GI-13 - Integration of Methods for Air Quality and Health Data, Remote Sensed and In-Situ with Disease Estimate Techniques

William Sonntag, Office of Environmental Information
Phil Dickerson, Office of Air and Radiation
Gary J. Foley, PhD, Office of Research and Development
US Environmental Protection Agency

BEST VIEWED AS A SLIDE SHOW

PRESENTATION OUTLINE

- GI-13 – A brief review of the GEO Work Plan Description
- Global map examples of PM2.5 satellite measures
- US Maps showing examples of fused in-situ and satellite data
- New AQ Monitoring approach with social value – **Village Green** example
- Computing and Systems Applied in Energy-Environmental-Climate-Air Quality Research
- Next Generation Monitoring Approaches
- PAHO Workshop on Health Indicators
- Discussion

GI-13 - Integration of Methods for Air Quality and Health Data, Remote Sensed and In-Situ with Disease Estimate Techniques

OVERVIEW

- Air pollution and resulting public health outcomes continue to dominate growing estimates of mortality and morbidity associated with environmental risks to communities and society. This GEO priority topic will seek to further develop and implement integration of air quality monitoring, related estimation and modeling protocols optimizing both remote sensing and *in-situ* platforms, including small sensors with the goal of providing improved information for use in public health assessment tools.
- There will be an initial focus on the Institute for Health Metrics and Evaluation (IHME), Global Burden of Disease (GBD) estimates, in particular those related to the United Nations (UN) Sustainable Development Goals, with the goal of providing results of sufficient granularity at a scale useful to citizens, communities and decision makers.

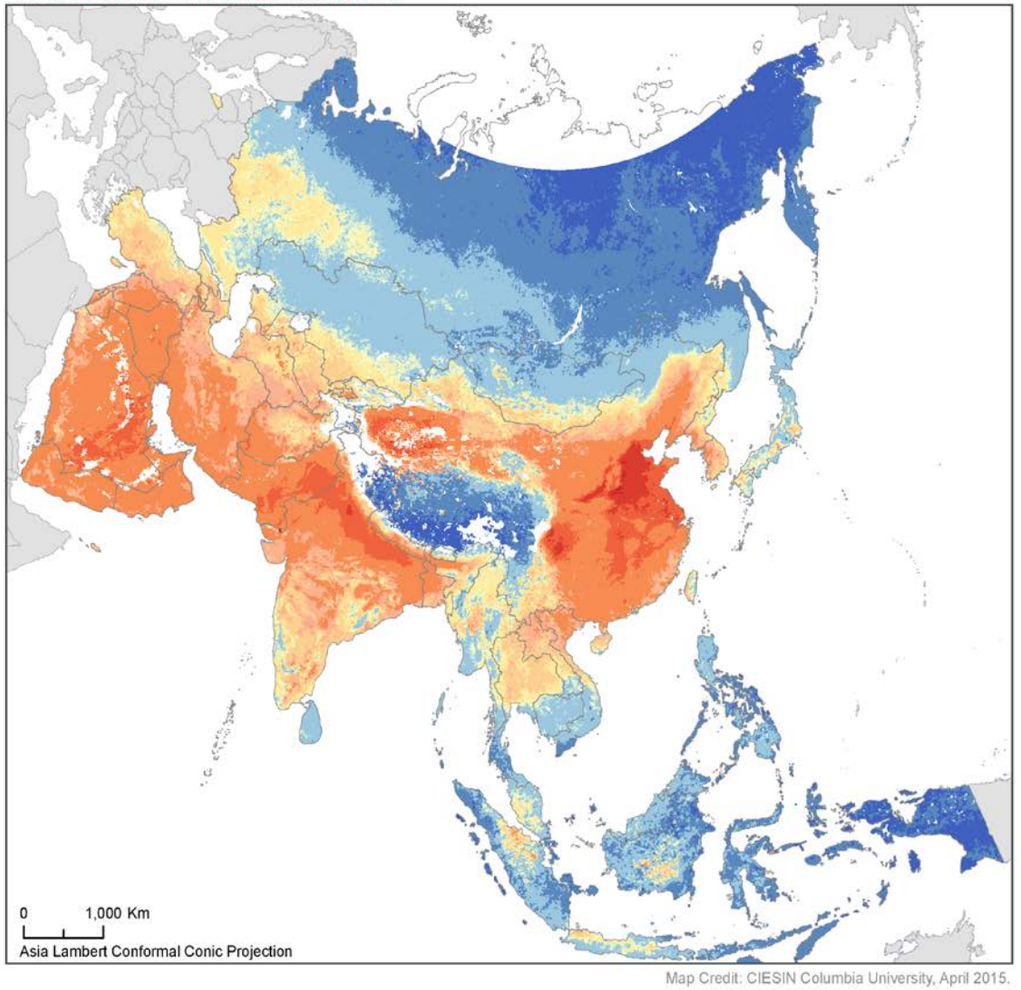
GI-13 - Integration of Methods for Air Quality and Health Data, Remote Sensed and In-Situ with Disease Estimate Techniques

Activities for 2016

- The priority task in part will examine and integrate current real-time 24-hour average and annual average modeling, calculations and techniques to optimize efficient use of data sources and platforms.
- Pilot(s) developed and deployed in a cloud-computing environment using the Environmental Protection Agency's (EPA) AirNow domestic and international technology will be used to test integration and modeling techniques. The resulting investigation and pilot should be completed within 2 to 3 years with further deployment over 10 years.

Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 2001–2010: Asia

Satellite-Derived Environmental Indicators



Map Credit: CIESIN Columbia University, April 2015.

The Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD) data sets represent a series of three-year running mean grids (1998–2012) of fine particulate matter (solid particles and liquid droplets) that were derived from a combination of MODIS (Moderate Resolution Imaging Spectroradiometer), MISR (Multi-angle Imaging SpectroRadiometer) and SeaWIFS (Sea-Viewing Wide Field-of-View Sensor) AOD satellite retrievals. A global decadal (2001–2010) mean PM2.5 concentration grid was also produced and is mapped here. Together the grids provide a continuous surface of concentrations in micrograms per cubic meter of particulate matter 2.5 micrometers or smaller (PM2.5) for health and environmental research. The raster grid cell size is approximately 10 km at the equator, and the extent is from 70 degrees north to 55 degrees south latitude.

Decadal (2001–2010) Mean
Fine Particulate Matter (PM2.5)
Concentration

1 2 5 10 12 20 50 100 200

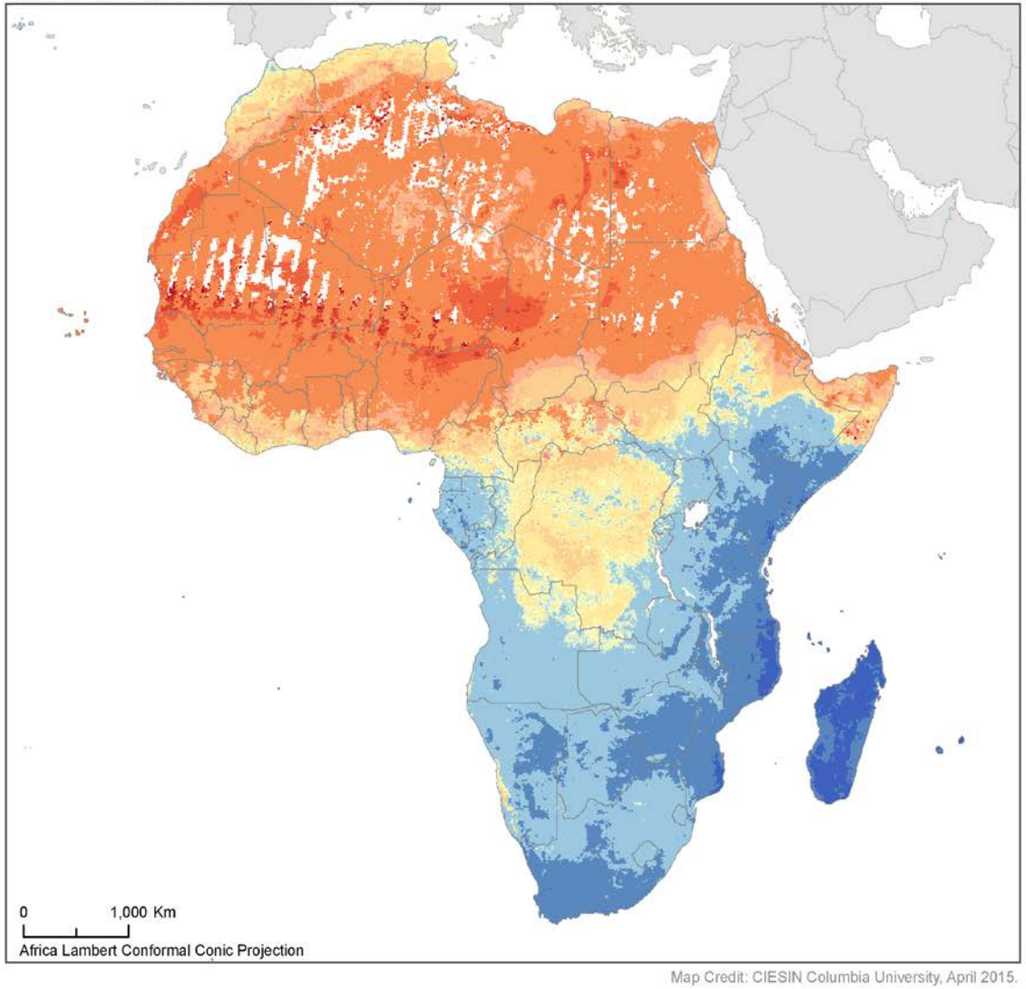
micrograms per cubic meter

Center for International Earth Science Information Network
Earth Institute | Columbia University

Data Source: van Donkelaar, A., R.V. Martin, M. Brauer, and B.L. Boys. 2015. Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2012. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4028PFS.

Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 2001–2010: Africa

Satellite-Derived Environmental Indicators



Map Credit: CIESIN Columbia University, April 2015.

The Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD) data sets represent a series of three-year running mean grids (1998–2012) of fine particulate matter (solid particles and liquid droplets) that were derived from a combination of MODIS (Moderate Resolution Imaging Spectroradiometer), MISR (Multi-angle Imaging SpectroRadiometer) and SeaWIFS (Sea-Viewing Wide Field-of-View Sensor) AOD satellite retrievals. A global decadal (2001–2010) mean PM2.5 concentration grid was also produced and is mapped here. Together the grids provide a continuous surface of concentrations in micrograms per cubic meter of particulate matter 2.5 micrometers or smaller (PM2.5) for health and environmental research. The raster grid cell size is approximately 10 km at the equator, and the extent is from 70 degrees north to 55 degrees south latitude.

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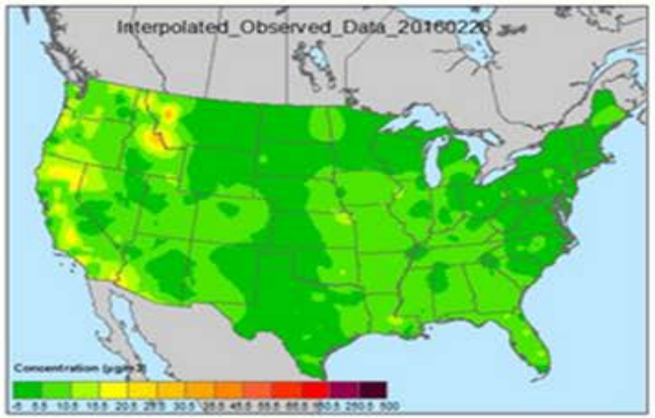
Daily Estimated $PM_{2.5}$ Concentrations ($\mu g/m^3$) and Weights

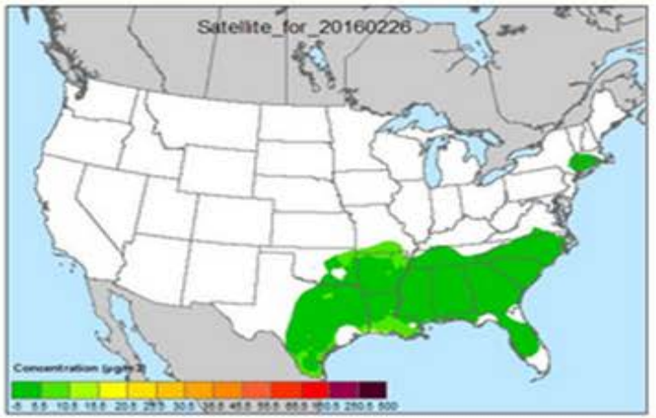
usion Method Weighted Average Date 2016-02-26 Test KMZ for 20160226 View Maps Show/Hide 6 Pane

Interpolated Observed Data



KML | JPG

Satellite-Estimated Data



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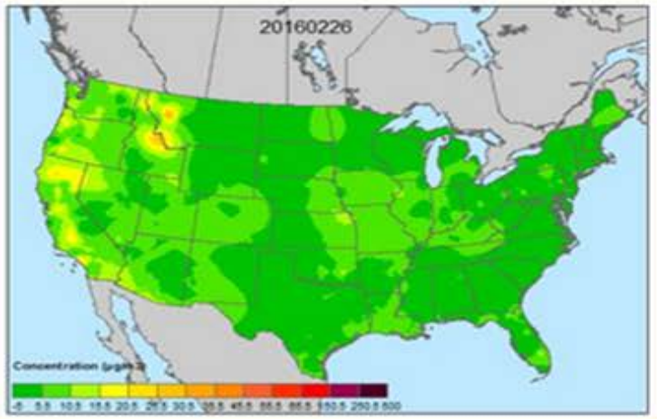
Fused Data



KML | JPG

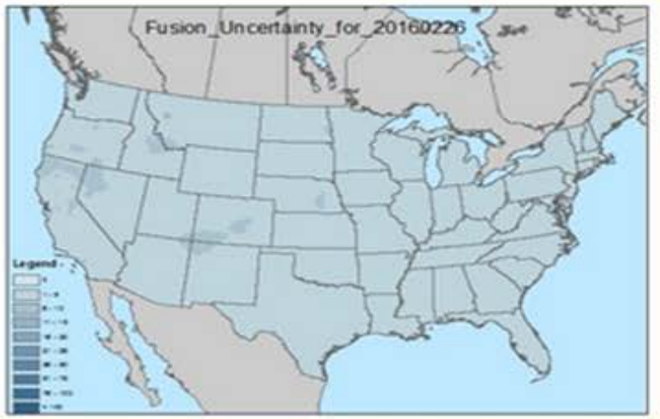
Interpolated Observed Weights

KML | JPG

Satellite-Estimated Weights

KML | JPG

Fused Uncertainty



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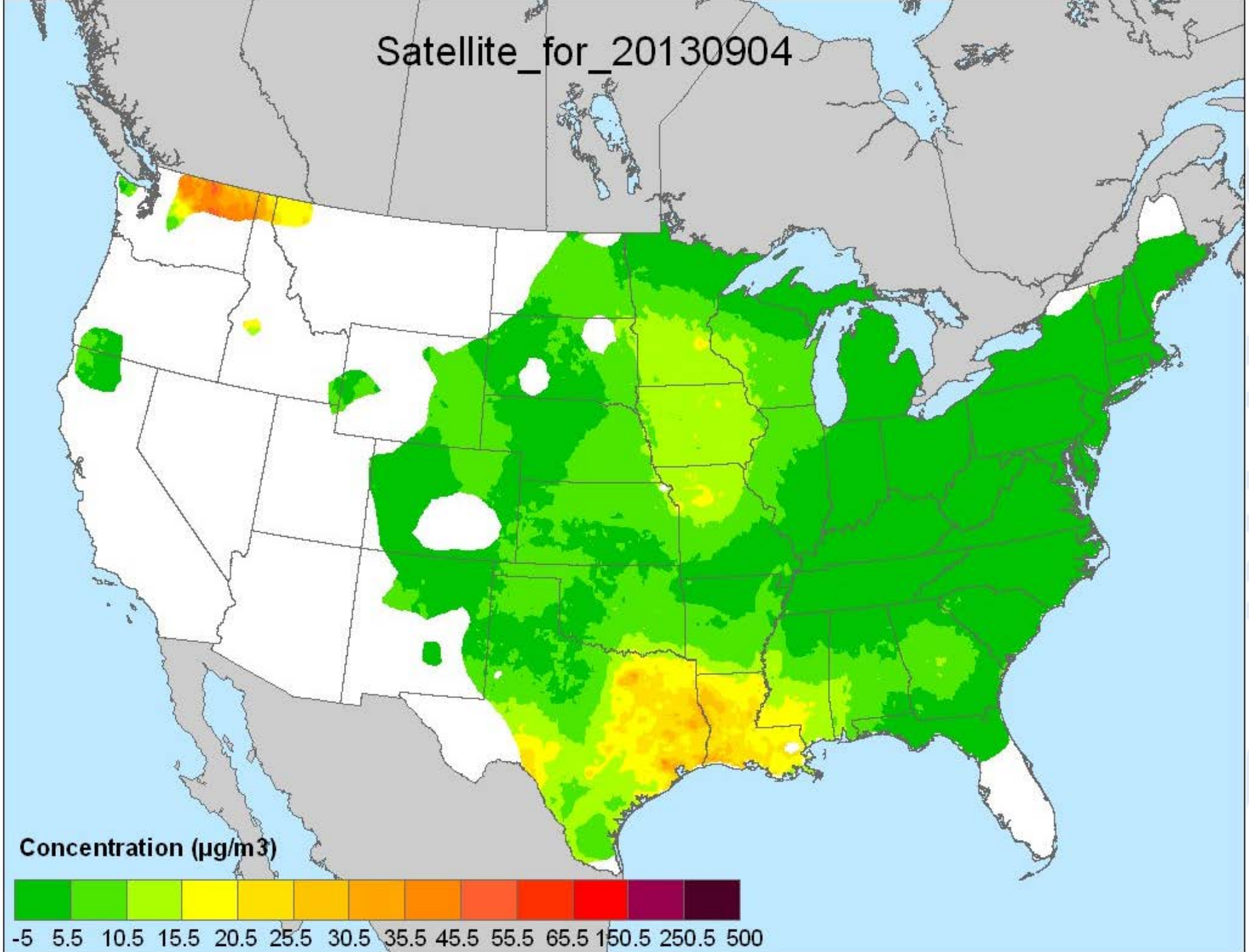
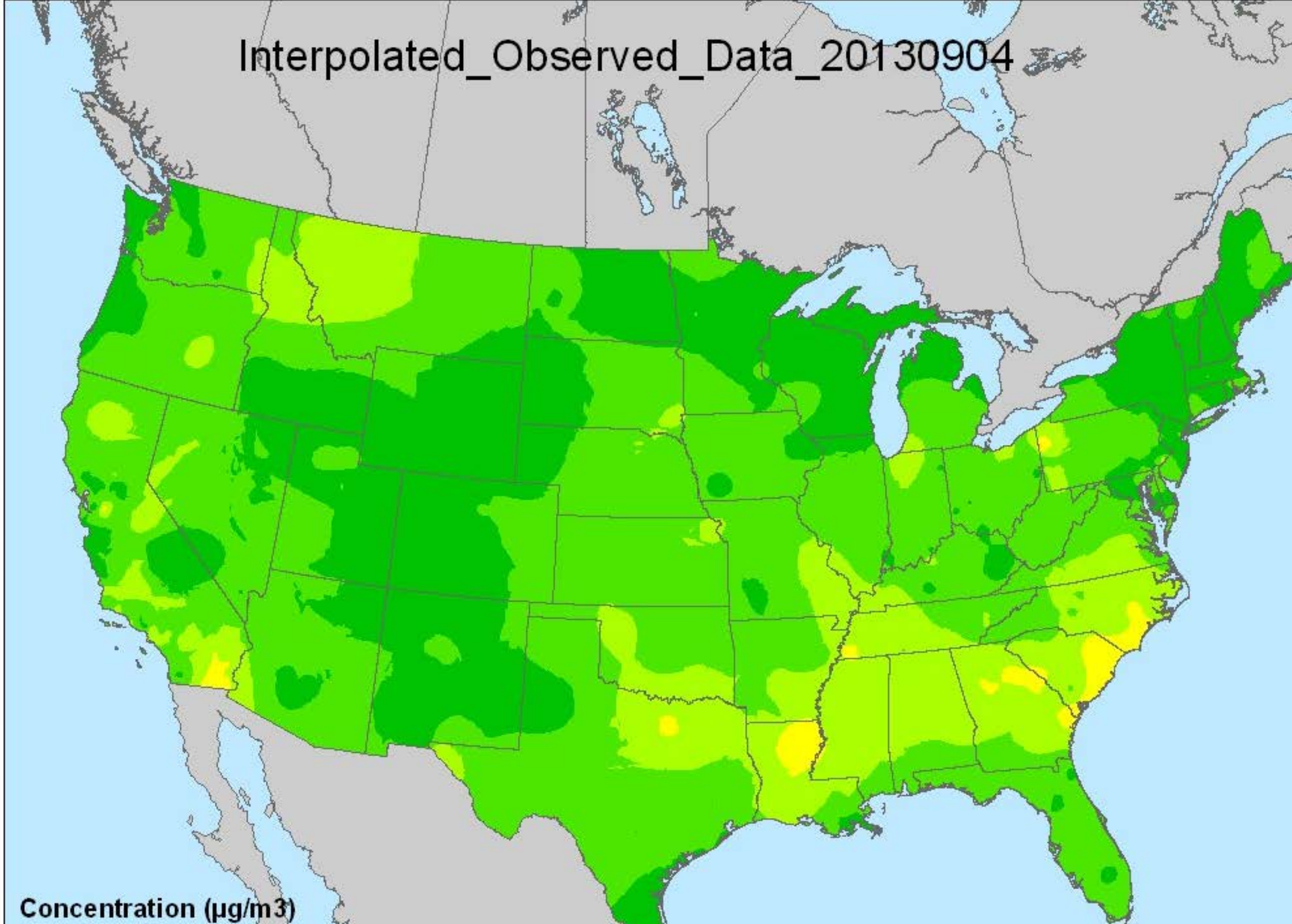
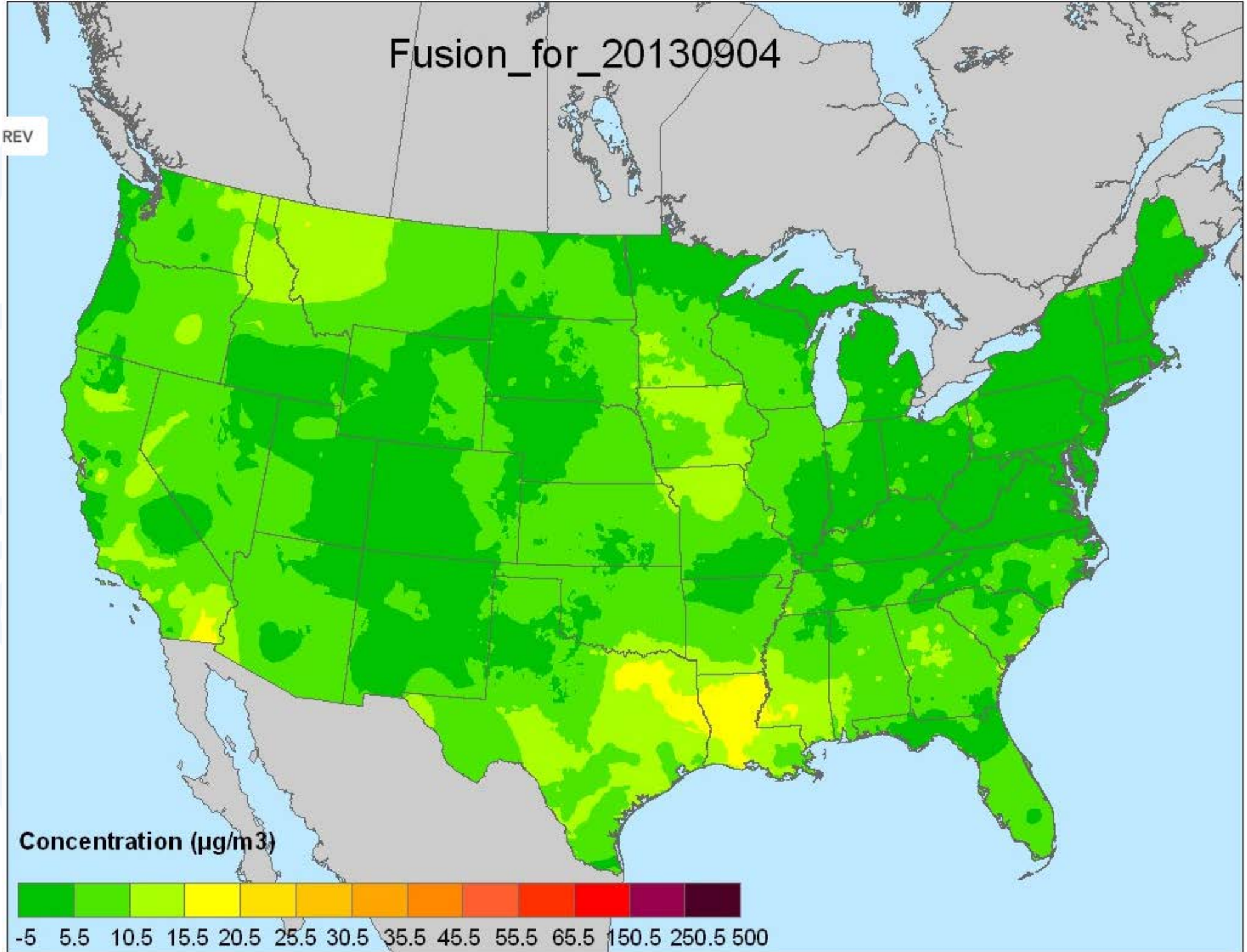

Satellite_for_20130904
Concentration (µg/m3)
-5 5.5 10.5 15.5 20.5 25.5 30.5 35.5 45.5 55.5 65.5 150.5 250.5 500


Interpolated_Observed_Data_20130904
Concentration (µg/m3)


Fusion_for_20130904
REV
Concentration (µg/m3)
-5 5.5 10.5 15.5 20.5 25.5 30.5 35.5 45.5 55.5 65.5 150.5 250.5 500

Performance Assessment of a Solar-powered Air Quality and Weather Station Placed on a School Rooftop in Hong Kong

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park, North Carolina
National Risk Management Research Laboratory
Fugitive and Area Source Research Group
Source and Fence Line Measurements
Methods and Technology Development

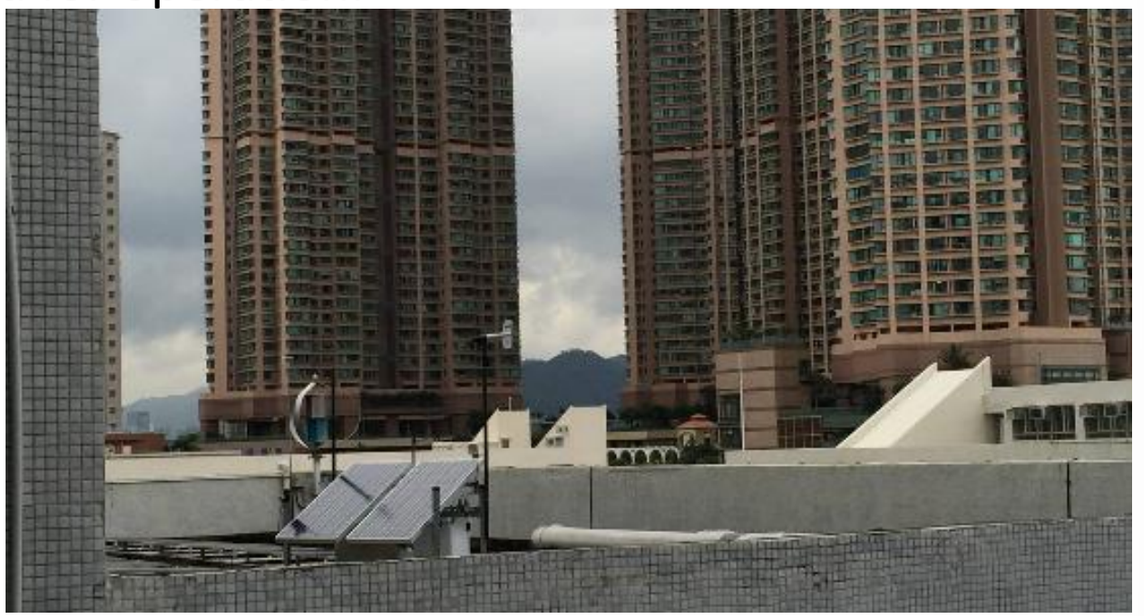
Background

- The Village Green Project original prototype has operated in Durham, North Carolina since June, 2013, outside a public library.

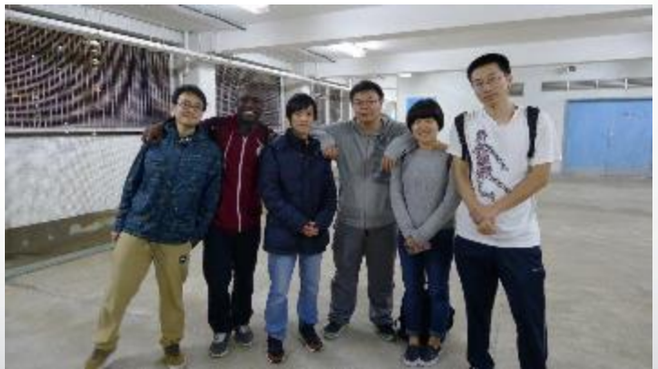
- Measurements include:
  - Ozone (OEM-106-L, 2B Technologies)
  - $PM_{2.5}$ (pDR-1500,Thermo Scientific)
  - Wind speed and direction
  - Temperature (ambient, enclosure)
  - Humidity (ambient and enclosure)

Hong Kong field deployment

- After receiving a permit to build a concrete base and secure the prototype to the school roof, station was installed for operation.

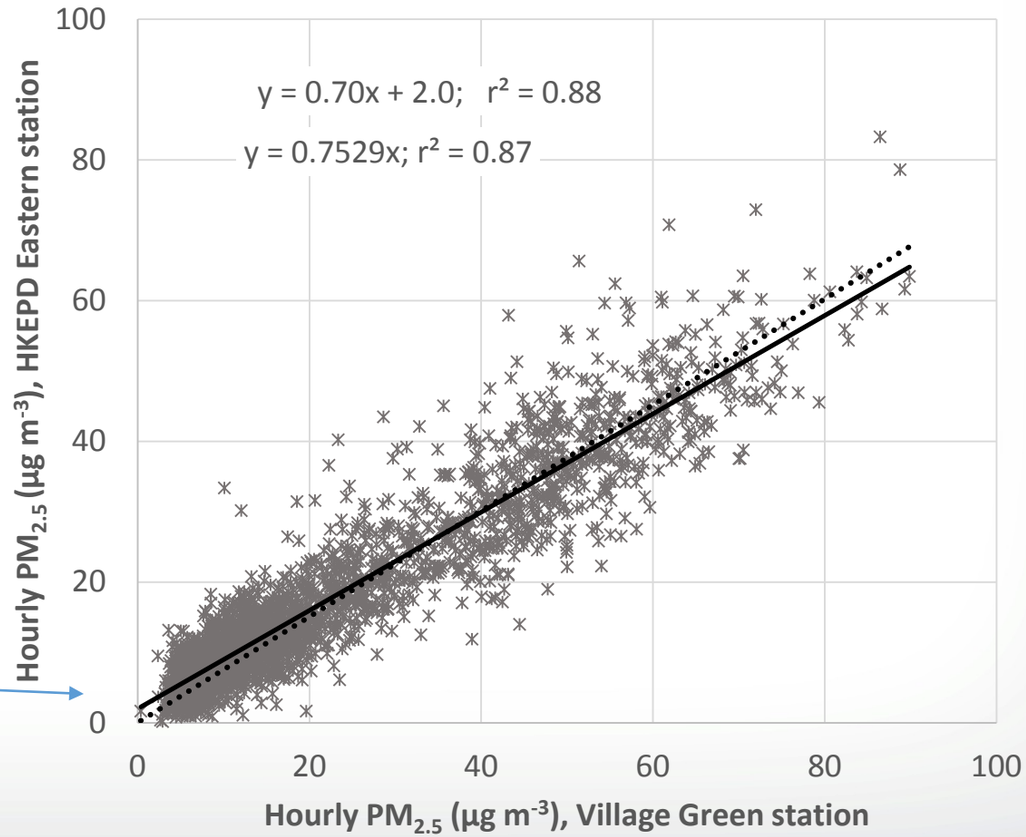


CityU students received training on station maintenance from the Bobby Sharpe (EPA/ARCADIS project engineer)



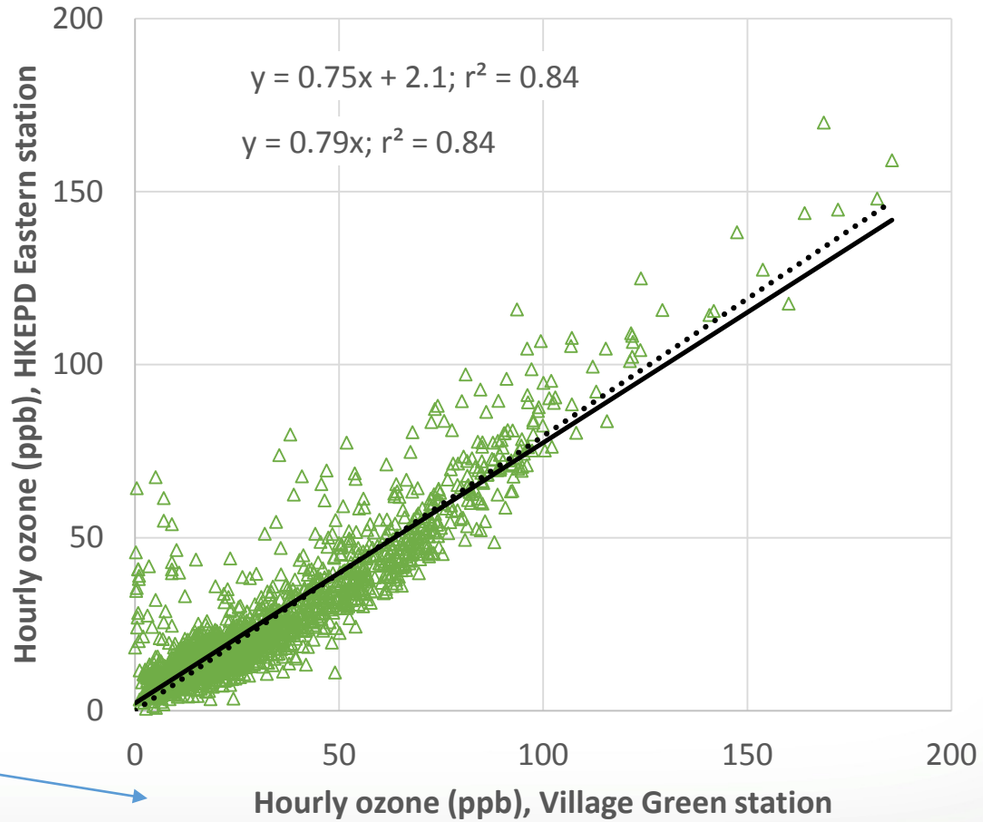
System performance

- Comparison with HKEPD data:
  - 2619 hours of valid $PM_{2.5}$ data from Village Green station (76% of measurement period)
  - Max $PM_{2.5}$ ~ 85 µg m^{-3}



System performance

- Comparison with HKEPD data:
  - 1956 hours of valid ozone data from Village Green station (57% of measurement period)
  - Max ozone ~160 ppb



Summary

- Rooftop version of the Village Green station maintained good correlation with nearby reference monitor over an extended period of time, under subtropical weather conditions with multiple major storm events

PAST AUGUST IN HONG KONG ONE OF THE HOTTEST ON RECORD

By Coconuts Hong Kong September 3, 2015 / 12:49 HKT

Hong Kong braces as tropical storm Linfa approaches

By: Agence France-Presse
July 10, 2015 2:28 AM

Women take photos from a viewing deck overlooking Hong Kong's Victoria harbor as Typhoon Linfa approaches on July 9, 2015. (AFP Photo/Isaac Lawrence)

July 2015

ENVIRONMENT & HEALTH HONG KONG

It's a washout: Heavy rain, strong winds to hit Hong Kong as tropical depression set to be upgraded

2 October 2015 11:23 · Karen Cheung · 2 min read

Hong Kong is expected to experience strong winds with swells and occasional heavy rain over the next couple of days as a tropical depression pushes across the South China Sea.

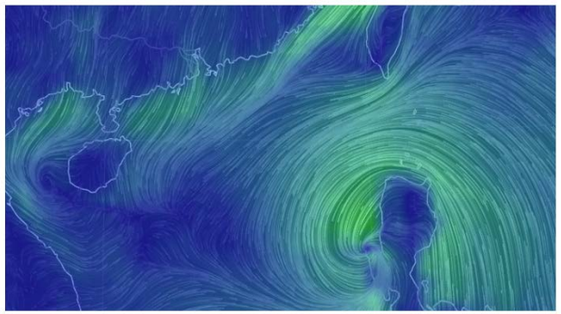


Photo: Earth.

Oct 2015

Rain, wind, and a lot of cloud: Hong Kong has a wet and wild week ahead thanks to tropical cyclone Vamco

Ernest Kao
ernest.kao@scmp.com

PUBLISHED : Monday, 14 September, 2015, 10:06am
UPDATED : Monday, 14 September, 2015, 3:09pm

A file picture of Hongkongers battling wet weather in Admiralty. Photo: SCMP Pictures

SHARE

325 1 1 2

Sept 2015

Computing and Systems Applied in Energy-Environmental-Climate-Air Quality Research

National Risk Management Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC

Air & Waste Management Association, Measurement Methods and Technology, March 15-17, 2016

Performance Assessment of a Solar-powered Air Quality and Weather Station Placed on a School Rooftop in Hong Kong

Gayle Hagler[1], Zhi Ning[2], Peter Louie[3], Robert Sharpe[4], Nicky YF Lam[2], and Ronald Williams[1]

1. United States Environmental Protection Agency, Office of Research and Development
2. City University of Hong Kong
3. Hong Kong Environmental Protection Department
4. Arcadis

Air Quality Futures

Objective: Explore air quality management in the U.S. over a range of possible futures.

Tool: MARKAL energy system optimization model

Method: Future Scenarios Method

Reference: Gamas, J., Dodder, R., Loughlin, D., and C. Gage (2015). "Role of future scenarios in understanding deep uncertainty in long-term air quality management." *Journal of the Air & Waste Management Assoc*. doi 10.1080/10962247.2015.1084783.

Computing and Systems applications
Air Quality Futures

We applied the Future Scenarios Method to develop a set of very different scenarios

Future Scenarios Method steps:

- Interview internal and external experts
- Select the two most important uncertainties and develop a scenario matrix
- Construct narratives describing the matrix's four scenarios
- Implement the scenarios into a modeling framework and evaluate

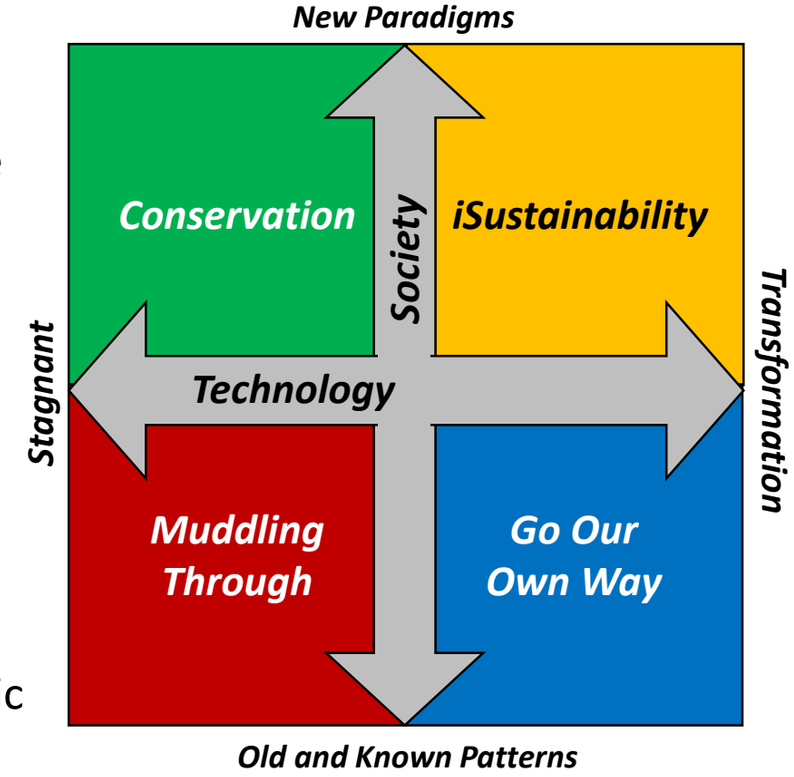
Levers for implementing the scenarios in MARKAL:

- Technology-specific hurdle rates
- Technology availability and cost
- Shifts in energy demands

Computing and Systems applications
Air Quality Futures

This is the resulting Scenario Matrix:

Conservation is motivated by environmental considerations. Assumptions include decreased travel, greater utilization of existing renewable energy resources, energy efficiency and conservation measures adopted in buildings, and reduced home size for new construction.



iSustainability is powered by technology advancements, and assumes aggressive adoption of solar power, battery storage, and electric vehicles, accompanied by decreased travel as a result of greater telework opportunities.

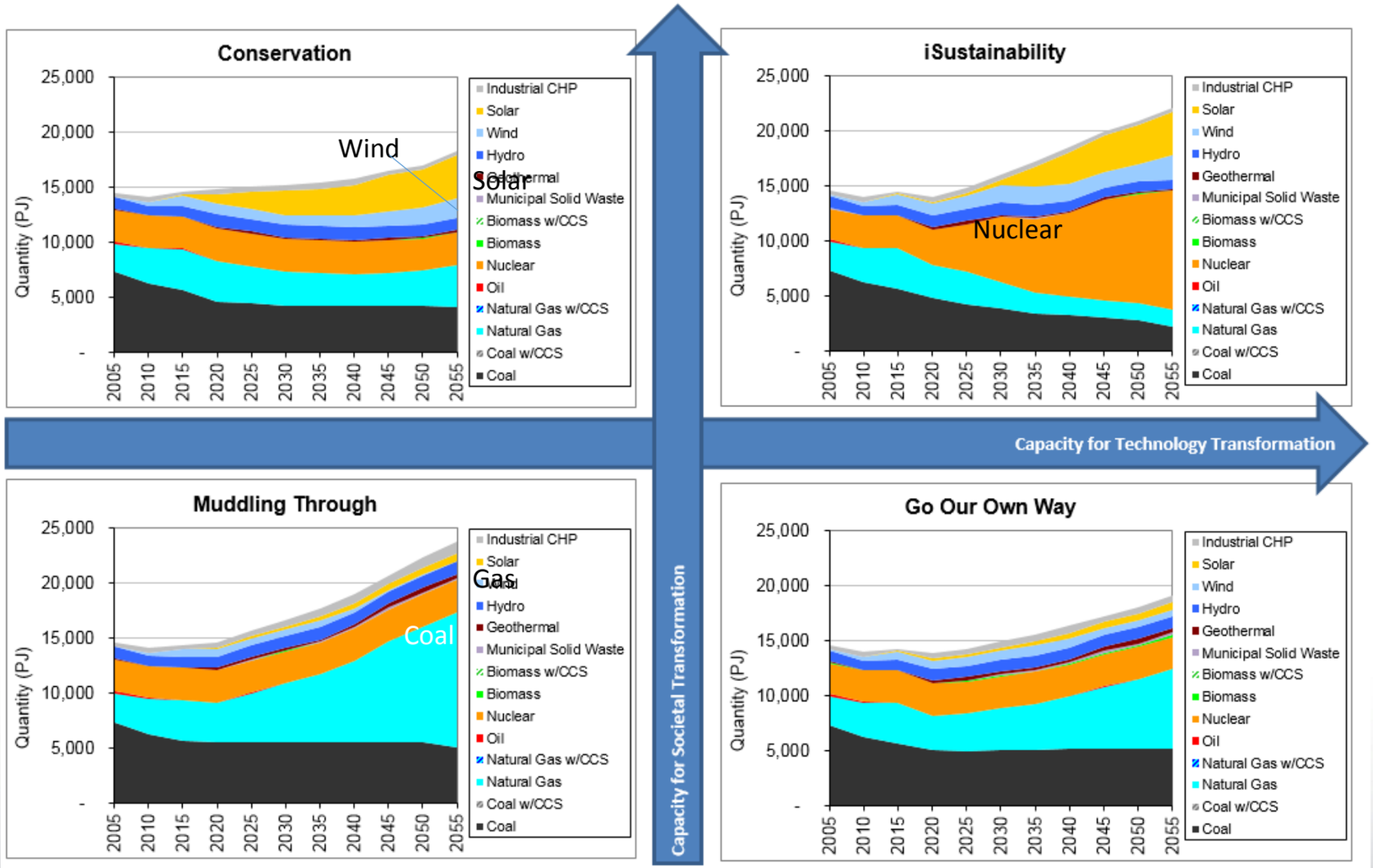
Muddling Through has limited technological advancements and stagnant behaviors, meaning electric vehicle use would be highly limited and trends such as urban sprawl and increasing per-capita home and vehicle size would continue.

Go Our Own Way includes assumptions motivated by energy security concerns. These assumptions include increased use of domestic fuels, particularly coal and gas for electricity production and biofuels, coal-to-liquids, and compressed natural gas in vehicles.

Computing and Systems applications
Air Quality Futures

Example of the differences from one scenario to another

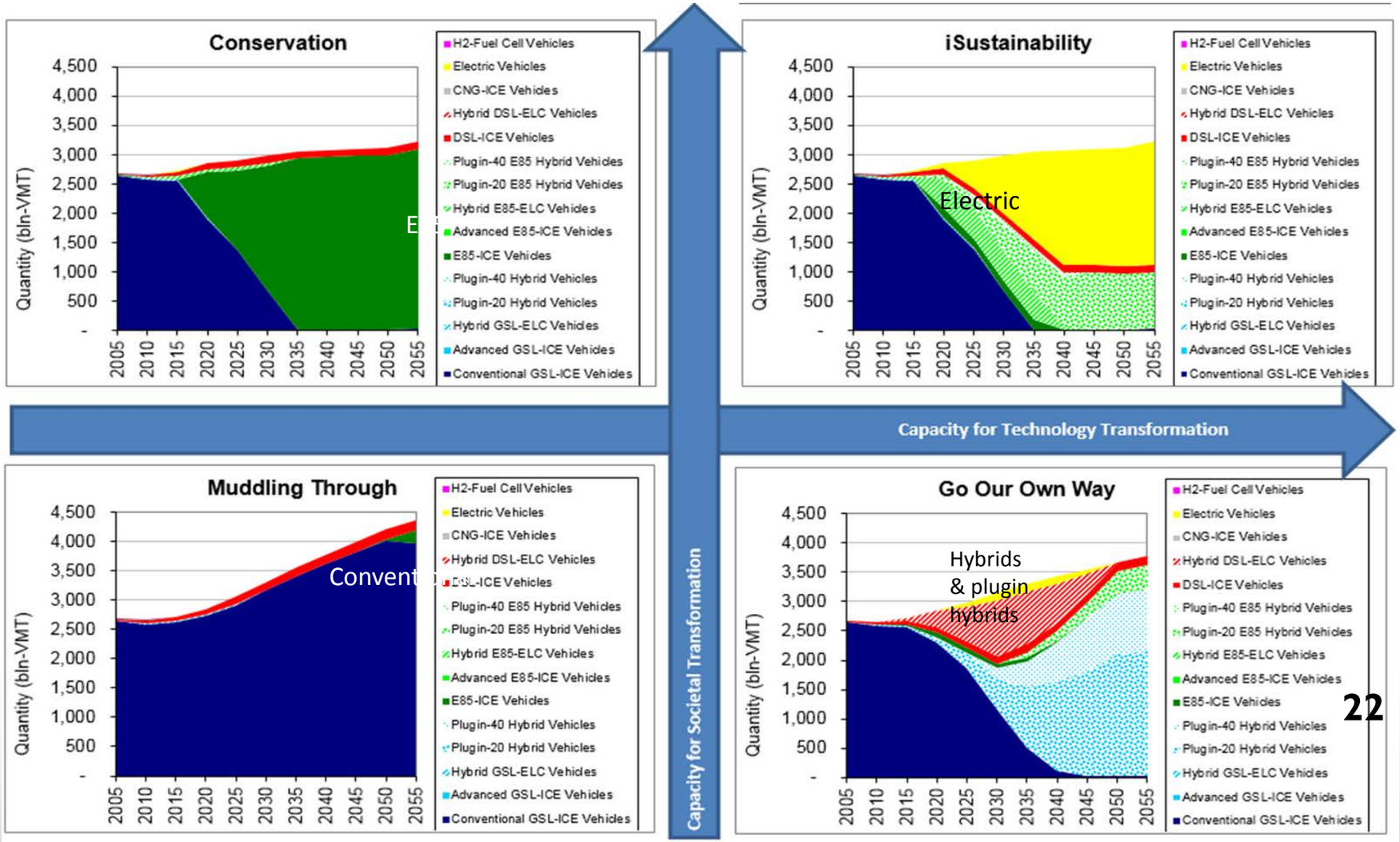
Electricity production by aggregated technologies



Computing and Systems applications
Air Quality Futures

Example of the differences from one scenario to another

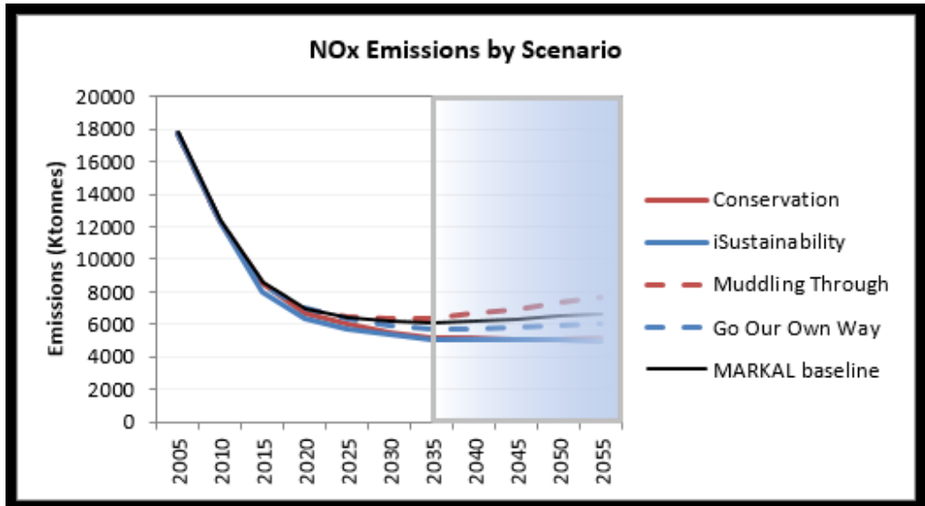
Light duty vehicle technologies

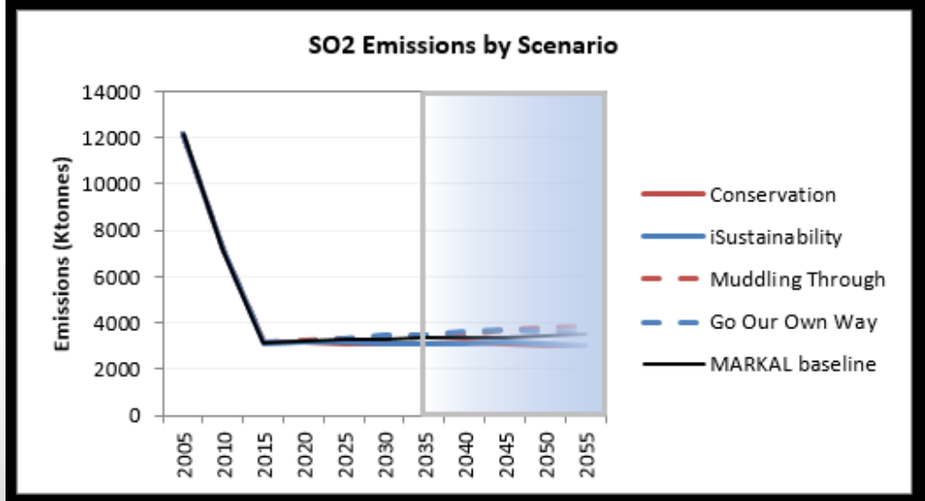


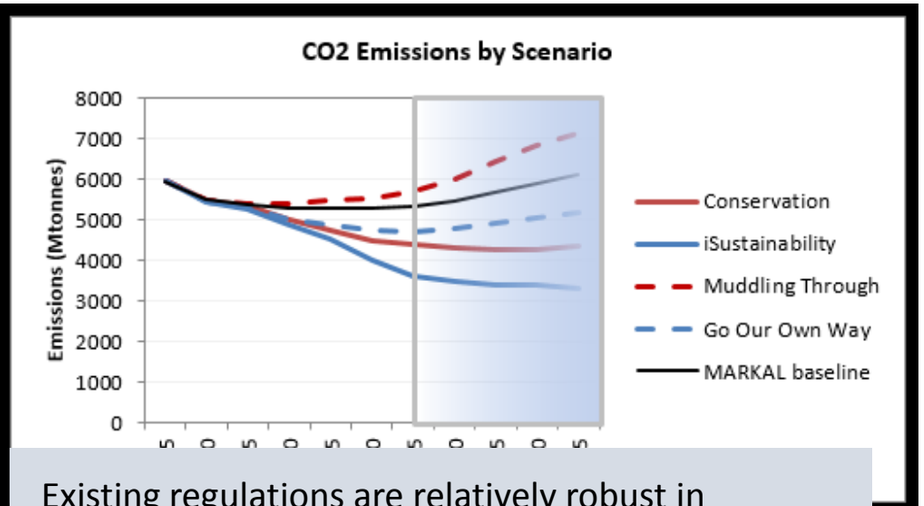
Computing and Systems applications
Air Quality Futures

Emission projections across the alternative baselines

Emissions of nitrogen oxides (NOx), sulfur dioxide (SO_2), and CO_2.







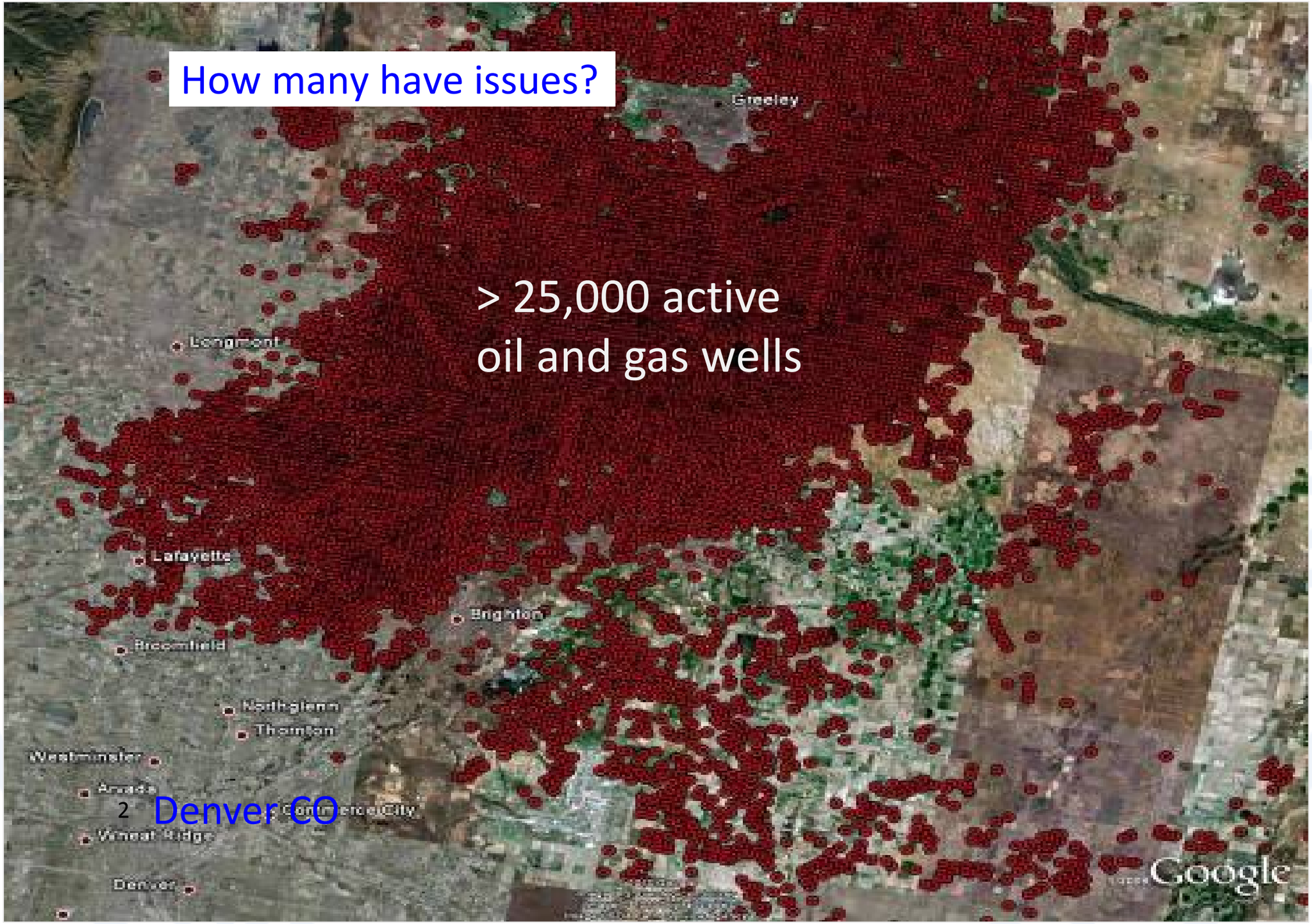
Existing regulations are relatively robust in locking in expected reductions of criteria pollutants.

The range of CO_2 emissions across the scenarios is considerably greater than that of the other pollutants.

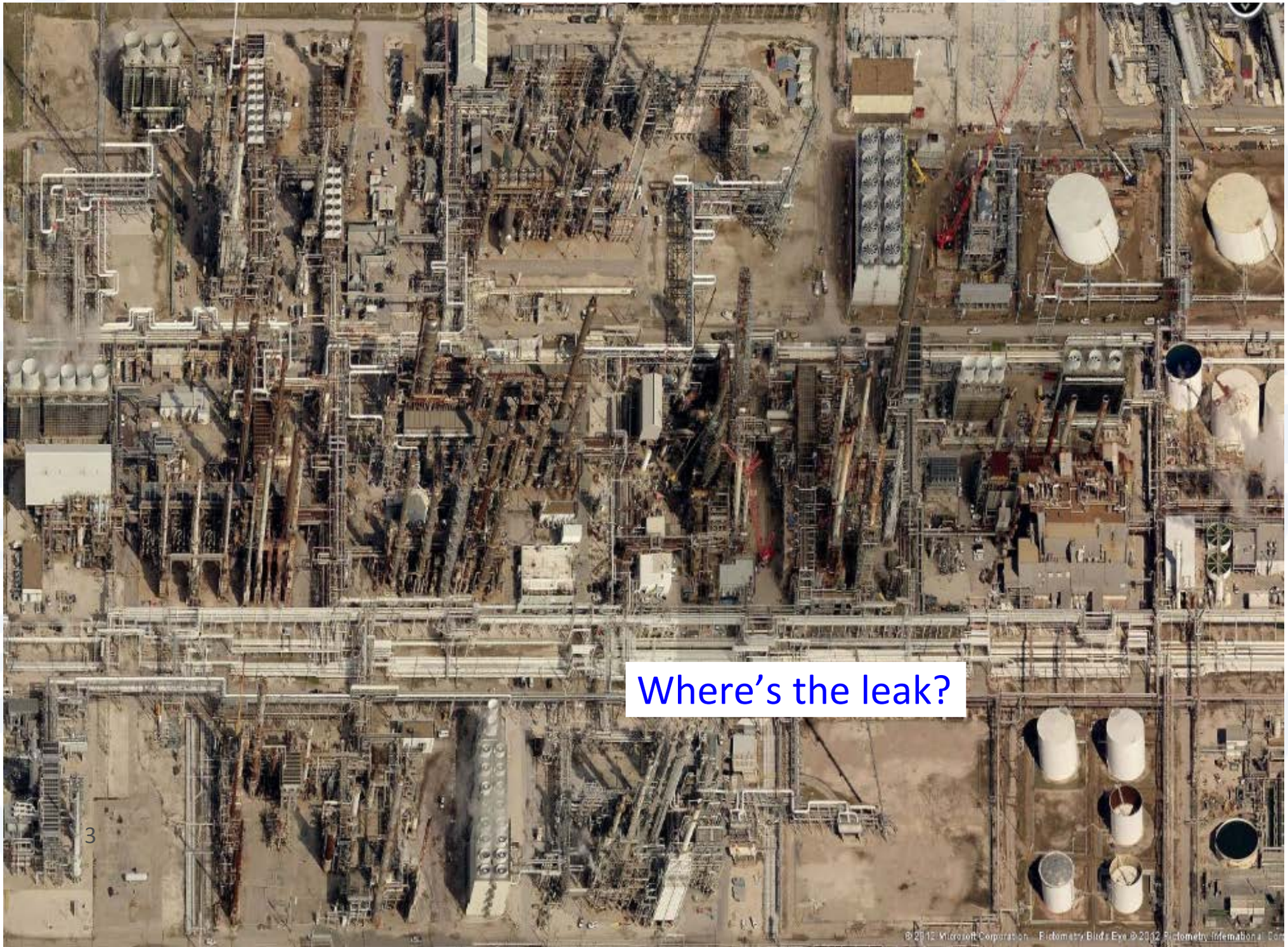
Note: The Clean Power Plan is not represented in these results

Next Generation Monitoring Approaches

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park, North Carolina
National Risk Management Research Laboratory
Fugitive and Area Source Research Group
Source and Fence Line Measurements
Methods and Technology Development

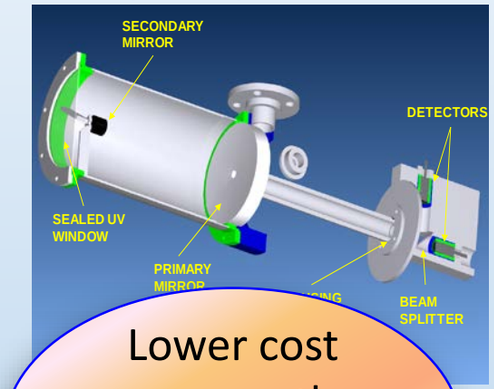

How many have issues?
Greeley
> 25,000 active
oil and gas wells
Longmont
Lafayette
Brighton
Broomfield
Northglenn
Thornton
Westminster
Arvada
Wheat Ridge
Denver
Google

 Denver CO


Where’s the leak?

Next Generation Emissions Measurement (NGEM)

Deep UV optical sensor

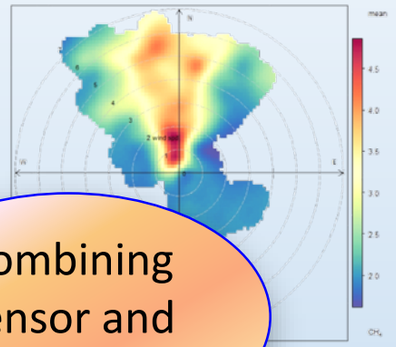


Lower cost open-path optical systems

Drive-by leak inspection

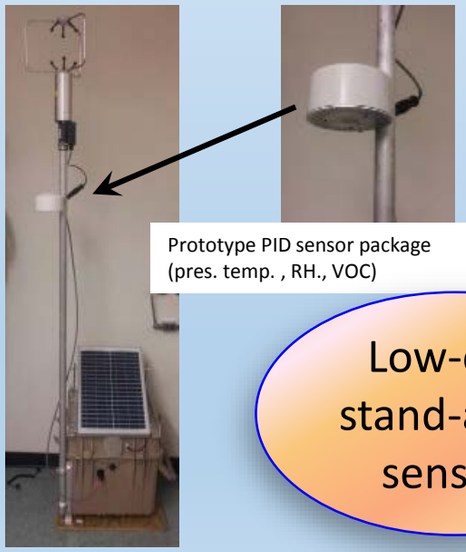
Mobile inspection systems

New leak-location algorithms



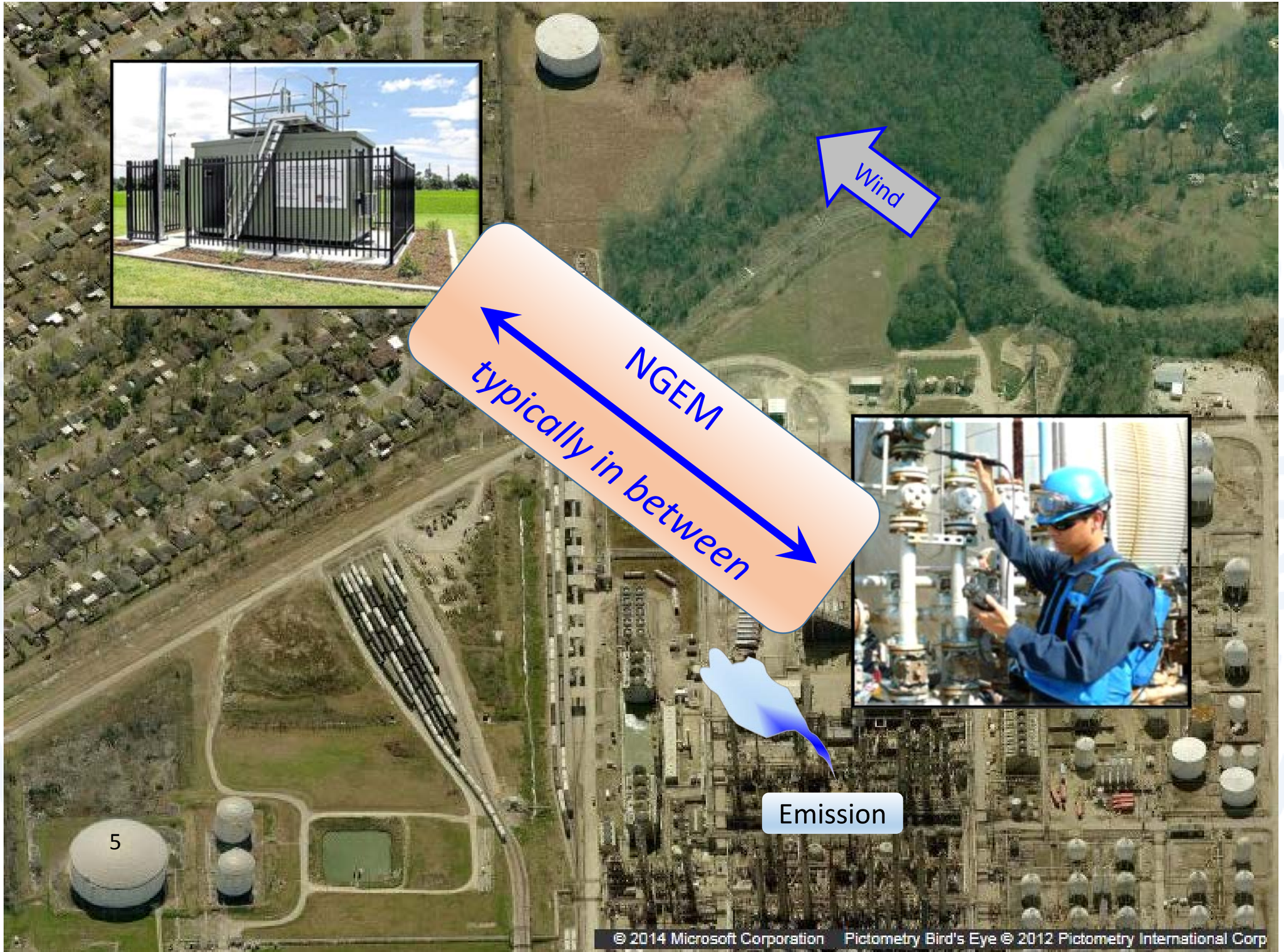
Combining sensor and wind data

Drop-in-place sensor packages



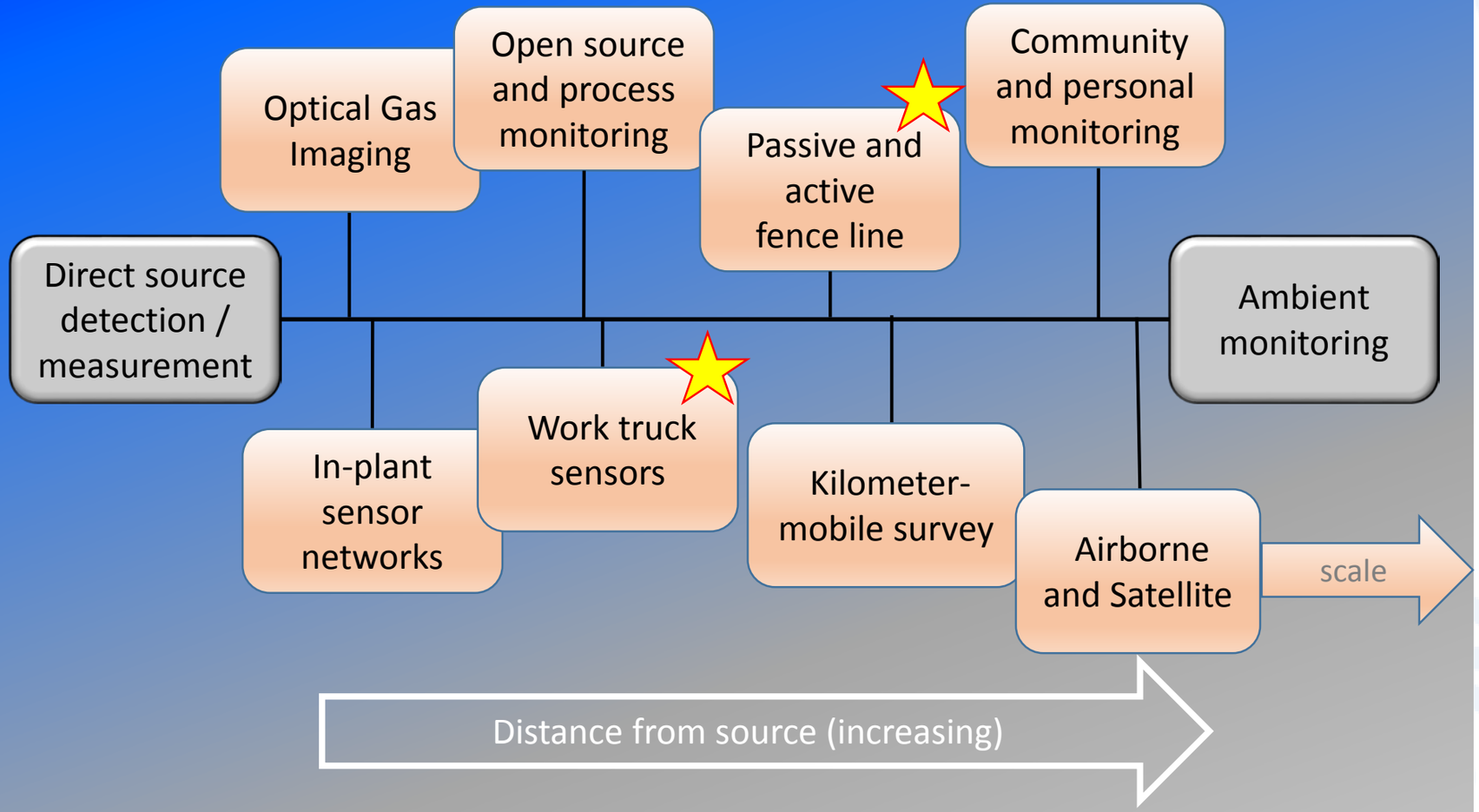
Prototype PID sensor package (pres. temp. , RH., VOC)

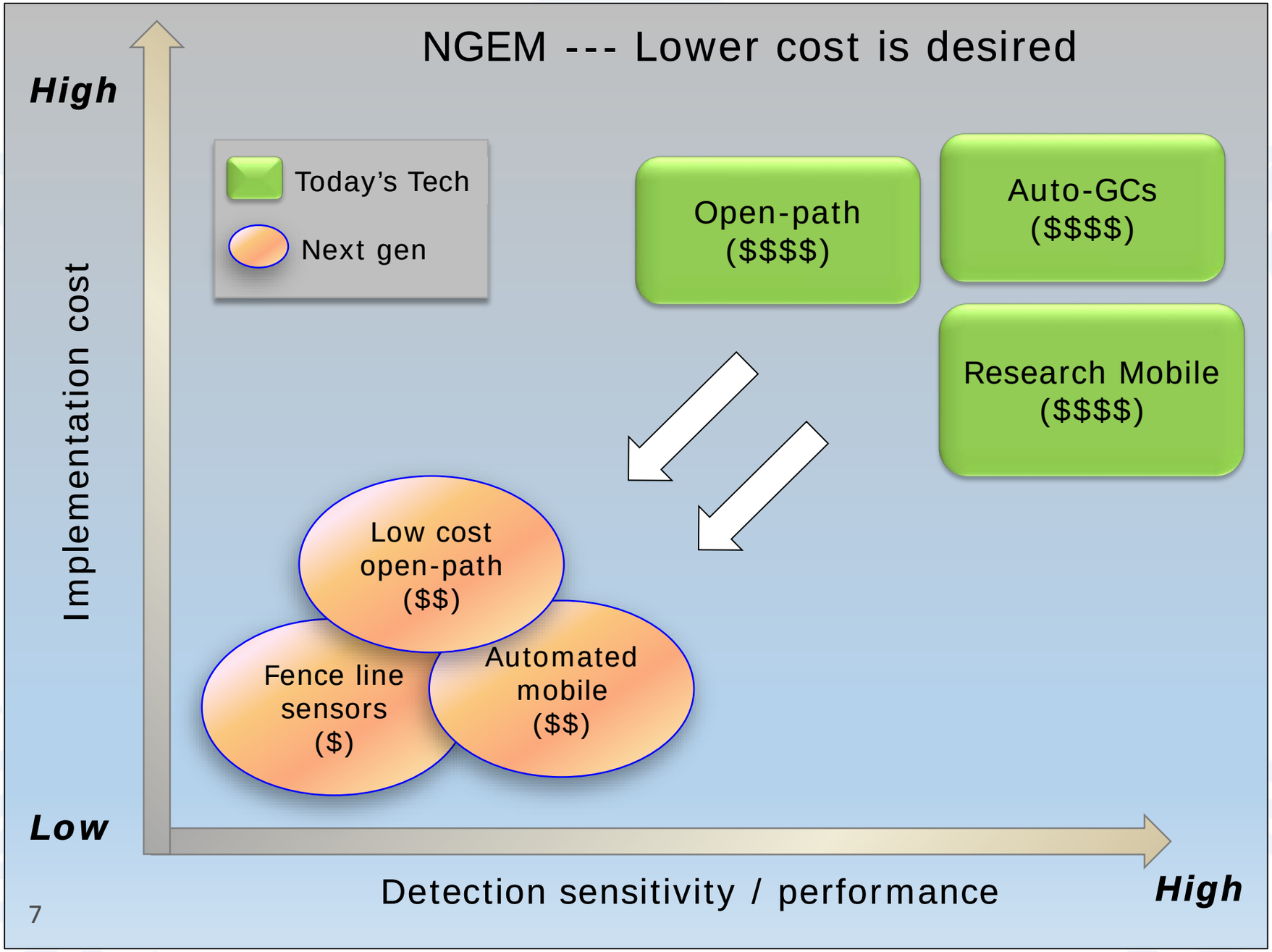
Low-cost stand-alone sensors

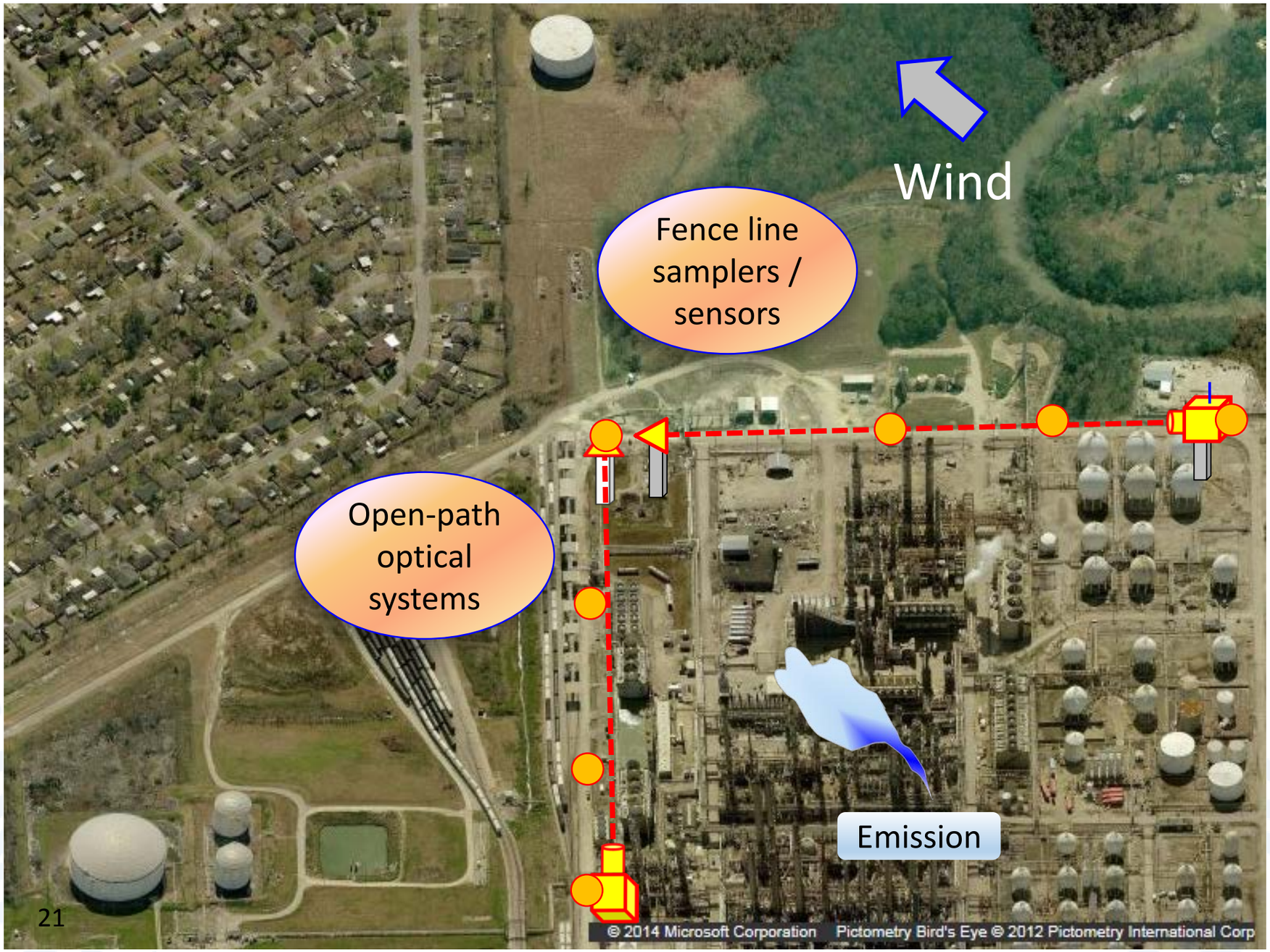

Wind
NGEM
typically in between
Emission
5
© 2014 Microsoft Corporation
Pictometry Bird's Eye © 2012 Pictometry International Corp

NGEM Tools

Some now, some future




NGEM --- Lower cost is desired
High
Implementation cost
Low
Today's Tech
Next gen
Open-path
($$$$)
Auto-GCs
($$$$)
Research Mobile
($$$$)
Low cost
open-path
($$)
Fence line
sensors
($)
Automated
mobile
($$)
Detection sensitivity / performance
High


Wind
Fence line samplers / sensors
Open-path optical systems
Emission
© 2014 Microsoft Corporation
Pictometry Bird's Eye © 2012 Pictometry International Corp

Source: Microsoft Bing Maps (© Microsoft Corporation Pictometry Bird's Eye © 2010 Pictometry International Corp)

PAHO WORKSHOP ON HEALTH INDICATORS

Workshop Assessing the Status of the Environmental Health Indicators for the Sustainable Development Goals (SDGs) in the Americas – Washington, DC April 11, 12, 2016

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park, North Carolina
National Risk Management Research Laboratory
Fugitive and Area Source Research Group
Source and Fence Line Measurements
Methods and Technology Development

KEY WORKSHOP HIGHLIGHTS/NEXT STEPS

- It was clear that the capabilities of the countries in the region vary from well-equipped to those searching for a path to effective reporting. The small island states of the Caribbean in particular have significant work ahead and limited resources.
- PAHO/WHO will continue review of the indicators, 31 of which were identified as tier one priorities with varying supporting data resources. PAHO will be drafting an environmental health indicators report for the region that will be subject to further country review and comment through the summer to be completed in early fall.
- The meeting and the process forward outlined by PAHO, with the direction and engagement of member countries, made it clear that this region, and these countries, will pick a tailored array of indicators as their priorities. Absolute universal reporting on all environmental health related SDG indicators is not anticipated nor plainly possible.
- EPA, other federal entities, regional and global partnerships have numerous opportunities to advance common interests and provide assistance through strategic engagement in regional meetings, workshops and other collaborative processes.

CLOSING THOUGHTS AND NEXT STEPS

- There are advancements in AQ monitoring and modeling occurring all over GEO Member Countries that need to be identified and shared.
- These advancement will generally improve health and well-being in selected parts of the world. Case studies that quantify these benefits are needed to be shared.
- GI-13 can make a visible difference in global health and well-being if the Member Countries and Participating Organizations support this activity by getting involved and sharing their AQ technology advancements.