Mobile ground-based column measurements using infrared Fourier transform spectroscopy

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Abstract

We plan to deploy a mobile, trailer-based, high-resolution, infrared Fourier transform spectrometer (FTS) to measure, in the vicinity of Mexico City, column abundances of a number of gaseous constituents to help characterize the chemical and physical transformations and the ultimate fate of pollutants exported from the urban area.

Technique

High-resolution (0.06 cm^{-1}) infrared spectra have been recorded by the NCAR Fourier transform spectrometer (FTS) during a number of NASA and NSF aircraft-based deployments for a wide range of latitudes. Surface-based observations have been made from sites in Colorado and in Greenland. Column amounts are retrieved by fitting of the observed spectra with calculated spectra. Details of the column retrieval method are discussed elsewhere (Mankin and Coffey, 1989; Coffey et al., 1989). Stratospheric gases that have been retrieved during the airborne field programs are listed in Table 1. The major chlorine reservoirs (HCl and $ClONO_2$), the important nitrogen-containing gases in the stratosphere (N_2O, NO, NO_2, and HNO_3), stratospheric and tropospheric tracers (HF, CH_4, C_2H_6, H_2O, CO_2), a major source CFC (CF_2Cl_2) and ozone may be routinely retrieved. Not all these gases can always be observed from the ground, depending on the local concentrations.

Table 1. Molecules observed with the NCAR Fourier Transform Spectrometer

N_2	H_2O	CO_2	CF_2Cl_2	HCN	N_2O	HCl	O_2
HDO	CO	$CFCl_3$	OCS	NO	HF	O_3	CH_4
SO_2	NO_2	C_2H_6	HNO_3	$ClONO_2$			

Measurements will be made of the atmospheric transmission in the infrared, with

wavelengths from 2 to 14 μm, using the sun as a source. The spectral coverage will be continuous from 2-14 μm, enabling us to produce columns of the gaseous species in Table 1. Based on the experience from previous campaigns we anticipate that the precision of the retrieved columns will be a few per cent. The absolute accuracy depends on a number of factors that vary from compound to compound, but is expected to be in the range of 10-30%.

For the analysis of spectra to retrieve gas amounts, we will use the SFIT2 routine, which has become the *de facto* standard in the ground-based infrared remote sensing community and has been extensively tested against other analysis codes (Rinsland et al., 1982). The SFIT2 fitting package employs the optimal estimation (OE) technique described by Rodgers, [1990].

Additionally, simulations have shown that for moderately polluted atmospheres we can retrieve column amounts for HCHO and other hydrocarbons. Recording of the full infrared spectrum also allows us to search for unanticipated absorptions by as yet unidentified constituents.

References

Coffey, M. T., William G. Mankin, and A. Goldman, Airborne measurements of stratospheric constituents over Antarctica in the austral spring 1987: 2. Halogen and nitrogen trace gases, *J. Geophys. Res.,* **94**, 16,597-16,614, 1989.

Coffey, M. T., W. G. Mankin, J. W. Hannigan, and G. C. Toon, Airborne spectroscopic observations of chlorine activation and de-nitrification of the 1999/2000 winter arctic stratosphere during SOLVE, *J. Geophys. Res.*, **108**, 8303, 2002.

Mankin, William G., and M. T. Coffey, Airborne measurements of stratospheric constituents over Antarctica in the austral spring 1987: 1. Method and ozone observations, *J. Geophys. Res.*, **94**, 11,413-11,421, 1989.

Mankin,W.G., M.T. Coffey, A. Goldman, M.R. Schoeberl, L.R. Lait, P.A. Newman, Airborne measurements of stratospheric constituents over the Arctic in the winter of 1989, *Geophys. Res. Lett.,* **17**, 473-476, 1990.

Rinsland, C. P., Smith, A. H., Rinsland, P. L., Goldman, A., Brault, J. W. and Stokes, G. M., Ground-based infrared spectroscopic measurements of atmospheric hydrogen cyanide, *J. Geophys. Res.*, **87**, 11,119-11,125, 1982.

Rodgers, C.D., Characterization and error analysis of profiles retrieved from remote sounding measurements, *J. Geophys. Res.* ,**95**, 5587-95 , 1990.