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Supplement of

Expendable bathythermograph (XBT) data collected along the Southern Ocean chokepoint between Aotearoa / New Zealand and Antarctica, 1994–2024

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Code S1. Python XBT data visualisation code example

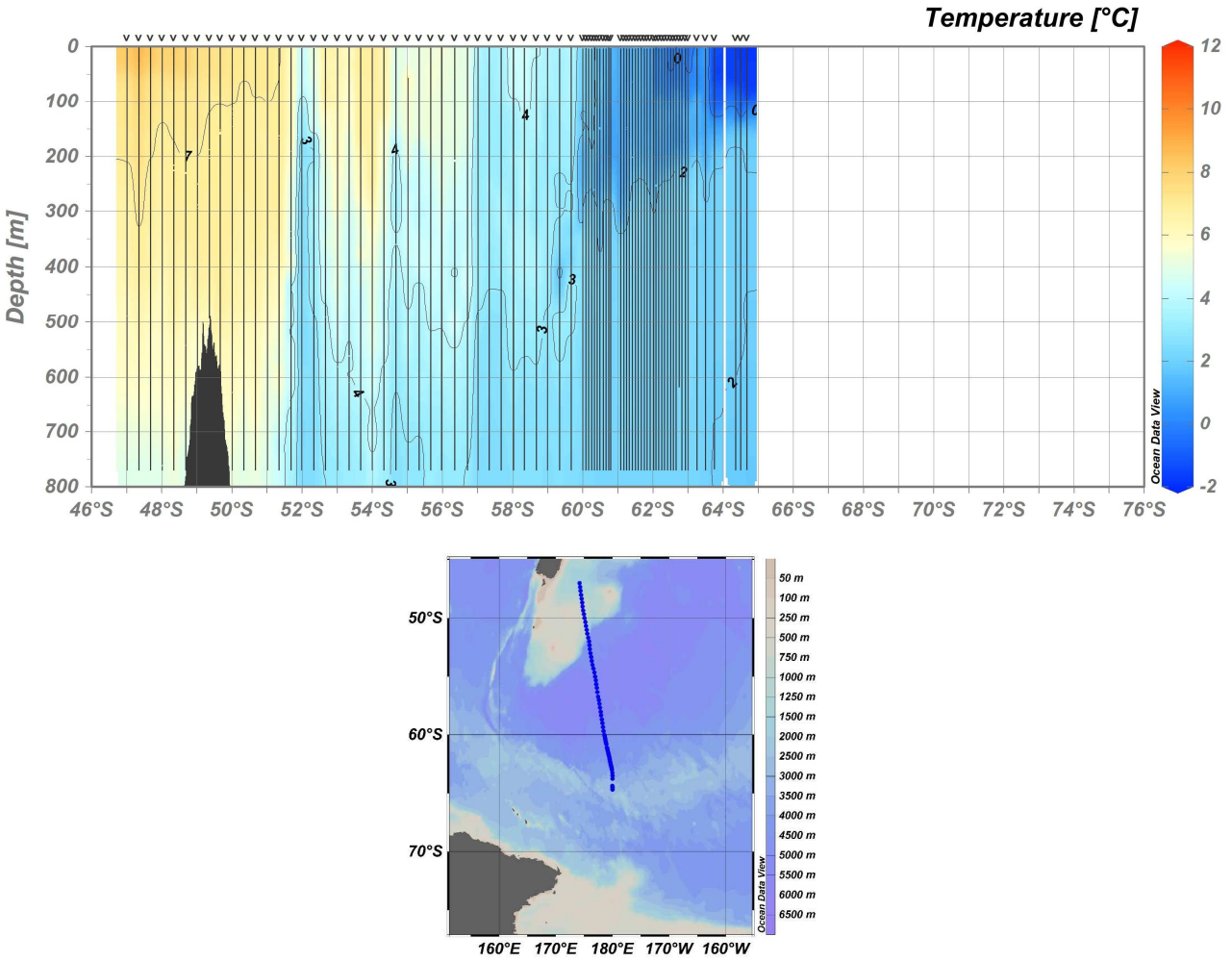

Figure S1. Temperature vertical section from XBT data collected during the first leg of the PNRA_X cruise conducted from 03 November 1994 to 06 November 1994 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

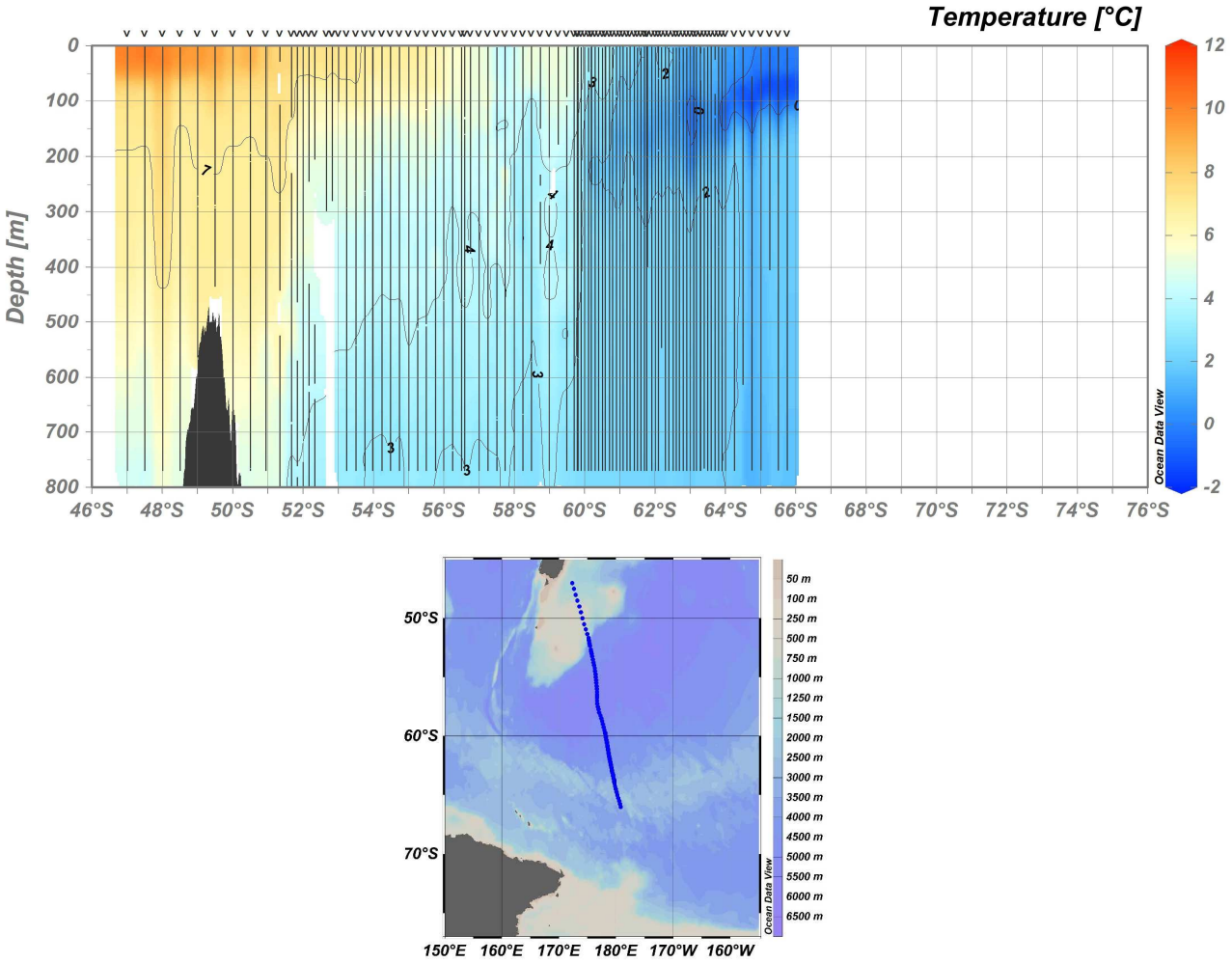

Figure S2. Temperature vertical section from XBT data collected during the second leg of the PNRA_X cruise conducted from 28 December 1994 to 01 January 1995 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

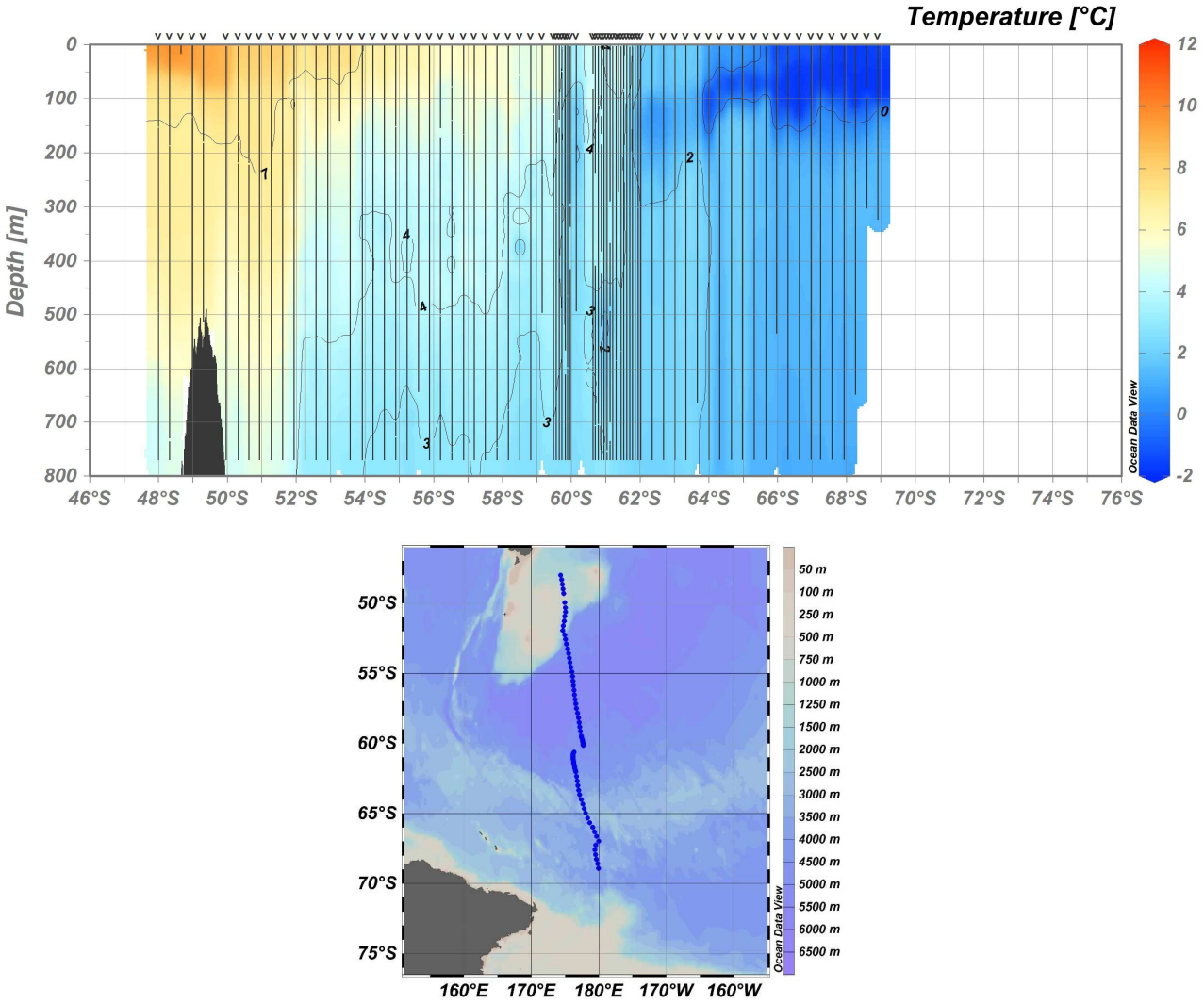

Figure S3. Temperature vertical section from XBT data collected during the third leg of the PNRA_X cruise conducted from 06 January 1995 to 11 January 1995 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

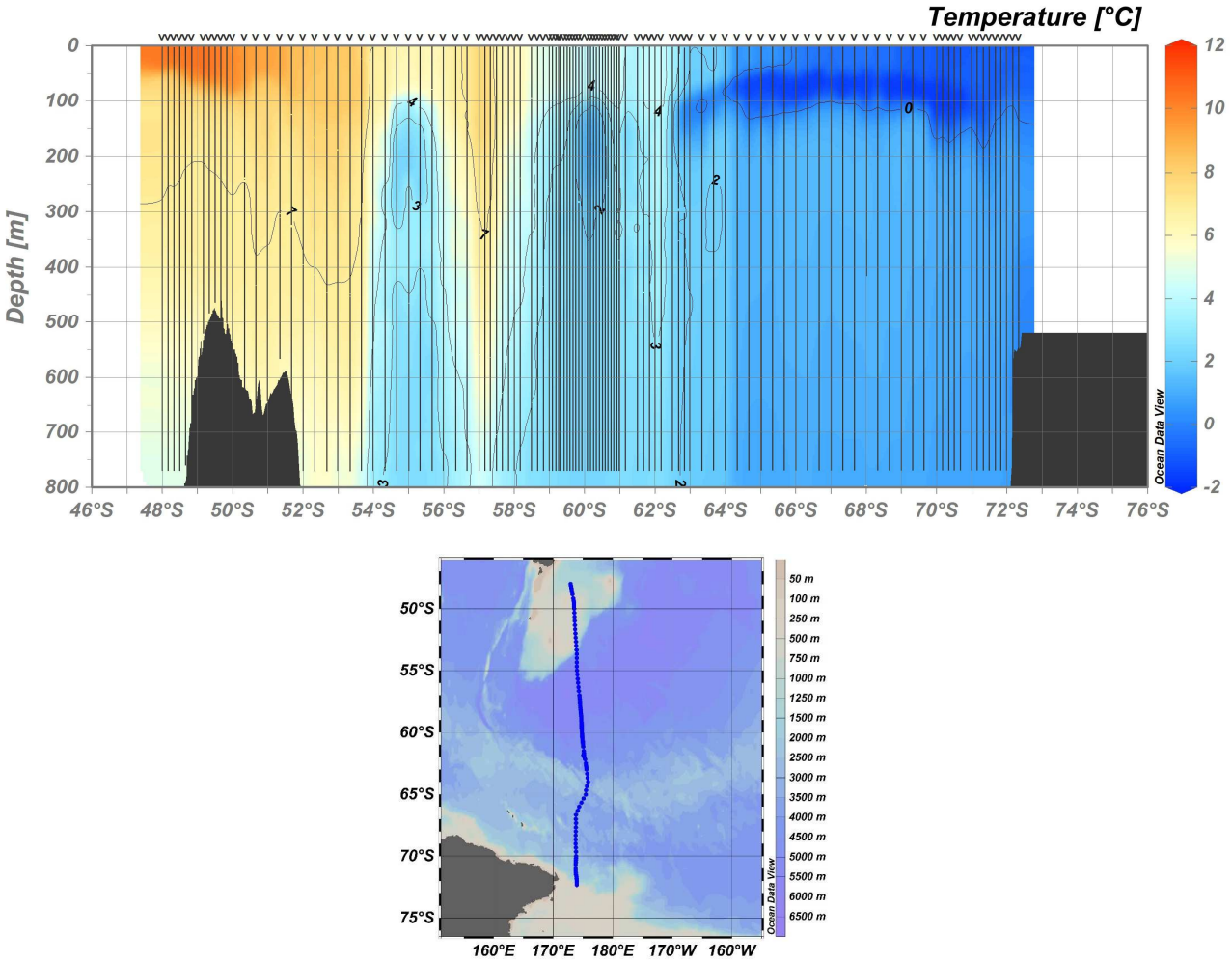

Figure S4. Temperature vertical section from XBT data collected during the forth leg of the PNRA_X cruise conducted from 26 February 1995 to 02 March 1995 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

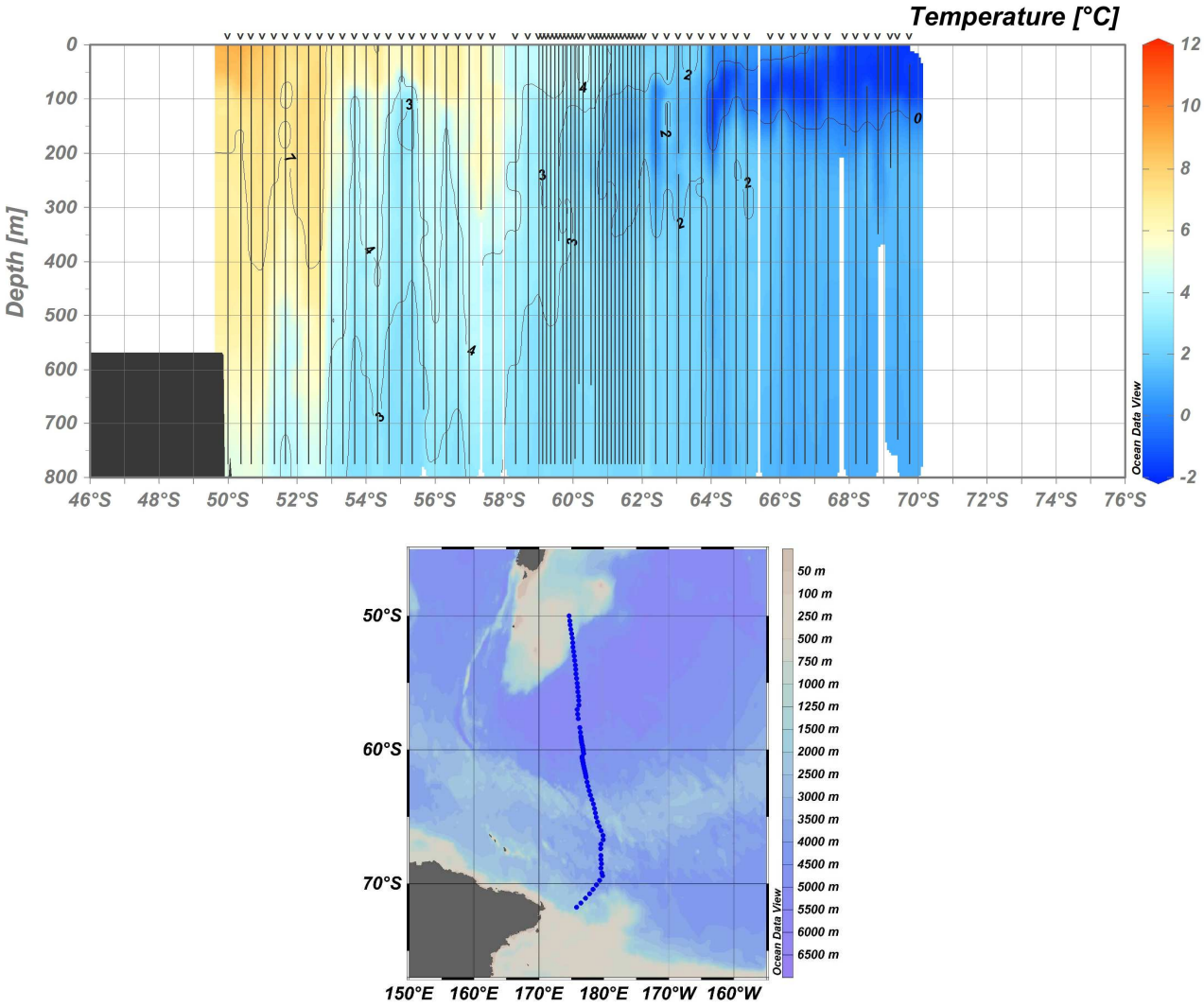

Figure S5. Temperature vertical section from XBT data collected during the first leg of the PNRA_XI cruise conducted from 07 January 1996 to 11 January 1996 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

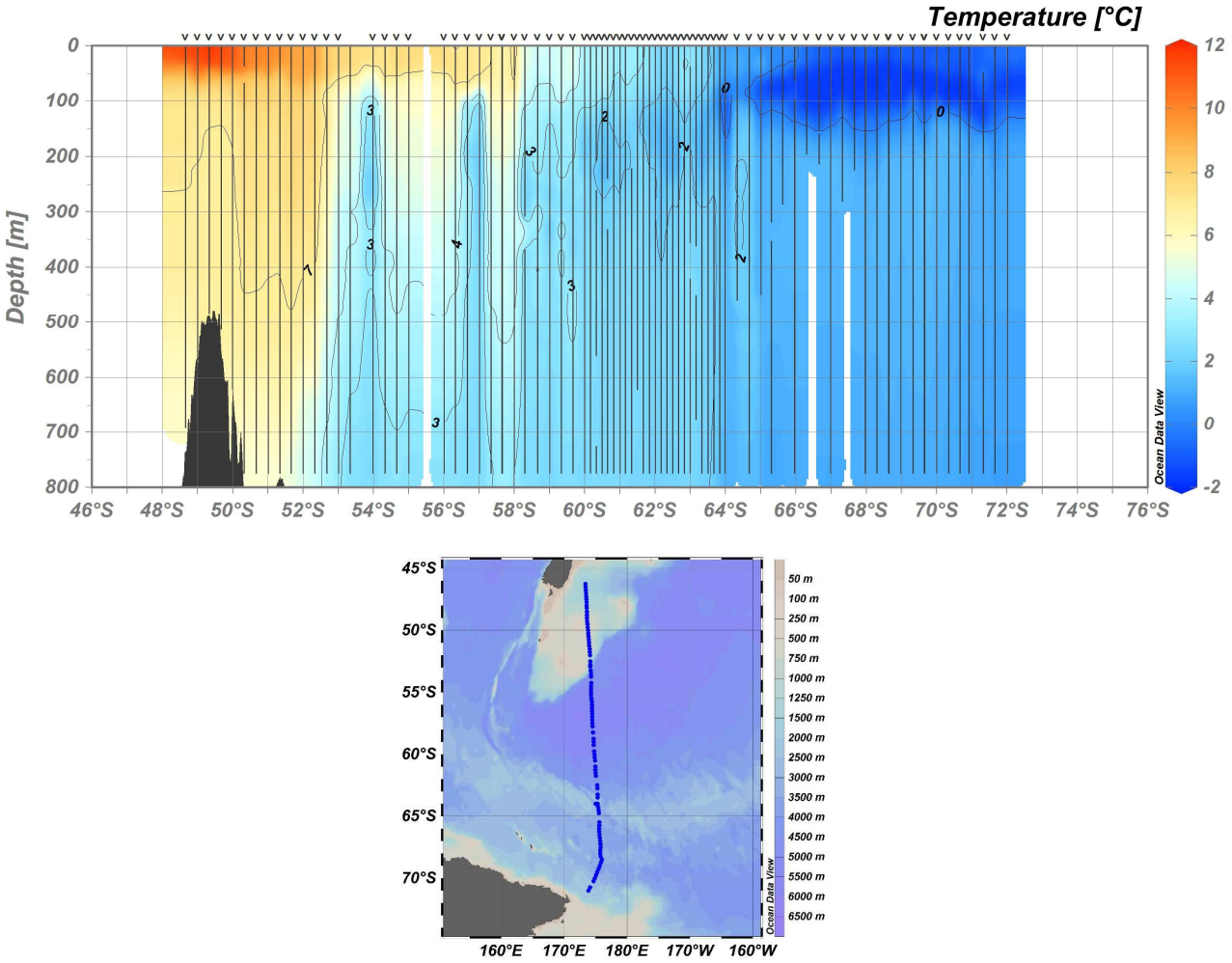

Figure S6. Temperature vertical section from XBT data collected during the second leg of the PNRA_XI cruise conducted from 13 February 1996 to 18 February 1996 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

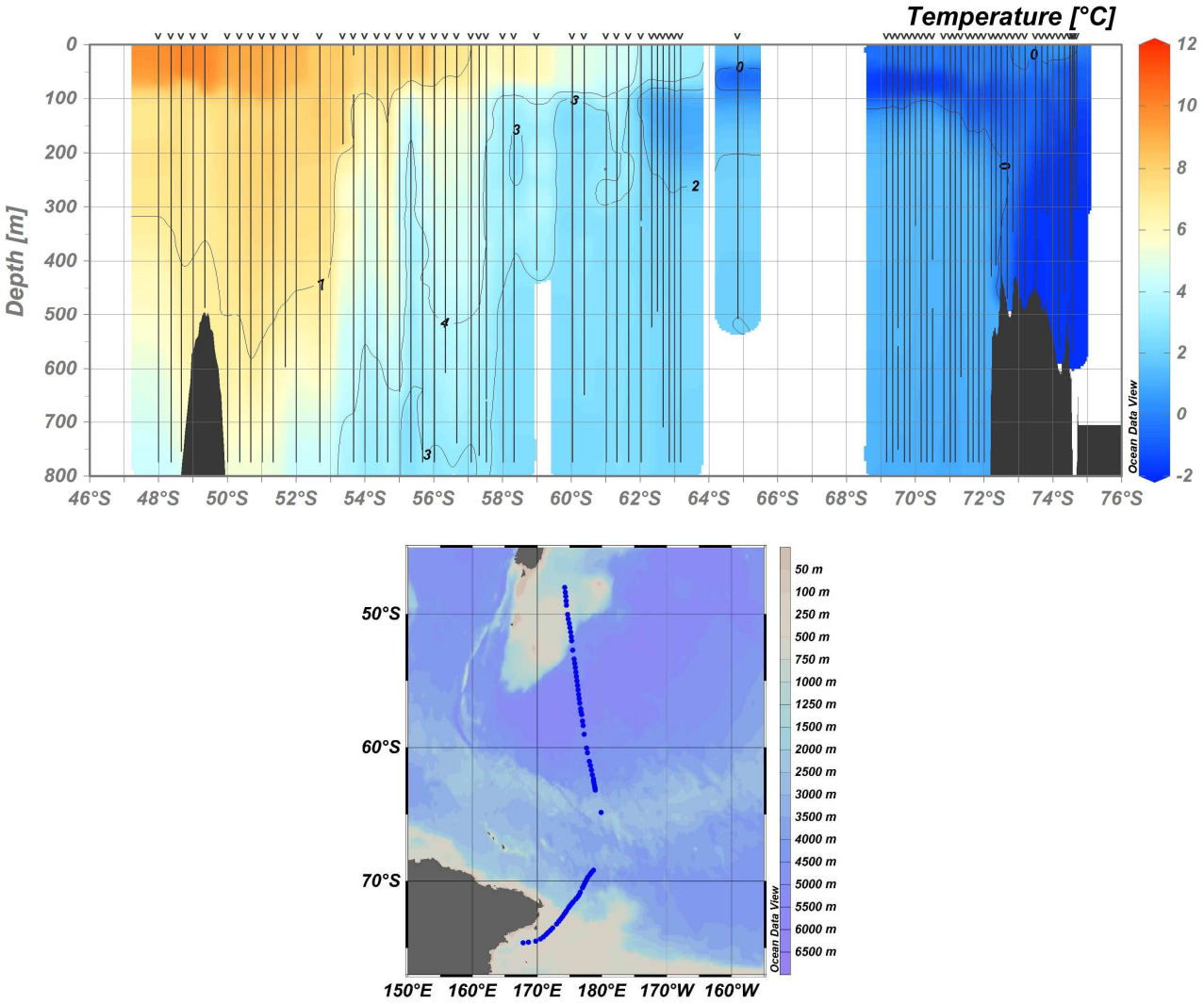

Figure S7. Temperature vertical section from XBT data collected during the first leg of the PNRA_XII cruise conducted from 26 January 1997 to 30 January 1997 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

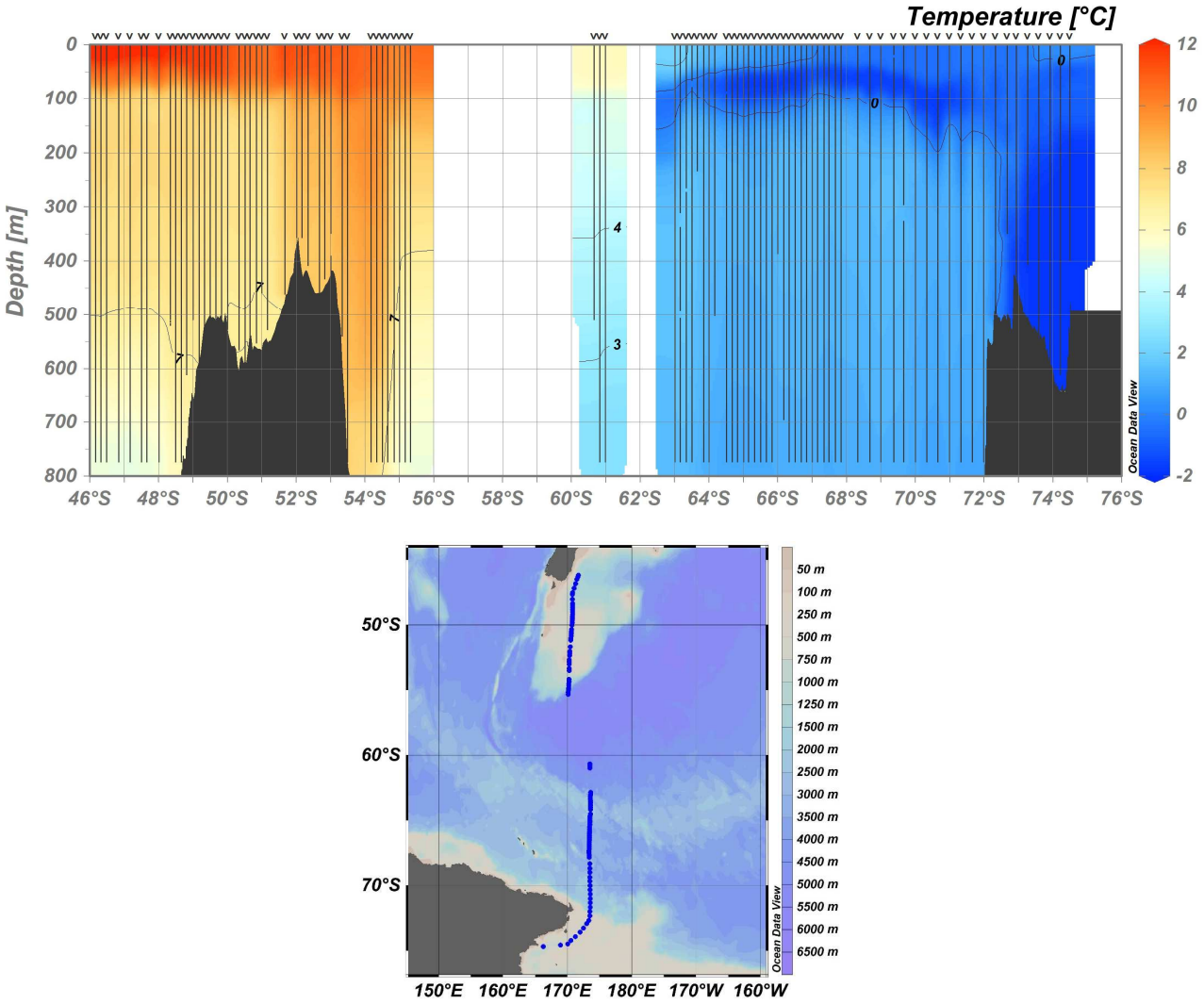

Figure S8. Temperature vertical section from XBT data collected during the second leg of the PNRA_XII cruise conducted from 14 February 1997 to 19 February 1997 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

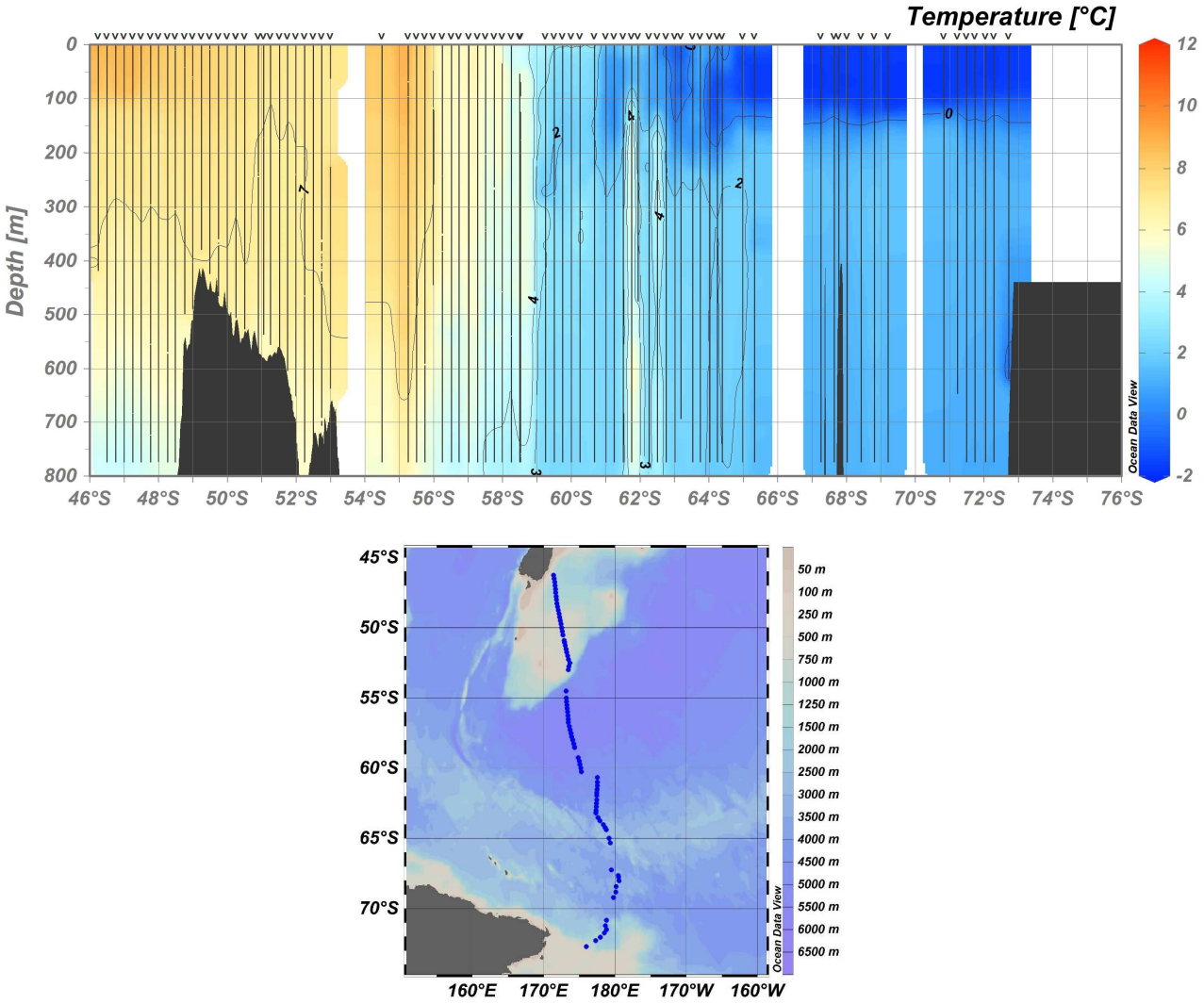

Figure S9. Temperature vertical section from XBT data collected during the first leg of the PNRA_XIII cruise conducted from 23 November 1997 to 28 November 1997 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

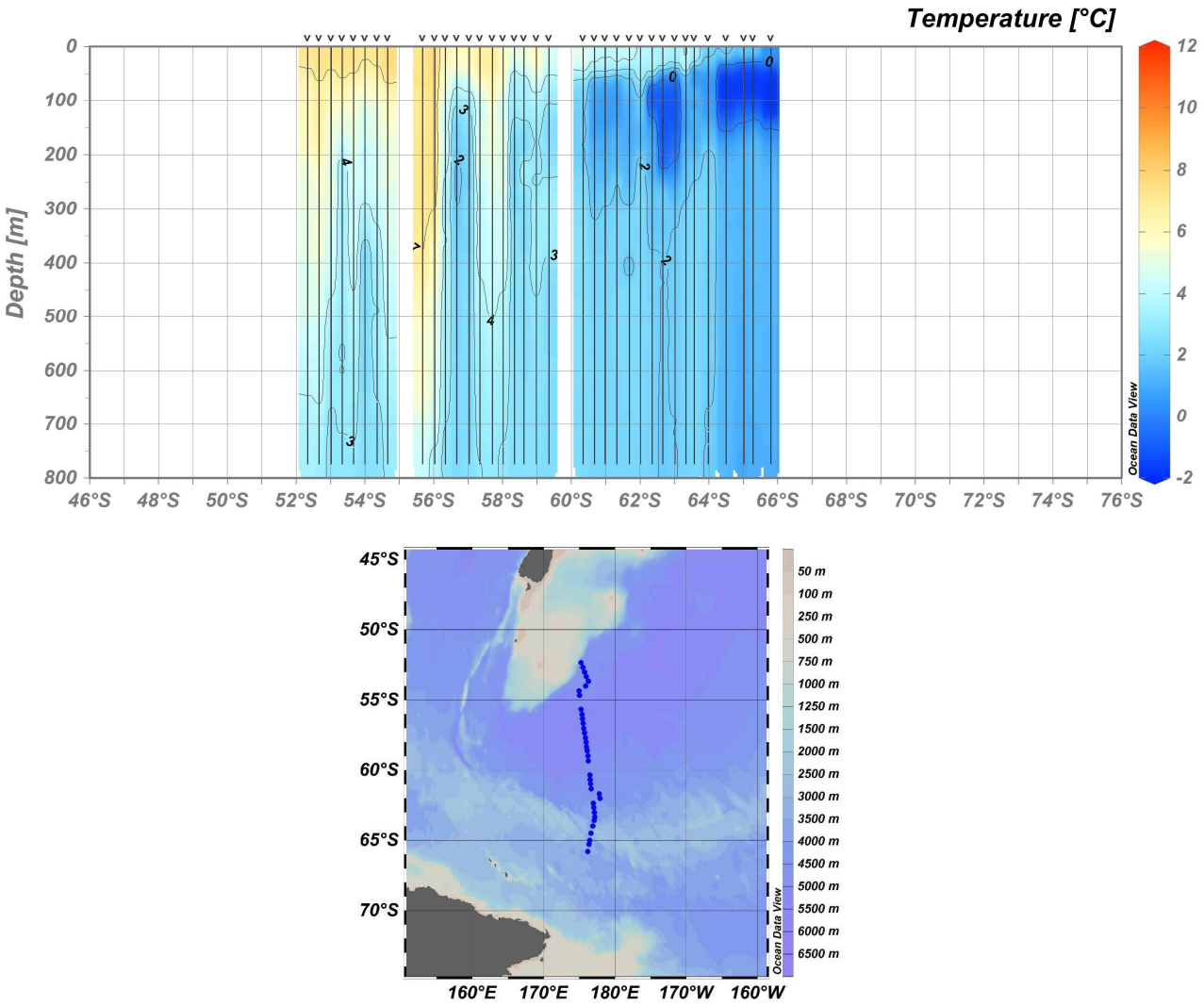

Figure S10. Temperature vertical section from XBT data collected during the second leg of the PNRA_XIII cruise conducted from 09 January 1998 to 12 January 1998 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

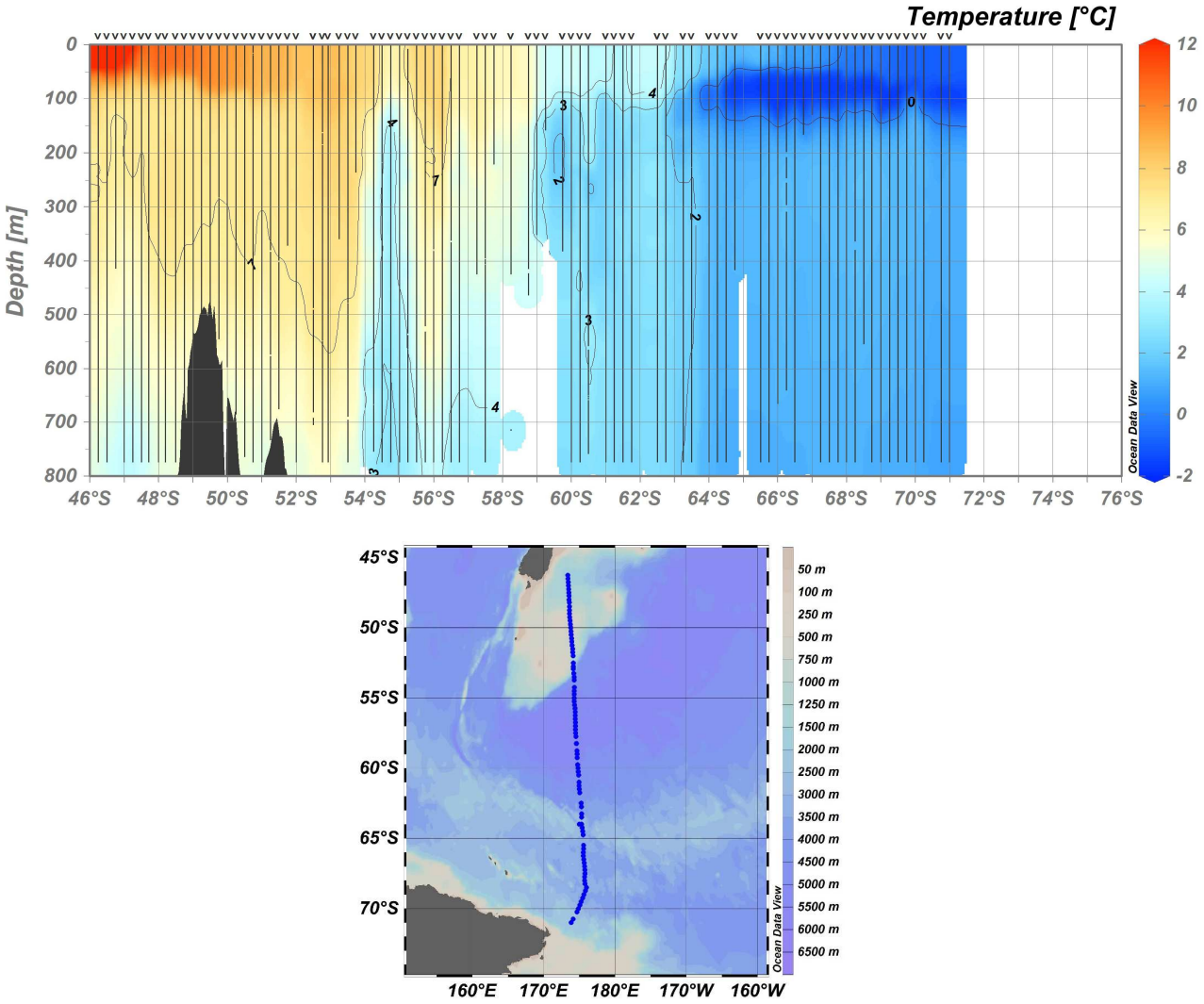

Figure S11. Temperature vertical section from XBT data collected during the third leg of the PNRA_XIII cruise conducted from 28 February 1998 to 06 March 1998 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

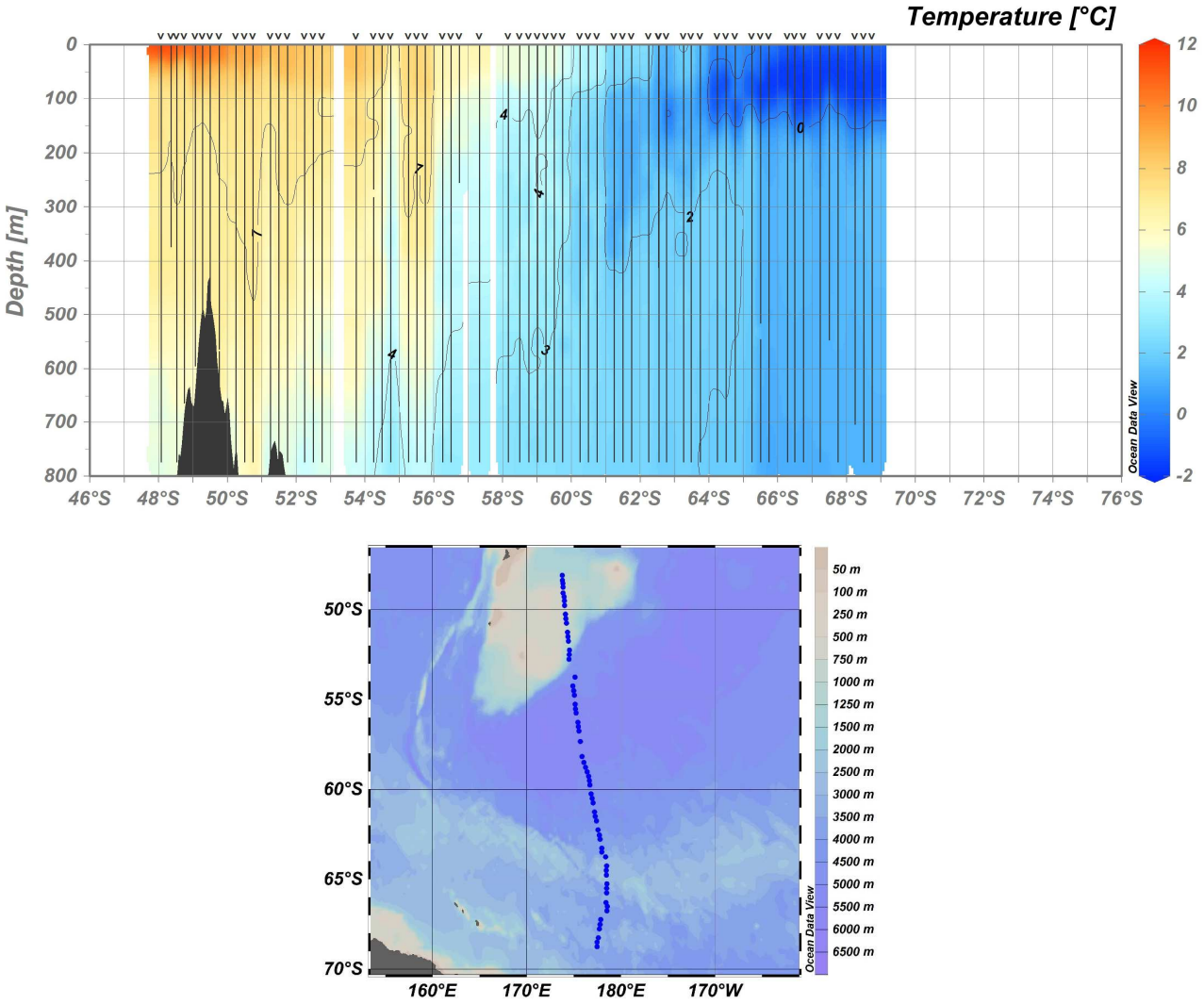

Figure S12. Temperature vertical section from XBT data collected during the PNRA_XIV cruise conducted from 05 January 1999 to 11 January 1999 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

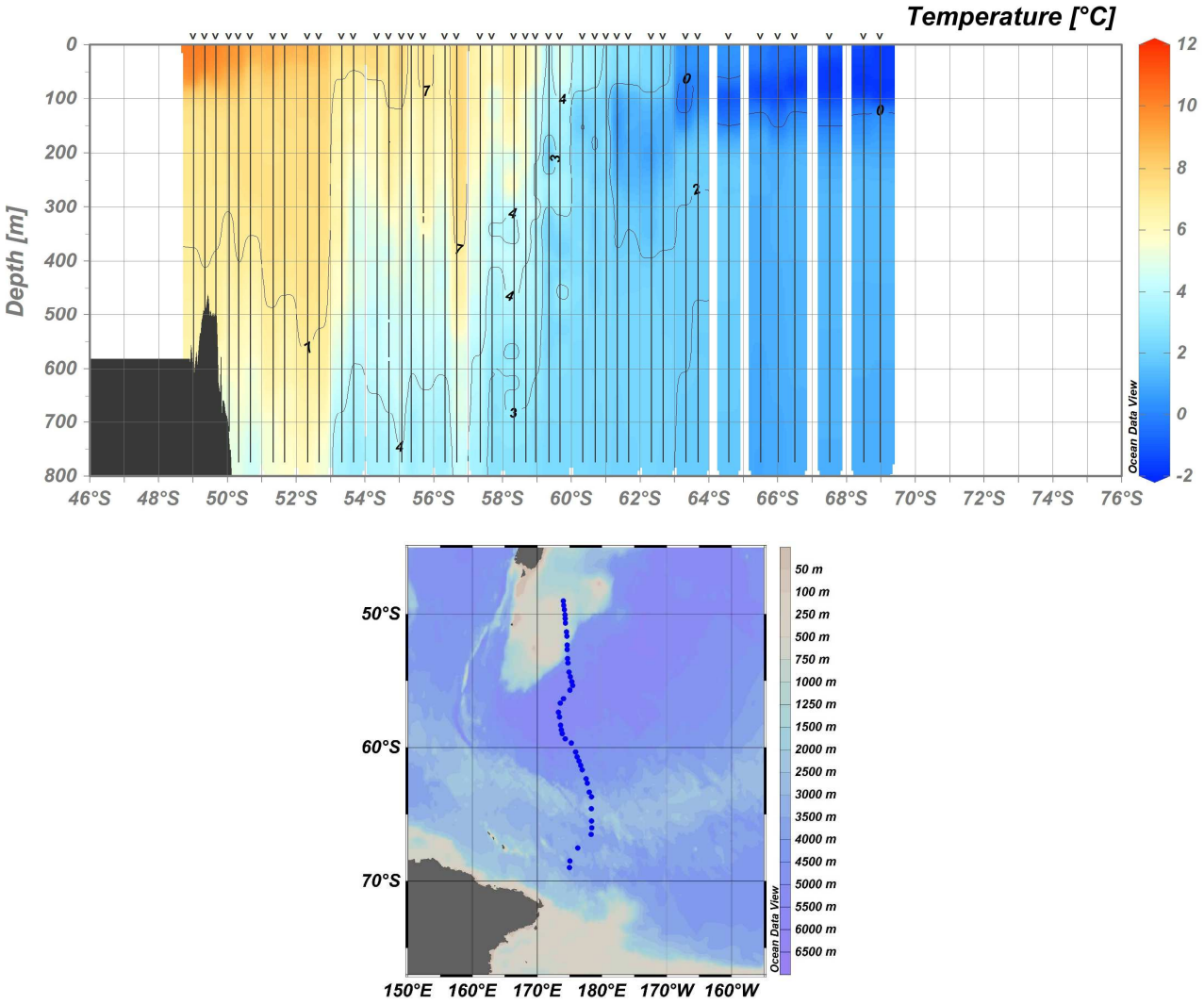

Figure S13. Temperature vertical section from XBT data collected during the PNRA_XV cruise conducted from 07 January 2000 to 12 January 2000 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

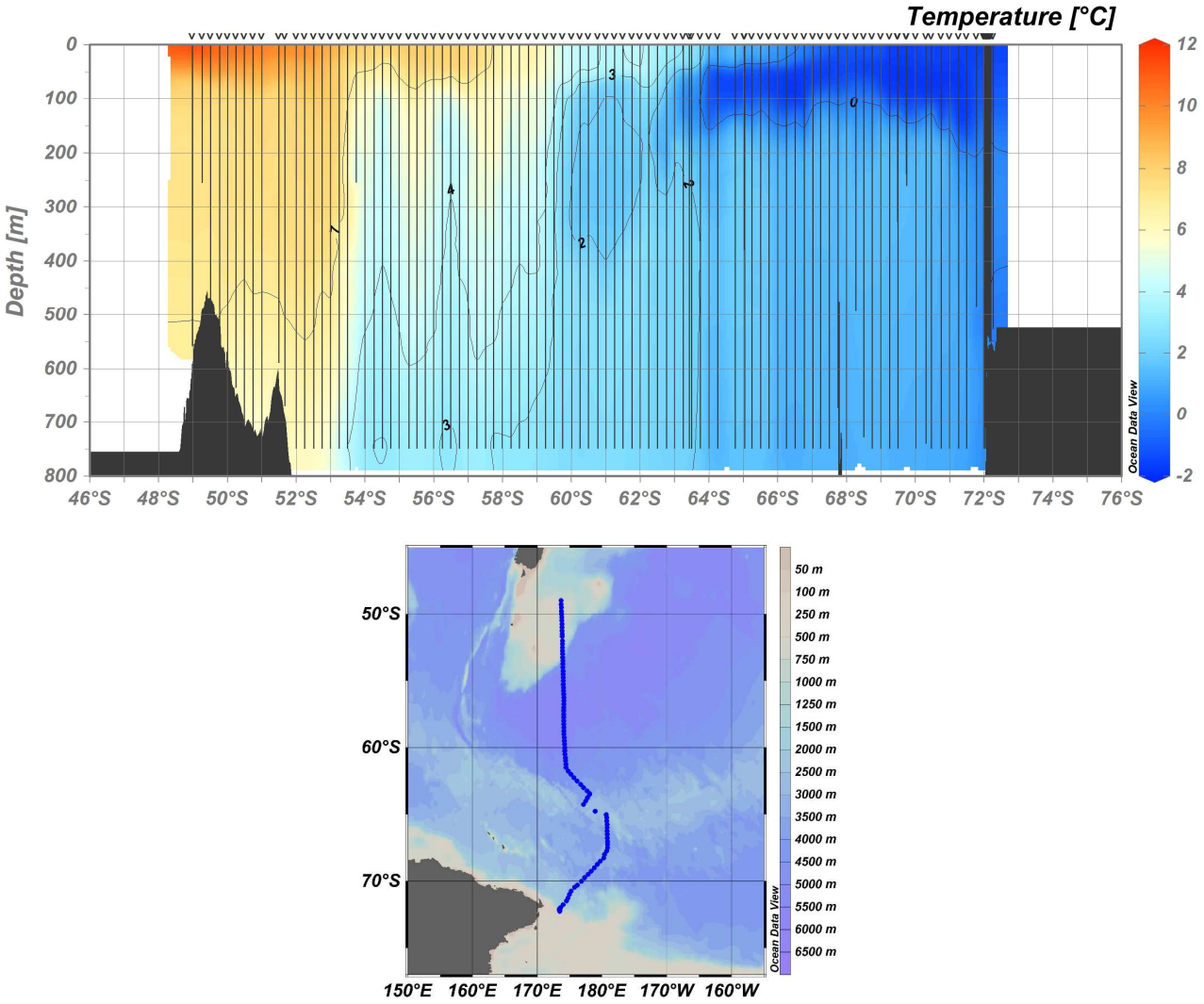

Figure S14. Temperature vertical section from XBT data collected during the first leg of the PNRA_XVI cruise conducted from 06 January 2001 to 10 January 2001 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

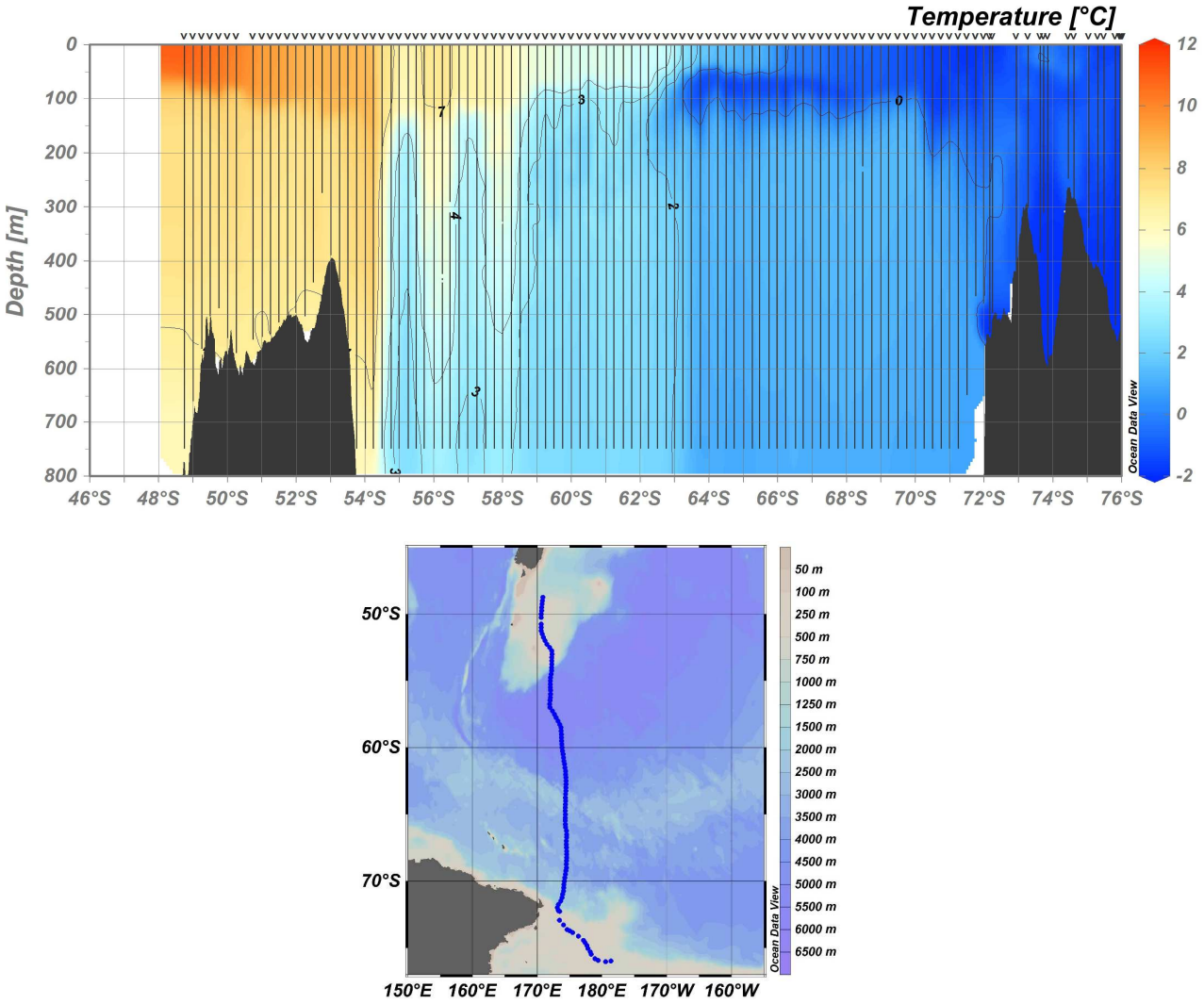

Figure S15. Temperature vertical section from XBT data collected during the second leg of the PNRA_XVI cruise conducted from 21 February 2001 to 26 February 2001 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

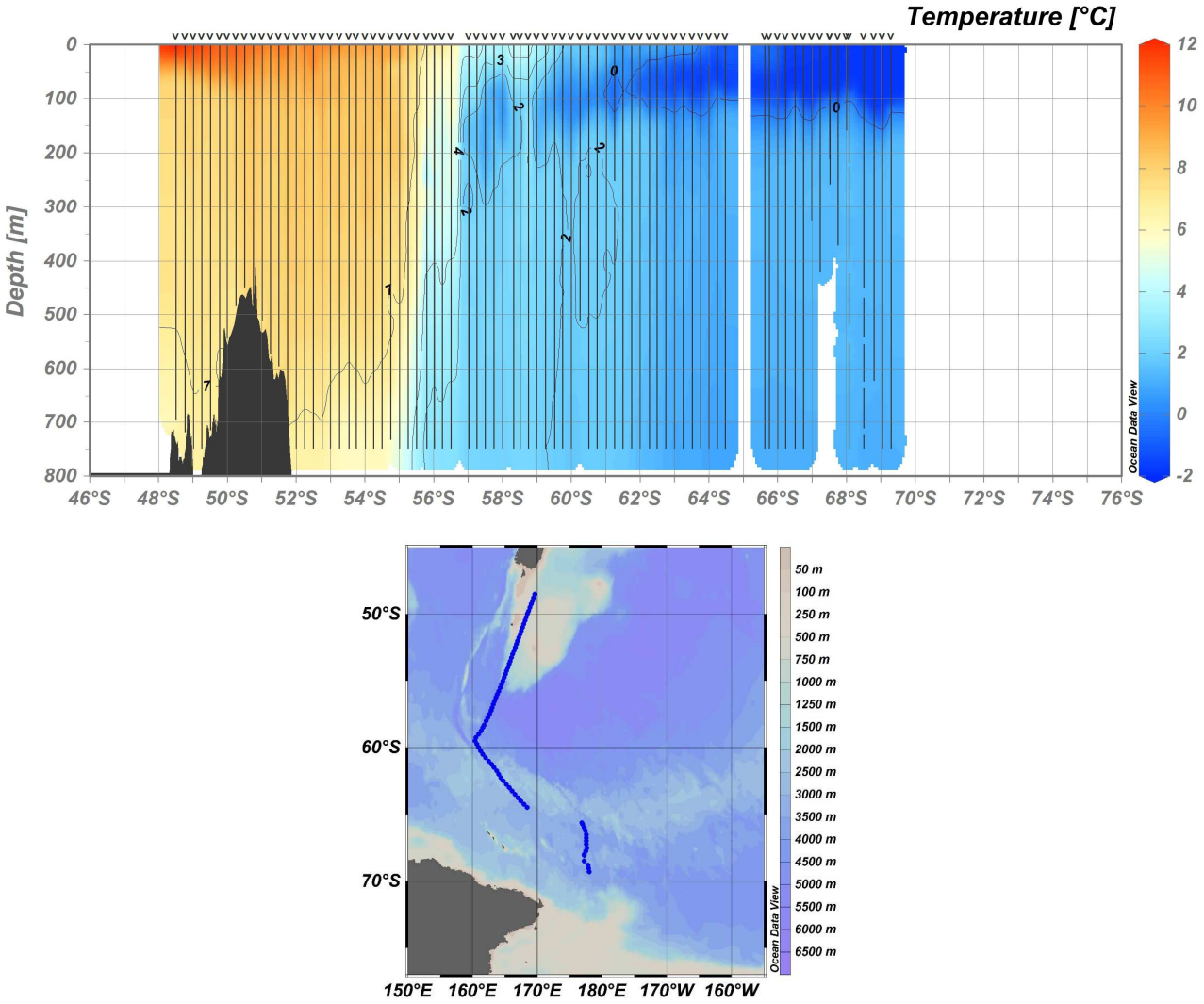

Figure S16. Temperature vertical section from XBT data collected during the PNRA_XVII cruise conducted from 24 December 2001 to 28 December 2001 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

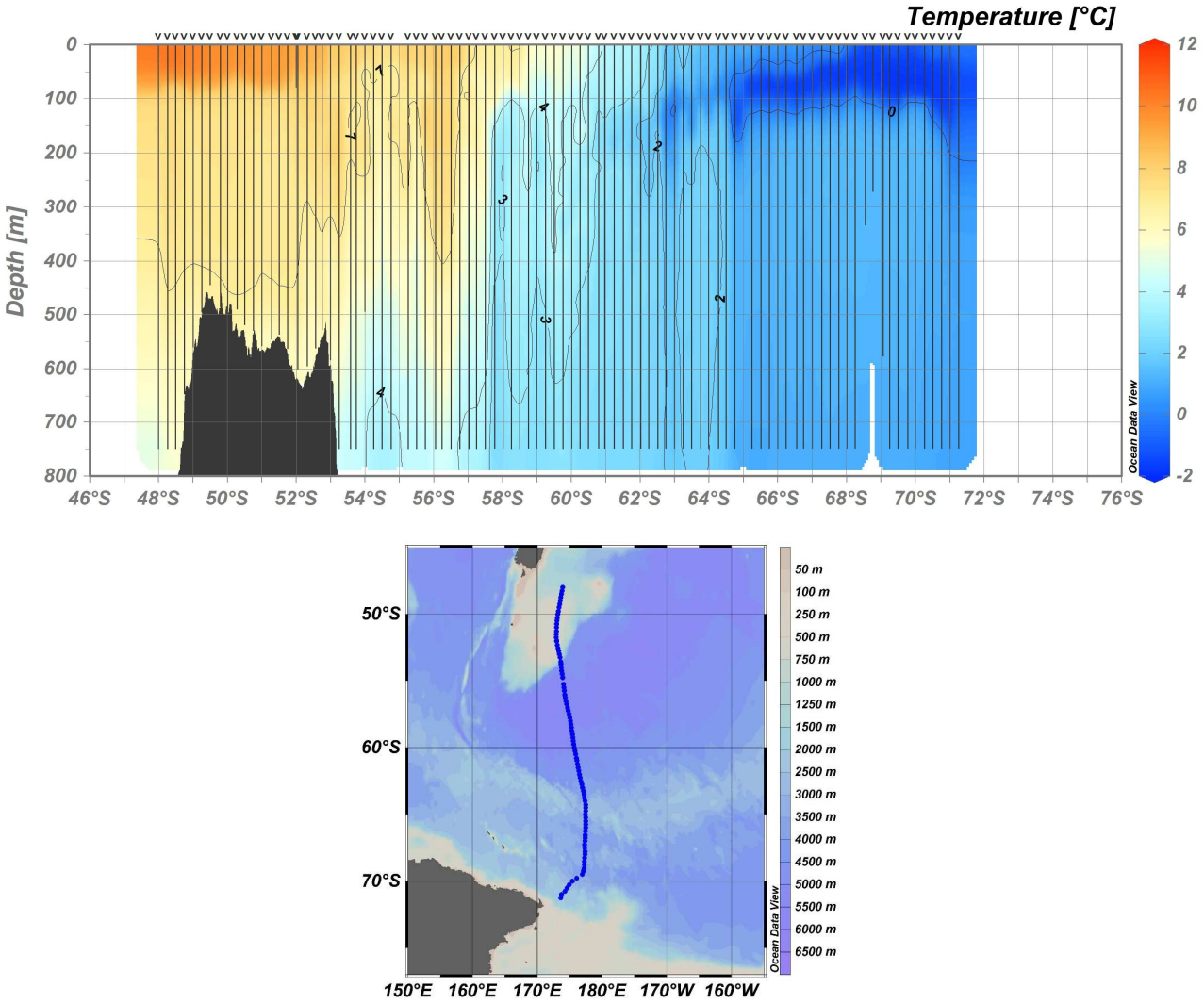

Figure S17. Temperature vertical section from XBT data collected during the PNRA_XVIII cruise conducted from 06 January 2003 to 11 January 2003 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

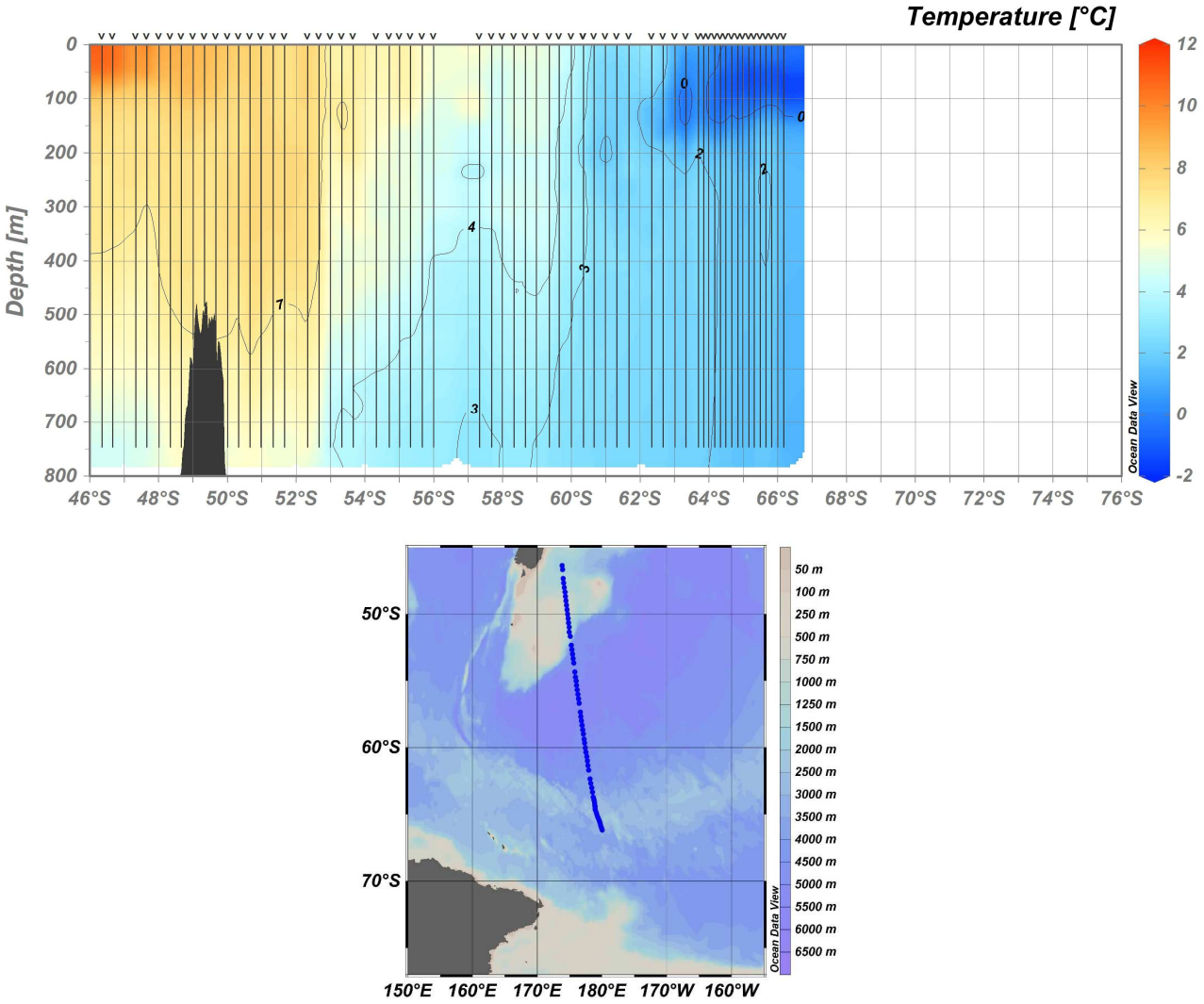

Figure S18. Temperature vertical section from XBT data collected during the PNRA_XIX cruise conducted from 24 December 2003 to 28 December 2003 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

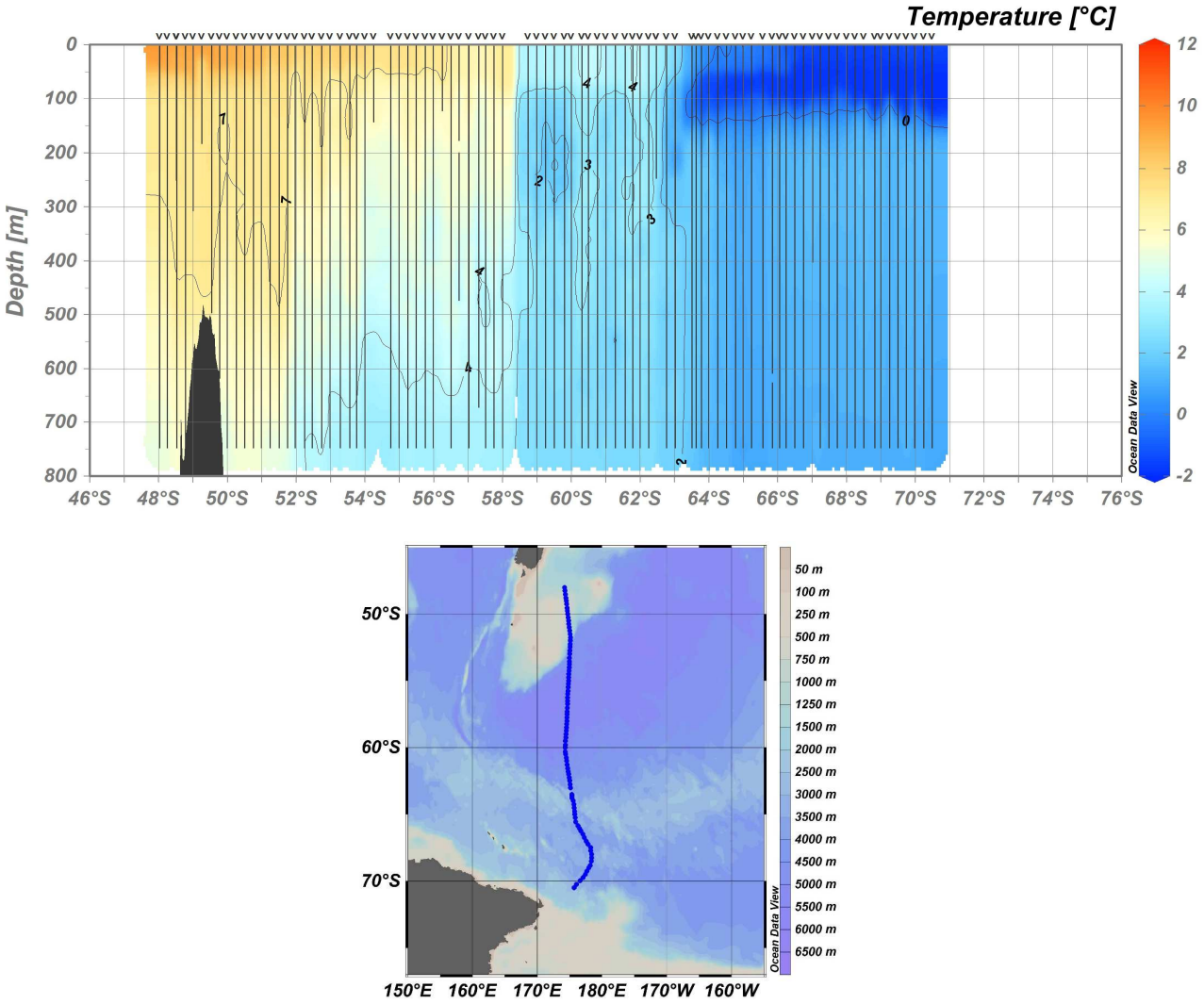

Figure S19. Temperature vertical section from XBT data collected during the PNRA_XX cruise conducted from 01 January 2005 to 06 January 2005 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

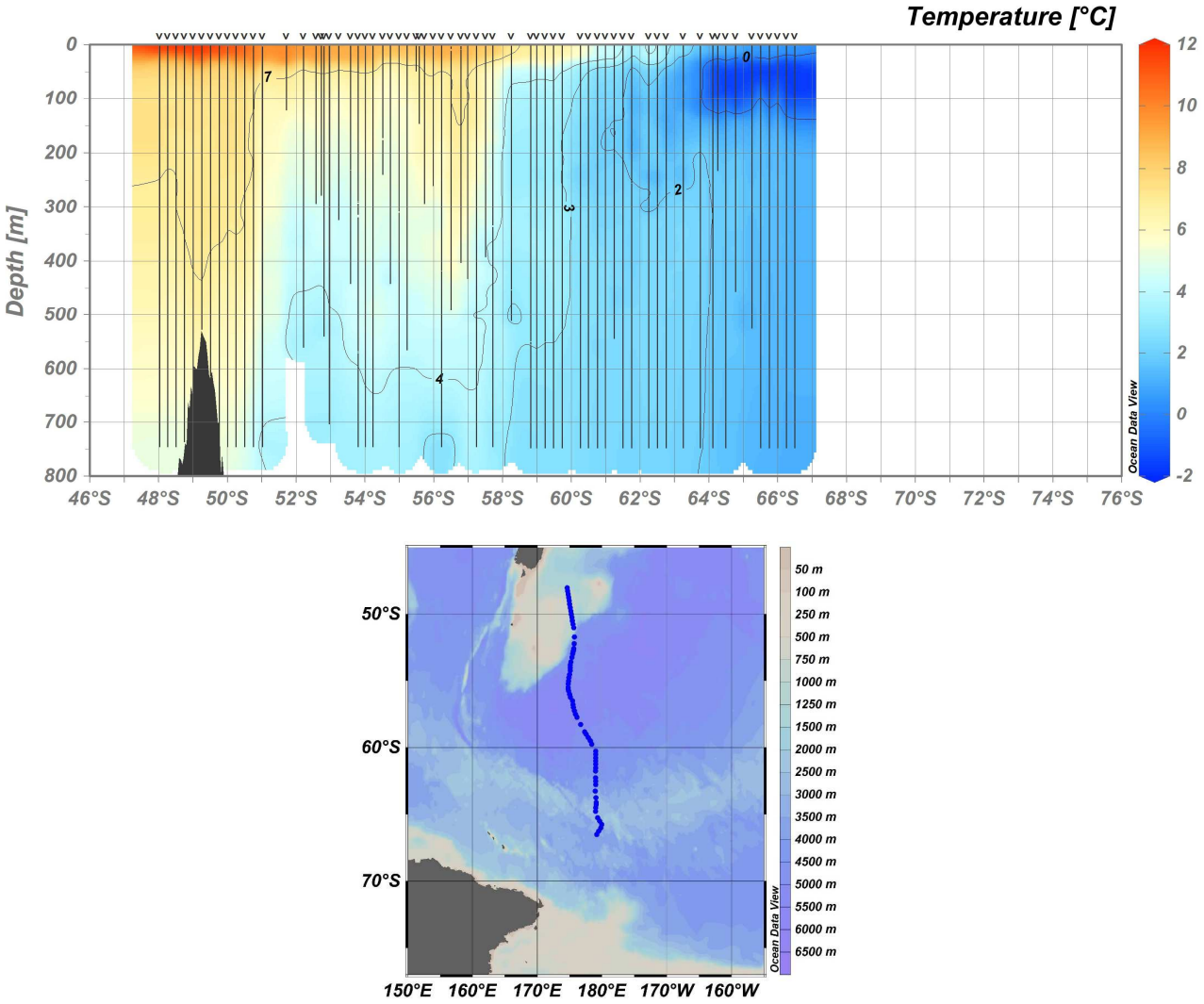

Figure S20. Temperature vertical section from XBT data collected during the PNRA_XXI cruise conducted from 01 January 2006 to 04 January 2006 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

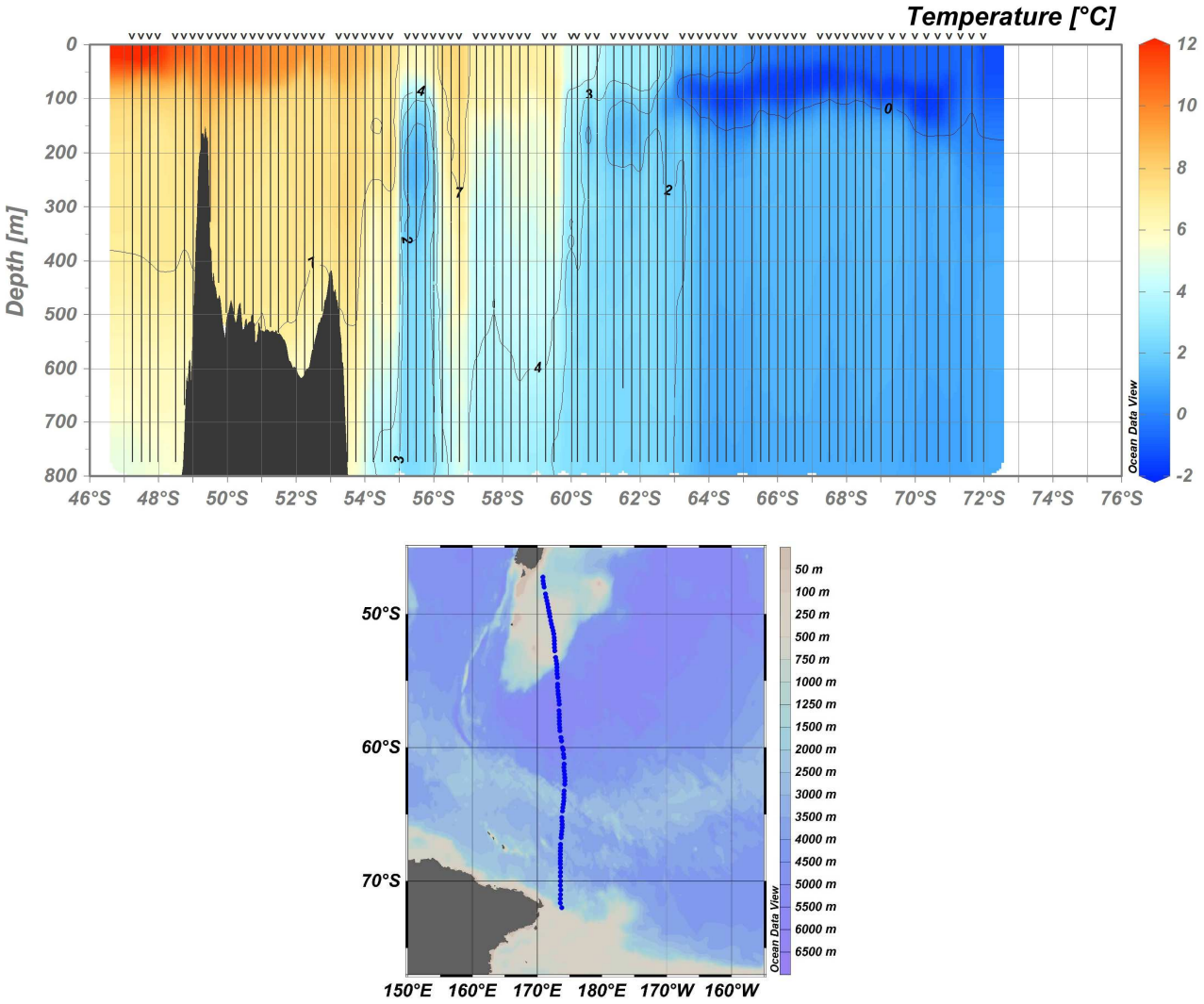

Figure S21. Temperature vertical section from XBT data collected during the PNRA_XXII cruise conducted from 05 February 2007 to 10 February 2007 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

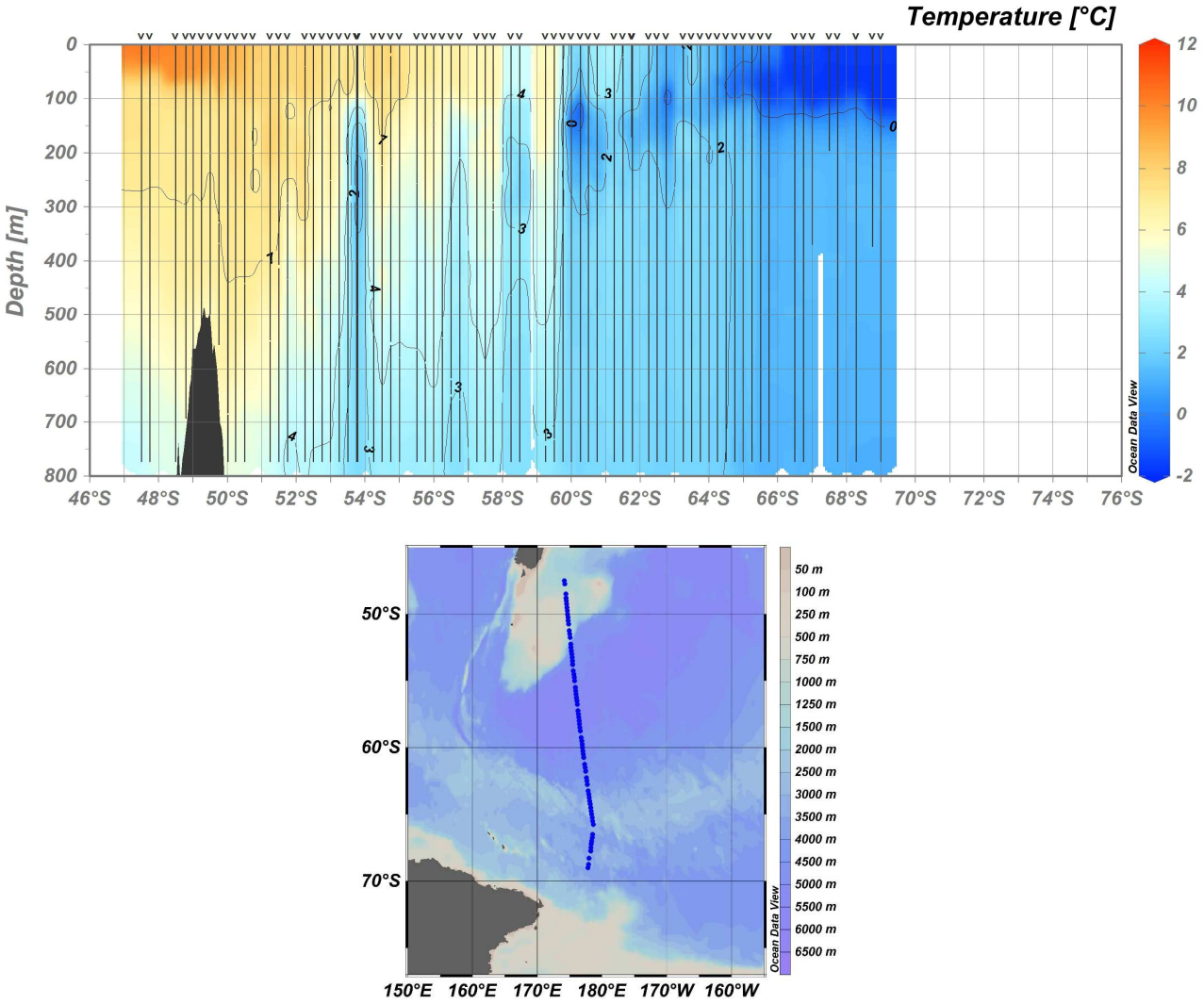

Figure S22. Temperature vertical section from XBT data collected during the PNRA_XXIII cruise conducted from 16 January 2008 to 21 January 2008 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

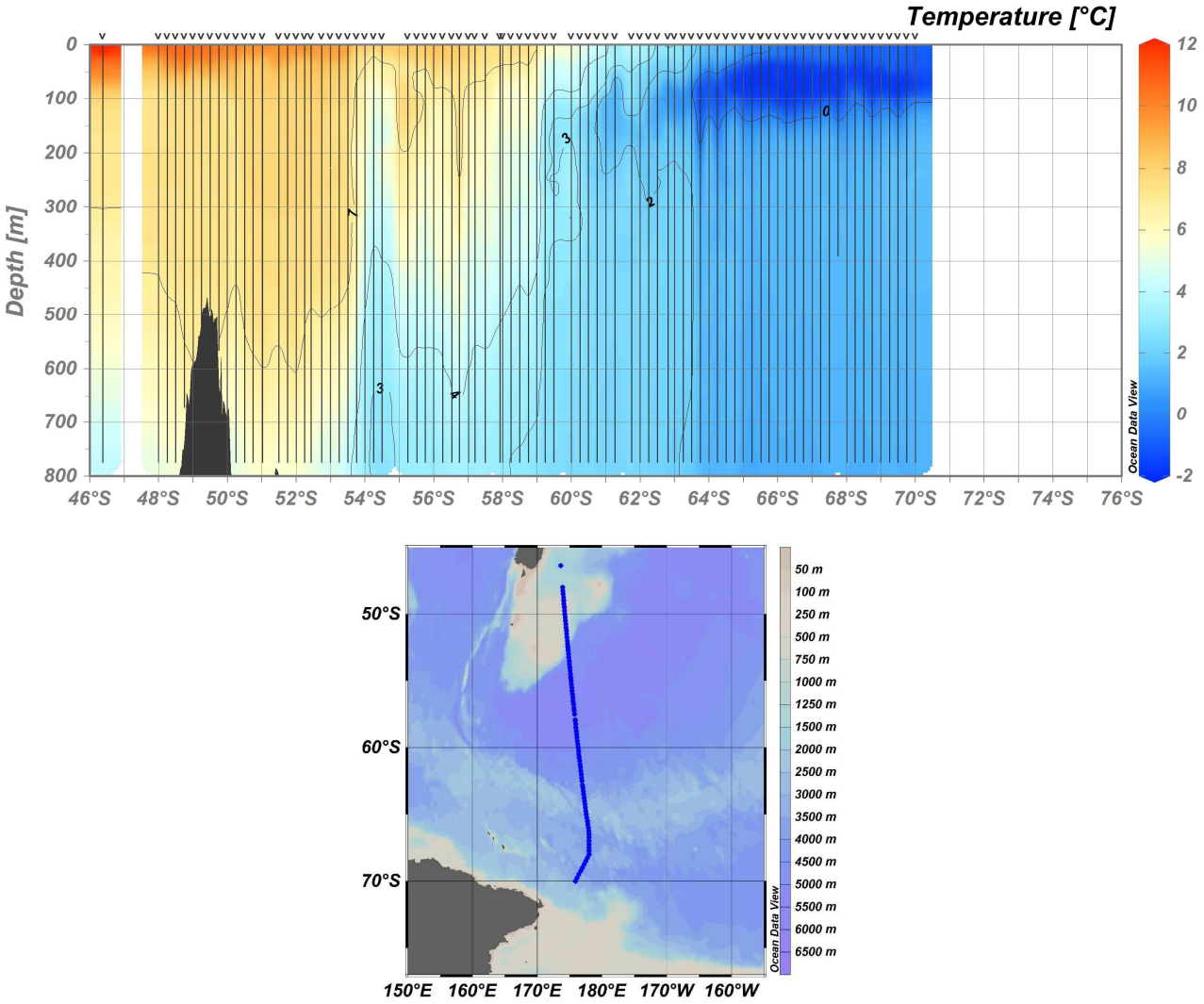

Figure S23. Temperature vertical section from XBT data collected during the PNRA_XXV cruise conducted from 25 January 2010 to 29 January 2010 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

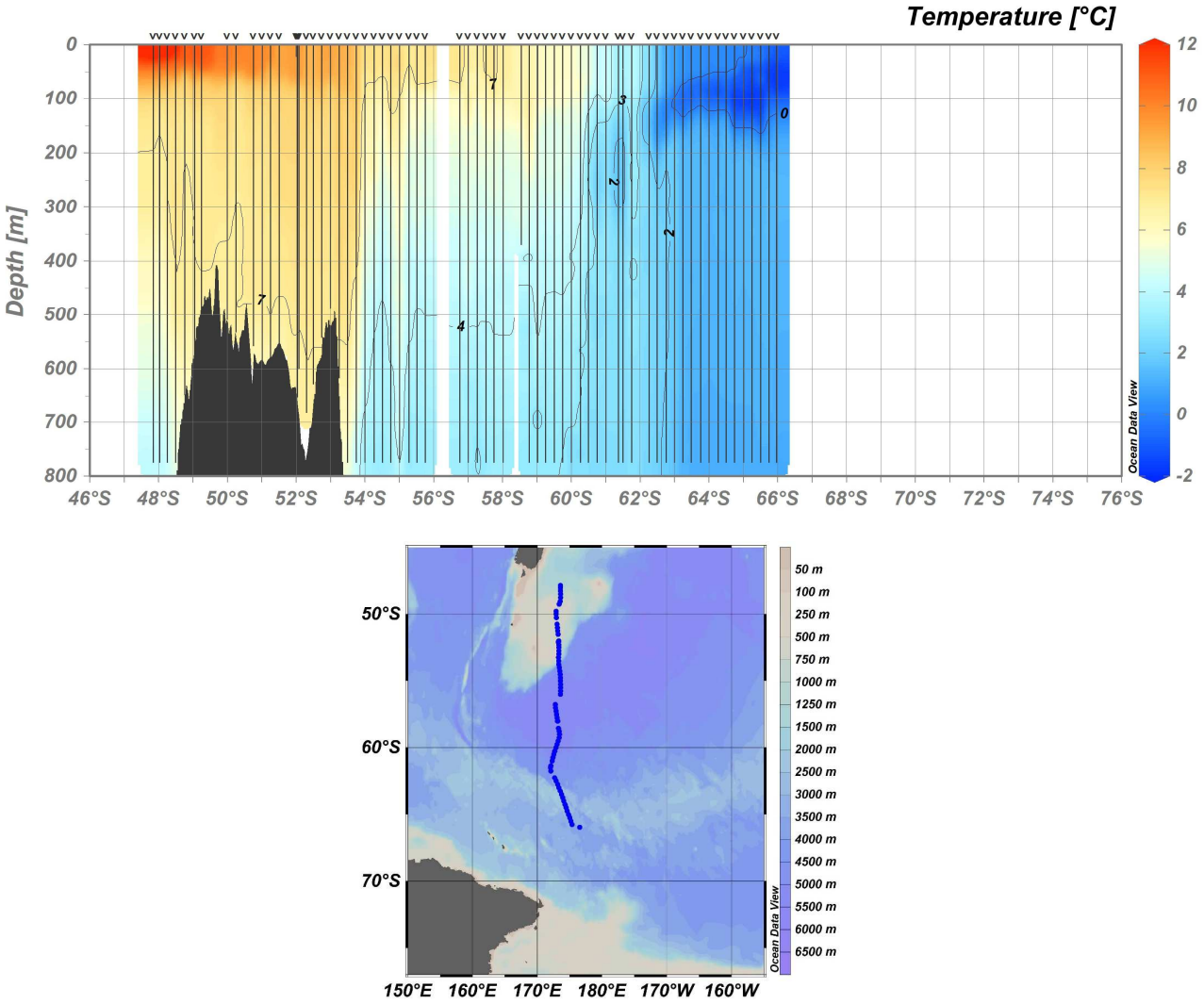

Figure S24. Temperature vertical section from XBT data collected during the PNRA_XXVII cruise conducted from 13 January 2012 to 19 January 2012 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

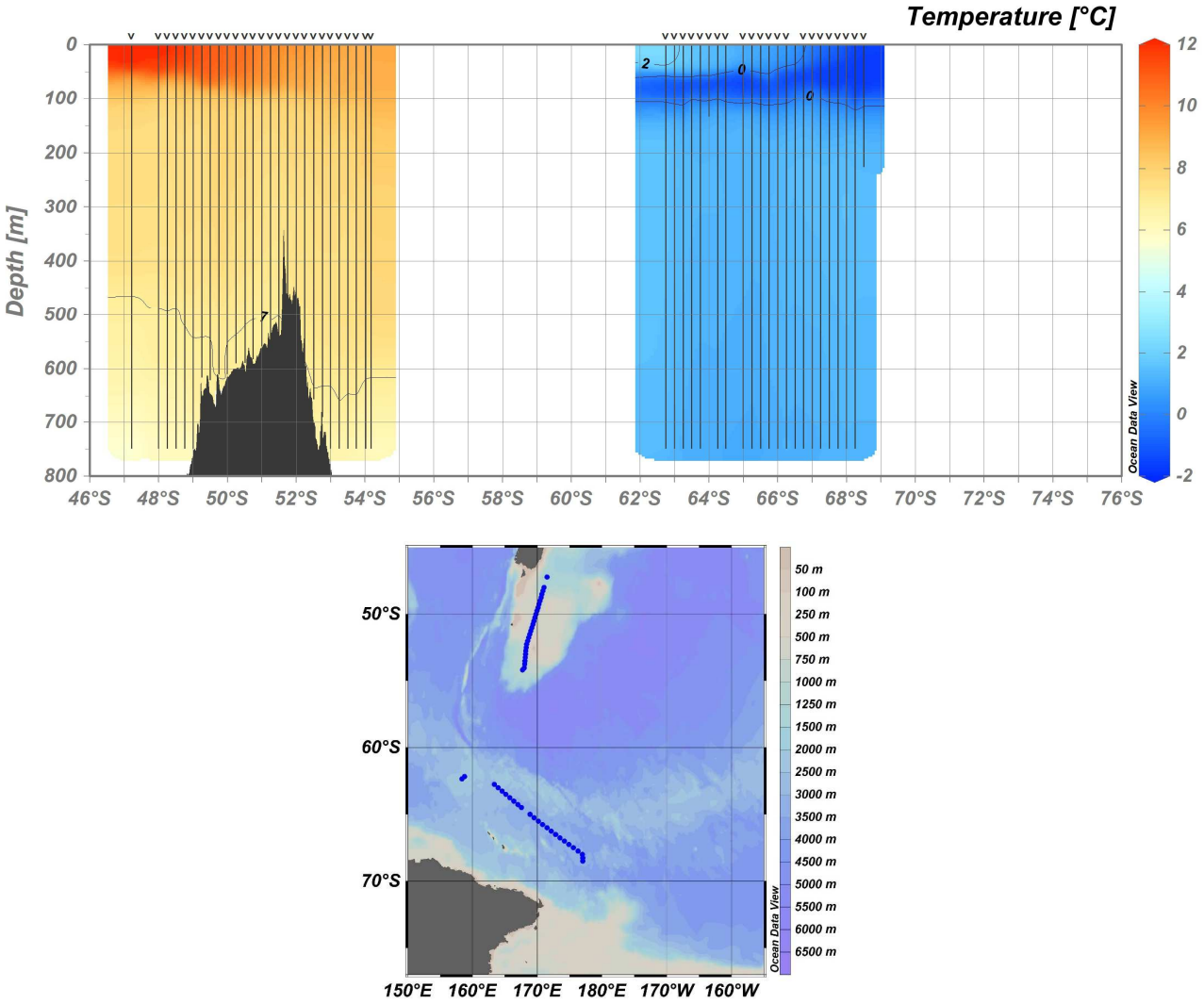

Figure S25. Temperature vertical section from XBT data collected during the PNRA_XXVIII cruise conducted from 24 January 2013 to 06 February 2013 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

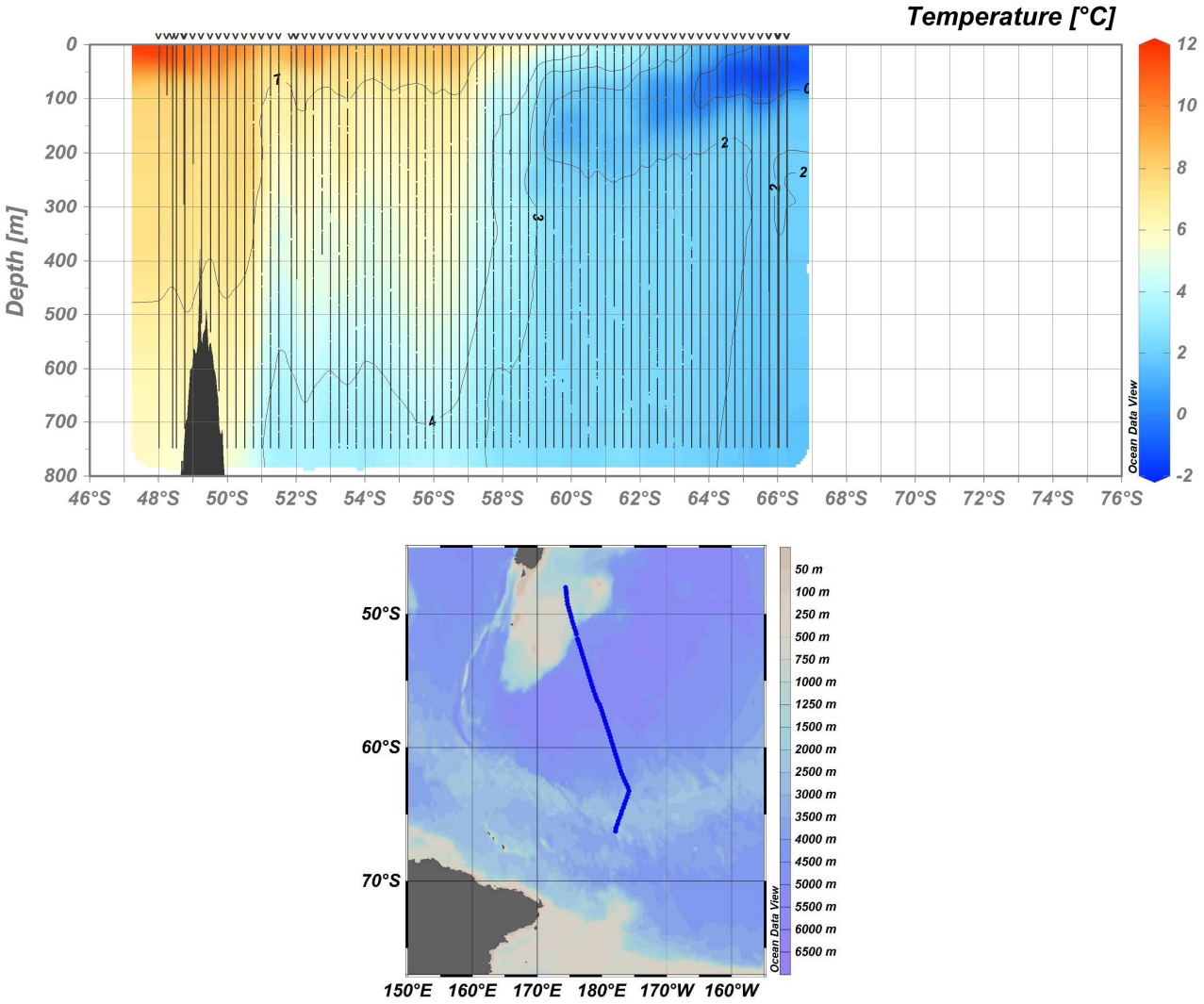

Figure S26. Temperature vertical section from XBT data collected during the PNRA_XXIX cruise conducted from 30 December 2013 to 03 January 2014 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

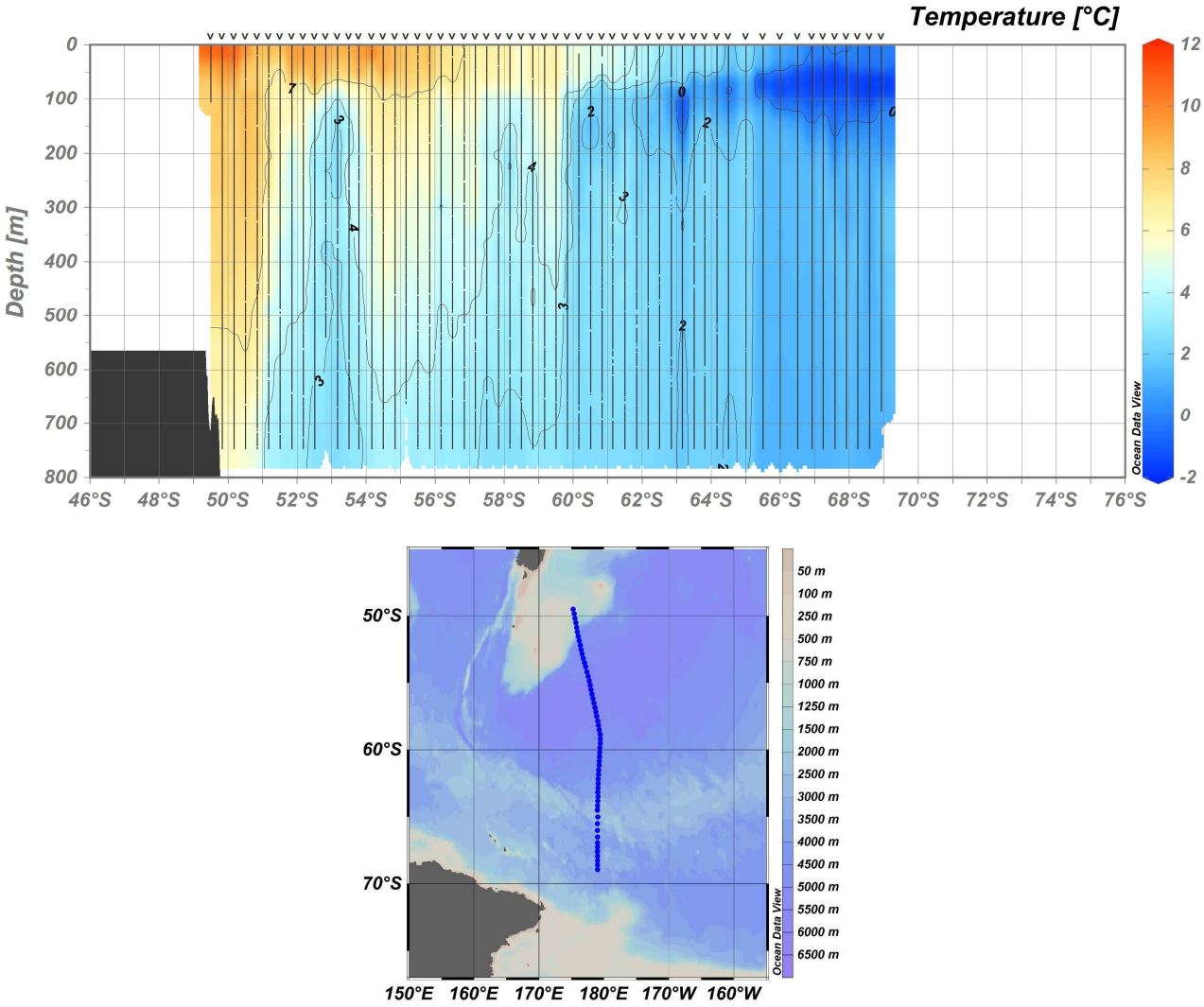

Figure S27. Temperature vertical section from XBT data collected during the PNRA_XXIX cruise conducted from 14 February 2014 to 18 February 2014 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

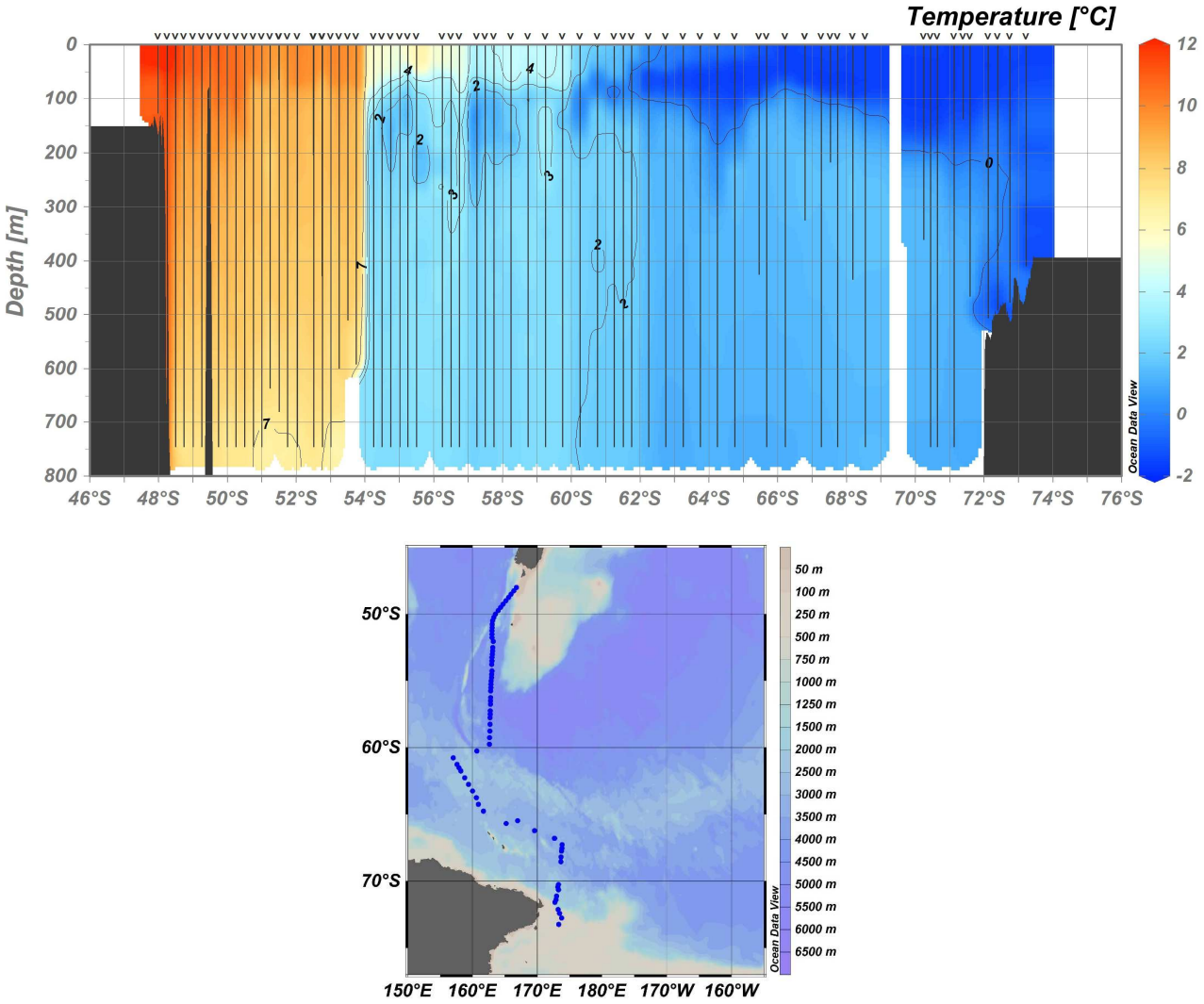

Figure S28. Temperature vertical section from XBT data collected during the PNRA_XXX cruise conducted from 02 January 2015 to 07 January 2015 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

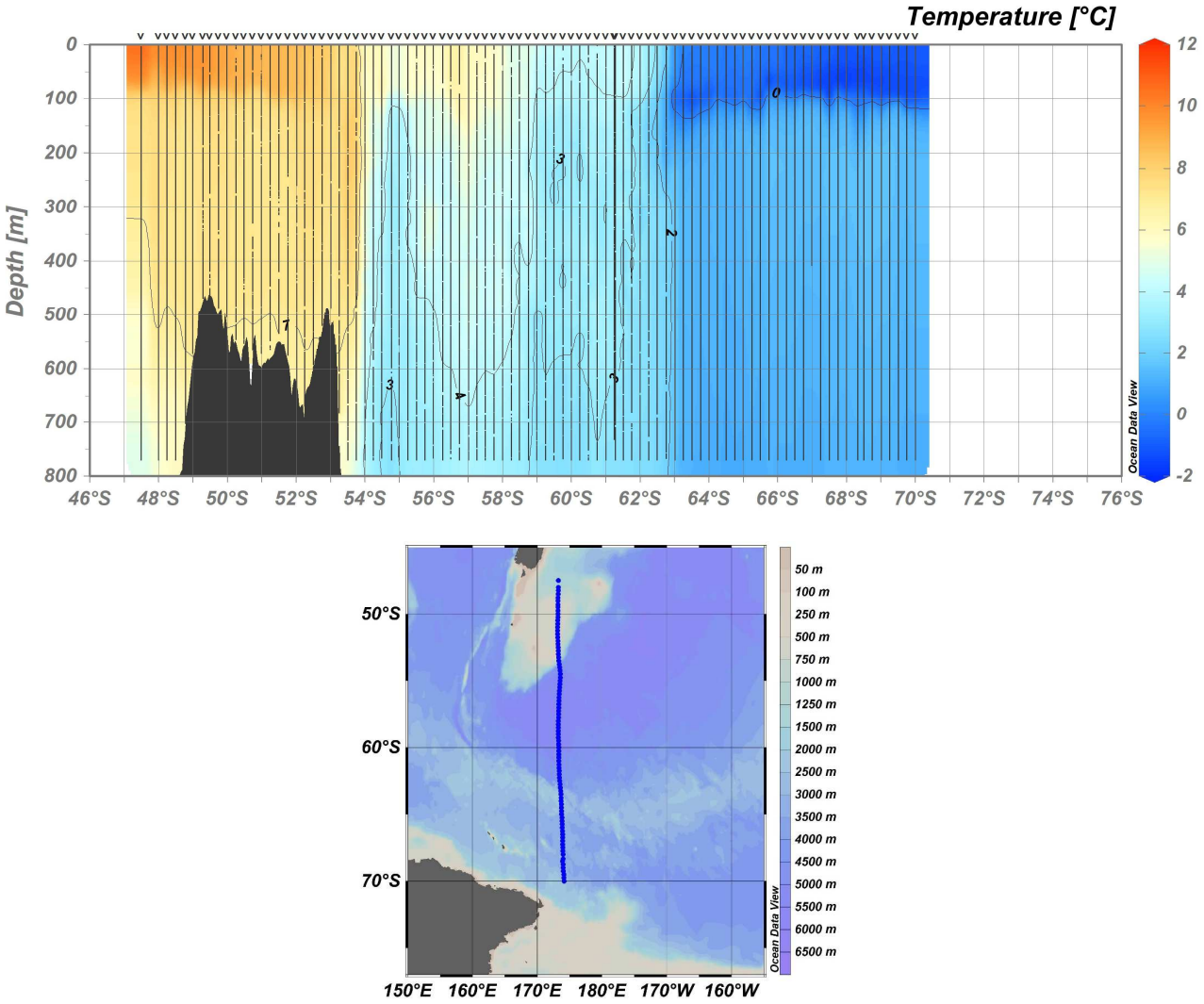

Figure S29. Temperature vertical section from XBT data collected during the PNRA_XXXI cruise conducted from 16 January 2016 to 21 January 2016 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

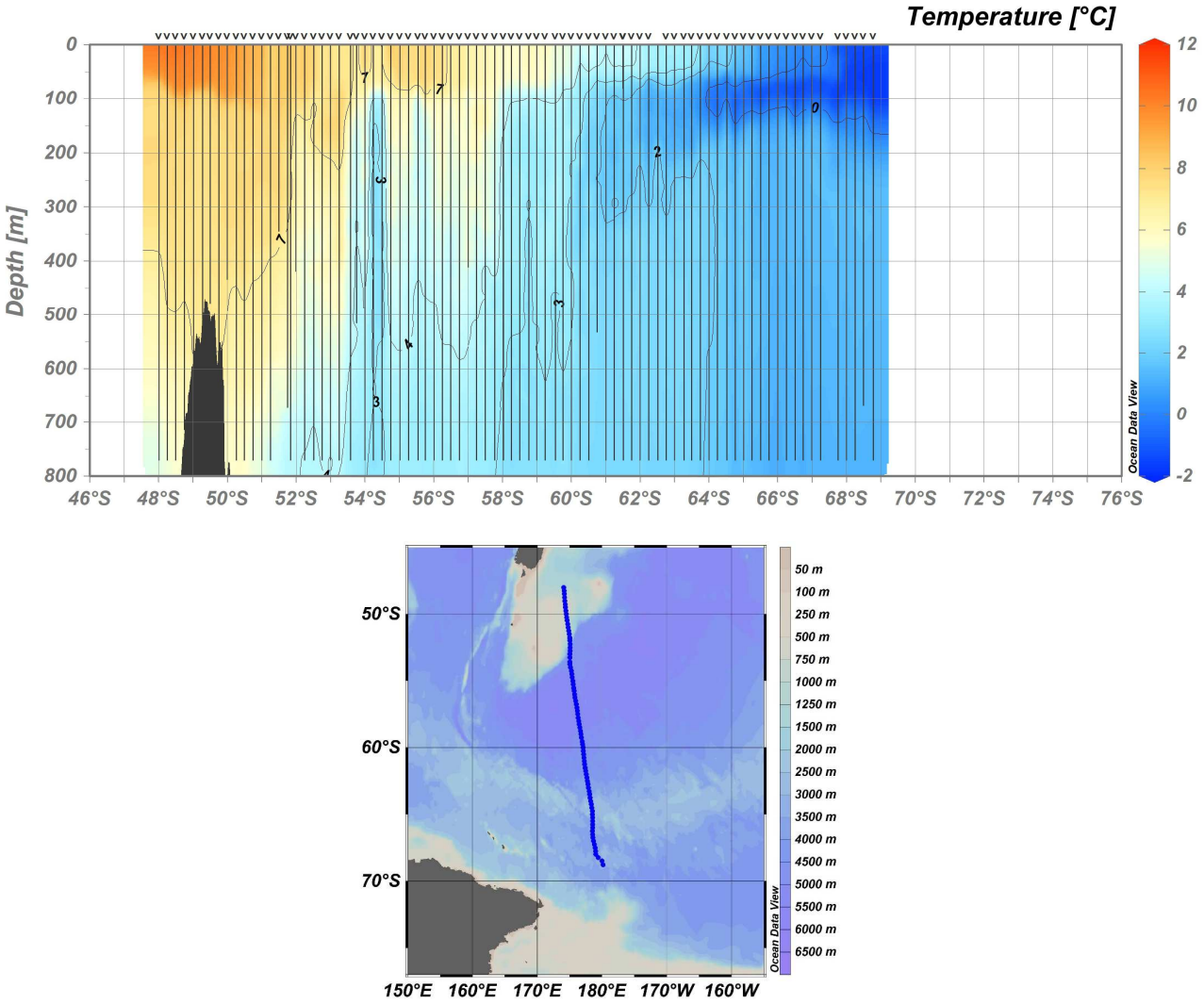

Figure S30. Temperature vertical section from XBT data collected during the PNRA_XXXII cruise conducted from 31 December 2016 to 05 January 2017 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

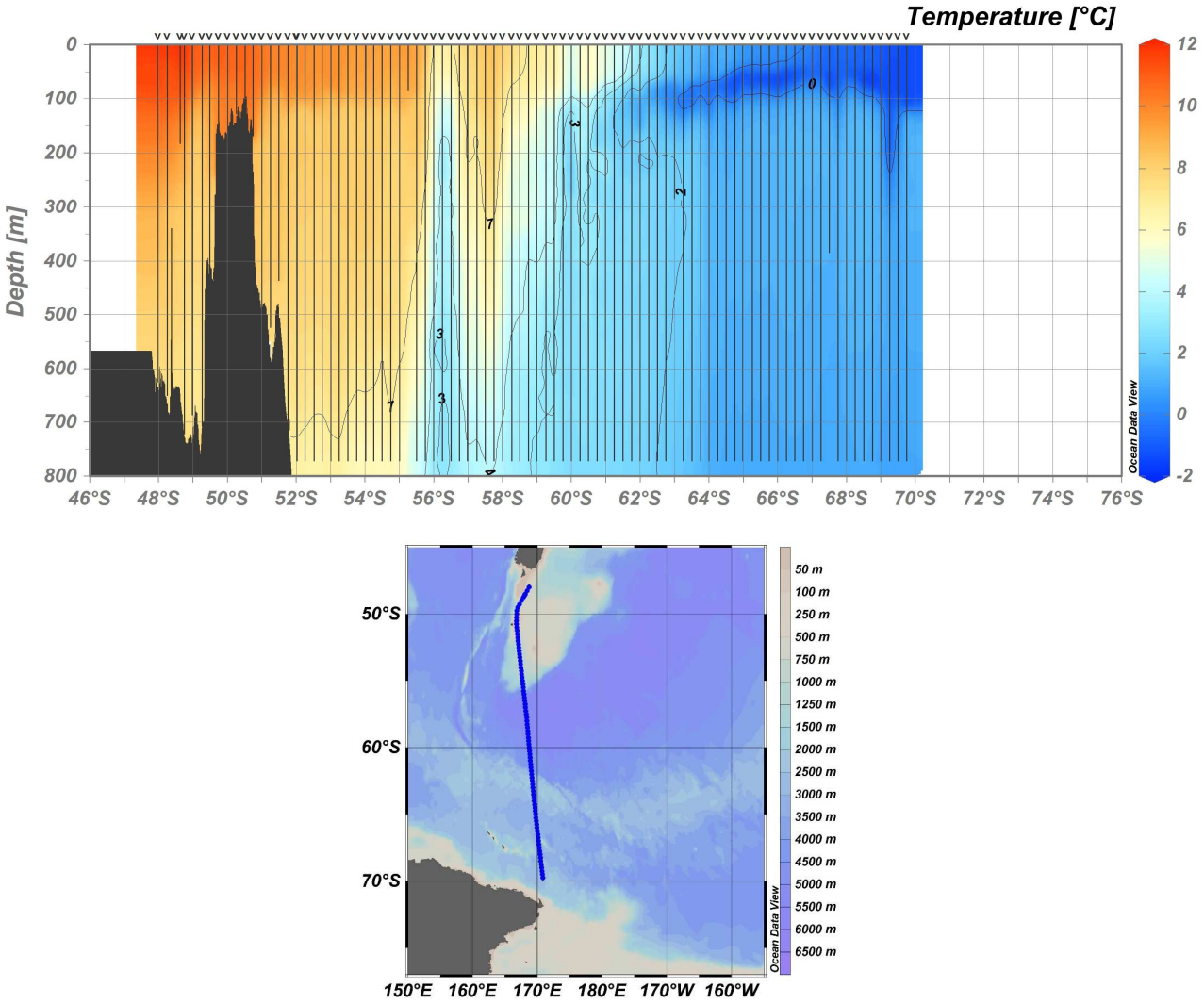

Figure S31. Temperature vertical section from XBT data collected during the PNRA_XXXIV cruise conducted from 08 February 2019 to 12 February 2019 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

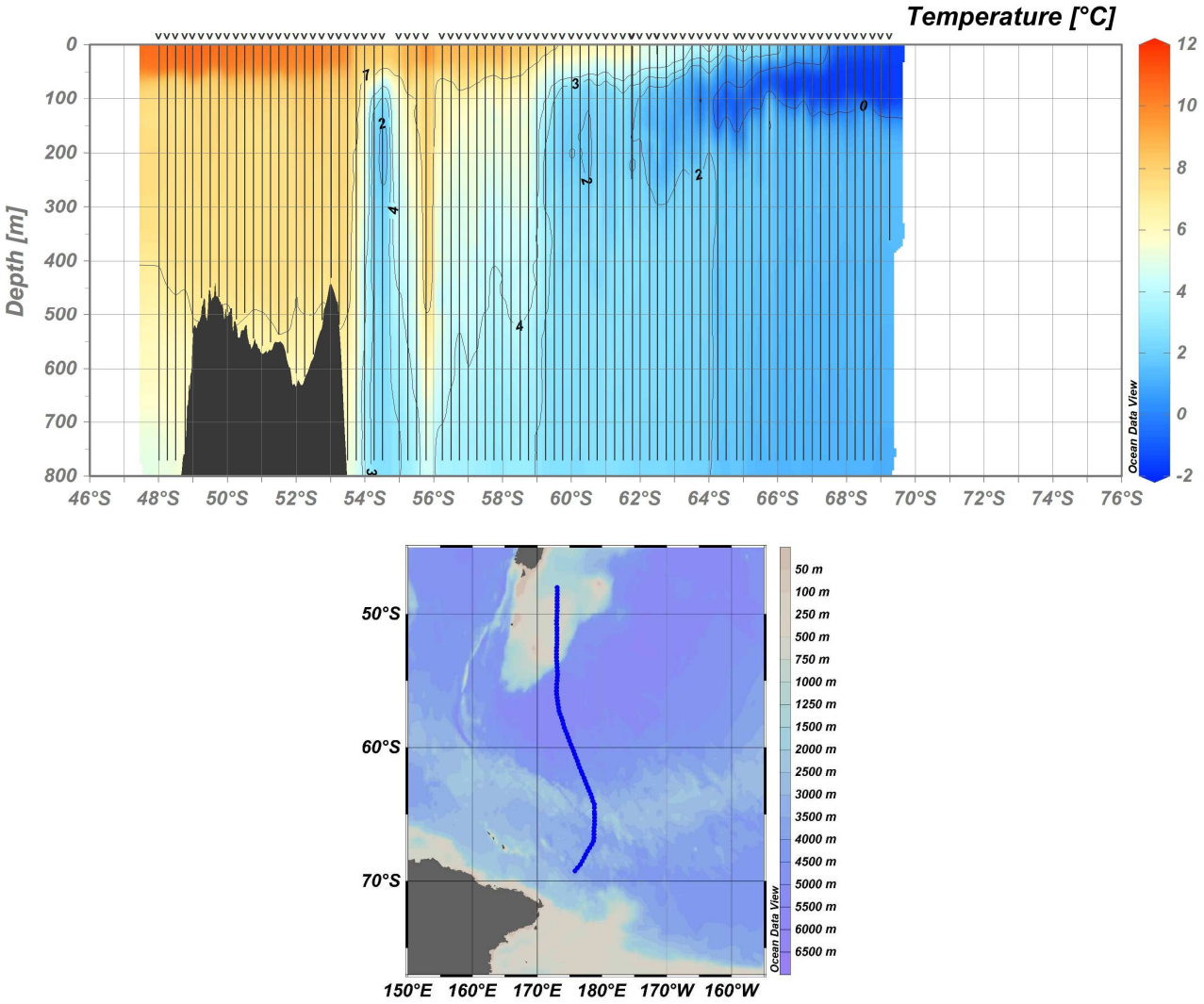

Figure S32. Temperature vertical section from XBT data collected during the PNRA_XXXV cruise conducted from 07 January 2020 to 12 January 2020 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

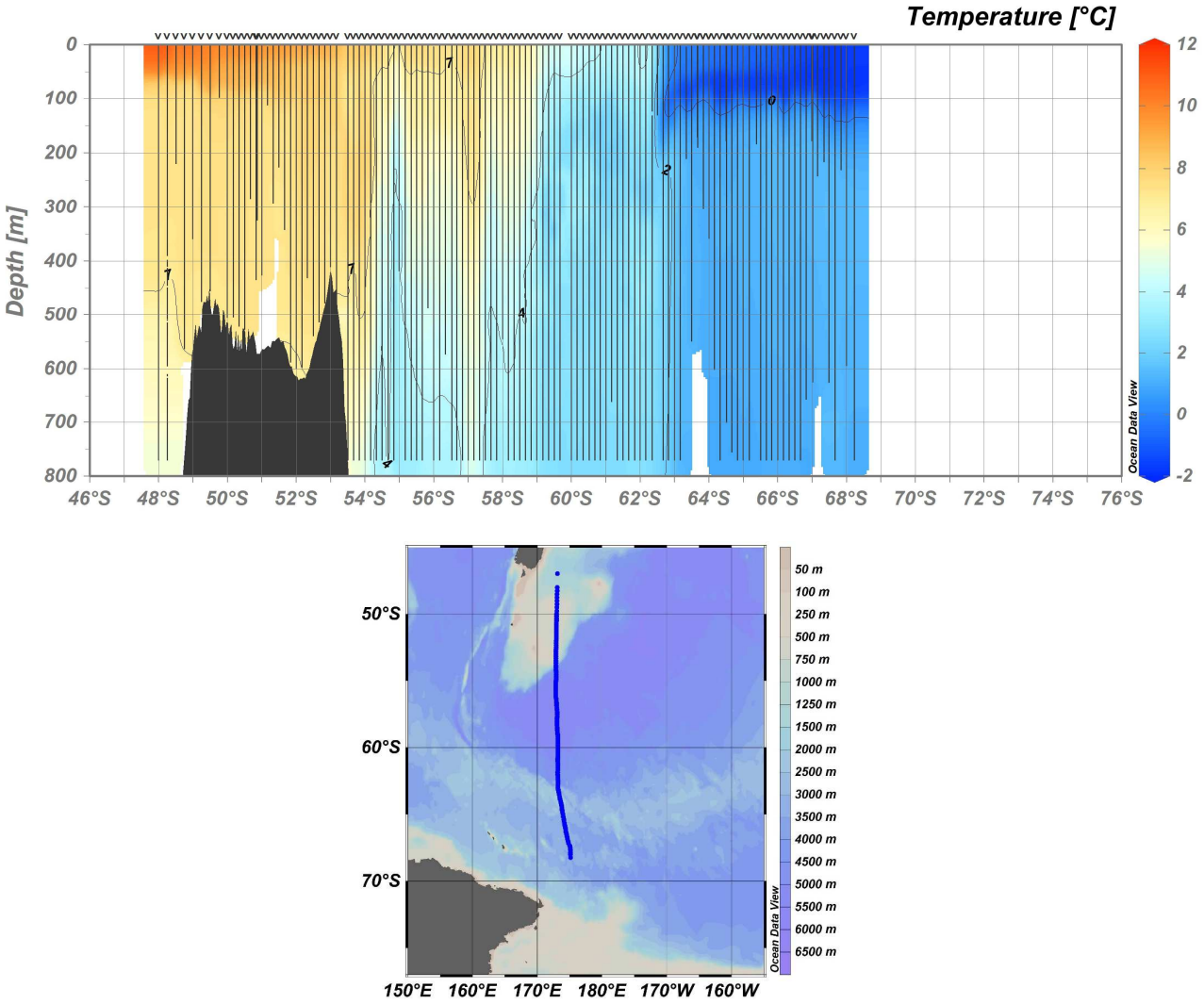

Figure S33. Temperature vertical section from XBT data collected during the PNRA_XXXVI cruise conducted from 25 December 2020 to 02 January 2021 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

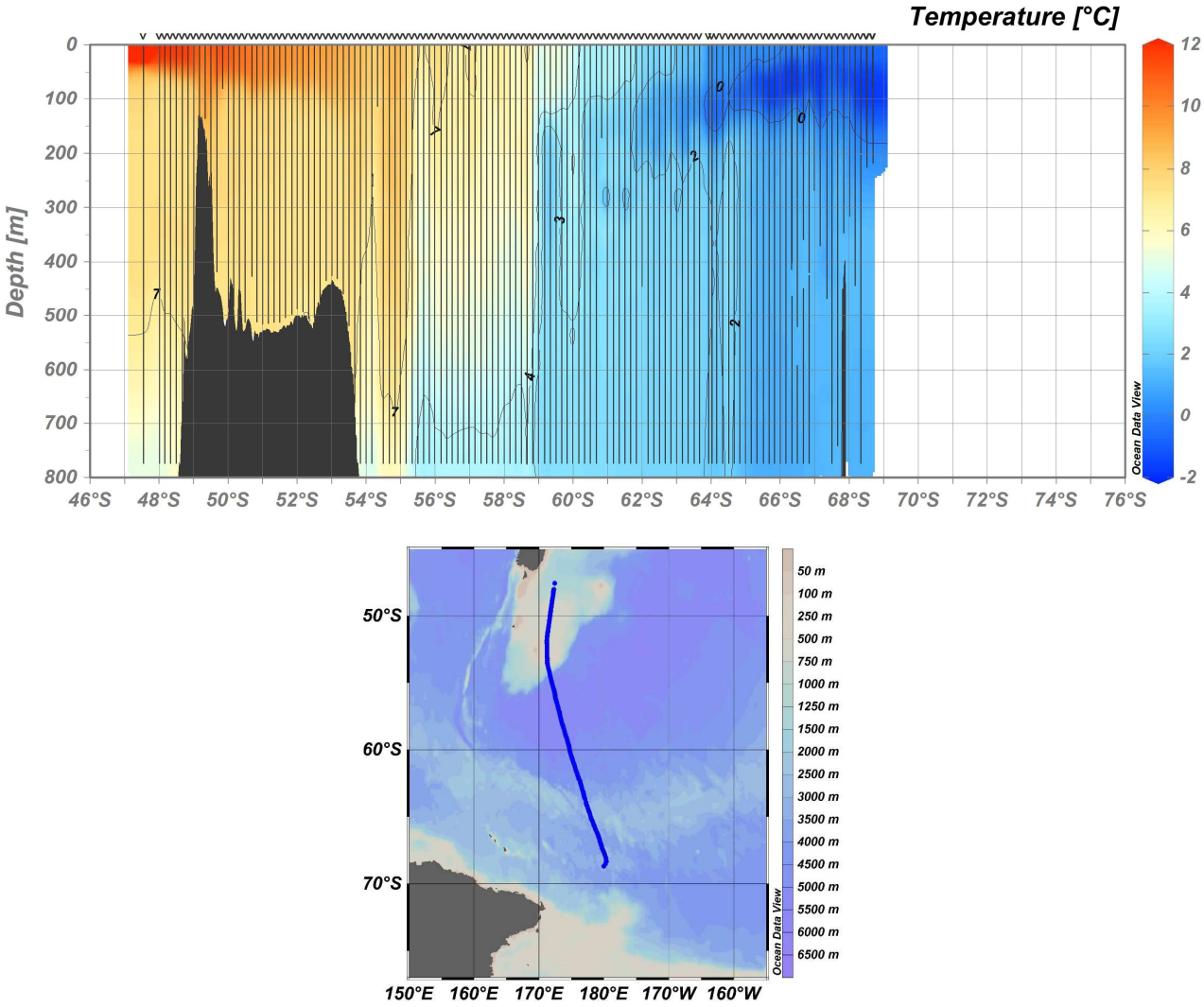

Figure S34. Temperature vertical section from XBT data collected during the PNRA_XXXVII cruise conducted from 08 January 2022 to 13 January 2022 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

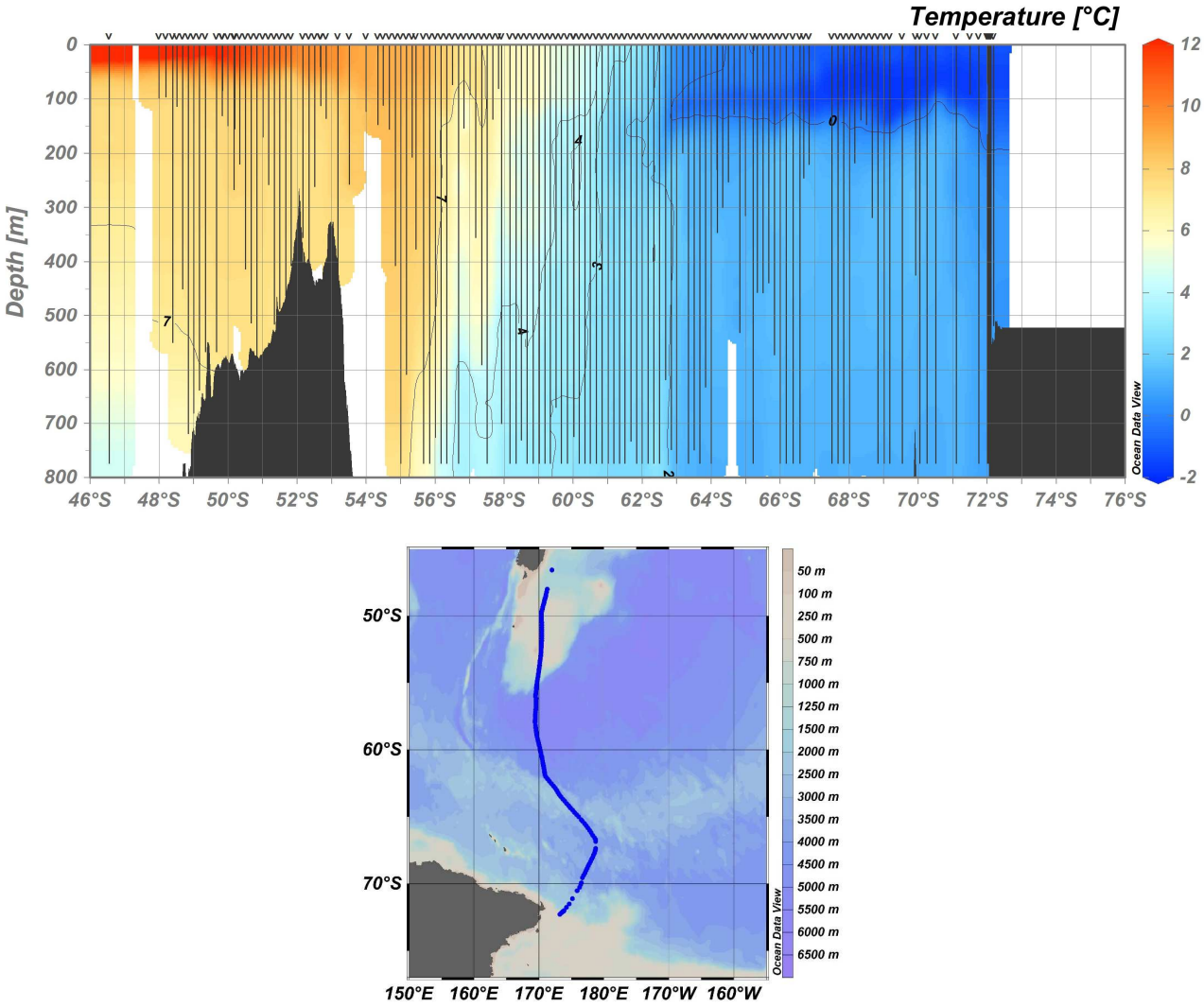

Figure S35. Temperature vertical section from XBT data collected during the PNRA_XXXVIII cruise conducted from 06 January 2023 to 12 January 2023 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

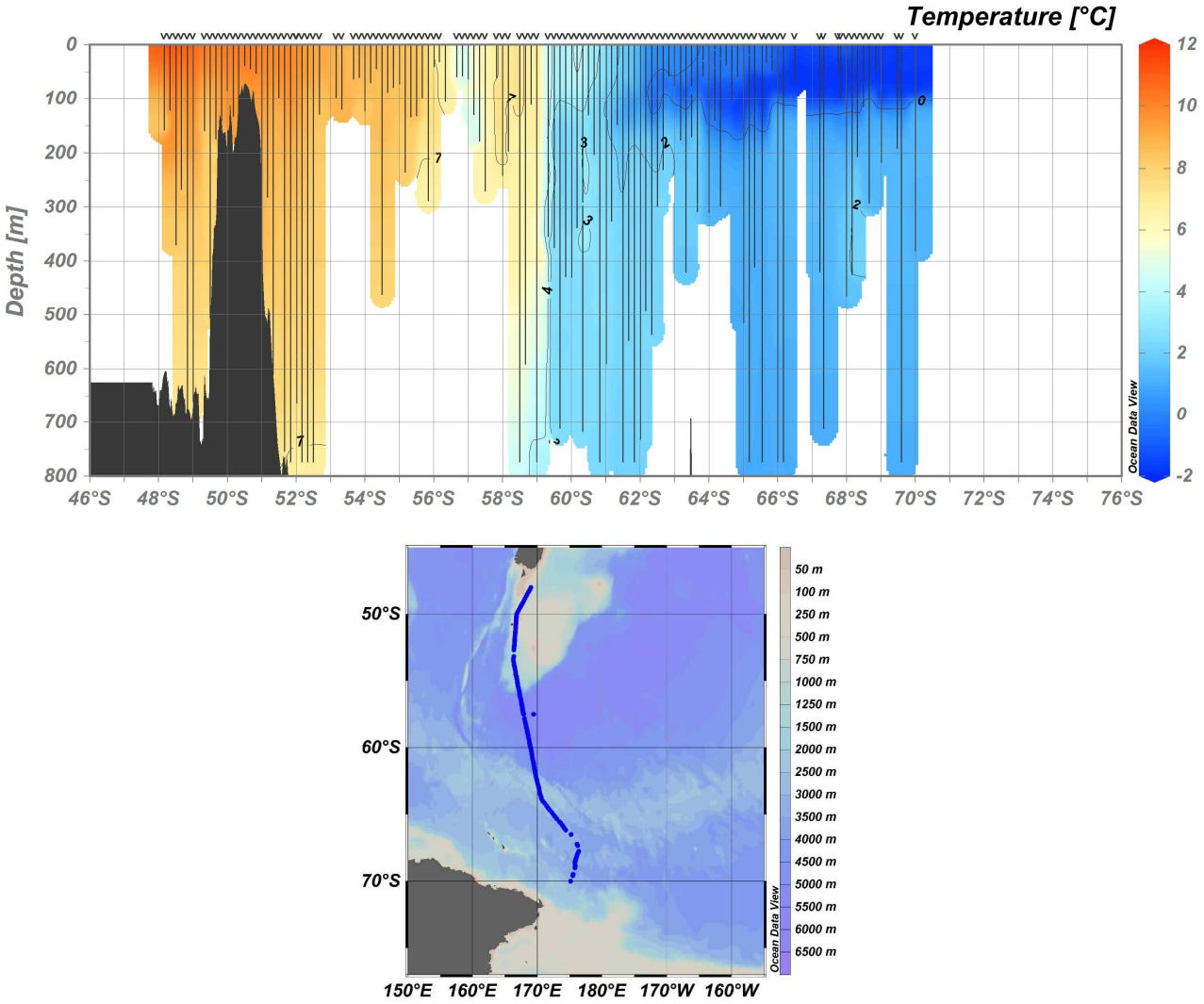

Figure S36. Temperature vertical section from XBT data collected during the PNRA_XXXIX cruise conducted from 07 January 2024 to 12 January 2024 along the New Zealand–Antarctica "chokepoint" - PX36 transect. Zonal interpolation is based on a spatial weighting model that incorporates three adjacent temperature profiles, considering a maximum influence range of 60 km along the zonal direction and 20 m along depth. The dark grey mask represents the bathymetry. The map of XBT casts positions is displayed below the section. Plots were realized using Ocean Data View software (Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2022).

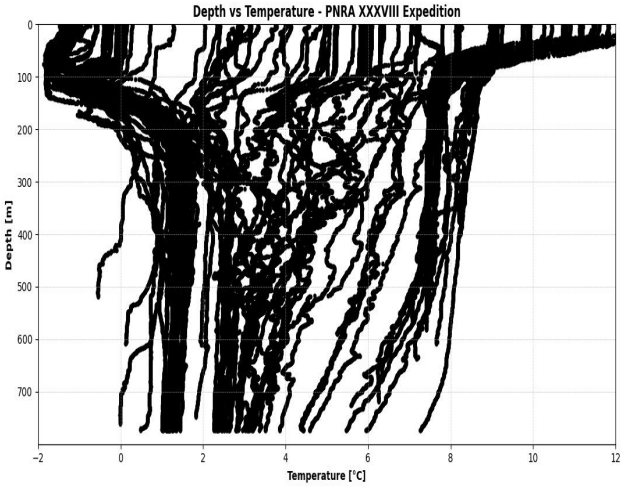

Figure S37. Temperature vertical profiles of the XBT good data (QF=1) collected during the PNRA_XXXVIII expedition realized through the Python code in Code S1.

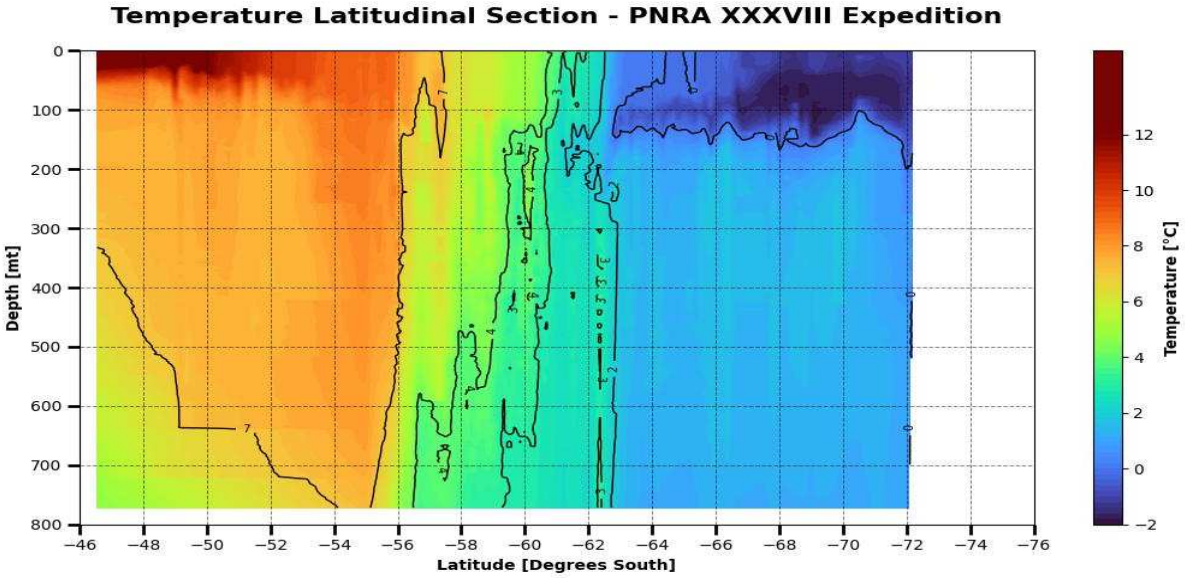

Figure S38. Temperature latitudinal section of the XBT good data (QF=1) collected during the PNRA_XXXVIII expedition realized through the Python code in Code S1.

Code S1. Python code for visualizing XBT data through a scatter plot of vertical temperature profiles and a latitudinal temperature section, as illustrated in S37 and S38

```
import pandas as pd
import numpy as np
from scipy.interpolate import griddata
import matplotlib.pyplot as plt
import os
# Define the file path
file_path = r'The relative file path to the .txt file, indicating its location in the file system. For example, it could be an absolute path like: C:\Users\User\Documents\example.txt'
# Remove lines starting with '//' from the file
with open(file_path, 'r', encoding='latin-1') as file:
    lines = file.readlines()
filtered_lines = [line for line in lines if not line.startswith('//')]
# Save filtered lines to a temporary file
temp_file_path = r'The relative path to the directory where the temporary file should be saved.'
with open(temp_file_path, 'w') as temp_file:
    temp_file.writelines(filtered_lines)
# Read the cleaned file into a DataFrame
df = pd.read_csv(temp_file_path, sep='\t', skiprows=0)
os.remove(temp_file_path)  # Remove the temporary file
# Add column names to the DataFrame
df.columns = [
    'Cruise', 'Station', 'Type', 'mon/day/yr', 'hh:mm',
    'Longitude [degrees_east]', 'Latitude [degrees_north]',
    'Bot. Depth [m]', 'Elapsed Time [s]',
    'Depth 1 [m]', 'Depth 2 [m]', 'Depth 3 [m]',
    'Temperature 1 [°C]', 'Temperature 2 [°C]', 'QF'
]
# Filter the good Data, where QF < 2 (Quality Filter)
df_filtered = df[df['QF'] = 1]
```

```
# --- SCATTER PLOT: Depth vs Temperature ---
plt.scatter(
    df_filtered['Temperature 2 [°C]'], df_filtered['Depth 3 [m]'],
    color='black', s=10
)  # Scatter plot with black dots
plt.gca().invert_yaxis()  # Invert y-axis for depth
plt.xlim(-2, 12)  # Temperature limits
plt.xticks(range(-2, 13, 2))  # Tick every 2 degrees
plt.ylim(800, 0)  # Depth limits
plt.yticks(range(0, 801, 100))  # Tick every 100 meters
# Add axis labels and title
plt.xlabel('Temperature [°C]', fontweight='bold')
plt.ylabel('Depth [m]', fontweight='bold')
plt.title('Depth vs Temperature, fontweight='bold')
# Add grid
plt.grid(which='both', linestyle='--', linewidth=0.5, alpha=0.7)
plt.show()
plt.close()
# --- INTERPOLATION AND CONTOUR PLOT ---
# Extract necessary columns: latitude, depth, and temperature
lat = df_filtered['Latitude [degrees_north]']
depth = df_filtered['Depth 3 [m]']
temp = df_filtered['Temperature 2 [°C]']
# Generate a grid for interpolation
# Create a latitude grid with 400 points between the minimum and maximum latitude
lat_grid = np.linspace(np.nanmin(lat), np.nanmax(lat), 400)
# Create a depth grid with 400 points between the minimum and maximum depth
depth_grid = np.linspace(np.nanmin(depth), np.nanmax(depth), 400)
# Create a meshgrid for latitude and depth (grid points for interpolation)
lat_grid, depth_grid = np.meshgrid(lat_grid, depth_grid)
```

```
# Combine data into a single array for processing and filter out rows containing NaNs
data = np.array([lat, depth, temp]).T  # Combine latitude, depth, and temperature into a single array
valid_data = data[~np.isnan(data).any(axis=1)]  # Remove rows with any NaN values
lat, depth, temp = valid_data[:, 0], valid_data[:, 1], valid_data[:, 2]  # Separate the cleaned data
# Perform linear interpolation of the temperature data on the generated grid
temp_grid = griddata(
    (lat, depth),  # Original data points (latitude and depth)
    temp,          # Corresponding temperature values
    (lat_grid, depth_grid),  # Interpolation grid
    method='linear'  # Use linear interpolation
)
# Plot the interpolated data as a contour plot
plt.figure(figsize=(10, 6))
contour = plt.contourf(
    lat_grid, depth_grid, temp_grid,
    levels=100, cmap="turbo", vmin=-2, vmax=12  # Set color range from -2 to 12°C
)
# Add a colorbar to the plot
cbar = plt.colorbar(contour, label="Temperature [°C]", ticks=np.arange(-2, 13, 2))
cbar.set_label("Temperature [°C]", fontweight='bold')  # Add a bold label for the colorbar
# Add specific contour lines on top of the filled contours
contour_levels = [0, 2, 3, 4, 7]  # Contour levels of interest
contour_lines = plt.contour(
    lat_grid, depth_grid, temp_grid,
    levels=contour_levels, colors='black', linewidths=1  # Black contour lines
)
plt.clabel(contour_lines, fmt='%1.0f', colors='black', fontsize=7)  # Add labels to contour lines
# Set axis labels and title
plt.xlabel("Latitude [Degrees South]", fontweight='bold')  # Label for latitude
plt.ylabel("Depth [m]", fontweight='bold')  # Label for depth
plt.title(
```

```
    "Temperature Latitudinal Section",
    fontweight='bold', fontsize=16, pad=20  # Bold title with padding
)
# Customize the depth axis (y-axis)
plt.gca().invert_yaxis()  # Invert depth axis to show 0 at the top
plt.ylim(800, 0)  # Set depth limits from 800 to 0
plt.yticks(np.arange(0, 801, 100))  # Tick labels every 100 meters
# Customize the latitude axis (x-axis)
plt.gca().invert_xaxis()  # Invert latitude axis for correct orientation
plt.xlim(-46, -76)  # Set latitude limits from -46 to -76 degrees south
plt.xticks(np.arange(-76, -45, 2))  # Tick labels every 2 degrees
# Customize plot margins and ticks
plt.tick_params(axis='both', which='major', length=7, width=2)  # Major tick appearance
plt.tick_params(axis='both', which='minor', length=4, width=1.5)  # Minor tick appearance
# Add a grid to the plot
plt.grid(True, linestyle='--', linewidth=0.7, color='black', alpha=0.5)  # Dashed black grid with transparency
# Show the plot
plt.show()
```