WORLD WAR II (1939-1945) OCEANOGRAPHIC OBSERVATIONS

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ABSTRACT

We document the geographical and temporal distributions of oceanographic vertical profile observations made during World War II (1939-1945) that are included in the "World Ocean Database" (WOD). The WOD is a product of the NOAA/National Oceanographic Data Center, USA and its co-located ICSU World Data Center for Oceanography. The WOD is the largest collection of ocean profile data available internationally without restriction. All data shown in this paper are available online without restriction and at no cost. The WOD is built upon the international exchange of oceanographic data with contributions of data received from many countries. Most of the data shown in this paper and the data within the WOD in which these data reside in a uniform format were gathered under the auspices of the International Oceanographic Data and Information Exchange (IODE) committee of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the ICSU (International Council of Science) World Data Center system, which is now part of the ICSU World Data System. The WOD contains 112,714 ocean station data casts and 45,003 mechanical bathythermograph profiles for 1939-1945

Keywords: World War II, WWII, Ocean, Data, Observations, Oceanography, Oceanology, World Ocean Database, WOD, Global Oceanographic Data Archaeology project, GODAR, Intergovernmental Oceanographic Commission, IOC, International Oceanographic Data and Information Exchange committee, IODE, National Oceanographic Data Center, NODC, ICSU, World Data Center, (WDC)

1 INTRODUCTION

We document oceanographic observations made during World War II (WWII) that are contained in the *World Ocean Database* (WOD) (Boyer et al., 2009). The WOD is a product of the National Oceanographic Data Center (NODC), USA and its co-located World Data Center for Oceanography-Silver Spring (WDC). The WOD is the world's largest collection of ocean vertical profile data available internationally without restriction. The comprehensiveness of the WOD results from the international exchange of data among many countries. This exchange has occurred under the sponsorship of two international organizations. The first is the Intergovernmental Oceanographic Commission (IOC), which sponsors the international exchange of oceanographic data under its International Data and Information Exchange (IODE) committee. The second is the World Data Centers for Oceanography, part of the International Council of Science (ICSU), an organization of non-governmental scientific unions.

Many oceanographic observations were made during World War II (WWII) in support of antisubmarine warfare. Many of these measurements were upper ocean vertical temperature profiles made mainly by ships of the United States (US) using mechanical bathythermograph (MBT) instruments. The related measurement distributions show an increase in geographical coverage as WWII progressed. The Union of Soviet Socialist Republics (USSR) made oceanographic observations in the western Pacific Ocean and the Caspian and White seas during WWII. In the White Sea, measurements were possibly made in support of ice forecasting for convoys sailing for Soviet ports in this region although we have not verified this speculation. Germany made oceanographic measurements in the fjords of Norway during WWII. Japan continued a very active ocean measurement program that began in the early twentieth century and continued through the early years of WWII but was severely decreased in scope as WWII progressed. All data shown in this paper are available as part of the WOD. The United States NODC and its co-located WDC for Oceanography have constructed and maintain global oceanographic databases, the contents of which are available internationally without restriction (www.nodc.noaa.gov). Some of the data described in this paper (from Japan and Germany) were acquired at the end of WWII by the Armed Forces of the United States. Some of the data described in this paper have been recovered as part of the Global Oceanographic Data Archaeology and Rescue (GODAR) project of the Intergovernmental Oceanographic Commission (IOC) (Levitus, 2012).

The near surface measurements of sea surface temperature that are part of the vertical profiles shown in this paper have become, or will become, part of the International Comprehensive Ocean-Atmosphere Data Sets (ICOADS) (Woodruff et al., 2011)

We are not historians. Our descriptions of WWII oceanographic vertical profile data observations are solely based on the data that exist at NODC/WDC, Silver Spring. We believe that additional data for this period exist, but these data have yet to be discovered, digitized, and made available.

In this paper we define a vertical "profile" as a set of measurements for a single variable (temperature, salinity, etc.) at discrete vertical depths taken as an instrument deploys downward or rises vertically in the water column. We define a "cast" as a set of one or more profiles measured concurrently or nearly concurrently. Data from Mechanical Bathythermograph (MBT) instruments only measure temperature as a function of depth. During the time period encompassed by the location of data shown in this paper, vertical temperature profile data from Ocean Station Data (OSD) casts represent temperature observations (made with reversing thermometers) and often salinity (measured from sea water samples gathered in sampling bottles known as "Nansen Bottles"). Sometimes other variables such as nutrients were measured from the water samples returned with the Nansen bottles.

We and others have endeavored to build the WOD and to minimize the number of errors in the data and metadata that comprise the WOD. However, it should be recognized that a small percentage of data shown here may have misreported metadata including positions, dates, and country of origin, among others.

In this paper we display the distributions of data in either of two formats. One format is a geographical scatter plot with the location of each individual profile or cast plotted at the latitude and longitude. The other format we refer to as "data density" plots. In this format we plot the number of profiles or casts that occur in each one-degree square as a colored dot in each one-degree square that contains data. The number of profiles/casts in each one-degree square is provided on each figure by a color table.

2 UNITED STATES OF AMERICA MECHANICAL BATHYTHERMOGRAPH PROFILES

The mechanical bathythermograph (MBT) was developed during the 1930s (Rossby & Montgomery, 1934; Spilhaus, 1938, 1987; Emery & Thomson, 1997; Locarnini et al., 2012). The MBT was an instrument used to measure vertical profiles of temperature of the upper ocean. Early versions of the US MBT reached observed depths of 60 or 140 meters (Pickard & Emery, 1990). The United States (US) MBT instrument could reach maximum depths of approximately 295 m before it was replaced by the expendable bathythermograph instrument around 1966.

Figure 1 shows the distribution of all United States (US) MBT temperature profiles for 1941-1945. Figures 2-7 show the distribution of US MBT profiles measured by US Navy ships using MBT instruments for the years 1940-1945. Inspection of these figures shows the increased use of the MBT as WWII progresses. This coincides with the

advancement of US forces as WWII progressed. For example, there are 9,952 individual MBT profiles for 1941 compared to 40,980 profiles for 1945. The US did not enter WWII until December, 1941. MBT data distribution for this year shows that the MBT instrument was being used mainly in the North Atlantic Ocean during 1941, with a smaller number of cruises deploying MBTs between the west coast of the United States and Hawaii. Several observations were made west of Hawaii, including some from December 7, 1941. These were made by US Navy ships, presumably on "picket" duty.

3 UNITED STATES OF AMERICA OCEAN STATION DATA CASTS

Figure 8 shows the distribution of all US Ocean Station Data (OSD) casts during 1939-1945. Figures 9-13 show the distribution of US OSD casts for 1939, 1940, 1941, 1942, and 1945. There are no US OSD casts for 1943 and 1944 in the World Ocean Database as of the date of this publication.

4 UNION OF SOVIET SOCIALIST REPUBLICS OCEAN STATION DATA CASTS

Figure 14 shows the distribution of all Union of Soviet Socialist Republics (USSR) OSD casts for the period 1939-1945. Figures 14-21 show the yearly distributions of Ocean Station Data (OSD) casts (Garcia et al. 2012) made by the USSR.

Observations made in the White Sea may have been made for the purpose of ice-forecasting. Ports in this region (e.g., Archangel) were the termini of convoys from the United States to the Soviet Union and the presence of sea ice would have been of concern for ship routing.

5 UNION OF SOVIET SOCIALIST REPUBLICS MECHANICAL BATHYTHERMOGRAPH PROFILES

Figure 22 shows the distribution of all USSR MBT temperature profiles for 1939-43. Figures 23-27 show the distribution of USSR MBT profiles for 1939-1943. The WOD does not contain any USSR MBT profiles from 1944-1945. We do not know if an MBT instrument was developed in the USSR independent of the US MBT instrument, or whether MBT instruments were provided to the USSR by the US.

6 JAPAN OCEAN STATION DATA CASTS

Figure 28 shows the distribution of all Japan Data (OSD) casts during 1941-1945. Figures 29-33 show the distribution of Japan OSD casts for 1939-1943. Modern hydrographic surveys in Japan were initiated in the late 19th century by predecessors of the present Japan Coast Guard (formerly Hydrographic Department), the Japan Meteorological Agency, and the Japan Fisheries Agency. The scale of such surveys expanded in the 1920s and reached its maximum in 1941-1942 as shown in the plots. The first large-scale survey in the tropical Pacific seems to have been made in 1938, and a number of ships (including vessels and catcher boats) were commandeered by the Japanese Imperial Navy for such purposes during WWII.

7 GERMAN OCEAN STATION DATA CASTS

Prior to WWII, Germany made a considerable number of OSD casts that were near-global in coverage (Defant, 1981; Wust, 1964, 1978). Figures 34-39 show German OSD cast locations for the years 1939-1945, except for 1943. WOD contains no German OSD casts for 1943. As shown by figures 34-40, German oceanographic measurements during WWII were mainly limited to the fjords of Norway.

8 GREAT BRITAIN OCEAN STATION DATA CASTS

Figure 41 shows the distribution of OSD casts made by Great Britain during 1939. The WOD contains no data from Great Britain for 1940-1945.

9 CANADIAN OCEAN STATION DATA CASTS

Figure 42 shows the distribution of OSD casts made by Canada during 1939-1945. Figures 43-49 show OSD cast locations for 1939-1945. OSD measurements were located in the near-shore waters of the east and west coasts of Canada. The data gathered near Vancouver Island consist of measurements of temperature, salinity, and oxygen in 1939 (17 casts) and 1941 (217 casts). The measurements appear to be on land but this is not the case. This is simply due to the coarseness of the land-sea distribution used in making these maps.

10 CANADIAN OCEAN MECHANICAL BATHYTHERMOGRAPH PROFILES

Figure 50 shows the distribution of Canadian ocean mechanical bathythermograph (MBT) profiles for 1940-1945. Figures 51-56 show the distribution of Canadian MBT profiles for individual years during 1940-1945. There are no MBT profiles from Canada in WOD for 1939.

11 AUSTRALIAN OCEAN STATIONS DATA CASTS

Figure 59 shows the distribution of Australian ocean OSD casts for 1939-1945. The majority of these data were collected by a fisheries research vessel as part of a biannual series of oceanographic cruises along the east Australian coastline. The cruises included extensive physical oceanographic measurements and plankton observations. In total, 366 stations from fourteen sections were sampled from 1939 up to July 1942. The research vessel was subsequently transferred to the Royal Australian Navy for war service (CSIRO, 1951a). Figures 60-63 show data distributions for individual years 1939 to 1942. With the withdrawal of the research vessel, a series of onshore coastal stations was established along the eastern Australian coast (CSIRO, 1951b). Figures 64-66 shows the distribution of these coastal stations for 1944-1945.

12 AUSTRALIAN OCEAN MECHANICAL BATHYTHERMOGRAPH PROFILES

Figure 67 shows the distribution of Australian ocean MBT profiles for 1944, the only year that the WOD contains any Australian MBT profiles. These data were collected by a Royal Australian Navy frigate operating in the Coral Sea and the Pacific Ocean between New Guinea and the Philippines. The MBT was fitted in 1943 and obtained from United States Naval authorities (Report of Proceedings HMAS Gascoyne, 1944).

13 DISCUSSION

Historical oceanographic data play an important role in documenting past states of the world ocean and will lead to improved estimates of the evolution of the state of the world ocean (Carton & Giese, 2008; Balmaseda et al., 2008)). Although the WWII data we describe here are limited in geographical coverage, these data still add to our knowledge of the variability of the world ocean. The surface components of the profiles described here can be merged with other surface marine observations from WWII (e.g., Woodruff et al., 2011) to improve knowledge of the variability of ocean surface conditions during WWII.

14 DATA AVAILABILITY AND ACCESS

As part of its commitment to the scientists, institutions, and countries that have made these oceanographic data available, the Global Oceanographic Data Archaeology and Rescue (GODAR) project (Levitus, 2012) through NODC/WDC has made all data available on CD-ROM and DVD media as well as on-line via the Internet from the NODC/WDC website (www.nodc.noaa.gov). Beginning with *World Ocean Database 1998*, all data have been made available on-line. In addition the Ocean Data View software is freely available to use (http://odv.awi.de/).

The most recent version of the World Ocean Database is the *World Ocean Database 2009* (WOD09) (Boyer et al., 2009) although the *World Ocean Database 2013* is nearly completed at the time of the writing of this paper. The online version of the *World Ocean Database* is updated every three months with more recently acquired and processed data and corrections made for data and metadata found to have been in error. We actively seek out guidance from scientists and data managers regarding possible problems with the data and metadata in the WOD. Conversely, we inform data originators of such problems when we encounter them. Each data profile in the WOD is identified by a unique identification number to make communication with colleagues easier.

The *World Ocean Database* products come with software conversion routines so that users of software packages, databases, and programming languages such as MATLAB, IDL, PC-Surfer, C, and FORTRAN, can access the data. In response to user requests, we have defined the WOD format to be as 'self-defining' as possible so as to eliminate, or at least minimize, the need for any structural changes to the format when new data types are added. All code tables, documentation, and software containing metadata are available on-line as well as on the CD-ROMs, which are used to distribute the WOD series. When a new database is released (every 3-4 years) users can acquire the new database or simply acquire data for those ocean stations that have been added or modified since the previous release. In addition, as corrections are made to the database after a release of WOD, users can acquire any modified data several days after the end of every month. There are a "Help Desk" and "Frequently Asked Questions" for the databases available online.

Selection software (WODselect) (developed by Mr. Tim Boyer, Ms. Olga Baranova, and Dr. Hernan Garcia) allows users to access data by specifying geographic area, observation dates, instrument type, measured variables, deepest measurement, country, ship/platform, project name, and institute. Data are made available in a Comma-Separated-Values (CSV) format. WODselect supports the goals of the IOC, ICSU WDC, and United States data exchange systems to promote open access to scientific data. Additionally, it supports the United Nations Framework Convention on Climate Change to "promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change".

15 ACKNOWLEDGMENTS

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Figure 1. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1940-1945.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 111,502.

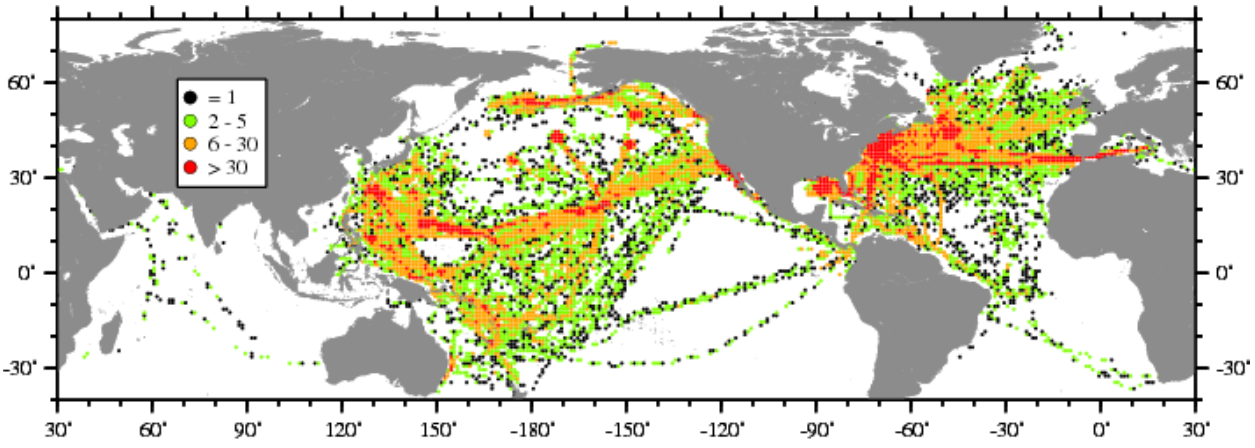


Figure 2. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1940.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 6.

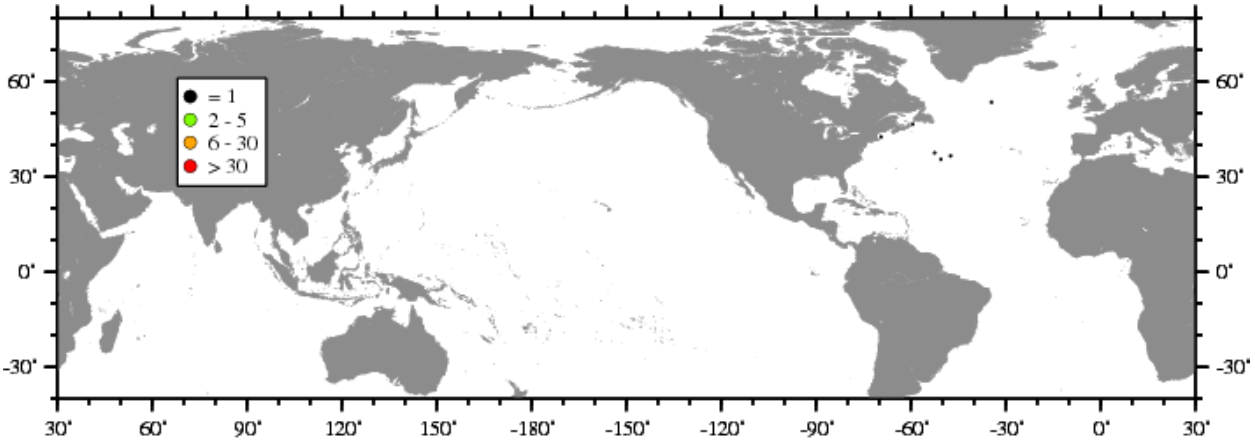


Figure 3. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1941.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 9,952.

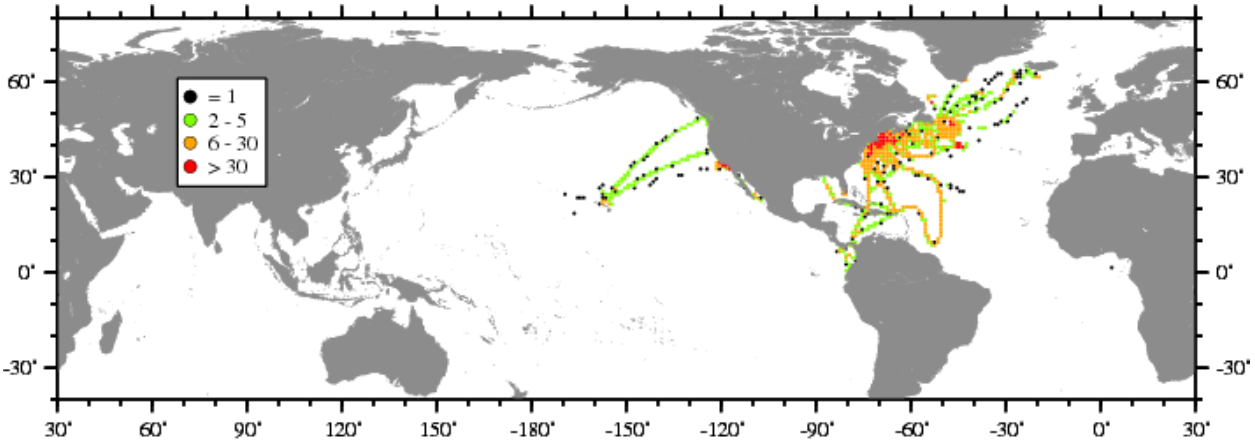


Figure 4. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1942.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 6,885.

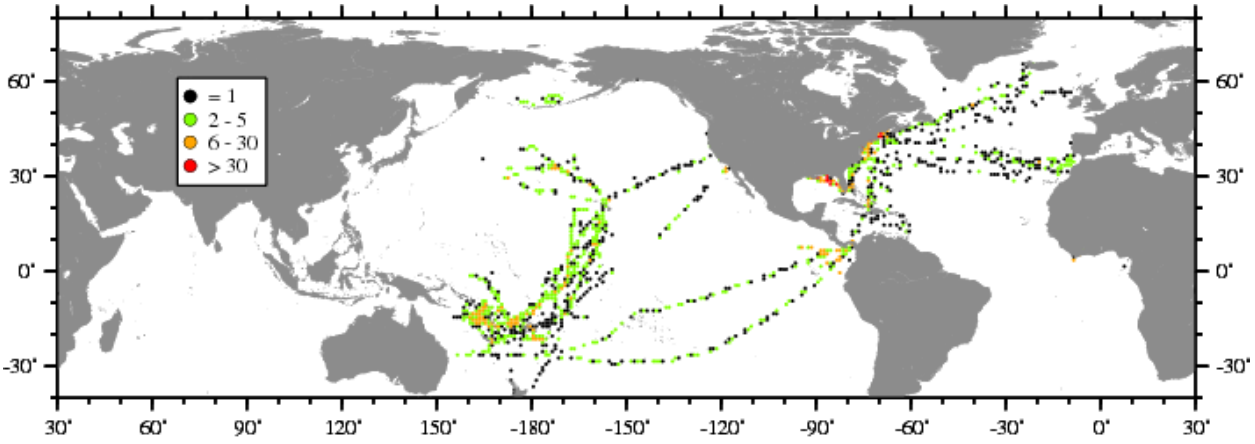


Figure 5. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1943.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 17,229.

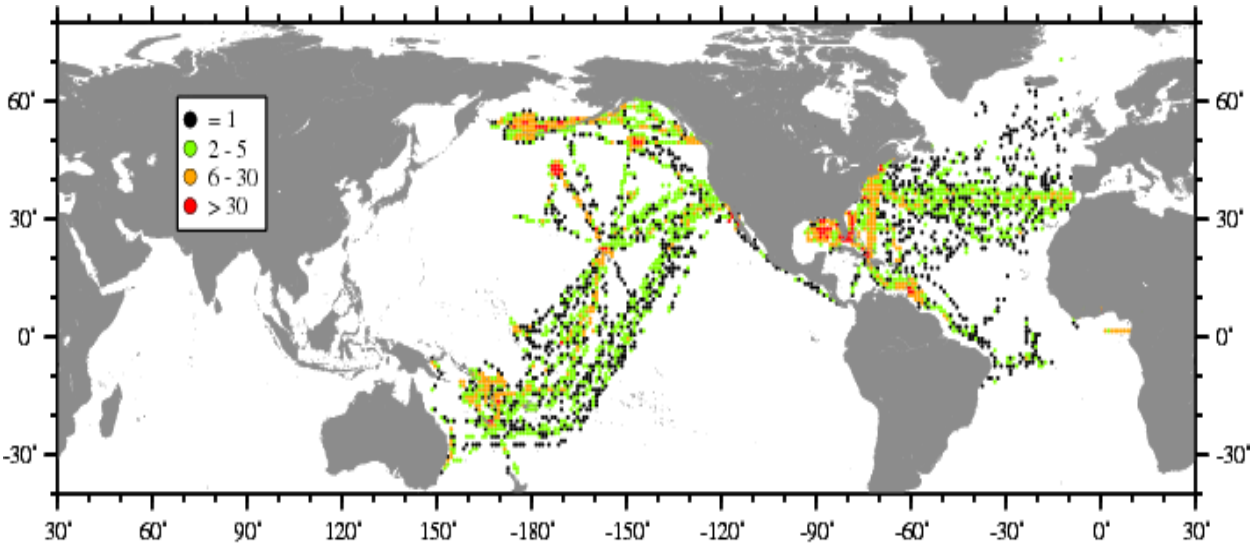


Figure 6. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1944.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 36,450.

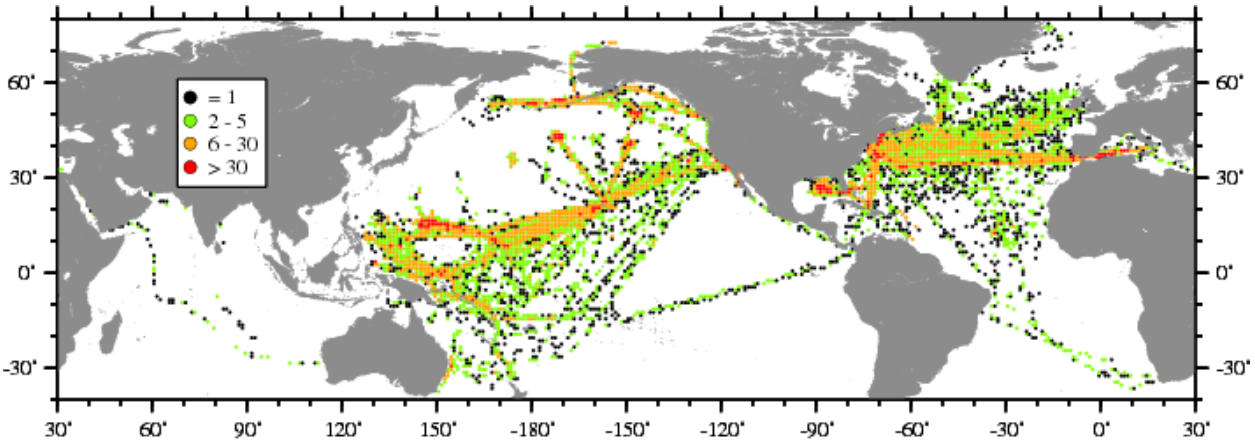


Figure 7. **United States**
Mechanical Bathythermograph (MBT) temperature profiles made during 1945.
Data density of the number of profiles by one-degree squares. See color scale on the figure.
Total number of profiles = 40,980.

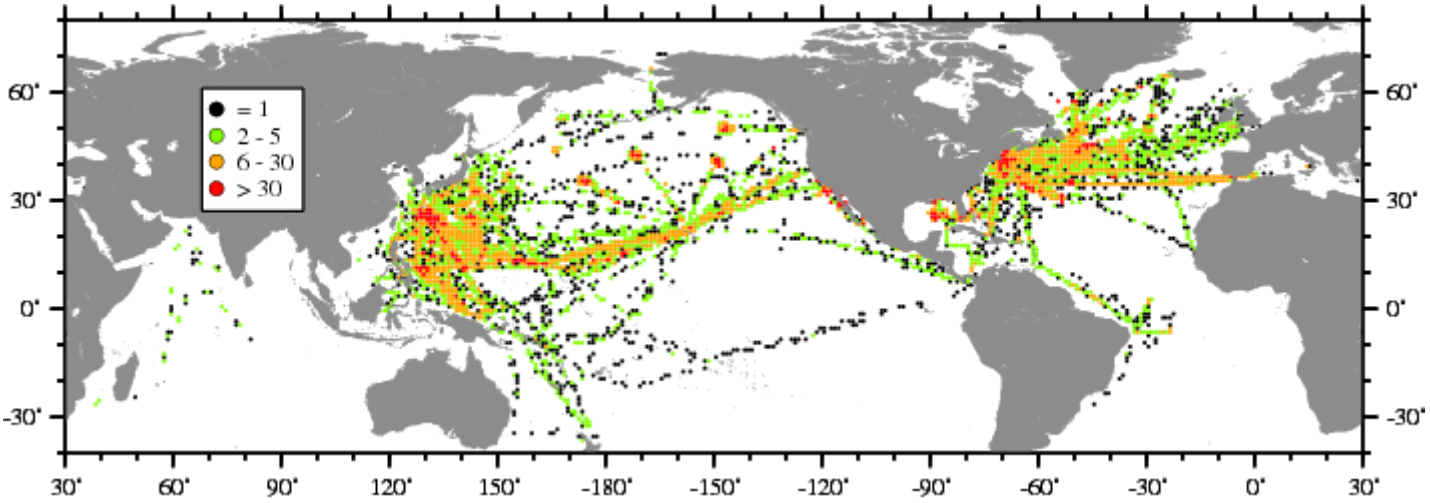


Figure 8. **United States**
Ocean Station Data (OSD) (Bottle) cast locations made during 1939-1945 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts is 3,568.

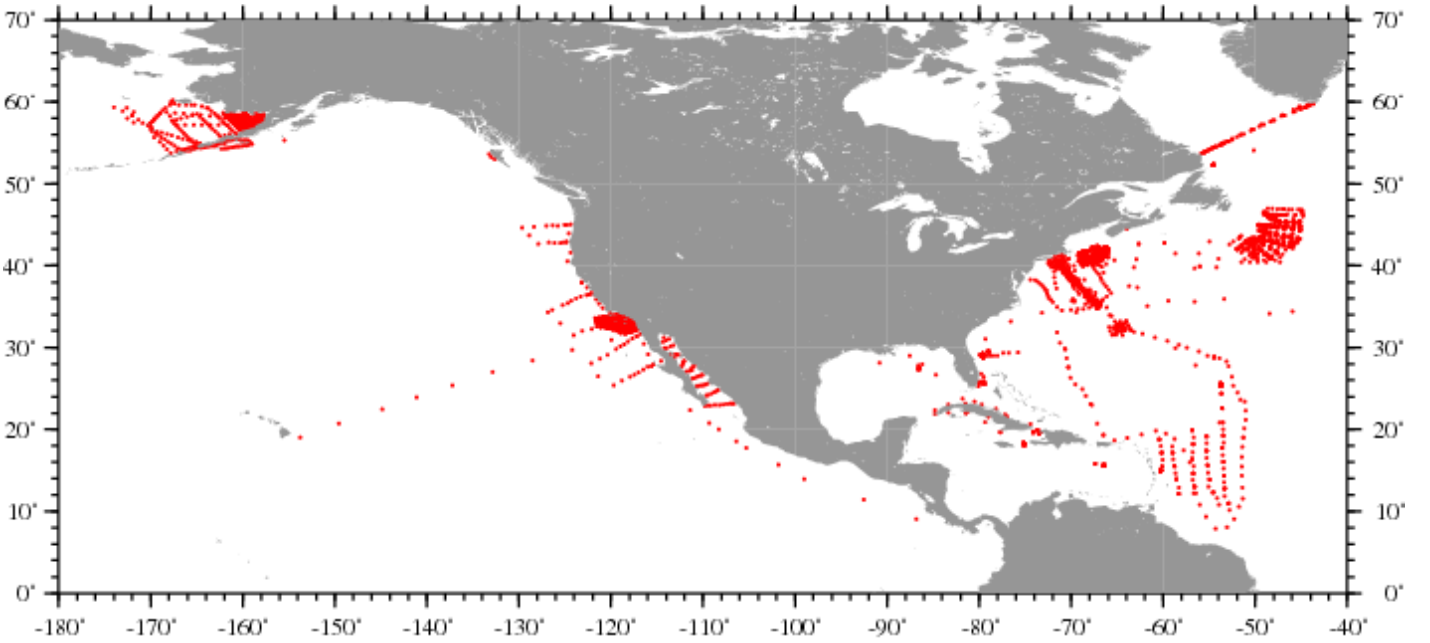


Figure 9. **United States**
Ocean Station Data (OSD) (Bottle) casts made during 1939 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts is 1,493.

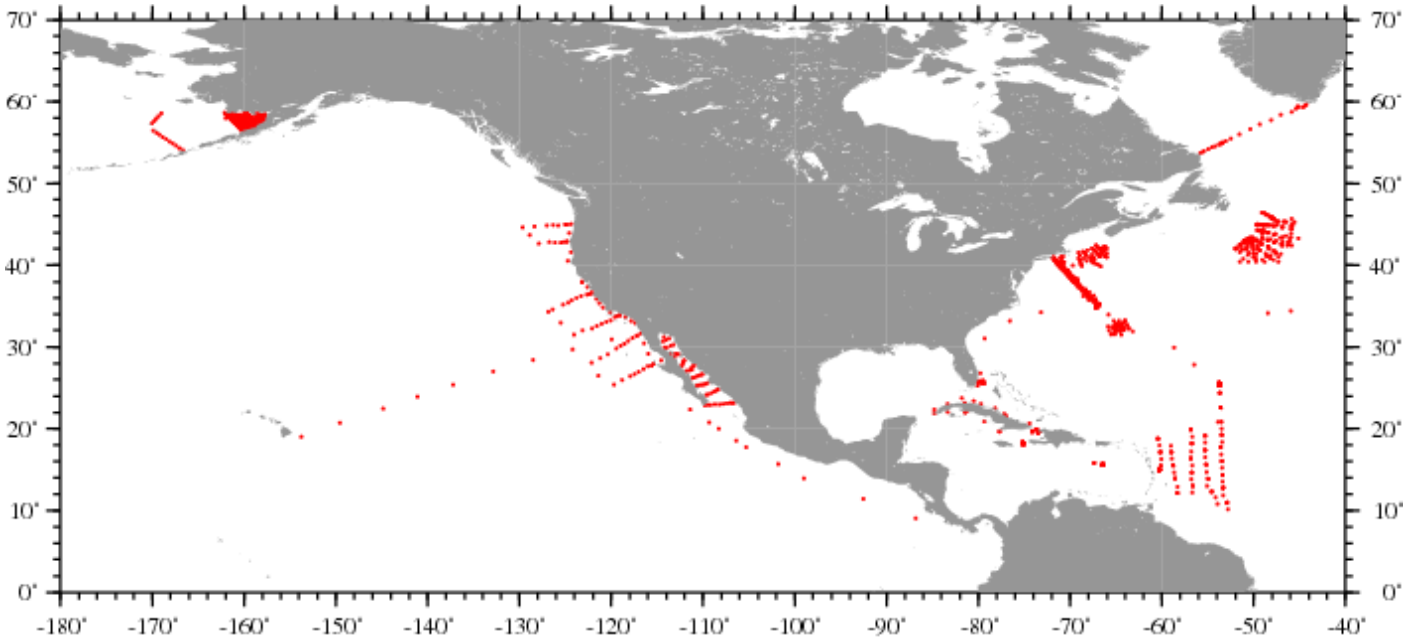


Figure 10. **United States**
Ocean Station Data (OSD) (Bottle) casts made during 1940 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts is 1,128.

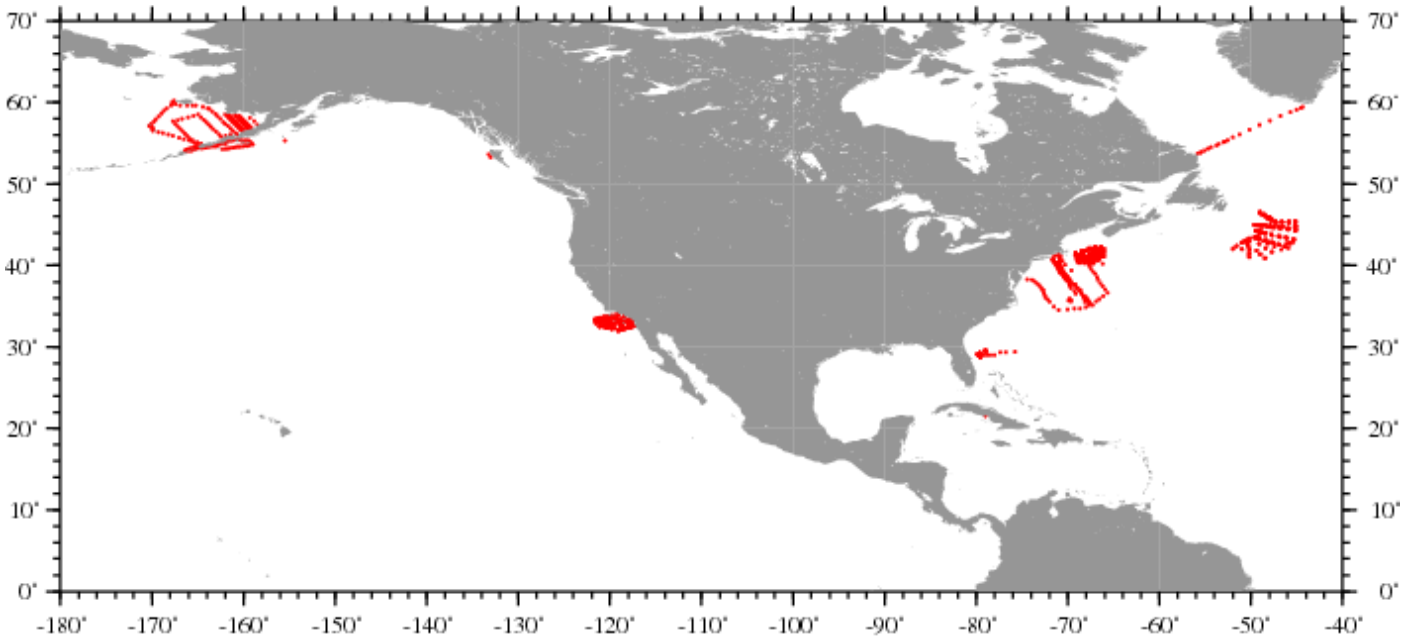


Figure 11. **United States**
Ocean Station Data (OSD) (Bottle) casts made during 1941 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts is 895.

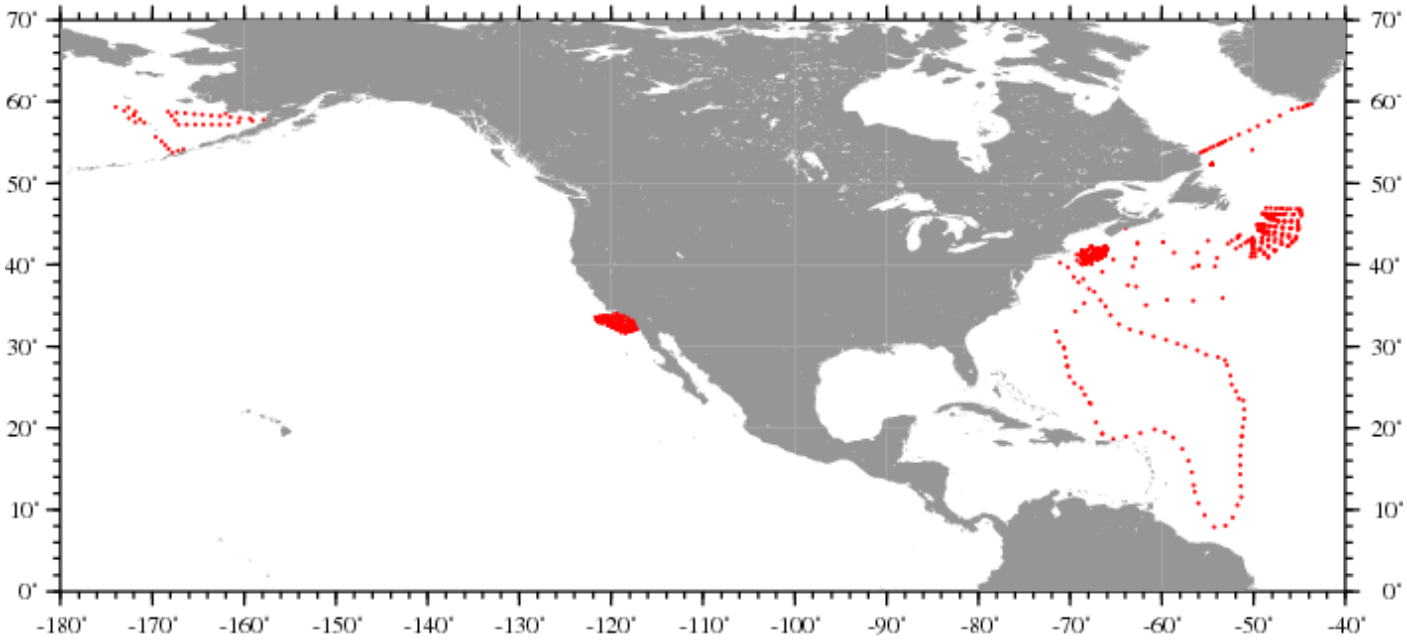


Figure 12. **United States**
Ocean Station Data (OSD) (Bottle) casts made during 1942 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts is 17.

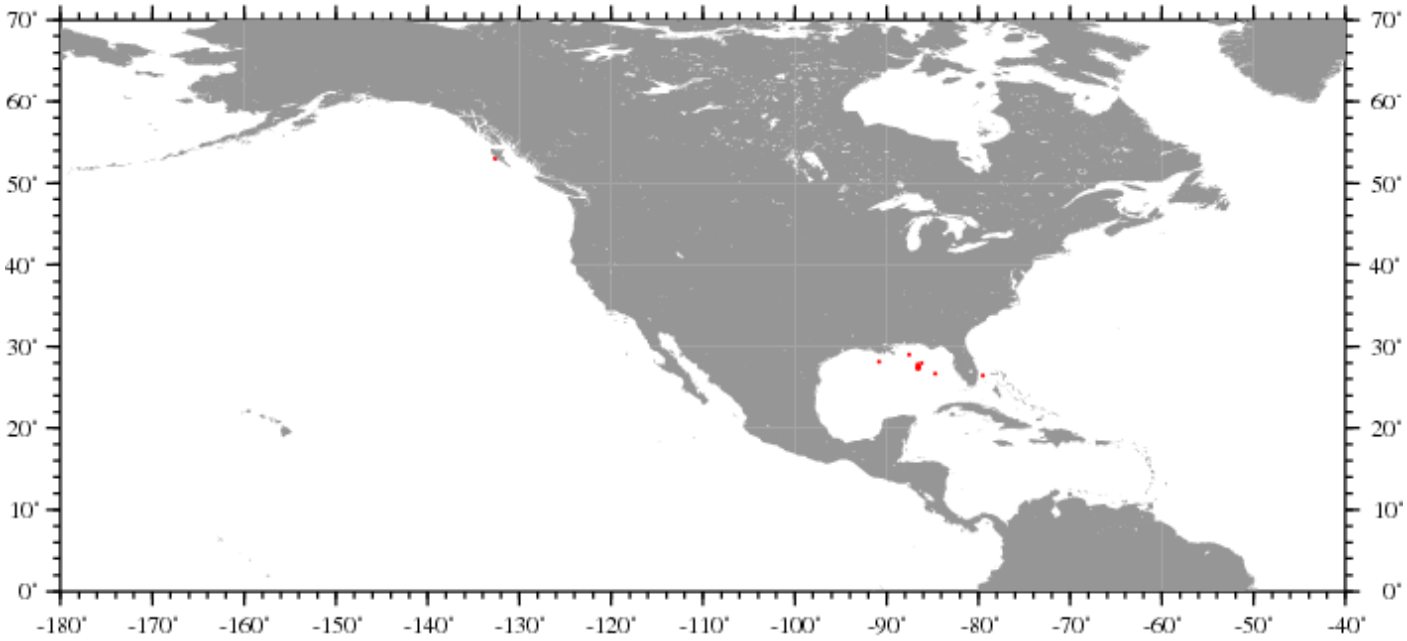


Figure 13. **United States. Ocean Station Data (OSD) (Bottle) casts made during 1945 shown as a scatter plot.**
The location of each cast is signified by a red dot.
Total number of casts is 35.

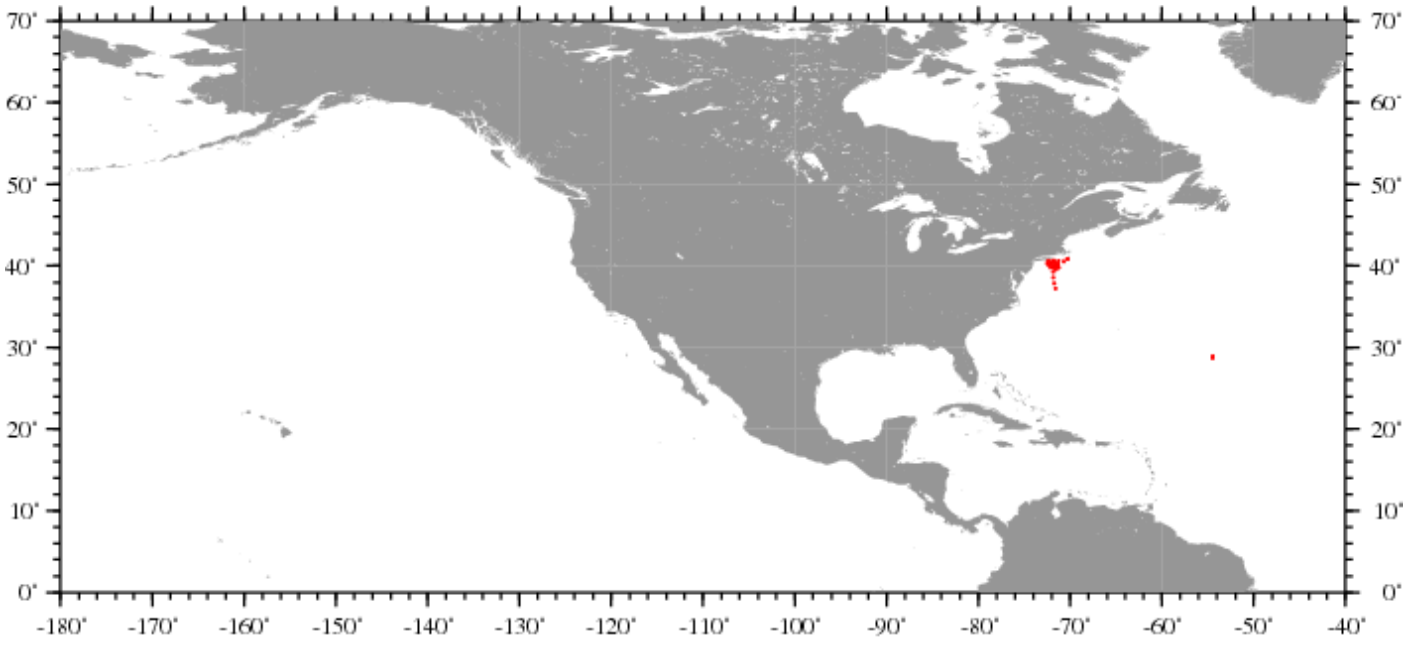


Figure 14. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1939-1945.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 11,091.

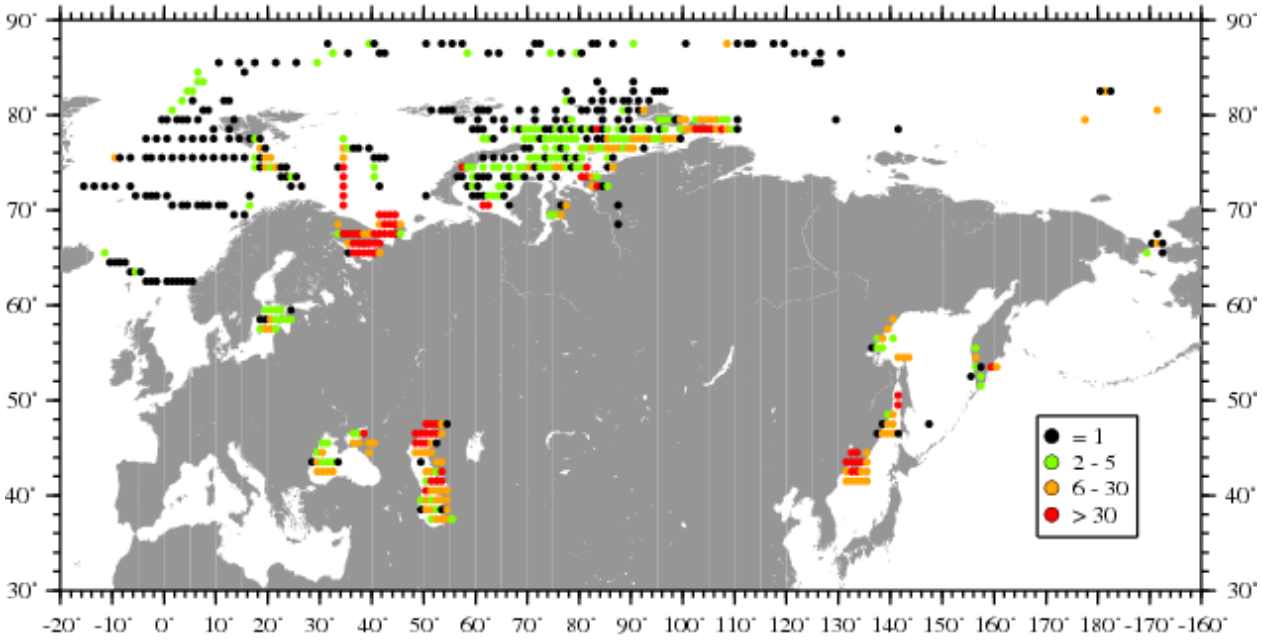


Figure 15. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1939.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1,814.

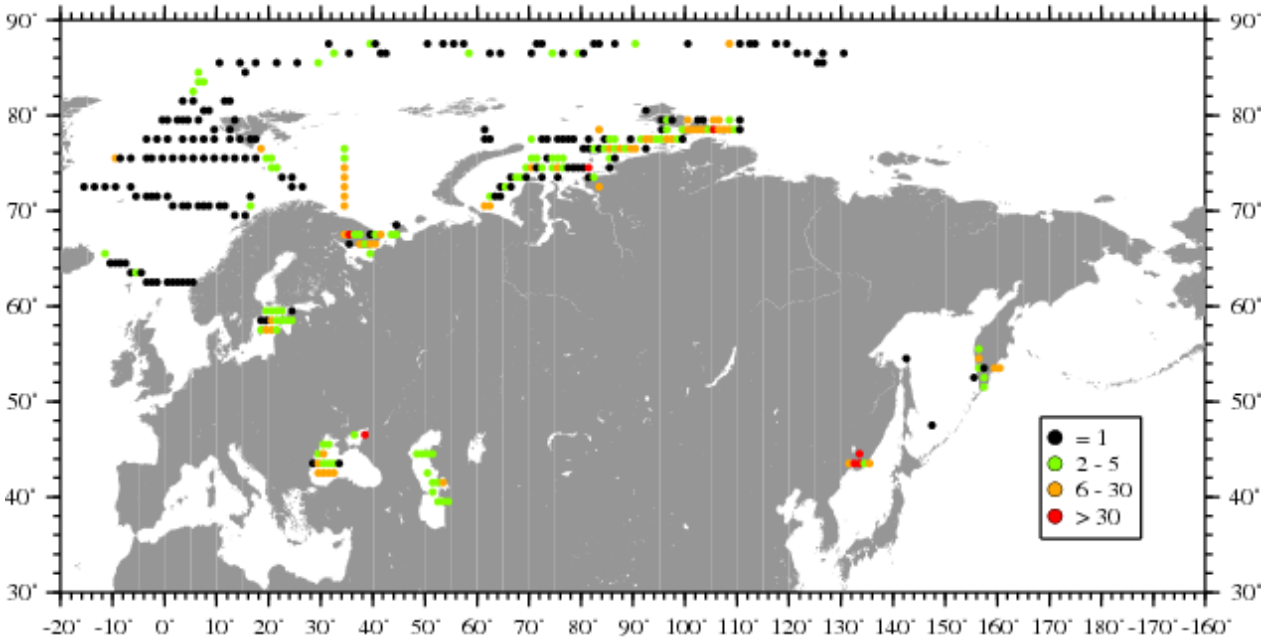


Figure 16. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1940.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 2,596.

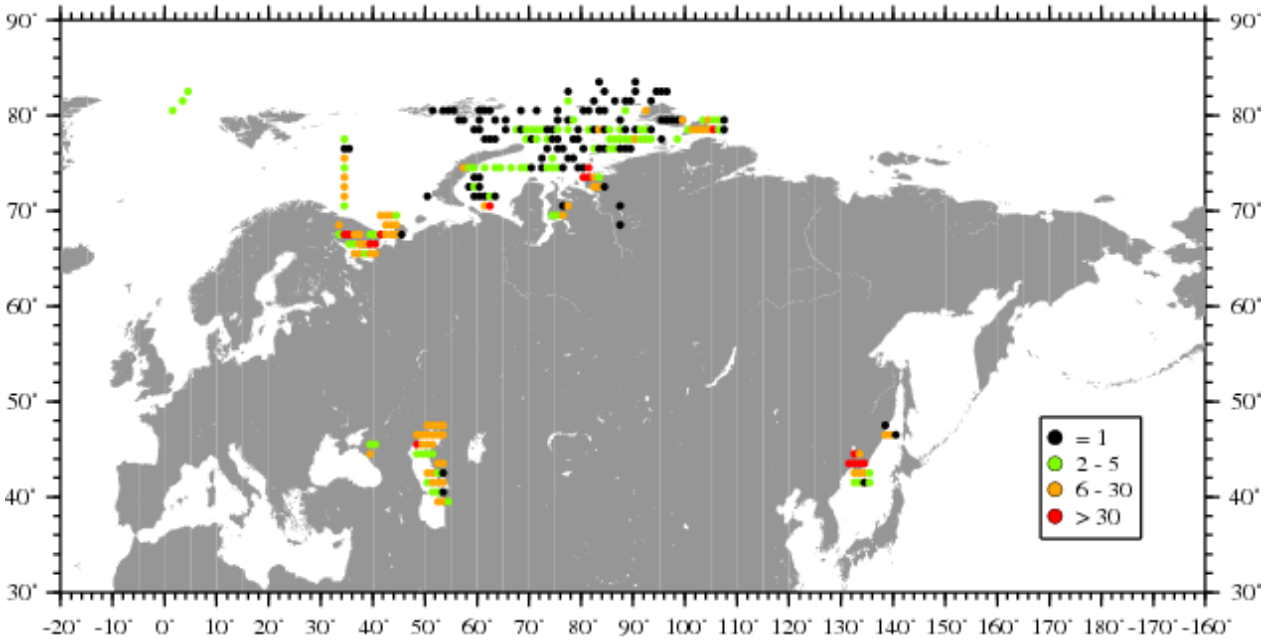


Figure 17. **Union of Soviet Socialist Republics Ocean Station Data (OSD) (Bottle) casts made during 1941.**
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1,473.

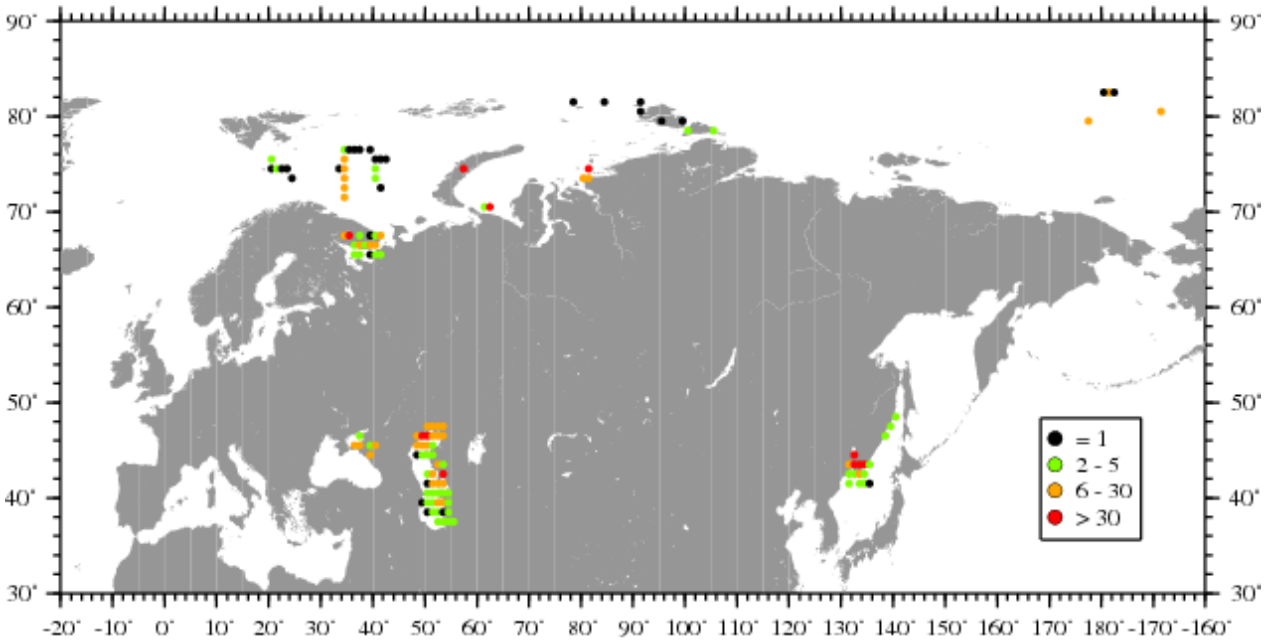


Figure 18. **Union of Soviet Socialist Republics Ocean Station Data (OSD) (Bottle) casts made during 1942.**
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1,895.

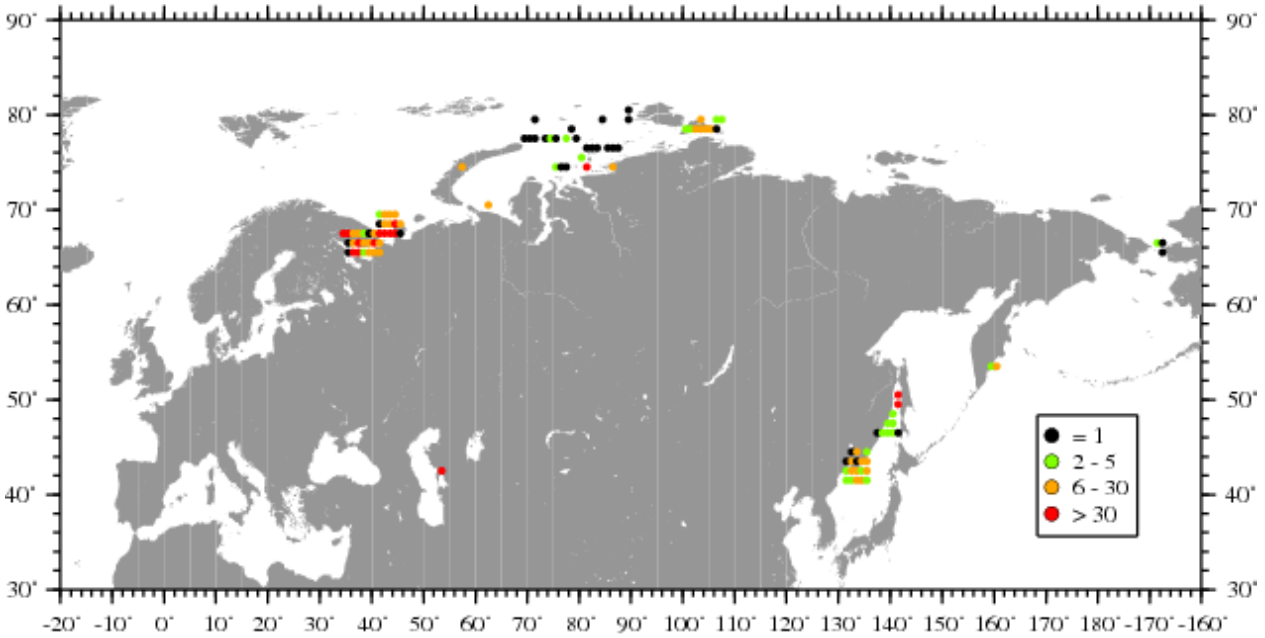


Figure 19. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1943.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1,412.

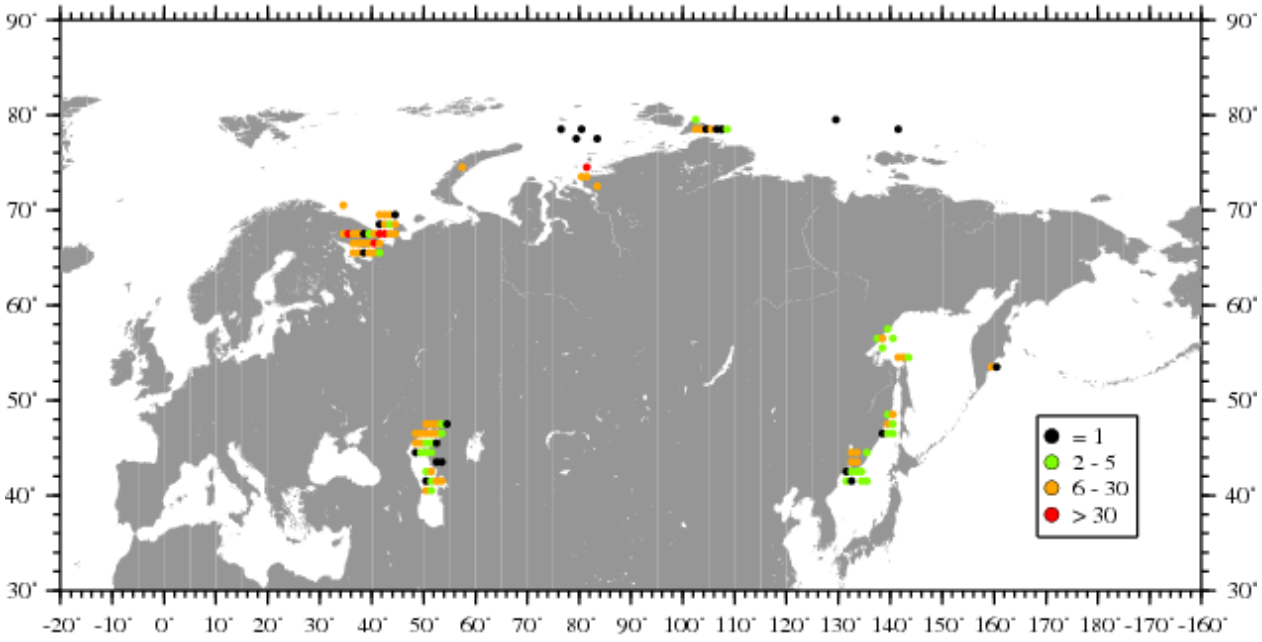


Figure 20. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1944 shown as a scatter plot.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1,210.

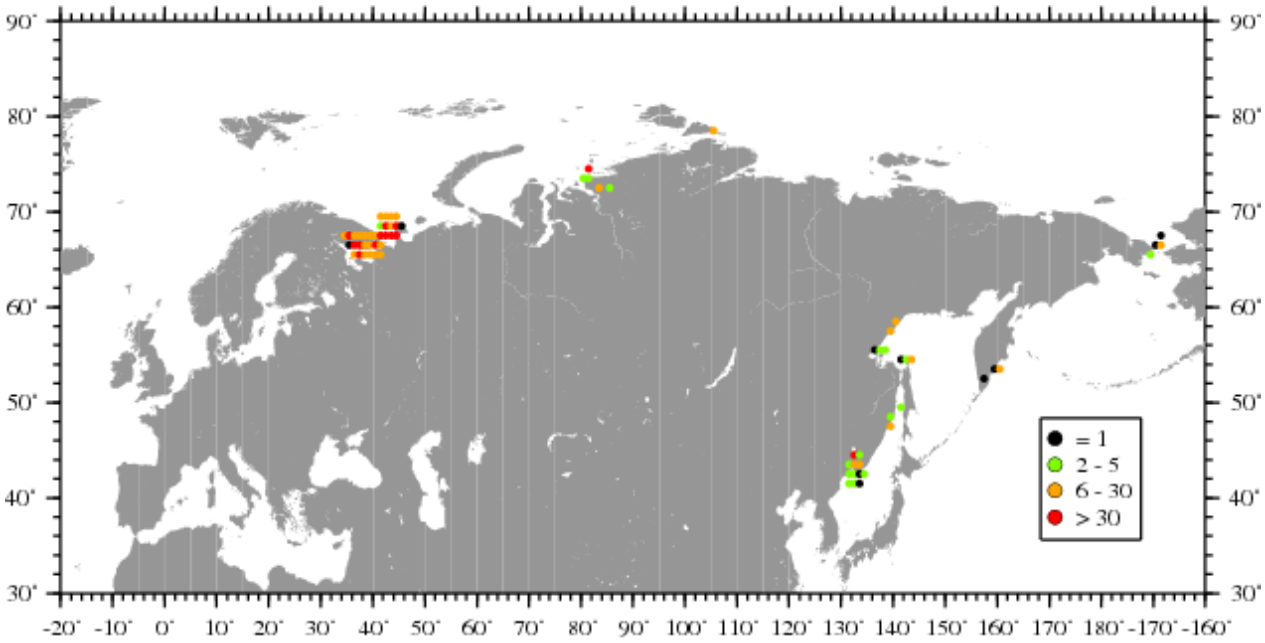


Figure 21. **Union of Soviet Socialist Republics**
Ocean Station Data (OSD) (Bottle) casts made during 1945.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 691.

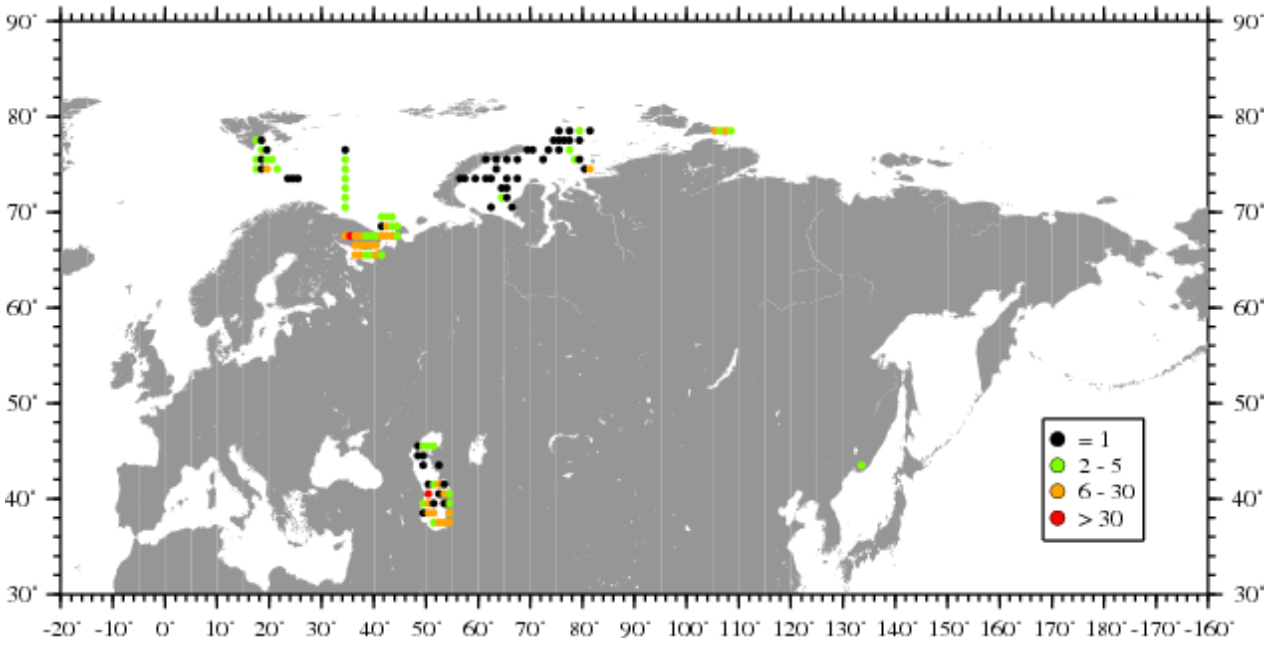


Figure 22. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made during 1939-1945 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 691.

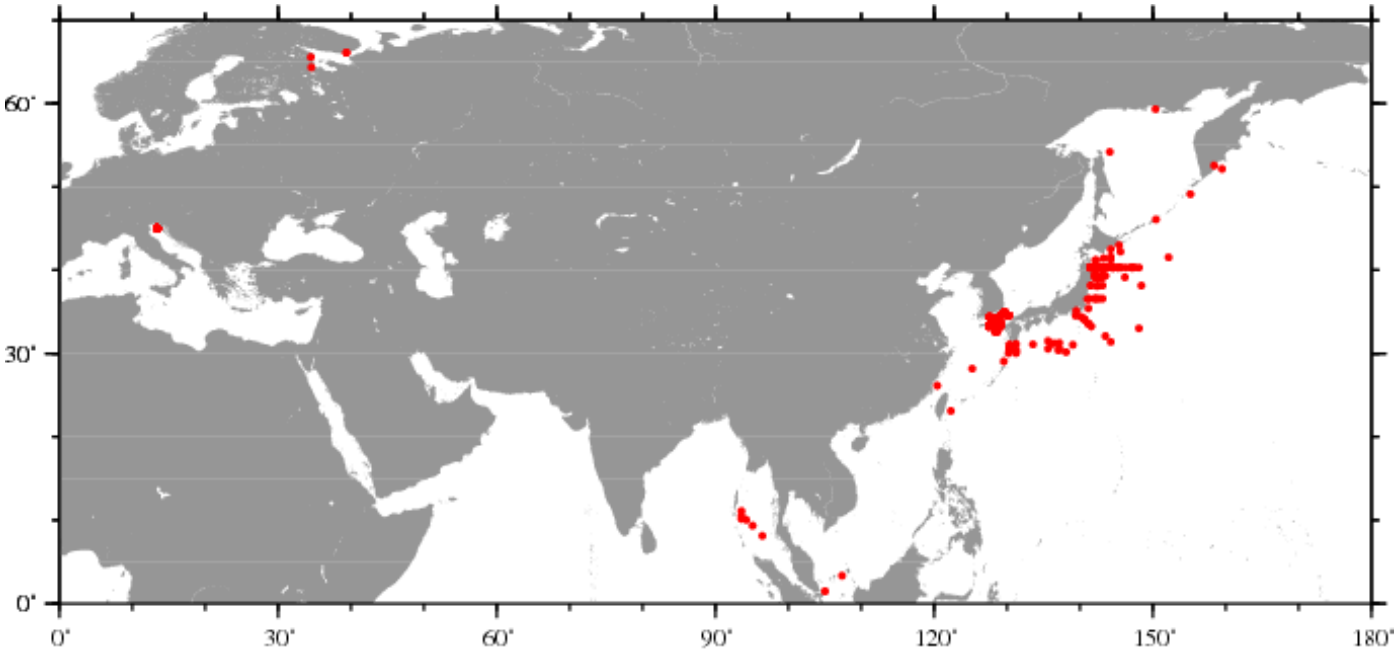


Figure 23. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made during 1939 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 104.

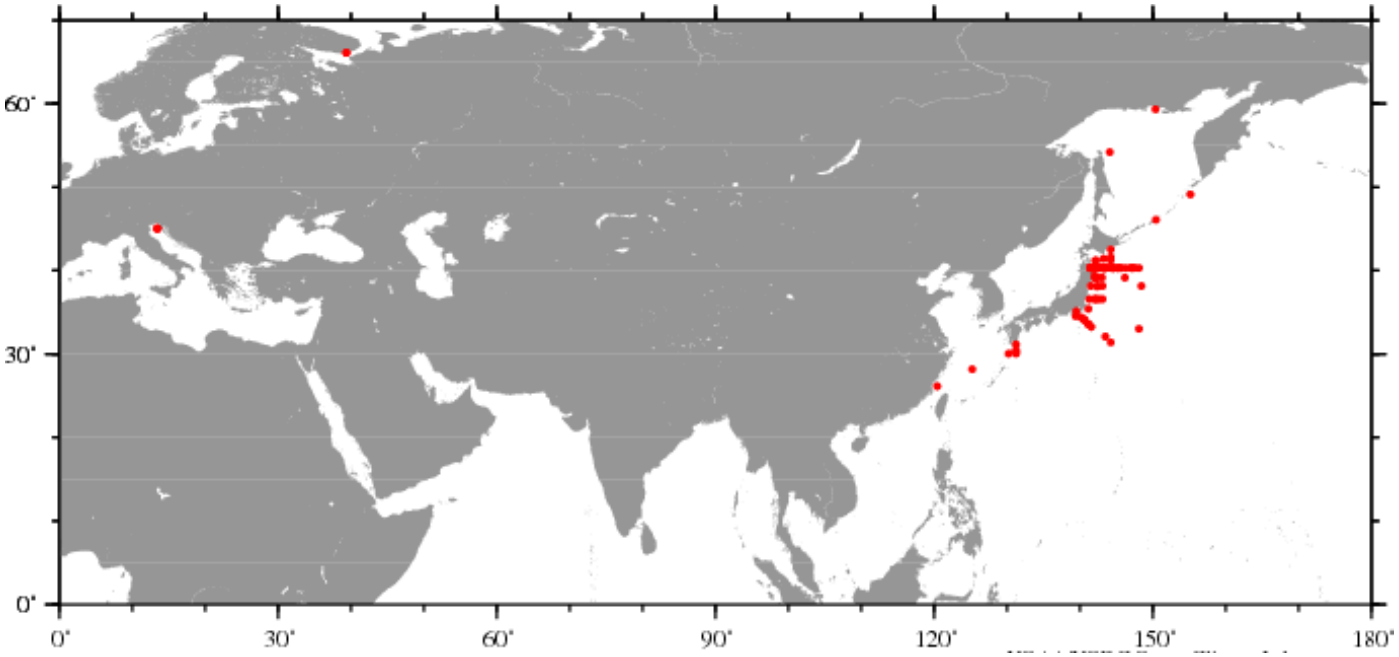


Figure 24. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made during 1940 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 53.

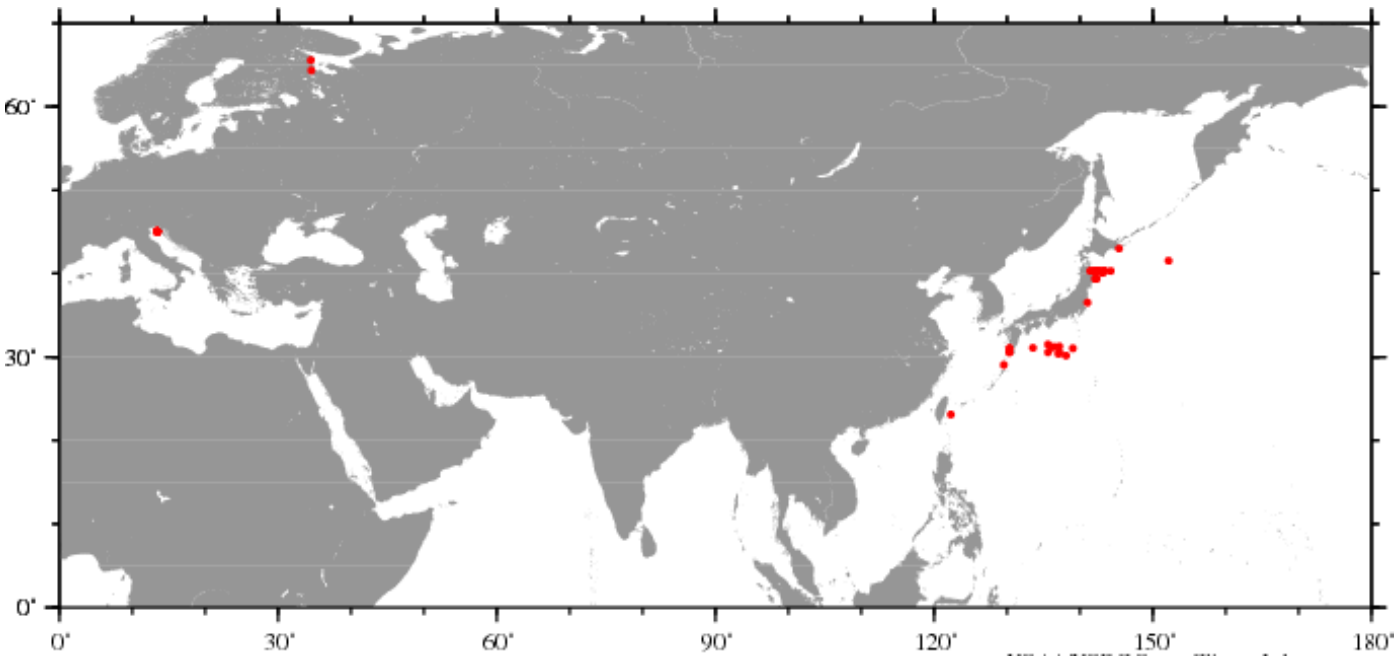


Figure 25. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made during 1941 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 53.

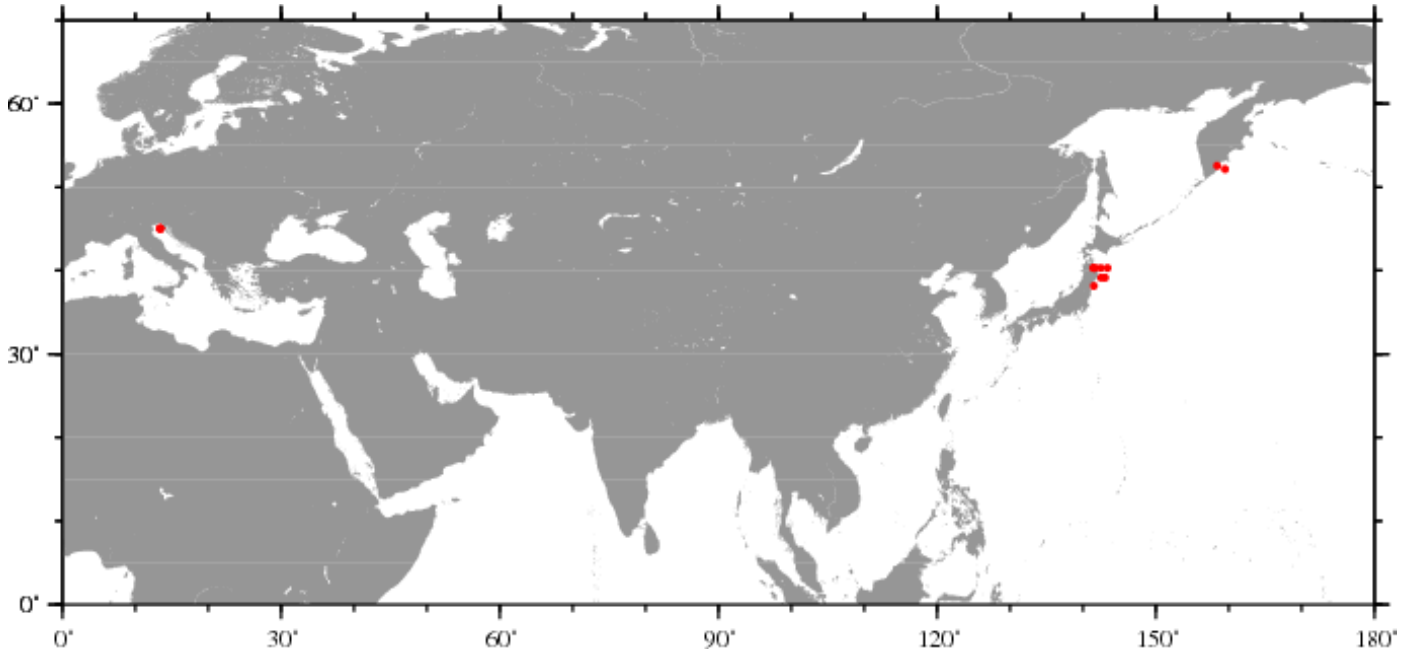


Figure 26. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made during 1942 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 15.

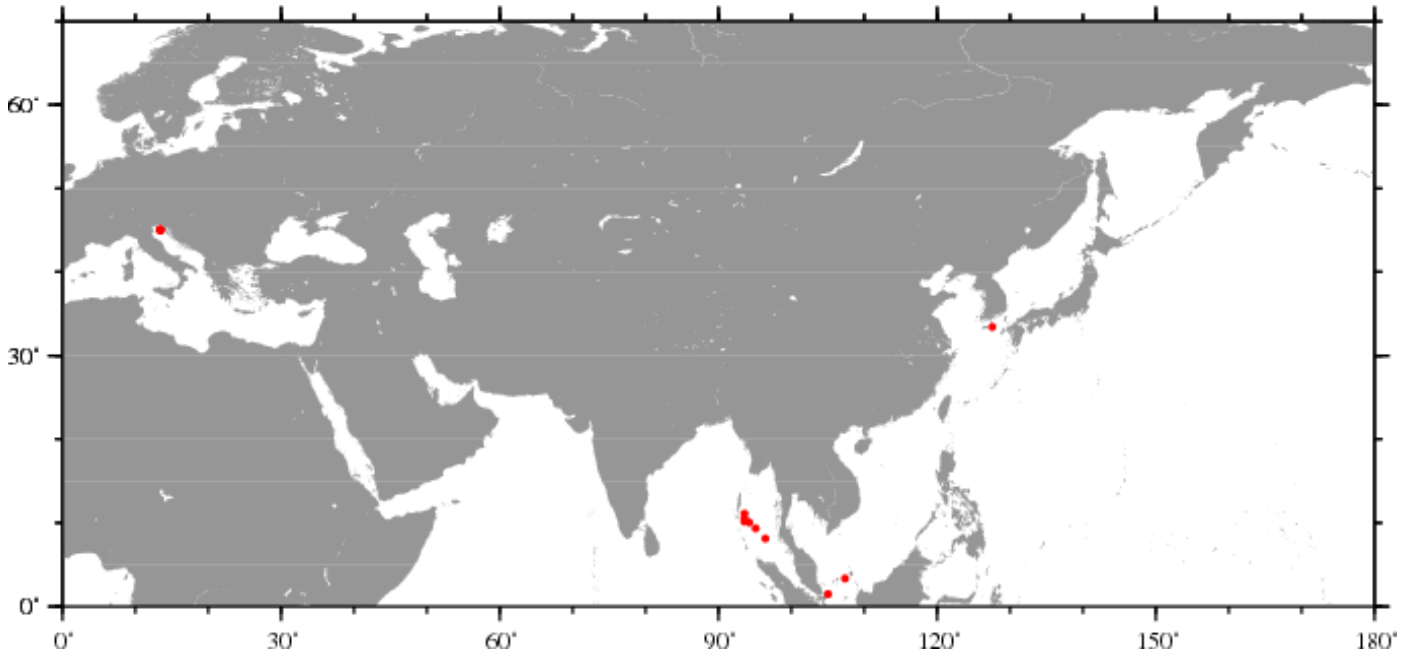


Figure 27. **Union of Soviet Socialist Republics**
Mechanical Bathythermograph (MBT) temperature profiles made in 1943 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 159.

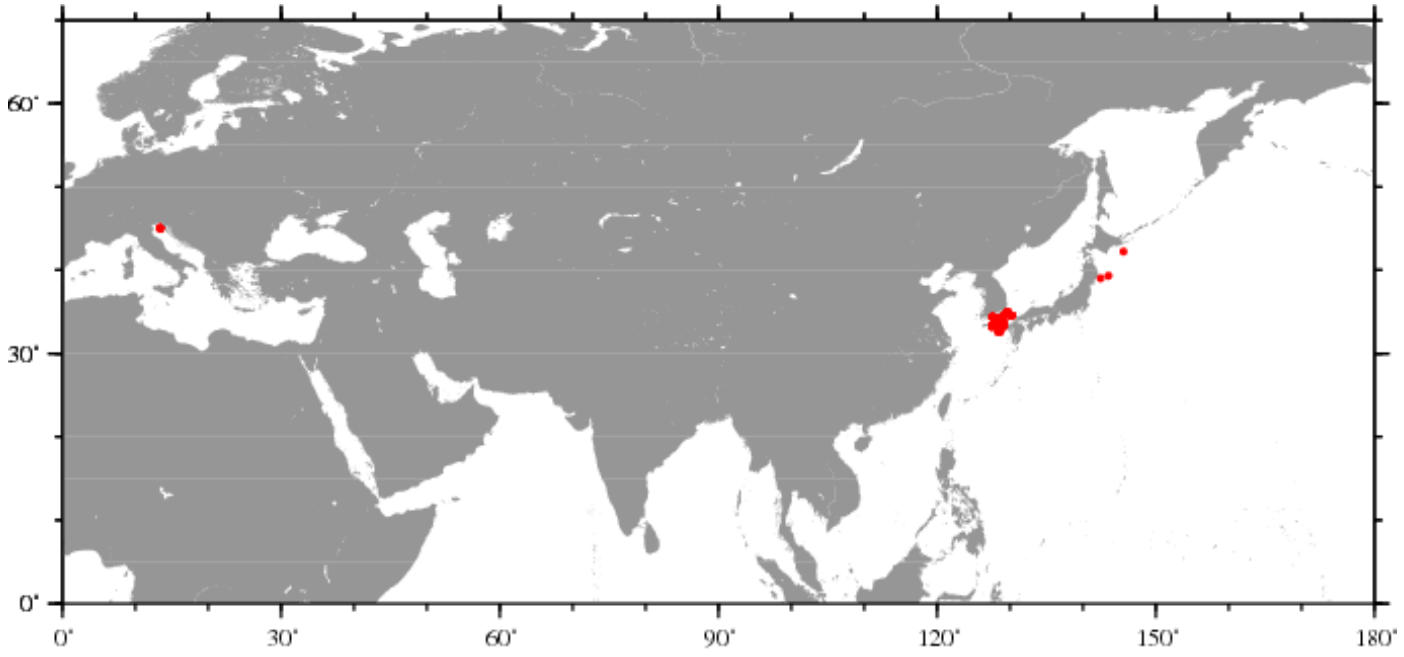


Figure 28. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1939-1945.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 26,653 casts.

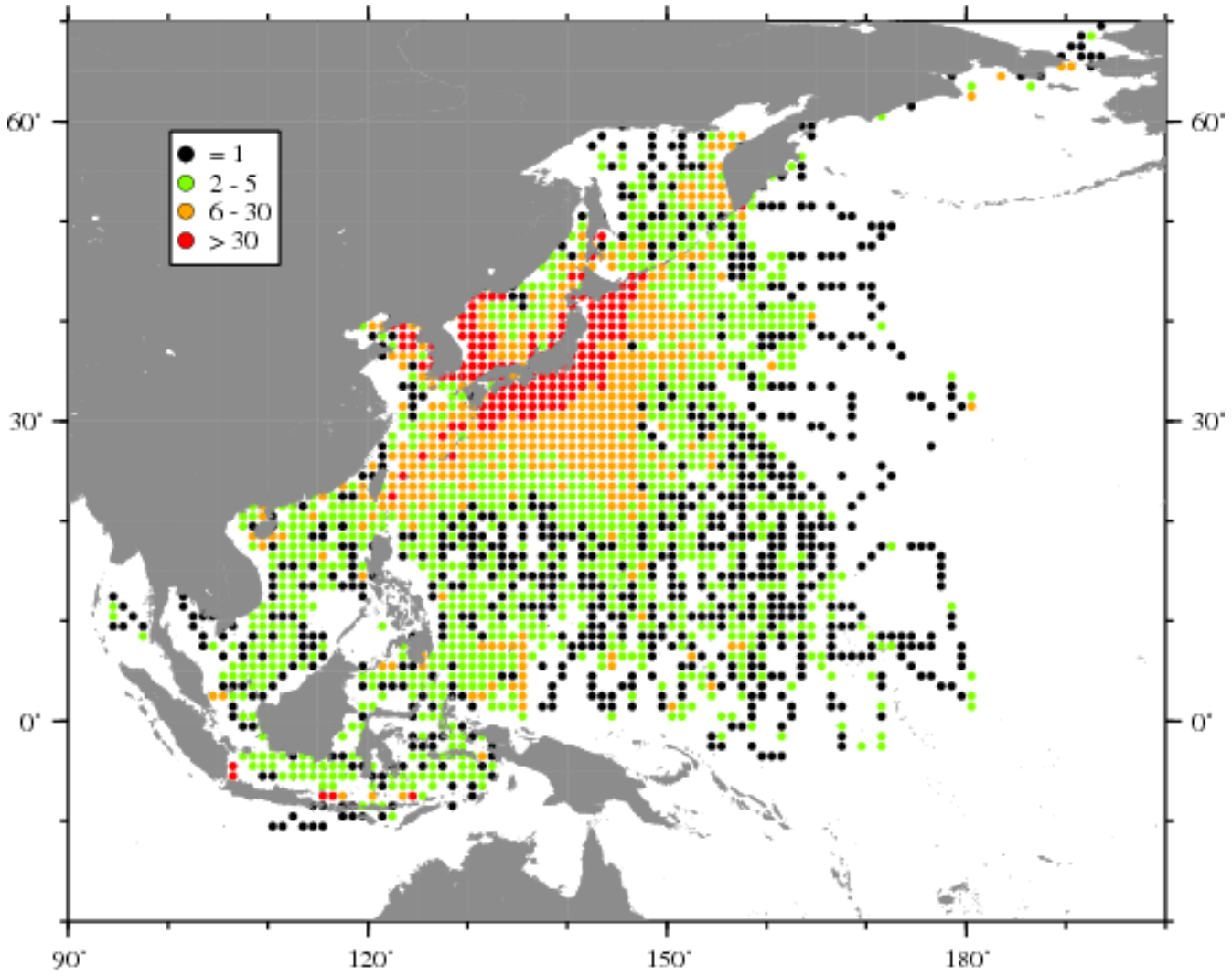


Figure 29. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1939.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 6,966.

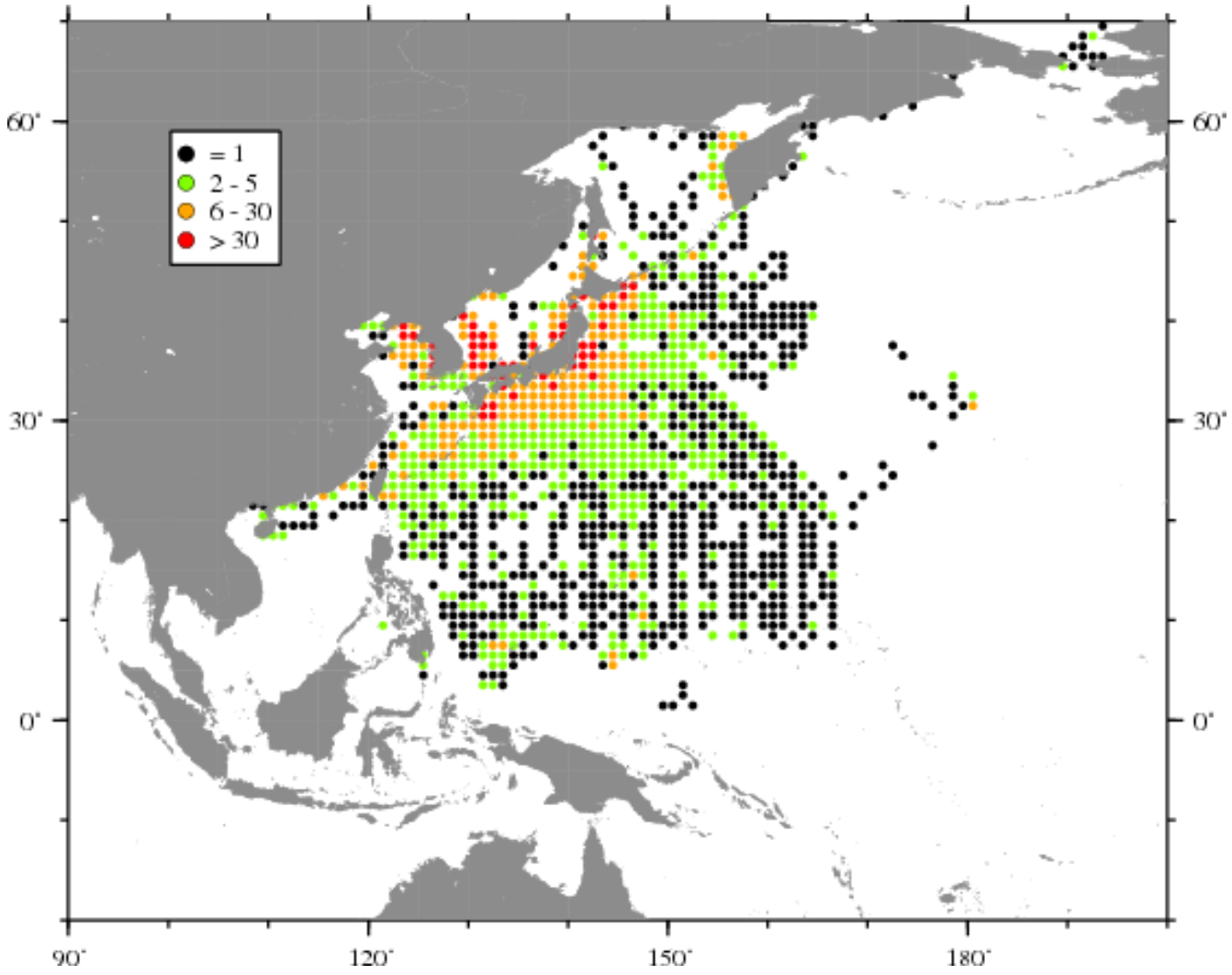


Figure 30. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1940.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 6,046.

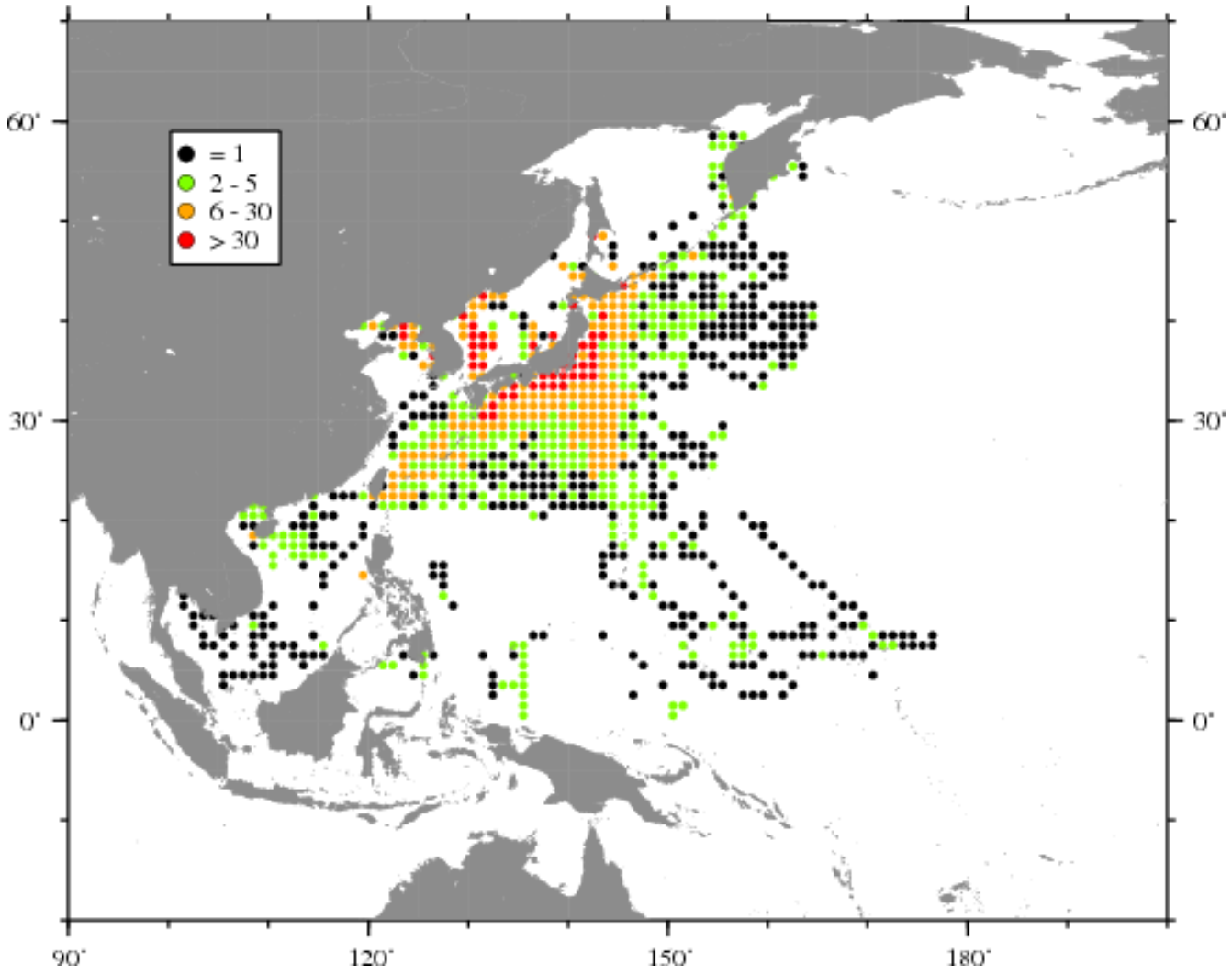


Figure 31. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1941.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 5,635.

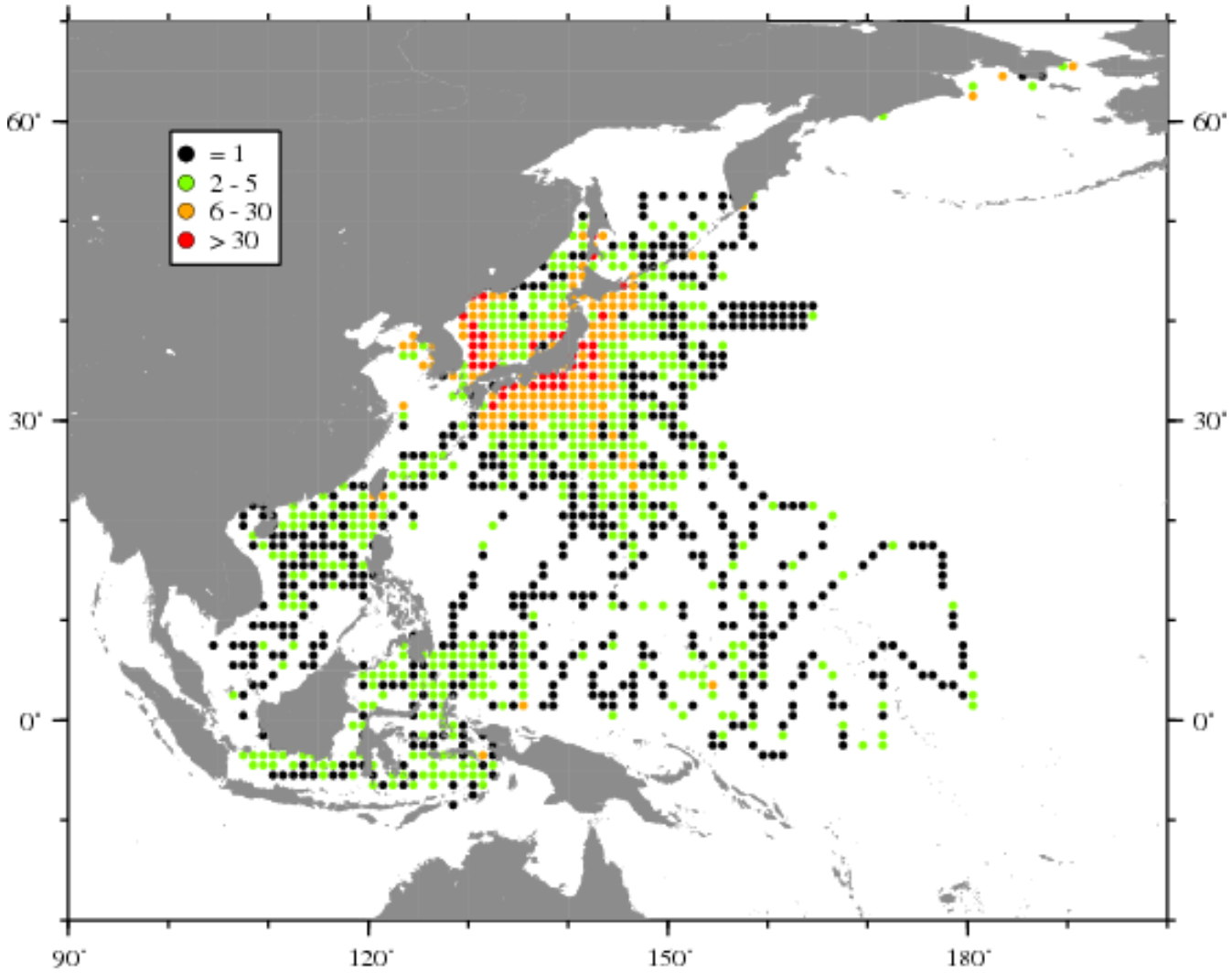


Figure 32. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1942.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 2,855.

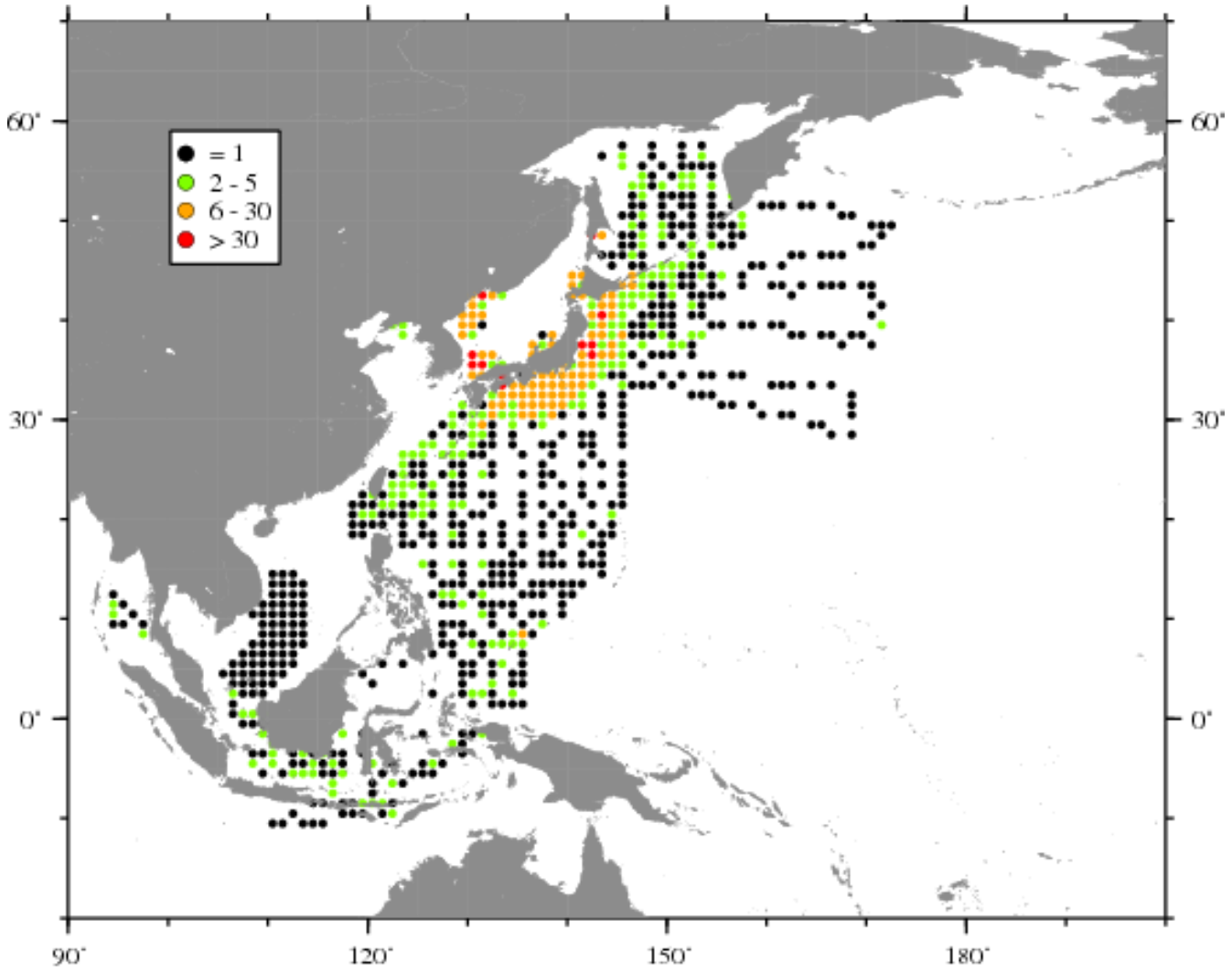


Figure 33. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1943.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total casts = 2,826.

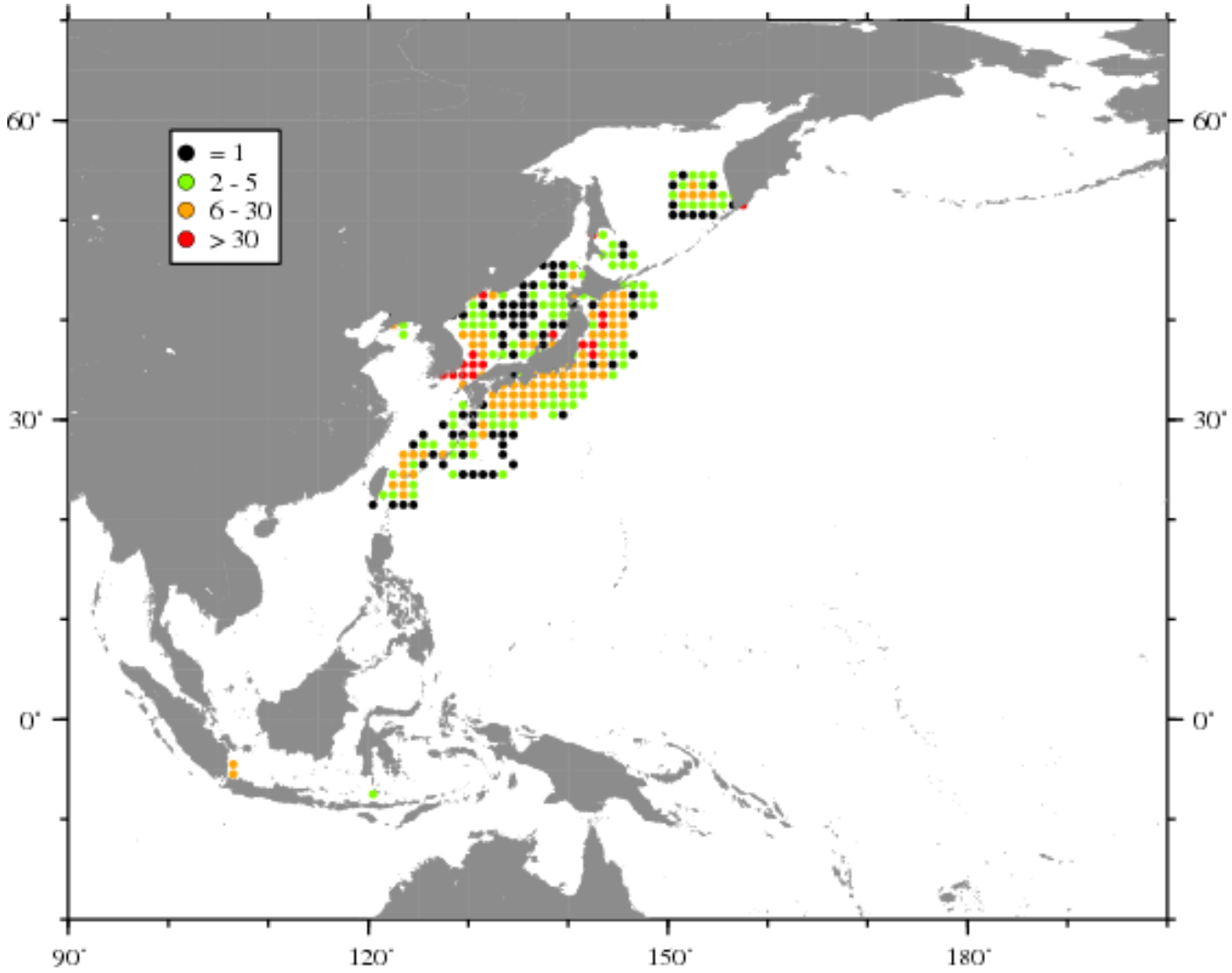


Figure 34. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1944.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 2,324.

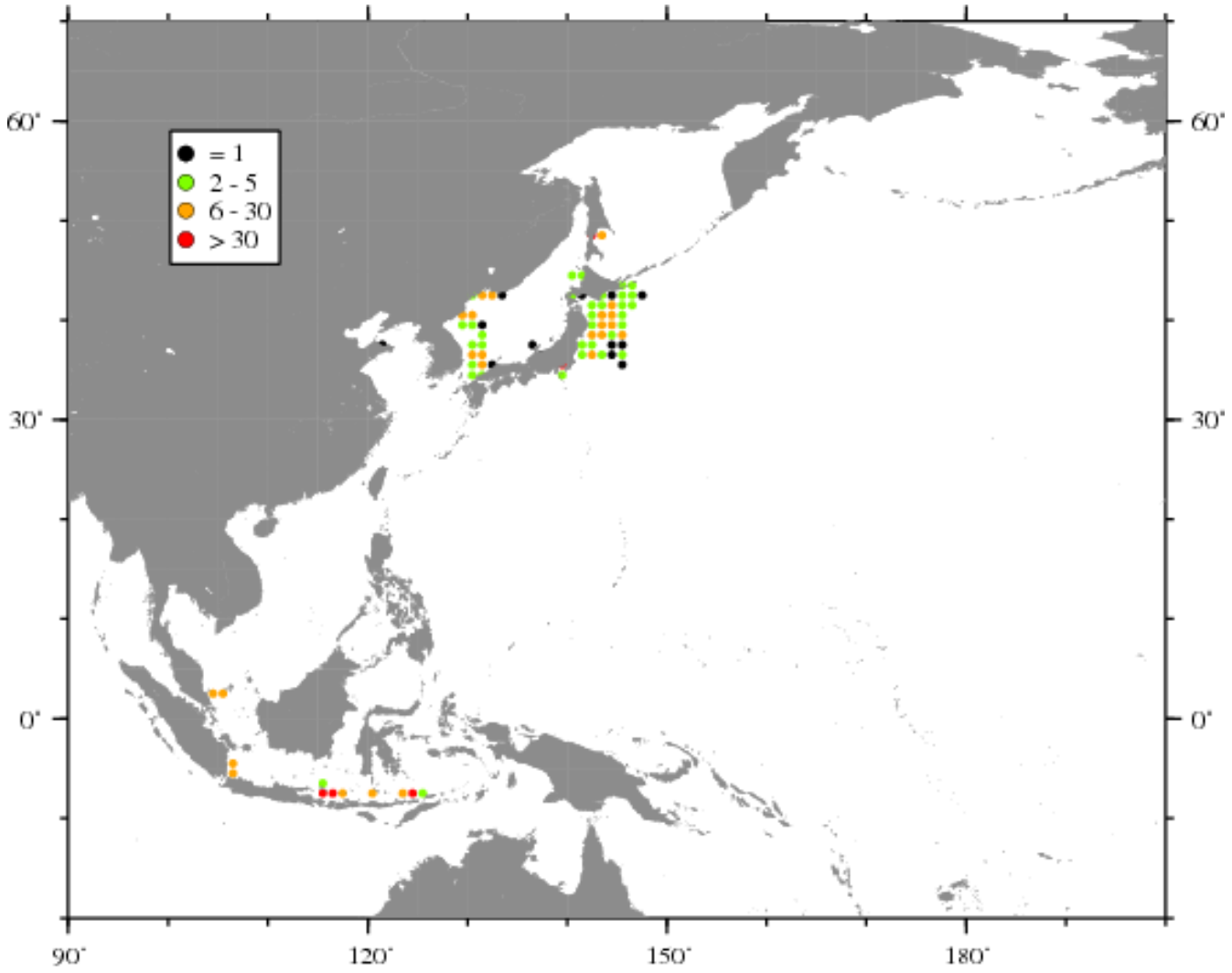


Figure 35. **Japan**
Ocean Station Data (OSD) (Bottle) casts made during 1945.
Data density of the number of casts by one-degree squares. See color scale on the figure.
Total number of casts = 1.

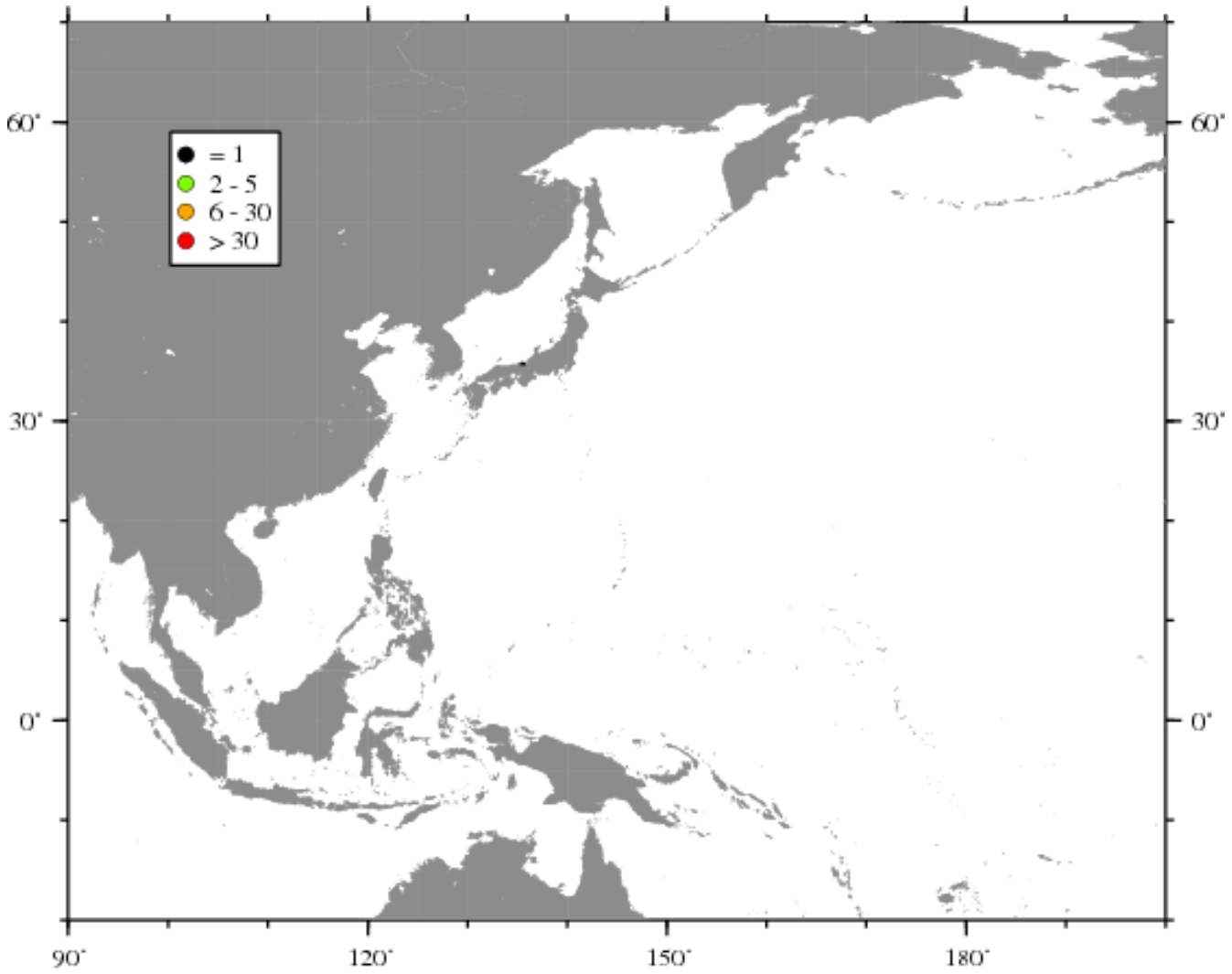


Figure 36. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1939-1945 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 2,202.

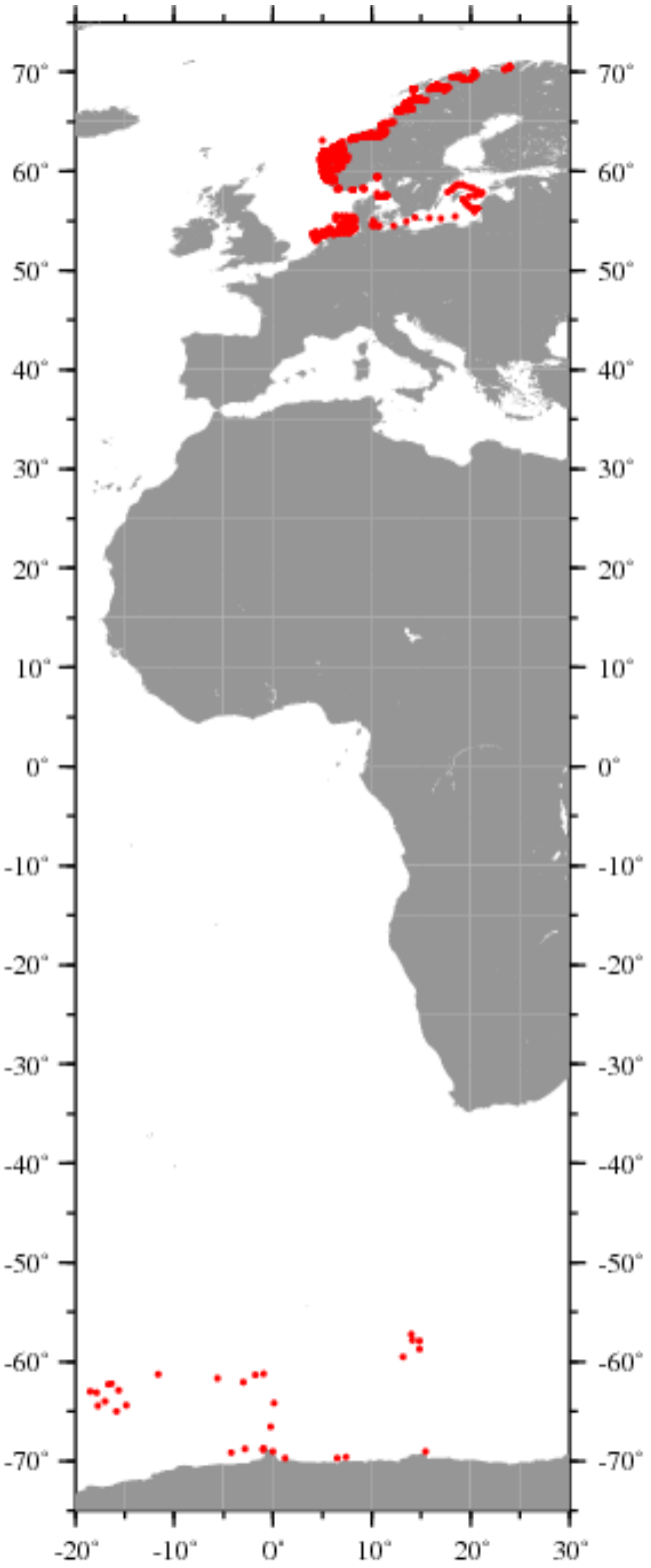


Figure 37. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1939 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 176.

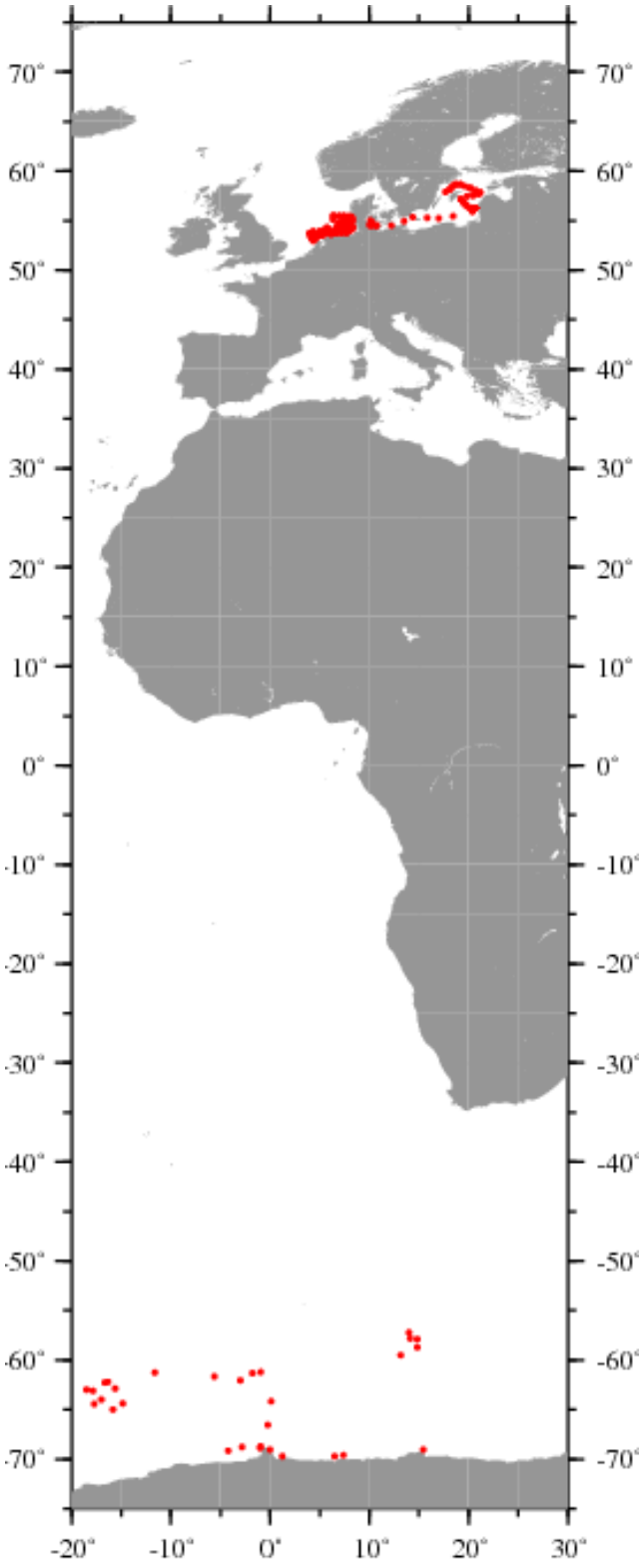


Figure 38. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1940 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 521.

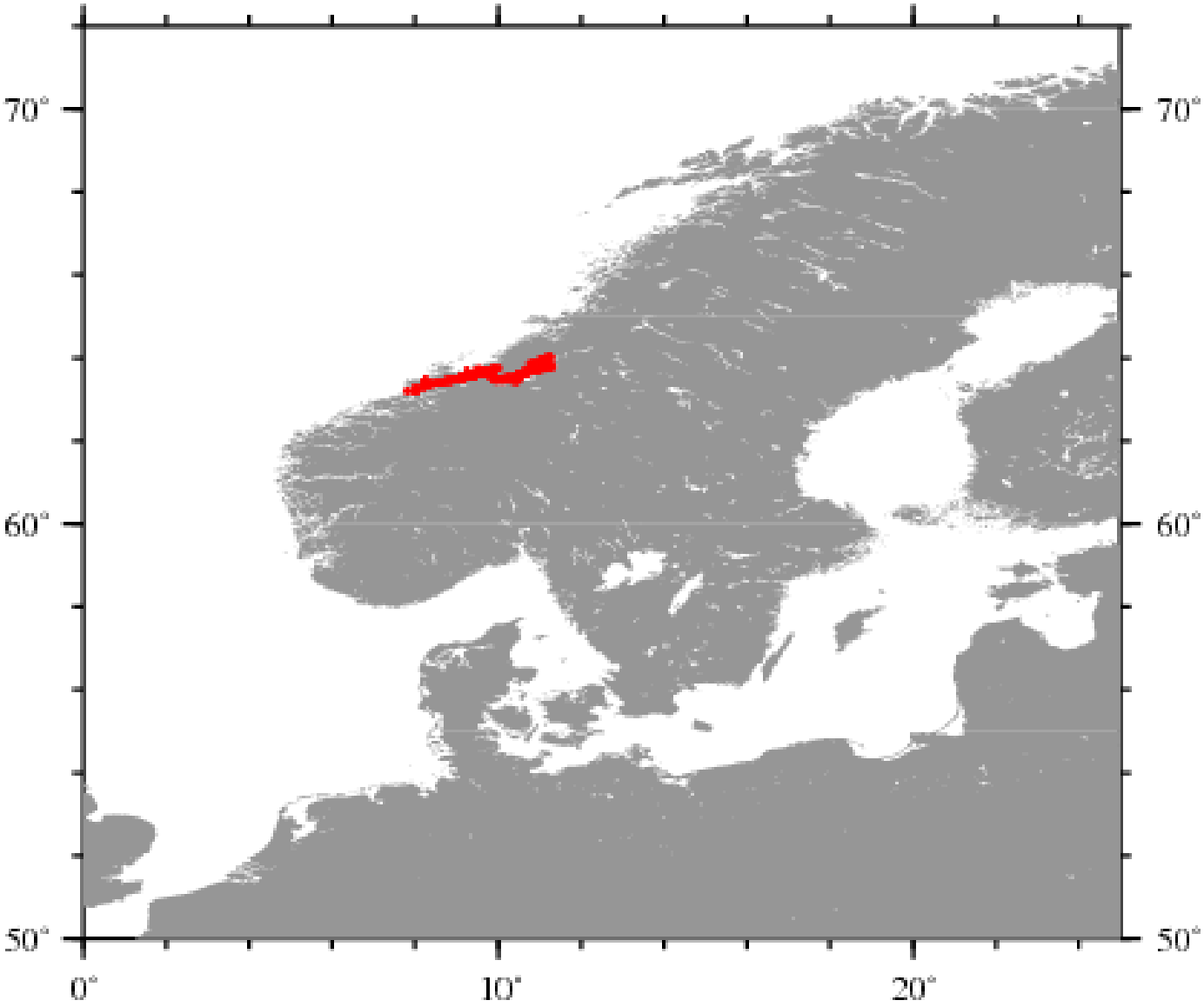


Figure 39. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1941 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 261.

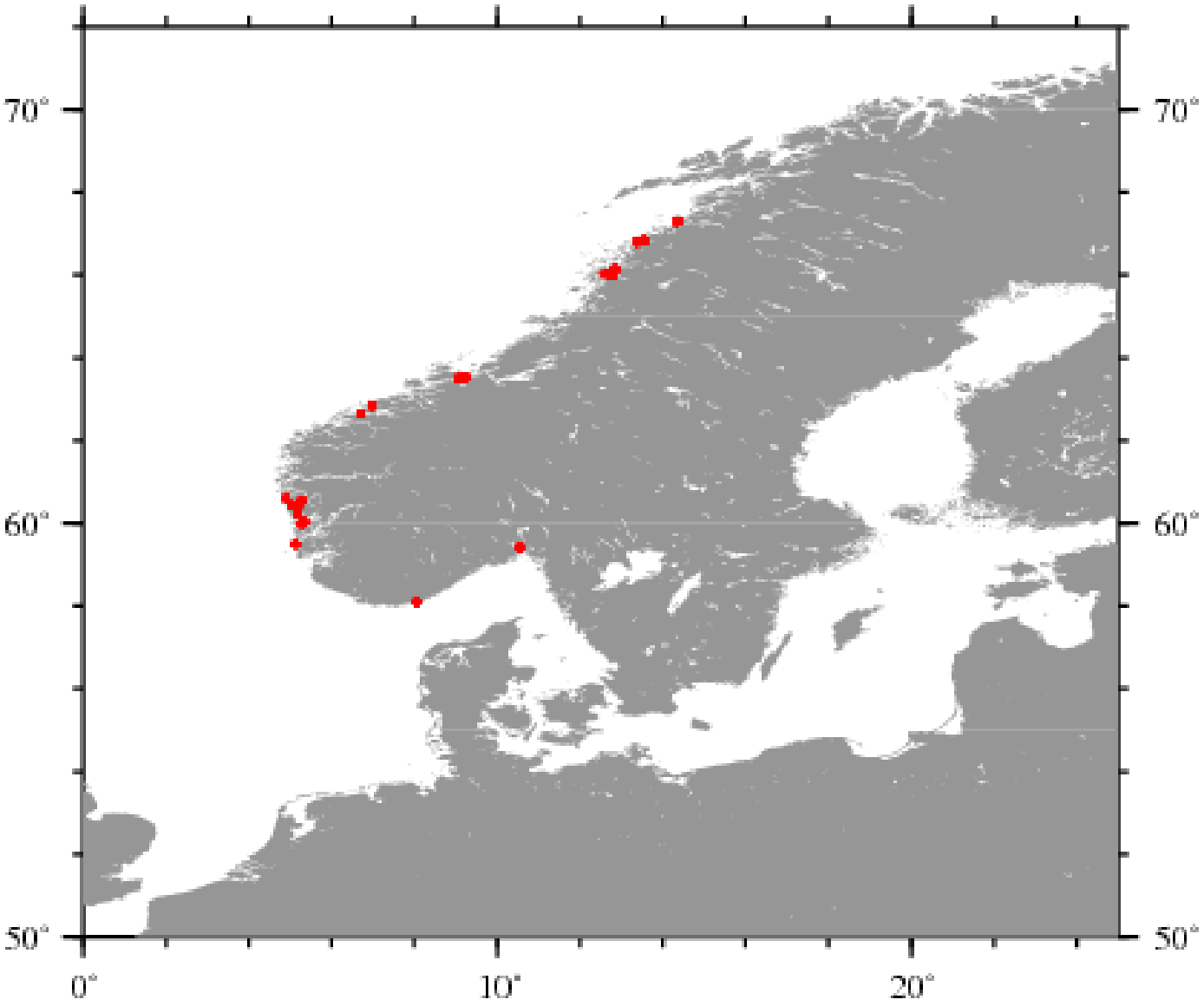


Figure 40. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1942 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 803.

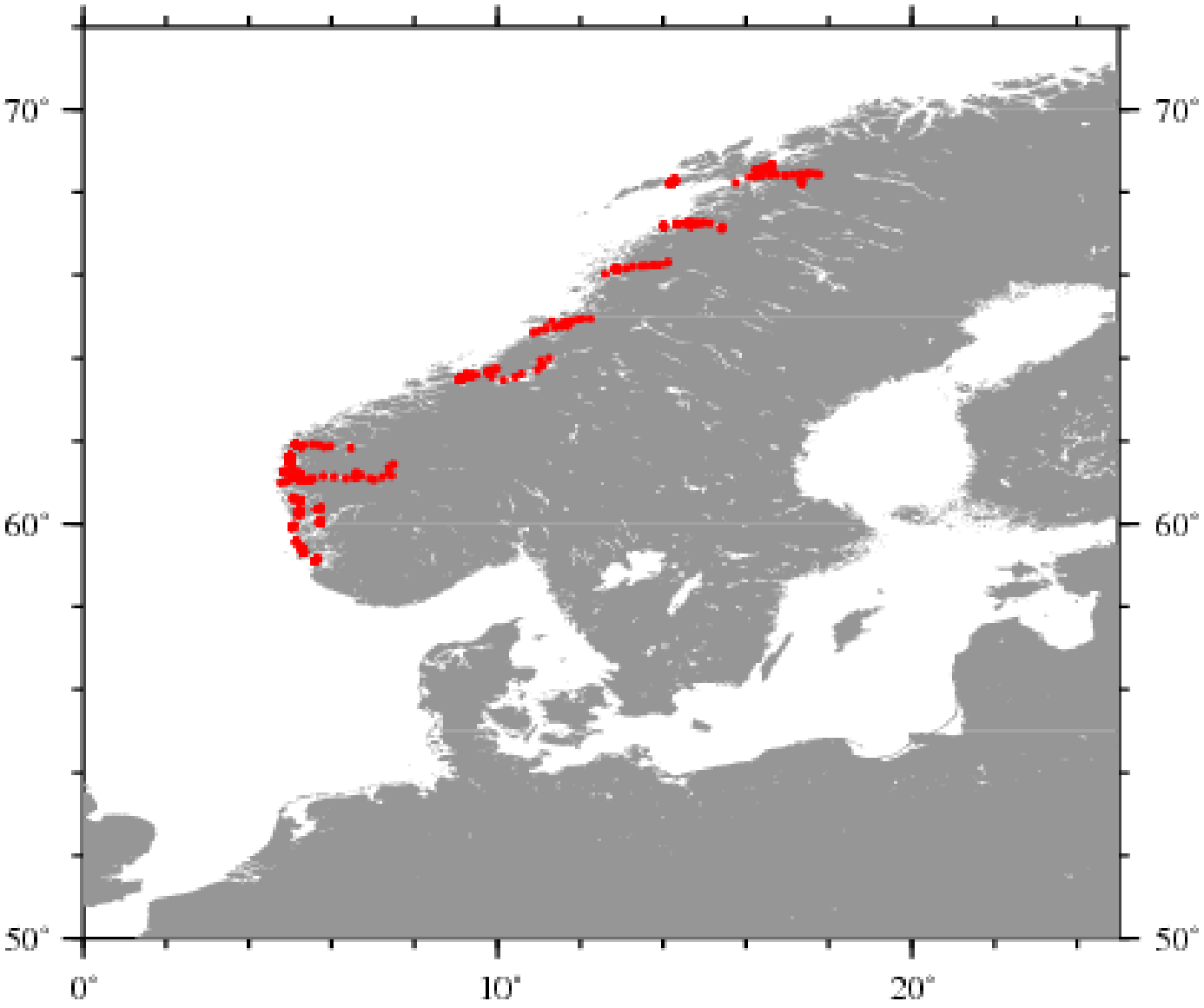


Figure 41. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1944 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 437.

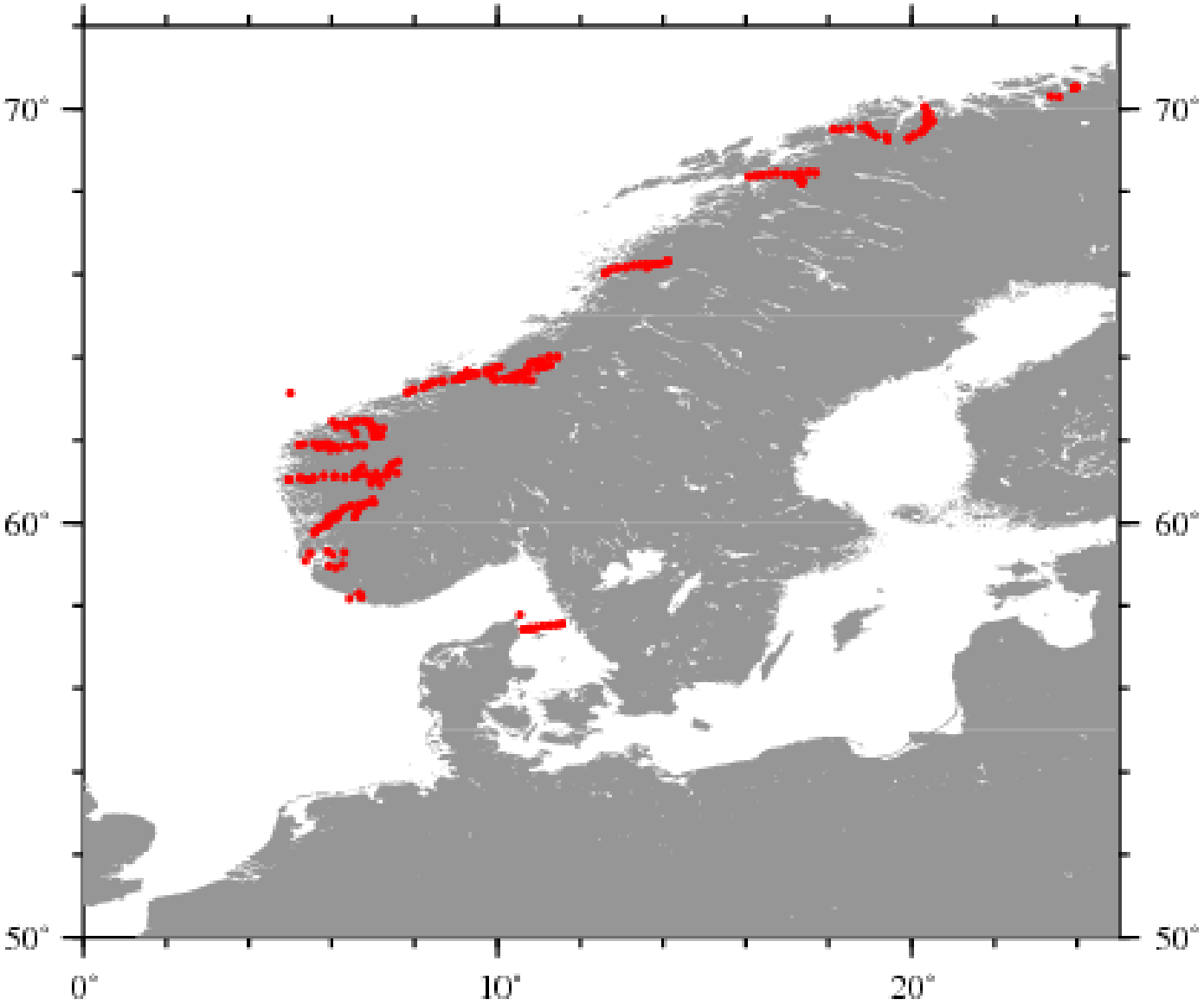


Figure 42. **Germany**
Ocean Station Data (OSD) (Bottle) casts made during 1945 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 4.

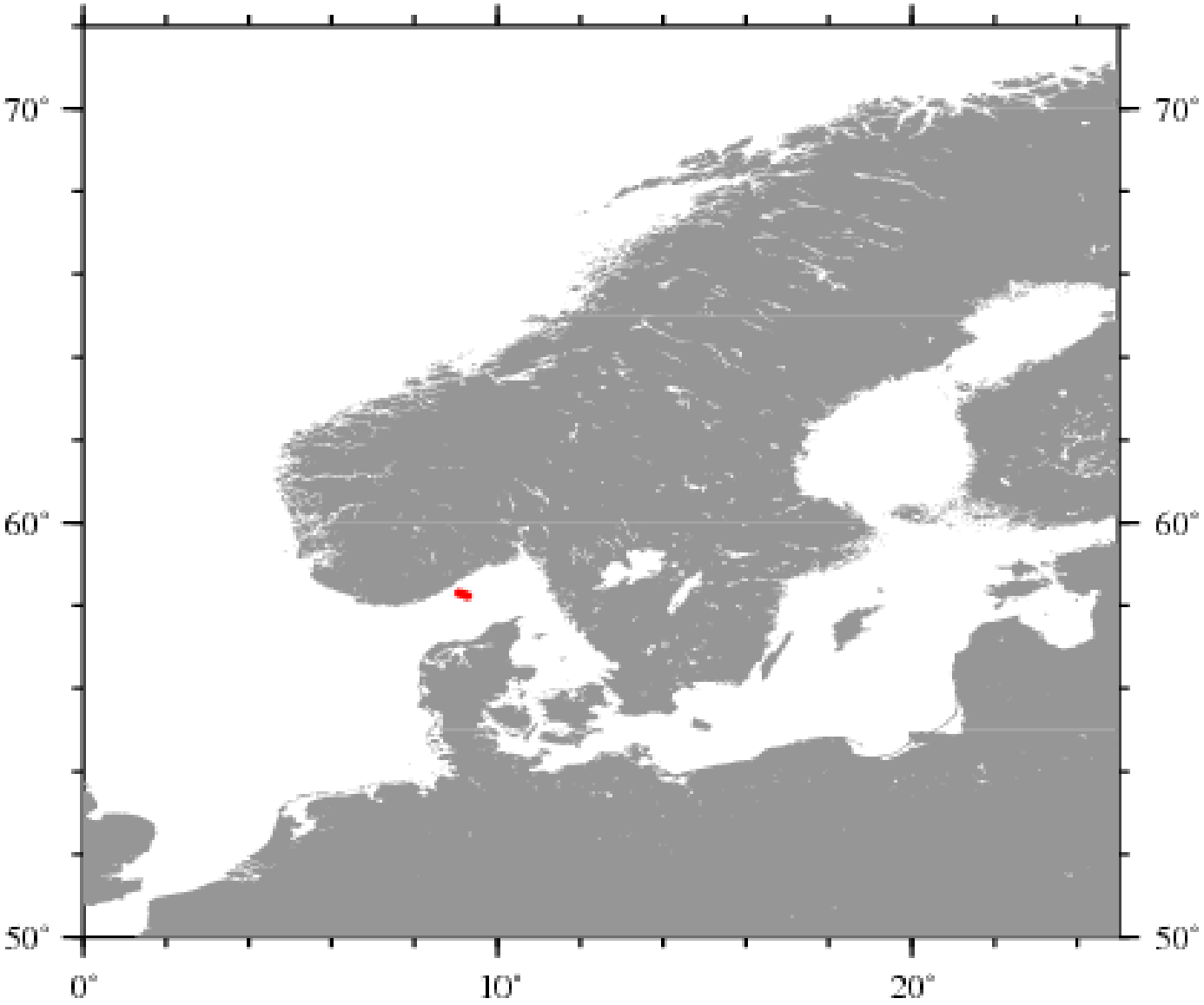


Figure 43. **Great Britain**
Ocean Station Data (OSD) (Bottle) casts made during 1939 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 564.

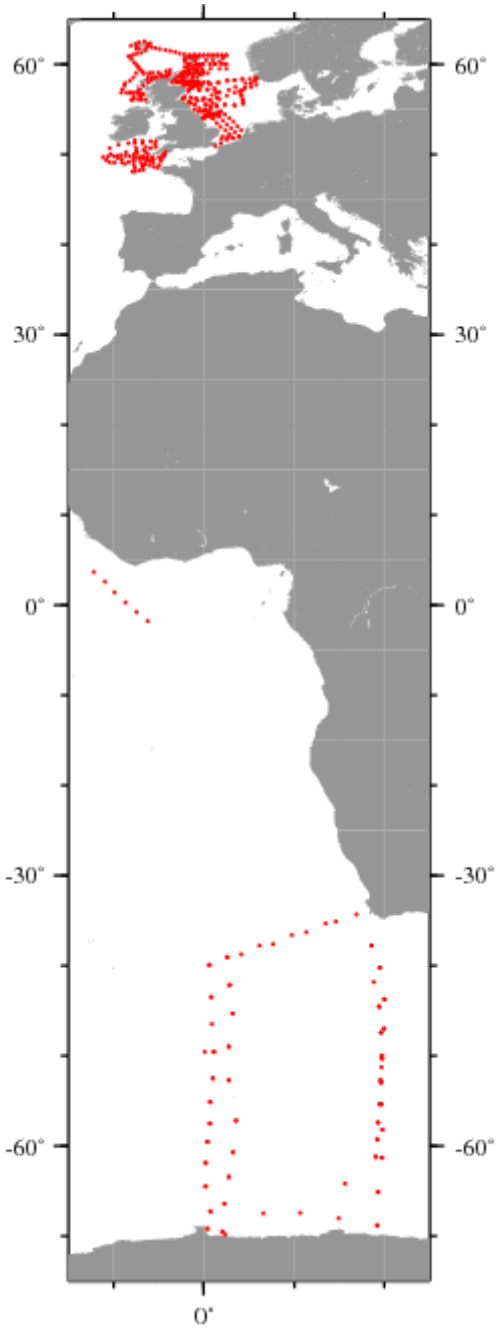


Figure 44. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1939-1945 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 410.

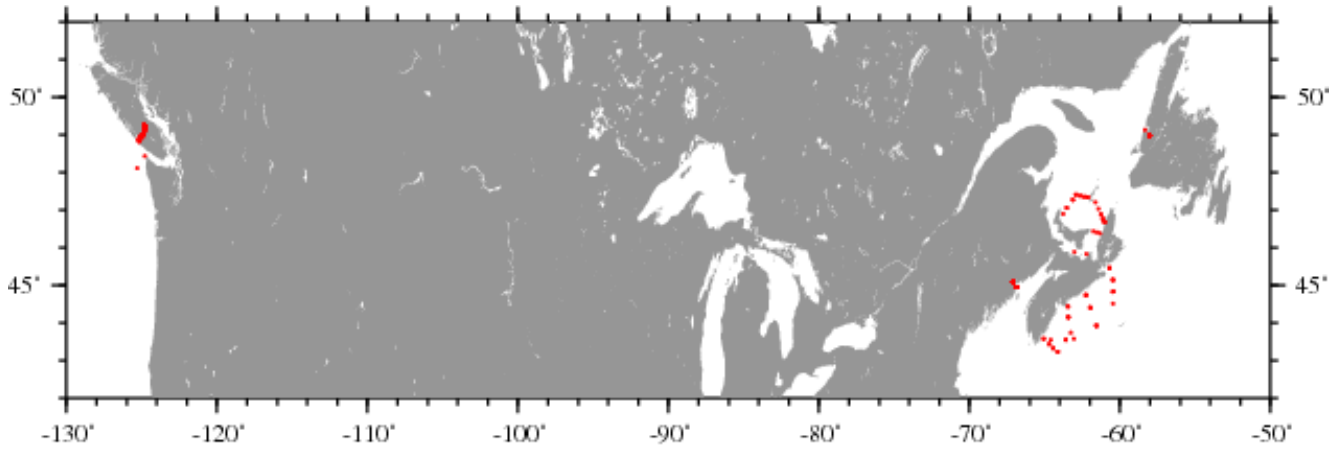


Figure 45. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1939 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 102.

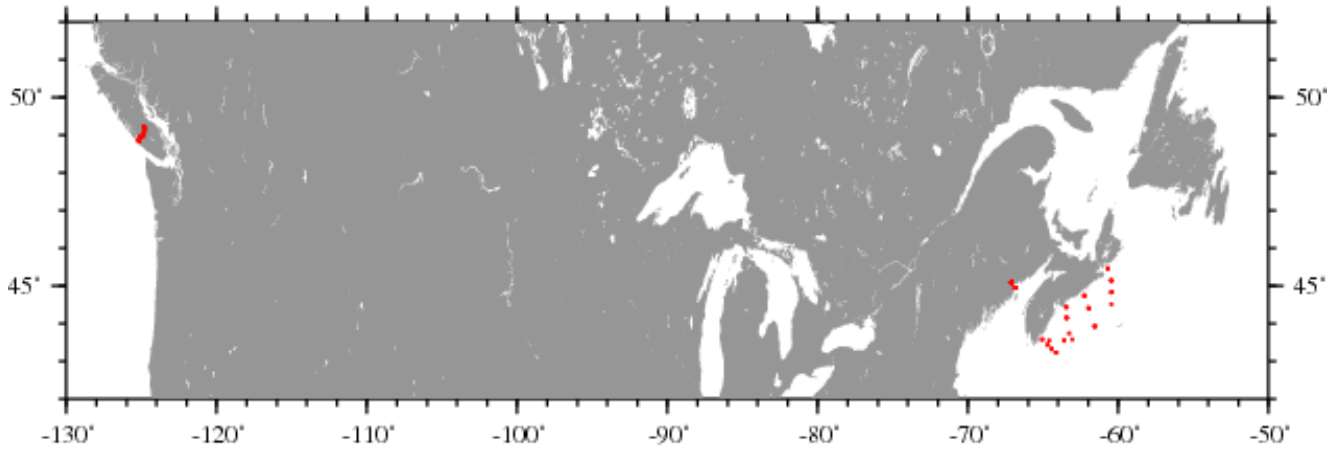


Figure 46. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1940 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 9.

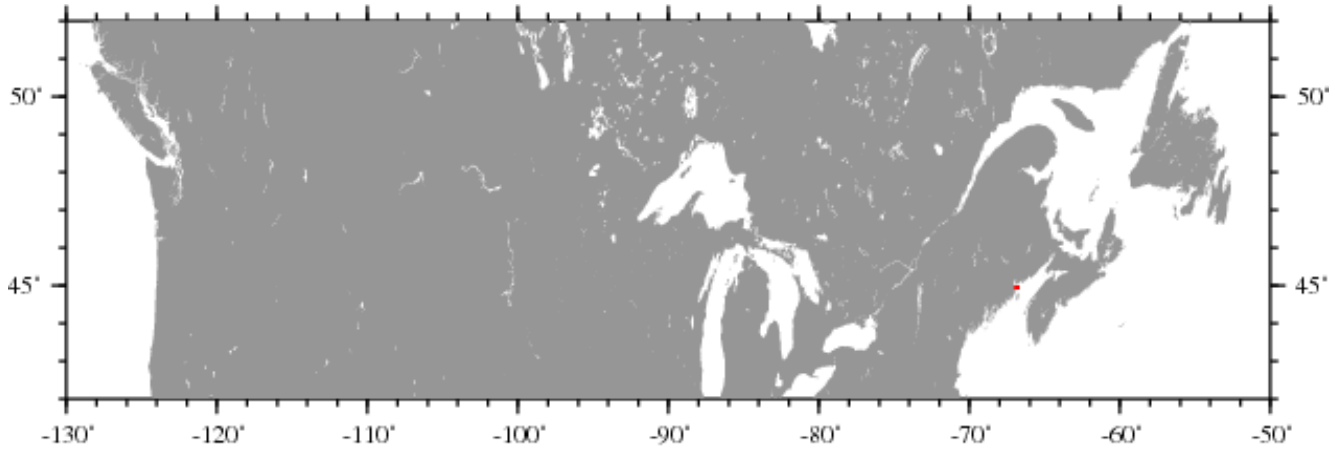


Figure 47. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1941 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 222.

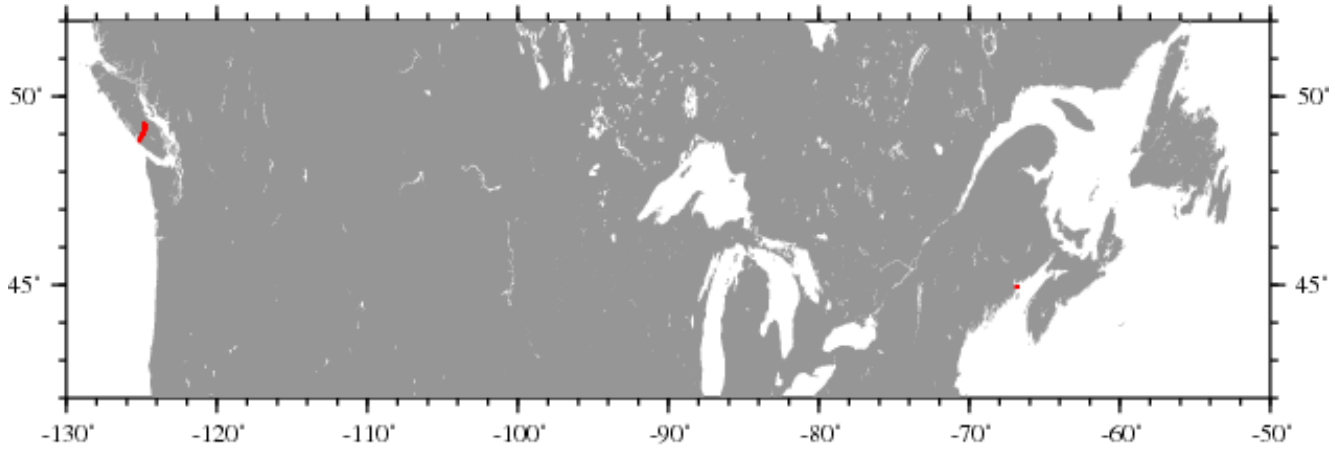


Figure 48. **Canada**
Ocean Station Data casts (OSD) (Bottle) made during 1942 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 10.

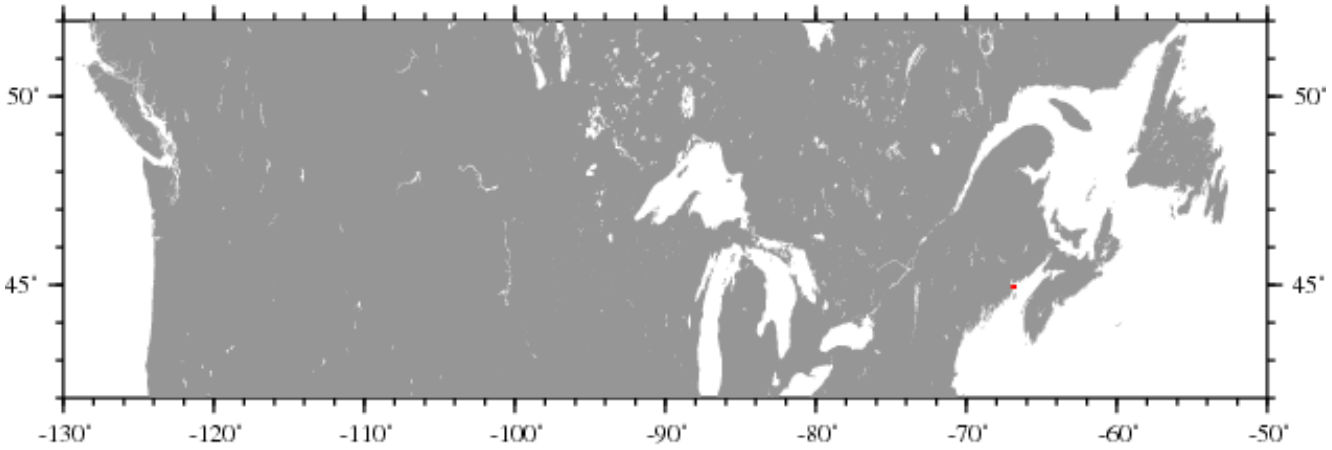


Figure 49. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1943 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 12.

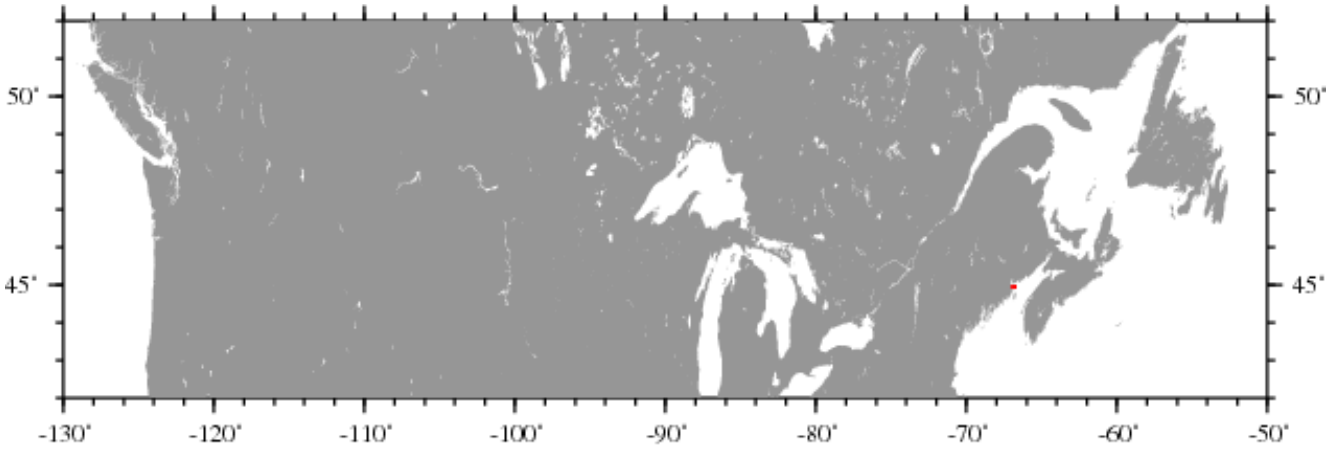


Figure 50. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1944 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 13.

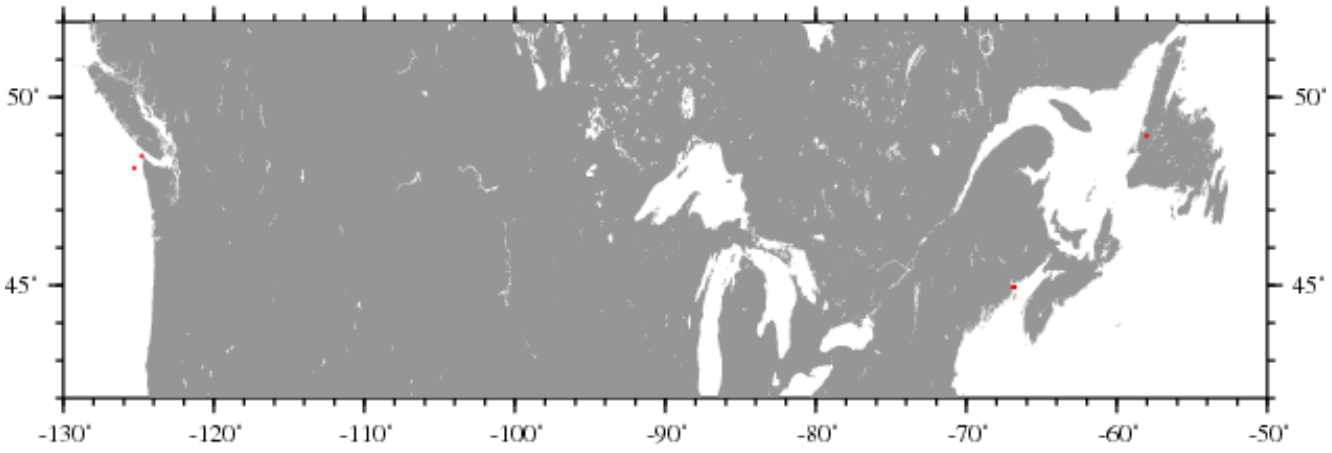


Figure 51. **Canada**
Ocean Station Data (OSD) (Bottle) casts made during 1945 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 42.

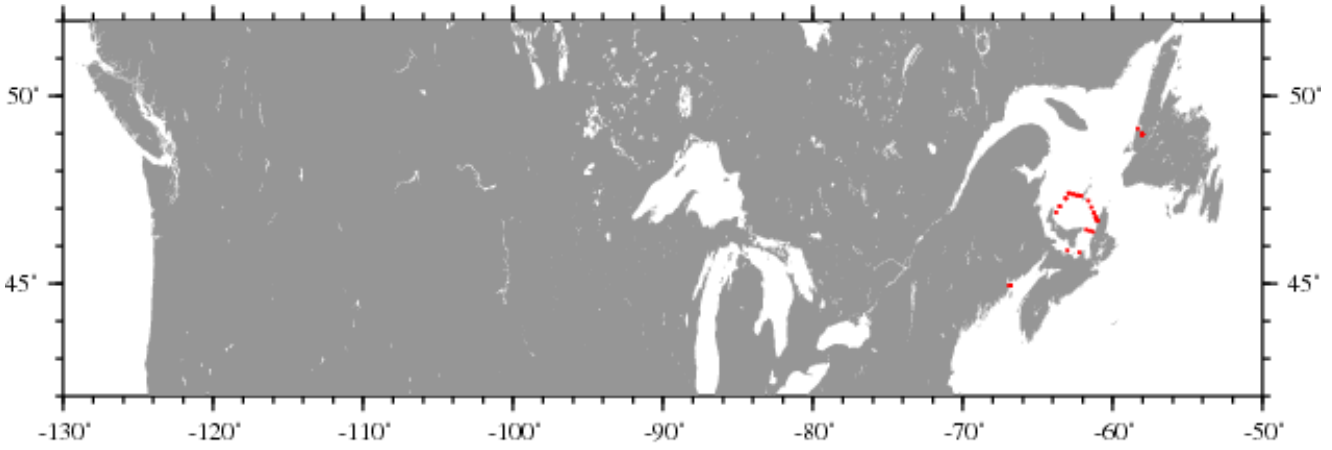


Figure 52. **Canada**
Mechanical Bathythermograph profiles made in 1940-1945 shown as a scatter plot. The location of each profile is signified by a red dot.
Total number of profiles = 741.

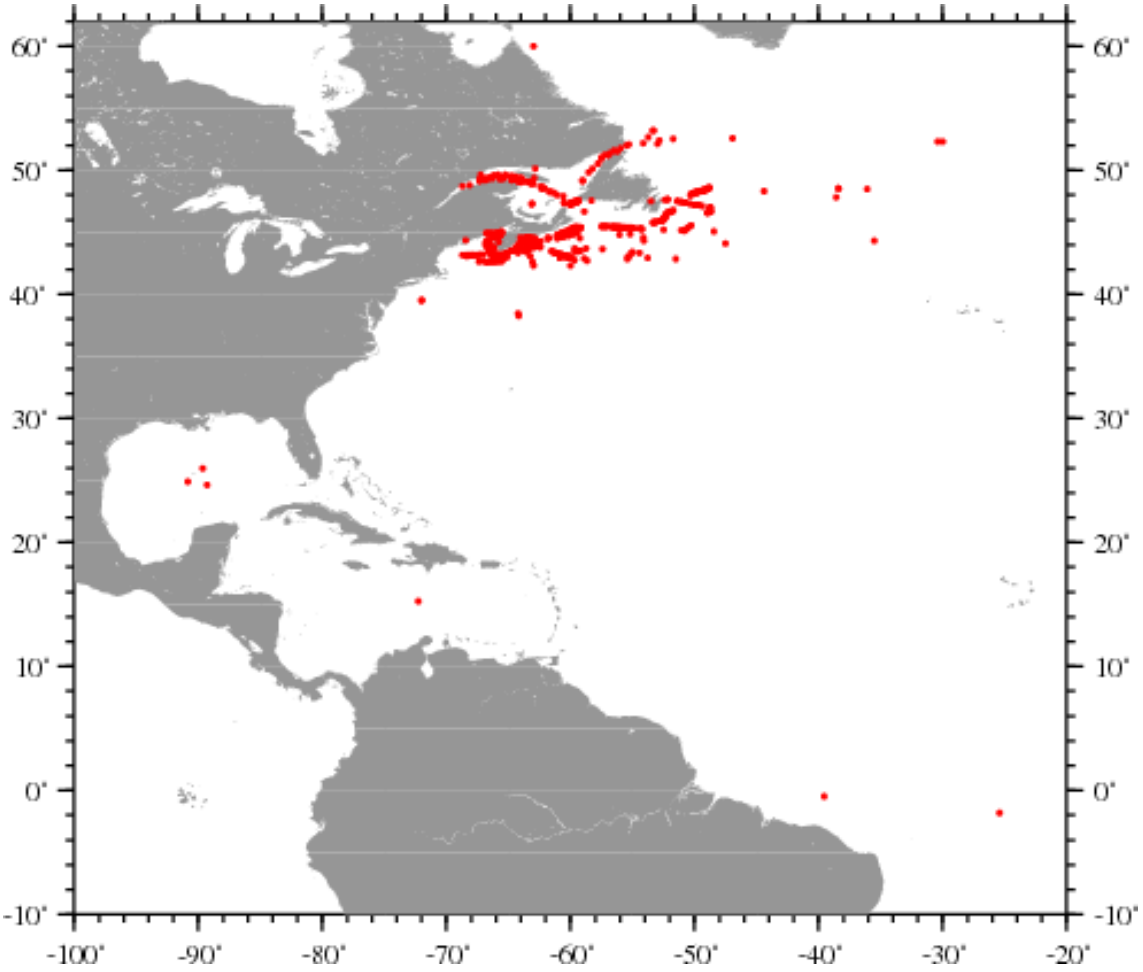


Figure 53. **Canada**
Mechanical Bathythermograph profiles made in 1940 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 1.

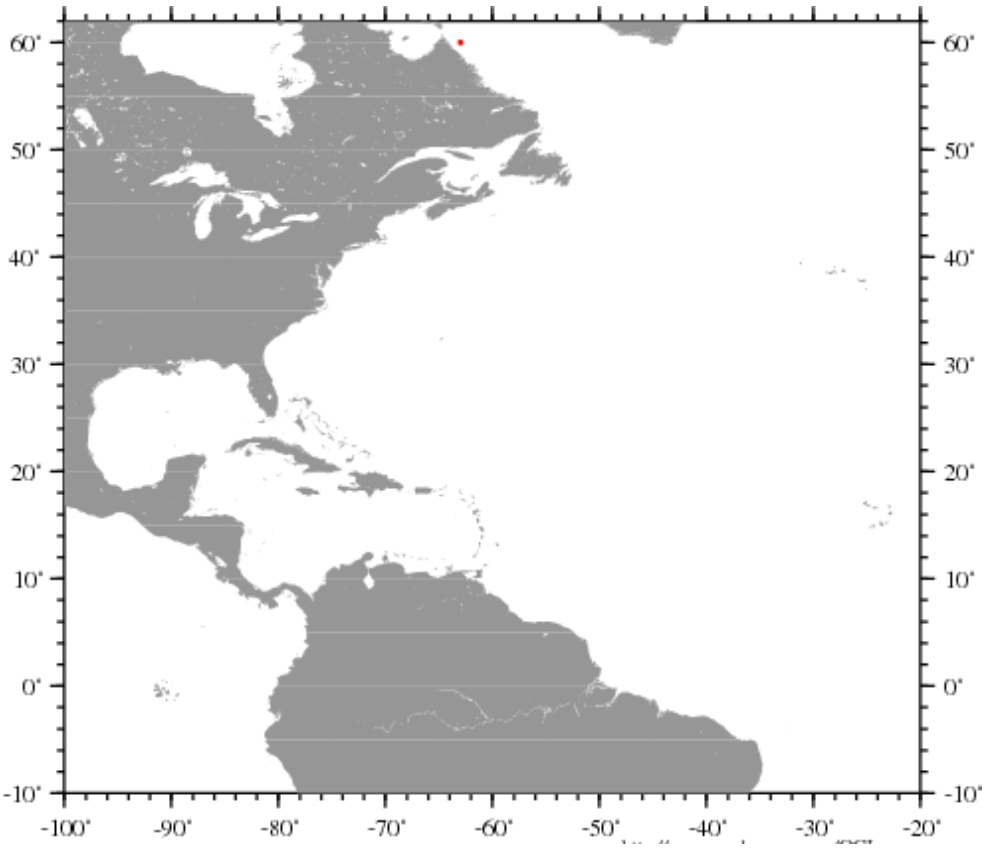


Figure 54. **Canada**
Mechanical Bathythermograph profiles made in 1941 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 1.

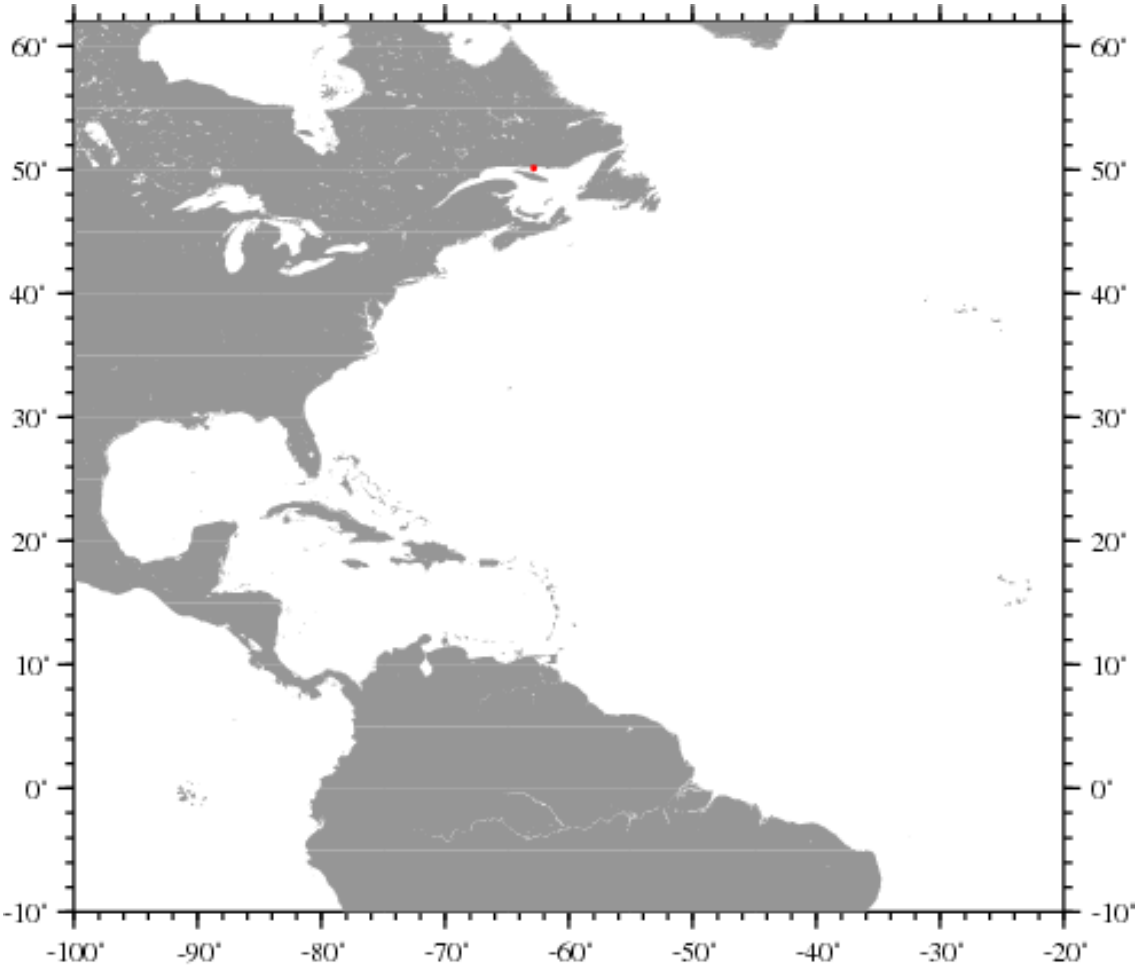


Figure 55. **Canada**
Mechanical Bathythermograph profiles made in 1942 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 2.

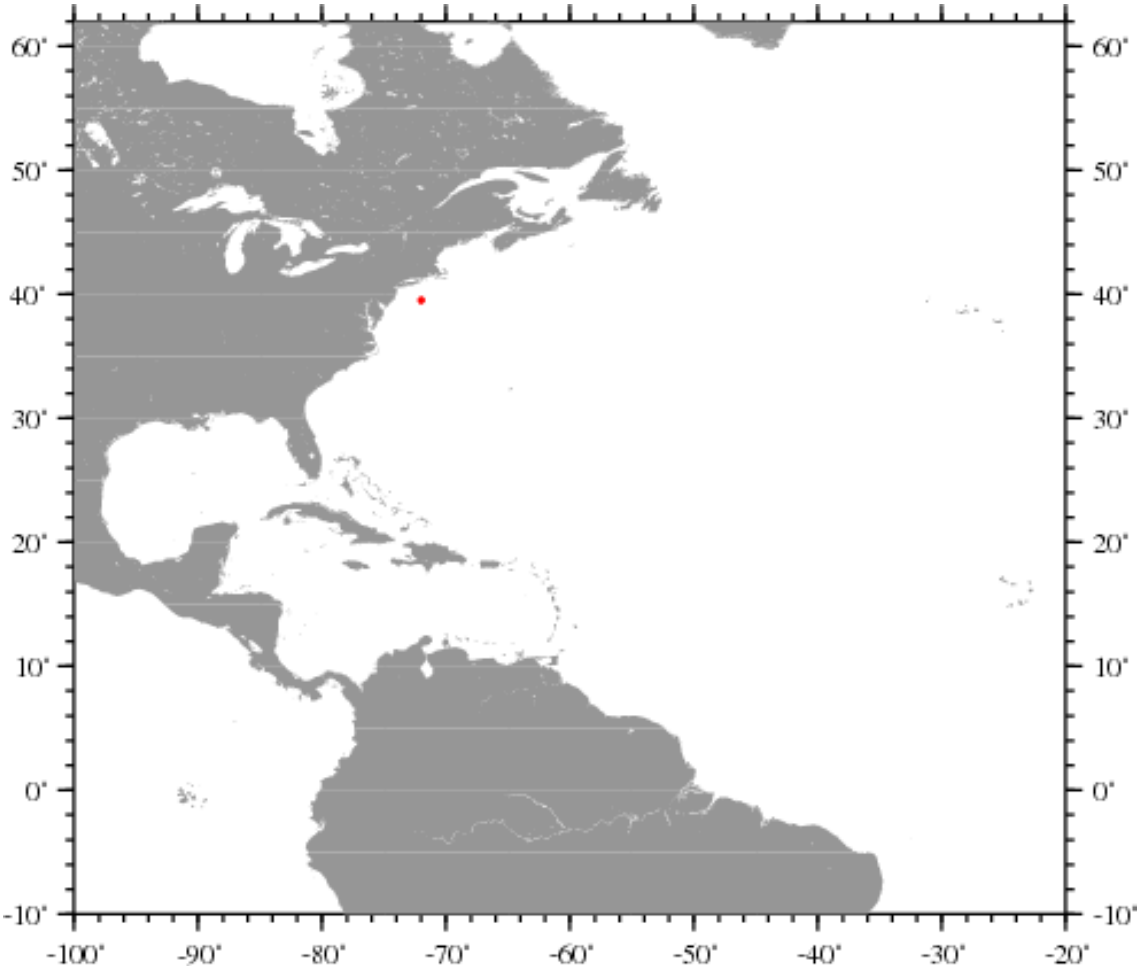


Figure 56. **Canada**
Mechanical Bathythermograph profiles made in 1943 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 376.

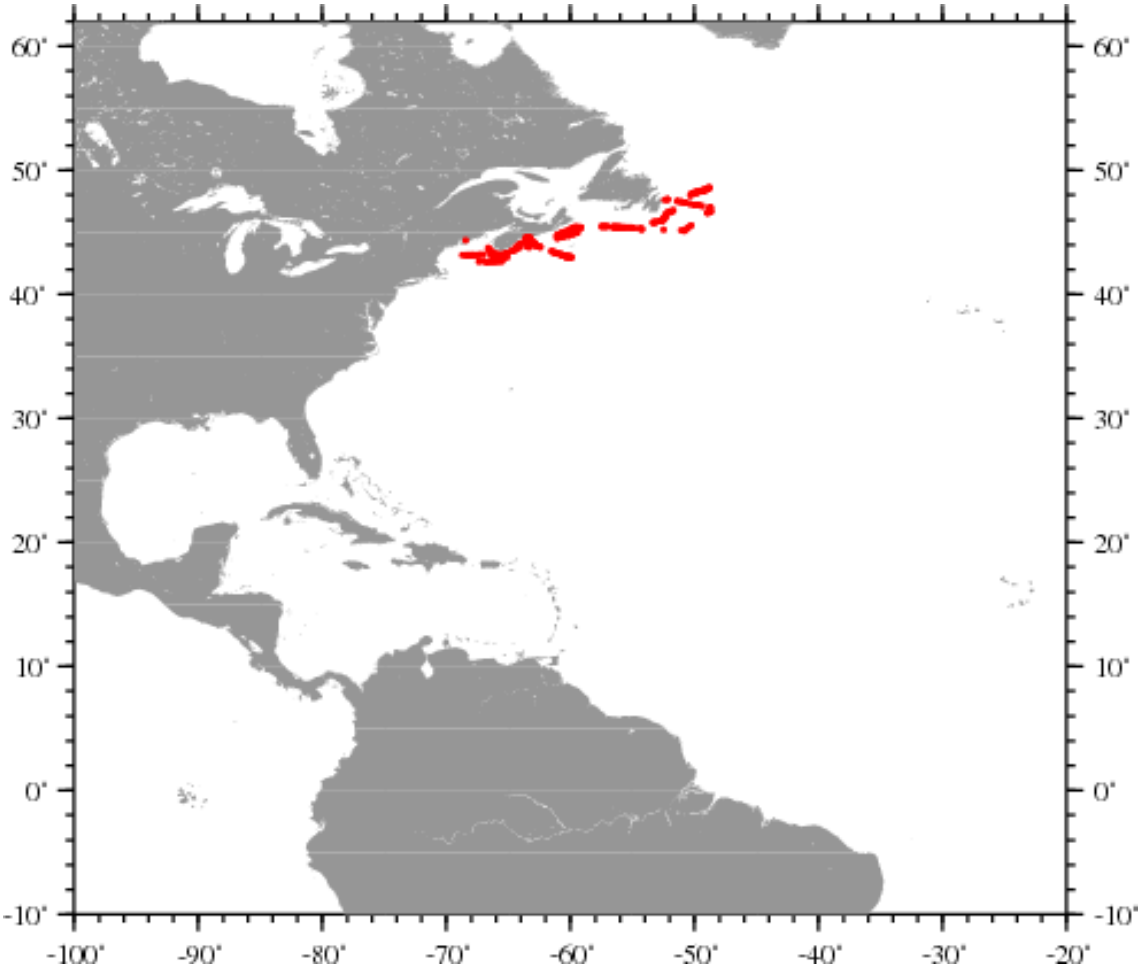


Figure 57. **Canada**
Mechanical Bathythermograph profiles made in 1944 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 256.

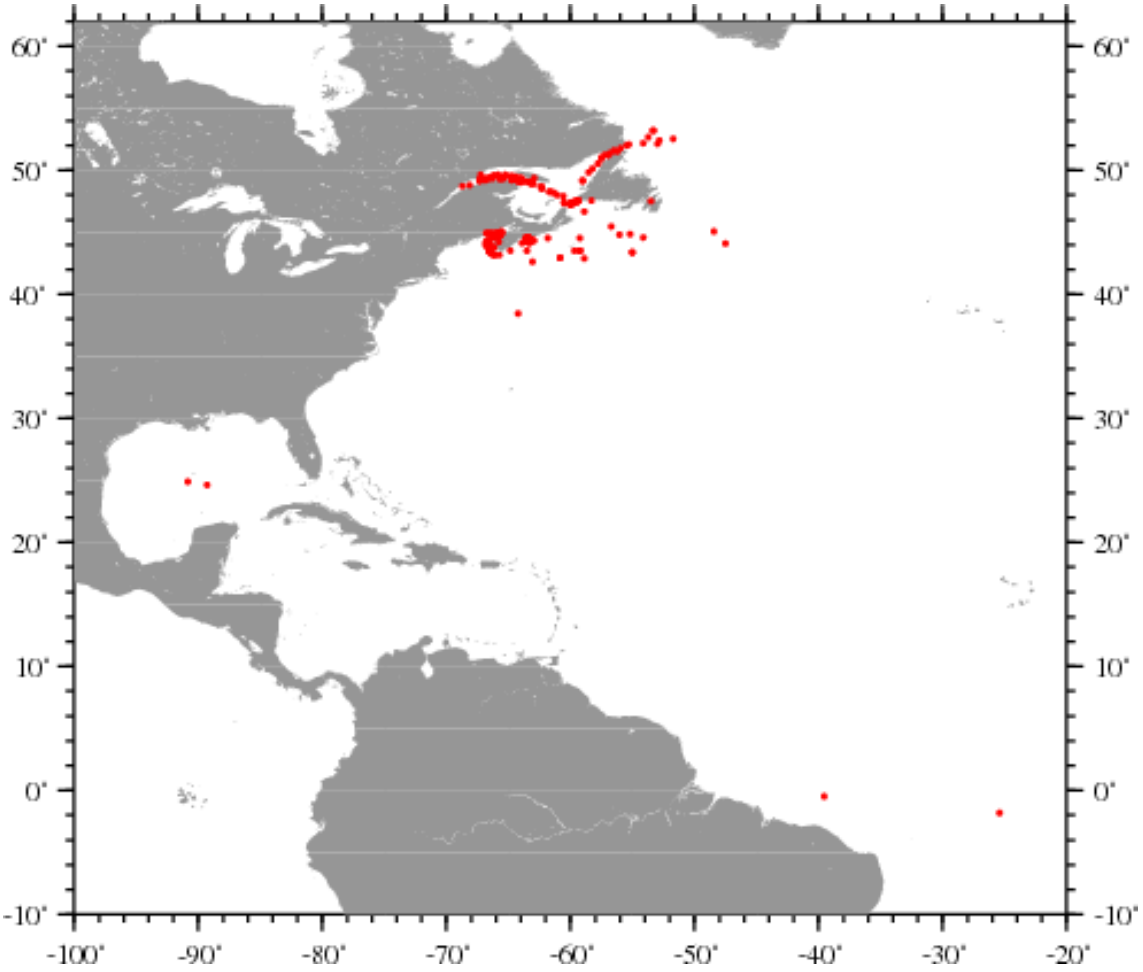


Figure 58. **Canada**
Mechanical Bathythermograph profiles made in 1945 shown as a scatter plot.
The location of each profile is signified by a red dot.
Total number of profiles = 105.

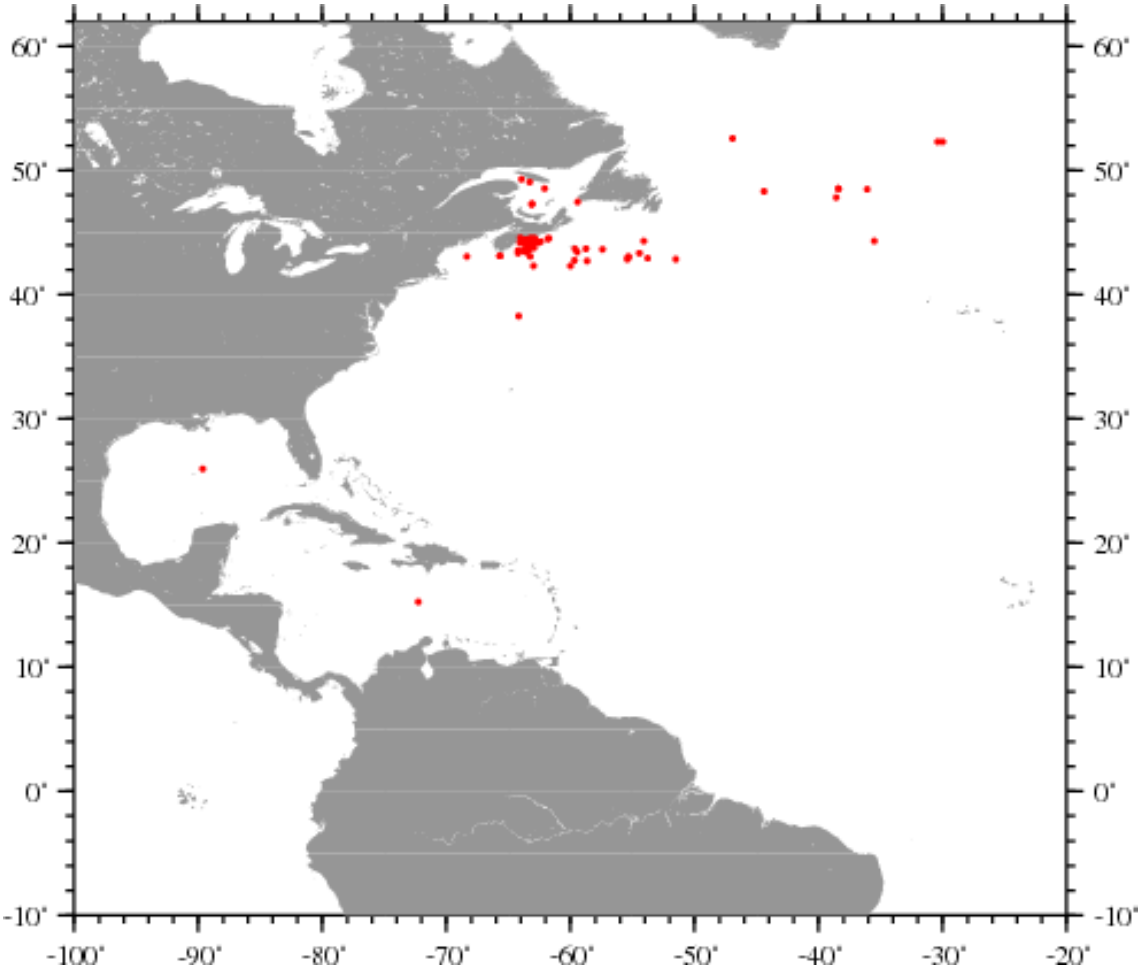


Figure 59. **Australia**
Ocean Station Data (OSD) (Bottle) casts made in 1939-1945 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 515.

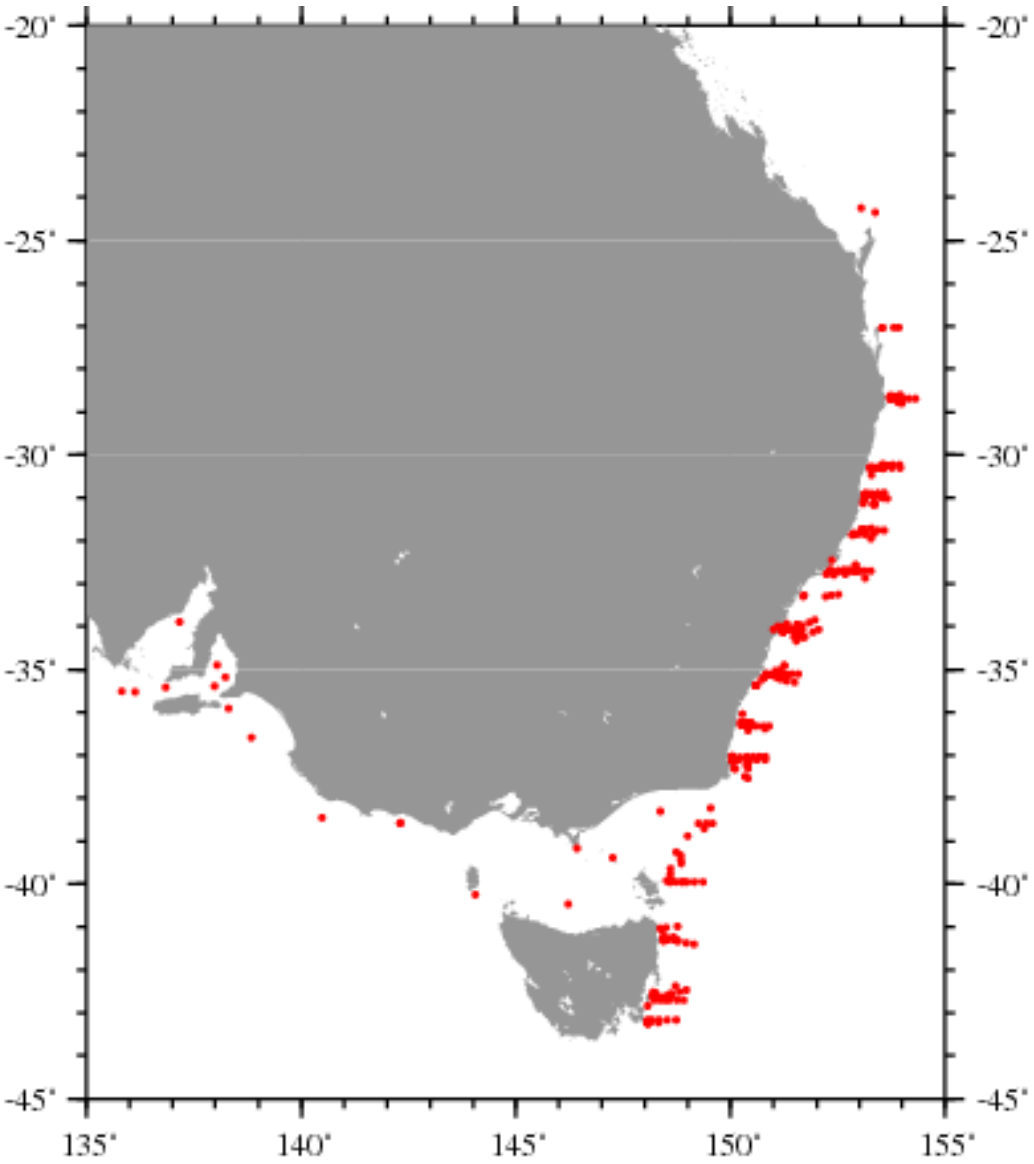


Figure 60. **Australia**
Ocean Station Data (OSD) (Bottle) casts made in 1939 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 122.

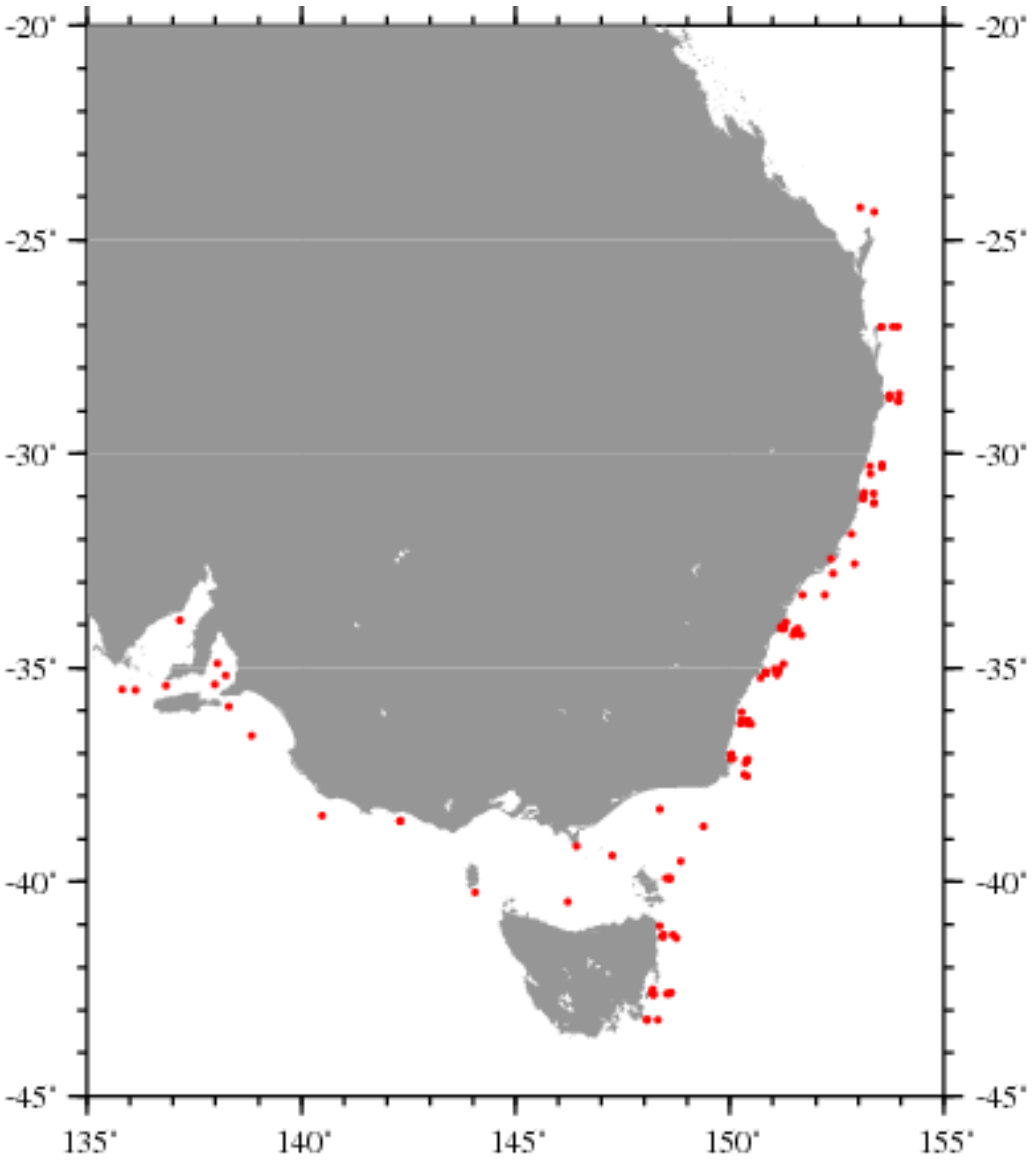


Figure 61. **Australia**
Ocean Station Data (OSD) (Bottle) casts made in 1940 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of casts = 116.

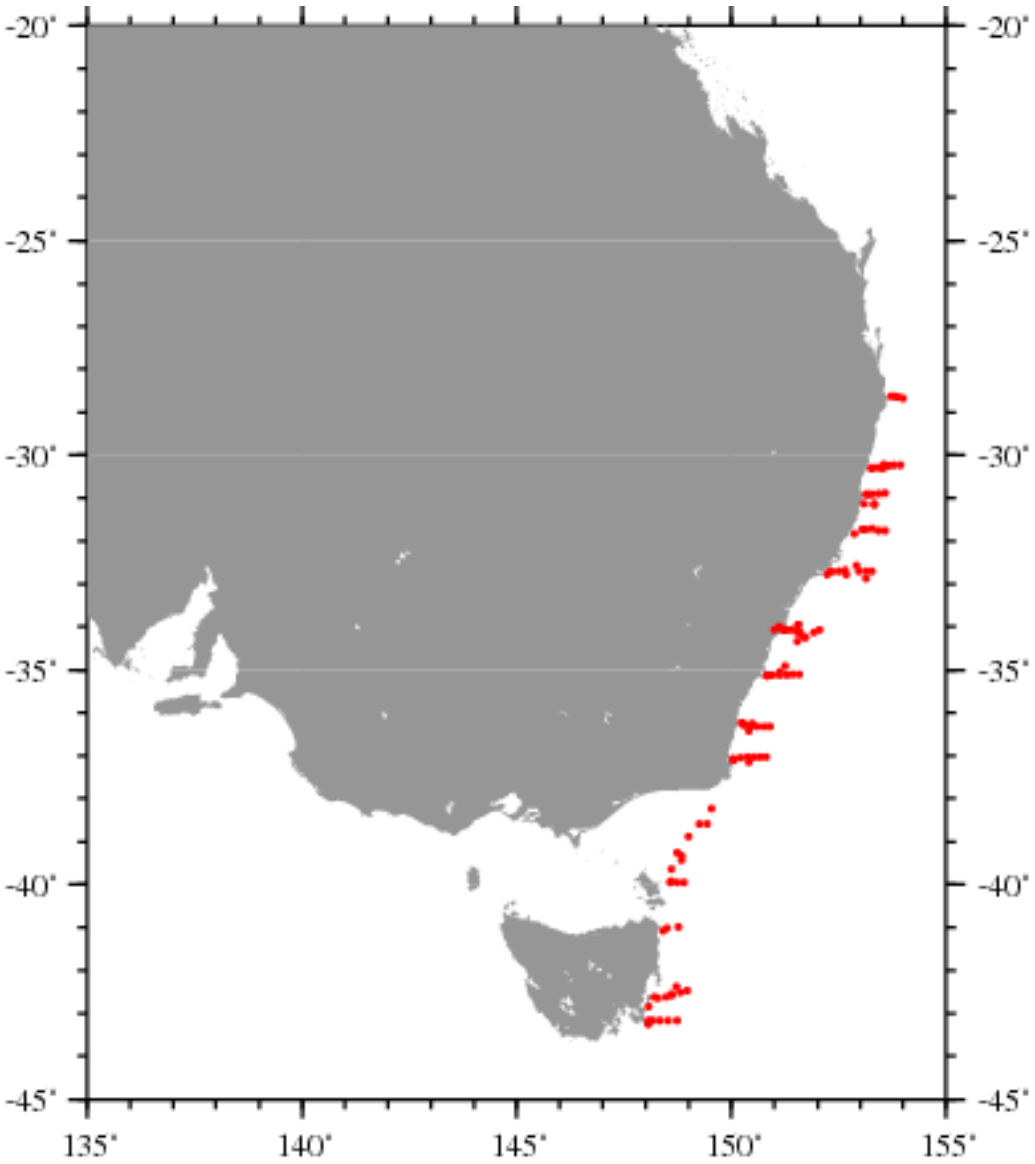


Figure 62. **Australia**
Location of Ocean Station Data (OSD) (Bottle) casts made in 1941 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 81.

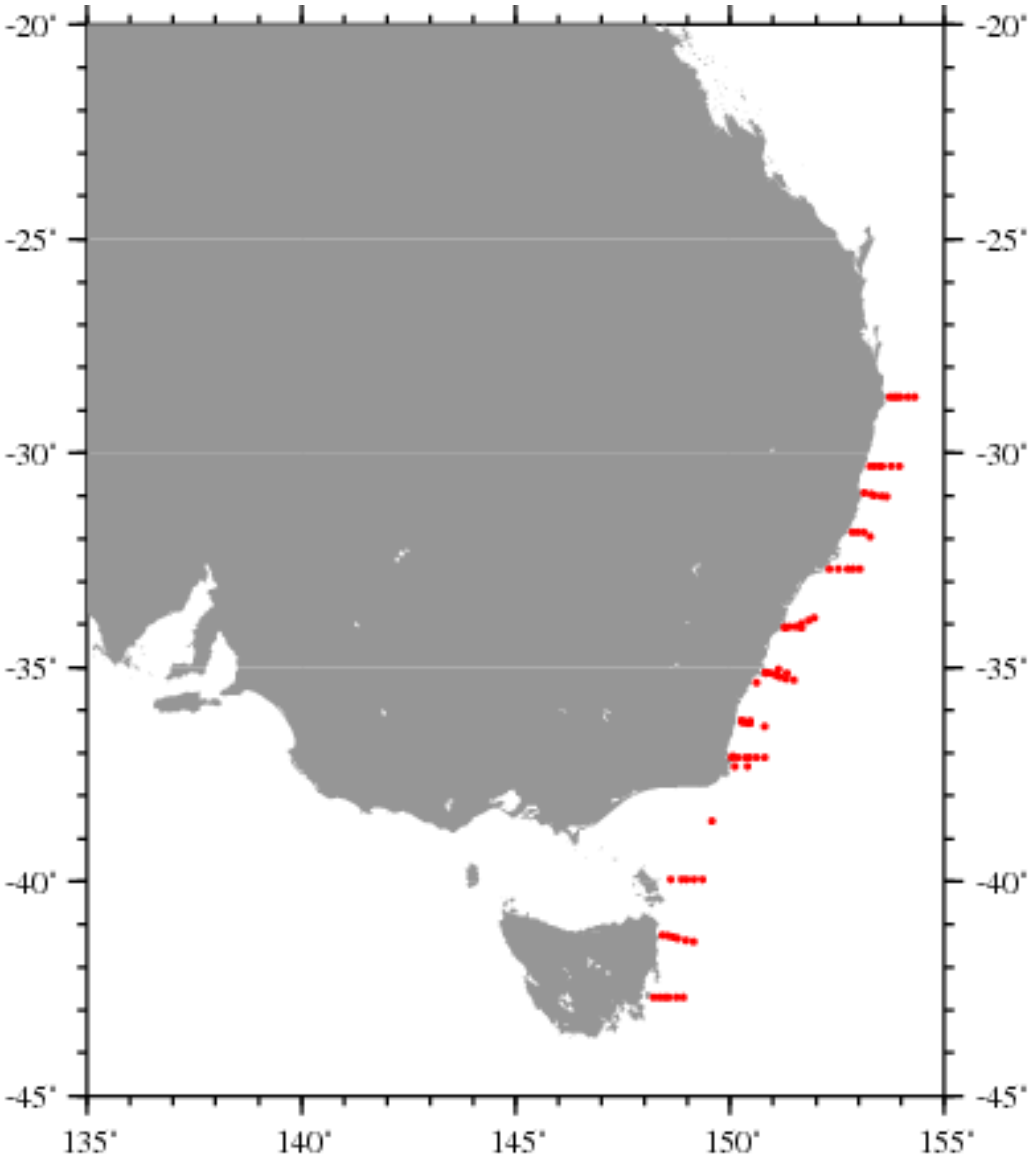


Figure 63. **Australia**
Location of Ocean Station Data (OSD) (Bottle) casts made in 1942 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 49.

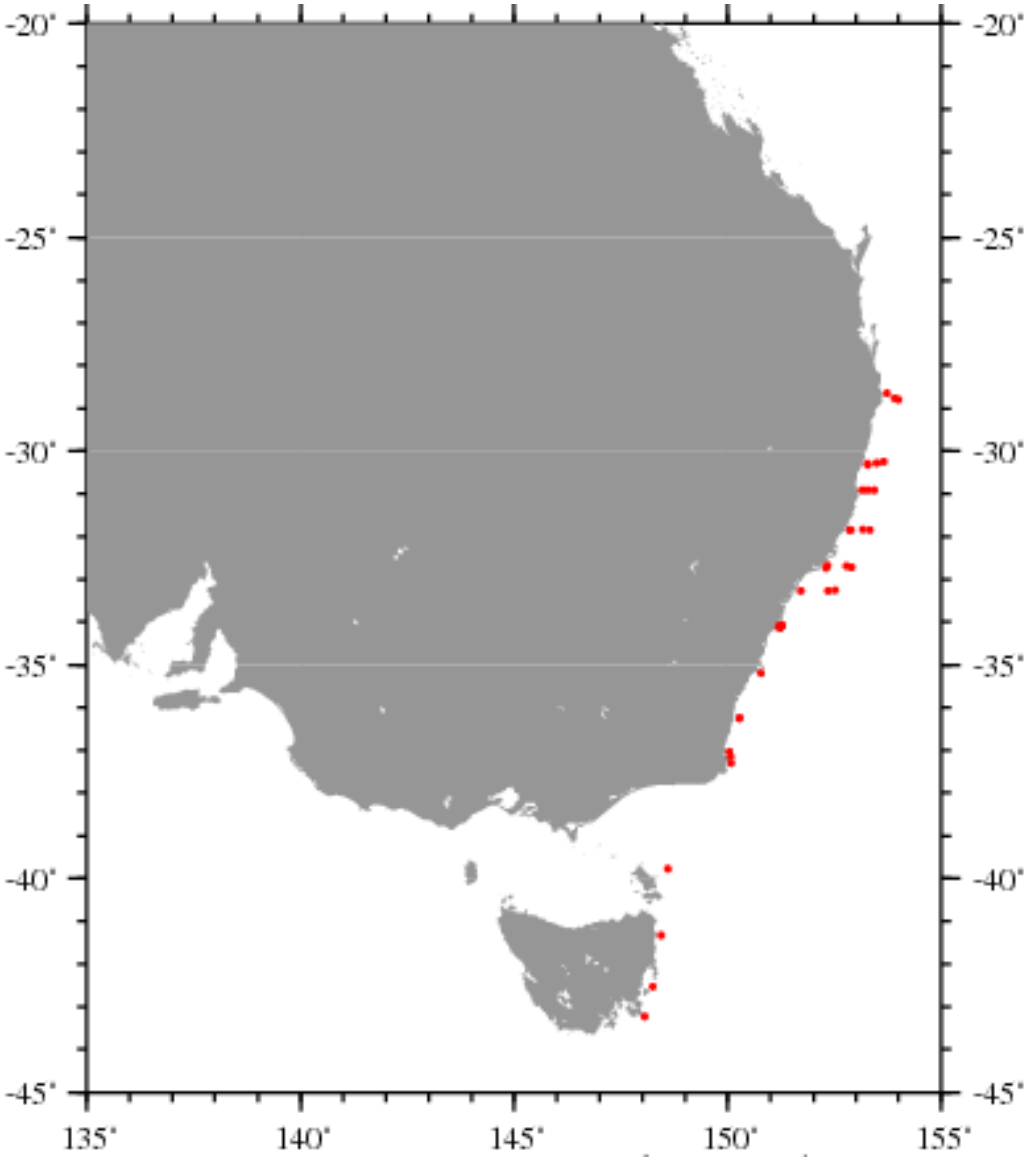


Figure 64. **Australia**
Location of Ocean Station Data (OSD) (Bottle) casts made in 1943 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 34.

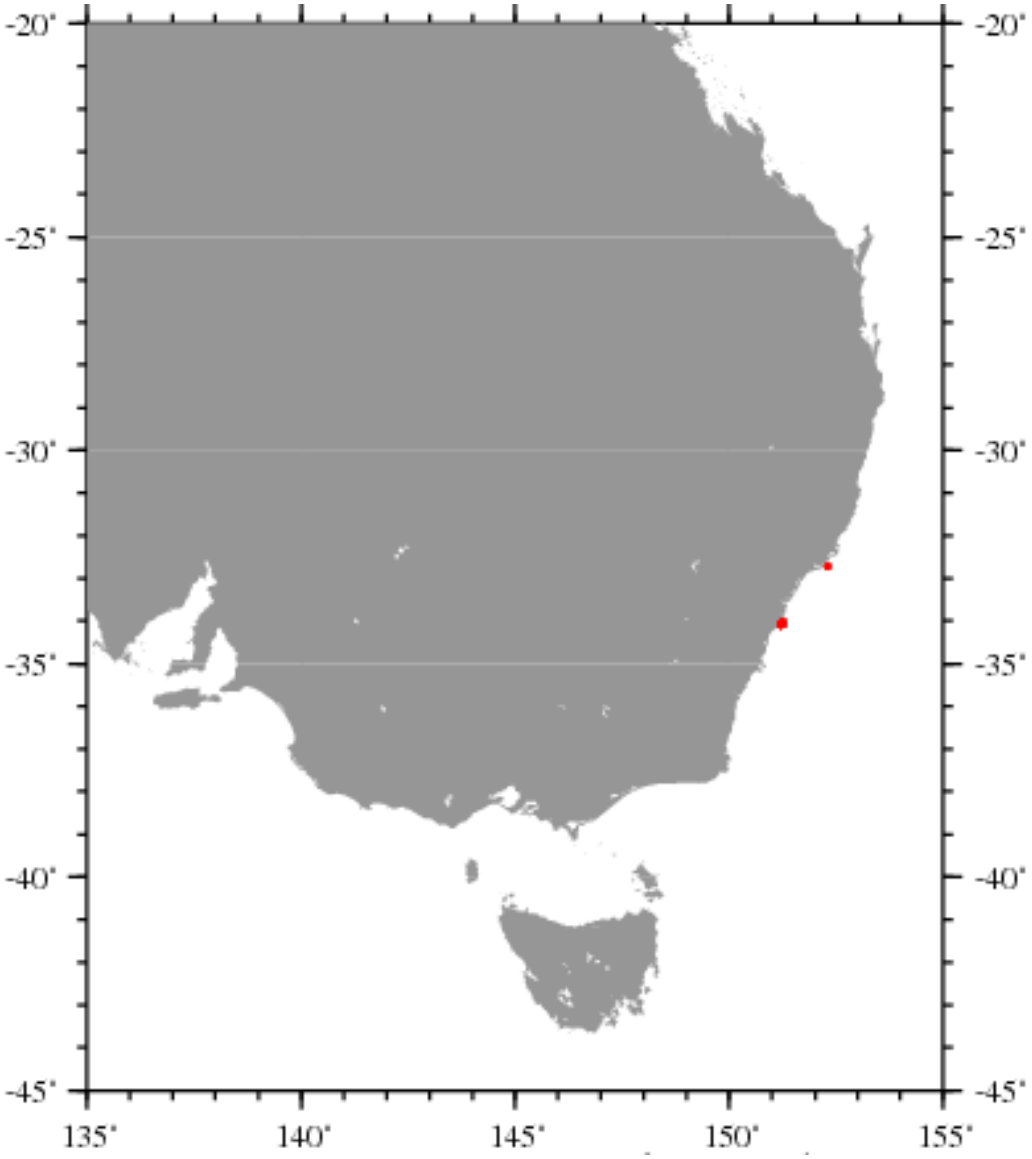


Figure 65. **Australia**
Location of Ocean Station Data (OSD) (Bottle) casts made in 1944 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 53.

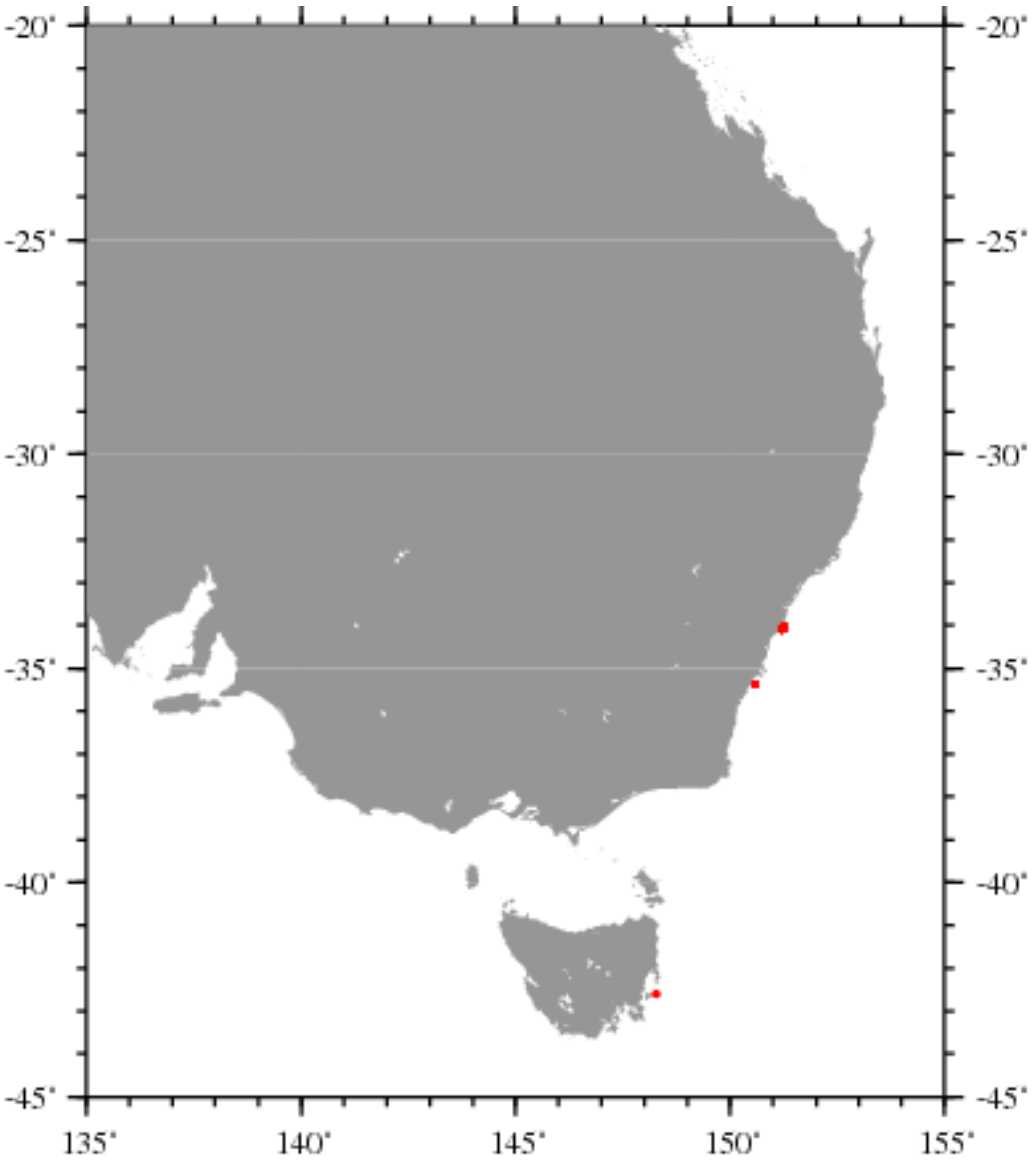


Figure 66. **Australia**
Location of Ocean Station Data (OSD) (Bottle) casts made in 1945 shown as a scatter plot. The location of each cast is signified by a red dot.
Total number of casts = 60.

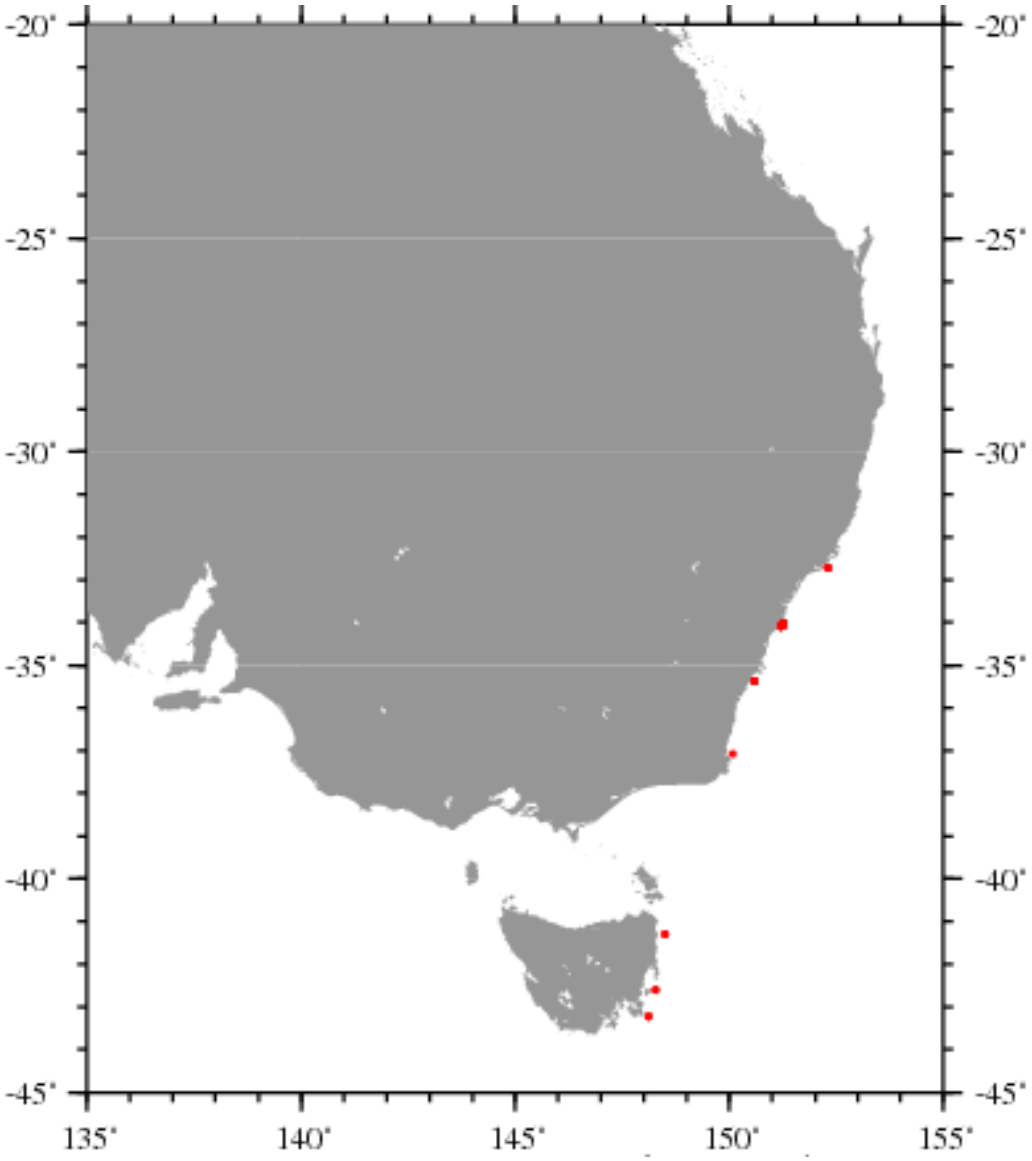
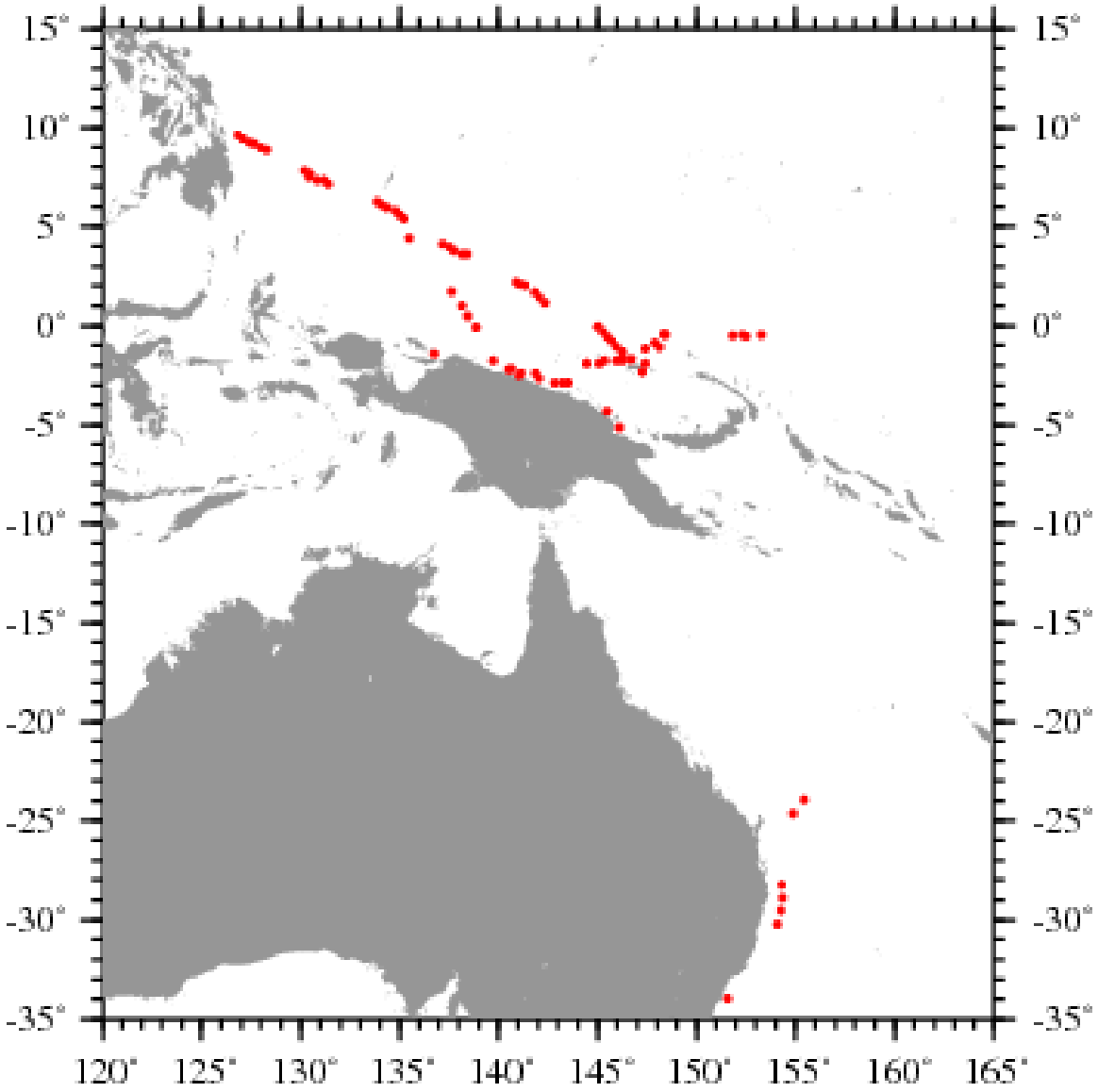


Figure 67. **Australia**
Location of Mechanical Bathythermograph profiles made in 1944 shown as a scatter plot.
The location of each cast is signified by a red dot.
Total number of profiles = 78.



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