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Interactive comment on "Idealized Models of the Joint Probability Distribution of Wind Speeds" *by* Adam H. Monahan

Anonymous Referee #2

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Summary: The article provides an empirical comparison of two statistical models for bivariate joint probability distribution of wind speeds. The bivariate Rice distribution is obtained by assuming that the projections of the two wind speeds on the X and Y axes are Gaussian and isotropic. The bivariate Weibull distribution arises from a non-linear transformation of components which are Gaussian, isotropic and centered. The comparison is performed in several different contexts: (i) 500hPa wind speeds at two different locations obtained from reanalysis data; (ii) 500hPa wind speeds at the same location at different moments in time, obtained from reanalysis data; (ii) observed wind speeds over land at the same location at 10m and 200m; (iv) see surface wind speeds at two different locations, obtained from satellite measurements. The two distributions are estimated by maximum likelihood, and statistical tests are performed to assess the

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Discussion paper

goodness of fit. The results are not completely unequivocal: for reanalysis data the bivariate Rice distribution seems to have a better performance, but the corresponding hypothesis is rejected in some statistical tests even for this law. For the measured land surface wind, neither of the two distributions fits the data well, but the performance improves for both laws when the data are conditionned on being in a specific wind regime.

Evaluation: both statistical distributions analysed in the present paper have already been published in the literature, and the main contribution of the present manuscript lies in the empirical analysis of their performance for wind speed modeling. The methodology of the paper is sound, and the results are well illustrated with data in several relavant settings. I see, however, several directions of improvement.

(i) The motivations of the paper are not fully clear. The analysis and the domain of applicability of the models, is limited to two dimensions. Where such two-dimensional wind speed models could be used? One possible use would be the vertical interpolation of wind speeds, with wind energy applications in view.

(ii) The conclusions are not crystal clear either. The author concludes that the Rice distribution is more flexible while the Weibull distribution is mathematically simpler and may be more convenient. Strictly speaking, for this conclusion one does not need the empirical analysis, they are clear simply by looking at the formulas. What precisely do we learn from the empirical study?

(iii) The message of the paper could be sharpened by considering more data. For example, (with the wind energy application in view) the goodness-of-fit for the wind speed distributions at different heights could be tested at many different locations, and the resulting p-values could be plotted on a map.

(iv) The interpretation of the results of the statistical tests could be improved. When the null hypothesis is rejected, is this due to the fact that the one-dimensional distributions do not fit the data well, or is it because the dependence structure is wrong? This question could easily be answered by goodness-of-fit tests for the one-dimensional laws.

(v) A detailed comparison with other multivariate models could be performed. I do not fully agree with the author's statement that 'it is unlikely that a copula-based model will admit analytically tractable expressions'. Some copula families (Clayton, Gumbel etc.) are quite tractable, allow for multidimensional extensions, and their dependence structure, in particular, in the tails, is well understood. Another possibility would be to use a Gaussian dependence structure but apply a nonlinear transform to the components to produce positive wind speed values.

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