



Development of novel ground-based microwave radiometer for earth science

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We have started to develop a next-generation microwave radiometer to be used in millimeter-wave spectroscopy for the high-resolution and high-precision monitoring of water vapor behavior. The new radiometer will be suitable for not only space geodetic techniques such as Very Long Baseline Interferometry (VLBI) and Global Navigation Satellite Systems (GNSS), but also field measurements such as monitoring volcanic activities and cumulonimbus cloud generation. The basic design concept of the new radiometer follows the previous version named KUMODES (KEK Universal Moisture and Oxygen Detection System) developed by the High Energy Accelerator Research Organization (KEK). The KUMODES can measure spectra using two receivers with frequency bands of 20–30 GHz and 50–60 GHz. The low-noise amplifier (LNA) of the first KUMODES receiver and a cold calibration source are implemented in a cryostat, which is maintained at 10 K to improve the sensitivity of detecting the characteristic broad peak of water vapor at approximately 22 GHz. The second receiver is used to measure the absorption peaks of oxygen (60 GHz). We have carried out comparative measurements of precipitable water vapor (PWV) to investigate the potential of KUMODES/PWV measurements. The preliminary results of PWV comparisons imply that KUMODES technology will be useful for retrieving the accurate behavior of water vapor with high temporal resolution. We will implement a wide bandwidth feed of 20–60 GHz into the new system on the basis of a previous comparison study. A signal is separated into two linear orthogonal polarized signals from the feed, one is in the 20–30 GHz feed and the other in the 50–60 GHz feed, using an orthomode transducer (OMT). The wideband feed, OMT, and the LNA for each signal are cooled at 77 K using a Stirling cryocooler to improve signal-to-noise ratio. The development of a new front-end module will be completed at the end of 2019, and we are planning to implement the module in an existing dish antenna to perform validation measurements.