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Wet scavenging limits the detection of aerosol effects on precipitation

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1. Influence of humidity on AOD

Whilst wet scavenging generates a negative correlation between AOD and precipitation, an increase in humidity can result in an increase in AOD. These plots show the spatial pattern of the changes in aerosol dry mass and water content in the study region and around the composite convective system.

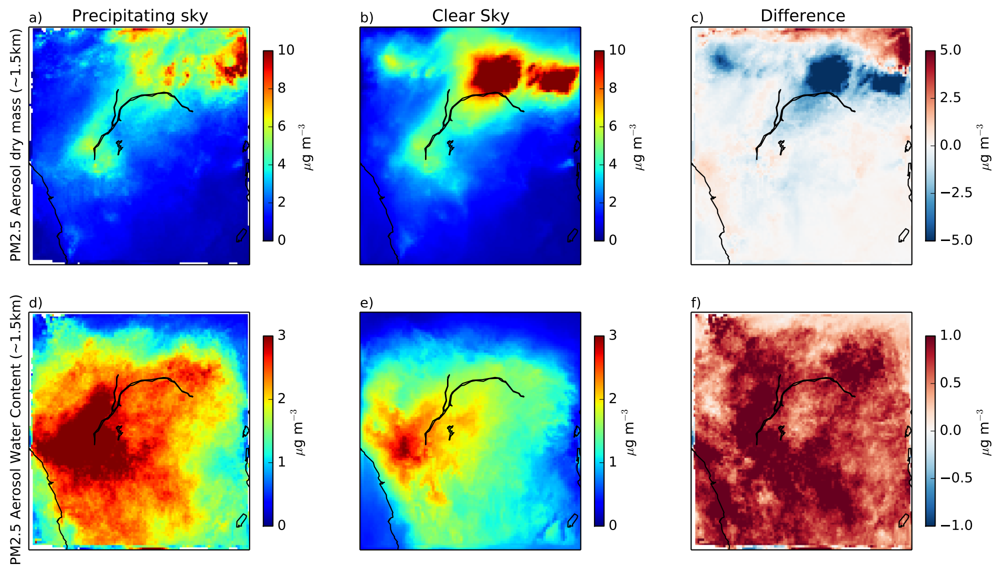

Figure S.1: PM2.5 aerosol dry mass in the study region in precipitating (>0.1 mmhr^{-1} - a) and clear (b) skies. The difference between them is shown in (c). The bottom row of plots are the same, but show the absolute values (d,e) and the changes (f) in PM2.5 aerosol water content. The aerosol dry mass and water content are shown from a model level at about 1.5 km.

Fig. S.1 shows that in precipitating locations, there is an increase in aerosol water content compared to the non-precipitating region, whilst there is a decrease in the aerosol dry mass in the precipitating skies (except for a small region in the north-east corner of the domain). This suggests that the small increases in AOD in the precipitating skies shown in Fig. 4 are primarily due to increases in aerosol water content.

Fig. S.2 shows that the decrease in AOD at the centre of the composite convective system shown in Fig. 5 is due to a reduction in aerosol dry mass, as would be expected from the wet scavenging of aerosol. The increases in AOD at the leading edge of the composite can be seen in Fig. S.2 to be primarily due to an increase in aerosol water content, which also shows a strong increase at the leading edge of the system.

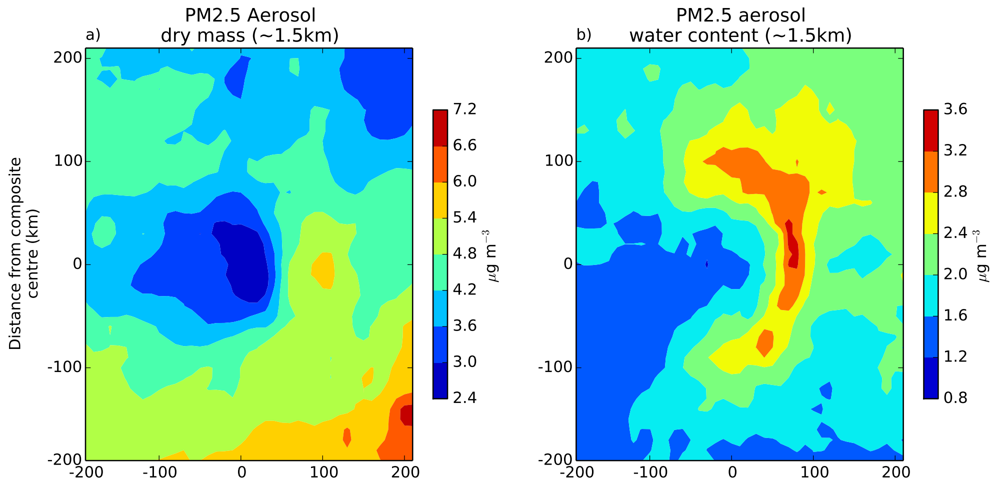

Figure S.2: The PM2.5 aerosol dry mass around the composite convective system (a) and the PM2.5 aerosol water content also around the composite system(b) shown in Fig. 5. The aerosol dry mass and water content are shown from a model level at about 1.5 km.

2. Higher resolution simulations

The compositing methodology in this work has also been applied to a convection-permitting simulation of the same region and period at a resolution of 4 km, running without a cumulus scheme. This run does not include aerosols or chemistry, but it does show the structure of the storm composite (Figs. S.3, S.4). Similar to the 10 km simulation, updraughts are located at the front of the system, drawing air into the system from nearby, non-precipitating regions (Fig. S.3). While the structure of the composite shows some differences, missing some of the inflow at the rear of the system (Fig. 5), the similarity of the composite system to the 10 km simulation suggests that the conclusions drawn in this work would be supported if the simulations were re-run at a higher resolution. This composite contains 22 separate systems.

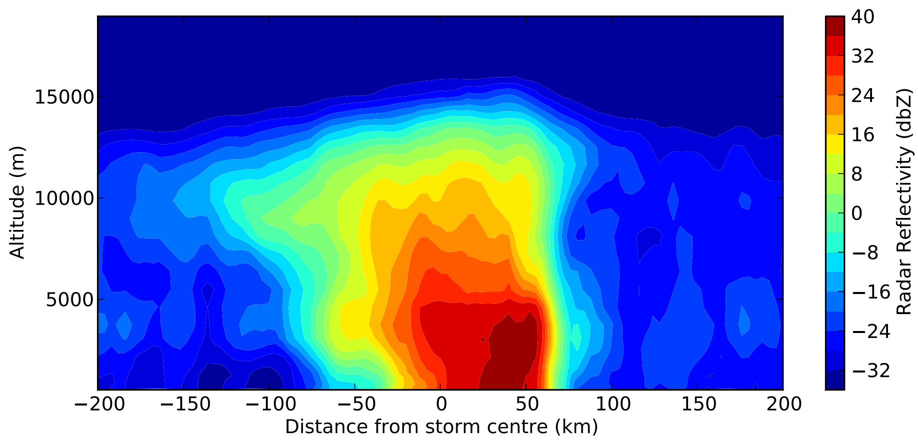

Figure S.3: Radar reflectivity structure of the storm composite from a one month run at 4km resolution. The direction of motion of the system is towards the right of the image.

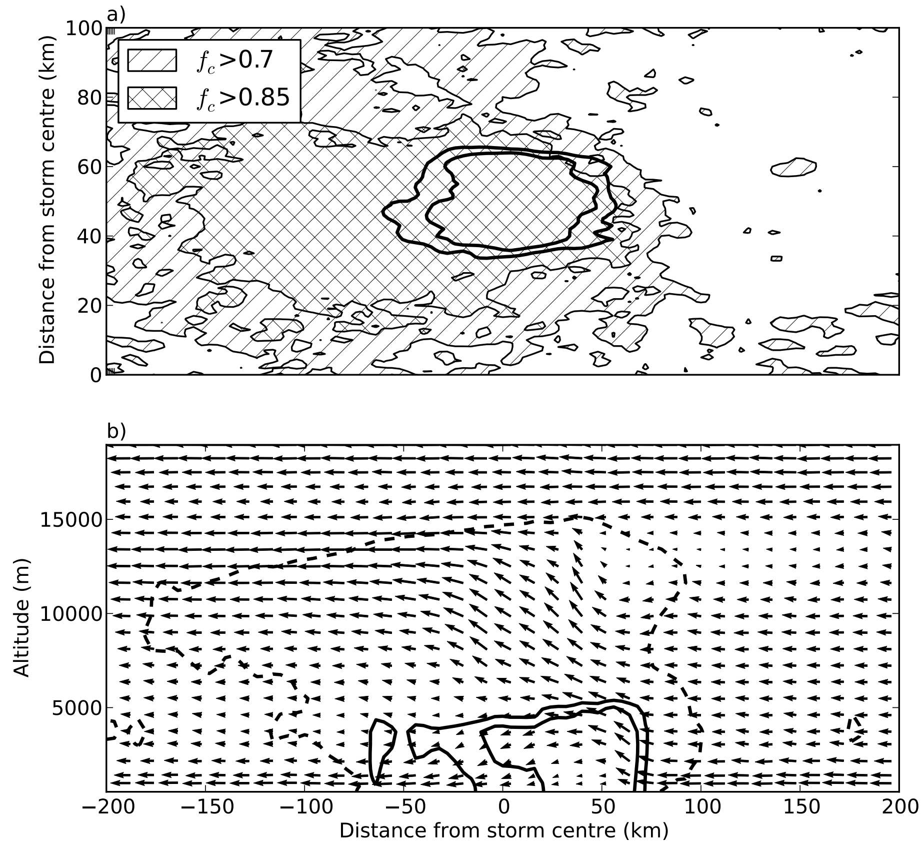

Figure S.4: a) A horizontal plot of the storm composite from the 4 km resolution WRF simulation. The hatched areas indicate the percentage of storms going into the composite with cloud in that region. Note the different limits for the contours compared to Fig. 5 due to the resolution dependence of cloud fraction. The solid lines are the 2 and 5 $\mathrm{mm\,hr^{-1}}$ rainrate contours. b) A vertical cross section through the centre of the system. The arrows indicate the wind direction relative to the storm centroid, enhanced by a factor of five to compensate for the different vertical and horizontal scales. The solid contours show the 0.2 and 0.8 $\mathrm{g\,kg^{-1}}$ levels of rainwater content and the dashed contour is the -20 dbZ radar reflectivity contour.