

Standards Development and Measurements to Support Global Climate Change Studies

Several species of gases that are found in the atmosphere and that can contribute to changes in the radiative environment of the earth have been developed by NIST as gaseous primary standards (PSMs). These gases are considered greenhouse gases and have been monitored throughout the atmospheric environment community worldwide for many years. These gases have also gained increased importance since the Kyoto protocol was implemented to promote reduced emissions of greenhouse gases.

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NIST had previously developed gaseous primary standards (PSMs) for methane (CH₄), carbon dioxide (CO₂), tetrafluoromethane (CF₄), nitrous oxide (N₂O), dichlorodifluoromethane (CCl₂F₂), trichlorofluoromethane (CCl₃F), sulfur hexafluoride (SF₆), 1,1,1,2-tetrafluoroethane (C₂F₄H₂), carbon tetrachloride (CCl₄), chloroform (CHCl₃), trichlorotrifluoroethane (C₂Cl₃F₃), 1,1,1-trichloroethane (C₂H₃Cl₃) and trichloroethylene (C₂HCl₃). These standards were developed to support the in-house standards base for SRM certification, international intercomparison programs between national metrology institutes (NMIs) to determine equivalence, the NIST Fourier transform infrared (FTIR) spectral database project, and the International Halocarbon Experiment (IHALACE) program sponsored by the World Meteorological Organization (WMO), the National Oceanographic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA).

Twenty laboratories around the world involved in atmospheric measurements participated in the IHALACE program to assess the agreement of measurements; the ultimate goal was to determine if a single traceable source of standards was necessary. NIST PSMs for global climate change measurements have served as the basis for NIST participation. These NIST PSMs were used to analyze one set of three atmospheric gas samples passed between 10 of the 20 labs. NIST analyzed and assigned values for CH₄, N₂O, CCl₂F₂, CCl₃F, CCl₄, CHCl₃, C₂Cl₃F₃, C₂H₃Cl₃, and C₂HCl₃ in the low pmol/mol concentration region.

More than 20 gravimetrically-prepared PSMs now exist and are used to define the NIST primary calibration scales for these key atmospheric species.

Eight of those PSMs were used to measure CH₄, N₂O, CCl₂F₂, and CCl₃F in the IHALACE samples sent to NIST. Four PSMs were used to assign concentrations to the IHALACE samples for CCl₄, CHCl₃, C₂Cl₃F₃, C₂H₃Cl₃, and C₂HCl₃. Those concentration determinations were completed and the results were sent to the IHALACE referencers to compile a final report when all measurements reported from laboratories around the world are received.

NIST participated in a Consultative Committee for Amount of Substance – Metrology in Chemistry (CCQM) intercomparison involving greenhouse gases. A suite of three NIST PSMs were used to value assign CF₄ and SF₆ concentrations in the CCQM-K15 sample sent to NIST. The K15 comparison was completed and results showed excellent agreement of better than 0.1 % at 100 μmol/mol between the four participating NMIs.

Development of these PSMs will underpin the SRM and NIST Traceable Reference Material (NTRM) programs, and serve to establish equivalency between NMIs and atmospheric research measurement laboratories.

Future Plans:

In 2006, these new PSMs containing the halogenated species will be used to analyze and determine concentrations in standards sent to NIST from KRISS, the South Korean NMI. NIST will also send a PSM to KRISS who will analyze and assign values as part of a bilateral comparison. NIST has been preparing PSMs containing pmol/mol level halocarbons since 1985 but there have been no other NMIs working at this low level until recently. This will be the first international comparison at these low levels between NIST and another NMI.