Lightning NOx Statistics Derived by NASA Lightning Nitrogen Oxides Model (LNOM) Data Analyses

William Koshak[1] and Harold Peterson[2]

[1]Earth Science Office, ZP11, NASA Marshall Space Flight Center, Robert Cramer Research Hall, 320 Sparkman Drive, Huntsville, AL 35805.
[2]Universities Space Research Association, Robert Cramer Research Hall, 320 Sparkman Drive, Huntsville, AL 35805. .

1. WHAT IS THE LNOM?

The NASA Marshall Space Flight Center (MSFC) Lightning Nitrogen Oxides Model (LNOM) [Koshak et al., 2009, 2010, 2011; Koshak and Peterson 2011, 2013] analyzes VHF Lightning Mapping Array (LMA) and National Lightning Detection Network™ (NLDN) data to estimate the lightning nitrogen oxides (LNOx) produced by individual flashes. **Figure 1** provides an overview of LNOM functionality.

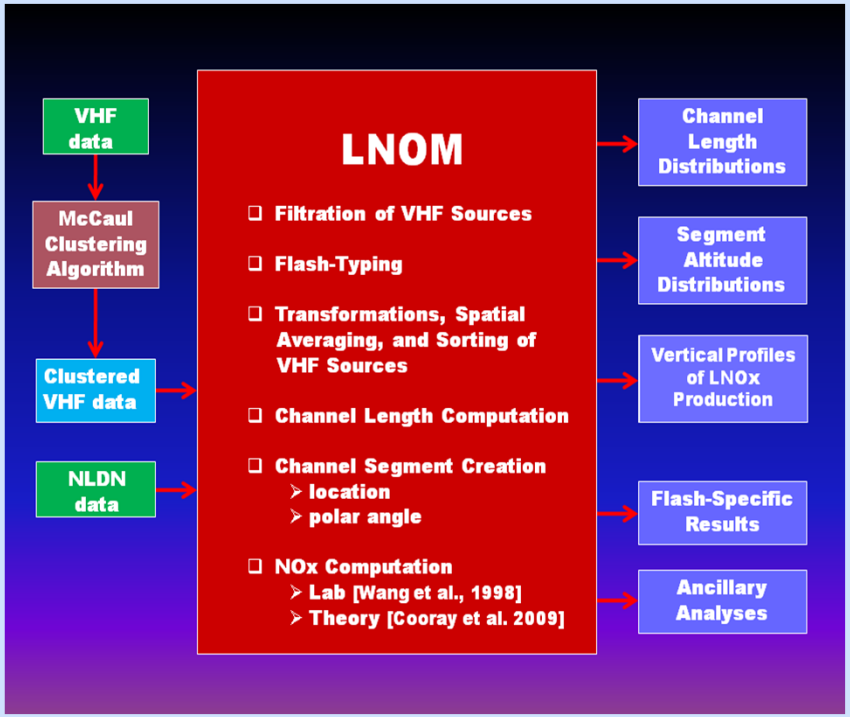

Figure 1. Overview of the LNOM showing input lightning data and output products.

2. BENEFITS OF LNOM

- Does away with unrealistic "vertical stick" lightning channel models for estimating LNOx.
- Uses ground-based VHF data that maps out the true channel in space & time to < 100 m accuracy.
- Therefore, true channel segment height (ambient air density) is used to compute LNOx.
- True channel length is used! (typically tens of kilometers since channel has many branches & "wiggles").
- Distinction between ground and cloud flashes are made.
- For ground flashes, actual peak current from NLDN used to compute NOx from lightning return stroke.
- NOx computed for several other lightning discharge processes (based on Cooray et al., 2009 theory):
  - Hot core of stepped leaders and dart leaders
  - Corona sheath of stepped leader
  - K-changes
  - Continuing Currents
  - M-components.
- LNOM statistics (see later) can be used to parameterize LNOx production for regional air quality models (like CMAQ), and for global chemical transport models (like GEOS-Chem).

3. STATISTICS

The LNOM data archive at (http://lightning.nsstc.nasa.gov/data/index.html#LNOM_DATA) now contains LNOx analyses for **468,928** flashes. Most of these flashes are derived from 9 years of North Alabama Lightning Mapping Array (Koshak et al, 2004) data as shown below in **Figure 2**; the remaining flashes are from 4 years of data derived from the DC metropolitan LMA network.

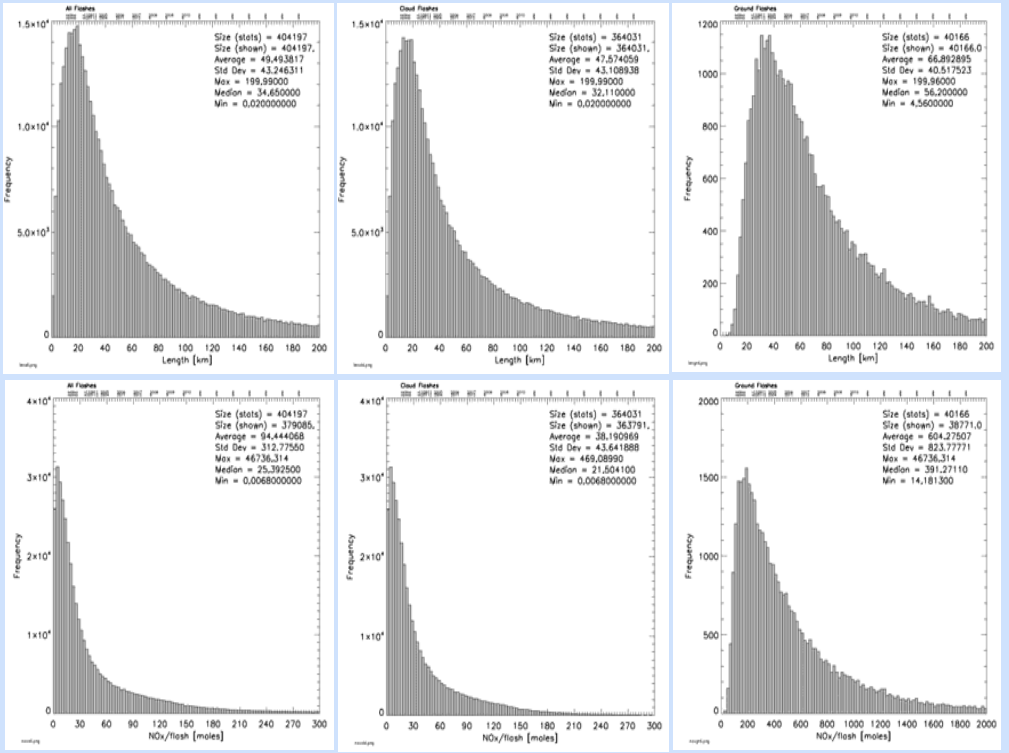

Figure 2. LNOM lightning channel length distributions (top 3 plots: all flashes, cloud flashes, ground flashes), and NOx per flash (bottom 3 plots). These distributions and associated statistics are derived from North Alabama thunderstorms.

4. REFERENCES

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