Supplementary Material for

Impacts on cloud radiative effects induced by coexisting aerosols converted from international shipping and maritime DMS emissions

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Introduction

This Supporting Information file includes 8 figures to provide additional and detailed information to support the analyses and discussion in the main text.

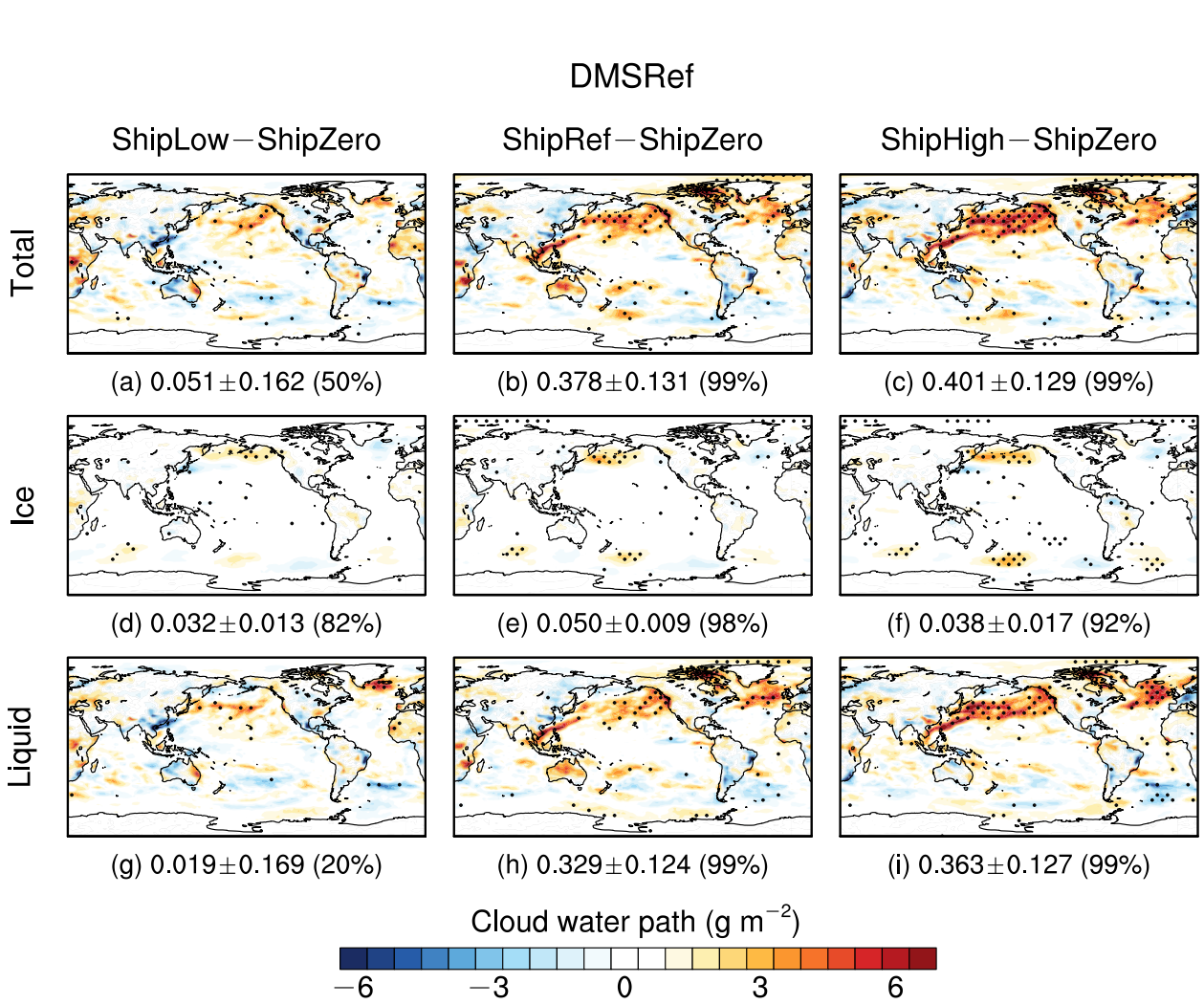

Figure S1. Spatial patterns of MARC simulated cloud water path (g m^{-2}) responses to international shipping emissions. The responses are calculated as the differences of cloud water integrated through the whole atmospheric columns between the simulation without shipping emissions and three simulations with various shipping emission rates (i.e., low, reference, high) over the 30-year simulation period. Both liquid and ice water path are calculated as well as the total water path (liquid+ice). All simulations use the emission rates of DMS at the reference level. The numbers below each panel are the global means, standard deviation across the 30-year period, and the confidence level. The black dots represent grid points that are statistically significant above the 90% confidence level based on the two-tailed Student's *t*-test.

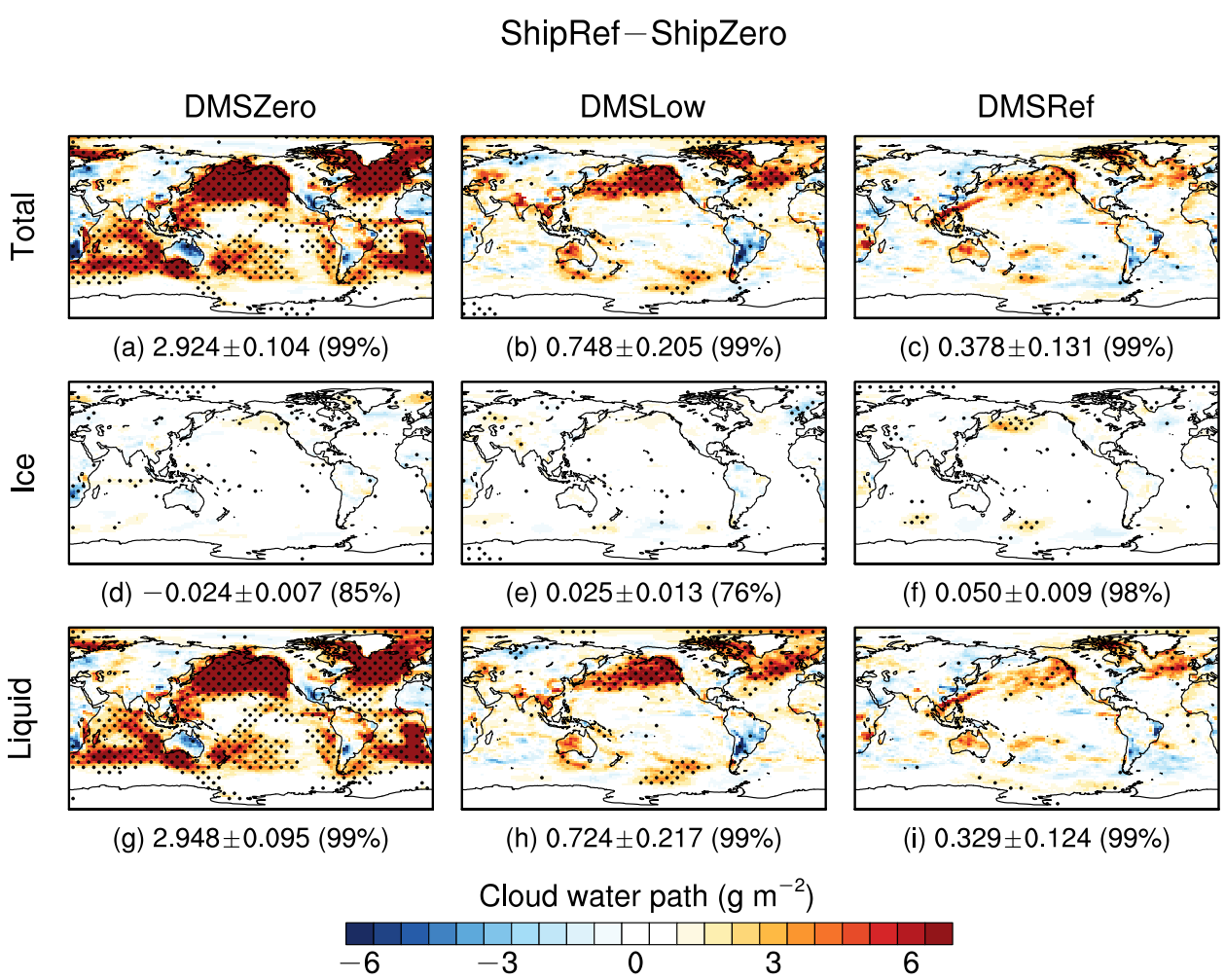

Figure S2. Spatial patterns of MARC simulated cloud water path (g m^{-2}) responses to international shipping emissions. The responses are calculated as the differences of cloud water integrated through the whole atmospheric columns between the simulation without shipping emissions and three simulations with the reference shipping emissions and various DMS emission levels (i.e., zero, low, and reference) over the 30-year simulation period. Both liquid and ice water path are calculated as well as the total water path (liquid+ice). The numbers below each panel are the global means, standard deviation across the 30-year period, and the confidence level. The black dots represent grid points that are statistically significant above the 90% confidence level based on the two-tailed Student's *t*-test.

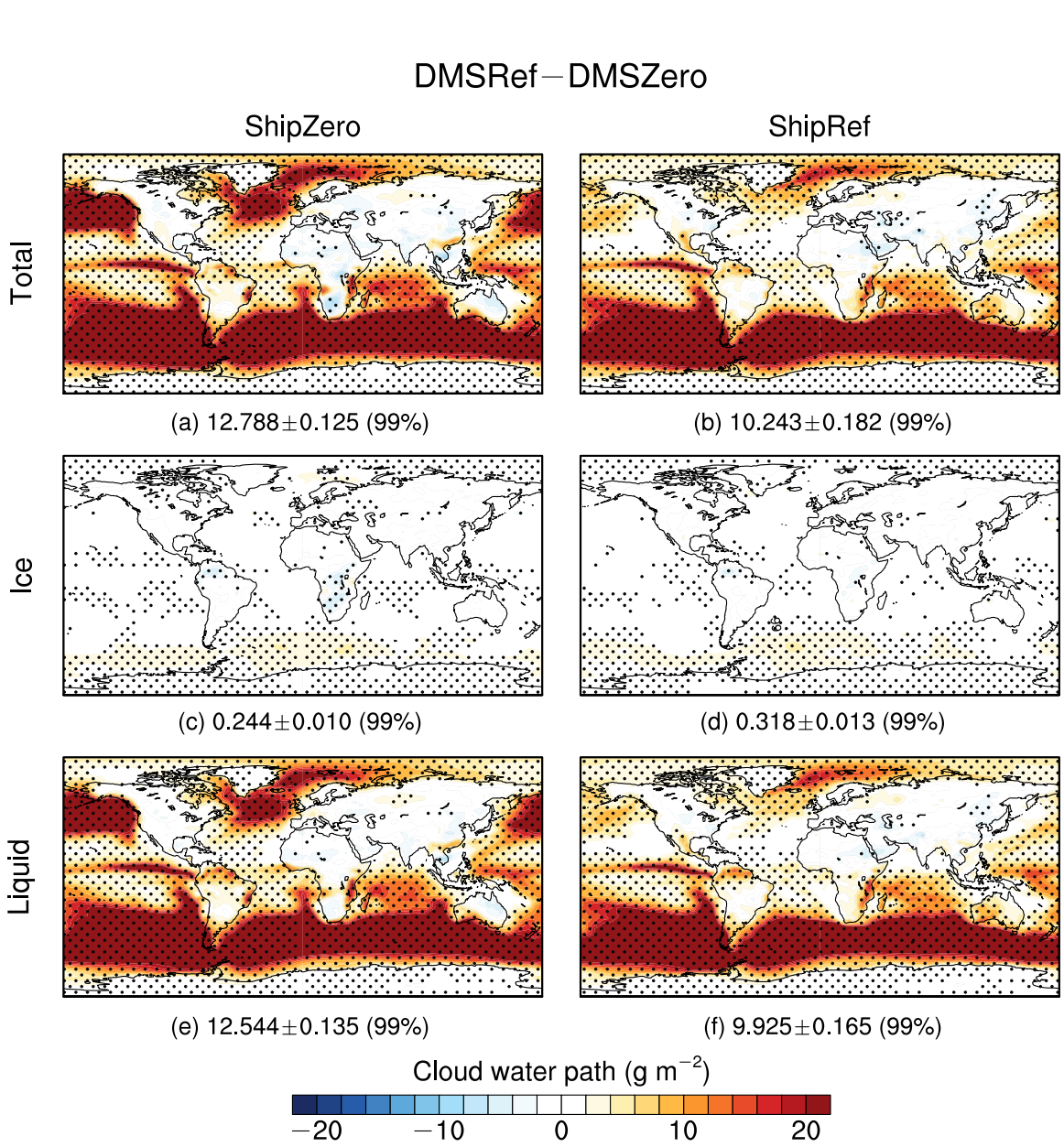

Figure S3. Spatial patterns of simulated cloud water path (g m^{-2}) responses to DMS emissions. The responses are calculated as the differences of cloud water integrated through the whole atmospheric columns between the simulation without DMS emissions and three simulations with the reference DMS emissions and various shipping emission levels (i.e., zero and reference) over the 30-year simulation period. Both liquid and ice water path are calculated as well as the total water path (liquid+ice). The numbers below each panel are the global means, standard deviation across the 30-year period, and the confidence level. The black dots represent grid points that are statistically significant above the 90% confidence level based on the two-tailed Student's *t*-test.

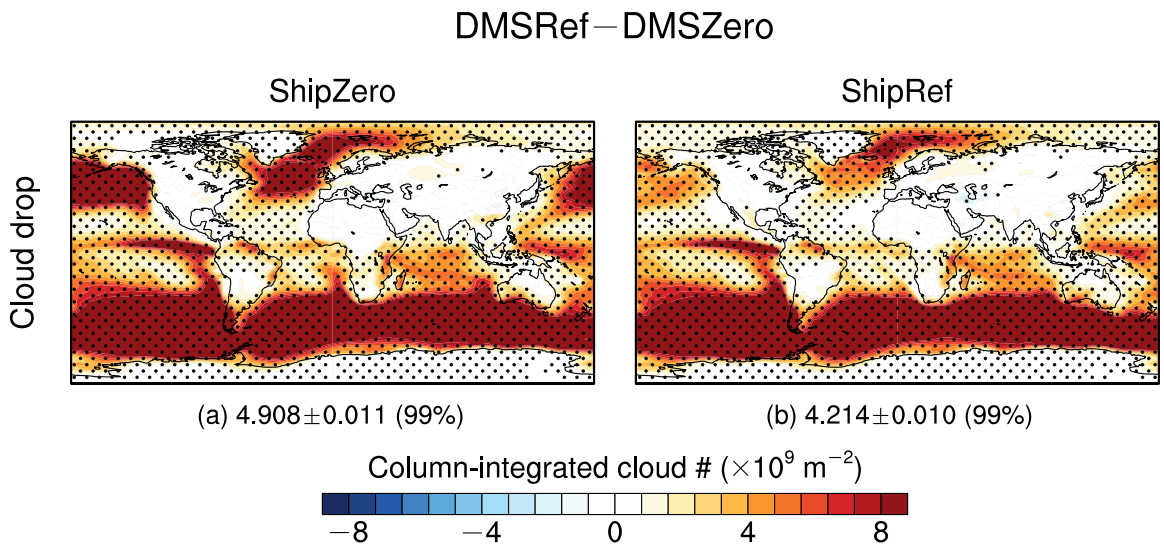

Figure S4. Spatial patterns of simulated cloud droplet number flux ($\times 10^9$ m^{-2}) response to DMS emissions. The responses are calculated as the differences of cloud droplet number integrated through the whole atmospheric columns between the simulation without DMS emissions and two simulations with DMS emissions at the reference level and various shipping emissions (i.e., zero and reference) over the 30-year simulation period. The numbers below each panel are the global means, standard deviation across the 30-year period, and the confidence level. The black dots represent grid points that are statistically significant above the 90% confidence level based on the two-tailed Student's *t*-test.

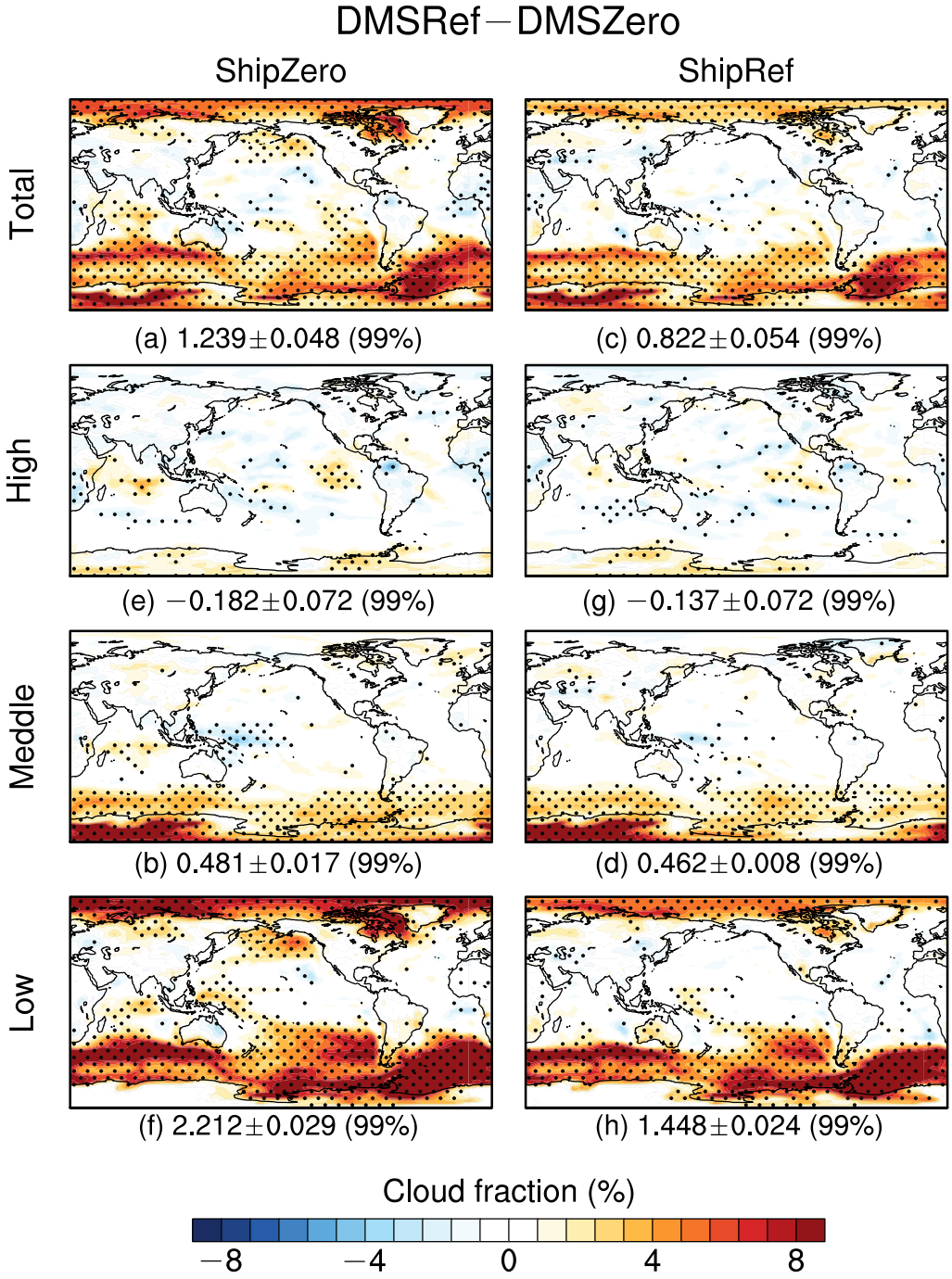

Figure S5. Spatial patterns of simulated cloud area fraction (%) response to DMS emissions. The responses are calculated as the differences of cloud area fraction between the simulation without DMS emissions and two simulations with DMS emissions at the reference level and various shipping emissions (i.e., zero and reference) over the 30-year simulation period. The numbers below each panel are the global means, standard deviation across the 30-year period, and the confidence level. The black dots represent grid points that are statistically significant above the 90% confidence level based on the two-tailed Student's *t*-test.

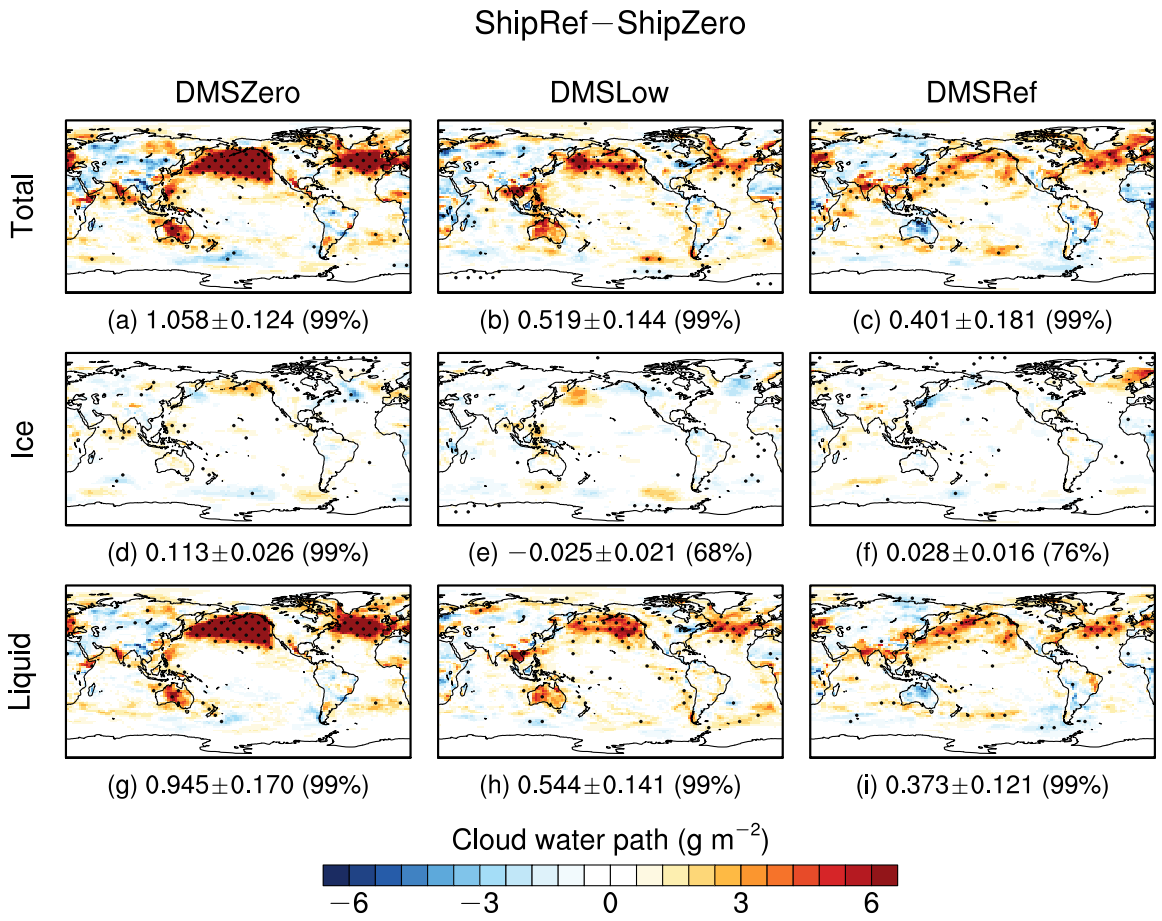

Figure S6. Same as Figure S2, but using a different aerosol module MAM3 rather than MARC.

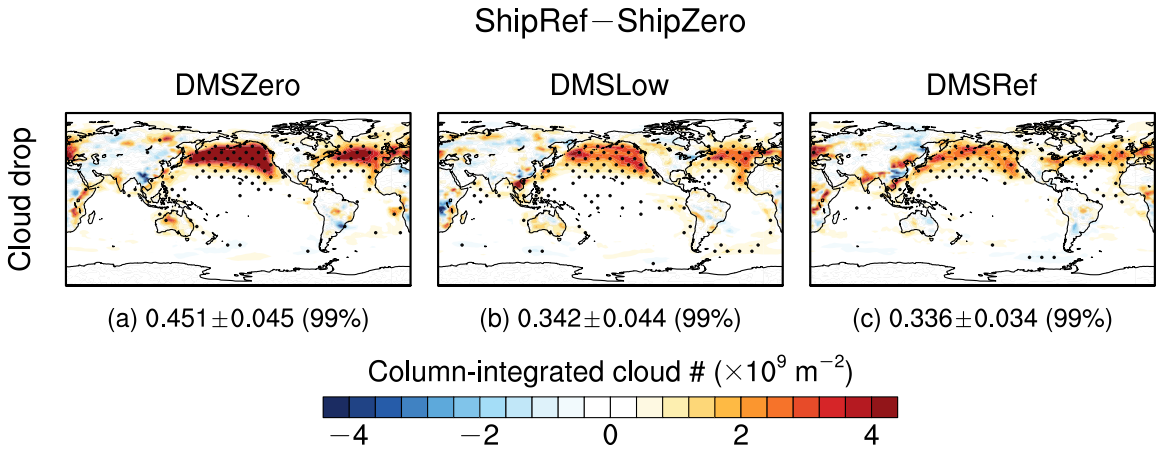

Figure S7. Same as Figure 7 in the main text, but using a different aerosol module MAM3 rather than MARC.

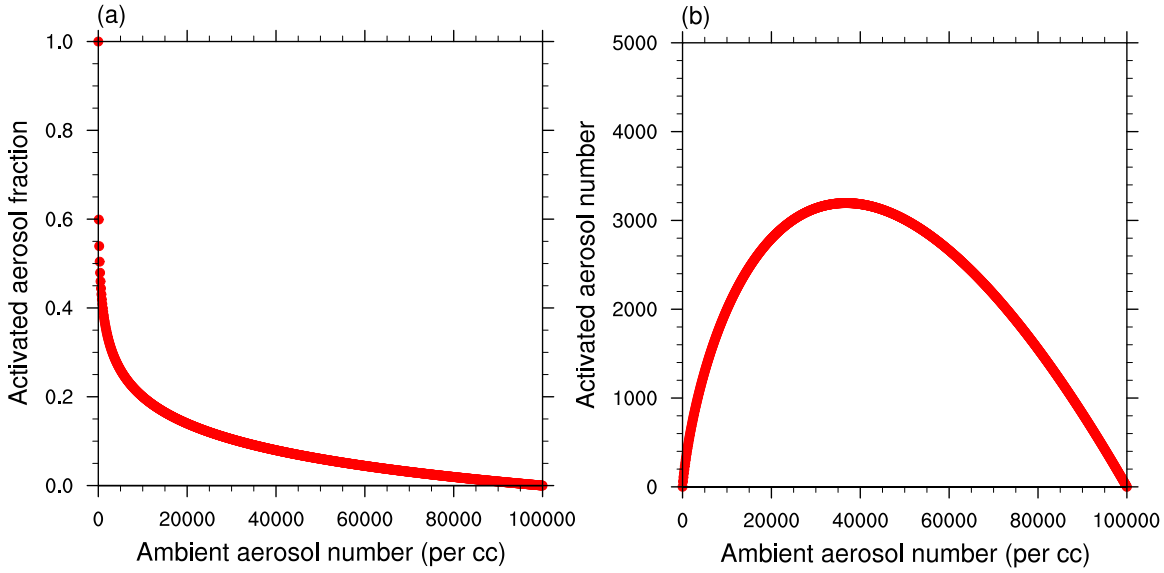

Figure S8. The relationship between ambient aerosol number concentrations and activated aerosols parameterized in the aerosol activation scheme. This relationship is retrieved when the temperature, pressure, and updraft velocity are 10°C, 800 mbar, and 5 m s^{-1}, respectively.