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Marine black carbon emissions: Identifying research gaps

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Tested vessels

Vessel	Engines	Engine load	Test fuel	Fuel S content
★ Icebreaker	ME	I / H	ULSD	0.0019 % S
★ Laker #1	ME	I / H	IFO 060	1.44 % S
★ Laker #2	ME	L / I / H	IFO 380	1.96 % S
★ Laker #3	ME	L / I / H	IFO 060	1.22 % S
★ Laker #4	ME	I / H	IFO 180 & MDO	1.62 % & 0.119 % S
★● Laker #5	ME ; AE	L / I / H ; Op. load	IFO 380	2.70 % S
★● Arctic vessel #1	ME ; AE	L / M / I / H ; Op. load	IFO180 & High S	1.48 % & 2.21 % S
★●▲ Arctic vessel #2	ME ; AE	I / H ; Op. load	IFO 380	2.23 % S
★ Container ship	ME	I / H	HFO & MDO	2.32 % & 0.0347 % S

Vessel	Engines	Test objective	Test fuel	Fuel S content
★ Harbour craft x 2	ME	Emission control technology (DOC)	ULSD	<15 ppm S
Harbour craft x 6	ME ; AE	Fuel sulphur, fuel borne catalyst, DOC	LSD	<500 ppm S
Ocean vessel	ME	Open loop sea water scrubber	IFO 380	1.77 % S
★▲ Laker	ME	Closed-loop fresh water scrubber	IFO 180	1.76 % S

★ thermal/optical EC ● micro-aethalometer ▲ laser induced incandescence

Information source: Mark McCurdy & Jill Hendren



Anticipated technical difficulties for real-world emission measurements

- Accessing sampling locations
- Available space for instrumentations
- Sampling time
- Instrumentation limitations
- Ambient working conditions (high temperature and RH)

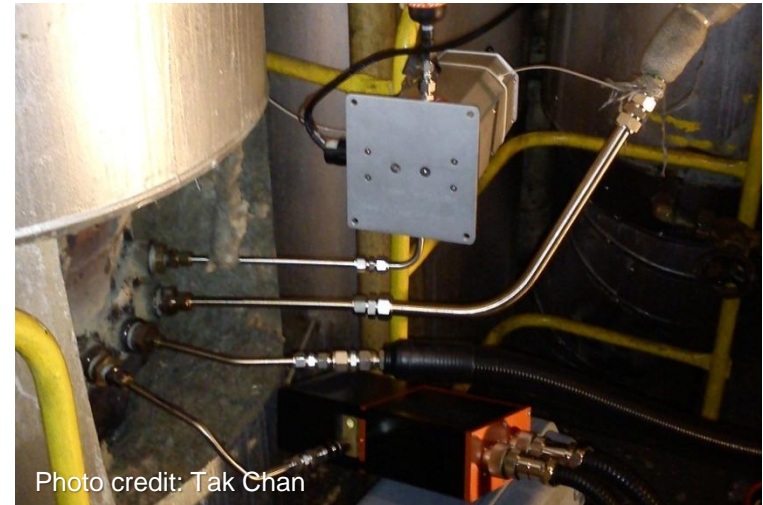


Photo credit: Tak Chan

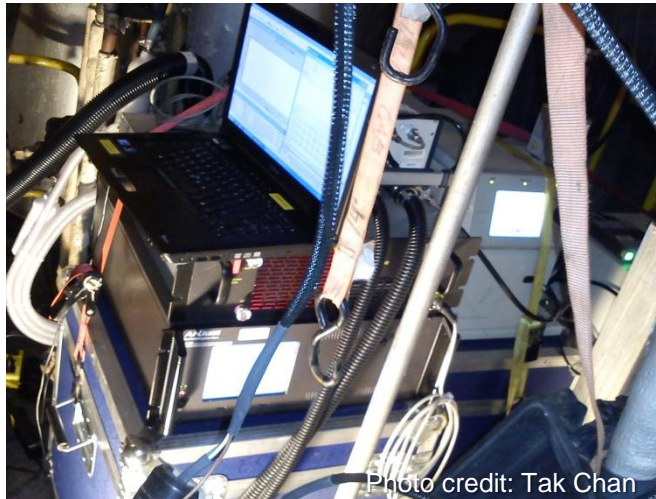


Photo credit: Tak Chan



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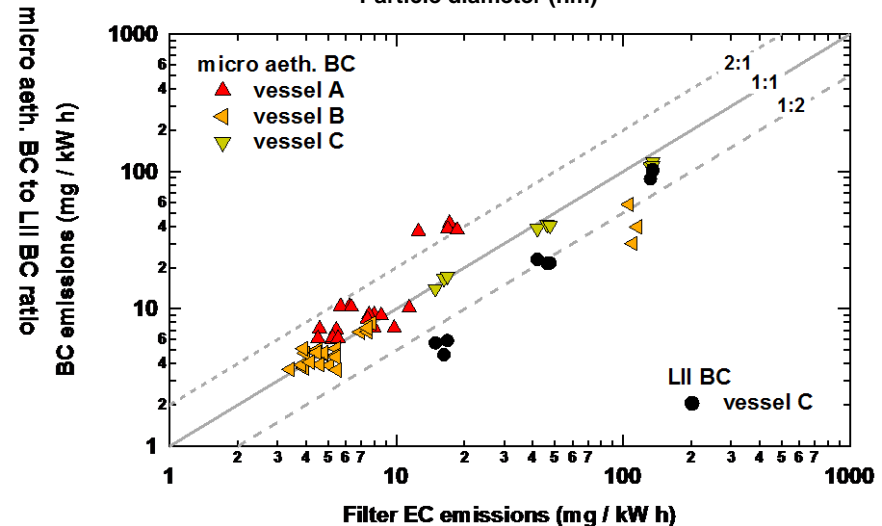
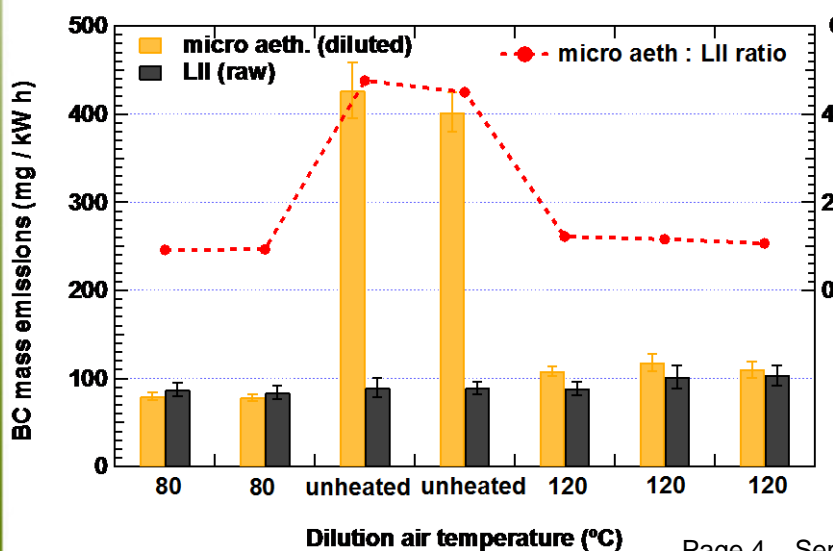
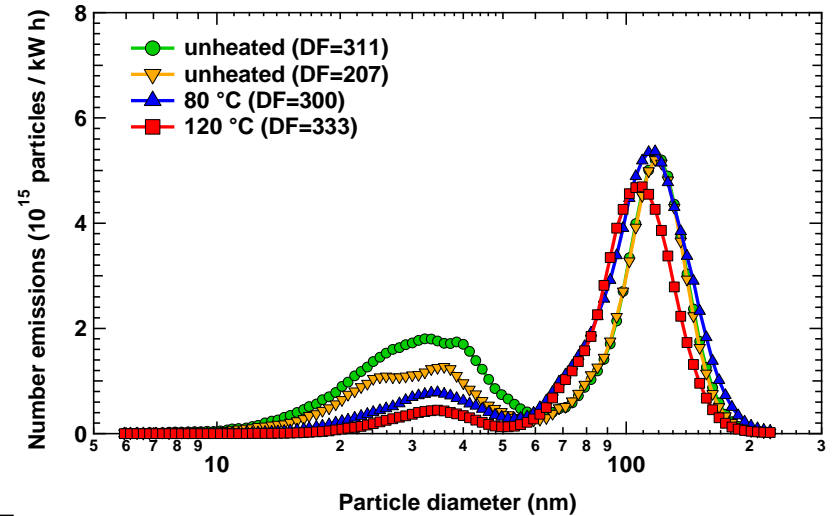


Photo credit: Tak Chan



Factors affecting BC emissions data

- Raw vs. diluted emissions
- Hot dilution
- Various BC measurement methodologies



ERMS emission system evolution

2006 BUS EMISSION TESTING

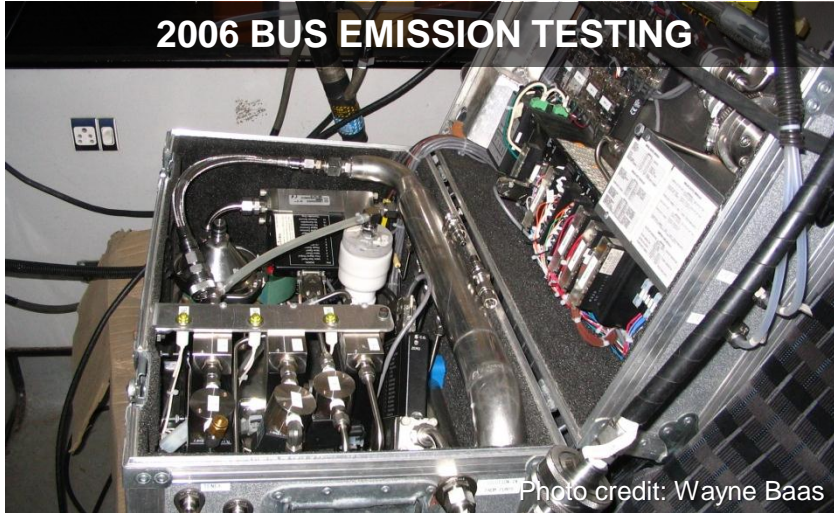


Photo credit: Wayne Baas

2007 LOCOMOTIVE EMISSION TESTING

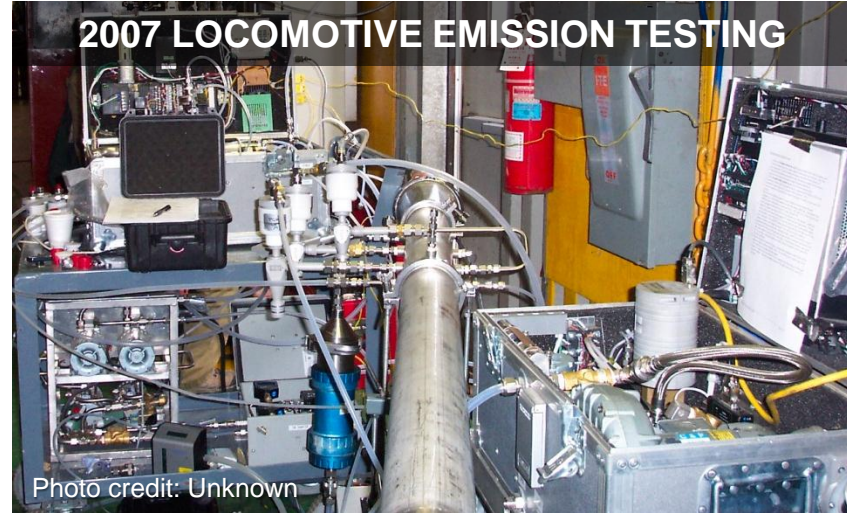


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2008 LOCOMOTIVE EMISSION TESTING

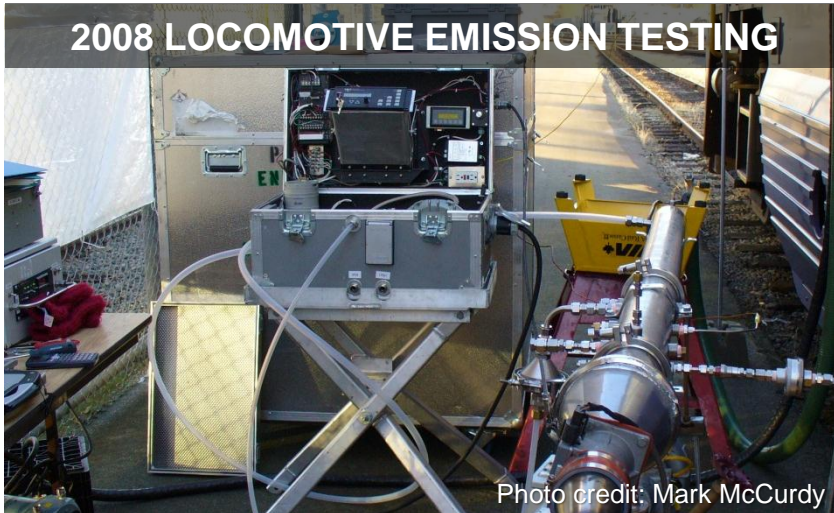


Photo credit: Mark McCurdy

2009 SHIP EMISSION TESTING



Photo credit: Tak Chan



ERMS emission system evolution

