



Supplement of

Evaluating simulations of ship tracks in a km-scale model

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S1. Precipitation at ship locations

In order to investigate the sensitivity of the model to the initial conditions of the cloud, before the ship sails through, we use the direction of travel of ships as a proxy for the background precipitation. Ships A-C travel away from the coast, whereas ships D and E travel from the open ocean towards California. In Fig. S1 we plot the surface rain rate at the location of the ship (in the control run so there is no effect from the ship aerosol), and demonstrate that this grouping of ships by direction of travel is a relatively good proxy for precipitating / non-precipitating conditions. We must note, however, that ships A-C are not purely non-precipitating, and do pass through some precipitating clouds towards the end of the simulation run. This explains why we do see some precipitation suppression in these tracks in Fig. 10.

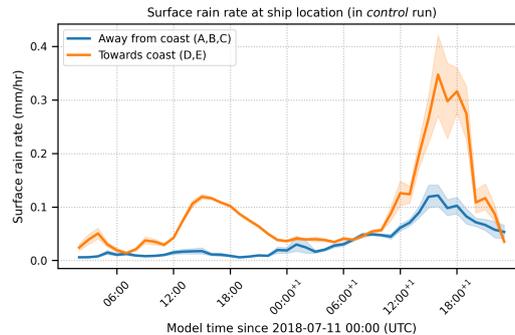


Figure S1. Surface rain rate at the ship locations, in the *control* run. Ships travelling towards the coast are travelling through clouds that are precipitating more than ships travelling away from the coast.

S2. Sensitivity in probability of precipitation to season

10 We compare the probability of precipitation (PoP) in our 48 hour model simulation to observations in the same domain across 4 years (2007-2011). This is done to ensure enough data coverage from observations. We make the argument that the PoP distribution within N_d -LWP space is a function of the microphysical processes, and should be the same day-to-day or season-to-season. In light of this, we separate our 4 years of observations into winter (DJF) and summer (JJA), and find that the PoP distribution is largely similar, with a small decrease in PoP in winter to summer. The pattern within N_d -LWP space is similar between summer and winter, and starkly different to the binary nature of the PoP in our model simulation.

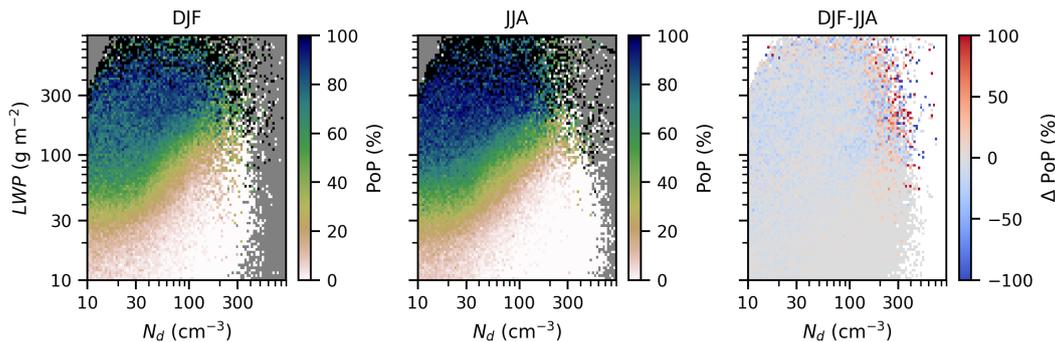


Figure S2. Probability of precipitation (PoP) in DJF, JJA, and difference. Observations from CCCM product, from 2007-2011.

15 S3. Aerosol Evaluation

In this work, a constant initial aerosol field is utilised to simplify our simulations. This initial field contains a constant concentration of accumulation mode aerosol everywhere, which is then allowed to freely evolve within the simulation. Some aerosol can enter other modes from the background emissions.

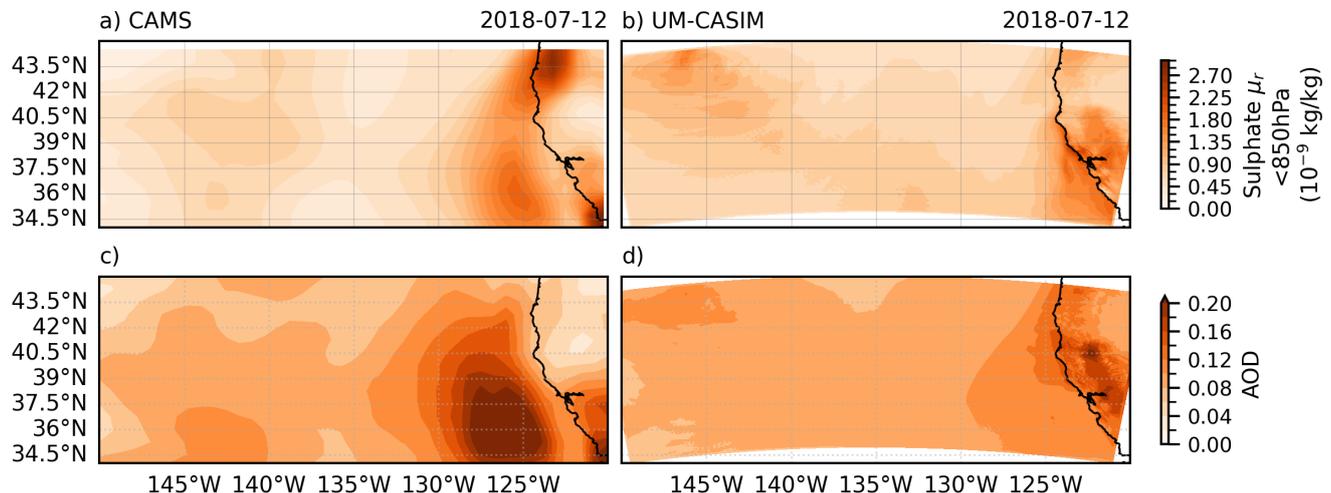


Figure S3. Daily mean sulphate mass mixing ratio (μ_r below 850 hPa on 12th July 2018 for (a) CAMS reanalysis, and (b) UM-CASIM simulation, and daily mean AOD from (c) CAMS reanalysis and (d) UM-CASIM simulation.

20 Firstly, we demonstrate that our selection of a roughly 200cm^{-3} field at model initialisation is able to reproduce the spatial distribution of sulphate throughout the domain in Fig. S3. There is a slight overestimation in the mass mixing ratio in the Central Pacific region of the domain, however in large the representation of the sulphate is well matched with the CAMS reanalysis.

25 Likewise, comparing the daily mean AOD after spin up from the UM-CASIM simulation to CAMS reanalysis (Fig. S3d and c), whilst the UM-CASIM simulation underestimates the AOD slightly near the Californian coast, the spatial pattern and magnitude is comparable. Even though the simulation is initialised from a constant aerosol field of accumulation mode, it does not appear to cause the aerosol field later in the simulation to be completely unconstrained. Evaluation against satellite derived AOD, such as from MODIS, is not possible since due to the lack of retrievals of AOD in cloudy scenes.

30 However, the main impact of our simplified initial aerosol configuration will be the neglecting of other size modes. In Fig. S4 we investigate the expected contribution to the AOD from different chemical components. We find that, whilst the sulphate is a significant contributor to the AOD, sea salt and organic matter are also significant. Sea salt, especially, is a significant contributor to the AOD near the coast, and the neglecting of this component in our initial field introduces some uncertainty into our results. These are discussed in the main paper Section 4.1.2.

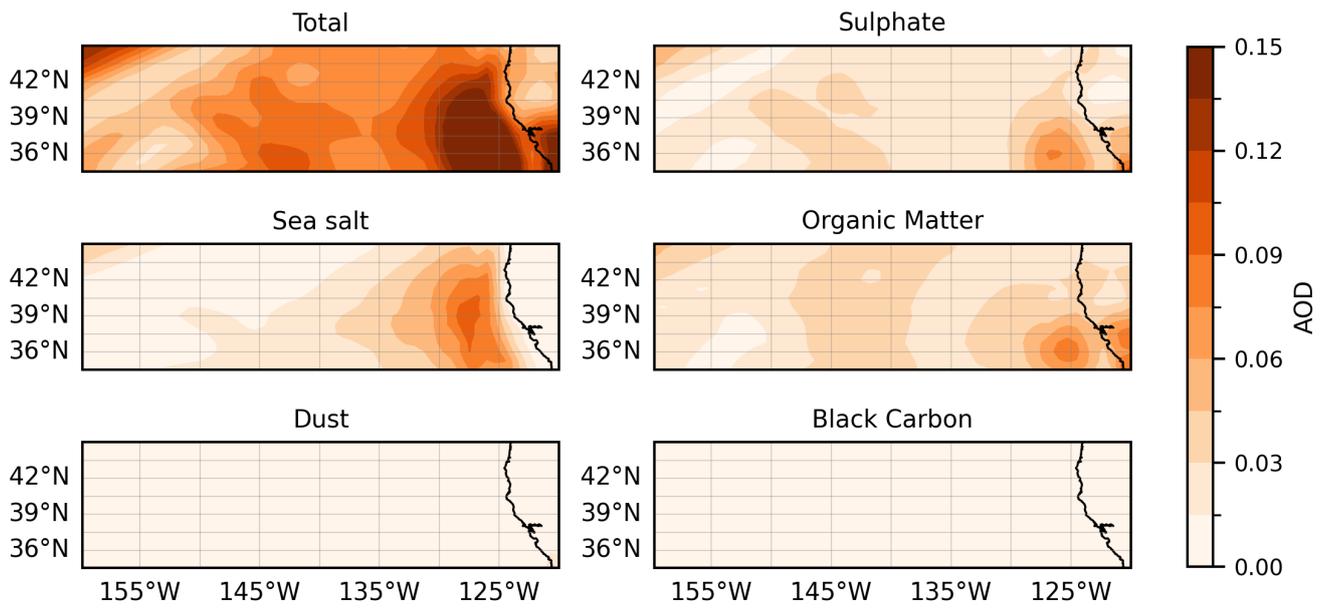


Figure S4. CAMS aerosol optical depth on 12th July 2018, and contribution from each chemical component.