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WORLD OCEAN DATABASE 2001
Volume 3: Temporal Distribution of Conductivity/Salinity-Temperature-Depth (Pressure) Casts

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Contents

LIST OF TABLES

LIST OF FIGURES

APPENDIX A

PREFACE

The oceanographic databases described by this atlas series greatly expands on the *World Ocean Database 1998* (WOD98) product. We have expanded these earlier databases to include data from new instrument types such as profiling floats and new variables such as pCO_2 and TCO_2. Previous oceanographic databases including the NODC/WDC profile archives, and products derived from these databases, have proven to be of great utility to the international oceanographic, climate research, and operational environmental forecasting communities. In particular, the objectively analyzed fields of temperature and salinity derived from these databases have been used in a variety of ways. These include use as boundary and/or initial conditions in numerical ocean circulation models, for verification of numerical simulations of the ocean, as a form of "sea truth" for satellite measurements such as altimetric observations of sea surface height, and for planning oceanographic expeditions. Increasingly nutrient fields are being used to initialize and/or verify biogeochemical models of the world ocean. The databases, and products based on these databases, are critical for support of international assessment programs such as the Intergovernmental Program on Climate Change (IPCC) of the United Nations.

It is well known that the amount of carbon dioxide in the earth's atmosphere will most likely double during the next century compared to CO_2 levels that occurred at the beginning of the Industrial Revolution. Regardless of one's scientific and/or political view of a possible "enhanced greenhouse warming" due to the increase of carbon dioxide, it is necessary that the international scientific community have access to the most complete historical oceanographic databases possible in order to study this problem, as well as other scientific and environmental problems.

The production of oceanographic databases is a major undertaking. Such work benefits from the input of many individuals and organizations. We have tried to structure the data sets in such a way as to encourage feedback from experts around the world who have knowledge that can improve the data and metadata contents of the database. It is only with such feedback that high quality global ocean databases can be prepared. Just as with scientific theories and numerical models of the ocean and atmosphere, the development of global ocean databases is not carried out in one giant step, but proceeds in an incremental fashion.

In the acknowledgment section of this publication we have expressed our view that creation of global ocean databases is only possible through the cooperation of scientists, data managers, and scientific administrators throughout the international community. I thank my colleagues at the Ocean Climate Laboratory of NODC for their dedication to the project leading to publication of this atlas series. Their commitment has made this database possible. It is my belief that the development and management of national and international oceanographic data archives is best performed by scientists who are actively working with the data.

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March 2002

Acknowledgments

This work was made possible by a grant from the NOAA Climate and Global Change Program which enabled the establishment of a research group, the Ocean Climate Laboratory (OCL), at the National Oceanographic Data Center. The purpose of the OCL is to prepare research quality oceanographic databases, as well as to compute objective analyses of, and diagnostic studies based on, these databases.

The data made available as part of this atlas include a part of the oceanographic data archives maintained by NODC/WDC as well as data acquired as a result of the IODE/IOC "Global Oceanographic Data Archaeology and Rescue" (GODAR) project. At NODC/WDC, "data archaeology and rescue" projects are supported with funding from the NOAA Environmental Science Data and Information Management (ESDIM) Program and NOAA Climate and Global Change Program. The majority of funding for these efforts is now provided by the ESDIM program. Support for this work from joint NASA/NOAA and DOE/NOAA Global Change data management programs is appreciated. Support for some of the regional IOC/GODAR meetings was provided by the MAST program of the European Union.

We acknowledge the scientists, technicians, and programmers who have submitted data to national and regional data centers as well as the managers and staff at the various data centers. Our database allows for the storage of metadata including information about Principal Investigators to recognize their efforts.

The OCL expresses thanks to those who provided comments and helped develop an improved *World Ocean Database 2001* (WOD01) product. In particular, Dr. Steve Worley of NCAR, and Steve Hankin of PMEL for testing the CD-ROMs prior to distribution. Roy Lowry (BODC) and Tom Whitworth (TAMU) for suggestions. Any errors in WOD01 are the responsibility of the Ocean Climate Laboratory.

Ervin Godfrey Trammell and Charlotte Sazama of the NODC International Data Exchange Team helped locate data in the WDC archives for digitization. We thank Mike Chepurin, Igor Minin, Dan Smolyar, Alexandra Grodsky, and Carla Forgy of the OCL for their work in data digitization and their assistance in quality control of the data and metadata in WOD01. Renee Tatusko identified many missing metadata. The OCL acknowledges the help received over the last several years from colleagues in other NODC divisions. Francis Mitchell helped with all the code lists and accessions, Melanie Hamilton supplied GTSPP data.

Declassification of naval oceanographic data by various navies is acknowledged. The Intergovernmental Oceanographic Commission has requested such declassification efforts in recent years.

World Ocean Database 2001, Volume 3: Temporal Distribution of Conductivity/Salinity-Temperature-Depth (Pressure) Casts

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ABSTRACT

This atlas describes a collection of scientifically quality controlled ocean Conductivity/Salinity-Temperature-Depth (Pressure) (CTD) casts. Yearly distributions for individual years of all CTD casts in the database are presented to provide information on the state of ocean CTD cast observations.

1. INTRODUCTION

Conductivity-Temperature-Depth (CTD) instruments measure temperature and conductivity as a function of pressure (depth) at relatively high (often referred to as "continuous") vertical resolution. Salinity is computed from the conductivity measurement. CTD data may be submitted to NODC/WDC-A at sub-meter vertical resolution. These data are now archived at this resolution whereas in the past, electronic storage limitations resulted in only selected levels being stored. An earlier version of the CTD instrument was the STD (salinity-temperature-depth) which computed salinity from a conductivity sensor as the instrument was moving though the water column. Because of instrument problems that led to erroneous data values (spikes), this method was replaced by the CTD method for which conductivity measurements are recorded from the instrument and then salinity computed with appropriate calibration information. Dissolved oxygen content can now be measured "continuously" with sensors placed on CTD instruments. New sensors are being developed to make "continuous" measurements of other variables. We refer to CTD "stations" or "casts" to recognize that more than one variable is being measured when a CTD instrument is deployed.

2. CTD Cast DISTRIBUTIONS

Figure 1 shows the number of CTD casts contained in WOD01 for the World Ocean as a function of year. Figures 2 and 3 show the time series for the northern and southern hemispheres respectively. There are a total of 312,344 CTD casts for the entire World Ocean with 40,587 profiles (13%) measured in the southern hemisphere and 271,757 profiles (87%) measured in the northern hemisphere. Table 1 provides the exact number of CTD casts included in WOD01 as a function of year. The geographic distribution of CTD casts for individual years for 1966-2001 are shown in Figures A1-A35. Most profiles have been made in the northern hemisphere, but the southern hemisphere coverage has been increased due to international data archaeology and rescue efforts and the World Ocean Database project (Levitus *et al.* 1994, 2002).

Table 1 National contributions of Conductivity/Temperature/Depth (CTD) casts sorted by percent contribution of each country

NODC Country Code	Country Name	CTD Count	% of Total
31	UNITED STATES	90067	28.84
18	CANADA	75612	24.21
32	UNITED STATES	30417	9.74
6	GERMANY, FEDERAL REPUBLIC OF	24355	7.8
35	FRANCE	16548	5.3
90	RUSSIA	13689	4.38
74	UNITED KINGDOM	10476	3.35
58	NORWAY	8469	2.71
48	ITALY	8109	2.6
9	AUSTRALIA	7336	2.35
29	SPAIN	4400	1.41
20	CHILE	4015	1.29
76	CHINA, THE PEOPLES REPUBLIC OF	2701	0.86
91	SOUTH AFRICA	2028	0.65
64	NETHERLANDS	1856	0.59
46	ICELAND	1816	0.58
33	UNITED STATES	1493	0.48
67	POLAND	1391	0.45
68	PORTUGAL	1289	0.41
49	JAPAN	1158	0.37
7	GERMANY, DEMOCRATIC REPLUBLIC OF	823	0.26
26	DENMARK	729	0.23
ZZ	MISCELLANEOUS ORGANIZATIONAL UNITS	564	0.18
99	UNKNOWN	475	0.15
36	GREECE	336	0.11
8	ARGENTINA	319	0.1
34	FINLAND	251	0.08
28	ECUADOR	217	0.07
11	BELGIUM	212	0.07
89	TURKEY	199	0.06
47	ISRAEL	195	0.06
77	SWEDEN	165	0.05
42	INDONESIA	159	0.05
41	INDIA	143	0.05
21	TAIWAN	107	0.03
61	NEW ZEALAND	102	0.03

57	MEXICO	59	0.02
24	KOREA, REPUBLIC OF	28	0.01
RU	RUSSIA	27	0.01
45	IRELAND	10	0

The United States, Russia, and Japan have multiple country codes. This is because the NODC Institution Code is limited to two digits and these countries each have more than 99 institutions that can potentially transfer data to NODC/WDC.

Table 2 The number of all CTD casts in WOD01 as a function of year for the World Ocean.

Total Number of Profiles = 312,344

YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE
1967	1526	1976	8010	1985	11269	1994	14761
1968	727	1977	8102	1986	12838	1995	13748
1969	2445	1978	10009	1987	16760	1996	9055
1970	561	1979	9295	1988	13272	1997	10928
1971	980	1980	8576	1989	13972	1998	8931
1972	3185	1981	11700	1990	15722	1999	6457
1973	4989	1982	8683	1991	14063	2000	340
1974	7205	1983	10756	1992	17148	2001	26
1975	6684	1984	11539	1993	18082		

Table 3 The number of all CTD casts in WOD01 as a function of year for the southern hemisphere.

Total Number of Profiles = 40,587

YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE
1967	607	1976	482	1985	1475	1994	3337
1968	191	1977	799	1986	1347	1995	2805
1969	57	1978	1009	1987	1649	1996	1729
1970	0	1979	745	1988	965	1997	1545
1971	62	1980	797	1989	2093	1998	213
1972	108	1981	401	1990	1465	1999	122
1973	174	1982	473	1991	1679		
1974	326	1983	2297	1992	4565		
1975	952	1984	2060	1993	4058		

Table 4 The number of all CTD casts in WOD01 as a function of year for the northern hemisphere.

Total Number of Profiles = 271,757

YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE	YEAR	PROFILE
1967	919	1976	7528	1985	9794	1994	11424
1968	536	1977	7303	1986	11491	1995	10943
1969	2388	1978	9000	1987	15111	1996	7326
1970	561	1979	8550	1988	12307	1997	9383
1971	918	1980	7779	1989	11879	1998	8718
1972	3077	1981	11299	1990	14257	1999	6335
1973	4815	1982	8210	1991	12384	2000	340
1974	6879	1983	8459	1992	12583	2001	26
1975	5732	1984	9479	1993	14024		

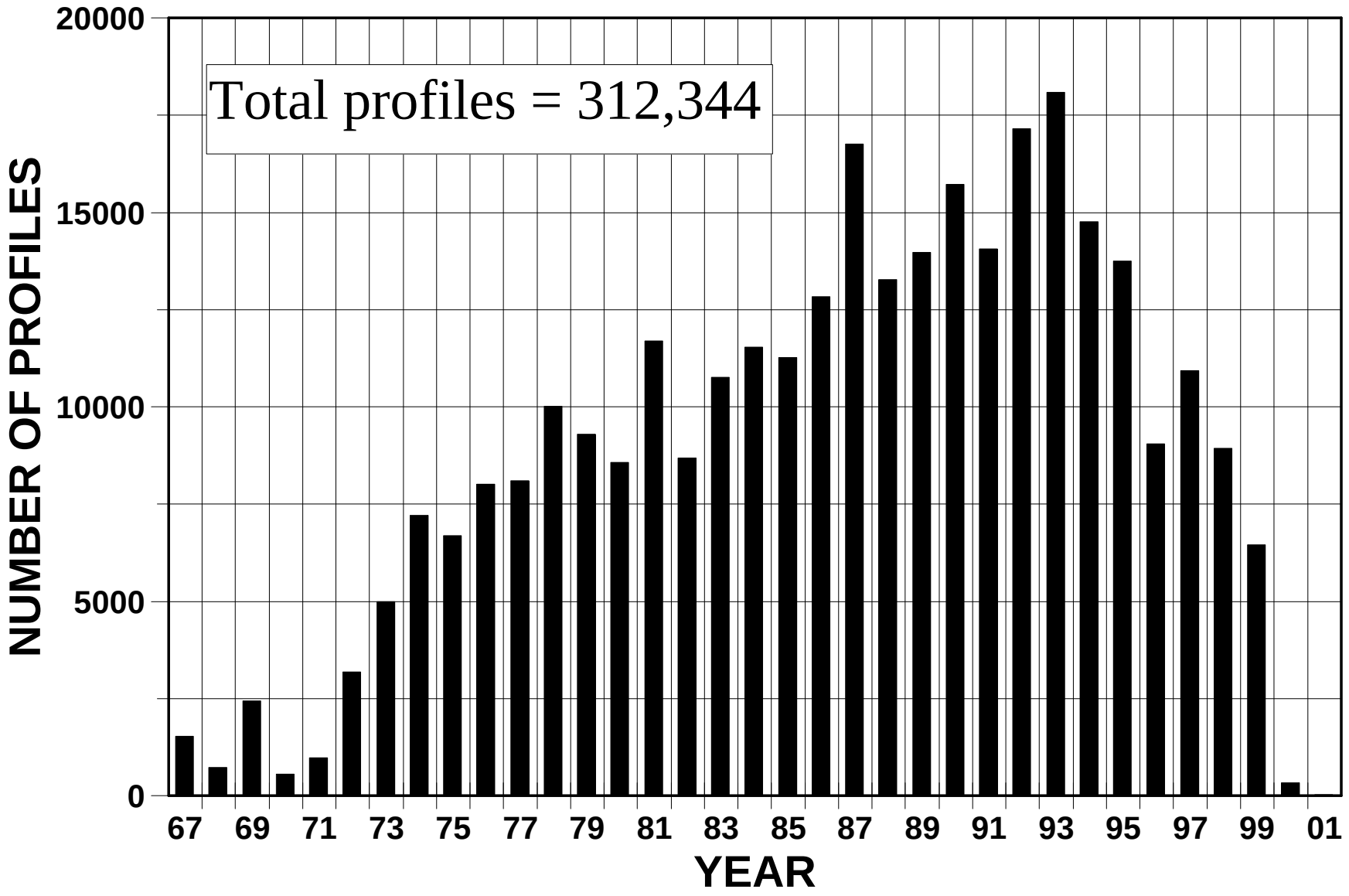

Fig. 1 Time series of CTD casts in WOD01for the world ocean as a function of year.

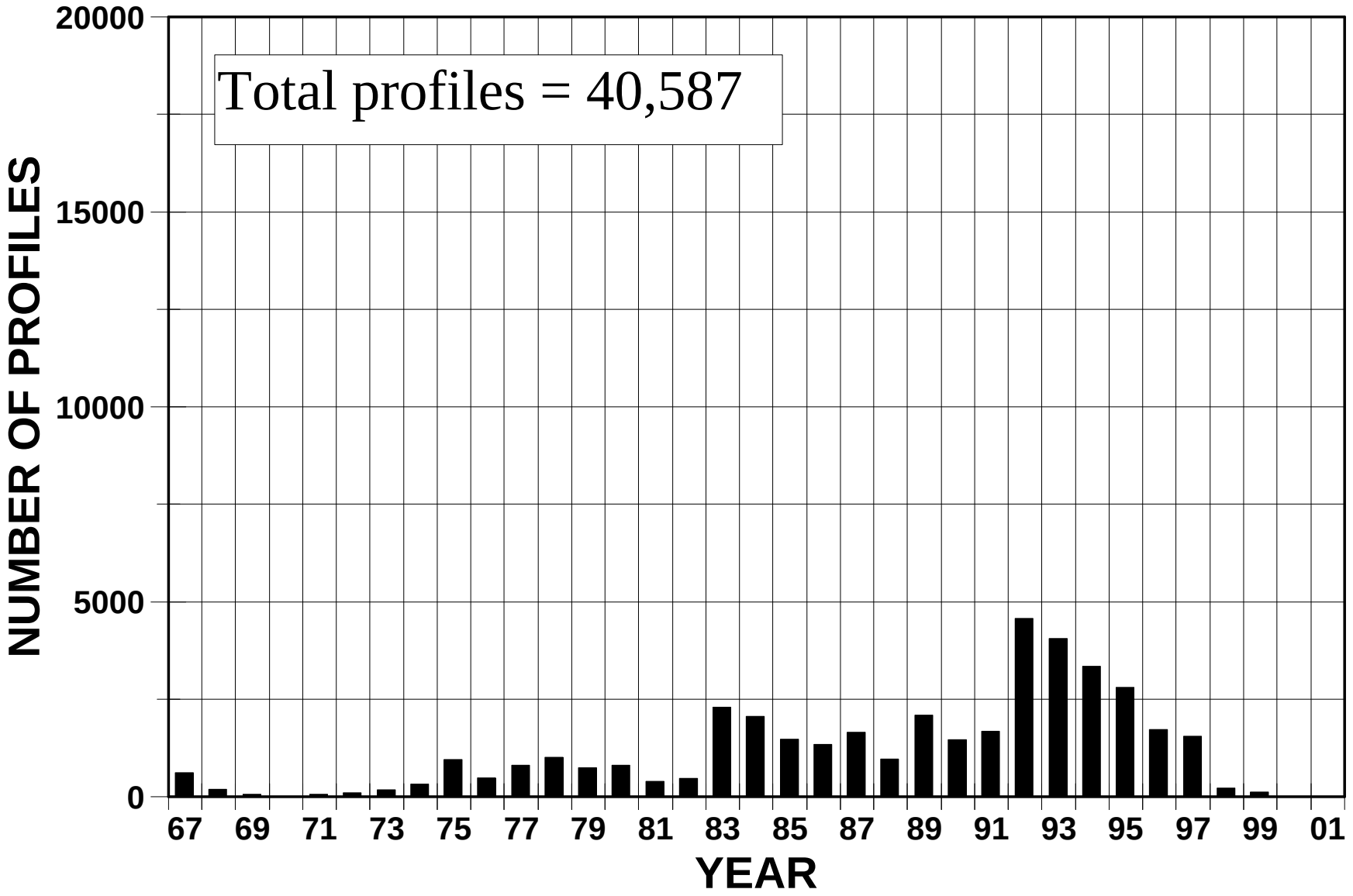

Fig. 2 Time series of CTD casts in WOD01 for the southern hemisphere as a function of year.

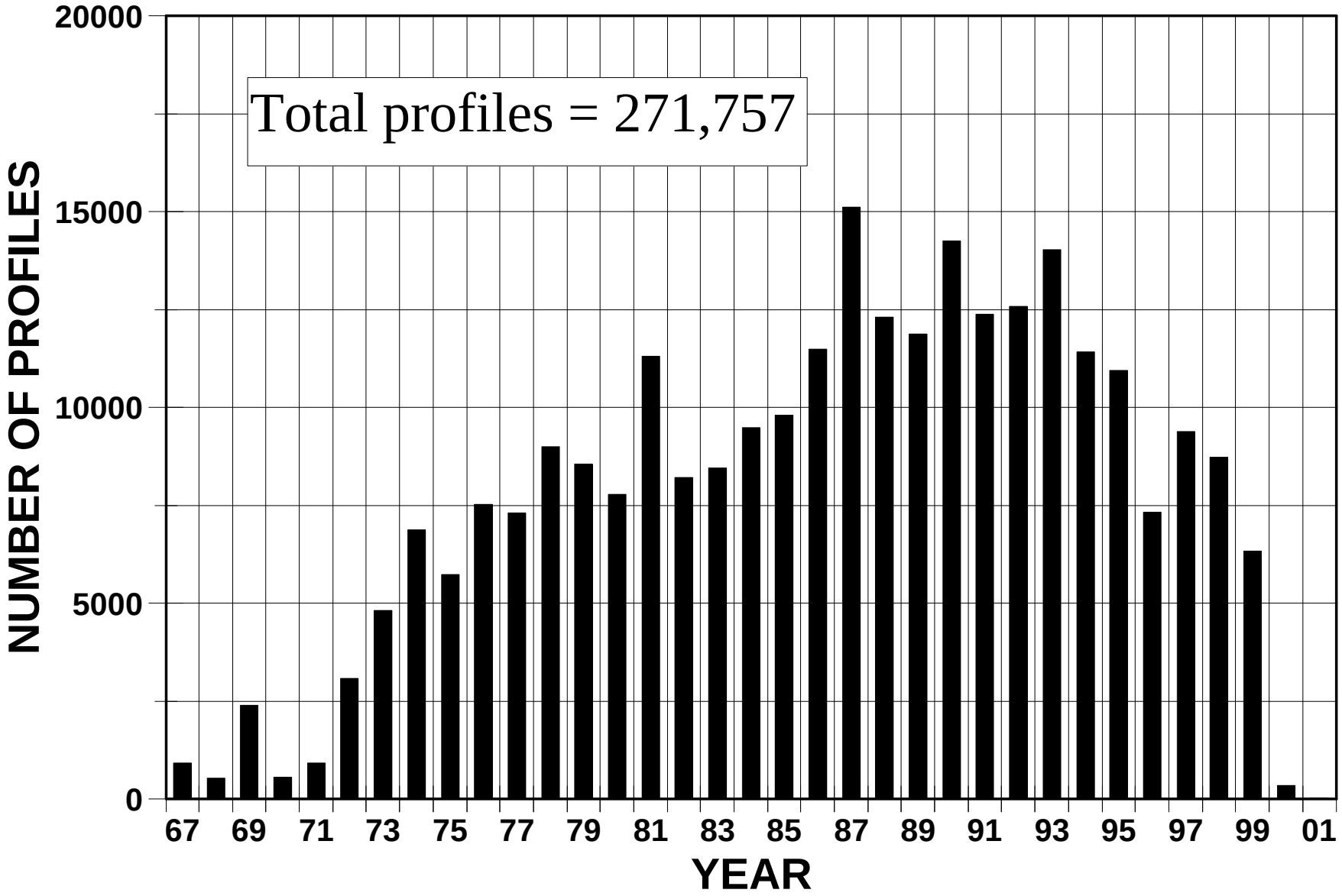

Fig. 3 Time series of CTD casts in WOD01 for the northern hemisphere as a function of year.

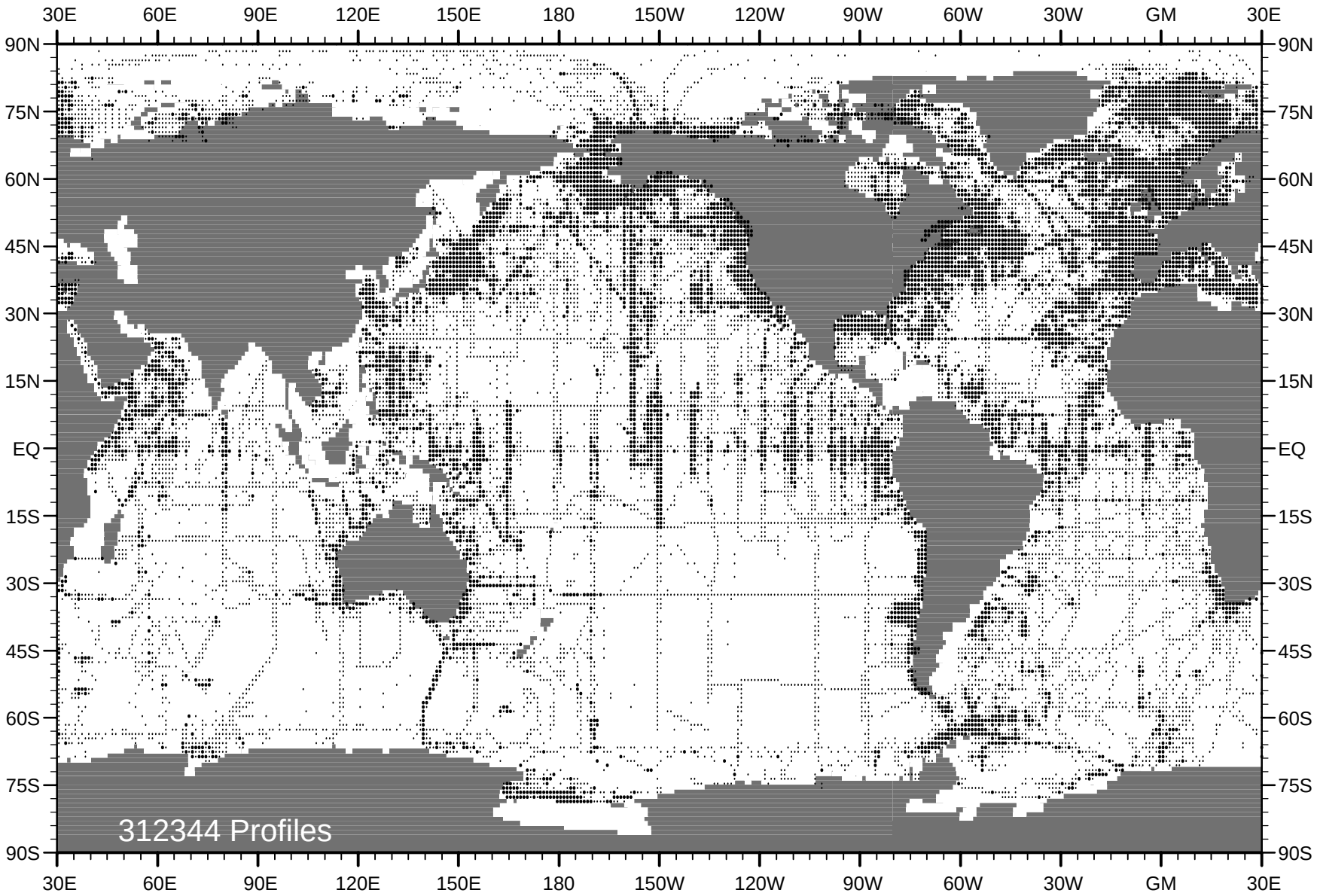

Fig. 4 Distribution of all casts in the CTD files of WOD01.
Dots show location of 1-degree squares containing any data.

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4. APPENDIX A: DISTRIBUTIONS FOR INDIVIDUAL YEARS OF ALL CTD CASTS IN WOD01

This appendix contains yearly cast distributions of all CTD casts contained in WOD01. These maps provide some history of the observational progress of the field of oceanography. They also serve as indicators of whether or not a particular data set from a scientist or institution is part of the NODC/WDC-A archive. The exchange of information provided by the publication of such maps has provided us with valuable information about deficiencies in the database. The locations of all WOD01 CTD casts are plotted including casts that may be erroneously located over land. However, WOD01 contains some casts from various lakes so care should be exercised in the use of these casts and the determination as to whether they represent errors in locations.

For all figures in Appendix A, a small dot indicates a one-degree square containing from one to four casts and a large dot indicates five or more casts.

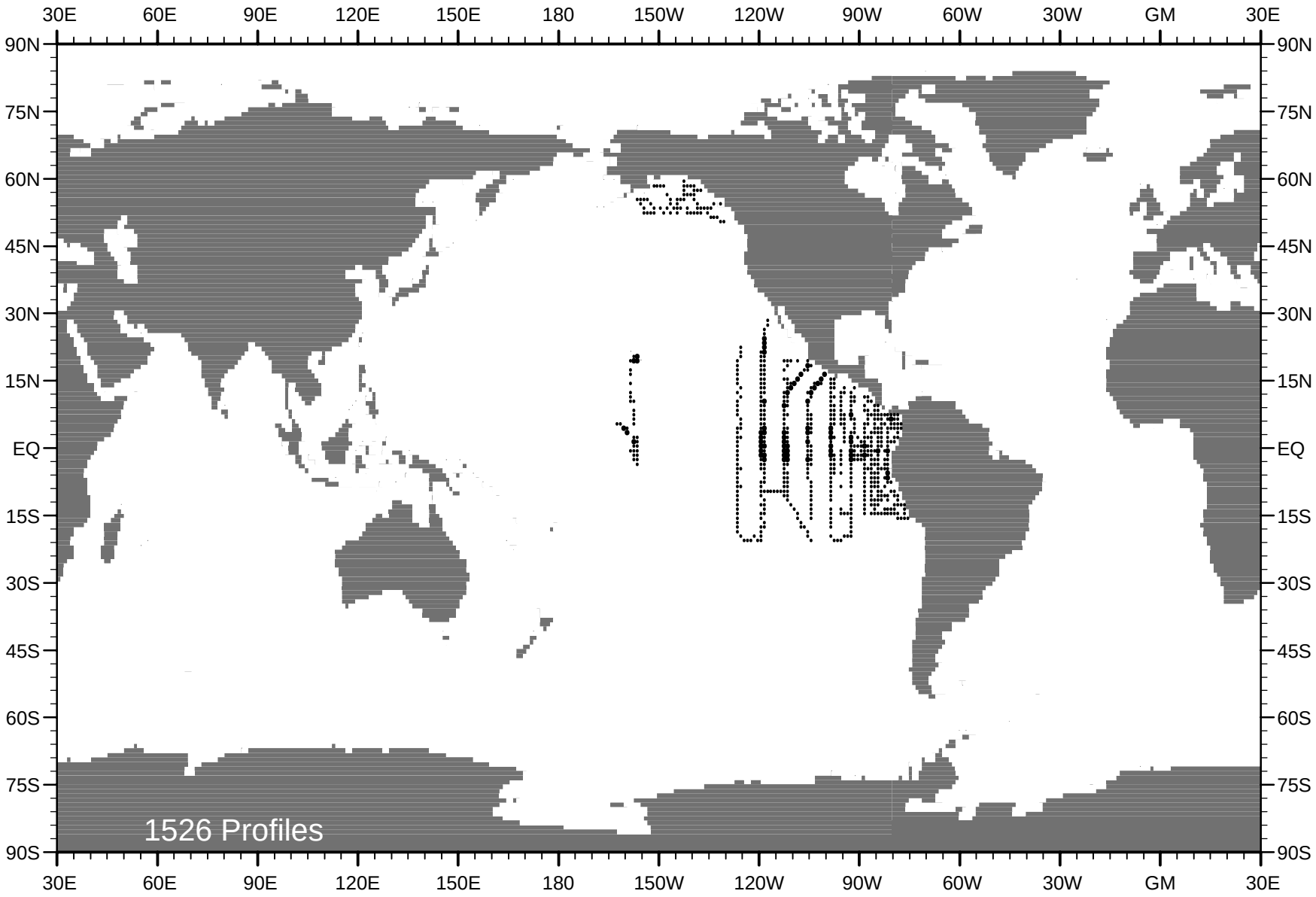


Fig. A1 WOD01 CTD cast distribution for year 1967 .

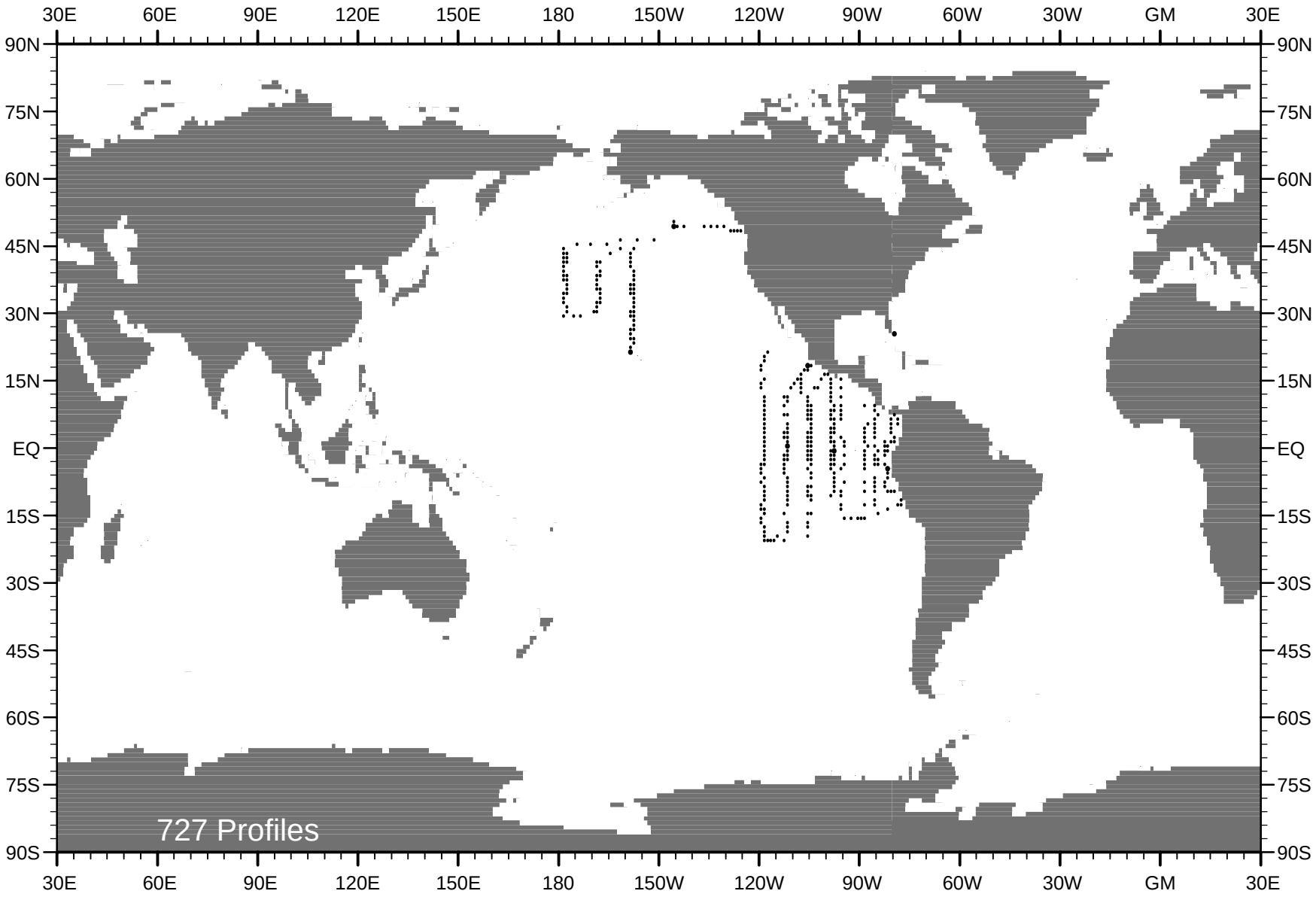


Fig. A2 WOD01 CTD cast distribution for year 1968 .

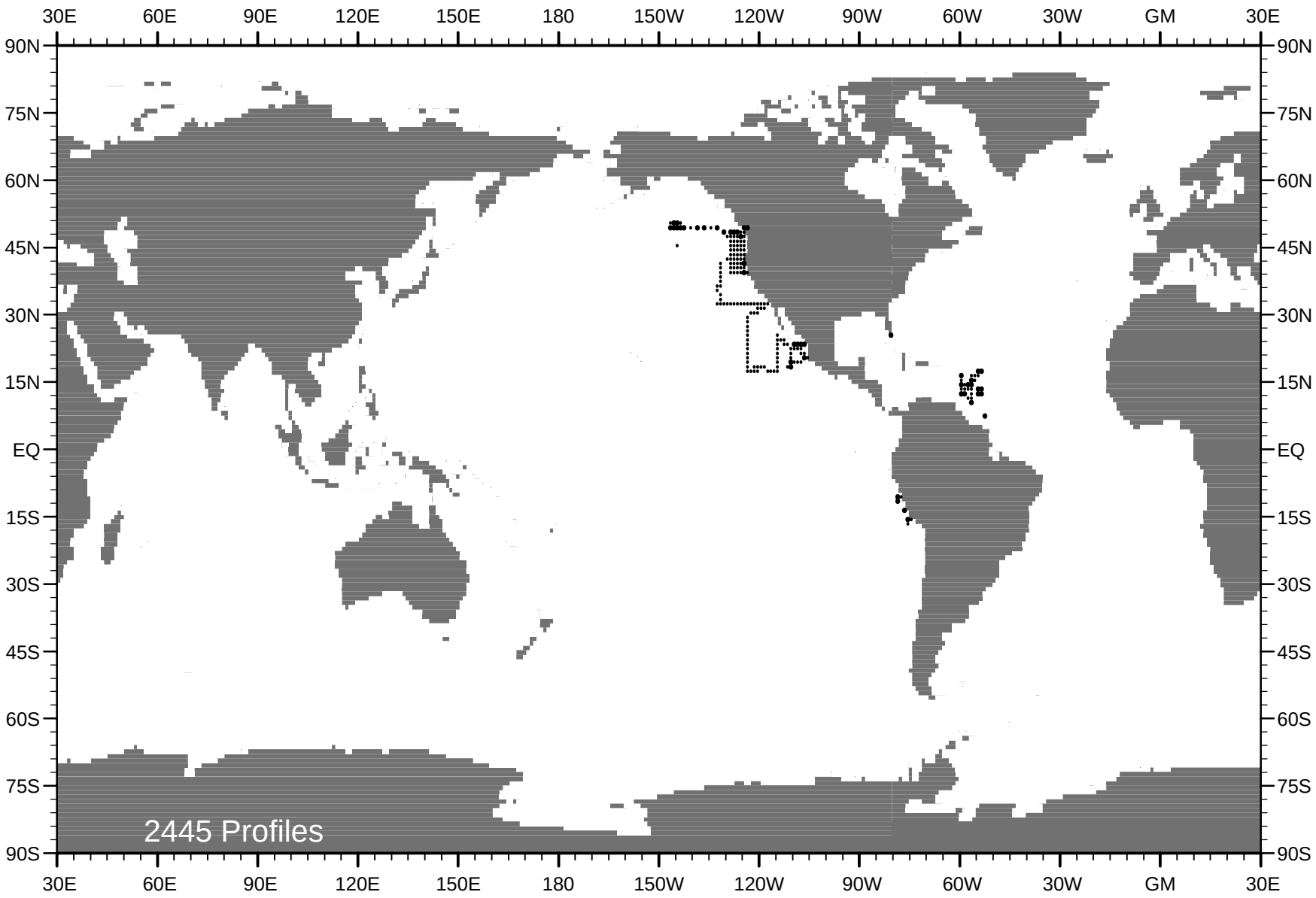


Fig. A3 WOD01 CTD cast distribution for year 1969 .

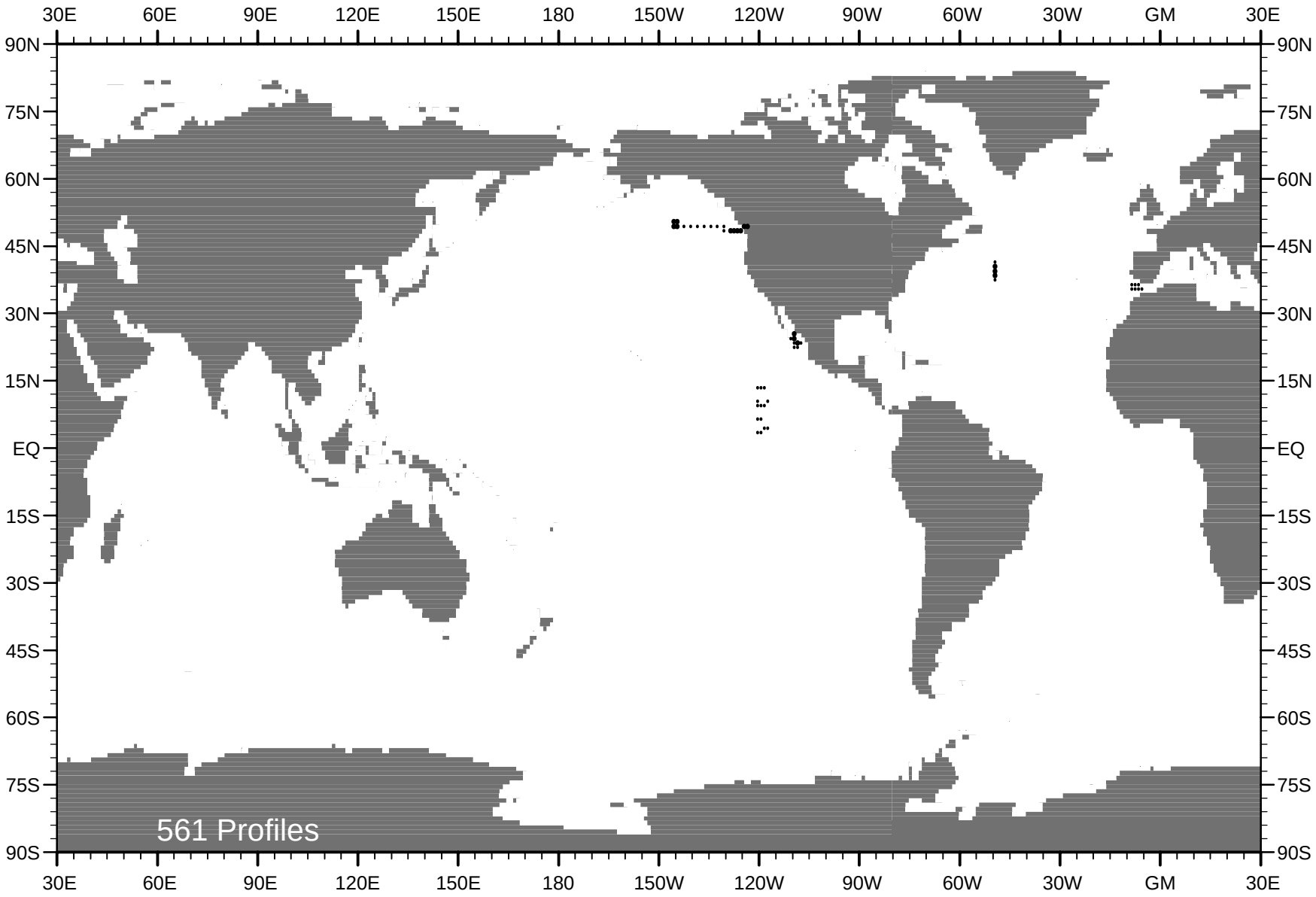


Fig. A4 WOD01 CTD cast distribution for year 1970 .

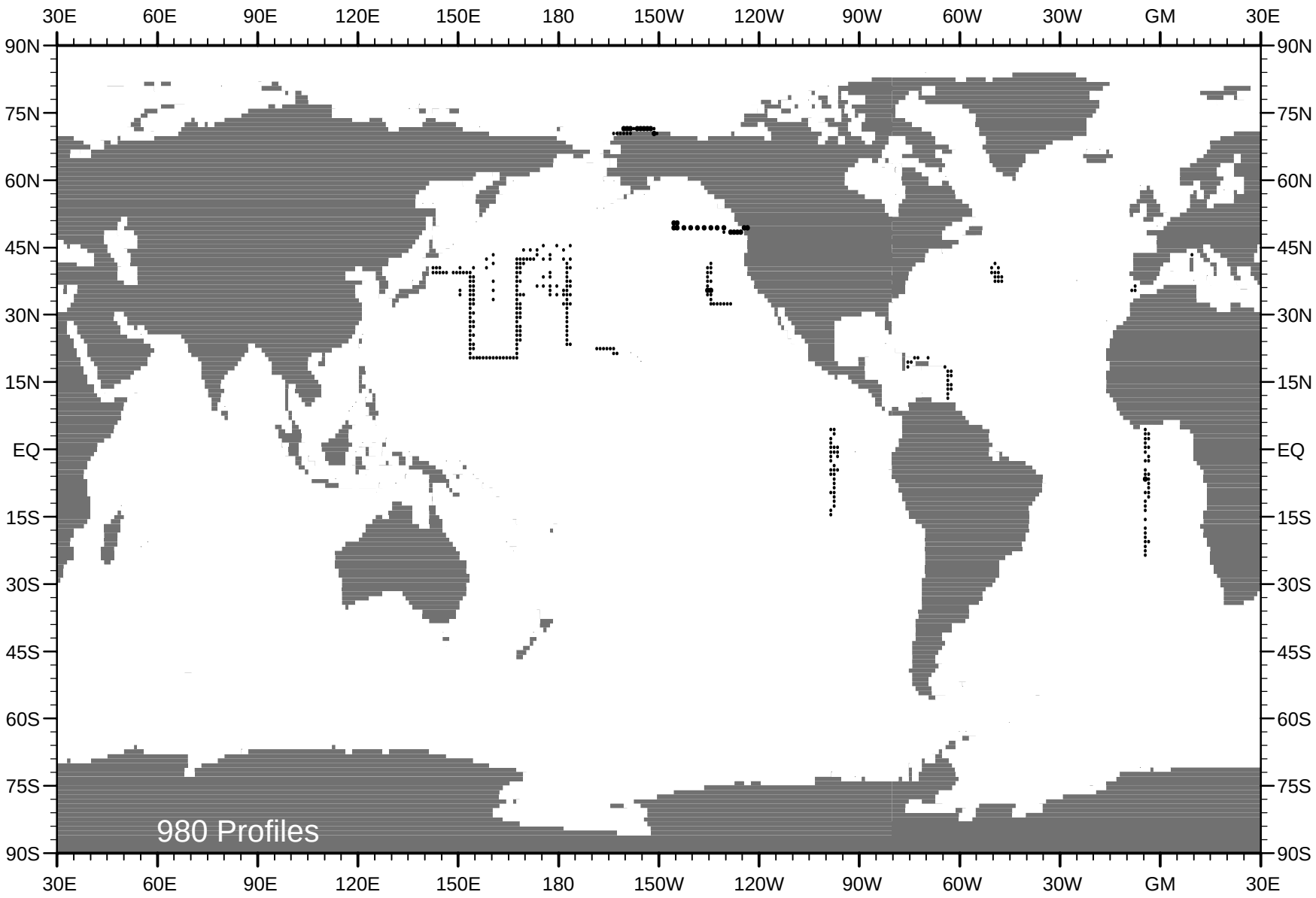


Fig. A5 WOD01 CTD cast distribution for year 1971 .

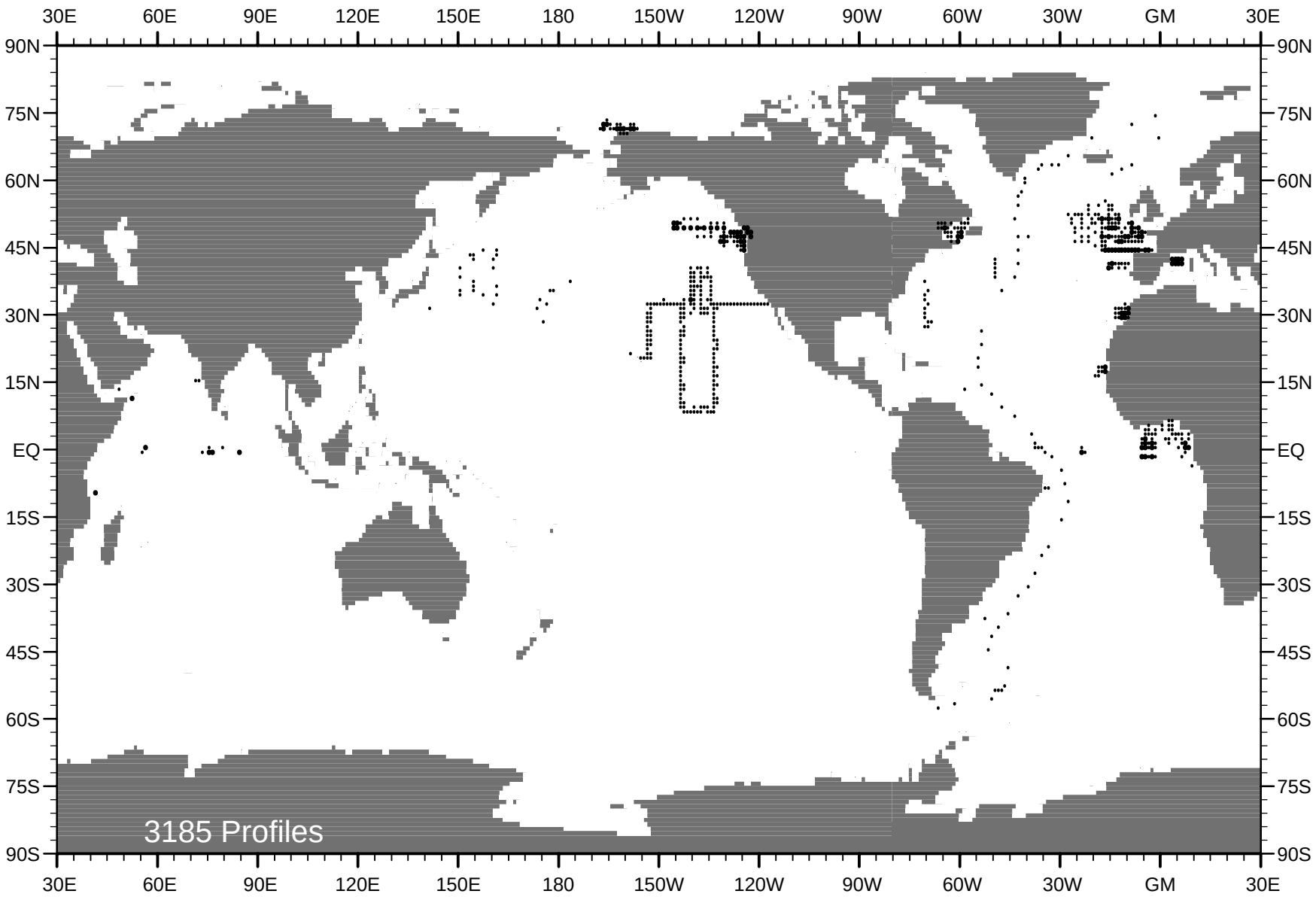


Fig. A6 WOD01 CTD cast distribution for year 1972 .

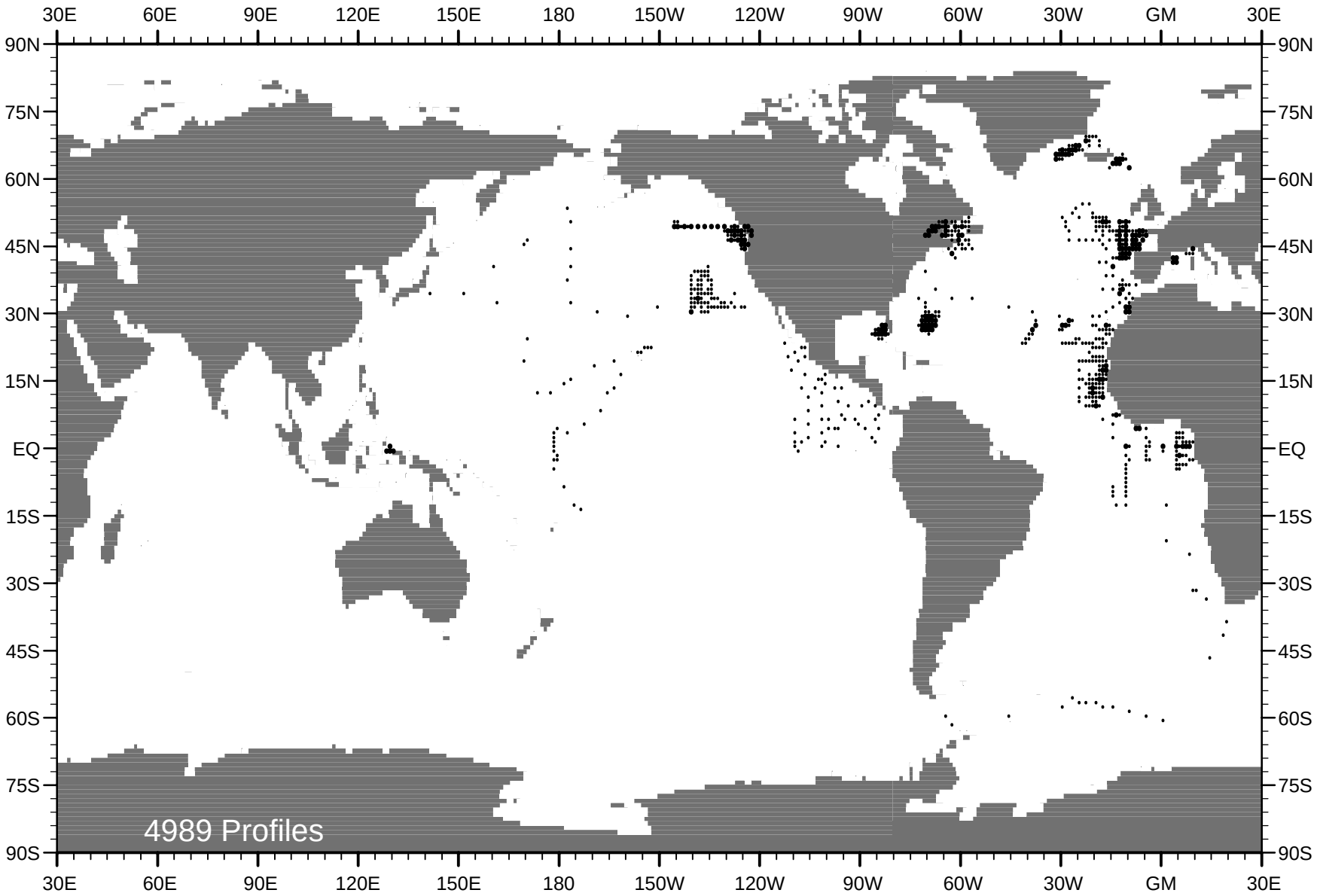


Fig. A7 WOD01 CTD cast distribution for year 1973 .

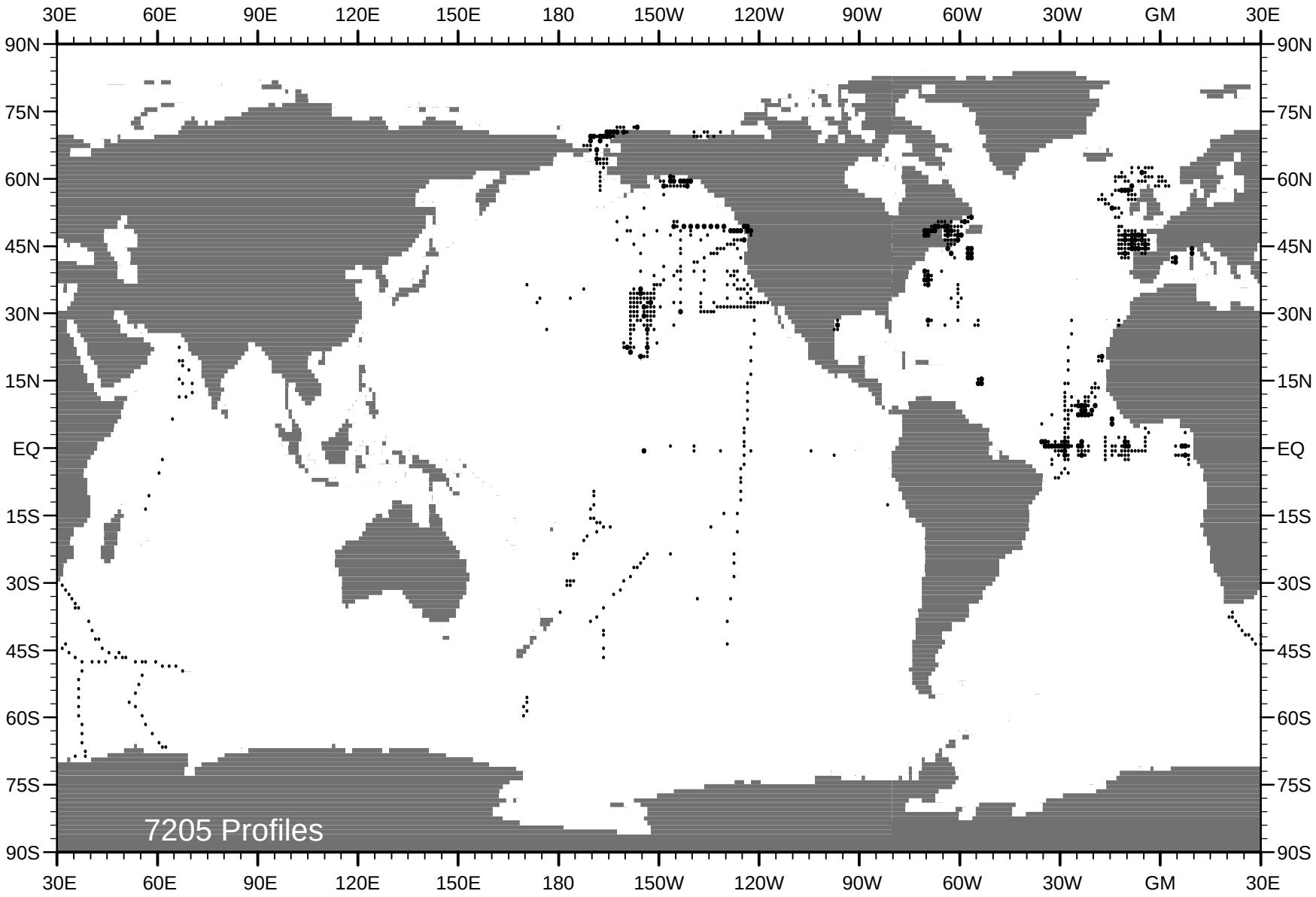


Fig. A8 WOD01 CTD cast distribution for year 1974 .

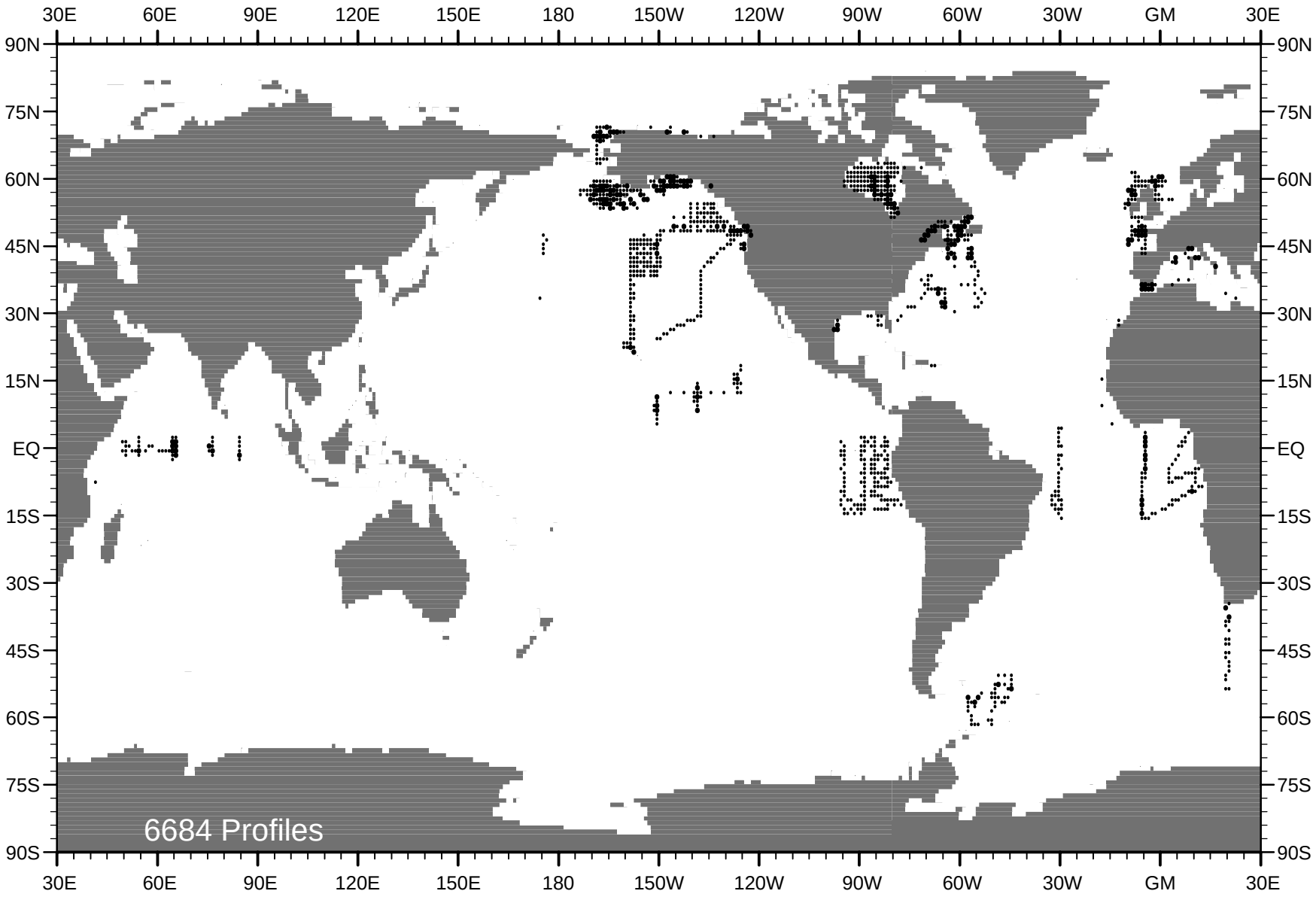


Fig. A9 WOD01 CTD cast distribution for year 1975 .

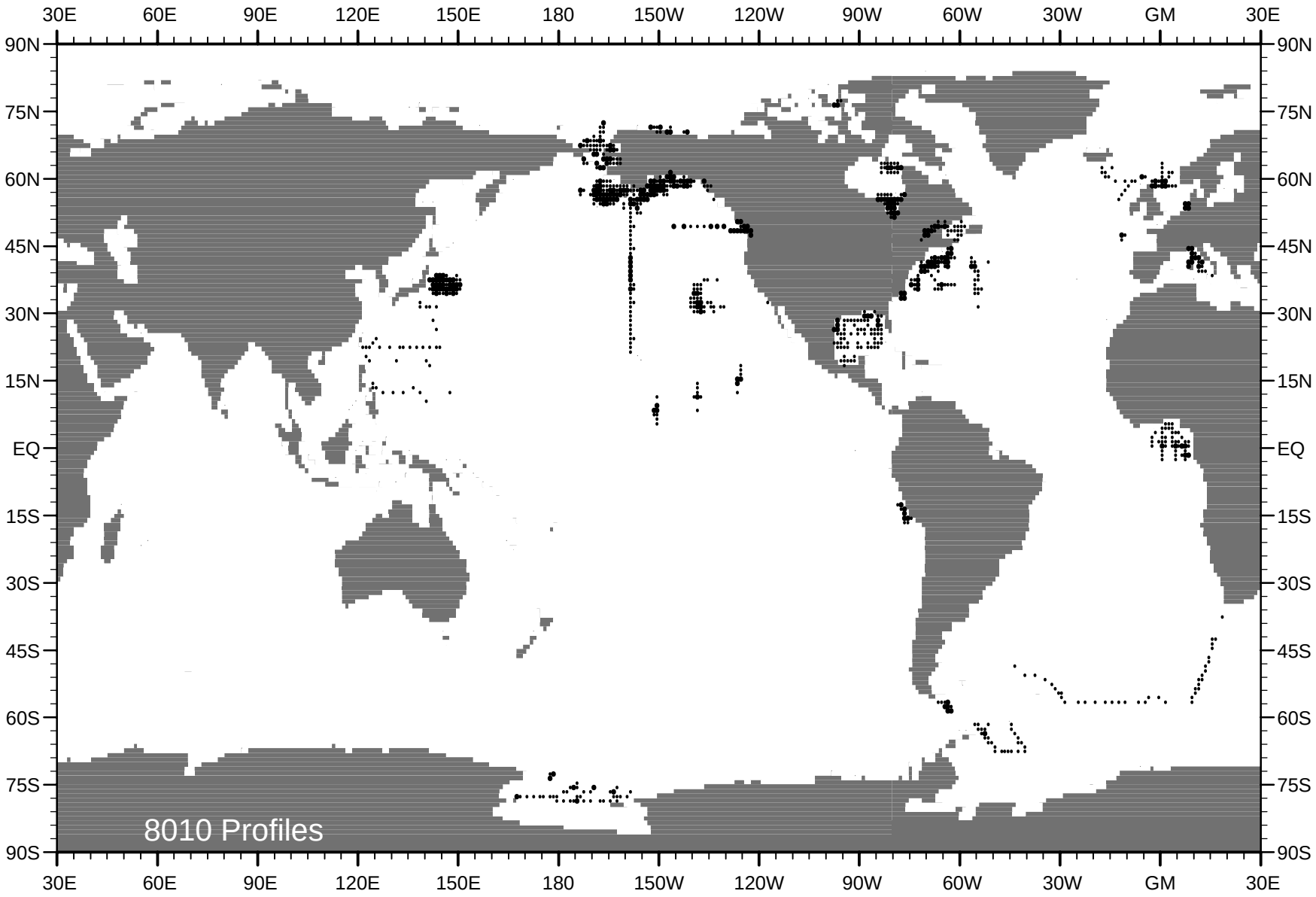


Fig. A10 WOD01 CTD cast distribution for year 1976 .

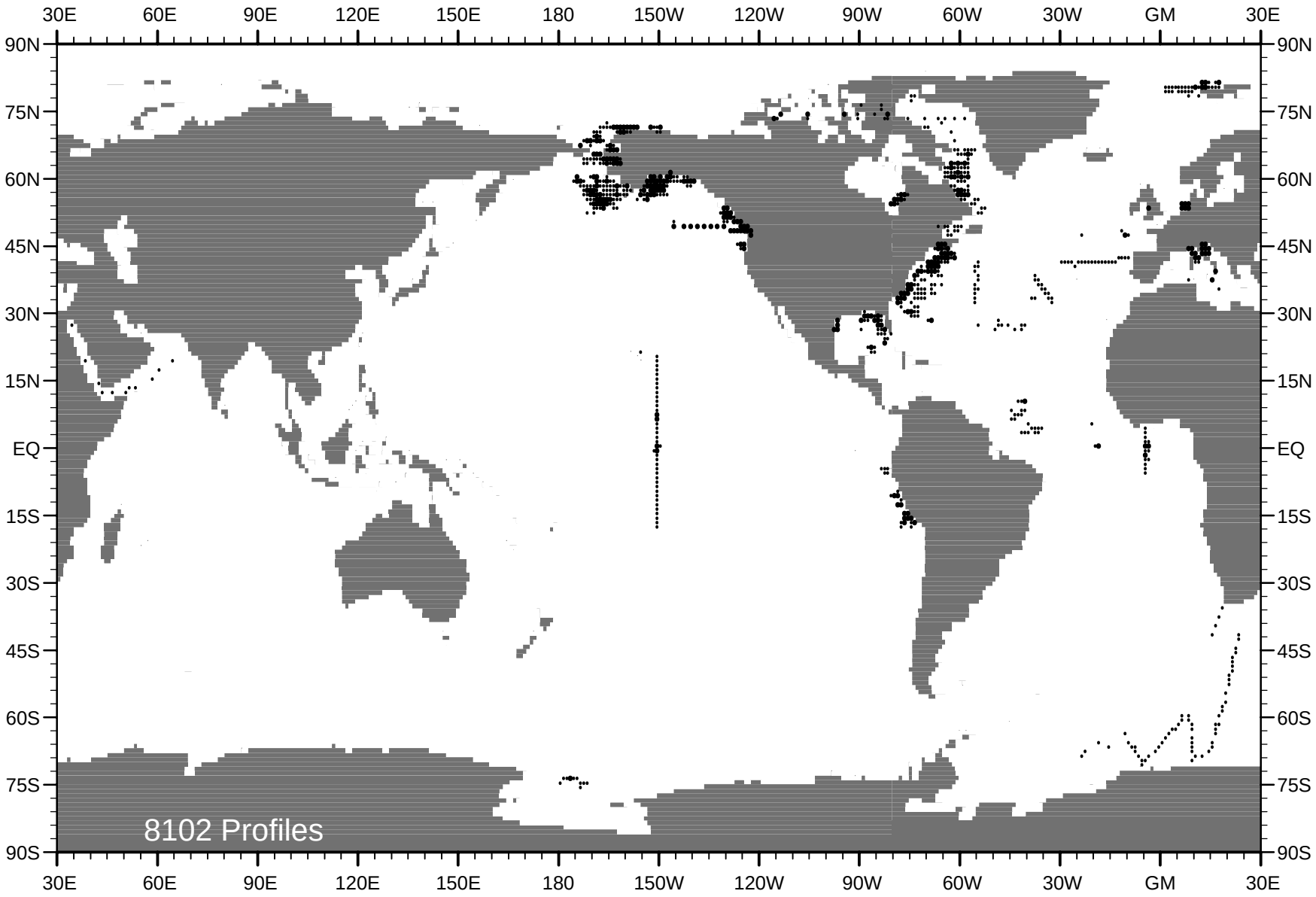


Fig. A11 WOD01 CTD cast distribution for year 1977 .

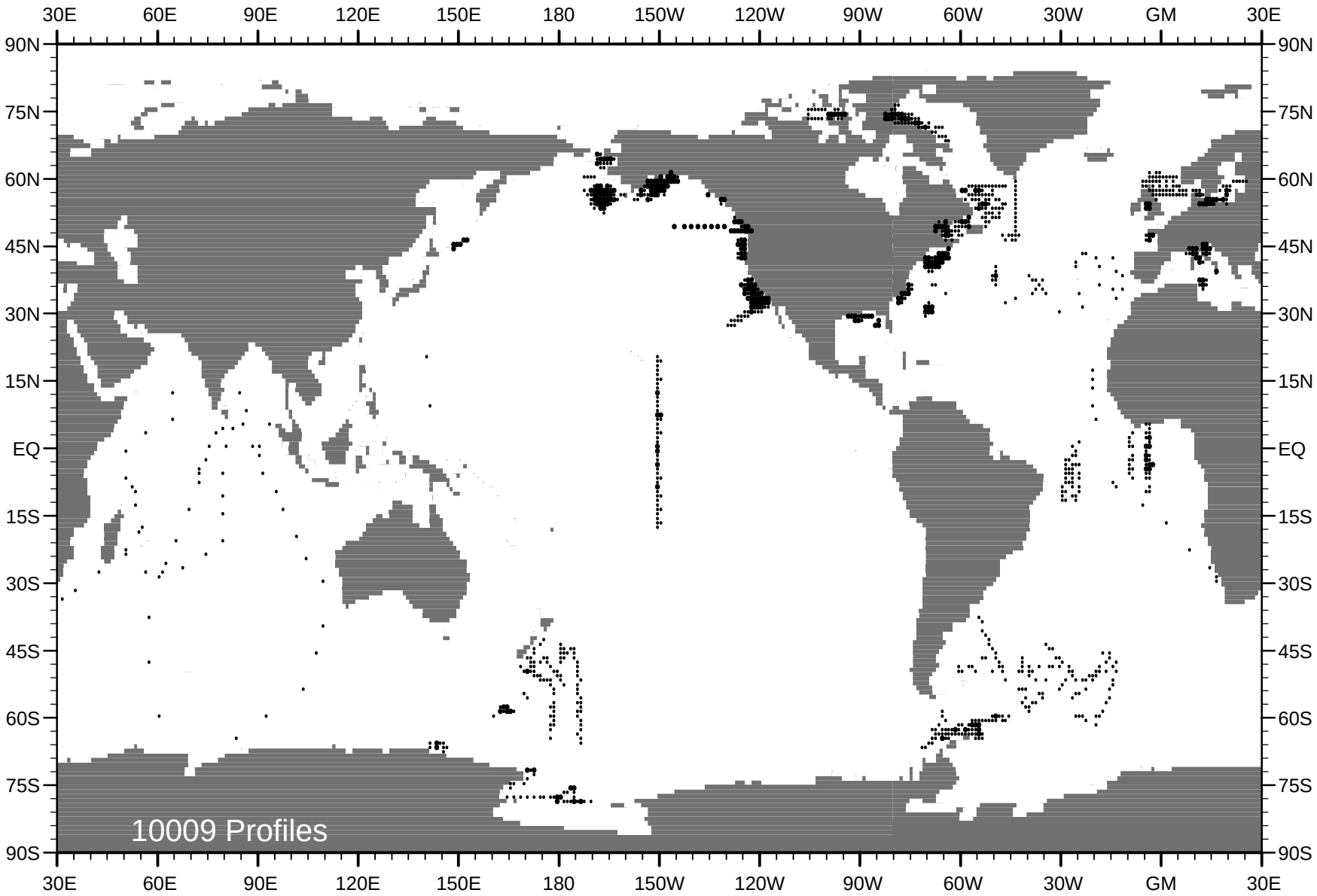


Fig. A12 WOD01 CTD cast distribution for year 1978 .

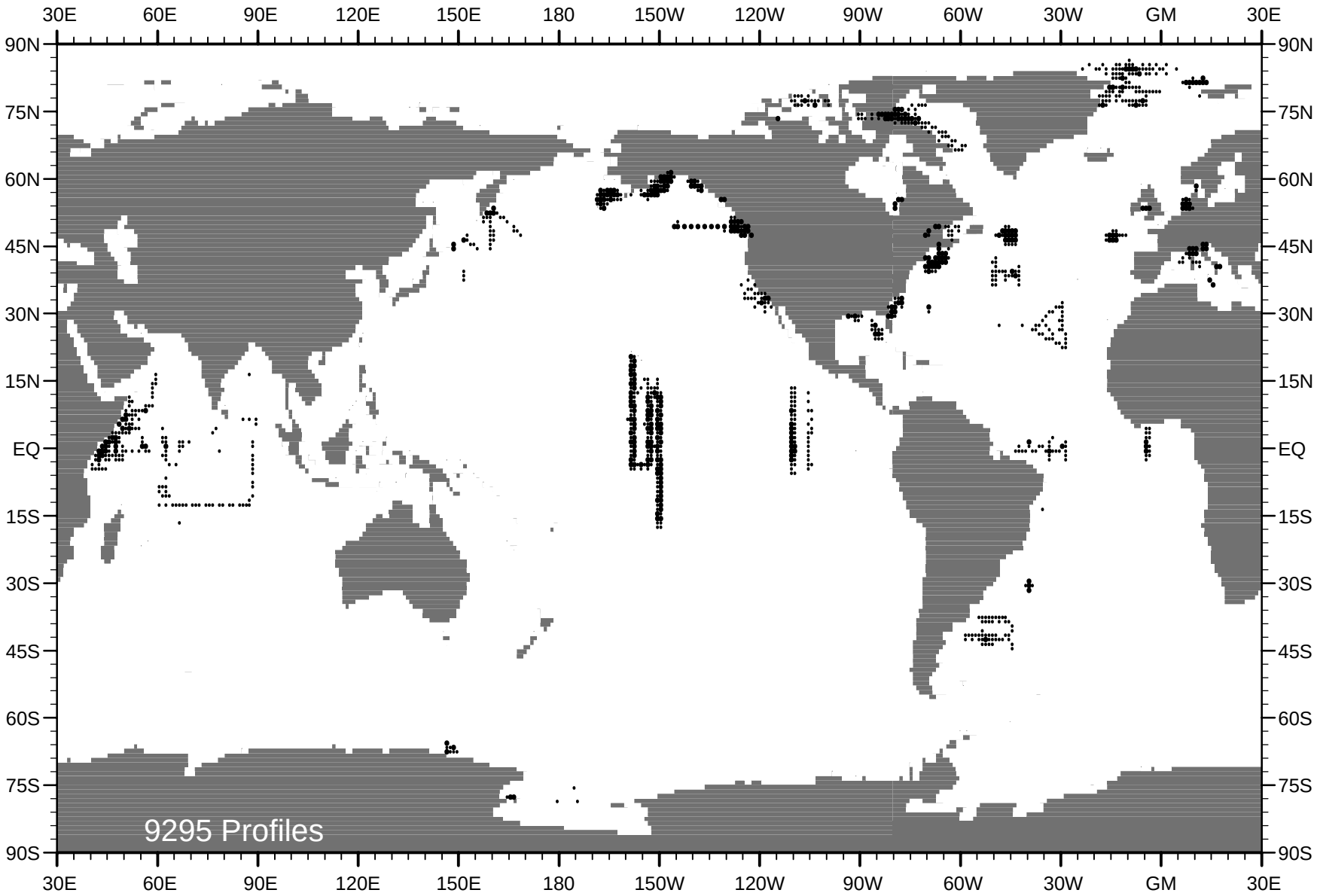


Fig. A13 WOD01 CTD cast distribution for year 1979 .

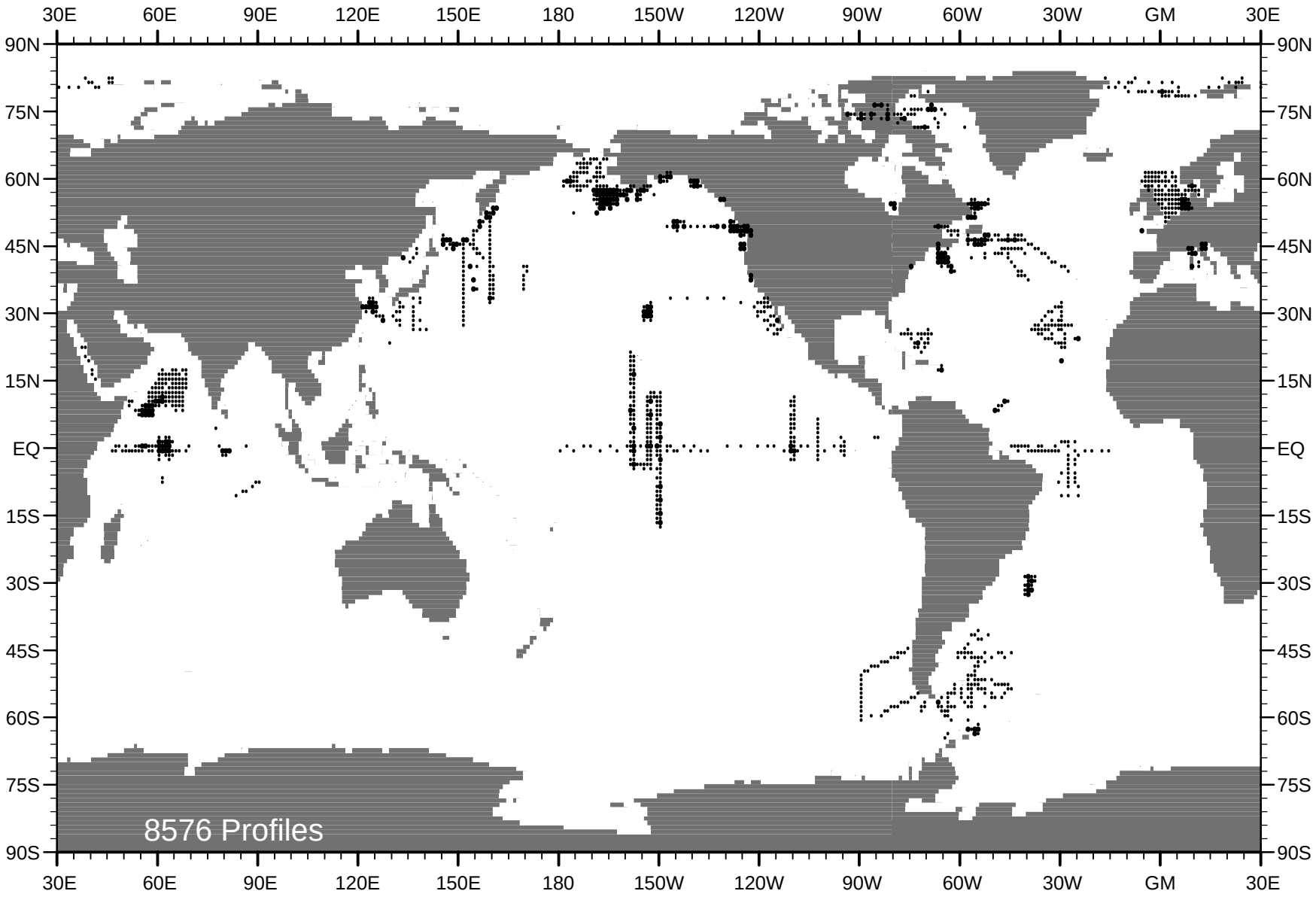


Fig. A14 WOD01 CTD cast distribution for year 1980 .

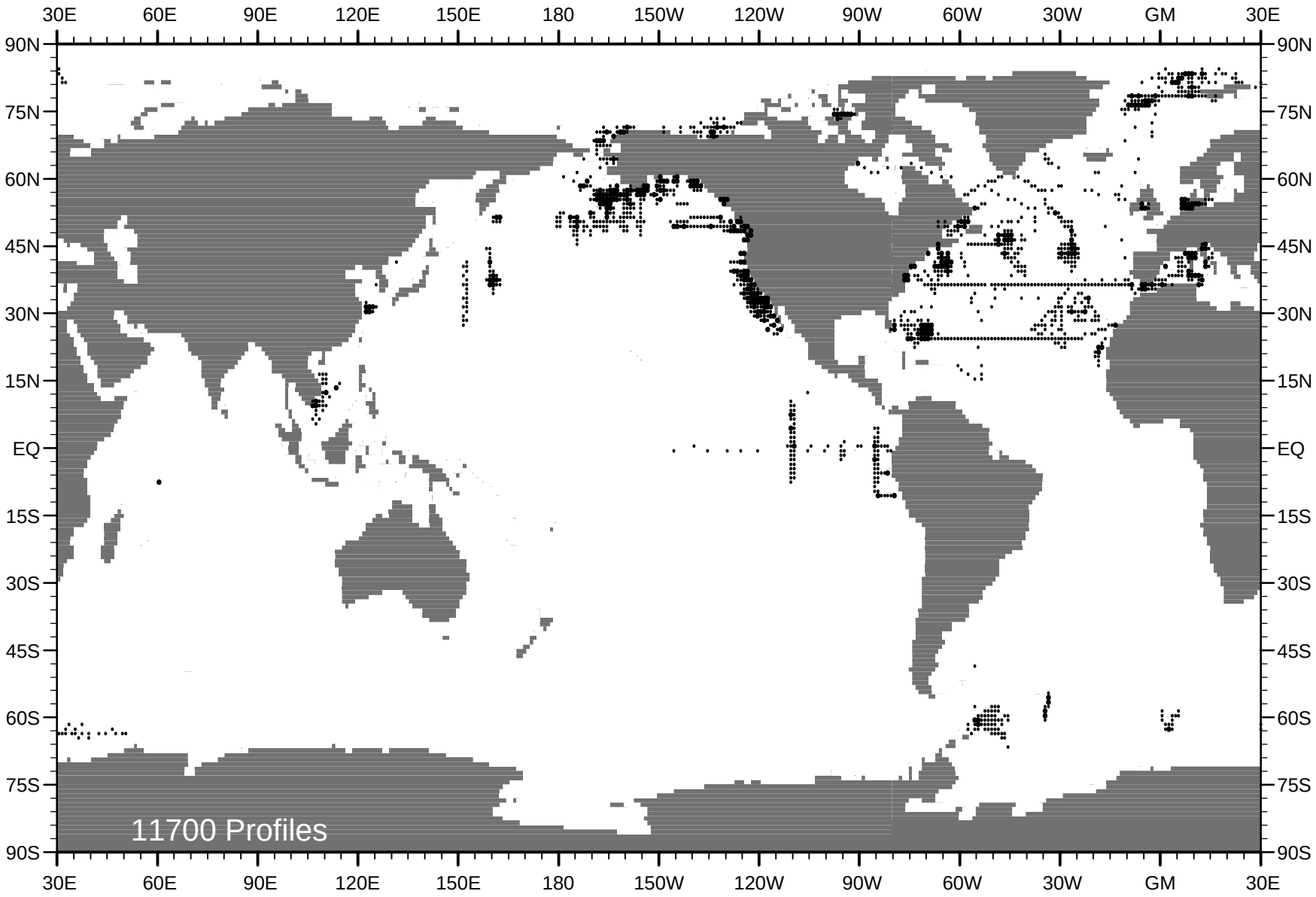
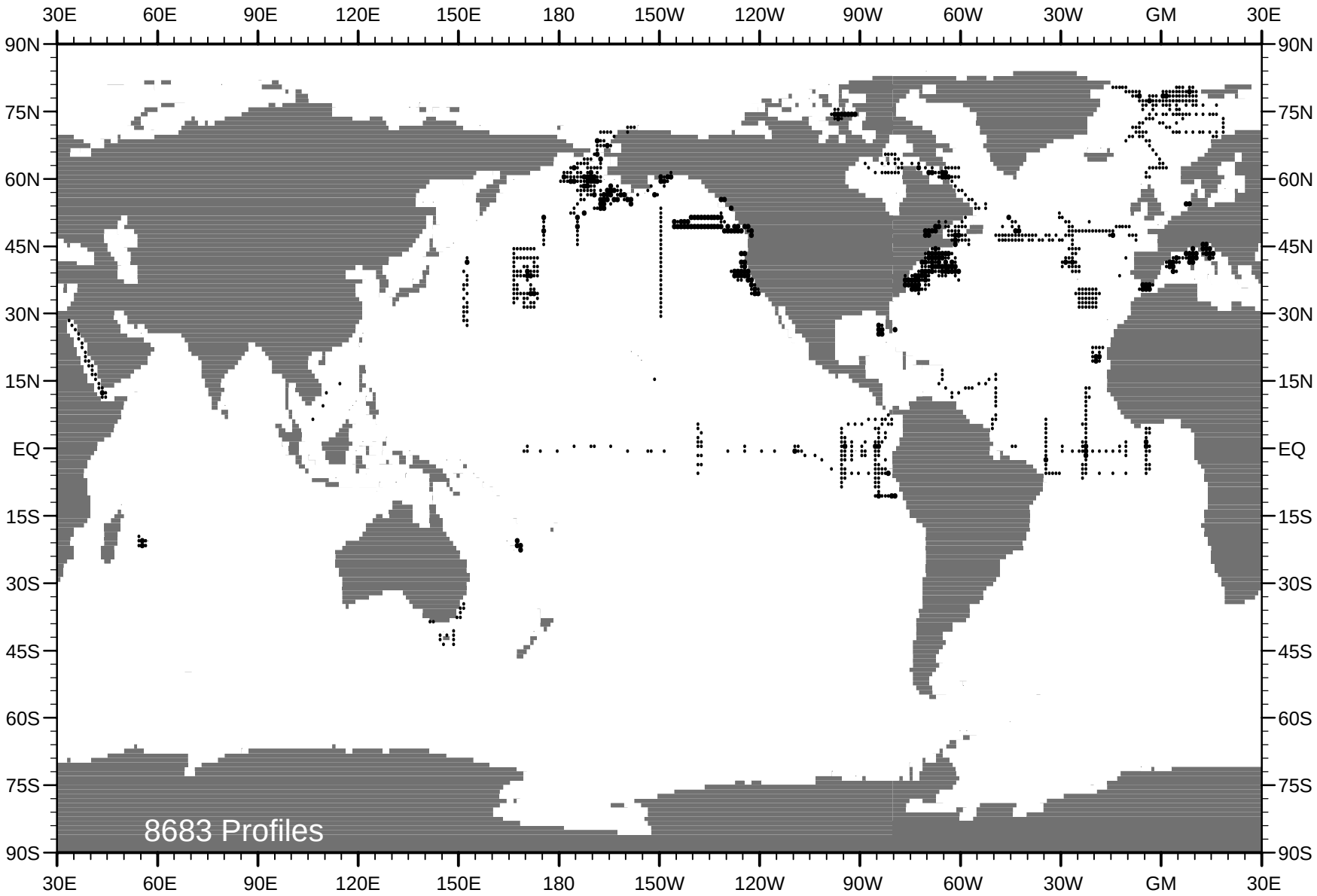


Fig. A15 WOD01 CTD cast distribution for year 1981 .



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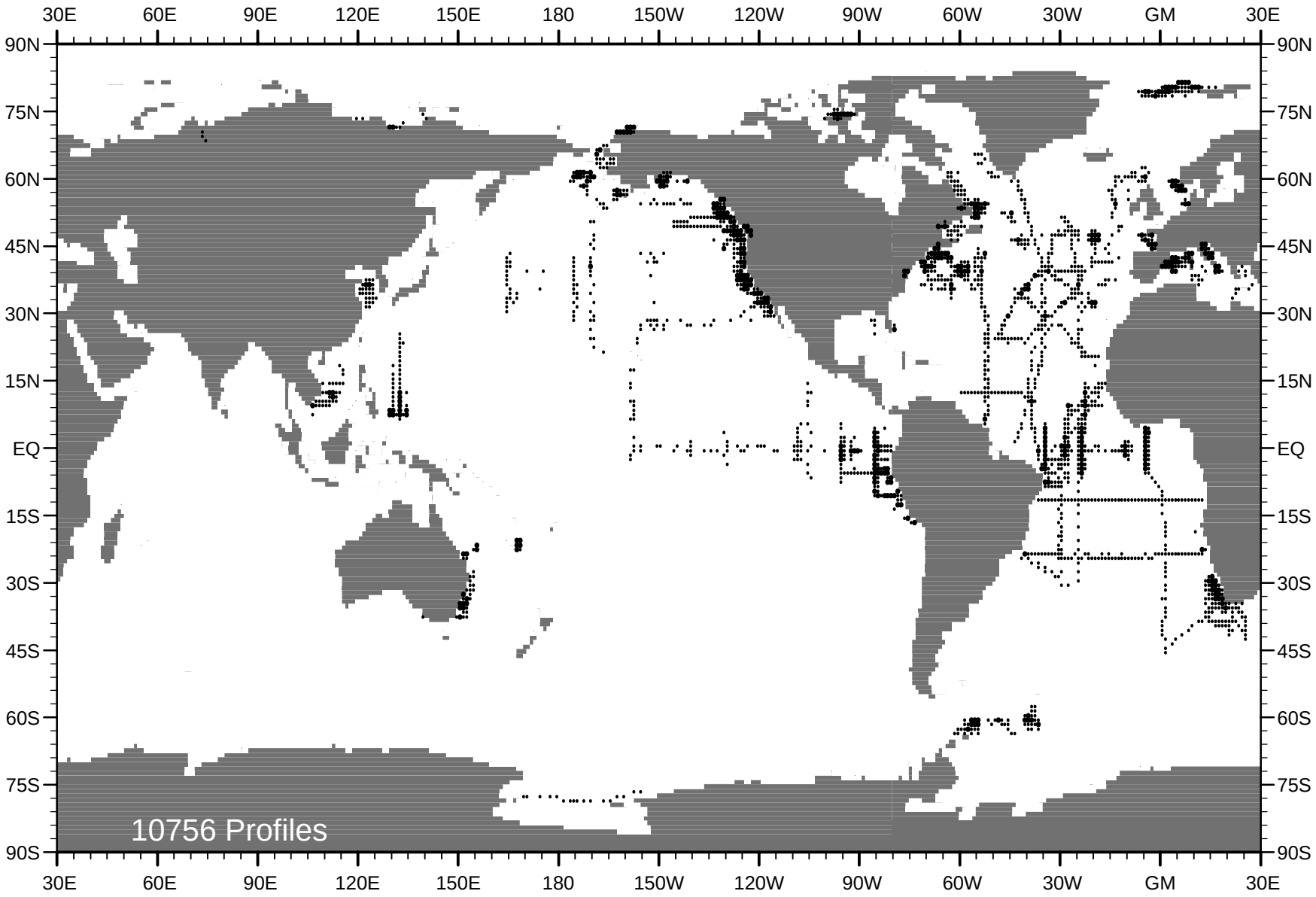

Fig. A17 WOD01 CTD cast distribution for year 1983 .

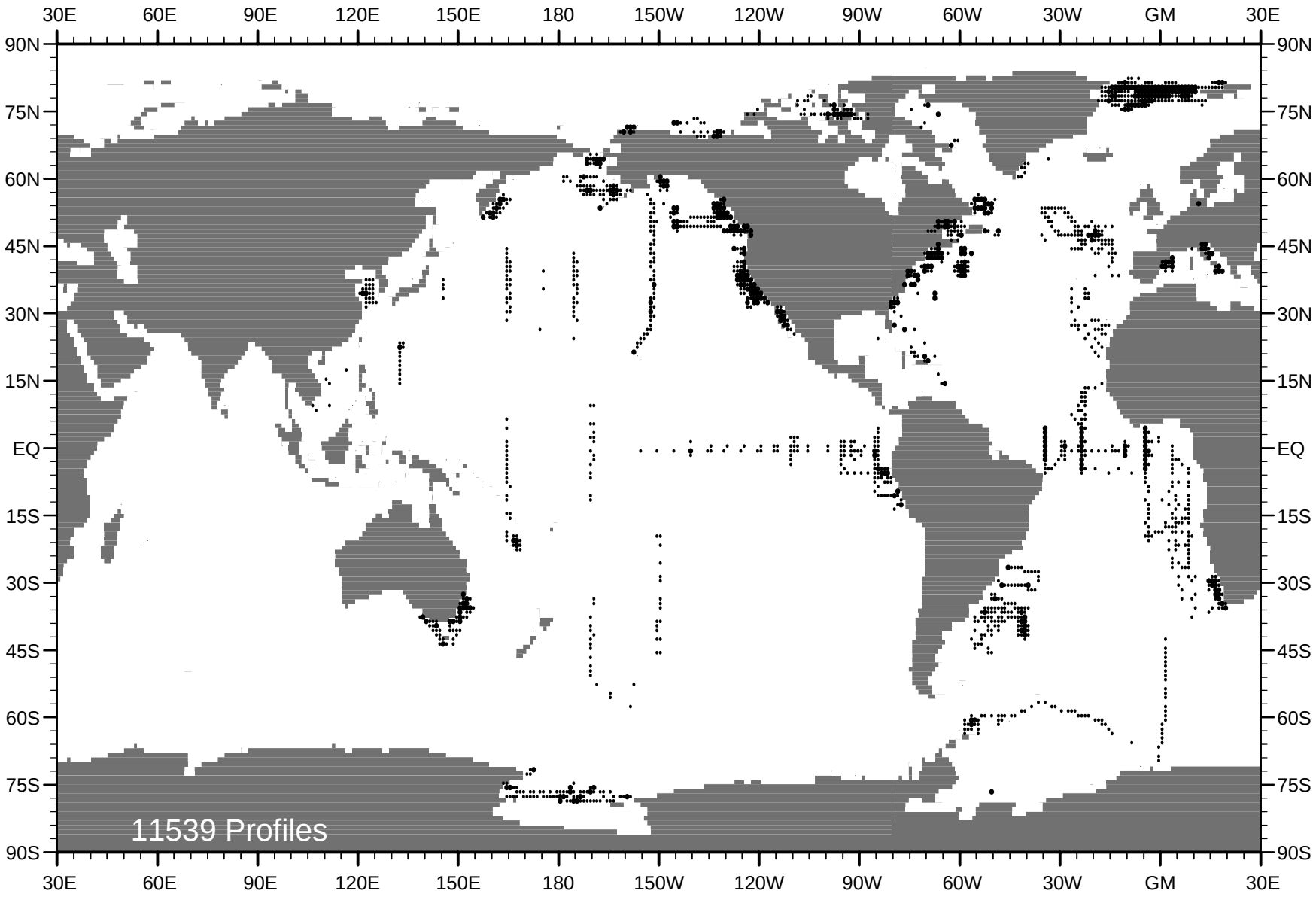

Fig. A18 WOD01 CTD cast distribution for year 1984 .

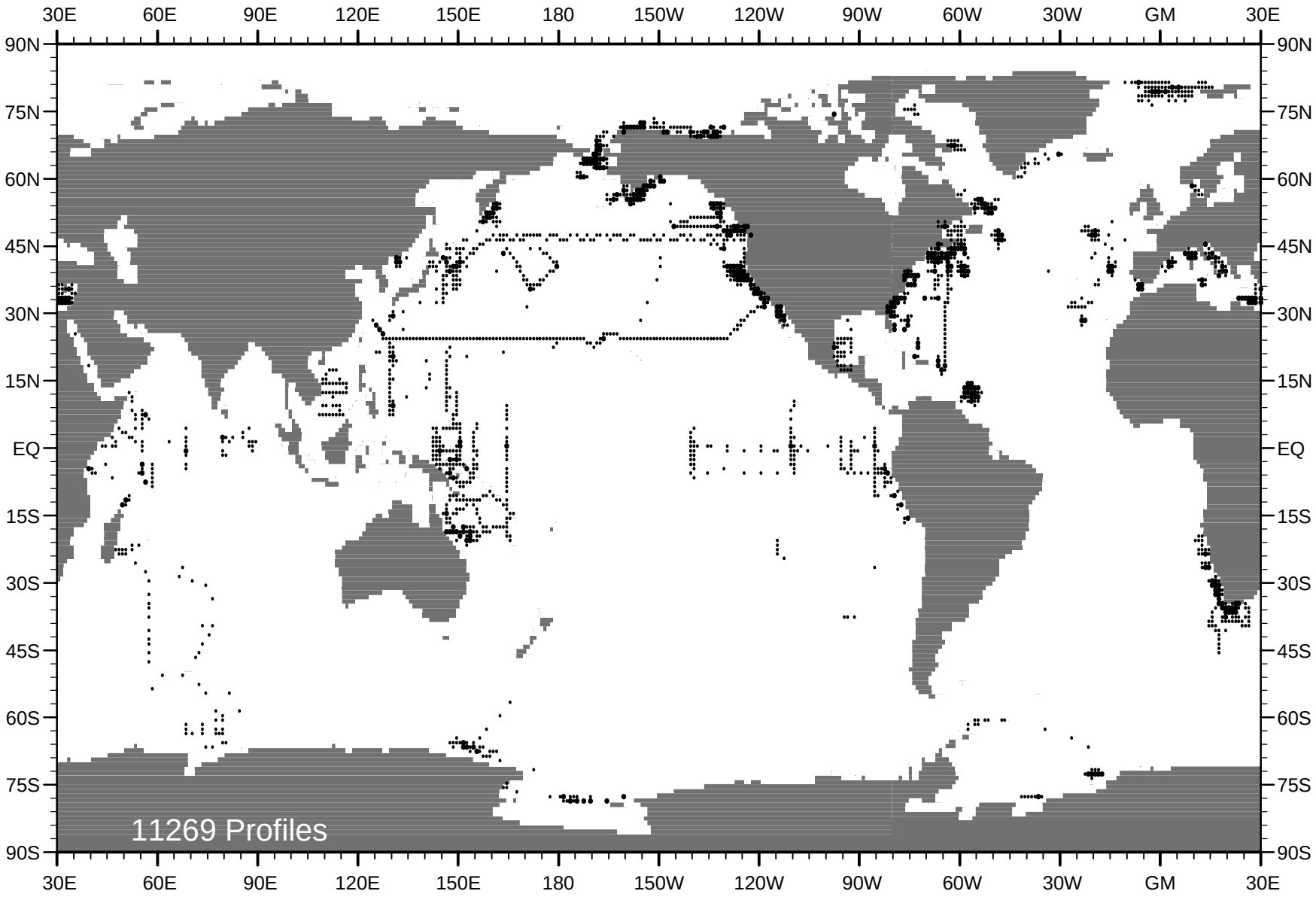

Fig. A19 WOD01 CTD cast distribution for year 1985 .

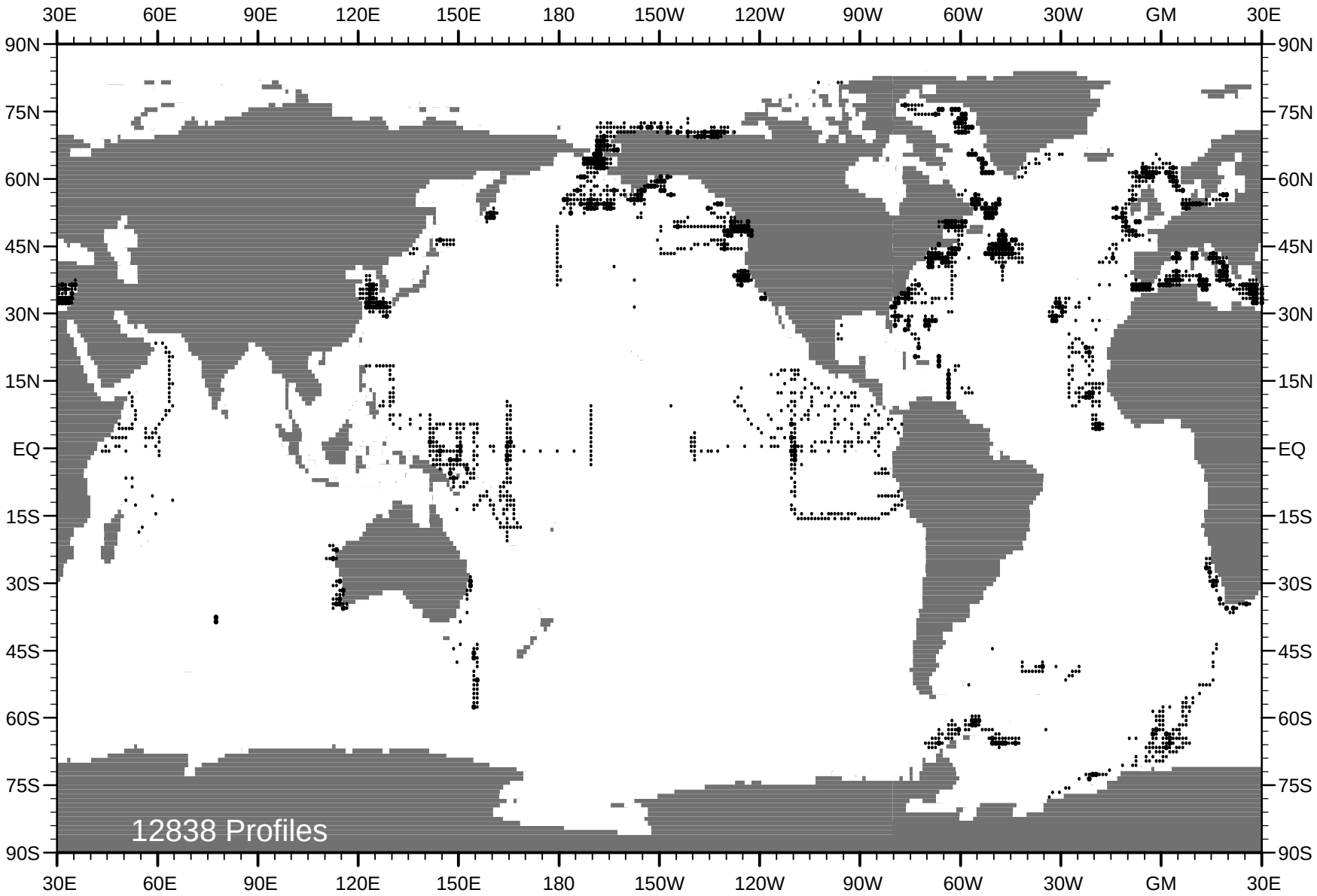

Fig. A20 WOD01 CTD cast distribution for year 1986 .

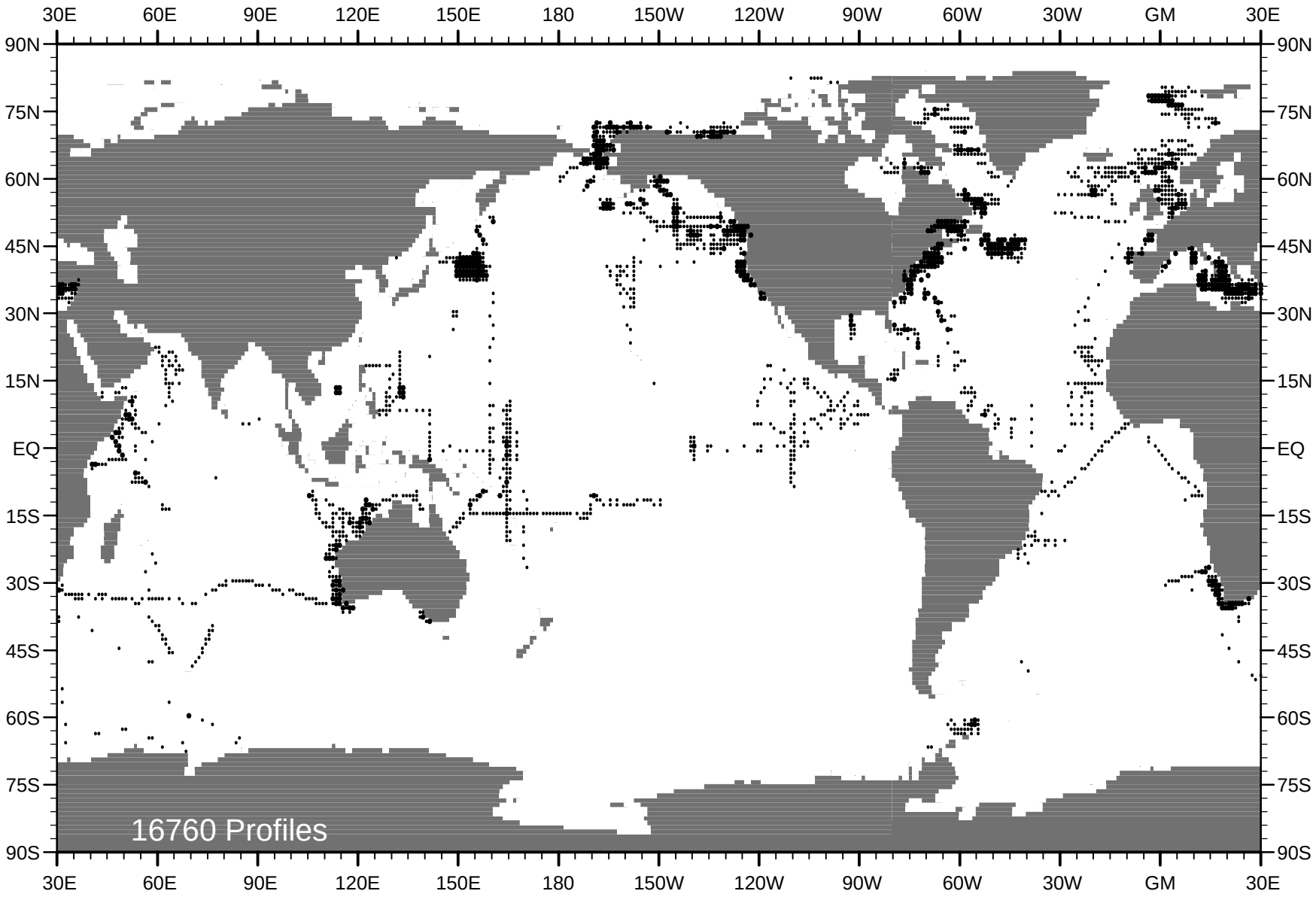

Fig. A21 WOD01 CTD cast distribution for year 1987 .

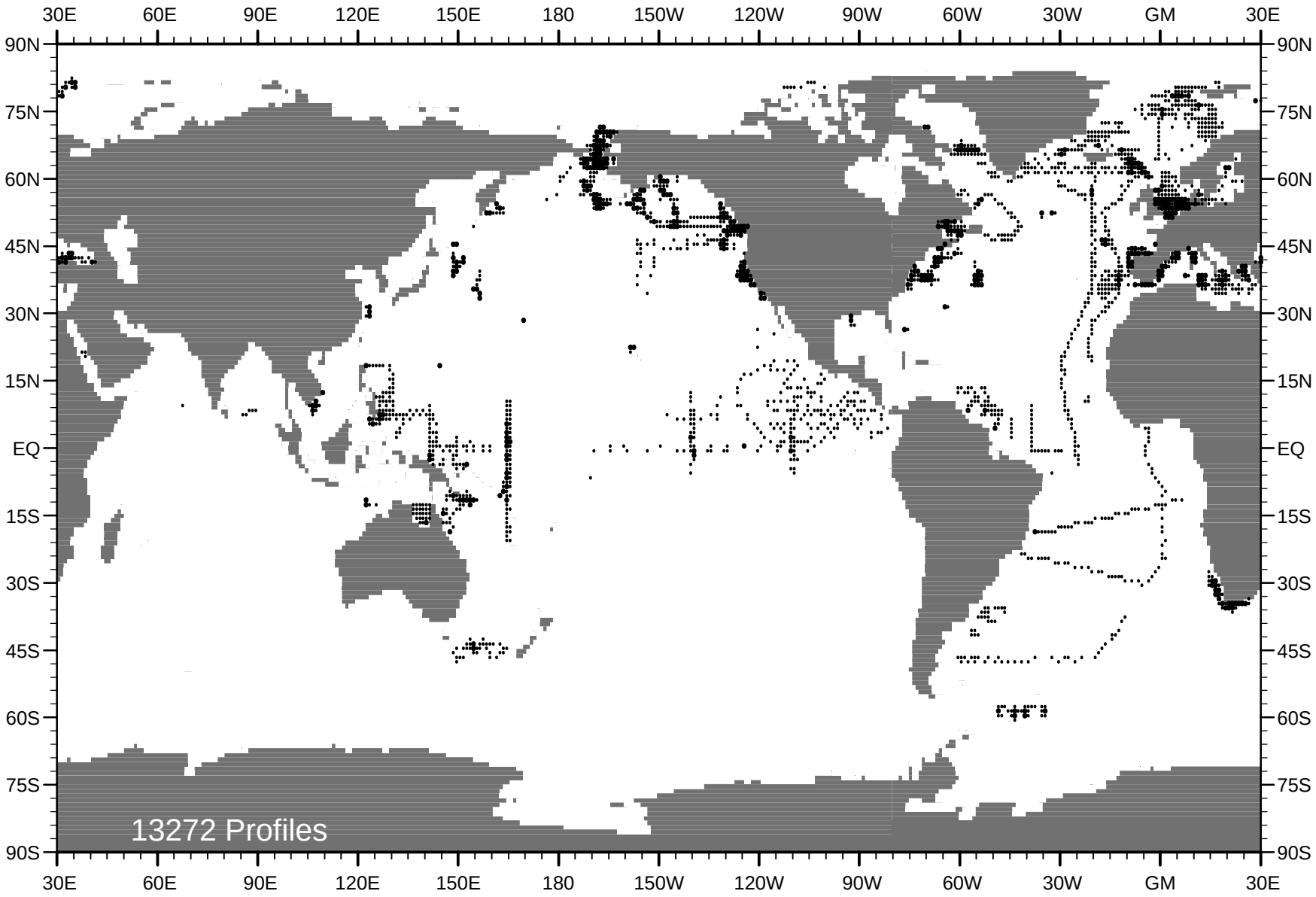

Fig. A22 WOD01 CTD cast distribution for year 1988 .

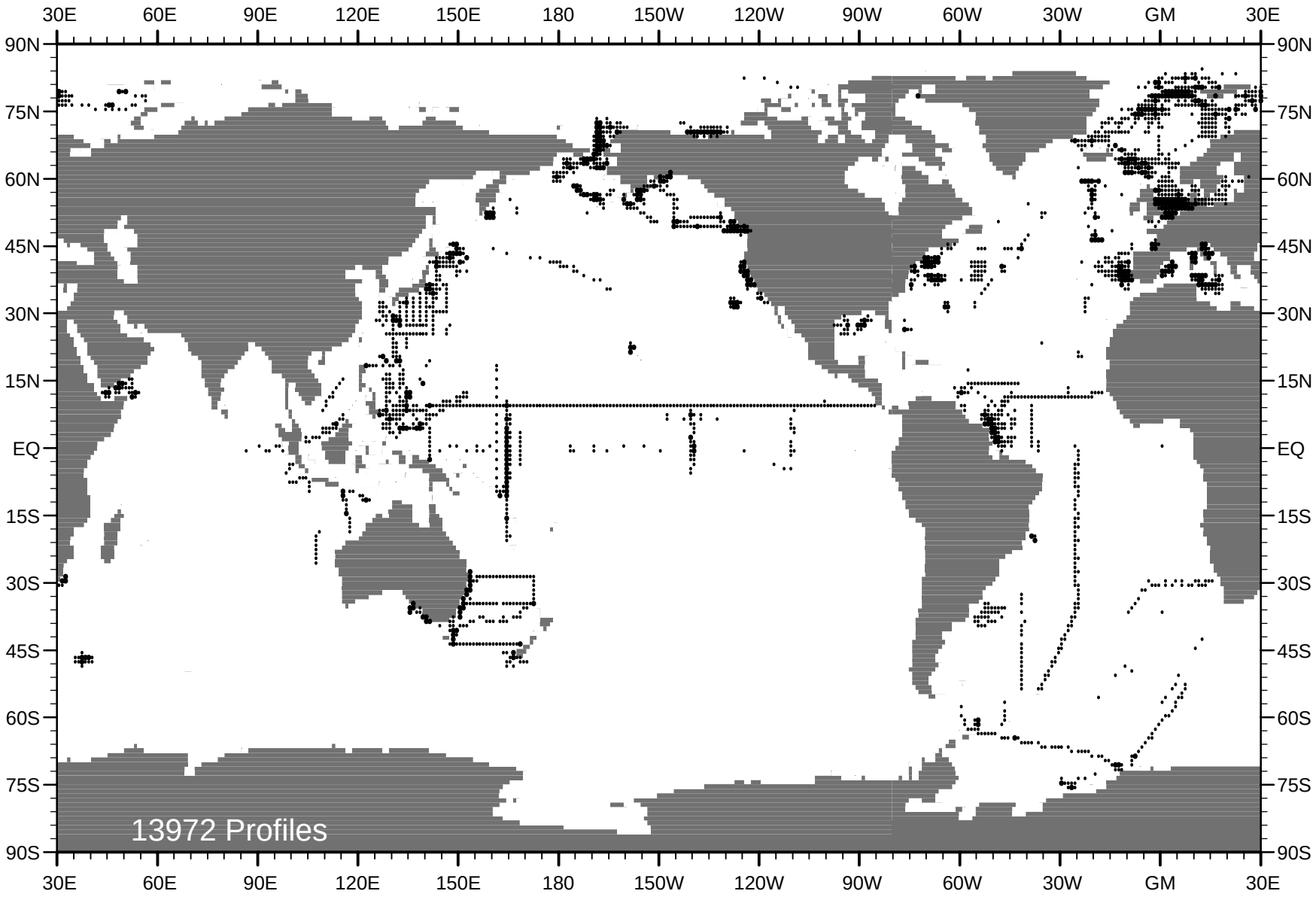

Fig. A23 WOD01 CTD cast distribution for year 1989 .

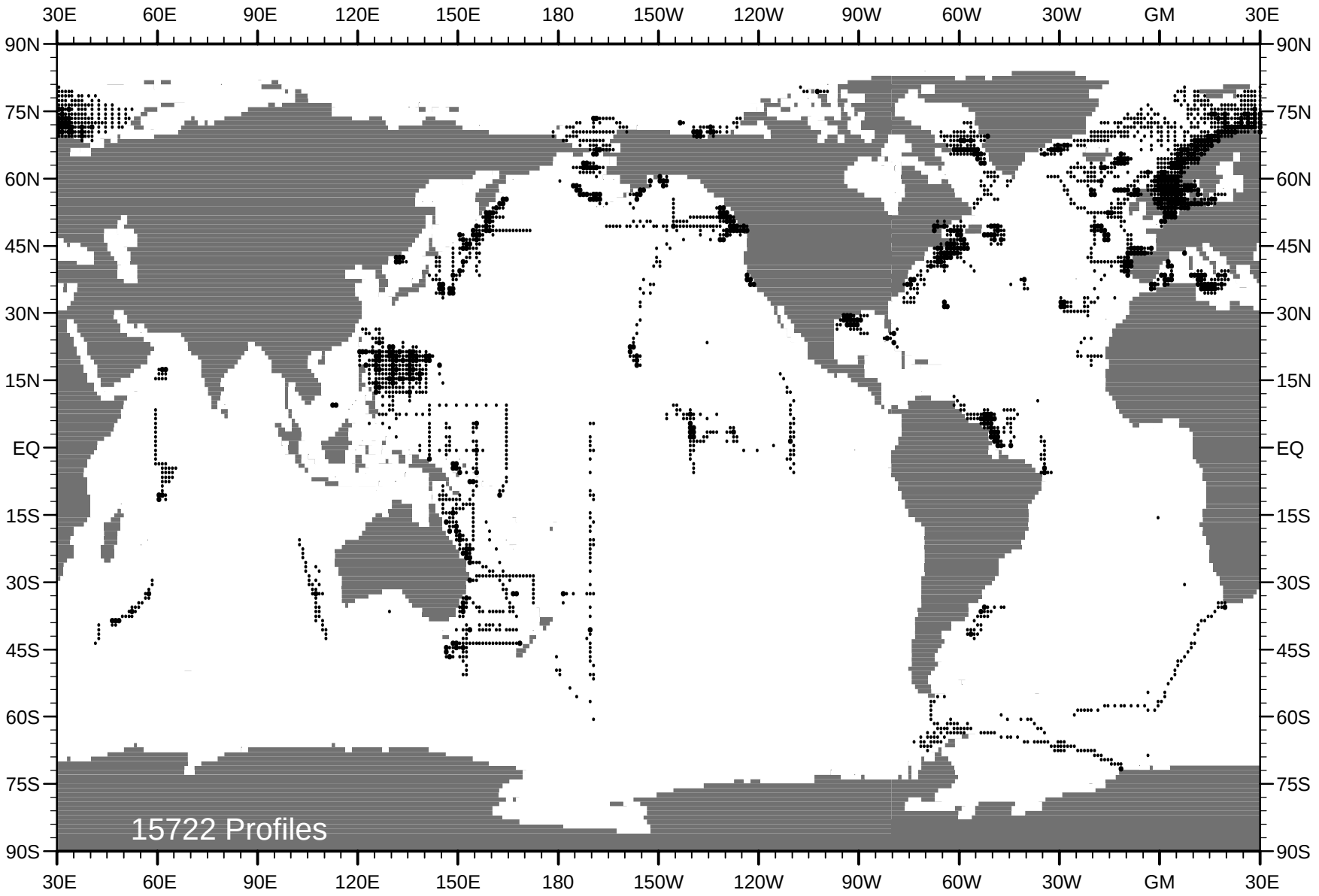

Fig. A24 WOD01 CTD cast distribution for year 1990 .

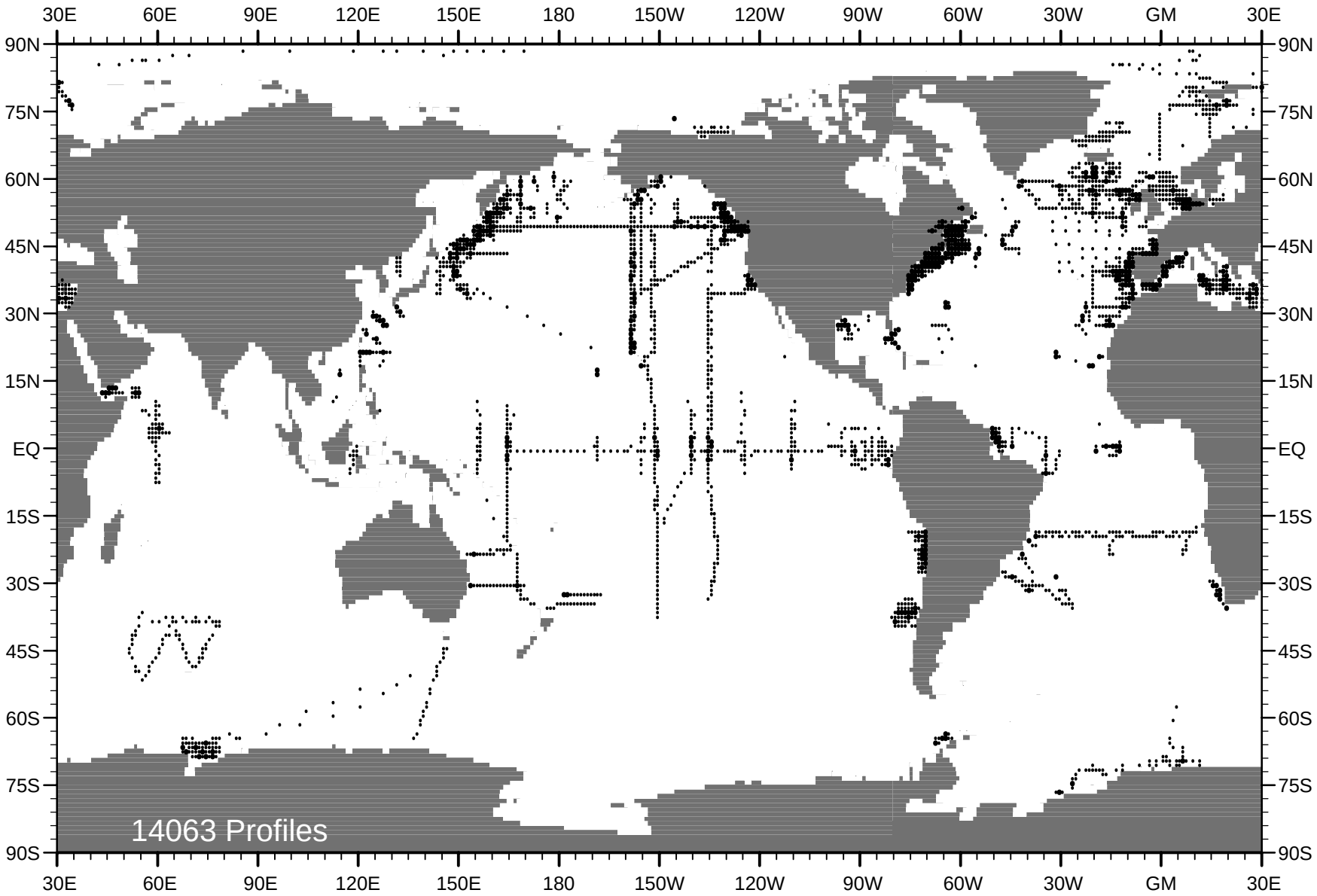

Fig. A25 WOD01 CTD cast distribution for year 1991 .

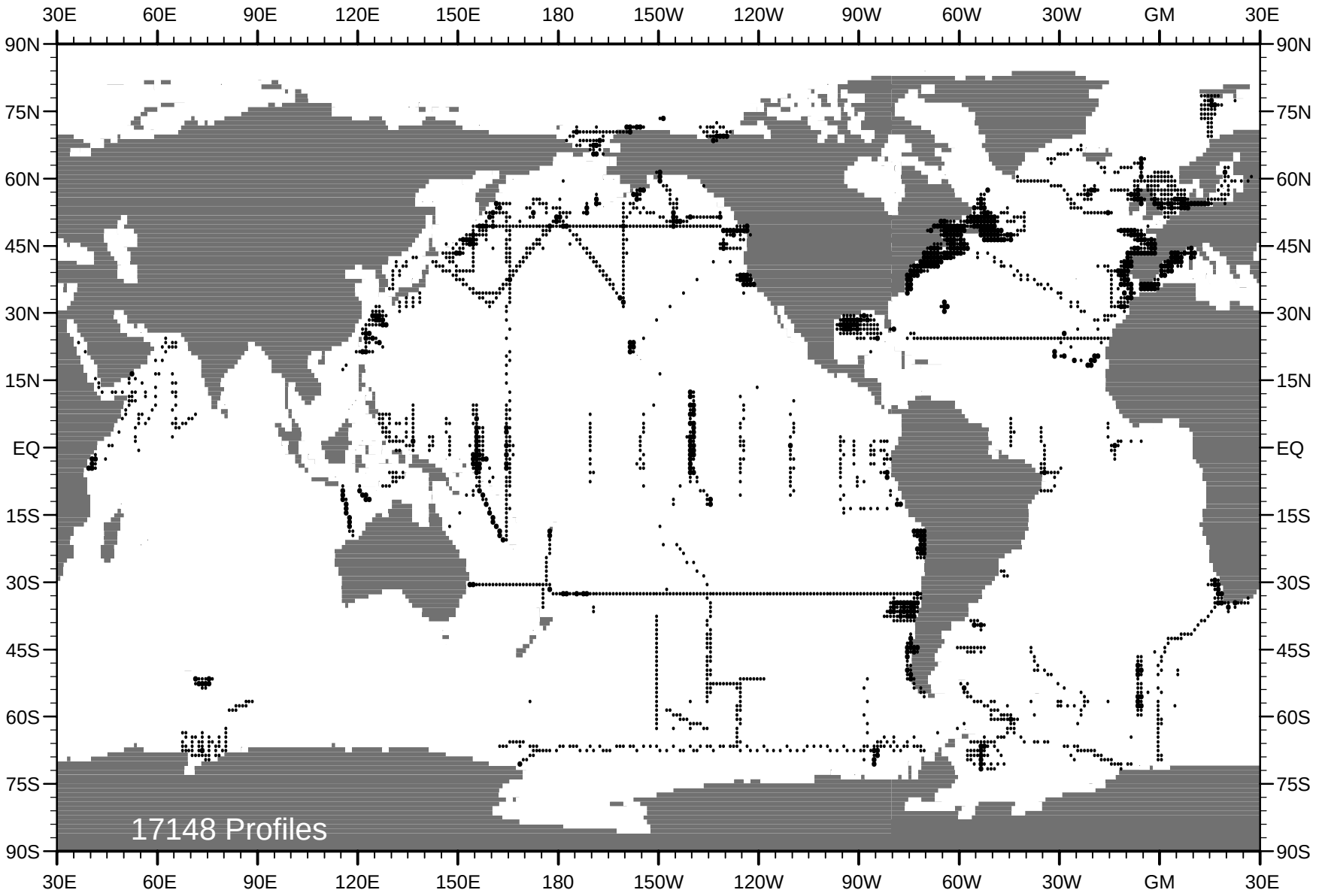

Fig. A26 WOD01 CTD cast distribution for year 1992 .

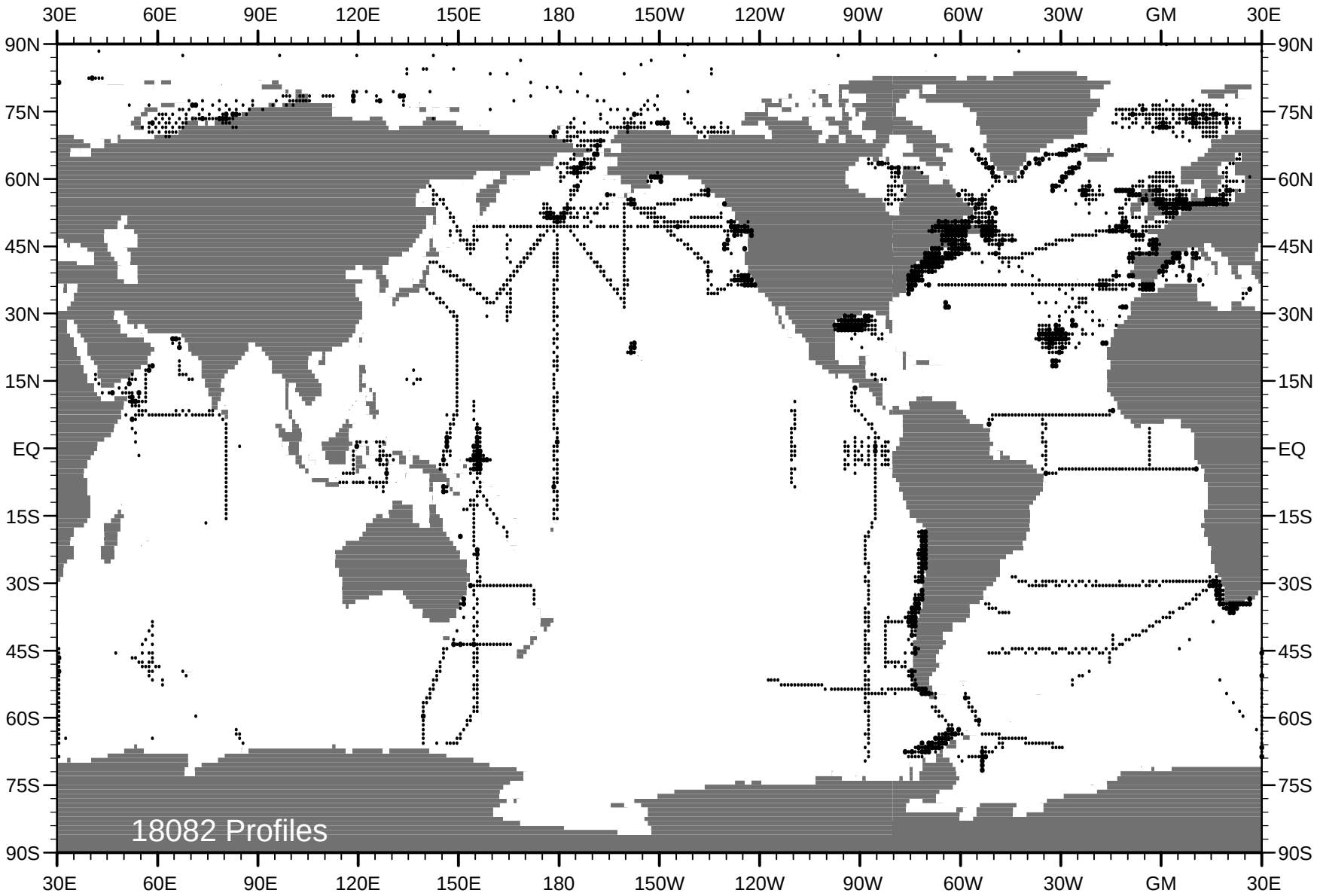

Fig. A27 WOD01 CTD cast distribution for year 1993 .

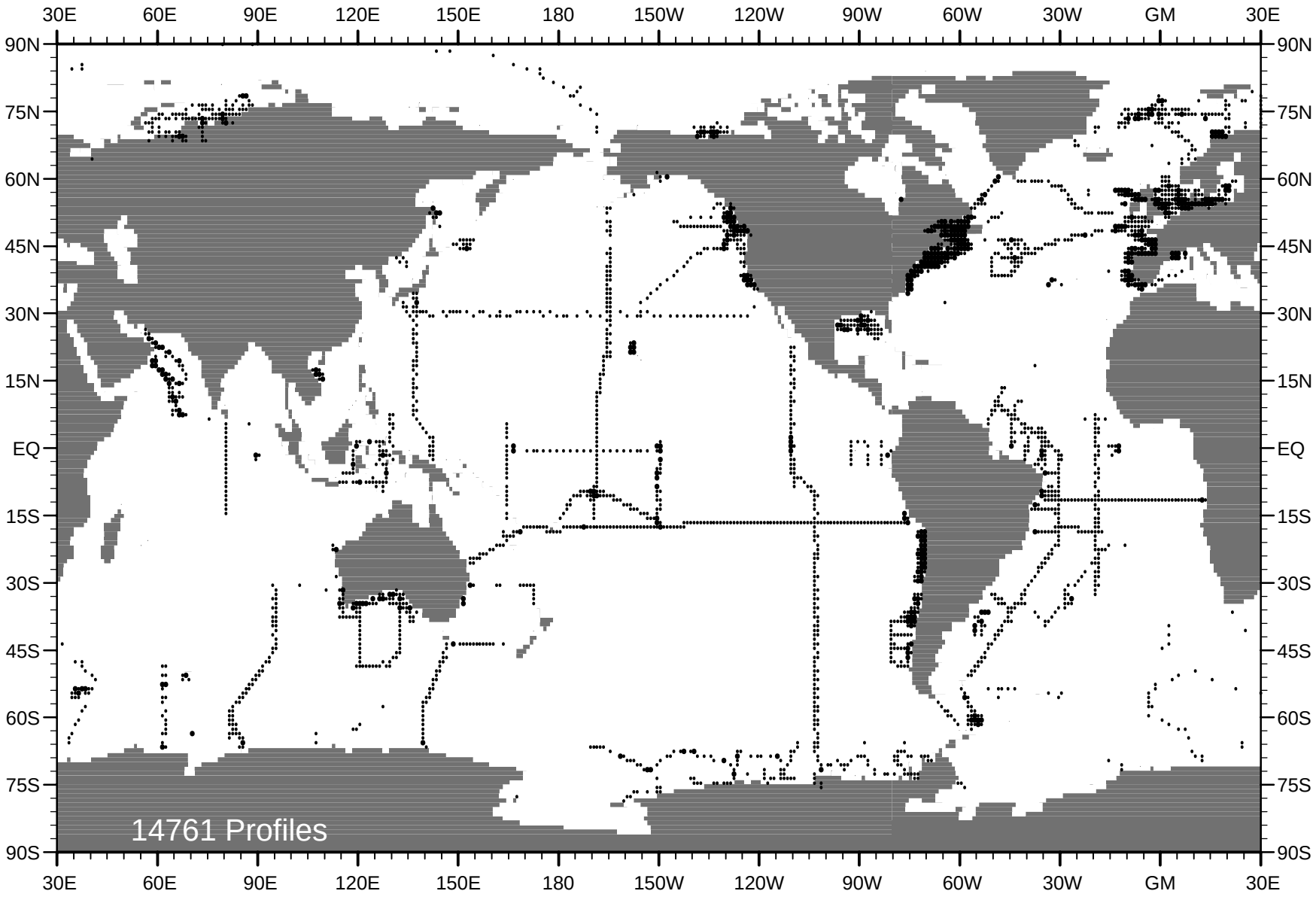

Fig. A28 WOD01 CTD cast distribution for year 1994 .

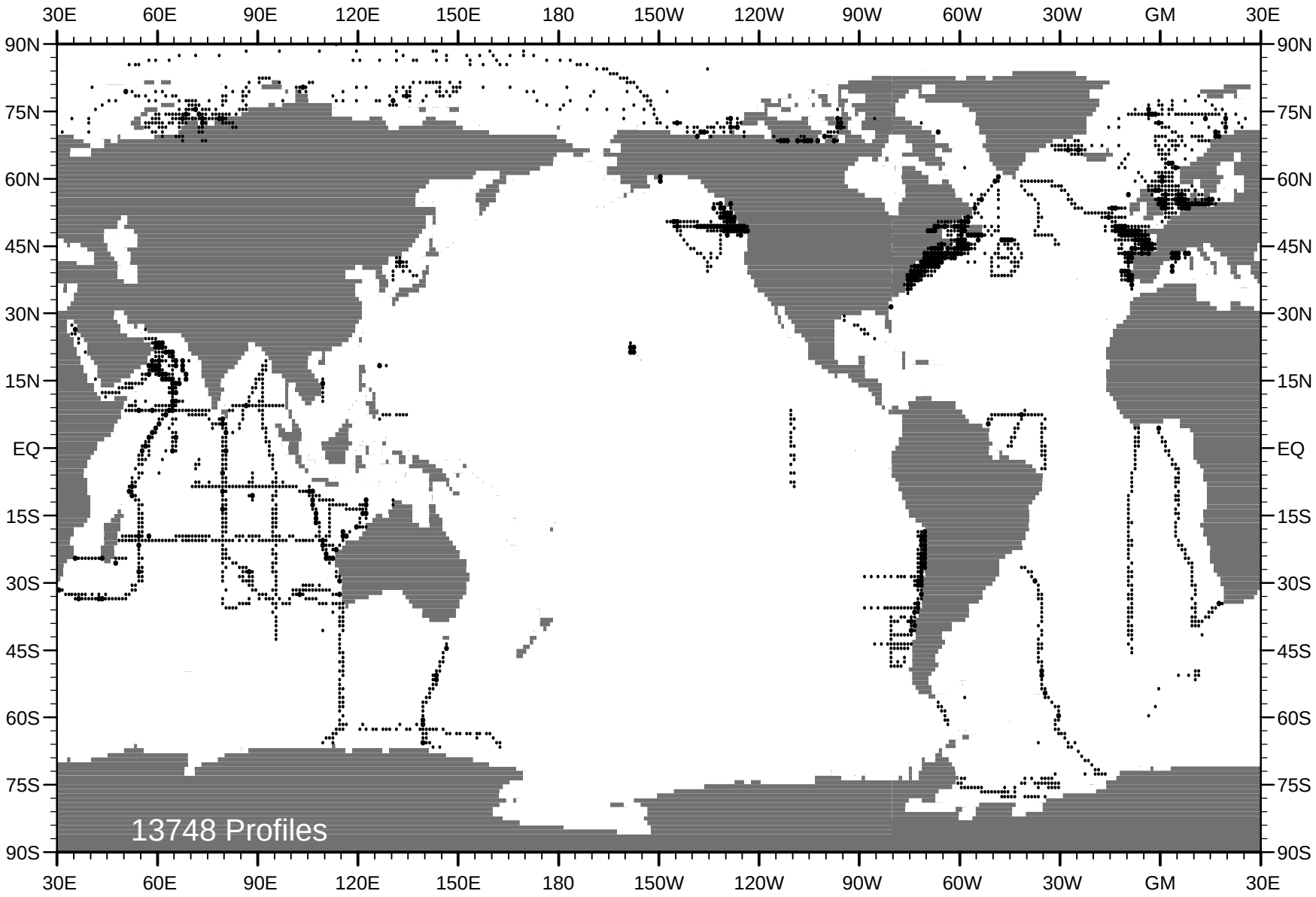

Fig. A29 WOD01 CTD cast distribution for year 1995 .

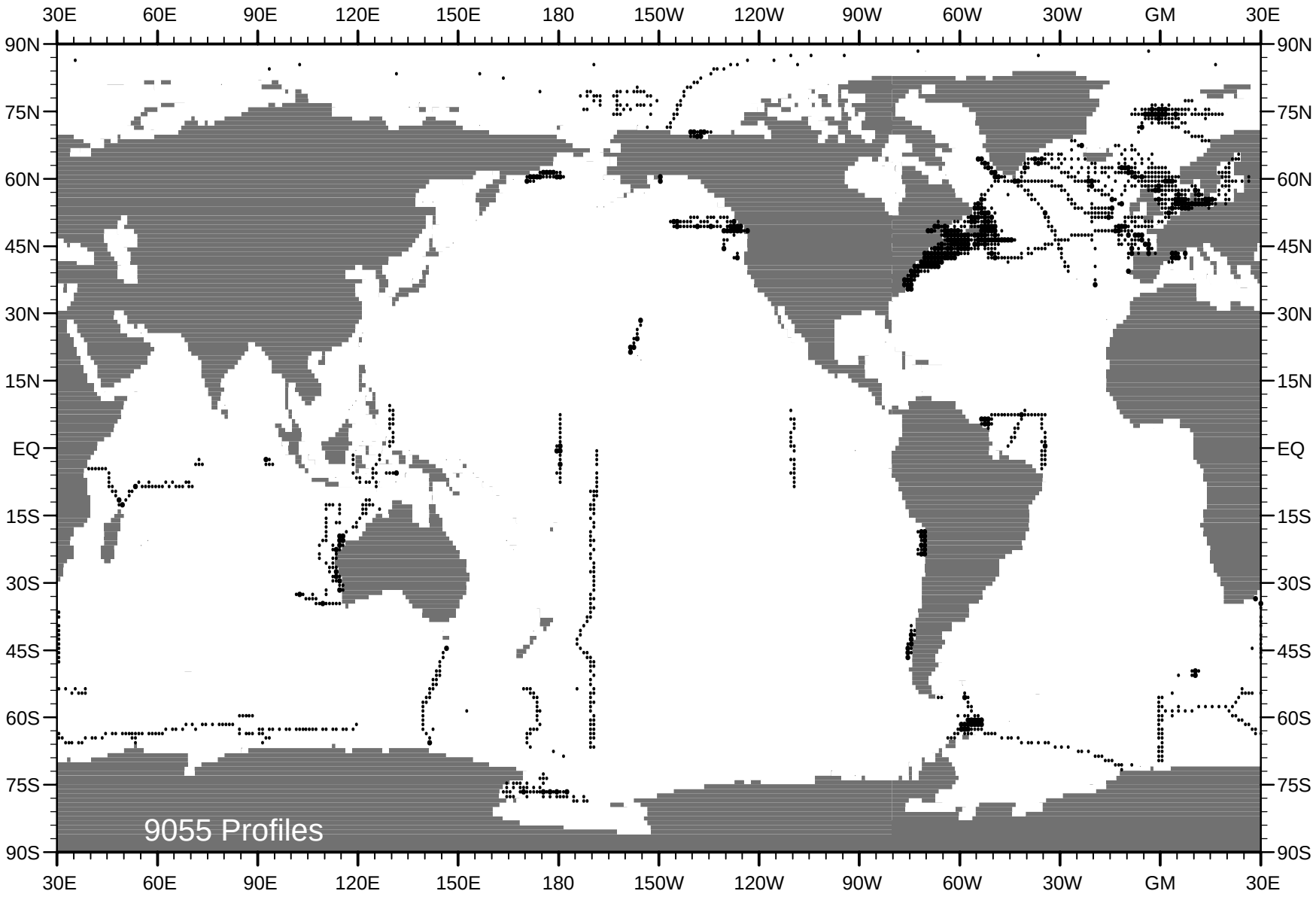

Fig. A30 WOD01 CTD cast distribution for year 1996 .

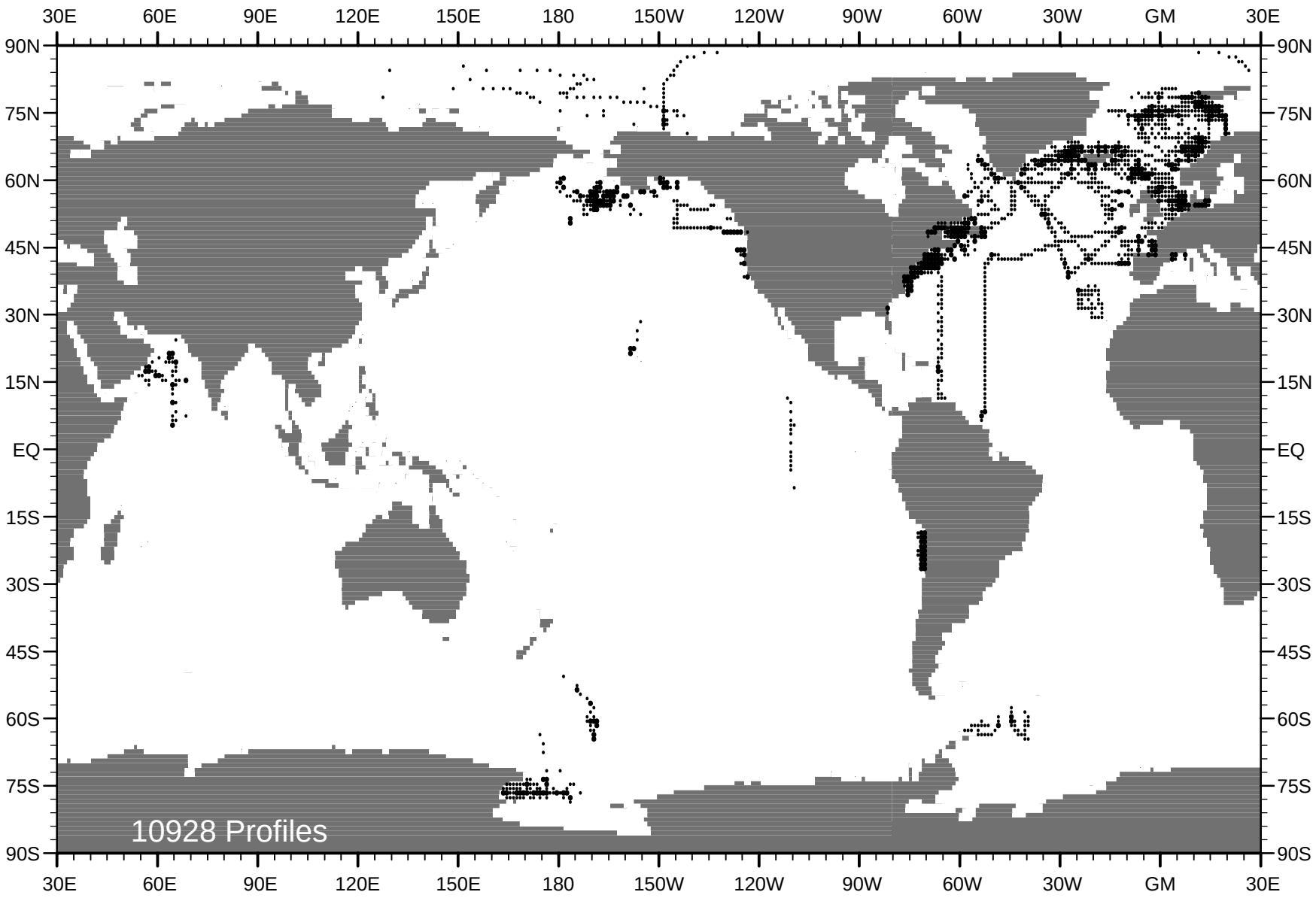

Fig. A31 WOD01 CTD cast distribution for year 1997 .

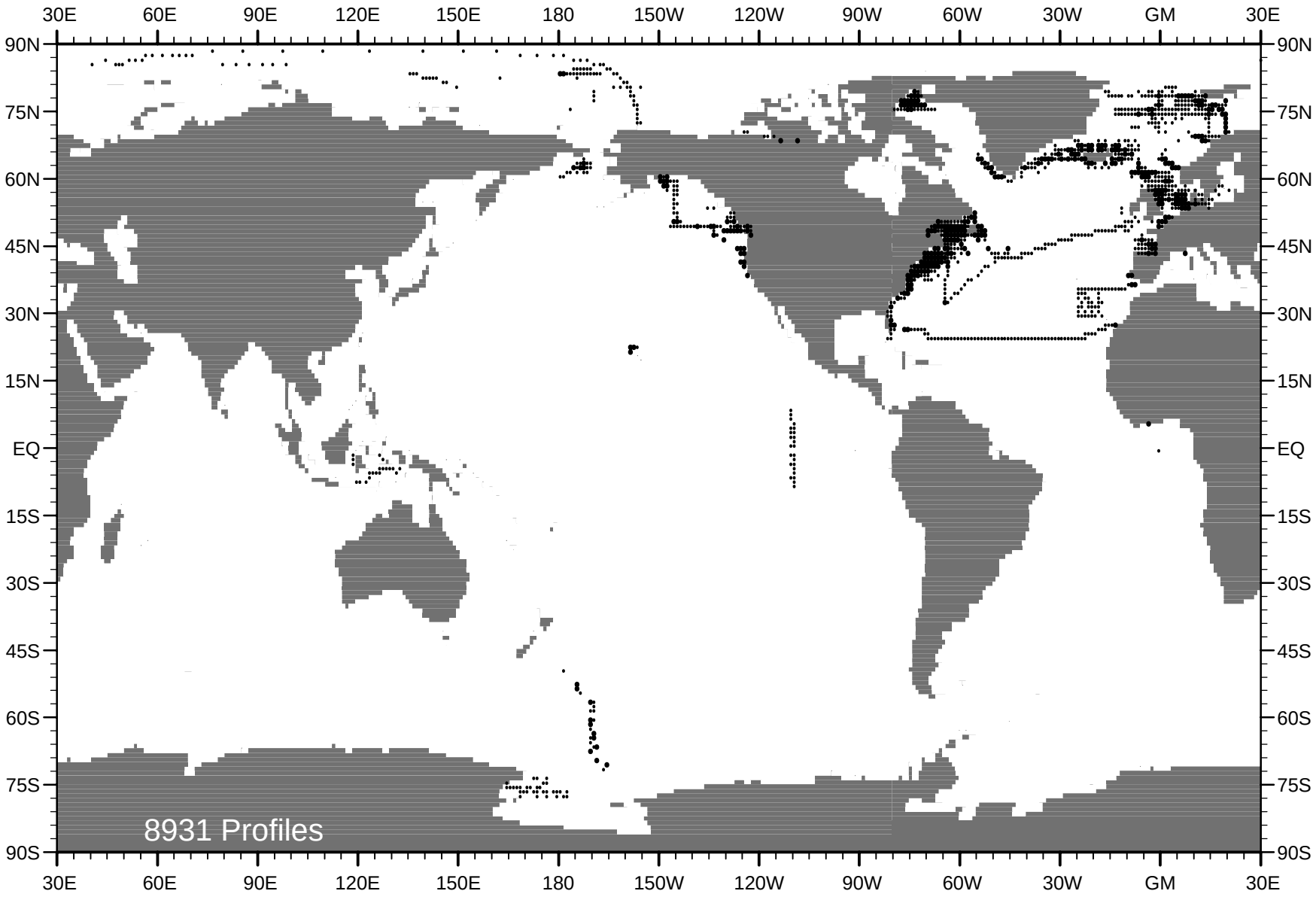

Fig. A32 WOD01 CTD cast distribution for year 1998 .

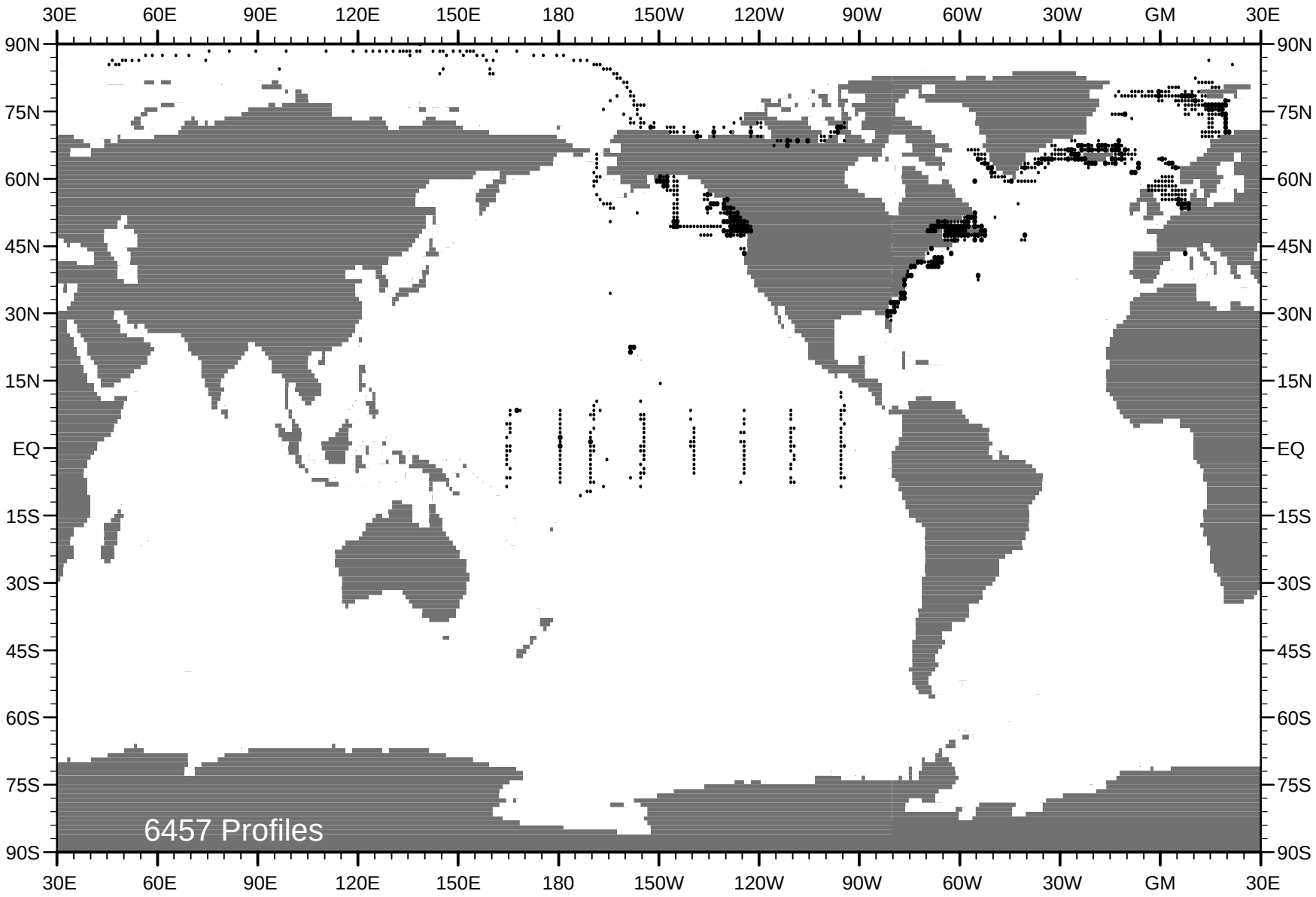

Fig. A33 WOD01 CTD cast distribution for year 1999 .

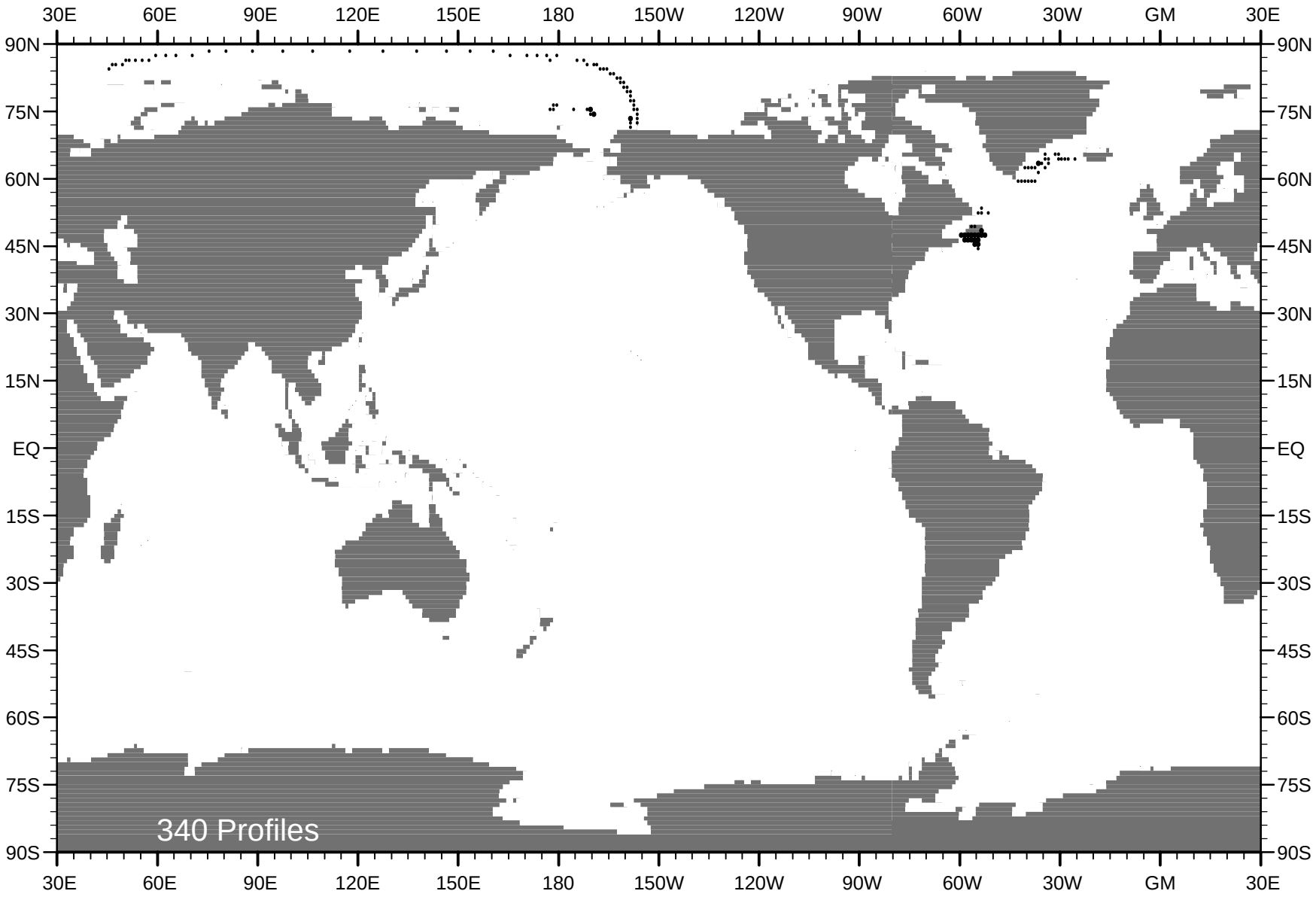

Fig. A34 WOD01 CTD cast distribution for year 2000 .

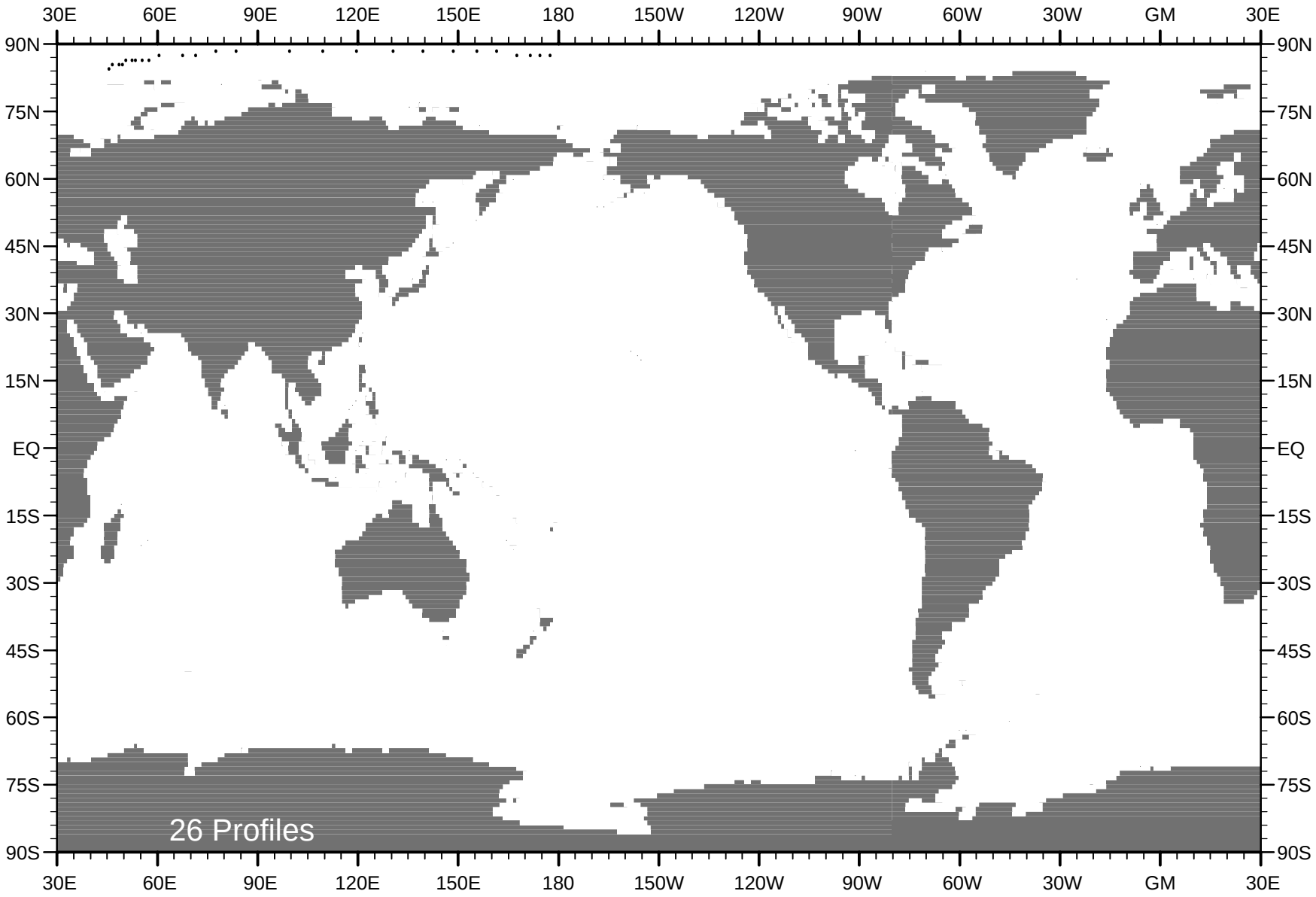

Fig. A35 WOD01 CTD cast distribution for year 2001 .