LASER APPLICATIONS IN ENVIRONMENTAL SCIENCES

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Since the middle of 2001 a ground-based elastic backscattering Lidar (Light Detection And Ranging) is working at the Laboratory of Environmental Laser Application at the Laser and Applications Center. This system is a single wavelength backscattering, pointing vertically to the zenith and is operated in a coaxial mode. The light source is based on a Nd:YAG laser operating at the second harmonic (532 nm), at a fixed repetition rate of 20 Hz. The average power can be selected up to 3.3 W, and, at ground level, the laser beam profile is about 7 mm of diameter and propagates with a divergence of 0.5 mrad. The laser beam is brought to the atmosphere through a Newtonian telescope with a 30 cm receiving mirror and a 1.3 m focal length. The optics setup is such that the overlap between the collecting optics and the beam starts at 300 m above the ground level. The backscattered radiation is collected by an appropriate detector in the laser wavelength and a narrow band (1 nm FWHM) interference filter selects the backscattered laser (light) radiation and reduces the background thus improving the signal-to-noise ratio. The collected backscattered light is brought to the detection system and processed in a transient recorder (12 bit resolution). Data are averaged between 2 to 5 minutes, with a typical spatial resolution of 15 - 30 m. This system allows the monitoring of the atmosphere for aerosol load up to 30 km in altitude and providing the aerosol backscattering and extinction coefficient profiles as can be seen in the picture below, (FIG.1). A picture of the system in operation is given below, (FIG.2).

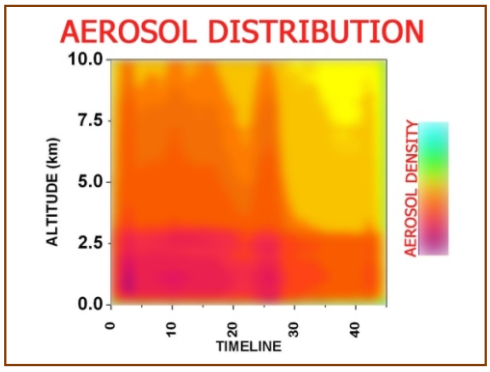

FIGURE 1 - Aerosol vertical distribution variation (2 hour period) in the atmosphere.

Three years of measurements of aerosol profile morphology allowed us to create an air quality categorization, in order to assess the Lidar measurements of meteorological (synoptical) conditions and to predict potential sources of aerosols.
At the present time the system is being upgraded to operate at UV wavelengths (355 nm) and retrieve also Raman signals from the atmospheric constituents as N_2 and water vapor improving thus the data precision and accuracy. Also a polarization channel is being added to the system in order to retrieve particle distribution in the atmosphere.

FIGURE 2 - Picture of the Lidar system in operation.

The group is also developing a Lidar using as a light source a fs (femtosecond), TW (terawatt) laser, the so called femtolidar, which will be a powerful tool for molecular detection in the atmosphere, this will allow the measurement of the atmosphere in a wider spectral range.

The main studies and activities carried out at the laboratory at present are:

- Troposphere profiling up to an altitude of 30 km
- Thermal Inversion and pollution correlation studies
- Lidar based air quality categorization
- Implementation of a web controlled Laboratory (WebLab)
- Satellite Validation through ground based measurements
- Aerosol transport in the atmosphere
- Remote Sensing of the Atmosphere with Lasers post-gradation course

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