Atmos. Chem. Phys., 7, 3823-3907, 2007
www.atmos-chem-phys.net/7/3823/2007/


# The global lightning-induced nitrogen oxides source

U. Schumann and H. Huntrieser
Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, 82230 Wessling, Germany

Abstract. The knowledge of the lightning-induced nitrogen oxides ($LNO_x$) source is important for understanding and predicting the nitrogen oxides and ozone distributions in the troposphere and their trends, the oxidising capacity of the atmosphere, and the lifetime of trace gases destroyed by reactions with OH. This knowledge is further required for the assessment of other important $NO_x$ sources, in particular from aviation emissions, the stratosphere, and from surface sources, and for understanding the possible feedback between climate changes and lightning. This paper reviews more than 3 decades of research. The review includes laboratory studies as well as surface, airborne and satellite-based observations of lightning and of $NO_x$ and related species in the atmosphere. Relevant data available from measurements in regions with strong $LNO_x$ influence are identified, including recent observations at midlatitudes and over tropical continents where most lightning occurs. Various methods to model $LNO_x$ at cloud scales or globally are described. Previous estimates are re-evaluated using the global annual mean flash frequency of 44±5 $s^{-1}$ reported from OTD satellite data. From the review, mainly of airborne measurements near thunderstorms and cloud-resolving models, we conclude that a "typical" thunderstorm flash produces 15 (2–40)×$10^{25}$ NO molecules per flash, equivalent to 250 mol $NO_x$ or 3.5 kg of N mass per flash with uncertainty factor from 0.13 to 2.7. Mainly as a result of global model studies for various $LNO_x$ parameterisations tested with related observations, the best estimate of the annual global $LNO_x$ nitrogen mass source and its uncertainty range is (5±3) Tg $a^{-1}$ in this study. In spite of a smaller global flash rate, the best estimate is essentially the same as in some earlier reviews, implying larger flash-specific $NO_x$ emissions. The paper estimates the $LNO_x$ accuracy required for various applications and lays out strategies for improving estimates in the future. An accuracy of about 1 Tg $a^{-1}$ or 20%, as necessary in particular for understanding tropical tropospheric chemistry, is still a challenging goal.

Final Revised Paper (PDF, 5180 KB) | Discussion Paper (ACPD)

Citation: Schumann, U. and Huntrieser, H.: The global lightning-induced nitrogen oxides source, Atmos. Chem. Phys., 7, 3823-3907, 2007. Bibtex | EndNote | Reference Manager