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Supplement of

The influence of the North Atlantic Oscillation and El Niño–Southern Oscillation on mean and extreme values of column ozone over the United States

I. Petropavlovskikh et al.

Correspondence to: I. Petropavlovskikh (irina.petro@noaa.gov)

Supplemental Material to

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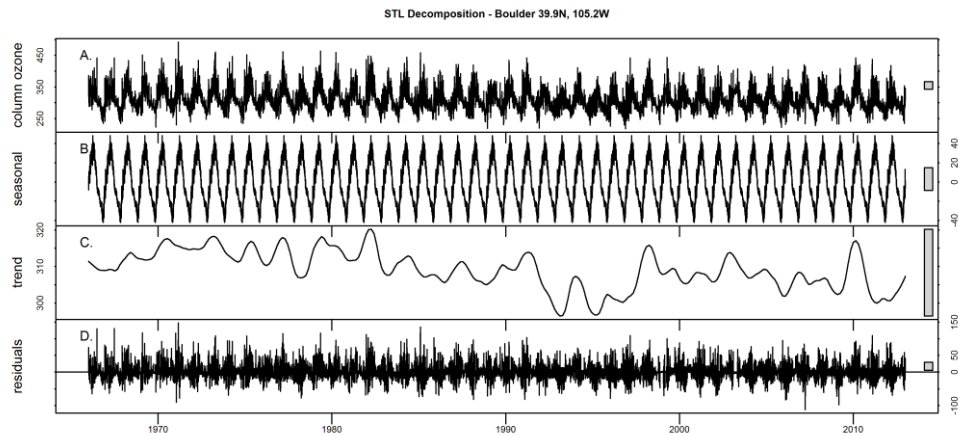


Figure S1: Decomposition Plot of the Boulder total ozone record based on the Seasonal-Trend decomposition procedure based on LOESS (STL): (A) daily mean column ozone values, (B) seasonal component, (C) trend component, (D) residuals (i.e, daily column ozone minus seasonal and trend component). All panels in DU. For convenience right hand bars in (A)-(D) refer to the same magnitude (25 DU).

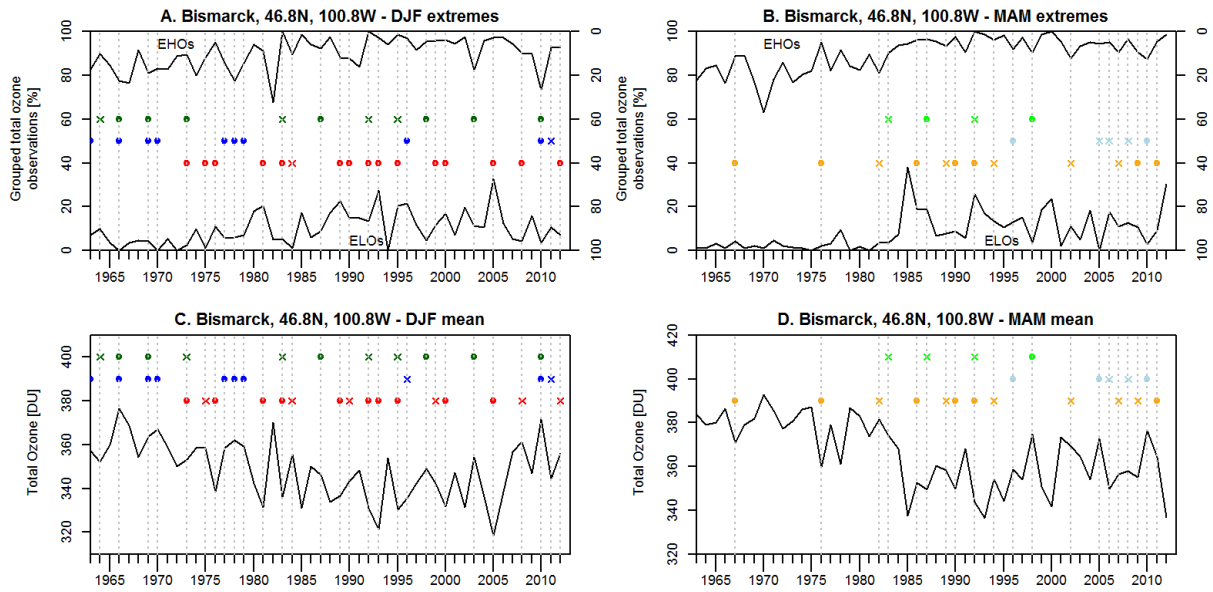


Figure S2: 'Fingerprints' of the NAO and ENSO as detected for Bismarck in the seasonal frequency time series of EHOs (right axis, top to bottom) and ELOs (left axis, bottom to top) for (A) winter (DJF), and (B) spring (MAM). Bottom panels (C) and (D) show 'fingerprints' in seasonal mean column ozone. Filled circles denote visible 'fingerprints' and crosses denote not visible 'fingerprints'. NAO positive (negative) phase is indicated for winter in red (blue) and for spring in orange (light blue), ENSO positive phase is indicated for winter (spring) in green (light green).

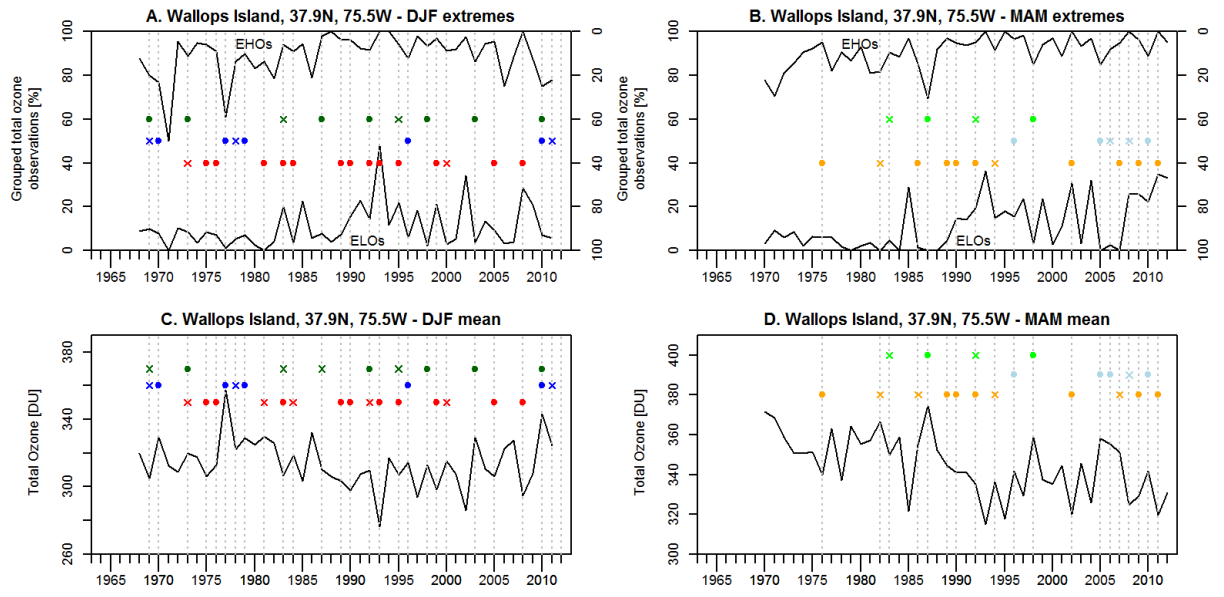


Figure S3: as Figure S2 but for Wallops Island.

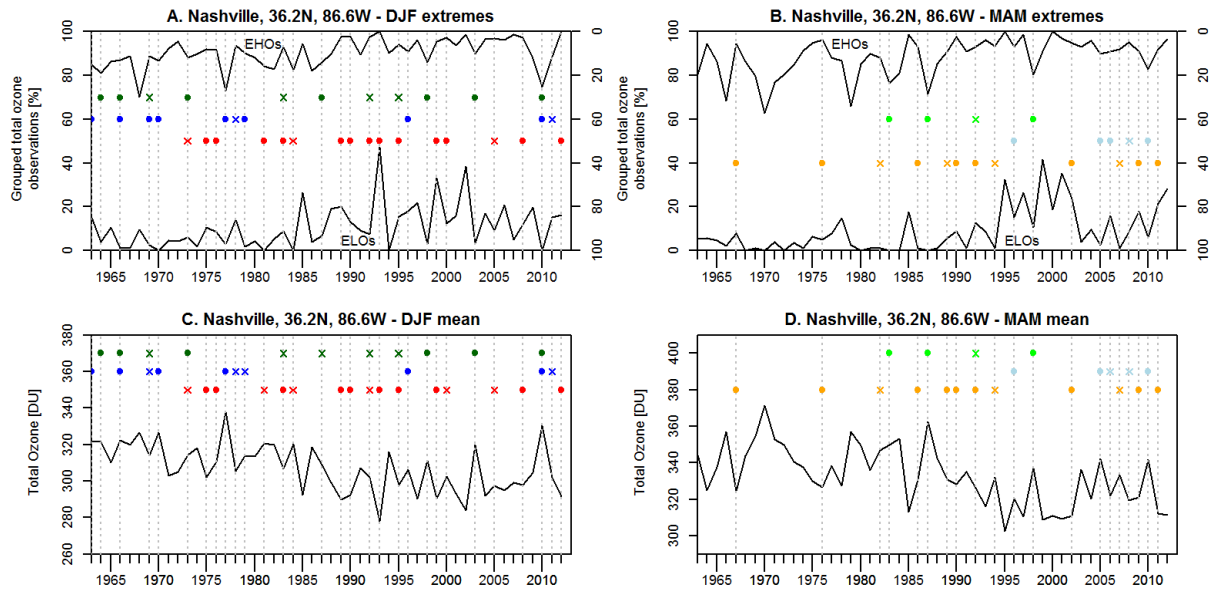


Figure S4: as Figure S2 but for Nashville.

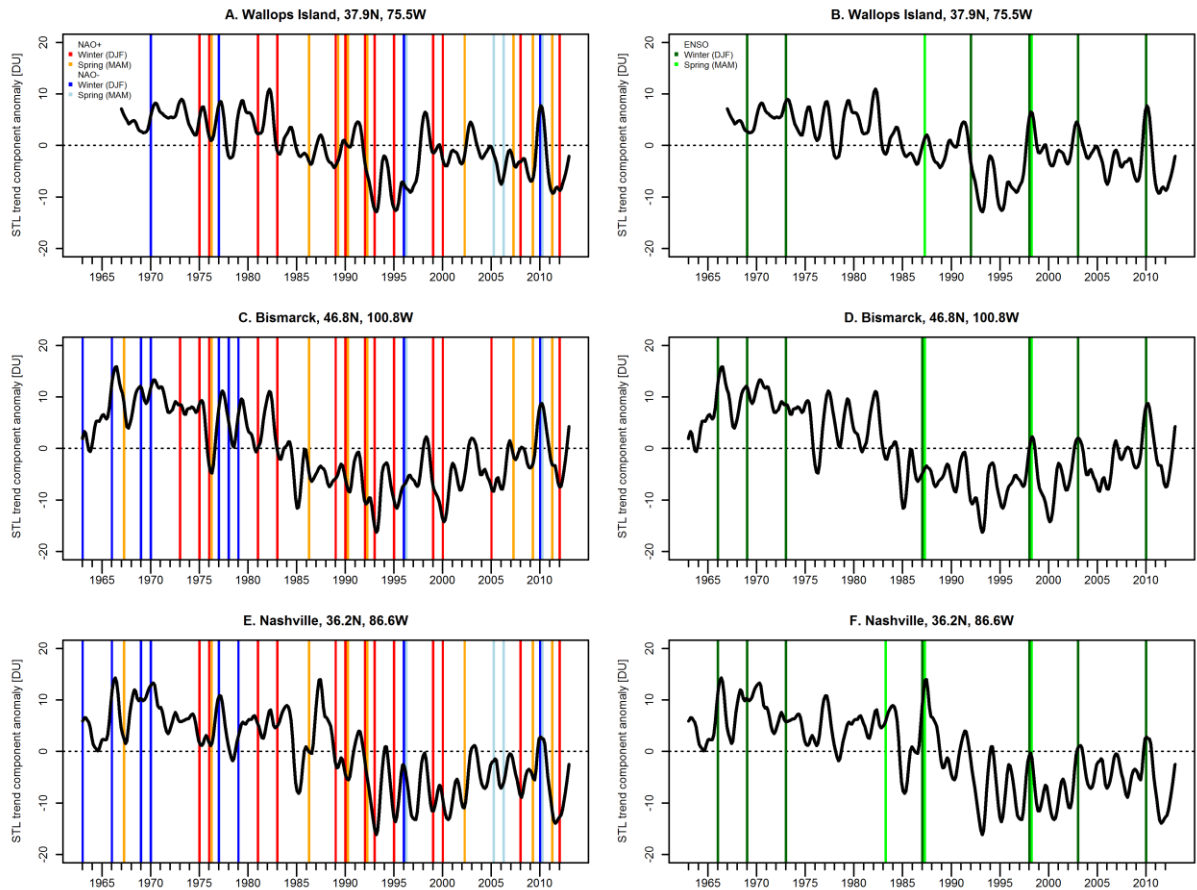


Figure S5: STL-trend component anomaly (in DU) in 1963-2012 for Wallops Island (top), Bismarck (center) and Nashville (bottom) with underlying marks (colored vertical bars) for ‘fingerprints’ of positive and negative NAO modes (left panels) and warm ENSO phases (right panels) on seasonal basis. NAO positive (negative) phase is indicated for winter in red (blue) and for spring in orange (light blue). Warm ENSO phase is indicated for winter in green and spring in light green.

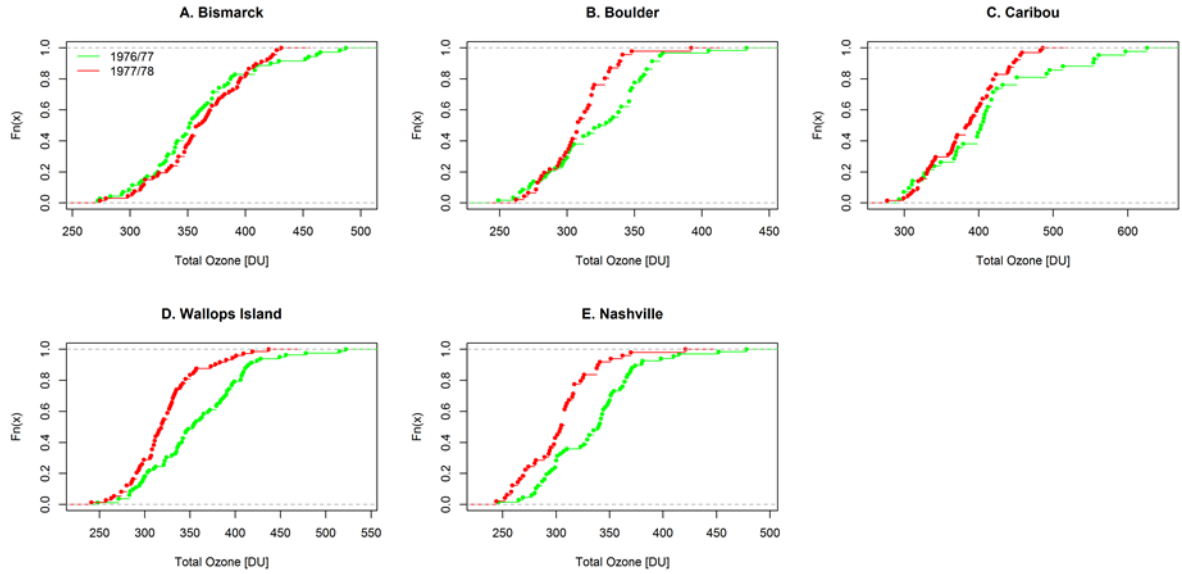


Figure S6: Empirical cumulative distribution functions (ecdf) of total ozone in winter 1976/77 (green) and 1977/78 (red). In 1976/77 ‘fingerprints’ of the negative NAO phase have been detected at all sites (increased frequency of high TOC values, i.e. EHOs), while a ‘fingerprint’ for the negative NAO phase in 1977/78 has been detected only at site Bismarck, i.e. reduced frequency of high ozone events at all other sites.

Table S1: Seasonal linear trends (in % per decade) for observed and extremes removed winter (DJF) and spring (MAM) column ozone time series in 1970-2000 and 1990-2010 at the 5 US ozone monitoring sites. Standard errors are given in parentheses, p-values are provided as superscript.

season/station	trend (in % per decade)			
	1970-2000		1990-2010	
	observations	no extremes	observations	no extremes
DJF				
Bismarck	-2.2 (± 0.6) ^{0.001}	-0.8 (± 0.3) ^{0.024}	+2.2 (± 1.3) ^{0.105}	+1.5 (± 0.7) ^{0.047}
Boulder	-1.7 (± 0.6) ^{0.014}	-0.5 (± 0.4) ^{0.279}	+1.1 (± 1.4) ^{0.449}	+0.3 (± 0.8) ^{0.737}
Caribou	-3.2 (± 0.8) ^{0.001}	-1.0 (± 0.5) ^{0.058}	+2.4 (± 1.5) ^{0.116}	+1.2 (± 1.2) ^{0.293}
Wallops Island	-2.4 (± 0.8) ^{0.007}	-1.0 (± 0.5) ^{0.087}	+3.1 (± 1.5) ^{0.046}	+1.6 (± 0.9) ^{0.086}
Nashville	-2.2 (± 0.7) ^{0.005}	-1.0 (± 0.4) ^{0.021}	+1.3 (± 1.4) ^{0.355}	+0.4 (± 0.7) ^{0.557}
MAM				
Bismarck	-3.6 (± 0.6) ^{0.001}	-1.6 (± 0.4) ^{0.001}	+2.0 (± 1.1) ^{0.096}	+1.2 (± 0.8) ^{0.139}
Boulder	-3.5 (± 0.7) ^{0.001}	-1.9 (± 0.4) ^{0.001}	+0.9 (± 1.4) ^{0.512}	+0.7 (± 0.7) ^{0.349}
Caribou	-2.3 (± 0.8) ^{0.005}	-1.0 (± 0.4) ^{0.024}	+1.0 (± 1.1) ^{0.342}	+0.1 (± 0.8) ^{0.879}
Wallops Island	-2.7 (± 0.7) ^{0.001}	-1.3 (± 0.5) ^{0.007}	+1.1 (± 1.3) ^{0.397}	+0.9 (± 0.9) ^{0.272}
Nashville	-3.5 (± 0.8) ^{0.001}	-1.9 (± 0.4) ^{0.001}	+1.0 (± 1.3) ^{0.478}	+0.5 (± 0.7) ^{0.512}