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Insoluble lipid film mediates transfer of soluble saccharides from the sea to the atmosphere: the role of hydrogen bonding

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Table S1. Experimental results of SSA production.

Exp. #	Materials	Total number concentration (# cm^{-3})	Mean (# cm^{-3})	Total mass concentration (μg m^{-3})	Mean (μg m^{-3})	Geometric mean diameter (nm)	Mean (nm)
1	SW	1.76×10^4	1.80×10^4	194.8	195.1	148.8	147.4
2	SW	1.83×10^4		195.4		146.4	
3	SW	1.81×10^4		195.1		146.9	
4	Glu+SW	2.03×10^4	2.08×10^4	255.1	253.4	153.3	152.5
5	Glu+SW	2.09×10^4		256.0		152.8	
6	Glu+SW	2.11×10^4		249.1		151.3	
7	Tre+SW	2.67×10^4	2.69×10^4	295.3	301.6	145.1	145.5
8	Tre+SW	2.64×10^4		307.1		146.3	
9	Tre+SW	2.76×10^4		302.5		145.2	
10	SW+(MA+PA+SA)	1.46×10^4	1.49×10^4	159.0	161.9	144.5	145.5
11	SW+(MA+PA+SA)	1.48×10^4		162.8		147.3	
12	SW+(MA+PA+SA)	1.53×10^4		163.8		144.8	
13	Glu+SW+(MA+PA+SA)	1.61×10^4	1.63×10^4	176.8	173.1	144.0	145.3
14	Glu+SW+(MA+PA+SA)	1.63×10^4		167.1		145.0	
15	Glu+SW+(MA+PA+SA)	1.66×10^4		175.4		146.9	
16	Tre+SW+(MA+PA+SA)	1.33×10^4	1.36×10^4	146.5	153.1	147.6	148.3
17	Tre+SW+(MA+PA+SA)	1.38×10^4		152.9		149.5	
18	Tre+SW+(MA+PA+SA)	1.37×10^4		159.8		147.8	

Table S2. The wavenumbers, reflectance-absorbance intensities, peak areas and full width at half maximum (FWHM, cm^{-1}) values of each fitted peak in the region of 3000–2800 cm^{-1}.

Subphase solution	**Vibrational Mode**	**Center λ**	**RA Int.**	**Area**	**FWHM**
SW	$\nu_{as}(CH_2)$	2918.5	-0.00185	-0.03309	16.808
	$\nu_{s}(CH_2)$	2851.2	-0.00111	-0.01608	13.57594
0.1 g L^{-1} Glu + SW	$\nu_{as}(CH_3)$	2958.4	-4.31864E-4	-0.00346	7.51782
	$\nu_{as}(CH_2)$	2918.9	-0.00171	-0.02182	11.99799
	$\nu_{s}(CH_2)$	2850.9	-9.72011E-4	-0.01068	10.32428
0.5 g L^{-1} Glu + SW	$\nu_{as}(CH_3)$	2956.0	-2.29947E-4	-0.0026	10.61544
	$\nu_{as}(CH_2)$	2918.6	-0.00201	-0.03608	16.87062
	$\nu_{s}(CH_2)$	2849.5	-0.00153	-0.02432	14.91072
1.0 g L^{-1} Glu + SW	$\nu_{as}(CH_3)$	2959.5	-4.19718E-4	-0.0052	11.62956
	$\nu_{as}(CH_2)$	2918.3	-0.00215	-0.03736	16.29126
	$\nu_{s}(CH_3)$	2885.6	-2.82189E-4	-0.00221	7.37158
	$\nu_{s}(CH_2)$	2850.1	-0.00134	-0.01984	13.88958

2.0 g L^{-1} Glu + SW	$v_{as}(CH_3)$	2954.4	-2.05472E-4	-0.00168	7.69794
	$v_{as}(CH_2)$	2918.5	-0.00213	-0.04015	17.74608
	$v_s(CH_3)$	2878.3	-1.1778E-4	-6.89695E-4	5.50113
	$v_s(CH_2)$	2850.2	-0.00120	-0.02324	18.2208
5.0 g L^{-1} Glu + SW	$v_{as}(CH_3)$	2963.5	-5.64995E-4	-0.00703	11.69719
	$v_{as}(CH_2)$	2916.2	-0.00203	-0.02984	13.82432
	$v_s(CH_3)$	2878.2	-1.3869E-4	-0.00106	7.19615
	$v_s(CH_2)$	2851.3	-0.00111	-0.01218	10.32791
0.1 g L^{-1} Tre + SW	$v_{as}(CH_3)$	2958.5	-2.00472E-4	-0.00167	7.83866
	$v_{as}(CH_2)$	2918.1	-0.00152	-0.02744	17.00659
	$v_s(CH_3)$	2886.7	-2.68355E-4	-0.00158	5.54736
	$v_s(CH_2)$	2848.6	-9.85504E-4	-0.01801	17.16883
0.5 g L^{-1} Tre + SW	$v_{as}(CH_3)$	2970.2	-3.67837E-4	-0.00554	14.15997
	$v_{as}(CH_2)$	2917.6	-0.00194	-0.03321	16.06815
	$v_s(CH_3)$	2884.0	-3.72886E-4	-0.00371	9.33563
	$v_s(CH_2)$	2849.6	-0.00127	-0.02004	14.82763
1.0 g L^{-1} Tre + SW	$v_{as}(CH_3)$	2954.8	-3.27869E-4	-0.00278	7.96068
	$v_{as}(CH_2)$	2917.7	-0.00183	-0.03066	15.75973
	$v_s(CH_3)$	2875.4	-2.02348E-4	-9.25882E-4	4.29858
	$v_s(CH_2)$	2850.8	-8.58981E-4	-0.01064	11.64005
2.0 g L^{-1} Tre + SW	$v_{as}(CH_3)$	2959.4	-4.53922E-4	-0.00561	11.60698
	$v_{as}(CH_2)$	2917.7	-0.00213	-0.03439	15.18866
	$v_s(CH_3)$	2879.7	-1.53721E-4	-0.00187	11.41895
	$v_s(CH_2)$	2850.6	-0.00136	-0.02186	15.10103
5.0 g L^{-1} Tre + SW	$v_{as}(CH_3)$	2958.8	-2.48494E-4	-0.00232	8.76669
	$v_{as}(CH_2)$	2917.7	-0.00237	-0.04167	16.50295
	$v_s(CH_2)$	2848.4	-0.00159	-0.02564	15.14432

Table S3. The wavenumbers, reflectance-absorbance intensities, peak areas and full width at half maximum (FWHM, cm^{-1}) values of each fitted peak in the region of 1800–1300 cm^{-1}.

Subphase solution	**Vibrational Mode**	**Center λ**	**RA Int.**	**Area**	**FWHM**
SW	$v(C{=}O)_1$	1733.7	-0.00116	-0.01125	9.14501
	$v(C{=}O)_2$	1724.6	-5.48813E-4	-0.00446	7.6382
	$v(C{=}O)_3$	1707.8	-4.34352E-4	-0.00289	6.2493
	δ(H-O-H)	1679.5	0.00119	0.01723	13.62018
	$v_{as}(COO^-)_1$	1563.7	-0.0061	-0.23525	36.21625
	$v_{as}(COO^-)_2$	1539.0	-0.00209	-0.0454	20.38112
	$\delta(CH_2)$	1468.4	-0.00193	-0.02351	11.43217
	$v_s(COO^-)$	1415.4	-0.00104	-0.0183	16.47793
0.1 g L^{-1} Glu + SW	$v(C{=}O)_1$	1732.8	-0.00119	-0.01412	11.15153

	$\nu(C=O)_2$	1718.8	-0.00154	-0.01807	11.05338
	$\nu(C=O)_3$	1704.2	-5.93786E-4	-0.00495	7.83349
	δ(H-O-H)	1673.0	0.00146	0.0272	17.4585
	$\nu_{as}(COO^-)_1$	1564.2	-0.00572	-0.18341	30.10244
	$\nu_{as}(COO^-)_2$	1544.2	-0.00216	-0.01935	8.43057
	$\nu_{as}(COO^-)_3$	1527.8	-0.00126	-0.01231	9.19952
	$\delta(CH_2)$	1468.5	-0.00229	-0.03705	15.18894
	$\nu_s(COO^-)$	1419.2	-7.39415E-4	-0.00712	9.04681
0.5 g L^{-1} Glu + SW	$\nu(C=O)_1$	1742.5	-0.00118	-0.00813	6.49399
	$\nu(C=O)_2$	1724.3	-9.52824E-4	-0.01023	10.08979
	$\nu(C=O)_3$	1709.3	-0.00227	-0.02795	11.57697
	δ(H-O-H)	1698.0	8.89955E-4	0.01806	19.05901
	$\nu_{as}(COO^-)_1$	1567.0	-0.00422	-0.0867	19.30369
	$\nu_{as}(COO^-)_2$	1544.3	-0.00371	-0.0907	22.98149
	$\nu_{as}(COO^-)_3$	1523.0	-7.76135E-4	-0.00659	7.97558
	$\delta(CH_2)$	1469.3	-0.00165	-0.01737	9.88728
	$\nu_s(COO^-)$	1411.6	-0.00104	-0.01235	11.1052
1.0 g L^{-1} Glu + SW	$\nu(C=O)_1$	1727.2	-0.00105	-0.01685	15.12109
	$\nu(C=O)_2$	1708.8	-9.93395E-4	-0.00898	8.49311
	δ(H-O-H)	1688.9	0.00103	0.01045	9.51712
	$\nu_{as}(COO^-)_1$	1568.9	-0.00524	-0.14135	25.32749
	$\nu_{as}(COO^-)_2$	1546.1	-0.00344	-0.06123	16.73342
	$\nu_{as}(COO^-)_3$	1530.6	-0.00124	-0.01301	9.82577
	$\delta(CH_2)$	1469.1	-0.00158	-0.01837	10.90628
	$\nu_s(COO^-)$	1410.5	-0.00113	-0.02047	17.04823
2.0 g L^{-1} Glu + SW	$\nu(C=O)_1$	1722.9	-0.00226	-0.03437	14.31677
	$\nu(C=O)_2$	1710.5	-0.00112	-0.01179	9.93448
	δ(H-O-H)	1685.8	0.00115	0.01126	9.17038
	$\nu_{as}(COO^-)_1$	1572.0	-0.00339	-0.07563	20.98252
	$\nu_{as}(COO^-)_2$	1550.3	-0.00353	-0.12405	33.0587
	$\delta(CH_2)$	1467.3	-0.00178	-0.0242	12.76879
	$\nu_s(COO^-)$	1402.8	-9.6072E-4	-0.01422	13.90561
5.0 g L^{-1} Glu + SW	$\nu(C=O)_1$	1734.3	-0.00262	-0.0142	5.0946
	$\nu(C=O)_2$	1720.4	-0.00179	-0.01514	7.93418
	$\nu(C=O)_3$	1702.2	-0.00187	-0.01683	8.47304
	δ(H-O-H)	1664.8	0.00154	0.01781	10.88637
	$\nu_{as}(COO^-)_1$	1565.6	-0.00485	-0.11179	21.6659
	$\nu_{as}(COO^-)_2$	1546.7	-0.00256	-0.03503	12.87336
	$\nu_{as}(COO^-)_3$	1523.4	-0.0021	-0.04584	20.51001
	$\delta(CH_2)$	1468.9	-0.00253	-0.03343	12.42385
	$\nu_s(COO^-)$	1408.4	-0.00101	-0.02691	25.06143
0.1 g L^{-1} Tre + SW	$\nu(C=O)_1$	1724.6	-0.00237	-0.04416	17.52295
	$\nu(C=O)_2$	1705.2	-5.93808E-4	-0.00421	6.65261

	δ(H-O-H)	1673.2	0.00162	0.02299	13.37156
	$\nu_{as}(COO^-)_1$	1567.5	-0.0045	-0.08177	17.06647
	$\nu_{as}(COO^-)_2$	1545.2	-0.00255	-0.03081	11.37012
	$\nu_{as}(COO^-)_3$	1529.5	-4.75626E-4	-0.00544	10.74177
	$\delta(CH_2)$	1467.7	-0.00294	-0.05194	16.59713
	$\nu_s(COO^-)$	1404.6	-7.2926E-4	-0.01062	13.67604
0.5 g L^{-1} Tre + SW	$\nu(C=O)_1$	1728.7	-0.00194	-0.03335	16.18182
	$\nu(C=O)_2$	1693.9	-8.97773E-4	-0.00871	9.11458
	δ(H-O-H)	1650.4	0.00133	0.0413	29.07776
	$\nu_{as}(COO^-)_1$	1571.1	-0.00454	-0.10362	21.42142
	$\nu_{as}(COO^-)_2$	1546.1	-0.00437	-0.10543	22.67422
	$\delta(CH_2)$	1467.1	-0.00157	-0.01584	9.45689
	$\nu_s(COO^-)$	1414.3	-7.47053E-4	-0.01205	15.15915
1.0 g L^{-1} Tre + SW	$\nu(C=O)_1$	1734.2	-9.12388E-4	-0.01234	12.70683
	$\nu(C=O)_2$	1715.6	-0.00131	-0.0322	23.12903
	δ(H-O-H)	1644.2	6.57338E-4	0.01655	23.65629
	$\nu_{as}(COO^-)_1$	1564.3	-0.0046	-0.11181	22.85851
	$\nu_{as}(COO^-)_2$	1539.3	-0.00216	-0.05266	22.92928
	$\delta(CH_2)$	1468.0	-0.00158	-0.01757	10.42847
	$\nu_s(COO^-)$	1423.5	-6.28405E-4	-0.00762	11.38607
2.0 g L^{-1} Tre + SW	$\nu(C=O)_1$	1745.2	-0.00113	-0.01039	8.66705
	$\nu(C=O)_2$	1723.5	-7.05295E-4	-0.00912	12.14158
	$\nu(C=O)_3$	1706.9	-0.00162	-0.01675	9.71563
	δ(H-O-H)	1680.1	0.0014	0.013	8.71047
	$\nu_{as}(COO^-)_1$	1564.4	-0.0065	-0.16176	23.36868
	$\nu_{as}(COO^-)_2$	1539.7	-0.00525	-0.12168	21.7841
	$\nu_{as}(COO^-)_3$	1519.2	-0.00335	-0.04819	13.52754
	$\delta(CH_2)$	1467.1	-0.00189	-0.02986	14.83903
	$\nu_s(COO^-)$	1412.2	-0.0012	-0.01803	14.10566
5.0 g L^{-1} Tre + SW	$\nu(C=O)_1$	1726.6	-0.00289	-0.04547	14.77103
	$\nu(C=O)_2$	1707.6	-0.00292	-0.08951	28.79412
	δ(H-O-H)	1655.7	0.0012	0.02371	18.58088
	$\nu_{as}(COO^-)_1$	1568.3	-0.00456	-0.09459	19.4977
	$\nu_{as}(COO^-)_2$	1545.7	-0.00371	-0.08251	20.90899
	$\nu_{as}(COO^-)_3$	1525.9	-0.00124	-0.01549	11.73075
	$\delta(CH_2)$	1467.1	-0.00192	-0.02074	10.17395
	$\nu_s(COO^-)$	1414.3	-0.0012	-0.01519	11.91514

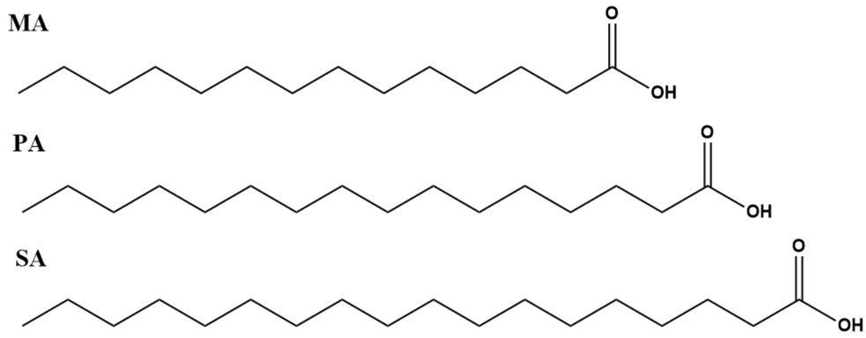

Figure S1. Chemical structures of the three fatty acids used in this study.

Figure S2. The physical drawing of a plunging jet-sea spray aerosol generator.

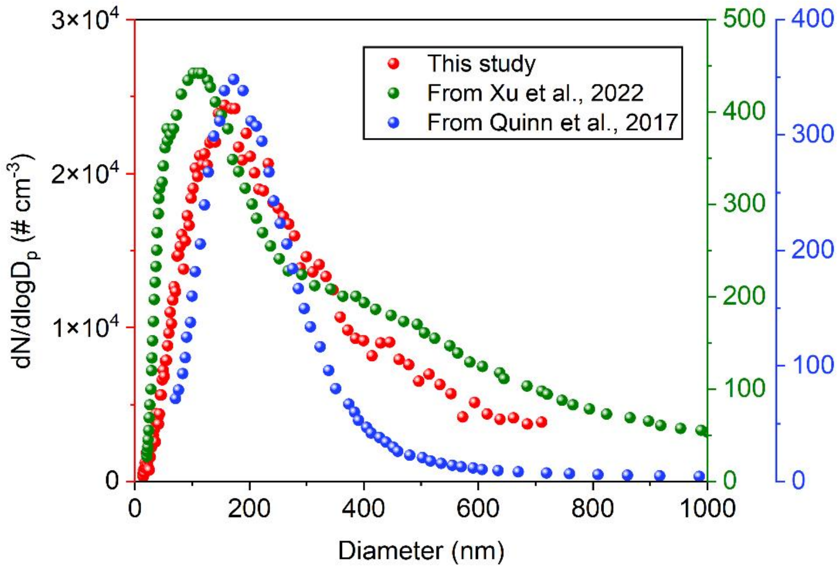

Figure S3. Comparison of particle number size distribution of SSAs generated by sea spray aerosol generator in our study with real SSA in the field measurements.

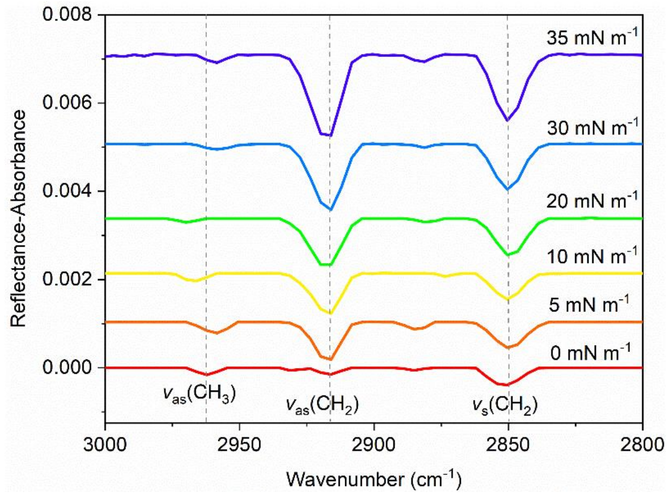

Figure S4. PM-IRRAS spectra (3000–2800 cm^{-1}) of mixed fatty acids at the air/seawater interface at different surface pressure.