



Supplement of

Physical Interpretation and Implications of Convective Impulses in Thunderstorms Based on Lightning and Polarimetric Radar Observations

Chuanhong Zhao et al.

Correspondence to: Chuanhong Zhao (zch@cuit.edu.cn) and Yijun Zhang (zhangyijun@fudan.edu.cn)

The copyright of individual parts of the supplement might differ from the article licence.

Figure S1. Evolutionary cycle of thunderstorm cell A. Composite reflectivity for the evolutionary cycle (from 17:18 to 19:00 Beijing time) of the isolated thunderstorm cell (case A, which occurred on 20 June 2016). The black line indicates the approximate boundary of this thunderstorm. The pink square indicates the first source location of one lightning flash.

Figure S2. Evolutionary cycle of thunderstorm cell B. Composite reflectivity for the evolutionary cycle (from 11:48 to 14:00 Beijing time) of the thunderstorm cell (case B, which occurred on 13 June 2016). The black line indicates the approximate boundary of this thunderstorm. The pink square indicates the first source location of one lightning flash.

Figure S3. Composite reflectivity and cross sections of case B at 12:42 (a) and (b), 12:48 (c) and (d), 12:54 (e) and (f), and 13:12 (g) and (h). The left column represents the composite reflectivity and the right column is for cross sections. The white lines in the left column represent the cross-section lines. Text A and B mark the ends of the cross-section line. The black line in the right column indicates the boundary site. The pink square indicates the first source location of one lightning flash in the left column.

Table S1. The sounding data for simulation.

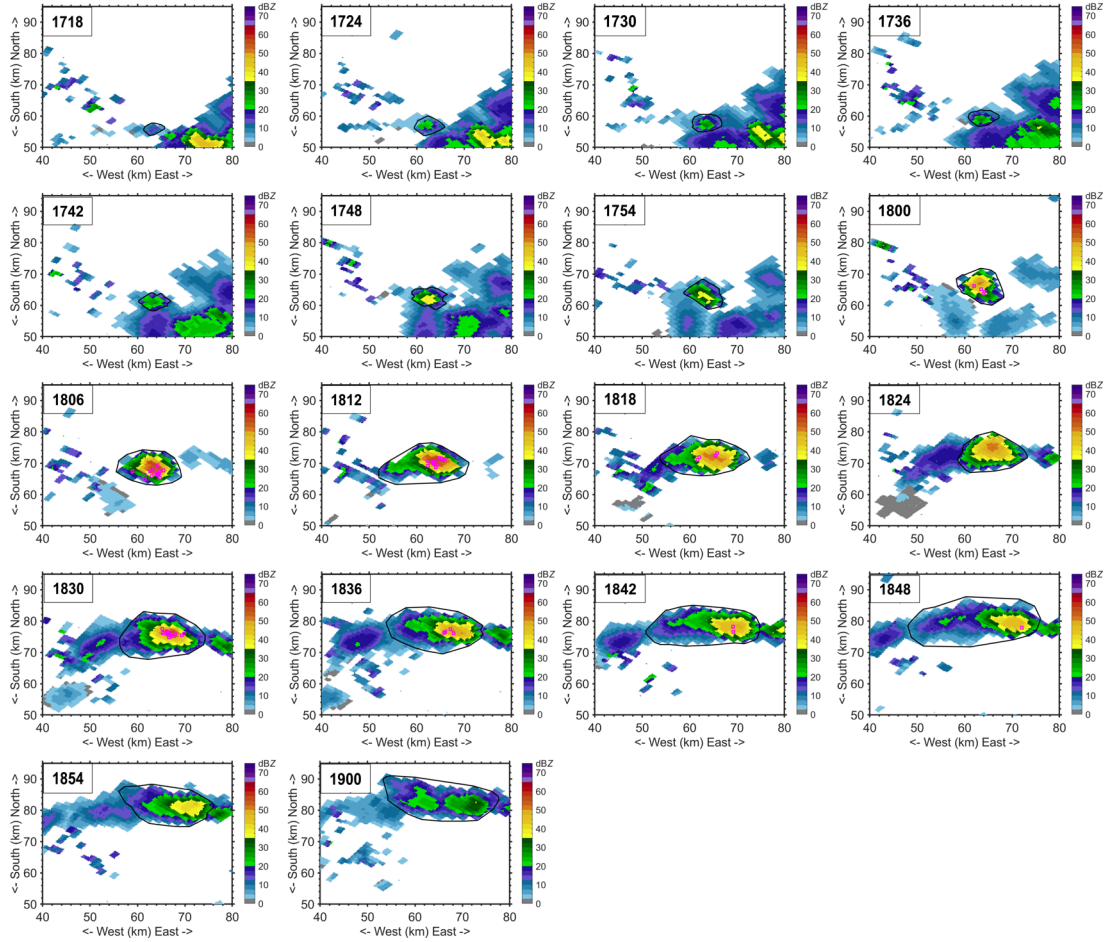


Figure S1. Evolutionary cycle of thunderstorm cell A. Composite reflectivity for the evolutionary cycle (from 17:18 to 19:00 Beijing time) of the isolated thunderstorm cell (case A, which occurred on 20 June 2016). The black line indicates the approximate boundary of this thunderstorm. The pink square indicates the first source location of one lightning flash.

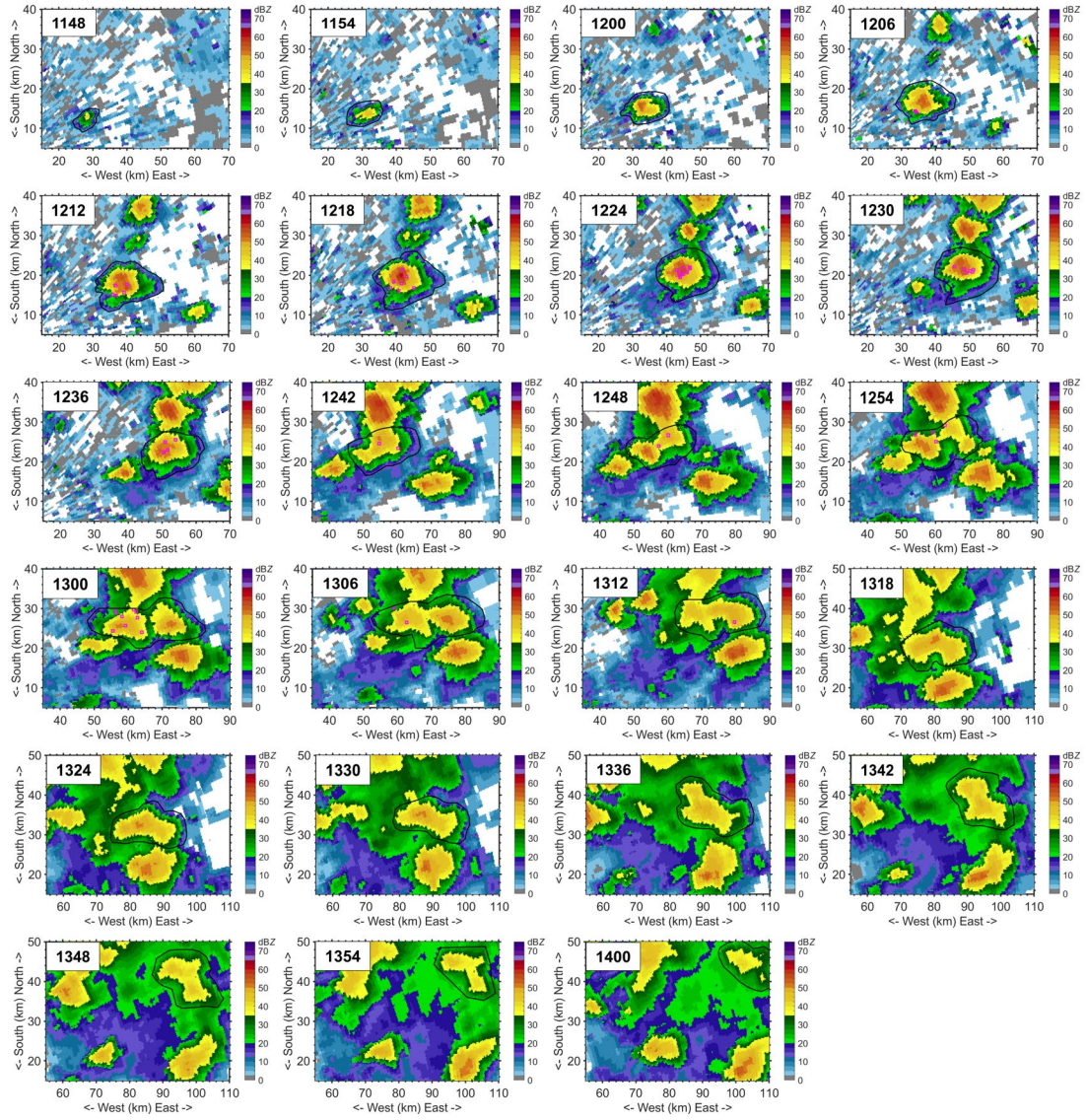


Figure S2. Evolutionary cycle of thunderstorm cell B. Composite reflectivity for the evolutionary cycle (from 11:48 to 14:00 Beijing time) of the thunderstorm cell (case B, which occurred on 13 June 2016). The black line indicates the approximate boundary of this thunderstorm. The pink square indicates the first source location of one lightning flash.

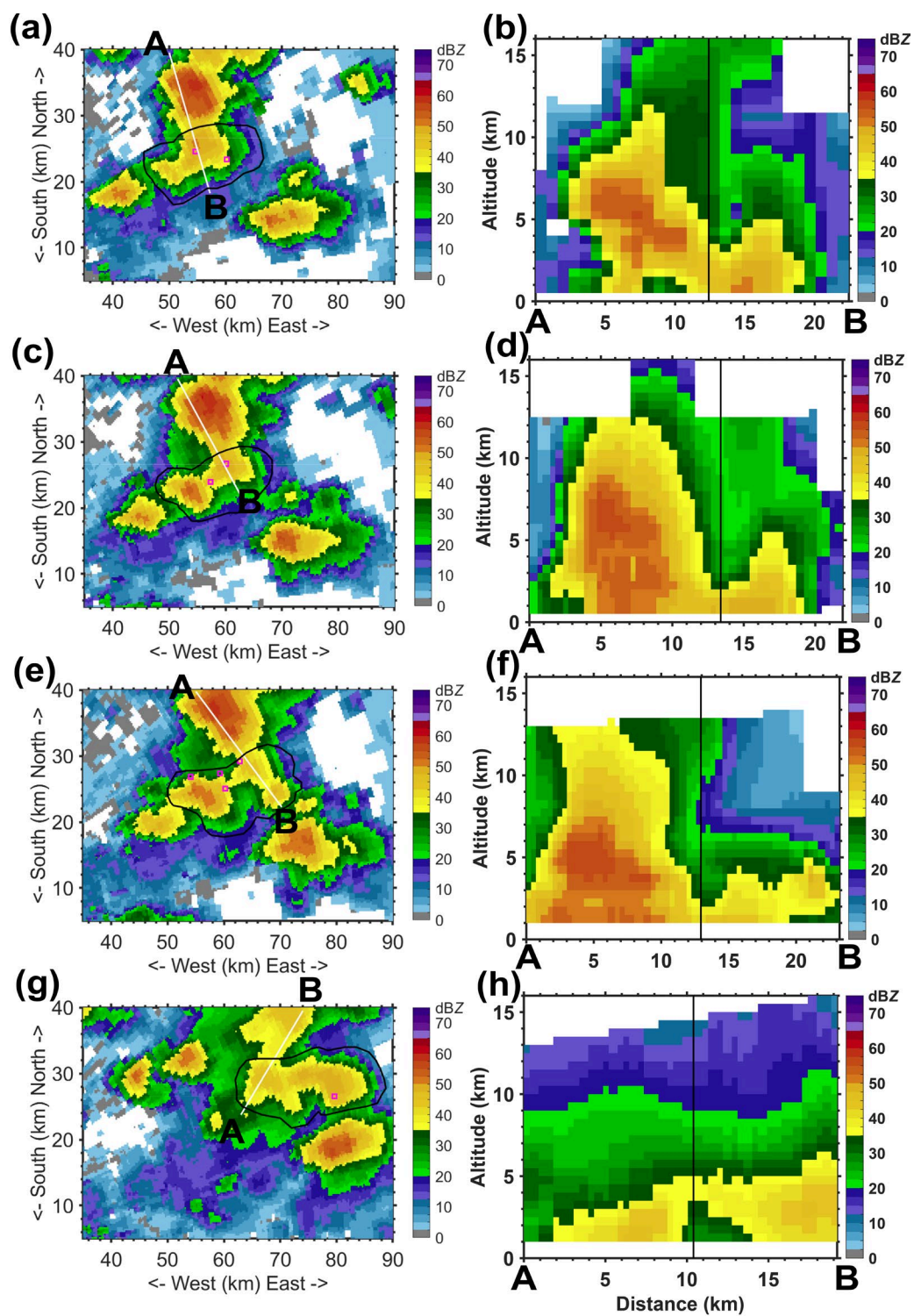


Figure S3. Composite reflectivity and cross sections of case B at 12:42 (a) and (b), at 12:48 (c) and (d), at 12:54 (e) and (f), and at 13:12 (g) and (h). The left column is for composite reflectivity and the right column is for cross sections. White lines in left column represent the cross-section lines. Text A and B mark the ends of the cross-section line. And the black line in right column indicates the boundary site. The pink square indicates the first source location of one lightning flash in the left column.

Table S1. The sounding data for simulation

Geopotential height (m)	Potential temperature (K)	Water vapor mixing ratio (%)	U-component of wind (m s ⁻¹)	V-component of wind (m s ⁻¹)
1000.0000	300	14	/	/
10.0000	300.0061	14	-8.0998	-4.9419
35.0000	300.0291	14	-8.0976	-4.7968
100.0000	300.1083	14	-8.0802	-4.4199
200.0000	300.2575	14	-8.0208	-3.8426
300.0000	300.4275	14	-7.9222	-3.2706
400.0000	300.6125	14	-7.7848	-2.7067
500.0000	300.8095	14	-7.6092	-2.1535
600.0000	301.0167	14	-7.3963	-1.6136
700.0000	301.2327	14	-7.147	-1.0894
800.0000	301.4566	14	-6.8626	-0.5835
900.0000	301.6877	14	-6.5442	-0.0982
1000.0000	301.9253	14	-6.1935	0.3642
1100.0000	302.1689	14	-5.8121	0.8017
1200.0000	302.4181	14	-5.4017	1.2121
1300.0000	302.6725	13.53823	-4.9642	1.5935
1400.0000	302.9319	13.01249	-4.5018	1.9442
1500.0000	303.196	12.50603	-4.0165	2.2626
1600.0000	303.4645	12.01805	-3.5106	2.547
1700.0000	303.7372	11.54775	-2.9864	2.7963
1800.0000	304.014	11.09446	-2.4465	3.0092
1900.0000	304.2947	10.65754	-1.8933	3.1848
2000.0000	304.5791	10.23633	-1.3294	3.3222
2100.0000	304.8671	9.830262	-0.7574	3.4208
2200.0000	305.1584	9.438754	-0.1801	3.4802
2300.0000	305.4532	9.0613	0.4	3.5
2400.0000	305.7512	8.697392	0.9691	3.5
2500.0000	306.0522	8.346541	1.5383	3.5
2600.0000	306.3564	8.008314	2.1074	3.5
2700.0000	306.6634	7.682274	2.6766	3.5
2800.0000	306.9733	7.367979	3.2457	3.5
2900.0000	307.286	7.065029	3.8149	3.5
3000.0000	307.6014	6.773075	4.384	3.5
3100.0000	307.9194	6.491694	4.9532	3.5
3200.0000	308.2401	6.220579	5.5223	3.5
3300.0000	308.5632	5.95936	6.0915	3.5
3400.0000	308.8887	5.707712	6.6606	3.5
3500.0000	309.2167	5.46535	7.2298	3.5
3600.0000	309.5471	5.231919	7.7989	3.5
3700.0000	309.8797	5.007156	8.3681	3.5

3800.0000	310.2146	4.790772	8.9372	3.5
3900.0000	310.5517	4.582475	9.5064	3.5
4000.0000	310.891	4.382025	10.0755	3.5
4100.0000	311.2324	4.18915	10.6447	3.5
4200.0000	311.5759	4.003582	11.2138	3.5
4300.0000	311.9214	3.825114	11.783	3.5
4400.0000	312.269	3.653495	12.3521	3.5
4500.0000	312.6185	3.488501	12.9213	3.5
4600.0000	312.97	3.329912	13.4904	3.5
4700.0000	313.3234	3.177519	14.0596	3.5
4800.0000	313.6786	3.031107	14.6287	3.5
4900.0000	314.0358	2.890485	15.1979	3.5
5000.0000	314.3947	2.755452	15.767	3.5
5100.0000	314.7555	2.625825	16.3362	3.5
5200.0000	315.1181	2.501423	16.9053	3.5
5300.0000	315.4823	2.382055	17.4745	3.5
5400.0000	315.8484	2.267572	18.0436	3.5
5500.0000	316.2161	2.15779	18.6128	3.5
5600.0000	316.5854	2.052551	19.1819	3.5
5700.0000	316.9565	1.951697	19.7511	3.5
5800.0000	317.3291	1.855075	20.3202	3.5
5900.0000	317.7034	1.76254	20.8894	3.5
6000.0000	318.0793	1.673951	21.4585	3.5
6100.0000	318.4567	1.58916	22.0277	3.5
6200.0000	318.8357	1.508036	22.5968	3.5
6300.0000	319.2162	1.430447	23.166	3.5
6400.0000	319.5982	1.356266	23.7351	3.5
6500.0000	319.9818	1.285369	24.3043	3.5
6600.0000	320.3668	1.217633	24.8734	3.5
6700.0000	320.7532	1.152943	25.4426	3.5
6800.0000	321.1411	1.091186	26.0117	3.5
6900.0000	321.5305	1.032253	26.5809	3.5
7000.0000	321.9212	0.976036	27.15	3.5
7100.0000	322.3134	0.922432	27.15	3.5
7200.0000	322.7069	0.871341	27.15	3.5
7300.0000	323.1018	0.822666	27.15	3.5
7400.0000	323.498	0.776311	27.15	3.5
7500.0000	323.8956	0.732186	27.15	3.5
7600.0000	324.2946	0.690203	27.15	3.5
7700.0000	324.6948	0.650276	27.15	3.5
7800.0000	325.0963	0.61232	27.15	3.5
7900.0000	325.4991	0.576257	27.15	3.5
8000.0000	325.9033	0.542009	27.15	3.5
8100.0000	326.3086	0.509499	27.15	3.5

8200.0000	326.7152	0.478655	27.15	3.5
8300.0000	327.1231	0.449407	27.15	3.5
8400.0000	327.5322	0.421687	27.15	3.5
8500.0000	327.9425	0.395429	27.15	3.5
8600.0000	328.354	0.370568	27.15	3.5
8700.0000	328.7668	0.347044	27.15	3.5
8800.0000	329.1807	0.324797	27.15	3.5
8900.0000	329.5958	0.30377	27.15	3.5
9000.0000	330.012	0.283907	27.15	3.5
9100.0000	330.4294	0.265156	27.15	3.5
9200.0000	330.848	0.247464	27.15	3.5
9300.0000	331.2677	0.230782	27.15	3.5
9400.0000	331.6885	0.215062	27.15	3.5
9500.0000	332.1104	0.20026	27.15	3.5
9600.0000	332.5335	0.186329	27.15	3.5
9700.0000	332.9577	0.173227	27.15	3.5
9800.0000	333.3829	0.160914	27.15	3.5
9900.0000	333.8093	0.14935	27.15	3.5
10000.0000	334.2367	0.138497	27.15	3.5
10100.0000	334.6652	0.128319	27.15	3.5
10200.0000	335.0948	0.118781	27.15	3.5
10300.0000	335.5254	0.10985	27.15	3.5
10400.0000	335.957	0.101493	27.15	3.5
10500.0000	336.3897	0.09368	27.15	3.5
10600.0000	336.8234	0.086381	27.15	3.5
10700.0000	337.2582	0.079568	27.15	3.5
10800.0000	337.6939	0.073214	27.15	3.5
10900.0000	338.1307	0.067294	27.15	3.5
11000.0000	338.5685	0.061782	27.15	3.5
11100.0000	339.0073	0.056656	27.15	3.5
11200.0000	339.4471	0.051892	27.15	3.5
11300.0000	339.8878	0.04747	27.15	3.5
11400.0000	340.3295	0.043368	27.15	3.5
11500.0000	340.7722	0.039568	27.15	3.5
11600.0000	341.2159	0.036051	27.15	3.5
11700.0000	341.6605	0.032799	27.15	3.5
11800.0000	342.106	0.029796	27.15	3.5
11900.0000	342.5526	0.027026	27.15	3.5
12000.0000	343	0.024473	27.15	3.5
12100.0000	344.5744	0.024922	27.15	3.5
12200.0000	346.156	0.025378	27.15	3.5
12300.0000	347.7448	0.025843	27.15	3.5
12400.0000	349.341	0.026317	27.15	3.5
12500.0000	350.9445	0.0268	27.15	3.5

12600.0000	352.5553	0.027292	27.15	3.5
12700.0000	354.1736	0.027793	27.15	3.5
12800.0000	355.7993	0.028304	27.15	3.5
12900.0000	357.4324	0.028825	27.15	3.5
13000.0000	359.073	0.029355	27.15	3.5
13100.0000	360.7212	0.029895	27.15	3.5
13200.0000	362.3769	0.030446	27.15	3.5
13300.0000	364.0402	0.031007	27.15	3.5
13400.0000	365.7112	0.031578	27.15	3.5
13500.0000	367.3898	0.032161	27.15	3.5
13600.0000	369.0761	0.032754	27.15	3.5
13700.0000	370.7702	0.033359	27.15	3.5
13800.0000	372.4721	0.033976	27.15	3.5
13900.0000	374.1817	0.034604	27.15	3.5
14000.0000	375.8992	0.035244	27.15	3.5
14100.0000	377.6246	0.035896	27.15	3.5
14200.0000	379.3579	0.036561	27.15	3.5
14300.0000	381.0992	0.037238	27.15	3.5
14400.0000	382.8484	0.037928	27.15	3.5
14500.0000	384.6057	0.038632	27.15	3.5
14600.0000	386.3711	0.039349	27.15	3.5
14700.0000	388.1445	0.040079	27.15	3.5
14800.0000	389.9261	0.040824	27.15	3.5
14900.0000	391.7159	0.041583	27.15	3.5
15000.0000	393.5139	0.042356	27.15	3.5
15100.0000	395.3202	0.043145	27.15	3.5
15200.0000	397.1347	0.043948	27.15	3.5
15300.0000	398.9575	0.044767	27.15	3.5
15400.0000	400.7887	0.045601	27.15	3.5
15500.0000	402.6284	0.046452	27.15	3.5
15600.0000	404.4764	0.047319	27.15	3.5
15700.0000	406.333	0.048203	27.15	3.5
15800.0000	408.1981	0.049104	27.15	3.5
15900.0000	410.0717	0.050022	27.15	3.5
16000.0000	411.954	0.050957	27.15	3.5
16100.0000	413.8449	0.051911	27.15	3.5
16200.0000	415.7444	0.052884	27.15	3.5
16300.0000	417.6527	0.053875	27.15	3.5
16400.0000	419.5698	0.054885	27.15	3.5
16500.0000	421.4956	0.055915	27.15	3.5
16600.0000	423.4303	0.056965	27.15	3.5
16700.0000	425.3738	0.058035	27.15	3.5
16800.0000	427.3263	0.059126	27.15	3.5
16900.0000	429.2878	0.060238	27.15	3.5

17000.0000	431.2582	0.061372	27.15	3.5
17100.0000	433.2377	0.062528	27.15	3.5
17200.0000	435.2263	0.063706	27.15	3.5
17300.0000	437.224	0.064908	27.15	3.5
17400.0000	439.2308	0.066132	27.15	3.5
17500.0000	441.2469	0.067381	27.15	3.5
17600.0000	443.2723	0.068654	27.15	3.5
17700.0000	445.3069	0.069952	27.15	3.5
17800.0000	447.3509	0.071275	27.15	3.5
17900.0000	449.4042	0.072624	27.15	3.5
18000.0000	451.467	0.073999	27.15	3.5
18100.0000	453.5393	0.075402	27.15	3.5
18200.0000	455.621	0.076832	27.15	3.5
18300.0000	457.7123	0.07829	27.15	3.5
18400.0000	459.8133	0.079777	27.15	3.5
18500.0000	461.9238	0.081292	27.15	3.5
18600.0000	464.0441	0.082838	27.15	3.5
18700.0000	466.174	0.084414	27.15	3.5
18800.0000	468.3138	0.086021	27.15	3.5
18900.0000	470.4633	0.08766	27.15	3.5
19000.0000	472.6228	0.089331	27.15	3.5
19100.0000	474.7922	0.091035	27.15	3.5
19200.0000	476.9715	0.092773	27.15	3.5
19300.0000	479.1608	0.094545	27.15	3.5
19400.0000	481.3601	0.096352	27.15	3.5
19500.0000	483.5696	0.098195	27.15	3.5
19600.0000	485.7892	0.100075	27.15	3.5
19700.0000	488.019	0.101991	27.15	3.5
19800.0000	490.259	0.103946	27.15	3.5
19900.0000	492.5093	0.10594	27.15	3.5
20000.0000	494.7699	0.107973	27.15	3.5
20500.0000	506.2297	0.118763	27.15	3.5
21000.0000	517.9549	0.130674	27.15	3.5
21500.0000	529.9517	0.143829	27.15	3.5
22000.0000	542.2263	0.158363	27.15	3.5
22500.0000	554.7853	0.174427	27.15	3.5
23000.0000	567.6351	0.192191	27.15	3.5
23500.0000	580.7826	0.211843	27.15	3.5
24000.0000	594.2346	0.233593	27.15	3.5
24500.0000	607.9981	0.257676	27.15	3.5
25000.0000	622.0805	0.284356	27.15	3.5
25500.0000	636.489	0.313926	27.15	3.5
26000.0000	651.2312	0.346716	27.15	3.5
26500.0000	666.3149	0.383097	27.15	3.5

27000.0000	681.748	0.423482	27.15	3.5
27500.0000	697.5385	0.468337	27.15	3.5
28000.0000	713.6947	0.518183	27.15	3.5
28500.0000	730.2252	0.57361	27.15	3.5
29000.0000	747.1385	0.63528	27.15	3.5
29500.0000	764.4437	0.703938	27.15	3.5
30000.0000	782.1495	0.780421	27.15	3.5