

Evaluation of ECHAM5/MESSy2

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1 Global views

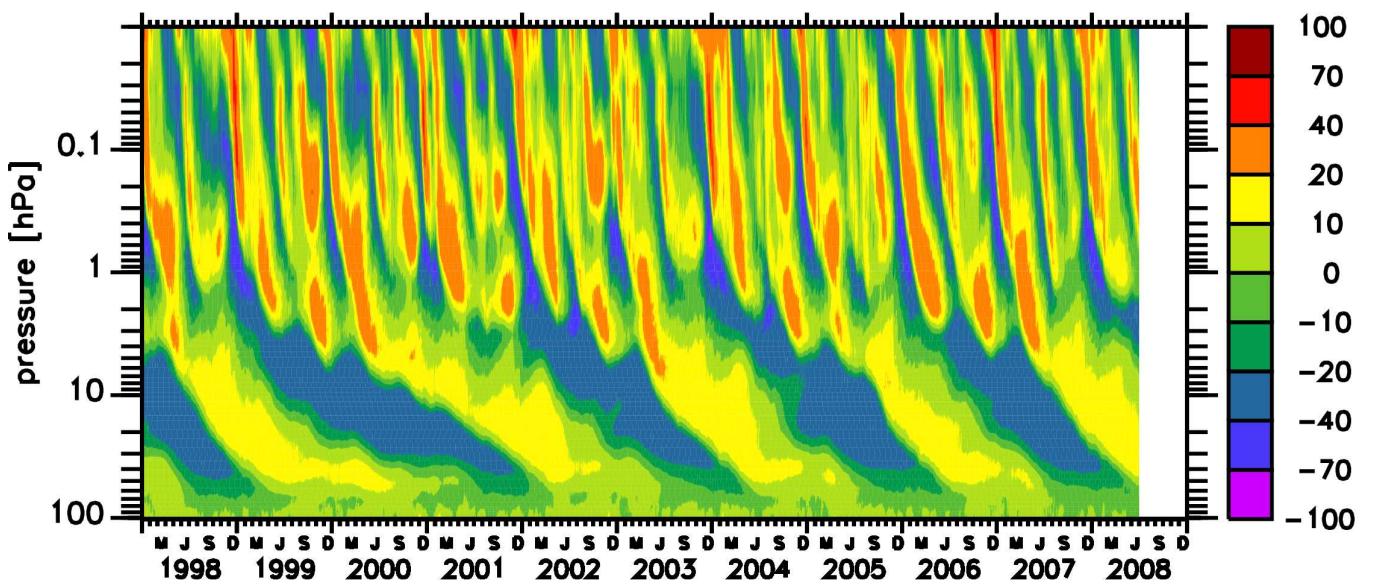


Figure 1: Simulated tropical zonal wind (in m/s) average between 2°S and 2°N and its quasi-biennial oscillation. This figure corresponds to Fig. 2 in Jöckel et al. (2006).

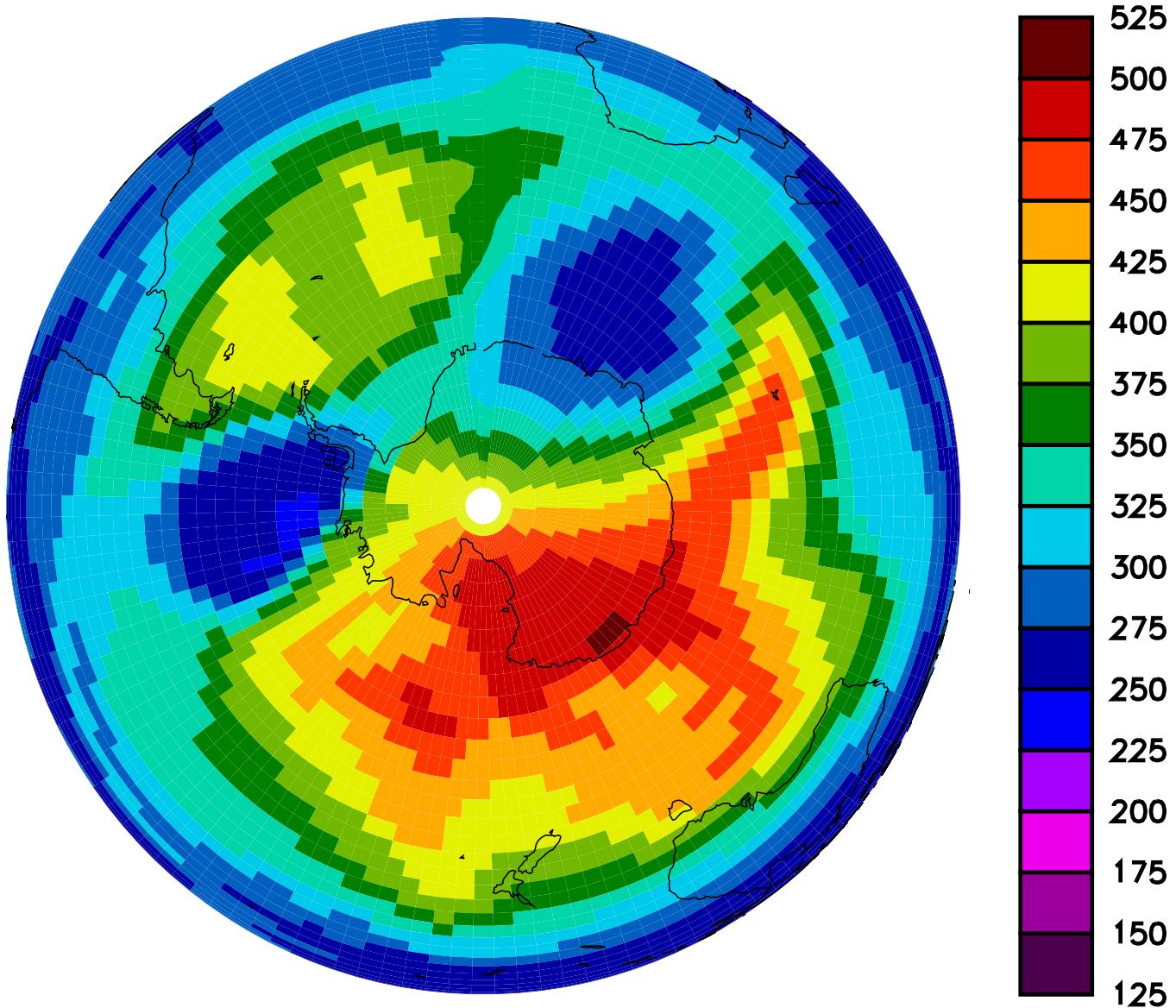


Figure 2: Simulated total ozone (in DU) on 26 September 2002. This figure corresponds to Fig. 7 in Jöckel et al. (2006).

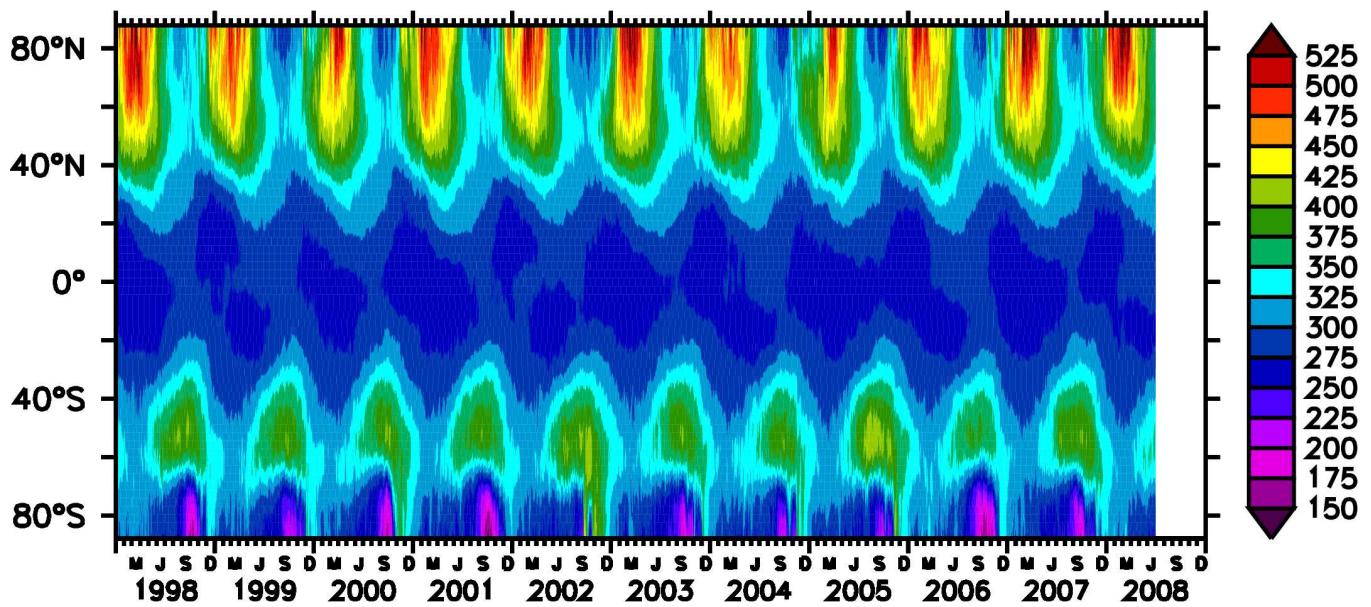


Figure 3: Time series of total ozone (zonally averaged, in DU). This figure corresponds to Fig. 9 in Jöckel et al. (2006).

2 Vertical profiles

The simulated vertical profiles (for the year 2000) are compared to the compilation of observational data (mainly from aircraft campaigns) by Emmons et al. (2000). The geographical areas of the individual campaigns are listed above the panels. The left vertical axes show the altitude (in km), the horizontal axes show the mixing ratio (in the indicated units). Numbers close to the right vertical axes list the number of measurements, the asterisks show the mean values of the measurements, the boxes indicate the corresponding standard deviation. The blue lines are the results of the S1 simulation (Jöckel et al., 2006), the red lines those of the new simulation. The lines denote the average within the geographical area and during the time of the year of the respective campaign, the dashed lines the corresponding (plus / minus) spatio-temporal standard deviations.

2.1 C₂H₄

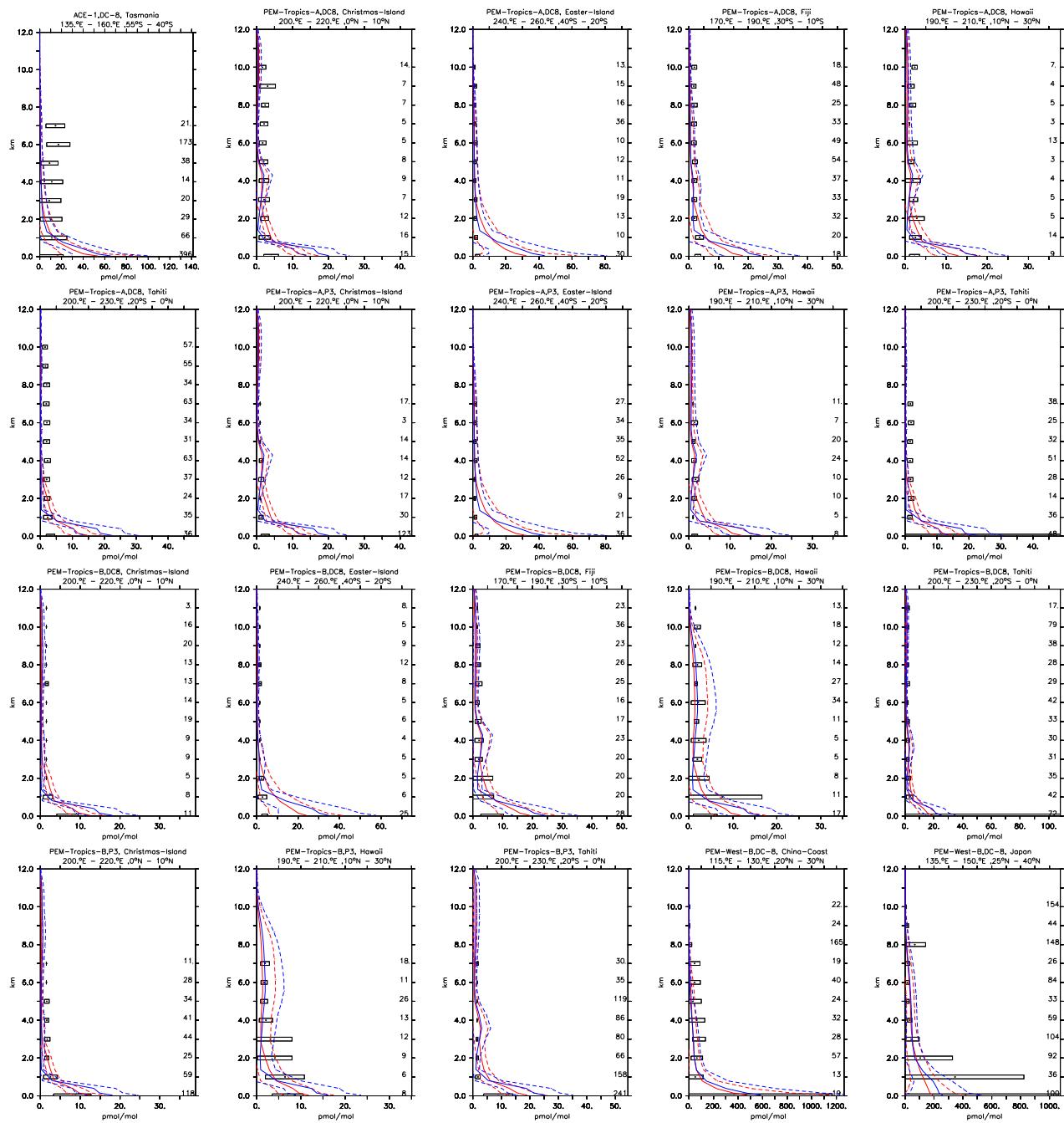


Figure 4:

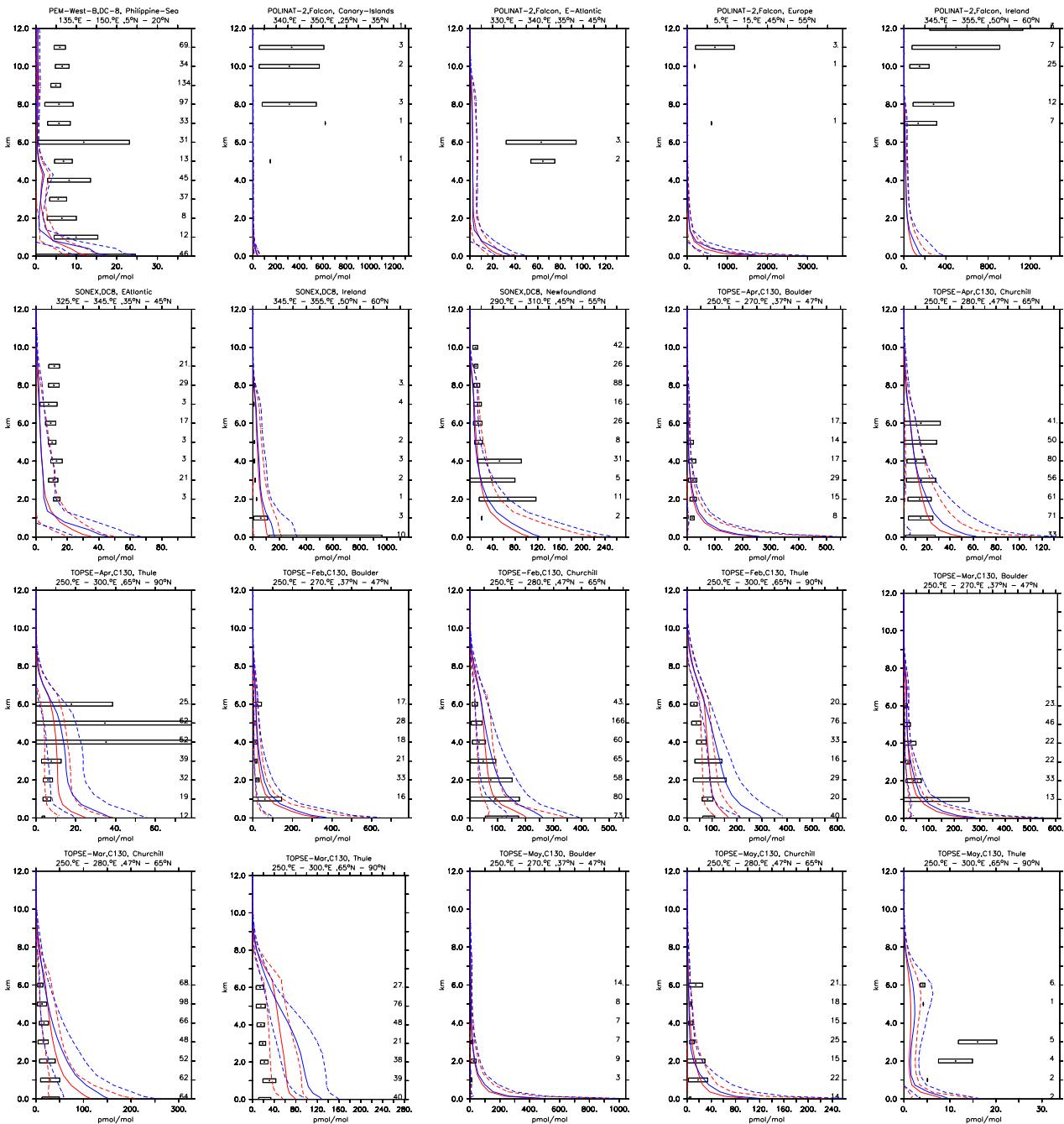


Figure 4: continued

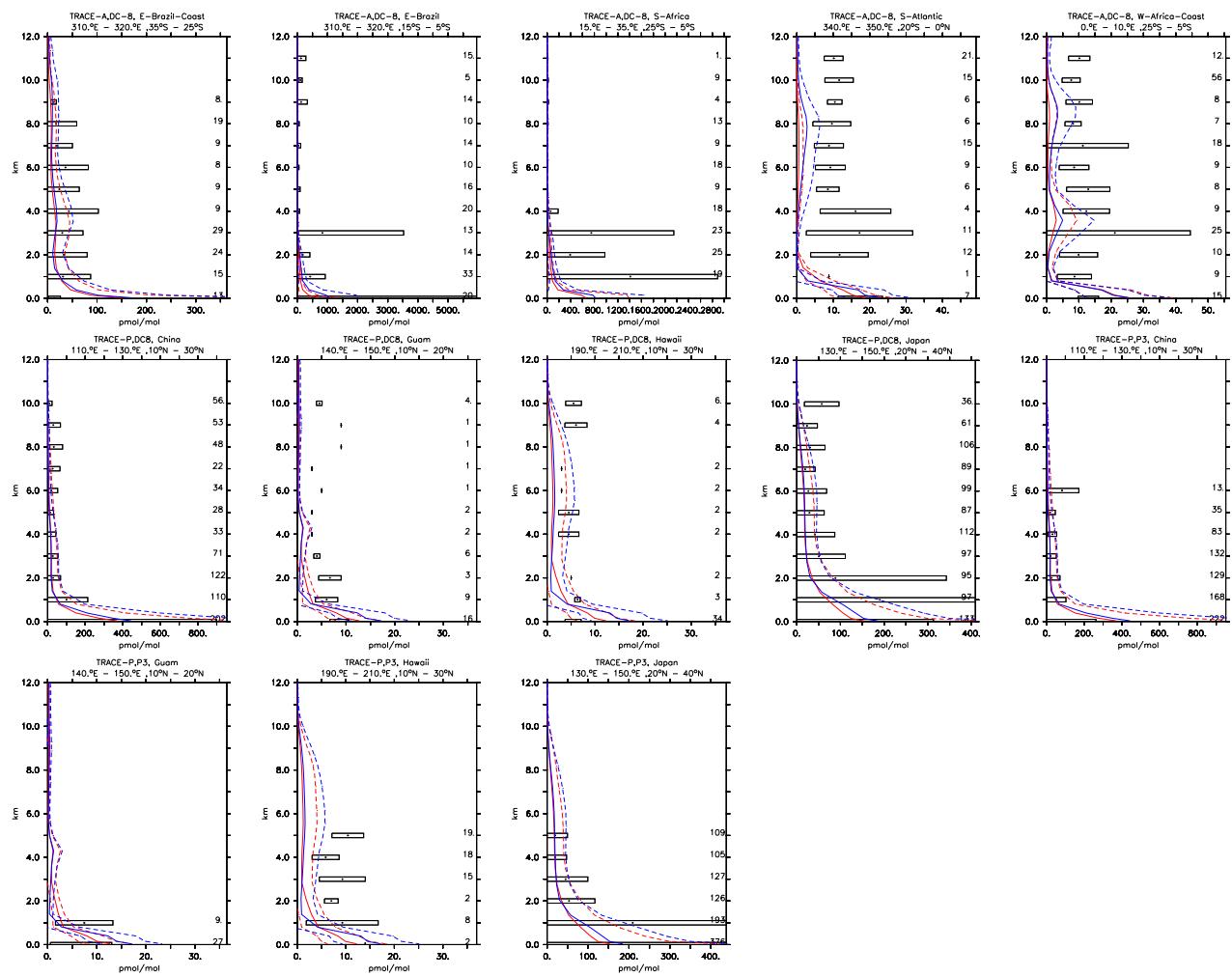


Figure 4: continued

2.2 C₂H₆

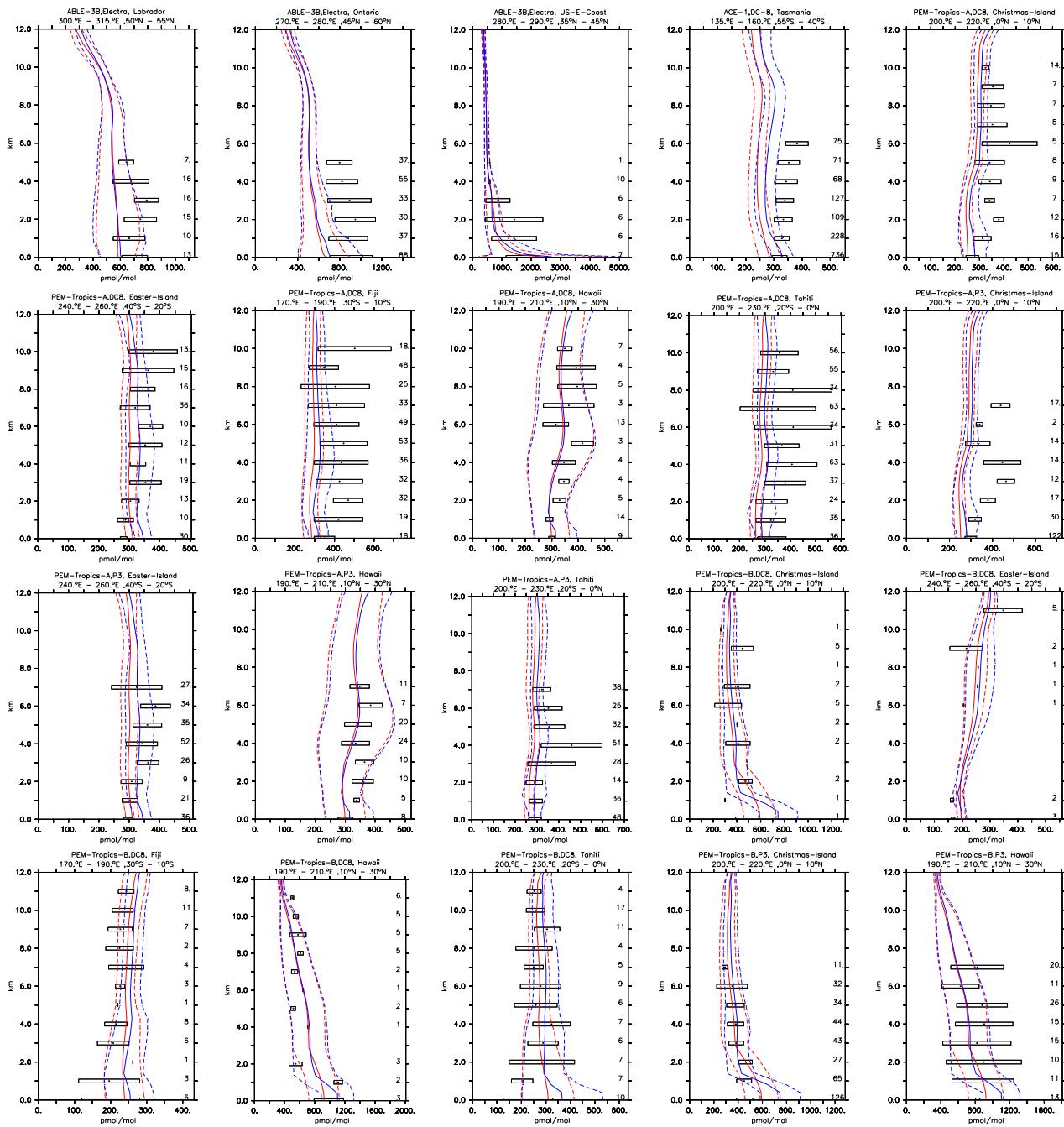


Figure 5:

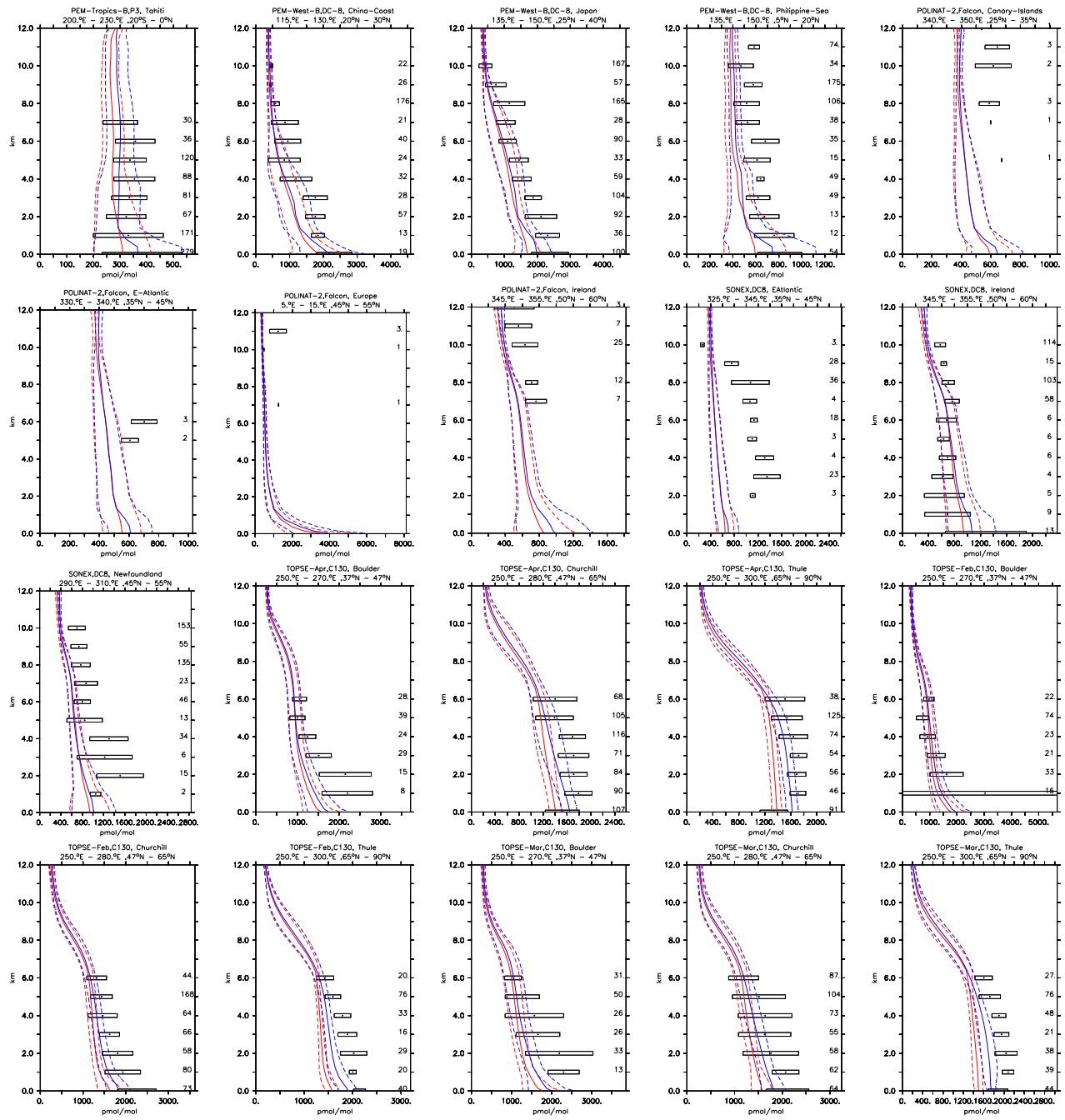


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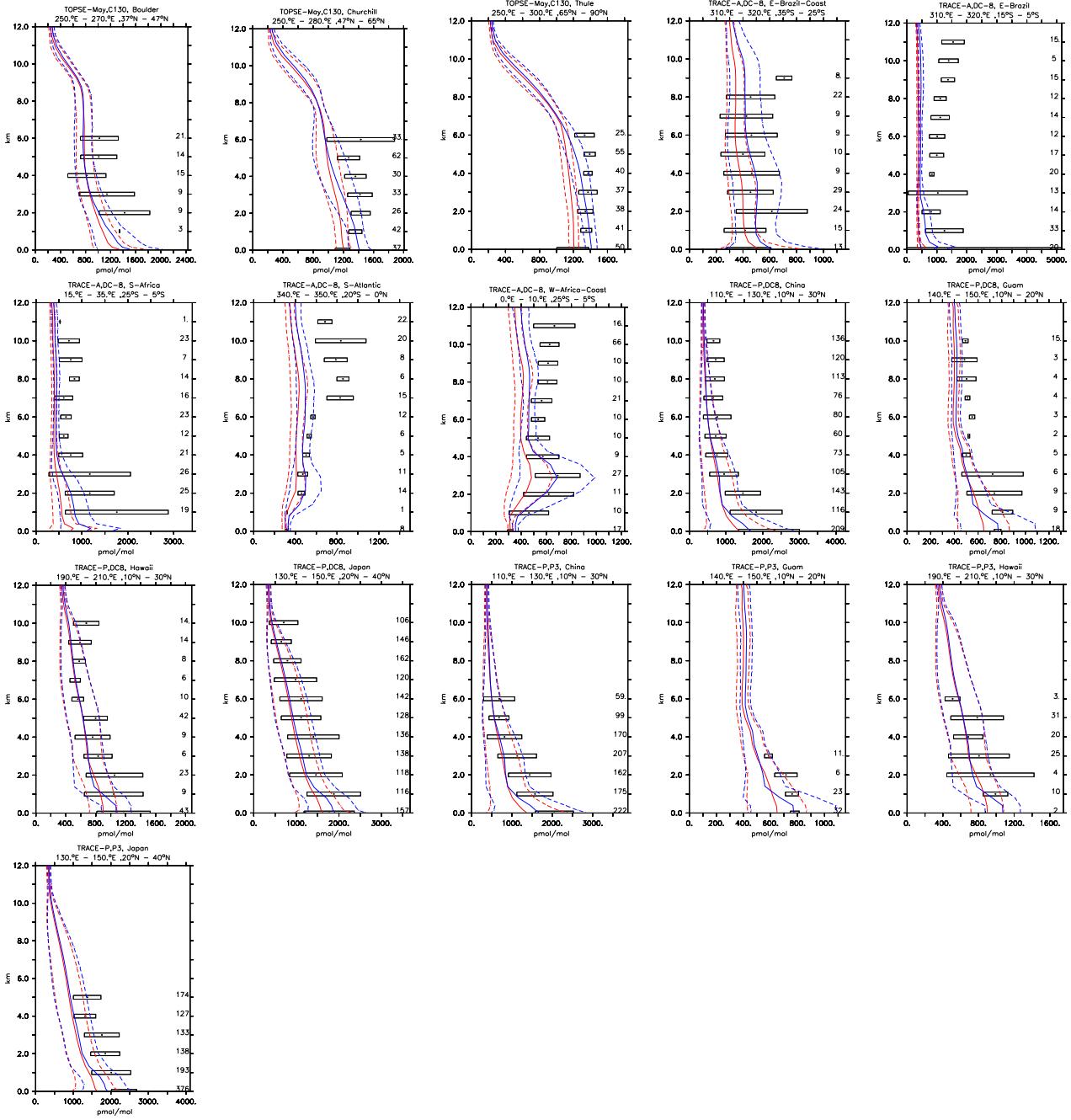


Figure 5: continued

2.3 C₃H₆

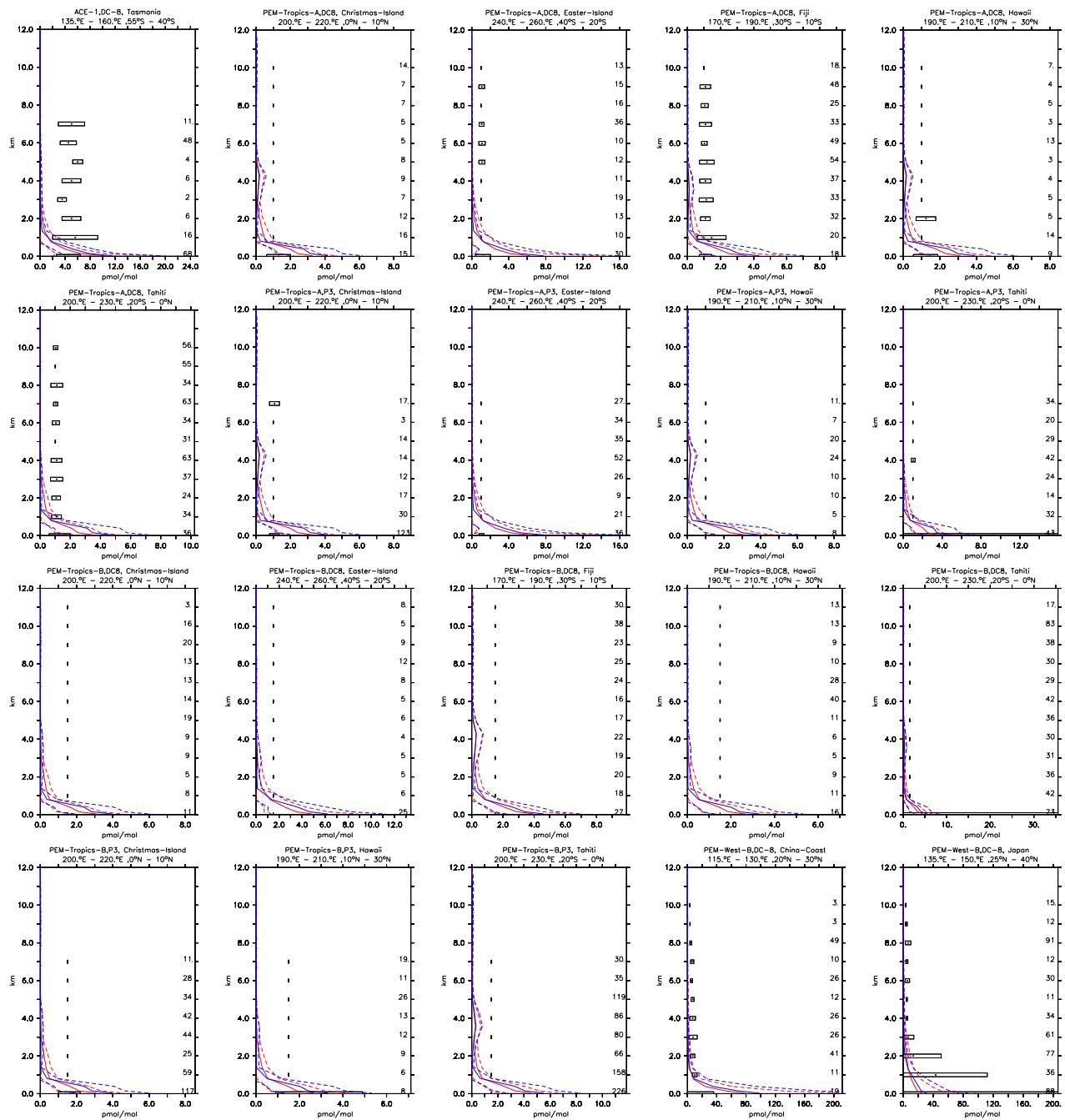


Figure 6:

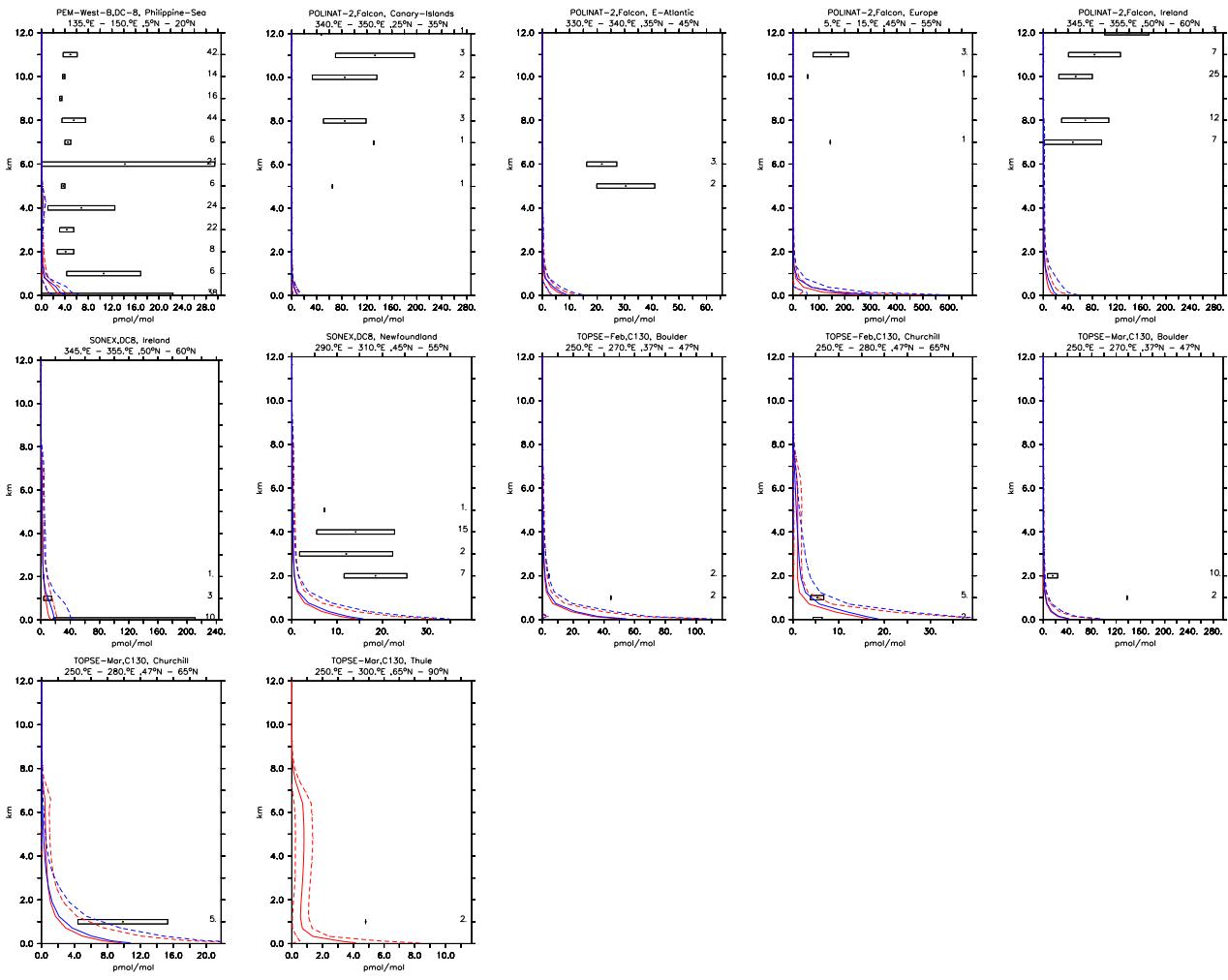


Figure 6: continued

2.4 C₃H₈

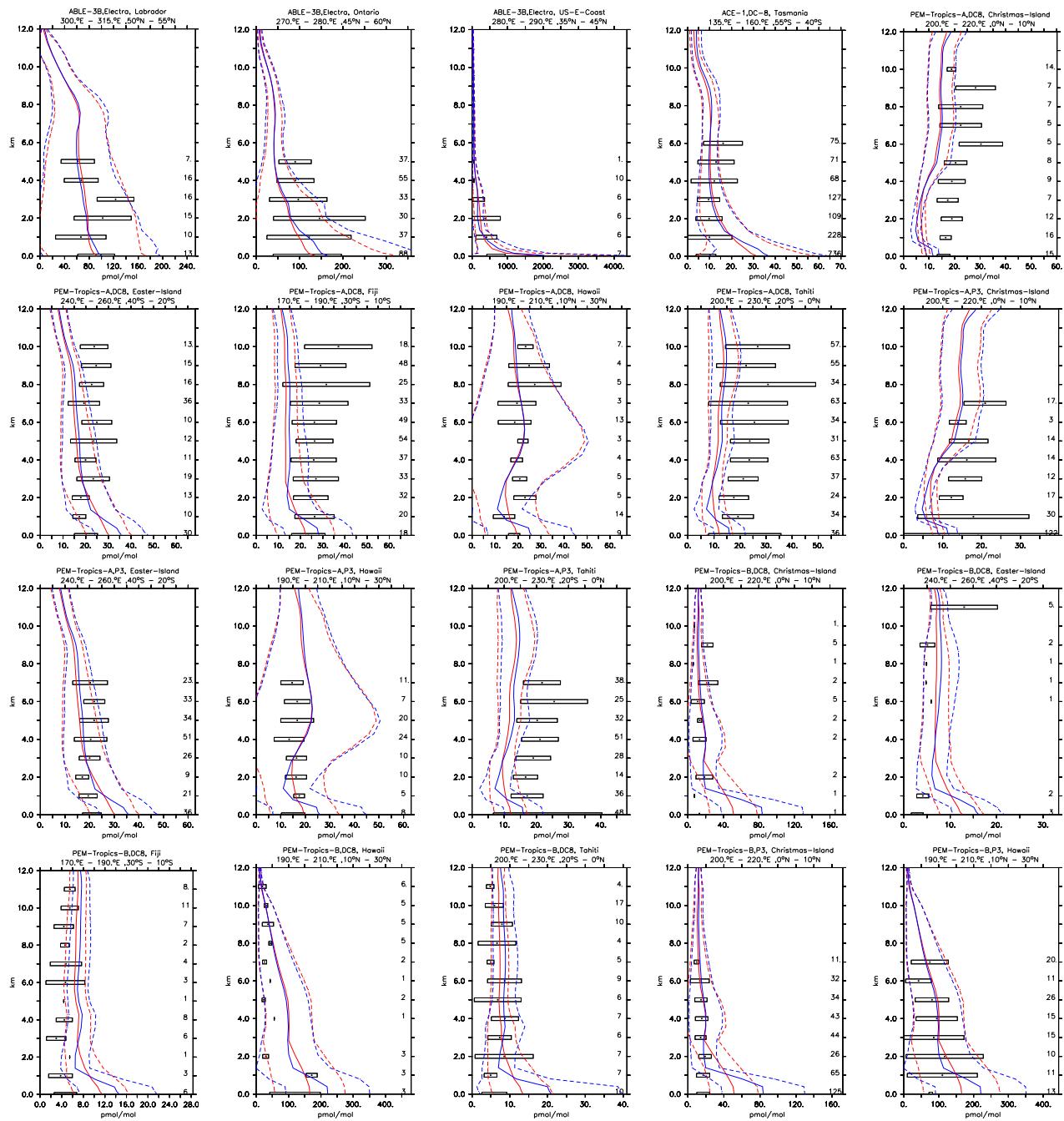


Figure 7:

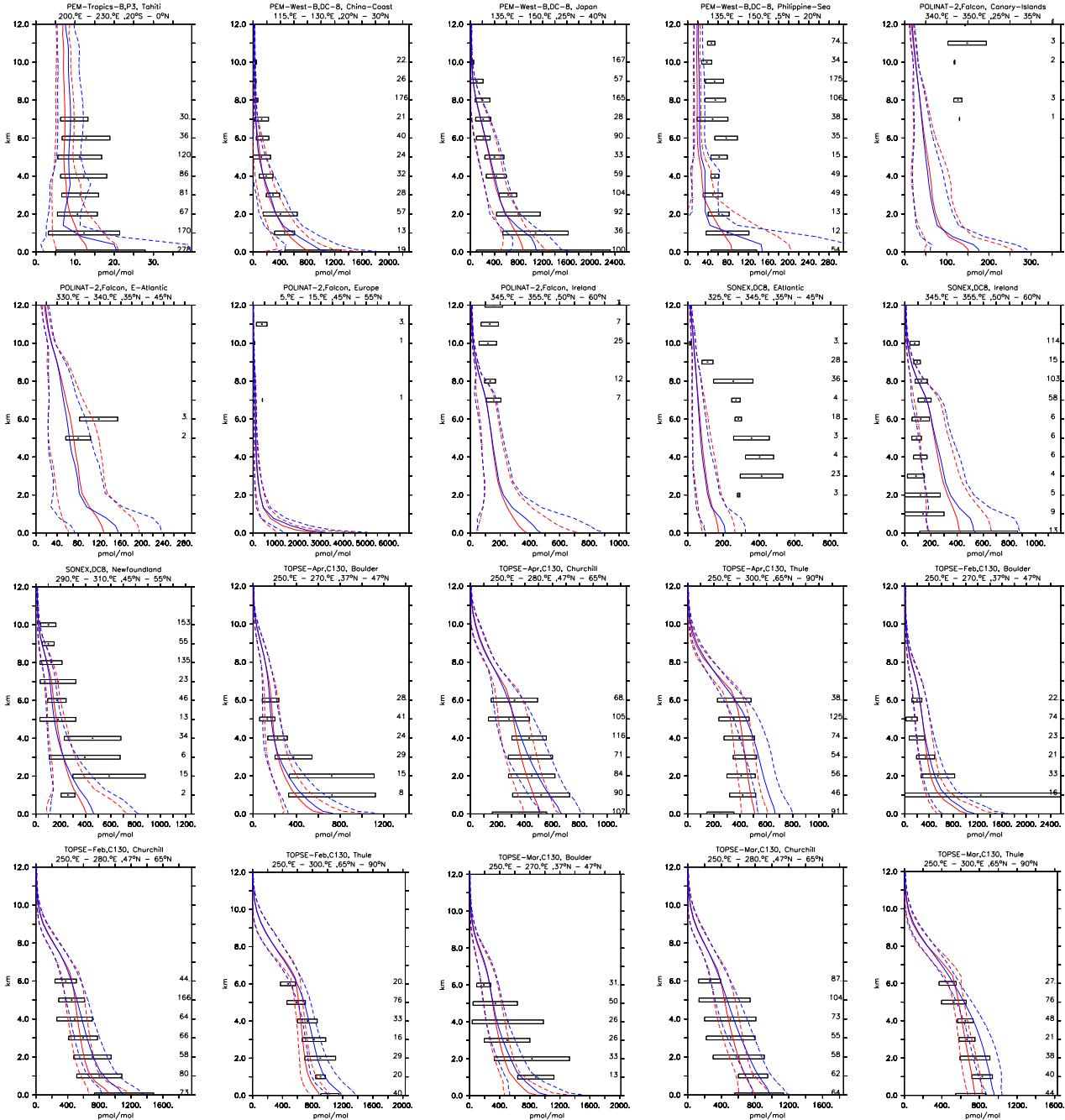


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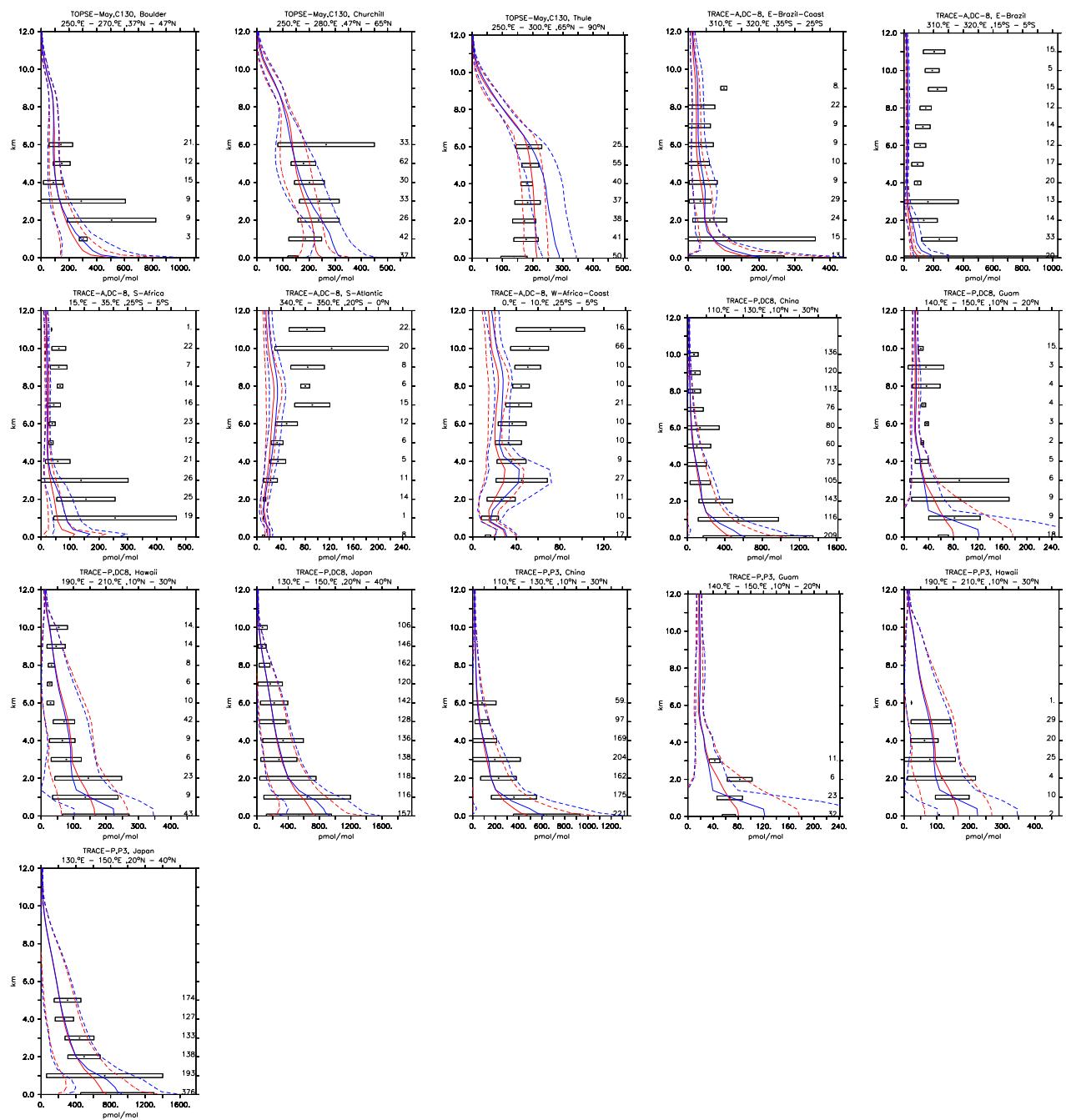


Figure 7: continued

2.5 CH_3COCH_3

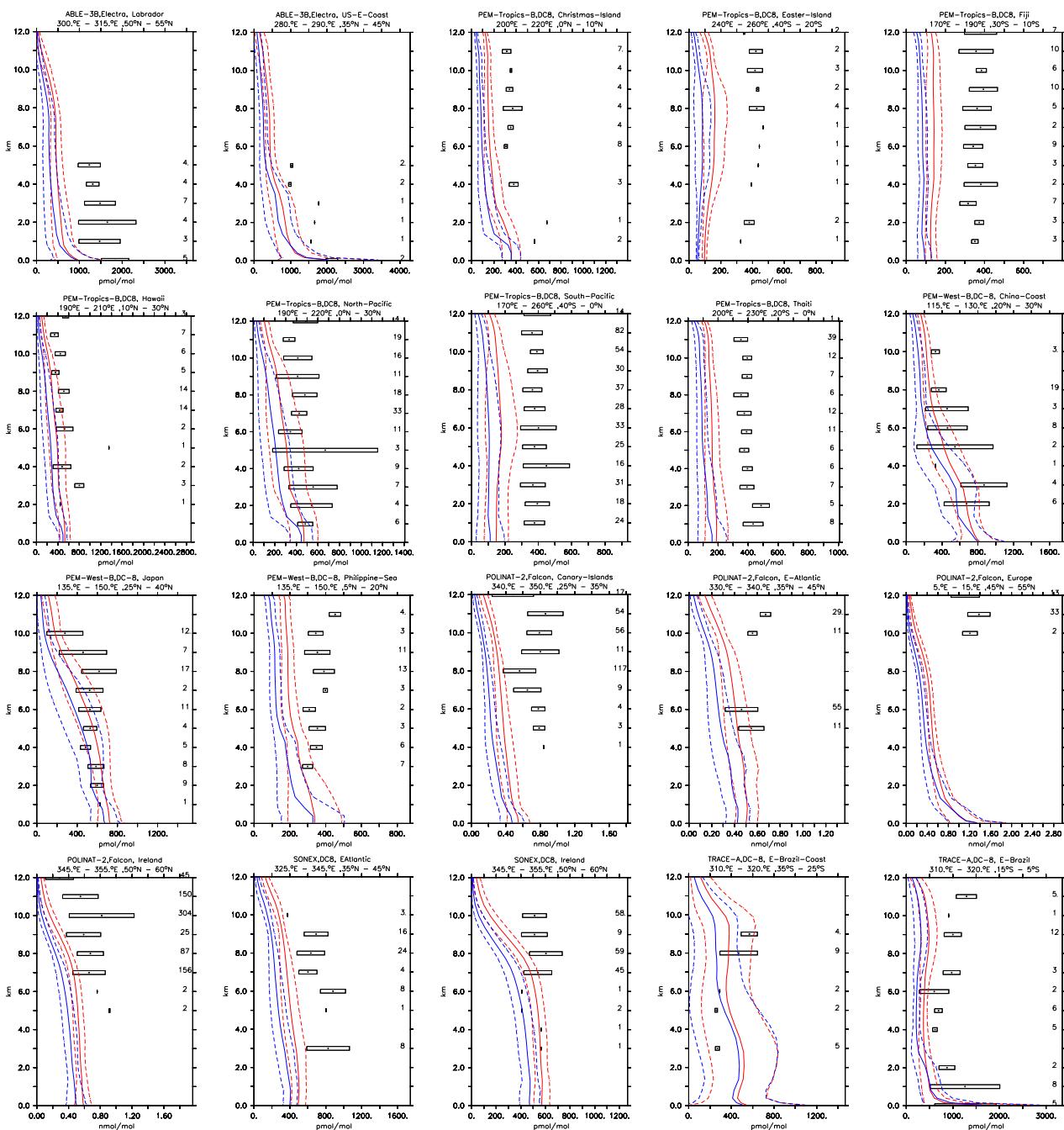


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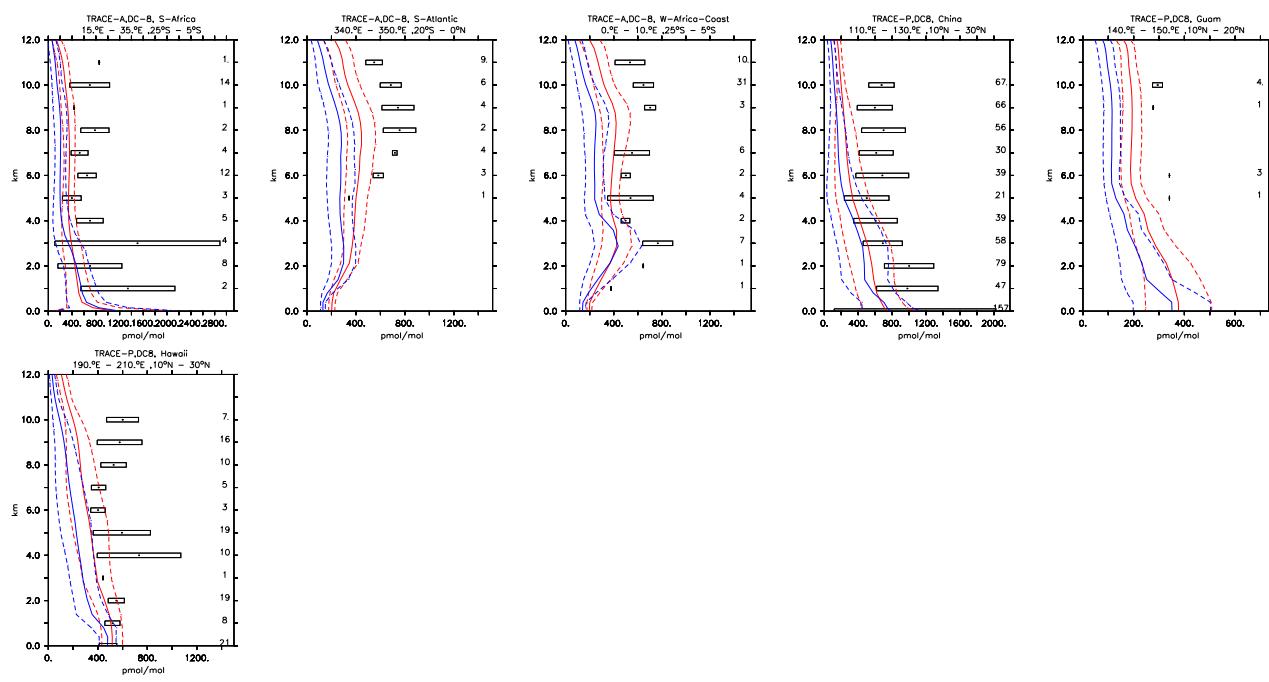


Figure 8: continued

2.6 CH₃OH

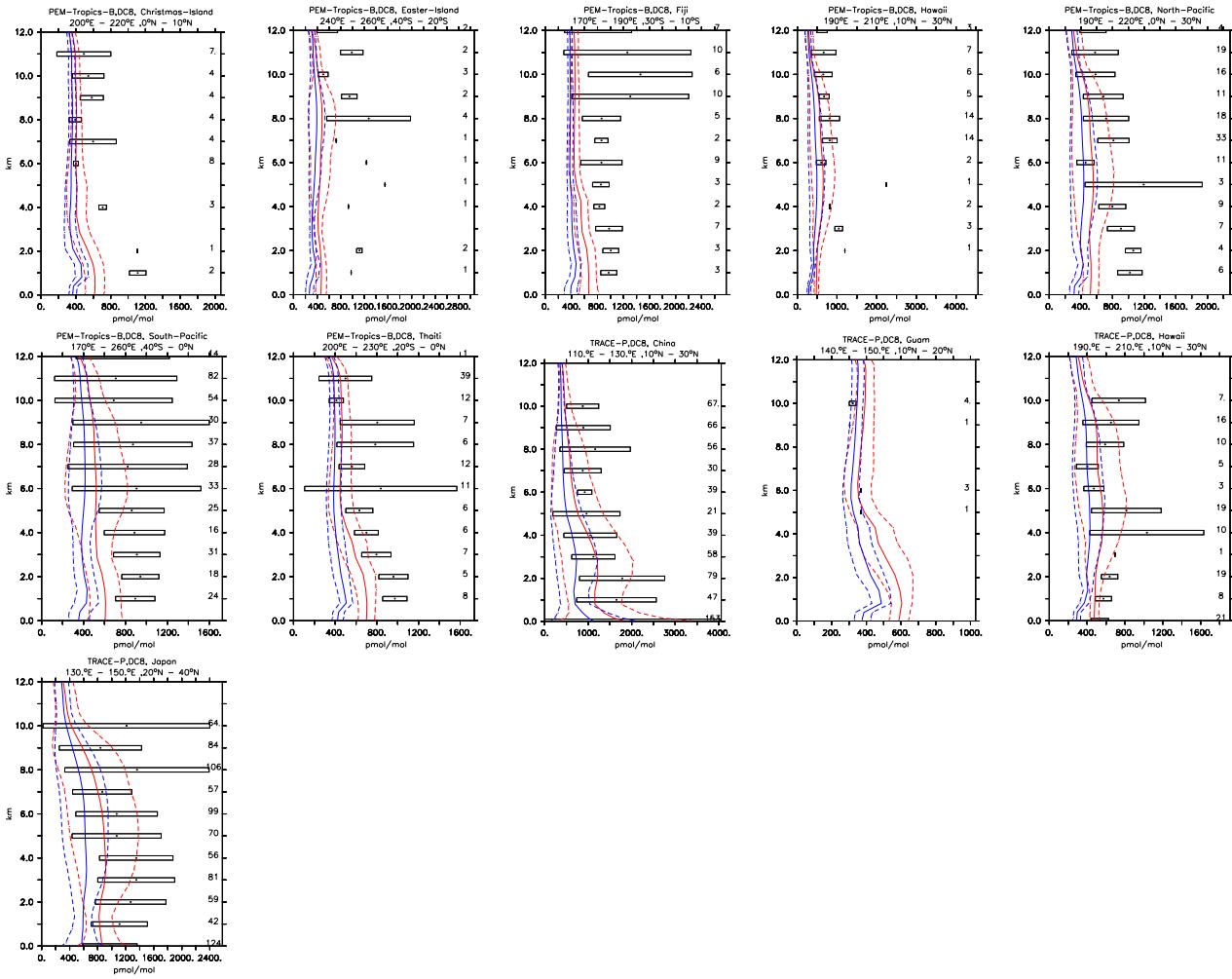


Figure 9:

2.7 CO

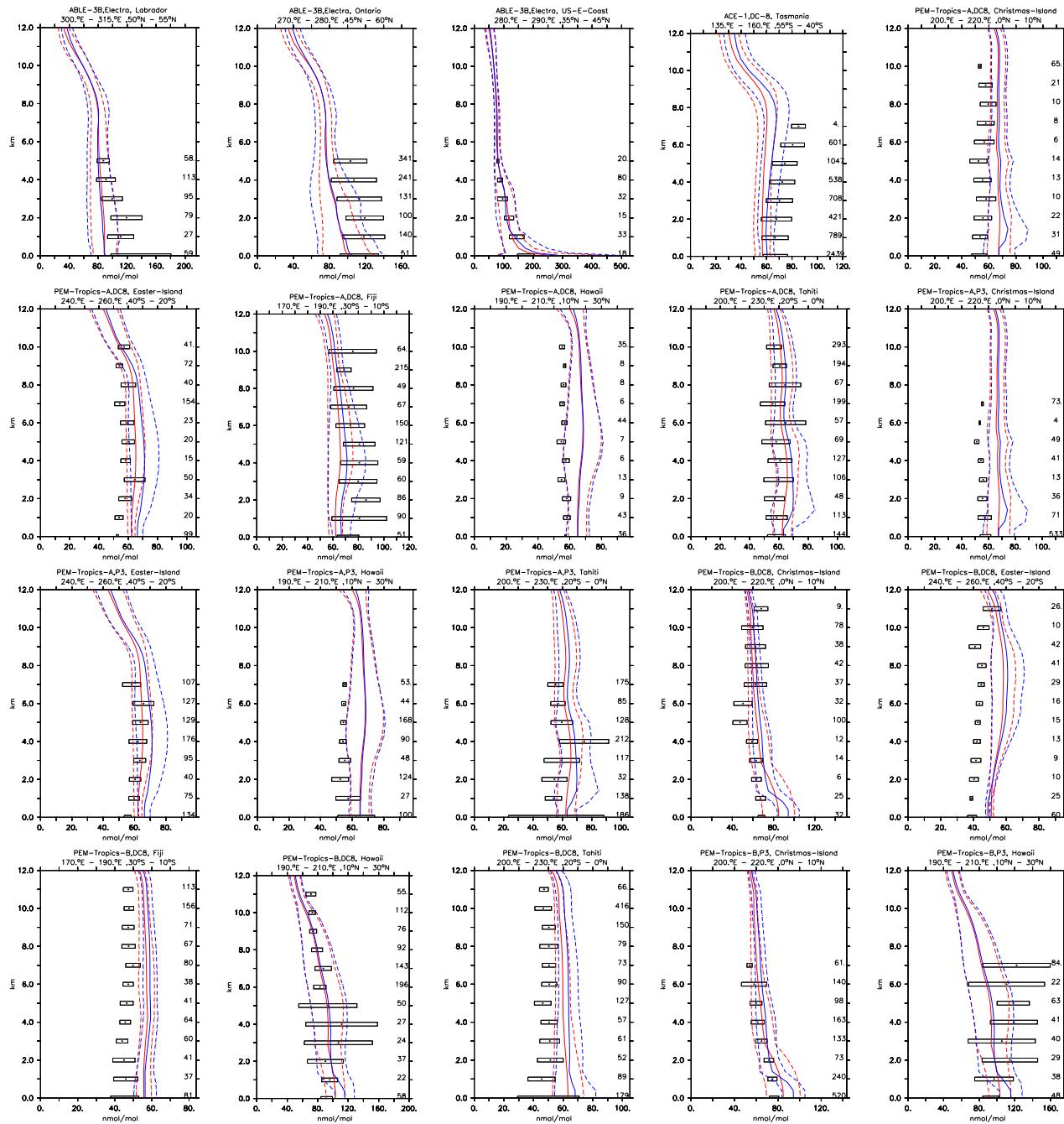


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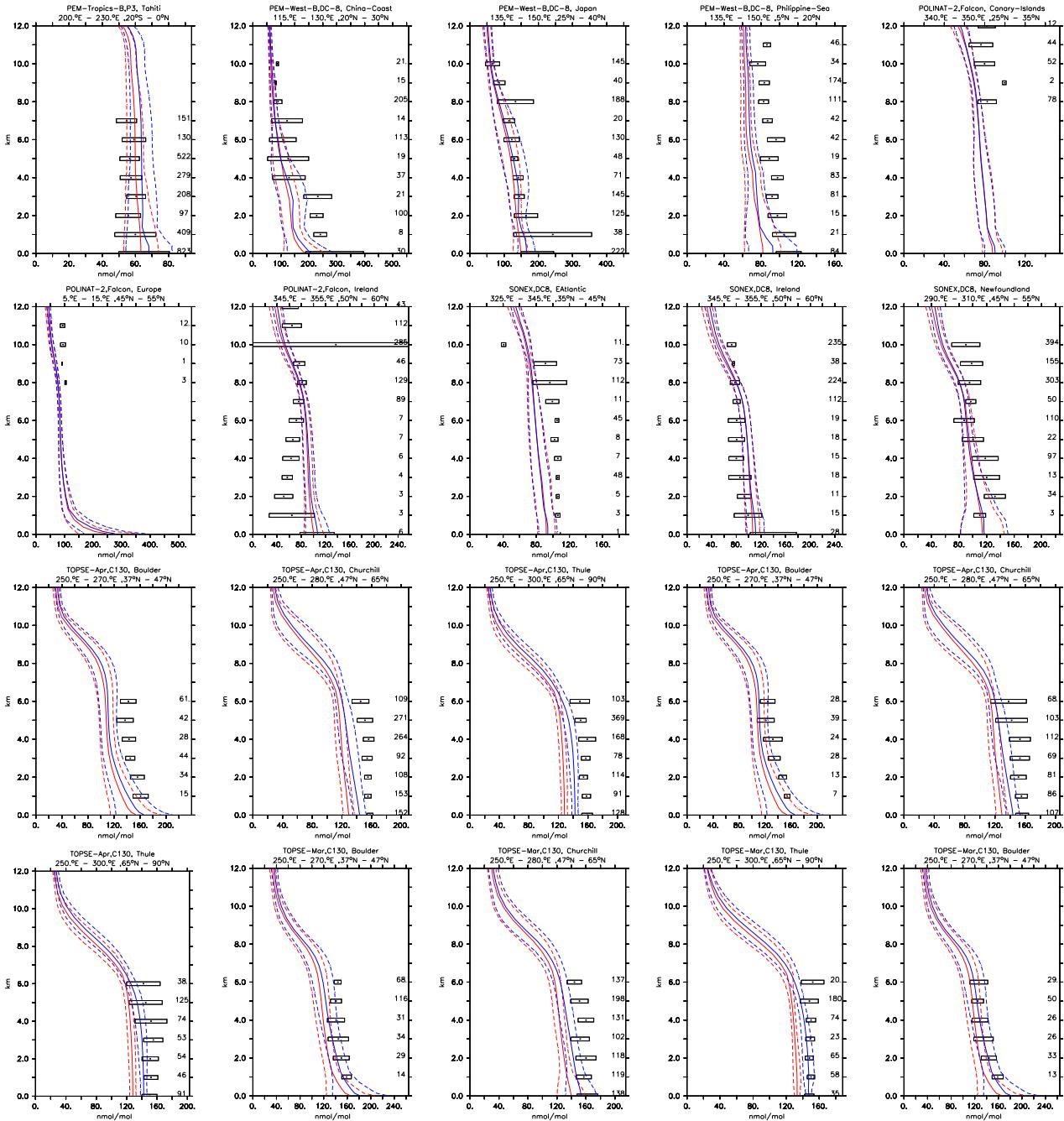


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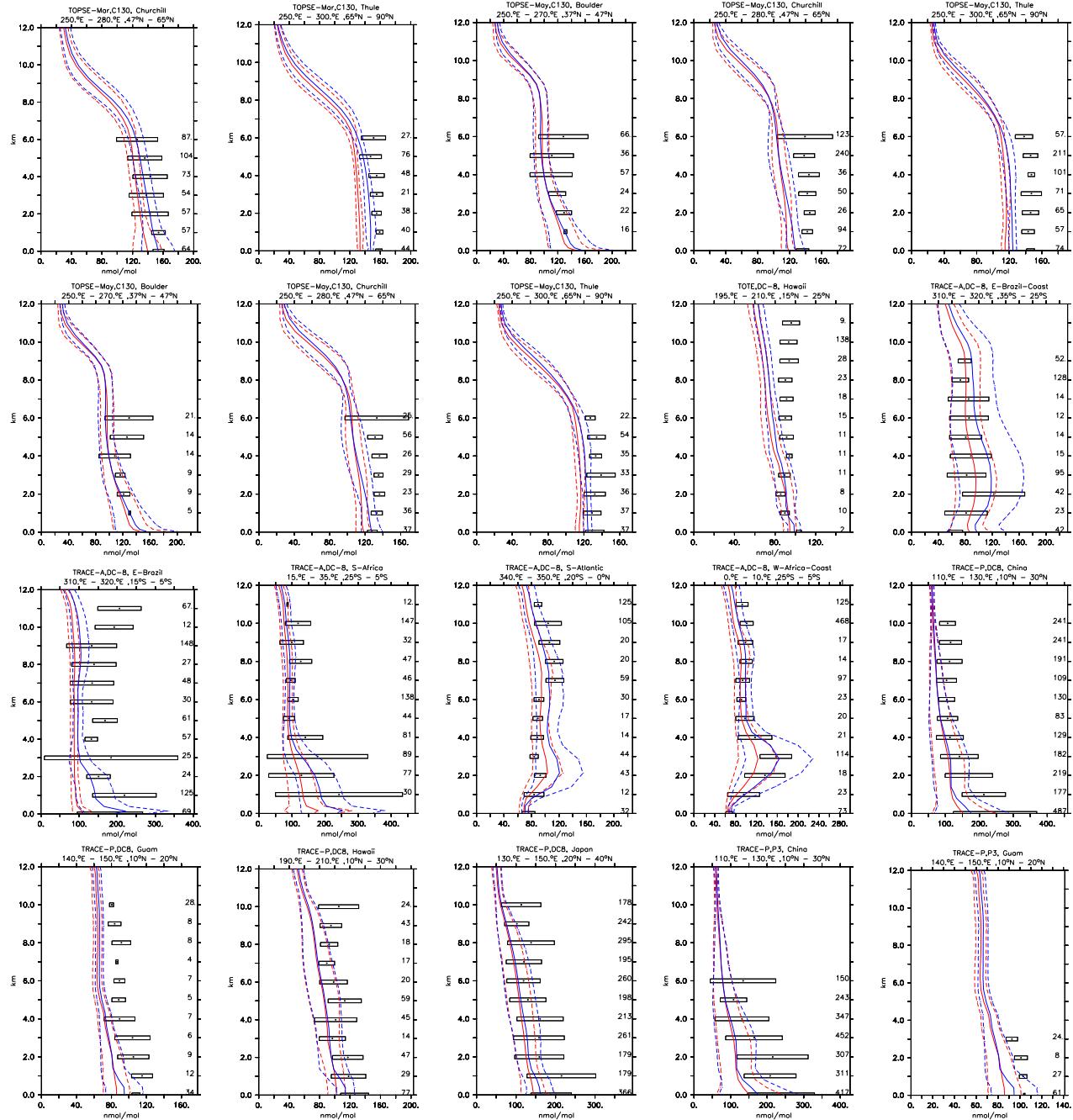


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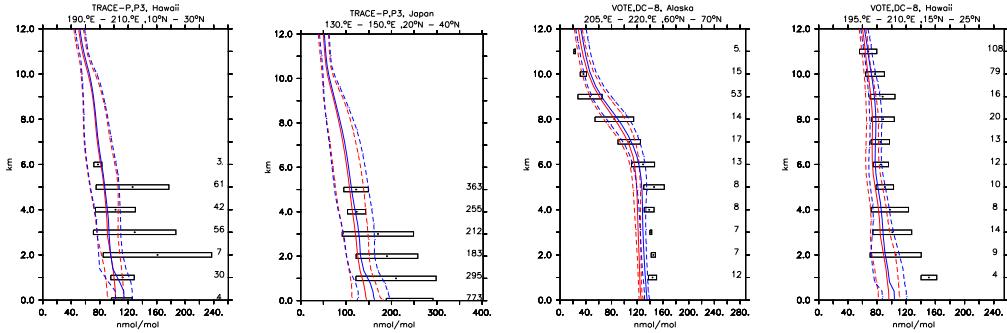


Figure 10: continued

2.8 H₂O₂

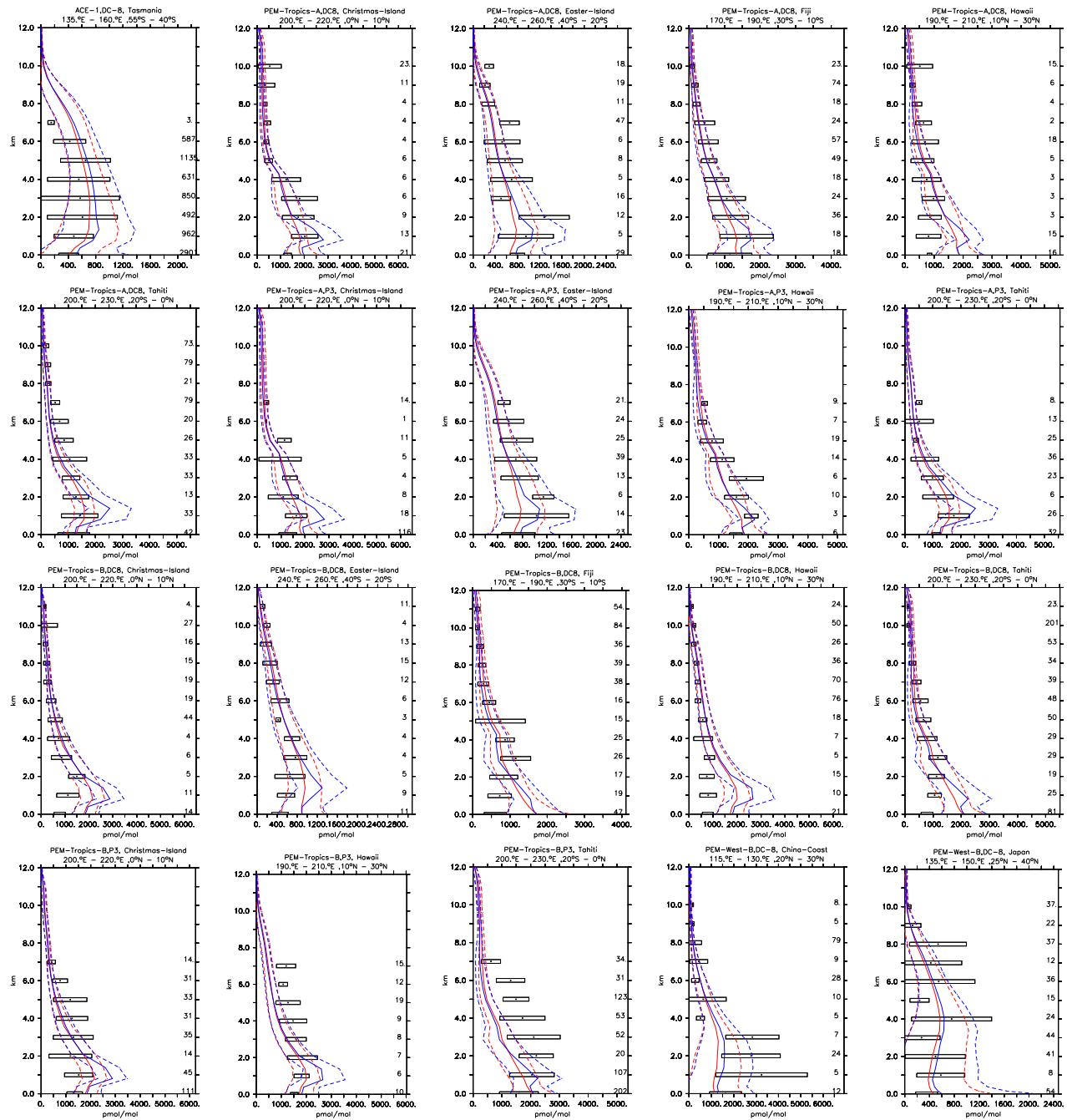


Figure 11:

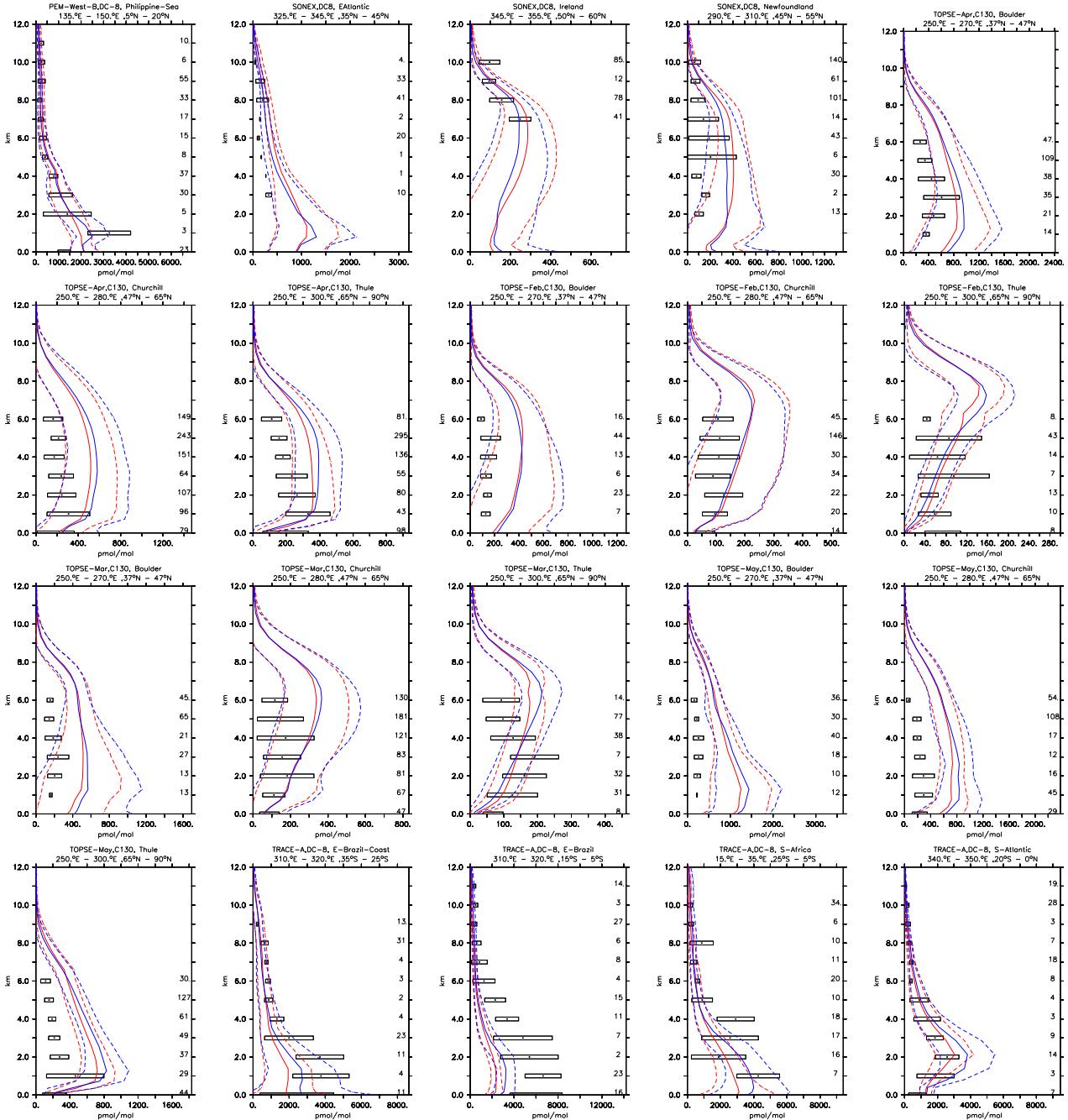


Figure 11: continued

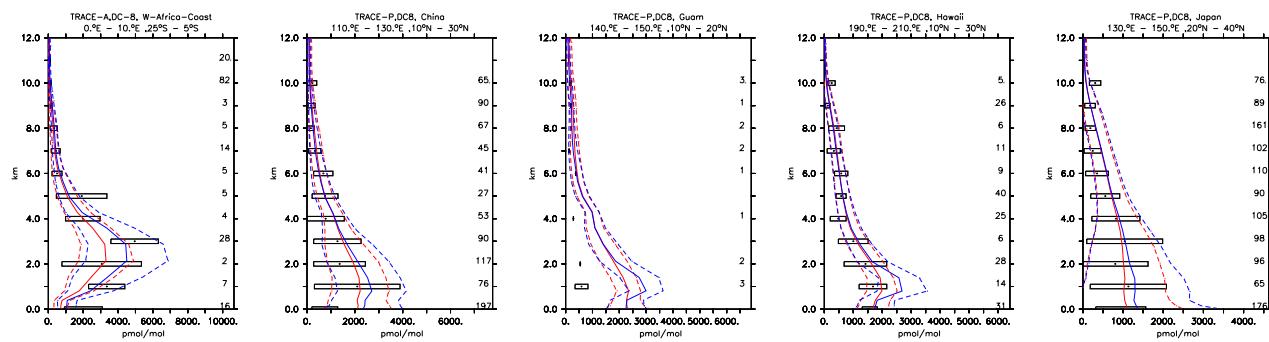


Figure 11: continued

2.9 HCHO

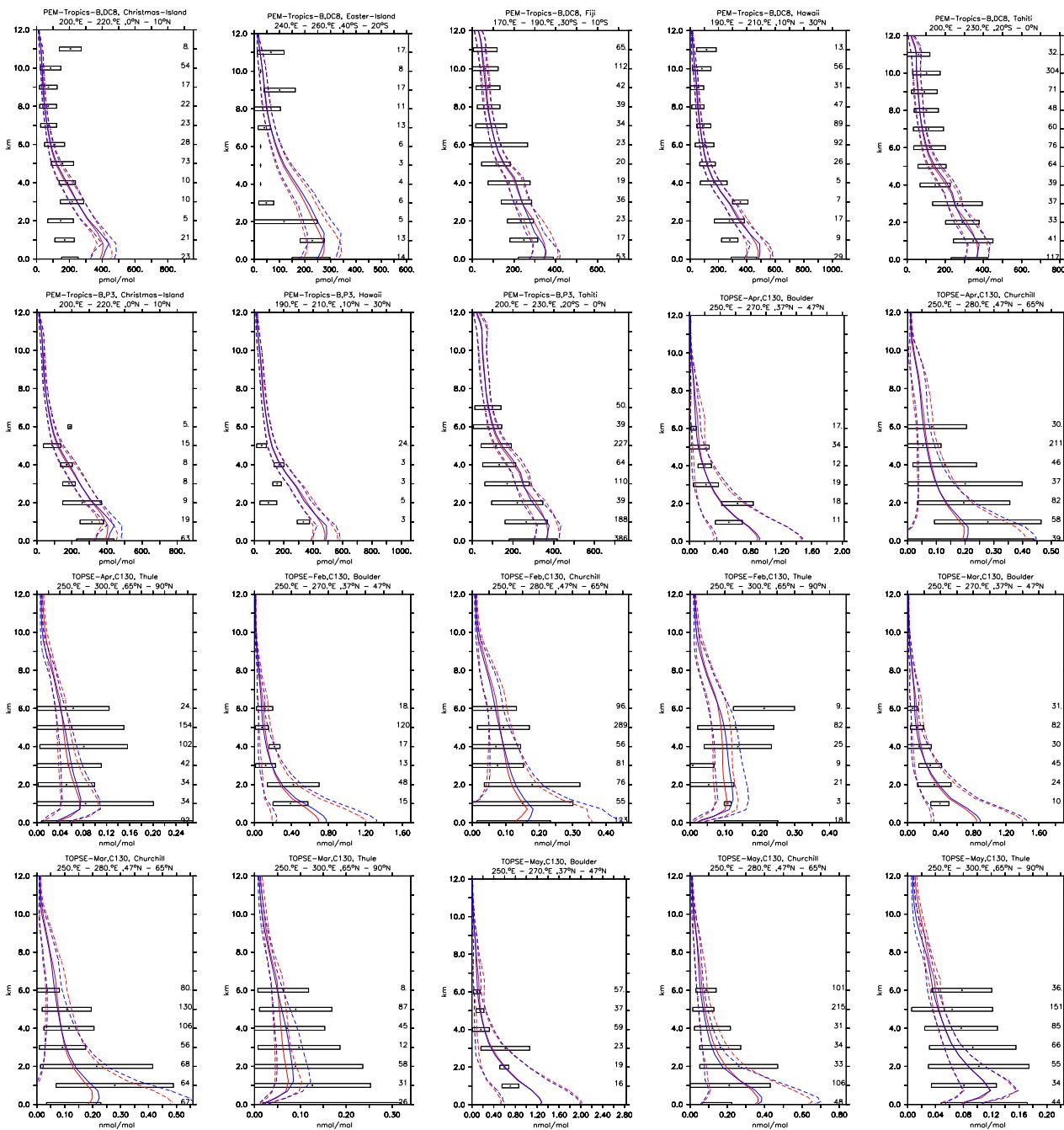


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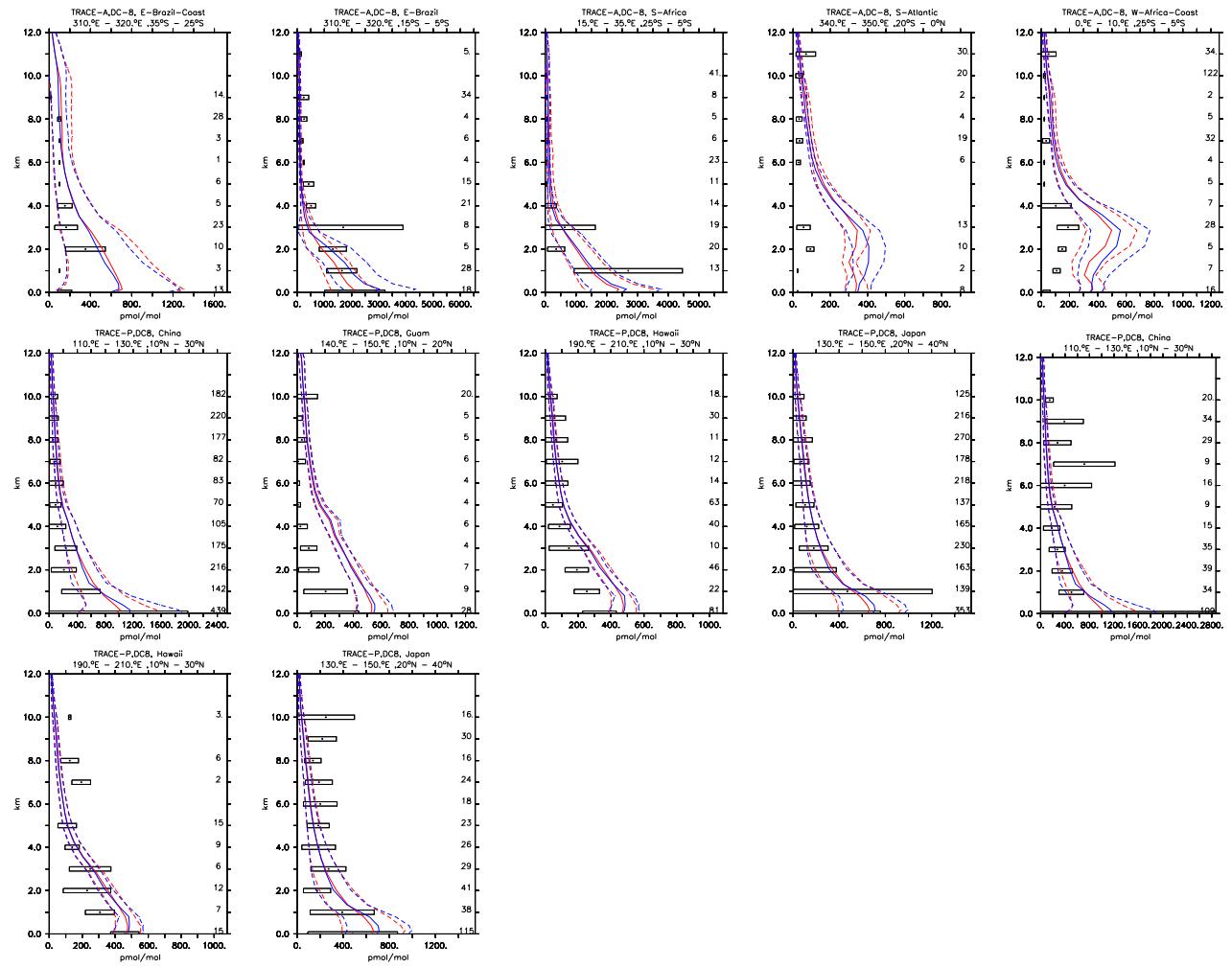


Figure 12: continued

2.10 HNO_3

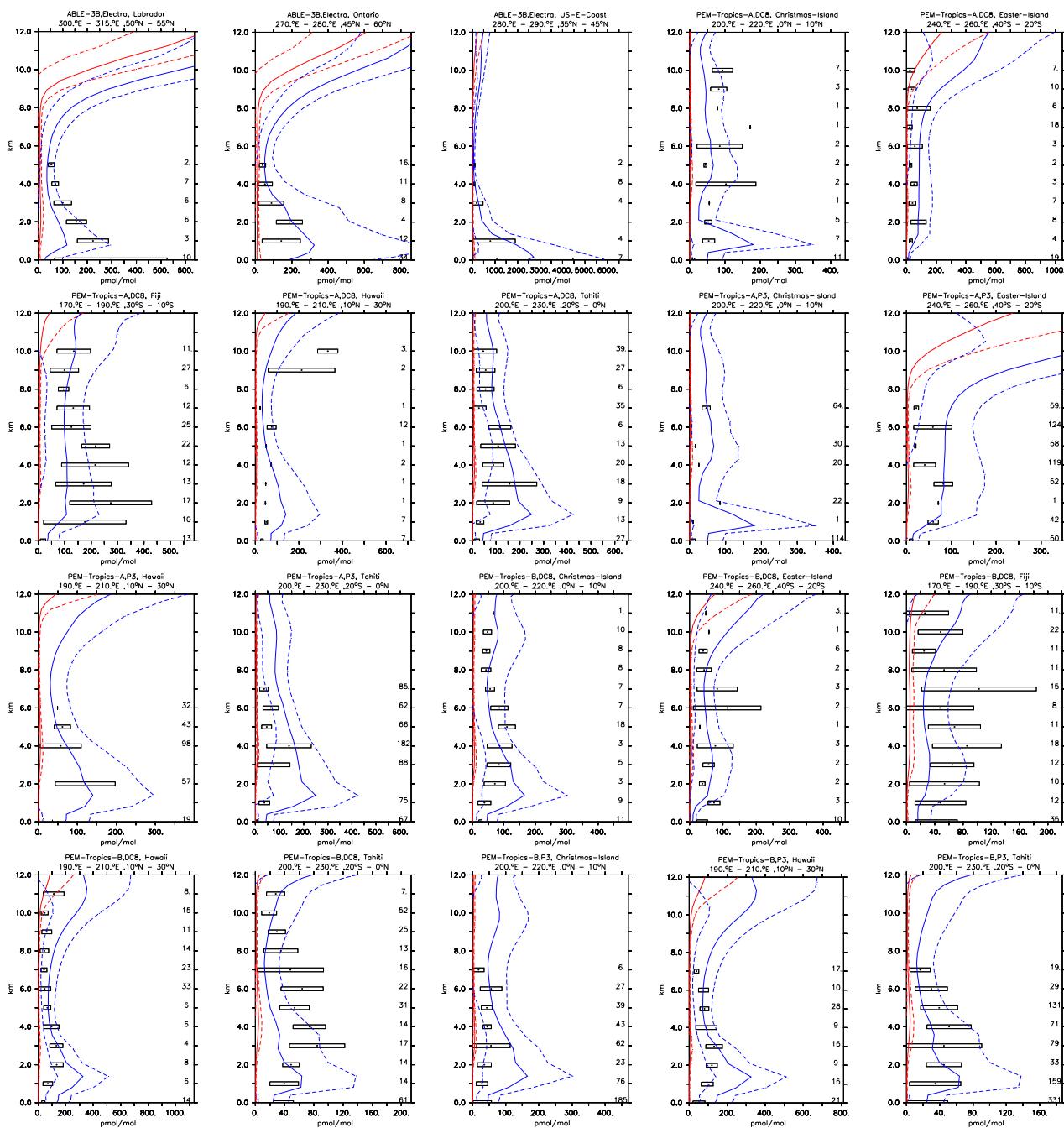


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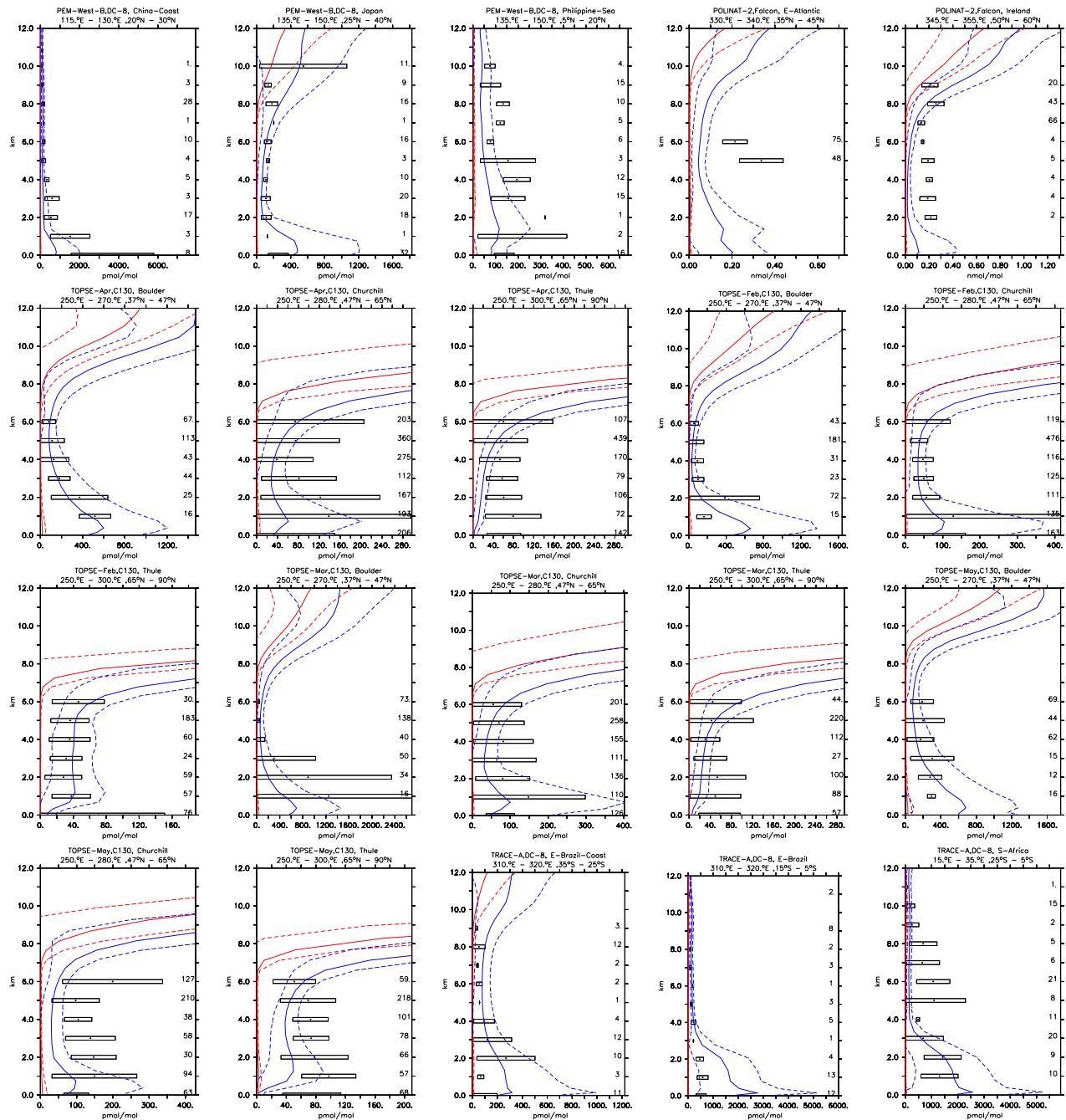


Figure 13: continued

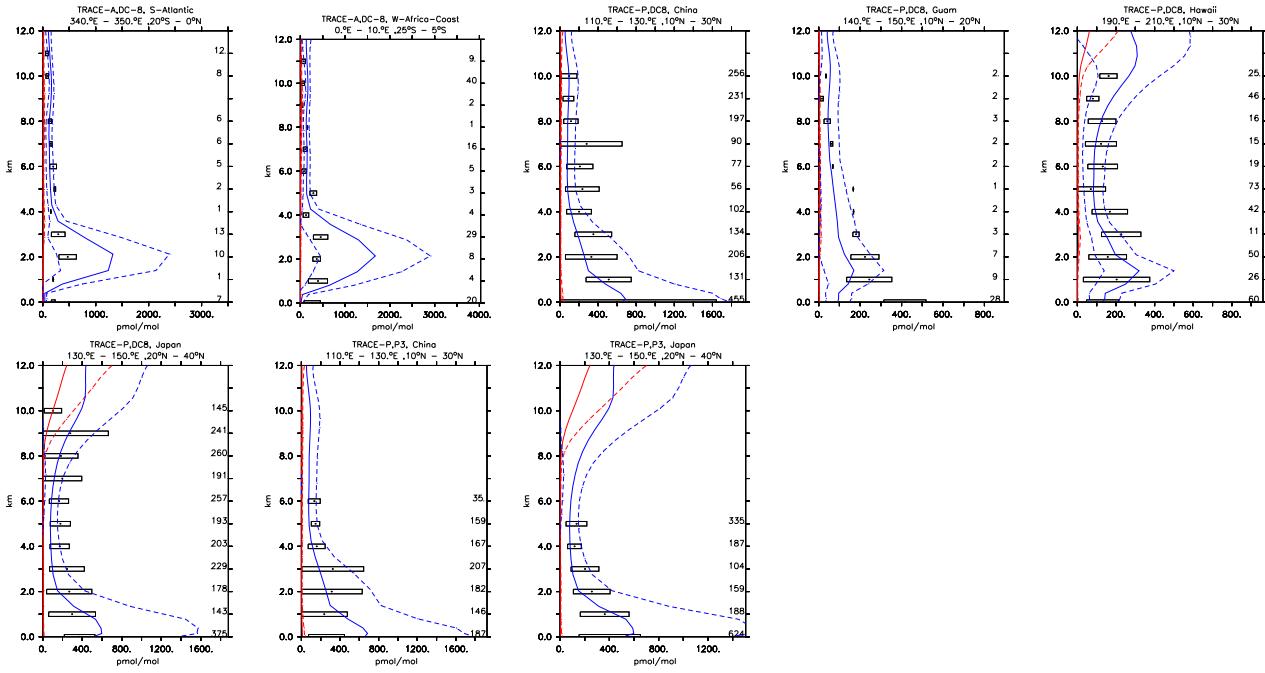


Figure 13: continued

2.11 $\text{HNO}_3 + \text{NO}_3^-$ (cs)

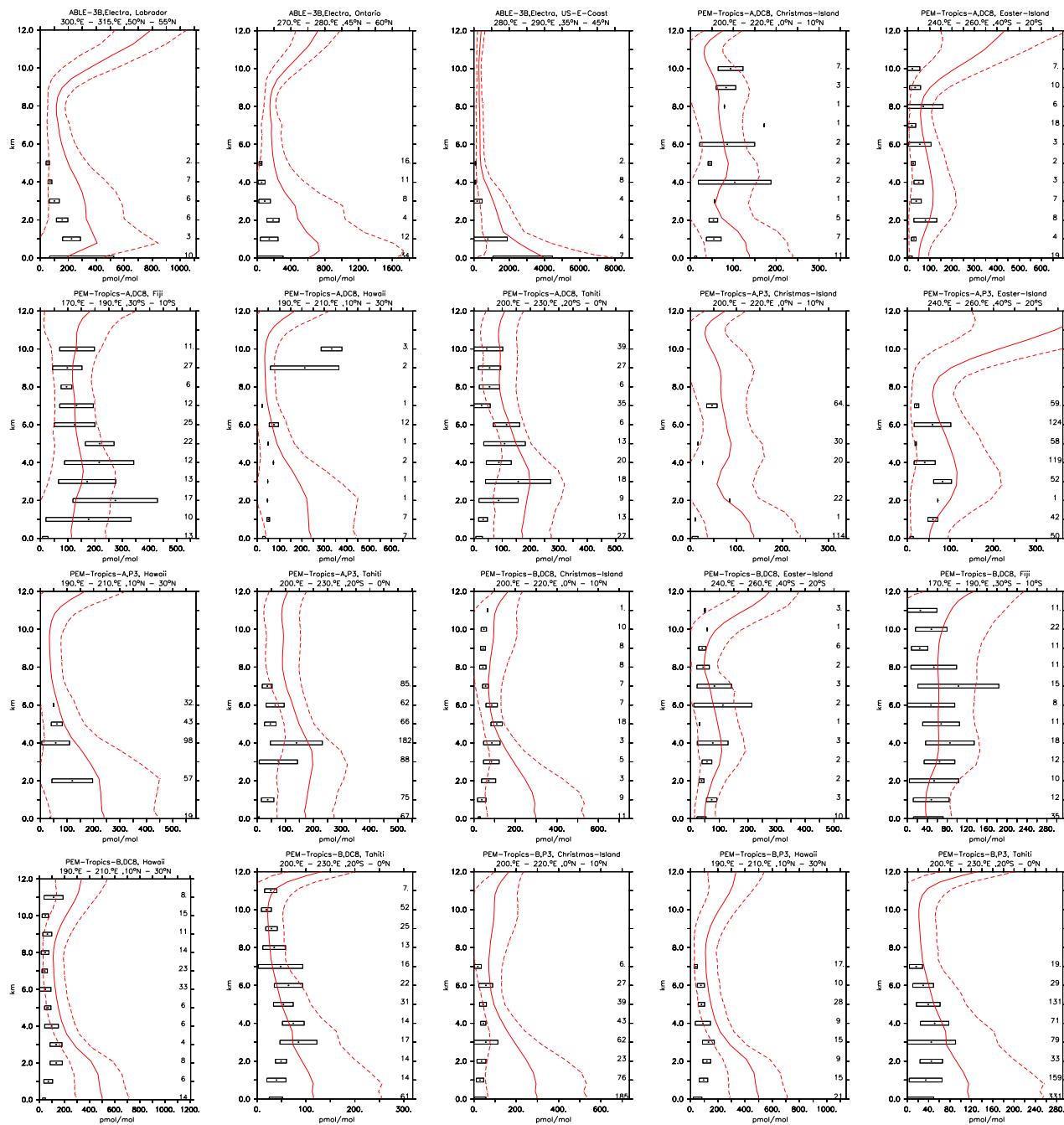


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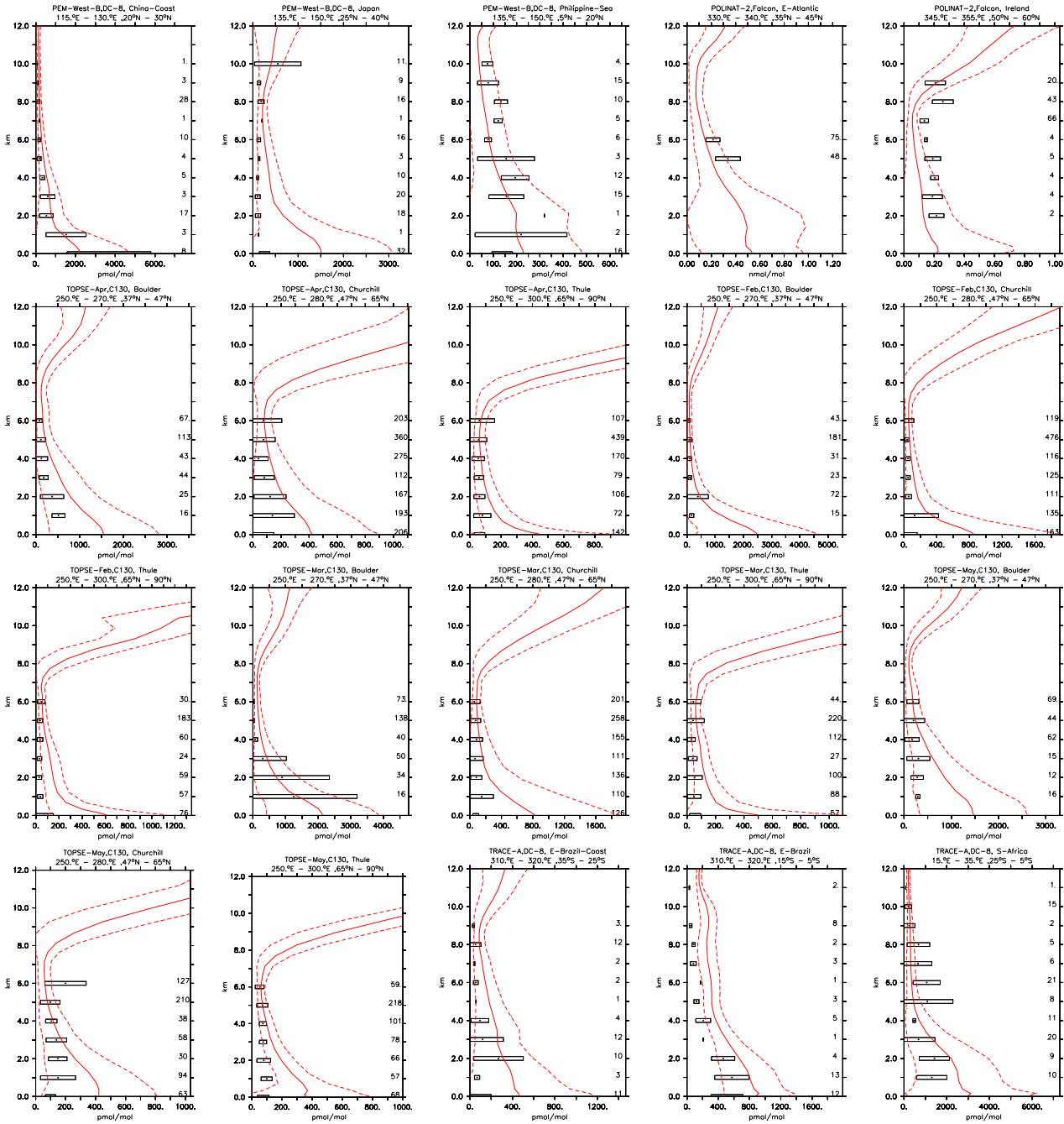


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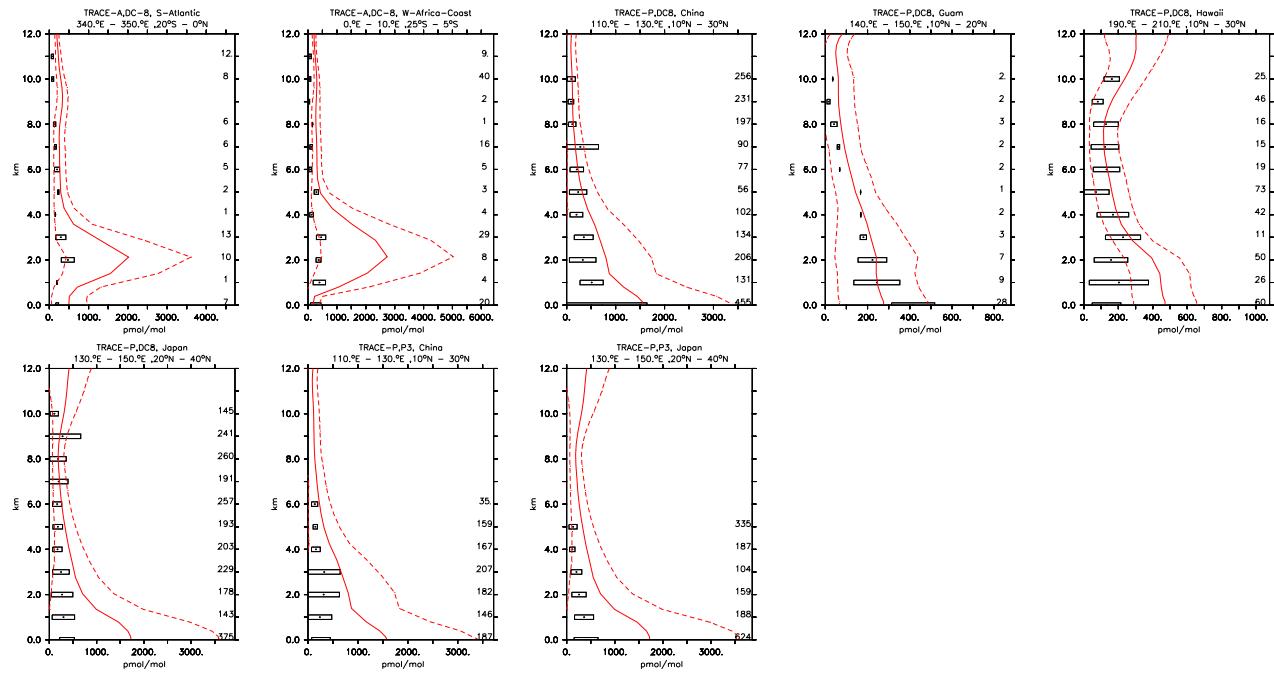


Figure 14: continued

2.12 O₃

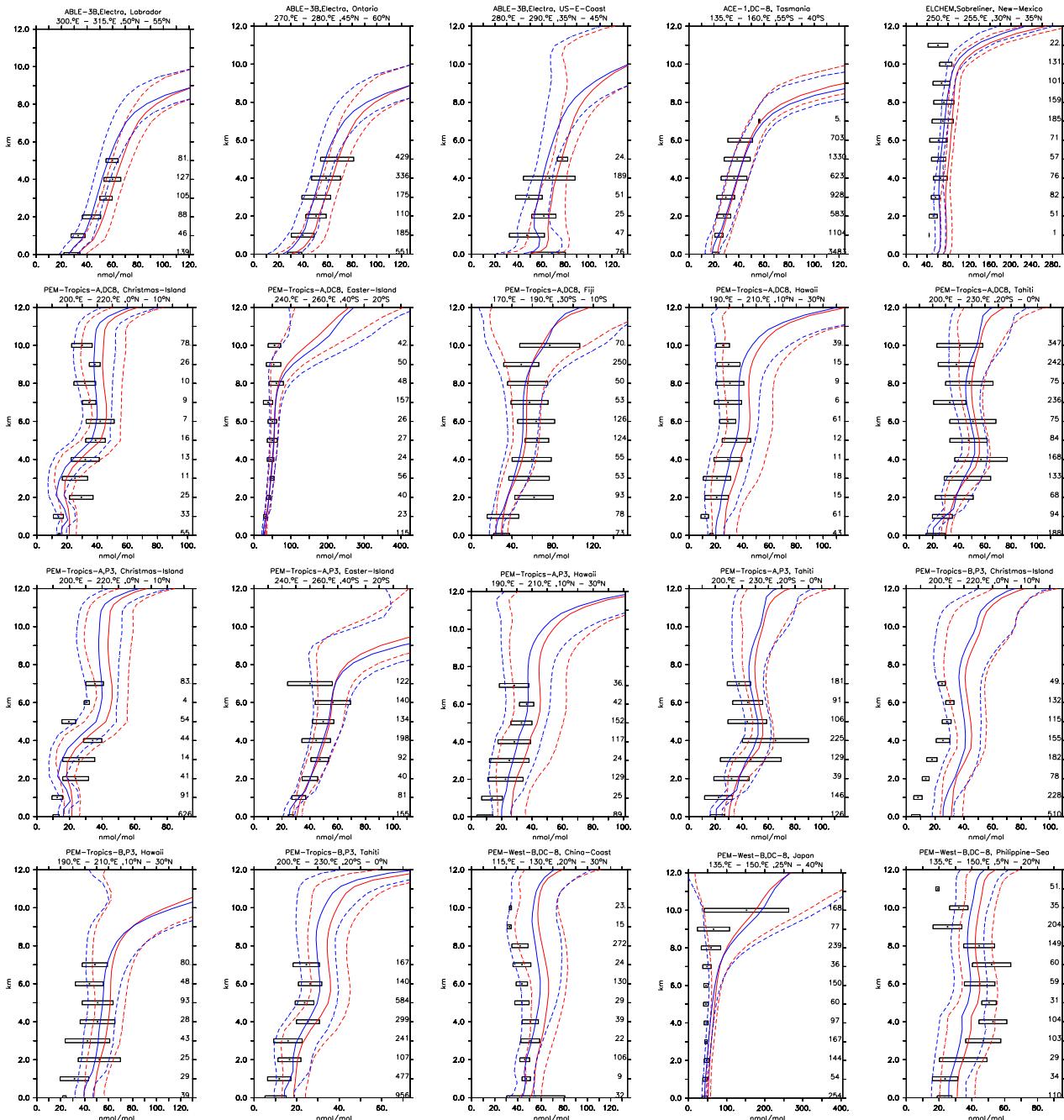


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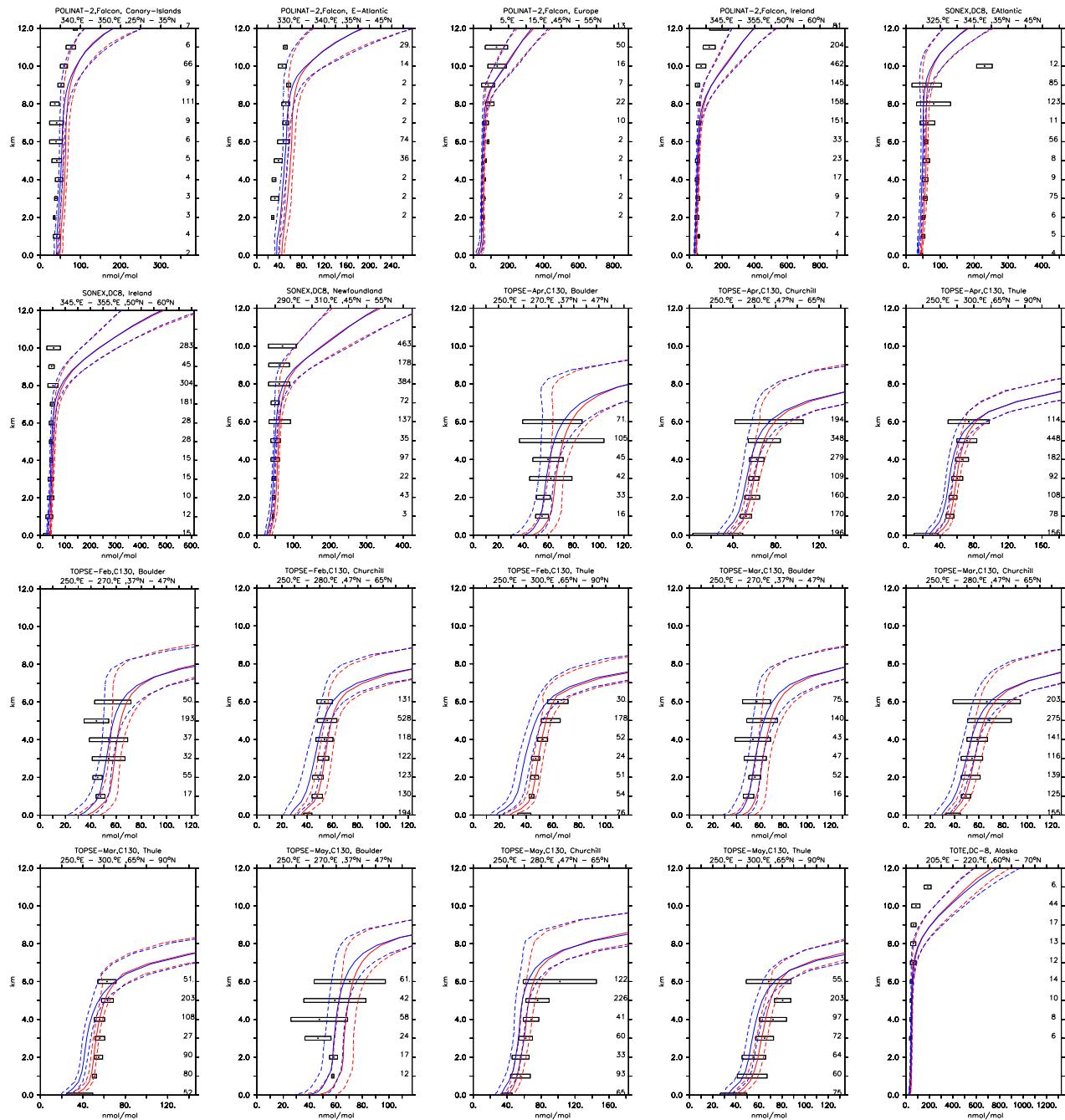


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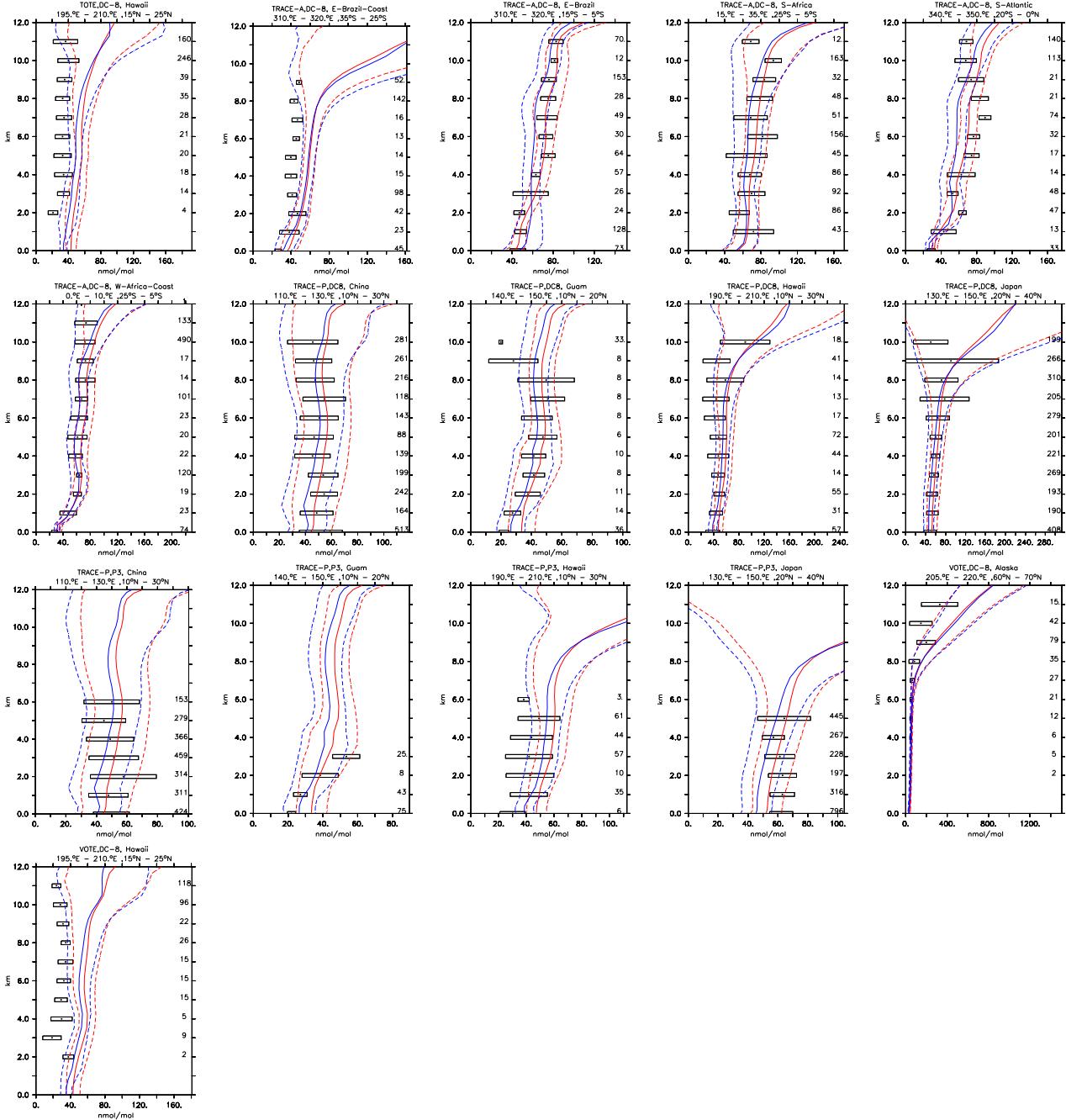


Figure 15: continued

2.13 ^{210}Pb

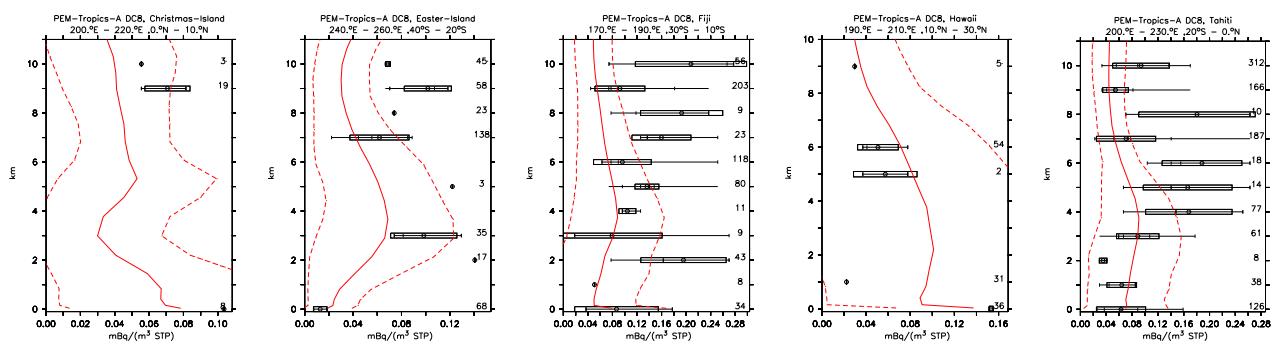


Figure 16:

3 Time series

3.1 CO

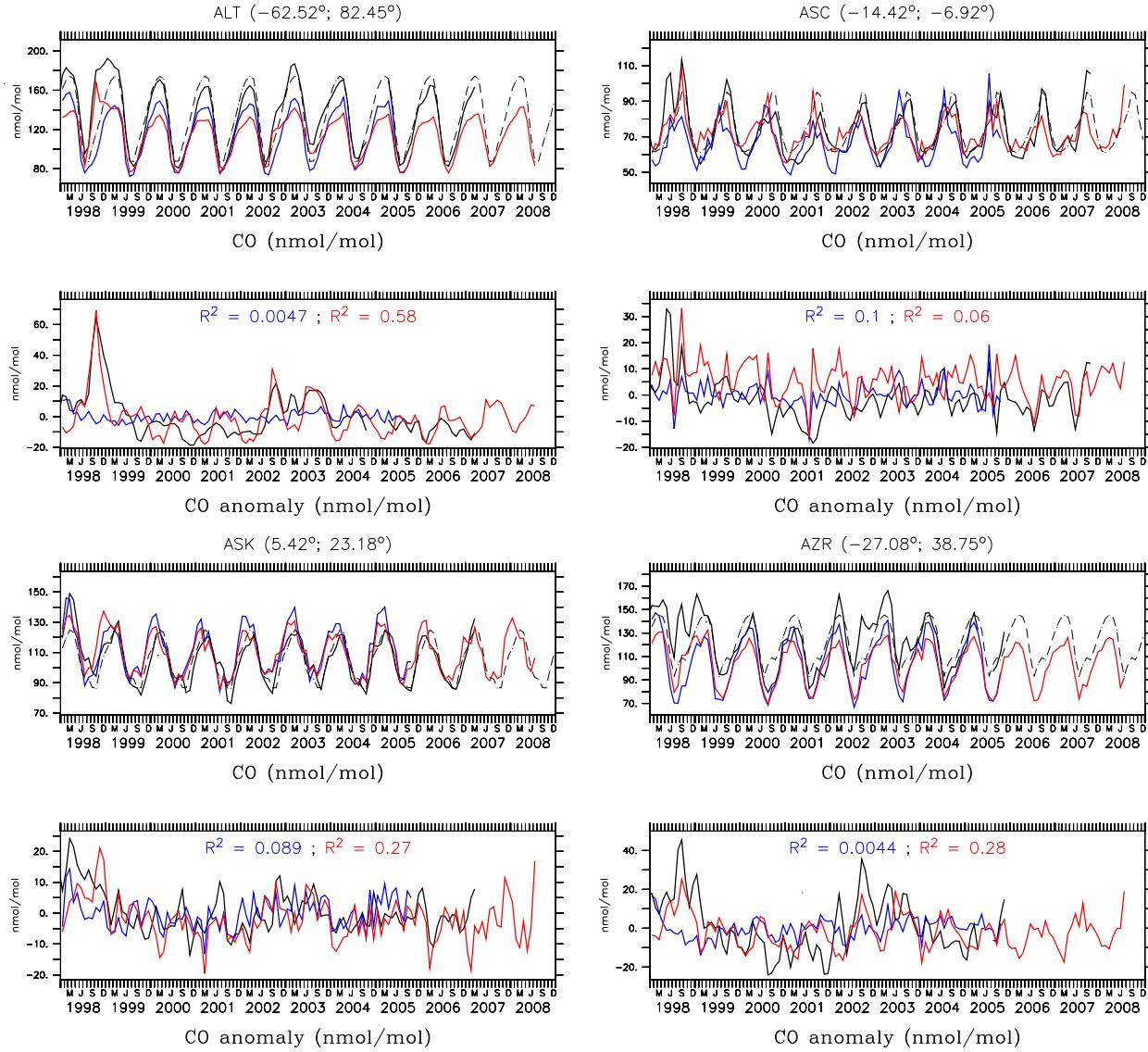


Figure 17: Comparison of simulated monthly average CO mixing ratios with observations (at several surface measurement stations) provided by the National Oceanic and Atmospheric Administration Earth System Research Laboratory (NOAA/ESRL) as originally presented by Novelli et al. (1998). The station identifier and geographical position is indicated at the top of the respective upper panel. The upper panel of each pair shows the absolute values: the black line denotes the observations, the dashed black line the corresponding climatological monthly average, the blue line the results of the simulation S1 (Jöckel et al., 2006) and the red line the results of the new simulation. The lower panel of each pair shows the deviations (anomalies) from the corresponding climatological monthly average in absolute units: black: observations, blue: simulation S1 of Jöckel et al. (2006), red: new simulation. The R^2 are the corresponding Pearson's correlation coefficients between the simulated and observed anomalies.

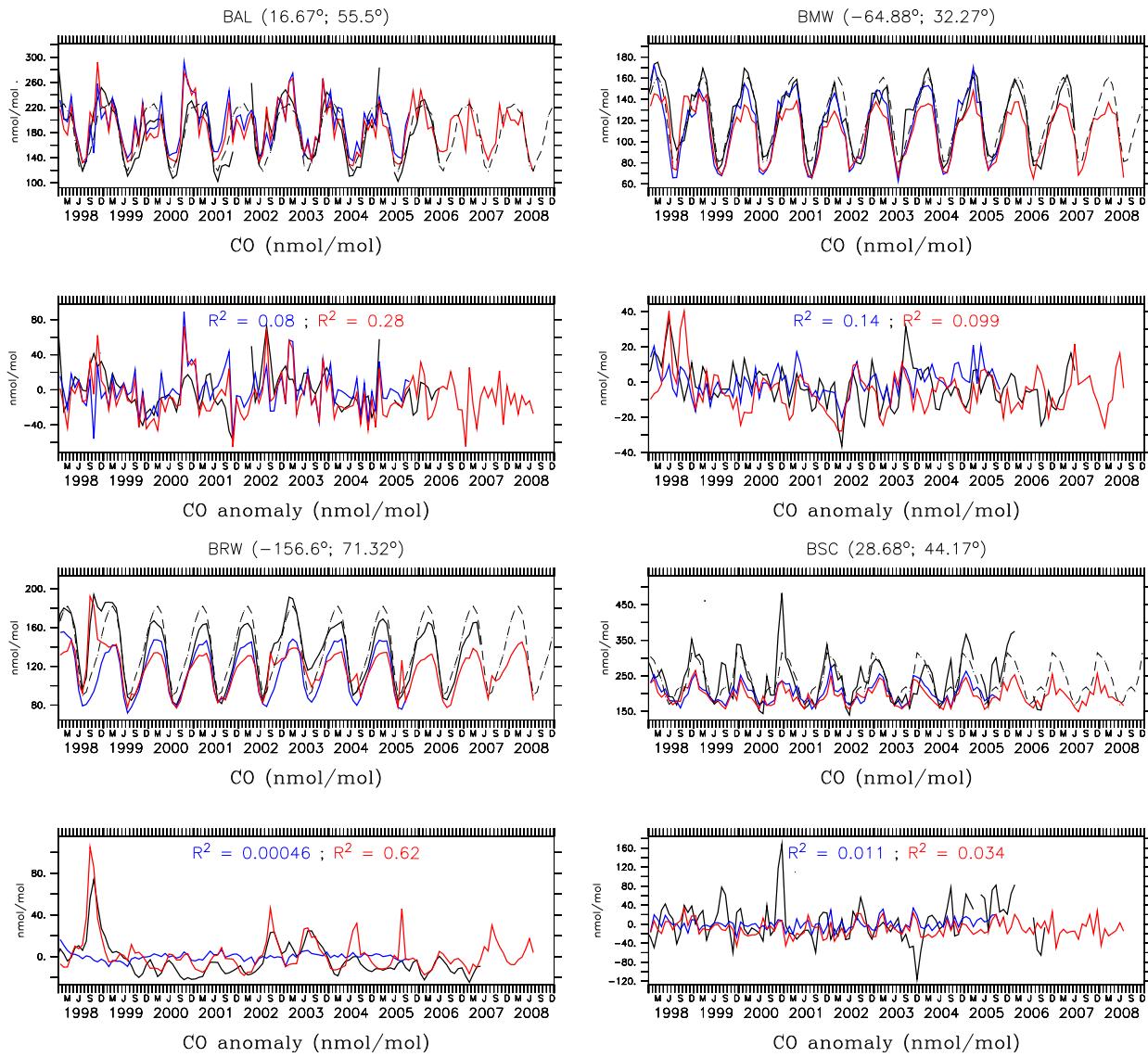


Figure 17: continued

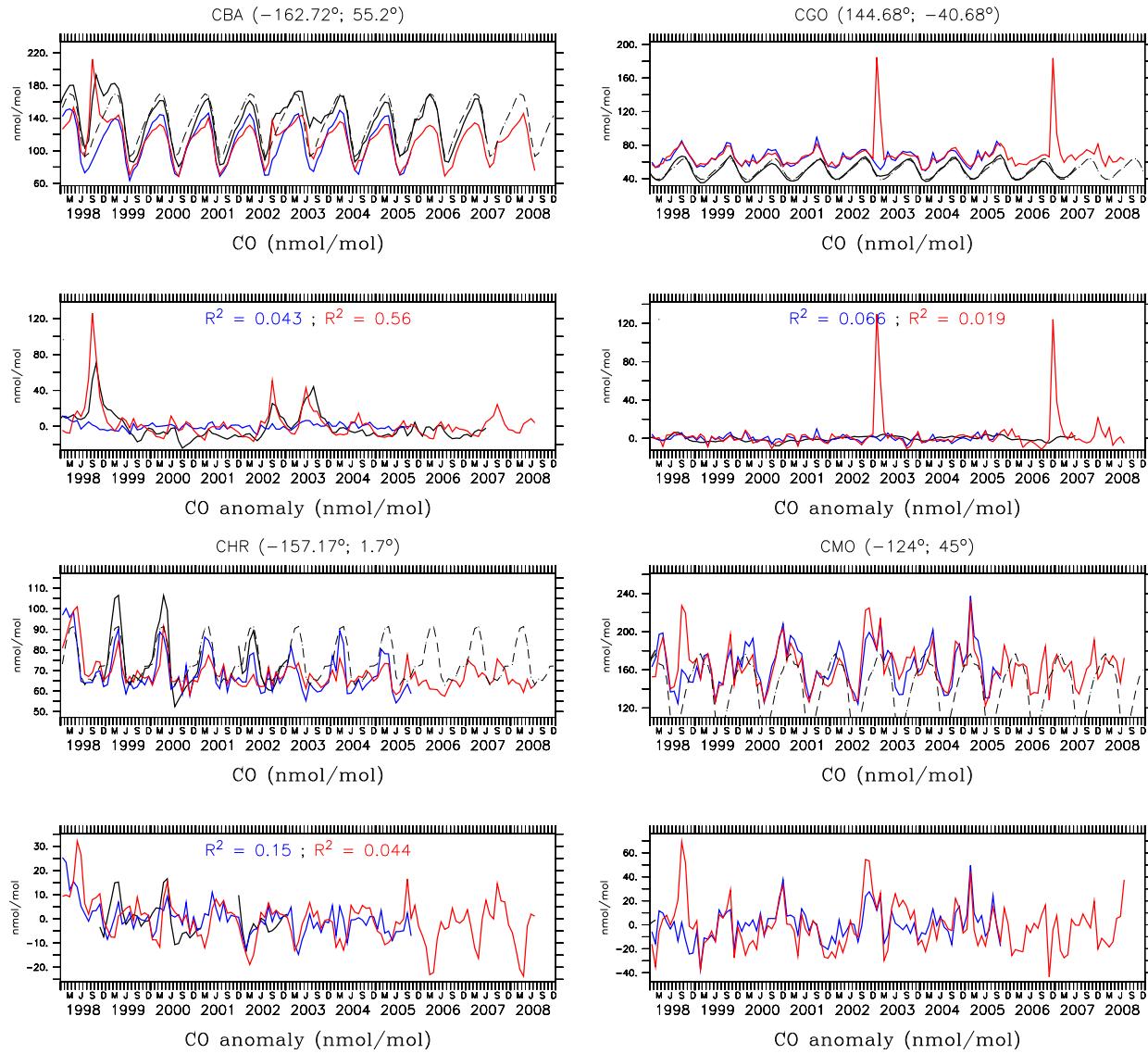


Figure 17: continued

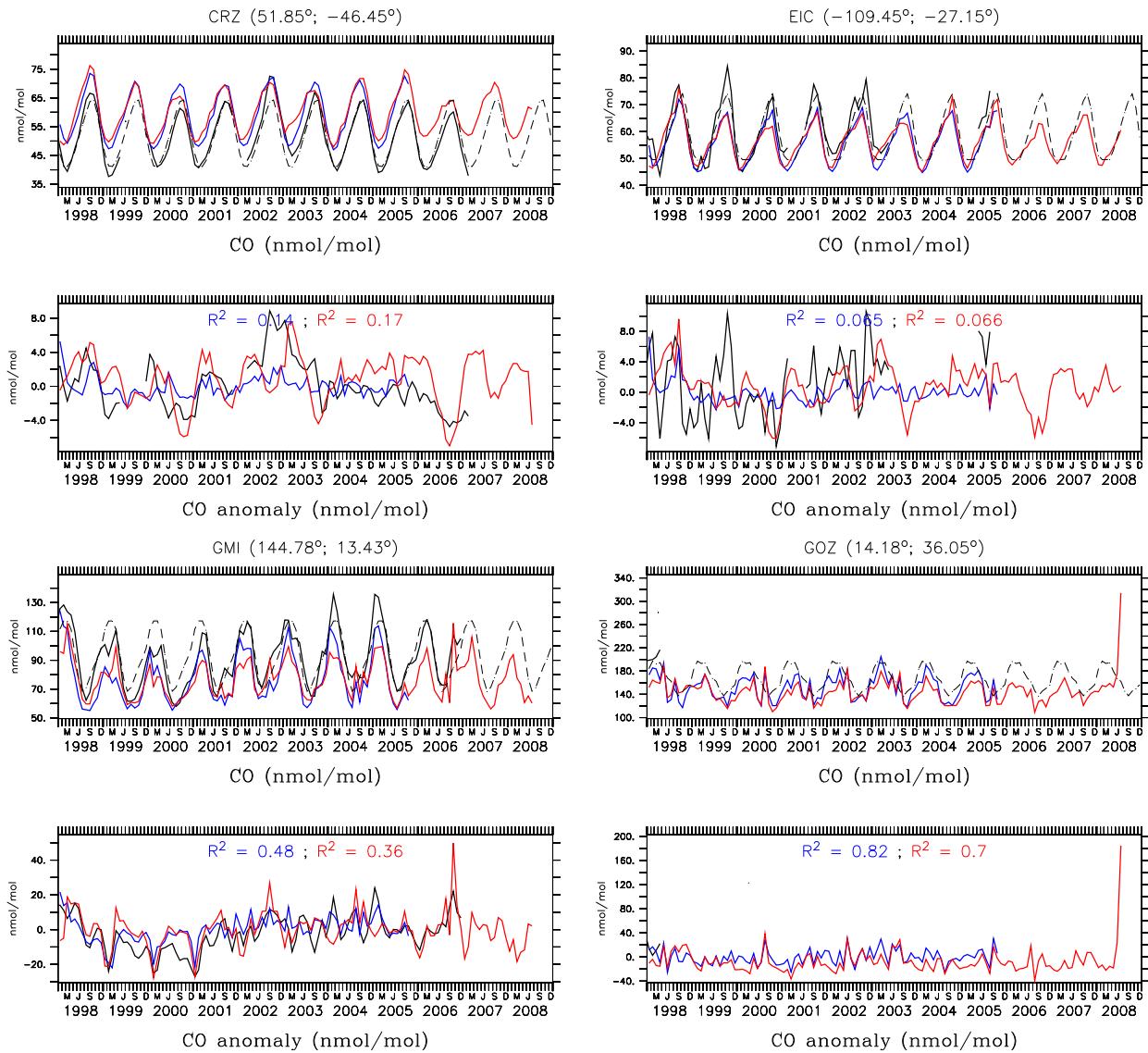


Figure 17: continued

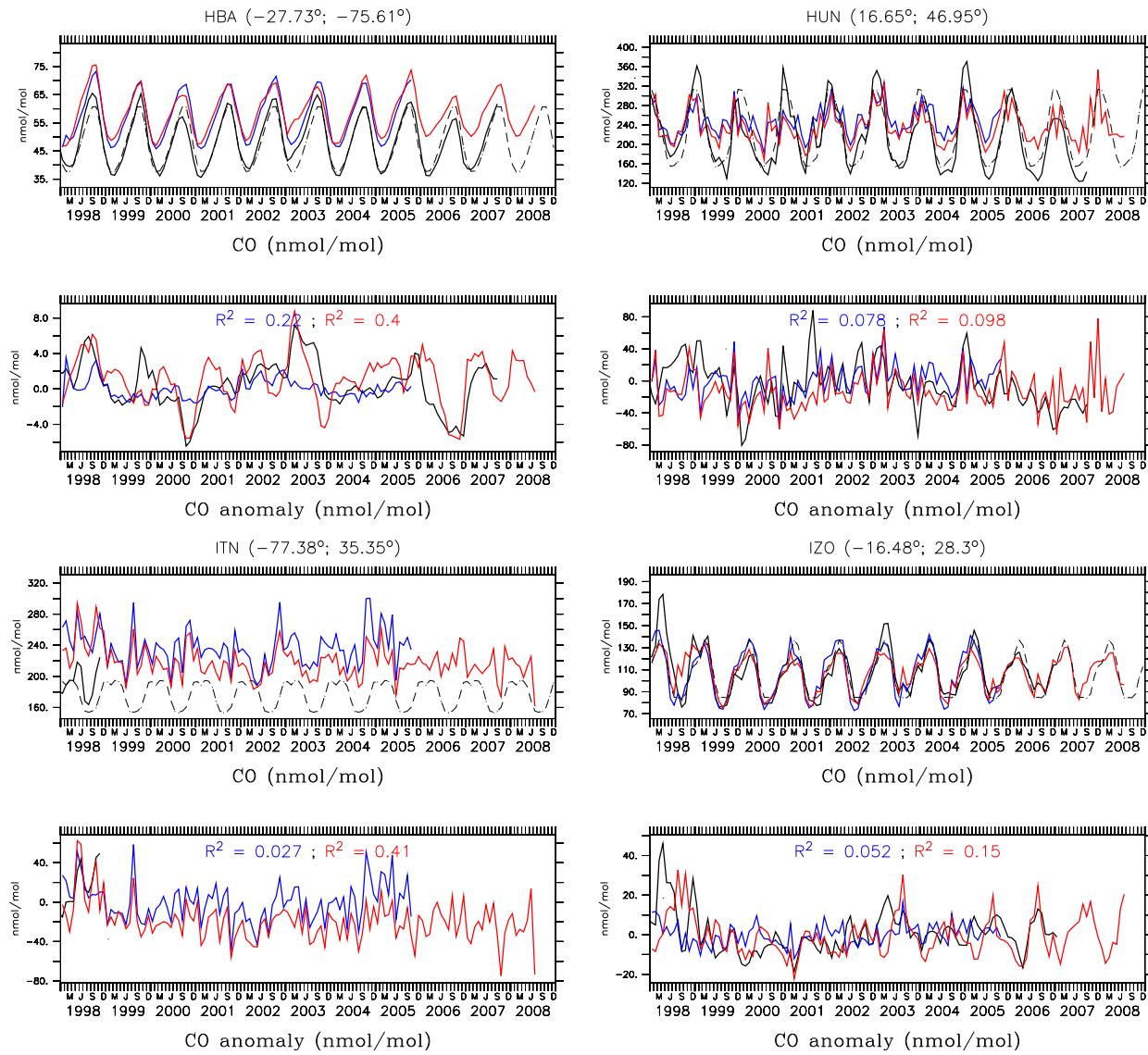


Figure 17: continued

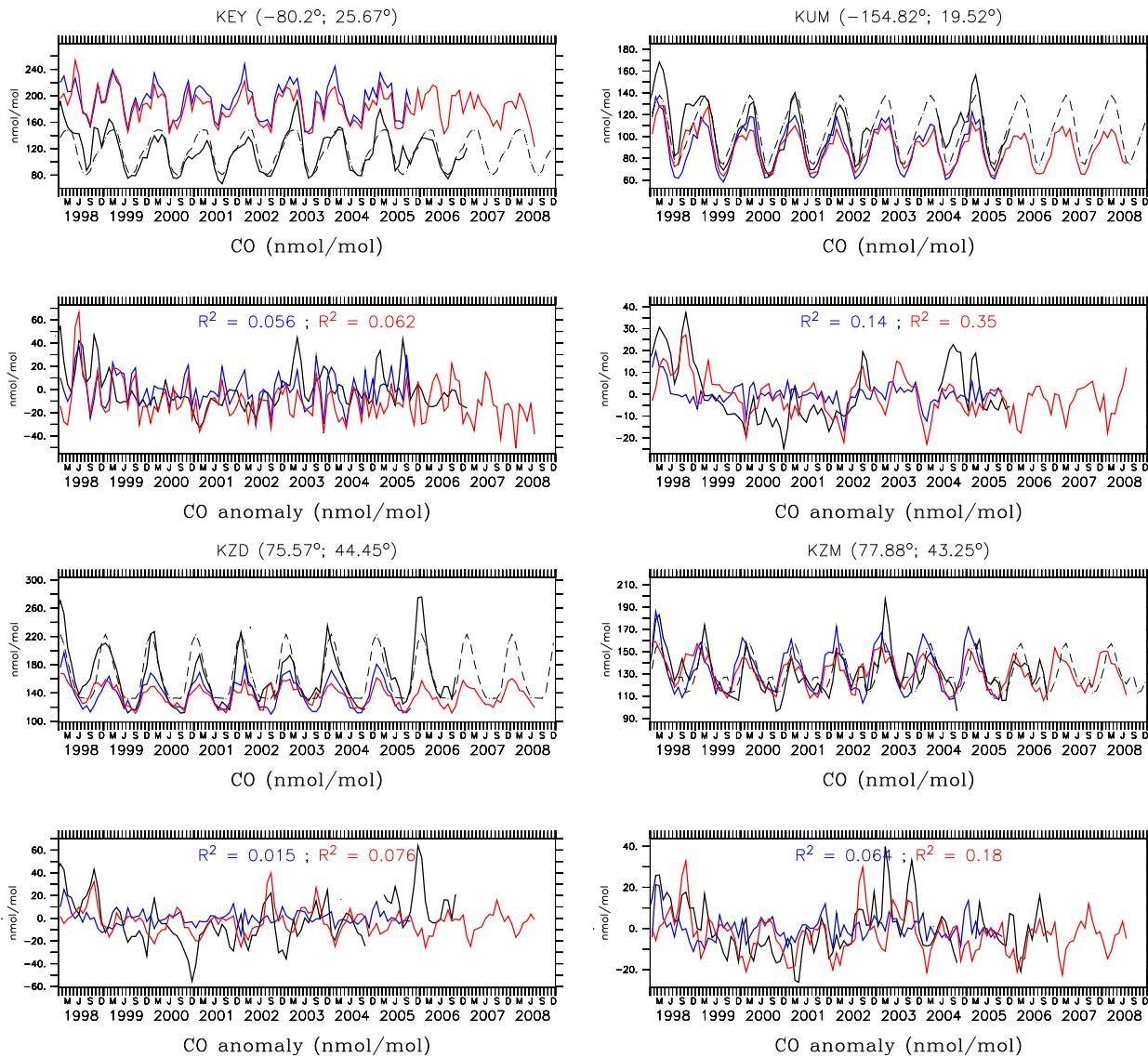


Figure 17: continued

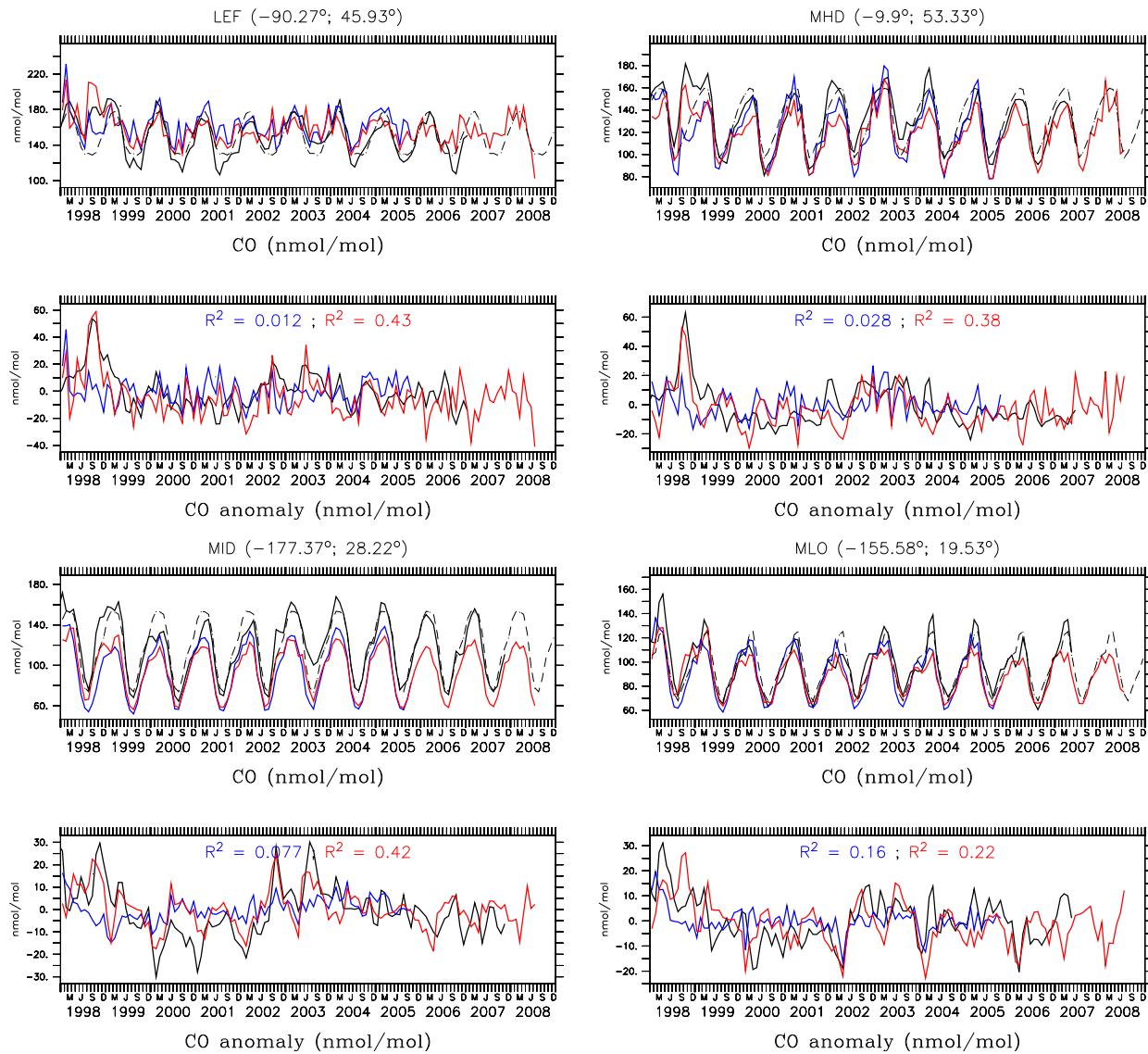


Figure 17: continued

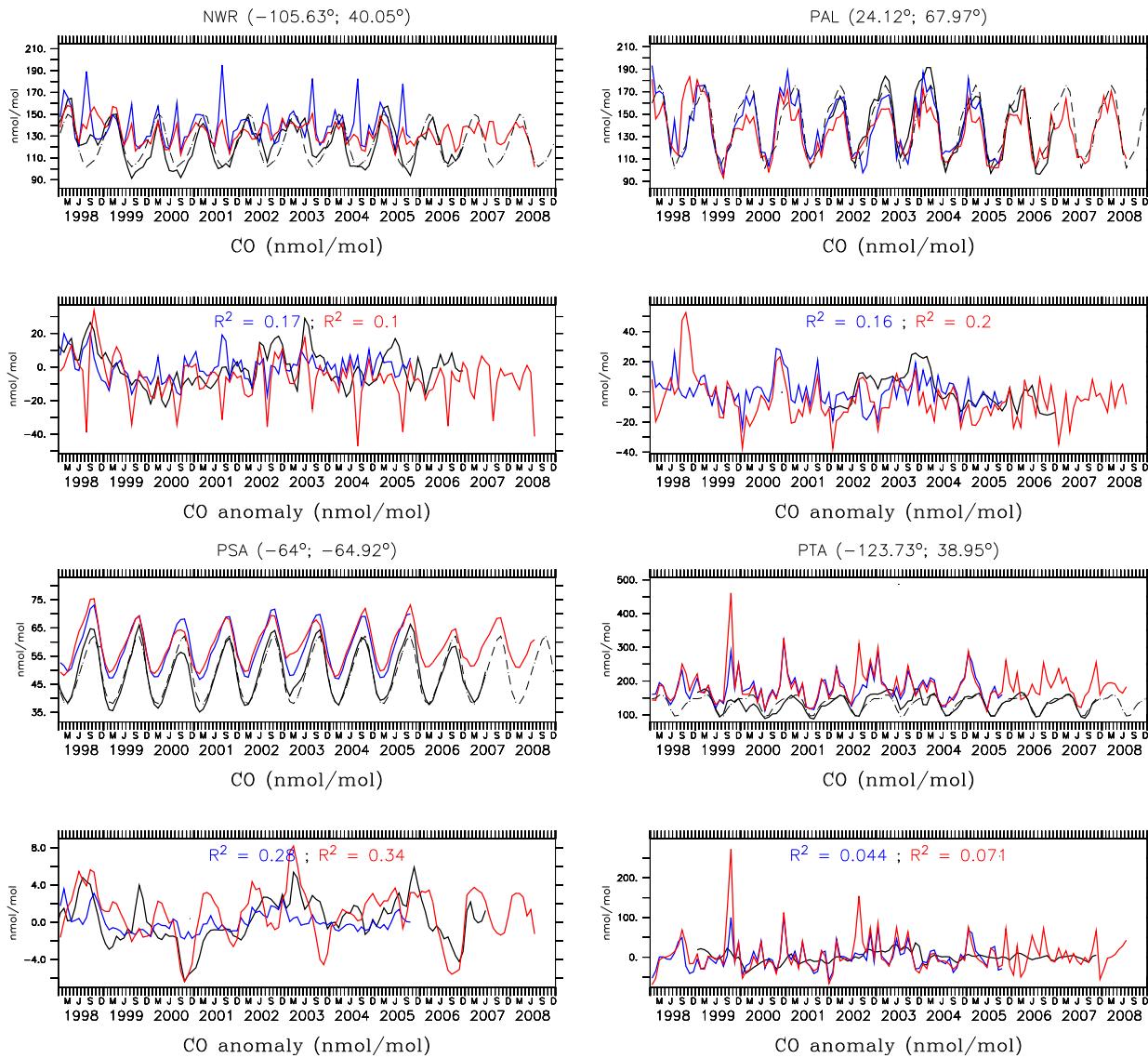


Figure 17: continued

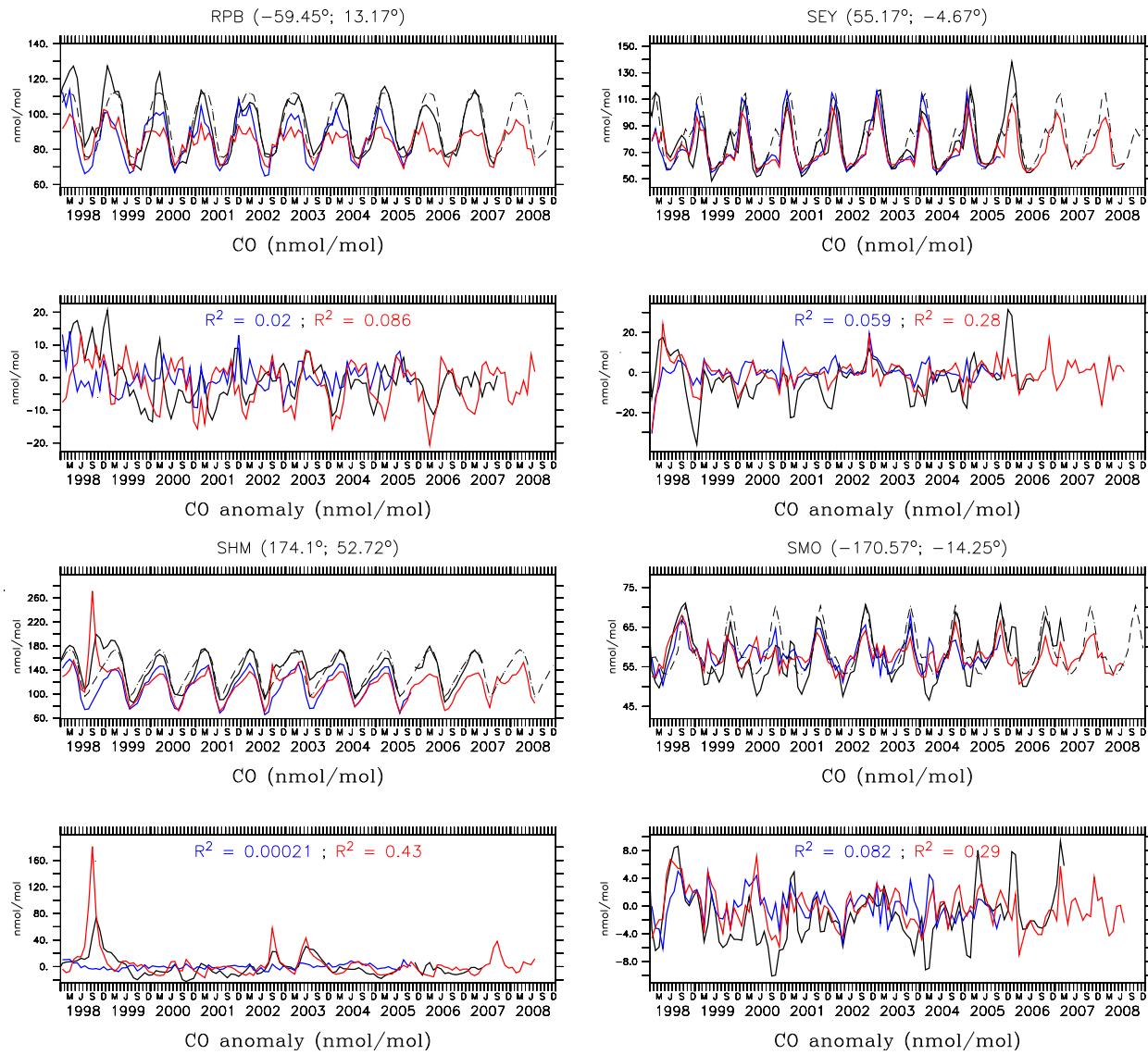


Figure 17: continued

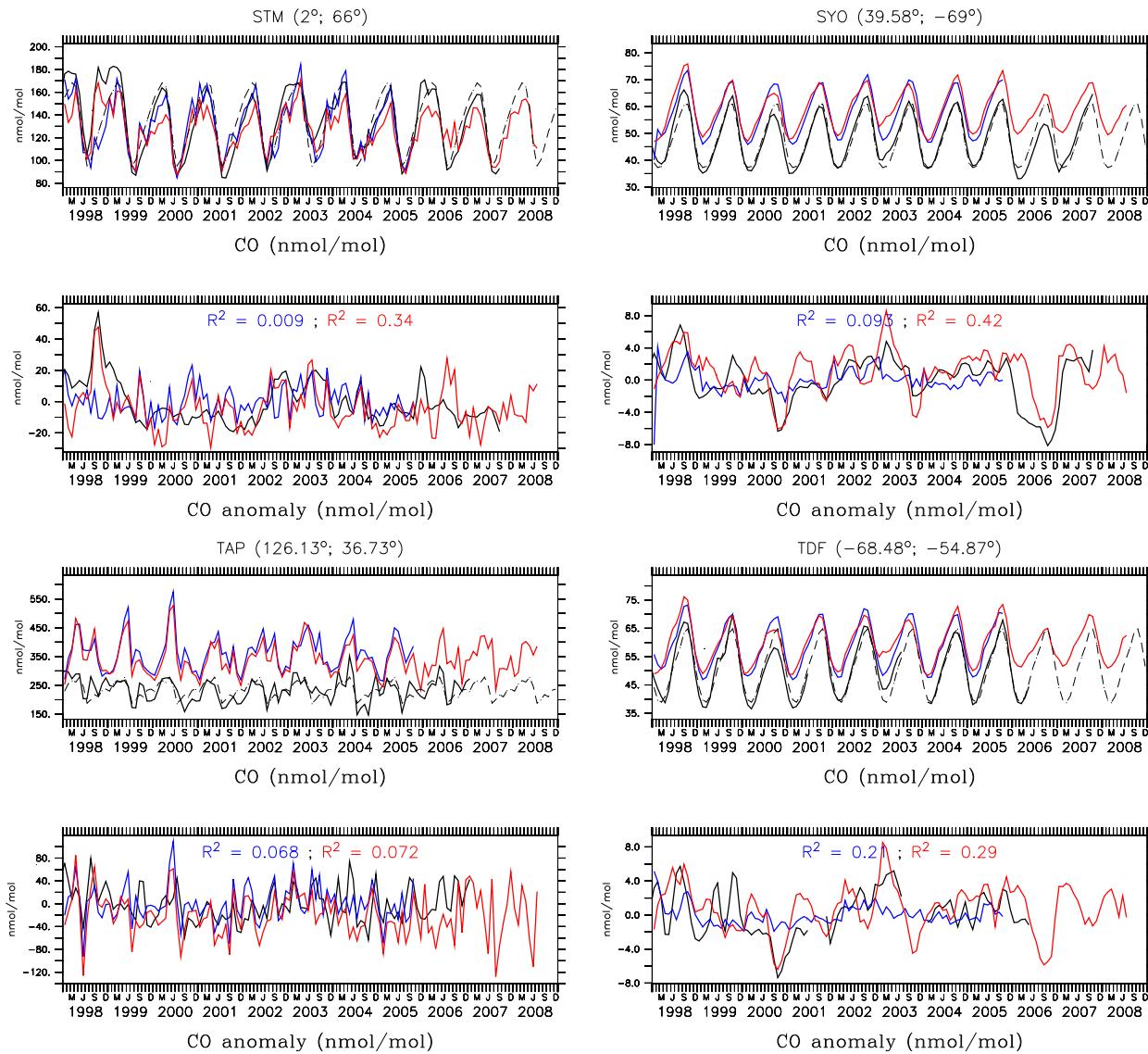


Figure 17: continued

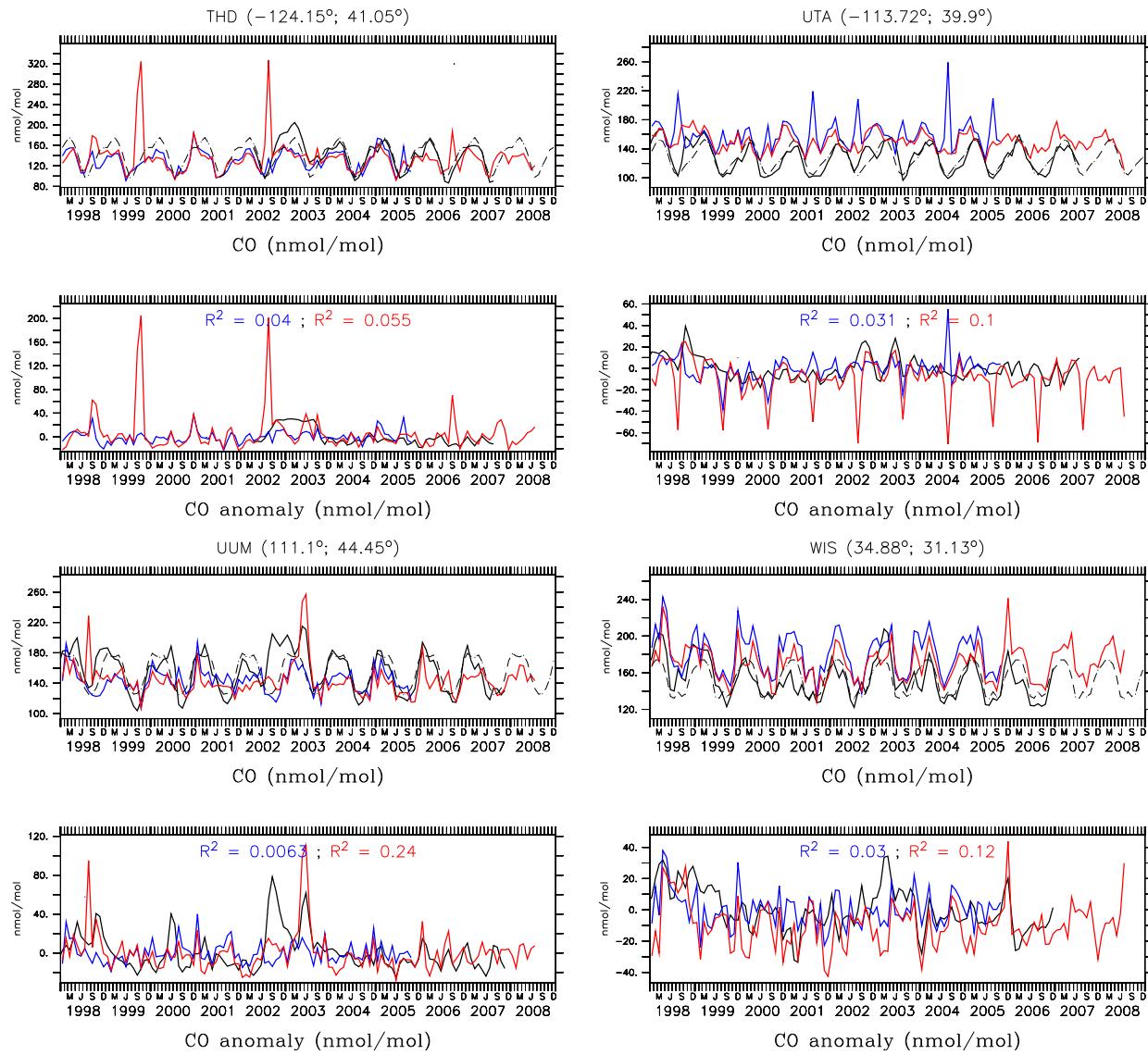


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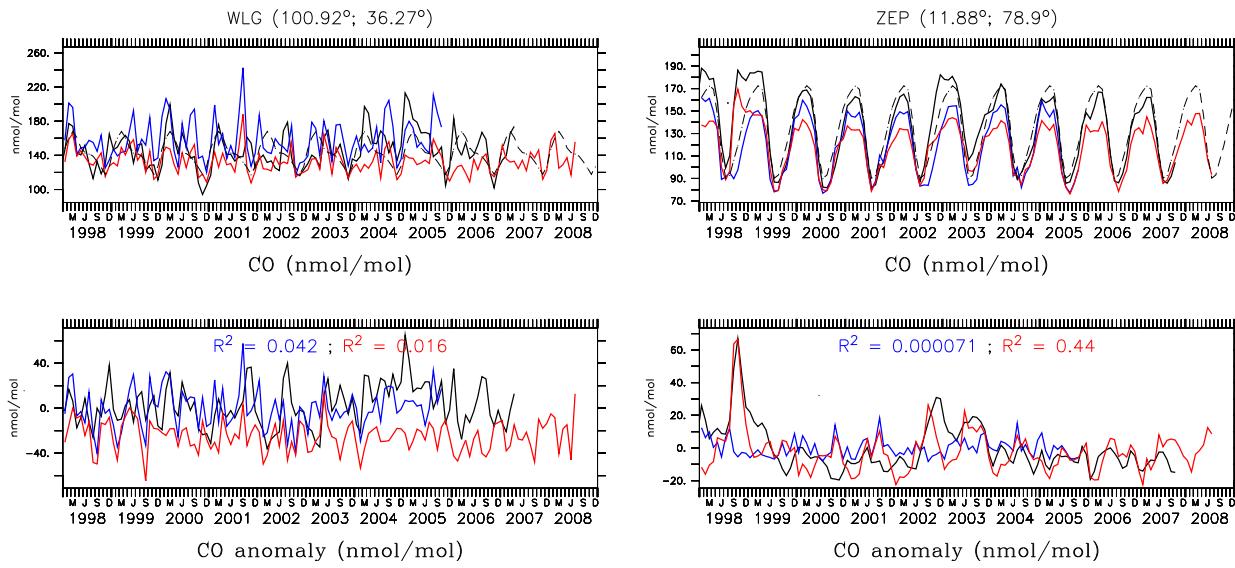


Figure 17: continued

3.2 ^{210}Pb

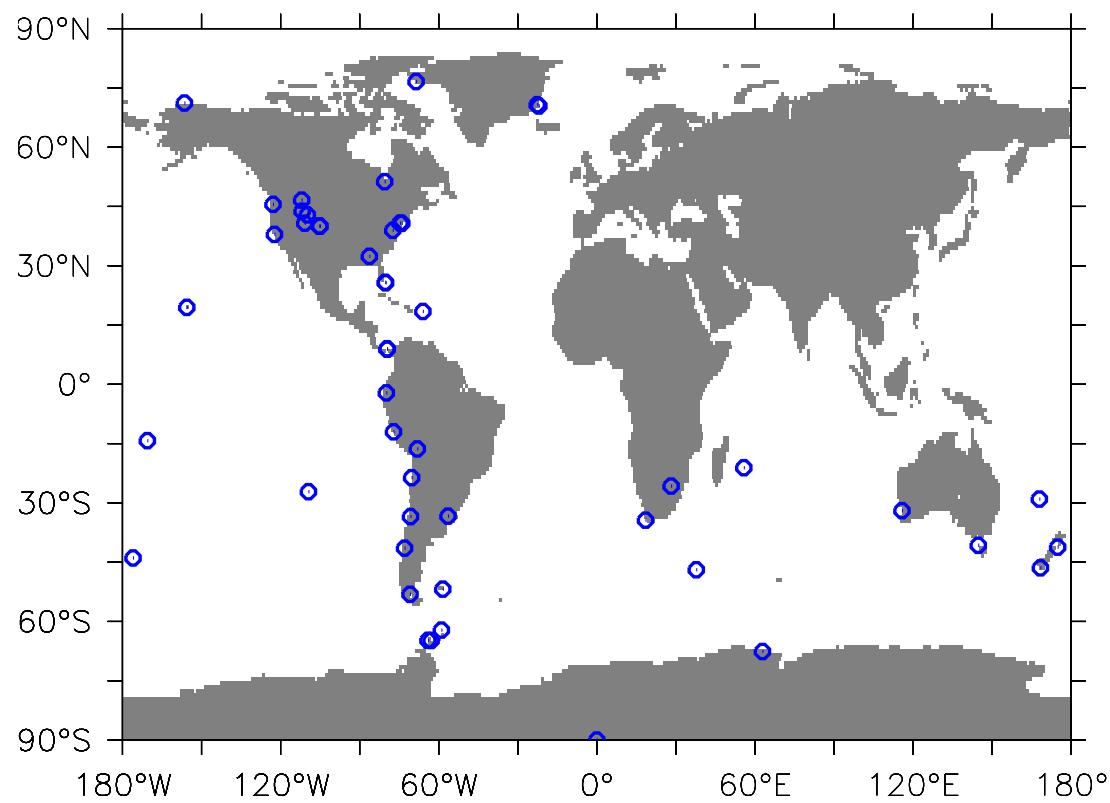


Figure 18: Positions of measurement sites with observations of ^{210}Pb provided by the National Urban Security Technology Laboratory Surface Air Sampling Program (NUSTL/SASP)².

²<http://www.eml.st.dhs.gov/databases/sasp/>

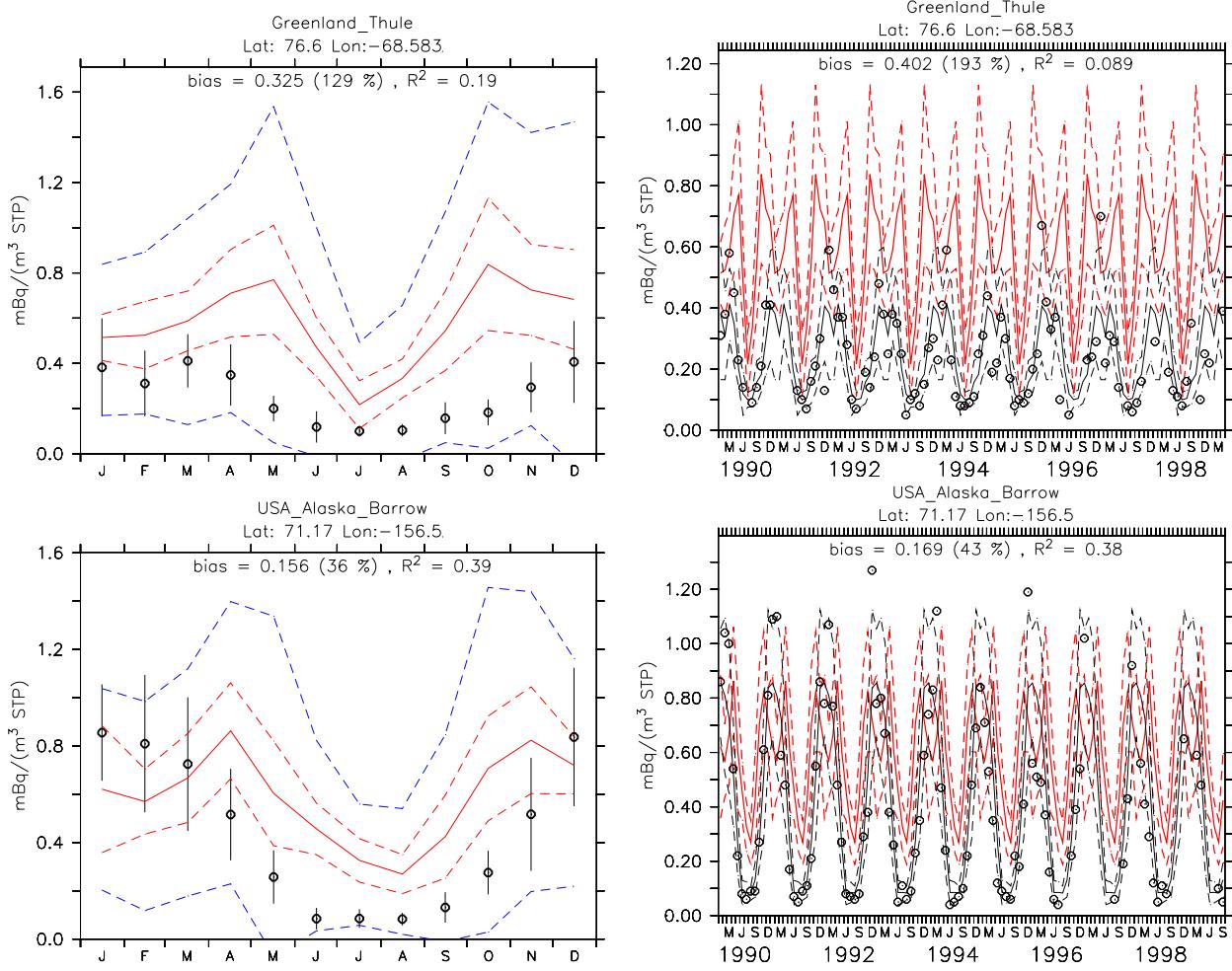


Figure 19: Comparison of simulated ^{210}Pb with surface observations provided by the National Urban Security Technology Laboratory Surface Air Sampling Program (NUSTL/SASP). The name of the sites and the geographical coordinates are listed at the top of each panel. The left panels show the multi-annual average of monthly averages (black symbols) with corresponding standard deviation (black error bars), i.e., the interannual variation of the monthly averages. If more than 10 years of data after 1990 are available, the calculation of the average is limited to the period starting January 1990. The red line denotes the simulated multi-annual (2000-2007) average of monthly averages, the dashed red lines indicate the interval of the corresponding standard deviation, i.e., the interannual variation of the monthly averages. The dashed blue lines show the interval of the full standard deviation (w.r.t. time) based on the 5-hourly model output. The bias is given as the average (12 months) difference between the simulated and the observed climatological monthly averages and as relative deviation (in %) of the simulated from the observed climatological average. R^2 is Pearson's coefficient of the correlation between the simulated and observed multi-annual monthly averages. The right panels show the individual monthly averages from the observations (open symbols), the corresponding multi-annual climatological monthly average (black lines) plus / minus standard deviation (black dashed lines) and the simulated multi-annual monthly averages (red lines) plus / minus the standard deviation (dashed red lines). Bias and R^2 are calculated between simulated multi-annual monthly averages and individual monthly observations.

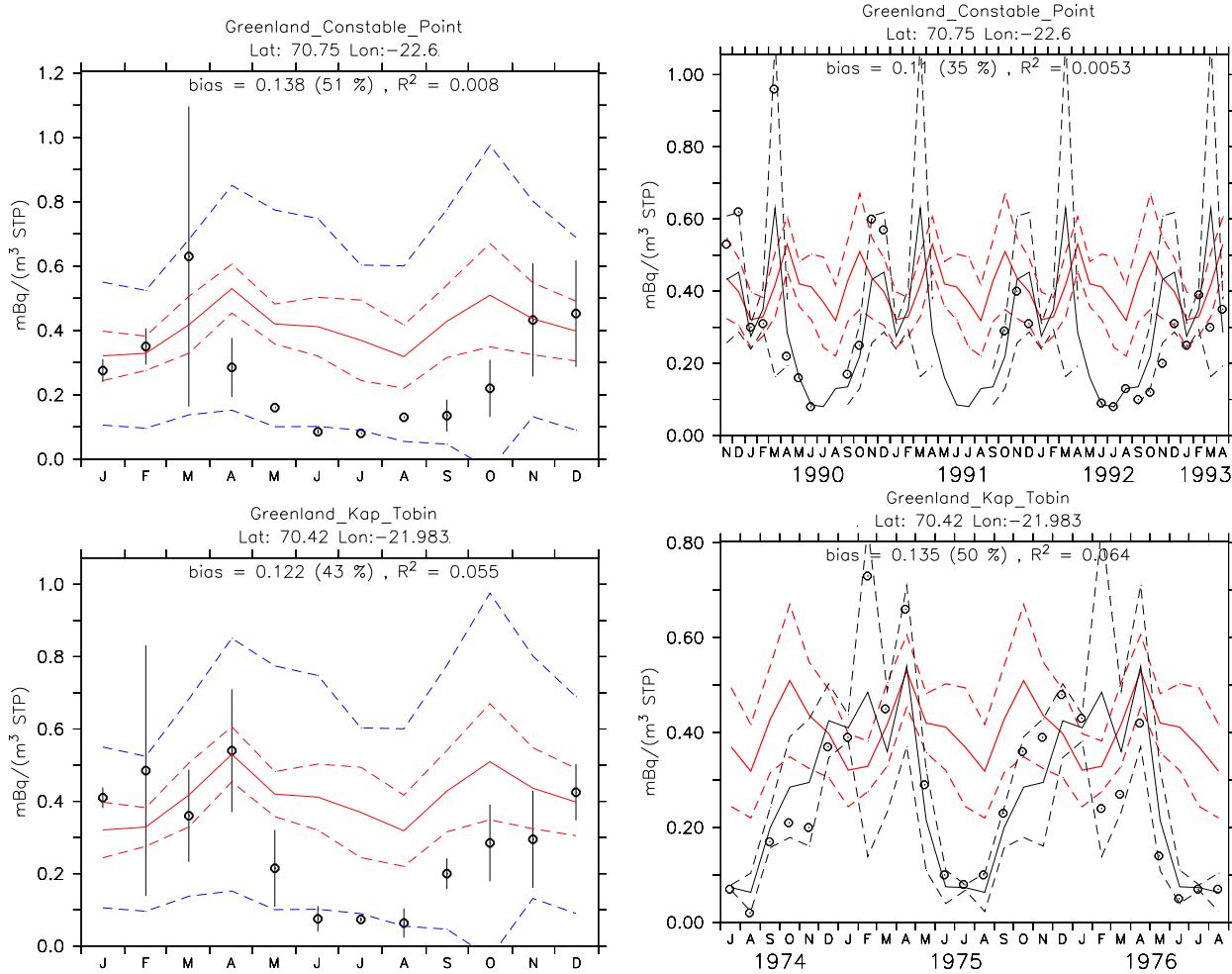


Figure 19: continued

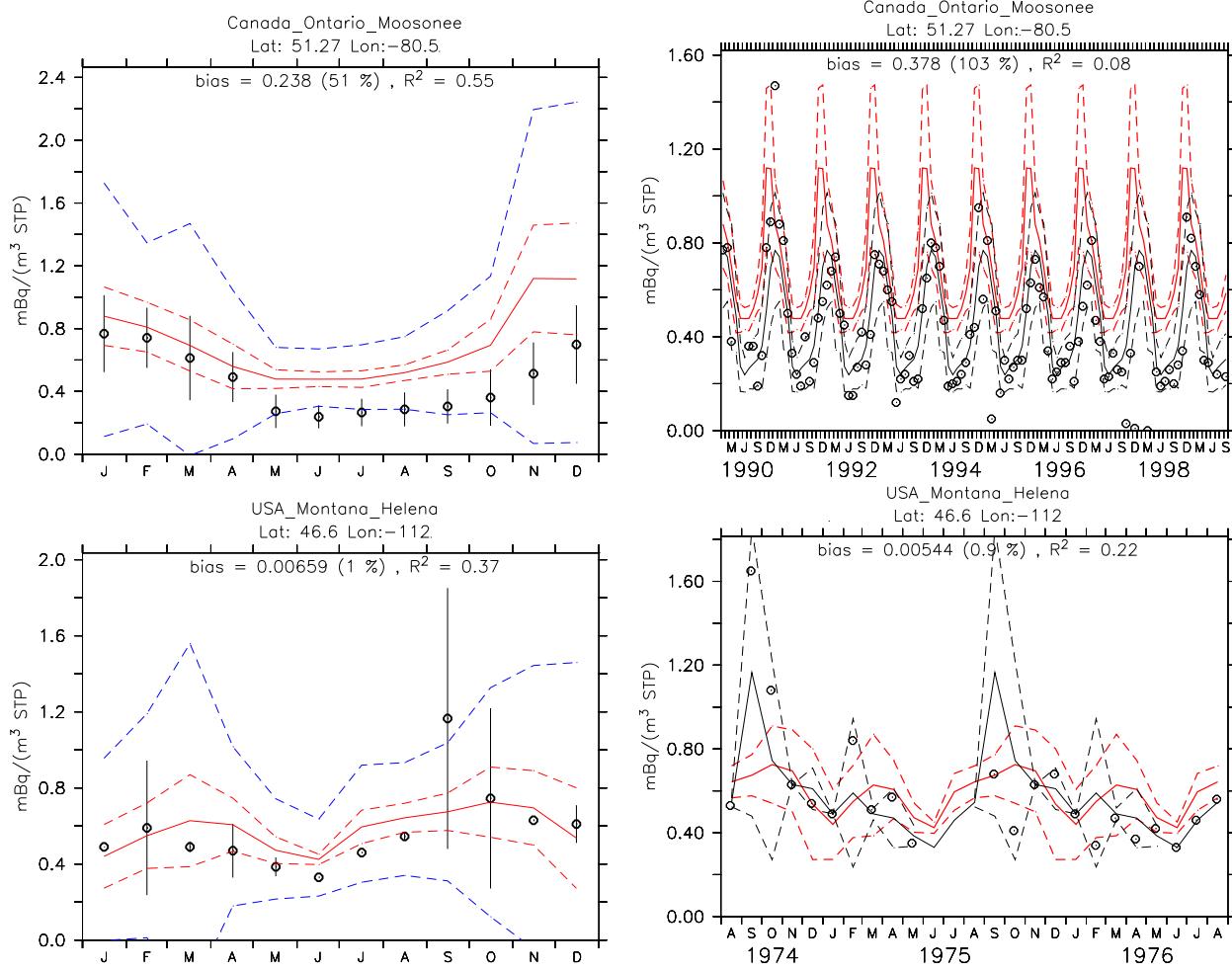


Figure 19: continued

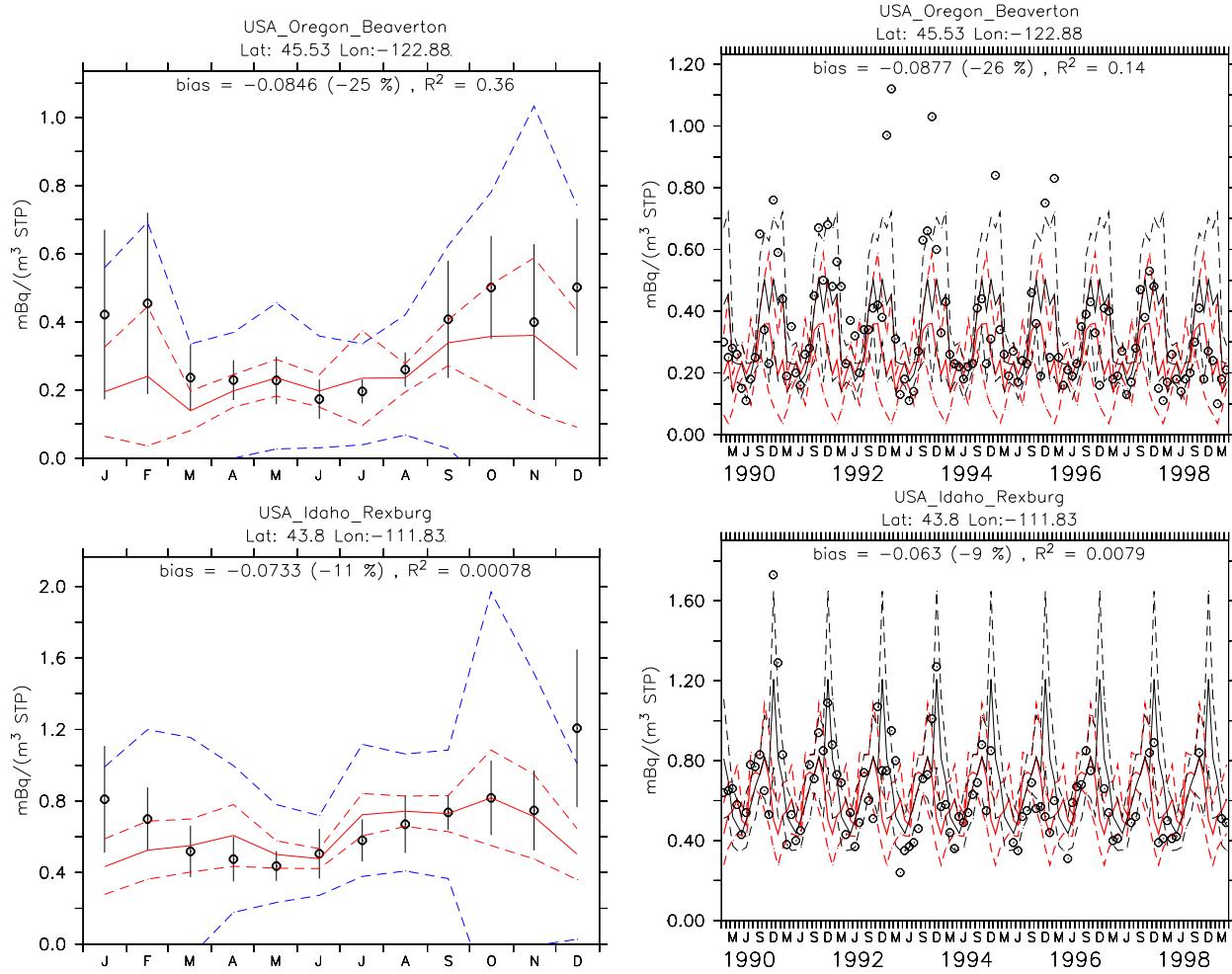


Figure 19: continued

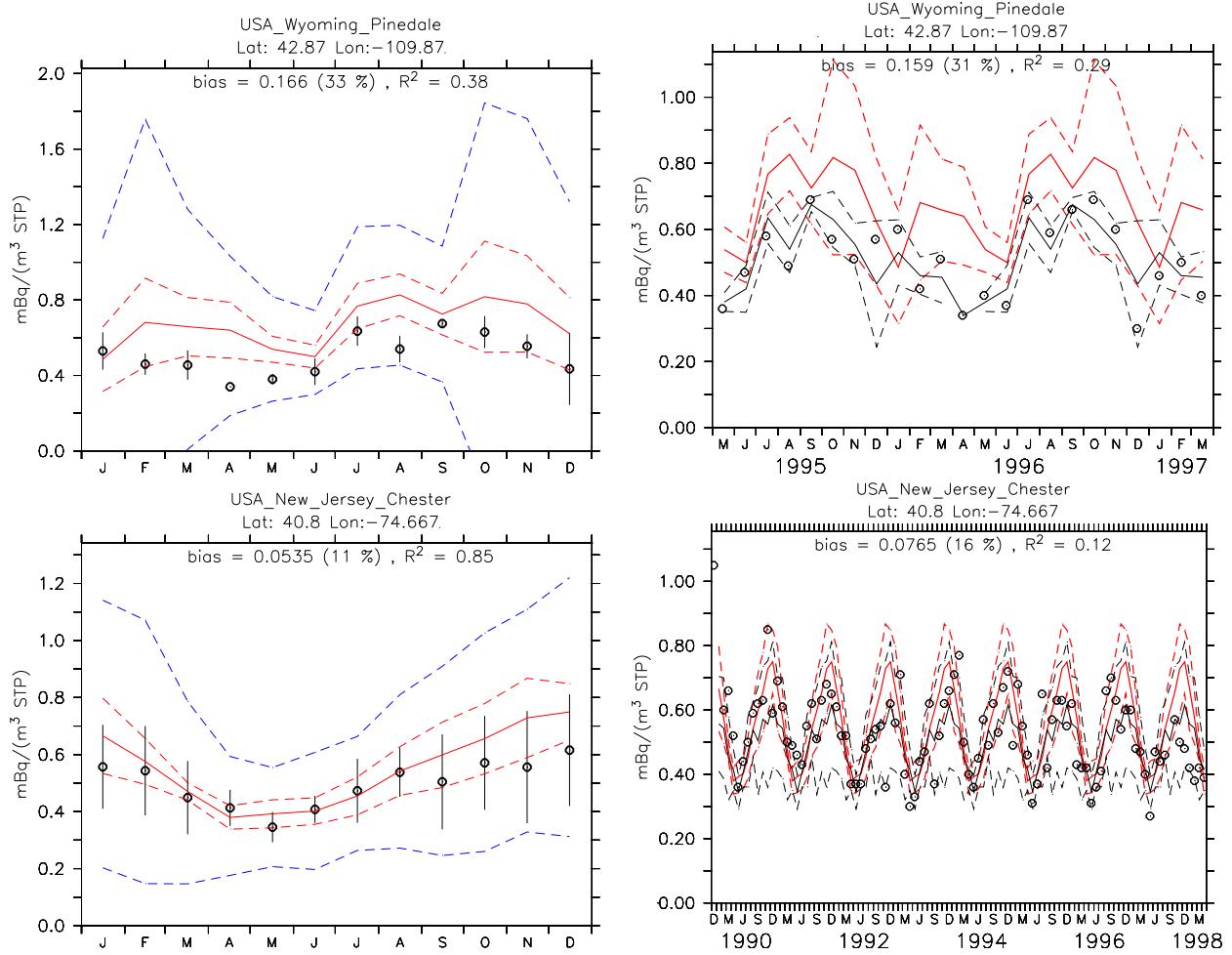


Figure 19: continued

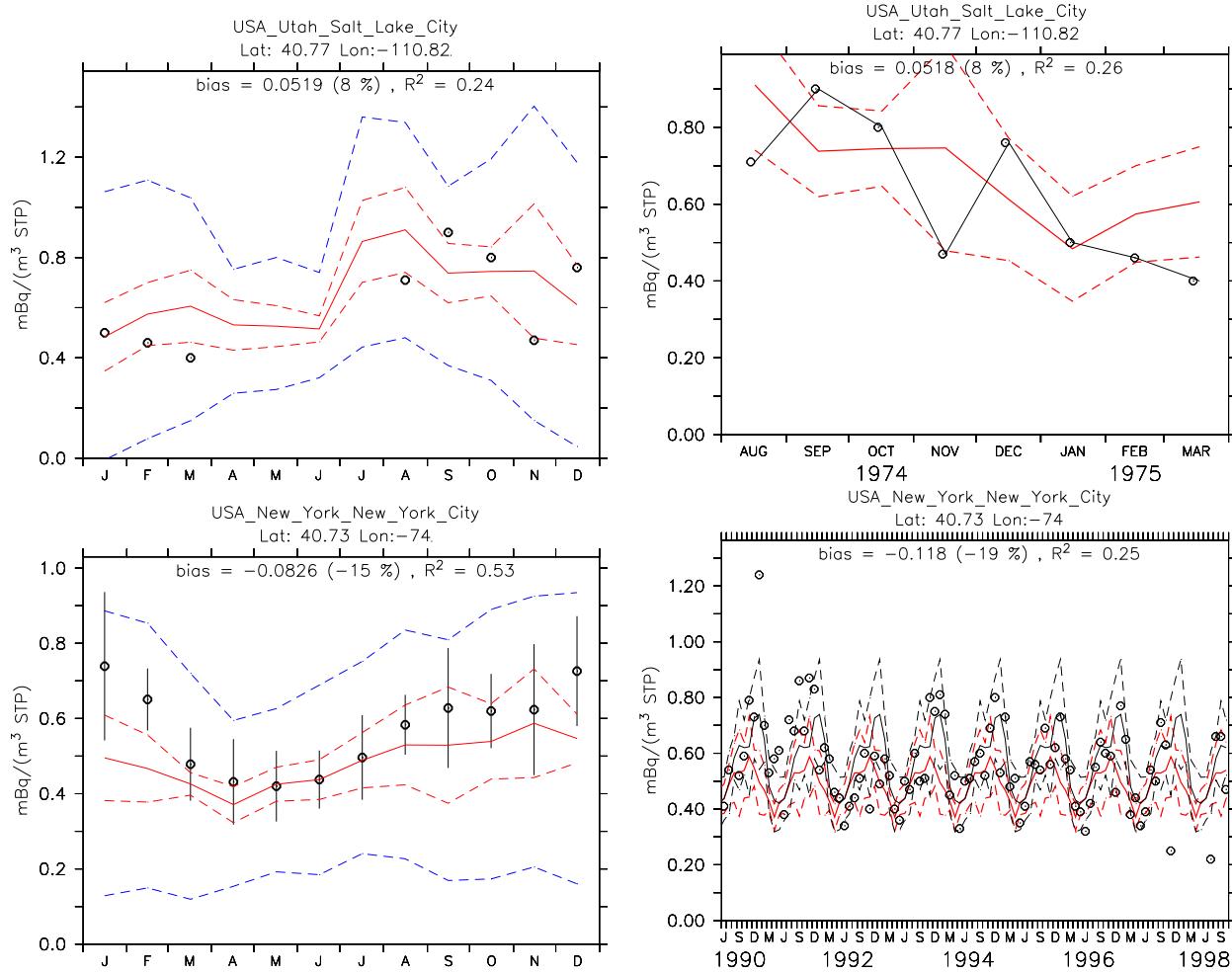


Figure 19: continued

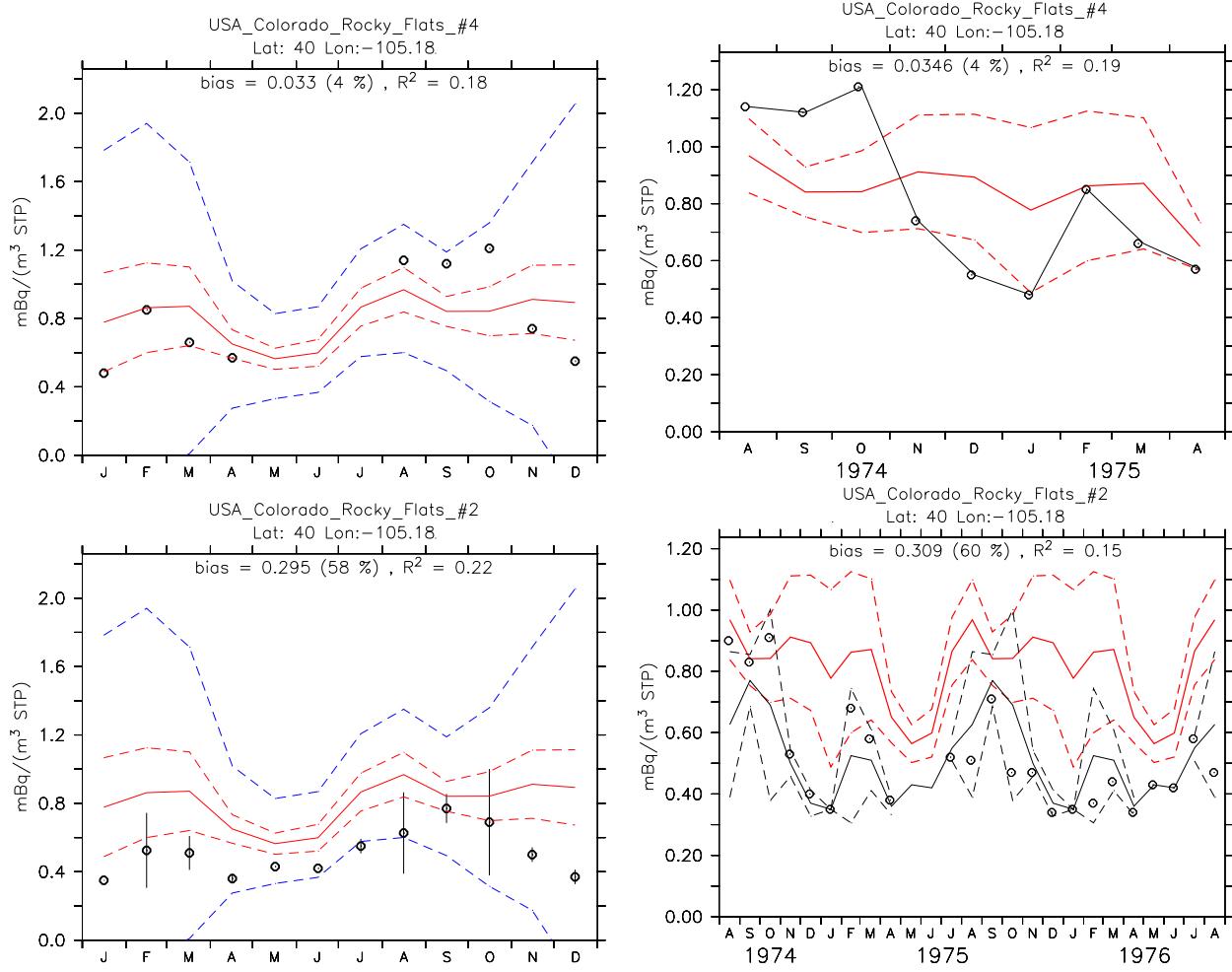


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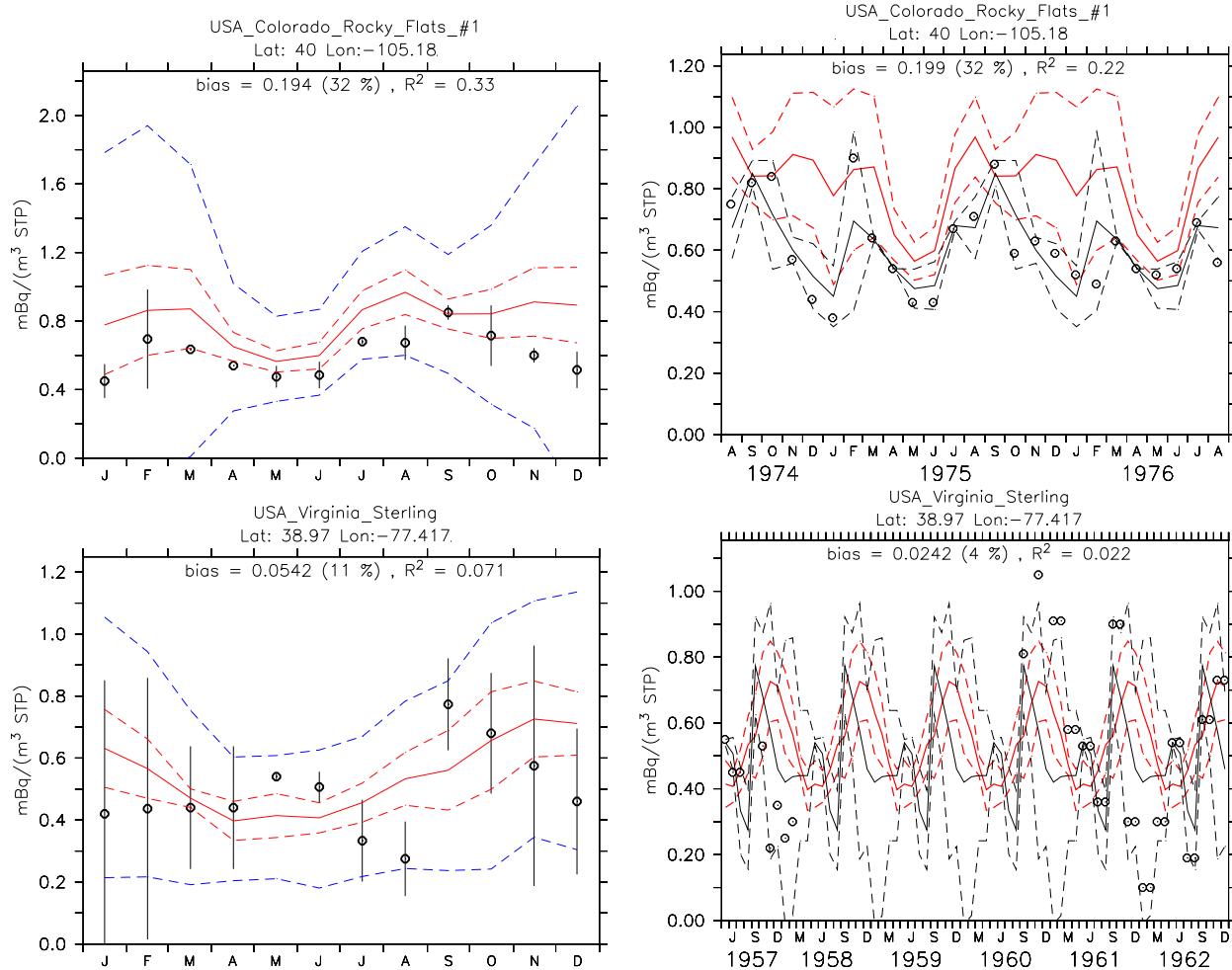


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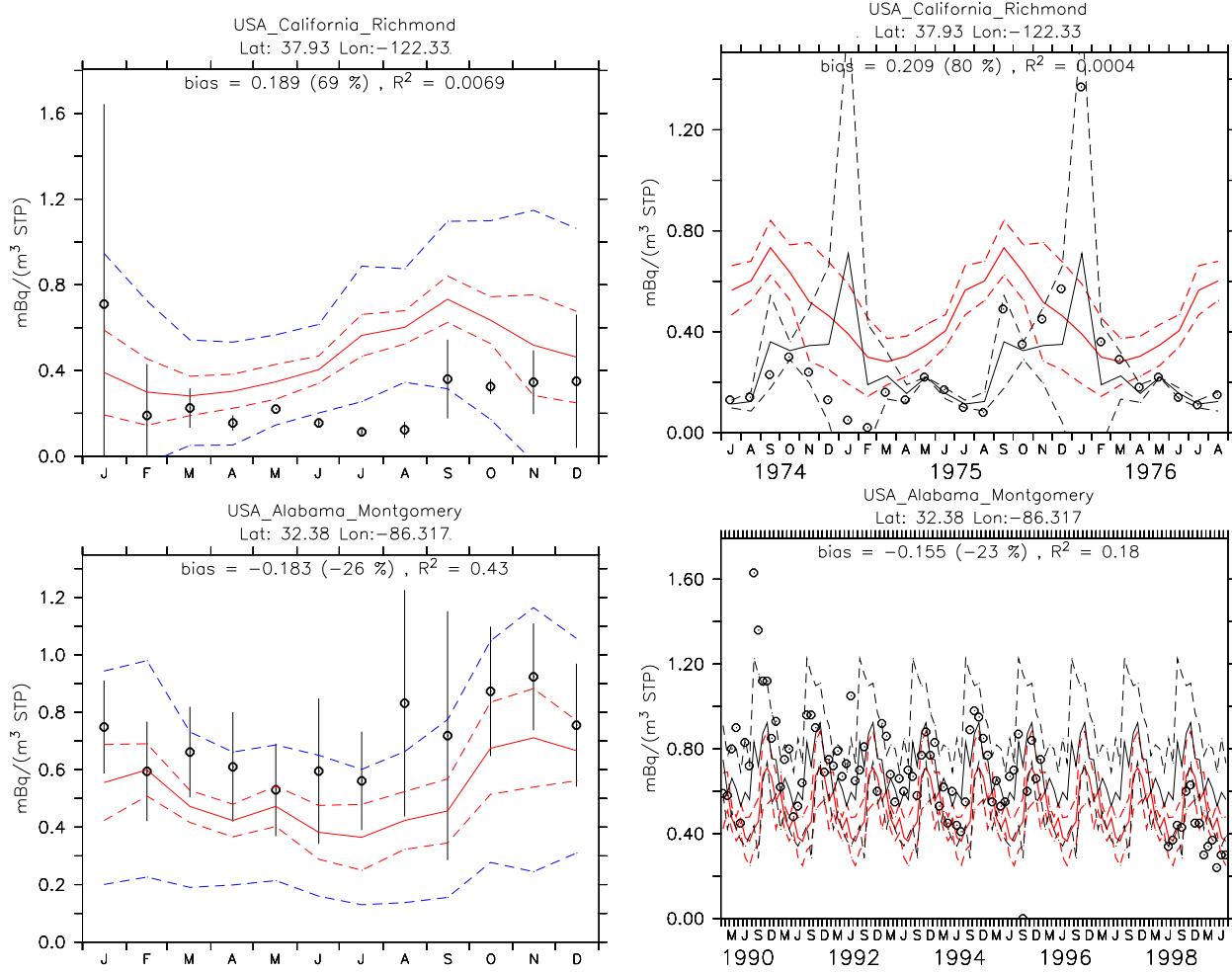


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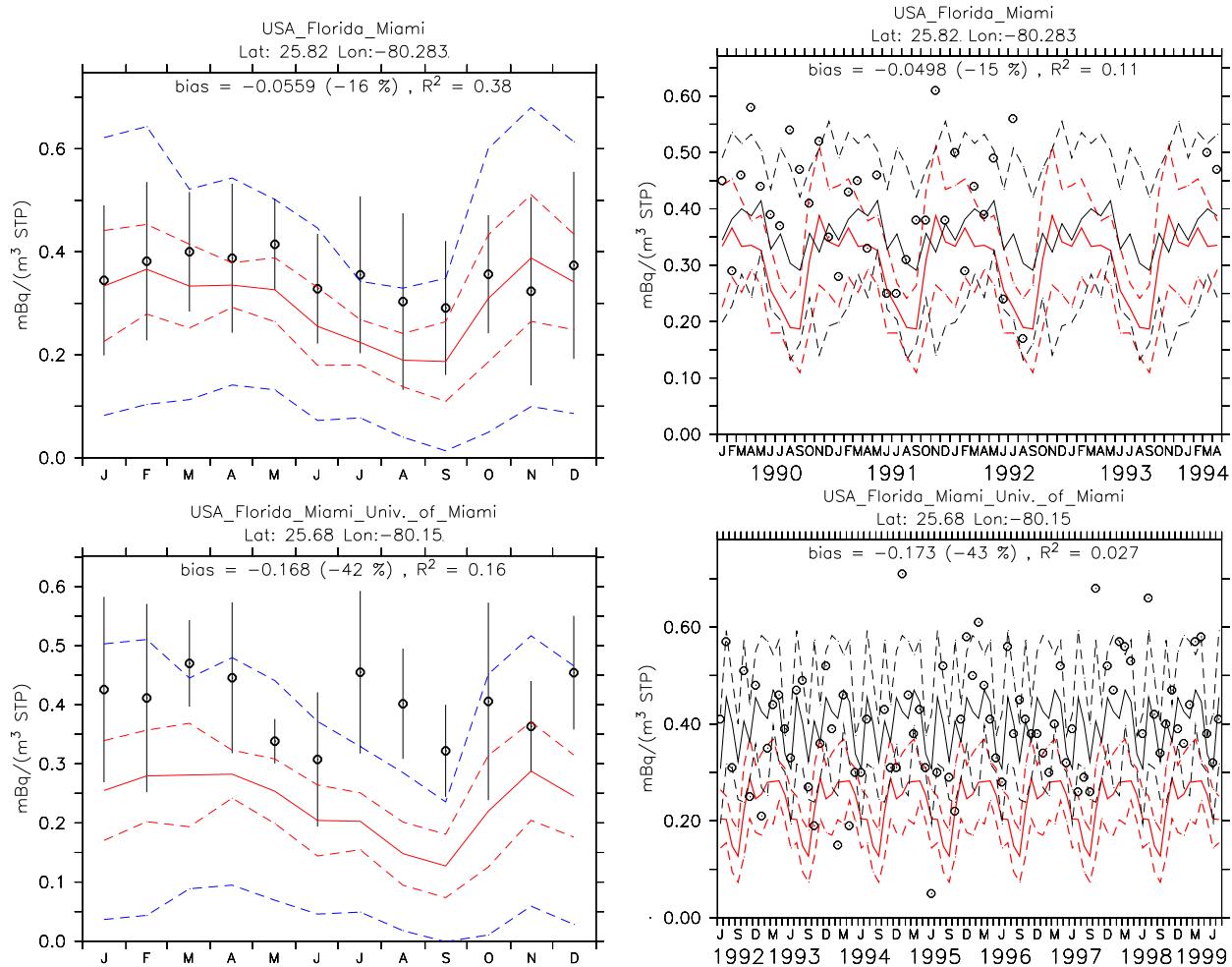


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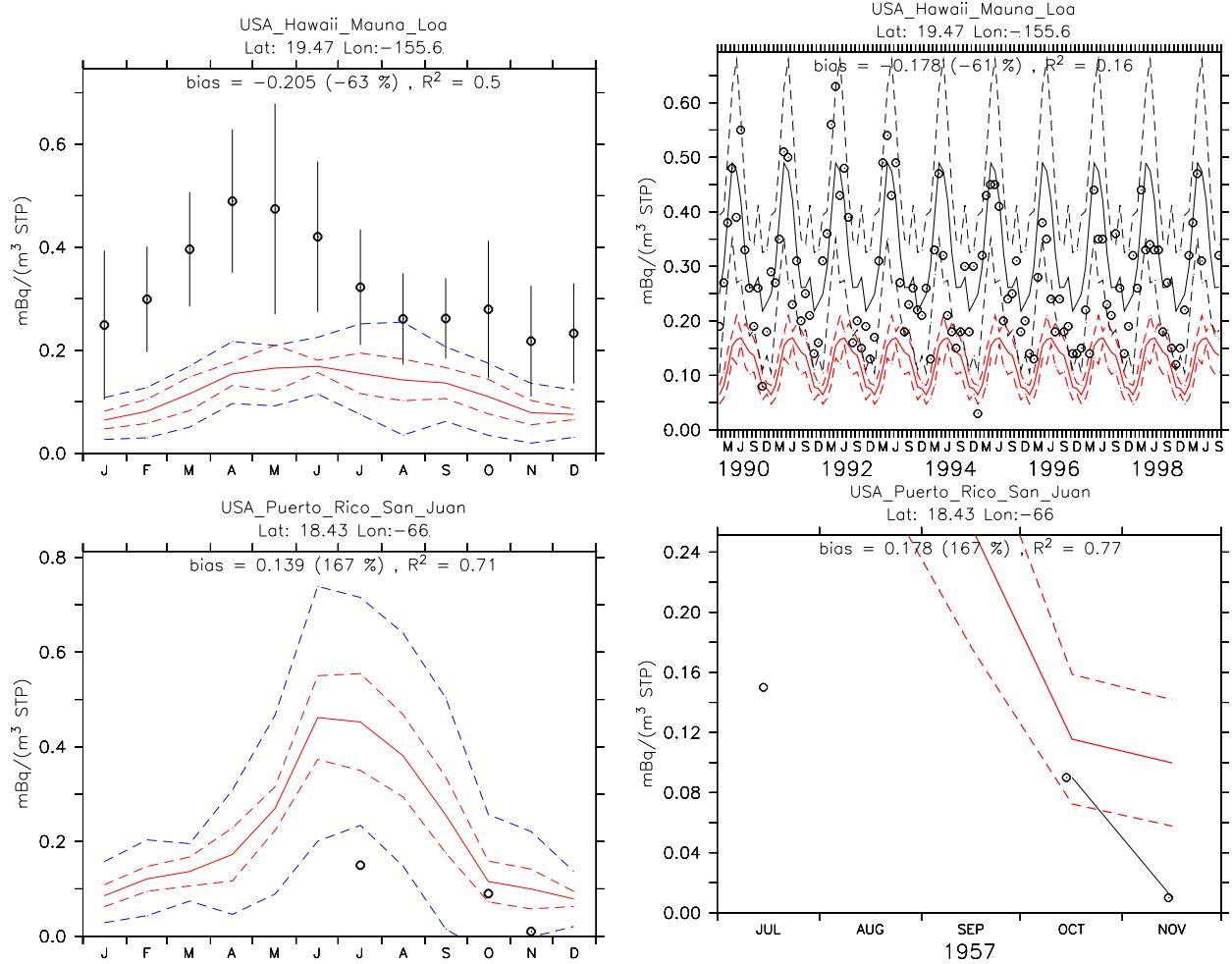


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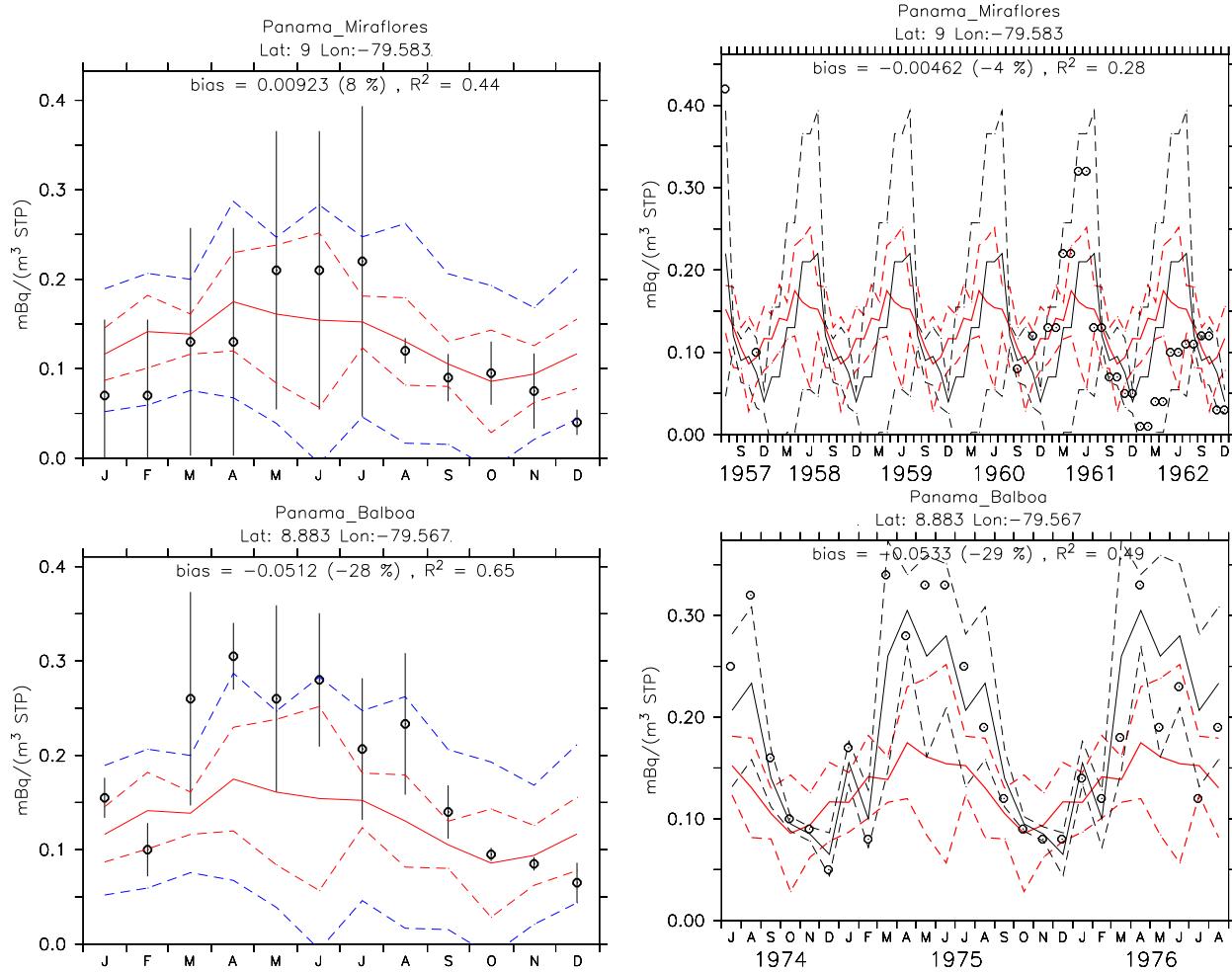


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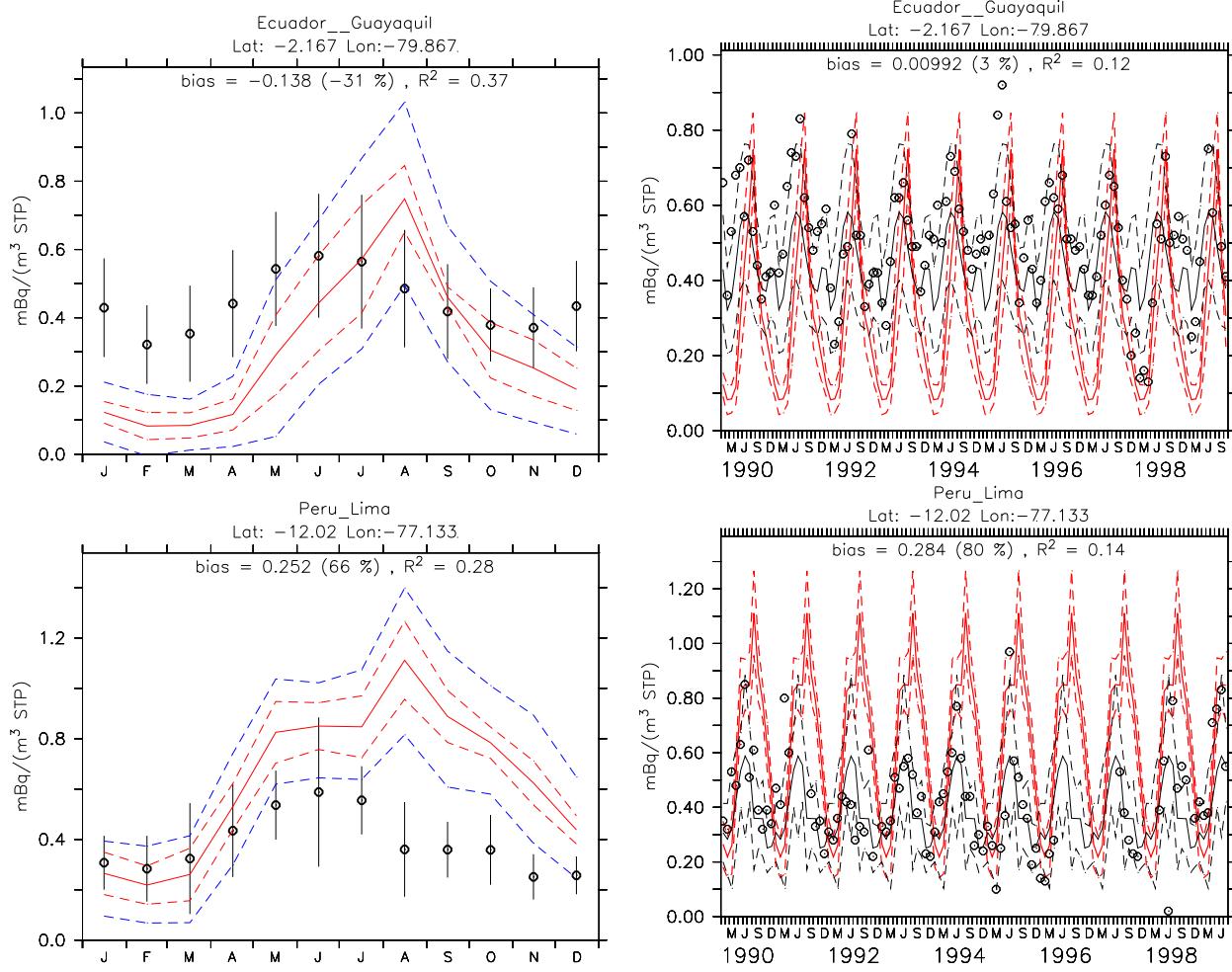


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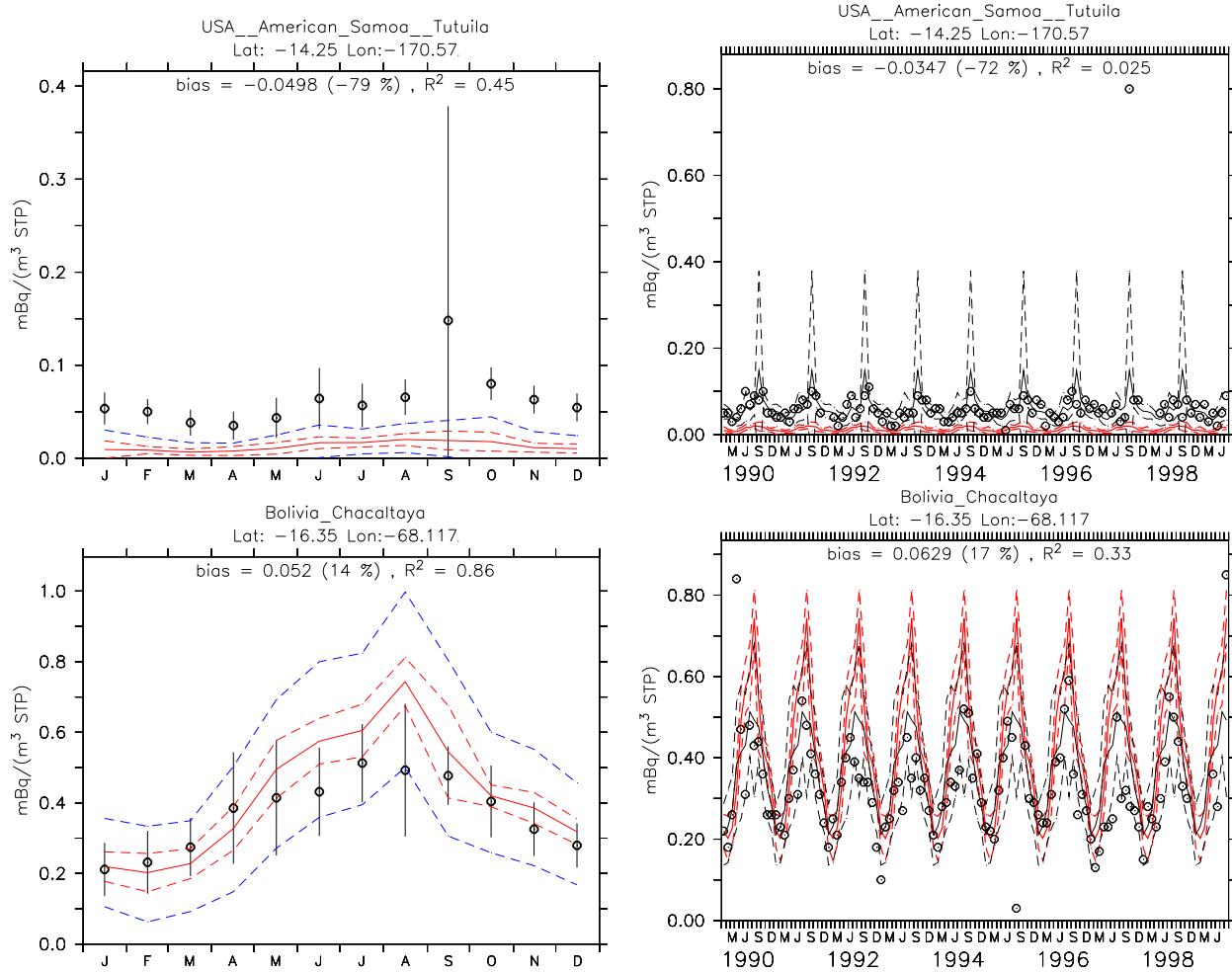


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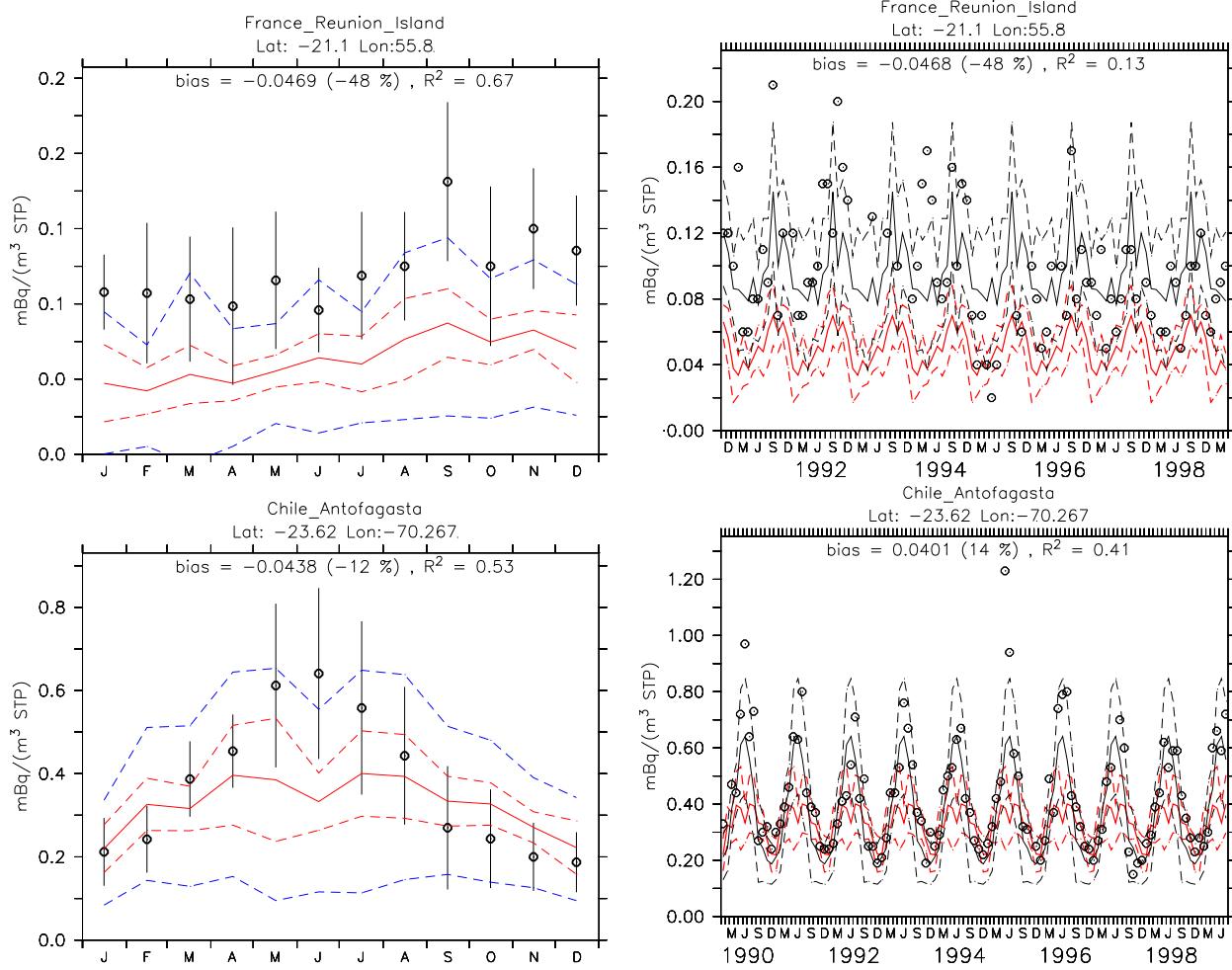


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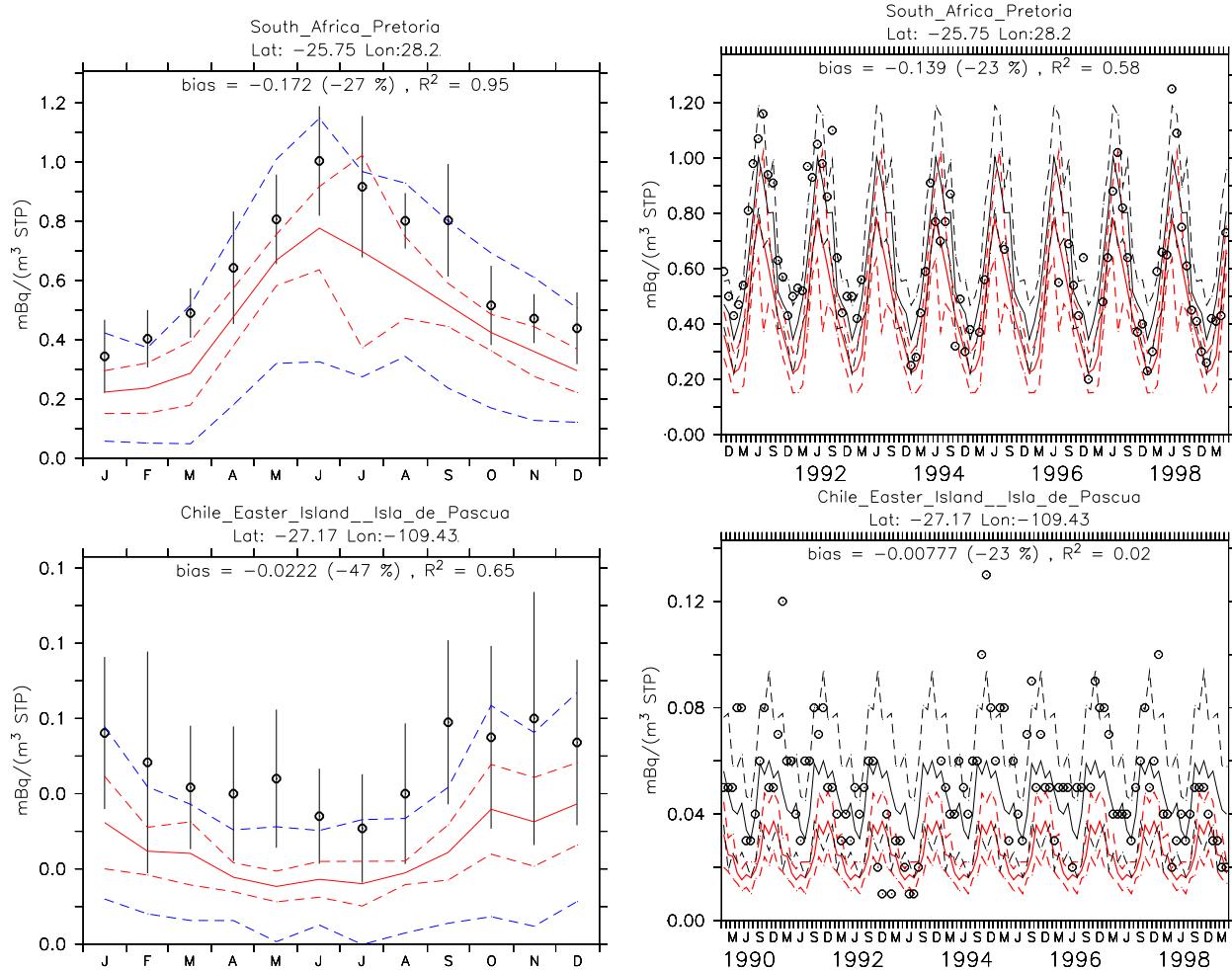


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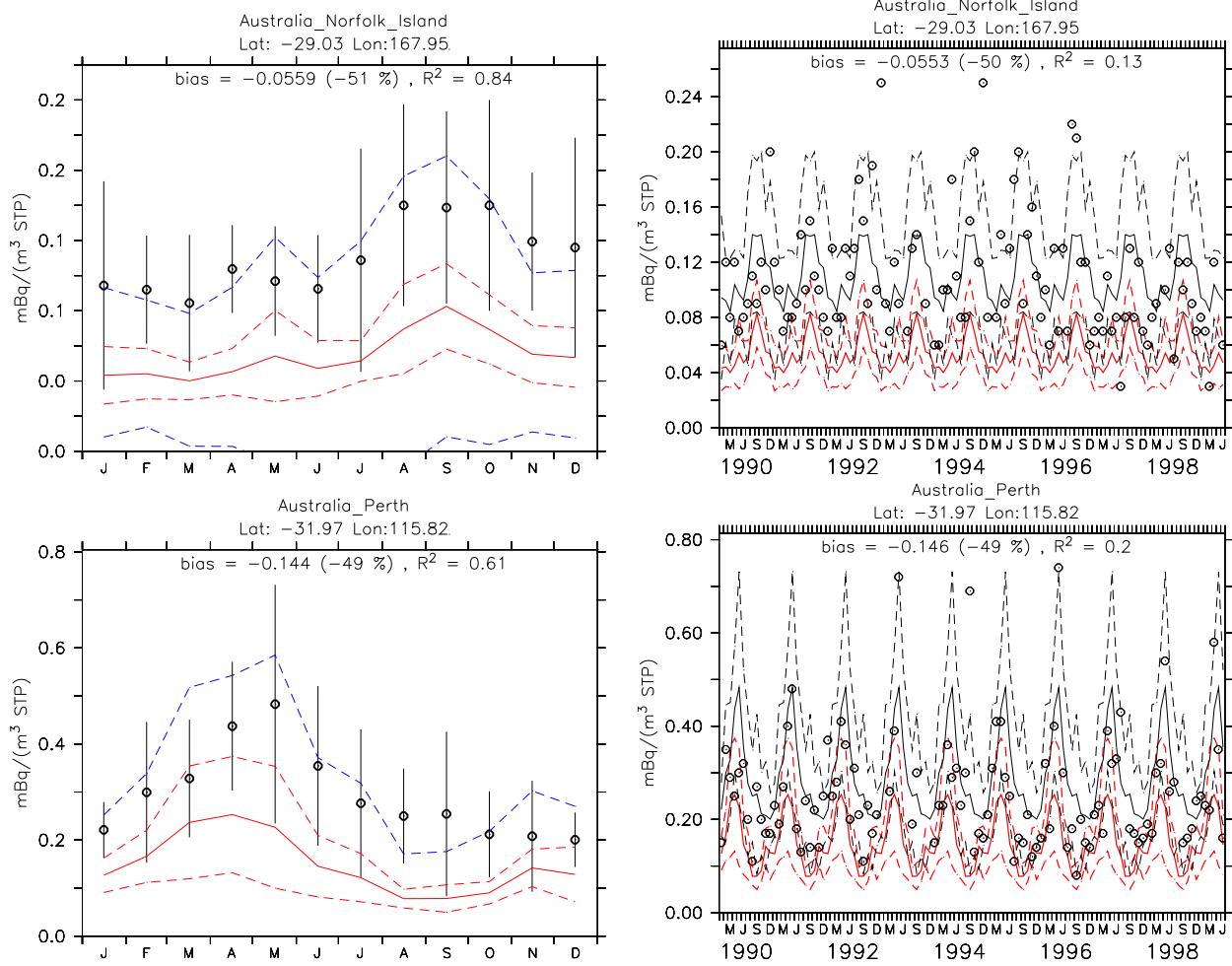


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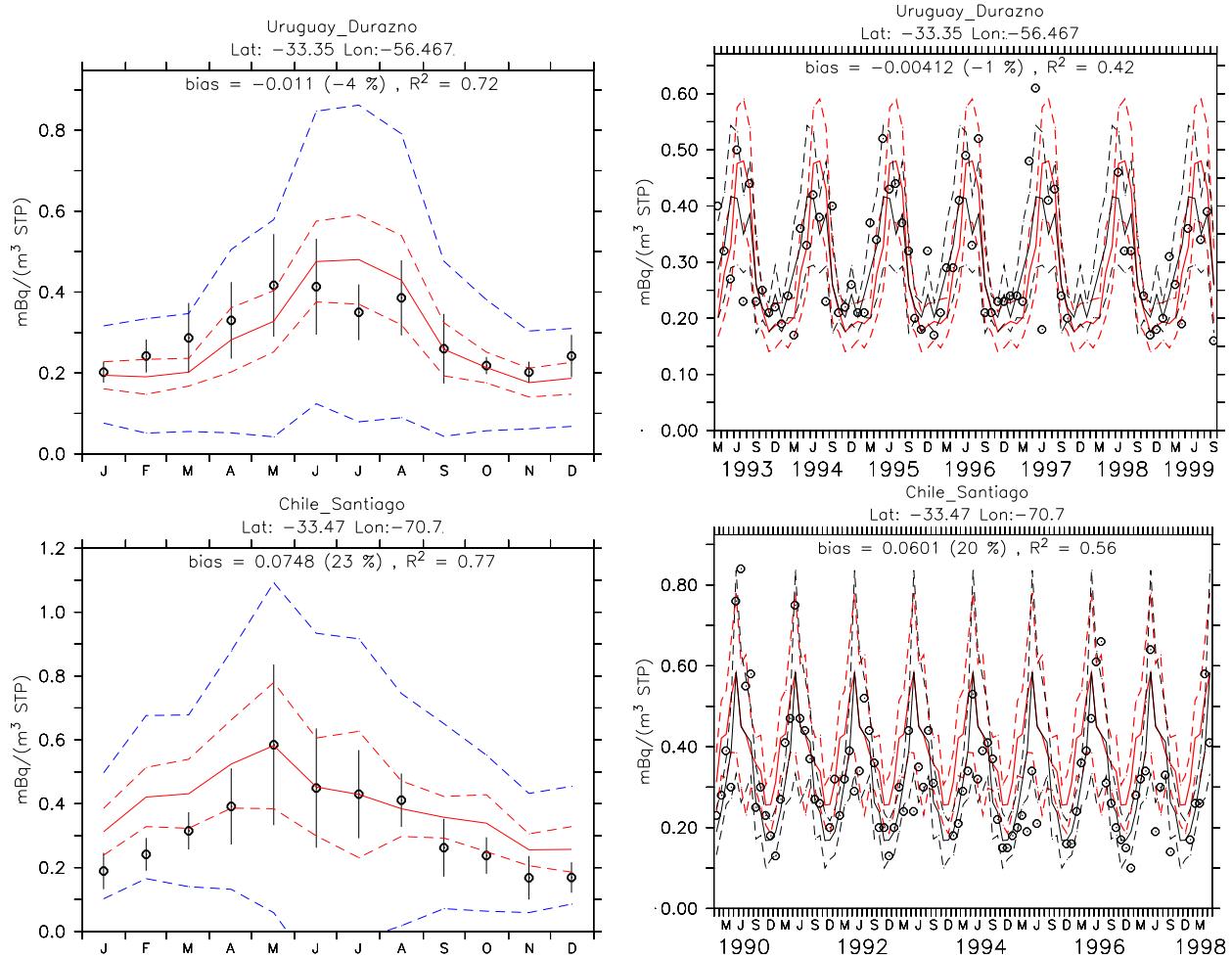


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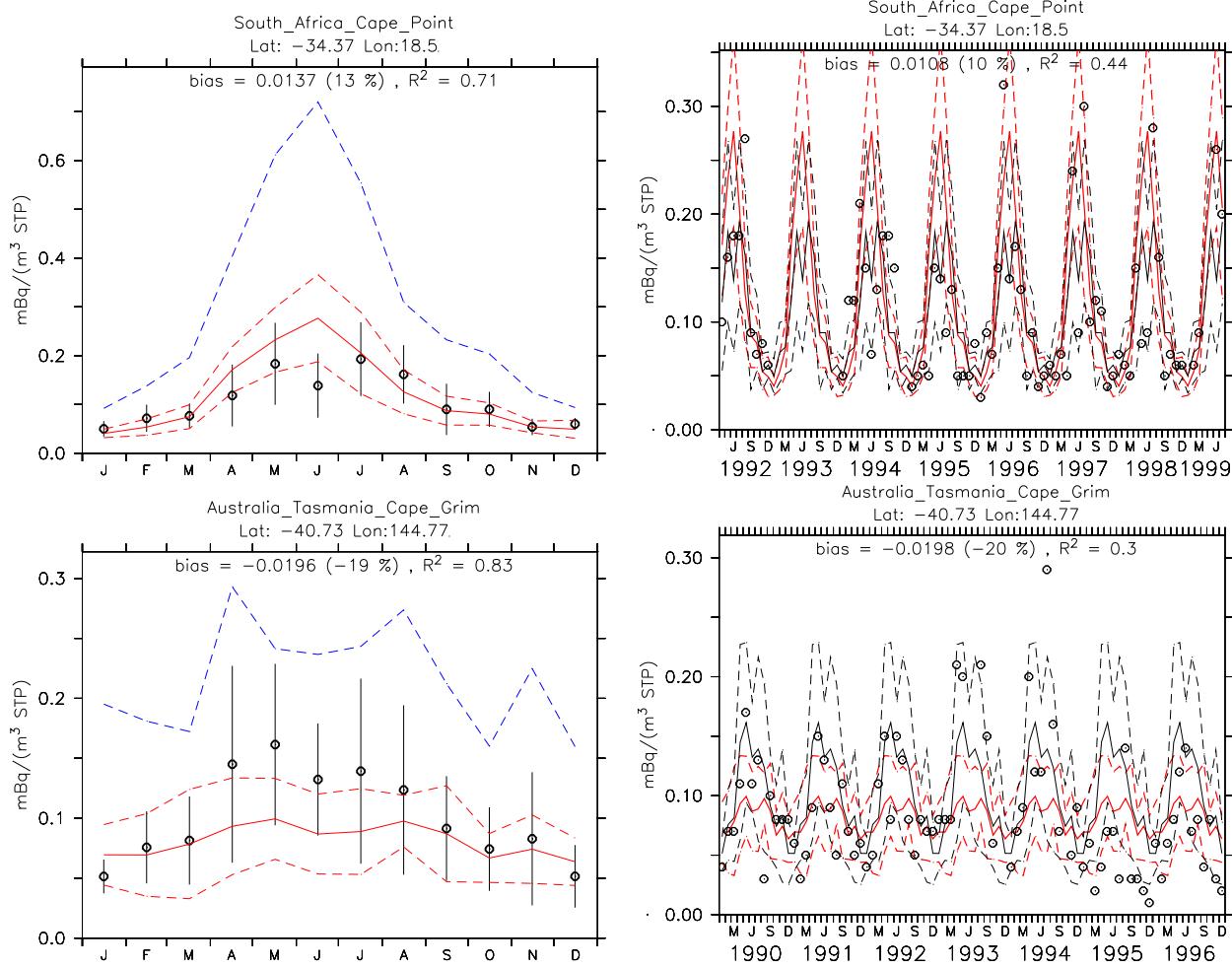


Figure 19: continued

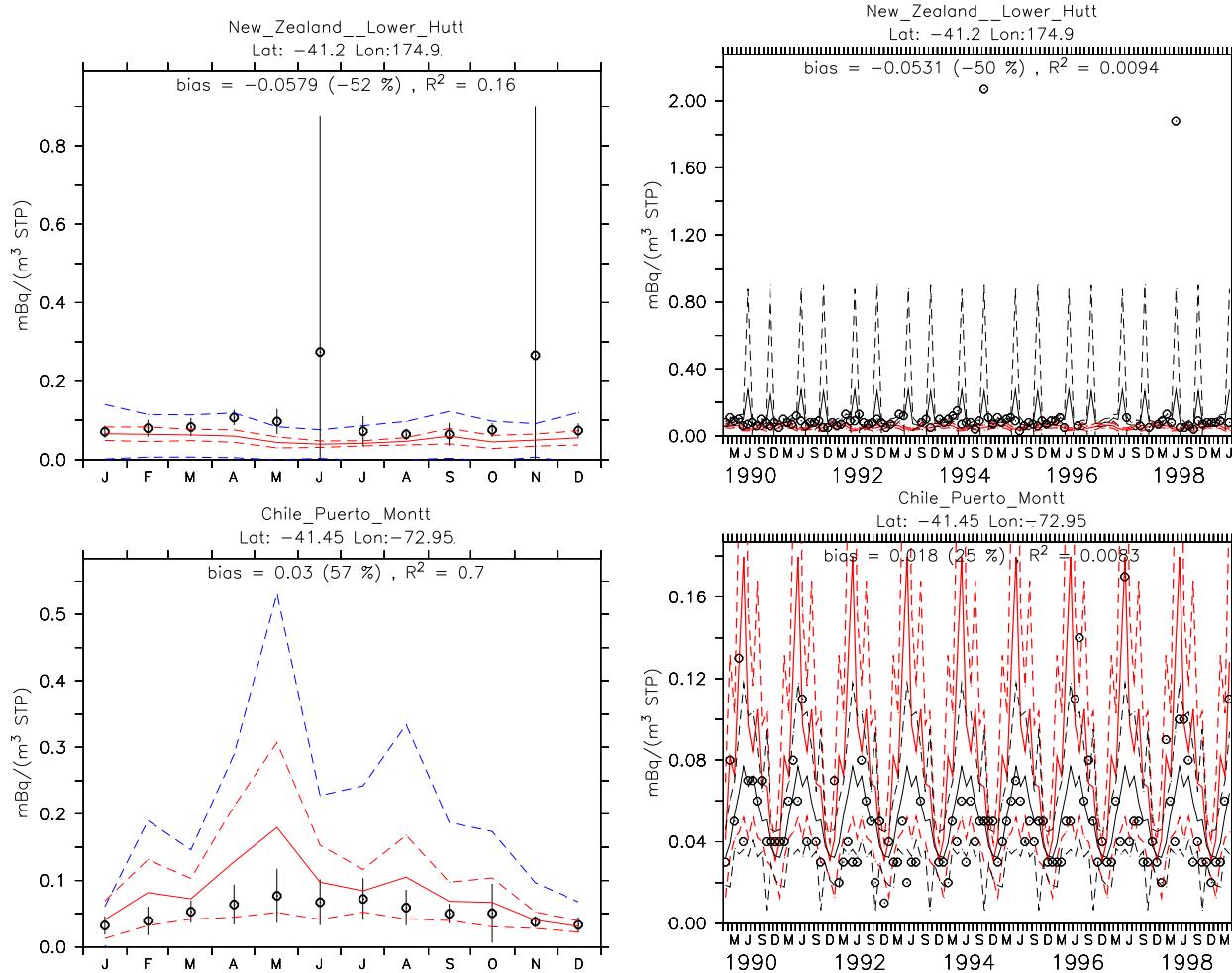


Figure 19: continued

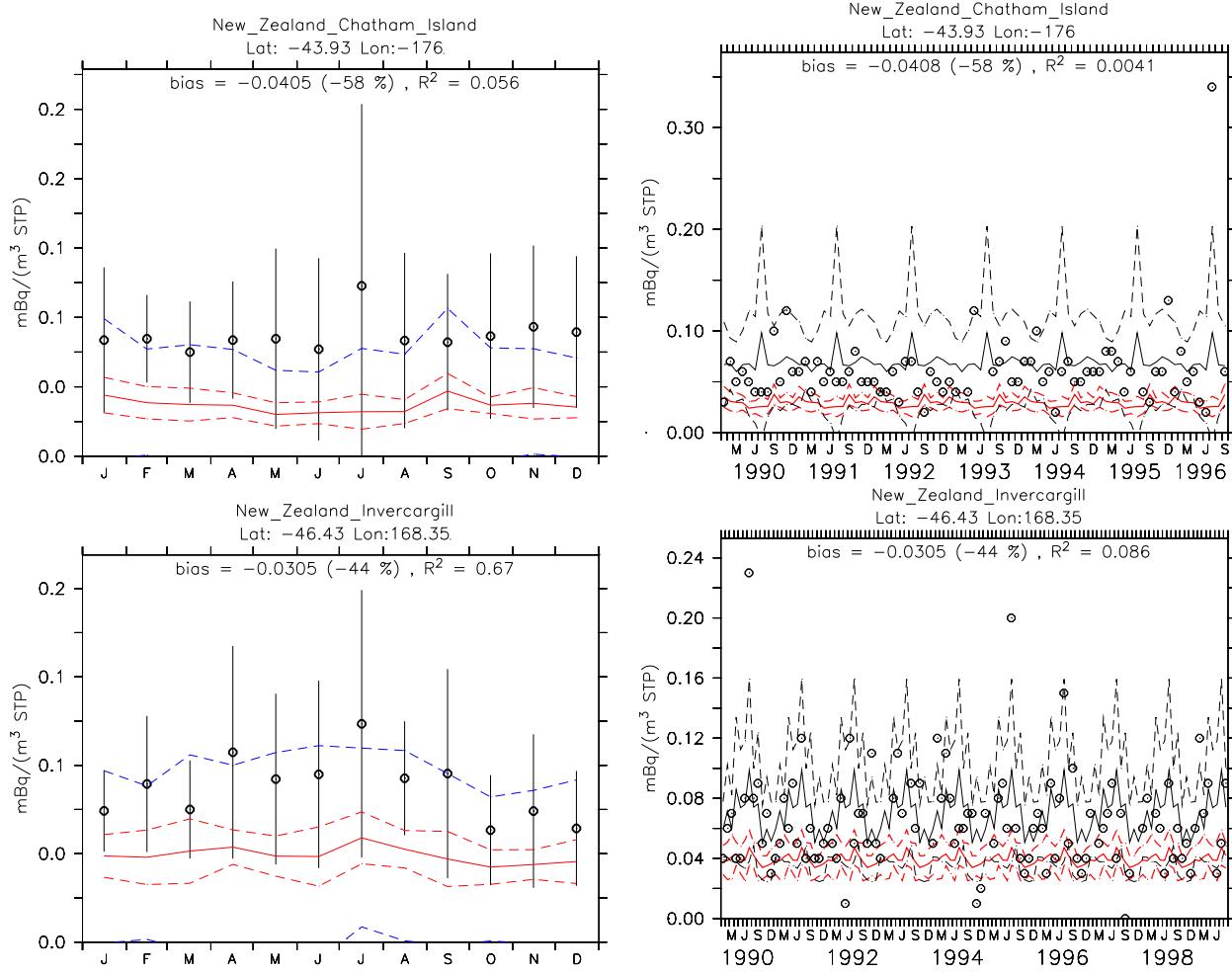


Figure 19: continued

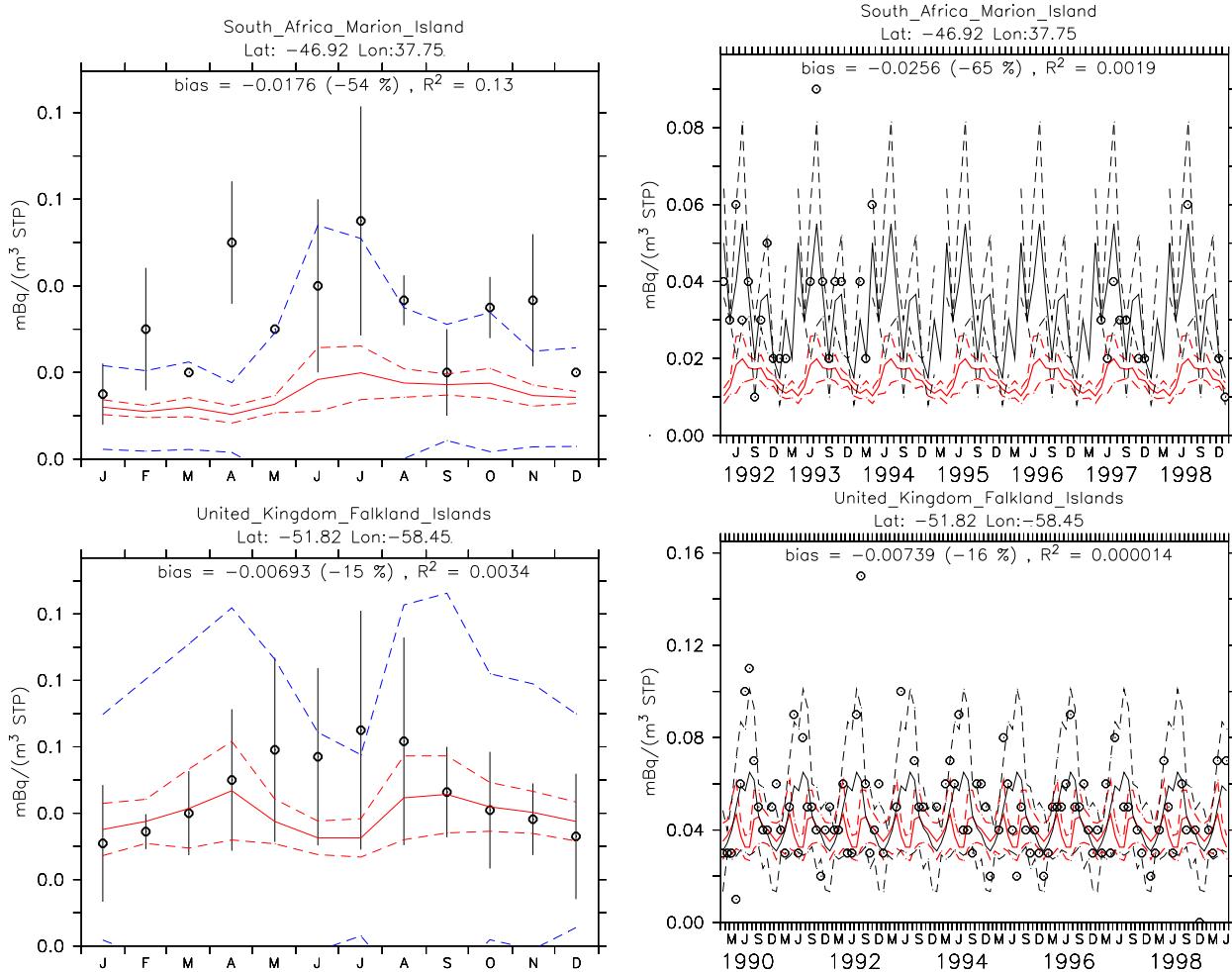


Figure 19: continued

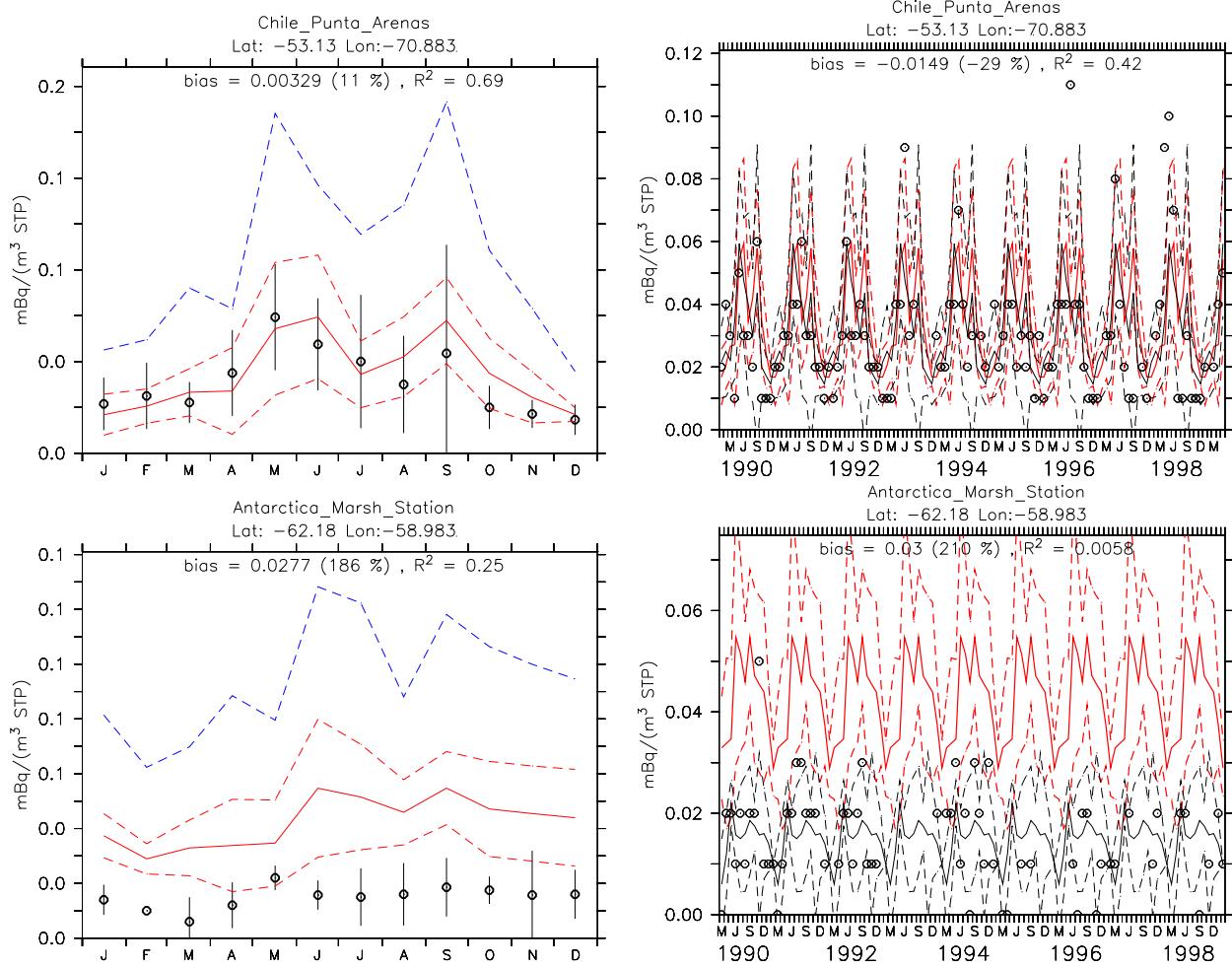


Figure 19: continued

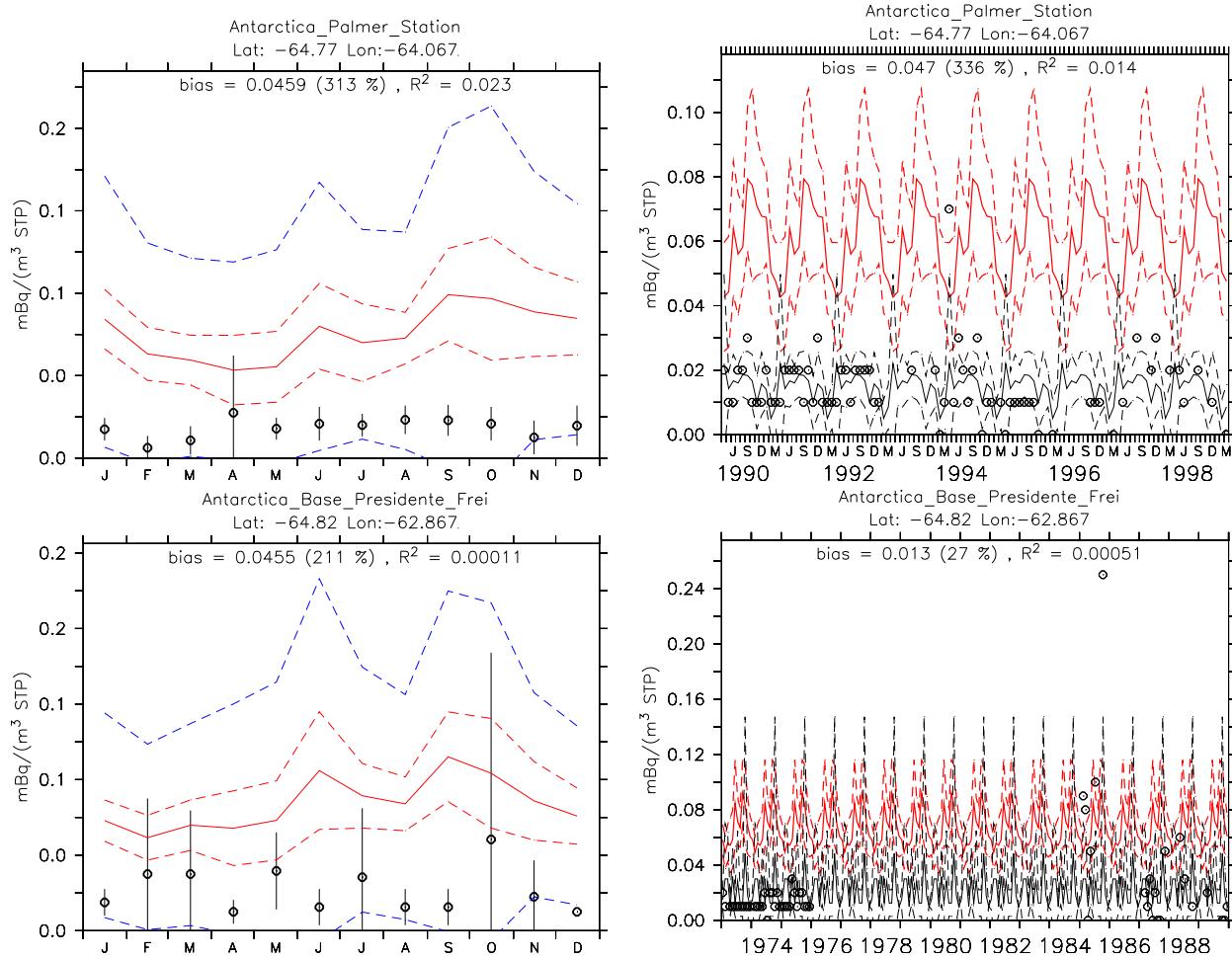


Figure 19: continued

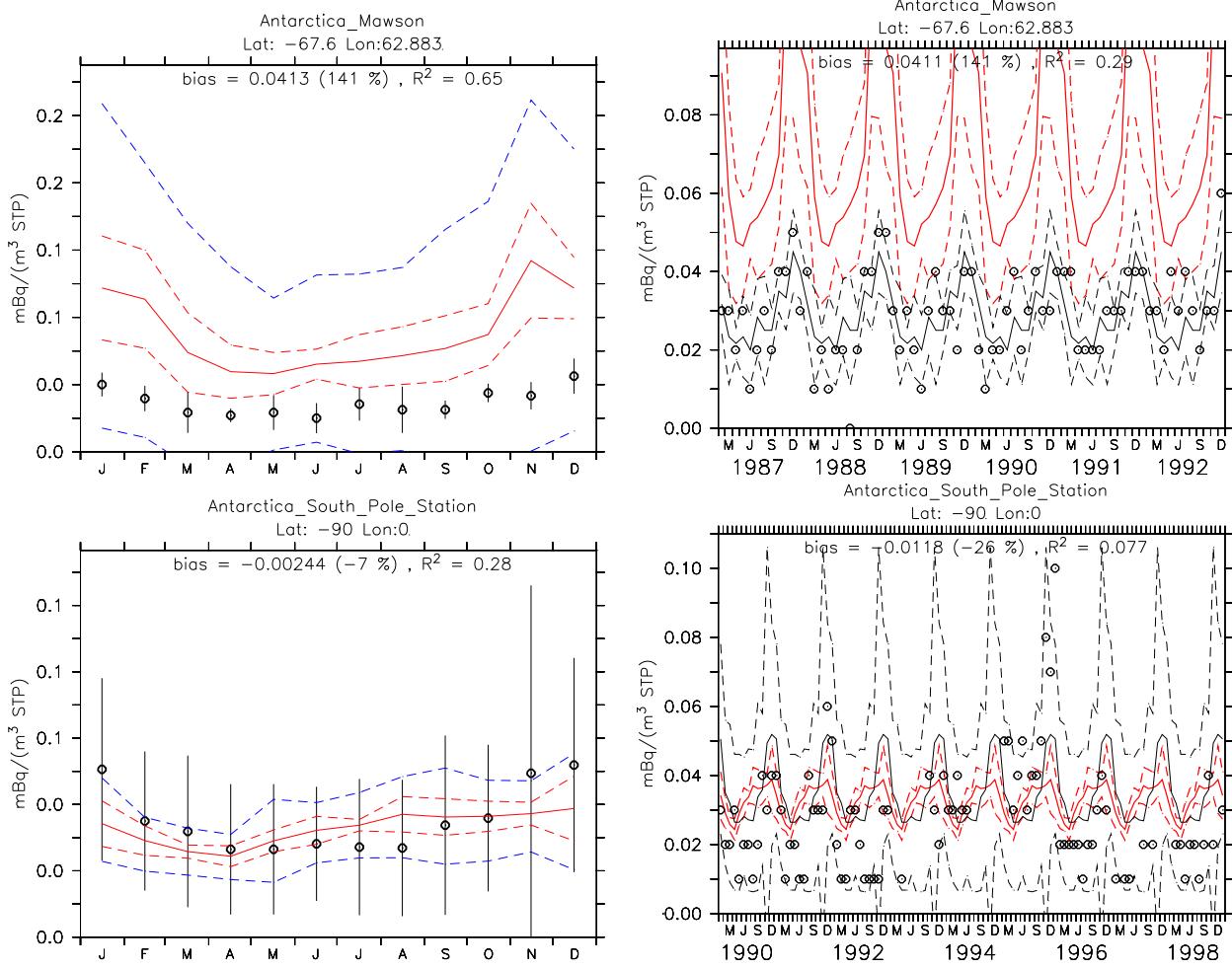


Figure 19: continued

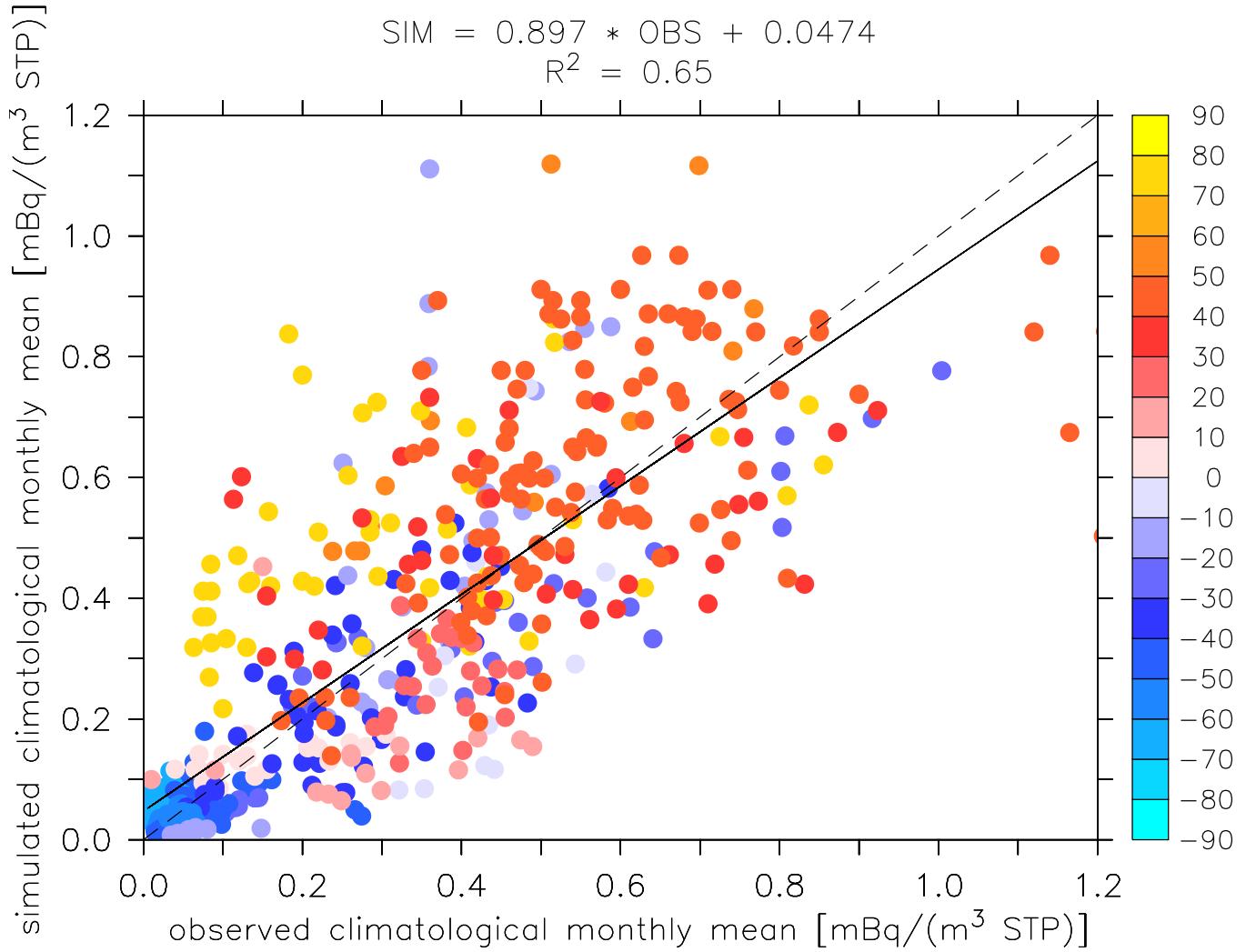


Figure 20: Simulated versus observed monthly climatological averages of ^{210}Pb (see Fig.19). The observations are from the National Urban Security Technology Laboratory Surface Air Sampling Program (NUSTL/SASP), the model results are from the years 2000-2007. The color denotes the geographical latitude, the dashed black line indicates the perfect correspondence. The black line shows the result of the linear regression analysis (as indicated in the top of the panel). R^2 is Pearson's correlation coefficient.

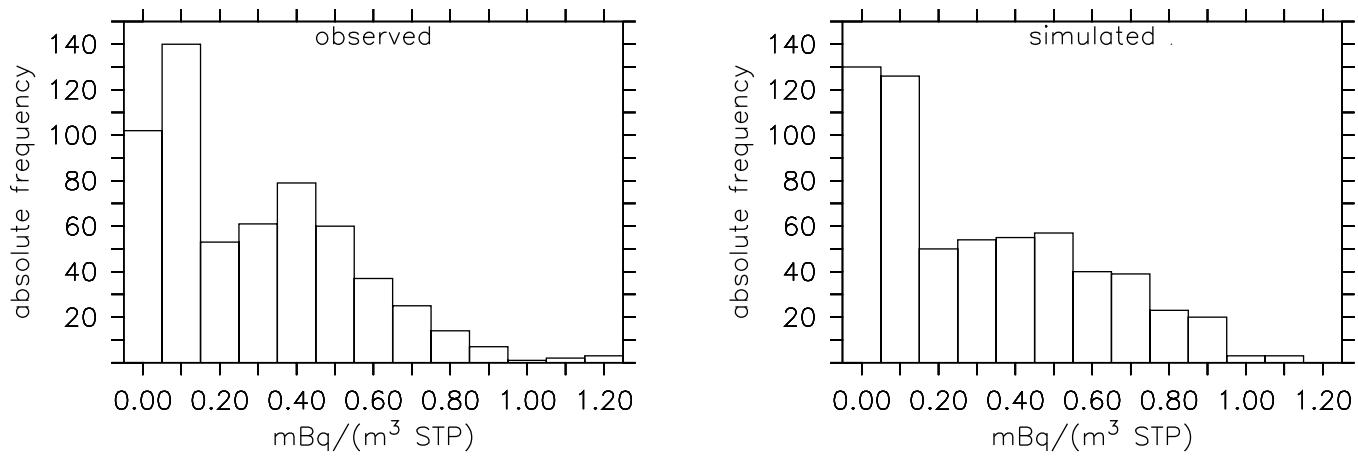


Figure 21: Frequency histograms of observed (left) and simulated (right) monthly climatological averages of ^{210}Pb (see Fig.19). The observations are from the National Urban Security Technology Laboratory Surface Air Sampling Program (NUSTL/SASP), the model results are from the years 2000-2007.

3.3 ^{222}Rn

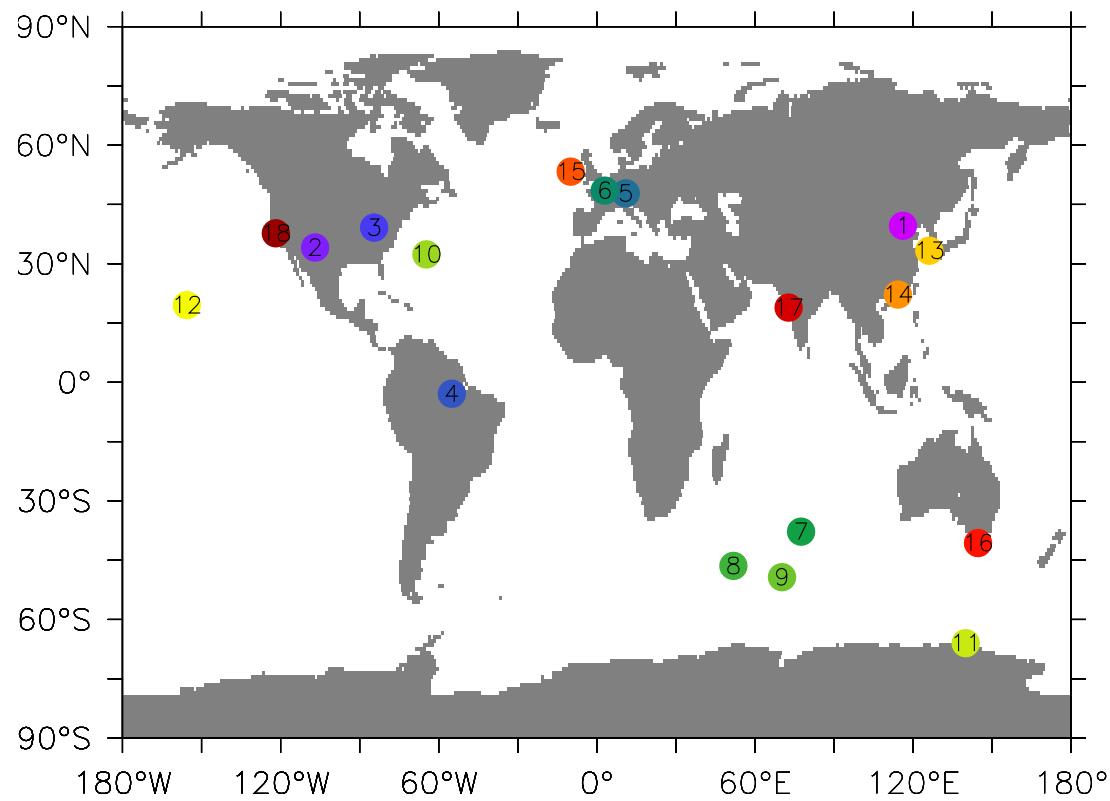


Figure 22: Geographical location of ^{222}Rn surface observations as used by Zhang et al. (2008, and references therein).

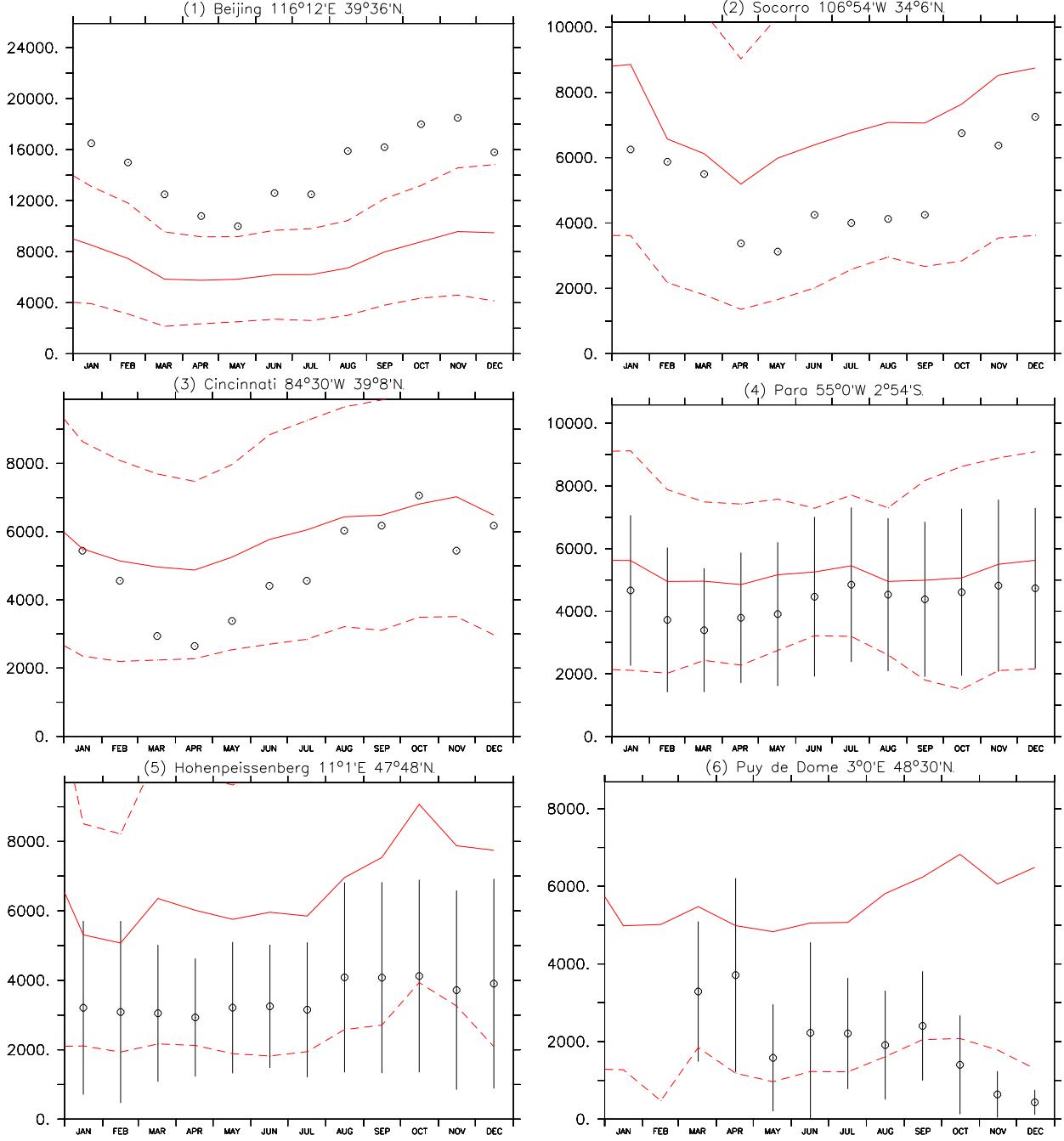


Figure 23: Observed (black symbols) and simulated (red lines) monthly average ^{222}Rn activity (in mBq/m³ STP) at ground level. The observations are the same as used by Zhang et al. (2008, and references therein), the model results are climatological monthly averages of the years 2000 - 2007. The black bars (if available) show the multi-annual standard deviation of the observations, the dashed red lines indicate the corresponding simulated standard deviations (plus / minus). The numbers in the titles correspond to the location labels in Fig. 22, the name of the sites and the geographical coordinates are listed in addition.

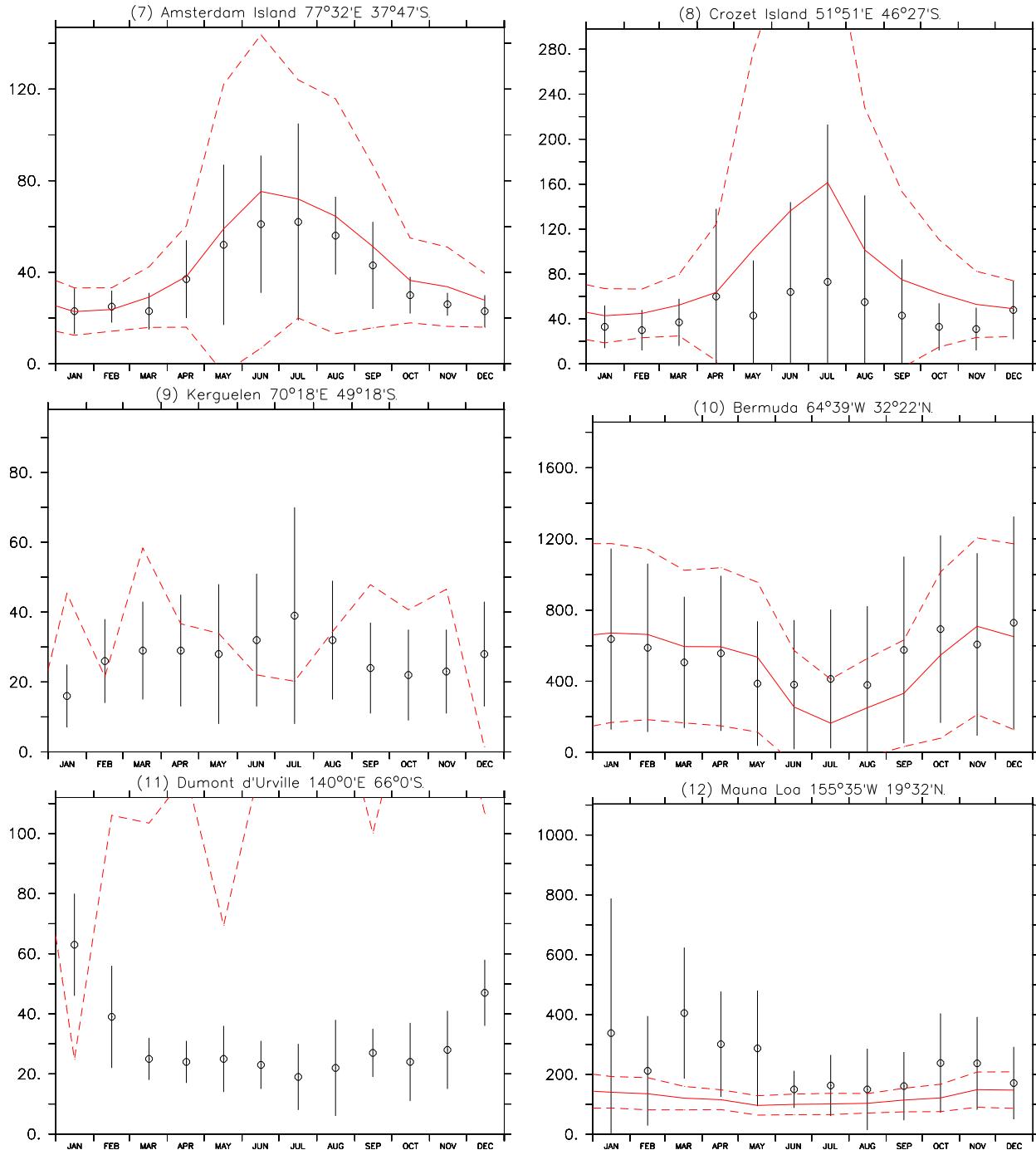


Figure 23: continued

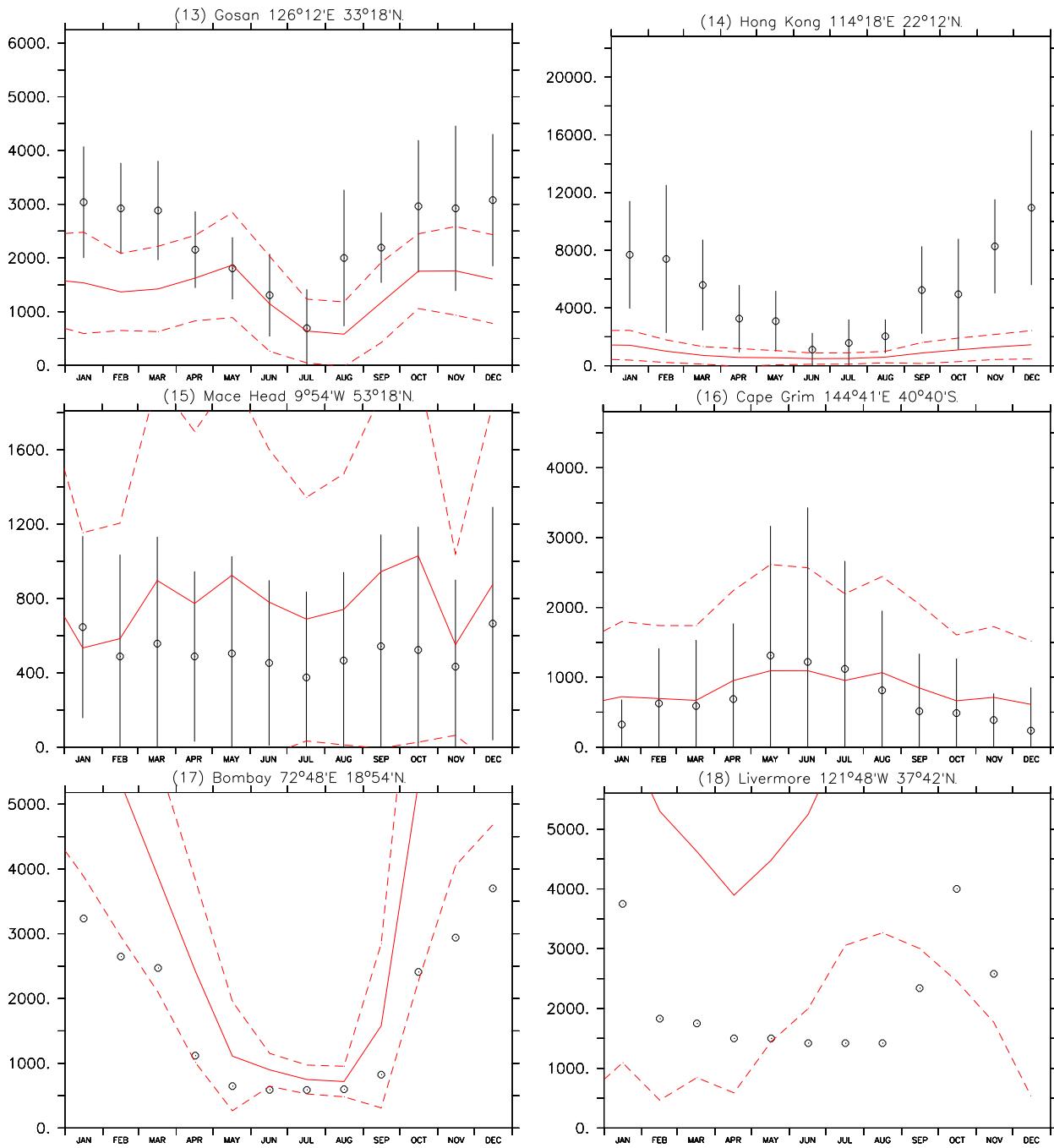


Figure 23: continued

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