



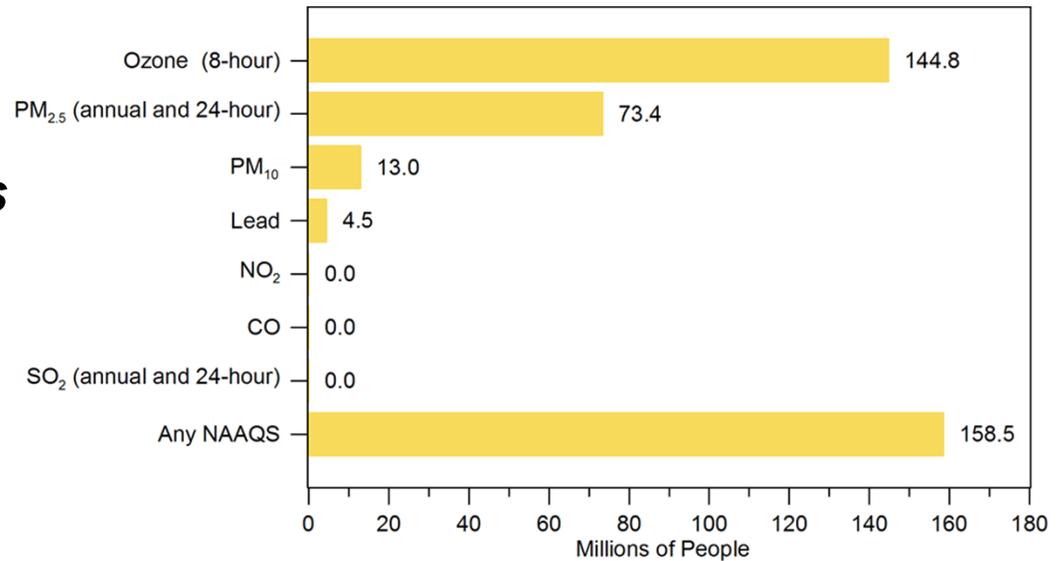
DISCOVER-Air Quality

Improving the View of Air Quality from Space

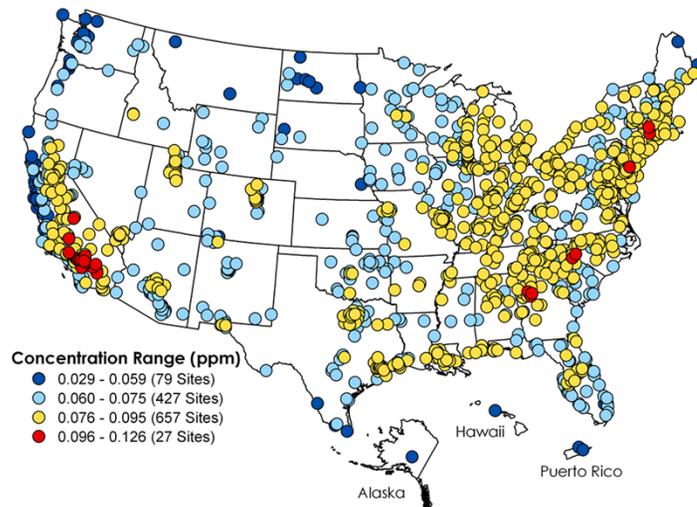
Jim Crawford
Science Directorate
NASA Langley



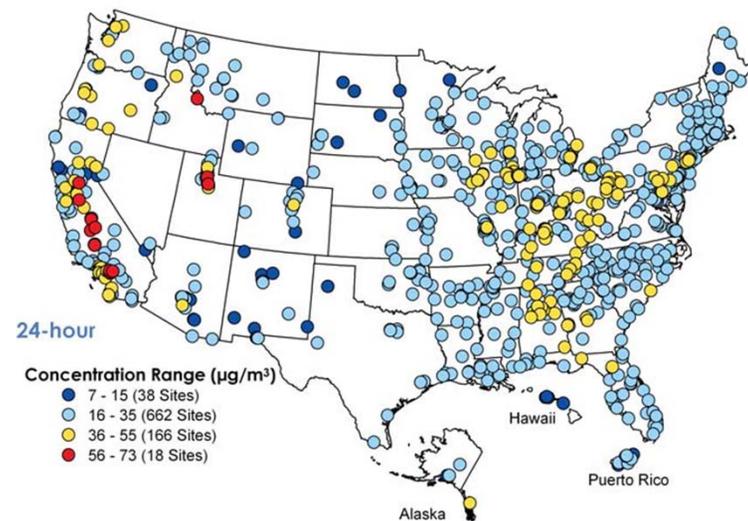
National Ambient Air Quality Standards (NAAQS): Violations are primarily related to ozone and fine particulate matter.



Ozone concentrations in ppm, 2007 (fourth highest daily max 8-hour concentration).



24-hour PM_{2.5} concentrations in µg/m³, 2007 (98th percentile 24-hour concentration)



*** Yellow and Red symbols represent levels in violation of NAAQS**

Taken from National Air Quality-Status and Trends through 2007 (<http://www.epa.gov/airtrends/2008/>)

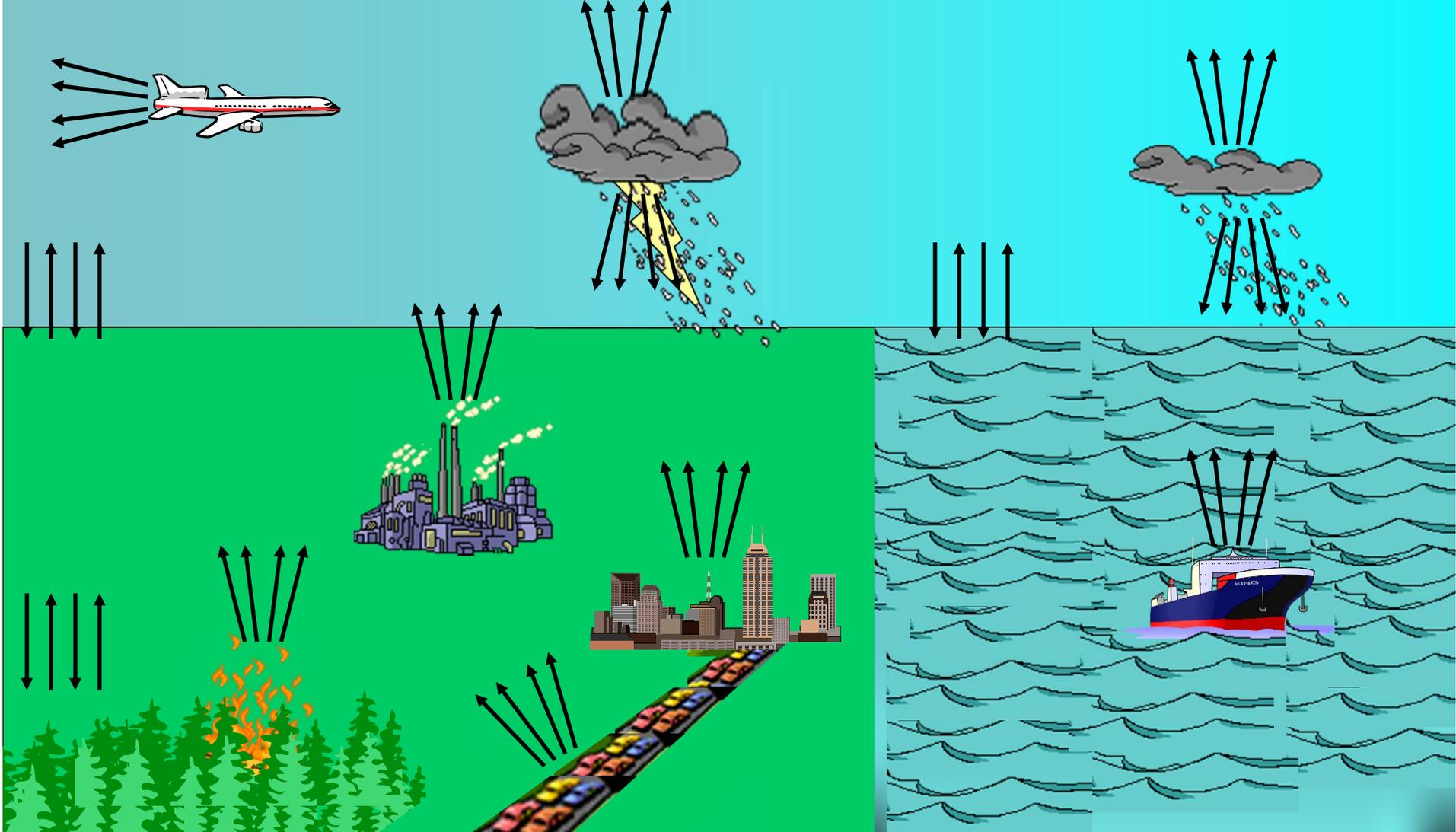


Emission → Transport/Transformation → Removal

(NO_x, CO, Hydrocarbons, particulates)

(O₃, OH, CH₂O, HO₂, RO₂, particulates)

(HNO₃, H₂O₂, ROOH, particulates)



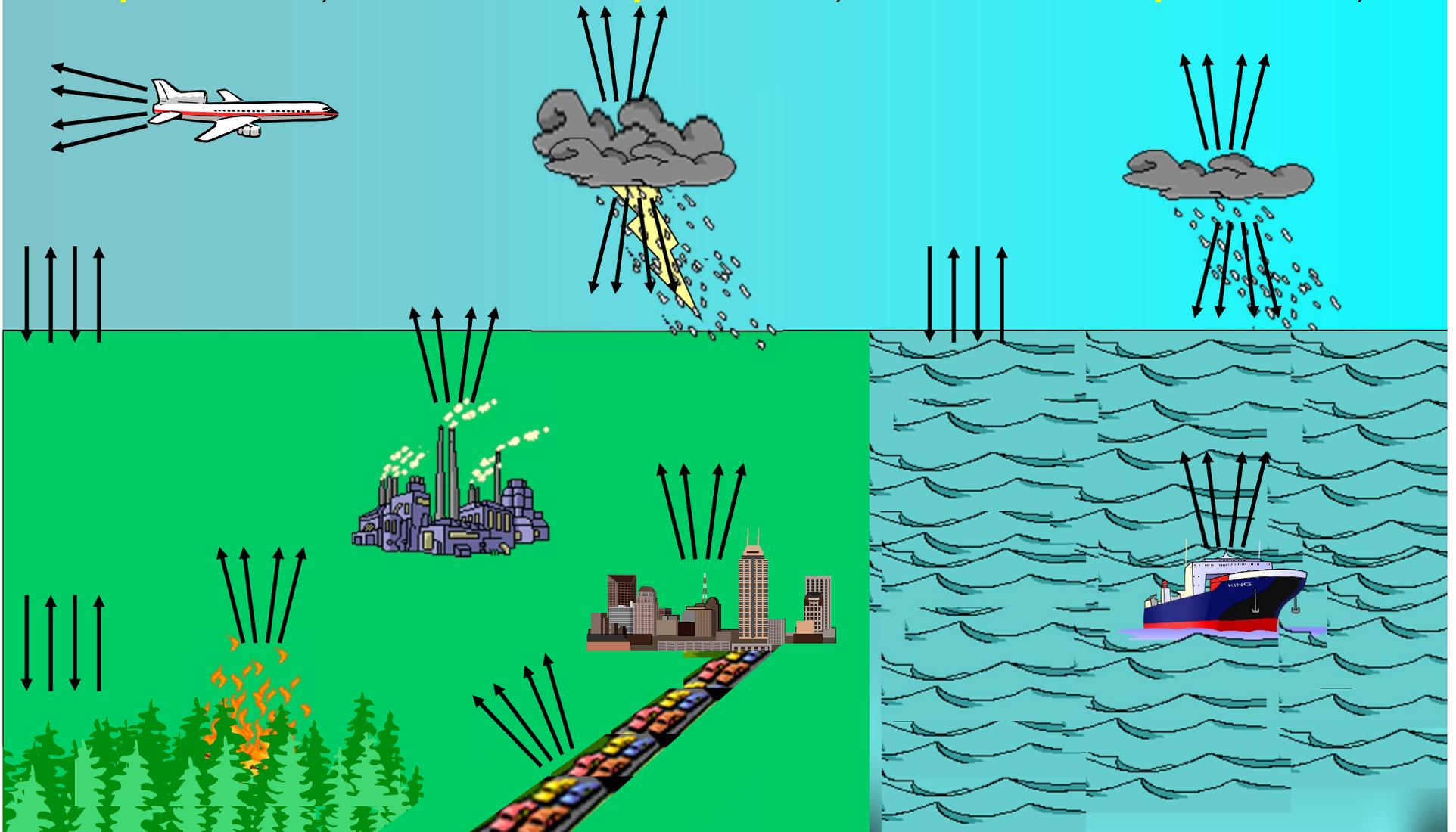


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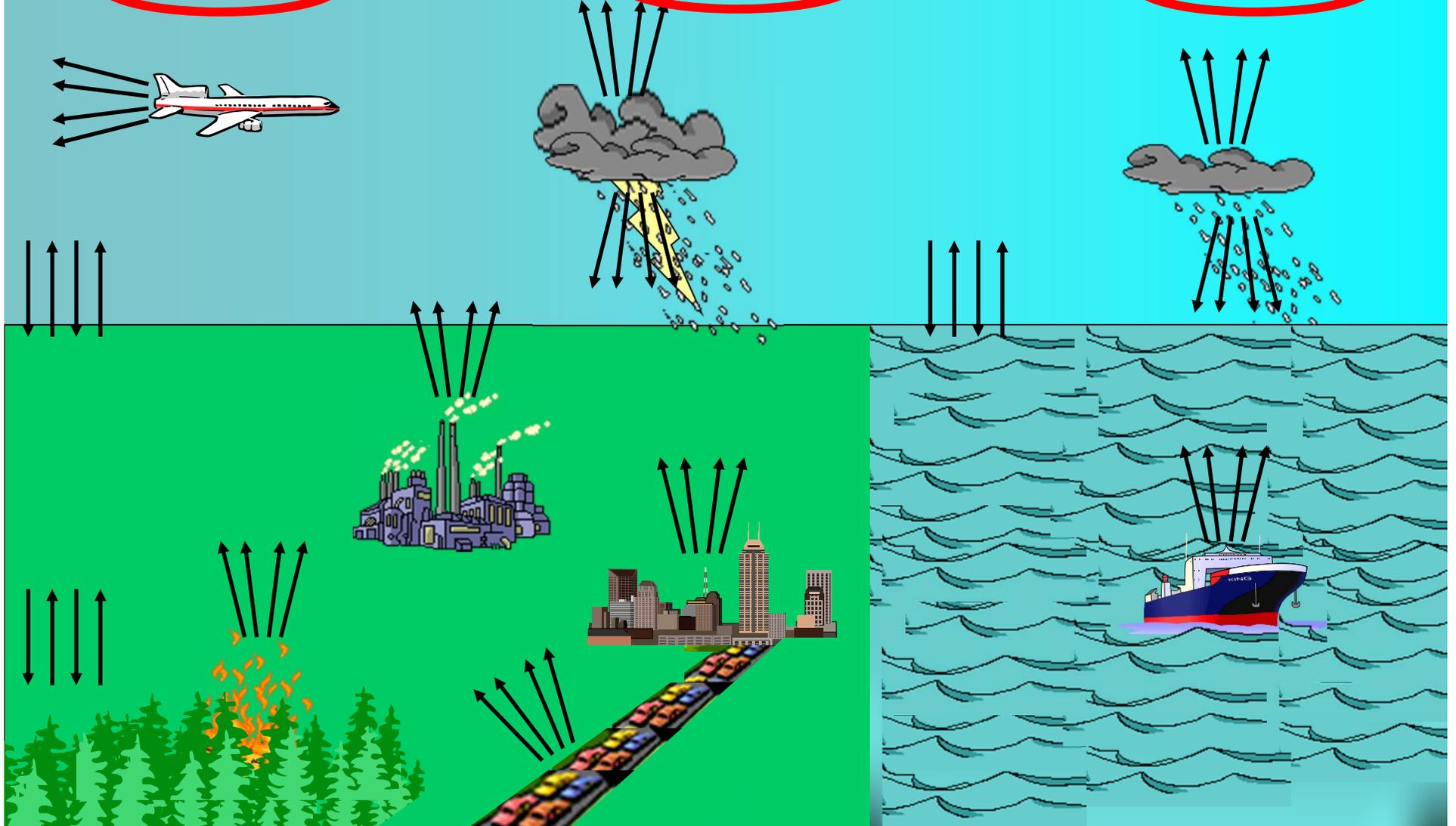


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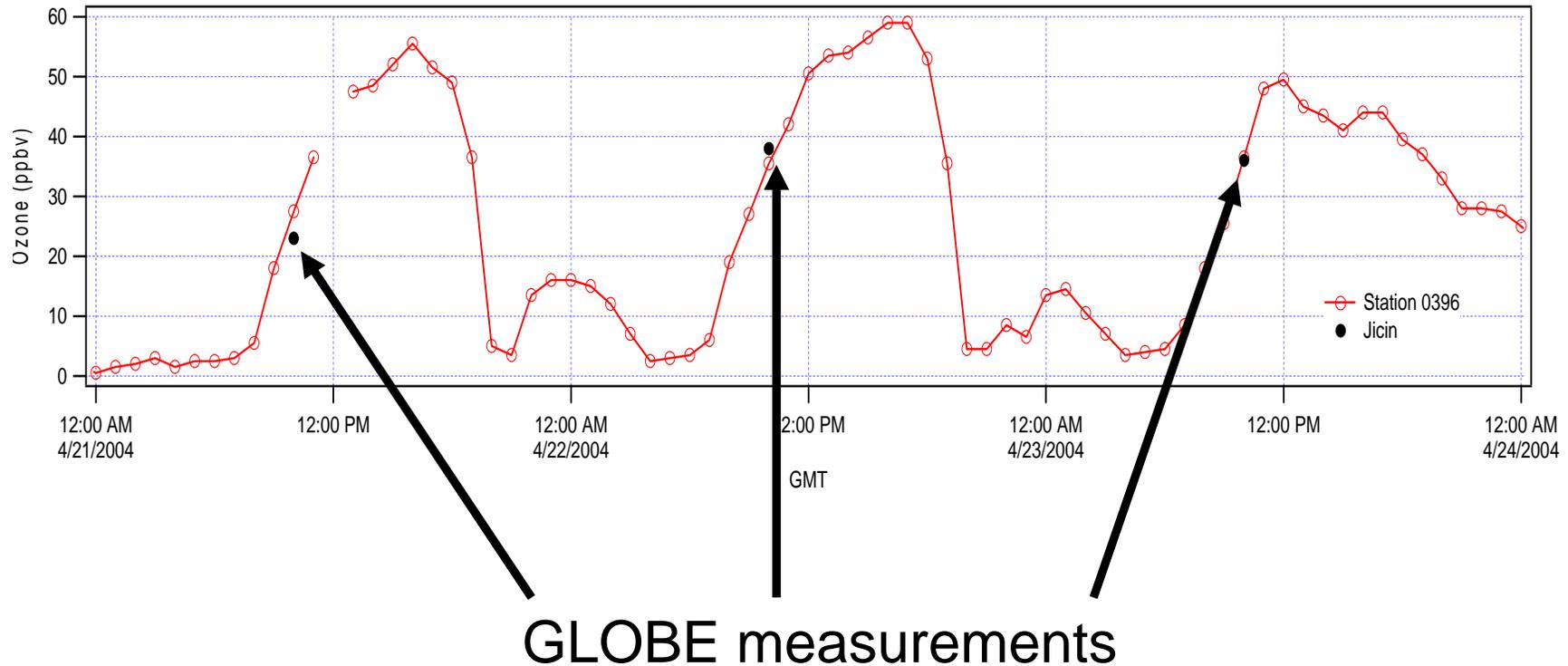
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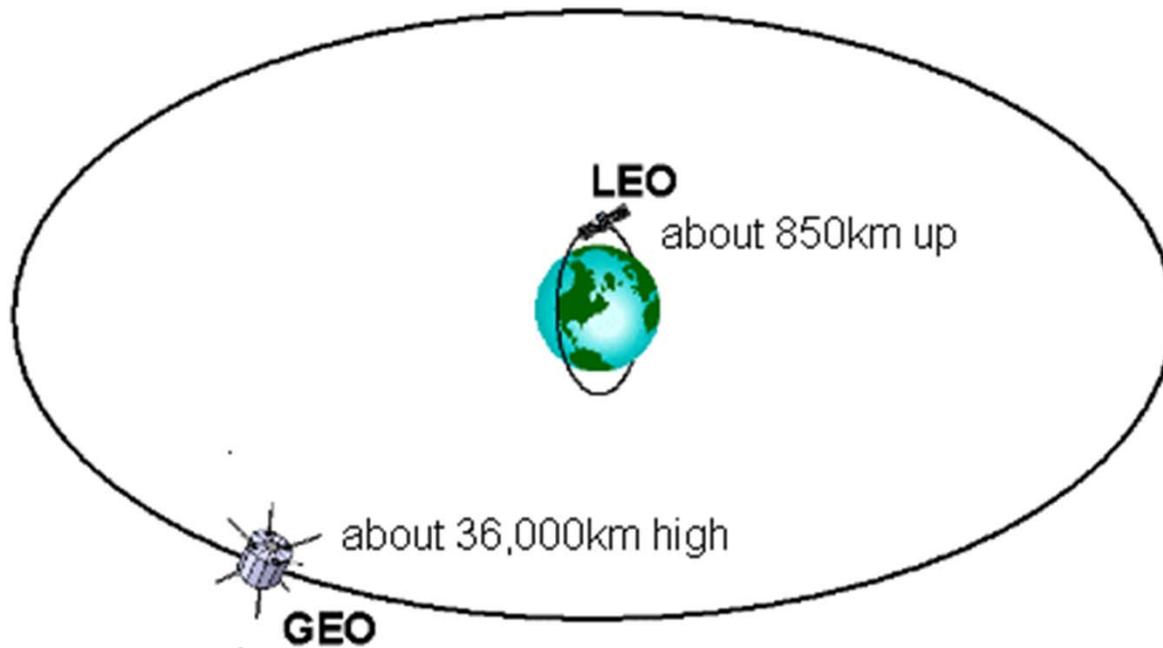


Ozone Data at Jicín, Czech Republic



- Air Quality observations require high temporal resolution
- Monitoring standard is hourly information
- Exposure is regulated based on 8-hour average values

Satellite Orbits used for Earth Observations.



Low Earth Orbit (LEO)

Global Coverage

Brief viewing time

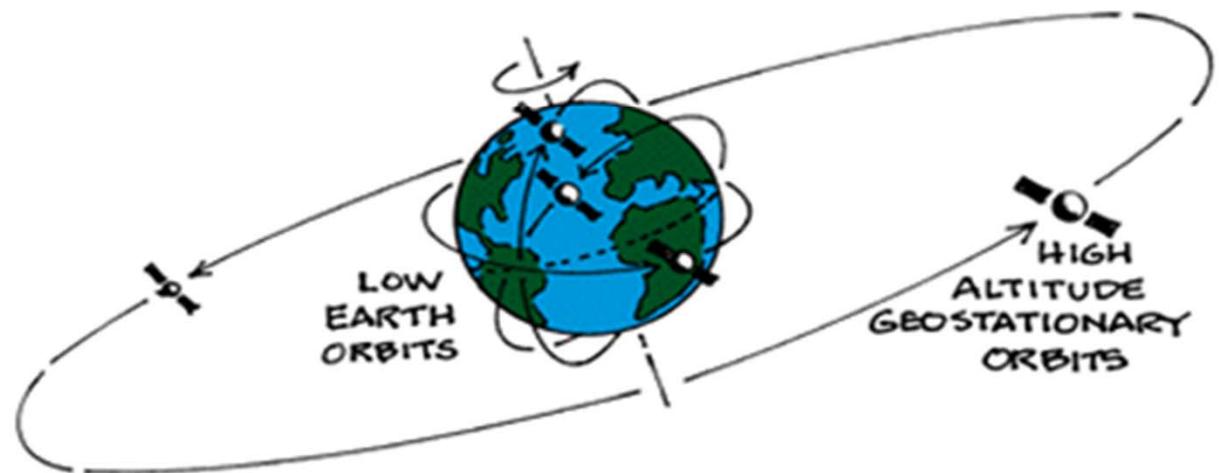
Relatively Close

Geostationary (GEO)

Hemispheric coverage

Continuous view

Far Away



Hourly atmospheric pollution from geostationary Earth orbit

Selected Nov. 2012 as NASA's first Earth Venture Instrument

- Instrument delivery September 2017
- NASA will arrange hosting on commercial geostationary communications satellite with expected launch in 2018/2019

Provides hourly daylight observations to capture rapidly varying emissions & chemistry important for air quality

- UV/visible grating spectrometer to measure key elements in tropospheric ozone and aerosol pollution
- Exploits extensive measurement heritage from LEO missions
- Distinguishes boundary layer from free tropospheric & stratospheric ozone

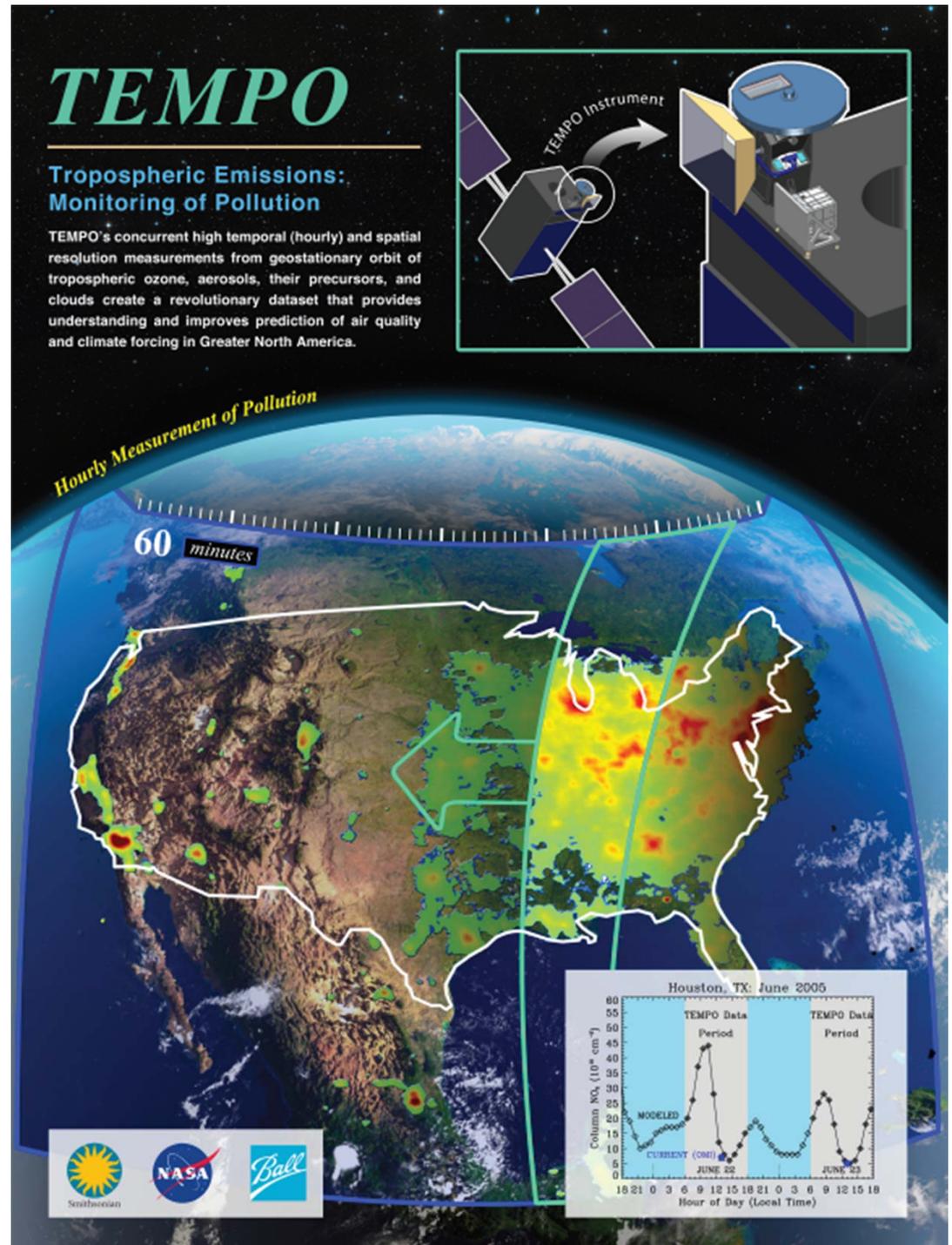
PI: Kelly Chance, Smithsonian Astrophysical Obs.

Instrument Development: Ball Aerospace

Project Management: NASA LaRC

Other Institutions: NASA GSFC, NOAA, EPA, NCAR, Harvard, UC Berkeley, St. Louis U, U Alabama Huntsville, U Nebraska

International collaboration: Korea, Europe, Canada



GLOBE Aerosols Protocol



Current GLOBE aerosol instrument

- sun photometer
- uses LEDs at 505nm and 625nm
- outputs voltage readings
- equations to calculate AOD
- *instrument availability limited*



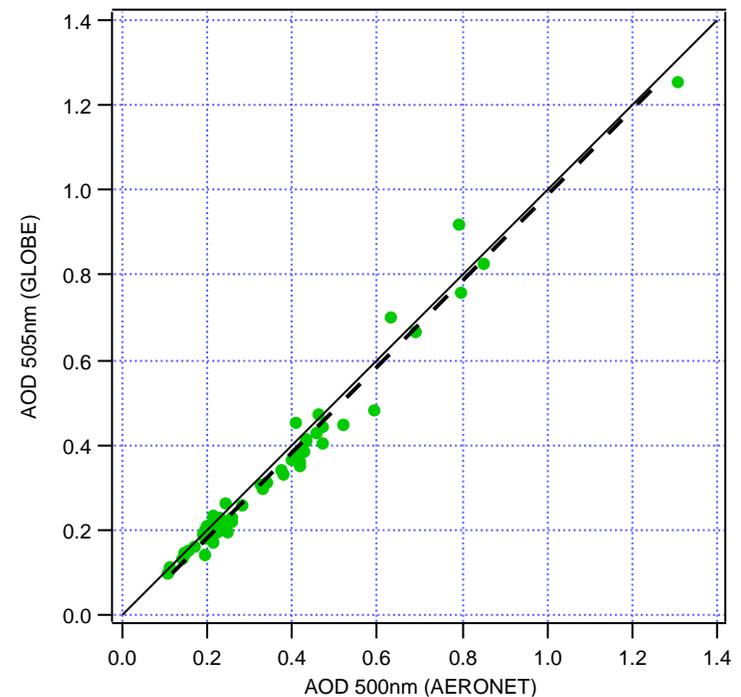
- simple kit to build instrument

AERONET Cimel Sun Photometer at Langley's CAPABLE site

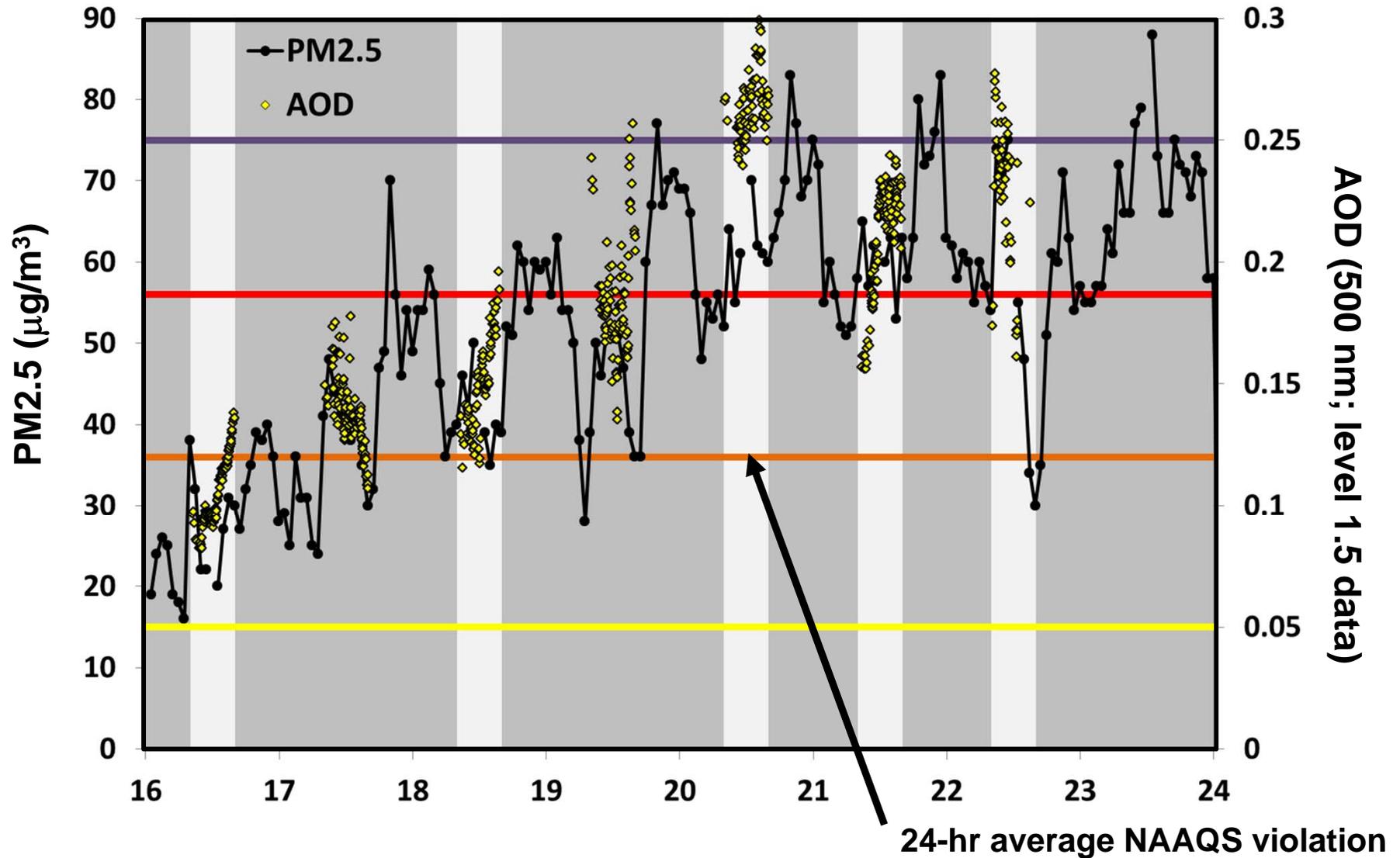


GLOBE sun photometer data collected during summer 2012 and 2013 compares very well with the research-grade sun photometer in the AERONET network

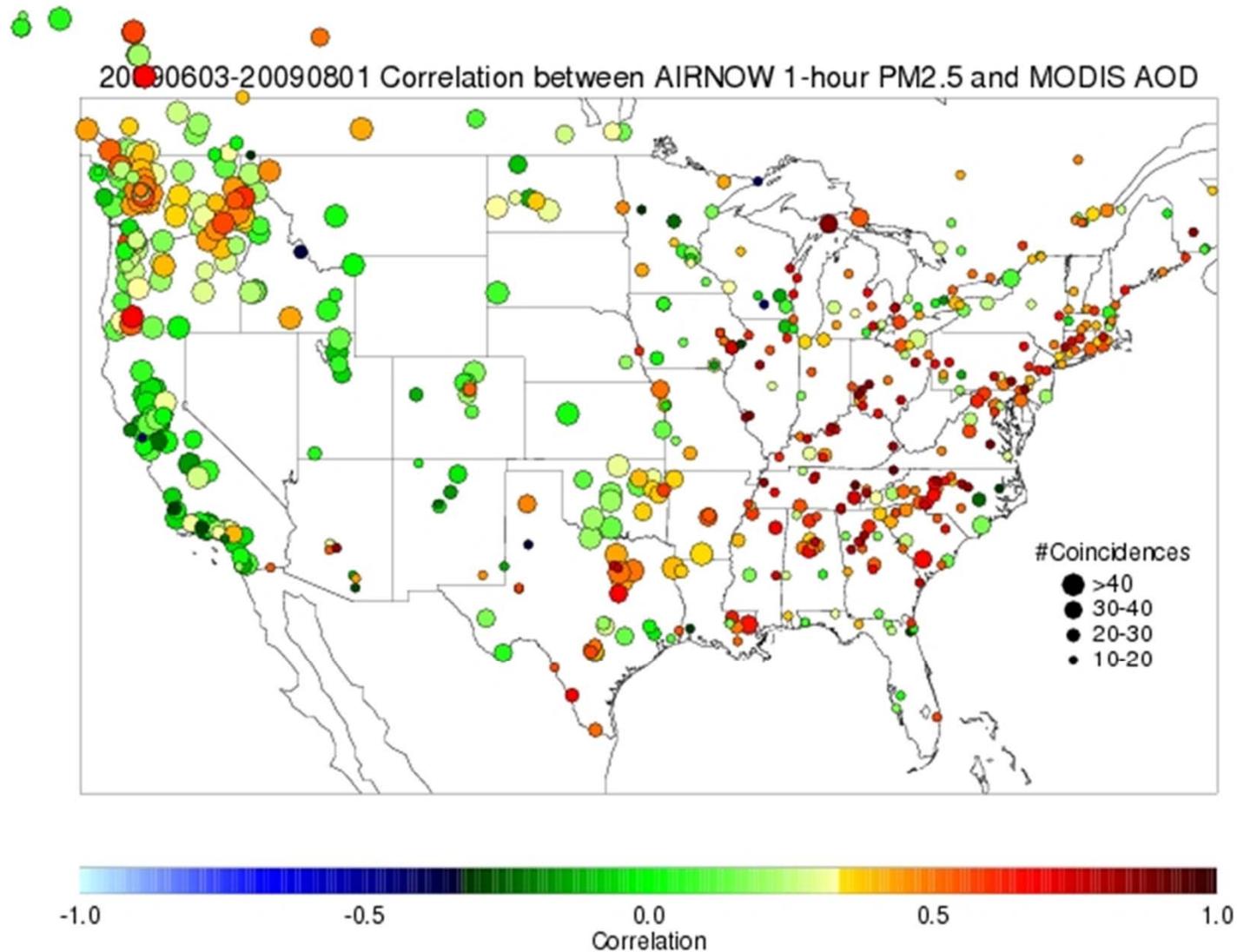
Comparison at 505nm



PM2.5 and Aeronet AOD build-up in Bakersfield, CA (16-24 Jan 2013)



Example of PM_{2.5} and MODIS Satellite AOD correlations



IDEA: Infusing satellite Data into Environmental Applications
(<http://www.star.nesdis.noaa.gov/smcd/spb/aq/>)

Near-surface pollution is one of the most challenging problems for Earth observations from space...

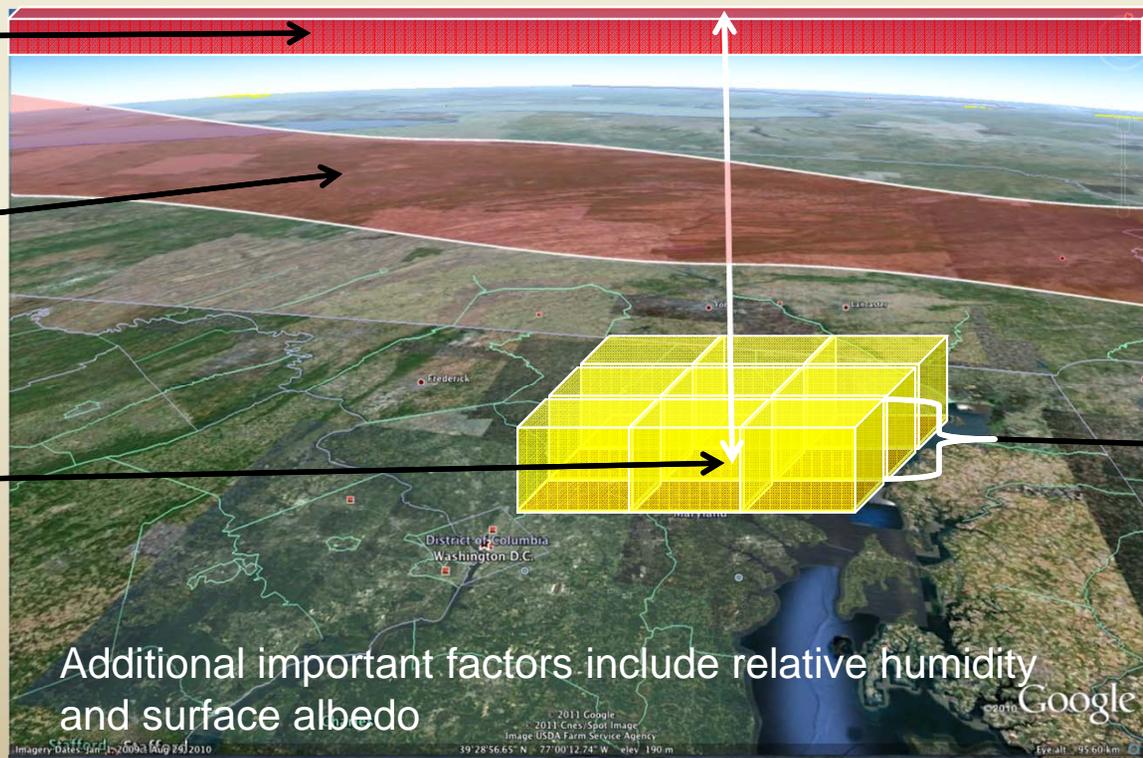
Near-surface information must be inferred from column-integrated quantities obtained by passive remote sensing from downward-looking satellite instruments.

Some constituents have large relative concentrations in the stratosphere and/or free troposphere (e.g., O_3 and NO_2) making it difficult to distinguish the near-surface contribution to the total column.

Stratospheric Burden

Long-range transport of pollution aloft

From space, the size of the measurement pixel matters (as does grid size for models)



Boundary layer depth influences the volume over which surface pollution is mixed

It also matters how well the pollution is mixed

Additional important factors include relative humidity and surface albedo



Investigation Overview



Deriving Information on Surface Conditions from Column and VERTically Resolved Observations Relevant to Air Quality

A NASA Earth Venture campaign intended to improve the interpretation of current and future satellite observations to diagnose near-surface conditions relating to air quality

Objectives:

- 1. Relate column observations to surface conditions for aerosols and key trace gases O_3 , NO_2 , and CH_2O*
- 2. Characterize differences in diurnal variation of surface and column observations for key trace gases and aerosols*
- 3. Examine horizontal scales of variability affecting satellites and model calculations*

Deployments and key collaborators

*Maryland, July 2011 (EPA, MDE, UMd, UMBC, Howard U.)
California, January 2013 (EPA, CARB, UC-Davis&Irvine)
Texas, September 2013 (EPA, TCEQ, U. of Houston)
Colorado, Summer 2014 (EPA, NSF, NOAA, CDPHE)*





Deployment Strategy



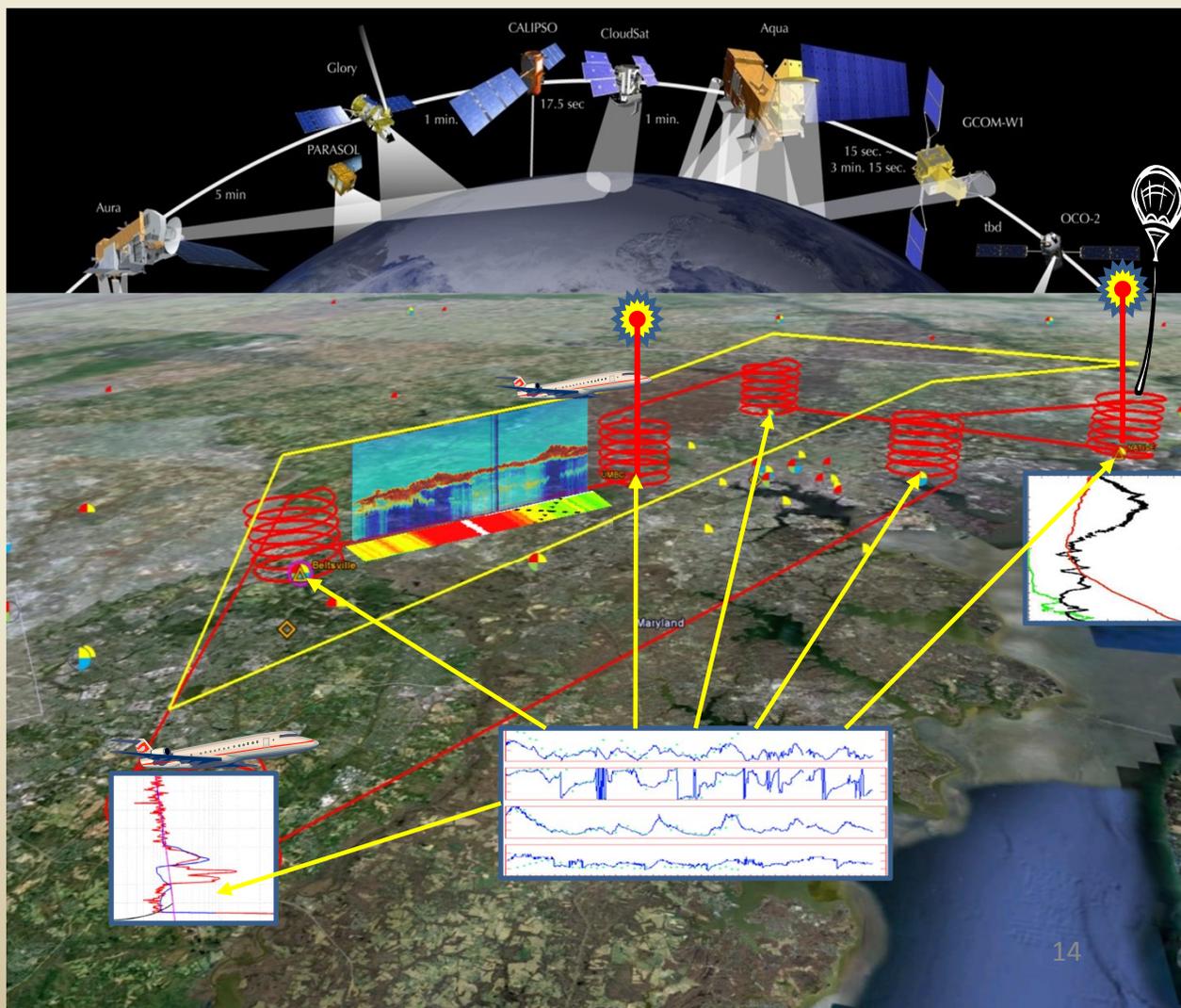
Systematic and concurrent observation of column-integrated, surface, and vertically-resolved distributions of aerosols and trace gases relevant to air quality as they evolve throughout the day.

Three major observational components:

NASA King Air (Remote sensing)
Continuous mapping of aerosols with HSRL and trace gas columns with ACAM

NASA P-3B (in situ meas.)
In situ profiling of aerosols and trace gases over surface measurement sites

Ground sites
In situ trace gases and aerosols
Remote sensing of trace gas and aerosol columns
Ozonesondes
Aerosol lidar observations





P-3B in action



Michael Charnick 2013



Outreach through Information and Data Management



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Home | Science | Instruments | Participants | Planning | Data | Events | Education | Multimedia

Discover-AQ Mission News

02.06.13: Final Calif. 2013 Flights on Feb. 6
DISCOVER-AQ will fly over the Central Valley of California on Wednesday, Feb. 6. This will be the tenth and final flight for the California 2013 leg of the DISCOVER-AQ mission.

02.05.13: No Flights Scheduled for Feb. 5
The DISCOVER-AQ team will not fly on Tuesday, Feb. 5, 2013.

02.03.13: Flights Set for Feb. 4
The DISCOVER-AQ team will conduct flights over the Central Valley of California on Monday, Feb. 4, 2013.

[Go To Archive](#)

Mission Highlights

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[3](#)
[4](#)
[5](#)
[6](#)
[7](#)
[8](#)

Packing for California 2013 Campaign
The Langley Aerosol Research Group (LARGE) is all packed up and ready to go. Their instruments are being integrated onto the P3-B for flights beginning in January 2013 in Central California's San Joaquin Valley.

Our Mission

Langley Research Center

[Download this video or view other multimedia](#)

DISCOVER-AQ is a four-year campaign to improve the use of satellites to monitor air quality for public health and environmental benefit.

Through targeted airborne and ground-based observations, DISCOVER-AQ will enable more effective use of current and future satellites to diagnose ground level conditions influencing air quality.

<https://discover-aq.larc.nasa.gov/>

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DISCOVER-AQ

Deriving Information on Surface Conditions from COlumn and VERTically Resolved Observations Relevant to Air Quality

Baltimore-Washington, D.C. 2011
California 2013
Texas 2013
TBD 2014

Data Archive: DISCOVER-AQ

Interactive Flight Tracks & Time / Profile Data Plotter **UPDATED!**

P3-B Profile Summaries - Percentiles Plots **UPDATED!**

P3-B Merged Data: Extract / Download one or more variables **UPDATED!**

P3-B Aircraft Forward / Nadir Videos

Reports: Outlook / Flight / Status / QuickLook

Flight Profile Summary

Flight / Profile Times: P3-B / B200

Satellite Overpass Tracks

Data Access & Other Data Sources

ICARTT Data Format Document

Data Management Plan

Related Links & News

Recent Activities

- DISCOVER-AQ Team Meetings / Presentations / Telecons **UPDATED!**
- California Site Survey Report (16-19 July 2012)

Flight Tracks: NASA P3B, B200

P3-B » [Click here to download *.KMZ file \(ALL Flights\)*](#)

B200 » [Click here to download *.KMZ file \(ALL Flights\)*](#)

Click on image to view full scale

* RightClick >> "Save Target As..." to save the *.kmz file; then open with GoogleEarth

The overarching objective of the DISCOVER-AQ investigation is to improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality. To diagnose air quality conditions from space, reliable satellite information on aerosols and ozone precursors is needed for specific, highly correlated times and locations to be used in air quality models and compared to surface- and aircraft-based measurements. DISCOVER-AQ will provide an integrated dataset of airborne and surface observations relevant to the diagnosis of surface air quality conditions from space. >> more

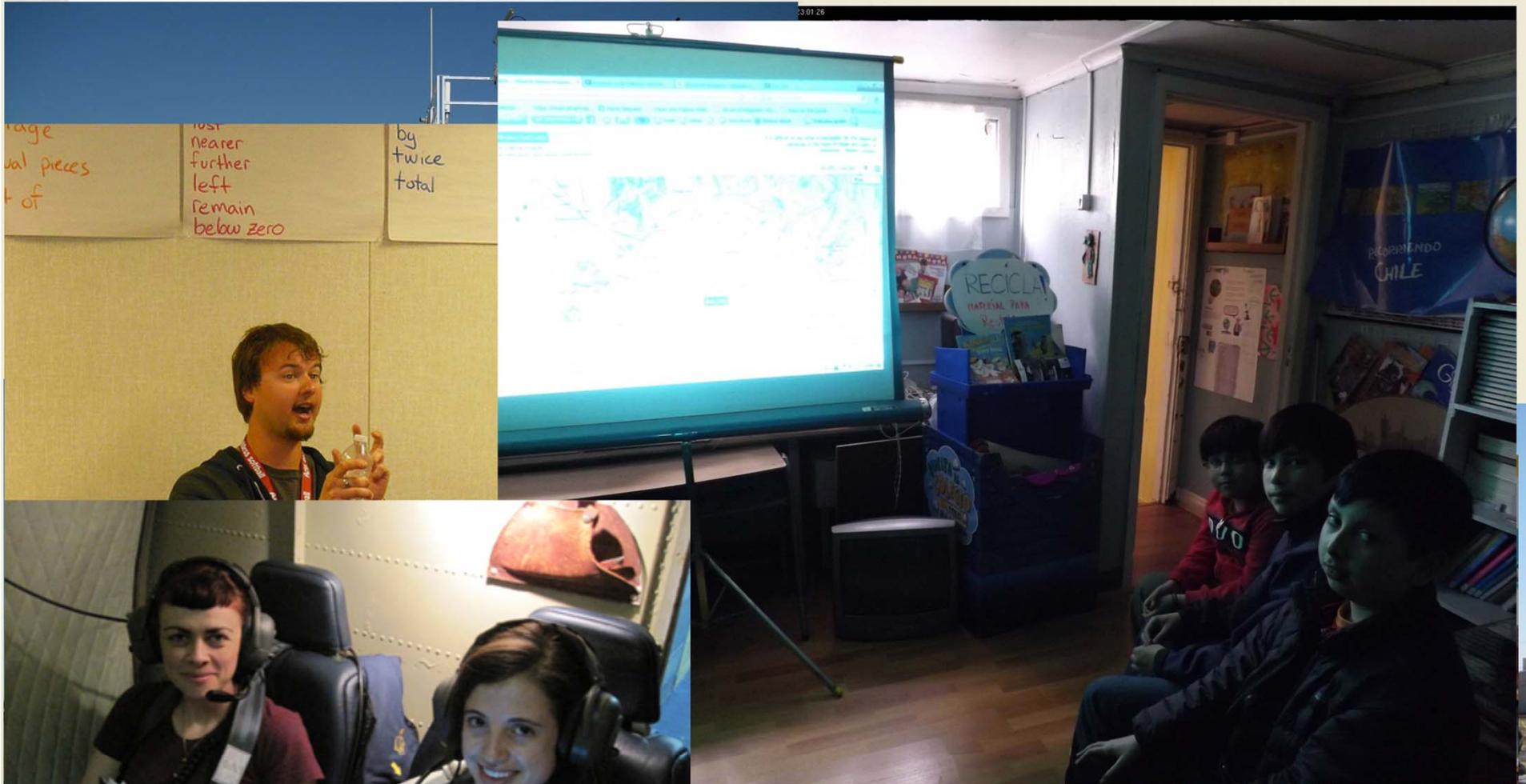
Tools

- Data Scanning/Submittal
- Register PI dataDs

<http://www-air.larc.nasa.gov/missions/discover-aq/discover-aq.html>



Outreach through Engagement



Porterville, CA
January 31, 2013





Outreach through Participation



Small Sensor technology is advancing at a rate that offers the possibility of widespread use of personal air quality monitors in the near future.

EPA has been evaluating these technologies.

Sensors will be shared with eight schools in the Houston area to determine the assess the current state-of-the-art and utility of these measurements.

Measurements will contribute to the much larger and more extensive DISCOVER-AQ network of observations.

Students will get to see how their monitors compare to conditions at nearby regulatory air monitoring sites.





Geotech AQMesh-5



The unit requires no power and operates unattended.

Subsequent to installation, visits would be only on an as needed basis and in many cases may not be necessary at all.

Sensors can be mounted on any pole (sign, flag, fence, etc.)

Units will continuously monitor five key pollutants:

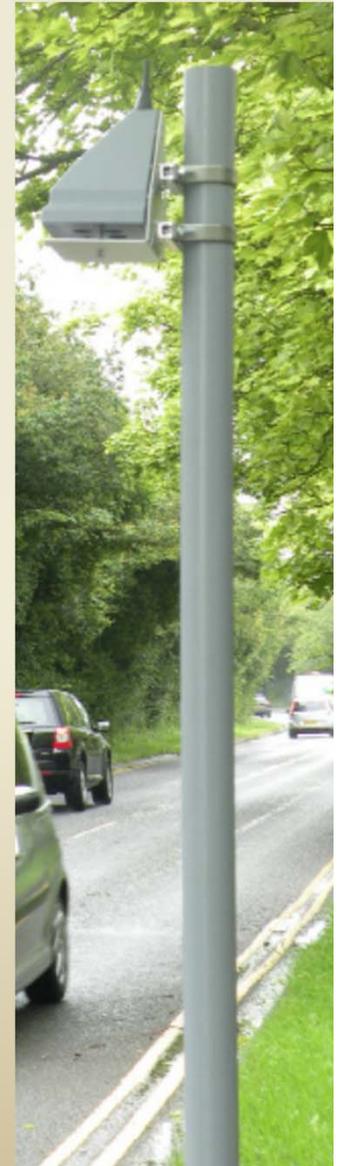
Ozone (O_3)

Nitrogen Dioxide (and NO_2)

Nitrous Oxide (NO)

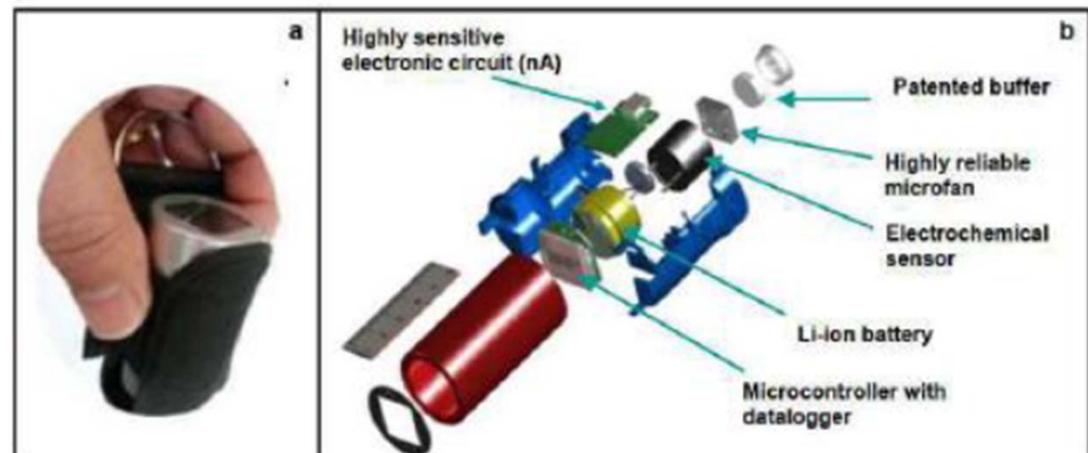
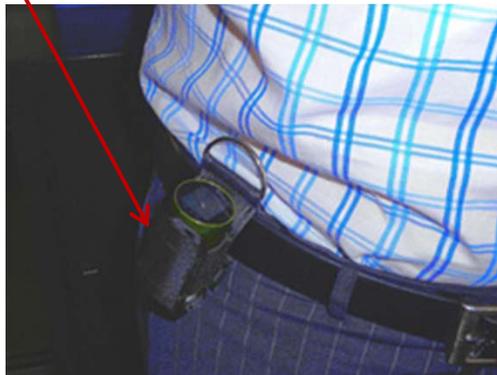
Carbon monoxide (CO)

Sulfur dioxide (SO_2)



CairClip Air Pollution Sensor

CairClip is an easy to use, air pollution sensor that measures ozone (O_3) and nitrogen dioxide (NO_2). These pollutants are regulated because they are formed by a number of pollution sources (such as vehicles and industry) and are known to cause harmful effects on human health and the environment. The **CairClip** sensor is made by CairPol, located in France.



(a) Picture of a Cairclip (b) schematic representation of its main components

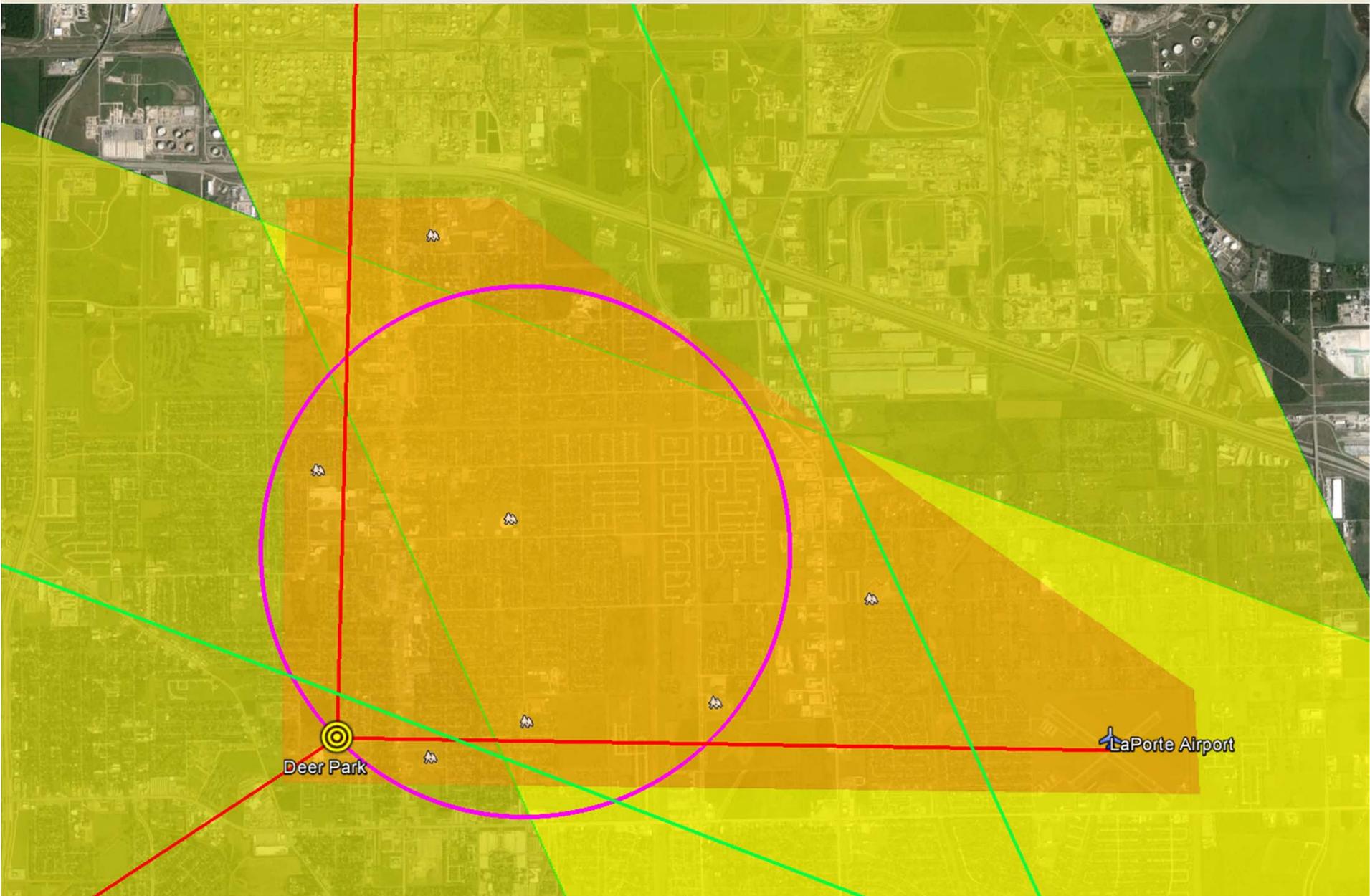
Features of the CairClip Sensor

- ✓ Detection range for O₃ and NO₂: 0 to 250 ppb
- ✓ Weight: 55 grams (about 0.12 pounds)
- ✓ Dimensions: 32 mm (1.26 inches) wide, 62 mm (2.44 inches) long
- ✓ Battery life: 24 hours
- ✓ Recharging battery: 4 hours to completely charge
- ✓ Battery charged with either a USB cable or AC adapter
- ✓ Can store about 28,800 data points; for example...
 - 1 point every minute = 20 days of data
 - 1 point every 15 minutes = 300 days of data
- Cairsoft user software (on provided USB thumb drive) to retrieve measurement data and set up measurement parameters





Small Sensor Network





Interested in Following DISCOVER-AQ Houston?



Even if you are not in Houston, there are opportunities to interact with DISCOVER-AQ scientists.

Online flight tracking and chat sessions during flights with active scientists is available.

For more information, contact Melissa Yang (melissa.yang@nasa.gov)

At least 10 flights are planned during September 2013, however, the actual flight days depend on weather conditions.

Flight announcements will be sent by email the afternoon before each flight day.

Flights last 8 hours, so there is plenty of time during the day to look in on us and ask questions.





Education and Public Outreach Team



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