Lower-tropospheric Ozone Derived from TOMS V7 Level-2 Data

Xiong Liu,1 Mike Newchurch,1 and Jae Kim1,2

1. Department of Atmospheric Science, University of Alabama, in Huntsville, USA
2. Department of Atmospheric Science, Pusan National University, Korea

Motivation
- Derive lower-tropospheric ozone (LTO) over the TOMS period of observation for long-term trend analysis.
- Reduce cloud and tropospheric aerosol contamination by using TOMS Level-3 data in the previous work (Jiang and Yung 1998; Kim and Newchurch, 1998, 1996).
- Apply the Topographic Contrast Method (TCM) to more regions (Figure 1). The derived LTO is probably due to ozone production associated with biomass burning season in these regions.

Data and Methodology
- Identify mountain peaks (< 1000 mb) from TOMS terrain pressure data where to derive LTO. Find average total ozone at mountain level within ±1º longitude and 100 mb < |average ozone - TOMS ozone| < 800 mb. Find average total ozone on each side of the mountains within ±1.5º longitude ±150 mb.
- Assume a well-mixed lower troposphere, calculate ozone mixing ratio between these two levels. If we can't find a pair of ozone measurements, then use the average corresponding ozone within ±2 days and ±1º latitude.
- Use monthly mean (at least 10-15 daily values) to average out the inconsistency in the ozone above mountain level between mountain top and sea level regions.

Seasonal Variation at Andes and Mexican Mountains (Figures 4a and 4b)
- LTO in the eastern Pacific Ocean (23º-30ºS) peaks during the austral late winter and spring (from August to November) and minimizes during the summer period. The maximum LTO of the Andes is similar but the minimum in the fall. The maxima LTO on both sides (23º-29ºS) that is consist with the biomass burning season are strongly linked to biomass burning on the South America continent. The maximum 23ºS (east side) south is probably due to stratospheric-troposphere exchange. The summer minimum (east side) is due to the high RH and low N2O in marine environment.
- LTO in northern tropics shows little seasonal variation on both sides.
- LTO west of Mexican Mountains is highest in the spring and lowest in the summer. At eastern side, LTO is lowest in the winter and the spring maximum at 15-20ºN (continental regions). The maxima 23ºS (east side) south is probably due to stratospheric-troposphere exchange. The summer minimum (east side) is due to the high RH and low N2O in marine environment.
- LTO in northern tropics shows little seasonal variation on both sides.
- LTO west of Mexican Mountains is highest in the spring and lowest in the summer. At eastern side, LTO is lowest in the winter and the spring maximum at 15-20ºN (continental regions). The maxima 23ºS (east side) south is probably due to stratospheric-troposphere exchange. The summer minimum (east side) is due to the high RH and low N2O in marine environment.

Seasonal Variation at Himalayas (Figures 4g, 4h)
- There is barely obvious ozone gradient in the summer (Figure 4g). In mountainous regions, such as Himalayas, there is a small seasonal variation on both sides (Figure 4h).
- The LTO at 1ºS-8ºN in the Kenya and Somalia coastal regions (1.9±4% year⁻¹, Figure 4g) and at 1ºS-8ºN in the Kenya and Somalia coastal regions (1.9±4% year⁻¹, Figure 4g) are largest in the biomass burning season. Negative trends are observed at the Andes (0.7±4% year⁻¹, Figure 4h) and at 29-32ºW west of the Mexican Mountains (0.5±3% year⁻¹, Figure 4h).
- Marginal trends occur at 23º-29ºS west of the Andes (0.6±4% year⁻¹, Figure 4h).
- Seasonal variation of derived LTO is quite reasonable.

Summary and Conclusions
- We derived the Lower Tropospheric Ozone (LTO) from TOMS L2 clear-sky measurements (corrected for aerosol and sun glint errors) near several mountainous regions. The derived LTO agrees very well with the seasonal variations of ozone measurements at Boulder, Crater Lake, Fiji, and Tahiti.
- The influence of biomass burning is evident in the seasonal variation of LTO on both sides of the Andes Mountains, between 23-29ºS, and in the Mexican Mountains (26-12ºS), where is subject too high concentrations of ozone precursors, high concentrations of ozone are usually found in a summer maximum.
- The importance of stratospheric intrusion is evident in the seasonal variation observed in the eastern Pacific Ocean at 15-20ºN and 30-35ºN, and the Himalayas in eastern China.
- In continental regions such as west and east of Rocky Mountains (35-40ºN), eastern, and western China, where is subject too high concentrations of ozone precursors, high concentrations of ozone are usually found in a summer maximum.
- We find positive trends significant at the 95% confidence level between 23-12ºS west of the Andes (0.5±4% year⁻¹, Figure 4h) and at 1ºS-8ºN in Kenya and Somalia coastal regions (1.8±4% year⁻¹, Figure 4). We find significant negative trends between 23-0ºE east of the Andes (0.8±3% year⁻¹, Figure 4).

www.nsstc.uah.edu/atmchem

Updated on January 13, 2001