Reply to Anonymous Referee #2

We thank the reviewer for the careful reading of our manuscript and helpful comments. We have revised the manuscript following the suggestion, as described below.

This manuscript is clearly written and on an important topic on SOA simulation. It is easy to follow and some of its conclusions are interesting. But I am not happy respecting to following points.

1) The model and the method used in this application are nearly the same as in Li et al. (2011b), and one major conclusion is obvious that NT-SOA produces higher SOA than T2-SOA, because the total amount of material (POA + SVOC + IVOC) introduced in the NT-SOA module is 7.5 times the particle-phase POA emissions. Besides, many studies have already shown that VBS produces higher SOA than the traditional 2-product SOA module.

We have clarified in Section 2: "*The WRF-CHEM model and the SOA modules in the present study are nearly the same as those in Li et al. (2011b), which are briefly introduced in Sections 2.1 and 2.2 for convenience.*"

We have included the following discussions in Section 3.2.1: "*The NT-SOA module produces higher SOA than the T2-SOA module because the total amount of material (POA + Semivolatile-VOC + Intermediate-VOC) included in the NT-SOA module is 7.5 times the particle-phase POA emissions, which is consistent with the conclusion obtained by Li et al. (2011). Besides, many studies have already shown that the VBS approach produces higher SOA than the traditional 2-product SOA module (e.g., Hodzic et al., 2009; Tsimpidi et al., 2010).*"

2) It does not clearly show whether diurnal (time) variation in SOA concentration is improved by including VBS than the traditional 2-product SOA module. NT-SOA module contains more precursors and production processes, is it good or not if "*The diurnal variations from the two models agree well with each other, with peak occurrence during noontime, caused by the enhanced photo chemical activities.*" as shown in Figure 10?

We have rephrased the sentence in the last paragraph of Section 3.2.1: "*Both the two modules produce peak SOA concentrations around noontime, but, apparently, the NT-SOA module yields much more SOA than the T2-SOA module because the NT-SOA module contains more precursors and production processes.*"

3) The model performances are evaluated against surface observed O_3, $PM_{2.5}$, EC and OA, but

the importance is not clearly seen to compare with satellite derived AOD. Contribution of OA or SOA to AOD is not significant, and it is not clearly stated in the manuscript how the model calculates AOD, and AOD values depend on aerosol number and size distribution, mixing state and air humidity, which are beyond the scope of this study. So good agreement between simulated and satellite retrieved AOD does not imply the model simulates $PM_{2.5}$ and OA well.

The AOD estimation follows the method in Li et al. (2011, doi:10.5194/acp-11-5169-2011), in which the extinction efficiency, SSA, and asymmetry factor are calculated using the Mie theory at a given wavelength. The aerosol spectrum is first divided into 48 bins from 0.002 μm to 2.5 μm, with radius r_i. When the bin's radius is less than 0.1 μm, the interval of bins ranges from 0.001 to 0.005 μm. When the bin's radius is greater than 0.1 μm, the interval is increased to 0.025 to 0.25 μm. The aerosols are classified into four types: (1) internally mixed sulfate, nitrate, ammonium, hydrophilic organics, hydrophilic black carbon, and water; (2) hydrophobic organics; (3) hydrophobic black carbon; and (4) other unidentified aerosols. These four kinds of aerosols are assumed to be mixed externally. The aerosol optical thickness (AOT or τ_a) at a given wavelength in a given atmospheric layer k is determined by the summation over all types of aerosols and all bins:

$$\tau_{\mathrm{a}}(\lambda,k)=\sum_{i=1}^{48}\sum_{j=1}^{4}Q_{\mathrm{e}}(\lambda,r_i,j,k)\pi r_i^2 n(r_i,j,k)\Delta z_k$$

where $n(r_i, j, k)$ is the number concentration of j-th kind of aerosols in i-th bin. Δz_k is the depth of an atmospheric layer.

Following the suggestion, we have excluded the AOD comparison part in this study.