Gust wind report

Theory

Gusts are calculated by moments of a site-specific spectrum inserted into Cartwright and Longuett-Higgins' formula for extreme-values in a Gaussian process. The gust estimate is

$$u_{gust} = u_{mean} + k_p \sigma_u = u_{mean}\left(1 + k_p I_u\right)$$

with the peak factor

$$k_p = \sqrt{2\ln(vT)} + \frac{\gamma}{\sqrt{2\ln(vT)}} \quad \text{with } \gamma = 0.577$$

Defined by the sample period T and a zero level up-crossing rate calculated by spectral moments

$$v = \sqrt{m_2/m_0} \quad \text{with} \quad m_n = \int_0^\infty \omega^n S(\omega) \frac{\sin^2\left(\frac{1}{2}\omega\tau\right)}{\left(\frac{1}{2}\omega\tau\right)^2} \frac{1}{1+(kl)^2} d\omega$$

The implicit assumptions are steady turbulence, neutral atmospheric stability and negligible turbulence from upstream separation zones. The spectrum is calculated at a reference wind speed and scaled by Tailor's hypothesis. Possible changes in surface roughness over water are ignored, so it may be necessary to recalculate and interpolate in case of high wind speeds over water. The scaled spectrum is preconditioned by a first-order cup-anemometer response filter and a moving-average filter with its time constant set to the gust duration. The regularity factor characterizes the distribution of local maxima, which according to the theory has a Rice distribution. This distribution approaches a normal distribution when the regularity factor equals zero and a Rayleigh distribution when it is unity. The normalized version of the Rice distribution is

$$f(\eta) = \sqrt{1-\alpha^2}\,\varphi\left(\eta/\sqrt{1-\alpha^2}\right) + \alpha\eta\exp\left(-\eta^2/2\right)\Phi\left(\alpha\eta/\sqrt{1-\alpha^2}\right) \quad \text{with regularity factor } \alpha = m_2/\sqrt{m_0 m_4}$$

Input

First select a site, a height, and a wind
During startup the script prompts for

- spectral model (default Kaimal)
- sample period T (default = 10 min)
- gust duration τ (default = 3 s)
- cup anemometer length scale l (default = 1.5 m)

Results

Excel sheet, see below example.

B16 | 18.7602215087362

Gust wind report

	A	B	C	D	E	F	G	H	I	J
1	Gust wind report									
2										
3	Wind case	60° at 14.81 m/s								
4	Spectrum type	Kaimal								
5	Site	Metmast, Port 06								
6	Location X [m]	577035								
7	Location Y [m]	4524805								
8	Height AGL [m]	55.0								
9	Site ref. speed [m/s]	24.3								
10	Site ref. dir [deg]	58.4								
11	Sample period [s]	600								
12	Gust duration [s]	3								
13	Anemom. length const. [m]	1.5								
14										
15	Wind speed [m/s]	15	20	25	30	35	40	45	50	
16	Gust speed [m/s]	18.76	25.06	31.37	37.71	44.07	50.35	56.75	63.05	
17	Gust st. dev. [m/s]	0.64	0.85	1.05	1.24	1.44	1.64	1.83	2.04	
18	Peak factor [-]	2.86	2.88	2.90	2.93	2.95	2.95	2.97	2.97	
19	Regularity factor [-]	0.044	0.043	0.037	0.032	0.030	0.027	0.035	0.027	
20										

Gust factors | Sheet2 | Sheet3