

OPAG-EPAC

GCOS, AOPC, and WMO/GAW

Report on Decisions, Progress, Activities

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Purpose of Document and Major Decision(s) Requested

This report provides a summary of progress on GCOS, AOPC, and WMO/GAW linkages

Summary of Activity

Activities involving linkages among WMO/GAW, AOPC, and GCOS are implemented under and consistent with the WMO/GAW 2008-2015 Strategic Plan, a contribution to the implementation of the WMO Strategic Plan 2008-2011, and the GCOS 2004 Implementation Plan. These activities involve greenhouse gases (e.g., CO₂, CH₄, N₂O, etc.), ozone and ozone depleting gases (e.g., CFC's, HCFCs), and aerosols. WMO/GAW continues its operations in all of these categories through its Scientific Advisory Groups (SAGs), Quality Assurance/Science Activity Centres (QA/SACs), Central Calibration Laboratories (CCLs), World Calibration Centres (WCCs), and World Data Centres (WDCs). These on-going efforts are studied, reviewed, and enhanced through periodic international meetings of experts, during which calibration, QA/QC, measurement, and data management activities are evaluated and revised as needed in response to evolving demand for information and progress in instrumentation and methodology. Following is a summary of specific goals outlined in the WMO/GAW strategic plan and an update on recent and upcoming activities relevant to these atmospheric constituents.

1. Carbon Dioxide

- 1.1. The WMO/GAW CO₂ network has been identified as a comprehensive network in GCOS as of October, 2005.
- 1.2. Goals for observations are (1) to continue to produce internally consistent CO₂, δ¹³C, δ¹⁸O, Δ¹⁴C and O₂/N₂ data sets through regular calibration and inter-comparisons of measurements, and scrutiny of archived data; (2) to expand the global CO₂ measurement network, emphasizing high-frequency measurements from continents, increased sampling (high or low frequency) in the tropics, increased sampling from vertical profiles, increased use of ships; and (3) to cooperate with process-oriented research programmes including the ocean carbon cycle community (e.g., IGBP projects SOLAS, IMBER, and GLOBEC, and

the WCRP project CLIVAR) and the terrestrial carbon flux community (e.g., FLUXNET). Cooperative efforts will depend upon flux measurement communities rigorously calibrating their measurements to the WMO CO₂ mole fraction scale.

- 1.3. Newly emphasized efforts in the WMO/GAW 2008-2015 include developing comprehensive mechanistic carbon cycle models that include soil, terrestrial ecosystem, and ocean processes and linking these models to WMO/GAW measurements through assimilated CO₂ mole fractions, flux measurements, and other auxiliary information (e.g., CarbonTracker). Emphasis on integrating satellite and in situ measurements of CO₂ is now a key component of the plan to ensure that remotely-sensed retrievals of CO₂ columns are validated with vertical profiles of in situ measurements and surface-based column abundances determined with FTIR spectrometry.
- 1.4. Recent Significant Meetings
 - 1.4.1. 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Helsinki, Finland, September 2007
 - 1.4.2. 50th Anniversary of the Global Record of Carbon Dioxide (co2conference.org), November 2007, co-sponsored by WMO/GAW and focusing on the interface between emission reduction efforts and monitoring of atmospheric CO₂.
- 1.5. Upcoming Meetings
 - 1.5.1. 15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Jena, Germany, September 2009
 - 1.5.2. 8th International Carbon Dioxide Conference (ICDC-8), Jena, Germany, September 2009
- 1.6. Note: The necessity for global reduction of CO₂ emissions, essentially to zero by the end of the century, has led to concern over the need for a global verification system for emission reduction efforts. Recognizing that no large-scale emission reduction effort has succeeded without verification of its the progress and outcome (e.g., reductions to address stratospheric ozone depletion, acid rain, and regional scale air quality), and recognizing the regional, sectoral, and political complexity of the human and natural systems in the carbon cycle, many in the atmospheric and other scientific communities are considering how such a system might come together, what its scientific and policy requirements would be, and how it might operate successfully (e.g., *Marquis and Tans, "Carbon Crucible", Science 320:460-61, 25 April, 2008*). CO₂ measurements will gain heightened attention in coming years and their usefulness will become increasingly important. Examples of such discussions include the following:
 - 1.6.1. AOPC IV (2008) Consolidated List of Conclusions, Recommendations, and Action Items: *"AOPC . . . recognized the critical significance of the issue of rising CO₂ levels and noted the needs for reliable verification of regional CO₂ sources, sinks, and transport processes. In order to address these needs, the Panel recommended expansion of the observing systems and enhanced reanalyses, as well as sustaining existing efforts in monitoring CO₂. It also stressed the need for an open data policy to make data available in real time and for enhanced participation in quality control measures, and encouraged GAW to continue to work with all partners towards this end."*

- 1.6.2. The Draft GEO 2009-2011 Implementation Plan calls for remapping carbon-related observation efforts into a global Carbon Observation and Analysis System, drawing from elements of Forest Mapping and Carbon Tracking (former AG-06-04) and Integrated Carbon Observation (former EC-06-01). Tentative language includes *“The Global Carbon Observation and Analysis System will provide an operational carbon observation network that can integrate both ground-based and satellite observing systems to quantitatively assess progress of greenhouse gas mitigation policies”*.
- 1.6.3. Impending launches of NASA’s Orbiting Carbon Observatory (OCO) and Japan’s GOSAT in 2009 have prompted several interagency, international discussions on validation, assimilation, reanalysis, and reporting.

2. Methane

- 2.1. The WMO/GAW CH₄ network has been identified as a comprehensive network in GCOS as of October, 2005.
- 2.2. Goals for Methane are (1) to produce an internally consistent CH₄ data set through the use of standards regularly calibrated by the CCL, audits by the WCCs, and inter-comparisons of measurements; (2) to improve coverage of the WMO/GAW network by adding sites in the tropics, in the Arctic, and on continents, emphasizing high-frequency measurements and vertical profiles; (3) to integrate satellite and *in situ* measurements of CH₄, emphasizing validation of remotely-sensed CH₄ columns with vertical profiles of *in situ* measurements.

3. Ozone –

- 3.1. The WMO/GAW network for ozone has been identified as a GCOS Baseline Observation Network.
- 3.2. The primary goal has been and is the measurement of changes in stratospheric total ozone with sufficient precision to determine the effects of human activity, which involves maintaining two independent networks of high quality total ozone measurements based on Dobson and Brewer spectrophotometers with transparent calibration histories. To making best use of this information for validation of satellite ozone observations, quality control of ground stations is to be improved by comparison with long-term satellite data records to address data gaps, correction of jumps, etc.

4. Nitrous Oxide

- 4.1. The WMO/GAW Strategic Plan goals for nitrous oxide are (1) to produce an internally consistent N₂O data set through regular calibration by the CCL, audits by the WCC, and inter-comparisons of measurements; (2) to improve coverage of the WMO/GAW network by adding sites in the tropics and on continents, emphasizing high-frequency measurements and vertical profiles; (3) to develop robust, inexpensive, precise techniques for measurement of atmospheric N₂O; and (4) to incorporate the WMO/GAW N₂O measurement network into the GCOS comprehensive network.
- 4.2. Nitrous Oxide is an important Kyoto gas maintained through WMO/GAW’s SAG for Greenhouse Gases (SAGGG), its CCL (NOAA, Boulder), its WCC (Forschungszentrum Karlsruhe, Institute for Meteorology and Climate Research, IMK-IFU, Garmisch-Partenkirchen), and its WDC for Greenhouse Gases (WDCGG at JMA, Tokyo).

- 4.3. The NOAA-2000 nitrous oxide mole fraction scale, which has been adopted as the WMO/GAW reference scale, was recently improved in 2006 (NOAA-2006 scale), resulting in a 0.06% adjustment. After several decades of improvement in both, the two most-used, independent scales for N₂O, NOAA and Scripps Institution of Oceanography (SIO), now yield virtually identical results. Over years, measurements based on both scales have been put into the WDCGG, but with caveats as to the historic differences between the two (~0.5-1.0 ppb, or 0.15-0.3%). This new adjustment positions WMO/GAW to nominate the WMO network as a GCOS comprehensive network.
5. Halocarbons (e.g., CFCs, HCFCs)
 - 5.1. The two dominant halocarbons (CFC11 and CFC12) are major contributors to both stratospheric ozone depletion (largest) and radiative forcing (third largest). Although they and other climatically relevant halocarbons have been monitored for years, are overseen by the WMO/GAW SAGGG, and their intercalibrated data delivered to the WDCGG, WMO/GAW has yet to assign a CCL or WDC for these gases.
 - 5.2. Near-completion of the WMO/GAW-sponsored IHALACE intercalibration exercise has positioned WMO/GAW to assign a CCL and a WCC for halocarbons. Negotiations to this end among WMO/GAW, NOAA, and SIO are underway, at which point WMO/GAW will work to incorporate halocarbon measurements into GCOS as a comprehensive network.
6. Aerosols
 - 6.1. Aerosol activities are a core component of WMO/GAW because of the importance of aerosols to a wide range of issues including global climate change, weather prediction, and air quality and health. Aerosol-related concerns may frequently be equally or more important on the regional scale than on the global scale. For the future, it will be important to enhance the coverage, effectiveness, and application of long-term aerosol measurements within WMO/GAW and with cooperating networks worldwide. One important task will be the delivery of aerosol observations at selected stations in near-real-time for use in data assimilation to improve numerical weather prediction.
 - 6.2. The WMO/GAW aerosol programme has been set up with the philosophy that it should address not only climate-related, but also air-quality issues. For developing countries in particular, regional aerosol issues may be equally or more important than global concerns. Aerosol properties are an essential climate variable identified in the GCOS implementation plan.
 - 6.3. Goals for the WMO/GAW aerosol effort are to enhance the coverage, effectiveness, and application of long-term aerosol measurements within WMO/GAW and with cooperating networks worldwide through a number of activities aimed at harmonizing aerosol measurements, promoting coordination of networks, contributing to the integration of satellite, aircraft, and surface-based aerosol observations, and fostering activities and contacts that result in greater data submission and utilisation of WMO/GAW aerosol data.