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Using ceilometers for renewable energy applications

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The installed renewable energy capacity has been increasing remarkably during recent years. As solar and wind resources can be highly variable in nature, mainly due to changing weather conditions, accurate forecasts of solar radiation and wind are also required as real-time conditions at renewable energy sites have a direct impact on renewable energy production. This includes conditions causing wind turbine icing, conditions which are desirable to both forecast and observe. Here, the focus has been on the use of ceilometer in renewable energy applications.

Ceilometer is a lidar-based instrument typically used for aviation to detect cloud base heights. Ceilometers can also report the full attenuated backscatter profile, and the information content can be used to obtain much more information than just cloud base heights. We will present identification algorithms for liquid cloud layers, precipitation (and ice clouds) and fog, based on ceilometer attenuated backscatter profiles. These algorithms would be applicable to hundreds of sites in Europe, thanks to a dense ceilometer network and the common effort to harmonise ceilometer network operation towards collecting the attenuated backscatter profiles through the EUMETNET E-PROFILE programme. Furthermore, these algorithms can be used for different renewable energy applications.

Here, the emphasis is on solar radiation and cloud cover forecast evaluation performed at a site in Helsinki, Finland, based on four years of solar radiation and ceilometer attenuated backscatter profile observations. The solar radiation and cloud cover forecasts were obtained from an operational numerical weather prediction model, the Integrated Forecast System by the European Centre for Medium-Range Weather Forecasts, and used to predict the expected power production at solar field day-ahead. The role of the cloud cover forecast in the solar radiation forecast error was investigated. It was found that there is a positive bias in the forecast incoming solar radiation even if the cloud cover forecast is correct and a negative bias in correctly forecast clear sky cases. Such studies can guide model improvements; this study highlighted deficiencies in the model aerosol climatology, and identified issues in the representation of liquid clouds

In addition, the liquid cloud layer and precipitation algorithms can be used to detect potential in-cloud icing conditions for wind energy. This is important as wind power production, especially in cold climates, suffers from icing conditions, and ice gathering on wind turbine blades is a serious safety issue.