Imaginary Refractive Indexes of Secondary Aerosol Components

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Introduction

- Atmosphere helps to maintain the Earth's energy balance
  - Energy balance is roughly zero
  - Affects path of solar radiation
- Keeps much harmful UV light from reaching Earth's surface (ozone layer)
- Aerosols are a major affecter of solar radiation
  - Scatter light to affect albedo
  - Can also absorb energy
- Origins, Concentrations, Interactions of these particles play a role in climate modeling

Refractive Index (m=n+ik)

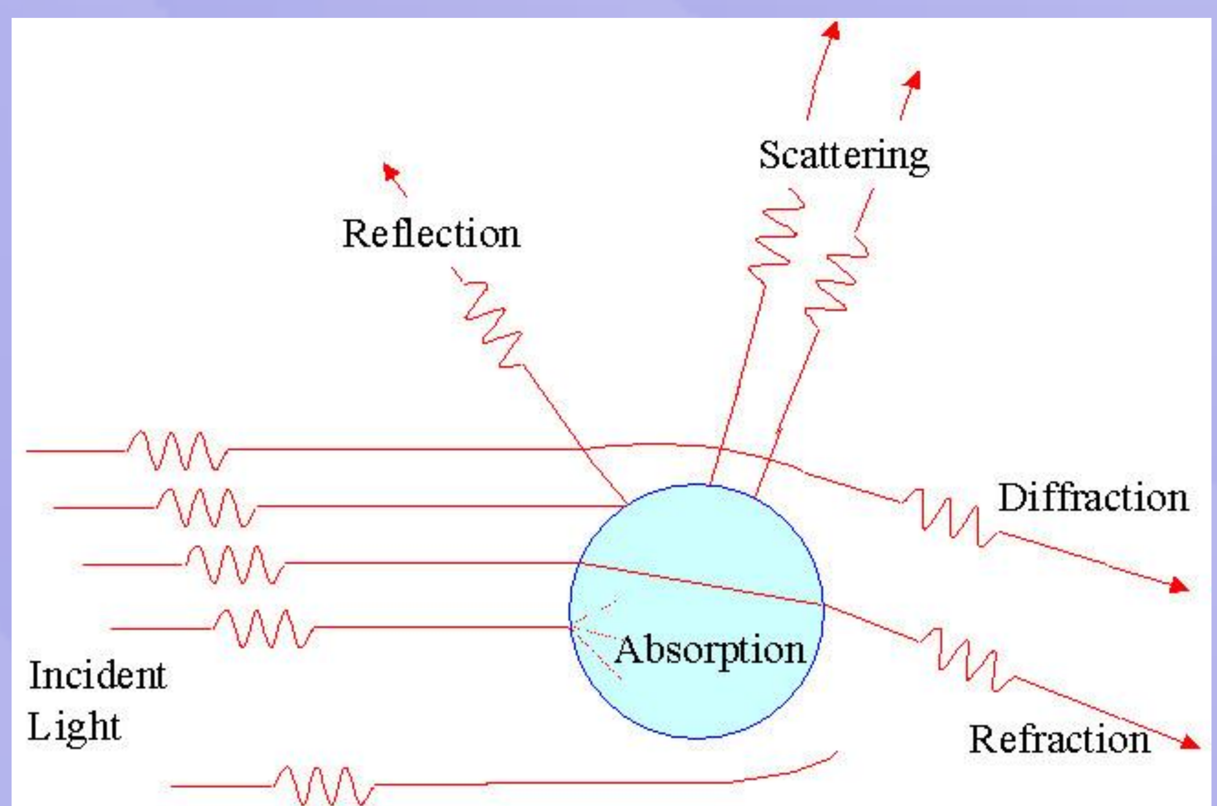


Figure 2. Light Interactions with an Aerosol..

- Refractive index is a measure of how a particle interacts with light
- Real refractive index affects albedo
- Imaginary index tells about particle's warming potential
- Refractive index is wavelength dependent

What Is an Aerosol?

Some Anthropogenic Aerosol Sources.

- Aerosol sources are both natural and anthropogenic
- Living things can be aerosol sources as well (biogenic)

- Aerosols are solid or liquid particles in the atmosphere
- 2 types of aerosols:
- Primary – released into the atmosphere already formed
- Secondary – form from gas molecules in the atmosphere

Volcanoes are Natural Aerosol Sources.

Experimental

- Three compounds known to nucleate in the atmosphere to form secondary aerosols identified (Figure 3).
  - All are aromatic carboxylic acids.
- Diluted in methanol to a concentration of $2x10^{-5}$ M,
- Absorbance spectra were run using a Cary 50 UV/Visible Spectrophotometer.

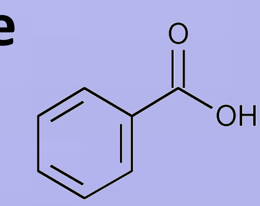
From UV/Visible data collected, the absorption coefficient (α) was calculated using the formula:

$$\alpha = 10^3 \rho \log\left(\frac{abs}{cL}\right) \quad [1]$$

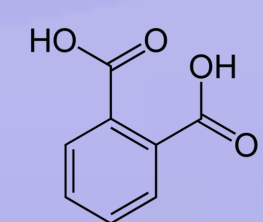
α was then used to calculate the imaginary refractive index, *k*:

$$k = \frac{\alpha\lambda}{4\pi} \quad [2]$$

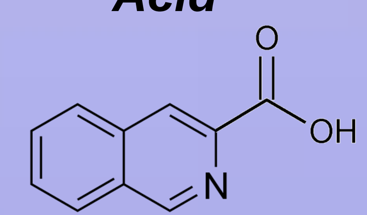
Equation Variable Key:
λ = wavelength
α = absorption coefficient
ρ = particle density
L = path length
c = concentration
k = imaginary refractive index



Benzoic Acid



Phthalic Acid



Isoquinoline-1-Carboxylic Acid

Aerosol Life Cycle

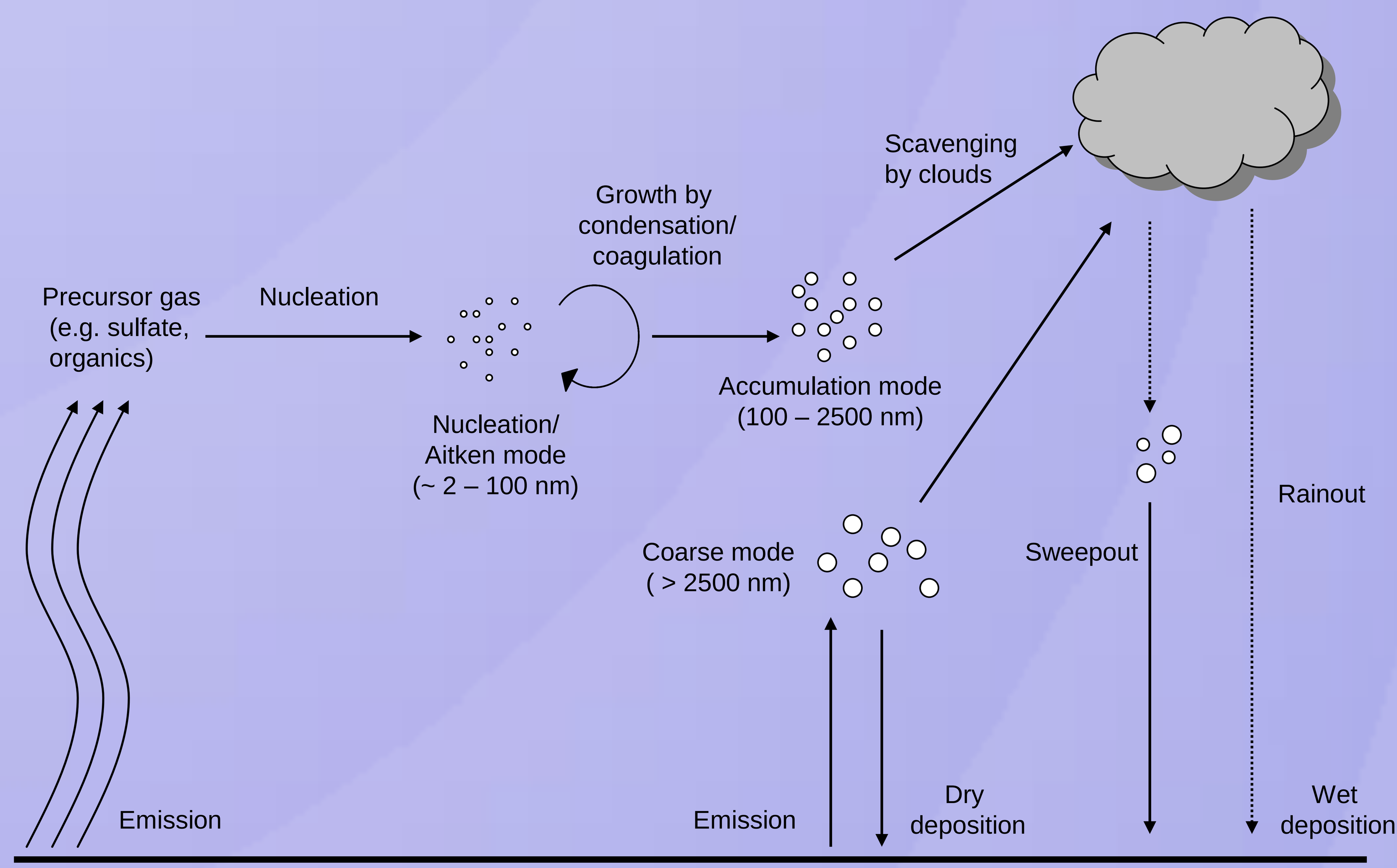


Figure 1. The Life Cycle of Atmospheric Aerosols.

Results and Future Work

- These compounds all have greater warming potentials when interacting with shorter wavelengths of light
  - Most likely due to aromatic chromophore
- The dicarboxylic acid (phthalic acid) had a much stronger max index than the others
- Next, determine wavelength dependency of *k*, compare solute *k* to aerosolized *k*.

Wavelength (nm)	Benzoic Acid	Phthalic Acid	Isoquinoline-1-Carboxylic Acid
658	$0.00392 \pm 1x10^{-5}$	0.001 ± 0.001	$0.0017 \pm 1x10^{-4}$
589	$0.003595 \pm 3x10^{-6}$	0.001 ± 0.001	$0.001649 \pm 2x10^{-6}$
532	$0.000488 \pm 3x10^{-6}$	0	0
480	$0.004340 \pm 2x10^{-6}$	$0.0045 \pm 2x10^{-4}$	$0.00249 \pm 1x10^{-5}$
226	$0.0052450 \pm 2x10^{-8}$	$0.0080 \pm 1x10^{-4}$	$0.0037147 \pm 3x10^{-7}$

Table 1. Imaginary Refractive Indexes at Selected Wavelengths.

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Acknowledgments

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