Monitoring Trends and Spatial Distributions of Carbon Cycle Greenhouse Gases and Related Tracers

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ESRL/GMD's Carbon Cycle Group began monitoring carbon dioxide (CO_2) from weekly discrete air samples collected at Niwot Ridge, Colorado in 1968. Since then, the network of air sampling sites has grown, with 55 active sites in early-2018, and we now precisely measure CO_2, methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), carbon monoxide (CO), and hydrogen (H_2). Additional tracers (non methane hydrocarbons and isotopic composition of CO_2 and CH_4) are measured by our colleagues at the University of Colorado, Institute of Arctic and Alpine Research.

The original intent of this monitoring program was to document changes in atmospheric components that affect climate: in other words, trends. Since then, the scientific motivation has evolved; our primary goal is now quantifying greenhouse gas (GHG) budgets at large spatial scales. Success or failure at meeting this goal depends primarily on measurement quality, long-term continuity of measurements, and ensuring sufficient network sampling density.

These long-term, internally consistent measurements are at the core of understanding GHG budgets. When combined with other information, the observations tell us that ~45% of CO_2 emitted by fossil fuel combustion has been removed from the atmosphere by sinks, and that historically, most of that sink has been in the ocean, although the terrestrial biosphere has also been important in recent decades. While details of changes to the global CH_4 budget remain uncertain, our observations constrain total global emissions and yield insights into where emissions are changing, or not. For SF_6, the global distribution of our air sampling network provides important constraints on atmospheric transport models, so the measurements are vital to data assimilation systems. While we still have a great deal to learn about GHG budgets, particularly how processes that emit and remove GHGs from the atmosphere will respond to climate change, these observations remain fundamental to our scientific understanding.

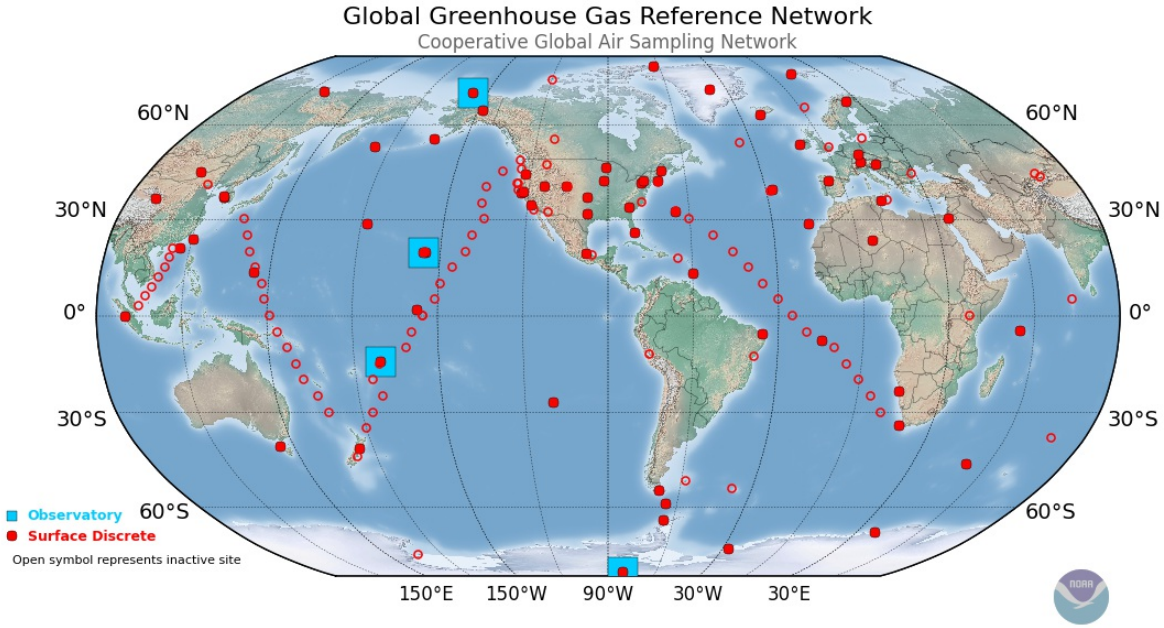

Figure 1. Carbon Cycle Group's Cooperative Global Air Sampling Network, a component of the Global Greenhouse Gas Reference Network.