



Supplement of

Numerical case study of the aerosol-cloud interactions in warm boundary layer clouds over the eastern North Atlantic with an interactive chemistry module

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Fig. S1. WRF-Chem simulated cloud fraction (CF; units: kg m⁻²) in the control runs at 10:00 UTC on (a) 1 July 2016, (b) 19 July 2017, and (c) 23 August 2019 over the ENA. (d), (e), and (f) are on the same day of (a), (b), and (c), respectively, but from the WRF-Chem in the perturbed runs.



Figure S2. The time series (local time; UTC – 1 hour) of potential temperature profiles (units: K) from ARM interpolated soundings at the Azores (39.09°N, 28.02°W) on (a) 1 July 2016, (c) 19 July 2017, and (e) 23 August 2019. Panels (b), (d), and (f) depict the same dates as (a), (c), and (e), respectively, but show the average relative humidity from WRF-Chem simulated data over a 20×20 grid centered on the Azores (approximately 4 km resolution).



Figure S3. The time series (local time; UTC – 1 hour) of relative humidity profiles (units: %) from ARM interpolated soundings at the Azores (39.09°N, 28.02°W) on (a) 1 July 2016, (c) 19 July 2017, and (e) 23 August 2019. Panels (b), (d), and (f) depict the same dates as (a), (c), and (e), respectively, but show the average relative humidity from WRF-Chem simulated data over a 20×20 grid centered on the Azores (approximately 4 km resolution).



Figure S4. The time series (local time; UTC – 1 hour) of BC profiles (units: $\mu g kg^{-1}$) from MERRA-2 at the Azores (39.09°N, 28.02°W) on (a) 1 July 2016, (c) 19 July 2017, and (e) 23 August 2019. Panels (b), (d), and (f) depict the same dates as (a), (c), and (e), respectively, but show the average aerosol concentration from WRF-Chem simulated data over domain 4.



Figure S5. The time series (local time; UTC – 1 hour) of OC profiles (units: $\mu g kg^{-1}$) from MERRA-2 at the Azores (39.09°N, 28.02°W) on (a) 1 July 2016, (c) 19 July 2017, and (e) 23 August 2019. Panels (b), (d), and (f) depict the same dates as (a), (c), and (e), respectively, but show the average aerosol concentration from WRF-Chem simulated data over domain 4.



Figure S6. The time series (local time; UTC – 1 hour) of sea salt profiles (units: $\mu g kg^{-1}$) from MERRA-2 at the Azores (39.09°N, 28.02°W) on (a) 1 July 2016, (c) 19 July 2017, and (e) 23 August 2019. Panels (b), (d), and (f) depict the same dates as (a), (c), and (e), respectively, but show the average aerosol concentration from WRF-Chem simulated data over domain 4.



Figure S7. (a) ERA5 and (b) WRF-Chem (d01) mean surface wind speed (contour; units: m sec⁻) on 23 August 2019.



Figure S8. (a), (c), and (e) are the time series (local time; UTC - 1 hour) of domain-averaged aerosol number concentration (Aiken mode and accumulation mode; units: cm⁻³) and CCN number concentration under 0.2% and 1.0% supersaturations (units: cm⁻³ averaged within 2000 m height over the domain 4 on 1 July 2016, 19 July 2017, and 23 August 2019, respectively, in the control runs. (b), (d), and (f) are the same as (a), (c), and (e) but in the perturbed runs.



Figure S9. (a), (b), and (c) are the time series (local time; UTC - 1 hour) of domain-averaged liquid water path (blue lines; units: g m⁻²) and rainfall intensity (red lines; units: mm 10-min⁻¹) for the control case (soild lines) and the perturbed case (dashed lines) on 1 July 2016, 19 July 2017, and 23 August 2019, respectively.



Figure S10. WRF-Chem simulated liquid water path (LWP; units: kg m⁻²) in (a) the control run and (b) the perturbed runs at 10:00 UTC on 19 July 2017 over the domain 4. (c) The logarithmic slope between LWP and CCN using data from 16 aggregate grid points (~25 km for each grid point; the orange grids) from (a) the control run and 16 aggregated grid points from (b) the perturbed run.



Figure S11. (a) and (b) are the mean liquid water path (LWP) and cloud radius (Re) susceptibilities for different cloud condensation nuclei (CCN) and LWP bins for three study cases, respectively. (c) and (d) are the same as (a) and (b), respectively, but for different cloud droplet number (Nc) and LWP bins.



Figure S12. (a), (c) and (e) are the time variable of LWP susceptibility for different CCN concentration on 1 July 2016, 19 July 2017, and 23 August 2019, respectively. (b), (d) and (f) are the time variable of LWP susceptibility for different Nc concentration on 1 July 2016, 19 July 2017, and 23 August 2019, respectively.