

## IGERT on Wireless Intelligent Sensor Networks Kick-off Meeting

Silvia Ferrari  
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IGERT WISeNet Program Coordinator

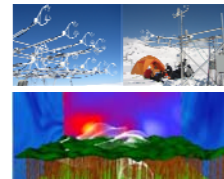
**Duke University, Durham, NC**  
August 28, 2012



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### WISeNet Graduate Training at Duke

WISeNet trainees contribute to the development of intelligent sensor systems that process, store, and learn from data so as to improve their ability to gather information over time. By participating in WISeNet laboratory and field experiments, trainees also contribute first hand to unprecedented observations of environmental and ecological processes, and more effective and reliable use of sensors for defense and national security.



### WISeNet is currently accepting applications

Trainees must be enrolled in a Ph.D. program in one of the participating departments at Duke University. Duke students who are interested in applying should request application material from the **WISeNet Program Director**, Prof. Silvia Ferrari (Email: [webmaster@lisc.pratt.duke.edu](mailto:webmaster@lisc.pratt.duke.edu)). Non-Duke students interested in WISeNet are strongly encouraged to apply to the graduate program of interest through Duke Graduate School (<http://gradschool.duke.edu/admissions/>).

For more information visit: <http://wisenet.pratt.duke.edu/>



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## Welcome WISeNet Students



### WISeNet Associates

### WISeNet Fellows

- Cassi Carley, Computer Science
- Tierney Foster-Wittig, Civil and Environmental Engineering
- Matthew Ross, Biology (Ecology) and earning a certificate in the University Program in Ecology from the Nicholas School of the Environment
- Keith Rudd, Mechanical Engineering and Materials Science
- Ashleigh Swingler, Mechanical Engineering and Materials Science
- Patrick Wang, Electrical and Computer Engineering
- Tiffany Wilson, Civil and Environmental Engineering
- Itay Cnaan-on, Electrical and Computer Engineering

## WISeNet Participation



### 1) IGERT Funding

IGERT funds are devoted almost exclusively to graduate student funding. Some exceptions include salary for co-PIs devoted to course development (first year), travel funds to set up international activities (first year), and salary for staff (program coordinator), and for seminar speakers' travel.

Graduate student funding includes a two-year research assistantship (RA), travel, living and moving expenses for participating in WISeNet experiments in the US and abroad, computers and equipment. In order to obtain funding for a graduate student, the student must first be selected as an IGERT fellow or trainee. Typically, fellows receive funding for a period of 2 years and, therefore, they must be supported by another fellowship or grant in other years of their Ph.D..

### 2) IGERT Fellowships

IGERT fellowships are available almost primarily to US citizens enrolled in a Ph.D. program at Duke. However, other students can and are encouraged to participate in the WISeNet certificate and activities. Also, emphasis will be placed on recruiting applicants from underrepresented minorities, defined by NSF as American Indian/Alaskan native, Black, Hispanic, Pacific Islander, a person with disability, and/or female. Please see our recruiting documents for information on how you can help recruit these potential applicants to Duke.

### 3) IGERT Application and Requirements

WISeNet applications for IGERT fellowships must be submitted by the student, on or before **April 30th** of every year. IGERT fellows (who receive funding) and all other IGERT students (who wish to obtain the WISeNet Certificate, but may not be funded directly by the IGERT) **MUST** complete all of the **WISeNet requirements**.

### WISeNet Team



#### 1) PIs (Duke University):

- Silvia Ferrari (Mechanical Engineering, Sec.: ECE, CS, DIBS)
- John Albertson (Civil and Environmental Engineering, Sec: NSOE)
- Gabriel Katul (NSOE, Sec: CEE)
- Ron Parr (Computer Science)
- Pankaj Agarwal (Computer Science, Sec: Math)

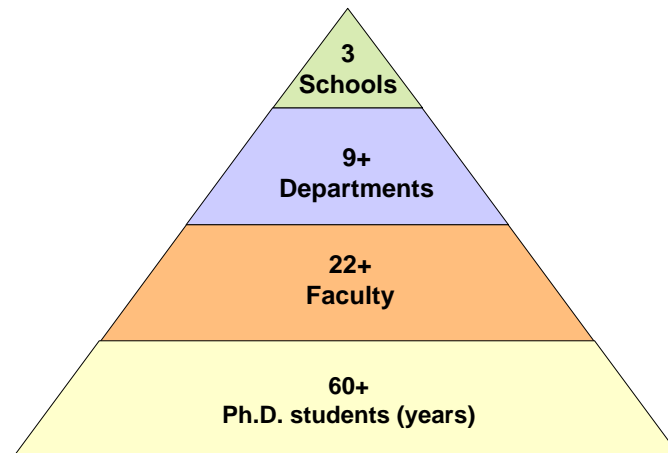
#### 2) International Participants

- Nicola Montaldo, University of Cagliari, Italy
- Lorenzo Marconi, University of Bologna, Italy
- Marc Parlange, EPFL, Switzerland
- Marco Marani, University of Padova, Italy
- Martin McGinnity, ISRC, University of Ulster, Ireland

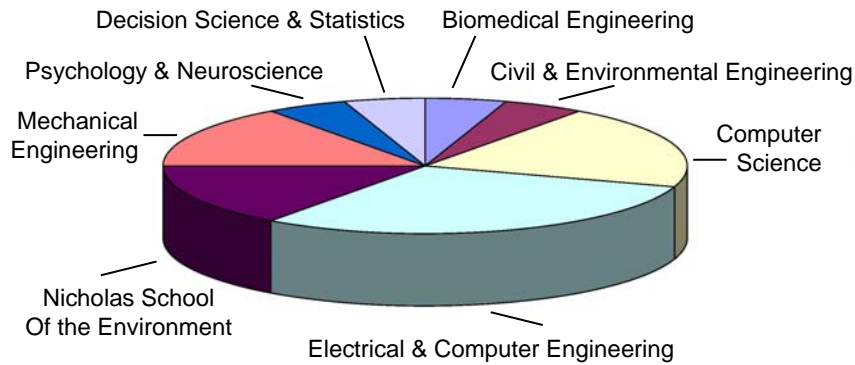
#### 3) Partners from Industry and Government Laboratories

- Caryl Johnson, Fellow, British Aerospace (BAE), Honolulu (HI)
- Gayle Hagler, Research Scientist, US Environmental Protection Agency (EPA), Raleigh (NC)
- Thomas Wettergren, US Navy Senior Technologist, Naval Undersea Warfare Center (NUWC), Newport (RI)

### WISeNet by the Numbers



**Faculty and Student Distribution by Department**



**WISeNet Research Areas**

- 1) Information-Driven Environmental Sensing and Prediction
  - Distributed sensor management
  - Ecosystem and eco-hydrological dynamic modeling and prediction
  - Climate-change impacts on terrestrial ecosystems and seasonal snow cover
  
- 2) Guidance and Control of Mobile Sensor Networks
  - Autonomous vehicles with onboard sensors and wireless communications
  - Integrated sensor feedback control and signal processing (active sensing)
  - Intelligent control and coordination of heterogeneous sensor networks
  
- 3) Biologically-Inspired Intelligent Sensor Systems
  - Rapidly coordinate movement, while integrating sensor information
  - Adaptation and learning
  - Transform sensory inputs into appropriate motor outputs
  - Design biologically-inspired artificial robotic sensors



**WISeNet Menu of Laboratory and Field Experiments**

- 1) **Drought Monitoring and Prediction in Semiarid Climates** (Sardinia, Italy)
    - J. D. Albertson (Duke) and N. Montaldo (Uni. Cagliari)
  - 2) **Alpine Search-and-Rescue Operations** (CASYS, Bologna)
    - L. Marconi (Uni. Bologna)
  - 3) **Sea-level Rise Mitigation and Adaptation Measures** (Venice Lagoon)
    - M. Marani (Uni. Padova)
  - 4) **Modeling and Prediction of Climate Impacts on Snow/Ice** (Swiss Alps)
    - M. Parlange (EPFL)
  - 5) **Geospatial Monitoring of Air Quality and Pollutants** (EPA, NC, USA)
    - G. Hagler (EPA)
  - 6) **Intelligent Robotic Games** (ISRC, University of Ulster, Ireland, UK)
    - M. McGinnity (ISRC)
- ....



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**WISeNet Menu of Laboratory and Field Experiments**

- 7) **Aforestation, Climate Change Mitigation and Prediction** (Duke Forest, NC)
  - G. Katul (Duke)
- 8) **Undersea Monitoring and Surveillance** (NUWC, Newport, RI)
  - T. A. Wettergren (NUWC)
- 9) **Littoral Demining by Unmanned Aerial Vehicles** (BAE Systems)
  - C. Johnson (BAE)
- 10) **Robotic Saccadic Adaptation and Visually-guided Auditory Plasticity** (Duke)
  - M. Sommer (Duke)

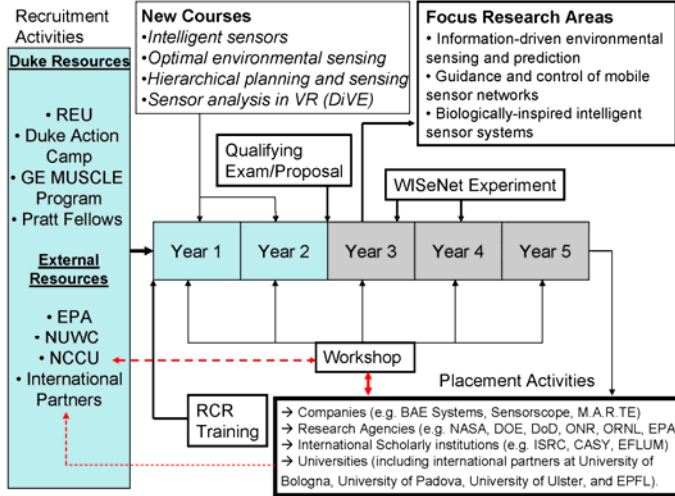
**Proposal Submission Deadlines**

**Fall Proposal Window:**  
 September 15, 2012 – November 15, 2012  
 September 15 – November 15, Annually Thereafter

**Spring Proposal Window:**  
 January 15, 2013 – March 15, 2013  
 January 15, 2013 – March 15, Annually Thereafter



WISeNet Graduate Training At-a-Glance



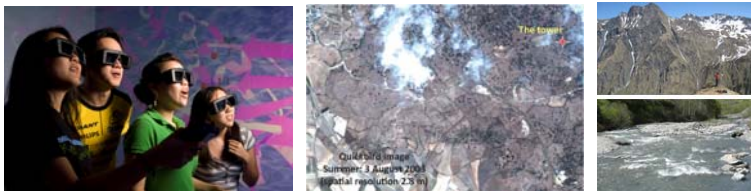
WISeNet Recruiting



The precise timing of the IGERT funding (WISeNet fellowship), which typically lasts two years, will be determined by the student's advisor and the program director (Silvia) on a case-by-case basis, to be best meet the student's needs. Note, however, that students must be on the WISeNet fellowship when funded to participate in their WISeNet experiment of choice.

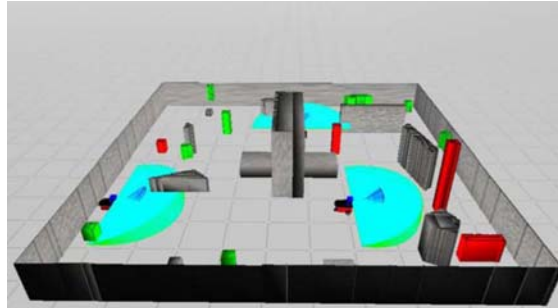
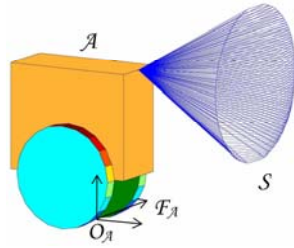
**Possible recruiting scenarios** are as follows:

- Student applies to Duke Graduate School to join WISeNet, if admitted, student notifies the department of choice by April 15, and submits a WISeNet application by April 30.
- Student applies to Duke Graduate School, is identified by a WISeNet participant as possible WISeNet fellow, if admitted, student notifies the department of choice by April 15, and submits a WISeNet application by April 30.
- Student is enrolled in a Ph.D. program in one of the participating departments, becomes interested in WISeNet, and submits a WISeNet application by April 30.



### Example: Treasure Hunt Problem

For a given layout  $\mathcal{W} \subset \mathbb{R}^3$  with  $r$  targets and  $n$  obstacles and a given joint probability mass function  $p(z, \xi, \lambda)$ , find the obstacle-free path that minimizes the distance traveled by a robot  $\mathcal{A}$  between two configurations  $q_0$  and  $q_f$ , and maximizes the total information value, for a sensor with field-of-view  $S$ , installed on  $\mathcal{A}$ .



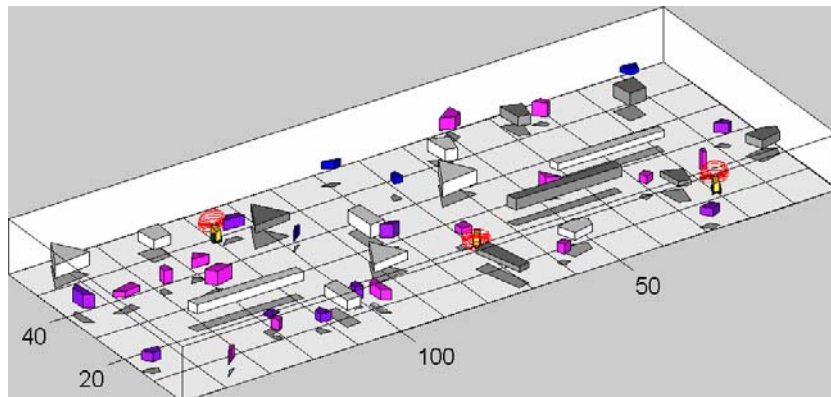
S. Ferrari and C. Cai, "Information-Driven Search Strategies in the Board Game of CLUE®," *IEEE Transactions on Systems, Man, and Cybernetics - Part B*, Vol. 39, No 3, June 2009.

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### Results of Information Potential Approach

Targets {   
 : High EER   
 : Low EER   
 : Med. EER   
 : Classified

Obstacles: {   
 : Undetected   
 : Detected

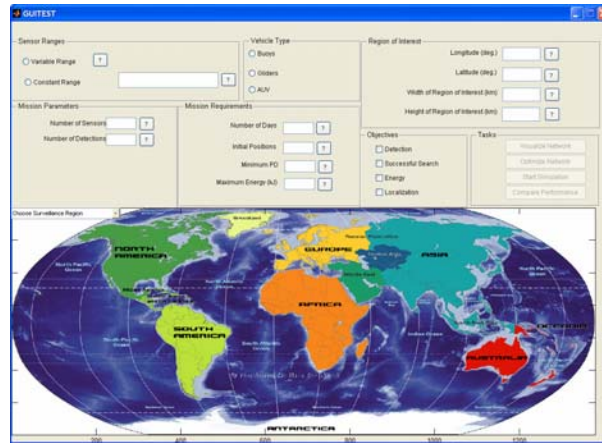


Sensors must also avoid collisions with other moving sensors, based on knowledge of their instantaneous configuration.

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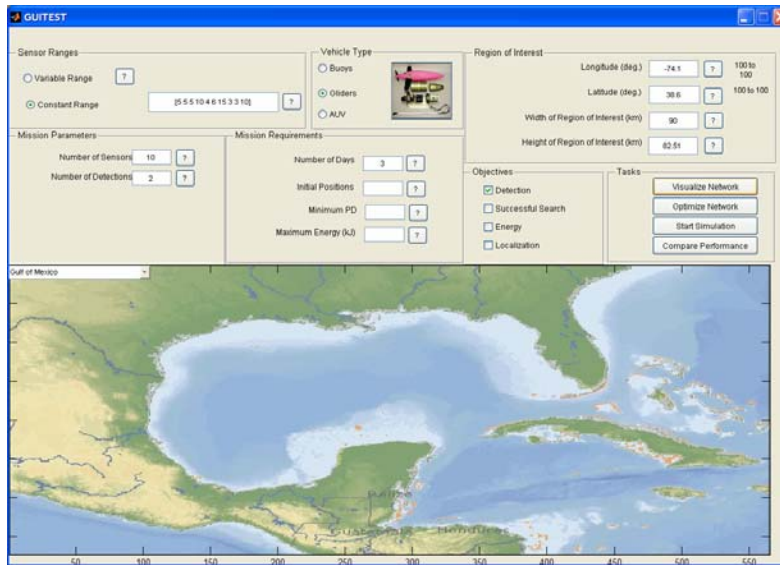
## Synthetic Sensor Simulation and Visualization Software (3SVS)

Over the years, Duke research efforts on sensor networks and environmental modeling have elucidated the need for an integrated simulation tool that can capture all important couplings and components of a sensor system. As part of their Certificate requirements, WISENet students will develop modular software components for simulating, visualizing, and analyzing sensor data, which will be integrated in a common package (3SVS), located in the WISENet CLUSTER (Hudson 226).



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## 3SVS Graphical User Interface (GUI)







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### 3SVS: Interdisciplinary Research Platform

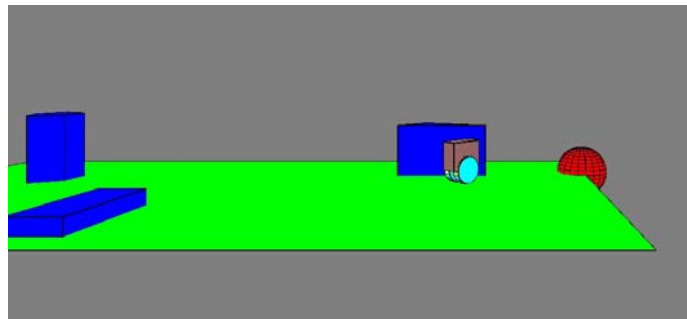


LABORATORY FOR INTELLIGENT SYSTEMS AND CONTROLS

### Duke immersive Virtual Environment (DiVE) Student Projects

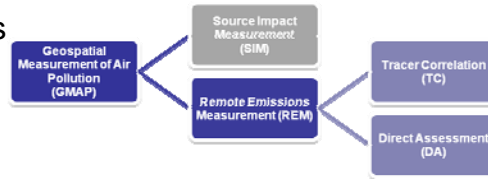
As part of their Certificate requirements, WISNet students will interface selected 3SVS modules and visualization software with the DiVE. The DiVE is one of only five 6-sided CAVE-like systems in the U.S., and resides in the Pratt School of Engineering. Students will utilize the DiVE to produce an immersive, interactive experience and virtual rendering of their major research finding or field experiment, and use the resulting DiVE application for furthering their scientific understanding, and for communicating and disseminating their research results.

#### Sensor Path Planning DiVE Project (Wenjie Lu)



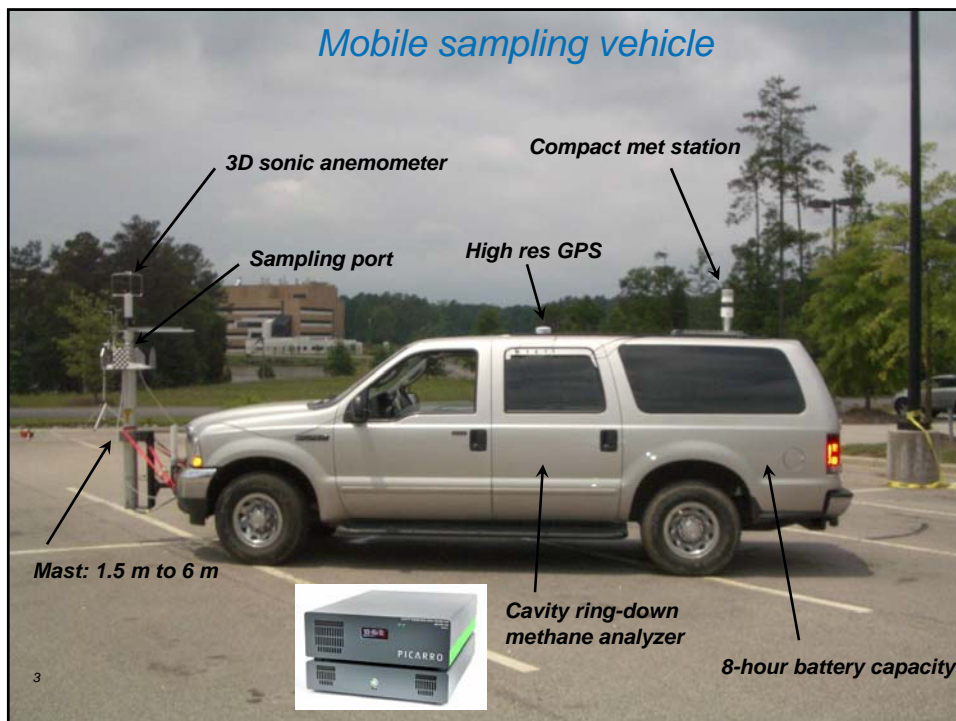
## GMAP-REM Concept:

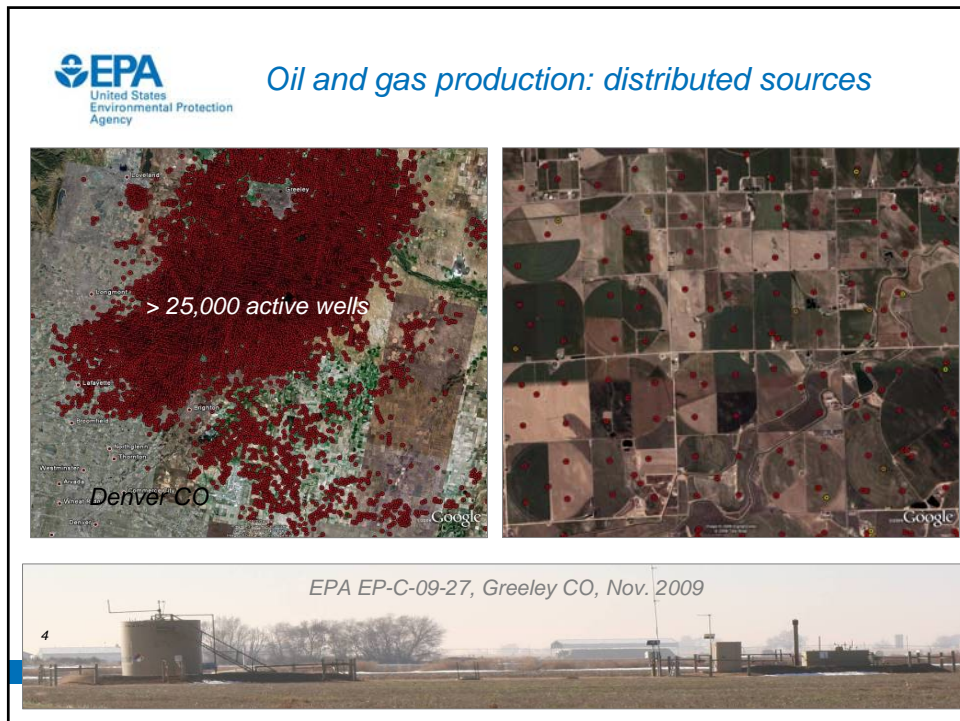
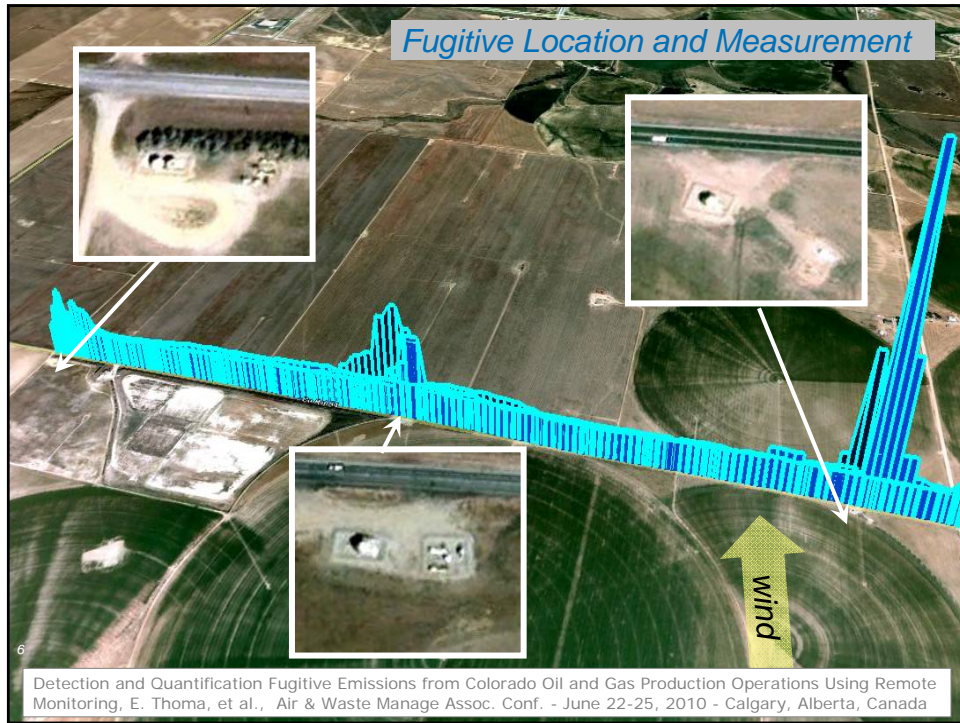
Detect and quantify emissions of a specific species from a large area or distributed source via mobile sampling and plume dispersion diagnostics.



## Example projects:

1. Detection of methane emissions from distributed oil and gas production wells using a Direct Assessment (DA) approach
2. Quantification of methane emissions from landfills using an acetylene tracer via the Tracer Correlation (TC) approach

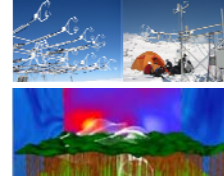




**WISeNet Action Points**

**WISeNet Faculty**

- Student recruitment for WISeNet fellowships
- Proposal writing with WISeNet partners
- Paper submission for WISeNet Workshop (March 2012)



**WISeNet Students**

- Signup for WISeNet courses
- Submit proposal for WISeNet experiment
- Submit requests for WISeNet equipment
- Plan WISeNet 3SVS and DiVE projects
- Identify two WISeNet mentors from WISeNet faculty and Advisory Board
- **Respond to NSF surveys promptly to avoid lapse in funding**



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