Tailoring coefficients in IMPROVE algorithm to assess site-specific chemical light extinction

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Introduction

Atmospheric aerosol (PM): variety of composition, size, shape of the particles — **Atmospheric gases**

different optical properties (**scattering**+**absorption=extinction**)

Effects at global and local scales (Earth energy balance, **visibility**, health)

Models to assess the influence of PM and gaseous pollutants on visibility: the most widespread is
U.S. IMPROVE (Interagency Monitoring of PROtected Visual Environments) algorithm
→ evaluation of atmospheric light extinction coefficient (b_{ext}) from compositional and meteorological data

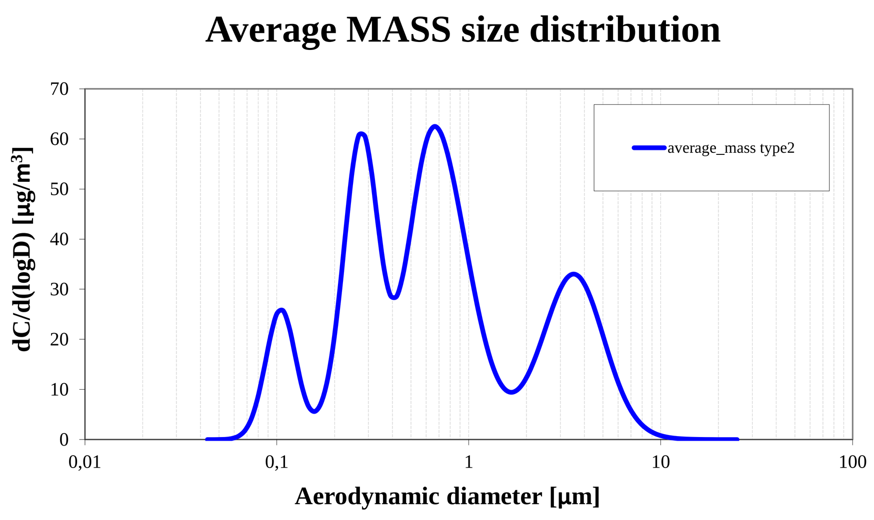
Visibility estimates (visual range from Koschmieder equation: $VR = -\ln 0.02/b_{ext}$)
→ possibility to understand the reasons of its impairment and to undertake emissions control strategies to remedy to it

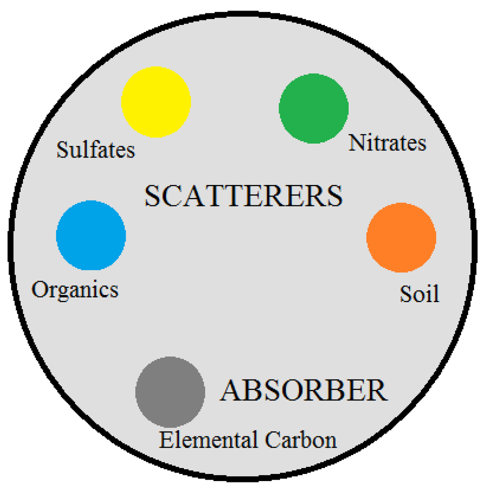
Credits to M. Lazzarini, ARPA Lombardia

Problem: coefficients in the IMPROVE equation are based on aerosol characteristics in U.S. national parks and the same **fixed coefficients** (dry mass extinction efficiencies and hygroscopic growth factors) are usually applied also at sites with different PM properties
→ need to **tailor coefficients** in order to make the algorithm more site-specific

Methodology

- For main aerosol components:
  - **Size distributions**
  - **Complex refractive indices** (from literature)

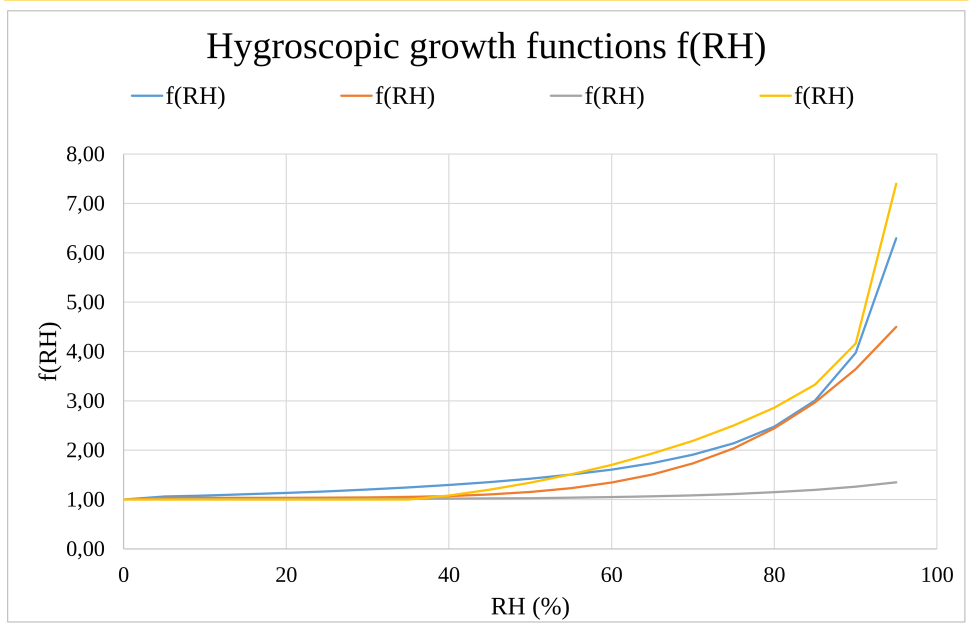




Mie calculations + Particles **densities** (from literature) → Tailored DRY MASS EXTINCTION EFFICIENCIES c_i of main aerosol components

	Dry mass extinction efficiencies (c_i)			
	AMSUL	AMNIT	OM	Soil
PM_{10}	4.44	5.16	5.04	1.21
$PM_{2.5}$	4.44	5.16	6.08	3.21
IMPROVE original	3.00	3.00	4.00	1.00

Mie calculations → Tailored HYGROSCOPIC GROWTH FUNCTIONS **f(RH)$_i$**



- **Meteorological parameters**: RH; T; P → Rayleigh scattering by gases **RS**
- **Concentrations** of main **aerosol components** and NO_2
- **PM light absorption coefficient b_{ap}**

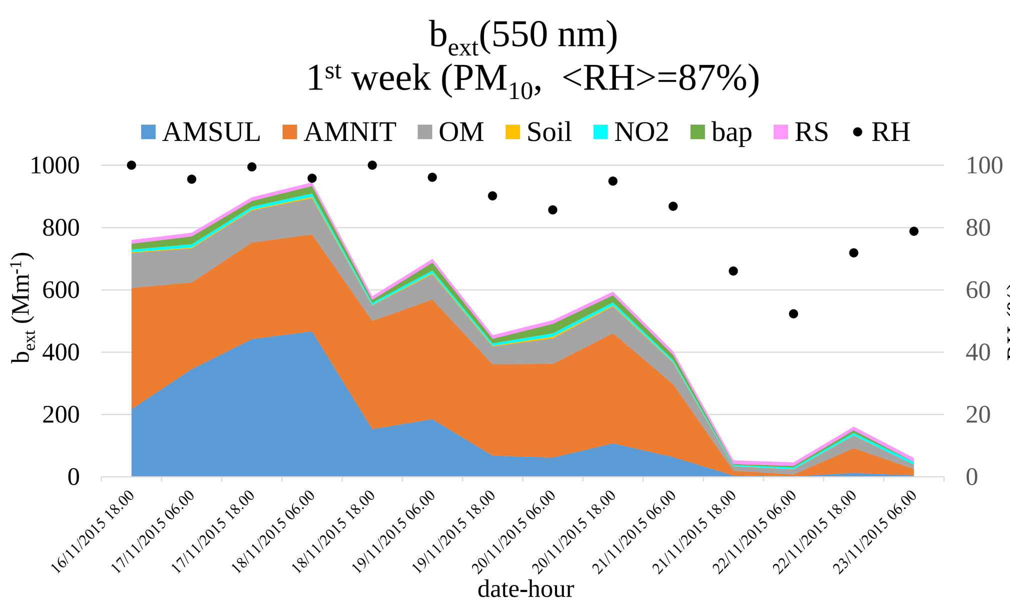
Site-specific chemical light extinction @ 550 nm:

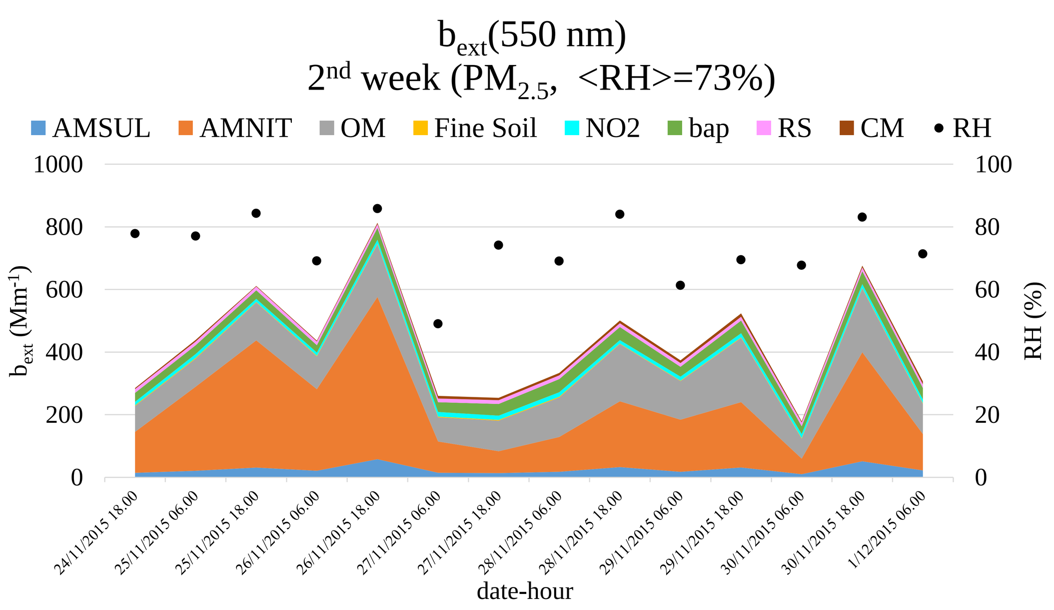
$$b_{ext}(RH) = c_1 f(RH)_1[AMSUL] + c_2 f(RH)_2[AMNIT] + c_3 f(RH)_3[OM] + c_4[Soil] + 0.60[CM] + b_{ap} + 0.33[NO_2] + RS$$

AMSUL: ammoniun sulfate; AMNIT: ammonium nitrate; OM: organic matter; CM: coarse mass

Model uncertainty: 15%

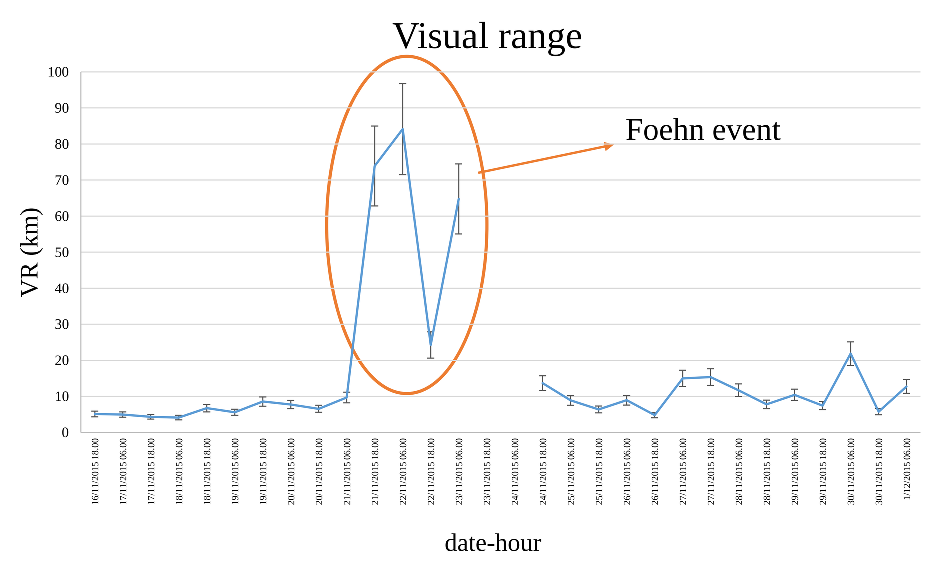
Preliminary results – application to a 2-weeks dataset (samples collected in Milan, period: 16/11/2015 – 01/12/2015)





Temporal variation of light extinction coefficient: different contribution of aerosol components due to RH effect (hygroscopicity) and variability of PM chemical composition

evaluation of visibility conditions



Outlooks

- Application to data retrieved from sampling campaigns devoted to PM compositional characterization, to gain information on chemical light extinction
- Use of the algorithm in standard monitoring networks, in order to obtain visual range as an additional parameter