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Features of positive ground flashes observed in Kathmandu Nepal

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ABSTRACT

Lightning vertical electric fields pertinent to the subtropical thunderstorms occurring over the rugged terrain have been measured and recorded at a hilly station Kathmandu, Nepal. In the present work, waveforms of the positive ground flashes have been selected from all the records and were analyzed. To the best of our knowledge, this is the first time that fine structure of electric field signature pertinent to the positive return stroke; have been analyzed and presented from Nepal. One hundred and thirty three (133) of the total of four hundred twenty-five (425) flashes were selected from seven thunderstorm days and analyzed. Of the data recorded for seven days, 133 flashes (31.3%) were positive flashes and 276 flashes (64.9%) were cloud flashes. Majority of the positive ground flashes were found to be single stroke ones, whereas, the average number of strokes per flash is found to be 1.1 with a maximum value of 4. Majority of the positive ground flashes were found either lacking the initial breakdown process and the leader stage or these processes could not be detected. The return strokes are found to be succeeded by large in cloud activity in the continuing current portion of the flash. The average zero-crossing time of the positive return strokes was found to be 60.45 μs with a range of 447.81 μs and the average rise time was found to be 9.44 μs with a range of 42.56 μs.

1. Introduction

Lightning positive ground flashes, in general, transport the positive charge from the cloud to the ground, occur very rarely. Of all the cloud to ground flashes, the positive ground flashes account for about 10% (Rakov and Uman, 2003). Considering the tripole structure of a thundercloud, the paucity of the positive ground flashes can easily be justified. However, the charge structure of the cloud still remains a mystery. Because of the paucity of their occurrence, positive ground flashes are considerably less studied and hence less understood as compared to their negative counterparts (Nag and Rakov, 2012).

According to Williams (1989), the lightning activity itself follows a specific pattern with the intracloud (IC) lightning normally appearing in the developing stage followed by the cloud-to-ground (CG) lightning during the mature stage, whereas, both types of lightning can occur in the decaying stage of thunderstorms. Lightning in thunderstorms is strongly linked to the microphysics and dynamics of thunderstorms and hence changes in the lightning activity can tell us about changes in the internal processes within the thunderstorms (Price, 2008). Positive ground flashes are of much interest to the lightning community because of their possible association with the upper atmospheric discharges, such as sprites, and due to the magnitude of current possessed by them. The positive ground flashes may also be related to the severe weather phenomena such as tornadoes, hails, derecho etc. Although, the negative ground flashes are predominant during the normal thunderstorms over their positive counterparts Price et al. (2009) has shown that the polarity of the CG lightning shifts to being primarily positive ground flash during the hail portion of the storm. Tornadoes are also associated with certain lightning signatures. Carey et al. (2003) showed that, during an episode of 5 tornadoes within 1 hour, the positive cloud to ground, fraction increased to about 60% of all CG lightning. This shift in lightning polarity is a common feature of tornado storms. Price and Murphy (2002) studied a derecho (severe wind storm with straight-line winds is called a derecho) that exhibited predominantly positive CG lightning activity during the most intense part of the storm.

Signatures of the lightning electromagnetic field pertinent to the subtropical mountainous country Nepal are of much interest to the scientific community as the rugged terrain and high hills may influence the occurrence and the nature of the lightning strikes. The hydrometeorological processes over the rugged terrain, development of the thundercloud, its charge structure and the signatures of lightning flashes are equally interesting for them. Moreover, atmospheric structure and hydrometeorological processes along the south slopes of the Himalayas are not well known or well documented mainly because of the rugged and remote terrain (Barros and Lang, 2003). Monitoring the lightning activity

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(with the help of flash counters) over Kathmandu and its vicinity for 21 months, Baral and Mackerras (1993), found the average proportion of positive ground flashes to the total ground flashes to be 0.28, the proportion was maximum in the postmonsoon with an average value of 0.38 and it is minimum during the pre-monsoon with an average value of 0.26.

This study aims to investigate the nature of occurrence of positive ground flashes, their features and fine structure. The features of positive ground flashes are compared with those from the other geographical regions. This is the first time that the fine structures of electric fields pertinent to the subtropical and mountainous country Nepal, were measured, analyzed and compared with those from other geographical regions.

2. Instrumentation and measurement

The lightning electric fields were recorded at a measuring station in Kathmandu, Nepal, which is situated at 27°44′N; and 85°19′E; and about 1300 m above the average sea level height. Based on the WSI Global Lightning Network (GLN), 133 positive return strokes, that have been recorded and analyzed, are ranged from 30 km to 500 km from the measuring station, however, precise location of each individual strike was not possible owing to the fact that our system was synchronised with that of WSI. The vertical electric fields pertinent to the lightning flashes were sensed by the flat plate antenna fixed on a 1.5 m high post and was placed on the rooftop of a house at a physical height of about 12 m from ground. The capacitance of parallel plate antenna is 60 pF. The parallel plate was connected to a buffer circuit through a 60 cm long RG 58 coaxial cable. The signal passing through buffer amplifier was fed to digital storage oscilloscope (Pico-scope 6404D) through a 20 m long RG 58 coaxial cable. The signals so received were recorded by the Pico-scope. The window size of the scope was varied from 200 ms to 500 ms at different sampling rates. Accordingly, the sampling rate was varied from 312 MS/s to 40 MS/s. Longer window size was chosen to capture the whole flash activity and its multiplicity and the shorter window was chosen to capture the details of the activity.Indeed, we might have missed some subsequent activities (strokes) by making the window size shorter, however, when the window size kept to 500 ms it was observed that the flash activity ceases after 200–250 ms. It is therefore we thought it fair to compare the multiplicity with that of others.

Electric field intensity at the measuring station is recorded as a function of digitizer voltage as

$E(t) = V(t)/h_{eff}$ where h_{eff} is the effective height of the antenna, $V(t)$ is the voltage between the upper plate of the antenna and the ground and $E(t)$ is the electric field to be measured. Also, $h_{eff}=0.149h_{phy}+0.039$ where h_{phy} is the Physical height of the antenna. However, owing to the fact that lightning flashes could not be exactly located, the field intensity was not calculated. A schematic diagram of the antenna and recording system that has been used in this study, is depicted in Fig. 1, and is adopted from Sharma et al. (2005, 2008) and Sharma (2007).

3. Observation

Electric field generated by the lightning flashes were recorded during the pre-monsoon 2015. A total of one hundred and thirty three positive ground flashes were selected and analyzed. Most of the positive ground flashes were found to have single strokes, however, some of the positive ground flashes consisted of two or more return strokes. The data acquired on the different days of March, April and May 2015, and analyzed in this study are depicted in Table 1. Also shown in Fig. 2 is the google map of the positive ground flashes that occurred on the different dates, mentioned in Table 1. As is depicted in Table 1, a total of 425 lightning flashes were recorded on different seven days of pre-monsoon, out of which 133 strikes were observed to be positive ground flashes, whereas the number of cloud flashes were 276 and the number of negative ground flashes were just 16. Evidently, the majority of ground flashes that have been observed during those days were of positive type.

By using the atmospheric electricity sign convention in which the air above the surface of Earth (in cloud) contains positive charge, while the Earth's surface charge is negative. So the current flows from the cloud containing positive charge to the ground containing negative charge. That means the negative charges flows from ground to cloud. The electric field signatures are classified based on the well established field structures and the polarity of the field. For example, the cloud flashes produce electric field that has in general two stages i.e. initial or active stage and late stage, and do not possess return stroke. Similarly, the negative ground flashes consisted of initial break down stage with positive field change followed by the stepped leaders and return strokes, whereas the positive ground flashes produce the negative field change. The actual number of flashes occurring during the activity was significantly higher than the number recorded and analyzed in this study. Although, the trigger level was set for both positive as well as negative field changes, the oscilloscope often did not trigger for the positive field change (that corresponds to the negative ground flash) and as a result the trigger level was set for

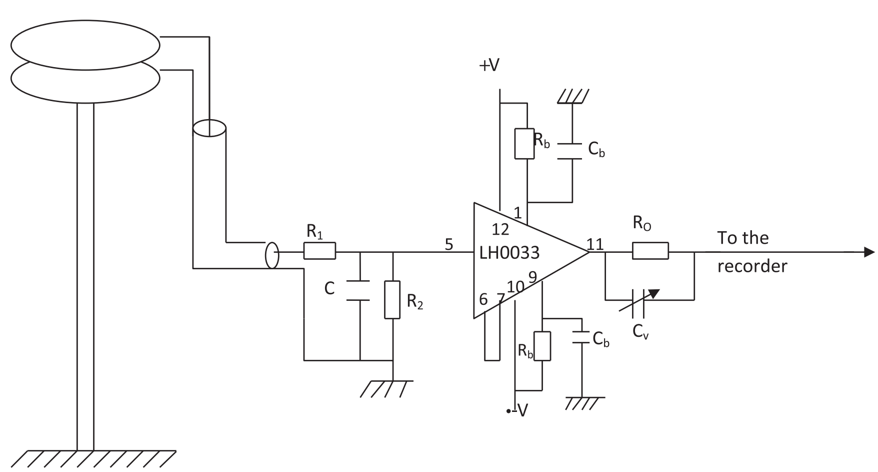

Fig. 1. The parallel plate antenna and the buffer circuit used in this study for the electric field measurement.

Table 1
Statistics of the flashes recorded on different days of March, April and May 2015.

	Date of recorded flashes	Total flashes recorded	Number of positive ground flashes	Number of negative ground flashes	Cloud Flashes	(Multiplicity) Flash containing			Total number of positive R.S.
						1 RS	2 RS	4 RS	
1	2015-03-30	50	26	5	19	23	3	0	29
2	2015-03-31	01	1	0	0	1	0	0	1
3	2015-04-12	20	13	0	7	12	1	0	14
4	2015-04-15	48	1	8	39	1	0	0	1
5	2015-04-16	104	6	3	95	4	2	0	8
6	2015-04-17	70	10	0	60	9	1	0	11
7	2015-05-11	132	76	0	56	72	3	1	82
8	Total	425	133	16	276	122	10	1	146

MS - Measurement station in Kathmandu

Fig. 2. Occurrence of positive lightning activities during the different days of pre monsoon 2015. (The google map is obtained from WSI Global Lightning Network). (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.)

negative field change (that corresponds to positive ground flash). This indicates that the occurrence of the positive ground flashes was quite frequent.

Of one hundred and thirty-three positive ground flashes, one hundred and twenty two flashes were found to have single strokes whereas 11 flashes were found to contain multiple strokes. Table 1 depicts the occurrence of the positive ground flashes on different days along with their multiplicity.

The map in Fig. 2 was obtained from WSI's global lightning network archive from which dots that represented negative ground flashes were manually deleted and only dots that represented positive ground flashes were kept. Moreover, in order to make the occurrence of activity clear in the map, information about the date, time and location (latitude–longitude) have also been were deleted. It is therefore, the map represents our data. As is seen in the map, Nepal stretches from east to west bordering with India in the south and with China in the north. Most (about 83%) of the land coverage of Nepal is being covered by hills and mountains whereas only a 17% of the land is flat land called Terai. Terai region is stretched in southern part bordering with India. It can also be seen from the map that most of the activities over hilly regions (dark green region and to the north). In fact our DSO was not synchronised with the GPS system used by the WSI GLN, so the each individual flash could not be located precisely. However, from the WSI google map the approximate distance could be estimated. While recording the data in 2015, the satellite imagery is managed by Google by integrating available satellite and aerial datasets which was from 2013, whereas the occurrence of lightning was recorded from 2015. Therefore, in Fig. 2, the lightning data from 2015 was incorporated in the google map that was updated in 2013. As depicted in Fig. 2, the positive ground flashes occurred almost all over Nepal, though mostly over the hilly regions. Only positive ground flashes were selected from the whole data set of all lightning flashes and presented in Fig. 2.

In this study, fine structures of the positive ground flashes have been analyzed. The fine structure includes basically the return stroke parameters such as rise time (t_r), Zero crossing time (t_z), full width at half-maximum (FWHM) and relative amplitude of electric field pertinent to different events of the same flash. In this study the rise time (t_r) is defined as the time of electric field change from 10% to 90% of the maximum field of the return stroke. Similarly, Zero crossing time (t_z) is defined as the time between

Table 2
Statistics of different parameters.

	Rise time (t_r)	Zero-crossing time (t_z)	FWHM	Amplitude
Number	146	146	146	146
Average	9.44 μs	60.45 μs	14.18 μs	414.26 mV
G.M.	8.18 μs	42.76 μs	12.04 μs	346.15 mV
Max	44.97 μs	460.30 μs	80.75 μs	2209 mV
Min	2.41 μs	12.49 μs	2.88 μs	79.05 mV
Range	42.56 μs	447.81 μs	77.87 μs	2129.95 mV
Median	7.64 μs	36.10 μs	11.16 μs	360.95 mV
S.D.	6.44 μs	72.41 μs	10.81 μs	287.09 mV
Variance	41.45 $(\mu s)^2$	5242.56 $(\mu s)^2$	116.92 $(\mu s)^2$	82,422.69 $(mV)^2$
Correlation coefficient	R_{12}, R_{13}, R_{14}	0.48	0.54	0.51
	R_{23}, R_{24}		0.62	0.51
	R_{34}			0.27

the rise of the electric field from the reference level and decrease of the field to the reference level. In the same manner, the FWHM is defined as the time duration between the 50% rise and 50% fall electric field, pertinent to a return stroke, from the reference level. Statistics of these parameters, such as arithmetic mean, geometric mean, median, standard deviation, variance etc., were calculated and have been presented in Table 2.

The arithmatic mean of the rise time of 146 first and subsequent return strokes is found to be 9.44 μs, and the geometric mean is found to be 8.18 μs with a range of 2.41 μs to 44.97 μs. The arithmatic mean of zero-crossing time is found to be 60.45 μs and the geometric mean is found to be 42.76 μs with a range of 12.49–460.3 μs. The arithmatic mean of the FWHM is found to be 14.18 μs, and the geometric mean is found to be 12.04 μs with a range of 2.88–80.75 μs. The standard deviation of the rise time is found to be 6.44 μs and the standard deviation of zero-crossing time, FWHM and amplitude are 72.41 μs, 10.81 μs and 287.09 mV respectively.

Possible correlations amongst the different parameters were also sought. The correlation coefficient between the rise time and zero-crossing time is found to be 0.48. The correlation coefficient between rise time and FWHM is found to be 0.54 and correlation coefficient of rise time and amplitude is 0.51. The correlation coefficient between zero-crossing time and FWHM is 0.62. The correlation coefficient of amplitude and zero-crossing time is 0.51 and correlation coefficient of amplitude and FWHM is 0.27.

4. Result and discussion

In the present work, 133 positive ground flashes, recorded on different thunderstorm days in Nepal, were analyzed and presented. The measuring station was being placed in Kathmandu at an elevation of 1300 m above the average sea level. As per the Weather Service International (WSI) Global Lightning Network (GLN), the lightning activities were mostly over the hilly region. Most of the positive ground flashes were characterized by single stroke flashes whereas the occurrence of the the multiple stroke flashes was relatively very rare. Of the 133 positive ground flashes, 122 flashes were single-stroke flashes, 10 flashes were two-stroke flashes and one flash consisted of four strokes. Accordingly, the proportion of single-stroke flashes is 91.7%, that of two stroke-flashes is 7.5% and that with four strokes is 0.8%. Considering the number of positive flashes recorded and analyzed in this study, the average number of strokes per flash or multiplicity is obtained as 1.1, and the statistics of the flashes is presented in Table 2. We did not have the knowledge of exact location of each stroke; the multiplicity was confirmed based on the continuity of the activity after the first stroke to the last stroke in the record. The frequency of occurrence was also taken into consideration to confirm the multiplicity.An example of a multiple stroke flash (with 4 strokes) has been depicted in Fig. 3, and was recorded on the 11th May 2015 (Flash no-20150511-0017 captured at 10.01 pm).

In this flash the time interval between first and second stroke is observed to be 56.83 ms and that between the second and third stroke is 27.4 ms. Whereas the time interval between third and fourth stroke is 245.4 μs only. For all the multiple strokes, the inter-stroke time intervals varied from 0.25 ms to 80.28 ms with an arithmetic mean 33.77 ms and geometric mean 16.69 ms.

Apart from the above mentioned positive ground flashes, some of the flashes were found to consist of return strokes subsequently succeeded by another peak what is here described as doubly

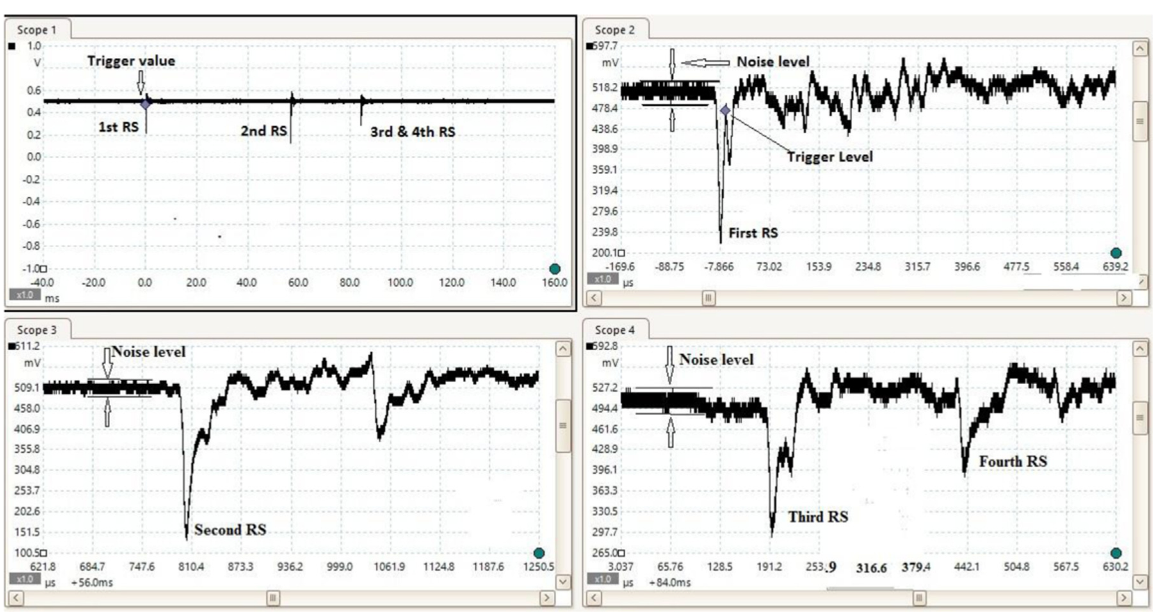

Fig. 3. An example of a four stroke flash recorded on the 11th May 2015 (Flash no-20150511-0017:10.01 pm) (1) Scope 1 shows the whole flash. (2) scope 2 is the zoomed signature of the first return stroke of the four-stroke positive flash. (3) Similarly, scope 3 depicts the expanded form of second return stroke and (4) scope 4 depicts the third and fourth return strokes of the same flash. Here the vertical axes in each scope is digitizer voltage, whereas, the horizontal axes in scope 1 is in ms and that of scope 2, 3 and 4 are in micro seconds.

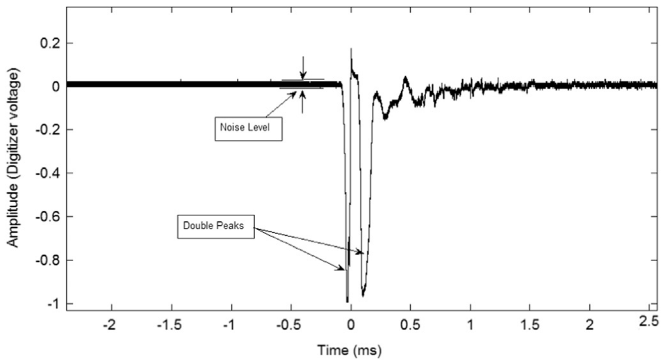

Fig. 4. An example of the waveform of a return stroke with double Peaks: Flash no-20150416-0113:08.24 pm.

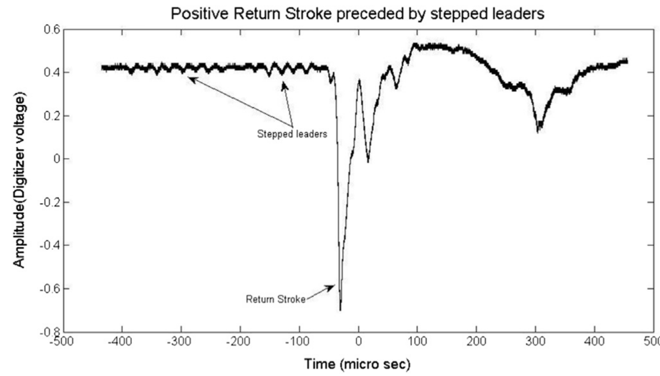

Fig. 6. An example of positive return stroke preceded by stepped leaders: Flash no-20150511-0059:10.14 pm.

peaked strokes. Such a peak can be viewed as due to the surge of the residual charge along the ionized channel. Depicted in Fig. 4 is an example of positive ground flash that apparently looks as consisting of a single return stroke.

The preliminary breakdown pulses pertinent to the positive ground flashes were found to be less pronounced as compared to those of the negative counter parts regional flashes. As a result only a few positive flashes were found to consist of pronounced PB pulses. An example of a flash consisting of PB pulses followed by positive return stroke is depicted in Fig. 5.

The stepped leader preceding the positive ground flashes were found to be less pronounced as compared to those of negative counterparts. As a result only a few positive flashes were found to consist of stepped leader. An example of a flash consisting stepped leader followed by positive return stroke is depicted in Fig. 6.

4.1. *Comparison of positive CG multiplicity from different geographical locations*

Analyzing a total of 23 positive CG flashes, Qie et al. (2002) reported that 87% of the flashes were single stroke ones and rest of the 13% of total flashes were characterized by multiple strokes with an average number of strikes per flash was found to be 1.13. Fleenor et al. (2009) observed that 96% of total 204 positive CG flashes were single-stroke ones and the rest of 4% of positive CG flashes were found to have two stroke with an average stroke per flash of 1.04. Saba et al. (2010) examined 103 positive flashes, of which 81% were found to be single stroke and rest of the 19% were found to be multiple stroke with an average multiplicity of 1.2 strokes per flash. Saba et al. (2010) also observed that GM of 21 inter-stroke interval to be 94 ms. Qie et al. (2013) reported that 94.59% of total 185 flashes were single-stroke flashes that were observed in Da Hingganling, China, having 1.06 strokes per flash. The average of inter-stroke interval was 64.20 ms and GM was 97.83 ms. The characteristics of positive CG flashes found in the literature compared with our study are shown in Table 3.

Of the 133 positive CG flashes that have been analyzed in this study, the rise time from 10% to 90% peak value of 146 strokes were found to vary from 2.41 μs to 44.97 μs with AM 9.44 μs and GM 8.18 μs. The sampling interval of the system was 3.2 ns and is good enough for the rise time. The comparison of return stroke rise time among different authors is shown in Table 3.

Hojo et al. (1985) found that the rise time from 10% to 90% peak value of field change by positive return strokes in Nilgata and Tokyo were 8.7 μs and 6.7 μs respectively. Cooray (1986) reported

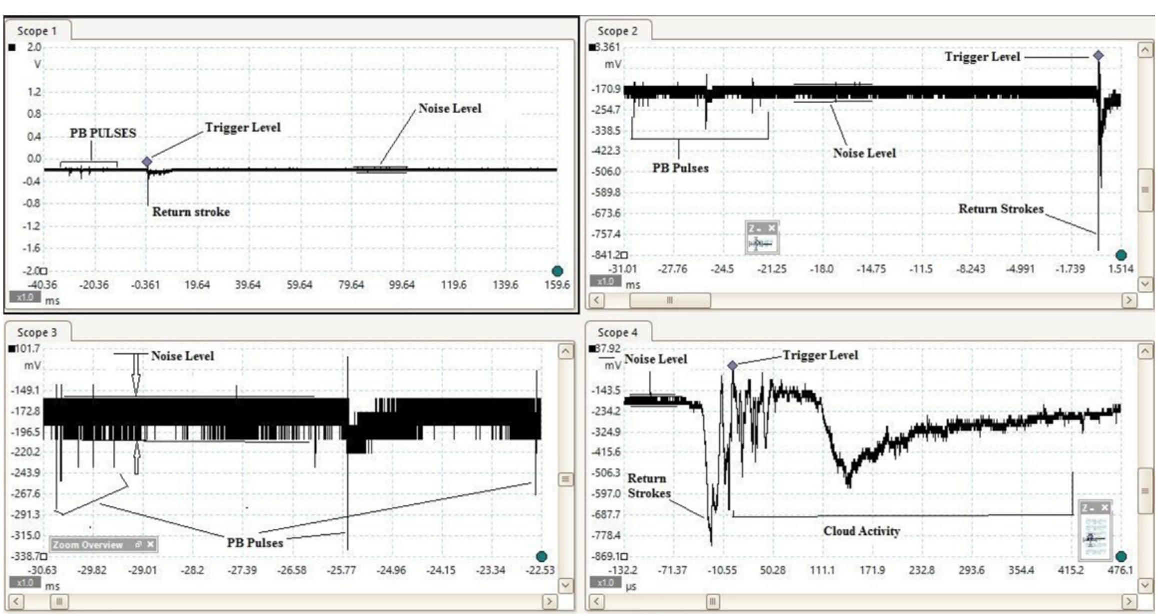

Fig. 5. An example of a preliminary breakdown pulses recorded on the 11th May 2015 (Flash no-20150415-0047:03.40 pm) (1) Scope 1 shows the whole flash of window 200 ms. (2) scope 2 is the zoomed signature of the PB pulses with the return stroke of the flash. (3) Similarly, scope 3 depicts the expanded form of PB pulses and (4) scope 4 depicts the expanded form of return strokes of the same flash. Here, the vertical axes in each scope is digitizer voltage, whereas, the horizontal axes in scope 1 and 2 are in ms and that of scope 3 and 4 are in micro seconds.

Table 3
Comparison of positive CG multiplicity, rise time etc. from different geographical locations.

Authors	Place	No of CG flashes (sample size)	Single strokes ratio	Sampling rate (Ms/s)	Strokes per flash	Inter-stroke interval (ms)	Rise time (μs)	Zero crossing time (μs)
Present study	Kathmandu, Nepal 27°44′N; and 85°19′E; and 1300 m above the sea level	133(146)	91.7%	312.5	1.1	33.77	9.44	60.45
Qie et al. (2013)	Da Hinggan ling, china 50.4°N, 124.1°E and 400 m above the sea level	185(196)	94.59%	5	1.06	97.83	7.77	–
Fleenor et al. (2009)	America	204(212)	96%	–	1.04	–	–	–
Qie et al. (2002)	Gansu,China	23(26)	87%	5	1.13	88.2	–	–
Saba et al. (2010)	Austria, Brazil, USA	103(124)	81%	–	1.2	–	–	–
Nag and Rakov (2012)	–	52(62)	81%	100	1.2	77	–	–
Hojo et al. (1985)	Tokyo, 35.7°N; and 139.8°E; and 37 m above the sea level	(44)	–	–	–	–	6.7	–
	Nilgata 37.9°N; and 139.02°E; and 8 m above the sea level	(32)	–	–	–	–	8.7	–
Schumann et al. (2013)	Brazil, 23.212°S and 45.867°W 635 m height above the sea level	(72)	–	5	–	–	5.7	–
Cooray (1986)	Sweden	(15)(20)	–	–	–	–	6.2	–
	59.837°N; and 17.646°E		–	–	–	–	8.9	–

Note: '–' indicates that those parameters have not been considered in the corresponding studies.

from 15 positive return strokes in Sweden that the average rise time was 6.2 μs. Schumann et al. (2013) found that the rise time of 72 positive CG flashes from Brazil was 5.7 μs. Qie et al. (2013) found that the rise time from 10% to 90% peak value of 196 positive return strokes was 7.77 μs on the average.

The rise time of the electric field change due to positive return strokes in the present study is relatively high as compared to those from other regions except for those from Nilgata (8.7 μs) and Uppsala (8.9 μs). The higher rise time can be attributed to the propagation effect over the rugged hills. In the present study, it is difficult at this moment to justify over those from Nilgata whereas the rise time in Sweden was taken from 0% to 100% of the peak amplitude that can easily be justified. However, by locating the lightning strikes, the propagation of the electric field could be described. Moreover, the high values of rise times observed at Nilgata and Uppsala may also have some propagation effect over the land.

Fine structures of each stroke were analyzed and different parameters were studied. Possible relation among those parameters was sought. The flashes were analyzed for duration of the stroke, rise time, FWHM, relative amplitude, etc. The correlation coefficient between rise time and zero-crossing time is found to be 0.48 means that the correlation coefficient between rise time and zero-crossing time is moderate. Similarly, correlation coefficient between rise time and FWHM is found to be 0.54 which is also moderate. Furthermore, the correlation coefficient between rise time and amplitude is found to be 0.51 which is again moderate. However, the correlation coefficient between zero-crossing time and FWHM is found to be 0.62 which is good, but, the correlation coefficient between amplitude and zero-crossing time is found to be 0.51 which is again moderate whereas the correlation coefficient between amplitude and FWHM is found to be 0.27 which is poor given in Fig. 7. The relations among the parameters analyzed are shown in the graphs below.

5. Conclusion

The characteristics of 133 positive CG flashes containing 146 return strokes were recorded at a measuring station (27°44′N and 85°19′E) in Kathmandu Nepal. Features of such flashes were analyzed and compared with those from various other geographical locations available in literature. A comparison of the features of positive ground flashes from this study and others is depicted in Table 3.

Positive ground flashes were frequently observed and recorded at the station. Although the total percentage of the positive ground flashes could not be calculated at this stage, their occurrence is relatively high as much as 34% during the pre-monsoon (Baral and Mackerras, 1993). Regardless of the geographical locations, the positive ground flashes seem to occur in isolation, as they are rarely followed by the subsequent return strokes. However, the interstroke interval observed in Kathmandu Nepal is found to be relatively shorter than those observed in other locations. This could be attributed to the relatively smaller distance between the hills and the clouds as compared to that between the sea level and the clouds. Furthermore, the average rise time of the positive return strokes is found to be longer than those observed at the other locations. The longer rise time can be attributed to the propagation effects over the rugged hills as compared to those measured over the flat lands and across the sea. The significant electric field strength and the corresponding current of the channel could not be calculated, though, information on lightning strikes was obtained from Global Lightning Network (GLN). Nepal being a hilly and mountainous subtropical country, most of the lightning activity are observed over the hills, consequently, most of the positive ground flashes observed in this study are from hilly regions.

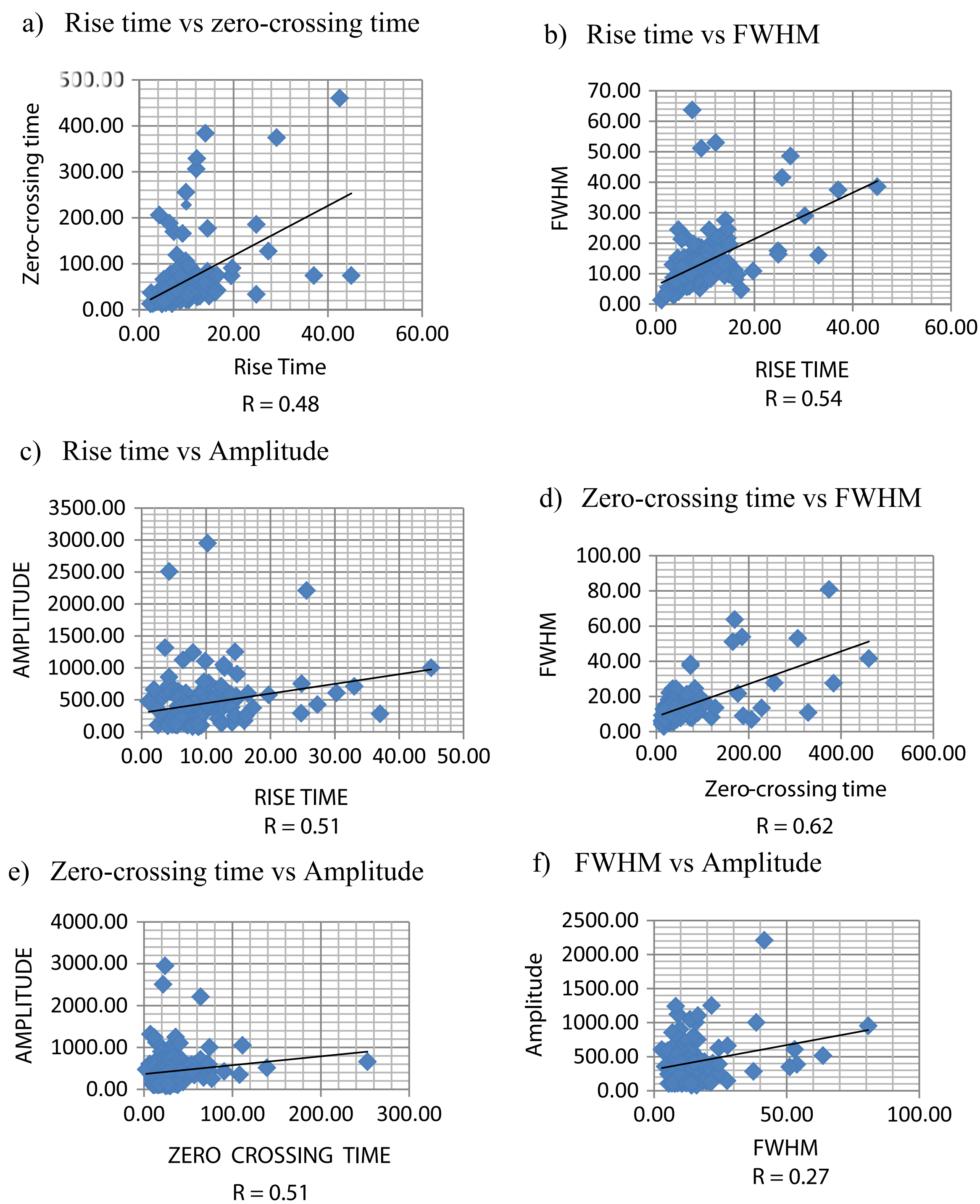

Fig. 7. Relations among the different parameters along with the value of correlation coefficients: (a) Rise time and zero-crossing time (b) Rise time and FWHM (c) Rise time and amplitude (d) Zero-crossing time and FWHM (e) Zero-crossing time and amplitude (f) FWHM and amplitude. Note: The value of correlation coefficient (r) is interpreted as, if r is less than 0.2, the correlation is very weak. If r is greater than and equal to 0.2 and less than 0.4, the correlation coefficient is weak. If r is greater than and equal to 0.4 and less than 0.6, the correlation coefficient is moderate. If r is greater than and equal to 0.6 and less than 0.8, the correlation coefficient is good. If r is greater than 0.8, the correlation is very good. However, the value of r^2 is preferred for more precise analysis and is called coefficient of determination. Further if the value of r is 0.71, then the value of r^2 would be 0.50 confirming that 50% of the points are in alignment, and so forth.

However, for precisely locating each strike, further improvement in the instrumentation is need. It can further be claimed that the rugged hills play important role in producing the positive ground flashes and also render propagation effect on the electro-magnetic field. As a result the rise time of the electric field observed in this study is relatively higher than those observed in the other geographical locations. Since, this is the first article of its kind from Nepal, it is difficult to conclude on the influence of hills in the occurrence of positive ground flashes, yet, it is likely that hills can influence various features of lightning electric field. We strongly recommend for further investigation on such electric fields with an improved instrumentation.

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