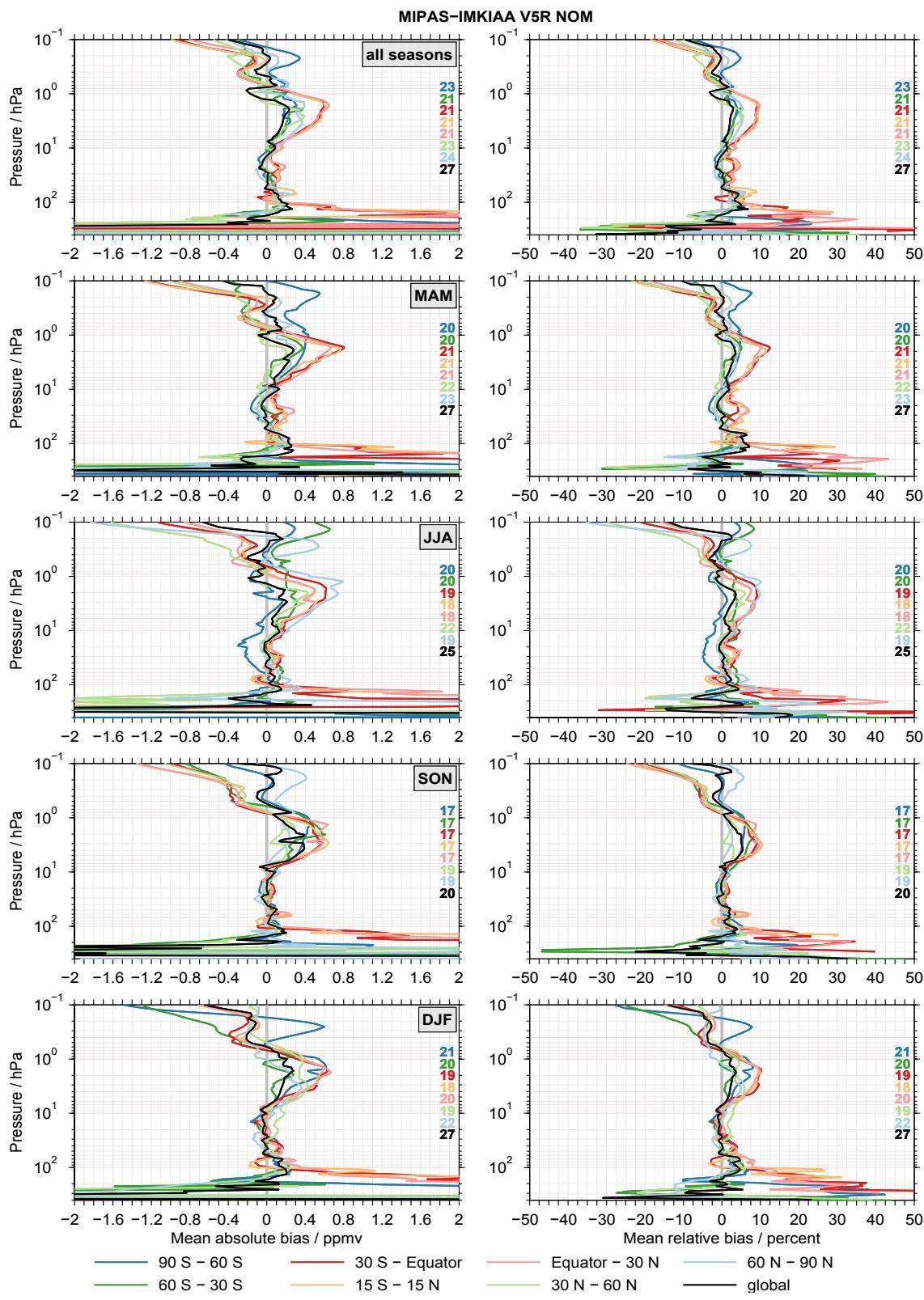
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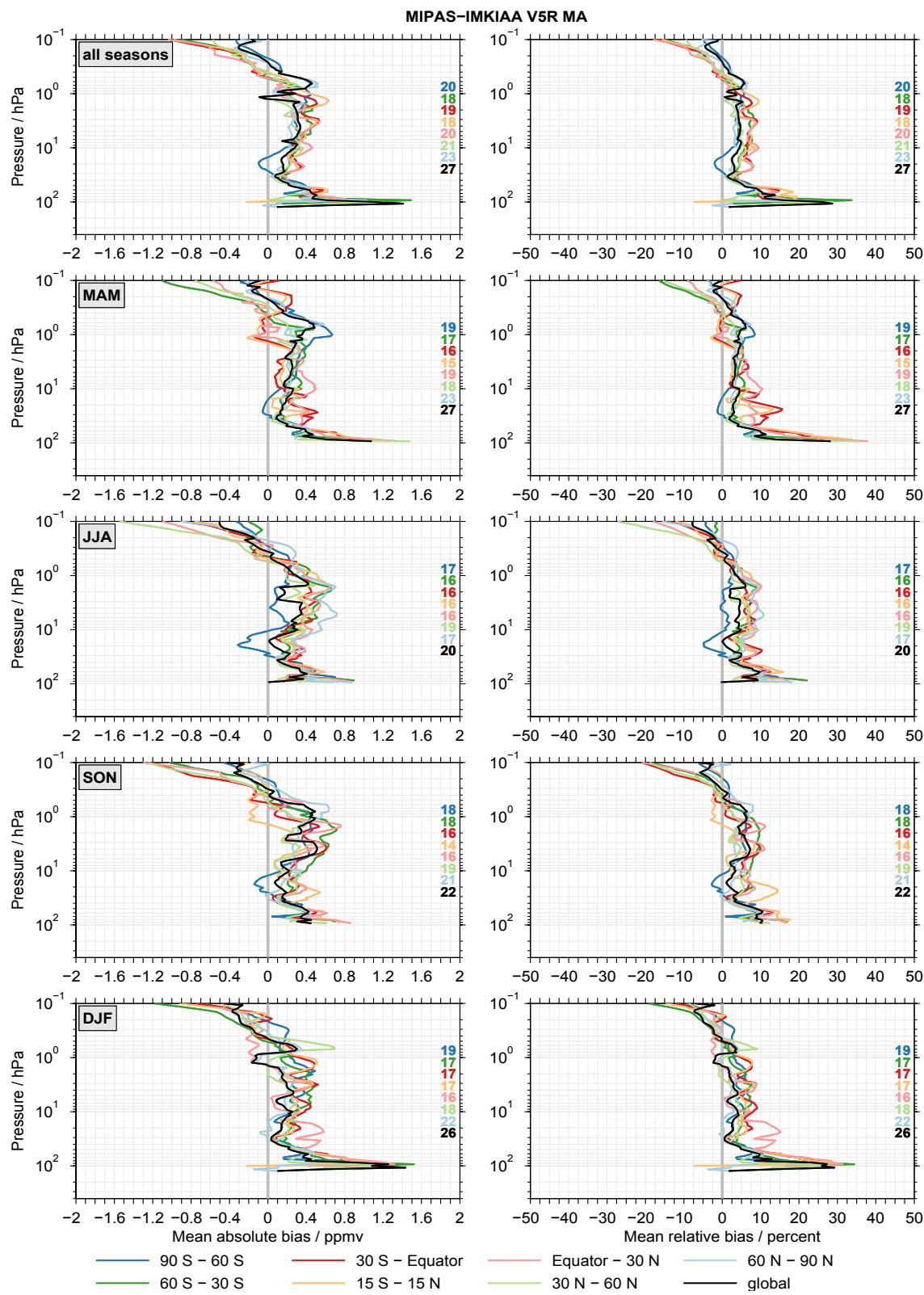
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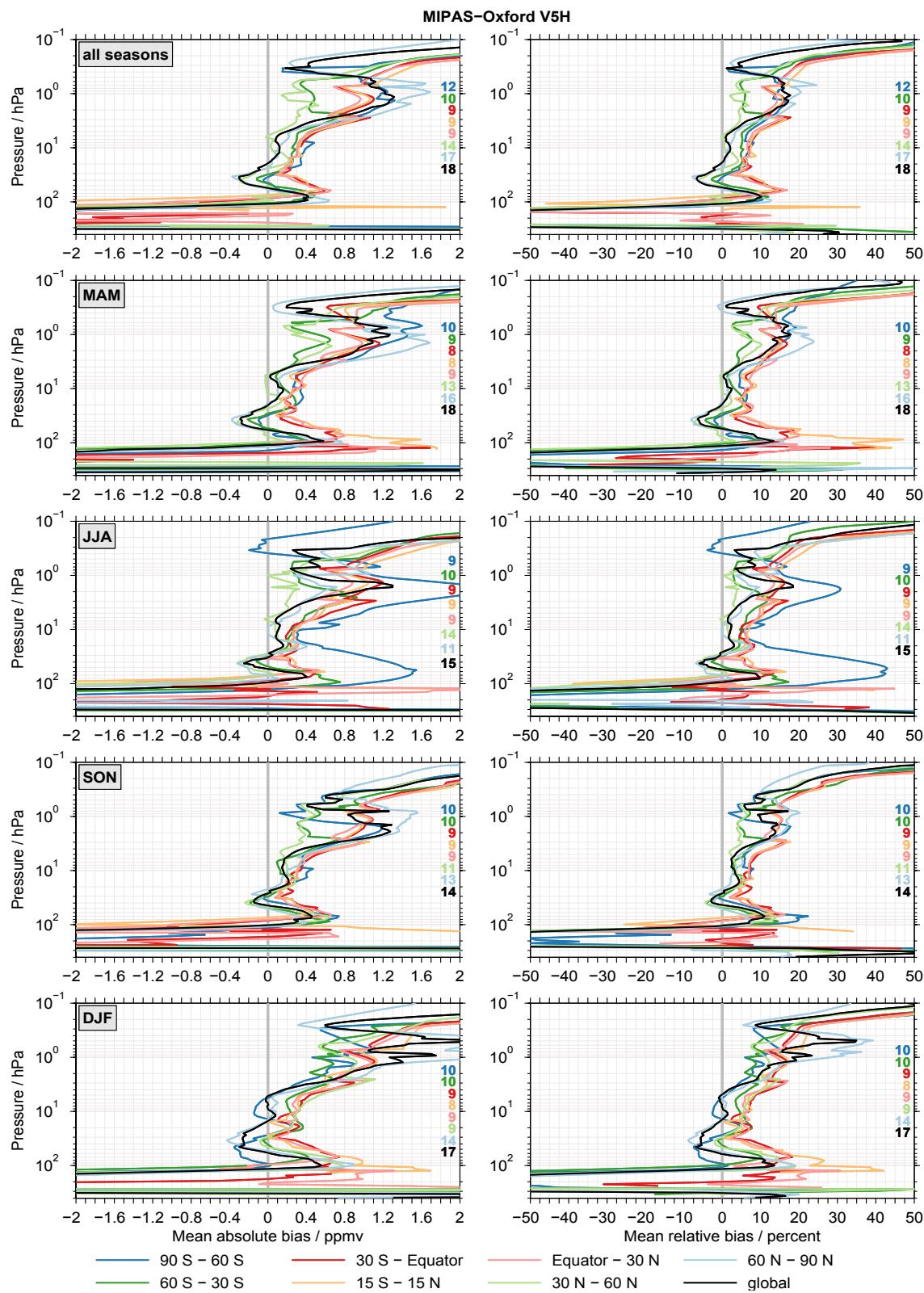


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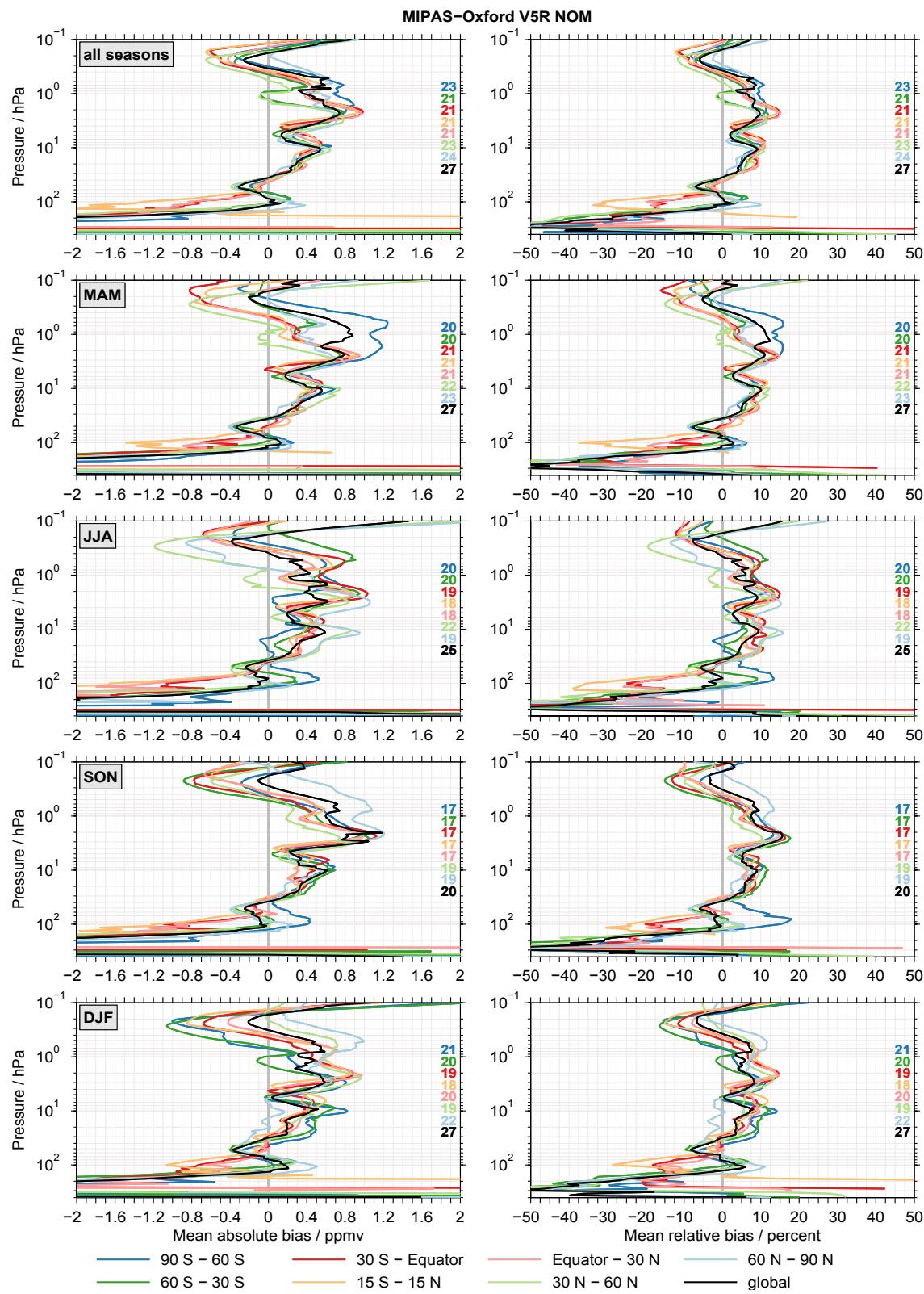


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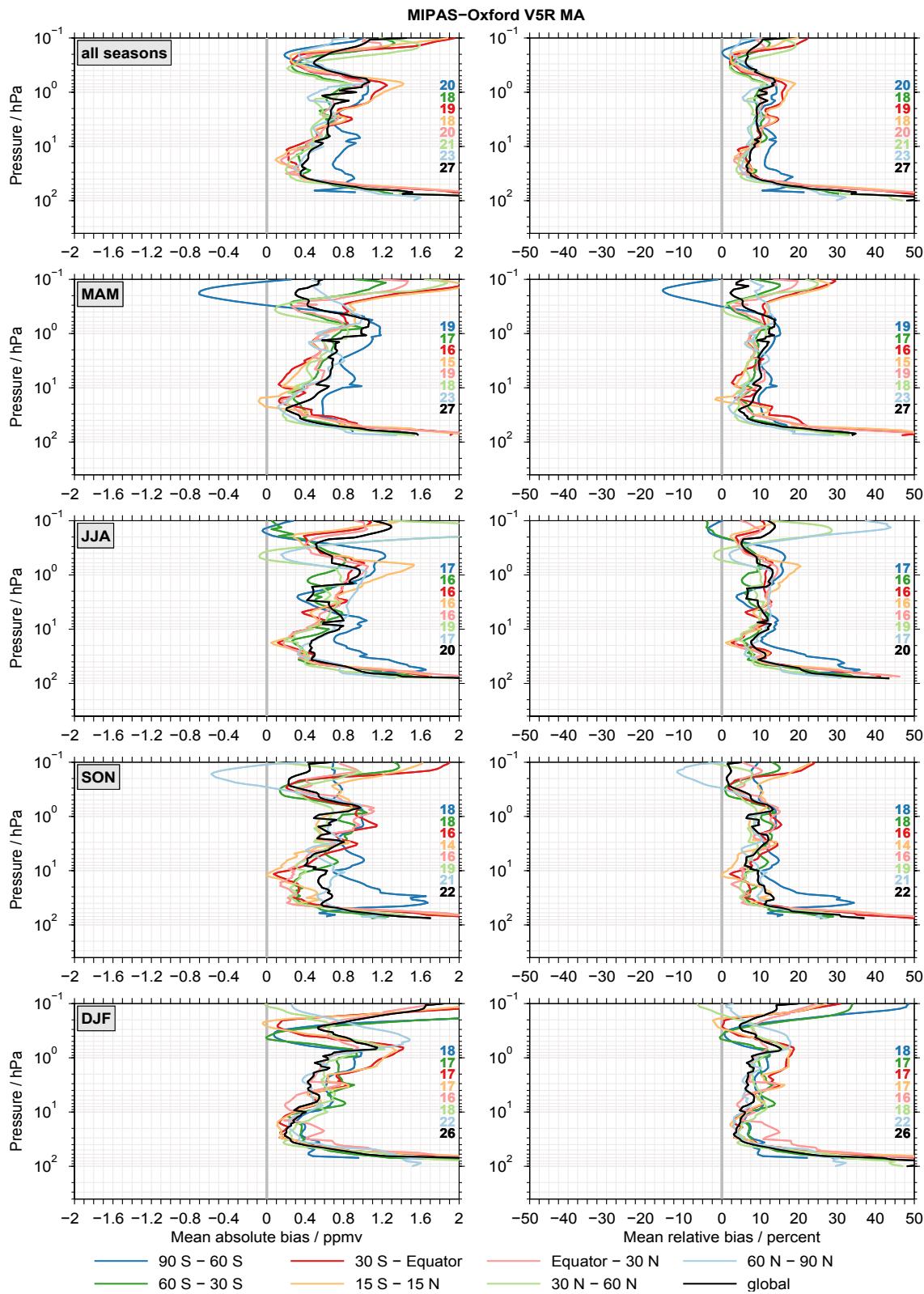
bias summary for MIPAS-Oxford V5H (18 of 33)



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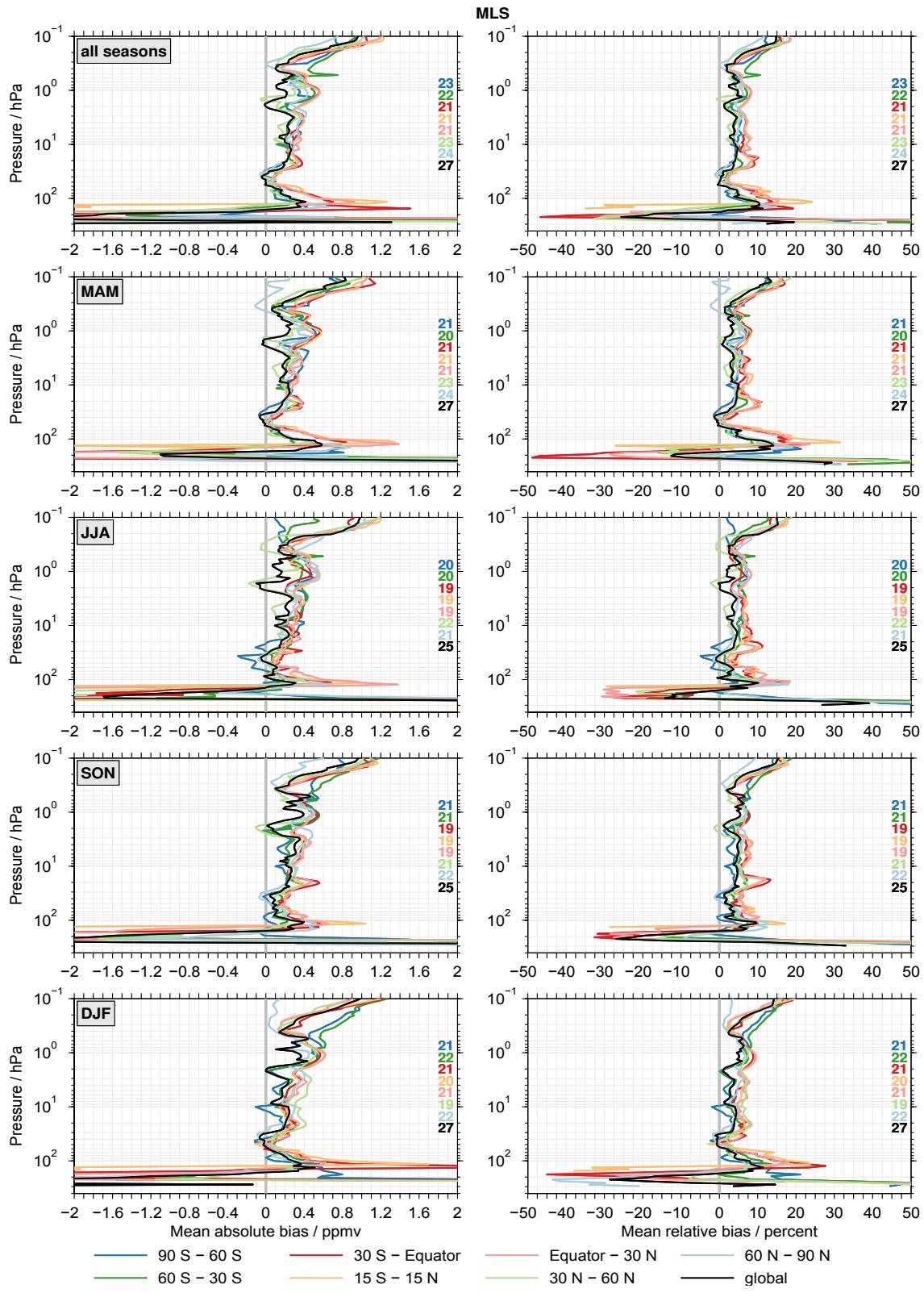


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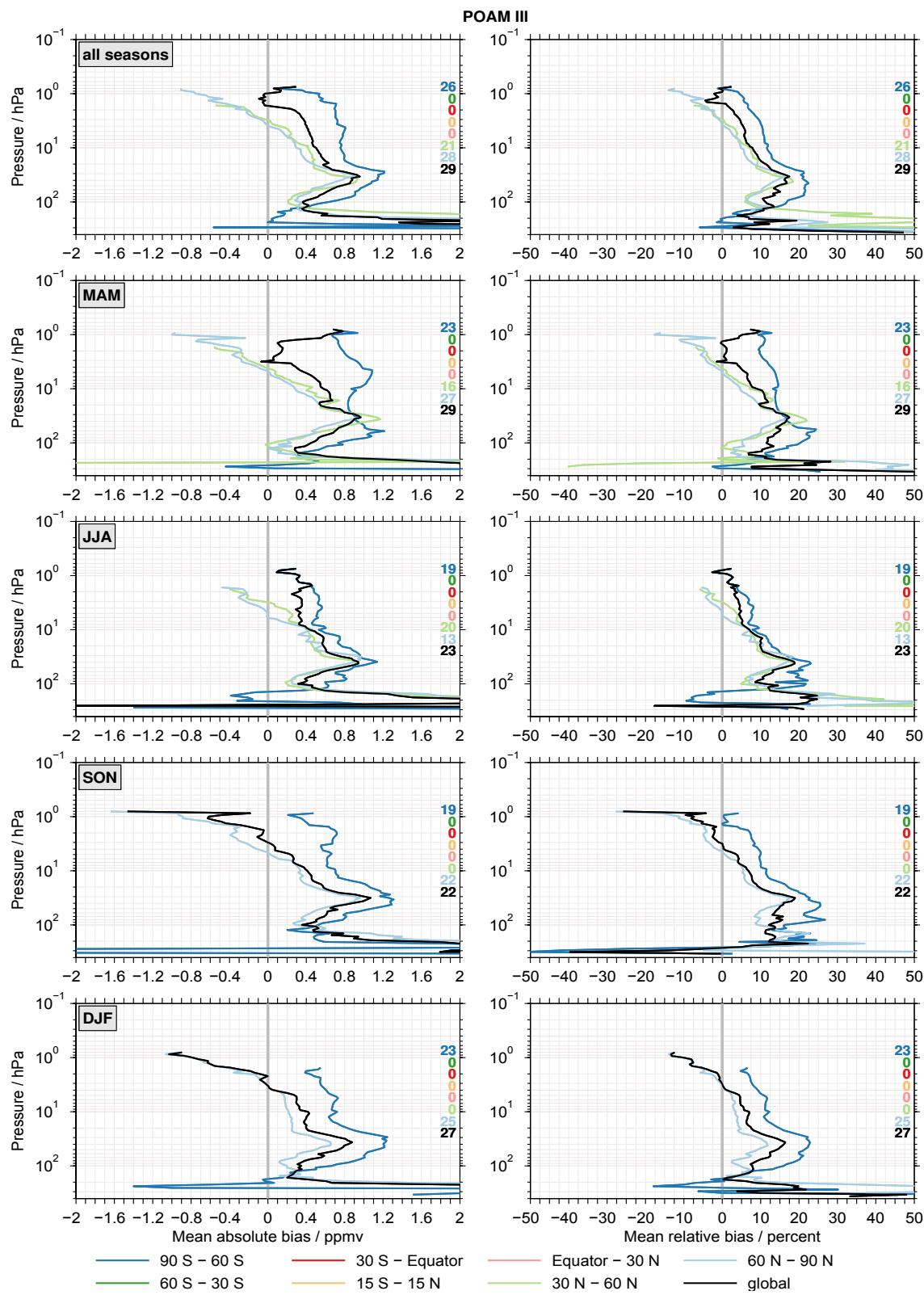


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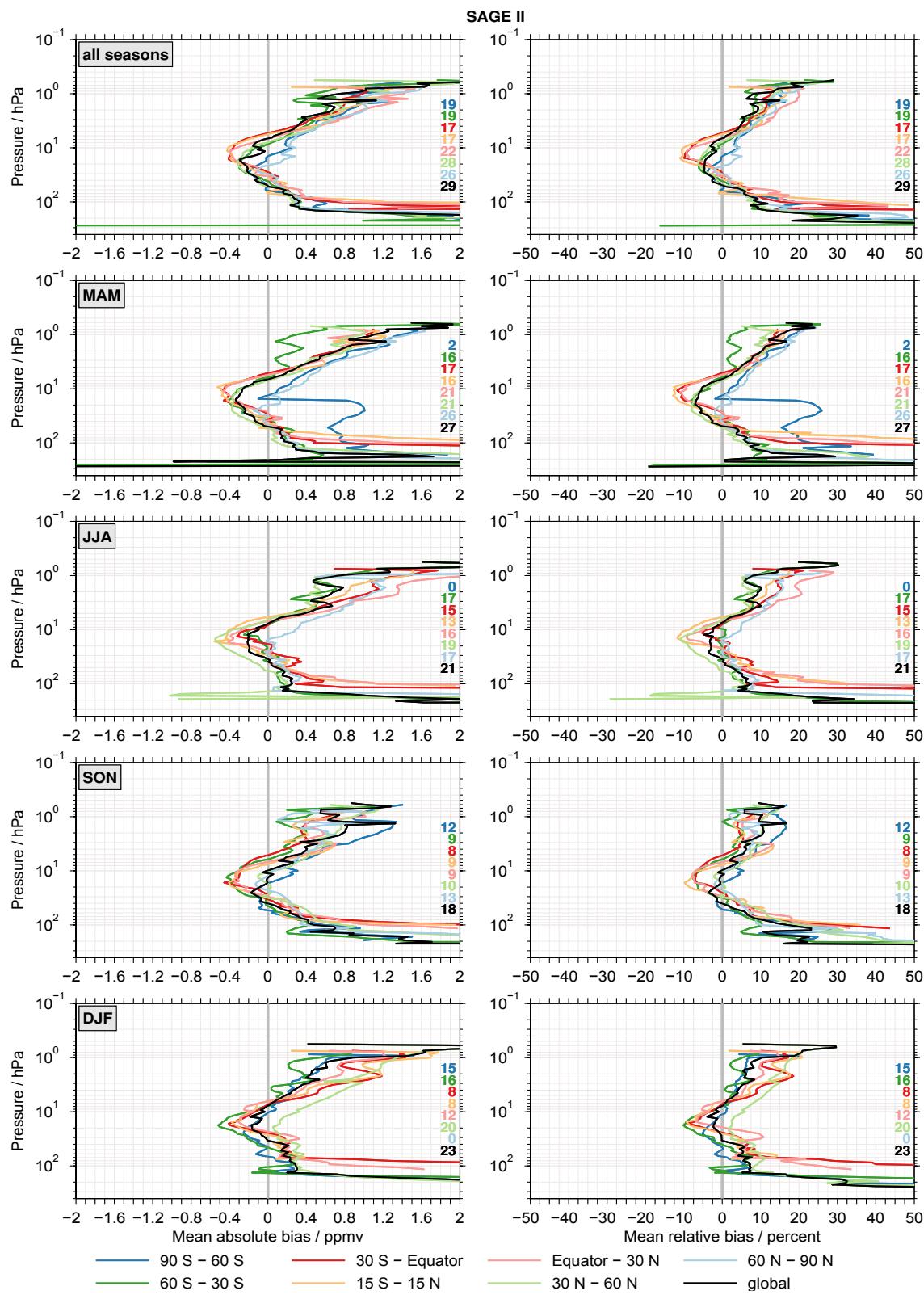
bias summary for MLS (21 of 33)



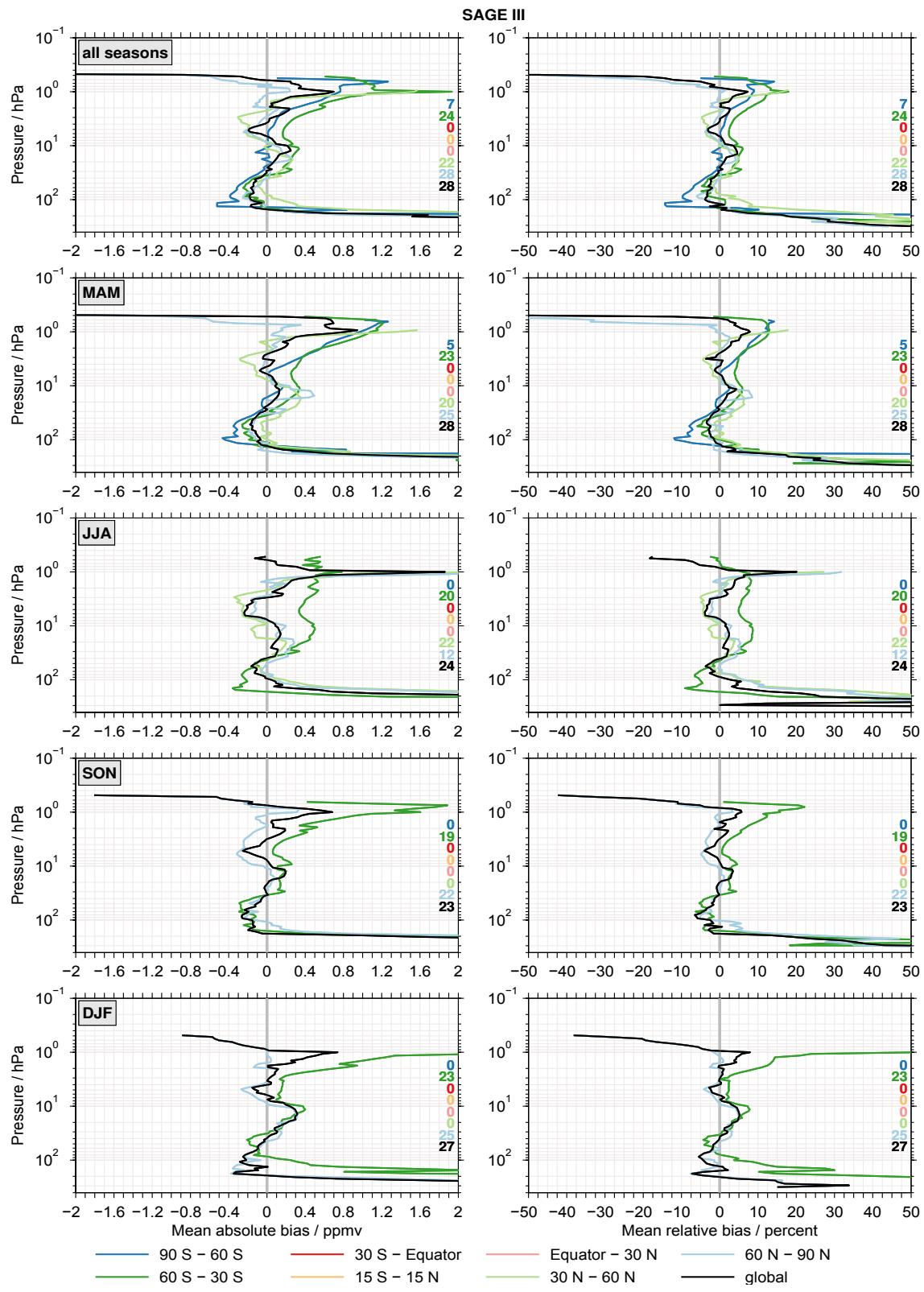
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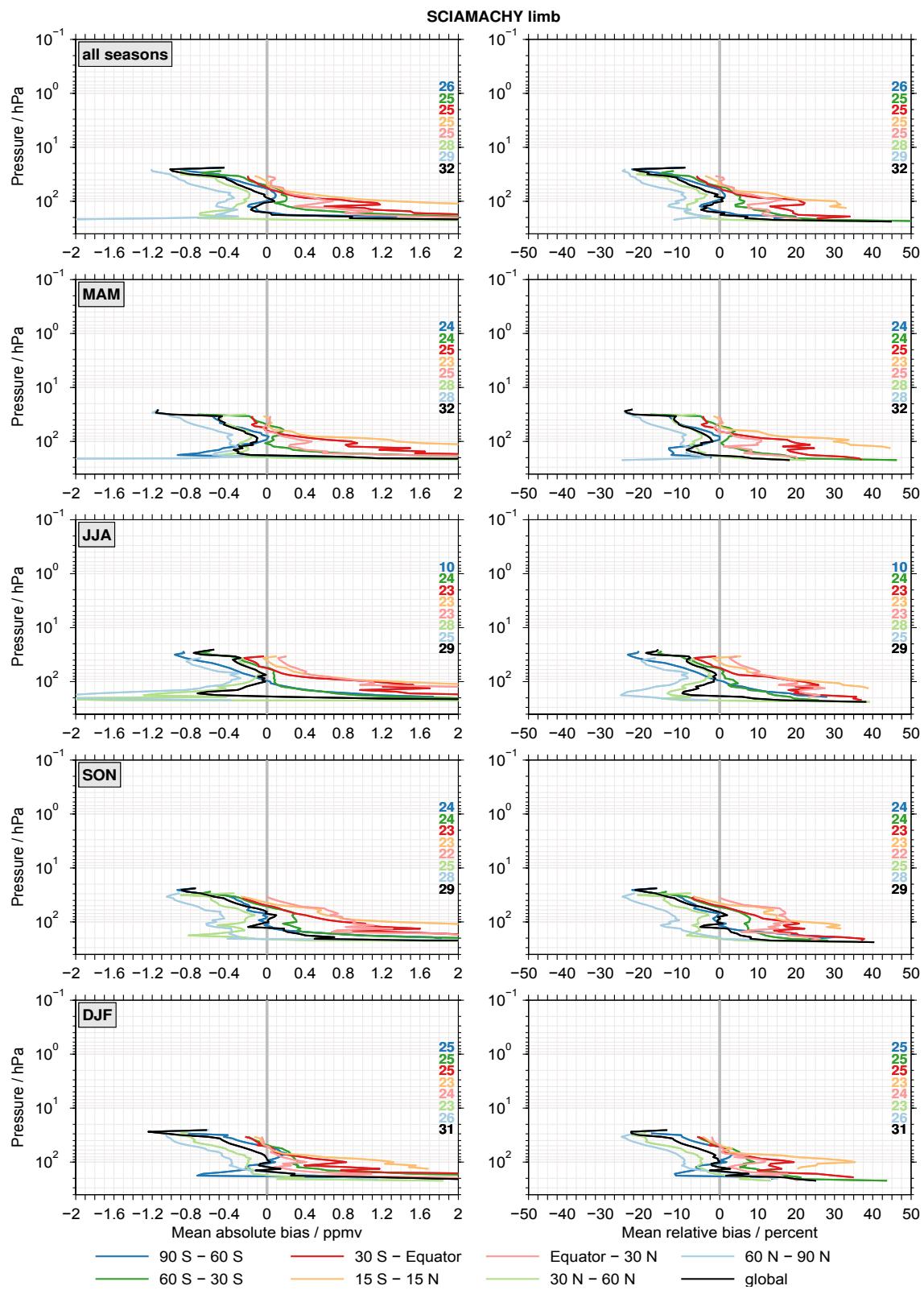
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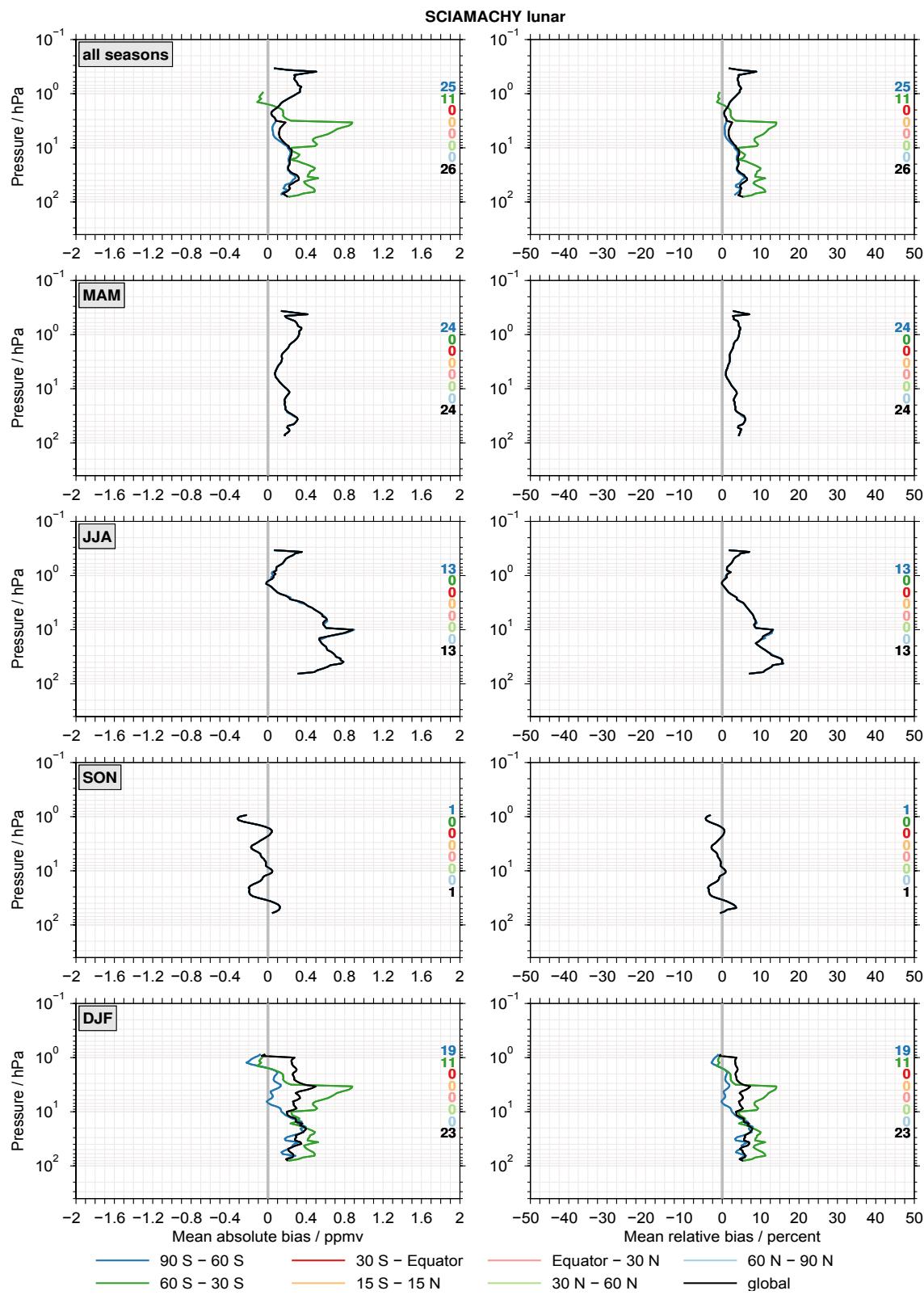


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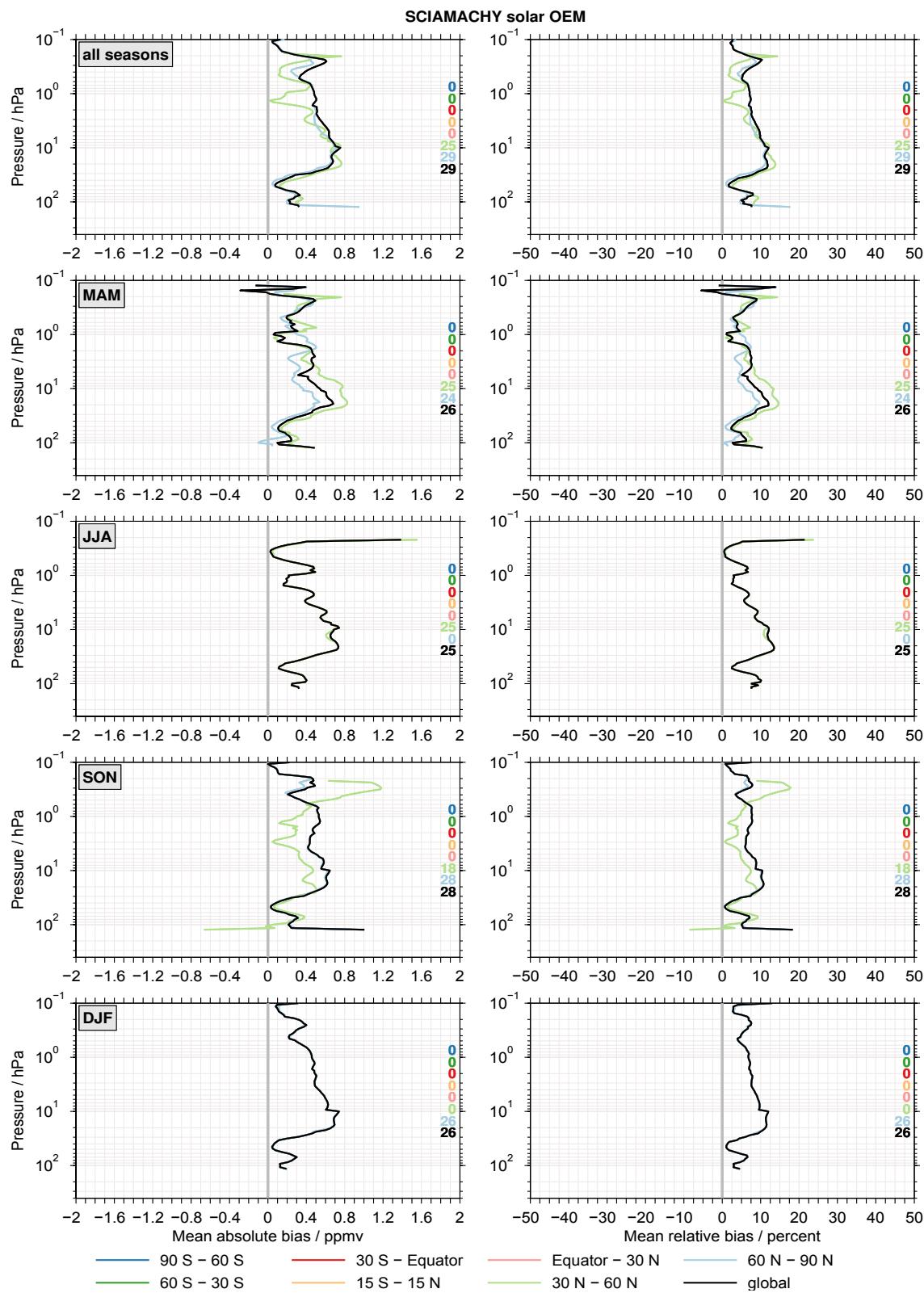


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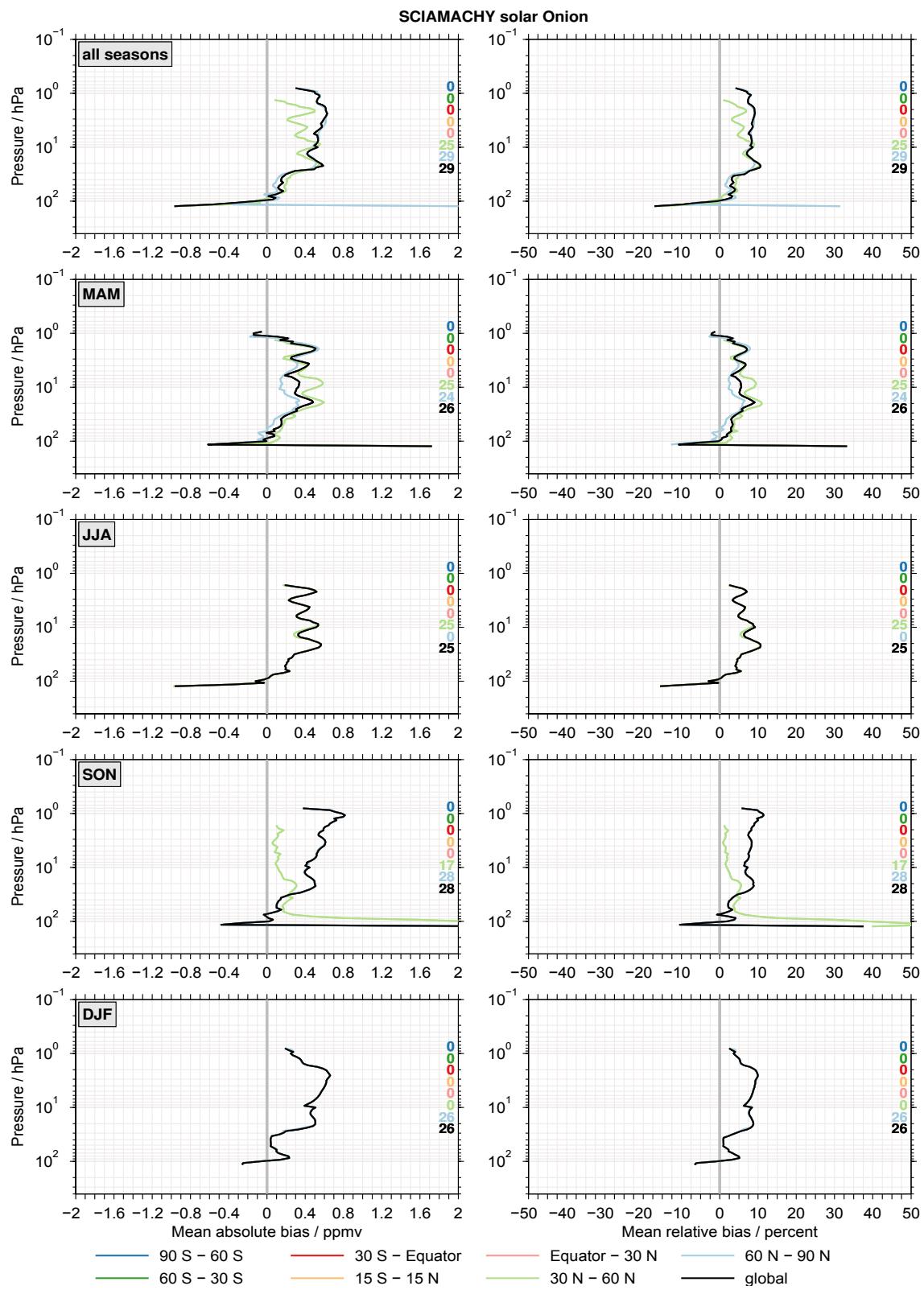
bias summary for SCIAMACHY lunar (26 of 33)



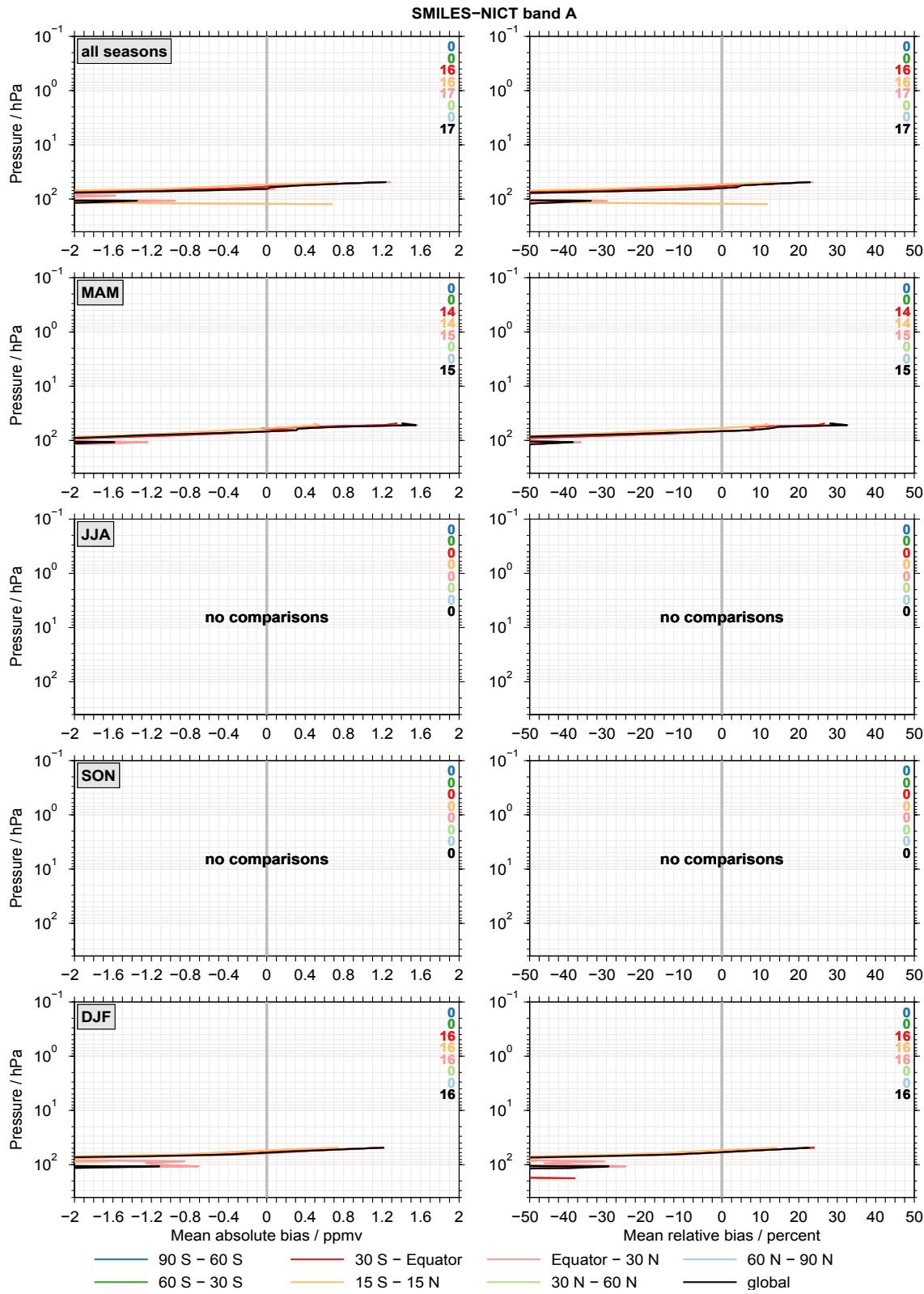
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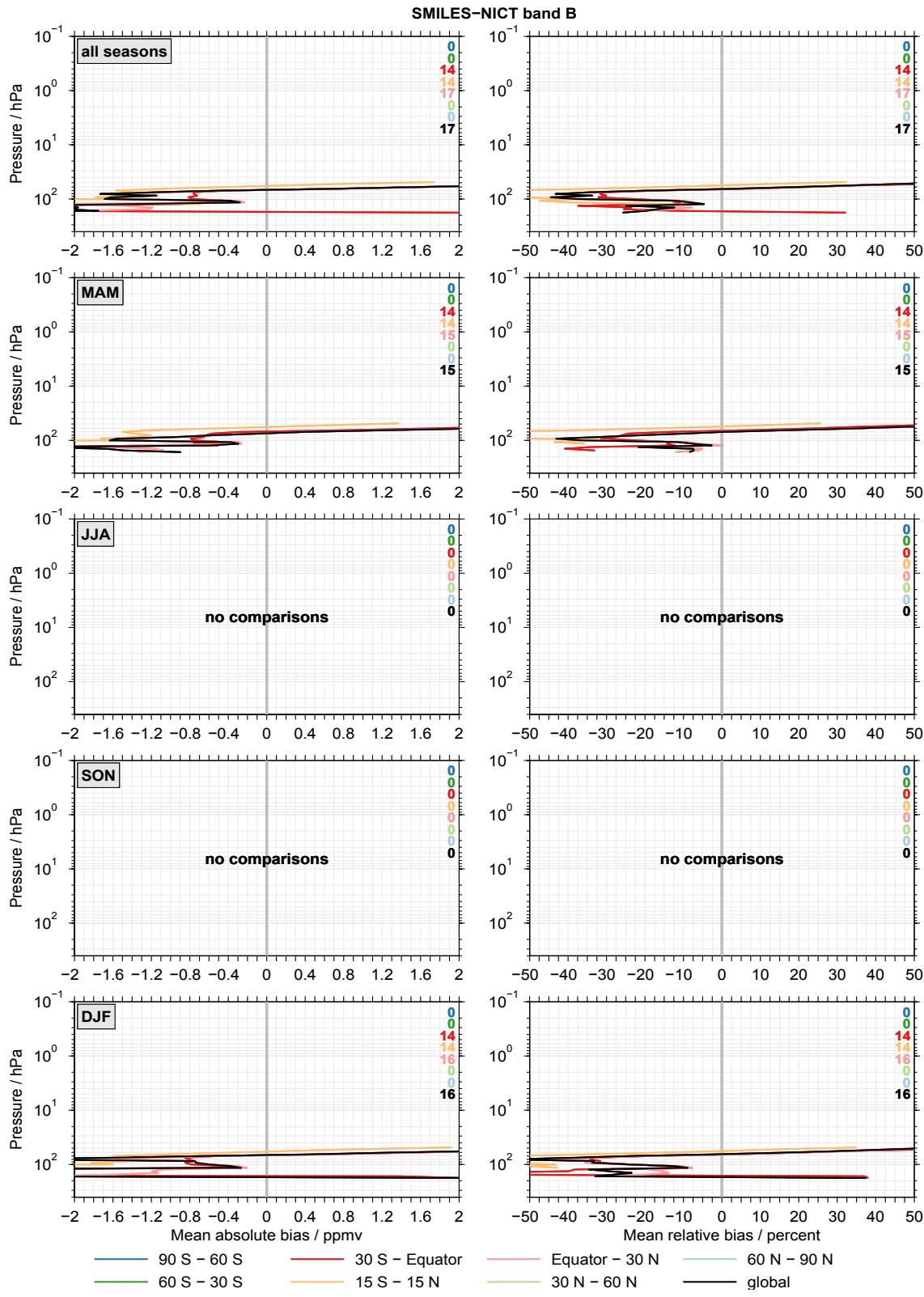


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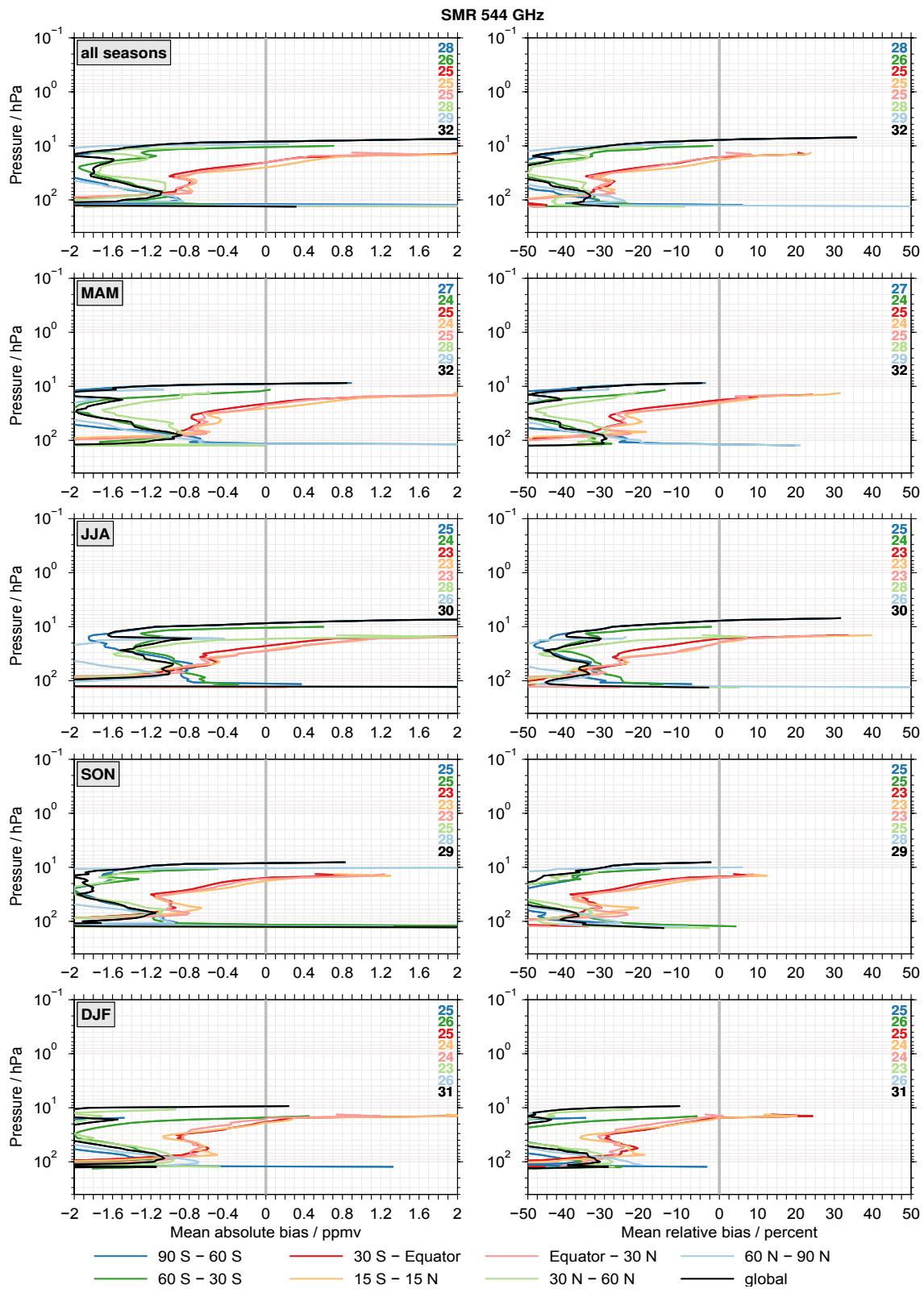
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bias summary for SMILES-NICT band B (30 of 33)



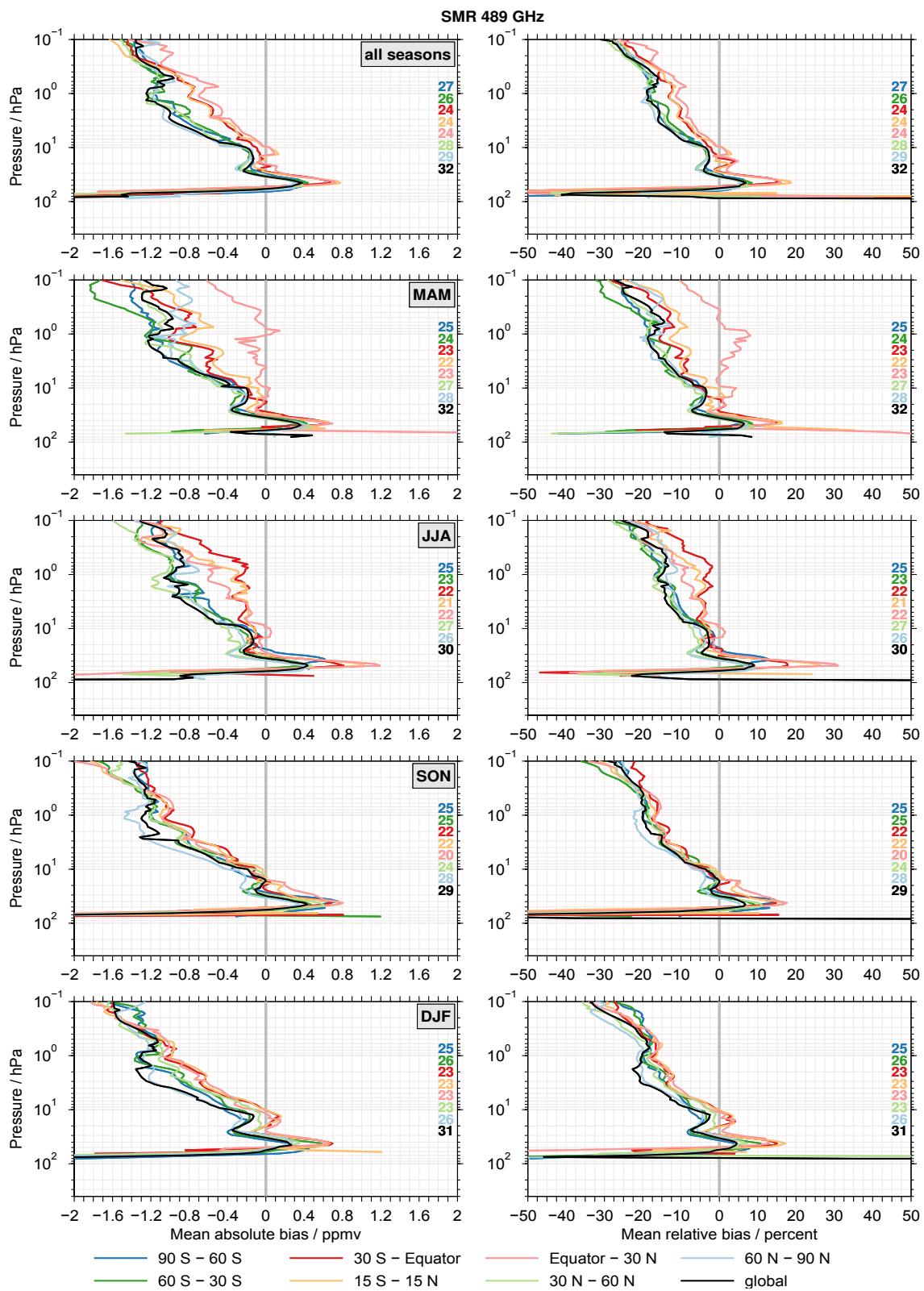
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bias summary for SMR 544 GHz (31 of 33)



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bias summary for SMR 489 GHz (32 of 33)



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bias summary for SOFIE (33 of 33)

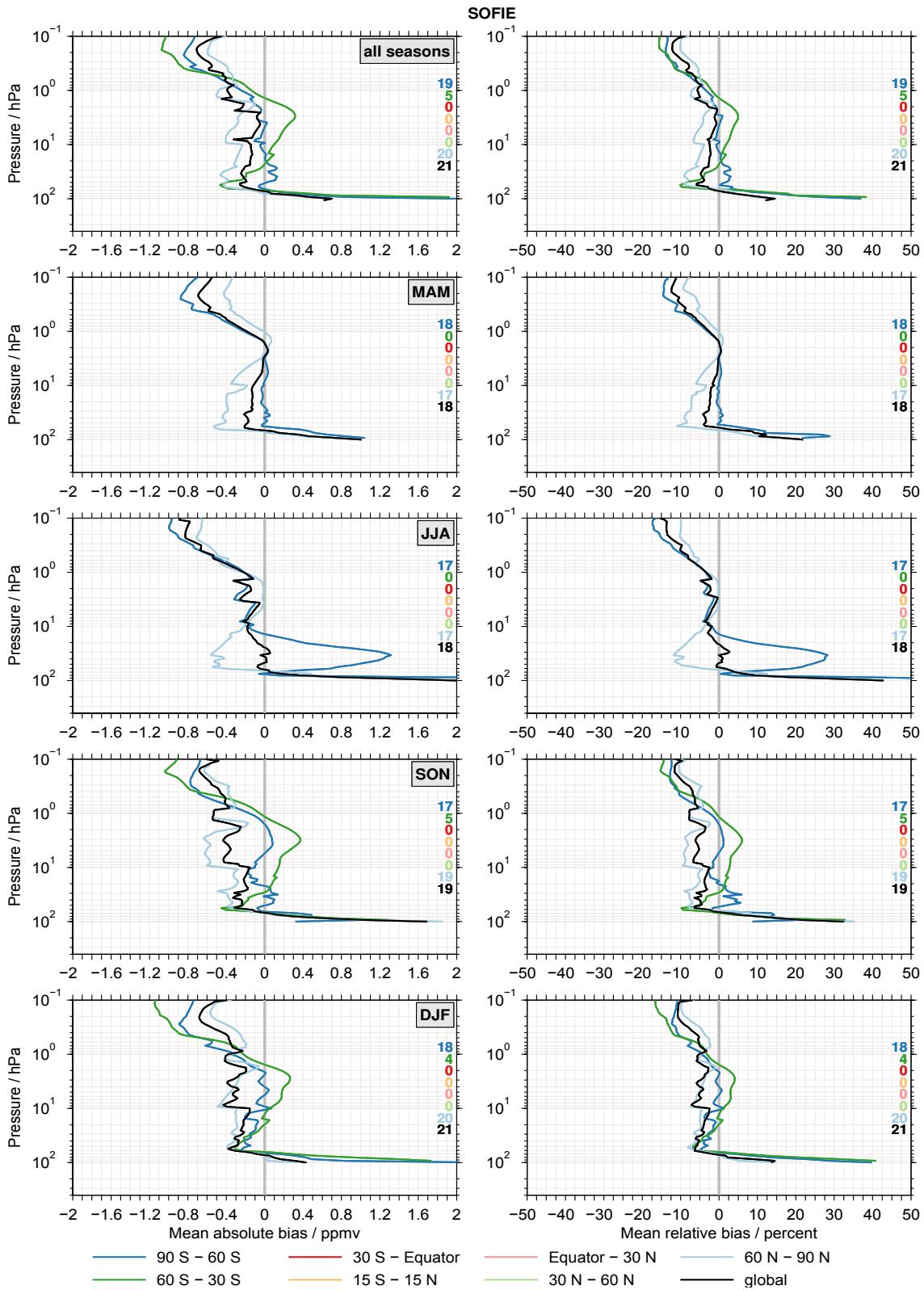


Figure S9: Summary of the bias results for the individual data sets. The left column shows the results for the absolute bias and the right column for the relative bias. The different rows consider the results for different seasons and the results for the different latitude bands are given by different colours. On the right of the individual panels the number of comparisons contributing to the summary is indicated.

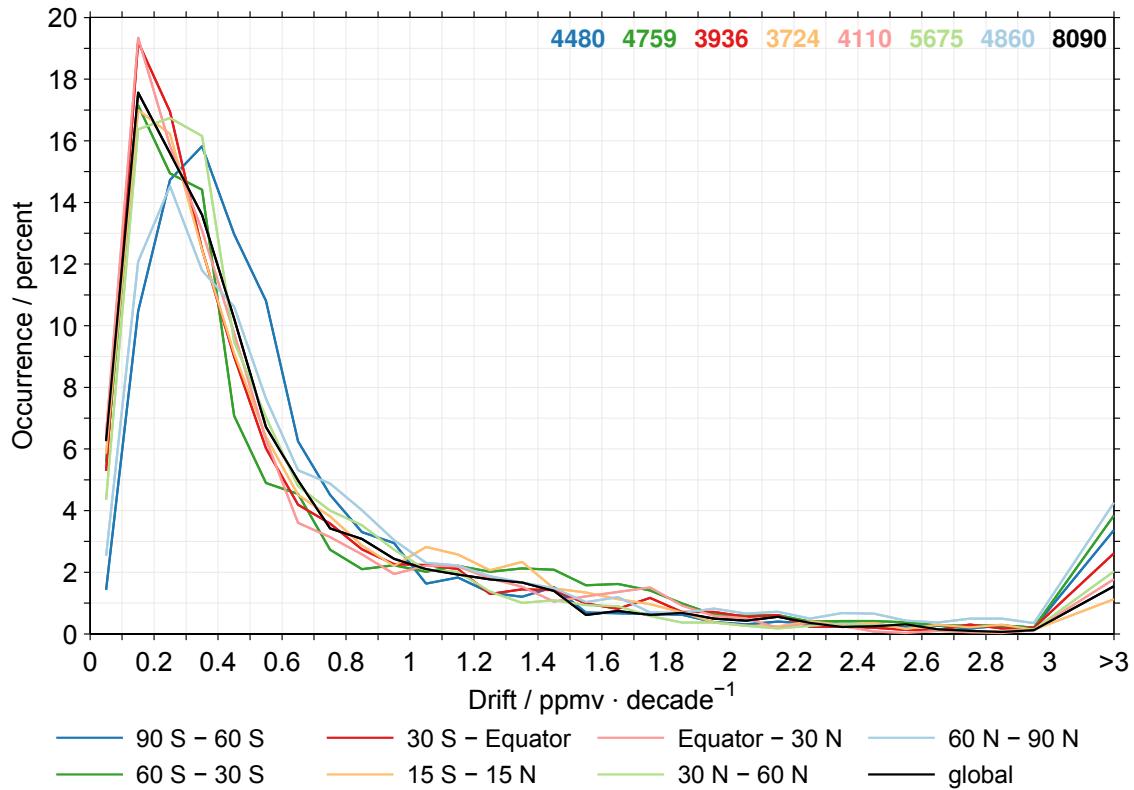
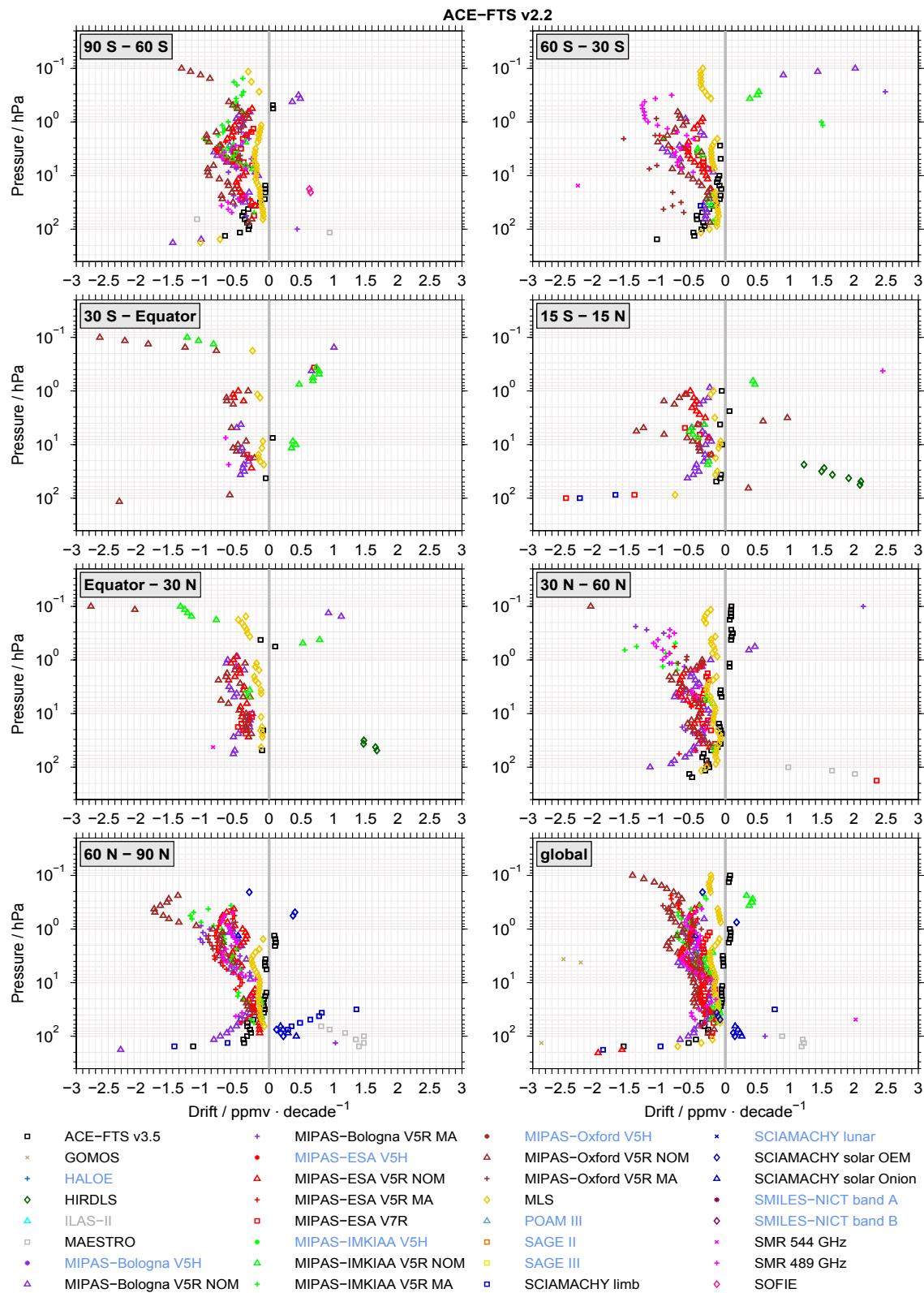
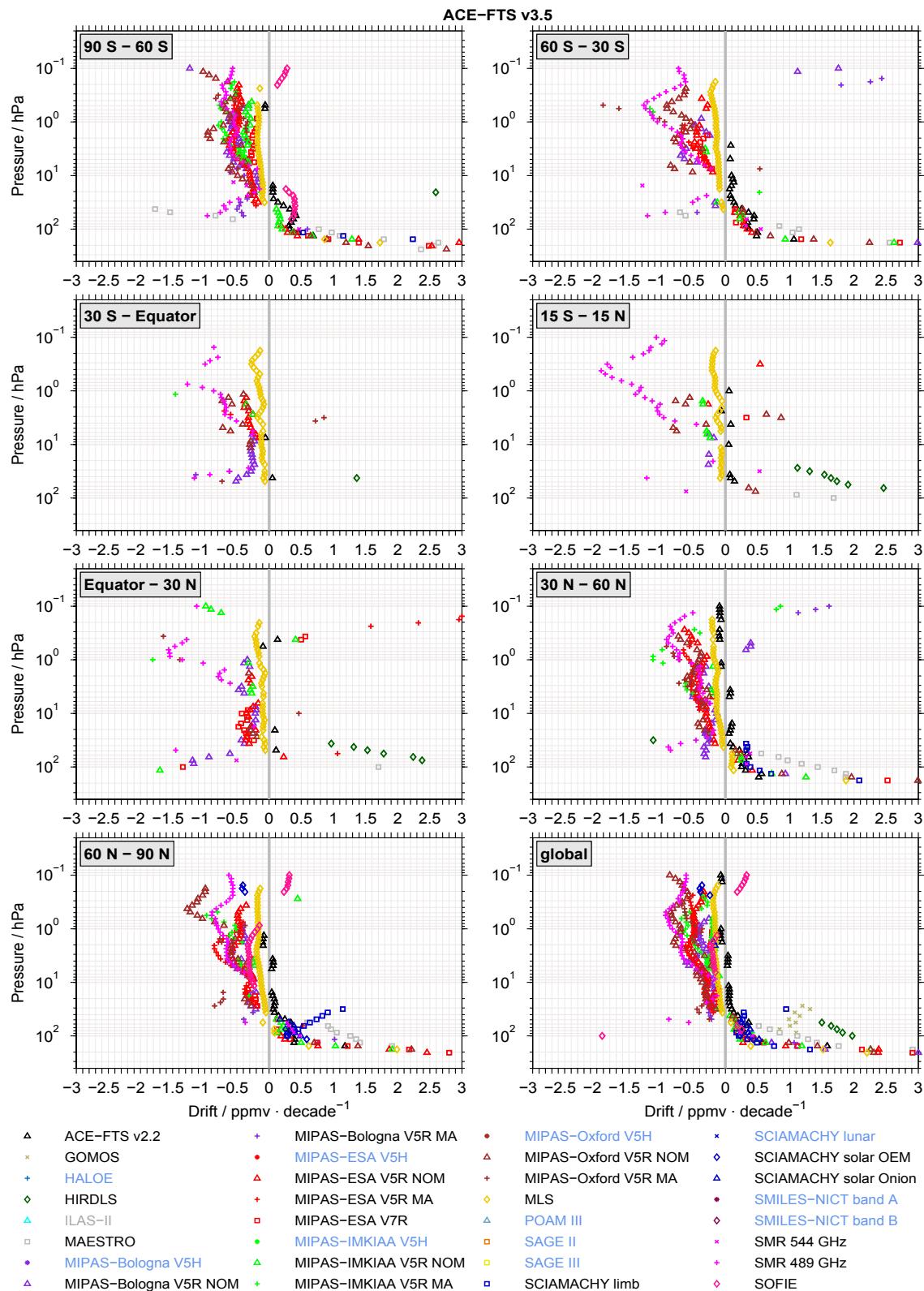


Figure S10: Drift histograms based on comparison at all altitudes and without any aggregation of the MIPAS results as Fig 12 in the main manuscript. For the calculation only positive and statistically significant drifts are taken into account. The results for the different latitude bands are given by the different colours. In the upper right corner the number of available data points is indicated.

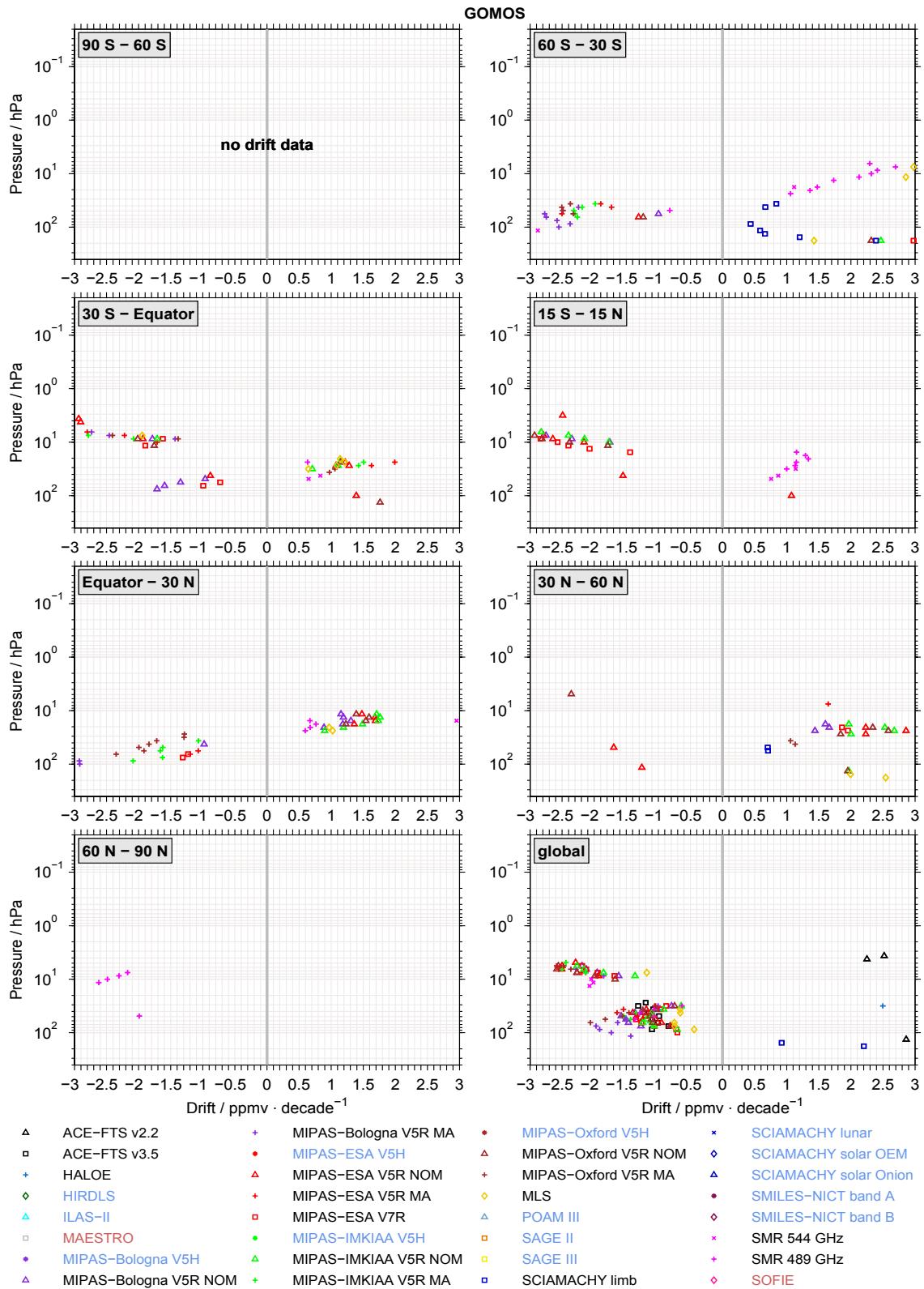


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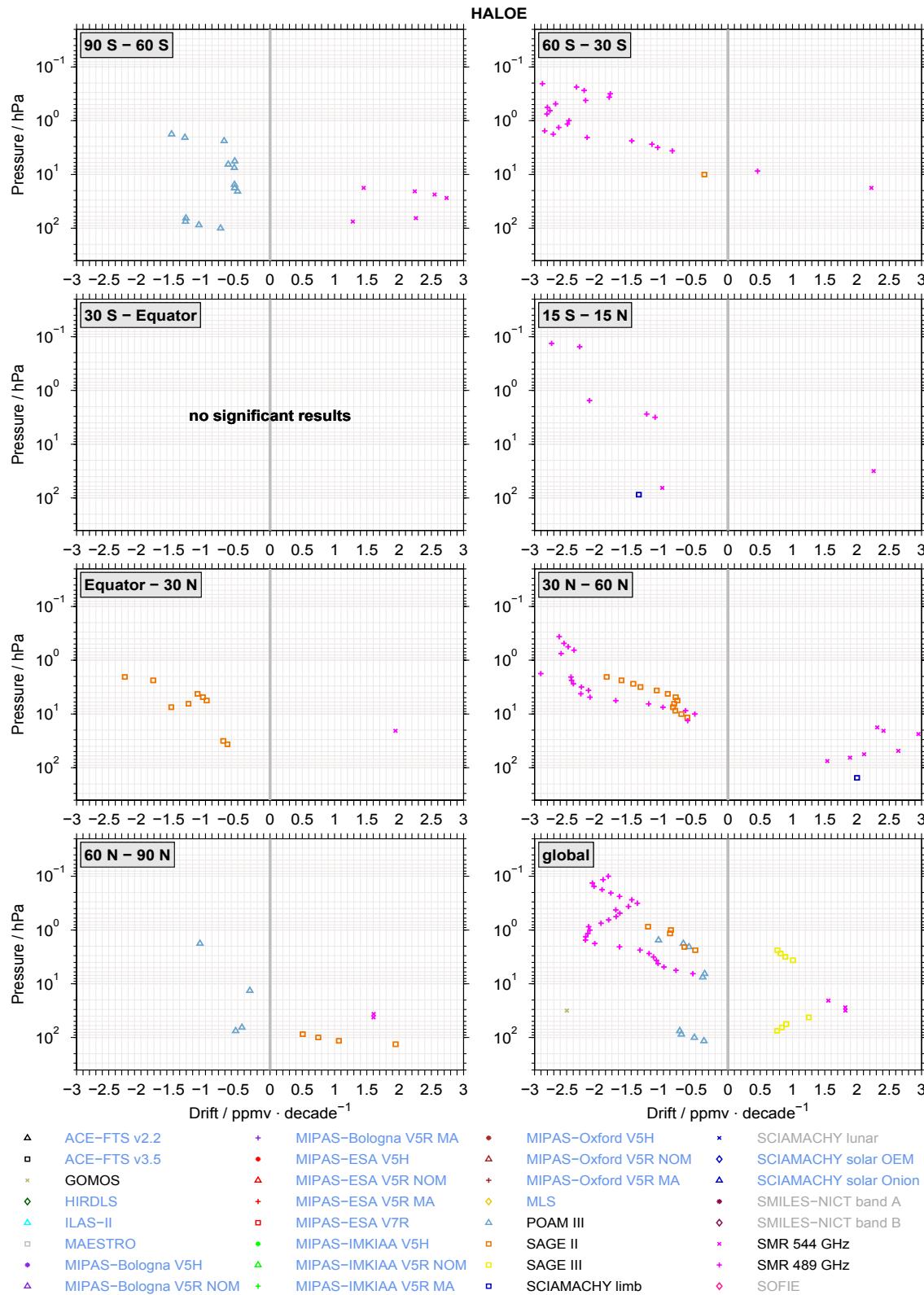
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drift summary for GOMOS (3 of 26)

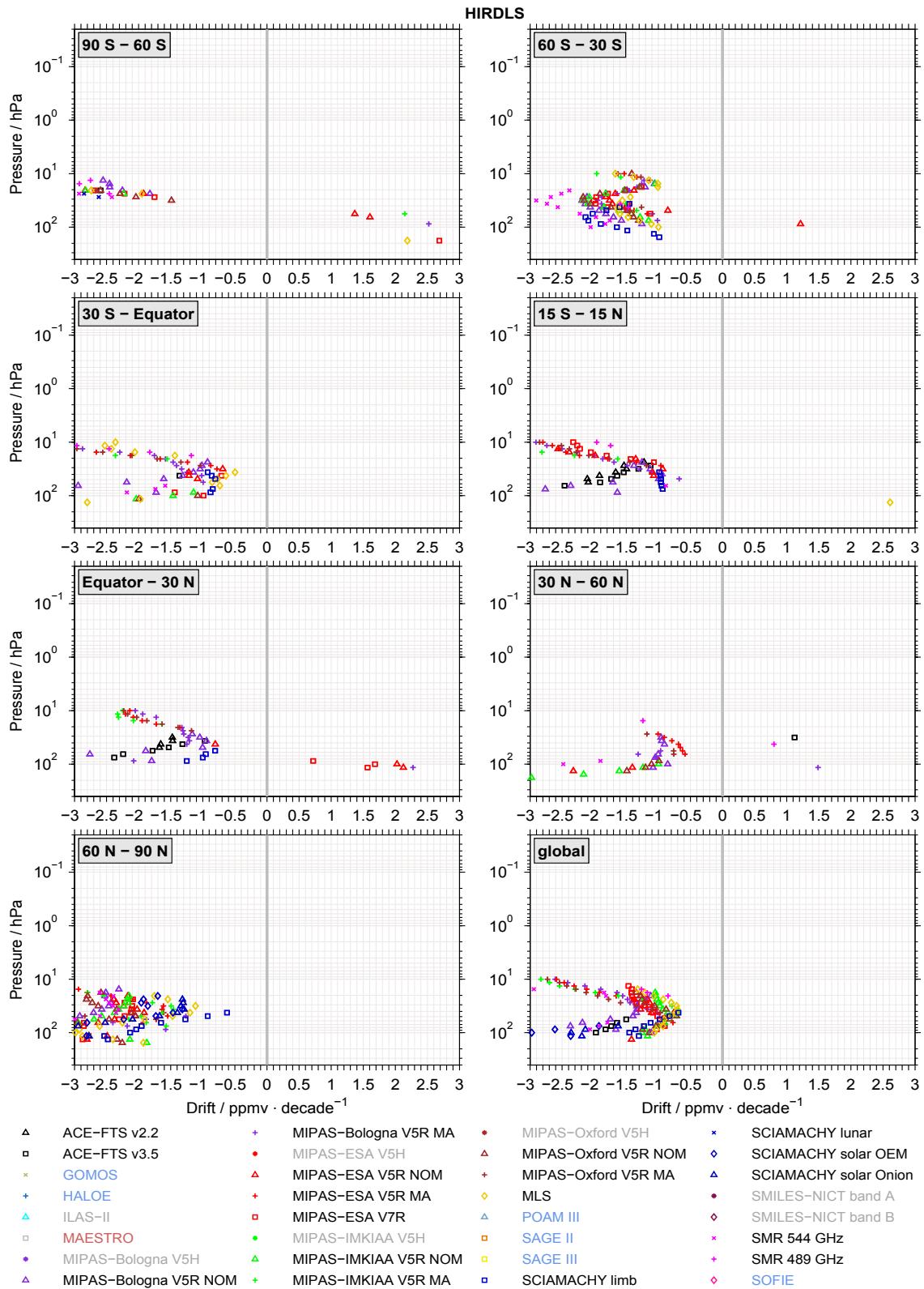


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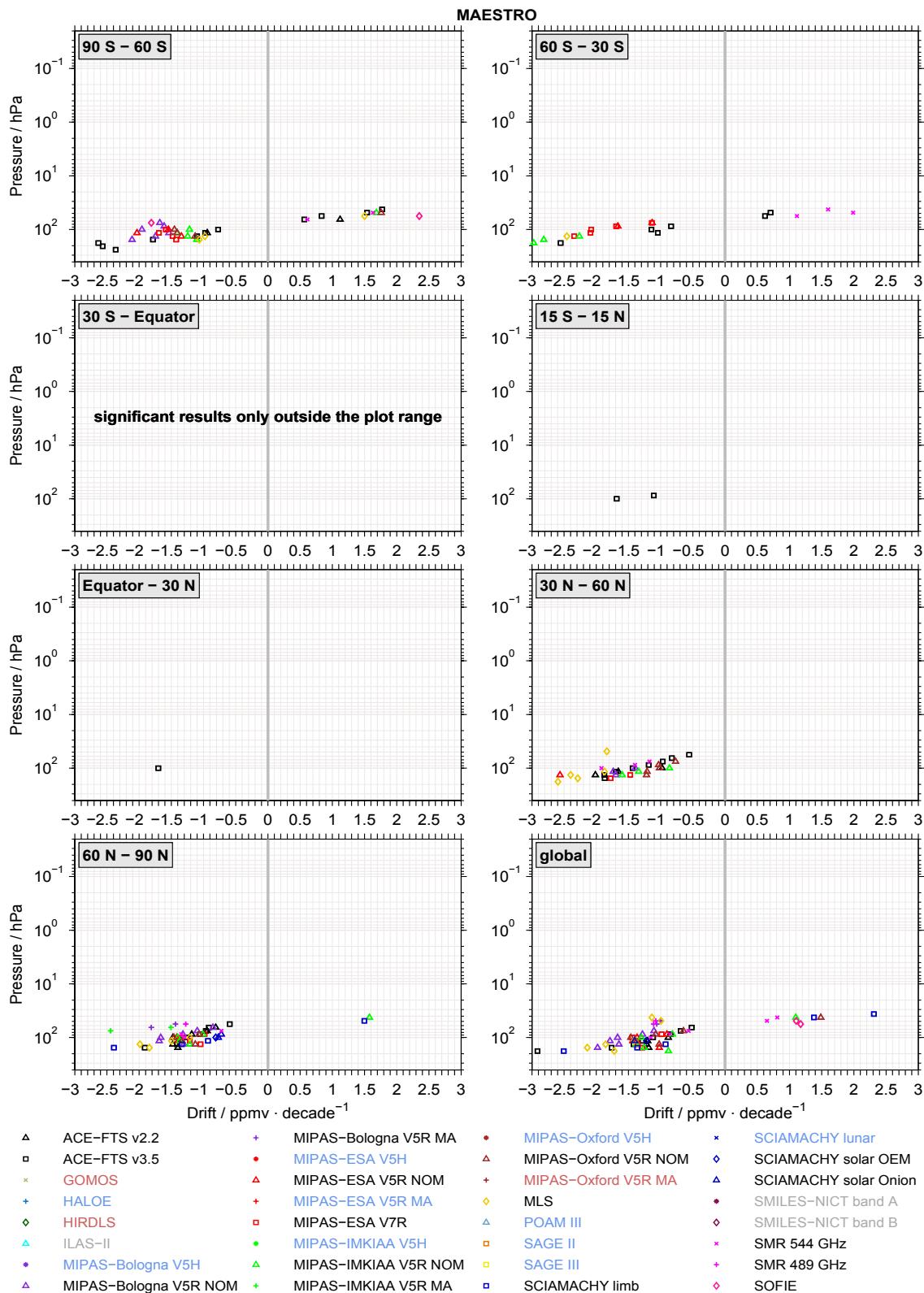
drift summary for HALOE (4 of 26)



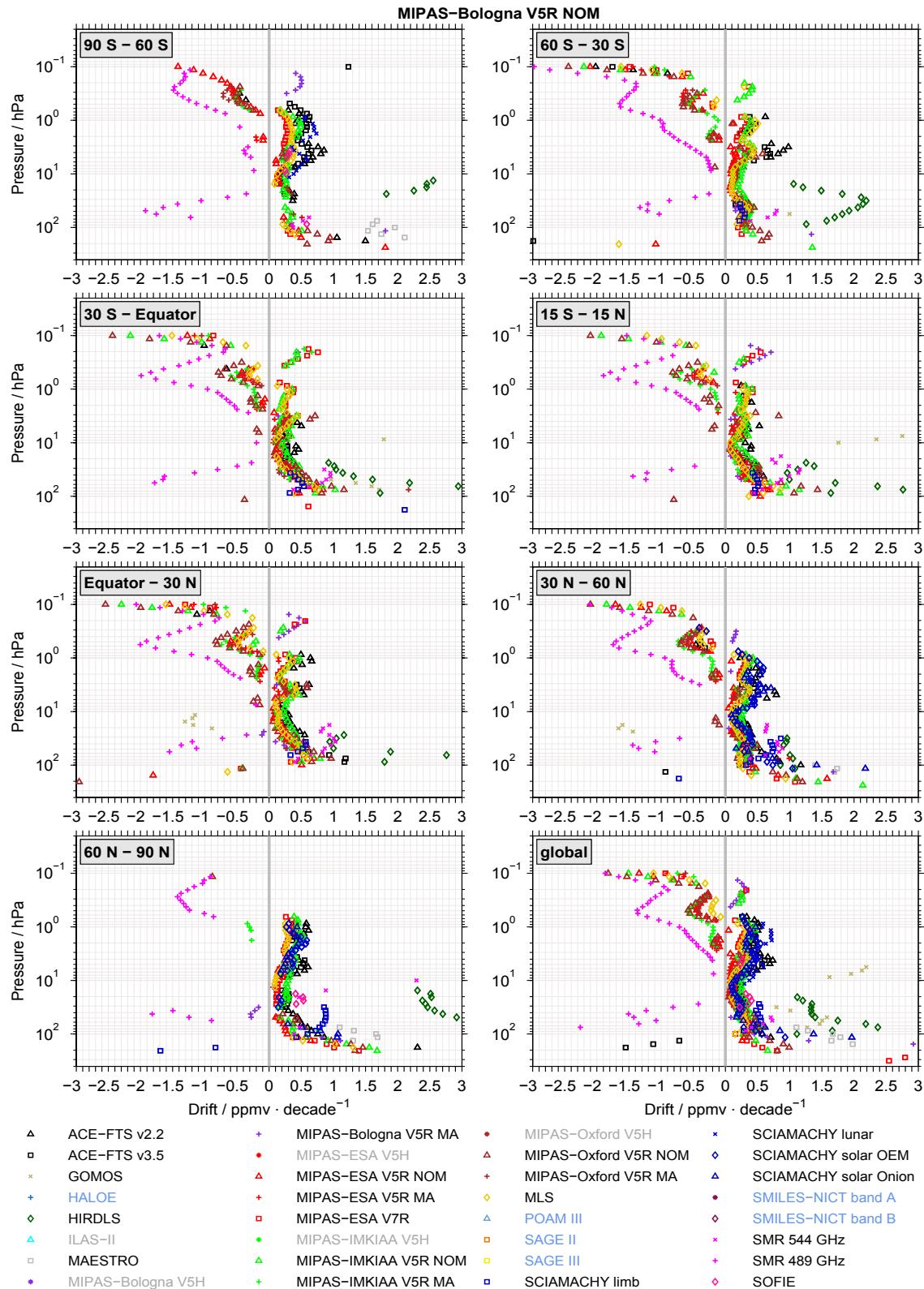
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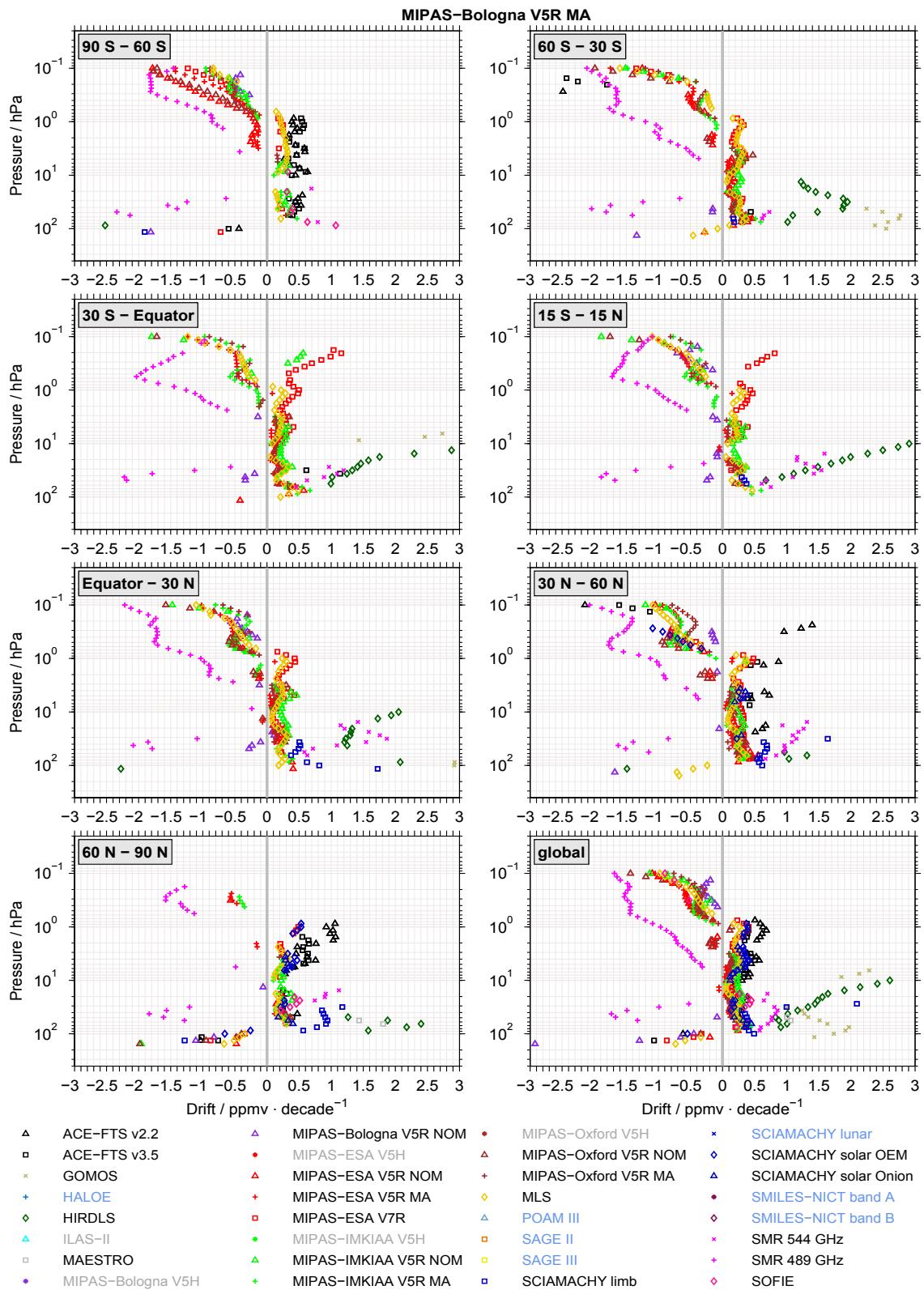
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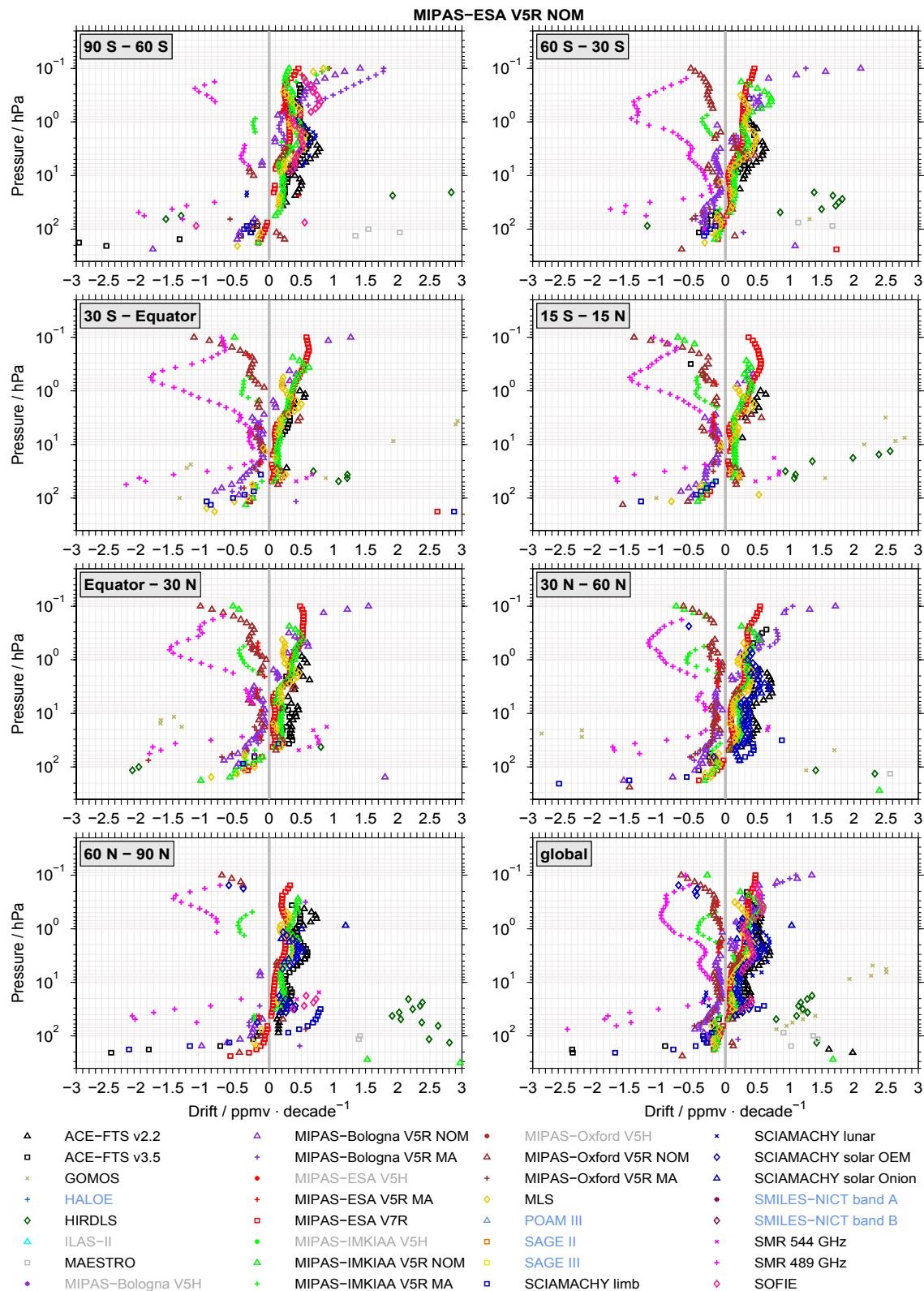
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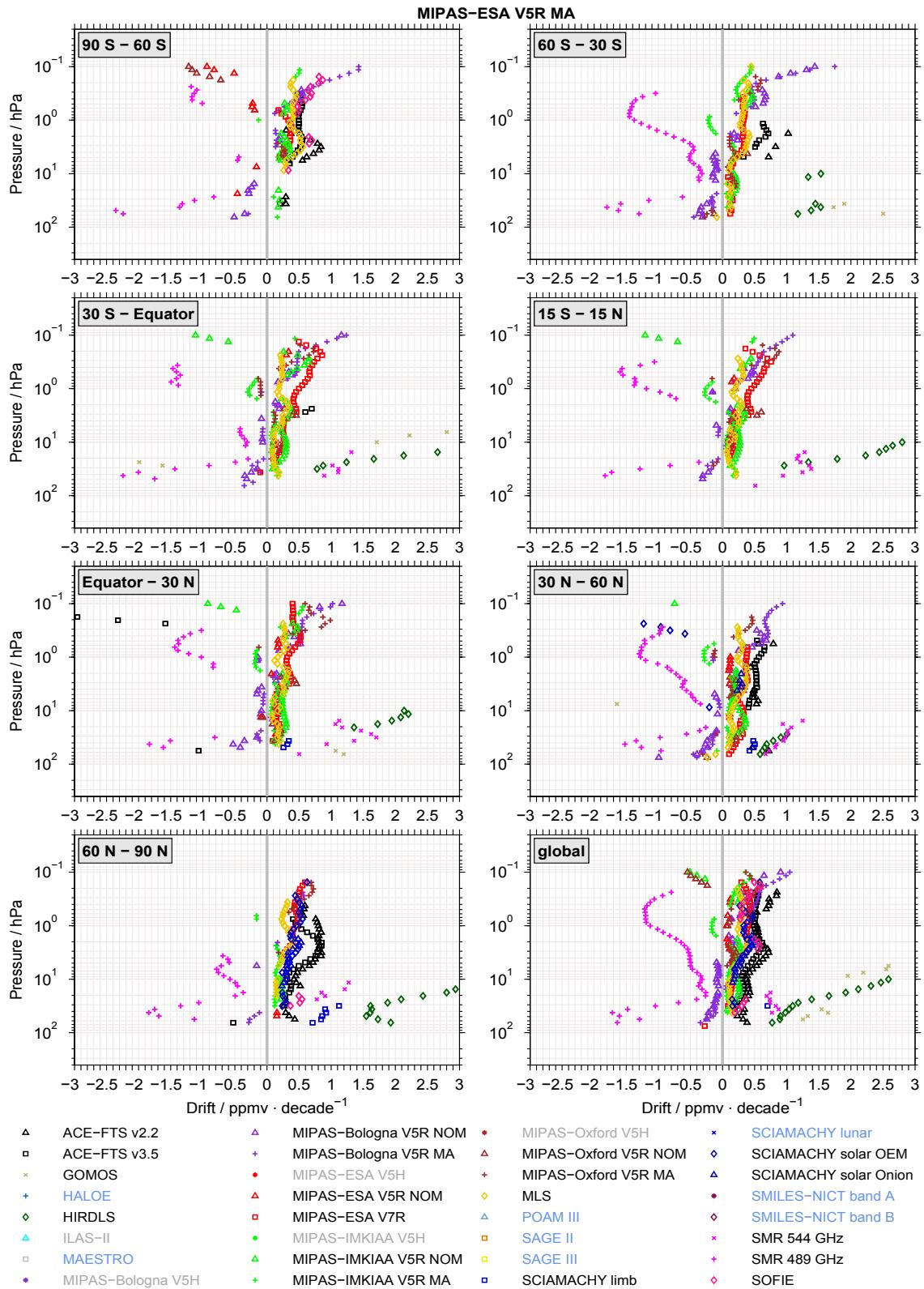
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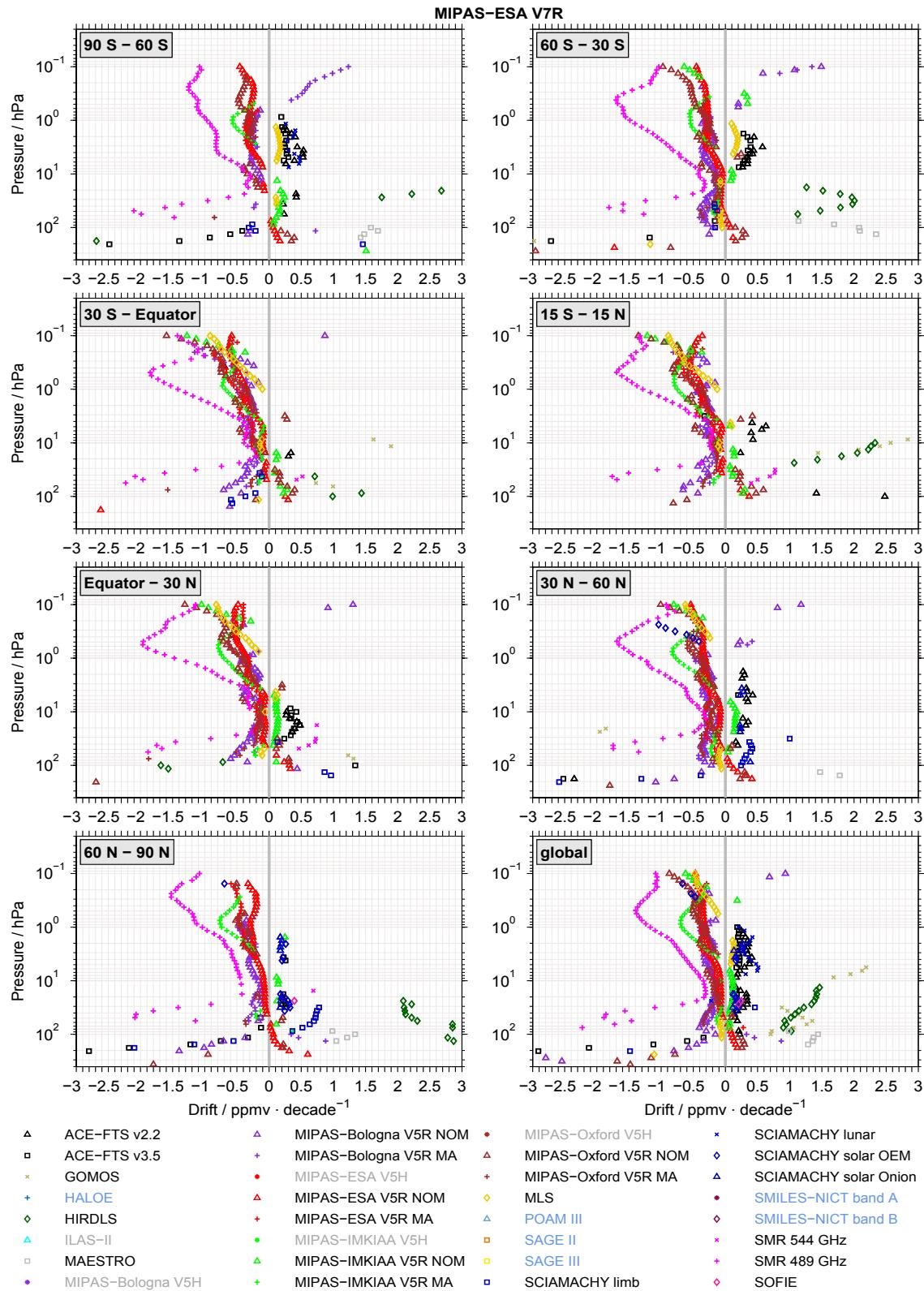
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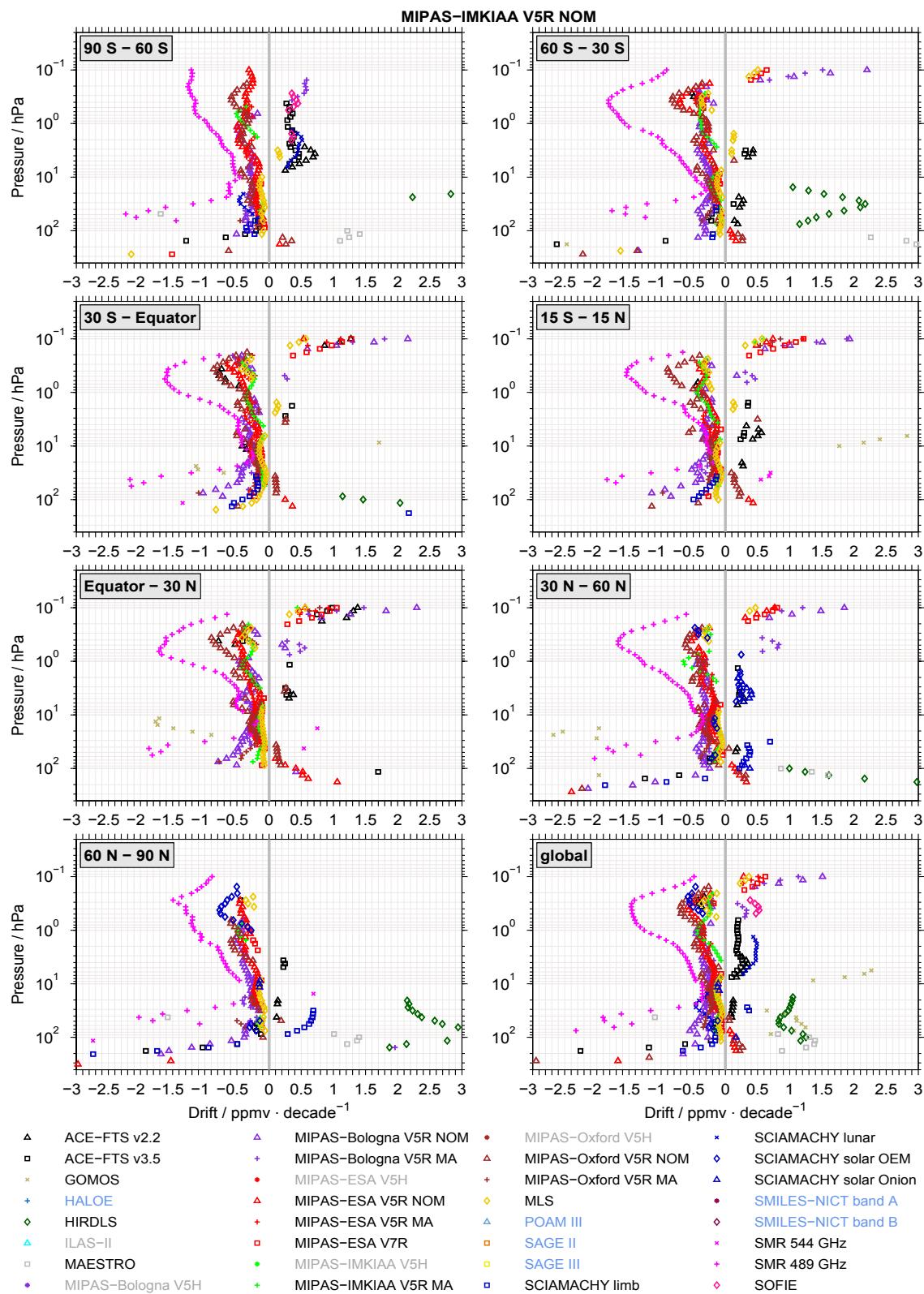
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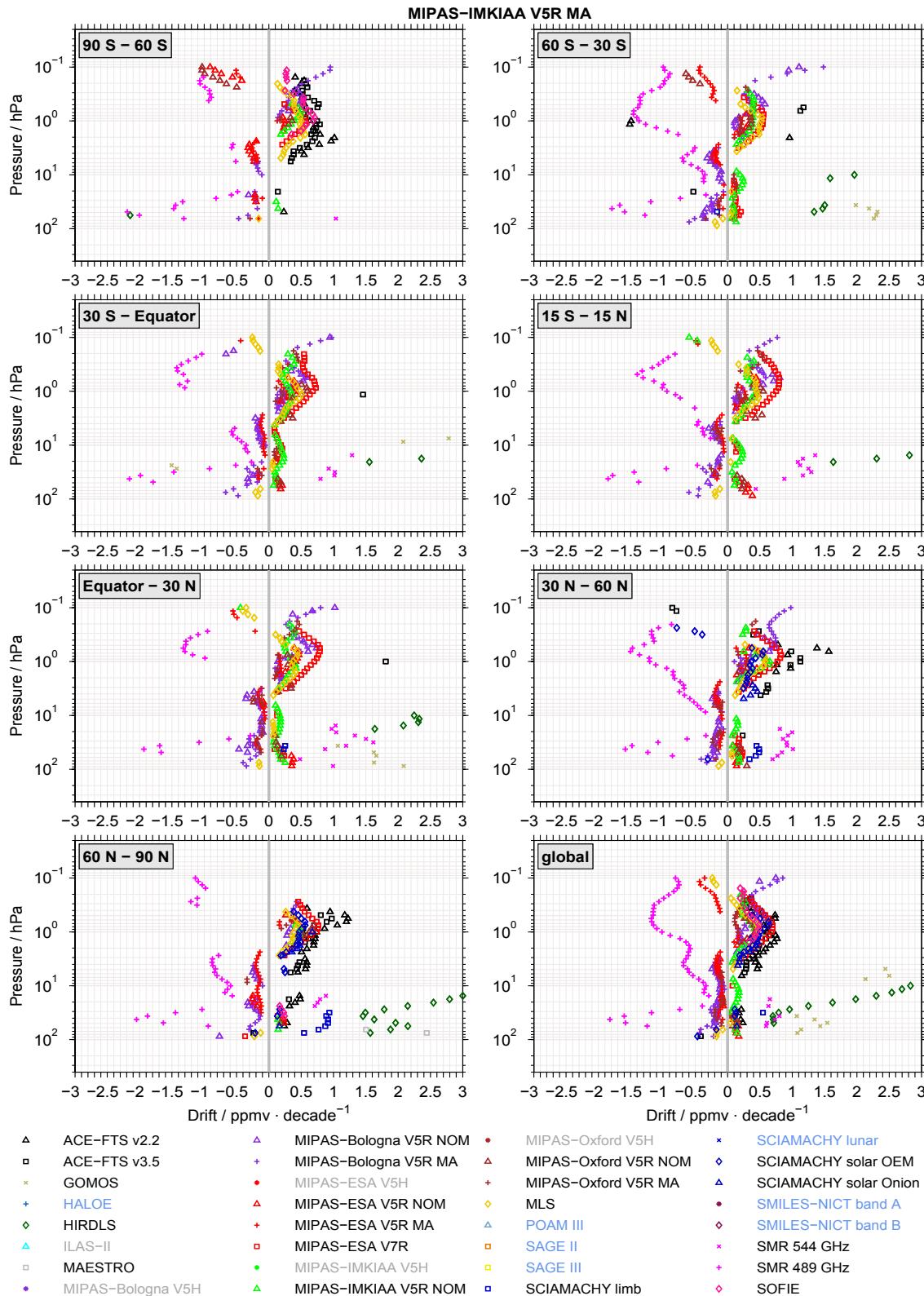
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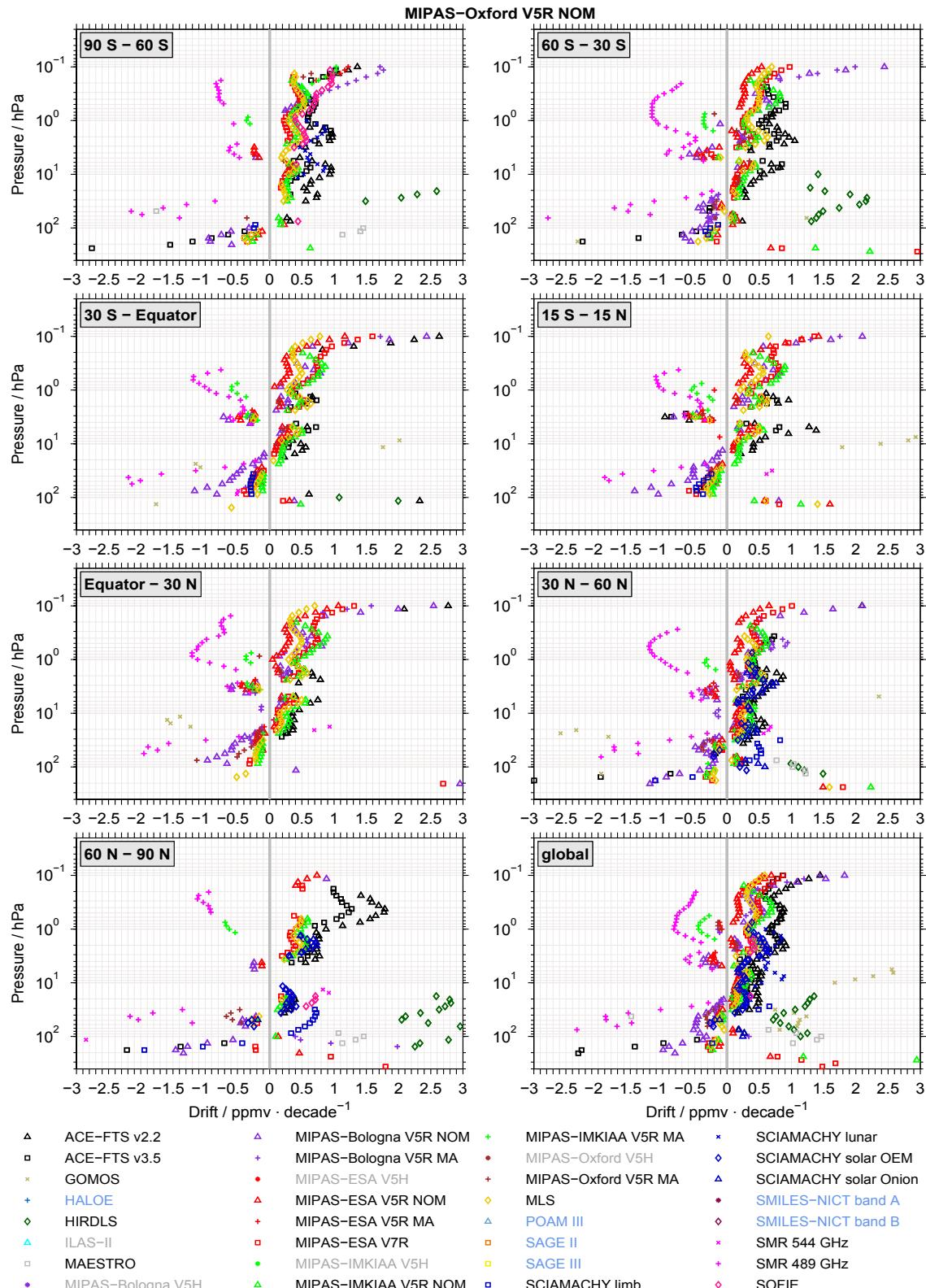
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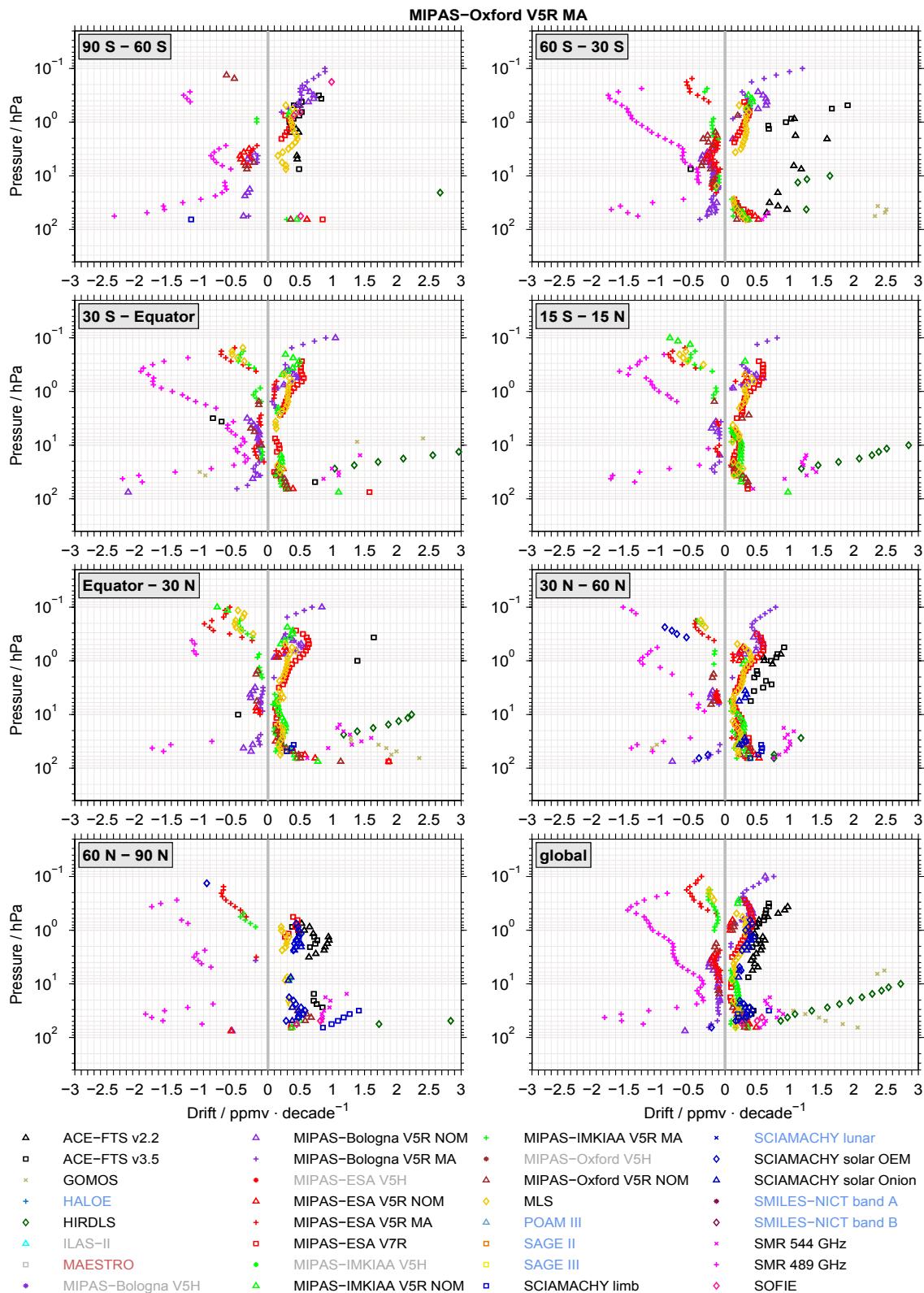
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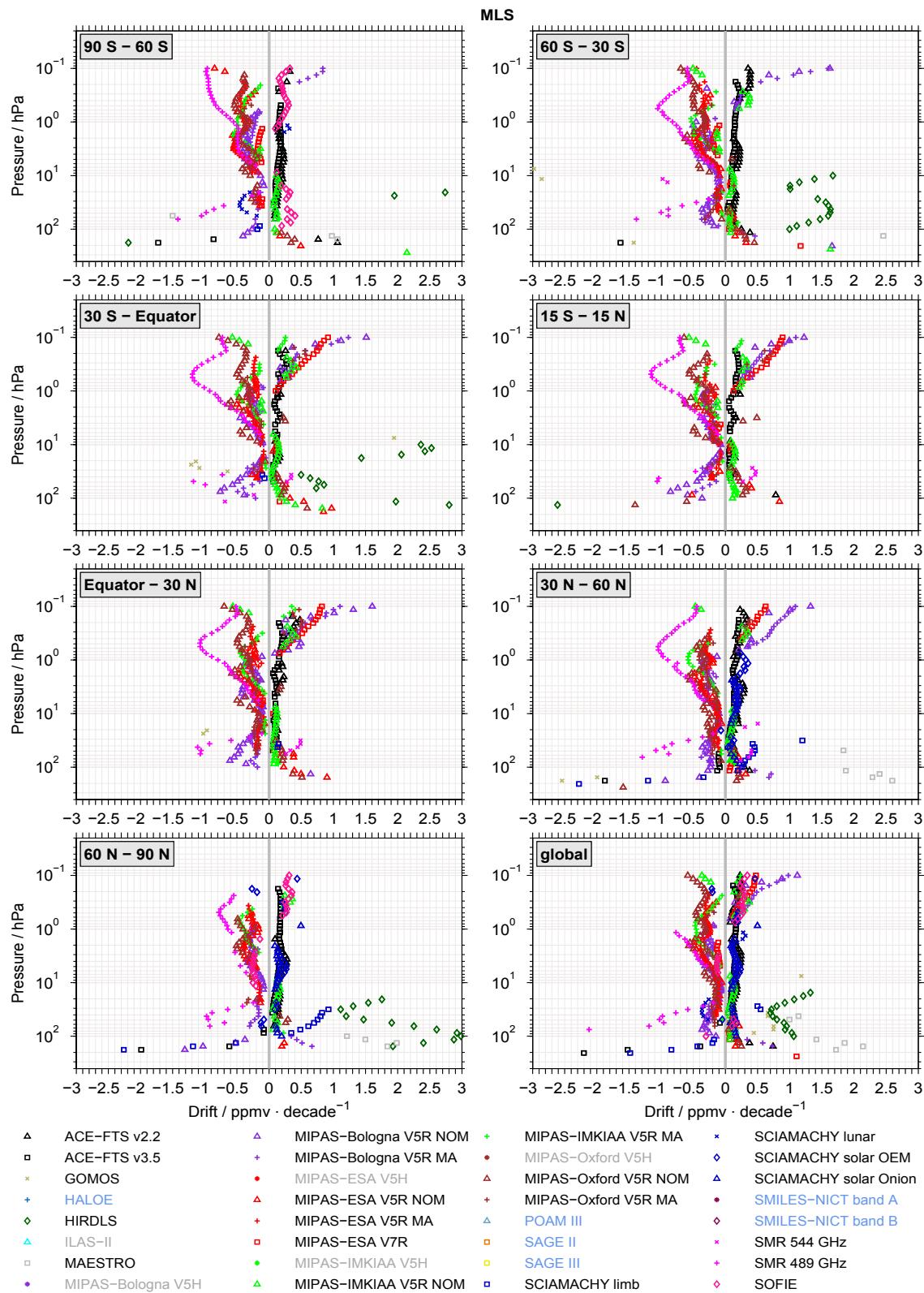
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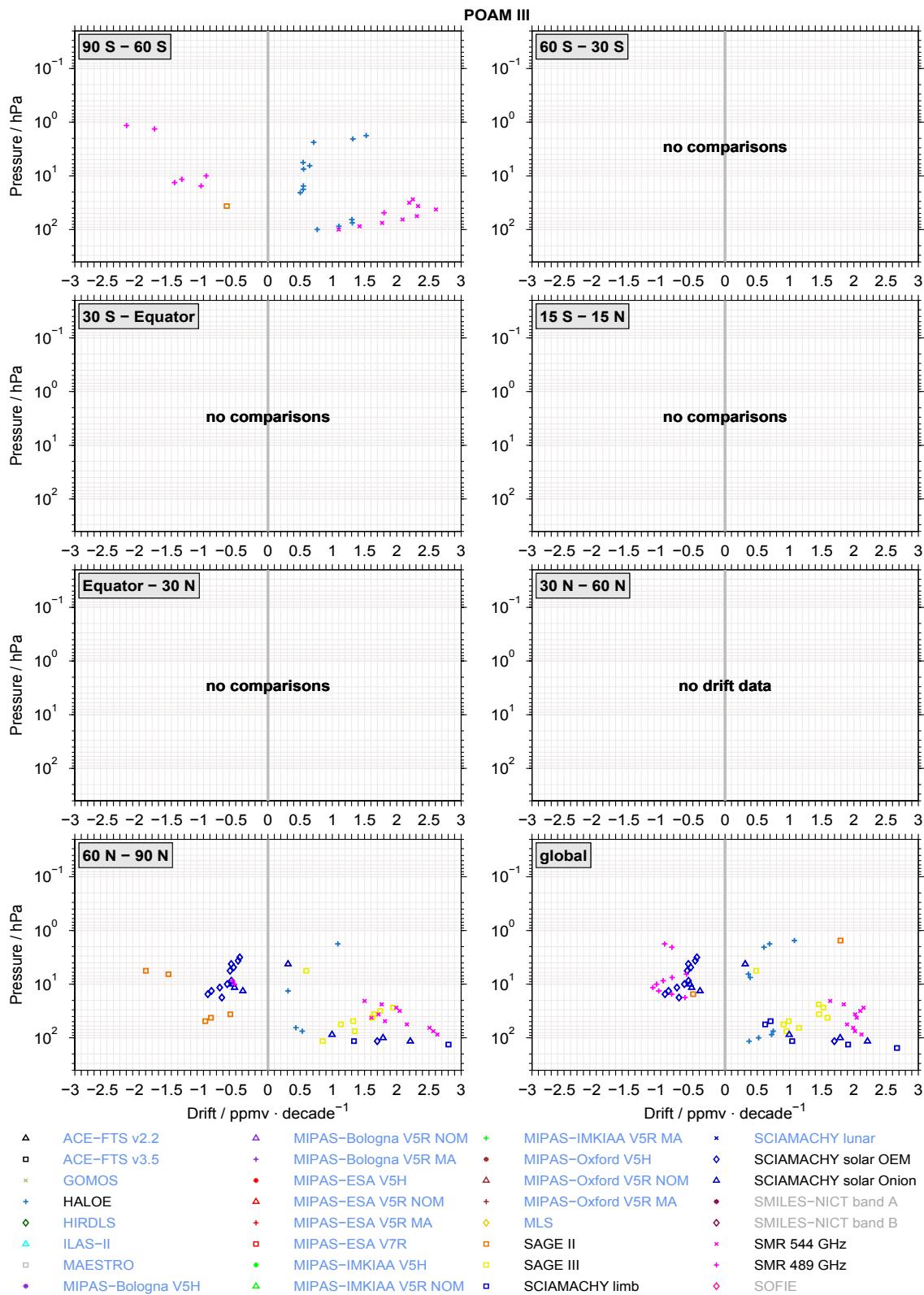
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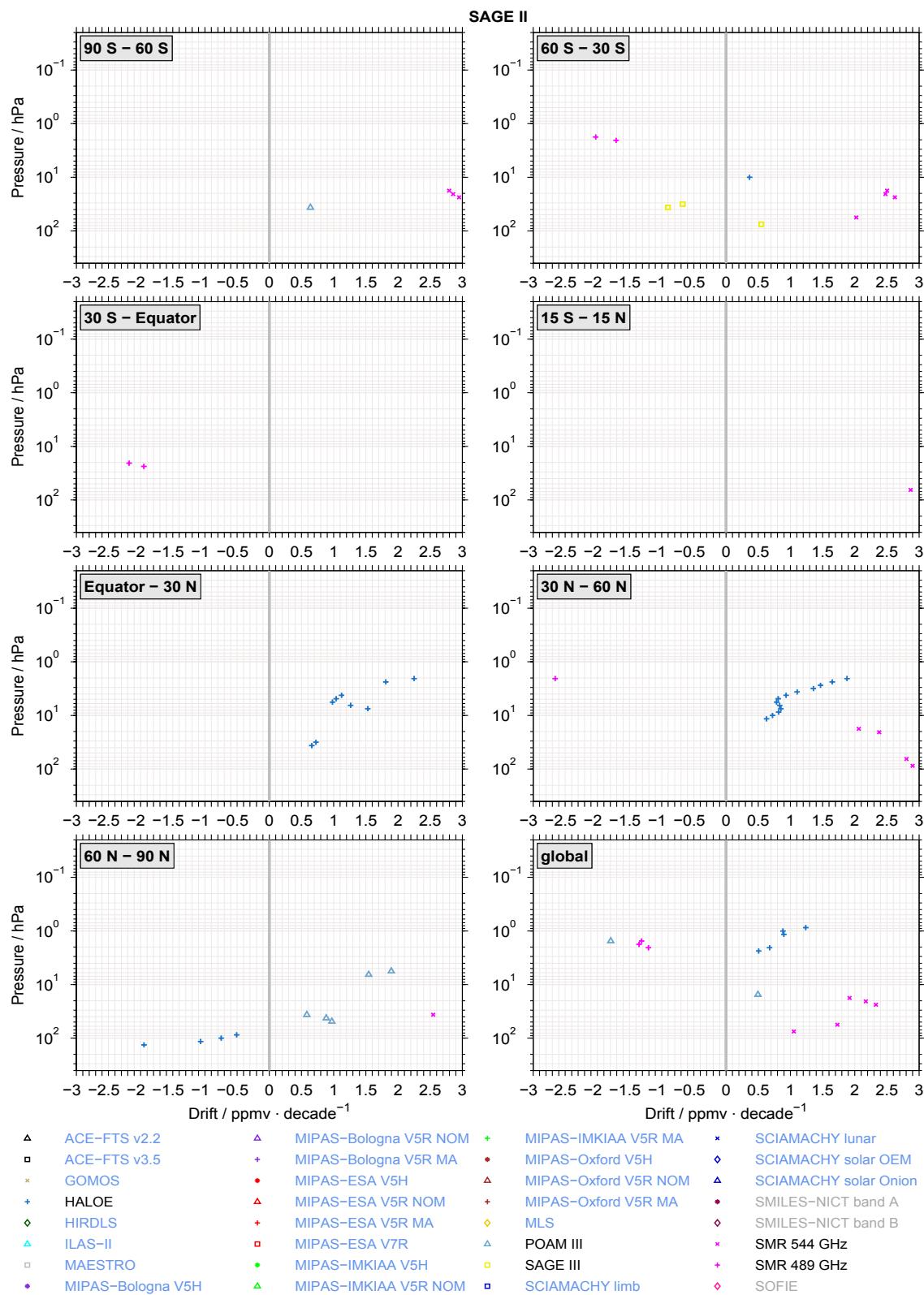
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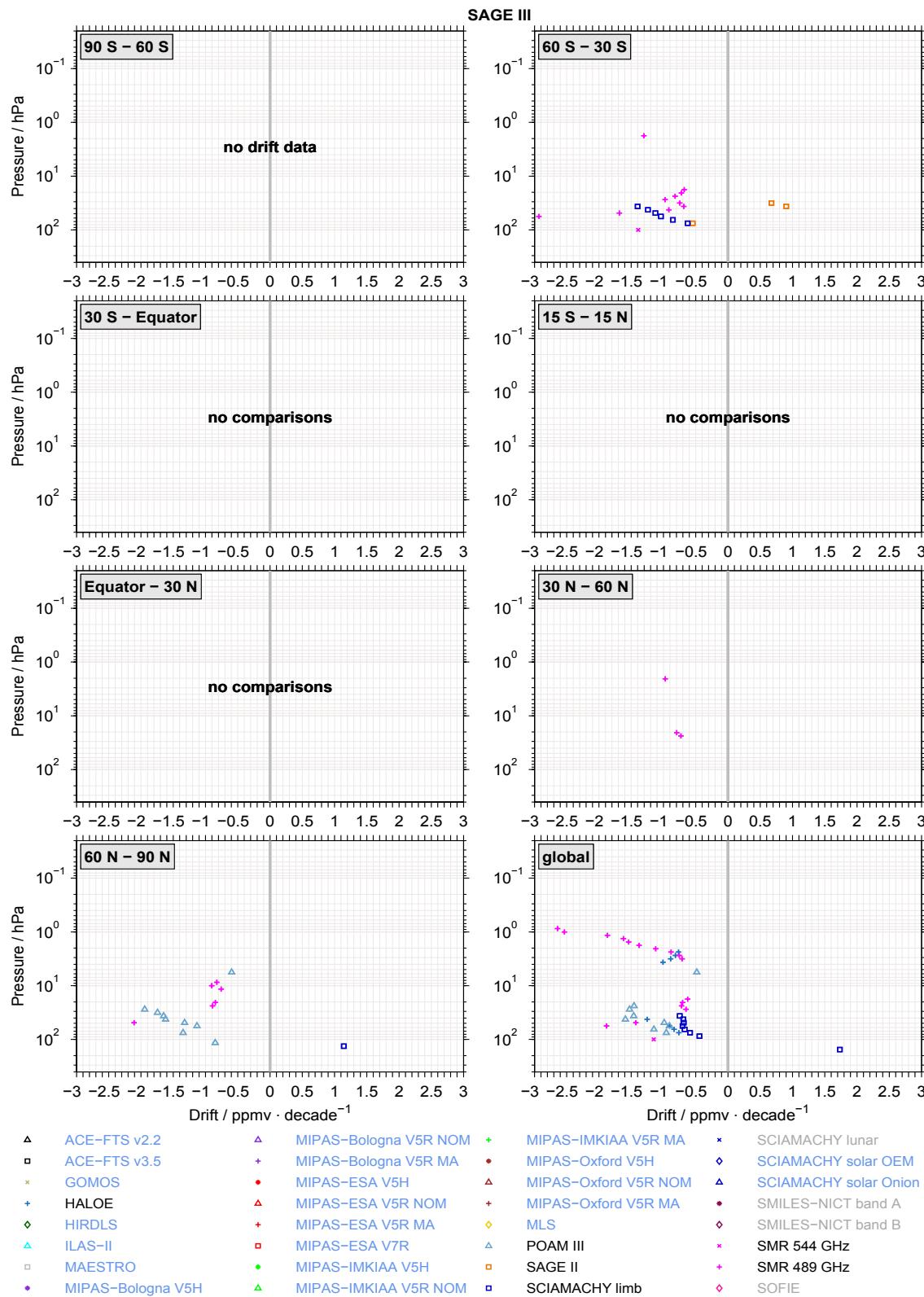
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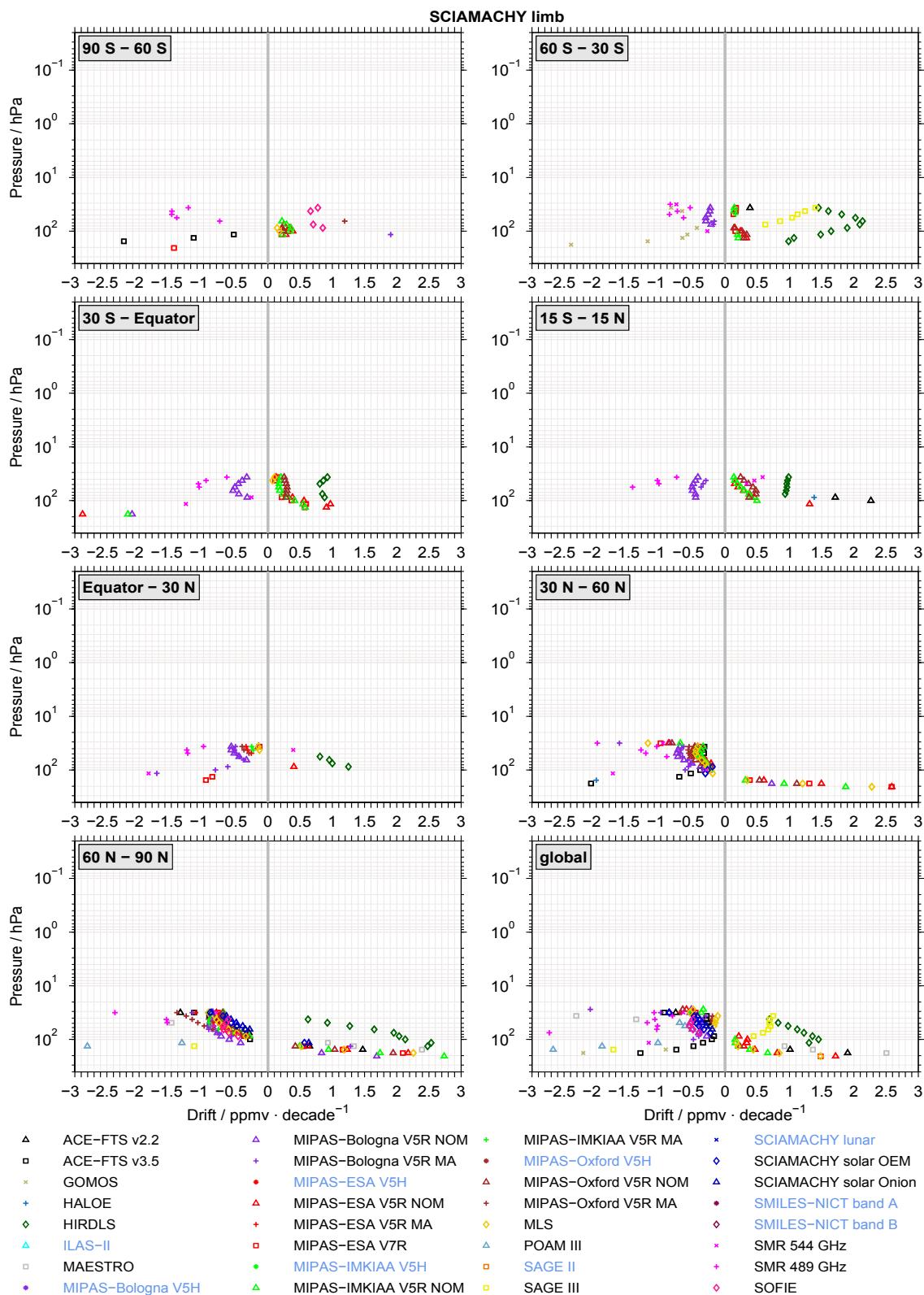


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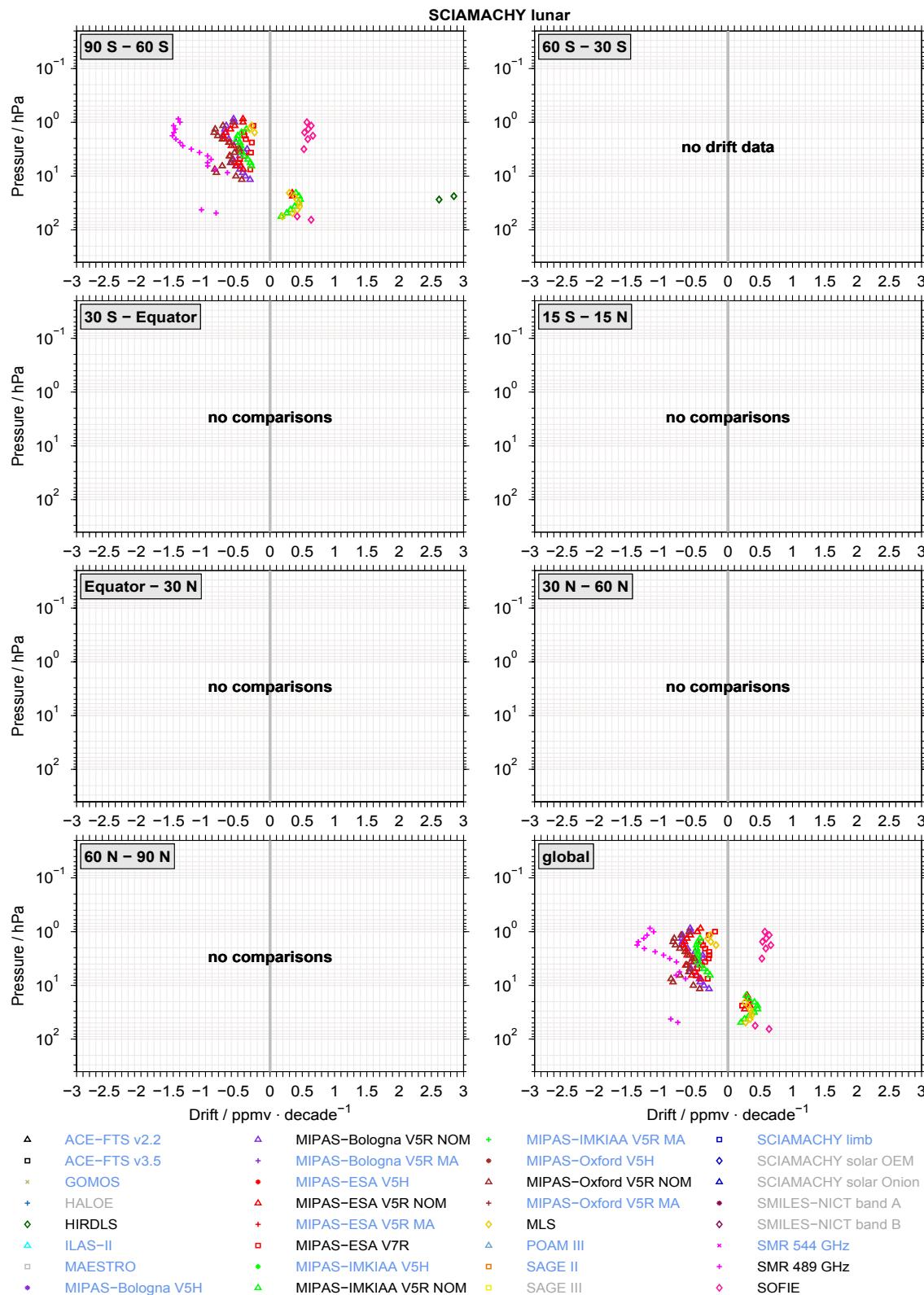


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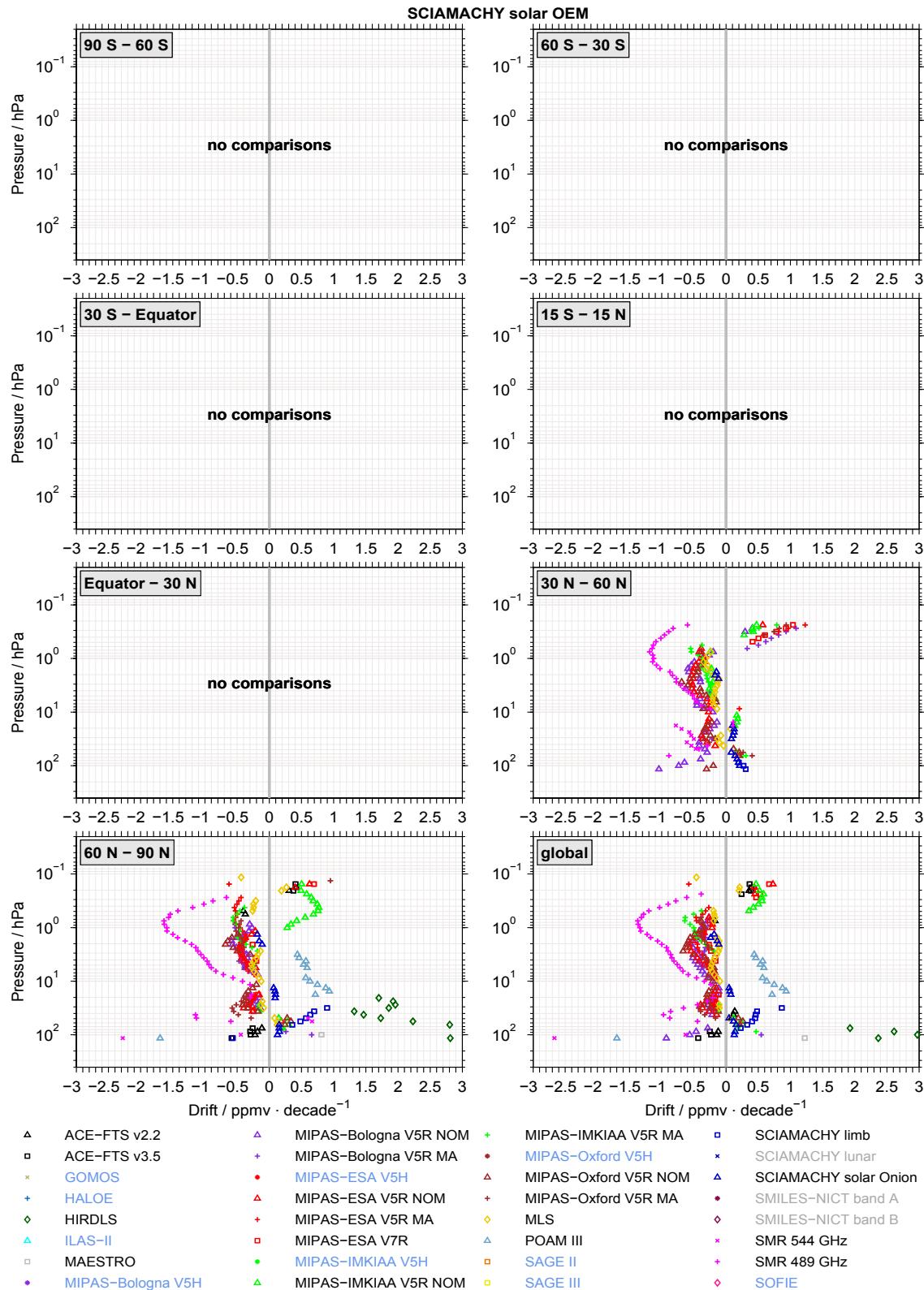
drift summary for SCIAMACHY limb (20 of 26)



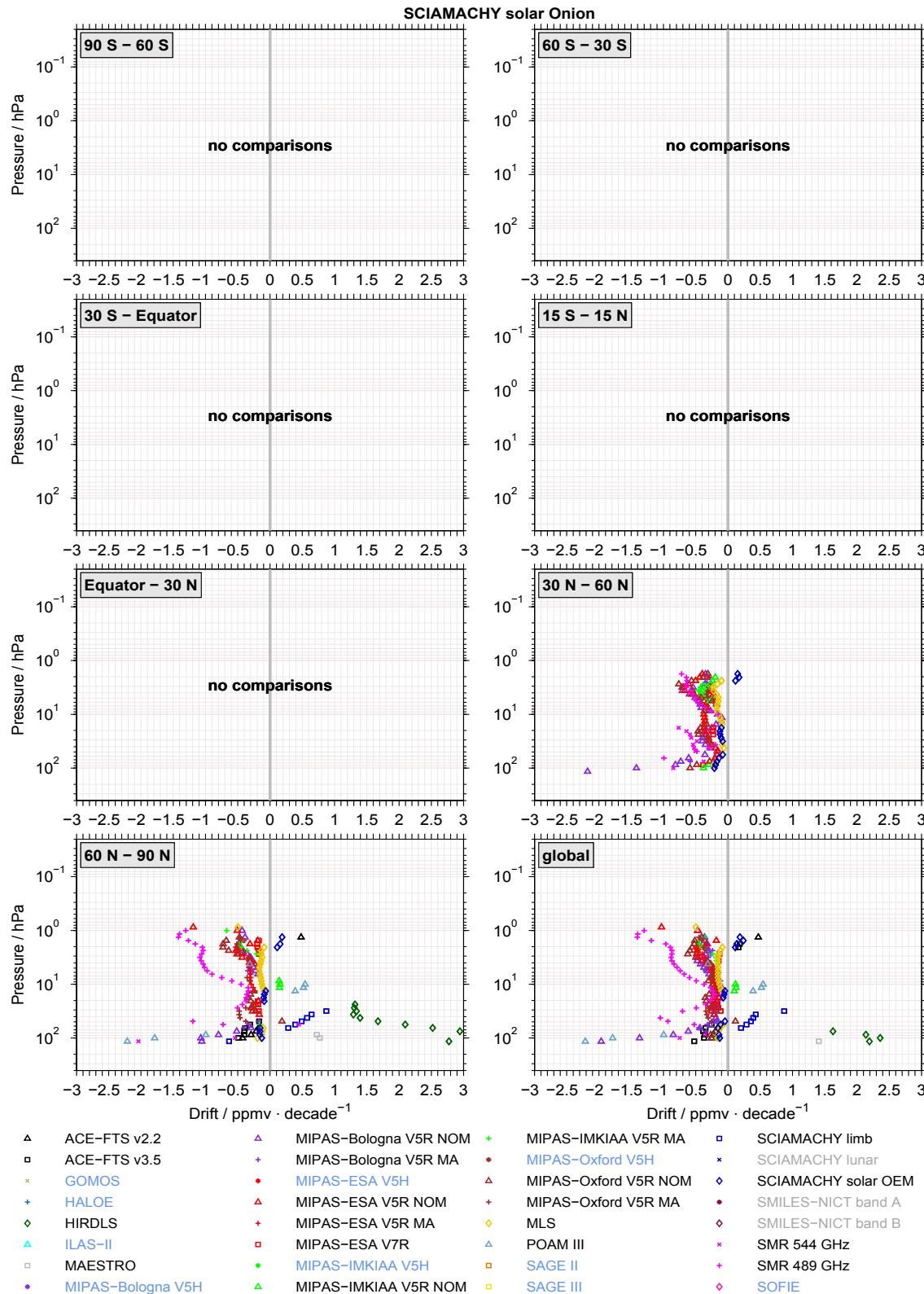
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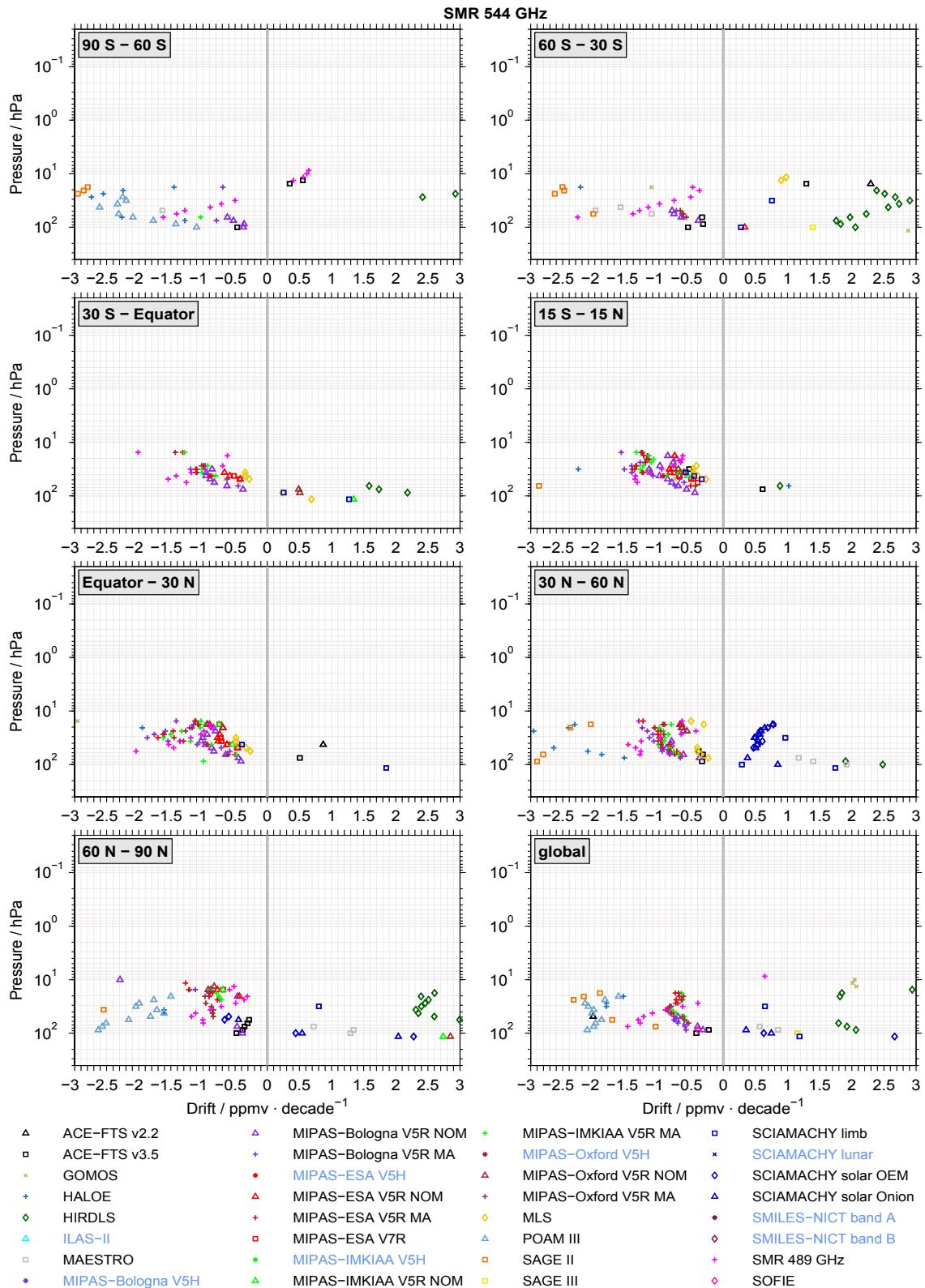
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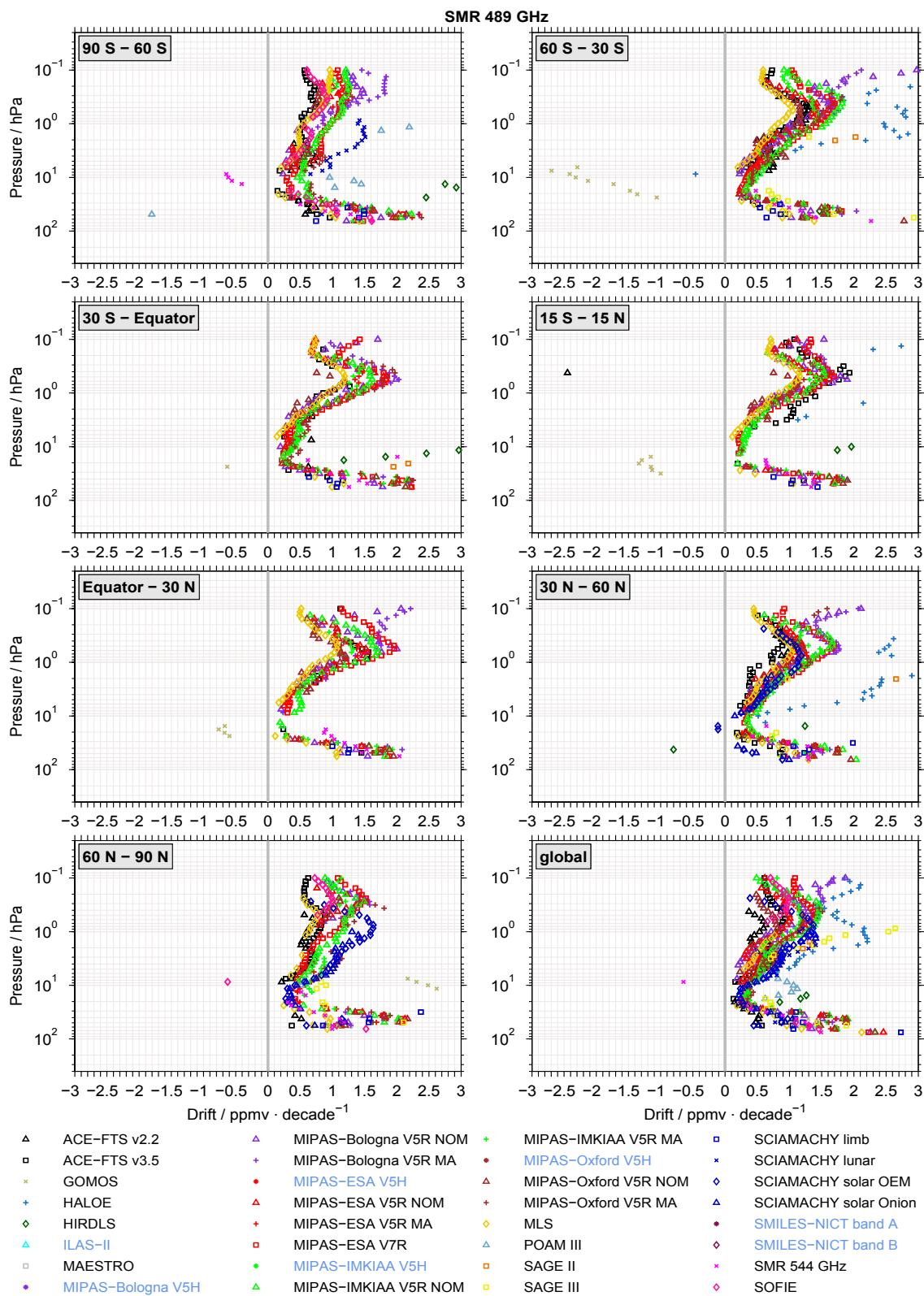


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drift summary for SMR 489 GHz (25 of 26)



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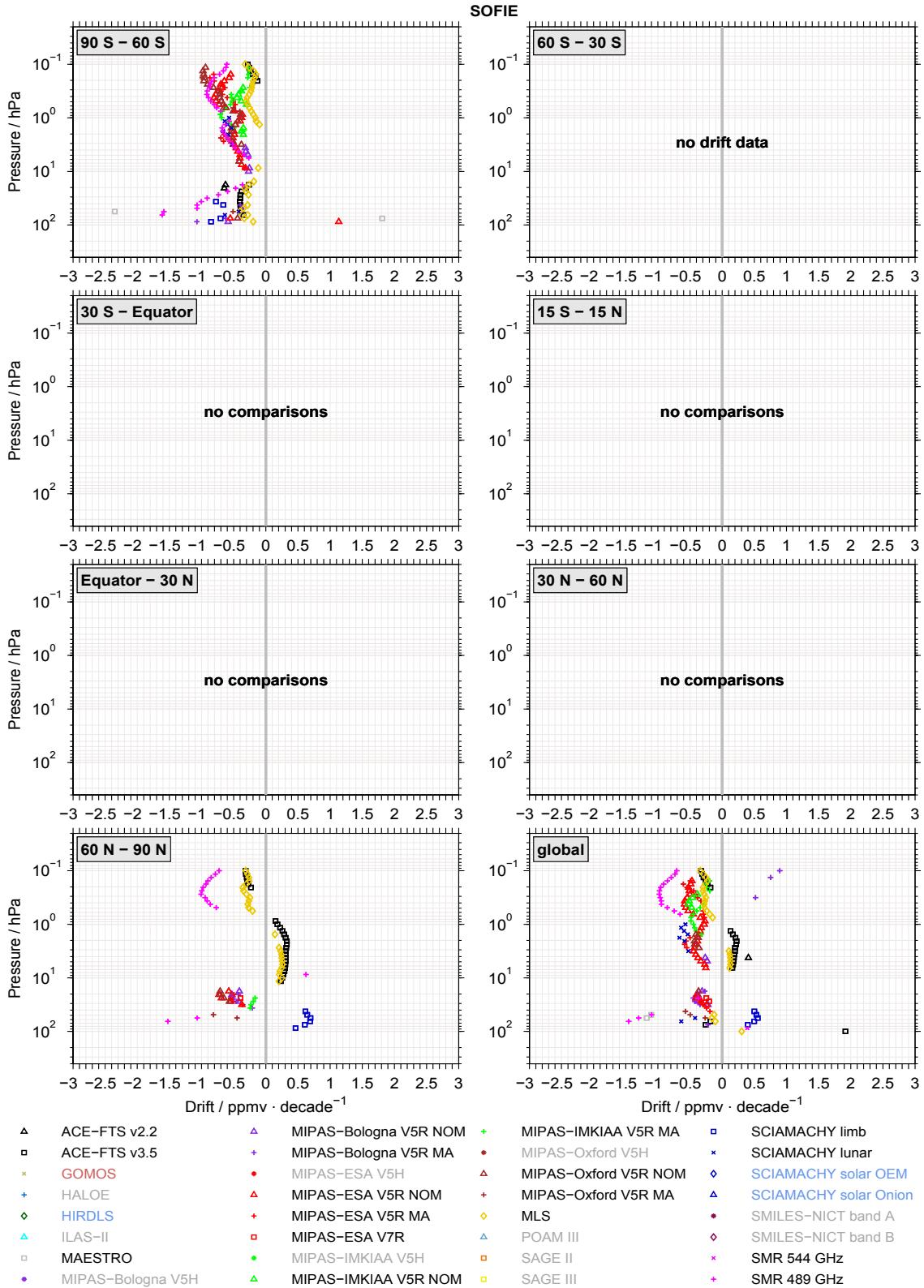


Figure S11: Drift summary for the individual data sets. This summary considers only drifts that are statistically significant at the 2σ uncertainty level. The different panels show the results for different latitude bands. For panels without any results an information is provided why this is the case, as described in Sect. 5.3 in the main manuscript. In the legend all possible data sets are listed. A colour-coding is used to provide additional information if the different data sets contributed a result or not as also described in Sect. 5.3.

drifts for the latitude band 15°S – 15°N

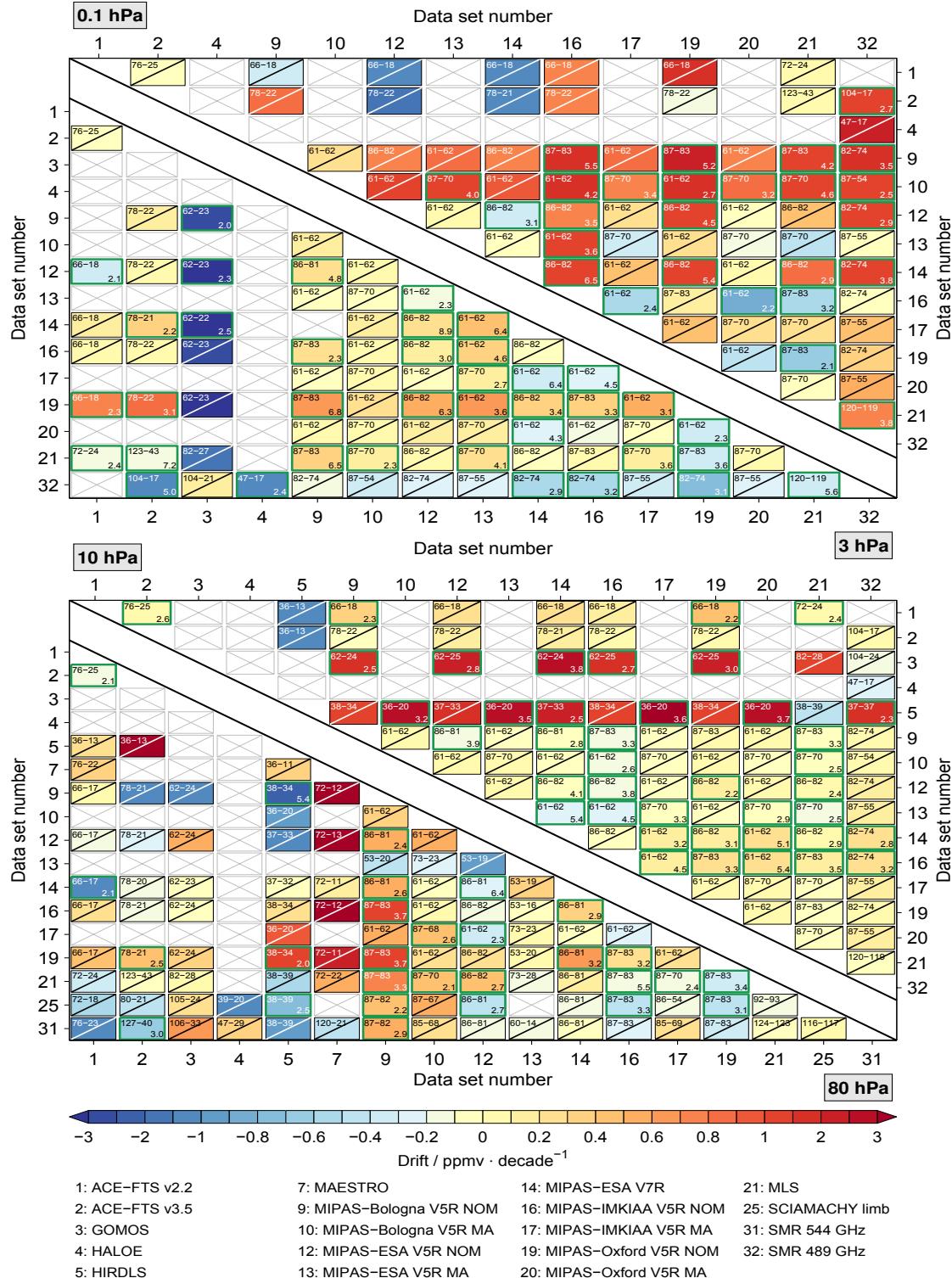


Figure S12: Drifts between the different data sets in the latitude band between 15°S and 15°N at 80 hPa, 10 hPa, 3 hPa and 0.1 hPa. The drift estimates are based on the difference time series between the data sets given at the x-axis and the data sets given at the y-axis. As in the main manuscript, data sets are only shown if they yield any result at a given altitude. The drift estimates are colour-coded. In addition, different types of auxiliary information is provided. In the upper left the overlap period of the two data sets is given first. The second number indicates how many months the data sets actually overlap. If a drift is not significant at the 2σ uncertainty level this is marked by a slant. If a drift is significant this is marked by a green frame and the significance level is noted in the lower right corner.

drift differences for the latitude band 15°S – 15°S

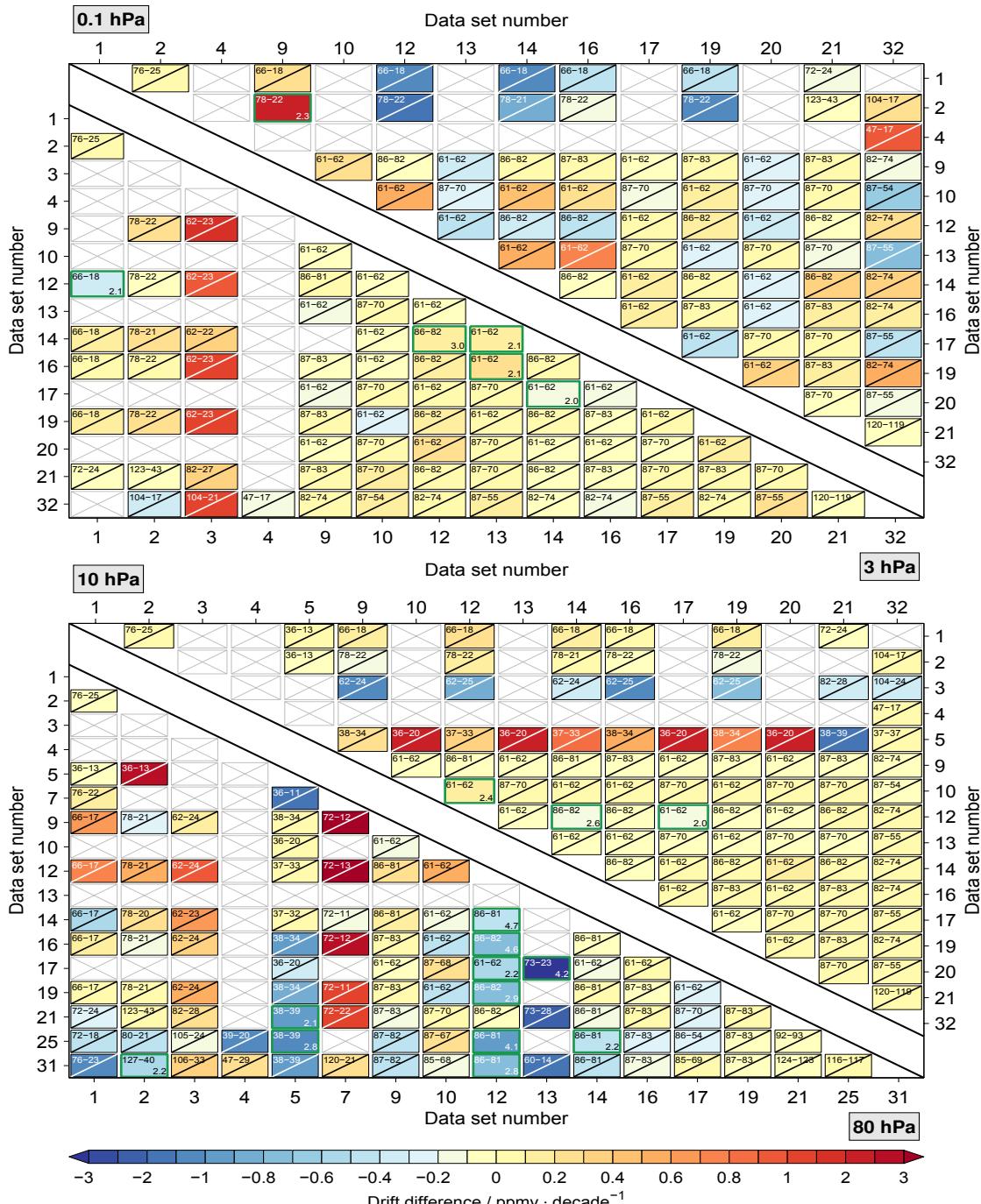


Figure S13: As Fig. S12, but here the differences between the drift estimates derived from the profile-to-profile comparisons and those obtained from the comparisons of zonal mean time series are shown, based on Eq. 13 in the main manuscript. The characteristic numbers in the result boxes correspond to the profile-to-profile comparisons. Differences not statistically significant at the 2σ uncertainty level are marked by a slant while for statistically significant differences the significance level is again provided in the lower right corner.

drifts for the latitude band 50°N – 60°N

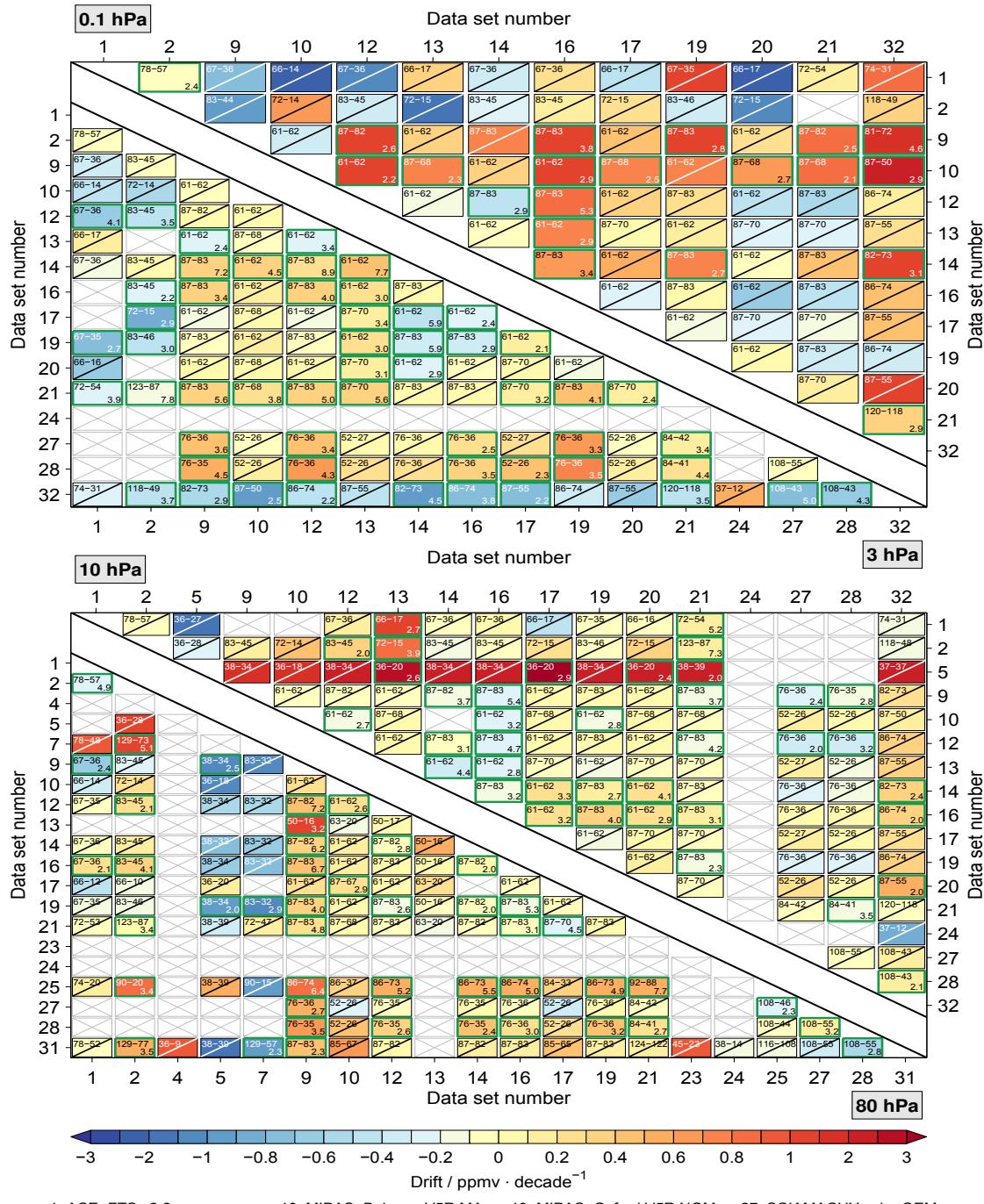


Figure S14: As Fig. S12, but here the results for the latitude band between 50°N and 60°N are presented.

drift differences for the latitude band 50°N – 60°N

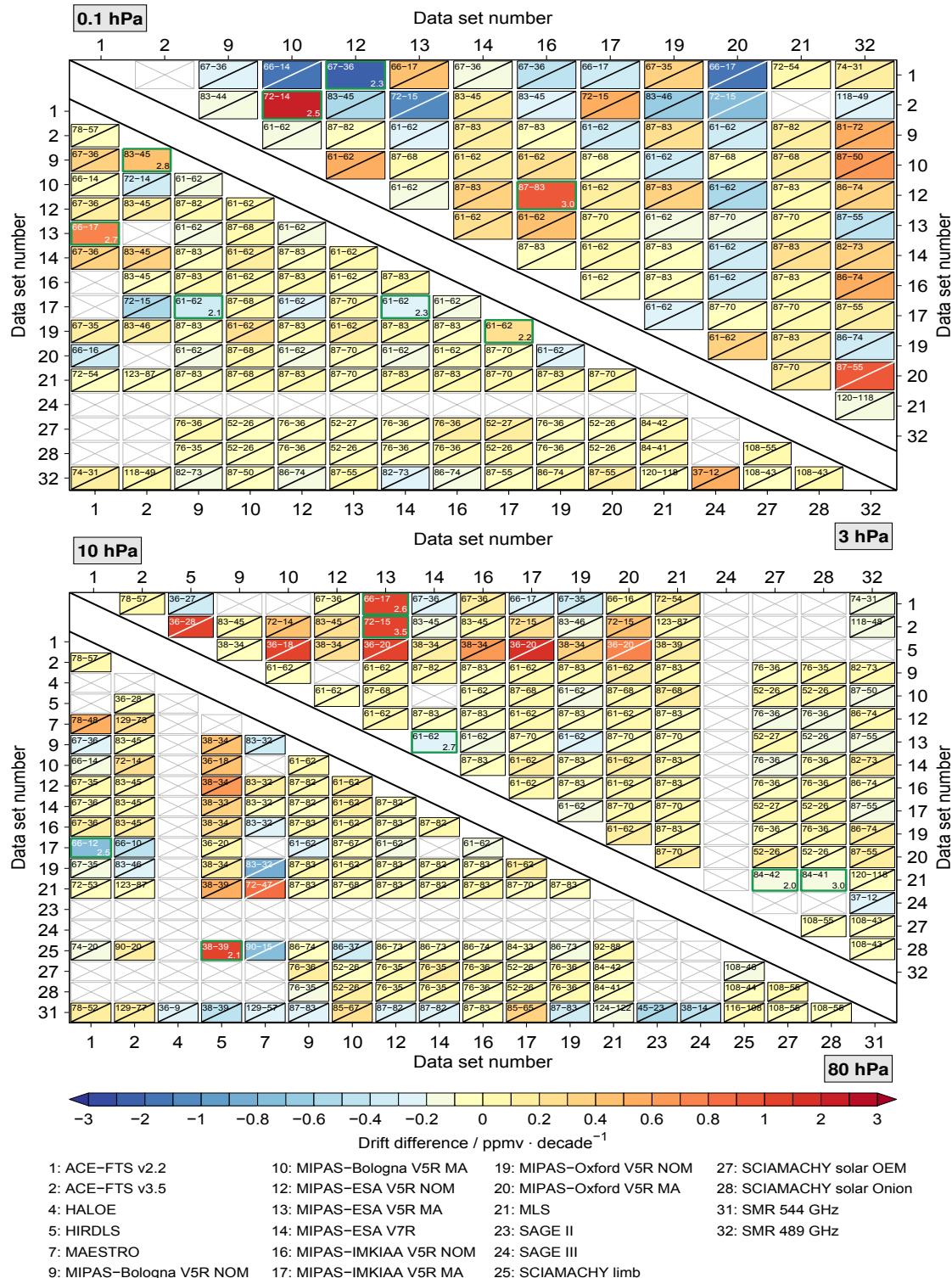


Figure S15: As Fig. S13, but here the results for the latitude band between 50°N and 60°N are presented.

References

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