



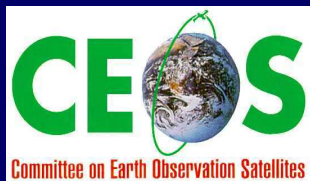
# **Air Quality from Space**

---

## **From Provider to User**

**Ernest Hilsenrath**  
**NASA-HQ**

**ESIP Federation Meeting**  
***Santa Barbara, CA***  
***July 7-10, 2009***





# CEOS ACC Background

- 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**



# **Constellation Science Questions for Air Quality and Climate**

- **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)



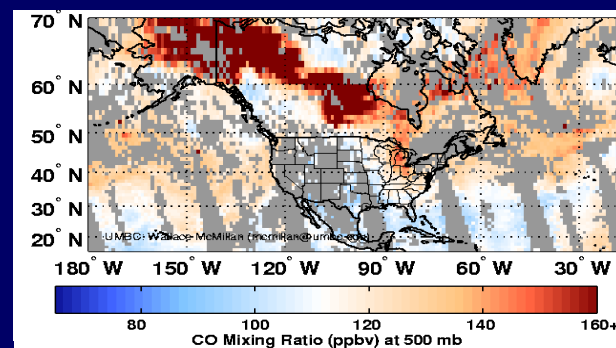
# Constellation Synergy: A-Train

**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

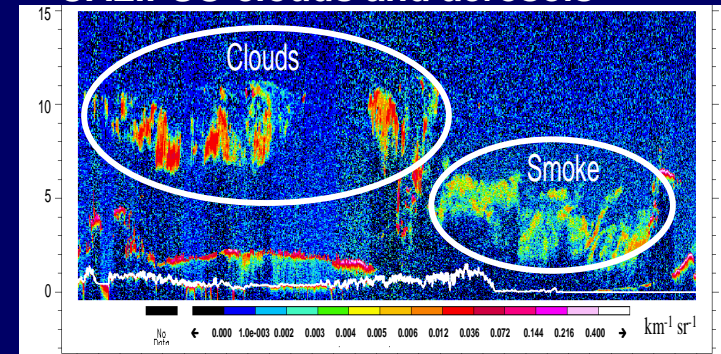
**AIRS Carbon Monoxide**



**A-Train is a good example of Constellation Science**

**CEOS provides an opportunity to extend international collaboration**

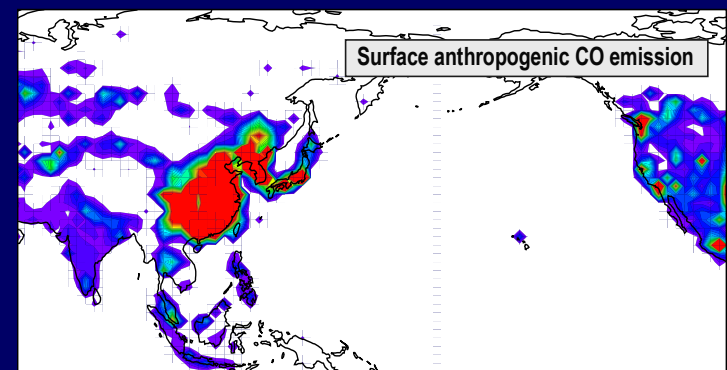
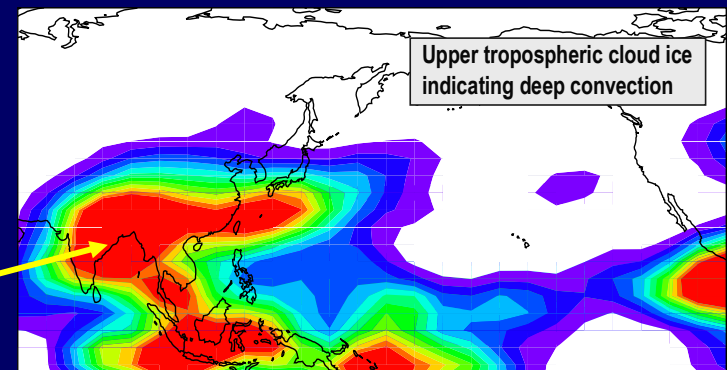
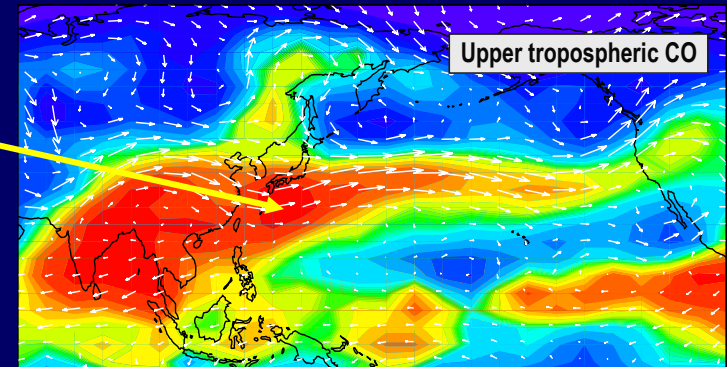
**CALIPSO clouds and aerosols**





# Surface Emissions and Long-range Transport

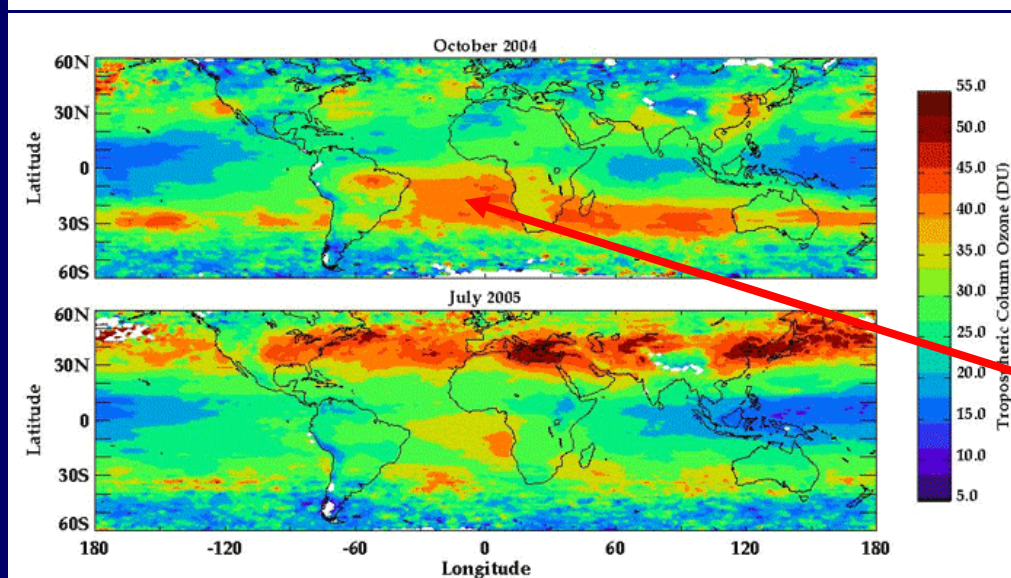
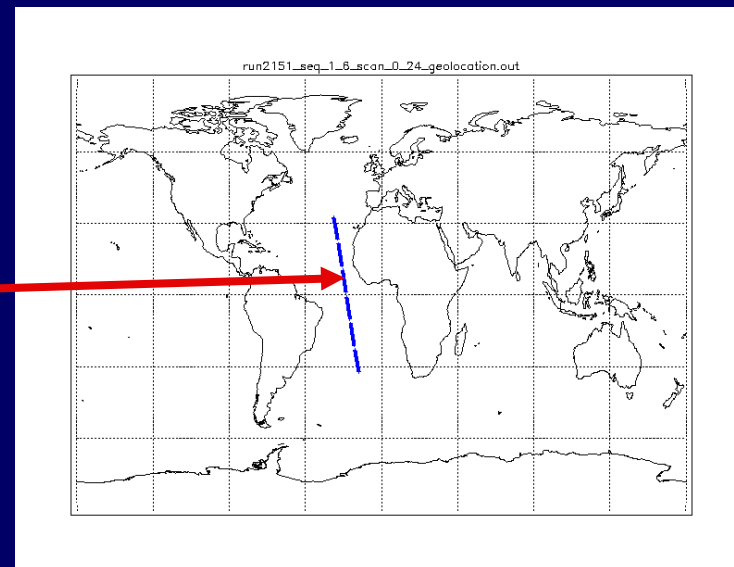
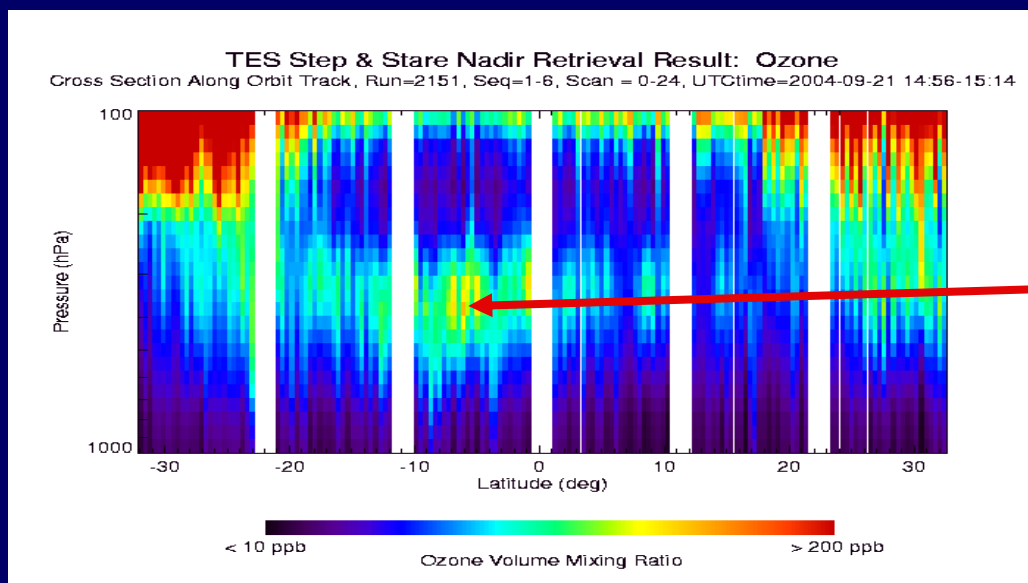
- The polluted air (MLS-CO) can then be transported by eastward winds across Pacific to North America
- Uplifting of concurrent smoke also observed by CALIPSO (not shown)
- A combination of surface emissions and deep convection (MLS cloud ice) controls the distribution of CO in the upper troposphere (UT)
- CO detected by AIRS peaks in northern summer from industrial sources. Convection is strongest over the Asian monsoon region







# Tropospheric Ozone – Biomass Burning



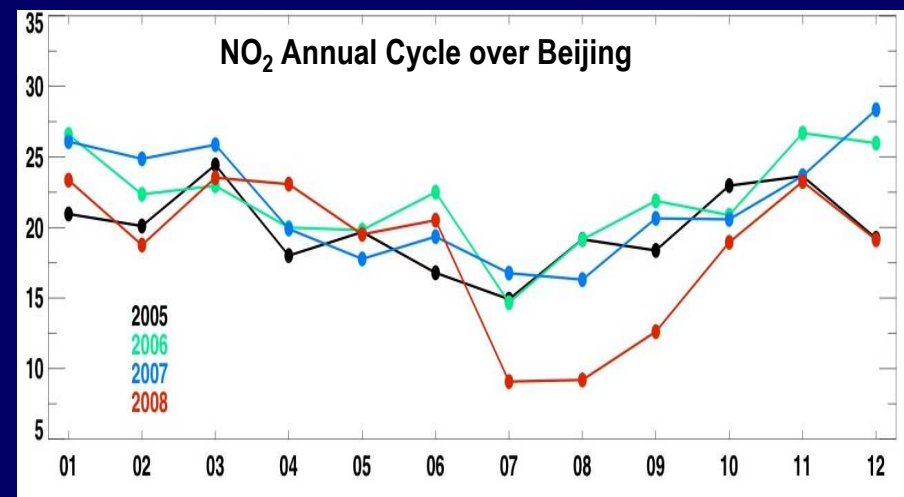
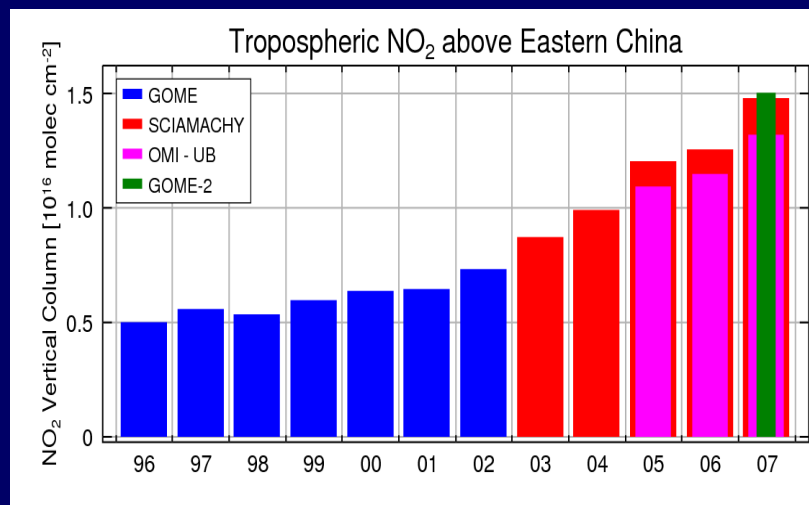
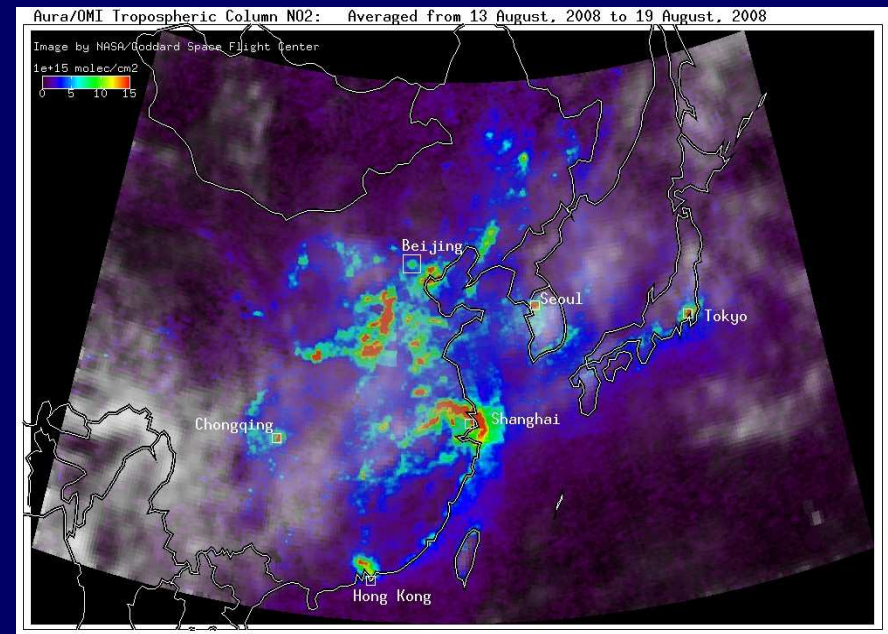
**TES** high tropospheric ozone profiles are likely due biomass burning from two continents

**OMI** maps tropospheric ozone using MLS (stratosphere)



# NO<sub>2</sub> - Trends

- Tropospheric pollution is on the rise in China (while declining in the US)
  - NO<sub>2</sub> increase follows increase in industrial activity
  - Efforts to regulate pollution during Olympics likely worked

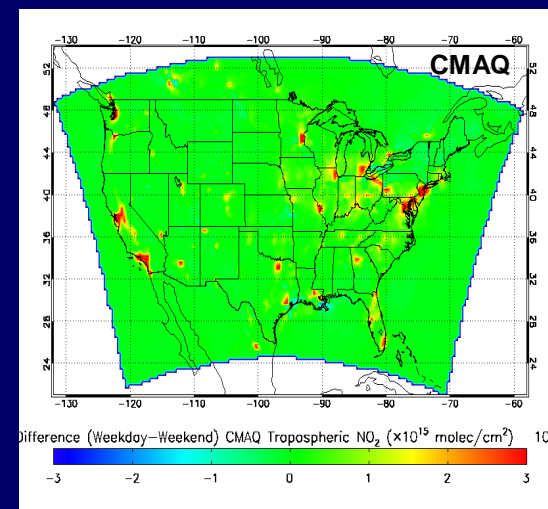
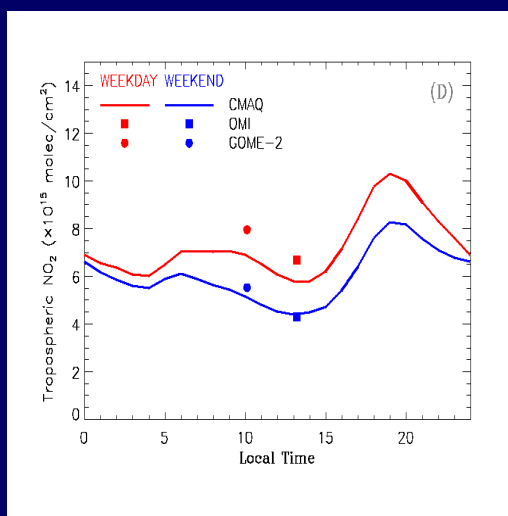
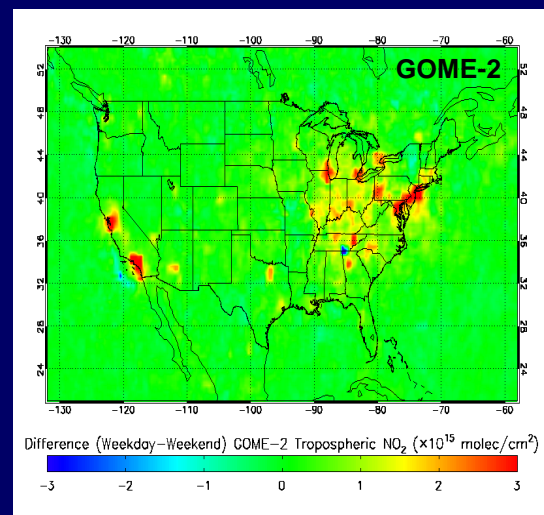




# NO<sub>2</sub> - Model vs Data

- 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







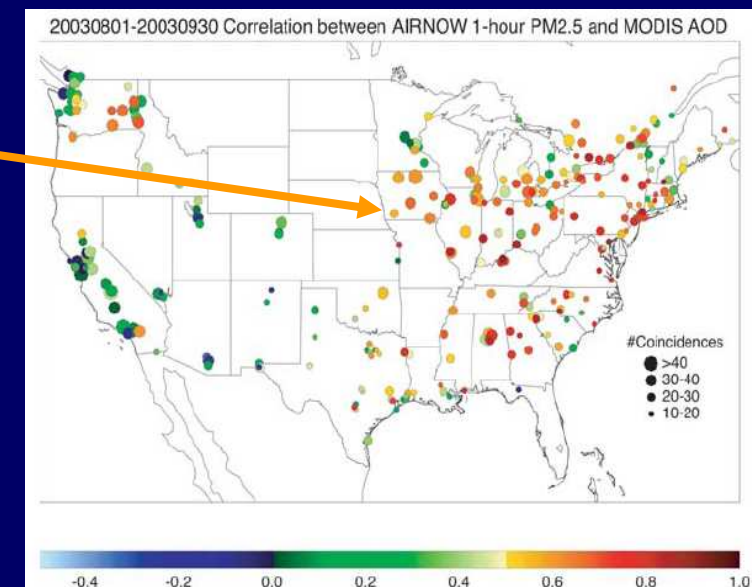
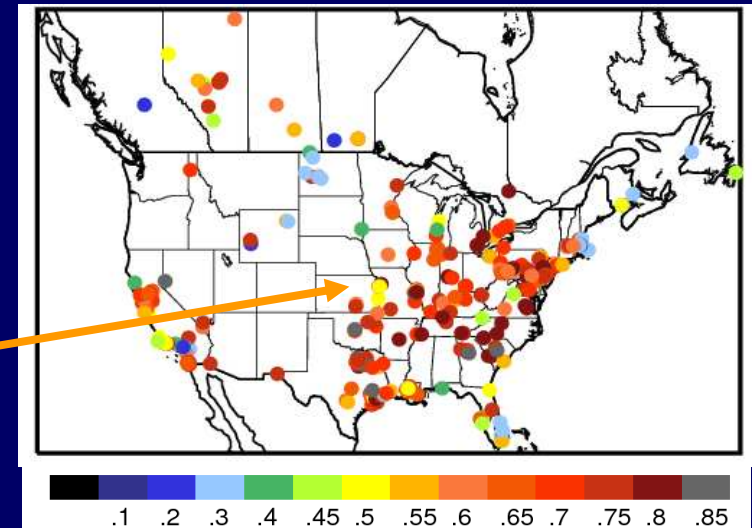
# Satellite vs Ground

- Correlating satellite with surface measurements is a major challenge for AQ

- OMI Trop. NO<sub>2</sub> vs Corrected in-situ NO<sub>2</sub>

- MODIS AOD vs in-situ PM 2.5

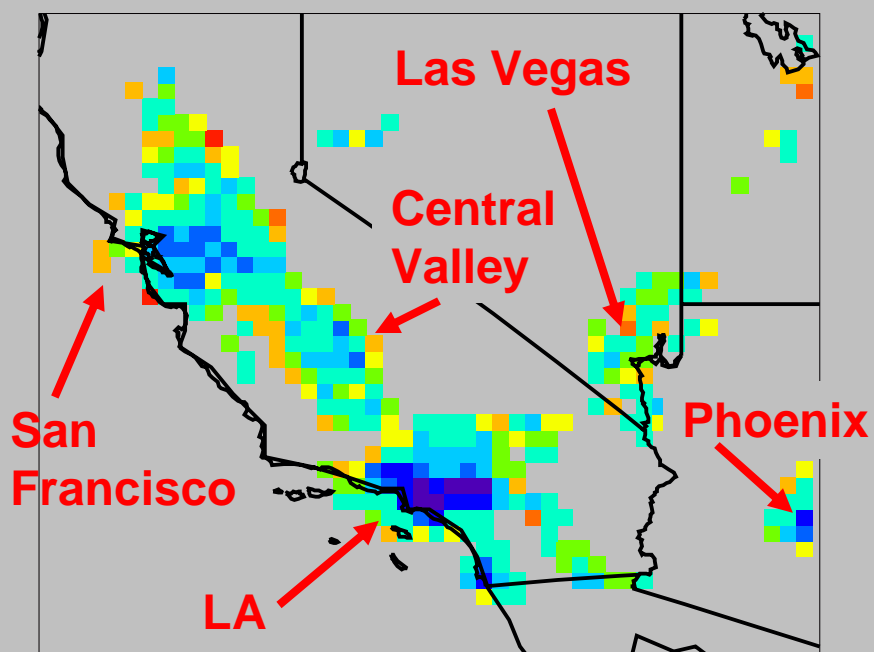
- Top-down calculations employ models to constrain layer height and other characteristics



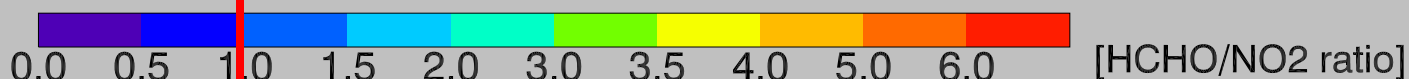
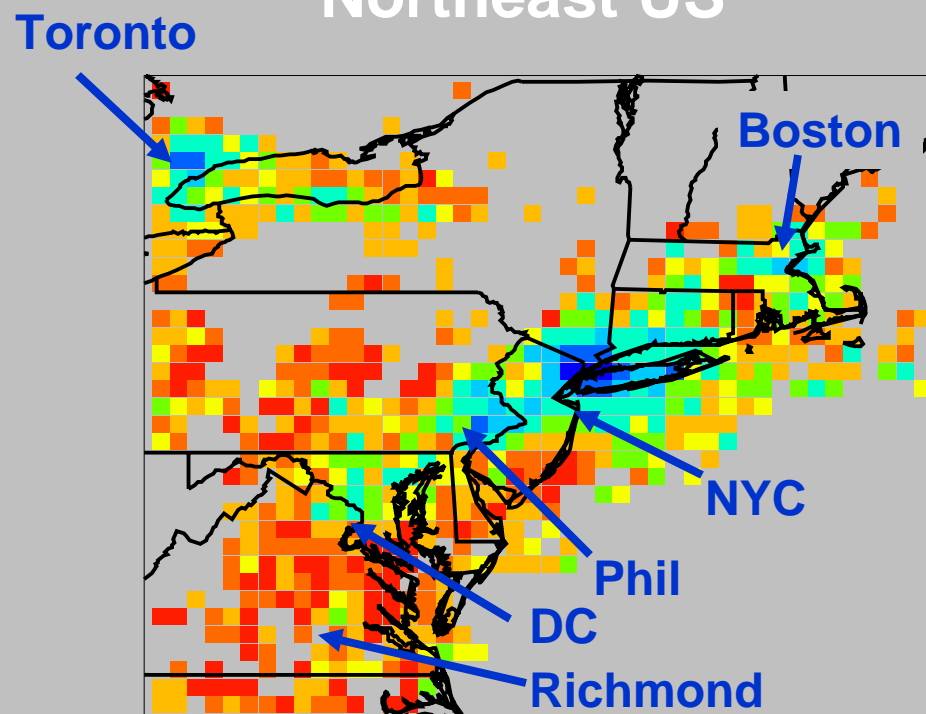


# Satellite Data and Controls

## Southwest US



## Northeast US



VOC controls  $O_3$  prod.  $NO_x$  controls  $O_3$  production  $\longrightarrow$

*B. Duncan, 2009*



# Satellite AQ Data Sources

- Many data sources with different:

- Registrations
- Protocols
- Data formats
- Tools
- Data sets

**PROMOTE**  
Project supported by the European Space Agency  
Stage 2 - Up-scaling the GSE Atmospheric Monitoring portfolio  
July 2006 - August 2009

**Mission**  
To deliver the Atmosphere GMES Service Element a sustainable and near real time atmospheric ozone depletion, surface UV exposure, air quality and climate change monitoring service.

**Overview of all services**

**Services by theme**

- Ozone Service
- UV Service
- Air Quality Service

**yourair for London** a **TEXT** service  
Air pollution alerts by text, email, and voicemail

Log in | Sign Up  
Font Normal | Larger+ | Larger++ | Text Only

Forecast for Sunday July 5th, 2009 - Central London

airTEXT alerts you if elevated pollution is expected in your chosen area.

Forecast of Air Pollution Index for Sunday July 5th, 2009  
Central London: LOW air pollution expected everywhere

Forecast selector:  
Choose a Zone  
Choose a pollution type  
Choose a date  
Zoom map to your post code

The World Data Center for Remote Sensing of the Atmosphere

Trace Gases

Trace Gas	Product
Ozone	Daily Vertical Column (near real time)
O <sub>3</sub>	Assimilated Daily Vertical Column (forecast / near real time)
topO <sub>3</sub>	Daily forecast of ground-level O <sub>3</sub> concentrations up to 72 hours for all of Europe
O <sub>3</sub>	Daily 4DVAR Analysis at 55.4 hPa (SACADA-17)
O <sub>3</sub>	One-Day Composites of Vertical Column (Near Real Time)
O <sub>3</sub>	Daily Vertical Column (near-real time)
O <sub>3</sub>	GDP 4.0 Total Ozone Record (1995-2005)
O <sub>3</sub>	GDP 4.0 Total Ozone Monthly Means and Statistics (1995-2005)

**Ozone and Atmospheric Chemistry Monitoring**

HOME OVERVIEW PRODUCTS DOCUMENTS FAQ

Welcome to the website of Satellite Atmospheric Chemistry Monitoring

Monitoring of ozone, other trace gases and aerosols from space is becoming increasingly important. The depletion of the atmospheric ozone layer is a global environmental concern. The resulting increased levels of ultraviolet radiation can harm water ecosystems, materials and people.

OSM SAF processes, archives, validates and disseminates atmospheric data and surface ultraviolet radiation using the measurements of the Meteorological Operational (MetOp) satellite.

The first satellite, MetOp-A, was successfully launched from Baikonur, Kazakhstan on 17 October 2006.

Near-real-time products are disseminated via EUMETSAT or internet. Offline products can be downloaded from the local archive.

Dissemination status: 21 operational and 2 pre-operational products are available.

Latest OSM SAF news:  
pre-operational. The product will become available to users in autumn.

NASA National Aeronautics and Space Administration

Goddard Earth Sciences Data and Information Services Center

Search DISC  
+ Advanced Search  
+ GO

+ ATMOS COMPOSITION + HYDROLOGY + A-TRAIN + AIRS + MODELING + NEESPI + PRECIPITATION

GES DISC  
Goddard Earth Sciences Data and Information Services Center

EARTH MEASUREMENTS  
+ ATMOS COMPOSITION  
+ A-TRAIN DATA DEPOT  
+ HURRICANES

**esa** EOLI Release Notes Screenshots

**EOLI** "ESA's Link to Earth Observation"

EOLI (Earth Observation Link) is the European Space Agency's client for Earth Observation Catalogue and Ordering Services.

Using EOLI, you can browse the metadata and preview images of Earth Observation data acquired by the satellites ENVISAT, ERS, Landsat, IKONOS, DMC, ALOS, SPOT, Kompsat, Proba, JERS, IRS, Nimbus, NOAA, SCISAT, SeaStar, Terra/Aqua.

Scientific Users with a registered account can order or download products of various processing levels.

Contacts  
For any question on the catalogue and ordering service, on registration, or any other EO related information, please contact our Help Desk:

EO Helpdesk



# Atmospheric Composition Portal

**Atmospheric Composition  
encompasses six GEO SBA's**

**A portal will:**

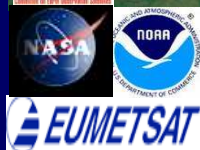
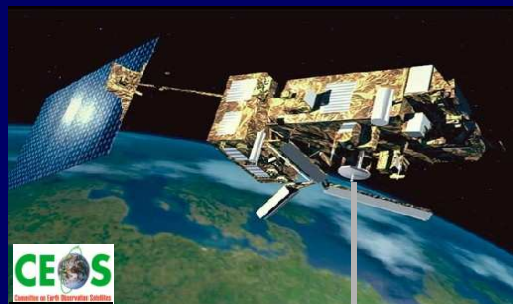
- Provide access, tools, and contextual guidance to scientists and value-adding organizations in using satellite data for information, and services.
- Help foster interoperability and application of satellite data, information and services worldwide.
- Identify unique requirements and common features of GEOSS users to provide a value-added and complementary capability







# The Future is Now



**AIRNow  
Satellite Data  
Processor  
(ASDP)**  
data ingest  
sat. processor  
fusion & mapping  
distribution



data to AQI  
a  
s data



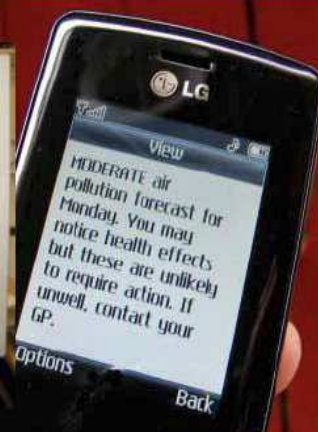
## AIRNow Outputs

- 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



SMS,  
mail



esa

**London**

**Los Angeles**





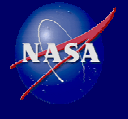
# Conclusions

- **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 - GEOS-5-like IT infrastructure can more accessibility and utility**



# THANK YOU

- ACC International partners



- For more information about satellites

- <http://www.ceos.gov>
- <http://nasascience.nasa.gov/earth-science/mission>
- <http://www.esa.int/esaEO/>
- <http://aura.gsfc.nasa.gov>

