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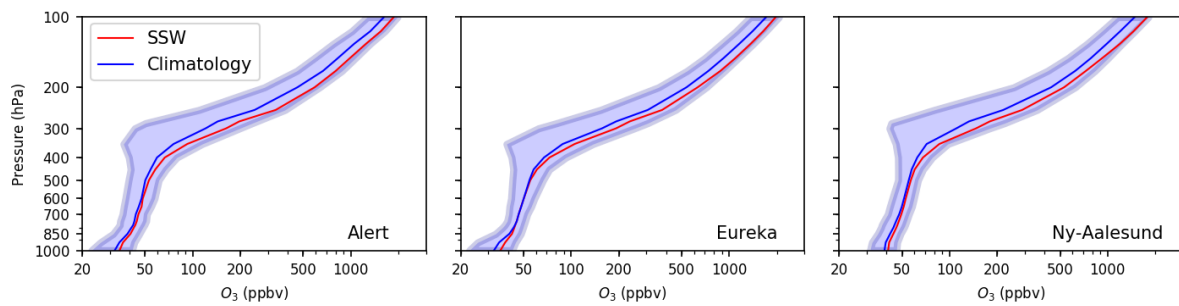
Figure S1 – Mean SSW profiles were composited from all profiles within -20 to +70 days of an SSW central warming date with remaining January–April profiles used in compositing a mean climatology profile (when such events occur more frequently). Blue shaded region represents 1σ around the climatological mean. The climatology is constructed excluding SSW events in each case.
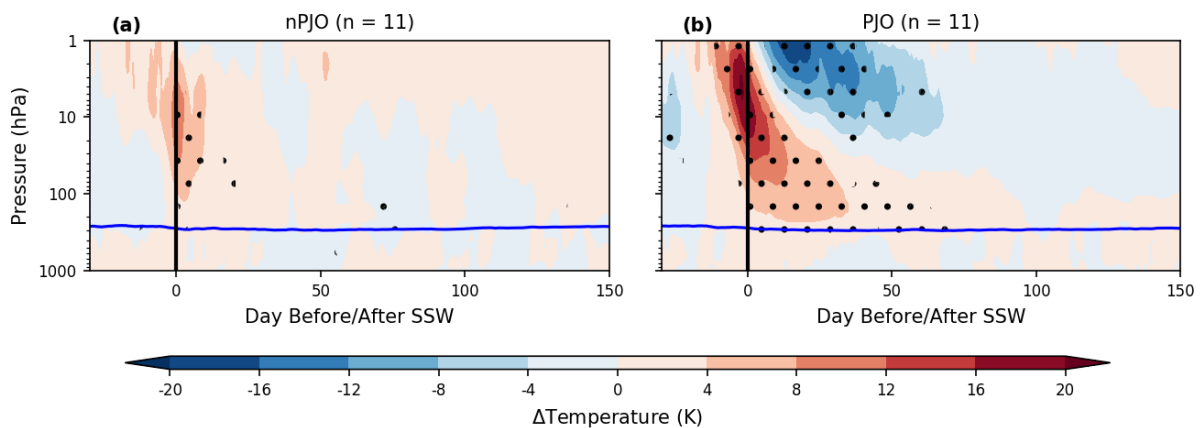
Figure S2 – Vertical-time composites of polar-cap (60–90° N) deseasonalised temperature (K) anomalies for (**a**) nPJO-type SSWs (n = 11) and (**b**) PJO-type SSWs (n = 11) (1980-2013) using specified-dynamics simulations from the EMAC CCM. Statistical significance at the 95 % level (p <0.05) is indicated by stippling. The World Meteorological Organisation (WMO) defined thermal tropopause is displayed for reference in each panel (blue solid line).
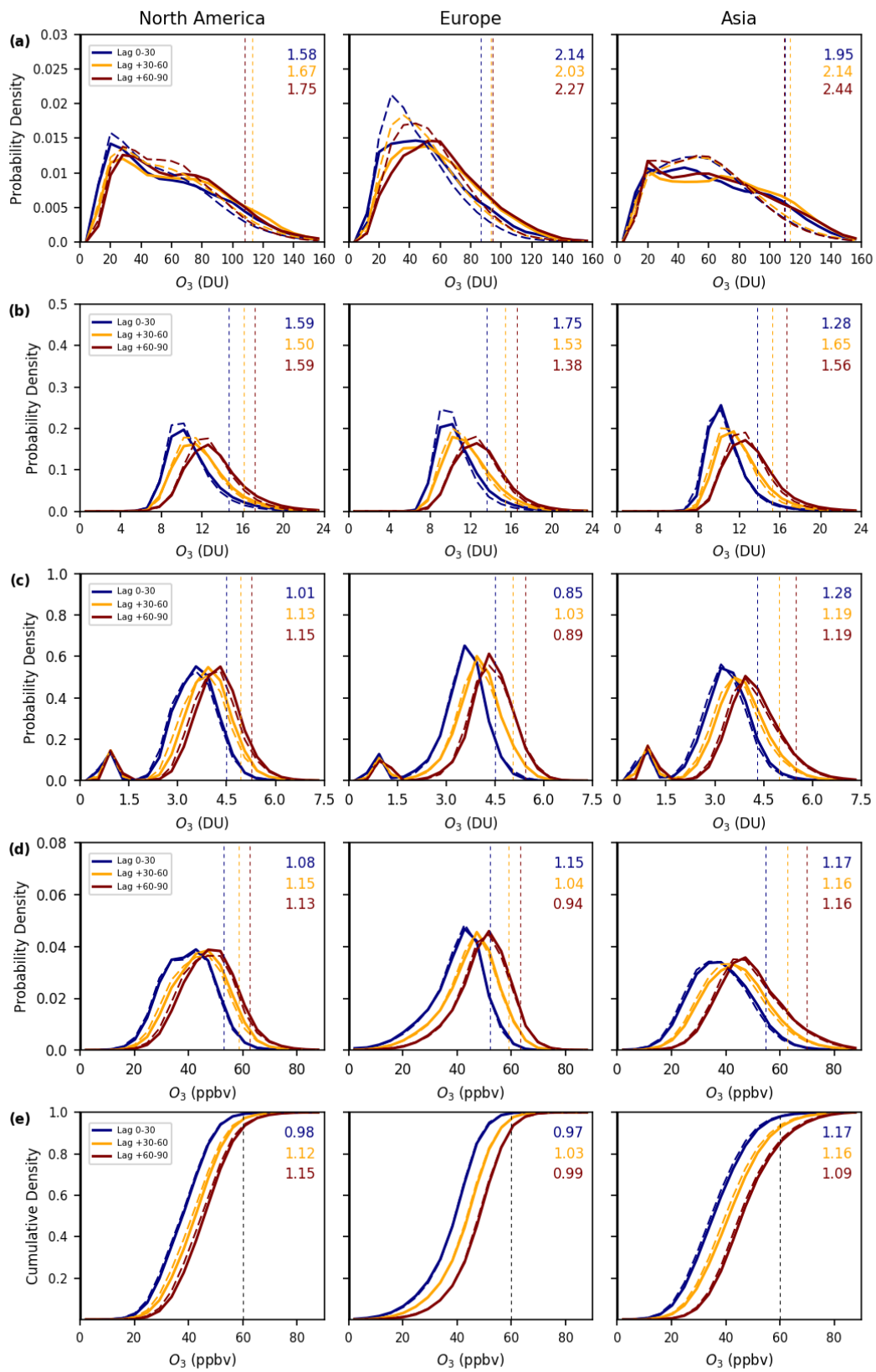
Figure S3 – Time-area averaged distributions for North America (30° N–70° N, 150° W–60° W), Europe (30° N–70° N, 30° W–30° E) and Asia (30° N–70° N, 30° E–180° E) for (**a**) the LMS (100-300 hPa), (**b**) upper troposphere (300–500 hPa), (**c**) the planetary boundary layer (900–1000 hPa) subcolumn ozone, as well as (**d**) modelled surface ozone mixing ratios (ppbv) for lags 0–30 days (blue lines), 30–60 days (orange lines) and 60–90 days (red lines) following the SSW central warming date. Solid lines represent SSW composite distributions and dashed lines represent the composite generated from the EMAC climatology (1980–2013) excluding SSW events. The cumulative ozone distributions with respect to climatology for the model surface level are additionally shown (**e**) to highlight the overall shift towards anomalously high ozone values even near the surface. Risk ratio (RR) values of the probability of an exceedance in the 95-percentile level of each climatological distribution (dashed vertical lines) are indicated, with the exception of (**e**) where the values represent a RR increase in the likelihood of an exceedance in the 60 ppbv threshold (a typical surface air quality standard).

Region	Statistic		Lag (days from onset)		
			0-30	30-60	60-90
North America	Median	Clim	55.79 ± 2.10 (51.62, 59.74)	60.35 ± 1.39 (57.42, 62.83)	60.34 ± 0.81 (58.61, 61.73)
		SSW	60.92 ± 2.71 (55.51, 66.15)	68.66 ± 1.63 (65.65, 71.89)	68.17 ± 2.24 (63.78, 72.59)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	Clim	104.55 ± 3.14 (97.66, 109.85)	106.33 ± 1.84 (102.46, 109.59)	102.99 ± 2.50 (98.07, 107.71)
		SSW	112.23 ± 2.39 (107.16, 116.64)	117.77 ± 2.30 (113.14, 122.24)	114.54 ± 4.18 (106.21, 122.62)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	118.32 ± 2.86 (111.84, 122.96)	119.14 ± 1.90 (114.94, 122.36)	115.81 ± 3.26 (109.08, 121.74)
		SSW	124.67 ± 2.54 (119.34, 129.50)	128.97 ± 2.46 (124.41, 134.06)	127.75 ± 5.23 (117.17, 137.49)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	Median	Clim	44.76 ± 1.76 (41.12, 47.96)	50.68 ± 1.51 (47.67, 53.59)	55.19 ± 1.08 (52.95, 57.19)
		SSW	53.38 ± 2.24 (49.22, 58.03)	59.88 ± 1.65 (56.87, 63.26)	62.50 ± 1.65 (59.59, 65.98)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	Clim	83.40 ± 2.24 (78.48, 87.20)	89.91 ± 1.90 (85.84, 93.25)	91.68 ± 1.43 (88.82, 94.34)
		SSW	96.88 ± 4.20 (89.37, 105.80)	102.12 ± 1.87 (98.42, 105.61)	105.53 ± 3.29 (98.47, 111.34)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	94.13 ± 2.34 (89.11, 98.29)	101.22 ± 1.91 (97.21, 104.68)	102.39 ± 1.58 (99.01, 105.20)
		SSW	110.01 ± 5.81 (99.75, 121.87)	113.24 ± 1.98 (109.30, 117.07)	117.14 ± 3.15 (110.55, 122.99)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	Median	Clim	59.71 ± 2.15 (55.13, 63.56)	62.75 ± 0.91 (60.95, 64.51)	61.42 ± 1.20 (59.07, 63.78)
		SSW	67.47 ± 2.45 (62.97, 72.61)	74.75 ± 1.36 (72.01, 77.30)	71.29 ± 2.40 (66.46, 75.68)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	Clim	102.66 ± 3.11 (96.06, 108.19)	105.87 ± 1.28 (103.27, 108.22)	103.17 ± 2.16 (98.79, 107.28)
		SSW	116.47 ± 3.91 (109.01, 124.27)	121.72 ± 2.38 (117.37, 126.68)	121.25 ± 3.30 (113.82, 126.64)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	115.02 ± 3.40 (107.69, 120.90)	117.94 ± 1.35 (115.13, 120.44)	115.06 ± 2.50 (109.70, 119.47)
		SSW	127.56 ± 4.22 (118.70, 135.10)	132.20 ± 2.63 (127.40, 137.46)	132.36 ± 2.96 (125.56, 137.08)
		P-Value	< 0.001	< 0.001	< 0.001

Table S1 – 100–300 hPa subcolumn median, 90th percentile and 95th percentile ozone of stratospheric origin (O_3S) values (DU) for each regionally derived climatological (Clim) and PJO-type SSW composited (n = 11) distributions over the 1980-2013 period of the EMAC model simulations. One standard deviation (1σ) around each value is indicated, with the numbers in parentheses representing the 95 % confidence intervals around each value (as determined through bootstrap sampling with replacement over 10000 iterations). The associated p-value from a two-sample t-test is additionally shown and highlighted in red where statistical significance is inferred ($p < 0.05$), as are cases where the 95 % confidence intervals do not overlap.

Region	Statistic		Lag (days from onset)		
			0-30	**30-60**	**60-90**
North America	**Median**	**Clim**	6.55 ± 0.21 (6.11, 6.93)	6.90 ± 0.11 (6.66, 7.08)	6.93 ± 0.06 (6.81, 7.05)
		SSW	6.74 ± 0.19 (6.36, 7.11)	7.10 ± 0.14 (6.83, 7.38)	7.35 ± 0.11 (7.13, 7.56)
		P-Value	0.038	0.001	< 0.001
	90th Percentile	**Clim**	11.47 ± 0.34 (10.75, 12.09)	12.40 ± 0.25 (11.88, 12.89)	12.98 ± 0.14 (12.70, 13.25)
		SSW	12.60 ± 0.41 (11.79, 13.41)	13.58 ± 0.48 (12.68, 14.54)	14.08 ± 0.24 (13.58, 14.52)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	13.22 ± 0.42 (12.35, 13.99)	14.35 ± 0.29 (13.72, 14.88)	14.97 ± 0.18 (14.60, 15.29)
		SSW	14.75 ± 0.51 (13.74, 15.72)	15.91 ± 0.62 (14.73, 17.09)	16.43 ± 0.27 (15.87, 16.92)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	**Median**	**Clim**	5.86 ± 0.16 (5.54, 6.19)	6.39 ± 0.17 (6.04, 6.70)	6.75 ± 0.09 (6.55, 6.91)
		SSW	6.48 ± 0.22 (6.06, 6.91)	6.83 ± 0.18 (6.50, 7.20)	7.17 ± 0.13 (6.93, 7.42)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	**Clim**	10.15 ± 0.39 (9.40, 10.91)	11.41 ± 0.37 (10.68, 12.12)	12.08 ± 0.21 (11.67, 12.47)
		SSW	11.41 ± 0.47 (10.55, 12.36)	12.37 ± 0.35 (11.72, 13.06)	12.68 ± 0.15 (12.38, 12.96)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	11.91 ± 0.49 (10.92, 12.85)	13.36 ± 0.43 (12.49, 14.12)	13.96 ± 0.20 (13.56, 14.36)
		SSW	13.30 ± 0.59 (12.18, 14.47)	14.45 ± 0.44 (13.61, 15.31)	14.64 ± 0.18 (14.28, 15.01)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	**Median**	**Clim**	6.27 ± 0.19 (5.89, 6.62)	6.67 ± 0.12 (6.42, 6.88)	6.92 ± 0.04 (6.85, 6.99)
		SSW	6.52 ± 0.17 (6.21, 6.87)	7.27 ± 0.16 (6.96, 7.61)	7.36 ± 0.13 (7.13, 7.63)
		P-Value	0.004	< 0.001	< 0.001
	90th Percentile	**Clim**	10.27 ± 0.30 (9.66, 10.81)	11.07 ± 0.23 (10.57, 11.49)	11.78 ± 0.18 (11.41, 12.12)
		SSW	10.88 ± 0.39 (10.13, 11.62)	12.73 ± 0.45 (11.83, 13.59)	13.20 ± 0.40 (12.38, 13.94)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	11.90 ± 0.36 (11.17, 12.56)	12.81 ± 0.28 (12.21, 13.31)	13.62 ± 0.20 (13.20, 13.99)
		SSW	12.64 ± 0.47 (11.71, 13.53)	14.81 ± 0.50 (13.80, 15.75)	15.25 ± 0.43 (14.36, 16.04)
		P-Value	< 0.001	< 0.001	< 0.001

Table S2 – Same as Table S1 but for the 300–500 hPa subcolumn (upper troposphere).

Region	Statistic		Lag (days from onset)		
			0-30	**30-60**	**60-90**
North America	**Median**	**Clim**	1.65 ± 0.04 (1.57, 1.72)	1.69 ± 0.03 (1.63, 1.74)	1.54 ± 0.08 (1.37, 1.67)
		SSW	1.75 ± 0.03 (1.69, 1.82)	1.86 ± 0.03 (1.80, 1.92)	1.75 ± 0.08 (1.58, 1.88)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	**Clim**	2.06 ± 0.03 (1.98, 2.11)	2.10 ± 0.02 (2.05, 2.14)	2.02 ± 0.04 (1.91, 2.09)
		SSW	2.15 ± 0.04 (2.08, 2.23)	2.30 ± 0.05 (2.21, 2.39)	2.24 ± 0.04 (2.16, 2.31)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	2.17 ± 0.03 (2.10, 2.22)	2.21 ± 0.03 (2.16, 2.26)	2.14 ± 0.04 (2.04, 2.21)
		SSW	2.26 ± 0.04 (2.18, 2.35)	2.42 ± 0.05 (2.32, 2.51)	2.36 ± 0.04 (2.29, 2.42)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	**Median**	**Clim**	1.71 ± 0.04 (1.62, 1.77)	1.72 ± 0.03 (1.65, 1.77)	1.56 ± 0.08 (1.39, 1.70)
		SSW	1.77 ± 0.03 (1.71, 1.83)	1.85 ± 0.04 (1.72, 1.91)	1.69 ± 0.09 (1.50, 1.85)
		P-Value	< 0.001	< 0.001	0.002
	90th Percentile	**Clim**	2.09 ± 0.04 (2.01, 2.15)	2.10 ± 0.03 (2.04, 2.15)	2.04 ± 0.05 (1.93, 2.13)
		SSW	2.19 ± 0.06 (2.08, 2.30)	2.25 ± 0.03 (2.18, 2.30)	2.25 ± 0.07 (2.11, 2.37)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	2.19 ± 0.03 (2.12, 2.25)	2.21 ± 0.03 (2.15, 2.26)	2.16 ± 0.05 (2.06, 2.24)
		SSW	2.30 ± 0.06 (2.19, 2.40)	2.36 ± 0.03 (2.30, 2.42)	2.38 ± 0.06 (2.25, 2.48)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	**Median**	**Clim**	1.61 ± 0.04 (1.52, 1.68)	1.65 ± 0.03 (1.59, 1.71)	1.52 ± 0.07 (1.38, 1.64)
		SSW	1.69 ± 0.04 (1.61, 1.77)	1.82 ± 0.03 (1.77, 1.87)	1.74 ± 0.07 (1.58, 1.84)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	**Clim**	2.00 ± 0.04 (1.92, 2.06)	2.04 ± 0.03 (1.97, 2.10)	1.96 ± 0.04 (1.86, 2.03)
		SSW	2.09 ± 0.05 (1.99, 2.18)	2.21 ± 0.04 (2.14, 2.29)	2.18 ± 0.04 (2.10, 2.25)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	2.10 ± 0.04 (2.02, 2.16)	2.15 ± 0.04 (2.07, 2.21)	2.07 ± 0.04 (1.98, 2.14)
		SSW	2.20 ± 0.05 (2.10, 2.29)	2.32 ± 0.04 (2.24, 2.40)	2.29 ± 0.04 (2.22, 2.36)
		P-Value	< 0.001	< 0.001	< 0.001

Table S3 – Same as Tables S1 and S2 but for the 900–1000 hPa subcolumn (PBL approximation).

Region	Statistic		Lag (days from onset)		
			0-30	**30-60**	**60-90**
North America	**Median**	**Clim**	17.94 ± 0.43 (17.05, 18.71)	18.28 ± 0.32 (17.61, 18.86)	16.71 ± 0.88 (14.78, 18.18)
		SSW	18.86 ± 0.39 (18.14, 19.64)	20.16 ± 0.40 (19.40, 20.95)	19.08 ± 0.88 (17.10, 20.49)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	**Clim**	23.88 ± 0.42 (22.97, 24.59)	24.29 ± 0.33 (23.58, 24.85)	23.13 ± 0.64 (21.69, 24.17)
		SSW	24.85 ± 0.51 (23.86, 25.82)	26.50 ± 0.45 (25.64, 27.40)	25.88 ± 0.50 (24.76, 26.68)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	25.45 ± 0.41 (24.53, 26.14)	25.94 ± 0.31 (25.28, 26.47)	24.94 ± 0.57 (23.65, 25.88)
		SSW	26.47 ± 0.59 (25.31, 27.58)	28.22 ± 0.53 (27.20, 29.30)	27.58 ± 0.41 (26.67, 28.25)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	**Median**	**Clim**	19.35 ± 0.47 (18.38, 20.19)	19.43 ± 0.38 (18.63, 20.13)	17.40 ± 1.02 (15.28,19.20)
		SSW	20.14 ± 0.38 (19.46, 20.96)	20.91 ± 0.49 (19.80, 21.71)	18.83 ± 1.23 (16.30, 20.99)
		P-Value	< 0.001	< 0.001	0.008
	90th Percentile	**Clim**	25.02 ± 0.46 (24.00, 25.81)	25.22 ± 0.39 (24.40, 25.90)	24.34 ± 0.66 (22.92, 25.48)
		SSW	26.20 ± 0.73 (24.92, 27.70)	26.95 ± 0.33 (26.26, 27.56)	26.99 ± 0.86 (25.21, 28.51)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	26.43 ± 0.44 (25.44, 27.18)	26.70 ± 0.38 (25.87, 27.34)	25.99 ± 0.65 (24.62, 27.09)
		SSW	27.84 ± 0.77 (26.33, 29.21)	28.47 ± 0.36 (27.73, 29.15)	28.72 ± 0.76 (27.10, 29.98)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	**Median**	**Clim**	17.06 ± 0.52 (15.95, 18.00)	17.89 ± 0.37 (17.15, 18.58)	16.87 ± 0.65 (15.44, 17.99)
		SSW	17.66 ± 0.51 (16.68, 18.67)	19.61 ± 0.36 (18.94, 20.36)	19.11 ± 0.70 (17.55, 20.29)
		P-Value	0.013	< 0.001	< 0.001
	90th Percentile	**Clim**	23.29 ± 0.47 (22.27, 24.10)	24.05 ± 0.37 (23.29, 24.72)	23.54 ± 0.44 (22.58, 24.28)
		SSW	24.33 ± 0.57 (23.23, 25.44)	25.99 ± 0.44 (25.13, 26.85)	25.69 ± 0.39 (24.91, 26.41)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	**Clim**	25.03 ± 0.46 (24.01, 25.81)	25.96 ± 0.38 (25.15, 26.65)	25.77 ± 0.32 (25.08, 26.33)
		SSW	26.14 ± 0.65 (24.83, 27.35)	27.80 ± 0.51 (26.79, 28.76)	27.66 ± 0.45 (26.77, 28.50)
		P-Value	< 0.001	< 0.001	< 0.001

Table S4 – Same as Tables S1–S3 but for the model surface level.

Region	Statistic		Lag (days from onset)		
			0-30	30-60	60-90
North America	Median	Clim	56.28 ± 2.12 (52.06, 60.30)	60.93 ± 1.39 (58.05, 63.45)	61.12 ± 0.76 (59.46, 62.46)
		SSW	61.48 ± 2.71 (56.18, 66.71)	69.28 ± 1.64 (66.22, 72.48)	68.97 ± 2.19 (64.73, 73.22)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	Clim	104.58 ± 3.17 (97.52, 109.84)	106.34 ± 1.84 (102.47, 109.67)	103.05 ± 2.47 (98.15, 107.74)
		SSW	112.26 ± 2.34 (107.37, 116.57)	117.81 ± 2.31 (113.14, 122.23)	114.61 ± 4.21 (107.43, 122.57)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	118.33 ± 2.88 (111.68, 122.94)	119.12 ± 1.90 (114.98, 122.39)	115.81 ± 3.21 (109.15, 121.69)
		SSW	124.69 ± 2.50 (119.55, 129.37)	128.99 ± 2.47 (124.37, 134.09)	127.80 ± 5.29 (117.19, 137.58)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	Median	Clim	45.68 ± 1.74 (42.06, 48.83)	51.66 ± 1.52 (48.64, 54.58)	56.37 ± 1.08 (54.09, 58.35)
		SSW	54.01 ± 2.23 (49.92, 58.64)	60.84 ± 1.66 (57.78, 64.25)	63.57 ± 1.62 (60.77, 67.17)
		P-Value	< 0.001	< 0.001	< 0.001
	90th Percentile	Clim	83.56 ± 2.17 (78.86, 87.33)	89.99 ± 1.90 (85.92, 93.29)	91.78 ± 1.41 (88.95, 94.42)
		SSW	96.86 ± 4.13 (89.52, 105.57)	102.17 ± 1.88 (98.49, 105.74)	105.60 ± 3.29 (98.62, 111.25)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	94.23 ± 2.29 (89.39, 98.36)	101.25 ± 1.92 (97.25, 104.71)	102.43 ± 1.58 (99.09, 105.23)
		SSW	109.89 ± 5.76 (99.82, 121.79)	113.25 ± 1.98 (109.38, 117.20)	117.15 ± 3.16 (110.53, 122.84)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	Median	Clim	60.15 ± 2.13 (55.70, 63.98)	63.35 ± 0.89 (61.62, 65.10)	62.26 ± 1.11 (60.06, 64.44)
		SSW	67.92 ± 2.43 (63.36, 72.99)	75.23 ± 1.33 (72.53, 77.74)	72.06 ± 2.30 (67.42, 76.32)
		P-Value	0.003	< 0.001	< 0.001
	90th Percentile	Clim	102.70 ± 3.09 (96.14, 108.26)	105.92 ± 1.28 (103.32, 108.28)	103.22 ± 2.16 (98.88, 107.28)
		SSW	116.57 ± 3.89 (109.20, 124.24)	121.75 ± 2.35 (117.55, 126.68)	121.28 ± 3.29 (113.84, 126.84)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	115.02 ± 3.38 (107.66, 120.92)	117.95 ± 1.36 (115.17, 120.45)	115.08 ± 2.51 (109.78, 119.42)
		SSW	127.65 ± 4.19 (118.98, 135.09)	132.22 ± 2.59 (127.49, 137.45)	132.35 ± 2.98 (125.44, 137.21)
		P-Value	< 0.001	< 0.001	< 0.001

Table S5 – 100–300 hPa subcolumn median, 90th percentile and 95th percentile ozone values (DU) for each regionally derived climatological (clim) and PJO-type SSW composited (n = 11) distributions over the 1980-2013 period of the EMAC model simulations. One standard deviation (1σ) around each value is indicated, with the numbers in parentheses representing the 95 % confidence intervals around each value (as determined through bootstrap sampling with replacement over 10000 iterations). The associated p-value from a two-sample t-test is additionally shown and highlighted in red where statistical significance is inferred ($p < 0.05$), as are cases where the 95 % confidence intervals do not overlap.

Region	Statistic		Lag (days from onset)		
			0-30	30-60	60-90
North America	Median	Clim	10.33 ± 0.28 (9.81, 10.90)	11.46 ± 0.35 (10.78, 12.14)	12.60 ± 0.32 (11.91, 13.16)
		SSW	10.65 ± 0.31 (10.08, 11.30)	11.72 ± 0.39 (10.98, 12.50)	12.92 ± 0.29 (12.41, 13.45)
		P-Value	0.020	0.115	0.023
	90th Percentile	Clim	13.62 ± 0.41 (12.79, 14.41)	15.07 ± 0.38 (14.27, 15.74)	16.26 ± 0.27 (15.68, 16.71)
		SSW	14.63 ± 0.50 (13.66, 15.63)	15.99 ± 0.55 (14.91, 17.05)	17.09 ± 0.27 (16.57, 17.62)
		P-Value	< 0.001	< 0.001	< 0.001
	95th Percentile	Clim	15.01 ± 0.47 (14.04, 15.87)	16.52 ± 0.38 (15.71, 17.19)	17.53 ± 0.26 (17.07, 18.08)
		SSW	16.33 ± 0.58 (15.17, 17.45)	17.81 ± 0.64 (16.49, 19.00)	18.71 ± 0.30 (18.16, 19.31)
		P-Value	< 0.001	< 0.001	< 0.001
Europe	Median	Clim	10.05 ± 0.25 (9.61, 10.59)	11.29 ± 0.41 (10.49, 12.08)	12.61 ± 0.37 (11.82, 13.26)
		SSW	10.43 ± 0.32 (9.84, 11.08)	11.55 ± 0.41 (10.79, 12.38)	12.81 ± 0.36 (12.09, 13.48)
		P-Value	0.006	0.153	0.214
	90th Percentile	Clim	12.87 ± 0.45 (11.97, 13.74)	14.62 ± 0.45 (13.66, 15.45)	15.88 ± 0.28 (15.25, 16.35)
		SSW	13.85 ± 0.51 (12.85, 14.80)	15.34 ± 0.53 (14.33, 16.26)	16.31 ± 0.31 (15.67, 16.88)
		P-Value	< 0.001	0.002	0.003
	95th Percentile	Clim	14.10 ± 0.53 (13.01, 15.05)	15.91 ± 0.48 (14.92, 16.79)	17.02 ± 0.26 (16.45, 17.46)
		SSW	15.29 ± 0.59 (14.08, 16.38)	16.81 ± 0.52 (15.76, 17.77)	17.61 ± 0.29 (17.01, 18.15)
		P-Value	< 0.001	< 0.001	< 0.001
Asia	Median	Clim	10.16 ± 0.26 (9.67, 10.69)	11.27 ± 0.37 (10.54, 12.00)	12.52 ± 0.36 (11.79, 13.20)
		SSW	10.34 ± 0.26 (9.86, 10.90)	11.69 ± 0.41 (10.93, 12.51)	12.87 ± 0.41 (12.00, 13.62)
		P-Value	0.120	0.020	0.046
	90th Percentile	Clim	12.90 ± 0.35 (12.17, 13.54)	14.32 ± 0.39 (13.49, 15.01)	15.76 ± 0.37 (14.99, 16.43)
		SSW	13.30 ± 0.47 (12.37, 14.19)	15.34 ± 0.53 (14.28, 16.32)	16.55 ± 0.45 (15.62, 17.37)
		P-Value	0.036	< 0.001	< 0.001
	95th Percentile	Clim	14.08 ± 0.39 (13.25, 14.79)	15.53 ± 0.39 (14.69, 16.21)	16.98 ± 0.35 (16.23, 17.60)
		SSW	14.63 ± 0.53 (13.55, 15.58)	16.89 ± 0.59 (15.72, 17.99)	18.00 ± 0.49 (17.01, 18.89)
		P-Value	0.012	< 0.001	< 0.001

Table S6 – Same as Table S5 but for the 300–500 hPa subcolumn (upper troposphere).

Region	Statistic		Lag (days from onset)		
			0-30	30-60	60-90
North America	Median	Clim	3.34 ± 0.08 (3.20, 3.50)	3.68 ± 0.11 (3.47, 3.89)	3.96 ± 0.08 (3.78, 4.11)
		SSW	3.41 ± 0.08 (3.28, 3.58)	3.79 ± 0.10 (3.59, 3.98)	4.07 ± 0.08 (3.90, 4.22)
		P-Value	0.053	0.024	0.004
	90th Percentile	Clim	4.25 ± 0.10 (4.05, 4.44)	4.65 ± 0.11 (4.42, 4.85)	4.92 ± 0.08 (4.75, 5.05)
		SSW	4.26 ± 0.09 (4.08, 4.42)	4.69 ± 0.11 (4.47, 4.89)	4.99 ± 0.07 (4.83, 5.12)
		P-Value	0.808	0.425	0.041
	95th Percentile	Clim	4.51 ± 0.12 (4.28, 4.74)	4.98 ± 0.12 (4.72, 5.18)	5.23 ± 0.08 (5.07, 5.37)
		SSW	4.51 ± 0.09 (4.32, 4.67)	4.96 ± 0.11 (4.73, 5.17)	5.29 ± 0.08 (5.12, 5.42)
		P-Value	1.000	0.688	0.094
Europe	Median	Clim	3.53 ± 0.08 (3.38, 3.70)	3.88 ± 0.12 (3.65, 4.10)	4.23 ± 0.10 (4.01, 4.41)
		SSW	3.51 ± 0.08 (3.37, 3.68)	3.92 ± 0.11 (3.70, 4.13)	4.27 ± 0.09 (4.08, 4.43)
		P-Value	0.564	0.444	0.336
	90th Percentile	Clim	4.30 ± 0.14 (4.04, 4.57)	4.80 ± 0.13 (4.51, 5.02)	5.16 ± 0.10 (4.94, 5.33)
		SSW	4.25 ± 0.13 (4.00, 4.50)	4.78 ± 0.16 (4.45, 5.07)	5.12 ± 0.10 (4.90, 5.29)
		P-Value	0.412	0.751	0.359
	95th Percentile	Clim	4.54 ± 0.16 (4.23, 4.85)	5.07 ± 0.13 (4.77, 5.27)	5.43 ± 0.10 (5.22, 5.60)
		SSW	4.48 ± 0.15 (4.18, 4.74)	5.05 ± 0.17 (4.68, 5.33)	5.37 ± 0.10 (5.14, 5.54)
		P-Value	0.375	0.760	0.170
Asia	Median	Clim	3.16 ± 0.09 (3.01, 3.35)	3.53 ± 0.13 (3.27, 3.77)	3.90 ± 0.11 (3.66, 4.10)
		SSW	3.22 ± 0.09 (3.06, 3.39)	3.59 ± 0.11 (3.38, 3.81)	3.98 ± 0.09 (3.79, 4.15)
		P-Value	0.134	0.257	0.077
	90th Percentile	Clim	4.05 ± 0.11 (3.85, 4.27)	4.60 ± 0.18 (4.24, 4.94)	5.13 ± 0.14 (4.82, 5.37)
		SSW	4.12 ± 0.10 (3.92, 4.31)	4.65 ± 0.17 (4.32, 4.96)	5.12 ± 0.14 (4.83, 5.38)
		P-Value	0.090	0.511	0.869
	95th Percentile	Clim	4.32 ± 0.13 (4.07, 4.55)	4.97 ± 0.20 (4.56, 5.31)	5.52 ± 0.14 (5.21, 5.76)
		SSW	4.40 ± 0.12 (4.16, 4.63)	5.01 ± 0.18 (4.62, 5.32)	5.53 ± 0.15 (5.20, 5.79)
		P-Value	0.149	0.627	0.863

Table S7 – Same as Tables S5 and S6 but for the 900–1000 hPa subcolumn (PBL approximation).

Region	Statistic		Lag (days from onset)		
			0-30	**30-60**	**60-90**
North America	**Median**	**Clim**	38.08 ± 1.00 (36.25, 40.14)	42.05 ± 1.24 (39.57, 44.45)	45.25 ± 0.95 (43.22, 46.94)
		SSW	38.39 ± 0.99 (36.57, 40.37)	43.13 ± 1.17 (40.80, 45.40)	46.45 ± 0.77 (44.87, 47.85)
		P-Value	0.473	0.049	0.004
	90th Percentile	**Clim**	50.32 ± 1.25 (47.92, 52.78)	55.12 ± 1.33 (52.27, 57.47)	58.30 ± 0.93 (56.24, 59.87)
		SSW	50.43 ± 1.27 (48.00, 52.84)	55.64 ± 1.35 (52.84, 58.06)	59.01 ± 0.88 (57.09, 60.53)
		P-Value	0.840	0.374	0.081
	95th Percentile	**Clim**	53.41 ± 1.45 (50.60, 56.18)	58.64 ± 1.47 (55.69, 61.33)	62.30 ± 0.94 (60.19, 63.88)
		SSW	53.47 ± 1.42 (50.58, 56.07)	59.05 ± 1.38 (56.06, 61.49)	62.84 ± 0.91 (60.87, 64.39)
		P-Value	0.923	0.508	0.186
Europe	**Median**	**Clim**	41.09 ± 1.01 (39.30, 43.19)	45.31 ± 1.43 (42.42, 48.00)	49.21 ± 1.13 (46.87, 51.25)
		SSW	40.90 ± 0.95 (39.22, 42.93)	45.57 ± 1.27 (43.12, 48.08)	49.63 ± 0.94 (47.62, 51.24)
		P-Value	0.654	0.645	0.355
	90th Percentile	**Clim**	50.54 ± 1.39 (47.80, 53.15)	56.00 ± 1.52 (52.76, 58.71)	60.27 ± 1.01 (57.92, 61.94)
		SSW	50.52 ± 1.63 (47.52, 53.74)	55.97 ± 1.58 (52.74, 58.87)	60.01 ± 0.99 (57.84, 61.69)
		P-Value	0.976	0.964	0.549
	95th Percentile	**Clim**	53.14 ± 1.51 (50.03, 55.92)	59.04 ± 1.55 (55.59, 61.71)	63.35 ± 1.08 (61.03, 65.27)
		SSW	53.28 ± 1.86 (49.49, 56.56)	59.04 ± 1.70 (55.40, 61.90)	62.86 ± 1.02 (60.66, 64.71)
		P-Value	0.848	1.000	0.287
Asia	**Median**	**Clim**	34.47 ± 1.25 (33.22, 38.03)	40.80 ± 1.78 (37.28, 44.24)	45.81 ± 1.34 (42.87, 48.16)
		SSW	35.95 ± 1.13 (32.77, 38.18)	41.49 ± 1.65 (38.21, 44.63)	46.43 ± 1.25 (43.75, 48.72)
		P-Value	0.009	0.357	0.275
	90th Percentile	**Clim**	50.18 ± 1.27 (47.83, 52.76)	56.87 ± 2.20 (52.50, 61.10)	63.49 ± 1.72 (59.73, 66.48)
		SSW	50.96 ± 1.25 (48.49, 53.39)	57.66 ± 1.96 (53.64, 61.29)	63.73 ± 1.88 (59.90, 67.24)
		P-Value	0.162	0.385	0.758
	95th Percentile	**Clim**	54.53 ± 1.53 (51.61, 57.49)	62.35 ± 2.38 (57.44, 66.76)	69.37 ± 1.74 (65.48, 72.29)
		SSW	55.38 ± 1.52 (52.46, 58.36)	63.02 ± 2.14 (58.51, 66.91)	69.91 ± 2.03 (65.53, 73.49)
		P-Value	0.206	0.496	0.511

Table S8 – Same as Tables S5–7 but for the model surface level.