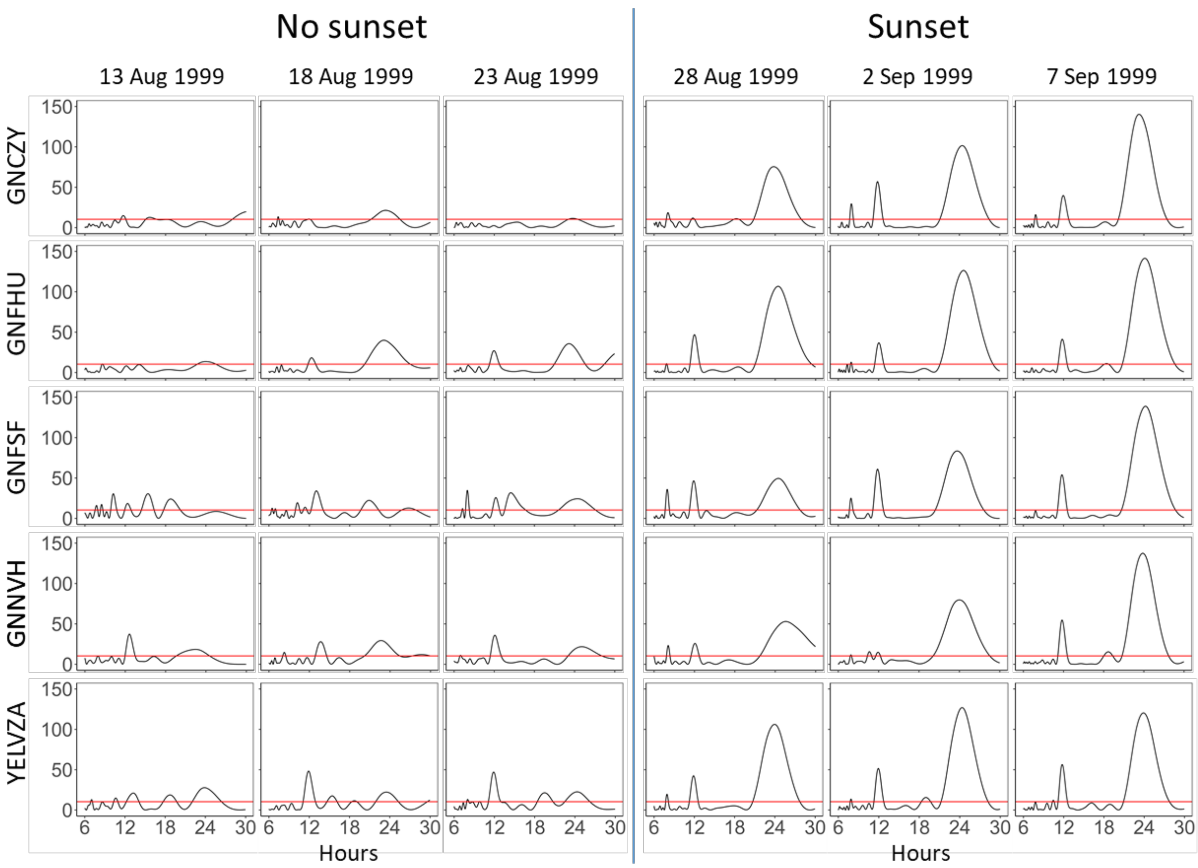
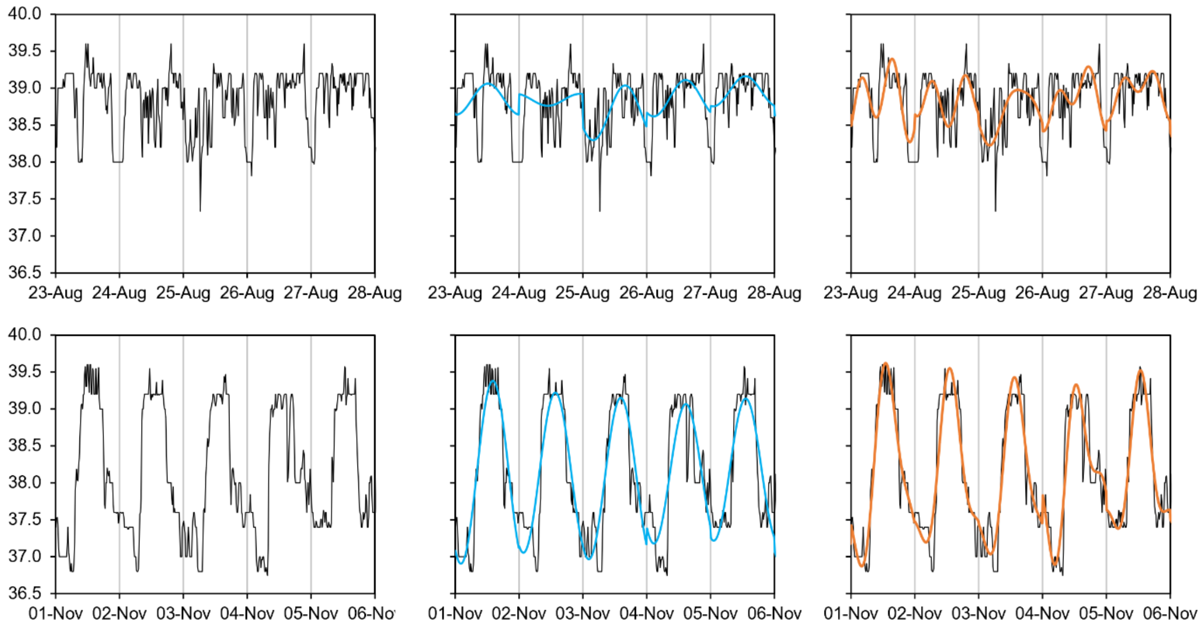
Supplementary Material

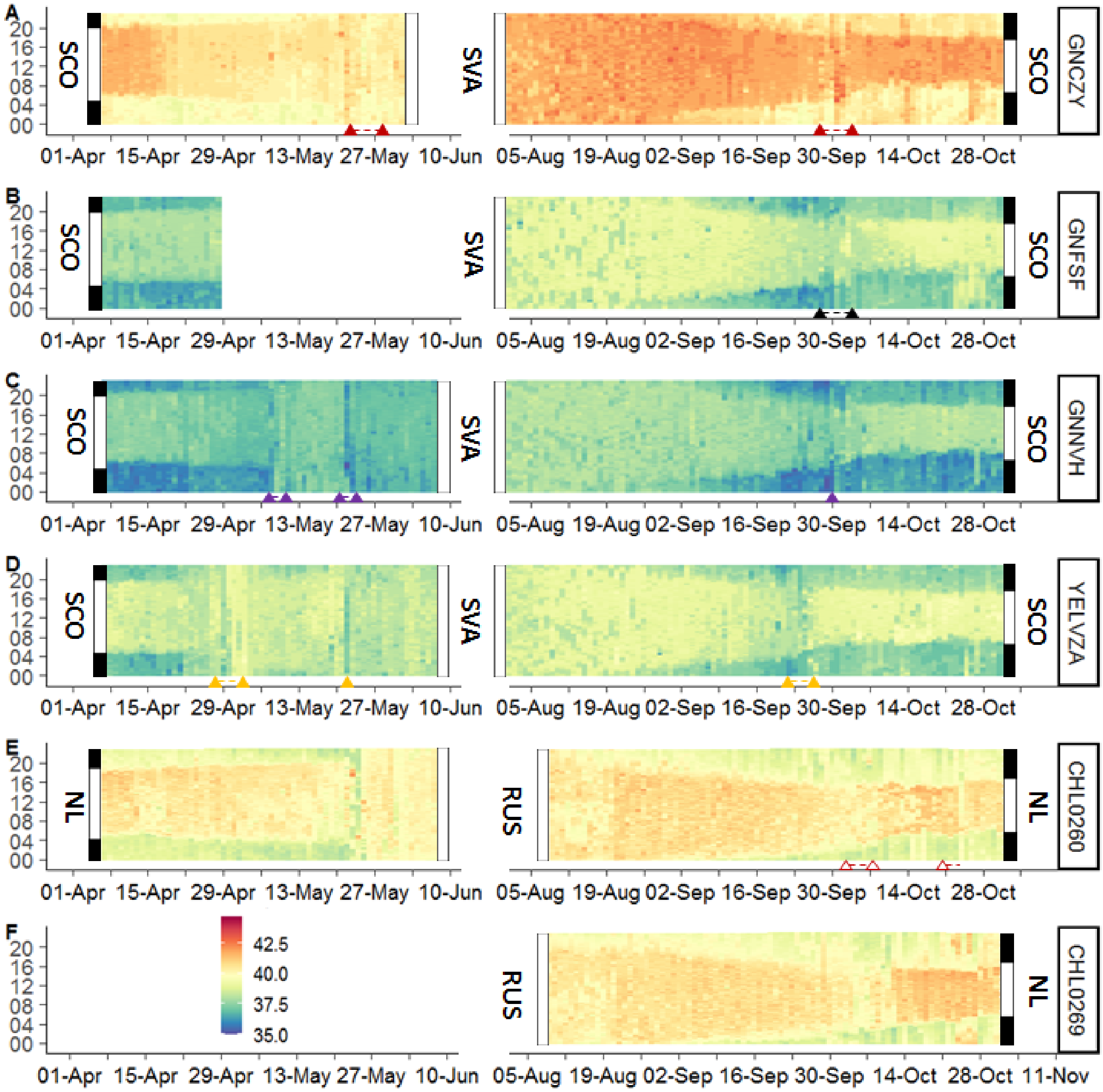
1 Supplementary Figures



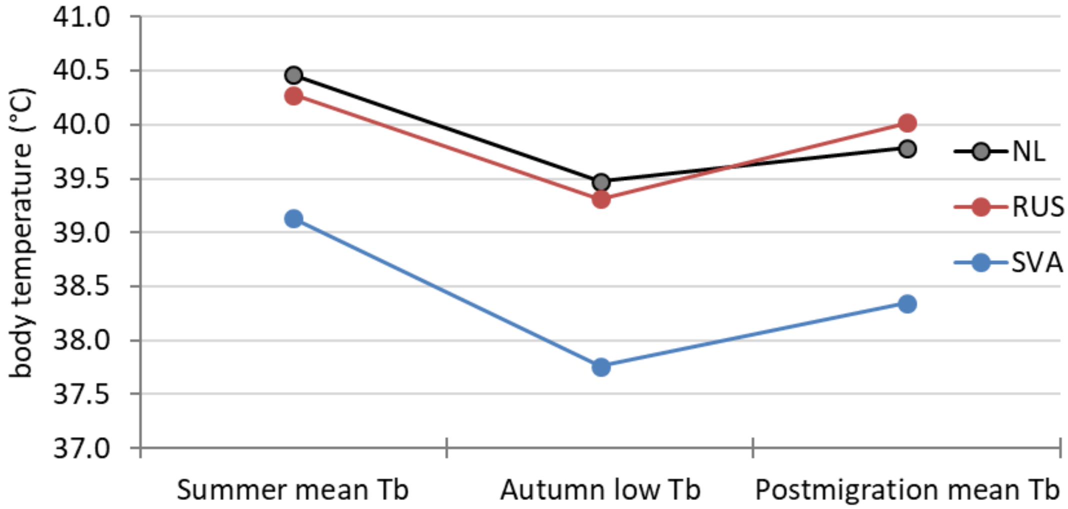
Supplementary Figure 1. Periodicity in Tb data of individual barnacle geese (ID given on the left) while in Svalbard during the transition from 24-hrs daylight conditions at the end of summer (marked by the vertical blue line) to a period with diel light-dark phases (see also main **Figure 4** for change in daylight). Shown are normalised power values (PN, black line) obtained from Lomb-Scargle periodogram analysis for periods ranging from 6 h to 30 h calculated for 5-day blocks of Tb data sampled at 15-min intervals (middle date of each block is given on top of figure). The horizontal red line in each plot marks the level of PN at which periods were considered significant at $P < 0.001$.



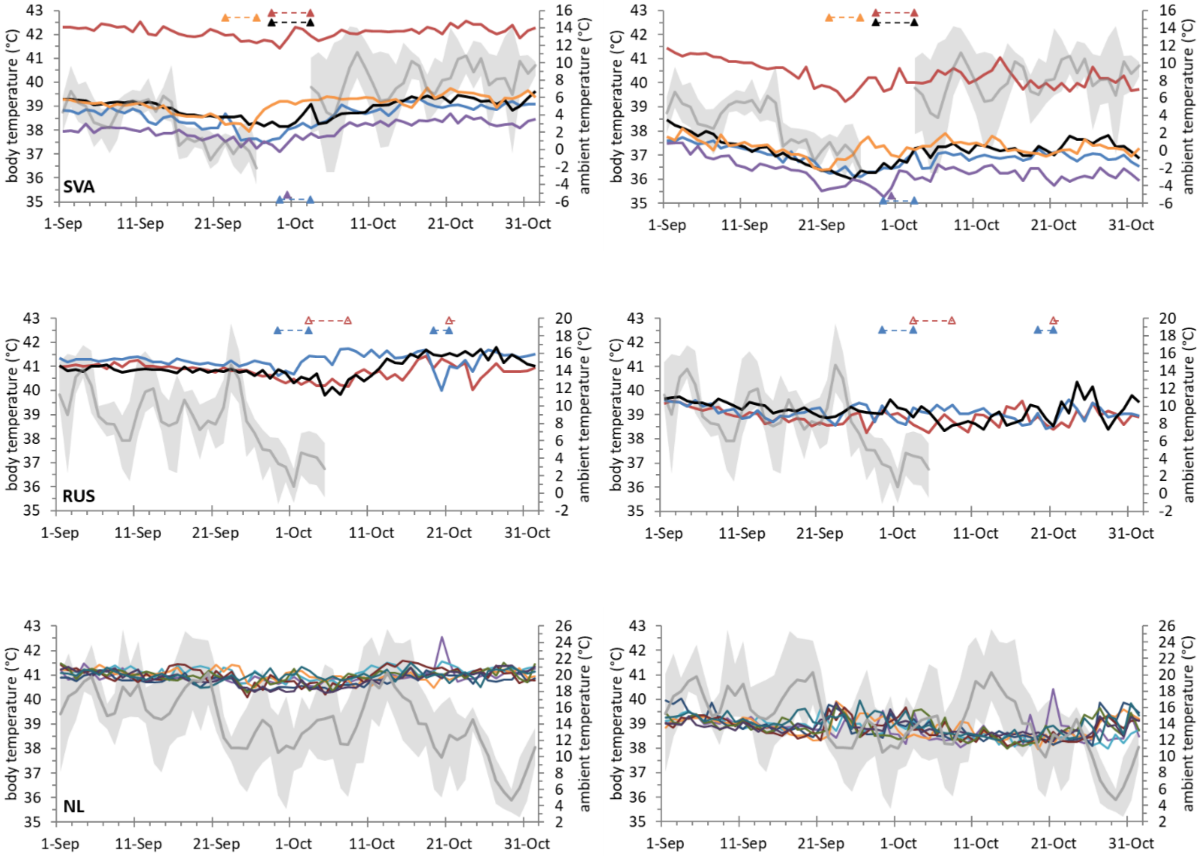
Supplementary Figure 2. Example traces of 5 days of raw Tb data (black traces) and the respective fitted single component cosinor (blue traces) and multicomponent cosinor model (orange traces) in an individual barnacle goose (GNFSF) when it was in Svalbard (top panels) and in its wintering grounds (bottom panels).



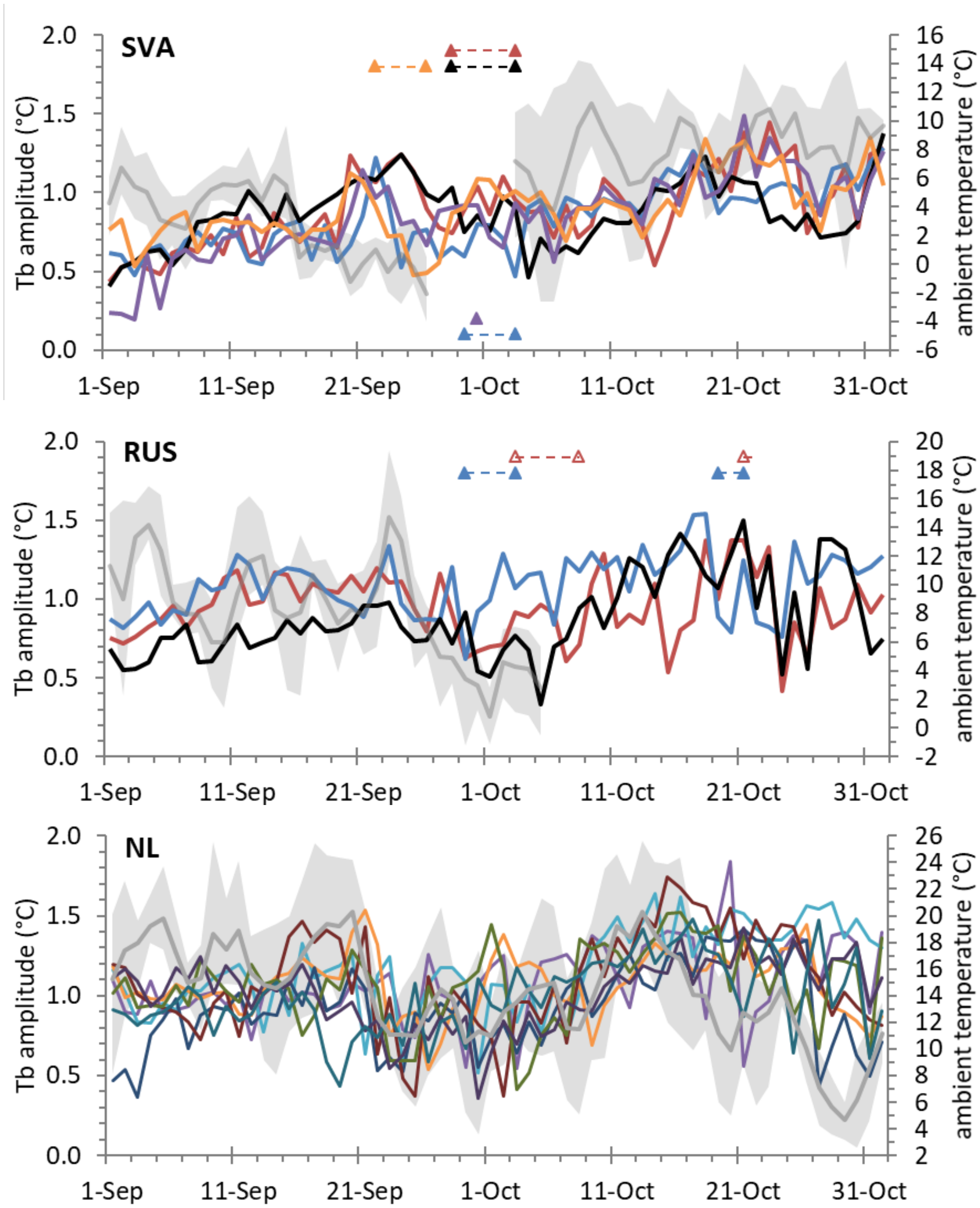
Supplementary Figure 3. Further examples (in addition to main **Figure 1**) of diel (vertical axis, in hours) and seasonal body temperature (Tb, in °C) patterns in individual barnacle geese (ID given on the right of each plot) from the Arctic-migratory populations (A-D: Svalbard, E-F: Russia). Vertical bars at the start and end of the Tb plots indicate the period of daylight, including civil twilight (white) and night (black) in the wintering and breeding areas (SCO - Scotland, SVA - Svalbard, NL-Netherlands, RUS - Russia). The time of day refers to GMT in all panels. Migratory movements are indicated by triangles; if the triangles are connected by dashed lines, then migratory activity was recorded throughout this period.



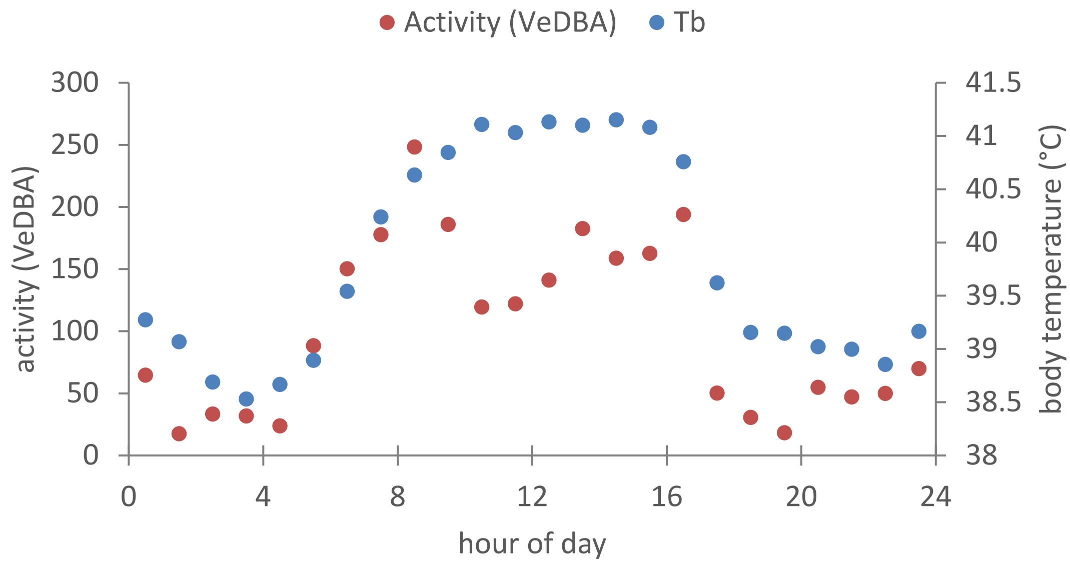
Supplementary Figure 4. Daily mean body temperature of barnacle geese from Arctic-migratory populations in Svalbard (SVA) and Russia (RUS), and from a non-migratory population in the Netherlands (NL) at three time periods / states around autumn migration. Plotted are the population averages given in **Table 1**, referring to mean Tb during 10 to 20 August ('Summer mean Tb'), lowest daily mean Tb found during 21 September to 21 October ('Autumn low Tb') and mean Tb during 23 October to 15 November ('Postmigration mean Tb').



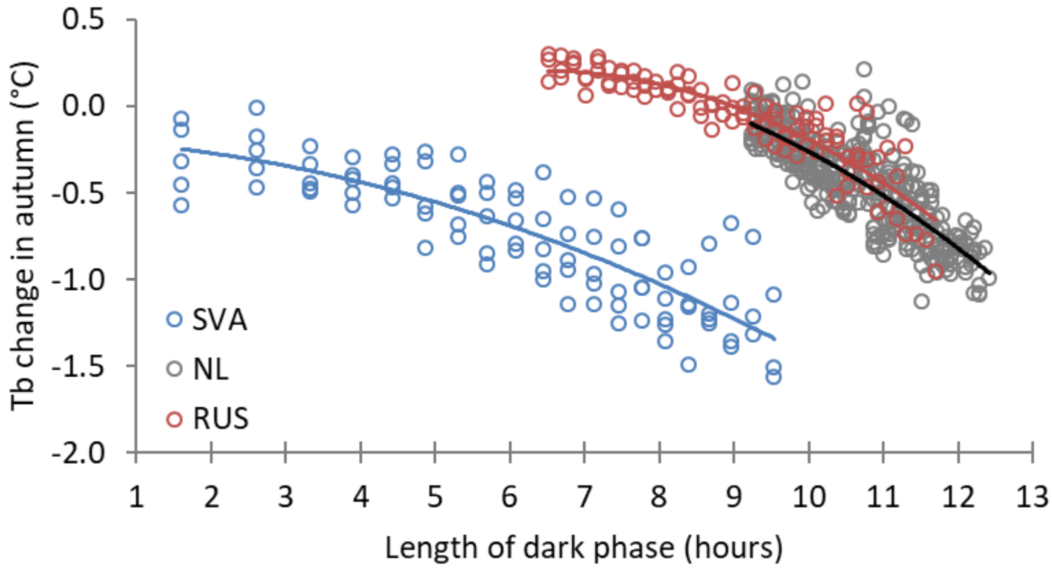
Supplementary Figure 5. Daily Tb (left axis) of barnacle geese before, during, and after their autumn migration from Svalbard (SVA) to the UK, from Russia (RUS) to (pre-) wintering grounds in the SW Baltic and Wadden Sea, and of non-migratory individuals in the Netherlands (NL). Shown are daily peak (left column of panels) and trough (right column of panels) of Tb rhythms modelled by multi-component cosinor analysis. Migratory movements are indicated by triangles matching in colour with the individual Tb series; if the triangles are connected by dashed lines, then migratory activity was recorded throughout this period. The timing of movements was derived from individual heart rate (SVA) or GPS tracking (RUS); in one case (open triangles) it was estimated from obvious phase shifts observed in Tb data (main **Figure 1**). The grey line and the borders of the grey shaded area surrounding it refer to daily mean, maximum, and minimum ambient temperature (right axis) as measured in the breeding area before most individuals departed; for Svalbard geese (with a condensed migratory period) ambient temperature is also shown in their Scottish wintering area. See methods for details.



Supplementary Figure 6. Daily amplitude of Tb rhythms (left axis) of barnacle geese before, during and after their autumn migration from Svalbard (SVA) to the UK, from Russia (RUS) to (pre-) wintering grounds in the SW Baltic and Wadden Sea, and of non-migratory individuals in the Netherlands (NL). Amplitude was derived from a multi-component cosinor model. Migratory movements are indicated by triangles matching in colour with the individual Tb series; if the triangles are connected by dashed lines, then migratory activity was recorded throughout this period. The timing of movements was derived from individual heart rate (SVA) or GPS tracking (RUS); in one case (open triangles) it was estimated from obvious phase shifts observed in Tb data (main **Figure 1**). The grey line and the borders of the grey shaded area surrounding it refer to daily mean, maximum and minimum ambient temperature (right axis) as measured in the breeding area before most individuals departed; for Svalbard geese (with a condensed migratory period) ambient temperature is also shown in their Scottish wintering area.



Supplementary Figure 7. Example of hourly mean body temperature (Tb) and activity level expressed as vectorial dynamic body acceleration (VeDBA) in an individual barnacle goose (CHL0289) throughout the 24-hr day. Hourly means were averaged over a four-day period (10 to 13 November 2018) based on original sampling rates of 5 minutes for VeDBA and 10 minutes for Tb. VeDBA was calculated as the square root of the sum of the dynamic body acceleration measured on the three axes; see Qasem et al. (2012) for details.



Supplementary Figure 8. Reduction in daily mean body temperature in individual barnacle geese from Arctic-migratory populations in Svalbard (SVA) and Russia (RUS), and from a non-migratory population in the Netherlands (NL) during autumn. Plotted are daily means for each individual and day relative to their summer mean Tb values (average over 10 to 20 August; given in **Table 1**) against increasing daily night length (period when sun was < -6° below horizon, i.e. not including civil twilight). Individual time series started with 1 September (RUS, NL) or 10 September (SVA; as the first day with nightfall), and ended when daily mean Tb reached its autumn low (Table 1), which coincided with the onset of migration in migratory geese (main **Figure 5**). The lines are quadratic fits through data for each population.

2 Supplementary References

Qasem, L., Cardew, A., Wilson, A., Griffiths, I., Halsey, L.G., Shepard, E.L.C., et al. (2012). Tri-axial dynamic acceleration as a proxy for animal energy expenditure; should we be summing values or calculating the vector? *PLoS One* 7**,** e31187. doi: 10.1371/journal.pone.0031187