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SIX- AND THREE-HOURLY METEOROLOGICAL OBSERVATIONS FROM 223 U.S.S.R. STATIONS

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ШЕСТИ- И ТРЕХ-ЧАСОВЫЕ МЕТЕОРОЛОГИЧЕСКИЕ НАБЛЮДЕНИЯ ПО ДАННЫМ 223-х СТАНЦИЙ СССР

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ABSTRACT

RAZUVAEV, V. N., E. G. APASOVA, and R. A. MARTUGANOV. 1995.
Six- and Three-hourly Meteorological Observations from 223 U.S.S.R. Stations. ORNL/CDIAC-66, NDP-048. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 133 pp.

This document describes a database containing 6- and 3-hourly meteorological observations from a 223-station network of the former Soviet Union. These data have been made available through cooperation between the two principal climate data centers of the United States and Russia: the National Climatic Data Center (NCDC), in Asheville, North Carolina, and the All-Russian Research Institute of Hydrometeorological Information – World Data Centre (RIHMI-WDC) in Obninsk. Station records consist of 6- and 3-hourly observations of some 24 meteorological variables including temperature, weather type, precipitation amount, cloud amount and type, sea level pressure, relative humidity, and wind direction and speed. The 6-hourly observations extend from 1936 to 1965; the 3-hourly observations extend from 1966 through the mid-1980s (1983, 1984, 1985, or 1986; depending on the station). These data have undergone extensive quality assurance checks by RIHMI-WDC, NCDC, and the Carbon Dioxide Information Analysis Center (CDIAC). The database represents a wealth of meteorological information for a large and climatologically important portion of the earth's land area, and should prove extremely useful for a wide variety of regional climate change studies.

These data are available free of charge as a numeric data package (NDP) from CDIAC. The NDP consists of this document and 40 data files that are available via the Internet or on 8mm tape. The total size of the database is ~2.6 gigabytes.

Keywords: U.S.S.R., former Soviet Union, Russia, hourly data, air temperature, dew point temperature, relative humidity, water vapor pressure, sea level pressure, visibility, cloud amount, cloud height, wind direction, wind speed, precipitation amount, soil temperature, weather type, atmospheric phenomena

РЕЗЮМЕ

РАЗУВАЕВ, В. Н., Е. Г. АПАЗОВА, Р. А. МАРТУГАНОВ. 1995. Шести- и трех-часовые метеорологические наблюдения по данным 223-х станций СССР. ОРНЛ/ЦАИ-66, ПЦД-048, Центр Анализа Информации по Углекислому Газу Окриджская Национальная Лаборатория, Ок Ридж, Теннесси. 133 стр.

Настоящий документ представляет описание базы данных, содержащей шести- и трех-часовые метеорологические наблюдения по данным 223-х станций бывшего Советского Союза. Эти данные оказались доступными благодаря сотрудничеству между двумя центрами климатических данных Соединенных Штатов Америки и России: Национальный Центр Климатических Данных (НЦКД) в Ашвилле, Северная Каролина и Научно-Исследовательский Институт Гидрометеорологической Информации — Мировой Центр Данных (ВНИИГМИ—МЦД) в Обнинске, Россия. Архивы станционных данных содержат записи 6- и 3-часовых наблюдений примерно 24х метеорологических переменных, включая температуру, тип погоды, количество осадков, облачность, давление на уровне моря, относительную влажность, а так же скорость и направление ветра. 6-часовые наблюдения были собраны в период с 1936 по 1965 годы; 3-часовые наблюдения проводились, начиная с 1966 года до середины 1980-х годов (1983, 1984, 1985, или 1986, в зависимости от станции). Все данные были подвержены тщательной проверке на качество во ВНИИГМИ—МЦД, НЦКД и Центре Анализа Информации по Углекислому Газу (ЦАИ). База данных содержит богатую метеорологическую информацию по огромной, климатически важной части суши Земли, и должна представлять большую пользу в процессе изучения регионального изменения климата.

Настоящие данные можно заказать бесплатно в виде Пакета Цифровых Данных (ПЦД) через ЦАИ. ПЦД состоит из настоящего документа и 40 файлов, которые доступны через Интернет или на 8-мм магнитной ленте. Общий объем базы данных составляет примерно 2.6 гигавайт.

Ключевые слова: СССР, бывший Советский Союз, почасовые данные, температура воздуха, температура точки росы, относительная влажность, испарение, давление на уровне моря, видимость, облачность, высота облаков, направление ветра, скорость ветра, количество осадков, температура почвы, тип погоды, атмосферный феномен.

PART 1

OVERVIEW OF THE DATABASE

1. BACKGROUND INFORMATION

In recent years, a great deal of meteorological data have been exchanged between the two principal climate data centers of the United States and the former Soviet Union: the National Climatic Data Center (NCDC), in Asheville, North Carolina, and the All-Russian Research Institute of Hydrometeorological Information–World Data Centre (RIHMI-WDC) in Obninsk, Russia. This was accomplished via Working Group VIII (*Influence of Environmental Changes on Climate*) of the bilateral initiative known as the *Agreement on Protection of the Environment*, established on May 23, 1972, by the United States and the U.S.S.R. Working Group VIII established the Climate Data Exchange and Management Agreement Project, the purpose of which is to promote the sharing of climatological data between NCDC and RIHMI-WDC. Surface meteorological and climatological data for the U.S.S.R. that have been received by NCDC from RIHMI-WDC to date include

- monthly mean temperature data from 243 stations (1891–1988),
- daily temperature and precipitation data from 223 stations (1881–1989),
- 6-hourly observations from the above 223 stations (1936–1965), and
- 3-hourly observations from the above 223 stations (1966–1983[1]).

The Carbon Dioxide Information Analysis Center (CDIAC), through a cooperative agreement with NCDC, has packaged and made available to the public the first two of the databases referred to above. The monthly mean temperature data from 243 stations (1891–1988) are included in the Global Historical Climatology Network database (Vose et al. 1992); the daily temperature and precipitation data from 223 stations (1881–1989) are documented in Razuvaev et al. (1993). The purpose of this document is to make available the 6- and 3-hourly observations from this 223-station network. These hourly data represent a wealth of meteorological information for a large and climatologically important part of the earth's land area and are described in the following sections.

2. DESCRIPTION OF THE DATABASE

The data records contained in this numeric data package (NDP) include 24 types of meteorological observations from each of the 223 U.S.S.R. stations. These observations appear in each record of the database in the order given below.

- Relative humidity
- Water vapor pressure
- Sea level pressure
- Humidity deficit
- Pressure tendency characteristic
- Pressure tendency value
- Horizontal visibility
- Height of cloud base
- Dew point temperature
- Ground state (description of the state of the ground surface)

[1]All records extend at least through 1983; some extend through 1984, 1985, or 1986.

- Total cloud amount
- Low-cloud amount
- Wind direction
- Wind speed
- Precipitation amount
- Air pressure at station level
- Near-surface air temperature
- Soil surface temperature
- Past weather
- Present weather
- Atmospheric phenomena
- High-level cloud type
- Mid-level cloud type
- Low-level cloud type
- Characteristic of wind irregularity (only present in 6-hourly observations)

Detailed descriptions of all variables are presented in Part 2. Observations of the last variable in the above list—characteristic of wind irregularity—are only present in the 6-hourly data, which run through 1965. Observations of all other variables are, for the most part, present throughout each station's record. Each record of the database contains entries for all variables at a specific observation hour. (Sample records are shown in Sect. 7, Table 8.) Over the period 1936–65 observations were carried out at 0100, 0700, 1300, and 1900 Local Mean Time (LMT). From 1966 through 1986, observations were made at 0000, 0300, 0600, 0900, 1200, 1500, 1800, and 2100 Moscow Legal Time (MLT). In the version of the database presented here, times of observation have been converted to Greenwich Mean Time (GMT) (3 h earlier than MLT); the GMTs of observations vary with station as a function of time zone (longitude). In converting LMT to GMT each station had to be assigned a specific time zone. For a small number of stations there was some uncertainty involved in this; however, the potential error is no more than 1 h in any case.

Not all stations have data for 1936–86; some station records begin after 1936, some have gaps ranging from one month to several years, and most extend only through 1983 or 1984. An inventory of the 223-station network—including each station's name, World Meteorological Organization (WMO) station number, latitude, longitude, elevation above sea level, and beginning and ending years of record—is given in Table 1. Stations with gaps in their period of record are identified in Table 1, with these gaps presented in detail in Table 2. A map showing the locations of all 223 stations is presented in Fig. 1.

Table 1. Inventory of stations in the 223-station U.S.S.R. network

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
1	20674	OSTROV DIKSON	73.50	80.40	42.0	01/1936	12/1984
2	20891[b]	HATANGA	71.98	102.47	30.0	01/1936	12/1984
3	21946[b]	COKURDAH	70.62	147.88	0.0	08/1944	12/1984
4	21982[b]	OSTROV VRANGELJA	70.97	181.63	2.0	01/1936	12/1984
5	22113	MURMANSK	68.97	33.05	57.0	01/1936	12/1984
6	22217	KANDALAKSA	67.13	32.43	26.0	01/1936	12/1984
7	22522	KEM'-PORT	64.98	34.7	7.3	01/1936	12/1983
8	22550	ARHANGEL'SK	64.58	40.50	8.0	01/1936	12/1983
9	22583	KOJNAS	64.75	47.65	63.0	01/1936	12/1983
10	22602[b]	REBOLY	63.82	30.82	179.0	02/1936	12/1983
11	22641	ONEGA	63.90	38.12	11.0	01/1936	12/1983
12	22802	SORTOVALA	61.72	30.72	17.0	01/1945	12/1983
13	22820[b]	PETROZAVODSK	61.82	34.27	110.0	01/1936	12/1983
14	22837	VYTEGRA	61.02	36.45	55.0	01/1936	12/1983
15	22887	KOTLAS	61.23	46.63	56.0	01/1936	12/1983
16	23146[b]	MYS KAMENNYJ	68.47	73.60	2.0	03/1950	12/1984
17	23205	NAR'JAN-MAR	67.65	53.02	5.0	11/1947	12/1983
18	23219	HOSEDA-HARD	67.08	59.38	82.0	01/1936	12/1983
19	23405	UST'-CIL'MA	65.45	52.17	72.0	01/1936	12/1983
20	23418	PECORA	65.12	57.10	54.5	09/1943	12/1983
21	23472	TURUHANSK	65.78	87.95	37.0	01/1936	12/1984
22	23631	BEREZOVO	63.93	65.05	27.0	01/1936	12/1984
23	23711	TROICKO-PECERSKOE	62.70	56.20	135.0	01/1936	12/1983
24	23724[b]	NJAKSIMVOL'	62.43	60.87	50.0	01/1936	12/1984
25	23804[b]	SYKTYVKAR	61.67	50.85	96.0	01/1950	12/1983
26	23849	SURGUT	61.25	73.50	44.0	01/1936	09/1984
27	23884[b]	BOR	61.60	90.00	62.0	01/1936	12/1984
28	23891[b]	BAJKIT	61.67	96.37	256.0	01/1936	12/1984
29	23921	IVDEL'	60.68	60.43	93.0	01/1936	12/1984
30	23933[b]	HANTY-MANSIJSK	60.97	69.07	45.0	01/1936	12/1984
31	23955	ALEKSANDROVSKOE	60.43	77.87	47.0	01/1936	12/1984
32	24125[b]	OLENEK	68.50	112.43	216.5	01/1936	12/1984
33	24266[b]	VERHOJANSK	67.55	133.38	136.0	01/1936	12/1984
34	24343[b]	ZIGANSK	66.77	123.40	88.0	02/1936	12/1984
35	24507	TURA	64.17	100.07	188.0	01/1936	12/1984
36	24641	VILJUJSK	63.77	121.62	110.8	01/1936	12/1984
37	24688	OJMJAKON	63.27	143.15	740.0	01/1943	12/1984
38	24738	SUNTAR	62.15	117.65	131.0	02/1936	12/1984
39	24817[b]	ERBOGACEN	61.27	108.02	284.0	03/1936	12/1984
40	24908[b]	VANAVARA	60.33	102.27	259.0	01/1936	12/1984

Table 1. (continued)

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
41	24944[b]	OLEKMINSK	60.40	120.42	223.0	01/1936	12/1984
42	24951[b]	ISIT'	60.82	125.32	117.0	01/1936	12/1984
43	24959	JAKUTSK	62.08	129.75	98.5	01/1937	12/1984
44	24966	UST'-MAJA	60.38	134.45	169.0	01/1936	12/1984
45	25173	MYS SMIDTA	68.92	180.52	3.3	01/1936	12/1984
46	25551[b]	MARKOVO	64.68	170.42	25.0	07/1937	12/1984
47	25563[b]	ANADYR'	64.78	177.57	64.0	01/1936	12/1984
48	25594[b]	BUHTA PROVIDENJA	64.43	186.77	9.0	01/1936	12/1984
49	25703[b]	SEJMCAN	62.92	152.42	206.0	01/1936	12/1984
50	25744	KAMENSKOE	62.48	166.22	33.0	01/1950	08/1986
51	25913	MAGADAN	59.58	150.78	115.0	01/1936	12/1984
52	25954[b]	KORF	60.35	166.00	2.0	01/1936	08/1986
53	26038	TALLIN	59.42	24.80	41.0	01/1947	12/1983
54	26063	ST. PETERSBURG-TOWN/VILLE	59.97	30.30	4.0	01/1936	12/1983
55	26188[b]	VEREB'E	58.68	32.70	116.0	01/1936	12/1983
56	26231	PJARNU	58.38	24.50	1.0	08/1945	12/1983
57	26258[b]	PSKOV	57.83	28.35	42.0	01/1936	12/1983
58	26406	LIEPAJA	56.55	21.02	4.0	06/1945	12/1983
59	26422	RIGA	56.97	24.07	7.0	01/1945	12/1983
60	26477[b]	VELIKIE LUKI	56.38	30.60	98.0	01/1936	12/1983
61	26629	KAUNAS	54.88	23.88	76.0	01/1943	12/1983
62	26702	KALININGRAD	54.70	20.62	20.0	01/1947	12/1983
63	26730	VIL'NJUS	54.63	25.28	162.0	01/1945	12/1983
64	26781	SMOLENSK	54.75	32.07	236.0	01/1944	12/1983
65	26850[b]	MINSK	53.87	27.53	222.0	01/1939	12/1984
66	27037	VOLOGDA	59.28	39.87	125.0	11/1983	12/1983
67	27196	VJATKA	58.65	49.62	165.0	01/1940	12/1985
68	27333	KOSTROMA	57.73	40.95	137.0	01/1936	12/1985
69	27553	NIJNIJ NOVGOROD	56.22	43.82	161.0	01/1936	12/1985
70	27595[b]	KAZAN'	55.78	49.18	116.0	01/1936	12/1983
71	27612[b]	MOSKVA	55.75	37.57	147.0	01/1936	12/1983
72	27648	ELAT'MA	54.95	41.77	132.0	01/1936	12/1985
73	27823[b]	PAVELEC	53.78	39.25	209.0	01/1936	12/1985
74	27947	TAMBOV	52.73	41.47	139.0	01/1936	12/1983
75	28064	LEUSI	59.62	65.78	72.8	01/1936	12/1984
76	28138[b]	BISER	58.52	58.85	463.0	01/1936	12/1984
77	28225	PERM	58.02	56.30	169.0	01/1936	12/1984
78	28275[b]	TOBOL'SK	58.15	68.18	48.5	01/1936	12/1984
79	28411	IZEVSK	56.82	53.27	155.0	01/1958	12/1985
80	28434	KRASNOUFIMSK	56.62	57.75	20.6	01/1936	12/1984

Table 1. (continued)

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
81	28440[b]	EKATERINBURG	56.80	60.63	282.0	01/1936	12/1984
82	28493[b]	TARA	56.90	74.38	73.0	01/1936	12/1983
83	28661	KURGAN	55.47	65.40	70.0	01/1936	12/1984
84	28679	PETROPAVLOVSK	54.83	69.15	134.0	01/1936	12/1985
85	28698	OMSK	54.93	73.40	121.0	01/1936	12/1984
86	28722	UFA	54.75	56.00	104.0	01/1936	12/1984
87	28900	SAMARA, BEZENCUK	53.25	50.45	137.0	01/1936	12/1983
88	28952	KUSTANAJ	53.22	63.62	169.0	01/1936	12/1985
89	29231	KOLPASEV	58.30	82.90	80.0	01/1936	12/1984
90	29263	ENISEJSK	58.45	92.15	77.0	01/1936	12/1984
91	29282[b]	BOGUCANY	58.42	97.40	134.0	01/1936	12/1984
92	29430	TOMSK	56.43	84.97	137.0	01/1936	12/1984
93	29574	KRASNOJARSK	56.00	92.88	274.0	01/1936	12/1984
94	29612	BARABINSK	55.37	78.40	120.0	01/1936	12/1984
95	29698	NIZNE-UDINSK	54.88	99.03	410.0	01/1940	12/1984
96	29807	IRTYSSK	53.35	75.45	93.0	01/1936	12/1985
97	29838	BARNAUL	53.33	83.70	153.0	01/1959	12/1984
98	29866	MINUSINSK	53.70	91.70	251.0	01/1936	12/1984
99	30054	VITIM	59.45	112.58	186.3	01/1936	12/1984
100	30230[b]	KIRENSK	57.77	108.12	256.0	01/1936	12/1984
101	30253	BODAJBO	57.85	114.20	278.0	01/1936	12/1984
102	30372[b]	CARA	56.92	118.37	708.0	06/1938	12/1984
103	30393[b]	CUL'MAN	56.83	124.87	843.9	01/1936	12/1984
104	30521[b]	ZIGALOVO	54.80	105.17	426.0	08/1937	12/1984
105	30555	TROICKIJ PRIISK	54.62	113.13	1315.0	03/1938	12/1984
106	30636	BARGUZIN	53.62	109.63	488.0	01/1936	12/1984
107	30673	MOGOCA	53.73	119.78	624.0	01/1936	12/1984
108	30692	SKOVORODINO	54.00	123.97	397.5	01/1936	12/1984
109	30710	IRKUTSK	52.27	104.35	467.0	01/1936	12/1984
110	30758	CITA	52.02	113.33	471.0	01/1936	12/1984
111	30777	SRETENSK	52.27	117.70	528.0	01/1936	12/1984
112	30823[b]	ULAN-UDE	51.80	107.43	514.0	01/1936	12/1984
113	30925[b]	KJAHTA	50.37	106.45	791.0	01/1936	12/1984
114	30949[b]	KYRA	49.57	111.97	907.0	01/1936	12/1984
115	30965[b]	BORZJA	50.38	116.52	675.0	01/1936	12/1984
116	31004	ALDAN	58.62	125.37	678.0	01/1936	12/1984
117	31088	OHOTSK	59.37	143.20	5.0	01/1936	12/1984
118	31168	AJAN	56.45	138.15	7.0	01/1936	12/1984
119	31253	BOMNAK	54.72	128.93	357.0	01/1936	12/1984
120	31329	EKIMCAN	53.07	132.93	540.0	01/1936	12/1984

Table 1. (continued)

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
121	31369[b]	NIKOLAEVSK-NA-AMURE	53.15	140.70	46.0	01/1936	12/1984
122	31388	NORSK	52.35	129.92	207.0	01/1936	12/1984
123	31416[b]	IM POLINY OSIPENKO	52.42	136.50	71.0	01/1936	12/1984
124	31510	BLAGOVESCENSK	50.27	127.50	130.0	01/1936	12/1984
125	31532[b]	CEKUNDA	50.82	132.17	271.0	01/1936	12/1984
126	31594	ARHARA	49.42	130.08	133.0	01/1936	12/1984
127	31707	EKATERINO-NIKOL'SKOE	47.73	130.97	72.0	01/1936	12/1984
128	31735	HABAROVSK	48.52	135.17	88.0	05/1952	12/1984
129	31829[b]	MYS ZOLOTOJ	47.32	138.98	27.0	01/1936	08/1986
130	31873	DAL'NERECENSK	45.87	133.73	97.0	10/1939	08/1986
131	31909	TERNEJ	45.03	136.67	51.0	02/1940	12/1984
132	31915	POGRANICNYJ	44.40	131.38	217.0	01/1936	08/1986
133	31960[b]	VLADIVOSTOK	43.12	131.90	183.0	01/1936	08/1986
134	32061	ALEKSANDROVSK-SAHALINSKIJ	50.90	142.17	30.0	01/1936	12/1984
135	32098	PORONAJSK	49.22	143.10	7.0	11/1946	12/1984
136	32165	JUZNO-KURIL'SK	44.02	145.82	44.0	01/1947	12/1984
137	32389	KLJUCI	56.32	160.83	28.0	01/1936	08/1986
138	32411[b]	ICA	55.70	155.63	10.0	01/1936	08/1986
139	32540[b]	PETROPAVLOVSK-KAMCATSKIJ	52.97	158.75	-999.9	01/1936	08/1986
140	32564	OKTIABR'SKAYA	52.67	156.23	6.0	01/1936	08/1986
141	33008	BREST	52.12	23.68	141.0	08/1944	12/1984
142	33038	VASILEVICI	52.25	29.83	139.0	03/1944	12/1984
143	33345[b]	KIEV	50.40	30.45	167.0	01/1936	12/1985
144	33377[b]	LUBNY	50.02	33.00	156.0	01/1936	12/1983
145	33393[b]	L'VOV	49.82	23.95	326.0	07/1940	12/1983
146	33562[b]	VINNICA	49.23	28.47	281.0	01/1936	12/1983
147	33631	UZGOROD	48.63	22.27	115.0	05/1946	12/1983
148	33658	CERNOVCY	48.27	25.97	239.0	03/1941	12/1983
149	33815	KISINEV	47.02	28.87	173.0	01/1945	12/1983
150	33837[b]	ODESSA	46.48	30.63	42.0	01/1936	12/1983
151	33889	IZMAIL	45.37	28.87	28.0	01/1946	12/1983
152	33910[b]	GENICESK	46.17	34.82	14.0	01/1936	12/1983
153	33915[b]	ASKANIJA-NOVA	46.45	33.88	28.0	01/1936	12/1983
154	33946	SIMFEROPOL'	45.02	33.98	204.0	01/1955	12/1983
155	33976[b]	FEODOSIJA	45.03	35.38	22.0	01/1936	12/1983
156	33983[b]	KERC'	45.37	36.43	32.0	01/1955	12/1983
157	34009[b]	KURSK	51.65	36.18	246.0	01/1936	12/1983
158	34122[b]	VORONEZ	51.70	39.17	147.0	03/1936	12/1983
159	34139[b]	KAMENNAJA STEP'	51.05	40.70	193.0	01/1940	12/1983
160	34163[b]	OKTJABR'SKIJ GORODOK	51.63	45.45	202.0	01/1936	12/1983

Table 1. (continued)

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
161	34172[b]	SARATOV	51.57	46.03	126.0	01/1936	12/1983
162	34300[b]	HAR'KOV	49.93	36.28	147.0	01/1936	12/1983
163	34391[b]	ALEKSANDROV-GAJ	50.15	48.55	23.0	01/1936	12/1983
164	34524[b]	DEBAL'CEVO	48.35	38.43	334.0	01/1936	12/1983
165	34646[b]	VOLGODONSK	47.73	42.25	64.0	01/1936	12/1983
166	34731[b]	ROSTOV-NA-DONU	47.25	39.82	66.0	01/1936	12/1983
167	34747[b]	CELINA	46.55	41.05	111.0	01/1936	12/1983
168	34824	PRIMORSKO-AHTARSK	46.03	38.15	3.0	01/1959	12/1983
169	34861	ELISTA	46.32	44.30	151.0	01/1936	12/1983
170	34880[b]	ASTRAHAN'	46.27	48.03	-22.0	01/1936	12/1983
171	35078	ATBASAR	51.82	68.37	303.0	01/1936	12/1985
172	35108[b]	URAL'SK	51.25	51.40	36.0	01/1936	12/1985
173	35121	ORENBURG	51.75	55.10	115.0	01/1936	12/1983
174	35133	ADAMOVKA	51.52	59.95	285.0	01/1936	12/1983
175	35188	AKMOLINSK	51.13	71.37	347.0	01/1936	12/1985
176	35229	AKTJUBINSK	50.28	57.15	219.0	01/1936	12/1985
177	35358[b]	TURGAJ	49.63	63.50	124.0	01/1936	12/1985
178	35394	KARAGANDA	49.80	73.13	550.0	01/1936	12/1985
179	35406[b]	KALMYKOVO	49.05	51.87	1.0	01/1936	12/1985
180	35416[b]	UIL	49.07	54.68	88.0	01/1936	12/1985
181	35542[b]	IRGIZ	48.62	61.27	114.0	01/1936	12/1985
182	35576[b]	KZYL-ZAR	48.30	69.65	361.0	11/1937	12/1985
183	35663	KARSAKPAJ	47.83	66.75	488.0	01/1936	12/1985
184	35700	GUR'EV	47.02	51.85	-24.0	01/1936	12/1985
185	35746[b]	ARAL'SKOE MORE	46.78	61.67	62.0	01/1936	12/1985
186	35796[b]	BALHAS	46.90	75.00	347.0	01/1936	12/1985
187	36034	RUBCOVSK	51.50	81.22	216.0	01/1936	12/1984
188	36177[b]	SEMIPALATINSK	50.35	80.25	195.0	01/1936	12/1985
189	36665	ZAJSAN	47.47	84.92	604.0	01/1936	12/1985
190	36729[b]	UC-ARAL	46.17	80.93	397.0	01/1936	12/1985
191	36859	PANFILOV	44.17	80.07	641.0	01/1936	12/1985
192	36870	ALMA-ATA	43.23	76.93	847.0	01/1936	12/1985
193	36974[b]	NARYN	41.43	76.00	2039.0	01/1936	12/1984
194	37031[b]	ARMAVIR	44.98	41.12	158.0	01/1936	12/1983
195	37050[b]	PJATIGORSK	44.05	43.03	531.0	01/1936	12/1983
196	37099[b]	SOCI	43.58	39.72	57.0	01/1936	12/1983
197	37235[b]	GROZNYJ	43.35	45.68	123.0	08/1938	12/1983
198	37385	SAMTREDIA	42.18	42.37	28.0	01/1936	12/1983
199	37472[b]	MAHACKALA	43.02	47.43	-21.0	01/1936	12/1983
200	37549	TBILISI	41.68	44.95	427.0	01/1936	12/1983

Table 1. (continued)

Ref. No.[a]	WMO No.	Station Name	Lat. (°N)	Long. (°E)	Elev. (m)	Beginning month/year	Ending month/year
201	37686	GUMRY	40.78	43.83	1523.0	01/1936	12/1983
202	37735	GYANDJA	40.72	46.42	308.0	01/1936	12/1983
203	37789	EREVAN	40.13	44.47	888.0	01/1936	12/1983
204	38198	TURKESTAN	43.27	68.22	206.0	01/1936	12/1985
205	38262	CIMBAJ	42.95	59.82	64.7	01/1937	12/1984
206	38353	BISHKEK	42.83	74.58	756.0	01/1939	12/1984
207	38413[b]	TAMDY	41.73	64.62	236.0	01/1936	12/1984
208	38457	TASKENT	41.27	69.27	477.0	01/1936	12/1984
209	38507[b]	KRASNOVODSK	40.03	52.98	89.0	01/1936	12/1984
210	38599	LENINABAD	40.22	69.73	425.0	01/1936	12/1984
211	38618	FERGANA	40.37	71.75	577.8	01/1936	12/1984
212	38687	CARDZOU	39.08	63.60	188.0	01/1936	12/1984
213	38696	SAMARKAND	39.57	66.95	725.0	01/1936	12/1984
214	38750[b]	GASAN-KULI	37.47	53.97	-24.0	01/1936	12/1984
215	38763	KIZYL-ARVAT	38.98	56.28	97.0	01/1936	12/1984
216	38836	DUSANBE	38.58	68.78	796.0	01/1936	12/1984
217	38880[b]	ASHABAD	37.97	58.33	227.0	06/1937	12/1984
218	38895	BAJRAM-ALI	37.60	62.18	240.0	01/1936	12/1984
219	38927[b]	TERMEZ	37.23	67.27	309.0	01/1936	12/1984
220	38933	KURGAN-TJUBE	37.82	68.78	427.0	01/1936	12/1984
221	38954[b]	HOROG	37.50	71.50	2077.0	09/1936	12/1984
222	38974[b]	SERAHS	36.53	61.22	275.0	01/1936	12/1984
223	38987[b]	KUSKA	35.28	62.35	625.0	01/1936	12/1984

[a]Reference number; assigned for ease in locating each station on the map shown in Fig. 1.
[b]Station has missing data for at least one month. See Table 2 for details.

Table 2. Gaps in the periods of record of the 223 U.S.S.R. stations

WMO No.	Month/year range of gap (inclusive)	WMO No.	Month/year range of gap (inclusive)
20891	07/1944 – 06/1946	27595	01/1942 – 03/1943
21946	08/1947 – 09/1947	27612	03/1941
21982	10/1943		12/1943
22602	03/1937	27823	10/1941 – 01/1942
	05/1937	28138	12/1955
	07/1937 – 08/1937	28275	04/1944
	02/1940 – 03/1940	28440	01/1938 – 12/1939
	06/1941 – 05/1945	28493	03/1944
22820	09/1941 – 07/1944	29282	07/1944
23146	07/1959		04/1945
23724	09/1947 – 11/1947	30230	10/1941
23804	01/1961 – 03/1961		01/1942
23884	01/1958 – 12/1958		04/1943 – 08/1943
23891	01/1936 – 01/1937		12/1943 – 01/1944
	05/1937 – 07/1937		07/1944 – 08/1944
23933	03/1960 – 07/1961	30372	12/1941
24125	04/1939 – 08/1939	30393	08/1936
	04/1945 – 08/1946		12/1936
	01/1949 – 03/1949		11/1943 – 03/1944
24266	07/1950 – 09/1950		08/1944 – 11/1944
24343	02/1954	30521	11/1937 – 12/1937
	04/1963		05/1938
24817	01/1937 – 05/1938		12/1946
	05/1944	30823	08/1942 – 09/1947
24908	04/1938 – 08/1938	30925	11/1944 – 02/1945
	05/1948		07/1946
24944	01/1942		03/1947
24951	04/1943 – 05/1943	30949	03/1936
	10/1943 – 12/1945		12/1937
25551	09/1937		01/1942 – 03/1942
	07/1938 – 08/1938		08/1942
	05/1940 – 12/1943		11/1942 – 12/1942
25563	12/1936		05/1943
	07/1949 – 08/1949		08/1943 – 04/1944
25594	03/1938 – 03/1939		03/1945 – 10/1945
25703	06/1938 – 12/1942		12/1945
25954	02/1946		02/1946 – 06/1946
	08/1946 – 04/1947	30965	06/1939
26188	08/1941 – 12/1943		08/1939
26258	07/1941 – 08/1944		07/1951
26477	06/1941 – 02/1946		
26850	04/1941 – 07/1944		

Table 2. (continued)

WMO No.	Month/year range of gap (inclusive)
31369	01/1945 – 07/1945
	01/1948
31416	05/1939 – 06/1939
31532	03/1936 – 04/1936
31829	10/1937 – 04/1938
31960	04/1944 – 01/1947
	04/1944 – 01/1947
	01/1960 – 10/1962
32411	05/1937 – 06/1937
	12/1948 – 02/1949
	04/1950
	08/1953 – 09/1953
32540	12/1937
33345	01/1938
	09/1941 – 12/1941
	09/1943 – 12/1943
33377	01/1941 – 02/1941
	09/1941 – 04/1943
	06/1943 – 07/1943
	09/1943 – 10/1943
33393	06/1941 – 11/1944
33562	01/1941 – 02/1941
	07/1941 – 09/1941
	01/1942 – 08/1943
	01/1944
	03/1944
33837	10/1941 – 12/1943
33910	09/1941 – 07/1943
	09/1943 – 01/1944
33915	08/1941 – 09/1941
	11/1941 – 12/1941
	10/1943 – 02/1944
33976	10/1941 – 12/1942
	02/1943
	10/1943 – 04/1944
34009	02/1943
34122	08/1941
34139	08/1941 – 12/1941
	06/1942 – 08/1942
34163	01/1943 – 02/1944
	03/1948
34172	09/1945
34300	09/1941 – 12/1945
34391	06/1960 – 10/1960
	04/1961 – 10/1961
	04/1962 – 10/1962
	04/1963 – 10/1963
	04/1964 – 10/1964
	04/1965 – 10/1965
34524	09/1941 – 11/1943
34646	07/1955 – 03/1957
34731	10/1941 – 12/1941
	07/1942 – 02/1943
	09/1943 – 12/1943
34747	07/1942 – 03/1943
34880	03/1938
	09/1946
35108	02/1942 – 03/1942
35358	11/1937 – 12/1939
	02/1939
	08/1950 – 12/1953
	05/1954 – 12/1954
35406	05/1943 – 06/1943
	11/1944 – 12/1944
	02/1945 – 07/1946
	05/1961
35416	09/1942
35542	10/1940
	08/1947 – 09/1947
	11/1951
35576	07/1945
	01/1946 – 03/1946
35746	10/1938
35796	02/1936
36177	08/1951
	09/1954 – 10/1954
	10/1955 – 11/1955
	08/1956 – 09/1956
36729	12/1938 – 03/1939
	02/1943 – 03/1943
	09/1945
	05/1947

Table 2. (continued)

WMO No.	Month/year range of gap (inclusive)	WMO No.	Month/year range of gap (inclusive)
36974	10/1938	38507	01/1946 – 12/1946
37031	07/1942 – 01/1943		06/1958 – 09/1960
37050	08/1942 – 02/1943	38750	05/1964 – 07/1964
	03/1948	38880	01/1945 – 12/1950
37099	07/1942 – 12/1944	38927	01/1946 – 12/1947
37235	08/1942	38954	12/1937
37472	01/1941	38974	10/1937 – 12/1937
	12/1946		10/1938
38413	02/1943		12/1938
		38987	07/1941

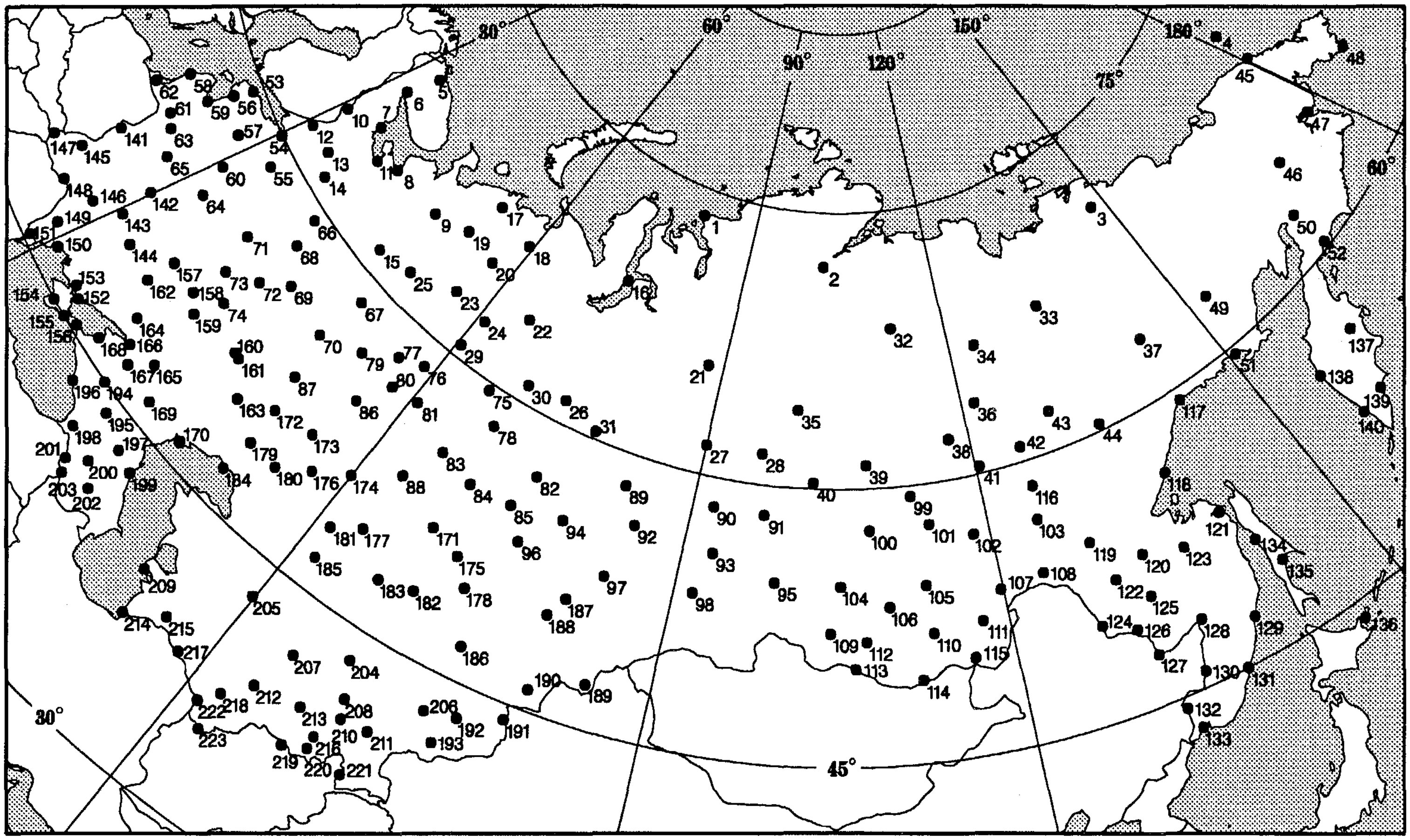

Figure 1. Locations of stations in the 223-station U.S.S.R. network. The number next to each locator symbol corresponds with the reference number assigned to each station in the far left column of Table 1.

3. CDIAC QUALITY ASSURANCE CHECKS

An important part of the data packaging process at CDIAC involves the quality assurance (QA) of data before distribution. Data received by CDIAC are rarely in a condition that would permit immediate distribution, regardless of their source. To guarantee data of the highest possible quality, CDIAC performs extensive QA checks, examining the data for completeness, reasonableness, and accuracy.

Some basic data checks had been performed by RIHMI-WDC and NCDC prior to the arrival of the data at CDIAC. Extensive documentation pertaining to the units, acceptable ranges, and coding of variables in the database was provided by RIHMI-WDC to CDIAC. This information provided a basis for data checks performed by CDIAC and comprises the bulk of the database description presented in Part 2. Descriptions of data checks performed and a few general comments on findings are presented below.

- **Station numbers** in data files were verified through comparison with station inventory information provided in a separate file by RIHMI-WDC.

- **Dates** in data records were checked. Checks included

  - ensuring that the year of all 6-hourly observations was ≥1936 and ≤1965 and that the year of all 3-hourly observations was ≥1966 and ≤1986;
  - ensuring that the month, day, and hour of each observation contained reasonable values (e.g., all months were checked for the correct number of days, and the hour of each observation was checked to make sure it corresponded with the hourly increments prescribed in the RIHMI-WDC documentation);
  - ensuring that data records were sorted chronologically.

- **Gaps** were searched for in the period of record of each station. This included

  - looking for missing individual hourly entries. Where these were discovered, an entry with the appropriate time was inserted that included missing indicators (composed of "9"s) for all meteorological variables. This was done to maintain hour-to-hour continuity (i.e., four and eight entries per day, for the 6- and 3-hourly observations, respectively);
  - checking for missing days in each month that had at least partial data for the month (hourly entries with missing data codes were inserted for the few missing days that were found);
  - checking for missing months or years of data. This type of occurrence is fairly common in the database. Records with missing data values were not inserted where these larger-scale gaps occurred; rather, these occurrences have been detailed in Table 2.

- **Values for each variable** were checked to make sure they were within the acceptable and reasonable ranges prescribed in the RIHMI-WDC documentation. When values outside these ranges were discovered, the complement and/or quality flags associated with that particular variable were set to 9 to indicate suspect data. (See Sect. 6 for details on ranges and data flags.)

Flags determined to be invalid based upon RIHMI-WDC documentation were set to 9 to indicate that the associated data value should be interpreted with caution.

4. HOW TO OBTAIN THE PACKAGE

The U.S.S.R. 6- and 3-hourly database is available free of charge from CDIAC. The files are available on 8mm tape or from CDIAC's anonymous FTP (file transfer protocol) area via the Internet. (Users are asked to contact CDIAC for assistance if neither of these mediums is suited to their particular computing environment.) Obtaining the data from CDIAC's anonymous FTP area requires a computer with FTP software and access to the Internet. A sampling of commands used to obtain the station inventory file from this database is shown below. CDIAC FTP server responses are shown in italics; user entries are bolded. For a full description of commands, contact CDIAC.

>ftp cdiac.esd.ornl.gov or **>ftp 128.219.24.36**
Name: **anonymous**
Password: **YOU@your internet address**
Guest login ok, access restrictions apply.
ftp> **cd /pub/ndp048**
ftp> **dir**
ftp> **get station.inv**
ftp> **quit**
ftp> Goodbye

For non-FTP data acquisitions, users may request data from CDIAC using the following information:

Address:	Carbon Dioxide Information Analysis Center Oak Ridge National Laboratory P.O. Box 2008 Oak Ridge, Tennessee 37831-6335, U.S.A.
Telephone:	(615) 574-3645 (Voice) (615) 574-2232 (Fax)
Electronic mail:	Internet: CDIAC@ORNL.GOV

5. REFERENCES

Razuvaev, V. N., E. G. Apasova, and R. A. Martuganov. 1993. Daily Temperature and Precipitation Data for 223 USSR Stations. ORNL/CDIAC-56, NDP-040. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Vose, R. S., R. L. Schmoyer, P. M. Steurer, T. C. Peterson, R. Heim, T. R. Karl, and J. K. Eischeid. 1992. The Global Historical Climatology Network: Long-term monthly temperature, precipitation, sea level pressure, and station pressure data. ORNL/CDIAC-53, NDP-041. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

PART 2

CONTENT AND FORMAT OF DATA FILES

6. FILE DESCRIPTIONS

This section describes the content and format of each of the 40 files that comprise this NDP (Table 3). File names and numbers and brief descriptions of the files are given below.

- **NDP048.DES** (File 1) describes the details of the database. It contains the text from Sects. 1–7 of this document.

- **INVENT.FOR** (File 2) contains a FORTRAN program for reading **STATION.INV** (File 12).

- **GAPS.FOR** (File 3) contains a FORTRAN program for reading **GAPS.DAT** (File 13).

- **TIMEZONE.FOR** (File 4) contains a FORTRAN program for reading **TIMEZONE.DAT** (File 14).

- **HISTORY.FOR** (File 5) contains a FORTRAN program for reading **STATION.HIS** (File 15).

- **DATA.FOR** (File 6) contains a FORTRAN program for reading **USSR01.DAT–USSR25.DAT** (Files 16–40).

- **INVENT.SAS** (File 7) contains a SAS® program for reading **STATION.INV** (File 12).

- **GAPS.SAS** (File 8) contains a SAS® program for reading **GAPS.DAT** (File 13).

- **TIMEZONE.SAS** (File 9) contains a SAS® program for reading **TIMEZONE.DAT** (File 14).

- **HISTORY.SAS** (File 10) contains a SAS® program for reading **STATION.HIS** (File 15).

- **DATA.SAS** (File 11) contains a SAS® program for reading **USSR01.DAT–USSR25.DAT** (Files 16–40).

- **STATION.INV** (File 12) contains the name, WMO number, latitude, longitude, elevation, beginning month and year of record, and ending month and year of record for each of the 223 stations.

- **GAPS.DAT** (File 13) contains information on stations that have at least one gap at least one month in duration at any time during their period of record.

- **TIMEZONE.DAT** (File 14) contains the time zone of each of the 223 stations, expressed as the number of time zones (hours) east of GMT (referenced by WMO number). This information may be used for converting observations at each U.S.S.R. station from GMT to LMT.

- **STATION.HIS** (File 15) contains information on rain gauge replacement dates and information on the date, direction, and distance of any station relocations.

- **USSR01.DAT–USSR25.DAT** (Files 16–40) contain the 6- and 3-hourly meteorological observations from the 223 stations.

Table 3. Size and format information for the NDP files

File number and description	File size[a] (kB)	Logical records	Record length
1. **NDP048.DES**: Electronic version of Sects. 1–7 of this document. Describes the database.	118.70	2,524	80
2. **INVENT.FOR**: FORTRAN program for reading **station.inv**.	0.42	13	80
3. **GAPS.FOR**: FORTRAN program for reading **gaps.dat**.	0.22	10	80
4. **TIMEZONE.FOR**: FORTRAN program for reading **timezone.dat**.	0.22	9	80
5. **HISTORY.FOR**: FORTRAN program for reading **station.his**.	0.36	11	80
6. **DATA.FOR**: FORTRAN program for reading **ussr01.dat–ussr25.dat**.	2.50	46	80
7. **INVENT.SAS**: SAS® program for reading **station.inv**.	0.20	7	80
8. **GAPS.SAS**: SAS® program for reading **gaps.dat**.	0.11	6	80
9. **TIMEZONE.SAS**: SAS® program for reading **timezone.dat**.	0.12	6	80
10. **HISTORY.SAS**: SAS® program for reading **station.his**.	0.18	7	80
11. **DATA.SAS**: SAS® program for reading **ussr01.dat–ussr25.dat**.	1.03	22	80

File number and description	File size[a] (kB)	Logical records	Record length
12. **STATION.INV**: contains station location data and period of record information. for each of the 223 stations.	16.06	223	71
13. **GAPS.DAT**: contains information on gaps in stations' periods of record.	5.20	200	25
14. **TIMEZONE.DAT**: contains time zone information for each station. Used for converting GMT to LMT.	2.00	223	8
15. **STATION.HIS**: contains information on rain gauge replacements and station relocations.	23.49	810	28
16. **USSR01.DAT**: contains 6- and 3-hourly data for stations 20674–22583	111,303	869,556	127
17. **USSR02.DAT**: contains 6- and 3-hourly data for stations 22602–23219	103,086	805,364	127
18. **USSR03.DAT**: contains 6- and 3-hourly data for stations 23405–23884	108,499	847,648	127
19. **USSR04.DAT**: contains 6- and 3-hourly data for stations 23891–24641	113,609	887,572	127
20. **USSR05.DAT**: contains 6- and 3-hourly data for stations 24688–25173	112,037	875,296	127
21. **USSR06.DAT**: contains 6- and 3-hourly data for stations 25551–26063	108,403	846,900	127
22. **USSR07.DAT**: contains 6- and 3-hourly data for stations 26188–26730	99,049	773820	127

File number and description	File size[a] (kB)	Logical records	Record length
23. **USSR08.DAT**: contains 6- and 3-hourly data for stations 26781–27648	110,294	861,672	127
24. **USSR09.DAT**: contains 6- and 3-hourly data for stations 27823–28440	110,341	862,044	127
25. **USSR10.DAT**: contains 6- and 3-hourly data for stations 28493–29263	114,435	894,028	127
26. **USSR11.DAT**: contains 6- and 3-hourly data for stations 29282–30054	109,746	857,396	127
27. **USSR12.DAT**: contains 6- and 3-hourly data for stations 30230–30692	112,845	881,608	127
28. **USSR13.DAT**: contains 6- and 3-hourly data for stations 30710–31088	112,660	880,160	127
29. **USSR14.DAT**: contains 6- and 3-hourly data for stations 31168–31594	113,706	888,332	127
30. **USSR15.DAT**: contains 6- and 3-hourly data for stations 31707–32098	109,230	853,360	127
31. **USSR16.DAT**: contains 6- and 3-hourly data for stations 32165–33377	110,867	866,148	127
32. **USSR17.DAT**: contains 6- and 3-hourly data for stations 33393–33915	101,154	790,268	127
33. **USSR18.DAT**: contains 6- and 3-hourly data for stations 33946–34300	101,576	793,568	127
34. **USSR19.DAT**: contains 6- and 3-hourly data for stations 34391–35078	105,500	824,224	127

File number and description	File size[a] (kB)	Logical records	Record length
35. **USSR20.DAT**: contains 6- and 3-hourly data for stations 35108–35416	114,889	897,572	127
36. **USSR21.DAT**: contains 6- and 3-hourly data for stations 35542–36665	116,835	912,780	127
37. **USSR22.DAT**: contains 6- and 3-hourly data for stations 36729–37385	112,486	878,804	127
38. **USSR23.DAT**: contains 6- and 3-hourly data for stations 37472–38413	111,924	874,412	127
39. **USSR24.DAT**: contains 6- and 3-hourly data for stations 38457–38836	113,595	887,468	127
40. **USSR25.DAT**: contains 6- and 3-hourly data for stations 38880–38987	87,210	681,332	127

[a]Actual size of files in non-compressed form. Files in CDIAC's anonymous ftp area are compressed and are ~¼ this size.

NDP048.DES (FILE 1)

This file provides a detailed description of the database. It is an electronic version of Sects. 1–7 of this document (figures excluded).

INVENT.FOR (FILE 2)

This file contains the FORTRAN program to read **station.inv** (File 12). The following is a listing of the program.

```
C FORTRAN program to read "station.inv" (File 12)
C
      INTEGER WMO, BMONTH, BYEAR, EMONTH, EYEAR
      REAL LAT, LON, ELEV
      CHARACTER NAME*25
      OPEN (UNIT=1, FILE='station.inv')
   10 READ (1,100,END=99)WMO, NAME, LAT, LON, ELEV, BMONTH,
     *                   BYEAR, EMONTH, EYEAR
  100 FORMAT (I5, 1X, A25, 1x, F5.2, 1x, F7.2, 1x, F6.1, 4x,
     *        I2, 1x, I4, 1x, i2, 1x, i4)
      GO TO 10
   99 STOP
      END
```

GAPS.FOR (FILE 3)

This file contains the FORTRAN program to read **gaps.dat** (File 13). The following is a listing of the program.

```
C FORTRAN program to read "gaps.dat" (File 13)
C
      INTEGER WMO
      CHARACTER GAP*17
      OPEN (UNIT=1, FILE='gaps.dat')
   10 READ (1,100,END=99)WMO, GAP
  100 FORMAT (I5, 3X, A17)
      GO TO 10
   99 STOP
      END
```

TIMEZONE.FOR (FILE 4)

This file contains the FORTRAN program to read **timezone.dat** (File 14). The following is a listing of the program.

```
C FORTRAN program to read "timezone.dat" (File 14)
C
      INTEGER WMO, ZONE
      OPEN (UNIT=1, FILE='timezone.dat')
```

```
   10 READ (1,100,END=99)WMO, ZONE
  100 FORMAT (I5, 1X, I2)
      GO TO 10
   99 STOP
      END
```

HISTORY.FOR (FILE 5)

This file contains the FORTRAN program to read **station.his** (File 15). The following is a listing of the program.

```
C FORTRAN program to read "station.his" (File 15)
C
      INTEGER WMO, YEAR, MONTH, DAY
      CHARACTER TYPE*4, DIST*2, DIRECT*3
      OPEN (UNIT=1, FILE='station.his')
   10 READ (1,100,END=99) WMO, TYPE, YEAR, MONTH, DAY, DIST,
     *                    DIRECT
  100 FORMAT (I5, 1X, A4, 1X, A4, 1X, I2, 1X, I2, 1X, A2, 1X, A3)
      GO TO 10
   99 STOP
      END
```

DATA.FOR (FILE 6)

This file contains a FORTRAN program for reading any of the U.S.S.R. 6- and 3-hourly data files (**ussr01.dat–ussr25.dat**; Files 16–40).

```
C FORTRAN program to read the USSR 6- and 3-hourly data files
C
      INTEGER WMO,YEAR, MONTH, DAY, HOUR, RH, RHQF, VAPORP,VAPQF,
     * SLP, SLPQF, HDEF, HDEFQF, PCHR, PCHRQF, PTND,
     * PTNDQF, VIS, VISCF, VISQF, HCLD, HCLDCF, HCLDQF, TDEW,
     * TDEWQF, GRND, GRNDQF, TCLD, TCLDCF, TCLDQF, LCLD, LCLDCF,
     * LCLDQF, WDIR, WDIRQF, WSPD, WSPDQF, PRCP, PRCPCF, PRCPQF,
     * STAP, STAPQF, SOILT, SOILQF, W, WCF, WQF, WW, WWQF, AIRT,
     * AIRTQF, APH1, APH1CF, APH1QF, APH2, APH2CF, APH2QF, APH3,
     * APH3CF, APH3QF, APH4, APH4CF, APH4QF, APH5, APH5CF,
     * APH5QF, APH6, APH6CF, APH6QF, APH7, APH7CF, APH7QF, CLDH,
     * CLDHCF, CLDHQF, CLDM, CLDMQF, CLDL1, CLDL1F, CLDL2,
     * CLDL2F, CLDL3, CLDL3F, WIR, WIRF
      OPEN (UNIT=1, FILE='ussr01.dat')
   10 READ(1,100,END=99)WMO,YEAR,MONTH,DAY,HOUR,RH,RHQF,VAPORP,
     * VAPQF, SLP, SLPQF, HDEF, HDEFQF, PCHR, PCHRQF, PTND,
     * PTNDQF, VIS, VISCF, VISQF, HCLD, HCLDCF, HCLDQF,
     * TDEW, TDEWQF, GRND, GRNDQF, TCLD, TCLDCF, TCLDQF, LCLD,
     * LCLDCF, LCLDQF, WDIR, WDIRQF, WSPD, WSPDQF, PRCP, PRCPCF,
     * PRCPQF, STAP, STAPQF, SOILT, SOILQF, W, WCF, WQF, WW,
     * WWQF, AIRT, AIRTQF, APH1, APH1CF, APH1QF, APH2, APH2CF,
     * APH2QF, APH3, APH3CF, APH3QF, APH4, APH4CF, APH4QF, APH5,
     * APH5CF, APH5QF, APH6, APH6CF, APH6QF, APH7, APH7CF,
     * APH7QF, CLDH, CLDHCF, CLDHQF, CLDM, CLDMQF, CLDL1, CLDL1F,
```

```
    * CLDL2, CLDL2F, CLDL3, CLDL3F, WIR, WIRF
100 FORMAT (I5, I3, 3I2, 2(I3,I1), I5, I1, I3, 3I1, I3, I1, I2,
    * 2I1, I2, 2I1, I3, 3I1, 2(I2,2I1), 2(I2,I1), I4, 2I1, I5,
    * I1, I3, 4I1, I2, I1, I4, 35I1)
      GO TO 10
 99   STOP
      END
```

INVENT.SAS (FILE 7)

This file contains the SAS®program to read **station.inv** (File 12). The following is a listing of the program.

```
* SAS program to read "station.inv" (File 12);
*;
DATA INVENT;
INFILE 'station.inv';
INPUT WMO 1-5 NAME $ 7-31 LAT 33-37 LON 39-45 ELEV 47-52
      BMONTH 57-58 BYEAR 60-63 EMONTH 65-66 EYEAR 68-71;
RUN;
```

GAPS.SAS (FILE 8)

This file contains the SAS® program to read **gaps.dat** (File 13). The following is a listing of the program.

```
* SAS program to read "gaps.dat" (File 13);
*;
DATA GAPS;
INFILE 'gaps.dat';
INPUT WMO 1-5 GAP $ 9-25;
RUN;
```

TIMEZONE.SAS (FILE 9)

This file contains the SAS® program to read **timezone.dat** (File 14). The following is a listing of the program.

```
* SAS program to read "timezone.dat" (File 14);
*;
DATA ZONES;
INFILE 'timezone.dat';
INPUT WMO 1-5 ZONE 7-8;
RUN;
```

HISTORY.SAS (FILE 10)

This file contains the SAS® program to read **station.his** (File 15). The following is a listing of the program.

```
* SAS program to read "station.his" (File 15);
*;
DATA HIST;
INFILE 'station.his';
INPUT WMO 1-5 TYPE $ 7-10 YEAR 12-15 MONTH 17-18 DAY 20-21
      DIST $ 23-24 DIRECT $ 26-28;
RUN;
```

DATA.SAS (FILE 11)

This file contains a SAS® program (listed below) for reading any of the U.S.S.R. 6- and 3-hourly data files (**ussr01.dat–ussr25.dat**; Files 16–40).

```
* SAS program to read "ussr01.dat" (File 15);
*;
DATA USSR;
INFILE 'ussr01.dat';
INPUT WMO 1-5 YEAR 6-8 MONTH 9-10 DAY 11-12 HOUR 13-14
      RH 15-17 RHQF 18 VAPORP 19-21 VAPQF 22
      SLP 23-27 SLPQF 28 HDEF 29-31 HDEFQF 32
      PCHR 33 PCHRQF 34 PTND 35-37 PTNDQF 38
      VIS 39-40 VISCF 41 VISQF 42 HCLD 43-44 HCLDCF 45
      HCLDQF 46 TDEW 47-49 TDEWQF 50 GRND 51 GRNDQF 52
      TCLD 53-54 TCLDCF 55 TCLDQF 56 LCLD 57-58 LCLDCF 59
      LCLDQF 60 WDIR 61-62 WDIRQF 63 WSPD 64-65 WSPDQF 66
      PRCP 67-70 PRCPCF 71 PRCPQF 72 STAP 73-77 STAPQF 78
      SOILT 79-81 SOILQF 82 W 83 WCF 84 WQF 85 WW 86-87 WWQF 88
      AIRT 89-92 AIRTQF 93 APH1 94 APH1CF 95 APH1QF 96
      APH2 97 APH2CF 98 APH2QF 99 APH3 100 APH3CF 101 APH3QF 102
      APH4 103 APH4CF 104 APH4QF 105 APH5 106 APH5CF 107
      APH5QF 108 APH6 109 APH6CF 110 APH6QF 111 APH7 112
      APH7CF 113 APH7QF 114 CLDH 115 CLDHCF 116 CLDHQF 117
      CLDM 118 CLDMQF 119 CLDL1 120 CLDL1F 121 CLDL2 122
      CLDL2F 123 CLDL3 124 CLDL3F 125 WIR 126 WIRF 127;
RUN;
```

STATION.INV (FILE 12)

This file contains the WMO number, name, latitude, longitude, elevation, beginning month and year of record, and ending month and year of record for each of the 223 stations. Stated in tabular form, the contents include

Variable	Variable type	Variable width	Starting column	Ending column
WMO	Numeric	5	1	5
NAME	Character	25	7	31
LAT	Numeric	5	33	37
LON	Numeric	7	39	45
ELEV	Numeric	6	47	52
BMONTH	Numeric	2	57	58
BYEAR	Numeric	4	60	63
EMONTH	Numeric	2	65	66
EYEAR	Numeric	4	68	71

where

WMO is the WMO No. of the station;

NAME is the name of the station;

LAT is the latitude of the station in decimal degrees north;

LON is the longitude of the station in decimal degrees east;

ELEV is the elevation of the station above sea level (meters)—missing elevations are coded as -999.9;

BMONTH is the beginning month of the station's period of record;

BYEAR is the beginning year of the station's period of record;

EMONTH is the ending month of the station's period of record; and

EYEAR is the ending year of the station's period of record.

GAPS.DAT (FILE 13)

This file contains information on stations that have at least one gap at least one month in duration at any time during their period of record. There are only two variables in the file: WMO (WMO station number, a numeric variable in columns 1–5) and GAP (month/year with no data or the range of months/years with no data, a character variable in columns 9–25).

TIMEZONE.DAT (FILE 14)

This file contains information for converting observations at each U.S.S.R. station from GMT to LMT. There are only two variables in the file: WMO (WMO station number, a numeric variable in columns 1–5) and ZONE (the number of hours that must be added to the GMT of an observation at that particular station to attain the LMT of the observation, a numeric variable in columns 7–8 ranging from 3 to 13 h).

STATION.HIS (FILE 15)

This file contains information on rain gauge replacement dates and information on the date, direction, and distance of any station relocations. There are two types of entries for each station. One type contains the station's WMO No. and rain gauge replacement date. The other type contains the station's WMO No. and a relocation date, distance, and direction. The file is sorted by WMO No., year, month, and day. Stated in tabular form, the contents include

Variable	Variable type	Variable width	Starting column	Ending column
WMO	Numeric	5	1	5
TYPE	Character	4	7	10
YEAR	Numeric	4	12	15
MONTH	Numeric	2	17	18
DAY	Numeric	2	20	21
DIST	Character	2	23	24
DIRECT	Character	3	26	28

where

WMO — is the WMO No. of the station;

TYPE — is the type of change indicated by this entry. The possible values of TYPE are as follows:

RAIN = rain gauge replacement (i.e., change from old-type gauge to Tretyakov-type gauge). Each station will have only one RAIN entry. When this type of entry is used, DIST and DIRECT (described below) are not relevant and thus are coded as blanks;

MOVE = station relocation. Each station will have at least one MOVE entry. If a station moved on more than one occasion, then separate entries are included for each relocation. If a station never moved, then that station will have only one MOVE entry; in this entry, YEAR, MONTH, DAY, DIST, and DIRECT (described below) are all coded as missing. In other words, if a station has only one MOVE entry, and if all variables in that MOVE entry are coded as missing, then the given station never moved;

YEAR — is the year in which the change took place. Missing years are coded as -999;

MONTH — is the month in which the change took place. Missing months are coded as -9;

DAY — is the day on which the change took place. Missing days are coded as -9;

DIST — is the distance (km) that the station was moved. Missing distances are coded as -9. A distance of zero indicates that the station moved less than 1 km. DIST only applies to station relocation entries (i.e., lines in which TYPE = MOVE). In rain gauge replacement entries (i.e., lines in which TYPE = RAIN), DIST is not relevant and thus is coded as blanks; and

DIRECT — is the direction in which the station was moved (e.g., N = north, SE = southeast). Missing directions are coded as -99. DIRECT only applies to station relocation entries (i.e., lines in which TYPE = MOVE). In rain gauge replacement entries (i.e., lines in which TYPE = RAIN), DIRECT is not relevant and thus is coded as blanks.

USSR01.DAT–USSR25.DAT (Files 16–40)

These files contain the 6- and 3-hourly meteorological observations from the 223 stations. The date and time in all data records correspond with GMT. Stated in tabular form, the contents include the following numeric variables

Variable	Variable width	Starting column	Ending column
WMO	5	1	5
YEAR	3	6	8
MONTH	2	9	10
DAY	2	11	12
HOUR	2	13	14
RH	3	15	17

Variable	Variable width	Starting column	Ending column
RHQF	1	18	18
VAPORP	3	19	21
VAPQF	1	22	22
SLP	5	23	27
SLPQF	1	28	28
HDEF	3	29	31
HDEFQF	1	32	32
PCHR	1	33	33
PCHRQF	1	34	34
PTND	3	35	37
PTNDQF	1	38	38
VIS	2	39	40
VISCF	1	41	41
VISQF	1	42	42
HCLD	2	43	44
HCLDCF	1	45	45
HCLDQF	1	46	46
TDEW	3	47	49
TDEWQF	1	50	50
GRND	1	51	51
GRNDQF	1	52	52
TCLD	2	53	54
TCLDCF	1	55	55
TCLDQF	1	56	56
LCLD	2	57	58
LCLDCF	1	59	59
LCLDQF	1	60	60
WDIR	2	61	62
WDIRQF	1	63	63
WSPD	2	64	65
WSPDQF	1	66	66
PRCP	4	67	70
PRCPCF	1	71	71
PRCPQF	1	72	72
STAP	5	73	77
STAPQF	1	78	78
SOILT	3	79	81
SOILQF	1	82	82
W	1	83	83
WCF	1	84	84
WQF	1	85	85
WW	2	86	87

Variable	Variable width	Starting column	Ending column
WWQF	1	88	88
AIRT	4	89	92
AIRTQF	1	93	93
APH1	1	94	94
APH1CF	1	95	95
APH1QF	1	96	96
APH2	1	97	97
APH2CF	1	98	98
APH2QF	1	99	99
APH3	1	100	100
APH3CF	1	101	101
APH3QF	1	102	102
APH4	1	103	103
APH4CF	1	104	104
APH4QF	1	105	105
APH5	1	106	106
APH5CF	1	107	107
APH5QF	1	108	108
APH6	1	109	109
APH6CF	1	110	110
APH6QF	1	111	111
APH7	1	112	112
APH7CF	1	113	113
APH7QF	1	114	114
CLDH	1	115	115
CLDHCF	1	116	116
CLDHQF	1	117	117
CLDM	1	118	118
CLDMQF	1	119	119
CLDL1	1	120	120
CLDL1F	1	121	121
CLDL2	1	122	122
CLDL2F	1	123	123
CLDL3	1	124	124
CLDL3F	1	125	125
WIR	1	126	126
WIRF	1	127	127

where

WMO	is the WMO number of the station;
YEAR	is the year (Greenwich) of the observations in the record;
MONTH	is the month (Greenwich) of the observations in the record;
DAY	is the day (Greenwich) of the observations in the record;
HOUR	is the GMT of the observations in the record;
RH	is the relative humidity of the air (expressed in percent) as determined by use of a psychrometer. Relative humidity is defined as the ratio of the observed vapor pressure to the saturation vapor pressure for the observed air temperature. Values of observations may range from 0 to 100%. Missing observations are coded as 999;
RHQF	is the quality flag for the relative humidity observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);
VAPORP	is the water vapor pressure of the air [expressed in tenths of hectopascals (hPa)] as determined by use of a psychrometer. The water vapor pressure is the partial pressure of the water vapor contained in the air. Values of observations considered valid may range from 0.0 to 95.0 hPa. Missing observations are coded as 999;
VAPQF	is the quality flag for the water vapor pressure observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);
SLP	is the sea level pressure of the air (expressed in tenths of hPa) as determined by use of a barometer. Because a station would rarely be able to position a barometer precisely at sea level, the air pressure measured at a station is "reduced" to sea level by using a standard barometric height formula. Values of observations considered valid may range from 900.0 to 1100.0 hPa. At stations located above a certain elevation (500 m through 1980; 800 m since 1981), air pressure is not reduced to sea level, but is assigned the missing code 99999;
SLPQF	is the quality flag for the sea level pressure observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);
HDEF	is the humidity deficit (saturation deficiency); the difference between the saturation vapor pressure and the actual water vapor pressure at a given temperature and pressure as measured in tenths of hPa. Valid values may range from 0.0 to 95.0 hPa. Missing observations are coded as 999;
HDEFQF	is the quality flag for the humidity deficit observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

PCHR is the pressure tendency characteristic, corresponding to the shape of the barograph trace of air pressure at the station for the preceding 3-h period. This is a coded value ranging from 0 to 8, as explained below (a missing value is coded as 9):

- 0 = increasing, then decreasing; pressure unchanged or higher than 3 h ago;
- 1 = increasing, then steady; increasing, then weaker increase; current pressure is higher than 3 h ago;
- 2 = uniform or non-uniform increase; current pressure is higher than 3 h ago;
- 3 = decreasing, then increasing; steady, then increasing; or increasing, then increasing more rapidly; current pressure is higher than 3 h ago;;
- 4 = steady; pressure is the same as 3 h ago;
- 5 = decreasing, then increasing; pressure is the same or lower than 3 h ago;
- 6 = decreasing, then steady; or decreasing then decreasing more slowly; current pressure is lower than 3 h ago;
- 7 = decreasing steadily or unsteadily; current pressure is lower than 3 h ago;
- 8 = increasing, then decreasing; steady, then decreasing; or decreasing, then decreasing more quickly; current pressure is lower than 3 h ago;

PCHRQF is the quality flag for the pressure tendency characteristic (0 indicates a valid observation; 9 indicates a suspect or missing observation);

PTND is the pressure tendency value (i.e., the absolute difference between the current air pressure at the station and that which was observed 3 h before). The sign of PTND is indicated by the value of PCHR: if PCHR is equal to 0, 1, 2, or 3, then PTND is positive; if PCHR is equal to 4 then PTND should equal 0; and, if PCHR is equal to 5, 6, 7, or 8, then PTND is negative. Values are given in tenths of hPa; observations considered valid may range from 0.0 to 20.0 hPa, and a missing observation is coded as 999);

PTNDQF is the quality flag for the pressure tendency value (0 indicates a valid observation; 9 indicates a suspect or missing observation);

VIS is the horizontal visibility, given as a coded value indicating distance in km. The horizontal visibility is defined as the maximum distance at which an absolutely black body of rather large angular dimensions (over 15 angular min) can be distinguished against the background of the sky in daylight, or the distance at which an unfocused light source of a given intensity becomes indistinguishable at night. Horizontal visibility depends on atmospheric phenomena. Thus, in the fog it can be reduced to zero, while in clear arctic air it can reach hundreds of kilometers. Coded values may range from 00 to 50 and from 56 to 99. Codes 00–50 and 56–89 are used when visibility is measured using instruments; codes 90–99 are used when visibility is estimated visually. The codes and their meanings are as follows:

00–50	=	indicates visibility in tenths of km (i.e., 0.0 km to 5.0 km). For example, 25 = 2.5 km (00 is the code for visibility less than 0.1 km);
51–55	=	not used;
56–80	=	the range 6 km to 30 km. Visibility in whole kilometers may be determined by subtracting 50 from the code, e.g., a code of 65 indicates the visibility is 15 km;
81	=	35 km;
82	=	40 km;
83	=	45 km;
84	=	50 km;
85	=	55 km;
86	=	60 km;
87	=	65 km;
88	=	70 km;
89	=	>70 km;
90	=	<0.05 km;
91	=	0.05 km;
92	=	0.2 km;
93	=	0.5 km;
94	=	1 km (about 1/2 mile);
95	=	2 km (about 1 mile);
96	=	4km (about 2 miles);
97	=	10 km (about 6 miles);
98	=	20 km (about 12 miles); and
99	=	>50 km (>30 miles).

If VIS = 99 with both the complement and quality flags set to 9 (see below), the observation is missing.

VISCF is the horizontal visibility complement flag. VISCF = 0 indicates the visibility corresponds to the value given for VIS; VISCF = 1 indicates the visibility is actually greater than the value given for VIS; VISCF = 9 indicates a suspect or missing observation;

VISQF is the quality flag for the horizontal visibility value (0 indicates a valid observation; 9 indicates a suspect or missing observation);

HCLD is the height above ground of the base of the lowest cloud. This height is usually coded in hundreds of meters, as detailed in the following:

00	=	≤ 50 m with fog present;
01–25	=	100 m to 2500 m, e.g., 10 = 1000 m;

98	=	no clouds below 2500 m, however there may be mid- or high-level clouds whose height has not been determined;
99	=	no clouds or traces of clouds whose height has not been determined; or observation is missing if both complement and quality flags are set to 9 (see below);

HCLDCF is the complement flag for the lowest cloud height observation. A value of 0 means the height was measured using instrumentation; a value of 1 indicates the height was estimated visually. This flag is set to 9 in the case of a suspect or missing observation;

HCLDQF is the quality flag for the lowest cloud height observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

TDEW is the dew point temperature in whole degrees celsius. The dew point temperature is defined as the temperature to which moist air must be cooled, with air pressure and water vapor pressure held constant, in order that it just reach saturation with respect to the water in the air. The dew point is determined by using a psychrometer. Observations considered valid may range from -70° to +40°C. Missing observations are coded as 999;

TDEWQF is the quality flag for the dew point temperature (0 indicates a valid observation; 9 indicates a suspect or missing observation);

GRND is the ground state, a visual observation of the state of the ground surface in the vicinity of the station made usually near 0800 and 2000 LMT. This is a coded value as detailed in the following:

0	=	surface of ground dry (no appreciable amount of dust or loose sand);
1	=	surface of ground moist (no pools);
2	=	surface of ground wet (standing water in small or large pools on surface);
3	=	surface of ground frozen;
4	=	glaze on ground, but no snow or melting snow;
5	=	ice, snow, or melting snow covering less than one-half of the ground;
6	=	ice, snow, or melting snow covering more than one-half of the ground;
7	=	ice, snow, or melting snow covering ground completely;
8	=	loose dry snow, dust, or sand covering more than one-half of the ground;
9	=	loose dry snow, dust, or sand covering ground completely (if GRNDQF = 0; otherwise, the observation is missing);

GRNDQF is the quality flag for the ground state observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

TCLD is the total cloud amount, estimated visually by an observer according to a 10-point system (i.e., in tenths of sky cover). A value of 0 indicates no clouds present or <1/10 sky cover, a value of 10 indicates an overcast sky (with or without gaps amounting to <1/10 sky cover; see explanation of complement flag below), and a value of 99 indicates a missing observation. The gaps between individual cloud elements, typical of some cloud genera (e.g., altocumulus and stratocumulus) are not to be included as part of the total cloud cover estimate (i.e., they are counted as clear sky);

TCLDCF is the total cloud amount complement flag. TCLDCF = 1 is used if 10-point cloudiness (overcast) is observed with gaps; TCLDCF = 0 is coded for all other valid cloud amounts; and TCLDCF = 9 indicates a suspect or missing observation;

TCLDQF is the quality flag for the total cloud amount observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

LCLD is the low-cloud amount, estimated visually by an observer according to a 10-point system (i.e., in tenths of sky cover). A value of 0 indicates no low clouds present or <1/10 of the sky is covered with low clouds. The gaps between individual cloud elements, typical of some cloud genera (e.g., stratocumulus and cumulus) are not to be included as part of the low cloud cover estimate (i.e., they are counted as clear sky). Missing observations are coded as 99;

LCLDCF is the low-cloud amount complement flag. TCLDCF = 1 is used if 10-point cloudiness (overcast) is observed with gaps; TCLDCF = 0 is coded for all other valid low-cloud amounts; and TCLDCF = 9 indicates a suspect or missing observation;

LCLDQF is the quality flag for the total cloud amount observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

WDIR is the direction **from** which the wind is blowing, as measured 10–12 m above ground level. This is a coded observation, the values for which are given as follows:

Code		Wind direction
00	=	calm winds
02	=	NNE
05	=	NE
07	=	ENE
09	=	E
11	=	ESE
14	=	SE
16	=	SSE
18	=	S

20	=	SSW
23	=	SW
25	=	WSW
27	=	W
29	=	WNW
32	=	NW
34	=	NNW
36	=	N
99	=	variable winds (if WDIRQF = 0; otherwise, the observation is missing);

WDIRQF is the quality flag for the wind direction observation (0 indicates a valid observation; 9 indicates a suspect or missing observation). Missing observations are coded as 99;

WSPD is the wind speed in m/s as measured 10–12 m above ground level. Observations considered valid may range from 0 to 60 m/s;

WSPDQF is the quality flag for the wind speed observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

PRCP is the precipitation amount to the nearest tenth of a millimeter. Observations considered valid may range from 0 to 5000 (0 mm to 500 mm). Missing observations are coded as 999. Rain gauges are positioned 2 m above ground level, and were read at 0700 and 1900 LMT from 1936 through 1965. In 1946, the old-style gauge (exact type unknown) was replaced with the Tretyakov-type gauge (see Appendix A for the date of implementation at each site). Beginning in 1966, gauges were read at 0300, 0900, 1500, and 2100 MLT in time zone 2; at 0300, 0600, 1500, and 1800 MLT in zones 3–5; at 0300 and 1500 MLT in zones 6–8; at 0000, 0300, 1200, and 1500 MLT in zones 9–11; and at 2100, 0300, 0900, and 1500 MLT in zone 12. Also, beginning in 1966, wetting corrections of ≤0.2 mm were applied to each hourly measurement. (Because four observations per day were collected at stations in time zones 2–5 and 9–12, four corrections were counted in the calculation of daily totals; therefore, total daily corrections are higher for stations in these areas.) From 1966 onward, readings at some stations were also taken at the observing hours closest to 0800 and 2000 LMT. Beginning in 1986, readings at 0300 and 1500 MLT were discontinued at all stations except those in time zone 2. (The term "time zone" in the preceding corresponds to assigning the numbers 1–12 to 12 time zones stretching from west to east across the former U.S.S.R. The time zone of each station in this sense may be obtained by subtracting 1 from the value of the ZONE variable in the file TIMEZONE.DAT.)

PRCPCF is the precipitation amount complement flag. It is set to 1 if a trace of precipitation has been measured, i.e., <0.1 mm. This flag is set to 0 for all other valid precipitation observations, and is set to 9 for suspect or missing precipitation observations;

PRCPQF	is the quality flag for the precipitation amount (0 indicates a valid observation; 9 indicates a suspect or missing observation);
STAP	is the pressure of the air at station level (expressed in tenths of hPa) as determined by use of a barometer. Values of observations considered valid may range from 600.0 to 1100.0 hPa. Validity is of course assessed by considering the station's elevation above sea level. Missing observations are coded as 99999;
SLPQF	is the quality flag for the station level pressure observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);
SOILT	is the soil surface temperature, expressed in whole degrees celsius. Soil surface temperature is measured at a smooth, unshaded site that is devoid of vegetation. When the ground is snow-covered, the thermometer is placed on the snow surface and the temperature of the snow cover is measured. Observations considered valid may range from -75 to +75°C. Missing observations are coded as 999;
SOILQF	is the quality flag for the soil surface temperature (0 indicates a valid observation; 9 indicates a suspect or missing observation);
W	is the past weather code, used in describing the meteorological conditions observed between the past and current observations. At 0000, 0600, 1200, and 1800 GMT this code describes weather from the previous 6-hour period; at 0300, 0900, 1500, and 2100 GMT it describes weather for the previous 3-hour period. The codes and their meanings are as follows:

0 = clear sky or no more than 5/10s cloud amount;
1 = variable sky; cloud amount was both less than and greater than 5/10 sky cover during the preceding three hours;
2 = overcast or cloud amount greater than 5/10s;
3 = sand or dust storm, or drifting or blowing snow;
4 = fog, ice fog, or thick haze or smoke;
5 = drizzle;
6 = rain;
7 = snow, or rain and snow mixed;
8 = shower(s);
9 = thunderstorm, with or without precipitation (if WQF = 0; otherwise, the observation is missing);

WCF	is the past weather complement flag. It is set to 0 when used with the previously defined past weather codes, however it is set to 1 for past weather codes 3, 7, and 8 if the past weather also included a snowstorm. The complement flag is set to 9 in the case of a suspect or missing past weather observation;

WQF is the quality flag for the past weather observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

WW is the present weather code, reflecting the meteorological conditions at the time of observation or during the preceding 1-h period. Codes range from 00 to 99 and are defined as follows:

Code		Present weather
00–19	=	no precipitation, fog, dust storm, sandstorm, drifting or blowing snow at the station at the time of observation and, except for codes 09 and 17, during preceding hour;
00	=	cloud development conditions unknown;
01	=	cloud generally dispersing;
02	=	state of sky on the whole unchanged;
03	=	clouds generally forming or developing;
04	=	visibility reduced by smoke or volcanic ash;
05	=	haze;
06	=	widespread dust in suspension in the air;
07	=	dust or sand raised by wind at or near the station at the time of observation;
08	=	well developed dust whirl(s) seen at or near the station;
09	=	dust storm within sight;
10	=	mist, steam mist (light fog);
11	=	patches of shallow fog, or, from 1966 onward, ice fog;
12	=	more or less continuous shallow fog, or, from 1966 onward, ice fog;
13	=	lightning visible, no thunder heard;
14	=	precipitation within sight, not reaching the ground;
15	=	precipitation within sight, reaching the ground or the surface of the sea, but distant (i.e., estimated to be more than 5 km from the station);
16	=	precipitation within sight, reaching the ground or the surface of the sea, near to, but not at the station;
17	=	thunderstorm, but no precipitation at the station or within sight;
18	=	squall;
19	=	funnel cloud;
20–29	=	precipitation, fog, ice fog, or thunderstorm at the station during the preceding hour but not at the time of the observation;
20	=	drizzle or snow grains;
21	=	rain;
22	=	snow;

23	=	rain and snow or ice pellets;
24	=	freezing drizzle or freezing rain;
25	=	showers of rain;
26	=	showers of snow, or of rain and snow;
27	=	shower of hail, or ice pellets;
28	=	fog or ice fog;
29	=	thunderstorm;
30–39	=	dust storm or sandstorm, drifting or blowing snow at the time of observation;
30	=	slight or moderate dust storm or sandstorm subsiding;
31	=	slight or moderate dust storm or sandstorm, no appreciable change during the preceding hour–;
32	=	slight or moderate dust storm or sandstorm, increasing;
33	=	severe dust storm or sandstorm, decreasing;
34	=	severe dust storm or sandstorm with no appreciable change;
35	=	severe dust storm or sandstorm, increasing;
36	=	slight or moderate drifting snow;
37	=	heavy drifting snow;
38	=	slight or moderate blowing snow;
39	=	heavy blowing snow;
40–49	=	fog or ice fog at the time of observation;
40	=	fog or ice fog near the station;
41	=	fog or ice fog in patches;
42	=	fog or ice fog decreasing, sky discernible;
43	=	fog or ice fog decreasing, sky not discernible;
44	=	fog, or, from 1966 onward, ice fog; sky discernible; no appreciable change;
45	=	fog, or, from 1966 onward, ice fog; sky not discernible; no appreciable change;
46	=	fog or ice fog, sky discernible, becoming thicker;
47	=	fog or ice fog, sky not discernible, becoming thicker;
48	=	fog, depositing rime, sky discernible;
49	=	fog, depositing rime, sky not discernible;
50–59	=	drizzle at the station at the time of observation;
50	=	drizzle intermittent, slight at time of observation;
51	=	drizzle continuous, slight at time of observation;
52	=	drizzle intermittent, moderate at time of observation;
53	=	drizzle continuous, moderate at time of observation;
54	=	drizzle intermittent, heavy at time of observation;
55	=	drizzle continuous, heavy at time of observation;
56	=	drizzle, freezing, slight;

57	=	drizzle, freezing, heavy;
58	=	drizzle and rain, moderate or heavy;
59	=	drizzle and rain, moderate or heavy;
60–69	=	rain at the station at the time of observation;
60	=	rain intermittent, slight;
61	=	rain continuous, slight;
62	=	rain intermittent, moderate;
63	=	rain continuous, moderate;
64	=	rain intermittent, heavy;
65	=	rain continuous, heavy;
66	=	rain, freezing, slight;
67	=	rain, freezing, moderate or heavy;
68	=	rain or drizzle and snow, slight;
69	=	rain or drizzle and snow, moderate or heavy;
70–79	=	solid precipitation not in showers at the time of observation;
70	=	intermittent fall of snow flakes, slight;
71	=	continuous fall of snow flakes, slight;
72	=	intermittent fall of snow flakes, moderate;
73	=	continuous fall of snow flakes, moderate;
74	=	intermittent fall of snow flakes, heavy;
75	=	continuous fall of snow flakes, heavy;
76	=	diamond dust;
77	=	snow grains;
78	=	isolated starlike snow crystals;
79	=	ice pellets;
80–90	=	showery precipitation at the time of observation;
80	=	rain shower(s), slight;
81	=	rain shower(s), moderate or heavy;
82	=	rain shower(s), violent;
83	=	shower(s) of rain and snow mixed, slight;
84	=	shower(s) of rain and snow mixed, moderate or heavy;
85	=	snow shower(s), slight;
86	=	snow shower(s), moderate or heavy;
87	=	shower(s) of snow pellets or small hail, slight;
88	=	shower(s) of snow pellets or small hail, moderate or heavy;
89	=	shower(s) of hail, slight;
90	=	shower(s) of hail, moderate or heavy;
91–99	=	thunderstorm during the preceding hour or at the time of observation;

91	=	slight rain at time of observation, thunderstorm during the preceding hour;
92	=	moderate or heavy rain at time of observation, thunderstorm during the preceding hour;
93	=	slight snow or hail at the time of observation, thunderstorm during the preceding hour;
94	=	moderate or heavy snow or hail at the time of observation, thunderstorm during preceding hour;
95	=	thunderstorm, slight or moderate with rain and/or snow at the time of observation;
96	=	thunderstorm, slight or moderate with hail at the time of observation;
97	=	thunderstorm, heavy, with rain or snow at time of observation;
98	=	thunderstorm, combined with dust storm or sandstorm at time of observation;
99	=	thunderstorm, heavy, with hail at the time of observation (if WWQF = 0; otherwise, the observation is missing);

WWQF is the quality flag for the present weather observation (0 indicates a valid observation; 9 indicates a suspect or missing observation);

AIRT is the air temperature (tenths of degrees celsius), measured 2m above ground or snow surface level. Observations considered valid may range from -70.0° to +55.0°C. Missing observations are coded as 9999;

AIRTQF is the quality flag for air temperature (0 indicates a valid observation; 9 indicates a suspect or missing observation);

APH1–APH7 are seven atmospheric phenomena groups, used for reporting various atmospheric phenomena during the ten minutes preceding the observation hour. These phenomena are observed visually, as are estimates of their intensity. Atmospheric phenomena intensity can be weak, moderate or strong. The phenomena are described by means of codes that are particular to each of the seven groups. A coded value of 0 indicates that atmospheric phenomena were not observed at the time of observation. Additional codes and their meanings are as follows:

APH1 group:	1	=	not used;
	2	=	not used;
	3	=	dew;
	4	=	rime;
	5	=	crystalline frost, grain frost;
	6	=	glazed frost;
	7	=	rime and crystalline frost;
	8	=	rime and glazed frost;
	9	=	crystalline frost and glazed frost;

APH2 group:	1	=	not used before 1966, from 1966 onward: snow haze;
	2	=	haze;
	3	=	mist;
	4	=	ground fog;
	5	=	crystalline fog, sky visible;
	6	=	ice fog;
	7	=	fog, sky visible;
	8	=	fog;
	9	=	not used before 1966, from 1966 onward: shallow ice fog;
APH3 group:	1	=	drifting dust;
	2	=	funnel cloud;
	3	=	dust storm;
	4	=	whirl;
	5	=	drifting snow;
	6	=	blowing snow;
	7	=	blizzard;
	8	=	snow storm;
	9	=	not used;
APH4 group:	1	=	before 1966: corona around sun/moon; not used from 1966 onward;
	2	=	sunshine;
	3	=	before 1966: halo around sun/moon; not used from 1966 onward;
	4	=	snow grains and sunshine;
	5	=	snow pellets and sunshine;
	6	=	snow grains;
	7	=	snow pellets;
	8	=	ice pellets;
	9	=	ice pellets and sunshine;
APH5 group:	1	=	not used;
	2	=	glazed rain;
	3	=	drizzle;
	4	=	rain;
	5	=	rain shower;
	6	=	glazed rain, rain;
	7	=	glazed rain, rain shower;
	8	=	not used;
	9	=	not used;
APH6 group:	1	=	not used;
	2	=	mirage;
	3	=	ice needles;
	4	=	snow melting;

5 = snow melting shower;
6 = not used;
7 = snow;
8 = snow shower;
9 = not used;

APH7 group:
1 = not used;
2 = sea soaring (lake or river soaring);
3 = polar lights;
4 = sea soaring and polar lights;
5 = summer lightning;
6 = before 1966, thunderstorm in the distance; not used from 1966 onward;
7 = thunderstorm;
8 = hail;
9 = thunderstorm and hail;

APH1CF–APH7CF are the corresponding complement flags for the seven atmospheric phenomena groups. These flags are used to denote whether or not an observation has been made, and if so, to denote the intensity of the phenomena. A complement flag of 0 accompanying an atmospheric phenomena code of 0 means none of the phenomena in a particular group have been observed. When accompanying a nonzero phenomena code, a complement flag of 0 denotes phenomena of weak intensity, 1 denotes moderate intensity, and 2 denotes strong intensity. A complement flag of 9, when accompanied by a quality flag of 9 (see below) indicates a suspect or missing observation;

APH1QF–APH7QF are quality flags for the seven atmospheric phenomena groups (0 indicates a valid observation; 9 indicates a suspect or missing observation);

CLDH is the coded value for the high-level cloud type. High clouds are defined as those with bases higher than 6000 m and include cirrus (Ci), cirrocumulus (Cc), and cirrostratus (Cs) clouds. Codes have the following meanings:

0 = cloud type is not indicated, but low- or mid-level clouds observed, with total cloud amount ranging anywhere from 1/10 to overcast with gaps; high-level clouds are absent or amount to less than 1/10 sky cover;
1 = Ci;
2 = Cc;
3 = Cs;
4 = Ci and Cc;
5 = Ci and Cs;
6 = Cc and Cs;
7 = Ci, Cc, and Cs;
8 = high cloud presence and type cannot be determined because of

continuous fog or snowstorm; or high-level cloud presence and type cannot be determined because of overcast conditions at lower levels;

9 = complete absence of clouds or, in the case of translucent fog, clear in the zenith (if CLDHQF =0; otherwise the observation is missing);

CLDHCF — is the high-level cloud type complement flag. It is set to 0 when the high-level cloud type has been determined with no fog present; set to 1 when the high-level cloud type has been determined with translucent fog or when the high-level cloud type cannot be determined because of continuous fog; and set to 9 if the high-level cloud type is suspect or missing.

CLDHQF — is the high-level cloud type quality flag (0 indicates a valid observation; 9 indicates a suspect or missing observation);

CLDM — is the coded value for the mid-level cloud type. Mid-level clouds are defined as those with bases between 2000 m and 6000 m; they include altocumulus (Ac) and altostratus (As) clouds. Codes have the following meanings:

0 = cloud type is not indicated, but high-level clouds (amount ranging from 1/10 to overcast) and/or low-level clouds (amount ranging from 1/10 to overcast with gaps) observed; mid-level clouds are absent or amount to less than 1/10 sky cover;
1 = Ac;
2 = As;
3 = not used;
4 = Ac and As;
5–7 = not used;
8 = mid-level cloud presence and type cannot be determined due to fog or snowstorm; or mid-level cloud presence and type cannot be determined because of overcast at lower levels;
9 = complete absence of clouds or, in the case of translucent fog, clear in the zenith (if CLDMQF =0; otherwise the observation is missing);

CLDMQF — is the mid-level cloud type quality flag (0 indicates a valid observation; 9 indicates a suspect or missing observation);

CLDL1 — is the first of three code groups for describing low-level cloud type. Low-level clouds are defined as those with bases lower than 2000 m; they include stratocumulus (Sc), stratus (St), nimbostratus (Ns), cumulus (Cu), and cumulonimbus (Cb) clouds. Codes have the following meanings:

0 = cloud type is not indicated, but high- or mid-level clouds observed, with total cloud amount ranging anywhere from 1/10

to overcast; low-level clouds of the CLDL1 group (see below) are absent or amount to less than 1/10 sky cover;

1 = Cu;
2 = Cb;
3 = not used;
4 = Cu and Cb;
5–7 = not used;
8 = low-level cloud presence and type cannot be determined due to fog or snowstorm;
9 = complete absence of clouds or, in the case of translucent fog, clear in the zenith (if CLDL1F =0; otherwise the observation is missing);

CLDL1F is the low-level cloud type quality flag for the first low-level cloud group (0 indicates a valid observation; 9 indicates a suspect or missing observation);

CLDL2 is the second of three code groups for describing low-level cloud type. Low-level clouds are defined as those with bases lower than 2000 m; they include stratocumulus (Sc), stratus (St), nimbostratus (Ns), cumulus (Cu), and cumulonimbus (Cb) clouds. Codes have the following meanings:

0 = cloud type is not indicated, but high- or mid-level clouds observed, with total cloud amount ranging anywhere from 1/10 to overcast; low-level clouds of the CLDL2 group (see below) are absent or amount to less than 1/10 sky cover;
1 = St;
2 = Sc;
3 = not used;
4 = St and Sc;
5–7 = not used;
8 = low-level cloud presence and type cannot be determined due to fog or snowstorm;
9 = complete absence of clouds or, in the case of translucent fog, clear in the zenith (if CLDL2F =0; otherwise the observation is missing);

CLDL2F is the low-level cloud type quality flag for the second low-level cloud group. (0 indicates a valid observation; 9 indicates a suspect or missing observation.);

CLDL3 is the third of three code groups for describing low-level cloud type. Low-level clouds are defined as those with bases lower than 2000 m; they include stratocumulus (Sc), stratus (St), nimbostratus (Ns), cumulus (Cu), and cumulonimbus (Cb) clouds. Codes have the following meanings:

0 = cloud type is not indicated, but high- or mid-level clouds observed, with total cloud amount ranging anywhere from 1/10

to overcast; low-level clouds of the CLDL3 group (see below) are absent or amount to less than 1/10 sky cover;

1 = not used;
2 = Ns;
3 = fractostratus (Fs) and fractocumulus (Fc) of bad weather (also known as scud);
4–5 = not used;
6 = Ns and Frnb;
7 = not used;
8 = low-level cloud presence and type cannot be determined due to fog or snowstorm;
9 = complete absence of clouds or, in the case of translucent fog, clear in the zenith (if CLDL3F =0; otherwise the observation is missing);

CLDL3F is the low-level cloud type quality flag for the third low-level cloud group (0 indicates a valid observation; 9 indicates a suspect or missing observation);

WIR is the wind irregularity characteristic. It is a coded value used to describe the wind speed as steady or gusty and the wind direction as constant or variable. The wind is considered to be steady if its speed remains essentially constant over the course of two minutes; otherwise it is considered gusty. The wind direction is considered constant if over the course of two minutes it varies within one compass point; otherwise it is considered to be variable. Observations of this variable are only present in the 6-hourly data records (i.e., in the pre-1966 data). The 3-hourly records (1966 onward) contain a value of 9 to indicate missing data. For the pre-1966 data, a value of 9 is also used to indicate a missing value. Codes for observations have the following meanings:

0 = no wind;
1 = steady speed, constant direction;
2 = steady, variable;
3 = gusty, constant;
4 = gusty, variable;
5 = characteristic is not defined;
6 = the wind speed and direction at this hour are considered suspect.

WIRF is the wind irregularity characteristic quality flag (0 indicates a valid observation; 9 indicates a suspect or missing observation).

7. VERIFICATION OF DATA TRANSPORT

The data files contained in this NDP can be read by using the FORTRAN and SAS® programs provided. Users should verify that the data have been correctly transported to their systems by visually examining each data file, where practical. To facilitate the visual inspection process, partial listings of each data file are provided in Tables 4–8. Each of these tables contains the first five and last five records of the data file.

Table 4. Partial listing of the file station.inv (File 12)

First five records of the file:

20674	OSTROV DIKSON	73.50	80.40	42.0	01/1936	12/1984
20891	HATANGA	71.98	102.47	30.0	01/1936	12/1984
21946	COKURDAH	70.62	147.88	0.0	08/1944	12/1984
21982	OSTROV VRANGELJA	70.97	-178.37	2.0	01/1936	12/1984
22113	MURMANSK	68.97	33.05	57.0	01/1936	12/1984

Last five records of the file:

38927	TERMEZ	37.23	67.27	309.0	01/1936	12/1984
38933	KURGAN-TJUBE	37.82	68.78	427.0	01/1936	12/1984
38954	HOROG	37.50	71.50	2077.0	09/1936	12/1984
38974	SERAHS	36.53	61.22	275.0	01/1936	12/1984
38987	KUSKA	35.28	62.35	625.0	01/1936	12/1984

Table 5. Partial listing of the file gaps.dat (File 13)

First five records of the file:

20891	07/1944 - 06/1946
21946	08/1947 - 09/1947
21982	10/1943
22602	03/1937
22602	05/1937

Last five records of the file:

38954	12/1937
38974	10/1937 - 12/1937
38974	10/1938
38974	12/1938
38987	07/1941

Table 6. Partial listing of the file timezone.dat (File 14)

First five records of the file:

```
20674 07
20891 08
21946 11
21982 13
22113 03
```

Last five records of the file:

```
38927 06
38933 06
38954 06
38974 05
38987 05
```

Table 7. Partial listing of the file station.his (File 15)

First five records of the file:

```
20674 MOVE 1938 -9 -9  0 -99
20674 PRCP 1953  3  2
20674 MOVE 1960 -9 -9  0 -99
20891 MOVE 1951  1 12  1 SSW
20891 PRCP 1953 12  1
```

Last five records of the file:

```
38987 MOVE 1904  4 -9 -9 -99
38987 MOVE 1910 -9 -9 -9 -99
38987 MOVE 1913  8 -9 -9 -99
38987 MOVE 1927  5 -9 -9 -99
38987 PRCP 1953  1  4
```

Table 8. Partial listings of the files ussr01.dat–ussr25.dat (Files 16–40)

USSR01.DAT:

First five records of the file:

```
20674935123118095000501017100020200020999999009999990000000180130999999101430999931037 0-27309999997209999999999999900909090909030
20674936010100096000801014300000700240999999999999990100010001601700000101011509999310390-25509999997209999999999999999999999999950
206749360101060980008010113000008001009999999999999991000100014018099999991008509999999390-24509999997109999999999999999999999999950
206749360101120950011010082000003000009999999999999901000100016016000000010055099999999390-22309999997109999999999999999999999999930
20674936010118094001101007500000990080999999999999999100099991600709999999100490999930 0720-21509999999500999999700999999999999999950
```

Last five records of the file:

```
225839831231030850016009976000307000607600091 0-17090100010000000000000000098920-140200020-14900000000000000000000000800800020009 9
2258398312310608500180099700003070006063000910-16099100010000000000000000098860-130200020-136000000000000000000000008008000200099
2258398312310908500200099670004060002050000900-15099100008001600100000000098840-120700700-125000000000000000710000800200020009 9
2258398312311208500160099620003070006060000910-17099100001001600100002000098780-210700020-149000000000000000000000003000000200099
2258398312311508600160099600003070002062000710-17099100010001800100000000098760-160200020-154000000000000000000000008008000100099
```

USSR02.DAT:

First five records of the file:

```
2260293601312299999999999999999999999999999999999999991000999918005099999990981509999999999-1360999999999999999999999999999999999999
2260293602010499999999999999999999999999999999999999991000999918005000020009778099999999 99-1370999999999999999999999999999999999999
2260293602011099999999999999999999999999999999999999991000999918003099999990976609999999999-1270999999999999999999999999999999999999
2260293602011699999999999999999999999999999999999999991000999918005000100009733099999999 99-1250999999999999999999999999999999999999
2260293602012299999999999999999999999999999999999999990000999909001099999990971709999999999-1860999999999999999999999999999999999999
```

Last five records of the file:

```
232199831231030790008010009000207000106000991 9-25090100000000000000000010098950-210700710-224000000000000000071000080040000000 99
2321998312310608000100100020002080006064001810-23099101002000000000000000098890-200700710-206000000000000000071000000040002000 99
2321998312310907900080099990002070004081009919-25099070000000000000000000098850-250700220-227000000000000000000000000010000000 99
2321998312311207700060099980002070002060009919-28099090000000000000000200098830-240700710-249000000000000000071000000040000000 99
2321998312311507800070099930002080005062009919-26099080000000000000000200098780-240700710-236000000000000000071000000040000000 99
```

Table 8. (continued)

USSR03.DAT:

First five records of the file:

```
23405935123120093004301005100030400430999999999-050991000999932009099999990994909999700360-04109999999510999999999999999999999999950
23405936010102076003201015800090300400999999999-090901000999932005000090010054099993 00030-05209999999999999999999999999999999950
23405936010108072002801020600110300270970096 99-110991000100036001099999910101099992 00030-06209999999999999999999999998008000100050
23405936010114078002901019300080800030999999999-100901000999911003000000010086099992 00720-06609999999999999999970099999999999999950
23405936010120093003501016100030800170999999999-090991000999911005099999910057099997 00720-06809999999999999999970099999999999999950
```

Last five records of the file:

```
23884984123100072000401013600020200100700 09919-3409003000000200010000010100540-350700020-30100000000000000000000001000000000099
23884984123103072000301015400010200180700 09919-350991000000000000000000100720-340100030-31200000000000000000000005000000000099
23884984123106071000301017100010200170840 09919-350991000000020001000000100890-340100020-31600000000000000000000005000000000099
23884984123109071000301018700010200160700 09919-360991000000000000000000101050-340200020-32200000000000000000000005000000000099
23884984123112072000301020600010200170670 09919-370990800000000000000200101220-360700710-33500000000000000007100005000000000099
```

USSR04.DAT:

First five records of the file:

```
23891935123118072000109999990000999999910 09999-460990000000000000009999999999999999999999-45209999999999999999999999009090909050
23891936010100073000109999990000999999910 09999-460900000000000000000009999999999999999-46009999999999999999999999009090909050
23891936010106072000109999990000999999970 09999-460990000000000000000999999999999999999999-42809999999999999999999999009090909050
23891936010112072000109999990000999999910 09999-460900000000000000000009999999999999999999-45309999999999999999999999009090909050
23891936010118072000109999990000999999910 09999-460990000000000000009999999999999999999999-46709999999999999999999999009090909050
```

Last five records of the file:

```
24641984123100077000201018700010200160700 09919-390900900000009001000020010025099997 00710-36600000000000000007100005000000000099
24641984123103076000201020000010200130980 09919-390991000000009001000000100380999997 00710-36500000000000000007100001000000000099
24641984123106077000201021900010200190980 09919-390991000000007002000000100570999997 00710-36400000000000000007100001000000000099
24641984123109077000201023800010200170700 09919-410990600000007001000000100740999997 00710-38100000000000000007100001000000000099
24641984123112076000201025200010200130841 09919-410990200000007001000060100870999997 00020-38700000000000000000000001000000000099
```

Table 8. (continued)

USSR05.DAT:

First five records of the file:

```
24688942123115999999999999999999930008098009999999999909009999000000999999091940999910002O-342099999999999999999999999999999999900
24688942123121999999999999999999930010098009999999999900000999900000000000000920209999000000-392099999999999999999999999999999999900
24688943010103999999999999999999930002098009799999999910100000180010999999092170999910003O-415099999999999999999999995001000000010
24688943010109999999999999999999930002097009999999999901000999900000000000000924609999200030-377099999999999999999999999999999999900
24688943010115999999999999999999930000097009900999999900000000000000999999092390999910000O-387099999999999999999999990090909090000
```

Last five records of the file:

```
251739841230180920007010321000107001005600991 9-270700000000003200400000000103150-280000100-261050031000000000000000009009090909099
251739841230210930007010304000007001702200991 9-270990000000002900600000000102980-280300360-263050031051000000000000009009090909099
251739841231000930007010283000007002109400110 0-270991000050029007000000000102770-270300360-260050030051000000000000008001000200099
251739841231030940008010242000007004101400090 0-260991000080032008000000000102360-260300360-251050030050000000000000008001000200099
251739841231060940008010220000007002201800100 0-250991000100032009000000000102140-250300360-242050030050000000000000008008000200099
```

USSR06.DAT:

First five records of the file:

```
2555193706301309401090999999900609999999999999999999999060004002200109999999101190999999999999008403109999999999999999999999999999950
2555193706301907000930999999905009999999999999999999999030003002200109999999101190999999999999014403109999999999999999999999999999950
2555193707010103100910999999920409999999999999999999999020002002700209999999101190999999999999023809999999999999999999999999999999950
2555193707010703400920999999917809999999999999999999999010001002200309999999101030999999999999022309999999999999999999999999999999950
2555193707011308300970999999902009999999999999999999999060004001800209999999101070999999999999009403109999999999999999999999999999950
```

Last five records of the file:

```
260639831231060910052009676000505000709919081 0-020901000100009002000940009669 0-020700730-010000000000000000007000008008000006099
260639831231090950045009704000302002709600081 0-040991000100005003000000009696 0-030700710-033000000000000000007100008008000006099
260639831231120870039009763000602005909710080 0-060991000100036005000000009755 0-040700220-040000000000000000000000008008000200099
260639831231150860037009823000602006009919080 0-070991000100002004000000009815 0-040700220-048000000000000000000000008008000200099
260639831231180830034009860000702003709919090 0-080991000100029003000450009852 0-060700020-052000000000000000000000008008000200099
```

Table 8. (continued)

USSR07.DAT:

First five records of the file:

```
26188935123122999999999999999999998001209600999999999999100010001800109999990998509999600620000509999999999999400999999800800010050
26188936010104999999999999999999996001209500999999999999100010001800200050000995809999600680000609999999999999999410999800800010050
26188936010110999999999999999999993000509300999999999999100010002200309999990997309999700520000909999320999999310999999800800010050
26188936010116999999999999999999990000309300999999999999100010001800300010000998209999400520001009999999999999310999999800800010050
26188936010122999999999999999999998000109400999999999999100010001800509999990998509999200030001209999999999999310999999800800010050
```

Last five records of the file:

```
267309831231060830056009983001102000506200991 9-0107007000000250100000300097910000070002000140000000000000000000000002000000099
26730983123109083005400999000110200070630099l9-020990400000025009000000000097980-01070002000100000000000000000000000001000000099
26730983123112078005401000600150200160650099l9-020990400000025010000000000098140-01070002000170000000000000000000000001000000099
2673098312311507800500100200014020013064009919-03099000000000250060000000000098270-04000002000060000000000000000000000009009090909099
2673098312311807300460100290016020009065009919-04099000000000250060001400098360-04000002000020000000000000000000000009009090909099
```

USSR08.DAT:

First five records of the file:

```
2678194312312208800410999999004099999999500999999999999100010001800309999990984609999999999-0360999999999999999999999998008000200099
2678194401010408700370999999005099999999500999999999999100010001800509999990988509999999999-0460999999999999999999999998008000200099
2678194401011009100390999999006099999999500999999999999100010001400709999990990609999999999-0500999999999999999999999998008000200099
2678194401011608200350999999006099999999500999999999999100010001400700000000989909999999999-0480999999999999999999999998008000006099
2678194401012208100350999999005099999999500999999999999100010002200709999990986509999999999-0500999999999999999999999998008000200099
```

Last five records of the file:

```
276489851231060740023010087000802005606000 1110-13099090009002500900000000099120-100300360-0880000000510000000000000000000000200099
276489851231090820025010127000502003906400 1310-12099040004002300700000000099510-100300360-0910000000510000000000000000000000200099
27648985123112081002701014300060200170650 01310-11099040004002000500000000099680-080300360-0810000000510000000000000000000000200099
2764898512311508600270101580004020014062009919-11099000000001800400000000099820-110300020-0870000000000000000000000009009090909099
27648985123118098006100991400010700300100008100000991000100016004000000000974700000700730000200003100000000004000008008000006099
```

Table 8. (continued)

USSR09.DAT:

First five records of the file:

```
27823935123121093004001025800030800060960099999999991000100020006099999910488099997000200-04509999999999999999700999999999999999950
278239360101030970045010231000208001409600999999998010001000200100000700104700999970036 0-0340999999500800999400999999999999999950
27823936010109096006001021800020800080960095999999991000100020012099999910463099996006800003099999999981099940099980080000 2050
278239360101150980061010223000103000409999995999999801000100022007000820010467099997000300004099999999999999999999998008000002050
278239360101211000061010235000004000409400000099999910001000220060999999104750999940046000020999810999999999999999998008080808050
```

Last five records of the file:

```
2844098412310308500090101780002070015096009919-24090000000000250020000000097980-270000100-2170700310000000000000000009009090909099
2844098412310608300100101480002070026097009919-23099000000000200040000000097720-230000020-2060700000000000000000000009009090909099
2844098412310908000140100980004070043097009919-19099100000002000500000000097290-160700710-1580510000000000000710000800200000099
2844098412311207400140100740005070021097009919-19099100000002300600002000097080-180700020-1510510000000000000000000800200000099
2844098412311507700160100590005070014097009919-18099030000002500500000000096940-180300360-1400000000510000000000000100000000099
```

USSR10.DAT:

First five records of the file:

```
284939351231190970031010239000108000409500949999999991000100022007099999910134099992000300-0870999999999999999999999998008000200050
28493936010101094002001021300030800060960098009999990020000002000500000001010609999200010-1320999999999999999999999991001000000050
28493936010107079002501021400080300000970098009999990900000025007099999910109099992000 20-0820999999999999999999999991001000000050
28493936010113082002901023800050300040960095999999990100002002200500000001013409999200030-0740999999999999999999999998001000200050
28493936010119088003201026500040300100960095999999991000100020005099999910160099997007 10-0700999999999999999999999998008000200050
```

Last five records of the file:

```
2926398412310008200080101570002020003057009919-25090100000000000000000400100490-260700710-2240000000000000000710000800100000099
2926398412310308300090101760002020017096009919-24099100000000000000000000100660-220700710-2220000000000000000710000100100000099
2926398412310608300100102100002020036098009919-22099100000002300200000000101020-280700020-2040000000000000000000000100100000099
2926398412310908100080102290002020017098009919-25099100000003200100000000101190-320200020-2220410000000000000000000100100000099
2926398412311208300080102370001020008058009919-25099100000002700200007000101270-280700710-2320000000000000000710000100100000099
```

Table 8. (continued)

USSR11.DAT:

First five records of the file:

```
2928293512311808000010999999001080007099999800999999050000000000009999999999999999000010-388099999999999999999999992000000000059
2928293601010007700010999999000040011099999900999990000000000000000000999999999999000000-406099980099999999999999990009090909059
2928293601010607600010999999000030005099999900999999000000000000000099999999999999000000-396099980099999999999999990009090909059
2928293601011207600010999999000020007099999900999990000000000000000000999999999999000000-411099980099999999999999990009090909059
2928293601011807700010999999000070013099999900999999000000000000000099999999999999000000-418099999999999999999999990009090909059
```

Last five records of the file:

```
300549841231000790006010208000102001509700991 9-290901000000000000000000500099440-290700710-266000000000000000071000030010000000 99
```

```
30054984123100079000601020800010200150970099919-29090100000000000000000500099440-290700710-2660000000000000000071000030010000000099
30054984123103079000501021700010200070960099919-30099100000000000000000000000099510-290700710-2770000000000000000071000030010000000099
30054984123106080000701023100020200180970099919-27099100000000160010000000099690-270700710-2460000000000000000071000030010000000099
30054984123109079000501024600010200100970099919-30099100000000000000000000099790-340700710-2770000000000000000071000030010000000099
30054984123112078000401026100010200120970099919-32099100000000000000000400099910-330700710-2960000000000000000071000030010000000099
```

USSR12.DAT:

First five records of the file:

```
302309351231179999999991036309999999999991009599999999910001000220040999999909975099997007 10-248099999999999999997009998008000200059
```

```
30230935123117999999999103630999999999999100959999999991000100022004099999990997509999700710-248099999999999999997009998008000200059
30230935123123999999999103540999999999994009599999999010001000270030000200099670999920010 0-242099999999999999997009998008000200059
30230936010105999999999103470999999999996009699999999910001000250030999999909965099992007 20-233099999999999999999999998008000200059
30230936010111999999999103390999999999991009699999999010001000270020000000099590999920003 0-228099999999999999999999998008000200059
30230936010117999999999103150999999999991009800999999060000002500409999999099945099992000 20-232099999999999999999999990002000000059
```

Last five records of the file:

```
30692984123100080000201028500010999999820099919-40090100000000360040001200097100-390700220-3810000000000000000000000008002000000099
30692984123103080000301027800010200050820099919-35099000000000000000000000097150-340100010-3260000000000000000000000009009090909099
30692984123106076000601026500020200050570099919-28099000000000090020000000097200-280100100-2530000310000000000000000009009090909099
30692984123109082000401029400010200170750099919-32099000000000050020000000097370-320000100-2990000310000000000000000009009090909099
30692984123112082000301032400010200190990099919-36099000000000070020000000097560-360000020-3410400000000000000000000009009090909099
```

Table 8. (continued)

USSR13.DAT:

First five records of the file:

```
3071093512311708600020104090001080006096009900-3509900000000020010999999909745099990000000-3260999999999999999999999999009090909010
3071093512312308300020103950000080008093009900-3609000000000040010000000009729099990000000-3410999999999999999999999999009090909010
3071093601010508600050103610001070006094000000-2709910100000040010999999909719099994007 20-2530999810999999999971099980020808080 10
3071093601011108600040103780000030004094009900-3109000000000040010000100009726099992000000-2920999999999999999931099990090909090 10
3071093601011708400030103810001080004095009900-3509900000000040010999999909719099990000000-3260999999999999999999999999009090909010
```

Last five records of the file:

```
31088984123021072001101011600050200110991999 19-21080100000003600600011001010 90-180200020-1710000000000000000000000008001000000099
31088984123100078001401013500040200190980013 00-19099100006003600500000101012 80-170700220-1590000000000000000000000008001000200099
31088984123103070001401013900060100040980012 00-19099100006003600400000001013 20-150200020-1430000000000000000000000008001000200099
31088984123106063001301014700070200080980012 10-19099101004003600500000001014 00-160800020-1420000000000000000000000000001020200099
31088984123109067001101014900060200020991999 19-22099040000003600400000101014 20-190100010-1650000000000000000000000000001000000099
```

USSR14.DAT:

First five records of the file:

```
3116893512311506100040999999900109999999700999999999990300000000000009999991019209999999999-2850999999999999999999999991000000000099
3116893512312107200040999999900309999999700999999999990900000000000009999991013109999999999-2800999999999999999999999900004000000099
3116893601010306600040999999900309999999700999999999990600060000000009999991014309999999999-2690999999999999999999999900000010200099
3116893601010906000030999999900309999999700999999999990200000000000009999991018009999999999-2910999999999999999999999991000000000099
3116893601011506800040999999900109999999700999999999990000000000000009999991021509999999999-2830999999999999999999999999009090909099
```

Last five records of the file:

```
315949841231000750003010234000102001809700991 9-3509008000000000000000000100400-350100020-3210400000000000000000001000000000099
315949841231030760005010237000201000809700991 9-3009902000000270010000000100480-220100020-2660400000000000000000001000000000099
315949841231060720006010249000303001409700991 9-2809900000000270020000000100620-230100020-2380000000000000000000009009090909099
315949841231090750006010268000202001606200991 9-2909900000000320010000000100780-320000020-2610000000000000000000009009090909099
315949841231120770004010278000201000906600991 9-3109900000000000000000000100870-320000020-2830400000000000000000009009090909099
```

Table 8. (continued)

USSR15.DAT:

First five records of the file:

```
31707935123115075000509999990010999999999999900-300990000000003600109999991010309999999999-27709999999999999999999999009090909059
31707935123121082000409999990000999999999999800-320990300000002001000000010101099999999999-31204003109999999999999991000000100059
31707936010103070000909999990040999999999999800-240990200000002000409999991008209999999999-19309999999999999999999995000000000059
31707936010109065000709999990040999999999999800-270990500000002700300000001013109999999999-21909999999999999999999995000000000059
31707936010115076000409999990010999999999999900-320990000000003200209999991014509999999999-28004009999999999999999999009090909059
```

Last five records of the file:

```
32098984123021088000801017000010200030980099 19-250800000000036003000000101590-260000020-23907100000000000000000009009090909099
```

USSR16.DAT:

First five records of the file:

```
32165946123114086004201009000070600040960099 00-050990000000002200409999991004009999000000-02909999999999999999999999009090909059
```

Last five records of the file:

```
33377983123106086006301004400100700060560099190000300900000002700500032000985100000800100002500003100000000000000001001000000099
```

Table 8. (continued)

USSR17.DAT:

First five records of the file:

```
333939400630220980148099999990040999999950099999999999000000000000009999990975409999999999990132099930099999999999999999009090909099
333939400701040990179099999990020999999950099999999999100010000500200000000097430999999999999015909993009999999999999999998008000100099
333939400701100770214099999990640999999970099999999999090009000200309999999097350999999999999022809999999999999999999999961000000200030 99
333939400701160780177099999990510999999970099999999999010001003600700003000973909999999999990196099999999999999999999999000001000009 9
333939400701220870148099999990230999999980099999999999080008003600509999999097500999999999999015009999999999999999999999999000000010009 9
```

Last five records of the file:

```
3391598312310609100680101230007070018098109919002010100000002000500000000100850001010003000280000000000000000000000001001000000099
3391598312310909400820101160006070006056009919004099080000000270060000000100790004020010000510000310000000000000000001001000000099
3391598312311208700770101150011060001057001100003099100010002700500000000100780004020010000510000310000000000000000008008000200099
3391598312311508000670101160016030001096009919001099100000002500300000000100790003020010000430000310000000000000000008001000000099
339159831231180670050010129002502001209800991 9-0309910000000270020000000100910001010002000290000000000000000000000008001000000099
```

USSR18.DAT:

First five records of the file:

```
339469541231220980049010258000102000609200001 0-030991000100004007099999990999509999400490-026051082099999999999999998008080808010
339469550101040960042010261000205000409300001 0-050501000100004006000000000999709999400490-044099981099999999999999998108080808010
339469550101100890064010237000807001309600929900109909000300040100999999909979099994001000022099930099999999999999991000000390010
339469550101160980058010250000202000609410001 0-010201000100004010000000009990099994004 50-003099980099999999999999998108080808030
339469550101220960061010236000301000809410010000000991000100004008099999990997709999400100000609993109999999999999998008000100030
```

Last five records of the file:

```
3430098312310609000570100290006070020094000800-01030100010002500700000100983800000800860000500000000000000008000008008020003099
3430098312310909200610100230005070006095000800000009910001000270060000000098320000080010000100000310000000000000000008008000203099
3430098312311208100600100190014070003096001000000009910001000270050000000098290000020010000280000310000000000000000008008000200099
3430098312311507000480100270020020007097001300-030990700070027007000000000983600000200020001400000000000000000000000000000200099
3430098312311807300470100280017020001097001310-04099040004002700700000100983 70-0201000200007000000000000000000000000000200099
```

Table 8. (continued)

USSR19.DAT:

First five records of the file:

```
34391935123121088001201039000010400050970099C0-2109900000000140030999999103550999900000-19404009999999999999999999999009090909059
34391936010103087001101088490010300010970099O0-2208000000000140030000000103500999900000-20009999999999999999999999999009090909059
3439193601010906900210103730011099009097009900-1409900000000160030999999103400999900000-08609999999999999999999999999009090909059
3439193601011508100160103670003080007097009900-1708000000000140030000000103320999900000-15109999999999999999999999999009090909059
3439193601012108500130103610001080001097009900-2009900000000180020999999103260999900000-17809999999999999999999999999009090909059
```

Last five records of the file:

```
3507898512310308800110103060001080004050000800-21090100010000000000000010098940-210700770-20205003100006100000000008008000100099
3507898512310608900130103020002080001096009919-19099000000000000000000000098930-220700100-18005003100000000000000009009090909099
3507898512310908900140102930002070008097009919-19099000000000000000000000098850-180000020-17705000000000000000000009009090909099
3507898512311208900120102960001030001050000800-20099100010000900100000010098860-190100100-18805003100000000000000008008000100099
3507898512311508900160102950002020005060000600-17099100010000000000000000098910-150200020-15605000000000000000000008008000100099
```

USSR20.DAT:

First five records of the file:

```
3510893512312007800110999999003099999999999999999999990000000000000099999910340099999999999-193099999999999999999999999999999999999
3510893601010208100090999999003099999999999999999999990000000000000000000010342099999999999-209051032099999999999999999999999999999
3510893601010806100190999999012099999999999999999999990000000018002099999910327099999999999-090099999999999999999999999999999999999
3510893601011407500170999999007099999999999999999999990000000000000000000010322099999999999-125099999999999999999999999999999999999
3510893601012008000110999999004099999999999999999999990000000000000099999910315099999999999-185099999999999999999999999999999999999
```

Last five records of the file:

```
3541698512310308900290102400004070024099191400-10090100010001600800000000101060-090200100-08305003100000000000000008008000200099
3541698512310608700290102380004080002097001100-10099100010001600800000000101040-070200020-08005000000000000000000008008000200099
3541698512310908800320102340004050004097000700-09099100010001800900000000101000-060200020-06905000000000000000000008008000200099
3541698512311209000360102220004070010097000900-07099100010001800800000000100900-050200020-05505000000000000000000008008000200099
3541698512311509100400102190004070002099190900-06099100010001800800000000100880-050200100-04305003100000000000000008008000100099
```

Table 8. (continued)

USSR21.DAT:

First five records of the file:

```
35542935123120999999999999999999999999999999999999991000999900000093999910226099999999999-16809999999999999999999999999999999999999
35542936010102999999999999999999999999999999999999991000999900000000000010240099999999999-12409999999999999999999999999999999999999
35542936010108999999999999999999999999999999999999991000999900000099999910242099999999999-09709999999999999999999999999999999999999
35542936010114999999999999999999999999999999999999991010999900000000000010240099999999999-09609999999999999999999999999999999999999
35542936010120999999999999999999999999999999999999991000999900000099999910220099999999999-15209999999999999999999999999999999999999
```

Last five records of the file:

```
366659851231030860006010429000107000609800991 9-280900400000000000000000000095990-300000030-26607000000000000000000000001000000099
366659851231060940012010391000107001409800991 9-210991010000000000000000000095850-190100030-20307000000000000000000000100100000099
366659851231090920010010386000107000909800991 9-220990600000000000000000000095760-180200010-21207000000000000000000000100000000099
366659851231120870008010385000107000907000991 9-260990400000000000000000000095670-260100010-24004000000000000000000000001000000099
366659851231150870007010384000107000207000991 9-260990000000000000000000000095650-260000010-24604000000000000000000000900909090909 9
```

USSR22.DAT:

First five records of the file:

```
3672993512311907900040999999001099999999999999999999999000099999999999999999098530999999999999-2960999999999999999999999999999999999999
3672993601010107800040999999001099999999999999999999999000099999999999000000098660999999999999-3070410310999999999999999999999999999999
3672993601010708000070999999001099999999999999999999999000099999999999999999098660999999999999-2480999310999999999999999999999999999999
3672993601011308000040999999001099999999999999999999999000099999999999000000098380999999999999-3050999999999999999999999999999999999999
3672993601011907800040999999001099999999999999999999999000099999999999999999098020999999999999-2950510999999999999999999999999999999999
```

Last five records of the file:

```
37859831231030800064010290001607000209919131000102010101010000000000000102560999910003000380000000000000000000000000000000200099
37385983123106080005901027600140700140990099 19-010990200000000000000000102420999910001000250000000000000000000000000001000000099
37385983123109070006901026600300700100990099190020990000000000000000000102320999900001000690000000000000000000000009009090909099
37385983123112053005901024500530700200990099 19-010990000000000900200000001021209999000020008700000000000000000000000009009090909099
37385983123115069006001021600280700300991999190000990000000000000000000101820999900002000510000000000000000000000009009090909099
```

Table 8. (continued)

USSR23.DAT:

First five records of the file:

```
3747293512312106600480999999902409999999999999999999999903000300160160999999102630999999999990023099999999999999999999999999999999999
3747293601010307400520999999901909999999999999999999999903000300160160000010102590999999999990019099999999999999999999999999999999999
3747293601010908500730999999901209999999999999999999999907000000160180999999102510999999999990047099999999999999999999999999999999999
3747293601011507600590999999901909999999999999999999999905000000160160000010102500999999999990032099999999999999999999999999999999999
3747293601012107200560999999902109999999999999999999999900000000160160999999102380999999999990032099999999999999999999999999999999999
```

Last five records of the file:

```
384139841231030900013010327000207000309800991 9-190500300000000900300000000100040-200000020-181040000000000000000000000001000000099
```

USSR24.DAT:

First five records of the file:

```
3845793512311905700200999999901909999999999999999999999900000000090020999999097770999999999999-0730410999999999999999999999999999999999
3845793601010106300190999999901109999999999999999999999900000000110010000000097660999999999999-0920410999999999999999999999999999999999
3845793601010704300280999999903609999999999999999999999900000000110010999999097530999999999990006099921099999999999999999999999999999
3845793601011307500310999999900909999999999999999999999900000000160010000000097390999999999999-0520410999999999999999999999999999999999
3845793601011908400250999999900509999999999999999999999900000000110010999999097170999999999999-0900410999999999999999999999999999999999
```

Last five records of the file:

```
388369841231030830036010301000703000209600991 9-070901000000025001000000000093120-040100100-048000031000000000000000000008004000000099
```

Table 8. (continued)

USSR25.DAT:

First five records of the file:

```
388809370531200440127099999991600999999999999999999999900000000000000999999098090999999999999023309999999999999999999999999999999999
388809370601020260100099999992920999999999999999999999900000000180030000000009799099999999999028609999999999999999999999999999999999
388809370601080110065099999995320999999999999999999999901000100090040999999097980999999999999036109999999999999999999999999999999999
388809370601140190099099999994310999999999999999999999903000200180030000000009782099999999999033909999999999999999999961099999999999999
388809370601200460140099999991630999999999999999999999900000000320030999999098030999999999999024209999999310999999999999999999999999
```

Last five records of the file:

```
3898798412310308500240102960004070001098009919-120300000000020001000000000094970-070000020-104040000000000000000000009009090909099
3898798412310607000360102700016070001098009919-070990000000000250020000000000949600000000020-023040000000000000000000009009090909099
3898798412310904100360102240052070023098009919-070990100000000200100000000009473000700000200051000000000000000000000001000000000099
3898798412311204700400102220045070003098009919-060991010000000200200000000009470000101000200046000000000000000000000001000000000099
3898798412311505300320102580029030021098009919-0909900000000007002000000000094910-010100010000000000000000000000009009090909099
```

APPENDICES

APPENDIX A

STATION HISTORIES

Station Histories

This appendix contains a list of all station history information for each of the 223 stations. The meanings of the column headings on each page are as follows:

WMO No. is the WMO No. of the station.

Type is the type of change indicated by this entry. The possible values of **Type** are as follows:

PRCP = rain gauge replacement (i.e., change from old-type gauge to Tretyakov-type gauge). Each station will have only one PRCP entry. In this type of entry, **Distance** and **Direction** (described below) have no meaning and thus are coded as blanks.

MOVE = station relocation. Each station will have at least one MOVE entry. If a station moved on more than one occasion, then separate entries are included for each relocation. If a station never moved, then that station will have only one MOVE entry; in this entry, **Year, Month, Day, Distance,** and **Direction** (described below) are all coded as missing.

Year is the year in which the change took place. Missing years are coded as -999.

Month is the month in which the change took place. Missing months are coded as -9.

Day is the day on which the change took place. Missing days are coded as -9.

Distance is the distance (in kilometers) that the station was moved. Missing distances are coded as -9. A distance of zero indicates that the station moved less than one kilometer. **Distance** only applies to station relocation entries (i.e., lines in which **Type** = MOVE). In rain gauge replacement entries (i.e., lines in which **Type** = PRCP), **Distance** has no meaning and thus is coded as blanks.

Direction is the direction in which the station was moved (e.g., N = north, SE = southeast). Missing directions are coded as -99. **Direction** only applies to station relocation entries (i.e., lines in which **Type** = MOVE). In rain gauge replacement entries (i.e., lines in which **Type** = PRCP), **Direction** has no meaning and thus is coded as blanks.

WMO No.	Type	Year	Month	Day	Distance	Direction
20674	MOVE	1938	-9	-9	0	-99
20674	PRCP	1953	3	2		
20674	MOVE	1960	-9	-9	0	-99
20891	MOVE	1951	1	12	1	SSW
20891	PRCP	1953	12	1		
21946	PRCP	1954	9	17		
21946	MOVE	1955	5	-9	1	NE
21982	MOVE	1929	9	2	0	E
21982	MOVE	1934	9	1	0	W
21982	MOVE	1940	6	4	0	E
21982	PRCP	1953	9	20		
22113	MOVE	1924	10	-9	3	S
22113	MOVE	1934	11	-9	1	SE
22113	PRCP	1953	1	1		
22217	PRCP	1953	1	1		
22217	MOVE	1960	10	-9	5	NW
22522	MOVE	1925	6	-9	0	NE
22522	MOVE	1933	6	30	1	N
22522	PRCP	1956	2	15		
22550	MOVE	1935	8	1	1	N
22550	MOVE	1943	6	16	0	E
22550	PRCP	1953	1	1		
22550	MOVE	1963	11	-9	2	E
22583	MOVE	1924	-9	-9	0	SE
22583	MOVE	1935	8	23	0	SE
22583	PRCP	1951	6	1		
22602	MOVE	1928	-9	-9	2	S
22602	MOVE	1930	-9	-9	1	N
22602	MOVE	1932	-9	-9	0	E
22602	MOVE	1934	-9	-9	0	SW
22602	PRCP	1951	9	-9		
22602	MOVE	1965	6	-9	0	W
22641	MOVE	1897	8	-9	0	-99

WMO No.	Type	Year	Month	Day	Distance	Direction
22641	MOVE	1900	5	-9	0	-99
22641	MOVE	1926	9	15	0	N
22641	PRCP	1953	1	15		
22802	MOVE	1948	11	-9	3	NE
22802	MOVE	1951	10	-9	0	E
22802	PRCP	1954	8	-9		
22802	MOVE	1957	12	-9	0	W
22820	PRCP	1949	6	23		
22820	MOVE	1954	6	-9	1	NE
22837	MOVE	1914	11	-9	0	-99
22837	MOVE	1932	9	30	0	-99
22837	MOVE	1937	-9	-9	0	E
22837	MOVE	1949	-9	-9	0	NW
22837	PRCP	1955	6	-9		
22837	MOVE	1970	5	-9	0	NW
22887	PRCP	1951	8	31		
22887	MOVE	1957	-9	-9	0	S
22887	MOVE	1969	7	-9	4	E
22887	MOVE	1971	1	-9	1	SE
22887	MOVE	1982	6	-9	1	NW
23146	MOVE	1951	8	21	0	-99
23146	PRCP	1953	10	2		
23146	MOVE	1960	12	-9	0	-99
23146	MOVE	1976	11	-9	0	W
23205	MOVE	1927	6	24	2	SW
23205	MOVE	1927	9	-9	0	S
23205	MOVE	1941	8	26	2	SW
23205	MOVE	1947	11	-9	1	E
23205	PRCP	1954	9	2		
23205	MOVE	1959	10	15	1	SE
23205	MOVE	1984	11	-9	1	SW
23219	MOVE	1937	8	9	0	NE
23219	PRCP	1955	9	25		
23405	MOVE	1899	10	-9	0	S
23405	MOVE	1904	-9	-9	1	NW

WMO No.	Type	Year	Month	Day	Distance	Direction
23405	MOVE	1915	8	14	0	-99
23405	MOVE	1918	11	21	0	W
23405	MOVE	1930	6	-9	0	E
23405	PRCP	1952	6	26		
23418	PRCP	1952	8	1		
23418	MOVE	1965	10	14	0	S
23472	MOVE	1898	6	-9	0	-99
23472	MOVE	1911	9	-9	0	-99
23472	MOVE	1915	6	-9	1	NW
23472	PRCP	1953	1	1		
23472	MOVE	1953	8	10	2	NW
23472	MOVE	1959	8	-9	4	SE
23631	MOVE	1893	-9	-9	0	-99
23631	MOVE	1898	-9	-9	0	-99
23631	MOVE	1937	10	13	0	S
23631	PRCP	1954	6	-9		
23711	MOVE	1892	10	8	1	SE
23711	MOVE	1901	6	-9	0	-99
23711	MOVE	1930	9	-9	0	-99
23711	MOVE	1935	10	-9	0	N
23711	MOVE	1940	6	12	3	SE
23711	PRCP	1952	11	25		
23711	MOVE	1960	3	4	1	E
23711	MOVE	1965	4	20	8	N
23724	MOVE	1935	1	8	1	SW
23724	PRCP	1955	9	-9		
23724	MOVE	1963	10	10	0	NNW
23804	MOVE	1894	-9	-9	0	NE
23804	MOVE	1925	-9	-9	0	W
23804	MOVE	1947	5	24	0	NW
23804	PRCP	1954	9	13		
23804	MOVE	1965	1	11	1	SW
23804	MOVE	1969	-9	-9	1	S
23804	MOVE	1982	2	1	4	NW
23849	MOVE	1887	-9	-9	-9	-99
23849	MOVE	1911	-9	-9	-9	-99

WMO No.	Type	Year	Month	Day	Distance	Direction
23849	MOVE	1939	7	10	5	E
23849	PRCP	1950	-9	-9		
23849	MOVE	1961	12	25	2	WNW
23884	MOVE	1949	6	29	1	W
23884	PRCP	1954	9	3		
23884	MOVE	1955	1	1	7	SW
23884	MOVE	1957	10	15	2	E
23891	PRCP	1953	7	24		
23891	MOVE	1957	6	19	0	-99
23921	PRCP	1952	7	-9		
23921	MOVE	1959	10	-9	4	S
23933	MOVE	1930	-9	-9	0	-99
23933	MOVE	1935	8	-9	0	-99
23933	PRCP	1955	6	-9		
23933	MOVE	1961	6	25	0	-99
23955	MOVE	1954	9	29	2	NW
23955	PRCP	1954	10	2		
23955	MOVE	1959	7	1	3	NW
24125	PRCP	1955	8	1		
24125	MOVE	1965	6	-9	2	ENE
24266	MOVE	1894	3	-9	0	-99
24266	MOVE	1894	11	-9	0	-99
24266	MOVE	1896	10	-9	0	-99
24266	MOVE	1897	3	20	0	-99
24266	MOVE	1898	10	21	0	-99
24266	MOVE	1900	4	-9	0	-99
24266	MOVE	1913	11	10	0	NE
24266	MOVE	1920	-9	-9	0	-99
24266	MOVE	1921	4	-9	0	E
24266	MOVE	1927	9	30	0	N
24266	MOVE	1940	10	30	2	NNE
24266	MOVE	1947	4	27	3	SSE
24266	PRCP	1953	1	1		
24266	MOVE	1954	10	19	1	E
24266	MOVE	1955	8	7	1	W
24266	MOVE	1960	6	22	0	NE

WMO No.	Type	Year	Month	Day	Distance	Direction
24343	PRCP	1953	1	-9		
24343	MOVE	1957	9	4	1	NW
24343	MOVE	1960	9	9	0	NW
24343	MOVE	1964	7	25	0	NE
24343	MOVE	1973	6	-9	0	SE
24507	PRCP	1953	9	19		
24507	MOVE	1962	3	11	1	NE
24641	MOVE	1898	5	-9	0	-99
24641	MOVE	1899	9	-9	0	-99
24641	MOVE	1929	-9	-9	0	-99
24641	MOVE	1939	8	1	0	W
24641	PRCP	1953	1	1		
24641	MOVE	1956	11	10	10	SE
24688	MOVE	1942	-9	-9	2	S
24688	PRCP	1953	2	1		
24738	PRCP	1957	1	1		
24738	MOVE	1960	9	19	2	NE
24738	MOVE	1973	9	7	3	N
24817	MOVE	1938	9	6	0	-99
24817	PRCP	1953	6	-9		
24817	MOVE	1953	9	11	0	-99
24817	MOVE	1956	11	10	0	ESE
24908	MOVE	1935	5	-9	0	-99
24908	PRCP	1953	1	15		
24908	MOVE	1956	-9	-9	0	-99
24908	MOVE	1957	6	-9	0	-99
24944	MOVE	1911	6	-9	0	-99
24944	MOVE	1938	8	-9	0	-99
24944	MOVE	1945	1	-9	0	-99
24944	PRCP	1953	1	1		
24944	MOVE	1958	8	-9	0	-99
24951	MOVE	1937	7	4	0	E
24951	MOVE	1942	10	3	7	SE
24951	MOVE	1945	9	4	7	NW

WMO No.	Type	Year	Month	Day	Distance	Direction
24951	PRCP	1953	1	-9		
24951	MOVE	1955	10	25	0	S
24951	MOVE	1959	9	30	0	E
24959	MOVE	1930	10	-9	0	-99
24959	PRCP	1953	1	1		
24959	MOVE	1964	11	-9	1	NW
24966	MOVE	1925	8	-9	7	SW
24966	MOVE	1943	9	15	0	-99
24966	PRCP	1953	1	1		
25173	MOVE	1933	-9	-9	0	S
25173	PRCP	1949	10	-9		
25551	MOVE	1904	-9	-9	25	E
25551	MOVE	1911	-9	-9	25	W
25551	MOVE	1940	-9	-9	25	E
25551	MOVE	1942	10	-9	25	W
25551	PRCP	1952	7	1		
25551	MOVE	1959	3	-9	0	E
25563	MOVE	1913	-9	-9	0	-99
25563	MOVE	1935	12	1	5	NE
25563	PRCP	1951	12	18		
25594	MOVE	1938	-9	-9	0	-99
25594	PRCP	1950	3	-9		
25594	MOVE	1960	-9	-9	0	-99
25703	MOVE	1941	12	-9	2	N
25703	PRCP	1954	1	-9		
25744	MOVE	1941	6	-9	2	SE
25744	MOVE	1946	12	-9	2	NW
25744	PRCP	1951	-9	-9		
25744	MOVE	1964	8	-9	8	S
25913	MOVE	1937	2	17	0	-99
25913	PRCP	1948	7	31		
25954	MOVE	-999	-9	-9	-9	-99
25954	PRCP	1951	10	24		

WMO No.	Type	Year	Month	Day	Distance	Direction
26038	MOVE	-999	-9	-9	-9	-99
26038	PRCP	1952	9	1		
26063	MOVE	1933	7	-9	5	NNW
26063	PRCP	1946	11	-9		
26063	MOVE	1970	6	-9	0	W
26188	MOVE	1934	3	-9	0	N
26188	PRCP	1954	6	-9		
26231	MOVE	1944	10	14	-9	-99
26231	MOVE	1947	11	7	2	SSE
26231	PRCP	1949	1	-9		
26231	MOVE	1964	12	-9	-9	-99
26258	MOVE	1910	3	-9	1	NW
26258	MOVE	1925	4	-9	0	-99
26258	MOVE	1934	9	-9	1	N
26258	MOVE	1944	8	-9	3	NNW
26258	PRCP	1948	12	-9		
26258	MOVE	1957	6	-9	4	SSW
26258	MOVE	1966	1	-9	5	E
26258	MOVE	1967	11	-9	2	NW
26258	MOVE	1986	6	-9	4	W
26406	MOVE	1922	-9	-9	-9	-99
26406	MOVE	1927	10	-9	-9	-99
26406	MOVE	1945	-9	-9	-9	-99
26406	PRCP	1953	1	1		
26406	MOVE	1961	7	5	5	SSE
26422	MOVE	1872	-9	-9	0	-99
26422	MOVE	1876	5	-9	0	-99
26422	MOVE	1923	-9	-9	0	-99
26422	MOVE	1941	5	-9	0	-99
26422	PRCP	1957	11	1		
26477	MOVE	1921	-9	-9	0	S
26477	MOVE	1924	7	-9	0	-99
26477	MOVE	1933	12	-9	10	NNE
26477	MOVE	1946	2	-9	5	NNE
26477	MOVE	1946	9	-9	2	SSW

WMO No.	Type	Year	Month	Day	Distance	Direction
26477	PRCP	1954	1	-9		
26477	MOVE	1955	10	-9	0	NNE
26629	MOVE	1922	-9	-9	0	-99
26629	PRCP	1952	1	1		
26629	MOVE	1955	6	26	1	E
26629	MOVE	1957	6	5	0	W
26702	MOVE	1889	10	-9	0	-99
26702	MOVE	1922	10	1	0	-99
26702	MOVE	1946	12	-9	0	-99
26702	PRCP	1952	1	1		
26730	MOVE	1892	1	1	0	S
26730	MOVE	1916	3	1	0	-99
26730	MOVE	1920	6	1	0	SSW
26730	MOVE	1922	7	1	0	W
26730	MOVE	1936	3	23	0	W
26730	PRCP	1952	1	1		
26730	MOVE	1953	12	14	3	NE
26730	MOVE	1964	6	1	0	-99
26781	MOVE	1900	2	-9	0	-99
26781	MOVE	1905	9	-9	0	-99
26781	MOVE	1911	-9	-9	0	-99
26781	MOVE	1936	-9	-9	0	-99
26781	PRCP	1951	10	-9		
26850	MOVE	1870	-9	-9	0	-99
26850	MOVE	1891	-9	-9	0	-99
26850	MOVE	1895	-9	-9	0	-99
26850	MOVE	1905	-9	-9	0	-99
26850	MOVE	1922	-9	-9	0	-99
26850	MOVE	1935	-9	-9	0	-99
26850	PRCP	1948	6	-9		
27037	MOVE	1945	10	-9	0	E
27037	MOVE	1951	10	-9	10	N
27037	PRCP	1954	4	-9		
27037	MOVE	1959	9	-9	2	S
27037	MOVE	1968	4	-9	0	SW
27037	MOVE	1979	9	-9	3	N

WMO No.	Type	Year	Month	Day	Distance	Direction
27196	MOVE	1922	12	3	0	S
27196	MOVE	1936	11	17	1	SW
27196	PRCP	1949	5	-9		
27196	MOVE	1957	2	15	1	SW
27333	MOVE	1883	-9	-9	0	-99
27333	MOVE	1913	3	-9	0	-99
27333	MOVE	1920	7	-9	3	SE
27333	MOVE	1924	6	-9	0	-99
27333	MOVE	1936	5	-9	1	W
27333	PRCP	1949	6	10		
27553	MOVE	1892	6	-9	1	SW
27553	MOVE	1904	12	-9	2	E
27553	MOVE	1922	5	-9	2	SE
27553	MOVE	1932	7	-9	7	SSW
27553	PRCP	1948	12	17		
27595	MOVE	1921	-9	-9	0	-99
27595	PRCP	1953	6	-9		
27595	MOVE	1962	8	22	0	NE
27595	MOVE	1988	8	-9	0	S
27612	MOVE	1939	8	1	0	-99
27612	PRCP	1952	-9	-9		
27648	MOVE	1919	-9	-9	0	N
27648	MOVE	1932	9	-9	1	W
27648	PRCP	1950	7	-9		
27823	MOVE	1930	11	-9	1	SE
27823	MOVE	1943	1	-9	1	W
27823	PRCP	1951	1	1		
27947	MOVE	1932	9	19	1	-99
27947	PRCP	1953	1	1		
27947	MOVE	1957	9	30	2	-99
28064	MOVE	-999	-9	-9	-9	-99
28064	PRCP	1953	1	10		
28138	MOVE	-999	-9	-9	-9	-99
28138	PRCP	1956	5	-9		

WMO No.	Type	Year	Month	Day	Distance	Direction
28225	MOVE	1938	4	-9	2	-99
28225	PRCP	1952	-9	-9		
28275	MOVE	1890	7	-9	0	-99
28275	MOVE	1895	4	-9	0	N
28275	MOVE	1895	10	-9	0	S
28275	PRCP	1951	1	-9		
28411	MOVE	1932	9	-9	-9	-99
28411	MOVE	1940	2	-9	7	SE
28411	MOVE	1940	12	-9	7	NW
28411	MOVE	1950	9	1	0	E
28411	PRCP	1951	5	30		
28411	MOVE	1961	6	1	5	E
28411	MOVE	1974	10	-9	10	E
28411	MOVE	1977	8	-9	1	NE
28434	PRCP	1949	9	-9		
28434	MOVE	1956	11	5	6	N
28434	MOVE	1963	9	6	0	S
28434	MOVE	1973	-9	-9	0	-99
28440	PRCP	1948	3	1		
28440	MOVE	1969	-9	-9	1	-99
28493	MOVE	1925	-9	-9	0	-99
28493	MOVE	1936	8	-9	3	-99
28493	MOVE	1951	10	-9	5	SW
28493	PRCP	1951	10	-9		
28493	MOVE	1986	-9	-9	0	-99
28661	MOVE	1935	-9	-9	0	-99
28661	MOVE	1942	8	-9	2	NE
28661	PRCP	1954	10	28		
28661	MOVE	1975	-9	-9	2	-99
28679	MOVE	1935	12	31	6	NE
28679	MOVE	1936	11	24	8	SSW
28679	PRCP	1951	1	-9		
28679	MOVE	1974	7	11	6	S
28698	MOVE	1935	-9	-9	0	W

WMO No.	Type	Year	Month	Day	Distance	Direction
28698	PRCP	1952	1	1		
28722	MOVE	1942	-9	-9	0	S
28722	PRCP	1954	-9	-9		
28722	MOVE	1957	-9	-9	0	N
28900	PRCP	1949	8	31		
28900	MOVE	1973	6	-9	0	NNE
28952	MOVE	1933	4	-9	7	SE
28952	PRCP	1952	9	1		
28952	MOVE	1953	7	18	0	SW
28952	MOVE	1957	6	28	0	NE
29231	MOVE	1935	12	24	9	W
29231	MOVE	1947	10	14	2	E
29231	PRCP	1950	7	1		
29231	MOVE	1963	8	-9	1	N
29231	MOVE	1983	12	-9	2	E
29263	MOVE	-999	-9	-9	-9	-99
29263	PRCP	1955	8	22		
29282	MOVE	1935	8	6	0	N
29282	PRCP	1953	8	3		
29282	MOVE	1960	12	9	2	NW
29430	MOVE	1883	7	29	0	-99
29430	MOVE	1897	8	21	0	SE
29430	MOVE	1934	4	18	3	-99
29430	PRCP	1947	6	25		
29574	MOVE	-999	-9	-9	-9	-99
29574	PRCP	1951	6	15		
29612	MOVE	1939	5	21	2	N
29612	MOVE	1949	10	20	4	NW
29612	PRCP	1955	9	19		
29612	MOVE	1958	12	4	0	NE
29698	MOVE	1905	-9	-9	0	-99
29698	MOVE	1911	-9	-9	0	-99
29698	MOVE	1915	-9	-9	0	-99

WMO No.	Type	Year	Month	Day	Distance	Direction
29698	MOVE	1932	11	1	0	-99
29698	MOVE	1939	8	1	0	-99
29698	MOVE	1946	10	16	1	S
29698	PRCP	1950	9	1		
29807	MOVE	-999	-9	-9	-9	-99
29807	PRCP	1951	7	1		
29838	PRCP	1951	6	25		
29838	MOVE	1970	9	-9	1	NW
29866	MOVE	-999	-9	-9	-9	-99
29866	PRCP	1951	8	6		
30054	MOVE	-999	-9	-9	-9	-99
30054	PRCP	1953	1	1		
30230	MOVE	-999	-9	-9	-9	-99
30230	PRCP	1950	1	-9		
30253	MOVE	1933	10	12	0	E
30253	MOVE	1942	8	29	0	E
30253	MOVE	1947	10	4	2	NE
30253	PRCP	1950	4	-9		
30372	MOVE	1949	10	-9	1	NE
30372	PRCP	1957	6	-9		
30393	MOVE	1940	9	12	1	S
30393	PRCP	1953	2	1		
30393	MOVE	1966	1	1	6	N
30393	MOVE	1988	7	-9	2	NE
30521	MOVE	1946	10	16	1	S
30521	PRCP	1951	10	-9		
30521	MOVE	1967	9	-9	3	E
30555	PRCP	1956	9	-9		
30555	MOVE	1969	2	-9	0	S
30636	MOVE	1931	7	-9	-9	N
30636	MOVE	1933	10	-9	-9	S
30636	MOVE	1936	3	-9	1	NE

WMO No.	Type	Year	Month	Day	Distance	Direction
30636	MOVE	1952	-9	-9	2	W
30636	PRCP	1954	6	-9		
30636	MOVE	1963	11	-9	0	SSE
30673	MOVE	1934	-9	-9	0	SSW
30673	MOVE	1937	-9	-9	1	NW
30673	PRCP	1950	5	-9		
30673	MOVE	1956	10	-9	0	NE
30692	MOVE	1932	10	-9	3	NE
30692	MOVE	1933	-9	-9	0	S
30692	MOVE	1937	6	-9	0	S
30692	PRCP	1953	9	10		
30710	MOVE	-999	-9	-9	-9	-99
30710	PRCP	1950	1	-9		
30758	MOVE	1913	6	-9	0	-99
30758	MOVE	1915	10	-9	0	-99
30758	MOVE	1931	10	-9	0	-99
30758	PRCP	1948	10	-9		
30758	MOVE	1955	3	24	0	N
30777	MOVE	1911	9	-9	-9	-99
30777	MOVE	1942	6	-9	3	SSW
30777	MOVE	1945	7	-9	0	NE
30777	PRCP	1949	7	-9		
30777	MOVE	1956	4	-9	1	SE
30823	MOVE	1901	8	-9	1	NE
30823	MOVE	1919	4	-9	4	SE
30823	MOVE	1934	11	-9	3	NE
30823	MOVE	1942	7	-9	12	WSW
30823	MOVE	1947	-9	-9	12	ENE
30823	PRCP	1949	11	-9		
30823	MOVE	1953	-9	-9	2	SW
30925	MOVE	1933	1	-9	-9	NE
30925	PRCP	1954	9	-9		
30949	PRCP	1951	12	11		
30949	MOVE	1956	7	-9	0	N

WMO No.	Type	Year	Month	Day	Distance	Direction
30965	PRCP	1952	4	-9		
30965	MOVE	1953	5	-9	1	NNE
31004	MOVE	1931	10	-9	1	-99
31004	MOVE	1941	12	-9	0	NE
31004	PRCP	1948	9	-9		
31004	MOVE	1952	7	-9	0	S
31004	MOVE	1970	8	11	0	NW
31088	PRCP	1952	-9	-9		
31088	MOVE	1969	10	7	1	NNE
31168	MOVE	-999	-9	-9	-9	-99
31168	PRCP	1950	9	24		
31253	MOVE	-999	-9	-9	-9	-99
31253	PRCP	1951	7	1		
31329	MOVE	1952	1	-9	0	-99
31329	PRCP	1955	9	20		
31369	MOVE	1909	10	-9	1	N
31369	MOVE	1925	8	22	0	N
31369	MOVE	1932	10	20	0	SE
31369	MOVE	1949	6	17	3	W
31369	PRCP	1953	10	-9		
31388	MOVE	1925	-9	-9	5	-99
31388	MOVE	1932	9	-9	1	S
31388	PRCP	1953	11	-9		
31416	MOVE	1914	-9	-9	0	-99
31416	MOVE	1939	10	-9	0	-99
31416	PRCP	1954	1	28		
31416	MOVE	1960	9	-9	1	N
31510	MOVE	1880	11	-9	0	-99
31510	MOVE	1898	9	-9	0	-99
31510	MOVE	1910	-9	-9	0	-99
31510	MOVE	1912	10	-9	0	-99
31510	MOVE	1943	10	11	0	-99
31510	PRCP	1953	1	31		

WMO No.	Type	Year	Month	Day	Distance	Direction
31532	PRCP	1954	6	8		
31532	MOVE	1979	6	-9	10	NE
31594	MOVE	1932	11	-9	0	S
31594	MOVE	1933	4	-9	0	N
31594	MOVE	1935	-9	-9	0	S
31594	PRCP	1953	12	26		
31707	MOVE	1912	-9	-9	1	E
31707	MOVE	1925	-9	-9	1	E
31707	MOVE	1931	6	-9	10	-99
31707	MOVE	1934	8	10	10	-99
31707	PRCP	1954	8	18		
31707	MOVE	1959	10	-9	1	SE
31735	MOVE	1890	-9	-9	0	-99
31735	MOVE	1910	-9	-9	0	-99
31735	MOVE	1914	-9	-9	0	-99
31735	MOVE	1927	8	-9	0	-99
31735	MOVE	1932	-9	-9	0	-99
31735	MOVE	1942	-9	-9	0	-99
31735	MOVE	1946	-9	-9	0	-99
31735	PRCP	1950	11	25		
31735	MOVE	1968	-9	-9	0	-99
31829	MOVE	-999	-9	-9	-9	-99
31829	PRCP	1950	8	-9		
31873	PRCP	1953	5	-9		
31873	MOVE	1960	10	-9	0	SE
31909	PRCP	1950	5	-9		
31909	MOVE	1975	6	-9	2	NW
31915	PRCP	1953	4	-9		
31915	MOVE	1953	4	27	1	SW
31960	MOVE	-999	-9	-9	-9	-99
31960	PRCP	1949	7	-9		
32061	MOVE	1899	1	-9	0	N
32061	PRCP	1950	5	20		
32061	MOVE	1960	12	1	3	N

WMO No.	Type	Year	Month	Day	Distance	Direction
32098	PRCP	1949	5	27		
32098	MOVE	1977	1	1	0	-99
32165	PRCP	1950	6	-9		
32165	MOVE	1957	1	1	5	E
32165	MOVE	1980	-9	-9	0	-99
32389	PRCP	1951	1	1		
32389	MOVE	1956	7	15	0	E
32411	MOVE	-999	-9	-9	-9	-99
32411	PRCP	1953	10	23		
32540	MOVE	1909	7	-9	0	NNW
32540	MOVE	1938	-9	-9	0	NW
32540	PRCP	1951	1	1		
32564	MOVE	1914	-9	-9	0	-99
32564	PRCP	1952	10	29		
33008	MOVE	1905	8	-9	0	-99
33008	MOVE	1912	5	-9	1	-99
33008	MOVE	1914	-9	-9	0	-99
33008	MOVE	1944	10	-9	0	-99
33008	MOVE	1945	10	8	2	WSW
33008	MOVE	1947	10	1	2	ENE
33008	PRCP	1949	6	-9		
33008	MOVE	1960	10	4	1	N
33038	MOVE	1923	-9	-9	1	E
33038	MOVE	1942	9	-9	0	-99
33038	MOVE	1945	4	-9	1	SSE
33038	PRCP	1949	9	28		
33038	MOVE	1987	-9	-9	0	-99
33345	PRCP	1948	-9	-9		
33345	MOVE	1982	-9	-9	6	E
33377	MOVE	1920	7	-9	1	-99
33377	MOVE	1928	11	1	2	SE
33377	MOVE	1943	9	22	2	NW
33377	MOVE	1951	10	-9	0	WNW

WMO No.	Type	Year	Month	Day	Distance	Direction
33377	PRCP	1953	1	1		
33393	MOVE	1900	-9	-9	0	-99
33393	MOVE	1940	5	-9	0	-99
33393	PRCP	1952	4	17		
33393	MOVE	1962	-9	-9	1	SE
33562	MOVE	1922	5	-9	1	NE
33562	MOVE	1927	1	1	5	WSW
33562	MOVE	1940	1	28	4	NE
33562	PRCP	1950	9	27		
33562	MOVE	1964	4	10	9	E
33562	MOVE	1983	-9	-9	4	N
33631	MOVE	-999	-9	-9	-9	-99
33631	PRCP	1952	10	-9		
33658	MOVE	-999	-9	-9	-9	-99
33658	PRCP	1954	3	1		
33815	MOVE	1940	-9	-9	2	SE
33815	PRCP	1952	1	3		
33815	MOVE	1975	-9	-9	0	-99
33837	MOVE	1924	-9	-9	1	-99
33837	PRCP	1947	-9	-9		
33889	PRCP	1953	1	1		
33889	MOVE	1959	1	-9	2	SE
33889	MOVE	1960	12	23	6	NNE
33910	MOVE	1910	-9	-9	0	-99
33910	MOVE	1936	2	1	1	-99
33910	MOVE	1943	12	-9	0	-99
33910	PRCP	1953	2	1		
33915	MOVE	1925	3	17	1	S
33915	PRCP	1949	10	15		
33915	MOVE	1964	12	12	0	SE
33946	MOVE	-999	-9	-9	-9	-99
33946	PRCP	1949	-9	-9		

WMO No.	Type	Year	Month	Day	Distance	Direction
33976	MOVE	1944	5	-9	1	NNW
33976	PRCP	1953	2	-9		
33983	MOVE	1948	6	25	0	-99
33983	MOVE	1949	11	30	7	SW
33983	PRCP	1953	1	1		
33983	MOVE	1958	5	13	0	E
33983	MOVE	1960	10	17	0	N
33983	MOVE	1973	10	31	3	N
34009	PRCP	1953	1	1		
34009	MOVE	1957	7	1	4	-99
34122	MOVE	1930	5	29	1	-99
34122	PRCP	1953	1	1		
34139	MOVE	-999	-9	-9	-9	-99
34139	PRCP	1953	1	1		
34163	MOVE	1931	-9	-9	-9	-99
34163	MOVE	1934	7	26	-9	NW
34163	PRCP	1954	4	18		
34163	MOVE	1960	9	21	0	NW
34172	MOVE	1922	5	-9	1	S
34172	MOVE	1952	11	-9	1	NE
34172	PRCP	1953	7	-9		
34300	MOVE	1933	-9	-9	0	-99
34300	MOVE	1938	7	-9	0	NE
34300	MOVE	1940	-9	-9	0	N
34300	PRCP	1951	-9	-9		
34391	PRCP	1953	10	-9		
34391	MOVE	1953	10	15	0	S
34391	MOVE	1967	9	-9	0	N
34524	MOVE	1929	11	24	1	SE
34524	MOVE	1934	12	13	4	NE
34524	PRCP	1951	-9	-9		
34646	MOVE	1933	10	6	1	N
34646	MOVE	1946	4	20	1	N

WMO No.	Type	Year	Month	Day	Distance	Direction
34646	MOVE	1951	11	14	2	SW
34646	PRCP	1955	4	-9		
34731	MOVE	-999	-9	-9	-9	-99
34731	PRCP	1951	2	1		
34747	PRCP	1947	8	10		
34747	MOVE	1978	8	-9	0	W
34824	MOVE	-999	-9	-9	-9	-99
34824	PRCP	1953	11	-9		
34861	MOVE	1944	4	19	5	ESE
34861	PRCP	1954	12	-9		
34880	PRCP	1953	5	13		
34880	MOVE	1962	2	1	10	-99
35078	MOVE	1910	10	-9	1	N
35078	MOVE	1925	-9	-9	0	-99
35078	MOVE	1936	8	28	3	N
35078	PRCP	1949	6	25		
35108	MOVE	1940	5	-9	0	-99
35108	PRCP	1951	-9	-9		
35108	MOVE	1962	8	1	0	-99
35121	MOVE	1846	-9	-9	0	-99
35121	MOVE	1859	-9	-9	0	-99
35121	MOVE	1863	-9	-9	0	-99
35121	MOVE	1914	9	-9	0	-99
35121	PRCP	1948	4	24		
35121	MOVE	1962	1	-9	1	NE
35121	MOVE	1975	1	-9	12	ENE
35133	MOVE	1935	9	28	1	NE
35133	PRCP	1949	12	1		
35188	MOVE	-999	-9	-9	-9	-99
35188	PRCP	1951	1	1		
35229	MOVE	1937	8	5	0	-99
35229	PRCP	1953	5	-9		

WMO No.	Type	Year	Month	Day	Distance	Direction
35358	MOVE	1951	-9	-9	0	-99
35358	PRCP	1952	5	-9		
35394	MOVE	1941	9	11	3	NNE
35394	MOVE	1944	8	16	13	S
35394	PRCP	1959	1	1		
35406	MOVE	1934	12	5	1	SW
35406	PRCP	1949	4	17		
35406	MOVE	1951	12	20	1	S
35416	MOVE	-999	-9	-9	-9	-99
35416	PRCP	1953	8	8		
35542	MOVE	1914	7	-9	0	-99
35542	MOVE	1922	8	13	0	-99
35542	MOVE	1932	3	-9	0	S
35542	MOVE	1939	7	-9	0	NW
35542	PRCP	1954	10	-9		
35542	MOVE	1959	11	-9	0	-99
35576	MOVE	-999	-9	-9	-9	-99
35576	PRCP	1953	3	19		
35663	PRCP	1960	9	8		
35663	MOVE	1962	8	12	1	S
35700	MOVE	1937	5	20	2	-99
35700	PRCP	1953	5	26		
35746	MOVE	1925	11	-9	0	S
35746	MOVE	1931	-9	-9	0	-99
35746	MOVE	1942	12	15	0	WSW
35746	PRCP	1953	1	31		
35746	MOVE	1953	11	30	6	SW
35796	MOVE	1937	6	-9	8	SSW
35796	MOVE	1941	8	-9	8	NNE
35796	PRCP	1952	9	24		
36034	MOVE	1928	3	1	0	W
36034	MOVE	1942	11	5	2	W

WMO No.	Type	Year	Month	Day	Distance	Direction
36034	MOVE	1943	5	6	2	SE
36034	PRCP	1954	-9	-9		
36034	MOVE	1955	10	11	9	NNW
36177	MOVE	1957	5	17	0	-99
36177	PRCP	1957	5	17		
36665	MOVE	1941	6	1	2	NW
36665	PRCP	1950	10	1		
36729	MOVE	1938	9	14	0	NNE
36729	PRCP	1952	2	20		
36729	MOVE	1955	7	27	2	SE
36729	MOVE	1957	12	-9	0	-99
36859	MOVE	1935	8	15	5	ENE
36859	MOVE	1936	6	9	0	SSE
36859	PRCP	1953	7	16		
36870	MOVE	1908	10	-9	0	-99
36870	MOVE	1915	-9	-9	2	NW
36870	PRCP	1951	6	-9		
36974	MOVE	1935	-9	-9	0	-99
36974	PRCP	1949	5	-9		
36974	MOVE	1960	12	-9	1	W
37031	MOVE	1933	9	5	1	SW
37031	PRCP	1955	1	12		
37031	MOVE	1963	9	13	6	N
37050	PRCP	1954	10	6		
37050	MOVE	1970	-9	-9	0	-99
37099	MOVE	-999	-9	-9	-9	-99
37099	PRCP	1958	6	1		
37235	MOVE	1917	-9	-9	0	-99
37235	MOVE	1925	-9	-9	0	-99
37235	MOVE	1937	6	-9	0	-99
37235	PRCP	1954	12	10		
37235	MOVE	1980	-9	-9	0	-99

WMO No.	Type	Year	Month	Day	Distance	Direction
37385	MOVE	1941	9	-9	2	N
37385	PRCP	1949	-9	-9		
37385	MOVE	1961	12	25	5	SE
37472	MOVE	1897	6	1	2	-99
37472	MOVE	1921	5	-9	0	-99
37472	PRCP	1949	-9	-9		
37472	MOVE	1983	-9	-9	0	-99
37549	MOVE	1851	-9	-9	1	-99
37549	MOVE	1861	-9	-9	0	-99
37549	PRCP	1947	7	-9		
37549	MOVE	1965	5	1	3	-99
37686	MOVE	1934	4	-9	3	SE
37686	MOVE	1941	6	12	1	NW
37686	MOVE	1952	10	2	3	N
37686	PRCP	1953	1	5		
37686	MOVE	1961	4	-9	-9	-99
37735	MOVE	1924	-9	-9	0	-99
37735	MOVE	1925	-9	-9	0	-99
37735	MOVE	1926	-9	-9	0	-99
37735	MOVE	1940	6	6	0	ENE
37735	PRCP	1948	-9	-9		
37735	MOVE	1951	4	7	0	-99
37735	MOVE	1958	3	20	1	SSW
37789	MOVE	1934	4	-9	0	-99
37789	PRCP	1950	5	-9		
37789	MOVE	1974	12	25	2	SSW
38198	MOVE	1930	11	26	5	W
38198	MOVE	1938	8	23	2	W
38198	PRCP	1955	3	-9		
38262	MOVE	1940	10	1	4	N
38262	MOVE	1950	4	12	5	NW
38262	MOVE	1955	10	14	3	E
38262	PRCP	1956	8	15		
38353	MOVE	1927	9	-9	0	-99
38353	MOVE	1939	12	-9	2	N

WMO No.	Type	Year	Month	Day	Distance	Direction
38353	MOVE	1940	-9	-9	1	E
38353	PRCP	1949	5	-9		
38413	MOVE	1936	8	-9	2	E
38413	PRCP	1950	3	6		
38413	MOVE	1957	12	19	3	W
38457	MOVE	-999	-9	-9	-9	-99
38457	PRCP	1953	-9	-9		
38507	MOVE	1883	-9	-9	0	-99
38507	MOVE	1904	-9	-9	0	-99
38507	MOVE	1915	8	-9	0	-99
38507	MOVE	1925	1	-9	0	-99
38507	PRCP	1953	6	1		
38599	MOVE	1929	8	-9	1	N
38599	MOVE	1940	8	11	15	S
38599	PRCP	1949	12	15		
38599	MOVE	1961	4	-9	1	S
38599	MOVE	1966	10	15	2	WSW
38618	MOVE	1881	-9	-9	0	-99
38618	MOVE	1889	-9	-9	0	-99
38618	MOVE	1921	10	-9	0	-99
38618	MOVE	1928	7	19	3	SE
38618	MOVE	1933	1	-9	2	W
38618	PRCP	1951	12	31		
38687	MOVE	1913	10	11	0	-99
38687	PRCP	1952	8	2		
38696	MOVE	-999	-9	-9	-9	-99
38696	PRCP	1951	1	1		
38750	MOVE	-999	-9	-9	-9	-99
38750	PRCP	1953	9	1		
38763	MOVE	1908	3	12	0	-99
38763	MOVE	1925	-9	-9	0	-99
38763	PRCP	1953	1	1		
38763	MOVE	1958	1	-9	2	W

APPENDIX B

REPRINT OF PERTINENT LITERATURE

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AN AMS CONTINUING SERIES

GLOBAL CHANGE

THIS ARTICLE IS THE SECOND IN A SERIES OF ARTICLES REPORTING ON THE U. S. GLOBAL CHANGE RESEARCH PROGRAM AND INTERNATIONAL GLOBAL CHANGE ACTIVITIES WITH PARTICULAR EMPHASIS ON THE WORLD CLIMATE RESEARCH PROGRAM, THE INTERNATIONAL GEOSPHERE–BIOSPHERE PROGRAM, AND THE HUMAN DIMENSIONS OF GLOBAL ENVIRONMENTAL CHANGE PROGRAM.

THE ARTICLES ARE SELECTED IN COOPERATION WITH THE BOARD ON GLOBAL CHANGE, BUT DO NOT NECESSARILY REFLECT THE OPINIONS OF THE NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL, OR THE AMERICAN METEOROLOGICAL SOCIETY.

A New Perspective on Recent Global Warming:

Asymmetric Trends of Daily Maximum and Minimum Temperature

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Abstract

Monthly mean maximum and minimum temperatures for over 50% (10%) of the Northern (Southern) Hemisphere landmass, accounting for 37% of the global landmass, indicate that the rise of the minimum temperature has occurred at a rate three times that of the maximum temperature during the period 1951–90 (0.84°C versus 0.28°C). The decrease of the diurnal temperature range is approximately equal to the increase of mean temperature. The asymmetry is detectable in all seasons and in most of the regions studied.

The decrease in the daily temperature range is partially related to increases in cloud cover. Furthermore, a large number of atmospheric and surface boundary conditions are shown to differentially affect the maximum and minimum temperature. Linkages of the observed changes in the diurnal temperature range to large-scale climate forcings, such as anthropogenic increases in sulfate aerosols, greenhouse gases, or biomass burning (smoke), remain tentative. Nonetheless, the observed decrease of the diurnal temperature range is clearly important, both scientifically and practically.

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1. Background

The mean monthly maximum and minimum temperatures are derived from an average of the daily maximum and minimum temperatures. The mean monthly diurnal temperature range (DTR) is defined as the difference between the mean monthly maximum and minimum temperatures. The dearth of appropriate databases that include information on the daily or mean monthly maximum and minimum temperature has previously impeded our ability to investigate changes in these quantities. The problem has historical roots. It arises because the climatological data that have been made accessible to the international community, by national meteorological or climate data centers throughout the world, do not normally include data with resolution higher than mean monthly temperatures. The data that are made available internationally are usually derived from the monthly climate summaries (CLIMAT messages) on the Global Telecommunications System (GTS), which do not include information on the maximum or minimum temperatures. The GTS is the means by which near-real-time in situ global climate data are exchanged. Moreover, the problem has been exacerbated because the World Meteorological Organization's retrospective data collection projects such as *World Weather Records* and *Monthly Climatic Data of the World* have always been limited to mean monthly temperatures. This has forced climatologists interested in maximum and minimum temperatures to either develop historical databases on a country-by-country basis (Karl et al. 1991) or try to work with the hourly GTS synoptic observations. The former is a painstakingly slow process, and the latter has been limited by poor data quality and metadata (information about the data) and records of short duration (Shea et al. 1992).

The first indication that there might be important large-scale characteristics related to changes of the mean daily maximum and minimum temperatures was reported by Karl et al. (1984). Their analysis indicated that the DTR was decreasing at a statistically significant rate at many rural stations across North America. Because of data accessibility problems, subsequent empirical analyses continued to focus on data from North America over the next several years (Karl et al. 1986a; Plantico et al. 1990). By 1990, however, a U.S./People's Republic of China (PRC) bilateral agreement organized by the U.S. Department of Energy and the PRC's Academy of Sciences provided the opportunity to analyze maximum and minimum temperatures from the People's Republic of China. Also about this time, the Intergovernmental Panel on Climate Change (IPCC) made arrangements with the Australian National Climate Centre to analyze maximum and minimum temperature data from southeastern Australia. The IPCC (1990) reported a significant decrease in the DTR from both of these regions. Meanwhile, work from another data exchange agreement, a bilateral agreement between the United States and the former USSR (Union of Soviet Socialist Republics), came to fruition as a dataset of mostly rural maximum and minimum temperatures was developed for the former USSR. Karl et al. (1991) reported on the widespread decrease of the DTR over the former USSR, PRC, and the contiguous United States that was reiterated by the IPCC (1992).

Additional data from other countries and updates to previous analyses have now been analyzed here and elsewhere. Additional data include the eastern half of Australia, Sudan, Japan, Denmark, northern Finland, some Pacific island stations, Pakistan, South Africa, and a few other long-term stations in Europe. Figure 1 shows the area of the globe that has now been analyzed for differential changes of the maximum and minimum temperature. The area now covers over 50% (10%) of the Northern (Southern) Hemisphere landmass, but still only about 37% of the global landmass.

2. Observed changes of mean maximum, minimum, and diurnal range

a. Spatial and season patterns of the contemporary trends

Daily maximum and minimum temperatures from more than 2000 stations were available for analysis in the countries shaded in Fig. 1 during the period 1951 to 1990 (except Sudan and the former USSR, which had data through 1987 and 1989, respectively). Selected subsets of these data were averaged within various regions of each country. Each region represents a compromise between climatic homogeneity and an adequate number of stations within its boundaries to reduce sampling error. The base period for calculating departures from the average included the years 1951–90 (or slightly fewer years in some countries, e.g., Sudan and the former USSR). The regions are delineated in Fig. 2 where, similar to other large-scale studies of the change of the mean annual temperature (Jones et al. 1986a,b; Jones 1988), the average of the trends of the mean annual maximum and minimum reveals a general rise of temperature. A decrease of the minimum temperature within any region is uncommon but is somewhat more frequent for the maximum temperature, as seen over the United States and the PRC. The differential rate of warming between the maximum and minimum temperatures is

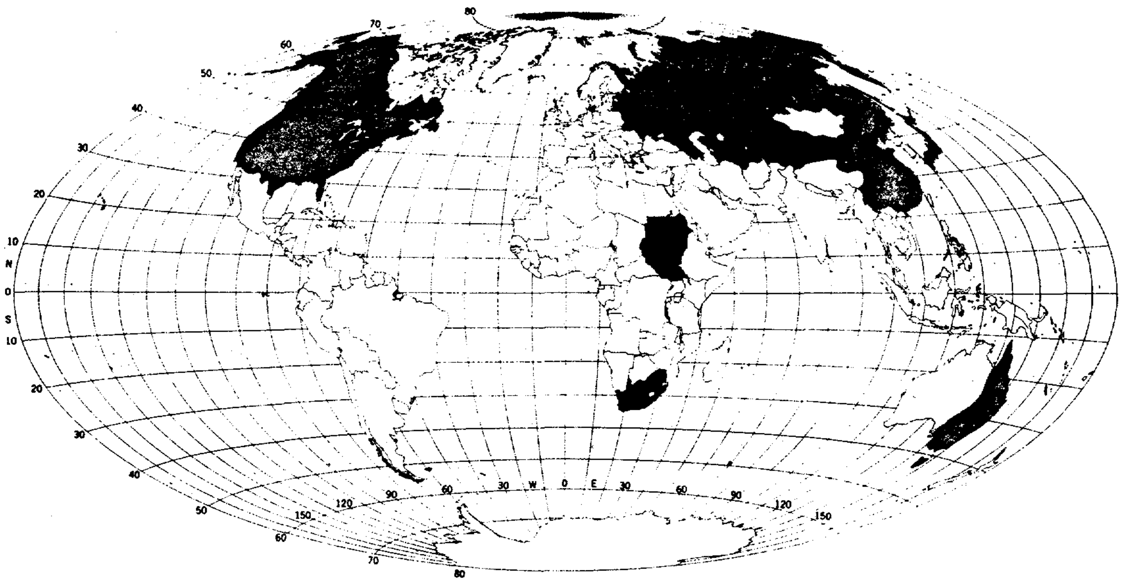

FIG. 1. Shaded areas represent areas of the world that have been analyzed for changes of mean maximum and minimum temperature.

apparent, with only a few regions reflecting an increase of the DTR. These weak exceptions occur in central Canada and southeasternmost Australia.

There are some seasonal variations of the rates of decreasing DTR, but they vary from country to country (Table 1). In Japan the decrease is not evident during summer, and it is not as strong during this season over the PRC. In the United States the decrease is weak during spring but quite strong during autumn. Alaska has strong decreases throughout the year, but Canada has only moderate decreases during summer and autumn. Over the former USSR the decrease in the DTR is significant throughout the year but somewhat weaker during the winter. Over Sudan, the rate of the DTR decrease is strong in all seasons except during the summer rainy season, where rains have been very sparse over the past few decades. Over South Africa, the DTR strongly decreases in the Southern Hemisphere spring, but actually increases slightly during autumn. In the eastern half of Australia the decrease of the DTR is apparent throughout the year but weakest during the Southern Hemisphere summer.

When collectively considered, 60% of the trends in Table 1 reflect statistically significant decreases of the DTR. A test for a change point in the trend (Solow 1987) indicates that for most seasons and areas there is insufficient evidence to suggest a statistically significant change point in the rate of the decrease.

The trends can be area weighted to reflect the overall rate of DTR decrease. Table 2 shows the decrease both north and south of the equator, but without any pronounced seasonal cycle in the Northern Hemisphere. The area of available data in the Southern Hemisphere is too small to make any general statements about trends in that portion of the globe, but the decrease in the Northern Hemisphere is quite apparent. The rate of the decrease in the DTR (−1.4°C/100 years) is comparable to the increase of the mean temperature (1.3°C/100 years).

For all areas combined (Fig. 3), a noticeable differential rate of warming of the minimum relative to the maximum temperature began in the 1960s. The minimum temperature has continued to warm relative to the maximum through the 1980s. The time series ends in 1989, the year after the major North American drought, as data from the former USSR were not available past 1989. The variance of the time series is significantly impacted when such large regions drop out of the analysis, which is why the series ends prematurely. The end of the time series is significantly impacted by the major drought in North America during 1988, which leads to an enhanced DTR. Nonetheless, Fig. 3 reflects a gradual decrease of the DTR through much of the past several decades.

b. Longer-term variations

Unfortunately, the coverage of the globe with maximum and minimum temperature data is currently limited prior to 1951. In the United States, a network of approximately 500 high-quality stations has remained intact back to the turn of the century, and in the former USSR a fixed network of 224 (165 stations if only rural

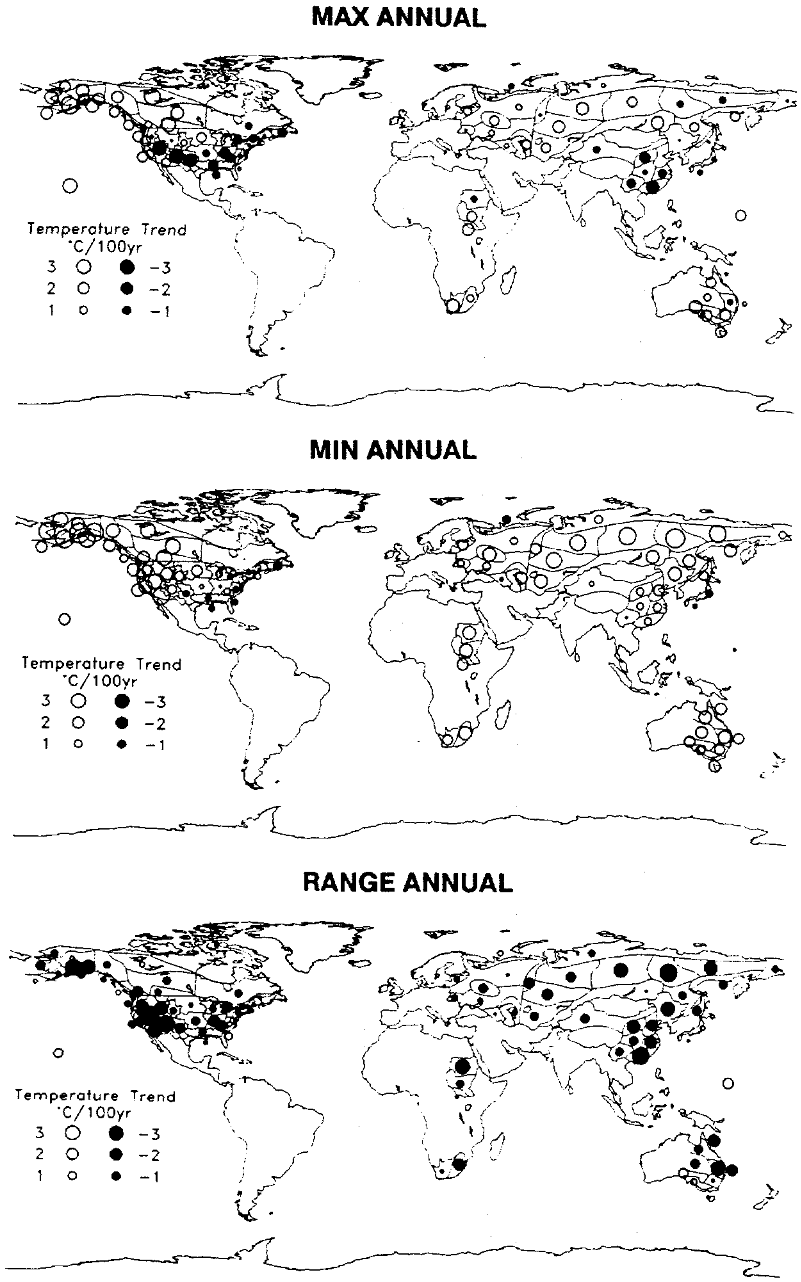

Fig. 2. Spatial patterns of annual trends of mean maximum, minimum, and diurnal temperature range (mostly 1951–90) in degrees Celsius per one hundred years. Diameter of circles is proportional to the trend and solid (open) circles represent negative (positive) trends. Circles pertain to regions within each country except for island stations, e.g., in the South Pacific and Hawaii.

stations are used) stations is available back to the 1930s. Time series from these countries reflect significant (Fig. 4) decadal variations in the DTR, as evident during the dry 1930s and early 1950s in the United States. The general decrease of the DTR did not begin in the United States until the late 1950s, and the DTR decreased rather dramatically in the mid- to late 1970s over the former USSR as part of substantial increases in the minimum temperature. The decrease of the DTR in these two countries is a phenomenon of recent decades. Data are also available farther back in time for smaller areas and countries, notably Japan, eastern Australia, and South Africa. Figure 5 indicates that the decrease in the DTR in eastern Australia occurs rather gradually since the steep decline in the late 1940s. In South Africa the decrease is predominately due to the sharp decline in the early 1950s.

A very long record of maximum and minimum temperatures was available from the Klementinum-Observatory in Prague, Czech Republic, as well as a benchmark station from northern Finland. Figure 6 portrays a remarkable *increase* of the DTR at the Klementinum-Observatory from the early to the mid–twentieth century, with a substantial decrease since about 1950. The increase coincides with the increase of mean temperature since the turn of the century, and the decrease occurs when the mean temperature reflects little overall change. In the first half of the nineteenth century, the DTR averages about 0.5°C lower compared with the latter part of the century. The DTR at Sodankylä, Finland, also displays a gradual decrease since 1950, but contrary to the Klementinum-Observatory, the decrease is evident back to the turn of the century. The mean temperature at Sodankylä reflects little or no change. The high-frequency variability of the DTR at

TABLE 1. Trends of temperature (°C/100 yr) for annual and three-month mean maximum (MAX), minimum (MIN), and diurnal temperature range (DTR) based on a weighted average of the regions (by country) in Fig. 1. Additionally, trends significant at the 0.01 level (two-tailed *t* test) are double underlined and those significant at the 0.05 level are single underlined. Trends with significant change points are denoted with an asterisk. The number of stations used to calculate the trends (in parentheses) and the time period relative to the trends is given for each country. PRC is the People's Republic of China, USA the contiguous United States of America, E. Australia the eastern half of Australia, USSR the former Union of Soviet Socialist Republics, and S. Africa the Republic of South Africa.

ALASKA (39) 1951–1990

Seasons	MAX	MIN	DTR
D–J–F	6.0	8.8	−2.8
M–A–M	3.1	6.3	−3.2
J–J–A	0.9	2.4*	−1.5
S–O–N	−1.4	0.4	−1.9*
ANNUAL	2.1	4.5	−2.4

USSR (FORMER) (165) 1951–1990

Seasons	MAX	MIN	DTR
D–J–F	2.8	4.2	−1.3
M–A–M	2.5	3.8	−1.2
J–J–A	−0.4*	0.9*	−1.3
S–O–N	0.6	2.2	−1.6
ANNUAL	1.4	2.8	−1.4

CANADA (227) 1952–1990

Seasons	MAX	MIN	DTR
D–J–F	1.8	2.1	−0.2
M–A–M	3.7	3.8	−0.1
J–J–A	0.5	1.4	−0.9
S–O–N	−2.2	−1.2	−1.0
ANNUAL	0.9	1.5	−0.6*

JAPAN (66) 1951–1990

Seasons	MAX	MIN	DTR
D–J–F	−0.5	−0.2	−0.2
M–A–M	−0.4	−0.7	0.3
J–J–A	0.5	0.0	0.4
S–O–N	−0.3	−0.5	0.2
ANNUAL	−0.2*	−0.4	0.2

USA (494) 1951–1990

Seasons	MAX	MIN	DTR
D–J–F	−2.3	−0.7	−1.5
M–A–M	2.3	2.5	−0.2
J–J–A	−0.3*	1.0*	−1.4
S–O–N	−1.7	1.3	−3.0
ANNUAL	−0.6*	1.0	−1.5

PRC (44) 1951–1988

Seasons	MAX	MIN	DTR
D–J–F	0.5	3.5	−3.0
M–A–M	−0.8	1.4	−2.2
J–J–A	−1.8	−0.8*	−1.0
S–O–N	−0.6	1.0	−1.6
ANNUAL	−0.7*	1.3	−2.0*

SUDAN (15) 1951–1987

Seasons	MAX	MIN	DTR
D–J–F	−1.2	2.7	−3.9*
M–A–M	0.4	3.3	−2.8
J–J–A	2.8	2.1	0.7
S–O–N	1.4	2.5	−1.1
ANNUAL	0.9	2.7	−1.7

S. AFRICA (12) 1951–1991

Seasons	MAX	MIN	DTR
D–J–F	0.8	2.0	−1.2
M–A–M	2.2	1.7	0.5
J–J–A	1.3	1.3	0.0
S–O–N	−0.7	1.8	−2.4
ANNUAL	0.9	1.7*	−0.8*

E. AUSTRALIA (44) 1951–1991

Seasons	MAX	MIN	DTR
D–J–F	1.8	2.3	−0.4
M–A–M	1.6	2.8	−1.2
J–J–A	0.8	1.4	−0.5
S–O–N	1.3	2.2	−0.9
ANNUAL	1.4	2.2	−0.7

both stations is less than that of their respective mean temperatures, but the converse is true for low-frequency variations.

If the data from the Klementinum-Observatory truly reflect the regional change of the DTR in central Europe, then the recent decrease of the DTR in this area is less persistent and less substantial than the increase prior to 1950. In light of the variations at the Klementinum-Observatory, what makes the results from Fig. 2 so remarkable is the fact that so many areas share an overall decrease of the DTR.

Recently, other investigators have also compiled information on the change of the DTR over other regions of the globe. Frich (1992) provides evidence to

TABLE 2. Trends of temperature (°C/100 yr) for annual and three-month mean maximum (MAX), minimum (MIN), and diurnal temperature range (DTR) for the areas denoted in Fig. 1 (less Pakistan, northern Finland, and Denmark). Percent of the land area covered for the Northern and Southern Hemisphere and the globe is denoted within parenthesis.

N. Hemisphere (50%) 1951–1990

Seasons	MAX	MIN	DTR
D-J-F	1.3	2.9	−1.5
M-A-M	2.0	3.2	−1.3
J-J-A	−0.3	0.8	−1.1
S-O-N	−0.4	1.3	−1.7
ANNUAL	0.5	2.0	−1.4

S. Hemisphere (10%) 1951–1990

Seasons	MAX	MIN	DTR
D-J-F	1.6	2.2	−0.6
M-A-M	1.7	2.5	−0.8
J-J-A	1.0	1.3	−0.4
S-O-N	0.8	2.1	−1.3
ANNUAL	1.3	2.0	−0.8

GLOBE (37%) 1951–1990

Seasons	MAX	MIN	DTR
D-J-F	1.3	2.9	−1.6
M-A-M	1.9	3.1	−1.2
J-J-A	−0.2	0.8	−1.1
S-O-N	−0.3	1.4	−1.7
ANNUAL	0.7	2.1	−1.4

indicate there has been a general decrease over Denmark since about 1950, based on an analysis of several long-term stations, most located in rural areas. Bücher and Dessens (1991) analyzed a long record of maximum and minimum temperatures from the Pic du Midi de Bigorre Observatory in the Pyrenees at a height of more than 2800 m. Their analysis revealed a significant decrease of DTR since the late nineteenth century, but an inhomogeneity in the record prevented a continuation of the analysis beyond 1970. Kruss et al. (1992) reported on changes of maximum and minimum temperature between the two 30-yr periods 1931–60 and 1961–90 over Pakistan. Despite considerable missing data, they managed to obtain at least 20 years of data from each of the two periods for 35 stations across Pakistan. Their analysis revealed a mix of decreasing and increasing changes of DTR. In our analysis of Pakistani data we could manage to identify only five stations with adequate data to analyze year-to-year changes; these were all located in the northern half of the country. These stations also depicted a decrease of the DTR.

c. Relation to variations of the seasonal and annual extremes

For a variety of practical considerations it is important to know whether the decrease in the mean DTR translates to a decrease in the extreme temperature range. Karl et al. (1991) provide evidence to suggest that indeed, over the United States and the former USSR (the only areas for which they had access to daily data), there was often a significant and substantial decrease in the seasonal and annual temperature extremes similar to the decrease in the seasonal and annual mean DTR. This similarity is also reflected in the time series of monthly extreme maximum and minimum temperature over Sudan (Jones 1992).

d. Data quality

A critical question arises related to the reliability of the data used to calculate the changes of the DTR. The data presented and discussed here have been subjected to various degrees of quality assurance. The degree to which precautionary measures have been taken to minimize data inhomogeneities varies considerably from country to country. In the United States,

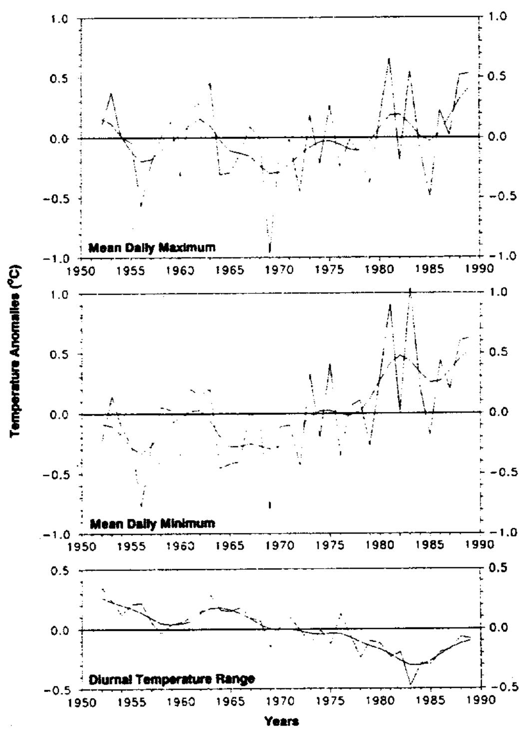

FIG. 3. Time series of the temperature anomalies of the annual mean maximum, minimum, and diurnal temperature range for 37% of the global landmass (areas shaded in Fig. 1). Smooth curve is a nine-point binomial filter with "padded" ends.

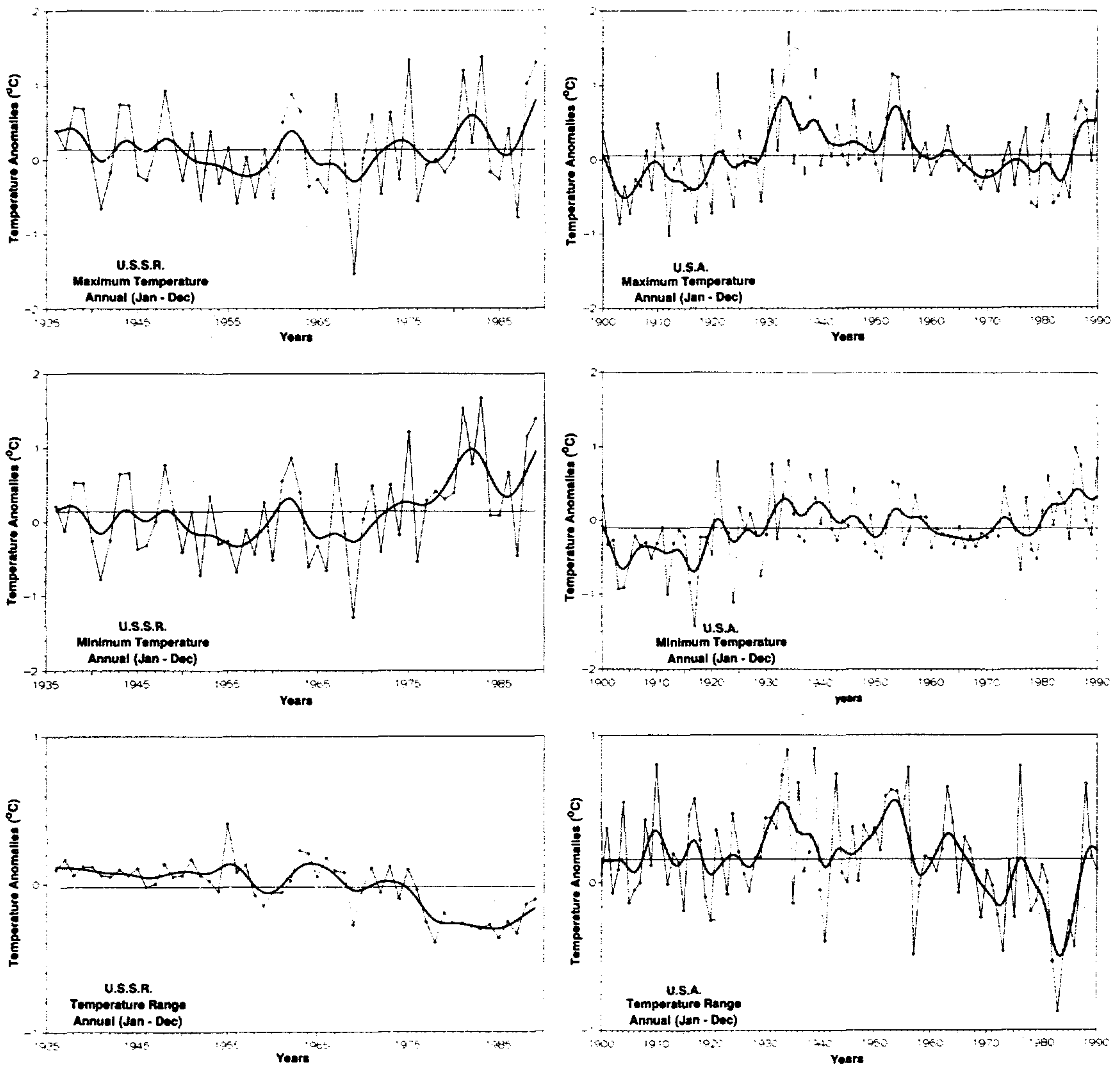

FIG. 4. Time series of the variations of the annual mean maximum, minimum, and diurnal temperature range for the contiguous United States and the former USSR. Smooth curve is the same as Fig. 3 and trends since 1951 are depicted by the dashed line.

a fixed network of stations in the Historical Climatology Network (HCN) is used (Karl et al. 1990), which largely consists of rural stations that have been adjusted when necessary for random station relocations, changes in instrument heights, systematic changes in observing times (Karl et al. 1986a; Karl et al. 1986b), the systematic change in instruments during the mid- and late 1980s (Quayle et al. 1991), and increases in urbanization (Karl et al. 1988). The potential warm bias of the maximum introduced by the HO83 series of thermometers (Gall et al. 1992) is not a factor in this network since the HO83 instrument is not used in the rural cooperative network that dominates the HCN (19 out of 20 stations).

In the former USSR the fixed network of 165 stations consists of rural stations (1990 populations less than 10 000 and local surroundings free of urban development). The former USSR data have not been adjusted for any random or systematic inhomogeneities. Station histories, however, indicate there have not been systematic changes in network operation over the course of the past 50 years.

In Canada, the results reported here are derived from a set of 227 rural stations (population less than 10 000). These data were selected from a network of 373 principal stations, but a large number of urban areas and stations, which relocated to airports, were eliminated from the analysis.

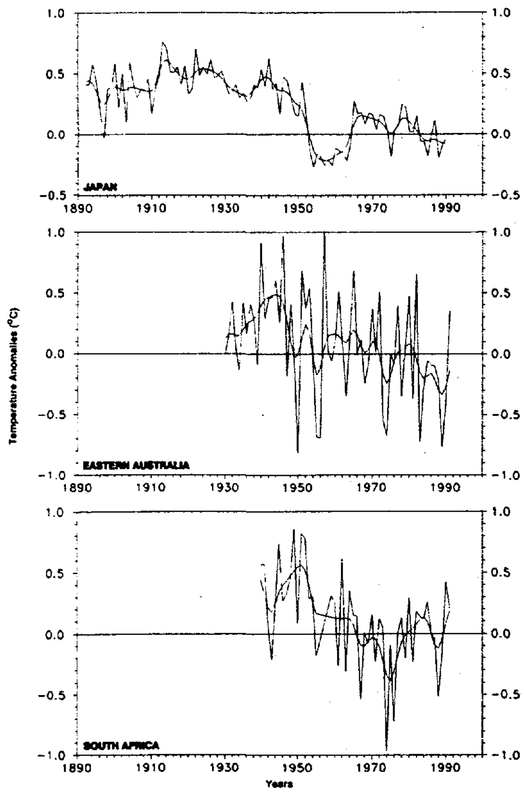

FIG. 5. Time series of the variations of the diurnal temperature range for Japan, eastern Australia, and South Africa. Smooth curve same as Fig. 3.

In Alaska, a network of 39 stations was used that included most stations operating in that state since the early 1950s with the exceptions of stations in the major cities of Juneau, Fairbanks, and Anchorage. Once again no attempt was made to adjust for station relocations, and the stations consist of a mix of instrument types with some changes at specific sites.

Station histories from the PRC do not reflect any changes in instrumentation, instrument heights, instrument shelters, or observing procedures relative to the maximum and minimum temperature. Our analysis is based on a subset of more than 150 stations available to us. No attempt was made to correct for random station relocations in the fixed network of 44 stations we finally selected from the larger network. The potential impact of urbanization precluded the use of many stations. We eliminated all stations that were in or near cities with populations of more than 160 000.

All stations in Australia are currently undergoing thorough homogeneity testing (Torok 1992, personal communication) but were unavailable for this analysis. Instead, stations were selected based on the length of record and distance from major areas of urbanization. All of the stations used in Australia are from small towns or rural areas, many from post office "backyards."

Fewer than half of the 154 stations available from Japan were used in this analysis. Similar to the PRC, many stations were eliminated because of their proximity to major urban areas. An inspection of the station histories reveals a number of network "improvements" related to the automation of the temperature measurements in recent years. A full assessment of the homogeneity of the data awaits a detailed analysis. The station networks from Sudan and South Africa include some stations from urban areas, but countrywide decreases of the DTR are not overwhelmed by these stations. Incomplete information was available regarding systematic changes in instrumentation at these locations during the past several decades, but the data were inspected and adjusted when necessary for station relocations based on temperature differences with neighboring stations. In total, four stations in South Africa were adjusted using the procedures outlined by Jones et al. (1986a).

3. Diurnal temperature range dependencies

a. Local effects

As more data become available from a variety of countries it becomes difficult to dismiss the general decrease of the DTR over the past several decades as an artifact due to data inhomogeneities. Observing networks are managed differently in each country. If local effects are significantly influencing the DTR, then at least three possibilities need to be explored. These include changes in urbanization, irrigation, and desertification. Evidence to support or refute the impact of these human-induced local and regional effects are discussed in subsequent subsections.

1) URBAN HEAT ISLAND

It is well known that the urban heat island often tends to manifest itself strongest during the nighttime hours (Landsberg 1981). In midlatitude North American cities the urban–rural temperature difference usually peaks shortly after sunset, then slowly decreases until shortly after sunrise, when it rapidly decreases, and for some cities actually vanishes by midday. In many cities, increases in urbanization would differentially warm the minimum relative to the maximum temperature.

A number of precautions have been taken to minimize the effect of increased urbanization in the climate records used in this analysis. In the contiguous United

States, the corrections for urban development recommended by Karl et al. (1988) have been applied to the data, so any residual heat island effect in this analysis should not be an issue. In Canada, only stations with population less than 10 000 were used in the analysis, and the average population of the cities in the proximity of the observing stations was slightly more than 1000. If the Canadian stations behave similarly to stations in the United States, the decrease of the DTR may be exaggerated by about 0.1°C due to urbanization. Similar values may also apply to Alaska. In the former USSR, the population limit for inclusion of any station into the network was 10 000, but in addition, no station could be within 1 km of any multistory urban development. If the impact of the effect of urbanization on the DTR in the former USSR is anything similar to that in the United States, the residual urban heat island effect on the DTR should be at least an order of magnitude smaller than the observed decrease of the DTR (nearly 1.5°C per 100 yr). In the PRC and Japan, a number of tests were conducted to identify the impact of urbanization on the DTR. Three networks of stations were categorized based on population. For the PRC, the categories included stations in proximity of cities with populations more than 1 000 000, less than 160 000, and those with populations between these two thresholds.

Categories in Japan were based on 500 000 and 50 000 threshold values. The PRC had 23, 42, and 44 stations, while Japan had 17, 71, and 66 stations, in each of the three population categories proceeding from high to low, respectively. Figure 7 shows that the decrease of the DTR actually becomes stronger in the PRC for the lowest population category compared with the moderate population category, while the trend of the average temperature continues to decrease. This suggests that urbanization effects in the PRC are dissimilar to those in the United States, as differential effects of the maximum and minimum temperature trends seem unaffected by urbanization in cities of 500 000 or less. In Japan, however, the impact of urbanization on the DTR is evident even in the lowest population category (less than 50 000); this is even more apparent for the average temperature. Based on these analyses it would seem that urbanization effects in the PRC are unlikely to significantly impact the trends reported in Tables 1 and 2.

A previous paper by Jones et al. (1990) investigated the impact of increasing urbanization in the land database used by the IPCC (1990, 1992) to calculate

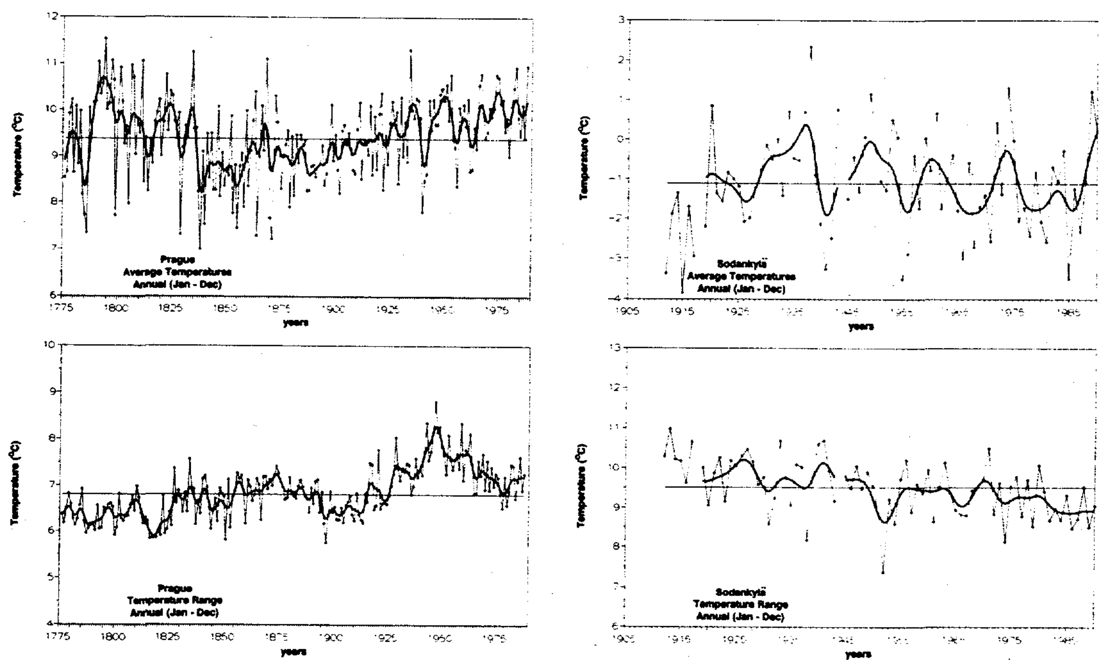

Fig. 6. Time series of the variations of the annual diurnal temperature range and the annual mean temperature from two long-term stations: Sodankylä, Finland, which has been designated as a climate reference station, and the Prague Klementinum-Observatory, Czechoslovakia. Smooth curve same as Fig. 3.

changes of global temperature. The conclusion from the work of Jones et al. (1990) was that any residual urban bias in the land-based average temperature records was about 0.05°C during the twentieth century. A comparison of the average temperature trends derived from the stations used in Tables 1 and 2 with the stations used by Jones (1988) revealed differences in trends from country to country, but virtually identical trends of temperature (within 0.02°C per 100 yr) were found when all areas depicted in Fig. 1 were considered. This suggests that the degree of urban-induced bias in these two datasets are of similar magnitude over the past 40 years, despite the use of substantially different station networks.

2) Irrigation

It can be argued that increases in irrigation may account for the decrease in the DTR. The evaporation associated with soil moisture would convert sensible to latent heat and thus significantly reduce daytime temperature. In order to test this hypothesis, the correlation coefficient (both Pearson product moment and the Spearman rank) was calculated using the values of the trends of the DTR and the change in land area under irrigation from 1950 to 1987 (U.S. Department of Commerce 1950, 1988) for each of the regions delineated in Fig. 2. No relationship was found between the change in the DTR and the increase of irrigated lands, and in fact many of the largest decreases of the DTR were associated with areas with the smallest increases of irrigation. Despite the significant decreases of the DTR over the past several decades and the relatively large increases of irrigation within the United States over the past 40 years compared to other countries, it seems unlikely that increases of irrigation can be regarded as a serious explanation for the widespread decreases of the DTR.

Table 3: Stations and years used to identify the sensitivity of the diurnal temperature range to various climatic variables.

Stations	Years
Sacramento, CA	1961–69
Tallahassee, FL	1962–70
Indianapolis, IN	1966–74
Worcester, MA	1961–69
Bismarck, ND	1973–81
Scotts Bluff, NE	1971–79
Reno, NV	1961–69
Oklahoma City, OK	1975–83
Pittsburgh, PA	1961–69
Columbia, SC	1971–79
San Antonio, TX	1973–81
Seattle/Tacoma, WA	1971–79
Spokane, WA	1966–75
Green Bay, WI	1971–79

3) Desertification

The converse of the theoretical effects of irrigation would result from increased desertification, i. e., an increase of the DTR. This might arise from poor land practices such as overgrazing or deforestation. Given the mid- and high-latitude bias of the results reported here, it seems unlikely that desertification would have a significant impact on the results reported in Tables 1 and 2. Moreover, this effect would tend to make the magnitude of the reported decreases too small, especially during the warm season, as desertification would increase the maximum and decrease the minimum.

b. Climatic effects

Since it seems unlikely that any of the human-induced local effects can provide a satisfactory answer to the widespread decrease of the DTR, a number of climatic variables that differentially affect the maximum and minimum temperature were analyzed to discern which climatic variables most strongly affect the DTR. More than 50 000 days of climatic observations were selected from the stations listed in Table 3 during periods of consistent measurement procedures for the variables defined in Table 4. The rationale for selection of variables to be studied was based on a priori information. For example, increases of the DTR over land have previously been related to snow cover ablation as simulated by the U. K. Meteorological Office's General Circulation Model (GCM) with doubled CO_2 (Cao et al. 1992). Our analysis included more than 4000 cases of snow cover. It is well known that the ability of the surface boundary layer to absorb, radiate, transform, and mix sensible heat differentially affects the maximum and minimum temperature. The relative humidity and cloudiness are two important climate variables that influence these surface-layer properties. In this analysis cloud-related information was contained in two climatic variables: the sky cover (in tenths) and an index of the ceiling height. The ceiling height (CIG) was categorized into seven categories. The cloud ceiling is defined as height above ground of the lowest cloud layer that covers 50% or more of the sky. The wind speed is an effective measure of the degree of mixing within the surface boundary layer as it affects and interacts with the frequency or intensity of inversions and super-diabatic lapse rates. Additionally, the DTR is affected by the seasonal and latitudinal changes of incoming solar radiation as well as the magnitude of day-to-day temperature differences. The inclusion of TRAD can also be regarded as a surrogate for temperature especially when used in conjunction with the other variables listed in Table 4. Karl et al. (1986b) demonstrate the impact of the interdiurnal temperature difference on the maximum and minimum temperature. These day-to-day changes of temperature are largely controlled by the thermal advection associated with synoptic-scale cyclones and anticyclones.

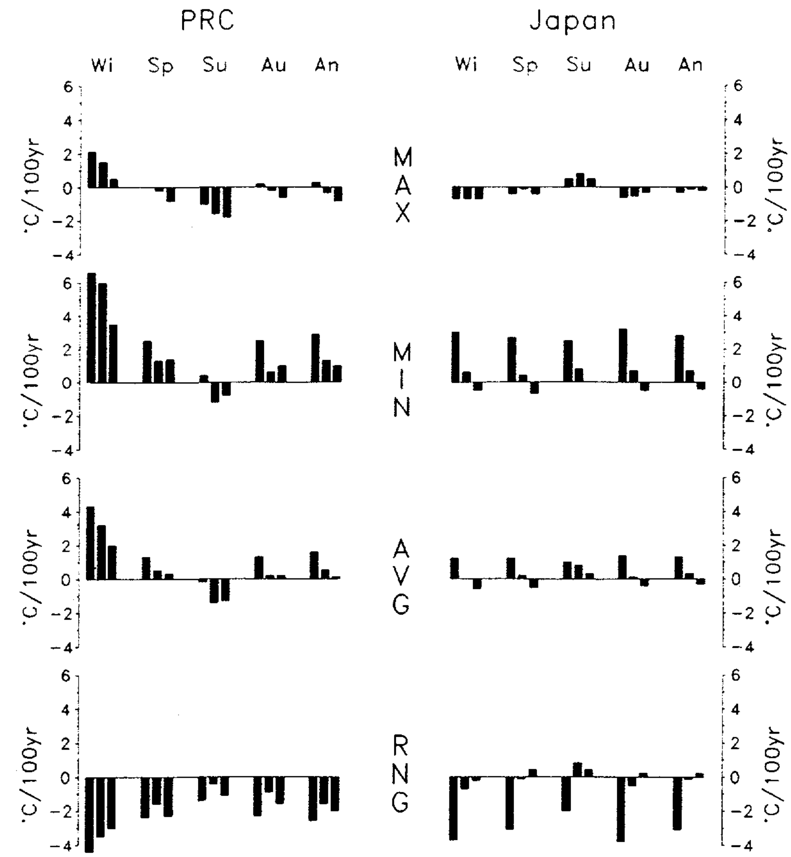

Fig. 7. Temperature trends using stations from various population categories (high, medium, low—left to right) as defined in text. Abbreviations; Wi—winter, Sp—spring, Su—summer, Au—autumn, MAX—maximum, MIN—minimum, AVG—average, and RNG—diurnal range.

All of the variables in Table 4 were used in a multiple regression analysis. Variables were regressed against the square root of the DTR, as opposed to the actual DTR, because the DTR is bounded by zero. Without the transformation, nonnormal residuals result in multiple linear regression analyses, making it more difficult to interpret the results. Figure 8a indicates that the partial correlation coefficients of each variable to the DTR are often significantly different from the simple linear correlation coefficients, making it difficult to speculate on the effect of changes in any one variable without knowing (or assuming constancy) the changes in the other variables. Given the huge sample size, very low correlations have high statistical significance (even considering the day-to-day persistence of the DTR). On a local basis, a generalized multiple linear regression model (one model for all stations and all days) based on the seven climatic variables in Fig. 8a explains about 55% (53% without the square-root transformation) of the daily variance of the DTR. Although the explained variance is substantial, it is apparent that other factors may also need to be considered with respect to explaining the variations of the DTR (e.g., better representations of the atmospheric stability, external forcing factors, more precise techniques to calculate the mean quantities used in the analysis), or that the relationships are not adequately expressed by a linear equation or both.

On a variable-by-variable basis the signs of all the partial correlations make qualitative physical sense. It is interesting to note the higher partial correlation of ΔTMP compared with the simple correlation coefficient (Fig. 8a) as the correlation between TRAD and ΔTMP mask the importance of ΔTMP in influencing DTR. The decrease of the partial correlation relative to the simple correlation for the variables RH, CIG, and SKY is to be expected because changes among each of these variables are related to each other. The decrease in the partial correlation of SNOW is particularly noteworthy, especially since Cao et al. (1992) attribute the ablation of snow cover in their model to an increase in the DTR. The empirical results in Fig. 8a suggest that SNOW is only weakly related to the DTR, especially compared to other variables.

In order to investigate the linearity, or lack thereof, of the relationships implicit in Fig. 8a, the data were

TABLE 4. Definitions and abbreviations of the climatic variables used to test the sensitivity of the diurnal temperature range.

Variables	Abbreviations
Diurnal temperature range (daily max–daily min)	**DTR**
Snow cover (binary, if snow depth 2.54 cm)	SNOW
Mean relative humidity (0600 LST and 1500 LST)	**RH**
Mean wind speed (0600 LST and 1500 LST)	WS
Mean sky cover (0600 LST and 1500 LST)	**SKY**
Mean ceiling (0600 LST and 1500 LST)	CIG
Total daily top of the atmosphere solar radiation	**TRAD**
Day-to-day temperature differences ($\lvert TMP_0 - TMP_{-1}\rvert + \lvert TMP_0 - TMP_{+1}\rvert$)	ΔTMP

partitioned by TRAD. Figure 8b provides strong evidence to suggest that the relationships change with the amount of TRAD. In particular, the partial correlation coefficients of RH, WS, and SKY become stronger as TRAD (and thus temperature) increases. This probably has more to do with a reduction of the maximum temperature than an increase of the minimum. During daylight hours high values of the RH, WS, and SKY are indicative of higher albedos, higher potential evapotranspiration, higher atmospheric water vapor absorption of incoming radiation, and larger than normal mechanical mixing. These factors act to retard the maximum temperature that would otherwise result from high intensity TRAD, which would be manifested as sensible heat within the surface boundary layer. The nonlinearity of RH as TRAD increases is substantially greater than WS (Fig. 8b). As the TRAD to the surface increases the temperature increases, and a greater portion of the TRAD can be used for evaporation compared with raising surface temperature, as would be anticipated by the Clausius–Clapeyron equation when integrated to obtain saturation vapor pressure as a function of temperature.

The reduction of the partial correlation of TRAD with the DTR after partitioning by TRAD (Fig. 8b) relates to the balance between long nights and short days. During the late autumn and early winter in the northern half of the United States (areas that include the lowest partition of TRAD), a moderate increase in the TRAD (by interseasonal and latitudinal variations) generally results in a higher DTR. Contrarily, in the warm half of the year, TRAD and its associated daylight are more than ample so that the relation between TRAD and DTR is near zero. In fact, a further partition of the TRAD into a very high category leads to negative partial correlations between TRAD and the DTR.

The reduction of the partial correlation of ΔTMP as TRAD increases is related to the decrease in intensity of the day-to-day changes of temperature during the warm season. Rossby waves and extratropical cyclones have reduced amplitude, speed, and intensity during the warm season.

A change in sign of the partial correlation coefficient of SNOW with the DTR (Fig. 8b) suggests that the length of night relative to the TRAD is a significant factor when considering the impact of changes in snow cover on the DTR. In the northern United States, around the winter solstice, TRAD is relatively low. Snow on the ground at this time of the year is important because of its excellent insulation (reduces heat flow from the soil) and high emissivity, which help lower the nighttime minimum. During the daytime the TRAD is already low, so the amount of solar radiation reflected by the snow cover is no longer as important. As a result, snow cover at this time of the year and these latitudes leads to an increase in the DTR. This is not the case as the season progresses or the latitude decreases, as reflected by the negative partial correlations (lower values of DTR with snow cover) associated with the highest category of TRAD; there were still nearly 1000 cases of snow cover. The data suggest that snow cover ablation will not necessarily lead to an increase of the DTR.

From the aforementioned analysis, it is apparent that there are many factors, often intricately related, that affect the DTR. Many of the variations in these variables are very much related to a greenhouse effect, some of which may be anthropogenically induced. Overall, the two variables related to changes in cloudiness, sky cover, and ceiling height explain the greatest portion of the variance of the DTR. Changes in cloudiness should be one of the first considerations in searching for an explanation of the observed decrease of the DTR (Fig. 2). Indeed, when large continental scales are considered, the relationship between cloud amount (or sky cover) and the DTR is quite impressive (Fig. 9). Plantico et al. (1990) have already demonstrated that the decrease in the DTR over the United States is strongly linked to an observed increase in daytime and nighttime cloud cover and a lowering of cloud ceilings.

Is there a general increase in cloud cover over much of the globe? Empirical evidence by Henderson-Sellers (1986, 1989, 1992) and Jones and Henderson-Sellers (1992) suggests this may be the case over Canada, the United States, Europe, the Indian subcontinent, and Australia. Analyses of cloud cover changes over the PRC from a network of 58 stations across the PRC are inconclusive, but there is evidence for a decrease in the sunshine (a 2% to 3% decrease in sunshine from the 1950s to the 1980s). The quality of the cloud data (and perhaps the sunshine data) is questionable because the correlation between monthly anomalies of sunshine and cloudiness at many sites is not high. Analyses of changes in cloudiness over the former USSR by Balling (1992, personal communication) reveal a general increase of cloud cover (3.5%) during the period 1965–86 with stratus and stratocumulus clouds (low ceilings) increasing in frequency by about 2%. He also found considerable interannual and interstation variability, so the quality of these data could also be called into question. Nonetheless, the trend over the former USSR is consistent with a decrease in the DTR. Frich (1992) and Bücher and Dessens (1991) also found that decreases in the DTR in Denmark and at the Pic du Midi de Bigorre Observatory occurred with an increase in cloudiness. An analysis of changes in cloud cover over Japan, using many of the same stations selected for the analysis of the maximum and minimum temperatures, indicates cloud cover may have increased on an annual basis by nearly 1% since 1951, but there is no apparent response in the DTR. Changes in sunshine in Japan are not altogether consistent with the increase in cloud cover, but a new sunshine instrument was introduced into the network in 1986.

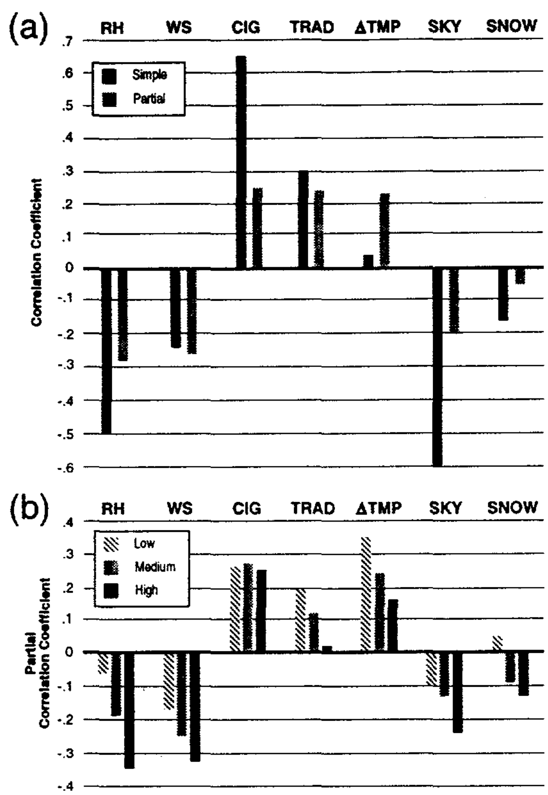

FIG. 8. Relationship between various climate variables and the diurnal temperature range. (a) Simple and partial correlation coefficients (removing the effects of all other variables) between each variable (defined in Table 4) and the diurnal temperature range. (b) Partial correlation coefficients of each variable for cases partitioned by the total daily solar radiation at the top of the atmosphere 170 Wm^{-2} (low); 271 Wm^{-2} (high); remainder (moderate)

4. Large-scale anthropogenic effects

a. Greenhouse gases

Interest in the potential change of the DTR with increasing anthropogenic greenhouse gases has prompted several modeling groups to publish information from their models regarding the projected change in the DTR from doubled CO_2 experiments. Table 5 summarizes the results of these models. For the GCM experiments, the magnitude of the decrease is small relative to overall warming of the mean global temperature. Moreover, these experiments reflect a level of CO_2 increase well in excess of present-day values, so even smaller changes should be expected in the observed temperature record.

Cao et al. (1992) also conducted a number of experiments with a one-dimensional radiative–convective model (RCM), which showed that the decrease in the diurnal temperature range with doubled CO_2 in that model is primarily due to a water vapor feedback. Only a 0.05°C reduction in the DTR was observed when the absolute humidity was held constant. Table 5 indicates that the increased sensible heat exchange and evaporation are also important factors leading to a reduction in the DTR in RCM simulations with enhanced CO_2.

Interestingly, the ratio of the DTR decrease relative to the increase of the mean temperature in the RCM compared with the GCM is closer to the observed ratio over the past several decades (Table 5). The RCM omits the positive feedbacks to the DTR from reductions in cloud and surface albedo as contained in the GCM simulations (Cao et al. 1992). This tends to increase the DTR because of reduced atmospheric (cloud cover) and surface (snow cover) albedo. Other GCM simulations have both increases and decreases in cloudiness with global warming: decreases in much of the troposphere, but increases in the high troposphere, low stratosphere, and near the surface in high latitudes (Schlesinger and Mitchell 1985). If the observational evidence is correct regarding the tendency for a general increase in cloud cover over the land (which now seems likely), then this could help explain the

Table 5. Summary of modeling results with respect to the relationship between doubled CO_2 concentrations and changes in the diurnal temperature range (DTR) and the maximum and minimum temperatures. Abbreviations are ΔT_{eq} is the equilibrium global temperature change (°C) for doubled CO_2 concentrations, ΔDTR is the equilibrium global change of the DTR (°C) for doubled CO_2 concentrations, CCC is the Canadian Climate Centre, GISS is the Goddard Institute for Space Studies, and UKMO is the U. K. Meteorological Office.

GCM Model	Author	Resolution Horiz.	Resolution Vert.	Ocean	T_{eq}	DTR_{eq}
CCC	Boer 1989	T32	10	Mixed layer	3.5	−0.28
GISS	Rind et al. (1989)	8° x 10°	9	Mixed layer	4.2	−0.7 (sum, USA) −0.1 (ann, USA)
UKMO	IPCC (1990)	8° x 10°	11	Mixed layer	5.2	−0.17
UKMO	Cao et al. (1992)	5° x 7.5°	11	Mixed layer	6.3	−0.26

Radiative Convective Model (Cao et al. 1992)

Type	Maximum T_{eq}	Minimum T_{eq}	DTR
Fixed absolute humidity	X	X	−0.05
No surface turbulence	2.5	2.9	−0.4
No evaporation	2.3	2.9	−0.6
Full surface exchange	1.5	2.2	−0.7

large discrepancy between the observed data and the model projections of the ratios of the decrease in the DTR range relative to the mean temperature increase. This assumes, of course, that the recent warming is induced by increases in anthropogenic greenhouse gases. On the other hand, this raises questions regarding the cause of the apparent change in cloudiness and how it has impacted the mean temperature.

The ability of present day GCMs to adequately simulate projected changes in the DTR with enhanced CO_2 is also affected by surface parameterizations of continental-scale evaporation. As Milly (1992) points out, present-day GCMs can overestimate the surface evaporation because of the failure to properly account for the cooling that occurs with the evaporation. Milly (1992) raises concerns about the veracity of the results from studies of soil moisture changes induced by an increase of greenhouse gases. Accurate projections of the change in the surface boundary-layer DTR with increases of anthropogenic greenhouse gases will be strongly dependent on adequate simulation of these processes.

Given the dependency of the DTR on surface-layer processes, interactions with the land surface, and cloudiness, all areas of significant uncertainties within present-day GCMs, it may not yet be possible to adequately project changes of the DTR with enhanced concentrations of greenhouse gases.

b. Tropospheric aerosols

It has recently been shown that increases in sulfate aerosols over and near industrial regions can significantly impact the earth's surface heat balance (Charlson et al. 1992). Charlson et al. (1991) and Charlson et al. (1992) provide evidence to indicate that the anthropogenic increase of sulfate (and carbonaceous) aerosol is of sufficient magnitude to compete regionally with present-day anthropogenic greenhouse forcings. This forcing is confined primarily to the Northern Hemisphere and is a combination of direct aerosol forcing (especially over the land) and indirect aerosol forcing leading to increases in cloud albedo (especially over the marine environment). At present, Charlson et al. (1992) conclude that it is too uncertain to estimate the effects of sulfate aerosols on the lifetime of clouds (smaller droplet sizes leading to a decrease in the fallout rate) which presumably could lead to an increase in cloud cover. Charlson et al. (1991) provide the geographic pattern where direct aerosol forcing should be greatest. It is difficult to identify a direct relation between the pattern and magnitude of the decrease in the DTR (Fig. 2) and the anthropogenic radiative forcing calculated by Charlson et al. (1991). Moreover, Karl et al. (1986a) and Karl et al. (1986b) provide evidence to suggest that there is little change of the maximum relative to the minimum temperature in the United States for cloudless skies even when the daily data are stratified by dewpoint and wind direction.

Recently, Penner et al. (1992) have argued that atmospheric aerosols from biomass burning also act to increase the planetary albedo both directly by clear-sky planetary albedo increases and indirectly through increases in cloud albedo. Since biomass burning is most extensive in subtropical and tropical areas, this effect may be directly relevant only to a small portion of the data analyzed here.

Two tropospheric aerosol forcing agents (aerosols from sulfur emissions and biomass burning) have been identified that tend to increase the clear-sky albedo. Neither forcing is believed to have dominant infrared forcing. The question arises whether either of these forcings has acted to reduce the maximum temperature and thereby the DTR. In the United States and northern (and perhaps eastern) Europe, however, where we detected a significant decrease in the DTR, there has actually been a net decrease in sulfur emissions over the past several decades that would qualitatively appear to eliminate sulfate aerosols as an influence on the DTR in these areas. There are reasons why such a conclusion may be premature. First, the climate forcing due to tropospheric aerosol loading is influenced both by the emission rate and the residence times of sulfate aerosol in the atmosphere. In the United States, at least, the effective heights, or stack heights, of the sulfur emissions have increased as a consequence of the U.S. Clean Air Act. This may have had an effect on the lifetime of the SO_2 and sulfate aerosols

5. Conclusions

Strong evidence exists for a widespread decrease in the DTR over the past several decades in many

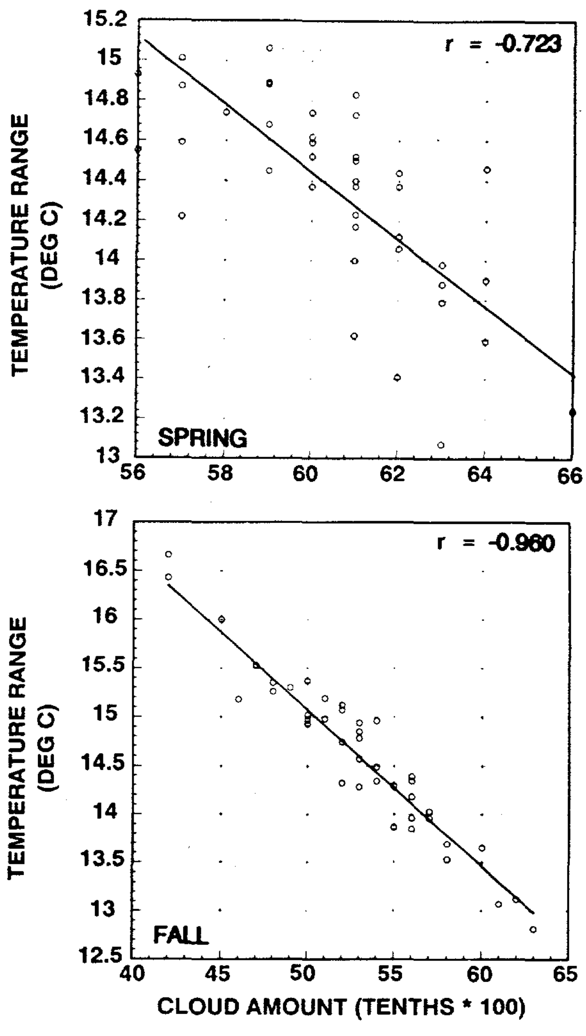

FIG. 9. Seasonal relationships between U.S. area-averaged cloud cover and the diurnal temperature range.

regions of the globe. There are many possible climatic factors that affect the DTR, but indications are that cloud cover, including low clouds, has increased in many areas that have a decrease in the DTR. The increases in cloud cover could be indirectly related to the observed global warming and increases of greenhouse gases, related to the indirect effects of increases in aerosols, simply a manifestation of natural climate variability, or a combination of all three.

A robust answer regarding the cause(s) of the decrease in the DTR will require efforts in several areas. First, an organized global effort is required to develop relevant and homogeneous time series of maximum and minimum temperature along with information on changes of climatic variables that influence the DTR such as cloudiness, stability, humidity, thermal advection, and snow cover. Second, improvements in the boundary-layer physics and treatment of clouds within existing GCMs are critically important. Third, the treatment of both anthropogenic tropospheric aerosols and greenhouse gases must be realistically incorporated into GCMs with a diurnal cycle. Fourth, measurements need to be made to help clarify the role of aerosols. Finally, imaginative climate change detection studies that link the observed climate variations to model projections will be required to convincingly support any relation between anthropogenic-induced changes and the DTR.

It will be difficult to satisfactorily explain the observed changes of the mean temperature until an adequate explanation for the observed decrease in the DTR can be determined. Moreover, the practical implications of projected temperature changes and whether they are likely to continue will be even more difficult to assess.

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References

Bücher, A., and J. Dessens, 1991: Secular trend of surface temperature at an elevated observatory in the Pyrenees. *J. Climate*, **4**, 859–868.

Cao, H. X., J. F. B. Mitchell, and J. R. Lavery, 1992: Simulated diurnal range and variability of surface temperature in a global climate model for present and doubled CO_2 climates. *J. Climate*, **5**, 920–943.

Charlson, R. J., J. Langner, H. Rodhe, C. B. Leovy, and S. G. Warren, 1991: Perturbation of the Northern Hemisphere radiative balance by backscattering from anthropogenic sulfate aerosols. *Tellus*, **43AB**, 152–163.

——, S. E. Schwartz, J. M. Hales, R. D. Cess, J. A. Coakley, Jr., J. E. Hansen, and P. J. Hoffmann, 1992: Climate forcing by anthropogenic aerosols. *Science*, **255**, 423–430.

Frich, P., 1992: Cloudiness and diurnal temperature range. Fifth International Statistical Climatology Meeting, Environment Canada, Toronto, 91–94.

Gall, R., K. Young, R. Schotland, and J. Schmitz, 1992: The recent maximum temperature anomalies in Tuscon: Are they real or an instrumental problem? *J. Climate*, **5**, 657–665.

Henderson-Sellers, A., 1986: Cloud changes in a warmer Europe. *Clim. Change*, **8**, 25–52.

——, 1989: North American total cloud amount variations this century. *Glob. and Planet. Change*, **1**, 175–194.

——, 1992: Continental cloudiness changes this century. *Geo Journal*, **27.3**, 255–262.

Intergovernmental Panel on Climate Change (IPCC), 1990: Scientific Assessment of Climate Change: World Meteorological Organization/United Nations Environmental Programme, Geneva, Switzerland, Cambridge University Press, 366 pp. incl. appendixes.

——, 1992: Climate Change 1992: The supplementary Report to the IPCC Scientific Assessment. World Meteorological Organization/United Nations Environmental Programme, Geneva, Switzerland, Cambridge University Press, 200 pp. including appendixes.

Jones, P. A., and A. Henderson-Sellers, 1992: Historical records of cloudiness and sunshine in Australia. *J. Climate*, **5**, 260–267.

Jones, P. D., 1988: Hemispheric surface air temperature variations: Recent trends and an update to 1987. *J. Climate*, **1**, 654–660.

——, 1992: Maximum and minimum temperature trends over Sudan. International Temperature Workshop, D. E. Parker, Ed. Hadley Research Centre.

——, S. C. B. Raper, R. S. Bradley, H. F. Diaz, P. M. Kelly, and T. M. L. Wigley, 1986a: Northern Hemisphere surface air temperature variations, 1851–1984. *J. Climate Appl. Meteor.*, **25**, 161–179.

——, ——, ——, ——, and ——, 1986b: Southern Hemisphere surface air temperature variations, 1851–1984. *J. Climate Appl. Meteor.*, **25**, 1213–1230.

——, P. Ya. Groisman, M. Coughlan, N. Plummer, W.-C. Wang, and T. R. Karl, 1990: Assessment of urbanization effects in time series of surface air temperature over land. *Nature*, **347**, 169–172.

Karl, T. R., G. Kukla, and J. Gavin, 1984: Decreasing diurnal temperature range in the United States and Canada from 1941–1980. *J. Climate Appl. Meteor.*, **23**, 1489–1504.

——, ——, and ——, 1986a: Relationship between temperature range and precipitation trends in the United States and Canada 1941–80. *J. Climate Appl. Meteor.*, **26**, 1878–1886.

——, C. N. Williams, Jr., and P. J. Young, 1986b: A model to estimate the time of observation bias associated with mean monthly maximum, minimum and mean temperatures for the United States. *J. Climate Appl. Meteor.*, **25**, 145–160.

——, H. F. Diaz, and G. Kukla, 1988: Urbanization: Its detection and effect in the United States climate record. *J. Climate*, **1**, 1099–1123.

——, C. N. Williams, F. T. Quinlan, and T. A. Boden, 1990: United States Historical Climatology Network (HCN) Serial Temperature and Precipitation Data. U.S. Dept. of Energy, ORNL/CDIAC-30 NDP-019/RI 83 pp. plus appendixes.

——, G. Kukla, V. N. Razuvayev, M. J. Changery, R. G. Quayle, R. R. Heim, Jr., D. R. Easterling, and C. B. Fu, 1991: Global warming: Evidence for asymmetric diurnal temperature change. *Geophys. Res. Lett.*, **18,** 2253–2256.

Kruss, P. O., K. A. Y. Khan, F. M. Q. Malik, M. Muslehuddin, and A. Majid, 1992: Cooling over monsoonal Pakistan. Fifth International Meeting on Statistical Climatology, Environment Canada, 27 pp.

Landsberg, H. E., 1981: *The Urban Climate.* Academic Press, 285 pp.

Milly, P. C. D., 1992: Potential evaporation and soil moisture in general circulation models. *J. Climate,* **5,** 209–226.

Penner, J. E., R. E. Dickinson, and C. A. O'Neill, 1992: Effects of aerosol from biomass burning on the global radiation budget. *Science,* **256,** 1432–1433.

Plantico, M. S., T. R. Karl, G. Kukla, and J. Gavin, 1990: Is recent climate change across the United States related to rising levels of anthropogenic greenhouse gases? *J. Geophys. Res.,* **95,** 16 617–16 637.

Quayle, R. G., D. R. Easterling, T. R. Karl, and P. M. Hughes, 1991: Effects of recent thermometer changes in the cooperative station network. *Bull. Amer. Meteor. Soc.,* **72,** 1718–1723.

Rind, D., R. Goldberg, and R. Ruedy, 1989: Change in climate variability in the 21st century. *Climate Change,* **14,** 5–37.

Schlesinger, M. E., and J. F. B. Mitchell, 1985: Model projection of the equilibrium climatic response to increased carbon dioxide. *Projecting the Effects of Increasing Carbon Dioxide.* M. C. MacCrochen and F. M. Luther, Eds. Department of Energy, DOE/ER-0237 57–80.

Shea, D., R. Jenne, and C. Ropelewski, 1992: NCAR data sets with daily maximum and minimum temperatures. International Temperature Workshop. D. E. Parker, Ed., Hadley Research Centre, 5 pp.

Solow, A. R., 1987: Testing for climate change: An application of the two-phase regression made. *J. Climate Appl. Meteor.,* **26,** 1401–1405.

U.S. Department of Commerce, 1950: Census of Agriculture, Vol. III. Irrigation of Agricultural Lands. (Available through the US Govt. Printing Office.)

——, 1988: Farm and Ranch Irrigation Survey. Vol 3, Part 1. (Available through the US Govt. Printing Office.)

Wang, W.-C., Z. Zeng, T. R. Karl, 1990: Urban heat islands in China. *Geophys. Res. Lett.,* **17,** 2377–2389.

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