Air Quality from Space

From Provider to User

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NASA-HQ

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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**

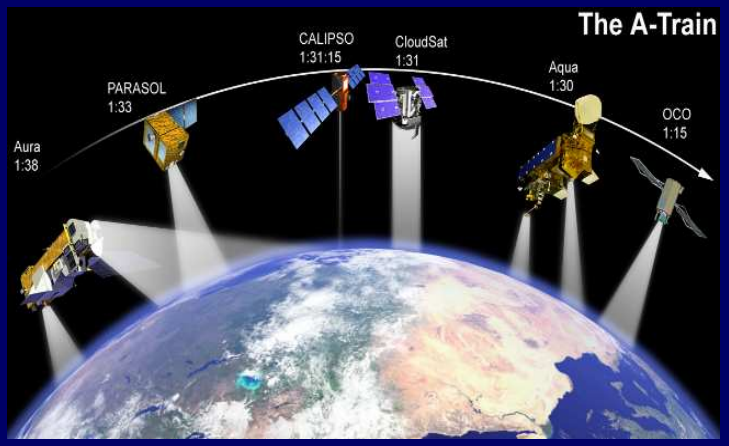
Constellation Science Questions for Air Quality and Climate

- **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 calbration**
- **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**

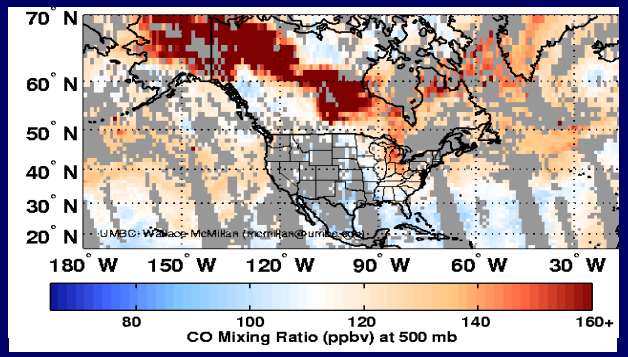


A-Train is a good example of Constellation Science

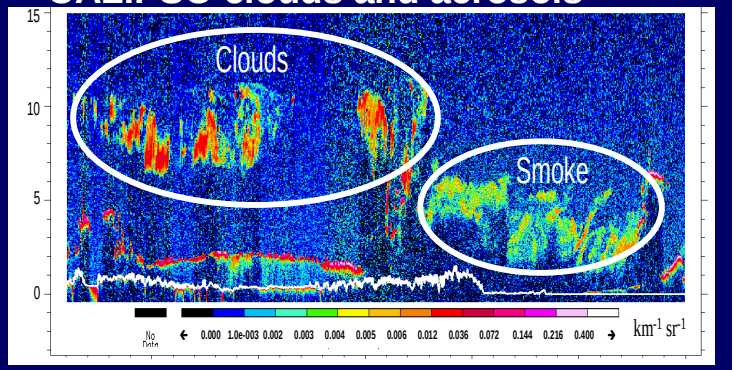
CEOS provides an opportunity to extend international collaboration

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

AIRS Carbon Monoxide



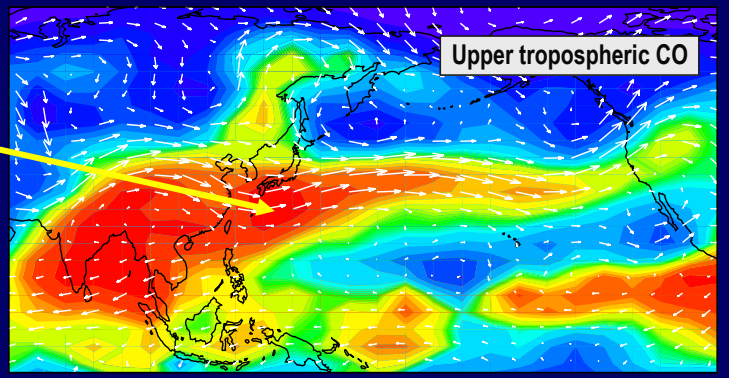
CALIPSO clouds and aerosols

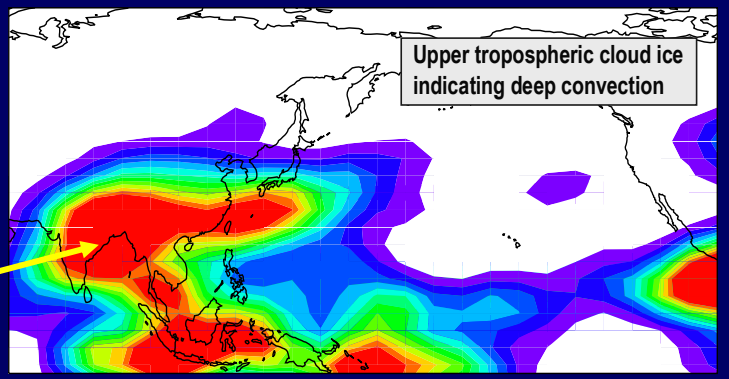


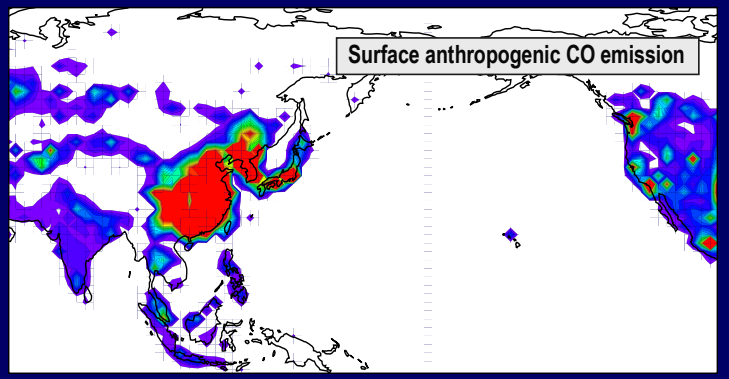
Surface Emissions and Long-range Transport

- 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

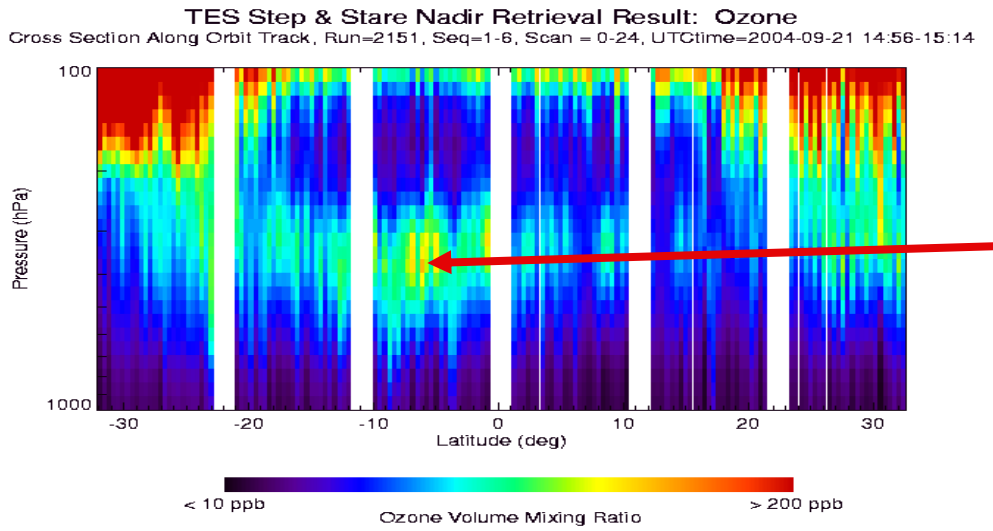
J. Jang - JPL, 2008

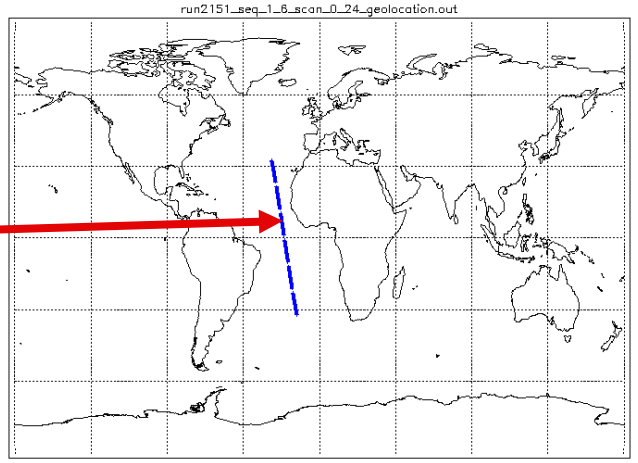


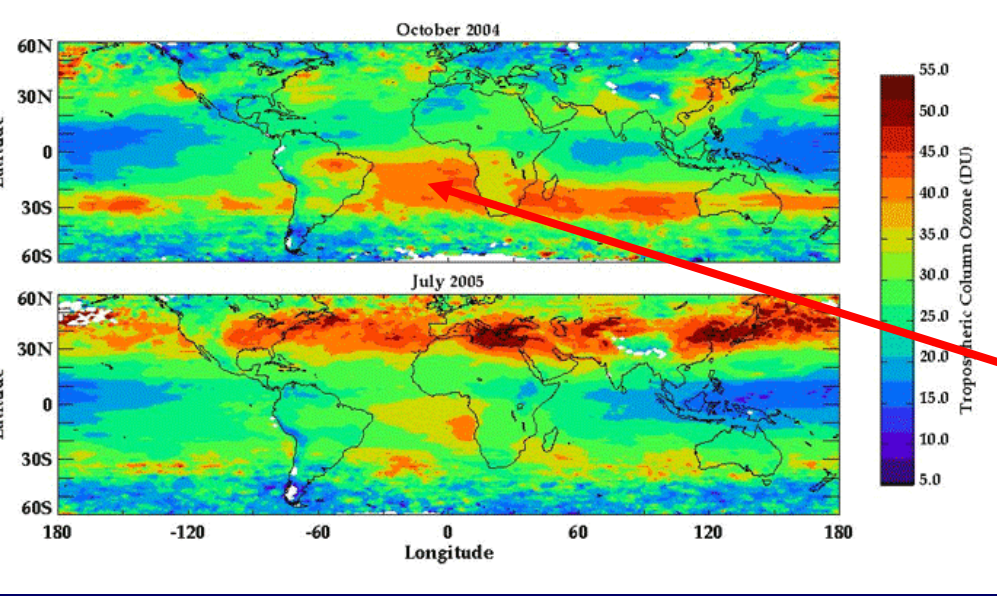




Tropospheric Ozone – Biomass Burning





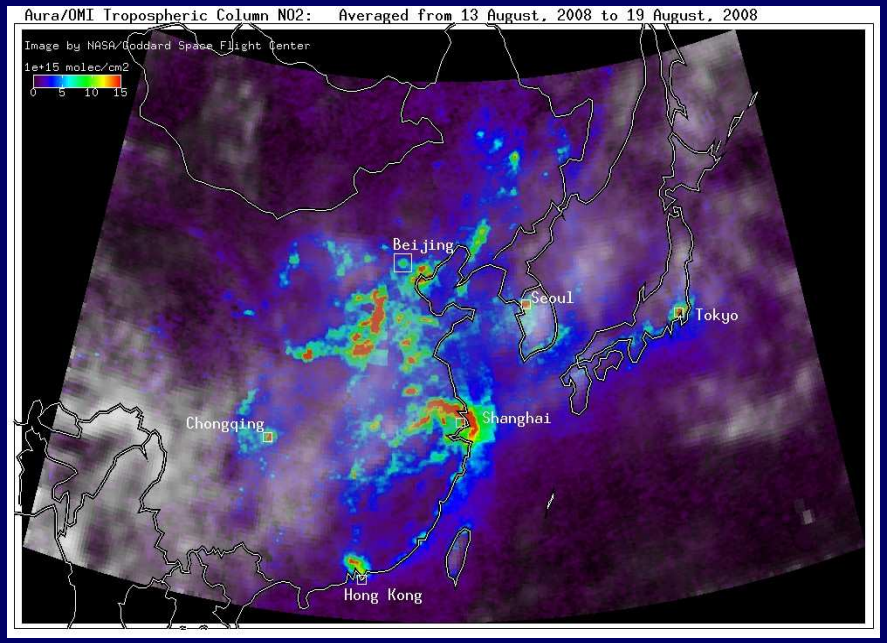


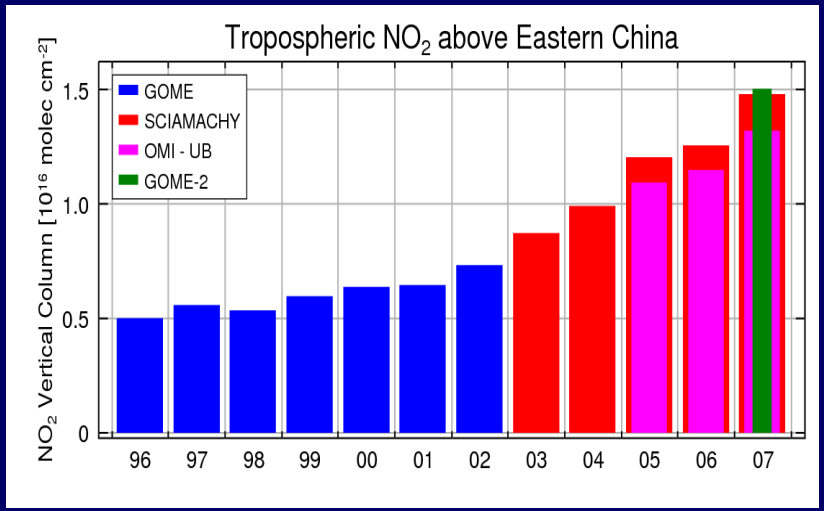
TES high tropospheric ozone profiles are likely due biomass burning from two continents

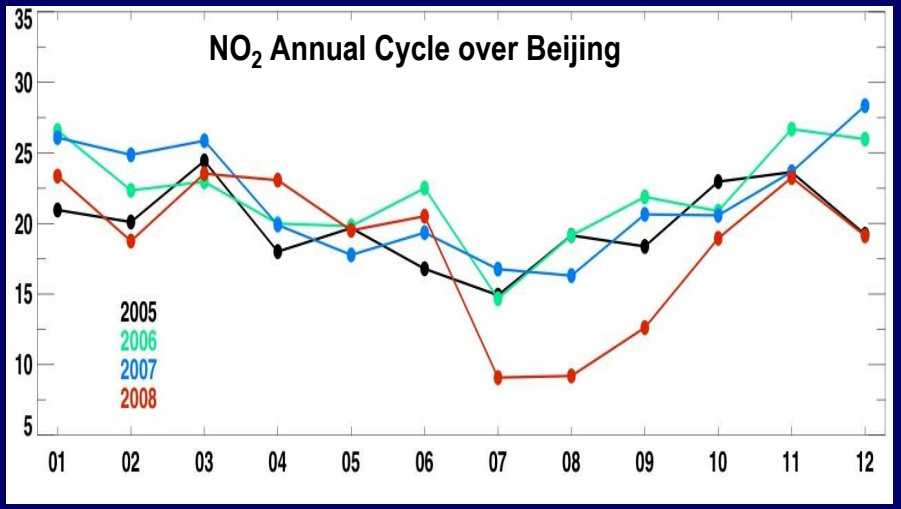
OMI maps tropospheric ozone using MLS (stratosphere)

NO_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**

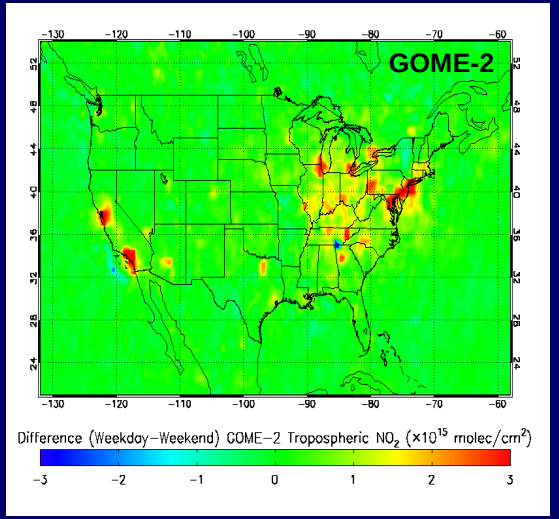


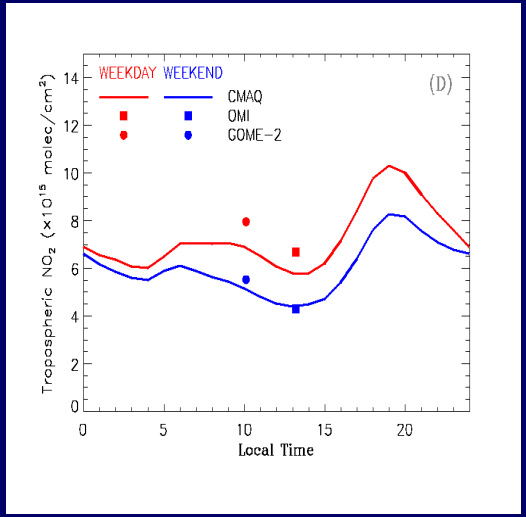


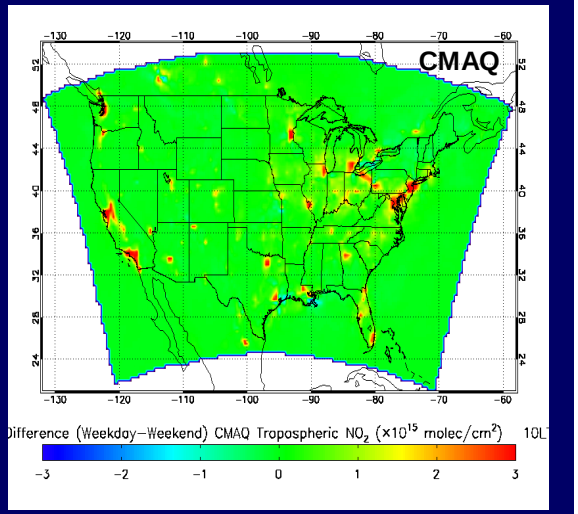


NO_2 - Model vs Data

- 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



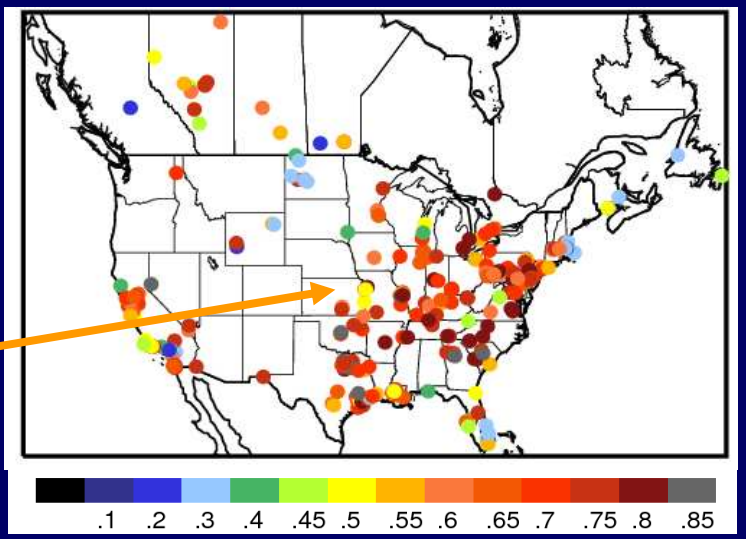


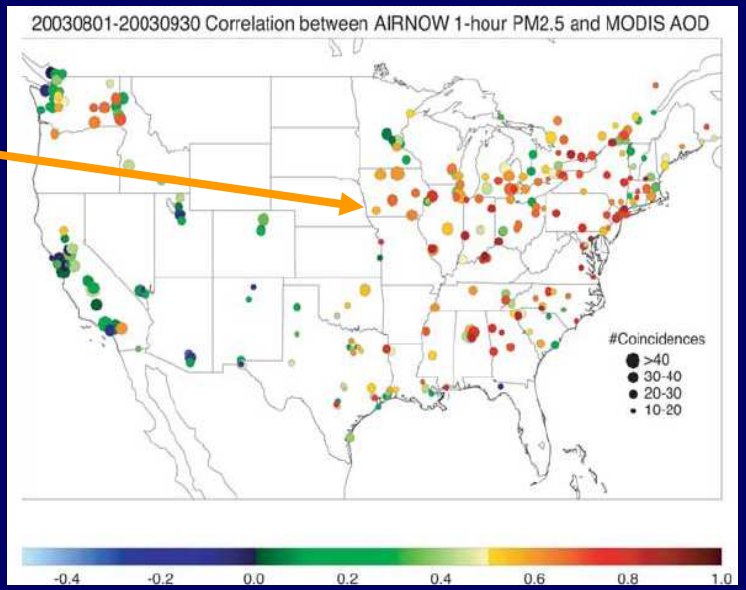


S. Kondraguta - NOAA, 2009

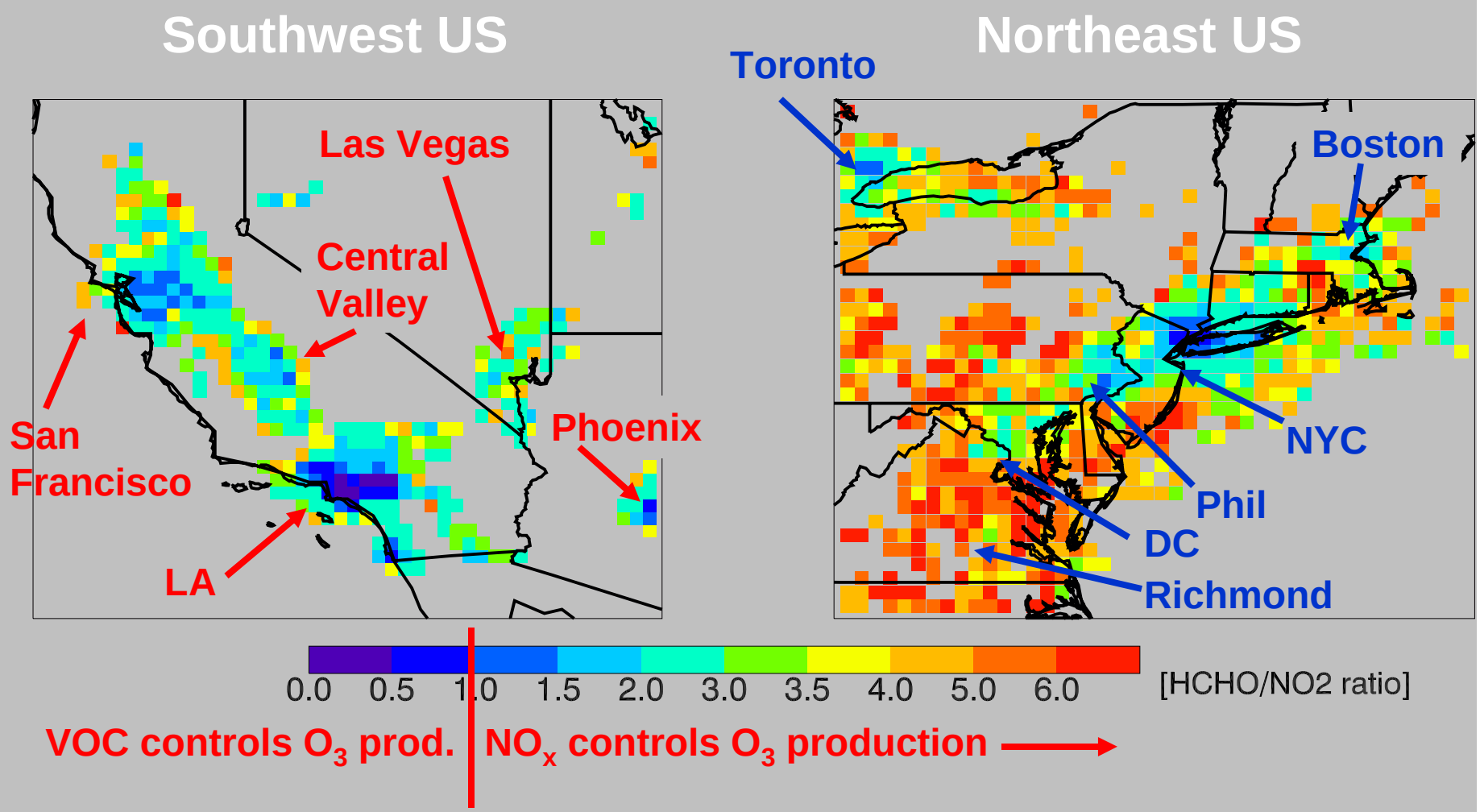
Satellite vs Ground

- **Correlating satellite with surface measurements is a major challenge for AQ**
  - **OMI Trop. NO_2 vs Corrected in-situ NO2**
  - **MODIS AOD vs in-situ PM 2.5**
  - **Top-down calculations employ models to constrain layer height and other characteristics**





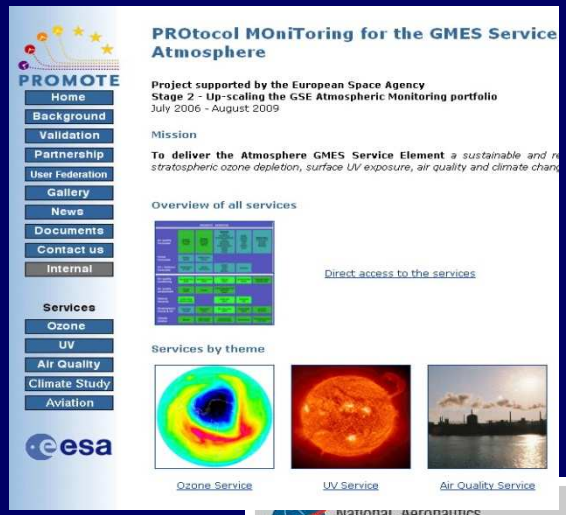
Satellite Data and Controls

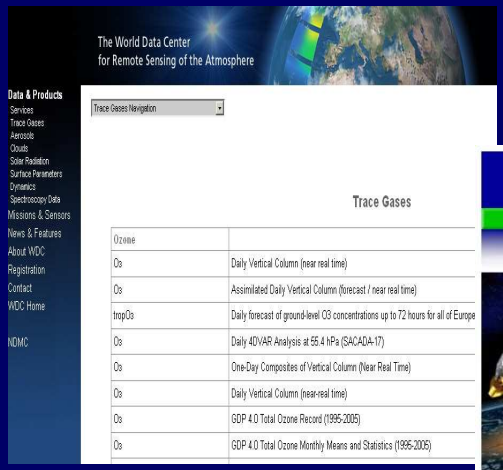


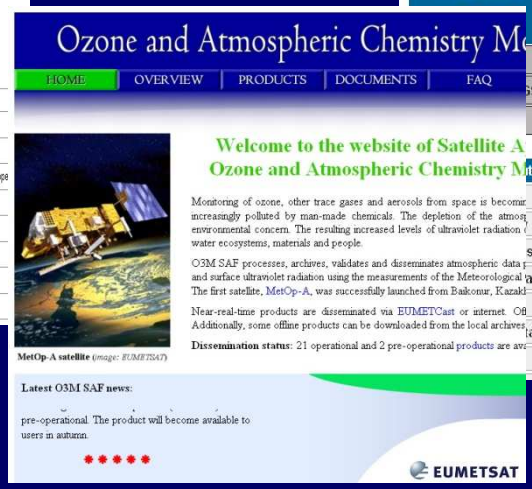
B. Duncan, 2009

Satellite AQ Data Sources

- **Many data sources with different:**
  - Registrations
  - Protocols
  - Data formats
  - Tools
  - Data sets







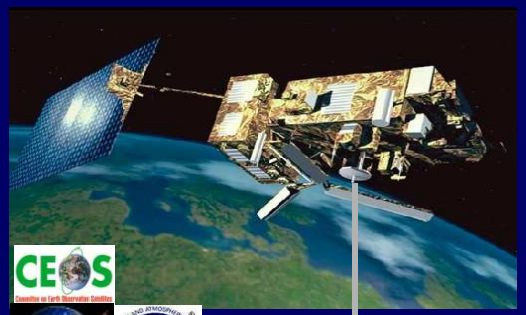
Atmospheric Composition Portal

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**

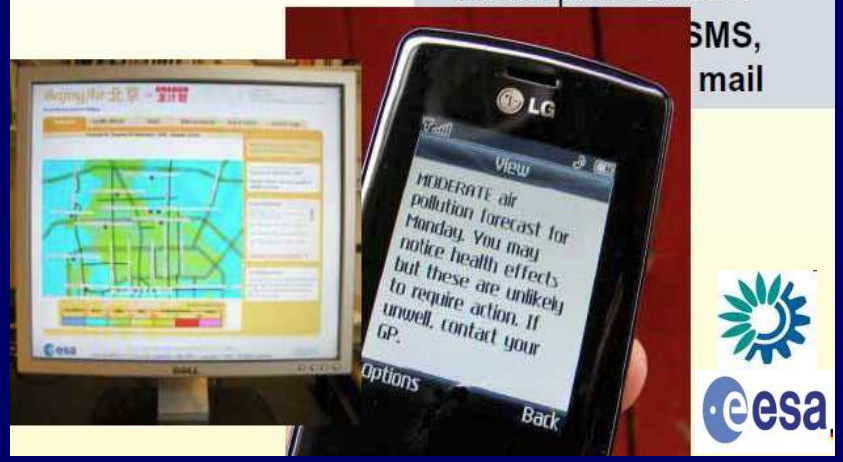
The Future is Now



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

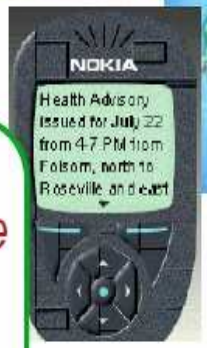
LOCAL FORECASTS
ADMS-Urban

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



London

data to AQI
s data



AIRNow Outputs

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

EPA United States Environmental Protection Agency

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

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