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Computer Simulation Studies of an Atmospheric Tunable Lidar/DIAL System

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We have developed a sophisticated computer simulation program which models the behavior of a tunable atmospheric Lidar system including slant-path propagation through the atmosphere. Initial comparisons with output from the program have been made with experimental Ho laser Lidar measurements, and good agreement has been observed.

Our computer Lidar/DIAL simulation program operates on an IBM-PC type computer and involves the following sections and models:

(1) Molecular Atmospheric Absorption: The HITRAN molecular spectroscopy database is used to calculate the high-resolution molecular spectrum of the atmosphere using standard pressure/Voigt line broadening theory. Slant-path geometries are taking into account using the U.S. Atmospheric Models (U.S. Standard, etc.) for altitude profiles of temperature and partial pressures. The molecular continuum is included. The modified version of the HITRAN-PC TRANS program is used to generate a high-resolution spectral data array of the molecular attenuation of the atmosphere as a function of wavelength and altitude.

(2) Aerosol/Cloud Backscatter and Attenuation: The backscatter and attenuation due to aerosols and other atmospheric phenomena (rain, fog, dust, volcanic ash, etc.) are calculated using a section of the BACKSCAT computer program developed by SPARTA Corp. under the direction of Phillips Lab. (AFGL). This program uses the LOWTRAN models to calculate the attenuation and backscatter coefficients as a function of altitude for a wide range of user selected atmospheric conditions at a single wavelength. This program has

been modified by us to produce a large data array of these parameter coefficients as a function of wavelength and altitude.

<u>(3) Lidar and Tunable DIAL Simulations:</u> The Lidar S/N ratio is calculated using the above atmospheric backscatter, absorption, and attenuation models and the standard Lidar equation. Both hard target returns and Range-Resolved atmospheric returns can be calculated. The Lidar geometry includes slant-path calculations which divides the atmosphere into a large number of atmospheric layers, and propagating the Lidar beam through these layers. For range-resolved tunable DIAL simulations, the Lidar return S/N is calculated as a function of range and wavelength. Figure 1 shows an example of a 3-D plot of the expected Lidar return signal for a Ho laser DIAL system as the Ho laser wavelength is tuned near 2.0 μm (5000 cm^{-1}) Also shown is the noise floor due to the NEP of the detector, which indicates the "S/N Detectability Floor" . Such information is important in determination of the optimal wavelengths to be used in a tunable DIAL application and the resultant gains in Lidar range which can be expected when the laser is tuned slightly off-line.

Further work is being planned for the development of this simulation program and comparison with future Lidar measurements.

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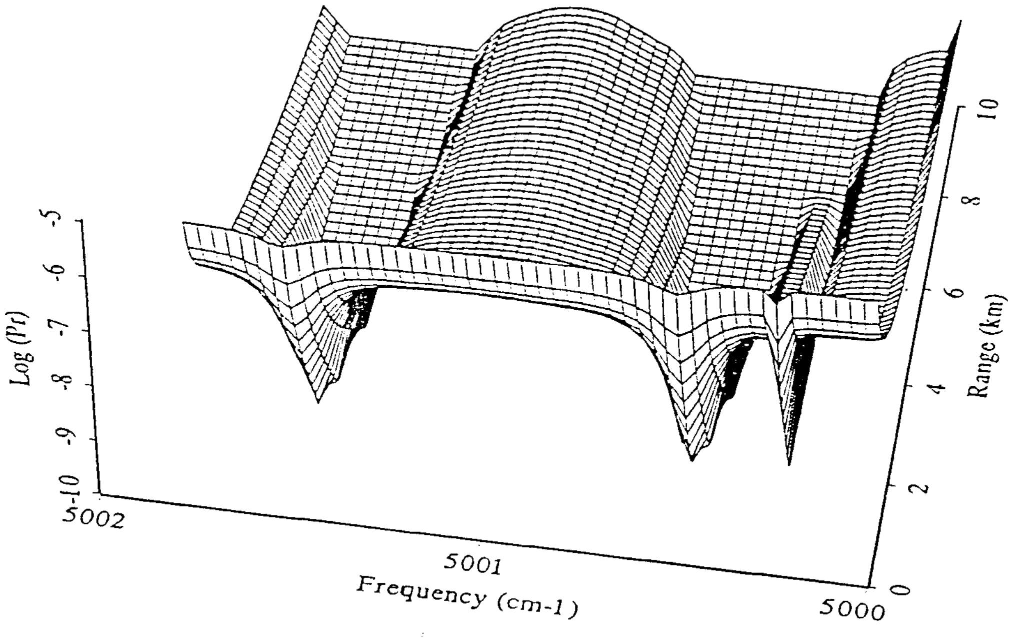

Example Of Output Showing LIDAR Return Power As A Function Of Laser Frequency (Wavelength) And Range.

Figure 1