Interactive comment on "Identification of the cloud base height over the central Himalayan region: Intercomparison of Ceilometer and Doppler Lidar" *by* K. K. Shukla et al.

Anonymous Referee #1

Received and published: 1 September 2016

General Comments

In this manuscript Doppler Lidar measurements that were taken at a high altitude site (Manor Peak, India) during an experimental campaign that took place from June 2011 until March 2012 are used in order to calculate the cloud base height (CBH). Six periods (each one of 5 hours) were selected and were further processed based on the cloud coverage. The CBH that was calculated with a Doppler Lidar during these cases was compared against the CBH obtained from a ceilometer, and CBH from MODIS overpasses, and the Lifted Condensation Level was calculated from both radiosonde data and standard surface meteorological measurements. The vertical velocity at the CBH was also reported. The main focus of the manuscript - a method for the CBH

detection from Doppler Lidar measurements – is a novel idea, which in view of the capability of the instrument to accurately measure the wind speed, would be a valuable contribution for future studies, and certainly within the scope of the journal. One major issue is that the methods are not outlined clearly: several important details are either missing or are poorly described; and therefore the results and conclusions are not solid. Furthermore, the results and conclusions would be far more robust if more cases were studied.

Specific Comments

1. The CBH detection method from the lidar measurements should be fully described since this is the first time it is reported in the open peer-reviewed literature. Examples showing the application of the method in real SNR profiles would be helpful to that regard. In it's present form the method is briefly described and one reference (a report) is given. 2. The results would be more robust and conclusions far more convincing if more cases were included. At the moment it's not clear why only six cases are selected out of a large dataset (June 2011 – March 2012). In fact, it is even obscure how these cases were selected. It is briefly mentioned that the selection was based on the cloud coverage, residence time of clouds and availability of simultaneous datasets (P3, LN 5); rather it would be expected that the exact method by which the selection was made should be fully detailed and analytically presented in the Methodology section.

Technical Comments

P1 LN25-26: "...diurnal pattern..." It is not correct to refer to "diurnal" patterns since you only show 5 hours of measurements. P2 LN35: "...from the fair-weather ABL clouds." It is not clear at all why these are fair weather cases. P3 LN 10-11: "...and shows an increase in the pollutants level in the current climate...". Not clear what you mean. P4 LN 8-9: It would be helpful if you discuss briefly the data process used for TSI images in order i) to obtain the presence of clouds ii) to estimate the percentage of thin and opaque clouds. Probably the part of the text in Results and

Discussion section should be moved here. P4 LN 14: "...over a high altitude site...". Is this Manora Peak? Please state so. P4 LN 14: "DL.." Please provide details of the instrument you used (company, model, technical characteristics, etc.). P4 LN 24: "-20 dB". How was this threshold decided? Any reference? P5 LN28-29: For the current data set, the averaging interval was 30 min oversampled for every 10 Min". It is not clear what you mean that. Can you please clarify? P6 LN3-4: "Additional checks are applied to minimize false detections by rejecting temporally isolated peaks". Which tests? Please be more specific. P6, Section 3.2. How was CBH from ceilometer calculated? 1) using equation (1) or 2) from backscatter coefficient profile. P6, Section 3.3. Please be clear from the beginning that you are using the method described in Hutchinson (2002). P7 LN 26-27: "...raw...and...masked...cloud images by TSI at hourly interval...". 1) What is the difference between "masked" and "raw" images? 2) How were these images obtained from the original 30 sec images? P8 LN 14-15: "If cloud is present in the atmosphere then red pixel value is greater than where no clouds." Please rephrase. P8 LN 14-15: Stull and Eloranta, 1985 and Zhang and Klein, 2013 references are missing from the reference list. P8 LN33: "...showing high percentage of opaque cloud during 12.5-14.5 LT". This text refers to Figure 3? If so clarify. P8 LN 32-6: It's not clear how the thin/opaque cloud percentage links to the SNR or backscatter time series in Figure 4. Please be more precise. P9 LN 1-2: "It is interesting to note that the temporal evolution and duration of thin and opaque clouds in both the instruments are in reasonable agreement during all events." How thin and opaque clouds can be inferred from ceilometers and Doppler lidars? P9 LN 11-13: "Figure 6 depicts the temporal variation of CBH observed by the DL and CM along with lifted condensation level (LCL) height estimated by using surface MET parameter and RS on (a) 12 October 2011 (b) 12 21 November 13 2011 (c) 11 December 2011 (d) 20 January 2012 (e) 08 February 2012 and (f) 14 March 2012". This is a repetition of the legend of Figure 6 and could be omitted or shortened. P9 LN15: "...during the convective period...". How is the convection period defined? P9 LN 16-20: "ABL cloud heights are estimated by using LCL (Stackpole, 1967). The well-mixed ABL air parcels

C3

which have a dry-adiabatic temperature profile and a constant mixing ratio are used to determine the LCL profile (Craven et al., 2002). For the detection of CBH, the LCL is a good approximation as the CBH depends on the relative humidity and temperature near the surface. The LCL depends on the temperature and dew point temperature above the surface and thus a good proxy for CBH.": This text could be moved to Section 3.4. P9 LN 22: "...LCL heights with the MET and RS shows a similar pattern..." In all cases RS LCL and LCL do not agree. Why? P9 LN 23-24: "From Figure 6 (a-f), it is clearly observed that in all the cases, CBH is coupled with the LCL estimated from the surface meteorological parameters.". The differences between CBH from lidar and ceilometer are not small in some cases (e.g. 12/10/2011 13.5 – 14.5) and even the trends are not always the same (e.g. 14/3/2011 11.5 – 13). P10 LN3: "...where the differences are slightly higher and need to be investigated for possible inconsistencies." Which would the reasons for these inconsistencies? P10 LN7: "R2=0.76" It is 0.81 in Figure 10. A general comment regarding the comparisonbetween CBH from lidar and ceilometer: would you expect any differences on the basis of the different operation wavelengths of the two instruments? P10 LN15: "...micropulse.." is micropulse P10 LN24: "...large scale updrafts...". More evidence would be required to support the statement that the detected updrafts are due to large scale movements. P11 LN4: "R2=0.76" same comment as above. P11 LN 13-27: Part of the text is more relevant with the "Results and Discussion" section rather than the "Summary and Conclusions". P14 LN16: Rodts et al., 2014 does not appear in the text. P14 LN21: Sarangi et al., 2014 does not appear in the text. P14 LN35: Stull, 1985 does not appear in the text. Figure 9: MODIS measurements for 12/10/2011 and 11/12/2011 can not be seen. Figure 10: Are the data points 10 minute mean means? Please provide all relevant information, Why are some values excluded from the dataset?