Reply to Referee#2

We thank you for your comments and suggestions to improve the paper. We have addressed your concerns as follows:

Comment related to the Title: Current title of the paper is "The Bihar Pollution Pool as observed from MOPITT (version 4), CALIPSO (version 3) and tropospheric ozone residual data"
Authors indicate that the pollution pool extends over the eastern parts of IGP including Bihar, West Bengal and Bangladesh and is attributed to strong localized subsidence and relatively calm winds and a stable atmosphere. In that case, why should the pollution pool be referred to as the Bihar Pollution Pool (BPP)? In fact the BPP is not a permanent feature as the distribution of pollution (including aerosols and trace gases) is quite different over the summer and pre-monsoon seasons (see Gautam et al., 2009, 2010) compared to the winter season. As shown in majority of the figures, for example in the tropospheric Ozone and aerosol loading plots, the high pollution region is not just specific to the state of Bihar. Figure #13 clearly shows maximum AOD around Kanpur during December 2006 and over Bangladesh during December 2009, with both regions outside the BPP.

The pattern of heavy pollution during winter-time being reported in this paper is therefore not specific to the Bihar region but is generally true for the eastern Indo-Gangetic Plains. Thus, the phrase "Bihar Pollution Pool" should be dropped from the title and "Eastern Indo-Gangetic Plains" AND "Winter" should be added to the title in order to correctly reflect the findings of the paper.

I also suggest dropping the version information from the title as it is too specific for a title. Instead, version information should be given in the Abstract, Data details and Conclusions sections and wherever applicable.

The term 'Bihar pollution pool' was coined by Di Girolamo et al. (2004) who had first reported the phenomenon from MISR data because the large AOD values were mostly seen within the state of Bihar. However we agree that the feature as seen in various datasets extends over a larger area and have accordingly changed the title of the paper as suggested by you as well as the first referee. Further, we have removed the version information from the title per your suggestion.

Specific Comments: - Fig. 1: Why is there significantly fewer profiles over the central IGP region (80.5 E) compared to the eastern IGP (84.5 E). Is it due to the higher fog cover in the western-central IGP compared to the eastern plains, therefore suggesting the sample drop in retrievals? I would think that the western IGP would experience significantly higher foggy conditions as the winter-time cold waves enter into the IGP from west-northwest and the airmass moves towards eastward. The surface temperatures also vary from west to east with the western IGP generally characterized by lower temperatures.

We examined the cloud fraction from Terra MODIS over the IGP area for December 2005 and found that the cloud fraction is higher over the central IGP region than over the Eastern IGP. This would explain the sparse MOPITT sampling over the central IGP region. Some of the low

altitude clouds in winter over the IGP region could even be fog as suggested by Gautam et al. (2007) and as you have mentioned. We have added the following sentence in the text:
"The number of profiles retrieved near 26.5^{o}N, 80.5^{o}E is significantly less than near 24.5^{o}N, 84.5^{o}E which might be attributed to higher cloud fraction near the former location as seen in the Terra MODIS data (not shown)".

Since the paper focuses on pollution over the Eastern IGP, authors should briefly discuss the meteorological background during winter-time over the IGP. They can refer to published literature and explain briefly the regional meteorology in relation to the pollution dynamics. The inter-annual variability discussion also needs to be bit expanded and mentioned in the manuscript that the high AOD region (as observed from MODIS) and the magnitude varies significantly depending on the prevailing meteorology (Gautam et al., 2007).

We have added the following sentences in the second paragraph of the introduction before discussing the pollution pool over Eastern IGP:

"The prevailing winds at low altitudes (surface to ~ 850 hPa) are northerly to northwesterly with low wind speeds (< 5 ms^{-1}) and the eastern parts of the IGP are impacted by a localized area of strong subsidence in winter (Di Girolamo et al., 2004, Jethva et al., 2005, Dey and Di Girolamo, 2010). These conditions tend to trap the pollution at low altitudes."

However we dropped the figure (Figure 13 in the discussion paper) showing the interannual variability of CALIPSO AOD as per the second referee's recommendation and only gave a brief statement about the inter annual variability.

Figure #5 is quite interesting. Some information about sample size would be useful.

The sample size changes from month to month. In particular very few profiles are retrieved over the Eastern region during the monsoon season because of the clouds. However ~60% of all months had about 70 profiles each in the eastern part and about 105 profiles each in the western part. We have added the following sentence:

"The number of profiles used to compute the means in the two regions vary from month to month. The median number of profiles for the Eastern IGP was 70 with the minimum number being 3; the median was 105 for the Western India with a minimum of 33."

- Characterization of layer top altitude (Figure #7). Caption says - December 2006-February 2007. However, plots for other three seasons are also shown. Figure caption and related text should be corrected.

Thank you. This has been corrected.

- Seasonal variations of aerosol types is shown in Fig. 8. Intra-seasonal variability of dust loading is captured well in the CALIPSO data. Authors should refer to previous studies of dust-loading observations (Gautam et al., 2009, 2010) and briefly discuss the transport pathways.

We have added the following:

"The IGP area is strongly affected by dust transported from the dry desert areas in the northwest India and Arabian peninsula during the pre-monsoon months as has been observed from the MODIS AOD and TOMS absorbing aerosol index data although the Eastern parts of the IGP are affected to a lesser extent (Jethva et al., 2005, Gautam et al., 2009, Gautam et al., 2010)."

- The text relevant to Figure 10 (layer top altitude as a function of optical depth) is too short. This can be expanded a bit or combined with other sections on aerosol loading.

This figure has been dropped per the first referee's suggestion.

- Correction to be made in the Acknowledgments section, the AERONET station at Kanpur was established by Brent Holben and Ramesh Singh in 2001. RS was the PI from 2001 till 2007 and can be seen from the AERONET Kanpur webpage. The Acknowledgments pertaining to AERONET data should therefore be rectified.

Thank you for pointing this out—this has now been corrected.

References:

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Jethva, H., Satheesh, S. K. and Srinivasan, J. : Seasonal variability of aerosols over the Indo-Gangetic plains, J. Geophys. Res., 110, D21204, doi:10.1029/2005JD005938, 2005.