ATMOSPHERIC AMMONIA MONITORING AROUND HOG FARM INDUSTRIES IN NORTH CAROLINA

By

Arun D. Shendrikar[1], Joette Steger[1], Hoke Kimball[1], Wayne Cornelius[1], Mark Yirka[2], Robert Bishop[3] and Neil Joyner[4]

[1]Ambient Monitoring Section, Division of Air Quality, North Carolina Department of Environment and Natural Resources, 1641 Mail Service Center, Raleigh, NC 27699-1641.

[2]Electronic Calibration Branch, Ambient Monitoring Section, Division of Air Quality, North Carolina Department of Environment and Natural Resources, 4403 Reedy Creek Road, Raleigh, NC 27607.

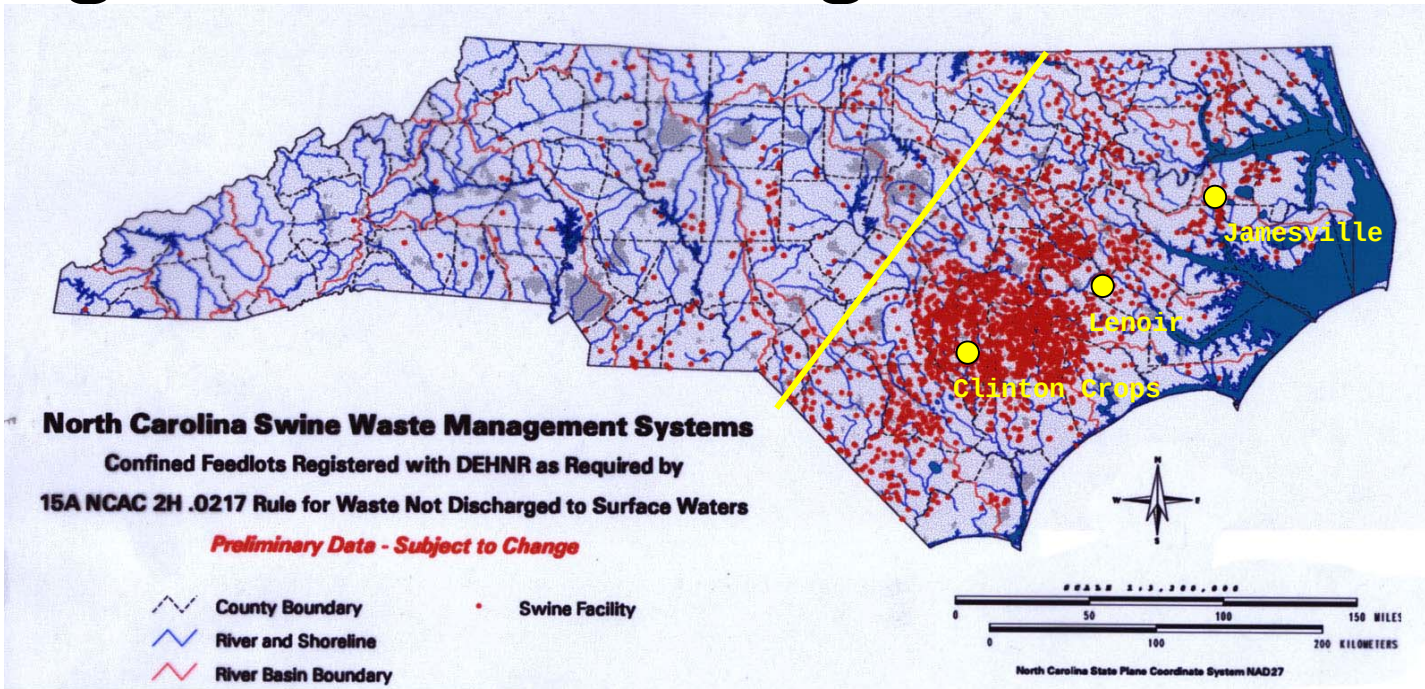
[3]Division of Air Quality, Washington Regional Office, North Carolina Department of Environment and Natural Resources, 943 Washington Square Mall, Washington, NC 27889.

[4]Division of Air Quality, Fayetteville Regional Office, North Carolina Department of Environment and Natural Resources, 225 Green Street, Suite 714, Fayetteville, NC 28301.

Preface

- Ammonia is the only abundant alkaline gaseous pollutant in our environment that has been gaining increasing attention from the public and regulatory agencies mainly because of its ability to form ammonium based fine particles (<2.5 micrometer in aero-dynamic diameter) aerosols that are of visibility and human health effects concern.
- In USA, agricultural activities are significantly contributing to such ammonium based fine particle aerosols in our atmospheres.
- In 1999, the Ambient Monitoring Section of Division of Air Quality (AMS-DAQ) started ammonia monitoring in the light of exponential growth of the regional hog farm industries.
- As required, the US-EPA approved AMS-DAQ prepared ammonia monitoring Quality Assurance Project Plan (QAPP), and all its protocols implemented.

Figure 1. Monitoring Site Locations



The three monitoring sites, located across a longitudinal transect in Eastern Northern Carolina, were selected because this area contains the highest density of animal farms, relative to the rest of the State. Additionally these sites were placed along the predominant wind corridor where at least 20 percent of winds come out of the Southwest and South-South-West, with wind speeds ranging from 2 to 20 miles per hour.[3]

Monitoring Sites Selected

- **Clinton Crops (Sampson County):** This site is surrounded by the hog farm industries. At this site, the impact of activities of these industries was expected to be monitored (in terms of ammonia emissions), over a time period.
- **Lenoir Community College (Lenoir County):** The Lenoir Community College (LCC) site is further away, approximately 50 miles, Northeast of the Clinton Crops site and at this site diluted impact of ammonia emissions from hog industries was monitored.
- **Jamesville (Martin County):** This site was Northeast, about 50 miles from LCC and was expected to monitor rather a further diluted impact of ammonia emissions from point sources (hog farms).

Figure 2. A Typical Site- Clinton Crops

Each site was equipped with:

–Temperature controlled shelter.

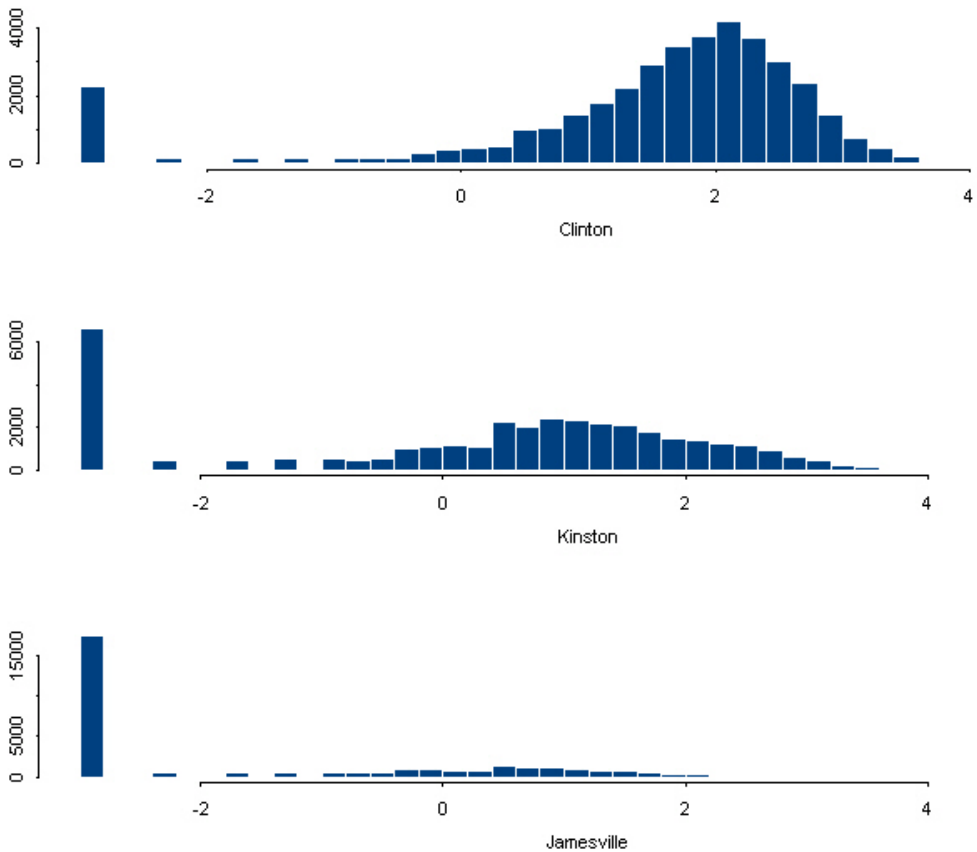
–Thermo Environmental Instruments (TEI), Model 17C ammonia analyzer.

–TEI, Model 146C Dynamic Gas Calibrator.

–TEI, Model 111 Zero-Air Supply System.

–Site dedicated PC and modem system, primary and secondary data loggers, sample in-take lines and other related accessories.

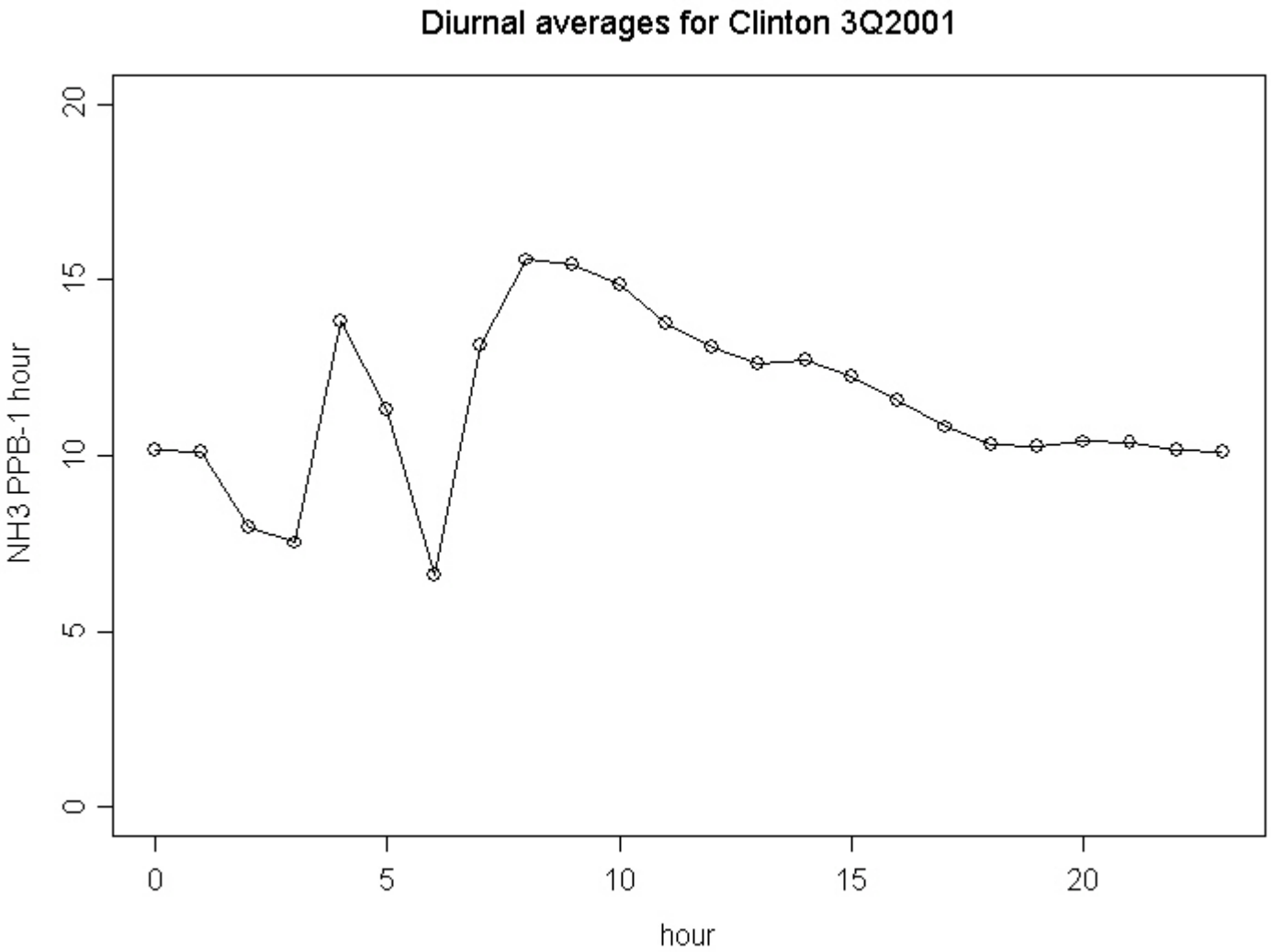
Figure 3. Project Period Average Ammonia Concentrations at Three Sites



Data Interpretations

- The accumulated data from years 2000 to 2005 indicate that overall ammonia concentrations at three sites are in the ranges of 0.002 to 0.015 PPM (1.52 to 11.38 µg/m^3).
- The monitored concentrations are considered to be low compared with the established ammonia Acceptable Ambient Level (AAL) of 2300 µg/m^3 (3.03 PPM). These low ammonia concentrations are expected not to pose any animal or human health related effects.
- A look at **Figure 3** indicates that the highest ammonia concentrations, during the monitoring period, are at the Clinton Crops site (surrounded by the hog farm industries) followed by LCC and Jamesville (Jamesville lowest).

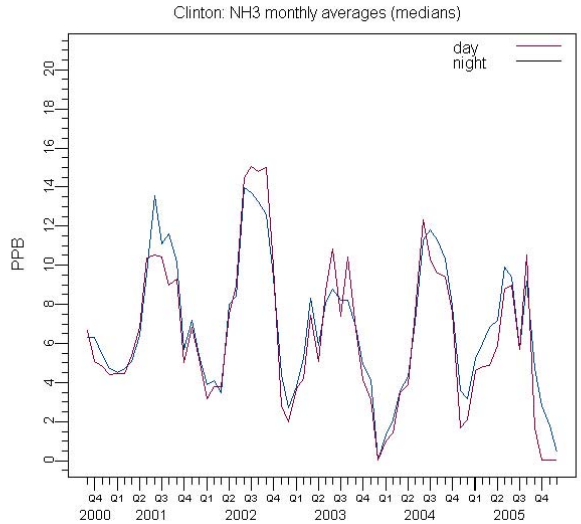
Figure 4. Typical Diurnal Ammonia Daily Hourly Averages

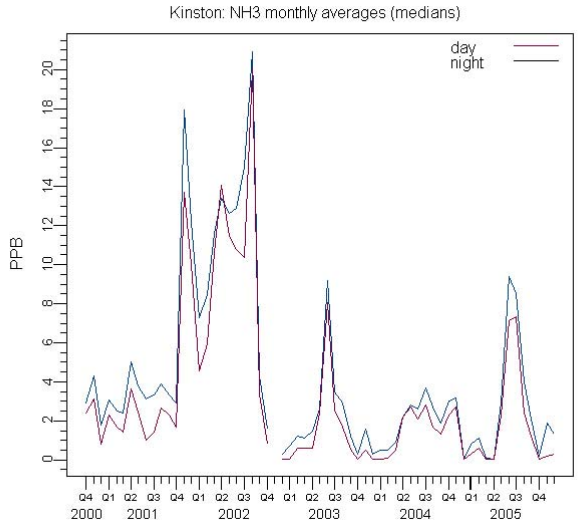


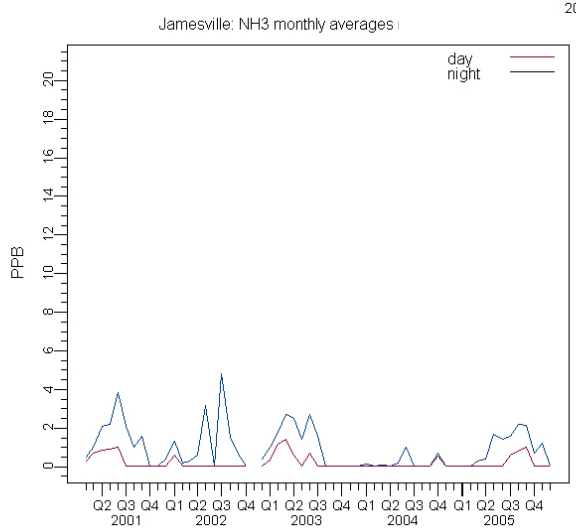
Conclusions

- An evaluation of daily ammonia concentrations by the hour at three sites indicates the presence of **three peaks** in a 24-hour monitoring period. The first peak appears around 4 AM, the second at 9 AM and third (relatively small) at around 2 PM **(see Figure 4).**
- This first peak (around 4 AM) disappears in the fourth quarter 2003 and does not show up in the following years of monitoring.
- Evaluations of daily hourly ammonia concentrations for the other two sites (LCC and Jamesville) show similar patterns.
- Further evaluation of daily hourly raw ammonia data indicated that the first peak (around 4 AM) was due to carry over problems with the ammonia calibration standards, as these standards were used for auto-calibration at all three sites around 4 AM, every other day.
- During 2nd and 3rd quarter of the year 2003, several tests were performed to resolve the issue of carry over of calibration standards. As a result, this 4 AM peak has not been observed during the monitoring period, for the following quarters and years at three sites.

Figure 5. Monthly Day & Night Time Averages of Ammonia Concentrations



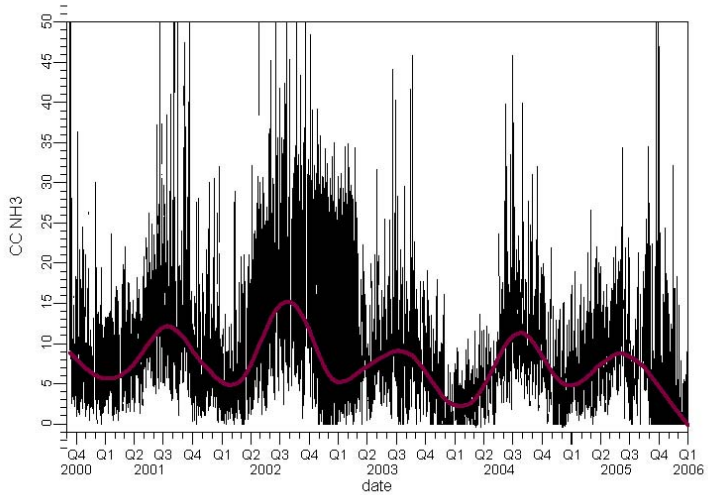


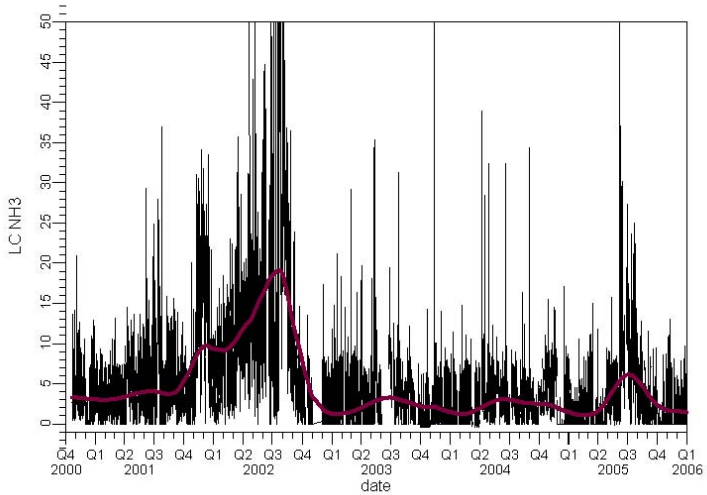


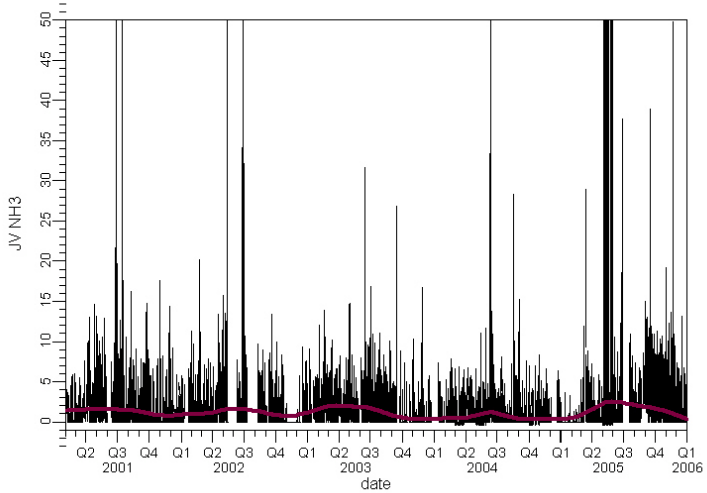
Data discussions

- A look at **Figure 5** indicates that there is greater degree of differences between daytime verses nighttime ammonia concentrations, particularly at Jamesville site than at Clinton Crops and LCC sites. In summary compared to other two sites, the ammonia concentrations at Jamesville are relatively higher at night than at daytime.
- Such concentration differences at the Clinton Crops and LCC are relatively small (probably negligible) and may be attributed to reactive atmospheres at these two sites due to the nearby hog farm industries. Additionally the chemical nature and/or quantities of atmospheric pollutant emissions and their abilities to react with free airborne ammonia gas at these two sites may also be contributing factors.

Figure 6. Yearly Ammonia Concentration Data Pattern for Years 2000 to 2005







Data Conclusions

- A look at **Figure 6** indicates there is a rise (peak) in airborne ammonia concentrations at all three sites somewhere in third quarter, every year for the last five years.
- Since Clinton Crops site is surrounded by the hog farm industries, this third quarter concentration rise is the highest at this site, followed by LCC and Jamesville.
- This rise in the third quarter (July, August and September) every year at three sites may be attributed to the regional applications of fertilizers that may include ammonium salts in their composition.
- Also these being summer months, the regional high temperatures may also be contributing to relatively increased ammonia emissions from point sources.

Study Conclusions and Recommendations

- Monitored data to-date indicate that the regional ammonia concentrations are low.
- There remains a merit to continue monitoring ammonia for the following reasons:
  - It is a well documented fact (through open literature) that agricultural practices have affects on increased ammonia emissions into the environment.
  - In North Carolina, the hog farm moratorium is scheduled to end on September 30, 2007; therefore it is imperative to continue monitoring ammonia to asses the local effects of the growth of the hog farm industry on the regional ammonia air emissions.

Reasons to continue Ammonia Monitoring (Continued)

- Ammonia gas is a precursor to $PM_{2.5}$ and thus responsible for $PM_{2.5}$ formation.
- Ammonia is considered to be responsible for acidic rain and acidic depositions through atmospheric reactions and conversions.