DETERMINATION OF SUBMILLIMETER ATMOSPHERIC OPACITY AT EL LEONCITO, ARGENTINA ANDES

Arline M. Melo[1], C G. Giménez. de Castro[2], Pierre Kaufmann[3], Hugo Levato[4], Adolfo Marún[5], Pablo Pereyra[6], Jean-Pierre Raulin[7]

[1] Graduate student at CCS – Unicamp, Campinas SP, Brazil and CRAAM – UniversidadePresbiteriana Mackenzie, São Paulo, SP, Brazil; E-mail: arline@craam.mackenzie.br

[2] CRAAM - Universidade Presbiteriana Mackenzie, São Paulo, SP, Brazil; E-mail: guigue@craam.mackenzie.br

[3] CRAAM - Universidade Presbiteriana Mackenzie, São Paulo, SP, Brazil and part-time researcher at CCS – Unicamp, Campinas, SP, Brazil; E-mail: kaufmann@craam.mackenzie.br

[4] CASLEO – Complejo Astronómico El Leoncito, San Juan, Argentina; E-mail: hlevato@casleo.gov.ar

[5]As (4) above; E-mail: amarun@casleo.gov.ar

[6]As (4) above; E-mail: pereyra@casleo.gov.ar

[7]As (2) above; E-mail: raulin@craam.mackenzie.br

ABSTRACT

We present submillimeter wave atmospheric opacity determinations obtained at 212 GHz and 405 GHz for the site of El Leoncito, San Juan, Argentina Andes, using the Solar Submillimeter wave Telescope (SST) located at an altitude of 2550 meters. The use of SST allowed the use and comparison of different methods of atmospheric transmission determinations: (a) directly derived from solar signal attenuation with elevation angle; and (b) indirect derivation from the sky brightness temperature variation with the elevation angle. Zenith opacities for 5 months in 2001 indicated most probable values of 0.18 nepers (212 GHz) and 0.9 nepers (405GHz).

SUMMARY

We present submillimeter wave atmospheric opacity determinations obtained at 212 GHz and 405 GHz for the site of El Leoncito, Argentina Andes, using the recently installed Solar Submillimeter wave Telescope (SST). The El Leoncito Astronomical Complex (CASLEO) is located in an extense and dry reservation in Argentina, Province of San Juan, where nearly 300 clear days are available for observations. The SST has been installed in April 1999 near the existing CASLEO facilities, at an altitude of 2550 meters While SST was undergoing tests, integration and optimization works, solar and sky observations started in short 1-2 weeks campaigns in 1999 and 2000. Nearly regular daily observations began in April 2001. The use of SST allowed the use and comparison of different methods of atmospheric transmission determinations: (a) the absolute method, for which the attenuation is directly derived from solar signal attenuation with elevation angle; and (b) the indirect derivation of opacity from the sky brightness temperature variation with the elevation angle, also called the tipping method. A third and very practical method (c) has been introduced, allowing the opacity determination from the solar observed antenna temperature at any elevation angle, adopting a parameter defined as the product of the solar brightness temperature times the beam efficiency. The first absolute method (a) is very accurate, and independent from any assumption on solar or sky brightness temperatures. However it presents two limitations: i. observations need to be done at low successive solar elevation angles, because at high angles the differences in antenna temperatures become too small for precise measurements; ii. for large attenuation conditions, the observed solar antenna temperatures might become too small to be well measured at low elevation angles, adding errors in the determinations. The second tipping method (b) is normally used when the aperture is too small to detect any signal external from the atmosphere or when using large reflectors, which cannot be pointed to the Sun. This method, however, have uncertainties because the sky temperature measured as a function of elevation angle may contain parasitic contributions not well known, especially from spillover and undesired ground contributions and reflections. The third method (c) depends on two magnitudes that are not well determined or measured: the solar brightness temperatures T_{sun} at the two submm-w frequencies and the beam efficiencies, $?_{eff}$. However, the product of these two magnitudes, $T_{eff} = ?_{eff} \times T_{sun}$, which correspond to the effective observed solar temperature outside the atmosphere, is well determined using the absolute method (a) for days with atmospheric opacity (in nepers). With the value of $_{Teff}$ well determined, the atmosphere opacity can be easily determined at any elevation angle. This method becomes useful for nighttime determinations using the Moon. The first submillimeter wave atmospheric opacity measurements at El Leoncito have been done using the absolute method (a) and the tipping method (b). For the 5 months of daily data obtained in 2001, the two methods have provided similar qualitative results, with more pronounced dispersion of data obtained with the tipping method. The first test results using the third method (c) are given and discussed. The distributions of optical depths (in nepers), derived from the absolute method in that period, present maxima at 0.18, for 212 GHz, and 0.8 for 405 GHz, which are the most typical values found. There is an indication that the mean ratio of optical depths measured at 405 GHz and 212 GHz is smaller compared to ratios obtained at other sites, which explain why the 405 GHz opacities comparable to values expected at higher altitudes. The excellent submillimeter waves opacities obtained for El Leoncito at a relatively low altitude (2550 m), might be connected to a net reduction in the total water vapor content in the micro-climate typical to the region between the two mountain ranges of the Andes: the pre Cordillera in the east and the main Cordillera at the west.

This research is partially supported by agencies FAPESP and CNPq (Brazil) and CONICET (Argentina).