QUALITY CONTROL PROCEDURES IN PROCESSING OCEANOGRAPHIC DATA

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ABSTRACT

The National Oceanographic Data Center (NODC) receives significant volumes of oceanographic environmental data for processing. These data vary from the conventional ocean station data and expendable bathythermograph data to a wide variety of biological and pollution data. The need for a more objective environmental quality control became evident as the volume of data continued to increase. At the same time, the resources--enriched computer capability and large climatological files of fully processed data--for developing such a system became available. The NODC procedures, prior to the development of environmental models, were based primarily on the initial quality control by data donors and subjective analysis by NODC oceanographers. This study describes the use of ocean models for quality controlling ocean serial and XBT data.

1. INTRODUCTION

The National Oceanographic Data Center (NODC) receives significant volumes of oceanographic environmental data. The quality control of these data can be performed in a variety of ways. The NODC has developed computer generated models for selected data parameters, to assist oceanographic analysis in data quality control. Temperature and salinity have been the most commonly measured parameters of the ocean. The well-known consistency of temperature-salinity (T-S) measurements within an ocean water mass makes the T-S relationship ideal for quality control. Therefore, models of temperature, salinity and the dependent parameter density (σ_t) were developed to provide an objective data evaluation tool. These statistically coherent models are applied during initial data processing to detect errors and inconsistencies in contemporary data in a cost-effective manner.

2. DATA SOURCES

The following climatological data files at the NODC were used in the generation of oceanographic environmental models.

- a. Ocean Station Data (Nansen cast). A world wide distribution of 670,149 observations recorded from the late 1800's to 1979.
- b. Mechanical Bathythermograph (MBT) Data. Approximately 946,000 observations distributed world wide from 1941 to the present.
- c. Expendable Bathythermograph (XBT) Data. A world wide distribution of 360,239 observations from 1968 to the present.

3. DATA ANALYSIS

Ocean Station Data Models

The need for objective models for data quality control has become more apparent as the volume and costs for processing oceanographic data increase. The NODC utilized the climatology of its data holdings to identify and flag gross errors in data submitted. Environmental models based on generally accepted principles of water mass characteristics have been developed.

Figure 1. Observed salinity data superimposed on salinity-density model.

Salinity-density data were summarized for each five-degree latitude-longitude square of the oceans. NODC compiled bivariate histograms of salinity-density historical observations using its geographically sorted data base. In

regions where there are fewer than ten valid observations, no models were produced. A computation of the upper and lower bounds and a midline of salinity as a function of density (σ_t) is stored on computer disk for each five-degree square. The model serves to accentuate questionable data so that oceanographers can make decisions about the validity of those values. At each observed depth of new data, lower, mid and upper values of salinity are obtained from the appropriate model. Contemporary salinity data for each observed depth is automatically compared to the historical salinity in the model (Figure 1). If data appear in error, questionable indicators are given to specific depth temperature and/or salinity values but the data are not automatically deleted.

Quality control of ocean station data is performed during the input processing phase when various parameter interpolations are performed. This permits a more cost-effective use of the man-computer interface. The computer compares historic salinities with contemporary salinities in an automated fashion, saving a considerable amount of time for oceanographic analysts processing these data. In the past, oceanographers performed a subjective analysis with a variety of quality control tools. The computer models provide a greater degree of objectivity in the analysis in a rapid manner. Computer modules also perform various logic edits during the input processing phase.

Expendable Bathythermograph (XBT) Data Models

The quality control of XBT data is much more difficult than ocean station data because of a high degree of variability in the near surface of the oceans. Seasonal changes of the near surface ocean structure present a complex problem in formulating climatology models.

The quality control of XBT data is designed to identify potential errors in data in a cost-effective, semi-automated fashion. When processing new data, the high resolution XBT analog record is digitized by a semi-automatic digitizer. These data are compressed to inflection points and each XBT record is automatically compared to a near surface ocean climatology. This climatology consists of averages of temperature-depth profile characteristics, developed from historical mechanical bathythermograph (MBT) and XBT data. These models are used as standards for comparing and judging the quality of XBT data before they are merged into NODC files. The computer generated models, based on historic BT data, were developed for each 1° square and month with sufficient data. These models incorporate the mean environmental computations of the following temperature-depth traits:

- a. Sea surface temperature as reported at zero meters by only historical XBT data.

CDNS NO	TIME HR MN	DATE BY MO YR	LAT DEG MN	LONG DEG MN	B G I CDE	CTY CDE	REF. NO.	SHIP CODE	CRUISE NUMBER	DNP CDE	CAL TEMP	CAL DEP	NO. TEMPS
093	18 39 21	08 77	41 59 N	068 47 W	8 6 1	31	52687	3182A4	77 07	1	167	+00	28
DEPTH TEMPERATURE											MODEL BASED ON		
											12 XBTs	61 MBTs	
0	20.33										TRAIT	OBSERVED	HISTORICAL
1	19.49										SUR. TEMP.	20.33	AVERAGE
2	18.63												16.60
5	18.15										GRAD. DEPTH	9	12
9	18.05										GRADIENT	-0.318	-0.193
12	17.74										DEPTH 2 DEG	NONE	NONE
15	16.98										DEPTH 5 DEG	57	NONE
16	16.45										DEPTH 10 DEG	24	49
17	15.35										DEPTH P.G.	99	72
18	13.74												
21	11.43												-25
24	10.02												27
26	9.48												
32	8.08												
34	7.86												
38	7.08												
40	6.90												
44	6.71												
45	6.60												
58	6.25												
67	6.06												
75	5.58												
82	5.57												
84	5.51												
86	5.28												
99	4.96												
116	5.12*												
144	5.02												

Figure 2. XBT data and comparison of observed temperature-depth profile traits to historical averages.

- b. Depth of significant gradient. We define the significant gradient as that portion of the profile in which the gradient is at least -0.03°C per meter and which contains the greatest total temperature change. Depth of the top of this segment is called depth of the significant gradient.
- c. Gradient magnitude. The total temperature change divided by total depth change of the significant gradient defined above.
- d. Depth of three isotherms. The depth of each isotherm is found by linear interpolation between inflection points. Isotherms are chosen according to geographic region.
- e. Depth of positive gradient. The depth of the top of the shallowest positive temperature change.

The average values of each parameter are based on historic XBT data, except that historic MBT digital data are also used in computing traits b, c, and e. Deviations from the historic mean conditions are computed and listed during edit routines in the initial processing. Figure 2 represents a listing with the comparison of a contemporary digitized XBT observation to a historical model.

4. CONCLUSION

Historical oceanographic data have been used to achieve a better understanding of the oceanographic environment. The advantage of setting up historical models to depict average physical environmental conditions in the ocean are significant. A more complete and objective method for the quality control of selected environmental parameters has been developed. These models have provided a greater degree of objectivity in data analysis in a cost-effective manner. The degree of input processing by oceanographers has been enriched by the computer and it is hoped that this concept can be extended to other parameters in the future.