

VARIABILITY OF EXTREME VALUES OF BIOCLIMATIC INDICES IN THE CRIMEAN RESORTS

Stefanovich A.A., Voskresenskaya E.N., Lubkov A.S.

Laboratory of large-scale air-sea interaction and climate change
FSBSI «Institute of Natural and Technical Systems» (INTS), Sevastopol

E-mail: amazurenko@mail.ru



PURPOSE

Purpose of the work: to analyze the variability of anomalous (extreme) values of bioclimatic indicators at the main resorts of the Crimean peninsula for all seasons of the year.

GEOGRAPHICAL LOCATION OF THE STUDY AREA AND LOCATION OF RESORTS



DATA AND METHODS

- Daily NCEP / NCAR R1 reanalysis data (2.5 ° × 2.5 ° grid), the reconstruction observation data of E-OBS (v17.0) reanalysis grid data (0.25 ° × 0.25 ° grid) for the period 1950 - 2017, as well as station observation data for the period 2005- 2017 (Internet resource rp5.ru) for 5 resort cities.

- Meteorological parameters:

- air temperature (TM, °C) (average daily and maximum)
- relative humidity (HU, %)
- atmospheric pressure (SP, mbar)
- wind speed (W, m/s)



- Bioclimatic indices :

- Equivalent-effective temperature (EET) (by A. Missenard) [2]:

$$EET = 37 - \frac{37 - t}{0,68 - 0,0014 \cdot f + \frac{1}{1,76 + 1,4 \cdot v^{0,75}}} - 0,29 \cdot t \cdot \left(1 - \frac{f}{100}\right)$$

where t – air temperature, °C; v – wind speed, m/s; f – relative humidity, %.

- Weight content of oxygen in the air (partial oxygen density) (pO_2) (by V.F. Ovcharova) [3]:

$$pO_2 = \frac{P - e}{R \cdot T} \cdot 0,2315 \cdot 10^6$$

where P – atmospheric pressure, mb; e – water vapor partial pressure, mb; R – specific gas constant for dry air at a pressure expressed in mb, equal to $2.87 \cdot 10^3 \text{ cm}^2 \text{ s}^{-2} \text{ deg}^{-1}$; T – absolute temperature, equal to $273 + t$ air temperature, °C; 0.2315 – oxygen content by weight in dry air; 10^6 – conversion factor pO_2 from kg/m^3 to g/m^3 .

- Wind cooling index (H_w) or index of «cold stress» (by L. Hill) [4]:

$$H_w = (0,13 + v^{0,5}) \times (36,6 - t) + (0,085 + 0,0102 v^{0,3}) \times (61,1 - e)^{0,75}$$

where v – wind speed, m/s; t – air temperature, °C; e – water vapor pressure, hPa.

2. Missenard F.A. Température effective d'une atmosphere Généralisation température résultante d'un milieu. In: Encyclopédie Industrielle et Commerciale, Etude physiologique et technique de la ventilation. Librairie de l'Enseignement Technique, Paris, 1933, p. 131–185.
3. Butieva I.V., Sheynova T.G. Metodicheskie voprosy integral'nogo analiza mediko-klimaticheskikh uslovij [Methodological issues of the integral analysis of climatic conditions]. Complex bioclimatic research, M., 1988, p. 97–108. (in Russian)
4. Isaev A.A. Jekologicheskaja klimatologija [Ecological climatology]. M.: Science World, 2001, 456 p. (in Russian).

RELATIVE THRESHOLDS METHOD

What is an extreme?

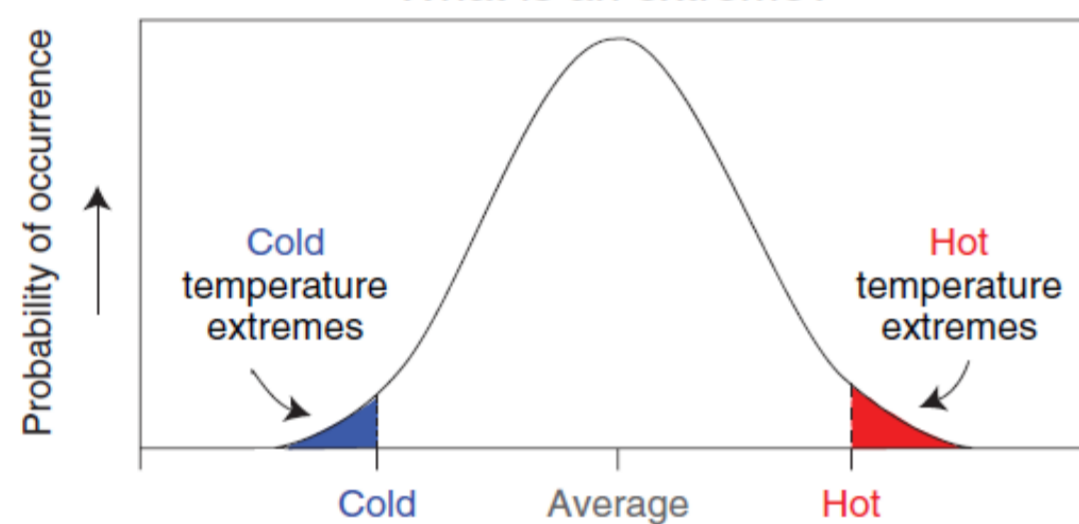


Fig.1. The probability distributions of daily temperature [1].

The values of meteorological parameters are considered **extreme** if their value is above or below a certain threshold.

The method of relative thresholds allows one to take into account the **local features of the climate and terrain**.

Periods and extremes:

EET: April-September - above 95%
October-March - below 5%

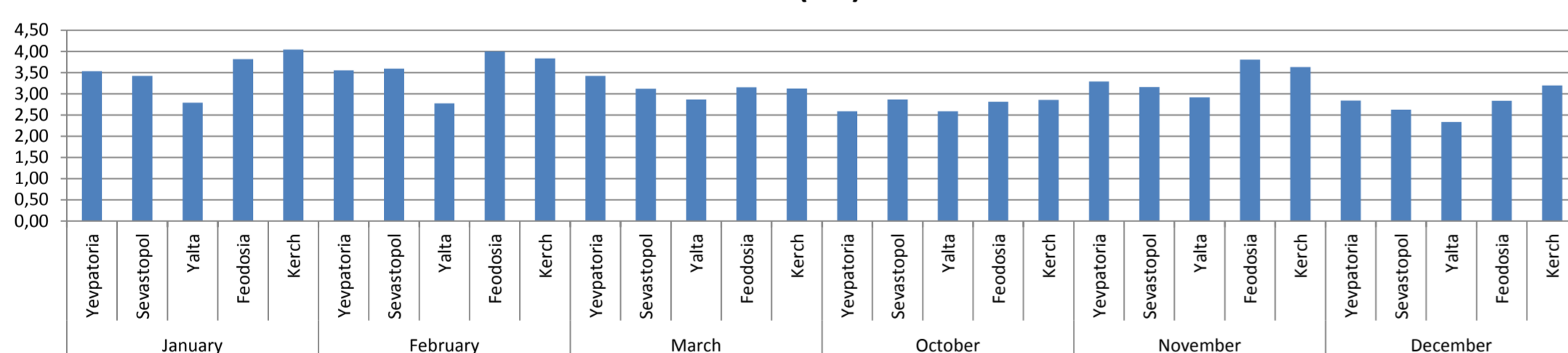
pO_2 : April-September - below 5%

H_w : October-March - above 95%

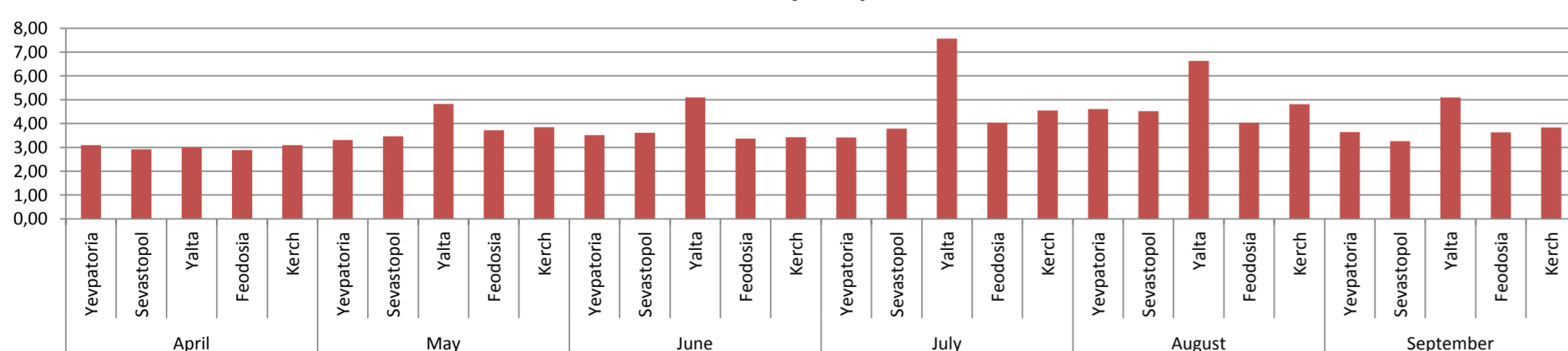
1. Zhang, X., Alexander, L., Hegerl, G.C., Jones, P., Tank, A.K., Peterson, T.C., Trewin, B., & Zwiers, T.W. Indices for monitoring changes in extreme based on daily temperature and precipitation data. WIREs Climate Change, no. 2, 2011, p. 851-870.

RESULTS

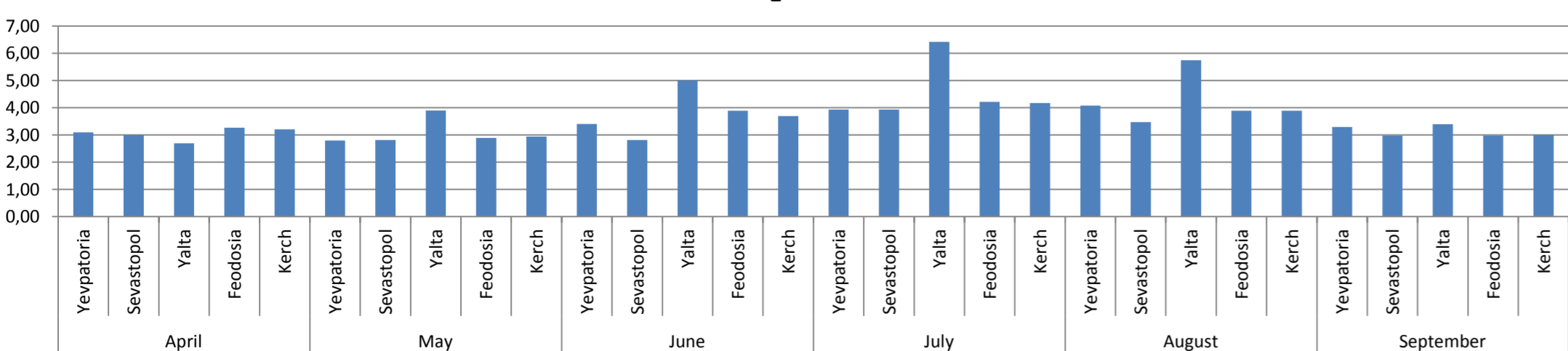
EET (5%)



EET (95%)



pO_2 (5%)



H_w (95%)

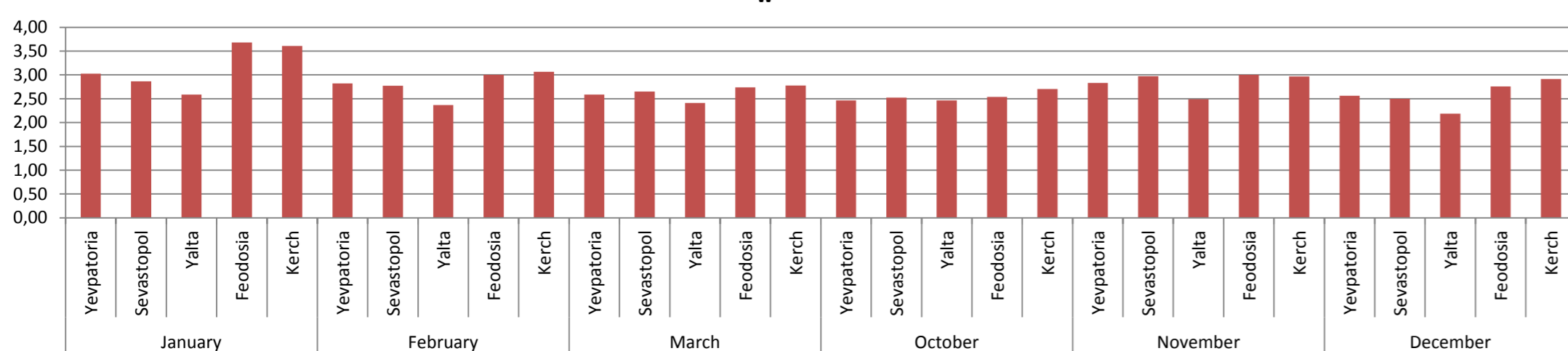


Fig.2. Frequency of days with EET, pO_2 and H_w below the 5th and above the 95th percentile (days/year) for the period 1950 - 2017.

CONCLUSIONS

- In general, the analysis of the extreme values of the considered bioclimatic indices indicates an **improvement in bioclimatic conditions in the cold season and in late-winter-early spring** at the resorts of Crimea.
- Evaluation of EET and pO_2 trends confirmed the likelihood of an **earlier start of the holiday season**, as well as an increased risk for outdoor recreational activities in the second half of summer.
- Based on the results of assessing the dynamics of the wind cooling index, significant **improvements in bioclimatic conditions are noticeable in the winter months and early spring**. This also confirms the fact that the time limits of the warm period of the year have been expanded with comfortable values of bioclimatic indicators, designed for effective organization of rest and treatment.

PRACTICAL SIGNIFICANCE

- The performed analysis of bioclimatic characteristics is applicable for the preparation of medical weather forecasts for people with increased meteosensitivity.
- The results of the work can be used to improve the efficiency of climatotherapy in the structure of sanatorium-resort treatment in Crimea, to improve complex medical and health-improving programs for different seasons of the year in resort organizations.
- The results obtained will be useful for the Ministry of Resorts and Tourism of the Republic of Crimea in planning and conducting various social events, to provide the population with information on the impact of weather and climatic factors on the health of local residents and vacationers.

The work was partly financially supported by the Russian Foundation for Basic Research according to the research project № 18-45-920063.