

LOOK TO THE LIGHT

Lidar can collaborate with other systems

When an air traffic crisis highlights the need for operational transboundary pollution Lidar observation

Ground-based remote sensing aerosol networks make a vital direct contribution to the monitoring of phenomena, such as the volcanic eruption in Iceland. They are a precious tool to calibrate and validate various satellite observations and diffusion models, none of which are workable alone. They provide information on the aerosol density, vertical structure, and motion, which are all critical parameters for efficient decision-making.

Among other ground-based remote sensors, Lidars are instruments that direct laser beams towards the sky. By analyzing the backscattered light, they measure with high accuracy the aerosol properties, cloud vertical structure, as well as wind speed and direction, continuously throughout time.

Relative density of particles in the air

The physical principle of an Aerosol Lidar System (ALS) is similar to the one of the radar: a short pulse of laser light is transmitted from the telescope to the atmosphere. As the pulse travels along, part of it is scattered by molecules, anthropogenic particles, water droplets, or other objects in the atmosphere. The greater the number of scatterers, the greater the part scattered. A small portion of the scattered light is scattered back, collected by the telescope, and detected. The detected signal is stored in bins according to how long it has been since the pulse was transmitted, which is directly related to how far away the backscatter occurred. The collection of bins for each pulse is called a profile.

A stronger concentration in aerosol will be evident by producing an increase or a spike in the backscattered signal profile. For example, the water droplets constituting clouds produce a lot of backscatter. It would be the same in the presence of particles, although small particles as pollution are better detected by short wavelength as UV or visible.

The primary information given by the Lidar will be the height of the aerosol layers and cloud structures, and also the visibility on the line of sight.

Moreover, the cross-polarized detection channel, in respect to the polarization of the



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WINDCUBE WLS70 and Cloud&Aerosol lidar ALS450 in Orsay, France August 2009

emitted laser beam, gives asphericity information on the particle that enables the observer to discriminate unspherical particles from others (soil dust from other aerosol, ice/water phase of the clouds).

During the weeks that followed the eruption of the Icelandic volcano Eyjafjallajökull, ALS users detected and studied the ash layers transported from Iceland. This ALS Lidar community spread from the south of France, in Toulouse, to the north of Denmark, with locations in the UK, The Netherlands, Germany, and Switzerland. Each ALS detected the ash layer at various heights and time extremely well thanks to its cross-polarized channel. This is due to the silica glass and crystals of feldspar present in ash plumes, which are irregularly shaped and depolarizing.

During the entire crisis, the intensity and cross-polarisation Lidar data from the ALS Lidars were delivered automatically on an hourly and a daily basis to local meteorological agencies, such as Meteo France for the validation of their transport models. The unforeseen eruptive event therefore accelerated the spontaneous need of ALS users to federate into a network.

The ad-hoc and spontaneous build-up network was a complement to the existing European Aerosol Research Lidar Network (EARLINET), established in 2000, with 26 European Lidar research institutes. EARLINET provides scientists with regular tri-dimensional information of the troposphere above Europe. This network is now participating to the specific action of GALION/GAW (Global Aerosol Lidar Observation Network/Global Aerosol Watch) Climate program of WMO.

The new network of automatic ALS stations may then also contribute at this level to the GAW program by automatically, under any meteorological conditions, providing homogeneous data to the community at low maintenance costs.

Following plumes and severe events

The ALS Lidars provide meteorologists with valuable data on aerosol concentration and properties but little information, if any, on the