How do experiments help modelling BC aging?

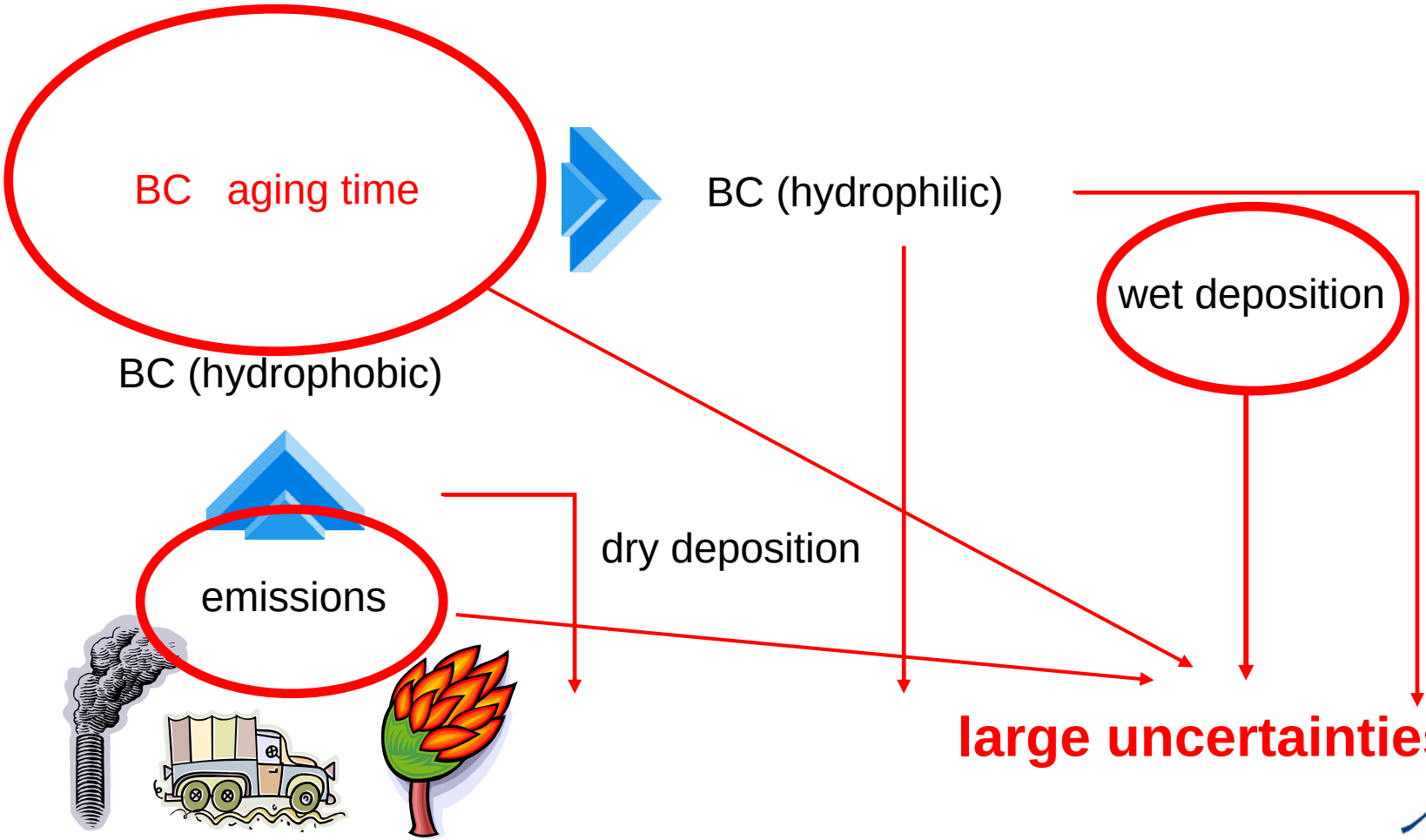
Example: large scale model parameterisations

Definition of BC aging

Processes that act changing the solubility of the BC system

- **Condensation of soluble material on BC particles**
- **Coagulation with other soluble particles**
- **Oxidation of organic material that coats the particles by O_3**

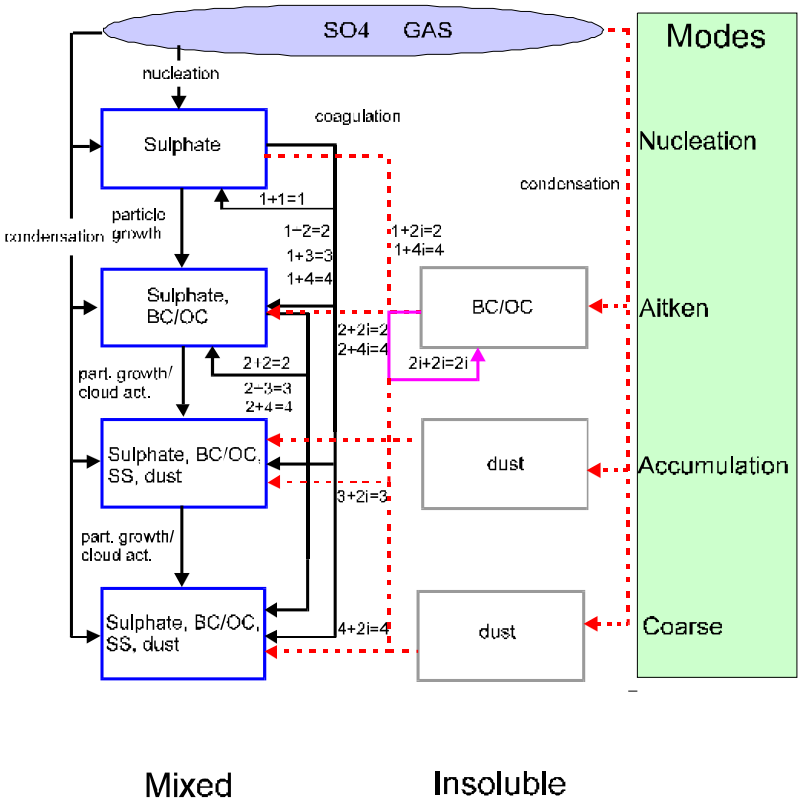
Black Carbon cycle



1) A very simplified approach for BC (TM5 aerosol bulk description)

- BC:
  - bulk, assumed as acc. mode (mass mean radius = 0.14 μm)
  - processes on BC: emissions, transport, dry and wet removal
  - cloud-free atmosphere: hydrophobic
  - in cloud: 30% interstitial, 70% behaves as hygroscopic

2) Aerosol dynamics



- M7 model: nucleation, cond. of H_2SO_4 and coagulation
- SO_4, BC, OC, ss, dust
- An insoluble BC particle becomes soluble/mixed when covered by a monolayer of H_2SO_4

3) Oxidation of BC coating material by O_3

Pöschl et al. (2001)

Pseudo-first order decay rate coefficient

$$k = \frac{K_\infty k_{O_3}[O_3]}{1 + k_{O_3}[O_3] + k_{H_2O}[H_2O]}$$

- When a BC particle is defined soluble?
  - When a monolayer of soluble material is formed on the particle: mean aerosol size of 0.25μm and a monolayer thickness of 2.5 nm from the particle surface (Tsigaridis and Kanakidou, ACP, 2003)

4) Fixed aging time

- Aging at a certain rate
  - $7.1 \times 10^{-6}\ s^{-1}$ (Cooke and Wilson, 1996)
  - Exponential decay (~1 day)
- Easy to use; global average
- It does not depend on presence of gases or other particles

Effects of the aging parameterisation on BC lifetime

Aging parameterisation	TM5	
	BC lifetime (days)	
Very simplified approach	4.16	
Oxidation by ozone	3.88 (?????)	
Aerosol dynamics	(5)	
Fixed aging time	5.7 (1.1 day e-folding t)	

Effects of the aging parameterisation on BC lifetime

Aging parameterisation	TM5	Can.Centre Clim.model*
	BC lifetime (days)	
Very simplified approach	4.16	
Oxidation by ozone	3.88 (?????)	9.5
Aerosol dynamics	(5)	5
Fixed aging time	5.7 (1.1 day e-folding t)	6.6 (1 day e-folding t)
No aging		98.1
Dynamics and oxidation		4.9

*** Croft et al. ACP, 2005**

Discussion

- How can we define the transition between soluble and insoluble BC particle?
  - How bad is the assumption of BC as sphere?
  - How good is the "monolayer" definition?
- Is it necessary to (and can we) improve the oxidation parameterisation?
- Oxidation versus aerosol dynamics: do they compete with each other?
  - which is the most efficient at atmospheric conditions?
- What is the estimation of an average BC lifetime from measurements?
- ……