Significance of the global air surface temperature trend

R.V. Bekryaev

St.-Petersburg State University, Russia (bekryaev@aari.nw.ru)

An analysis of observational records shows that the global air surface temperature (SAT) has increased by $\sim 0.6^o$C since 1861, with a slightly higher rate of warming in the twentieth century (Jones et al, 1999). Trends (especially linear trends) are frequently used as indicators of climate change. However identification of long-term trends is complicated by strong low-frequency variability. The climatic time series have a high level of serial correlation and tests of statistical significance of computed trends may be complicated substantially. Traditional trend analysis approaches usually do not take into account the intrinsic serial correlation, and postulate the hypothesis of identically distributed independent random variables. As a result they may lead to false conclusions, and special caution should be exercised interpreting these estimates.

In the proposed research we have explored the variance of climatic trends as a variance of the generalized stochastic integral. This approach has been broadly accepted for estimates of variance of statistical sample means (von Storch and Zwiers, 1999). We propose a theoretical approach which allows calculations of variance of sample trends.

First unresolved problem is connected to the random nature of the estimated sample variance. The existing methods are based on the calculation of decorrelation time. However decorrelation time determined as a nonlinear function of the sample coefficients of autocorrelation is a random value. Moreover the decorrelation time is not determined for the broad class of long-range dependent processes. That means the application of traditional statistical approaches leads to overestimation of statistical significance of observed trends. We have suggested a special Student-type statistics for avoiding of that problem in the case of short-range dependent processes. Second problem arises from the sufficient correlation of sample trend and sample trend variance. We have explored some ways for avoiding of that correlation. Suggesting the normality of the surface air temperature we have constructed the density distribution function of the coefficients of linear regression. We have analyzed some climatic surface air temperature time series. For the Northern Hemisphere air surface temperature trends from 1901 to 2001 we have found that null hypothesis should be rejected at the 2 - 5% significance level. In the same time the trend significance level estimated on the base of routine procedure is less then 0.1%. Results of provided analysis are in a concordance with analysis of global and Northern Hemisphere air surface temperature data and support the existing global warming concept.