Supplementary Information

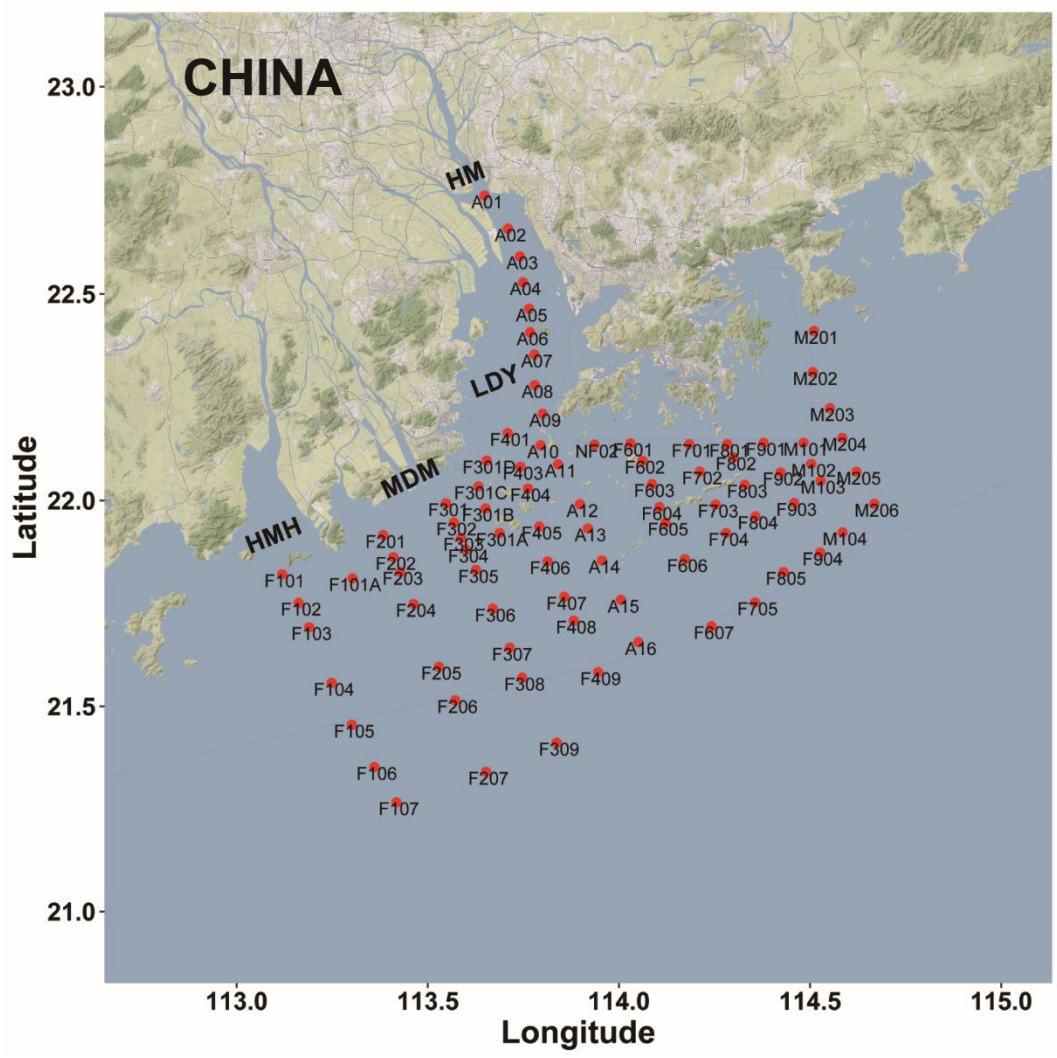

Figure S1. Total sampling stations of 2017 Pearl River estuary summer cruise. The sampling location information was overlaid on Google Maps (© Google Maps) image using "ggmap" with "ggplot2" in R (D. Kahle and H. Wickham, 2013)

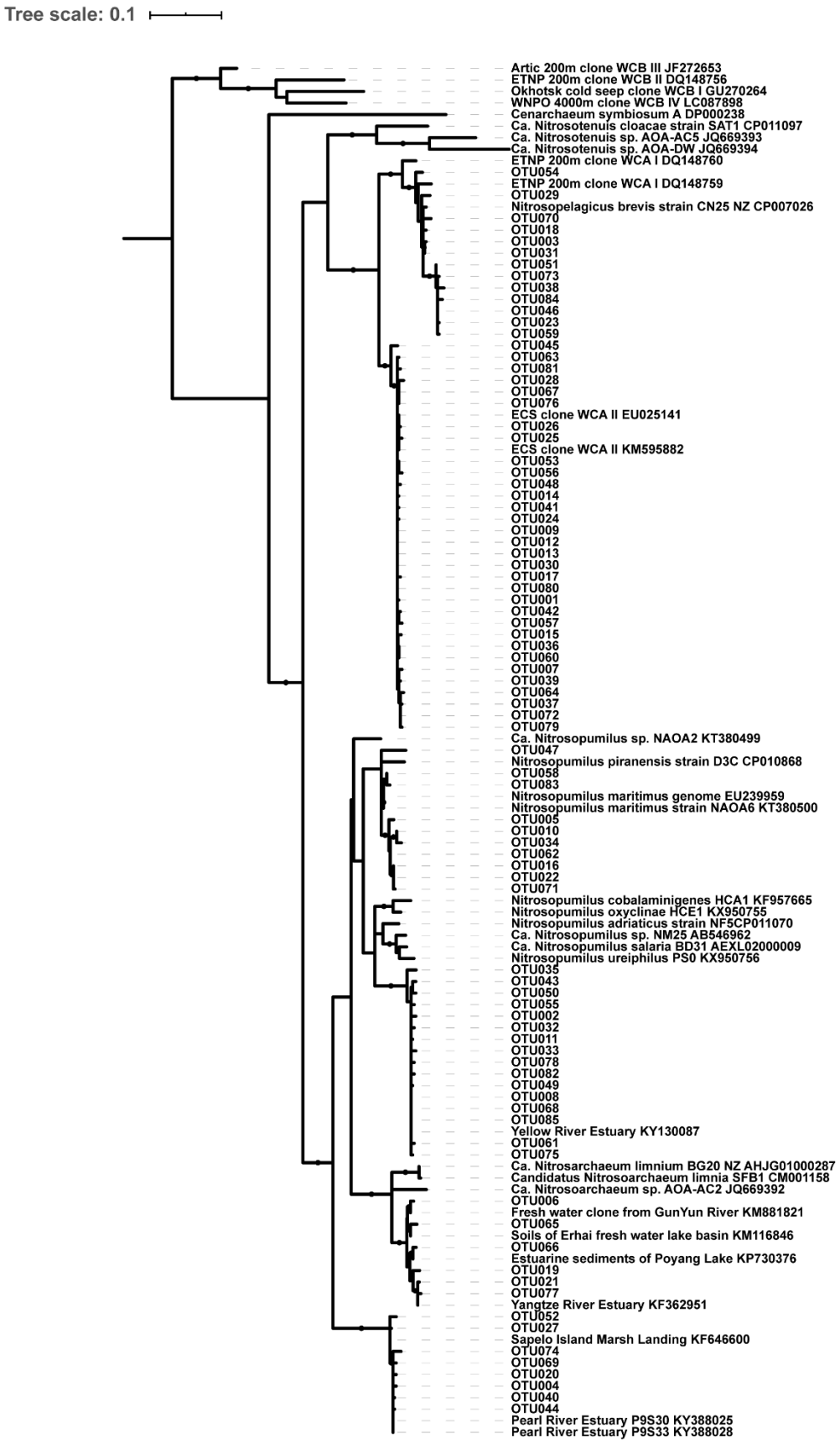

Figure S2. Maximum likelihood phylogenetic tree of *amoA* gene sequence of top 85 OTUs and Nitrosopumilales *spp.* using on T92+G+I model with 1000 bootstrap.

Table S1. Comparison of estuarine ammonia-oxidizing microorganism studies

Estuary	Sample	Method	DNA based			RNA based		AOA Niche Partition	Nitrification rates	Reference
			Abundance of *amoA* gene	AOA Diversity	AOB Diversity	AOA Diversity	Abundance of *amoA*-transcript			
Bahi'a del To'bari, Mexico	Sediment	Clone library	–	+	+	–	–	–	–	Beman and Francis 2006
San Francisco Bay, CA	Sediment	Clone library	+	+	+	–	–	Low-salinity adaptation	–	Mosier and Francis 2008
Barn Island salt marsh, CT	Sediment	Clone library	+	+	+	–	–	–	+	Moin et al., 2009
Westerschelde estuary, The Netherlands	Sediment	Clone library	+	+	+	–	–	–	–	Sahan and Muyzer 2008
Changjiang estuary, China	Sediment	Clone library	–	+	+	–	–	–	–	Dang et al., 2008
Plum Island Sound estuary, MA	Sediment	Clone library	+	+	+	–	–	–	+	Bernhard et al. 2010
Douro River estuary, Portugal	Sediment	Clone library	+	+	–	–	–	–	+	Magalhães et al 2009
Elkhorn Slough Estuary, CA	Sediment	Clone library	+	+	+	–	–	–	+	Wankel et al. 2011
Colne Estuary, UK	Sediment	DGGE	+	+	+	–	–	–	+	Li et al. 2015
Ems estuary, Germany	Sediment	qPCR	+	–	–	–	–	–	+	Sanders and Laanbroek 2018
Derwent Estuary, Australia	Sediment	T-RFLP	+	+	+	+	+	–	–	Abell et al. 2011

Huntington Beach, CA	Water	Clone library	+	+	+	–	–	–	–	Santoro et al., 2008
Pearl River Estuary, China	Water	Clone library	+	+	+	–	–	–	+	Hou et al. 2014
Chesapeake Bay estuary, USA	Water	Clone library	+	+	–	–	–	–	–	Bouskill et al. 2012
Changjiang estuary, China	Water	Clone library	+	+	+	–	–	–	+	Zhang et al. 2014
Pearl River Estuary, China	Water	Ion-Torrent	+	+	–	+	+	+	+	This study

* '+' represents data available, '–' represents data not available.

11 **Table S2. Quantitative PCR results at DNA level of both AOA and β-AOB in 23 stations**

Station	Lon (E º)	Lat (W º)	Layer	Salinity (PSU)	DO ($mg \cdot L^{-1}$)	Ammonium ($nmol \cdot L^{-1}$)	Nitrification rate ($nmol \cdot L^{-1} \cdot h^{-1}$)	AOA-PA ($Copy \cdot L^{-1}$)	AOA-FL ($Copy \cdot L^{-1}$)	AOB-PA ($Copy \cdot L^{-1}$)	AOB-FL ($Copy \cdot L^{-1}$)
F107	113.42	21.27	S	32.30	4.53	155.70	0.21	1.54E+04	7.93E+04	1.81E+02	8.05E+02
			B	34.51	4.09	48.64	0.96	3.31E+04	1.22E+08	7.77E+02	3.03E+03
F104	113.25	21.56	S	16.69	6.80	ND	0.14	2.92E+04	1.27E+05	4.90E+02	7.56E+02
			B	34.45	4.26	ND	0.33	1.09E+06	1.76E+07	5.17E+03	2.83E+03
F101	113.12	21.82	S	10.20	6.38	67.03	1.18	4.20E+04	1.19E+06	1.11E+02	2.57E+03
			B	33.73	0.54	34.78	36.62	2.61E+07	3.95E+08	1.67E+03	2.00E+03
F309	113.84	21.41	S	33.91	4.47	32.41	ND	1.24E+03	2.67E+05	1.31E+02	1.35E+03
			B	34.51	4.21	56.68	0.40	1.31E+05	1.10E+08	2.57E+03	2.02E+03
F305	113.63	21.83	S	9.04	7.08	233.66	1.84	4.83E+04	3.21E+05	4.77E+02	8.42E+02
			B	34.43	3.47	44.11	1.28	7.27E+07	7.42E+07	1.08E+04	2.80E+03
F303	113.59	21.91	S	7.54	6.82	104.01	0.48	7.55E+06	6.09E+06	2.89E+04	3.42E+04
			B	34.45	1.44	42.73	36.37	1.40E+08	1.62E+08	1.65E+04	3.16E+03
F301	113.55	21.99	S	6.70	7.67	865.79	5.20	5.80E+04	3.29E+04	ND	ND
			B	23.17	2.10	1423.19	41.94	5.04E+03	3.54E+05	ND	ND
F405	113.79	21.94	S	12.29	6.53	250.81	1.48	2.48E+05	2.65E+06	9.73E+02	6.54E+03
			B	34.43	2.61	34.19	1.04	5.88E+07	4.39E+08	1.10E+04	1.08E+04
F403	113.74	22.08	S	7.56	4.11	24.08	3.07	2.02E+06	3.63E+06	9.57E+03	3.62E+04
			B	22.46	1.31	24.16	9.91	1.42E+07	3.11E+07	7.75E+03	1.59E+04
A16	114.05	21.66	S	33.67	4.73	35.32	ND	1.70E+07	1.33E+07	ND	ND
			B	34.52	4.21	111.37	0.65	3.90E+07	9.95E+07	6.91E+03	2.12E+01
A14	113.96	21.85	S	24.15	5.26	69.85	0.44	1.20E+05	1.16E+06	ND	4.77E+02
			B	34.39	4.00	355.19	0.06	5.12E+06	1.50E+07	4.68E+03	1.85E+03
A12	113.90	21.99	S	19.56	6.68	278.65	0.80	9.21E+05	2.73E+05	1.80E+02	2.25E+01
			B	34.41	2.62	56.18	1.13	6.00E+07	2.61E+08	3.69E+03	3.37E+03
A11	113.84	22.09	S	13.88	6.37	47.10	1.13	1.24E+06	6.56E+05	2.69E+01	2.83E+03

Station	Lon (E º)	Lat (W º)	Layer	Salinity (PSU)	DO ($mg \cdot L^{-1}$)	Ammonium ($nmol \cdot L^{-1}$)	Nitrification rate ($nmol \cdot L^{-1} \cdot h^{-1}$)	AOA-PA ($Copy \cdot L^{-1}$)	AOA-FL ($Copy \cdot L^{-1}$)	AOB-PA ($Copy \cdot L^{-1}$)	AOB-FL ($Copy \cdot L^{-1}$)
A09	113.80	22.21	B	32.15	0.97	120.77	2.64	1.02E+08	2.58E+08	1.49E+03	6.81E+02
			S	17.52	5.39	161.39	2.58	1.36E+06	3.50E+07	2.56E+02	2.60E+03
			B	33.36	1.15	91.45	22.43	4.73E+07	3.85E+08	1.10E+03	8.10E+02
A05	113.77	22.46	S	2.28	3.27	865.84	1.90	5.07E+06	3.77E+06	6.03E+04	3.52E+04
			B	14.96	2.45	1673.87	35.10	2.04E+07	2.93E+07	1.92E+04	8.13E+01
A01	113.65	22.74	S	0.11	2.00	2043.89	94.78	9.76E+06	1.74E+06	8.79E+04	1.92E+04
			B	0.11	1.93	786.73	17.32	5.08E+07	3.26E+07	4.18E+04	1.04E+04
F607	114.24	21.69	S	32.74	4.88	61.84	ND	2.08E+03	6.07E+04	3.70E+01	5.30E+02
			B	34.49	4.51	483.80	1.33	3.32E+05	4.07E+07	7.57E+03	2.97E+03
F605	114.12	21.95	S	30.11	4.64	ND	1.91	4.98E+03	1.29E+06	1.11E+02	2.07E+03
			B	34.39	2.75	ND	7.08	1.53E+07	7.23E+07	8.69E+03	4.27E+03
F603	114.09	22.04	S	29.09	4.46	358.38	1.68	1.78E+03	1.44E+06	5.56E+01	8.82E+02
			B	34.40	2.42	79.18	2.97	1.13E+07	6.04E+07	2.65E+03	3.12E+03
F602	114.06	22.10	S	27.08	4.86	ND	0.33	6.10E+03	4.69E+05	6.18E+01	2.17E+02
			B	34.27	1.56	ND	4.36	2.68E+06	6.48E+07	4.47E+03	2.32E+03
F601	114.03	22.14	S	25.32	5.09	983.39	16.09	3.58E+04	7.92E+04	4.85E+01	1.29E+03
			B	32.98	0.53	372.06	7.22	1.68E+06	3.04E+08	1.03E+03	2.22E+03
F701	114.18	22.14	S	26.57	4.63	1682.83	0.51	1.33E+03	4.86E+05	ND	ND
			B	34.16	1.18	1993.45	19.13	7.90E+05	5.41E+07	ND	ND
F804	114.36	21.96	S	31.78	4.47	121.59	0.05	2.43E+03	7.00E+05	1.14E+02	1.14E+03
			B	34.47	3.46	55.20	2.86	1.47E+07	4.71E+07	6.91E+03	3.16E+03

* S-Surface; B-Bottom; PA-Particle attached (> 3 μm); FL-Free-living (3-0.2 μm); ND-Under detection limit.

Table S3. Nitrification, community respiration rates and corresponding oxygen demand.

Station	Layer	Nitrification rate ($nmol \cdot L^{-1} \cdot h^{-1}$)	Nitrification oxygen Demand ($mg\ O_2 \cdot L^{-1} \cdot d^{-1}$)	Community respiration rate ($mg\ O_2 \cdot L^{-1} \cdot d^{-1}$)	NOD/CR%
F101	S	1.1770	0.0017	1.4400	0.1186
F101	B	36.6152	0.0531	0.1499	35.4532
F104	S	0.1443	0.0002	1.6813	0.0125
F104	B	0.3277	0.0005	0.1146	0.4152
F107	S	0.2057	0.0003	0.2264	0.1319
F107	B	0.9596	0.0014	0.2191	0.6358
F301	S	5.1961	0.0075	1.1372	0.6632
F301	B	41.9434	0.0609	0.4283	14.2155
F303	S	0.4847	0.0007	1.0797	0.0652
F303	B	36.3678	0.0528	0.5141	10.2685
F305	S	1.8411	0.0027	0.6203	0.4308
F305	B	1.2795	0.0019	0.0023	81.7661
F701	S	0.5144	0.0007	0.9343	0.0799
F701	B	19.1291	0.0278	0.0121	229.2100
A14	S	0.4443	0.0006	1.0191	0.0633
A14	B	0.0609	0.0001	0.8222	0.0108
A12	S	0.8040	0.0012	0.9928	0.1175
A12	B	1.1319	0.0016	0.2256	0.7282
A09	S	2.5768	0.0037	1.3144	0.2846
A09	B	22.4347	0.0326	0.6340	5.1367
A05	S	1.9032	0.0028	0.2582	1.0700
A05	B	35.0975	0.0509	0.4280	11.9023
A01	S	94.7793	0.1376	0.6128	22.4514
A01	B	17.3175	0.0251	0.3231	7.7801

* S-Surface; B-Bottom.

Table S4. Quantitative PCR results of cDNA (template for RNA level) of AOA and β-AOB in 13 stations

Station	AOA-PA (copy·L^{-1})	AOA-FL (copy·L^{-1})	AOB-PA (copy·L^{-1})	AOB-FL (copy·L^{-1})
A01	3.10E+03	3.08E+03	ND	ND
A01	ND	1.16E+03	ND	ND
A05	8.24E+02	1.02E+04	ND	ND
A05	1.30E+03	6.03E+02	ND	ND
A09	ND	1.18E+05	ND	ND
A09	1.77E+03	1.47E+06	ND	ND
A11	ND	2.56E+03	ND	ND
A11	3.61E+04	1.14E+05	ND	ND
A16	ND	ND	ND	ND
A16	2.62E+04	ND	ND	ND
F101	ND	1.82E+03	ND	ND
F101	7.43E+03	1.87E+04	ND	ND
F104	ND	1.43E+03	ND	ND
F104	1.21E+03	8.26E+03	ND	ND
F107	ND	ND	ND	ND
F107	ND	1.74E+06	ND	ND
F301	2.99E+03	ND	ND	ND
F301	5.09E+03	1.85E+05	ND	ND
F305	ND	8.07E+02	ND	ND
F305	1.05E+04	9.98E+03	ND	ND
F403	6.46E+03	1.18E+05	ND	ND
F403	3.30E+03	1.17E+05	ND	ND
F601	ND	ND	ND	ND
F601	4.28E+03	3.21E+06	ND	ND
F603	ND	3.72E+03	ND	ND
F603	1.03E+03	2.50E+05	ND	ND

* S-Surface; B-Bottom; PA-Particle attached (>3 μm); FL-Free-living (3-0.2 μm); ND-Under detection limit.

Table S5. Basic sample information of sequencing samples and corresponding Shannon index, Margalef richness.

Station	Lon (E °)	Lat (W °)	Sample Cat.	Sequence No.	Shannon index	Margalef richness
A01	113.65	22.74	A01CS0.2	4469	4.26	42.06
			A01DB0.2	25484	3.70	39.66
			A01DB3	33527	3.73	37.25
			A01DS0.2	28147	3.64	37.09
			A01DS3	30179	3.68	39.3
A05	113.77	22.46	A05CS0.2	10504	4.21	43.33
			A05DB0.2	32747	3.25	33.3
			A05DB3	28121	4.00	40.49
			A05DS0.2	27297	3.33	35.85
			A05DS3	20389	3.42	33.75
A09	113.80	22.21	A09CB0.2	21803	3.78	39.07
			A09CB3	16585	3.87	41.38
			A09CS0.2	12693	4.14	43.61
			A09DB0.2	21927	4.04	37.99
			A09DB3	21343	3.71	33.55
			A09DS0.2	10794	4.07	29.95
			A09DS3	25603	3.53	37.12
A11	113.84	22.09	A11CB0.2	29345	4.12	43.19
			A11CB3	26206	3.78	39.4
			A11CS0.2	4080	3.26	28.6
			A11DB0.2	24215	3.82	37.84
			A11DB3	22422	3.72	36.47
			A11DS0.2	20568	3.62	38.78
			A11DS3	29216	3.18	34.89
A16	114.05	21.66	A16CB0.2	20644	4.12	40.51
			A16CB3	24676	4.01	41.43
			A16CS0.2	16931	3.88	39.06
			A16DB0.2	30526	3.31	35.74
			A16DS0.2	31112	3.02	31.63
			A16DS3	28739	3.25	35.5
F101	113.12	21.82	F101CB0.2	20949	3.67	38.37
			F101CS0.2	2523	2.61	23.22
			F101DB0.2	20840	3.61	30.87
			F101DB3	15602	3.96	36.95
			F101DS0.2	8348	3.90	35.38
F104	113.25	21.56	F104CB0.2	33200	3.60	32.74
			F104CB3	16037	3.69	31.77
			F104CS0.2	33670	2.22	17.82
			F104DB0.2	30782	2.84	28.32
			F104DB3	30769	2.69	26.59
			F104DS0.2	6990	3.01	30.22

			F107CB0.2	21167	3.89	40.88
F107	113.42	21.27	F107CB3	5633	3.89	38.1
			F107DB0.2	20909	3.90	35.52
			F301CB0.2	17778	3.76	34.19
			F301CB3	16657	3.48	34.53
			F301CS3	5653	4.03	37.6
F301	113.55	21.99	F301DB0.2	22088	3.82	38.42
			F301DB3	3436	4.19	31.49
			F301DS0.2	7823	3.40	27.44
			F301DS3	20310	3.51	26.54
			F305CB0.2	27580	3.35	36.05
			F305CB3	27095	3.20	33.45
F305	113.63	21.83	F305DB0.2	18856	3.96	33.86
			F305DB3	21410	3.78	35.12
			F305DS0.2	7007	4.20	42.21
			F403CB0.2	10000	3.86	37.69
			F403CB3	8858	3.69	38.31
			F403CS0.2	4431	3.57	31.38
F403	113.74	22.08	F403CS3	4166	3.04	28.24
			F403DB0.2	21959	3.91	40.19
			F403DB3	21744	3.85	38.99
			F403DS0.2	19571	4.26	43.7
			F403DS3	20370	3.83	36.83
			F601CB0.2	27041	4.12	43.22
			F601CB3	22320	3.75	38.81
F601	114.03	22.14	F601DB0.2	18421	3.82	34.78
			F601DB3	20092	3.80	33.59
			F601DS0.2	23411	3.70	37.44
			F601DS3	15932	2.94	33.22
			F603CB0.2	30619	3.55	37.54
			F603CB3	9410	3.55	38.81
F603	114.09	22.04	F603CS0.2	5859	3.90	39.93
			F603DB0.2	16912	3.96	40.71
			F603DB3	19693	3.81	35.48
			F603DS0.2	18314	3.78	36.1

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