



# National Ocean Survey Abstracts - 1978

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## PREFACE

The National Ocean Survey (NOS) provides charts and related information for the safe navigation of marine and air commerce. NOS also furnishes other Earth science data from geodetic, hydrographic, oceanographic, geomagnetic, seismologic, gravimetric, and astronomic surveys, observations, investigations, and measurements.

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Alger, D. E.

Implementation of the National Geodetic Survey's data base system. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 247-257. GPO #003-017-0426-1

Currently the National Geodetic Survey (NGS) is implementing a data base system that is being developed in-house. This system will be used in the following capacities: It will (1) serve as the custodian of NGS data, (2) act as a tool for the new adjustment of the North American Datum, and (3) provide the basis for an automatic data publication system. Many problems were encountered in data collection and storage during implementation of the data base. Some of these problems and their solutions are discussed.

Appell, G. F.

A review of the performance of an acoustic current meter. Proceedings of a Working Conference on Current Measurement, NOAA, Delaware Sea Grant College Program, Jan. 1978, p. 35-58.

Laboratory tests were performed by the National Ocean Survey's Test and Evaluation Laboratory on a new electromagnetic-type current sensor. The simulation methods are described for attaining a performance description of the sensor's dynamic response and steady flow characteristics in the laboratory. Test results and data interpretation are discussed.

Banks, N. E., and Fefe, C. X.

Bathymetric mapping. Presented to the Ninth International Conference on Cartography, International Cartographic Association, College Park, Md., July 26-Aug. 2, 1978, 8 pp. (LISD)

More than ever before our Nation is concentrating its scientific and engineering capabilities toward the development of the oceans' natural resources and toward finding ways to preserve or reduce the impact of these offshore activities on our coastal states. The key to achieving the goals of these two objectives is the application of marine cartographic skills and techniques to produce detailed bathymetric maps and topographic/bathymetric maps of the coastal zone. Having foreseen the need for such maps, the National Ocean Survey has undertaken a program to produce a series of 1:250,000-scale bathymetric maps covering potential leasing areas on the Continental Shelf and a second program to produce, jointly with the U.S. Geological Survey, a series of 1:24,000-, 1:100,000-, and 1:250,000-scale topographic/bathymetric maps of the coastal zone. This paper will discuss past and current program activities, the purpose of these products, and the cartographic procedures/methods used in their construction.

Banks, N. E., and Lennart, J. (USGS)

Coastal zone mapping: a topographic/bathymetric and bathymetric approach. Coastal Zone '78, vol. 2, American Society of Civil Engineers, Conservation Foundation, NOAA Office of Coastal Zone Management, Mar. 1978, p. 919-927.

Effective management of coastal zone programs and projects requires maps that accurately delineate the topographic features of both the land and ocean. In response to this important need, the National Ocean Survey (NOS) and the U.S. Geological Survey (USGS) have undertaken a joint program to produce a series of topographic/bathymetric maps covering the entire coastal zone of the United States. These multi-purpose maps, commonly referred to as "topo/bathy maps," represent a joining of the NOS bathymetry (topography of the ocean bottom) and the USGS land topographic information into a single product. This new series of 1:24,000-, 1:100,000-, and 1:250,000-scale maps can meet varying coastal planning and management requirements, such as marine resource studies, determination of sediment flows, beach replenishment projects, land use planning, wetland assessments and other related environmental studies. The bathymetry and shoreline on these maps are developed from tide-coordinated data, and are shown in as much detail as the scale of the maps will allow. Present and future topo/bathy mapping programs, the technical operations that are performed in the preparation of these maps, and plans for possibly adjoining bathymetric maps to the topo/bathy maps are discussed.

Beardsley, R. (Woods Hole Oceanographic Institution), Boicourt, W. (Johns Hopkins Univ.), Scott, J. (SUNY), and Huff, L. C.

CMICE 76: a current meter intercomparison experiment conducted off Long Island in February-March 1976. Proceedings of a Working Conference on Current Measurement, NOAA, Delaware Sea Grant College Program, Jan. 1978, p. 153-155.

A current meter intercomparison experiment (called CMICE 76) was conducted about 6 km off the southern coast of Long Island near 40°47'N, 72°30'W during February and March 1976. A total of 20 current meters were deployed on 6 moorings set in roughly linear array, parallel to the local coastline and topography. The instruments included the Aanderaa RCM-4, the AMF VACM, the Brookhaven National Laboratory spar buoy system using cylindrical and spherical Marsh-McBirney electromagnetic sensors, the EG&G 850 and CT-3, and the Chesapeake Bay Institute-modified ENDECO 105. Local mean water depth was 27.8 m, and current meters were clustered near four depth levels (3.5 m, 7.4 m, 15.7 m, and 25.0 m). Wave data were also obtained at the array site, and 10-m-wind and tidal data were obtained from nearby coastal stations. Inter-comparisons of 1-hour-vector average velocities, measured with similar instruments deployed near the same depth level, indicated sufficient horizontal homogeneity that most differences in the observed current data have been attributed to real differences in instrument and mooring performance. Detailed discussions of the observed data, instrument and mooring characteristics and performance, and the effect of surface wave and wave-induced mooring motion on different measurement systems are presented.

Bender, P. L. (National Bureau of Standards), and Goad, C. C.

Probable LAGEOS contributions to a worldwide geodynamics control network. Proceedings of the Satellite Geodesy Symposium, International Association of Geodesy, May-June 1978.

The need to establish a worldwide reference system for geodynamics is clear. We have carried out simulations on the contributions which laser range measurements to LAGEOS can make in establishing such a system. A distribution of 10 fixed ranging stations was assumed for most of our calculations, using stations located in the United States, South America, Western Europe, Australia, and Japan. A single 7-day arc was used, and measurements were assumed to be made only every 10 minutes to avoid artificial reductions in the uncertainties due to oversampling. As is well known, the gravity field model will initially be the main contributor to the station coordinate uncertainties. However, if some of the harmonic coefficients are adjusted using LAGEOS data, the gravity field model effects can be substantially reduced. Simulations in which we solved for all of the tesseral harmonic coefficients through degree 5, plus 20 additional terms, have shown that an rms station coordinate uncertainty of 4 to 5 cm can be achieved for random range measurement errors and range biases between 0.7 and 2 cm. The scaled GEM-10 standard deviations were used both as a priori uncertainties for the adjusted coefficients and for calculating the effects of the remaining unadjusted coefficients. When further improvements in the gravity field models have been made, it seems likely that retrospective analyses of the LAGEOS ranging data obtained in the next few years will be limited mainly by the atmospheric correction uncertainty and the range measurement biases, even if the bias uncertainty is only 0.7 cm. The future value of the data for determining tectonic motions will be a strong function of the measurement accuracy. Some comments also are made on possible procedures for maintaining a worldwide geodynamics reference system.

Blust, F. A.

The water levels of the Great Lakes. Coastal Zone '78, vol. 3, American Society of Civil Engineers, Conservation Foundation, NOAA Office of Coastal Zone Management, Mar. 1978, p. 1549-1569.

Background information on the water levels of the Great Lakes needed by Great Lakes coastal zone planners and managers is presented. The subject is introduced through a discussion of the hydraulic system of the Great Lakes, the vertical datums used, and how elevations have been established on the lakes and along the connecting rivers. The flow of water from Lake Superior at the head of the system through the lower lakes to its eventual discharge via the St. Lawrence River is described, including special factors affecting the flow such as control structures; pertinent flow data are also given.

Bolton, R. M., and Neidermair, F. R.

Quantitative and qualitative factors in studying the feasibility of auto-

mating radar video map production. Presented to the Ninth International Conference on Cartography, International Cartographic Association, College Park, Md., July 26-Aug. 2, 1978, 1 p. (LISD)

The quantitative and qualitative factors of automating Radar Video Map (RVM) production were studied from cost, human factor, hardware, and software viewpoints. It was ascertained that it was technically and economically feasible to produce RVM's utilizing an automated system. During the final phases of the study, a prototype system was developed which produced RVM's utilizing existing hardware; the operation of the prototype system verified the findings of the study.

Bossler, J. D.

Status of the new adjustment in the United States. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 31-39. GPO #003-017-0426-1

The status and progress of the data processing effort in the United States are discussed, and the predicted completion dates of important milestones are presented. Costs of the new adjustment incurred to date and estimates for the future are cited. An error analysis of a specific aspect of the orientation problem is discussed. Some ideas are presented for determining the final orientation.

Bossler, J. D.

The new adjustment of the North American Datum as it affects the land surveyor. Presented to the American Congress on Surveying and Mapping Spring Meeting, Denver, Colo., Feb. 28, 1978, 12 pp. (LISD)

The new adjustment of the North American Datum is proceeding on schedule. The numerical problems associated with the solution of 500,000 unknown parameters, simultaneously, appear to be minimal. The orientation of the datum will be achieved to an accuracy of several meters, and some preliminary results are discussed. The status of our program for predicting the deflections of the vertical is mentioned. The results of a test adjustment of 3,500 stations using the Helmert Block software system indicate the adjustment can be achieved in an efficient manner. Several new policies affecting a variety of users are defined, and some thoughts related to a posteriori error propagation are discussed.

Brewer, R. K.

Project planning and field support for NOS bathymetry. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 55-66.

Successful data acquisition for the NOS photobathymetry program is highly

dependent on office project planning, scheduling, and field support. Considerable effort is expended prior to the aerial photography phase in developing the horizontal and vertical control specifications, tidal datum requirements, and flight parameters. Specifications for all field support activities are conveyed to the field unit by detailed instructions, job diagrams, and pertinent data collected during the planning phase. Field operations, which include premarking horizontal and vertical control stations and obtaining tidal data, are accomplished in conjunction with the photographic mission and are critical to the success of the data reduction.

Carter, W. E.

Modern methods for the determination of polar motion and UT1. Proceedings of the Tenth Annual Precise Time and Time Interval Applications and Planning Meeting, NASA Technical Memorandum #80250, Goddard Space Flight Center, NASA, Greenbelt, Md., Nov. 1978, p. 569-583.

Applications that relate to Doppler satellite observations, laser ranging to artificial satellites and the Moon, and astronomic radio interferometry for monitoring polar motion and UT1 are discussed. Emphasis is placed on the measuring capability of each method, its fundamental limitations, and developmental status. The methods are evaluated as candidates for the next generation to monitor the international polar motion and UT1 monitoring service.

Carter, W. E., and Pettey, J. E.

Goldstone validation survey--phase 1. NOAA Technical Memorandum NOS NGS 15, Nov. 1978, 39 pp. PB292310

The results of a special purpose study conducted by the National Ocean Survey's National Geodetic Survey at NASA's Jet Propulsion Laboratory MARS Deep Space Station, located at the Goldstone Deep Space Communication Complex in California, are presented. The purpose of the study was to determine the components of an approximately 330-m base line, used in space system validation studies, with an accuracy of  $\pm 1$  cm; three-dimensional geodetic techniques were employed. The observational methods of measurement are described, and input and output of the least-squares adjustment program, HAVAGO, are included as appendices.

Carter, W. E., Pettey, J. E., and Strange, W. E.

The accuracy of astronomic azimuth determinations. Bulletin Geodesique, vol. 52, No. 2, p. 107-113.

Astronomic azimuths are used in classical geodesy, through the Laplace equation, to control the orientation of geodetic networks. The method most commonly used by the United States National Geodetic Survey for the determination of astronomic azimuth is often referred to as the "direction method," and is based on observations of Polaris at any hour angle. We have

analyzed repeat determinations, by analysis of variance (ANOVA) techniques, to derive realistic estimates of the expected accuracy of typical astronomic azimuths to be used in the readjustment of the North American Datum. We found that the dominant errors are systematic in nature, with a very important source being observer bias, or "personal equation." We were unable to decompose the remaining systematic error, which presumably consists primarily of instrument biases, anomalous refraction, and setup errors. We found, from an analysis of determinations that were first corrected for observer bias, an increase in the variance of repeat azimuth determinations as a function of latitude that agrees reasonably well with theoretical expectations.

Carter, W. E., Robertson, D. S., and Abell, M. D.

An improved polar motion and Earth rotation monitoring service using radio interferometry. Proceedings of the International Astronomical Union Symposium No. 82: Time and the Earth's Rotation, May 1978.

The National Ocean Survey's National Geodetic Survey has begun project POLARIS (POLar-motion Analysis by Radio Interferometric Surveying) to establish and operate a three-station network of permanent observatories for monitoring polar-motion and Earth rotation (UT1) by radio interferometric observations of quasars. The POLARIS observatories will be equipped with a new generation of instrumentation and software, the Mark III data acquisition and processing system now being developed by a multi-organizational team. Computer simulations indicate that the POLARIS network will be capable of determining the x and y coordinates of the pole to  $\pm 10$  cm, and UT1 to  $\pm 0.1$  millisecond of time, in an averaging period of less than 24 hours. The first two observatories are expected to be fully equipped and conducting operational tests during 1980. The full POLARIS network should be operational by the end of 1981.

Carter, W. E., and Vincenty, T.

Survey of the McDonald Observatory radial line scheme by relative lateration techniques. NOAA Technical Report NOS 74 NGS 9, June 1978, 33 pp. PB287427

During May and June 1977, the National Ocean Survey's National Geodetic Survey performed a special survey in the vicinity of the University of Texas' McDonald Observatory. This was the initial phase of an extensive geodetic-geophysical study to detect any secular or episodic motions of the observatory relative to prominent topographic features within a region extending as far as 100 km from the observatory. An important part of the study plan is the monitoring, by periodic resurveys, of any changes in the lengths of a radial pattern of lines that are as long as 93 km. A method of relative lateration, the "ratio method," using electromagnetic distance measurements is being tested. Independent May and June measurements were consistent to the level of a few parts in  $10^7$ , the largest discrepancy amounting to only 10 mm on a 52-km line, approximately 0.2 parts per million. Descriptive information about the methods employed in the

collection, reduction, and analysis of the survey data, tabulations of the observational data, and the numerical and interpretive results of our analyses are presented.

Chappas, W. J.

National Ocean Survey's cartographic data base forecasts. Proceedings of the American Congress on Surveying and Mapping 38th Annual Meeting, Feb.-Mar. 1978, p. 284-288.

As early as 1962, the National Ocean Survey (NOS) conceptualized computerized cartographic production processes. The concepts were ultimately determined to be technically and economically feasible, and were instrumental in the establishment of two major NOS programs -- the Marine Data Systems Project (MDSP) and the Aeronautical Chart Automation Project (ACAP). Both projects, as conceived, require centralized digital data bases. The MDSP project is related to the production of nautical charts and envisions a very large data base containing information that is fairly stable and not subject to change. The ACAP project is related to the production of aeronautical charts and envisions a relatively small data base containing information that is unstable and subject to frequent change. This paper describes NOS' present manual cartographic processes, the uses of the products produced by these processes, current production problems, impact of new requirements, NOS plans for cartographic data bases, and present requirements for the future benefits of NOS digital data bases.

Chovitz, B. H.

Global gravity field solution combining data from satellite tracking, surface gravity, and altimetry. Proceedings of the Helmert Colloquia, Zentralinstitut fur Physik der Erde, Sept. 1978.

Comprehensive solutions for the global gravity field, containing almost 600 parameters, have been developed. Such solutions are required to model the field with accuracy sufficient for precise tracking of geodetic satellites. Because of the large amount of data utilized, as well the great number of parameters, these solutions are also very expensive in terms of computer time and capacity. The motivation for the solutions discussed in this paper is to employ as wide a variety of data as possible to ascertain the effect of additional data classes, and to carry this out in as economical a manner as possible. To this end, two different solution schemes have been devised.

Chovitz, B. H.

Perspective projections in terms of the metric tensor to the second order. Bollettino di Geodesia e Scienze Affini, vol. 37, No. 2-3, Apr.-Sept. 1978, p. 451-463.

Consider the perspective mapping of a sphere of radius  $r$  onto a tangent

plane. Let  $h$  be the directed distance of the plane to the perspective point (the positive direction being outward from the sphere at the point of tangency.) An infinite series of perspective projections is generated as  $h$  varies continuously from  $-\infty$  to  $+\infty$  (with the exception of  $h=0$ ). Such an arrangement in a continuous mode is useful because it mirrors the view of the Earth from a satellite (for  $h>0$ ). A systematic classification of perspective projections can be constructed on the basis of the author's previously published general theory which defines a map projection in terms of the coefficients of a Taylor expansion to the second order of the metric tensor of the spherical surface. Under this correspondence, for example, the orthographic, gnomonic, stereographic, azimuth equidistant, and azimuthal equal-area projections are defined by  $h = \infty, -r, -2r, -3r,$  and  $-4r,$  respectively.

Chovitz, B. H.

Various representations of the residual gravity field. Proceedings of the International Association of Geodesy Special Study Group 4.45, June 1978, p. 21-28.

This expository paper collects in one place transformations between various representations of the residual gravity field, and indicates their relative usefulness. Thus, if the field is expressed in one form, and the use of another is desired, this summary may be a convenient reference. The discussion contains the following representations of the gravity field transformations between them: spherical harmonics, geoidal heights, gravity anomalies, and simple density layout.

Cohen, P. M.

Techniques for mapping the distribution of waste materials in coastal waters. Proceedings of the American Congress on Surveying and Mapping Fall Technical Meeting, Oct. 1978, p. 95-104.

Mapping the spatial and temporal distribution of waste materials disposed in coastal waters is one diagnostic technique in certain marine pollution studies. Among the wastes involved are sewage sludge, industrial chemicals, dredged materials, and pharmaceuticals, with some concern evidenced on geographic patterns of concentration and dispersal routes. Determining the ultimate fate of such materials presents a challenge to effective monitoring, with such aspects as surface and sub-surface currents, submarine topography and morphology, the impact of disposal in rings (or eddies), and the interaction of water mass boundaries posing complex mapping problems. Tools assembled to quantify and map these factors include modified acoustic sounders, remote sensors, and submersibles, in conjunction with test disposal operations by NOAA and the Environmental Protection Agency, with end products in the form of tapes, lists, and predictive reports as well as traditional map graphics. These are discussed together with recent results.

Cohen, P. M.

Recent distinctive sea maps. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 12 pp. (LISD)

Sea maps characterized by the depiction of sea floor topography as a primary aim show features that have measurable relief or that can be delimited by relief. Modern sea maps are relatively accurate due to advances in echo sounding technology, geodetic control, and application of automated data processing principles. Certain of these graphics are distinctive by virtue of content or format, or both, reflecting important phases in current sea map evolution. Format is at least as important as content in many of these cartographic presentations, with the ultimate intent to transfer information effectively. At the same time, it is important to distinguish between coastal graphics on the shelf and slope and those in deep areas, both as to data density and to data utilization in compilation phases. Data which do not meet necessary standards still pose a failing in the mapping of many areas; however, there are hopes that new conceptual sounding systems will fill this gap.

Cohen, P. M.

Sea-floor map accuracy standards as functions of survey and compilation procedures. Proceedings of Ocean Expo '78, Oceanology International, Mar. 1978.

The depiction of sea floor relief on maps used for engineering-associated work in the oceans, and in particular, selected factors that can govern realistic interpretation of such information is discussed. Sea floor maps (more properly, "bathymetric" maps) are constructed generally for engineering or scientific use, as opposed to nautical charts, a category of graphics used chiefly for navigation.

Collins, J.

Photogrammetric determination of coastal boundaries. Presented to the American Society of Photogrammetry Fall Technical Meeting, Albuquerque, N.M. Oct. 15-20, 1978, 6 pp. (LISD)

The National Ocean Survey has been mapping U.S. Coastal boundaries for the past 160 years. During the past 40 years, photogrammetric techniques have been increasingly used and have virtually eliminated field survey procedures. The appropriateness of the photogrammetric method of determining these boundaries is discussed. Examples of how historic and recent photogrammetric surveys are used as aids to the litigation process are presented.

Collins, J.

Cost benefits of photobathymetry. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 97-102.

The National Ocean Survey has recently completed photographing approximately 60 square nautical miles of underwater area surrounding St. Croix, V.I. Analysis of the field, data acquisition, and processing costs for this underwater mapping project show that photobathymetry is a cost-effective surveying technique. A comparison between photogrammetric underwater mapping and conventional launch hydrography gives a cost benefit ration of 6:1 in favor of photobathymetry.

Collins, J.

Photobathymetry results to date. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii, East-West Center, Aug. 7-9, 1978, 2 pp. (LISD)

In 1973 the National Ocean Survey began using photogrammetric techniques to map underwater areas. Recent advances in methodology include the development of real-time processing of observed water depths and the optimized scanning of photographic stereographic imagery. Cost comparisons between conventional hydrographic mapping and photogrammetric techniques show significantly lower costs for the photogrammetric method.

Collins, J.

National Ocean Survey support programs for coastal zone management. Proceedings of the Federal Coastal Zone Management Session Symposium, NOAA Office of Coastal Zone Management, May 1978.

The National Ocean Survey maintains a file of historic and current 1:20,000-scale shoreline maps that can be of significant help to the coastal managers. Similar data banks of offshore bathymetric information can also be used to aid coastal managers and engineers. In addition to these cartographic data, NOS maintains an array of horizontal and vertical survey control markers to which various measured parameters can be referenced. The significance and uses of these surveyed data and how they relate to the coastal management problems will be discussed.

Collins, J.

The National Ocean Survey Coastal Mapping Program. Coastal Zone '78, American Society of Civil Engineers, Conservation Foundation, NOAA Office of Coastal Zone Management, Mar. 1978, p. 907-918.

The National Ocean Survey and its predecessor, the U.S. Coast and Geodetic Survey, have been mapping the shoreline of the Nation for the past 161

years. The basic purpose of this shoreline mapping effort is to support the production of up-to-date nautical charts, which is the primary mission of NOS.

Collom, J.

Early mapping of the Louisiana coast. Proceedings of the Symposium on Measurement, Mapping, and Management in the Gulf Coastal Zone, American Congress on Surveying and Mapping, May 1978.

In 1776, the British produced a few charts for use in the Revolutionary War. However, these charts were based on incompleting investigations. By 1806, the survey of the Louisiana Coast, in conjunction with the Louisiana Purchase, had been completed. With the growth of the Nation, more shipwrecks occurred, increasing the need for more accurate charts. Therefore, on February 10, 1807, Congress authorized a survey of the coast. Surveys of the upper Gulf of Mexico coast began in 1845 and continue to the present. This paper gives a brief history of the early mapping efforts prior to 1845, and details the National Ocean Survey's role in this early mapping.

Dillinger, W. H.

Helmert block higher level system. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 417-426. GPO #003-017-0426-1

In solving a very large system of unknowns using the Helmert blocking technique, the data are first partitioned into many initial level blocks. For each block, the normal equations are formed and partially reduced. The higher level system then accumulates the partially reduced normal equation elements for the junction unknowns of the lower level blocks to form a new higher level normal equation system. The new junction unknowns are automatically identified, and the associated partially reduced normal equation elements are passed onto the higher level blocks. The complete "tree structure" defining the blocking strategy is processed in this manner, reducing the normal equations to the Cholesky factor. The tree structure is then followed in reverse, completing the back solution. A new reordering procedure is used to minimize the storage and number of operations for each higher level Helmert block. This procedure identifies groups of unknowns, called "cliques," which can be considered as single nodes in the reorder problem. This reduces an otherwise intractably large reorder problem to one of manageable proportions.

Douglas, B. C.

Geodetic and steric leveling: together at last? EOS: Transactions of the American Geophysical Union, Dec. 1978, p. 1000-1001.

An apparent systematic difference appears between geodetic leveling and mean sea level along the U.S. coasts. New leveling surveys have been performed

between the San Francisco and San Pedro tide stations and compared to previous surveys. A trend from geodetic leveling indicates that San Pedro is rising with respect to San Francisco, or that San Francisco is subsiding with respect to San Pedro, at an average rate of about 70 mm/yr. However, the tidal records do not reveal significant changes in mean sea level. The indicated relative movement rate from leveling is about 30 times greater than the rate indicated by tidal observations.

Douglas, B. C., and Goad, C. C.

The role of orbit determination in satellite altimeter data analysis. Boundary Layer Meteorology, No. 13, 1978, p. 245-251.

The satellite-borne radar altimeters on GEOS 3 and SEASAT produce high-precision measurement of distance from the satellite to the ocean surface. However, the precision of the GEOS 3 altimeter (~50 cm) and especially the forthcoming SEASAT (~10 cm) instrument far exceeds our ability to determine the position of either satellite using conventional electronic or laser-tracking methods. Thus special techniques are required to prevent the uncertainty of the satellite position from degrading the value of the altimeter data. The altimeter data themselves provide a solution to this problem. Using the condition that intersections of passes of altimeter data must measure the same time-invariant part of the sea-surface height, the root-mean-square error of 292 intersections of 47 passes of GEOS 3 altimeter data from the Atlantic Ocean was reduced from 17 m to 44 cm. Simulations of the SEASAT problem also show that altimeter data can aid in determining the satellite orbit, and have their greatest value when radar or laser tracking is sparse.

Dracup, J. F.

The rejuvenation of the United States geodetic control networks. Proceedings of American Congress on Surveying and Mapping Fall Technical Meeting, Oct. 1978, p. 112-124.

The horizontal control network of the United States has been in a continual state of development since 1832, and the vertical network since 1856. Today, there are about 240,000 stations of first-, second-, and third-order accuracy in the horizontal net and some 500,000 bench marks where elevations have been determined to first- and second-order standards. Although the last adjustment of the primary horizontal net, initiated in 1927, provided a fundamental base of excellent quality, various circumstances and practices eventually created a situation where the inherent accuracy of the observational data was not being fully realized. To overcome this problem, a new adjustment of the network has been in progress since 1974 and will be completed in 1983. Since the last general adjustment in 1929, the leveling network has grown immensely, but age has now become a serious problem. Leveling especially is affected by tectonic events, economic development, and monument deterioration. The solution was to reobserve the basic lines and readjust the entire net. Releveling of the principal lines began in May 1978. By 1985, 100,000 km of new surveys and a new adjustment of the overall network will be completed.

Dracup, J. F.

National networks of geodetic control and the user. Proceedings of the Symposium on Measurement, Mapping, and Management in the Gulf Coastal Zone, American Congress on Surveying and Mapping, May 1978.

The National networks of geodetic control are multipurpose products essential to the accurate mapping and charting of coastal zone regions. Two major efforts are in progress. The new adjustment of the North American horizontal datum (NAD) and the releveling of the principal lines of the vertical control network are certain to have a profound effect on the user. With the completion and publication of the redefinition of the NAD in 1983, the adjusted data will represent the highest accuracy attainable from the observations, an objective not heretofore obtained due to the piecemeal fitting together of surveys. Similarly, the vertical control network, unconstrained by the effect of tidal variations, will become almost totally geodetic in character, thus providing a better base to aid in delineating tidal boundaries.

Dracup, J. F.

New adjustment of the North American Datum and the surveyor. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 481-486. GPO #003-017-0426-1

With the completion and publication of the new adjustment of the North American Datum (NAD) in 1983, the data will represent, for the first time, the optimum accuracy obtainable from the observations included in the geodetic networks of North America. To the surveyor now using the published coordinates and associated data, it will mean that survey closures can be evaluated without undue consideration of the constraints inherent in the present network. For example, to have a good understanding of the closures, today many users must ascertain by one method or another the relative accuracies of adjacent networks which were adjusted at different times. Since the new adjustment will be a simultaneous computation which should provide the best approximation of a homogenous framework, this practice can be substantially reduced or eliminated. Other surveyors who have been discouraged because of the numerous readjustments in the past, which resulted in constant changes in the published results, may once again become advocates. To those now entering the profession, the advantages of becoming a user will be more pronounced. Modern technology will be used with confidence, eliminating the necessity of applying disproportionate corrections to the observations.

Dracup, J. F.

The National Ocean Survey time machine--Humboldt Bay revisited. Proceedings of the American Congress on Surveying and Mapping 38th Annual Meeting, Feb.-Mar. 1978, p. 389-399.

The original hydrographic and topographic survey of Humboldt Bay, Calif., in 1851 is of particular interest for several reasons, including the fact that it was one of the first surveys of a prominent feature on the Pacific coast that undertook both hydrographic and topographic operations simultaneously. Since the various phases of the project would cover several papers, only a single aspect of the project, the establishment of the horizontal control, is discussed. Specifically, geodetic instrumentation was not used in observing the control network. But, even today, the observational data are of sufficient accuracy to meet the requirements. The tests employed would have been impractical a decade or so ago, but the application of statistical techniques and the use of high-speed electronic computers have proved the long held contention that survey data are timeless.

Floyd, R. P.

Geodetic bench marks. NOAA Manual NOS NGS 1, Sept. 1978, 56 pp. PB296427  
GPO #003-017-00442-2

Geodetic survey control points must be remarkably stable to establish geodetic control. All monuments are subject to the effects of geologic and soil activity. Vertical control points are particularly vulnerable because this activity results in vertical movements much more so than horizontal motion. In addition to natural disturbances, damage inflicted by mankind is a critical problem in monumentation. This manual explains how and where to set bench marks for maximum stability and calls attention to the factors that affect vertical instability.

Frey, H. R.

Northeastward drift in the northern mid-Atlantic bight during late spring and summer 1976. Journal of Geophysical Research, vol. 83, No. C1, p. 503-504.

Surface drifters were air-dropped on a monthly basis from December 1975 to September 1976 at 40°23.2'N, 72°21.5'W, approximately 28 nautical miles due magnetic south of Shinnecock Inlet, Long Island. This study was part of an investigation of the pollution potential of a sunken World War II tanker, the M/V COIMBRA. It was anticipated that the drifters released during the late spring and early summer months would be recovered on the beaches of Western Long Island, following a westerly drift. However, drifters released during this period followed a northeasterly drift and were recovered at Cape Cod, Martha's Vineyard, and Nantucket. The average speed of the northeastward drift was 3 cm sec<sup>-1</sup>. Close packing of recovered drifters indicates that they were advected with little dispersion. The observed northeastward drift is attributed to anomalously persistent winds over the New York Bight during the late spring and early summer of 1976.

Fritz, L. W.

The NOSAP--a unique analytical stereoplotter. Presented to the American

Society of Photogrammetry 44th Annual Meeting, Washington, D.C., Feb. 26-Mar. 4, 1978, 12 pp. (LISD). Proceedings of the International Symposium on Equipment for Analytical Photogrammetry and Remote Sensing, International Society for Photogrammetry, Sept. 1978.

The National Ocean Survey Analytical Plotter (NOSAP, a sophisticated state-of-the-art analytical plotter system contracted from the OMI Corporation of America, is designed to provide a photogrammetric capability to process any type and combination of photo imagery to obtain metric information. The NOSAP contains computer program-controlled servo systems that move the photostages, rotate the optics, change the zoom magnification, change the size of the measuring marks, and drive the coordinatograph. The combined features of the NOSAP that make it unique include: (1) a new OMI-designed optical train that maintains a resolution of 150 lp/mm; (2) an independent photostage zoom magnification range of 5 to 30 X, the apparent size of individual measuring marks maintained throughout entire zoom range; (3) photostage slewing speeds of 40 mm per second; (4) measurement by linear encoders with an accuracy ( $\sigma$ ) of 1.8  $\mu$ m throughout the two large (23 by 46 cm) photostages; (5) a Concord Control Inc. coordinatograph specified to 32  $\mu$ m accuracy ( $3\sigma$ ) throughout a 1.45 by 1.15 m area; and (6) a Digital Equipment Corporation PDP 11.45 controller and peripherals for multitask processing. The entire system is supported by the elegant US-1 software programs developed by the Bendix Research Laboratories. The NOSAP is a state-of-the-art extension of photogrammetric mensuration and compilation capabilities. It will provide a photogrammetric tool that will enable the National Ocean Survey to respond to any conceivable photogrammetric task anticipated by the agency in the future.

Fritz, L. W., and Slama, C. C

Future NOS analytical instruments for photobathymetry. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 89-95.

Present photobathymetric techniques employ analog instruments in conjunction with correction graphs to compile water depth data. To improve upon both the efficiency and the accuracy of this data collection, the NOS photogrammetric research team has proposed two analytical approaches. The first is a software development that will take advantage of the inherent capabilities of a newly developed sophisticated analytical stereoplotter system, the National Ocean Survey Analytical Plotter (NOSAP). The other is the development of a modification to an analog restitution instrument, the Wild B-8 stereoplotter, to perform an on-line semi-analytical solution. The concepts and advantages of each development are discussed with particular emphasis on applications for photobathymetry.

Fury, R. J.

Automated recognition of collocated geodetic and astronomic stations. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of

Canada, Danish Geodetic Institute, Apr. 1978, p. 269-289. GPO #003-017-0426-1

The establishment of an integrated geodetic data base in the National Ocean Survey's National Geodetic Survey (NGS) requires the recognition of station names of collocated triangulation and astronomic observing stations prior to entry into the data base. It is highly desirable to automate the process because of the large number of station names that need to be compared and identified. Difficulties in automated identification are caused by abbreviations and various qualifiers in station names. A rigorous system would be cost-prohibitive, but experiments with correlation analysis techniques indicate that an effective semiautomated system would reduce the human effort by 80 percent. Experience with real data has verified the value of the technique in practical applications, and it has been adopted by NGS.

Gergen, J. G.

North American Datum new adjustment logistics. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 457-462. GPO #003-017-0426-1

The new adjustment of the North American horizontal datum is a major task involving a variety of special requirements and the systematic ordering of these tasks to assure their completion according to schedule. This paper presents an overview of the new adjustment responsibilities of the Horizontal Network Branch of the National Ocean Survey's National Geodetic Survey to provide an indication of the complexities of such an undertaking from the point of view of personnel allocation and computer requirements.

Goad, C. C., and Douglas, B. C.

Lunar tidal acceleration obtained from satellite-derived ocean tide parameters. Journal of Geophysical Research, vol. 83, No. B5, p. 2306-2310.

Analysis of 100 sets of mean elements of GEOS 3 computed at 2-day intervals has yielded observation equations for the  $M_2$  ocean tide from the long periodic variations of the inclination and node of the orbit. If the second-degree Love number is given the value  $k_2 = 0.30$  and the solid tide phase angle is taken to be  $0^\circ$ , the values are  $(3.99'' + 0.4) \times 10^{-2} \sin[\sigma(\tau) + 327^\circ \pm 4^\circ] = 1.26''/\text{cm} \times 10^{-2} C_{22}^+ \sin[\sigma(\tau) + \epsilon_{22}^+] - 0.32''/\text{cm} \times 10^{-2} C_{42}^+ \sin[\sigma(\tau) + \epsilon_{42}^+] + \dots$  for the inclination and  $(2.73'' + 0.7) \times 10^{-2} \cos[\sigma(\tau) + 291^\circ + 13^\circ] = -0.24''/\text{cm} \times 10^{-2} C_{22}^+ \cos[\sigma(\tau) + \epsilon_{22}^+] - 3.38''/\text{cm} \times 10^{-2} C_{42}^+ \cos[\sigma(\tau) + \epsilon_{42}^+] + \dots$  for the node, where  $\sigma(\tau) = 2\Omega - 2M^* - 2\omega^* - 2\Omega^*$ ;  $M^*$ ,  $\omega^*$ , and  $\Omega^*$  are the lunar mean anomaly, argument of perigee, and right ascension of the ascending node, respectively; and  $\Omega$  is the GEOS 3 right ascension of the ascending node. Combining these equations with the result obtained by Goad and Douglas (Determination of  $M_2$  ocean tide parameters from satellite orbit perturbations. Journal of Geophysical Research, vol. 82, p. 898-900, 1977)

for the satellite 1967-92A gives the  $M_2$  ocean tide parameter values  $C_{22}^+ = 3.23 \pm 0.25$  cm,  $\epsilon_{22}^+ = 331^\circ \pm 6^\circ$ ,  $C_{42}^- = 0.87 \pm 0.19$  cm, and  $\epsilon_{42}^+ = 113^\circ \pm 6^\circ$ . Under the assumption of zero solid tide phase lag the lunar tidal acceleration is mostly (85 percent) due to the  $C_{22}^+$  term in the expansion of the  $M_2$  tide with additional small contributions from the  $O_1$  and  $N_2$  tides. Using Lambeck's (Effects of tidal dissipation in the oceans on the Moon's orbit and Earth rotation, Journal of Geophysical Research, vol. 80, p. 2917-2925, 1975) estimates for the latter, we obtain for the tidal acceleration in lunar longitude the value  $\dot{\alpha} = -27.4 \pm 3$  arc sec/(100 yr)<sup>2</sup>, in excellent agreement with the most recent determinations from ancient and modern astronomical data. The mean elements of GEOS 3 are also presented in tabular form.

Guenther, G. C., and Enabnit, D. B.

Laser bathymetry for near-shore charting application: a status report. Presented to the Ninth International Conference on Cartography, International Cartographic Association, College Park, Md., July 26-Aug 2, 1978, 13 pp. (LISD)

Near-shore bathymetric measurements by the National Ocean Survey are presently accomplished primarily with down-looking acoustic equipment (sonar) mounted in small boats which work along linear track lines at relatively low speeds. A scanning airborne laser bathymetric system has the potential to provide a higher quality product with more timely and less costly results in critical coastal and inland waters, and, as a member of the hydrographic team, also promises new or improved services.

Guenther, G. C., and Goodman, L. R.

Laser applications for near-shore nautical charting. Ocean Optics V, vol. 160, Society of Photo Optical Instrumentation Engineers, p. 174-183.

An airborne scanning lidar-bathymetric system has been flight tested to determine vertical accuracy, operational constraints, and the effects of system variables. Test results are described, and an analytical performance model based on optical interactions is presented.

Guenther, G. C., Goodman, L. R., Enabnit, D. B.; Swift, R. N., and Thomas, R. W. (EG&G Environmental Consultants)

Laser bathymetry for near-shore charting application: preliminary field test results. Oceans '78, Institute of Electrical Engineers, Marine Technology Society, Sept. 1978, p. 390-396.

An airborne lidar system has been extensively flight tested to study the operational feasibility of using a scanning, rapidly pulsed laser beam, projected into water from a fixed-wing aircraft, for near-shore hydrographic applications. Field test results for vertical accuracy, environmental constraints, and effects of system parameters are discussed. Detailed utili-

zation studies indicate that such a system should yield significantly reduced cost as well as increased volume of near-shore bathymetric data for charting purposes.

Hanson, R. H.

A posteriori error propagation. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 427-445. GPO #003-017-0426-1

One of the system design requirements for the redefinition of North American geodetic networks is a means for estimating the accuracy of results. This can be done by generating normal equation matrix inverse elements, from which selected variance and covariance terms can be derived. Another solution is to use the reduced normal equations directly to generate variance-covariance matrices for functions of the normal equation unknowns. With the former, the relative merits of generating complete or partial inverses for both full and sparse matrices by in-place and bordering techniques are discussed. Numerical operation counts are used to show that for sparse normals, such as those associated with geodetic network adjustments, it is more economical to generate inverse terms corresponding to all nonzero connections in the reduced normals by an in-lace technique than it is to generate only diagonal terms by bordering. The problem of tradeoffs between computing time and data storage is illustrated by a discussion of two matrix inverse routines designed for the Helmert blocking system of adjustment. Concerning the latter, a method has been devised for using Helmert blocking techniques and computer software for error propagation involving normal equation unknowns which are not in the same Helmert block.

Hardy, R. L.

The application of multiquadric equations and point mass anomaly models to crustal movement studies. NOAA Technical Report NOS 76 NGS 11, Nov. 1978, 63 pp. PB293544

The basic theory of multiquadric (MQ) equations relevant to crustal movement studies is summarized. Both the hyperboloid and reciprocal hyperboloid kernels of an MQ function are given a point mass anomaly interpretation. They are applied to a realistic "error-free" model of subsidence in the Houston-Galveston area, in a pure prediction test. The standard error of a single prediction was found to be less than 0.5 cm/yr for optimum depths of point mass anomalies, using either the hyperboloid or reciprocal hyperboloid as kernels. The rectangular study area of about 88 by 124 km included 49 "error-free" sample points in an irregular pattern, and 49 "error-free" prediction points in a grid pattern. Subsidence rates in the area ranged from about -1 cm/yr to -9 cm/yr. Only subsidence information provided by geodetic leveling (simulated) was used. Geophysical interpretation beyond developing the point mass anomaly model was somewhat limited. Future tests should include details of the gravity anomalies and topography to determine the full potential and limitations of point mass models for interpreting the mass redistribution associated with crustal movement.

Hicks, S. D.

An average geopotential sea level series for the United States. Journal of Geophysical Research, vol. 83, No. C3, p. 1377-1379.

For climate monitoring purposes an average sea level series for the United States, from which a representative curve and a single-value rate were derived, is presented. In addition, the use of dynamic height is introduced to take into account the greatly differing latitudes of the tide stations used in the study. The series was obtained by averaging, by coastal area, common length, uninterrupted sea level elevations reduced from the tide gage measurements of each station. The curve, with amplitudes of the averaged meteorological and oceanographic oscillations of periods of less than 5 1/3 yr attenuated more than 90 percent, shows the relative apparent secular trend and its changes for the United States as a whole. During the 36-yr period, 1940-1975, sea level rose along the coast of the United States at the average rate of 1.5 dynamic mm/yr.

Holdahl, J. H., and Spencer, J. F.

Products and services of NOAA's National Geodetic Information Center. Proceedings of the American Congress on Surveying and Mapping Fall Technical Meeting, Oct. 1978, p. 187-192.

The mission of the National Geodetic Information Center of the National Ocean Survey's National Geodetic Survey is to collect, maintain, publish, and distribute geodetic and cartographic information pertaining to the National geodetic networks. This mission will continue to remain basically the same; however, its magnitude, operational procedures, and related services are drastically changing. The users of geodetic data and the need for improved accuracy have been steadily increasing due to such factors as technological advances, population growth and redistribution, environmental problems, and resource allocation. The user of geodetic information has expanded beyond the traditional user (i.e., the land surveyor) to include economists, regional planners, ecologists, policy analysts, lawyers, and citizens' groups. In response to these increasing user needs, the National Geodetic Information Center has undertaken a massive automation program and has expanded geodetic services and products.

Holdahl, S. R.

Models for extracting vertical crustal movements from leveling data. Proceedings of the Ninth Geodesy/Solid Earth and Ocean Physics (GEOP) Conference: An International Symposium on the Applications of Geodesy to Geodynamics, Ohio State University Department of Geodetic Science Report No. 280, Oct. 1978, p. 183-190.

Various adjustment strategies are now being used in North America to obtain vertical crustal movements from repeated leveling. The more successful models utilize polynomials or multiquadric analysis to describe elevation change with a velocity surface. Other features permit determination of non-

linear motions, motions associated with earthquakes or episodes, and vertical motions of blocks where boundaries are prespecified. The preferred models for estimating crustal motions permit the use of detached segments of releveling to govern the shape of a velocity surface and allow for input from nonleveling sources such as tide gages and paired lake gages. Some models for extracting vertical crustal movements from releveling data are also excellent for adjusting leveling networks, and permit mixing old and new data in areas exhibiting vertical motion. The new adjustment techniques are more general than older static models and will undoubtedly be used routinely in the future as the constitution of level networks becomes mainly relevelings.

Holdahl, S. R.

Removal of refraction errors in geodetic leveling. Proceedings of the International Astronomical Union Symposium No. 89: Refractional Influences in Astrometry and Geodesy, Aug. 1978.

The refraction correction for leveling was developed by T. J. Kukkamaki in 1937. The vertical temperature difference between two heights which correspond to the limits of the readable portion of the rod is an essential variable in the correction. It must be measured while the leveling is done, or estimated in some way. A recent experiment in California showed that the recommended table for estimating  $dt/dz$  was inadequate for the United States, apparently because it is based on measurements made at a high latitude (England) and, therefore, gives values that are much too small even when times of sunrise and sunset are considered. Ignored thus far is Lambert's Law, which states that the intensity of sunlight on the ground decreases in proportion to the cosine of the angle between the Sun's rays and the normal to the terrain surface. Lambert's Law accounts for observed values in California being several times as large as tabular values, and also negates the old assumption that refraction error accumulated while leveling up the south face of a mountain will be cancelled adequately when leveling down the north side. Future estimation of  $dt/dz$  for the United States will take into consideration the zenith distance of the Sun, average sky cover, and the slope of the terrain.

Hopkins, R. D., and Mobley, W. L.

Recent developments in automated hydrographic and bathymetric survey systems in the National Ocean Survey. Proceedings of the Tenth Annual Offshore Technology Conference, vol. 3, Institute of Electrical and Electronics Engineers, May 1978, p. 1493-1502.

The design and development of a new generation of hydrographic and bathymetric swath survey systems presently under development by the National Ocean Survey is described. The Bathymetric Swath Survey System merges several recent developments in instrumentation into a system that will provide a quantum step forward in the art of bathymetric and hydrographic survey techniques. New instrumentation (a high resolution multibeam swath sonar, a Heave-Roll-Pitch sensor, real-time tide telemetry instrumentation,

as well as navigation sensors and a powerful minicomputer) will form the core of system hardware. Software will sample all of the various sensors and provide for vessel navigation, sonar beam vertical depth and position determination, continuously zoned real-time tide correction, and real-time bathymetric contour graphics, as well as archived raw sensor data.

Hothem, L. D., Robertson, D. S., and Strange, W. E.

Orientation and scale of satellite Doppler results based on combination and comparison with other space systems. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 167-180. GPO #003-017-0426-1

Satellite Doppler positions have been established at the location of Very Long Baseline Interferometry (VLBI), Lunar Laser Ranging Experiment (LURE), and Deep Space Network (DSN) stations. Intercomparisons between Doppler results and the results derived from the other systems permit proper scaling of the Doppler results. These intercomparisons also determine the rotations required to relate the Doppler coordinate system to a desired coordinate system as defined by the Conventional International Origin (CIO), Bureau International de l'Heure (BIH) time, and the FK4 star positions. Preliminary results have been obtained. Definitive results are expected when final analysis is completed for a special Doppler observation campaign executed during January and February 1978. During the campaign, Doppler observations were obtained simultaneously with one another and with VLBI, satellite laser ranging, and lunar laser ranging observations. Present results indicate that Doppler results are comparable to VLBI chord distance determinations at the 20- to 30-cm level or a scale discrepancy of less than 0.1 ppm. A longitude rotation of 0"8 applied to Doppler results will bring the Doppler longitudes to an agreement of +0"05 with VLBI, LURE, DSN, and optical astronomic determinations of longitude origin. The Doppler-derived equatorial plane orientation agrees to within +0"08 of other high accuracy determinations.

Hothem, L. D., Strange, W. E., and White, M.

Doppler satellite surveying system. Journal of Surveying and Mapping Division, American Society of Civil Engineers, vol. 104, No. SU1, proceedings paper 141322, Nov. 1978, p. 79-91.

The Doppler Satellite System has become an indispensable tool for the surveyor. Because of its portability, all weather capabilities, reasonable cost, and accuracies at the sub-meter level, the Doppler satellite surveying technique is increasingly being used by surveyors around the world to meet control requirements for a variety of applications. The National Ocean Survey's National Geodetic Survey, which has utilized Doppler positioning since 1973, has found that with improved tracking instrumentation, field operating procedures, and refinements in the data reduction programs, positional rms errors are now less than 50 cm for 40-pass solutions and 10 to 25 cm for differential positions. While studies are continuing to determine the

limiting accuracy of the present Doppler system, improved Doppler satellite surveying using the Global Positioning System is being researched. Preliminary studies indicate this system may be more practical and cost effective in meeting the needs of the worldwide surveying community by giving better than 10-cm accuracy within a day's observations.

Hubbard, J. R.

Information and services of the Tides and Water Levels Division, Office of Oceanography, NOS/NOAA. Presented to the American Society of Civil Engineers, National Capital Section, Water Resources Engineering Technical Committee Symposium on Water Data Management Systems, Reston, Va., Nov. 29, 1978, 3 pp. (LISD)

The National Ocean Survey, formerly the U.S. Coast and Geodetic Survey, has collected and analyzed marine data since 1834. Since that time, the ever-increasing economic and political importance of the coastal environment has accelerated the demand for an efficient and responsive data management system. The Tides and Water Levels Division, NOS Office of Oceanography, is responsible for the operation and maintenance of 130 permanent tide gages (primary control) throughout the United States, 54 water level gages on the Great Lakes, and approximately 300 short-term gages in the overall program. The information and services available from the Tides and Water Levels Division and other programs in the NOS Office of Oceanography are briefly described.

Hull, W. V.

The national tide and water level observation network: uses and applications. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 15 pp. (LISD)

An excellent system for real-time tide reductions in hydrographic surveying is established. In view of reduced net resources, utilization of real-time reductions for routine surveys is doubtful in all but remote areas. Economic pressures on the coastal zone have demanded a diversion of effort to Federal-State cooperative marine and coastal boundary surveys. Additional stations in support of extended jurisdiction legislation will significantly augment the National Tide and Water Level Observation Network. Water level monitoring responsibility for Great Lakes level predictions of the U.S. Army Corps of Engineers and regulatory relations with Canada will continue. Tide gage reliability problems and the necessary human handling factors for corrections in an otherwise automated processing system continue to sustain a backlog of data and delay the final product. Telemetering plans for lake and marine gages promise greater efficiency.

Hull, W. V.

The use of tidal datums in coastal problems. Shore and Beach, vol. 46, No.

1, p. 17-20. (See also: The significance of tidal datums to coastal zone management. Coastal Zone '78, vol. 2, American Society of Civil Engineers, Conservation Foundation, NOAA Office of Coastal Zone Management, Mar. 1978, p. 965-971.)

Tidal datums are the fundamental reference from which all coastal and marine boundaries are derived. Their fundamental nature is based on historical precedence, judicial doctrine, and definition-based computational procedures. In fulfilling one of its statutory obligations, the National Ocean Survey provides tidal datums to all private, State, and Federal interests without interference in the responsibilities or prerogatives of any person, organization, or governmental unit. The National Ocean Survey Federal-State Marine Boundary Program extends the datum to coastal and marine boundary delineation in a fully cooperative plan. It has been demonstrated that this program is not only mutually beneficial to all parties concerned, but extremely efficient at a time of high costs and major resource demands.

Isner, J. F.

Helmert block initial level system. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 405-426. GPO #003-017-0426-1

Regardless of the method chosen for the adjustment of geodetic data, two basically different approaches to adjustment system design are possible. The "batch" approach is characterized by the insulation of the user from the adjustment process. In the "interactive" approach, the user plays a vital role in the adjustment process. The method of Helmert blocking has been implemented as an interactive process in which an individual or organizational unit handles a single subtask, as suggested directly by the Helmert blocking tree. The Initial Level Subsystem of the North American Datum adjustment system has the Helmert block as its basic unit of input, and follows a transition diagram under the control of simple user options. The combination of these two design features allows the system to be used in a wide range of applications, including simple batch adjustments and block validation, and as part of the multilevel Helmert block adjustment system to be used for the readjustment of North American horizontal control network.

Isner, J. F., and Alger, D. E.

A process chart of the new adjustment. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 385-404. GPO #003-017-0426-1

Hierarchy plus Input-Process-Output (HIPO) is a documentation method which appears to have great potential for describing the new adjustment of the North American horizontal control network. Its greatest advantage is its accessibility to management and the system development team alike. It achieves this by a recursive subdivision of function, beginning at an "over-

view" level (unique to HIPO) and ending at the lowest level of human or machine activity. A HIPO document is a living document that can easily change to reflect the changes in operating concept that occur quite naturally during system evolution. The most powerful weapon against misunderstanding is the "structured walkthrough" in which a HIPO document is used to guide a review of the system at various stages in its implementation. A complete example, based on actual HIPO documentation now in progress at the National Ocean Survey's National Geodetic Survey, is presented.

Isner, J. F., and Young, G. M.

Horizontal data entry. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks. NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 233-246. GPO #003-017- 0426-1

The new adjustment of the North American horizontal control network requires an elaborate data entry system for removal of error prior to the zeroth iteration of the Helmert block adjustment. Helmert blocking localizes error, but in the presence of many errors, this advantage turns into a drawback. Project level validation removes as much error as possible at the level of the single archival project and is based on a knowledge of the rules governing field surveys. Block validation regards the network as a whole and looks at medium-size geographic areas to see how projects behave in combination. The unit of data in block validation is the Data Entry Module (DEM), which is created by a Helmert block partitioning of observations. The DEM is also the unit of data loaded into the National Ocean Survey's National Geodetic Survey data base, eliminating the need for additional data handling beyond block validation. Both project and block validation use least-squares adjustment as the main validation tool. Data base consistency checks are a final, economic way to ensure the consistency of DEM's at their junctions. Choice of a Helmert block partitioning scheme, which is nearly optimal with respect to data entry, combined with data base consistency checks, should ensure that the data base contains a minimum of data which are invalidated with respect to adjustability.

Kalvaitis, A. N.

The vertical planar motion mechanism: a dynamics test apparatus for evaluating current meters and other marine instrumentation. Department of Commerce-Environmental Protection Agency Interagency Energy/Environment R&D Program Report, EPA-600/7-78-145, July 1978, 37 pp. PB286571/5BE

The overall objective in the development of the Vertical Planar Motion Mechanism (VPMM) was to provide a dynamic test apparatus that could produce known, controlled high-frequency dynamics for the evaluation of current meters and other marine instrumentation. Of primary interest was the establishment of flow sensor measurement capabilities to assure data quality in an unsteady flow environment. The VPMM generates three major modes of dynamics--vertical-circular, vertical, and horizontal--at length scales from 0.15 to 1.22 m and time scales from 5 to 12 s. The VPMM mounts on a tow

carriage which provides the steady velocity while the VPMM superimposes oscillatory motions on full-size current meters. The VPMM is instrumented so that the instantaneous velocities of the test sensors and their outputs can be measured at a 20-Hz sampling rate; an on-board computer allows for near-real time data analysis. This report describes the development and wet acceptance testing of the VPMM using several types of current sensors, including the electromagnetic and the acoustic variety. Current sensor dynamic response is also documented. No deleterious interactions were noted between the VPMM and the test instruments; the VPMM performance was within specifications for all conditions investigated. This report covers the period March 1975 to July 1977.

Keller, M.

A study of applied photogrammetric bathymetry in the National Oceanic and Atmospheric Administration. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 45-54.

Classical hydrographic mapping in shallow waters with surface craft is slow, hazardous, and expensive. The remarkable water penetration capability of several currently used film emulsions provides an alternative tool and supplement for mapping the seabed in waters of moderate depth. This paper outlines photogrammetric bathymetry's potential for: (1) improving the accuracy and completeness of the hydrographic survey; (2) reducing the cost and time of the field hydrographic survey; and (3) reducing ship requirements for a particular hydrographic survey, thereby releasing some of the craft for other assignments and/or enlarging the size of the coastal water areas that can be surveyed within a given time frame. An investigation of the potential for accomplishing photogrammetric bathymetry was made in 10 regions of high priority along the United States east coast and the Gulf of Mexico. The results of the time/cost study are presented in tabular form.

Konop, D.

Monitoring ocean dumping. Sea Technology, vol. 19, No. 10, p. 26-28.

The Marine Protection, Research, and Sanctuaries Act of 1972 (Public Law 92-532), commonly called the "Ocean Dumping Act," ended the unrestricted dumping of waste materials off the U.S. coast and set flexible timetables for phasing out all dumping so that alternative disposal methods could be developed. Implementation of the Ocean Dumping Act was assigned primarily to the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, the U.S. Coast Guard, and the National Oceanic and Atmospheric Administration (NOAA). NOAA's National Ocean Survey established a program to monitor the effects of this regulated dumping, under controlled conditions, as part of NOAA's responsibility to provide the EPA and Corps of Engineers with the scientific and technical information needed for their regulatory decisions. A key long-range goal of NOS' monitoring program is to develop ocean pollution monitoring techniques and theoretical models and tools for assessing the impact and lessening the environmental damage caused by dumping. NOS' fourpronged study approach (characterizations of baseline conditions at

dumpsites, characterizations of the wastes themselves, studies of waste dispersion, and investigations of the biological effects of dumping) is outlined, with emphasis on monitoring techniques and on how the components of the NOS study approach are melded to determine the effects of dumping. Recent NOS field studies at dumpsites off the Atlantic coast and in the Gulf of Mexico are examined as examples of NOS' ocean dumping monitoring program.

Kouba, J. (Geodetic Survey of Canada), and Hothem, L. D.

Compatibility of Canadian and U.S. Doppler station network. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 195-208. GPO #003-017-0426-1

The Geodetic Survey of Canada (GS), Surveys & Mapping Branch, Department of Energy, Mines & Resources, and the National Ocean Survey's National Geodetic Survey, NOAA, have used the Navy Navigation Satellite System since 1973 to establish over 350 stations in support of the redefinition of the North American Datum (NAD). To ensure compatibility of the Doppler positional results, GS and NGS have been coordinating efforts to determine whether there are biases which might exist between their Doppler survey networks. The first step in this study was carried out by reducing, with the GS and NGS Doppler reduction programs, IAG SSG 2.44 standard data set no. 1 and 14 United States-Canadian border Doppler station data sets. Comparisons of GS and NGS results are presented, including a description of the options and characteristics of the data processing used in the compatibility studies. Also, proposed improvements in the Doppler reduction programs, which may lead to even better agreement, are discussed.

Kumar, M.

Geodetic leveling for monitoring crustal deformations: a critical review. Proceedings of Conference VII: Stress and Strain Measurements Related to Earthquake Prediction, U.S. Geological Survey Office of Earthquake Studies, Open-File Report 79-370, Sept. 1978, p. 277-292.

Some of the critical problems and limitations inherently involved in leveling data are described in the context of the usefulness and importance of geodetic leveling in measuring and monitoring crustal deformations and geodetic leveling's possible use in predicting earthquakes in seismic zones. Possible improvements in data handling, procedural treatment, and statistical analysis are also suggested. Once the use of available leveling data has established a "trend" in crustal movement investigations, it is essential that a specific experiment be designed and executed over statistically computed time intervals for accurate rate determination. The proper design of such an experiment depends basically on the reliable accuracy estimates for the repeat leveling surveys. Then, the time and effort spent in complete testing of and errors for the results obtained will always be rewarding in terms of analyzed inferences or deductions.

Kumar, M.

Geodetic leveling in land subsidence studies. Evaluation and Prediction of Subsidence: Proceedings of the International Conference on Evaluation and Prediction of Subsidence, Saxena, S. K. (editor), American Society of Civil Engineers, Pensacola Beach, Fla., Jan. 15-20, 1978, p. 538-548.

With increased public awareness of the changing environment, the development of newer and better scientific techniques, and the economic and inflationary impact caused by rapidly disappearing natural resources, the worldwide community has even started showing greater concern for phenomena that are as subtle as crustal motion and land subsidence. The advent of artificial Earth satellites in 1957 brought about many modifications to existing geodetic techniques and helped develop new concepts and extremely accurate methods, such as the spaceborne lasering system. And although spaceborne lasering systems have excellent potentials, geodetic leveling, one of the most accurate systems known to geodesists, is still very widely used in determining and locating crustal motion and subsidence. In addition to geodesists' strong concern with the crustal movements--which affect their measurements, the validity of heights established, and the 'reference' systems--inferences from repeated levelings are made to correlate crustal movements with other geodynamical and tectonic phenomena. It is also hoped that efforts to improve methods of determining the extent and the nature of crustal movements in seismically active areas, and a detailed analysis of the results obtained, may also contribute to an earthquake prediction capability sometime in the future. As a new approach, this paper proposes complete testing of both  $\alpha$  and  $\beta$  errors in statistical assessments of land subsidence investigations.

Kumar, M., and Mueller, I. I. (Ohio State University)

Detection of crustal motion using spaceborne laser ranging system. Bulletin Geodesique, vol. 52, No. 2, p. 115-130.

The spaceborne laser ranging (or lasering) system provides a method of precise positioning of a large number of points on the Earth's surface in a short period of time. That is, a measure of the relative location of geodetic markers from a space platform can maintain horizontal and vertical control from 2 to 5 cm. At this level of control, small Earth surface crustal motions should be detectable. Development of a model for the strain field can be constructed. Furthermore, the spaceborne lasering system can survey an area in a very short period of time (1 to 2 weeks) and resurvey the area as required. System design parameters are now being established by NASA for a possible test flight aboard the Shuttle in 1982. These include design specifications of economical corner cubes for ground retroreflectors, coupled with the evolution of engineering-model to flight-model development. If the shuttle experiment proves successful, it is hoped that the laser can be placed in a free flight satellite. The results of a simulated analysis of this satellite emplacement are presented.

Kumar, M., and Smith, D. E. (NASA)

Spaceborne laser ranging system and its applications in crustal motion investigation. Proceedings of the International Workshop on Monitoring Crustal Dynamics and Earthquake Zones, European Seismological Commission, European Geophysical Society, Aug.- Sept. 1978, p. 625-643.

The spaceborne laser ranging system will provide a method of precise positioning of a large number of points on the Earth's surface in a short period of time. With the system envisaged as a station network of passive, maintenance free, and comparatively inexpensive ground retro-reflectors, coupled with a spaceborne laser ranger, the results indicate significant potential for detecting and monitoring crustal motion and also for providing geodetic control.

Love, J. D., and Drosdak, J.

The new adjustment of the North American horizontal datum: positional data--storage, retrieval, and maintenance. American Congress on Surveying and Mapping Bulletin, No. 62, p. 19-20.

Beginning in November 1976 and continuing through 1977, the geographic coordinates, best available elevations, and other closely related positional information for approximately 200,000 horizontal geodetic control stations were entered into the National Geodetic Control Data Base. These data, as initial input in the data base, will serve as the foundation upon which all other horizontal publication files will be entered, retrieved, and/or maintained. Each station when entered was assigned a unique identifier by the National Ocean Survey's National Geodetic Survey-designed Data Base Management System. Procedures are defined to update the positional data as new survey projects are processed and to revise existing data, with the security of historical archives as the foremost consideration. The horizontal portion of the base is established to support the new adjustment of the North American Datum, but its utility is immediate to users of geographic positional data, especially those desiring these data in machine-readable form.

Love, J. D., and Drosdak, J.

Positional data--storage, retrieval, and maintenance. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 259-267. GPO #003-017-0426-1

Beginning in November 1976 and continuing through mid-1978, the geographic coordinates, best available elevations, and other closely related positional information for about 200,000 horizontal geodetic control stations were entered into the National Geodetic Survey control data base. These data, as initial input into the data base, will serve as the foundation upon which all other horizontal publication files will be entered, retrieved, and maintained. The process of digitizing, validating, and entering these posi-

tional data are discussed. Procedures are defined to update the positional data as new survey projects are processed and to revise existing data, with the security of historical archives as the foremost consideration.

Lucas, J. R.

Photogrammetric control densification project. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 507-518. GPO #003-017-0426-1

In conjunction with the new adjustment of the North American Datum, the National Ocean Survey's National Geodetic Survey has a requirement to provide State and local agencies with geodetic control in selected urban areas at a spacing of 1 to 2 km. This densification can be accomplished photogrammetrically at less than half the cost of conventional traverse. However, in order to obtain geodetic accuracy, new improved photogrammetric equipment and techniques were necessary. All ground points are marked with targets, and a special lens designed for maximum resolution of the targets is used. A focal plane reseau is used to minimize film distortion errors, and a 67-percent forward and side overlap is maintained to provide nine intersections of each point. To satisfy the needs of the land surveyor, the distance and azimuth between all pairs of intervisible points are computed in addition to their geodetic positions. Computation of the standard errors associated with these additional parameters has required the development of an adjustment program specifically tailored to densification. An operational test of the system has shown that an accuracy approaching 1/100,000 of the flying height can be obtained.

McCaffrey, E. K.

A review of the Bathymetric Swath Survey System. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 12 pp. (LISD)

The appearance in recent years of large ships with drafts approaching 30 meters has a serious impact on U.S. charting requirements. Previously, detailed approach surveys were accomplished sufficiently to define hazards within the 20-m contour. The new larger commercial ships now require surveys to assure that all hazards and obstructions within 30 m of the surface are located in charted channels, harbor approaches, and ship fairways. The multibeam Bathymetric Swath Survey System (BS<sup>3</sup>) described here has the potential to meet these new survey needs. The BS<sup>3</sup> employs a vertical fan-shaped array of 21 acoustic beams which forms a swath beneath the vessel with a width equal to 2.6 times the sounded depth. In addition to the usual vertical acoustic sounding, oblique soundings are recorded and processed in real time to display contours of bottom features shoaler than the vertical depth. A computer is part of the BS<sup>3</sup>, utilizing a real-time operating system to merge soundings, navigation inputs, real-time telemetered tides, and ship motions to output corrected soundings graphically and to a magnetic

data tape. System development began in July 1976; the system was delivered in September 1977. Results of preliminary field tests on a launch and results of tests recently concluded on the NOAA Ship DAVIDSON are now being evaluated. Indications are that the system will soon be certified and delivered to the NOAA survey fleet as an operational marine chart survey system.

Meissl, P.

The new adjustment of the North American horizontal datum: prediction of roundoff errors. American Congress on Surveying and Mapping Bulletin, No. 60, pp. 17 & 21.

The new adjustment of the North American Datum requires the solution of a system of about 500,000 simultaneous linear equations which must be solved for 400,000 unknowns. The roundoff errors that will occur in the final iteration are summarized.

Mobley, W. L., and Hopkins, R. D.

Bathymetric Swath Survey System: an effective bottom mapping survey system for the hydrographer. Presented to the United States/Japan Cooperative Program in Natural Resources Marine Electronics Communications Panel, Tokyo, Japan, Oct. 1978, 15 pp. (LISD)

National needs require improvement in present survey systems and techniques for acquiring and processing bathymetric data. The objectives of the National Ocean Survey's Bathymetric Swath Survey System (BS<sup>3</sup>) Project are: (1) to improve the effectiveness of marine surveying, (2) to improve data quality, and (3) to provide useful engineering data for nautical charts and bathymetric maps. Instrumentation (a high-resolution multi-beam swath sonar, heave-roll-pitch sensor, tide telemetry instrumentation, as well as navigation sensor and a powerful minicomputer) has been developed to provide a total survey system for the hydrographer. The system software will sample all the various sensors and provide for vessel navigation, sonar beam vertical depth and position determination, continuously zoned real-time tide correction, and real-time bathymetric contour graphics, as well as archived raw sensor data. The BS<sup>3</sup> surveying and processing techniques, aimed at improving the effectiveness of bottom mapping, are now being demonstrated aboard the NOAA Ship DAVIDSON based in Seattle, Wash.

Moses, R. E.

The National Ocean Survey Automated Information System for nautical chart compilation. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 18 pp. (LISD)

The National Ocean Survey (NOS) Computer-Assisted Nautical Charting System is described, with emphasis on that portion of the system which has yet to

be completed--the NOS Automated Information System. Accomplishments to date and work in progress are described. Those products of the Automated Information System that are of interest to the hydrographer are discussed briefly.

Patrick, A. J.

Navigable area and chart evaluation surveys versus basic hydrographic surveys for nautical charting. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea-Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 12 pp. (LISD)

The proliferation of activities in the Nation's coastal zone has impacted and changed the field survey requirements of the National Ocean Survey. Recognition of the need for modern surveys to describe critical water depths in areas of increased commercial interest and the need for more frequent updating of charted information have resulted in the development of the navigable area survey and the chart evaluation survey programs. These programs were developed by modifying the extent of field work requirements associated with basic hydrographic surveys and reconnaissance surveys.

Perry, L. H.

An NOS-developed backlighted reseau and its effect on coordinate refinement. Proceedings of the American Society of Photogrammetry Fall Technical Meeting, Oct. 1978, p. 431-438.

The use of reseau photography is increasing due to new demands on accuracy and to advancements in computers that make it possible to handle both mensuration and reduction of the reseau information. Of the two types of reseaus, the glass reseaus have seen greater use and development; however, this greater use has exposed some of their drawbacks. The problems of calibration and poor quality of reseau images associated with glass reseaus have stimulated consideration of backlighted reseaus. An improved backlighted reseau design that uses light emitting diodes (LED's) as the light source and glass beads as the lenses is discussed. The glass reseau, its advantages (with emphasis on its use with analytical plotters), and its potential for photogrammetric applications are also discussed.

Pettey, J. E., and Carter, W. E.

Uncertainties of astronomic positions and azimuths. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 135-141. GPO #003-017-0426-1

Model II Analysis Of Variance (ANOVA) methods have been used to analyze repeat determinations of astronomic latitude, longitude, and azimuth to derive accuracy estimators. We found that these astronomic observations are significantly degraded by systematic errors. Our studies concluded that the

accuracy of the National Ocean Survey's National Geodetic Survey latitude determinations, using the differential zenith distance method, has changed minimally over the more than 125 years of observational history. Relatively simple equations for computing the estimated accuracy of latitude determinations are derived. The history of longitude determinations is comparatively complex. Discontinuities exist because of the introduction of new catalogs, changes in the accepted longitude of the U.S. Naval Observatory, and technological improvements in the keeping, distribution, and recording of time. Accuracy estimators have been derived for the several distinctive periods within the total time span of the data. Our studies found an unexpectedly high observer bias, or personal equation, error component in astronomic azimuth determinations. The accuracy estimates developed during these studies have been incorporated into the astronomic data base to be used in generating a priori weights for the new adjustment of the North American Datum.

Pfeifer, L.

The new adjustment of the North American horizontal datum: automated publication of horizontal control data. American Congress on Surveying and Mapping Bulletin, No. 61, p. 17-18.

The elements of automated publication of horizontal control data, which are the station synopses and station descriptions, are traced through the digitizing process. A new computer-generated horizontal control data sheet is illustrated and described.

Robertson, D. S., Carter, W. E.; Corey, B. E., Cotton, W. D., Counselman, C. C., Shapiro, I. I., Wittels, J. J. (Massachusetts Institute of Technology); Hinteregger, H. F., Knight, C. A., Rogers, A. E. E., Whitney, A. R. (Haystack Observatory); Ryan, J. W., Clark, T. A., Coates, R. J. (NASA); Ma, C. (University of Maryland); and Moran, J. M. (Smithsonian Astrophysical Observatory)

Recent results of radio interferometric determinations of a transcontinental baseline, polar motion, and Earth rotation. Proceedings of the International Astronomical Union Symposium No. 82: Time and the Earth's Rotation, May 1978.

Radio interferometric observations of extragalactic radio sources have been made with antennas at the Haystack Observatory in Massachusetts and the Owens Valley Radio Observatory in California during ten separate experiments distributed between September 1976 and June 1977. The components of the baseline vector and the coordinates of the sources were estimated separately from the data from each experiment. The root-weighted-mean-square scatter about the weighted (repeatability) of the estimates of the length of the 3,900-km baseline was approximately 7 cm, and of the source coordinates, approximately 0".015 or less, except for the declinations of low-declination sources. With the source coordinates all held fixed at the best available a posteriori values, and the analyses repeated for each experiment, the repeatability obtained for the estimate of baseline length was 3 cm.

Changes in the x component of polar motion and the Earth's rotation (UT1) were estimated. Comparison with the corresponding results obtained by the Bureau International de l'Heure (BIH) discloses systematic differences. In particular, the trends in the radio interferometric determinations of the changes in polar motion agree more closely with those from the International Polar Motion Service and from the Doppler observations of satellites than with those from the BIH.

Rodkey, R. W., Jr.

The use of historic surveys in shoreline movement analysis. Presented to the American Congress on Surveying and Mapping 38th Annual Meeting, Feb. 26- Mar. 4, 1978, 8 pp. (LISD)

With the increasing interest in the coastal zone, there has been a multitude of papers discussing the various problems facing the land-sea interface. As man prepares to spend millions of dollars in constructing devices to help stabilize the shoreline, one can realize the importance of the analysis of those forces which act in this important zone. Shoreline movement is a dynamic force which has caused great concern; whether it be one citizen's fight to control an eroding shorefront or a city's fight to maintain its recreational beaches, there should be information resources available to help analyze the problem and offer solutions. The National Ocean Survey has in its archives topographic manuscripts, some of which date back to the early 1800's. These manuscripts, when compared to later surveys of the same geographic area, could provide important information which, when combined with storm, tide, geologic, and demographic data, could form a sound data bank for shoreline movement analysis.

Roman, C. M.; Wild, R. K., and Lukinbeal, G. E. (Progress Electronics Corp.)

A remote water level telemetry system. Coastal Zone '78, vol. 4, American Society of Civil Engineers, Conservation Foundation, NOAA Office of Coastal Zone Management, Mar. 1978, p. 2857-2864.

A new data collection system, referred to as the Water Level Telemetry System, that was developed to meet the requirements of the National Ocean Survey's automatic collection of tidal, water level, and meteorological data from remote locations is discussed. The program is being implemented to collect the data in near real time using a minicomputer-based master control station, controlling a network of microprocessor-based remote units. The data are collected via conventional sensors and stored in solid state memory at the remote site. Normal interrogation is done automatically by the master control station computer over telephone lines on a daily basis during non-business hours. The incoming data are analyzed prior to being stored on the disc storage unit and magnetic tape. In addition to phone line transmission, the system is adaptable to RF as well as satellite telemetry. Remote sites can be put into a fast scan data collection and transmission mode from the master control station for near real-time applications involving such programs as the collection of Tsunami and storm surge data.

The main advantage of having the remote units microprocessor-based is the flexibility offered by adding other sensors, making this system superior to others currently in use by the National Ocean Survey.

Safford, R. W.

Field data entry system. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 291-297. GPO #003-017- 0426-1

The National Ocean Survey's National Geodetic Survey (NGS) has installed remote data terminals at each of its horizontal field parties to provide them with sophisticated programming techniques available only on large computers. Thus, field parties using Terminal ENtry COmmand Language (TENCOL) statements can enter, store, and adjust their data, and verify their field observations prior to submitting the data to NGS headquarters. The key to this system is the party's field data entry.

Schmid, E.

An algorithm to compute the eigenvectors of a symmetric matrix. NOAA Technical Report NOS 75 NGS 10, Aug. 1978, 5 pp. PB287923.

A method to compute iteratively both the eigenvalues and the corresponding matrix of eigenvectors simultaneously is outlined and illustrated by example. The program is applicable to symmetric matrices with real eigenvalues and, in particular, to the positive definite matrices of least-squares theory. A high degree of precision, limited only by the capacity of the computer, is attainable with relatively few iterations that approach the result exponentially.

Schwarz, C. R.

Deflection computations for network adjustment in the U.S. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 91-102. GPO #003-017-0426-1

In the new adjustment of the U.S. portion of the North American Datum, the National Ocean Survey's National Geodetic Survey (NGS) plans to correct all horizontal angles for the effect of deflection of the vertical. Gravimetric deflections will be computed for each of the approximately 160,000 occupied points in the network. The data base for these computations consists of about 1 million point gravity anomalies in the United States and offshore, about 14 million point elevation values, and almost 5,000 existing astronomic-geodetic deflections. The classical Vening-Meinesz equation has been selected as being consistent both with the accuracy goal of 1" (second of arc) and with the finite computer resources available. In addition to selection of the mathematical model, it was necessary to design a variety of

data bases and to define the amount of data to be processed as a project. After organizing the data for large-scale computations, the computer time required to compute a single deflection was held to 2.5 seconds.

Schwarz, C. R.

TRAV10 horizontal networks adjustment program. NOAA Technical Memorandum NOS NGS 12, Apr. 1978, 52 pp. PB283087

The TRAV10 adjustment program, which performs a two-dimensional adjustment on the ellipsoid, is the major tool for the adjustment of horizontal survey networks at the National Ocean Survey's National Geodetic Survey. Many features are similar to those of other programs used by other agencies. The handling of the normal equations, especially for large networks, is the most important design criterion. The TRAV10 program uses the Cholesky solution method with a variable band storage scheme. The normal equations are partitioned into variable sized blocks, stored on random access secondary storage, and paged into main memory as needed. A reordering of the unknowns is used to reduce both the required storage and the number of arithmetic operations.

Simpson, D. C., Devine, M. F., Warsh, C. E., Meyer, E. R., O'Connor, T. P., and Park, P. K.

Ocean dumping research and monitoring: strategies and tools. Journal of Ocean Engineering, vol. OE-3, No. 4, p. 165-171.

Ocean dumping studies are designed to establish critical indexes of environmental quality to assess the impacts of ocean dumping. Strategies emphasized are: (1) source function characterization, including determinations of toxicities of original wastes, (2) environmental characterization, (3) waste dispersion studies in the laboratory and at sea, and (4) waste biota interaction studies, both in the short term, within a life cycle of organisms affected, and in the long term, over many life cycles. Present tools include: (1) quantitative mapping of pollutant distribution by aerial remote sensing and moored and drifting arrays, (2) real-time tracking of waste dispersion in the ocean by 20- and 200-KHz acoustic records, (3) continuous multidepth water sampling to obtain sea truth, (4) in situ bioassay devices, and (5) mathematical dispersion models, some of which are similar to atmospheric chimney plume dispersion models.

Slama, C. C

High precision analytical photogrammetry using a special reseau geodetic lens cone. Presented to the International Society of Photogrammetry Commission III Symposium on Mathematical Analysis of Data, Moscow, U.S.S.R., July 31-Aug. 5, 1978, 16 pp. (LISD)

The National Ocean Survey (NOS) began an investigation in 1975 of high-precision analytical triangulation for possible densification of geodetic

ground control. The system under investigation employs a special Wild Aviogon II geodetic lens cone with projected reseau. Also, all ground points are targeted, mensuration is partially automated, and optimum geometry is obtained through special flight coverage. Systematic errors are minimized through image optimization, calibration of the lens inner geometry using stellar methods, thorough calibration of the camera's reseau, multiple pointing during mensuration, complete calibration of the mensuration device, and rigorous treatment of atmospheric corrections during the adjustment. Test data flown over the Casa Grande target range provide eight different photo coverage configurations to study the relationship between geometry and final accuracy. The scale of photography is 1:24,000 and covers the entire 16-mile-square range with 196 first-order geodetic positions for accuracy comparison. Final results of the optimum case show an RMS difference of .046 meters between the geodetic positions and those determined photogrammetrically. This represents a ratio of photo scale factor to error in meters of 516,158, or a five times improvement over that previously reported by NOS. Future plans include an application of the system to the densification of control in an urban area. A scheme for optimization of the geodetic densification problem is discussed.

Smith, J. T.

NOS photographic operations for photobathymetry. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 67-68.

Photographic operations for photobathymetry, including techniques and methods that will facilitate proper photography for photobathymetry requirements, are discussed.

Smith, N. D., and Maloney, F. W.

Automated production of nautical charts at the National Ocean Survey. Presented to the Ninth International Conference on Cartography, International Cartographic Association, College Park, Md., July 26- Aug. 2, 1978, 9 pp. (LISD)

The mission of the National Ocean Survey (NOS) is to provide safe and efficient nautical charting, subject to the changing requirements of the user. The need to automate this operation was recognized in the late 1960's when it became apparent that with the increase in user demand, the increase in the amount of documents needed to maintain the charts, and the diminishing pool of highly skilled cartographers, the mission of NOS would be severely impaired unless steps were taken to remedy such problems. As a result of these findings, NOS established the Marine Data Systems Project to develop and implement a completely automated cartographic system. The objective of this system is to provide an interactive data base for all charting requirements. The overall system, including its three subsystems--input, storage retrieval and update, and graphic output, is described.

Smith, R. A., and Leffler, R. J.

Sea level variations and highest water levels along the California coast. Presented to the International Symposium on the Interaction of Marine Geodesy and Ocean Dynamics, Battelle-Columbus, NOAA, University of Miami, Miami, Fla., Oct. 10-13, 1978, 30 pp. (LISD)

Variations in sea level, with time and distance, along the California coast are examined using tidal measurements from San Diego, Los Angeles, the Golden Gate area, and Crescent City. The highest water levels at these locations are displayed. Daily, monthly, annual, and long-period sea level variations are described and correlated with glacial-eustatic, tectonic, climatological, and oceanographic features. Conditions resulting in extremely high water levels are discussed.

Snay, R. A.

Solvability analysis of geodetic networks using logical geometry. NOAA Technical Memorandum NOS NGS 14, Oct. 1978, 28 pp. PB291286. Manuscripta Geodaetica, vol. 3, No. 4, p. 321-346.

A complete solvability analysis of leveling networks can be efficiently performed on the computer without recourse to real number arithmetic. Attempts to generalize this statement to include horizontal networks have been unsuccessful. With leveling networks the solvability analysis relies on a mechanism of identifying solvable subnetworks of a solvable network. A horizontal network can be solvable and yet have no nontrivial solvable subnetworks.

Snay, R. A.

Solvability analysis of horizontal networks by the identification of rigidity components. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 347-355. GPO #003-017-0426-1

SOLV1 is a newly developed algorithm that identifies rigid subnetworks of a horizontal geodetic network. In addition, the algorithm checks each of these subnetworks for scale, orientation, and translational control. With this information, one can select a set of mathematical conditions which will allow for the determination of station positions without overconstraining the observed data. SOLV1 employs no real number arithmetic. The solvability status of the network is established with the use of logical tests and counting procedures.

Snay, R. A.

Applicability of array algebra. NOAA Technical Memorandum NOS NGS 15, Feb. 1978, 22 pp. PB281196

Matrix equations associated with gridded data reduce to equivalent array equations, with proper assumptions for the mathematical model and the weight matrix. Array equations involve significantly fewer computations and less computer storage than the equivalent matrix equations.

Snay, R. A., and Gergen, J. G.

Monitoring regional crustal deformation with horizontal geodetic data. Proceedings of the Ninth Geodesy/Solid Earth and Ocean Physics (GEOP) Conference: An International Symposium on the Application of Geodesy to Geodynamics, Ohio State University Department of Geodetic Science Report No. 280, Oct. 1978, p. 87-92.

The National Ocean Survey is developing an automated system to derive parameters of horizontal crustal motion from existing geodetic data by the process of least-squares estimation. The estimated parameters will describe crustal motion as a function of geographic position. The system will first be tested in the Imperial Valley region of southern California, using data from eight individual field projects spanning four decades.

Spencer, J. F., Jr., and Holdahl, J. H.

National Geodetic Information Center. Proceedings of the American Congress on Survey and Mapping Fall Technical Meeting, Oct. 1978, p. 187-192.

The mission of the National Geodetic Information Center of the National Ocean Survey's National Geodetic Survey is to collect, maintain, publish, and distribute geodetic and cartographic information pertaining to the National geodetic networks. This mission will continue to remain basically the same; however, its magnitude, operational procedures, and related services are drastically changing. The users of geodetic data and the need for improved accuracy have been steadily increasing due to such factors as technological advances, population growth and redistribution, environmental problems, and resource allocation. The user of geodetic information has expanded beyond the traditional user (i.e., the land surveyor) to include economists, regional planners, ecologists, policy analysts, lawyers, and citizens' groups. In response to these increasing user needs, the National Geodetic Information Center has undertaken a massive automation program and has expanded geodetic services and products.

Stanley, W. A.

An American philosopher. NOAA, vol. 8, No. 2, p. 16-19.

The activities of the U.S. Coast and Geodetic Survey (now the National Ocean Survey) reached a high point during the latter part of the nineteenth century, and Charles Sanders Peirce--scholar, cartographer, mathematician, and metrologist--contributed much to the agency's legacy with his work in algebra, geodesy, and weights and measures. During his 30 years with the Coast and Geodetic Survey, Peirce developed numerous theories, including

"The Theory of Economy," which in essence provided the formula and mechanisms for the development of automatic data processing. Peirce's development as one of the most original and versatile American thinkers, his theories and personal life, including his relationship with his father Benjamin, a superintendent of the agency, and comparisons of technique and accomplishments are detailed. The solar eclipse of 1870 and Peirce's observations, his role in the development of the Office of Weights and Measures, and his theory of "pragmatism" are also discussed.

Strange, W. E., and Hothem, L. D.

Establishment of scale and orientation for satellite Doppler positions. Proceedings of the Royal Society Discussion Meeting on Satellite Doppler Tracking and Geodetic Applications, London, England, Oct. 1978.

The scale of satellite Doppler results and the orientation of the coordinate system in which the results are obtained, relative to more conventional coordinate systems, must be known for many applications. Sources of this information are comparisons with external standards. Comparisons indicate that Doppler positions obtained by the National Ocean Survey (using its standard program and the precise ephemeris) require a longitude rotation of  $0.8 \pm 0.05$  seconds of arc eastward and a decrease in scale of  $0.4 \pm 0.1$  p.p.m. to be compatible with results obtained by comparisons of astro-Doppler and gravimetric deflections. To apply these results to those of other investigators, using other reduction programs and techniques, will require intercomparison of programs using standard data sets such as those used by Special Study Group 2.44 of the International Association of Geodesy.

Suloff, D. L.

Chart evaluation surveys in the National Ocean Survey. Lighthouse-Special Edition: Proceedings of the 17th Annual Canadian Hydrographic Conference, Canadian Hydrographers Association, Apr. 1978, p. 59-63.

The National Ocean Survey (NOS) recently instituted a chart evaluation survey (CES) program to expeditiously provide hydrographic data in response to a recognized need for timely maintenance of published charts. This survey program is designed to address several primary areas of concern. Chief among these are the investigation of all discrepancies which result from the necessary charting of reported data prior to field verification, and the resolution of deficiencies reported or discovered subsequent to the most recent chart production. Field units assigned to the program also evaluate the adequacy of existing hydrographic information charted by employing a system of reconnaissance sounding lines and actively pursue the verification or revision of the information published in the appropriate Coast Pilot. Finally, a public relations effort is emphasized to inform the boating community and other nautical data users of the products and services of NOS and to obtain from them feedback pertinent to improving these products and services. The CES program makes it possible for NOS to satisfy chart data requirements within time constraints mandated by the cyclic chart printing

schedule without being restricted to the relatively slow and expensive procedures of complete hydrographic surveys. In those areas found to be inadequately charted or in need of extensive updating hydrography, this program serves the additional purpose of documenting deficiencies and justifying a basic survey effort.

Thomas, R. W. L. (EG&G Environmental Consultants), and Guenther, G. C.

Theoretical characterization of bottom returns for bathymetric LIDAR. Proceedings of the International Conference on LASERS '78, Society for Optical and Quantum Electronics, Dec. 1978, p. 48-59.

The two parameters that are most important in describing and evaluating the performance of an airborne, pulsed lidar bathymetry system are accuracy and penetration. Monte Carlo simulation results for multiple scattering and diffusion in a homogeneous medium are extended analytically to provide estimates of expected temporal response shape, depth bias errors, and round trip signal loss profiles as a function of optical depth and scattering parameters. These formulations will provide several of the key relationships necessary for extrapolation of performance parameters in an optimized system from existing experimental data sets.

Tibbit, D. R.

From sea to chart. Presented to the Seventh Joint Meeting of the United States/Japan Cooperative Program in Natural Resources Sea Bottom Surveys Panel, University of Hawaii East-West Center, Aug. 7-9, 1978, 12 pp. (LISD)

The development of a domestic nautical chart by the National Ocean Survey is described, including an overview of the general production procedures followed from "sea to chart." The chart used as an example covers the Pacific approach and the western waters of the Strait of Juan de Fuca between the State of Washington in the United States and the Province of British Columbia in Canada. The overview begins with the chart requirement and covers hydrographic survey requirements, data collection, data processing, and chart compilation and production. The latest compilation and negative preparation techniques, demonstrating advancements in the use of computers and automated equipment, are emphasized.

Timmerman, E. L.

The new adjustment of the North American horizontal datum: a test of the new adjustment system. American Congress on Surveying and Mapping Bulletin, No. 63, p. 15.

Success of the 1983 network adjustment will depend on the integrity of the massive amount of geodetic data gathered, sorted, validated, and entered into the data base. A summary of the four-member task force that rigorously tested the complex computer software and data handling methods indicates the procedures are sound.

Timmerman, E. L.

A test of the North American Datum horizontal new adjustment system. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 447-455. GPO #003-017-0426-1

A pilot test of the new adjustment system for the North American Datum was made by a task force of the National Ocean Survey's National Geodetic Survey (NGS). The purpose of the test is defined and the impact of the test results on the new adjustment system is discussed. Strategies and procedures which were used to accomplish specific tasks of the experiment included the gathering and validating of large blocks of geodetic observational data, simulating the entry of these data into the NGS data base, and performing a Helmert block adjustment of over 21,000 observations referring to 3,380 geodetic positions.

Vanderhaven, G.

Data reduction and mapping for photobathymetry. Proceedings: Coastal Mapping Symposium, American Society of Photogrammetry, Aug. 1978, p. 69-88.

Photogrammetric compilation of bathymetric detail by the National Ocean Survey (NOS) is accomplished stereoscopically from overlapping pairs of photographs using analog plotting instruments. Present methods require a graphical correction for the deformation of the stereoscopic model introduced by refraction at the water-air interface. The correction factor by which the apparent depth must be multiplied is a variable whose magnitude depends on the apparent water depth, the index of refraction, and the location of the submerged feature in the stereoscopic model. NOS recently acquired a Wild B-8S Aviograph stereoplotter, interfaced with digital output, and the cumbersome graphical correction routines used in the past are now being replaced by computer programs that mathematically compensate for model deformation and the effect of refraction at the water-air interface.

Vincenty, T.

Closed equations for the solution of intersection on the ellipsoid. Survey Review, vol. 24, No. 189, p. 291-294.

The intersection problem in triangulation is solved on the ellipsoid without mathematical approximations, using normal section azimuths. The solution is numerically stable in all practical cases. No restrictions are imposed on the sizes of triangles or the lengths of lines.

Vincenty, T.

The use of the relative lateration method for reducing errors in length measurements. Survey Review, vol. 24, No. 189, p. 295-302.

The method of measuring lines in groups was applied in a survey of seven radial lines ranging in length from 32 to 93 km. Measurements made a month apart and adjusted to a common scale were totally consistent and agreed within 0.2 parts per million. The remarkable results encourage further studies in the applications of this method.

Vincenty, T.

Vergleich zweier Verfahren zur Bestimmung der geodatischen Breite und Höhe aus rechtwinkligen koordinaten. AVN (Allgemeine Vermessungs-Nachrichten), vol. 85, No. 7, p. 269-270.

The methods of Bowring and of Bopp and Krauss for transformation of rectangular to geodetic coordinates are examined. The former method is preferred because of its rapid rate of convergence, which makes it unnecessary to iterate in most practical situations. It can be applied to any point inside the ellipsoid with an alternate starting approximation for latitude.

Vincenty, T., and Bowring, B. R. (Surbiton, Surrey, United Kingdom)

Application of three-dimensional geodesy to adjustments of horizontal networks. NOAA Technical Memorandum NOS NGS 13, June 1978, 7 pp. PB286672. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 379-384. GPO #003-017-0426-1

A method is proposed for adjustment of directions and distances in space with heights held fixed and without reductions of observations to the ellipsoid. Programming hints are included to reduce the time needed for forming observation equations. The adjustments can be performed in the rectangular or in the geographic coordinate system. This method is simpler and faster than customary methods.

Wallace, J. L.

The present level of automation in the United States with special reference to depth. Proceedings of the Symposium on Depth Measurement and Sonar Sweeping, Hydrographic Society, Apr. 1978.

The ways that the various automated hydrographic systems presently in use in the United States treat the problem of depth editing are described. Included are discussions of the NOS HYDROPLOT; U.S. Army Corps of Engineers HYDROPLOT; NAVOCEANO HDAS, BDAS, and HYSURCH; HYDROCARTA: AUTOCARTA; ROSS Channel Sweep; and the NOS Bathymetric Swath Survey System.

Whalen, C. T.

Control leveling. NOAA Technical Report NOS 73 NGS 8, May 1978, 21 pp.  
PB286838

Control leveling is used to determine precise elevations of bench marks (monumented points) above or below a reference surface called a datum. The National Ocean Survey's National Geodetic Survey (NGS) determines elevations in meters above or below the National Geodetic Vertical Datum of 1929. Bench marks are located at distances of about 1.6 km along railroads and highways in the United States to form level lines, which in turn form a net of closed loops. The present program for development of the fundamental vertical control net calls for first-order lines at approximately 160-km intervals with a subdivision of second-order lines spaced at 40 to 80 km. In certain areas of intense development, the net is again subdivided by second-order lines spaced at 8 to 16 km. The current net consists of 370,000 km of first- and second-order leveling.

Whalen, C. T.

NGVD readjustment program. Proceedings of the Second International Symposium on Problems Related to the Redefinition of North American Geodetic Networks, NOAA, Geodetic Survey of Canada, Danish Geodetic Institute, Apr. 1978, p. 617-627. GPO #003-017-0426-1 [See also: Plans for releveling of the vertical datum. Presented to the Canada-United States Mapping and Charting Committee, Norfolk, Va., June 13-16, 1978, 20 pp. (LISD)]

The National Oceanic and Atmospheric Administration is undertaking a National Geodetic Vertical Datum (NGVD) readjustment program which will be accomplished from 1978-85, cost an estimated \$26 million, and require 928 staff-years. The framework for the readjustment will be Basic Net A, which consists of 120,000 km of first-order level lines. Surveys will relevel and replace destroyed marks on 100,000 km of level lines of Basic Net A, using first-order procedures. An additional 20,000 km of first-order leveling, observed since 1963, will be considered for inclusion in Basic Net A. Any portion of this recent leveling that does not form satisfactory loop closures with the new work will be relevelled. Data for 728,000 km of previous leveling observations and descriptions will be obtained from the archives, automated, and loaded into the National Ocean Survey's National Geodetic Survey data base. Geographic positions will be determined from maps for all bench marks loaded in the data base. A study will be made to determine how to define the datum for the new adjustment. The entire national network of first- and second-order leveling will be readjusted to produce a homogeneous set of new heights on a common datum. The readjustment will be accomplished in geopotential units using gravity values observed bench marks or interpolated from data base files. After adjustment, the geopotential heights will be changed to a height system, as yet unspecified, for publication and distribution.

Wittels, J. J., Shapiro, I. I. (Massachusetts Institute of Technology);  
Hinteregger, H. F., Knight, C. A., Rogers, A. E. E., Whitney, A. R.

(Haystack Observatory); Clark, T. A., Ma, C., Hutton, L. K. (NASA); Robertson, D. S. (NOS); Ronnang, B. O., Rydbeck, O. E. H. (Onsala Space Observatory and Chalmers University of Technology, Sweden); and Niell, A. E., and Resch, G. M. (Jet Propulsion Laboratory/California Institute of Technology)

A high declination search at 8 GHz for compact radio sources. Astronomical Journal, vol. 83, No. 6, p. 560-567.

Very Long Baseline Interferometry observations, over a baseline of length  $20 \times 10^6 \lambda$  at  $\lambda = 3.8$  cm, disclose compact cores in 7 out of 37 candidate sources with declinations above 50 degrees. For these seven sources, the cores have diameters estimated to be smaller than about 5 milliarcsec and flux densities between about 0.5 and 2 Jy. In one of these sources, 4C 67.05, the radiobrightness of the core can be adequately represented by an elliptical Gaussian function with a major diameter smaller than 1 milliarcsec. For another such source, 3C 418, the compact core has a diameter smaller than 0.4 milliarcsec and is accompanied by an asymmetric extended component. For the 30 other sources, an upper limit of about 0.3 Jy was placed on the flux density of any compact core. Caution should be exercised in drawing statistical inferences about the fraction of sources with compact cores whose accompanying flux densities exceed a given limit, since the sample discussed here was incomplete and was selected without consideration of possible bias.

Yeager, J. A.

Offshore positioning techniques and systems. Proceedings of the Symposium on Measurement, Mapping, and Management in the Gulf Coastal Zone, American Congress on Surveying and Mapping, May 1978.

In addressing systems and techniques for offshore positioning, the terms "static" and "dynamic" classify into broad categories the techniques and systems available to satisfy various requirements for offshore positioning. Electromagnetic, satellite, and acoustic systems are addressed from the standpoint of their suitability and applicability to provide relative and absolute positional control. The basic requirement for position dictates the desired accuracy; the system selected to meet that requirement follows, taking into account a wide range of error sources and economic considerations. Presently available systems, as well as the generalized accuracies that can be expected, are described. A brief review of the Global Positioning System now under development is also presented.