A FRAMEWORK FOR INTEGRATED GLOBAL ATMOSPHERIC CARBON OBSERVATIONS: IGCO AND IGACO

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ABSTRACT

A major challenge in reaching a better understanding of global change is the integration of global carbon observations at different scales, made in the atmosphere, ocean and terrestrial domains. This is essential to optimize efforts supporting national, regional and international policy related to the global carbon cycle. The partners of the Integrated Global Observing Strategy (IGOS-P) representing all players in carbon cycle research and monitoring recognised this and produced, with the help of an international panels of experts, published theme reports on the Carbon Cycle (IGCO) and on Atmospheric Chemistry (IGACO). These themes contain recommendations on how to more effectively coordinate and fill gaps in global Earth observations.

OVERVIEW

The global carbon cycle is a closed loop; therefore as we improve our knowledge of one component, the relative uncertainty on other components decreases. However, the research community tends to tackle the problem one reservoir at a time, i.e. process modelling of the ocean carbon fluxes, inverting of atmospheric CO_2 concentrations or collecting extensive forestry inventory data. A combined approach using information from *in situ* terrestrial, oceanic and atmospheric measurements as well as remotely sensed fields has the potential to more rapidly advance our knowledge. This is exactly what is being implemented over a few regions of the globe as part of regional programmes (NACP, CARBOEUROPE). Yet, a significant challenge to this approach is to have all the different types of data available in compatible formats and in an appropriate timeframe. The goal of IGCO is to harmonize the common interests of the in situ and remote sensing communities and to produce a strategy to expand the current observing system. The IGCO is a cross section through the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), Global Terrestrial Observing System (GTOS) and the WMO/Global Atmospheric Watch (GAW) each of which has a strategy for observations. For the atmospheric observations of CO_2, CH_4 and CO, the IGCO overlaps with the atmospheric chemistry theme of IGOS (IGACO) led by WMO and including the GAW network. GAW sets data quality objectives, measurement guidelines and standard operating procedures as well as coordinating the global networks for greenhouse gases.

The volume of observations of the carbon cycle has grown dramatically over the last 20 years. (Figure 1) There has been an increase from around 28 stations to over 120, with that number increasing. But more important is the increase in types of observations involved, from the surface stations to tower, aircraft and ship-based. Similar increases in volume of data have been seen in the coverage provided by the FluxNet eddy covariance tower network (http://daac.ornl.gov/FLUXNET/), and the ocean pCO2 network coordinated by GOOS. However these observations are not yet contributing to the global long term CO_2 data bases. Aircraft observations of greenhouse gases have been undertaken on a routine basis by Japan Air Lines and NOAA is now instituting a light aircraft sampling programme. Enormous amounts of data that are becoming available from satellites. TOVS and AIRS retrievals are now available, and with the GOSAT and OCO missions set for launch in 2008 it will be important that the community is ready to ingest this data when it becomes available (Table 1). The challenge of IGACO for Greenhouse Gases is to integrate observations through "smart interpolator" models for optimal effect.

KNOWLEDGE CHALLENGES

There are several key questions which need to be addressed to advance the integration of satellite and in situ measurements. These include:

- How do we compare discrete *in situ* measurements with column integrals? Most measurements are at the surface and the longwave satellite IR sensors do not see through to the ground.
- How do we manage the data such that it is of known quality and widely available in the shortest possible time?
- How do we incorporate *in situ*, aircraft and remotely-sensed data into the models?
- How can we use sophisticated data assimilation systems to integrate information and bring it to bear in addressing user needs. The IGCO and IGACO will continue to work with experts in these fields to provide strategy to best meet these challenges.

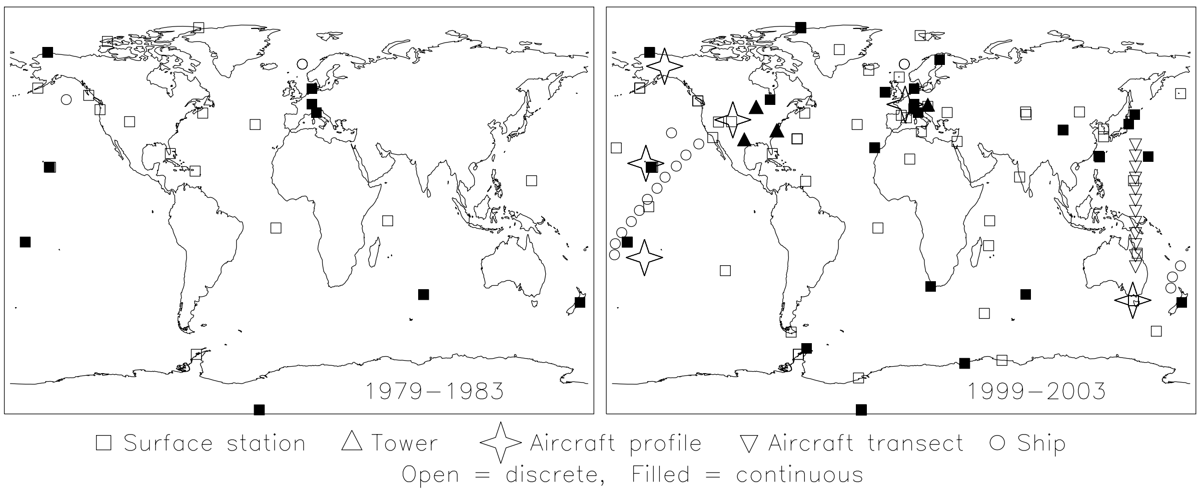

Fig. 1. The locations of GAW CO_2 monitoring stations with data available over the period 1979-1983 (left panel) and from 1999 to 2003 (right panel). Based on data in the GAW World Data Centre for Greenhouse Gases of the Japan Meteorological Agency and the NOAA/Globalview analysis product

Table 1. List of satellites currently in orbit and planned for launch that are sensitive to CO_2, CH_4 and CO.

Instrument/Satellite	**Launch date**	**Data description**
	Satellites currently in orbit	
TOVS/NOAA 10	1986	CO_2 upper troposphere column integrals
MOPITT/Terra	1999	CO profiles
AIRS/Aqua	2002	CO_2, CH_4, CO, integral of 700mb to the tropopause
SCIAMACHY/Envisat	2002	CO_2, CH_4, CO
	Satellites planned for launch	
IASI/METOP	2005	CO_2, CH_4, CO
GOSAT	2008	CO_2
OCO	2008	CO_2 total columns integral over land at 10km resolution
CrIS/NPOES	2010	CO_2 800-300mb integral 15km resolution