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# Statistical analysis of global surface temperature and sea level using nonstationary methods: Evidence for multidecadal internal variability?

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Global averages of both surface temperature and sea level have risen through the past century. We analyse the relationship between these two non-stationary time series using a bivariate VAR approach in combination with the Johansen rank test for cointegration. These are well-known methods within econometrics and can with advantage be adopted for the analysis of climatic time series.

We find that the two series are cointegrated (the non-stationary analog to correlation), i.e. inter-related in the long run which confirms our a priori expectation. But the VAR analysis tells us more: namely that changes in the sea-level influences changes in the surface temperature while the opposite is not the case. This is in accordance with the notion that the major part of the heat capacity of Earth's climate system reside in the ocean.

Also the short run deviations from the equilibrium cointegration relationship are interesting. It turns out that the disequilibrium of the global temperature is quasi-oscillatory with a multi-decadal time scale and with an amplitude of 0.3 deg. C and maxima around 1940 and 2000, concurrent with the 'Atlantic Multidecadal Oscillation' (AMO). This information will be used to discuss whether the AMO is externally forced or is due to internal redistribution of heat.