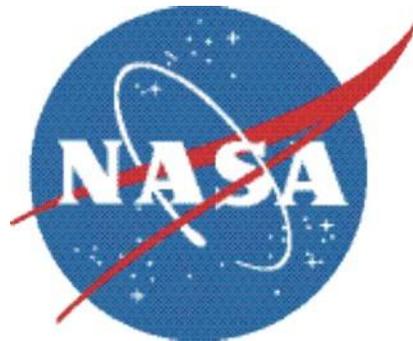# Read-Me File for the
Lightning Nitrogen Oxides Model (LNOM)

William Koshak, NASA/MSFC
Version 11-29-2011

This document describes the basic purpose, format, and variable description of various LNOM output data files.

LNOM File Name Format

Format:

LNOM_YYYY_MM_vhfnet_DDDDD_vmmddyy.ext

Key:

LNOM: A 4 character string header acronym which stands for *Lightning Nitrogen Oxides Model*

YYYY: The 4 digits of the year.

MM: month (01 = Jan, 02 = Feb, … , 12 = Dec).

vhfnet: a 5 character string which identifies the VHF network used; choices are (but not limited to) the following:
- 'nalma' = North Alabama Lightning Mapping Array
- 'dclma' = D. C. Lightning Mapping Array
- 'oklma' = Oklahoma Lightning Mapping Arrary
- 'wtlma' = West Texas Lightning Mapping Array
- 'splma'= Sao Paulo Lightning Mapping Array

DDDDD: a 5 character string descriptor defining the type of physical data in the file (see tables 1a-c to follow).

vmmddyy: a 7 character string defining the version of the LNOM code used to generate the file.
- 'v' = version
- Date of the LNOM version = mm-dd-yy, where mm = month, dd = day, and yy = year. Note that version year yy ranges from 09-99 (i.e., from year 2009 to 2099).

ext: the file extension (either .txt, or .png).

Explanation of DDDDD Descriptor

Table 1a. Explanation of the DDDDD descriptors.	
DDDDD	**Explanation**
FLASH	Flash-by-flash LNOM results
SUMRY	Summary of LNOM results
LtFRE	Frequency Distribution (FRE) of lightning channel length (L) produced by flashes t.
LtPDF	Probability Distribution Function (PDF) of lightning channel length (L) produced by flashes t.
NtPRO	NOx Profile (N) within the LNOM Analysis Cylinder due to production mechanism (PRO) by flashes t.
SADtX	Segment Altitude Distribution (SAD) produced by flashes t. The X character has no meaning and is just a place holder.

Table 1b. Definition of the type of flashes included (t) variable.	
t	**Definition**
g	ground flashes
c	cloud flashes
a	all flashes = ground flashes + cloud flashes

Table 1c. Definition of the NOx production mechanism (PRO) variable.	
PRO	**Definition**
TOT	Total NOx production from all mechanisms in flash
CCC	Contribution from Continuing Currents
CCS	Contribution from Corona Sheath
CHD	Contribution from Hot Core Dart Leader
CHS	Contribution from Hot Core Stepped Leader
CKC	Contribution from K-Changes
CMC	Contribution from M-Components
CRS	Contribution from Return Strokes

File: **LNOM_YYYY_MM_vhfnet_FLASH_vmmddyy.txt**

Purpose: This file provides NOx (and other flash information) on a flash-by-flash basis for every flash not filtered out by LNOM during the analysis MONTH of a particular YEAR.

Format:
printf,ifilenum,dom,tstart,latave,lonave,altave,type,cur,mul,lcap,noxfull,noxtrun
format='(i3,f9.2,f9.4,f10.4,f8.1,a2,f8.1,i4,f9.2,2f11.4)'

> *NOx Profile within the LNOM Analysis Cylinder Produced by the Flash (m is usually 210)*
> for k=0,m-1,10 do begin
>   printf,ifilenum,nprof(k),nprof(k+1),nprof(k+2),nprof(k+3),nprof(k+4), \$
>   nprof(k+5),nprof(k+6),nprof(k+7),nprof(k+8),nprof(k+9),format='(10f11.4)'
> endfor

Variable Description:

- dom: day of month that the flash occurs in.
- tstart: seconds into the day of month of the 1st VHF source of the flash.
- latave: the average geodetic latitude (in degrees) of the VHF sources of the flash.
- lonave: the average geodetic longitude (in degrees) of the VHF sources of the flash.
- altave: the average geodetic height (in meters) of the VHF sources of the flash.
- type: the flash type ('g' = ground flash, 'c'= cloud flash, 'a' = ambiguous).
- cur: peak current (in kiloamps) of the flash. The peak current of a cloud flash is assigned a value of 0 kiloamps to indicate "unknown".
- mul: multiplicity = # of strokes in the flash.
- lcap: the total estimated channel length (in kilometers) of the flash.
- noxfull: the entire amount of NOx (in moles) produced by the flash.
- noxtrun: the amount of NOx (in moles) the flash contributes to the LNOM analysis cylinder (i.e., some flashes are only partially inside the LNOM cylinder hence are truncated).
- NOx Profile Produced By The Flash: The NOx (in moles) contributed to each vertical 100 meter layer by the flash, starting near the surface and moving upward, is provided; it is held in the array nprof. There are normally m = 210 one hundred meter vertical layers in the LNOM analysis cylinder so there are 21 records, each containing 10 NOx values. Hence, the 1st record moving from left to right provides the layer 1 (sfc to 100 m), layer 2 (100 m to 200 m) , … , layer 10. The second record from left to right provides layer 11, layer 12, …, layer 20. And so on for the remaining records. The file format printed out is provided above. The IDL code "\$" is just a line continuation symbol.

Purpose: File provides: (1) Basic Statistics & Ancillary Information, (2) NOx Profile Results, (3) Segment Altitude Distribution (SAD) Profile Results, and (4) the seven component NOx profiles whose sum equals the NOx Profile Results in item (2) above. The seven contributional NOx profiles are: RS = Return Stroke, CS = Corona Sheath, KC = K-Change, HS = Hot-core Stepped, HD = Hot-core Dart, CC = Continuing Current, MC = M-Component.

Format:
Basic Statistics & Ancillary Information (several records)
Text: "NOx PROFILE RESULTS (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground TNP, Cloud TNP, All TNP), format: i4, 3f20.5
Text: "SAD PROFILE RESULTS (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground SAD, Cloud SAD, All SAD), format: i4, 3f15.0
Text: "NOx Return Stroke Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground RS, Cloud RS, All RS), format: i4, 3f20.5
Text: "NOx Corona Sheath Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground CS, Cloud CS, All CS), format: i4, 3f20.5
Text: "NOx K-Change Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground KC, Cloud KC, All KC), format: i4, 3f20.5
Text: "NOx Hot Core Stepped Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground HS, Cloud HS, All HS), format: i4, 3f20.5
Text: "NOx Hot Core Dart Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground HD, Cloud HD, All HD), format: i4, 3f20.5
Text: "NOx Continuing Current Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground CC, Cloud CC, All CC), format: i4, 3f20.5
Text: "NOx M-Component Contribution (Layer, Ground, Cloud, All) WITHIN THE LAC:"
(layer number (order is top to bottom), Ground MC, Cloud MC, All MC), format: i4, 3f20.5

Variable Description: The various NOx profiles and the SAD have already been described in several conference papers, and png image profiles produced by LNOM show all the profiles & units.

Important Note: For the "NOx PROFILE RESULTS (Layer, Ground, Cloud, All) WITHIN THE LAC:" we have artificially assigned the NOx for the first two layers near the surface to equal the average of the NOx of the 5 layers above these two layers; i.e.:

NOx (layer 2) = [NOx(layer 3)+NOx(layer 4) + NOx(layer 5) + NOx(layer 6)+NOx(layer 7)]/5.0
NOx (layer 1) = [NOx(layer 3)+NOx(layer 4) + NOx(layer 5) + NOx(layer 6)+NOx(layer 7)]/5.0

This was done for the (ground, cloud, all) NOx profiles and only for LNOM data derived from the North Alabama Lightning Mapping Array for the years 2005-2010. It was done because these profiles are typically used to feed CMAQ grid cells and it is unnatural to have the NOx zero in layer 1 and layer 2. Note also that the above artificial assignments were NOT done for any of the Contribution Profiles, and were not done for ANY of the NOx profile plot .png images.

For Huntsville AL (i.e. for the North Alabama LMA network) the NOx is zero in layer 1 and layer 2 because these layers are under-ground; i.e., Huntsville is 200 meters above sea level and each layer is 100 m thick.

File: **LNOM_YYYY_MM_vhfnet_LtPDF_vmmddyy.txt**

Purpose: Provides a probability density function (pdf) of the lightning channel length distributions. The normalized distribution function is only computed for channel length ranges 0-200 km, and the bin widths are 2 km wide and proceed as follows: 0-2 km, 2-4 km, 4-6 km, … , 198-200km.

Format:

```
for ibar=0,nbar-1 do begin
  prob=double(barcount(ibar))/double(nplt)
  printf,11,ibar,midbin(ibar)-half,midbin(ibar)+half,barcount(ibar),prob
  probsum=probsum+prob
endfor
printf,11,'Sum of bin probabilities (between 0-200 km only) is ',probsum
```

Variable Description: The variable ibar is the bin. The variable midbin(ibar)-half is the left edge of the bin. The variable midbin(ibar)+half is the right edge of the bin. The variable barcount(ibar) is the frequency in that bin. The variable prob is the fractional frequency in that bin.