Retrieval of aerosol properties for the Asian fine-coarse mode aerosol mixtures over urban areas from PARASOL measurements

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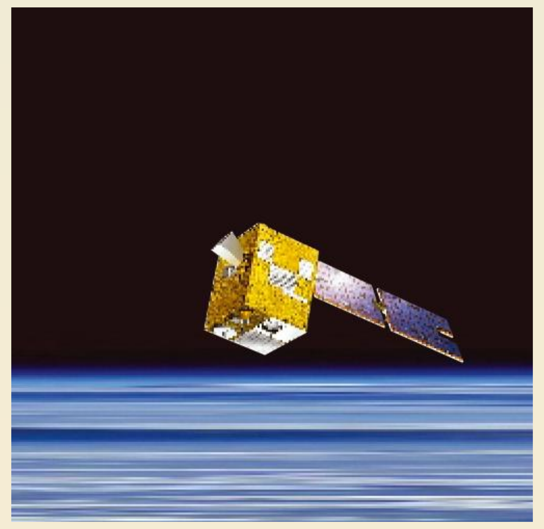
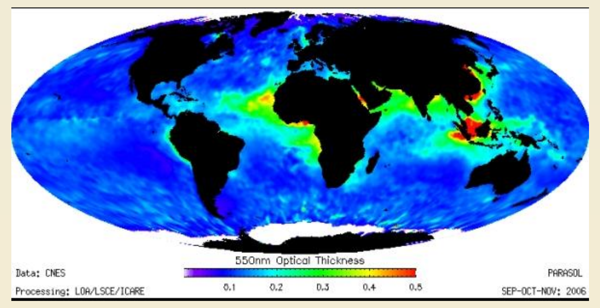
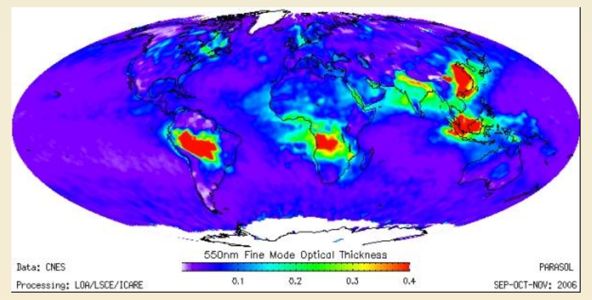
1 Introduction

PARASOL is the only operating satellite that performs multi-spectral, multi-directional and polarized measurements. The current operational aerosol inversion strategy, detailed in Deuzé et al. (2001), provides only the fine mode AOD over land since the sunlight scattered by the small particles is highly polarized while coarse-mode aerosols polarize very little. A new aerosol retrieval algorithm developed by Dubovik et al. (2010) is an attempt for the retrieval of both the optical properties of aerosol and underlying surface .The retrieved values of AOD agree reasonably well with AERONET data of Banizoumbou (Niger) and Mongu (Zambia).







We here proposed an aerosol retrieval algorithm to obtain the total AOD and Fine Mode Volume Weighting (FMVW) using PARASOL measurements of multi-angle total intensity and polarization and looks in details at the performance of the algorithm at Beijing, China

2 Algorithm Description

- ***preliminary retrieval of aerosol properties***

The spectral reflectance shape invariance principle developed by Flowerdew & Haigh (1995) is applied to PARASOL observations with the goal of eliminating aerosol models and optical depths which are grossly at odds with this principle .

In the case of PARASOL, the spatially averaged HDRF can be approximately expressed as Diner et al. (2005):

$$\rho_\lambda(\mu_s,-\mu_v,\Delta\varphi)=\frac{L_\lambda^{\text{meas}}(\mu_s,-\mu_v,\Delta\varphi)-L_\lambda^{\text{atm}}(\mu_s,-\mu_v,\Delta\varphi)}{[\exp(-\tau_\lambda/\mu_v)+t_\lambda^{\text{diff}}(-\mu_v)]\cdot L_\lambda^{\text{surf}}(\mu_s)}$$

the normalized HDRF, is given by $\rho_{\text{dirnorm},\lambda}(i)=\frac{\rho_\lambda(i)}{\langle\rho_\lambda(i)\rangle_{\text{dir}}}$ For a given aerosol model the wavelength independence condition may be defined as

$$X^2_{\text{angular}}(\tau_{\text{a}},\text{model})=\frac{\sum_\lambda w_\lambda\sum_i q_i[\rho_{\text{dirnorm},\lambda}(i)-\langle\rho_{\text{dirnorm}}(i)\rangle_\lambda]^2}{(0.05)^2\sum_\lambda w_\lambda\sum_i q_i}$$

Similar with the above definition , this independence can also be measured as a fit function, defined as

$$X^2_{\text{spectral}}(\tau_{\text{a}},\text{model})=\frac{\sum_\lambda w_\lambda\sum_i q_i[\rho_{\text{bandnorm},\lambda}(i)-\langle\rho_{\text{bandnorm},\lambda}\rangle_{dir}]^2}{(0.05)^2\sum_\lambda w_\lambda\sum_i q_i}$$

The algorithm allows a weighted linear combination, of the two fit functions, i.e

$$X^2_{\text{shape}}(\tau_{\text{a}},\text{model})=\beta X^2_{\text{angular}}+(1\text{-}\beta)\ X^2_{\text{spectral}}$$

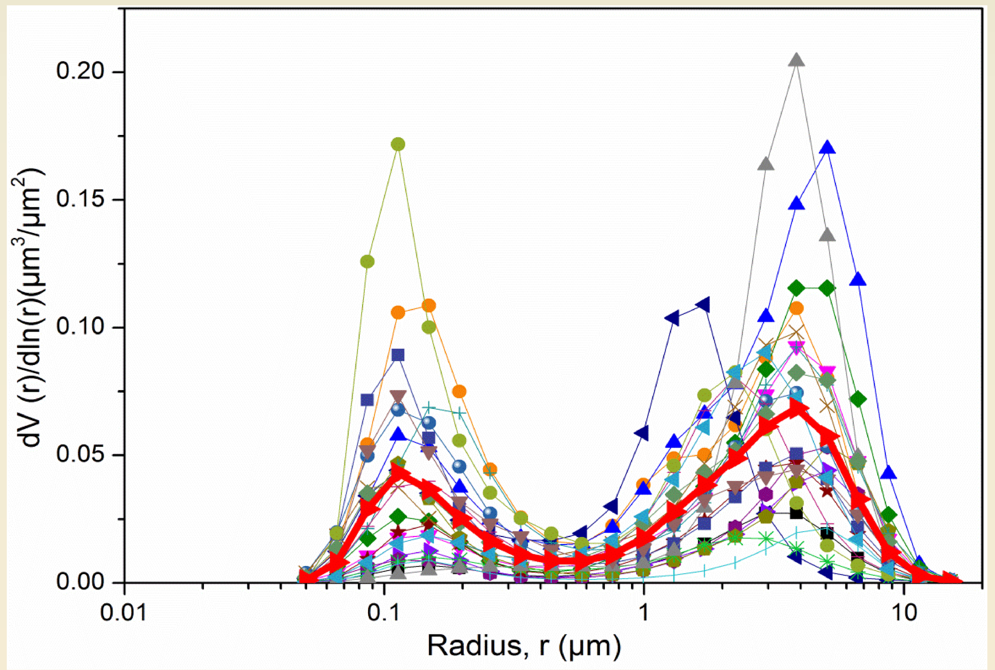
where β is set to be 0.5. the aerosol properties satisfying the threshold of X_{shape} are retained as possible solution.

- ***final decision on the aerosol retrieval***

Since polarization is mainly controlled by small particles, Gu et al. (2011) proposed a sensitive radius of 0.35 μm for polarized detection of aerosol particles. The magnitude of relative difference is used in this study to correct PARASOL AOD products for a better match with AERONET fine mode AOD truncated at 0.35 μm. The final retrieved aerosol parameters τ_{total} and FMVW correspond to those that give the best agreement between the corrected fine mode AOD from Parasol and the recomputed $\tau_{0.35\,\mu\text{m}}$.

3 Data Processing

In this work, Beijing(39.9° N, 116.4° E), China, is chosen as the study area of the algorithm. According to our statistic result in Beijing, correction coefficients for fine mode AOD retrievals from PARASOL over Beijing are set to be 0.88, 0.70, 0.50 for FMVW of 60% and 50%, 40% and 30%, less or equal to 20%, respectively for the best agreement between them.

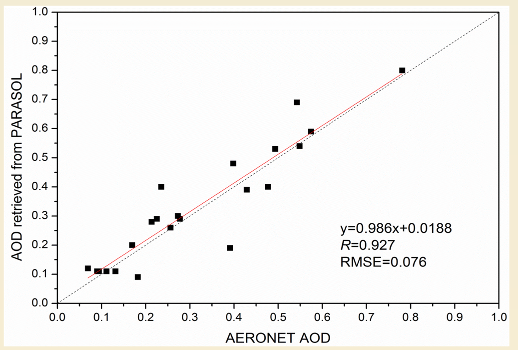


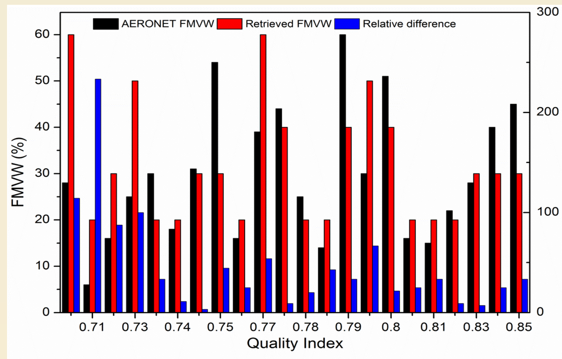
The parameters except for FMVM of assumed aerosol models are obtained by averaging the corresponding parameters of different samples from AERONET retrievals.

Aerosol mode	Fine mode	Coarse mode
r_g (μm)	0.076	0.970
σ	0.49	0.61
Effective radius (μm)	0.139	2.385
Real refractive index	B:1.530; G:1.535; R: 1.540; N:1.550	
Imaginary refractive index	B:0.020; G:0.017; R: 0.016; N:0.016	
FMVW	20%,30%,40%,50%,60%	

4 Results

The closest AERONET Level 2.0 measurements are used. The two datasets indicate a significantly high correlation and a low from the 22 collocations. A high Gfrac of 82% ,a slope of 0.986 and an intercept of 0.0188 suggest the algorithm is promising. It is found from the statistics that our retrieval agreement with AERONET data depends significantly on the data quality index. For the cases with Qmean>0.75, the average AOD retrieval error is obvious lower than for the case When Qmean is greater than 0.75. Another primary error source for the aerosol retrieval comes from the discrepancy in the pre-assumed and the true aerosol models.





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