# ELECTRONIC APPENDIX

This is the Electronic Appendix to the article

**Evidence of a shift in the cyclicity of Antarctic seabirds dynamics linked to climate**

by

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We conducted a sliding window correlation of the number of breeding pairs, breeding success and environmental variables to highlighted change in correlation pattern over time. As specified in the Methods, we focused on periods between 2 and 8 years due to the maximum length of demographic time series of 40 years. Therefore, the Pearson's product-moment correlations were conducted for overlapping 7-year intervals incremented by one year and the correlation value of each window was affected to the central year of the window. We tested the sensitivity of the results to the length of the sliding window correlation, and showed that the results are consistent for a window length varying from 5 to 12 years.

From this sliding window correlation analysis we obtained correlation patterns between demographic and environmental parameters (correlation coefficient as a function of year, see figure 4). We also calculated overall correlation coefficients (Table 1), and focus on the significant relationships. We studied the relationships that showed strong change of correlation coefficient sign, i.e. when the sliding window correlation coefficient was outside the confidence intervals calculated with bootstrap methods with time series of the same length than the window. We estimated the probability that observed correlations were obtained by chance alone by bootstrap analyses. We also calculated the probability that each change, called "$p_c$", characterised by a change of coefficients correlation sign, was obtained by chance by bootstrap analyses. We randomised 1000 times the demographic time series, and calculated for each simulation, each correlation with the untransformed environmental time series that characterise a pattern.

Table A1 : The relationships between the demographic data (figure 1*b* and 2*b*) and the environmental data (figure 3*b*) used in the analyses (i.e. : we removed low frequencies in our time series using a 8-year high-pass Gaussian filter and used the difference between the unfiltered and low-pass filtered times series). The sliding window correlation analysis (figure 4) determined several time period where the responses of population size, and breeding success to environmental variable changed. We defined a change as a change of correlation coefficient sign. During these periods an overall correlation coefficient (r) and its significance by bootstrap methods were calculated. Significant correlations at a 0.10 ($^{*}$), 0.05 level ($^{**}$) and 0.01 level ($^{***}$) are indicated. The significance of the pattern of change was also calculated by bootstrap methods ($p_c$). SF stands for southern fulmar, SP for snow petrel and EP for emperor penguin.

| figure 4 | Species | Period | r | $p_c$ |
|---|---|---|---|---|
| (a) | SF | Negative phase before change | -0.28 | 0.073 |
| | | Positive phase after change | 0.10 | |
| | SP | Negative phase before change | -0.38$^{*}$ | 0.03 |
| | | Positive phase after change | 0.09 | |
| (b) | EP | Negative phase before change | -0.12 | <0.001 |
| | | Positive phase | 0.40$^{**}$ | |
| | | Negative phase after change | -0.16 | |
| (c) | SP | Negative phase before change | -0.15 | 0.015 |
| | | Positive phase after change | 0.47$^{*}$ | |
| (d) | SF | Negative phase before change | -0.44$^{**}$ | <0.001 |
| | | Positive phase | 0.28 | |
| | | Negative phase after change | -0.83$^{***}$ | |
| | EP | Positive phase before change | 0.58$^{***}$ | <0.001 |
| | | Negative phase after change | -0.01 | |