Update on Methodologies and Findings of the NAEMS Open Source Component

PURDUE UNIVERSITY

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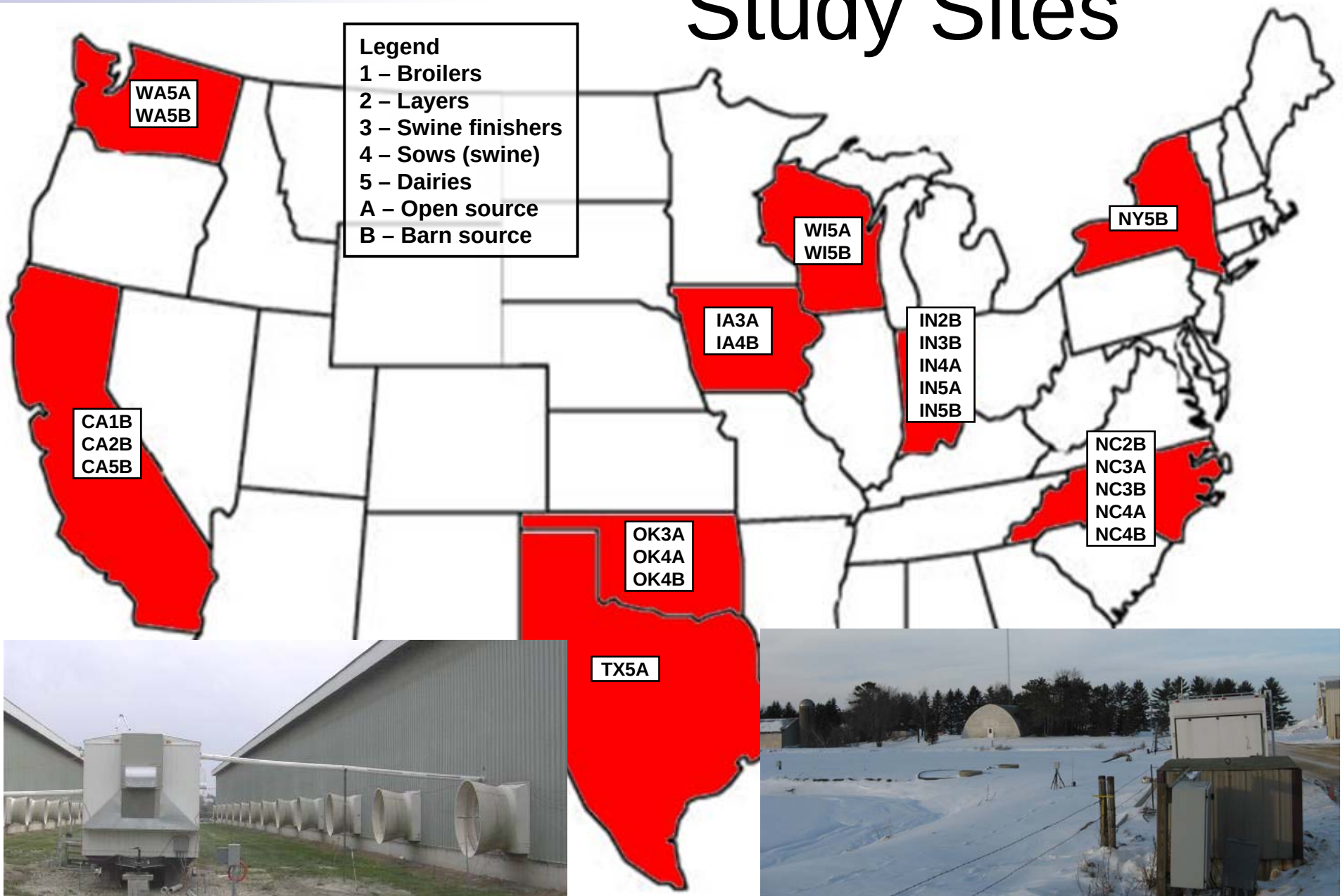
National Air Emissions Monitoring Study

- Study of emissions from barns and open sources on CAFOs funded by industry, science overseen by EPA and Industry
  - Particulates, H_2S, NH_3, CH_4 and other VOCS
- A regulatory study
  - Result of EPA-Industry Consent Agreement with CAFOs in 2005
  - Jun. 2007 Start routine measurements
  - Feb. 2010 End of study

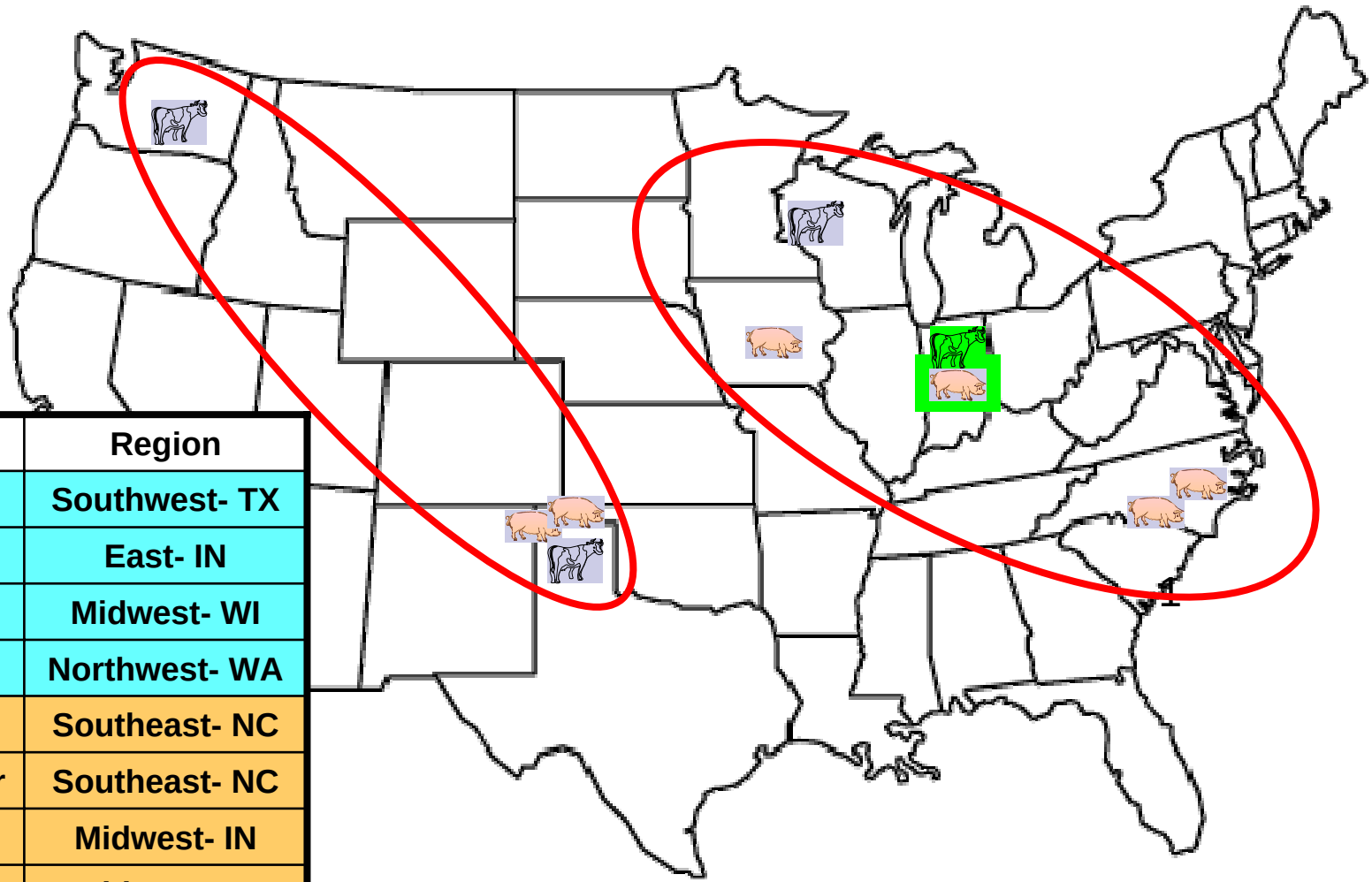
Study Sites


Legend
1 – Broilers
2 – Layers
3 – Swine finishers
4 – Sows (swine)
5 – Dairies
A – Open source
B – Barn source
WA5A
WA5B
CA1B
CA2B
CA5B
IA3A
IA4B
WI5A
WI5B
IN2B
IN3B
IN4A
IN5A
IN5B
NY5B
NC2B
NC3A
NC3B
NC4A
NC4B
OK3A
OK4A
OK4B
TX5A

NAEMS Open air component

- 8 locations monitored each quarter, 2 locations monitored 1 year continuous each
  - Measure NH_3 by TDLAS
  - Measure H_2S by pulsed fluorescence
  - Measure CH_4 (NH_3) by photoacoustic spectroscopy
  - Measure met: 3D winds, solar radiation, Pressure, T/RH, wetness
  - Measure lagoon: pH, redox, T

Measurement sites



Type	Region
Dairy	Southwest- TX
Dairy	East- IN
Dairy	Midwest- WI
Dairy	Northwest- WA
Pork-sow	Southeast- NC
Pork-finisher	Southeast- NC
Pork-sow	Midwest- IN
Pork-finisher	Midwest- IA
Pork-sow	West- OK
Pork-finisher	West- OK

Roving teams visit each area source once each quarter

Swine

- Barns typically close to lagoon
- Sites chosen to minimize fan exhaust to lagoon
- 6 farms

Dairies

- 4 farms

Measurements

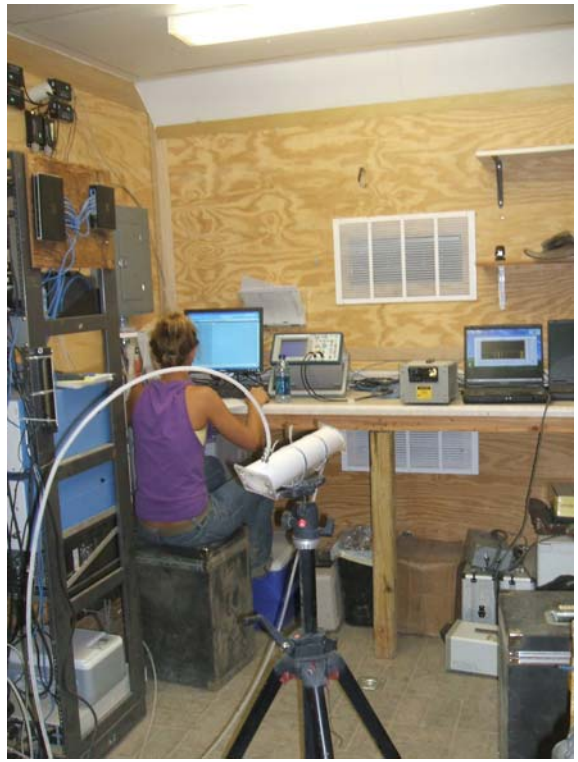
Gas Concentration	Gas Emissions
■ NH_3 ; TDLAS	Radial plume mapping (RPM)
■ H_2S; S-OPS/PF ■ VOCs; S-OPS/PAS	Backward Lagrangian Stochastic (bLS) or Ratiometric

Continuous concentration and meteorological measurements for 8-21 days per season at each site.

Emissions calculated every ½ hr.

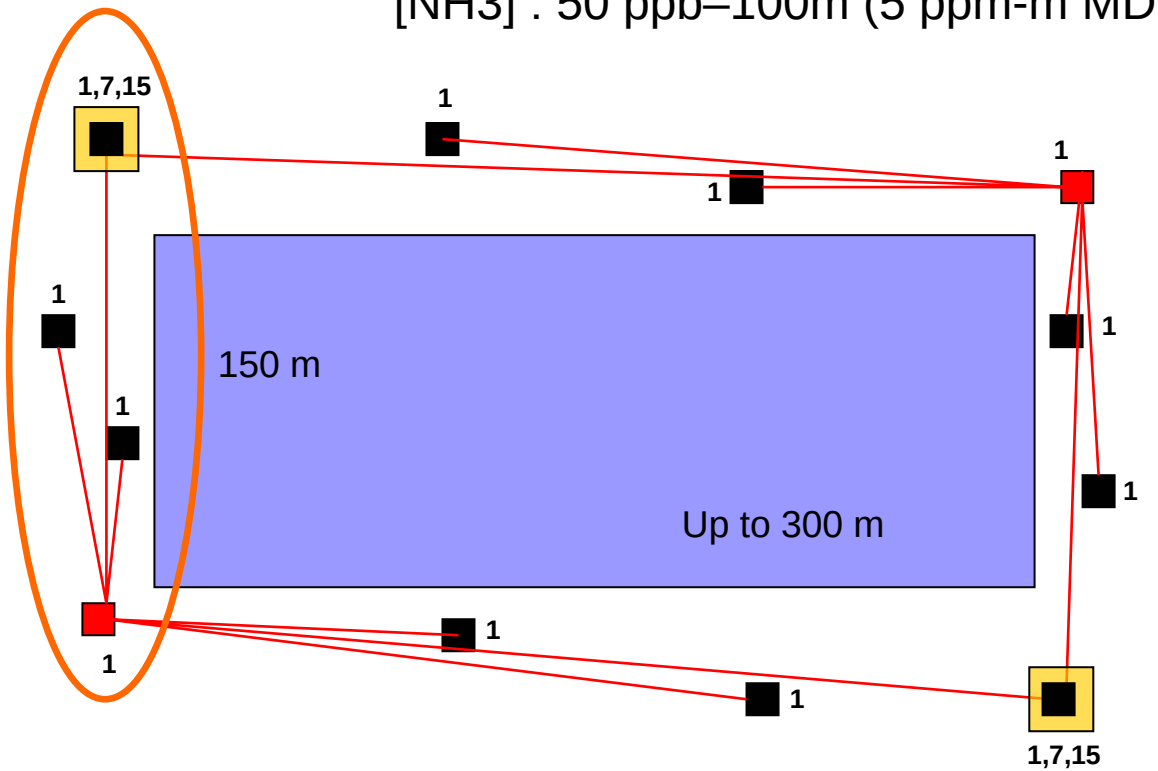
Measurement QA/ QC

- QAPP (700+ pages, SOPs, SMPs)
- Calibration every 6 mos.
- Calibration verification at beginning and end of each measurement period
- Internal equipment status checks
- Daily remote access operational checks
- Daily measurement data quality checks
  - Automated
  - Manual



NH_3 Measurements: TDLAS

[NH3] : 50 ppb–100m (5 ppm-m MDL)



Retro-reflectors

1-5 cubes for most paths

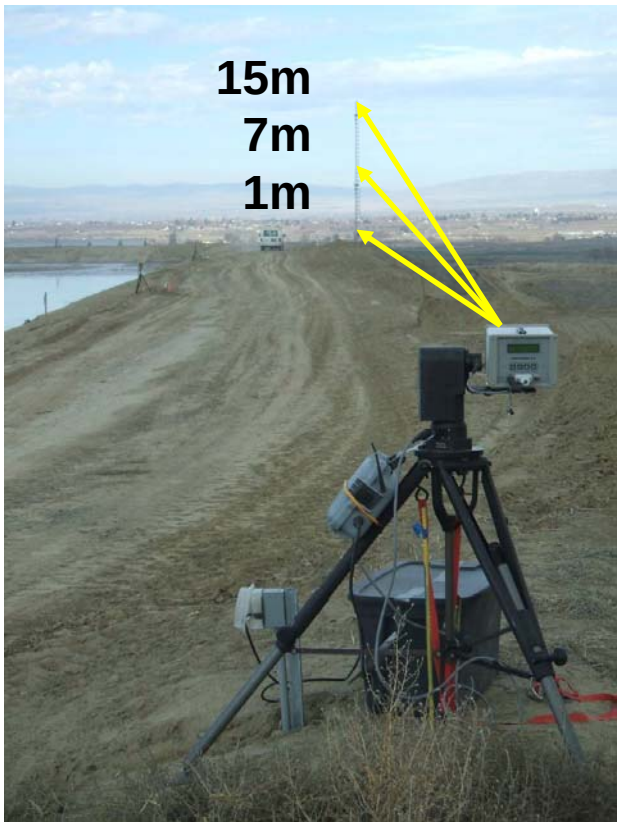
21 cubes for 750 m paths

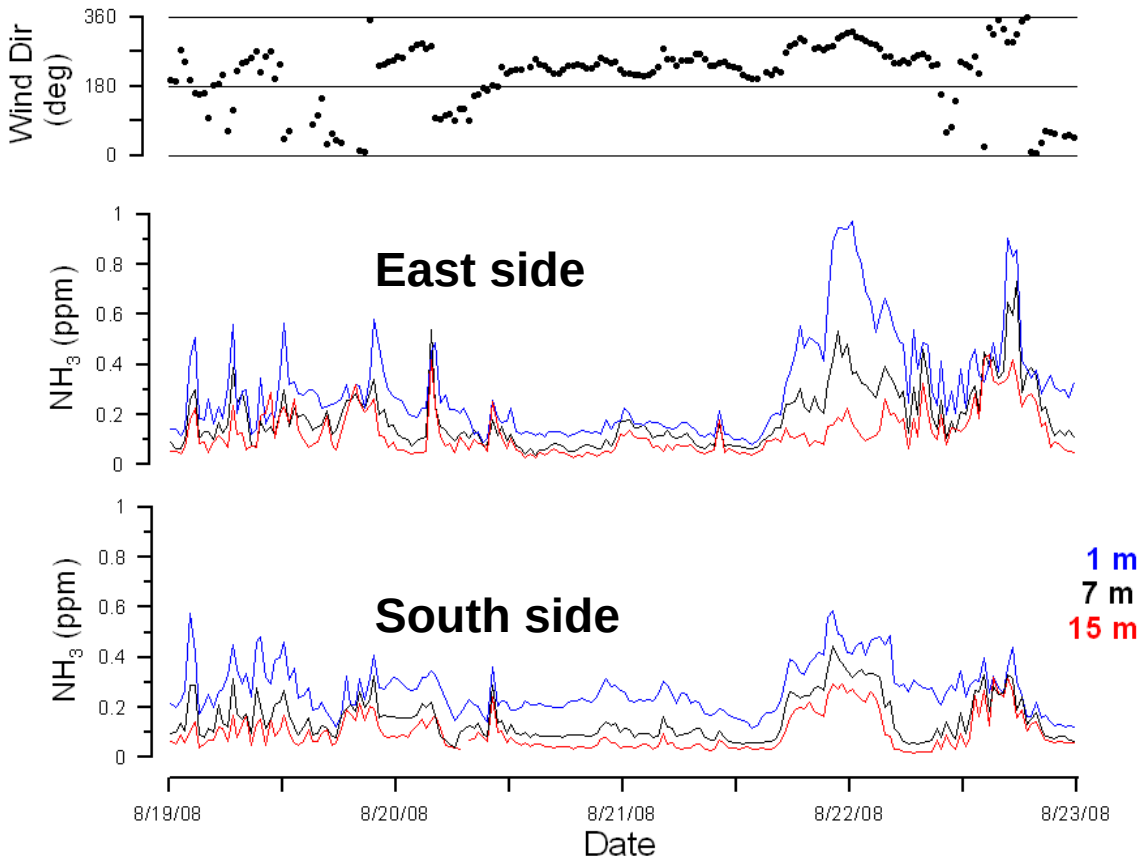
All retro's heated, pressure vented

TDLAS reflector

TDLAS

Example scanning TDLAS measurements on towers

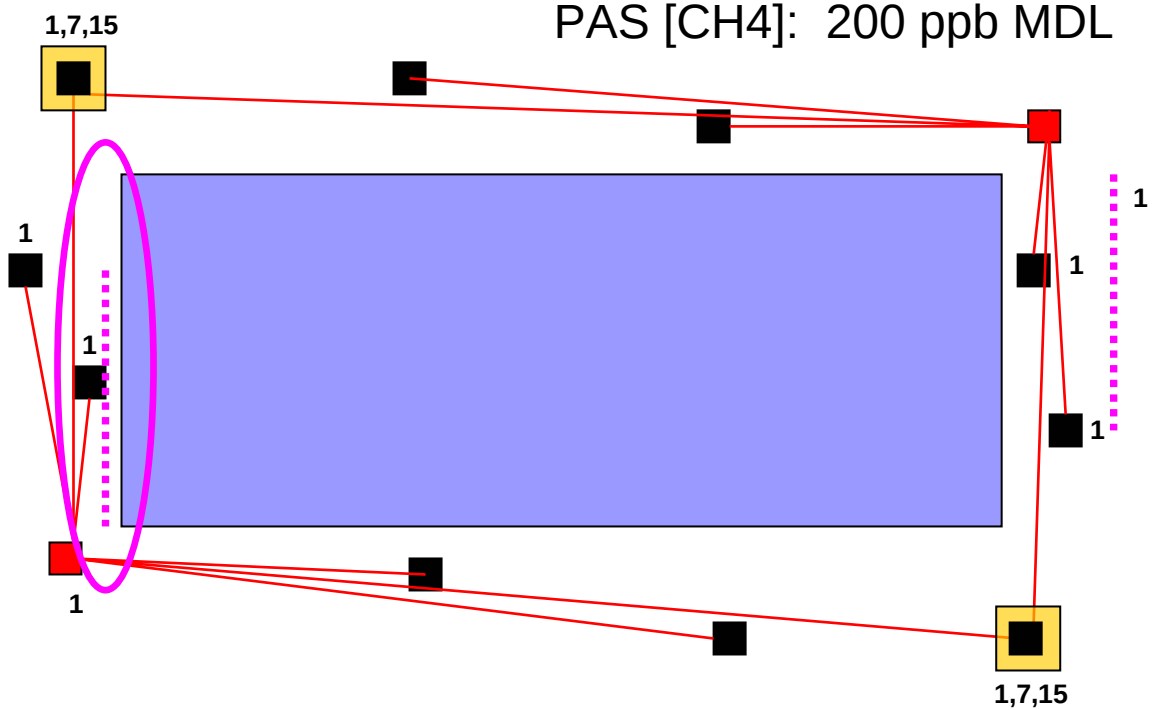




CH_4, H_2S Measurements: S-OPS

PF [H2S] : 2 ppb MDL
PAS [CH4]: 200 ppb MDL

50 m path

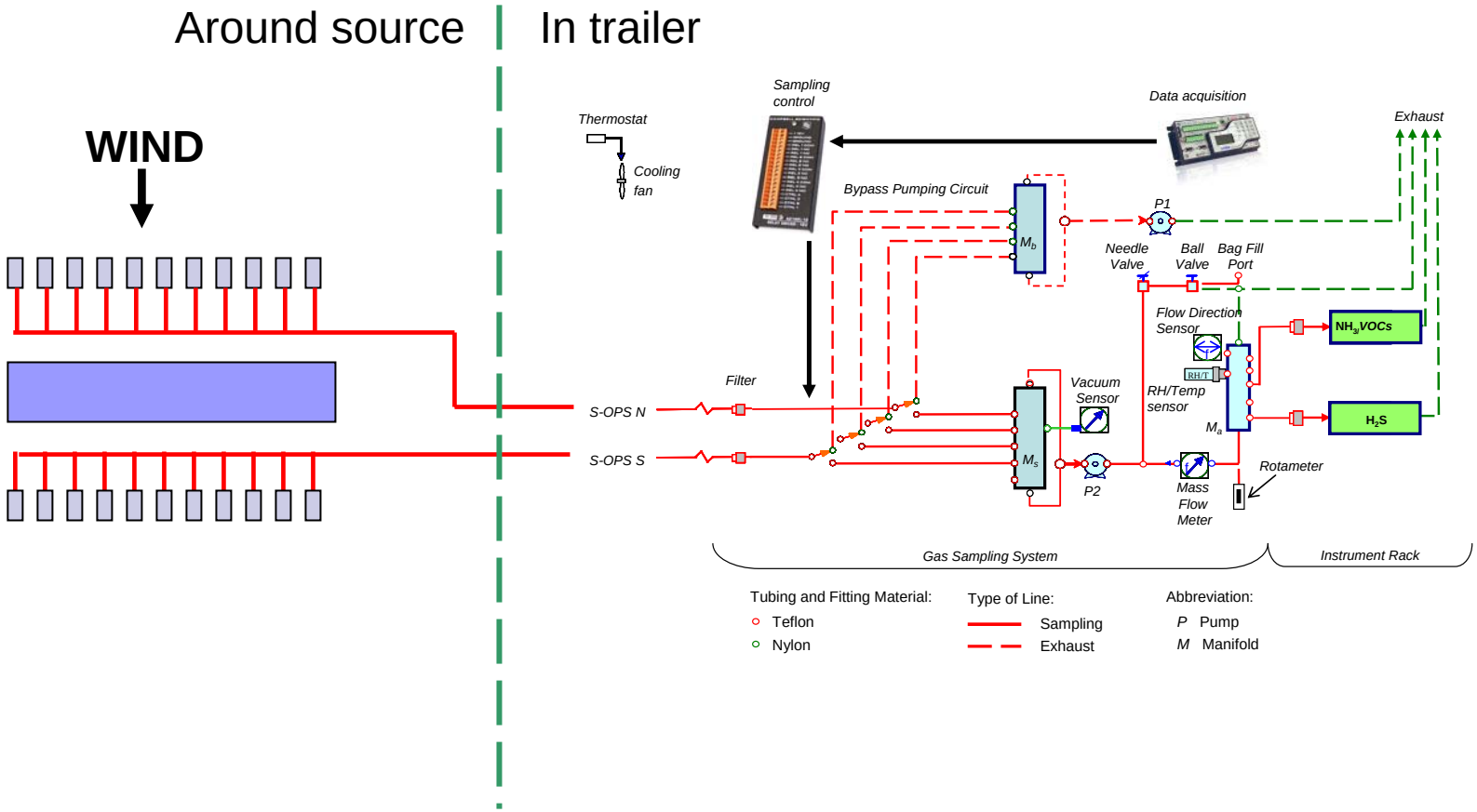


S-OPS

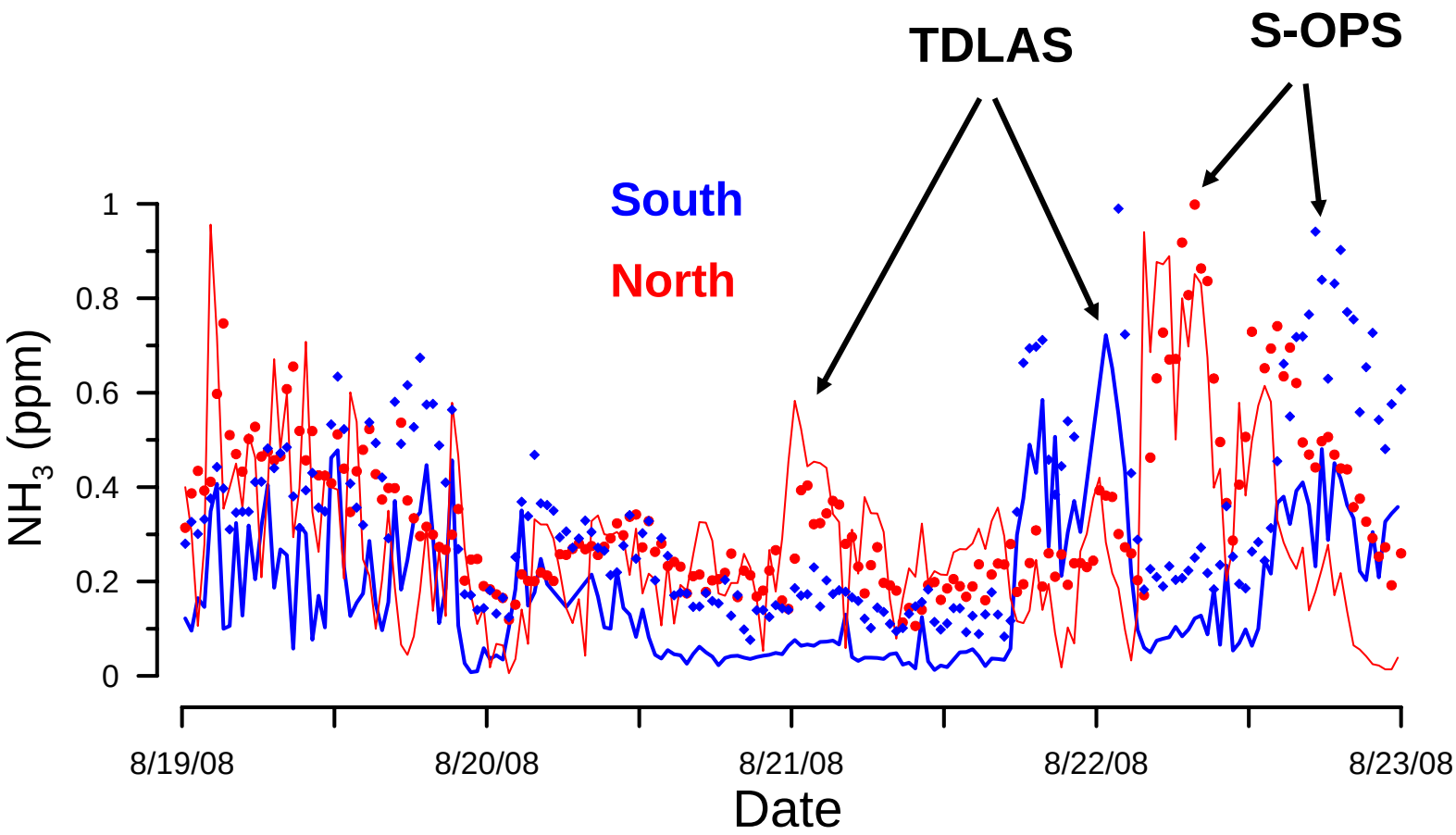
TDLAS reflector

TDLAS

S-OPS/ Gas sampling system

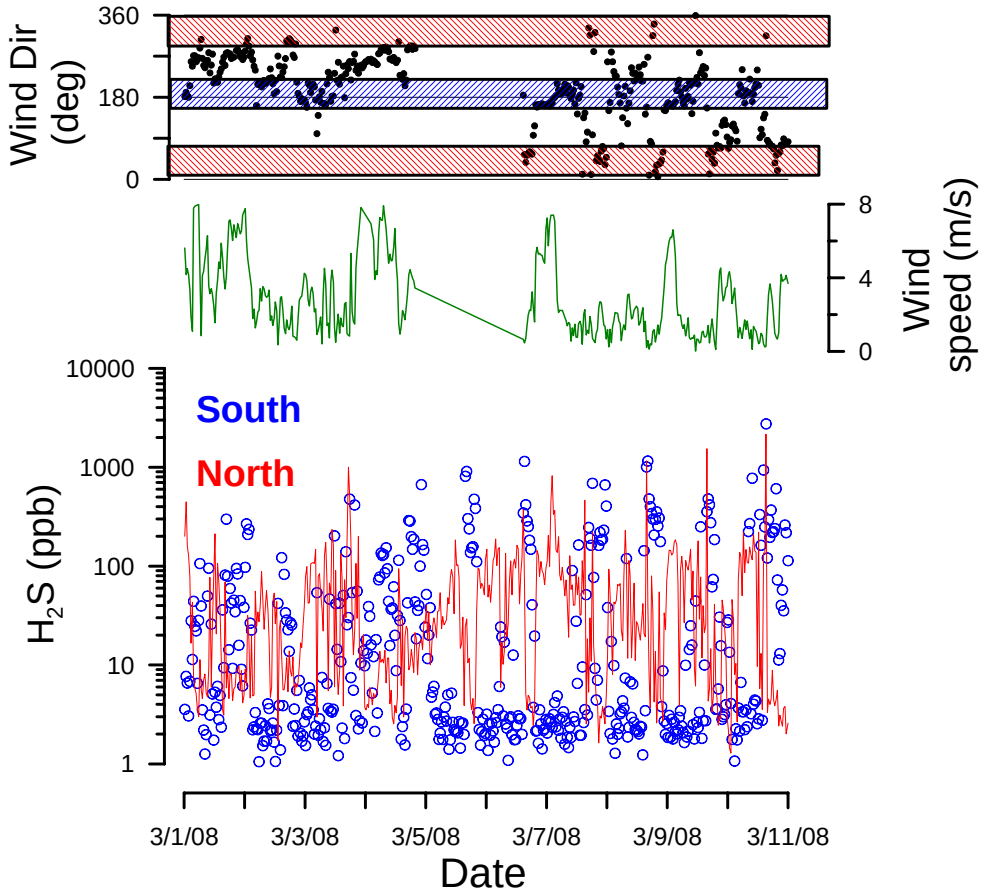


NH_3 TDLAS/S-OPS Comparison



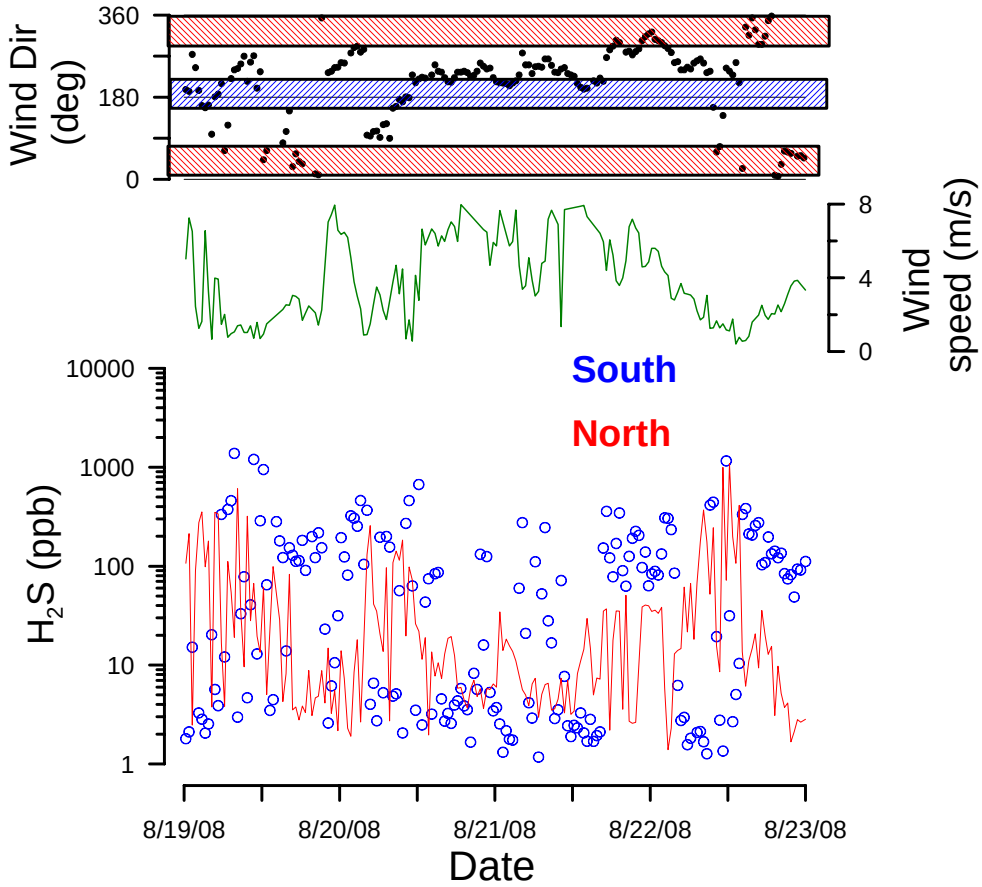
H_2S Measurements- open lagoon

- Uses S-OPS and GSS for upwind/ downwind



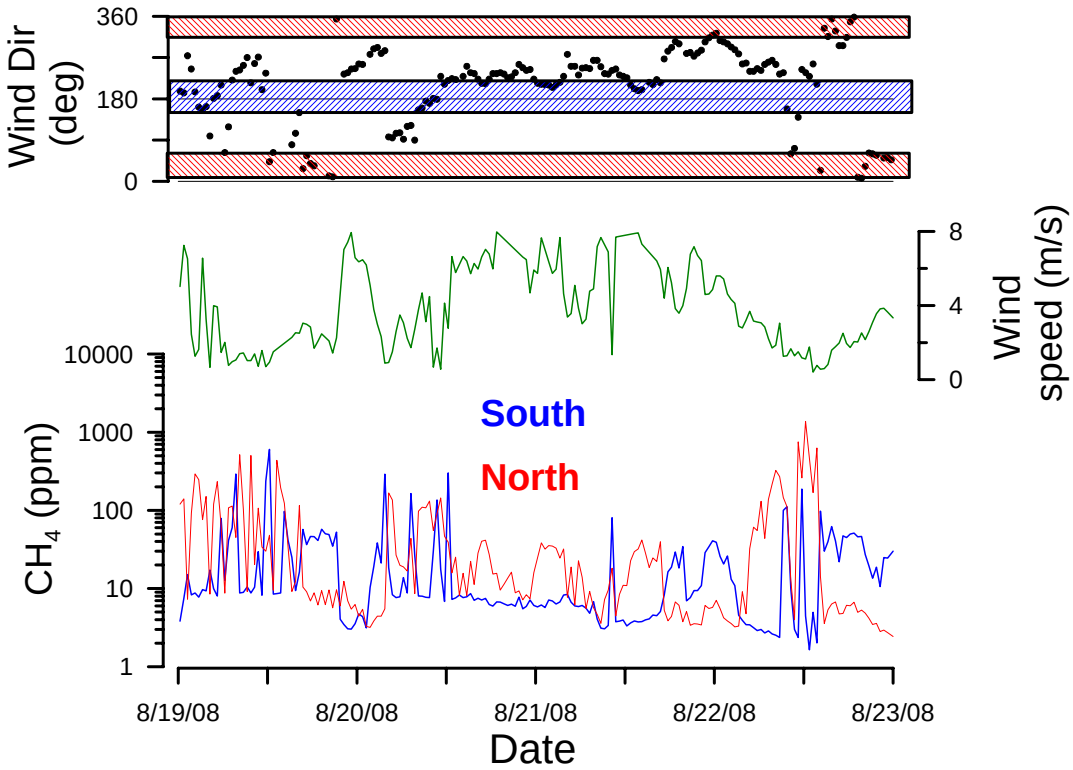
H_2S Measurements- crusted lagoon

- Uses S-OPS and GSS for upwind/ downwind

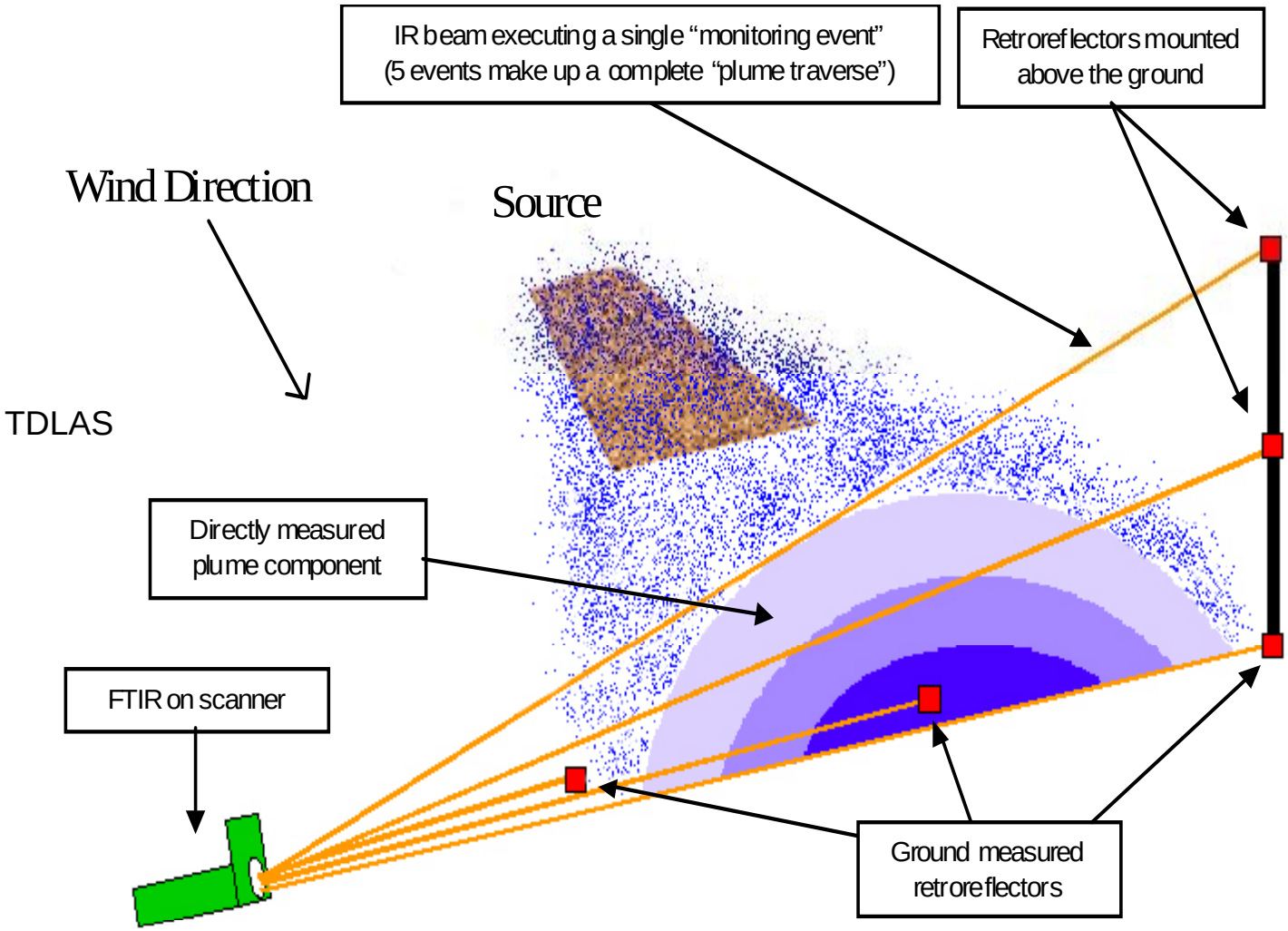


CH_4 Measurements- crusted lagoon

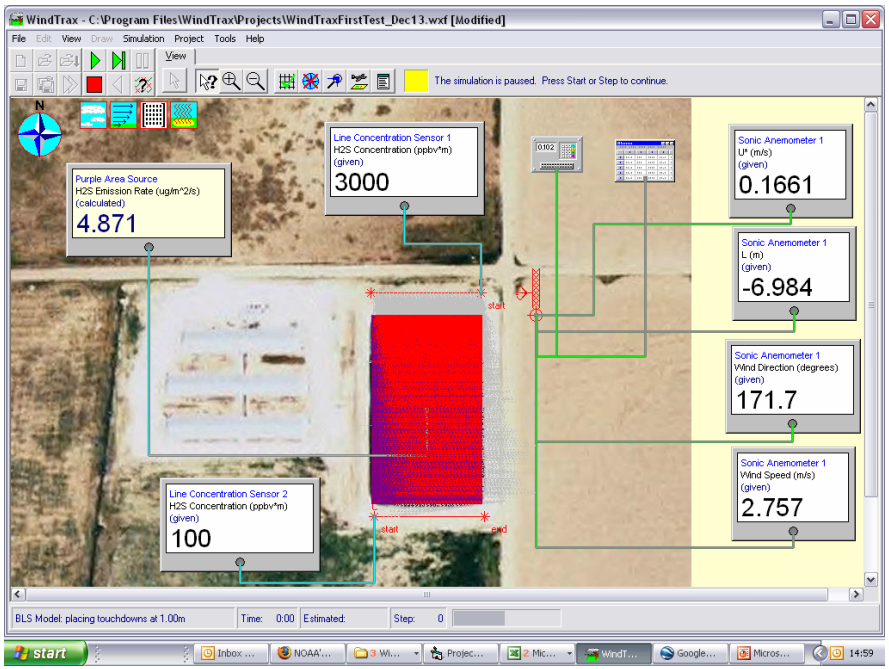
- Uses S-OPS and GSS for upwind/ downwind



RPM emissions

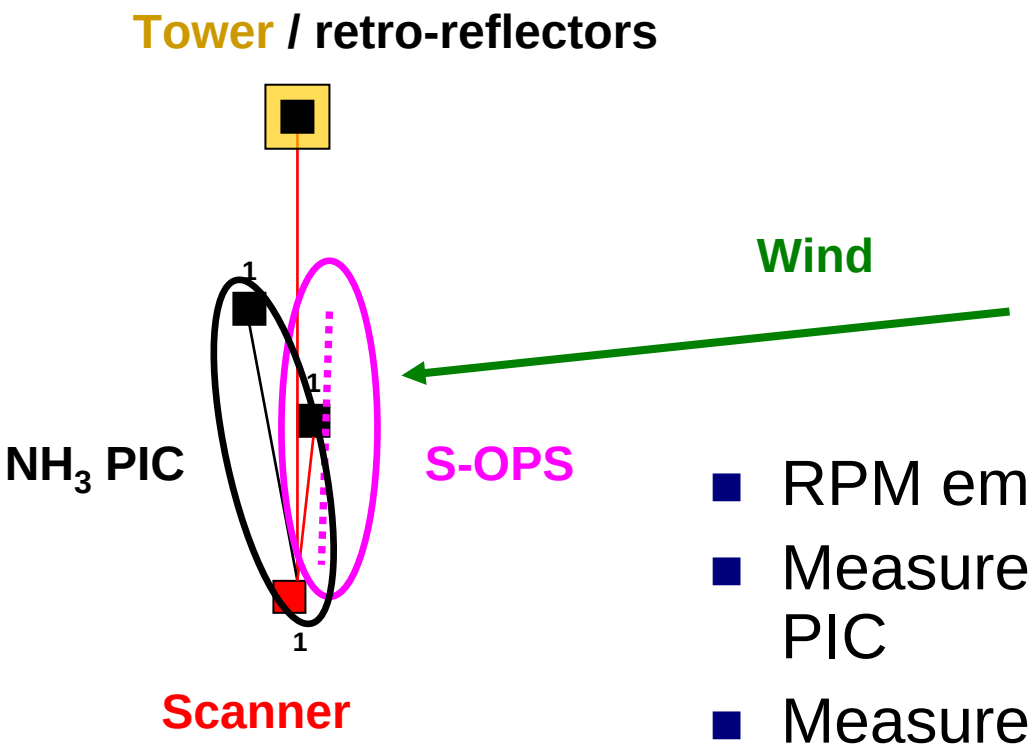


bLS emissions



- Measured turbulence and concentration of
  - NH_3 PIC from TDLAS
  - H_2S from S-OPS
  - CH_4 from S-OPS

Ratiometric emissions



- RPM emissions of NH_3
- Measured NH_3 of nearby PIC
- Measured concentration of H_2S (or CH_4) from S-OPS

Status of measurements

- 41 measurement period/locations completed
  - All weather conditions (Blizzards, Ice storms, tropical storms)
- Measurements to continue until mid Aug 2009