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RADIOMETER DEVELOPMENT AT UDEC AND PWV DATA AT CHAJNANTOR

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The Radioastronomy Laboratory of the Department of Astronomy at U. de Concepción has two projects involving radiometers: (a) the development of low cost radiometers with digital backends for water vapor and oxygen lines at 22 GHz and 50–60 GHz respectively, and (b) the refurbishment of two ALMA testbed 183 GHz radiometers. Both 183 GHz radiometers are now installed in the Chajnantor area taking PWV measurements. We also plan to develop long-term studies of PWV with these instruments to validate 60 years of data from NCEP/NCAR reanalysis data for the Chajnantor area.

With the development of new technologies, a new affordable oxygen radiometer is being built at the Radioastronomy Laboratory at U. de Concepción. An integrated receiver at 55–60 GHz including horn, tunable oscillator, mixer, and amplifiers from Vubiq is used as a front-end for measuring the oxygen lines. An ADC converter connected to a ROACH board with a Xilinx Virtex 5 FPGA from CASPER is used as a back-end to obtain a digital spectrum of the oxygen bands in 1 GHz slices and thus derive the temperature profile of the atmosphere. An add-on front-end has been designed for a 18–31 GHz receiver to measure the water vapor line at 22 GHz and liquid water feature near 29 GHz.

Both radiometers are currently under construction and testing of these instruments are expected in the near future. The main advantage of these new devices is the achievement of reasonable sensitivities at a low cost.

As a second project, we have completed the refurbishment of two ALMA testbed 183 GHz radiometers; these are now being calibrated at Chajnantor. These two radiometers took PWV measurements in Chajnantor from 1998 to 2002. After a loan from ALMA, they were moved to the laboratory at U. de Concepción where we completely replaced the data acquisition system, the motors and motor control for the main mirror, and implemented new software for observing control and communication. The first of these radiometers was installed at the QUIET site (5000 m) in Chajnantor in April 2010 and was calibrated with the APEX (5000 m) radiometer. After a successful calibration campaign, it was moved to the ACT site in Cerro Toco (5200 m) in December 2010 to take PWV measurements.

The second radiometer was installed at the APEX telescope site in January 2011 for calibration. It will be moved to the CCAT site at the top of Cerro Chajnantor (5600 m) after the calibration campaign.

The combination of data from these radiometers will enable: (a) estimation of the PWV profile from three sites at three different altitudes (5 000 m, 5200 m, and 5600 m); (b) quantification of the sky quality for sub-millimeter Radio-Astronomy and the improvement of installing telescopes at the top of Cerro Chajnantor compared to the Llano de Chajnantor and Cerro Toco; (c) site characterization for the CCAT telescope and other instruments planned for the top of Cerro Chajnantor; (d) calibration of CMB data for the ACT telescope; (e) determination of the strength and variations of the inversion layer capping the Llano de Chajnantor; (f) long-term studies using NCEP/NCAR reanalysis data.

For long-term studies, it will be possible to validate PWV data from NCEP/NCAR reanalysis for the Chajnantor area using these refurbished radiometers. Reanalysis data provide useful information for long-term variations and cycles of PWV over 60 years. In particular, in Bustos et al. (2000) it is shown that winter months (May to October) are correlated with El Niño (ENSO) events while summer months, where severe snow storms occur from the so-called Invierno Boliviano (Bustos 2001), has no correlation with ENSO. Understanding these cycles are important to characterize and to forecast intense or moderate summers and to plan accordingly for the projects installed in the Chajnantor area.

REFERENCES

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