SHADOZ Temperature and Ozone Anomalies Associated with QBO and ENSO

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Abstract

Temperature and ozone profiles from SHADOZ (1998-2005) radiosondes and ozonesonde soundings are analyzed. Principal components of the ozone profile time series at Kuala Lumpur (3N, 101E) are adopted as a stratospheric QBO index to study tropospheric temperature and ozone signatures associated with the QBO. A downward propagating QBO ozone signal extends to the mid-troposphere. The maximum tropospheric ozone anomalies associated with the QBO are ~8 ppbv, about 10-20% of that of typical tropical tropospheric ozone values.

Temperature and ozone fields, linearly regressed against the QBO index, suggest that dynamical processes, including horizontal transport, play an important role for the observed tropospheric ozone anomalies. Temperature profiles, regressed against the Southern Oscillation Index (SOI), reveal anomalously cool, but also wavy lower stratospheric temperature anomalies. Tropospheric ozone profiles associated with the SOI show a statistically significant signal that is consistent with anomalous vertical motions that are known to occur during ENSO.

Data

The SHADOZ (Southern Hemisphere Additional Ozonesondes) network has collected over 4000 profiles over 14 stations from 1998-2007 (Thompson et al., 2003). The ozone measurement is made with electrochemical concentration cell ozonesondes (precision is 5-7%). Temperature and pressure are recorded by standard radiosondes from Vaisala at all sites except Ascension and Natal, where Sippican instruments are used. These data are archived at http://croc.gsfc.nasa.gov/shadoz.

EOF analysis

1. The first two principal components of the ozone profiles from the SHADOZ (1998-2005) program are shown to be a viable QBO index. The combined fractional variance of the first two EOFs exceeds 90% for all four sites examined in this study.

2. The maximum tropospheric ozone anomalies associated with the QBO are ~8 ppbv, about 10-20% of typical tropospheric ozone values.

3. Temperature regression based on the inverted SOI confirms the tropospheric warming and stratospheric cooling associated with the ENSO. In addition, the UT/LS region reveals a wavy structure, implying a possible role by vertically propagating tropical waves in the UT/LS.

Conclusions

1. The first two principal components of the ozone profiles from the SHADOZ (1998-2005) program are shown to be a viable QBO index. The combined fractional variance of the first two EOFs exceeds 90% for all four sites examined in this study.

2. The maximum tropospheric ozone anomalies associated with the QBO are ~8 ppbv, about 10-20% of typical tropospheric ozone values.

3. Temperature regression based on the inverted SOI confirms the tropospheric warming and stratospheric cooling associated with the ENSO. In addition, the UT/LS region reveals a wavy structure, implying a possible role by vertically propagating tropical waves in the UT/LS.

4. In Nairobi and Kuala Lumpur, the temperature response to the ENSO reflects the aggregated effect of interannual time-scale processes.

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