

Spatial and temporal variations in seafloor temperatures using the Dense Oceanfloor Network system for Earthquakes and Tsunamis (DONET) installed in the Nankai Trough

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Seafloor temperature changes encompass various components influenced by water pressure, sediment gravity flow, hydrothermal activity, and other oceanographic phenomena. Recent advancements in seafloor observation networks, like the Dense Ocean Floor Network system for Earthquakes and Tsunamis (DONET), have enabled continuous monitoring such as the velocity of the seafloor displacement, the seafloor pressure, and seafloor temperatures, providing valuable data for studying these complex underwater environments such as the intricate interplay of various oceanographic phenomena including water pressure, sediment gravity flow, and hydrothermal activity (e.g., Takemura et al., 2022; Gomberg et al., 2021; Otsuka et al., 2023). Despite the wealth of data, there has been little research specifically concentrating on the spatial correlation of seafloor temperatures using extensive, multi-year datasets. This study uses data from DONET, spanning April 2017 to May 2023, to conduct a meticulous examination of the spatial and temporal correlations of seafloor temperatures across the Nankai Trough. The objective is to unravel the complex influences governing these temperatures, particularly focusing on the relationship between water depth and temperature fluctuations over a substantial time scale. Our findings include that the average seafloor temperature was observed to range between 1.45 to 3.59 degrees Celsius at varying depths of 1077 to 4449 meters, exhibiting a clear trend of decreasing temperature with increasing depth. A strong correlation of seafloor temperatures was noted between site pairs situated at similar water depths, but the similarity diminished as the absolute depth difference between the sites widened. To evaluate the dependence on the water depth and the distance between sites, we introduce R values corresponding to the correlation of the cross-correlation and both water depth and the distance in the analysis. Specifically, cross-correlation coefficients (CCs) between site pairs were strongly influenced by the depth difference, as evidenced by an R-value of -0.57, underscoring a robust depth-dependent temperature similarity. In contrast, the CCs displayed a little dependence on the horizontal distance between sites, as indicated by an R-value of -0.21, suggesting that depth plays a more critical role in temperature correlation than horizontal separation. Additionally, the study uncovered that temperature fluctuations with periods extending over ten days markedly affected the depth dependency of seafloor temperature. We interpret these findings to be the influence of long-period oceanographic processes, such as topographic Rossby waves of the coastal trapped wave, in shaping the observed thermal variations on the seafloor (e.g., Hamilton et al., 1990; Louis et al., 1982; Uehara and Miyake, 2000). In conclusion, this study offers invaluable insights into the spatial and temporal characteristics of seafloor temperature within the Nankai Trough, emphasizing the significant impact of water depth on temperature correlation and the notable role of extended-period fluctuations. These insights not only enhance our understanding of the multifaceted dynamics that govern seafloor temperature but also lay a robust foundation for future oceanographic studies in observational oceanography.

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Keywords: Seafloor temperature, DONET, Coastal trapped wave