

## **Modes of Variability in Observed Near Surface Temperatures**

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Earth's climate system displays various modes of variability, ranging from intra-seasonal to inter-decadal time scales. A comprehensive study of this natural variability as observed in the near-surface temperature record is presented. A non-parametric Singular Spectrum Analysis (SSA) approach is employed that enables the study of non-periodic --- so-called "quasi-periodic" --- oscillations (QPOs) and determine their statistical significance. SSA is performed on the observed temperatures after contributions by both humanity and the Sun are removed, thereby revealing the statistically significant natural QPOs therein. In comparison to similar work performed in 1994, almost 15 additional years of temperature, greenhouse-gas and aerosol emission data are employed herein to reveal the natural variability during the time period 1950 to 2004. Five statistically significant oscillations with periods 69, 20, 9, 5 and 4 years are found in the global climate system. A regional study reveals that the global 69-year oscillation is the result of 49- to 90-year oscillations. These oscillations are present in all oceanic regions, other than the Eastern Equatorial Pacific Ocean, and in the land regions surrounding the North Atlantic Ocean. The strong multidecadal oscillations in the South Atlantic, North Pacific, Western Equatorial Pacific, South Pacific and Indian Oceans found in this study have not been previously reported. Possible causes of all the five significant oscillations are discussed.