# Radiatively Important Trace Species (RITS) Project

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In June of 1983, a NOAA Research Program Plan called "Radiatively Important Trace Species (RITS)" was written by five Environmental Research Laboratories (ERL); namely, Aeronomy Laboratory (AL), Atlantic Oceanographic and Meteorological Laboratory (AOML), Air Resources Laboratories (ARL), Geophysical Fluid Dynamics Laboratory (GFDL), and Pacific Marine Environmental Laboratory (PMEL). This initiative sought funding and positions to initiate a research program assessing the climatic role of the radiatively important trace species other than $CO_2$. It would begin in October of 1984, the beginning of the 1985 US government fiscal year, and continue for many years into the future.

The following information is taken from the Plan Summary:

"There is evidence that radiatively active species other than $CO_2$ (chlorofluorocarbons, methane, nitrous oxide, and tropospheric ozone) are accumulating in the atmosphere. Furthermore, it is estimated that, if such increases continue, the global "greenhouse" warming from these other species will be comparable, and in addition, to that expected from $CO_2$. Since there is considerable scientific evidence to show that the climatic changes from increasing $CO_2$ will have disruptive economic consequences worldwide, it is imperative that the climatic implications of all of the radiatively important trace species be understood."

"The five NOAA Environmental Research Laboratories propose a joint research program that will:

- determine the temporal trends and spatial distributions of the radiatively important trace species other than $CO_2$,
- define their anthropogenic and natural sources and sinks and global budgets,
- study the processes controlling their distribution over the ocean and the exchange between air and sea,
- determine their chemical and physical behavior, and
- model their potential to alter the earth's climate."

Taken from the body of the initiative:

"Therefore, an accurate assessment of the problem requires a research effort that (a) monitors the concentrations of the radiatively important trace species other than $CO_2$, (b) characterizes their atmospheric processes, and (c) models their climatic role."

"It is clear that research focused on the climatic role of trace species other than $CO_2$ must be added to the NOAA Climate Program. The NOAA/ERL laboratories are particularly capable of undertaking this initiative." "ARL already has four global baseline observatories and a long history of precisely measuring atmospheric parameters."

This report deals with the RITS implementation by ARL's Geophysical Monitoring for Climatic Change (GMCC) Nitrous Oxide And Halocarbons (NOAH) group when the proposal was approved and subsequent documentation of program changes. GMCC is now Global Monitoring Division (GMD) and the group is Halocarbons and other Atmospheric Trace Species (HATS).

Nitrous oxide ($N_2O$), trichlorofluoromethane (CFC-11), and dichlorodifluoromethane (CFC-12) were routinely measured by collecting air samples in flasks at the four GMD baseline observatories followed by gas chromatographic analysis at the central GMD laboratory in Boulder, Colorado [Thompson et al., 1985]. Table 1.1 gives information about the collection site names, locations, and when the RITS project was started there. The RITS initiative emphasized the continued measurement of $N_2O$, CFC-11, and CFC-12 and measuring two additional trace gas species, namely, carbon tetrachloride ($CCl_4$) and methyl chloroform or 1,1,1-trichloroethane ($CH_3CCl_3$). Stability of these gases in metal flasks had been studied and surface passivation techniques had been successfully employed. $CCl_4$, however, continued to have stability problems. It was then determined that the flask project should continue independently and that the RITS project would develop fully automated gas chromatographs to be deployed at the remote ground based observatories. This should preclude flask storage problems and the data from each project could then be compared and consistency determined.

## RITS Locations

### a.) GMD Baseline Observatories

*Barrow, Alaska (BRW)*
Latitude: 71.323 ˚N
Longitude: 156.609 ˚W
Elevation: 8 m
RITS Start: October 1986

*Mauna Loa, Hawaii (MLO)*
Latitude: 19.539 ˚N
Longitude: 155.578 ˚W
Elevation: 3397 m
RITS Start: June 1987

*Tutuila, American Samoa (SMO)*
Latitude: 14.232 ˚S
Longitude: 170.563 ˚W
Elevation: 77 m
RITS Start: June 1986

*South Pole, Antarctica (SPO)*

Latitude: 89.997 ˚S
Longitude: 102.0 ˚E
Elevation: 2837 m
RITS Start: (Pre-RITS implementation December 1983), February 1988

**b.) Other Field Sites**

*Niwot Ridge, Colorado (NWR)*
Latitude: 40.036 ˚N
Longitude: 105.543 ˚W
Elevation: 3018 m
RITS Start: February 1990

## RITS Timeline

*Barrow, Alaska (BRW)*

1999-02-17
Both gas chromatographs shut off.

1993-12-22
Install ECD B:L4288.

1993-11-30
Remove ECD B:L1007.

1988-12-09
Remove ECD A:L0098.
Install ECD A:L1006.

1987-07-04
Install Simadzu 8A gas chromatograph; ECD C:SS413.

1986-10-15
Install HP5890 gas chromatograph; ECD A:L0998 B:L1007.

*Mauna Loa, Hawaii (MLO)*

2000-12-18
Channel B of the HP5890 gas chromatograph shut off.

2000-04-10
CHannel A of the HP5890 gas chromatograph shut off.

Shimadzu 8A gas chromatograph shut off.

1988-04-12
Remove ECD A:L1006.
Install ECD A:L0991.

1987-06-23 Install HP5890 and Shimadzu 8A gas chromatograph; ECD A:L1006 B:L0995 C:SS422.

*Tutuila, American Samoa (SMO)*

2000-09-30
Shimadzu 8A gas chromatograph shut off.

2000-04-22
HP5890 gas chromatograph shut off.

1993-10-26
Remove ECD B:L1012.

1987-07-01
Install Shimadzu 8A gas chromatograph; ECD C:SS420.

1986-06-11
Install HP5890 gas chromatograph; ECD A:L0996 B:L1012.

*South Pole, Antarctica (SPO)*

2000-11-30
Both gas chromatographs shut off.

1999-04-30
Remove ECD 1:SS289.
Install ECD 1:SS604.

1991-12-13
Remove ECD 2:SS103.
Install ECD 2:SS900.

1988-12
Spare Shimadzu Mini2 gas chromatograph; ECD:SS604.

1988-01-28

Install Shimadzu Mini2 gas chromatograph; ECD1:SS289 2:SS103.

1987-06
Install EC:SS382.

1987-02-25
Remove ECD:SS150.

1983-12-18
Install Shimadzu Mini2 gas chromatograph; ECD:SS150.

*Niwot Ridge, Colorado (NWR)*

2001-08-07
Both gas chromatographs shut off

2000-07-24
Replace Shimadzu 8A gas chromatograph; ECD C:SS413

1994-02-28
Install ECD A:L1941

1994-02-16
Remove ECD A:L0998

1993-05-03
Install ECD B:L1231

1993-04-22
Remove ECD B:L0990

1990-02-01
Install HP5890 and Shimadzu 8A gas chromatograph; ECD A:L0998 B:L0990 C:SS410

## Calibration Scales for Various Trace Gases

NOAA ESRL GMD is the World Meteorological Organization (WMO), Global Atmospheric Watch (GAW) Central Calibration Laboratory (CCL) for $CO_2$, $CH_4$, $N_2O$, $SF_6$, and CO. NOAA ESRL also maintains internal scales for a number of trace gases that are not part of the set of WMO GAW CCL scales. Scales are defined by a specific set of primary standards. Mixing ratios (expressed as dry air mole fraction) are assigned to the primary standards based on the mean response observed on GC-ECD or GC-MSD instruments. The scales are tied to a specific set of primary standards and named according to the year in which they were adopted.

Thus, the preparation and use of new primary standards for a particular compound results in a new scale for that compound. Additional information can be found on the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) Global Monitoring Division (GMD) Halocarbons and other Atmospheric Trace Species Group (HATS) Central Calibration Laboratory website.

$N_2O$
Previous Scale: 2005
Current Scale: 2006A
Number of Primary Standards: 13
Note: WMO GAW CCL scale

*CFC-11*
Previous Scale: 1992
Current Scale: 2016
Number of Primary Standards: 5
Range: 100-260 ppt
Conversion Equation: $Y = -1.7948e\text{-}6*X^3 + 7.4134e\text{-}4*X^2 + 0.89385*X + 6.54$ (where Y = value of CFC-11 on the 2016 scale and X = value of CFC-11 on the 1992 scale)

*CFC-12*
Previous Scale: 2001
Current Scale: 2008
Number of Primary Standards: 15
Range: 150-650 ppt
Conversion Equation: $Y = 1.0021 * X + 5.807$ (where Y = value of CFC-12 on the 2008 scale and X = value of CFC-12 on the 2001 (or 1997) scale)
Note: The 2008 CFC-12 scale is 1.3% higher than the 2001 scale, see scale page for more information. Update using $Y = 1.002*X + 5.807$ ppt.

$CCl_4$
Previous Scale: 1996
Current Scale: 2008
Number of Primary Standards: 7
Range: 25-150 ppt
Note: Seven standards prepared from 2001-2004 are now used to define the scale. These seven standards are consistent to within 0.5%. Four standards prepared in 1996 have been removed from the scale. For ECD-based results the conversion is 0.9954 at 95 ppt. For GCMS results the conversion is 0.9853.

$CH_3CCl_3$
Previous Scale: 2003
Current Scale: No Change
Number of Primary Standards: 10
Range: 10-180 ppt