We thank the reviewer for the thoughtful comments and helpful suggestions. We have made changes to address the reviewer's comments.

In addition to those changes, we note that we have removed discussion of the NO_2 lifetime from the observations over Dubai (Section 6). In subsequent research motivated by these observations, we were able to establish that the land/sea-breeze that we had assumed constant in our calculation of NO_2 lifetime had reversed direction and thus that the shape of the plume was dominated not by chemical effects but by the meteorology. We still believe that the super-zoom dataset greatly enhances the ability to calculate the NO_x lifetime downwind of individual power plants and urban centers and are working toward a more robust method.

Responses to Reviewer 2

Major Issue 1: Method to assess uncertainty.
Both reviewers posed particular concern about the method we selected to assess the uncertainty of the super-zoom slant column NO_2 observations. Both reviewers believed that the uncertainty should be discussed in terms of the variability observed over a remote ocean in a region where NO_2 is assumed not to vary.

Response
As suggested by both reviewers, we have assessed uncertainty in terms of observational precision over the remote ocean in a method adapted from Boersma et al. (2007). We present an image of a swath that includes the remote Arabian Desert and the nearly cloud-free Indian Ocean to replace the series of SNR images in the original AMTD manuscript.

As part of the clarification we reordered some of the sections of the paper (4 and 5) so that discussion of the uncertainty precedes discussion of the atmospheric variability.

Text: Figure 2 shows slant column NO_2 retrieved over the Arabian Peninsula and the Indian Ocean from a super-zoom mode orbit on 21 November 2004. To assess the uncertainty in retrieved slant column NO_2, we use a method similar to Boersma et al (2007). We find that slant column NO_2 retrieved at operational resolution is normally distributed with 1σ variability of 0.8×10^{15} molecules cm^{-2} over the remote ocean and 0.6×10^{15} molecules cm^{-2} over the remote desert (Fig. 2c), well within the range of values determined previously (Boersma et al., 2007). The precision of slant column NO_2 retrieved from the super-zoom mode is approximately a factor of $\sqrt{8}$ worse, which is expected for a system with 8 fewer measurements and dominated by random noise (Fig. 2b).

Major Issue 2: Definition of fitting error
The reviewer requests a better definition of the fitting error.

Response

Despite using precision of slant NO_2 retrieved over the remote ocean to assess uncertainty (see Major Issue 1), we still discuss fitting error for sake of interest. Fitting error over the remote ocean does not scale as expected if random noise were dominant ($\sqrt{8}$) indicating unresolved biases. We removed all previous discussion of fitting error and add the following text.

Text: The NO_2 fit error computed from DOAS residuals does not increase by a factor of $\sqrt{8}$ for super-zoom observations (not shown) indicating that there are systematic residuals not reduced by averaging. While the origin of these systematic residuals is unknown, we speculate that there is slight spectral misalignment in the DOAS fitting procedure. One possible explanation for this misalignment is the lack of a shift and squeeze adjustment to improve the spectral calibration of individual spectra. However, the magnitude of any uncertainty that remains is negligible in comparison to the signal observed over sources of interest (Fig. 3)

Major Issue 3: Limit of Detection

A limit of detection is mentioned in the text, but it is unclear how it was determined (page 1994, l 23).

Response

Originally, a detection limit of 1.5×10^{16} molecules cm^{-2} was determined by taking three-times the fitting error (2.5×10^{15}) plus the background average (7.5×10^{15}) of slant NO_2 retrieved off the coast on the same orbit. We now discuss the observed enhancements in terms of the precision and background retrieved over the ocean (see also Issue 1).

Text: Super-zoom observations capture a maximum in slant column NO_2 directly to the south of the Satpura Power Plant in Sarni, India (Fig. 3j; 2.2×10^{16} molecules cm^{-2}), a value that is seven times larger than the variability and average observed over the remote ocean on the same overpass.

Responses to Reviewer #2 detailed comments

We have made changes as suggested by the reviewer for the detailed comments. We note below the ones that require a response.

1. The paragraph on the retrieval needs rewording and more details

and

2. Also, it should be noted that water vapour has considerable absorption structures in the wavelength region selected for analysis

Response:

We added the water vapor cross-section to the DOAS fit procedure and modified the paragraph describing our DOAS retrieval as follows:

Text: We have attempted to emulate the operational retrieval. We retrieve slant column NO_2 by performing a DOAS linear least squares fit (Platt and Stutz, 2008;Wenig et al., 2005) of an NO_2 cross section (Vandaele et al., 2002), an O_3 cross section (Bogumil et al., 2001), a Ring spectrum (Chance and Spurr, 1997;Chance and Kurucz, 2010), a water vapor cross section (Harder and Brault, 1997), and a third-order polynomial to the logarithm of the observed reflectance. We perform the fit over the 405-465 nm spectral window.

3. Where does the estimate for the stratospheric column (page 1996, line 9) come from?

Response:
We originally used a relatively clean local background average to estimate the stratospheric contribution. However we now refer to any relative variations in slant NO_2 with the background included. As such, we removed any references to assumed stratospheric contributions in the paper.

4. It might be worthwhile to mention that measurements with even higher spatial resolution have been performed from aircrafts as reported in Heue et al., Atmos. Chem. Phys., 8, 6707–6717, 2008.

Response:
We added a citation to Heue et al. (2008) to already existing text.

Text: High resolution observations offer the possibility of direct measurement of the spatial gradients in the NO_2 column in regions where such gradients depend on the chemical loss rates of NO_2 more strongly than on emissions (e.g., Heue et al., 2008).

5. For individual overpasses, striping is an important problem in OMI data. The authors correct this for their Dubai case but not for the other figures.

Response: We applied a de-striping algorithm to all overpasses and added text to the Methods section to reflect such.

Text: It has been shown that the averaging of solar spectra reduces noise and detector anomalies known as “striping” in the NO_2 retrieval (Celarier et al., 2008;Dobber et al., 2008). We apply a de-striping algorithm to retrieved slant column NO_2 following Boersma et al. (2007).

6. The application shown for the estimation of the NO2 lifetime is in my opinion questionable

Response: We removed any discussion of lifetime.

7. In Fig. 1, please use the same region in the plots of MODIS and OMI reflectivity. Also, please use a colour scale that does not saturate so that the reader can better compare the two figures. In panel c) of this figure, it would be good to indicate the individual points. How exactly have the MODIS data been gridded to the OMI data?

Response: We have made changes to Figure 1 following the suggestions of the reviewer. For panel c, MODIS observations had originally been gridded to the OMI grid using a linear interpolation algorithm. We now plot the individual OMI and MODIS data points within single OMI transect.

Caption: **Figure 1.** Top-of-atmosphere reflectance (459-479 nm) observed by **a**) MODIS and **b**) the super-zoom mode of OMI over Qatar on November 19, 2004. **c**) Normalized top-of-atmosphere reflectance observed by MODIS (red) and OMI (blue) along a transect perpendicular to the Qatari coastline (white boxes, a-b).