Air Quality from Space
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From Provider to User

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• Establish a framework for long term coordination among the CEOS agencies where the “Constellation” will identify specific opportunities for meeting science and application requirements.

• Collect and deliver data to improve predictive capabilities for coupled changes in the Ozone Layer, Air Quality, and Climate Forcing associated with changes in the environment.

• Objectives meet participating Agency priorities and are aligned to the GEO SBA’s:
  – Demonstrate how Constellation data can add value to data products serving the GEO SBA’s through Projects.
  – Explore existing and upcoming international missions for potential collaboration.

• Eight research and operational space agencies are participating in ACC.
• What is interaction between climate and air quality?
  – Improve emission inventories of air quality precursors
  – Impact of long range transport of pollution on air quality
  – Improve AQ forecast

• How do aerosol characteristics impact air quality and climate?
  – Aerosol characteristics (direct forcing) and transport
  – Interactions with clouds (indirect climate forcing)
Opportunity for conducting AC science and providing Societal Benefits using multiple instruments across international platforms

- Collaboration efficiency: take advantage of each instrument’s unique capability
- Cross instrument calibration
- Improved spatial and temporal coverage: e.g. different equator crossing times
- Enhanced data products: e.g. aerosol and cloud characteristics, pollution and its transport for assessments and forecasting
- More accurate trends by comparing and combining data sets

Example:
Geographic extent of CO from biomass burning combined with smoke vertical distribution improves assessment of total emissions and downstream impacts

A-Train is a good example of Constellation Science

CEOS provides an opportunity to extend international collaboration
• The polluted air (MLS-CO) can then be transported by eastward winds across Pacific to North America

• Uplifting of concurrent smoke also observed by CALIPSO (not shown)

• A combination of surface emissions and deep convection (MLS cloud ice) controls the distribution of CO in the upper troposphere (UT)

• CO detected by AIRS peaks in northern summer from industrial sources. Convection is strongest over the Asian monsoon region

J. Jang - JPL, 2008
Tropospheric Ozone – Biomass Burning

TES Step & Stare Nadir Retrieval Result: Ozone
Cross Section Along Orbit Track, Run=2151, Seq=1-8, Scan = 0-24, UTTime=2004-09-21 14:58-15:14

- TES high tropospheric ozone profiles are likely due to biomass burning from two continents.
- OMI maps tropospheric ozone using MLS (stratosphere).
NO$_2$ - Trends

- Tropospheric pollution is on the rise in China (while declining in the US)
  - NO$_2$ increase follows increase in industrial activity
  - Efforts to regulate pollution during Olympics likely worked

![Map showing NO$_2$ concentration over Beijing and China](image1)

![Graph showing Tropospheric NO$_2$ above Eastern China and NO$_2$ Annual Cycle over Beijing](image2)
• GOME-2 and OMI are similar instruments
• 10:15 and 13:30 crossing times
• Two instruments were inter-calibrated
• Diurnal effect is detected
• Measurements and model agree

S. Kondraguta - NOAA, 2009
Satellite vs Ground

- Correlating satellite with surface measurements is a major challenge for AQ
  - OMI Trop. NO$_2$ vs Corrected in-situ NO$_2$
  - MODIS AOD vs in-situ PM 2.5
  - Top-down calculations employ models to constrain layer height and other characteristics
Satellite Data and Controls

Southwest US
- Las Vegas
- Central Valley
- San Francisco
- LA

Northeast US
- Toronto
- LA
- Boston
- NYC
- Phil
- DC
- Richmond

VOC controls O₃ prod.  \( \text{NO}_x \) controls O₃ production

B. Duncan, 2009
Satellite AQ Data Sources

- Many data sources with different:
  - Registrations
  - Protocols
  - Data formats
  - Tools
  - Data sets
Atmospheric Composition encompasses six GEO SBA’s

A portal will:

• Provide access, tools, and contextual guidance to scientists and value-adding organizations in using satellite data for information, and services.

• Help foster interoperability and application of satellite data, information and services worldwide.

• Identify unique requirements and common features of GEOSS users to provide a value-added and complementary capability
The Future is Now

AIRNow Satellite Data Processor (ASDP) data ingest, processor fusion & mapping distribution

AIRNow Outputs
- Real-time Maps, Website
- Email, SMS alerts
- Target info / formats for media, health

LOCAL FORECASTS
ADMS-Urban

- Text and number summaries
- Alerts to TV, the public, health professionals

London

Los Angeles
Conclusions

- Ground based measurements remain the major source of AQ data

- Satellites will complement not replace ground measurements
  - Can not cover sub-urban scales, however relevant to regional scales. Can fill in where ground data are absent
  - Trends over different areas, regional emission sources, assimilation into regional scale AQ models
  - Applicable for trend assessment, model assimilation, and emission estimation
  - Used for evaluation and adjustment of model emission inventories for air quality forecast

- Satellite data will improve with the Constellation concept

- Satellite data are accessible from several sources by the data producers

- More user support is needed - GEOSS-like IT infrastructure can more accessibility and utility
• ACC International partners

• For more information about satellites
  – [http://www.esa.int/esaEO/](http://www.esa.int/esaEO/)