

Appendix 7: Meteorological Data

This appendix lists the meteorological data of various locations. Since this kind of information can be obtained over the Internet, data for only a few selected locations are presented—mostly used in examples and problems of the book. The data presented for the U.S. locations are from <http://www.nrel.gov/redc>, except the monthly average clearness index, which is calculated from Eq. (2.82a), and the estimation of extraterrestrial horizontal radiation, given by Eq. (2.79) for the average day of Table 2.1. For the other locations, the NASA Internet site, <http://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?email=> (requires free registration), can be used by entering the longitude and latitude of each location found from www.infoplease.com/atlas/latitude-longitude.html. For the degree days presented, the base temperature for both cooling and heating is 18.3 °C for the U.S. locations and 18 °C for all other locations.

The data recorded are the following:

$\bar{H}$ = Monthly average radiation on a horizontal surface (MJ/m²).

$\bar{K}_T$ = Monthly average clearness index.

$\bar{T}_a$ = Monthly average ambient temperature (°C).

HDD = Heating degree days (°C-days).

CDD = Cooling degree days (°C-days).

The data reported are for the following locations.

In the United States: Albuquerque, NM; Boulder, CO; Las Vegas, NV; Los Angeles, CA; Madison, WI; Phoenix, AZ; San Antonio, TX; Springfield, IL.

In Europe: Almeria, ES; Athens, GR; London, UK; Nicosia, CY; Rome, IT.

In the rest of the world: Adelaide, AU; Montreal, CA; New Delhi, IN; Pretoria, SA; Rio de Janeiro, BR.

United States

Table A7.1 Albuquerque, NM: Latitude (N), 35.05°, Longitude (W), 106.62°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	11.52	15.12	19.44	24.48	27.72	29.16	27.00	24.84	21.24	16.92	12.60	10.44
$\bar{K}_T$	0.63	0.65	0.66	0.68	0.69	0.70	0.66	0.67	0.67	0.67	0.65	0.62
$\bar{T}_a$	1.2	4.4	8.3	12.9	17.9	23.4	25.8	24.4	20.3	13.9	6.8	1.8
HDD	531	389	312	167	49	0	0	0	10	144	345	512
CDD	0	0	0	4	36	155	233	188	70	6	0	0

Table A7.2 Boulder, CO: Latitude (N), 40.02°; Longitude (W), 105.25°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	8.64	11.88	15.84	20.16	22.32	24.84	24.12	21.60	18.00	13.68	9.36	7.56
$\bar{K}_T$	0.57	0.58	0.58	0.58	0.56	0.60	0.59	0.59	0.60	0.61	0.57	0.55
$\bar{T}_a$	-1.3	0.8	3.9	9.0	14.0	19.4	23.1	21.9	16.8	10.8	3.9	-0.6
HDD	608	492	448	280	141	39	0	0	80	238	433	586
CDD	0	0	0	0	6	71	148	113	35	4	0	0

Table A7.3 Las Vegas, NV: Latitude (N), 36.08°; Longitude (W), 115.17°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	10.80	14.40	19.44	24.84	28.08	30.24	28.44	25.92	22.32	16.92	12.24	10.08
$\bar{K}_T$	0.61	0.63	0.67	0.70	0.70	0.73	0.70	0.70	0.71	0.69	0.65	0.62
$\bar{T}_a$	7.5	10.6	13.5	17.8	23.3	29.4	32.8	31.5	26.9	20.2	12.8	7.6
HDD	336	216	162	79	8	0	0	0	0	34	169	332
CDD	0	0	12	64	163	332	449	408	258	91	0	0

Table A7.4 Los Angeles, CA: Latitude (N), 33.93°; Longitude (W), 118.4°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	10.08	12.96	17.28	21.96	23.04	23.76	25.56	23.40	19.08	15.12	11.52	9.36
$\bar{K}_T$	0.53	0.54	0.58	0.61	0.58	0.57	0.63	0.62	0.59	0.59	0.57	0.54
$\bar{T}_a$	13.8	14.2	14.4	15.6	17.1	18.7	20.6	21.4	21.1	19.3	16.4	13.8
HDD	143	119	124	88	53	30	5	3	12	18	71	143
CDD	0	4	4	6	14	42	76	98	94	49	14	4

Table A7.5 Madison, WI: Latitude (N), 43.13°; Longitude (W), 89.33°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	6.84	10.08	13.32	16.92	20.88	23.04	22.32	19.44	14.76	10.08	6.12	5.40
$\bar{K}_T$	0.52	0.54	0.51	0.50	0.53	0.55	0.55	0.54	0.51	0.48	0.42	0.46
$\bar{T}_a$	-8.9	-6.3	0.2	7.4	13.6	19.0	21.7	20.2	15.4	9.4	1.9	-5.7
HDD	844	691	563	327	163	38	7	21	93	277	493	746
CDD	0	0	0	0	17	58	110	78	7	0	0	0

Table A7.6 Phoenix, AZ: Latitude (N), 33.43°; Longitude (W), 112.02°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	11.52	15.48	19.80	25.56	28.80	30.24	27.36	25.56	21.96	17.64	12.96	10.80
$\bar{K}_T$	0.60	0.64	0.65	0.71	0.72	0.73	0.67	0.68	0.68	0.68	0.64	0.61
$\bar{T}_a$	12.0	14.3	16.8	21.1	26.0	31.2	34.2	33.1	29.8	23.6	16.6	12.3
HDD	201	126	101	42	4	0	0	0	0	9	74	192
CDD	4	12	53	123	242	387	491	457	343	173	23	4

Table A7.7 San Antonio, TX: Latitude (N), 29.53°; Longitude (W), 98.47°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	11.16	14.04	17.28	19.80	21.60	24.12	24.84	23.04	19.44	16.20	12.24	10.44
$\bar{K}_T$	0.52	0.54	0.54	0.54	0.54	0.59	0.61	0.61	0.58	0.58	0.54	0.52
$\bar{T}_a$	9.6	11.9	16.5	20.7	24.2	27.9	29.4	29.4	26.3	21.2	15.8	11.2
HDD	274	184	93	18	0	0	0	0	0	17	100	227
CDD	4	6	36	89	181	287	344	343	238	106	23	7

Table A7.8 Springfield, IL: Latitude (N), 39.83°; Longitude (W), 89.67°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	7.56	10.44	13.32	18.00	21.60	23.40	23.04	20.52	16.56	12.24	7.92	6.12
$\bar{K}_T$	0.49	0.51	0.48	0.52	0.54	0.56	0.57	0.56	0.55	0.54	0.48	0.44
$\bar{T}_a$	-4.3	-1.8	4.9	11.8	17.5	22.7	24.7	23.2	19.6	13.1	6.1	-1.3
HDD	703	564	417	201	92	4	0	4	24	174	368	608
CDD	0	0	0	4	67	136	198	154	63	12	0	0

Europe

Table A7.9 Almeria, ES: Latitude (N), 36.83°; Longitude (W), 2.45°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	9.83	12.89	17.35	22.03	24.48	27.40	27.54	24.52	19.44	14.08	10.26	8.57
$\bar{K}_T$	0.56	0.56	0.58	0.61	0.61	0.65	0.67	0.66	0.61	0.56	0.54	0.53
$\bar{T}_a$	11.0	11.8	13.7	15.8	18.7	22.5	25.1	25.5	22.8	19.0	15.0	12.2
HDD	210	168	128	70	20	0	0	0	0	10	88	172
CDD	0	0	1	5	41	133	221	237	147	45	3	0

Table A7.10 Athens, GR: Latitude (N), 37.98°; Longitude (E), 23.73°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	7.70	10.37	14.40	19.33	23.15	26.86	26.50	23.83	18.76	12.38	7.85	6.23
$\bar{K}_T$	0.45	0.46	0.49	0.54	0.57	0.64	0.65	0.64	0.60	0.51	0.42	0.40
$\bar{T}_a$	10.2	10.1	12.2	16.1	21.1	25.7	28.1	27.9	24.5	20.1	15.2	11.5
HDD	234	218	179	71	6	0	0	0	0	13	87	195
CDD	0	0	0	10	95	225	308	305	195	81	9	0

Table A7.11 London, UK: Latitude (N), 51.50°; Longitude, 0.00°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	2.95	5.26	8.82	13.39	16.96	17.89	17.93	15.62	10.55	6.44	3.56	2.23
$\bar{K}_T$	0.35	0.37	0.39	0.42	0.44	0.43	0.45	0.46	0.41	0.38	0.36	0.32
$\bar{T}_a$	4.1	4.3	6.6	8.8	12.8	16.2	18.8	18.9	15.7	11.9	7.4	4.9
HDD	429	381	348	273	163	73	22	22	76	183	316	405
CDD	0	0	0	0	2	15	44	50	9	1	0	0

Table A7.12 Nicosia, CY: Latitude (N), 35.15°; Longitude (E), 33.27°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	8.96	12.38	17.39	21.53	26.06	29.20	28.55	25.49	21.17	15.34	10.33	7.92
$\bar{K}_T$	0.49	0.53	0.58	0.59	0.65	0.70	0.70	0.68	0.66	0.60	0.53	0.47
$\bar{T}_a$	12.1	11.9	13.8	17.5	21.5	25.8	29.2	29.4	26.8	22.7	17.7	13.7
HDD	175	171	131	42	3	0	0	0	0	1	36	128
CDD	0	0	1	26	112	234	348	353	263	146	29	0

Table A7.13 Rome, IT: Latitude (N), 41.45°; Longitude (E), 12.27°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	7.13	10.51	15.55	19.73	24.41	27.50	27.61	24.16	18.29	12.24	7.60	6.08
$\bar{K}_T$	0.49	0.52	0.56	0.57	0.61	0.65	0.68	0.66	0.61	0.55	0.47	0.47
$\bar{T}_a$	9.6	9.5	11.2	13.1	17.6	21.4	24.7	25.1	21.8	18.6	14.2	10.9
HDD	247	233	204	146	37	2	0	0	0	17	108	207
CDD	0	0	0	0	23	99	202	221	118	42	2	0

Rest of the world

Table A7.14 Adelaide, AU: Latitude (S), 34.92°; Longitude (E), 138.60°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	24.66	22.36	17.96	13.61	9.94	8.32	9.22	11.92	15.73	19.69	22.75	24.19
$\bar{K}_T$	0.57	0.57	0.55	0.54	0.52	0.51	0.53	0.53	0.54	0.54	0.54	0.54
$\bar{T}_a$	22.8	23.0	20.5	17.4	13.9	11.2	10.1	10.9	13.3	16.0	19.3	21.5
HDD	2	2	13	50	124	190	228	206	142	85	33	10
CDD	152	147	90	32	6	0	0	0	7	24	73	118

Table A7.15 Montreal, CA: Latitude (N), 45.50°; Longitude (W), 73.58°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	5.69	9.07	13.03	16.06	18.32	20.20	19.87	17.68	13.57	8.57	5.22	4.61
$\bar{K}_T$	0.47	0.51	0.51	0.48	0.46	0.48	0.49	0.50	0.48	0.42	0.38	0.44
$\bar{T}_a$	-11.2	-9.6	-4.2	4.7	12.6	18.5	21.0	19.9	15.1	7.7	0.7	-7.1
HDD	912	788	689	397	178	43	7	17	103	317	519	783
CDD	0	0	0	0	7	53	97	80	23	0	0	0

Table A7.16 New Delhi, IN: Latitude (N), 28.60°; Longitude (E), 77.20°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	13.68	16.85	20.88	22.68	23.11	21.85	18.79	17.28	18.18	17.39	15.05	12.67
$\bar{K}_T$	0.61	0.62	0.64	0.60	0.57	0.53	0.46	0.45	0.53	0.60	0.64	0.60
$\bar{T}_a$	13.3	16.6	22.6	28.0	31.1	31.7	29.2	28.0	26.7	23.7	19.3	14.7
HDD	129	48	2	0	0	0	0	0	0	0	5	79
CDD	2	19	149	295	399	405	346	311	269	190	62	4

Table A7.17 Pretoria, SA: Latitude (S), 24.70°; Longitude (E), 28.23°

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\bar{H}$	23.76	22.10	20.16	17.89	16.60	15.23	16.52	18.68	21.96	22.57	23.04	23.40
$\bar{K}_T$	0.55	0.55	0.57	0.60	0.68	0.69	0.72	0.69	0.67	0.59	0.55	0.54
$\bar{T}_a$	23.2	23.1	22.1	19.4	16.0	12.6	12.4	15.5	19.4	21.3	22.0	22.5
HDD	0	0	0	8	59	148	161	80	18	6	2	0
CDD	163	145	130	56	10	0	0	9	62	109	122	142

Table A7.18 Rio de Janeiro, BR: Latitude (S), 22.90°; Longitude (W), 43.23°												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\overline{H}$	18.76	19.48	17.14	15.48	13.18	13.14	13.18	15.55	15.05	17.06	17.89	18.04
$\overline{K}_T$	0.44	0.48	0.48	0.51	0.52	0.57	0.55	0.55	0.45	0.44	0.43	0.42
$\overline{T}_a$	24.6	24.7	23.7	22.5	20.6	19.6	19.4	20.5	21.3	22.3	22.8	23.6
HDD	0	0	0	0	2	8	17	10	6	3	1	0
CDD	212	196	189	148	98	74	72	98	110	142	153	187