Atmospheric phase correction for ALMA with water-vapour radiometers

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Abstract

Phase fluctuations due to the irregularities in the troposphere impede sub-mm interferometric observations by reducing the time available for observations to stable-weather conditions and restricting the maximum usable baseline length in even the best conditions. To reach its goals of resolution as fine as 5 milli-arcseconds and a high operating efficiency, ALMA will need to effectively correct these phase fluctuations. In this talk I will review ALMA's strategy, which consists of periodic switching to nearby calibrators ('fast-switching') combined with measurements from 183 GHz Water Vapour Radiometers (WVRs). It is anticipated that in normal operation periodic switching will remove phase errors on time scales of about 100 seconds and longer while measurements from the WVRs will be used to correct the residual phase fluctuations down to the one second time-scale, which is characteristic cutoff time-scale defined by the antenna diameter and typical wind speeds at the site.

The accuracy of WVR phase correction depends on the noise performance of the radiometers and on the accuracy with which we can estimate coefficients that convert the fluctuations in WVR outputs into antenna phase correction factors. I will present the progress on the development of Bayesian algorithms to estimate these coefficients. These algorithms can optimally incorporate available information about weather conditions (such as ground pressure, temperature, humidity and wind speed) while marginalising over parameters that we have few constraints on (such as the height of the turbulent layer, temperature lapse rate, and the total water vapour content of the atmosphere). A promising refinement of these algorithms is to make of use of the *observed* correlations between outputs of the radiometers and the antenna based phase errors (derived through short observations of quasars) as a further input to the Bayesian models.

I will also present simulations that model the performance of individual radiometers and the overall ALMA phase correction strategy.