Marine Black Carbon Emissions: Identifying Research Gaps

Technical Workshop – Black Carbon Definition

Dan Lack

September 9th and 10th, 2014

Ottawa, Canada
BC Definition

• General Definition — What is BC?

• Physical Property Definition — What physical properties are used to measure BC?

• Measurement-Specific Definition — What do we call it once we measure it?
The BC Playing Field

• BC is complicated:
  – It’s not just one molecule (e.g. CO$_2$).
  – Can include a range of highly absorbing conjugated C=C bonds that lead to a lot of light absorption.
  – It has several physical properties that can be used for measurement of subtly different things.
  – To what extent are these ‘different measurements’ giving us the same thing?
BC General Definition

“A distinct type of carbonaceous material that is formed primarily in flames, is directly emitted to the atmosphere, and has a unique combination of physical properties.”

Bond et al. (2013)
BC Physical Property Definitions ➔ Measurement Methods

1. It strongly absorbs visible light, with a MAC value above 5 m² g⁻¹ at a wavelength λ = 550 nm for freshly produced particles ➔ **Light Absorption**

2. It is refractory, with a volatilization temperature near 4000 K ➔ **Laser-induced incandescence, Thermal-Optical Analysis**

3. It is insoluble in water, in organic solvents including methanol and acetone, and in the other components of the atmospheric aerosol ➔ **Gravimetric**

4. It consists of aggregates of small carbon spherules of < 10 nm to approximately 50 nm in diameter ➔ **Imaging**

5. It contains a high fraction of graphite-like sp²-bonded carbon atoms ➔ **Spectroscopy**
Measurement Type → Measurement Definitions

- Equivalent BC (eBC): **Light Absorption** * Mass Absorption Coefficient (MAC)
- Refractory BC (rBC): **Incandescence.**
- Elemental Carbon (EC): **Thermal-optical** methods (High temp. oxidation)
- Elemental Carbon: **Insolubility**
Measurement Definitions (Petzold et al., 2013)

**eBC:**
Data derived from optical absorption* methods, together with a well defined mass absorption coefficient (MAC) and a specified approach for separating potential contributions of BrC or mineral dust.

**rBC:**
Data derived from measurements that address the thermal stability of carbonaceous matter and require light-absorbing efficiency of the analyzed particulate matter derived from incandescence methods.

**EC:**
Data derived from methods specific to carbon content of carbonaceous matter.