IEICE Communications Express

Online ISSN : 2187-0136

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Volume 7 , Issue 2

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Type: LETTER
2018 Volume 7 Issue 2 Pages 48-53
Published: 2018
Released: February 01, 2018
[Advance publication] Released: December 06, 2017

DOI https://doi.org/10.1587/comex.2017XBL0175

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Type: LETTER
2018 Volume 7 Issue 2 Pages 54-59
Published: 2018
Released: February 01, 2018
[Advance publication] Released: December 08, 2017

DOI https://doi.org/10.1587/comex.2017XBL0167

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Edited and published by : The Institute of Electronics, Information and Communication Engineers
Produced and listed by : Komiyama Printing Co.,Ltd.

Preliminary Experiment of Meteor Burst Communications in Equatorial Region

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Abstract: The aim of the study is to explore the possibility of the use of Meteor Burst Communications (MBCs) in equatorial regions. We installed the master and the remote stations at Yogyakarta, Java Island and Jimbaran, Bali Island, Indonesia, respectively. As a preliminary experimental result, we confirmed that some packet transmissions between the two stations were achieved through meteor bust channels.

Keywords: Meteor burst communications, Equatorial regions, Indonesia

Classification: Transmission systems and transmission equipment for communications

References

[1] D. L. Schilling, *Meteor Burst Communications: Theory and Practice*, Wiley, 1993.

[2] A Fukuda, *Meteor Burst Communications*, Corona-sha, 1997. (in Japanese)

[3] "Snow Telemetry (SNOTEL) and Snow Course Data and Products", Natural Resources Conservation Service, United States Department of Agriculture, https://www.wcc.nrcs.usda.gov/snow/, accessed Aug. 23, 2017

[4] R. I. Desourdis, et. al., "The ARPA high-ERP meteor burst link experiment," Proc. 1993 IEEE Military Communications Conference, pp. 407–412, 1993. DOI:10.1109/MILCOM.1993.408636

[5] J. Weitzen, M. Sowa, R. Scofidio, J. Quinn, "Characterizing the Multipath and Doppler Spreads of the High-Latitude Meteor Burst Communication Channel," *IEEE Trans. Communications*, vol. COM-35, no. 10, pp.1050-1058, October 1987. 10.1109/TCOM.1987.1096690

[6] K. Mukumoto, et. al., "Data Transmission Experiments Using Meteor Burst Communication Equipment Conducted during Japanese 43-rd and 44-th Expeditions in Antarctica," *IEICE Trans. Communications*, vol. J88-B, no. 9, pp. 1875-1885, September, 2005 (in Japanese).

[7] A. Fukuda, et. al., "MBC Data Transmission Experiment Conducted During Japanese 45-th Expedition in Antarctica," *IEICE Trans. Communications*, vol. J90-B, no. 2, pp. 199-207, February, 2007 (in Japanese).

DOI: 10.1587/comex.2017XBL0136
Received September 4, 2017
Accepted November 17, 2017
Publicized November 30, 2017

[8] T. Tsuda, "Observations of Lower Thermosphere Dynamics with a Meteor Wind Radar," Tenki - Journal of the Meteorological Society of Japan, vol. 43, no. 1, pp.9-23, January, 1996 (in Japanese)
[9] K. K. Kumar, T. M. Antonita, S. T. Shelbi, "Initial results from SKiYMET meteor radar at Thumba (8.5、N, 77、E): 2. Gravity wave observations in the MLT region," Radio Science, vol. 42, issue 6 December, 2007. DOI:10.1029/2006RS003553

1 Introduction

When meteors enter into the Earth's atmosphere, ionized gas columns, which are called "meteor bursts," are generated by friction with the atmosphere. Meteor Burst Communications (MBCs) are non Line - of - Site communication methods using reflection phenomena of low VHF band waves by the meteor bursts[1]-[7]. MBC systems can realize data transmission between stations apart from each other by at most 2000 km. Moreover, MBC systems can be easily and inexpensively constructed compared with satellite communications, etc.

Since the existence time of the meteor bursts is as short as about several hundreds milliseconds, MBCs are suitable for communications which need small data transmission and allow some delay. For this reason, MBC systems are applicable for data transmission for environmental and meteorological observation systems which allow some delay and do not require massive data transmissions.

A famous application of MBCs is SNOTEL operated by Natural Resources Conservation Service (NRCS), United States Department of Agriculture [3]. SNOTEL is a snow telemetry system and collects weather data from the Rocky Mountains and Alaska. About 800 remote stations of SNOTEL are located where access is often difficult or restricted. Several master stations collect the data from the remote stations and transmit them to the central computer of NRCS.

Some MBC experiments and operations have been also done in high-latitude regions[5]-[7]. The experiments exhibit some interesting results from various points of view such as within-day variation and seasonal variation. From the experiments in Antarctica, some unique results have been obtained, which are different from the results in mid-latitude regions.

However, to the best of our knowledge, there have been no MBC experiments and operations in equatorial regions. Some astronomical observation results in equatorial regions showed that the appearance of meteors has some difference with that in mid-latitude regions, e.g., there are smaller variations in the height of meteor bursts, smaller seasonal fluctuations, etc [8][9]. Therefore, we expect to obtain unique properties about MBC in equatorial regions.

In this study, we try to conduct MBC experiments to obtain communication performance of MBCs and to explore the possibility of MBCs in equatorial regions. In May 2017, we have conducted a preliminary experiment about MBCs in Indonesia. In this article, we provide the result of the MBC experiment and show the possibility of using MBCs in equatorial regions.

2 Conditions of the Experiment

2.1 The Locations and the Period of the Experiment

The locations of the stations are listed below:

- The master station: Gadjah Mada University, Yogyakarta, Java Island, Indonesia (S 7°48'5", E 110° 21'52"), time zone: +7.
- The remote station: Udayana University Jimbaran Campus, Jimbaran, Bali Island, Indonesia (S8°22'9", E115°8'18"), time zone: +8.

The stations are located in approximately an east-west direction and the distance between them is about 530 km. We carried out the experiment from May 9 to May 11, 2017 including installation of the stations. The effective period of the experiment was about 26 hours, which was from May 10, 2017, 6:00 am UTC to May 11, 2017, 8:00 am UTC.

2.2 Equipment

The antennas of both the master and remote stations are Yagi antennas with 3 elements. The elevation angle of the antennas is set at 18°. The direction angle of the master and remote antennas are 97° and 276° clockwise from the North. Both stations used the same type of MBC modems: MRC565, Maiden Rock Communications, LLC. The specifications of the modems are: the carrier frequency is 48.375 MHz, the transmission rate is 4000 bps, the modulation scheme is DEPSK and the transmission power is set at 100 W. The remote station periodically makes 20-byte test data every five minutes for sending to the master station.

3 Data Transmission Procedure

Figure **1** illustrates the packet transmission procedure. In this figure, $M \rightarrow R$ means packets from the master station to the remote station and $R \rightarrow M$ means packets in vice versa. The principal of the packet transmission procedure is explained as follows:

- The master station periodically sends Probe Packets (PPs) to the remote station.
- When the remote station successfully receives a PP, the remote station transmits a Data Packet (DP) to the master station.
- If the master station successfully receives the DP, the master station sends an Acknowledgment Packet (AP) to the remote station.

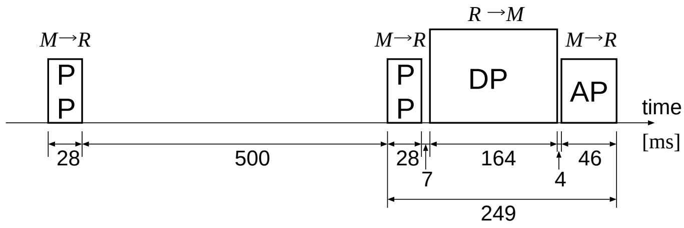

Fig. 1. Packet Transmission Procedure

- If the remote station receives the AP, the remote station removes the data which has been transmitted to the master station from the buffer in the remote station.

As shown in this figure, the time required for the successful packet transmission is about 250 ms.

We note that the shorter the period of transmission of PPs is, the better performance the master station yields. However, we set the duration of PPs to 500 ms to prevent a heat problem with the modem.

4 Experimental Result

Figure **2** shows the observed noise power at both of the stations during the experiment period. Since acceptable noise power for the MBC system is −115 dBm or less, we observed that most of the the experiment period was appropriate for the MBC experiment. However, at the master station, the noise power level was slightly higher than the acceptable noise level in the beginning of the experiment period.

Figure **3** shows the number of received packets. By the transmission procedure, the received PPs and APs were counted at the remote station and the received DP was counted at the master station.

From this figure, we observe that, during most of the experiment period, PPs were received by the remote station even when the number of them was not so large. The result means that the reflection of PPs by meteor bursts occurred during most of the period.

We also observe that many data transmissions were achieved in the period from May 10, 8:00 pm to May 11, 4:00 am UTC. In order to clearly identify a reason of the phenomena, we would need further experiments to collect more data. For now we suppose the following possibilities.

One possible reason is that the number of meteors increased during the period. The period- of-interest was during the morning in Indonesia. Some past studies in mid-latitude regions showed that many meteor burst channels were established in the morning, especially, around the time near sunrise. Another possible reason is related to the noise level. From Fig.2, we find that the noise power level of the period- of-interest was lower than other periods. We also need to take other possible reasons, e.g., sporadic E propagation, into account.

The total numbers of received PPs, DPs and APs were 390, 79 and 51, respectively. Since the transmission interval of PPs was set to 500 ms, the

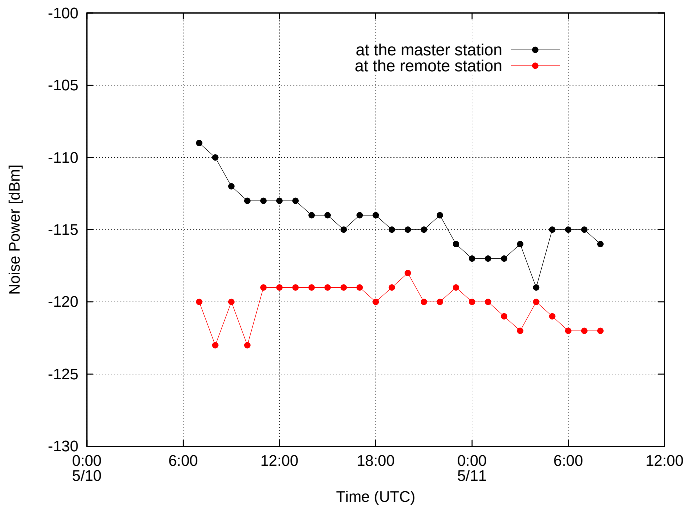

Fig. 2. Observed Noise Power

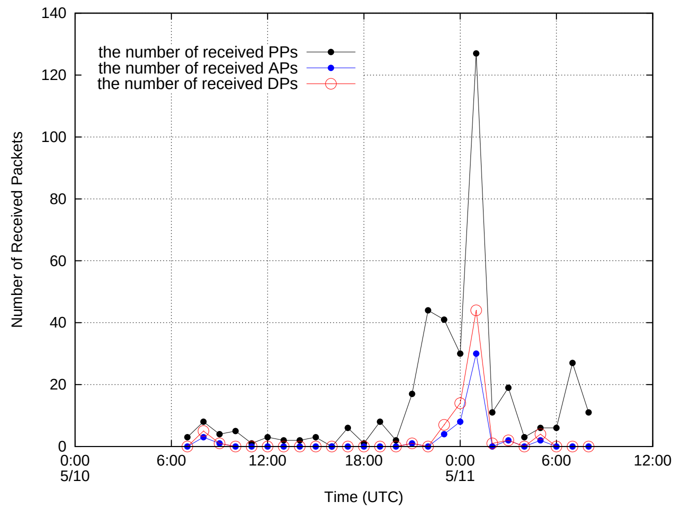

Fig. 3. The Numbers of Received Packets

number of probe packets was about 7200 per hour. Therefore, the PP reception rate was about 0.208% (=390/(7200×26)).

Since the number of accepted PPs at the remote station should be the same as the number of data packets, 390 data packets have been transmitted from the remote station. Therefore, the acceptance ratio of the DPs at the master station was 20.3% (=79/390). From the viewpoint of the remote station, out of 79 DPs, the remote station recognized that 51 data packets have been accepted by the master station. Thus the successful data transmission rate for the remote station was 64.6% (=51/79).

5 Conclusion

In this article, we provided an overview of our preliminary MBC experiment in Indonesia and showed the possibility of applying MBC in the equatorial region. Since we expect to observe unique properties and/or communication performance of MBCs in equatorial regions, we will continue MBC experiments to obtain additional results.

Acknowledgments

The authors would like to thank the staff and students of Gadjah Mada University and Udayana University for assistance with the experiments. This work was supported by JSPS KAKENHI Grant Number (Kiban C)16K06347.