Severe weather phenomena such as localized heavy rainstorms in urban areas are social issues these
days. Their dimensions are small in time and space, and it is still difficult to predict when and where they
occur. Water vapor is an essential parameter for weather forecast because it is the origin of raindrops.
However, it is one of the most difficult physical quantities to measure by remote sensing.

We have developed a method to measure water vapor in horizontal direction using digital terrestrial
broadcasting waves [Kawamura et al., 2017]. Radio waves are delayed due to water vapor through
propagation. Water vapor can be estimated using propagation delay of radio waves. In this study, we
estimate water vapor near a ground surface from the horizontal propagation delay of digital terrestrial
broadcasting waves. The main features of this observation are, no need for transmitters (small and low
cost due to receiving only), applicability wherever digital terrestrial broadcasting is available, and its high
time resolution. Because the delay due to water vapor is quite small, very precise measurements (at least
several tens of picosecond order) are needed for effective observations. We have developed a real-time
delay measurement system with a software-defined radio technique, and started to deploy it around
Tokyo metropolitan area. This system can measure the propagation delay in a few ps order with the time
resolution of 1 s. If many small receivers are deployed, 2-D water vapor variations can be monitored with
high time and space resolutions. Our target is to improve the accuracy of numerical weather forecast for
severe weather phenomena such as localized heavy rainstorms in urban areas through data assimilation.

There are some standards in digital terrestrial broadcasting all over the world. In this study, we propose a
way to measure water vapor using Integrated Services Digital Broadcasting for Terrestrial Television
Broadcasting (ISDB-T) system, which is adopted in Japan. However, we believe it is possible to use any
other systems for water vapor observation if only we can derive delay profiles, which are determined as
the power of a certain broadcasting wave as a function of path delay.

In this presentation, we will introduce a method to measure water vapor using digital terrestrial
broadcasting waves, some observed results, initial results of data assimilation, and future plans.

Reference


Keywords: water vapor, propagation delay, digital terrestrial broadcasting wave