

Development of Optical Remote Sensing Protocol for the Measurement of Nonpoint Emission Sources



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Need Statement



No recognized method exists for making direct nonpoint source measurements. An accurate and cost-effective method is needed to quantify area emission sources.





Project Sponsor

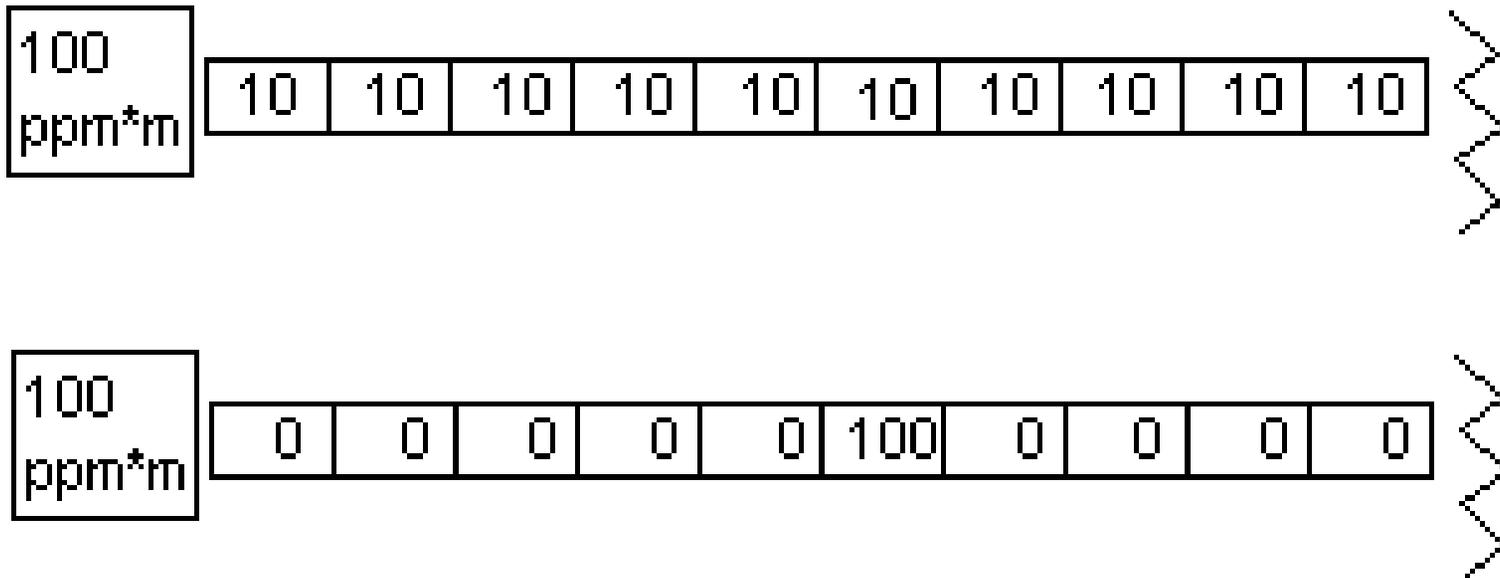


**Environmental
Security
Technology
Certification
Program**





Path Integrated Concentration





OP Instrument Summary



Spectroscopic Methods:

- Open Path Fourier Transform Infra Red (OP-FTIR)
- Differential Optical Absorption Spectroscopy (DOAS)

Advantages:

Multiple compounds simultaneously
Potential Particulate Matter

Disadvantages:

Interference
Relatively slow

Laser Based Techniques:

- Tunable Diode Laser Absorption Spectroscopy (TDLAS)
- Differential Absorption Lidar (DIAL)

Advantages:

Fast
Interference free
Long range

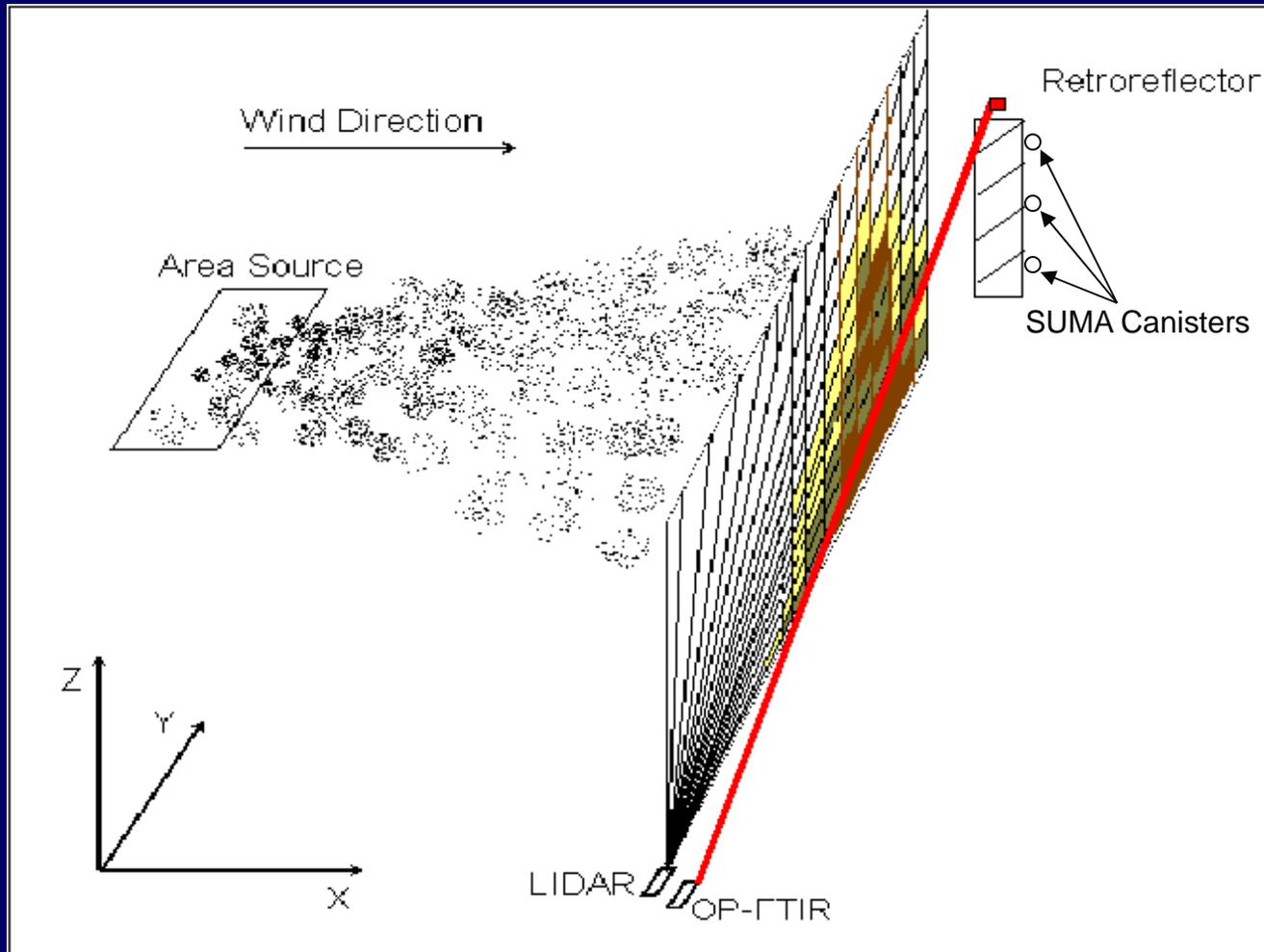
Disadvantages:

Typically single compound
Expensive



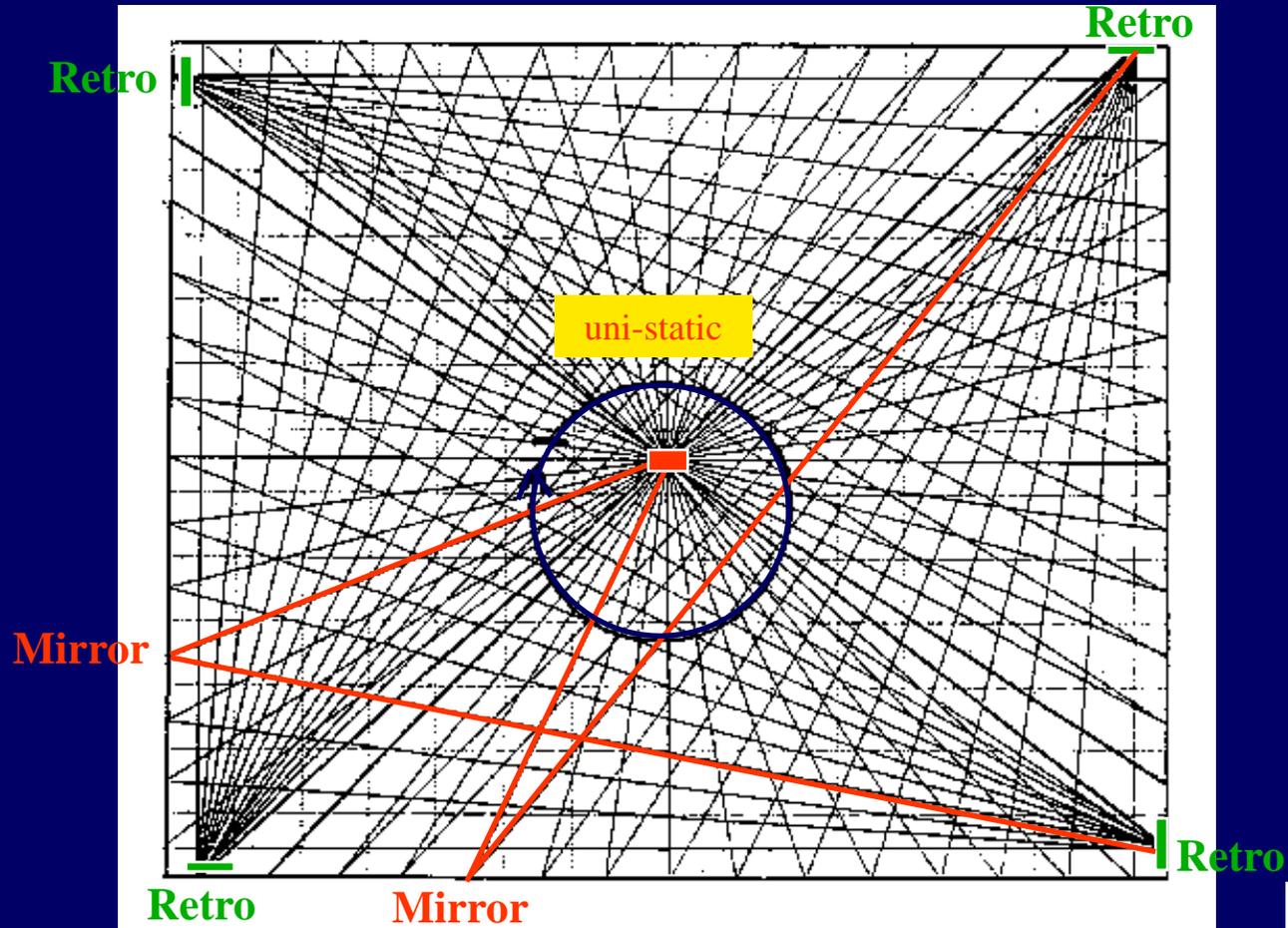


Current Methods for Area Measurements





Intersecting Geometry The Conventional CT Approach



courtesy of Drescher *et al.* (1996)





New Method Summary

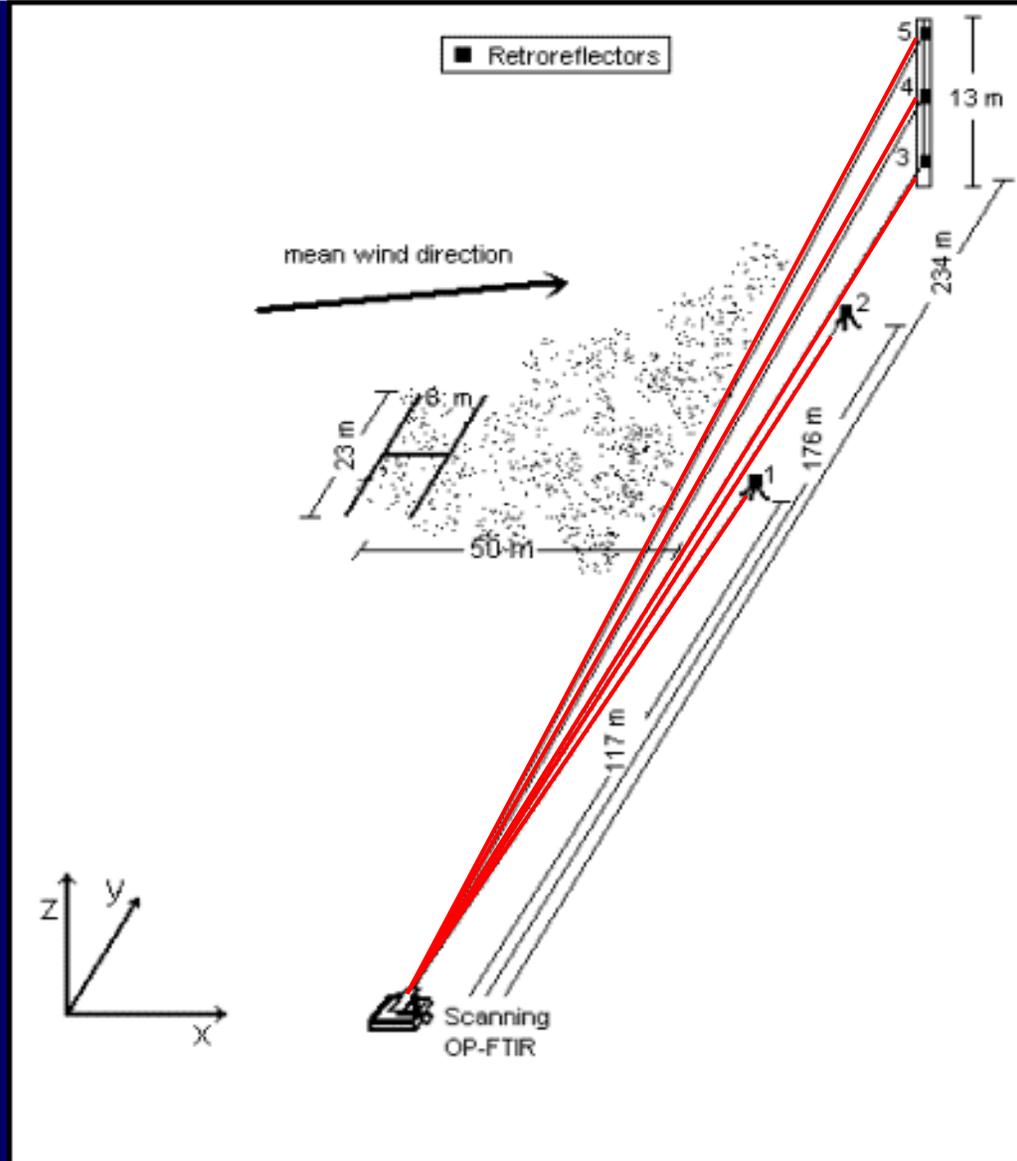


- **Beam Configuration: OP-FTIR (or other OP method) multiple beams to determine vertical and horizontal gradients**
- **Optimization algorithms to directly reconstruct the mass equivalent plume downwind from the source**
- **No need for tracer release or inverse dispersion modeling approach for plume characterization**
- **Plane-integrated concentration x wind speed = emission flux**





Example: Oxford NC Test





Radial Scanning





Oxford NC Test Results



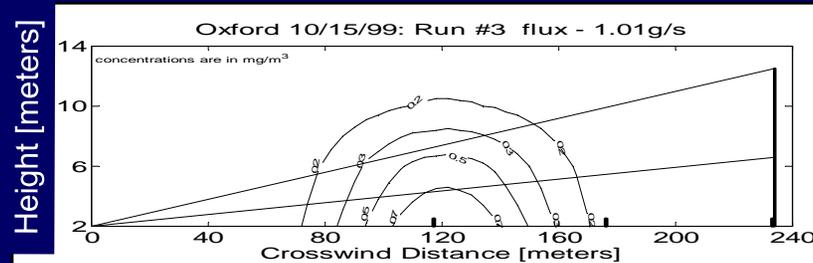
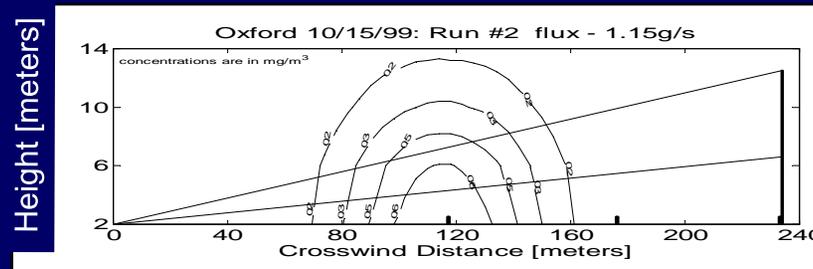
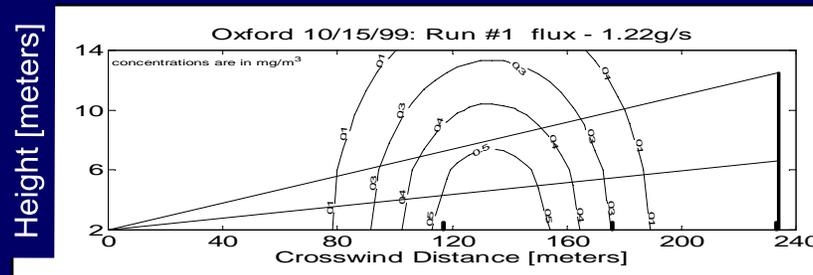
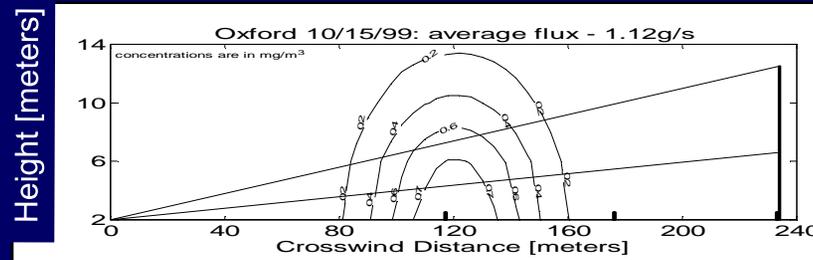
Reconstructed Plumes

Actual release rate = 1.7 g/s

Calculated flux = 1.2 g/s

Measured σ_θ - 50.7 degrees

(Pasquill-Gifford Stability A - unstable)





Oxford NC Test Results



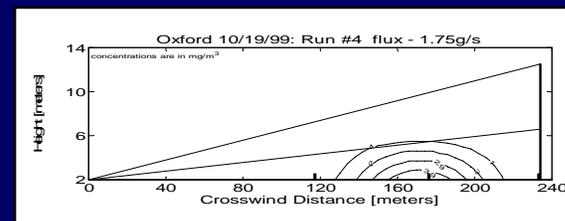
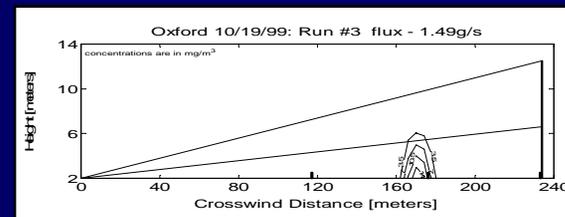
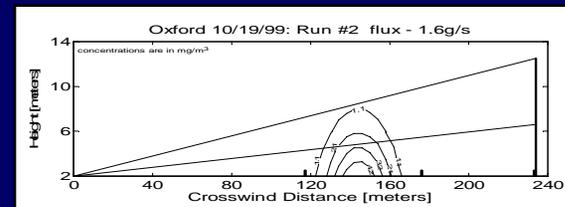
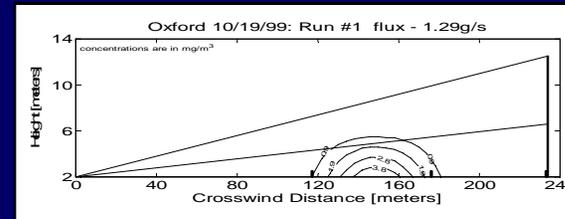
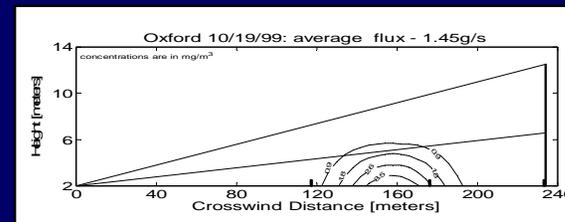
Reconstructed Plumes

Actual release rate = 1.7 g/s

Calculated flux = 1.5 g/s

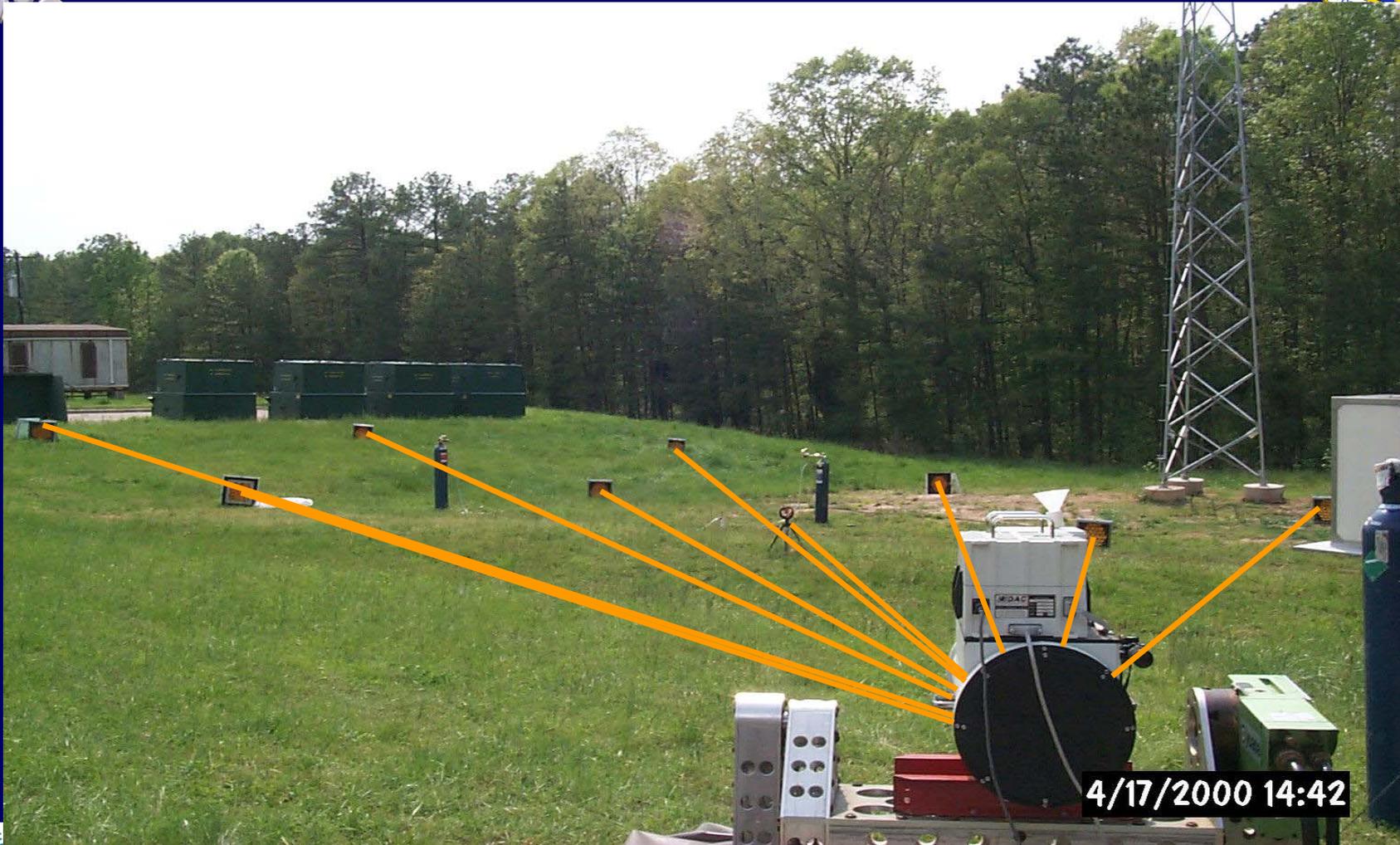
Measured σ_θ – 12.7 degrees

(Pasquill-Gifford Stability C-D - neutral)



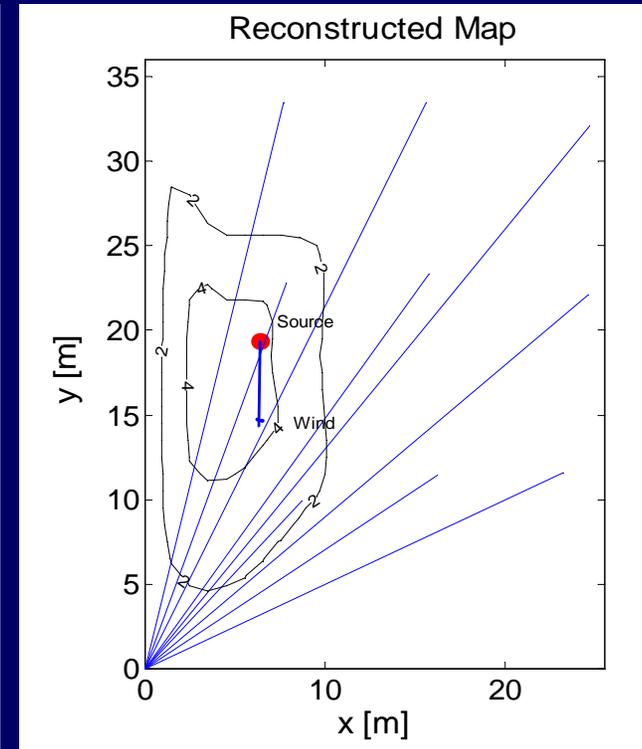
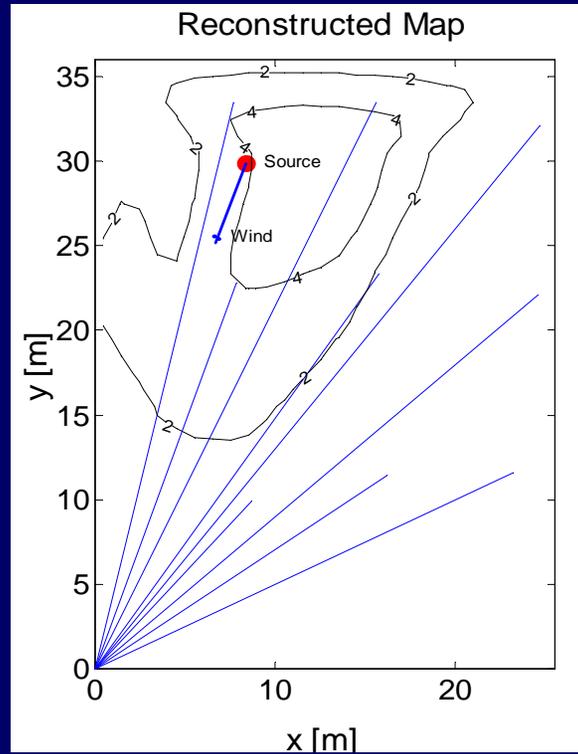
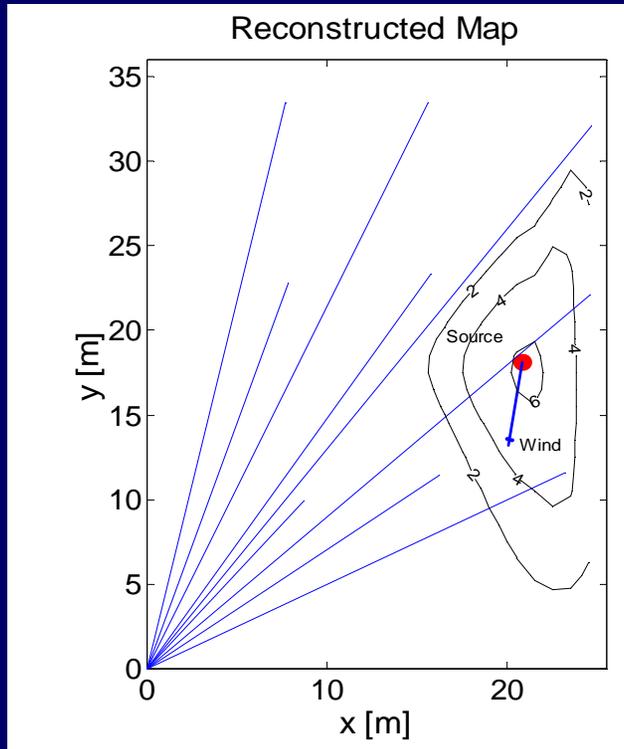


Radial Scanning





Radial Scanning for Hot Spots





Cost Comparison Estimate

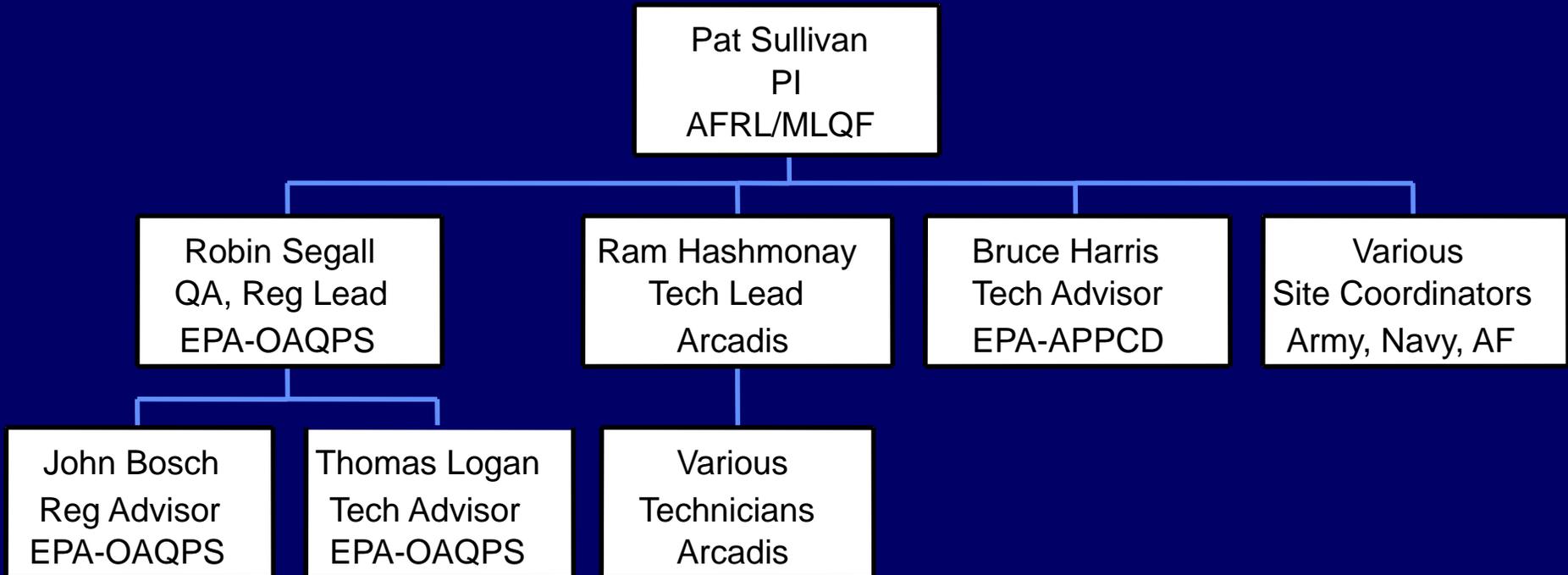


#	Task	Conventional (\$)	ORS + Conventional (\$)
1	Preparation	22,000	7,000
2	Set-up	6,000	3,000
3	Test	50,000	30,000
4	Report	25,000	10,000
5	Travel	7,000	5,000
6	Subcontractor Expenses	60,000	15,000
7	Other Expenses	20,000	30,000
	Total	190,000	100,000





Key Performers





Controlled Validation Design

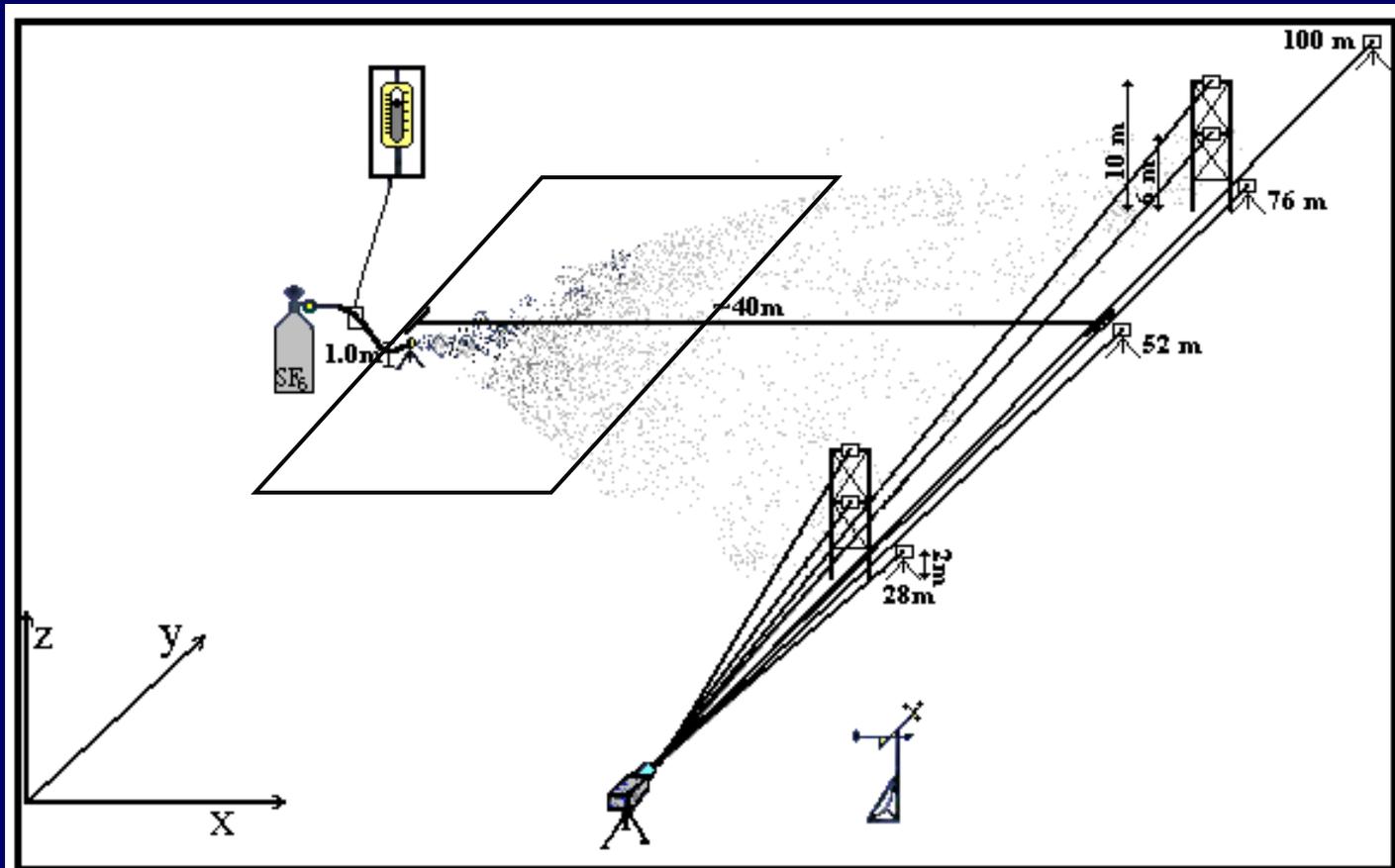


- Soaker hose in 'H' pattern to simulate area source
- Point release to simulate a "hot spot"
- Ethylene (area), N₂O test gas (point)
- Plane-integrated OP-FTIR downwind
- Radial scanning OP-FTIR over the source
- Met station and optical anemometer for wind
- Self-calibrated Gilson Tapered-tube flowmeter
- Weigh the gas cylinder before and after a 1-hour run to confirm the flowmeter





Controlled Validation Design





Demonstration



- **Actual area sources at DoD installations will be measured and protocols refined**
- **Examples: WWTP, Landfills, Flightline Operations**
- **Methodology and actual costs to be documented**





Technology Transfer



Published EPA Method

Optimization algorithms will be licensed to equipment manufacturers

Optimization algorithms will be licensed to A&E firms providing base support services





Summary



New OP multiple beam method can provide accurate quantification of area sources, with lower cost and complexity than conventional methods. This project will validate/demonstrate this method.

This demonstration is strongly supported by the EPA. The project objective is to publish a standard protocol for measuring nonpoint sources.

The OP multiple-beam method can become a powerful tool for DoD and industrial facility managers to solve P2 and compliance problems.

