

Atmospheric Chemistry Subgroup (ACSG)



Ernest Hilsenrath
NASA Goddard Space Flight Center



CEOS WGCV Plenary
Hobart, Australia
12 February 2003



Outline

- **Justification, goals and objectives of ACSG**
- **CEOS and IGOS (Atmospheric Chemistry)**
 - Interactions
 - Some emerging problems
- **Action Items and progress from ACSG-2**
- **Recommendations**

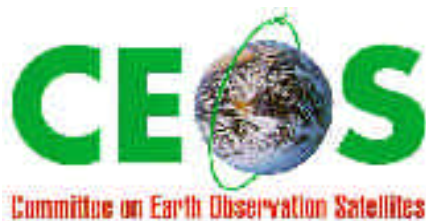
CEOS and IGOS

CEOS established six Pilot Projects to assess the feasibility of achieving the objectives of IGOS. The “Ozone Project” resulted in the

WMO-GAW No. 140 - WMO/CEOS Report on a Strategy for Integrating Satellite and Ground-based Observations of Ozone

IGOS-P Atmospheric Chemistry theme

CEOS WGCV Subgroup on Atmospheric Chemistry (ACSG)



WMO #140 focused on an integrated system for observing ozone and related key atmospheric parameters

**Theme: Long term continuity and spatial comprehensiveness of key
observations needed for environmental research and climate applications**

- Considered atmospheric chemistry in connection with ozone depletion, air quality,

Compiled science and user requirements

Catalogued research and operational missions (ground and space)

Defined an integrated approach, which incorporates satellite and ground based
observations highlighting missing components

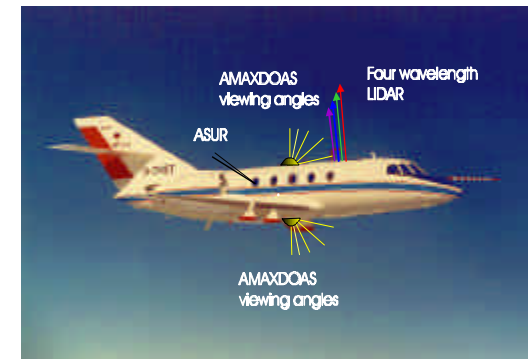
Recommended research needed to improve understanding so that observations

**Goal: Use improved data and knowledge for
informed policy making decisions**

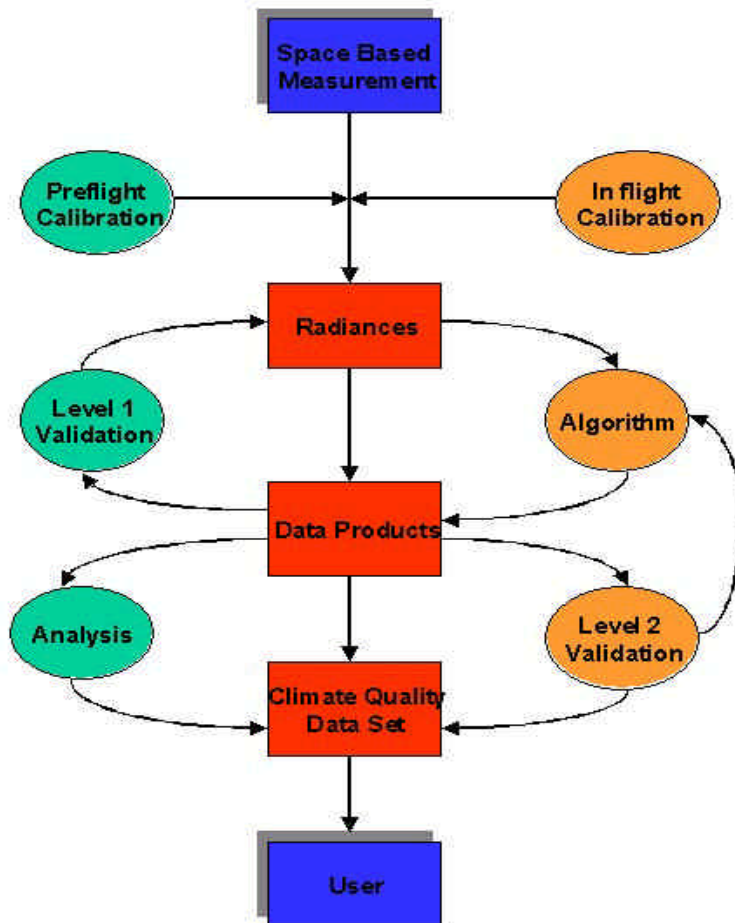


Chapter dedicated to Calibration/Validation

- **End-to-end cal/val:**
 - National standards and procedures for pre-launch calibration
 - Pre launch with calibration scientist and user involvement
 - Validation criteria (coincidences, etc)
 - Data quality control and archiving for easy access by user
 - Post launch validation of Level 1 as well as Level 2 products
 - Algorithm and RTM comparisons and improvements
 - Science analysis with CTM and DA
- **General:**
 - Coordinated operations to enhance science and minimize gaps
 - Documentation and archival
 - Iterative process
 - Space agency commitment for support for ground networks



End-to-End Cal/Val



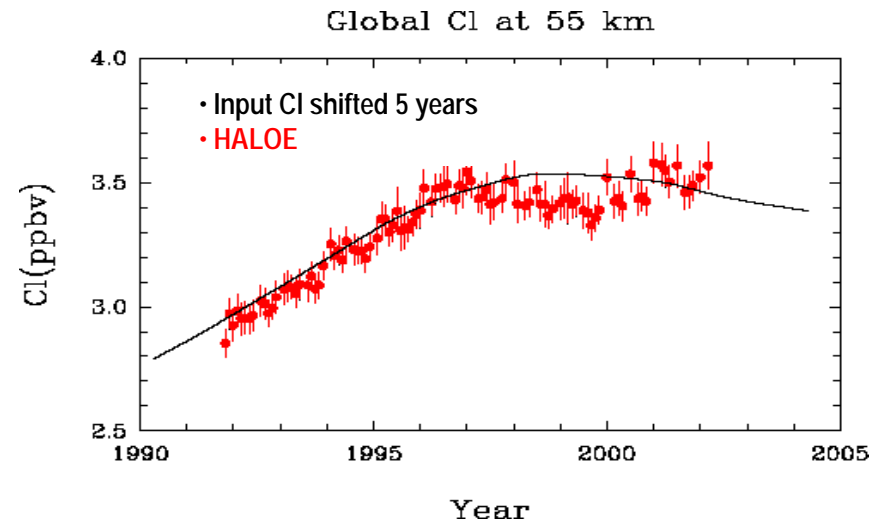
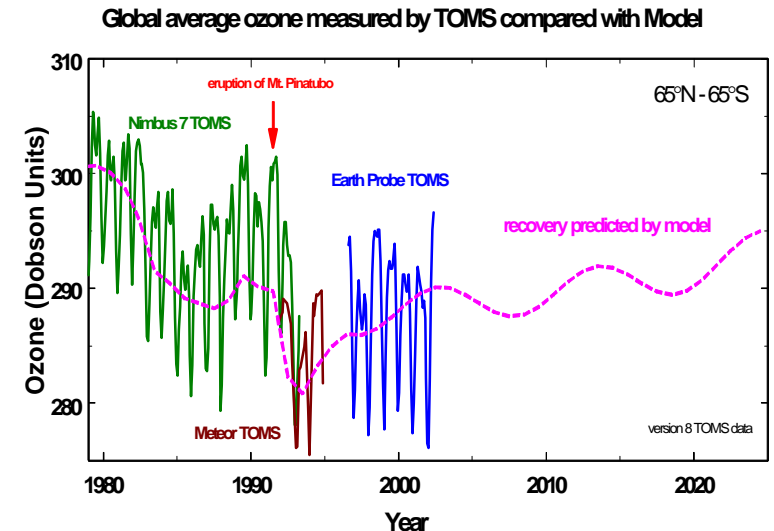
1. Prelaunch, inflight calibration, and Level 1 validation checks instrument sensitivity changes.

2. Level 2 comparisons and data analysis with chemical transport models and data assimilation validates geophysical data

3. Long term validation for climate research requires reprocessing by reiterating through

Ozone recovery will be difficult to detect

- Detected ozone change matches models
- Ozone recovery will be slower than the decrease detected to date
- In order to explain ozone change other active chemical species must be
- UARS/HALOE measured HCl in stratosphere which matches expected decrease based on CFC phase out.
- HCl measurements will be continued by Aura/HIRDLS using a different technique

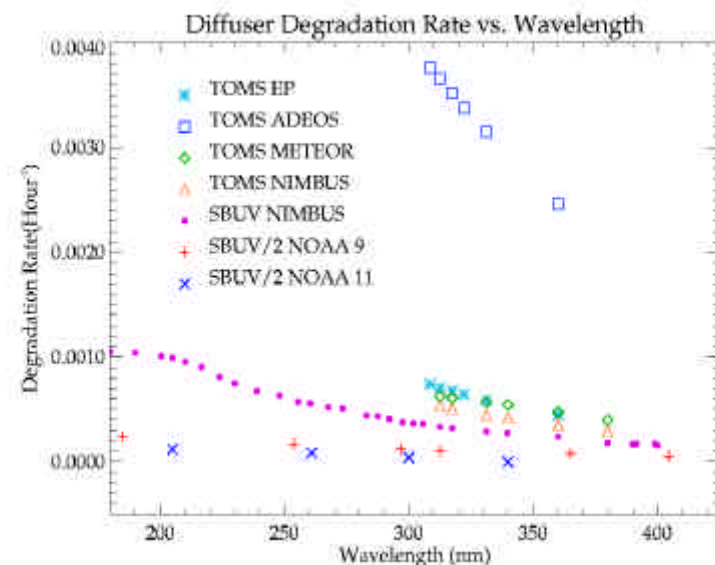
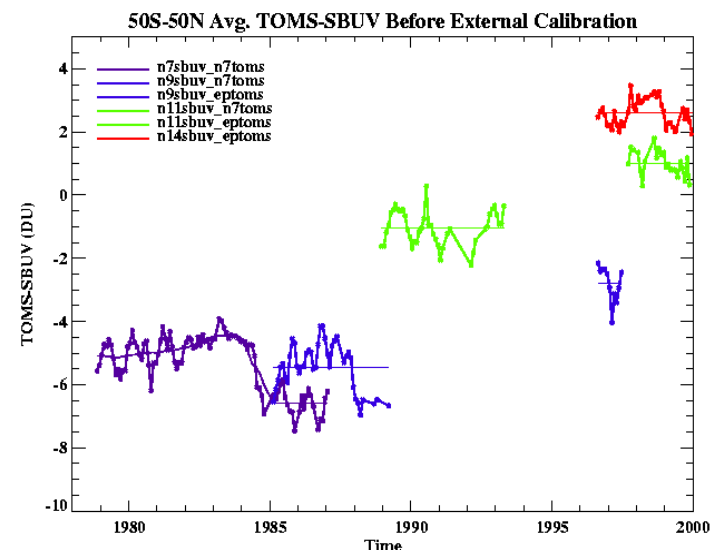


Detecting trends in Atmospheric chemistry remains a challenge

Even same type satellite instrument flown repeatedly just barely meets requirement for trend detection.

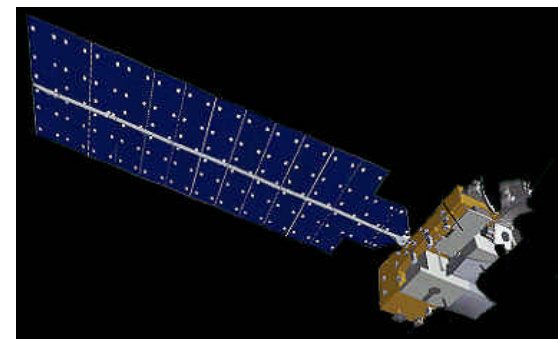
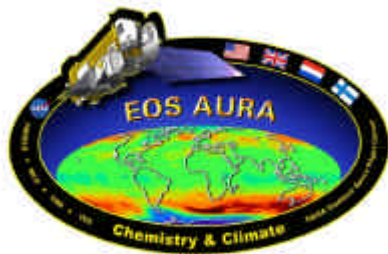
Orbiting instruments from different agencies will provide important redundancy, but will impose special challenge for validation

Calibration diffuser degradation differ from one instrument to the next and is unpredictable



ACSG Goals

- Insure accurate and traceable calibration of remotely sensed atmospheric chemistry radiance data and validation of higher level products, for application to atmospheric chemistry and climate research, from Earth Observing satellite missions.
- Support the calibration/validation recommendations of
- 23 instruments on 16 missions for observing atmospheric chemistry will be flown by 2015.



Atmospheric Chemistry Satellite Timeline (23 instruments, 16 Missions)

Year

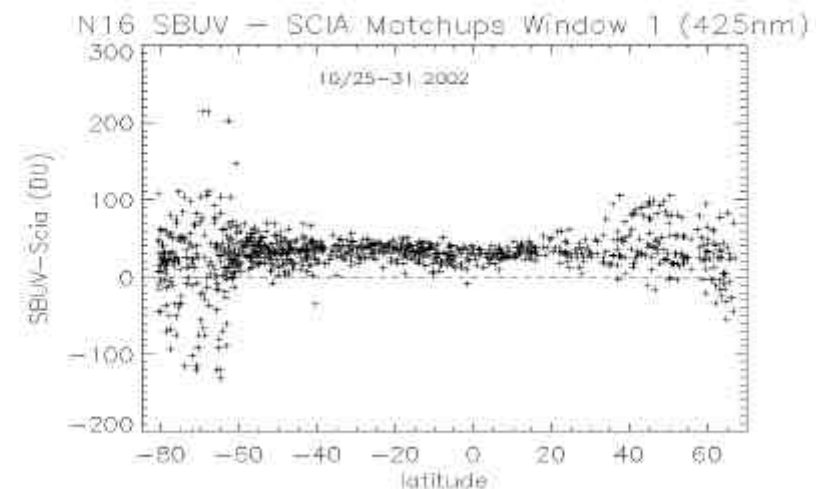
[illegible]

ACSG Objectives-1

- **Promote international collaboration and technical exchange to ensure sufficient use and maintenance of calibration/validation resources required for atmospheric chemistry missions.**
- **Verify accurate scientific products encouraging an end-to-end approach to the calibration and validation of Level 1 and Level 2 data products and subsequent re-calibration and reprocessing.**
- **Ensure that validation sensors are calibrated to traceable national standards with documented statements of accuracy and repeatability**
- **Encourage interaction between calibration scientists and data
to enable a better understanding of data uncertainties and user requirements.**

ACSG Objectives-2

- Develop comprehensive data validation methods that employ ground, aircraft, balloon, and satellite measurements and data assimilation with chemical transport models.
- Recommend a network of validation sites and to encourage continuous observation and quality control of data through the use of standard procedures and inter-comparisons.
- Specify a comprehensive, consistent and quality- controlled multi-mission validation data base in an accepted format employing user friendly tools.



ACSG - Status

- **Participants (15 members):**
 - CNES, DLR, ESA, NASDA, NASA, KNMI, MSC, NOAA, (. of Bremen, Toronto, Waterloo, NYU
- **Meetings:**
 - Past: May '02 (Ottawa), December '02 (
 - Next: July '03 (Toulouse with IGARSS, CNES hosting)
- **WGCV Brochure: ACSG now included**
- **Reports: NDSC Steering meeting (Toronto, Sept 2002)**
 - NASA Headquarters (Washington DC, Jan '03
 - IGOS Atmospheric Chemistry theme (Geneva, Jan '03)
- **Projects:**
 - Cross mission (Envisat-Aura) AC Validation Data Center
 - Continuity of Envisat validation assets for Aura validation
 - Seeking support from space agencies. Four projects submitted, two
 - Ground station cross calibration
 - New sites for under- sampled locations (e.g. Northern tropics, Southern hemisphere)
 - Future missions: Metop, NPP, NPOESS, Advanced chemistry

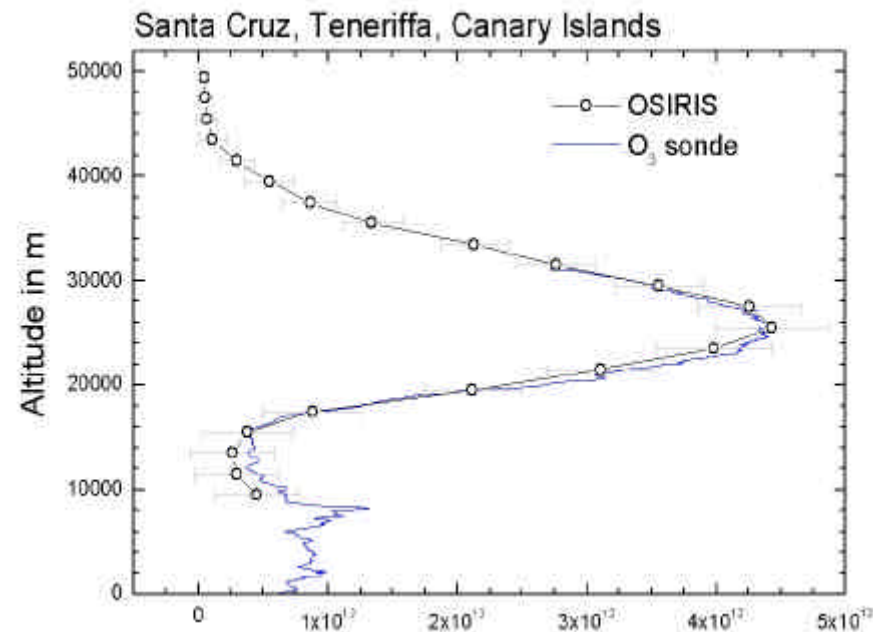
Topics from ACSG-2 (1)

- **SOLVE-2**
 - NASA, EC, and ESA support of SAGE-III and Envisat, (OSIRIS, ILAS-II)
 - DC-8, ER-2, balloons, and VINTERSOL (EC)
- **VINTERSOL**
 - EC funded comprehensive science/validation
 - Arctic, spring 2003; tropics 2003 & 2004, Antarctic
 - Available for Envisat, POAM, GOME, ODIN, ILAS-II
 - Working towards consensus data format
 -
- **GOME- Data processor upgrade**
 - 50% improvement total ozone quality
 - New data disseminated to users



Topics from ACSG-2 (2)

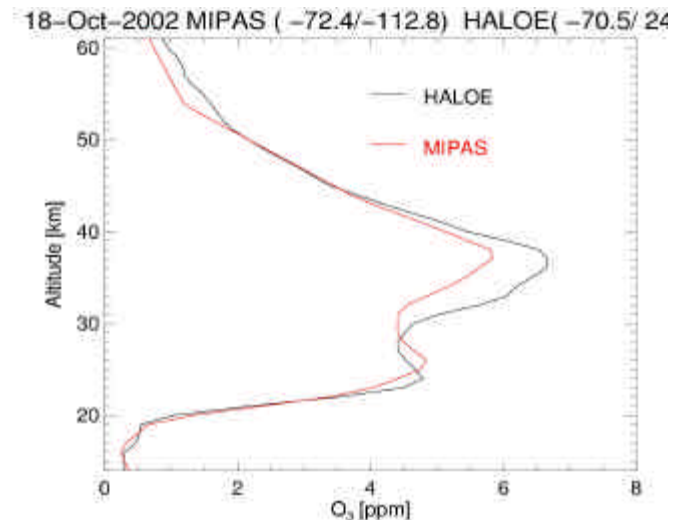
- OSIRIS validation – no funded validation program, relies on existing capabilities through coordination
- Two instruments: UV/VIS/NIR and SMR
 - O₃, NO₂, OClO, and aerosols
 - Initial campaigns shows good performance
 - Comparisons with balloon sondes and POAM
 - Algorithm assessments
- Upcoming validation
 - Envisat
 - ACE
 - Ground networks



Topics from ACSG-2 (3)

- **Envisat validation – Chemistry instruments (3)**

- Ground data system is behind
- ESA's ACVT campaigns nearly completed (balloons, a/c, ground networks)
- CNES heavy involvement (balloon, a/c, and ground based campaigns)
- MIPAS is in fairly good shape
- GOMOS requires Level 1 and 2 algorithm refinements
- SCIAMACHY requires Level 1 and 2 algorithm updates and refinements, icing problem, solar irradiance offset and dark current in NIR channels
- Science Team expressed concerns about inadequacy of support to maintain validation and reprocessing



Topics from ACSG-2 (4)

Aura validation- Full NASA funding with collaboration expected

- Begins after commission phase (+ 6 months)**
- Requirements established**
- Implementation studies underway**
- First of two AO's released: 1) New instrumentation, 2) implementation**
- Major a/c campaigns**
 - Intex – Intercontinental transport off**
 - TC³ – Tropical Composition & Climate Coupling (TTL)**
- Emphasis on troposphere**
- Balloons – Kiruna and Ft Collins**
- Networks: WOUDC, NDSC, etc.**
- Will establish data center modeled after Envisat/ACVT**

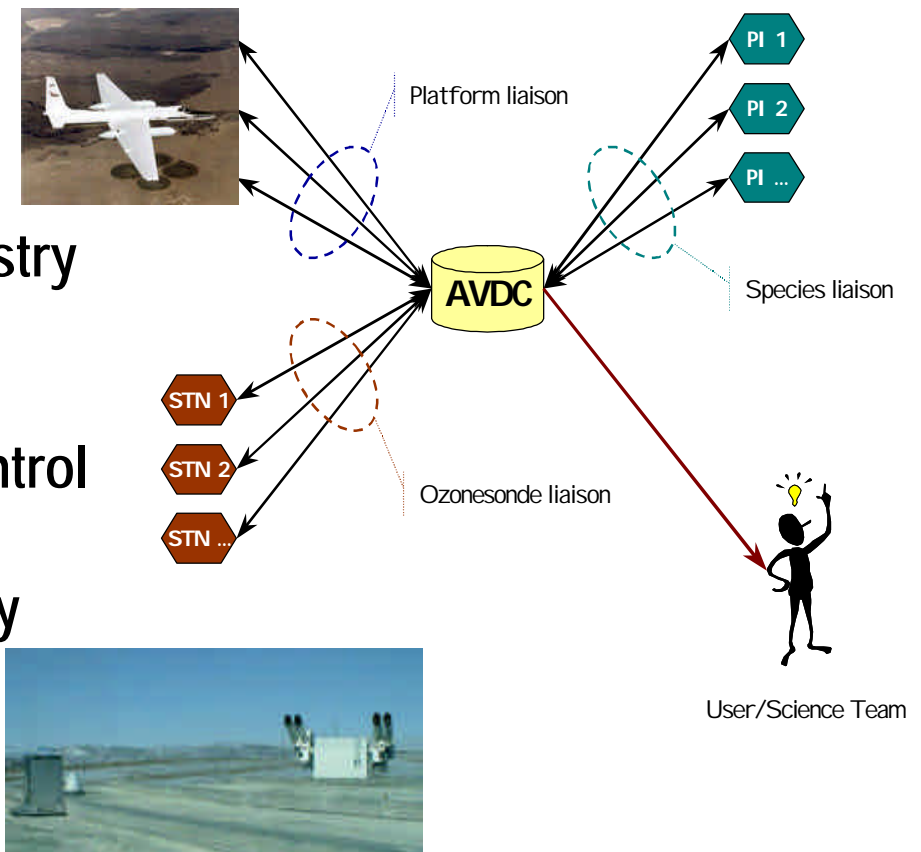


Topics from ACSG-2 (4) - summaries

- **CNES – Science driven but provides validation**
 - VINTERSOL, ACVT, ILAS-II, SOLVE
 - Balloons, ground based, and aircraft
 - Data assimilation
- **ACE – Launch 2003, no funded validation campaigns**
 - Relies on existing validation infrastructure and collaboration-volunteer validation team in place
 - Ground based and satellite intercomparisons
- **ADEOS/ILAS-II – Launched December 2002**
 - Funded core experiments
 - Cooperative experiments and data exchange
- **Ground based measurements**
 - WMO sponsored GAW is a major ground based activity for ozone and
 - Maintains quality control
 - Supports underdeveloped sites
 - Eureka shutdown
 - WOUDC (Canada data center) is part of GAW

Long Term AC Validation Data Center

- Modeled after Envisat Cal/Val - NILU
- Being considered for Aura
- Provides data source for smaller chemistry
- Liaison provides “scientific” quality control
 - Central contact point
 - Data quality control and homogeneity
 - Feedback between Val PI/Mission



Atmospheric Chemistry Validation Data Center (ACDC)

- **Concept**

- Centralized data center – Possibly at GSFC
- Well defined Meta data – Envisat model
- Homogeneous file format
- Employ “Liaison” – Likely Aura science team members
- Support tools – conversion from native to HDF
- Mission support: Orbit prediction, auxiliary data, aircraft support
- Long term commitment

- **Status**

- Proposal to Aura project in preparation
- Ames maintains data archive for aircraft missions
- Support is highly likely

Yves-Louis Desnos carried forth two recommendations from the ACSG to the CEOS Plenary in November 2002

- 1) Establishment of two ozone calibration centres, one in South America and the other one in Africa to maintain the quality of column ozone data from 17 developing countries (at an €300k per station);
- 2) Establishment of five new ozone-sonde stations within a five-year programme in developing countries (selected from Africa, continental Asia, Central and South America, and island nations) to improve the geographic distribution of high quality monitoring stations.

“congratulated” the work of WGCV and noted their close collaboration with the Global Atmosphere Watch responsible for cal- for atmospheric chemistry parameters. He suggested that written requirements from CEOS would help the funding for the proposed projects to be secured - by identifying the value of the proposed in-situ stations for the work of the space agencies.

Mohr (EUMETSAT/SIT Chair) recognised the importance of the proposal and noted that this was an issue to be addressed as an integral part of the IGOS Atmospheric Chemistry
He urged WGCV to take the issue forward with the Theme and noted that this would foster the stronger links between CEOS and IGOS Themes which the 16th Plenary had asked for.

The Chairman supported the suggestion of Tillmann Mohr and summarised the decision of theth Plenary with regards to the WGCV Report:

- 1) CEOS NOTES the need for sustained support for ground networks to complement space observing systems for climate change, and further notes that:
 - 1) Ground networks are complementary and necessary components for surveying's atmosphere and detecting global climate change;
 - 2) Ground networks provide observations that cannot be made from space and correlative data for space missions to validate their observations;
 - 3) Observations of climate change due to changing composition of the atmosphere demand accuracy and continuity that are at the brink of our capabilities.

CEOS RECOMMENDS that:

- 1) Ground network station operators and interested space agencies commit to sustained financial support of existing network stations and should locate stations in under-sampled regions of the globe;
- 2) Ground network stations should commit to established guidelines for data

- *What is next?*

IGOS-P Atmospheric Chemistry Theme (IGACO)

Summary from Jan 7-8 2003 Geneva Meeting

- **New leadership – L. Barrie (WMO) and J. development of IGACO theme**
- **Theme will focus on science requirements for atmospheric chemistry observations and demonstrate the need for integration**
- **Draft outline with writing assignments**
- **Progress report to CEOS/SIT June 2003**
- **Theme completed November 2003 and submitted to IGOS**

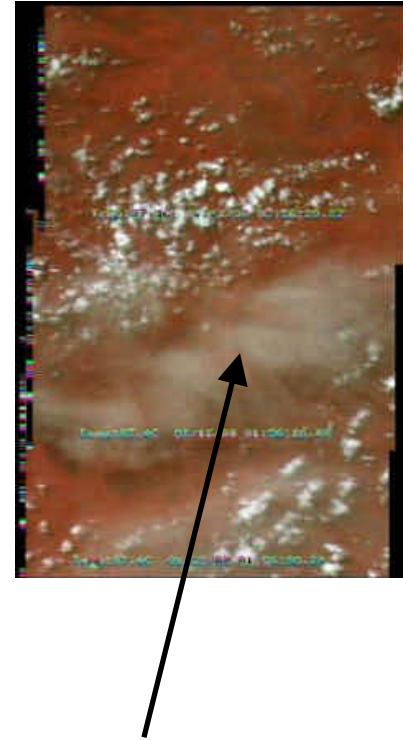


Action Items from ACSG-2 (sample)

- **Continue to pursue CEOS support to appeal to agencies for ground station support. At the present time recommendations are being bounced**
- **Refine recommendation for aerosol stations with interested parties at**
- **Initial ACVDC activity: Consider HDF 4↔5 conversion to insure compatibility between Envisat and Aura validation data.**
- **Consider policy supported by ACSG for publication, referencing and**
- **Encourage participant to ACSG from**
- **Begin coordination of validation planning between**

Validation of aerosol characteristics

- Optical thickness
 - Single scattering albedo
 - Absorption coefficients
 - Height distribution
 - Size distribution
 - Angstrom exponent
- **This maybe too much for ACSG**
 - **Possible new subgroup for aerosols**



(Image taken by I.Ramon during MEIDEX/STS-107)

MODIS

MISR

MERIS

SCIAMACHY

ICESat

OMI

POLDER

Calipso

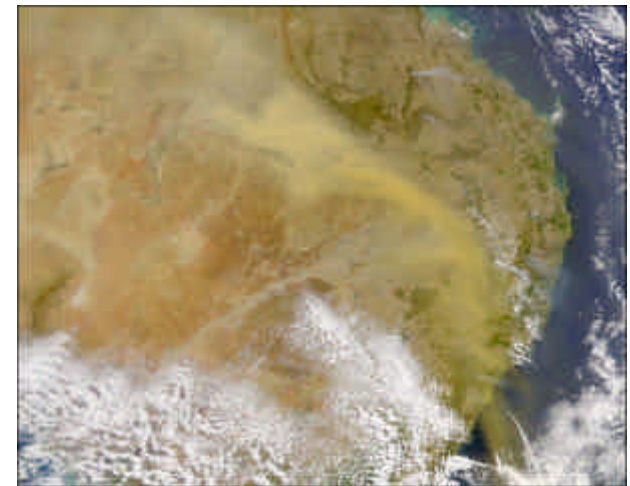
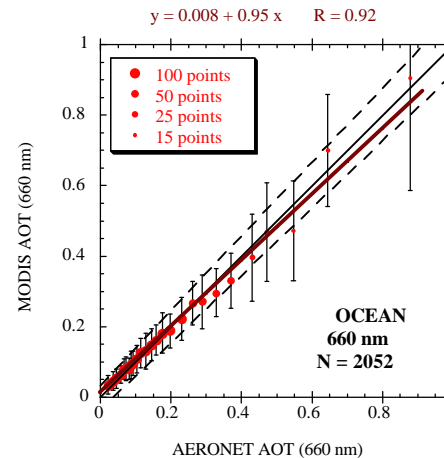
Parasol

GOME-2

VIIRS

Australian dust and smoke detected by SeaWiFS and MODIS

- Validation Instruments
 - Cimel
 - Micro pulse lidar
 - Sun photometer
 - Shadow band radiometer
- Networks
 - Aeronet
 - ARM
- Aircraft campaigns
 - CRYSTAL, TARFOX, SAFARI



ACSG Recommendations - Summary

- **Stable funding needed for ground based network to continue quality and timely validation data.**
- **ESA and national partners provide resources for long term validation of satellite data.**
- **For satellite data processing development, better phasing activities to include algorithm implementation during commissioning phase followed by validation**

Further considerations for WGCV

- **End-to-end approach for Cal/Val**
- **Aerosol Subgroup?**
- **Further interactions between calibration and data product scientists**
- **Eumetsat representative**