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To test the significance of residuals, a standard bootstrap method was employed in this section (Mudelsee 2010; Ezer & Corlett 2012). The method is technically based on random resampling to estimate confidence intervals. From the daily Ross Sea Polynya (RSP) size data or yearly RSP occurrence time data, long-term trends can be obtained from the residuals derived from Ensemble Empirical Mode Decomposition (EEMD), and the anomaly data for them can be estimated as follows:

$$ε=x-R,$$

where $ε$ indicates the time series of an anomaly for the size or occurrence time of the RSP and *x* and R represent the real data and residuals, respectively.

There are three steps to construct the bootstrap method. First, an artificial data resampled ($ε\_{rand})$ is produced by randomly sampling the anomaly data, and then the artificial data and residual are added again.

$$x^{\*}=ε\_{rand}+R$$

Second, EEMD is performed on the added data, and $x^{\*}$ and the artificial trend can be obtained. Last, the first and second processes are repeated a given number of times (*M*) and then the mean artificial trend can be estimated from the individual bootstrap simulations, $R(x\_{i}^{\*}$), for trend.

$$\overbar{R^{\*}}=\frac{1}{m}\sum\_{i=1}^{M}R(x\_{i}^{\*})$$

In addition, the standard deviation, *s,* and confidence intervals, CI, can be calculated from all the artificial trends. Using the standard Student’s t-distribution, *t*, 95% confidence intervals were calculated as follows:

$$CI=\overbar{R^{\*}}\pm tsM^{-{1}/{2}}.$$

In this study, the bootstrap with *M* = 100 iterations was conducted, and the results for the size and occurrence time of RSP are shown in Figs. 6 and 13. In the test result for RSP size shown Fig. 6, although the artificial mean trend (red solid line) slightly differed from the original trend (black solid line), the overall trend did not change significantly. However, the turning point of the artificial mean trend was approximately one year earlier than that of the original trend (Fig. 6). The trends of the RSP occurrence time, as shown Fig. 13, had a similar pattern. Overall, the EEMD method is statistically significant within a 95% confidence interval.

**References**

Ezer T. & Corlett W.B. 2012. Is sea level rise accelerating in the Chesapeake Bay? A demonstration of a novel new approach for analyzing sea level data. *Geophysical Research Letters* *39*, L19605, doi: 10.1029/2012GL053435.

Mudelsee M. 2010. *Climate time series analysis: classical statistical and bootstrap methods*, Dordrecht: Springer.