Lightning NOx Production Breakout Summary

Dale Allen, UMD

Ken Pickering, NASA/GSFC

Uncertainties Associated with LNOx Estimation Techniques from Aircraft Data

Volume vs. Flux Methods give insight into uncertainty

Outflow sampling limited (are sampled levels representative of NOx distribution in anvil

Did we sample where highest outflow would be expected? 3-d views of storms wrt location of aircraft are needed

Radar images (surface area uncertainty; >20 dbZ threshold for LNOx residence, but perhaps too strict?)

Flash rate assumptions (NLDN → LMA based methods)

Storm to storm variability may be large, but only a few cases are amenable for this analysis

Analysis will add a few cases to existing data base of LNOx/flash estimates

New insight into LNOx/flash length (which may be a better metric) can be gained

Analysis of MCS storms versus isolated convection needed

Focus by Ilana and Andy is on OK storms so far. Analysis of OK storms less complicated? Isolated storms in low-NOx bkgn. Need to analyze CO and AL storms.

Uncertainties in OMI-based estimates of production per flash

- Consider all cases where outflow is sampled by OMI as opposed to selected cases where OMI sees obvious enhancement (bias issues)
- Ratio of NOx/NO2 in UT lower than expected from model
- Model chemistry could induce biases in ratio
- Be mindful of possible NO2 measurement interferences
- Uncertainty in estimation of anthropogenic background NO2

Refinement of LNOx schemes in cloud-resolved models

- Accurate simulation of storm is needed. How realistic are model storms? Assimilation of radar and lightning data could help.
- Utilization of LMA data (channel length as function of altitude "SADS"→ Segment Altitude Distributions) will help in specifying LNOx vertical placement in model
- Is >20 dBZ threshold appropriate for locating LNOx. Need analysis of LMA vs. radar data
- Can explicit lightning models be employed and linked with chemistry?

Regional variations in LNOx Production

- Cloud-resolved cases will be run in each region
- Macro-view (global scale models) vs micro-view (cloud-resolved models) both provide bounds
- Does one parameterization fit all storms globally or regionally?

What LMA products are needed?

- **Currently or soon to be available:**
  Gridded products -- 2-D 3-km horizontal resolution; 5-min time res.
    Source density – number of VHF sources per grid cell
    Flash initiation density – number of flashes initiating in a grid cell (flash counts)
    Flash extent density – number of flashes passing through a grid cell (local flash count)
    Mean flash area – Sum of areas of each flash passing through a grid cell divided by flash extent density (related to flash length)

    Higher horizontal and temporal resolution can be generated on request for specific cases.

- **High priority: Flash length as function of altitude**

- **Other possibility: Flash power (radiative VHF power per source). Flash power could be determined by several possible methods, but it is unclear how related it is to NOx production;**
  Power may be related to NO production if corona was a primary producer of NO. But, hot channel thought to be primary NOx producer
  Are power estimates sensitive to details in networks?

Additional LMA analyses

- LNOx production in “anomalous” storms versus “normal” storms. Does it matter? Affects vertical distribution (NOx production is pressure-dependent) and ratio of IC/CG
- Impulsive current vs. continuous currents (NO freeze out if temperature falls below 2000K); Multiplicity (number of return strokes) may influence NO production?

Potential Papers

- Aircraft data analysis (Ilana Pollack et al.)
- Aircraft data analysis (Heidi Huntrieser et al.)
- CAM-Chem large-scale LNOx impact; top-down constraints (Louisa Emmons/Frank Flocke)
- WRF-Chem 15 km regional scale LNOx (Mary Barth)
- Cloud-resolved WRF-Chem (Kristin Cummings & Yunyao Li)
- EMAC (Patrick Joeckel)
- Electrification model (Ted Mansell & others)
- OMI NO2 (Ken Pickering)
- LMA flash properties related to LNOx (Eric Bruning et al.)