Earth System MONITOR

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Dobson Ozone Data Workshop

A data workshop on the assessment and evaluation of total ozone data derived from ground-based Dobson instruments was held September 11-13, 1991, in Lanham, Md. Sponsored by the Data Archeology Project of the Information Management Core Project of the NOAA Climate and Global Change Program, the workshop was international in makeup. Attendees represented several of the operators of Dobson instruments at stations in the international network as well as scientists engaged in the analysis of the Dobson data record for climatic and other research needs. The workshop was enthusiastically endorsed by our colleagues at the NASA Goddard Space Flight Center and the WMO ozone project which provided travel support for a European scientist to attend the workshop.

During the workshop deliberations, particular emphasis was placed on the quality and continuity of the data presently archived at the World Ozone Data

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INSIDE

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

ESDIM Fosters NOAA-wide Data and Information Management

Capt. Carl W. Fisher
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The previous issue of Earth System Monitor *introduced the new Deputy Assistant Administrator for Environmental Information Services, Gregory Withee, who is responsible for coordinating the operation of NOAA's national data centers, and developing and managing a NOAA-wide data and information management program. An earlier series of articles highlighted activities of the national data centers; this article focuses on the NOAA-wide data and information management program.*

The Earth System Data and Information Management (ESDIM) Program began in FY 1991 as a NOAA-wide effort to address critical data management concerns so that NOAA can be responsive to present and future demands for its environmental data. The program was conceived through a joint effort with the Office of the Chief Scientist with Dr. Vernon Derr leading NOAA-wide planning and program formulation. Now that the ESDIM Program has been approved and funded, NESDIS's Deputy Assistant Administrator for Environmental Information Services is tasked with implementation and management of the program, and Vernon Derr will continue to serve as an adviser and address key data quality and continuity issues.

Specific objectives of the ESDIM Program are:

- Build a top-level consensus within NOAA on data and information issues and formulate a vision of the agency's data and information management strategy for the 1990s and beyond;
- Rescue critical NOAA environmental data currently at risk of being lost;
- Improve access to NOAA environmental data and information for scientists and decision-makers;
- Modernize and interconnect environmental data systems throughout NOAA to increase their capability and responsiveness;
- Assist in developing standards for data documentation, data quality, and network connectivity; and
- Provide agency-wide guidance on developing policies related to environmental data management.

The ESDIM Program's strategic plan focuses on preparing NOAA to efficiently and effectively manage the great increase in environmental data expected during the next decade and build the capability to respond to the increased demand for these data and information. In addition, the ESDIM Program strategy is to provide an end-to-end view of NOAA data management from instrument design to the storage and retrieval of data and products, in order to maintain data quality and continuity. This will require continuing coordination with the NOAA Line Offices and Programs observing and using these data for operational or research purposes.

Many elements of the ESDIM strategy have already been initiated, including:

- Establishing a formal project management system to coordinate and monitor the extensive activities of the ESDIM Program;

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ESDIM Program, *from page 1*

- Developing the NOAA master directory commencing with a pilot project in FY 1989 and now well into the implementation stage;
- Setting up a data tracking system that will provide information on data acquisition, storage, and usage;
- Documenting and publishing NOAA's data management plans via in-house publications, journal articles, seminars, and workshops;
- Inaugurating an external R&D effort with universities and inviting industry to join in a cooperative effort;
- Establishing scientific advisory boards in various environmental disciplines to review and certify data holdings and advise on priorities;
- Participating in various national and international standards forums on data management and telecommunications issues; and
- Developing an educational program in NOAA on environmental data management-related topics.

The FY 1992 activities planned to accomplish ESDIM Program objectives as part of this strategy include:

- Coordinating ESDIM Program planning with the data management activities of the NOAA Line Offices and other NOAA-wide program offices through continued interaction with the ESDIM Program Team and review by the NOAA Program Development Board. This includes managing and implementing the Information Management element of the NOAA Climate and Global Change Program. This effort is being developed by another NOAA-wide team under the leadership of the Deputy Assistant Administrator for Environmental Information Services;
- Developing a detailed plan for rescuing endangered NOAA environmental data based on NOAA-wide evaluation and review;
- Assessing the software and hardware systems currently available in NOAA to manage and distribute environmental data. A national data center requirements study was completed in June 1991, and a NOAA-wide requirements analysis will be completed in FY 1992, building upon the data centers study;
- Developing a concept plan for modernizing NOAA's data systems, and commencing the studies and analyses required to prepare an implementation plan;
- Reviewing the problems of data quality and continuity in NOAA and presenting findings and recommendations to the NOAA Program Development Board. The board's recommendations and those of a previous NOAA-wide meeting on data continuity will be combined into a set of options for consideration by the NOAA Administrator. Also, commence planning for an interagency data continuity workshop in FY 1993 to identify existing and potential problems in the continuity of U.S. environmental data sets;
- Continue implementing the NOAA Earth System Data Directory through NOAA-wide inventory of data sets and entry of descriptions. Over 1,200 NOAA data sets will be described in the directory by the end of FY 1992;
- Prioritizing the utility of NOAA's archived environmental data through periodic reviews by panels of external scientists. The operations of the National Data Centers have been reviewed by advisory panels and recommendations will be provided. Future scientific needs for NOAA's environmental data will be projected through evaluation of requirements established by advisory science working groups. NOAA has recently established Land Surface, Oceanic Variables, and Atmospheric Science working groups in support of the Pathfinder data effort that is addressing the migration of high priority satellite data to more stable and accessible media.
- Working with the Department of State and other U.S. government agencies to promote and seek international reciprocity for U.S. full and open global change data management principles, thereby assuring NOAA access to important foreign satellite and *in situ* data. The ESDIM Program will also coordinate the development of NOAA plans for acquiring, processing, disseminating, and archiving data from non-NOAA satellites needed to carry out NOAA programs. ■

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HELPLINE:

National Climatic Data Center (NCDC)

Climate Services:	*Satellite Services:*
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704-259-0682	301-763-8399

National Geophysical Data Center (NGDC)
FTS 320-6958
303-497-6958

National Oceanographic Data Center (NODC)
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202-606-4549

NOAA Earth System Data Directory
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202-606-4548

FTS 266-4636 (Douglas Hamilton)
202-606-4636

NOAA Central Library
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301-443-8330

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U.S. DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
John A. Knauss, Under Secretary and Administrator

The Validation of Historical Daily Climate Data

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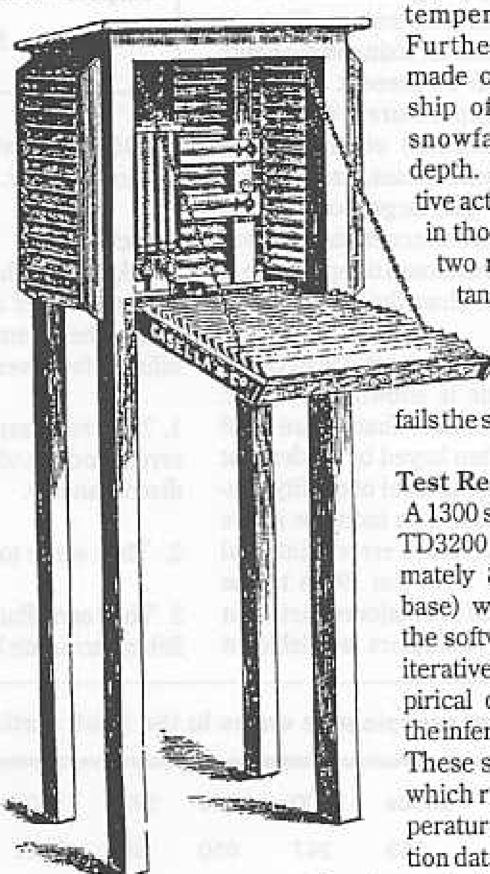
For over one hundred years thousands of volunteer weather observers have faithfully recorded daily weather data on forms supplied by the National Weather Service (and its predecessors). These forms found their way to regional or national processing centers where the information was extracted for use in publications such as the current *Climatological Data*. As punch cards came into wider use in the late 1940s, the production of publications was automated. This collection of punch cards continued to grow until magnetic tape became the medium of choice for data storage in the late 1960s. Still the *Climatological Data* publication remained the primary reason for digitization of these data.

As computers became more commonplace, the value of these digital data became increasingly apparent. Before 1948 daily observations were digitized under the terms of agreements with various state universities. After this time the federal program began in earnest. To date, this database, known as TD3200, contains many decades of data from some 25,000 stations of varying lengths of record. This treasure trove of data has been used for hundreds of climatic studies. As its usage grew, however, the problem of data quality became more acute.

Quality Control Background

Over the years quality control (QC) ranged from none to sophisticated spatial comparison techniques. The National Climatic Data Center (NCDC) introduced the use of GIS (Geographic Information System) and ES (Expert System) techniques to increase the level of sophistication and automation of the QC process. Before the advent of these and predecessor automated QC systems, identified errors were often corrected only on the manuscript or publications. The punched cards (pre-1970s database) were not always corrected as well. Other common problems were: loss of punched cards; destruction or misreading/mispunching of cards by ADP machines; introduction of errors during the transfer of data from punch cards to tape; and introduction of errors by certain regional keypunch procedures. New storage media such as optical disc have increased the accessibility of these data, but have also served to highlight these and other types of errors.



ValHiDD Rules

The approach taken in the development of NCDC's "Validation of Historical Daily Data" (ValHiDD) project is based on a pre-determined systematic empirical set of rules to be used by an inference process. ValHiDD utilizes these rules in converging upon a fix/delete/flag-as-suspect solution. The errors detected by ValHiDD fall into two distinct categories –observer errors and digitizing errors. Digitizing errors are often the most obvious and are thus reasonably easy to locate. For example, a maximum temperature of 548 degrees is an undisputable error. Generally, observer errors are much more subtle. A repeating maximum temperature for three days is possible, but for five days, ten days, or longer, such a "flatliner" becomes increasingly unlikely. Specific sets of rules, divided into logical groups, have been defined for each error category. There are eight such groups of rules. These include checks against an extremes table, and tests for internal inconsistencies, flatliner temperatures, excessive diurnal ranges, and spikes in the temperature series. Further checks are made on the relationship of precipitation, snowfall, and snow depth. Finally, corrective action is triggered in those cases where two rules fail simultaneously or where an element subject to correction fails the second iteration.

Test Results

A 1300 station subset of TD3200 data (approximately 8% of the database) was used to test the software during the iterative process of empirical development of the inference rules base. These stations, most of which record both temperature and precipitation data, represent the long term stations in the database and are representative of all geographical areas of the conterminous United States. Over one thousand errors and their potential correction modalities were manually verified against the original manuscripts on file at the NCDC to measure and improve ValHiDD's ability to correctly reproduce the original manuscript data.

The results of the processing were very encouraging as only a 0.04% data error rate was found. However, over 75,000 potential discrepancies were flagged, deleted, or corrected. This number, which would be much higher if individual days of each flatliner scenario were considered, is far too large (projected at

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Climate Data, *from page 3*

nearly 1 million for the entire database) not to warrant attention.

Table 1 summarizes the results of the 1300 station test by data element and outcome. Several entries stand out, such as the absence of fixes for snow depth and the seemingly large number of fixes for the maximum temperature. Since no rules were defined for fixing snow depth (snow depth can be present even with very warm temperatures since hail amounts are included) other than the deletion of extreme values, a zero total is to be expected. The largest category of temperature internal inconsistencies was found to be the maximum temperature of today being less than the minimum of yesterday.

A summary of the most conspicuous errors by decade is shown in Table 2. One should remember that before 1948 the data were often keyed by students at universities, and the level of quality control varied greatly. The increase in the number of temperature errors (internal inconsistencies) from the 1970s to the 1980s is attributed to a major reduction in the number of validators available at NCDC and a switch of emphasis to spatial consistency.

Table 1. Results of the 1300 station test by data element

	Maximum temp.	Minimum temp.	Precipitation	Snow	Snow depth	TOTAL
Deletes	1,481	1,295	465	3,263	42	6,546
Fixes	16,886	707	6,325	193	0	24,111
Suspect	2,335	653	12,157	14,786	5,518	35,449
Flatlines	5,386	7,734	--	--	--	13,120

Conclusion

Although the number of discrepancies uncovered and resolved may seem small, their removal/correction is significant for several reasons:

1. They represent the most conspicuous errors and are often culprits in statistical discordancies.

2. They serve to discredit the database.

3. They contribute to confusion in establishing accurate historical climatological record extremes.

4. They infect climate models and climate summaries.

5. They are systematic in nature.

ValHiDD has proven an effective tool for removing those errors most often highlighted in critical reviews of the TD3200 database. By removing these derogating values the confidence level of the database is greatly elevated. In early 1992 the entire TD3200 database will be updated using the ValHiDD process, creating a new baseline quality database to support climate research projects. ■

Table 2. Most conspicuous errors in the 1300 station test by decade

Decade	1800s	1900	1910	1920	1930	1940	1950	1960	1970	1980-87
No. of Errors	153	247	650	809	1081	997	496	172	77	180

Enhanced Geosat Data Released on CD-ROM

The National Oceanographic Data Center (NODC) and the National Ocean Service (NOS) are collaborating in the production of a series of CD-ROMs containing improved geophysical data records (GDRs) from the Geosat altimeter Exact Repeat Mission (ERM), November 1986 to October 1989. The new Geosat GDRs have been prepared by the NOAA/NOS Satellite and Ocean Dynamics Branch. The previous versions were based on operational satellite orbits computed by the Naval Aeronautics Group (NAG) and are referred to as "NAG GDRs". A new satellite ephemeris, more precise by an order of magnitude, has since been computed by NASA's Goddard Space Flight Center. These new orbits have been incorporated in the new "T2 GDRs" (so called because the orbits are based on the GEM-T2 gravity model). In addition, the T2 GDRs contain other new fields that significantly increase the overall accuracy of the Geosat data.

Data on the CD-ROMs is in exactly the same binary format as the original Geosat GDRs distributed by the NODC on magnetic tape. The only difference is the storage/transfer medium. Any programs written by Geosat data users to operate on the tapes should be able to read and process data directly from the CD-ROMs.

The first three of a projected series of seven CD-ROMs have already been completed. A flier/order form giving further details about this data set is available from the National Oceanographic Data Center, NOAA/NESDIS E/OC21, 1825 Connecticut Avenue, NW, Washington, DC 20235. Telephone: 202-606-4549. FAX: 202-606-4586.

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Media Mania: The Past and Future of Archival Data Storage

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SECOND OF TWO ARTICLES ON DATA STORAGE MEDIA

In the early 1950s computers became commercially available and began proliferating beyond those few uniquely fabricated computing machines developed to count the census and to calculate projectile trajectories. From the very beginning media technologies became as essential to advances in computers as calculating technologies. Punched cards and paper tape originally used to enter source programs and data gave way to higher capacity, faster, and more efficient magnetic tapes with oxidized iron surfaces for recording information.

Early commercial magnetic tapes stored data with a density of 200 bits per linear inch on a half-inch wide computer tape. Eventually, the deposition of iron particles on the tape surface was improved to allow up to 556 bits per inch (since 7 tracks were used, each linear bit position represented a 6-bit character).

Magnetic tape consists of three principal components: the substrate, the pigment, and the binder. The substrate is a strip of clear polyester plastic. The magnetic sensitive surface or "pigment" is a chemical paint of oxidized iron particles spread as evenly as possible to allow for discrete magnetization of the iron particles. This magnetic sensitive surface is bound to the substrate by a chemical binder.

The recording density of a tape is determined by the size and the number of sensitive particles exposed to the write/read recording head above the sensitized surface. Much of data storage history revolves around advances in how well the sensitive material or active layer is presented to the write and read electronics (the evolution of recording head technology is a full discussion in itself).

As computers were applied to solving problems in more and more fields, data storage requirements continued to expand. The need for even denser and faster recording technologies drove computers from the old six-bit character environment to a wider character of eight bits, which was termed a "byte". Thus a new set of terms evolved in tandem with the new technology: a *bit* for a single memory logic element and a *byte* for a group of eight bits.

New tape transports were built to linearly record nine tracks of information at a time, eight data bits and a parity bit. Tapes then recorded data at 800 linear bit positions per inch, or 800 bytes per inch. Before long the nine tracks expanded to 1600 bits per inch and then to 6,250 bits per inch, yielding over 150 million eight-bit bytes of information per tape. Throughout this development, the magnetizing material of choice continued to be iron oxide pigment.

The data storage problem will reach a critical point beginning in 1998, so we must plan now to be ready before then.

In 1984 IBM introduced the 3480 computer tape cartridge which packaged a capacity similar to the 6,250 bits per inch open reel tape into a compact 4- by 4-inch cartridge. This reduced the shelf space to store computer tapes by a factor of almost four. At the same time, advanced error correction logic improved the error performance of the tape from one error in ten million to one error in a trillion. The 3480 system records data in eighteen parallel tracks with a recording density of 36,000 bits per inch. To allow for the higher density recording, IBM replaced the relatively large oxidized iron particles with a compound of chromium oxide .

In late 1990, IBM announced that the density of this medium has been increased to 36 tracks, doubling the potential data capacity of one tape cartridge from 200 million bytes to 400 million bytes. The National Institute of Standards and Technology conducted a comprehensive study to apprise the risk of using this medium for data archiving. The study found the new cartridge medium to be superior to the standard open reel tape. This data capacity in a small carrier will suffice to meet NOAA's archival data storage needs for the immediate future.

Just as we are becoming comfortable with the current level of computing power and storage media, however, new data sources and data processing requirements will begin to strain these capacities. NOAA is on the brink of a major increase in the volume of data to be collected and archived. New data will soon flow from expanding surface observations from the Weather Service modernization programs, new shipboard recording technologies, and a new generation of environmental satellites. Even the small tape cartridges will be unable to provide the needed amount of storage space. So a new storage capability is being sought for the future. The data storage problem will reach a critical point beginning in 1998, so we must plan now to be ready before then.

The enormous storage requirements on the horizon will exceed the capabilities provided by the current stable iron and chromium oxide materials, as particle size is a limiting factor. The video industry and its enormous data volumes, i.e., three colors times 625,000 display elements, thirty times each second, requires substantially higher recording densities operating at very fast data rates. Video employs unoxidized metal (iron) particles in its recording surface pigment. The smaller, unoxidized particles provide a denser array of particles to magnetize. The greater the number of separate recording particles in the field of the recording head, the higher the signal to noise ratio and more precise the recording integrity. In other words, the more

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the better is the name of the game in this world. Particle sizes are measured in angstroms (one hundred-millionth of a centimeter). The chromium dioxide particles used in 3480 tapes, for example, are 1,200 by 300 angstroms. Even these small particles, however, are too big to provide data densities needed by the video industry.

Because of their greater data densities, video recording technologies are now being adopted for digital recording. These densities allow the smallest sized cassette of video tape to hold 250 times more data than the 3480 computer tape cartridge. Furthermore, data can be transferred to and from this material three times faster than on standard computer tape. So why don't we begin using this medium now? Remember that the pigment is made with unoxidized metal. The unoxidized metal is more susceptible to corrosive air pollutants that could alter the recording surface and result in loss of data.

But, that's not the worst part. The video recording rates and densities are achieved by recording the data in a helical scan mode versus the linear mode used in recording conventional computer tapes. The rate at which the rotating recording head crosses the tape requires that the head be as close as possible to the magnetizing source in order to rapidly alter and detect flux change. As a result, this mode of recording ultimately requires that the head be in contact with the pigment surface. This unfortunately requires attention to the discipline of tribology–the science of friction and rubbing.

In helical scan recording, the tape is cupped around a curved head surface so the recording mechanism is always perpendicular to the tape. Because of this, it must appear as flat and rigid as possible. This rigidity factor is referred to as high modulus. To accomplish this, the substrate (the polyester backing material) is stretched taut at a very high tensile force to remove its elastic properties before the pigment material is applied. Tape prepared in this manner is referred to as *tensilized* tape.

Over time, however, this stretched material will relax as the polymer compounds inherently retain some memory of their pre-stretched state. This relaxation is accelerated by high heat and humidity. What all of this means is that these factors present some degree of risk to the data in a time-extended archive environment. We are watching the development of the Exabyte tape, a metal particulate coated tensilized tape now being used in over 250,000 systems worldwide. The success of this system will provide useful data for predicting metal particle tape performance characteristics over time.

The major drawback to optical media is their data recording rates, which are very slow compared to their data capacities.

Even denser recording technologies are being developed by the Japanese recording industry. They have developed a technology that allows even smaller metal particles to be evaporated onto the recording surface, allowing for highly precise and dense recording. Products already available in this form are 4mm DAT audio tapes and 8mm Hi-8 video recording cassettes. Like the metal particulate media, these tapes are tensilized before the metal particles are coated on the surface.

If these media do not hold up well over time there could be curious consequences. An entire generation could be lost for posterity if people are capturing their children and grandchildren on Hi-8 video tapes. These images could disappear within a matter of a few years, especially if those tapes are stored in damp basements or hot attics. However, the Japanese are close to marketing a polyester substrate which does not require tensilization. This new material, called PEN (versus the PET currently in use), may cost more to manufacture but offers improved head-to-tape and longevity performance.

What about the optical recording technologies? We all know that the CD-ROM has been a smashing success. This is the only optical medium that has any semblance of a standard and that works across a variety of computing platforms. However, its limited capacity of 600 million bytes of information is not much these days. The small disk appears to be very stable and it likely will retain data longer than could be expected on a magnetic computer tape. The CD-ROM is regarded mostly as a convenient and cost effective medium for widely distributing useful amounts of data.

The other optical recording media such as the 12-inch and 14-inch diameter write once, read many (WORM) disks are not supported by sufficient standards to use them across a number of computer platforms, and the large platters are considered to lack the stability of the smaller CD-ROM disk. Because fundamental questions still exist about the longevity of optical disks, they are considered risky for archival use. System costs are also substantially higher than for CD-ROM, and they have been slow to enter the market place. The major drawback to optical media is their data recording rates, which are very slow compared to their data capacities.

A magneto/optical (MO) recording device has been developed which offers CD-ROM capacities on a 5.25-inch disk with the added feature that the disks can be written many times as compared to the write once for the WORM devices. There are no accepted industry standards for this media and the cost is higher than that of CD-ROM. Its archival qualities are unknown. This is currently considered an emerging technology.

An optical tape recording system has been developed by a Canadian firm which is called the CREO system. It uses a 12-inch reel of 35 mm wide tape which is coated with an optically sensitive recording surface. Data are recorded on the material with lasers and information is written on the media in 32 parallel tracks in a cross tape mode. The recording spots are micron sized allowing for very high density recording. A 12-inch reel of this material weighs 22 pounds and holds a terabyte, a trillion bytes. There are six systems in existence, and as this is a new and relatively untried media, only time will tell if it can be used to archive data for extended time periods. The CREO medium is manufactured by the British firm, Imperial Chemical Industries (ICI).

The ICI optical tape material is being used by a U.S. company which has a trademark product called DOT (for digital optical tape.) This company is putting the same material as used by the Canadian CREO system into a standard IBM 3480 tape cartridge. Because the optical surface can be recorded so densely, the cartridges can hold as much as 50 billion bytes of information. This is equivalent to 2,500 magnetic tape cartridges. This development is at least two years away, however, and then several years of use will be necessary before its archive characteristics are understood.

Magnetic storage technologies have advanced at a pace to keep up with new storage requirements as they have evolved. There is no reason to believe that this pace will change in the future. Optical technologies have been slower to develop and appear to be just emerging. Thus, they have some time to go before being considered as an archival medium. It is unsettling to see the rate of change evolving on a two or three year cycle rather than the five to eight years as in the past. Program managers and consumers cannot afford to change at such a fast rate. New technologies offering vast capacities and very high data transfer rates currently appear to present a higher risk to the recorded information over time and may not be suitable for open-ended archival use. Only time will tell.

Anyone wishing to retain data for an indefinite period, as NOAA seeks to do, will have to plan on migrating their data to newer media periodically to ensure longevity. All the while, the magnetic media technologies continue to improve and many of the fears we have concerning the applicability of these media for long-term archive will disappear. Just as the optical technologies are beginning to emerge, new developments in the use of blue light lasers may make obsolete everything available today. Thus, as magnetic media technologies continue to advance and improve, optical media technologies that may eventually supersede them continue to emerge. ■

The *Earth System Monitor* Toolbox

Like many publications today, the *Earth System Monitor* is produced using a desktop publishing system. This brief note is in response to a number of inquiries from readers wishing to know how the *Monitor* is produced. Persons unfamiliar with desktop publishing or those who are just beginning to apply this new technology to their own projects may find it helpful to know the tools used to prepare this publication.

The *Monitor* is produced on an Apple Macintosh desktop publishing system that has grown and expanded to keep up with new hardware and software features and capabilities and to accommodate the increasing size and complexity of the products created on it. This system is used to create a variety of publications and presentation materials and the *Earth System Monitor* is only a small fraction of its output.

Although this Macintosh system is not yet part of a network, it coexists happily in an office that is predominantly PC-based. With an external drive that reads and writes 5.25-inch, MS-DOS diskettes and software modules that translate back and forth, files are easily exchanged between Mac and PC systems. In cases where Mac and PC versions of the same or similar software packages are available, files created on the Mac can be opened and used directly on the PC and vice versa without intermediate translation. In addition, with a scanner and text recognition software, articles submitted as hard copy can be digitized and saved as word processor files.

The box below gives a summary of the principal tools currently used in the production of the *Earth System Monitor*. This listing should not be construed as an endorsement or recommendation. There are competing products that may work as well as or better than the ones we currently use. And anyone who tries to keep up-to-date with new developments in the personal computer arena knows that new versions of products keep leapfrogging one another as vendors try to keep up with or jump ahead of the competition. Like everyone else in this game, we read reviews in the trade magazines and try to get products that will meet our needs over the long haul and give us the most for our procurement dollar.

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Earth System Monitor

HARDWARE:

CPU:	Macintosh IIci with 8 MB RAM and 205 MB internal hard disk
Monitor:	Radius 19-inch two-page color display
Scanner:	Microtek 600ZS scanner
External drive:	Daynafile, 5.25-inch, DS/DD, MS-DOS
Printers:	Apple Laserwriter IINTX (300 dpi, draft copy) LaserMaster LaserMAX 1000 (1000 dpi, final camera copy)

SOFTWARE:

Word processing:	Microsoft Word (v. 4.0)
Page layout:	Aldus PageMaker (v. 4.0)
Technical illustration:	Adobe Illustrator (v. 3.0)
Text scanning:	Caere Omnipage (v. 3.0)

TYPOGRAPHY:

Text:	Century Old Style
Display type:	Franklin Gothic
Graphic elements:	Zapf Dingbats

Ozone Workshop, *from page 1*

Center, Toronto, Canada. The need for this arose from the work of the International Ozone Trends Panel that concluded that examination of the published ozone record revealed a need for revision of the data. It was noted that reexamination of the records of several North American and European stations improved the quality of the records significantly, thus improving the precision of the total ozone data sets from the respective stations. The fact that this was the result of the reanalysis has a larger implication than the application of the Dobson data to other current measurements. The Dobson data set covers an extended period and thus the possibility exists of extending the information on ozone trends 35 years back in time. It would then be truly an archeological data set.

The workshop attendees specifically addressed the following:

- Could the precision of the data from the other stations not reanalyzed be improved in a similar fashion?
- What procedures should be employed in this reanalysis?
- Which stations should be reanalyzed first?

It was noted that of all the Dobson stations, 10 have had their data records completely revised; 12 are currently being reevaluated; 10 are thought to be in good condition but have not been completely revised; and 42 require reanalysis. While the highest priority effort is the revision and documentation of the best possible data from all stations, scientific considerations will guide the near-term effort.

It was the unanimous feeling of the workshop participants that certain Dobson stations have already shown the ability to produce a highly precise data set of total ozone amount. The participants also suggested a second workshop at which scientists who have already performed such reanalyses can describe their procedures to representatives of the organizations of other stations especially those of high scientific priority.

On the basis of the recommendations of the workshop, a proposal for the continuation of this evaluation and assessment of the Dobson data set will be submitted to the Information Management Core Project.

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