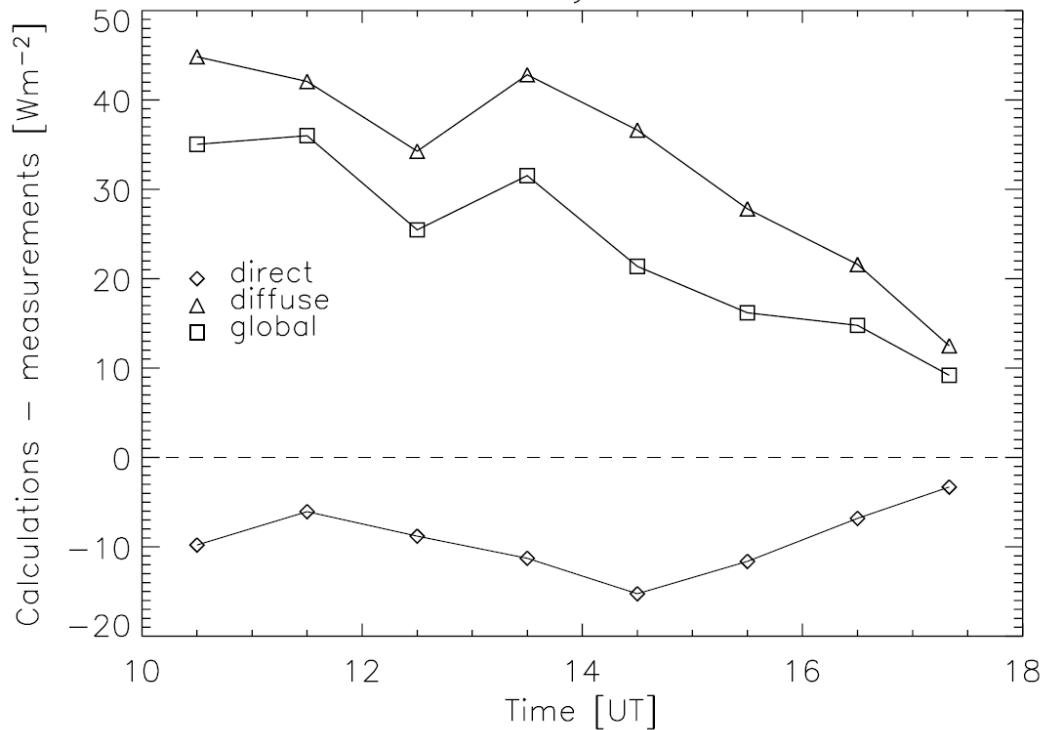


# **CONFLICT BETWEEN STANDARDS FOR PARTICLE NUMBER CONCENTRATION FOR EMISSIONS REGULATIONS AND AMBIENT AIR MONITORING**

› Bas Henzing

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### › First encounter

- › aerosol light absorption is key for irradiance closure
- › absent consistent nomenclature
- › BS and absorption photometers recorded mass concentrations



<http://www.cesar-observatory.nl>

# REGULATION AND LEGISLATION INITIALLY BASED ON BLACKNESS OF EXHAUST SMOKE

- › ISO-10054 steady-state diesel engines “Filter-Type Smokemeters”
- › ISO-11614 internal combustion engines – “Opacimeters”
- › ISO-9835 ambient air – “black smoke index”
  
- › “The method specified in this International Standard can be used to measure the absorption coefficient on any filter material, but the conversion of absorption coefficient or extinction coefficient to what is, by convention, known as the black smoke index, is purely an arbitrary operation which is carried out by reference to tables or graphs. The BS method does not measure the mass concentration of particles directly.”

# SUMMARY OF REGULATION REQUIREMENTS LIGHT-DUTY VEHICLES AND HEAVY DUTY ENGINES

Area	Cat.	Standard	Particulate Mass limit	Particle Number limit
<b>Type approval conformity of production durability</b>				
EU	LD	Euro 5 (2011)	4.5 mg/km	6×10 <sup>11</sup> km <sup>-1</sup>
	HD	Euro VI (2014)	10 mg/kWh	6×10 <sup>11</sup> kWh <sup>-1</sup> (UN/ECE 49)
				8×10 <sup>11</sup> kWh <sup>-1</sup> (EU 64/2012)
US	LD	Tier 3 (2017)	3 mg/mi (FTP; CFR 40/86)	None
			10 mg/mi (US06; CFR 40/1066)	
	HD		10 g/bhp-hr	None
<b>In-Service conformity (EU) or in-use compliance (US)</b>				
EU	LD	Euro 5 (2011)	None	Under evaluation
	HD	Euro VI (2014)	Under evaluation	None
US	LD	Tier 3 (2017)	6 mg/mi interim	None
			3 mg/mi	
	HD	2007	15 g/bhp-hr	None
<b>Roadworthiness</b>				
EU	All		None	None

## WHY BASE REGULATION ON PARTICLE NUMBER?

- › With introduction of DPFs limit of gravimetric detection was reached.
- › US sought improvements to decrease the limit of detection
- › EU launched Particle Measurement Program to develop new methodology
  - › SPN – solid particles > 23 nm
- › The choice for >23 based on repeatability issues w.r.t new particle formation and sampling and measurement artefacts.
- › Solid to avoid volatility issues.
- › SPN allows for reliable procedure for PNC within European legislative framework.

# AUTONOMOUS DEVELOPMENT AMBIENT AIR

- › In ambient air many particles < 23 nm.
- › Not solid particles also suspected of adverse health effects.
- › Ambient air standard → all particles > 7 nm
  
- › If techniques are very effective on solid particles larger than 23 nm than semi-volatiles form new particles.
- › Thus a very effective measure on emissions may not necessarily lead to a reduction of ambient particle number concentrations.
- › This potentially frustrates evaluation of emission reduction measures

# MARINE BLACK CARBON EMISSIONS

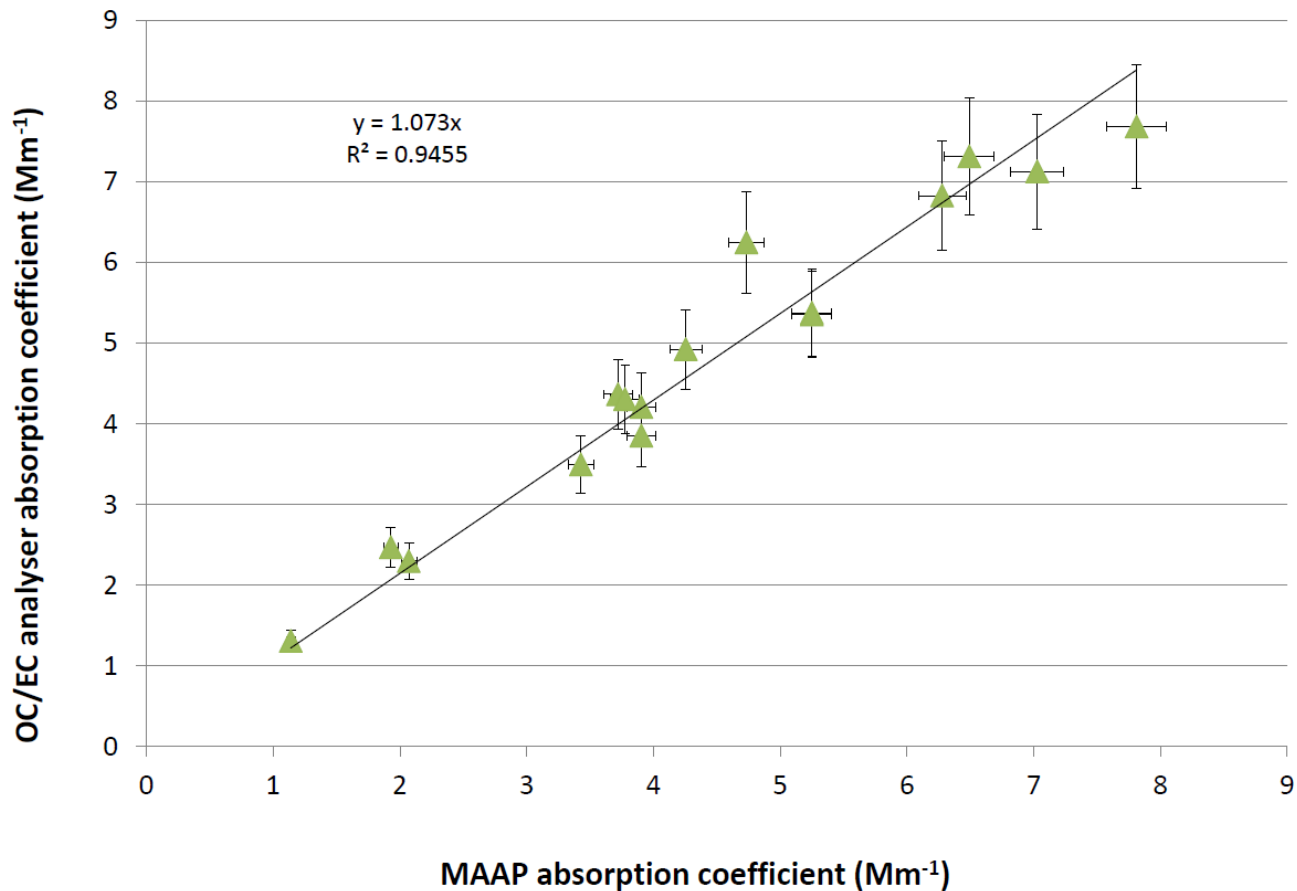
- › Motivation: BC is ShortLived Climate Forcer
- › Impact and evaluation studies will be based on absorption properties?
- › Emission guidelines/regulations/legislations will be based on mass?
  
- › What will be the preferred BC property?
- › EFs are needed for a refined global marine BC inventory
  
- › The relation between mass (EC) and absorption (eBC) is strong.

# RELEVANT EUROPEAN DEVELOPMENTS WITHIN ACTRIS

- › JRA1: Improving the accuracy of aerosol light absorption determinations
- › multi-wavelength light absorption
- › assess the relationship between absorption and black carbon concentration.
- › establish relationships between aerosol sources and light absorption, targeting the needs of the model and satellite communities.
- › Absorption  $\equiv$  Extinction minus Scattering!



# RELEVANT EUROPEAN DEVELOPMENTS WITHIN ACTRIS



**MAKE SURE THAT EMISSION REGULATION IS  
SUITED FOR LATER USERS**