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NATIONAL OCEAN SURVEY ABSTRACTS - 1976

Rockville, Md.
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Koch, December 1971. (COM-72-10135)

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(COM-73-10670)

NOS 13   Trends and Variability of Yearly Mean Sea Level 1893-1972. Steacy D. Hicks and James E.
Crosby, March 1974. (COM-74-11012)

NOS 14   Some Features of the Dynamic Structure of a Deep Estuary. Michael Devine, April 1974. (COM-74-10885)

NOS 15   An Average, Long-Period, Sea-Level Series for the United States. Steacy D. Hicks and James
E. Crosby, September 1975. (COM-75-11463)

NOAA Technical Memorandum NOS 21

NATIONAL OCEAN SURVEY ABSTRACTS - 1976

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TITLE INDEX

Alger, David E.

The new adjustment of the North American horizontal datum--Data base management system, American Congress on Surveying and Mapping Bulletin, no. 54 (August 1976), p. 15.

This is the fourth in a series of articles in the ACSM Bulletin on the new adjustment of the North American Datum. The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment.

The data base management system (DBMS) which will be used to place the NGS archives into computer readable form is discussed. The DBMS is comprised of three major subsystems: query language, supervisor, and application.

Berry, Ralph M.

History of geodetic leveling in the United States, Surveying and Mapping, v. 36, no. 2 (June 1976), p. 137-153.

The term "geodetic leveling" is defined in broad terms. Development of basic instrumentation for leveling is discussed. Geodetic leveling seems to have been started by the U.S. Coast Survey in 1856 along the Hudson River. The U.S. Lake Survey (Corps of Engineers) began geodetic leveling in 1875, based on the Coast Survey leveling of 1856. The Coast Survey commenced the Transcontinental Leveling at Hagerstown, Md., in 1877. Geodetic leveling was started by the U.S. Geological Survey in 1884, with a loop from Morehead City, N.C., inland to Knoxville and Chattanooga, Tenn., and back to Brunswick, Ga. The first general adjustment of the geodetic leveling network in the United States was made in 1900, containing links by the Coast and Geodetic Survey, Corps of Engineers, Geological Survey, and several railroads. Other adjustments were made in 1903, 1907, 1912, and 1929, the last of which defined the currently used National Geodetic Vertical Datum of 1929.

Berstis, Knute A., and Stawnychy, Mykola

Stable ship-deployable transducer fixture, Exposure, v. 4, no. 3 (July 1976), p. 5-8.

The article describes the design of an acoustic transducer fixture that can be deployed while underway on a class III NOAA vessel for applications such as acoustic positioning with ocean bottom-based transponders or acoustic relocation and retrieval of instrumentation packages.

Bivins, Luther E., and Appell, Gerald F.

Turbulence effects on current measuring transducers, Exposure, v. 3, no. 6 (January 1976), p. 1-5.

The paper describes a laboratory test program to investigate the effects of turbulence on the output of current measuring transducers. A description

of the test facilities are provided and the test methods and instruments tested are discussed. Graphical results are displayed depicting errors induced by the presence of mean stream turbulence.

Bivins, Luther E., and Russin, Eugene M.

Marine instrument testing--the need for a national program, Journal of Environmental Sciences, November/December 1976, p. 9-16.

The existing situation concerning marine instrumentation performance and reliability is described as not having greatly improved even though the need for improvement has been unanimously expressed in the past. The systems approach has not been adopted by program managers and thus activities which reflect on performance and reliability are neglected. Testing is described as a viable means of defining and highlighting areas of neglect. Instrument failure experience during laboratory tests are reported with possible causes being traced to inadequate consideration for the quality assurance procedures necessary for guaranteed performance and reliability. The Testing Program of the National Oceanographic Instrumentation Center and the facilities it uses to simulate the marine environment are briefly described with some attention given to future facility needs, especially those concerning dedicated use and dynamic simulation. Specific testing activities and results covered are: (1) current meters; (2) salinity conductivity, temperature and depth measuring systems; (3) acoustic devices; (4) wave instruments; and (5) direct measuring water quality instruments, which include the parameters of pH, dissolved oxygen, and turbidity. Pollution studies and monitoring activities are indicated as having introduced new parameters and added environmental constraints which create a demand for more performance information. A new type of instrument user has also emerged, i.e., one who only wants to monitor to assure that his legal obligations are being met and has little scientific interest. This requirement makes independent quality assurance activities even more important. NOIC's testing has found that prototype sensors are too quickly introduced to the market as operational units, only to have later field experience and testing show disappointing results. Some degree of standardization is recommended as the solution to certain problems, especially in the data processing area.

Bolton, R. M.

New technique for computing and plotting isogonic and grid variation lines on charts, 16 p. (unpublished)

A method for plotting section lines of a ship has been adapted to contouring of Isogonic and Grid Variation (GV) charts. The method converts a discrete set of surface data into a double power polynomial approximation; this approximation can be differentiated to give the components of the gradient of the surface elevation. The method utilizes the gradient to find the nearest point on a specified contour and then utilizes the gradient to find the direction of tangency along the contour. The use of the gradient is more economical and reliable than other methods of interpolation which have been used in the construction of Isogonic and GV charts.

This method is the basis for a new CDC 6600 Fortran program which has been prepared by Ronald M. Bolton for use by the Office of Aeronautical Charting and Cartography, National Ocean Survey.

Bossler, John D.

Changing views on control networks, Proceedings of the International Symposium: The Changing World of Geodetic Science, Ohio State University, Columbus, Ohio, October 1976.

This paper was presented on the occasion of the 25th anniversary of The Ohio State University's Department of Geodetic Science. From a modest beginning in 1807, when Congress initiated "the Survey of the Coast," geodesy has kept pace with a rapidly developing nation. Today the National Geodetic Survey oversees an inventory of over 200,000 horizontal and 500,000 vertical control points. These data are used primarily by surveyors, civil engineers and, more recently, land information specialists and geophysicists. A comprehensive, precise readjustment of our National horizontal and vertical control networks is in progress. A horizontal adjustment was last undertaken by the Coast and Geodetic Survey in 1927, before the advent of automatic data processing. When the new adjustment of both control networks is completed in 1983, it will be of optimal value to all users. Future emphasis will be on data management and its roll in our society as the world's population increases and arable land diminishes.

Bossler, John D.

The new adjustment of the North American horizontal datum, EOS, Transactions of the American Geophysical Union, v. 57, no. 8 (August 1976), p. 557-562.

The National Geodetic Survey is in the midst of an eight-year project to redefine the North American Datum. Actively assisting the United States in this task are Canada, Mexico, the republics of Central America, and Denmark (Greenland). The new adjustment will be completed in 1983 at a cost of approximately $18 million. When completed, the presently used North American 1927 Datum will be replaced by the North American 1983 Datum. The new datum will not be related to a single point, but to numerous stations which will have been determined from satellites or other superprecise methods. This paper discusses the history and development of the project, methods of adjusting the data, and present status of the task.

Boyd, James E.

Performance evaluation of Guildline Model 8400 Laboratory Salinometer, NOAA Technical Memorandum NOS 18, July 1976, 20 p. PB-259 696

The performance of the Guildline Model 8400 Laboratory Salinometer (Autosal) was evaluated in detail by the National Oceanographic Instrumentation Center of the National Ocean Survey of the National Oceanic and Atmospheric Administration. The salinometer is designed to offer high accuracy (± 0.003

part per thousand) and employs a measurement principle entirely different from that of other available instruments. The investigation included testing for overall accuracy, repeatability, and stability of the conductivity ratio measurements as well as the effects of variations in bath temperature, ambient temperature, and power supply voltage and frequency. The performance of the instrument was found to exceed the published specifications of the manufacturer. Results are presented in detail, notably that the conductivity ratio accuracy was better than ±1 part per million equivalent salinity. Graphs and other illustrations are included in the report.

Chovitz, Bernard H.

Monitoring geodetic networks by space techniques, Proceedings of the Third International Symposium on Geodesy and Physics of the Earth, Weimar, Germany, October 1976.

Modern space techniques include laser ranging to satellites like Lageos and Starlette, laser ranging to reflectors on the Moon, and radio interferometry. These techniques have the potential capability of measuring both horizontal and vertical components of position to the order of a centimeter.

One application relates to the new determination of the North American horizontal datum, presently under way, and the vertical datum, shortly to commence. The main benefit of the new space techniques will be to monitor positions periodically to ascertain if the network is shifting or being distorted as a function of time. The ideal locations of the monitoring stations will be most likely at the junction points of the North American transcontinental traverse lines.

A second application involves the study of polar motion. It will be highly desirable to intercompare the new techniques with the conventional astronomic methods for polar motion determination, and to ascertain if additional information can be gained on secular motion of the pole. This could provide the basis for a new Earth dynamics reference system as discussed at the 1974 Torun symposium.

A third application concerns the discrepancy between geodetic and oceanographic leveling about the slope of mean sea level. Measurement of geometric height differences at selected tidegauge stations by the new techniques (supplemented, of course, by geoid height determinations at the same points) will help resolve this controversy.

Crump, David R.

Test results on an electromagnetic current sensor with an open design, NOAA Technical Memorandum NOS 19, August 1976, 11 p. PB-260 444

An electromagnetic current sensor with a unique "open" design was developed by J. R. Olson of the Naval Undersea Center. It was tested for steady flow accuracy and cosine response in the horizontal and vertical planes. The sensor's configuration was designed to minimize hydrodynamic disturbances of the current flow and to offer good linearity and directivity response. Test data revealed the sensor's steady-flow measurement uncertainty to be ±2.5

percent of full scale. Horizontal directivity errors were less than ±4 cm/s and 5 cm/s for half- and one-knot test flows. The major contributor of error for the cosine response was determined to be an imbalance in amplifier gain between the sensor's two measuring axes. Vertical directivity results were too noisy for reliable analysis, and the problem was believed to be caused by a distortion of the sensor's magnetic field during testing.

Dillinger, W. H., and Hanson, R. H.

Status of the computer system for the new adjustment of the North American Datum. Presented to the American Geophysical Union Annual Fall Meeting, San Francisco, California, December 6-10, 1976, 13 p. (unpublished)

The Helmert-blocking technique for partitioning geodetic networks has been selected for use in readjusting the North American Datum (NAD). Designing a procedure for the computer that is sufficiently general to handle any number of first-level blocks and any number of levels of blocking has required solving several problems related to computer implementation. A first "breadboard" version is now working and is being tested and evaluated. Though much work remains to be done before a final production version is available, the first results are promising. Empirical tests suggest that roundoff error is actually less with these procedures than in the standard production programs. Successful computer runs with multiple levels of blocking indicate that we will be able to handle as large a network as is necessary for the NAD.

Dracup, Joseph F.

Updating survey networks--a practical application of satellite Doppler positioning, Proceedings of the International Geodetic Symposium on Satellite Doppler Positioning, New Mexico State University, Las Cruces, New Mexico, October 1976, p. 657-674.

The National Geodetic Survey (NGS) has carried out several tests involving Doppler-determined positions to control or to strengthen classical geodetic networks. These studies have shown that improvements in scale and orientation can be expected and, in fact, entire networks can be controlled by strategically placed Doppler positions. There are other uses to which these positions may be employed. Among these applications are those directed to improving the relative positioning of badly constrained or poorly designed systems, or to update positions located on land masses which may have shifted as a block, due to some tectonic event. The latter is a practical solution to an otherwise costly operation where the control is primarily used in hydrographic, topographic, or cadastre surveys. The study involved here is primarily concerned with the updating of geodetic control on the Alaska Peninsula, which is known to be distorted due to past adjustment practices. Major hydrographic surveys, in addition to the land definition projects by the Bureau of Land Management (BLM), are underway in this area. It is essential that the control be determined to the highest accuracy that can be obtained from available observational data, with a further stipulation that the positions remain unchanged until a new adjustment of the entire Alaskan network is made. An examination of the

adjusted results furnish good assurance that both conditions have been met. In addition, this test shows conclusively that networks of the type studied can be updated by judicious use of Doppler positions. Also included is a review of the possibilities of local crustal motion and a shift of the entire Peninsula and other evaluation of the use of Doppler positions as basic control.

Dracup, Joseph F.

Tests for evaluating trilateration surveys, Proceedings of the American Congress on Surveying and Mapping, September/October 1976, p. 96-131.

The National Geodetic Survey is employing trilateration procedures on more projects than heretofore. Although the National specifications provide some guidance, simple tests to evaluate the acceptability of the measurements are required. Such tests are particularly needed by field parties, expecially when the surveys are being made in remote areas and communication with the office or computer facilities is not readily available. In 1975, the NGS carried out trilateration surveys in two rather extensive areas of southwestern Alaska in support of Bureau of Land Management operations. Newly developed instrumentation was employed. When using these instruments, the antennae can be elevated where the need arises, while the heavier receiving and transmitting portions of the equipment remain on the ground. Since few stations were scheduled to be occupied with a theodolite, special portable pole signals were constructed to support the antennae. Elevations required to reduce the measured distances were determined to sufficient accuracy for the purpose by a variety of procedures.

There were no major problems involved in carrying out the computations. The major source of concern was deciding whether the specifications had been met because trilateration affords such few checks. During the past few years a study in regard to this matter had been underway in the office and procedures developed for ascertaining the acceptability of trilateration networks. These evaluation methods had proved quite successful and do not require a major computing effort. The tests are made using a table similar to that for determining the strength of triangulation. Detailed instructions with regard to trilateration in general and these testing procedures in particular were issued to the field unit. These instructions, including the table, have now been prepared in a format suitable for issuance to the public and serve as the basis for this paper.

Dracup, Joseph F.

National Geodetic Survey data: availability, explanation, and application, NOAA Technical Memorandum NOS NGS 5, June 1976, 39 p. PB-258 475

Geodetic data have been issued by the National Ocean Survey and its predecessors for more than 100 years. During this period, the data were furnished in a variety of formats, finally evolving into the present-day tabulations. Although much of the data is available in a modern standardized form, some material is still published on old-style listings. Explanations are given to assure that the user fully understands the published information.

Some of the data were computed on several reference surfaces, which must be considered when the information is used to related maps and charts of the past with the present. Explanations are provided in regard to survey accuracies and problems inherent to certain geometric configurations.

Since hundreds of publications and thousands of papers dealing with geodetic surveys have been published or presented, the compilation of a complete bibliography would be a formidable task. This report gives a concise listing of publications and papers of general interest and their sources of availability. Also included are detailed references to the application of geodetic control and practices, as only a brief discussion of this subject is presented in the text.

Dracup, Joseph F.

The United States horizontal control network 1816-1976, Proceedings of the American Congress on Surveying and Mapping, February 1976, p. 252-261.

All things must have a beginning. This was the case with the horizontal control network of the United States. From a modest effort starting in 1816, this country now has a framework of almost 200,000 stations. The task was not easy, but the men who fathered this great endeavor were well founded both in science and in determination. Different periods in the long history produced different accomplishments, but in the end these accomplishments all led to the product as we know it today: a network second to none.

Fritz, Lawrence W., and Slama, Chester C.

Multi-plate, multi-exposure stellar calibration. Presented to the XIII International Society for Photogrammetry Congress, Helsinki, Finland, July 1976, 31 p. (unpublished)

A series of field and data reduction procedures has been developed to obtain highly accurate camera calibration constants for metric reseau cameras from time exposures of the star field. The calibration techniques include combined data from several two-and-one-half hour chopped and precisely timed exposures. Each exposure is made with the camera rigidly mounted and oriented to a different direction about the zenith. The double measurement of up to 2400 catalogued star images evenly spaced throughout the format of each plate provides sufficient redundancy to determine accurately the systematic deviations of all rays in the format from a central perspective. Special provisions have been included in the data reduction processes to minimize the influence of measurement errors, atmospheric refraction anomalies, thermal variations, and random variations in plate flatness. The calibration of the reseau coordinates is performed from redundant measurements of multiple photographic flash plates. All calibration parameters and coordinates are defined in a common coordinate system and are provided with complete error analysis and a thorough graphical portrayal of their values.

Results from a single aperture-filter calibration of two special aerial mapping reseau cameras (Wild RC-8 and Zeiss RMK 15/23) as part of an ISP Commission I Working Group Investigation are presented.

Hanson, Robert H.

The new adjustment of the North American horizontal datum--The network adjustment, American Congress on Surveying and Mapping Bulletin, no. 55 (November 1976), p. 21-22.

This is the fifth in a series of articles in the ACSM Bulletin on the new adjustment of the North American Datum. The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment.

Four attributes are outlined which will make possible the solution and inversion of least squares normal equations containing hundreds of thousands of unknowns. These are matrix symmetry, matrix sparseness, peripheral storage computer hardware, and the Helmert blocking technique.

Henriksen, Soren W.

The role of extremely accurate surveying techniques in existing geodetic networks, Proceedings of the Scientific Applications of Lunar Laser Ranging Conference, University of Texas, Austin, Texas, June 1976, p. 149-156.

The Lunar Laser Ranging Experiment (LURE) and similar projects are able to produce highly accurate data concerning a small number of points. These data, therefore, can be used only to support, not supplant, other kinds of geodetic data which, while perhaps less accurate, apply to a vastly larger number of points. What is the effect of combining highly accurate data about a few points with less accurate data about a large number of points? There are two ways of finding an answer. One method is to set up the general equations governing geodetic networks and see what happens to the covariance matrices as we add the very accurate data. This is the approach undertaken here. It turns out that, for networks such as those we could expect to find in the U.S.A., the highly accurate data have their greatest effect in setting the scale of the network, and that probably only a small amount of data is needed. Increasing the number of points affected can help weak spots in the networks, but such identification can also be done by analyzing the less accurate data.

Another method is to take actual networks and see what happens to them when the highly accurate data are added. This has been done by Robert E. Moose of the National Ocean Survey. The results of a typical computation are shown, and the relation of these to the theoretical results above is discussed. It appears that the two approaches are in reasonably good agreement. It should be remembered, of course, that the complexity of the theoretical approach is great enough that detailed information cannot be practically extracted from it; the numerical approach, whose results are cited here, is limited in generality, since its results apply only to one network which may not be typical.

Holdahl, S. R.

Recent elevation change in Southern California, Proceedings of the Second International Symposium on Land Subsidence, International Association of Hydrological Sciences, Anaheim, California, December 1976.

Velocities of elevation change for two time periods have been determined from Southern California leveling data. Two periods were selected for study: 1906 through 1962 and 1959 through 1976. The study area extends from San Pedro north to latitude 35.°5, and between longitudes 117° and 119.°5. The shape of the fitted velocity surface for the latter epoch agrees with the original uplift established by Castle et al. (1976) with the exception that no eastern termination is evidenced within the study area. The velocity surface for the earlier time period shows negligible subsidence of 1 mm/yr at Palmdale, increasing to 9 mm/yr at Bakersfield. The 11 mm/yr maximum uplift velocity determined for the period 1959 through 1976 is approximately twice the corresponding standard deviation. Weighted velocities, extracted from tidal records at six stations on the coast, were used to provide input for absolute height change.

Hothem, Larry D., and Strange, William E.

The use of Doppler satellite positioning for extension of offshore geodetic control, Proceedings of the American Congress on Surveying and Mapping, September/October 1976, p. 295-317.

Doppler satellite positioning has become an important technique for offshore geodetic control surveys. Depending on the Doppler satellite ephemeris system and method of reduction utilized, position accuracies of better than 1 meter have been achieved on land. Offshore oil platforms serve as a unique stable structure for offshore surveys. In cooperation with the offshore oil industry, the National Geodetic Survey began Doppler satellite offshore positioning with a test project in the Gulf of Mexico in February 1974. Eventually, a total of 15 Doppler stations, including one reoccupation, was established. Provided certain site conditions are met and equipment operation is normal, the accuracy of Doppler satellite positioning of offshore structures is estimated to be 0.5 to 1.0 meter rms in each coordinate. The desirable spacing for the Doppler stations is given. Transformed Doppler positions can be used to determine useful values for the geoid separation where the height above MSL is available for the Doppler stations. Finally, to benefit from the accuracy inherent in Doppler positioning, care must be taken in relating the Doppler positions based on the satellite coordinate system to the NAD 1927 datum coordinate system and other local datums.

Keller, Morton

Analytic aerotriangulation utilizing Skylab Earth Terrain Camera (S-190B) photography, Photogrammetric Engineering and Remote Sensing, v. 42, no. 11 (November 1976), p. 1375-1383.

The feasibility of utilizing Skylab spacecraft Earth Terrain Camera (S-190B) 1:946,000 scale photography in analytic aerotriangulation procedures to provide low-order, high-density control suitable for small-scale mapping operations was investigated.

The long-range application is the employment of this technique for coastal zone mapping at medium and small scales, surveys in remote areas, forest and

range management, various planning activities, and route location for highways, pipelines, transmission lines, and canals.

The National Oceanic and Atmospheric Administration, National Ocean Survey (NOAA/NOS), office-identified the locations of 29 photo control points of known position and elevation on a strip of 12 photographs ranging along a 350-mile track from Charlotte, North Carolina, to the Rappahannock River in Virginia. The coordinates of pertinent images on each photograph were observed on comparators operated by NOS, and the resulting data were then processed through an established analytic aerotriangulation system of computer programs. A block adjustment was performed holding to 14 of the office-identified photo control points. The accuracy of the solution was evaluated by comparing the analytically computed ground positions of the 15 withheld photo control points with their known ground positions. A horizontal position RMS error of 15 metres was attained. The maximum observed error in position at a control point was 25 metres.

Keller, Morton

NOS study of applied photobathymetry. Presented to the Canada-United States Mapping, Charting, and Aerial Photography Committee, Defense Mapping Agency Aerospace Center, St. Louis, Missouri, June 1976, 12 p. (unpublished)

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 and their dramatic presentation of submerged detail provides an alternative tool and supplement for mapping the seabed in shoals and waters of moderate depth. Photogrammetric bathymetric surveys preceding hydrography can show many of the rocks, reefs, shallow areas, photogrammetrically observed depth measurements and depth curves, and other features and thereby assist the hydrographer whose work is more difficult because he does not have the overall view of the bottom to guide his operations in developing important details.

The objective of this paper is to advance the comprehension of the potential of photogrammetric bathymetry to provide the following benefits:
1. improve the accuracy and completeness of the hydrographic survey;
2. reduce the cost and time of the field hydrographic survey; and,
3. reduce 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.

The investigation of the potential for accomplishing photogrammetric bathymetry was restricted to ten regions of high priority along the East Coast and the Gulf of Mexico. A five-year photobathymetry program is envisaged that will require a maximum of 10,765 man-days of work and cost $1,154,750. These figures can be substantially reduced by the employment of digitized stereoscopic plotting instruments and the development of advanced, sophisticated photogrammetric analytic aerotriangulation procedures.

Kelley, Carl F., and Holdahl, Jeannie H.

NGSIC and the user. Presented to the American Society of Photogrammetry (Rocky Mountain Region)/American Congress on Surveying and Mapping (Colorado Section) Annual Symposium, Denver, Colorado, January 8-9, 1976, 11 p. (unpublished)

The products and services provided by the NGSIC in the past, present, and future will be discussed. This includes information on the NGS Data Base, a proposed National Geodetic Control Data Bank, and the data standardization guidelines presently being established by NGS.

Marsh, J. G. (NASA), Douglas, B. C., Vincent, S. (Wolf R & D Group), and Walls, D. M. (Wolf R & D Group)

During the Skylab 4 mission the S-193 radar altimeter was operated nearly continuously for a revolution around the world on January 31, 1974. This direct measurement of the sea surface has provided for the first time an independent basis for the evaluation of the precision of global geoids computed from satellite-derived earth gravity models. This paper present comparisons between the Skylab data and several recent gravity models published by Goddard Space Flight Center, the Smithsonian Astrophysical Observatory, and the National Oceanic and Atmospheric Administration. The differences between the altimeter geoid and the satellite geoids were as large as 20 m, rms values ranging from 8 to 10 m. These differences also indicated a systematic long wavelength variation ($\sim 100°$) not related to error in the Skylab orbits. Truncation of the models to degree and order 8 did not eliminate the long wavelength variation, but in every case the rms agreement between the satellite geoids and the altimeter geoid was slightly improved. Orbits computed with the truncated models were in contrast found to be inferior to those computed with the complete models.

Meade, B. K.

The historical Mason-Dixon Line, the east-west boundary between Pennsylvania and Maryland, was determined in a survey by Mason and Dixon during the period 1765-1767. Prior to this survey, Mason and Dixon established the north-south boundary between Delaware and Maryland in 1764. In the survey of the north-south boundary, monuments were placed at one-mile intervals by Mason and Dixon.

Results from a resurvey of the Maryland-Delaware, north-south boundary, performed by the U.S. Coast and Geodetic Survey in 1961-62, indicated the monuments established by Mason and Dixon were spaced at average intervals of 5,292 feet. The Maryland-Delaware, east-west boundary, laid out by Colonial surveyors in 1751, was resurveyed by the National Ocean Survey in 1974. Results from this resurvey show the unit of measurement used by the Colonial surveyors was in close agreement with the Mason-Dixon value; that is, the unit used in the Colonial and Mason-Dixon surveys was about one part in 400 greater than our present value of 5,280 feet per mile.

Results obtained from modern resurveys of the Pennsylvania-Maryland-Delaware boundaries are compared with results from the Colonial and Mason-Dixon surveys.

Meade, B. K.

Errors of Doppler positions obtained from results of transcontinental traverse surveys, Proceedings of the International Geodetic Symposium on Satellite Doppler Positioning, New Mexico State University, Las Cruces, New Mexico, October 1976, p. 813-830.

Point to point inversed distances in space, using Doppler data and preliminary results from the high precision transcontinental traverse survey network of the U.S., have been compared in order to obtain error estimates of Doppler results. The average chord distance difference, Doppler minus TT, was 0.50 m. for 15 lines in a north-south direction and 0.65 m. for 25 lines in an east-west direction. These results are in close agreement with standard errors in latitude and longitude as determined previously from repeated Doppler observations at several stations. The average distance between Doppler stations used in these comparisons was 300 km.

As a byproduct of these computations in space, the azimuths computed from Doppler data were converted to geodetic azimuths referred to the Clarke 1866 Spheroid. These converted azimuths, along with distances from the TT, were used to compute position closures of the 6 loops of the traverse net. The results are compared with closures obtained from the TT azimuths.

Moose, Robert E., and Henriksen, Soren W.

Effect of Geoceiver observations upon the classical triangulation network, NOAA Technical Report NOS 66 NGS 2, June 1976, 65 p. PB-260 921 (Also Proceedings of the International Geodetic Symposium on Satellite Doppler Positioning, New Mexico State University, Las Cruces, New Mexico, October 1976, p. 591-656.)

This paper investigates the use of Geoceiver observations as a means of improving triangulation network adjustment results. A test network of real data is used in this study, which is comprised of 32 separate projects and contains 838 first-order and 489 second-order stations in the States of Mississippi, Louisiana, and Alabama. Statistics are provided on a sequence of adjustments of the network in which the number of azimuth, baseline, and Geoceiver observations were systematically varied. From an analysis of this sequence of adjustments, three important conclusions are made. First, the most effective separation for Geoceiver observations is about 250 km and greater. Second, there is a limit to the improvement in the a posteriori standard error that Geoceiver observations can effect in a triangulation network. Third, Geoceiver observations are an effective means of controlling distortions in the local network. The theory of how Geoceiver observations combine with the classical observations is explained.

Morrison, Foster

Algorithms for computing the geopotential using a simple density layer, Journal of Geophysical Research, v. 81, no. 26 (September 10, 1976), p. 4933-4936.

Several algorithms have been developed for computing the gravitational attraction of a simple-density layer; these are numerical integration, Taylor series, and mixed analytic and numerical integration of a special approximation. A computer program has been written to combine these techniques for computing the higher frequency components of the gravitational acceleration of an artificial Earth satellite. A total of 1640 equal-area, constant surface density (5° x 5°) blocks on an oblate spheroid is used. The special approximation is used in the sub-satellite region, Taylor series in a surrounding zone, and numerical quadrature in the remaining regions. The relative sizes of these zones are readily changed. An auxiliary program can generate all the parameters for different equal-area block configurations. Different orders may be used in the numerical quadrature done in connection with the special approximation. Numerical tests comprising integrations of equations of satellite motion and static gravity simulations indicate the simple-density layer model is not only feasible, but highly practical and very easy to use.

Nicholson, W. M.

Ocean instrumentation. Presented to the 4th Joint Oceanographic Assembly, Edinburgh, Scotland, September 1976, 14 p. (unpublished)

The importance of accurate, repeatable and reliable instrumentation to our expanding knowledge of the ocean is incontestable. Our growing awareness of the fragility of our environment and our efforts to better understand and manage that environment are placing considerable pressure on the quality as well as the quantity of our measurements. This, together with constantly improving communications on a world-wide basis, is leading to more and larger international investigations and to an increasing need for data exchange. In one tabulated review of standards and procedures for 31 oceanographic measurements, only 10 percent of the standards and procedures are considered adequate to meet all present and anticipated requirements. Two thirds of the standards and procedures are considered clearly inadequate. International intercalibrations had been performed on only four of the 31 sensor classes considered. An attempt is made to state present and estimated future requirements for range and accuracy of measurements in 120 marine parameters. These are presented for review without any attempt to quantify the demand for these measurements.

The problem of improving international standards and procedures was recognized at the first IOC meeting and the Secretary was requested to arrange international intercalibrations and symposia to address this problem. Unfortunately in the last decade resources were not available for this program. It is now urgent that we reassess the problem. The paper presents U.S. ocean related budget figures and specific current problem areas to illustrate the need for action and recommends the following steps to alleviate the situation:

1. We must find ways to support the development of new improved standards and instrumentation. Financing might be obtained by directing a reasonable portion of our program finances to support instrument programs. Improved statements of requirements for instrumentation must also be obtained for effective use of the limited funds available.

2. We need a more active and unified international approach through centers such as COB, NOAA, and JAMSTEC. Possibly creation of additional national centers can help in the future.

3. Technical and scientific societies and program managers must emphasize development of standards, procedures, and instruments to measure critical parameters, particularly those relating to environmental impact.

4. We need a formal program of international intercalibration to achieve a better focus on the problem areas.

5. It is suggested that ECOR sponsor a regular international workshop including both scientific and engineering groups involved to address these problems. The first meeting is suggested to be in the Fall of 1977 in the United States.

Pijanowski, Barbara S.

Test and evaluation of the InterOcean Systems, Inc. Model 500 CTD/O₂ pH In-situ Monitor System, <u>NOAA Technical Memorandum</u> NOS 20, August 1976, 27 p. PB-260 442

Test and evaluation results are reported for a system which is designed to measure temperature, conductivity, depth, dissolved oxygen, and pH to depths of 100 meters. The system is described and manufacturer's specifications are listed along with representative performance data such as accuracy, stability, power variation, and environmental effects for the five parameters. In addition, an extended performance summary is provided which details the history of the system, the modifications required during the course of the testing program, and a list of required replacement parts. General comments are offered for the benefit of potential and current users.

Pope, Allen J.

The statistics of residuals and the detection of outliers, <u>NOAA Technical Report</u> NOS 65 NGS 1, May 1976, 133 p. PB-258 428

Insofar as possible it is desirable to base the criteria for the detection of bad data on rigorous statistical arguments. This report recapitulates the statistics involved and describes the "tau" criterion in detail. This criterion is especially suited for use in simultaneous least-squares adjustments of triangulation networks. Special note is taken of yet unsolved problems involved in the rigorous derivation of still more efficient and exact criteria.

Powell, Allen L.

Determining baselines for offshore boundaries, <u>Proceedings of the Eighth Annual Offshore Technology Conference</u>, May 1976, p. 971-976.

Offshore boundaries and related marine base lines are determined by tidal datums which are computed from long-term tide level measurements. This paper describes the technical problems involved with boundary location and presents a new program of the National Ocean Survey (NOS) for high-accuracy marine boundary determinations along the United States coast line based on computed tidal datums. Boundary data requirements for the Federal government, state governments, local jurisdictions, and private sector will be discussed.

Powell, Allen L.

National Ocean Survey--the government's first technical agency. Presented to the Joint Plenary Session, American Congress on Surveying and Mapping/American Society of Photogrammetry Annual Meeting, Washington, D.C., February 22-28, 1976, 95 p. (unpublished)

This paper is a condensed history of the National Ocean Survey which was established by Congress in 1807 to survey United States coastal waters and prepare nautical charts for the purpose of improving the safety of coastal navigation and promoting waterborne commerce. It was conceived as a scientific and technical agency, planned under direction of the Nation's leading scientists, and organized by a scientist/engineer with exceptional farsighted principles and ingenuity. Major events, significant achievements, and individual accomplishments are traced over 169 years of public service in the fields of geodesy, hydrography, nautical charting, photogrammetry, oceanography, marine engineering, instrumentation, naval architecture, seismology, geomagnetism, gravity, aeronautical charting, and printing.

Safford, Robert W., and Whiting, Marvin C.

New trends at National Geodetic Survey. Presented to the American Congress on Surveying and Mapping Annual Meeting, Washington, D.C., February 22-28, 1976, 7 p. (unpublished)

The Terminal ENtry COmmand Language (TENCOL) will enable National Geodetic Survey (NGS) field parties to communicate over telephone lines to a host computer, thus giving field parties direct access storage for their observations, data descriptive text, and computer printouts. At the conclusion of a project, or at any time, all stored field data is in machine-readable form and can be submitted to NGS Headquarters.

Schemery, Lawrence W.

Copperplate engraving, Proceedings of the American Congress on Surveying and Mapping, February 1976, p. 188-191.

Copperplate engraving, as a means of reproducing nautical navigational charts, was first used in the United States in the early 1830's. The Coast and Geodetic Survey, recognized as the Nation's first Federal chart maker, was established in 1807 and employed copperplate engravers for chart engraving from the 1830's into the early 1940's, spanning a period of over 100 years. In 1970 the Coast and Geodetic Survey underwent a reorganization and at that time became the National Ocean Survey.

During the 100-year period that the C&GS was engaged in the copperplate engraving art, this function, as applied to chart production, attained a level of artistry in the agency that was unexcelled in the world. To aid the navigator, scenes were frequently engraved onto the charts depicting important landmarks along the route. One of the best known engravers to be employed was James M. Whistler who painted the famous portrait "Whistler's Mother" and became world renowned for this and other works of art.

In 1844 the agency produced 169 copies of nautical navigational charts. This figure increased steadily until the Civil War when the total yearly output reached more that 50,000 copies. By the turn of the century the volume increased to about 100,000 copies annually.

The Coast and Geodetic Survey began its transition to lithographic offset printing as early as 1897. As the demand for charts increased and the desire to use colors to show detail developed, copperplate chart printing was gradually phased out during the period from 1916 through the early 1940's. Thereafter charts were entirely reproduced by the photolithographic method.

Snay, Richard A.

Reducing the profile of sparse symmetric matrices, NOAA Technical Memorandum NOS NGS 4, June 1976, 24 p. PB-258 476 (An abbreviated version published in Bulletin Geodesique, v. 50, no. 4, 1976, p. 341-352.)

An algorithm for improving the profile of a sparse symmetric matrix is introduced. Tests on normal equation matrices encountered in adjustments of geodetic networks by least squares demonstrate that the algorithm produces significantly lower profiles than the widely used reverse Cuthill-McKee algorithm.

Spencer, John F., Jr.

Final report on responses to geodetic data questionnaire, NOAA Technical Memorandum NOS NGS 2, March 1976, 39 p. PB-254 641 (Also Proceedings of the American Congress on Surveying and Mapping, September/October 1976, p. 141-205.)

Prior to the mailing of the geodetic data questionnaires and information packets to every licensed land surveyor in the U.S., there was virtually no information available to the National Geodetic Survey that could be used to evaluate user requirements for geodetic data or to determine surveyor awareness of its availability from this office.

This office's evaluation of responses to the questionnaire is contained herein. The results of this evaluation will have considerable influence on the development of programs and priorities by the National Geodetic Survey of the National Ocean Survey, National Oceanic and Atmospheric Administration.

Starr, Robert F.

Decoders convert binary code for hexadecimal display, Electronics, v. 49, no. 14 (July 8, 1976), p. 107.

The article describes a design technique to generate and display alpha-numeric characters (0-9 and A-F) using a seven-segment numerical display.

Stem, James E.

NGS data base as a central depository of geodetic control data, Proceedings of the American Congress on Surveying and Mapping, February 1976, p. 49-57.

Requirements to manipulate the data for the new horizontal datum adjustment demonstrated that the means of data handling, storage, and retrieval being used were inadequate, and improvements to the system should consider the total automation of all NGS data including both field computations and publication facilities. The design of the Data Base Management System to assist in this automation was described in a paper presented at the 1975 Annual ACSM Conference by Messrs. David Alger and Joseph Gurley.

NGS is in the process of selecting the data elements to be stored in the data base and establishing the standards and formats for use by other organizations. The product of this definition stage will result in a publication of Input Formats and Specifications for the submission of geodetic data to NGS and for the utilization of NGS software.

Strange, William E., and Hothem, Larry D.

The National Geodetic Survey Doppler satellite positioning program, Proceedings of the International Geodetic Symposium on Satellite Doppler Positioning, New Mexico State University, Las Cruces, New Mexico, October 1976, p. 207-227.

In support of the readjustment of the North American horizontal datum, some 160 Doppler stations are being established within the 50 states of the United States. Approximately 140 of these stations are already established. The present stations have been used to derive the deformations from the 1927 NAD, to indicate the best transformations from the 1927 NAD to a geocentric system, and to investigate the internal consistency of existing satellite solutions in North America. Doppler positioning results, in conjunction with space system results, optical satellite results, and astronomic data, are also being used to establish scale and coordinate system orientation for the new North American horizontal datum. Some preliminary results are presented.

Thomas, Ernest E.

National Ocean Survey nautical charting after the next decade, Proceedings of the 15th Annual Canadian Hydrographic Conference, Ottawa, Ontario, Canada, April 1976.

Nautical charts, as nations publish them, are designed for specific end-purpose objectives. However, such objectives have had to be broad enough to satisfy "all" users. Current computer-supported charting is a new evolution in charting. It does not have the constraints of the slow manual processes, but does have the ability to produce a relatively quick and economical generation of output in a more flexible range and in a variety of charting layouts and formats. The National Ocean Survey (NOS) nautical chart cartographer is currently using these new tools in his daily cartographic applications of new source material. The cartographer's use of the graphic document as compared to its digital form will eventually diminish. More and more, the chart planner will provide greater variety in charting concepts for NOS management to select for its presentation to the user, and with such activities will come the tightening of the requirements for our charting end products from reactions to the many prototypes on issue.

Possibly, not all charts published after 1985 will be in document hardcopy form as they are today. But whatever its display form shall take, the NOS charting product must be responsive to our users, but with proven economics, and effectiveness in supplying any new innovations.

Vincenty, T.

Determination of North American Datum 1983 coordinates of map corners, NOAA Technical Memorandum NOS NGS 6, October 1976, 8 p. PB-262 442. (Also Proceedings of the International Geodetic Symposium on Satellite Doppler Positioning, New Mexico State University, Las Cruces, New Mexico, October 1976, p. 831-838.)

This publication describes the use of Doppler data in predicting approximate changes of coordinates of map corners from the North American Datum 1927 (NAD 27) to the North American Datum 1983 (NAD 83) system. A brief description of the computer program and pertinent mathematical formulas are included.

Vincenty, T.

A method for determination of the geodetic height of a point, Allgemeine Vermessungs-Nachrichten, 5, 1976, p. 179.

A formula for conversion of rectangular space coordinates to geodetic coordinates, as given by Bartelme and Meissl, is modified in order to improve convergence. The improved formula is non-iterative for all practical purposes.

Ward, G. K.

Evaluation of some ion-selective electrodes for applications in the marine and estuarine environments, Proceedings of the American Geophysical Union, December 1976, p. 12.

Specific ion electrodes from several manufacturers were used to measure the concentrations of various ions in pure water; $35°/oo$ to $5°/oo$ salinity artificial seawater; standard IAPSO seawater; natural seawater ($\approx5°/_{oo}$ S); polluted Chesapeake Bay water ($\approx5°/_{oo}$ S); polluted river water (Potomac River); and clean freshwater in connection with possible utilization of the electrodes for in situ water quality measurements. Each electrode was evaluated for repeatability, shore-term drift (≈3 hrs.), long-term drift (several weeks), temperature effects, response time and sensitivity to variations in flow conditions and light intensity.

The electrodes were chosen for the capability of direct measurement in seawater without sample pretreatment and were specific for sodium, potassium, calcium, magnesium, and chloride ions. The time responses were significantly longer than those given by the manufacturers and the millivolt response versus time curves varied for each electrode type. The minimum time required for the electrode readout to reach 99% of the final value was 5-10 minutes, and longer times were required to respond to a decrease in concentration. Some electrodes had a continuous drift and therefore required frequent recalibra-

tion. Experimental results show that the sodium ion-selective electrodes do not give the theoretical Nernstian response over the temperature range from 10°C to 25°C. From direct ion-electrode measurements, the concentration of free sodium ion was found to be 0.5571, 0.5541, and 0.5543 gm/kg/Cl°/$_{oo}$ in IAPSO standard sea-water, Atlantic coastal water ($\approx$32°/$_{oo}$ S), and Chesapeake Bay water ($\approx$5°/$_{oo}$ S), respectively, compared to literature values for seawater of 0.5567 and 0.5555 gm/kg/Cl°/$_{oo}$ (Riley and Skirrow, 1975).

Whalen, Charles T., and Balazs, Emery I.

Test results of first-order class III leveling, NOAA Technical Report NOS 68 NGS 4, November 1976, 30 p. PB-265 421

The National Geodetic Survey has programmed for a partial releveling of the first-order, National vertical control net and for readjustment of the entire first- and second-order net during 1977 through 1985. In the past, first-order, class I or II, double-run leveling was used exclusively to establish and relevel the first-order net. Programmed funds permit releveling and replacing destroyed marks on approximately half of the National first-order net by double-run leveling, or on essentially the entire net by new first-order, class III, single-run leveling. The new specifications, based on an analysis of leveling errors, were field-tested on a level line from Waldorf to Baltimore, Md. between December 1975 and April 1976. Test results indicate that first-order, class III leveling can provide a viable alternative to first-order, class I leveling for releveling the first-order, National vertical control net.

Whiting, Marvin C., and Pope, Allen J.

Adjustment of geodetic field data using a sequential method, NOAA Technical Memorandum NOS NGS 3, March 1976, 11 p. PB-253 967

Using remote terminals, National Geodetic Survey (NGS) field parties are now able to carry out limited adjustments for the purpose of evaluating their observations. Such an adjustment must be able to handle incomplete networks. The method adopted was developed by Creusen (1965). It is a sequential adjustment using a modified arithmetic which automatically handles all problems of possible singularities, giving for indeterminate parameters their pseudo-inverse solution accompanied by appropriate flags. The modified arithmetic is based on the Laurent series $\Sigma = A_1\epsilon^{-1}+A_2+A_3\epsilon+A_4\epsilon^2+$ . . . with ϵ a double variable. A_1 thus has infinite variance relative to A_2 which has infinite variance relative to A_3. For a sequential adjustment only two terms are necessary. A_1 becomes a projection matrix and A_2 a covariance matrix. A_1 is initially set to I and at each step of the sequential adjustment becomes $I-N^+N$, while $A_2=N^+$. At determinancy N^+ becomes N^{-1} and A_1 becomes zero, thus providing a flag on the determination of the unknowns. The main disadvantage of this method is large core requirements in a computer. With the residuals from the adjustment and their standard errors, the NGS field observers can immediately determine if their work satisfies first-order requirements.

Woodward, William E., and Callahan, Michael R.

Aanderaa compass calibrations, <u>Exposure</u>, v. 4, no. 2 (May 1976), p. 9-12.

The Testing Division of the National Oceanographic Instrumentation Center (NOIC) initiated a program to investigate if compass calibrations of Aanderaa current meters are affected by the rotor and/or follower magnets.

In order to assess and quantify any effects, it is necessary to first perform two compass calibrations, one with the rotor fixed with respect to the case in an arbitrary position and another with the rotor fixed 180 degrees from the first. If there are any biasing effects from the magnets, systematic differences will exist between the curves of the two fixed rotor calibrations. A third calibration should then be performed with the rotor spinning. Because spinning the rotor would break up the d.c. field, this curve should lie in the middle of the previous curves. Tests performed to date verify these expected results.

Young, Gary M.

The new adjustment of the North American horizontal datum--Data capture and validation, <u>American Congress on Surveying and Mapping Bulletin</u>, no. 52 (February 1976), p. 19.

This is the third in a series of articles in the <u>ACSM Bulletin</u> on the new adjustment of the North American Datum. The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment.

It is estimated that this effort will involve 5,000 archival projects, containing collectively 2.25 million observations (horizontal directions, zenith distance observations, taped and electronically measured distances, and astronomic positions and azimuths), which will be directly involved in the new adjustment. Following data capture, the data are evaluated and analyzed using sophisticated edit and adjustment software and are stored in the NGS data base to await subsequent phases of the new adjustment. An effort equivalent to 200 staff-years will be required to accomplish the data capture and validation phases.

NOS 16   Deep Sea Tide and Current Observations in the Gulf of Alaska and Northeast Pacific. Carl A. Pearson, December 1975.

NOS 17   Deep Sea Tide Observations Off the Southeastern United States. Carl A. Pearson, December 1975.   (PB-250072)

NOS 18   Performance Evaluation of Guildline Model 8400 Laboratory Salinometer.   James E. Boyd, July 1976.

NOS 19   Test Results on an Electromagnetic Current Sensor With an Open Design. David R. Crump, August 1976.   (PB-260444)

NOS 20   Test and Evaluation of the Interocean Systems, Inc. Model 500 CTD/Oxygen pH In-Situ Monitor System. Barbara S. Pijanowski, August 1976. (PB-260442)