



Supplement of

Secondary ozone peaks in the troposphere over the Himalayas

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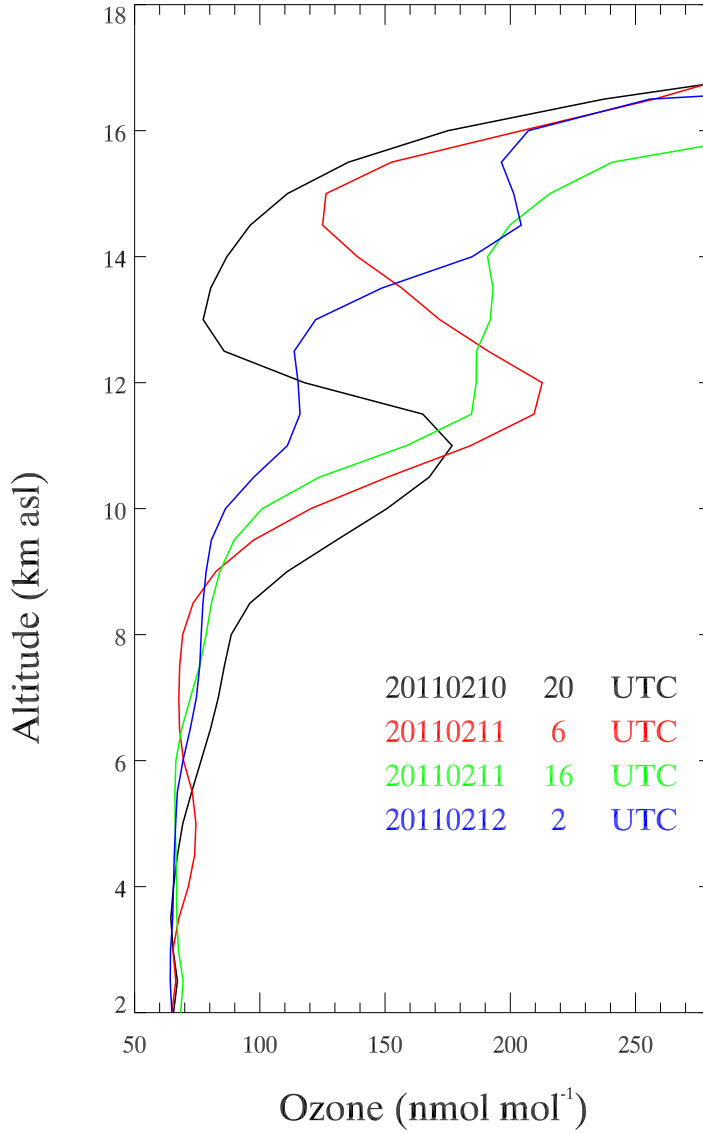


Figure S1: EMAC simulated time-evolution of ozone vertical profiles at each model time step during 10–12 Feb 2011.

Table S1: A comparison of average PV values at 10.5 km (peak of PV profiles during SOPs (Supplementary material-Fig.2) between SOP timesteps and No-SOP timesteps derived from the EMAC model over Nainital during 2000–2014.

SOPs			NO-SOPs	
Season	PV(PVU)	Counts	PV(PVU)	Counts
DJF	3.0±1.3	91	1.5±1.3	3159
MAM	2.6±1.1	286	1.4±1.0	3025
JJA	1.8±0.5	13	0.3±0.2	3302
SON	2.8±0.9	5	0.8±0.8	3269

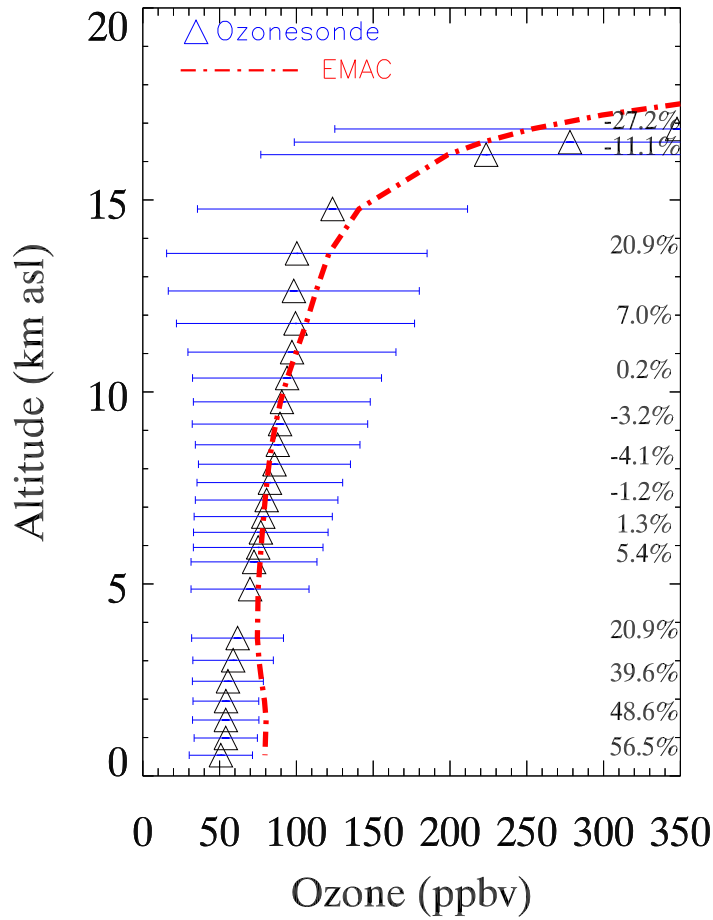


Figure S2: Comparison of ozone climatology over Delhi derived from ozonesonde observations and EMAC simulations for the period 2000-2009. The difference between model and observation in percentage is also indicated. Ozonesonde observations at Delhi conducted by Indian Meteorological Department (IMD) were obtained from the WUOUC database.

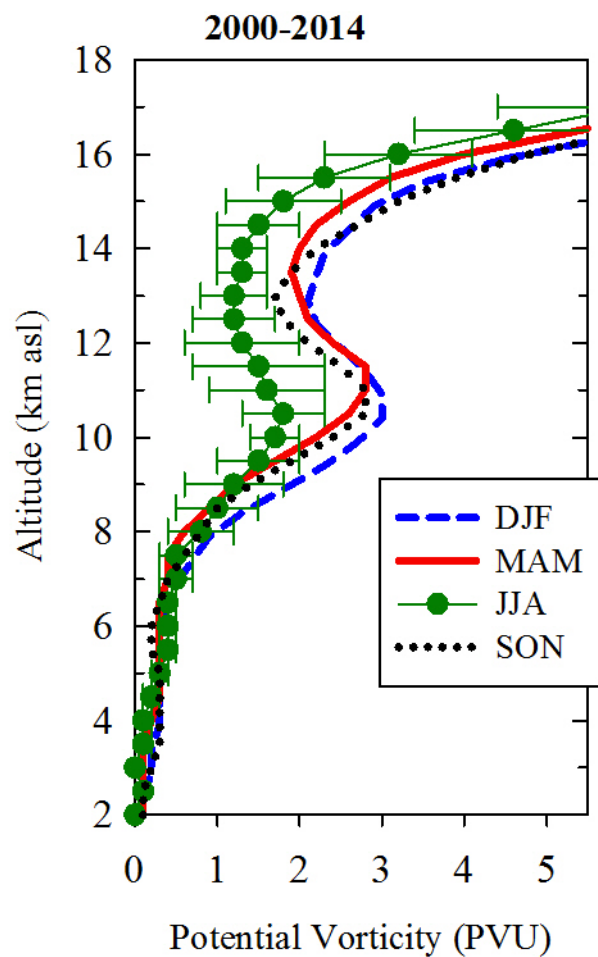


Figure S3: Average vertical profiles of EMAC derived Potential Vorticity (PV) during the SOPs over Nainital aggregated into four seasons: DJF (Winter), MAM (Spring/ pre-monsoon), JJA (summer monsoon), and SON (autumn) for the period 2000–2014.

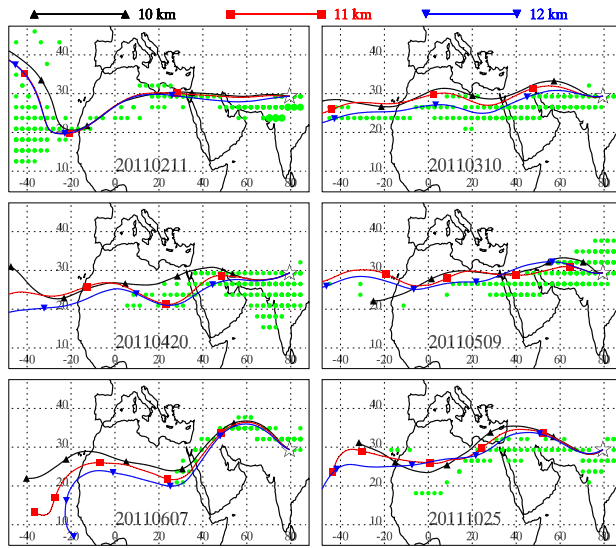


Figure S4: 5-days backward air trajectories over Nainital for all events, with starting altitude of 10, 11 and 12 km. The difference between symbols on trajectories represent a time period of 1 day. The locations of tropopause folds during this period of air mass transport, obtained from EMAC simulations are also shown. The location of Nainital site is shown by the star symbol. Small green circles represent shallow tropopause folds and bigger green circles (such as on 11thFeb) represent medium tropopause folds.

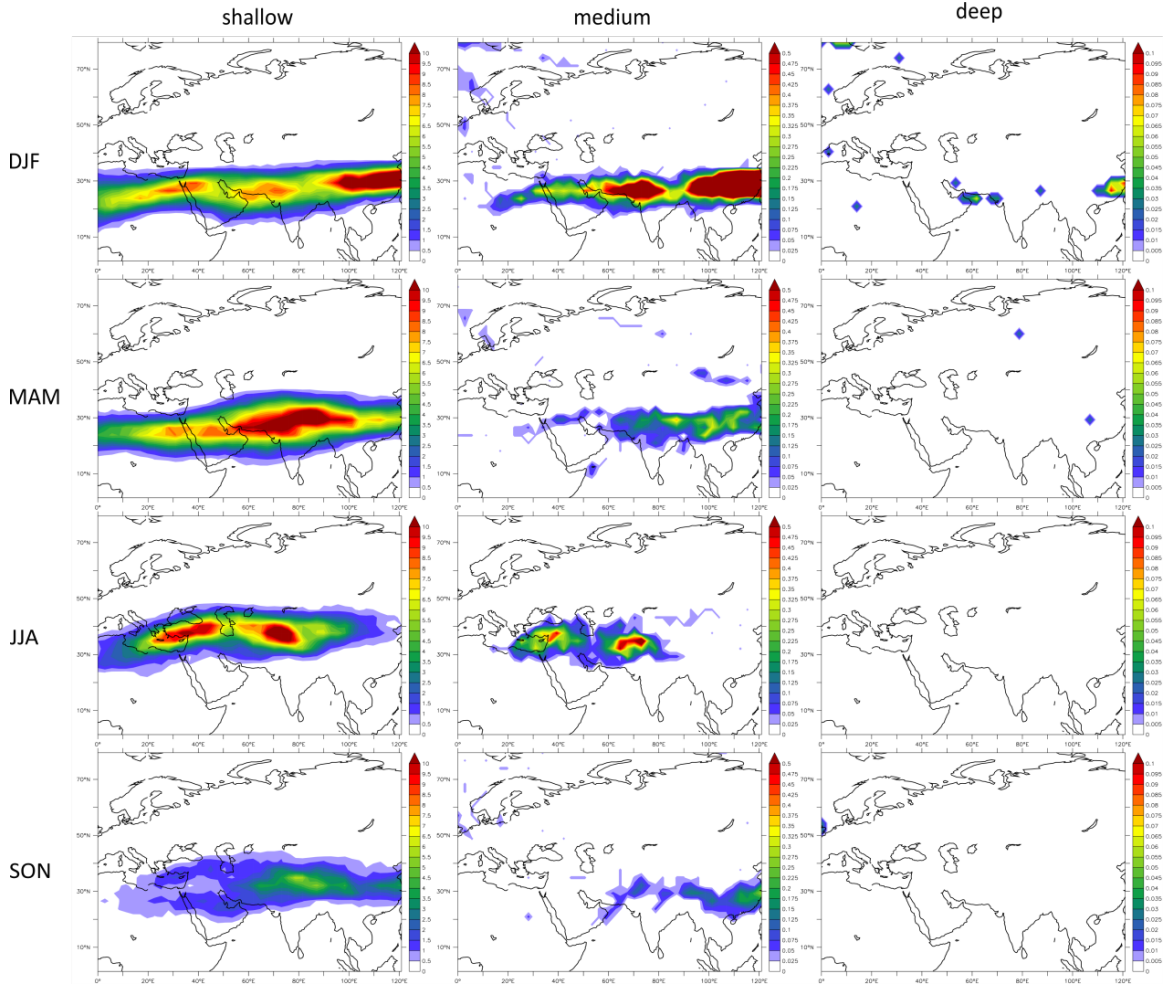


Figure S5: Mean seasonal climatology of shallow, medium and deep tropopause fold frequencies (%) over the period of 2000–2014 derived from EMAC simulations.

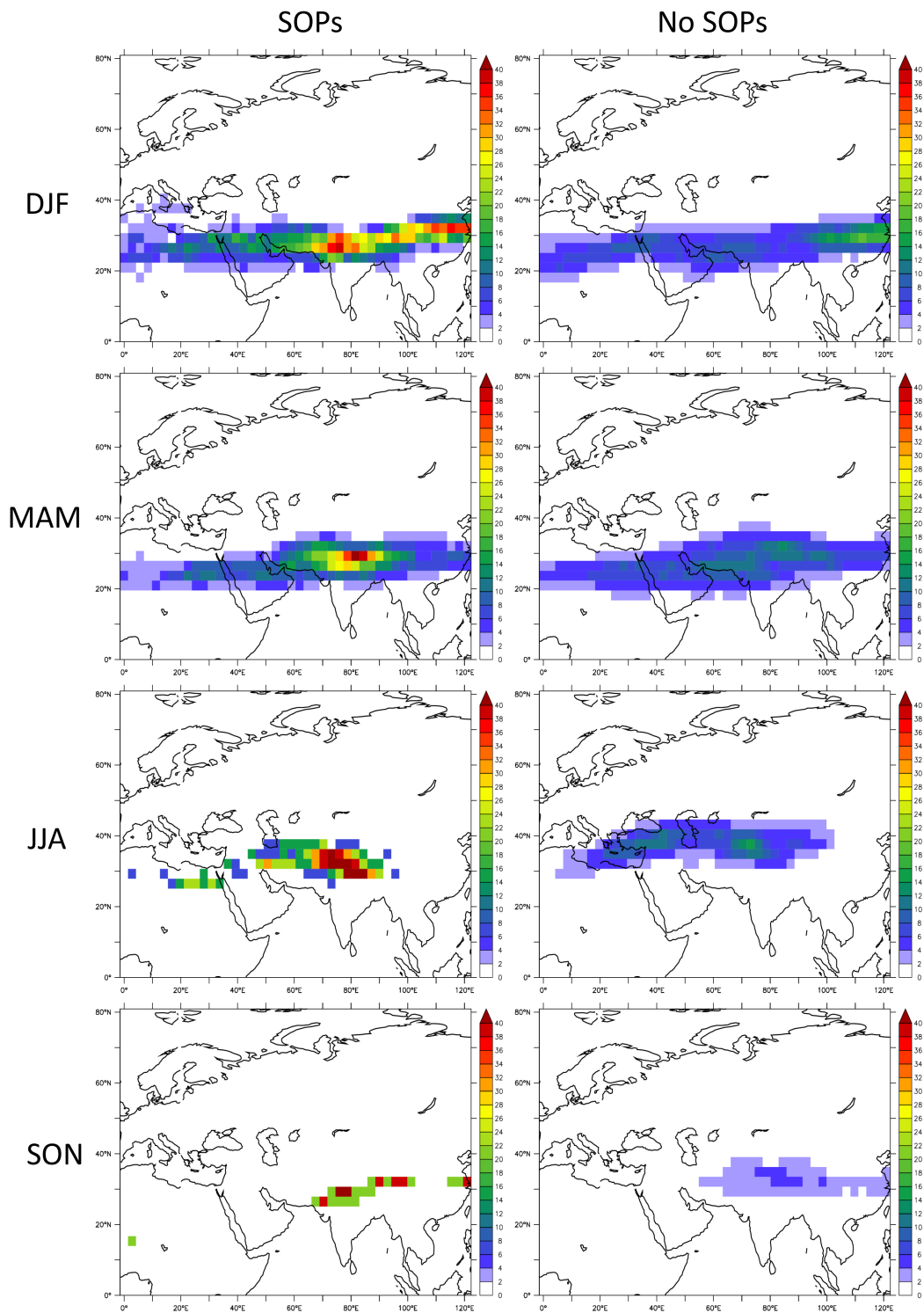


Figure S6: Seasonal composites of total fold (shallow+medium+deep) frequencies during SOPs and no SOPs over the period 2000-2014. For each season, the frequencies are calculated as the number of fold occurrences (shallow or medium or deep) in a grid point during the SOP (no SOP) events over the total number of SOP (no SOP) events.

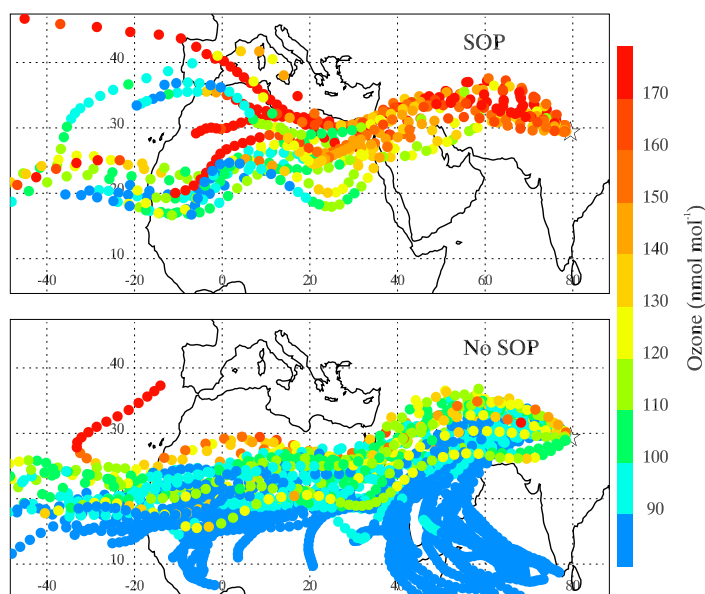


Figure S7: EMAC simulated evolution of O_3 along 5-days backward air trajectories over Nainital during SOPs and No SOPs with starting altitude of 11 km for the month May 2002. The difference between symbols on trajectories represent a time period of 3h. The location of Nainital site is shown by the star symbol.

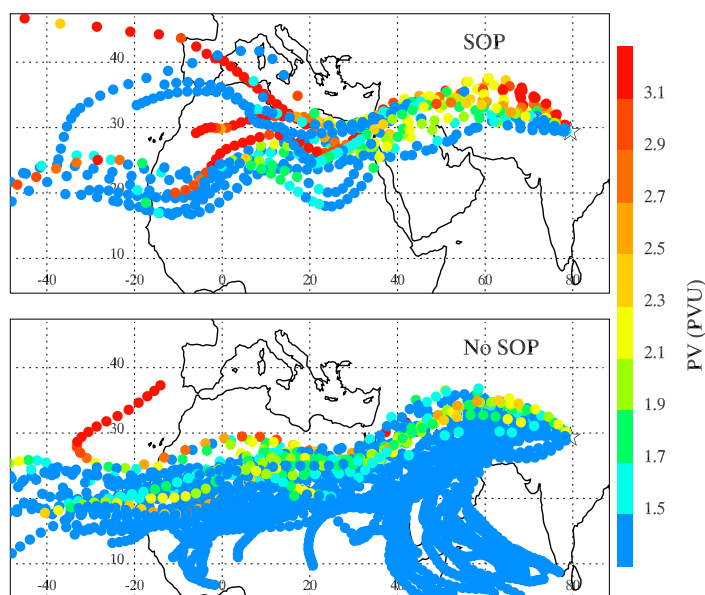


Figure S8: EMAC simulated evolution of Potential Vorticity (PV in PVU) along 5-days backward air trajectories over Nainital during SOPs and No SOPs with starting altitude of 11 km for the month May 2002. The difference between symbols on trajectories represent a time period of 3h. The location of Nainital site is shown by the star symbol.

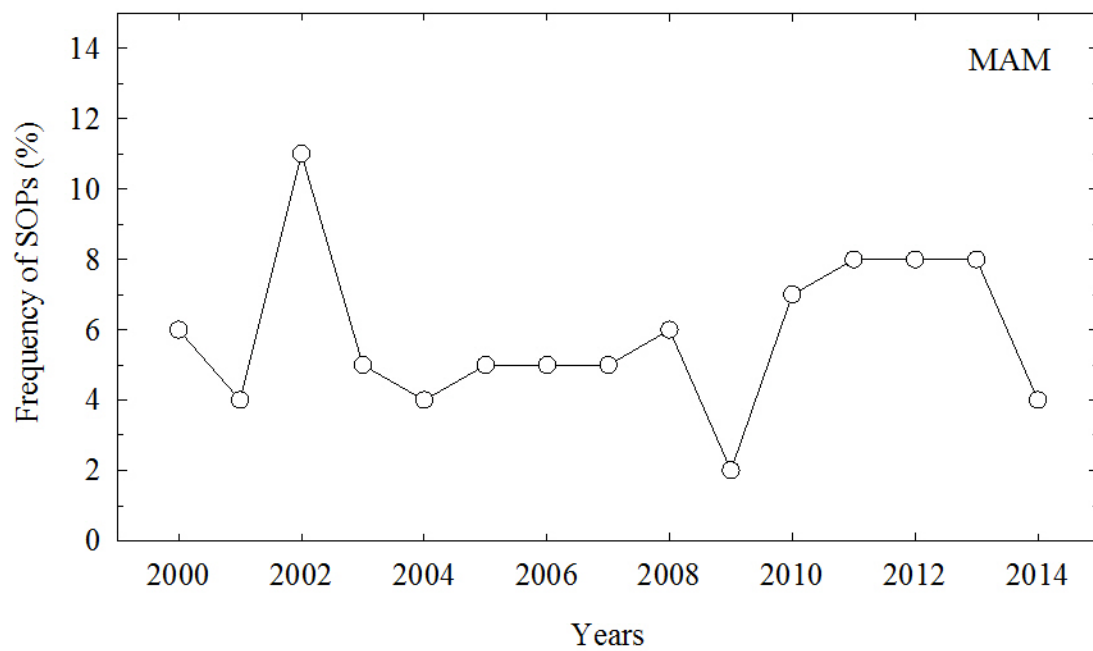


Figure S9: EMAC derived long-term trend in the frequency of SOP events (% of the times) for spring/pre-monsoon season (MAM) over Nainital for the period 2000–2014.