**Figure 1.** KAXIS survey region and the MIDOC sampling stations (n = 34) over the southern Kerguelen Axis. Inset panel locates region (black box) off East Antarctica. Background displays bathymetry in 1000 m intervals. Sea ice concentration is shown on February 18th 2016. The voyage track is highlighted by the solid black line. The solid purple lines show major oceanographic fronts as determined from the voyage oceanographic sampling (Bestley et al. 2020): the Southern Antarctic Circumpolar Circulation Front (SACCF), the Southern Boundary (SB) of the ACC, the Antarctic Slope Front (ASF), and the Fawn Trough Current (FTC). The dotted black lines indicate climatological locations of the major Antarctic circumpolar current (ACC) fronts (Orsi, Whitworth III and Nowlin Jr 1995).

**Figure 2.** Biomass (g m⁻³) of mesopelagic micronekton sampled with a midwater trawl (0-1000 m) across 34 MIDOC stations, between January and February 2016, separated by major taxonomic groups.

**Figure 3.** Distribution of fish biomass across the K-axis survey region. Data from 34 MIDOC sampling stations are overlaid on the mean biophysical features during the survey period: **(A)** sea surface temperature (◦C); **(B)** near-surface geostrophic velocities during the survey period (scale capped above 25 cms-1); **(C)** sea-surface chlorophyll-*a*, note that the colour bar is on a natural log scale; **(D)** ice history, the colour scale indicates time since ice melt (days) at the end of the survey (16th February). Sea ice concentration is shown on February 18th 2016. See Table 1 for details on data sources and resolution. The voyage track is highlighted in magenta. The solid black lines show major oceanographic fronts as determined from the voyage oceanographic sampling (Bestley et al. 2020): the Southern Antarctic Circumpolar Circulation Front (SACCF), the Southern Boundary (SB) of the ACC, the Antarctic Slope Front (ASF), and the Fawn Trough Current (FTC). The dotted black lines indicate climatological locations of the major Antarctic circumpolar current (ACC) fronts (Orsi et al., 1995).

**Figure 4.** Heat maps and bar charts of fish (panel A, C) cephalopods (panel B, D) organised by time of day sampled and illuminated lunar fraction across the survey region (34 MIDOC stations). Grey tiles on the heat maps indicate strata where no biomass was captured. Bar charts along the top panel show the sum of the biomass between 0-1000 m at each station. Time of day is indicated by bar colours: sunrise (pink), day (yellow), sunset (red), and night (blue). Lunar illumination is shown by greyscale bar colours and icons: full moon (white circle), half-moon (half-filled circle), and new moon (black circle).

**Figure 5.** Depth-structured generalised additive mixed-effects models (GAMMs) of fish biomass from 0-1000 m. Panel (A) shows fitted relationships between fish biomass per depth strata and solar angle (o) relative to the horizon. Positive values indicate the sun above the horizon, and negative values indicate the sun below the horizon. Panel (B) shows fitted relationships between fish biomass per depth strata and the fraction of the illuminated surface of the moon, which serves as a proxy for lunar phase, with 0 indicating a new moon with no illumination and 1 indicating full moon. Solid lines are the estimates of the smooths, grey shaded areas are the 95% confidence intervals and points are the observation partial residuals. *p*-values are represented by red asterisks or circles; with <0.001 = ‘\*\*\*’ , <0.01 = \*\* , <0.05 \*, <0.1 = • .

**Figure 6.** Select panels illustrating results from the depth-structured generalised additive mixed-effects models (GAMMs) for cephalopod biomass. The illuminated surface of the moon serves as a proxy for lunar phase, with 0 indicating a new moon with no illumination and 1 indicating full moon. Solid lines are the estimates of the smooths, grey shaded areas show the 95% confidence intervals and points are the observation partial residuals. *p*-values are represented by red asterisks or circles; with <0.001 = ‘\*\*\*’ , <0.01 = \*\* , <0.05 \*, <0.1 = · .

**Figure 7.** Depth-integrated generalised additive models for fish, cephalopods and krill biomass across four remotely sensed environmental factors; sea surface temperature, current speed, chlorophyll-*a* and time since ice melt. Note that three extreme values of SST <0oC were removed from this analysis, as outlined in the methods. Current speed is near surface geostrophic velocities during the survey period, capped above 25 cms-1**.** Chlorophyll-*a* is the mean sea surface chlorophyll-*a* across the K-axis survey period at 4.6km resolution, on a natural log scale. Time since melt indicates the ice history, with days since ice melt at the end of the survey (16th of February). Solid lines are the estimates of the smooths, grey shaded areas are the 95% confidence intervals and points are the observation partial residuals. *p*-values are represented by red asterisks or circles; with <0.001 = ‘\*\*\*’ , <0.01 = \*\* , <0.05 \*, <0.1 = · .