3D-AQS: A Three Dimensional Air Quality System

Applications of Environmental Remote Sensing into Air Quality and Public Health
Potomac, MD May 8-9, 2007

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MODIS 29 April 2007
Data from NASA GSFC and University of Wisconsin
The same plume in the vertical

This is why ground monitors in GA are not ringing bells

(more on this later…..)
Overview

• Overview of 3D-AQS project
• Current data and why EPA is interested in satellite and lidar data for aerosols
• Quick overview of existing satellite data
• Quick overview of lidar
• Status of 3D-AQS project
• How you can access these data and provide input to 3D-AQS
Why are we interested in measuring air quality data in 3D?

- Regional haze and regional scale events
- Long and medium range transport
- Clean Air Interstate Rule
- Improved modeling and validation of models
- Regulatory accountability
- Health endpoints?

Satellite sensors can provide horizontal data coverage, ground and space-based lidar can measure aerosols in the vertical dimension.

"At this point, we are ants on a two dimensional world...."
Current Datasets: Ambient Air Monitoring for Aerosols

- "True" measure of air quality
  - Varying temporal scales (hourly, daily, 1 in 3 days)
  - Sparse networks spatially
- Ground-based concentration in mass units (µg / m³)
- Monitors usually sited in urban or rural areas only, e.g.,
  - Urban FRM network
  - IMPROVE in Class I areas
- Used for forecasting and historical analysis (including compliance)
- Decision support systems include:
  - AQS / AirQuest (http://www.epa.gov/ttn/airs/airsaqs/)
  - AIRNow (http://www.airnow.gov)
Some key air quality satellite sensors

OMI
MODIS
AIRS
CALIPSO
MODIS Direct:  
http://eosdb.ssec.wisc.edu/modisdirect/
IDEA:  http://idea.ssec.wisc.edu/

MODIS Terra, October 10, 2006  
MODIS Direct and IDEA run by UW-SSEC
UMBC data can all be found at http://alg.umbc.edu
Daily posts

NASA satellite images, EPA data, etc.

Daily posts from 3.5 years
~ 35,000 visitors per month, including universities, EPA, NASA, NOAA, & States, and general public

U.S. Air Quality (The Smog Blog), http://alg.umbc.edu/usaq
Elastic Lidar Facility (ELF)

Atmosphere
Smoke, Haze, Dust, Clouds, Aerosols

14” Schmidt-Cassegrain Telescope

Receiver

Transmitter

Nd:YAG 532, 1064 nm

PMT
http://alg.umbc.edu/REALM
Integrate operationally NASA satellite sensor and lidar data into EPA’s air quality data systems: AQS/AirQuest, AirNow

Provide greater accessibility and usability of satellite and lidar data to all users of these systems: IDEA, Smog Blog, REALM

Develop visualization tools in horizontal and vertical dimensions for forecasting and retrospective analysis
Integrated System Solutions for 3-D AQS Impacting Air Quality & Public Health

Sun-Earth Observations and Models for Predictions/Assessments/Forecasts

- Observations
  - Terra/Aqua MODIS AIRS LIDAR REALM MPLNet GOES GASP Aura OMI CALIOP CALIPSO AERONET
- Models
  - NOAA Hysplit LaRC modified IMPACT trajectory model

3D-AQS

USAQ Weblog

IDEA

Partnership Area

Decision-Support Tools
- AIRNow/AQS-EPA/NOAA
  - Increase synoptic data for PM$_{2.5}$ forecasters
- AQS/AIRQuest (EPA)
  - Multi-dimensional aerosol related data and analyses:
    - Assess general state of air quality and trends
    - Assess progress of SIPs and compliance
    - Waivers to air standards
    - Air quality rule development
- NEPHTN-PHASE (CDC)
  - Produce better AQ maps through statistical models

Value & Benefits to Citizens & Society

- Increase accuracy in AQ forecast: reduce poor air quality health impacts.
- Increase knowledge in causes or poor air quality – leading to improvements in AQ and confidence in government.
- Improved prevention initiative targeting.

Inputs
- NASA/NOAA/EPA/UMBC/CIMSS/BMI

Outputs
- EPA/NOAA/CDC

Outcomes

Impacts
3D-AQS integrates disparate datasets - our vision
Baltimore, MD Summer 2004

Old Town (Baltimore) Summer 2004

July 9 High altitude smoke
July 21 Mixed down smoke
Aug 10 Normal haze
Aug 24 Transported haze

Air Quality Index Categories for PM2.5

<150.5

Good

Moderate

Sensitive

Unhealthy

Surface PM2.5 (µg/m³)

Aug 10 Normal haze
Aug 24 Transported haze
July 9 High altitude smoke
July 21 Mixed down smoke

MODIS AOD

Terra

Aqua

Total Fine Mass

Total Carbon

Total Sulfate

K_ion *
Sulfate transport to Maryland
24 August 2004
Alaskan Smoke over Maryland
9 July 2004

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10 July 2004, am
Direction of changes to the website

IDEA* → “3D-IDEA”

* Infusing satellite Data into Environmental Applications
Progress of 3D-AQS Project

Progress

• Determined priority datasets:
  • MODIS AOD and PM$_{2.5}$ monitor matched data
  • GASP AOD, AERONET AOD, LIDAR profiles and AOD
• Porting historical MODIS AOD-PM$_{2.5}$ matched station data to AirQuest
• Started development of finer resolution AOD data (5x5km and 2x2 km)
• Started development of 3D visualization methods
• Transferring IDEA to operational NOAA environment
• Formation and interaction with end user committee

Timeline

• 2007-08: Evaluation of other sensors (OMI, AIRS) for integration into AirQuest. Implementation of 3D visualization and data output.
• 2008-09: Complete data integration and transition to operations
3D-AQS Needs Input

- End user input needed
  - Input sought through end user committee
  - Email always welcome: engelcoxon@battelle.org

- Type of input needed
  - Data types of interest
  - Level of processing and format required
  - Type and style of visualization
  - Temporal and spatial needs

- Better data accessibility = more use and demand for environmental information = greater understanding of our atmosphere
Questions?
Backup
August 10, 2006 CALIPSO Validation