**Naval Oceanographic Office**

Systems Integration Department
Stennis Space Center, Mississippi 39522-5001

OAML-DBD-20G (Rev.)

# DATA BASE DESCRIPTION FOR THE MASTER GENERALIZED DIGITAL ENVIRONMENTAL MODEL (GDEM)

**JANUARY 1996**

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# FOR THE
# MASTER GENERALIZED DIGITAL ENVIRONMENTAL MODEL (GDEM)

## VERSION 5.1

**JANUARY 1996**

**Supersedes *OAML-DBD-20F* Released September 1995**

**Naval Oceanographic Office**
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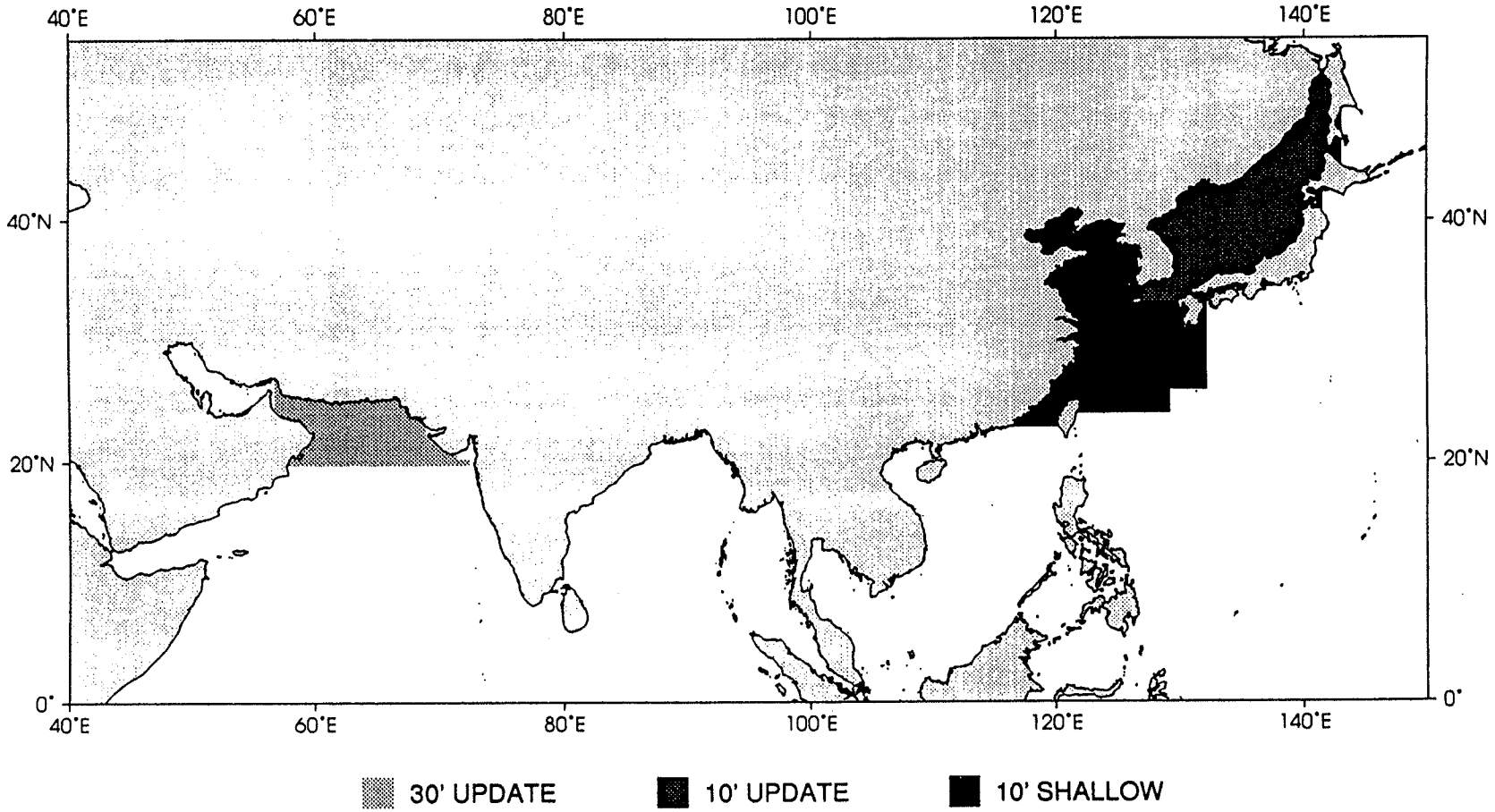
## Updates for version 5.1



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# DATA BASE DESCRIPTION FOR THE MASTER GENERALIZED DIGITAL ENVIRONMENTAL MODEL (GDEM) VERSION 5.1

## 1.0 INTRODUCTION

### 1.1 Purpose

The purpose of this Data Base Description (DBD) is to provide technical information to software managers for installing the Master Generalized Digital Environmental Model (GDEM) and its associated variability statistics. It is intended to serve as a reference for users of the data and for configuration management. It provides descriptive information on the data set and documents the stored parameters, area coverage, and temporal resolution.

### 1.2 Background

Master data bases to support the Naval Sea Systems Command (NAVSEASYSCOM) were identified by the Chief of Naval Operations (CNO) in CNO *ltr Ser 952D/4U342023* of 23 June 1984. Requirements for subsets to be extracted from these master data bases were provided in COMNAVSEASYSCOM *ltr 9460 Ser 63D3/18* of 6 March 1985. Commander, Naval Oceanography Command (COMNAVOCEANCOM), directed the Naval Oceanographic Office (NAVOCEANO) to provide these CNO standards in COMNAVOCEANCOM *ltr 9460 Ser 3/167* of 19 March 1985.

### 1.3 Data Base Changes

This version incorporates updates to GDEM for the Sea of Japan, Yellow Sea, and northern Arabian Sea (including the Gulf of Oman). The northern Arabian Sea now extends to the 50-meter (m) isobath and the Sea of Japan and Yellow Sea to the 5-m isobath. In addition to the updated 30-arcminute version of GDEM, the Sea of Japan is also provided at 10-arcminute spacing as separate seasonal files, and the Yellow Sea at 10-arcminutes as separate monthly files. The Master GDEM data base version number is now 5.1.

## 2.0 GENERALIZED DIGITAL ENVIRONMENTAL MODEL (GDEM)

### 2.1 Scope

The GDEM is a four-dimensional (4-D) steady-state digital model of ocean temperature and salinity. The model consists of gridded sets of coefficients with a grid spacing of 30 arcminutes (′) in space and 3, 6, or 12 months in time with the exception of the

coefficient describing sea-surface temperature, which is gridded at a 1-month interval. Utilizing these coefficient sets with the appropriate one-dimensional linear or cubic spline interpolation in time, vertical profiles of historical temperature and salinity extending from the surface to the bottom may be computed for a desired time for all locations where the water depth is at least 100 m. The updates discussed in section 1.3 used a variety of techniques and extended into shallower waters.

The VGDEM is a 4-D model of ocean temperature variability. A number of accumulations and parameters exists for each grid cell such that statistics on the observations can be derived; statistics based on comparing the observations with GDEM can be computed; and statistics computed for the mixed-layer depth and the in-layer and below-layer gradients. The percent of the observations suggesting half-channel is also available. Variability models will be constructed only in the ocean basins where data density permits. Therefore, models for the South Atlantic, South Pacific, and Arctic Oceans will not be developed at this time.

## 2.2 Source

The original source of data for the construction of these climatological models is the Master Oceanographic Observation Data Set (MOODS), which contains over 4.5-million profiles of temperature/salinity dating back to 1920. This data base is maintained by NAVOCEANO and is continually updated.

## 2.3 Application

The GDEM data bases provide the sound speed profile input to various acoustic propagation-loss models and all other applications that require a temperature, sound speed, or density profile. The variability models will provide temperature envelopes to quality-control at-sea observations and to provide the expected range of those parameters included in the variability files.

## 2.4 Coverage

The GDEMs cover the North Pacific (0°–67° N) and North Atlantic (0°–75° N) Oceans, Mediterranean and Arctic (65°–90° N) Seas, Indian Ocean (40° S–30° N), and the South Atlantic (60° S–0°) and South Pacific (60° S–0°) Oceans. The VGDEMs cover the same area for the Mediterranean Sea and from 0°–70° N for the North Atlantic and 0°–65° N for the North Pacific. The VGDEM area for the Indian Ocean is 20° S–30° N. The area covered by GDEM is shown in Figure 1 and the area by VGDEM in Figure 2.

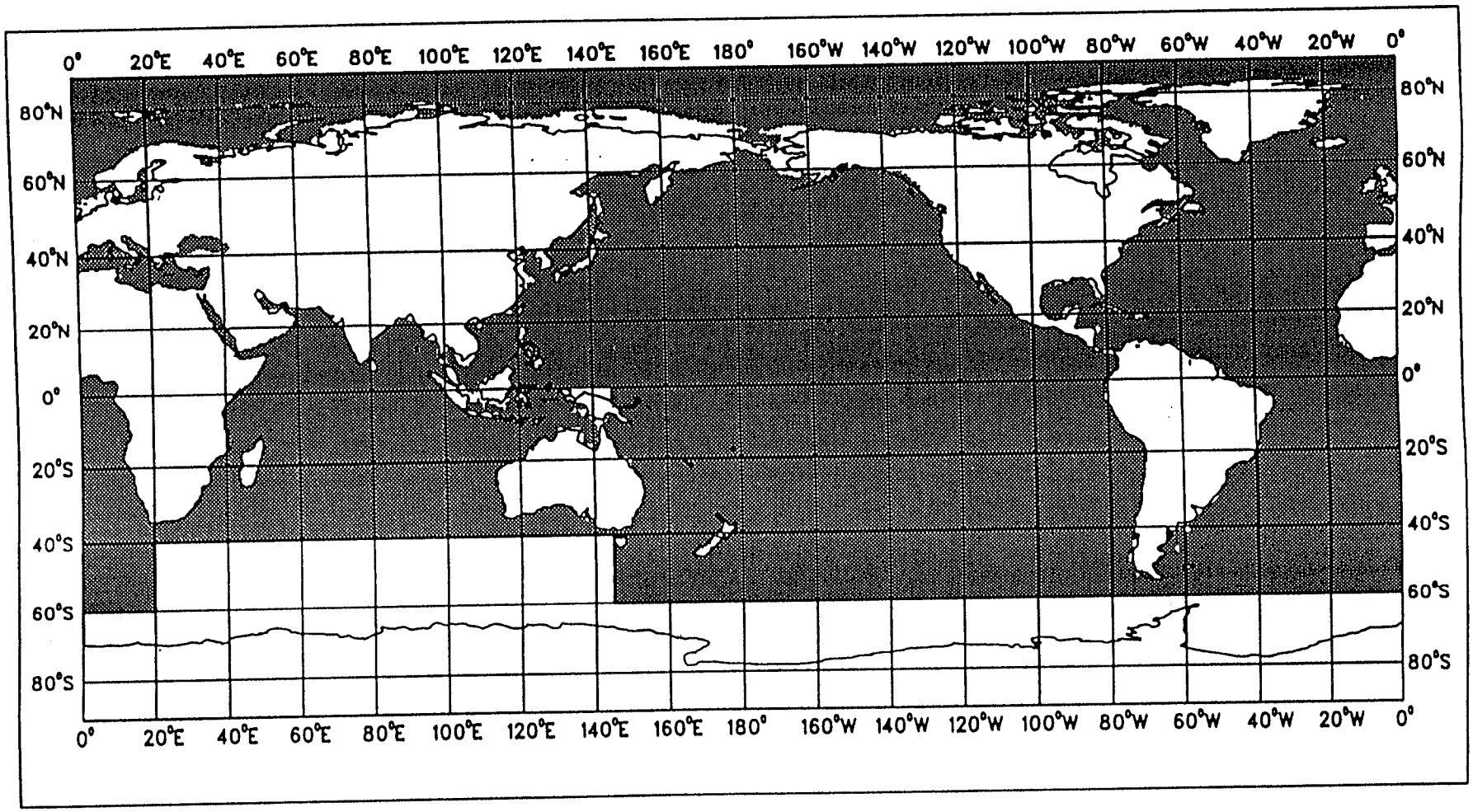


**Figure 1. Area Covered by GDEM.**

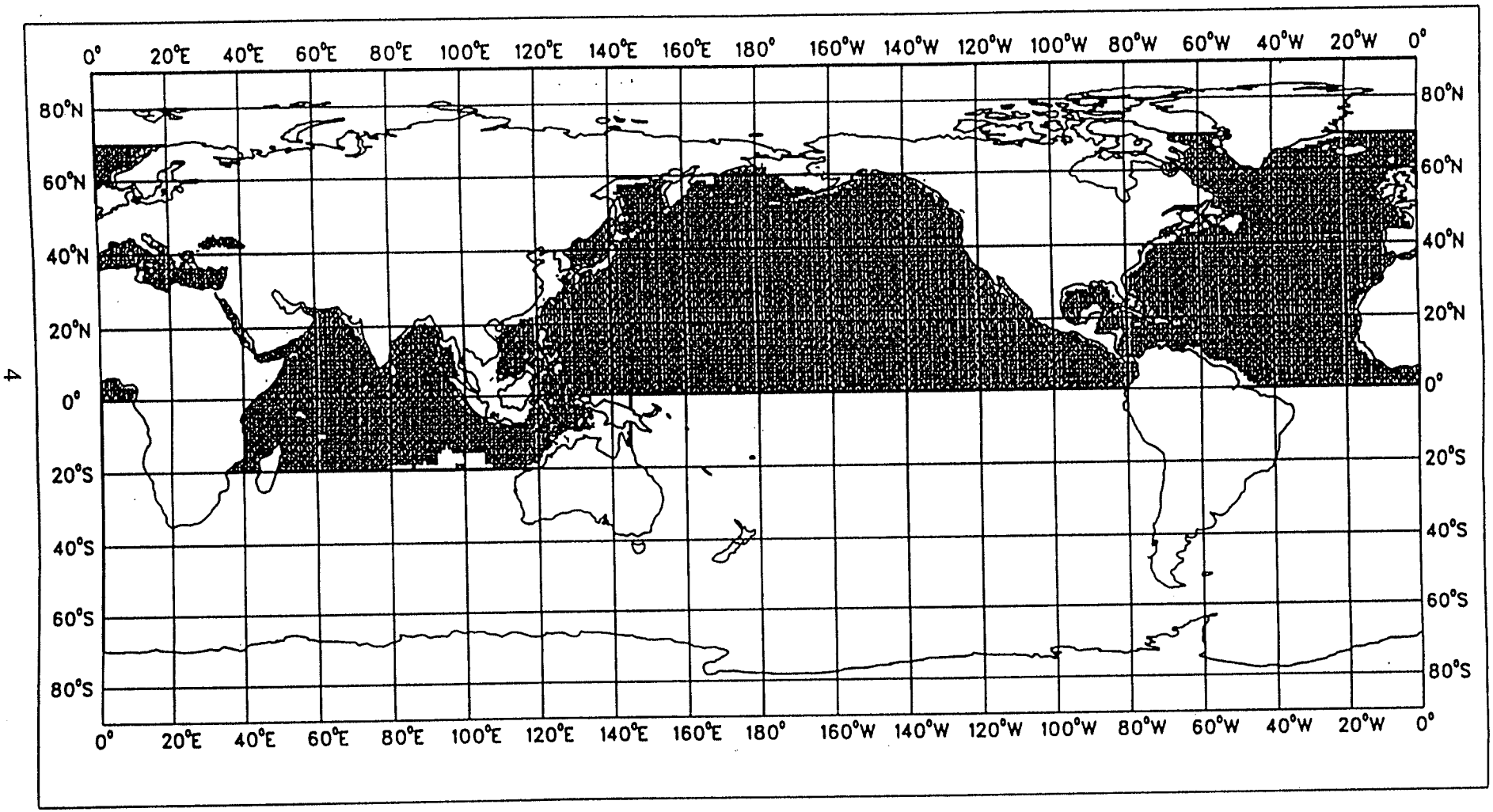


**Figure 2. Area Covered by VGDEM.**

## 2.5 Resolution

The spatial resolution of both GDEM and VGDEM is 1/2° (30′) of latitude and longitude (vertical resolutions for GDEM and VGDEM are shown in Table 1). VGDEM does not extend deeper than 5,000 m. The temporal resolution is seasonal as shown below.

| | Indian Ocean | Arctic | All Others |
|---|---|---|---|
| Season 1 | mid-Oct to Feb | Nov–Apr | Jan–Mar |
| Season 2 | Mar to mid-May | May | Apr–Jun |
| Season 3 | mid-May to mid-Jul | Jun–Sep | Jul–Sep |
| Season 4 | mid-Jul to mid-Oct | Oct | Oct–Dec |

## 2.6 Organization

The GDEM and VGDEM data bases are organized into four seasonal files for each region.

**TABLE 1. GDEM/VGDEM STANDARD DEPTHS (m)***

| | | | |
|---|---|---|---|
| 0 | 250 | 1200 | 6000 |
| 10 | 300 | 1300 | 7000 |
| 20 | 400 | 1400 | 8000 |
| 30 | 500 | 1500 | 9000 |
| 50 | 600 | 1750 | |
| 75 | 700 | 2000 | |
| 100 | 800 | 2500 | |
| 125 | 900 | 3000 | |
| 150 | 1000 | 4000 | |
| 200 | 1100 | 5000 | |

*Bottom depth follows last standard depth for both GDEM and VGDEM, except VGDEM does not extend below 5000 m.

## 2.7 Size

The combined GDEMs cover approximately 140,000 grid cells and the VGDEMS, 57,000 grid cells. Table 2 defines each area size. Each GDEM block contains 10 records of 1,200 characters each; and each VGDEM block contains 10 records of 1,732 characters each.

## TABLE 2. GRID CELL AREA SIZES

| Area | GDEM Records/ Season | Blocks/ Season | Total Blocks |
|---|---|---|---|
| North Atlantic | 18708 | 1871 | 7484 |
| South Atlantic | 16128 | 1613 | 6452 |
| North Pacific | 30328 | 3033 | 12132 |
| South Pacific | 33087 | 3309 | 13236 |
| Mediterranean | 1039 | 104 | 416 |
| Indian | 18287 | 1829 | 7316 |
| Arctic | 21881 | 2189 | 8756 |
| Persian Gulf (10′) | 795 | 80 | 320 |
| Gulf of Aden (5′) | 538 | 54 | 216 |
| Sea of Japan (10′) | 4080 | 408 | 1632 |
| Yellow Sea (10′month) | 6073 | 608 | 7296 |

| Area | VGDEM Records/ Season | Blocks/ Season | Total Blocks |
|---|---|---|---|
| Mediterranean | 1170 | 117 | 468 |
| Black Sea | 215 | 22 | 88 |
| Red Sea | 195 | 20 | 80 |
| North Atlantic | | | 7028 |
| Winter | 16688 | 1669 | |
| Spring | 17754 | 1776 | |
| Summer | 18308 | 1831 | |
| Autumn | 17520 | 1752 | |
| North Pacific | | | 11909 |
| Winter | 29443 | 2945 | |
| Spring | 29860 | 2986 | |
| Summer | 30215 | 3022 | |
| Autumn | 29560 | 2956 | |
| Indian Ocean | | | 4848 |
| Winter | 10579 | 1058 | |
| Spring | 10703 | 1701 | |
| Summer | 10438 | 1044 | |
| Autumn | 10448 | 1045 | |

## 2.8 Parameters

The GDEM data bases contain both geographic and ocean profile parameters (see Table 3). The VGDEM data bases contain both geographic and statistical parameters, which are listed in Table 4.

## 2.9 Data Storage

The GDEM and VGDEM data bases are available on magnetic media in ASCII format. The GDEM data are arranged in blocks of 10 records, each record having a length of 1,200 characters. The VGDEM data are also arranged in blocks of 10 records, but each record has a length of 1,732 characters. Details covering the data format and reading of the data tape are provided in section 3.

**TABLE 3. GDEM DATA PARAMETERS**

| Data | Unit | Precision | Maximum Value/ Record | Value Range |
|---|---|---|---|---|
| Latitude | deg (°) | 1 | 1 | 0 to 90 |
| | min (′) | 1 | 1 | 0 to 59 |
| | hemisphere | N/A | 1 | N or S |
| Longitude | deg (°) | 1 | 1 | 0 to 180 |
| | min (′) | 1 | 1 | 0 to 59 |
| | hemisphere | N/A | 1 | E or W |
| Season | N/A | 1 | 1 | 1 to 4 |
| Bottom Depth | m | 1 | 1 | 0 to 9999 |
| Number of Levels (monthly Yellow Sea) | N/A | 1 | 1 | 2 to 35 (2 to 60) |
| Sea-Surface Temperature | °C | 0.01 | 3 | -1.80 to 33.70 |
| Depth | m | 1 | 35 | 0 to 9999 |
| Temperature | °C | 0.01 | 35 | -1.91 to 33.70 |
| Salinity | ppt | 0.01 | 35 | 11.79 to 40.95 |
| Sound Speed | m/s | 0.1 | 35 | 1415.3 to 1637.8 |

**TABLE 4. VGDEM DATA PARAMETERS**

| Data | Unit | Precision | Maximum Value/ Record | Value Range |
|---|---|---|---|---|
| Latitude | deg (°) | 1 | 1 | 0 to 90 |
| | min (′) | 1 | 1 | 0 to 59 |
| | hemisphere | N/A | 1 | N or S |
| Longitude | deg (°) | 1 | 1 | 0 to 180 |
| | min (′) | 1 | 1 | 0 to 59 |
| | hemisphere | N/A | 1 | E or W |
| Season | N/A | 1 | 1 | 1 to 4 |
| Number of Levels | N/A | 1 | 1 | 5 to 30 |
| Layer Depth | m | 1 | 1 | 0 to 265 |
| Layer Depth Dev | m | 1 | 1 | 0 to 168 |
| Above-layer Gradient | °C/m | 0.01 | 1 | -3.70 to 0.597 |
| Above-layer Gradient Dev | °C/m | 0.001 | 1 | 0 to 11.421 |
| Below-layer Gradient | °C/m | 1 | 1 | 0 to 61.220 |
| Below-layer Gradient Dev | °C/m | 1 | 1 | 0 to 30.149 |
| Half-channel | % | 1 | 1 | 0 to 94 |
| Depth | m | 1 | 30 | 0 to 5000 |
| Temperature (min./max.) | °C | 0.01 | 30 | -2 to 35 |

## 2.10 Data Quality

The GDEMs and VGDEMs are assumed to be accurate for the areas covered.

## 2.11 References

Countryman, K.A. and M.J. Carron, The Naval Ocean-Temperature Temporal-Variability Model, *Conference Proceedings Oceans '95*, San Diego, CA, October 1995.

Davis, Thomas M., Kenneth A. Countryman, and Michael J. Carron, Tailored Acoustic Products Utilizing the NAVOCEANO GDEM (a Generalized Digital Environmental Model), *Proceedings of the 36th Naval Symposium on Underwater Acoustics*, San Diego, CA, April 1986.

Teague, William J., Michael J. Carron, and Patrick J. Hogan, A Comparison Between the Generalized Digital Environmental Model and Levitus Climatologies, *J. Geophysical Research*, Vol. 95, No. C5, 1990.

Wilson, W., Speed of Sound in Sea Water as a Function of Temperature, Pressure and Salinity, *J. Acoustic Society of America*, Vol. 32, 1960.

## 2.12 Distribution

The GDEMs are restricted to Department of Defense (DoD) and DoD contractors only, restricted technology; distribution statement D applies. The VGDEMs are UNCLASSIFIED. All requests shall be referred to the Commander, Naval Meteorology and Oceanography Command (N311) at Stennis Space Center, Mississippi.

## 2.13 Point of Contact

Any general questions relating to the GDEM and VGDEM data bases should be directed to

Commanding Officer
Naval Oceanographic Office
1002 Balch Boulevard
Stennis Space Center, Mississippi 39522-5001

ATTN: Code N54

COMM: (601) 688-5160
DSN: 485-5160

# 3.0 DATA BASE FORMAT AND TAPE READ INSTRUCTIONS

## 3.1 General

Media formats available:

- 9-track ASCII format tape
- SUN-compatible cartridge tape (DC 6150 or QIC-150 DC)
- CD-ROM (February 1996).

## 3.2 Tape Read Instructions

The following sections provide tape read instructions for the Master GDEM data base, Version 5.1.

### 3.2.1 GDEM Files

GDEM files are organized into blocks containing 12,000 characters (10 records of 1,200 characters each). Each block is formatted and incomplete blocks are padded out with zeros. There is a seasonal profile centered on each 30′ by 30′ of ocean area wherever the maximum depth within the 30′ box is at least 50 m. Each seasonal profile is sequential and ordered first by latitude and then within each latitude by longitude. Each record contains

LATD, LATM, LATH, LOND, LONM, LONH, ISEAS, IBOTZ, NT, BDEP, T4(1), T4(2), T4(3), SST(1), SST(2), SST(3), DEPTH, TEMP, SAL, SV, DUMMY

where

LATD = latitude degree (°)

LATM = latitude minute (′)

LATH = latitude hemisphere (N or S)

LOND = longitude degree (°)

LONM = longitude minute (′)

LONH = longitude hemisphere (E or W)

ISEAS = season (see section 2.5)

IBOTZ = depth at grid location (m)

NT = number of DEPTH/TEMP/SAL/SV sets in record

BDEP = ignore

T(1,2,3) = ignore

SST(1,2,3) = sea-surface temperature (°C) for first, second, and third month in season

DEPTH(J) = depth (m) for J = 1 to NT

TEMP(J) = temperature at DEPTH(J) (°C)

SAL(J) = salinity at DEPTH(J) (ppt)

SV(J) = sound speed at DEPTH(J) (m/s) using Wilson's Equation (Wilson, 1960)

DUMMY(J) = zero-filled to pad out record.

The format is as follows:

2I2,A1,I3,I2,A1,I1,I4,I2,7F8.2,6X,140F8.2 .

For the monthly Yellow Sea files:

2I2,A1,I3,I2,A1,I1,I4,I2,7F8.2,6X,240F8.2 .

### 3.2.2 VGDEM Files

The VGDEM is organized into blocks containing 17,320 characters (10 records of 1732 characters each). Each block is formatted and incomplete blocks are padded with zeros. There is a separate file for each season. Within each seasonal file, there are data centered on

each 30′ by 30′ of ocean area. Each data record is sequential and ordered first by latitude and then within each latitude by longitude. Each record contains

LATD, LATM, LATH, LOND, LONM, LONH, ISEAS, NT, DLAYER, STDLAY, ULGRAD, ULGSTD, BLGRAD, BLGSTD, HALF, (DEPTH(J), T1MIN(J), T1MAX(J), T2MIN(J), T2MAX(J), T3MIN(J), T3MAX(J),J=1,NT), (DUMMY(J),J=1,30-NT)

where

| | | |
|---|---|---|
| LATD | = | latitude degree (°) |
| LATM | = | latitude minute (′) |
| LATH | = | latitude hemisphere (N or S) |
| LOND | = | longitude degree (°) |
| LONM | = | longitude minute (′) |
| LONH | = | longitude hemisphere (E or W) |
| ISEAS | = | season (see section 2.5) |
| NT | = | number of DEPTH levels in record |
| DLAYER | = | mean mixed-layer (sonic) depth (m) |
| STDLAY | = | standard deviation (STD) of layer depth |
| ULGRAD | = | mean in-layer gradient (°C/m) |
| ULGSTD | = | STD of in-layer gradient |
| BLGRAD | = | mean below-layer gradient (°C/m) |
| BLGSTD | = | STD of below-layer gradient |
| HALF | = | observation (%) suggesting half-channel |
| DEPTH(J) | = | depth (m) for J = 1 to NT |
| T1MIN(J) | = | -1 STD of temperature at DEPTH(J) |

T1MAX(J) = +1 STD of temperature at DEPTH(J)

T2MIN(J) = -2 STD of temperature at DEPTH(J)

T2MAX(J) = +2 STD of temperature at DEPTH(J)

T3MIN(J) = -3 STD of temperature at DEPTH(J)

T3MAX(J) = +3 STD of temperature at DEPTH(J)

DUMMY(J) = zero-filled to pad out record.

The format is as follows:

2I2,A1,I3,I2,A1,I1,I2,2F5.0,4F6.3,F4.0,210F8.2 .

## 4.0 SUBSET EXTRACTION

Subset extraction refers to the process of forming lower resolution data sets from the standard 30′ resolution data base. The GDEM has been subsetted as the GDEM Province Subset Data Base (see document *OAML-DBD-18C*, May 1993).

### 4.1 Grid Location

All locations are in the center of the grid cell. For example, the GDEM profile at 30°00′ N 70°00′ W represents the cell bounded by 29°45′–30°15′ N and 70°15′–69°45′ W.