Videosonde and HYVIS cloud particle imaging radiosondes: Carrier frequency migration from 1680 to 400 MHz

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The Videosonde and HYVIS (Hydrometer Videosonde), which are weather-balloon-borne special instruments for observing cloud/precipitation particles, have been developed since the late 1980s to understand cloud microphysics. They are able to downlink images of cloud/precipitation particles to the ground station by using 1680 MHz band radiowaves. The Videosonde captures video images of precipitation particles in the air without contact to those particles. It sends those images to the ground station in real time and can provide information on the size and shape of those particles such as raindrops, snowflakes and graupel. It also has an induction ring to measure the electric charge of the particles. On the other hand, the HYVIS focuses on cloud particles, utilizing a method in which the images of cloud particles deposited on a clear filmstrip are taken with a microscope and sent to the ground station in real time.

The Videosonde and HYVIS have been used as a strong tool for understanding cloud microphysics. In the 2000s, with the progress of remote sensing technology such as cloud radars, and with the progress of cloud-resolving models, these instruments were started to be used also as a reference instrument.

Although the 1680 MHz carrier radiowaves used in the Videosonde and HYVIS systems have been designated as a meteorological band until now, the band is being considered worldwide to be open for other uses in the future. Therefore, the migration of the frequency to 400 MHz also needs to be considered for Videosonde and HYVIS. In the current Vidoesonde and HYVIS, the NTSC video signals of 30 fps outputted from the cameras are connected directly to the transmitter and are downlinked to the ground receiving system with 1680 MHz radiowaves. Because these video signals are analog, the received images become lower in quality as the balloon goes higher and farther. As a result, there is larger uncertainty when analyzing cloud/precipitation particles taken at a longer distance from the ground receiving system. In addition, it is not easy to utilize automatic image processing softwares to analyze the particle images because the quality of the images is unstable. To solve these issues, a digital transmission that does not cause image degradation within the data receivable range needs to be considered.

The bandwidth allowed for the 400 MHz band is 60 KHz. Experiments were conducted with various communication rates, modulation depths, and modulation methods. It was found that baudrate of 56 Kbps, deviation of 14 KHz, and modulation index of 0.5 are the upper limits that conform to the radiowave standard. Assuming that the transmission rate is 50 Kbps, 6 KBytes of data can be sent per second. A black-and-white image of 640 x 480 pixels is 50 to 100 KBytes per image, depending on complexity of the image. Considering the balance between the image quality and the image size, the optimal setting may be to compress the image to 10 KByte or less and to transmit one image every 2 seconds. Unlike analog images, digital images do not deteriorate with the transmission distance. Thus, stable image quality can be expected.

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