

Supplementary Material

Records Segmentation methodology: Appendix C

The G/B time series used for record segmentation analysis was created by normalising the three short coral G/B records (MAS1, MAS3, ANDRA) and taking an average, therefore creating a single composite record. To detect shifts in the G/B composite, PDO index and SST time series, we applied a segmentation analysis. Webster (1979) aims to divide a given time series into relatively (statistically) homogeneous segments (Webster, 1979). In order to do so, a window, split about its midpoint, is moved along the sequence, from one end to the other, while at each position in the record the two halves are statistically compared by calculating the D^2 statistic, i.e. the Mahalanobis distance. In the next step, the D^2 statistic is plotted as ordinate against the window midpoint position, thereby indicating division points in the time series as local maxima. Following Webster (1979), we chose a window size of 20 years, hence comprising two half windows of each 10 years, allowing us to detect points of maximum change at decadal time scales (Webster, 1979). Given our record has a monthly time resolution, $10 \times 12 = 120$ points comprise the half window size. This means that at every point in the time series we compare the statistics of 120 point backward to the statistics of a window of 120 points forward. We apply the segmentation analysis predominantly to detect points at which a major transition takes place in the G/B, PDO and SST time series. Although the 95% significance of the D^2 statistic is reached at a level of $D^2 = 0.05$, it is important to note that not the absolute value but rather the local maxima should be considered as the transitions or change point in the time series. It is important to keep in mind that, given the window size of

2 x 10 years, we are not able to interpret change points in the first and the last 10 years of the time series.

References

Webster, R.: Divide: A FORTRAN IV program for segmenting multivariate one-dimensional spatial series, *Computers and Geosciences*, 6, 61-68, 1979.