



Supplement of

**Current dynamics, drivers, and vertical thermal structure
around Sir Bu Nair Island (Arabian/Persian Gulf)**

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Supplement

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Introduction

Figure S1 presents the long-term and regional sea surface temperature context for Sir Bu Nair Island (SBN), including the 1985–2025 July–September SST record, comparison with in situ observations, and spatial SST anomalies during 2021 and 2022. Figure S2 provides the regional and long-term circulation context from CMEMS, showing interannual variability in surface current speed, the regional circulation pattern during the 2021 observational period, and comparisons between regional and in situ currents at SBN. Figure S3 presents the full-record power spectral density of the surface-to-bottom temperature difference at SBN-S, providing longer-term context for the frequency-dependent thermal variability identified during the May–June 2021 case-study period.

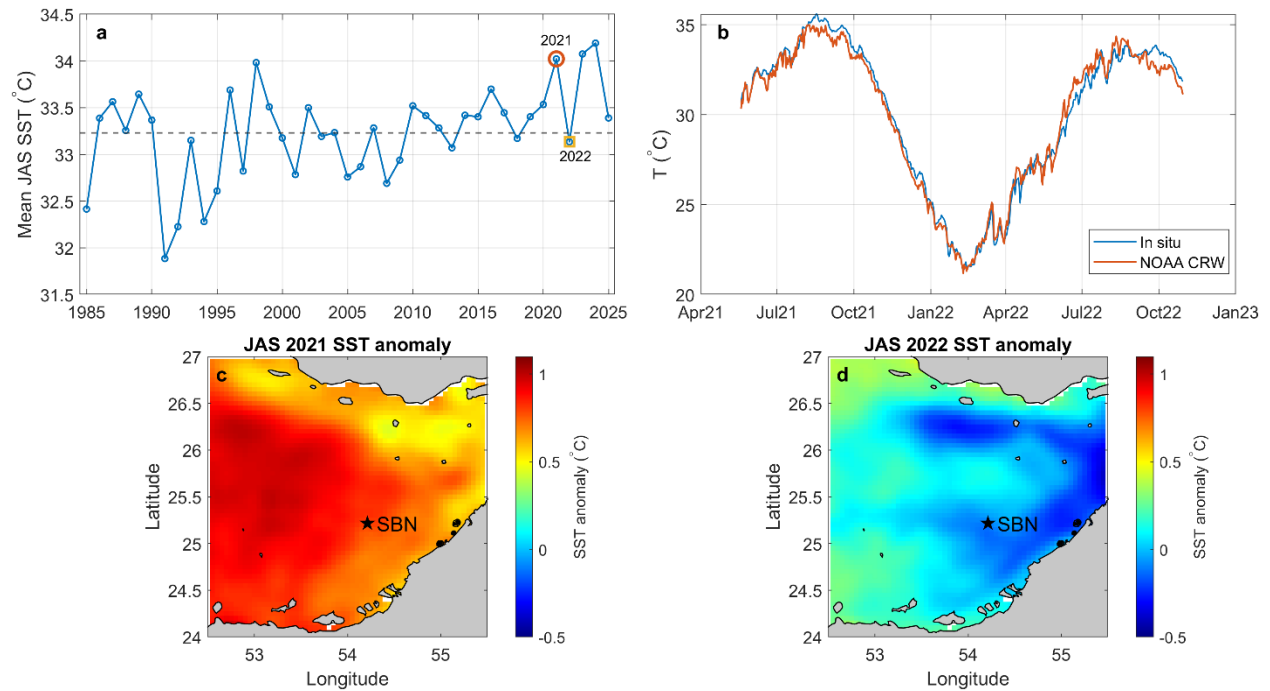


Figure S1. Long-term and regional context of sea surface temperature (SST) at Sir Bu Nair Island (SBN). (a) Mean July–September (JAS) SST at SBN from NOAA Coral Reef Watch (CRW) for 1985–2025. The dashed line indicates the 1985–2025 JAS mean, with 2021 and 2022 highlighted. (b) Comparison of daily NOAA CRW SST with daily mean temperature from the shallow in situ sensor at SBN-S over the observational period. (c–d) Spatial distribution of JAS SST anomalies relative to the 1985–2025 JAS climatology for (c) 2021 and (d) 2022. The star indicates the location of SBN. NOAA CRW CoralTemp v3.1 SST has a spatial resolution of approximately 5 km.

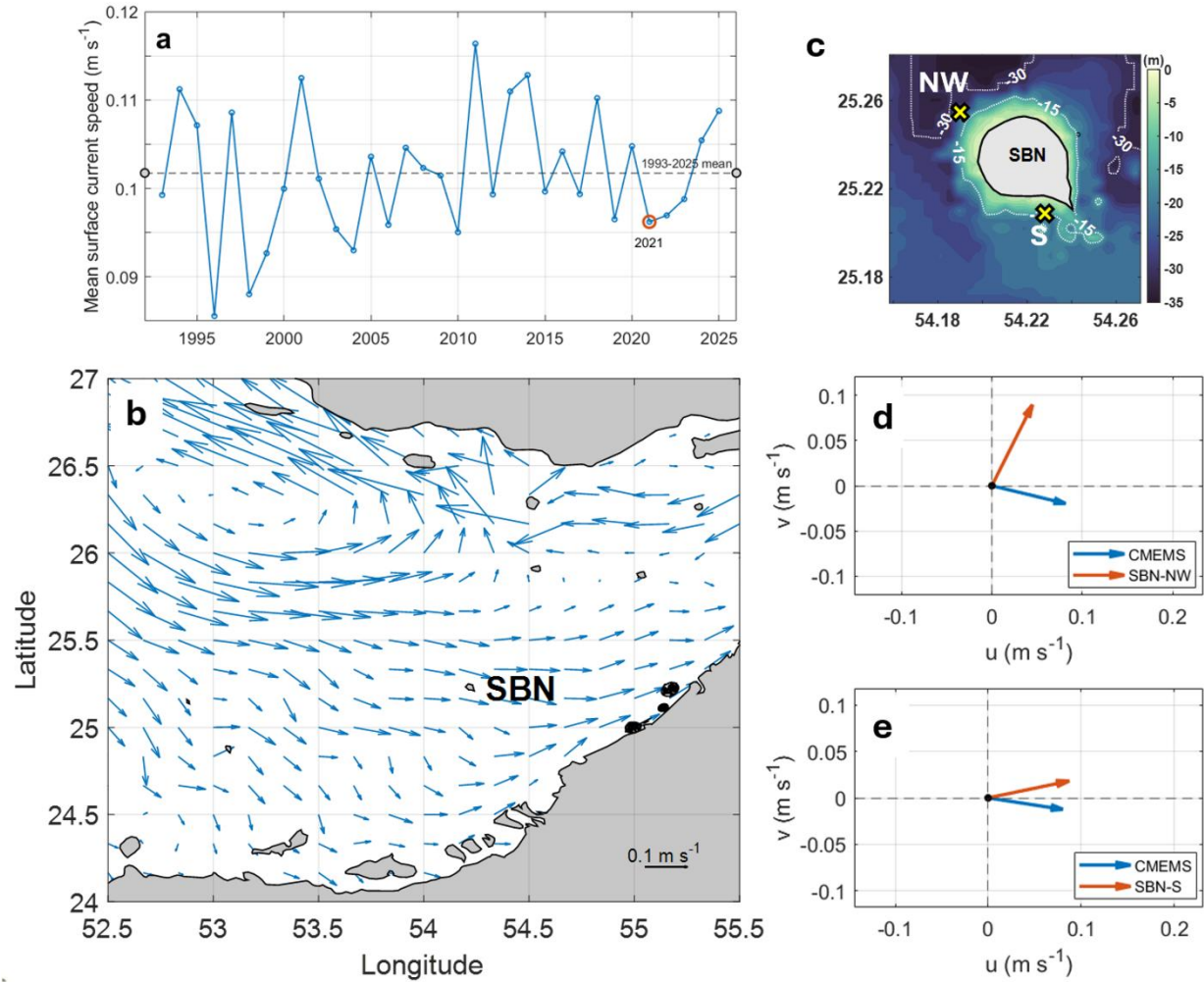


Figure S2. Regional and long-term context of surface circulation around Sir Bu Nair Island (SBN). (a) Mean surface current speed during the observational period (20 May–19 September) for each year from 1993 to 2025, averaged over the regional domain ($53.5\text{--}55.0^\circ \text{ E}$, $24.5\text{--}26.0^\circ \text{ N}$) from CMEMS daily surface currents. The dashed line indicates the 1993–2025 mean, and 2021 is highlighted. (b) Mean CMEMS surface-current vectors during 20 May–19 September 2021, showing the regional circulation surrounding SBN. (c) Bathymetry around SBN showing the locations of the northwest (SBN-NW) and southern (SBN-S) ADCP moorings. (d–e) Comparison of mean current vectors from CMEMS and the depth-averaged ADCP observations at (d) SBN-NW and (e) SBN-S over the common observational period (20 May–19 September 2021). CMEMS currents correspond to the uppermost model layer (0.494 m depth). Vector components u and v represent eastward and northward velocity, respectively.

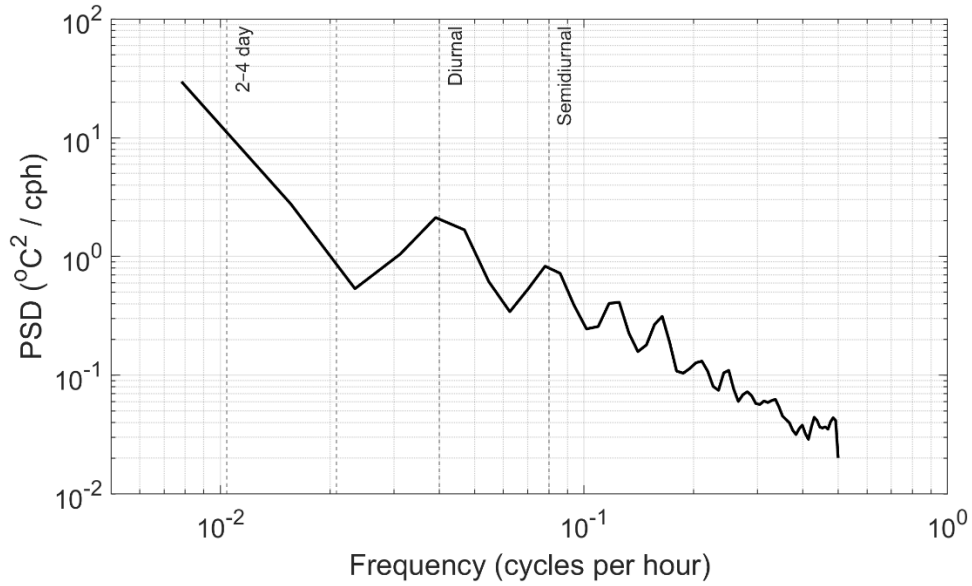


Figure S3. Full-record power spectral density (PSD) of the surface-to-bottom temperature difference (ΔT) at SBN-S. The spectrum was calculated using the complete available SBN-S temperature record from May 2021 to October 2022. Vertical dashed lines indicate the 2–4-day, diurnal, and semidiurnal frequency bands used in the analysis. The full-record spectrum shows that the diurnal and lower-frequency variability identified during the May–June 2021 case-study period was also evident over the longer observational record.