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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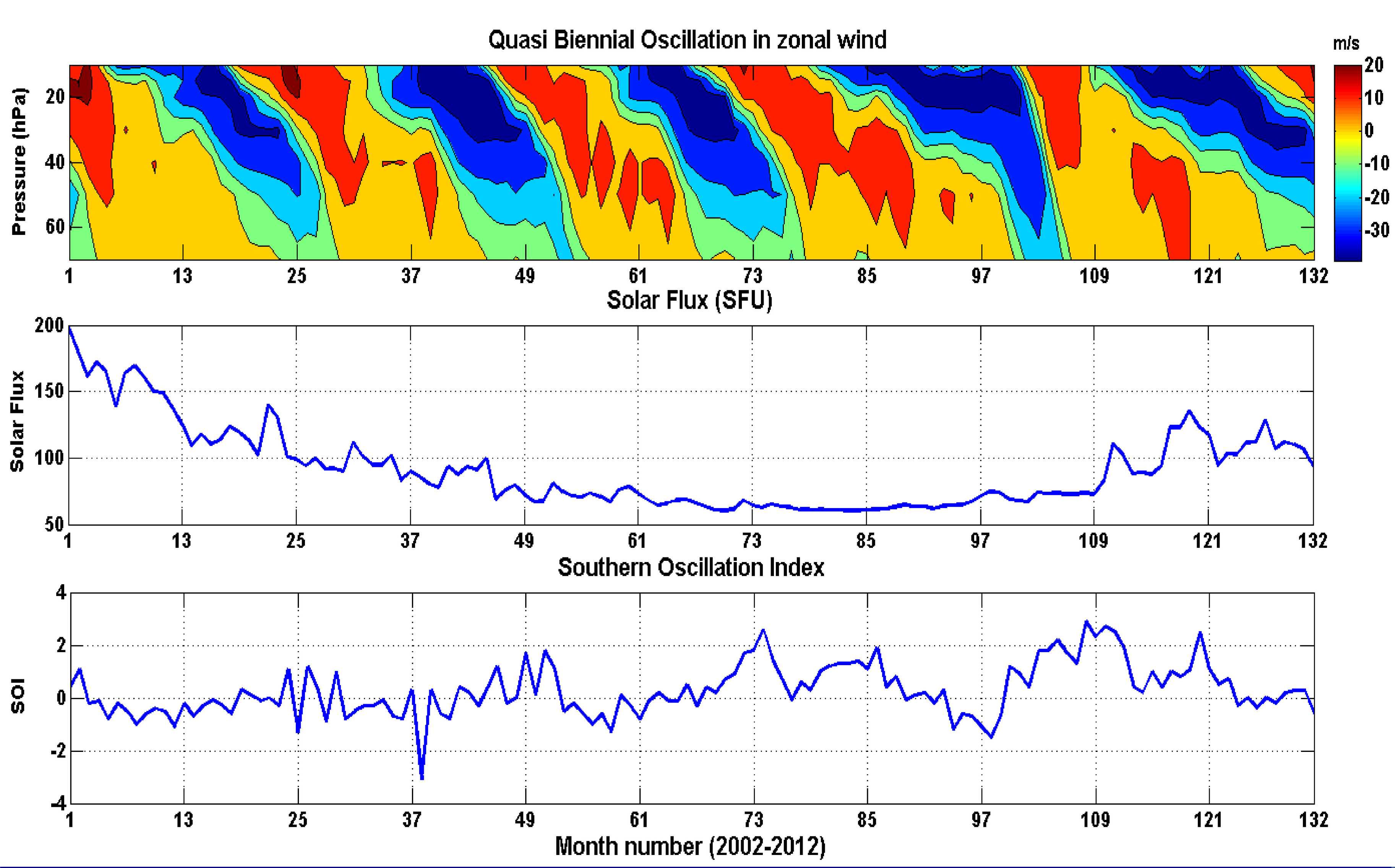
Abstract

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 El Niño-southern oscillation(ENSO) have been investigated using monthly averaged zonal mean Sounding of Atmosphere by Broadband Emission Radiometry (SABER) observations at 10–15°N for the years 2002–2012.

1.Introduction

Interannual variability of middle atmospheric temperature and composition are mainly influenced by the major natural forcings namely quasi-biennial oscillation, 11 year solar cycle and ENSO (El niño-Southern Oscillation).



Data set: Singapore monthly mean QBO zonal winds (m/s) at 30 hPa as QBO_1, differences in QBO zonal winds between 70 hPa and 10 hPa as QBO_2 proxy, F10.7 solar radio flux as solar proxy and Southern Oscillation Index (which is the normalized Tahiti [18˚S,150˚W] minus Darwin [13˚S,131˚E] monthly-mean sea-level pressure [hPa]) as the ENSO proxy

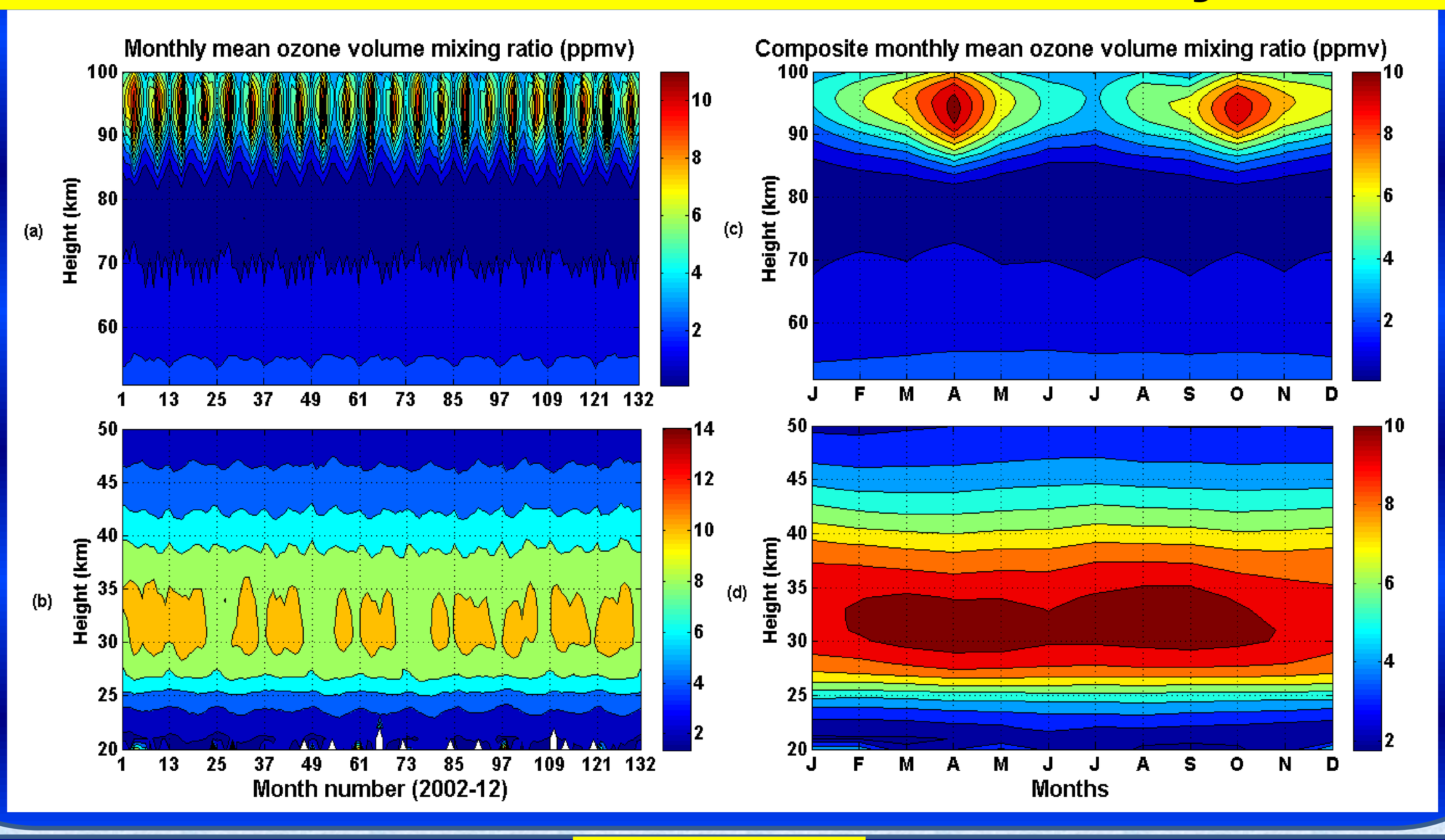
The regression model used for this study is given by(influenced by Randel and Cobb, 1994):

$$T(t)=\alpha(t)+\beta(t)t+\gamma_1(t)QBO_1(t)+\gamma_2(t)QBO_2(t)+\delta(t)solar(t)+\varepsilon(t)ENSO(t)+resid(t)$$

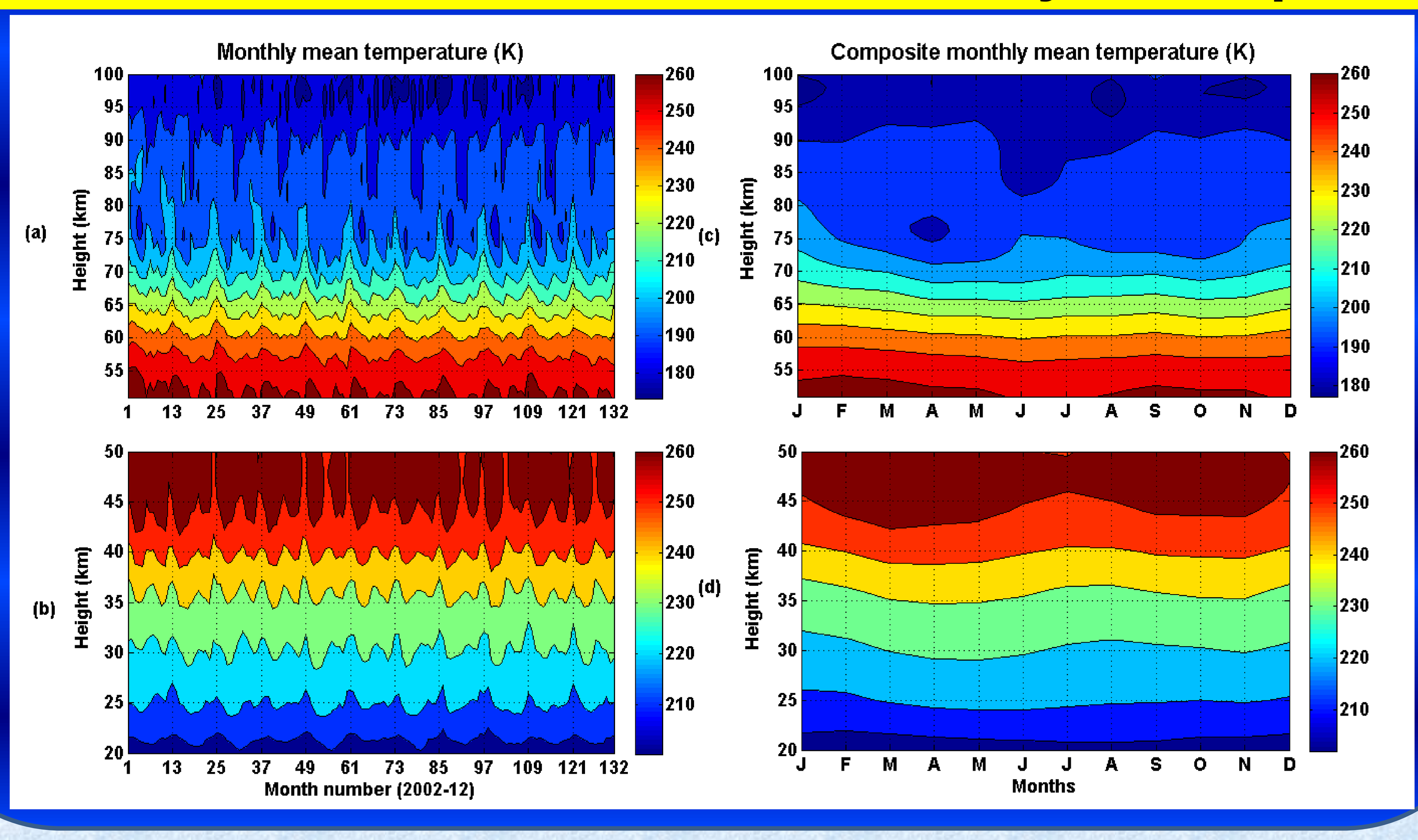
$$\alpha(t)=A_0+\sum_{i=2}^{12}[A_i\cos\omega_i t+B_i\sin\omega_i t]$$

$$\omega_i=\frac{2\pi i}{24}$$

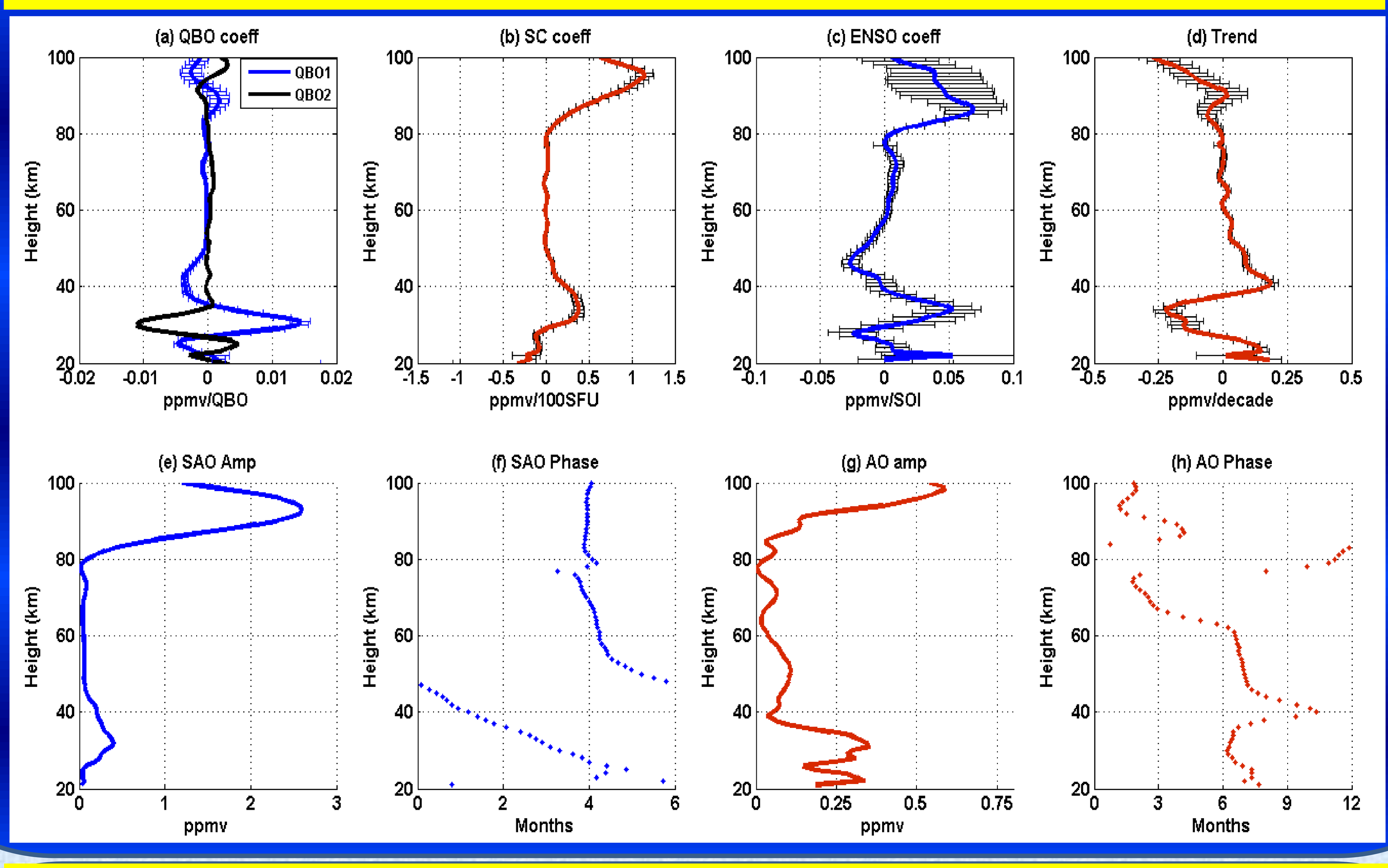
2.1 Interannual & Intra-annual variability of ozone



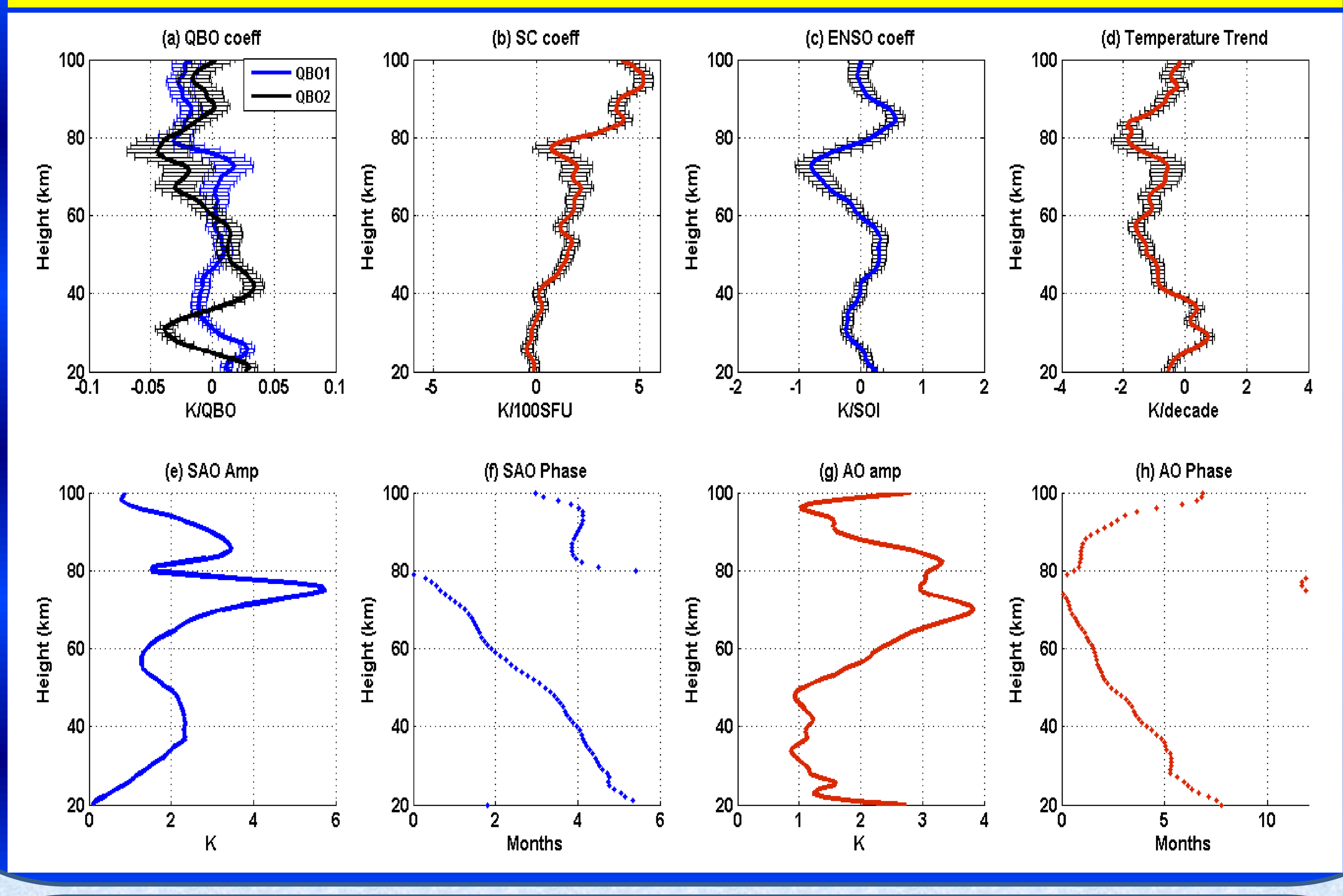
2.2 Interannual & Intra-annual variability of temperature



2.3 Ozone trend and its response to QBO,SC & ENSO



2.4 Temperature trend and its response to QBO,SC & ENSO



3.Conclusions

- OVMR response to solar cycle is highly positive in the upper mesosphere where temperature response is also positive(McCormack and Hood, 1996).
- OVMR response to ENSO shows positive value at 26 km and negative at 26 km.
- OVMR shows decreasing trend in mesosphere (>91 km). It is attributed to increase in green house gases. In lower stratosphere the trend is increasing around 31 km whereas it is decreasing around 35 km.
- Temperature response to solar cycle is over all positive.
- Temperature response to ENSO shows lot of variabilities with height. In the tropics, small group and phase velocities of the equatorial Rossby waves, together with the mean zonal winds present there, confine vertical propagation of the ENSO signal by Rossby waves to the troposphere and lowermost stratosphere (Garcia et al.,2006).
- Temperature trend shows consistent cooling trend above 40 km, peaking at 58 km. Upto 90 km, cooling trend is exhibited. Cooling trend in mesosphere causing due to doubling of CO_2 concentration (Beig, 2003). In stratosphere, cooling is there due to depletion of ozone (Ramaswamy et al.,2001).

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