Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34620

Quantifying Atmospheric Trends and Emissions of Ozone Depleting Substances and Greenhouse Gases by Direct Measurement - *H.C. Urey Award Lecture*

PROF. RAY F. WEISS, PHD

Scripps Institution of Oceanography, University of California San Diego

The multinational Advanced Global Atmospheric Gases Experiment (AGAGE) research collaboration operates a network of automated high-frequency measurement stations around the globe that monitors tropospheric abundances of a wide range of stratospheric ozone depleting substances (ODSs) and anthropogenic greenhouse gases (GHGs). The longer-term "background" trends quantify emissions and lifetimes on global and hemispheric scales, while the higher-frequency variations above background values are used to quantify and map regional emissions via inverse modeling of atmospheric transport and mixing. Examples include the mapping and quantification of spurious Chinese emissions of CFC-11 (trichlorofluoromethane), an ODS and GHG now banned under the Montreal Protocol, and the subsequent verification that these emissions were successfully abated. Other examples include the as-yet unresolved excessive emissions of the potent GHG HFC-23 (trifluoromethane), an industrial byproduct that is required to be destroyed under the Kigali Amendment of the Montreal Protocol. These and other anomalous findings have spurred efforts to fill the large gaps in the regional geographic coverage of existing monitoring networks. While these initiatives create opportunities to improve compliance with emissions control agreements, they also come with significant scientific and practical challenges. These include building the required observational infrastructure, training the necessary technical personnel, advancing scientific interpretive and modeling capabilities, and securing long-term financial support. Station location selections are complex and depend upon the availability of local infrastructures and resources, as well as on using Observing System Simulation Experiments (OSSEs) and exploratory flask sampling to assess location suitability. Calibration standards and their propagation are also major issues, with national metrology institutes now recognizing the need to establish and maintain ambient-level real air calibration scales. Open sharing of instrument-level data is also critical to maintaining quality and comparability across stations and networks. Examples include the open collaboration between AGAGE and the independent NOAA (National Oceanic and Atmospheric Administration) global flask network that strengthens the integrity of these parts-per-trillion measurements in both programs. Maintaining the long-term quality of large and growing observing networks has proven to be more difficult than their initial establishment, with an overriding need for rigor and attention to detail.