Data Article

5th generation millimeter wave wireless communication propagation losses dataset for Indian metro cities based on corresponding weather conditions

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ABSTRACT

In this paper, we present 5th generation (5G) millimeter wave (mmWave) wireless communication propagation losses dataset for four Indian major urban cities like Delhi, Mumbai, Kolkata and Chennai based on corresponding weather conditions. Weather effect on mmWave is calculated in terms of mmWave path losses by considering various atmospheric weather conditions. Propagation of mmWave is affected by weather impairments (WIs) and due to that mmWave attenuation takes place and Indian metro cities have variety in weather variations. 5G mmWave propagation attenuation is calculated due to WIs like water vapour, oxygen, rain and fog for frequencies 28 GHz, 37 GHz and 39 GHz. Individual WI effects during the season are calculated and shown using graphs and tables.

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Keywords:
5th generation (5G)
Millimeter wave (mmWave)
Weather impairments (WIs)
### Specifications table

| Subject area       | Engineering                                      |
|--------------------|--------------------------------------------------|
| More specific subject area | Telecommunication Engineering                   |
| Type of data       | Tables, graphs and figures                      |
| How data was acquired | Dataset generation calculations are performed |
| Data format        | Raw, analyzed                                    |
| Experimental factors | Season or Weather Effects                      |
| Experimental features | Attenuation datasets                             |
| Data source location | Delhi, Mumbai, Kolkata and Chennai (Indian metro cities) |
| Data accessibility | Datasets are with this article                   |
| Related research article | S. K. Agrawal and P. Garg, “Calculation of Channel Capacity Considering the Effect of Different Seasons for Higher Altitude Platform System”, Wireless Personal Communications, Springer, Wireless Personal Communications: Volume 52, Issue 4 (2010), Page 719 [6]. |

### Value of the data

- In India, 5G research and deployment are under year 2020 plan and such dataset is not specifically available for Indian Metro cities (like Delhi, Mumbai, Kolkata and Chennai).
- This proposed data set of the mmWave attenuation values for various Indian metro cities in various seasons will be highly useful for future 5G research and 5G system deployment.
- This Indian scenario 5G dataset can be used during network planning, determine the additional transmission power margin and operations.
- It is quite important for mmWave power link budget and reliable system operations which is feasible using this data.
- Based on presented dataset adaptive mmWave power transmission techniques can be used for large fixed link power budget margins for 5G mmWave communication system.
- Based on the presented dataset the 5G can be used to utilize resources in an efficient manner and controls the power transmission in an optimum manner.

### 1. Data

Four major Indian cities are considered here to generate the mmWave frequencies propagation path losses data set for 5G mmWave communication system under various weather conditions. The various weather conditions are like; summer, rain and winter. The four major Indian cities are Delhi, Mumbai, Kolkata and Chennai. The summer season attenuation calculation considers propagation path losses due to atmospheric gases impairments (water vapour and oxygen) only for all four cities. The rainy season attenuation calculation considers propagation path losses due to atmospheric gases (water vapour and oxygen) and rain for all four cities. The winter season attenuation calculation considers propagation path losses due to atmospheric gases (water vapour and oxygen) and fog for Delhi. Further, the winter season attenuation calculation considers propagation path losses due to atmospheric gases (water vapour and oxygen) for rest three cities [1–5].

In this article, we have considered that both transceiver units are having direct or line of sight communication link and there is no non line of sight path. This data article calculates mmWave frequencies propagation path losses due to WIs for the certain mmWave frequencies. This article shows data for mmWave propagation under different WIs [5–10].
2. Experimental design, materials, and methods

The calculations/experiments were carried out with MatLab for four Indian Metro cites during summer, rain and winter season. The seasons were considered along with their corresponding type of attenuation causes. As per recent analysis done by The United States Federal Communications Commission (FCC) for mmWave frequency bands: 28, 37 and 39 GHz, FCC authorizes and proposes broadband device operations in these mmWv bands [3–9]. Atmospheric parameters for the four Indian metro cities were collected as per literature and simulation was performed for the same using software experiment/calculations. The details about equations and related functions are explained the cited reference [5–10]. As per propagation loss equations; the attenuation due to atmospheric gases (combined water vapour and oxygen) has been plotted with mmWave frequencies for the four Indian metro cities i.e. Delhi, Mumbai, Kolkata and Chennai.

As per the Figs. 1–4 atmospheric water vapor shows high value resonances at 22 GHz for all four metro cities. The variation of attenuation due to the atmospheric gases along with mmWave frequencies is shown in the graphs. Tables 1–3 show the attenuation values for the four metro cities for various seasons like summer, rain and winter. Table 4 shows the attenuation values due to rain for 0.01% of a year for four Indian metro cities. Table 5 shows the attenuation values due to fog for Delhi. Further, the graphs also plots rain attenuation for the rain season for these four cities. Figs. 5–8 represents the attenuation for four cities respectively. Fig. 9 shows the fog attenuation for Delhi in winter season. Figs. 10–13 show the plot of the total atmospheric attenuation due to water vapour, oxygen, rain and fog for Delhi, Mumbai, Kolkata and Chennai. The attenuation applicability due to water vapour, oxygen, rain and fog have been considered as per cities respectively Delhi, Mumbai, Kolkata and Chennai.
Fig. 2. Attenuation due to atmospheric gases for 5G mmWave Communication System (Mumbai).

Fig. 3. Attenuation due to atmospheric gases for 5G mmWave Communication System (Kolkata).
Table 1  
Attenuation due to atmospheric gases for four Indian metro cities (Summer).

| City   | Frequency (28 GHz) | Frequency (37 GHz) | Frequency (39 GHz) |
|--------|--------------------|--------------------|--------------------|
| Delhi  | 0.81               | 0.73               | 0.77               |
| Mumbai | 1.31               | 1.21               | 1.30               |
| Kolkata| 0.82               | 0.75               | 0.70               |
| Chennai| 1.30               | 1.20               | 1.31               |

Table 2  
Attenuation due to atmospheric gases for four Indian metro cities (Rain).

| City   | Frequency (28 GHz) | Frequency (37 GHz) | Frequency (39 GHz) |
|--------|--------------------|--------------------|--------------------|
| Delhi  | 1.80               | 1.81               | 1.93               |
| Mumbai | 2.41               | 2.52               | 2.71               |
| Kolkata| 1.85               | 1.86               | 1.99               |
| Chennai| 2.41               | 2.50               | 2.71               |

Table 3  
Attenuation due to atmospheric gases for four Indian metro cities (Winter).

| City   | Frequency (28 GHz) | Frequency (37 GHz) | Frequency (39 GHz) |
|--------|--------------------|--------------------|--------------------|
| Delhi  | 1.31               | 1.21               | 1.32               |
| Mumbai | 1.81               | 1.82               | 1.91               |
| Kolkata| 1.31               | 1.21               | 1.33               |
| Chennai| 1.81               | 1.82               | 1.91               |

Fig. 4. Attenuation due to atmospheric gases for 5G mmWave Communication System (Chennai).
Table 4
Attenuation due to rain for 0.01% of a year for four Indian metro cities.

| Percentage (of Year) | Frequency (GHz) | Delhi Attenuation (dB) | Mumbai Attenuation (dB) | Kolkata Attenuation (dB) | Chennai Attenuation (dB) |
|----------------------|-----------------|------------------------|-------------------------|--------------------------|--------------------------|
| 0.01                 | 28              | 26.71                  | 37.29                   | 36.65                    | 30.09                    |
| 0.01                 | 37              | 33.43                  | 45.58                   | 44.09                    | 37.29                    |
| 0.01                 | 39              | 34.12                  | 47.03                   | 45.48                    | 38.79                    |

Table 5
Attenuation values due to fog for Delhi.

| Temperature (°C) | Frequency (GHz) | Attenuation (dB) |
|------------------|-----------------|------------------|
| 7                | 28              | 6.6              |
| 7                | 37              | 10.2             |
| 7                | 39              | 11.3             |

Fig. 5. Attenuation due to rain for 5G mmWave Communication System (Delhi).
Fig. 6. Attenuation due to rain for 5G mmWave Communication System (Mumbai).

Fig. 7. Attenuation due to rain for 5G mmWave Communication System (Kolkata).
Fig. 8. Attenuation due to rain for 5G mmWave Communication System (Chennai).

Fig. 9. Attenuation due to fog for 5G mmWave Communication System (Delhi).
Fig. 10. Attenuation due to Seasons (Summer, Rain and Winter) for 5G mmWave Communication System (Delhi).

Fig. 11. Attenuation due to Seasons (Summer, Rain and Winter) for 5G mmWave Communication System (Mumbai).
Fig. 12. Attenuation due to Seasons (Summer, Rain and Winter) for 5G mmWave Communication System (Kolkata).

Fig. 13. Attenuation due to Seasons (Summer, Rain and Winter) for 5G mmWave Communication System (Chennai).
Acknowledgments

The researchers are kindly thankful to Samsung India and Delhi Technological University (DTU) India. We don’t have funding for this research.

Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.12.003.

References

[1] Shu Sun, et al., Investigation of prediction accuracy, sensitivity, and parameter stability of large-scale propagation path loss models for 5G wireless communications., IEEE Trans. Veh. Technol. 65 (5) (2016) 2843–2860.
[2] S.K. Agrawal, Kapil Sharma, 5G Millimeter Wave (mmWave) communication system with software defined radio (SDR), in: Proceedings of the International Conference on Recent Trends in Engineering & Science (ICRTES-16), 29th–30th September 2016.
[3] Zhouye Pi, et al., An introduction to millimeter-wave mobile broadband systems, IEEE Commun. Mag. 49 (6) (2011) 101–107.
[4] J.G. Andrews et al., What will 5G be? IEEE JSAC Special Issue On 5G Wireless Communication Systems, May 2014.
[5] Theodore S. Rappaport, et al., Millimeter wave mobile communications for 5G cellular: it will work! IEEE Access 1 (2013) 335–349.
[6] S.K. Agrawal, P. Garg, Calculation of channel capacity considering the effect of different seasons for higher altitude platform system, Wireless Personal Commun. (2010) 719–729.
[7] S.K. Agrawal, P. Garg, "Calculation of the channel capacity in the presence of vegetation and urban-site environment for higher altitude platform communication system", to wireless personal communications, IET Microw. Antennas Propag. 3 (4) (2009) 701–713.
[8] S.K. Agrawal, K. Sharma, Software defined radio based channel capacity in 5G millimeter wave communication system, in: Proceedings of the International Virtual Conference on Computer Science, Engineering and Technology, Indore, India, 25th–28th December, 2016.
[9] S.K. Agrawal, K. Sharma, 5G Millimeter Wave (mmWave) communication system with software defined radio (SDR), Int. J. Innov. Res. Sci. Technol. 2 (9) (2016).
[10] S.K. Agrawal, K. Sharma, 5G Millimeter Wave (mmWave) communication system with software defined radio (SDR), in: Proceedings of the International Conference on Recent Trends in Engineering & Science (ICRTES-16), 29th–30th September, 2016.