Calibration of Extreme Value Analysis methods for peak-over-threshold wind data

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This paper presents the calibration of the design once in 50 year wind speed, V_{50}, estimated by various methods of Extreme Value Analysis (EVA) for peak-over-threshold (POT) wind speed data. Absolute calibration of V_{50} requires a known parent distribution of independent events so that its value can be determined analytically, then the methods can be calibrated by "Bootstrap" sampling methods operating on this distribution. This paper uses a Weibull distribution with shape factor w = 2, scale parameter C = 26.1 kt and an annual rate of independent events r_i = 91.3, for which V_{50} = 75.7 kt. These parameters were chosen to replicate the observed annual rate of events, r_u = 14.3, exceeding the threshold u = 35.5 kt for R = 20 years of non-thunderstorm 4-day maxima at Newark, NJ, USA, from [1]. It is not necessary that the parent distribution for wind data is actually Weibull, but the EVA methods must be accurate for this distribution in order to be valid for use with observed wind data.

Despite the analytically-based criticism by Galambos & Macri [2] and Harris [3], the generalised Pareto distribution (GPD) has become popular as the model for POT wind speed data. This paper uses "Bootstrap" sampling methods to calibrate the bias error inherent in the GPD model and compares this with better alternative models. The figure below shows that the GPD model V_{50} approaches the true value from below as the threshold value is raised. At the point that insufficient data remains above the threshold to implement the method, the GPD model has a bias error of -3% and variance error ±7%. In comparison, the best alternative method has a bias error of +0.1% and variance error of ±2% when both w and C are fitted, and a bias error of +0.02% and variance error of ±1.2% when w = 2 is assumed and only C is fitted. The dashed curve, "Datum", in the figure represents the maximum possible accuracy for R = 20 years, determined analytically from the statistical uncertainty in P = 0.98.

References

1. Lombardo, F.T., Main, J.A., Simiu, E.: Automated extraction and classification of thunderstorm and non-thunderstorm wind data for extreme-value analysis, JWEIA, 2009, 97, 120-131.
2. Galambos, J. & Macri, N.: Classical extreme value model and prediction of extreme winds, ASCE J. Struct. Eng., 1999, 125, 792-794.
3. Harris, R.I.: Generalised Pareto Methods for Wind Extremes. Useful Tool or Mathematical Mirage?, JWEIA, 2005, 93, 341-360

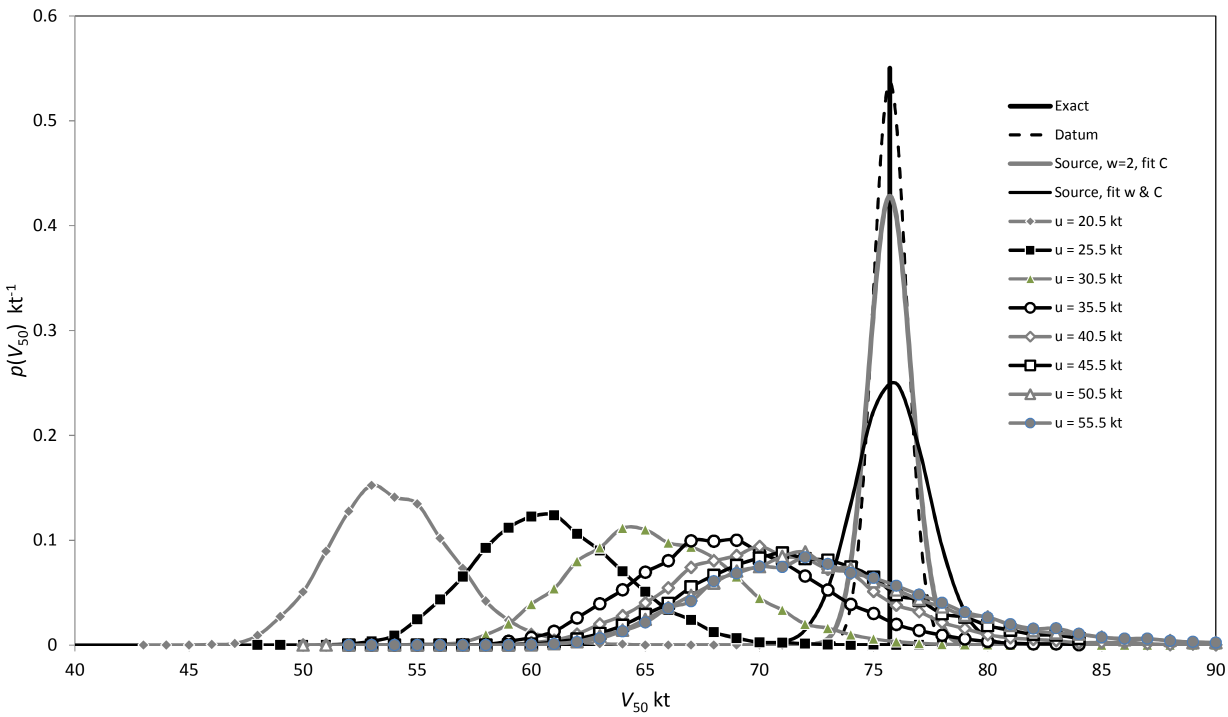

Figure 1. Threshold dependence of deHaan GPD method for 20 year wind record of 4-day maxima