AMS100

Poster number: 227

Extreme wind analysis: a comprehensive algorithm

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ICCLIPP 2019

Introduction

Each building code includes a "Basic Wind Speed Map". This map is usually built based on the regional stations' 50-year wind speed estimates which are being obtained with various Extreme Value Analysis (EVA) techniques.

The questions to be answered are:

- ❑ How to get the reliable input?
- ❑ What is the best EVA distribution?
- ❑ What method is the best for the distribution parameters' estimation?

Extreme Wind Tool - EWT

The comprehensive algorithm called the "Extreme Wind Tool" (EWT) answering the above questions has been developed and implemented at the Israel Meteorological Service (IMS). The EWT has been applied to the wind speed records from 71 automatic weather stations (AWS) maintained by the IMS over 1999-2017.

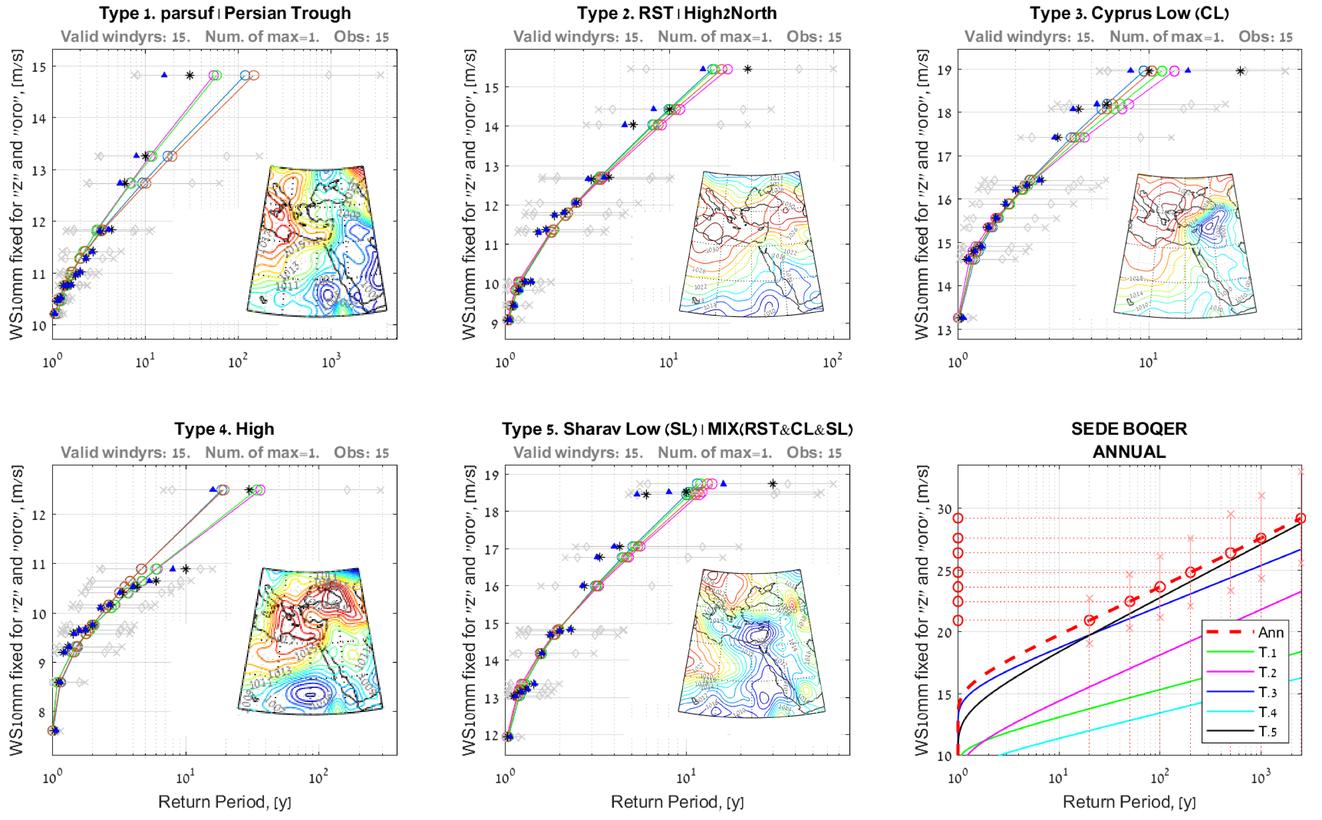
EVA distribution. The Gumbel distribution family (Extreme Value Distribution, EVD) was chosen as commonly used for the extreme wind speed estimation.

Methods of estimating the EVD parameters. Compared 4 methods:
BLUE - Best Linear Unbiased Estimation,
MOM - Method of Moments,
LMOM - Lin. combination of Moments,
MLE – Maximum Likelihood Estimation.

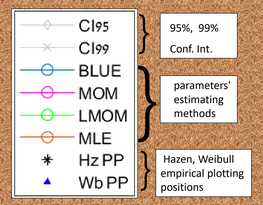
Goodness-of-fit test. The Modified Anderson-Darling test for the upper tail.

Final quantiles. To be computed numerically after treating each synoptic mechanism separately.

Location of the Israel Meteorological Service AWS.
https://ims.data.gov.il/sites/default/files/israelIMS.pdf



Data preprocessing. The input data were selected from the AWS WS10mm channel (a 10-minute max Wind Speed ending up in each standard 10-minute time chunk). Each WS10mm value was adjusted for standard roughness and orography. The 1999-2017 time axis was split manually into separated synoptic events using the regional daily synoptic classification and reanalysis 6-h sea level pressure chart sequences. The EWT then automatically depicted two highest wind speed values for each station, each valid wind-year and each one of the five synoptic mechanisms (the second annual value was automatically included by the EWT for very short stations with the data length < 10).
Checking reliability started with a manual wind-year validity analysis and ended by testing stability of the annual WS maxima time series based on the von Neumann test.

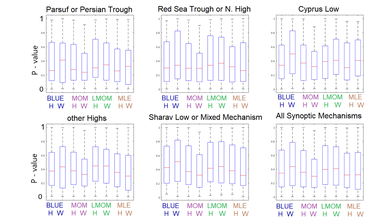


Ann = Annual Total
T.1 ... T.5 = Synoptic Types (Synoptic Mechanisms)
T.1 = Parsuf or Persian Trough (PT)
T.2 = Red Sea Trough (RST) or High to North
T.3 = Cyprus Low (CL)
T.4 = other Highs
T.5 = Sharav Low (SL) or Mixed pattern of RST, CL, SL

Results

The BLUE and LMOM methods for estimating the Gumbel distribution parameters showed the highest p-values for the two leading synoptic mechanisms which are mainly contribute in the extreme wind speed quantile estimates for most stations: (1) "Cyprus Low"; (2) "Sharav Low" or Mixed Mechanism ("Red Sea Trough"/"Cyprus Low"/"Sharav Low").

P-value boxplots for all stations per synoptic mechanism and total



Comparison BLUE, MOM, LMOM and MLE methods for parameters' estimating, applying the Hazen (H) and Weibull (W) plotting positions

Discussion and Conclusion

To finally decide about the best common method for estimating the Gumbel distribution parameters, we built two maps of the 50-year wind-speed estimates for all stations: one map using the BLUE method for estimating the 98% quantiles for separated synoptic mechanisms, while second map - using the LMOM method. The BLUE map showed more homogeneity over the regions with a relatively denser station network, so the BLUE method was eventually defined as the best one.

Refs:
1. NIST, 2018, Special-Purpose Software: BLUE Extreme Value Type I Estimation, www.itl.nist.gov/div898/winds/gumbel_blue/gumbblue.htm
2. JP Palutikof, BB Brabson, DH Lister and ST Adcock, 1999. *A review of methods to calculate extreme wind speeds*. Meteorol. Appl. 6, 119–132.
3. H Shin, Y Jung, C Jeong and J-H Heo, 2011. *Assessment of modified Anderson–Darling test statistics for the generalized extreme value and generalized logistic distributions*. Stochastic Environmental Research and Risk Assessment, DOI 10.1007/s00477-011-0463-y