

Long-term variabilities and tendencies in zonal mean TIMED–SABER ozone and temperature in the middle atmosphere at 10–15°N

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Long-term variabilities and trends of middle atmospheric (20–100 km) ozone volume mixing ratio (OVMR) and temperature and their responses towards quasi-biennial oscillation (QBO), solar cycle (SC) and ElNiño-southern oscillation (ENSO) have been investigated using monthly averaged zonal mean Sounding of Atmosphere by Broad-band Emission Radiometry (SABER) observations at 10–15°N for the years 2002–2012. Composite monthly mean of OVMR shows semi-annual oscillation (SAO) predominantly in the lower stratosphere (20–30 km) and in the upper mesosphere (above 90 km), whereas that of temperature shows SAO in the upper stratosphere (45–55 km) and lower mesosphere (60–75 km).

Amplitudes of SAO and annual oscillation (AO) in OVMR show enhancement above 80 km and 90 km respectively in the mesosphere and both show maximum around 30 km in the stratosphere. The amplitudes of SAO and AO in temperature show maxima just below and above 80 km in the mesosphere, whereas in the stratosphere, they show maxima around 40 km and 20 km respectively. The phase profiles of SAO and AO in temperature show downward progressions below 80 km, whereas the phase profile of SAO in OVMR shows downward progression only below 40 km and the phase remains constant above 80 km. Regression analysis of OVMR shows increasing trend at 23 km, and small decreasing trend at 30 km, 34 km and above 80 km. Above 92 km, the trend sharply decreases. OVMR response to QBO winds at 30 hPa shows negative maxima at 30 km and 91 km, positive maximum at 26 km and is insignificant at other heights. The OVMR response to SC is positive in the middle stratosphere peaking at 31 km and in the upper mesosphere peaking at 95 km. The OVMR response to ENSO shows mixed behavior in stratosphere and positive in the upper mesosphere. It is positive in the lower height region 20–27 km with maximum at 25 km. The response to ENSO is insignificant up to 70 km and it is positive above 80 km with two maxima at 87 km and 97 km. Regression analysis of temperature shows cooling trends in most of the stratosphere and the mesosphere (40–90 km). The temperature response to SC is increasingly positive above 40 km. The temperature response to ENSO is negative in the middle stratosphere and positive in the lower and upper stratosphere. In mesosphere, it is largely negative in the height range 60–80 km and positive above 80 km.