Measurement and Monitoring of Surface Radiative Forcing from Individual Greenhouse Gases

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A new network is proposed to monitor the radiative forcing of global warming by greenhouse gases. The calibrated spectrum of greenhouse radiation at the surface has been measured for the last 10 years in the Great Lakes area of Ontario, Canada. The surface radiative forcing flux from each greenhouse gas been extracted from these measurements. A 10-year record exists of the radiative fluxes from carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (CFCs). The increase of these fluxes represent the forcing function of global warming, which is an experimental version of radiative forcing similar to, but different from, the radiative forcing metric used by IPCC. It is proposed that this climate forcing be monitored like the ozone layer with a world monitoring network of instruments similar to Brewer and Dobson spectrophotometers. The AERI instrument already exists; 12 AERIs, manufactured by ABB BOMEM, are deployed around the world. The spectral measurements are being processed to extract the radiative forcing fluxes from each greenhouse gas; this is related to the work of Philipona et al. (2007) who measured the total radiative forcing increase due to all greenhouse gases with broadband instruments. The methodology will be to process the AERI infrared spectrometer measurements into the downward surface radiation flux in W/m^2 from each of the major greenhouse gases. Well calibrated infrared spectral measurements of the downward infrared long-wave radiation have been made routinely by the AERI at three DOE ARM Climate Research Facility (ACRF) sites for more than 7 years with a 12-year record at the Southern Great Plains (SGP) site. These measurements are being processed into longwave radiation fluxes from each of the major greenhouse gases using a methodology already developed for our similar measurements at 44° N in the Great Lakes area. Comparisons with surface radiation fluxes calculated from global climate models (GCMs) will be conducted using the methodology already successfully used to compare previous 44° N data with the Canadian and NCAR GCMs. The uses of the data would be to: investigate the seasonal and climate regime variations of the surface greenhouse radiation flux, compare the measurements with climate model simulations of the surface forcing radiation fluxes for each greenhouse gas, evaluate the reduction of the surface forcing radiation by various types of clouds by measuring the reduction in surface radiation forcing under cloudy conditions, conduct complementary measurements of surface radiative forcing with radiative trapping measured from space with overpasses of satellites and monitor the trends in the surface radiative forcing from each gas. This network will provide a new experimental dataset to complement the calculated radiative forcings from current climate models. It will provide the experimental capability to conduct long-term monitoring of increases in radiative forcings from individual greenhouse gases without using an intervening climate model and add a new climate observation that potentially could be used to compare changes in the longwave radiation balance of the atmosphere with other climate variables. The data from ACRF AERI sites, combined with the other existing AERI instruments deployed around the globe, would be a big step toward building a network to monitor radiative forcing.

Greenhouse Gas	Emission Band (cm^{-1})	GL Flux (W/m^2)	AERI Flux (W/m^2)
CFC-11	830 - 860	0.10	0.12
CFC-12	all bands	0.21	0.26
CFC-11 + 12	all bands	0.31	0.38
CH_4	1200 - 1400	1.02	1.21
N_2O	1200 - 1300	1.19	1.32
O_3	900 - 1100	3.34	3.02
CO_2	all bands	30.9	37.3

Figure 1. A comparison of Great Lakes and AERI SGP surface radiative forcing greenhouse fluxes in winter.