Many thanks for the valuable comments. We have revised our manuscript significantly. Below are the summary of the reply.

Question 1: The Tang et al (2005) reference is used as a justification/description for the methodology. This paper could use a much more in depth summary because not all readers will be familiar with this "alternative" MODIS retrieval history.

Answer 1:

That is a good suggestion. The algorithm description is rearranged as follows:

The transmission process of electromagnetic radiation on atmosphere is described by radiative transfer equation. Chandrasekhar (1960) and Kondratyev (1969) gave the expression of the radiative-transfer equation as follows:

$$\frac{Cos\theta'}{\rho}\frac{\partial I^{\lambda}(z,r)}{\partial z} = \frac{\sigma}{4\pi}\int I^{\lambda}(z,r')\gamma^{\lambda}(z,r',r)d\omega' - (\kappa+\sigma)I^{\lambda}(z,r) \quad (1)$$

Where θ' is the zenith angle between the transmission and the vertical direction; ρ is the mass density; I^{λ} *(z, r)* is the intensity of the radiation at height *z* and direction *r*; σ and κ is the coefficient of scattering and the mass scattering cross section, respectively; γ^{λ} (z, *r′, r)* is the scattering function that characterizes the scattered light intensity distribution in the direction (z, *r′, r)*.

Eq. (1) cannot be solved analytically for I^{λ} (z, r). Xue and Cracknell (1995) introduced an optical depth $\tau = \int_0^z \sigma\rho dz$ with taking the case of shortwave radiation transfer in a non-absorbing atmosphere and eliminated the integral in Eq. (1) using a two-stream approximation based on the assumption that radiation attenuation is determined by the primary scattering influence only. For a depth *dz*, the variation in the upgoing flux and is caused by two factors. One of these factors is the extinction by backscattering of the original upgoing flux, and the other is the increment by backscattering of the downcoming flux:

$$\begin{cases} \frac{1}{\rho}\frac{dF_1^{\lambda}(z)}{dz} = -\sigma m_1^{\lambda}(z)\Gamma_1^{\lambda}(z)F_1^{\lambda}(z) + \sigma m_2^{\lambda}(z)\Gamma_2^{\lambda}(z)F_2^{\lambda}(z) \\ -\frac{1}{\rho}\frac{dF_2^{\lambda}(z)}{dz} = -\sigma m_2^{\lambda}(z)\Gamma_2^{\lambda}(z)F_2^{\lambda}(z) + \sigma m_1^{\lambda}(z)\Gamma_1^{\lambda}(z)F_1^{\lambda}(z) \end{cases} \quad (2)$$

Where F_1 and F_2 are upgoing and downcoming fluxes, respectively, at height z and

$$m_1^{\lambda}(z) = \frac{\int_{2\pi^+} I_1^{\lambda}(z,r')d\omega'}{\int_{2\pi^+} I_1^{\lambda}(z,r')\cos\theta' d\omega'}$$

$$m_2^{\lambda}(z) = \frac{\int_{2\pi^-} I_2^{\lambda}(z,r')d\omega'}{\int_{2\pi^-} I_2^{\lambda}(z,r')\cos\theta' d\omega'}$$

$$\Gamma_1^\lambda(z) = \frac{\int_{2\pi^-} I_1^\lambda(z,r')\beta_1^\lambda(r')d\omega'}{\int_{2\pi^+} I_1^\lambda(z,r')d\omega'}$$

$$\Gamma_2^\lambda(z) = \frac{\int_{2\pi^+} I_2^\lambda(z,r')\beta_2^\lambda(r')d\omega'}{\int_{2\pi^-} I_2^\lambda(z,r')d\omega'}$$

In our model, the upgoing radiation is assumed isotropic. As a consequent, $m_1^\lambda = 2$. The angular distribution of the downcoming radiation has a very marked maximum at direction θ and $m_2^\lambda = \sec\theta$. The backscattering coefficients of the upgoing and downcoming fluxes are $\Gamma_1^\lambda(z)$ and $\Gamma_2^\lambda(z)$. Typically, they have a value of 0.1.

We have boundary conditions at the top of atmosphere (TOA) and the bottom of atmosphere (BOA):

$$F_2^\lambda(\infty) = E_0^\lambda\cos\theta \qquad \text{at } \tau^\lambda = \tau_0^\lambda\sec\theta' \qquad (3)$$

$$F_1^\lambda(0) = RF_2^\lambda(0) \qquad \text{at } \tau^\lambda = 0 \qquad (4)$$

where E_0^λ is the extraterrestrial solar irradiance, $\tau_0^\lambda = \int_0^\infty K_\lambda dz$, θ' is the zenith angle of the sensor, R' is the reflectance at the top-of-atmosphere and R is the Earth's surface reflectance.

$$\begin{cases} R' = \frac{F_1^\lambda(\infty)}{F_2^\lambda(\infty)} \\ \frac{dF_1^\lambda(z)}{d\tau^\lambda} = \frac{dF_2^\lambda(z)}{d\tau^\lambda} = -\varepsilon\sec\theta F_2^\lambda(z) - 2\varepsilon F_1^\lambda(z) \end{cases} \qquad (5)$$

Solving the system of ordinary differential equations, Eq. (5), with the boundary conditions of Eqs. (3) and (4), it returns the results for the case of a clear sky and sec(q):

$$R = \frac{(R'b-a)+a(1-R')\exp[(a-b)\varepsilon\tau_0^\lambda\sec\theta']}{(R'b-a)+b(1-R')\exp[(a-b)\varepsilon\tau_0^\lambda\sec\theta']} \qquad (6)$$

Where *a=secθ* and *b=2;* ε is the backscattering coefficient, typically 0.1. The solar zenith angle is calculated from latitude, longitude and time. The atmospheric optical depth τ_0^λ is determined by the turbidity state of the atmosphere.

Eq. (6) describes an approximate relationship between R, R' and τ_0^λ.

For our model SRAP (Synergic Retrieval of Aerosol Properties), which only takes into account the scattering of atmospheric molecular and aerosol particles, we assume that the atmospheric optical depth τ_0^λ consists of two parts: the molecular Rayleigh scattering $\tau_M^\lambda(\infty)$ and the scattering of aerosol particles $\tau_A^\lambda(\infty)$. Linke (1956) provided an approximate expression that is sufficiently accurate for most applications in remote sensing:

$$\tau_M^{\lambda}(\infty) = 0.00879\lambda^{-4.09} \quad (8)$$

and Ångström (1929) suggested a single formula for aerosol scattering optical depth that is generally known as Ångström turbidity formula and is given by the following:

$$\tau_A = \beta\lambda^{-\propto} \quad (9)$$

Tang et al. (2005) assumed that, for two MODIS observations within short time intervals between the overpasses of Terra and Aqua, the ground surface bidirectional reflectance properties and aerosol types and properties (α) did not change.

Flowerdew and Haigh (1995) proposed that the surface reflectance be approximated by the variation in the wavelength and the variation in the geometry. Under this assumption, the ratio of the surface reflectance from both Terra MODIS and Aqua MODIS in morning and early afternoon can be expressed as follows:

$$K_{\lambda_i} = \frac{A_{1,\lambda_i}}{A_{2,\lambda_i}} \quad (10)$$

where *i* =1, 2 indicates the observation of Terra MODIS and Aqua MODIS, respectively. Three visible bands (0.47, 0.55, and 0.66 m) of MODIS were used to retrieve the AOD data.

Question 2: What is the "physical" interpretation of Eq (1)? What is θ? Why 0.1 for ε? Why secθ?

Answer 2: Please see the answer in details for Question 1.

Question 3: What are terms in Eq 4? How does one derive values for β and α? Presumably, one must know what "type" of aerosol in particular situations, and that will make a huge difference when matching to MODIS visible bands. Can you justify why α should not change during time interval. What is the difference between Terra and Aqua overpass time over China?

Answer 3: α and β is the wavelength exponent and Angstrom's turbidity coefficient, respectively. We don't assume what type of aerosol but to solve the optical depth as a whole.

For the two pass observations of very short time interval, aerosol types and properties do not change. Accordingly, we assume that the wavelength exponent α is invariant and what may change is the concentration of aerosol particles, namely, Angstrom's turbidity coefficient b.

Question 4: Page 6649 line 8. MODIS is not a "next generation" satellite anymore. It is now old technology!

Answer 4: Thank you for pointing out this error. We will delete this sentence!

Question 5: Page 6649, section 3.2. Why not use Level 2.0 AERONET data? Also, it is probably justified to interpolate between AERONET wavelengths (see T. Eck et al., 1999) using quadratic fits, and then there won't be problems of missing wavelengths.

Answer 5: That is a good suggestion. Level 2.0 AERONET data is quality-assured. However, the number of collocated AERONET sites with level 2.0 data is much less than that of the collocated AERONET sites with level 1.5 data.

Question 6: Page 6650 Section 3.3: Why HYSPLIT? What levels are being calculated?

Answer 6: Because the case study of this paper is cut, there is no need using the HYSPLIT analysis.

Question 7:

Page 6650: The bullets in section 3.4 are insufficient.

a. Why cloud mask of MOD35? Note that the "dark-target" aerosol algorithms (e.g. Remer et al., 2005; 2008) use their own cloud masks because MOD35 has real problems identifying and separating clouds from dust and smoke.

Answer 7(a): This paper focuses on aerosol optical depth. We can only believe that the MOD35 product should be OK for cloud mask purpose.

b. What do you mean by "geo-reference?" What happens if Terra has a measurement and Aqua does not? What happens if Terra and Aqua retrieve at slightly different locations? Is there a spatial/temporal tolerance?

Answer 7(b): This method is invalidated if only one satellite measurement is available for a pixel.

c. What is LEvenberg-marquardt (need reference)? And what kind of errors does it produce? Note that my comment #3 is very relevant here.

Answer 7(c): Levenberg-Marquardt (Press et al. 2007) is a popular numerical method for solving differential equations.

W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, 2007, Numerical Recipes 3rd Edition: The Art of Scientific Computing (3rd Ed.). (Cambridge, Cambridge University Press)

d. What is "Grid" workflow, and why does the reader need to know about the computer hardware?

Answer 7(d): That is a good suggestion. We will delete the content of Grid workflow.

Question 8

Page 6651: Validation strategy:

a. AERONET is quality controlled, are the SRAP retrievals also quality controlled in some way?

Answer 8(a): We are working on the quality control and quality assurance of the dataset. The complete dataset China Collection 2.0 will be available by the end of 2012.

b. Why are there differences between Terra and Aqua? Any suspicions? Note that the MODIS calibration team has recently discovered that the calibration of MODIS-Terra may not be as stable as once believed. They are working on "corrections" that may, in part, reduce the differences between Terra and Aqua.

Answer 8(b): The AOD values at the overpass times for both Terra (about 10:00 local time) and Aqua (about 14:00 local time) are different. We only assume that the aerosol types for such a short time interval are same.

c. How are the error envelopes picked? Note that both the MODIS and the MISR aerosol teams use a combination of relative (e.g. %) and absolute error. For example, MODIS dark-target uses (0.05 + 15%) to account for differing types of errors at low range (precision) and high range (accuracy).

Answer 8(c): Follow this suggestion, the caption as follow is written for Figure 4.

SRAP-MODIS AOD at 0.55μm collocated with AERONET to the same wavelength, for both (the union of) Terra and Aqua datasets. Data are sorted according to ordered pairs (AERONET, MODIS) of AOD in 0.5 intervals, so that color represent the number of cases (color bar) having that particular ordered pair value. The dashed, dotted and solid lines are the 1-1 lines, EE for land AOD ± (0.05+0.2), and the linear regression of the pre-sorted scatter-plot, respectively. Text at the top describes: the number of collocations (N), the percent within expected error, the regression curve, correlation (R), and the RMS error of the fit. Note that each axis ranges from 0.1 to 3.0.

Question 9: Page 6652: Section 5.1: Again, I find the case study of aerosol transport as being superfluous to the main message (long-term AOD, section 5.2). Except for showing details of satellite/sunphoteomter "validation". Plus many items need discussion. What is API (reference?). There is a lot of meteorology that needs discussion.

Answer 9: Following the comments, we will delete this Section and focus on AOD retrieval etc..

Question 10

Page 6654: Summary of AOD over 9 years.

a. How are the satellite data "averaged?" Levy et al., (IEEE-TGRS, 2009) show that "how" you average data (what assumptions) make a huge difference. How are data quality controlled? Are they quality controlled at all?

Answer 10(a): We use the standard averaging method. We are working on the quality control and quality assurance of the dataset. The complete dataset China Collection 2.0 will be available soon.

b. Page 6655: These are some interesting speculations about the links between meteorology and aerosol transport. If the sections 5.1 should be kept within the discussion, I would like to see these concepts linked.

Answer 10(b): We agree with the suggestion that it is better to focus on AOD retrieval. We will remove the Section 5 and prepare another paper for the usages/applications of China Collection 1.0 AOD dataset.

Question 11: Page 6656: Lines 20-30, seems like wild speculation. Especially, the link to May 2008 earthquake?

Answer 11: We agree with the suggestion that it is better to focus on AOD retrieval. We will remove the Section 5 and prepare another paper for the usages/applications of China Collection 1.0 AOD dataset.

Question 12: Page 6657: There is an AERONET in Beijing. Does temporal variability of AOD from satellite match AERONET? The speculation is that socio-economic trends caused aerosol trends, but what if changes in dust transport affected AOD over Beijing? anthropogenic emissions of both primary particles and pre aerocursor gases contribute significantly to the total aerosol load [Andreae and Rosenfeld, 2008]

Answer 12: We will add the analysis of AOD from both satellite and AERONET site in Beijing.

Question 13: Discussion/conclusion: One paragraph does not make discussion/conclusion. Needs more.

Answer 13: Further modification is in progress and will be added.

Question 14:

14. Figures:

a. Fig 1: Could be chopped at 60 E so that text can be magnified

The Figure 1 is modified following the suggestion.

b. Fig 2: needs more of a caption

The Figure 2 is modified following the suggestion.

c. Fig 3: Unnecessary

Delete it.

d. Fig 4: Interesting that AERONET is interpolated here, but it is not discussed in main text. Please make legends bigger and/or better resolution. What are spatial/temporal "tolerances" of satellite and sunphotometer?

The Figure 4 is modified following the suggestion.

e. Fig 5: Cannot read at all. Much too small. Maybe can be summarized in small table.

The Figure 5 is modified following the suggestion.

f. Fig 6: See comment #10a. What are spatial/temporal tolerances?

The Figure 6 is modified following the suggestion.

g. Fig 7: Again, small fonts are unreadable.

h. Fig 8: If deciding to keep HSYPLIT discussion. Would be nice to also provide RGB (like in Fig 7)

i. Fig 9: What is API (should be discussed in text). Also, where in text does it describe how to retrieve dust-type AOD?

j. Fig 10:

Answer 14 (g-j): Figures 7-10 has been removed from this paper with the remove of case study.

k. Fig 11: Pretty picture, but see comment #10a. Do you believe high AOD values over Tibet? I wonder if it is snow?

We can see the same features from MODIS datasets. One reason is the sand dust from middle east Asia.

l. Fig 12: Comment #10a. An entire paper could be made based on this figure. The seasonal variation of aerosol in China is very interesting. How does this “climatology” compare with other datasets?

We will include the comparisons with other AOD datasets such as MODIS AOD datasets etc.

m. Fig 13: Probably unnecessary vis-à-vis Fig 12. (Or if you really want, write the “average” values on Fig 12). Are there error bars?

We will remove it.

n. Fig 14: By now, the reader is tired of these kind of plots. How about one plot, which shows AOD “trends”, that are separated by statistical “significance”. To make this plot, you would have to take into account aggregation, averaging, quality control, and instrument calibration, but I think ,well worth the effort. It would be even more interesting to separate trends into seasons. One can then begin to answer questions of what “type” of aerosol may be dominating all-China trends.

We will make one plot following the suggestions and include the analysis of trends into seasons.

o. Fig 15-16 could be combined in one plot. The column graphs could be substituted for the scenic pictures. Although, I still think “seasonal” plots are more informative then entire year plots. Standard deviation probably does not mean much for the entire year.

We will revise them following the suggestions.

p. Fig 17: What happens during “July?” or “September?” I believe that the discussion would be better justified by presenting a “null” case of some kind.

We select August of each year for the analysis mainly because the Beijing Olympic Game was in August 2008. It shows that from 2005, the aerosol from industrial developments increase until 2007 then the Chinese government started to control the industrial developments with poor pollution control as well as the traffic etc.