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WIND SPEED ON ULTRA HIGH FREQUENCY (UHF) OF RADIO SIGNAL

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ABSTRACT

East coast of Peninsular Malaysia has received average wind speed up to 55km/h which equivalent to 15.4m per second and 30 knot, especially during monsoon. These circumstances had affected the radio signal by degrading its strength and quality. This study observe the relationship of wind speed and radio signal in Ultra High Frequency band. The statistical spearman correlation were applied and graph relationship of two variables were plotted in order to investigate these two variables. The measurement were done at 24 hour in February and July 2016 at Kusza Observatory. Analysis of result shown that high correlation strength (r = 0.555) was indicated in first of observation (1-O) at frequency of 382.5MHz. No high correlation were quantified in second of observation (2-O). These findings related to the observed high wind speed which is brought high of water vapor, hence attenuating the radio signal.

Keywords: radio signal strength; wind speed; correlation.

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1. INTRODUCTION

Wind is occurring due to the differences in the atmospheric pressure. An atmospheric air moves from the higher to the lower pressure regions causing the variation of wind speeds. Additionally, contributed by the average velocity of the atmosphere over a 5 minutes period measured in miles per hour [1]. Wind is inclusive of most weather occurring at the trosphophere. These combinations of wind speed, humidity, air temperature and pressure can determine the quality of local atmospheric conditions [2]. Radio communication such as wireless communication (cordless telephones and mobiles) is commonly affected by the atmospheric condition as it propagates through trosphospere region. The atmospheric condition can lead radio waves to reflect or diffract or refract, hence attenuating the signal [3]. Very High Frequency (VHF) and UHF band is type of band used by radio communication services as listed by International Telecommunication Unions (ITU). Table 1 shows the details of designation radio frequency band nomenclature listed by ITU. The focus of this study is to investigate the relationship of wind speed and radio signal in UHF band. There was statistically significant effect found between radio signal and wind combined with rain and humidity factor [4-5]. Apart of that, wind also increase the foliage density within foliage channel hence affecting the radio wave propagation [6-7]. Propagation in high air humidity also caused the radio signal to be refracted, resulting in radio signal attenuation [8].

Table 1. ITU radio bands [9]

Band Name	Frequency Range	Example of User
Very Low Frequency (VLF)	3 to 30 kHz	Navigation, geophysic
Low Frequency (LF)	30 to 300 kHz	Amateur radio, AM (long wave) broadcasting
Medium Frequency (MF)	300 to 3000 kHz	Amateur radio, AM (medium wave) broadcasting
High Frequency (HF)	3 to 30 MHz	Shortwave broadcast, marine
Very High Frequency (VHF)	30 to 300 MHz	Television broadcast, ground-to-aircraft and aircraft-to-aircraft communication
Ultra High Frequency (UHF)	300–3000 MHz	mobile phones, Wireless LAN
Super High Frequency (SHF)	3–30 GHz	microwave communications,

		satellite radio
Extremely High Frequency (EHF)	30–300 GHz	microwave remote sensing, amateur radio
Terahertz or Tremendously high frequency (THF)	300–3000 GHz	time-domain spectroscopy, condensed-matter physics

2. METHODOLOGY

In this study, the receiver system used comprises as following: antenna, Low Noise Amplifier (LNA) and 9 GHz spectrum analyzer (Keysight N99150) connected to the computer for data collection. The instrument setup was shown as in Fig. 3.The measurement was done in February 2016 and July 2016 with 24 hour observation at KO. Data of radio signal (dBm) and wind speed (km/h) were collected. Simultaneously, humidity and rain rate of data also were collected. These observation site which KO located in east coast of Peninsular Malaysia with latitude 5^{o} 32' 10" N and longitude 102^{o} 56' 55" E, feature on top of hill, surrounded with rainforest and nearby South China allows received the strong wind and far from human-made RFI.

In order to identify the relationship between wind speed and radio, spearman correlation was employed. In correlation analysis, range value of varies from +1and -1. On the other hand, the value of correlation indicates the strength of correlation. Where 0.1 is defined small correlation, 0.3 is medium correlation and strong correlation is 0.5 [16]. Since correlation value determined, the significance test is done by testing the hypothesis. There were 2 of hypothesis were involved which are null and alternative. Null was declared no correlation between two variables, instead alternative indicates there is correlation between the variables. In this case, the significance level was assumed as 0.05. When the significance value (p) less than significance level (α) (0.05), then null hypothesis is rejected and shows there are significant and two variables are related. Otherwise, the null hypothesis fails to reject then there are insignificant and no relation between two variables [17].

3. RESULTS AND DISCUSSION

The average of radio signal against frequency in February and July 2016 was demonstrated as in Fig. 1. Four highlighted prominent peaks were identified; 382.5MHz, 945MHz, 1867.5MHz and 2160MHz. These frequencies were in UHF band and most allocated for mobile phones and digital trunked radio by ITU and Malaysian Communication and Multimedia Commission (MCMC). The radio signal of 4 prominent peaks was determined by the relationship with wind speed by applying spearman correlation. Simultaneously, dual of y-axis graphs has been plotted against time (x-axis) for each of 4 prominent peaks. There was radio signal (dBm), wind speed (km/h) versus time of graph.

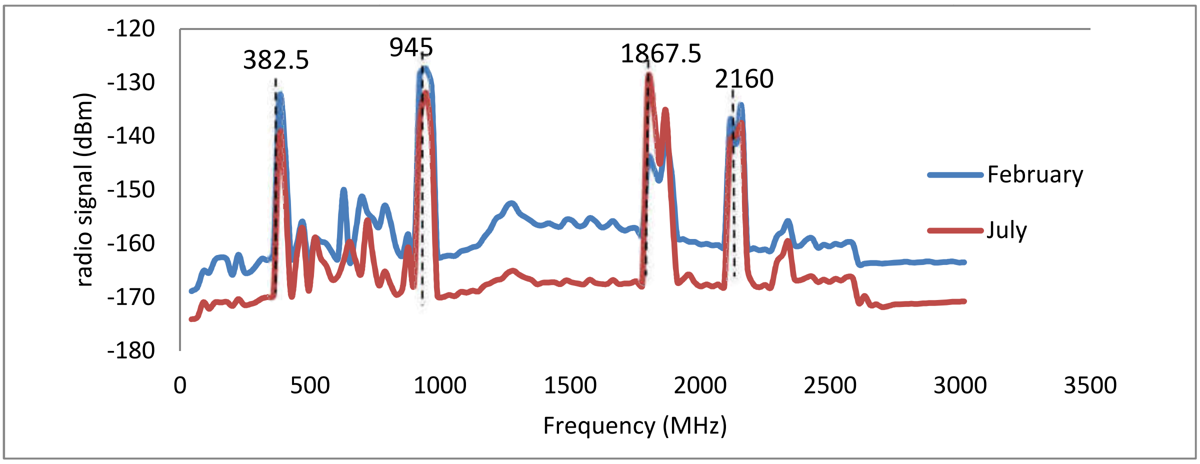

Fig.1. Average of radio signal against frequency in February and July 2016 with 4 prominent peaks labelled

Based on Table 2, obviouslyFebruary shown the significant and negatively high correlation at frequency of 945MHz and 1867.5MHz with the value of r = -0.550 and -0.506, Whereas, small and medium correlation with value r = -0.148 and -0.368 at frequency 382.5MHz and 2160MHz. Meanwhile, no high correlation were quantified on July.Medium correlation was detected only at peak of 382.5MHz, instead small correlation for 945MHz, 1867.5MHz and 2160MHz. From the observation, July been seen the highest range of wind speed (0-44.63km/h) and average of wind speed (13.02km/h) compared at February. As refered Beaufort wind scale as in Table 3, these range and average of wind speed described of the combination of calm, light, gentle, moderate, fresh and strong breeze. Concurrently, there were calm, light, gentle, moderate and fresh breeze combination for February with wind range of 0-37.04km/h and average at 10.74km/h.

Table 2. Spearman correlation coefficient for February and July

Date	Range of Wind Speed/ Average (km/h)	Range of Humidity/ Average (%)	Range of Rain Rate/ Average (mm/h)	Spearman Correlation Coefficient, r Frequency (MHz)			
				382.5	945	1867.5	2160
February 2016	0-37.04 /10.74	70-83 /73.89	0-110.7 /2.23	-0.148 Small corr. p = 0.0	-0.550 High corr. p = 0.0	-0.506 High corr. p = 0.0.	-0.368 Medium corr. p = 0.0
July 2016	0-44.63 /13.02	68-74 /71.09	0-197.6 /2.70	-0.319 Medium corr. p = 0.0	-0.160 Small Corr p = 0.0	-0.187 Small corr. p = 0.0	-0.153 Small corr. p = 0.0

These negatively high correlation explained the wind speed indirectly affected the radio signal (dBm) by conveyed the high of water vapour molecule caused by high humidity. The range and average humidity at February was 70%-83% and 73.89%, whereas 68%-74% and 71.09% in July. This high humidity led to abundant water vapour in the atmospheric column. As the greater of water vapour content in air lead to high water molecules interacted with radio waves [10-11]. Eventually, the greater absorption of water vapour occurred and the radio waves propagation is refracted [12]. As result of that, higher of attenuation hence negatively high correlation strength was computed.

The high correlation at February corresponded to the plotted graph as in Fig. 2. There were lesser in radio signal (dBm) as the wind speed (km/h) increased during 12.02am-1.05am at frequency of 945MHz and 1867.5MHz. Subsequently, there were also same event occurred at frequency of 382.5MHz and 2160MHz at same time duration. It seems the radio signal, wind speed versus time of graph as in Fig. 3 at July not exhibited the decreased in radio signal (dBm) as wind speed was higher. The high wind speed that brought high raindrop due to rain rate range seems not gave no high effect occurred at July. These was supported by [13-14] studies found that rain rate gave the minor effect on radio signal in UHF band.

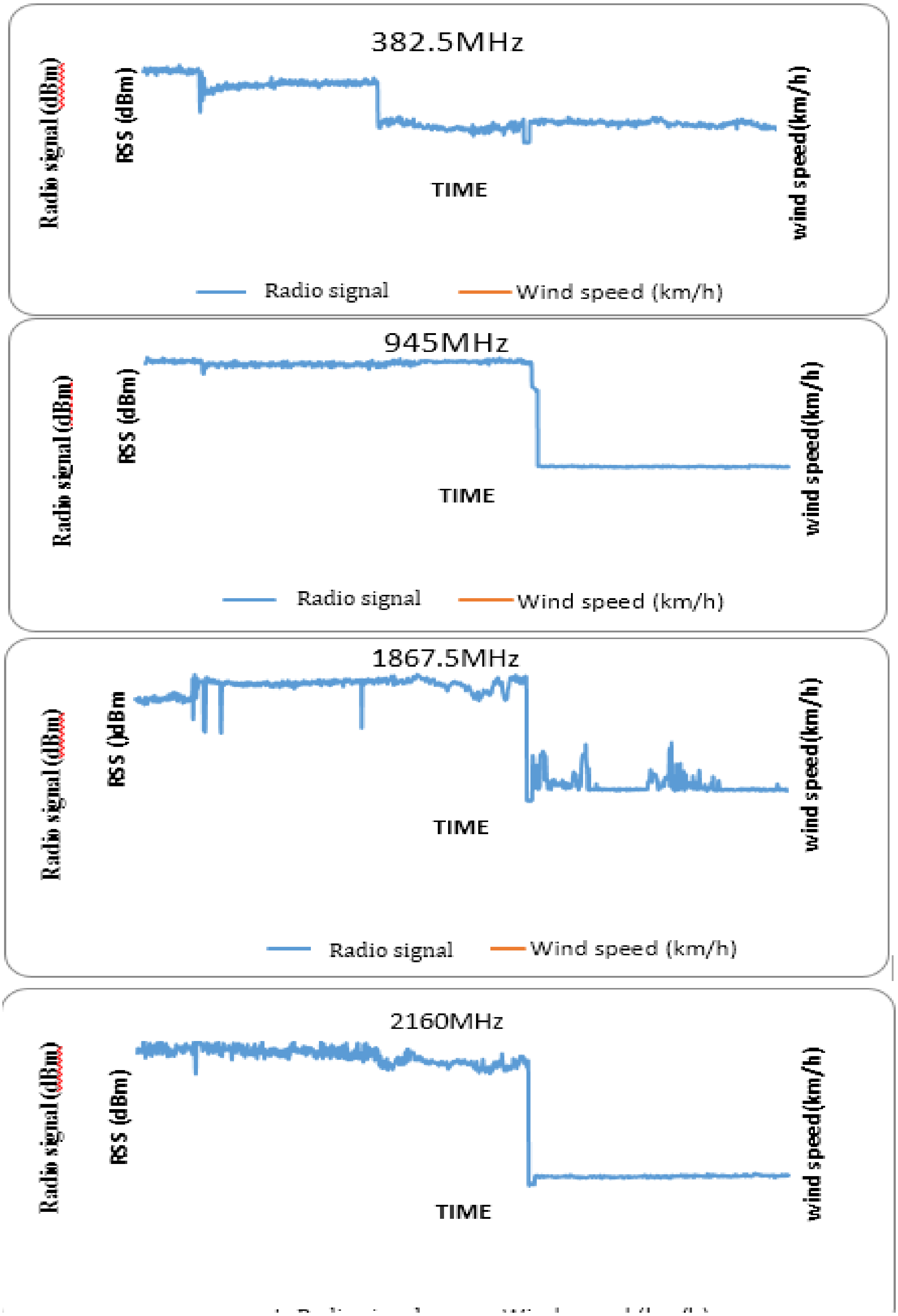

Fig.2. Graph of radio signal, wind speed versus time for 4 prominent peaks at February 2016

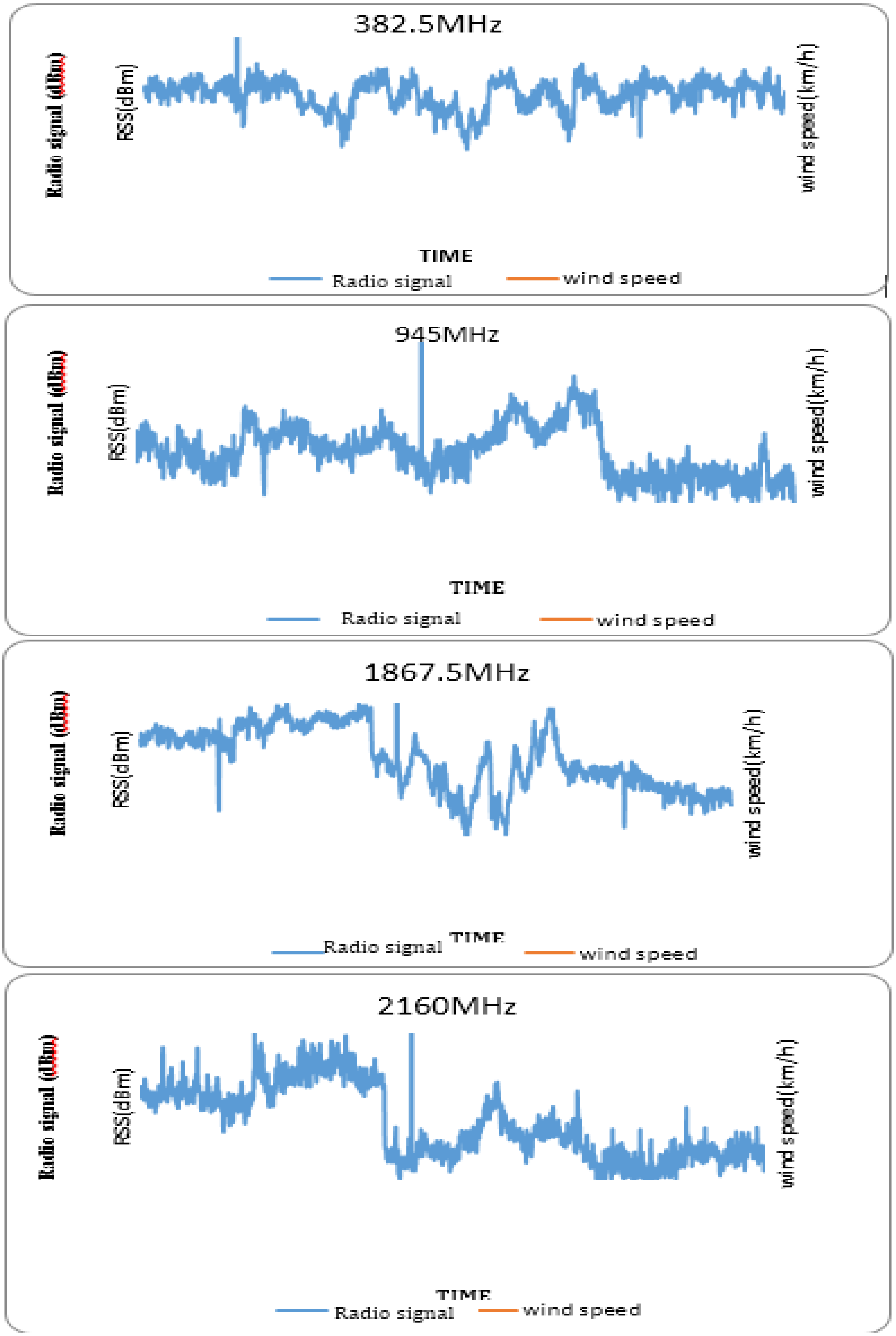

Fig.3. Graph of radio signal, wind speed versus time for 4 prominent peaks at July 2016

Table 3. The Beaufort wind force scale [15]

Beaufort Scale	Range of Wind Speed/Average (km/h)	Descriptive Term
0	1.85/0	calm
1	1.85-7.41/5.56	Light bright
2	9.26-14.81/12.96	Light breeze
3	16.67-22.22/20.37	Gentle breeze
4	24.07-29.63/27.78	Moderate breeze
5	31.48-38.89/35.18	Fresh breeze
6	40.74-48.15/44.44	Strong breeze

4. CONCLUSION

In this paper, it was concluded that wind speed indirectly attenuated radio signal by conveying high of water vapour due high of humidity. The propagation [18] of radio signal through high of water vapour causes the absorption and scattering on radio signal, resulting degradation of signal strength thus negative high correlation was acquired. In the other hand, the high of wind speed brought high raindrop due to high rain rate denoted small impact on radio signal. This is consistent to the small correlation computed.

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