EPA Handbook for

Optical Remote Sensing

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Outline

- Strategy
- What to Expect
- Chapter Description
- Deadlines and Next Steps

What do we mean by Remote Sensing?

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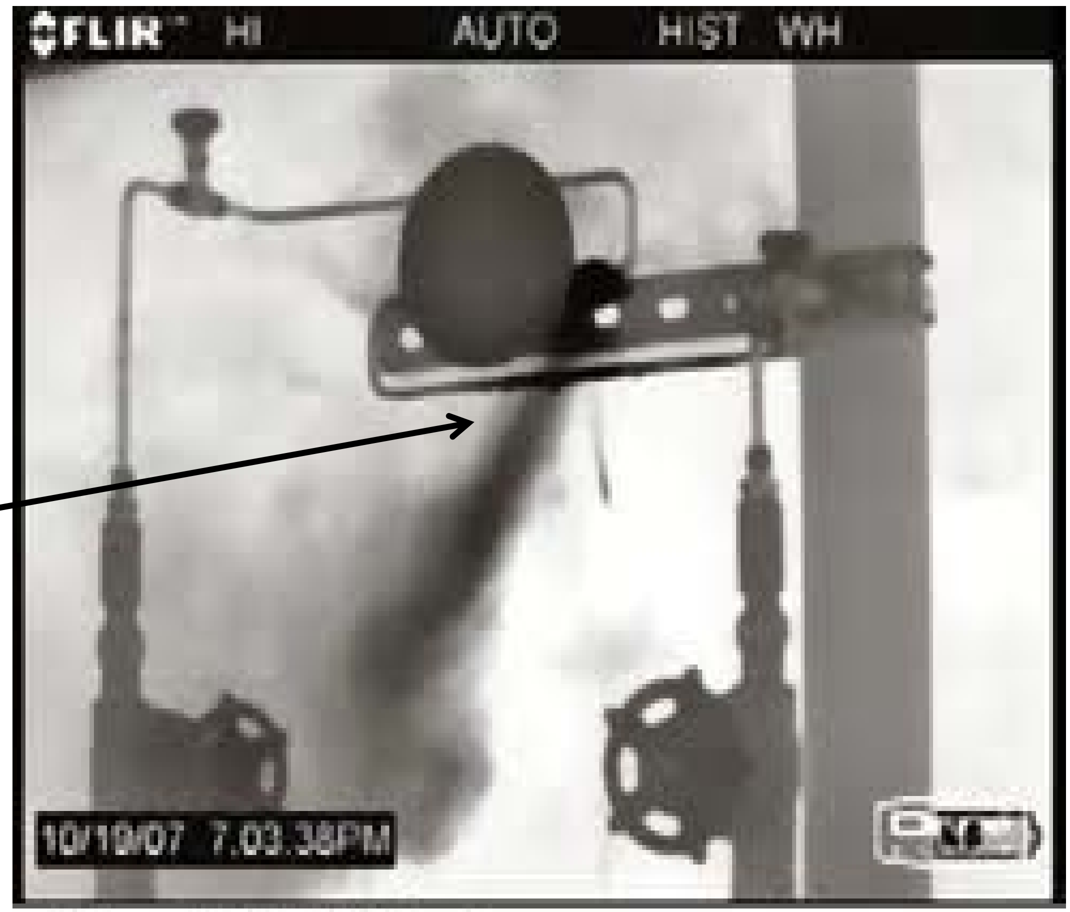
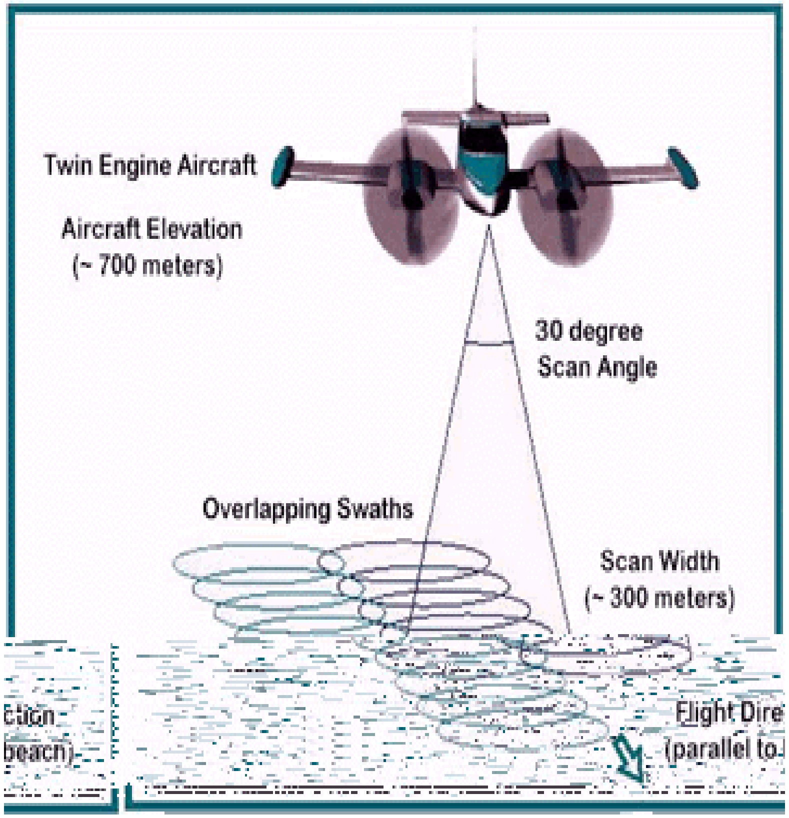
Leak Detection



What do we mean by Remote Sensing ?

Roadside Monitoring

Air borne LIDAR – Leak Detection



Strategy

Industry, researchers and State/Local/Federal agencies have been requesting EPA guidance

Reasoning: create a document that can be of <u>significant</u> use to the <u>non-spectroscopist.</u>

Target Audience: Engineers, scientists, monitoring professionals

Create a comprehensive, but *living* document!!

What to Expect

We will attempt to address issues related to Optical Remote Sensing

- Technology and Technique Crosswalk
- Strengths and Limitations
- Instrument Descriptions
- Lists of Target Compounds
- Method Descriptions
- Data Validation

Chapter 1 – Introduction

- Purpose
- Evolution and Updates
- EPA Quality System Summary

  Range, Sensitivity, Measurement Errors and Uncertainty

<u>Selecting the Right Tool for Program Objectives</u>

Chapter 1: Technology/Technique Crosswalk

Application	Technology
Emission Flux Applications	
DIAL	LIDAR
SOF	
Emission Factor	ORS FTIR, UV-DOAS, TDL
bLS	ORS FTIR, UV-DOAS, TDL
Emission Concentration Applications	
ID VRPM	ORS FTIR, UV-DOAS, TDL
Tracer Correlation	CRDS/TDL, Mobile FTIR
Leak Detection Applications	
Optical Imaging	FTIR Camera

Chapter 1: Strengths and Limitations

Strengths	Limitations
Fourier Transform Infrared Spectroscopy – 2.1	
Relatively low instrument cost (about $80,000 - $125,000)	Gas-phase water spectral interference as well as CO and CO_2 interference[5,12,13]
FTIR equipment is fairly rugged and easily portable	Not applicable to homonuclear diatomic gases such as chlorine, oxygen, and nitrogen[1,2,3]
There are a large number of compounds that are infrared active (absorb IR light)	Weak IR absorption features for many inorganic molecules such as sulfur dioxide and nitrogen oxides[6]
Large number of compounds can be analyzed simultaneously	Infrared beam has a limited range and may not be sensitive enough to meet ambient data quality objectives. Maximum path length is on the order of 400–500 meters.
No gas calibration standards necessary (uses standard reference spectral library)	Multiple vertical or horizontal path measurements necessary to calculate plume flux, can require significant time and cost to set up and implement
FTIR can be used to locate discrete emissions hotspots at a facility/area source	Typical infrared detectors require cryogenic cooling to operate. Liquid nitrogen used for detector cooling must be refilled and maintained regularly (weekly).
Multi-compound coverage makes FTIR ideal for leak detection or source location where the facility being monitored has multiple compounds present (e.g., chemical plants)	Typical set-up time usually requires about 5 to 8 hours and a minimum of two people
Equipment can be allowed to run unattended for months at a time with remote access to check instrument operation and recover data	Single beam open-path method measures concentration along a path. The path must capture most if not all of an analyte plume to provide accurate measure of emissions.
No sample collection, handling, or preparation is necessary	Field implementation and data collection requires highly experienced personnel

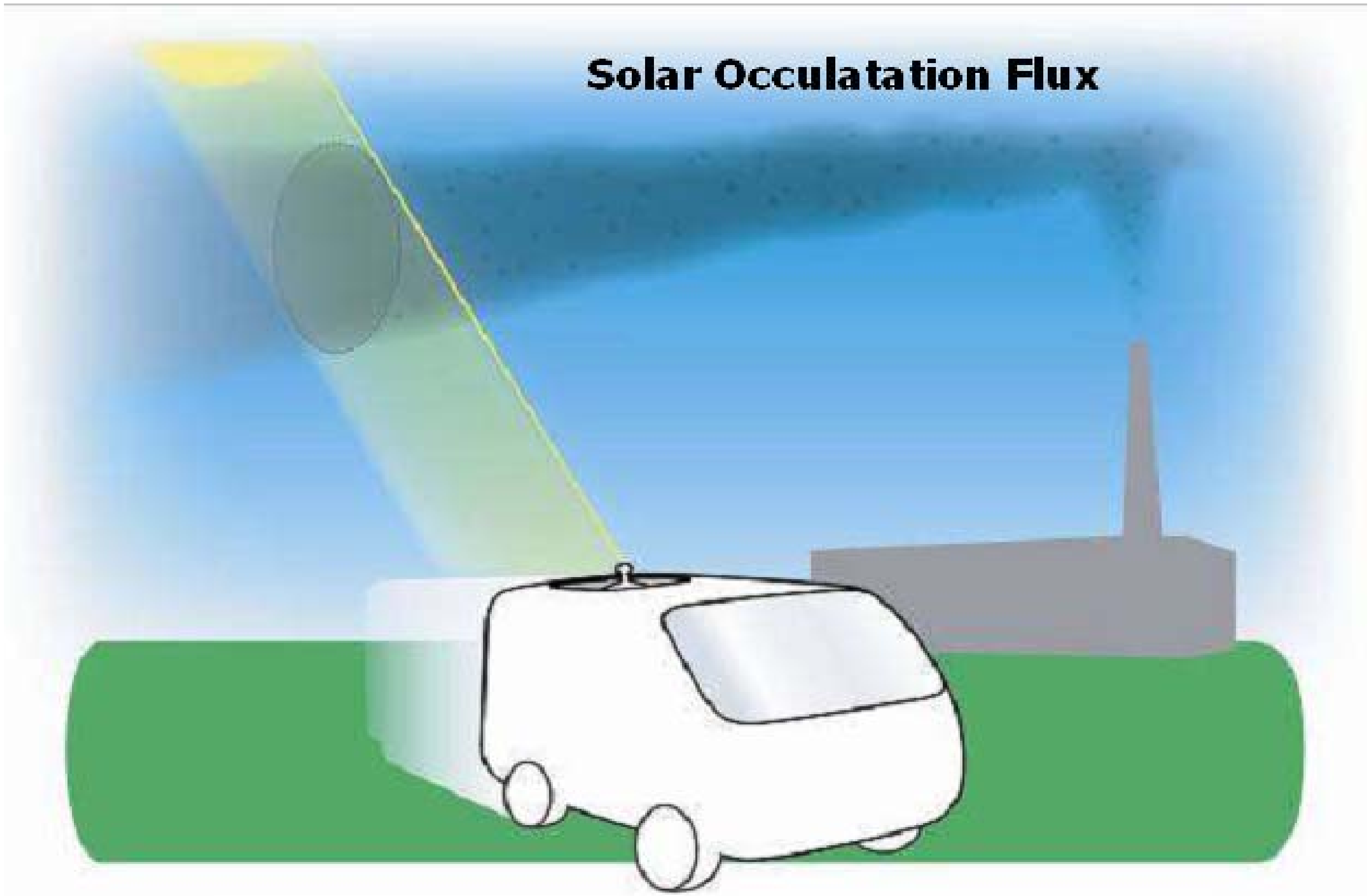
Chapter 2: Target Compounds

Laser Type	λ Range (nm)	Target Compounds
AlGaInP	630-690	NO_2
AlGaAs	750-1000	O_2, NH_3
Vertical Cavity	650-1680	H_2O, C_2H_2, HF, H_2S, O_2, H_2O, NH_3
Antimonide*	2000-4000	CO, CO_2, NO, N_2O, CH_4, HCl, HBr, H_2CO
Quantum Cascade**	4000-12000	H_2O, CO, CO_2, NO, NO_2, N_2O, SO_2, C_2H_2, HCN, NH_3, PH_3, 0_3
Lead-salt**	3000-30000	H_2O, CO, CO_2, NO, NO_2, N_2O, SO_2, CH_4, C_2H_2, HCl, HBr, HCN, NH_3, H_2CO, PH_3, O_3

Chapter 2 – Compounds and Detection

Species (Tuneable Diode Lasers)	Approximate near-IR λ (nm)	Reported Detection Limit (ppm-m)
ammonia	760, 1500	0.5-5.0
carbon monoxide	1570	40-1,000
carbon dioxide	1570	40-1,000
hydrogen chloride	1790	0.15-1
hydrogen cyanide	1540	1.0
hydrogen fluoride	1310	0.1-0.2
hydrogen sulfide	1570	20
methane	1650	0.5-1
nitric oxide	1800	30
nitrogen dioxide	680	0.2
oxygen	760	50

Chapter 3 – Measurement Approaches



Chapter 4 – Ancillary Data

- Types of data that is typically collected

- Meteorological Measurements

  How is Met data used to calculate flux
  Monitoring location siting

- Process information: Emission factors, through-put, stack height, exit velocities
- Other useful data: GPS

Chapter 5: Data Validation and Verification

Full post test Validation ofn ofn ofn ofn ofdel36.0Via10Q3

Timeline

- OAQPS – requested 2010 fiscal year funds
- Work Assignment just ended
- Sections 1 – 5 are written
- All sections are under external and internal review

<u>First Draft must be finished by December 2010</u>

Timeline

- Due to time constraints:
- Modified the original Table of Contents
- Focusing on the “flux” determination methods
- Intend to expand document to include:
  - Ambient – Near roadway monitoring
  - Mobile Monitoring
  - Fence-line Monitoring

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