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Using lidar together with cloud radar and wind profiler data to investigate an optically thick layer of aerosol over Great Britain and Ireland

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Abstract: Measurements from both a cloud radar and Doppler lidar system that captured the passage of an aerosol layer over Chilbolton Atmospheric Observatory (CAO) in the United Kingdom on 16th October 2017. The layer consisted of Saharan dust and Portuguese forest fire smoke. As the radar and lidar are both sensitive to different sized aerosol, an attempt was made to disentangle the different aerosol components.

1. Introduction

On 16th October 2017 a layer of optically thick aerosol was advected over the British Isles [1,2]. This layer made it possible to view the sun with the naked eye in the middle of the day and gave the sun a red colour. Initially, the layer was reported in the media as being Saharan dust which had been well forecast. But the previous day, forest fires had broken out in Portugal. This paper sets out to analyse the aerosol layer in more detail using ground-based remote sensing techniques.

2. Method and Results

To detect aerosol layers in the atmosphere, lidar is the best choice as light is strongly scattered by aerosol. Using a network of lidars on Great Britain and Ireland it was possible to track the strongly absorbing layer. Figure 1 shows an example of the layer as captured by the HALO Doppler lidar (in blue) based at the Chilbolton Atmospheric Observatory (CAO) in the United Kingdom (UK). It shows a sloping and in places deep layer of aerosol. The bottom part of this layer rises as the layer passes overhead. This is reflected in measurements at other sites in the UK.

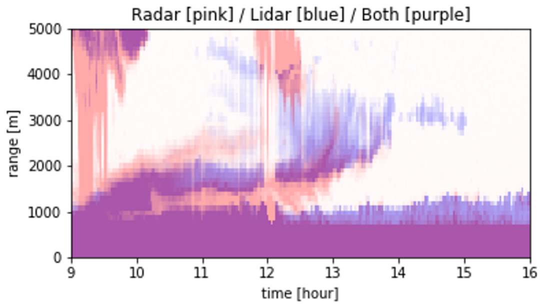

Figure 1. Radar reflectivity (pink) and lidar backscatter (blue) for 16th October 2017. The values are scaled to provide a comparison between the two datasets. Areas where both datasets overlap is shown in purple.

Interestingly, the layer of aerosol also shows up in the Copernicus Cloud Radar at CAO. Figure 1 shows the return power of the radar (in pink). The aerosol layer can be seen clearly. As the radar is designed to detect cloud, its wavelength is chosen to scatter most efficiently of cloud droplets and ice crystals. Cloud droplets have a typical diameter of 10-40 µm. So, aerosol particles being detected by the radar are of that size order.

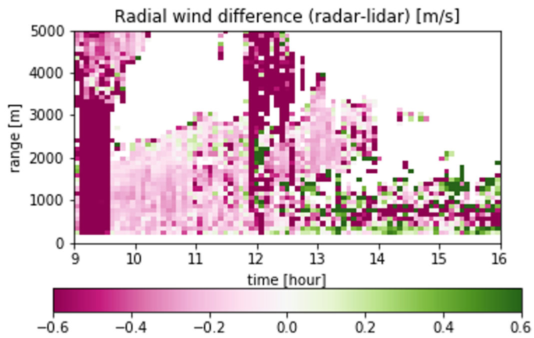

Figure 2. Difference between radial wind (vertical velocity) as measured by the radar and the lidar where both instruments measured a vertical velocity (16th October 2017).

The Doppler velocities of the aerosol layer as measured by the radar and lidar differ by about 0.4 m.s-1 (Figure 2), indicating that they are seeing different aerosol populations. Using the boundary layer wind profiler at CAO it will be possible to retrieve particle fall velocities of the particles detected by the lidar and the radar.

Details of the passage of the aerosol layer across the British Isles will be presented as well as an in-depth analysis using the lidar and radar data.

3. References

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