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GCOS Reference Upper Air Network (GRUAN): The case for better observations of atmospheric humidity

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The need for better observations of atmospheric humidity and water vapor content for climate applications has been demonstrated in many studies. Here we make a case that reference-quality observations of upper air humidity from the GRUAN stations can greatly help improve the humidity records from regular radiosonde observations around the world, leading to much improved humidity data for use in future atmospheric reanlayses and trend analyses. We first demonstrate that existing radiosonde humidity records from weather stations contain many large discontinuities resulting from instrumental and observational changes. Although statistical methods can help detect and remove most of the major discontinuities, they cannot remove any systematic biases in the data of the reference period that are used to adjust the whole series. Reliable observations of atmospheric humidity at select locations can be very helpful in quantifying the systematic biases associated with modern humidity sensors. This bias information can then be used to help create a bias-free reference segment at other radiosonde stations for use in the statistical adjustments to the earlier part of the records. In addition, a reliable reference record of upper air humidity can be used to evaluate the performance of the statistical methods in terms of their ability to detect breakpoints and homogenize historical radiosonde records. Other applications of a reference humidity record include calibrating satellite observations and quantifying long-term changes in atmospheric humidity and water vapor content.