World Surface Pressure Data; Obs and Grids

- Collections of monthly surface weather station data
- NCAR has daily N. Hem SLP grids for 1899-on
- List of surface air pressure data (Aug 1995)
- List of datasets with surface weather obs that are going into reanalysis
- Long records of temperature and pressure data
- Analysis for S. Hemisphere, 1951-on
- Pressure data at NCAR

Ready to scan May 27, 2004 (62 p), RJ 0356

May 27, 2004
Roy Jenne
World Surface Pressure Data; Obs and Grids

Roy Jenne
May 26, 2004

1. Collections of monthly surface weather station data (Jenne and Spangler, 2002, 3p)
2. A discussion with Phil Jones
   - Our questions, his answers
3. Baker in UK wants a dataset list
5. My list of surface air pressure data
   - Oct 1992 version
   - Update Aug 1995 (See this 1995 version)
6. List of datasets of surface weather obs for reanalysis
   - Summary of world weather records books (Monthly data, Spangler)
8. Status of surface pressure data (Oct 1999)
9. Long records of temperature and pressure data (July 1999)
   - 11 stations in Europe are listed and 14 other stations in N. Hemisphere. Five start in
     1700’s. for temperature, a bit later for pressure
   - Also show some long stations in NCAR files.
10. Three long stations
    - Iceland starts Jan 1821
    - Gibraltar starts Jul 1821
    - Azores start Jan 1865
11. Grid pressure and station pressure (Jenne, 1971)
13. Analysis for S. Hemis 1951-on
14. Some papers about SLP data
   - Title pages of 4 research papers
15. Pressure data at NCAR (Jenne, Mar 2002)
16. Examine the N. Hem SLP dataset
17. Antarctic SLP (Reconstruction back to 1957), Jones and Wigley
18. Daily and monthly SLP grids, 1899-on (Jenne, 1983)
   - Examine the N. Hem SLP dataset (in previous paper P51)
19. Eddy statistics in S Hem at 500 mb (Tiedtke)
Collections of Monthly Surface Weather Station Data

Roy Jenne
Will Spangler
NCAR
July 2002

During 1970 – 2000, there has been an increasing interest in climate issues. We certainly need good records of observed monthly surface data that can be used to monitor the climate. One of the problems with certain present datasets is that they do not have enough data for the recent 10 or 15 years. The data needs to be gathered more quickly. We will now describe some of the main datasets that are available.

1. World Monthly Surface Station Climatological Data (WMSSC)
   This dataset was developed by NCAR, based on various inputs. There is a text. The monthly reports generally have data for pressure, temperature, and precipitation. Since they have pressure, these reports are often from the larger reporting stations (that have pressure gages), and which have better communication methods. The monthly reports flow into Asheville from the world, and NCAR obtains an update each year. Asheville puts the data into a publication, “Monthly Climatic Data for the World.” In recent years, Asheville (NCDC) puts it on ftp on the Web. NCAR also has WMSSC on the Web. Some of these stations used in WMSSC have moved too much and may suffer from city heat island effects. But they have the advantage that they are received quickly.

   For the US, the best stations to use for climate trends are a subset of 1200 co-op stations that measure, temp, precip, and snow. These stations are not in WMSSC.

2. Monthly Data from the World Weather Record Books (WWR)
   Each decade, NCDC has gathered monthly data from stations around the world. They are printed in six books for the world, by continents, etc. By the time the books are printed, the most recent data is about 7 or 8 years old. For the selection of stations for WWR, they try to select stations with fewer effects from station moves and city effects, if they can. Thus these stations are somewhat different from the stations that get into the “Monthly Climatic Data for the World” dataset, and onto NCAR’s WMSSC tapes.

   About 1970, Wolbach (from Harvard College Observatory) paid Asheville a lot ($30,000) to key-enter the data from the early WWR books. He kindly gave NCAR a copy and that was put into WMSSC to give old data. NCAR has digital datasets from NCDC for the books from the decades 1961-70, 1971-80, and 1981-90. These data are on the mass store and online. The latter decades are not merged into WMSSC. The reason is that the selection of stations for one city may be different in the two sets, making the merge hard and somewhat dangerous. For the 1961-70 decade, we did merge some of this data into WMSSC (all but Asia and Africa).

3. US Historical Station Climatic Net (HCN)
   NCDC and the US state climatologists selected about 1200 cooperative stations from the US with long and “best” records. These stations are not in WMSSC. These data can give the best information on trends of temp and precip over the USA.
   - NCAR has the HCN data for 1880 – 12/1994 (1221 stations). It needs an update from NCDC.
   - The daily data for these stations are also available from NCDC or from NCAR.
   - Info on updates: CDIAC at Oak Ridge has this data through 12/1994 and NCAR has this (Vsn 3).
   - NCDC has a beta test version that includes data as in CDIAC through 1994, but it has data through 2000 in a different format (as of 07/2002). The newer data has not been through the added QC done by CDIAC. NCAR got these data through 1997 in year 2000.

   4) Still latest version in June 2003
4. The “DOE” Tapes
Some groups got Department of Energy funds and gathered more monthly surface station data. People first got the data on NCAR’s WMSSC tape. Then they added more data that they gathered. Then another group was able to add more data, so this process led to newer versions of the DOE tape.

There was one “DOE” tape for monthly temperature data and another for precipitation from stations. There was not a “pressure” tape.

NCAR will soon have a version of the “DOE” tapes that we sometimes call the Eischedt tapes (a person in a NOAA group in Boulder, CO).

5. Monthly Surface Data for Climate Trends in Some Countries
Document RJ0156 has some information about monthly data in selected countries. It is mainly about daily data, but there is also information about monthly data. It has information about projects in SE Asia, Canada, Australia, New Zealand, China, etc.

6. The Global Historical Climatic Data (GHCN) by NCDC
About 7 or 8 years ago, NCDC started to prepare a merged version of the global surface monthly data. During about 2000 – on, I have been told that this set seems to have as much data as is on the DOE tapes.

NCAR has two versions of this GHCN that have data for 1701 – 1990. This data has:

- 6039 Stations with temperature
- 7533 Precip stations
- 1883 Sea level pressure stations
- 1873 Stations with pressure at station elevation (surface pressure)

7. An Historical Note
The calculation of trends of temperature over the earth’s land surface has been done using these datasets above. The trends in temperature over the ocean are based on surface water temperature using the COADS ship and buoy dataset (from ~1850) plus satellite information since 1981.

We need to make certain that the trend data is based on the most reliable stations possible. Also, some of the data needs to be gathered faster! There is more work to be done!

8. The Phil Jones Global Surface Temperature Trends Data
Phil Jones helps to gather some of the monthly surface temperature data that gets into the “DOE” tapes. Each year he prepares a 5° lat-lon grid. The temperature over land is a monthly surface air temperature based on the monthly station data. This is temperature about 1.5 m above the ground. The temperature grid data over the ocean is prepared by the Hadley Centre in the UK. Over the ocean it is possible to prepare a fairly consistent set of sea surface water temperature (SST) trend data, so SST is used for the global grids (not air temp over the ocean).

- The Phil Jones monthly temperature grids at NCAR are now for years ____________.
- The NCAR Web points to the Phil Jones Web site for more recent data.
- NCAR has an early version of monthly station data used by Phil Jones. We got it in 1985.
- Phil Jones has gathered more data. See his message of __________ (2002).
Phil Jones monthly obs data
- See next page

- Get file of Phil's obs data that went into the global temperature grids

- Best to have 2 data files available
  - The basic monthly files w/o the homew words
  - The same stations after the homew work

Questions for Phil

- How big a problem is it to get recent updates of data?
  - How many stations are there each year during the past 15 years? Do the counts drop off a bit?

- What data do you use for the USA?
  - The best data source for the US for trends would be a set of 600 or 700 stations from the Coop set of 1200 US HCN (Historical clim net) stations

- Want copy of paper

See next page

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Telephone +44 (0) 1603 592090
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Email p.jones@uea.ac.uk
Dear Will,

Thanks for the congrats.

In response to your questions.

1. For temperature it is monthly, and updated grids go on to our web site. This is all done in conjunction with the Hadley Centre, who do the SSTs/NMATs and we do the land stations. (see other sources).

   For MSLP, we use the same sources (CLIMAT and MCDW mainly) but only do it every few months. I add the data in monthly, but I spend some time looking for missing data. For MSLP, we are only updating the SH stations and this also requires emailing to get some stations (mainly NZ controlled) which don’t report over CLIMAT.

   For the NH, the Met Office update the daily and monthly, 5 lat by 10 long gridded MSLP poleward of 15N, in real time. We get files from them fairly regularly. We are generally happy to give people the gridded files (subject to the MO agreeing) but don’t advertise this on the web site like we do for temperatures.

2. I have a new update paper for temperature tentatively accepted by J. Climate. This includes a whole lot of additional stations from GHCN and your file we got in Oct 99 and the CLIMAT/MCDW data for the recent few years.

   The paper uses a lot of other sources though. These include data we’ve received from countries around the world (some unlikely ones like Iran) but also homogenised datasets put together by countries/regions (all of Canada, Fennoscandia, Austria and Australia). All these were considered better than what we had so replaced what we had. These sort of data represent an issue for you. They are better but they are not the original measurements. GHCN have this problem also, but they have several different versions of 'measured' temperature for many sites. Will you want to include 'homogenised' data? Also only some of the variables get this treatment, mainly temp and precip.

   I also add in a lot of Antarctic data which comes directly from the station by email (eg South Pole every month) or from contacts with Antarctic Institutes like BAS and the Russian one in St. Petersburg. The latter have much of their monthly data on the web, by the way.

   CLIMAT reports are not great from Antarctica. South Pole never appears on it.

Hope this is of some help. I can send the paper if you want. The text has much more on the issue of updating and sources.

I have a question. Do you include the additional variables that have come in on the new CLIMAT code since Nov 1994? Thinking here of max/min monthly average temps.

cheers,

Phil Jones
Date: Tue, 27 Sep 94 22:37:21 BST
To: jenne@ncar.ucar.edu
From: Richard Baker <rb00hp@harpt.demon.co.uk>
Subject: Global max-Min Temperature Datasets

Dear Roy,

I much enjoyed meeting you in Norwich. I'm not sure whether we properly introduced each other but I was the bearded person who shared minibus rides with you to and from the hotel! I trust you had a safe journey home.

After the meeting, I had another look at the NCAR dataset list you circulated and wished I had asked you more about the global daily & monthly datasets you keep. I have managed to communicate with your WWW server and obtained some more information but I still have some questions. I hope you don't mind my asking you directly.

We would like to map accumulated temperatures on an European and global scale. Ideally, we would like to show not only what happens in average conditions, e.g. over a 30 year period, but also the range, e.g. in very hot summers such as 1976 and 1990 in Europe.

However, most global and European datasets concentrate on long term monthly temperature means and even with monthly maxima and minima it is difficult to calculate accumulated temperatures accurately.

Ideally this should be done from daily data. I am therefore intrigued to know whether the NCAR global dataset (ds512.0?) would be available for such a study. I can fully appreciate that the data set is very large and that it would be costly to send on tape. Is it available by ftp? Can its size be minimised by only requesting maximum and minimum temperatures, or only stations for Europe or only stations for a specific time period?

I would be very grateful indeed if you could give me details of availability and possible options for data transfer and costs.

I would also be very interested if you know of any other attempt to calculate current or predict future accumulated temperatures on a global or regional scale.

With best wishes and many thanks in advance,

Yours sincerely,

Richard Baker

(To reply please use rb00hp@harpt.demon.co.uk and not rb00hp@harpm!)

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NORTHERN HEMISPHERE MONTHLY AND ANNUAL MEAN-SEA-LEVEL PRESSURE DISTRIBUTION FOR 1951-66, AND CHANGES OF PRESSURE AND TEMPERATURE COMPARED WITH THOSE OF 1900-39

BY

H. H. LAMB, M.A., P. COLLISON, B.Sc., and R. A. S. RATCLIFFE, M.A.
NORTHERN HEMISPHERE MONTHLY AND ANNUAL MEAN-SEA-LEVEL PRESSURE DISTRIBUTION FOR 1951–66, AND CHANGES OF PRESSURE AND TEMPERATURE COMPARED WITH THOSE OF 1900–39

SUMMARY

Monthly average mean-sea-level pressure charts are produced for the period 1951–66 together with an annual average, and each of these average charts is compared with the corresponding chart for the period 1900–39. Charts showing how the monthly average temperature over Europe has changed between the two epochs are also included.

The principal change apparent in sea-level pressure since 1939 is the expansion and intensification of the polar high-pressure régime (especially in winter) and a corresponding weakening and southward displacement of the pressure gradient which produces the common westerly winds in middle latitudes. Comparison with data for 1968 and 1969 shows that these changes were still continuing at that time.

Changes in the level of monthly average temperature over much of Europe reflect the pressure changes; there is clear evidence that winters (particularly January and February) have been colder in the more recent period and there are smaller but interesting changes in other months.

1 – INTRODUCTION

For many years the most reliable set of average pressure charts with which to compare the situation observed in any individual month or year were 40-year average monthly mean-sea-level pressure charts derived from the U.S. Historical Daily Weather Maps series covering the years 1900–39, particularly the version produced in the Meteorological Institute of the Free University of Berlin which incorporated a judicious adjustment of the values over the regions near the North Pole in the light of experience that the original daily charts were biased by a faulty presupposition of a more or less permanent polar anticyclone. The Berlin charts, slightly modified in a few areas to include some extra station reports, were used for many years in climatological and long-range forecasting research in the Meteorological Office as a datum from which to measure the departures or anomalies observed in any given year. It is this Berlin series which has been used here for comparison with the 1951–66 period.

The period 1900–39, though chosen by an accident of history (that it was the first period of any such length for which daily charts covering the northern hemisphere had been fully and carefully analysed), had special characteristics which made it an unusually convenient datum from which to measure deviations. For some purposes it may always remain the most convenient datum. This is because it was marked by the most sustained vigour of the general atmospheric circulation, and generally highest values of the zonal indices and mean pressure differences \( P_m \) measured across most of the world's prevailing windstreams, of any period for which observations are available: see, for example, the trend curves illustrated in Lamb reproduced here as Figure 1 and the graphs, maps and tabulated values in Lamb and Johnson. It was also an unusually homogeneous period, as shown for instance by a frequency, indeed a preponderance, of general westerly-type situations over the British Isles (and, according to some investigators, over the whole northern hemisphere) unparalleled within the last 100 years (and probably for very much longer than that). Deviations from this 1900–39 standard are therefore simple to interpret as (a) exceptionally strong development of the zonal circulation, (b) displacements of the zonal circulation to higher or lower latitudes, (c) weaker circulations, or (d) more meridional circulations of various types.

* The superscript figures refer to the Bibliography on page 36.
By the same tokens, however, the 1900–39 pressure distribution was quite wrongly called 'normal' and is very inconvenient for purposes of describing (especially to the layman or the general public) departures from what appears normal and familiar in other climatic periods.

Since about 1950 there has been a marked (and, up to the late 1960s at least, increasing) reversion to weaker, more meridional and more diverse, circulation patterns. Blocking anticyclones in the higher latitudes have been more frequent and have occurred in a great variety of positions, as is characteristic of the weaker, less zonal circulations. There have been far more anticyclones over Greenland, north-eastern Canada and the sea areas near Iceland in the recent period. Correspondingly conditions south of 50°N have been less anticyclonic than in 1900–39, and rainfall in the Azores has increased (at Ponta Delgada by 36 per cent when 1941–60 annual totals are compared with 1894–1940). Available evidence suggests that these patterns resemble the behaviour of the circulation at various times in the nineteenth century more than that at any time between 1900 and 1940. The frequency of Westerly-type situations over the British Isles, which averaged 101 days/year for 1900–39 (and 100 days/year for 1900–49), fell by the 1960s to lower values than at any time since 1860 (see Figure 2).

Table 1 shows the frequencies decade by decade of the seven types recognized in Lamb's classification of the daily isobaric patterns over the British Isles since 1861; it is seen that the fall off in frequency of Westerly situations from 1950 onwards has been compensated by higher frequencies than before of Northerly, Easterly and Cyclonic types. After

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<thead>
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<th>W</th>
<th>NW</th>
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<th>Anticyclonic</th>
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<td>number of days per year</td>
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<td>1861–69</td>
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<td>1890–99</td>
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<td>1900–09</td>
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<td>1910–19</td>
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<td>1920–29</td>
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<td>1930–39</td>
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<td>1940–49</td>
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<td>19</td>
<td>30</td>
<td>34</td>
<td>31</td>
<td>84</td>
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</table>

*Defined by Lamb.7

allowing for the fact that the weather of successive days is usually correlated, a chi-square test applied to Table I shows that there was a significant excess of Westerly types in the 1920s. The only assumption made in this test is that the last 11 decades are a representative sample of British climate; the significant level of the abnormalities in the 1920s and 1960s reaches the 1 per cent level. With a 15 per cent decline (20 per cent in the 1960s) in the frequency of Westerly situations it has clearly become desirable to use charts of the period since 1950 to...
FIGURE 1. SELECTED INDICATORS OF THE STRENGTH OF THE MAIN CURRENTS OF THE ZONAL WIND CIRCULATION

- 10-year means plotted against the middle of the period covered at 5-year intervals. Broken lines indicate unreliable information.

FIGURE 2. NUMBER OF DAYS OF GENERALLY WESTERLY TYPE IN THE BRITISH ISLES EACH YEAR

- 10-year means, plotted at 5-year intervals. \[\text{yearly frequency.}\]
FIGURE 18(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, JANUARY.

FIGURE 19(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, FEBRUARY

FIGURE 20(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, MARCH

FIGURE 20(b). DIFFERENCE OF AVERAGE MONTHLY TEMPERATURE 1951–66 MINUS 1900–39, MARCH
FIGURE 22(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, MAY

FIGURE 22(b). DIFFERENCE OF AVERAGE MONTHLY TEMPERATURE 1951–66 MINUS 1900–39, MAY
FIGURE 24(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, JULY

FIGURE 24(b). DIFFERENCE OF AVERAGE MONTHLY TEMPERATURE 1951–66 MINUS 1900–39, JULY
FIGURE 27(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, OCTOBER

FIGURE 27(b). DIFFERENCE OF AVERAGE MONTHLY TEMPERATURE 1951–66 MINUS 1900–39, OCTOBER
FIGURE 28(a). DIFFERENCE OF AVERAGE MONTHLY PRESSURE 1951–66 MINUS 1900–39, NOVEMBER

FIGURE 28(b). DIFFERENCE OF AVERAGE MONTHLY TEMPERATURE 1951–66 MINUS 1900–39, NOVEMBER
(a) Averaged over all longitudes

(b) Averaged over the Atlantic sector 0° to 50°W

FIGURE 30. LATITUDE MEANS OF SEA-LEVEL PRESSURE CHANGE 1951-66 MINUS 1900-39

AVERAGED MONTH BY MONTH WITH YEARLY AVERAGE
FIGURE 31. GENERAL TRENDS OF MONTHLY AVERAGE TEMPERATURE MONTH BY MONTH AT SELECTED STATIONS 1951–66 MINUS 1900–39
FIGURE 32. ANOMALIES OF 5-YEAR RUNNING MEANS OF TEMPERATURE FROM 1900–39 AVERAGES AT HELSINKI FOR EACH SEASON PLOTTED AT MIDDLE YEAR OF PERIOD COVERED.
FIGURE 33. ANOMALIES OF 5-YEAR RUNNING MEANS OF TEMPERATURE FROM 1900-39 AVERAGES OVER CENTRAL ENGLAND FOR EACH SEASON PLOTTED AT MIDDLE YEAR OF PERIOD COVERED
My list of Surface Air Pressure Data

1) One list is dated 28 Oct 1992. It has items 1-10 (you can ignore this one).


Roy Hanna
May 2004

Side subject

TD13 has 100,000,000 obs of RFC synop data for early years (1901-1971)

See the docs:
RJ0335 "TD13; Early world surface synop, mostly 1929-1971" (33p)
RJ0323 "RF synop data coverage up to 1901-1980" (37p)
From psmsl@unixa.nerc-bidston.ac.uk Wed Aug 16 04:14:23 1995
From: psmsl@unixa.nerc-bidston.ac.uk (Phil Woodworth)
Date: Wed, 16 Aug 95 11:14:14 +0100
Subject: air pressure advice

I would like advice on how to update this information and I mailed
Dr. Jenne a few weeks ago without reply, but Phil Jones told me that he
may be near retiring(?). Anyhow, I wonder if you or someone could
read it through and if necessary add/correct anything? This information
is used by many people studying mean sea level changes and it would
be much appreciated.

Best wishes Philip Woodworth (Director Permanent Service for Mean
Sea Level)

Dr. Jenne's file from 1992 follows:

(a) Information from Roy Jenne on datasets available from NCAR
and other places (28 October 1992).

Summary of Available Sea Level Pressure Grid Data

This text summarizes the basic SLP grid point data that are
available. Other datasets have the basic observations from ocean
areas, land areas, and ice caps.

1. Northern Hemisphere Daily (and Monthly) SLP, 1899-on

The data came from several sources including the U.S. Navy.

but often don't. Another possibility would be to derive a SLP that has
horizontal pressure gradients consistent with those at the elevated surface.

PSMSL, Bidston Observatory, Birkenhead, Merseyside L43 7RA, U.K.
Tel: +44 - 151 - 653 8633 Fax: 653 6269 Internet: psmsl@pol.ac.uk
============================================================================
Summary of Available Sea Level Pressure Grid Data

This text summarizes the basic SLP grid point data that are available. Other datasets have the basic observations from ocean areas, land areas, and ice caps.

1. Northern Hemisphere Daily (and Monthly) SLP, 1899-on

The data came from several sources including the U.S. Navy. In the last 20 years we have tried to select sources that avoid most problems. A list of sources used is available.

The basic monthly grids are derived from the daily grids, but there is a tape by Trenberth where a few corrections have been applied to the basic monthly grids.

2. NMC Daily Global Analyses

SLP is okay from the start date 1 Jul 1976. Wind grids are bad in the tropics until Sep 1978.

3. Southern Hemisphere Daily SLP Grids for:

a. IGY, Jun 1957 - Dec 1958; all Southern Hemisphere data is from South Africa. The quality is very good.

b. 60-210E, 1957-1978, from New Zealand. The data were based on NZ operational analyses, and then adjusted to account for information in later data taken up to 24 hours beyond analysis time. We think that the quality should be almost as good as for the IGY grids, except on the Western edge.

c. Southern Hemisphere, Apr 1972-on, from Australia. Australia used satellite cloud pictures to help position fronts.

d. Southern Hemisphere, 1974-on, from the U.S. Navy

e. Southern Hemisphere, Jan 1950 - May 1957, daily grids from South Africa. The quality is poor in some areas, especially the S E Pacific.

4. COADS Yr-Mo SLP Statistics

Data is for 2-degree boxes, for many years. When analyses exist, they should be better than these statistics. The number of samples in a box is often too small for a stable mean.

5. Northern Hemisphere Daily SLP Data from the USSR (in 1987)

This data is for a 5 x 10 grid, 1880-1979, and is on 4 tapes.

Note: Consider the monthly SLP data that started 1880; I think that it has become confused whether the original source was the UK or Russia. In any case, the 1899-on data in item No. 1 is different, and it is from U.S. sources.

6. Reanalysis Data

There is an NMC/NCAR project to reanalyze the whole atmosphere (and ocean) each 6 hours, from 1958-on. See Bull AMS, Dec 1991. This would produce atmospheric analyses, SLP, 10m winds, and ocean flux terms (radiation, heat, etc.) We are now working hard to prepare mountains of data. Maybe the analysis can start Sep 1993.
7. Climatology

We have good monthly world SLP means and 5-degree grids based on all data up to about 1960 or 1965. These data should be good, even in parts of the Southern oceans, where the data is thin to define yr-mo means.

8. Southern Hemisphere Monthly SLP

Phil Jones wrote a paper which is published in the Journal of Climate, Dec 1988, where he used monthly gridded data to determine patterns of SLP. This information was then used with the available older station data to try to determine the best monthly analyses (S. Hemisphere) for the whole period back to 1957. Another paper went back to 1911, but this is on shaky ground (International Journal of Climate, Vol II, P585-607, 1991).

9. Conservation of Atmosphere Mass

We need some more comparisons between the various SLP datasets. We should prepare RMS differences of SLP between some key datasets over remote areas. The total mass of dry air in the atmosphere should be very close to constant. Global water vapor can vary some from month to month, but it isn’t a large term. Global analyses of SLP can be evaluated to see if mass is conserved (a calculated surface pressure is actually used). Trenberth did some work on this (JGR, D12, Dec 20, 1987).

10. Sea Level Pressure and Surface Pressure

A station pressure is always what is measured and that is some height above sea level. To calculate a sea level pressure, some assumption must be made for the temperature of the fake air column between the surface and sea level. Over the oceans and for low elevations, this is no problem. For high elevations, and especially for sharp cold air surface inversions, it is a problem. Rules were developed so that land stations can calculate a fairly reasonable SLP. Therefore, the best gridded SLP has often been obtained by using the reported station SLP in the analyses.

For the past 15 years or so, the main analysis schemes do not use SLP from most land stations; they define a model surface elevation and analyze for surface pressure at that height. This is actually the best thing to do because it involves using information that is measured rather than guesses about fake air temperatures underground. The only problem has been that when the centers do derive a sea level pressure, they often have not taken enough care to estimate a reasonable mean temperature. They could do this better than an observer at a station can, but often don’t. Another possibility would be to derive a SLP that has horizontal pressure gradients consistent with those at the elevated surface.

- End -

27

-2-
March 1994

Date: Fri, 25 Mar 94 10:23:06 GMT
To: olivia@niwot.scd.ucar.EDU (Olivia Bortfeld)
From: Philip Woodworth <plw@unixa.nerc-bidston.ac.uk>
Via: subnode.uk.ac.nerc-bidston.unixa (bisan); Fri, 25 Mar 94 10:25:47 GMT
Subject: Re: help with air pressures

Roy - a year or two ago you were kind enough to fill me in on the availability of air pressure fields.

My immediate problem is that I am studying sea level changes at Ascension and St.Helena Islands in the tropical Atlantic for 1983-1993 and would like corresponding air pressure data. Now, I have 1987-present 6 hourly data from Ascension from the UK Met Office and will have 6 hourly data for St.H for the whole period. So, the problem is getting data for 1983-1986 at Ascension.

I am very surprised that no-one has such data. It includes the period after the Falklands War when the Ascension airfield was used intensively. Also I have monthly means from CDIAC up to 1980 which implies that other months/ies exist later, as many of their records stop in 1980.

Can you help, either by pointing me at station data for 83-86, or failing like can I use analysed fields for the period, and some overlap period 87-on so I can test if the fields are ok? I recalled that you said that there were NMC daily analyses on gridded fields and that there is a NMC/NCAR project to redo all fields for 1958 on.

Please forgive me if this is being directed at the wrong office. If so I'd be grateful if you have any ideas whom I could ask.

Best wishes and many thanks again.

Philip Woodworth

Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, U.K. Tel: +44 - 51 - 653 8633 Fax: 653 6269
Internet: plw@pol.ac.uk Omnet: POL.BIDSTON

====================================================================================================
Date: Wed, 26 Jul 95 14:55:56 +0100  
From: plw@unixa.nerc-bidston.ac.uk (Philip Woodworth)
To: jenne@ncar.ucar.edu
Subject: air pressure data

Dr. Jenne -

a few years ago I assembled a file of information on the availability of air pressure data, especially monthly means to correspond to the PSMSL MSL dataset. I enclose the bit I have from you below. Would it be possible to check if it is still valid, or put me onto someone who can?

Many thanks for any help.
Philip Woodworth

(a) Information from Roy Jenne on datasets available from NCAR and other places (28 October 1992).


This text summarizes the basic SLP grid point data that are available. Other datasets have the basic observations from ocean areas, land areas, and ice caps. The text now also includes a little information about station data.

1.1 Northern Hemisphere Daily (and Monthly) SLP, 1899-on

The data came from several sources including the U.S. Navy. The data are based on U.S. weather service maps until around 1960. In the last 20 years we have tried to select sources that avoid most problems. A list of sources used is available.

The basic monthly grids are derived from the daily grids, but there is a tape by Trenberth where a few corrections have been applied to the basic monthly grids.

2. NMC Daily Global Analyses

SLP is okay from the start date 1 Jul 1976. Wind grids are bad in the tropics until Sep 1978.

Note: We updated the 1992 text in Aug 1995

- Woodworth sent the message in Jul 95 - probably with the 1992 text
- He sent it again in 16 Aug 1995
- The text given here has the start of his July 95 message plus then out NCAR Aug 95 update - Roy Jenne
Summary of Available Sea Level Pressure Grid Data

This text summarizes the basic SLP grid point data that are available. Other datasets have the basic observations from ocean areas, land areas, and ice caps. The text now also includes a little information about station data.

1. **Northern Hemisphere Daily (and Monthly) SLP, 1899-on**

   The data came from several sources including the U.S. Navy. The data are based on U.S. weather service maps until around 1960. In the last 20 years we have tried to select sources that avoid most problems. A list of sources used is available.

   The basic monthly grids are derived from the daily grids, but there is a tape by Trenberth where a few corrections have been applied to the basic monthly grids.

2. **NMC Daily Global Analyses**

   SLP is okay from the start date 1 Jul 1976. Wind grids are bad in the tropics until Sep 1978.

3. **Southern Hemisphere Daily SLP Grids for:**

   a. **IGY, Jun 1957 - Dec 1958;** all Southern Hemisphere data is from South Africa. The quality is very good.

   b. **60-210E, 1957-1978, from New Zealand.** The data were based on NZ operational analyses, and then adjusted to account for information in later data taken up to 24 hours beyond analysis time. We think that the quality should be almost as good as for the IGY grids, except on the Western edge.

   c. **Southern Hemisphere, Apr 1972-on, from Australia.** Australia used satellite cloud pictures to help position fronts.

   d. **Southern Hemisphere, 1974-on, from the U.S. Navy**

   e. **Southern Hemisphere, Jan 1950 - May 1957, daily grids from South Africa.** The quality is poor in some areas.

4. **Summary for S. Hemisphere Daily Grids:**

   a. **For Jun 1957-95, there are daily grids for the NZ sector (60-210E).**

   b. **The whole S. Hemisphere has grids for Jun 1957 - Dec 1958 and Apr 1972-on. S. Africa has map analyses through 1963 that could be digitized to help fill gaps.**

   c. **There is now a gap for two-thirds of the hemisphere for Jan 1959 - Mar 1972.**

   d. **There are grids also for Jan 50 - May 1957.**

5. **Data for Tropical Storms**

   Tropical storms are often very intense. Because of grid resolution and other problems, they often have not been represented well in the analyses. NCAR has a dataset (and text) giving
tropical storm data. The central pressure, and often winds, are given each 6 or 12 hours. The dataset spans many years.

6. COADS Surface Marine Observations

Observations from ships and buoys are sent on GTS each few hours. They are also recorded on logbooks on ships. The logbooks are digitized. A big project called COADS brings all this data together into one dataset. These reports (pressure, temperature, wind, SST, etc.) are being used for reanalysis. Also, year-month statistics are prepared directly from the ship data.

7. COADS Yr-Mo Statistics for SLP, Winds, Temperature, etc.

Data is for 2-degree boxes, for many years. When analyses exist, they should be better than these statistics. The number of samples in a box is often too small for a stable mean.

8. Northern Hemisphere Daily SLP Data from the USSR (in 1987)

This data is for a 5 x 10 grid, 1880-1979, and is on 4 tapes.

Note: Consider the monthly SLP data that started 1880; I think that it has become confused whether the original source for earlier years was the UK or Russia. In any case, the 1899-on data in item No. 1 is different, and it is from U.S. sources.

9. Reanalysis Data for 1957-on

There is an NMC/NCAR project to reanalyze the whole atmosphere (and ocean) each 6 hours, from 1957-on. See Bul AMS, Dec 1991 (and late 1995). This would produce atmospheric analyses, SLP, 10m winds, and ocean flux terms (radiation, heat, etc.) NCAR is now working hard to prepare mountains of data. The production phase started Jun 1994. By late Aug 1995, data for 1982-93 (12 years) had been completed.

These data should turn out to be better and more consistent than other data available for the same time period.

10. Climatology

NCAR has good monthly world SLP means on 5-degree grids based on all data up to about 1960 or 1965. These data should be good, even in parts of the Southern oceans, where the data is thin to define yr-mo means. For the S. Hemisphere, these are based on "Climate of the Upper Air, Part 1 - Southern Hemisphere," Taljaard et al., 1969. NVair 50-1C-55. A good summary is in "A Selected Climatology of the Southern Hemisphere: computer methods and data availability." NCAR TN/STR-92, Jenne et al., 1974.

11. Southern Hemisphere Monthly SLP

Phil Jones wrote a paper which is published in the Journal of Climate, Dec 1988, where he used monthly gridded data to determine patterns of SLP. This information was then used with the available older station data to try to determine the best monthly analyses (S. Hemisphere) for the whole period back to 1957. Another paper went back to 1911, but this is on shaky ground (International Journal of Climate, Vol II, P585-607, 1991).
12. Conservation of Atmosphere Mass

We need some more comparisons between the various SLP datasets. We should prepare RMS differences of SLP between some key datasets over remote areas. The total mass of dry air in the atmosphere should be very close to constant. Global water vapor can vary some from month to month, but it isn't a large term. Global analyses of SLP can be evaluated to see if mass is conserved (a calculated surface pressure is actually used). Trenberth did some work on this (JGR, D12, Dec 20, 1987), and (JGR Vol 99, D11, Nov 20, 1994).

13. Monthly Pressure Data from Stations

NCAR has a tape with year-monthly data for around 2000 stations, global coverage. The elements given are typically temperature, precipitation, station pressure, and sea level pressure.

14. How to Obtain the Data

Nearly all of the above data is in the NCAR archives.

15. Sea Level Pressure and Surface Pressure

A station pressure is always what is measured and that is some height above sea level. To calculate a sea level pressure, some assumption must be made for the temperature of the fake air column between the surface and sea level. Over the oceans and for low elevations, this is no problem. For high elevations, and especially for sharp cold air surface inversions, it is a problem. Rules were developed so that land stations can calculate a fairly reasonable SLP. Therefore, the best gridded SLP has often been obtained by using the reported station SLP in the analyses.

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16. The message that started this text

From: PSMSL.POL
To: r.jenner
Subj: Air pressure data

> Roy - I have been asked by the GLOSS (global tide gauge) community to compile a short list of datasets available on air pressures, and maybe winds also if possible. Bruce Douglas told me that he obtained from you a monthly mean gridded northern hemisphere dataset from about 1900 or so. Could you tell me something about this and any other datasets that NCAR produces that would be of interest to us?
The monthly products sounds a little like one included in the WMO INFOCLIMA book, and one produced privately by the UK Met Office. However, I guess each agency has similar products. Of course, we are interested in the S. Hemisphere also, and not just for monthly means.

Any help would be much appreciated.

Phil Woodworth (PSMSL)

Note: Phil also obtained an update in Aug 1995.

Address for Woodworth: Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, U.K.
Tel: +44 - 151 - 653 8633 Fax: 653 6269
URL: http://www.nbi.ac.uk Internet mail: plw@pol.ac.uk

Roy - many thanks for the update. That's very useful, I'll change our file to include it. I was in Boulder for the IUGG but did not get the chance to visit NCAR. I hope we get to meet sometime.
Best wishes. Phil Woodworth

Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, U.K. Tel: +44 - 151 - 653 8633 Fax: 653 6269
URL: http://www.nbi.ac.uk Internet mail: plw@pol.ac.uk
Backups for Surface Land Observations
(3-Hour Synop, Hourly Airways)

Roy Jenne
15 Apr 2002
Rev 26 May 2004

A. WORLD COVERAGE OF SURFACE 3-HR DATA (1967 - ON)

For reanalysis we used items 1 and 2 below. We should check coverage in items 3 and 4.
Item 2 was extracted from an earlier item 3 by NCDC. All of these 1-6 are important.

<table>
<thead>
<tr>
<th></th>
<th>DATES</th>
<th>YEARS</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>World 3-hr sfc (NCEP) GTS</td>
<td>02/75 - 01/01</td>
<td>26.0</td>
</tr>
<tr>
<td>2.</td>
<td>USAF world GTS, Dick Davis</td>
<td>01/67 - 12/80</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>- Use reanal format, 1967 - 76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>USAF GTS, Datsav, rc 10/03 (compress)</td>
<td>1973 - 2003</td>
<td>31</td>
</tr>
<tr>
<td>5.</td>
<td>Navy 3-hr sfc synop, GTS</td>
<td>1971 - 12/96</td>
<td>26.0</td>
</tr>
<tr>
<td>6.</td>
<td>Earlier Navy</td>
<td>10/66 - 11/70</td>
<td>4.2</td>
</tr>
</tbody>
</table>

B. DATA TO HELP OLDER YEARS

<table>
<thead>
<tr>
<th></th>
<th>DATES</th>
<th>YEARS</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>NCDC US sfc, 3-hr (from hrly), reanal</td>
<td>1938 - 1983</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>- DS470.0: about 300 stns, some start 1938</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>USSR sfc, 1936 to -1986</td>
<td>1936 - 1986</td>
<td>51.0</td>
</tr>
<tr>
<td></td>
<td>- DS5233.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>US sfc hrly (05/2004: 90% done)</td>
<td>1928 - 1948</td>
<td>20.5</td>
</tr>
</tbody>
</table>

C. OTHER SMALLER SETS

<table>
<thead>
<tr>
<th></th>
<th>DATES</th>
<th>YEARS</th>
<th>VOLUME</th>
</tr>
</thead>
</table>

D. REGIONAL ARCHIVES

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<th>VOLUME</th>
</tr>
</thead>
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<tr>
<td>11.</td>
<td>DS472.0 N. Amer sfc hrly airways</td>
<td>12/1976 - on</td>
</tr>
<tr>
<td></td>
<td>- 1000 to 2000 stns (TDL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- DS472.0</td>
<td></td>
</tr>
</tbody>
</table>

E. THE BIG TD13 DATASET (1920 - 1971)

<table>
<thead>
<tr>
<th></th>
<th>DATES</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Backups for the big TD13 sfc synop dataset</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Mainly 1920-1971. Has 100,000,000 obs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="http://dss.ucar.edu/docs/papers-scanned/">http://dss.ucar.edu/docs/papers-scanned/</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Backups:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Want the reanalysis vsn for whole period.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Want character vsn (stn order). This is before</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conversion of the front part of each rpt to binary. Each rpt has initial 64 bits of sort stuff.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Want the separate small stn library.</td>
<td></td>
</tr>
</tbody>
</table>

Atmospheric Surface Pressure Data
(Roy Jenne, NCAR, June 2000)

- There are many analyses of sea level pressure, and some of pressure at a mean elevation.
  - The NCEP/NCAR global reanalysis gives grids each 6-hours, for 1948 - 2000.

- There are hourly 3-hour or 6-hour observations of pressure at many stations.
  - Global coverage of about 7500 stations from 1967 - on.
  - NCAR has about 100,000,000 surface synop observations (including pressure) for the period prior to 1967. (There are the obs in TD13).
Summary of World Weather Records (WWR) data

Prior to 1951, each decade was published as a single volume with the first including all data through 1920. The NCAR library has all these volumes and DSS has the data on tape as part of ds570.0.

From 1951 on the WWR have been published for each decade in 6-volume sets,

- Volume 1 - North America
- Volume 2 - Europe
- Volume 3 - West Indies, South and Central America
- Volume 4 - Asia
- Volume 5 - Africa
- Volume 6 - Islands of the World

Decade | NCAR library | DSS library | DSS data tapes
--- | --- | --- | ---
1951-1960 | Volumes 1-6 | | All data in ds570.0
1961-1970 | Volumes 3, 4, 5, 6 | Volumes 1, 2, 3, 6 | *
null | Volumes 1, 2 | | **
1971-1980 | Volume 2 | Volumes 1, 2 | ***
1981-1990 | Volumes 3, 4, 5, 6 | Volumes 1-6 | ****

* We received the data for these four volumes in 1982; they were reformatted and merged with the data in ds570.0, which at that time had data through 1980.

** We received data for the complete 6 volume set in 1987; archived but no further action.

*** We received data for Volume 2 only in 1987; we received the complete 6 volume set in 2000; archived but no further action.

**** We received the complete 6 volume set in 2000; archived but no further action.

+ DSS library volumes received as follows:

1961-1970, Volume 3, received dec1982
1961-1970, Volume 4, received feb1985
1961-1970, Volume 5, received may1986
1961-1970, Volume 6, received jan1981
1971-1980, Volume 1, received feb1990
1971-1980, Volume 2, received dec1987
1981-1990, Volume 4, received dec1999
1981-1990, Volume 5, received dec1999
1981-1990, Volume 6, received déc1999

Note: Bundle RJ0156 also has some info about surface monthly data. -Roy Jones

#36

There are inventories of monthly data by location.
Status of Surface Pressure Data

1. Station Pressure Data is Useful
   - Both daily (3 to 6-hr) and monthly

2. Monthly Surface Data for World
   a. Stations give temp, precip, stn P, SLP
   b. Most of stations in the world still report
      - Still have surface pressure
      - Still have SLP
   c. The US stations
      - Still report SLP
      - Most of US quit stn pressure in mid-1996
      - Alaska – quit after part of 1997

3. The Hourly US Surface from NCDC (about 300 stations) *
   a. They did have station surface pressure
   b. But in 1998: only a few months of stn pressure

4. An Option
   US stations: Digitize surface reports prior to 1948?
   a. Why? -To have some pressure data to use along with temperature data.
   b. Prefer to have 3 or 4 reports per day.

* Digitized by NCDC from 1948 - on. In 2002 and 2003
[Digitized by NCDC from 1948 - on. In 2002 and 2003
they have been preparing the older data - Roy Jenne, May 2003

Roy Jenne
Oct 1999
Long Records of Temperature and Pressure Data

Roy Jenne
July 1999

It is useful to know where the long records of temperature and pressure in the world were taken. Alina Prigancova (Slovak Academy of Science) compiled a list and put it on a poster at IUGG-99 held in Birmingham, England in July 1999. Following is her List 1 and List 2. Note that the first of these stations that measured pressure started 1818 to 1841 (6 stations). The poster had interesting plots of the temperature and pressure data.

List 1: Central Europe 5 to 25 Degrees East

<table>
<thead>
<tr>
<th>Stations</th>
<th>Lat</th>
<th>Long</th>
<th>Temp (Years)</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budapest</td>
<td>47.50</td>
<td>19.00</td>
<td>1780 – 1991</td>
<td>1841 – 1988</td>
</tr>
<tr>
<td>Hurbanova</td>
<td>47.87</td>
<td>18.18</td>
<td>1871 – 1995</td>
<td>1871 – 1995</td>
</tr>
<tr>
<td>DeBilt</td>
<td>52.10</td>
<td>5.18</td>
<td>1706 – 1997</td>
<td>1849 – 1989</td>
</tr>
<tr>
<td>Kobenhaven</td>
<td>55.70</td>
<td>12.60</td>
<td>1798 – 1991</td>
<td>1821 – 1988</td>
</tr>
<tr>
<td>Helsinki</td>
<td>60.32</td>
<td>24.97</td>
<td>1829 – 1997</td>
<td>1845 – 1989</td>
</tr>
</tbody>
</table>

List 2: Other Stations 35 to 55 Degrees North

<table>
<thead>
<tr>
<th>Stations</th>
<th>Lat</th>
<th>Long</th>
<th>Temp (Years)</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zurich</td>
<td>47.38</td>
<td>8.57</td>
<td>1864 – 1997</td>
<td>Incomplete</td>
</tr>
<tr>
<td>Astrachan</td>
<td>46.28</td>
<td>48.05</td>
<td>1845 – 1997</td>
<td>Incomplete</td>
</tr>
<tr>
<td>Orenburg</td>
<td>51.68</td>
<td>55.10</td>
<td>1886 – 1995</td>
<td>1886 – 1989</td>
</tr>
<tr>
<td>Barnaul</td>
<td>53.43</td>
<td>83.52</td>
<td>1838 – 1995</td>
<td>Incomplete</td>
</tr>
<tr>
<td>Irkutsk</td>
<td>52.27</td>
<td>104.32</td>
<td>1882 – 1991</td>
<td>1882 – 1989</td>
</tr>
<tr>
<td>Nikolajevsk</td>
<td>53.15</td>
<td>140.70</td>
<td>1857 – 1997</td>
<td>Incomplete</td>
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<tr>
<td>Cheyenne</td>
<td>41.15</td>
<td>-104.82</td>
<td>1871 – 1996</td>
<td>1871 – 1990</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>44.88</td>
<td>-93.22</td>
<td>1820 – 1996</td>
<td>1837 – 1990</td>
</tr>
<tr>
<td>Boston</td>
<td>42.37</td>
<td>-71.03</td>
<td>1871 – 1997</td>
<td>1818 – 1990</td>
</tr>
</tbody>
</table>

Email of Alina Prigancova is geofrria@savba.sk.

The next page shows how much of this data NCAR has. We should try to get a more complete record of the data at NCAR.

- Roy Jenne
Selected monthly data at NCAR

world monthly surface station climatology in character format, 12/10/98
station position changes or gaps in the period of record are not indicated

negative lat is south, negative lon is east
sl=sea level pressure, st=station pressure, t=temperature, pt=precipitation

<table>
<thead>
<tr>
<th>logical rec no</th>
<th>name</th>
<th>wmo</th>
<th>lat</th>
<th>lon</th>
<th>years</th>
<th>sl</th>
<th>st</th>
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<td>380</td>
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<td>53</td>
<td>58</td>
<td>98</td>
<td>71</td>
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<td>99</td>
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<td>74</td>
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<tr>
<td>263641</td>
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<td>128400</td>
<td>475</td>
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<td>1780-1995</td>
<td>20</td>
<td>86</td>
<td>99</td>
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<tr>
<td>244296</td>
<td>HURBANOVO</td>
<td>118580</td>
<td>479</td>
<td>-182</td>
<td>1996-1997</td>
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<td>37</td>
<td>37</td>
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<tr>
<td>228897</td>
<td>WIEN/HOHE-WARTE</td>
<td>110350</td>
<td>483</td>
<td>-164</td>
<td>1775-1997</td>
<td>65</td>
<td>65</td>
<td>99</td>
<td>65</td>
</tr>
<tr>
<td>119118</td>
<td>DE BILT</td>
<td>62600</td>
<td>521</td>
<td>-52</td>
<td>1849-1997</td>
<td>92</td>
<td>51</td>
<td>99</td>
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</tr>
</tbody>
</table>

Note: NCAR has monthly data for many stations. This list shows what we had in 1998 for the stations on the previous page.

Roy Forbes

This list was edited by Will Spangler.
1. Three stations with long pressure records

The Climatic Research Unit of East Anglia, England has three long series of monthly pressure data posted on their Web server. The North Atlantic Oscillation is very important for the climate changes in Europe. It can be calculated from the pressures given here for Iceland and Gibraltar.

<table>
<thead>
<tr>
<th>place</th>
<th>dates for pressure data</th>
<th>missing months</th>
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<td>11 mo. missing in 1821, 1823, 1824</td>
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<td>Azores</td>
<td>Jan 1865 - Dec 1997</td>
<td>none missing</td>
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</tbody>
</table>

- Roy James
NCAR

2. The Rise in Global Sea Level

Global sea level has risen about 9 centimeters during the past 50 years, according to the Global Historical Tide Gauge Network. (A rate of 1.8 mm per year). See Science, 21 Feb 1997, p 1053.

Note: For each 1 inch of sea level rise, the air pressure changes by one mb for each 8 meters of elevation.
MEMO TO: Roger Olson  
FROM: Roy Jenne  
SUBJECT: Grid pressure and station pressure data  

21 September 1971

Grid sea level pressure data

There is a German set of daily grid data for 1881-99 (100W - 100E, Suspect 80 - 100W) that we could get from England or Germany for probably $500 to $1000 or for about $100 if it is on tape. We should also obtain this set independently of this project.

We are now obtaining the set of historical sea level pressure grids for 1899-1939. About a year of clean-up work was done on these grids in Briar's shop to at least catch errors over 10 mb.

We have the MIT set for July 1939 through November 1944.

From several sets of grids that we have, we can put together a set from about 1945 or 46 to the present. There may still be a gap in late 1944 and 1945.

About three weeks will be needed to prepare the last 25 years in one format, and six weeks or more will be needed, depending on the amount of error checking done. Sooner or later this will have to be done for other projects.

Station pressure data

Long time series of pressure data for stations are not easy to obtain. We wanted:

Adak       1942-71  
Fairbanks  1923-29  
Anchorage  1922-71  
Chicago     1890-71  
Seattle     1890-71  
Bismarck    1890-71

Costs (from Jerry Haller at NCC):  

1. Five stations 1948 on (4 tapes/stn), $240/stn  
   $1,200

2. Cards to bring stations up to date, $50/stn-year. About:  
   $ 300

3. It would cost $1000 per station to transcribe the data onto special forms. Shouldn't do this.

4. To reproduce earlier records, it will cost about $200 per station for the 1890-1948 years. Thus for the earlier years:  
   $ 900
   (Note that the reproduced records will require keypunching at NCAR.)

- end of memo -
Chapter 2: Selected Daily Grids at NCAR
(Pressure, Height, Temperature)

Analyses discussed here are for the northern hemisphere unless otherwise stated and usually do not extend to the equator. The NMC octagonal grid goes to about 15°N. See Figure 2-1.

1. Daily Sea Level Pressure Grids 1899-Current

a. Sea Level Pressure Grids from Historical Maps

These grids cover January 1899 through June 1939. The data are on a diamond 5° latitude 10° longitude grid 20-80°N, with no data at 75°N. G. Briar's laboratory in Environmental Data Service did a lot of work cleaning these grids. Data are missing where the historical maps could not be analyzed. Eastern Russia (40-80°N, 35-150°E) is missing for 1916-1920, for three months in 1921, for one month in 1922 and in 1931, and for six months in 1938 and in 1939. (On three tapes.)

b. Sea Level Pressure Data from MIT

These data cover July 1939 through November 1944. They are for each 5° latitude and even 10° longitudes for 15-80°N. This grid is always complete. Data for 85°N are also available for ten days. (On one tape.)

c. Sea Level Pressure Data from the Navy

Sea level pressure grids for November 1945 through March 1955 (daily at 152) and April 1960 through June 1962 (12002) were digitized with a curve follower at NCC under Navy contract. The Navy then used the points along the contours, and used the high and low centers in their objective analysis program which is also used on current data. The operational analyses from the Navy are available starting in July 1963. See Chapter 14 for more information.

d. Daily Sea Level Pressure Grids 1899-1972

These grids are daily data on a uniform 5° latitude-longitude grid taken from a, b, c above and from the (ESSPO) data as prepared by NCAR, which is described later in this chapter. We have received monthly mean 1945 data from NORPAX. The missing 5° latitude-longitude points from a and b are interpolated, except that large missing areas are left as missing.
Chapter 2

2. Sea Level Pressure and Surface Temperature Data from Air Force Global Weather Central (AFGWC)

100 mb height (H) 15 May 1963 - 2 Jan 1965 (00 and 12Z)
Surface temperature (T) 15 May 1963 - 2 Jan 1965 (00 and 12Z)

The 1000 mb height (in tens of feet) was calculated from the sea level pressure using the formula:

\[ Z_{1000} = T_{sfc} [9.58 \times \log(P_{sea\ lvl}) - 66.18] \]

3. Sea Level Pressure and Surface Air Temperature from NMC B-3

Pressure 18 May 1965 - current (00 and 12Z)
Surface (T) 4 Oct 1965 - current (00 and 12Z)

4. Sea Level Pressure and 700 mb Height and Temperature from Extended Forecast Laboratory

Sea level pressure Jan 1947 - Aug 1967 (00 and 12Z)
700 mb H, T Jan 1947 - Jun 1967 (00 and 12Z)

Many missing in the early months. On a diamond grid (5° latitude and 10° longitude) from 15°N to the pole. In earlier years the grid coverage was less.

5. 300 mb Data from University of Wisconsin

300 mb H 1 Jan 1950 - 31 Dec 1957 (15Z)

Values read to nearest 100 ft from USAF and WBAN charts. Ten days are completely missing. Data in parts of eastern hemisphere are missing for three months. See the atlas by Lahey et al. 1960. Diamond grid 15°N to the pole (each 5° latitude, 10° longitude, with fewer points near the pole). Grids are on one tape with a 5° grid and 15-bit pack at NCAR. Original height data were read to the nearest 100 ft. The University of Wisconsin provided the original 170,000 cards.

6. 433L ESSPO Project Grid Data

Data for every other point (one-fourth of the points) in the NMC grid were manually read from many charts for April 1955 through March 1960 (all twice daily). The data have been cleaned up and are now in the standard NMC grid format.
Analyses for S. Hemisphere, 1951–on

Primary S. Hemisphere analyses at NCAR (daily)

— In recent years (from 1978-on) there are global daily analyses from NMC and ECMWF.

— Australian. Analyses for whole S. Hem. Has SLP; has H, T, U, V 1000 - 100 mb; started Apr 1972. 250 mb starts Nov 75. Mixing ratio 1000 - 500 mb. 47x47 grid; 2x/day, 24 Apr 72 – 9 June 84. 49 tapes (13 at 6250 bpi). Data through 1989 is at NCAR.


— DS 106: IGY SLP. June 1957 – Dec 1958. Tropical analyses (72x11 points) by Germany

— Navy S. Hem. analyses start Aug 1974

— Primary sets of global analyses start July 1976. (Tropical winds are bad until Sept 1978. Another set has ok winds.)

Comments (How good were the early analyses?)

From about 45°S and northward, one can accept the analyses as good 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 at NCAR said (in 1989) that the summer (Nov–March) analyses from Nov 1955 –on were of equal quality with IGY analyses. (He worked on the IGY analyses in S. Africa.) 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 whaling ships 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.

The S. East Pacific Sector

In early years (about 1952–Nov 1954), the Analysts believed that the subtropical 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.

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.

Published maps for 1959–Dec 63.

NOTOS published daily and monthly maps through 1963 (surface and 500 mb). At one time the East Anglia group (CRU) was going to digitize the monthly maps, but we think that this did not happen.
NOTOS: S. Hemisphere daily Analyses

This is 30 Aug 1962.

1962
Interannual Variations of Mean Monthly Sea-Level Pressure in January

HARRY VAN LOON AND ROLAND A. MADDEN

National Center for Atmospheric Research, Boulder, CO 80307

(Manuscript received 15 December 1982, in final form 4 February 1983)

ABSTRACT

The standard deviations of mean sea-level pressure in January are compared for five discrete 16-year periods between 1901 and 1980. The changes from one period to another are large and larger in the North Atlantic than in the North Pacific Ocean. The differences between the periods are associated with variations in the position and central pressure of the Aleutian and Icelandic lows. There is no consistent link between the two lows as their central pressure varied in parallel till the late 1930s and oppositely thereafter.

1. Introduction

Maps of the standard deviations of monthly or seasonal mean pressures at sea level are available in the following publications: 1) Schumann and van Rooy (1951), Northern Hemisphere, 39 years; 2) Blackmon et al., (1979), Northern Hemisphere, 11 years; 3) Trenberth and Paolino (1981), Northern Hemisphere, 53 years; 4) Godbole and Shukla (1981), Northern and Southern Hemispheres, 16 years.

It is immediately evident from a comparison of these publications that the standard deviation (SD) of sea-level pressure (SLP) is far from stationary, and that it is affected both by the length and the time of the period which is used. We shall give a description below of how the SD varied in one winter month, January, during 1901–1980, link the variations to the position and intensity of the Icelandic and Aleutian Lows and provide a brief comparison with the Southern Hemisphere.

2. The data

The data are SLP at grid points in the historical data set described by Jenne (1975). The set has flaws, many of which have been pointed out by Williams and van Loon (1976) and Trenberth and Paolino (1980), and there is no doubt that the SDs below may be affected by these flaws in some places and periods, although it is impossible to say, with accuracy, how big the effect is. An inspection of the daily synoptic maps indicates that the number of ships in the North Atlantic Ocean was always sufficient to ensure a reliable analysis of monthly means, in conjunction with island and coastal stations. The number of ships crossing the North Pacific Ocean in the early years of the century was low in comparison. A serious defect in that sector was, however, the lack of observations in Alaska and on the Aleutians.

We computed the SDs for the 80 years as a whole and for five discrete 16-year periods, 16 years being an arbitrarily chosen interval. The five periods are: (1) 1901–1916; (2) 1917–1932; (3) 1933–1948; (4) 1949–1964; and (5) 1965–1980, and the standard deviation is

$$\sigma = \left[ \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

3. Change in interannual variability

The general distribution of the 80-year standard deviations, Fig. 1, is well known with maxima near the Aleutian and Icelandic Lows and in the Asian Arctic. We examine the interannual variability along two meridians; the one, 35°W, runs through the largest SDs in the Atlantic Ocean, and the other, 165°W, does likewise in the Pacific Ocean. The Atlantic profiles in Fig. 2 show that the difference between the five periods is less than one millibar near 20°N but that at 35°N the 16-year SDs already have a range of 3 mb, which they retain as far as the polar circle for periods 2–5. The profiles do not necessarily run through the region of largest SD in each period. For this reason, the grid point with the largest standard deviation is shown on the illustration for each period.

Period I is quite different from the other four as the SD is not only well below the mean at all latitudes, but it decreases toward the north from 50°N. One’s first reaction is not to believe the standard deviations from this period, but as mentioned above, there were abundant ships’ observations and stations in Iceland.

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1 The National Center for Atmospheric Research is sponsored by the National Science Foundation.
The Northern Hemisphere Sea-Level Pressure Data Set: Trends, Errors and Discontinuities

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(Manuscript received 10 September 1979, in final form 25 February 1980)

ABSTRACT

A detailed examination of the Northern Hemisphere monthly mean sea-level grid-point pressures shows a disappointingly large number of problems. The data set extends from 1899–1977 but has originated from eight different sources and discontinuities have been identified with every change in source. We have documented corrections for many of these and have also catalogued 3263 serious errors. These have been corrected or set to missing. Most of the errors are over Asia and are predominant before 1922 or during World War II.

Analyses of several different aspects of the data that reveal both the problems and real changes in the atmospheric circulation are presented, along with a comparison of the monthly mean operational U.S. Navy versus U.S. National Meteorological Center analyses. A plea is made for a greater effort in archiving quality controlled climatological data.

1. Introduction

One of the few sets of instrumental data covering a substantial portion of the globe for a long period is the series of Northern Hemisphere daily sea-level pressure grids beginning in 1899. This series has been summarized into monthly means and is potentially useful for investigations into changes in the atmospheric circulation. As made available through NCAR, it consists of grid-point values at every 5° of latitude and longitude from 20°N to the pole, although several values are missing prior to 1946, most notably at high latitudes (see Table 1).

The grid-point data originate from several sources, as shown in Table 1. Unfortunately, these changes in source and the corresponding analysis techniques used have introduced several spurious inhomogeneities into the data set which limit its usefulness. There are also quite a large number of points in error. It is the purpose of this paper to outline the procedures we have used 1) to check for and eliminate errors, 2) to document and remove some discontinuities in the data, and 3) to consider the reality, or otherwise, of long-term trends. We also report on a comparison between the Navy and NMC monthly mean analyses.

Our original version of the data set contained Navy analyses through November 1975 and NMC analyses for December 1975–February 1977, but recently we obtained an update of Navy analyses through 1977. Our original error analysis found many inexplicable errors in the 1970’s, and a comparison of the NMC-Navy analyses for the overlap period showed poor agreement. Subsequently, it was realized that the Navy analyses were offset by one grid square of the original Navy polar stereographic grid (~340 km) due to an error in the NCAR computer program that translates from the Navy grid to a latitude-longitude grid. Cross-checks revealed the error was present in all Navy analyses January 1973–November 1975 and accounted for all of the previously unexplained errors found in this period. With the corrected Navy analyses, further comparisons with the NMC analyses were carried out and the entire discontinuity analysis reported here was redone.

van Loon and Williams (1976a,b) used this data set to outline certain changes in the circulation that have taken place this century, and they discovered several flaws in the data. These were further documented by Madden (1976) and Williams and van Loon (1976) but the latter used only seasonal averages in their analysis and warn that their listing of flaws is far from complete. They note that use of seasonal means can mask errors in individual months, and an example can be found in Table 1 and Fig. 4 of Williams and van Loon which indicates that an error occurred in winter of 1906 at and

1 NCAR is the National Center for Atmospheric Research and is sponsored by the National Science Foundation.

2 NMC (the U.S. National Meteorological Center) operational analyses have undergone many procedural changes and the Navy analyses have been preferred for this data set (Jenne, personal communication). See Fig. 10 for an example of this.
Characteristic Patterns of Variability of Sea Level Pressure in the Northern Hemisphere

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Laboratory for Atmospheric Research, University of Illinois, Urbana 61801

(Manuscript received 6 October 1980, in final form 20 January 1981)

ABSTRACT

Seasonal and annual mean sea level pressures for the Northern Hemisphere have been analyzed to determine the dominant modes of interannual and longer period variability using monthly sea level pressure analyses as revised by Trenberth and Paolino (1980). Empirical orthogonal function (EOF) analysis is used to reveal the modes which explain most of the variance for the period 1925–77. In winter, Kutzbach’s (1970) EOF 1 for January remains the dominant mode and a closely related pattern dominates all seasons and the annual means. Although there are differences in detail in each season, the dominant mode is basically a high-latitude zonal-index-type pattern with departures in pressure at high latitudes corresponding to anomalies of opposite sign in low latitudes. EOF 1 is linked to the North Atlantic Oscillation, but the north-south fluctuations in mass also occur in the Pacific and, to a lesser extent, elsewhere. Time series associated with this pattern have highly significant spectral peaks at the quasi-biennial and 6-year periodicities. The latter is related to the Southern Oscillation.

Time series associated with higher order EOF’s reveal significant low-frequency fluctuations. In spite of the significant non-randomness present, preliminary attempts at prediction using autoregressive techniques indicate only very limited skill to be possible.

Correlation of sea level pressures with those of Darwin are used to define Southern Oscillation patterns in the Northern Hemisphere. In all seasons and annually, a characteristic pattern is present across the United States. High pressures over the central United States are associated with low pressures in the Pacific and Atlantic, and vice versa. This pattern is often referred to as the North Pacific–North American teleconnection pattern, but it appears that its origins stem from well beyond the North Pacific and that a global perspective is needed before we can hope to fully understand interannual variability.

1. Introduction

The atmospheric circulation is characterized by various “centers of action” which are spatially interdependent. Anomalous atmospheric conditions in one area can affect another area through teleconnections. The objective of this research is to investigate interannual and long-period fluctuations in the Northern Hemispheric circulation and to document the type of patterns that are important. Some preliminary aspects of predictability of these patterns will also be considered.

One method used in this study for revealing the dominant modes of the circulation is empirical orthogonal function (EOF) analysis of the sea level pressure (SLP) fields. With this type of analysis, most of the variance of the pressure fields can usually be represented by only a few EOF patterns and their corresponding time series.

Previous studies of circulation variability using EOF’s include Kutzbach (1967, 1970), Kidson (1975a,b), Trenberth (1975), Davis (1976, 1978), Walsh (1978), Rogers (1979)² and Heddinghaus and Kung (1980). Many of these are regional studies designed to study such areas as the Southern Hemisphere (Trenberth, 1975), the Northern Hemispheric polar region (Walsh, 1978) and the North Pacific Ocean region (Davis, 1976, 1978). Heddinghaus and Kung analyzed various meteorological parameters at the 700, 500 and 300 mb levels, but included the annual cycle in their data set and therefore effectively analyzed only the annual cycle. Kutzbach (1967) used EOFs to analyze monthly pressures, temperatures, and precipitation over North America. The only hemispheric EOF analyses of SLP appear to be by Kutzbach (1970), Kidson (1975a) and Rogers (1979). Kidson (1975b) also performed a global EOF analysis.

In dealing with statistics of climatic data over a specified period of time (a climatic state; N.A.S.,

¹ Present affiliation: Sigma Data Services, Goddard Space Flight Center, Greenbelt, MD 20771.

Seasonal Variations in Global Sea Level Pressure and the Total Mass of the Atmosphere

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The annual cycles of sea level and surface pressures and the atmospheric pressure owing to water vapor have been analyzed in detail. Global sea level pressures undergo an annual cycle of 0.5 mbar range with a maximum in the northern winter. Global surface pressures, which represent the total mass of the atmosphere, also undergo an annual cycle of 0.5 mbar range but with the maximum in the southern winter. The changes in water vapor concentrations are responsible for the latter—water vapor has a maximum in the southern winter. The constancy of the mass of dry air is used as a check on the accuracy of computations. The total mass of the atmosphere is $513.7 \times 10^{16}$ kg with a standard error of $0.02 \times 10^{16}$ kg and an annual cycle of amplitude $0.1 \times 10^{16}$ kg. The corresponding global mean surface pressure of the atmosphere is 984.68 mbar. The mean total mass of water vapor is $1.3 \times 10^{16}$ kg which corresponds to 2.53 cm of precipitable water or 12906 km$^3$ of water at 0°C. The distribution of pressure and mass as a function of latitude are also presented. A substantial annual exchange of mass occurs between the hemispheres amounting to $0.7 \times 10^{16}$ kg of dry air (2.7 mbar range in hemispheric averaged pressure). Maximum pressures occur in winter, and the summer loss of mass is partially compensated for by increased water vapor amounts. The maximum net meridional flow occurs across 5°N in the transition seasons. In the northern hemisphere, water vapor undergoes an annual cycle with a range of 1.5 mbar (area averaged) and a summer maximum, and the sea level pressure owing to dry air undergoes an annual cycle of range 5 mbar and a winter maximum. Of this, 54% is due to exchanges with the southern hemisphere and 46% is due to changes in the artificial atmospheric mass used to correct from the surface to sea level.

INTRODUCTION

There have been many estimates in the past of the total mass of the earth's atmosphere but all involve approximations and assumptions which leave our knowledge of this fundamental quantity in some doubt. The previous studies will be reviewed in detail in the following section. An outcome of this study is a new estimate of the total mass of the earth's atmosphere and how the mass is distributed as a function of the time of year.

Our interest in determining the total mass of the atmosphere arose as a by-product of an attempt to make use of the fact that the total mass of the atmosphere is presumably very nearly constant. This may be used as a constraint in analysis of global atmospheric pressure or, alternatively, as a check on the accuracy of such analyses made without this constraint. The principle of conservation of mass that has been invoked here ignores such things as outgassing from volcanoes and losses to space which have been negligible for our purposes in recent times [e.g., Johnson, 1975]. For instance, over the past century the increase in carbon dioxide in the atmosphere is estimated to be of order 40 parts per million by volume [Mitchell, 1975] or 0.006% by weight. Such changes are in the noise level of our computations. However, it is necessary to divide the atmosphere into the two parts (1) the mass of dry air, and (2) the mass of water vapor in the atmosphere. The latter is a potentially variable constituent of the atmosphere and, as we will see, undergoes large seasonal variations in each hemisphere and for the globe as a whole.

We have therefore made separate estimates of the total masses of dry air and water vapor in the atmosphere for each month of the year based on global sea level pressure analyses converted to global surface pressures. Since the pressure analyses were not made by using the constraint that mass is conserved, any spurious variations from month to month in the total mass of dry air provide an estimate of the accuracy of the analyses and our methods of reduction. The latter is presented in detail since it allows an assessment of the many possible sources of errors or spurious fluctuations that may arise in considering only sea level pressures, as is common practice in meteorology. Mean seasonal changes in the latitudinal distribution of mass are also presented.

PREVIOUS STUDIES

The first attempt to compute the total mass of the atmosphere appears to have been made by Mascart [1892]. He became bogged down in the complexity of the problem but estimated some parameters which, Verani [1966] suggests, would give the somewhat high value of about $6 \times 10^{18}$ kg. The first charts of the global distribution of sea level pressure, however, appeared much earlier [Buchan, 1869] and the first hemispheric and global mean pressures appear to have been given by Kleiber [1887] (see Table 1). Ekholm [1902] included substantial improvements and estimated a mass quite close to the present value (see Table 2). He made use of pressure data from Farrell [1877] which produced global values closer to the current values than those of Kleiber. (Note that it is fair to compare only global integrals since changes in the atmospheric general circulation may have caused some redistribution of mass between the two hemispheres.)

Many other authors did not consider pressure data in any detail but simply assumed a mean surface pressure of 74 cm of mercury. Shaw [1936] produced a very comprehensive set of global pressure charts but did not give hemispheric or global values and, like Belinskii [1948], Forsythe [1959], and others, simply stated a value for the total mass of the atmosphere without stating its origin. von Hann [1926] and von Hann and Sáringer [1943] analyzed pressure data (see Tables 1 and 2) but preferred a 'rounded' figure of 74 cm of mercury for their calculations of total mass.

Mints and Dean [1952] give global pressure values, and their global mean was used by Verani [1966] to estimate the total mass. More recent estimates of the global distribution of pres-
Pressure Data at NCAR

Roy Jenne
12 Nov 1999
Rev Mar 2002

1. What daily station pressure do we have? at NCAR?

NCAR has documents with figures and tables that give an idea of the data coverage. The following observations contain pressure and many other variables at NCAR.
- US stations 1948 – on (300 stns), hourly data
- NCEP or USAF from GTS, 1967 – on (7500 stns), 3-hourly observations
- Data from Russia for 1936 – on, each 3 or 6 hours
- Data from TD13 for early years (100,000,000 observations)
- Surface observations from Australia (1939 – 1984 at NCAR)
  - 15 to 50 stations 1939 – 1956. Then 280 to 380 stations.

2. What do we need (for years 1800s to 1947)?
- 3 to 8 observations for US stations for early years (pressure, temp, wind, SLP, etc.)

3. Climate needs
- Need both daily and monthly data for many years.
- The world monthly data now gives us part of what is needed.

4. Pressure grids

People will also use grids of SLP, but we do need more of the actual observations of stn P and SLP.

5. Pressure grids from reanalysis
- From the NCEP/NCAR reanalysis, we have global analyses, each 6-hours, for years 1948 – 2001. This includes SLP grids.

6. A number of stations in the USA measured pressure from 1843 – on. A few stations had earlier data.
- See: Jenne, R.: Dec 2000, Early Meteorological Observations in the US, 18 pages, NCAR. This will also be on-line. - Roy Jenne
An Examination of the Northern Hemisphere Sea-Level Pressure Data Set

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(Manuscript received 14 July 1976, in revised form 17 August 1976)

ABSTRACT

For each grid point (5° latitude by 5° longitude) and each season, the long-term mean sea-level pressure (1899–1972) and its standard deviation were found, using a data set compiled by NCAR. Individual deviations from the mean greater than three standard deviations were compared with nearby station data from World Weather Records. Some deviations were found in the sea-level pressure data and not in the station pressure data. Comparison was made between the NCAR sea-level pressure data set and the United Kingdom Meteorological Office data set; large differences are found since 1940 when the data sets started using different sources.

1. Introduction

van Loon and Williams (1976a, b) have studied surface temperature trends and circulation changes for the winter and summer of the Northern Hemisphere for the period 1900–72. The circulation changes were analyzed using sea-level pressure data, available for the period 1899–1972 on a 5° latitude-longitude grid for 20°N–85°N. As van Loon and Williams (1976a) pointed out, the sea-level pressure data are not without flaws. For the winter season (DJF) two examples of problems with the data were given: over the Asian highlands the average pressure rose 10 mb between 1956 and 1957 and in the Indian area there was a drop in the sea-level pressure between 1939 and 1940. For the summer season (JJA) van Loon and Williams (1976b) showed two further examples of problems: an abrupt change in the level of the pressure values at 20°N, 40°E in the early 1940’s and a probably fictitious downward trend in Arctic sea-level pressures. The latter, a result of a lack of observations in the earlier part of the century and a tendency of the analysts to draw a semi-permanent high over the Arctic, was described by Rodewald (1950).

Madden (1976) has analyzed daily sea-level pressure values for the period 1899–1972 using the same data set. He found that over all of North Africa and South Asia north of 20°N, which is the southern limit of the data, the values of the sea-level pressure had abnormal variations during the period of World War II in general.

This paper reports on two further examinations of the sea-level pressure data, in order to find data problems. The first part compares large deviation\(^5\) from the long-term mean in the sea-level pressure data with station pressure data, thus defining grid points where large sea-level pressure deviations are not found in nearby station pressure data. The second part looks at the differences between two sets of sea-level pressure data, one compiled by the National Center for Atmospheric Research (NCAR) and the other by the United Kingdom Meteorological Office.

As our work on trends was based on seasonal averages we have examined the sea-level pressure by means of seasonal averages, too. A single monthly value may be quite wrong, but the seasonal mean containing it may nevertheless be acceptable according to our criteria. The reader should be aware of this and of the fact that the paper is therefore not a complete listing of the flaws in the data but only an indicator of limitations to its use.

The NCAR sea-level pressure data set is for the period 1899–1972 for a 5° latitude-longitude grid from 20°–85°N. The sources of the data are described by Jenne (1975). From 1899 to 1939 the data are from the U.S. Historical Map Series. Since 1939 several sources have been used.

2. Examination of large deviations from the mean in the sea-level pressure data

Since studies of the pressure data by van Loon and Williams (op. cit) have concentrated on seasonal means, the data in this analysis were similarly grouped into four 3-month seasons. Winter consisted of December, January and February, spring of March, April and May and so on.

For each grid point and for each season the long-term mean sea-level pressure (1899–1972) was calculated and the standard deviation from this mean...
4. Discussion

van Loon and Williams (1976a, b) and Madden (1976) have previously pointed out problems with
Table 1. Summary of grid points at which large sea-level pressure deviations (>3σ) are not found in nearby station pressure data.*

<table>
<thead>
<tr>
<th>Grid point(s)</th>
<th>Year</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td><strong>SUMMER (JUNE, JULY, AUGUST)</strong></td>
<td></td>
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</tr>
<tr>
<td>20°N, 10°E</td>
<td>1941</td>
<td>itm=1008.2, ρ=1012.1. Compared with Aoulef, 27°N, 1°E (no nearer stations for check).</td>
</tr>
<tr>
<td>25°N, 45°E</td>
<td>1941</td>
<td>itm=1000.9, ρ=1004.9. Compared with Khanaquin, 34°N, 45°E (no nearer stations).</td>
</tr>
<tr>
<td>70°N, 70°E</td>
<td>1922</td>
<td>itm=1010.8, ρ=1017.5. Compared with Surgut, 61°N, 73°E.</td>
</tr>
<tr>
<td>20°N, 145°W</td>
<td>1909</td>
<td>Looked at 25°N, 125°W. itm=1016.6, ρ=1019.2. Compared with San Diego, 32°N, 117°W.</td>
</tr>
<tr>
<td>25°N, 150°W</td>
<td>1941</td>
<td>itm=1000.9, ρ=1004.9. Compared with Khanaquin, 34°N, 45°E (no nearer stations).</td>
</tr>
<tr>
<td>30°N, 150°W</td>
<td>1945</td>
<td>itm=1010.8, ρ=1017.5. Compared with Surgut, 61°N, 73°E.</td>
</tr>
<tr>
<td>20°N, 140°W</td>
<td>1946</td>
<td>Looked at 25°N, 125°W. itm=1016.6, ρ=1019.5. Compared with San Diego, 32°N, 117°W.</td>
</tr>
<tr>
<td><strong>AUTUMN (SEPTEMBER, OCTOBER, NOVEMBER)</strong></td>
<td></td>
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</tr>
<tr>
<td>20°N, 105°E</td>
<td>1939</td>
<td>itm=1009.5, ρ=1009.9. Compared with Fort Bayard, 21°N, 110°E.</td>
</tr>
<tr>
<td>55°N, 115°W</td>
<td>1906</td>
<td>itm=1017.8, ρ=1035.0. Compared with Dawson, 64°N, 139°W.</td>
</tr>
</tbody>
</table>

* itm=long term mean sea-level pressure (1899–1972); ρ=sea-level pressure at grid point for season and year in question.
was found. Seasonal values of sea-level pressure for each year were examined to find out if they deviated by more than three standard deviations from the mean. As far as possible, the years with large deviations (>3σ) have been compared with station pressure data from World Weather Records. Although not all large deviations are necessarily errors, and some values ≤3σ are of course erroneous, the screening should isolate large errors which have been introduced as the sea-level pressure maps were analyzed or as the data were compiled into a data bank for the computer. Where the large deviation occurs in both the sea-level pressure and station pressure, there is still the possibility of observer or instrumental error, but this has not been further investigated. In some cases no station is located near the grid point at which the large deviation occurs, so the value cannot properly be checked.

In Table 1 we list for each season the grid points where and years when deviations from the long-term mean greater than three standard deviations occur, and where nearby station pressure data showed no evidence of the large deviation. In some cases it was not entirely clear whether the deviations were evident in the station pressure data and for these we have conservatively assumed that the sea-level pressure data are correct. When the deviation occurs at a number of grid points over an area, one of the grid points was compared with station data. Since station pressure data are not available in World Weather Records after 1960, and since some grid points are not close to available stations with pressure data, Table 1 does not represent all of the large deviations found in the sea-level pressure data set. For instance, for the winter season (DJF), 35 occasions of a deviation >3σ were found in the sea-level pressure data set and 11 of these could not be compared with nearby station pressure data. For autumn 9 out of 33 large deviations could not be checked and similar numbers are found for the other two seasons.

The first point to note from examination of Table 1 is that most of the large deviations present in the sea-level pressure but not in the station pressure occur before the 1940’s. The summer season (JJAS) has more data problems than the other three seasons; although many of the deviations in the summer are only 3–4 mb from the long-term mean the standard deviations are correspondingly small. The largest deviation in the summer season is found at a number of grid points at 70°N, an example of which is 70°N, 120°E in 1920 when the long-term mean of 1009.9 mb was exceeded by more than 10 mb. At a nearby station (Yakutsk, 62°N, 129°E) this large deviation in the pressure is not seen. Such an anomalously high value in the sea-level pressure data will influence trends computed for periods containing the deviation, particularly those starting or ending in 1920.

Figs. 1–5 illustrate some of the data problems listed in Table 1. In Fig. 1 the sea-level pressure at 25°N, 125°W is compared with the station pressure at San Diego (32°N, 117°W) for the summer season. At 25°N, 125°W there are large deviations from the long-term mean pressure value in 1909, 1913 and 1946. Fig. 2 illustrates the sea-level pressure at 35°N, 50°E and station pressure at Krasnovodok (40°N, 53°E) again from the summer season. Two features are noteworthy in this comparison. First, the sea-level pressure in 1944...
Antarctic Gridded Sea Level Pressure Data: An Analysis and Reconstruction Back to 1957

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(Manuscript received 20 January 1988, in final form 24 June 1988)

ABSTRACT

The reliability of the Australian (June 1972–April 1985) and NOTOS (1957–62) gridded monthly-mean, mean sea level pressure datasets over Antarctica is examined by comparison with station data from 29 sites over the continent. After rejecting about 30% of the months in both sets of gridded data, the remaining "good" months are used in a principal component regression technique to reconstruct gridded data from the station data for 1957 to 1985. The regression technique uses the "good" Australian data for calibration and verifies the statistical relationships developed between station and grid point pressure data with the "good" NOTOS data. The reconstructions are shown to be reliable over all of Antarctica between 60° and 75°S except in the area to the east of the Ross Sea and adjacent areas of the southern Pacific Ocean.

The reconstructions are used to compare the NOTOS data with the more recent Australian gridded pressure data. Major differences between the two datasets are found over eastern Antarctica and the extreme southern Pacific and adjacent areas of western Antarctica. The first problem region was found to be related to extrapolation of the NOTOS data beyond their region of reliability as defined by the original published maps. The second problem region has a 10 mb difference between the two datasets, with the NOTOS data higher than the Australian. As this is the region of poorest data coverage anywhere in the world, the difference is difficult to resolve. In contrast, comparisons with the Taljaard et al. (1969) climatology show that this dataset contains fundamental spatial inconsistencies, and its further use cannot be recommended.

A composite dataset linking the Australian, NOTOS and the reconstructed data can be produced for the whole region except for the southern Pacific and west Antarctic region. This extended dataset is used to examine changes in pressure patterns between the January 1957–May 1972 and June 1972–April 1985 periods. Some of the changes in temperature that have occurred over this period can be explained by changes in surface circulation patterns.

1. Introduction

Studies of long-term changes in the atmospheric circulation over Antarctica are limited by the shortness of the available database. Monthly-mean, mean sea level pressure (MSLP) analyses from the World Meteorological Centre (WMC) in Melbourne, Australia are available only since June 1972. In addition, operational charts of MSLP from January 1957 to December 1962 have been published as part of the NOTOS chart series (van Loon 1972). Such short and fragmented records are in marked contrast to the Arctic, where analyses are available continuously for about 100 yr.

Many countries have operated stations on Antarctica since or even just before the International Geophysical Year (IGY) of 1957/58. It should therefore be possible to produce a continuous gridded dataset back to 1957. Here we will construct gridded monthly-mean MSLP values over the Antarctic region using these station data, for the region south of and including 60°S, from January 1957 until May 1972. As well as developing a gridded database of known quality for nine extra years (1963–May 1972) the analysis will help in addressing three specific issues.

First, the quality and reliability of the early NOTOS chart series can be assessed, allowing these charts to be directly compared with the Australian analyses. Second, the reliability of the Australian gridded analyses can be examined. Third, the magnitude and character of circulation changes over the Antarctic over a 30-yr period can be studied.

Operation of the Global Telecommunications System (GTS) for the transmission of observations from synoptic meteorological stations in Antarctica to WMCs and other centers is well known for inadequacies at certain times. The World Meteorological Organization (WMO) has carried out annual studies of the number of synoptic reports received from Antarctic stations at operational centers around the world and their timeliness (WMO 1986). For the Antarctic region as a whole, the reception of reports from observing stations is generally good, and considerably better at 0000 UTC than for South America and southern Africa (Karoly et al. 1986). However, for certain stations in Antarctica, few observations are received at WMC. The operational analyses produced in Melbourne may...
therefore suffer at times through the lateness or lack of these basic data. Any serious deficiencies introduced into the gridded analyses through such operational problems will be revealed by this study, through comparisons of the gridded and station data.

2. Data

a. Sources of station data

The basic source of climatological data, including pressure and temperature for the Antarctic region, is World Weather Records (WWR; Jenne 1975, updated). Data from Antarctica are, however, frequently missing or in error in this source. For example, sea level and station-level pressures are often interchanged and temperatures are often recorded in degrees Fahrenheit to further confuse the unwary analyst.

The only way to compile a reliable dataset of Antarctic pressure data is by contact with the various national agencies operating meteorological stations in Antarctica. Records were obtained for 19 stations operated by Argentina, Australia, France, Japan, New Zealand, South Africa, United States, USSR, and the UK. The stations are listed in Table 1 and located on a map of the continent in Fig. 1. Monthly mean MSPL data were also assembled for six sub-Antarctic islands in the zone 45°–60°S (Table 1). Apart from islands near the mainland of South America, no other islands have suitable data available. Near South America more stations could have been selected but this would have produced duplication and uneven coverage.

Despite most of the monthly-mean sea level, and station-level pressure data being obtained through personal contacts, it is still necessary to check the homogeneity of the station records using methods outlined by Jones (1987). Some erroneous data were found for stations on the Antarctic Peninsula. Details of these homogeneity checks and tables of the assembled basic data are given in Jones and Limbert (1987). Although every attempt has been made to produce error-free, homogenous station data there is still a possibility that, in some isolated months, station data may still be in error.

For Vostok, monthly-mean MSPL data have been published in Monthly Climatic Data for the World. These data, calculated at the Russian base, show no agreement with either the station-level data or with the Australian gridded analyses. The data show hardly any variability, and all monthly-mean values between 1980 and the end of 1985 are within 1 mb of 1007.5 mb. Monthly-mean station-level pressure and the Australian gridded data show interannual variability in any given month of ±15 mb. The method of reduction to mean sea level is not known, but the mean sea level pressure data as published are clearly in error.
Table 3. Spatial anomaly correlations (×100) between station data and data interpolated to the station from the Australian analyses.

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<td>838</td>
<td>969</td>
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</table>

* Numbers in italics have r values less than 0.825.

The two high-altitude stations were omitted for reasons already discussed. The other three stations have incomplete records for the 1957–62 period and were omitted so that the 1972–85 correlations could be directly compared with those made over 1957–62 with the NOTOS data (see below). It should be noted that the spatial anomaly correlation is a particularly stringent test of the data, especially when the anomaly field contains only weak anomalies. In such cases, errors in the anomaly field of only fractions of a millibar may lead to a low, or even negative, anomaly correlation.

The results of this analysis are presented in Table 3. Most correlations are relatively high reflecting the quality of the Australian charts for these months. Although only two (June 1973 and January 1983) are near zero, there are a number of others (30%) which have r values less than 0.825 (68% of the variance in common) between the two datasets. Months with low spatial anomaly correlations identify the poorer quality months in the Australian gridded data series. Such data errors may be related to reduced reporting rates from Antarctic stations.

2) NOTOS DATA

van Loon (1972) has reviewed early work on the sea level pressure field over the Southern Hemisphere and has extensively analyzed the chart series developed at the South African Weather Bureau from 1951 to 1962 (the NOTOS series). These monthly-mean charts were derived from daily weather charts for the Southern Hemisphere which were begun during 1950. All daily and monthly-mean pressure maps have been published for the years 1951–62 in the journal NOTOS. For the years 1951–56, gridded values at 5° × 5° intersections have been published from 15°S to 60° or 65°S and to 70° or 75°S for 1957–58. These gridded data, which originate from, and were digitized at, NCAR, were obtained from K. Mo (personal communication). This dataset is exactly the same as the published NOTOS material but contains extrapolations over central Antarctic grid points at 70° and 75°S, i.e., the gridded data extends beyond the coverage of the original maps. Some of the errors found later with the NOTOS charts relate to this extrapolation and do not apply to the published material (van Loon, personal communication).

To extend the gridded NOTOS series temporally, we digitized the published monthly NOTOS charts for the 4 yr 1959–62. Gridding for these years generally extends to 70°S, and to 75°S only over parts of the western Antarctic. We did not digitize data for 1959–62 beyond the coverage of the original charts.

The quality of the NOTOS dataset and further details of the data sources are given by Taljaard (1972) and van Loon (1972). As with the Australian data, the main data sources are reports from fixed meteorological stations. Over Antarctica, the station network for 1957–62 was similar to that operating in the Australian period so the charts ought to be of similar quality. For 1951–62, the NOTOS charts include whaling ship data sources for the southern oceans between 45° and 65°S, particularly during the summer half of the year. Because of a ban on whaling introduced during the 1960s, practically no high-latitude ship reports entered the Australian analyses for these ocean areas. The importance of having data for these regions was seen clearly during FFGGE in 1979. Intuitively, therefore, over the southern oceans around 60°S, the NOTOS data for the summer season should be more reliable than the pre-FGGGE Australian data. This assertion will be tested later.

As with the Australian analyses, we have correlated at each station the station MSLP data with the gridded NOTOS data (interpolated to the station) for the 6 years...
Dear colleague,

In the 1960's the South African Weather Bureau produced daily mean sea level pressure analyses for the southern hemisphere that covered the 1950's and 60's that coincided with establishment of Antarctic stations during IGY. Many of these data, including monthly averages, were published in the Notos publication and this included tabulated actual daily pressure values at grid points with 5 deg. resolution. We require:

a) Monthly mean sea level pressure for the southern hemisphere
b) Daily "

for the 1950's and 60's.

I expect that Dr. Jenne is aware of these data and I wondered if you had any in digitized form at your Centre. I have been in contact with Phil Jones at the Climatic Research Unit in Norwich and he has monthly average mean sea level pressure data for the 1950-1960 period only. I recall that Harry van Loon has made use of some of the South African data in his papers. I should also note that I have been in contact with the South Africans but they also do not keep any data on computer.

Finally, Phil Jones has mentioned that the US had another project to produce southern hemisphere data sets (charts I think) that ran in the 1960's and perhaps through to the early 1970's. This may be another possibility.

I would very much welcome any assistance you could provide with acquiring any such data.

Yours sincerely

Stephen Harangozo
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The data are SLP at grid points in the historical data set described by Jenne (1975). The set has flaws, many of which have been pointed out by Williams and van Loon (1976) and Trenberth and Paolino (1980), and there is no doubt that the SDs below may be affected by these flaws in some places and periods, although it is impossible to say, with accuracy, how big the effect is. An inspection of the daily synoptic maps indicates that the number of ships in the North Atlantic Ocean was always sufficient to ensure a reliable analysis of monthly means, in conjunction with island and coastal stations. The number of ships crossing the North Pacific Ocean in the early years of the century was low in comparison. 


The following give information for very recent years (Doesn't apply to the above SLP)


Observed Southern Hemisphere Eddy Statistics at 500 mb: Frequency and Spatial Dependence

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ABSTRACT

Nearly eight years of daily Southern Hemisphere analyses at 500 mb have been used to define the spatial dependence of the variance fields of geopotential height and the two geostrophic wind components, the corresponding covariance fields, and the transient kinetic energy. The fields are further examined in the frequency domain by using Lorenz' (1979) "poor man's spectral analysis" technique. In view of the small variation in eddy statistics as a function of the time of the year in the SH, this study removes the first four harmonics of the annual cycle and then considers all data together, so that contributions from all time scales from 2 to 4096 days (~11 years) can be resolved. The main results are based on analyses from May 1972-January 1978 but are verified with analyses from the relatively data-rich FGGE period.

Results for the zonal mean statistics are compared with those from previous studies. The zonal means of the geopotential height and westerly wind component have spectra which roughly follow that of the red noise with an autocorrelation of about 0.5, whereas the northward wind component spectra closely resembles red noise with autocorrelation of 0.2, resulting in considerable anisotropy in the wind fields. The northward component of transient kinetic energy is larger than the eastward component at high frequencies in middle latitudes but the reverse is true for periods greater than two months. The westerly momentum flux by the transient eddies has a broad spectral peak at 8-32 days and is dominated by contributions from fluctuations of less than about two weeks.

The geographical dependence of the eddy statistics is mapped for four broad frequency bands covering periods of roughly less than one week, one week to two months, two months to two years, and greater than two years, thereby separating out contributions from transient baroclinic eddies, episodes of blocking, and intermonthly and interannual variability. The spatial patterns of the statistics are interpreted in the light of synoptic behavior of systems and storm tracks as defined by synoptic studies and satellite observations in the Southern Hemisphere. For periods less than a week, variances are largest in the southern Indian Ocean and relationships between the storm tracks and eddy statistics are similar to those found in the Northern Hemisphere by Blackmon, Lau, Wallace and others. However, there also are differences associated with the differences in the mean flow in each hemisphere and these are discussed in the context of baroclinic theory. At periods longer than a week geopotential height variances are largest near southern New Zealand and, to a lesser extent, southeast of South America and appear to be related to the incidence of blocking in the Southern Hemisphere. The corresponding transient kinetic energy has a maximum further north in association with cutoff cold-centered lows. In general, the high-frequency transient eddies play a much larger role in the circulation of the Southern Hemisphere than is true for the winter circulation of the Northern Hemisphere, and the eddy statistics are more zonally symmetric.

1. Introduction

For many years, studies of the general circulation emphasized the zonally averaged flow (Lorenz, 1967; Oort and Rasmusson, 1971), but there are many other important circulation features that are averaged out by taking the zonal mean. Recent emphasis on local climate variability has focused attention on the departures from the zonal mean fields and the availability of new data sets has permitted local effects to be studied in detail in the Northern Hemisphere (NH) (Blackmon, 1976; Blackmon et al., 1977; Lau et al., 1978; Lau, 1978, 1979; and several other papers in this series).

The spatial patterns of eddy statistics are rather complicated but their interpretation can be somewhat simplified if the statistics are broken down into scale and frequency dependence. There are large-scale quasi-stationary forced waves in the atmosphere which have different characteristics in each hemisphere (van Loon and Jenne, 1972; van Loon et al., 1973). There also are transient baroclinic eddies "steered" by the larger-scale flow. This has led to the concept of storm tracks and has been found very useful for interpreting the eddy statistics in the NH. The large-scale quasi-stationary waves are baroclinically active by transporting heat poleward in the NH in winter and their contribution
based on a more complete set of observations than ever before. Some differences between Figs. 9 and 10 may be due to a seasonal bias as this period is two summer months short of two years. Also, the mean fields contain negative departures relative to the "normal" from the earlier period of up to 67 gpm in the South Pacific Ocean (65°S, 120°W). Heights were close to normal over Antarctica but below normal everywhere in the southern oceans surrounding Antarctica. Since heights were slightly above normal north of 50°S, except for the South Pacific, the westerlies were enhanced between 50 and 60°S. Nonetheless, Figs. 9 and 10 contain very similar features. The maxima are most intense in Fig. 10, as should be expected for a short period, but are located in the same places. Largest differences in σ(z'), of just over 20 gpm, occur in the South Pacific and south Atlantic Oceans, both regions which previously suffered from lack of data. It we assume that independent analyses occur about every five days, these differences are significant using an F test at the 2% level. In general, however, the differences between Figs. 9 and 10 are not much more than should be expected from sampling theory. We are led to conclude that the variances represented by Fig. 9 are fairly representative of the SH circulation with the possible exception of the South Pacific.

The variances of the wind field components and the transient kinetic energy are presented in Figs. 11 and 12. Maxima in w² occur along 50°S in the eastern half-hemisphere but coincide with maxima in z² only in the south Indian Ocean. w² exhibits maxima to the north and south of this region in a pattern characteristic of the band-pass-filtered fields in the vicinity of storm tracks in the NH (Blackmon et al., 1977). This pattern is not present in the other areas, such as south of New Zealand, and we will see that this reflects the different dominant frequencies of the disturbances in each region. A comparison of Figs. 9 and 12 also enables us to draw some inferences about the dominant scales of the
Documents About
Surface Land Observations

1. Summary of documents for world surface observations

2. World surface synop on TD13, from USAF, 100m observations
   - For early years to 1971

   - The "Dick Davis" set, based on USAF GTS

4. Some other surface land observations (see the summary)
   - NCEP world surface 1975 – 2001
   - USAF world surface 1973 – 1981 (not in reanalysis yet)
   - USA surface observations 1948 – on (US48, Alaska, Pacific Islands, Caribbean)

5. USSR surface synop data for 1936 – 1986 (45 p)
   - 223 stations each 3 or 6 hours

6. Surface observations for Australia, 1939 – 1984 (~30 p)
   - About 45 stations for 1943 – 1956
   - Then 280 to 375 stations for 1957 – 1982

7. University of Wisconsin surface net for Antarctica

8. Early hand weather maps for reanalysis comparisons
   - Includes Southern Hemisphere maps for 1958 – 1972
   - Done 3/13/2001, 13 items and 52 pages (RJ0088)

9. USAF hourly synoptic data worldwide (351 items)
   - We could not get this as a separate data set.
   - These often go back to the 1930s.

10. Data for Brengel, 1990 (RJ0216, 53 p)
    - This is the only data.

Roy Jenne
22 Oct 2001