Applications of Remote Sensing to Hazardous Spill Incidents

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Remote sensing techniques may be particularly well suited for monitoring the distribution of hazardous spill concentrations. These techniques provide the means for real-time viewing of large atmospheric volumes over remote distances that have extremely high spatial and temporal resolution. Atmospheric remote sensing has been used extensively in air pollution research programs and is currently being developed for the military for toxic agent applications. This paper discusses some previous studies that demonstrate capabilities that should be considered for application to hazardous spill incidents.

Remote sensing techniques are classified as either active or passive and capabilities differ greatly between these classifications. Active systems provide their own energy sources; passive systems point at naturally occurring energy sources (e.g., sunlight, thermal radiation from terrain, and atmospheric species). Most active systems used for atmospheric observation use laser transmitters and optical receivers; passive systems have only optical receivers. Because lasers operate at only a finite number of wavelengths and because the cost of the sensor increases greatly as the number of wavelengths increases, only one or two wavelengths are typically used.

Passive sensors can perform wavelength scans economically over large wavelength intervals and thus are well suited for discriminating between agents that have different wavelength-dependent absorption or emission spectra. The major advantages of the active system are that the energy can be transmitted in pulse form (hence, range information can be obtained by using radar principles) and discrimination against background radiation is simplified. Because of the differences in active and passive sensor techniques, they are complementary and their combined capabilities are being considered in several development programs.

REFERENCES

brightness is proportional to the logarithm of plume backscatter and therefore is a measure of relative aerosol concentration. Concentration profiles at several distances from the lidar are plotted in Figure 2. A plume cross section can be obtained in about 1 min. (greatly reduced with new systems) so that the three-dimensional distribution of plume constituents can be determined rapidly.

A second example illustrates the capabilities of the airborne lidar plume and haze analyzer (ALPHA-1), a two-wavelength, downward-directed lidar operated from the SRI Queen Air aircraft (Figure 3). In this example (shown in Figure 4) the lidar was flown across a smoke plume about 500 m downwind of a small forest fire. Relative concentration patterns provide quantitative information on transport and diffusion downwind of the source. Surface returns have been analyzed in terms of vertical plume transmission, and the two-wavelength (0.53 and 1.06 μm) transmissions provide information on particle size needed for estimates of absolute concentration (1).

A third data example illustrates the capabilities of a differential absorption lidar (DIAL) for observing the distribution of gaseous constituents. A DIAL system transmits energy at two closely spaced frequencies, which are then monitored (Figure 5) to determine the concentration of the gas of interest. This method is particularly useful for monitoring emissions from industrial sources or for atmospheric studies.
Figure 6. Horizontal cross section of sulfur dioxide concentrations derived downwind of Kincaid coal-burning power plant (3 km to right of lidar location) derived with the DIAL system.

Figure 7. Application of proposed ALARM airborne lidar system.

CONCLUSIONS

Although remote sensing techniques have yet to be applied to the observation of hazardous spills, applications to observation of air pollution and military toxic agents have demonstrated their unique capabilities for detection, identification, and mapping of concentration distributions for particulate and gaseous materials. Remote sensing systems are available in ground mobile and airborne configurations to facilitate rapid movement to isolated incidents. Because of their ability to make observations in real time over extended remote distances with high spatial and temporal detail, remote sensors may be ideally suited for application to hazardous spill incidents.

REFERENCES