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Site characterization for ground-based CMB observations with a 183GHz radiometer

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The cosmic microwave background (CMB) is a rich source of information about the cosmos. Over the past ten years, gains in experimental sensitivity have enabled ground-based instruments to begin the search for B-mode polarization in the CMB as a test of the inflationary paradigm. However, the atmosphere is not fully transparent in the 35-270GHz region targeted by these observations. Poorly-mixed and rapidly-varying water vapor in the atmosphere presents a challenging source of sky noise for CMB telescopes. Ground-based experiments minimize atmospheric perturbations by selecting dry, high-altitude sites where the amount of precipitable water vapor (PWV) in the atmosphere is as low and as stable as possible. The leading sites in use for present experiments are the South Pole and Chajnantor Plateau, Chile. The next-generation CMB-S4 experiment will make use of these two locations but is also turning an eye to potential sites in the northern hemisphere with the goal of increasing the observed sky fraction.

To better understand the effects of PWV on current and future CMB experiments, we have undertaken the first coordinated measurement of atmospheric water vapor fluctuations with high time resolution over long time scales at sites around the world. We use the Dicke-switched 183GHz water vapor radiometer (WVR) initially commissioned for the Atacama Large Millimeter/submillimeter Array (ALMA) and built by Omnisys Instruments AB, with the addition of custom azimuth/elevation scanning optics and a temperature-controlled environmental enclosure. Two identical units are currently deployed at the South Pole and Summit Station, Greenland. We report here on the performance and measurements from these WVRs, and we discuss how these atmospheric measurements might drive site selection and design choices for future telescopes.

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