

Figure S1. Climatological annual cycle in the ABA region (8°E-coast, 25°S-15°S) of (a) SST [C], and (b) depth of the 15C isotherm [m]. The orange line denotes CFES, while the blue and green lines denote, respectively, (a) OISST and Hadley Centre SST, and (b) NODC World Ocean Atlas and SODA reanalysis. Other lines indicate various IPCC AR4 models.



Figure S2. Frequency distribution of Benguela Niños and Benguela Niñas [%] stratified by month and normalized by the total number of events. Events are defined as extrema in the AB1 region that exceed 1.5 standard deviations. The individual panels show, from top left to bottom right: OISST, Hadley Centre SST, CFES, and several IPCC AR4 models. CFES compares quite well with the observations, featuring a peak in boreal spring and a secondary peak boreal fall. The peak in June, however, does not feature in observations.



Figure S3. Evolution of a composite Benguela Niño based on SODA reanalysis. The upper panel is a longitude-time section along the equator, the lower panel a latitude-time section along the southwest African coast. Shading indicates upper ocean heat content (J*E19) in both panels while contours indicate (a) zonal wind stress (0.2 N m-2*10), and (b) meridional wind stress (0.2 N m-2*10). Dashed contour lines indicate negative values. Compositing is based on the 8 events for which the AB1 SST anomaly exceeds +2 standard deviations. The abscissa shows time (months) relative to the peak of the composite event. 3 months before the peak, northerly wind stress anomalies develop along the southwest African coast, and this is accompanied by a rapid increase in upper ocean heat content around 20°S. Easterly wind stress anomalies along the equator set in one month later. As in the case of CFES, the temporal evolution suggests that along-shore winds in the AB1 region play a crucial role in the development of the event.



Figure S4. Horizontal maps of ERA-40 anomalous SST (shading; K), surface wind stress (arrows; N m-2*100), and SLP (contours; 0.25 hPa interval) composited on the ABA SST index. Only events with standard deviations greater than 2 are selected. Dashed contour lines indicate negative values. At the peak and one month prior, patterns are similar to the CFES simulation (Figure 3 of the manuscript). Three months before the peak, however, weakened sea-level pressure is not apparent, and zonal equatorial wind stress anomalies have different signs in the eastern and western part of the basin.



Figure S5. Latitude-time sections of daily SST anomalies (shading; K), and mean meridional surface wind anomalies (contours; interval 1 m s-1). The panels show (a) year 51 of the CFES simulation, and (b) year 2008 of the QuickSCAT and AVHRR satellite observations. Fields have been zonally averaged between the coast and 4° (2°) offshore for CFES (observations). Dashed contour lines indicate negative values.