FIRST AND SECOND-ORDER TRENDS OF WIND SPEED IN THE 0-30 KM ATMOSPHERIC LAYER FROM GLOBAL AEROLOGICAL DATASETS

O. A. Aldukhov and I. V. Chernykh
Russian Institute of Hydrometeorological Information – Word Data Center, Obninsk, Russia,
E-mail: aoa@meteo.ru, civ@meteo.ru

Introduction

The knowledge about long-term changes in wind speed (S) distributions in the atmosphere obtained from hourly values is necessary to study global climate change and to solve many practical problems. The paper presents the series of the 1-st and 2-nd order trends [1] of wind speed at standard heights in the 0–30-km atmospheric layer over sea level for the year as a whole, for different months and seasons.

Data and methods

Results of radiosounding observations from the CARDS global aerological dataset [2] that were updated by current data from RIHMI-WDC [3] for the period 1964–2018 were used in this study. The calculations are based on the dataset from 770 stations with relatively homogeneous observations. The necessary condition for including a station in the research was 15-year observations for the full observation period including 2018.

The Akima cubic spline interpolation method was used to calculate S values and their standard deviations (σ_S) in the 0–30-km layer above sea level on the basis of standard pressure levels and specific points of vertical profiles. The trends were computed for each station by using the least squares method. The anomalies were calculated with respect to the corresponding long-term means for the period 1964–2018. The values obtained for all the stations were averaged taking into account the area of the station influence.

Results

The Figure shows that the spatiotemporal distributions of the 1-st order trends (classical linear trends) for anomalies and standard deviations of wind speed are nonuniform in the 0–30-km atmospheric layer above sea level.

The annual changes in the long-term monthly means of the wind speed S in the 0–30-km layer range from 4.26 to 23.24 m/s. The annual changes of the 1-st order trends of the long-term monthly means anomalies in the 0–30-km layer range from -0.034 to 0.256 m/s per decade for S. The global wind speed in this layer mainly increases at 0–1 km and at 15–19 km for all months, while at 28–30 km it increases in May, November and December.

The annual changes in standard deviations σ_S of wind speed range from 3.26 to 16.53 m/s. The 1-st order trends of σ_S are negative for all months in the entire 5–12-km layer and positive for all months throughout the 14–30-km layer. The most intense decrease of σ_S (with significance of more than 95%) is detected at 3–9 km in winter and at 5–7 km for spring and autumn. The most intense increase of σ_S (with significance of more than 95%) is detected in the entire 18–30-km layer for summer and autumn. Significant increase in σ_S is detected throughout the 0–1-km layer for spring, summer and autumn

The 2-nd order trends for S are mostly positive, which implies the acceleration of changes for S with the year 2018 approaching. The annual changes in the 2-nd order trends of the long-term monthly means anomalies in the 0–30-km layer range from -0.085 to 0.405 m/s per decade^2 for S. The highest positive accelerations of changes for S were detected at 20–24 km in summer and autumn.

The 2-nd order trends of standard deviations σ_S are positive in the 0–17-km layer for winter and spring, in the 0–30-km layer, for summer, and in the 0–22-km and 28–30-km layers, for

autumn. The annual changes in the 2-nd order trends of standard deviations σ_S in the 0–30-km layer range from -0.155 to 0.294 m/s per decade^2.

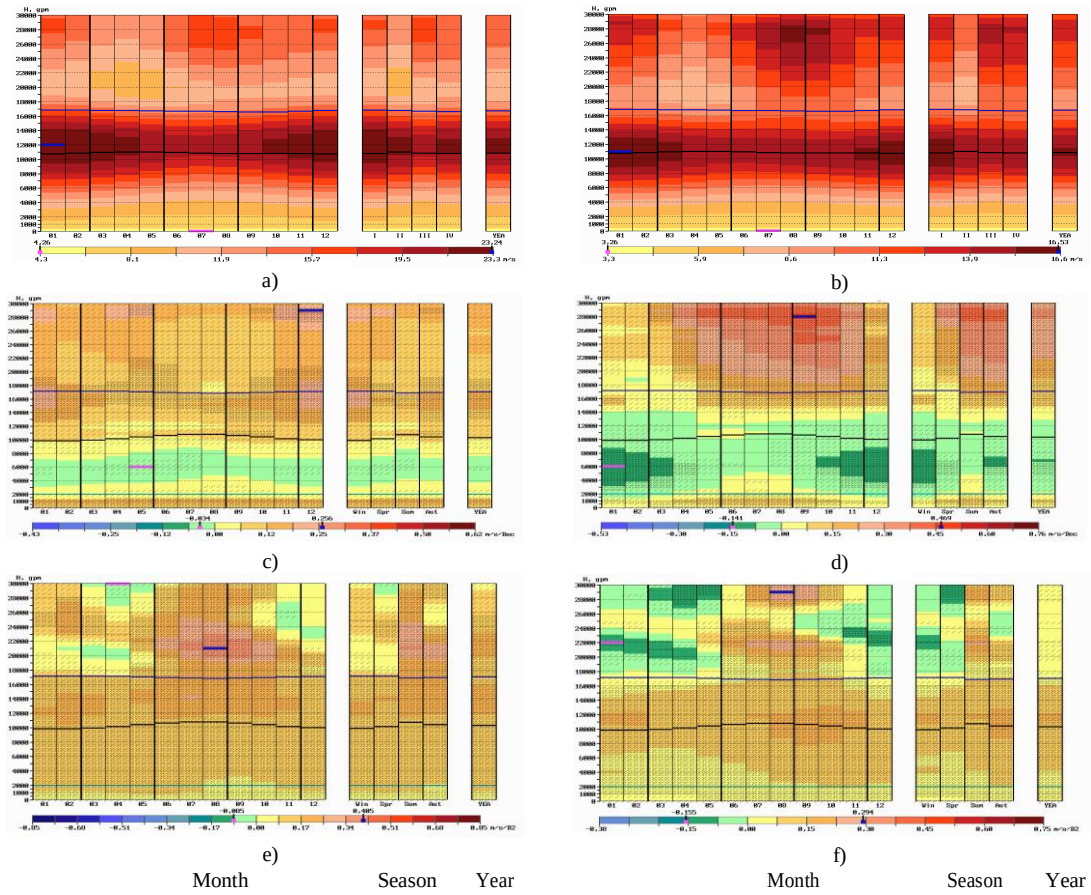

Figure. Long-term means (a), first-order trends of anomalies of long-term means for S (c, m/s/decade), second-order trends of anomalies of long-term means for S (c, m/s/decade^2), and standard deviations (b), first-order (d) and second-order (f) trends of standard deviations σ_S in the 0–30-km atmospheric layer for each month, season and the year as a whole. The global statistics for months and seasons were subject to twofold smoothing. Three–points smoothing was used. Trends with significance of not less than 50% are marked by the sloping line segments and those with significance of not less than 95% – by lattice. Blue and pink segments correspond to maximum and minimum values. 1964–2018.

Conclusions

Spatiotemporal distributions of the linear trends of wind speed anomalies are not uniform in the 0–30-km atmospheric layer above sea level. The wind speed increases mainly at the 0–1-km and at 15–19-km heights for all months, while at 28–30-km it increases in May, November and December.

References

1. Aldukhov O.A., Chernykh I.V. First and second-order trends of air temperature at the surface level from global radiosonde data // Research activities in Earth system modelling. Working Group on Numerical Experimentation. Report No. 50. WCRP Report No.12/2020. Ed. E. Astakhova, July 2020, WMO, Geneva. pp. 2-03-2-04. http://bluebook.meteoinfo.ru/uploads/2020/docs/02_Aldukhov_Oleg_GlobalTemperatureTrends.pdf
2. Eskridge R.E., et. al. A comprehensive aerological reference dataset (CARDS): rough and systematic errors // Bull. Amer. Meteor. Soc. 1995. **76.** 1759-1775.
3. Rudenkova T.V. Format for archiving of the current aerological data, received from GTS for PC // Proc. RIHMI-WDC, 2010, N 174, p. 41–63.