LASER HETERODYNE SYSTEM FOR OBTAINING HEIGHT PROFILES OF MINOR SPECIES IN THE ATMOSPHERE

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ABSTRACT

An infrared Laser Heterodyne system for obtaining height profiles of minor constituents of the atmosphere has been developed and set up at National Physical Laboratory, New Delhi. A brief description of the system is given here. The system consists of a tunable CO_2 waveguide laser in the 9-11 μm band, that is used as a local oscillator and a heliostat that follows the sun and brings in solar radiation, that is mixed with the laser beam in a high speed (1 GHz) liquid Nitrogen cooled Mercury Cadmium Telluride detector. The detected signal is analysed in an RF spectrum analyser that allows tracing absorption line profiles. Absorption lines of a number of minor constituents in the troposphere and stratosphere, such as O_3, NH_3, H_2O, SO_2, ClO, N_2O, are in the 9-11 μm band and overlap with that of CO_2 laser range. The experimental system has been made operational and trial observations taken. Current measurements are limited to ozone height profiles. Results will be presented.

A computer program of the inversion technique has been developed based on the inverse solution of the radiative transfer equation. In the present analysis, a Lorentz profile was used below 25 km, while above 25 km, a Voigt profile was used where Doppler broadening is dominant, for computation of line parameters such as line half width, line strength etc. for a strong Ozone absorption line, 1053.96 cm^{-1}. In all, sixteen channels, one at line center and fifteen in the wings of the line, were chosen to resolve the line and hence to get proper height resolution (1 to 3 km). The spectral intensity for each channel was computed using the U.S. Standard atmosphere (1976) Ozone model. To invert the computed spectral intensity of these channels an initial uniform vertical distribution of ozone, say 3 ppmv, was assumed. This distribution was modified in each iteration and in 20 iterations the profile was obtained. Proper interpolation was done to get a complete profile up to a 40 km altitude. The inverted profile compares well with the model ozone profile. The inversion method was tested with different assumed distributions and found to be independent of the initial assumptions.