

# NUMERICAL STOCHASTIC MODEL OF NON-STATIONARY TIME SERIES OF AIR TEMPERATURE AND MODULE OF WIND SPEED

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**This work is devoted to elaboration of methods of investigation the statistical properties of adverse weather conditions, which is based on numerical stochastic models of actual meteorological processes.**

**The models are constructed for:**

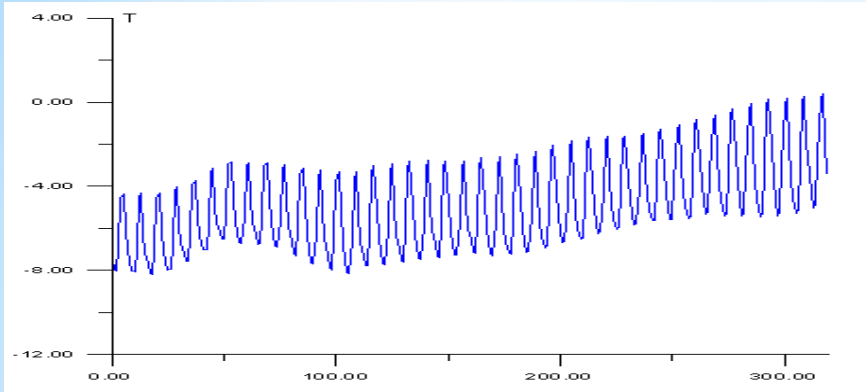
- the non-stationary time series of air temperature for spring-summer period,**
- the joint non-stationary time series of air temperature and wind speed module subject to their diurnal and seasonal variations.**

**The estimation and verification of model parameters are based on the observed data of the weather stations « Astrakhan» and «Sverdlovsk».**

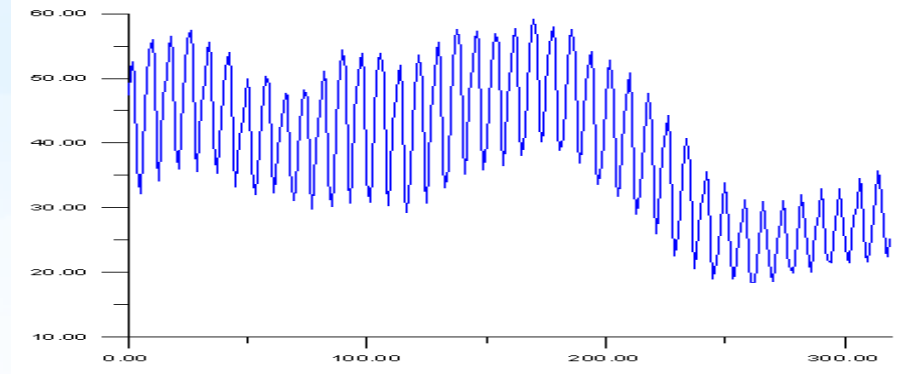
**Model-based numerical evaluations of:**

- durational frost**
  - sharp temperature differences**
  - adverse combinations of meteorological variables**
- are carried out.**

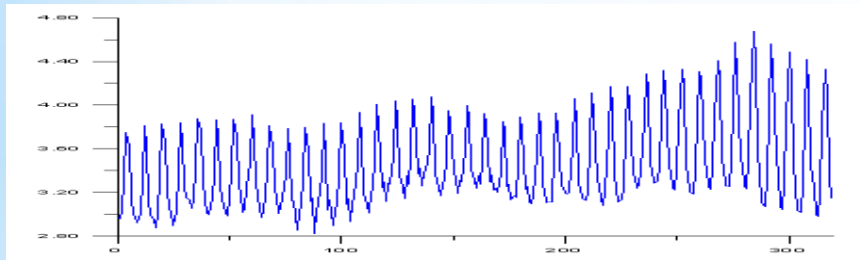
# Empirical characteristics of time series of surface air temperature



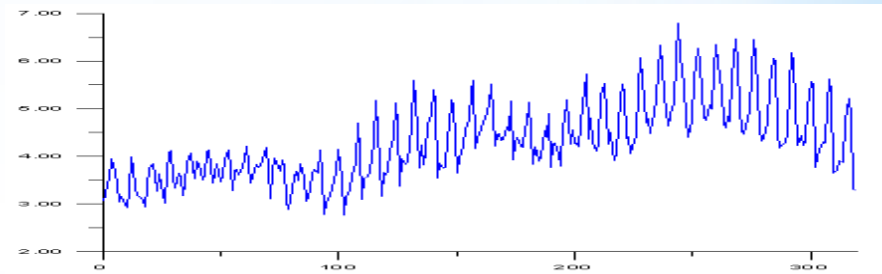
Mean values



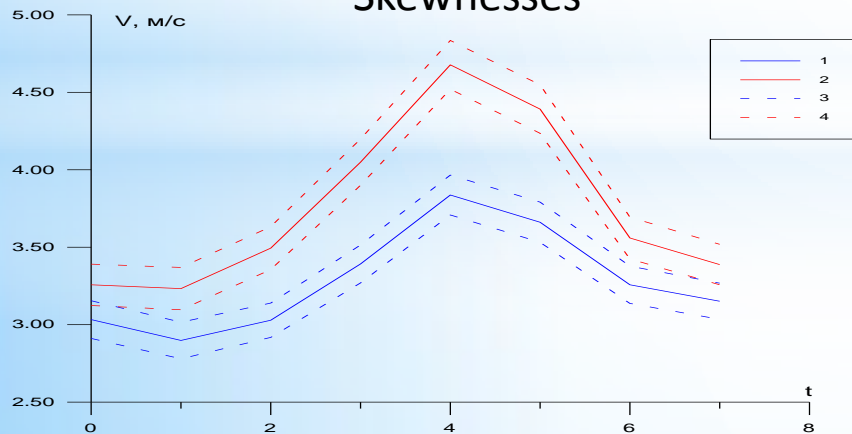
Variances



Skewnesses



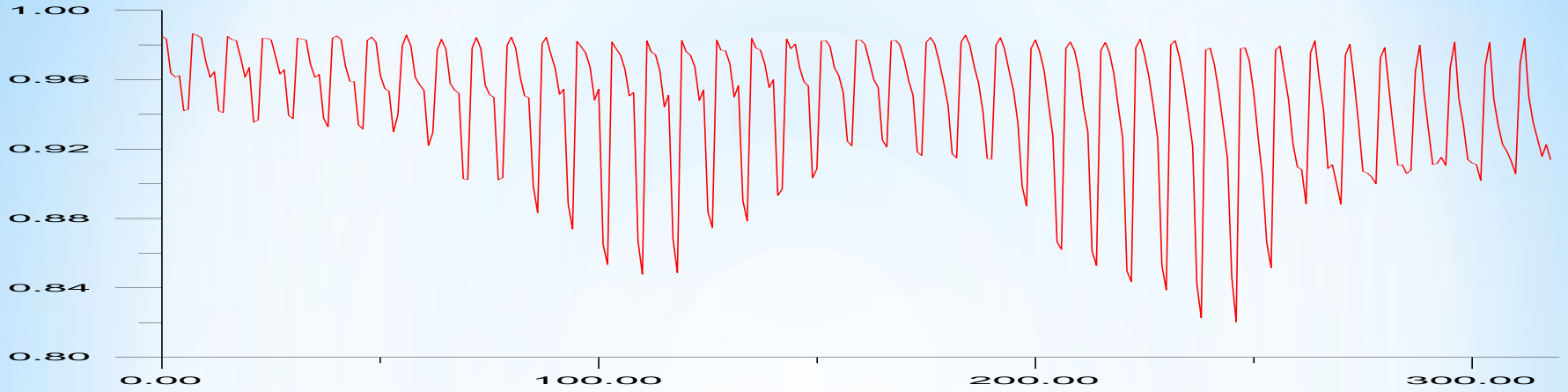
Kurtosises



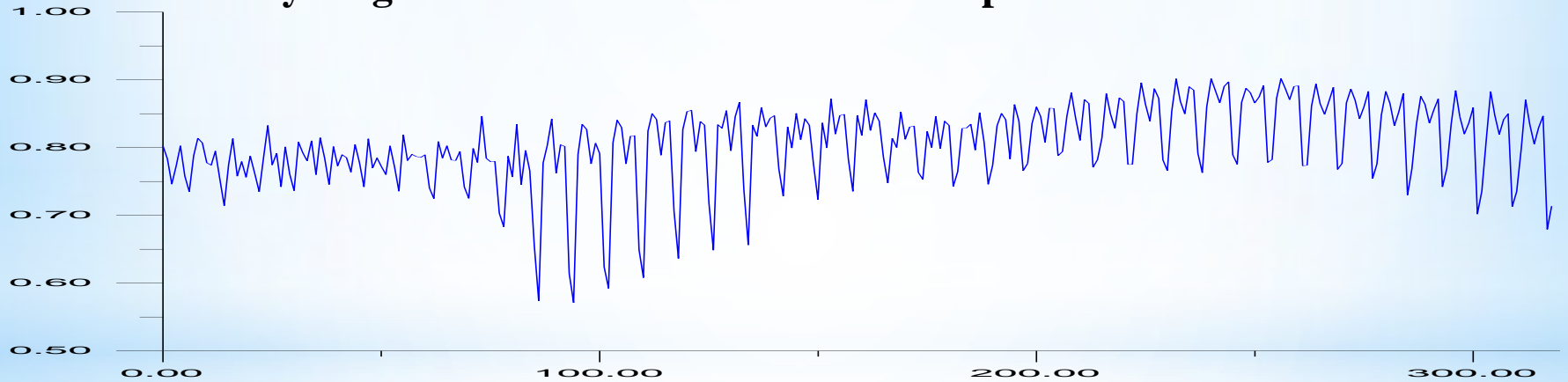
$$\vec{m}_k^{*(i)} = \frac{1}{(2L+1)N} \sum_{l=-L}^L \sum_{n=1}^N \vec{\xi}_{k+l}^{*(i)} [n],$$

$$\vec{s}_k^{*(i)} = \frac{1}{(2L+1)N-1} \sum_{l=-L}^L \sum_{n=1}^N \left( \vec{\xi}_{k+l}^{*(i)} [n] - \vec{m}_k^{*(i)} \right)^2.$$

# Structure of correlation matrix



## First secondary diagonal of correlation matrix of temperature



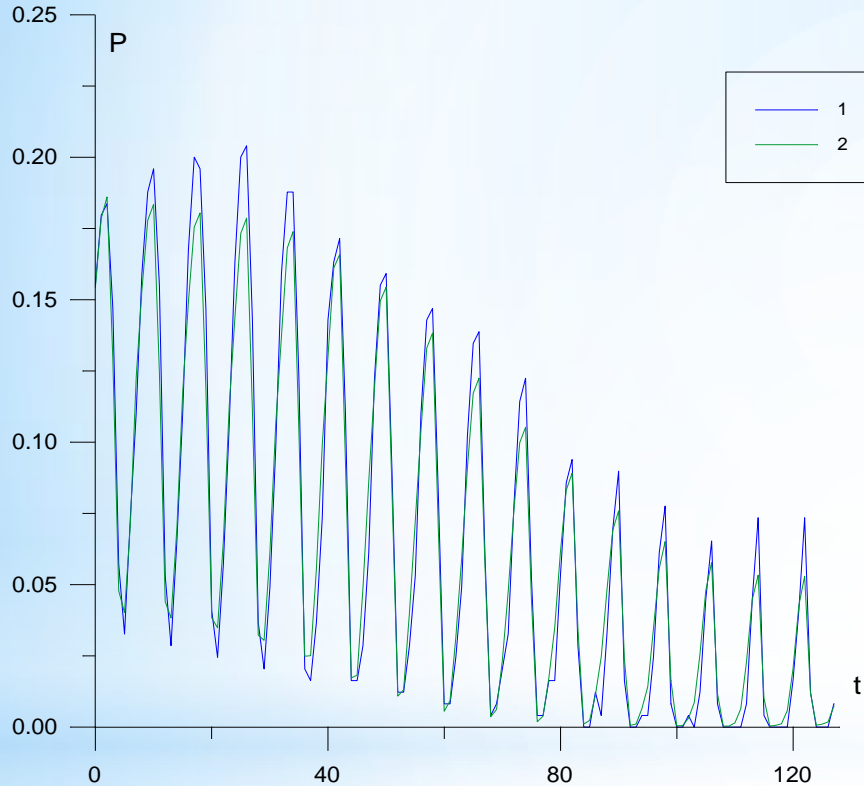
## First secondary diagonal of correlation matrix of wind speed module

$$R_{ks}^{*(ij)} = \frac{1}{(2L+1)N-1} \sum_{l=-L}^L \sum_{n=1}^N \left( \vec{\xi}_{k+l}^{*(i)}[n] - \vec{m}_k^{*(i)} \right) \left( \vec{\xi}_{s+l}^{*(j)}[n] - \vec{m}_s^{*(j)} \right)^T.$$

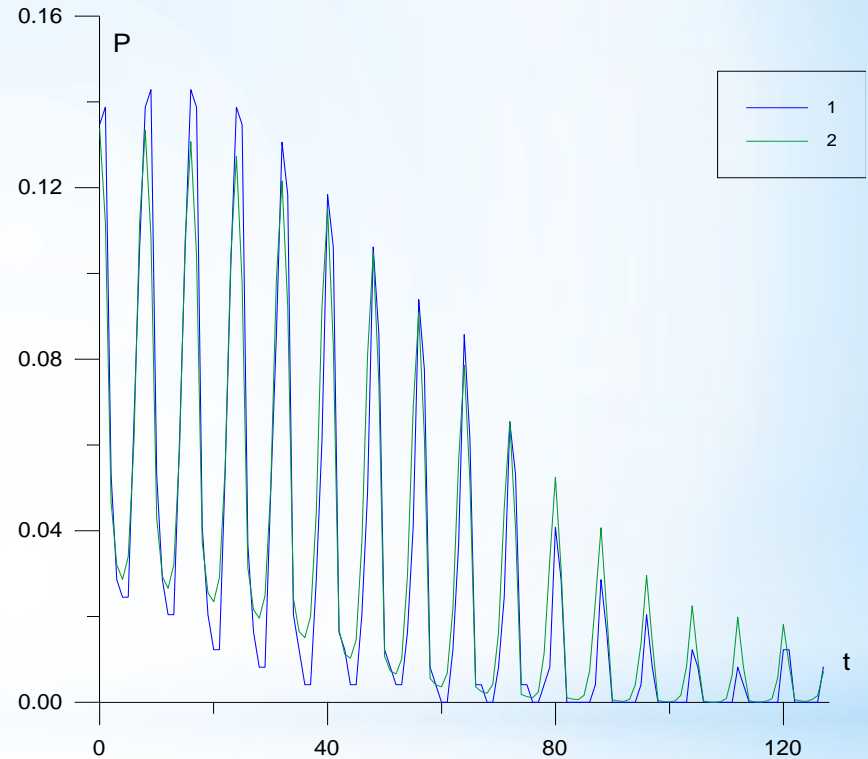
# **Simulation methods**

- **Method of inverse distribution functions**
- **Method of conditional distributions**

# The probabilities of decreasing the temperature below $-15$ ( $^{\circ}\text{C}$ ) with duration $L$ hours



$L=3$

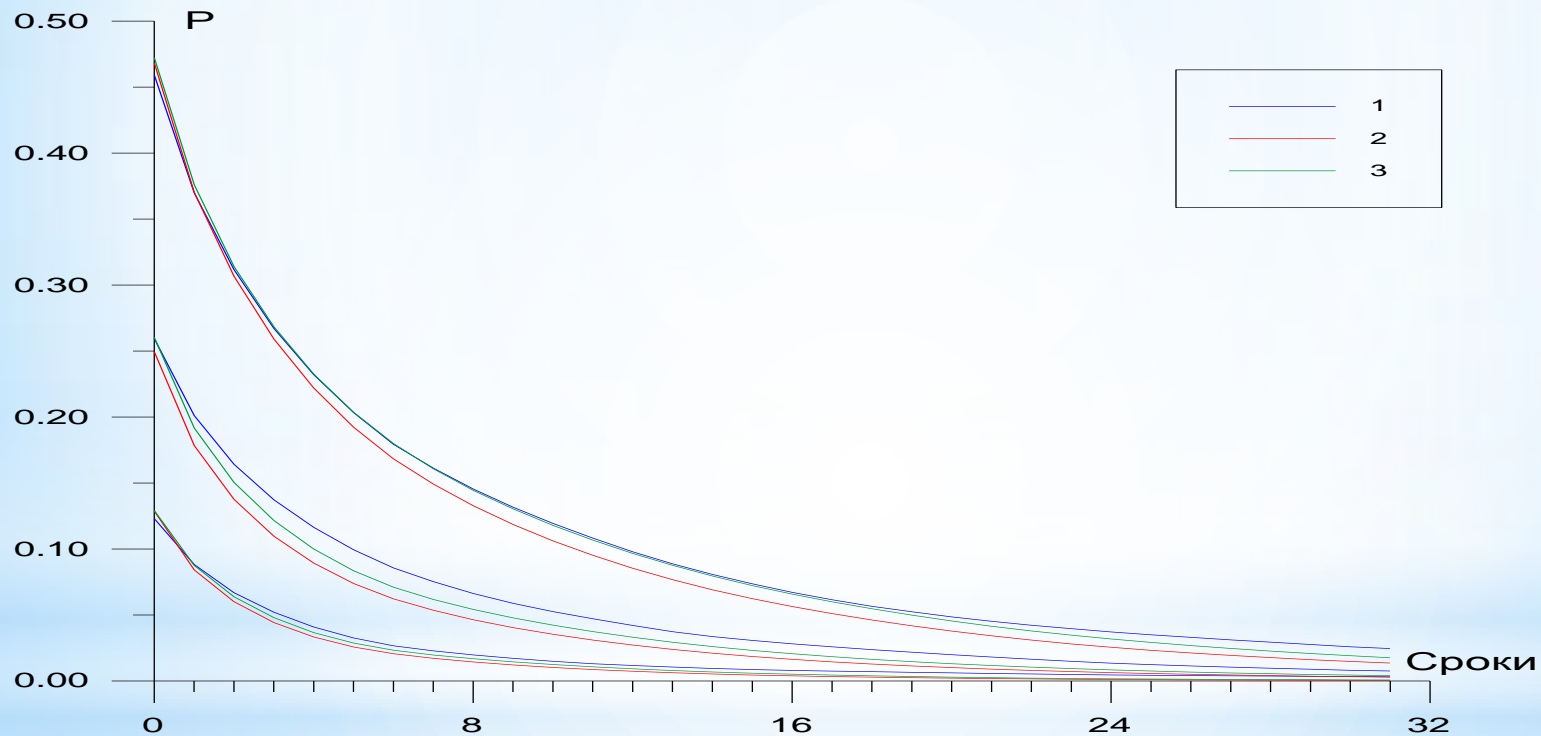


$L=9$

1 – model-based probability,  
2 – observed probability

# Results for joint model of air temperature and wind speed module

The probability of event «temperature is less than  $a$ , wind speed module is stronger than  $b$  pending time  $t$ » for different  $a$  and  $b$



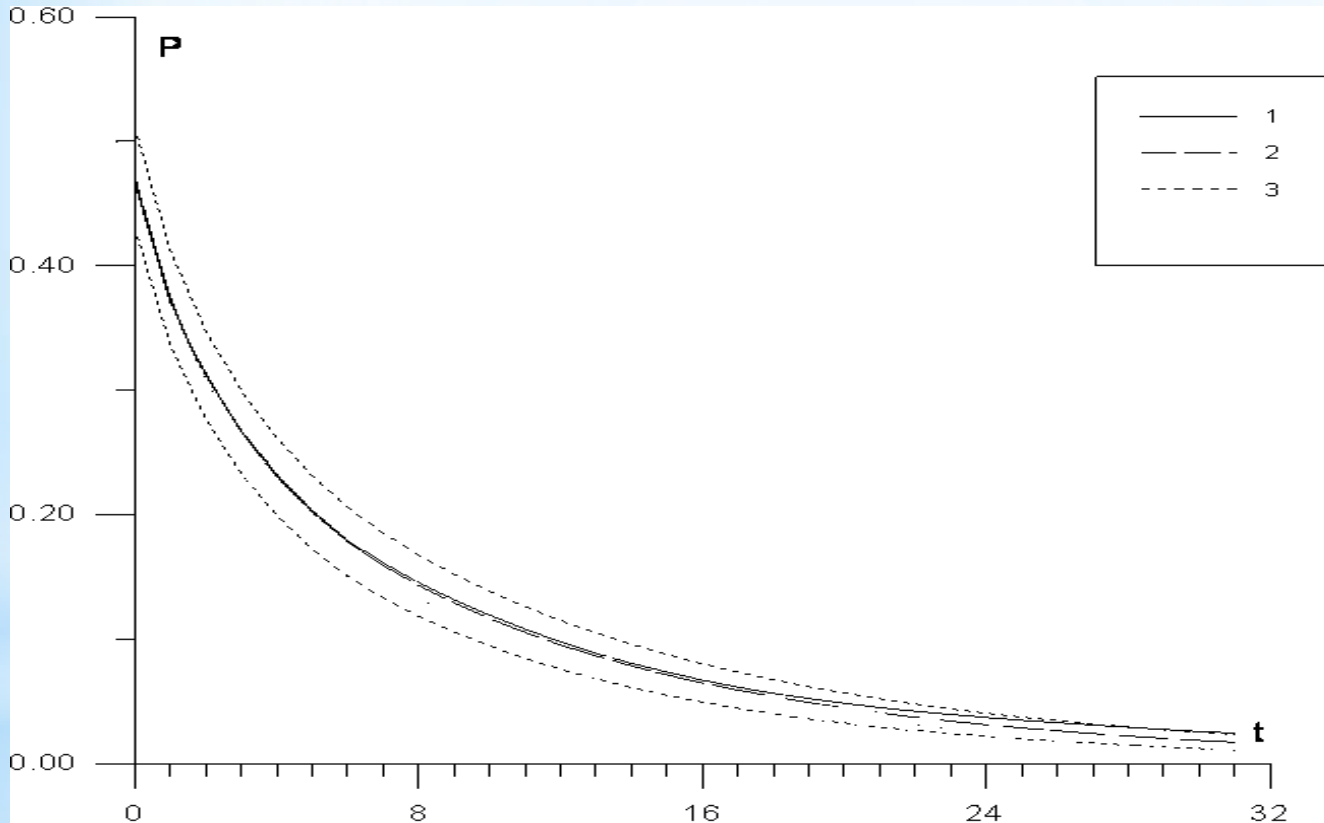
1 – the estimation based on actual data,

2 – based on stationary vector model,

3 – based on non-stationary model.

# Results for joint model of air temperature and wind speed module

## Statistical error bounds of such estimations



**1 – the estimation based on actual data,**

**2 – on model data,**

**3 – the bounds of standard deviation from model estimation.**



***Thank you for your  
attention!***