This paper reports surface-based measurements of aerosols in the sub-Himalayan location of Nainital, as part of the Ganges Valley Aerosol Experiment (GVAX), for the period June 2011 – March 2012. Spectral aerosol absorption and scattering coefficients are reported for the ~10-month long period, based on soot absorption photometer and nephelometer measurements. Major observational finding in this paper suggests enhanced absorption due to coarse aerosol particles exceeding that due to fine particles. The estimated clear-sky aerosol radiative forcing during the observation period suggests a significant contribution of solar absorption due to coarse particles to the total aerosol forcing.

Authors are commended for analyzing the ~10-month long dataset of key aerosol optical properties in the Gangetic-Himalayan region. Aerosols in this region have received growing attention due to their potential impacts on regional climate forcing, monsoon rainfall and accelerated snowmelt. The quantitative information reported in this paper, particularly related to aerosol absorption, contribute to the understanding of aerosols in the elevated Himalaya, and could be a useful dataset for future aerosol-climate forcing-monsoon research.

The paper is generally well-written, but is limited in its interpretations of the results and lacks insights into the observational portrayal of several aspects including aerosol characterization, its seasonal/diurnal variations, influence of regional meteorology, and implications to radiative forcing.

I recommend publication with major revisions following the suggested specific comments:

- The title of the paper contains "giant aerosol particles". Authors discuss their results based on measurements of aerosols in two size ranges (with the aerodynamic diameter <1 micron and <10 micron). It is probably true that coarse particles were present during the measurement period, and the authors in fact show the possibility of coarse particles based on spectral absorption/scattering coefficients. However, the 10 micron cutoff includes fine particles as well (<1 micron), and a significant absorption is reported in the paper specifically for fine particles. Moreover, there is no information provided regarding the aerosol size distribution (number or volume concentration). Unless authors show more quantitative information (e.g. size distribution), it is difficult to justify “giant aerosol” in the title. I think replacing “giant aerosol” with “coarse aerosol” reflects well the results presented in the paper.

- In the Introduction section and elsewhere, authors should refer to (and possibly compare their results with) previous studies in the literature that reported aerosol related measurements in the Himalaya, for example:

Pant et al. 2006, Dumka et al. 2010, Hegde-Kawamura 2012 (at Nainital),
Hyvarinen et al. 2008 (at nearby Himalayan site- Mukteshwar),
Marinoni et al. 2010 (at NCO-Pyramid site),
Gautam et al. 2011 (at several locations in the Gangetic-Himalayan region).

- The observed diurnal pattern in aerosol absorption shown in Figure 1 is quite interesting, especially during the post-monsoon period. But there is no explanation or discussions associated with the diurnal pattern, which has a significant amplitude (daytime absorption is twice as large as during nighttime). Similar observations are found for scattering coefficient shown in supplementary figure 2. Explain/discuss why this occurs.
(It would also be useful to visualize the absorption pattern (figure 1) by enhancing the colorscale, i.e. beyond 100Mm-1, as the red color is almost saturated across all the sub-figures)

- Can the authors discuss the nature of the spectral absorption/scattering coefficients in terms of perhaps aerosol type, or atleast provide some insights into the aerosol composition and its seasonal variations? (there is not a lot of but some literature available for insitu/chemical analysis of aerosols that authors can refer to, see References).

- The aerosol absorption tends to have had weakened around January. In fact, there appears to be a dip during this period (around January) from the post-monsoon to pre-monsoon time series. Does the decrease in scattering and absorption efficiency around January indicate a seasonal shift in aerosols?, when aerosol loading in general reduces after the peak post-monsoon emission period (considering Nainital probably represents free-troposphere environment during winter as the PBL is shallow during peak winter months). Thereafter (February onwards) starts to build up again likely associated with enhanced convection during March (beginning of pre-monsoon period). Authors should discuss as to the seasonal variation of the aerosol extinction and the potential causes.

- In addition, for better understanding of the observed seasonal and diurnal variations in aerosol scattering and absorption, I think it would be useful to show/discuss the corresponding data for RH, temperature (and PBL data if available).

- It seems authors have not accounted for the humidity dependence of aerosol backscatter, i.e. the aerosol humidification factor - f(RH). At higher RH values, aerosol scattering, in particular, is strongly influenced by humidification leading to swelling of hygroscopic particulates. See for example, Kotchenruther et al. 1998. The aerosol humidification should be accounted for in the analysis shown in the paper.

- Since the scattering and absorption coefficients are already shown in the paper. Why don't authors also show the corresponding single scattering albedo (SSA) for the entire period, and discuss their results in terms of spectral SSA as well? The SSA is a more direct quantity that can be readily compared with other studies/locations, as well as perhaps more useful for climate modelers for aerosol radiative forcing estimations.

- How do the measured aerosol scattering and absorption coefficients (and SSA) compare with other locations in the Himalaya and the Indo-Gangetic Plains (IGP)? It would be useful to have some comparative analyses of the results from this study over Nainital. For example, Hyvarinen et al. 2008 also showed aerosol surface measurements over Mukteshwar in the western Himalaya.

- In terms of the seasonal variations of spectral aerosol extinction, was any distinct pattern found suggesting variations in aerosol type?. For instance, influx of dust has been observed over Nainital during pre-monsoon season (Ram et al. 2010). Does the March data indicate any influence of dust aerosols particularly in the D10 micron spectrum relative to the post-monsoon period when dust loading is, in general, lowest over the western Himalaya and the IGP.

- Aerosol Radiative Forcing: Authors briefly mentioned in section 3.6 about Aerosol Optical Depth (AOD) and SSA without any details. Please also show/discuss the calculated and measured AOD/SSA here, so the reader has a better handle on the seasonal variation of AOD and SSA, and can conveniently associate the range/variations of AOD, SSA with the estimated aerosol radiative forcing.

- In addition to the radiative forcing, I think it is also important to report the aerosol radiative forcing efficiency (Forcing per unit AOD). This would be particularly useful to infer the aerosol absorption (since the loading is probably small) and draw comparisons to other studies dealing with radiative forcing/forcing efficiency (e.g. Pant et al. 2006).

- Was there a significant variation in the aerosol radiative forcing during the measured 10-month period? Most likely, Yes. It will be interesting to see the variations during monsoon, post-monsoon and winter periods.

- Introduction section (last sentence on page 19838)-
"Several observational and modeling studies have addressed the properties of aerosols in this region and their impact on monsoon rainfall in southern Asia (Bahadur et al., 2012; Costabile et al., 2012; Russell et al., 2010; Bergstrom et al., 2002; Dubovik et al., 2002)."

It seems there is a mixup of references here, the appropriate references should be inserted here. None of the cited papers in the above sentence are related to the effects of aerosols on monsoon rainfall in southern Asia.

Sincerely,

Ritesh Gautam
GESTAR/NASA GSFC

References:

Dumka, U. C., Moorthy, K. K., Kumar, R., Hegde, P., Sagar, R., Pant, P., Singh, N., and Babu, S. S.: Characteristics of aerosol black carbon mass concentration over a high altitude location in the Central Himalayas from multi-year measurements, Atmos. Res., 96, 510–521, doi:10.1016/j.atmosres.2009.12.010, 2010.

Gautam, R., Hsu, N. C., Tsay, S. C., Lau, K. M., Holben, B., Bell, S., Smirnov, A., Li, C., Hansell, R., Ji, Q., Payra, S., Aryal, D., Kayastha, R., and Kim, K. M.: Accumulation of aerosols over the Indo-Gangetic plains and southern slopes of the Himalayas: distribution, properties and radiative effects during the 2009 pre-monsoon season, Atmos. Chem. Phys., 11, 12841-12863, doi:10.5194/acp-11-12841-2011, 2011.

Hegde, P. and Kawamura, K.: Seasonal variations of water-soluble organic carbon, dicarboxylic acids, ketocarboxylic acids, and α-dicarbonyls in Central Himalayan aerosols, Atmos. Chem. Phys., 12, 6645-6665, doi:10.5194/acp-12-6645-2012, 2012.

Hyvarinen, A. P., Lihavainen, H., Komppula, M., Sharma, V. P., Kerminen, V. M., Panwar, T. S., and Viisanen, Y.: Continuous measurements of optical properties of atmospheric aerosols in Mukteshwar, Northern India, J. Geophys. Res., 114, D08207, doi:10.1029/2008JD011489, 2009.

Kotchenruther, R. A., P. V. Hobbs, and D. A. Hegg (1999), Humidification factors for atmospheric aerosols off the mid-Atlantic coast of the United States, J. Geophys. Res., 104(D2), 2239–2251, doi:10.1029/98JD01751.

Marinoni, A., Cristofanelli, P., Laj, P., Duchi, R., Calzolari, F., Decesari, S., Sellegri, K., Vuillermoz, E., Verza, G. P., Villani, P., and Bonasoni, P.: Aerosol mass and black carbon concentrations, a two year record at NCO-P (5079 m, Southern Himalayas), Atmos. Chem. Phys., 10, 8551–8562, doi:10.5194/acp-10-8551-2010, 2010.

Pant, P., Hegde, P., Dumka, U. C., Sagar, R., Satheesh, S. K., Moorthy, K. K., Saha, A., and Srivastava, M. K.: Aerosol characteristics at a high-altitude location in central Himalayas: Optical properties and radiative forcing, J. Geophys. Res., 111, D17206, doi:10.1029/2005JD006768, 2006.

Ram, K., Sarin, M. M., and Hegde, P.: Long-term record of aerosol optical properties and chemical composition from a high-altitude site (Manora Peak) in Central Himalaya, Atmos. Chem. Phys., 10, 11791–11803, doi:10.5194/acp-10-11791-2010, 2010.