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Evaluation of radiosonde humidity sensors at low temperature using low-temperature humidity chamber

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Accurate measurements of temperature and water vapour in the upper-air are of great interest in relation to weather prediction and climate change. Those measurement is mostly conducted using radiosondes equipped with a variety of sensors that are flown by a balloon up to lower stratosphere ($\sim$ 35 km) and transmit sensing signals to the ground. Reference Upper Air Network (GRUAN) has identified water vapour pressure as one of the most important measurands and has set an accuracy requirement of 2% in terms of the mixing ratio. However, there are many errors in the humidity measurement due to the temperature dependence of sensitivity characteristic, long response time, freezing and so on, since the humidity sensors of radiosonde pass through low-pressure(10 hPa) and low-temperature(-80 oC) environment in the upper-air. According to the results of the 8th Radiosonde International Comparison conducted by WMO, the difference in the humidity measurement values of each manufacturer were as much as 24 %rh.
In this paper, the sensitivity characteristic and response time of radiosonde humidity sensors were investigated at low temperature, using developed low-temperature humidity chamber which is based on two-pressure humidity generator. This chamber can provide calibrations for radiosondes with 2% uncertainty and traceability to SI units. The sensitivity of the radiosonde sensors was measured up to -80 °C, and it was confirmed that the temperature dependency of humidity characteristics was more than 15 %rh. Based on this, calibration curves of the humidity sensor and the temperature sensor were obtained. The response time of humidity sensor from room temperature to -40 ° C slowly increased from 52 sec to 116 sec, and then rapidly increased to almost one hour at -80 °C. Since the practical radiosonde is measured while flying at an average speed of 5 m/sec, the information on the response time is very important information for the correction of the measurement data. Evaluation of the radiosonded sensors on the ground by low-temperature humidity chambers will improve the accuracy and reliability of the upper-air observation data.