RevMexAA (Serie de Conferencias), **19**, 75–80 (2003)

TWENTY YEARS OF WEATHER AND OBSERVING STATISTICS IN SAN PEDRO MÁRTIR, BAJA CALIFORNIA, MEXICO

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RESUMEN

Se presenta una nueva compilación de los datos estadísticos acerca del uso por los pasados 20 años del telescopio de 2.1m del Observatorio Astronómico Nacional en San Pedro Mártir, Baja California, México, con especial énfasis en los aspectos climáticos básicos como la fracción de noches total y parcialmente despejadas y las mayormente nubladas. La fracción de noches perdidas debido a mal clima fue de 22.2% en el periodo julio 1982 a diciembre de 2002. De enero 1984 a diciembre 2002, el 63.1% de las noches fueron "fotométricas" mientras que el 80.8% de las noches fueron "espectroscópicas". Durante los últimos siete años de "sequía" en la zona, la fracción de noches de calidad fotométrica subió al 73.5% aunque la fracción de noches espectroscópicas no cambió sustancialmente respecto a años anteriores. Estas cifras son similares a las reportadas para los observatorios en Chile y mejores que cualquiera de los del hemisferio norte.

ABSTRACT

Statistics are presented covering 20 years of use of the 2.1m telescope of the Observatorio Astronómico Nacional at San Pedro Mártir, Baja California, Mexico. As in the previous compilation, the fractional number of nights with totally clear, partially clear and mostly cloudy skies were determined. The fraction of nights lost due to bad weather was 22.2% in the period July 1982 to December 2002. From January 1984 to December 2002, 63.1% of the nights were of "photometric" quality and 80.8% were of "spectroscopic" quality. During the past seven years of "drought" in the area, the fraction of photometric quality nights increased to 73.5%, but the fraction of spectroscopic nights remained similar to previous years. The figures are similar to those reported for the Chilean sites and are better than those for Northern Hemisphere observatories.

Key Words: **SITE TESTING**

1. INTRODUCTION

The Observatorio Astronómico Nacional de México at San Pedro Mártir is located 31°02′39″ N and 115°27′49″ W, some 100 km east of the Baja Californian West Coast. It has three Ritchie-Chrétien telescopes of diameters 0.84 m, 1.5 m and 2.1 m in operation. The latter

started continuous operation in 1981. It is expected that in the near future, the Mexican astronomical community engages in the construction and operation of a larger (4 to 8 meter class) telescope to be located at San Pedro Mártir. This

site is also being evaluated as a candidate for locating other international large telescope projects.

Since the construction of the observatory, several studies of the climatological properties of this site have been reported. Most of those made made during the first years of operation of the observatory (Mendoza 1971, 1973; Mendoza et al. 1972; Walker 1971, 1983; Westphal 1974; Alvarez 1982, 1984 and Alvarez and Maisterrena 1977) are based on data covering short periods. The most recent site studies are the subject of these *Proceedings*.

The present work refers mainly to the nocturnal cloud cover that is the prime factor affecting optical and infrared ground-based observations. It describes the data gathered in a consistent manner during the last twenty years of operation of the 2.1 m telescope concerning mainly the cloud cover and observing statistics for this telescope. The data covers the period 1 July 1982 to 31 December 2002 (7489 calendar nights). The results described in this paper constitute a natural extension of those presented ten years ago by Tapia (1992). For consistency, all definitions and methodology are identical to those used for that study. The data were compiled from the observing log that is filed at the end of each night by the 2.1 m telescope night assistants. Weather data were not recorded only during most of the major engineering runs and some non-scheduled nights, most of which occurred during the first five years of the study period.

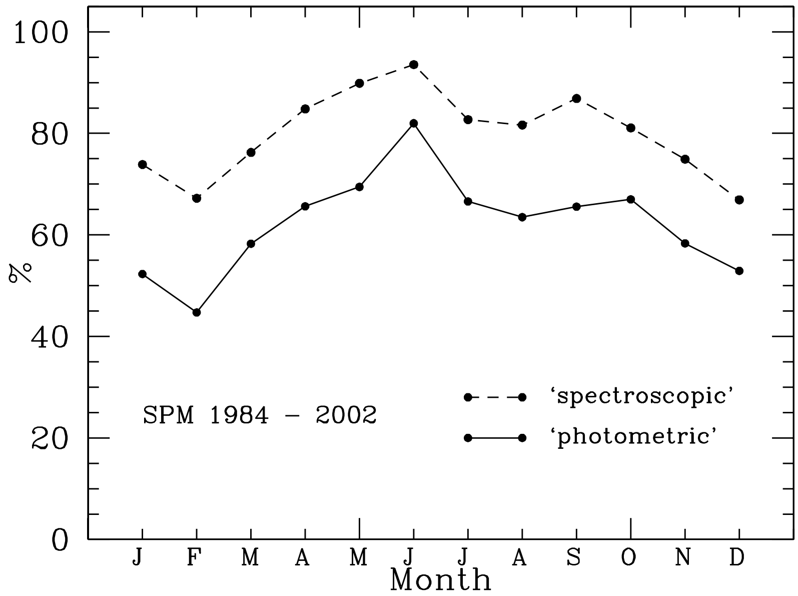

Fig. 1. Monthly fraction of nights of photometric and spectroscopic quality in San Pedro Mártir during the period January 1983 to December 2002.

TABLE 1

SPM 2.1 M TELESCOPE OBSERVING STATISTICS: JULY 1982 TO DECEMBER 2002

	Number of nights	% over total number of calendar nights	% over number of scheduled nights
Total calendar	7489	100.0	–
Engineering	496	6.6	–
Scheduled for observation	5645	75.4	100.0
Observed	3996	53.4	70.8
Lost due to weather	1255	–	22.2
Lost due to telescope/dome/guider failure	121	–	2.1
Lost due to instrument failure	189	–	3.3
Lost due to other circumstances	87	–	1.5
Not scheduled	1349	18.0	–

The basic units for the statistics were *half nights*, meaning a period of five hours during the night. *Photometric* sky was defined when the percentage of cloud cover was less or equal to around 15%. In the great majority of the cases, if clouds were present, they were reported seen near the horizon or present anywhere in the sky for no more than thirty minutes in a five hour period. It was considered *Spectroscopic* when the percentage of cloud cover was less than 65%; this applied either to the percentage of the sky covered by clouds or to the percentage of time with the sky covered. Finally, the time *observed* is when actual observations took place, meaning that they were not impeded by bad weather (including high winds, very high humidity and very bad seeing) or other causes (including telescope or instrument failure). Obviously, the nature of the observational project and technique dictated the minimum acceptable sky conditions each night.

2. RESULTS

The twenty-year observing statistics for the 2.1m telescope is given in Table 1. All entries are self explanatory. Table 2 gives the mean monthly percentage of photometric and spectroscopic nights compiled for all months of the January 1984 to December 2002 period. The yearly fractions are given in Ta-

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TABLE 2

PERCENTAGE OF PHOTOMETRIC AND SPECTROSCOPIC NIGHTS: JANUARY 1984 TO DECEMBER 2002

Month	% over scheduled nights	
	photometric	spectroscopic
January	52.3	73.8
February	44.7	67.2
March	58.3	76.2
April	65.6	84.8
May	69.4	89.9
June	82.0	93.5
July	66.6	82.7
August	63.5	81.6
September	65.6	86.9
October	67.0	81.1
November	58.3	74.9
December	52.9	66.9
Total	63.1	80.8

ble 3. Previous to January 1984, no report of the percentage of clouds is available, only the fraction of nights lost due to bad weather. The data of both tables are plotted in Figs. 1 and 2. In the latter, the fraction of nights actually used for observation (from July 1982 to December 2002) is also shown.

Along with a sustained increase in the quality and reliability of the instrumentation used at the observatory (a human achievement) the fraction of clear nights over San Pedro Mártir (a natural phenomenon) has gone up considerably in the last seven years. The fraction of photometric-quality nights in the 1984 to 1993 period was 57.6% (57.2% for 1984 to 1995). In 1996, it suddenly increased to more than 70% and has remained relatively constant till the end of 2002, while at the same time the fraction of spectroscopic nights has not shown a significant change since the beginning of the present survey (see Fig. 2).

In order to probe a human factor that could have resulted in the above discontinuity, I revised all possible human causes with negative results. No changes occurred in the methodology or criteria for

filling the observing log sheets, nor were there changes in the telescope operator personnel. Since 1982, the extraction and compilation

of the information has been carefully done by myself. Statistically, the data appear self-consistent. The seasonal distribution of clear and useable nights remained similar throughout the survey, as shown in Fig. 3.

TABLE 3

PERCENTAGE OF PHOTOMETRIC AND SPECTROSCOPIC NIGHTS: JANUARY 1984 TO DECEMBER 2002

Year	% over scheduled nights	
	photometric	spectroscopic
1984	63.8	86.2
1985	59.9	81.8
1986	57.3	79.7
1987	56.0	77.8
1988	67.7	80.2
1989	53.6	79.8
1990	48.1	79.0
1991	54.9	77.6
1992	51.2	78.9
1993	54.4	74.9
1994	61.6	76.0
1995	52.9	78.1
1996	78.9	85.2
1997	72.3	89.8
1998	71.2	80.9
1999	73.2	86.6
2000	70.1	80.6
2001	76.9	85.9
2002	79.9	86.6

As the fraction of spectroscopic nights remained constant, the observed effect appears to be caused by a lower number of nights with thin cirrus

or with short periods of local cloud forming. I could not find other known large scale effects (such as "el niño") to climatically explain the higher frequency of clear nights in the last seven year period of observations. It is well known that the southwestern California and Northwestern Mexico region is suffering from a drought that started in 1995, with a single spell of heavy rain in the January to March months of 1996. The raining season

occurs in winter and is primarily caused by southern tails of North Pacific winter storms reaching Southern California and Northern Baja California. This explains also the low percentage of clear and useable nights in winter. Fig. 4 shows the total amount of winter (September to April) precipitation recorded in San Diego, California, from 1976 to 2002. The mean of that 27-year distribution coincides with the mean of the 150-year period of the climatic archive, (10.2 ± 4.2 inches; dashed line in Fig. 4). Six of the last seven years have had a very low amount of precipitation for the region. In fact, the total precipitation during the 2001-2002 winter

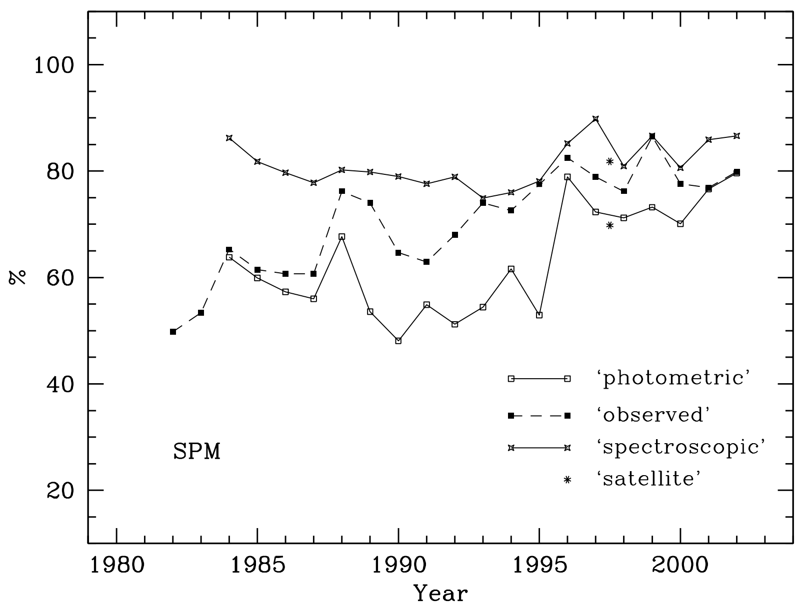

Fig. 2. Yearly fraction of nights of photometric and spectroscopic quality in San Pedro Mártir during the period January 1984 - December 2002. Also shown is the actual use of the 2.1m telescope from July 1982 to December 2002. The asterisks refer to the mean satellite June 1997 - May 1998 measurements by Erasmus and van Staden (2002).

was the lowest recorded since 1884-1885. I ignore the causes of this apparent correlation between lack of winter storms and large amount of year-round cloudless nights. Interestingly, during the 2002-2003 winter, the total precipitation was above the mean value.

Erasmus and Sarazin (2002) described a new method, based on satellite data, of determining an objective assessment of the transparency of the atmosphere (cloud cover and also water content determination) above existing and potential observatory sites. They combined two infrared band satellite imaging (6.7 μm and 10.7 μm) with a spatial resolution of 4 to 8 km and a fraction of a day time resolution for determining the opacity and water content of the atmosphere over a pre-selected site.

The above method was applied for San Pedro Mártir and other existing and potential observatories in North America by Erasmus and van Staden (2002) in a study conducted for the CELT project. In particular, a direct comparison of the satellite results with the present ones was made. Partial "ground-based" data from this work (provided by me) were compared with simultaneous data from their satellite survey by Erasmus and van Staden (2002). For the June 1997 to May 1998 study period, it was found that, except for a single month, the monthly results from both studies agreed within 5%. For the mean yearly fractions, the discrepancies were lower than 2.5% for the photometric and spectroscopic figures. This confirms that the methods used for the present compilation and the large-scale study by Erasmus and collaborators in the Southern and Northern Hemispheres are fully compatible.

3. CONCLUSIONS

The present compilation describes, for the site of the Observatorio Astronomico Nacional at San Pedro Mártir, Mexico, the behaviour of one of the main climatological effects that determine the possibility of performing ground-based optical and infrared observations, the cloud cover. For the period July 1982 to December 2002, the fraction of photometric nights is found to be 0.63 while the fraction of spectroscopic nights is 0.81. Most likely due to long term climatological fluctuations, the fractional number of totally clear, photometric, nights has increased considerably, from 57.2% prior to 1996 to 74.6% in the last seven years.

The present work provides evidence that the long-term climatological conditions that affect the infrared and optical observations at San Pedro Mártir are similar or better to those presented for shorter periods by Tapia (1992) and Erasmus and van Staden (2002). Based on the comparative data presented by these authors, San Pedro Mártir is con-

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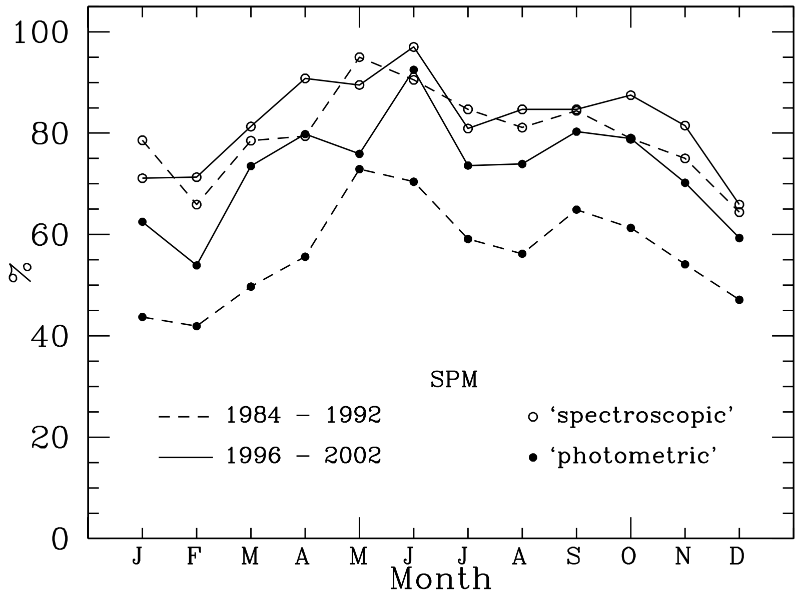

Fig. 3. Monthly fraction of nights of photometric and of spectroscopic quality in San Pedro Mártir during the 1984 - 1992 and 1996 - 2002 periods at San Pedro Mártir.

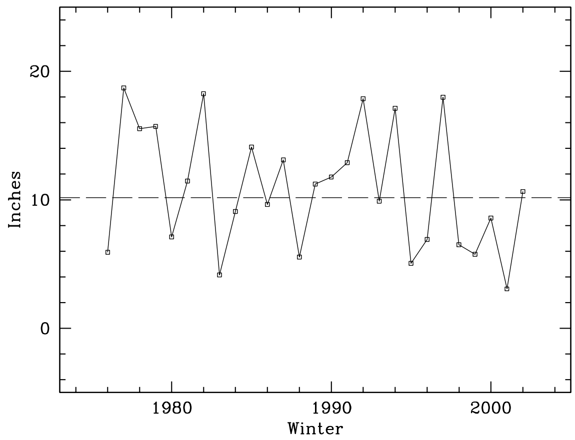

Fig. 4. Total winter (October to April) precipitation recorded in San Diego, California from 1996-1997 to 2002-2003. The dashed line marks the mean of all winters since the records began in 1850. Practically no precipitation occurs from May to September.

firmed to have the largest fraction of clear nights of any existing or potential observatory site in North America or even, in the Northern Hemisphere.

The cooperation of the following night assistants is greatly appreciated. Without their careful and persistent work over the years, this compilation would not have been possible: Javier Ojeda, Jaime López, Octavio Sánchez, Antonio Chaidez, Marco García, Gabriel García, Juan Ruiz, Celso Valle, Eduardo López, Ricardo Flores, Alvaro Lepe, Salvador Monrroy, Celso Valle, Francisco Martínez, Alfonso Paredes,

Joel Rodríguez, Felipe Montalvo, Gustavo Melgosa and Roberto Velazco. I acknowledge the members of the Site Working Group of the CELT project for making available to us the Satellite Survey report by Erasmus and van Staden (2002).

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