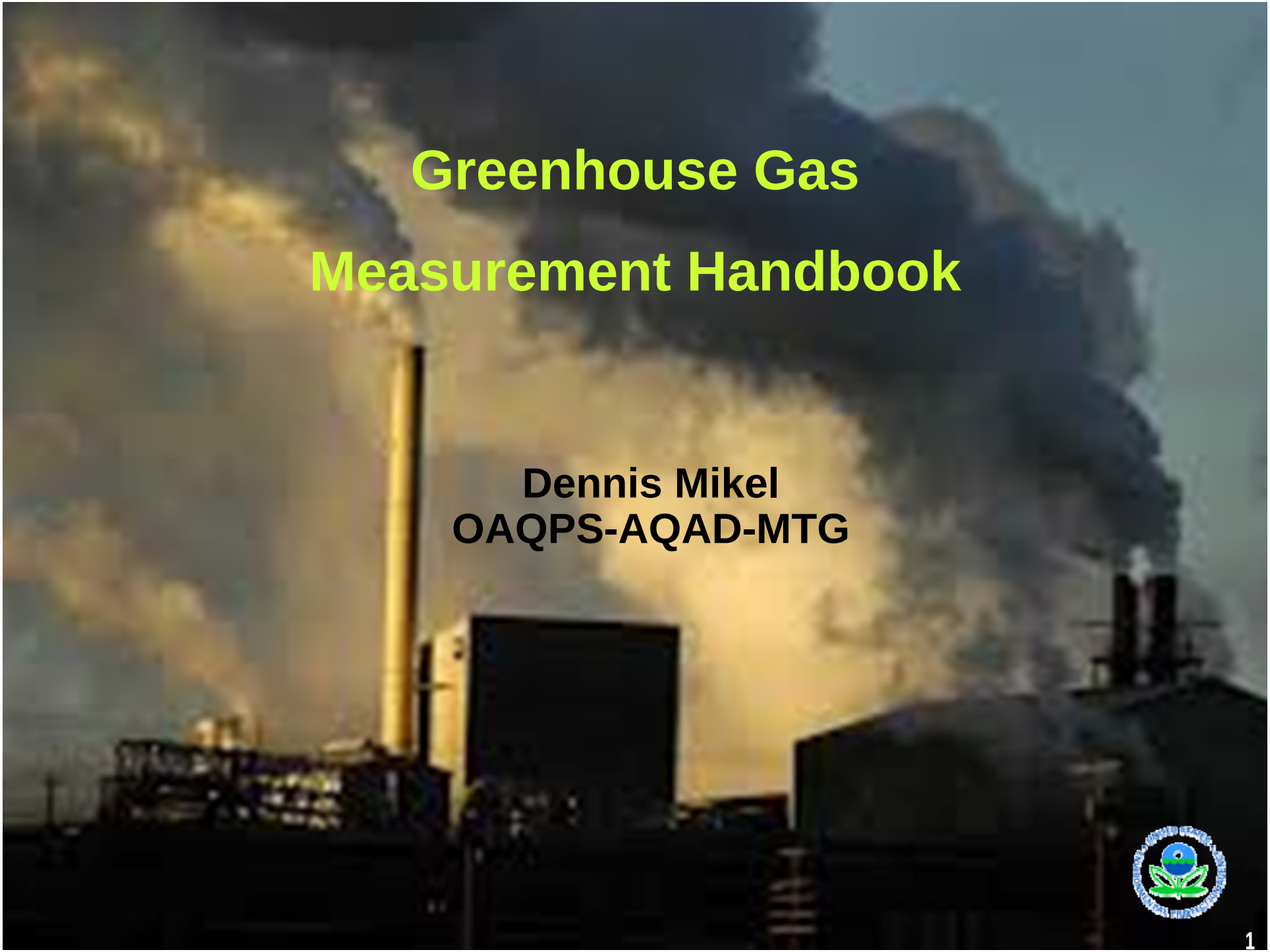

Greenhouse Gas Measurement Handbook

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Outline

- Strategy
- What's in There?
- Introduction
- Source Methods
- Non-point Methods
- Global/Research Methods

Strategy

In late 2009, the Measurement Technology group (MTG) received a request for help from Office of Atmospheric Policy to review a part of the GHG Reporting Rule (GHGRP).

MTG reviewed a portion of the rule 40 CFR 98 Subpart I

In 2011, MTG received funds to create a handbook to describe how GHGs are measured.

MTG's strategy was to create a comprehensive, and living document that could be updated periodically

What's in there?

There are four Sections in the Handbook:

Section 1: Discusses global emissions their impact on the environment. It also has a number of tables that have a "crosswalk" between the different technologies

Section 2: Describes the stationary source GHG measurements

- Those codified within EPA regulations, 40 CFR 60, 40 CFR 75 and 40 CFR 98, the recently finalized GHG Reporting Rule
- In addition, non-EPA methods, (e.g., ISO and ASTM) are described

Section 3: Discusses measurement of fenceline, ambient or background concentrations

Section 4: Discusses satellite measurements, upper tropospheric and stratospheric measurement methods

Chapter 1: Introduction

Purpose of Handbook

- **What is this handbook? What is it not?**
- **Define stationary vs. open source monitoring**

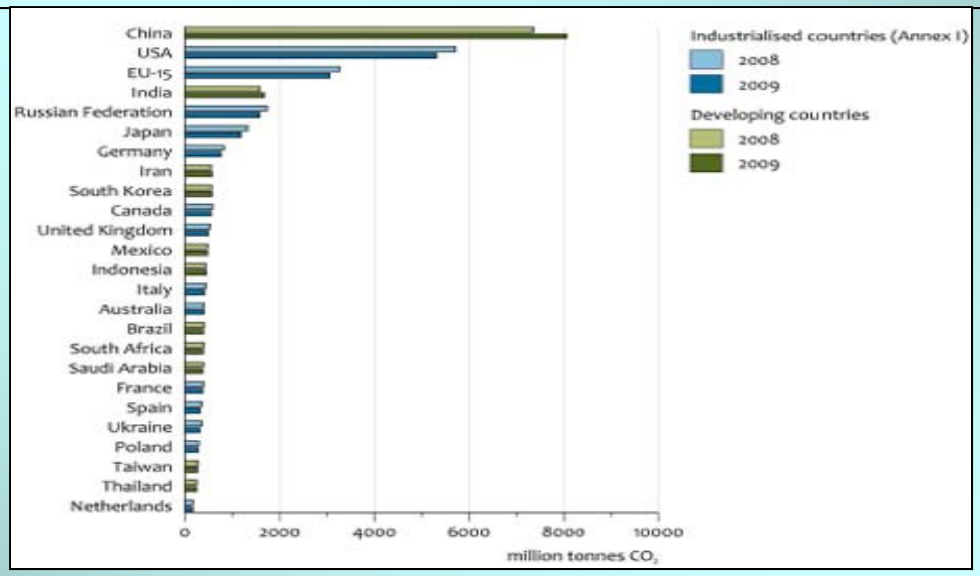
What are the sources of the GHGs and relative emissions?

Explanation of content and items to be aware of in handbook sections

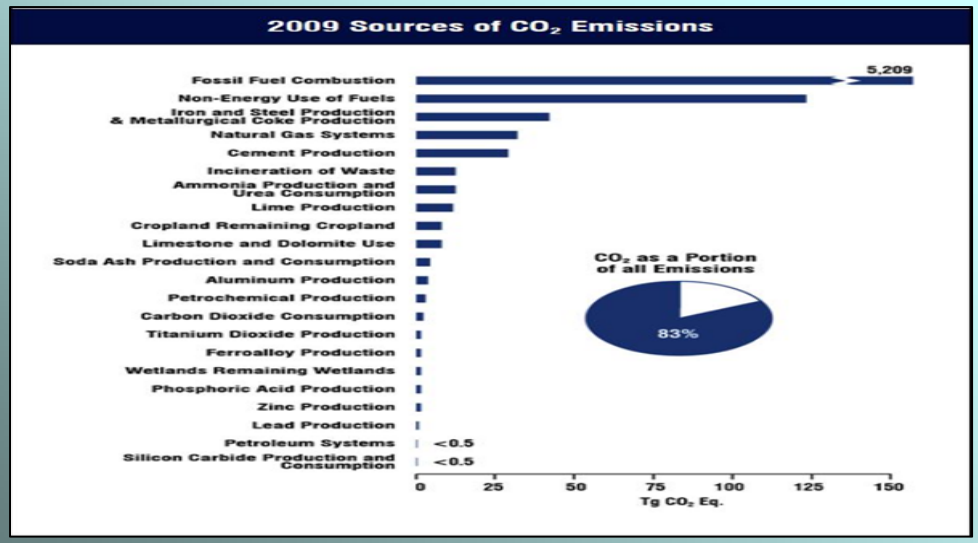
General discussion of EPA Quality Systems

Summary table of strengths and limitations of each approach

Section 1: Introduction



Section 1 has charts that show the distribution of pollutants by country



This Section also has charts that illustrate emission rates by pollutant

Chapter 1: Introduction

Table 1-3 Measurement Technologies for Stationary Point Sources

Measurement Technology*	Greenhouse Gas					
	CO_2	CH_4	N_2O	FC	SF_6	NF_3
EPA Reference Test Methods						
Flame ionization detector		✓				
Fourier transform infrared spectroscopy	✓	✓	✓	✓	✓	✓
Gas Chromatography		✓				
Non-dispersive infrared detector	✓	✓				
Thermal conductivity detector	✓	✓				
Non EPA Test Methods						
Atomic emission detector				✓		
Electro-chemical and colorimetric analysis						✓
Electron capture device			✓		✓	
Flame ionization detector		✓				
Fourier transform infrared spectroscopy	✓	✓	✓	✓	✓	✓
Mass spectrometer				✓	✓	✓
Non-dispersive infrared detector	✓	✓	✓	✓		
Photoacoustic absorption spectroscopy		✓	✓	✓	✓	

Chapter 2: Stationary Methods

Longest Section in the Handbook

Organized by Pollutant, not by Method!

First Section discusses Stack Gas Velocity, Flow Molecular Weight and Density, Moisture Content

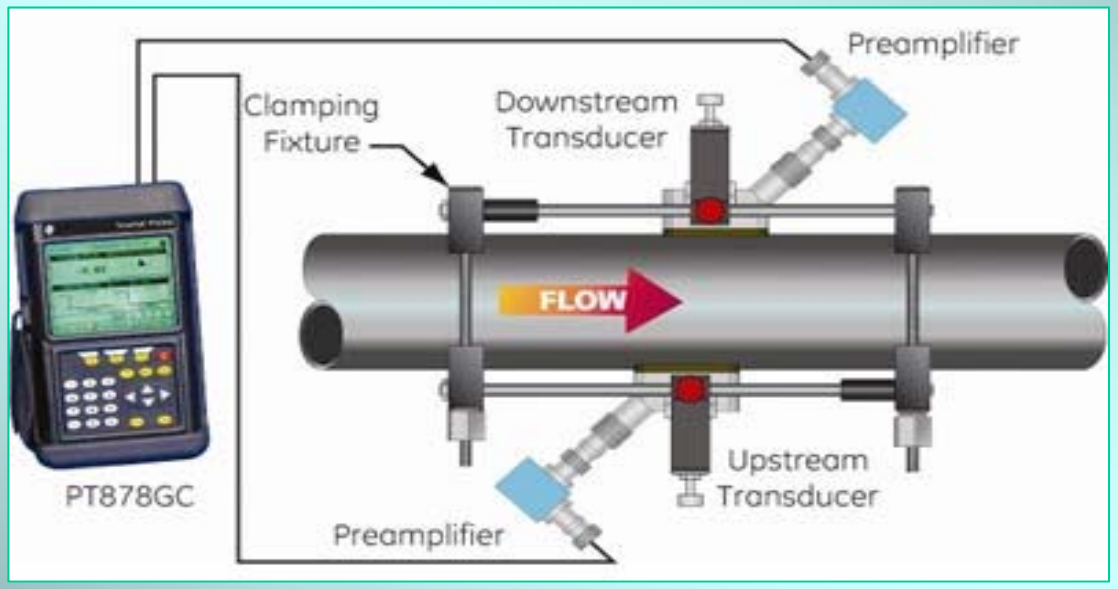
Measurement Methods of each GHG

Discusses EPA vs. Non-EPA method

Example Applications and Vendors

Strengths/Limitations

Chapter 2: Source Methods



Section 2 has illustrations of state of the art instruments. This is an example of an ultrasonic flow meter.

FTIR measurement system measuring stack gas concentrations in-situ

Chapter 2: Source Methods

Technology	Strength	Limitation
FID	• Rugged design. • Extremely sensitive. • Wide range of linearity. • No interference from H_2O, CO, or NOx.	• Sample is destroyed by flame (must be the last detector if applied in series). • Must be used with GC or gas cutter to obtain speciated data.
FTIR	• Simultaneous measurement of multiple analytes. • Enhanced signal-to-noise ratios and higher frequency band resolution. • Fast, reproducible, and highly-accurate measurements.	• Complex design. • Relatively expensive. • Interference from water vapor • Interference from HCl, HCHO and alkanes
NDIR	• Relatively simple design. • Relatively low instrument cost. • Sensitive and precise. • Can provide continuous data for multiple gases. • Non-destructive -can be used in series with other gas analyzers.	• Requires regular maintenance to replace saturated sample filters. • Prone to instrument drift due to changing temperature and pressure conditions over time. • Potential interferences from water and other compounds. • GC or gas cutter must be used to obtain speciated measurements. • In-depth training is required for all NDIR operators.

Chapter 3: Non-point Methods

Focus on methodology, not Pollutant (opposite of Chapter 2)!!

OTM-10: Radial Plume Mapping

Mobile Tracer Correlation

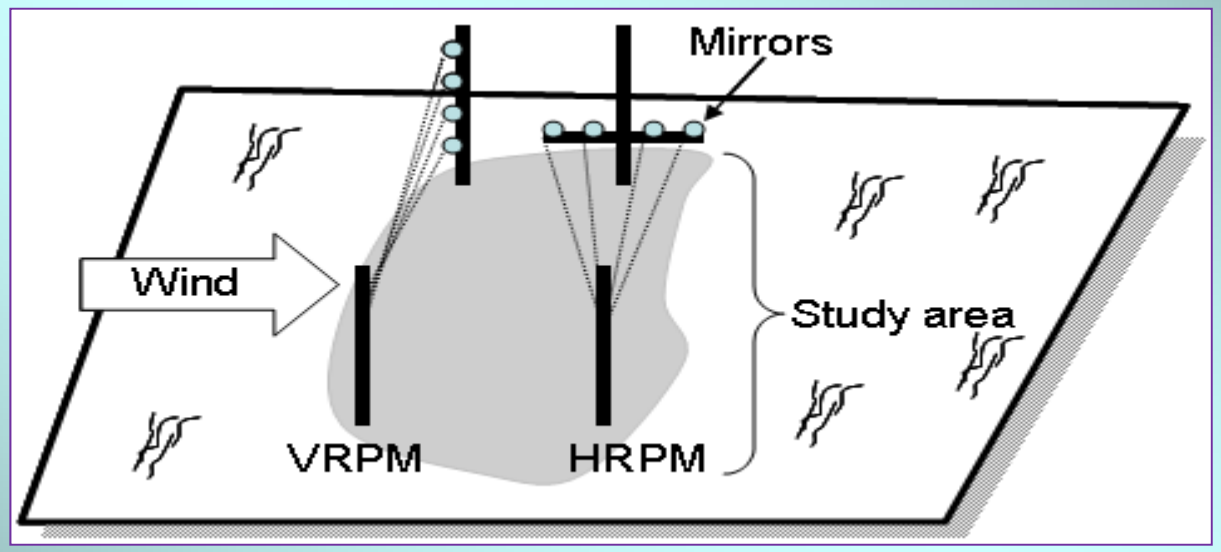
Aerostat Aloft Platforms

Airplane LIDAR

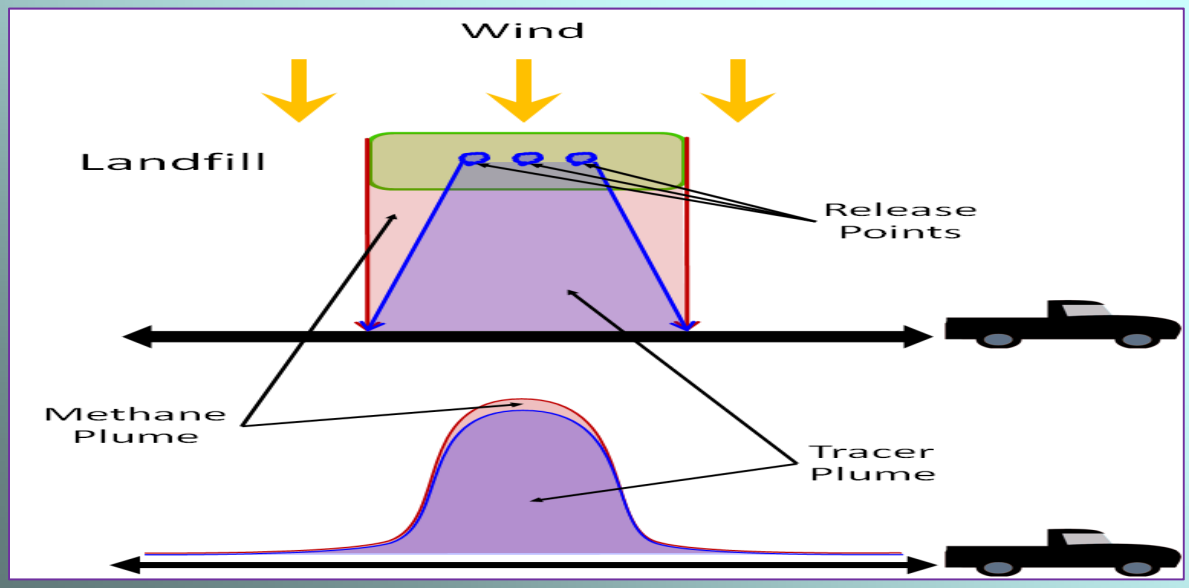
Optical Gas Imaging

Eddy Covariance Methods

Chapter 3: Non-point Methods

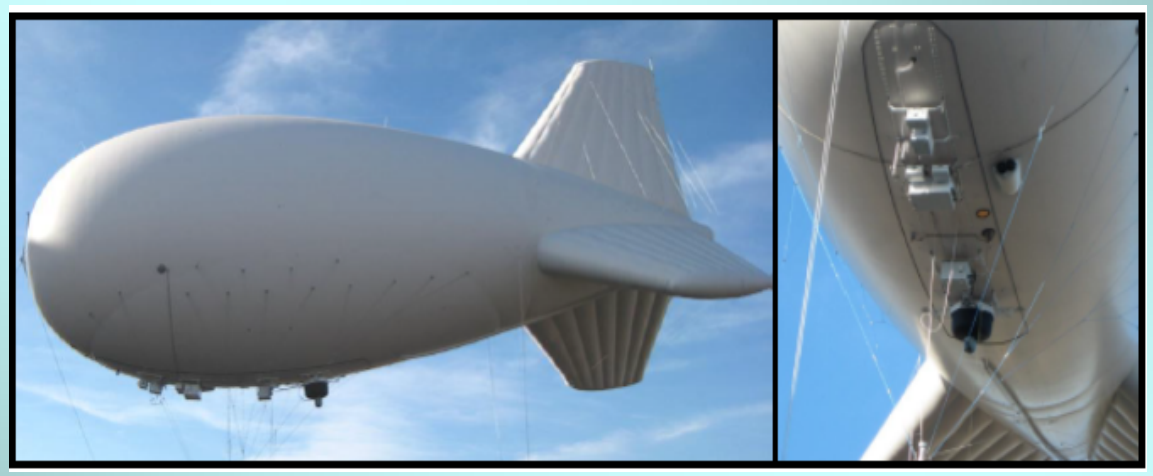


This Section has descriptions of different optical remote methods, and their role in measurements



This Section also discusses different techniques such as mobile tracer technology

Chapter 3: Non-point Methods



Some other techniques that are available: Aerostat balloon platforms to measure inside plumes

Airplane LIDAR that can detect leaks in pipelines.

Chapter 4: Global Measurements

Research and Satellite Measurements

Examples of different research instruments/methods being used by other Federal agencies and researchers

NASA - Satellite Measurements

LANDSAT, ENVISAT

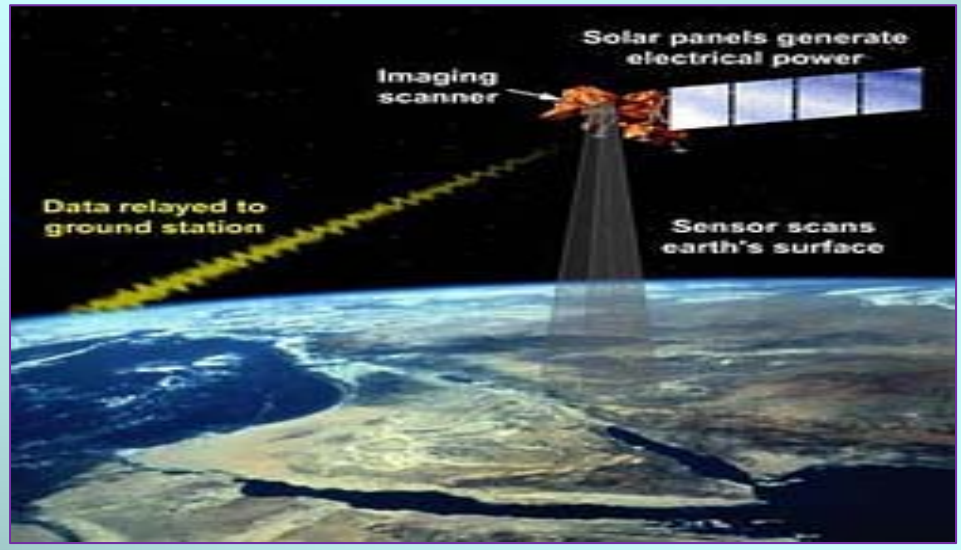
CO2 measurements and thermal imaging

UV-Visible Radiometry

NOAA – Unmanned Aerial Systems

Unmanned Chromatographs Aerial Systems (UCATS)

Chapter 4: Global Measurements



Chapter 4 discusses satellite measurements and how to get those data sets

This Section also discusses GHG measurements in the upper troposphere and stratospheric measurements

Timeline

In December 2014, Handbook was sent to an internal EPA review group

Comment due back this month

Will send to Office of General Counsel – Legal Review

Divisional and OAQPS Review

Projected to be final Fall 2015