1. Introduction

On 25 and 26 April 1991, a Reanalysis Workshop took place at the National Meteorological Center (NMC), under joint sponsorship by NMC and by the Climate System Modeling Project (CSMP). The objectives of the workshop were to inform the leading scientists of the research community about the NMC/NCAR plans for reanalysis, to elicit their guidance and consensus on major decisions required regarding the strategy to be followed, and to determine possible coordination with other reanalysis projects (see Bengtsson and Shukla 1988; and Kinter and Shukla 1989 for earlier discussions about reanalysis).

The objectives of the NMC/NCAR Reanalysis Project are 1) to develop the necessary long-term observational database, 2) to develop an efficient, but state-of-the-art, four-dimensional data-assimilation/quality-control system, and 3) to perform long-term (up to 35 years), homogeneous reanalyses of the 4D global data. The collection, basic formatting, and some quality control of the data will be performed by NCAR, with the collaboration of the Geophysical Fluid Dynamics Laboratory (GFDL), the National Climatic Data Center (NCDC), and the University of Missouri. The reanalyses, which will be made available to the research community, will be performed at NMC and will be a very useful database for diagnostic climate studies, for long-term climate monitoring, and for developing El Niño and Southern Oscillation (ENSO) prediction techniques. In addition, a long-term, quality controlled and uniformly formatted observational database will be generated as a by-product of the reanalysis.

The workshop had wide national and international participation, including leading scientists representing the different groups of researchers interested in using reanalyses, as well as the United Kingdom Meteorological Office (UKMO) and the European Centre for Medium Range Weather Forecasts (ECMWF). The areas of research represented included climate modeling, atmospheric transports, interannual variability, short-term climate prediction, climate diagnostics, angular momentum and length of day, coupled ocean-atmosphere modeling, tropical ocean–global atmosphere (TOGA), and long-term climate change. Other organizations interested in performing reanalysis, such as the Center for Ocean–Land–Atmosphere Interactions (COLA) of the University of Maryland, in addition to ECMWF, were also represented. Also present were representatives of the major funding agencies, NOAA, NASA, and NSF, as well as the National Research Council.

In this note we summarize the presentations made at the workshop, the discussions, and the main conclusions reached.

2. Summary of the presentations

Introductory remarks were made by Ron McPherson, director of NMC, who quoted Rick Anthes, president of UCAR, as saying that the Reanalysis Project is an opportunity for NMC to shine. However, McPherson added, the project is of such a magnitude that it is also a great opportunity for NMC to fail, so that the purpose of the workshop was to involve the community in the project early and thoroughly, in order to ensure success. Jay Fein indicated the support and interest of the NSF for reanalysis in general and for the NCAR/NMC project in particular.

a. Session 1: The proposed NMC/NCAR Reanalysis Project

Eugenia Kalnay (NMC, co-Principal Investigator of the proposed Reanalysis Project) presented the basic strategy (Fig. 1): first, perform a “pocket” (quick) reanalysis with a lower-resolution but otherwise state-of-the-art system extending 35 years from the IGY (1957/58) to 1993. The 35-year pocket reanalysis will take 2–3 years and will be started in early 1993. This will be followed by a “full” reanalysis by an identical system as the Climate Data Assimilation System.
FIG. 1. Schematic of the proposed strategy for CDAS and re-analysis (CDAS), which should become operational in 1993. The full (CDAS) reanalysis will extend from 1979 through 1993, combining with the ongoing CDAS to provide a high-resolution analysis made with a frozen system (i.e., using an analysis/forecast system that remains unchanged except for changes in the observing systems). This analysis is ideal for detecting interannual variability, and will include an ocean data-assimilation component.

Kalnay also pointed out that a major obstacle facing reanalysis is the presence of “spinup” (or spindown) during the assimilation. The spinup or spindown is apparent in the precipitation, especially the convective rain in the tropics. It also affects the secondary circulations associated with the precipitation, such as the Hadley and Walker circulations, and the intensity of the tropical surface stress and surface heat flux and evaporation. The spinup lasts about two days, so that the analysis cycle, which uses the first 6 hours of the forecast as a first guess for the next analysis, suffers from maximum spinup effects.

The spinup is affected by several factors:

1) The model resolution: at NMC, the version of the Global Data Assimilation System (GDAS) with a model with horizontal triangular truncation of 80 waves (T80, equivalent to a grid size of 160 km) has a small spindown. The T126 (105 km) version has a stronger spindown, whereas the T40 (320 km) version suffers from significant spinup.

2) The physical parameterizations: the version of the T40 model that Ants Leetmaa and collaborators have tuned to enhance the strength and organization of the tropical convection, and that has been very successfully coupled to an ocean model, has an even stronger spinup and, therefore, weaker precipitation and surface fluxes during the assimilation cycle.

3) The method of analysis: the new Spectral Statistical Interpolation (SSI) analysis system very significantly reduces the spindown at both the T80 and T126 resolutions. (It has not yet been tested at T40). The SSI, a form of 3D analysis, was developed by Parrish and Derber (1991) and became operational at NMC in June 1991, replacing the conventional Optimal Interpolation (OI) analysis scheme currently in use in most operational centers.

It was also noted that the spinup affects the second-
ary circulations and surface fluxes, but not the slow quasigeostrophic circulation, so that in a pilot study performed for CDAS the geopotential field analyses were almost identical at the T40, T60, and T80 resolutions. Moreover, even those fields that are influenced by the spinup were affected in magnitude but not in the geographical distribution (e.g., the location of easterlies and westerlies showed excellent agreement among the three different resolutions). This suggests that even if some spinup is present in the final pocket system, it would still be possible to perform bias corrections in a multiplicative fashion.¹

Robert Kistler (NMC, project manager for the reanalysis) gave a sobering view of the magnitude of this project and presented information on the impact of the four horizontal resolutions considered and different output options on the size of the output and the supercomputer cpu requirements (Figs. 2–4). He indicated that in order to perform 35 years of reanalysis in 2 years, it was necessary to plan to perform a month of reanalysis per day and work at 85% efficiency. He estimated that it would require three people to work in the production of the reanalysis, and the availability at NMC of a second supercomputer in addition to the present CRAY YMP 832 is essential.

He classified the possible output in five categories, in order of need by the majority of users: 1) level 2 data plus mandatory pressure analyses; 2) 2D horizontal fields such as surface fluxes, precipitation, and others, as well as a number of zonally averaged fields (including heating rates and others)—these fields are presently sent to NCAR from the NMC operational GDAS; 3) Sigma (model level) model variables; 4) a set of four 3D diagnostic fields of diabatic and frictional effects (total heating, total moistening, and deceleration of the two velocity components); and 5) 12 additional 3D diagnostic fields, which split those effects into their components. Figure 2 presents the resulting output in number of tapes (each with 200 MB) per 5 years of reanalysis, and for possible horizontal resolutions of T40, T62, T80, and T126 (corresponding to a Gaussian grid resolution of 320, 210, 160, and 105 km, respectively).

Figure 3 shows the total number of tapes estimated for the 35 years of pocket reanalysis plus 15

¹After the implementation of the SSI at NMC, on 25 June 1991, further experiments have confirmed that the spinup at T126 resolution is now very small. Furthermore, experiments with the SSI and a T62 model tuned to reduce the spinup indicate that this system, proposed for the pocket analysis, also has minimum spinup, and its Hadley circulation, precipitation, and surface fluxes are all very close to those obtained at T126 resolution.

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**Figure 2.** Number of tapes of output per five years of reanalysis as a function of horizontal resolution (see text).

**Figure 3.** Total number of tapes for 15 years of CDAS reanalysis and 35 years of pocket reanalysis (see text).

**Figure 4.** Number of clock hours required to perform a 30-day reanalysis using six processors on a Cray YMP 832 computer.
years of CDAS reanalysis assumed to be performed at T126 resolution. The size of the output for the higher options prompted the comment that it was necessary to avoid the generation of a "write only" database. Figure 4 presents the number of clock hours on the CRAY YMP 832 needed to perform 30 days of reanalysis, assuming 18 model levels and the access to 6 processors.

Kistler indicated that the software for the reanalysis launcher is in a fairly advanced stage, except for the automatic monitoring system, which still is in its design stage ("vaporware"), and for which the guidance of the community is desirable.

Roy Jenne (NCAR, co-Principal Investigator of the Reanalysis Project proposal) reviewed the philosophy of the reanalysis and the strategy for the collection of the level 2 data. He indicated that the goal of the data preparation is to prepare a first set of data inputs (version 1) in 26 months, in time for the pocket analysis. This database will be much more extensive than the data available in real time, but continuing work will be necessary to improve it for later reanalyses.

Version 1 will contain:

1) Rawinsondes: a combination of MIT data with GTS (at NCAR, originally from NMC) for May 1958 to present. This will lack Southern Hemisphere data from May 1963 through May 1966, and selected national data sources from Canada, Australia, and Antarctica will be used to help fill the gap.

2) Surface marine data: an updated Comprehensive (COADS) that also contains much more older data is being prepared.

3) Global surface data: land-surface observations for the first reanalysis will be available only from 1967 onward. However, for earlier periods, the marine observations and the rawinsonde data will be available.

4) Aircraft data: several databases will be merged to provide data from 1960 to 1990.

5) Cloud winds: data from NMC and from the Satellite Data Services Division (SDSD) will provide data as available, from 1970 on.

6) Satellite soundings: NCAR did not promise to prepare this data as part of the 26-month project, but will collaborate with others. NCAR has the radiances for SIRS (Satellite Infrared Spectrometer) (April 1969–April 1971), VTPR (Vertical Temperature Profile Radiometer) (November 1972–February 1979), and TOVS (from 29 October 1978 on). The 26-month project was initially funded in April 1991 with initial partial funding from NOAA and from NSF (via Shukla’s grant). The funding now supports about 75% of the required 2.3 persons. Since the initial funding was delayed by 8 months, the project start was also delayed, but the COADS work proceeded in any case. NCAR is hoping to have the version 1 data ready by about April 1993. This is very optimistic compared to, say, the experience with FGGE (First GARP Global Experiment), but Jenne believes that it can be done. Jenne also described cooperative efforts with the University of Missouri (E. Kung), GFDL (A. Oort), and NCDC. Additional questions, such as the possible use of older available analyses for the Southern Hemisphere, were also posed.

Robert Quayle (NCDC) reviewed the Climatological Aerological Reference Data System (CARDS), which aims to produce a complete database starting with the advent of the upper-air network during and after World War II. This project will be coordinated with the reanalysis. It will not be ready for the pocket reanalysis, but will be very helpful for the full (CDAS) reanalysis.

b. Session 2: Other reanalysis projects

J. Shukla and Jim Kinter (University of Maryland/COLA) reviewed their project currently under execution to reanalyze 18 months corresponding to the El Niño episode of 1982/83. They are performing it remotely at NCAR, using the COLA model (similar to the NMC model), at rhomboidal truncation of 40 waves, R40 resolution, and including SiB, a simple biosphere model). The GRADS (Grid Analysis and Display System), recently developed by COLA scientists and designed to be portable, modular, and to greatly facilitate the manipulation of the analysis fields in an interactive fashion, attracted special interest from the audience.

Tony Hollingsworth (ECMWF) discussed the plans for reanalysis at the ECMWF. If the necessary financial support is forthcoming from the European community, the ECMWF plans to reanalyze 15 years (from 1979 through 1993). This would be performed using an early 1991 system (with the T106, 19-level model). If supported, ECMWF would build up the preparation effort in 1992, perform the 15-year reanalysis in 1993/94, and "clean up" in 1995.

Richard Swinbank (UKMO) indicated that the British Meteorological Office and the associated new Hadley Center have a plan of climate data assimilation somewhat similar to the CDAS, with the development of a Forecast Ocean–Atmospheric Model (FOAM). Special emphasis is being placed on the use of UARS (upper-atmosphere research satellite) data. At this point, the UKMO has no plans for reanalysis, although it plans to collaborate with Dick Reynolds from NMC on a reanalysis of SSTs. This SST reanalysis probably would not be ready for use in the NMC’s pocket reanalysis, which could instead use the earlier monthly analyses already available from the UKMO. This analysis would have to be combined with climatological SSTs in areas where the analysis is not available.
Chris Folland (personal communication) has indicated that the UKMO plans to revise their SST analysis and develop a unified ice analysis from previous U.S. Navy and John Walsh analyses, and that they would be able to provide these products for the pocket reanalysis.

c. Session 3: On-line reanalysis climate monitoring and climate output requirements

Kingtse Mo (NMC) showed examples of a number of summary diagnostics that have been generated at NMC, as well as an example of line diagrams checking the continuity of the product that would generate “alarm bells” if a problem with the data or the model occurred during the reanalysis. She indicated that the monitoring of the CDAS would be easier than that of reanalysis, since it could be directly compared with the operational GDAS. During the discussion, several suggestions were offered for additional diagnostic checks, especially including comparisons with climatology and between model and observed outgoing radiation in different channels.

Kevin Trenberth (NCAR) showed some of the apparent climate discontinuities associated with either models or analysis improvements in the ECMWF analysis, especially in the mean-layer temperature, stressing again the desirability of a reanalysis. He also showed the extent to which the ECMWF analysis does not conserve mass, and the influence of initialization on the mass conservation, an important consideration for the transport of tracers. He made a number of suggestions about data checks (such as to perform quality control of isolated observations before the analysis in order to ensure the proper use and acceptance of these data) and analysis checks against independent data (OLR, MSU channel 2, previous analyses, etc.). Trenberth recommended that the output include accurate surface pressure (at the true earth’s surface), archival on pressure surfaces every 50 hPa four times daily in addition to model (sigma) output, and the inclusion of diagnostic fields like precipitation minus evaporation and diabatic heating.

Maurice Blackmon (NOAA/CRD) showed examples on how postprocessing such as sigma to pressure interpolation could seriously affect the accuracy of diagnostic analyses of the circulation. He pointed out several needs that the reanalysis archives must satisfy in order to be useful for studies of atmospheric dynamics (resolution of diurnal cycle, e.g., at least four times a day; use of sigma coordinates; availability of spectral transforms; etc.)

Francis Bretherton (CSMP) reviewed two important facets of reanalysis that should be considered for application to the CSMP: atmospheric transports and water vapor. He indicated that the reanalysis work-shop should determine a mechanism for decision process, not the final specifications to the project. He also emphasized the need to provide an estimate of the uncertainties in the analysis, as well as the need to calibrate the impact of changes in the observing systems.

Fritz Zaucker of the Goddard Institute for Space Studies (GISS) presented a summary of the estimated needs for additional quantities for use in transport models (such as those defining the time-averaged mass fluxes, rather than time-averaged velocities). Mark Cane (Lamont-Doherty) presented a summary of requirements prepared by Mike Prather (GISS) on a similar subject. Given that complete estimates of the turbulent mass fluxes among all layers of the model are impractical [it would require arrays of IM x JM x KM dimensions, where IM, JM, and KM are the zonal, meridional, and vertical dimensions (respectively)], scientists working in transports will explore the use of alternative methods to obtain summary turbulent transport estimations.

d. Session 4: Review of CDAS

The last part of the day was devoted to a progress review of the CDAS project, taking advantage of the presence of the members of the CDAS Advisory Panel (Julia Nogues-Paegle, chair).

The characteristics currently envisioned for the CDAS were reviewed by Kalnay.

1) It will remain frozen from its operational implementation (1993) until about 2000. If it became necessary to make changes, their effect on the analysis would be carefully calibrated.

2) CDAS will be performed as a “post analysis,” seven days after real time. This delay will still allow the output to be used for the Climate Diagnostics Bulletin.

3) A “look ahead and behind” component in the complex quality control will be included.

4) Some delayed data will be ingested. The bulk of the delayed data (i.e., ship and classified Navy XBT observations), however, will take between a month and two years to arrive.

5) The new high-resolution OI SST analysis will be utilized. An ocean 4D assimilation component, but with one-way coupling, will be also included.

6) In principle, the CDAS will be the same as the most advanced GDAS available at the time of the implementation, probably with a T126, 28-level model. The possibility of using a lower-resolution T80 model was left open.

7) The combination of the CDAS and the “full” (CDAS) reanalysis (Fig. 1), will provide a 15–20-year-long, high-quality, homogeneous analysis to study interannual variability.

8) The CDAS reanalysis will still benefit from long-
TABLE 1: Comparison between the Spectral Statistical Interpolation and the Conventional Optimal Interpolation.

<table>
<thead>
<tr>
<th></th>
<th>OI</th>
<th>SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observations</strong></td>
<td>$u, v, p_s, Z, RH$</td>
<td>$u, v, p_s, T, q, or p_w.$</td>
</tr>
<tr>
<td><strong>Analysis variables</strong></td>
<td>$u, v, p_s, Z, RH$ (on a grid)</td>
<td>Scaled vorticity, divergence, nonbalanced heights, $q$ (spectral coefficients)</td>
</tr>
<tr>
<td><strong>Dynamic balance constraint</strong></td>
<td>Geostrophic</td>
<td>Linear global-balance equation (weak constraint, includes surface friction)</td>
</tr>
<tr>
<td><strong>Forecast error statistics</strong></td>
<td>Inverse squared exponential (in grid space)</td>
<td>Estimated from 24-h forecast errors (in spectral space)</td>
</tr>
<tr>
<td><strong>Method of solution</strong></td>
<td>Determine data weights using local data only</td>
<td>Solve for the complete global field as a single problem, using all data at once.</td>
</tr>
<tr>
<td></td>
<td>Invert a different small matrix for each grid point</td>
<td>Solve a single huge matrix iteratively.</td>
</tr>
</tbody>
</table>

delayed data (e.g., ship, classified XBTs), OI reanalysis of SST, and interactive satellite temperature retrievals.

Derber (NMC) reviewed the characteristics (Table 1) of the new Spectral Statistical Interpolation (Parrish and Derber 1991), which replaced the operational OI in June 1991. The new SSI, which performs global analysis directly on the model variables and uses all data at once, has been found to have a number of important advantages over the conventional OI analysis: the forecasts are, on the average, more skillful, the data are generally better fit, there is much less spinup, there is no need to perform normal-mode initialization, and the fact that it is based on a variational formulation makes handling of nonstandard data much easier. It should be emphasized that the SSI, although clearly superior to OI, will still undergo further development in the next 18 months.

Glenn White (NMC) showed that the SSI analyses had a somewhat weaker Hadley circulation and somewhat stronger Walker circulation than the OI analyses, but considerably less spinup, both in terms of tropical precipitation and of the Hadley circulation.

Bill Collins (NMC) reviewed the characteristics of the complex quality-control (QC) system for rawinsondes that he developed and showed statistics indicating that temporal interpolation will provide a very valuable addition to the QC. He pointed out that the time-interpolation check will complement the OI-based complex QC implemented by Jack Woollen at NMC.

Lev Gandin (UCAR/NMC) described the advantages and characteristics of the technique denoted "optimal averaging," which, although widely used in the Soviet Union, is new in the West. It provides better estimates of areal averages, and, most importantly, it estimates the errors of those averages. He showed examples indicating that if the data are not uniformly distributed, the error in the estimated areal average can be much larger than the optimal $1/2$ value generally assumed.

The inclusion of optimal averaging in the CDAS/reanalysis systems should make them considerably more useful for climate-change detection.

Wayman Baker (NMC) reviewed the promising results of the "interactive" satellite temperature-retrieval method currently being tested collaboratively with Henry Fleming of NESDIS. In this method, the model 6-hour forecast is used as a first guess for the retrieval, and, as a result, the vertical components of the sounding that cannot be retrieved from satellite observations are retained from the first guess, instead of being replaced by climatological estimates. Baker showed that the interactive retrieval soundings had errors considerably smaller than the operational retrievals, and better than those of the first guess. During the discussion it was indicated that the variational assimilation of radiances currently under test at ECMWF also eliminates spurious changes to the first guess. In addition, the variational method may have an advantage in the fact that radiance errors are less correlated than the retrieval errors. The interactive system, on the other hand, may be better able to handle cloud effects, which are a large source of errors. Both systems will undergo tests in the next couple of years.

Paul Julian (NMC) briefly described the new NMC
database-management system under development, which will provide access to the data needed for both CDAS and reanalysis. In the short term, an interim database should be ready by early 1992, containing observational data (30 days of GTS data plus non-GTS “special effort” data), limited metadata (increments of the observations with respect to the 6-hour forecast, plus QC information), and fields and products to be determined. The format for this database (internal to NMC) is IFOD (Interface Format for Observational Data), and GRidded Binary (GRIB) for fields. The software for this interim database, which will reside on two 3380 disk packs, includes IFOD and GRIB translators that have been developed. Beyond this interim database, a relational database-management system (RDBMS) with a longer data hold of at least 40 days is planned for 1994. The format will be appropriate to the RDBMS, which has not yet been chosen, but will probably be a commercial software. A prototype of this system is under development.

Ants Leetmaa (NMC) reviewed the status of the ocean data-assimilation system, which will be a component of the CDAS in a one-way coupling mode. The system assimilates surface temperature observations, which are abundant due to the AVHRR measurements of SST, and initializes the interior of the ocean using XBT data, which are much sparser. He showed comparisons between surface fluxes determined from the atmospheric data-assimilation system and from the energy balance of ocean boxes, which indicated a reasonable agreement on time scales of weeks, but also the presence of significant bias. He also reviewed the status of the new sea surface temperature analysis based on OI, which was recently implemented at NMC by Dick Reynolds. The new OI SST analysis has higher effective spatial and temporal resolutions (about 2° and one week) and closer fit to independent buoy observations than the operational SST analysis (with an effective resolution of 5° and two weeks). (The nominal grid resolution of the new and old SST analysis is 1° and 2°, respectively). It is planned that for the CDAS and the full reanalysis this improved SST analysis will be used.

Stanley Grotch reviewed the AMIP (Atmospheric Model Intercomparison Project), which plans to compare 10 years of simulations using observed monthly anomalies of surface boundary conditions (including the Climate Analysis Center (CAC)/COLA SST analyses). More than 30 models are scheduled to participate in this comparison.

Abraham Oort (GFDL) showed comparisons between temperature seasonal means derived from station data by GFDL (Oort 1983), from a subset of station data by Angell (1988), and from the NMC operational analysis. The three datasets compare well for average temperatures between 850 and 300 hPa, but there is a clearly spurious drop of about 1°C in the NMC analysis between 1975 and 1979 at 700 hPa due to changes in the analysis system. Such apparent (but spurious) climate changes emphasize the need for reanalysis, and the fact that a reasonably good agreement was obtained despite the use of a 4D analysis system, which is quite crude compared to the present state-of-the-art, suggests that a modern reanalysis combined with judicious optimal averaging can considerably reduce the uncertainty of the estimated changes in average temperatures.

3. Discussion, conclusions, and recommendations

The CDAS Advisory Panel, chaired by Julia Nogues-Paegle (University of Utah), met after the CDAS review and will provide a separate report.

The major conclusions of the workshop, reached by consensus after intense discussions, were as follows.

1) The workshop participants indicated strong support for all the proposed reanalyses, and in particular for the NMC/NCAR Reanalysis Project and its three main components: (a) the Climate Data Assimilation System, which will be used for “postanalysis” one week after real time starting in early 1993, and will remain frozen until about 1998; (b) the “pocket” (lower resolution) reanalysis, which will be used to perform a homogeneous 35-year reanalysis (1958–93) during 1993-95; and (c) the “full” or CDAS reanalysis (covering 1979–93), which will be performed with a system identical to CDAS from 1996 to 1998, providing a 20-year homogeneous analysis for CDAS. These schedules assume the availability of a second supercomputer at NMC. They also require access to a mass storage device.

2) The participants felt that the effort to gather the level 2 data is of paramount importance, and the magnitude of this effort should not be underestimated. A consensus was reached that the collection of the data, its quality control, and the estimation of errors was a major useful product of the reanalysis effort.

3) A consensus was reached that an optimal strategy will be to perform the 35-year pocket reanalysis, starting with the last period (1985–93) first, followed by 1979–85, then by 1970–79, etc. This will allow faster access to the 1985–90 period by the TOGA researchers and will test the reanalysis system on a period for which there are additional analyses. The enhanced COADS data for this period should be used. Of all the potential resolutions considered, T62/L28 was chosen as the most appropriate for the pocket reanalyses, although further efforts to improve the spinup were needed.
(Since that time, the problem of the spin-up has been substantially eliminated.)

4) It was agreed that the participation of the research community is essential for the success of the reanalysis project. The funding agencies will be requested to issue an “Announcement of Opportunity” program to encourage research related to reanalysis.

5) A central distribution point for the reanalysis dataset and products should be established as an integral element of the project. The NOAA/Climate Research Division (M. Blackmon) expressed its willingness to act as a “Library of Congress” for this purpose. NCDC is willing to archive the data as part of its mission as a permanent official records center. NCAR and NASA/GSFC also offered to archive the reanalysis.

6) A provisional steering group, formed by representatives of each of the different research groups interested in reanalysis, was identified to coordinate the collaboration before a reanalysis science team is formally created:

* TOGA prediction and ocean surface fluxes: Ants Leetmaa (NMC) and J. Shukla (COLAI)
* Interannual variability: Kevin Trenberth (NCAR) and J. M. Wallace (U. Wash., not present)
* GCM model verification and circulation diagnostics: Maurice Blackmon (CRD)
* Land-surface fluxes and hydrology: Jim Kinter (U. Md./COLA), Roger Pielke (Colorado State University, not present) and G. Milly (GFDL, not present)
* Long-term climate change: E. Kung (U. Mo.) and A. Oort (GFDL)
* Chemical transports: Inez Fung (GISS, not present)
* Angular momentum: David Salstein (AER)

7) The need to coordinate and collaborate with other possible reanalysis producers (ECMWF, U. of Md., UKMO) was also agreed on. In particular, it was agreed that the NMC/NCAR plans and the ECMWF plans are complementary. The goal of “unification” of the level 2 data for the NMC and ECMWF reanalyses is highly desirable and should be attained for the second series of reanalyses (ca. 1996). It should be noted that the 1979 (FGGE) data is already unified. The CAC/COLA monthly averaged SST analysis for the period 1982–92 will be used for the pocket analysis. If and when they become available, UKMO/NMC reanalysis of SST before 1982 will be used. The new OI/SST reanalysis of SST for 1982 onward will be a valuable improvement for the latter period and should be completed as soon as possible.

9) A follow-on Reanalysis Workshop should be called for mid-1992, to further discuss progress and plans.

10) The availability of a second supercomputer and of a mass storage device (such as a robotic system capable of handling 6000 square tapes) by late 1992 is essential in order to start the reanalysis in 1993.

Other recommendations discussed include:
(a) Document error assumptions; include estimates of analysis error. Provide summaries of different observing-system differences with respect to first guess.
(b) Extend the pocket reanalysis to 1945 as soon as possible.
(c) Perform pilot studies for the 1985 period simulating pre-1979 observing systems.
(d) Perform no data (GCM) experiments to evaluate influence of model.
(e) Include a full restart record for every month of reanalysis, to allow repetition of experiments with different methods, data, output, etc.
(f) Make the CDAS/reanalysis launcher available and enhance the communication network between NMC and the research community to allow them to perform limited experiments.

4. Conclusion

After a final acknowledgment to the participants of the Workshop for their very constructive suggestions, to Julia Nogues-Paegle and other members of the CDAS Advisory Panel who guided the development of the CDAS and suggested that NMC consider a reanalysis project, to CSMP, and NMC for sponsoring the workshop, and to Bonnie Sharpe, Joyce Peters, and Pam Brandts for their outstanding support in its organization, the workshop was closed.

References


