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Supplement of

Quantifying stratospheric ozone trends over 1984–2020: a comparison of ordinary and regularized multivariate regression models

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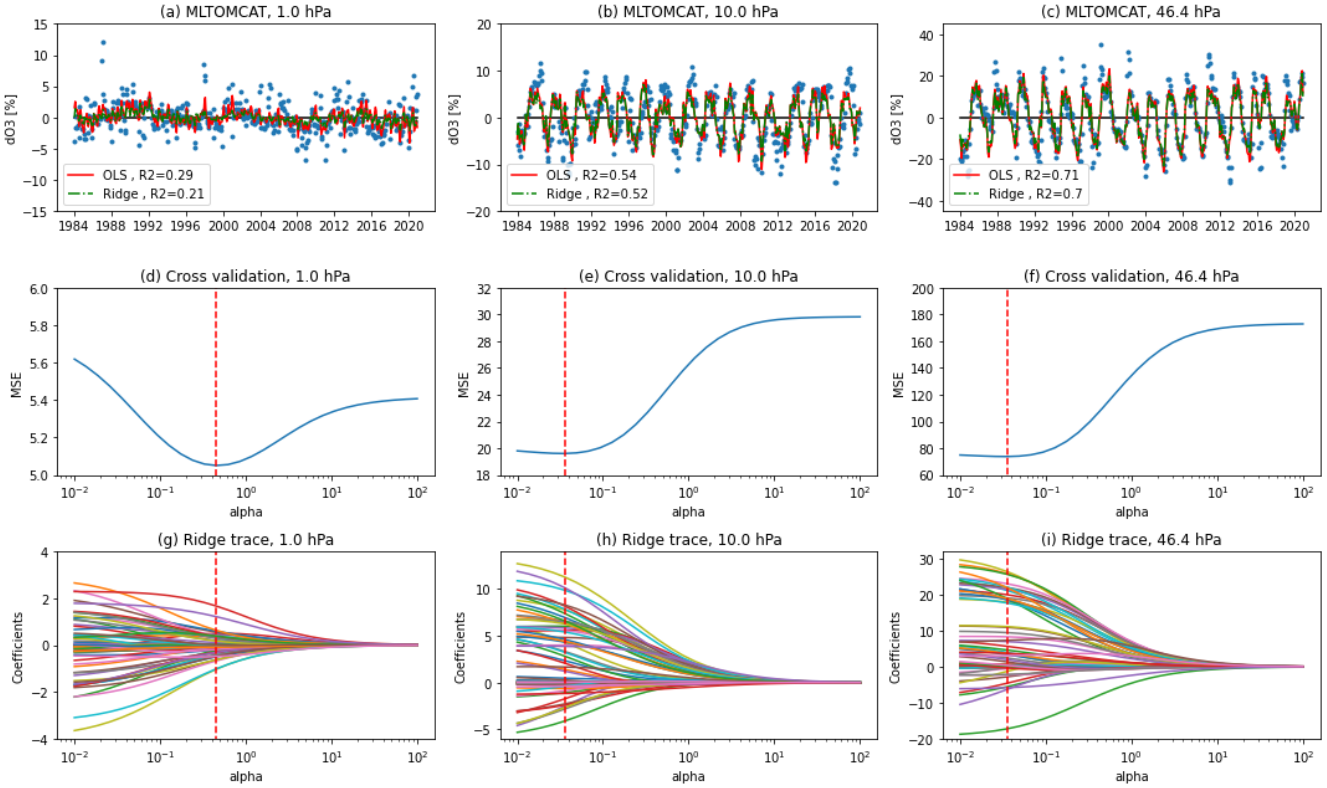

Figure S1: (a-c) Monthly ozone anomalies (blue dots) and the OLS (red line) and Ridge fitting (green dot-dashed line) from ML-TOMCAT data during 1984-2020 at the pressure levels of 1 hPa (left column), 10 hPa (middle column) and 46.4 hPa (right column) for the 1 °N latitude. (d-f) Cross-validated MSE values as well as (g-i) Ridge regression trace of the coefficients that change with alpha (α) are also shown. The vertical red dashed line indicates the optimal tuning value (α_0) for Ridge regression where MSE is minimum.

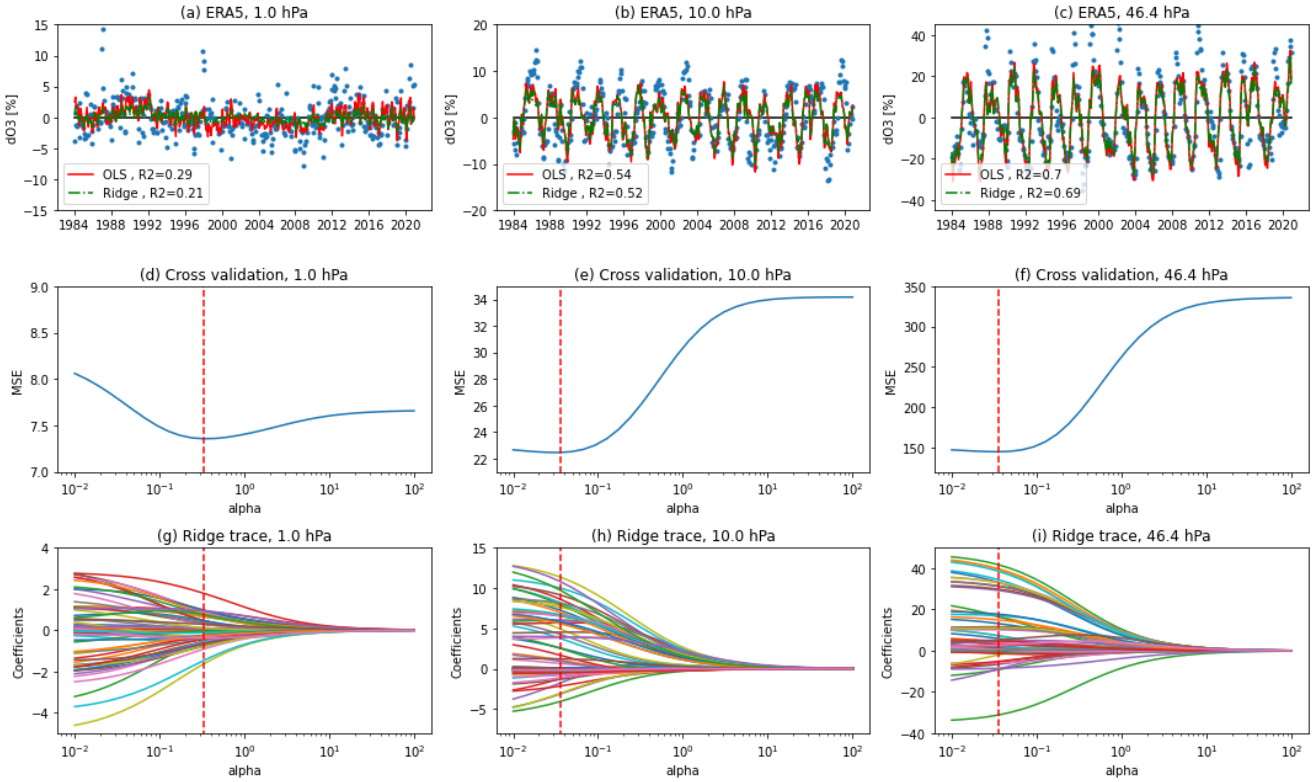

Figure S2: Same as Figure S1 but for simulation ERA5 during 1984-2020.

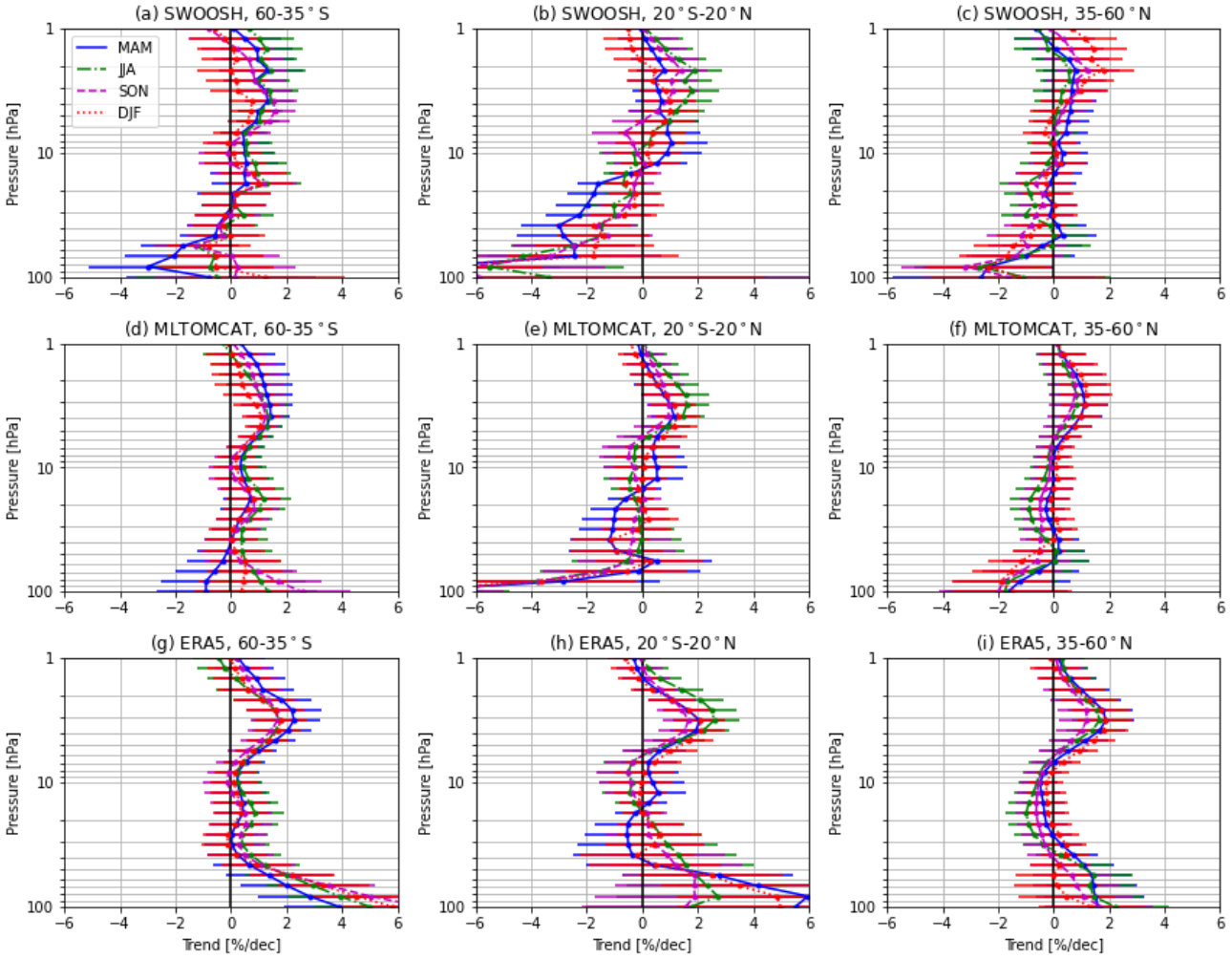

Figure S3: Profiles of seasonal ozone trends (blue for MAM, green for JJA, magenta for SON, and red for DJF) during post-1998 time periods from (a-c) SWOOSH, (d-f) ML-TOMCAT and (g-i) simulation ERA5 averaged over three latitude bands (60-35°S, 20°S-20°N, 35-60°N) based on the Ridge regression method. Error bars are 2-σ uncertainties.

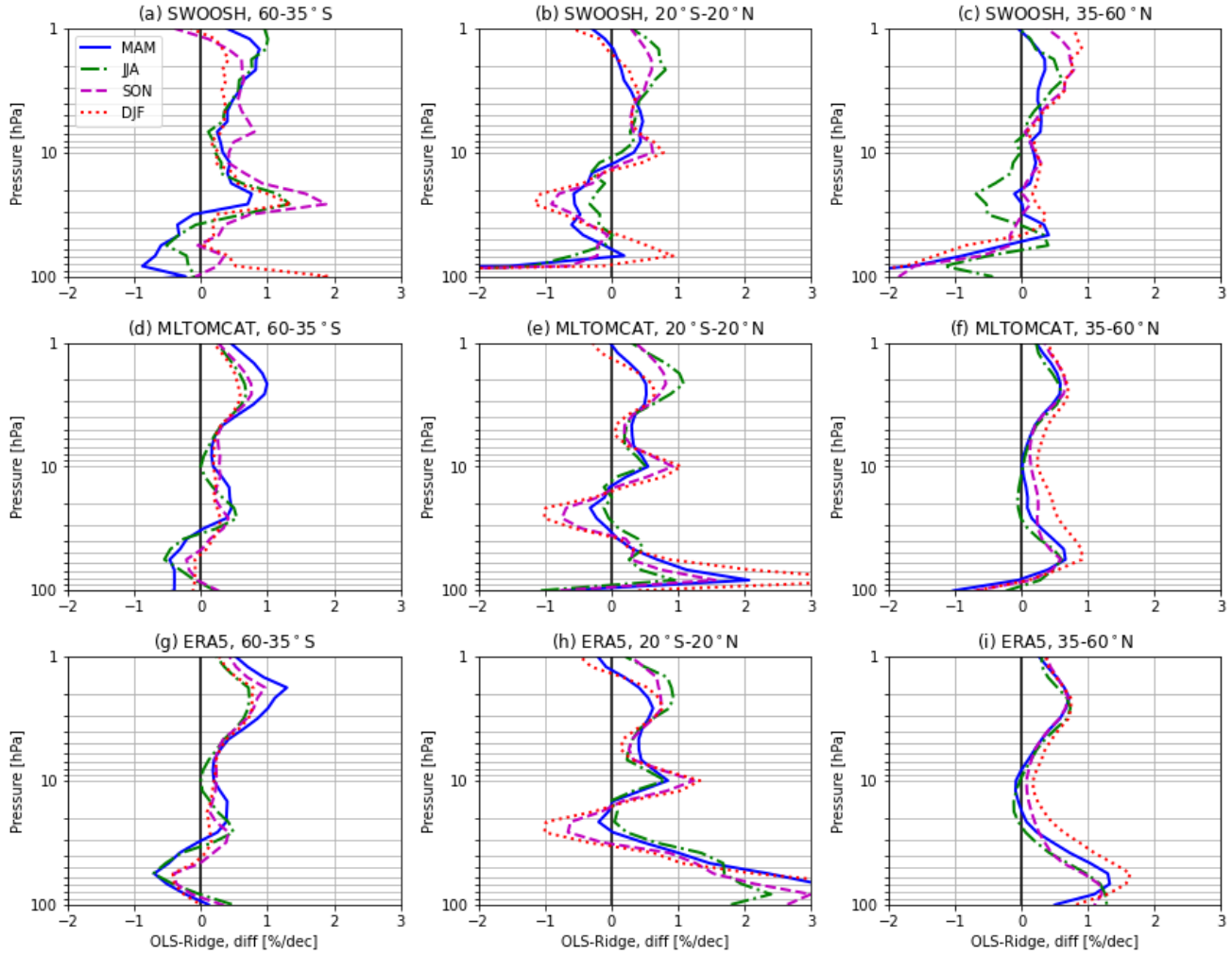

Figure S4: OLS-Ridge Differences of seasonal ozone trends (blue for MAM, green for JJA, magenta for SON, red for DJF) between OLS and Ridge regression methods averaged over three latitude bands (60-35°S, 20°S-20°N, 35-60°N) from (a-c) SWOOSH, (d-f) ML-TOMCAT and (g-i) simulation ERA5 during post-1998 time periods.

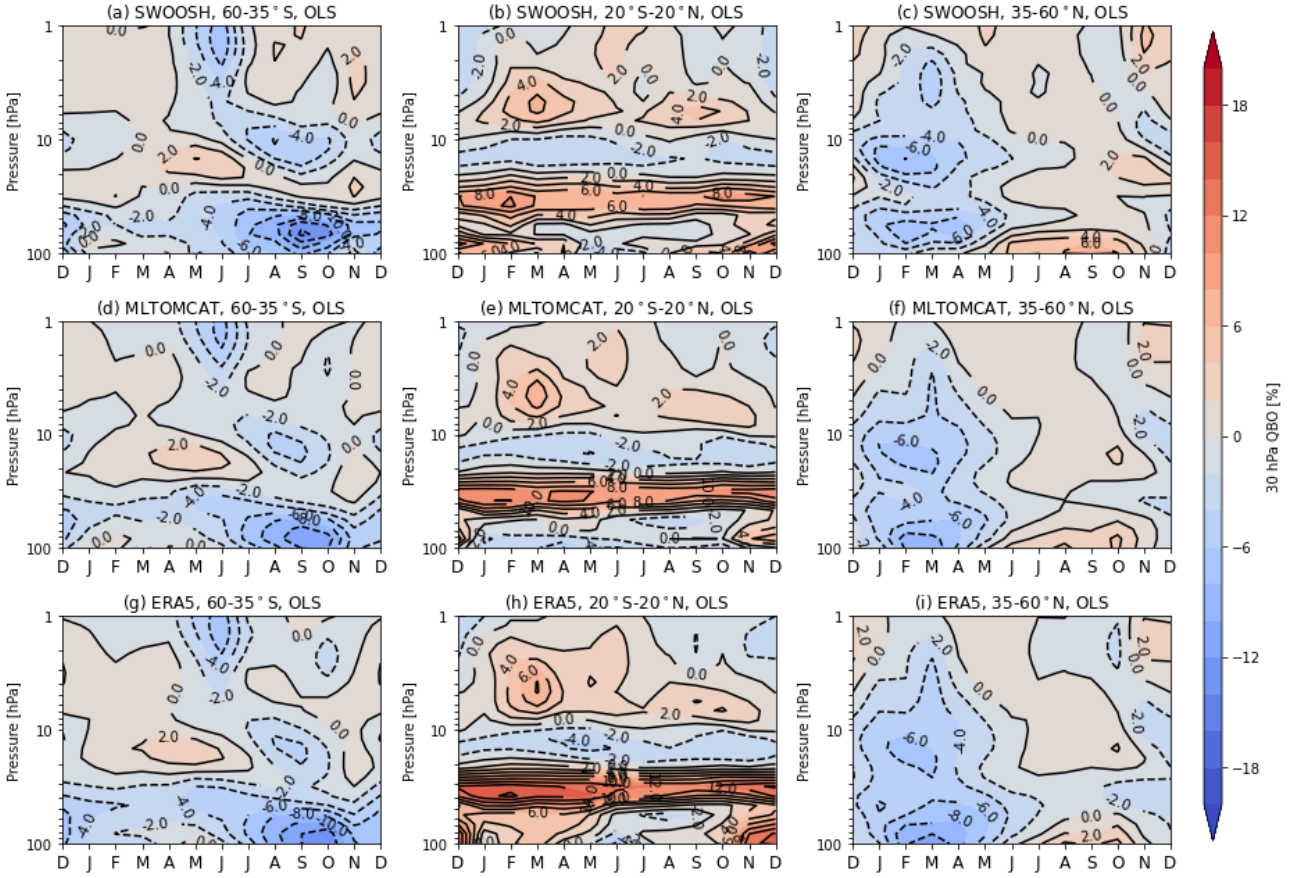

Figure S5: Pressure-season variation of the 30 hPa QBO response in ozone (%) from (a-c) SWOOSH, (d-f) ML-TOMCAT and (g-i) simulation ERA5 for three selected latitudinal bands (60-35°S, 20° S-20°N, 35-60°N) based on the OLS regression method.

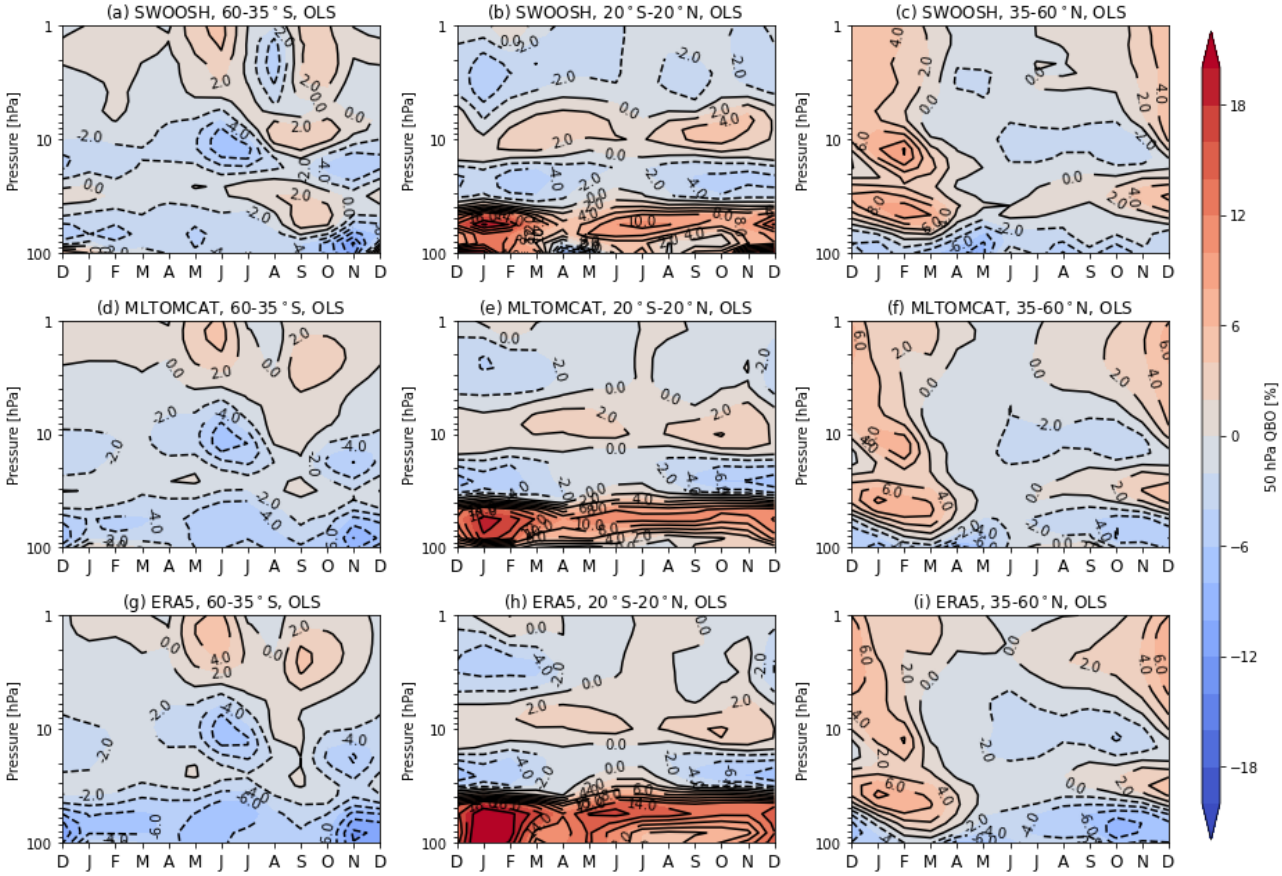

Figure S6: Same as Figure S5 but for the 50 hPa QBO response in ozone (%).

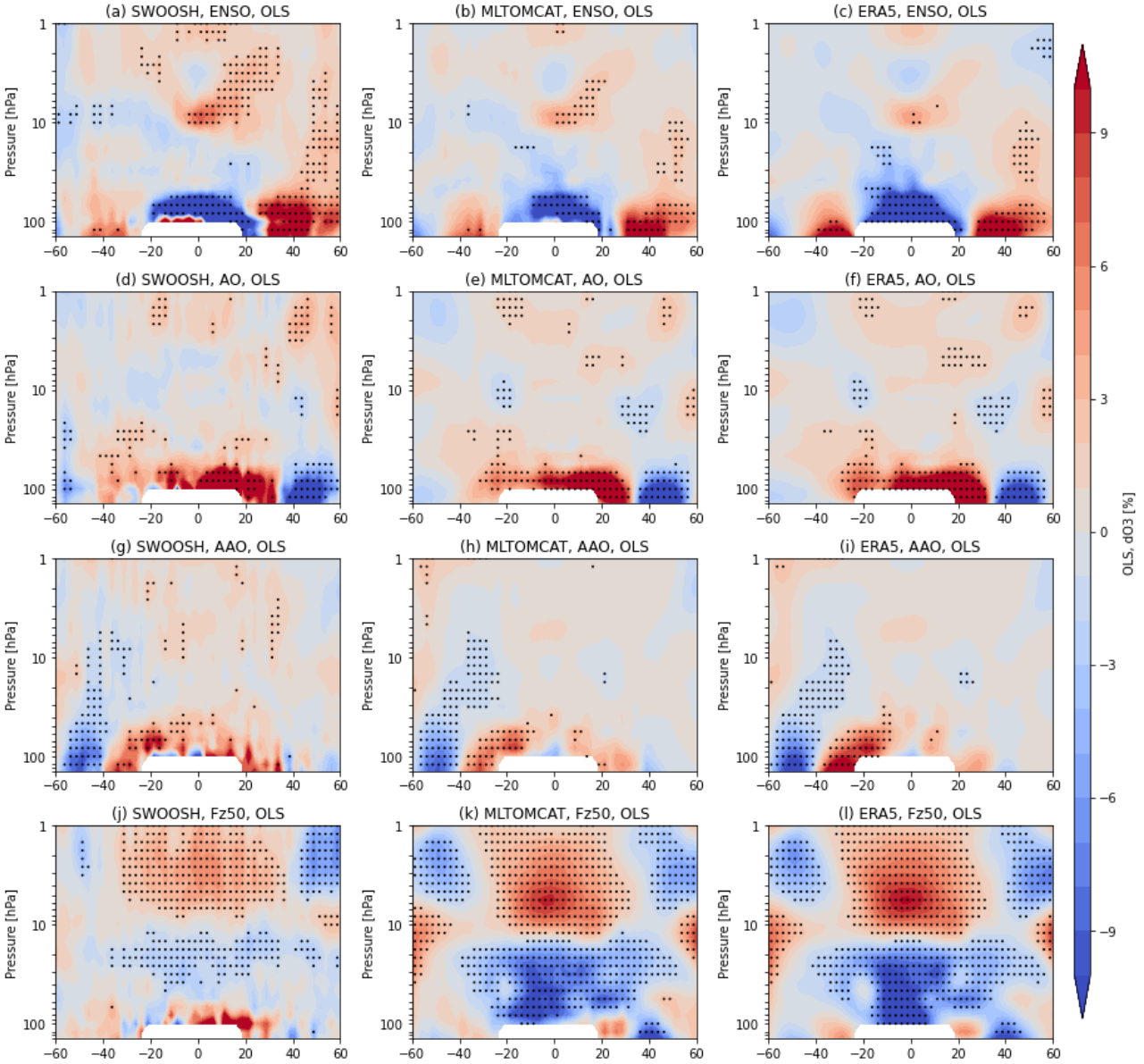

Figure S7: Pressure-latitude cross sections of the natural ozone variations (%) associated with (a-c) ENSO, (d-f) AO, (g-i) AAO and (j-l) EP flux (Fz50) derived from SWOOSH, ML-TOMCAT, and TOMCAT simulation ERA5 based on the OLS regression method. The stippling indicates regions that are significant at the 95 % level.