Data for Certain Types of Research, Selected Texts

Roy Jenne, Dec 2000

Pages:
Cover through TOGA: 58 pp
Polar through CD 65 pp
WOCE through India: 59 pp
Total: 183 pp
Data for Certain Types of Research, Selected Texts
Roy Jenne, Dec 2000
(These texts were made during 1973 – 93)

1. Data Availability for Climate Studies, Rev Apr 1992, 4 pp
2. Selected Climatological Data (Data at NCAR) by Jenne, Feb 1990, 11 pp
3. Selected Data Information Available from NCAR, by Jenne, July 1993, 11 pp
5. Data for TOGA, 19 Sep 1985, 12 pp
7. Data for Hydrological Studies, 6 Nov 1991, 20 pp
   Has a discussion of US river flow data, US water measurements, river data in Canada, USSR (Russia) river data, UNESCO rivers, etc. Monthly precip for Africa, etc. And precip based on microwave data.
8. Global Databases for Climate Forecasting Research, 19 Aug 1981, 19 pp
9. Data for Climate and Sun Weather Studies, est 1977 in Russia, 14 pp
10. Data Management for Climate and Global Change, 13 Feb 1990, 4 pp
    - Only one page here
12. Selected Datasets for WOCE Research, 3 Dec 1993
13. Data Archived at NCAR, Sep 1973, 5 pp
14. Several Large Texts About Data Holdings
    - Several large texts have been scanned
    - They are located elsewhere
15. Meteorological Data, Aug 1989, 19 pp
    - Slides for a talk
16. India – US Science and Technology Agreement, 1984
    - Slides for program and available data
    - This was a US-India program (started by Reagan & Gandhi in Jul 1981).
    - Jenne was task leader for “Development of long term records of data” and US focal point for data planning and exchange.
Data Availability for Climate Studies

The purpose of this text is to present sources of information about data that are available. Some indication of the types of information that can be found within each of these major sources is also included. The primary information sources are as follows, including a few key data centers.

1. INFOCLIMA (Catalogue of Climate System Datasets), 1989 edition, WMO/ID-No. 293, Geneva

   The WMO (World Meteorological Organization) in Geneva includes divisions for both meteorology and hydrology. This data catalog has 507 pages (2.5 cm thick). It includes individual observations and summaries held at various data centers. It lists data centers world-wide. It has dataset descriptions in the categories:
   
   - Upper air data (54 pages).
   - Surface climatological data (140 pages).
   - Radiation data at the surface (36 pages).
   - Maritime and ocean data (50 pages).
   - Cryosphere data (14 pages).
   - Atmospheric composition data (18 pages).
   - Hydrological data (42 pages).
   - Historical and proxy data (28 pages).

   A total of 920 datasets are listed. Datasets that cover global and regional areas are handled separately from those that include only national data. A table is included to show the number of datasets (if any) that each country has listed in each category above. The catalog may be made available on computer floppy disks in 1991.

   WMO published a 31-page supplement (WCDP-5 dated March 1992) to the 1989 INFOCLIMA. The initial INFOCLIMA catalog was published in 1986. Earlier dataset descriptions were prepared by WMO in the 1970s (see the Catalog of Data for Meteorological Research).

2. Handbook of Applied Meteorology, 1985

   This book has a 107-page data chapter by Jenne and McKee, 1985, including help from other contributors. It gives a brief history of the invention of observing instruments, and of the world’s first surface and upper-air observing networks. It describes many types of data including solar data, pollution data, severe storms, meteorological data, hydrology, Landsat pictures, other satellite data, and aerial photographs.
It gives sources of microfilm of weather maps, describes many climatological data summaries, and publications. It describes the delivery of services by various data centers in the United States and Canada. The book covers the US and Canada most thoroughly, but many of the datasets are global in scope.

The Handbook also lists primary monthly climate statistics for about 250 stations around the world.

3. US National On-line Data Catalog (Master Directory)

An effort was organized by NASA, starting about 1987, to provide a central point where the user community could do an online computer search to help locate datasets (for climate and other disciplines). Various government agencies (NOAA, USGS, and others) and research laboratories contribute information about their datasets. This central catalog has descriptions of about 1000 datasets, and listings of various data sources. It has the broad information (description, time period, resolution, volume, etc.) that a person needs to decide if a given datasets may be useful to him. Each data center is encouraged to have more detailed catalog and inventory information. Example: the national central catalog might show one dataset with 2,000 reporting stations having observing periods for 30 to 150 years. The inventory at the local archive would list the stations and show the time period and data gaps for each station. In many cases, a user can be “passed” directly from the online search in the master directory to an online search at a requested local archive.

To reach the online catalog from Internet use: $ TELENET 128.183.10.4, username:NSSDC. It is also possible to enter from Telenet, direct dial, or Span. Contact NSSDC, code 633, Goddard, Greenbelt, MD 20771 (301) 286-9761.

4. National Climatic Data Center

This NOAA center (NCDC) at Asheville, NC gathers the climate observations for the US. It also helps WMO by gathering selected world data such as monthly surface and upper air data, CO2 flask observations, and atmospheric turbidity for the world. There are many datasets. The most comprehensive summary of data there, is in the Handbook of Applied Meteorology (Jenne and McKee, 1985). Also see the INFOCLIMA listings.

The Air Force Data Center (USAF-ETAC) is co-located with NCDC. It has done a fine job of gathering selected world-wide observations. There are many sets of digitized observations that were not prepared elsewhere, especially international data for periods prior to 1965.

5. National Center for Atmospheric Research (NCAR)

The relatively small data center within NCAR has a large archive of over 380 datasets (over 16 trillion bits). The data are from many sources: NMC, NCDC, various countries, ECMWF, USAF, research laboratories, etc. The catalog "Data Availability at NCAR," (June, 1989, 45 pp), describes the datasets within 24 categories of data. (The data categories include analyses, rawinsondes, ocean data, stratospheric datasets, paleoclimate, clouds, data received from the USSR, etc.). The publication includes references to catalogs at other centers. Data are also described within the Handbook of Applied
Meteorology, and some are in INFOCLIMA. The publication “Datasets for Meteorological Research” (Jenne, 1975) described data at various data centers in the U.S. It is still useful, but not up-to-date.

The data at NCAR include one of the most complete collections of global and hemispheric analyses from several sources, both daily and monthly data. There are supporting data such as world elevation, ocean depth, vegetation cover and soil types. There is climate model data (from Greenhouse simulations), from several of the world’s models, organized for easy input into climate assessment studies.

6. DOE Carbon Dioxide Information Center

This center at Oak Ridge, TN has a number of datasets relating to the carbon cycle and to climate. These include carbon dioxide measurements, fossil fuel emissions, and the role of oceans (tracers, coral growth, etc.). Many sets of biospheric data are included (carbon in vegetation, FAO land use, changes in soils, carbon in rivers, etc.).

A number of climate and paleoclimate data series are also available (northern hemisphere temperature, 1851 - 1900; central England temperature, 1659 - 1983; worldwide cloud cover, etc.). Some of the paleoclimate series include: Climate data 18,000 years ago; tree ring data bank; dryness/wetness indices in China for the past 500 years (U.S.-DOE, 1989).

Some volcanic information is included: world-wide chronology of volcano eruptions, dust veil index, etc.

7. Data Availability at NASA

NASA has many datasets from a variety of spacecraft, starting about 1960. These datasets include digital data and pictures; catalog listings are also available. The data listings are in the on-line Master Directory (described above). Many datasets are in the National Space Science Data Center (NSSDC). There are subdiscipline data centers for climate, ocean, and land data.

8. World Climates

The World Survey of Climatology is a major source of information about climates around the World. There are 15 volumes, the first one was published in 1969 (senior editor was H.E. Landsberg). Page 1248 of the Handbook of Applied Meteorology lists the volumes.

9. References

Jenne, R.L. and T.B. McKee, 1985: "Data," a 105 pp chapter (other authors helped) in the 
(This book won the first runner-up for best science book of the year).

Wallis, Alva L. Jr., 1988: "Climate Research Data Catalog." Includes a listing of selected 
datasets from NCDC, (NODC) Ocean data, University of WA, Scripps (Ocean), CO2 
Information Analysis Center, and NCAR. From NCDC, Asheville, NC about 60 pp. 
Note: In several cases there are later listings from other centers.

Jenne, Roy L., 1989: "Data Availability at NCAR." NCAR, P.O. Box 3000, Boulder, 
CO 80307. 45 pp.

Olsen, Lola M., 1990: "Data Set Availability through NASA’s Climate Data System 
(NCDS). NASA/GSFC, Code 634, Greenbelt, MD 20771. 9 pp

Jenne, Roy L., 1975: "Datasets for Meteorological Research." NCAR-TN/IA-111, 
Boulder, CO 80307.

WMO 1989: INFOCLIMA, Catalog of climate system datasets, WMO/TD-No. 293, 
SELECTED CLIMATOLOGICAL DATA
(Data at NCAR)

1. Global Climatology to 100 mb

Has monthly global climatological data on a 5°grid for surface through 100 mb. Winds weren’t directly analyzed, but geostrophic winds are given.

- DS 200: (S. Hem.) Southern Hemisphere Climatology, sfc - 100 mb, 1 tape by Taljaard, van Loon, Crutcher, Jenne. Has: Surface data (SLP, sfc air temp, dew point) and upper air levels to 100 mb (H, T, U, V, moisture).
- DS 205: (N. Hem.) Northern Hemisphere Climatology, sfc - 100 mb, 1 tape by Crutcher and Meserve with NCAR inputs. Note: Volume DS 200 plus DS 205 is 16.60 MB.

See NCAR TN 111, p73
DS 200 (S. Hem), DS 205 (N. Hem), both on one tape.

- Rand Climatological Data (DS 207)

Global Rand clim; sfc, 850 mb, 400 mb Z, T, RH, U, V, four seasons. 4x5°grid. Surface includes SST, clouds, precip, evap, albedo, absorbed solar, long-wave rad, rad balance, sensible heat flux, heat balance. Surface temp, DP and upper air clim interpolated from DS 200, 205 above. 1 tape, 1600 bpi.

See NCAR TN111, p73

- Stratospheric Climatology (N. Hem) (DS 210)

See NCAR TN111, p73

- Tropical Wind Climatology from Sadler (DS 208)

Contains lon-term mean winds, each month, for 30°S to 45°N (each 2.5° lat-lon) for 200, 250, 300 mb. Sadler collected aircraft winds for the tropics for the period 1960 through 1973. See DS 365. Many of these winds were punched from aircraft logs that were obtained from many aircraft routes that often didn’t get on the GTS. The GTS data was received from the Weather Service in Honolulu and from FNOC (Monterey).

Sadler summarized the winds for each month by 5°lat-lon squares. He then used these summaries together with average rawinsonde data to make manual analyses of streamlines and isotacks. These grids contain directions and speeds at each 2.5°lat-lon point. The data were manually read from the maps. When he has used the derived U and V winds, he first applies a light smoother (this text Apr 1978 by Jenne).

The climatology grids are archived at NCAR. Sadler’s basic aircraft reports are also available at NCAR.

The analyses are printed in: Sadler, James C, 1975: “The Upper Tropospheric Circulation over the Global Tropics.” Department of Meteorology, University of Hawaii, 35pp, oversize.

- Global Monthly Gridded Surface Air Temperature (1851-1984), Jones (DS 215)

This grid point (5°lat-lon) data set of year-monthly surface air temperatures has input data for the region 65°S - 85°N. It starts in 1851.
This data set was based on a project to gather more of the old monthly station data; it therefore became practical to start this grid point data earlier in time (1851) than before. Checks for station homogeneity were made, combined with data adjustments where necessary. The input data includes islands and fixed position weather ship data. The analysis was made as follows: Anomalies for each station were prepared relative to 1951-70. Data for a station was only allowed to affect the closest grid point. A given grid point (5°lat by 10°lon) may be influenced by data from more than one station. Grid points were left missing if there was no close data. This dataset replaces the previous results from Jones, et al, prepared in about 1982.

See Jones, et al, in the Feb 1986 *Journal of Climate and Applied Meteorology* (JCAM) for a full description and for comparisons with their previous results and with other temperature series. This reference applies to the Northern Hemisphere and the information about the Southern Hemisphere will be published later.

The DOE publication TR022, July 1985, "A Grid Point Surface Air Temperature Dataset for the Northern Hemisphere," gives additional details about the dataset.

- **Global Surface Air Temperature and Precipitation, Long-period Grid Means, Legates and Willmott (DS 236.0)**

  Measured global monthly precip grids, corrected monthly precip, monthly air temperature, standard errors for precip corrections. All are on a 0.5 x 0.5° grid. The input datasets consisted of 17,986 independent land stations and 6,955 ocean grid-point records. See Legates and Willmott, in *Theoretical and Applied Climatology*, early 1989.

  (Volume = 83 MB) (R. Jenne Apr 1989)

- **Climatology by D. Shea (45°S - 90°N, each 2.5°) (DS 290)**

  Shea used year-mo station data and ship data for 30 years (1950-79) to calculate means and interannual variability of surface air temperature, precipitation, sea level pressure and sea surface temperature. Data are given for each month and seasons for land and ocean areas. A station (perhaps on an island) could influence an area out to a distance of about 8°lat. The first guess for precipitation was Jaeger except, over the Pacific it was Taylor for 30°S - 30°N and farther North, Dorman and Bork (see MWR, 1979, p896).

  COADS yr-mo ship statistics on 2° squares for the oceans were used to analyze SST, air T, and SLP, and also used to calculate interannual variability of each. Land data at islands also influenced the analyses. A first guess helped fill in data poor areas. For SST, the Alexander and Mobley (Rand, 1974) atlas was the first guess data. The first guess for air T and SLP were NCAR datasets DS 200 and DS 205, which together cover the full earth. NCAR TN269+STR by Shea, June 1986 describes this dataset in more detail.

- **Global Ocean Heat Flux and Wind Stress (DS 209)**

  Global ocean radiation and heat budget data (4x5° grid) are described in OSU CRI Report 29. Files of wind stress over the oceans are on a 5x5° grid, CRI Report 26. Long period data for each month, compiled by Esbensen and Kushnir (heat budget) and by Han and Lee (stress) in 1981. (One tape)

  The heat budget variables are:

  Surface wind speed | Sea level pressure
  SST                | Available solar radiation
  Sea/Air temp difference | Net upward ionwave radiation
  Air temp           | Net downward radiative flux
  Specific humidity  | Latent heat flux
  Sea/Air spec. humidity difference | Sensible heat flux
Cloudiness

Net downward heat flux

- **Ocean Current Climatology (DS 280.0)**

G. Meehl (NCAR) prepared a 5°lat-lon dataset of lon-period ocean currents based on pilot charts covering the world ocean to about 50°S. The pilot charts are based on summaries of ship drift data. One of the charts was updated about 1984, after the tape data was prepared. The digital data is available for Jan, April, July, Oct. Described by Meehl in NCAR TN/IA-159+STR, 23 pp. Also see J of Phys ocean, 1982, p538.

- **Tropical Marine Climatic Atlas (wind, stress, SLP, SST) (DS 272.0)**

This atlas (Sadler, et al 1987) and associated tape at NCAR gives lon-period means of wind (direction, speed), wind stress, SLP, and SST for each month. It is an analysis made from COADS ship statistics for each 2° square for the 80-year period, 1900-1979. The maps usually are for 30°S - 40°N. The atlas publications are UHMET 87-01 and 02, 1987 (Univ. of Hawaii).

- **Gridded Precip and Derived Evaporation, Soil Moisture (DS 865)**

These climatological data for each month of the year (4x5° grid) are from John Limpert at NASA Goddard. The basic data are the Jaeger global precip (obtained from Bob Mobley at Oregon State Univ.) and surface air temperature from NCAR (DS 200, DS 205). Cort Willmott’s program was used to derive the other fields of data. The tape has the data:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSUR</td>
<td>Input values of temperature</td>
</tr>
<tr>
<td>RAIN</td>
<td>Input values of precipitation</td>
</tr>
<tr>
<td>AEF</td>
<td>Actual evapotranspiration</td>
</tr>
<tr>
<td>APEF</td>
<td>Adjusted potential evapotranspiration</td>
</tr>
<tr>
<td>PEF</td>
<td>Unadjusted potential evapotranspiration</td>
</tr>
<tr>
<td>DF</td>
<td>Precipitation minus adjusted potential evapotranspiration</td>
</tr>
<tr>
<td>BETA</td>
<td>Which has been calculated using ST(x)/(0.7 x 150) = BETA(x), where 150mm is the soil moisture storage capacity.</td>
</tr>
<tr>
<td>STF</td>
<td>Soil moisture storage</td>
</tr>
<tr>
<td>DSTF</td>
<td>Change in storage from the preceding month</td>
</tr>
<tr>
<td>DEFF</td>
<td>Soil moisture deficit</td>
</tr>
<tr>
<td>SURF</td>
<td>Soil moisture surplus</td>
</tr>
</tbody>
</table>


**GEOPHYSICAL DATA** (elevation, depth, land use, etc.):

- **Sfc Elevation and Ocean Depth Data, Global. (DS 750-780)**

(1 tape each set) (1 degree, 10 minutes global, 1 km elev. USA, 5 minutes ocean depth).

- **World Elevation and Ocean Depth, One Degree Resolution (DS 750.1)**

Data prepared by Scripps, Rand did some final cleaning. Each point gives ocean depth, land elevation, or lake surface elevation. Volume 0.43 MB, characters.

- **Elevation Each 10 min Lat-lon, Water vs. Land Flag, Land Cover Types, Percent Urban (DS 754)**

No ocean depth. Prepared by Navy (FNOC) with data help by NCAR. Volume 18.7 MB binary; or 56.3 MB if characters.
- GISS Vegetation, Land Use and Albedo (1°) (DS 765)
  Information *JCAM* Mar 1983 (from E. Matthews, GISS). Volume 1.81 MB
- Soil and Vegetation Type Data from Henderson-Sellers on 1° Global Grid (DS 767)
  Information *J of Clim*, UK, about Mar or Apr 1985, Vol 5, P114. (Also called the "Wilson tape"). Volume 0.65 MB
- World Ecosystems by Carbon in Live Vegetation by Olson, 0.5° Grid (DS 769)
  See Carbon Dioxide Info Center publ. NDP-017 (1985, at Oak Ridge) for info.
- Emissions of Methane by Cattle
  A tape, covering the world, is available. Gives present sources, not a time history.
- Wetlands Tape (Matthews, Oct. 1989) (DS 765.5)
  Natural wetlands distribution, characteristics and methane emissions. Each of five databases here give information about the world's wetlands -- in 3,233 wetland locations that cover 5.3 x 10^12 m^2.

Five global 1° arrays are included (1) wetland data source, (2) wetland type, (3) fractional cover in square, (4) vegetation type (from Matthews, 1983), and (5) soil type (from Zobler [1986]).

The first four types were published by Matthews and Fung (1987). Volume: Small
- Global Data for Soil Type, Texture, Surface Slope, Other Properties. 1° Lat-lon Resolution (DS 770)
  (Volume: soil type file 971 KB, texture and slope each 65 KB, other 130 KB)
- FAO Soil Data (DS  ) (R. Jenne, Apr 1989)
  FAO prepared a series of soil maps on 1:5,000,000 scale (1.0 mm = 5 km). The maps were very new about 1982. The maps have been digitized in a polygon format (a series of x, y points outline an area having the same type of soil). The digital version is not clean except for the African sheets (FAO comment, Feb 1989. NCAR is corresponding with FAO.
- Elevation Data for the USA
  1. Data each 90 m for all 50 states of the USA
     Data are taken from 1:250,000 maps (1° x 2°) (1 map cm = 2.5 km). These are sold in 1° x 1° size. The data for all 50 states are on 77 tapes, 6250 bpi. There are 1381 data units, each for a 1° x 1° area. Called three second data. Cost for all 77 tapes is $9,757.
  2. Data each 30 m for 30% of USA
     These data are taken from more detailed maps than the above. Data are available mostly for the western USA.
  4. NCAR 30 second set for 48 states (about 1 km resolution)
A scientist in NOAA prepared this set by selecting one point in ten (in each direction) from the three second set above. Packed onto one tape at NCAR. A similar 30 second set at NGDC is the result of a four or five point smoother on this basic data.

SST DATA FROM CAC
(Yr-mo, 1970 - Sept 87)

Talk with Dick Reynolds, CAC

One set of year-month SST analyses (40°S-60°N, 2°Lat/Lon grid from Reynolds) are for 1970 through 1984, based only on ships and fixed buoys, not on drifting buoys.

The year-month SST for the overlapping 1982-on is a blend of satellite and ship data. Dick says his blend is a distinct improvement over the analyses that only use ship data. When the ship-only analyses are compared with drifting buoys, get pocks where buoys are. The blended set is OK.

Buoys are used to calibrate the methods to get spot SST from Satellite. Get a spot SST about each 50 Km.

Drifting buoy data have not been through QC so the program has to be cautious in using them.

The daytime SST satellite data are about 1° warmer than night SST in calm clear areas. I noted that this is about what is expected. He lumps day and night spots together in getting SST. There are about three times as many daytime SST spots vs night.

Dick says 1, 2 Jan 86 SST data spots (from satellite) were off location by 110°Lon so thrown away.

What lon-period mean data was used for calculation of anomalies? Until Aug 86, Reynolds used a SST climatology based on ships for all years. It had a cold bias compared to other climatologies based on more recent years. The new CAC climatology is based on COADS data for 1950-79. All anomalies on the tape are based on this recent climatology. The new climatology is described in a three-page article in TOAN, Jan 1987 (Tropical Ocean-Atmos Newsletter). The tape has yr-mo SST and anomalies. Long-period monthly means can thus be calculated from data for any given yr-mo.

For information on spot satellite data, monthly analyses, talk to Bill Pichel, a hands-on data person 763-4310.

Where are analyses methods going, talk to Paul McLain, 763-4248.

Some satellite data being sent to WCRP archive (Kaneshige).
CLIMATOLOGICAL DATA FOR CLOUDS OVER THE GLOBE FROM SURFACE OBSERVATIONS

CONTENTS: Total cloud cover and cloud type amounts over both land and ocean, usually at 5° latitude - longitude resolution.

This dataset includes multi-year seasonal (and some monthly) grids of total cloud cover and the amount of each cloud type, as well as grids for individual years (11 years for land, 30 years over the ocean). Average cloud data for eight individual synoptic hours and for only the daytime are also given. Seasonal average amounts of low, middle, and high clouds are included. Frequency of occurrence and amount when present are given for each cloud type. Low cloud base heights, analysis of annual and diurnal cycles, interannual variations and trends and cloud type co-occurrences are also given. Data for FGGE are given at 2.5° latitude - longitude resolution for land. The tape has all the data from five cloud atlases, (NCAR tech. notes 201, 241 and 273, and two in preparation). Information about what fields are available is given in Tables 0 and 5 of the documentation. The documentation includes references to the atlases. To reference the dataset, the documentation supplied with the tape (Hahn et al 1987) should be cited as well as one or more of the atlases, if appropriate.

This study is intended to update, extend and supersede earlier published ground-based cloud climatologies.

DATA VOLUME: 69.75 Mbytes, in 12 files on one magnetic tape.


THE TAPE: The full global grid at a nominal 5° grid resolution has 1,820 grid cells. The data are given on land and ocean subsets of the grid. For the land cloud data there are 863 cells; there are 1,493 cells for each ocean grid at this resolution. The sum of these is more than 1,820 cells because 536 cells have both land and water data so there are separate statistics for each. A map group for land (for example) starts with a 24 character logical header record followed by 863 logical records (also 24 char each) that have data for each of the grid cells. These 864 logical records are in 3 blocks (physical records) on the tape, each having 300, 300, and 264 logical records. Several different statistics are included in one 24 character data record. Tables 4, 5, 6, 7 in the documentation summarize format information.
MARINE DATA
(Climatology, Yr-mo Analyses, Obs)

Call from Dave Parker, UK Meteorological Office

1. Marine Climatology Tape

Prepared under their project with MIT. Could we distribute the tape? Yes. Reginald Newell from MIT will probably call me.

The tape has average data for 1951-80, on one degree squares, based on one degree summaries. Smoothed in time by harmonics through the year. Complicated procedures so that extreme data doesn’t upset reasonable means. Also, includes interannual variability and Lag correlations on a five degree grid. Basic data from the Alexander Mobley Rand atlas, and procedures from R. Reynolds are used to fill in areas with no ship coverage.

2. Tape of Actual SST for Individual Year/months, 1856-1987, 5° Grid

This dataset will be improved and updated within about five months. We will wait for the new one. Standard cost of this tape is £500 (~$900). Because of item #1, he may work out a special deal or a swap.

Question: When this task is completed, would the climatology derived from it be as good (on a 5° resolution) as the climatology in item #1 above? Yes, as good or better.

3. Tape of Night Marine Air Temps, Year/months, 1856-1987 (I think)

Question: If this is used with item #2, will the air-sea temp difference be correct? The SST tape uses obs from all times of the day. Since the real diurnal change of SST is about 0.4°C in the most extreme regions, the average bias in a calculated difference is probably under 0.2°C.

Dick Reynolds sent me charts of day/night SST differences based on satellite date (sent March 1986).

Wright wrote the paper: Problems in the Use of Ship Observations for the Study of Interdecadal Climate Change (MWR, June 86). In it, he showed that there are unlikely changes in the air-sea temp differences as a function of time (see the Atch). Have similar plots been made from the UK data tapes?

I should ask D. Parker if he has grids of the day/night temperature difference from their studies.

4. SST Temperature

When the UK analyzed the N. Pacific, they found that the SST was somewhat too low compared to the air temp. Most (all?) of the Japanese ships had colder SST
than other ships. He wonders if the tenths on Celsius temps may have been truncated. This could explain the average cold bias of about 0.25°C. It was deck 1118 (TD-11) of Japanese ships for 1933-1953. The problem seems to exist only for 1933-1939. They are doing more checks. Does anyone here in the US know about this?

5. Bucket Corrections

They have applied a bucket correction to the SST data. It is a function of each month of the year and each 5°Lat-Lon of location.

*Question: What about the 1° data?*

6. Digitizing Ship Logs

Parker is interested in punching perhaps 300,000 past ships from US records for selected areas. I argued for doing all of a particular ship log --or none. He bought this. I will talk with Henry Diaz re his interest. Parker wrote to Diaz.

Parker wants the sheet saying what US ship logs have not be digitized. I will send it. Maury ships: He is interested in the Maury data. I told him that the US-India project to digitize the 1,000,000 Maury obs is in limbo.

Dave will write Chris Mooers, INO, a letter that encourages selective digitizing of the older US ship logs. In WCP-19, p117, we noted that there are also ship logs in other countries that have not been digitized.

Feb 11: Henry Diaz is hoping to work out a way to digitize the 17,000,000 US obs, mostly for WWI and WWII, that have not been digitized.

7. Present UK Ship Data Efforts

The UK ship logs aren't punched anymore. They rely on GTS. But they do a thorough QC. Now starting to do this for 1981-87; probably the same data we get from GTS via NMC decode. This project of cleanup will be done about July 1988. Sometime their tape and NMC data should be compared.

8. Omnet Message

We can send Dave Parker an Omnet message by using the name D.Jones.
Problems in the Use of Ship Observations for the Study of Interdecadal Climate Changes

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(Manuscript received 7 April 1984, in final form 25 November 1985)

ABSTRACT

Time series of sea surface temperature (SST) and air temperature (AT) for 1870–1969 based on ship observations over the Pacific are examined. The familiar signals of interannual variability in the equatorial and northeast Pacific are evident. Inhomogeneities are found in the interdecadal variations, in agreement with other workers. In particular, SST values in 1920–39 were too low relative to 1949–68 throughout the Pacific. A regional and seasonal analysis of this error reveals a close relationship with SST minus AT, suggesting that a contributory cause could be the cooling of uninsulated buckets. Cloudiness data also exhibited spatially consistent inhomogeneities during 1920–50.

1. Introduction

Many efforts are being made to determine the patterns of global-scale climatic changes on interdecadal time scales. Most studies have used only land-based data (e.g., Jones et al., 1982). The recent availability of datasets based on ship observations (Fletcher et al., 1983; Folland et al., 1984) has made it possible to extend the coverage of interdecadal studies to large areas of the globe where there are no fixed stations.

Unfortunately, the marine data have various problems. First, errors can arise in a time series due to variations of sampling density with time and space, and to errors in individual observations (e.g., Saur, 1963; James and Fox, 1972). Such errors can be very large; however, they are essentially random in incidence and their effects can be reduced if the data are averaged over a season or year and over large space scales.

For studies of interdecadal variability, a different problem arises—the possible existence of systematic errors, in which the mean value of a variable in one decade is biased relative to that in another decade due to a cause unrelated to climate. Before interdecadal climatic changes can be documented, all such systematic errors must be eliminated.

This paper presents evidence of systematic errors in SST and air temperature measurements made from ships in the Pacific, and indicates the widespread extent of these errors. These results reinforce those of Barnett (1984) and Folland et al. (1984) who made independent studies using different but overlapping datasets. The present results support the suggestion that changes in the method of measurement of SST were a major contributing factor. In addition, a stratification by month and region reveals additional statistical characteristics of one of the systematic errors. An explanation of this behavior is offered. Evidence is also presented of systematic errors in cloudiness observations.

2. Data

We analyzed a preliminary version of the Comprehensive Ocean–Atmosphere Data Set (COADS) (Fletcher et al., 1983). This set, kindly supplied by J. O. Fletcher, comprised monthly mean values of sea surface temperature (SST), air temperature (AT) and several other meteorological variables over most of the Pacific Ocean (Fig. 1). Figure 2 shows the number of observations each month. We computed anomalies in 4° latitude by 10° longitude boxes (see Appendix), then formed monthly mean anomalies over the eight regions shown in Fig. 1 for the entire period of record.

3. Results

a. Time series of monthly data for regions

Figure 3 shows time series of monthly values of SST in each region. They exhibit a number of interesting characteristics.

(i) For all the series, intermonthly variations were large in the earlier years but smaller in later years. This change may be assumed to be due to sampling variations associated with changes in the numbers of observations (Fig. 2).

(ii) Many of the series exhibit marked interannual variability. Of particular interest is the pattern of series 4, which closely resembles the Southern Oscillation signal (e.g., Wear et al., 1976). Also, the series for regions 2 and 3 exhibit a marked negative correlation ($r = -0.41$ during 1946–69), in agreement with results of Namias (1972). These interannual signals stand out...
Flat Plates NIMBUS

Garrett had all N-6 primary data on ~3 tapes/yr. Gave copy of it to Dale Bess at Langley. Garretts copy got purged.

For N-7 Garrett got 1 tape/mo with daily data (pure flat plate, whole period). The whole period (~8 yrs) of this fits onto 1 optical disk, 2 GB. Data in a 5x5 lat-lon box for 6 yrs was wide field only.

On flat plate, half power point is about diam. of 15°lat (half of energy from within).

Now have 8 yrs N-7 —to ~Oct 86. Probably NASA will quit ~Mar 87. Instrument still on until sometime in 1988. Kept turning it on to get solar const too.

Comparison Ship Clouds to Satellite

Campbell compared these. Sometimes satellite shows clouds and ship doesn’t. Think in hazy sky, ship may not see thin high clouds, but satellite does. Needs more checks. (info from G. Campbell)
Selected Data Information Available From NCAR

This text has lists of texts that are available from the Data Support Section (DSS) at NCAR. Some of these texts are also available in on-line files.

SELECTED TEXTS ABOUT DATA AVAILABILITY

1. Data Availability at NCAR (Jun. 1989)

This is a 45-page document that lists the datasets with a brief description of each. There are over 350 datasets. WMO, NASA, NOAA, etc. also prepare data catalogs. A selected brief list of catalogs is included in this text.

2. Datasets at NCAR, Brief List and Volume (Rev. Apr. 1992)

This lists many of the datasets at NCAR in very brief summary format. The length of record and volume (in Mbytes) is given (Jenne, 6 pp).


This text lists many CD-ROMs (over 200) that are available from a number of places or which will soon be ready. It includes ocean data, meteorological data, gridded ozone, ice and snow, river data, planetary data, etc. It also includes some discs such as Mammals, Financial statistics, birds of America (Jenne, 79 pp). It also has information about other CD-ROM catalogs.

4. Data Availability for Climate Studies (Apr. 1992)

A heavy summary (3 pages) about where to find information. Includes WMO, NCAR and other sources. This was prepared for Gene Rasmusson, University of Maryland. He will use it in a book.

5. Selected Data for Oceanographic Research (Oct 1992)

Summary information (spatial and temporal coverage, dataset size, and inclusive variables) for approximately 60 datasets used for ocean research. The categories of data described cover ship observations, sea surface temperature, surface wind and wind stress, air-sea heat budgets, ocean depth topography, moored and drifting buoys, sea ice, subsurface climatology, and datasets from operational analyses (Worley, 11 pp).

This 5-page text gives information about various inventories that can be obtained free of charge from our on-line data system. One dataset may have data for 2000 stations. These inventories give information about each station. You can access on-line files by anonymous ftp to ncardata.ucar.edu. For information, send e-mail to datahelp@ncar.ucar.edu.


Gives observing network history and data information, especially for the US and Canada. Please see the book; reprints are not available. This is a long chapter with information about many data holdings in several organizations in the U.S. A several-page special index to this chapter is available.

8. Datasets for Meteorological Research (NCAR TN/IA-111)

A 1975 document that surveys data availability across the US. It contains information about several archives: meteorology, oceanography, and others. Most of the information is still pertinent, though not up-to-date. "Data Availability at NCAR" updates this document.

INFO ABOUT SELECTED CATEGORIES OF DATA


This lists the new NMC archives that have started in 1989-1990. It also lists the main datasets that are available. Documents that provide further information about the analyses (changes, methods, problems, etc.) are listed.

2. ECMWF Data at NCAR (Aug. 1990)

Includes the ECMWF "WMO" archive. Has all the ECMWF/WCRP advanced archives with data for 1985 through 1989. Most of these archives have some use restrictions (they are mainly available to the US University community).

3. Data for Hydrological Studies (6 Nov. 1991)

This document has information about precipitation observations, runoff, gridded precip, precip estimates from satellites and data from climate studies. It has additional information about other sources of information.

4. Climate Model Data for Assessment Studies (16 Apr. 1993)

Data are available from several of the world's climate model runs for single and double CO2 and for transient runs. The data is at NCAR. This is a 2-page text that lists the texts that describe what model datasets are available, and other texts that provide information about the data and about the climate assessment studies. A paper that gives a feeling for the nature of climate models and their physics is also included.
4.1 Studies of the Effects of Climate Change (Rev. 8 March 90)

A brief indication of the projects that have been supported, for EPA since Sep. 1987, to help the various climate assessment modeling groups obtain necessary climate model outputs, and part of the observed data needed.

4.2 Status of Selected CO₂ Climate Model Runs (Mar. 1990)

This gives information about selected climate model runs; several are recent so the data has not been released, as yet.

5. Data to Verify Climate Models (1 Apr. 1991)

This text gives brief information about many datasets NCAR has that can help people to verify climate models.


This document (10 pp) gives more information about selected climatology datasets. It includes data for sfc - 10 mb, elevation and depth, vegetation, soil types, sea surface temperature, etc.


A 4-page summary of satellite datasets at NCAR. Also see "Data Availability and Access at NCAR."

8. Satellite Microwave Data

Includes info about the SSMI microwave data emitted from the surface. Used to derive sea ice, surface winds, etc. This briefly describes the basic data and some products.

9. Data Availability for Australia (Apr. 1990)

Includes 90% of what is needed (a major text). Visited there in Dec. 1990.

10. Data Available for Brazil (Apr. 1990)

Includes 80% of what is needed (a major text). Visited there Apr. 1990.

11. Analyses for S. Hemisphere, 1951-on

A 2-page summary of available data


(especially early data)
   Short report, draft — 60% completed.

14. Other Papers about Data Status

14.1 Selected Cloud Data Available (7 pp) 23 Apr 1993

14.2 Clouds, ISCCP (Rossow) (2 pp) 18 May 1993

14.3 Ozone Data (2 pp) 6 May 1993

14.4 Turbidity Data (2 pp) 13 Jul 1993

14.5 Analyses at NCAR (4 pp) 17 Feb 1993

14.6 Elevation Data (includes 3-second data) (4 pp) 17 Mar 1992

14.7 Ice Cap Buoys (2 pp) 4 Jun 1993

14.8 Summary of Available Sea Level Pressure Data (2 pp) 28 Oct 1992

14.9 Monthly World Rawinsonde Data (1 pp) 21 Oct 1992

14.10 Sea Surface Temperature Data (3 pp) 1 Feb 1993

14.11 Sea Ice Data (3 pp) 2 Apr 1993

14.12 Dataset of Tropical Storm Locations (3 pp) 26 Jan 1993

14.13 TOVS Sounding Data (3 pp) 25 Jan 1993

14.14 Missing Data in the TOVS 2.5° Archive (7 pp) 1 Mar 1993

14.15 Analyses for S. Hemisphere, 1951-on (2 pp) 18 Mar 1993

14.16 NMC Upper Air Data, Inventories 1973-on (4 pp) 12 Mar 1993

14.17 Status of Reanalysis Data (6 pp) 1 Apr 1993

TECHNOLOGY AND METHODS FOR DATA STORAGE AND COMPUTING

1. Technology for Data Transfer and Storage (Rev Apr. 1993)

Reviews a number of options to store and transfer data. The options include CD-ROMs and tapes and they include the ability to save large volumes of satellite data. The lower-cost options are emphasized. Draft, 95% complete. Written during 1987 - Oct. 1990, mostly Jan. - Oct. 1990, and again Sep. 1992 - Mar 1993. About 75 pages
2. Handling Large Datasets (Rev Mar. 1993)

Several organizations are handling very large datasets. This text discusses the technology, gives costs, and makes comparisons. More info is in the Data Methods section. This is an important paper for people dealing with large datasets.

3. Computing Power from PCs to Supers (Sep. 1992, 4th draft)

Compares the computing capability of a small selection of supercomputers from 1960 to 1989 with the capability of present computers (PCs, workstations, mini-supers, supers).


This paper briefly summarizes the history of computing power at NCAR for 25 years. It mainly compares the power and cost of fast computing options for the 1990-95 period.

DOCUMENTS ABOUT RESEARCH AREAS

1. Climate Trends Articles

A document with figures and selected text (xerox) from many papers. News and science papers. The purpose is to present the flavor of the scientific discussion and public debate during about 1988-1989.

2. The Big Reanalysis Project

NCAR has the primary role to prepare data for the big reanalysis projects. The actual reanalysis efforts by NMC and ECMWF will start about Jan 1994. The University of Maryland also did initial work in 1993.

2.1 List of Papers About the Big Reanalysis Project (Aug. 1992)

These papers are about a project to reanalyze the atmosphere for 35 years (each 6 hours). A workshop about reanalysis in April 1991 was described by Kalnay and Jenne in the Dec. 1991 issue of Bull AMS.

The short list has:

- papers about reanalysis
- papers about the proposals
- papers about the details of the data
- papers about the status of data projects
2.2 Data for Reanalysis; Inventories (Nov. 1992)

This document has maps with inventory information about surface and upper air data for about 1948-1992. The inventories show data availability for reanalysis, but the data are also useful for many other projects. Countries in Europe got a copy of this text in Nov 1992.

2.3 Status of the Reanalysis Project (Summary) (30 Sep. 1990)

A broad summary of the overall status of several large subprojects to prepare data for a global daily (6-hr.) reanalysis that uses data for 1957-1990.


This text outlines the paleoclimatic data needed to understand past climates and to aid in the verification of climate models. Data for the period back to 150,000 years ago is especially important. More information is also needed back to 200 million years ago (5 pp).

4. What Caused the Mass Extinction 65 Million Years Ago?

This text (2 pp) points to six papers (mostly reviews) that summarize the status of evidence on this question. A flavor of the review arguments is in this short paper.

NCAR DATA SUPPORT AND SOME PLANNING DOCUMENTS:


This outlines the philosophy and approach to handling various data tasks in the Data Support Section at NCAR. We emphasize personal use of the data and limited browse. We emphasize efficiency and the need to easily share data around the world. Discusses how to support some subset selection. Covers advantage of distributed data and advantage of data on demand. Discusses data transportability and run control automation. This is short, but it should be quite useful.

2. Accomplishments of Data Support over Several Years (Rev 16 Jun. 1993)

This text shows some of the main data projects that we have worked on. It includes information about staffing and resources (9 pages).


This provides a little more detail on plans for the various projects (9 pages).

4. Data Support Tasks (Summary), (1 Oct. 1990)

A summary of our main data projects, 2 pp
This is a summary of plans to obtain satellite data for NCAR archives, on 4 pages. It was prepared at the request of Dickinson, for his EOS proposal.

Has information about the atmosphere/ocean mean state and variability that is needed to develop and verify climate models. A few of the available datasets are listed.

7. ENHANCED DATA SUPPORT FOR GLOBAL CHANGE RESEARCH (23 Feb. 1990)
— For Dickinson’s EOS proposal.

8. Some Possible Data Projects at NCAR with NASA (7 Nov. 1989)
Lists possible projects, steps to build a national data system, future views of data and computing.

9. Various Other Documents Are Also Available
A list should be developed from older lists.

DATA METHODS

1. Data Management Methods; Data for Europe (1988)
This paper discusses data strategy, data progress, and gives a history of selected data ideas over the last 20 years. This information is in a NATO book. We sometimes call this the “Belgium paper” because it was presented there. It is an important paper.

2. Handling Large Datasets (Rev Mar. 1993)
The strategy and costs of handling large datasets are discussed. This includes examples of several groups that are handling datasets with volumes in the tens of terabytes. Some of the experiences and costs are very encouraging. This is an important paper. The first version was prepared for a "Terabyte" meeting in Sep. 1993. Related briefing slides are also available. This text has 27 pages.

Issues about formats have been brewing more strongly again in the U.S. during 1990-1992. Formats are strongly connected with issues of ease-of-use and efficiency. This is a set of over 15 short papers, letters, etc., that have a bearing on the format discussion.

4. User Friendly, the Complexity of Systems (23 Sep. 92)
This has a set of clippings about the complexity of various systems.
5. Preparation of Meteorological Data for University Research

Copy of slides presented at an ICSU conference (Moscow, Aug. 1988) for data planning for global change research.


A few short papers review how scientists use data for both calculations and browse functions. This includes examples, a paper on "Levels of Data Support" (Oct. 1988), etc.


This five-page note has an overview of our Data Support Section and the projects we work on. More information is in the annual report of the Scientific Computing Division.


Clippings from articles. Gives some examples of big systems. Purpose is to stimulate thinking about what to avoid in systems planning.


10. Some Attributes of Desirable Data Structures (22 May 1989);

This is a short, six-page report that discusses some aspects of data structures. This paper was also included in a NOAA report*.


This includes information about data volume and formats. It shows the sampling and data volume from geosynchronous satellites. It includes storage costs.


This is a set of short articles that give some information about the exchange of data between PC programs. (8 pages)

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NATIONAL DATA PLANNING

1. Data Management for Climate and Global Change (13 Feb. 1990)

NSF sponsored a meeting about Scientific Data Management at the University of Virginia in Feb. 1990. Participants were asked to submit a “position paper.” This was the paper by R. Jenne. A good national system must be able to evolve smoothly with time. This paper is aimed at a national level view of the problems and tasks needed. Even within one discipline area, new “standard” formats appear each two or three years. This paper covers the problems of data system design, complaints about data access, the problems of bulk data packaging, and data activities that are needed. This paper is included in a NOAA report * (only 4 pp, important paper). It is also included in "Readings About Data Formats."

2. Interagency Data Planning - Guidelines (1 May 1989)

Various ideas about national data planning. It was written because it seemed that a very complicated system was about to be designed.


Selected slides from three talks by Jenne that outline data planning ideas, distributed data (CD-ROM, DAT, etc.), How Data are Used. Displays, Data Structures, Rules for Flexibility.

4. Planning Guidance for the World Climate Data System, 1982 (By Roy Jenne)

See INTERNATIONAL DATA PLANNING for details

5. Data Management Examples (Oct. 1988)

Relates part of the history for TOGA, GALE, GOFS, systems with displays, rapid prototype mode.


There has been a concern that data planning for EOS could become too big, complicated, and expensive. This describes some aspects of planning satellite data. It includes some info about the problems and costs users face to obtain satellite data.

7. Data Management for Global Change (1 Dec. 1988)

A model for future data use. Defining a working system that is flexible. What do scientists want in a data system. These were comments in reference to a Nov. 1988 national meeting on Data Planning for Global Change.
8. **Thoughts on NASA Data** (Nov. 1989)

Has some ideas about how to separate the overall data problem into parts. Under "National Data Priorities," it describes "**Approach 1**" and the contrasting "**Approach 2.**" Please note these approaches.


Has a little background info on EOS plans (only the little I've seen). Since Mar. 1986-on. (This document is only intended for limited distribution.)

**INTERNATIONAL DATA PLANNING**

1. **Data Management Methods; Data for Europe** (1988)

This paper discusses data strategy, data progress, and gives a history of selected data ideas over the last 20 years. We often call this the "Belgium Paper." Important paper.

2. **Essential Global Measurements** (Sep. 1989)

This is the Bretherton list.

3. **Planning Guidance for the World Climate Data System, 1982** (by Roy Jenne)

Surveys data requirements. Lists the variables. Discusses data management strategy. It is document WCP-19 of WMO. The planning for climate includes mos: of the variables needed for "Global Change." Jenne spent two months in Geneva, at WMO, to write this in 1980.

**OTHER TEXTS ABOUT FORMATS AND DATA STRUCTURES**

1. **Information about Formats** (5 Dec. 1991)

This provides general information about data formats and how data are delivered for use in calculations or displays. Some display packages can work from unpacked native formats; others require their own structure. Some data formats expand the volume too much. Selected information about the Net CDF format is included. A list of about ten different common formats is briefly discussed. It poses the question "What would a good data structure look like?" (This is included in "Readings About Data Formats.")

2. **NASA Goddard Data Systems** (6 Dec. 91)

There have been discussions among Goddard scientists about what kind of data support they want. This text is mostly made up of a short paper by Richard Rood at Goddard (written May 1991). (Included in "Readings about Data Formats.")
   (December 13, 1991)  
   This has about 22 pages in the long version; and only four pages in the short version.

4. **Common Data Formats: Common Data Problems?**  
   (17 Jan. 92)  
   These are notes about a paper by Haberman and Mock at the AMS Annual Meeting, January 1992, Atlanta.

5. **STORM; Data exchange format evaluation and recommendations**  
   (11 Feb 91, 2nd draft). Written by Storm Project Office, NCAR.

6. **Graphics at the University of Maryland**  
   (8 Jan. 92).  
   The Department of Meteorology developed a display system (GrADS) that has been getting good reviews. This is a very brief description of the system. There are paragraphs called "complexity of data access" and "importing data." NCAR is now including GrADS on CD-ROMs that we make.

7. **Data Handling and Distribution by NCAR DSS**  
   (4 Feb. 92)  
   This has information about the preparation of datasets, properties of 50-year formats, access to data, transportability, and the future handling of logical records. (This is included in "Readings About Data Formats.")

- End -
DATA AVAILABILITY AT NCAR
(Selected Datasets)

This report briefly summarizes the datasets that are available from the Data Support Section (Scientific Computing Division) of NCAR. The data can be copied on tape at cost. It can be used on-line at NCAR by those who have an NCAR computing project number. For use on-line there is usually a simple access program that accomplishes the data unpacking tasks. NCAR TN/IA-111 (1975) has much more explanation about the data than given here. This listing is very brief; other more recent papers about data are also available (see below).

We try to update this document approximately once per year.

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For additional information about data available at NCAR and elsewhere see:

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NATIONAL CENTER FOR ATMOSPHERIC RESEARCH*
P.O. Box 3000 Boulder, Colorado 80307

Roy L. Jenne
7 October 1982

Global Data for Climate Diagnostic Research

We will discuss the data that are needed for climate research of various types, especially climate diagnostics research. We will consider the general status of data sets, mention several data problems, and discuss present areas of emphasis in preparing data sets.

The report, Planning Guidance for the World Climate Data System, Jenne, 1982 includes a table of climate data requirements, based on the efforts of several working groups. It also briefly outlines requirements for impact studies. It briefly describes data availability and the sources of information. Then the data necessary for the Climate Programme are listed, and ways to accomplish the goals are outlined. In this paper, the status of selected data will be briefly given, along with references to additional information.

Recent reports (i.e. NAS, 1978) have recognized the importance that the present FGGE data will have for climatic research. It will give us a more complete description of one annual cycle than we have had. The FGGE analyses from ECMWF are available and GFDL recently completed their analyses. Many of the research studies using FGGE data will also need data from other years for comparison. Data for these other years are becoming more readily available.

We will now consider the present general status of climate data. In (Jenne, 1975) we considered many of the data sets that are available in the United States. These data are often global in coverage. Some are similar to the FGGE data set, but of course the observations weren't as extensive as during FGGE. Only a few foreign sources of data were included in the 1975 report. During the last few years, several drafts of a report, "A Global Data Base For Climatic Research," have been prepared for the JOC, (Jenne 1981). It considers more data types and discusses some of the problems with the present status of the data. In 1978, WMO published the Catalogue of Meteorological Data for Research.

A brief summary of the status of several types of climate data will not be given.

Monthly Surface and Upper Air Data

The monthly surface data from the old Smithsonian publications and from World Weather Records through 1979 have been placed onto two magnetic tapes. This includes about 1,800 stations in recent decades. There are still many

---

*The National Center for Atmospheric Research is sponsored by the National Science Foundation.

Note: a shorter version was also made.
problems, including gaps in records where observations were taken. Some improved regional data sets are being gathered. Sharon Nicholson, (Clark University) with the aid of Dennis Joseph at NCAR, has completed the preparation of long records of monthly precipitation data for about 1,000 stations in Africa.

The monthly UA data from World Weather Records is on tape with little quality control. During the 1950's, few winds are reported.

**Daily Surface Data**

For various climate studies, one needs daily max-min temperature and precipitation for many stations. Because of the variability of precipitation, there should be one precipitation measurement at least each 70 Km. The U.S. archives of daily cooperative station data, with many stations back to 1900, is now accessible at reasonable cost and effort. However, similar archives from elsewhere have not been drawn together. CAC prepares such daily archives from global GTS data, about 7000 stations, but it is available only from 1977.

The Air Force gathered about 107 million surface synoptic observations, worldwide, for varying periods between 1930 and 1965. These usually include rainfall. They also include elements such as clouds, winds, pressure and humidity that are needed. They are on tape at Asheville and at NCAR. Table 1 shows a sample of the data. Synoptic observations from telecommunications are archived since 1966.

**Marine Ship Synoptic Data**

These data have been collected by the weather centrals as decoded from tele-type bulletins, and also have been punched in delayed time from ship logs. Since many ocean areas have few observations, (even over a whole year), it is important that the ship data be better prepared and exchanged than has been done. The old data are especially important in order to analyze time changes of climate along ship routes that have been well used for many years. In recent years, satellite data are becoming useful to help provide us with global information about sea surface temperature. However, volcanic dust from events such as the May 1982 El Chichon eruption, make it much more difficult to derive reliable sea surface temperature data.

The Asheville "Atlas" marine data set is the most complete data set, but much data is not included in it, and it has some correctible errors. It contains about 29 million observations for 1860 to 1952, and 16 million for 1952 through 1972. The data from the 1860-1960 Historical (HSSTD) project is now on 64 tapes in TDF-11 format. It has only bucket temperature data.

A cooperative project between CRES-ERL, NCC, and NCAR, will merge data from several sets of marine ship data, and eliminate duplicates. This will result in a significantly more complete set of ship synoptic data than has been available. For the period 1854-1969, 76 million observations will be processed, and 50 million unique reports are expected. The major input data sets are the NCC "Atlas" files, the data files from the historical data project for 1860-1960, and a dozen other smaller sets that help complete the files. About 16 million observations have not been punched, so they can't be used. Other
Proceedings of the Seventh Annual Climate Diagnostics Workshop

Held at the

National Center for Atmospheric Research
Boulder, Colorado

October 18-22, 1982

March 1983

Session 3: Climate Data, Precipitation, and Snow Cover

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator
tapes contain about 18 million observations for 1970-79, giving a total of 68 million for 1854-1979. Year-month summaries of the data will be prepared.

Figure 1 shows the density of ocean ship data received in real time during 1-15 September 1980. Each dot shows the location of one report. The dots over land areas indicate that a number of ships still have location errors.

Oceanographic Station Data

Prior to about 1950, most BT's only went to 400 or 450 feet. Then new MBT's that went to 900 feet were developed and used until about 1965. Then XBT's were used which usually went to 450 meters but some to about 1800 m. About 3 million of these ocean station observations are now available. The National Oceanographic Data Center in Washington has most of these. Some analyzed grids are also available. Surface water temperature is available with the XBT data.

Hydrological Data

Daily precipitation data are available for about 140,000 stations in the world. In the United States, for example, there are about 9,000 daily stations and 3,000 that report hourly precipitation. About 14,000 stations report stream flow in the United States. WMO No. 464 (1977) contains information about the station density of hydrological data including precipitation, stream flow, evaporation, etc.

Rawinsonde Data

NCC and NCAR have upper air data from two basic sources, one source is data for nearly 800 global sites decoded from global telecommunications by weather centrals. The data for 1962-72 are included on 116 tapes at NCAR, and rawinsondes and piballs are on 130 tapes for 1973 to January 1982. The data are in "synoptic order;" all data for each data time are together. Later data and other types of upper air data are also available. Figure 2 summarizes the observed upper air data.

Data in station time series order: NCC (At Asheville) has prepared the United States daily rawinsonde data (includes Pacific Islands) for 1948-current. Data are for each 50 mbs plus significant levels. Data for Mexico, Chile, and Easter Island are included. The data are available in a character format from NCC and are in a binary format at NCAR on 50 tapes through 1981. Data from the permanent ships are not yet as convenient to access. NCAR also has Australian data through 1978 (starts 1943-55), New Zealand through 1975, and French Polynesia through 1973. Rawinsonde data from India was recently received. Many countries have prepared all or part of their historical upper air data. Figure 3 summarizes the availability of these raob data.

Aircraft Data

Data at the 200-300 mb level from aircraft, balloons, and satellite cloud winds are important to help define both the average climatology of remote areas and also the daily patterns. The daily divergence patterns help to depict areas with surface rainfall.
Sadler collected about 13 years of aircraft wind reports over the Pacific Ocean, and about 10 years over the Atlantic. The files start in 1960. Most of the data are at 300 mb or above. Much of the data was prepared from aircraft logs. He used these data together with rawinsondes to prepare his wind atlas (Sadler, 1975). The atlas has the best climatology of tropical winds at these levels that is known to exist. Tapes with the aircraft data and the climatology are at NCAR. Aircraft data from NMC are available on the archive tapes which start in 1962.

Under the NASA GASP program to sample trace gases, several commercial planes produced data tapes which include winds, starting in March 1975. The program includes a Quantas plane which flew mostly tropical and Southern Hemisphere routes. Data archives in other countries should be inspected for additional data.

**Southern Hemisphere Drifting Balloon Data**

EOLE balloons: Period 21 August 1971 to 23 December 1972. NCAR has several tapes with the data.

TWERLE: Period July 1975 through 10 August 1976. On 17 August 75, 95 balloons were working, 29 balloons on 9 August 76, 16 on 1 December 1976. They flew near 150 mb. The data includes wind, temperature, pressure, and geometric height.

FGGE ARGOS tropical balloons: January-July 1979. About 330 balloons were launched near 135 mb. The data includes temperature and wind.

**Cloud Drift Winds From Satellites**

Cloud drift winds from stationary satellites have been on the NMC tapes stored at NCAR starting in June 1969. The stationary satellites see a disk over 100° latitude by 100° longitude. NESS has a separate archive of these cloud data starting October 1974. The NESS archive was prepared on one tape per month; it is now compacted onto four tapes through July 1982. NCAR has prepared a separate file of the cloud drift winds from the NMC tapes starting 1 February 1975. Starting in about 1978, winds from the Japanese and European satellites are also on the tapes.

In April 1976, NESS was producing 5000 to 6000 cloud winds a day from the two satellites. About 60% to 70% of these were from low level clouds; most of the rest were high clouds, plus a few middle cloud winds.

**Gridded Analysis**

NCAR's collection of Northern Hemisphere daily sea-level pressure gridded data begins in 1899 and is complete except for a span of ten months in 1945. The height and temperature grids are available for 700 mb since 1947, heights at 500 mb since 1946, 300 mb since 1950, and 100 mb since July 1957. Other stratospheric grids are available from July 1957 through June 1959, and continuously since 1962 or 1964 (usually to 10 mb), depending on the source. Many of the earlier grids have a resolution of only about 5° latitude by 10° longitude, whereas most of the later grids have a spacing of about 400 km.
Global daily grid point data are available primarily from July 1976. Australian analysis for the Southern Hemisphere start April 1972, and South African ones start August 1977. Figure 4 summarizes available analyses.

Many of the daily analyses have been summarized into year-month grids.

Long-term mean monthly climatological data are available on one magnetic tape for each hemisphere. They include height, temperature, dew point, and geostrophic winds from the surface to 100 mb. Another tape has a climatology of the Northern Hemisphere stratosphere from 100 to 10 mb. German stratospheric analyses are available for each month since July 1964.

Tropical Storm Centers

The locations (each several hours) of individual tropical storms are available at Asheville.

Satellite Data

Figure 5 gives the time periods for which major sets of satellite digital data are available. Note the major increase of these data in late 1972, with the launch of NIMBUS-5 and the main series of NOAA satellites. Data from Geosynchronous satellites are also available.

Satellite Imagery

The archives of imagery started early in the life of the first geostationary satellites. The EDIS Satellite Data Service Division, located with NESS, has prepared an informal writeup (January 1980) about the archives from these satellites. It includes information about pictures, microfilm, movies, and tapes. The "Catalog of Operational Satellite Products", (Hoppe and Ruiz, ed., 1974) also contains information about archives.

Twice per day imagery from orbiting satellites have been saved. Tropical strip film overlays (on standard Mercator projections) show detailed cloud pictures from USAF satellites starting about 1973. The film can be borrowed (at cost) for reasonable periods. Contact World Data Center A For Glaciology in Boulder, Colorado.

NOAA Satellite Digital Data Archives

Daily 5-degree latitude-longitude satellite brightness: period 1 January 67 through 31 August 1972. These global NOAA vidicon tube data are at NCAR. The data were prepared from higher resolution data having a gray scale with only five levels. These data are also available through October 1972 on 735 tapes at NCC-SDSD in a higher resolution grid. Vidicon tubes have major calibration problems.

Tropical Nephanalysis Data: Period February 1965 through July 1973 (at NCAR). J. Sadler of the University of Hawaii has prepared daily cloud cover grids for the equatorial strip, 27.5°S to 30°N, with the data each 2.5° of latitude and longitude. These data are based on the nephanalysis charts from the Satellite Service which are, in turn, based on brightness data from satellites. Maps of
total average monthly cloudiness (30°N - 30°S) are given in Atkinson and Sadler (1970).

NOAA scanner data (orbiting satellite): These are 2600 tapes of gridded scanning radiometer data from March 1973-15 March 1978 at NCC-KSROD. Each day there is one visible grid and two IR grids, (1024 x 1024 points each hemisphere). Resolution is 13 km at equator, 25 km at mid latitudes. The data could be placed on 315 tapes (1600 BPI).

From June 1974-15 March 1978 and after January 1979, the above grid data also have been averaged on 125 x 125 grids for each hemisphere (resolution 100 km at equator). Seven tapes contain the data at NCAR. The data also have been interpolated from this basic grid onto a 2.5 degree latitude-longitude grid.

VTPR IR radiance soundings: The data for November 72 – December 78, are on 1150 tapes at SDSD. It could be placed on 130 tapes (1600 BPI). The coverage is global, the spot resolution is about 55 km.

The archive of satellite sea surface temperature spot data is very poor in quality prior to April 1976. New data could be derived from the VTPR data and from the scanner data.

- Tiros-N data: Scanner data starts about 21 October 1978: There is a global archive of 4 km data, 2 visible and 2 IR channels. Volume about 5800 tapes (1600 BPI) per year; about 95.2 minutes/tape.

- Sounder data: Resolution about 17 km, 42 km between spots, 27 channels, includes visible, IR, and microwave data sensors. Volume 1.7 tapes per day. Starts 21 October 1978.

- Synchronous satellite data: EDIS-NESS started the 3-hourly GOES archive about 3 September 1978 for 40°S to 50°N. For each satellite (E and W), it has 13 grids a day for IR plus 5 visible grids during daylight. All have 8 km resolution. A more limited archive of 5 IR grids and 1 visible each day, per satellite, started 9 August 1976. Volume: 3 tapes per day per satellite, could be packed into less space. NASA has a selection of digital VISSR data starting July 1974. The University of Wisconsin has archives of high resolution data generally starting in 1978. The archives are discussed in more detail in WMO, 1981.

Radiation Budget and Solar Constant Data (1962-1971)

Vonder Haar, Campbell and others at Colorado State University used data from several early satellites (1962-1971) to prepare monthly grids of the radiation budget and surface albedo (minimum brightness). A tape is available that has the early months of data, plus 35 months from Nimbus-6 and long period means for each month. The tape has emitted IR, planetary albedo (based on noontime reflected energy) and calculated monthly reflected, incident, and net energy. NASA recently (Oct. 1982) released a tape with radiation budget data from Nimbus-7 for Nov. 1978 through Oct. 1979. The NOAA satellite visible and window IR data has been used to estimate monthly heat budget data starting 1974, with a gap in 1978. Nimbus 6 and 7 measured the solar constant, as well as radiation budget parameters. The data started in 1976 as shown in Figure
Daily solar constant data has been published and/or prepared for both NIMBUS-6 and -7. Similar solar constant data from the solar maximum satellite is also available starting February 1980. It will be some time before final data are available. When the solar constant is lower than usual, it has been found that the near UV is also lower.

Snow and Ice

Weekly ice analyses have been prepared by the Navy from about 1970. They are published from 1972 (Arctic) and 1973 (Antarctic). Microwave data was used from about March 1973 when available. NESS prepared weekly Northern Hemisphere charts of snow and ice boundaries from 1966. Kukla, at Lamont, has digitized a significant amount of the above data. Grids of Northern Hemisphere snow depth have been prepared from 1974. J. Walsh, University of Illinois, has prepared monthly grids of Northern Hemisphere sea ice coverage, starting 1953.

The basic microwave data (ESMR-5) from Nimbus-5 for December 11, 1972, to May 8, 1977, has been prepared by NASA on 115 tapes (6250 BPI). Sea ice grids have been prepared by J. Zwally, NASA. Basic microwave data from NIMBUS-7 starts November 1978.

Microwave Data From SEASAT and NIMBUS-7

SEASAT gave only 99 days of data ending 10 October 1978. NIMBUS-7 was launched in October 1978 and is still operating. The inclination of the SEASAT orbit was about 72°; NIMBUS views the entire earth to the poles. Sherman (1968), NASA (1979) and Jenne (1975, 1982) give information about data from these and other satellites that will not be included here.

SMMR: Scanning microwave instrument on both satellites. There are 5 channels with nadir resolution 22 to 100 km. Information about SST, sea ice mapping, surface wind speed, liquid water content, and water vapor can be derived. The surface wind speed changes the capillary wave structure, which in turn changes the microwaves sensed by the satellite. The scan width is about 700 km. The satellite data rate is 2000 Bits/second including housekeeping, thus it could be written on 210 tapes/year or 105 tapes for NIMBUS 7 since it is active every other day. Basic radiance data with a resolution of 30 km will be on 61/tapes/year for NIMBUS 7, data resolutions of 60 to 156 km will be on another 61 tapes. These will be the basic tapes to obtain from NASA. The associated calculated parameters will be on 60 tapes. The Seasat SMMR data are on other tapes.

Elevation and Depth Data

A tape with global 10 minute elevation data recently became available. It also has some land use information which has been used by ECMWF to calculate a generalized roughness. Five minute elevation data have been prepared for much of N. America and Europe. In addition there is a set of 1 Km resolution data for the U.S.
Northern Hemisphere ocean depth has just been prepared at 5 minute resolution, and the Southern Hemisphere is being worked on. Other data sets with 1 degree resolution are also available.

Data Management

Many sets of world climate data are in need of major improvements. Many data are not on computer tape. Many of the data now on tapes should be better organized and checked so that they may be used more easily. More surface based observations should be gathered into global or regional archives.

A particular problem occurs with many types of satellite data: The data volume may be so high that it is difficult or impossible to use the data for long period studies, even when it has been saved. For example, the data from one stationary satellite over the equator fills one tape (1600 BPI) each 4 minutes when it is all saved. We are now in the process of defining a selection of satellite archives that will be much easier to use, but which will still capture much of the information. The archives will emphasize basic radiance data as well as the calculated final parameters. We should also remember that some archives of satellite data such as cloud drift winds, and clear column radiance soundings often are in data sets that are already easy to use unless they have been grouped with too much other data.

Within each discipline area, we need to continue the process of identifying the useful data, and finding the problems with it. In addition, the supporting data such as land vegetation, soil types, and ocean depth must be of a quality and resolution to support future modelling needs.

Resources

NCAR maintains a brief up-to-data listing of "Data Availability at NCAR". It contains references to other sources of information. Several motion pictures show aspects of climate, circulation patterns, and tropical sea surface temperature.

References:

4. Goddard Space Flight Centre, 1979: Candidate NASA data sets applicable to the climate programme.


Table 1. Daily surface synoptic data at Asheville, prepared by the USAF. Many stations do not cover the entire period of record (POR). The number of station-decades of data is included to indicate data coverage. The file is global. A sample of the data is listed below. The data are on 9 track, 1600 BPI tapes, about 75,000 observations per tape at Asheville, and on higher density tape at NCAR. The data are in time series order on the tapes. (From Jenne, 1975).

<table>
<thead>
<tr>
<th>Area</th>
<th># stns</th>
<th>POR</th>
<th># YR-MO</th>
<th>Stn-Decades</th>
<th># obs (Thousands)</th>
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<tr>
<td>Pacific Ocean Islands</td>
<td>180</td>
<td>39-68</td>
<td>18,144</td>
<td>151</td>
<td>3,576</td>
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<tr>
<td>S.E. Asia</td>
<td>352</td>
<td>43-66</td>
<td>39,988</td>
<td>333</td>
<td>6,600</td>
</tr>
<tr>
<td>Indonesia</td>
<td>80</td>
<td>42-66</td>
<td>10,740</td>
<td>134</td>
<td>712</td>
</tr>
<tr>
<td>Central and S. America</td>
<td>739</td>
<td>30-71</td>
<td>65,741</td>
<td>548</td>
<td>4,308</td>
</tr>
<tr>
<td>Philippines, Australia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formosa, Japan, New Zealand</td>
<td>305</td>
<td>45-69</td>
<td>39,958</td>
<td>333</td>
<td>11,168</td>
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<tr>
<td>Europe, Br. Isles</td>
<td>1600</td>
<td>26-72</td>
<td>127,960</td>
<td>1066</td>
<td>18,464</td>
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<td>Middle East</td>
<td>602</td>
<td>35-68</td>
<td>47,149</td>
<td>393</td>
<td>4,155</td>
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<td>Africa</td>
<td>757</td>
<td>41-68</td>
<td>63,431</td>
<td>529</td>
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Upper Air Observations

UA observed data from GTS (rawinsonde, etc.)

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<tr>
<th></th>
<th>1960</th>
<th>65</th>
<th>1970</th>
<th>75</th>
<th>1980</th>
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<tr>
<td>US - NMC</td>
<td>N Hem global</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mar 62</td>
<td>Jun 66</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Germany</td>
<td>Aug 66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
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</tbody>
</table>

UA observed data, not GTS

From MIT

1958-1963

Also see Fig. 2

Special Aircraft Data

Sadler winds

<table>
<thead>
<tr>
<th></th>
<th>1960</th>
<th>1972</th>
</tr>
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<tbody>
<tr>
<td>Air Quality</td>
<td></td>
<td></td>
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<tr>
<td>AIDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASDAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balloons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Hem. TWERLE (winds, H)</td>
<td>Jul 75</td>
<td></td>
</tr>
<tr>
<td>S. Hem. EDLE (winds)</td>
<td>Aug 71-Dec 72</td>
<td></td>
</tr>
<tr>
<td>FGGE Tropical (winds)</td>
<td></td>
<td></td>
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</tbody>
</table>

Rockets

6 stations 33 stns needs work 1968

Satellite

Cloud winds GTS separate

<table>
<thead>
<tr>
<th></th>
<th>Jun 69</th>
<th>Oct 74</th>
<th>archive</th>
</tr>
</thead>
<tbody>
<tr>
<td>I R sounders</td>
<td></td>
<td></td>
<td>Nov 72</td>
</tr>
<tr>
<td>TIROS-N (IR and microwave)</td>
<td></td>
<td></td>
<td>Jan 79</td>
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</table>

Figure 2 Upper Air Observations
Rawinsonde Data

Not Collected in Real Time

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>USA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Americas</td>
<td>Prepared</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific</td>
<td>Includes Alaska, Pacific Islands, Caribbean, Mexico, Central America. Chile, not Argentina or Brazil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>Prepared</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>10 stns UK, 3 Atlantic ships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1948</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19 stns overseas, completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>45 stns including islands</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>1943-1955</td>
<td></td>
<td></td>
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<tr>
<td>New Zealand</td>
<td>13 stns including islands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>20 stns completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1951</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>USSR</td>
<td>Prepared</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Many other countries have similar data sets.

Figure 3 Rawinsonde data
### Daily Analyses

<table>
<thead>
<tr>
<th>Year</th>
<th>SFC-500 mb</th>
<th>SFC-300 mb</th>
<th>N. Hem</th>
<th>SFC-10 mb</th>
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<tbody>
<tr>
<td>1950</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**N. Hem**

- **Daily N. Hem (USSR)**: 500 mb
- **Daily N. Hem (USN)**
- **Daily N. Hem (German)**: Mar 66
- **Daily Strato H,T (German)**: 50-10 mb, 50-30 mb
- **Mo heights (German)**: 100 - 10 mb, 50-30 mb
- **Weekly analyses (US and German)**: 2 and .4 mb, add 5 mb
  - 1968: 1973

**Global**

- **Daily global (NMC)**
  - Dec 72
- **Monthly global (GFDL)**: 1958-1973
  - Aug 74: Poor Improvement
  - Jun 74
- **Daily SLP and SST (USN)**
- **Daily SST (NESS)**
- **Mo SST (NESS)**
  - Sep 73
- **Mo SST (from ship data - several sources, for many years, still problems)**

**Tropical**

- **Daily Tropical (NMC)**: 700-200 mb
  - Jan 68, sfc-200 mb
  - Jan 73
- **Daily Tropical (USN)**

**S. Hemisphere**

- **Daily S. Hem (Australia)**: 500 mb
  - 1968, Apr 72, sfc-100 mb
- **Daily S. Hem (S. Africa)**
- **Daily S. Hem (USN)**: sfc-100 mb
  - Aug 77, Jul 73

**N. Hem SST**

- **Daily (USN)**: Sea Surface Temperature
  - 1961

**Note:** This is not a complete listing of available analyses

**Figure 4** Daily Analyses. Most sets of analyses have both strong and weak points that must be further determined and considered when using them.
Figure 5: Satellite digital data. Data are also available from synchronous satellites.
Data for TOGA

1. Surface ship data: NCDC, CIRES, and NCAR have prepared the best datasets for 1854-1979. A 1980-85 update is planned. These efforts rely on the international IMMPC dataflow, and on other sources. The location problem of ships needs to be examined by WMO and others.

2. Cloud drift winds: NCAR has the GTS archive (from NMC) of these starting 1967. There is an archive in NESDIS for U.S. data from 1974. Japan, and probably Europe, have archives of their data. NCAR will attempt to obtain the Japanese archive.

3. Aircraft reports
   NCAR will prepare a set, starting 1960, given inputs
   - Have NMC and Sadler inputs
   - Need several other inputs

4. Land surface synop
   - Volume of data is a problem
   - Need some older data (takes international action)
   - Most action is needed by ETAC, NCDC, NCAR

5. Rawinsonde
   - NCAR has GTS data (from NMC) from 1962, needs file separation
   - Have older data from countries and TD54 from ETAC
   - Need selected stations for TOGA (should define this list of stations that will receive special attention).
   - Actions by NCAR, NCDC, countries

6. Analyses
   - NCAR has analyses from NMC, Australia and other sources, and some from ECMWF.
   - Archives at WDCs, ECMWF, NCAR

A note in Dec 2000: The NCAR Data Support Section (now DSS) prepared many many observations for reanalysis during 1991-2000. We got data from many sources, for raobs, raobs, raobs, aircraft, cloud winds, satl, raobs, raobs, raobs, ocean raobs, raobs (COADS).
- NCAR will make special surface subsets from the above

7. Drifting buoys
   - Canada has main archives
   - Partial US archives
   - Need research work on cross comparisons between buoys

8. Fixed buoys
   - US NDBC/NODC archives
   - Other countries?
   - Need a reduced archive

9. XBT
   - Most complete data are in NODC and Roger Bauer efforts. Need to define a best combined set.
   - Need international agreements
   - Preserve real-time archive also

10. Tide data
    - Use Hawaii and UK tide center
    - Need to define time/space scales wanted (need hourly and monthly)
    - Need to define an international data flow for the selected stations

11. Current meter data
    - W. Nowlin and NODC could make a set
    - Need international inputs

12. Operational satellite data
    - SDSD has sounders, GAC, AVHRR from TIROS
    - Need to copy the Nov 72 to Feb 79 VTPR data (it is on old tapes)
    - NCAR has most of previous SIRS data

13. Geosynchronous satellite data
    - Use ISCCP archives (these start July 1983)
- Obtain some 3 hr/8 km data prior to ISCCP (task of SDSD, Japan, Meteosat)

14. Ocean satellite data
   - Need experiment data groups and need other groups to prepare data subsets and help users.
   - JPL, Navy, NASA, and NCAR will have efforts

15. Satellite products, such as precipitation, surface radiation
   - Precipitation from geosynchronous satellite groups
   - Surface radiation from special groups, using ISCCP data
   - Most active groups: Scripps, Clim. Anal. Center, Goddard, Grants Programs

16. Ocean time series of data
   - Task for NODC, International units

17. Subsurface drifters, bottom pressure, etc.
   - Define data tasks

18. Involvement of many countries:

   There is a problem if too much of the activity focuses on the USA. We would not obtain needed data inputs, and it wouldn’t be a vital international program. Regional centers that help gather inputs (such as ships, aircraft, XBT, etc. help). Some (or all) of these centers could also obtain a copy of the full global set of data. The centers could also prepare delayed analysis products, and make intercomparisons.

Also see: "Data for Toga", 6 May 1985 (Rev. 4 June). It has many more details about the data.
List of satellite data needed for climate studies

Roy Jenne
4 Jan 1985

Selected Satellite Data

<table>
<thead>
<tr>
<th>Archive Tapes</th>
<th>Gbts</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Soundings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. VTPR Radiance &amp; Soundings 11/72 - 2/79</td>
<td>1194</td>
<td>95.2</td>
</tr>
<tr>
<td>2. DMSP Sounder 3/77 - 2/80</td>
<td>1115</td>
<td>44.8</td>
</tr>
<tr>
<td>3. NOAA TOVS Soundings 1/79 - on</td>
<td>190/yr</td>
<td></td>
</tr>
<tr>
<td>B. Polar Orbitor Scans</td>
<td></td>
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</tr>
<tr>
<td>1. AVHRR 4 Km global data (GAC) 11/78 - 12/84</td>
<td>8,920</td>
<td></td>
</tr>
<tr>
<td>2. AVHRR 1 Km local data 10/78 - 10/82</td>
<td>11,898</td>
<td></td>
</tr>
<tr>
<td>3. NASA THIR - 50,000</td>
<td>70/yr</td>
<td></td>
</tr>
<tr>
<td>4. NOAA SR grids 01/73 - 03/78</td>
<td>2,600</td>
<td>95</td>
</tr>
<tr>
<td>C. Geosynchronous Satellites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 3 hour/8Km GOES Archive 7/76 - 10/82 at SDSD</td>
<td>10,316</td>
<td>1,155.2</td>
</tr>
<tr>
<td>2. GOES-West 11/78 - 10/82 Univ. of Wisconsin</td>
<td>31,864</td>
<td></td>
</tr>
<tr>
<td>3. GOES - East 2/78 - 10/82 Univ. of Wisconsin</td>
<td>39,816</td>
<td></td>
</tr>
<tr>
<td>4. GOES Indian 12/78 - 11/79 Univ of Wisc.</td>
<td>5,312</td>
<td></td>
</tr>
<tr>
<td>5. GOES Vas Data 7/81 - 10/82 (Univ of Wisc)</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>6. GMS Back Archive (in Japan) (FGGE year is at Univ. of Wisc)</td>
<td>Many</td>
<td></td>
</tr>
<tr>
<td>7. Several years of earlier data at University of Wisconsin has mostly been purged.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
D. ISCCP Data - Starts July 1983

<table>
<thead>
<tr>
<th></th>
<th>Total gbites/yr</th>
<th>B1: 8 Km/3 Hr Archive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Goes-West</td>
<td>25,501</td>
</tr>
<tr>
<td>2.</td>
<td>Goes-East</td>
<td>25,501</td>
</tr>
<tr>
<td>3.</td>
<td>Meteosat</td>
<td>3,685</td>
</tr>
<tr>
<td>4.</td>
<td>Insat</td>
<td>332</td>
</tr>
<tr>
<td>5.</td>
<td>GMS</td>
<td>4,968</td>
</tr>
<tr>
<td></td>
<td>=========</td>
<td>=========</td>
</tr>
<tr>
<td>6.</td>
<td>Tiros 4 Km GAC</td>
<td>1,440</td>
</tr>
<tr>
<td>7.</td>
<td>B-3: 25 Km data, for all of above</td>
<td></td>
</tr>
</tbody>
</table>

E. Microwave Data (for ice and precipitation)
- Include ESMR 5 and 6 starting 1973
- Basic Nimbus-7 - SMMR (Nov 1978-on) could be 32 gbites a year. 30 Km cell tapes could be about 18 gbites a year.

F. Other Data

<table>
<thead>
<tr>
<th>Tapes</th>
<th>Gbits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nimbus-7 CZCS</td>
<td>6,147</td>
</tr>
<tr>
<td>11/78 - 10/82</td>
<td>1475.2</td>
</tr>
</tbody>
</table>

* Needed for long period climate archive
Data for TOGA

We will consider some of the data that could be used for TOGA research. Some of the data options are quite inexpensive. Both the cost and the relative value should be considered when setting priorities. Data bases are needed to understand, detect, and monitor El Nino warmings, etc. This requires many years of older data to measure the frequency and amplitude of the various events and processes.

Surface Ships

1. NCAR, CIRES, and NCDC have merged the ship data for 1854-1979, and calculated statistics.

2. The update effort for 1980-84 data should be supported. This involves a relatively small CIRES grant.

3. Through US-India and US-USSR data exchanges, we are trying to obtain more ship data.

4. Prepare selected US marine data for WW-1 and WW-2. NCDC has identified about 930,000 ship logs, which have about 17 million ship observations for the war periods. At present, there is almost no digital data available for the war periods. A TOGA working group should review this problem and recommend whether a small selection of these data should be key entered for TOGA. The group should consider ways to reduce key entry costs, by: 1) typing plus optical scan, (2) typing into micro-computers, and, (3) overseas key entry. NCDC says that a person can average about 1000 cards (obs)/day without verification (this is 2/minute). NCDC charges about $150 per 1000 cards.

5. NCDC has good datasets from US permanent ships (now stopped).

Dataset of Cloud Drift Winds

- NCAR and SDS have tapes from NESS having US cloud winds for Oct 1974 - current.

- NCAR could extract cloud winds from tapes of NMC GTS data. The winds started June 1969.

- An enhanced set of winds is on the FGGE tapes.

- A combined dataset could be made from the above sources, and this should be done. It would cost NCAR about $2000 to extract data from the different primary tapes. An update from NESDIS costs about $400. It would
cost an additional $2000 or more (if checks and dupelim are done) to prepare a merged dataset.

Dataset of Aircraft Reports (1960-on)

Selective reanalyses of the tropical circulation are needed. An important input data type is aircraft wind data. The following datasources should be considered:

1. Aircraft data from NMC GTS decode. These can be extracted from about 160 tapes at NCAR.
2. Aircraft data from USAF decode. Need to check with Asheville ETAC.
3. Australian GTS decode.
4. Indian Ocean data from Krishnamurti.
5. India has located several years of aircraft log data.
7. NASA GASP data. Several years of winds from wide-body aircraft, many on tropical routes.
8. Aircraft data from FGGE tapes.

Note: NCAR could do the data extraction and perhaps the data merging if the ETAC data, GASP data, and recco data are sent to us.

Ocean Time Series

1. NODC should be requested to make an inventory list of long records (15 years or more) that may be of interest to TOGA. This would include SST or salinity measured on the up-current side of an island, etc. A TOGA working group should look over this inventory and see if any of the time series of data need to be made readily available.

2. Scripps should be requested to make a generalized inventory of the years for which given XBT trans-sections are available for the Pacific Ocean. This should include comments on the approximate sampling frequency.

3. The Research Literature has many carefully prepared time series. People often like to have the numbers later for cross-correlations, etc. Selected important time series data should be prepared on a card image—self descriptive file on tape. The contents would include the contributor, format, reference to literature, and data. NCAR or other archives would put many of these on a tape, if PIs submitted the data in clean form.
XBT

1. The best world dataset may now be the Bauer-Robinson-Navy set. NODC (Jim Churgin) and Bauer need to define whether additional initiatives are needed.

Drifting Buoys

A combined set of drifting buoy data should be prepared. Several countries had drifting buoys out well before FGGE. We should determine if countries have prepared cleaned up sets of buoy data. If so, we should assemble these sets.

Since different buoys measure different data, we should be careful when using common formats that important data are not lost. There should be a common format for two or three most common variables, then a format code indicator plus whatever data is pertinent for the buoy in question.

Buoy and Rig Data

When preparing satellite SST data, NESDIS uses certain buoys to help determine the accuracy of the derived SSTs. Is there a writeup on the approximate location versus time of these buoys? Do we need a dataset? How can people find them in the NMC GTS data?

Do we need hourly or 3 hourly data from selected oil rigs? I think that some have wind, T, Td versus height.

Tide Data

See the report from the IOC Data Panel for WOCE-TOGA that met in Paris in October 1984.

Land Surface Synoptic

Prepare a dataset of 3, 6, or 12-hourly surface synoptic observations for islands in the Pacific Ocean. These data have observations of wind, T, Td, clouds, etc.

1. From NCAR's TD-13 holdings (prepared by USAF), NCAR can make maps to show data coverage every several years over the Pacific, if requested. To include the whole world, NCAR would require about $10K to obtain copies of the tapes with data for the USSR and China.

2. US station data is available from 1948-on. Prior to 1948, TOGA should consider punching data for a few hours per day for selected stations. Dick Davis at NCDC is checking on data availability.

Rawinsonde

Further steps are needed to prepare the past raob data. The sources are: GTS decode, Air Force ETAC files, countries. NCAR intends to do more work along these lines.
NCAR will probably make station time series of the GTS decode raobs from NMC, starting 1962.

- NCAR has some of the ETAC files of raobs. We need some help in obtaining the more complete files.

- Time series data from selected US stations is still in poor shape.
  - The Record from Diego Garcia is spotty.
  - Canal Zone not prepared.
  - Several years of the data from Ascension Island are very hard to obtain.
  - Clark field no longer prepared (I think).

Geosynchronous Satellite Radiance Data

1. Data collection of 3 hr/8 Km data and 3 hr/25 Km data started July 1983 for the ISCCP (Satellite Cloud Climate). Clouds for 250 Km regions will be calculated by GISS.

   The data can be used to calculate convective rain rates, surface radiation budgets, planetary radiation, cloud heights, cloud coverage, etc.

   The world 8 Km data (geosynchronous satellites) for ISCCP will be on about 350 tapes/year (6250 BPI) in the NOAA archives. Funds will be needed to move significant parts of the archive to NCAR and perhaps to other places where significant amounts of calculations will be made.

2. EDIS-NESS

   EDIS-NESS started the 3-hourly GOES archive about 3 September 1978 for 40°S to 50°N. For each satellite (E and W), it has 13 grids a day for IR plus 5 visible grids during daylight. All have 8 Km resolution. A more limited archive of 5 IR grids and 1 visible each day, per satellite, started 9 August 1976. Volume: 3 tapes per day per satellite, could be packed into less space. The University of Wisconsin has archives of high resolution data generally starting in 1978. The archives are discussed in more detail in WMD, 1981.

   The data for July 1976–on were on 10,316 tapes at SDSD having 144 Gbytes of data as of Oct 1, 1982.

   Recommendation: There is only one copy of these tapes for the 2 US satellites. If they are not soon copied the data will be lost. The data should be copied to full 6250 BPI tapes, and a copy sent to a computing center. Some data could be purged during the copy. The minimum cost expected to accomplish this would be about $150K to $300K. I believe that it would be more expensive to extract similar data from the Wisconsin archives.
3. Japanese GMS Satellite

It may be possible to obtain 3 or 6 hour/8 km data from GMS starting late 1978 to the time that ISCCP archives starts. I can check on whether certain research efforts in Japan were able to pull out a subset before the data was purged.

4. Meteosat

It may still be possible to obtain data for most of the time from FGGE-on. However, it would probably be very expensive to get it.

NOAA Satellite Sounder Data

The NOAA VTPR Sounder Data for the World for November 1972 - February 1979 is on 1194 tapes at NOAA SDSD and is the only tape copy anywhere. Some of the data now on tapes is 13 years old. Tapes should be copied by age 8 years. All the data can be copied onto 100 tapes (6250 PPI), and this should be done. The spot resolution of the data is about 55 km. It can be used for further cloud, radiation, and SST work. The cost to copy the tapes and send off a copy will be about $25,000 to $50,000.

Data from earlier sets of NASA SIRS-A and -B data at NCAR will complement the above. To prepare the best recalculations of SST, visible channel data from a different dataset should also be made available for cloud discrimination. The visible data would be expensive to prepare.

NASA Satellite Data

The availability, data volume, and usefulness for TOGA of older NASA data for radiation budgets, SST, surface wind speed, rain rates, etc., should be reviewed.

Grid Point Data

1. NCAR will maintain sets of grid point data from NMC, Navy and Australia.

2. I understand that reported ship winds are not used in the NMC surface analyses in the tropics (or elsewhere). I suggest that Rasmusson and Reynolds talk about NMC surface analyses in general, with the NMC analysis section to see what improvements in wind T, Td can be made. Model precipitation grids for 12-24 hour and 24-36 hour forecasts should also be archived.

3. TOGA should make a list of requested grids (surface and upper air) that ECMWF could provide. I would like to help make this list.

3-D Nephanalyses

These cloud data are now on so many tapes that they can't be used except in limited regions. There are programs almost ready which would make the data much more accessible. Data could be prepared for smaller regions instead of the whole world. The group should consider the need for this data. I think
it would be useful, but it should be lower priority.

Summary

- Surface ship data should be updated.
- Study to see if some WW-1 and WW-2 ship data should be prepared.
- Make satellite cloud drift winds readily available (about $5K).
- Prepare a dataset of aircraft data (probably $10K and much donated effort).
- Ocean time series data: Make an inventory and then decide on any action.
  - Prepare a home for small datasets of research time series.
- XBT data: Obtain expert opinion
- Drifting buoys
  - A dataset is needed
- Buoy and oil rig data
  - Some questions need to be answered
- Tide data: Needed (monthly and hourly)
- Land surface synoptic
  - Decide whether data prior to 1948 is needed for some US Pacific Islands.
- Rawinsondes
  - Need preparation. Most needed is about $20K plus donated effort. A full scale effort to do many more data checks would be much more costly.
  - Some US stations need preparation. Guess $40K?
- Geosynchronous satellite data
  - Make ISCCP archives more available for calculations
  - Prepare NOAA GOES data on modern tapes for 1976 - 1983 ($150K to $250, probably $200K).
  - Find information on GMS and Meteosat data for 1978-83
- NOAA satellite sounder data
- Put VTPR data on modern tapes ($25 to 50K)
  
- NASA Satellite
  
- The availability, usefulness for TOGA, and data volume needs review
  
- Grid analysis data
  
- Some steps needed to improve these and obtain past ECMWF data. (Small cost.)
DATA FOR POLAR REGIONS RESEARCH

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Abstract

Datasets for Polar Research on global change topics are summarized. Emphasis is given to data that define the large scales. This includes rawinsonde data, surface meteorological observations, cloud drift winds, atmospheric analyses, sea ice, planetary radiation, and ocean forcing. Plans are discussed for making improved atmospheric analyses, using existing data. The use of CD-ROMs and DAT technologies for data distribution is summarized.

1. SNOW COVER DATA

There are datasets of weekly sea ice and land snow cover. Many land stations report snowfall, but this data is still often hard to obtain, worldwide. A workshop “Snow Watch 85: Workshop on CO₂ /Snow Interactions” produced a report “Snow Watch 85,” which has over 20 papers that describe snow cover datasets, and make comparisons. It includes a discussion of weekly sea ice charts available from 1972. Weekly charts of N. Hemisphere snow and sea-ice boundaries have been prepared starting 1966.

2. MICROWAVE DATA FOR SEA-ICE, ETC.

Satellites that observed passive microwave data from which sea-ice and other variables can be estimated are: NIMBUS (ESMR instrument), Dec. 72-May 77; NIMBUS-7 (SMMR), Oct. 78-Aug 87; DMSP (SSMI instrument), 9 July 87-present. The status of the ice products evolves with time. The data are primarily located at NSIDC (Goddard), JPL, and the Snow and Ice Data Center (WDC-A) in Boulder, CO. Sea-ice products on CD-ROM are becoming available.

For the N. Polar area, NCAR has a tape from John Walsh that has tenths of ice coverage on a 1° (60 n.mi) resolution grid. The period is for each month (1953-1988 inclusive).

3. DRIFTING ICE ISLANDS

The US took surface and upper-air observations from two Arctic Ocean Ice Islands, some for a number of years. The data for the IGY period (July 1957-Dec. 1958) are described in the report "Climatological Data for Arctic Stations." The surface data includes the normal meteorological variables, and radiation. Similar data are also available for other years.

To be published in “Proceedings of the International Conference on the Role of the Polar Regions in Global Change.”
4. ANALYSES FOR S. HEMISPHERE

The availability of daily meteorological analyses for the S. Hemisphere is summarized in Figure 1. Most of these are on tape, at NCAR.

![Diagram showing data sources and years]

Figure 1. Meteorological daily analyses for the S. Hemisphere. SLP means sea level pressure. Automated analyses at many levels start in 1972. The data are all digital except for the one marked “paper.” Archive details, and data are at NCAR.

5. COMMENTS ABOUT DATA FOR ANALYSES IN S. HEMISPHERE (1951-57)

From about 45°S and northward, one can accept the analyses for the whole 1951-57 period. To describe conditions further south, there were lots of ship reports for the summer whaling season (Nov.-March) for Nov. 1955 and later. Van Loon says that the summer (Nov.-March) analyses from Nov 1955-on were of equal quality with IGY analyses. The sector for S. America, Ant. Penn. and Falklands had enough observed data for the whole period. There were very few Antarctic stations before 1956. The IGY analyses started June 1957.

The whalers were in the Atlantic and Indian Ocean areas for summers prior to Nov. 1955, but the Pacific Ocean did not have good ship observations until the Nov. 55 summer.

5.1 The S. East Pacific Sector

In early years (about 1952-Nov. 1954), the Analysts believed that the sub-tropical high pressure area should extend farther south than it really does. Thus, they kept trying to force high pressures down into that no-data area.

5.2 Bad Easter Island Pressure

The pressure at Easter Island was about 9 mb too low for 18 months; good data started 24 Jan. 1958. This was determined from passing ships etc. Dumb WMO rules forced the analysts (Van Loon and others) to plot the bad pressure on the maps for IGY, etc. German monthly analyses (published) were affected by the bad pressure.

Van Loon says that the IGY analyses and the summer analyses (Nov. 55 and later) were not affected by the bad pressure. He is fairly sure that all analyses for 1951-58 used the corrected pressure for Easter Island.
6. ANALYSES FOR N. HEMISPHERE

Daily sea-level pressure analyses starting 1899 are available from NCAR on tape. The Arctic sea level pressure was too high for many years. The analysts had few observations, and believed that an intense polar high pressure cell must exist. NCAR has hemispheric upper air analyses starting about 1946, at 700 and 500 mb. Other levels start in 1950 (300 mb) and 1963 (many levels).

7. NEW ANALYSES OF PAST ATMOSPHERIC CONDITIONS

From 1987-90, there has been an increasing interest in making daily reanalyses of the global atmosphere. The data assimilation methods used to analyze the state of the atmosphere, have shown major advances during the 1985-90 period. A forecast is a part of these methods; therefore, the analyses improve when the forecast model is improved. There has been a large advance in the capability of forecast models.

First there was talk about reanalyzing about two years in the 1980s as a pilot project. There has also been a clear interest in doing the whole period 1979-90. Now there are plans to get ready to do the whole period 1958-90. There were very few Antarctic observations prior to 1956.

Do we have the data inputs needed to reanalyze the atmosphere? There are many source datasets that can be combined to produce datasets that will be significantly better than the data that any center used for the operational analyses that are now available. Such projects to prepare data are starting for surface land data, rawinsonde data, aircraft data, and satellite cloud wind observations.

For the surface marine data, a project (COADS) was started in 1982 to prepare the best dataset of world observations from 1854-on. This has involved cooperation between NOAA/ERL, NCAR and NCDC/Asheville, (Woodruff, et al, 1987). MEDS, Canada is helping to prepare the drifting buoy data. We obtain a significant number of additional ship reports by waiting until delayed reports become available. The following table shows the number of reports after duplicates are eliminated for different delay times (during the 1980s):

<table>
<thead>
<tr>
<th>Ship Reports Available</th>
<th>Delay Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200K per year</td>
<td>Real time</td>
</tr>
<tr>
<td>1860K per year</td>
<td>after 1 year</td>
</tr>
<tr>
<td>2100K per year</td>
<td>after 2 years</td>
</tr>
<tr>
<td>2220K per year</td>
<td>after 5 years</td>
</tr>
</tbody>
</table>

There are several existing datasets of global surface land observations, and rawinsonde data. Data are available from both telecom (real-time), from delayed, high quality, archives in national data centers and from previous data collection projects. The plan is to combine data from several sources and have initial datasets ready to start long-period reanalyses by Nov-1992. It will take a 10-year effort to keep improving the availability and quality of data, especially for the earlier years. The results of these data preparation efforts will be valuable for many purposes besides reanalyses.

What data would be available from a reanalysis effort? The normal variables (temperature, pressure, wind, moisture) for the atmosphere would be available. In addition diagnostic terms such as precipitation, clouds, surface radiation, total surface energy budget, etc. would also be available.
The new surface winds would be used to drive ocean models for the whole period. Also, the boundary layer conditions over the ocean and ice caps will be saved.

Bengtsson and Shukla (1988) published a paper that helped to start the movement toward planning for reanalyses. In early 1989, a small workshop was held to consider the initiative of making reanalyses (Kinter and Shukla, 1989).

A paper is available that summarizes the status of datasets (and years of coverage) that can be combined to provide inputs for reanalyses. It also gives a history of reanalyses done for the FGGE period (1979) to help scale the effort (Jenne, 1988). Many additional details are available at NCAR.

8. OUTPUT OF SNOW, TEMPERATURE, RADIATION, ETC., FROM ANALYSES

In the most recent years, the assimilation schemes used to analyze the atmosphere are good enough to produce many diagnostic terms from the associated forecast model. The variables include precipitation, snowfall, temperature, winds, clouds, radiation, surface stress, surface heat fluxes, etc. NCAR has a list of the variables that are available.

When reanalyses are made, these terms will be saved from the models, in addition to the normal pressure, temperature, wind, etc.

9. SATELLITE SOUNDER DATA

Several sets of global satellite sounder data are available. The sounder data has channels (such as window IR) that can be used for other purposes besides deriving atmospheric temperature soundings.

- NIMBUS SIRS, April 1969 - April 1971
- NOAA VTPR, Nov. 1972 - 28 Feb. 1979 (8 IR channels)
- NOAA TOVS, 29 Oct. 1978 - Present (channels in VIS, IR, microwave, and for stratosphere)

10. DATA FROM CLIMATE MODELS (Double CO₂, etc.)

NCAR has data from several of the world's climate models. This includes five different model experiments for the present climate (1x CO₂), and for a doubling of CO₂ (2x CO₂). There are also two transient runs from GISS, one to the year 2062. EPA sponsored this effort (starting in 1987) to prepare data in common formats to support assessment studies of climate changes on crops, forests, rivers, etc. The primary datasets are 10 to 20 variables (precipitation, temperature, surface radiation, etc.) to support these studies. There is data for 10-year monthly means of 1x and 2x CO₂ climates. For some runs there is data for each individual model month. For one GFDL run we have daily output for a sample of three years in each of the 1x and 2x runs. The resolution of most climate models is now about 500 km, so they can't show the details of climate changes caused by local topography. Some higher resolution data will be available in May 1991.

11. USE OF CD-ROM AND DAT TECHNOLOGIES TO DISTRIBUTE DATA

The first CD-ROMs with data for the geosciences were produced in mid-1987. Now a flood of them, are being prepared. A CD-ROM holds about 650 MB, compared to 125 on a high-density half-inch tape. The access time to any part of the disk is about 0.5 seconds. A reader costs about $700. The 4 mm digital audio tape drives (DAT) can now
be purchased for about $2,200. The price may come down to $1000 in a year. These small tapes hold 1300 MB of data.

When a CD-ROM is received, software to access the data on a PC is also provided. Some simple browse displays are often included.

12. SOURCES OF INFORMATION ABOUT AVAILABLE DATA

Selected sources of information about data that are available are presented. Some indication of the types of information that can be found within each of these major sources is also included.

12.1 World Data Center for Glaciology (snow and ice)

The snow and ice data center is located at the University of CO (Boulder, CO, 80309). It has listings of many datasets, including satellite film data. A few available reports are briefly listed to give a flavor of what is available:

GD7 (1979): Inventory of snow cover and sea-ice data
GD15 (1984): Workshop on Antarctic Climate Data
GD17 (1985): Marginal ice zone bibliography

12.2 Infoclima (Catalogue of Climate System Datasets),
1989 edition, WMO/TD-No. 293, Geneva

The WMO (World Meteorological Organization) in Geneva includes divisions for both meteorology and hydrology. This data catalog has 507 pages (2.5 cm thick). It includes individual observations and summaries held at various data centers. It lists data centers world-wide. It has dataset descriptions in the categories:

- Upper air data (54 pages).
- Surface climatological data (140 pages).
- Radiation data at the surface (36 pages).
- Maritime and ocean data (50 pages).
- Cryosphere data (14 pages).
- Atmospheric composition data (18 pages).
- Hydrological data (42 pages).
- Historical and proxy data (28 pages).

A total of 920 datasets are listed.Datasets that cover global and regional areas are handled separately from those that include only national data. The catalog may be made available on computer floppy disks in 1990.

12.3. US National Online Data Catalog

An effort was organized by NASA, starting about 1987, to provide a central point where the user community could do an online computer search to help locate datasets (for climate and other disciplines). Various government agencies and research laboratories contribute information about their datasets. This central catalog has descriptions of about 1000 datasets, and listings of various data sources. Contact NSSDC, code 633, Goddard, Greenbelt, MD 20771.
12.4. National Center for Atmospheric Research (NCAR)

The relatively small data center within NCAR has a large archive of over 350 datasets (over 16 trillion bits). The data are from many sources: NMC, NCDC, various countries, ECMWF, USAF, research laboratories, etc. The catalog “Data Availability at NCAR,” 1989, describes the datasets within 24 categories of data. (The data categories include analyses, rawinsondes, ocean data, stratospheric datasets, paleoclimate, clouds, climate models, data received from the USSR, etc.). The publication includes references to catalogs at other centers.

12.5. DOE Carbon Dioxide Information Center

This center at Oak Ridge, TN has a number of datasets relating to the carbon cycle and to climate. These include carbon dioxide measurements, fossil fuel emissions, and the role of oceans (tracers, coral growth, etc.). Many sets of biospheric data are included (carbon in vegetation, FAO land use, changes in soils, carbon in rivers, etc.).

A number of climate and paleoclimate data series are also available (northern hemisphere temperature, 1851 - 1900; central England temperature, 1659 - 1983; worldwide cloud cover, etc.). Some of the paleoclimate series include: Climap data 18,000 years ago; tree ring data bank; dryness/wetness indices in China for the past 500 years.

12.6. National Climatic Data Center and USAF/ETAC

This NOAA center (NCDC) at Asheville, NC gathers the climate observations for the US. It also helps WMO by gathering selected world data such as monthly surface and upper air data, CO₂ flask observations, and atmospheric turbidity for the world. There are many datasets. The most comprehensive summary of data there, is in the Handbook of Applied Meteorology. Also see the INFOCLIMA listings.

The Air Force Data Center (USAF-ETAC) is co-located with NCDC. It has done a fine job of gathering selected world-wide observations. There are many sets of digitized observations that were not prepared elsewhere, especially international data for periods prior to 1965.

12.7 Other Data Information

A book about the Antarctic (van Rooy, 1957) has much information about data and science. Chapter 2 (Sources of Meteorological Data for the Antarctic) includes the number and distribution of ship observations from 1920-1955. Radiosonde observations as early as 1939 are listed on page 173. Monthly surface data, sunshine observations, and cloudiness are also included.

13. REFERENCES


Olsen, Lola M., 1990: “Data Set Availability through NASA’s Climate Data System (NCDS).” NASA/GSFC, Code 634, Greenbelt, MD 20771. 9 pp

Snow Watch ‘85: Glaciological Data, GD-18, WDC-A Glaciology,” University of CO, Boulder, CO, 80309.


DATA FOR HYDROLOGICAL STUDIES

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Abstract. A selection of datasets that are available for hydrological studies will be discussed, primarily precipitation and runoff. Both daily and monthly station data will be considered. This will include Nicholson's set of 1,000 stations with monthly precipitation for Africa, and another global set having 5,300 monthly stations for many years. Precipitation derived from satellite data is discussed. Upper air observations and analyses that can be used for budget studies will also be considered. A selection of data from several of the world's climate models is also available.

1. Introduction

It is often difficult to locate information about data that are needed for research. Several useful datasets are described and sources for much more information are given. First the river data for the US and Canada will be described. Another project will provide discharge data for many rivers in the Soviet Union.

Gridded precipitation datasets are discussed and the best present global dataset of monthly station precipitation data is described. Ocean water temperatures are important for continental precipitation, and are listed. Some scientists want to study the effect of changing climate on water resources; selected climate model data are described. Since time and space do not permit a thorough guide to all useful data, some sources for additional information are given. CD-ROMs are receiving significant use as a way to distribute scientific data. Some information about this technology is included.

*Sponsored by the National Science Foundation.
2. US River Flow From Undisturbed Basins

The USGS is preparing a set of river discharge data for about 1650 rivers that have not been heavily disturbed by dams or water diversions. Therefore they are useful for studies of climate variation and change. The average record length is 40 years and a few sites give more than 100 years of observations; the longest is 115 years. Most sites provide daily data, about 50 rivers only have monthly discharge in this dataset. The data is in three forms on a CD-ROM; one form is simple ASCII files. The area covered is 50 states, Pacific Islands and Puerto Rico. The CD-ROM will be available in the Fall of 1991 from National Water Data Exchange, USGS, 421 National Center, Reston VA 22092. The cost will probably be under $100.

3. US Water Measurement Sites

During the 1980s the U.S. had the following approximate number of sites that measured water data:

- Stream flow (continuous) 7,000 sites
- Stream flow (partial data) 3,500
- River sediment data 1,100
- Surface water quality 3,500
- Lake and reservoir data 1,000
- Ground water levels 34,000
- Ground water quality 8,000

The daily and monthly river discharge data are on magnetic tapes for long periods of record. Other data are also available.

WMO (1977) contains information about the global station density of hydrological data in many countries. The data includes precipitation, stream flow, evaporation, etc.
4. **River Discharge and Water-level Data in Canada**

Canada has long records of daily and monthly river discharge and lake-level data that are available on magnetic tape or CD-ROM. There were 600-900 stations during 1912-1945. The network gradually increased to 3000 sites in 1970 and has been about 3400 since then. In recent years about 2680 sites give river discharge data and 800 give water level for lakes and reservoirs. Sediments are measured at 275 locations. About 2200 (of the 2680) sites now have unregulated flows. Note that 174 unregulated sites have over 40 years of data, 88 over 50 years, and 17 over 60 years (there were 44 stations in 1909). All daily station data and monthly data will be on a CD-ROM made by Canada. It will include the extreme high and low instantaneous flows for each year. A station list is included. The daily data is in binary form. The data can be exported for other use on a PC. Software is available for common displays. Volume III of the CD-ROM is due September 1991. It will contain data for the whole period of record through 1990, and sediment data through 1989. It replaces previous volumes. For information about the CD-ROM, contact: Water Resources Branch, Environment Canada, Ottawa, K1A 0H3. The cost will be reasonable.

5. **US-USSR Exchange of River Data**

Under US-USSR bilateral agreements, each side has expressed the desire to exchange monthly river discharge data for about 450 river gage sites with long records in each country. Activities leading to this exchange started about 1987. Some of the criteria for selecting stations were:

- Choose sites that will measure most of the continental water flowing into oceans.
- Include other sites to give runoff from different regions of the land mass.
- Give data for river gages that are not strongly affected by changes caused by man.
- Include the sites on the UNESCO river list.
- Choose river sites having long records of data, where possible.
There is a good chance that these data will be exchanged during 1992. Stations lists have been prepared.

6. Year-Monthly Stream Flow Data Published by UNESCO

Based on recommendations made by the Coordinated Council of the International Hydrological Decade (IHD), UNESCO made the following publications available: "Discharge of Selected Rivers of the World," Volumes I, II, III. An introductory volume gives a list of 1,000 stream gage stations over the world. The location, general characteristics and period of operation is given for each station.

Volume II lists the discharge data for each year and month from the beginning of record through 1964 for a selection of stations that are most characteristic of the regions and which furnish the oldest and most valid data. NCAR digitized the river data from this UNESCO publication, but not for the US area because that could be obtained from tapes. Without the US, there is data for 66 world rivers in 1930, 80 in 1938 and 98 in 1964.

Volume III gives data after 1964 and has more stations. Part I was published in 1971. Part 4 lists data for 1976-79. NCAR has digitized the data through 1972. The NCAR tape has 267 stations in 1965, increasing to 341 in 1972 (US not included).

The USGS and Australia did similar work to digitize the UNESCO publications. The datasets need to be combined.

7. River Data for Northern and Western Europe; the FRIEND Data

The FRIEND river flow archive contains daily river flow from 1350 catchments with an average record length of just over 20 years (as of April 1991). Most have an area of less than 500 km², and none have been
significantly disturbed by human activities. The record lengths are being extended and more catchments will be added. The data base includes a number of morphological, soil, and land use indices for each catchment. The 13 countries include Scandinavia, UK, France, Germany, and Austria. The data are described by Nigel Arnell in this volume.

8. A CD-ROM for Hydrology in Europe

It is suggested that a CD-ROM be prepared that has rainfall and precipitation data for all of Europe, for many years. A goal might be to include data for approximately 4000 daily precipitation stations and 2500 rivers. Both daily and monthly files could be recorded. A station list would also show the period of record. The hard task of data gathering would need to be a cooperative project, but with one or two central groups to assemble the files; the resulting CD-ROM would be widely available to all groups.

9. River Data for SE Australia

A CD-ROM has monthly river flow data for SE Australia (New South Wales). Prepared in Australia. Additional information is not yet available.

Contact David Malone, Water Data Unit, NSW Water Resources, P.O. Box 3720, Paramatta, NSW, 2150, Australia (Fax +61-2-895-7281).
10. Trends of River Discharge Data

Fifty major rivers of the world were used by Probst and Tardy (1987) to study long trends in river discharge. Only one figure from their paper is presented here, Fig. 1, to hint at the relationship between trends in runoff in different parts of the world.

Figure 1. Comparison between the total runoff fluctuations for the different continents and for the whole world. Five-year moving averages were calculated on standardized data. [From Probst and Tardy, 1987.]
11. Monthly Precipitation for Africa

Monthly precipitation for about 1087 African stations was gathered by Sharon Nicholson. The record often starts about 1900. The typical ending dates in the data at NCAR are about 1972. Updates for at least half of the stations are in other datasets.

12. World Monthly, Land Precipitation Grid

The basic monthly precipitation dataset builds on previous projects by Bradley, Jones, Diaz and Eischeid. It includes data from the NCAR tape with monthly surface data. Initially there were 6699 stations in the basic dataset. To calculate anomalies they needed a common reference period; they chose 1951-70. After demanding that a station had at least 15 years of data during the reference period, they were left with 5359 stations. The stations were individually tested and visually inspected for the presence of spurious trends, jumps and other measurement biases. The final dataset had 5328 stations. An update was made November 1991. There are now over 200 new stations for Mexico. Gaps in other stations have been filled. Now there are 5563 stations. Monthly anomalies were calculated for all stations based on the new data. Station anomaly data within each 4 x 5° grid box were used to calculate an anomaly for each box with data. There are four resulting datasets: (1) the basic monthly observed station data (5563 stations), (2) twelve grids of average monthly precipitation based on station averages for the 1951-70 period. (3) world land anomaly grids for 1851-1981. (4) grids of actual monthly precipitation (not anomalies) for 1951-1989. This monthly dataset (for 40 years) is prepared by analyzing the actual precipitation for each station. As stations start and stop the grid averages may jump. The user can combine #2 and #3 to obtain a more stable set of grids of “real” precipitation. More information is in Eischeid, et al, 1991. Higher resolution grids may be prepared.
These data and grids do not have corrections for the under-catch of precipitation gages. In many areas, data coverage in the 1980s is poor.

13. **Northern Hemisphere Gridded Precip, from USSR** (DS 891.0)

The archive has the following precipitation data:
- Monthly data for 1891-1960 (received in 1987 at NCAR)
- Data for 0-85° North, and 0 to 357.5 East, each 2.5°
- The data give percentage of monthly normal precip at the gridpoints for each month of each year.

The data are given as percentages of multi-year means and are divided by a factor of 10 (for example: 2 corresponds to 20%; 15 means 150% of normal). In constructing the archive, the USSR monitored the precipitation that exceeded permissible limits of variation of 3.5 sigma.

14. **Networks of Station Precipitation**

A WMO meeting was held in 1985 to review the requirements for area-averaged precipitation data (WMO, 1985). It includes figures and tables that summarize the correlation of station precipitation with increasing distance between stations. In one study, it was found that in summer, there was a 32% average daily error in summer area average rainfall for a 250 km box, if only 18 stations were available. With only five stations this became 64%. For monthly average precipitation, the showers tend to average out so that the errors were 9% for 18 stations and 27% for five stations.

15. **Geosynchronous Satellite Data**

Complete satellite datasets are often very high in volume. However, some selections of data are useful for a number of studies. Table 1 shows that
two selections of data from a geosynchronous satellite would require only seven CD-ROMs per year. In the case of the US GOES satellite, about 3500 CD-ROMs per year are needed to save all original data! One selection is a full disk view each three hours that has data from about 60°S to 60°N. The other would have hourly data, and 8 km resolution for a region the size of the United States (48 of the 50 states). A similar subset of data started July 1983 to support cloud research. It has 3-hourly data and samples each 8 km for one set and each 25-30 km for another dataset.

TABLE 1: Options for Geosynchronous Satellite Data on CD-ROMs. Large amounts of data are produced by a geosynchronous satellite. It is possible to sample the data to obtain a useful dataset for hydrology. Information about the US GOES data is given below. Archives such as number 2 below could be prepared for all satellites, with a selection of regions (as in 3).

<table>
<thead>
<tr>
<th>Area</th>
<th>Sample Time</th>
<th>Space Sample</th>
<th>Channel</th>
<th>Volume per Year</th>
<th>CD-ROMs per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All GOES Data</td>
<td>0.5 hour</td>
<td>1 km</td>
<td>2</td>
<td>3500 GB</td>
<td>5400</td>
</tr>
<tr>
<td>2. Full Disk</td>
<td>3.0 hours</td>
<td>25 km</td>
<td>2</td>
<td>1500 MB</td>
<td>2.3</td>
</tr>
<tr>
<td>3. US (10⁷ km²)</td>
<td>1.0 hour</td>
<td>8 km</td>
<td>2</td>
<td>2800 MB</td>
<td>4.3</td>
</tr>
</tbody>
</table>

16. Precipitation Based on Satellite Microwave Data

The SSM/I passive microwave instrument was launched in July 1987. Monthly precipitation for 5° lat-lon boxes has been derived (over oceans) by Alfred Chang at NASA Goddard. The data is part of the Global Precipitation Climatology Project (of the World Climate Research Program). The precipitation rate is almost linear with sensor output; it saturates at very high rates but this fact probably doesn’t affect the output very much. The satellite is in a sun-synchronous orbit, with crossing times near 6 a.m. and 6 p.m. A second satellite has been up since December 1990, but it samples at nearly the same time of day. Monthly data for 5° boxes, 50°S-50°N are available starting August 1987 through mid-1990 (the processing delay time is about nine months). Contact NCAR or CAC for the data.
The algorithm is described in Wilheit, et al, 1990. This paper also describes similar data from the ESMR instrument on Nimbus 5, launched in 1972.

17. Tropical Precipitation Based on Geosynchronous Satellite Data

Five-day and monthly precipitation data exists starting January 1986 for 40°S - 40°N. It is for 2.5° boxes. Five-day periods start on January 1 of each year. It is primarily based on three-hourly data from geosynchronous satellites. The operators of geosynchronous satellites prepare 16-class IR temperature histograms. The precipitation is now assumed to be linearly related to the fraction of clouds colder than a standard temperature threshold. This seems to work rather well for the typical cumulus clouds in the tropics. In a few places the algorithm can get fooled by long sheets of cold stratoform clouds. It can also be fooled by very cold surface temperatures on the Tibetan Plateau in Winter. This is part of the Global Precipitation Climatology Project of WMO. Contact NCAR or CAC for the data.

A paper is available that describes the methods used to prepare precipitation estimates based on a threshold of cloud-top temperature, Janowiak and Arkin, 1991. The resulting precipitation for 1986-89 is displayed and discussed.

18. Monthly Ocean Surface Water Temperatures

Ocean water temperatures often influence precipitation over continental regions. The two datasets that follow give monthly ocean temperature for many years.
19. Long-Term Monthly Global Gridded Temperatures from UK

These data from Jones and Wigley, UK, give global surface temperature anomalies on a 5° grid for January 1854 through April 1990. The NCAR tape of these data includes a 5° world climatology that is used by people who need a full temperature rather than only anomalies.

Over ocean areas the analysis is for sea surface temperature (not air temperature), and is based on COADS statistics. The data for early years include ship bucket corrections. For land areas (continents and islands), surface air temperature anomaly data was analyzed. The data on the tape is anomalies of the water temperature over oceans, and land air temperature data for continents. For grid squares with both land and ocean data, a blend of the two anomalies is given.

Checks for station homogeneity were made by the UK, combined with data adjustments where necessary. The input data includes islands and fixed position weather ship data. The analysis was made as follows: Anomalies for each station were prepared relative to 1951-70. Data for a station was only allowed to affect the closest grid point. A given grid point (5°latitude by 5°longitude) may be influenced by data from more than one station. Grid points were left missing if there was no close data. Previous versions of these data were received by NCAR about 1982 and 1986. NCAR compared the 1990 version of these analyses with the 1986 version for sample years. The earlier data appeared noisy; the newer data are smoother and more plausible. The long-period plots of global means appear the same.

See Jones, et al, in the February 1986 Journal of Climate and Applied Meteorology (JCAM) for a full description and for comparisons with their previous results and with other temperature series. This paper applies to the N. Hemisphere; the S. Hemisphere is discussed in other papers.
20. Sea Surface Temperature Data from CAC

This sea water temperature dataset now includes gridded ocean data for January 1970-June 1990, at NCAR. The files are:

- A SST climatology based on COADS for the years 1950-1970, and an ice climatology. The resolution is 2° latitude by 2° longitude.
- Monthly data based only on in-situ data (from COADS) for January 1970 through 1981. 2° resolution, 40°S-60°N.
- Global blended analyses that use both real-time in-situ data and satellite data. For 1982-June 1990. The data properly blends with ice limits. Presented at 2° resolution.

The year-month SST for the data 1982-on is a blend of satellite and ship data. Dick Reynolds (NMC) says his blend is a distinct improvement over the analyses that only use ship data. When the ship-only analyses are compared with drifting buoys, we see pocks where buoys are. The blended set is OK. Buoys are used to calibrate the methods to derive spot SST data from satellite radiances. A spot SST is available about each 50 km, when clouds permit.

This new dataset with data for 1982-on became available about July 1990. The previous version had troubles near the ice boundaries. For this set, the ice boundaries are known for each year-month, and the water temperature there is assumed to be -1.8° C. The analysis blends smoothly with these edge conditions. The monthly data are presented as anomalies from the climatology.

The smoothing of these analyses is quite strong. The given resolution of the data is 2° latitude by 2° longitude; the equivalent resolution is about 5°. The precision of the data is now xx.xx° C, compared with xx.x° C before.

The daytime SST satellite data are about 1° warmer than night SST in calm clear areas. I noted that this is about what is expected. He lumps day and night spots together in getting SST. There are about three times as many daytime SST spots as night points.
21. Atmospheric Analyses

The main sets of analyses are from major weather centers such as NMC-Washington, ECMWF, and Melbourne. Digital analyses for early years often were a result of special projects such as the IGY. NCAR has one of the more complete archives of various analyses.

One interesting type of hydrological study is moisture budget research where atmospheric winds and moisture are integrated to give the total atmospheric inflow and outflow of moisture for some region of the world. The difference should be precipitation minus evaporation, which is also equal to the runoff. These studies can use a line of rawinsonde stations around the region or analyses. The analyses would potentially be better, but I suspect that the quality of analyzed winds and moisture is only good enough in recent years. Also, data for the 1.5 km-thick boundary layer often has not been archived so that it can readily be used.

22. Data from Climate Models for Increasing Greenhouse Gases

NCAR has data from several of the world’s climate models. The emphasis is to operate a small data center to support assessment studies for the effects of climate change. The datasets include about eight different model experiments for the present climate (1x CO₂) and for a doubling of CO₂ (2x CO₂ ). There are also two transient runs from GISS, one to the year 2062. EPA sponsored this effort (starting in 1987) to prepare data in a common format to support assessment studies of climate changes on crops, forests and rivers. The primary datasets contain 10 to 20 variables (e.g., precipitation, temperature and surface radiation) to support these studies. There are data for 10-year monthly means of 1x and 2x CO₂ climates. For some runs there are data for each individual model month. For one GFDL run, NCAR has daily output for a sample of three years in each of the 1x CO₂ and 2x CO₂ runs. The resolution of most climate models is now about 500 km, so they cannot show the details of climate changes caused by local topography. The model resolution is improving.
23. **Sources of Information About Available Data**

Selected sources of information about data that are available are presented in the sections that follow. Some indication of the types of information that can be found within each of these major sources is also included.


The WMO (World Meteorological Organization) in Geneva includes divisions for both meteorology and hydrology. This data catalog, WMO 1989, has 507 pages (2.5 cm thick). It includes individual observations and summaries held at various data centers. It lists data centers world-wide. It has dataset descriptions in the categories:

- Upper air data (54 pages).
- Surface climatological data (140 pages).
- Radiation data at the surface (36 pages).
- Maritime and ocean data (50 pages).
- Cryosphere data (14 pages).
- Atmospheric composition data (18 pages).
- Hydrological data (42 pages).
- Historical and proxy data (28 pages).

A total of 920 datasets are listed. Datasets that cover global and regional areas are handled separately from those that include only national data. The catalog may be made available on computer floppy disks in 1991.

25. **National Center for Atmospheric Research (NCAR)**

The relatively small data center within NCAR has a large archive of over 380 datasets (over 16 trillion bits). The data are from many sources: NMC, NCDC, various countries, ECMWF, USAF, Navy, and research laboratories.
The catalog "Data Availability at NCAR," Jenne 1989, describes the datasets within 24 categories of data. (The data categories include analyses, rawinsondes, ocean data, stratospheric datasets, paleoclimate, clouds, climate models, data received from the USSR, etc.). The publication includes references to data catalogs at other centers. Earlier data is reviewed in more detail in Jenne, 1975.

26. Gathering Water Data

Global datasets of precipitation and runoff data are needed for some studies. Data such as solar radiation are also needed for the surface energy budget. One strategy is to make certain that good data is available, at least for the countries that have large land areas, plus islands. Thus, if there is data for Canada, US, Brazil, Argentina, Greenland, USSR, China, India, and Australia, a considerable amount of the earth’s land area is covered. This doesn’t solve the problem, but is gives a start without having to initially work with all countries. It also leaves out Africa. WMO projects, and regional projects are still needed to achieve a complete dataset.

In Jenne, 1989, I discussed a proposed database for Europe. Under this concept, a subset of available data would be gathered together from all countries in Europe. Different laboratories would gather different types of data so that one large data center did not have to be formed.

Leading up to the FGGE global weather year, 1979, it was recognized that types of data in addition to meteorological surface synoptic reports and rawinsonde data were needed. A WMO meeting at GFDL was held about 1976 that led to the gathering of reports called IIc data that included daily precipitation and river discharge. The present work to gather world discharge data and precipitation data in Germany is helping to meet research needs. The Global Runoff Data Centre is located in Koblenz, Germany.
27. Information about Other Data

There are a number of documents that contain information about data sources. NCAR maintains an overview of this information; three more detailed papers are Jenne, 1989 and Jenne, 1990 and 1991.

28. New Analyses of Past Atmospheric Conditions

The existing daily atmospheric analyses for the period 1950-present are not of sufficient quality to permit the type of climate studies we need. There are several reasons for this: (1) there were many changes of analysis procedures, (2) much of the observed data did not reach the operational centers, and (3) the methods used were not good enough. For example, it is only since about 1986-88 that the ocean surface-wind analyses have been good enough to drive ocean models.

As early as 1985 there were discussions about the possibility of making reanalyses that would help achieve the goals of the TOGA Experiment (Tropical Ocean, Global Atmosphere). Shukla helped to push this option. Some efforts to argue for a reanalysis project can be traced to as early as about 1982. From 1987-91 there has been an increasing interest in making daily reanalyses of the global atmosphere. The data assimilation methods used to analyze the state of the atmosphere have shown major advances during the 1985-90 period. A forecast is a part of these methods; therefore, the analyses improve when the forecast model is improved and when the methods improve. There have been large advances in the capability of forecast models and analysis methods.

Bengtsson and Shukla (1988) published a paper that helped to start the movement toward planning for re-analyses. In early 1989 a small workshop was held to consider the initiative of making reanalyses (Kinter and Shukla, 1989). There has been a clear interest in analyzing the period 1979-90 starting with two years in the 1980s as a pilot project. Now there is a NMC/NCAR project to reanalyze the whole period from 1958-on. There
were very few Antarctic observations prior to 1956. Therefore, if we go back farther in time, data will not be available to help the analysis in some regions.

The archives from reanalyses will contain data each six hours. There will be the normal fields such as temperature, humidity and winds. Boundary layer analyses will be archived. Many diagnostic fields such as precipitation, evaporation and surface radiation fluxes will also be available.

29. Use of CD-ROM and Tape Technologies to Distribute Data

The first CD-ROMs with data for the geosciences were produced in mid-1987. Now a flood of them, are being prepared. A CD-ROM holds about 660 MB, compared to 125 on a high-density half-inch tape. The access time to any part of the disk is about 0.5 seconds. A reader costs about $400-700. The 4 mm digital audio tape drives (DAT) can now be purchased for about $2,000. We hope that the price will come down to $900-1,200 in one or two years. These small tapes hold 1300 MB of data. Exabyte tape drives hold more data than a DAT tape, have a faster data rate and cost as little as $2,400-3,500.

When a CD-ROM is received, software to access the data on a PC is also provided. Some simple browse displays are often included. A list of primary CD-ROMs for several discipline areas is available from NCAR (Jenne, 1991). This includes information about some of the commercial CD-ROMs, and where to find several additional catalogs.

30. References

Janowiak, JE, Arkin, PA (1991) Rainfall variations in the tropics during 1986-89, as estimated from observations of cloud-top temperature. JGR


(1989) Data availability at NCAR. NCAR PO Box 3000 Boulder CO 80307:45 pp (updated each 15-20 months)


(1991) Data available on CD-ROMs. This will be an NCAR TN, Boulder, CO. 80 pp

Kinter J, Shukla J (1989) Reanalysis for TOGA. Panel meeting Univ. of MD College Park MD 20742


(1977) Statistical information on activities in operational hydrology. WMO No. 464, Geneva (includes numbers of observing stations by country for rainfall, evaporation, stream flow, etc.)

(1985 Review of requirements for area-averaged precipitation data, surface-based and space-based estimation techniques, space and time sampling, accuracy and error; data exchange. WCP-100, Geneva: 70 pp.
Figure 2: Change of US annual precipitation as given by five climate models. The numbers given are the precipitation in 2x CO2 climate divided by the 1x control run. For example, 1.17 means 17% more precipitation in the double CO2 climate.
Figure 3: Simulation of African annual precipitation by five models compared with climatology. Example: 1.15 means that the model simulates 15% more precipitation for the present than is given by climatology. The upper left chart is the present climatology.