Water vapor estimation using digital terrestrial broadcasting waves - Field test in Tokyo metropolitan area and trial production of small devices -

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We have developed a method to measure water vapor in horizontal direction using digital terrestrial broadcasting waves [1]. Radio waves are delayed due to water vapor through propagation. Water vapor can be estimated using propagation delay of digital terrestrial broadcasting waves. The basic idea of using propagation delay is the same as that of retrieving PWV by using GNSS. 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. 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.
We have developed a real-time delay measurement system with a software-defined radio (SDR) technique, whose main components are USRP-N210 and PC (prototype). Seven measurement systems are now under operation around Tokyo metropolitan area. Although the main source of digital terrestrial broadcasting waves in Tokyo area is the Tokyo Skytree, some small radio towers that transmit Television Saitama, Chiba Television, Television Kanagawa, and do on can be also available. If plural radio waves from different radio towers are available, we can use plural base-lines to estimate water vapor. Outline of demonstration experiment in Tokyo metropolitan area and its initial results are introduced.
Small devices which can measure propagation delay using digital terrestrial broadcasting waves are now under trial production through a joint research by NICT and Socionext. These devices use FPGA for calculate propagation delay of digital terrestrial broadcasting waves. Their size and electricity consumption is smaller than those of prototype. If many small receivers are deployed, 2-D water vapor variations can be monitored with high time and space resolutions. Such a network system will contribute to increasing the accuracy of numerical weather forecast for severe weather phenomena such as localized heavy rainstorms.

Reference
[1] Kawamura, S., et al. (2017), Water vapor estimation using digital terrestrial broadcasting waves, *Radio Sci.*, *52*, 367-377, doi:10.1002/2016RS006191.

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