Article

Long-Term Tropospheric Ozone Data Analysis 1997–2019 at Giordan Lighthouse, Gozo, Malta

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Abstract: Long-term data analysis of the hourly ozone volume fractions in the middle of the Mediterranean Seawas carried out covering a period of 22 years. It was noticed that the amount of ozone during this period very rarely exceeded the recommended upper limit value of 80 ppb and that the amount of tropospheric ozone in the area is rather low. Fourier data analysis shows the presence of only a seasonal cycle in ozone concentrations. Statistical analysis of the data is showing a slightly negative trend in ozone concentrations of −0.46 ± 0.08 ppb/year for average values and a slightly higher negative trend of −0.54 ± 0.11 ppb/year for the 95th percentile values. These results obtained through simple linear regression were confirmed using the more appropriate Mann–Kendall test. The possible quadratic trend was not observed for the whole series of data. Air mass trajectories were calculated for those days in the year with the highest pollution, indicating that during those days horizontal air transfer, in most cases, brings the air mass from the North and from Sicily in Southern Italy.

Keywords: ozone; troposphere; pollution; data analysis; air trajectories; photosmog

1. Supplementary material

In this supplementary material additional figures are shown which are better suitable to be shown here because of the better transparency of the main text. Those figures can help to better understand and describe the main text.

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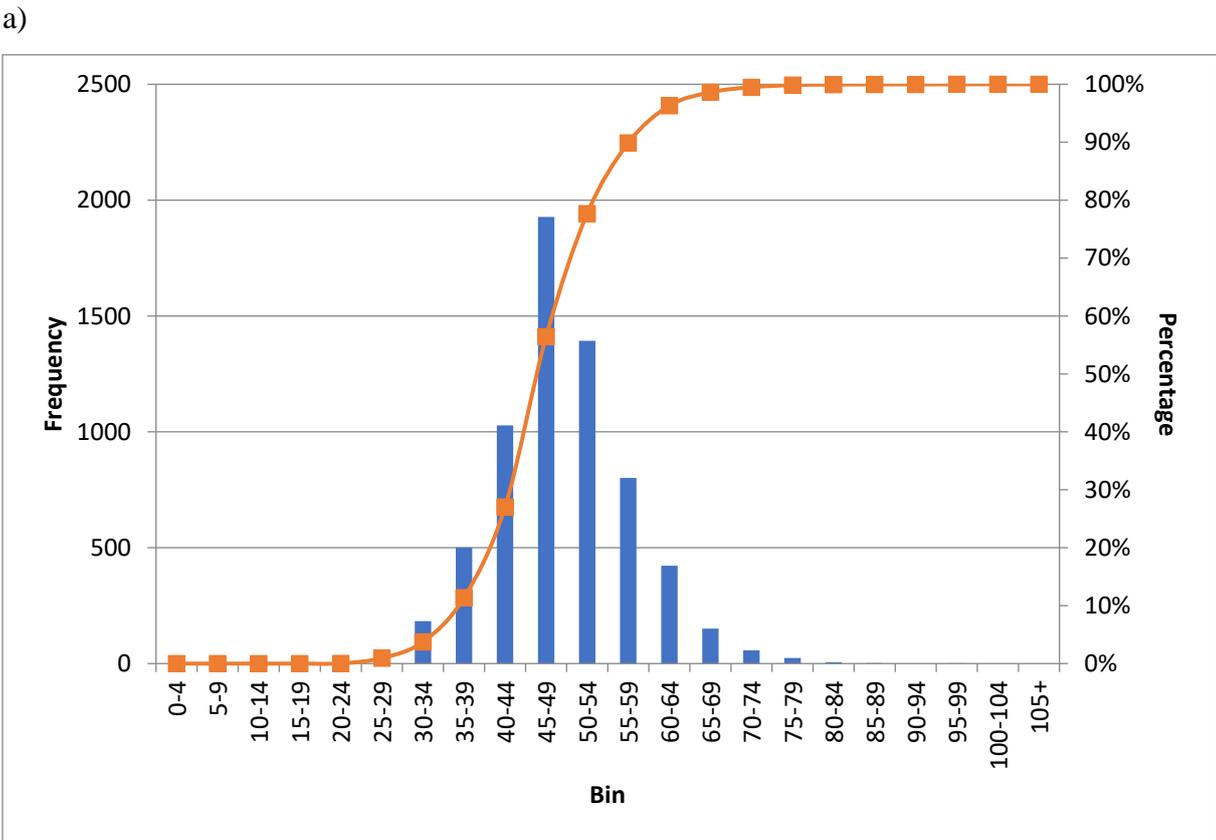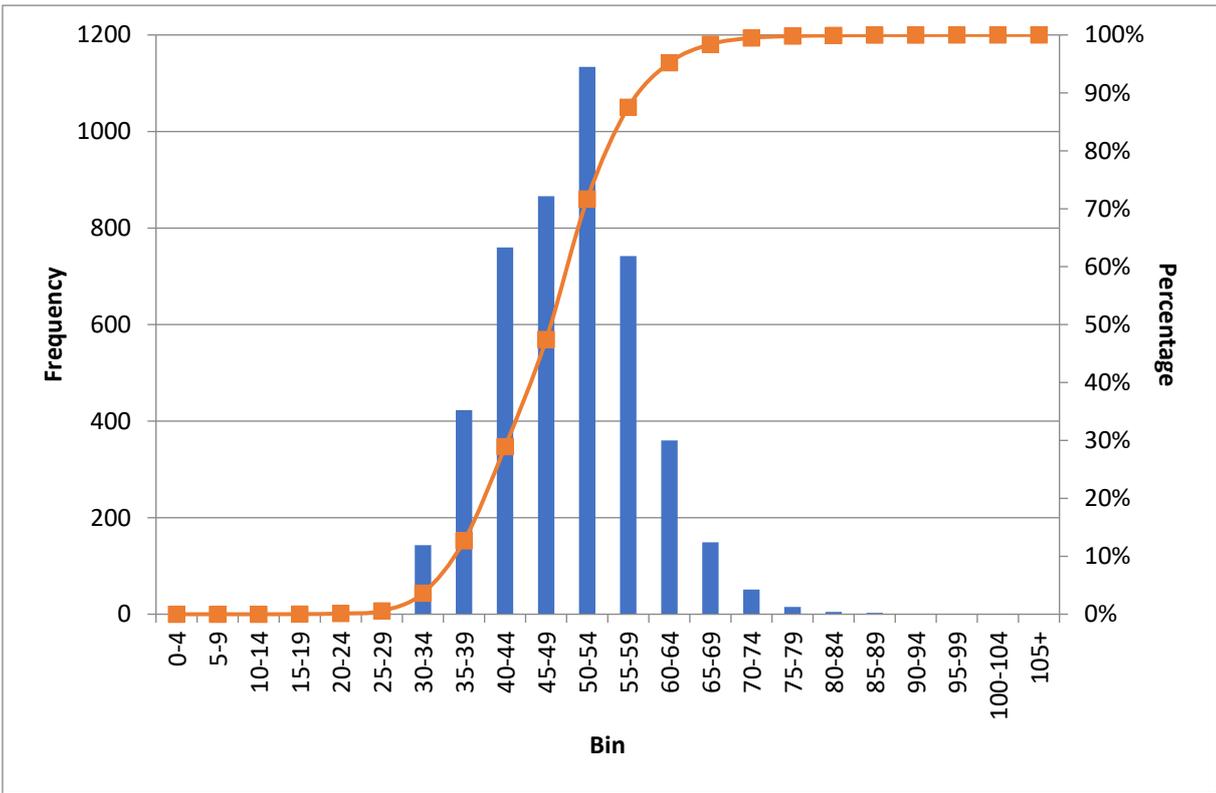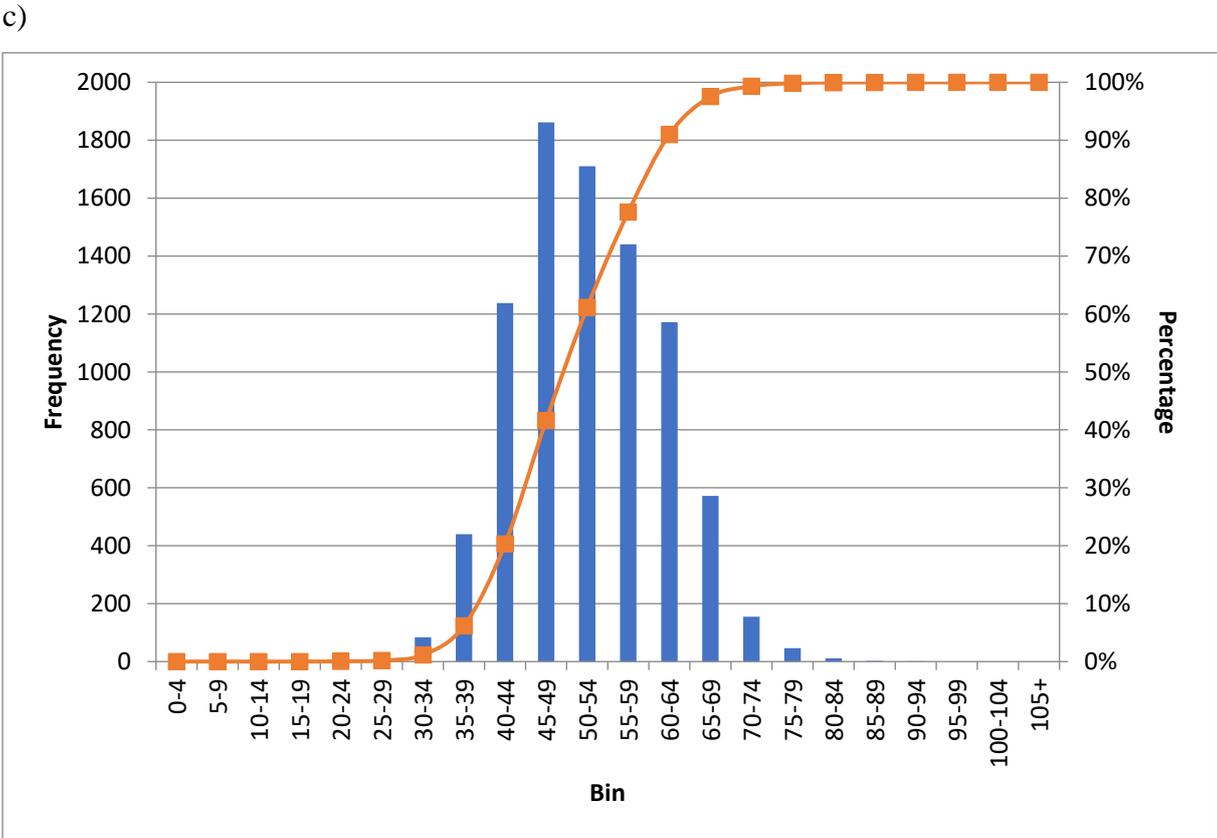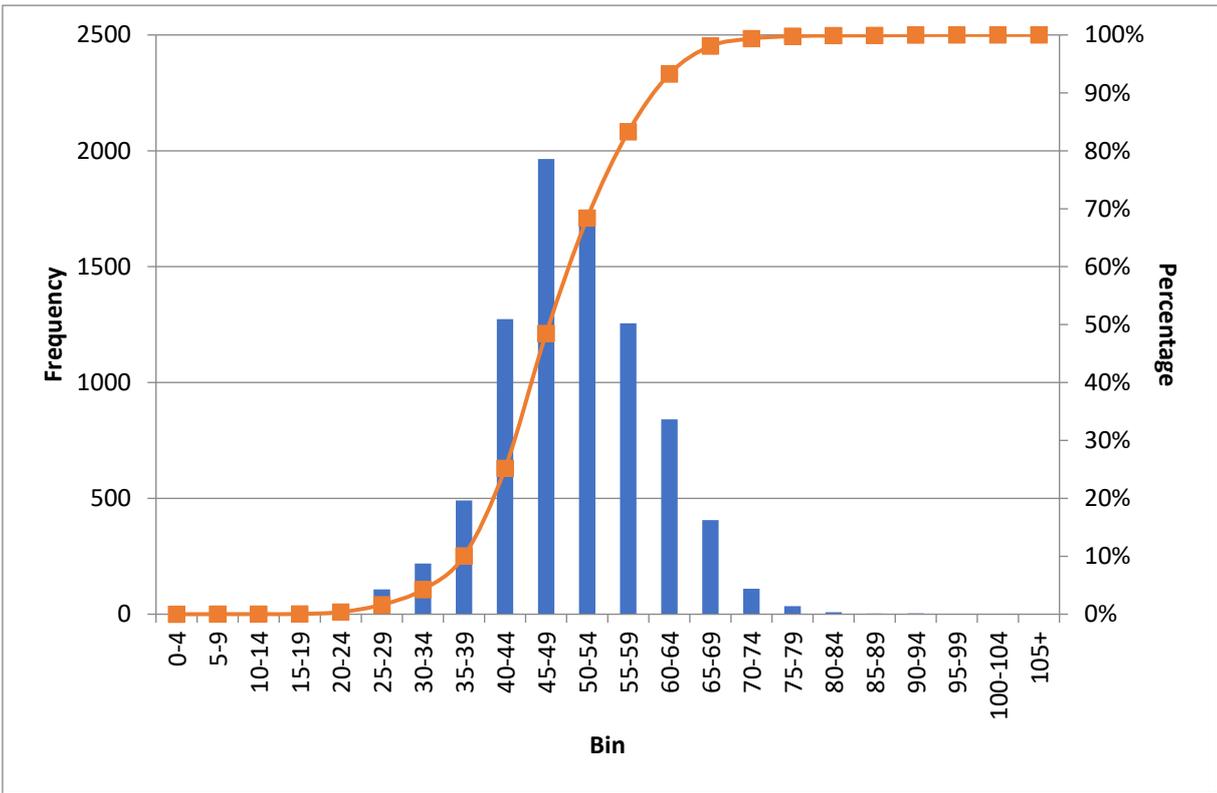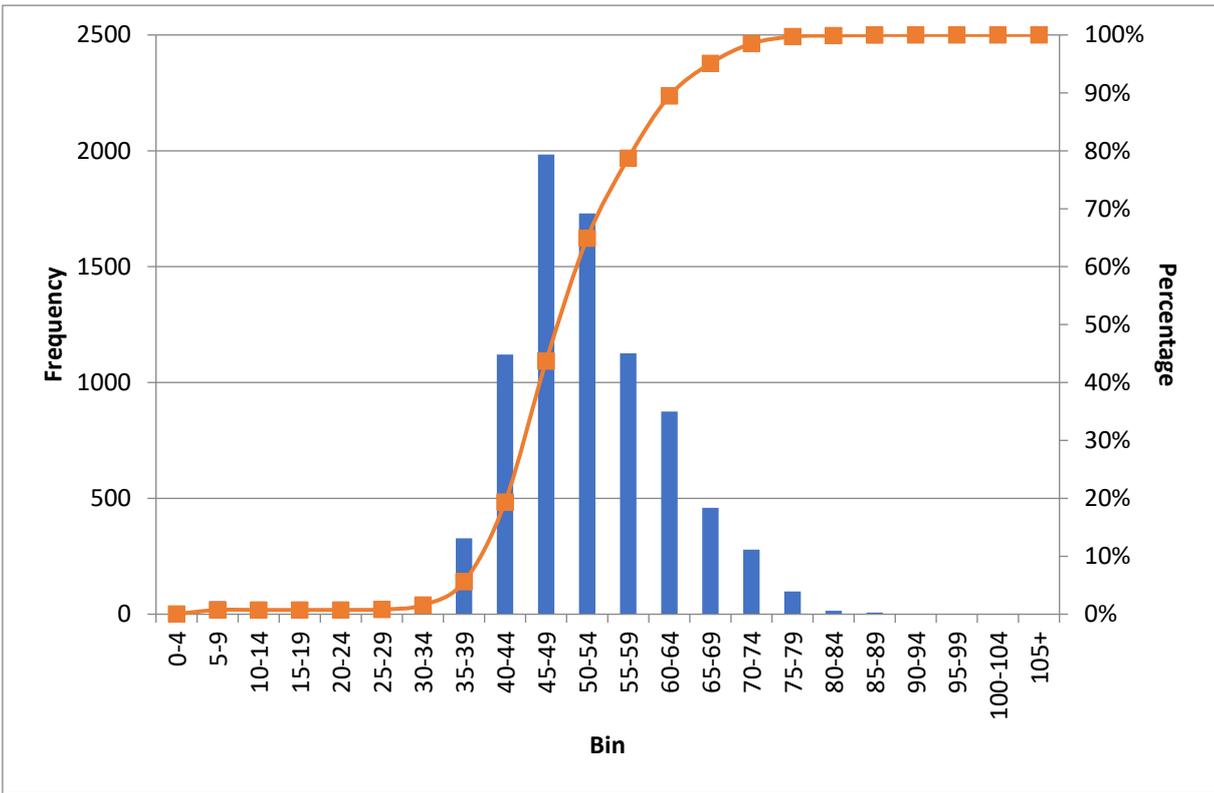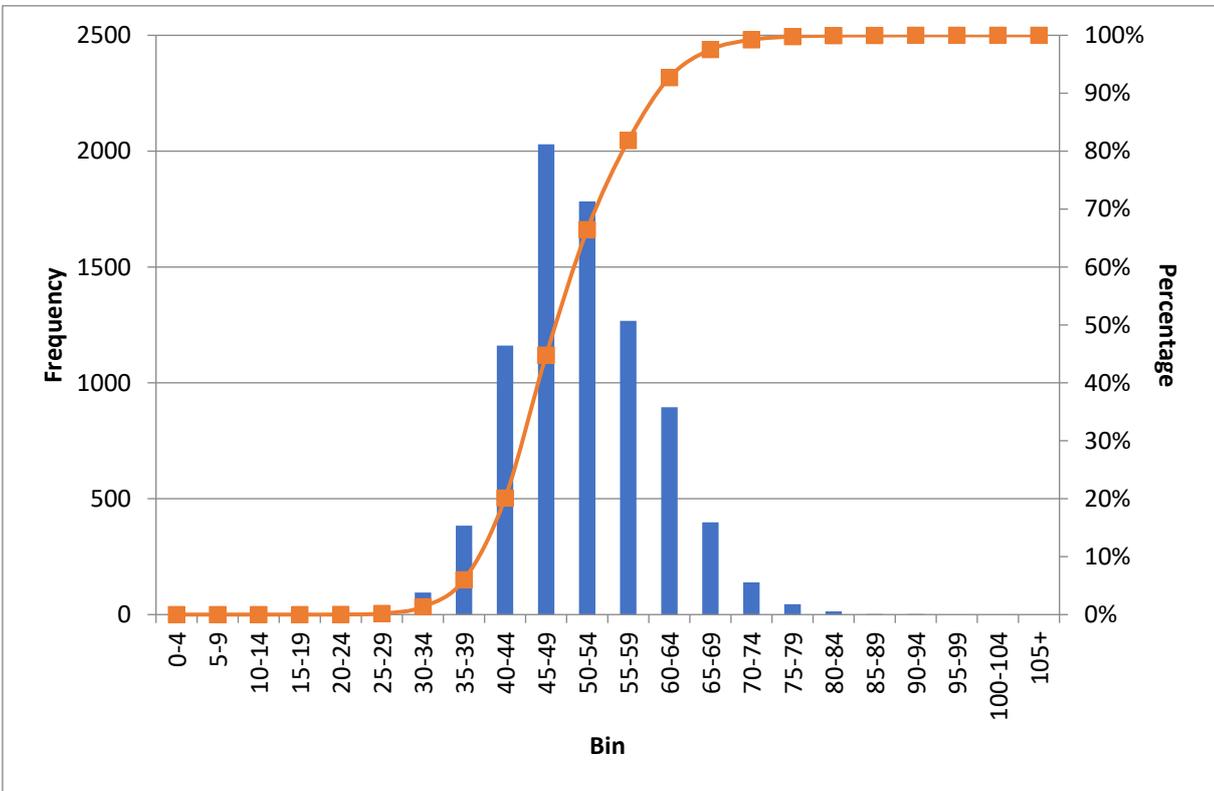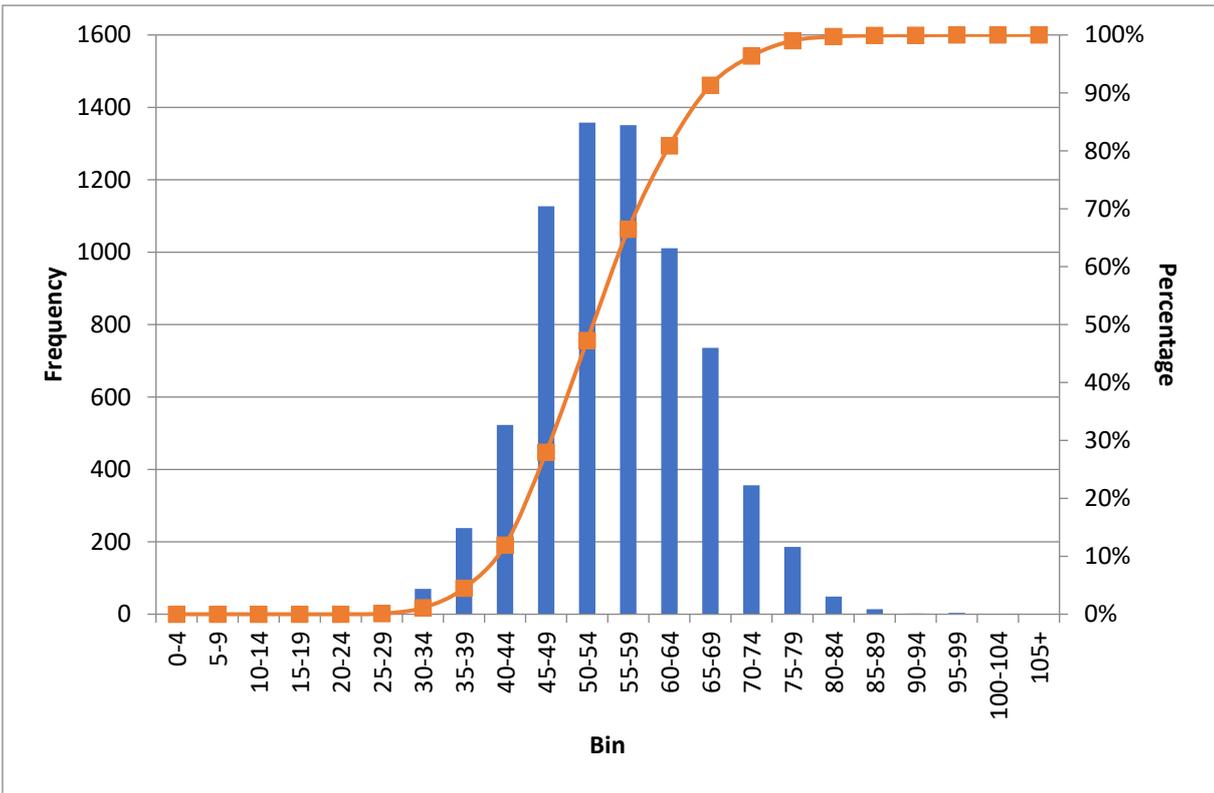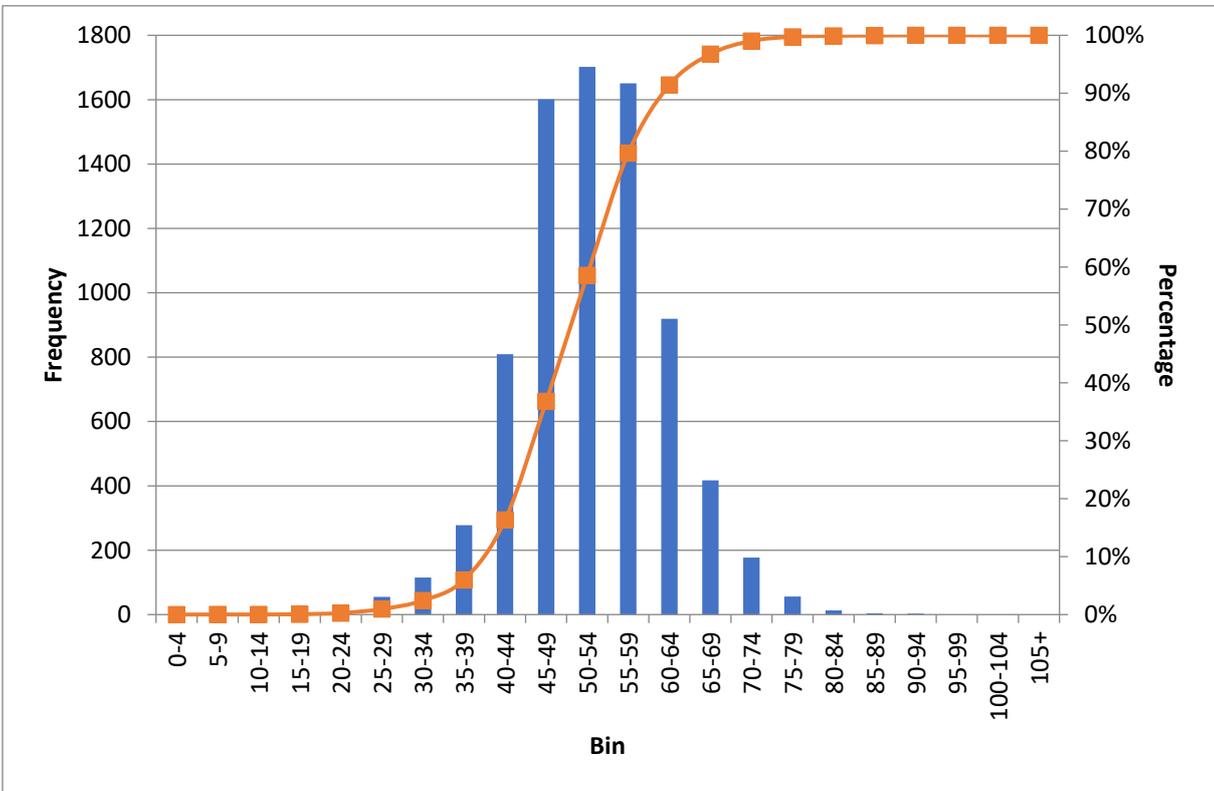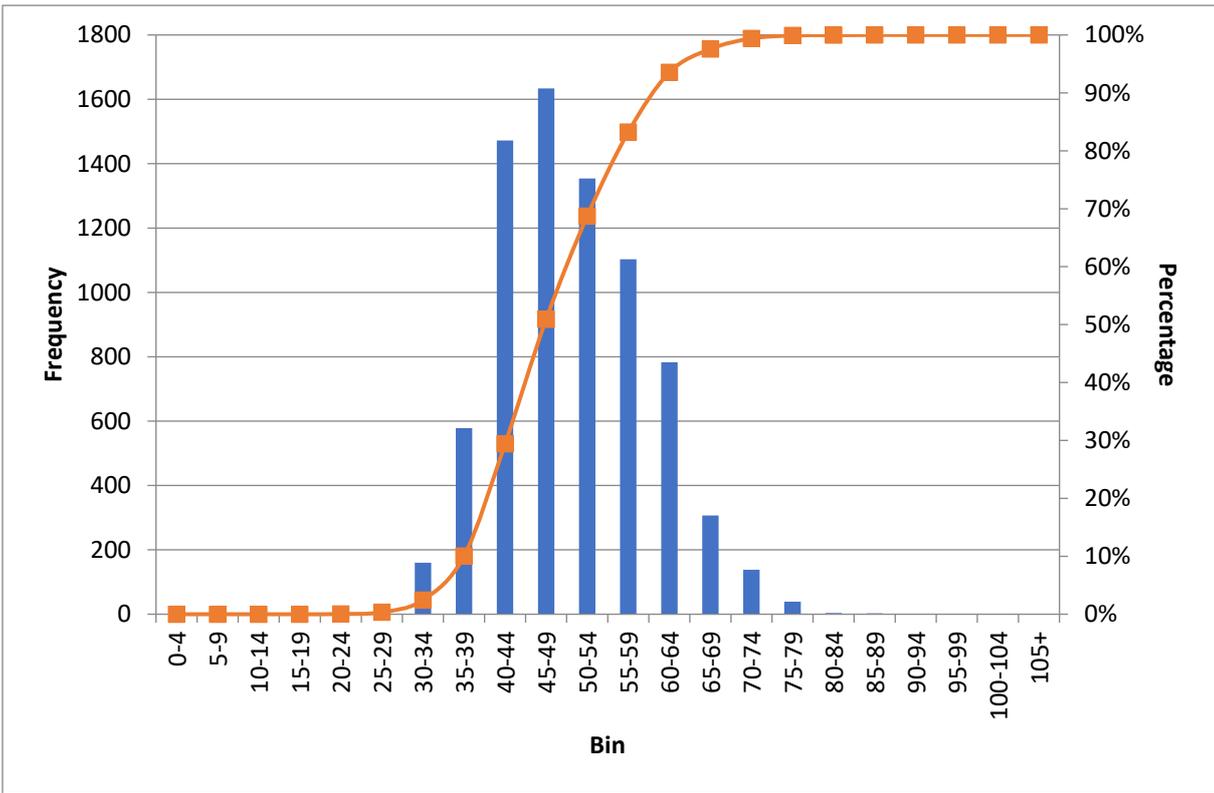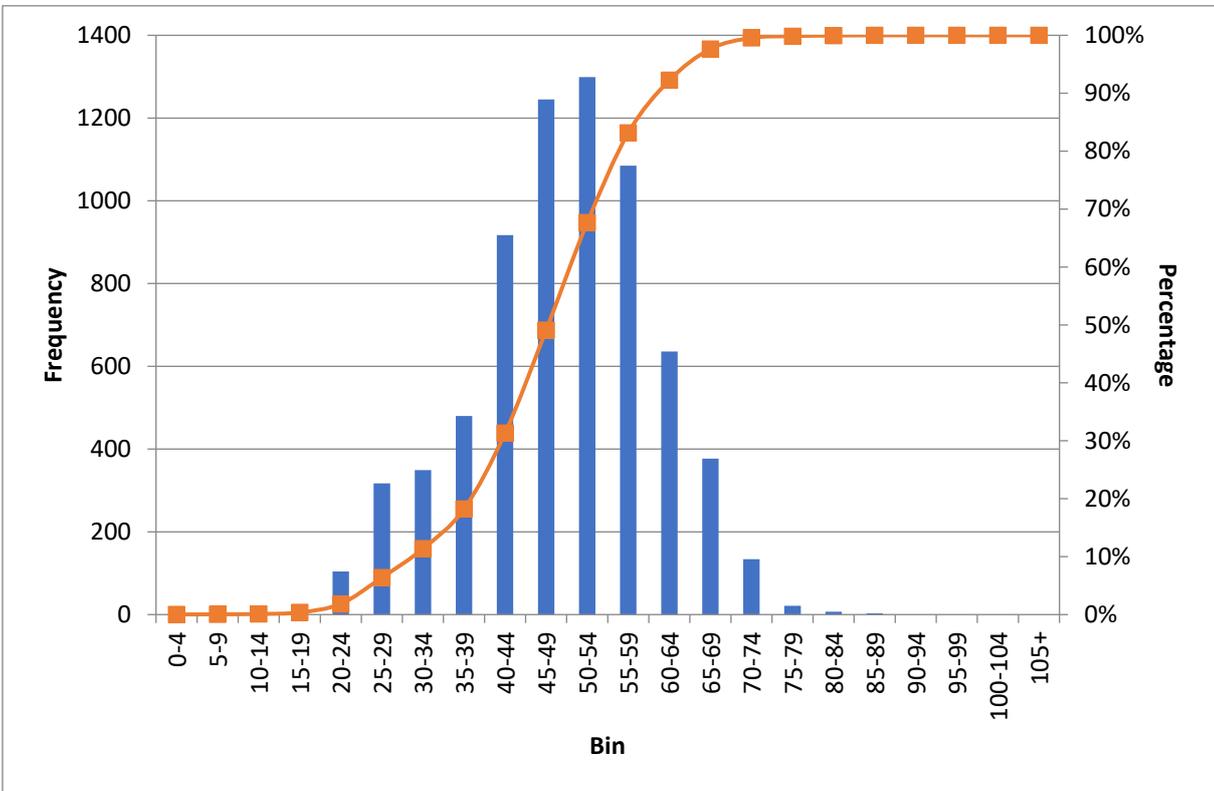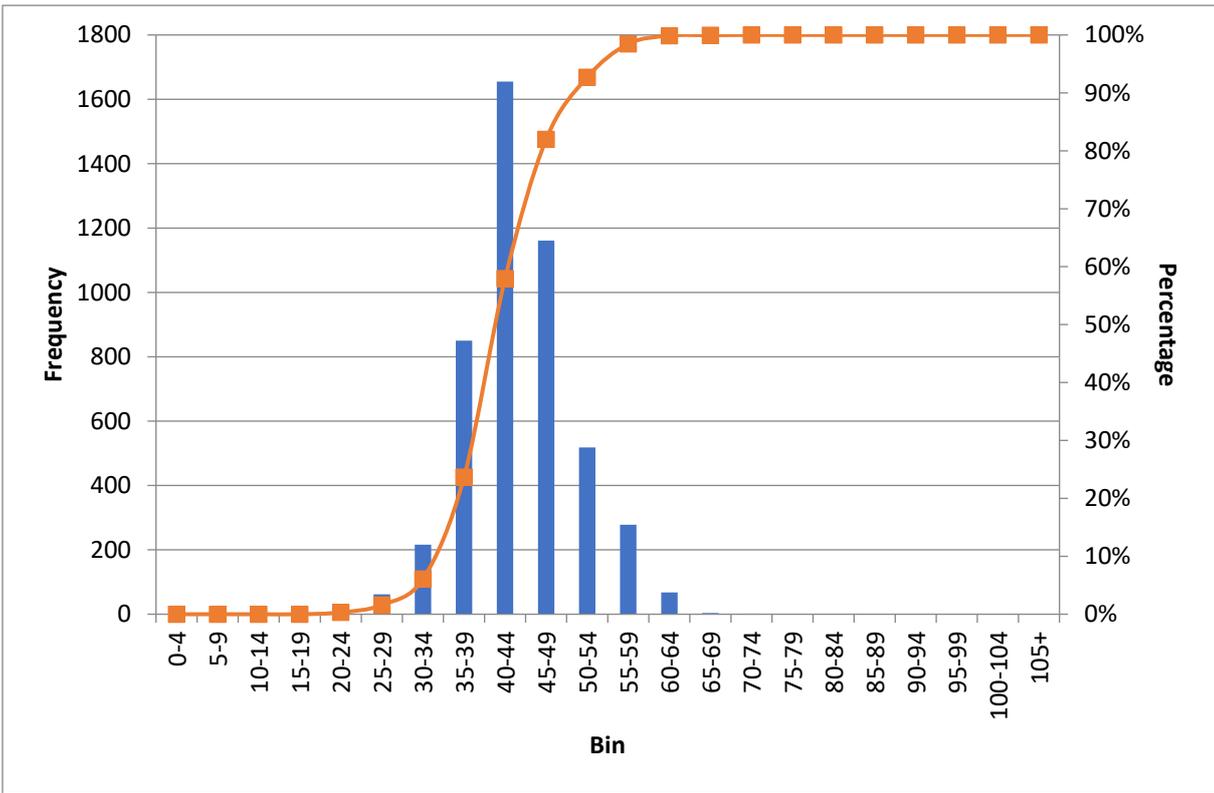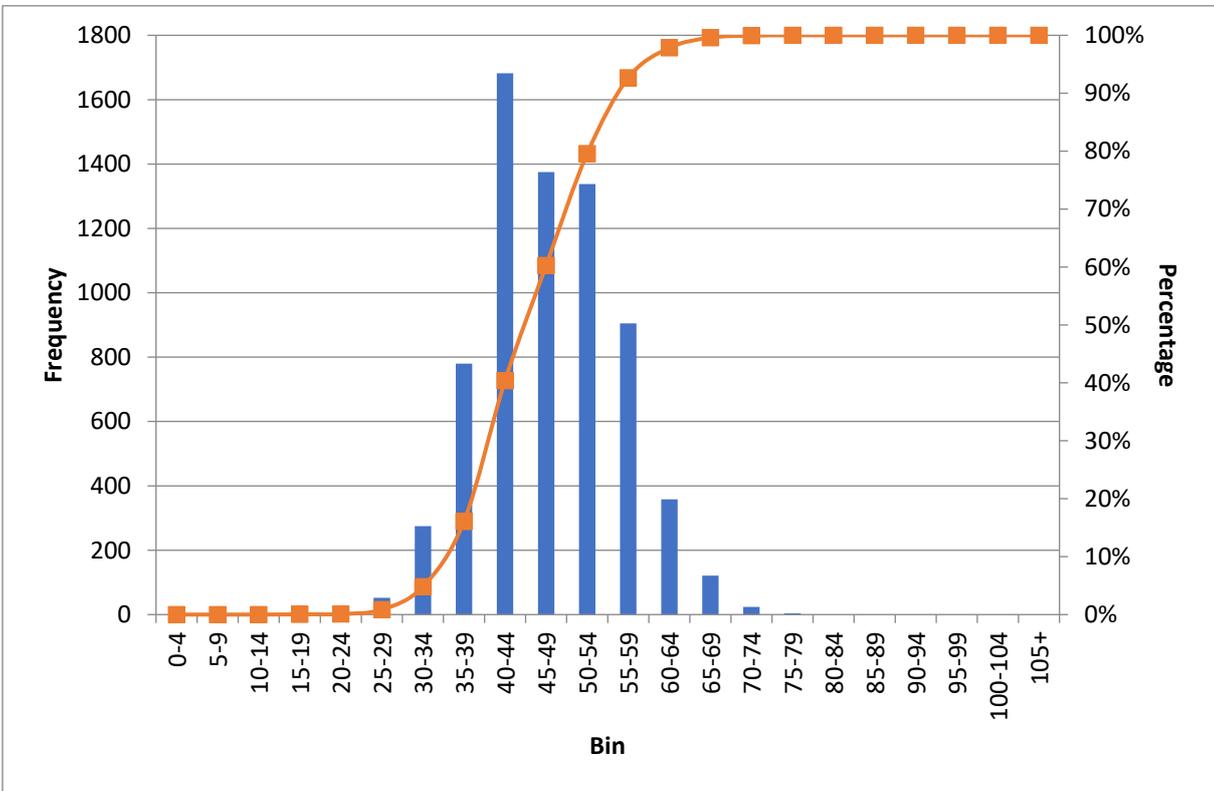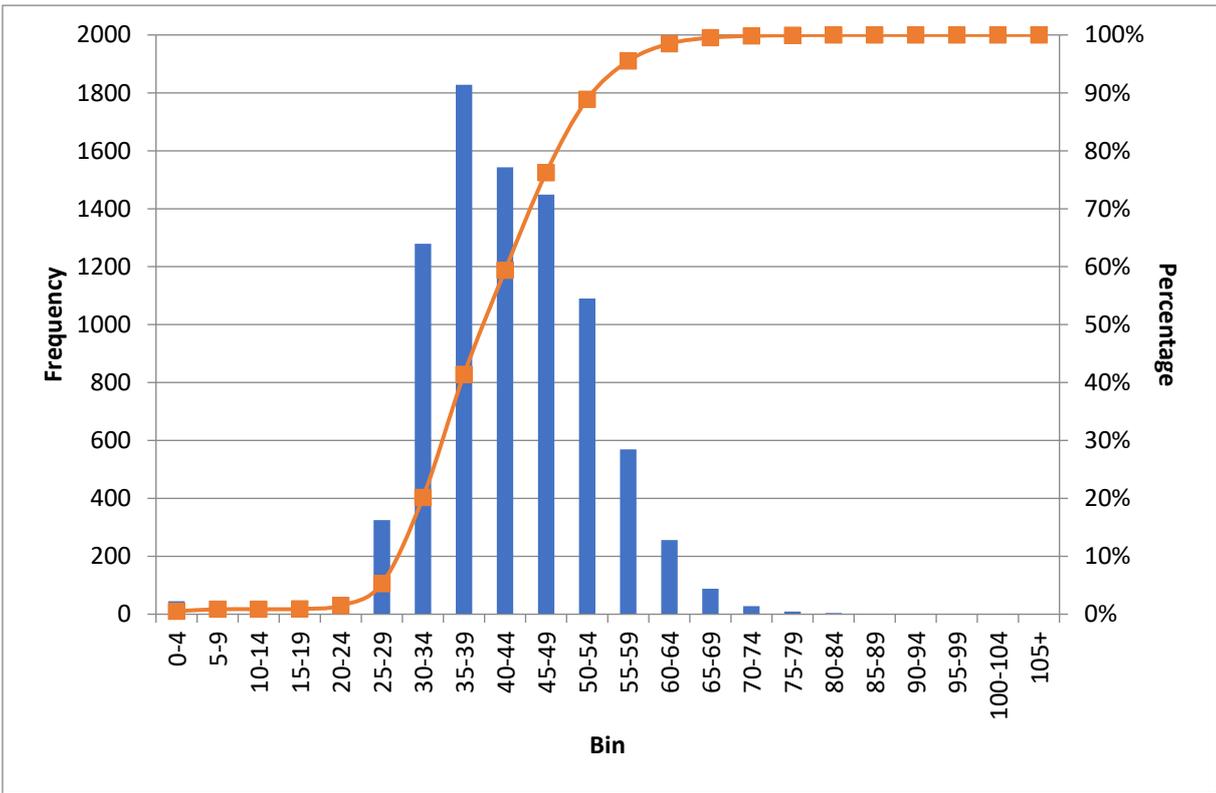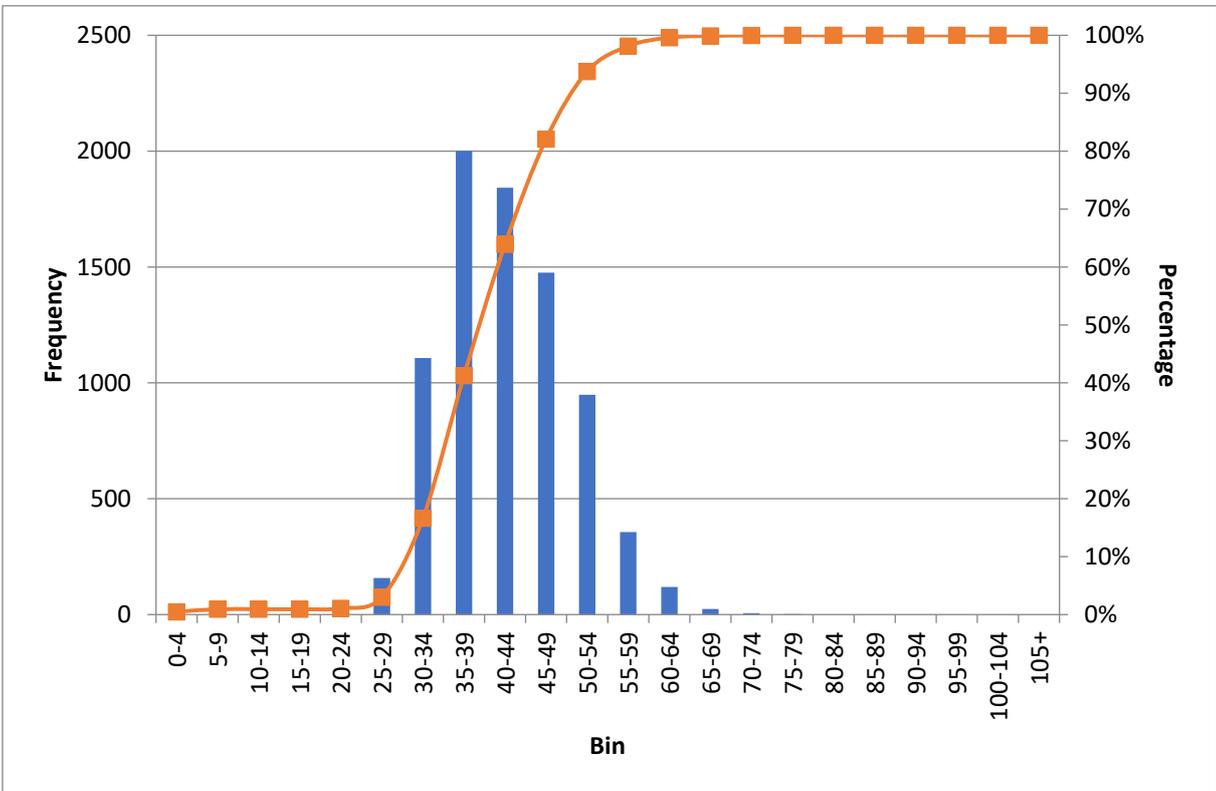
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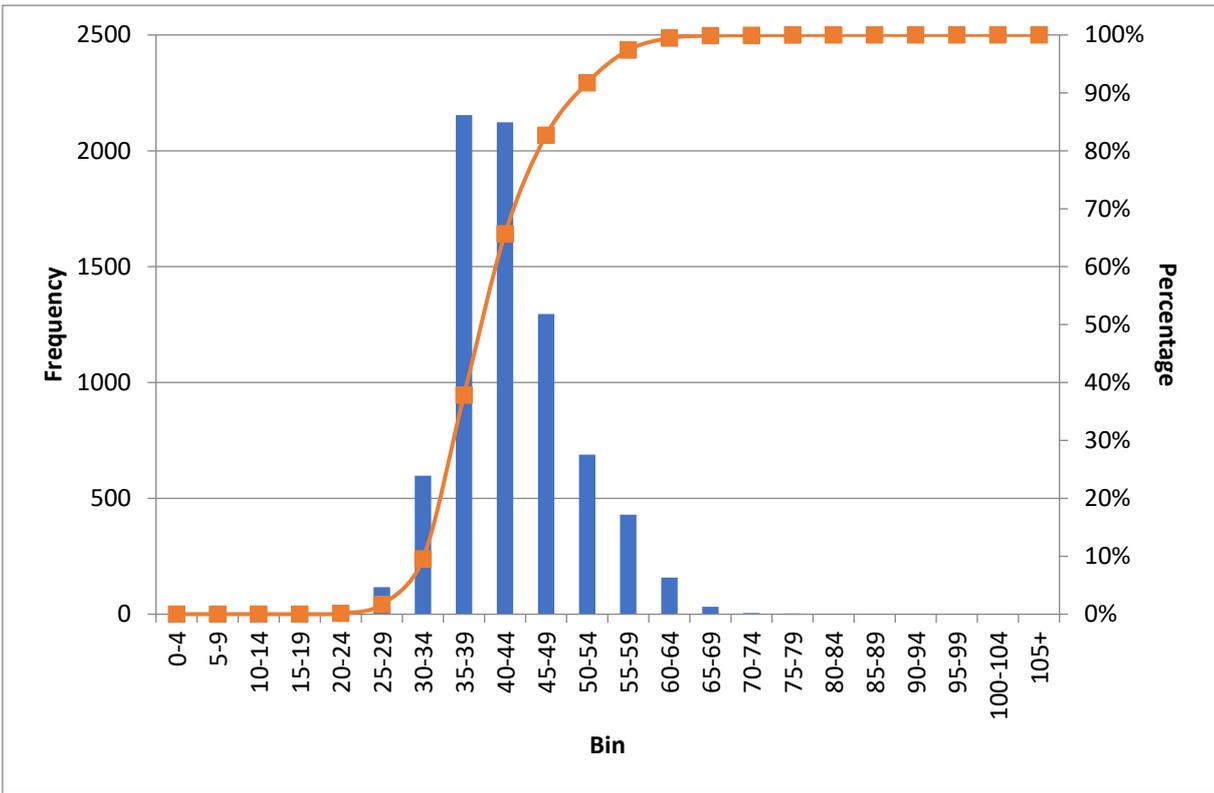
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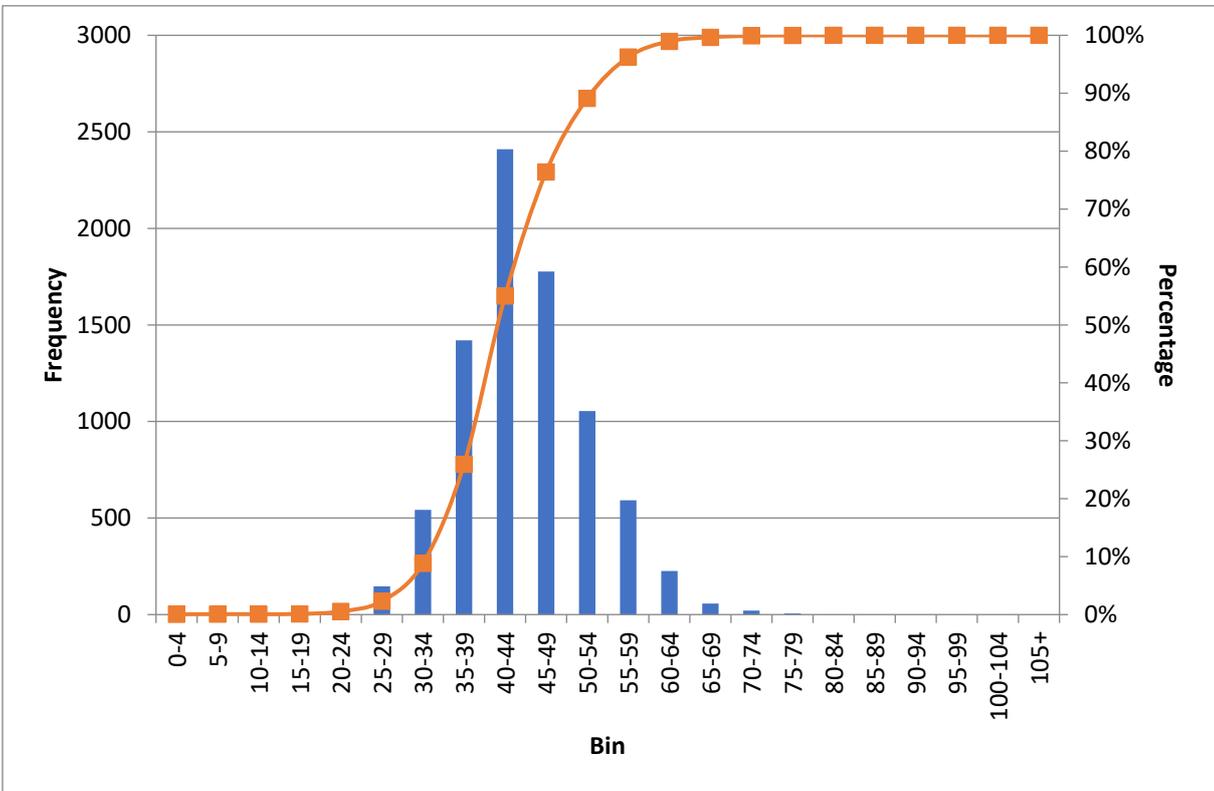
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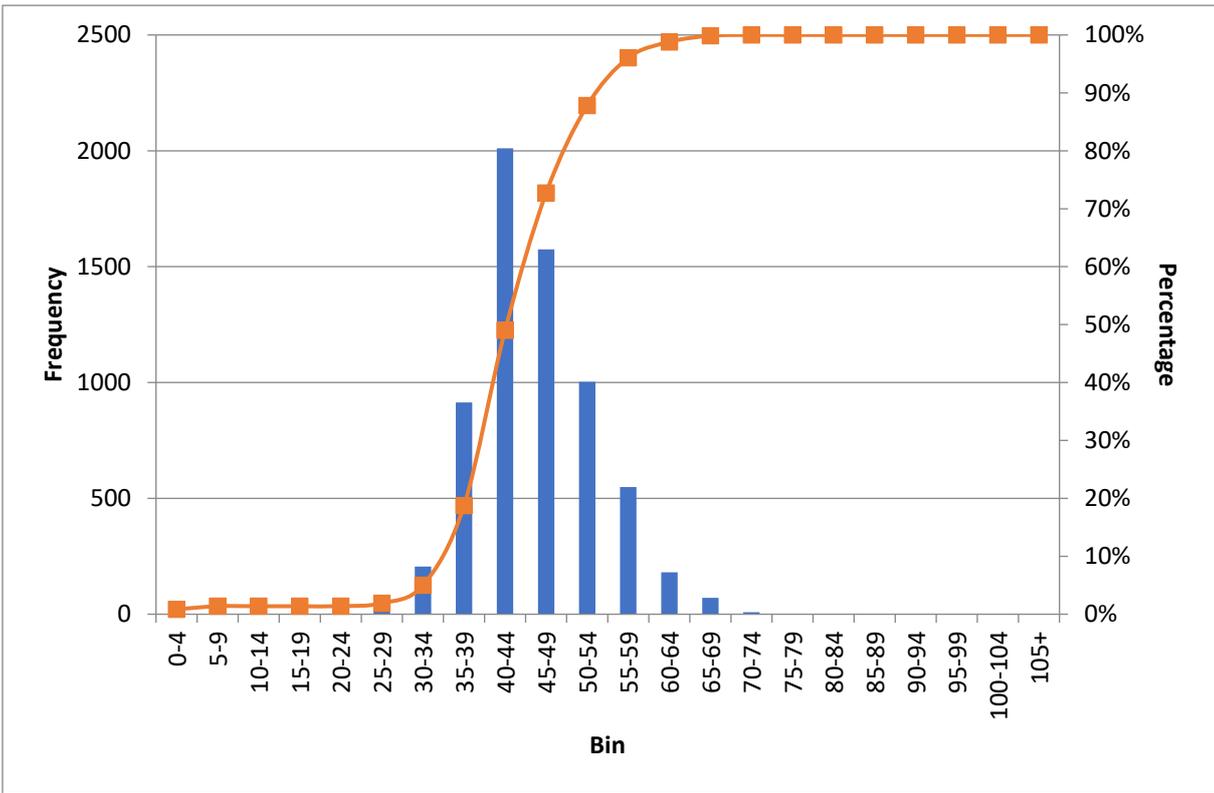
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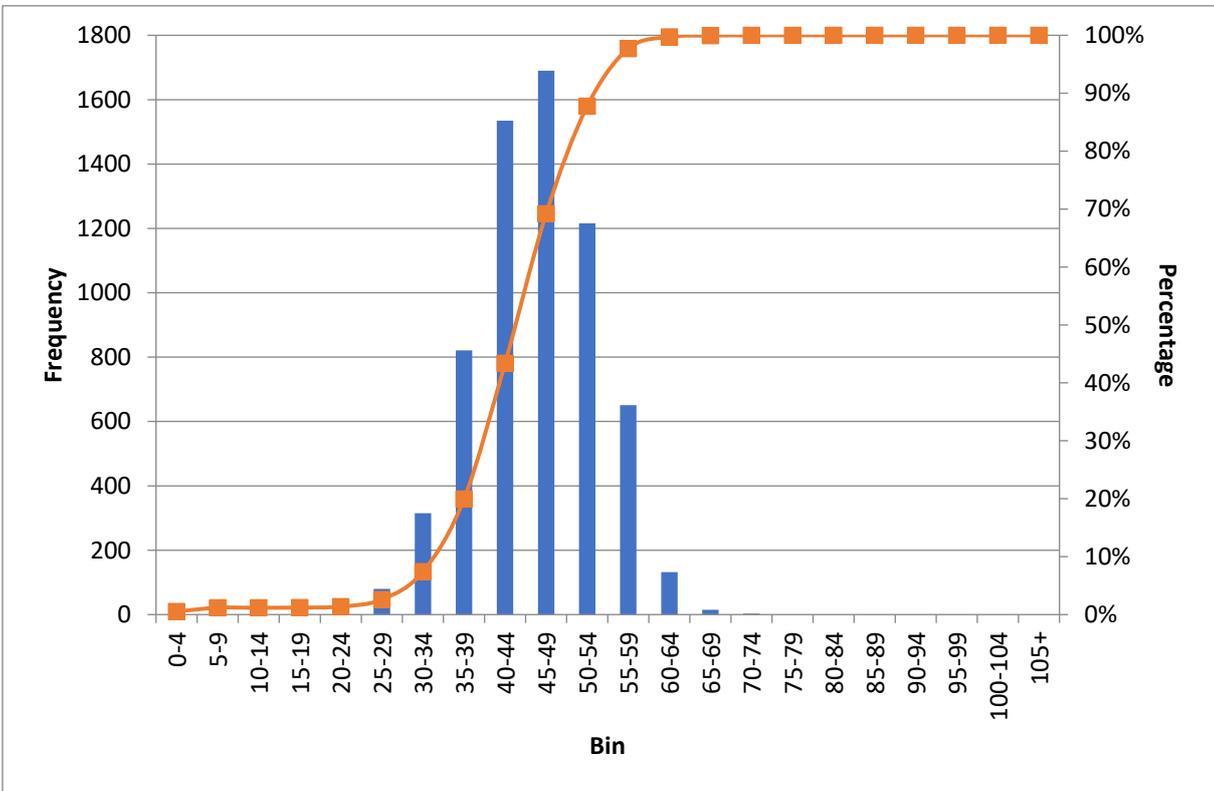
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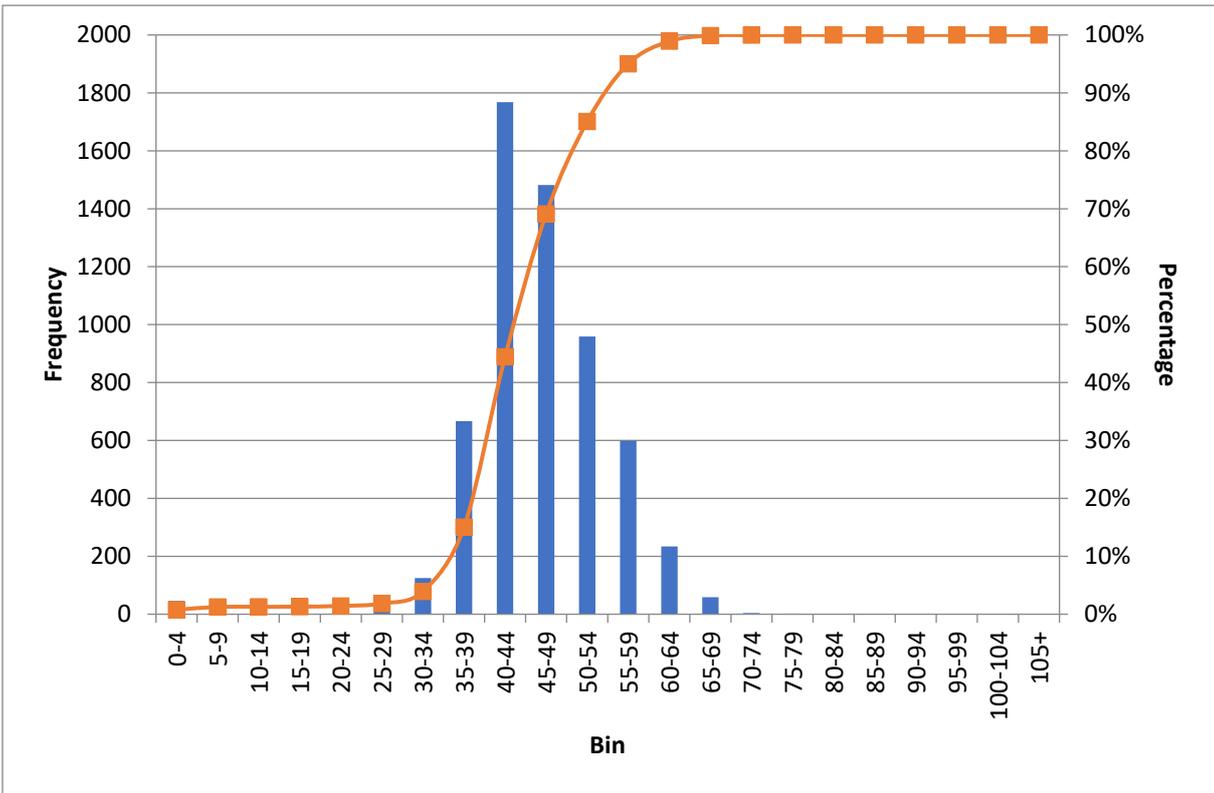
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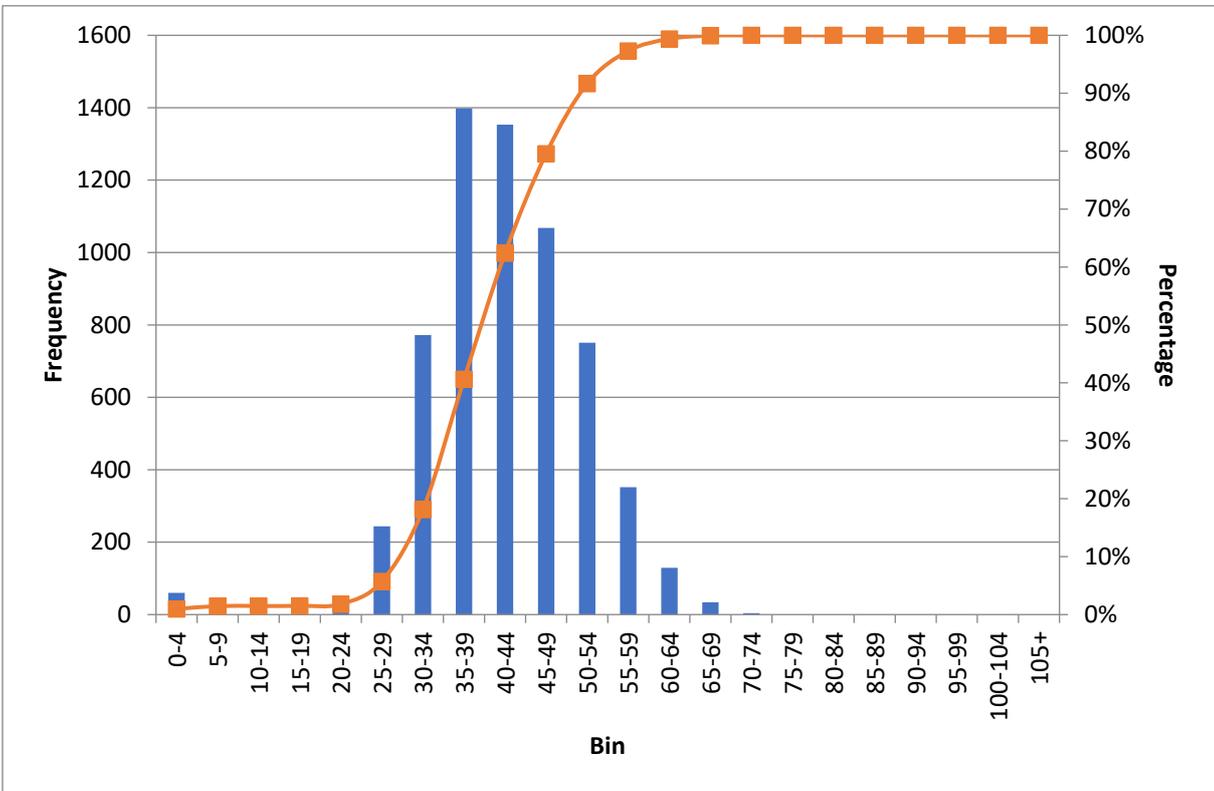
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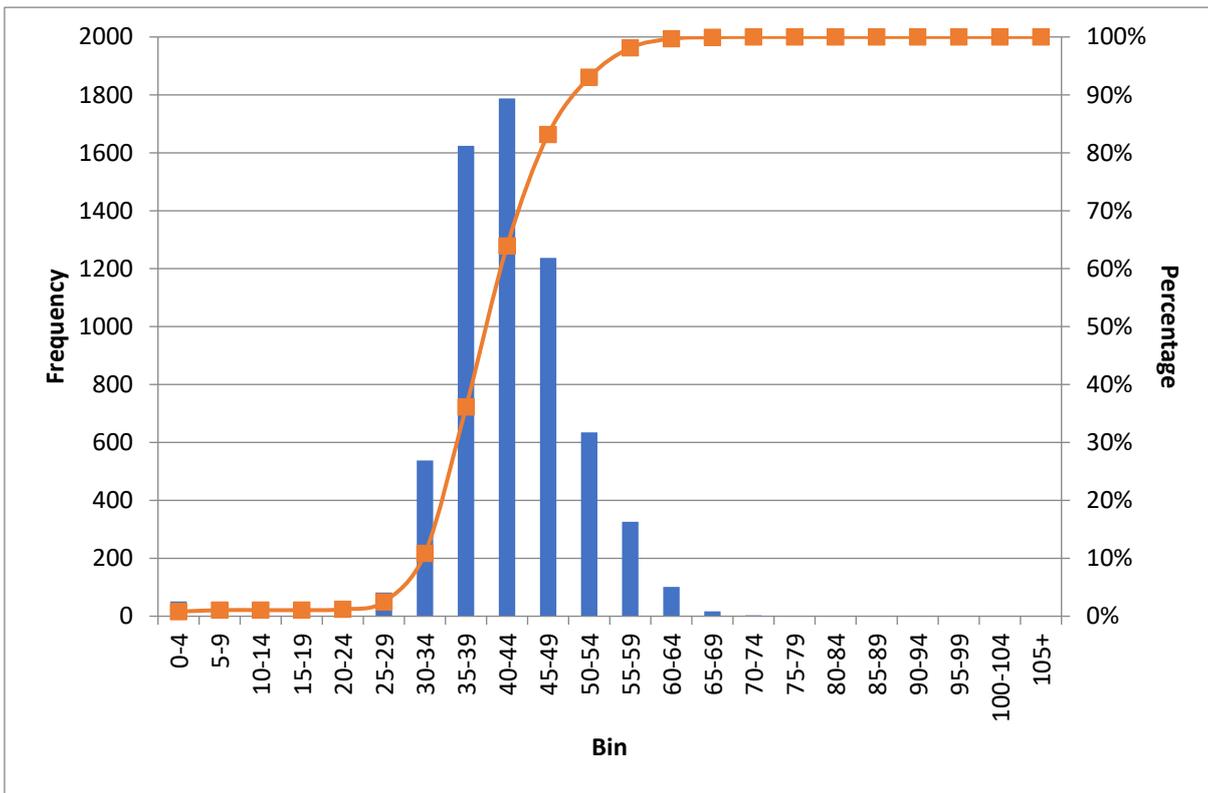
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Figure S1. Distribution of the hourly average ozone volume fractions in the year 1997 (a), 1998 (b), 1999 (c), 2000 (d), 2001 (e), 2002 (f), 2003 (g), 2004 (h), 2005 (i), 2006 (j), 2007 (k), 2008 (l), 2011 (m), 2012 (n), 2013 (o), 2014 (p), 2015 (q), 2016 (r), 2017 (s), 2018 (t) and 2019 (u). Hourly averages of the ozone volume fraction are distributed in sets with the range of 5 ppb and shown with vertical columns. The red line shows the percentage of hourly averages of ozone volume fractions considered until the given set.

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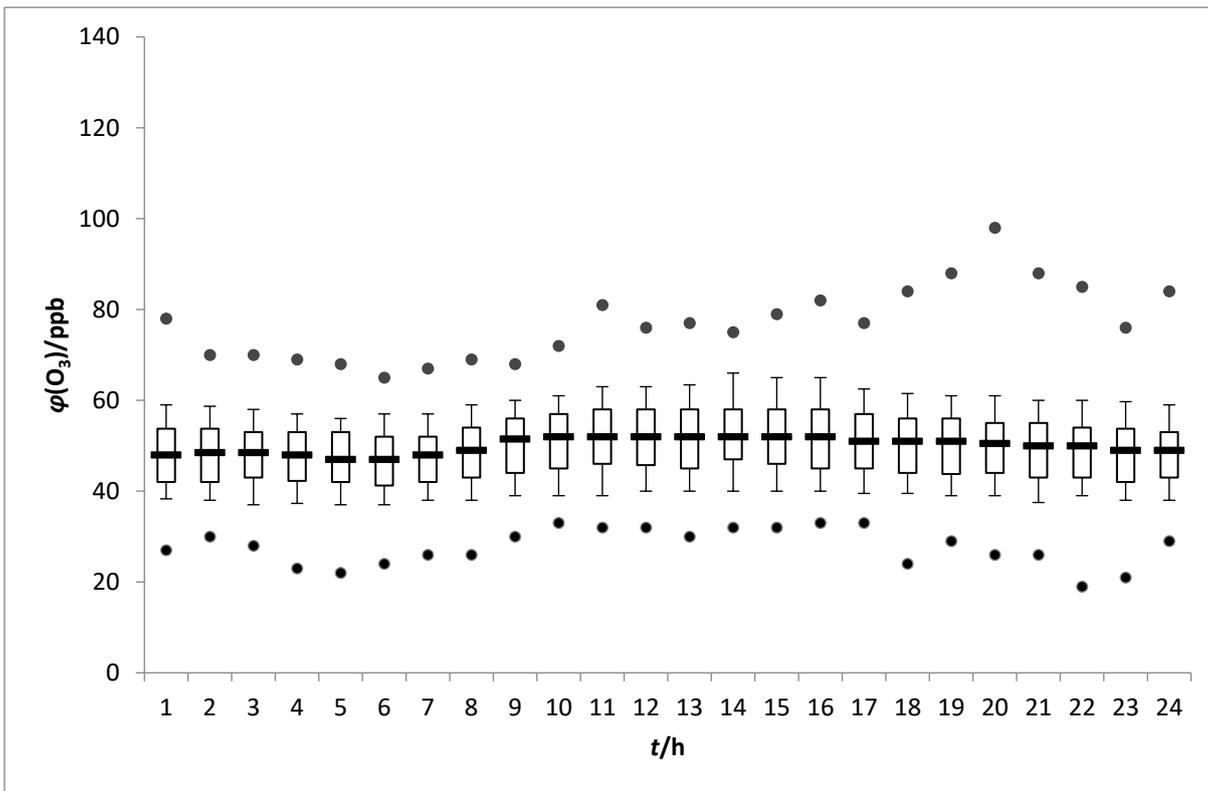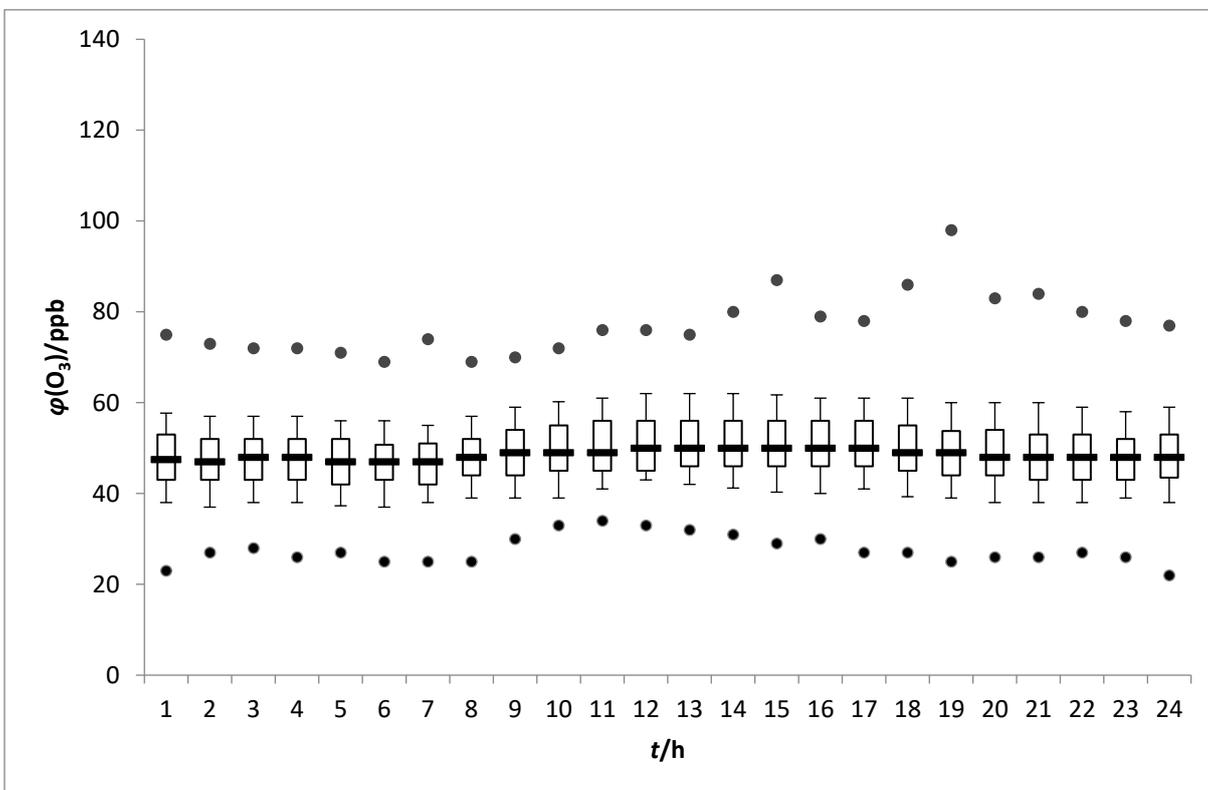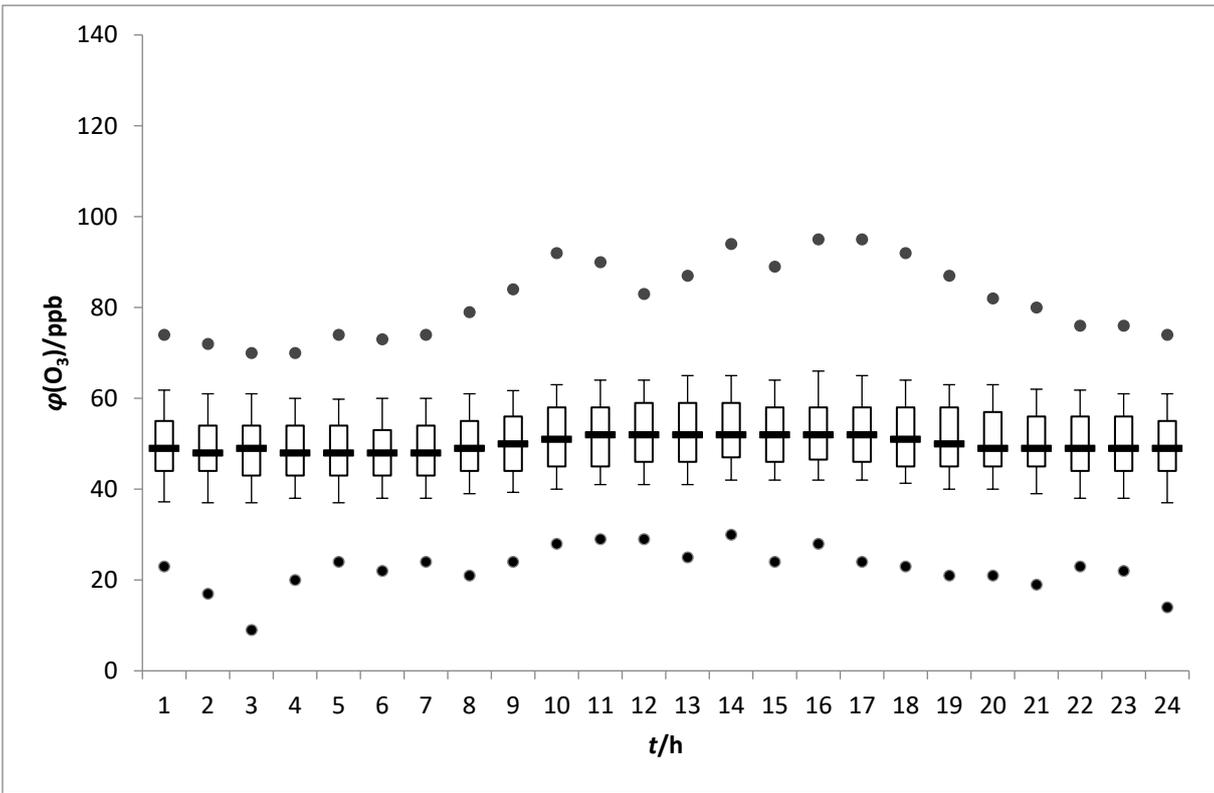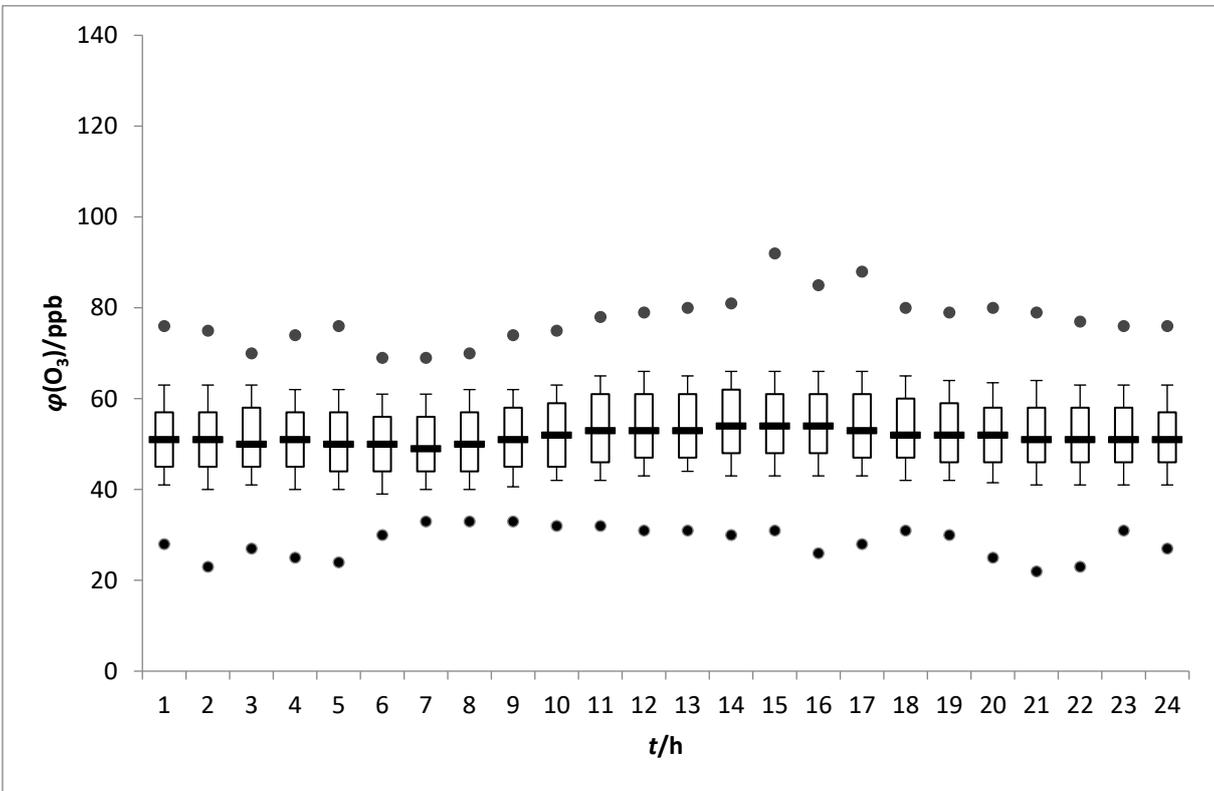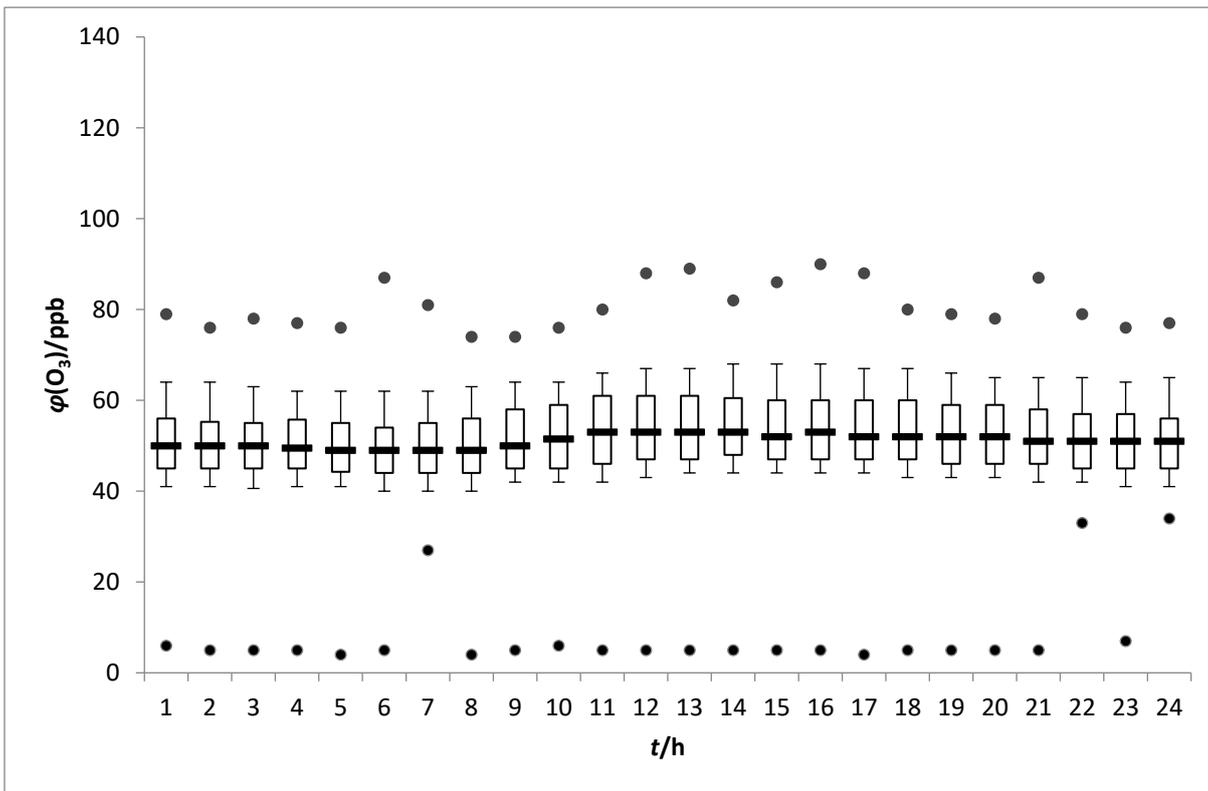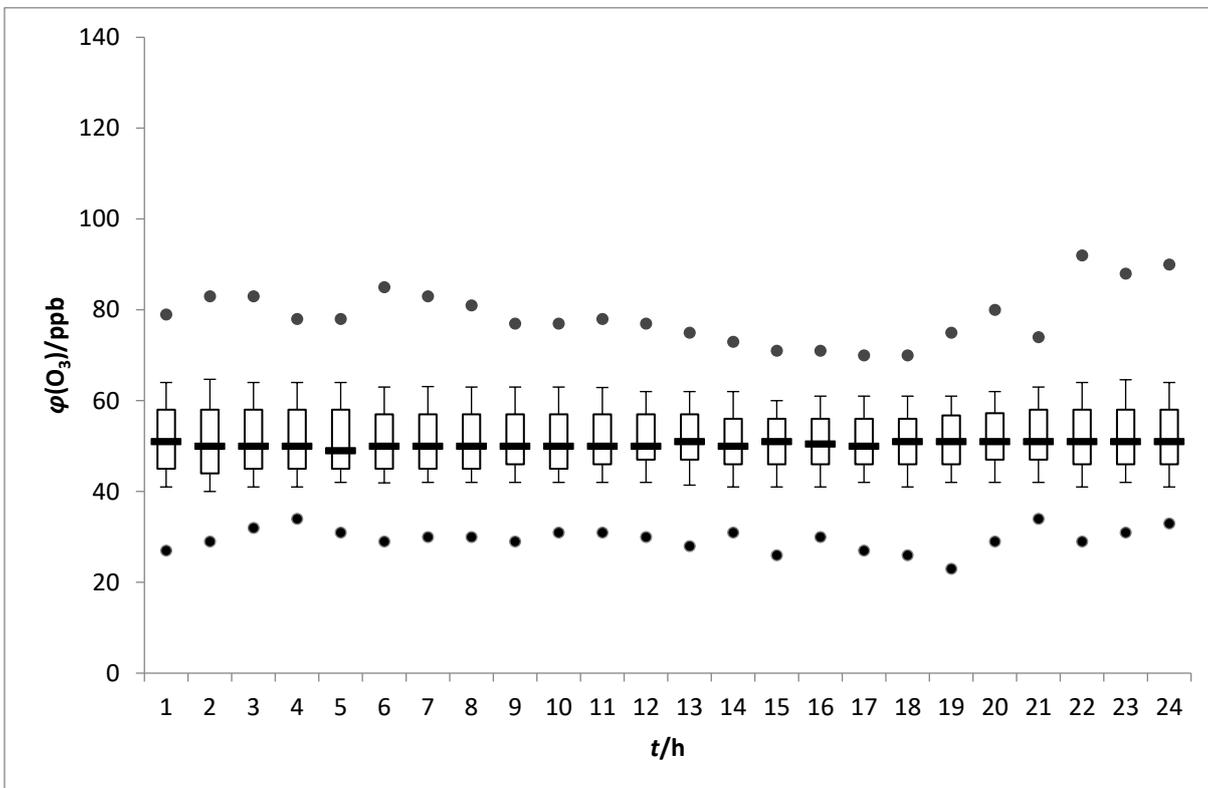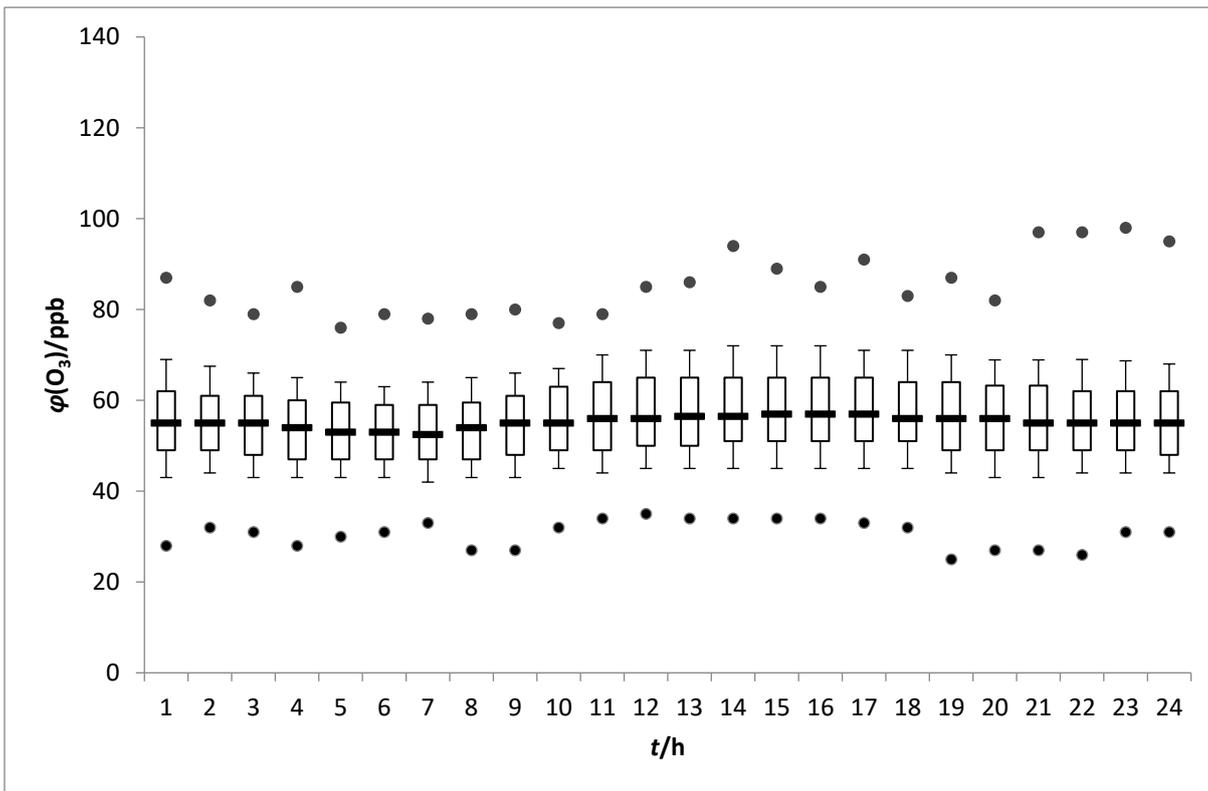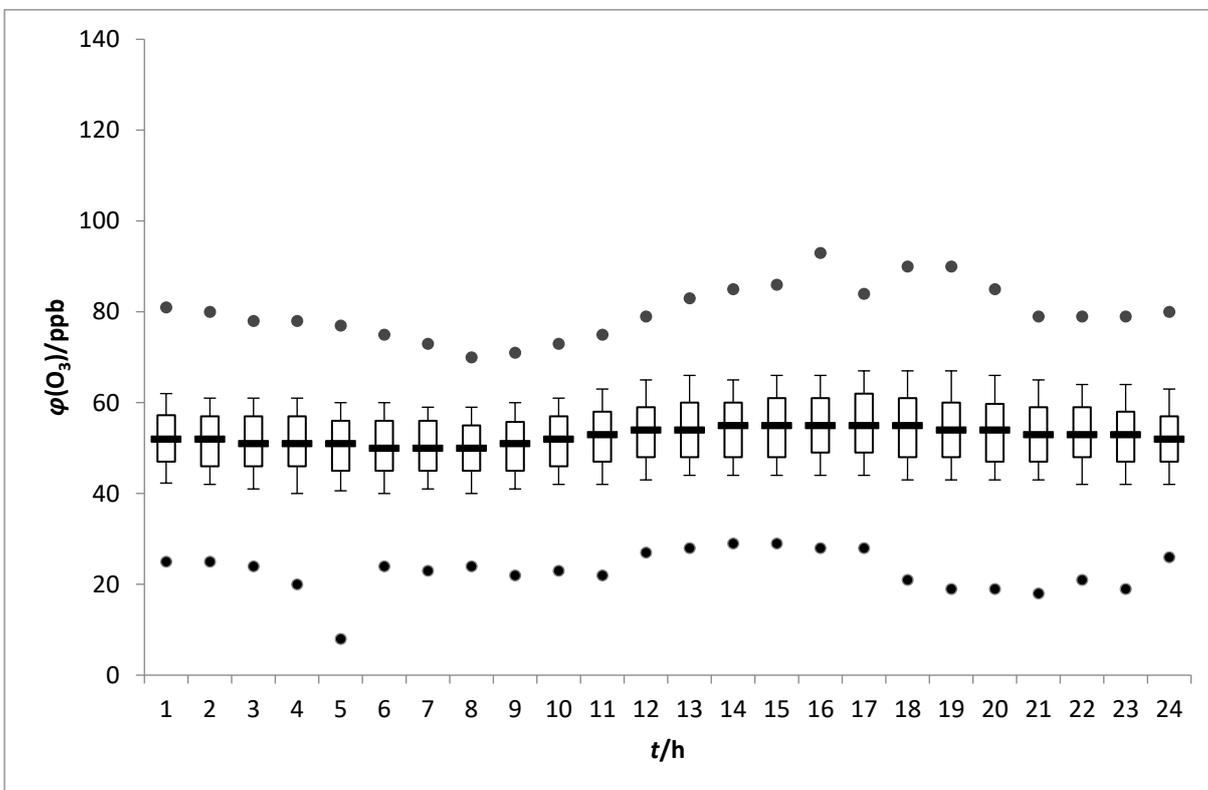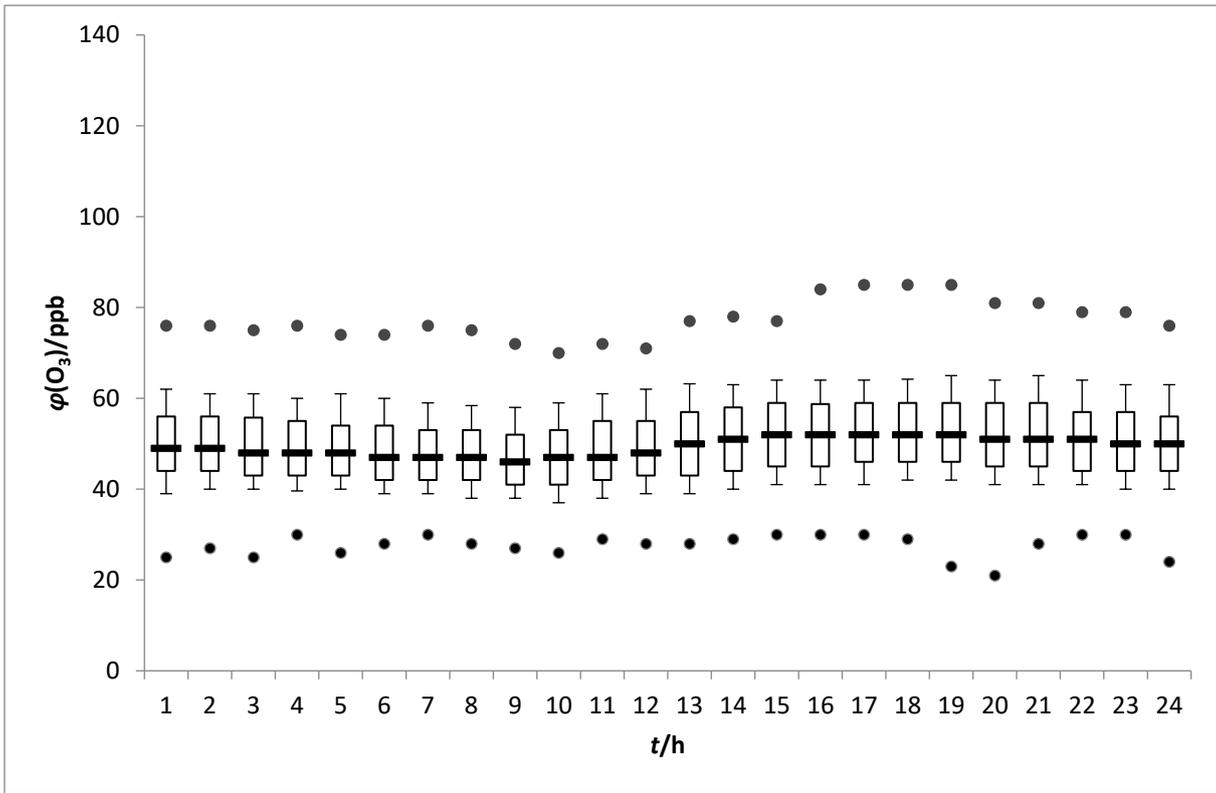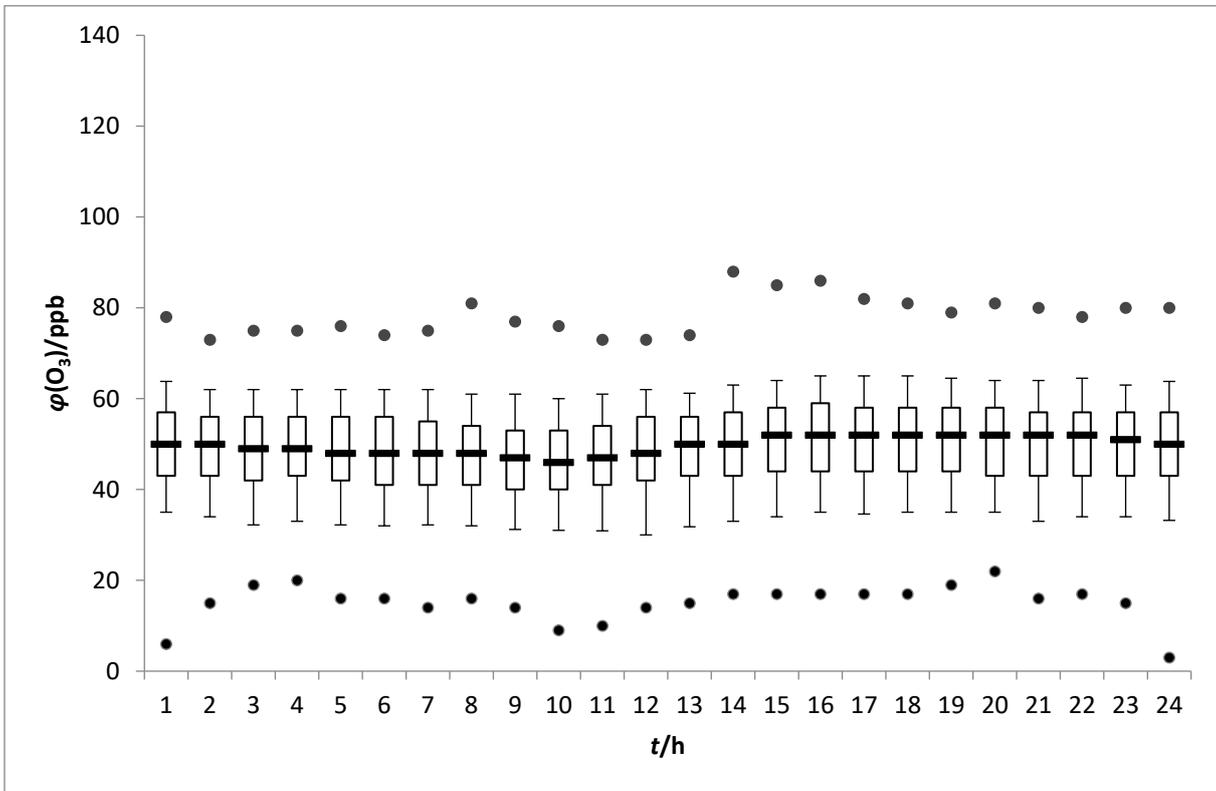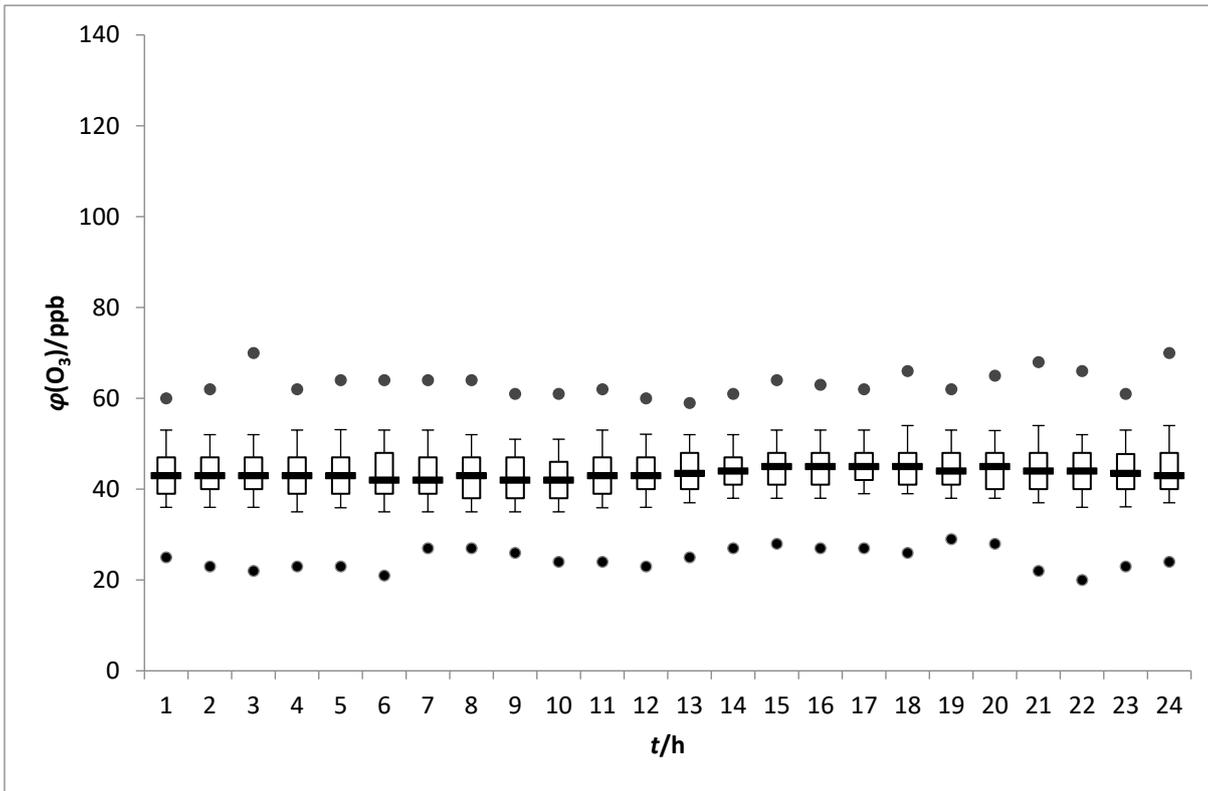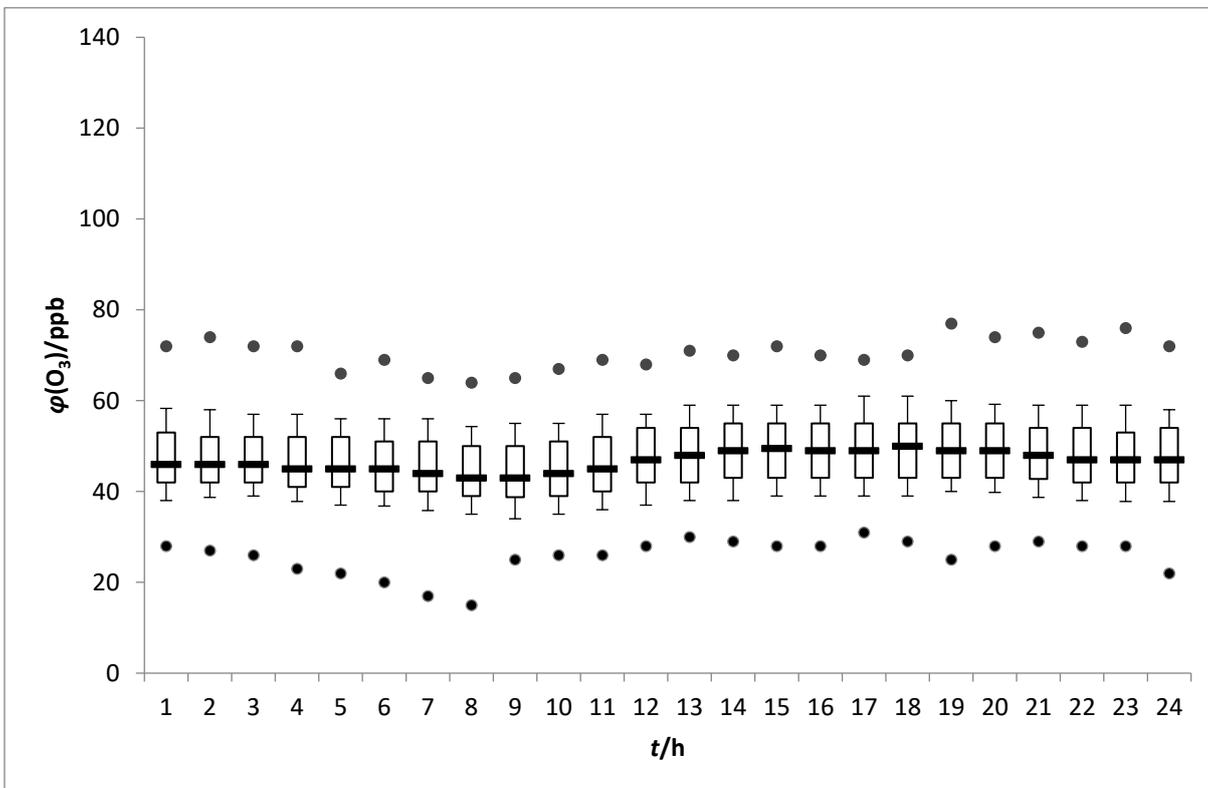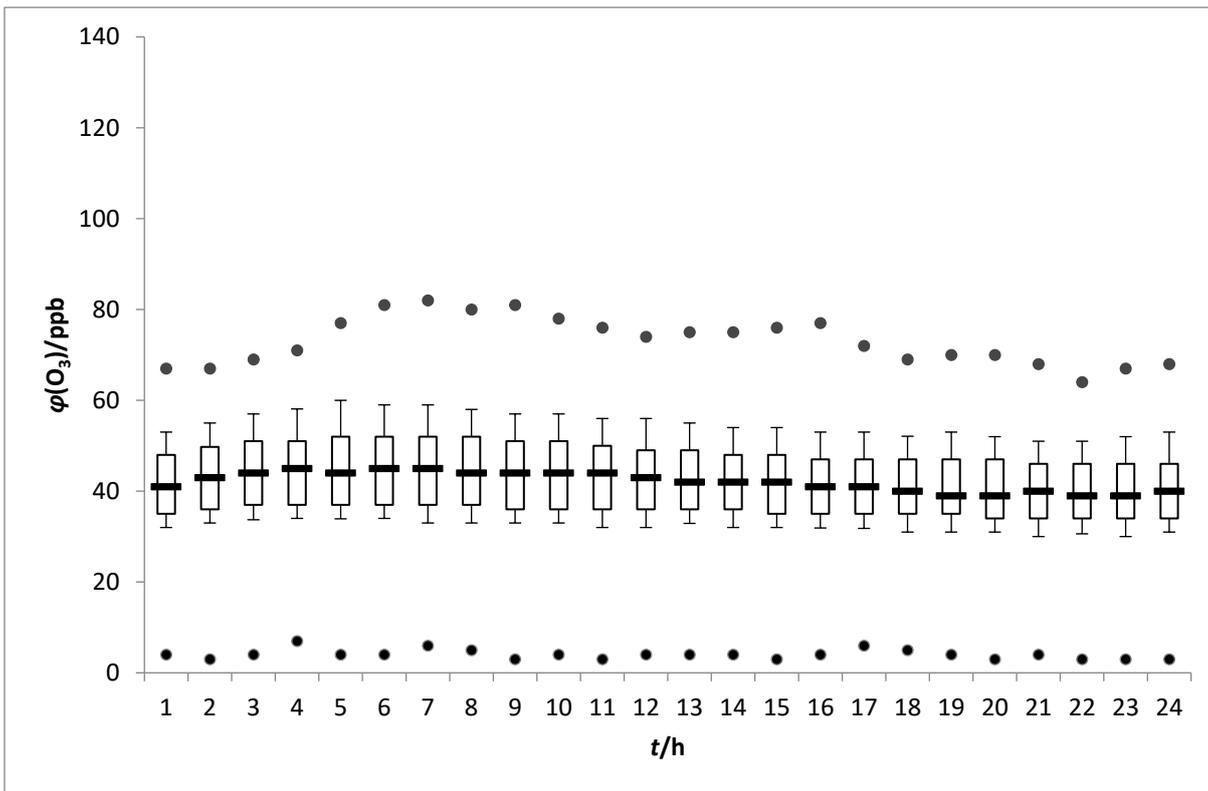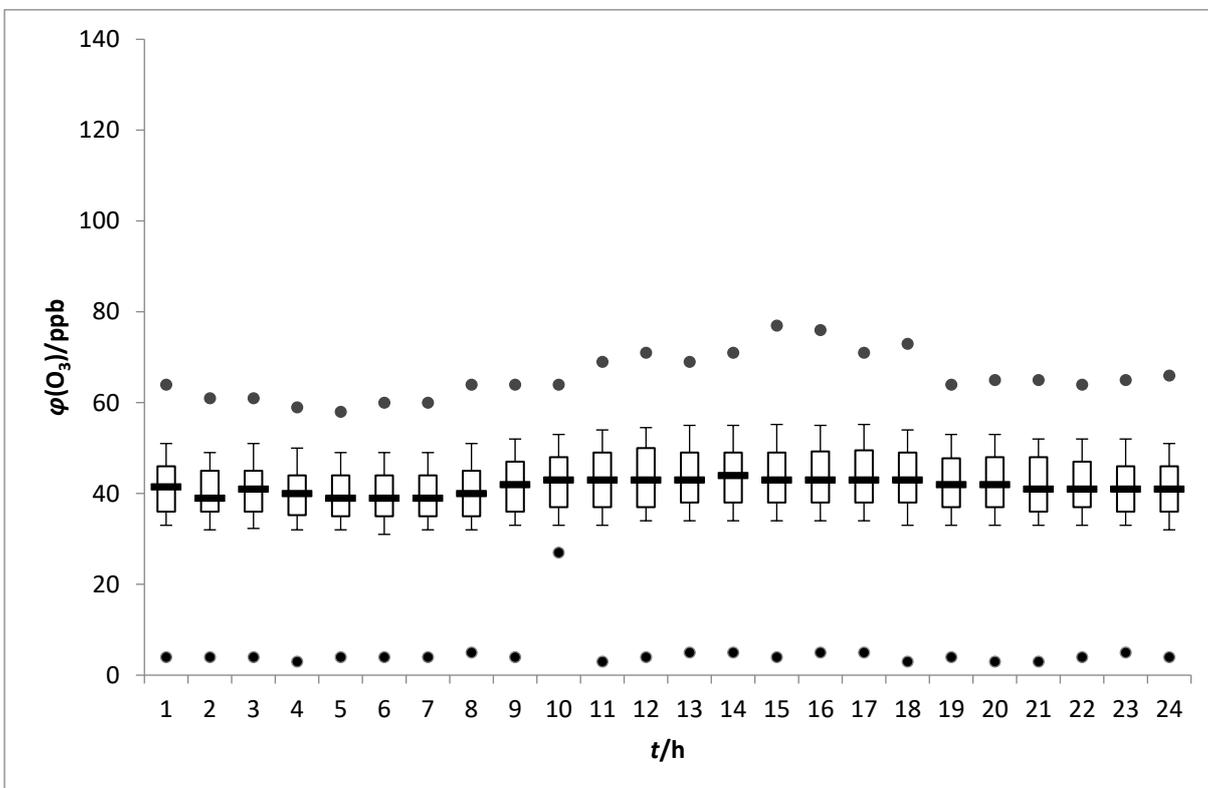
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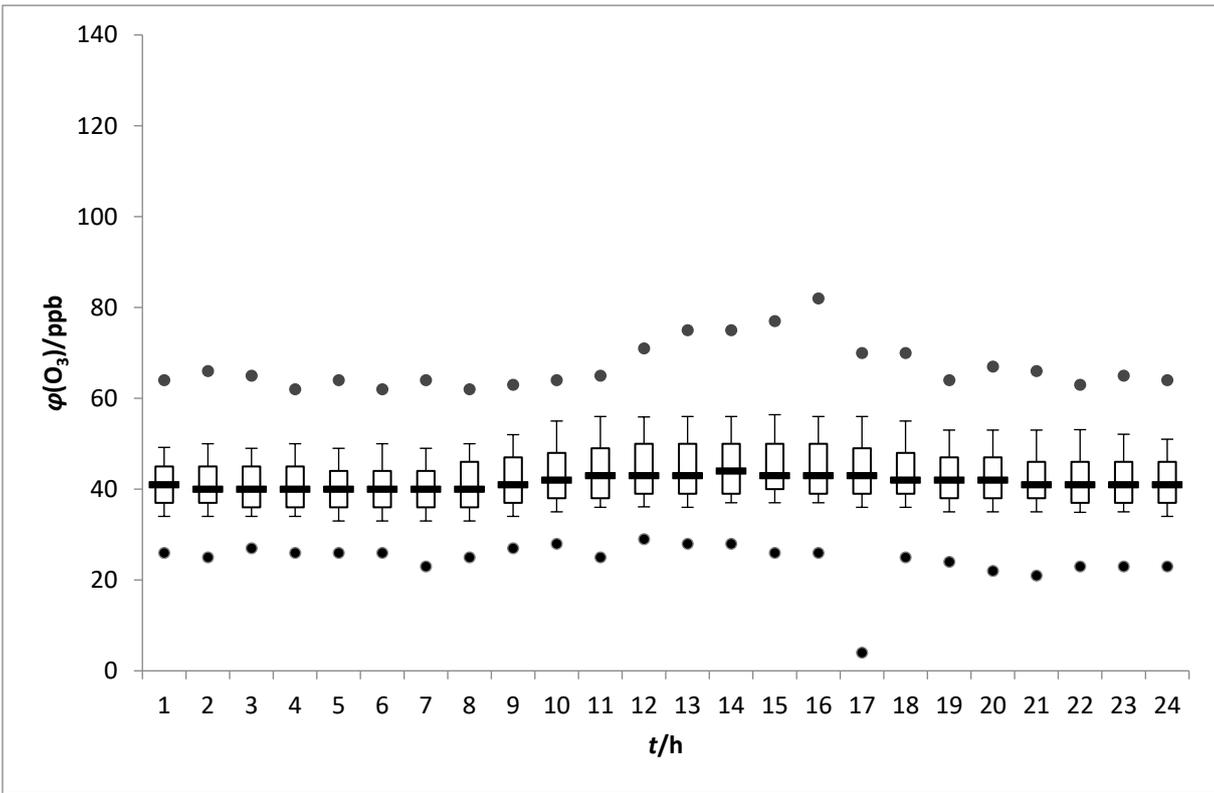
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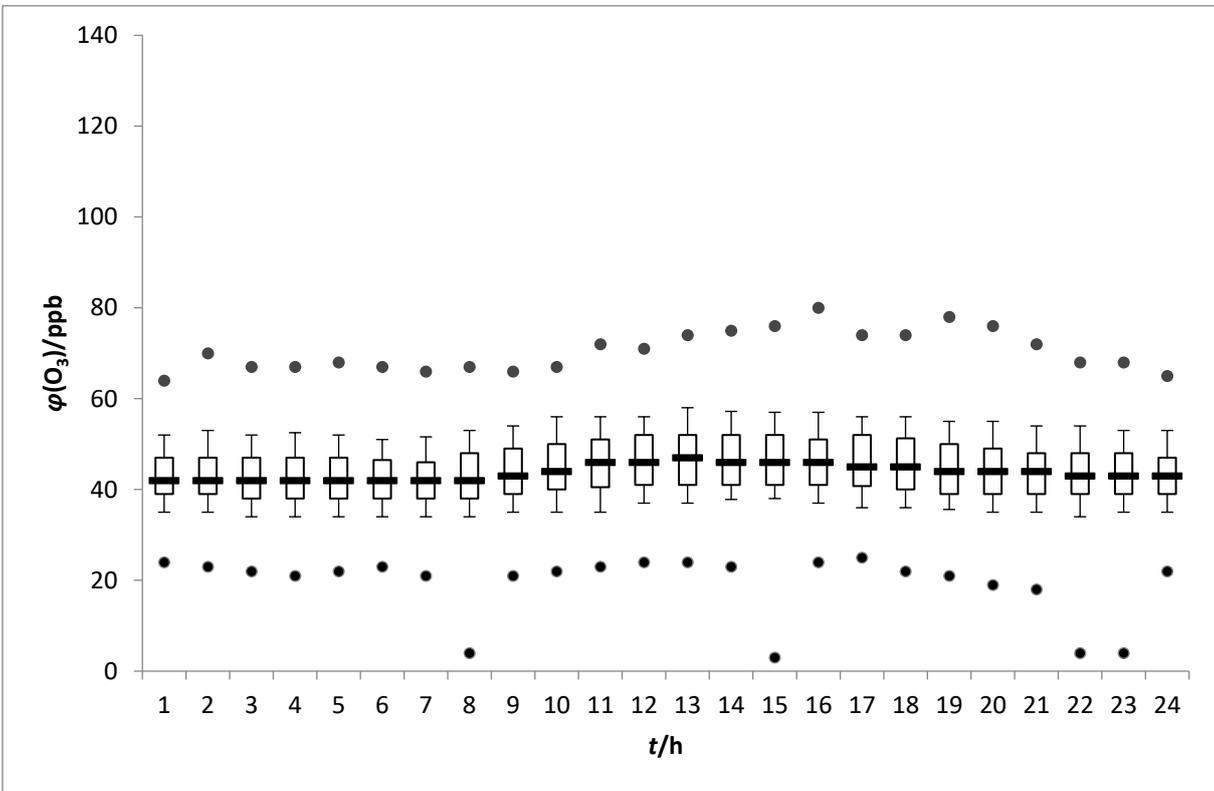
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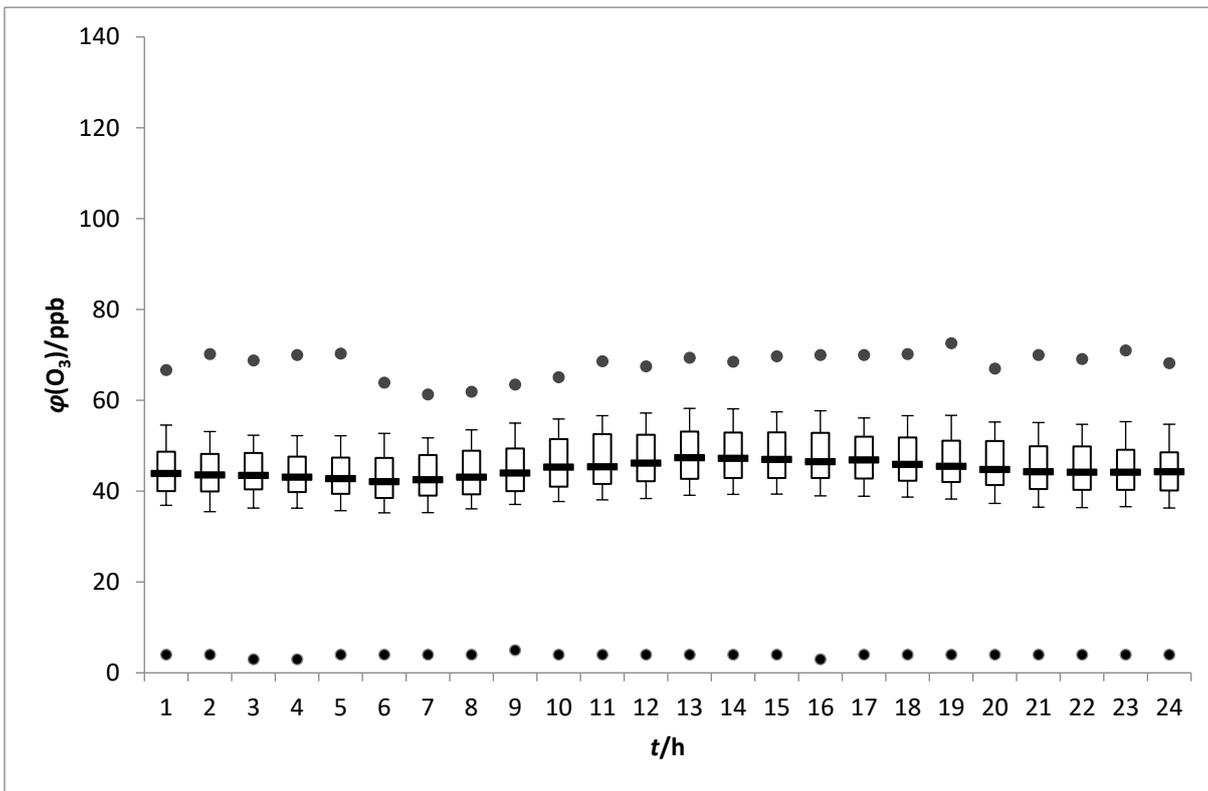
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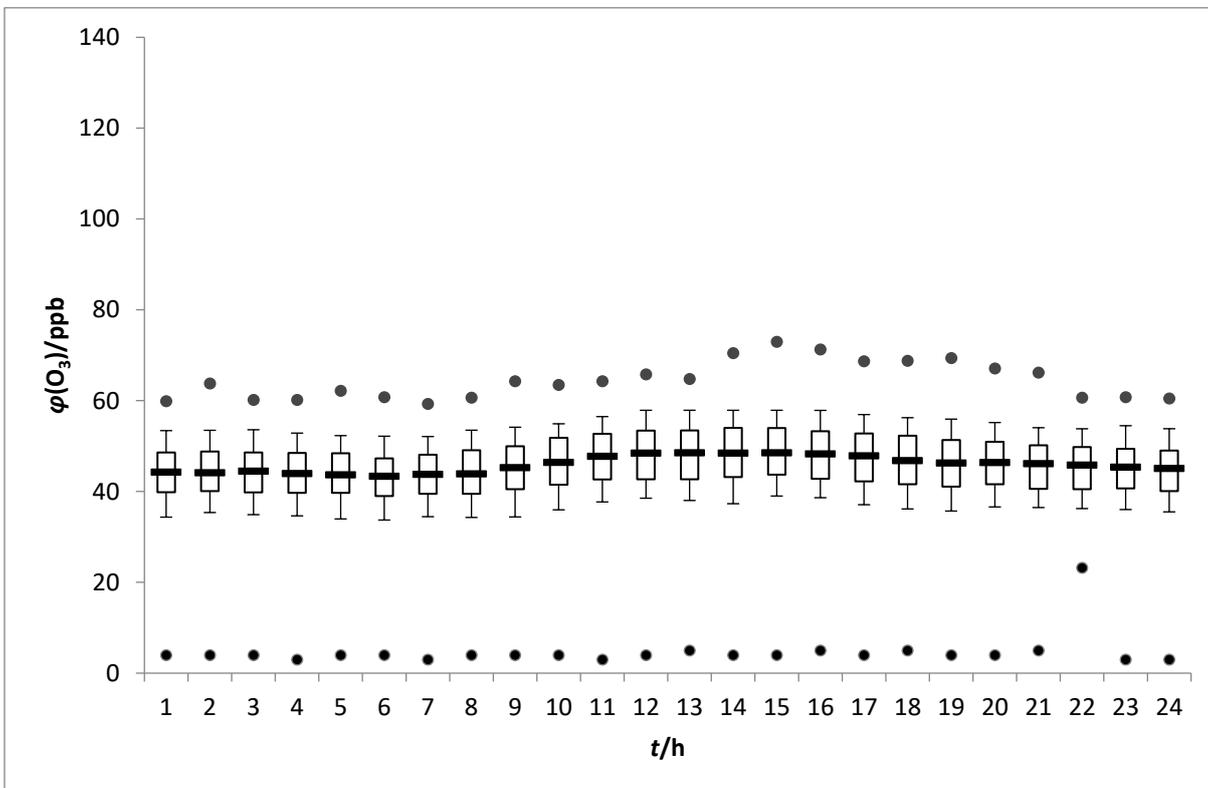
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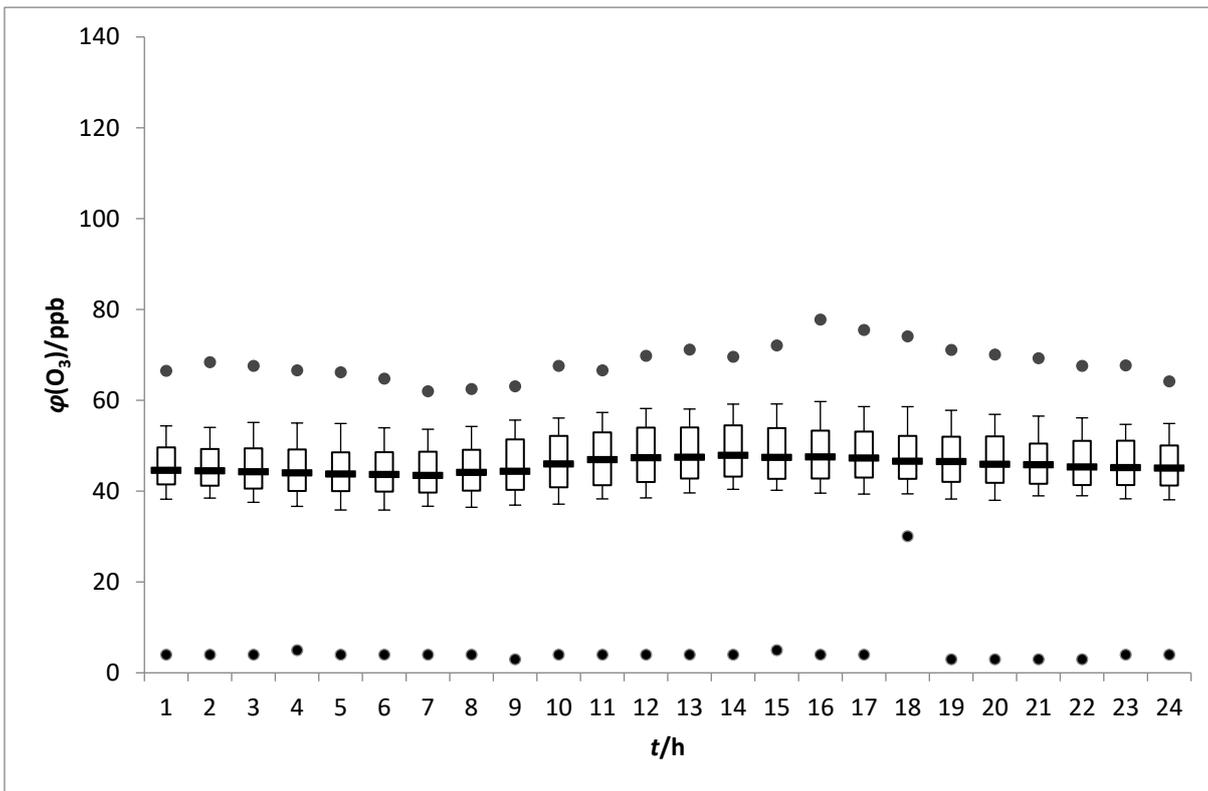
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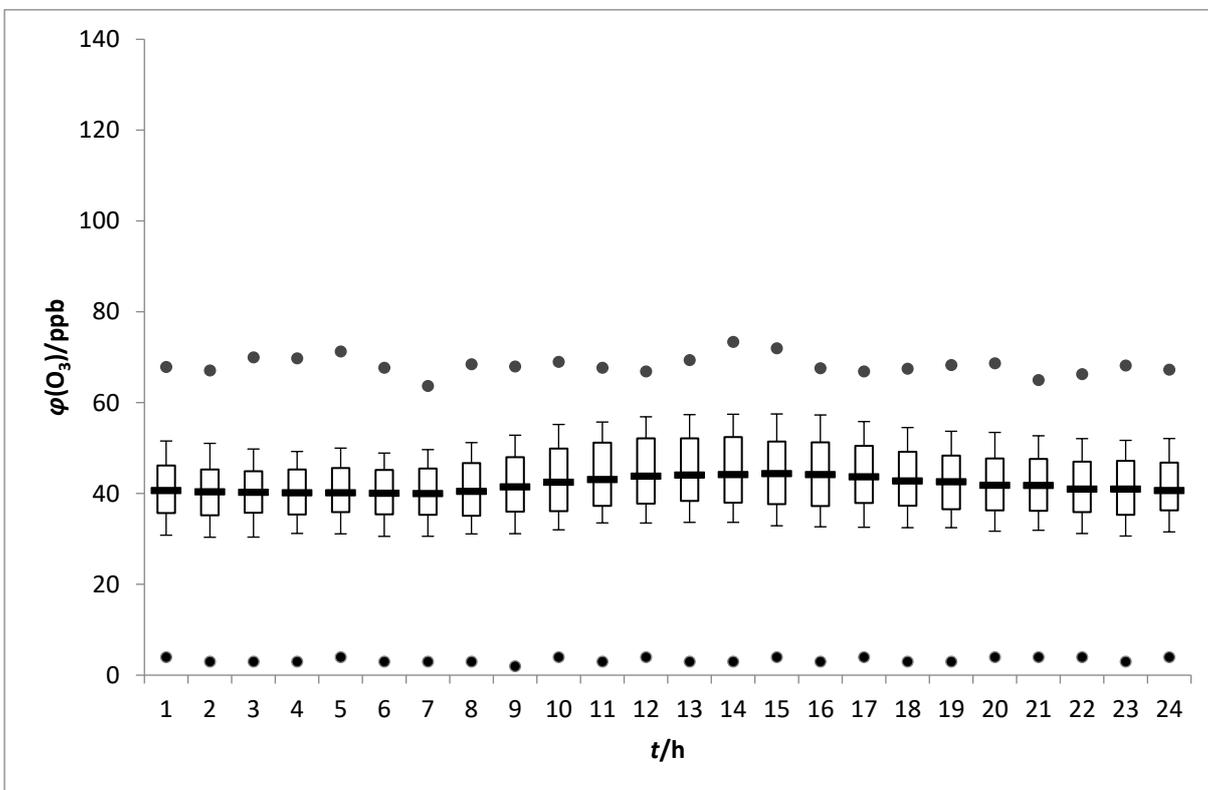
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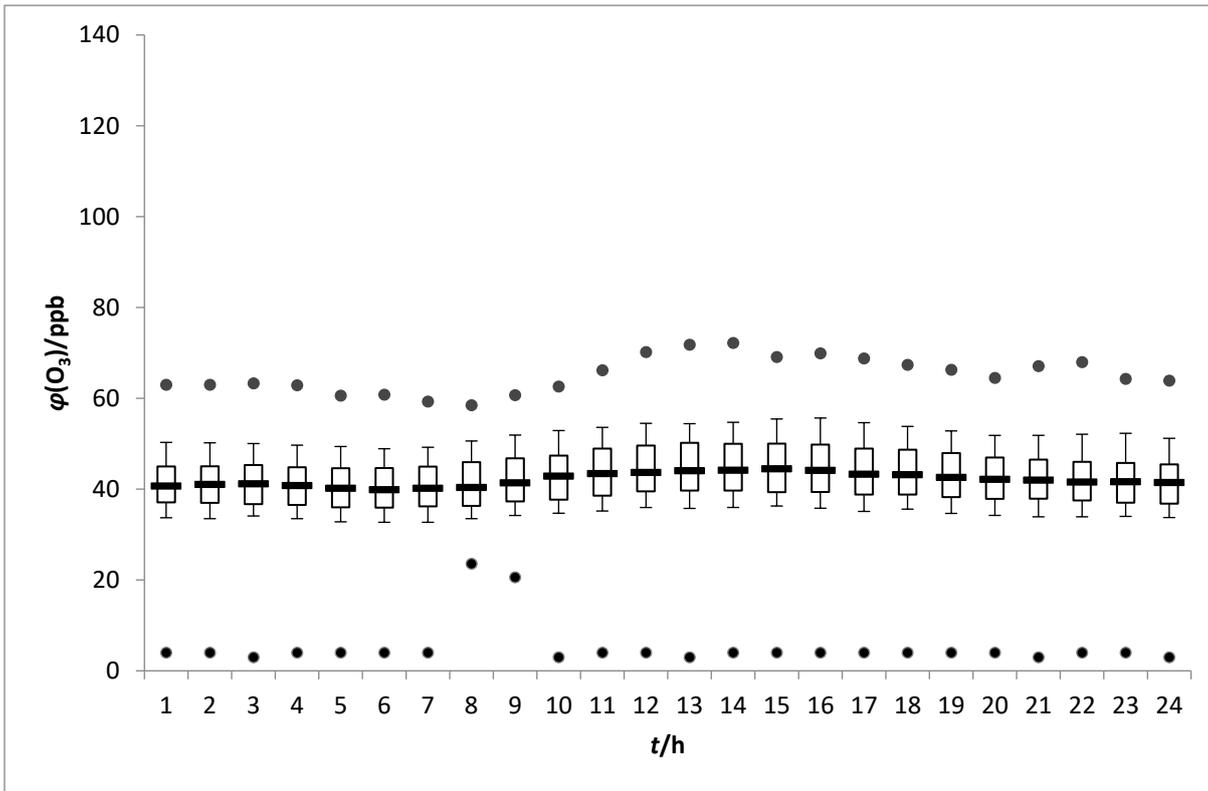
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Figure S2. Box & whiskers plot of the hourly ozone volume fractions with statistical values from the years 1997 (a), 1998 (b), 1999 (c), 2000 (d), 2001 (e), 2002 (f), 2003 (g), 2004 (h), 2005 (i), 2006 (j), 2007 (k), 2008 (l), 2011 (m), 2012 (n), 2013 (o), 2014 (p), 2015 (q), 2016 (r), 2017 (s), 2018 (t) and 2019 (u). Maxima and minima (upper and lower extremes) are shown with a dot, the upper whisker shows the 90-percentile, the upper box line shows the 75-percentile, the inner box line shows median, the lower box line shows the 25-percentile and the lower whisker line shows the 10-percentile. $\varphi(O_3)$ stands for hourly ozone volume fractions.

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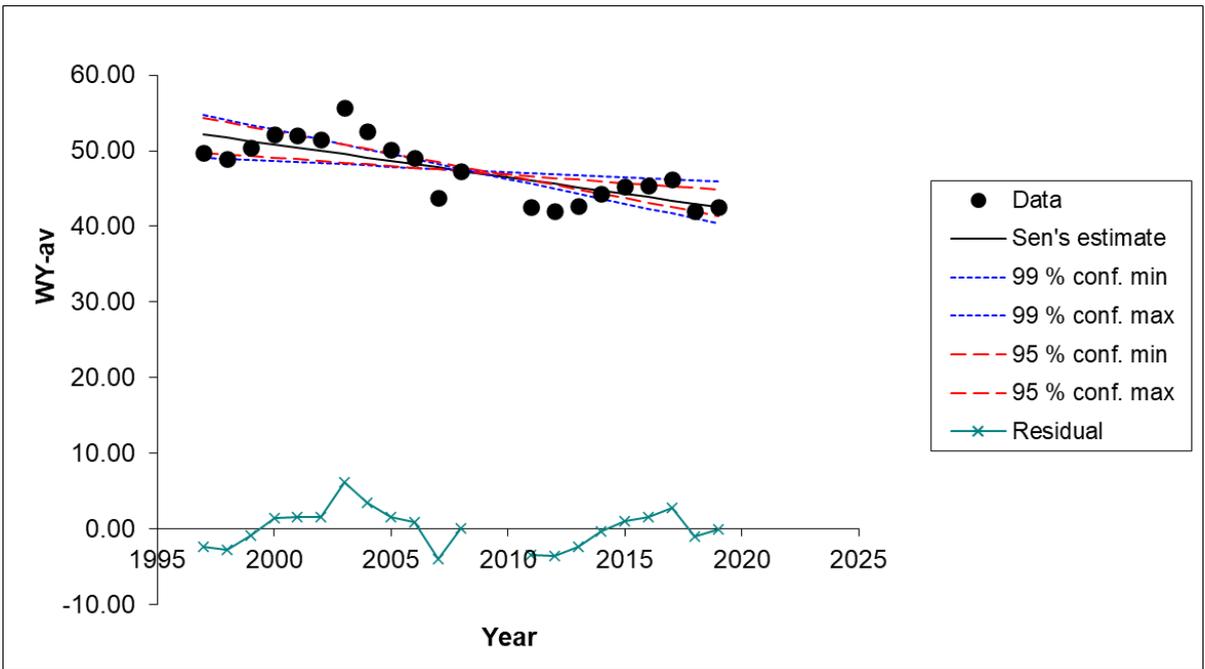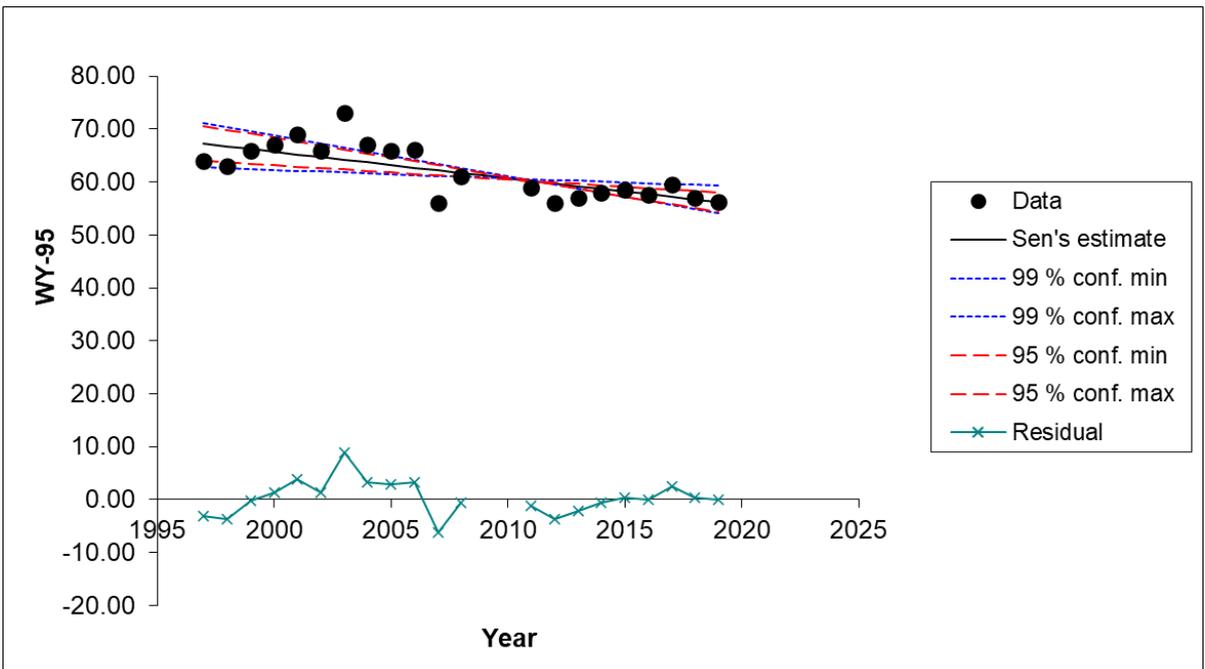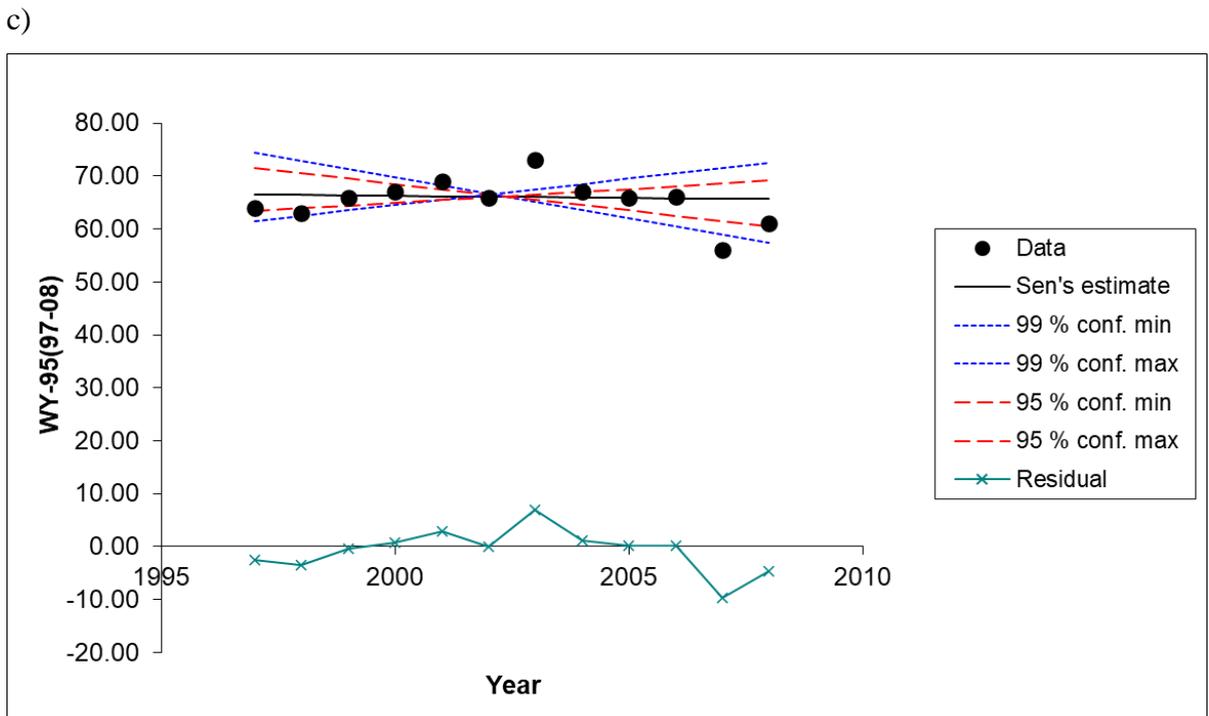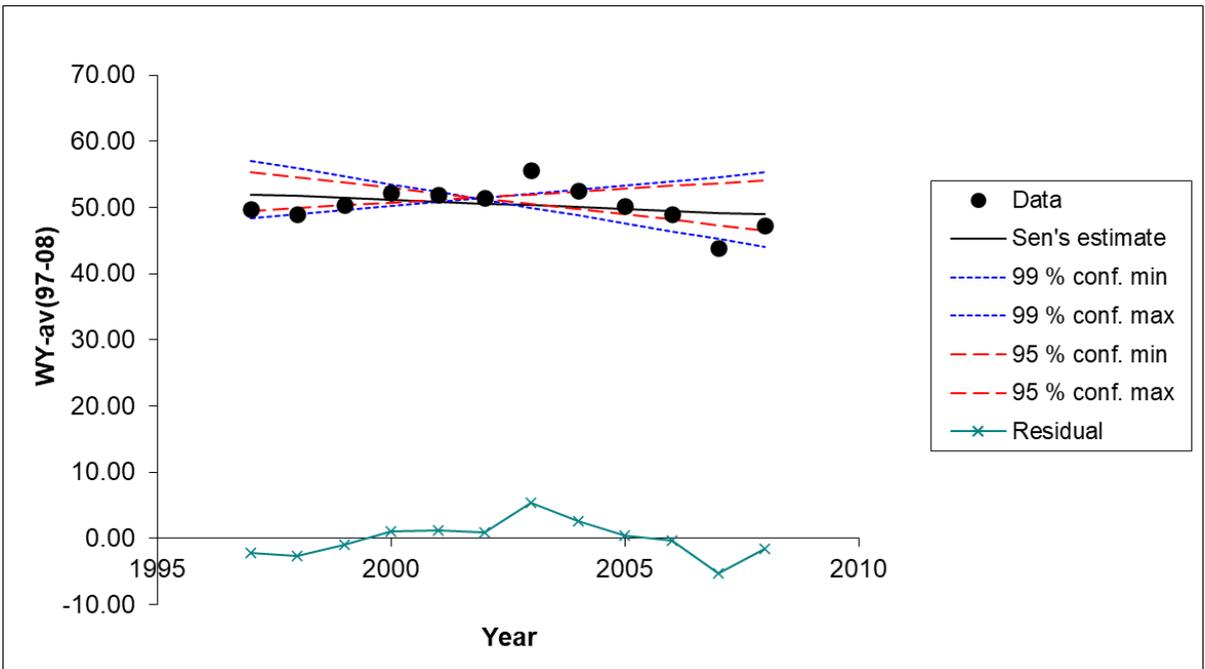

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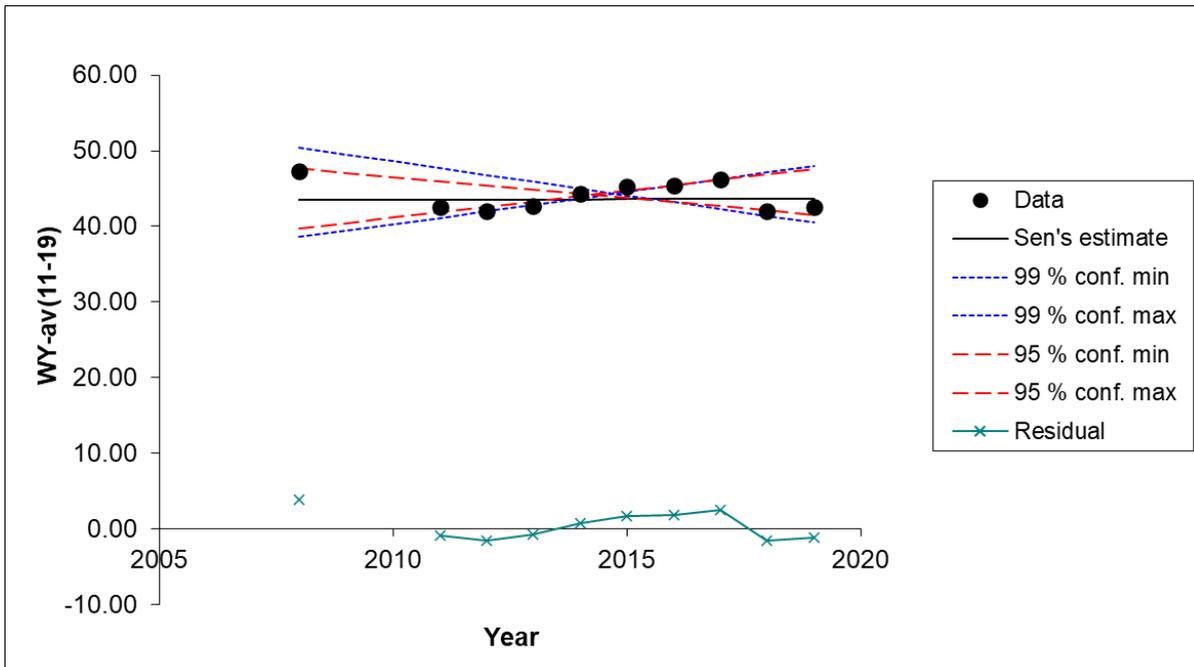
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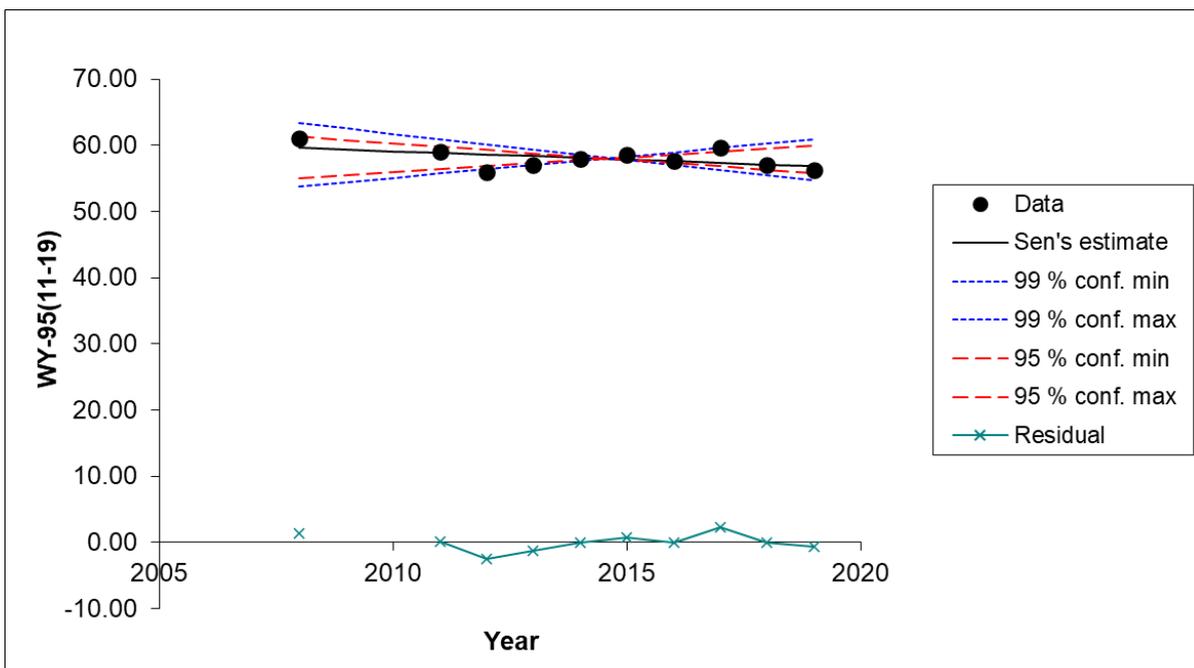
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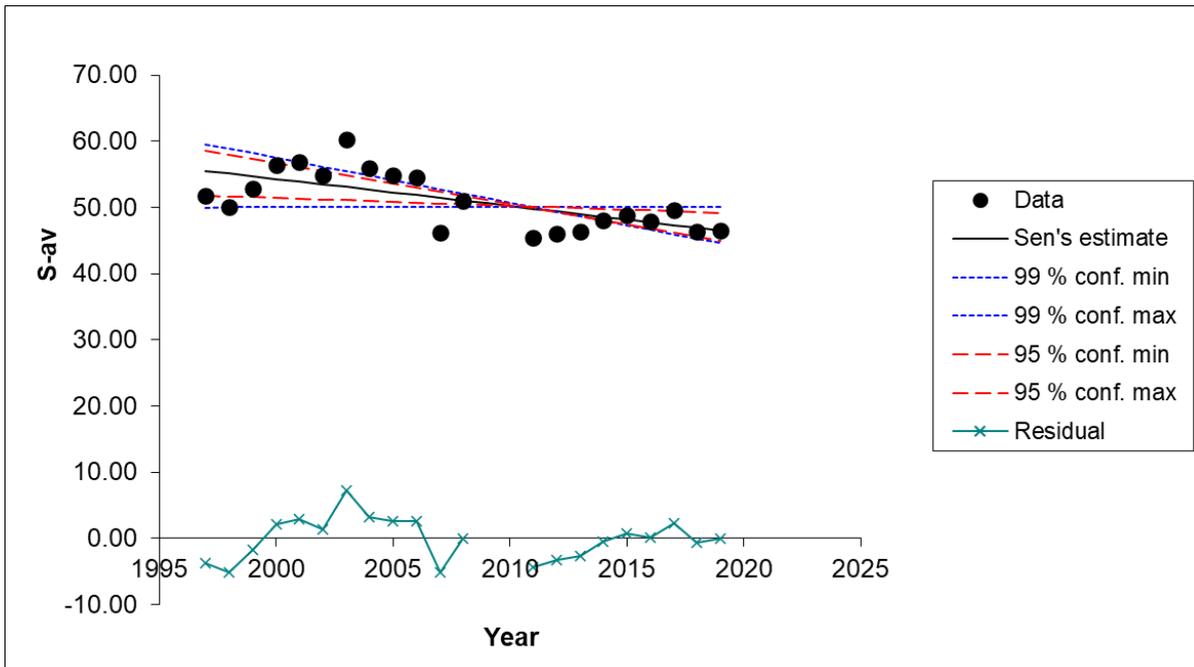
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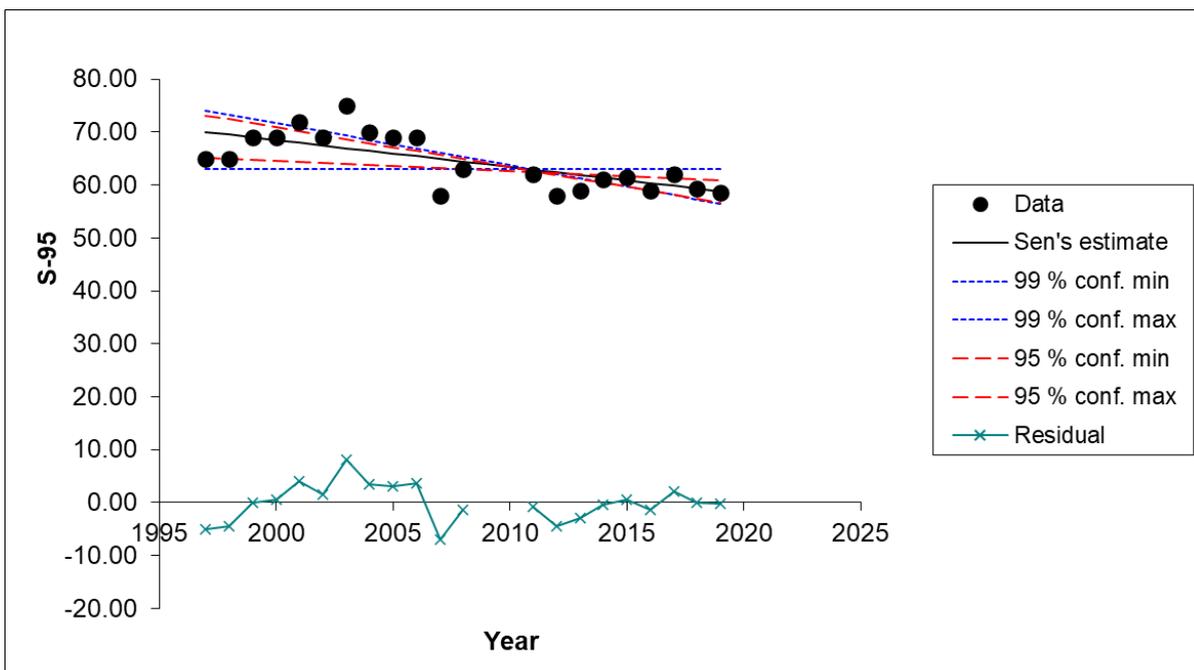
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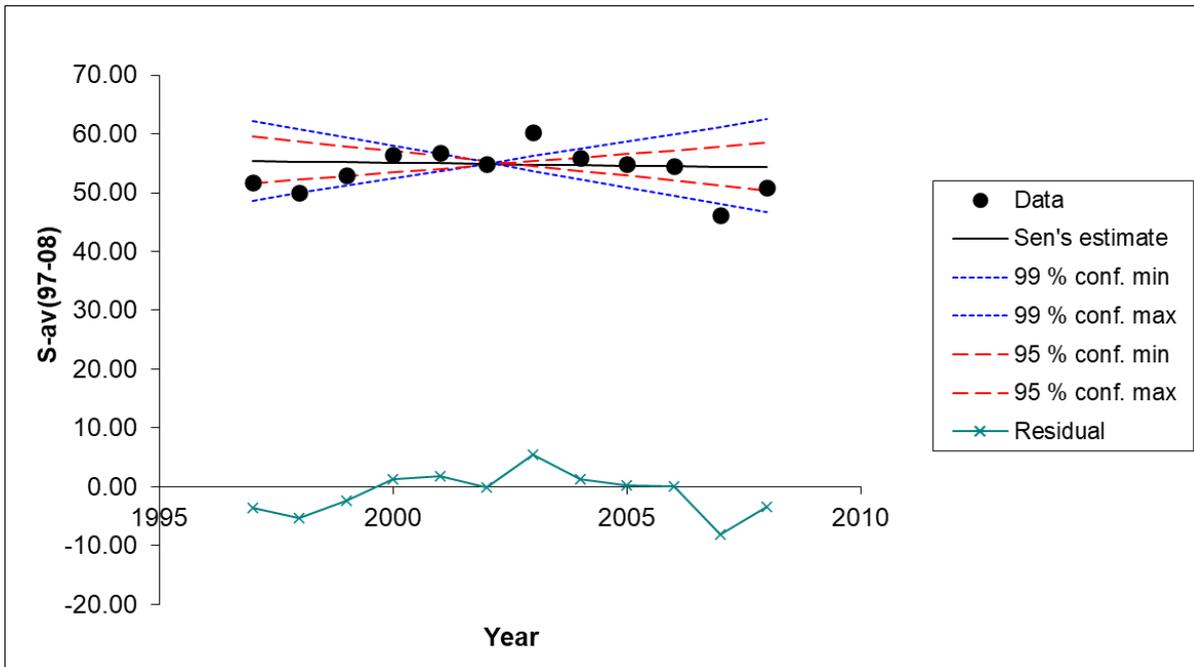
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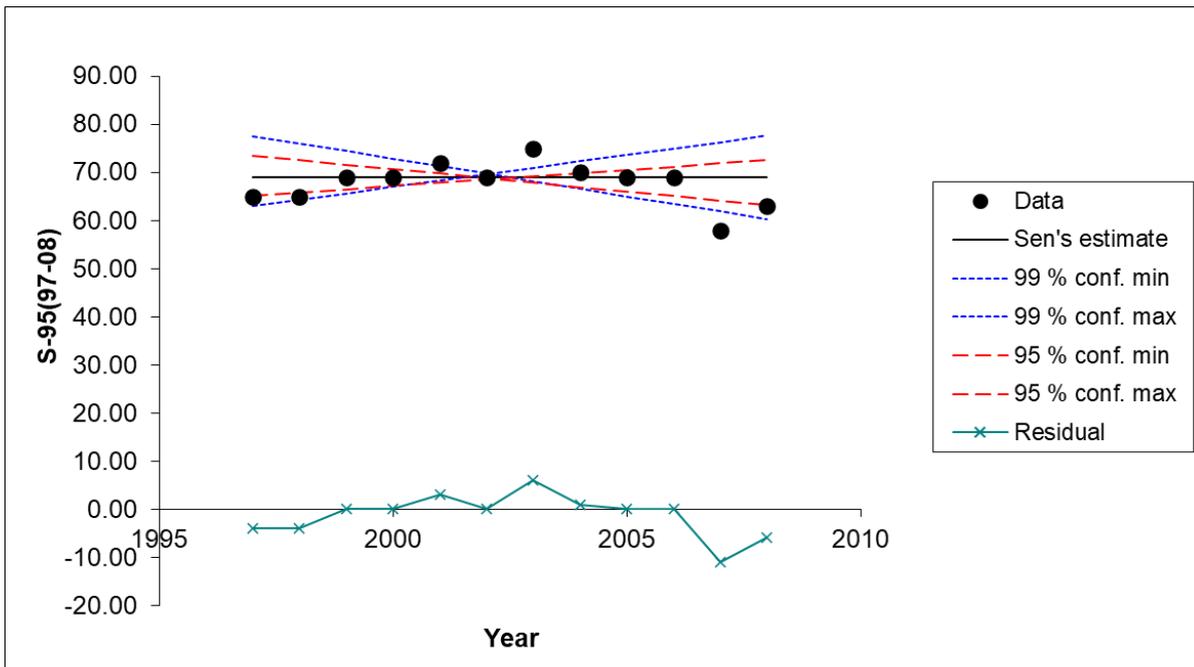
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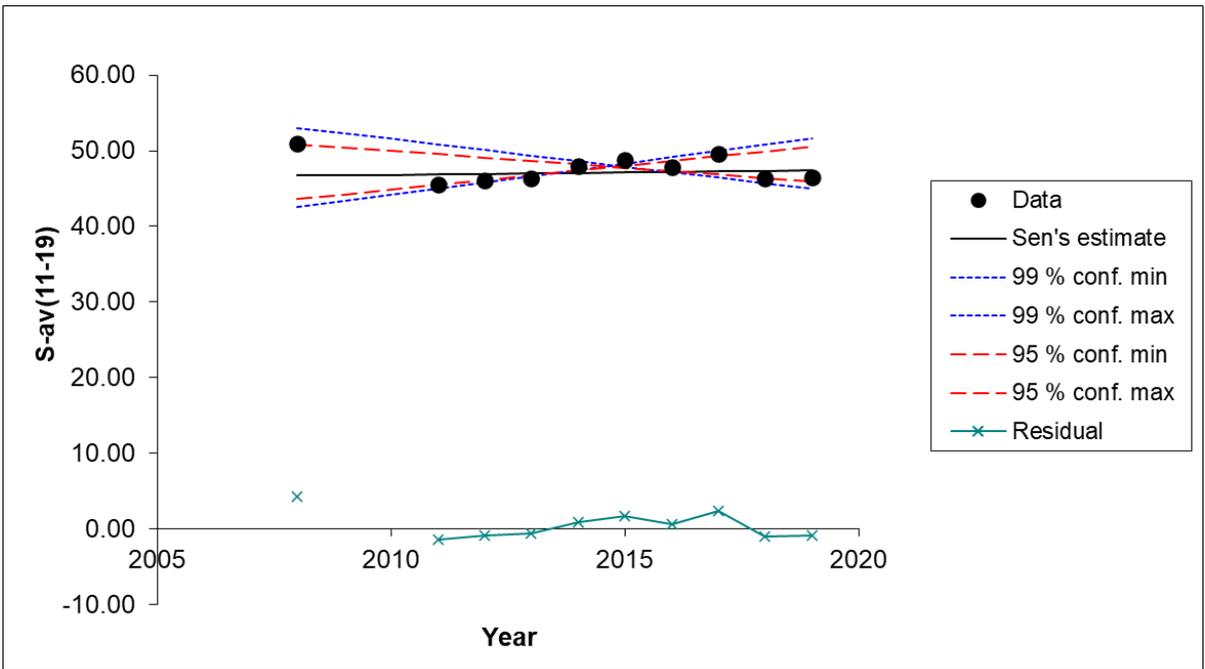
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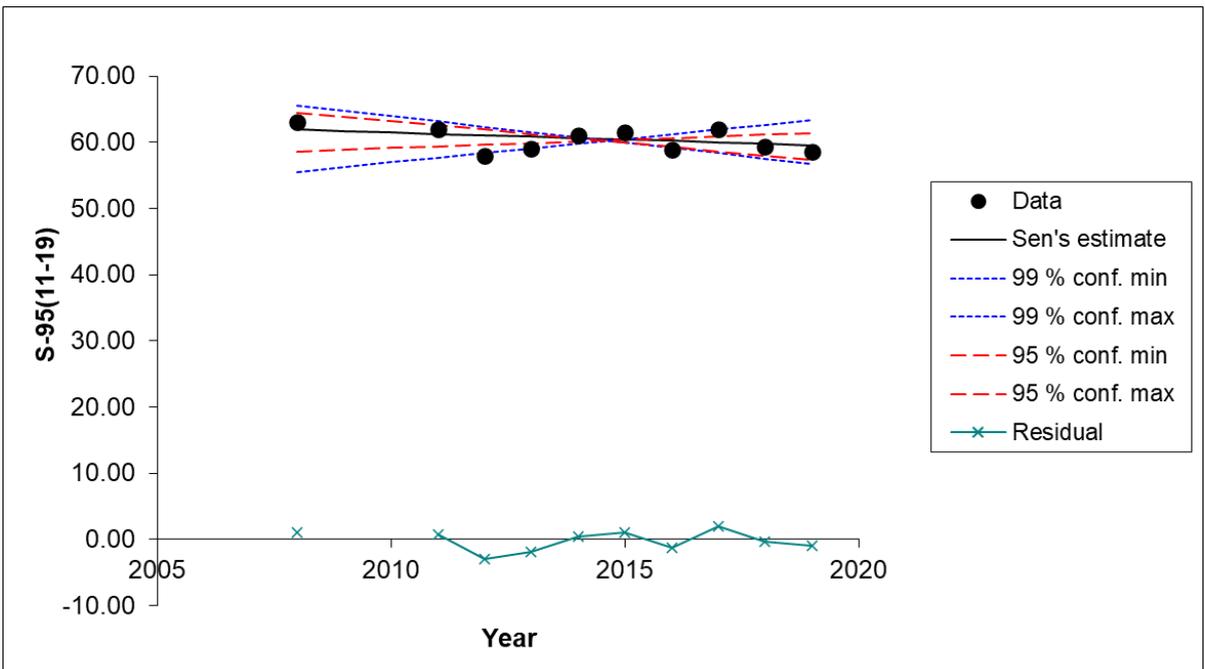
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Figure S3. Mann-Kendall's test analysis of the mean hourly ozone volume fractions for the whole year or season of the years indicated in parentheses. Sen's estimate is equal to the trend slope. Blue and red lines show confidence intervals for the analysis (95 and 99 % respectively). Designations on ordinate axis stands for the whole year data (WY) and seasonal data (S).

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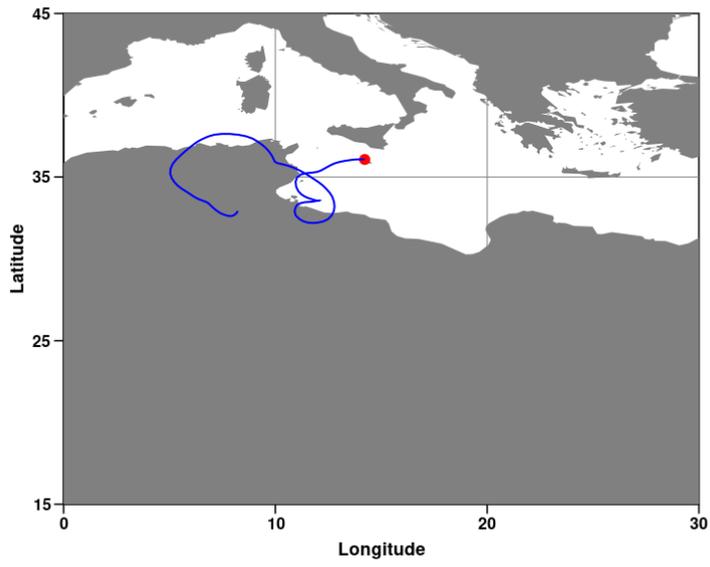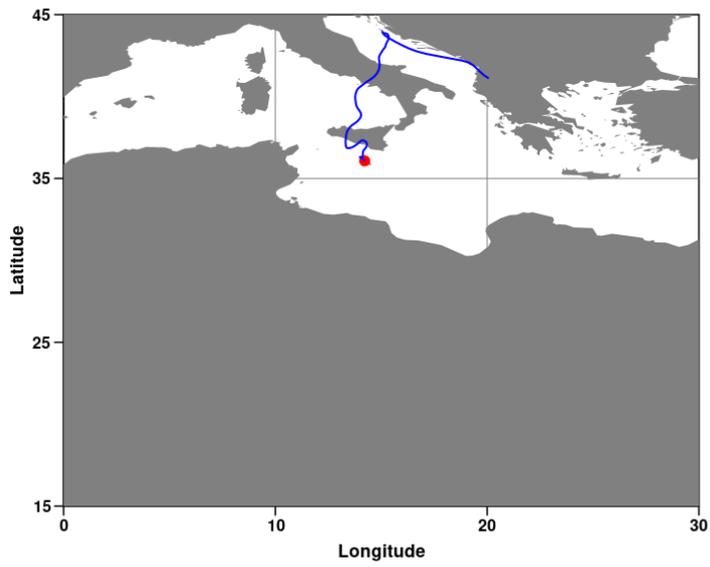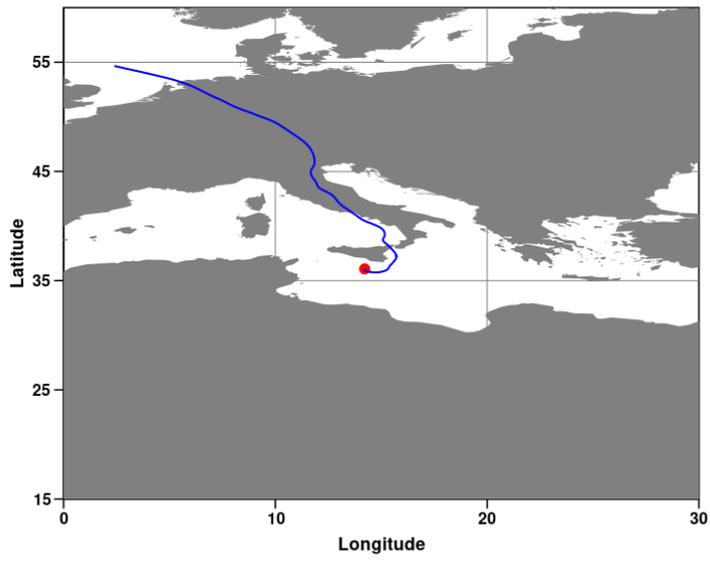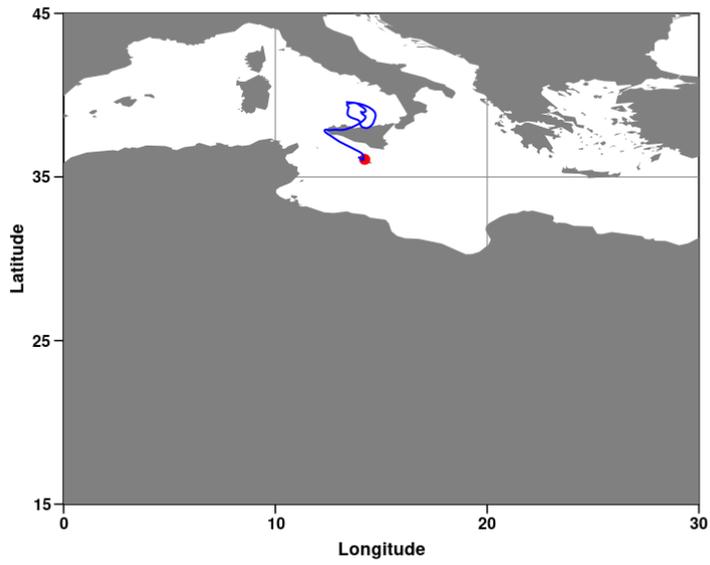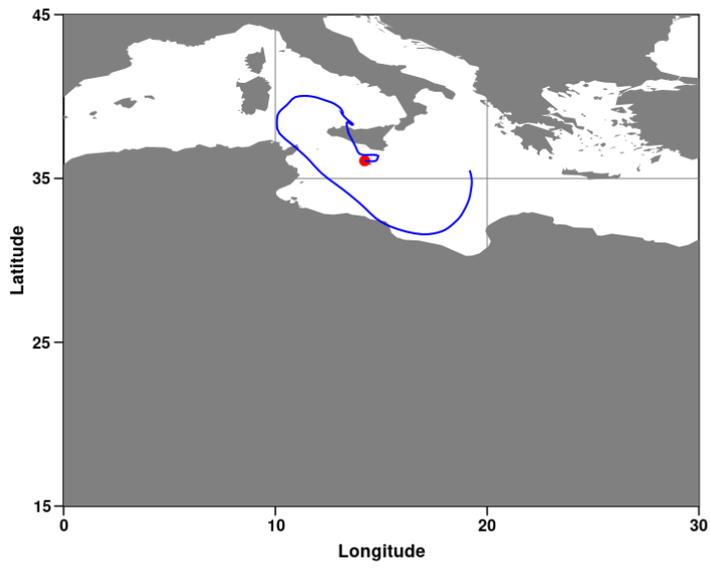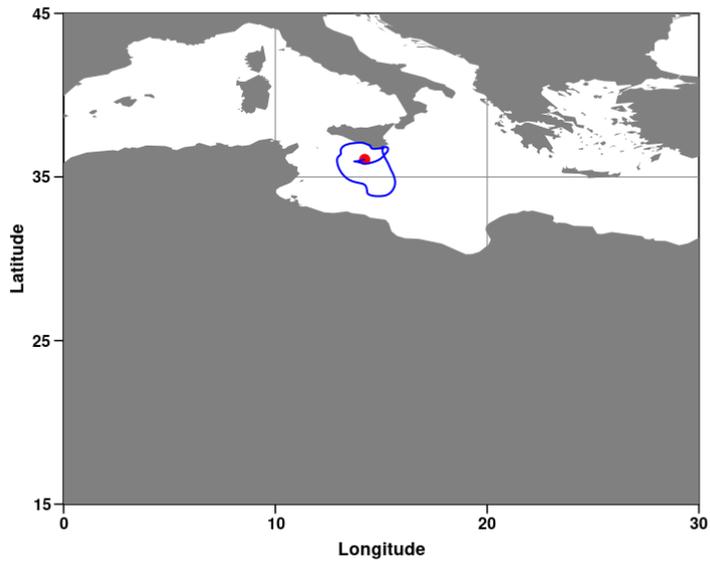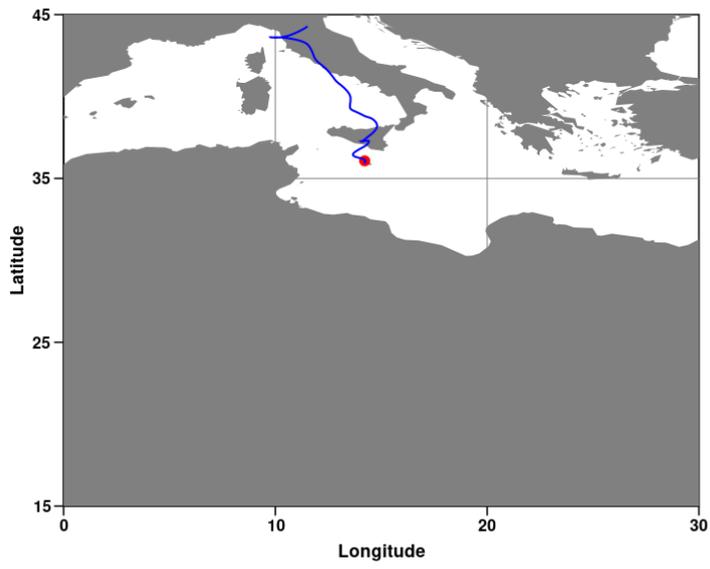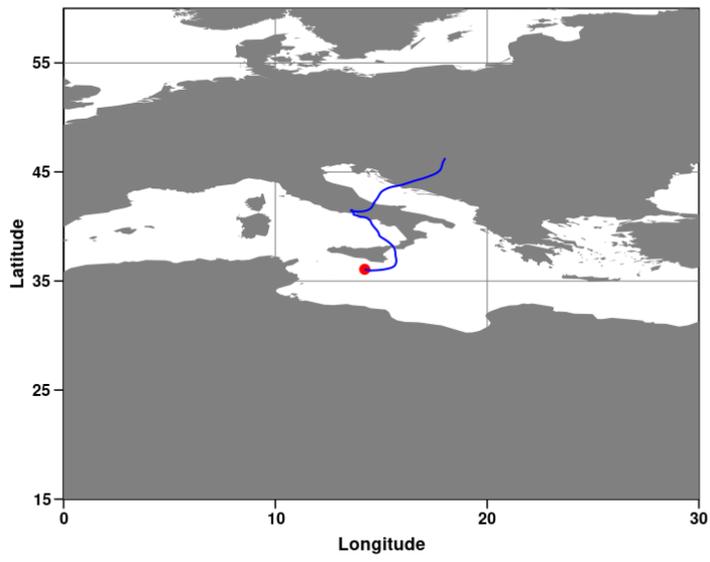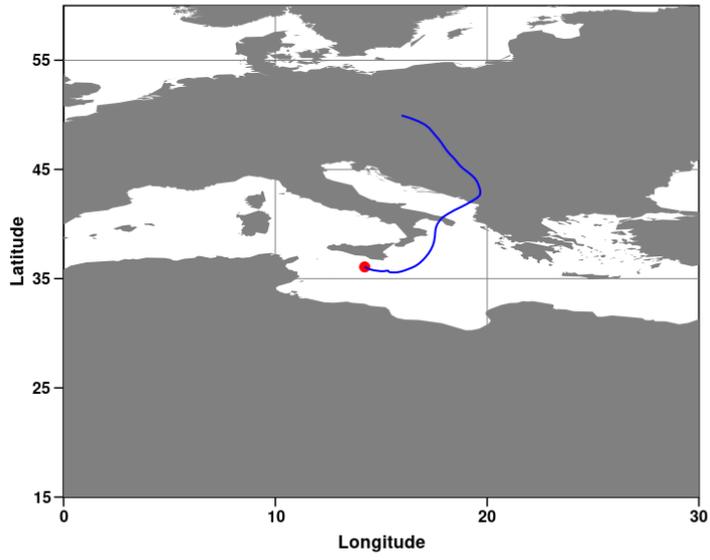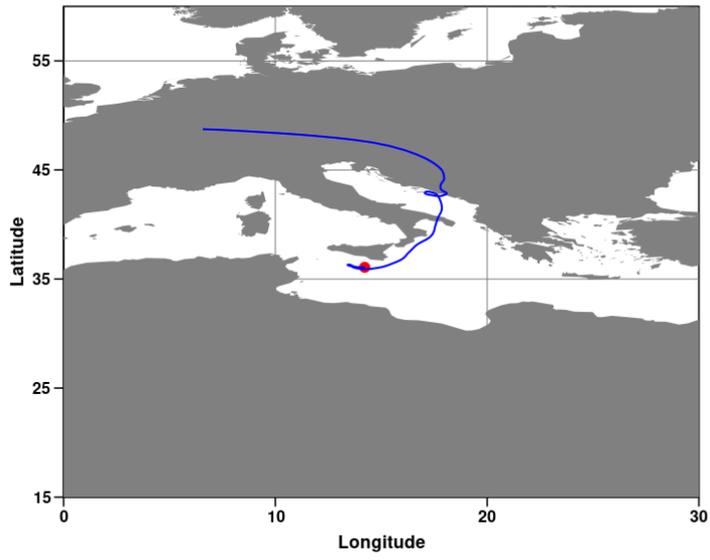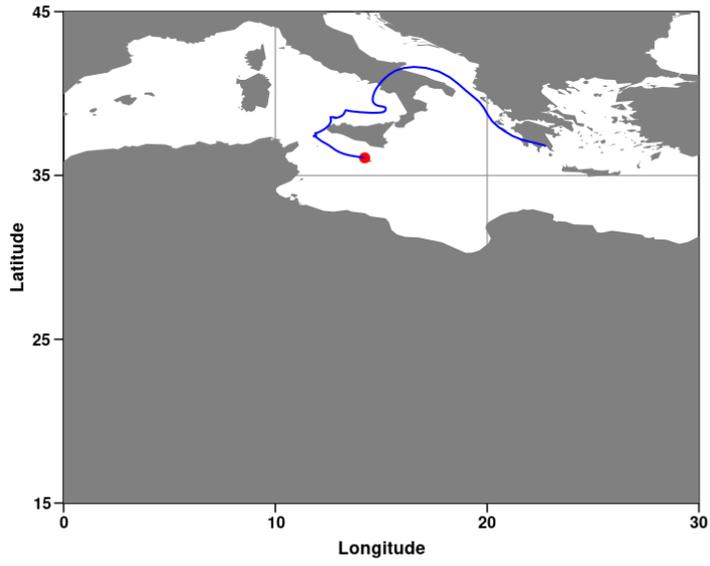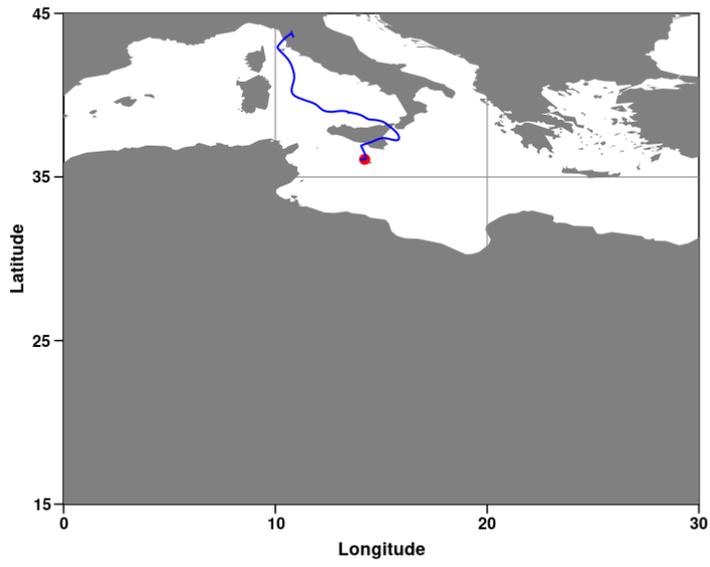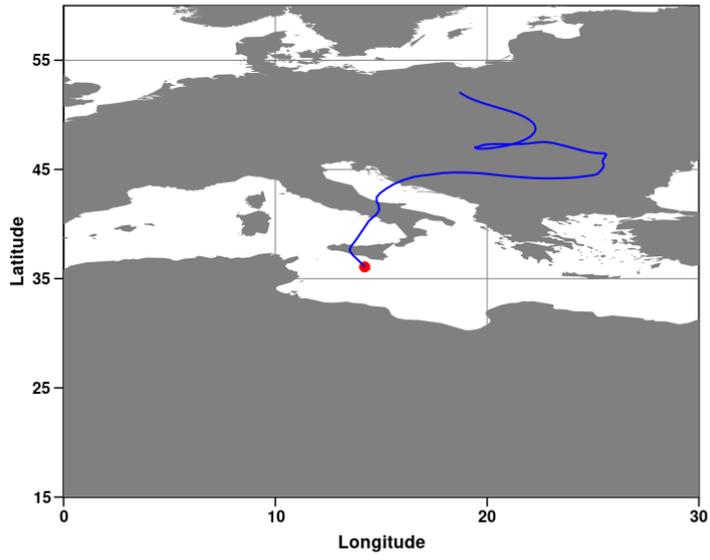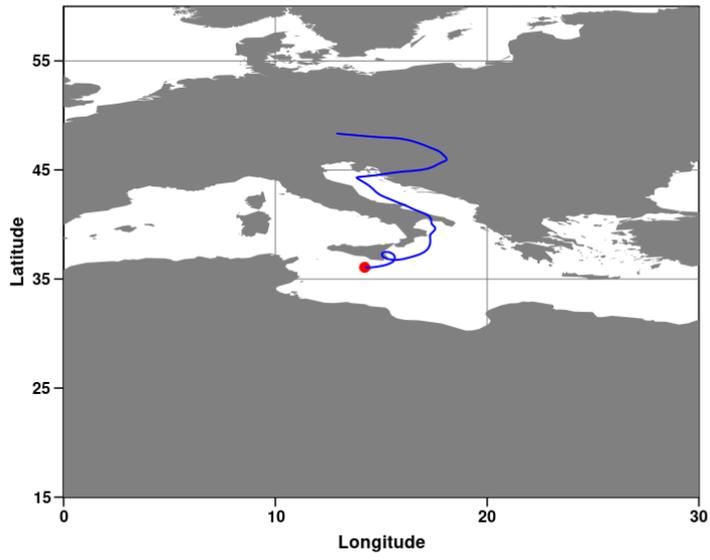
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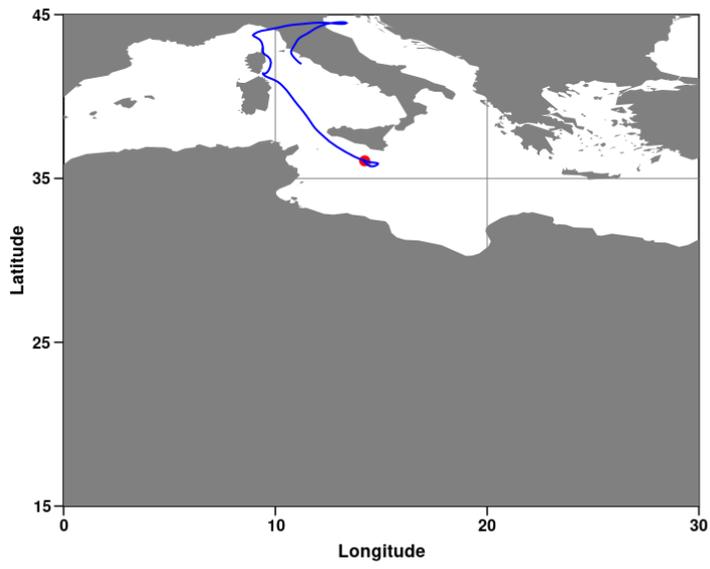
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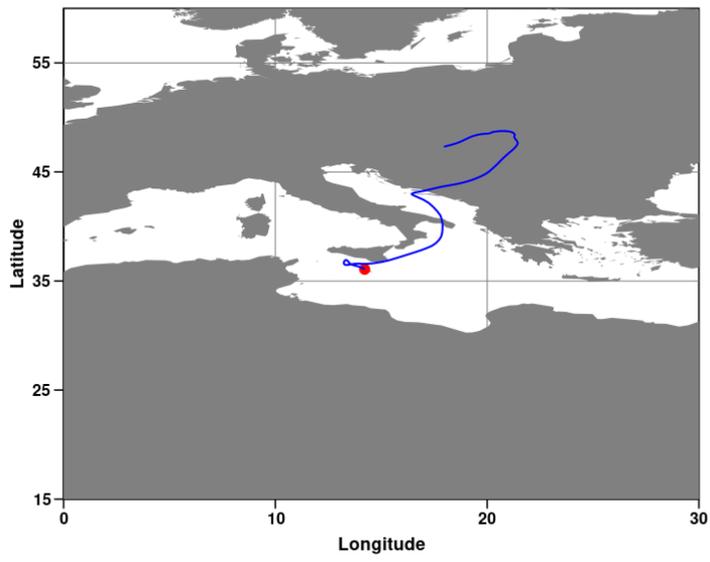
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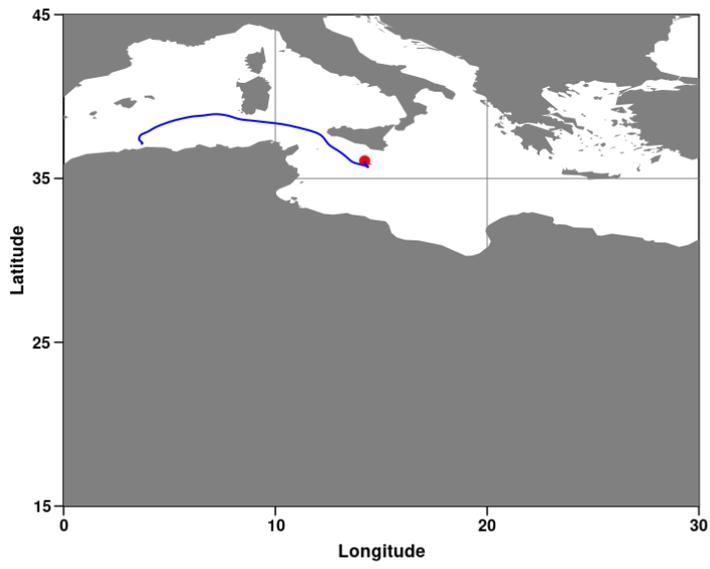
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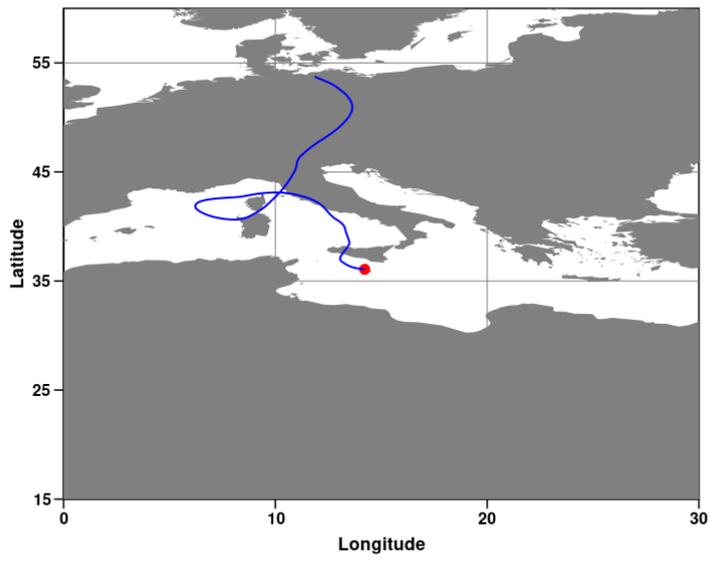
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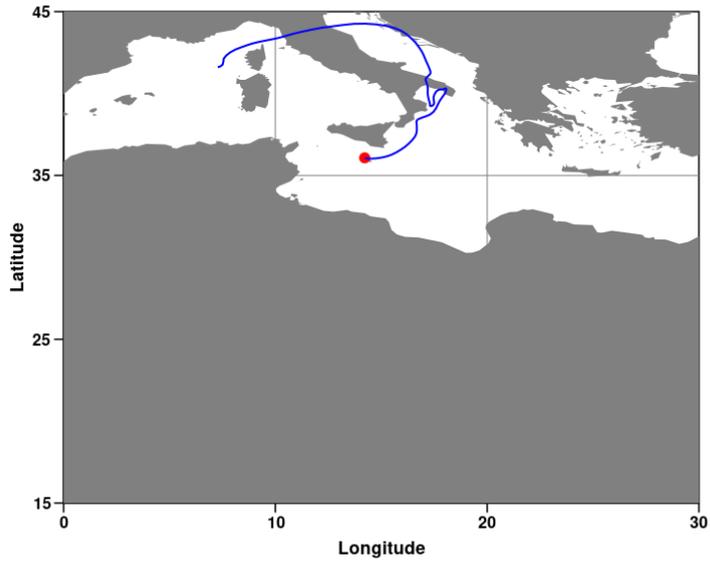
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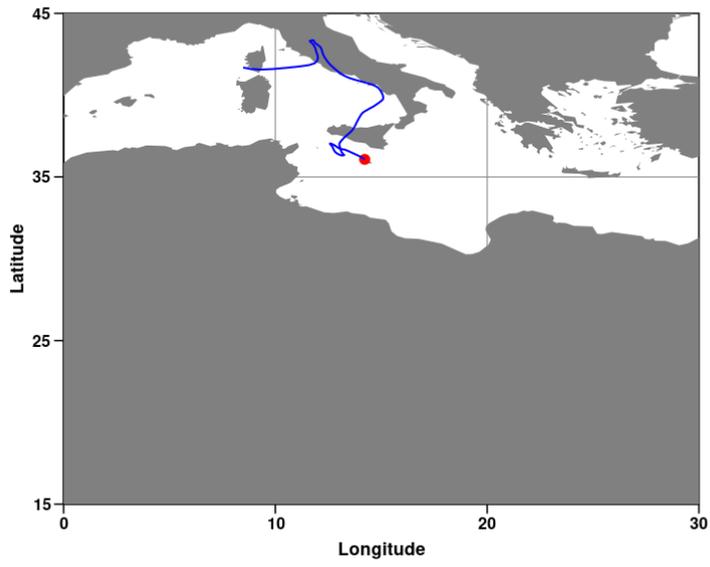
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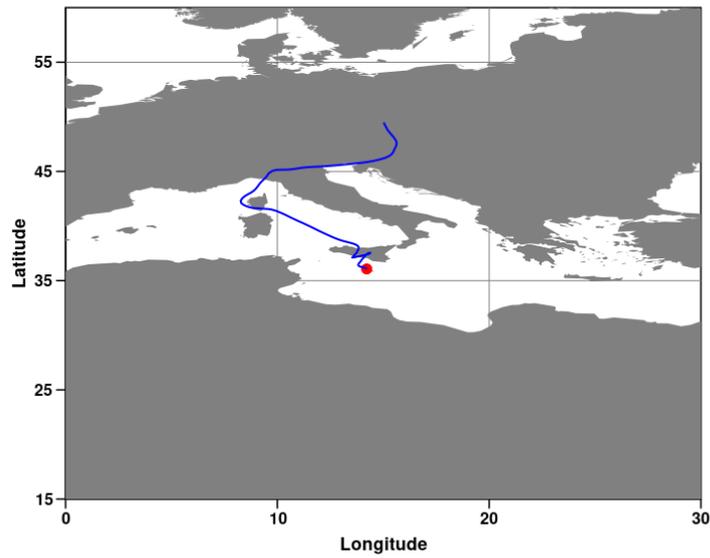
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Figure S4. Air trajectories calculated for the Giordan lighthouse observation site using METEX software and kinematic model (Zeng et al. 2003). Calculations are carried on for the following days marked with letters: 13th of June 1997 (a), 12th of August 1998 (b), 25th of June 1999 (c), 22nd of August 2000 (d), 9th of July 2001 (e), 22nd of June 2002 (f), 14th of August 2003 (g), 10th of June 2004 (h), 1st of May 2005 (i), 8th of September 2006 (j), 9th of April 2007 (k), 30th of August 2008 (l), 10th of May 2011 (m), 20th of August 2012 (n), 7th of July 2013 (o), 10th of June 2014 (p), 3rd of May 2015 (q), 20th of July 2016 (r), 8th of August 2017 (s), 30th of August 2018 (t) and 19th of July 2019 (u). Trajectories are calculated for 5 days backwards from the date mentioned above.