REAL-TIME ATMOSPHERIC ABSORPTION SPECTRA FOR IN-FLIGHT TUNING OF AN AIRBORNE DIAL SYSTEM

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Real-time measurements of atmospheric absorption spectra are displayed and used to precisely calibrate and fix the frequency of an Alexandrite laser to specific oxygen absorption features for airborne Differential Absorption Lidar (DIAL) measurements of atmospheric pressure and temperature.

The DIAL system used contains two narrowband tunable Alexandrite lasers: one is electronically scanned to tune to oxygen absorption features for on-line signals while the second is used to obtain off-line (non-absorbed) atmospheric return signals. Other system components pertinent to the tuning capabilities are a 0.5 m Czerny-Turner spectrometer with 0.25 cm^{-1} (15 pm) resolution, a microcomputer terminal for display and keyboard input, software to process and output data in real time, and the atmospheric path over which measurements are made. A one meter multipass gas cell can alternatively be used instead of the atmosphere.

In operation, the two lasers are coarsely tuned to within 0.5 cm^{-1} of the desired frequencies utilizing the spectrometer which has an X-Y CRT display of its reticon detector, with a cursor and channel number readout. The laser outputs are transmitted through the atmosphere, and a real-time plot of atmospheric transmission versus time is displayed on the microcomputer's console terminal. The lidar operator may select the number of shots to be averaged, the altitude, and altitude interval over which the signals are averaged using single key stroke commands. The on-line laser is electronically tuned with a constant scan rate while the display is continuously updated. The operator determines exactly which oxygen absorption lines are scanned by comparing the line spacings and relative strengths with known line parameters, thus calibrating the laser wavelength readout. The CRT is either refreshed or overwritten every 512 laser shots, and a hardcopy of the screen may be obtained using a graphics printer.

After determining the wavelength calibration, the on-line laser is manually tuned to the desired absorption feature; either a transmission peak (absorption trough) for pressure measurements or an absorption peak for temperature measurements and recording of data on magnetic tape commences.

The system just described was used successfully to measure the atmospheric pressure profile on the first flights of this lidar, November 20, and December 9, 1985, aboard the NASA Wallops Electra aircraft. It has been used previously in our groundbased laboratory to make upward-looking measurements of pressure and temperature and to measure the spectral purity of the Alexandrite laser.

A system for long-term control of the laser frequency using a stabilized high resolution etalon is currently under development.