Extinction, SSA and SU/BC ratios

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2 'new' data sets:
'*in-situ*' DRY aerosol extinction coefficient & SSA
Sulfate/BC mass ratios
at selected surface sites

Extinction, SSA and SU/BC ratios

Local closure check on aerosol mass fields and optical model. Comparison with column AOT agreement

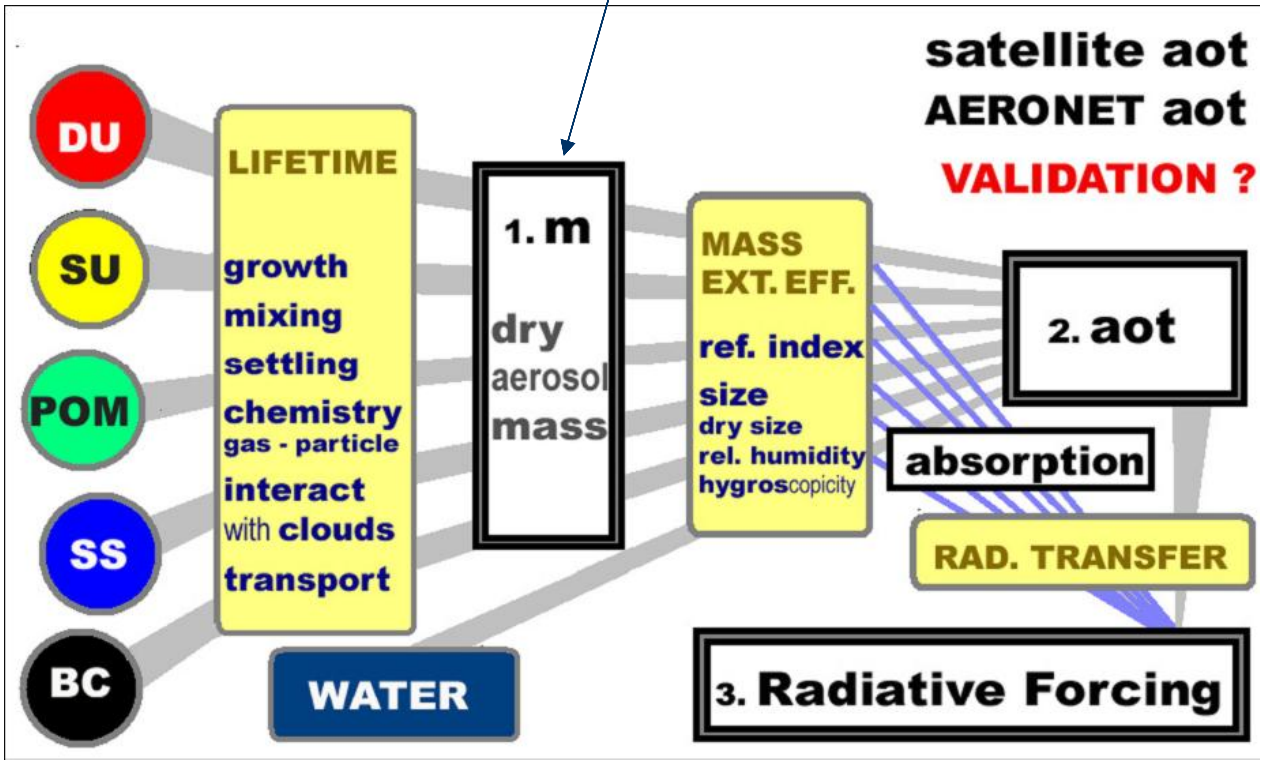


Fig 2 from Kinne et al., 2006 - AEROCOM optical properties

Why Dry Extinction and SSA ?

$$\sigma_{ext} = \sigma_{scat} + \sigma_{abs}$$

$$\omega_{o\,=} = \sigma_{scat} / \sigma_{ext}$$

Malm et al (1997) & others have shown that the differences in refractive index and scattering and absorption efficiencies from using external vs internal aerosol mixing models c 10%.

$$i.e. = \Sigma\, \alpha_{si}\, m_i + \alpha_{ai}\, m_i$$

where α_{si} and α_{si} are the specific scattering and absorption efficiencies for aerosol species i.

Water soluble aerosol species have varying patterns of hygroscopic growth – changes both scattering and absorption

Aerocom Optical Properties (Kinne et al., 2006)

"At 0.11 to 0.14, simulated aot values are at the lower end of global averages suggested by remote sensing from ground (AERONET ca. 0.135) and space (satellite composite ca. 0.15). More detailed comparisons, however, reveal that larger differences in regional distribution and significant differences in compositional mixture remain. ***Of particular concern are large model diversities for contributions by dust and carbonaceous aerosol, because they lead to significant uncertainty in aerosol absorption (aab)".***

Table 4.

MAX/MIN DUST = 11 (1.4)
MAX/MIN BC = 6.6 (1.8)
MAX/MIN WATER = 7.1 (3.1) – 9 models
WATER 28 – 79% of total (AOT)

Why Dry Extinction and SSA ?

Dry removes all the water vapour effects in the model, for in-situ comparison & treatment of water in the models is very variable & uncertain.

Dry reduces the scattering response in absorption measurements (Bond et al, 1999) – reduces the uncertainties in the measurements.

Currently in calculating extinction, use BC models that are 'validated' by comparison with optical Equiv. BC data (specific absorption coeff.). In calculating the BC contribution to specific extinction other optical properties likely to be assumed –> systematic & variable bias effectively a function of instrument calibration. If instead absorption measurements are only compared to calculated absorption, single use of specific absorption coeff. in the model calculation.

What is required?

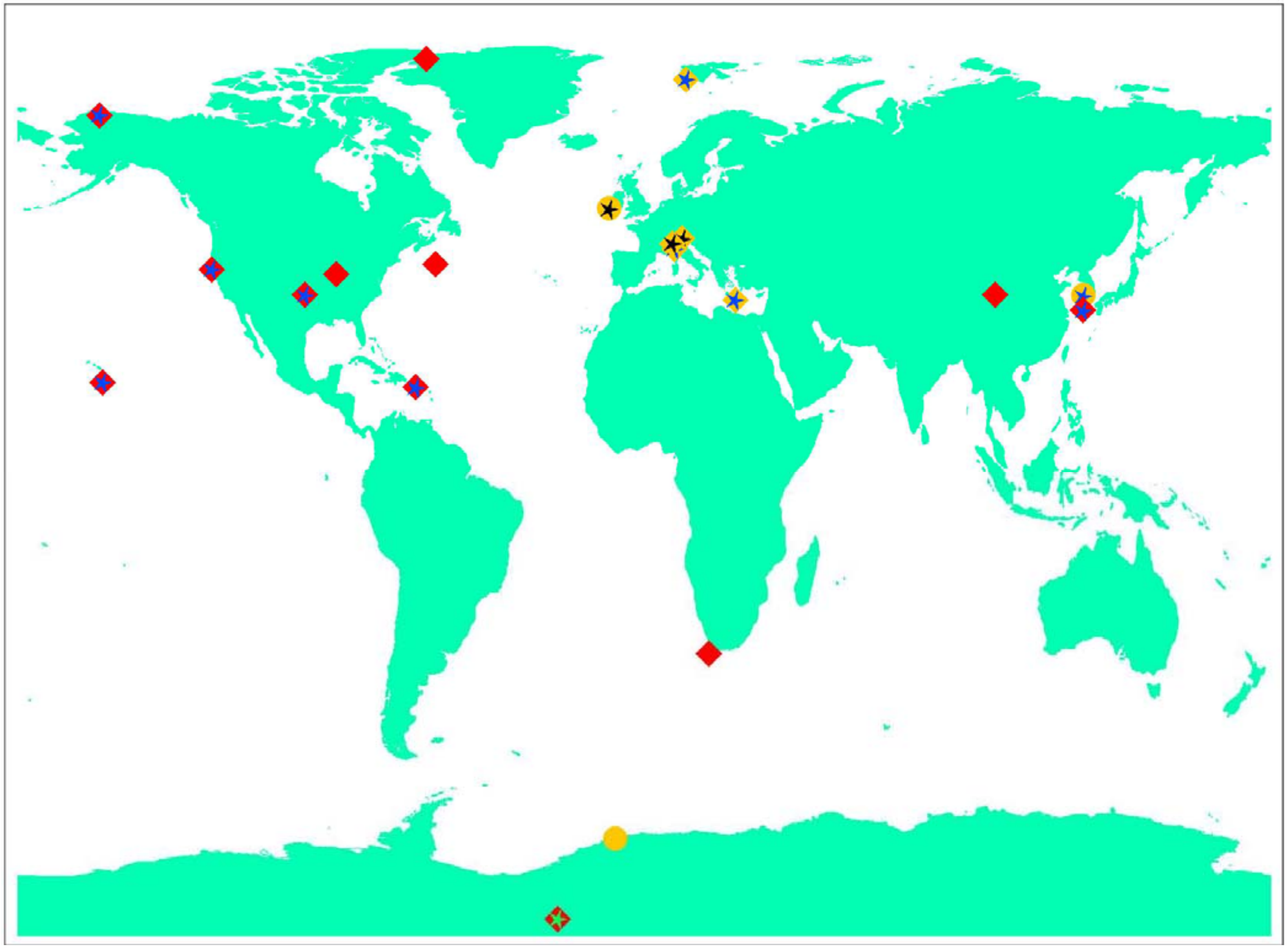
*•**Co-located QA'd measurements of aerosol scattering (nephelometer) and aerosol absorption (absorption photometer). For aerosols of known size range, temperature pressure and humidity & with the humidity < 40% to minimise hydroscopic growth effect of water soluble components.***

*•**Nephelometers – continuous narrowband measurements including 550nm or possibility to interpolate data to 550nm. Data corrected for truncation errors.***

*•**Absorption Photometers - continuous measurements at 550nm (or possibility to interpolate data to 550nm) on same time resolution as Nephelometer to permit correction of absorption data for scattering response (K_1 of Bond et al. 1999) 550nm or possibility to interpolate data to 550nm*. Data corrected for scattering response, filter loading and calibrated to a reference absorption.***

*** Feasible for other narrow band & spectral absorption measurements, for broadband (see Bodhaine, 1995) the difficulty is in assessing the uncertainties.***

‘dry’ aerosol extinction coefficient sites



CMDL and partner sites, + those that can meet the criteria

CMDL pack (TSI3563+PSAP@ controlled humidity) – *in-situ* 550nm extinction co-efficient @ STP ♦
3563/903 Neph + narrowband absorption – *in-situ* 550nm extinction co-efficient @STP feasible - ♦
3563/903 Neph + broadband absorption – uncertain *in-situ* extinction “co-efficient“- ●
CIMEL Sunphotometer co-located *
PFR Sunphotometer co-located *
SP01A Sunphotometer co-located *

Station Details

Region	Station	AOD	Light Scattering (nm)	Light Absorption (nm)	RH
Arctic	Alert		450, 550, 700 (3563)	550 (PSAP)	<40%
Arctic	Ny Alesund	CIMEL, PFR, BSRN	450, 550, 700 (3563)	450, 550, 700 (CUSTOM)	Ambient
Arctic	Point Barrow	CIMEL, SPO1A, BSRN	450, 550, 700 (3563)	550 (PSAP)	<40%
Europe	Mace Head	PFR	450, 550, 700 (3563)	broadband (AE-9)	<45%
Europe	Hohenpeissenberg	PFR	450, 550, 700 (3563)	532 (MAAP), & Broadband AE-10)	T=?
Europe	Finokalia	CIMEL (Heraklion)	530 (903)	550 (PSAP)	Unknown
Europe	Ispra	CIMEL	450, 550, 700 (3563)	370, 450, 571, 615, 660, 880, 950 (AE-31)	Ambient
Americas	Bondville	BSRN	450, 550, 700 (3563)	550 (PSAP)	<40%
Americas	Lamont SGP	CIMEL, BSRN	450, 550, 700 (3563)	550 (PSAP)	<40%
Americas	Sable Island (to 2000)		450, 550, 700 (3563)	550 (PSAP)	<40%
Americas	Trinidad Head	CIMEL, BSRN?	450, 550, 700 (3563)	550 (PSAP)	<40%
Americas	Cape San Juan	CIMEL	450, 550, 700 (3563)	550 (PSAP)	<40%
Asia	Anmyeon-do	CIMEL	450, 550, 700 (3563)	broadband ?	Unknown
Asia	Kosan (2000-2001)	CIMEL	450, 550, 700 (3563)	550 (PSAP)	<40%
Africa	Cape Point		450, 550, 700 (3563)	550 (PSAP)	<40%
Antarctic	S. Pole	SPO1A, BSRN	450, 550, 700 (3563)	550 (PSAP)	<40%
Antarctic	Neumayer	BSRN	450, 550, 700 (3563)	broadband ?	Unknown
F. Trop	Jungfraujoch	PFR	450, 550, 700 (3563)	370, 450, 571, 615, 660, 880, 950 (AE-31)	T=25 C
F. Trop	Mount Waliguan		450, 550, 700 (3563)	550 (PSAP)	<40%
F. Trop	Mauna Loa	CIMEL	450, 550, 700 (3563)	550 (PSAP)	<40%

PFR = 368, 412, 500, 862 nm, SP01A = 412,500,675, 862 nm,

CIMEL = 1020, 870, 675, 440, 936, 500, 340, 380 nm

Data Summary from Delene & Ogren, 2002.

Station	Pm10 σ_{ap} (Mm^{-1})	Pm10 σ_{sp} (Mm^{-1})	Pm10 σ_{extp} (Mm^{-1})	ω_p
Point Barrow	**0.39 ± 0.41**	**9.76 ± 5.20**	**10.2 ± 5.41**	**0.965 ± 0.023**
Bondville	**4.66 ± 2.27**	**57.7 ± 17.7**	**62.4 ± 18.8**	**0.924 ± 0.028**
Lamont SGP	**2.46 ± 1.09**	**46.9 ± 16.9**	**49.4 ± 17.4**	**0.947 ± 0.025**
Sable Island	**1.88 ± 0.73**	**39.9 ± 7.2**	**41.8 ± 7.56**	**0.956 ± 0.015**

Station	Pm1 σ_{ap} (Mm^{-1})	Pm1 σ_{sp} (Mm^{-1})	Pm1 σ_{extp} (Mm^{-1})	ω_p
Point Barrow	**0.36 ± 0.38**	**6.17 ± 3.61**	**6.53 ± 3.8**	**0.954 ± 0.023**
Bondville	**3.94 ± 1.80**	**48.7 ± 14.7**	**52.6 ± 15.6**	**0.924 ± 0.028**
Lamont SGP	**2.08 ± 0.98**	**37.5 ± 12.7**	**39.6 ± 13.2**	**0.944 ± 0.025**
Sable Island	**1.51± 0.66**	**13.6 ± 7.2**	**15.1 ± 7.53**	**0.897 ± 0.031**

Monthly average dry optical properties at 4 CMDL sites for the period 1997-2000 (94-2000 Sable Island, 96-2000 Bondville).

Estimated calibration uncertainties for Scattering 7%, Absorption 20%.

BC/Sulfate Ratio data Set

Why

- ***Still uncertainty in how best to model BC, many models make reference to sulfate in modelling the atmospheric processing of BC.***
- ***BC/Sulfate ratios therefore provide a means to observe the actual measured spatial variation in BC/Sulfate and compare these ratios with the modelled ratios to give insight into the extent of the 'coupling' of the two atmospheric cycles.***

How

Data sets:
CMDL sites (PSAP -> BC + Sulfate from PMEL filter analysis)
IMPROVE
EMEP EC/OC campaign + standard EMEP sulfate.
Other GAW (C. Grim, Mace Head etc.)
Data separated by BC method.

Problems and Remaining issues?

Problems

•Including broadband measurements (after Bodhaine,1995) – uncertainty issues.

•Optical properties at 550 nm, but AOD at other wavelengths – 500 or 675.

Issues

•What temporal resolution ? Hourly is available but probable autocorrelation differences between the measurements and the models, 6h 12h or 24 h averages?

•Time period – data from 97 onwards, and with the exception of Kosan & Sable Island all active. – 2005 as a reference year or 2000-2005?

Other candidate sites?

Frequency of updates – especially for the broadband sites where several revisions may be necessary.