Others:

1. Would it be possible to reduce the size of Figure 7 so that it is consistent with the rest of the figures in the manuscript?

2. Additionally, after an earlier correspondence with Vitaly Muravyev, I would like to rewrite Section 2.2.1 (P3, lines 32 - 64) and should be read as the paragraphs given below. I have two versions of this section. The first one is the latex version and the other is the text. Reason: to provide a clearer rationale for using the Morales-Betancourt and Nenes (2014) scheme.

Latex version:

The parameterization schemes used in the global models showed systematic biases for parameters describing the aerosol size distribution and updraft velocity compared to the cloud parcel model that can lead to very low (high) maximum supersaturation (S$_{max}$) for cases when high (low) aerosol loads combined with low (high) updraft velocity. Simpler schemes such as the \cite{abd00} and \cite{shi15} parameterizations typically used in GCMs showed larger biases compared to the more comprehensive schemes such as the \cite{bar10} and \cite{mor14} schemes in clean marine regions, particularly over the Southern ocean. The reason that the latter capture the response of droplet number better is because they explicitly treat the condensation of water vapor to the largest of particles which are known to have a strong effect on the rate of condensation at the early stages of cloud formation (hence S$_{max}$). Such effects were not considered at all – or incompletely treated - in previous works.

Hence, the cloud activation scheme of \cite{abd00} is replaced by the \cite{mor14} scheme in the FORCeS version of the EC-Earth3-AerChem model. This scheme makes use of the population splitting concept wherein the growing population of droplets is divided into 3 populations, based on their proximity to the critical diameter, enabling a more accurate estimate of the rate of condensation of water vapor at the point of S$_{max}$ – which in turn gives a better estimate of cloud S$_{max}$ and hence droplet number. The code used also features a number of numerical accelerations, which includes polynomial approximations of the error function \cite{mor14} and integrations over a vertical velocity PDF using a Gaussian Quadrature with integration points that are determined through Legendre polynomials. This method requires far fewer function calls (4 vs 10 or 20 with the pre-existing method used) for the same accuracy of integration.

Text version:

The parameterization schemes used in the global models showed systematic biases for parameters describing the aerosol size distribution and updraft velocity compared to the cloud parcel model that can lead to very low (high) maximum supersaturation (S_{max}) for cases when high (low) aerosol loads combined with low (high) updraft velocity. Simpler schemes such as the Abdul-Razzak and Ghan (2000) and Shipway (2015)

parameterizations typically used in GCMs showed larger biases compared to the more comprehensive schemes such as the Barahona et al. (2010) and Morales-Betancourt and Nenes (2014) schemes in clean marine regions, particularly over the Southern ocean. The reason that the latter capture the response of droplet number better is because they explicitly treat the condensation of water vapor to the largest of particles which are known to have a strong effect on the rate of condensation at the early stages of cloud formation (hence S_{max}). Such effects were not considered at all – or incompletely treated - in previous works.

Hence, the cloud activation scheme of Abdul-Razzak and Ghan (2000) is replaced by the Morales-Betancourt and Nenes (2014) scheme in the FORCeS version of the EC-Earth3-AerChem model. This scheme makes use of the population splitting concept wherein the growing population of droplets is divided into 3 populations, based on their proximity to the critical diameter, enabling a more accurate estimate of the rate of condensation of water vapor at the point of S_{max} – which in turn gives a better estimate of cloud S_{max} and hence droplet number. The code used also features a number of numerical accelerations, which includes polynomial approximations of the error function Morales-Betancourt and Nenes (2014) and integrations over a vertical velocity PDF using a Gaussian Quadrature with integration points that are determined through Legendre polynomials. This method requires far fewer function calls (4 vs 10 or 20 with the pre-existing method used) for the same accuracy of integration.