Numerical stochastic model of time series of air heat content indicators with considering for diurnal and seasonal nonstationarity

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The purpose of comfort air-conditioning is to provide an environment, which is comfortable for the majority of the occupants. Air conditioning is the process of treating air to control its temperature, humidity, cleanliness and distribution to meet the requirements of the conditioned space. When designing air-conditioning systems such climatic characteristics as temperature, atmosphere pressure and humidity are used. For the optimal functioning of air-conditioning systems, it’s desirable to have an idea of the detailed characteristics of the change and variability of the various atmospheric air indicators. In the first place, it’s desirable to know such characteristic as the enthalpy of moist air. The enthalpy is used when calculating cooling and heating processes. The enthalpy of moist air  is the sum of the enthalpy of dry air and the enthalpy of water vapor associated with the same dry air:

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where – air temperature,  – relative humidity,  – atmosphere pressure,  – saturated water vapor pressure at a temperature ,  – specific heat of vaporization,  – specific heat of dry air at constant pressure,  – specific heat of water vapor at constant pressure. The enthalpy is measured in kilojoule per kilogram (kJ/kg) of air.

Several types of models of non-stationary time series of enthalpy are considered in this work. One of the models is a model of periodically correlated series of enthalpy at a time interval of one month. For the middle month of any season in the year, the process can be represented as a vector stationary non-Gaussian sequence, where components of each of the vectors are the enthalpy values at the specified observation times within a day. Here the matrix correlation function of the process is estimated from the data of long term observations. One-dimensional empirical distributions for each observation period are approximated by mixtures of normal distributions.

On time intervals of several months, the process experiences not only diurnal changes but also seasonal ones. Seasonal changes also need to be considered in the models. For the construction of correlation matrices of this process, various methods of smoothing the estimates of correlation of the vector process and correlation matrix correction are used to ensure the positive definiteness of the matrices.

For simulation of processes of this type, the method of inverse distribution functions was used in this work. For the case of stationary processes in the simulation of latent Gaussian processes, the autoregressive vector process was used. For the case of nonstationary vector processes, the method of a correlation matrix spectral decomposition was used. On the basis of the constructed models of time series of enthalpy the probabilities of various critical (extreme) events were estimated by direct statistical modeling.

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