Stratospheric Ozone Interannual Variability Measured by Lidar at Mauna Loa and Table Mountain

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Two Jet Propulsion Laboratory lidars, one at the Mauna Loa Observatory, Hawaii (MLO, 19.5°N, 155.6°W) and one at the Table Mountain Facility (TMF, California (34.5°N, 117.7°W), have been measuring vertical profiles of stratospheric ozone routinely since the early 1990's. Multi-linear regression analysis was performed on the deseasonalized monthly mean lidar ozone time series (from -2 ppmv to 4 ppmv) for each 1 km-altitude bin between 18 and 46 km from January 1995 to December 2010 (a period of low volcanic aerosol loading). We have selected interannual and annual components representing the 11-year solar cycle (SC), El Nino Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO), the Eliassen-Palm flux (EPf), horizontal and vertical transport, and a linear trend. Noise sensitivity on the regression model has been tested. Increasing the noise fraction on the original time series gives a limit beyond which the model becomes purely mathematical. For each station, proxies were chosen by a backward elimination method, and eventually selected if the percentage of variance exceed 5%. For both stations, the explained variances from the regression fit are between 40% and 80%. At MLO, a nearly-tropical site, the analysis revealed the dominance of the QBO (-1 ppmv to 1 ppmv), a strong positive springtime signature of the solar cycle and ENSO and a strong negative wintertime signature of the horizontal transport (~0.2 ppmv/indice). Linear trends obtained are between -0.2% and 0.5% per decade. The explained variance for the TMF time-series revealed a mixed influence of each proxy on each side of the ozone maximum altitude with a strong seasonal dependence, typical of mid-latitudes. The use of a mid-latitude Ozone Depleting Gas Index for TMF instead of the classical trend proxy increased the explained variance by 15% above 30 km and 9% below while reducing statistical error and increasing trends. Statistically significant maxima (~0.2 ppmv/indices) were found at 27 km in the annual response to SC, Ozone Depleting Gas Index (ODGI), ENSO and at 37 km for EPf. Higher maxima were found at 42 km in the annual response to Solar Cycle. QBO response is out-of-phase compared to MLOs. Trends are negative below 25 km (down to -0.5%) and positive above, reaching 1.5% with a linear proxy and 4% with the ODGI index at 42 km

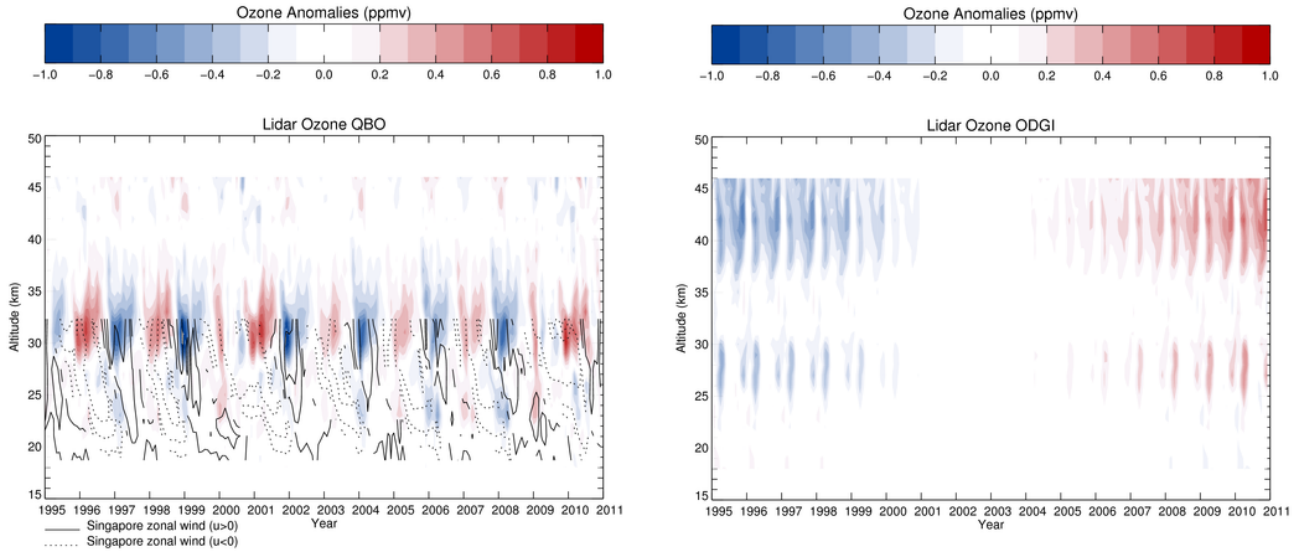

Figure 1. LIDAR ozone response time series (ppmv) versus altitude. Left: response to QBO at MLO. Right: response to ODGI at TMF.