

1. Status and schedule for data from the last two deployments
2. Fall AGU
3. AQAST meeting attendance
4. Upcoming science team meeting
5. Colorado site survey plans
6. Science presentations

### California

- Still waiting for a few data sets
- P-3B is complete except for DACOM (which is imminent)
- P-3B merges have been updated since our last telecon and will be updated again as soon as DACOM data becomes available

### Houston

- Merges are now available for all P-3B flights
- This represents the data available for use in presentations at the AQAST meeting in January (please contact anyone whose data you are using)
- Final data deadline is 31 January 2014
- Please let Gao know if your circumstances will require an extension beyond the deadline

24 Abstracts covering 15 Sessions

Something to see everyday, only vacant period is Thursday AM

All 24 entries can be found by searching the abstracts for "DISCOVER-AQ"

## MONDAY, DECEMBER 09, 2013

### ☒ **A11C, A11C. Emissions and Impacts of Short-lived Climate Forcers | Posters (cosponsored by AMS)** [View Session Details](#) ☐ Include All in Itinerary

Convener(s): Luisa Molina (Molina Center for Energy & Env), Charles Kolb (Aerodyne Research Inc) and Rebecca Sheesley (Baylor University)  
8:00 AM - 12:20 PM; Hall A-C (Moscone South)

8:00 AM - 8:00 AM	A11C-0062. Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX <i>Rebecca J. Sheesley; Tate E. Barrett; Subin Yoon; Adelaide Clark; Sascha Usenko</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
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### ☒ **A13D, A13D. Sources and Chemistry of Atmospheric Oxidants | Posters** [View Session Details](#) ☐ Include All in Itinerary

Convener(s): Timothy Bertram ( ) and Kerri Pratt (University of Michigan Ann Arbor)  
1:40 PM - 6:00 PM; Hall A-C (Moscone South)

1:40 PM - 1:40 PM	A13D-0247. Indicators of photochemistry in DISCOVER-AQ observations: Implications for diagnosing ozone production and photochemical intensity from space. <i>James H. Crawford; Jennifer R. Olson; Gao Chen; Mary M. Kleb; Andrew J. Weinheimer; David J. Knapp; Denise Montzka; Alan Fried; James Walega; Glenn S. Diskin; Glen W. Sachse; Armin Wisthaler; Tomas Mikoviny; John D. Barrick; Scott J. Janz; Matthew G. Kowalewski; Melissa M. Yang; Kenneth E. Pickering</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
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## TUESDAY, DECEMBER 10, 2013

- ☐
**A21D, A21D, Meso-scale Aerosol Processes, Comparison and Validation Studies from DRAGON Networks within AERONET I Posters [SWIRL\_DA] (cosponsored by AMS)**
[View Session Details](#)
☐ Include All in Itinerary
- Convener(s): Itaru Sano (Kinki University) and Thomas Eck (Nasa Goddard SFC)  
8:00 AM - 12:20 PM; Hall A-C (Moscone South)
- 
- 8:00 AM - 8:00 AM
 

A21D-0071, Aerosol Optical Thickness comparisons between NASA LaRC Airborne HSRL and AERONET during the DISCOVER-AQ field campaigns  
*Amy J. Scarino; Richard A. Ferrare; Sharon P. Burton; Chris A. Hostetler; Johnathan W. Hair; Raymond R. Rogers; Timothy Berkoff; Anthony L. Cook; David B. Harper; Raymond M. Hoff; Brent N. Holben; Joel Schafer; Matthew J. McGill; John E. Yorks; Kathleen O. Lantz; Joseph J. Michalsky; Gary Hodges*  
[View Presentation](#)

☐ Include in Itinerary
- 
- ☐
**A21F, A21F, Recent Advances in Spectro-polarimetric Studies of Aerosols, Clouds, and Earth's Surface Properties I Posters [SWIRL\_DA]**
[View Session Details](#)
☐ Include All in Itinerary
- Convener(s): Olga Kalashnikova ( ), Bastiaan van Dierenhoven (Columbia University in the City of New York), Kirk Knobelspiesse (NASA Ames Research Center) and Leigh Munchak (NASA Goddard Space Flight Center)  
8:00 AM - 12:20 PM; Hall A-C (Moscone South)
- 
- 8:00 AM - 8:00 AM
 

A21F-0118, Polarized Imaging Nephelometer Scattering Measurements from the Winter of 2013 Discover-AQ Field Mission  
*Reed Espinosa; Jose-Vanderlei Martins; Gergely Dolgos; Oleg Dubovik; Luke D. Ziemba; Andreas J. Beyersdorf*  
[View Presentation](#)

☐ Include in Itinerary

<b>A23A. A23A. Atmospheric Composition and Chemistry Posters</b>		<a href="#">View Session Details</a>	<input type="checkbox"/> Include All in Itinerary
Convener(s): Natasha Andronova (UM Atm, Oce & Spc Sci) and Melody Avery (NASA Langley Research Ctr) 1:40 PM - 6:00 PM; Hall A-C (Moscone South)			
1:40 PM - 1:40 PM	A23A-0191. Chemical Characterization of Gas and Particle-phase Water-Soluble Species during Winter 2013 DISCOVER-AQ Campaign in Fresno, CA <i>Caroline Parworth; Hwajin Kim; Qi Zhang</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary	
1:40 PM - 1:40 PM	A23A-0211. Comparison of airborne and ground-based aerosol optical measurements made during DISCOVER-AQ California <i>Kenneth L. Thornhill; Gao Chen; Edward Winstead; Bruce E. Anderson; Luke D. Ziemba; Andreas J. Beyersdorf; Suzanne Crumeyrolle; Richard Moore; Michael Shook; Mary M. Kleb</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary	
<b>A24C. A24C. Meso-scale Aerosol Processes, Comparison and Validation Studies from DRAGON Networks within AERONET II [SWIRL_DA] (cosponsored by AMS)</b>		<a href="#">View Session Details</a>	<input type="checkbox"/> Include All in Itinerary
Convener(s): Brent Holben (NASA/GSFC) and Jhoon Kim (Yonsei Univ Dept Atmos Science) 4:00 PM - 6:00 PM; 3006 (Moscone West)			
5:15 PM - 5:30 PM	A24C-06. Analysis of Aerosol Spatial Variability from AERONET-DRAGON and MISR High-Resolution Data during DISCOVER-AQ <i>Olga Kalashnikova; Michael J. Garay; Ralph A. Kahn; Jim Limbacher; Richard A. Ferrare</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary	
5:30 PM - 5:45 PM	A24C-07. Multi-sensor Approach on Air Quality Application and Assessment Using Measurements in DISCOVER-AQ as a Testbed <i>D. Allen Chu; Richard A. Ferrare; Jasper R. Lewis; Erica L. McGrath-Spangler; Ellsworth J. Welton; Jennifer Hains; James Szykman; Brent N. Holben</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary	



## **A31C. A31C. Measurements, Modeling, and Evaluation of Emissions I Posters**

[View Session Details](#)
☐ Include All in Itinerary

Convener(s): Gregory Frost (NOAA), Monika Kopacz ( ) and Lucy Hutyra (Boston University)

8:00 AM - 12:20 PM; Hall A-C (Moscone South)

8:00 AM - 8:00 AM	A31C-0071. Spatial variability of ammonia and methane dairy emissions in the Central Valley, California with open-path mobile measurements during NASA DISCOVER-AQ 2013	<input type="checkbox"/> Include in Itinerary
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*David J. Miller; Kang Sun; Lei Tao; Mark A. Zondlo*

[View Presentation](#)

8:00 AM - 8:00 AM	A31C-0093. Aerosol Composition and Variability in the San Joaquin Valley Measured during DISCOVER-AQ	<input type="checkbox"/> Include in Itinerary
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*Andreas J. Beyersdorf; Suzanne Crumeyrolle; Luke D. Ziemba; Sally E. Pusede; John B. Nowak; Sharon P. Burton; Gao Chen; Ronald C. Cohen; Kaitlin Duffey; Richard A. Ferrare; Chris A. Hostetler; Robert Martin; Richard Moore; Kenneth L. Thornhill; Edward Winstead; Bruce E. Anderson*

[View Presentation](#)

## **A31K. A31K. Meso-scale Aerosol Processes, Comparison and Validation Studies from DRAGON Networks within AERONET III [SWIRL\_DA] (cosponsored by AMS)**

[View Session Details](#)
☐ Include All in Itinerary

Convener(s): Jhoon Kim (Yonsei Univ Dept Atmos Science) and Brent Holben (NASA/GSFC)

8:00 AM - 10:00 AM; 3006 (Moscone West)

8:00 AM - 8:15 AM	A31K-01. Evaluation of Extinction Profiles and Aerosol Optical Depth from Lidar and DRAGON in the Baltimore-Washington DISCOVER-AQ Experiment ( <i>Invited</i> )	<input type="checkbox"/> Include in Itinerary
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*Raymond M. Hoff; Patricia Sawamura; Brent N. Holben; Joel Schafer; Shobha Kondragunta; Richard A. Ferrare; Amy J. Scarino; Raymond R. Rogers; Michael D. Obland; Johnathan W. Hair; Chris A. Hostetler; Timothy Berkoff; Ruben Delgado*

[View Presentation](#)

8:15 AM - 8:30 AM	A31K-02. Measurements of aerosol distributions and properties from Airborne High Spectral Resolution Lidar and DRAGON during the DISCOVER-AQ California Experiment ( <i>Invited</i> )	<input type="checkbox"/> Include in Itinerary
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*Richard A. Ferrare; Sharon P. Burton; Amy J. Scarino; Chris A. Hostetler; Johnathan W. Hair; Raymond R. Rogers; Detlef Mueller; Eduard Chemyakin; Anthony L. Cook; David B. Harper; Richard Hare; Brent N. Holben; Joel Schafer; Bruce E. Anderson; Patricia Sawamura*

[View Presentation](#)

9:15 AM - 9:30 AM	A31K-06. Intercomparison of aerosol optical and micro-physical properties derived from AERONET surface radiometers and LARGE in-situ aircraft profiles during the 2011 DRAGON-MD and DISCOVER-AQ experiments	<input type="checkbox"/> Include in Itinerary
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*Joel Schafer; Thomas F. Eck; Kenneth L. Thornhill; Brent N. Holben; Bruce E. Anderson; Aliaksandr Sinyuk; Luke D. Ziemba; David M. Giles; Edward Winstead; Andreas J. Beyersdorf; Peter Kenny; Alexander Smirnov; Ilya Slutsker*

[View Presentation](#)

	<b>A33A. A33A. Advances in Atmospheric Inverse Modeling of Land-Atmosphere Exchange Processes II Posters [SWIRL_CU] (cosponsored by AMS)</b>	<a href="#">View Session Details</a>	<input type="checkbox"/> Include All in Itinerary
Convener(s): Abhishek Chatterjee (National Center for Atmospheric Research), Mathias Goeckede (MPI Biogeochemistry) and Andrew Schuh (Colorado State University)			
1:40 PM - 6:00 PM; Hall A-C (Moscone South)			
1:40 PM - 1:40 PM	A33A-0191, Application and evaluation of the WRF-CMAQ modeling system to the 2011 DISCOVER-AQ Baltimore-Washington D.C. study <i>Wyat Appel; Robert C. Gilliam; George A. Pouliot; James M. Godowitch; Jonathan Pleim; Christian Hogrefe; Daiwen Kang; Shawn J. Roselle; Rohit Mathur</i> <a href="#">View Presentation</a>		<input type="checkbox"/> Include in Itinerary

☐ **A43A. A43A. Atmospheric Boundary Layer Processes and Turbulence I Posters**  
(cosponsored by AMS)

[View Session Details](#)

☐ Include All in Itinerary

Convener(s): Christoph Thomas (Oregon State University), Elie Bou-Zeid (Princeton University) and Marcelo Chamecki (Pennsylvania State University)  
1:40 PM - 6:00 PM; Hall A-C (Moscone South)

1:40 PM - 1:40 PM      A43A-0205, COMPARISON OF OBSERVED AND SIMULATED BOUNDARY LAYER HEIGHT ESTIMATES DURING DISCOVER-AQ JULY 2011

☐ Include in Itinerary

*Clare Flynn; Kenneth E. Pickering; Richard A. Ferrare; Amy J. Scarino; Ruben Delgado; Douglas K. Martins; Donald H. Lenschow; Christopher Loughner; Anne M. Thompson*

[View Presentation](#)

1:40 PM - 1:40 PM      A43A-0228, Daily Evolution of Boundary Layer Properties based on NASA DISCOVER-AQ Airborne Profiles over the California San Joaquin Valley

☐ Include in Itinerary

*Michael Shook; Mary M. Kleb; Gao Chen; Bruce E. Anderson; John D. Barrick; Glenn S. Diskin; David P. Van Gilst; Andrew J. Weinheimer; Melissa M. Yang; Donald H. Lenschow*

[View Presentation](#)

☐ **A43I. A43I. Measurements, Modeling, and Evaluation of Emissions V**

[View Session Details](#)

☐ Include All in Itinerary

Convener(s): Gregory Frost (NOAA), Monika Kopacz ( ) and Lucy Hutyra (Boston University)  
1:40 PM - 3:40 PM; 3008 (Moscone West)

3:10 PM - 3:25 PM      A43I-05, The National Emissions Inventory Significantly Overestimates NO<sub>x</sub> Emissions: Analysis of CMAQ and in situ observations from DISCOVER-AQ

☐ Include in Itinerary

*Daniel C. Anderson; Russell R. Dickerson; Christopher Loughner*

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☐ **A44F. A44F. Measuring and Modeling the Greenhouse Gas Emissions of Cities and Localized Rural Sources I [SWIRL\_US] (Virtual Option) (cosponsored by AMS)**

[View Session Details](#)

☐ Include All in Itinerary

Convener(s): Riley Duren (Jet Propulsion Laboratory) and Irène XUEREF-REMY (IPSL-LSCE)  
4:00 PM - 6:00 PM; 2022 (Moscone West)

5:30 PM - 5:45 PM      A44F-06, Spatial surveys of CH<sub>4</sub> emissions with a mobile multi-gas sensing platform during DISCOVER-AQ and CAREBEIJING-NCP field campaigns

☐ Include in Itinerary

*Lei Tao; Kang Sun; David J. Miller; Tong Zhu; Mark A. Zondlo*

[View Presentation](#)



## FRIDAY, DECEMBER 13, 2013

### A51A, A51A, Aerosols Above Clouds | Posters [SWIRL\_DA] (cosponsored by AMS)

[View Session Details](#)
☐ Include All in Itinerary

Convener(s): Omar Torres (NASA Goddard Space Flight Center), Hiren Jethva (USRA/GESTAR) and Eric Wilcox (Desert Research Institute)

8:00 AM - 12:20 PM; Hall A-C (Moscone South)

8:00 AM - 8:00 AM

A51A-0009. Multi-wavelength Airborne High Spectral Resolution Lidar Observations of Aerosol Above Clouds in California during DISCOVER-AQ

☐ Include in Itinerary

*Chris A. Hostetler; Sharon P. Burton; Richard A. Ferrare; Raymond R. Rogers; Detlef Mueller; Eduard Chemyakin; Anthony L. Cook; David B. Harper; Luke D. Ziemba; Andreas J. Beyersdorf; Bruce E. Anderson*

[View Presentation](#)

- A53A. A53A. Atmospheric Impacts of Oil and Gas Development III Posters (cosponsored by AMS)**

[View Session Details](#)
☐ Include All in Itinerary

Convener(s): Randal Martin (Utah State Univ), James Roberts (NOAA/ESRL) and Gabrielle Petron (NOAA)  
 1:40 PM - 6:00 PM; Hall A-C (Moscone South)

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1:40 PM - 1:40 PM	A53A-0133, Wintertime Air Quality Measurements in the Southern San Joaquin Valley as Part of Nasa's Discover-aq Campaign <i>Douglas K. Martins; Ryan M. Stauffer; Hannah Halliday; Anne M. Thompson; Andrew J. Weinheimer; Glenn S. Diskin; Nathan Trevino</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
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- A53C. A53C. Constituent Source Characterization, Transport and Chemistry II Posters (cosponsored by AMS)**

[View Session Details](#)
☐ Include All in Itinerary

Convener(s): Nicola Blake (University California Irvine), Eric Apel (NCAR) and Vivienne Payne (Jet Propulsion Laboratory)  
 1:40 PM - 6:00 PM; Hall A-C (Moscone South)

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1:40 PM - 1:40 PM	A53C-0175, Highly Size- and Time- Resolved Aerosol Source Allocation at Urban and Rural Sites During NASA - DISCOVER-AQ Winter Study 2013 in the San Joaquin Valley, CA <i>Richard A. VanCuren; Yongjing Zhao; Kevin D. Perry</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
1:40 PM - 1:40 PM	A53C-0183. Investigation of the impact of volatile organic compounds on air chemistry measured in Maryland, California and Texas during NASA's DISCOVER-AQ campaign <i>Hannah Halliday; Debra E. Kollonige; Douglas K. Martins; Anne M. Thompson; Jose D. Fuentes</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
1:40 PM - 1:40 PM	A53C-0184, Large Vertical Gradient of Reactive Nitrogen Oxides in the Boundary Layer: Modeling Analysis of DISCOVER-AQ Observations <i>Yuzhong Zhang; Yuhang Wang; Gao Chen; Charles Smeltzer; Zhen Liu; James H. Crawford; Jennifer R. Olson; James Szykman</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary
1:40 PM - 1:40 PM	A53C-0188, A Transport Analysis of In Situ Airborne Ozone Measurements from the 2011 DISCOVER-AQ Campaign <i>Heather L. Arkinson; Lacey C. Brent; Hao He; Christopher Loughner; Jeffrey W. Stehr; Andrew J. Weinheimer; Russell R. Dickerson</i> <a href="#">View Presentation</a>	<input type="checkbox"/> Include in Itinerary



## **NASA Air Quality Applied Sciences Team (AQAST) 6th Biannual Meeting Rice University January 15-17, 2014**

We could support travel for a few team members to attend.

Who is interested?

The meeting will precede the data deadline.

What preliminary data and/or model analyses could be ready?

[Home](#) [Program](#) [Registration](#) [Venue and Accommodations](#)

### **6th NASA AQAST MEETING (AQAST6)**

The 6th meeting of the NASA Air Quality Applied Sciences Team (AQAST6), will be held on January 15-17, 2014, at Rice University in Houston, TX. The meeting is open to all, and air quality managers are particularly invited to attend.

AQAST is a NASA-funded team of atmospheric scientists focused on serving air quality management needs through the use of Earth Science data and tools. AQAST conducts a wide range of projects in partnership with air quality agencies at the local, state, regional, and national levels. It has the flexibility to continually take on new projects based on input from the air quality management community. For more information please visit the [AQAST website](#).

AQAST meetings are held every six months and bring together team members, air quality managers, and research and applications partners. The goals of these meetings are to:

1. Share information and progress on AQAST activities;
2. Hear from air quality managers about pressing issues and determine how AQAST can help;
3. Inform air quality managers of the resources available through AQAST.

**This is an important opportunity to identify items of high priority for the science team meeting in February**



## Science Team Meeting



When: 24-28 February

Where: NASA Langley Research Center (Hampton, VA)

Preliminary Agenda: (different from last telecon)

24 February	Maryland
25-26 February	California
27-28 February	Houston

Venue: Reid Conference Center

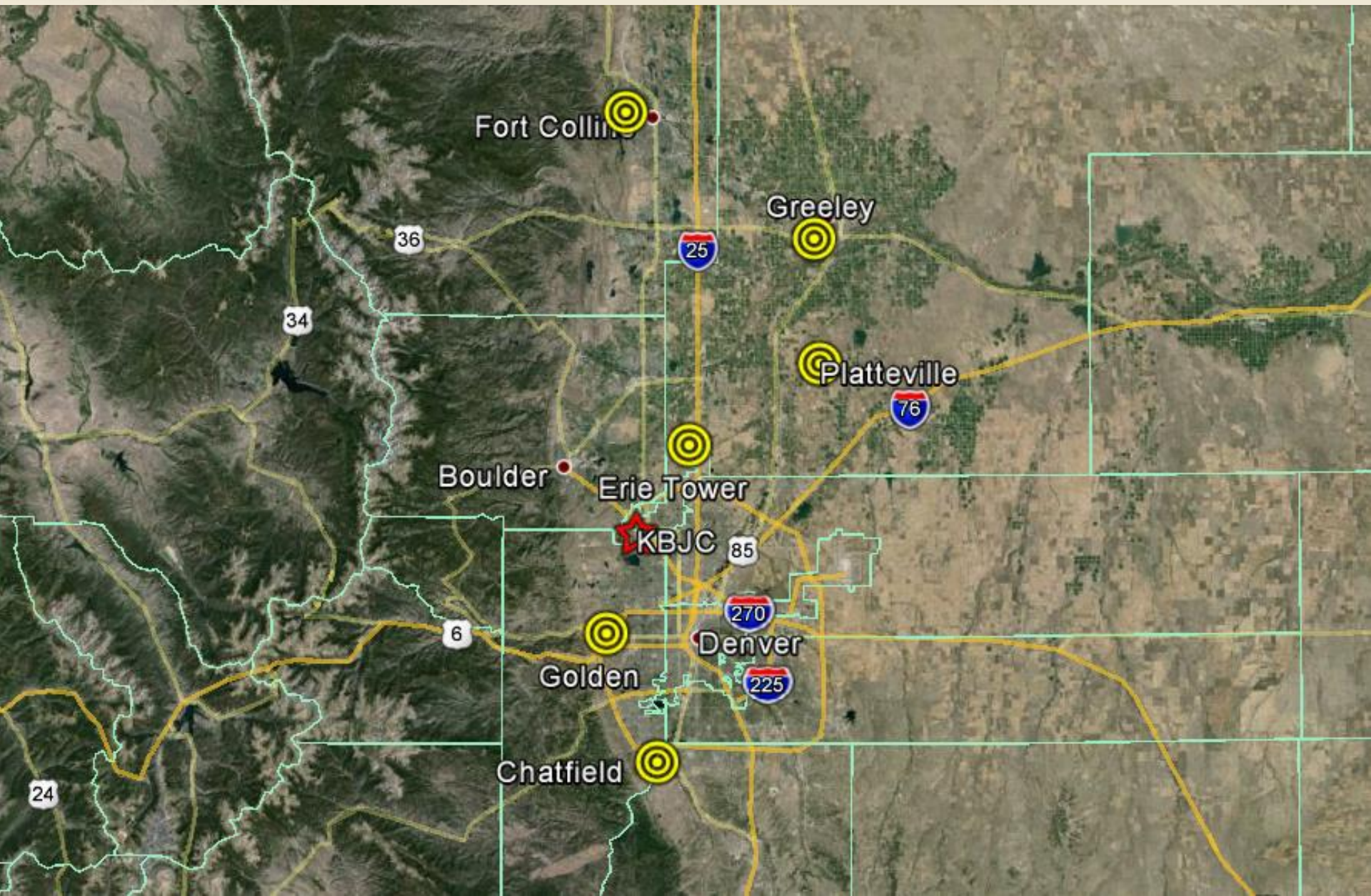
Travel Support: The project has budgeted for the typical travel support for each PI plus one group member to attend. We are willing to consider additional requests and would appreciate any creative solutions (e.g., sharing of accommodations) to increase attendance.

Badging: Badges will be necessary since the meeting is on the NASA grounds

Please start informing Mary Kleb of attendees from your group.

Travel instructions will be available by the next telecon.







Limited dates for site survey due to AGU, NSF-CONTRAST mission, and CDPHE activities

Preliminary dates: 16-19 December

16 Dec (PM) – Visit hotels in Louisville and Broomfield area

17 Dec (AM) – Visit airfield

17 Dec (PM) – Tour ground sites in Denver

18 Dec (all day) – Tour ground sites north of Denver

19 Dec (AM) – Meet with NCAR/NOAA partners (also finish ground site tours if necessary)

Who is available? If not available, let's make sure that we are prepared to get answers to all of your questions.

Chatfield



# Agricultural ammonia and methane emissions in the Central Valley, California: High resolution, mobile measurements during NASA DISCOVER-AQ 2013

**David J. Miller<sup>1</sup>, Kang Sun<sup>1</sup>, Lei Tao<sup>1</sup>, and Mark A. Zondlo<sup>1</sup>**

***1. Department of Civil and Environmental Engineering, Princeton University***

***AGU Poster (December 11): A31C-0071***

***Collaborators:***

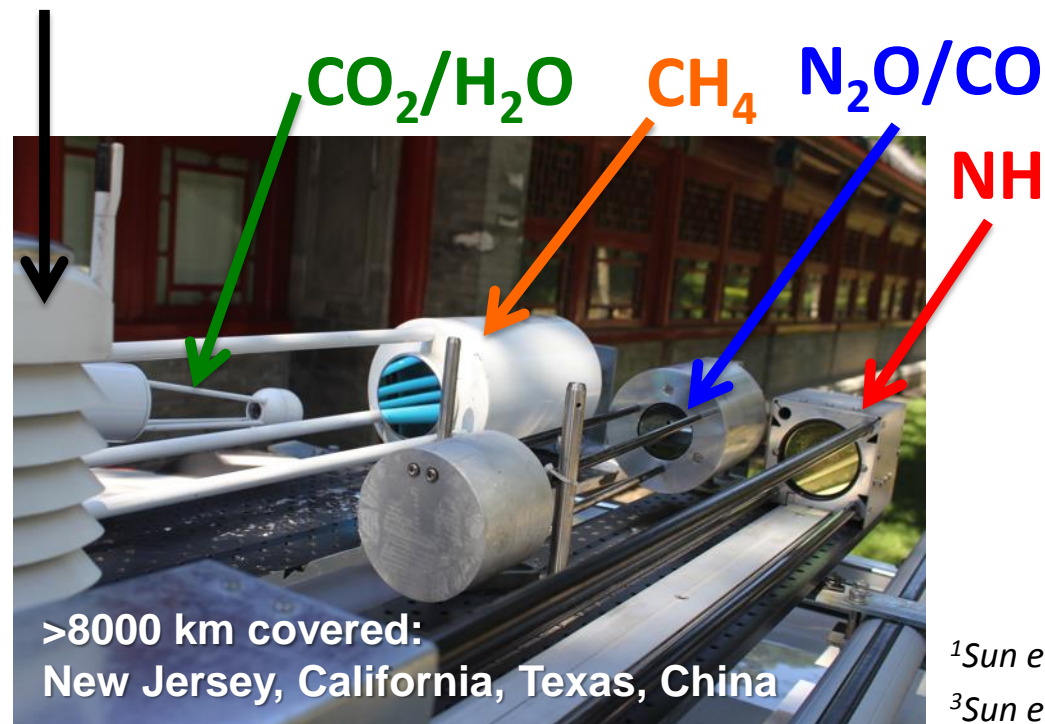
***John Nowak (P3-B NH<sub>3</sub> measurements)***

***Zhen Liu (WRF wind simulations)***



# Multi-gas, Open-path, Mobile Platform

<u>Species</u>	<u>Precision</u>	<u>Mass</u>	<u>Power</u>	<u>Make</u>
<b>NH<sub>3</sub></b>	<b>0.15 ppbv</b>	<b>15 kg</b>	<b>50 W</b>	<b>ref 1-3</b>
<b>N<sub>2</sub>O</b>	<b>0.07 ppbv</b>	<b>10 kg</b>	<b>40 W</b>	<b>ref 4</b>
<b>CO</b>	<b>0.2 ppbv</b>	-	-	<b>ref 4</b>
<b>CH<sub>4</sub></b>	<b>2 ppbv</b>	<b>4 kg</b>	<b>15 W</b>	<b>LICOR</b>
<b>H<sub>2</sub>O</b>	<b>&lt;1%</b>	<b>2 kg</b>	<b>5 W</b>	<b>LICOR</b>
<b>CO<sub>2</sub></b>	<b>0.1 ppmv</b>	-	-	<b>LICOR</b>
met. data (T, p, RH)				Vaisala



## Open-path design:

- Fast response time, high resolution
- Compact and low power (two car batteries)

## Multi-gas approach

- Distinguish between NH<sub>3</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub> and CO sources
- Emission ratio calculations

<sup>1</sup>Sun et al., Appl. Phys. B, 2012    <sup>2</sup>Miller et al., AMT 2013

<sup>3</sup>Sun et al., ES&T, revised 2013    <sup>4</sup>Tao et al., Optics Exp., 2012





# Mobile Platform Measurements

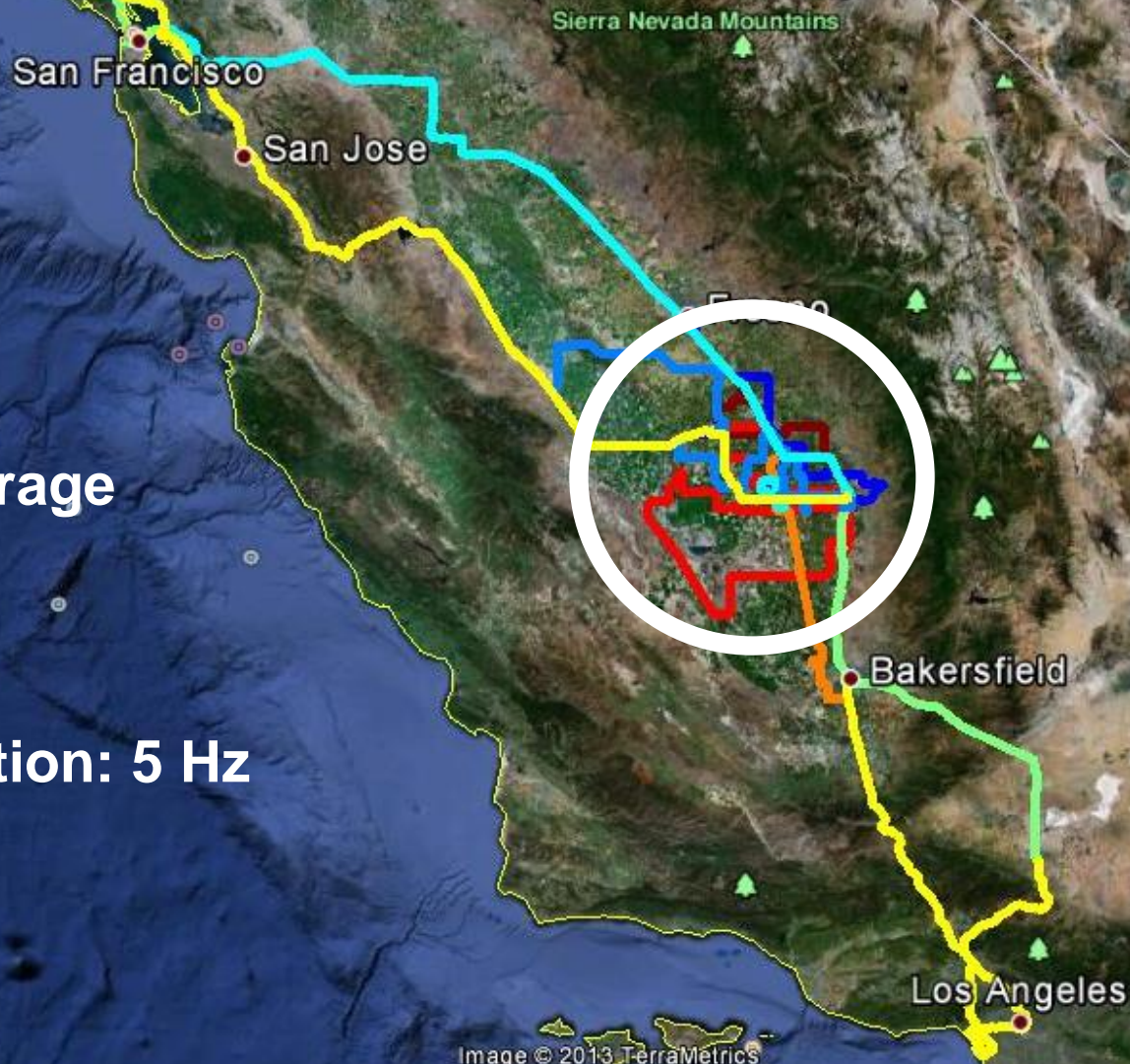
**NASA DISCOVER-AQ 2013 Central Valley, California**



## Spatial Coverage

- ~4300 km
- 12 days

**Time Resolution: 5 Hz**







# Mobile Platform Measurements

NASA DISCOVER-AQ 2013 Central Valley, California

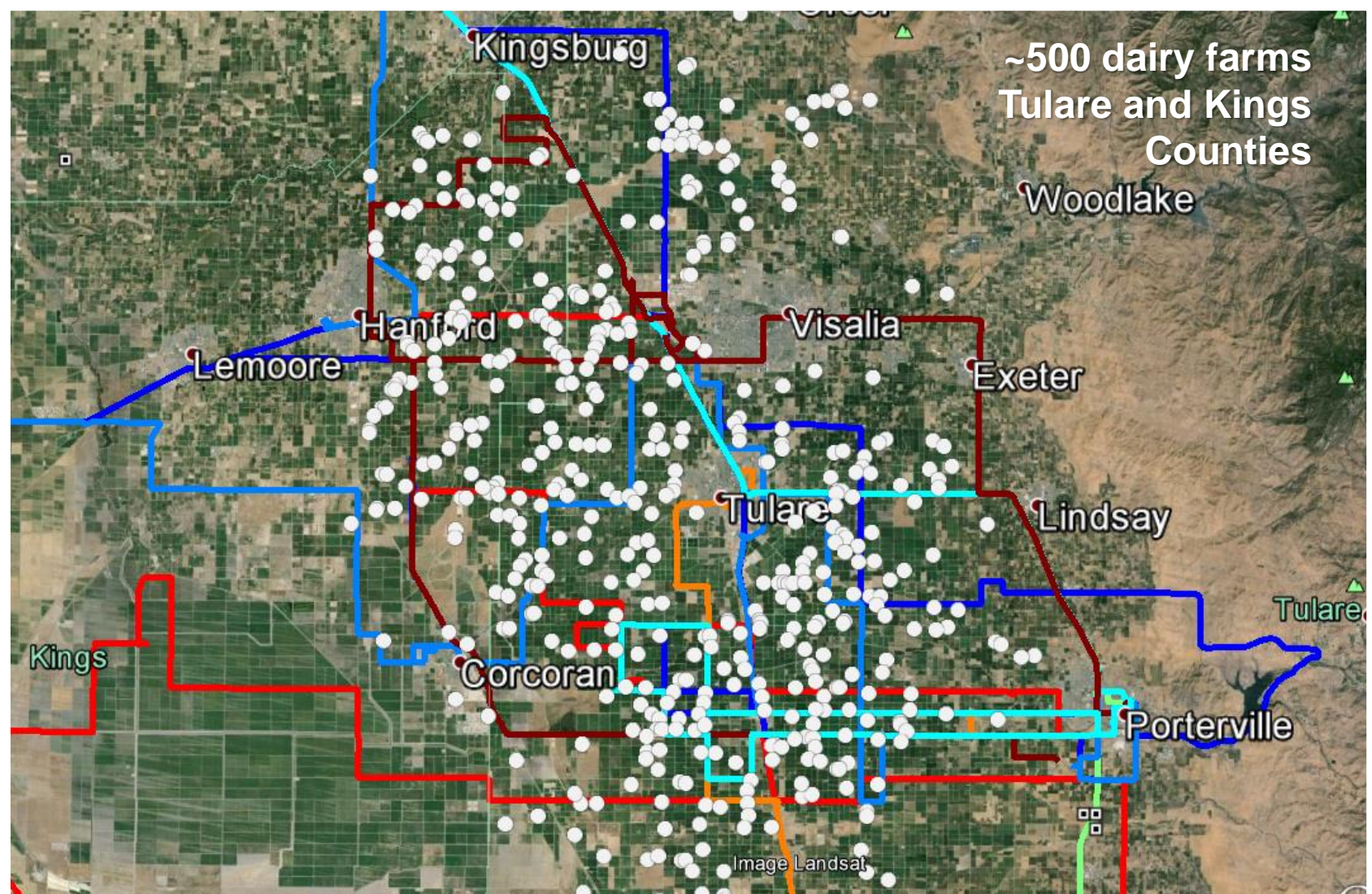


Image © 2013 TerraMetrics

© 2013 Google

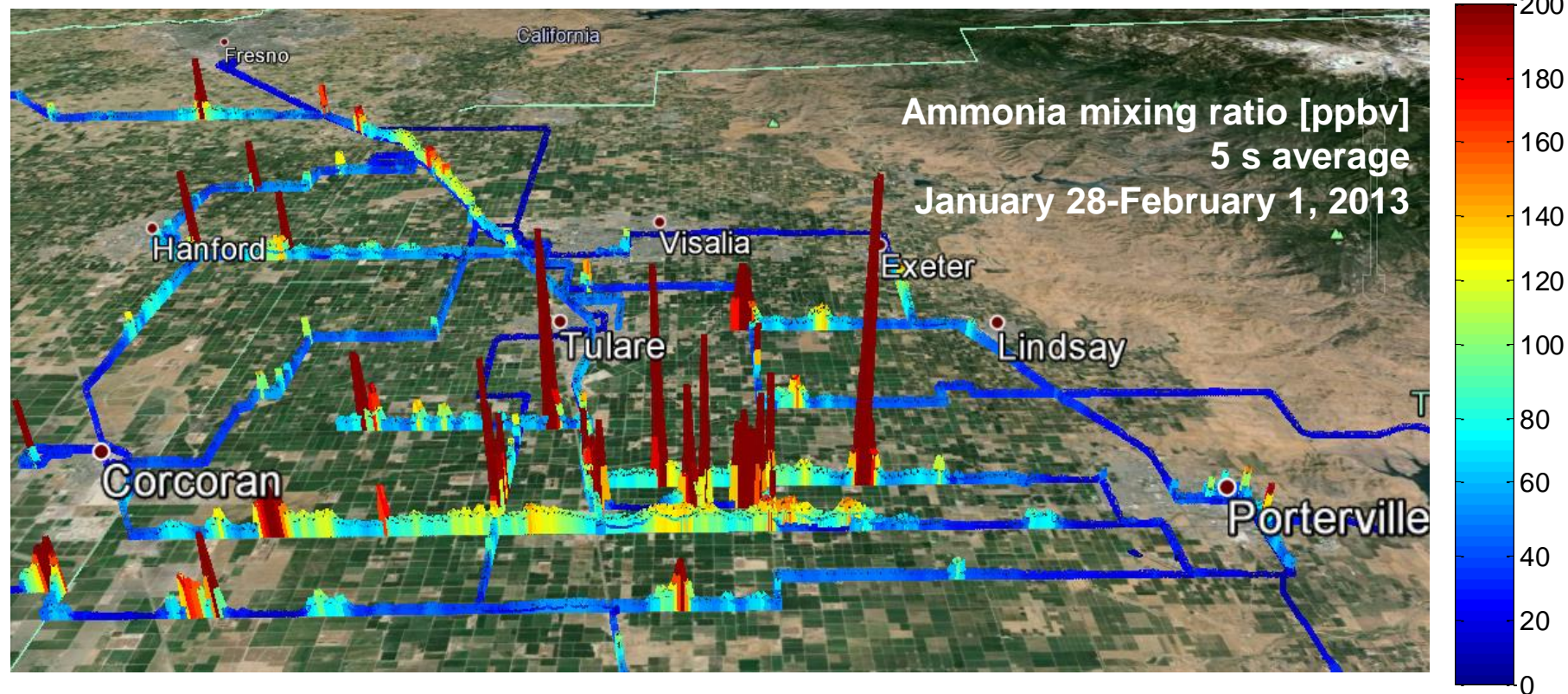




# Ammonia Mobile Measurements



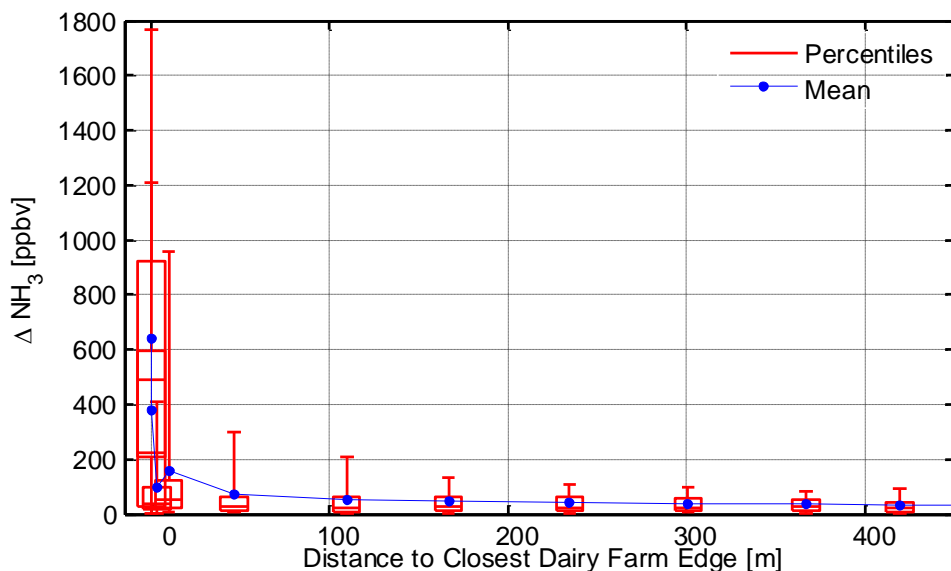
## Spatial distribution of $\text{NH}_3$ mixing ratios in dairy region:



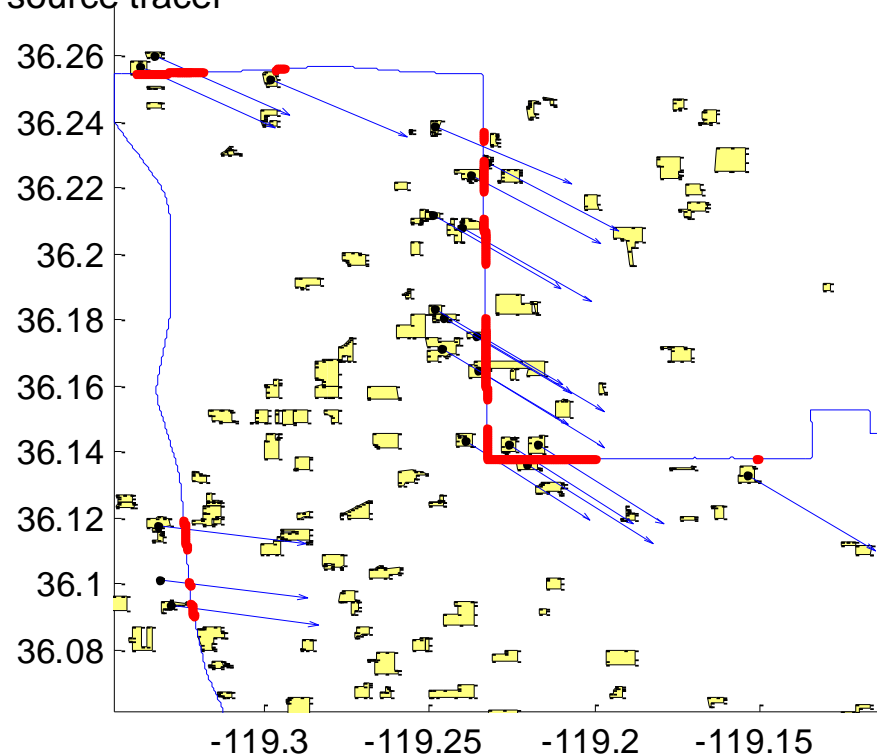
- Goals:**
- Calculate dairy farm emission ratios ( $\Delta \text{NH}_3 / \Delta \text{CH}_4$ ) and statistics
  - Compare with emission ratios from aircraft measurements and current dairy emission inventories
  - Distributions valuable for emission inventory and aerosol modeling

# Downwind Mobile Measurement Selection

- Isolate measurements directly downwind of each dairy farm location
- Sampling distance limit of 600 m from farm center chosen to minimize biases due to  $\text{NH}_3$  dry deposition and partitioning
- Removed vehicle exhaust with CO fossil fuel source tracer



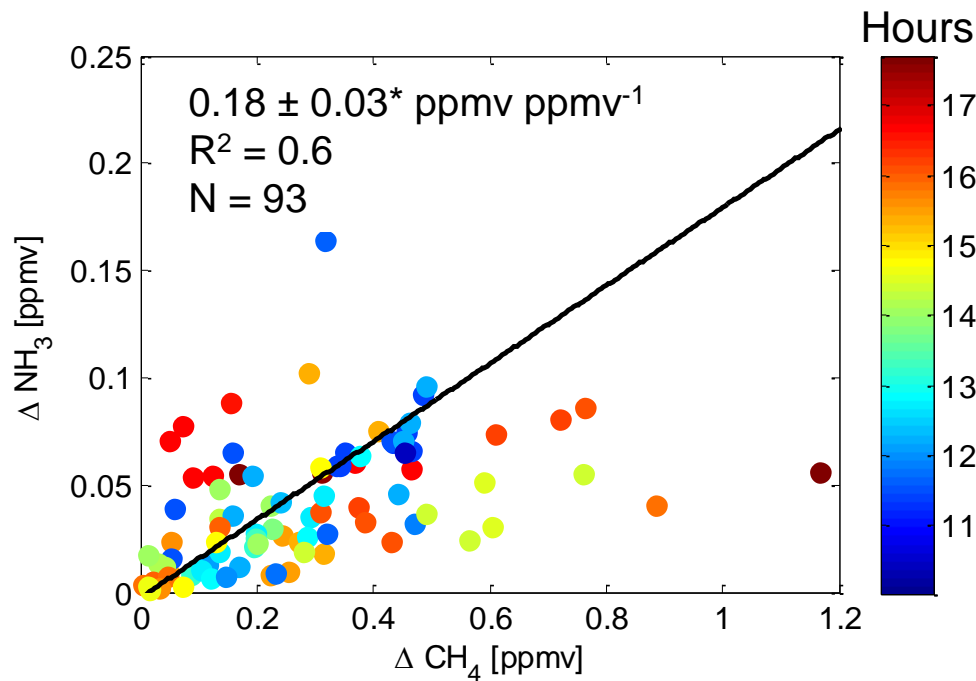
- **$\text{NH}_3$  enhancements localized to <100-200 m distance from dairy farm, consistent with turbulent dispersion & dry deposition**
- Short-term  $\text{NH}_3$  losses (dry deposition, partitioning)



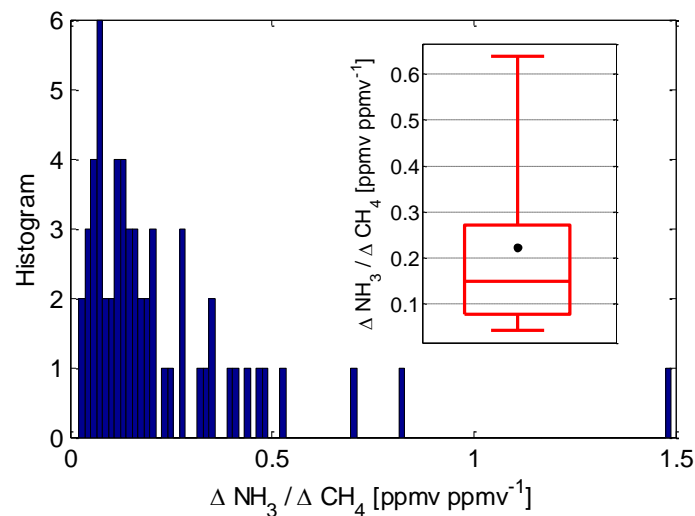
- **Dairy farm locations:**  
California Land & Water Use Dataset
- **Wind field simulation (WRF)**  
Hourly, 4 km grid-scale at 10 m altitude  
Courtesy: Zhen Liu, Sandia National Lab

# Emission Ratio Summary

Mean enhancements at all farms



Distribution of mean emission ratio calculated at each farm



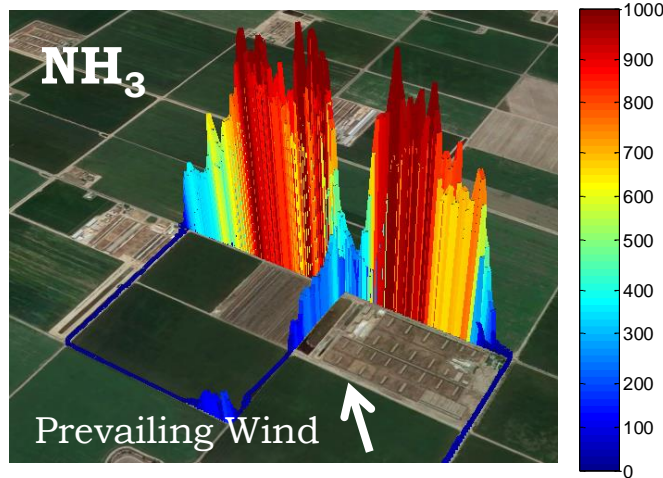
58 downwind plumes (62%) had statistically significant linear correlation ( $p < 0.05$ )

Summary	$\Delta \text{NH}_3 / \Delta \text{CH}_4 \text{ [ppmv ppmv}^{-1}]$
Mobile platform mean	$0.22 \pm 0.04^{**}$
Mobile platform median	$0.15 \pm 0.03^{**}$
Bjorneberg et al. 2009 Open-lot dairy; winter [ $\text{kg d}^{-1}$ ]	0.10
Leytem et al. 2010 Open-lot dairy; winter [ $\text{kg d}^{-1}$ ]	0.24

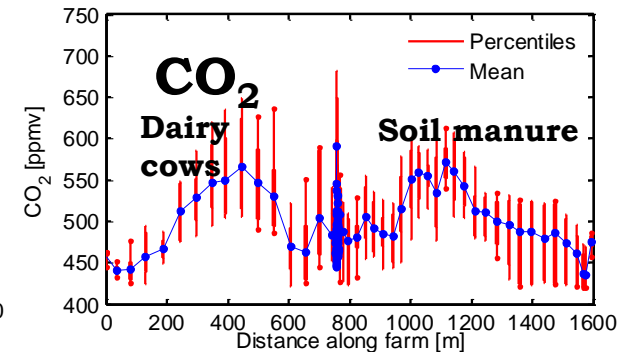
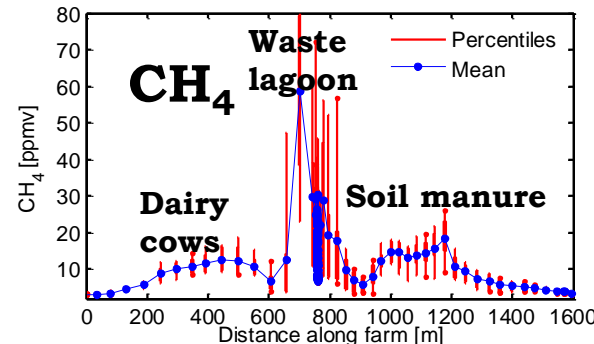
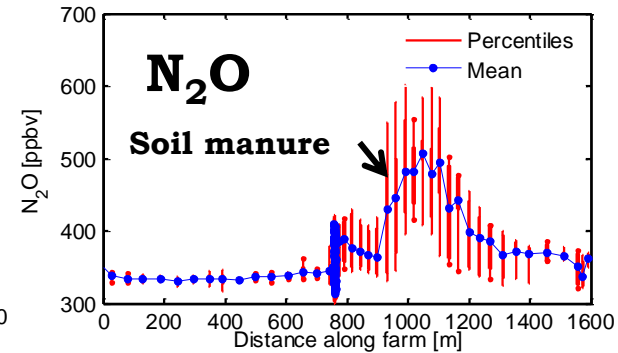
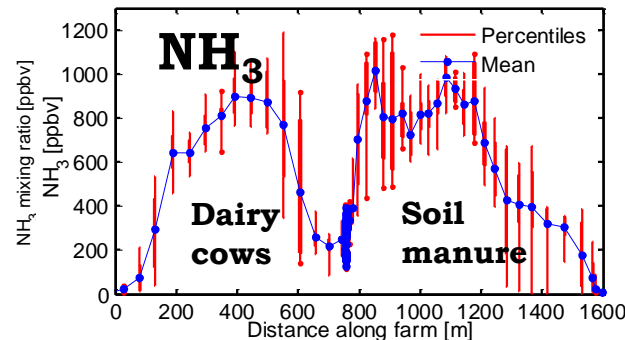
\* Uncertainty in slope  
(95% confidence)  
\*\* Measurement  
uncertainty:  $\pm 20\%$



# Spatial Heterogeneity at Single Farm



## Spatial distributions at individual farm:



- Spatial distributions at sub-dairy farm scales are highly heterogeneous
- Categorize different sections of farms: cows, surface urea, lagoon, manure
- Lagoon CH<sub>4</sub> sources must be accounted for in dairy emission factors

# Aircraft Transect Emission Ratio

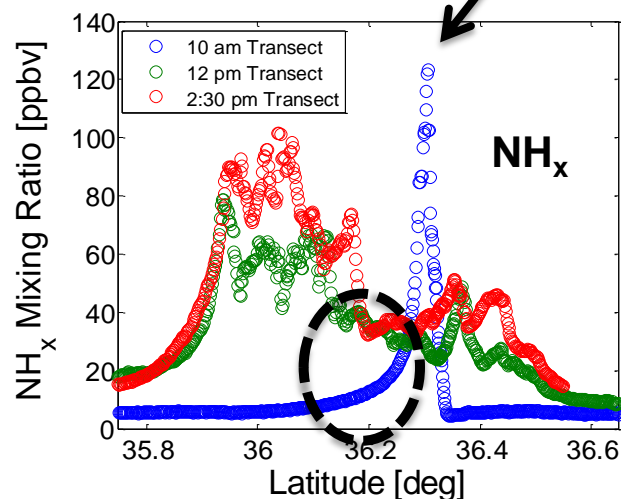
## Aircraft boundary layer transects:

- 3 times per day at 300-500 m altitude for 100 km distance
- Vertical profile at Visalia

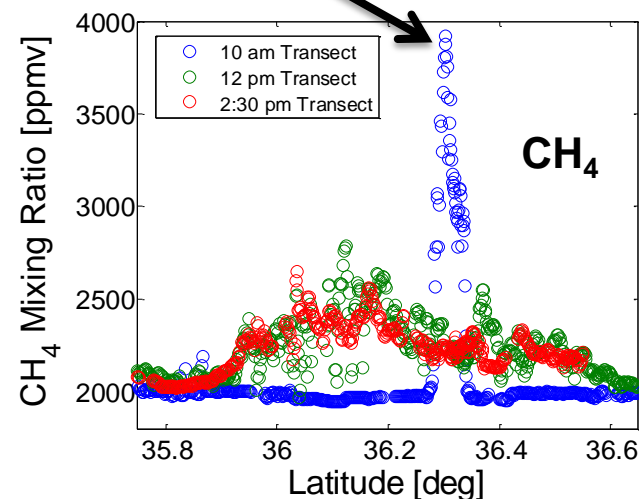


## NASA P3-B aircraft data:

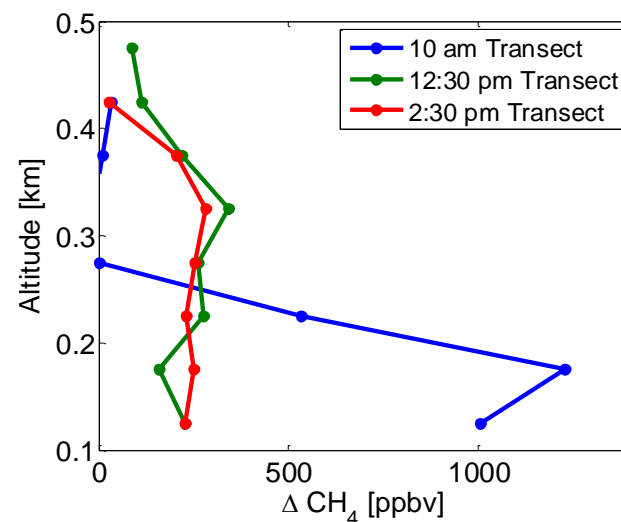
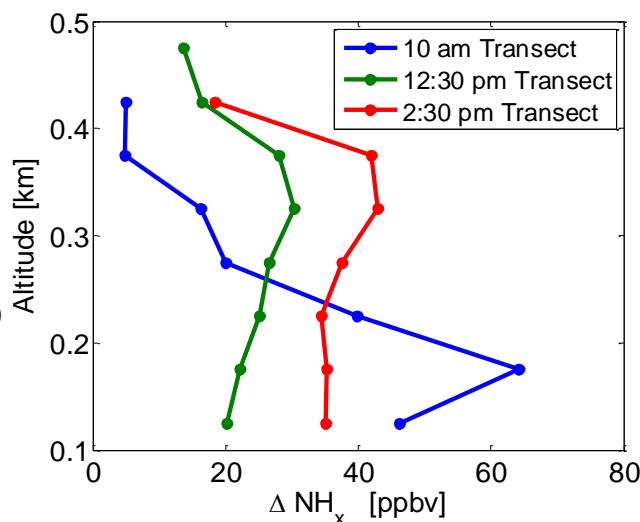
- $\text{NH}_3$  (3 s, NOAA Picarro CRDS, Nowak)
- Preliminary  $\text{CH}_4$  (1 s, NASA DACOM, Diskin)
- $\text{NH}_4^+$  (250 s, NASA PILS-IC, Anderson)



Missed approach



$\text{NH}_x = \text{NH}_3 + \text{NH}_4^+$  used to account for partitioning ( $\text{NH}_4^+ < 10\%$  of  $\text{NH}_x$ )



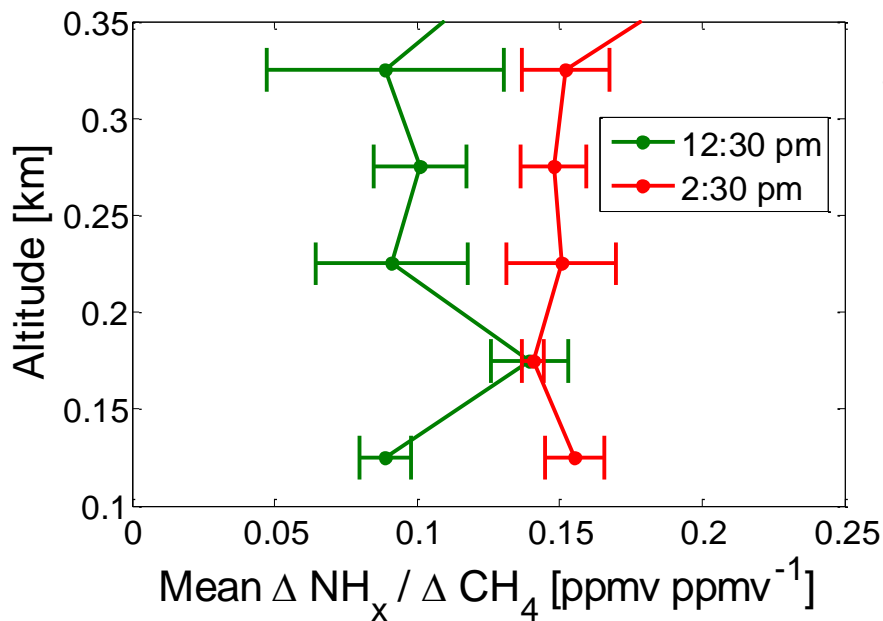




# Aircraft Transect Emission Ratio

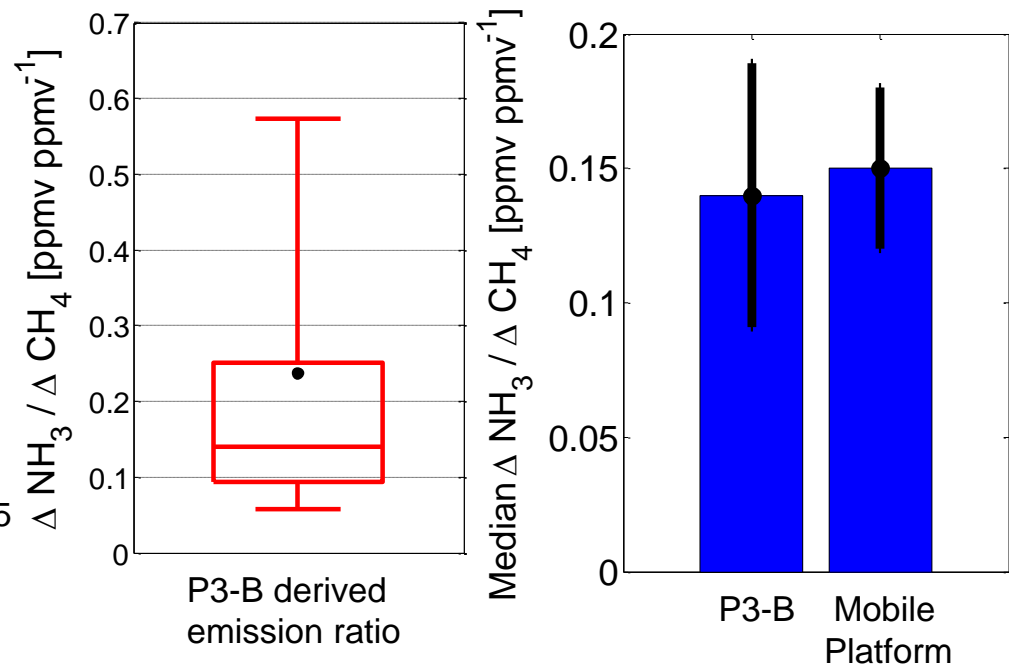


Boundary layer well-mixed in afternoon



- Morning transect shows low bias (significant deposition below 200 m) and not used in total emission ratio estimate

Aircraft integrated emission ratio estimate comparable to surface mobile measurements



- $\text{NH}_3$  measurement time response (8-20 s) in large plumes relative to  $\text{CH}_4$  introduces bias (ongoing work)



# Atmospheric Implications

- **High resolution open-path mobile measurements:**
  - $\text{NH}_3$  to  $\text{CH}_4$  emission ratio and distribution quantified during NASA DISCOVER-AQ (Central Valley winter)
- **Aircraft measurements:**
  - $\text{NH}_x$  to  $\text{CH}_4$  emission ratio median comparable to surface measurements
  - $\text{NH}_3$  measurement time response relative to  $\text{CH}_4$  in plumes introduces bias
  - Future aircraft top-down  $\text{NH}_3$  emissions estimates must consider under-sampling of surface (<100 m altitude) where depositional losses occur and sensitivity to background variation within dairy region





# Future Directions

- Quantify  $\text{NH}_3$  deposition and losses (coarse and fine mode)
- Compare with emission inventories (EPA NEI, CARB), regional models
- Combine bottom-up emission ratios with top-down mass balance approach for  $\text{CH}_4 \rightarrow$  total  $\text{NH}_3$  emissions



- First open-path  $\text{NH}_3$  eddy covariance measurements: long-term stationary 20 Hz  $\text{NH}_3$  and  $\text{CH}_4$  measurements  $\rightarrow$  temporal variability at single farm



# Acknowledgements



- **Zondlo Group:** Josh DiGangi, Anthony O'Brien, Lin Wang, Da Pan, Levi Golston
- **Professor M. Amir Khan**
- **James Crawford, Discover-AQ 2013 science team**
- **Trent Proctor, USFS**
- **John Nowak, Glenn Diskin (P3-B data)**
- **Zhen Liu (WRF wind simulations)**
- **LICOR Biosciences**
- **Professor James Smith Group, Princeton**
- **Professor Claire Gmachl Group, Princeton**
- **Professor Elie Bou-Zeid Group, Princeton**
- **Professor Gerard Wysocki Group, Princeton**
- **Prof. Denise Mauzerall Group, Princeton**
- **Professor Tong Zhu Group, Peking University**

## Funding:





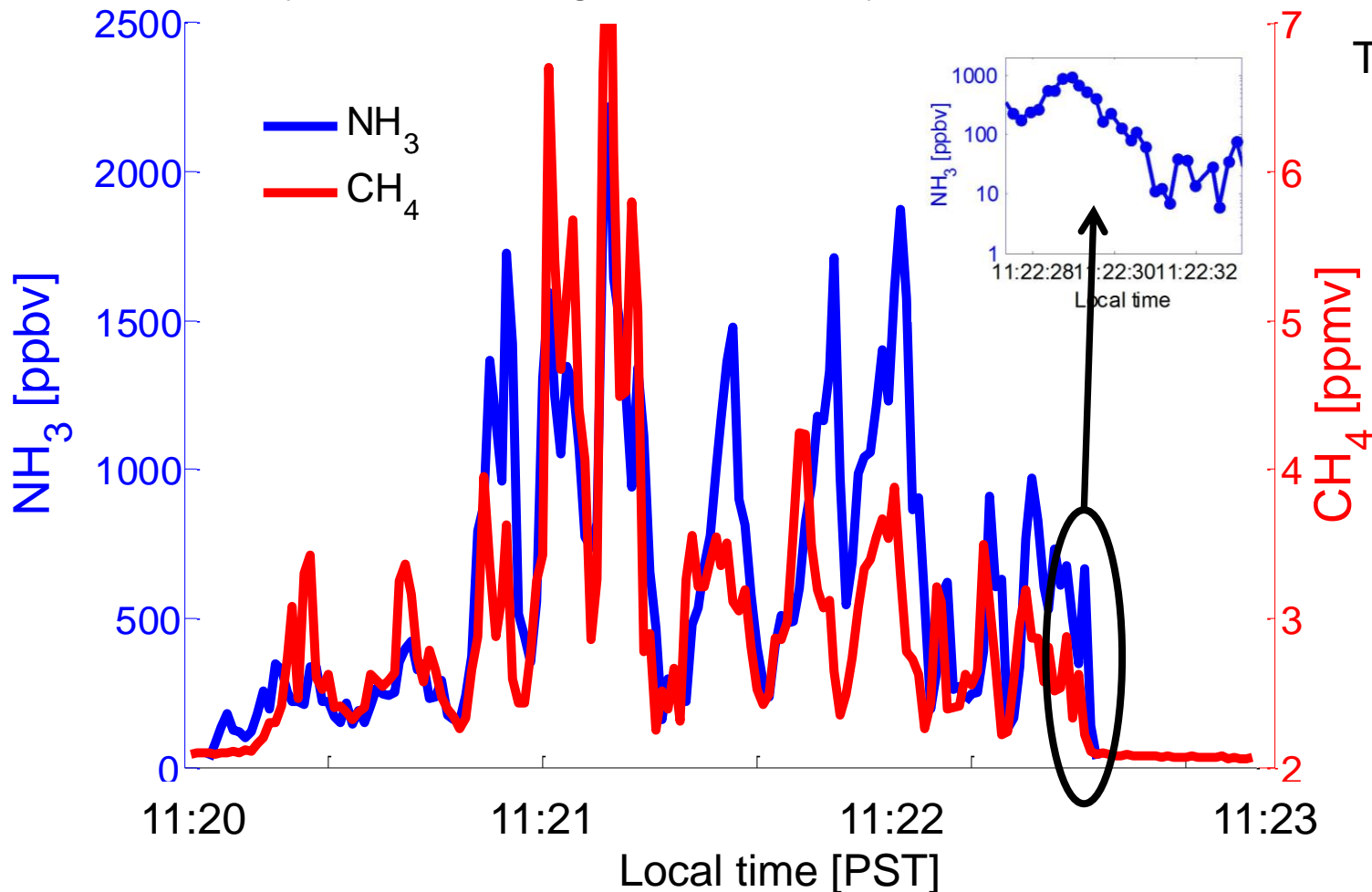
# Extra Slides





# Ammonia and Methane Time Series

Dairy farm sampling: Central Valley, CA

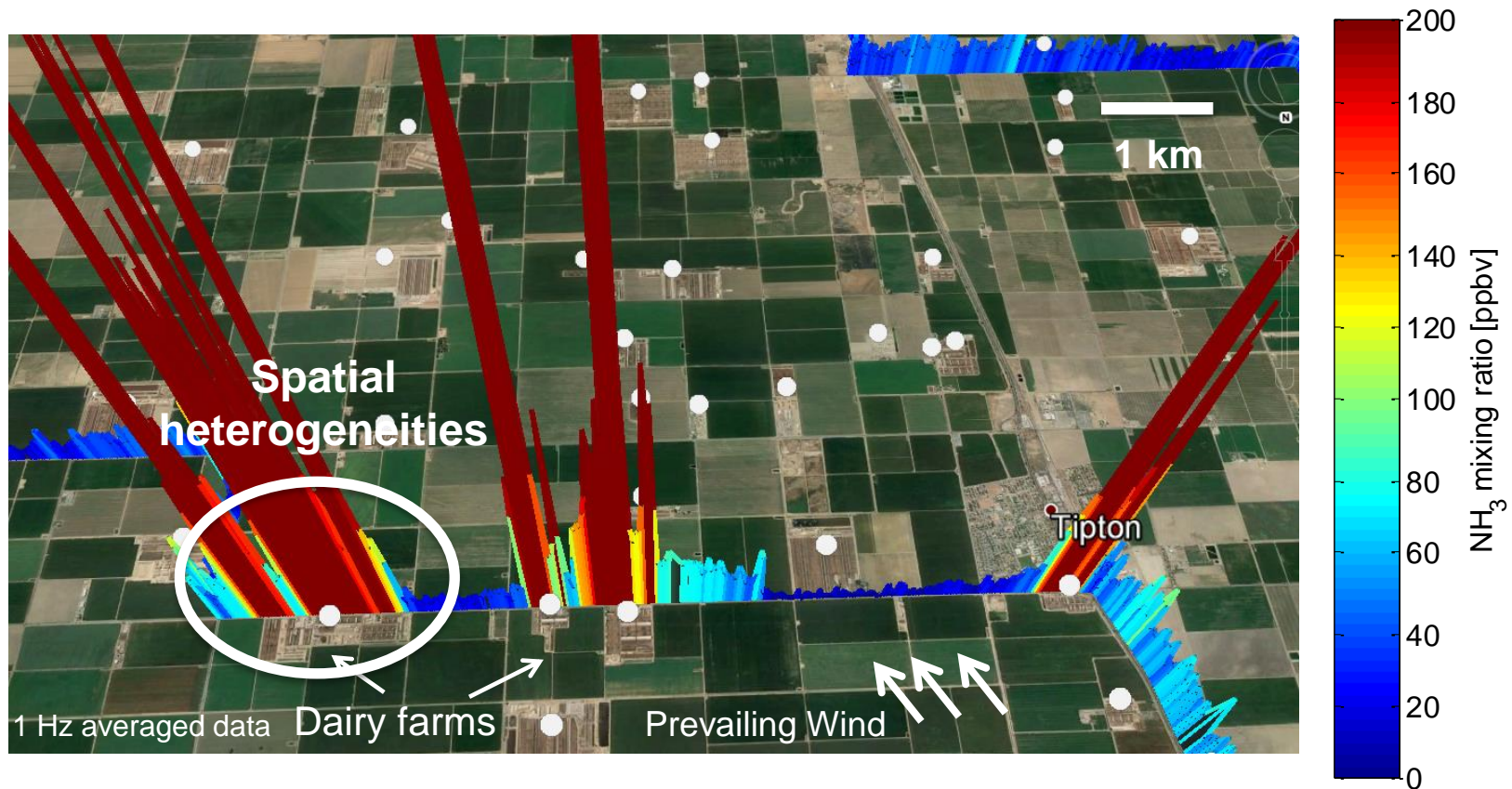


Two orders of magnitude decrease to background within 2 seconds

**Background trend**  $\rightarrow$  1 percentile over 400 s time window (>plume widths), similar to method by Bukowiecki et al. (2002)

# Ammonia Plume Measurements

High resolution (5 Hz) open-path mobile  $\text{NH}_3$  measurements



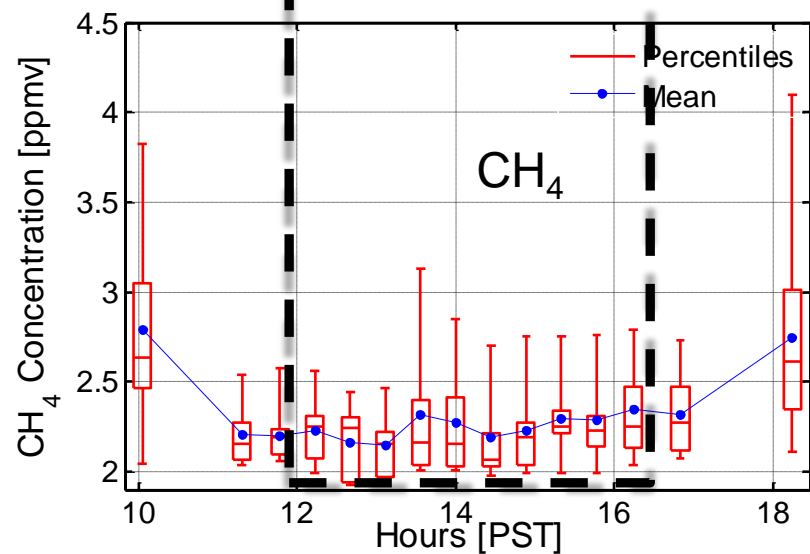
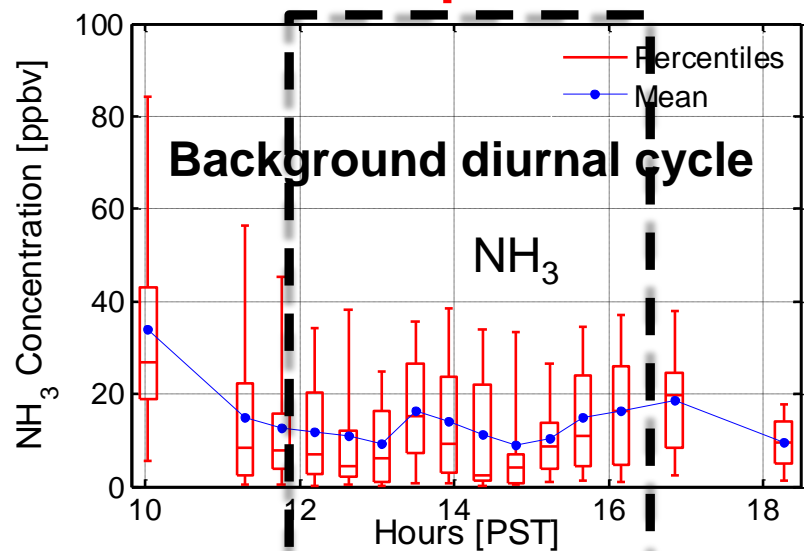
- Plumes measured on road only if downwind
- Ammonia plumes localized to individual dairy farms, show fine structure



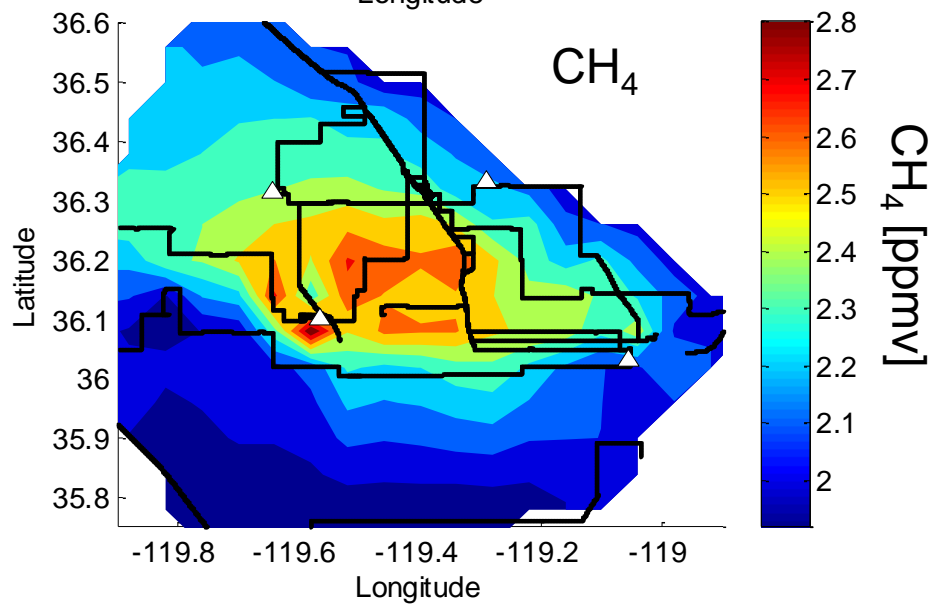
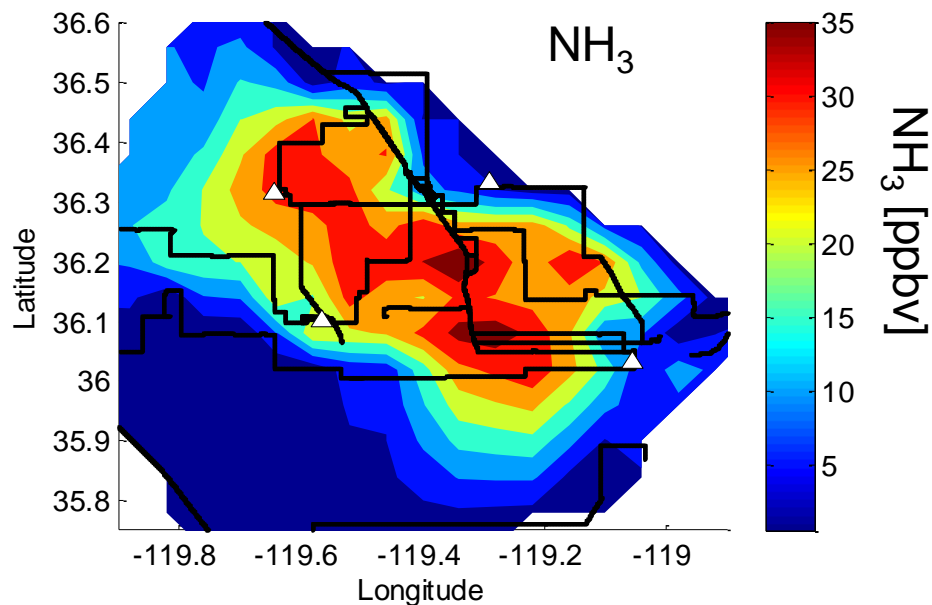
# Background Mixing Ratio Variability



## Temporal

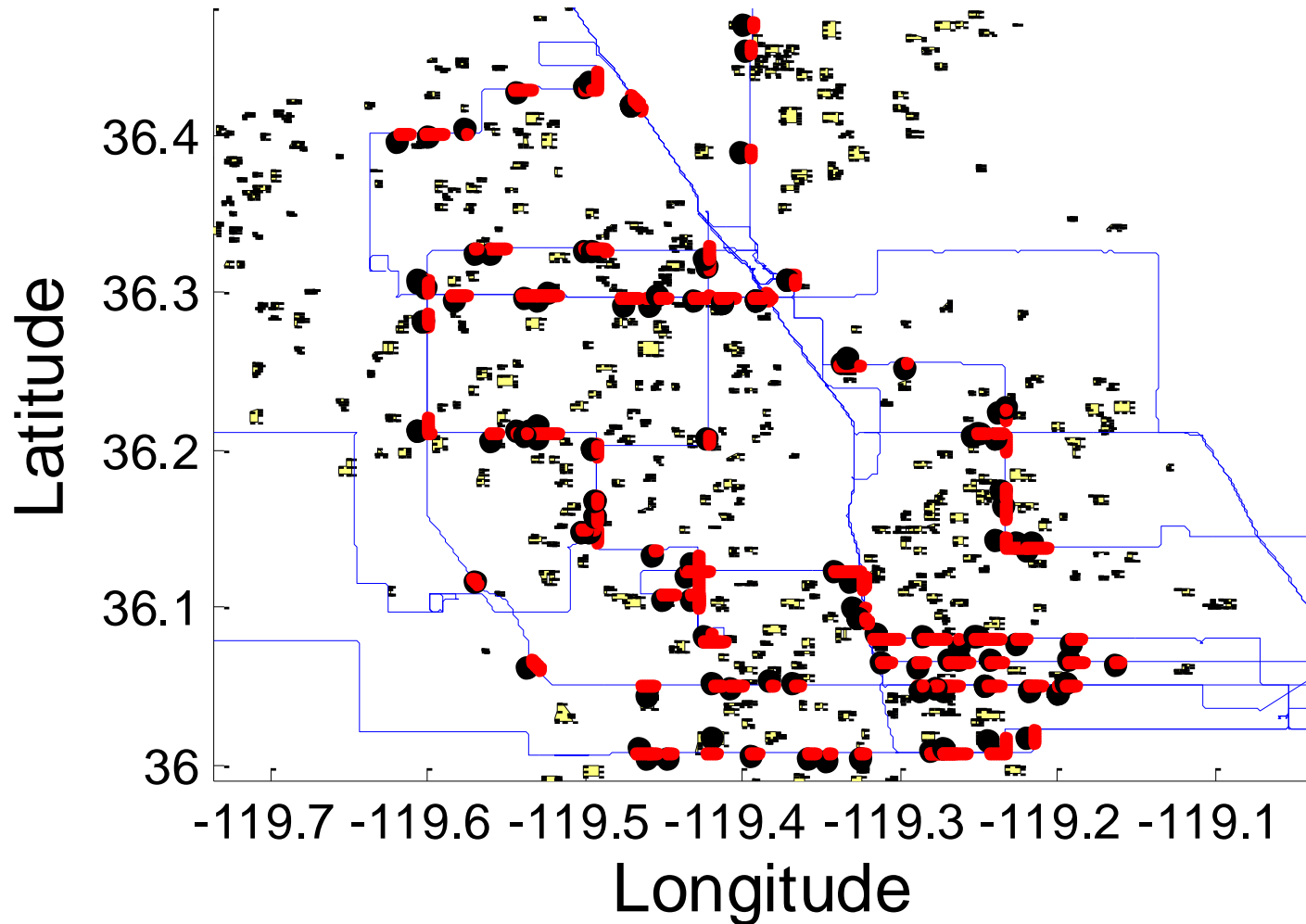


## Spatial





# Mobile Ammonia Measurements



- 93 downwind “plumes” of  $\text{NH}_3$  and  $\text{CH}_4$  sampled
- Most farms sampled at <100 m from farm edge