Minutes of the First Atmospheric Composition Constellation Workshop (ACC-1)
ACC-1 was held at the US Geological Survey in Reston, Virginia on 27-28 March 2007

The Atmospheric Composition Constellation (ACC) is one of four Constellations proposed by CEOS to support the overall goals of GEO and to provide prototype space-based Earth-observation systems for GEOSS. The meeting was attended by representatives from participating CEOS agencies to the AC Constellation Study. These include ESA, JAXA, CSA, CNES, NIVR, Eumetsat, NOAA, and NASA. Representatives from Eumetsat and CNES did not attend. Other institutions had representatives in attendance and included JPL, Harvard University, U.S. EPA and the USGS. We gratefully acknowledge the USGS for hosting the workshop.

The Workshop had three sections: 1) Overview of the CEOS, the Constellations and key AC science questions, 2) AC contributions from the member space agencies, and 3) Proposed ACC projects and Action Items which appear at the end of this report.

The workshop Agenda and participant list are attached to these minutes. The presentations can be found at: http://avdc.gsfc.nasa.gov/phpgdv2/avdc_tablefile.php?id=2356

1) Overview of CEOS and Constellations and Science Questions

The workshop was opened by the ACC chair E. Hilsenrath who reviewed the constellation concept, objectives, and goals which were classified as near-, mid-, and long-term. The importance of identifying near-term projects that will demonstrate ACC capabilities was emphasized since it is required for the GEO Summit to be held in South Africa in November 2007.

B. Ryan, the Associate Director for Geography at the USGS and the current CEOS chair gave (via telecom) an overview of CEOS and relation to GEO and emphasized the importance of CEOS delivery of the spaceborne observations for GEOSS in support of GEO Societal Benefit Areas (SBA). She also pointed out that CEOS is the focal point for collaboration of space agencies around the world.

Also via telecom, M. Kisza, the Associate Administrator for NOAA/NESDIS and in-coming chair for the CEOS-SIT, discussed the overall structure of CEOS and how it will provide a forum for international collaboration and agreed with Ryan that CEOS should make a strong effort to contribute to GEO.

These introductory remarks were followed by two lectures on key science questions in atmospheric composition. R. Salawitch, from JPL, discussed challenges in measurements and modeling in the upper troposphere and stratosphere. He made it clear that stratospheric ozone depletion is not a solved problem and there will be difficulties in resolving the impacts of the Montreal Protocol and climate change. Water vapor and aerosols distributions will play important roles and must be modeled and observed carefully to fully understand the impacts of

the decline in ODS and climate change. He strongly endorsed continued refinement of spectroscopic data bases to support satellite missions. D. Jacob, from Harvard University, discussed results from modeling and observations in the upper troposphere and key questions for Air Quality. He noted that satellites are still not able to observe surface ozone, but observation of background amounts is of considerable value for air quality models. He demonstrated how new AC satellite data was providing breakthrough information for air quality assessments and forecasting, but that better horizontal coverage and higher spatial resolution was urgently needed. Multispectral or active ozone sensors could provide vertical resolution in lower free troposphere. However, he demonstrated how the Constellation concept could approach the coverage needed by combining Envisat and Aura NO_2 data to show hour of day changes.

M. Shoerberl, Aura Project Scientist and Chief Scientist of NASA/GSFC's Earth Science Division, provided an overview of the recently released US National Academy of Science's Decadal Survey. The Decadal Survey is a broad recommendation on how NASA, NOAA, and USGS should proceed for the next several decades to study the Earth system and its response to climate change. Proposed missions were prioritized by needs of science and application over three time segments beyond 2020. Four of the 15 missions proposed involved AC over this time frame. There was a strong recommendation that the climate suite removed from NPP and NPOESS be re-manifested. He pointed out that there were no proposed missions to observe chemically active gases in the stratosphere after the Aura and Envisat missions end, and recommended a reflight of the highly successful CSA SciSat/ACE. Of major concern was that NASA planned budgets were declining with respect to funds needed to implement the Decadal Survey recommendations and would only be half the amount needed at 2020.

NASA contributions to GEO were discussed by T. Fryberger, head of NASA's Applied Sciences Program. She pointed out that an "Air Quality Assessment and Forecast System" was one of the six USGEO near-term opportunities. She showed how the flow from Earth system models and observations led to the SBAs through informed decision support systems with several examples now in place.

B. Cramer, NASA Deputy Director for the Earth Science Division, provided further insight into how the Constellation process would benefit all the participating space agencies through CEOS. Although national priorities were major drivers for supporting the space agency budgets, international collaboration should be highly complimentary. He described the elements and schedule for the CEOS Implementation Plan and how the four Constellations were key elements to demonstrate how CEOS will provide the space component to GEOSS.

Requirements, participants, scope, and planned implementation of the AC Constellation were further detailed by E. Hilsenrath. Missing capabilities from orbiting and upcoming missions for AC data were listed and proposed as the basis for defining a Constellation. He showed the traceability of AC data products to the GEO SBAs and to the GCOS climate requirements. Near-, mid-, and long-term requirements were defined in context of the AC Constellation.

Furthermore the CEOS WGCV and WGISS major role in the implementation of the Constellation was strongly endorsed. He also noted that ground, balloon, and aircraft observations with complimentary modeling are major elements of a Constellation system. The AC Constellation program has already initiated a Requirements and Gap Analysis study which will survey all in-orbit and upcoming missions and compare their outputs to established requirements. He then reviewed the NASA OSSE program to conduct theoretical studies on how well AC missions might meet both science and application users.

2) AC contributions from the member agencies

The rest of the first day reviewed the ongoing and upcoming missions from ESA, Eumetsat, NIVR, CSA, NOAA, and JAXA and the start of discussions of possible projects for demonstrating Constellation capabilities.

ESA is involved in eight instruments for AC observations including its own and in collaboration with CSA and Eumetsat. ESA also has a series of missions planned under its Living Planet Program that includes Earth Watch and Earth Explorer which have the Core and Opportunity missions. Of particular interest to AC are the three Earth Explorer missions which have just begun their Phase 0 studies. ESA also supports the EU space initiatives and provides instrument development for Eumetsat.

NIVR has made major contributions to AC measurements, starting with, Envisat/SCIAMACHY and Aura/OMI. They have collaborated with nearly all the space agencies in Europe with regard to instruments and data analysis. They have supported major developments in hyperspectral and high resolution UV/VIS observations for trace gases and aerosols and are planning to further advance these capabilities. NIVR is looking forward to further collaborations on upcoming AC missions.

CSA continues to make important contributions to AC through low cost but high capability missions. High efficiency is achieved by close collaboration with Universities and other government agencies. The CSA has interest in three international missions as well as their highly successful SciSat. A second launch in this series is expected by 2010 with one of two instruments contributing to AC. CSA is supporting several instrument technology developments and will be releasing an AO for a possible flight opportunity

JAXA reviewed their upcoming GCOM missions which will cover a range of climate observations where aerosols are of particular interest to AC. The GOSAT mission is highly complimentary to NASA's OCO for greenhouse gas observations. Collaboration is underway and a MOU is in preparation to share cal/val resources. There are no plans to exchange spectroscopy data basis or algorithms. Greenhouse gas observations should certainly be part of the AC Constellation and JAXA endorsed the Constellation concept through cooperation in data distribution and utilization.

NOAA is collaborating with nearly all operational agencies involved in meteorological observations directly or through international forums such as CEOS and GEO. NOAA also has mandates for Air Quality forecasting and assessments and will continue observing climate parameters. NOAA is committed to strengthening its cal/val capabilities through collaboration with national and international entities.

EU/GMES is developing the GEMS program as a pre-operational global monitoring system for greenhouse gases, reactive gases, and aerosols in the troposphere and in the stratosphere by early 2009. Examples showed how data assimilation of satellite CO_2 data (AIRS) could be used to identify deficiencies in flux models. This system will have the capability to combine various observational data sources into a consistent estimate of the atmospheric state. A constellation of research satellites will be very useful for development, but near real-time data with global coverage are needed to be operational

3) AC Constellation Projects and Action Items

The Constellations have been charged to conduct projects that demonstrate how joint agency collaboration can be achieved and that enable enhanced data products contributing to the nine GEO SBAs. There was a lively discussion of potential projects by the attendees illustrating how existing data and resources could be used synergistically for both science and application users. As the discussions evolved and ideas developed, each proposer was asked to prepare a 1-2 page document describing the concept and possible implementation. The criteria for its development should involve the use of more than one satellite, engage several members of the AC Constellation agencies, and encompass data accessibility and delivery and include a component for outreach and capacity building, which are major GEO goals.

This discussion was kicked off with a presentation by P.K. Bhartia who proposed two projects after the serious warning that we are now experiencing an unprecedented number of AC measurements capable of providing "virtual" constellation data now, but that these assets will soon be gone with the uncertainty of their replacements. The two proposed projects include:

- Creation of long-term datasets of tropospheric ozone and aerosols, and
- Development of air quality products by combining morning and afternoon constellations

An example of the second suggestion was all ready demonstrated by D. Jacob in his earlier presentation. Both of these projects are essential for AC science and applications, and worthy of intensive international collaboration.

The second day of the meeting began with a report on the new CEOS Constellation System Engineering Office (SEO) by S. Sandford from NASA's Langley Research Center who offered his interpretation of a constellation. He noted that a Constellation should be considered end-to-end in the delivery of data products starting with data product requirements, instrument specification and deployment, mission operations, cal/val, data delivery and utilization. The

implementation of a constellation could then be well served with a systems engineering approach. The SEO aims to optimize space assets by facilitating requirements definition, mission assessment and constellation planning among the international CEOS members. It will rely on

resources at Langley Research Center and other NASA field centers to, other Government agencies, industry, academia and the CEOS international partners. Benefits include providing systems engineering support for CEOS constellations to optimize the capabilities of spaceborne observations. The SEO will foster communications among CEOS partners and Constellation groups and will provide a framework for a coherent science and engineering plan to support the international community. The SEO will provide decision support tools for constellation trade studies and the assessment of execution options. The SEO plans to install the following capabilities in time for the GEO Summit in November 2007.

(1) Develop a systems requirement document for the AC Constellation a potential for application to the other three Constellations.
(2) Establish a file server and website to support all aspects of Constellation development. Facilitate communication between and among the Constellations through newsletters and regular telcons.
(3) Finally, conduct a "Requirements and Gap Analysis" for the AC Constellation, which enable the definition of a future constellation architecture that will fulfill missing capabilities and future needs as the Earth responds to environmental changes.

Further Points of Discussion

EPA emphasized an important aspect for the Constellation from user perspective. It follows from a basic GEO requirement for improving data accessibility and delivery for real-time and archival data and for outreach and capacity building. The latter is to insure that users with limited resources can make use of data products delivered by the GEOSS components. Two user groups in GEO were identified for AC data: Air Quality (AQ) forecasters for public health and Global and regional chemical transport model evaluation. CEOS should develop an integrated data set or archive for CEOS observations that would support these users. For surface AQ observations, NILU is becoming the global archive for compiling integrated data sets under several EU-funded projects.

There was a general discussion on how to use or enhance existing data portals that were applicable to AC data relevant to GEO SBAs. These include:
AirNow: http://airnow.gov/
TEMIS: http://www.temis.nl/
IDEAS: http://idea.ssec.wisc.edu/index.php
SEVIR: http://servir.nsstc.nasa.gov/
GEONetCast: http://www.earthobservations.org/progress/GEONETCast.html
GIOVANNI: http://daac.gsfc.nasa.gov/techlab/giovanni/
These sites could be used as portals for project outputs discussed below. Connections with WMO's CAS AER Programme should also be pursued.

There was a general concern on maintaining global satellite cal/val resources and their upgrades that will be necessary for GEOSS. This has been an on-going issue that CEOS continues to tackle since cal/val support (upgrades and intercalibration) by space agencies follows focused mission requirements. The maintenance of these capabilities should be encouraged by organizations such as the WMO with support from CEOS. The AC Constellation will rely heavily on WGCV and notes the upcoming GEO / CEOS Workshop on Calibration and Validation Processes in Geneva October, 2007.

Although the AC Constellation includes GHGs, it does not encompass the Carbon Cycle (CC) Theme. The CC Theme may be worthy of a Constellation of its own or could be incorporated into the AC Constellation. The AC agencies will consider this matter internally.

Proposed Projects

Each proposer was asked to prepare a 1-2 page document describing a proposed project and possible implementation. The criteria for its development should involve the use of more than one satellite, engage several members of the CEOS (AC Constellation) agencies, and encompass data accessibility and delivery and include a component for outreach and capacity building, which are major GEO goals. An initial short-term project will developed in time for a demonstration at the GEO Summit. Mid-term projects will be further discussed at ACC-2 in September 2007 (location TBD). The following five projects were singled out for further consideration. At least one of these will be developed for CEOS Plenary and the GEO Summit in November 2007. The remainder would require support from member agencies since they have longer term objectives.

1. Production of high-quality tropospheric ozone products using two methods which can be compared with each other. Total column ozone from a nadir UV sensor (TOMS, GOME, SCIAMACHY, OMI, GOME-2) minus stratospheric column ozone from a limb sensor (SAGE, SCIAMACHY, MIPAS, MLS). Assimilation/ joint retrieval of radiances measured by nadir UV sensors (OMI, GOME, SCIAMCHY) and nadir IR sensors (AIRS, TES, IASI) – Proposed by PK Bhartia

2. Air-Quality study from multiple instruments. ENVISAT/METOP are in morning orbits, Aura/Aqua/Parasol are in afternoon orbits. They provide twice daily coverage for reflected sensors, four times for IR sensors which can provide diurnal variation of tropospheric species. CALIPSO/CLOUDSAT provides 3-dimensional view of clouds and aerosols to help in the interpretation of AQ data (BL height, transport). NO_2 from SCIAMACHY and OMI will provide an example of this capability – Proposed by S. Kondragunta, D. Jacobs, and P.K. Bhartia.

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

4. Develop a global data product for fires and aerosols. This project will make use of 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 guidance products for global operational purposes can use the IDEA prototypes and apply them to instrumented multiple platforms. - Proposed by J. Fishman, T. Keating, and S. Kondragunta.

5. Long-term aerosol data set. This project will employ many 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 parameters. – Proposed by J. Langen, PK Bhartia

Other projects will be also be considered.

Action Items – on following page

Respectfully submitted April , 2007 by

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