관측 및 예보 분과 [P-255]

Error Budgets of Radiosonde Measurements and Implications for Weather Observations

Reno Kyu-Young Choi

Observation Research Division, National Institute of Meteorological Sciences, KMA

Radiosondes are indispensable for global weather and climate monitoring, yet the accuracy of their observations is shaped by multiple interacting sensor systems. This study presents a multidisciplinary assessment of radiosonde error budgets, highlighting that uncertainties cannot be attributed to individual sensors alone. Temperature sensor performance was evaluated using the Upper-Air Simulator, cyclic chamber experiments, and thermal bath tests. These revealed baseline uncertainties from sensor physics, including hysteresis, drift, and response time degradation at low pressure. However, analysis with a GPS signal simulator demonstrated that altitude uncertainties of only a few meters propagate into additional temperature errors, particularly in the upper troposphere and lower stratosphere, underscoring that temperature accuracy is coupled to GPS performance. Similarly, humidity sensor accuracy was found to depend not only on sensor behavior but also on simultaneous temperature measurements, since relative humidity is intrinsically derived from both variables. Environmental challenges such as icing further complicate the error structure by introducing time lags and recovery biases. These results show that radiosonde data quality cannot be judged from a single sensor in isolation. Instead, temperature, humidity, and GPS errors interact to form an integrated error budget that determines the effective reliability of upper-air observations. Recognizing these multidisciplinary links is essential for designing correction strategies, improving data assimilation, and ensuring that radiosonde observations continue to provide robust inputs for numerical weather prediction and climate monitoring.

Keywords: Radiosonde characterisation, Error budget, In Situ temperature and humidity measurements, GPS altitude accuracy

※ This work was supported by the National Institute of Meteorological Sciences (KMA2018-00221).