Modeling of aerosol optical properties with CHIMERE and OPAC and validation with Brewer and Cimel measurements at Brussels, Belgium

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1 INTRODUCTION

The Aerosol Optical Depth (AOD) and Single Scattering Albedo (SSA) of aerosols above Brussels, Belgium (50°48'N, 4°21'E, 100m asl) are modeled for the period between 1991-2010, using a combination of CHIMERE (a chemical transport model (CTM); Vautard et al. 2001) and the OPAC (Optical Properties of Aerosols and Clouds; Hess et al. 1998) software package. The modeled values are compared to measured values from two Brewer ozone spectrophotometers and a Cimel sunphotometer located at Brussels.

2 DATA AND METHOD

2.1 Brewer and Cimel

- Brewer: AOD either from direct sun measurements at **306.3**, 310.1, 313.5, 316.8 and 320.1nm or from sun scans at **340**nm
- Cimel: AOD from solar extinction measurements at 340, 380, 440, **500**, 670, 870 and 1020nm (level 2.0 data)
- Cimel: SSA at **440**, 675, 870 and 1020nm as inversion products (level 2.0 data)
- Brewer AOD at 306.3nm and 340nm and Cimel AOD and SSA at 500nm and 440nm respectively are used for comparisons with the model

2.2 CHIMERE

- CTM for the prediction and simulation of air quality
- provides chemical composition of aerosol particles (in μg/m3) up to a height of 5.5km
- forced by meteorological fields of ECMWF's ERA-INTERIM reanalysis
- emissions taken from EMEP database
- uses different aerosol components: Salt, HNO_3, H_2SO_4, NH_3, Organic Carbon (OC), Black Carbon (BC), Primary Particulate Matter (PPM), Secondary Organic Aerosols (SOA) and DUST

Assignment of CHIMERE aerosol components into OPAC aerosol classes:

- BC => Soot
- Dust => Mineral coarse mode
- NH_3+H_2SO_4+HNO_3 => Soluble
- OC + PPM + SOA => Insoluble
- Salt => Seasalt coarse mode

2.3 OPAC software package

- provides **optical properties of atmospheric particulate matter** in the solar and terrestrial spectral range
- optical properties of aerosols are calculated based on microphysical data (size distribution and spectral refractive index) under the assumption of spherical particles
- data are given for 61 wavelengths (between 0.25 and 40μm) and 8 values of relative humidity (RH) (0, 50, 70, 80, 90, 95, 98, 99%)
- values of RH are chosen to be closest to the observed values from our synoptical station
- the Mixing Layer Height (MLH) is needed as input: MLH taken either from **balloon soundings** or from **ALADIN model** output

3 RESULTS

3.1 Comparison with Brewer and Cimel

AOD and SSA values at 11 UT, modeled with OPAC, have been compared to Brewer and Cimel measurements (closest to 11 UT). The correlation between OPAC and the instruments can be found in Table 1 and the comparison with Cimel AOD and SSA values is presented in Figures 1 and 2. The best agreement is found between the AOD values from OPAC and the Cimel sunphotometer at 500nm. For the SSA values, the correlation coefficient is close to 0, which means that the modeled and measured values do not compare well.

			Correlation
AOD	OPAC 300nm	Brewer 306nm	0.339
	OPAC 350nm	Brewer 340nm	0.405
	OPAC 500nm	Cimel 500nm	0.541
SSA	OPAC 450nm	Cimel 440nm	0.043

Table 1. Correlation coefficients between measured and modeled AOD and SSA.

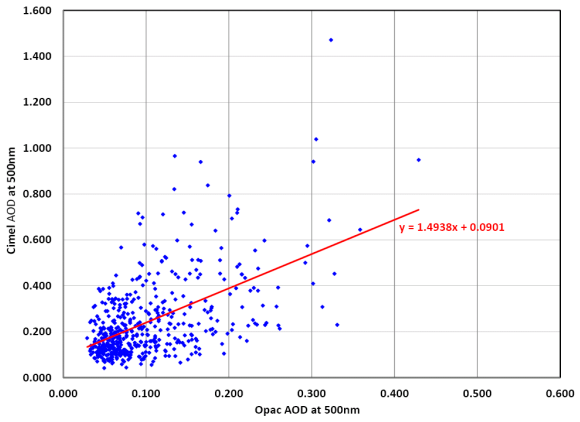

Figure 1. Comparison of Cimel AOD values and modeled OPAC AOD values, both at 500nm.

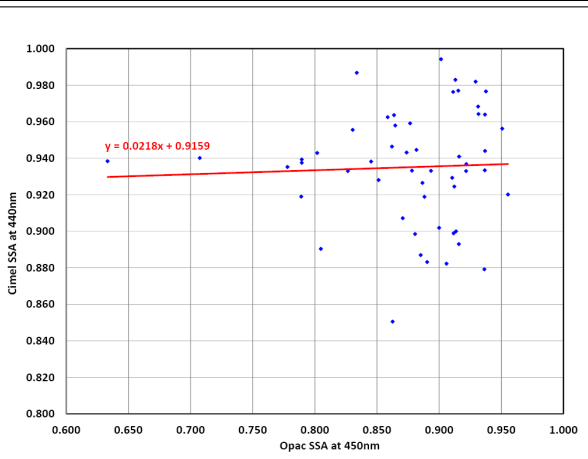

Figure 2. Comparison of Cimel SSA values at 440nm and modeled OPAC SSA values at 450nm.

3.2 Modeled AOD and SSA in function of different parameters

The correlation between the modeled AOD and SSA and different input parameters is shown in Table 2. Some of the relations are highlighted in Figures 3 to 5.

CORRELATIONS		
	OPAC SSA 350nm	OPAC AOD 350nm
RH class	0.68	0.08
MLH	-0.34	0.36
Seasalt	-0.39	0.27
Water Soluble	0.39	0.59
Mineral	-0.27	0.29
Insoluble	-0.03	0.00
Soot	-0.60	-0.03
Wind direction	0.07	-0.12
Wind speed	-0.05	-0.28

Table 2. Correlation coefficients between modeled AOD and SSA from OPAC and different parameters.

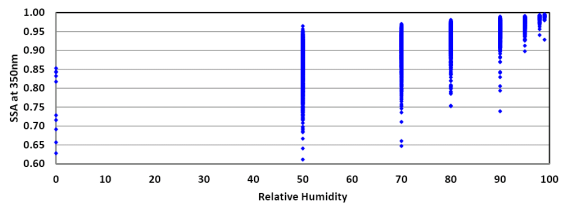

Figure 3. Modeled SSA at 350nm in function of Relative Humidity (RH).

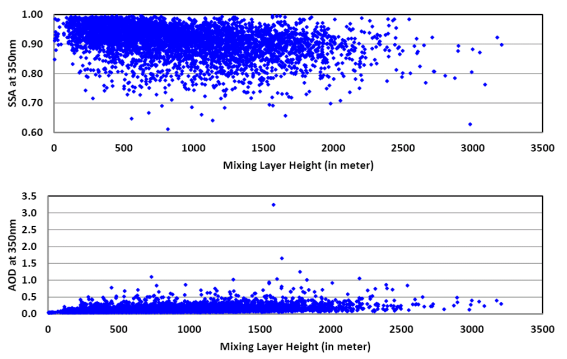

Figure 4. Modeled SSA (upper panel) and AOD (lower panel) at 350nm in function of Mixing Layer Height (MLH).

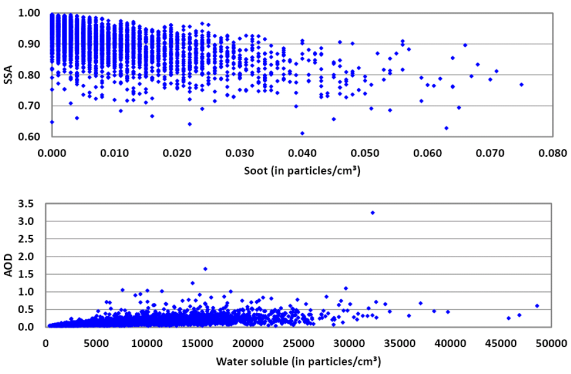

Figure 5. Modeled SSA at 350nm in function of soot (upper panel) and AOD at 350nm in function of Water soluble (lower panel).

4 CONCLUSIONS

Using CHIMERE and OPAC to model AOD and SSA gives acceptable results for AOD. The bad agreement between the OPAC and Cimel SSA could be a signal that the values from the Cimel might need a revision.

The modeled SSA are especially influenced by the relative humidity class and the amount of soot. For AOD, the amount of water soluble particles and the mixing layer height play the most important role.

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