Using CrIS Ammonia Observations To Improve Decision Making on PM$_{2.5}$ Control Policies

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**NH₃ sources are not well known**

**Biomass burning**

**Industry**
- Fertilizer
- Coal Mining
- Power generation

**AGRICULTURE**
- Animal waste (temperature dependent)
- Fertilizer application

**Automobiles (catalytic converters)**
- Large urban centers
  - 50% of NH₃ in LA area (Nowak et al., GRL, 2012)

**Bi-directional Flux**
CrIS can identify NH$_3$ sources

- CrIS Satellite NH$_3$ warm season (Apr. – Sept., 2013) average surface map, with corresponding AMoN surface network measurements overlaid.

CrIS Ground-Level NH$_3$

(Apr-Sep, 2013)
Schematic Overview of Project Workflow

1. **AQcast pre-processors**
2. **CMAQ Baseline**
3. **CMAQ Perturbed**
4. **CMAQ NH₃ Retrievals**
5. **Emission Scaling Factor Calculation**
6. **CMAQ Optimized**
7. **Output Formatter**
8. **Model-Ready Files**

**Process Flow:**
- **Once per month in CrIS Record**
  - **Iteration Loop**
  - **Evaluation w/ surface & aircraft data**
- **Once per user request**
  - **User Output Specs Via API**
  - **Independent data evaluation**
Latest Updates: Calculation of Final NH$_3$ Emissions using bidirectional flux
Update: Final Weighted Emissions Scaling Factors for Bidirectional Input and All Other NH$_3$ Emissions

Applied to Bidirectional Flux Input

\[ E_{t_{bidi}} = E_{abidi} \left(1 + \frac{\Omega_o - \Omega_a}{\Omega_a} \left(\frac{NH_3_{FESTC}}{NH_3_{TOTAL}}\right) \beta_{festa}\right) \]

Limit: 0 – 5

Applied to All Other NH$_3$ Input

\[ E_{t_{other}} = E_{a_{other}} \left(1 + \frac{\Omega_o - \Omega_a}{\Omega_a} \left(\frac{NH_3_{OTHER}}{NH_3_{TOTAL}}\right) \beta_{other}\right) \]

Limit: 0 – 5
Pre-inversion NH$_3$ (June 2015, 12US2)

CrIS Monthly-Averaged Surface Conc (ppb)

CMAQ Base Monthly-Averaged Surface Conc (ppb)

Difference (CMAQ minus CrIS)
Post-inversion NH$_3$ (June 2015, 12US2)
12 km Run Comparison with AMoN

**CMAQ BASE Comparison with AMoN**

Monthly-Average NH₃ (μg/m³) Bias (BASELINE - AMON)

CMAQ vs. AMoN for CMAQ RUN = BASELINE

$R = 0.6628238455949185$

$R = 0.66$
CMAQ Iteration 1 – Surface Inversion Comparison with AMoN

Monthly-Average NH3 (ug/m3) Bias (SURFACE - AMON)

R = 0.7

CMAQ vs. AMoN for CMAQ RUN = SURFACE
R = 0.7038771051094318
36 km Run Comparison with AMoN

Baseline minus AMoN

Post-Inversion minus AMoN

Baseline

Post-Inversion

R = 0.58

R = 0.67
Current Work

- Working with ECCC to get better prior NH$_3$ emissions over Canada

- Working with EPA to get 12US1 simulations for April 2018

- Finalizing all code for distribution runs
Project ARL

- Start-of-Project ARL = 3 (11-16-2018)
- Goal ARL = 7
- Current ARL = 5 (8-16-2021)
Summary

• This work will provide improved NH$_3$ emission inventories to air quality forecasters, managers, and other stakeholders.

• Application of the inversion using bidirectional NH$_3$ flux for the first time for June 2015 proved successful. The process improved comparisons with CrIS and an independent dataset, AMoN.

• Our ongoing work will make the approach applicable at 36 km across NA and provide EPA with emissions files for testing in their existing decision-making activities.