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Atmospheric Chemistry and Physics Discussions
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Interactive comment on "The value of remote marine aerosol measurements for constraining radiative forcing uncertainty" *by* Leighton A. Regayre et al.

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These figures and tables have all been included in response to reviewer comments. They need to be viewed alongside our responses, so that reviewers can appreciate how their comments have shaped our manuscript. Figure and table captions are included here, followed by the figures and tables themselves.

Fig S1: Measured CCN0.2 values between the 3rd and 10th January 2017, after filtering for possible ship stack contamination. The ACE-SPACE vessel transited through 5 model gridboxes during this period. We average all measurements collected in locations, over one or more days, within each model gridbox, for comparison with monthly

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mean model output. These average values and one standard deviation of the measurement data are shown in red at the central time for each measurement subset. From left to right, these values correspond to the five model gridboxes in Fig. 1 between around 60oE and 90oE, at the following latitude and longitudes: 1) 49.5oS, 65.5oE, 2) 49.5oS, 69.5oE, 3) 54oS, 77oE, 4) 54oS, 84.5oE and 5) 56.5oS, 92oE.

Fig. S3. Two-dimensional marginal probability density distributions for a) sea spray emission flux scale factor (Sea_Spray) and the Accumulation aerosol mode dry deposition velocity scale factor (Dry_Dep_Acc), b) sea spray emission flux scale factor and dimethylsulfide surface water concentration scale factor (DMS), c) sea spray emission flux scale factor and cloud droplet pH (Cloud_pH), and d) Accumulation aerosol mode dry deposition velocity scale factor and dimethylsulfide surface water concentration scale factor. Individual parameter ranges are plotted according to their constrained values (table S3), not the full range of values used in the original sample of model variants as shown in Fig. 3, Fig. 5 and Fig. S2.

Fig. S4. Ratio of ERA-Interim wind speed differences (between measurement and simulated years) to the measurement year. Monthly mean winds from 2006 (matching the AER PPE) were subtracted from monthly mean winds for December 2016 to April 2017 (matching the ACE-SPACE campaign) to calculate the differences. The map is an assimilation of data between months, where data is presented at each location for months corresponding to the timing of the ACE-SPACE measurement campaign.

Table 1. Annual and monthly mean cloud drop number concentrations over the Southern Ocean (over the region between 50oS and 60oS at around 1km altitude above sea level) in the original unconstrained sample and the sample of model variants constrained to ACESPACE campaign measurements. Mean values and 95% credible interval values are shown for each sample, with interquartile ranges in brackets. For comparison, we show cloud drop concentrations calculated from MODIS instrument data following Grosvenor et al., (2018) for the year 2008 (SI Methods: Measurements).

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Table S1: Individual measurement type constraint threshold values and exceedance tolerance values for December to April, as well as the percentage of the one million member sample retained by each constraint. Exceedance tolerances values are percentages of the number of measurements in each month.

Table S2: Threshold values and exceedance tolerance values for December to April, as well as the percentage of the one million member sample retained by each constraint. Exceedance tolerances values are percentages of the number of measurements in each month. These constraints are combined to retain around 3% of the one million member sample of model variants, as described in the main article.

Table S3. Ranges and inter-quartile ranges of marginal parameter distributions from individual constraints using measured concentrations of CCN0.2, CCN1.0, non-sea-salt sulfate and N700, as well as for the combined constraint. These individual constraints are those described in table S2 and were combined to constrain the model and make Fig. 3. Values are marked in bold where the individual measurement type constraint moves the range, 25th or 75th percentile closer towards the range or percentiles of the combined constraint than other measurement types, relative to the unconstrained values.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1085, 2019.

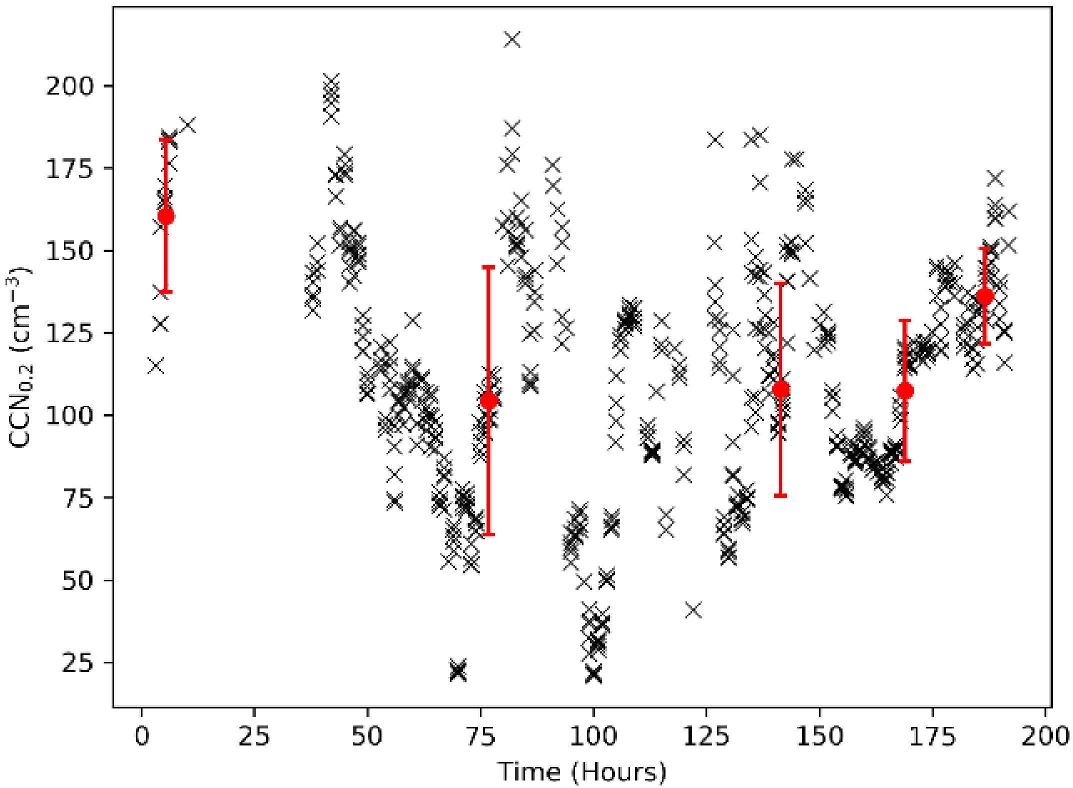

Fig. 1. Fig. S1. A new figure in response to reviewer comments

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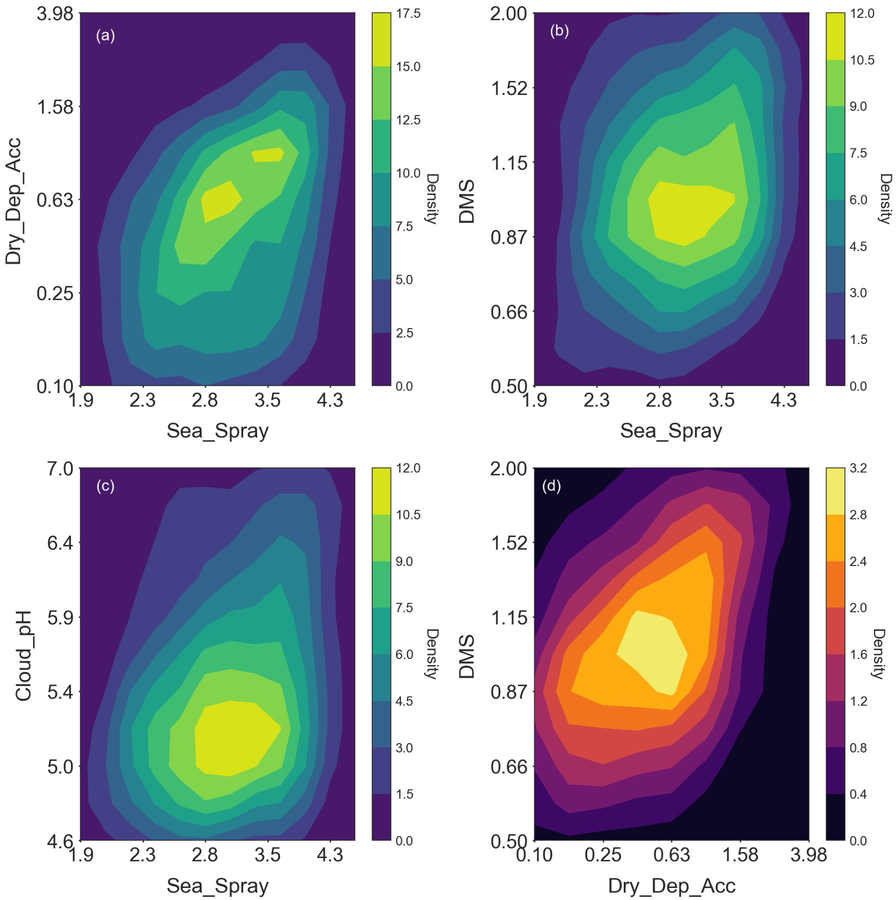

Fig. 2. Fig. S3. A new figure in response to reviewer comments

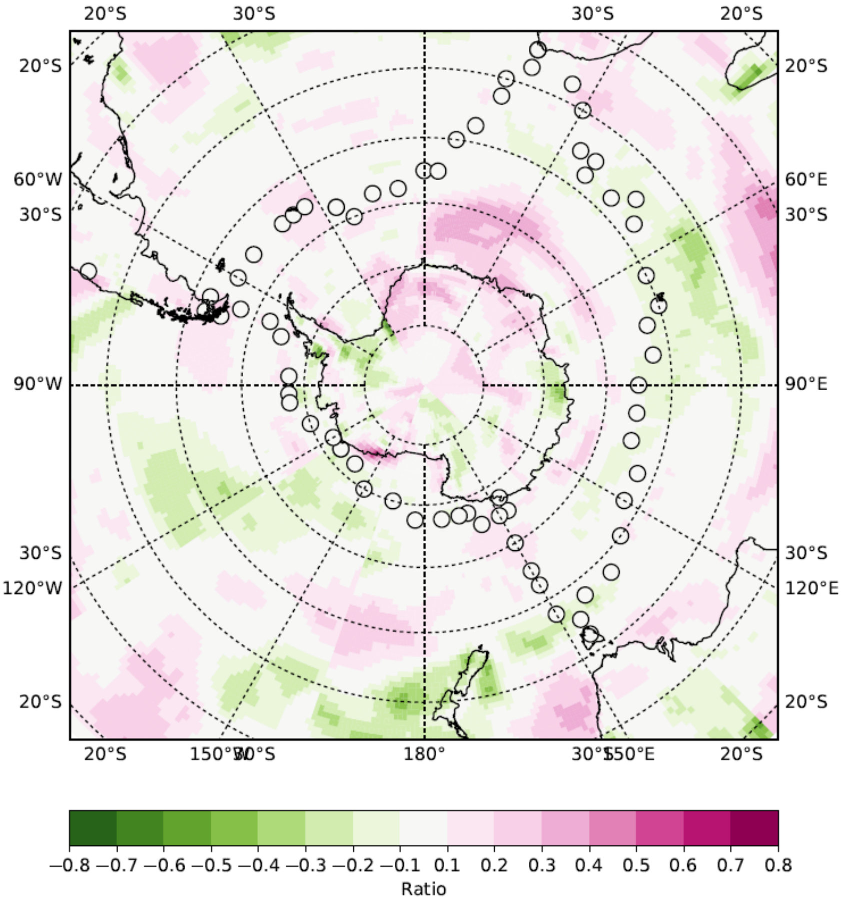

Fig. 3. Fig. S4. A new figure in response to reviewer comments

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	Annual	December	January	February	March	April
MODIS (cm^{-3})	73	89	91	90	82	63
Unconstrained mean (cm^{-3})	38	39	39	41	42	39
Unconstrained credible interval (cm^{-3})	7-125 (112)	8-115 (103)	8-117 (109)	7-122 (115)	7-129 (122)	7-118 (111)
Constrained mean (cm^{-3})	66	67	69	72	76	70
Constrained credible interval (cm^{-3})	41-96 (55)	43-96 (53)	44-99 (55)	45-105 (60)	47-111 (64)	44-101 (57)

Fig. 4. Table 1. A new table in response to reviewer comments

	$CCN_{0.2}$	$CCN_{1.0}$	Nss-sulfate	N_{700}
Implausibility Threshold	3.5	3.5	3.5	3.5
Exceedance tolerance (%) Dec-Apr	15,15,20,20,10	2,2,2,5,2	15,20,20,15	20,20,25,20,20
Percentage retained	3.3	3.0	6.2	3.0

Fig. 5. Table S1. A new table in response to reviewer comments

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	$CCN_{0.2}$	$CCN_{1.0}$	Nss-sulfate	N_{700}
Implausibility Threshold	4.5	4.5	4.0	4.5
Exceedance tolerance (%) Dec-Apr	30,30,30,30,10	25,30,30,15,5	20,20,20,15	25,25,25,30,25
Percentage retained	20.6	18.1	29.9	24.2

Fig. 6. Table S2. A new table in response to reviewer comments

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Parameter Name	Unconstrained	$CCN_{0.2}$	$CCN_{1.0}$	Non-sea-salt sulfate	N_{700}	Combined
BL_Nuc	0.1,10.0 [0.3,3.2]	0.1,10.0 [0.3,**3.5**]	0.1,10.0 [0.3,3.0]	0.1,10.0 [0.3,3.3]	0.1,10.0 [0.3,3.2]	0.1,10.0 [0.3,3.5]
Ageing	0.3,10.0 [2.7,7.6]	0.3,10.0 [3.0,7.9]	0.3,10.0 [2.5,7.5]	0.3,10.0 [2.7,7.6]	0.3,10.0 [2.6,7.5]	0.3,10.0 [2.7,7.6]
Acc_ Width	1.2,1.8 [1.4,1.6]	1.2,1.8 [**1.3**,1.7]	1.2,1.8 [1.4,1.7]	1.2,1.8 [1.4,1.7]	1.2,1.8 [**1.3**,1.7]	1.2,1.8 [1.3,1.7]
Ait_Width	1.2,1.8 [1.3,1.6]	1.2,1.8 [1.3,1.7]	1.2,1.8 [1.3,1.6]	1.2,1.8 [1.3,1.7]	1.2,1.8 [1.3,1.7]	1.2,1.8 [1.3,1.6]
Cloud_pH	4.6,7.0 [5.2,6.4]	4.6,7.0 [**5.1**,6.4]	4.6,7.0 [**5.1**,**6.2**]	4.6,7.0 [5.2,6.4]	4.6,7.0 [5.2,6.4]	4.6,7.0 [5.1,6.2]
Carb_FF_ Ems	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]
Carb_BB_ Ems	0.25,4.00 [0.50,2.00]	0.25,4.00 [0.52,**2.16**]	0.25,4.00 [**0.48**,2.01]	0.25,4.00 [0.50,2.01]	0.25,4.00 [0.49,2.03]	0.25,4.00 [0.49,2.06]
Carb_Res_ Ems	0.25,4.00 [0.50,2.00]	0.25,4.00 [**0.45**,**1.78**]	0.25,4.00 [0.48,2.02]	0.25,4.00 [0.49,2.00]	0.25,4.00 [0.50,2.02]	0.25,4.00 [0.48,1.94]
Carb_FF_ Diam	30,90 [45,75]	30,90 [45,**76**]	30,90 [44,75]	30,90 [45,75]	30,90 [45,75]	30,90 [45,76]
Carb_BB_ Diam	90,300 [143,248]	90,300 [141,**250**]	90,300 [**140**,249]	90,300 [142,248]	90,300 [141,248]	90,300 [141,249]
Carb_Res_ Diam	90,500 [193,398]	90,500 [193,**404**]	90,500 [**190**,399]	90,500 [192,400]	90,500 [193,400]	90,500 [189,400]
Prim_SO4_ Frac	1.0e-6,1.0e-1 [1.8e-5,5.6e-3]	1.0e-6,1.0e-1 [1.7e-5,6.5e-3]	1.0e-6,1.0e-1 [**1.3e-5**,**4.2e-3**]	1.0e-6,1.0e-1 [1.7e-5,5.6e-3]	1.0e-6,1.0e-1 [1.6e-5,6.0e-3]	1.0e-6,1.0e-1 [1.6e-5,5.2e-3]
Prim_SO4_ Diam	3,100 [27,76]	3,100 [26,**75**]	3,100 [**29**,**78**]	3,100 [27,76]	3,100 [26,77]	3,100 [28,77]
Sea_ Spray	0.1,8.0 [0.4,2.8]	1.5,8.0 [2.7,3.8]	**1.9**,8.0 [**3.8**,**5.7**]	0.1,8.0 [0.3,2.8]	1.5,**5.2** [2.5,3.6]	1.6,5.1 [2.6,3.7]
Anth_SO2	0.6,1.5 [0.8,1.2]	0.6,1.5 [0.8,1.2]	0.6,1.5 [0.7,1.2]	0.6,1.5 [0.8,1.2]	0.6,1.5 [0.8,1.2]	0.6,1.5 [0.8,1.2]
Volc_SO2	0.7,2.4 [1.0,1.8]	0.7,2.4 [1.0,1.8]	0.7,2.4 [1.0,1.8]	0.7,2.4 [1.0,1.8]	0.7,2.4 [1.0,1.8]	0.7,2.4 [1.0,1.8]
BVOC_ SOA	0.8,5.4 [1.3,3.4]	0.8,5.4 [1.3,3.5]	0.8,5.4 [1.4,3.5]	0.8,5.4 [1.3,3.4]	0.8,5.4 [1.3,3.4]	0.8,5.4 [1.3,3.4]
DMS	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.5]	0.5,2.0 [0.7,1.4]	0.5,2.0 [**0.8**,1.5]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.8,1.3]
Dry_Dep_ Ait	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.3]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]
Dry_Dep_ Acc	0.1,10.0 [0.3,3.2]	0.1,9.3 [**0.2**,**0.9**]	0.1,**6.7** [**0.2**,1.0]	0.1,10.0 [0.3,1.9]	0.1,10.0 [0.3,3.2]	0.1,6.4 [0.2,0.8]
Dry_Dep_ SO2	0.2,5.0 [0.4,2.2]	0.2,5.0 [0.4,2.2]	0.2,5.0 [0.4,2.4]	0.2,5.0 [0.4,2.2]	0.2,5.0 [0.4,2.2]	0.2,5.0 [0.4,2.2]
Kappa_ OC	0.1,0.6 [0.2,0.5]	0.1,0.6 [0.2,0.5]	0.1,0.6 [0.2,0.5]	0.1,0.6 [0.2,0.5]	0.1,0.6 [0.2,0.5]	0.1,0.6 [0.2,0.5]
Sig_W	0.1,0.7 [0.3,0.5]	0.1,0.7 [0.2,0.6]	0.1,0.7 [0.2,0.6]	0.1,0.7 [0.2,0.6]	0.1,0.7 [0.2,0.6]	0.1,0.7 [0.2,0.6]
Dust	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]	0.5,2.0 [0.7,1.4]
Rain_Frac	0.3,0.7 [0.4,0.6]	0.3,0.7 [0.4,0.6]	0.3,0.7 [0.4,0.6]	0.3,0.7 [0.4,0.6]	0.3,0.7 [0.4,0.6]	0.3,0.7 [0.4,0.6]
Cloud_Ice_ Thresh	0.1,0.5 [0.2,0.4]	0.1,0.5 [0.2,**0.3**]	0.1,0.5 [0.2,0.4]	0.1,0.5 [0.2,0.4]	0.1,0.5 [0.2,0.4]	0.1,0.5 [0.2,0.4]

Fig. 7. Table S3. A new table in response to reviewer comments