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THE IMPACT OF THE ALTIPLANIC WINTER ON ALMA'S OBSERVING CONDITIONS AT LLANO DE CHAJNANTOR

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Using the available NRAO's site characterization data, we study the observing conditions (PWV and Phase Stability) at Llano de Chajnantor during the "Altiplanic Winter" and their impact on ALMA scientific operations. The results suggest that during this period ALMA observations will be limited to lower frequency bands and compact array configurations. In terms of only the PWV, observations are possible until Band 6 ($\sim$230 GHz) the 70% of the time. Phase stability conditions suggest that atmospheric phase correction is strictly necessary during this period, allowing us to observe in the compact configurations at Band 3 ($\sim$100 GHz) about 55% of the time.

In the summer season, the water vapor content increases as the result of the South American Monsoon System (Bustos 2005). During this period occurs the "Altiplanic Winter", characterized by intense rainstorms in the Altiplano region. At Llano de Chajnantor, high PWV events are present. These events have being defined (Bustos 2005) as the periods where the daily average is greater than 5.9 mm. The PWV daily average for event days is 7.5 mm, which constrast with the PWV daily average for "no event" days which is 2.84 mm. During these events is when we expect to get the worsest conditions for ALMA Observations.

In order to investigate the impact of the "Altiplanic Winter" in ALMA observing conditions, we analyzed the weather data (opacity, temperature, wind speed and wind direction) from the NRAO's site characterization[3] since 1995 to 2004. The phase stability data from NRAOs 300 m baseline phase monitor[4] was provided by Simon Radford.

Based on the temporal distribution of the "Altiplanic Winter" events, we found that the worst conditions occurs between February 1st and March 15th (days 30–75 UT). In order to assess the reliability of using the different ALMA bands and the weather conditions, we calculated the cummulative distribution functions (CDFs) for opacity (PWV), temperature and wind speed.

In the case of the phase stability data, the phase rms data was scaled from 11.198 GHz to 100 GHz, corrected to the zenith, and computed for baselines of 100 m, 300 m, and 1000 m. We calculated the uncorrected phase rms limits ($\Phi_{\rm rms}(R)$) for the cases of coherence $R = 0.95$, $R = 0.97$, and $R = 0.99$. We compared CDFs for the uncorrected phase rms with these limits in order to assess if the weather conditions will allow ALMA to meet the expected calibration requirements.

The results in terms of the opacity (PWV) shows highly variable conditions with periods where within one hour the PWV goes from 2 mm to 6 mm. The PWV median is 3.35 mm worse than the annual median of 1.2 mm. Band 7 weather (345 GHz; PWV $<$ 2 mm) is present about a 30% of the time, but with little continuity ($\sim$30 min), making high frequency project hard to schedule. On the other hand, low frequency projects (40 GHz–90 GHz) can be used on any time excepting storms, this is about a 70% of the time.

Phase stability conditions shows that without atmospheric phase correction (Fast switching, Holdaway & D'Addario 2004; WVR Correction, Hills et al. 2005; Nikolic et al. 2008), we only can observe a 20% of the time in compact configurations (baselines $\sim$100 m). Thus, atmospheric phase correction is necessary in order to observe during the Altiplanic winter. If this is the case, Band 3 (100 GHz) observations will be possible a 55% of the time, and Band 6 (230 GHz) about 12%. Higher frequency bands requires excellent conditions, so observations should be limited to lower frequency bands.

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[3]`http://alma.nrao.edu/development/site/Chajnantor/data.c.html`.

[4]`http://www.submm.caltech.edu/~sradford/site-eval/phimon.html`.

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