Field Performance of Monitor for Aerosols and Gases (MARGA)

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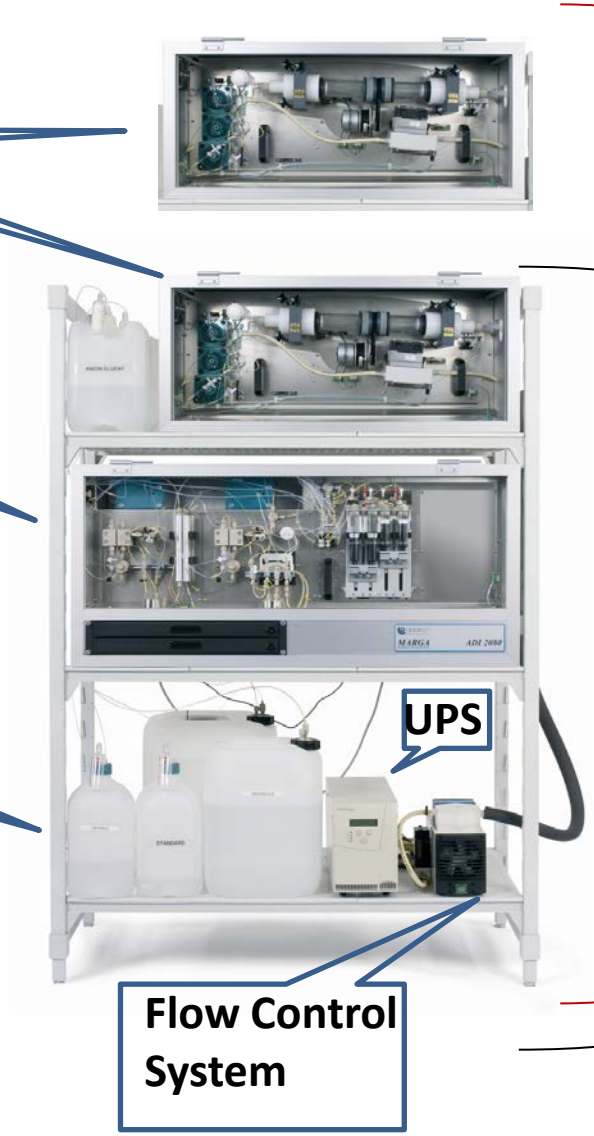
Outline of MARGA project

1. Description of instrument
2. EPA Background & History
3. Summarizing the Monitoring effort and challenges
4. Collocation Results and Investigation
5. Use of Results
6. Conclusions & Future Efforts

MARGA: Instrument Setup



Wet Rotating Denuder (WRD) to remove water-soluble gases

Steam Jet Aerosol Collector (SJAC) to remove water-soluble aerosol

Can run as a "1S" or a "2S" system

Can be operated remotely

Background & History

Hourly-resolved N gases (HNO_3, NO_2, HONO, NH_3), inorganic nitrogen aerosol (NH_4^+, NO_3^-), sulfur dioxide gas (SO_2) and sulfate aerosol (SO_4^{2-}) , and base cations (Ca^{2+}, Mg^{2+}, K^+, Na^+)

EPA Objectives:

1. **Monitoring instrument** to supplement CASTNET suite of measurements
2. **Research instrument:**

- Capability for direct flux measurements
- Improvements to Air Quality models (high resolution, simultaneous PM and gases)

Collaboration with EPA ORD

MARGA 1S ETV
MARGA 2S (two sample boxes, single analyzer). Numerous research projects

Outside Agency Collaboration (Colorado State University)

MARGA 1S Theodore Roosevelt NP; FRAPPE

Field Monitoring Specifics (BEL116)

Instruments:

Three MUs have passed through. Two early versions (EPA1&2) and a newer version (EPA3) installed in May 2013.

EPA1 & 2 passed **Environmental Technology Verification (ETV) Fall of 2010**

Manuscript published in ACP (Rumsey et al. 2014) on additional correction methods and QA/QC procedures to optimize MARGA performance.

Laboratory: Space and access to 18.2 MΩ cm^{-1} water source provided by C.Hapeman and L. McConnell's group at BARC-ARS Beltsville facility (7 mi from site)

Maintenance: Single MU requires ~30 L of solution (absorbing media and IC eluents) per week.

Cleaning, flow checks, parts replacement.

Challenges

1. **Operator skill and time requirements**
   - Post-doc or advanced graduate level with guidance
   - Typical day fills up fast:
     - 4 hrs solution prep
     - 2 hrs clean & reseat parts
     - Calibrations, diagnostics, & adjustments as needed
     - Can take hours of instrument stabilization to observe effects

2. **Non-routine major fixes difficult to ID and are inevitable**

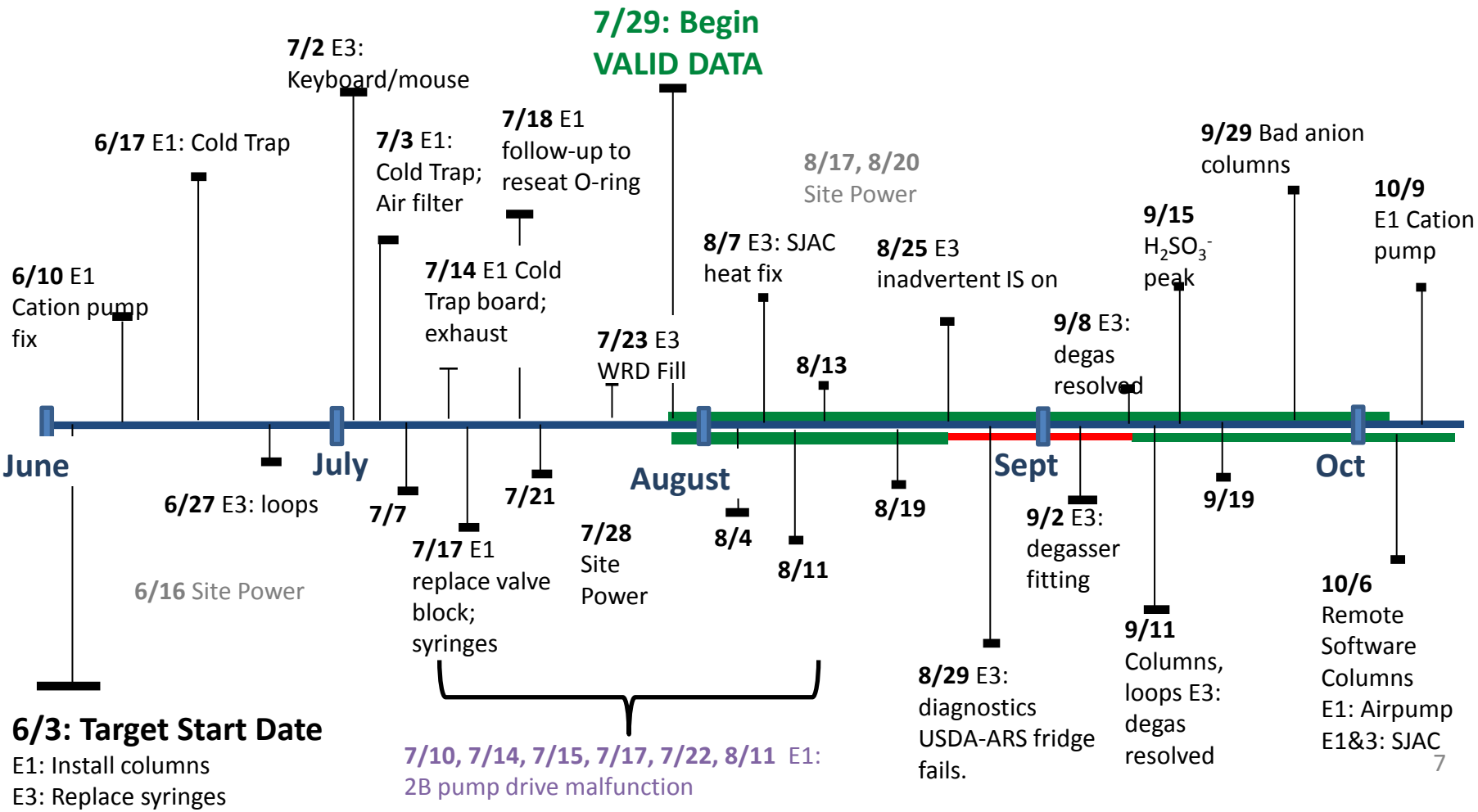
3. **Large costs associated with specialized parts**

4. **Estimated cost:** ~$40,000 yr^{-1} for parts and supplies

Timeline of Site Visits

Problems that arise cannot be addressed on 1-2 visits week^{-1} schedule

April 2014: Instrument prep: ~1-2 site visit wk^{-1}. Fixing major items, upgrading parts.
May 2014: Active Test and Optimization period. Repairs, cleaning, adjustments, flow checks, etc.



Data Analysis Challenges

Large number of parameters and correction factors scattered in differing formats:

- .csv, .mdb, .xml
- different time intervals
- Organized similar data into different files & separated by folders for day
- Any flags are coded into hexadecimal system

Had a sophisticated database in place…BUT

New operating software platform changed the entire set-up.

Alarms can be set to validate data based on parameters:

- convenient, but not a catch-all
- if something runs off, very time-consuming to go back and correct
  -minor flags, misintegrations, etc
- needs to be done one at a time

Manufacturer Support

Only seem to be interested in marketing as a monitoring instrument

-Instrument has been under constant development :
    -4 software versions in the past year
    -4 different data file structures

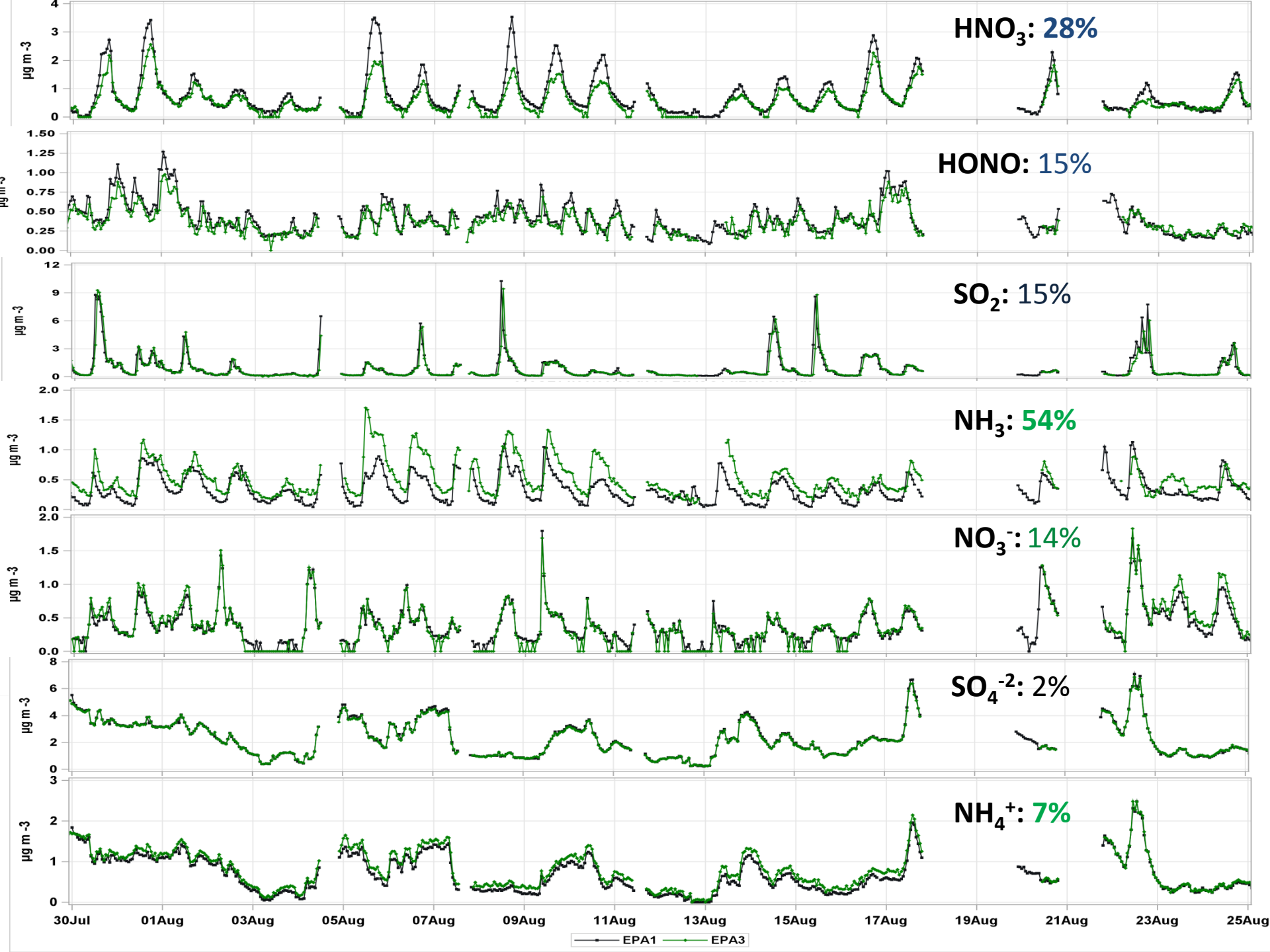
-Changes in management:
    - Metrohm bought Applikon
    - Shifting US operations to US

-Struggle to keep parts in stock and are poorly catalogued

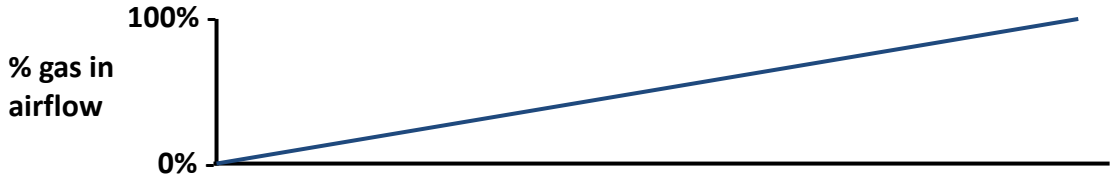
-XP platform
    -Risky to check software remotely,
    -remote operation is essential

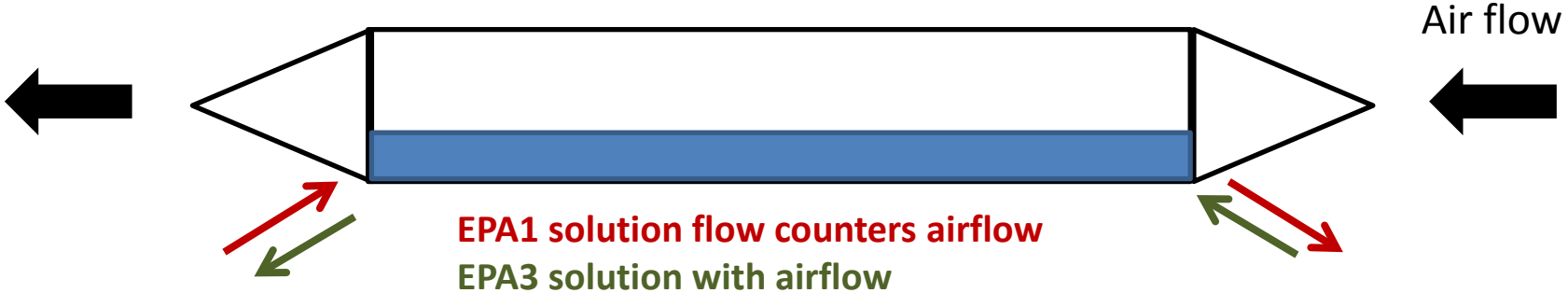
Meeting Challenges

- NEW Database in place (September) that currently auto-loads data on a daily basis (Gary Lear)
- Automated graphing procedures and data output in place
- Working with ORD (John Walker, Doris Chen) on methods to download and reintegrate rawdata to circumvent limitations to batch reprocessing data.
- …and DATA (N=~500)


HNO_3: 28%
HONO: 15%
SO_2: 15%
NH_3: 54%
NO_3^-: 14%
SO_4^{-2}: 2%
NH_4^+: 7%
µg m-3
30Jul
01Aug
03Aug
05Aug
07Aug
09Aug
11Aug
13Aug
15Aug
17Aug
19Aug
21Aug
23Aug
25Aug
EPA1
EPA3

WRD Intercomparison Artifact





EPA1 solution flow counters airflow

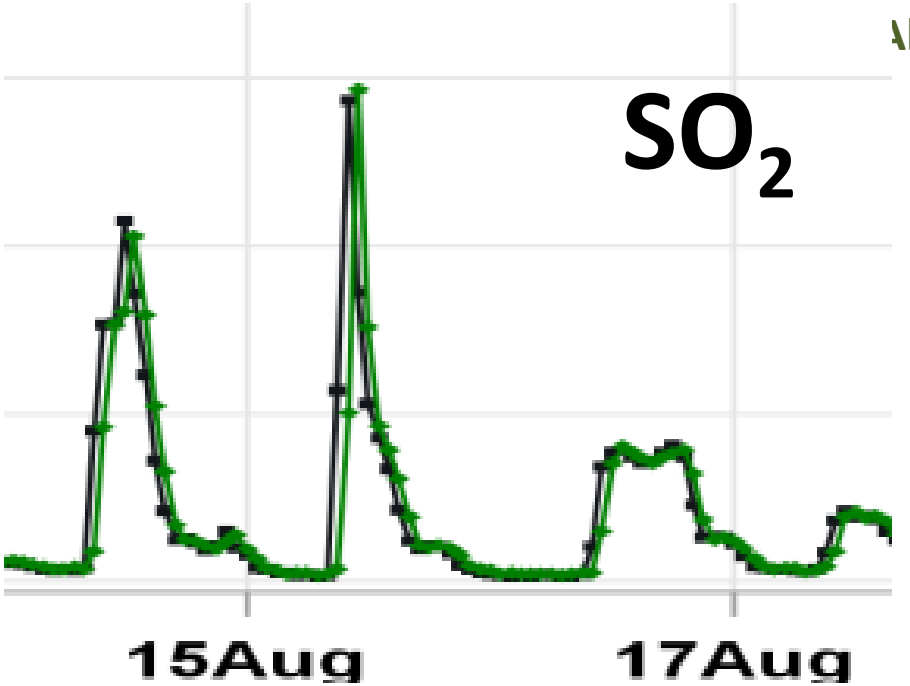
EPA3 solution with airflow

Absorbing solution IN

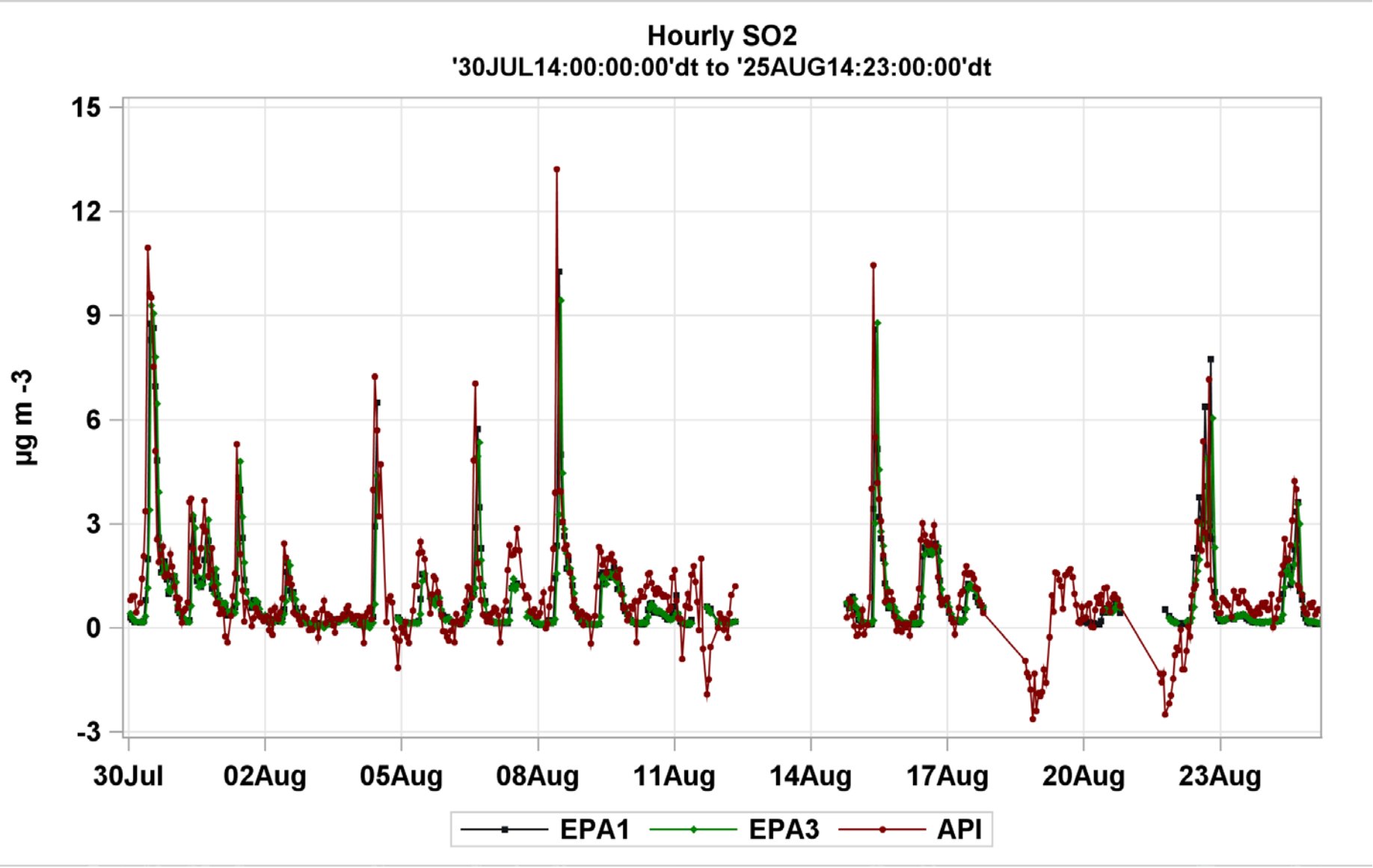
Sample OUT

Sample OUT

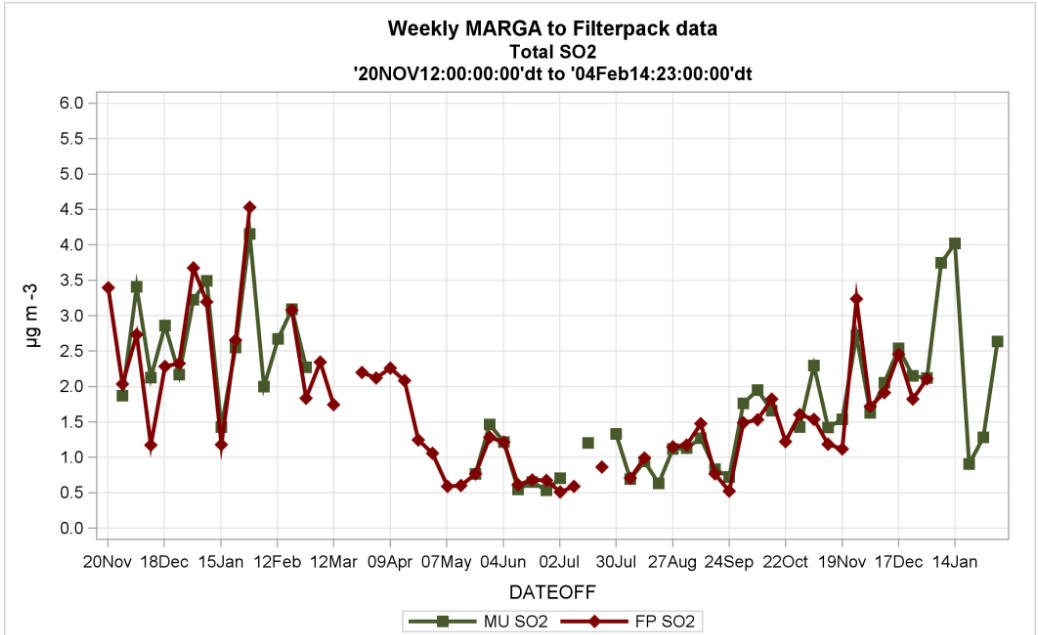
Absorbing solution IN

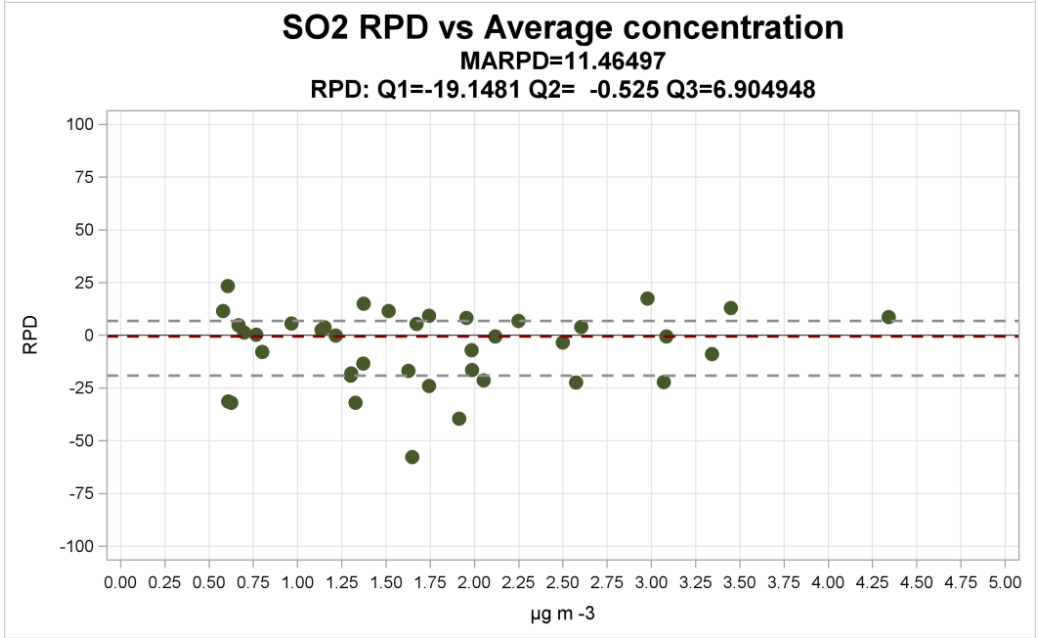


Comparison against collocated SO_2 (PFA)



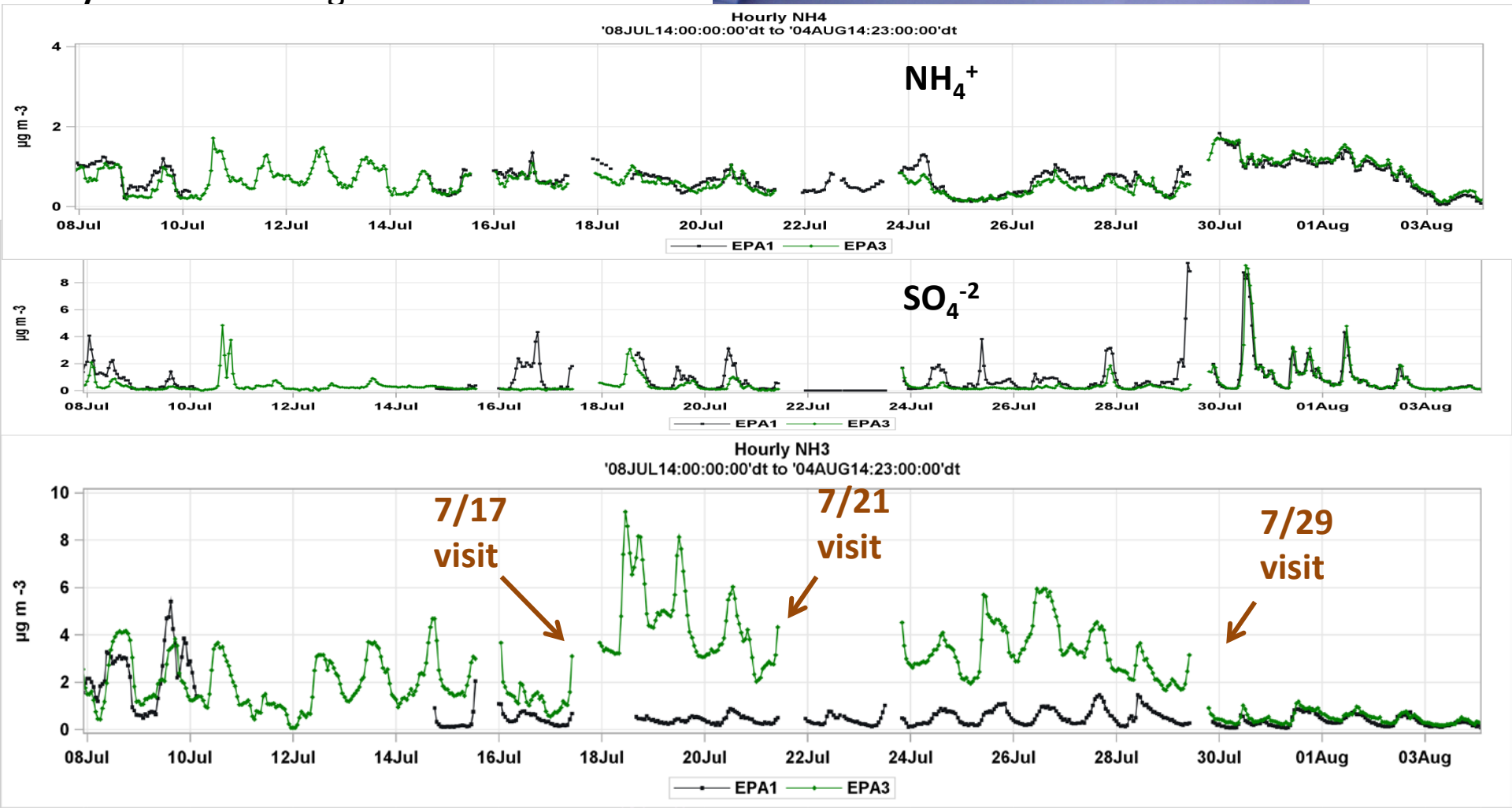
Comparison against weekly CASTNET SO_2





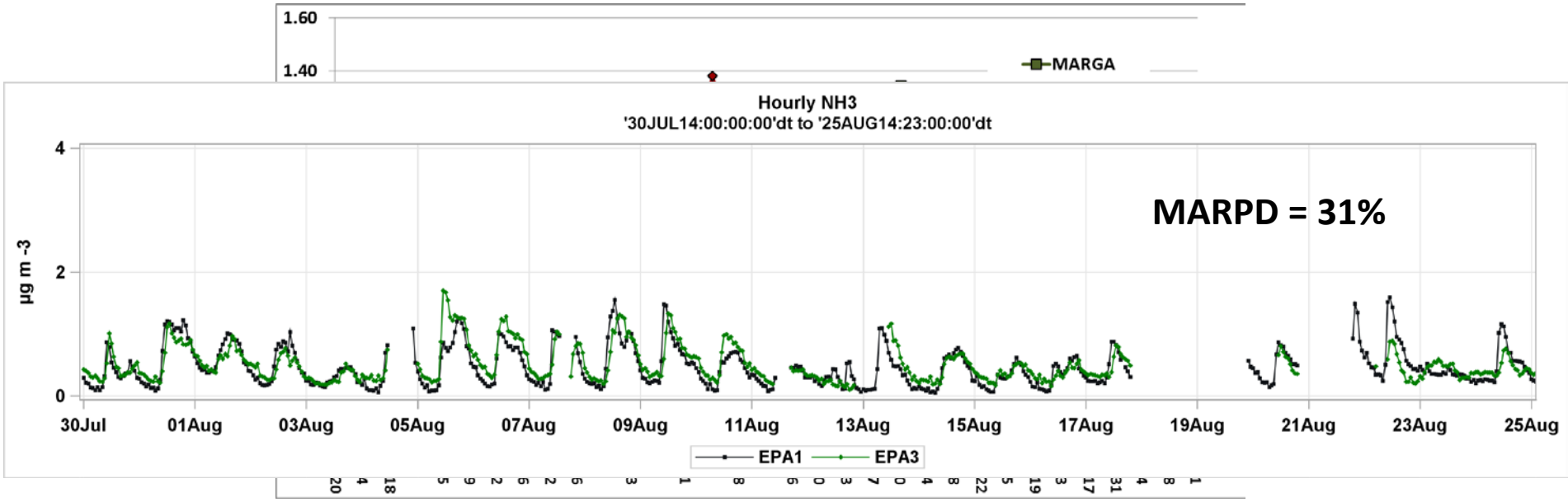
SO_2 performance indicator and Mold

7/17: Noticed bug in WRD and mold



- All points are flagged as VALID data
- More rigorous cleaning methods necessary
- NH_3 consumption associated with cleans frequently observed (Rumsey et al., 2014)
- SO_2 or NH_4^+ doesn't indicate problem

MARGA aggregated and AMON [NH_3] Averages

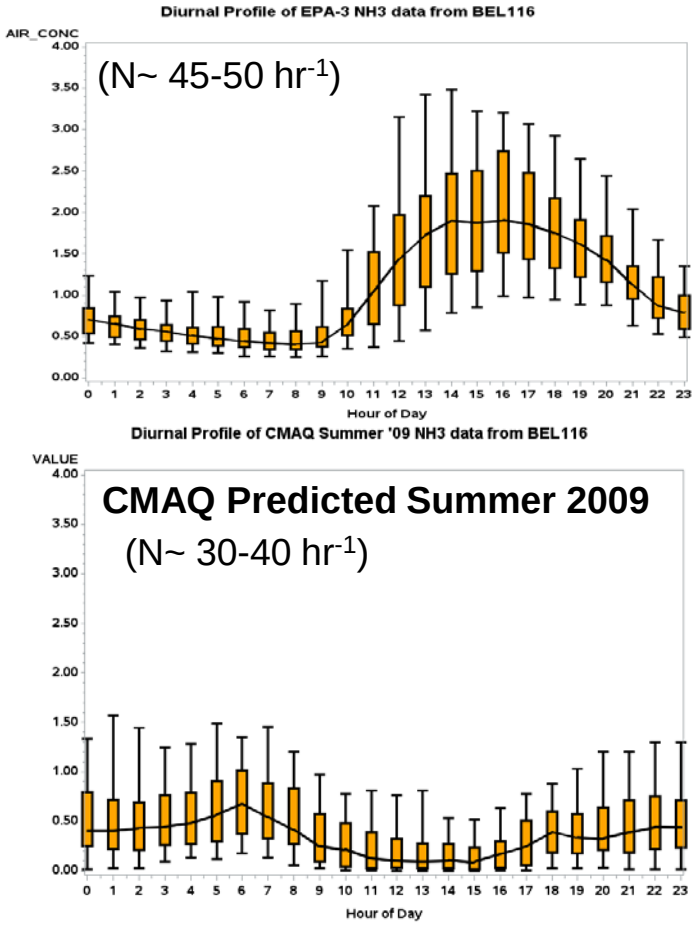


Note: winter artifact of low MU values could inlet adsorption or MDL

Weekly integrations between MU gives **35 ± 7%** difference
Good diurnal profile
Can use integrated passive samplers to estimate a response correction
Response correction to weekly aggregation improves MARPD from **54** to **31%**

Diurnal NH_3: CMAQ predicted vs. observed MARGA

Summer 2013



Diurnal patterns show that CMAQ values do not show Summer diurnal increase during daylight hours.

Observed MARGA values suggest that CMAQ algorithms should be revised.

Conclusions

-Better suited for Research intensives

-Expect more than a visit per week

-Artifacts:

-inlets are suspected to be problematic

-WRD types

-Detection method/Response issues (not a problem in 2S)

-Use of hourly SO_2 and integrated measurements are a good check and could be used as correction

-frequent cleaning imperative

Future Plans for the MARGA as a Research Instrument

Fall/early Winter 2014

1. Fix Cation pump
2. Evaluate Nitrogen components by collocating instruments with the Nitro-Train study and existing NO_y measurements.
3. Feed a standard addition NH_3 cal gas into an instrument to evaluate NH_3 response
4. Shorten the inlets by half of the length

Late Winter 2015

Upgrade 1S instruments into a 2S system to monitor direct deposition flux measurements in different locales.