

CHAPTER 7

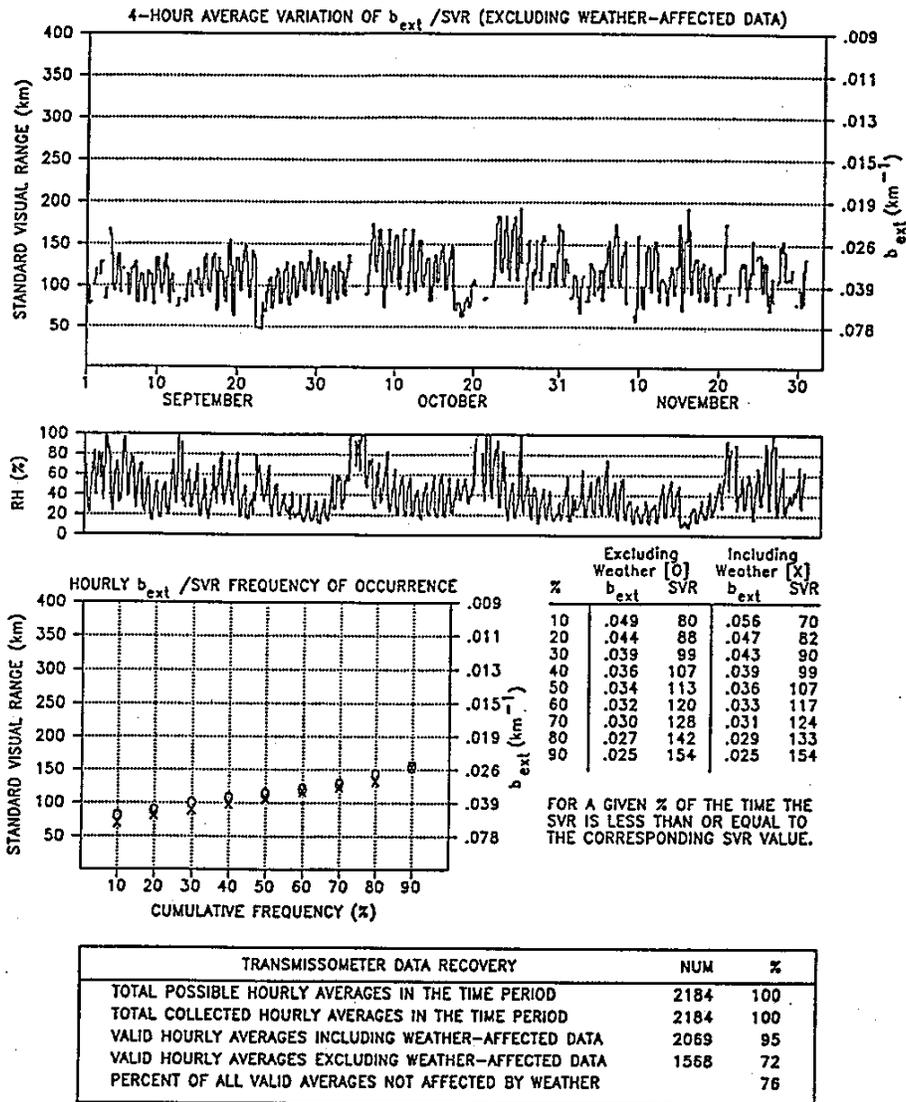
MEASURED LIGHT EXTINCTION

Light extinction data from the 20 IMPROVE sites with transmissometers are summarized in Appendix I. A typical data summary for one season at one site, as shown in Figure 7.1, includes a time plot of extinction (b_{ext}) or standard visual range ($SVR=3.91/b_{ext}$), an accompanying time plot of relative humidity (RH), and a plot of the cumulative frequency distribution of b_{ext} values occurring in the period, both for all the b_{ext} values (points denoted by an "x") and for only those values which are not tagged as weather-affected (points denoted by an "o"). The meaning of weather-affected b_{ext} values and the algorithm used to identify them are discussed in Section 2.2.2.

Stacked timelines of the extinction for the sites arranged by region are given in Appendix J. The average seasonal and annual extinction, both excluding and including weather-affected values, is presented by region in Figure 7.2. The measured and reconstructed extinctions are compared in Table 7.1 (where measured b_{ext} excludes weather-related events), and values of the standard visual range calculated from these extinctions are compared in Table 7.2. The reconstructed light extinction, discussed in detail in Chapter 6, is based on twice-weekly 24-hour particle samples, while extinction is measured by transmissometer every hour of every day. Furthermore, extinction is not measured at all sites; and where it is measured, values that are deemed weather-affected are not used. Therefore, a detailed comparison of the measured and reconstructed light extinction values requires matching the time period of each 24-hour particle sample with the closest corresponding sequence of valid hourly measured extinction values for those sites having measured extinction. Time constraints prevent such a level of comparison in this report; and the values presented in Table 7.1 simply compare reasonably-defined seasonal averages of reconstructed and measured light extinction.

Table 7.1 shows good agreement (to better than about 10%) in the East, in the Central Rockies and Colorado Plateau, and in the Northern Great Plains. The other regions show underestimation of extinction by reconstruction. Reconstructed extinction is typically 70-80% of the measured extinction. The ratio of reconstructed to measured extinction is also about 80% at the Appalachian site (Shenandoah), during the summer season. This may be due to the fact that sulfate is acidic in this season and acidic sulfate has a higher light scattering efficiency than that of ammonium sulfate assumed here. The worst agreement is in Sierra Nevada (Yosemite), where the reconstructed extinction is only 50% of the measured value. This may be due to the fact that the aerosol monitor is located above the mixed layer much of the time. At this time it is not clear why reconstructed extinction is less than measured extinction in California and in southern Arizona and northwestern Texas.

CHIRICAHUA NATIONAL MONUMENT, ARIZONA
 Transmissometer Data Summary
 Fall Season: September 1, 1989 - November 30, 1989



DATE PREPARED: 8/27/91

Figure 7.1 Example transmissometer data summary.

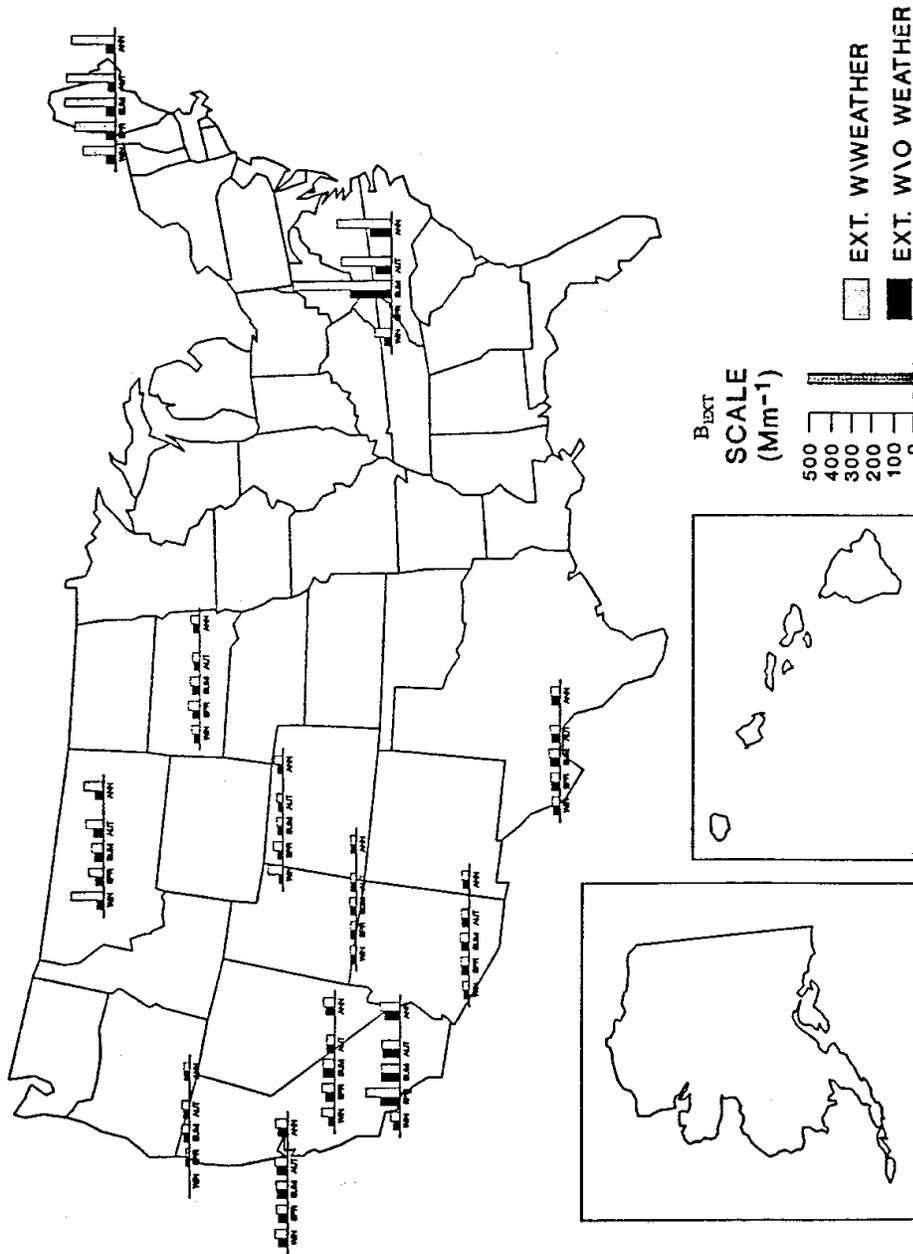


Figure 7.2 Spatial and seasonal variation of measured light extinction coefficient (Mm^{-1}) in the United States for the three-year period, March 1988 through February 1991. From left to right, the bars show winter, spring, summer, autumn, and annual averages. Open bars include all time periods; dark bars exclude periods with fog, precipitation, and low clouds.

Table 7.1 Comparison of measured and reconstructed light extinction coefficient (Mm^{-1}) averaged over the three-year period, March 1988 through February 1991, by region for every season. Measured values are averages of the daily median extinction, excluding weather-related events. The two versions of reconstructed extinction assume dry organics (D) and 50% wet organics (W), respectively.

REGION	SEASON	MEASURED	RECON D	RECON W
Appalachian	winter	48	49	51
	spring	.	.	.
	summer	182	144	151
	autumn	92	99	104
	annual	123	109	114
Colorado Plateau	winter	24	24	25
	spring	27	25	25
	summer	30	30	30
	autumn	27	25	25
	annual	27	26	26
Central Rockies	winter	18	19	19
	spring	24	23	23
	summer	28	29	30
	autumn	24	23	23
	annual	24	23	24
Pacific Coast	winter	48	42	42
	spring	47	37	38
	summer	54	41	41
	autumn	52	41	41
	annual	50	40	41
Northeast	winter	43	45	47
	spring	44	40	41
	summer	37	40	42
	autumn	37	39	40
	annual	41	42	43

Northern Great Plains	winter	32	31	32
	spring	37	32	32
	summer	38	34	35
	autumn	29	30	30
	annual	33	31	32

Table 7.1 Continued

REGION	SEASON	MEASURED	RECON D	RECON W
Northern Rockies	winter	32	35	38
	spring	45	39	42
	summer	48	36	39
	autumn	53	44	48
	annual	46	38	41
Southern California	winter	48	33	33
	spring	94	90	92
	summer	101	73	74
	autumn	83	56	57
	annual	79	61	62
Sonoran Desert	winter	29	26	27
	spring	39	27	27
	summer	44	34	34
	autumn	37	28	29
	annual	37	29	29
Sierra Nevada	winter	46	20	20
	spring	71	31	32
	summer	72	36	36
	autumn	45	31	31
	annual	59	29	30
West Texas	winter	34	27	28
	spring	48	33	34

	summer	54	35	35
	autumn	49	33	33
	annual	44	31	32

Table 7.2 Comparison of measured and reconstructed standard visual range (SVR) by region for every season, based on averages of the daily median extinction (Table 7.1). Units are kilometers (km).

REGION	SEASON	MEASURED	RECON D	RECON W
Appalachian	winter	82	79	77
	spring	.	.	.
	summer	21	27	26
	autumn	42	40	38
	annual	32	36	34
Colorado Plateau	winter	161	163	159
	spring	145	156	155
	summer	132	131	130
	autumn	146	156	154
	annual	145	151	149
Central Rockies	winter	213	208	204
	spring	160	170	167
	summer	138	134	131
	autumn	163	172	169
	annual	165	167	164
Pacific Coast	winter	82	94	92
	spring	84	105	104
	summer	73	95	94
	autumn	76	97	95
	annual	78	98	97
Northeast	winter	90	86	84
	spring	90	98	96

	summer	106	98	93
	autumn	106	100	97
	annual	96	94	91
Northern Great Plains	winter	123	128	123
	spring	106	123	121
	summer	102	116	112
	autumn	136	132	129
	annual	120	127	123

Table 7.2 Continued

REGION	SEASON	MEASURED	RECON D	RECON W
Northern Rockies	winter	121	112	103
	spring	87	101	93
	summer	81	108	101
	autumn	73	90	81
	annual	84	103	95
Southern California	winter	81	118	117
	spring	42	43	42
	summer	39	53	53
	autumn	47	69	69
	annual	49	64	63
Sonoran Desert	winter	136	149	147
	spring	100	145	144
	summer	90	116	115
	autumn	105	137	136
	annual	105	135	134
Sierra Nevada	winter	85	195	192
	spring	55	126	122
	summer	54	109	108

	autumn	87	126	124
	annual	66	133	131
West Texas	winter	116	143	141
	spring	82	117	116
	summer	72	113	111
	autumn	80	119	118
	annual	89	124	123

Figure 7.2 should also be compared with Figure 6.6 showing reconstructed extinction by region. The relative importance of sulfate in the East is easily noted, as well as that of nitrate in California. The effect of weather upon the extinction is marked in several regions, particularly in the East.

In fact, the measured extinction data can be classified into three broad-based categories, closely tied to the way the weather algorithm handles the data in each category: 1) Western States, 2) Eastern States, and 3) Sites Influenced by Diurnal Haze. These categories are discussed below.

7.1 Western Sites

The majority of sites are in this category; they are all located west of the Mississippi River. At these locations, the weather algorithm flags only 10%-20% of the data and has very little effect on the mean extinctions. Figure 7.3 shows a typical weather algorithm plot of western regional data. The most apparent exception to this is the in-canyon transmissometer at Grand Canyon National Park (Figure 7.4). During winter, the measured below-rim extinction is frequently five to ten times higher than the measured extinction above the canyon.

7.2 Eastern Sites

Ambient RH levels at Acadia and Shenandoah National Parks are much higher than those at the western monitoring sites (with the notable exception of the Glacier National Park site, whose transmissometer sight path is over Lake McDonald, and close to the water); and this increases the severity of the visual air quality impacts. The weather algorithm flags more data at these sites (up to 70% at Acadia, 80% at Shenandoah) due to a higher frequency of fog, precipitation, and relative humidity above 90%. Figure 7.5 presents a typical weather algorithm plot for data from these sites. Seasonal summaries of Acadia and Shenandoah extinction data are plotted with a different scale than the western sites, to allow for the much higher extinction levels.

7.3 Sites Influenced by Diurnal Hazes

Extinction data collected at San Geronio Wilderness and Yosemite National Park exhibit a strong diurnal pattern due to daily incursions of severe hazes from areas of high pollution west of the Sierra Nevadas. Large, rapid, and wildly varying fluctuations in measured extinction are caused by these hazes. Thus, the rate of change test in the weather identification algorithm is not used at these sites; only the humidity and maximum extinction flags are used. Figure 7.6 presents an example of this diurnally fluctuating data.

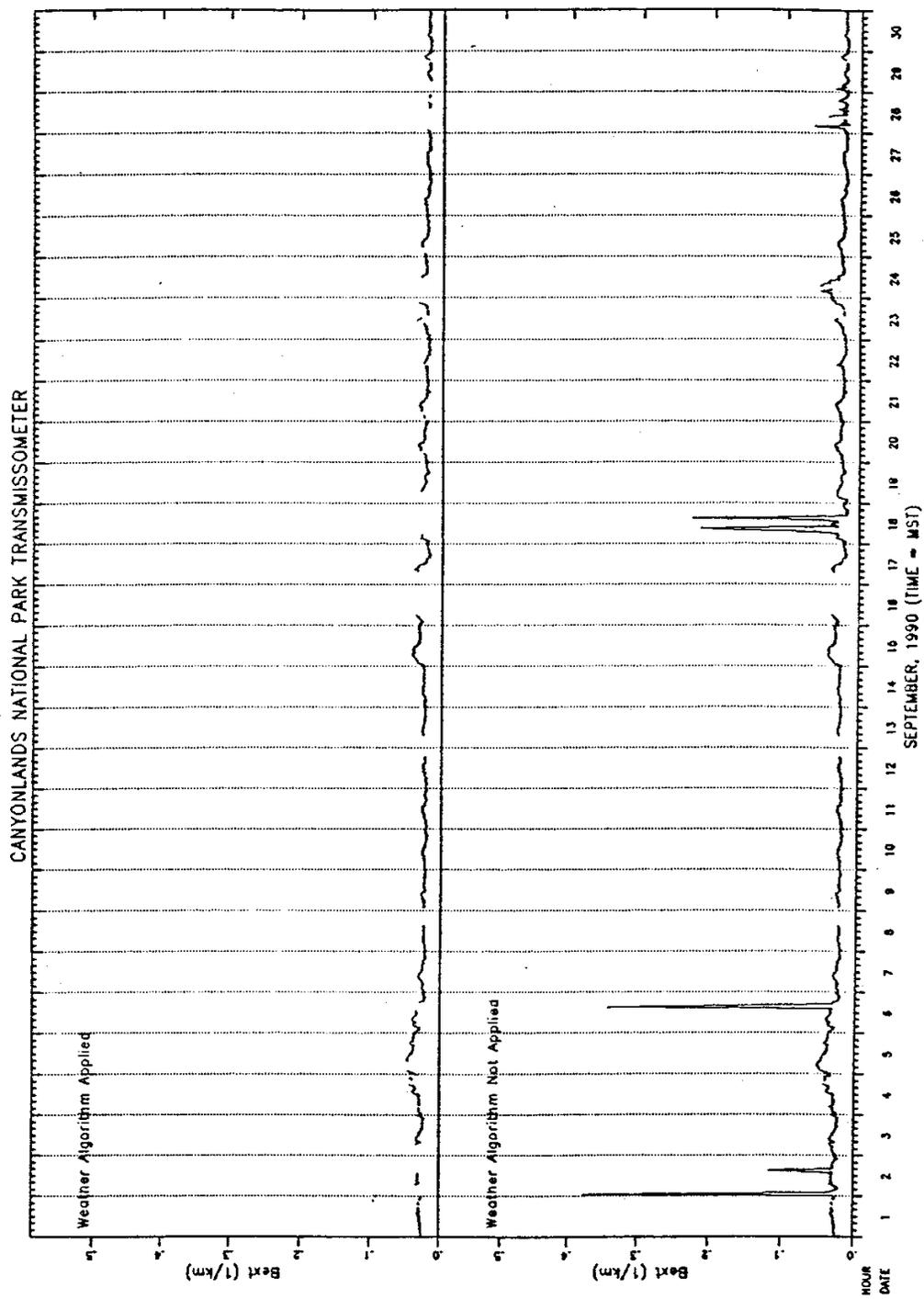
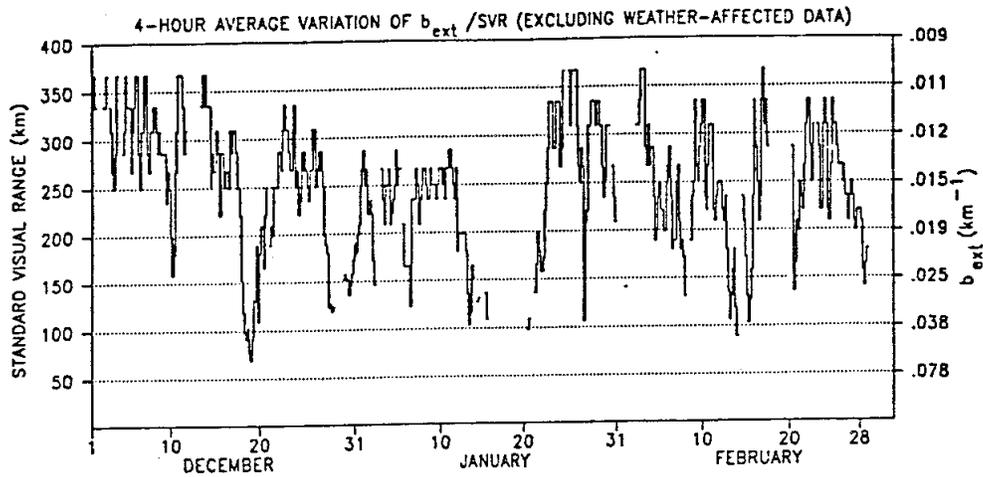


Figure 7.3 Example Weather-Algorithm Plot, Canyonlands National Park, September 1990.

GRAND CANYON NATIONAL PARK (SOUTH RIM), ARIZONA
 Transmissometer Data Summary
 Winter Season: December 1, 1989 - February 28, 1990



GRAND CANYON NATIONAL PARK (IN CANYON), ARIZONA
 Transmissometer Data Summary
 Winter Season: December 1, 1989 - February 28, 1990

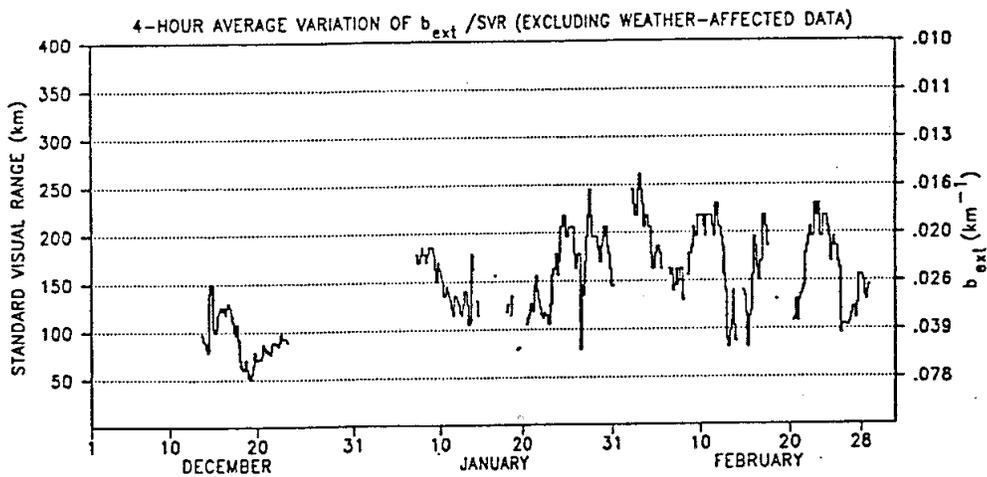


Figure 7.4 Comparison of b_{ext} at Grand Canyon, on Rim vs. In-canyon.

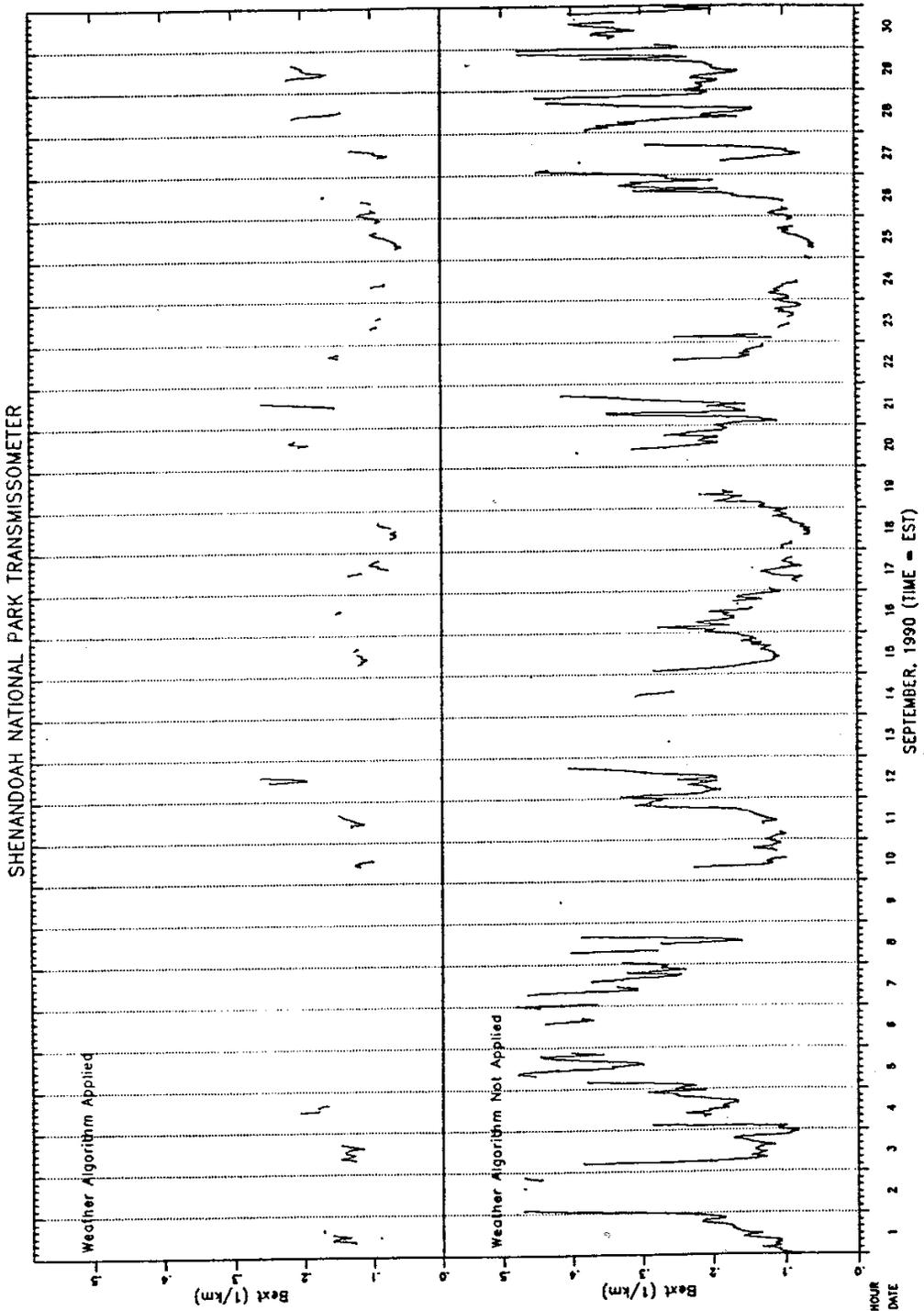


Figure 7.5 Example Weather-Algorithm Plot, Shenandoah National Park, September 1990.

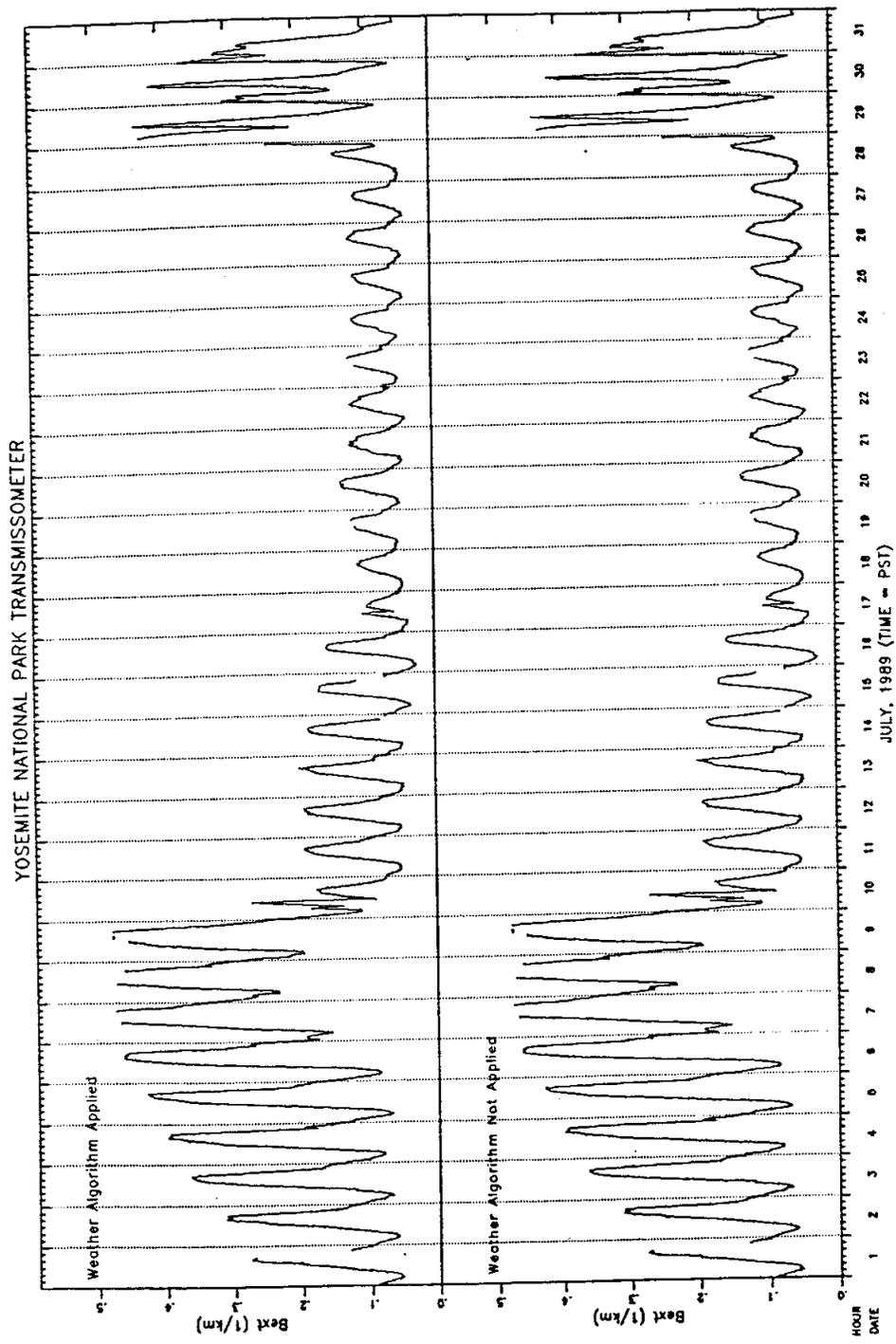


Figure 7.6 Example Weather-Algorithm Plot, Yosemite National Park, July 1989.

