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Interactive comment on "Evaluation of black carbon emission inventories using a Lagrangian dispersion model – a case study over Southern India" *by* H. S. Gadhavi et al.

Anonymous Referee #2

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The manuscript by Gadhavi et al. presents a comparison of observed and model simulated equivalent black carbon (BC) concentrations. The observations were obtained with an aethalometer at a rural site in Southern India (Gadanki) during 2008 to 2012. The model simulations are based on a Lagrangian dispersion model (FLEXPART with NCEP Global Forecast Systems Final meteorological analysis data). For each day, a potential emission sensitivity (PES) field is obtained by a 10-day backward model run initialized from the receptor point. Model BC concentrations at the observation site are then calculated based on the PES using three different emission inventories.

It is reported that the model simulates well the seasonal cycle of BC measurements,

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with highest concentrations in winter and lowest in summer. However, the model results are biased low in winter, spring, and summer. The biases appear to be correlated to fire radiative power observed by satellites. It is thus concluded that all three BC emission inventories may have under-estimated BC fluxes from open biomass burning over the Southern India. The manuscript is very interesting and well written. The work is very important for understanding the role of Indian sources of BC aerosol in global climate and regional hydrological cycle, and is suitable for publication in ACP.

Major comments:

1. Page 26911, lines 14-16. "The PES values in the bottom most layer (so-called footprint layer; 0-100 m a.g.l.) were multiplied by the emission fluxes to calculate the BC concentration at the receptor." This method is given without an explanation or evaluation. It may be argued that the entire planetary boundary layer (PBL) should be considered the footprint layer, because PBL height-based PES would be less sensitive to model uncertainties in surface layer mixing and dry deposition. Rapid vertical mixing of BC through the PBL is caused by turbulence in the day. Mean PBL depth retrieved by the CALIPSO satellite over India varies from 1000-1500 m in winter (DJF) to 2500-3000 m in summer (JJA) (McGrath- Spangler and Denning, 2013; Figure 3). A stable surface layer prevents vertical mixing in the night. However, this effect is often too large in models lacking a "background mixing" (intermittent mixing events are often observed at night). The PBL-based PES would be larger than estimated for 0-100 m if the model predicts a large decrease of tracer towards the surface.

2. Table 1. Wet deposition parameters. Wet scavenging is proportional to rain fall rate in the model, with a pre-factor A=2.E-7 per second per 1 mm/h of rain fall. This coefficient is typical for below-cloud scavenging of accumulation mode aerosols (Jung and Shao, 2006; Seinfeld and Pandis, 2006). However, in-cloud droplet nucleation occurs with hydrophilic aerosols. It is much more efficient for wet removal, and may be responsible for most of the loss of atmospheric BC aerosol (cf. Liu et al. 2011; Table 2).

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3. Combining above comments, is it possible that the model has under-estimated both the PES and the rate of wet deposition, with (incomplete) compensating effects?

4. Previously, Zhang et al. (2008) estimated the mass absorption coefficient for dust to be 1.3 mˆ2/g on average, at the wavelength (880 nm) used by the aethalometer. Are dust aerosol concentrations high enough to cause significant interference to BC measurements at Gadanki, especially when BC concentration is low and wind speed is high (in summer)?

Minor comments:

1. Page 26912, line 24. "due to decent" is confusing. Do you mean "due to ascent of air mass as it moves backwards (in time) from Gadanki to Arabia".

2. Figure 5. (I) The shaded circles indicating altitude is barely visible. Suggest keep the circles to indicate latitude and longitude location of the mean trajectory, and add panels to indicate altitude as a function of days before measurements. (II) The heading "Sensitivity at footprint m.a.g.l." above each panel implies that the PES is estimated for the indicated altitude, which is inconsistent with stated in the text (see above, Major comment #1).

References:

Jung, E.J., and Shao, Y.: An inter-comparison of four wet deposition schemes for dust transport model, Global Planet. Change, 52, 248-260, 2006.

Liu, J., Fan, S., Horowitz, L.W., and Levy II, H.: Evaluation of factors controlling long-range transport of black carbon to the Arctic, J. Geophys. Res., 116, D04307, doi:10.1029/2010JD015145, 2011.

McGrath-Spangler, E.L., and Denning, A.S.: Global seasonal variations of midday planetary boundary layer depth from CALIPSO space-borne LIDAR, J. Geophys. Res., 118, 1226-1233, doi:10.1002/jgrd.50198, 2013.

Seinfeld, J.H., and Pandis, S.N.: Atmospheric Chemistry and Physics, From Air Pollution to Climate Change, 2nd ed., John Wiley, Hoboken, N.J., 2006.

Zhang, X.Y., Wang, Y.Q., Zhang, X.C., Guo, W., Niu, T., Gong, S.L., Yin, Y., Zhao, P., Jin, J.L., and Yu, M.: Aerosol monitoring at multiple locations in China: contributions of EC and dust to aerosol light absorption, Tellus, 60B, 647-656, 2008.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 26903, 2014.