The Measurement of Atmospheric Aerosols

POM Sky Radiometer distributed world-wide by Kipp & Zonen

POM Sky Radiometers

With the increasing interest in urban air quality, climate change and global warming research, the effects of atmospheric aerosols are being studied in greater detail. Primarily, this refers to water vapour and suspended particles such as smoke, dust, sand and ash. These absorb and scatter solar radiation, act as nuclei for the formation of clouds, and promote atmospheric chemical reactions.

Understanding atmospheric aerosols

Solar radiation drives almost every dynamic process on the Earth's surface and above, from ocean current circulation to weather, climate, eco-systems and life itself. Aerosols, and the increase in clouds that they generate, have a significant impact on the amount of solar radiation reaching the lower atmosphere and the ground. They are generally agreed to be one of the major causes of 'Global Dimming' and may be offsetting some of the 'Greenhouse Gas' effects contributing to Global Warming.

Understanding atmospheric aerosols is one of the most important ways in which scientists can improve models for weather and air quality forecasting and for climate change prediction. These aerosols are typically in, or above, the atmospheric 'mixing layer'. They are normally at least 1 km above the ground and can often be high in the stratosphere. These aerosols should not be confused with ground level Particulates Monitoring by PM 10 and PM 2.5 samplers.

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Major sources of atmospheric aerosols are industry, power generation, aircraft, surface traffic, volcanoes, dust from deserts, and forest fires (both natural, caused by lightning, and deliberate deforestation to grow crops). These particles can be entrained in high level air currents and carried a long way around the globe, 'Sahara Dust' for example. There is a need to monitor aerosols in real-time, particularly in the industrial and urban environments where many of them originate.

In order to gather information on the size and shape of particles suspended in the atmosphere it is necessary to measure the characteristics of the light from the sun in two ways. Firstly the light that is directly absorbed by the aerosols and, secondly, the light scattered by them. It is also necessary to measure the light at a number of wavelengths from the Ultraviolet (UV) to the Near Infrared (NIR). Larger particles in the atmosphere need to be characterised using longer wavelengths of light.

One of the most widely used instruments

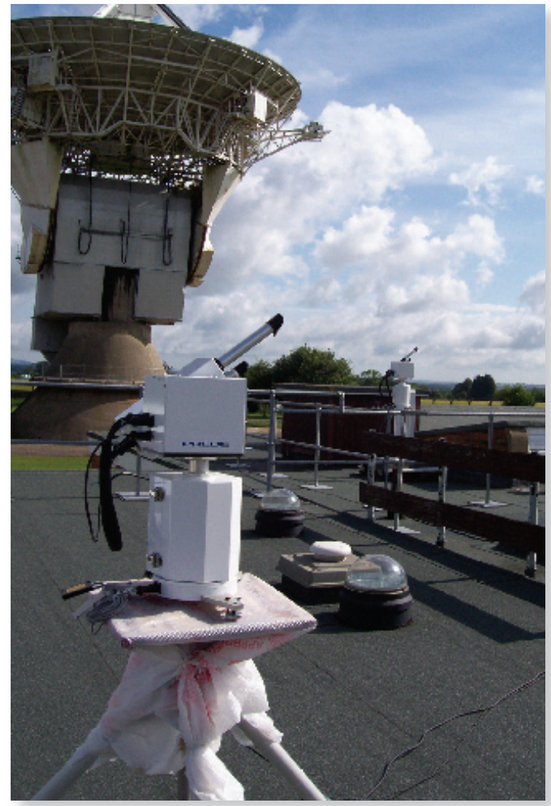
The instrument for measuring the direct radiation from the sun at a number of wavelengths is termed a Sun Photometer. It must be mounted on a highly accurate automatic Sun Tracker that keeps the optical system aligned exactly on the centre of the sun at all times of the year as it follows its arc from horizon to horizon. When the instrument is also capable of making pre-programmed measurements in angular patterns away from the sun it is often called a Sky Radiometer.

> "POM forms the basis of the Asia-Pacific SKYNET and is used by meteorological and air quality organisations around the world"

Sky Radiometers are used for both real-time ground-based measurements and for validating (ground-truthing) the data from spectral instruments aboard meteorological satellites. The measurement specifications are largely defined by the requirements of global organisations such as the World Meteorological Organisation (WMO) and NASA, and international networks such as AERONET in North America and SKYNET in the Asia-Pacific region.

One of the most widely used instruments for this purpose is the POM Sky Radiometer, manufactured by Prede Co. Ltd. in Tokyo and distributed world-wide by Kipp & Zonen. The POM is mounted on a dedicated, high accuracy, sun tracker that keeps it pointing at the centre of the sun and is connected to a PC running the control and measurement software. At user selectable intervals the POM-01 makes measurements of the radiation reaching the ground at wavelengths of 315, 400, 500, 675, 870, 940, and 1020 nm. The user can also programme the POM to make scattered light measurements at any (or all) of these wavelengths at angles up to 160° away from the sun. The data is stored to the computer disk for analysis.

The measurement wavelengths are chosen to suit WMO and satellite data validation requirements and are selected by optical filters inserted into the detection system under microprocessor control. The filters and detection system are temperature controlled to optimise stability under a wide range of environmental conditions. The latest generation of ground-based and satellite instruments measure further into the infrared to monitor larger sizes of aerosols and for this purpose the POM-02 has an additional detection system that measures at 1600 and 2200 nm.



POM inter-comparison at the Chilbolton Observatory, UK

The data can be processed to derive quantities such as Aerosol Optical Depth, Scattering Coefficients, Aerosol Distribution and sun and sky spectral energy distributions. POM forms the basis of the Asia-Pacific SKYNET and the UK aerosol monitoring network and is used by meteorological and air quality organisations around the world. ■

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