Tropical tropospheric ozone: Implications for dynamics and biomass burning

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Abstract

This paper studies the significance of large scale transport and pyrogenic (i.e, biomass burning) emissions in the production of tropospheric ozone in the tropics. Using aerosol index (AI) and tropospheric column ozone (TCO) time series from 1979 to 2000 derived from the Nimbus-7 and Earth Probe TOMS measurements, our study shows significant differences in the seasonal and spatial characteristics of pyrogenic emissions north and south of the equator in the African region and Brazil in South America. Notwithstanding these differences, most of the observed seasonal characteristics are well simulated by the GEOS-CHEM global model of tropospheric chemistry. The only exception is the northern African region where modeled and observed TCO differ significantly. In the Indonesian region, the most significant increase in TCO occurred during September-December 1997, following large-scale forest and savanna fires associated with the El Niño-induced dry condition. The increase in TCO extended over most of the western Pacific well outside the burning region and was accompanied by a decrease in the eastern Pacific resembling a west-to-east dipole about the dateline. These features are well simulated in the GEOS-CHEM model which suggests that both the biomass burning and changes in meteorological conditions during El Niño period contributed almost equally to the observed increase in TCO in the Indonesian region. During 1997, the net increase in TCO integrated over the tropical region between 15^{o}N and 15^{o}S was about 6-8 Tg (1 Tg = 10^{12} gm) over the mean climatological value of about 77 Tg. The GEOS-CHEM model suggests that of most of this increase may have been caused by biomass burning in the Indonesian region since dynamical components of El Niño induced changes in TCO tend to cancel out in the area averaged data. In addition to biomass burning, the interannual variability in the area-averaged column ozone in the tropics is influenced by a number of factors including the quasi-biennial oscillation and solar cycle.

The full text of this paper is available as a [pdf].