To the editorial board of HESS

Re:HESS-2017-740 "**Real time rainfall estimation using microwave signals of cellular communication networks: a case study of Faisalabad, Pakistan"**

Dear Reviewer

To begin with, I would like to thank you for considering our paper for your valuable comments. Below is response to your comments.

Best regards,
Muhammad Sohail Afzal

Comments of the reviewer/Reply

Anonymous Referee #1

Received and published: 24 February 2018

Comment 1:
Clarifying the claimed contribution. The claim contribution can be in empirical results for rainfall in Pakistan, or in presenting improvements to the algorithm of OLU, or in specifying challenges in applying it to an area different from Holland, where it'sPoC has been demonstrated. The authors must focus on their claim contributing so the paper can be evaluated accordingly

Reply:
The focus of this research is to adopt rainfall link based approachin under developed country like Pakistan, where other rain gauges or satellite data are limited or very expensive and not affordable. By testing the RAINLINK code developed in R language, we claimfollowing list of contributions, which are concluded below:

1. *As Pakistan is under developed country,only 97 rain gauge stationsare operated by PMD (Pakistan Meteorological Department) Source (PMD website), which are very limited, even the rain gauges which are available are outdated and installed since 1970 and their validity has reduced with time.More than 70 % rain gauges are manual and remainingautomatic with systemic and personal errors. Similarly satellite data is also available butare very expensive with high spatio-temporalresolution, therefore, most of the researchers and scientists depend only on the PMD rainfall data. Some institutions installed their own rain gauge in their regional offices without considering the TOR of the installation and subsequently rainfall data manifest biasness.This link based approach introduced in Pakistan is unique and will help in real time monitoring of different studies. The main focus and*

contribution of this conducted research is to adopt and promote this new method of rainfall estimation in Pakistan.

2. *After adoption of this new method of rainfall estimation on high spatial and temporal resolution, this method can be further used for different studies including real time irrigation scheduling and to develop a system, as it is working in California "California Irrigation Management Information system(CIMIS)",flood monitoring and forecasting, climate changeadoption and sustainable groundwater management.*
3. *The operating frequency of the signal used is 38 GHz and signal is vertically polarized having 15 min temporal resolution, which is the first initial point to move further investigation because the same operating frequency is used in Holland with vertical polarization. The detaileddescription of parameters especially a and b chosenis given in reply of comment 2.*
4. *In Faisalabad, wind speed is insignificant and attenuation in the signal is purely due to rainfall intensity therefore values ofaand b have been calibrated and validated (see comment 2). All the observed rainfall in the three observation points matches with the signal based rainfall at the corresponding location of observed rain gauges station. Also the statistical measure mean, SD, CV,and R^2 represent good agreement between observed and signal based rainfall.*
5. *To study the spatial rainfall analysis, RAINLINK code is run which confirms that rainfall is a stochastic variable and it shows variations within 1-2 km range.*
6. *In future studies, calculation of a and b for different geographical location of Pakistan will be tested because rainfall varies between 250-1500 mm in different area of Pakistan.Of course, the rainfall intensity is affected by wind speed, attitude and temperature. In next paper, we are working to derive the values of a and b at different attitudes in Pakistan. Again, we believe that in Faisalabad, the climate is very stable and values of a and b have been fitted/calibrated based on the vertical polarization and 38 GHz frequency and shows good agreement between observed and predicted values.*
7. *Based on the sensitivity of the algorithm, it is concluded that smaller path length should be selected for link based approach for best results of rainfall estimation along with high frequency.*

Comment 2:
Detailed and accurate description of the methodology. The methodology must be detailed to a level where it can be used by other. Unfortunately, in this paper the details are not even sufficient to evaluate the validity of the results. Just few examples (out of many!): The code developed by OLU required setting of many parameters. Which parameters have used in this paper? How are they set and why?In particular, which values of b and d were used in (3)? What was calibrated in section 3.2 and how? What is a "corrected maximum and minimum received power"? How is the rain maps validated? Etc

- Detailed and accurate description of the methodology. The methodology must be detailed to a level where it can be used by other

Reply:
Detail stepwise algorithm methodology regarding different rainfall retrieval steps included preprocessing; dry-wet classification, references signal level etc will in cooperated in final revised manuscript. Initially we provided the detailed methodology firs each step of rainfall processing but in initial submission according to the editor directions, we change the methodology into abstracted form. Now, revised manuscript has been incorporated with detailed methodology.

- The code developed by OLU required setting of many parameters. Which parameters have used in this paper? How are they set and why? In particular, which values of b and d were used in

Reply:
There are different parameters used in this study. Some parameters are fixed and recommended by Overeem et al 2016 to test in different geographical areas of the world. For exampleattenuation due to wet antenna A_a*=2.3 and coefficient* α*=0.33. Among all the parameters, values of c=a and d=b for local climatic conditions are also very important.*

The snapshot of small section of input file used to process through RAINLINK codeis given below in Figure1. Fromthis Figure, it is clear that the frequency of link that has been used in this study is 38GHz and the signal is vertically polarized. The same operating frequency link has been used in Holland. The Figure 2 hasbeen used as reference to fit/calibrate the values of ***c=3.69 and d=1.04.****These values have been selected after a number of simulations until the observed and simulated values match each other. The output file during the simulation of rainfall algorithm is shown in Figure 3 which same values of c and d for each time step (15 min interval)and these values have been finalized after a number of simulation.*

Frequency	YearMonthDaytime	RxLevelMin	RxLevelMax	path -length	x-start	y-start	x-end	y-end	Link ID	Link ID
38	201606220015	-41.8	-43.3	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220030	-41.8	-42.7	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220045	-41.8	-42.7	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220100	-41.8	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220115	-41.8	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220130	-41.8	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220145	-41.8	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220200	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220215	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220230	-41.8	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220245	-41.6	-42.3	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220300	-41.6	-42.3	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220315	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220330	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220345	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220400	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309
38	201606220415	-41.6	-42.5	0.88	31.4147	73.0276	31.41	73.035	1	FFD316-FFD309

Figure 1.

A. Overeem et al.: Retrieval algorithm rainfall mapping microwave links 2431

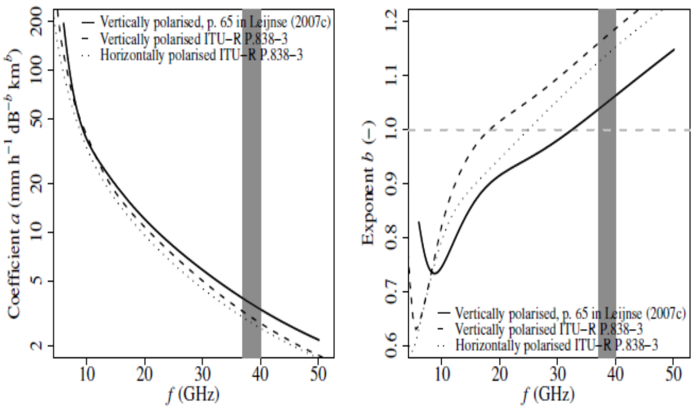

Figure 2. Values of coefficients in the relationship to convert specific attenuation to rainfall intensity for frequencies ranging from 6 to 50 GHz. The grey-shaded area denotes the 37.0–40.0 GHz range. Note the logarithmic vertical scale in the left figure. Here values have been computed from one data set of measured drop size distributions (p. 65 in Leijnse (2007c); solid lines). The values recommended by the International Telecommunication Union (ITU, 2005), meant for computing specific attenuation for given rain rates and for worldwide application, are also plotted (dashed and dotted lines).

- What was calibrated in section 3.2 and how?

Reply:

In section 3.2,two differentthings were calibrated and validated, firstly input parameters and secondly signal based rainfall estimated from RAINLINK code was calibrated and validated with local rain gauges data available.

CalibrationofInput parameters.After selection of all input parameters which include c, d, A_a and α etc as described above (reply of comment 2), allthe parameters have been used initially to test the sensitivity of algorithm and the RAINLINK codehas been run *forcalibrationtime period of32 days(including rainy and non rainy days) from year 2012-2014. The RAINLINK code has been run for different number of days and value of c and d have been checked in the output file of RAINLINK code, which are in agreement with the local condition values as shown in Figure 2. This represents that values of c and d have been calibrated as rainfall calculated from RAINLINK code and observed rainfall represents very good agreement. After final calibration of RAINLINK code in term of (signal based rainfall with local rain gauges data) then the all the parameter were fixed and run the RAINLINK code for 33 days (including rainy and non rainy days) for validation purpose for year 2015-2017. The rainfall estimated from RAINLINK code for validation period also represents good agreement of observed rainfall with the signal based calculated rainfall. This shows that fitted parameters in the calibration process have been validated for selected site in Faisalabad.*

- What is a "corrected maximum and minimum received power

Reply:

*The Figure 3 is used to response this comment. The corrected maximum and minimum received powers have been calculated for maximum and minimum power which is provided as input data and also shown in Figure 1**(received maximum power (Rmax) and received minimum power (Rmin)**. A detail stepwise procedure has been used to first calculate reference signal power and then compared the received maximum and minimum power with reference signal to calculatecorrected maximum and minimum power which is described below. The Figure 3 shows the final output file of all the parameter including maximumreceivedpower (Rmax), received minimum power (Rmin), reference signal power (ref_level)and corrected maximum power (Rmax_final) and corrected minimumpower (Rmin_final). The graphical representation of this corrected power has been presented in Figure 2 in the manuscript for just 3 links **(L1, L7 and L19**).*

```
ID a b Am_max Am_min path_length interval_number x_start y_start x_end y_end meanval F frequency RXMIN RXMAX RXMIN_final RXMAX_final ref_level DATETIME
1 3.69764294 1.04616225 0 0 1.04 1 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 0.218210468908474 38 -40.3 -41.3 -39.9 -39.9 -39.9 20160524
1 3.69764294 1.04616225 0 0 1.04 2 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 0.114199670239992 38 -40.3 -41.3 -39.9 -39.9 -39.9 20160524
1 3.69764294 1.04616225 0 0 1.04 3 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 0.0260551234881563 38 -40.3 -41.3 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 4 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.086785703525205 38 -40.3 -41.1 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 5 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.166476071559794 38 -40.3 -41.1 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 6 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.20172962640757 38 -40.1 -41.1 -39.9 -39.9 -39.9 20160524
1 3.69764294 1.04616225 0 0 1.04 7 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.274224648074277 38 -40.1 -41.1 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 8 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.275969193094607 38 -40.1 -41.1 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 9 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.390141368867499 38 -40.3 -41.3 -39.9 -39.9 -39.9 201605
1 3.69764294 1.04616225 0 0 1.04 10 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.478581626205393 38 -40.3 -41.3 -39.9 -39.9 -39.9 20160
1 3.69764294 1.04616225 0 0 1.04 11 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.541632070653474 38 -40.1 -41.3 -39.925 -39.925 -39.925
1 3.69764294 1.04616225 0 0 1.04 12 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.625361308111157 38 -40.1 -41.1 -39.95 -39.95 -39.95 201
1 3.69764294 1.04616225 0 0 1.04 13 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.725881571685626 38 -40.3 -41.3 -39.95 -39.95 -39.95 201
1 3.69764294 1.04616225 0 0 1.04 14 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.812176140902729 38 -40.3 -41.1 -39.95 -39.95 -39.95 201
1 3.69764294 1.04616225 0 0 1.04 15 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -0.943360573366271 38 -40.3 -41.3 -39.95 -39.95 -39.95 201
1 3.69764294 1.04616225 0 0 1.04 16 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.11623491622751 38 -40.3 -41.1 -39.975 -39.975 -39.975
1 3.69764294 1.04616225 0 0 1.04 17 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.18764719983344 38 -40.1 -41.1 -40 -40 -40 201605241215
1 3.69764294 1.04616225 0 0 1.04 18 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.25132838531547 38 -40.1 -41.1 -40 -40 -40 201605241230
1 3.69764294 1.04616225 0 0 1.04 19 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.33002195791489 38 -40.1 -41.1 -40 -40 -40 201605241245
1 3.69764294 1.04616225 0 0 1.04 20 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.42717811796236 38 -40.1 -41.1 -40 -40 -40 201605241300
1 3.69764294 1.04616225 0 0 1.04 21 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.54917891553189 38 -40.1 -41.1 -40 -40 -40 201605241315
1 3.69764294 1.04616225 0 0 1.04 22 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.69919528625866 38 -40.1 -40.9 -40 -40 -40 201605241330
1 3.69764294 1.04616225 0 0 1.04 23 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.75883304674027 38 -39.9 -40.9 -40.025 -40.025 -40.025
1 3.69764294 1.04616225 0 0 1.04 24 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.87418569929209 38 -40.1 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 25 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -1.96481785008675 38 -39.8 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 26 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.17070570950038 38 -40.1 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 27 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.32017798661264 38 -40.1 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 28 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.36364073115499 38 -39.9 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 29 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.46927842594535 38 -39.9 -40.9 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 30 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.64356832006019 38 -40.1 -41.1 -40.05 -40.05 -40.05 201
1 3.69764294 1.04616225 0 0 1.04 31 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.79859170576356 38 -40.1 -41.1 -40.075 -40.075 -40.075
1 3.69764294 1.04616225 0 0 1.04 32 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -2.97785921726915 38 -40.1 -40.9 -40.1 -40.1 -40.1 201605
1 3.69764294 1.04616225 0 0 1.04 33 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -3.15191133887278 38 -40.1 -40.9 -40.1 -40.1 -40.1 201605
1 3.69764294 1.04616225 0 0 1.04 34 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -3.21351781284941 38 -40.1 -41.1 -40.1 -40.1 -40.1 201605
1 3.69764294 1.04616225 0 0 1.04 35 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -3.32057442368834 38 -40.3 -41.3 -40.1 -40.1 -40.1 201605
1 3.69764294 1.04616225 0 0 1.04 36 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -3.41449607987165 38 -40.3 -41.3 -40.1 -40.1 -40.1 201605
1 3.69764294 1.04616225 0 0 1.04 37 -1.57495168234073 4.37060578284481 -1.36211045376138 3.51424230730211 22 -3.51028197903072 38 -40.3 -41.1 -40.15 -40.15 -40.15 201
```

Figure 3

Detail methodology which has been adopted is listed below to calculate corrected maximum and minimum power and then rainfall

Power law

Microwave links are the main source of communication between the telecommunication towers.In these links electromagnetic signal move from one antenna of one tower(transmitter) to the other antenna of the other tower(receivers) and during rainfall these sending signal from one tower to other tower attenuate due to rainfall intensity [Upton et al., 2005]. This attenuation of the signal due to rainfall intensity can be measured by the state of the art using power law [Atlas and Ulbrich , 1977] which is the relationship between rainfall and specific attenuation which is given as below :

$$R = ck^{d} \qquad (1)$$

In the above equation k is the specific attenuation, R is the intensity of rainfall(mmh^{-1}), c is the coefficient and d is the exponent and the valves of these coefficient and exponent depend upon frequency and polarization mainly and these parameters have been described above (Reply of comment 2). The final form of rainfall intensity is given below and detailed explanation will be presented in final revised manuscript

$$< R >= c \; [\frac{Fref(L) - F(L)}{L}] \qquad (2)$$

Pre- processing:

This is the first step in which input file is corrected on the basis certain checks, which is readily discussed in paper. ***In pre-processing*** *file free from errors including unique time interval having multiple records, missing link data for the selected unique link,and variation in frequency, link coordinates, path length for a unique link is prepared.*

Dry-Wet classification:

The second step in rainfall estimation for signal is to distinguish between the dry and wet signal.The stepwise procedure how to differentiate between the dry and wet spells is given below (Overeem et al., 2016):

1. *In first step select a link having 24 hours period.*
2. *All the links should be less than 15 km from the selected link.*
3. *Continuous to select the link within range of 15 km of selected link having all data available of present and pervious day. There should be at least 3 links within range of 15 km otherwise neglect the selected link and go to first step to select another link.*
4. *Now calculate the specific attenuation* $\Delta F_L = \frac{Fmin - max(Fmin}{L}$ *and calculate the median values of all calculated values* ΔF *and* ΔF_L *of all the selected links.*
5. *Now there is a criteria that if the median value of* ΔF_L *is less than -0.7 dBkm*$^{-1}$ *and median value of* ΔF *is less than -1.4 dB then the signal is classified as wet signal .*
6. *All time intervals that have not been classified as wet are classified as dry for them link selected in step 1.*
7. *Do the same procedure for the other entire link having time interval of 24 hours period.*

Reference Signal Level and corrected received power

The path average rainfall which is calculated by the differentiation between the maximum and minimum received power and the reference signal power which is selected on the day weather condition. The reference signal is calculated for all the selected links and for all 15 min resolution time interval by taking the median of the time interval for present and pervious 24 hours time period which is classified as dry weather condition. After this now rainfall is not estimated from signal if dry days having 15 min resolutions are less than 1 that is 2.5 h in 24h. Corrected signals F^{C}_{min} *are then applied on which next analysis is performed:*

$$F^{C}_{min} = Fmin \quad if\ wet\ AND\ Fmin < Fref \quad Eq.(3)$$

$$F_{ref} \quad if\ dry\ OR\ F_{min} \geq F_{ref}$$

Subsequently, the corrected maximum received power is calculated as follows: Similarly corrected power received is estimated as below formula

$$F^{C}_{max} = \begin{cases} Fmax & if\ F^{C}_{min} < Fref\ AND\ Fmax < Fref \\ Fref & if\ F^{C}_{min} = Fref\ OR\ Fmax \geq Fref \end{cases} \quad Eq.(4)$$

Determination of path average rainfall intensity

In this step rainfall has been calculated from the maximum corrected received power and minimum corrected received power with 15 min resolution. In this step the attenuation due to wet antenna and temporal variation also taken into account. The rainfall intensity due to attenuation of the signal can be calculated by using following relation given below

$$Amin = Fref - F^{C}_{max} \quad (5)$$

$$Amax = Fref - F^{C}_{min} \quad (6)$$

$$kmax = \frac{Amax - Aa}{L} H(A_{max} - A_{a}) \quad (7)$$

$$kmin = \frac{Amin - Aa}{L} H(Amin - Aa) \quad (8)$$

$$< R >= \alpha a k^{b}_{max} + (1 - \alpha)\ a\ k^{b}_{min} \quad (9)$$

Where k_{min} and k_{max} are the maximum and minimum attenuation in decibel per kilometer, Aa is attenuation due to wet antenna, α is a coefficient that is calculated by the contribution of the minimum and maximum attenuation having 15 min resolution and H is the Heaviside function (if the argument of H is smaller than zero, H = 0, else H = 1).

Note: all the above explained steps are scripted in RAINLINK code which is written in R language and modified according to our input data. Detail explanation of all above steps has been included in the revised final manuscript.

- How is the rain maps validated?

Reply:

Rainfall maps has beendeveloped in ArcMap by interpolation techniquei.e IDW and for validation purpose, three raingauges(UAF-RG, WASA-RG, WMRC-RG and AR-RG) have been located within study area and used for validation of obserbed and simulated rainfall. The results have been incorporated in the final revised manuscript.

The detail procedure which has beenadopted to validate the rainfall maps given below

1. *Rainfall map has been prepared in Arcmap by IDW interpolation technique*
2. *Shape file of three selected rain gauges has been prepared*
3. *The shape file of selected rain gauges have been added on the rainfall map in arc map*
4. *The shape file of selected rain gauges exactly overlaps the rainfall map*
5. *Then with the help of cursor, predicated rainfall values against each pixel where the rain gauges exactly located are noted.*
6. *Statistical analyses in term of mean, RMSE, coefficient of variance and coefficient of determination* R^2 *has been performed between the observed rainfall values from rain gauges and pixel information from rainfall maps against each overlap rain gauge has been recorded.*
7. *By adopting this procedure, revised manuscript has been set accordingly.*

Comment 3:

Major improvement of the writing and the presentation of the paper. Few examples: The abstract is too long; many terms were not defined; many details are missing, and more. In addition, there are numerous minor points that must be corrected

Reply:

Yes, we have incorporated your comments to further improve the abstract and given detailed information about the missing parameters. Minor corrections have also been incorporated in the revised final manuscript.

.