



CEOS Virtual Constellations *Atmospheric Composition*

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GEO User Interface Committee
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CEOS Virtual Constellations - Outline

- **CEOS Virtual Constellations and GEO**
 - Goals and benefits
 - Traceability to requirements
- **Atmospheric Composition Constellation (ACC)**
 - Participants and assets
 - Science and societal benefits
 - Links to GEO Tasks
- **ACC Workplan**
 - Status & Milestones
- **ACC and GEO UIC**

CEOS Virtual Constellations

- **CEOS has agreed to provide the space component for GEOSS. GEO Work Plan calls for “virtual constellations” to provide value added satellite data products for the SBA’s**
- **Four pilot projects to bring about technical/scientific cooperation and collaboration among space agencies that meet GEO objectives and also support national priorities**
- **Constellations will identify missions or data delivery that serve the science and applications communities that can be advocated by the CEOS agencies**
- **Constellation studies will prioritize user requirements and define missions or a “virtual” system consisting of space and ground segments to include archives and data distribution systems that meet science and application user requirements**

CEOS Virtual Constellations

Four “Virtual” Constellations:

- **Land Surface Characterization (Leads: USGS & ISRO)**
- **Precipitation (Leads: JAXA & NASA)**
- **Ocean Surface Topography (Leads: NOAA & EUMETSAT)**
- **Atmospheric Composition (Leads: NASA & ESA)**

The Atmospheric Composition Constellation is a ‘pathfinder’ for the other constellations.

- **NASA is providing support for formulation of all four constellations**

AC Constellation: Participants

- The NASA Science Plan recognizes that partnerships are essential, “...because of the complexity and breadth of these issues and that the atmosphere links all nations”.
- US National Academy of Sciences Decadal Survey recommended: “...leverage international efforts, ..teaming...missions...data access”
- Participants have major assets for AC missions
 - USA: NASA (Lead), NOAA
 - Europe:
 - ESA (Co-lead), EU/GMES, Eumetsat
 - Netherlands (NIVR), France (CNES), Germany (DLR)
 - Canada (CSA)
 - Japan: (JAXA)
 - China: NSMC, CSSAR, CAST.....*Contacted*

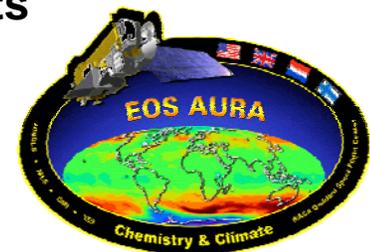


ACC – Requirements and Goals

- Requirements for Atmospheric Composition measurements have been developed by national and international agencies and panels
 - IGOS/IGACO, US Decadal Survey, CAPACITY, GMES, GAW, NASA Science Plan, ESA Living Planet, etc
 - Consistent with GEO SBA's and GEOSS
- Requirements are mature and are supported by CEOS agencies by ongoing and planned mission and definition studies.
- The AC Constellation goal is to collect and deliver data to develop and improve predictive capabilities for coupled changes in the *ozone layer, air quality, and climate forcing* associated with changes in the environment.
- Three specific users types:
 - Forecast services: National weather and environmental protection agencies
 - Assessments: IPCC, Montreal Protocol, USCCSP
 - Monitoring: Montreal and Kyoto Protocols, IPCC, GCOS, CCSP, PROMOTE (GMES)

Atmospheric Composition: Space Capabilities

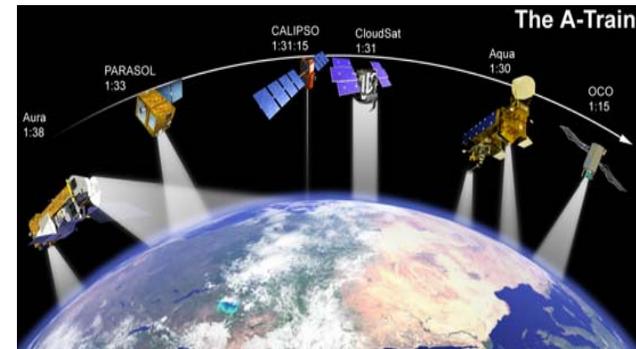
- **Existing:** Aura, Envisat, ACE, ODIN, CALIPSO, Cloudsat, Terra/MOPITT/CERES, Aqua/AIRS/CERES, POESS/SBUV-2, POLDER, Metop/GOME-2/IASI
- **Upcoming approved:** OCO, GLORY, NPP/NPOESS (aerosol and ozone, no chemistry), EarthCARE, ADM-Aeolus, GOSAT, FY-3/SBUS-TOU, SWIFT
- **ESA EE Pre-Phase A:** TRAQ (AQ), PREMIER (UT/LS), A-SCOPE (CO₂)
- **Under Consideration:** High resolution multispectral nadir and limb imagers in coordinated orbits: GMES and US Decadal Survey missions (two AC), NASA Mission Concepts for LEO & GEO



ACC Constellation Synergy

Unique opportunity for conducting AC science and providing Societal Benefits using multiple instruments across international platforms

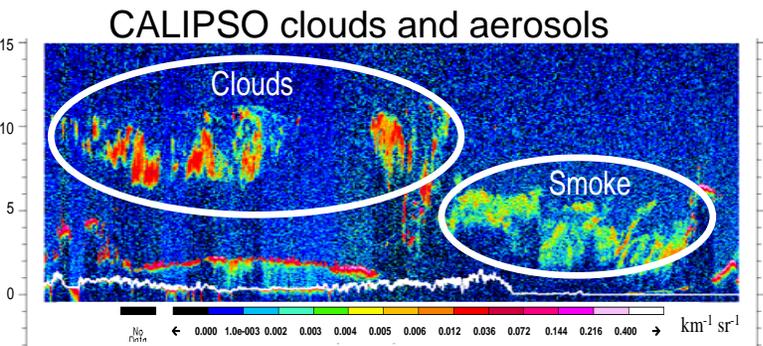
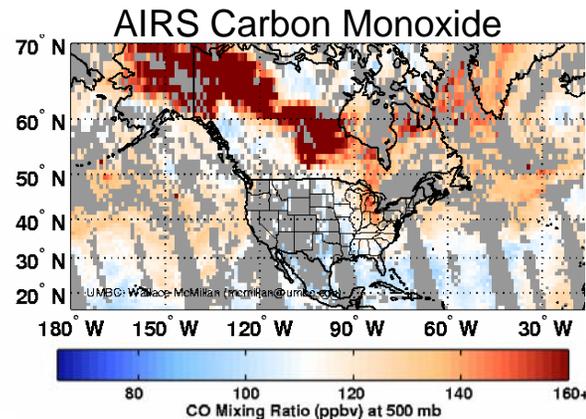
- Collaboration efficiency: take advantage of each instrument's unique capability
- Cross instrument validation
- Improved spatial and temporal coverage: e.g. different equator crossing times
- Enhanced data products: e.g. aerosol and cloud characteristics, pollution and its transport for assessments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

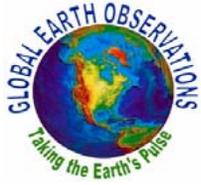


A-train is a good example of Constellation Science and applications

CEOS provides an opportunity to extend collaboration internationally

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





ACC Traceability to Five GEO SBAs

SBA	Science and Measurements	GEO 2007-2009 Work Plan	GOESS 2-year Targets	GEOSS 6-year Targets	GEOSS 10-year Targets
Disaster	<p>Fires: smoke and ash</p> <p>Seismicity: volcanic ash aerosols, SO₂</p> <p>Pollution events: emissions, mapping</p>	<p>DI-06-07: Multi-hazard zonation and maps</p> <p>DI-06-09: Use of Satellites for Risk Management</p> <p>DI-06-13: Implementation of a Fire Warning System a a Global Level</p>	Strengthening the International Charter on Space and Major Disasters and similar supporting activities. Production of an inventory of hazards zonation maps.	Facilitating real-time monitoring of volcanic activities. Expansion of the production of an inventory of hazards zonation maps.	Hyper-spectral capability for monitoring smoke and pollution plumes.
Climate	<p>Atmospheric Composition: CO₂, CH₄, Trop O₃, other GHG, and Aerosol Properties</p> <p>Long term measurements: IGOS and GCOS connections</p>	<p>CL-06-02: Key Climate Data from Satellite Systems</p> <p>CL-07-01: Seamless Weather and Climate Prediction System</p>	Adhere to the GCOS Climate Monitoring Principles and commit to the suite of instrument, supporting research program to support development of observational capabilities for ECV's.	Development and operation of new instruments. Establishment of data archive centers for all ECVs, institutional commitment to provide integrated global analysis of all ECVs, data integration facilities for exchanging data, products and information between climate sectors and socio-economic benefit areas need to be coordinated.	New and extended re-analysis programs for atmospheric domains and implementation of an integrated observing system for atmospheric composition monitoring in support of climate policy through an optimal combination of ground-based networks, LEO and GEO satellites and models are ultimate goals.
Health	<p>Air Quality: ozone precursors, particulates, SO₂, allergens</p> <p>Stratospheric: ozone and UV radiation</p>	<p>HE-06-03: Forecast Health Hazards</p> <p>HE-07-01: Strengthen Observation and Information Systems for Health</p> <p>HE-07-02: Environment and Health Monitoring and Modeling</p> <p>HE-07-03: Integrated Atmospheric Pollution Monitoring, Modeling and Forecasting</p>	New, high-resolution Earth observations relevant to health needs are advocated. Facilitating development of products and systems that integrate the Earth science database with health information	Monitoring methods and systems to detect health-related change	Early detection and control of environmental risks to human health through improvements in the sharing and integration of Earth observations, and early warning systems are required.
Energy	<p>Chemical forecasting: aerosols, GHGs</p> <p>Climate statistics: aerosols, GHGs, radiation</p>	<p>EN-06-04: Using New Observation Systems for Energy</p> <p>EN-07-01: Management of Energy Sources</p> <p>EN-07-02: Energy Environmental Impact Monitoring</p> <p>EN-07-03: Energy Policy Planning</p>	New generation of operational observing systems.	An evaluation of the observing system progress and its revision.	Implementation of operational observing systems and provision of timely data in support of energy operations.
Ecosystem	<p>Carbon fluxes/exchange: CO₂, CO₂, CH₄</p> <p>Solar radiation: UV radiation</p>	<p>EC-06-01: Integrated Global Carbon Observation (IGCO)</p> <p>EC-07-01: Global Ecosystem Observation and Monitoring Network</p>	Facilitating full implementation of the IGOS-P Carbon (IGCO) Theme report. Facilitating a globally agreed classification scheme.	Implementation of a global nitrogen observing system.	Facilitating globally agreed spatial-resolved information on ecosystem change.

AC Constellation Implementation

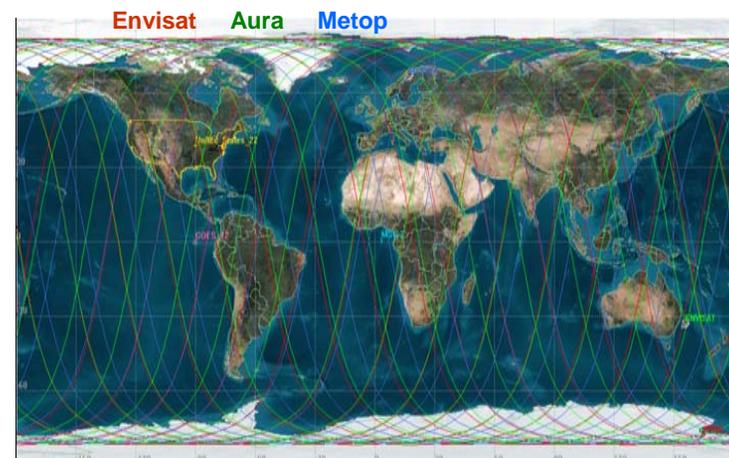
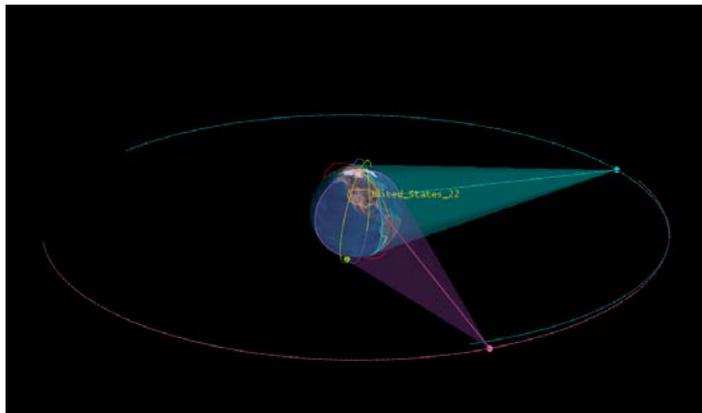
- Establish a framework for long term coordination among the CEOS agencies where the “Constellation” concept will identify specific opportunities for meeting science and application requirements
- Assemble international Study Team consisting of CEOS Agencies with Atmospheric Composition interests and assets and authorized to commit resources
- Complimentary advisory group from science and application community to insure requirements are being considered. Participate in establishing priorities
 - Develop a consensus for priorities based on and established user requirements and emerging societal needs from both operational and research communities
 - Evaluate existing and upcoming missions, both operational and research and compare with requirements
 - Establish how existing and approved missions could work synergistically to meet the international user community requirements and in particular the GEO Societal Benefit Areas
 - Define enhancement in the area of cal/val, quality control, and data accessibility and interoperability, major rolls for WG/ISS and WGCV (ACSG and GEO/CEOS Cal/Val WS)
 - Develop rationale, strategy and standards for new mission(s) to meet requirements not being met and for possible new requirements. *Strategy to include architecture, schedule, and possibly costs*

ACC Implementation - Status

- **First ACC Workshop (March 2007 in Washington)**
 - Agree on the AC Constellation concept and its objectives
 - Agreement of space agencies and users to participate
 - Agree on goals and projects (CEOS definitions parallel GEOSS):
 - Near term: Available today or very soon
Concentrate on refinement, use, access to and distribution of existing data products - *combined and synergistic data set*
 - Medium-term: Feasible within a few years
Extends product specification and interoperability - *improved data product. Also define new mission architecture leading to a Constellation*
 - Long-term: Achievable within ~10 years
 - AC Constellation proposed project and demonstration in time for GEO Summit
- **ACC Work Plan (2nd Draft in review by Study Team):**
 - Objectives (in terms of GEO SBA's and GCOS)
 - Participants -- Space assets
 - Assessments -- Projects
- **Next ACC Workshop – September 12-13, 2007 at Eumetsat (Germany)**
 - Assessments and Project development are major Workshop objectives

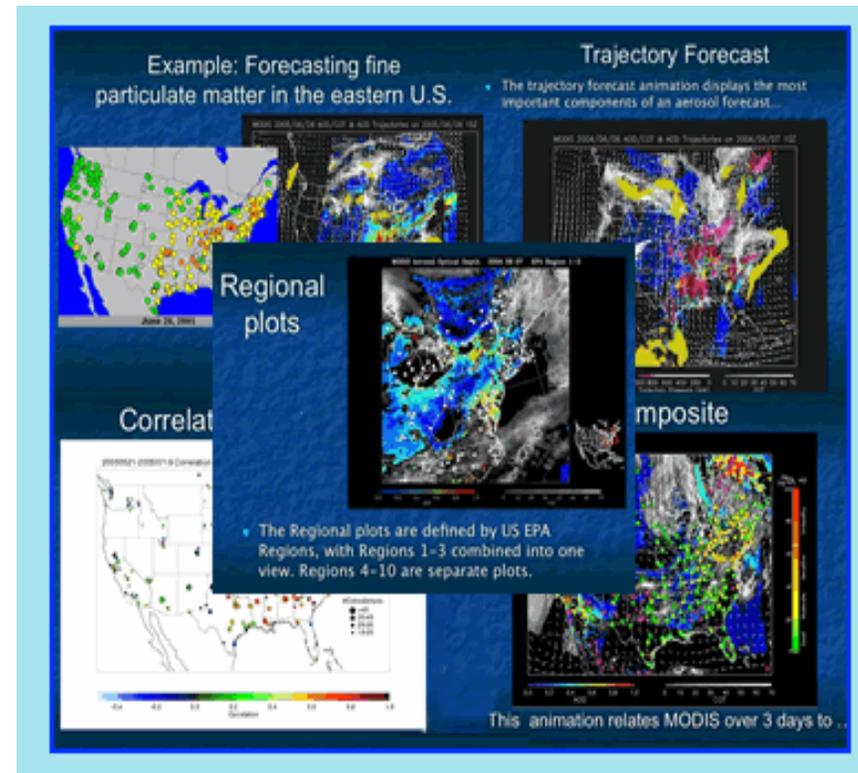
Work Plan - Assessments

- **Prepare an ACC system priorities and requirements report** to include “standards” (RT/algorithm, end-to-end cal/val, data interoperability), resulting in “virtual” or real mission requirements including architecture:
Draft by November 2007 CEOS Plenary
- **Preliminary assessment and gap analysis report of existing and near-term planned AC missions by CEOS agencies** against user requirements (Forecasting, Scientific assessment and Climate monitoring):
Draft by November 2007 CEOS Plenary
- **NASA’s AC Program is supporting four studies (OSSE) to investigate AQ current capabilities** and assess future measurement requirements and mission design: *Status report for CEOS Plenary*



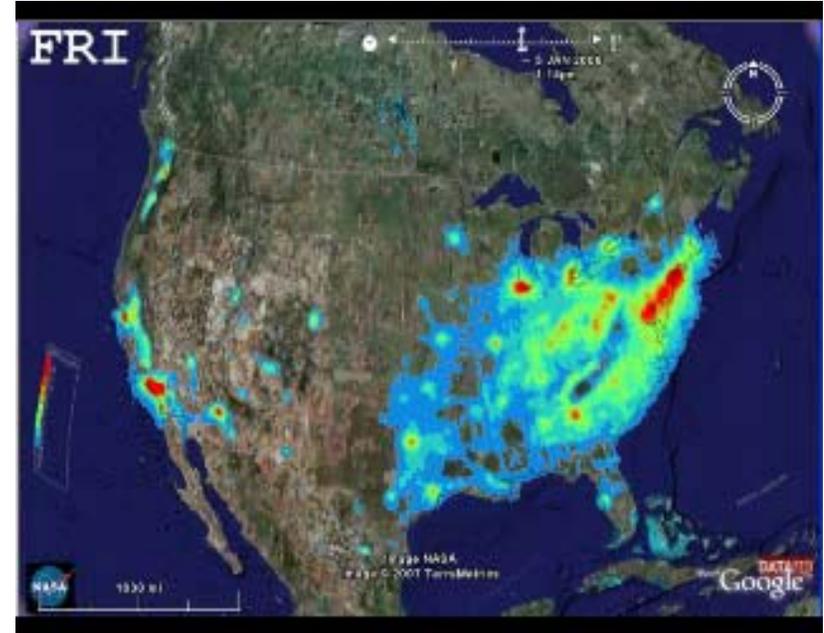
Work Plan - Near Term Projects

- Short term projects will emphasize synergistic and enhanced data products from multiple missions and include a component for outreach and capacity building
 - Demonstration and implementation plan for CEOS Plenary and GEO Summit
1. Instruments in constellation provide a 4-D perspective of the atmosphere, which can enhance troposphere and the BL. Data will be used for inventory improvements and AQ forecasts. Diurnal variations of NO₂ will demonstrate this capability
 2. Aviation alert and control for volcanic eruptions. ESA and NASA support development of SO₂ and ash products from Envisat and Aura covering the Pacific Rim, Europe, and Africa for distribution to VAACS through the meteorological service to the ICAO. ACC proposes to support combined services resulting in more timely data and global coverage.
 3. Global fire and aerosol data products for forecasts and assessment. Use the IDEA (Infusion of Satellite Data for Environmental Applications) project which is now operational (<http://idea.ssec.wisc.edu/>). Extending the capability of developing fire, aerosol, and subsequent forecast products for global operational purposes



ACC AQ Demonstration Project

- Aura's OMI collects daily global maps of NO₂ (~20X20 km) in the BL
- 3 years of data (cloud free) over NA were compiled to demonstrate seasonal and daily variations
- Daily and Seasonal variations are observable in the average
- Time varying amounts can be used to improve inventories and possibly AQ forecasts



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- Constellation data (Envisat and GOME-2 whose orbits differ from Aura) will reveal time of day variations further improving forecasts



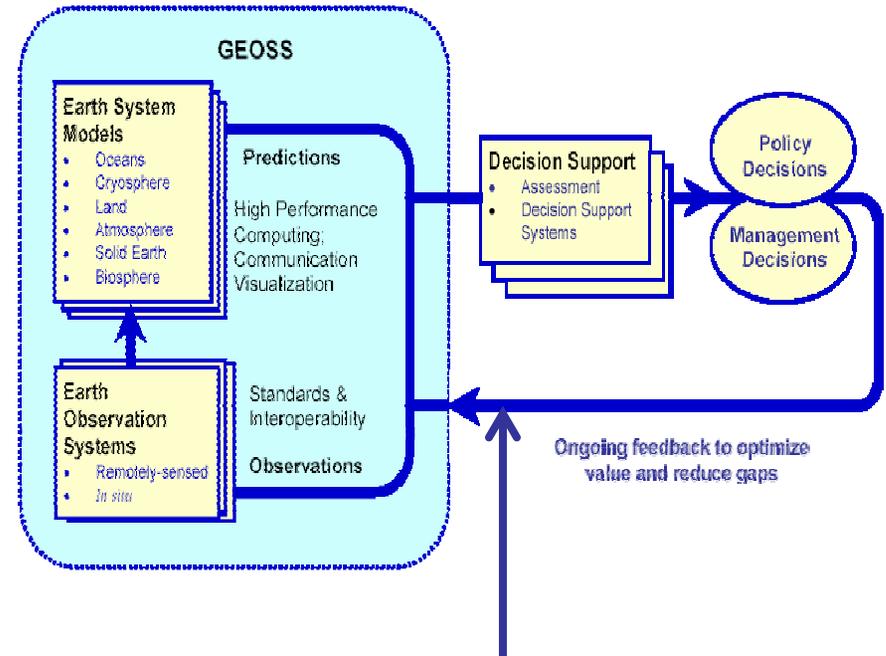
Work Plan – Mid-Term Projects

1. High-quality tropospheric ozone products using two methods to be compared with each other. Total column ozone from TOMS, GOME, SCIAMACHY, OMI, GOME-2 minus stratospheric column ozone from SAGE, SCIAMACHY, MIPAS, MLS. Assimilation/ joint retrieval of radiances measured by nadir UV sensors and nadir IR sensors (AIRS, TES, IASI). *GCOS Requirement*
2. Long-term aerosol data set. This project will employ several international satellites where aerosol properties are measured in different ways with some overlap. These data will be of value assets for climate modeling, pollution inventories, and monitoring. Ground based observations will play a key role in validation and providing additional aerosol parameter. *GCOS Requirement*
3. Assemble and array of AC products being developed CEOS agencies for near real time distribution. The products will relevant to GEO SBAs and meet the following criteria; Availability, Quality and Functionality. A user workshop will be assembled to define data enhancements and distribution. *GEO Goal*

ACC and GEO UIC

Multiple UIC Tasks Related to ACC:

- HE-06-03: Forecast Health Hazards
- HE-07-01: Observation Systems for Health
- HE-07-03: Integrated Atmospheric Pollution Monitoring, Modeling, and Forecasting
- DI-06-07: Multi-Hazard Zonation
- DI-06-09: Satellites for Risk Management
- CL-06-02: Key Climate Data from Satellites
- CL-07-01: Weather and Climate predictions
- EN-06-04: New Obs Systems for Energy
- EN-07-01: Management of Energy Systems
- US-06-01: Critical Earth Obs. Priorities



Challenges to the User Interface Committee

- UIC & Health group should collaborate with ACC in assessing fulfillment of requirements at user and decision support end. UIC should serve as the “feedback voice” to aid the Constellations
- UIC can facilitate the application of Constellation products to new Health users and communities
- What information can UIC give to ACC on user interests for integrated data products?
- UIC needs to articulate its “products” & “services” to the ACC, other Constellations, and CEOS

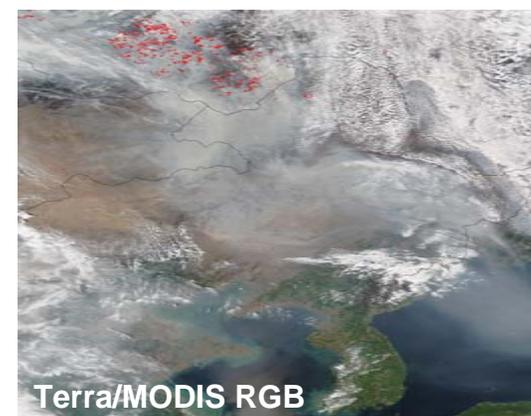
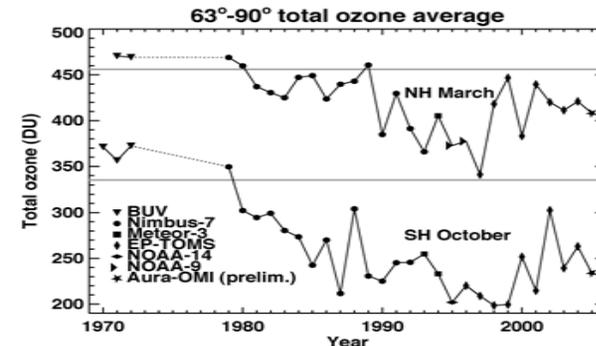
CEOS Atmospheric Composition Constellation

Back-up Slides

AC Constellation – Science Questions

- How is stratospheric ozone responding to the Montreal protocol and what are the effects of climate change on expected ozone recovery?
- What are the impacts of long range transport of pollution on local and regional air-quality? How do changes in air quality effect ecosystems?
- How do changes in atmospheric composition (radiatively active gases and aerosols) affect climate? How does climate change affect atmospheric composition?

“Observations have clearly shown that human activities are changing the composition of the Earths atmosphere. Research has demonstrated that there are important consequences of such changes for climate, human health, and the balance of ecosystems..”, IGOS/IGACO, 2004





GCOS Priorities for AC

- GCOS (<http://www.wmo.ch/web/gcos/gcoshome.html>) has established a set of requirement for Global Climate Observations endorsed by WMO, UNEP, ICSU and the space agencies.
- GCOS data requirements can be mapped into the AC Constellation (encouraging international collaboration)

Essential Climate Variable	Characteristic	Action required
Ozone mapping	Profiles, columns	– Reprocessing to remove biases and gaps, improved algorithms, integrated product
Aerosol characteristics	Profiles, columns	– Employ Data Assimilation for data homogeneity and integration
Water vapor content	Profiles, columns	– Research observations enhanced and standardized for upcoming operational missions
Cloud characteristics	Profiles	

- GCOS specifically recommends deployment of “advanced observations” for Atmospheric Composition using multi-view and multi-spectral systems