Supplementary Material

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1 SUPPLEMENTARY DATA

The Simple Ocean Data Assimilation (SODA) reanalysis version 3 covering the period 1980–2016 (Carton et al., 2018) at a spatial resolution of 0.25°but available as 5-day averages, was used to investigate the relationship between the Sea Surface Temperature (SST) and the Mixed Layer Depth (MLD) in figure S4. the momentum and heat fluxes influence on the MLD in figure S5.

2 SUPPLEMENTARY TABLES AND FIGURES

2.1 Figures

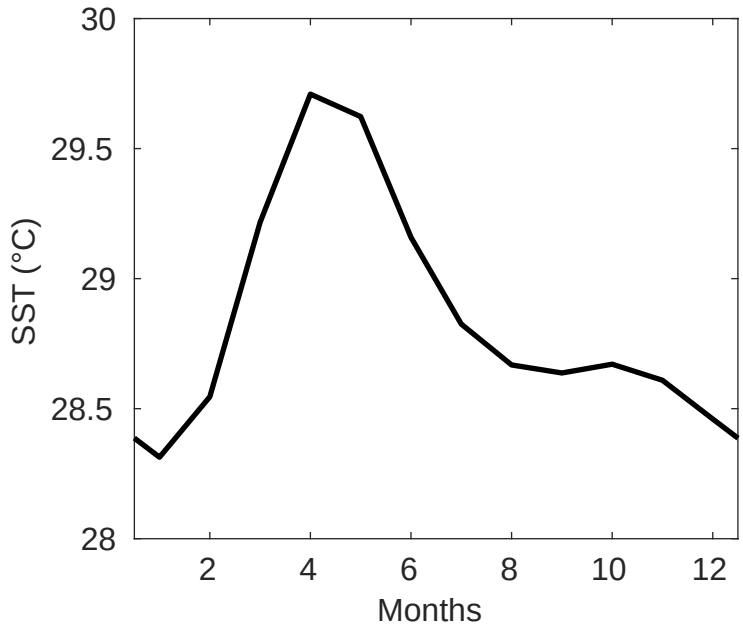

Figure S1. Climatological (1982-2018) seasonal cycle of the SST averaged over the domain from GHRSST

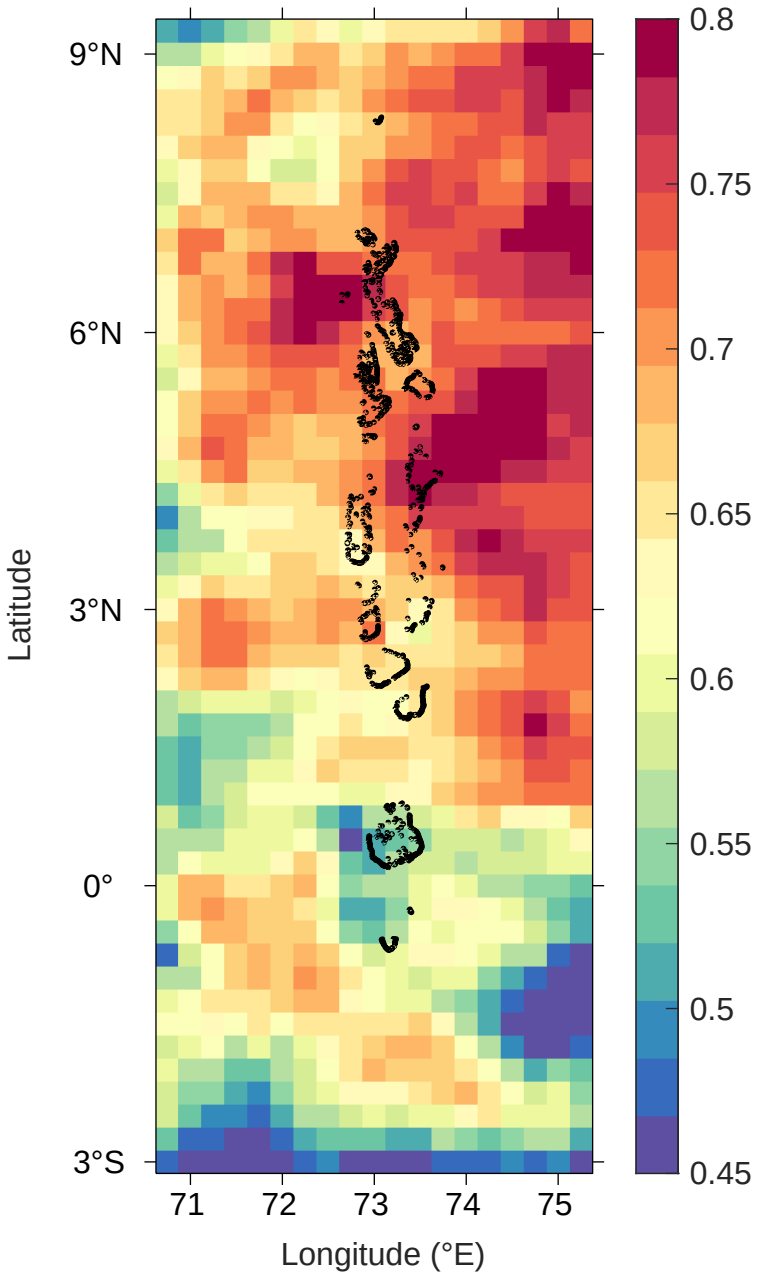

Figure S2. Correlation coefficient of April-May maximum daily surface temperatures on maximum annual ONI for the 1982 - 2018 interval.

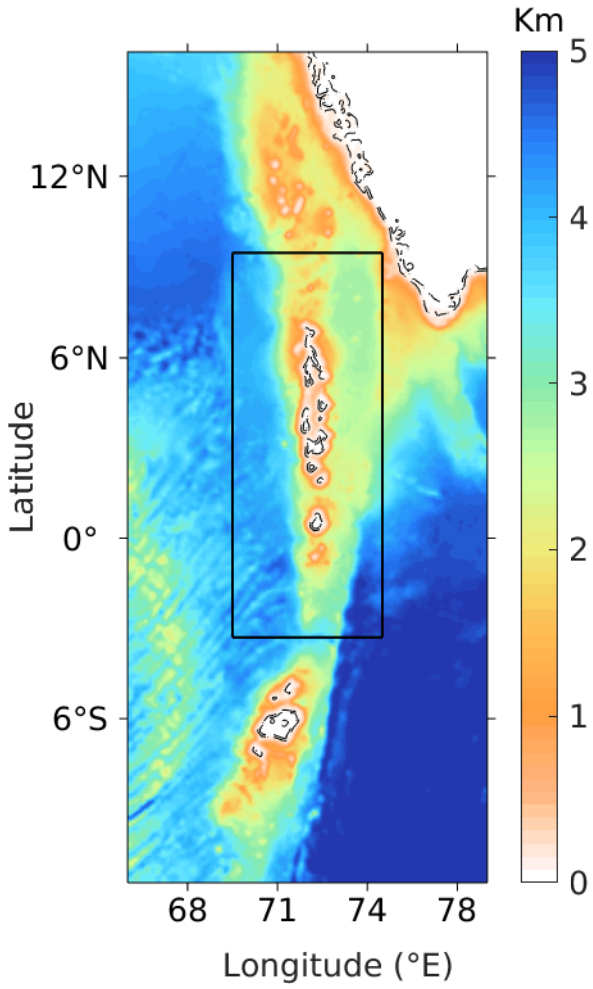

Figure S3. Smoothed bathymetry used in the CROCO simulation at 5 km resolution, with 50 and 100 m contour lines. The inner box identifies the analysed domain.

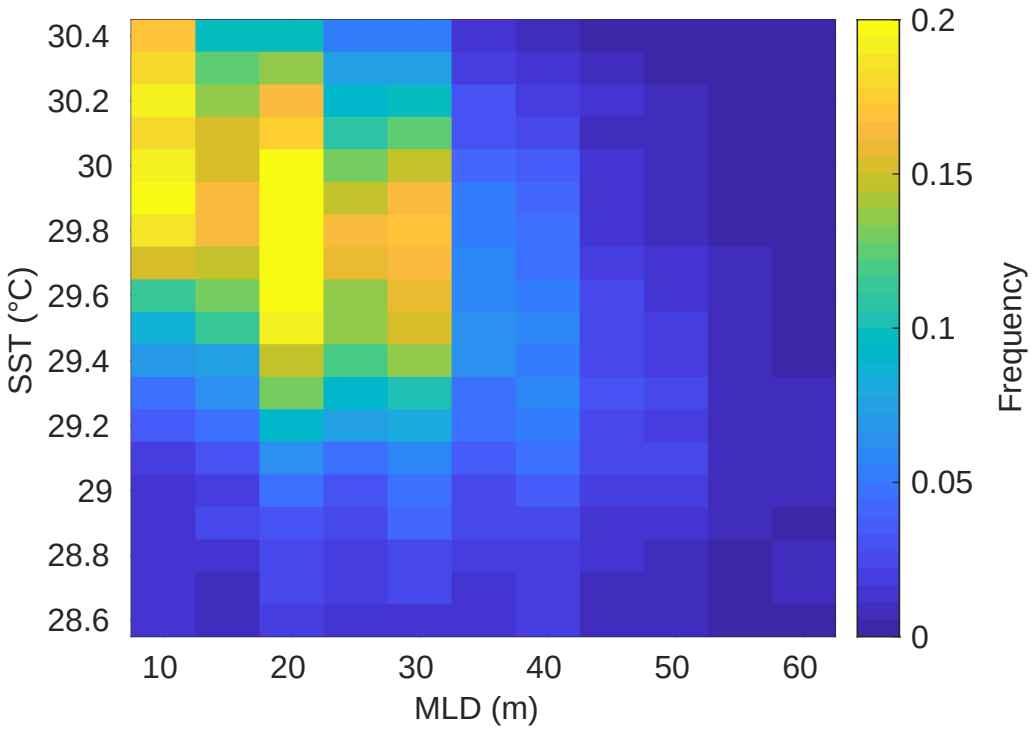

Figure S4. Mixed Layer Depth and corresponding temperature (at 5 m depth) 2 variable distribution, from SODA3

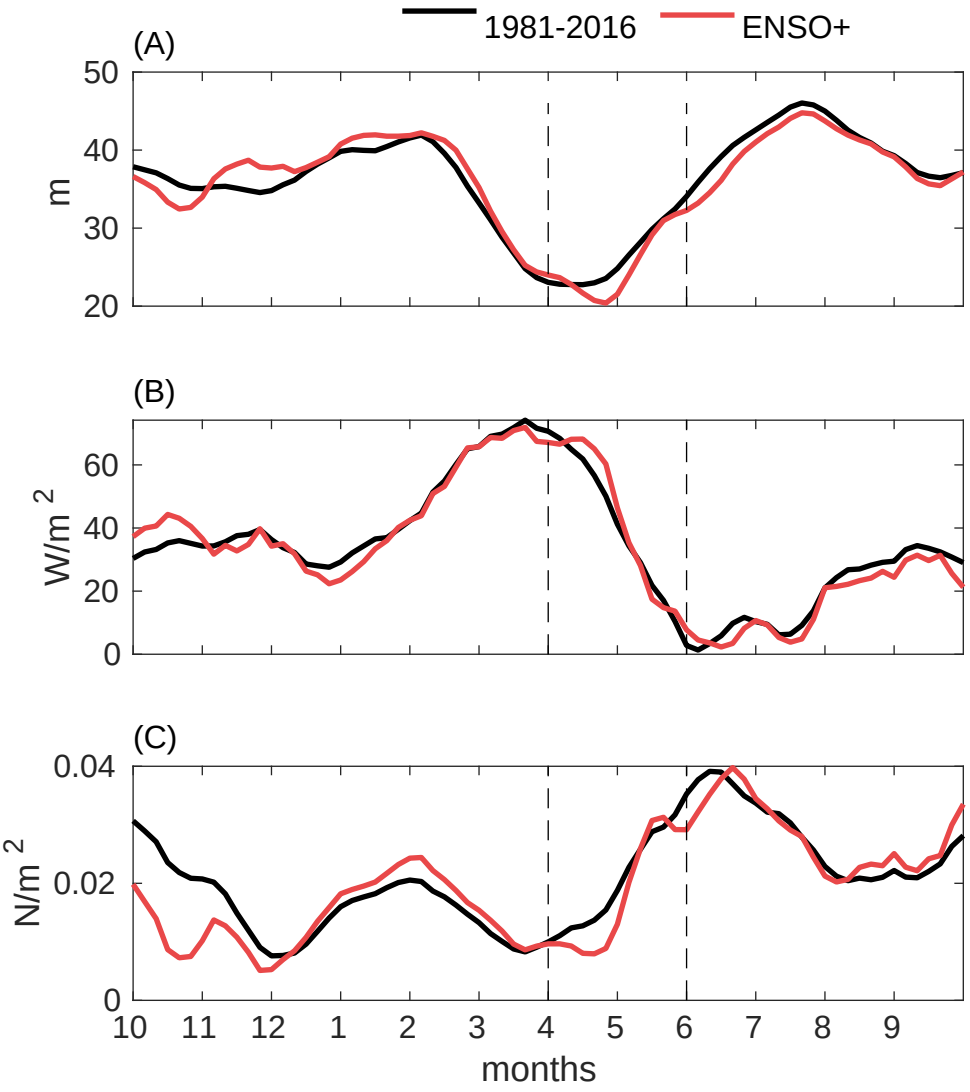

Figure S5. (A) 20-days running mean of the climatological seasonal cycle of the mixed Layer Depth (MLD) from SODA3 for all the available year and only the El-Niño years. (B) 20-days running mean of the climatological seasonal cycle of the net heat flux from SODA3 for all the available year and only the El-Niño years.(C) 20-days running mean of the climatological seasonal cycle of the surface wind stress from SODA3 for all the available year and only the El-Niño years. The shallower mixed layer in April and May during ENSO+ years shown in panel a is due both to slightly stronger heat fluxes (b) and weaker wind stress (c).

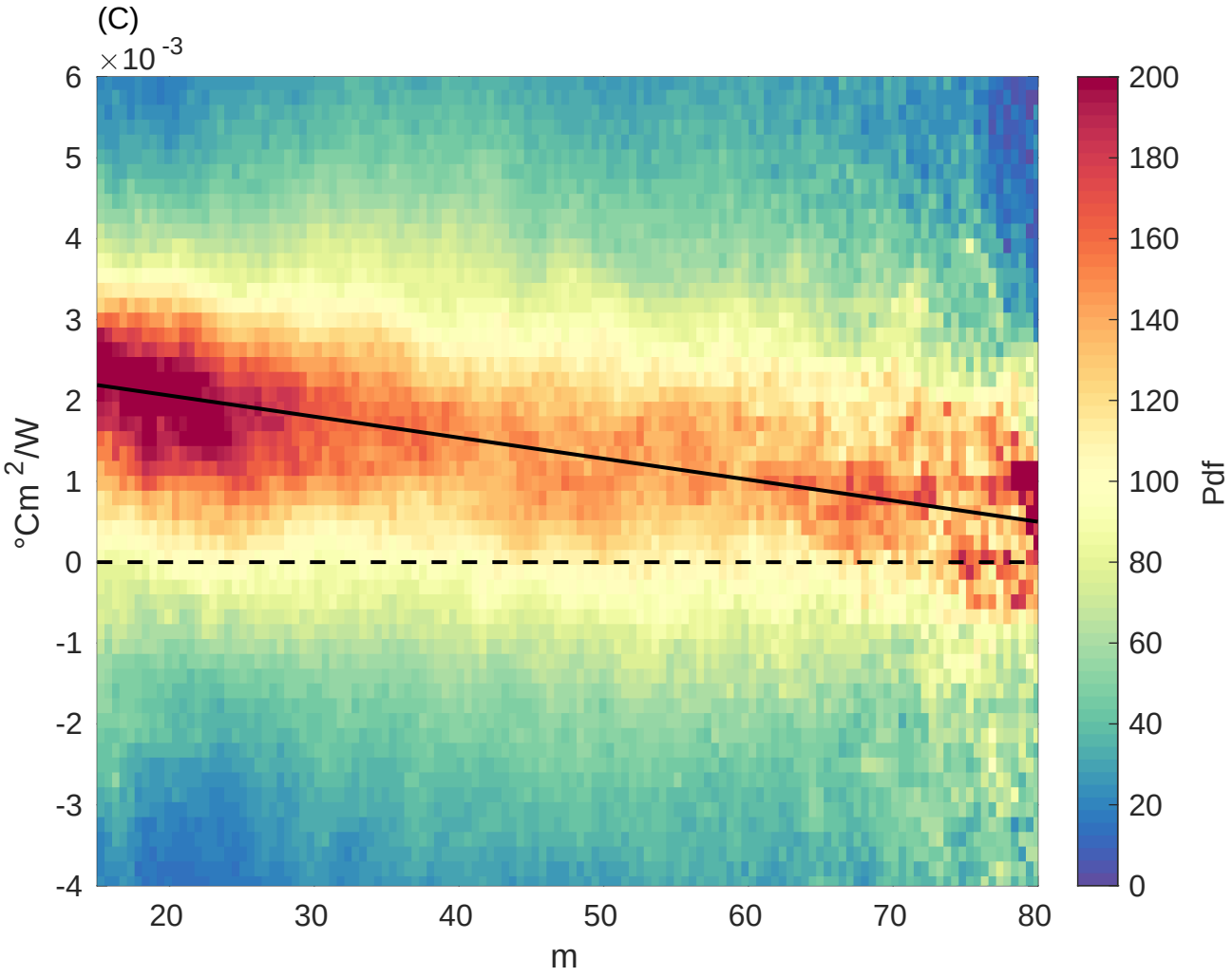

Figure S6. Probability density functions of the temperature at 5m change normalized by the heat flux, as function of the mixed layer depth. , from CROCO simulation. The peak of the distribution moves to smaller thermal variations for deeper mixed layer. The solid line is obtained from the linear regression of the points corresponding to the peak of frequency for each MLD bin; the dashed horizontal line indicates a null thermal variation.

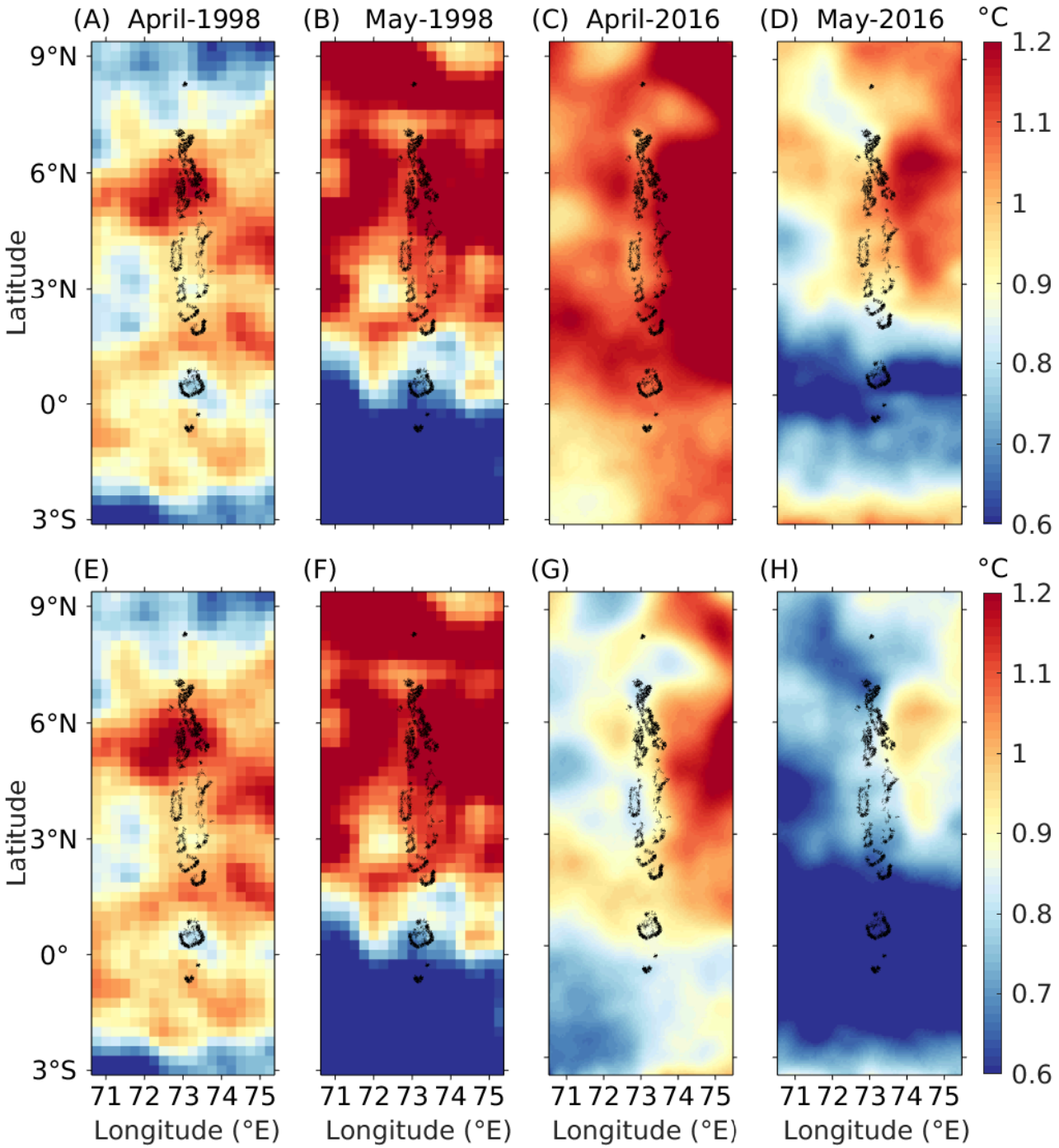

Figure S7. GHRSST SSTa (obtained as SST departures from local MMM) for April and May 1998 and 2016 in panel (a-d) and the same SSTa detrended with the 0.3^{o}C warming trend (e-g). At a 25km resolution for the 1998 (a,b and e,f) and 5km resolution for the 2016 (c,d and g,h).

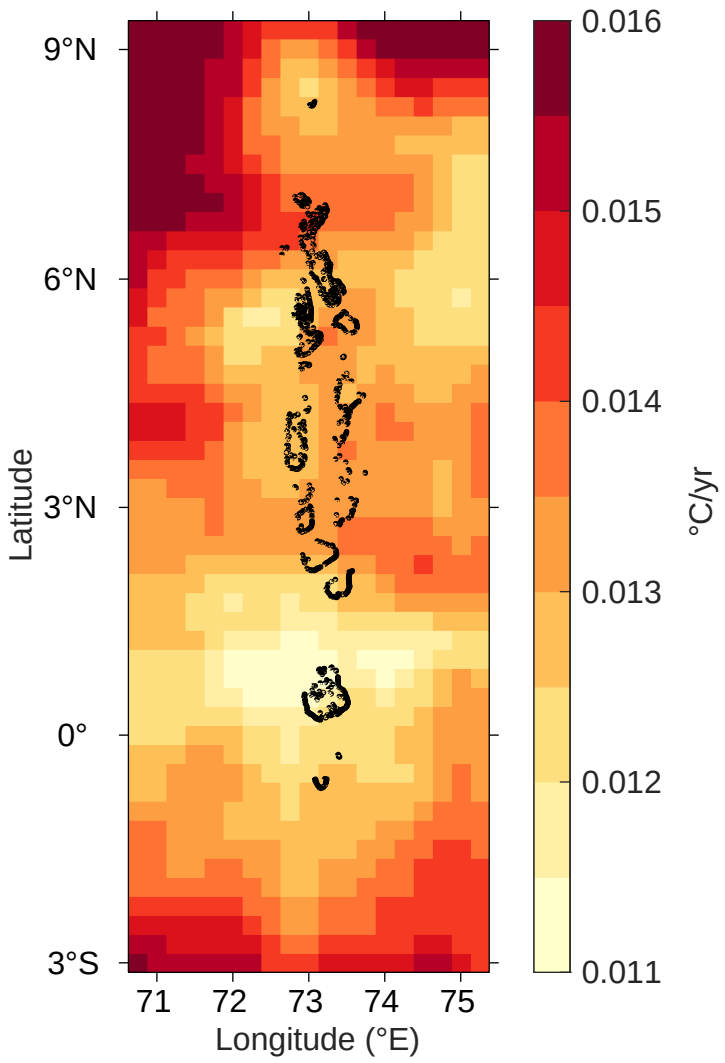

Figure S8. Annual trend of the temperature from 1982 to 2018, from GHRSST data, at 25km resolution.

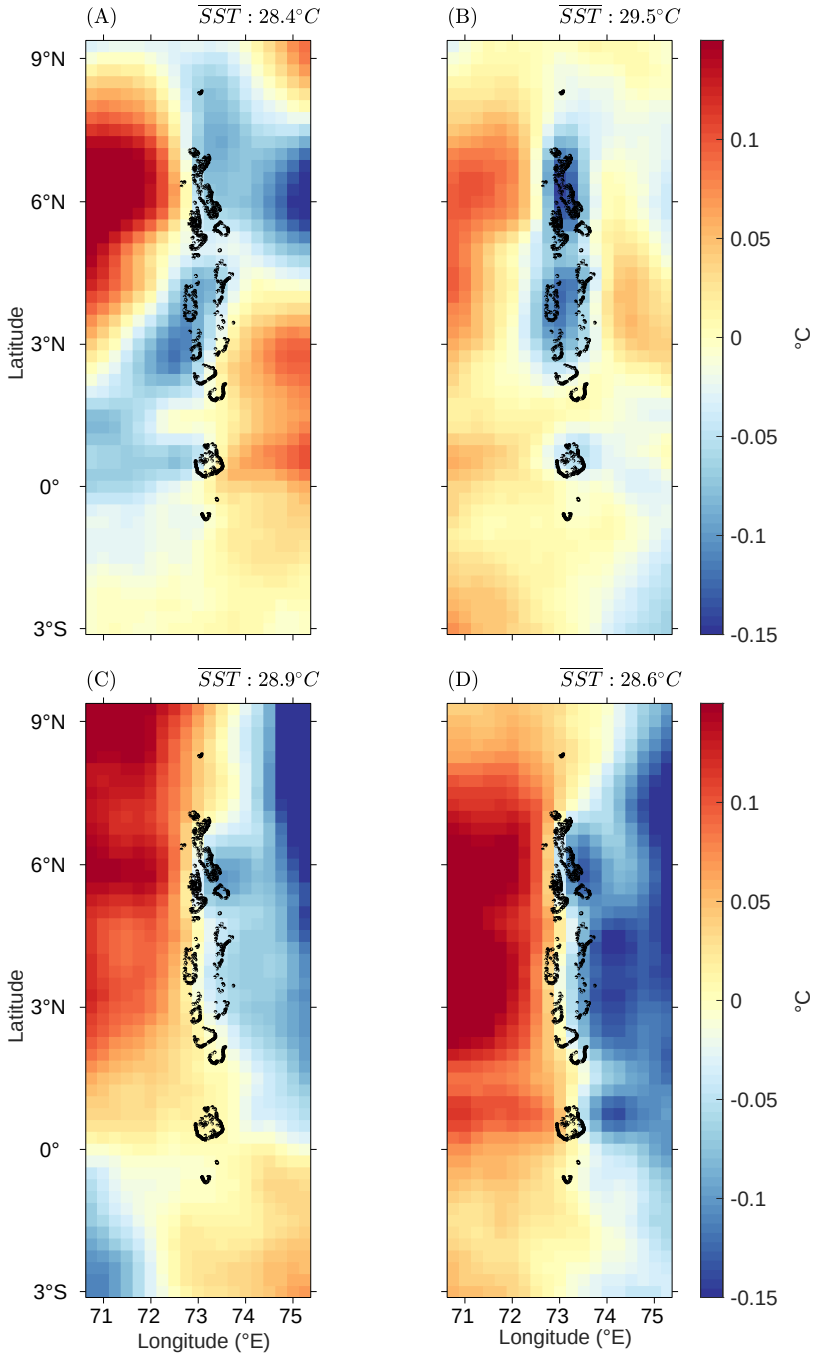

Figure S9. SST anomalies with respect to the zonal (latitudinal) mean from GHRSST (25 km horizontal, daily temporal resolution) 1982-2018. In the top right corner the mean SST of each period averaged over the domain. (A) December - February (DJF). (B) March - May (MAM). (C) June - August (JJA). (D) September - November (SON).

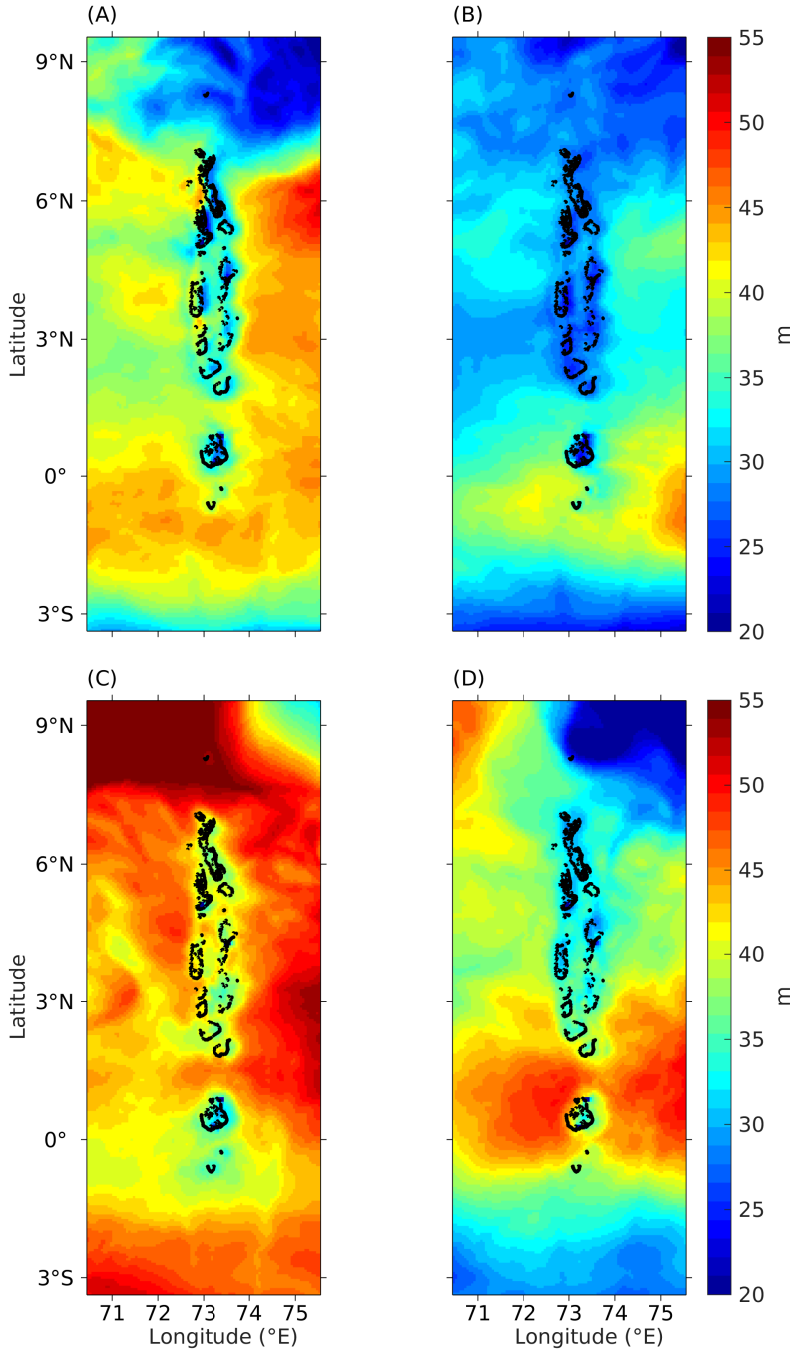

Figure S10. Mixed layer depth annual cycle from CROCO simulation. (A) DJF. (B) MAM. (C) JJA. (D) SON.

Table S1. ENSO+ (El-Niño) and ENSO- (La-Niña) years, defined from October to September.

ENSO+		**ENSO-**	
1986-1987	2006-2007	1984-1985	2005-2006
1987-1988	2009-2010	1988-1989	2007-2008
1991-1992	2014-2015	1995-1996	2008-2009
1994-1995	2015-2016	1998-1999	2010-2011
2002-2003		1999-2000	2011-2012
2004-2005		2000-2001	

REFERENCES

Carton, J., Chepurin, G., and Chen, L. (2018). Soda3: A new ocean climate reanalysis. *Journal of Climate* 31. doi:10.1175/JCLI-D-18-0149.1