# BROADBAND OBSERVATIONS OF ANOMALY IN TV BROADCASTING PROPAGATION POSSIBLY RELATED TO EARTHQUAKE

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## ABSTRACT

We observed broadband spectra in VHF band to investigate anomaly of propagation of distant TV broadcasting waves. We found that TV broadcasting waves from China, Philippines, Thai and Malaysia can sometimes propagate and there are three types of propagations. Seasonal and daily variations of received broadcasting waves were investigated through one-year observations. In this result and a simulation result, we may conclude that China TV is reflected by Es layer, and Thai, Malaysia and Philippines TV are reflected by F2 layer in the ionosphere.

## INTRODUCTION

In recent years, various electromagnetic phenomena have been reported which are possibly associated with earthquakes. The observed frequency ranges of these phenomena vary from DC to VHF (Very High Frequency) as reported and discussed in monographs [1][2]. However, the characteristics of these phenomena still have not been fully revealed yet because of the insufficient number of well-observed earthquakes.

We have observed electromagnetic waves in VHF band in Chiba prefecture, Japan since 1999. In this observation, we found anomaly of long distance propagation of TV broadcasting waves, which was possibly affected by ionospheric turbulences accompanied with earthquakes [3]. However, ionosphere turbulences are also generated under influences of solar activity, meteorological conditions, and so on. Therefore, we have to understand the behavior of the waves under the normal conditions. For this reason, we observed long distance propagation of TV broadcasting waves about 1 year. We use a LPDA (Log-Periodic Dipole Array) antenna in order to observe a wide frequency band.

## OBSERVATION SYSTEM

We have observed electromagnetic waves in VHF band at Tateyama observatory in Chiba prefecture, which locates the south end of Boso peninsula [4][5]. The observatory locates on a small hill in several kilometers away from the city area of Tateyama. A horizontally polarized 5-element Yagi antenna and a wide-band LPDA antenna was used for the observations set to the west at horizontal direction. We observed 47.5-52.5MHz band using the Yagi antenna, and 50-76MHz band using the LPDA antenna. The altitude of the position of the antennas is about 64m above the sea level. Received signal with the antenna was amplified with a pre-amplifier attached right under the antenna and transferred to an observation house by 50m-long coaxial cable. The gain of the pre-amplifier is about 25dB. A spectrum analyzer obtained the spectral characteristics of the observed signal. The analyzed data of every 20 seconds are stored on a hard disk of a personal computer.

## OBSERVATION RESULTS

Upper panel of Fig.1 shows a typical example of spectra in autumn (October 23, 2001) with the LPDA the Yagi antenna and lower panel of Fig.1 shows a typical example of spectra in summer (August 15, 2001).

In Circle A in Fig.1, fluctuation depending on frequency can be seen in daytime (8:00-20:00JST), and several spectral lines (48.25MHz, 49.75MHz, 53.75MHz and 55.25MHz) can be seen. In Circle B in Fig.1, many spectral lines can be seen. In Circle C in Fig.1, spectral lines independent on frequency can be seen.

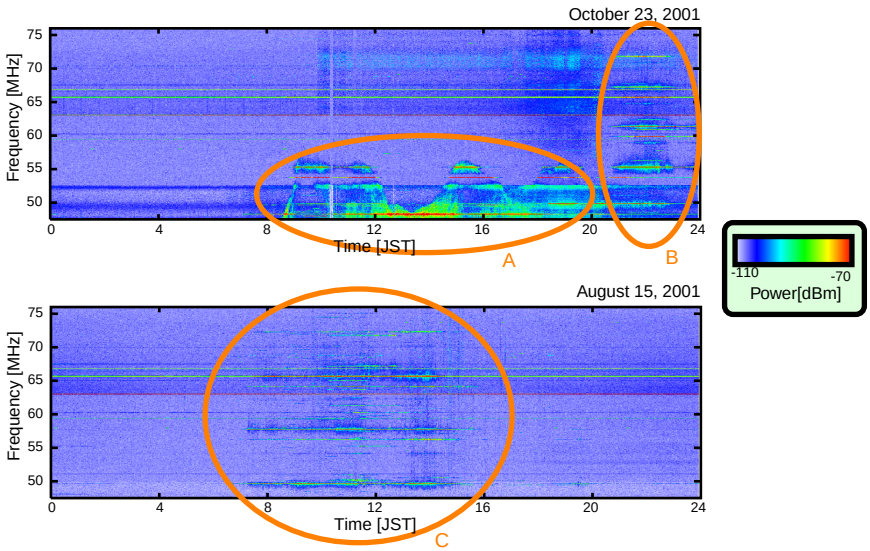


Fig.1. Typical daily spectra in spring (upper panel) and summer (lower panel)

## LONG DISTANCE TV BROADCASTING WAVES

In Japan, the band including these frequencies is allocated to Japanese army, radio ham and emergency broadcast. No domestic broadcasting station exists. Intensities of signals change with time, but each frequency is fairly stable as shown in Fig.1. Signals shown in Fig.1 seem to have side bands emission in a few MHz width. These facts suggest that these signals are TV broadcasting waves from outside of Japan and propagate occasionally with some conditions in the ionosphere.

In order to ascertain it a TV broadcasting wave, we received the signal at 49.75MHz using a worldwide TV receiver and found it is the first channel of Chinese TV broadcasting (see Table 1). We identified the frequencies from other broadcasting stations. Cut of the spectrum at 22:00 of upper panel of Fig.1 is shown in Fig.2. We can find many broadcasting stations were received. We compared these frequencies to TV broadcasting stations of surrounding countries of Japan. The identified frequencies from China, Thailand & Malaysia (CCIR) and Philippines are shown in Fig.2 and listed in Table 1.

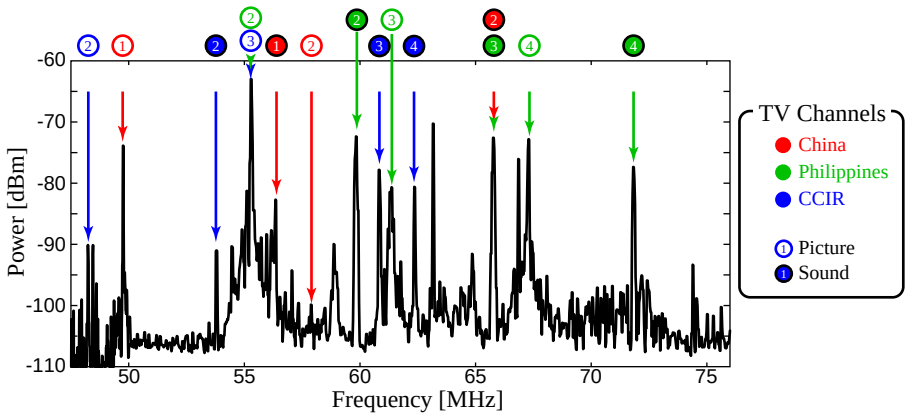


Fig.2. Received TV signal spectrogram at 22:00JST on Aug.15, 2001

Table 1. TV stations and frequencies

| China [system: CHINA] | | Philippines [system: USA] | | Thailand, Malaysia [system: C.C.I.R] | |
|---|---|---|---|---|---|
| Channel | Frequency [MHz] | Channel | Frequency [MHz] | Channel | Frequency [MHz] |
| 1 | 49.75 | 2 | 55.25 | 2 | 48.25 |
| 1 (sound) | 56.25 | 2 (sound) | 59.75 | 2 (sound) | 53.75 |
| 2 | 57.75 | 3 | 61.25 | 3 | 55.25 |
| 2 (sound) | 64.25 | 3 (sound) | 65.75 | 3 (sound) | 60.75 |
| 3 | 65.75 | 4 | 67.25 | 4 | 62.25 |
| | | 4 (sound) | 71.75 | | |

## SEASONAL AND DAILY VARIATIONS OF RECEIVED TV BROADCASTING WAVES

We observed these TV broadcasting waves from January 1 to December 31, 2001. Seasonal and daily variations of selected TV broadcasting waves are shown in Fig 3 - Fig.5.

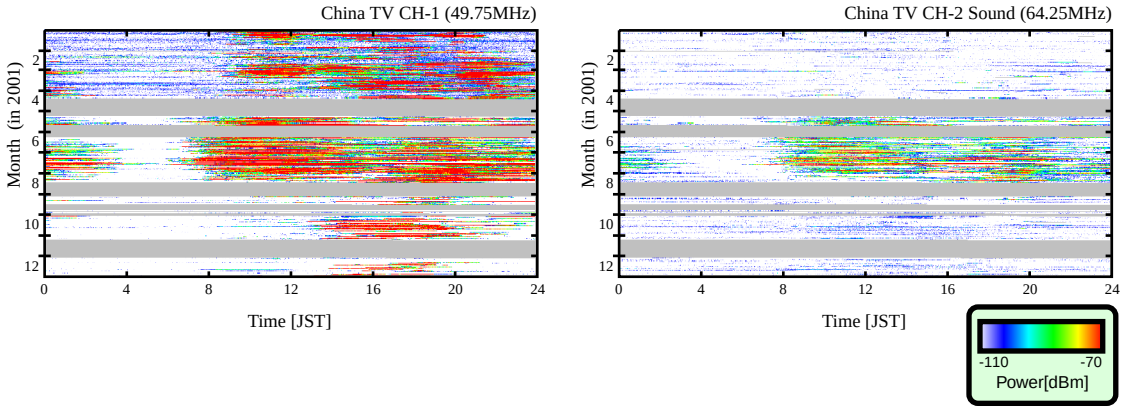


Fig.3. Variation of received TV broadcasting wave from China (49.75MHz & 64.25MHz)

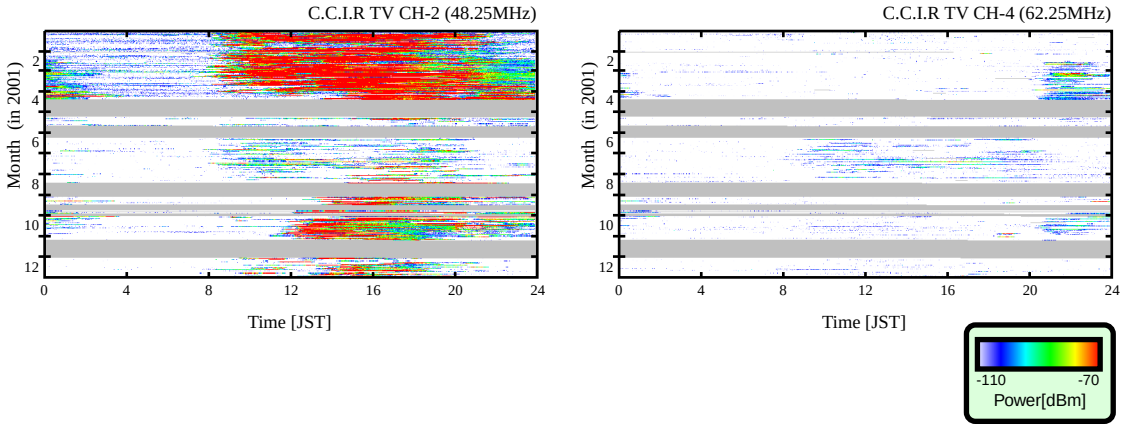


Fig.4. Variation of received TV broadcasting wave from Thai, Malaysia (CCIR) (48.25MHz & 62.25MHz)

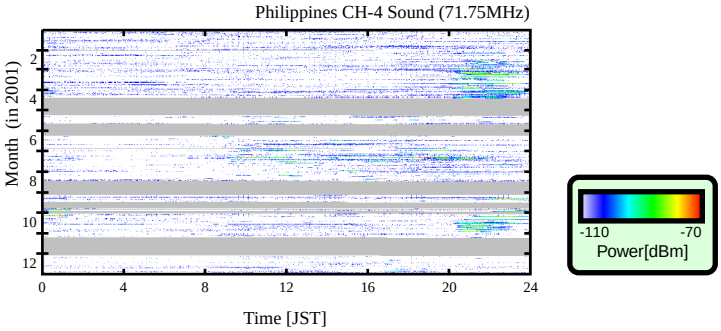


Fig.5. Variation of received TV broadcasting waves from Philippines (71.75MHz)

Type A to Type C shown in Fig.1 can be also recognized in Fig.3 to Fig.5. For example of Type C, China CH2-sound (64.25MHz) in Fig.3 spreads from 8:00JST to 20:00JST in summer. China CH1 at 49.75MHz also spreads in similar way in Fig.3. Thai & Malaysia CH4 (62.25MHz) in Fig.4 and Philippines CH4-sound (71.75MHz) in Fig.5 propagate from 20:00JST to 24:00JST in spring and autumn that corresponds to Type B. China CH1 (49.75MHz) in Fig.3 and Thai & Malaysia CH2 (48.25MHz) in Fig.4 propagate from 8:00JST to 20:00JST in spring and autumn but higher frequencies in both stations do not propagate as shown in Fig.3 and Fig.4. These are the characteristics of Type A in Fig.1. Seasonal and daily variations of received TV broadcasting waves are summarized in Table 2.

Table 2: Characteristics for each type of the long distance propagation of broadcasting waves

| Type | Season | Time [JST] | Frequency | Broadcasting Stations |
|---|---|---|---|---|
| A | Spring & Autumn | 8-20 | 48-60 | All Stations |
| B | Spring & Autumn | 20-24 | 48-72 | Thai & Malaysia, Philippines |
| C | Summer | 8-20 | 49-70 | China |

## DISCUSSION

The distance from the observation point to the Chinese, Malaysia, Philippines TV station is 800km, 5200km, 2800km, respectively. Supposing that a broadcasting wave is reflected with one-hop by the ionosphere, it calculated that the Es layer altitude is required to reflect the China-TV wave, and the F2 layer altitude is required for the Malaysia and Philippines TV waves. The profiles of electron density in ionosphere shows seasonal and daily variation. Es layer becomes active in summer and F2 layer becomes active in spring and autumn. These characteristics seem to fit for Types A, B, and C in Table 2.

We are also performing the simulation by the ray tracing method. In results, F2 layer from daytime to evening in spring and autumn refracts 50MHz electromagnetic wave. Moreover, change of the maximum frequency with time are also obtained that corresponds to characteristics of Type A propagation. These facts suggest that Type A is mainly Malaysia broadcasting wave reflected by F2 layer, and Type C in mainly Chinese broadcasting wave reflected by Es layer.

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