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Statistics of weather data and telescope usage at Kitt Peak National
Observatory and Cerro Tololo Inter-American Observatory

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Abstract

Eighteen years of observing data for the largest telescopes at Kitt Peak National Observatory and six years of similar data at Cerro Tololo Inter-American Observatory are given in Tables 1 and 2. Precipitation data for the same period at KPNO are contained in Table 4. Some summaries of these data and a few conclusions useful for telescope design considerations are discussed.

Introduction

Existing data on telescope usage at KPNO and CTIO (and to a limited extent at other observatories) have been compiled. These data can give some indication of site quality, temporal cycles, and so forth. Some general weather data have also been collected and analyzed, and compared to the observing data. Subsets of these data are useful as inputs for telescope design considerations. This paper gives a few tables indicative of the data sets, and calls attention to some of the conclusions.

The data

Table 1 contains a summary of the observing data with the largest telescope operating at KPNO: the 2.1-m from 1964-1974 and the 4-m from 1975-1981. Included are the total hours observed each month and the total nights down, the latter due generally to scheduled or unscheduled maintenance. The annual total hours observed are also included. It is seen that the best years have about 2650 hours useable of the total. About 3810 possible total hours have been assumed, varying from 8 hrs. per night in July to 12 hrs. per night in December, January and February. The percent of possible hours that were useable is shown at the bottom of the column, from 1970 to 1981. It was calculated as hours observed/(total hours - hours down time). The overall 10 year average is 68%, with 61% the worst year and 75% the best year. Note that several good years, or bad ones, can come together in a row. This is typical at all observing sites, and must be taken into account in any site survey, particularly those that last only a year or so.

Table 2 contains similar data for the 4-m telescope at CTIO, for the period 1977-1982. Here, however, "hours down time" are used rather than "nights down time." The overall 6 year useable percentage is 80%. Note that over this period, percentage wise CTIO's worst years are about the same as KPNO's best years.

A summary of the percentage data is given in Table 3, where average monthly percentages are given. Year to year scatter can be large, but the overall trend is clear. At KPNO, July is clearly the worst month, followed by August. The first half of September is worse, generally, than the last half. This bad period is during southern Arizona's summer cloudy rainy period: "the summer monsoons." Winter observing is better, but can be erratic (a large variation from year to year). May, June and November are the best months.

AT CTIO, the summers are nearly perfect, usually; similar to the west coast observatories in the United States. Winters are worse. July is the worst month (as at KPNO, but for different reasons). Some summer months at CTIO give percentages greater than 100%, as observers stretch observing into extreme twilight with certain instruments. Those "nights" where infrared observing at KPNO or CTIO began or continued into daylight hours were truncated to the "hours possible" value.

Table 4 contains rainfall data for KPNO. The overall average is 25.3 inches, in 64 days. As a comparison, the average annual rainfall in Tucson is 11.1 inches per year, on about the same number of days as at Kitt Peak. While the summer season is always wet, the greatest amount of rain has occurred in December (not every year, of course), in years when southern Arizona has received the tail-ends of west coast tropical storms.

Observing conditions correlate rather well with "days of rain", much better than with "amount of rain."

Records for the 0.9-m telescopes at KPNO, where mostly photometry is done, show that the long term photometric percentage at KPNO is 51%, over the last 20 years. (Compare to the "spectrographic" on large telescope average of 68%).

TABLE 1
KPNO OBSERVING HOURS AND NIGHTS "DOWN" TIME
4-m (1975-1981) and 2.1-m (1964-1974) Telescopes

Month	1964		1965		1966		1967		1968		1969	
	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.
Jan.	159	2	200	0	224	0	306	0	262	0	177	0
Feb.	154	1	162	0	174	0	238	0	187	0	175	0
Mar.	82	13	236	0	253	0	201	0	188	0	243	0
Apr.	86	8	174	0	256	1	190	0	202	0	238	0
May	13	29	221	0	195	0	210	0	210	0	190	0
June	142	2	193	0	187	0	211	0	228	0	220	0
July	68	4	90	0	109	0	103	0	118	0	118	0
Aug.	92	2	149	0	142	2	26	26	136	3	110	1
Sept.	144	0	199	0	202	0	203	0	235	1	214	0
Oct.	199	6	280	2	282	0	277	0	290	0	254	0
Nov.	203	1	186	0	278	0	241	0	251	0	225	0
Dec.	162	7	135	0	226	1	183	0	224	0	230	1
TOTAL	1504		2225		2528		2389		2531		2404	

Month	1970		1971		1972		1973		1974		1975	
	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.
Jan.	272	0	294	0	288	0	230		214		262	7
Feb.	205	0	234	0	244	0	163		259		248	0
Mar.	242	0	284	0	278	0	139		219		212	0
Apr.	213	1	234	0	239	0	232		213		250	0
May	243	0	226	0	185	0	225		217		254	0
June	208	0	212	0	178	0	236		185		230	0
July	120	0	132	0	136	0	154		90		109	3
Aug.	131	0	123	2	170	2	143		198		187	2
Sept.	212	0	226	0	239	1	292		170		154	5
Oct.	298	0	214	0	172	0	280		192		279	0
Nov.	312	0	256	0	291	0	245		282		250	3
Dec.	174	0	194	0	244	0	303		243		222	4
TOTAL	2630	69%	2629	69%	2665	71%	2642	69%	2482	65%	2657	75%

Month	1976		1977		1978		1979		1980		1981	
	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.	Hrs.	Nts.
Jan.	272	0	146	0	175	0	156	0	152	0	174	1
Feb.	162	3	274	1	184	0	178	0	192	0	222	0
Mar.	209	0	192	5	170	0	163	0	210	0	172	1
Apr.	195	1	224	1	232	1	260	0	225	3	181	1
May	165	5	206	1	201	0	170	0	234	1	204	1
June	206	5	189	3	199	1	170	0	218	1	190	1
July	93	0	63	12	110	2	163	1	118	4	123	0
Aug.	189	0	118	10	166	2	148	2	124	10	32	26
Sept.	156	2	139	3	240	0	242	0	242	1	234	1
Oct.	242	1	208	3	205	1	245	0	307	0	252	1
Nov.	272	4	286	2	181	0	269	2	295	1	256	1
Dec.	279	2	208	3	202	1	243	1	250	3	278	3
TOTAL	2486	70%	2281	67%	2265	61%	2407	64%	2567	72%	2318	67%

TABLE 2
CTIO OBSERVING HOURS and HOURS "DOWN" TIME
4-m Telescope: 1977 - 1982

Month	1977		1978		1979		1980		1981		1982	
	Used	Down	Used	Down	Used	Down	Used	Down	Used	Down	Used	Down
Jan.	233	27	262	0	241	24	245	18	276	11	279	7
Feb.	228	16	234	30	240	37	250	23	227	7	273	6
Mar.	291	21	322	0	313	31	275	4	301	8	300	10
Apr.	294	22	312	0	283	16	136	49	248	9	299	8
May	333	0	332	0	231	50	177	26	206	14	239	9
June	254	16	186	0	279	37	232	39	290	3	118	33
July	253	0	210	0	233	18	177	37	239	78	185	9
Aug.	258	0	252	0	215	12	264	14	259	11	197	14
Sept.	251	9	222	22	157	115	192	27	248	11	169	8
Oct.	210	64	223	10	268	8	206	10	254	6	274	6
Nov.	268	9	221	0	201	27	197	46	252	2	237	12
Dec.	258	0	272	0	216	13	243	21	246	23	223	28
TOTAL	3131	184	3048	62	2877	388	2594	314	3046	183	2793	150
% of possible	85%		80%		83%		73%		83%		76%	

TABLE 3
MONTHLY AVERAGES of "PERCENT of POSSIBLE TIME OBSERVED"
KPNO (16 years) and CTIO (6 years)

Month	KPNO	CTIO
Jan.	64%	97%
Feb.	62%	93%
Mar.	61%	96%
Apr.	73%	(83%)
May	77%	71%
June	83%	67%
July	46%	62%
Aug.	59%	69%
Sept.	67%	69%
Oct.	72%	82%
Nov.	76%	90%
Dec.	60%	97%

The () for CTIO denotes that one year of the six was considerably below the other five, thus depressing the average (90% for the other five).

TABLE 4
PRECIPITATION ON KITT PEAK

1964 -1981

Month	1964		1965		1966		1967		1968		1969	
	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days
Jan.	0.29	1	1.15	6	4.36	5	0.25	1	0.88	7	2.04	8
Feb.	0.16	1	1.06	4	6.11	5	0.11	2	1.91	6	1.56	7
Mar.	1.00	6	0.80	4	0.70	3	1.32	4	2.41	7	1.23	5
Apr.	1.35	2	3.58	6	0.20	1	0.81	3	1.20	4	0.14	1
May	0.09	1	0.12	1	0.02	2	0.18	3	0.00	0	0.60	3
June	0.52	2	0.39	2	0.36	3	2.69	2	0.00	0	0.00	0
July	5.55	16	2.54	16	4.04	15	4.68	16	5.26	10	6.75	11
Aug.	8.22	16	4.31	10	5.74	8	4.78	13	4.03	10	7.11	15
Sept.	3.55	8	2.56	8	2.55	8	2.48	9	0.00	0	0.85	11
Oct.	3.40	3	0.06	1	0.63	4	0.32	2	0.39	2	0.04	1
Nov.	2.03	4	1.50	5	1.95	3	1.19	7	1.06	4	3.23	7
Dec.	0.90	2	13.53	13	1.60	5	9.22	7	4.67	3	1.56	7
TOTAL	27.06	62	31.60	76	28.26	62	28.03	69	21.81	53	25.11	76

Month	1970		1971		1972		1973		1974		1975	
	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days
Jan.	0.01	1	0.11	1	0.00	0	0.52	4	4.60	8	0.60	3
Feb.	0.40	3	1.20	3	0.00	0	3.30	6	0.00	0	0.01	1
Mar.	3.30	7	0.00	0	0.00	0	6.04	10	1.38	6	3.88	7
Apr.	0.44	2	0.02	2	0.00	0	0.23	1	0.00	0	1.82	3
May	0.00	0	0.00	0	0.13	3	0.32	1	0.00	0	0.00	0
June	0.00	0	0.00	0	1.96	8	0.85	2	0.06	2	0.00	0
July	1.62	10	4.02	8	3.62	11	3.01	7	6.85	18	6.80	19
Aug.	5.77	13	11.35	22	3.74	8	2.08	12	3.04	7	1.81	7
Sept.	8.76	6	2.64	5	0.42	4	0.00	0	5.02	17	3.00	7
Oct.	0.34	4	6.94	10	8.42	12	0.00	0	3.61	14	0.01	1
Nov.	0.03	1	0.98	3	2.38	7	1.78	4	0.00	0	1.76	2
Dec.	1.23	6	3.70	8	1.63	4	0.00	0	1.29	4	2.43	6
TOTAL	21.90	53	30.96	62	22.30	57	18.13	47	25.81	76	22.12	56

Month	1976		1977		1978		1979		1980		1981	
	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days	Inch	Days
Jan.	0.44	3	3.30	12	4.06	11	8.90	10	2.49	9	2.80	8
Feb.	1.66	7	0.16	1	3.84	11	2.04	4	4.49	10	0.70	2
Mar.	0.72	1	0.96	3	3.79	8	2.46	7	2.05	6	4.54	7
Apr.	2.38	3	0.69	2	0.63	3	0.03	1	0.30	3	0.46	2
May	0.00	0	0.66	1	2.23	3	0.97	9	0.22	2	0.92	4
June	0.00	0	0.00	0	0.65	3	1.10	7	0.11	1	0.99	4
July	6.71	16	2.90	11	4.37	17	4.23	10	3.22	9	5.66	17
Aug.	2.18	7	3.00	9	1.95	13	2.63	8	4.47	9	4.33	9
Sept.	4.74	10	0.57	8	1.88	5	0.55	4	1.12	4	3.03	7
Oct.	1.47	6	3.22	10	3.85	8	0.78	1	0.87	3	0.80	3
Nov.	0.89	3	0.54	3	5.59	11	0.31	2	0.02	1	1.98	2
Dec.	0.73	4	2.58	6	10.96	8	0.46	4	0.41	3	0.00	0
TOTAL	21.92	60	18.14	66	43.80	101	24.46	66	19.77	60	26.21	65

Table 5 shows the extremes of temperature at Kitt Peak, data useful for telescope design specifications. The temperature range from day to night at Kitt Peak averages 20.5°F, with a dispersion about this value of 3.0°F. The pattern of temperature change from one nights minimum to the next nights minimum has an average of 0° (of course), with a dispersion of 3.7°F.

Considerable data are on file, and additional summaries exist or are being prepared, including comparisons to other observatories. Inquiries are welcome, as are input data from other locations. Full details will be published separately.

TABLE 5
TEMPERATURE EXTREMES ON KITT PEAK
1961-1982

Month	High	Year	Low	Year
Jan.	71°F	1971*	2°F	1979
Feb.	75	1963	9	1979*
Mar.	74	1971	9	1971
Apr	81	1977	15	1976
May	89	1964	24	1969
June	98	1979	37	1968
July	94	1978	41	1969
Aug.	100	1976	42	1977
Sept.	91	1979	40	1982*
Oct.	88	1980	20	1971
Nov.	77	1975	14	1975
Dec.	69	1981*	6	1968
Year	100	Aug. 1976	2	Jan. 1979

*Means "also on additional earlier year(s)"