OCEANOGRAPHIC DATA ARCHEOLOGY

FINDING HISTORICAL DATA FOR CLIMATE AND GLOBAL CHANGE RESEARCH

By Bruce B. Parker

A CRITICAL REQUIREMENT for climate and global change research is the availability of global oceanographic data covering long time periods. Substantial resources are presently being allocated for various global ocean programs and for the establishment of a true global ocean-observing system. However, researchers dealing with long-term changes in the ocean will have to wait many years (even decades) for long enough data sets to accumulate from these projects. Our only recourse, therefore, is to take full advantage of data that have been collected over the past decades. Unfortunately, it has been estimated that perhaps half of all historical global ocean data do not presently reside in any of the maintained data archives around the world and thus are not available to climate and global-change researchers. Many of these data may be at risk of being lost forever. It is time to put forth an ambitious integrated effort to recover these data before it is too late.

The term used to describe efforts to salvage historical ocean data is "oceanographic data archaeology." A report to the NOAA Panel on Climate and Global Change by the Working Group on Data Management defines "data archaeology" as "the reconstruction of past climate and other aspects of global change from existing data. It involves a mix of seeking out, restoring, evaluating, correcting and interpreting past data sets." We are now at a critical juncture when interest in climate and earth history is high and funds are available. This may be our last chance to save many of these valuable old data.

The US National Oceanographic Data Center (NODC) hosted an international workshop, funded by the NOAA Climate and Global Change Program, on oceanographic data archaeology. The participants included scientists and data managers from seven countries (USSR, Japan, Korea, Chile, Australia, Denmark, and the USA) who had an understanding of the needs of the research community and a broad knowledge of the availability of historical data and of possible methods for finding and acquiring those data. The participants collectively provided coverage of most regions of the globe.

Prior to the workshop, a working draft plan for an Oceanographic Data Archaeology Project was sent to each workshop participant, as well as to other interested individuals who were unable to attend, in order to provide a framework for discussions at the workshop and to help stimulate ideas. Responses to and ideas stimulated by the draft plan were incorporated into the workshop.

The main objective of the workshop was to obtain enough information from the participants to design an integrated data-archaeology approach for the efficient and extensive acquisition of historical global oceanographic data for use by the climate and global change research community. A second objective was to gain an initial sense of priorities—specifically, to determine in which areas data are most needed and which aspects of data archaeology are most important to pursue—so that an archaeology program can begin right away and take advantage of whatever funding can be obtained.

An integrated approach to oceanographic data archaeology will include activities such as

- setting priorities based on geographic and temporal needs of the research community and on the need to "rescue" data at risk;
- summarizing existing archived digital data sets in the world's data centers and data-gathering institutions;
- summarizing known manuscript and analog data that should be digitized;
- discovering the existence of historical data;
- convincing institutions to provide the newly discovered historical data (preferably in digitized form) and the necessary documentation;
- digitizing (optically or manually) manuscript and analog data;
- performing quality control activities;
- making the data accessible to the scientists who need them; and
- increasing communication among international scientists and data managers about oceanographic data sets and data archaeology efforts.

Each of these topics was discussed in detail at the workshop.

In addition, the participants provided information on historical data in manuscript form that they already knew about and thought should be digitized. For example, Sydney Levitus mentioned that there are ~158,000 mechanical bathythermograph profiles at the Scripps Institution of Oceanography, dating back as far as 1942. The World Data Center A for Oceanography (WDC-A), collocated at NODC, has a large collection of valuable historical data in manuscript form.

A significant immediate benefit of the workshop was the discovery of a few data "treasures" as a result of these discussions. In preparation for the workshop, Harry Dooley, the Hydrographer of the International Council for the Exploration of the Sea (ICES), prepared a report that summarized, country by country, a century of hydrographic data stored at ICES. In the process of writing this report, Dr. Dooley discovered, in the cellar of ICES, 200,000 cards of hydrographic data. These cards were all originally thought to be included in the ICES computer database. That database, however, includes only data from the *Bulletin Hydrographique,* which ICES published from 1902 to 1956; and these cards contain considerably more data—including data from the *Rapport Atlantique,* which the ICES Atlantic Slope Committee published from 1921 to 1935. At least 5000 of these cards contained deep-water data, down to 3000 meters, from the

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eastern North Atlantic, an area where historical data have been scarce. In the basement of Charlottenlund Castle (the former ICES headquarters), Dr. Dooley discovered an additional 20,000 cards of geographically sorted Danish data, also not in the computer database. Some of these cards contained data from the 1896 *Ingulf* Expedition in the Norwegian Sea.

The workshop participants agreed that initially the archaeology effort should concentrate on hydrographic profile data, including nutrient data. It was felt that the data-archaeology approach developed with these initial data types would be applicable to other data types. It was also agreed that certain high-priority activities should begin as soon as possible.

For example, the NODC and WDC-A agreed to begin producing data distribution maps of their hydrographic data holdings on a country-by-country basis for decadal, pentadal, or interannual time periods (to assure that individual cruise tracklines will be visible). Appropriate maps will be sent to data centers and data-gathering institutions in every country. From these maps, institutions will be able to tell whether all their data are in the archive, and the total extent of archived data. The World Data Center A will also help other countries produce data-distribution maps of their holdings if such help is required.

An inventory will be compiled of manuscript and analog data sets of which the workshop participants are now aware. With this information, priorities for expending resources to digitize data can be decided upon. By distributing this list to various data centers, it also can be determined whether any of these data already have been digitized. This inventory will be continually updated as new historical data sets are discovered.

The participants thought that data archaeology was an activity that would benefit from a newsletter. A frequently published Ocean Data Archaeology Newsletter would help make the scientific and data-management communities aware of data-archaeology efforts and would provide the kinds of information that would stimulate the discovery of unarchived historical data sets, such as data distribution maps, lists of known manuscript and analog data, updates on newly discovered data, rumors and leads that need substantiation, articles about research and archaeology projects at various institutions, and even interesting historical articles dealing with cruises and data. In addition, a telemail bulletin board (or mailbox) would allow for rapid communication about archaeology issues and potential data sets.

These techniques will play an important role in discovering and acquiring historical data sets. Many other techniques were proposed and discussed, including visiting scientist programs and joint research projects using historical data; monetary support of "regional archaeology centers" and institutions with historical data in need of digitization and quality control; use of an automated ROSCOP/cruise report system to point to data collected but never archived; bibliographic searches of published and gray literature to discover additional historical data sets; use of the WDC-A *Catalogue of Data and Catalogue of Accessioned Publications;* compilation of an inventory of researchers and data managers working with particular data types; the development of a personal-computer program for quality-controlled data entry and format conversion to aid manual digitization efforts at some institutions; and the compilation of instrumentation and quality control methods used over the years for particular data types.

Workshop participants included Harry Dooley, ICES, Copenhagen, Denmark; Nikolai Mikhailov, World Data Center B, Obninsk, USSR; Arkady Alekseev, Pacific Oceanological Institute, USSR Academy of Science, Vladivostok, USSR; Shin Tani, Japanese Oceanographic Data Center, Tokyo, Japan; Ben Searle and Gary Hopwood, Australian Oceanographic Data Center, North Sydney, Australia; Kee-Soo Nam, Korean Ocean Research and Development Institute, Seoul, Korea; Ricardo Rojas, Instituto Hidrografico de la Armada, Valparaiso, Chile; Joe Reid and Warren White, Scripps Institution of Oceanography, LaJolla, CA, USA; Ronald Moffat, WDC-A/US NODC; Sydney Levitus, US NODC; Pembroke Hart, WDC-A Coordination Office, US National Academy of Sciences; and Bruce Parker (chairman), WDC-A/US NODC.

For a copy of the Report of the Oceanographic Data Archaeology Workshop or to be added to the mailing list for the newsletter, telephone Robert Gelfeld at (202) 606-4571. ❑

LET ROGER REVELLE SPEAK FOR HIMSELF

By Walter H. Munk and Edward A. Frieman*

IN THE April 1991 issue of the *Cosmos Club Journal*, Singer, Revelle and Starr published a paper, "What To Do About Greenhouse Warming: Look Before You Leap." Roger died in July 1991. One year later, in a discussion of Senator Gore's book *Earth In Balance*, Gregg Easterbrook notes that Senator Gore failed to mention that "before his death last year, Revelle published a paper that concludes, 'The scientific basis for greenhouse warming is too uncertain to justify *drastic* action at this time.' " (Italics ours; see Green Cassandras, *The New Republic*, 6 July 1992.) Easterbrook goes on to say, "A lifetime of study persuaded Revelle that carbon emissions should be restricted, but are far less hazardous than initially feared."

S. Fred Singer wrote the paper and, as a courtesy, added Roger as a co-author based upon his willingness to review the manuscript and advise on aspects relating to sea-level rise. The whole, it seems to us, is rather less than the sum of its parts, relative to Roger's stance on these issues.

The key is the use of the word *drastic*. Roger's last written statement on the subject was "What Can We Do About Climate," presented at the AAAS (American Association for the Advancement of Science) session, *Climate Change: Scientific Uncertainties and Policy Responses* in New Orleans on 16 February 1990. It outlines a possible set of actions designed to mitigate or delay climatic warming. It includes attempts to modify society's use and mix of fuels. While these may not be viewed as *drastic*, there is also no evidence that he believed that "emissions . . . are far less hazardous than initially feared."

Roger attended a joint meeting of the American Philosophical Society and the Royal Society in London in May 1991, just a few months before he died. One of us was present and noted that in a public discussion of foreign climate research, he criticized the lack of certain types of measurements, which he believed necessary to understand the phenomena. Roger's strongly held personal conviction called for *informed activism*, a combination of research and public policy action, a view he held at the time of his death.

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