

4.197 Lightning NO_x Production as Determined Using OMI NO₂ Retrievals and WWLLN Stroke data.

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Abstract:

Nitrogen oxide (NO_x) production by lightning is estimated using Ozone Monitoring Instrument (OMI) nitrogen dioxide (NO₂) slant columns and detection-efficiency adjusted flashes from the ground-based World Wide Lightning Location Network (WWLLN) during the boreal summers of 2007 to 2011. Utilizing an algorithm that includes air mass factors appropriate for grid boxes affected by convection, NO₂ slant columns are converted to vertical columns of tropospheric NO_x ($V_{\text{LNO}_x^*}$), which are then converted to vertical columns of tropospheric NO_x due to recent lightning (V_{LNO_x}) by subtraction of a tropospheric background that is given by the mean $V_{\text{LNO}_x^*}$ at the same locations on non-flashing days. Estimates of LNO_x production efficiency (PE) per flash for the tropics and midlatitudes are obtained using summation- and regression-based approaches. In the summation approach, mean V_{LNO_x} over flashing grid boxes is divided by mean flashes during a flash window prior to the time of the OMI overpass. In the regression approach, mean daily $V_{\text{LNO}_x^*}$ values over a region are regressed against mean daily flashes during the window. LNO_x PE is determined to be greater over marine locations than over continental locations possibly because marine flashes are more energetic. LNO_x PE is found to be greater over the tropical Pacific where flash rates are low than tropical Africa where flash rates are high. Overall, the PE decreases by an order of magnitude for a two-order of magnitude increase in flash rate. The mean LNO_x PE for the midlatitudes and tropics are inferred to be 321 ± 170 and 161 ± 74 moles per flash, respectively, which corresponds to a global source of 4.1 ± 1.9 Tg N per year. The main contributors to uncertainty in approximate order of importance are uncertainties in WWLLN detection efficiency, upper tropospheric NO_x lifetime in the near field of convection, tropospheric background, and flash window.