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Interactive comment on "Year-to-year correlation, record length, and overconfidence in wind resource assessment" *by* Nicola Bodini et al.

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Response to Referee 4

RC4: . . . this manuscript does not report a new finding or result, but rather illustrates it (i.e. the presence of internal climate variability) again. Thus, the manuscript lacks a transformative (or novel) aspect (i.e. it illustrates a well-known challenge to the industry), it uses standard statistics (though presented in a somewhat jargon-istic manner), the results are not generalizable (i.e. the uncertainties in P50 and P90 are inevitability going to be location specific) and it does not present a 'pathforward' for the industry or advance diagnostic understanding of causes of uncertainty in P50 and P90. Further, use of monthly mean wind speeds at 10-m (presumably also confounded by

instrumentation and other changes) renders the analysis 'results' very highly suspect for real-world applications.

Authors: We respectively disagree with the opinion of Referee 4. The challenge to the wind industry is to translate climate variability (the existence of which we agree needs no further illustration) into quantitative assessments of financial risk. It is not the purpose of our paper to survey the troubled history of resource assessment, but a glance at the following recent reports from the leading engineering firms and financial institutions evidences the industry's continuing concern over widespread risk- and performance-assessment errors. It is far from "old hat."

1. C. J. Kim, "Breezing Past P50," Moody's Investor Service (2010). *Forecasts for US based wind projects appear to have been overly optimistic since actual production is far below the expected level of generation typically represented by the P50.*

2. N. G. Mortensen, H. E. Jørgensen, M. Anderson, and K.-A. Hutton, "Comparison of Resource and Energy Yield Assessment Procedures," presented at the EWEA Annual Conference and Exhibition, Copenhagen, 2012, http://orbit.dtu.dk/ws/files/10376800/Comparison_of_Resource.pdf.

3. AWS Truepower, "Closing the gap on plant underperformance," (revs'd 2012). *The study found that the methods in place at AWS Truepower at that time, though much improved over prior methods, overestimated actual energy production by an average of 3.5%, after correction for relative windiness.*

4. N. G. Mortensen, and H. E. Jørgensen, "Comparative Resource and Energy Yield Assessment Procedures (CREYAP) Pt. II," presented at the EWEA Technology Workshop: Resource Assessment 2013, Dublin, 2013, http://orbit.dtu.dk/files/70667004/Comparative_Resource_and_Energy_Yield.pdf.

5. J. Babajeva, G. Remec, F. Gronda, C. Kuti, and N. Czarny, “Wind Projects: High Risk of Production Shortfalls,” FitchRatings, https://www.fitchratings.com/creditdesk/reports/report_frame.cfm?rpt_id=749633 (2014). *Fitch Ratings compared the performance of 19 operating wind projects with its expectations when the ratings were assigned. There are chronic production shortfalls below base case expectations at a majority of the projects. Actual production only occasionally exceeds base case levels. . . .*

6. R. Z. Poore, “Wind Power Project Performance White Paper: Actual vs. Predicted,” DNV GL - Energy, Renwables Advisory, http://www.gl-garradhassan.com/assets/img/content/DNV_GL_Wind_Power_Project_Performance_White_Paper.pdf (2014).

7. R. Istchenko, “Yield and Uncertainty Validation for Pre- and Post Construction Wind Resource Assessment,” presented at the AWEA WindPower 2014, Las Vegas, http://www.phoenixengg.com/Publications/2014_YieldAndUncertaintyValidation.pdf 2014. *Historically, project yields haven't met expectations: bias of 8-10%.*

8. M. Stoelinga, and M. Hendrickson, “A Validation Study of Vaisala's Wind Energy Assessment Methods,” Vaisala, http://www.vaisala.com/en/press/news/2015/Pages/Page_1973472.aspx (2015). *For the last decade, underperformance has been a key concern of the wind industry and investigations have revealed that more sophisticated assessment methods are required to improve pre-construction energy estimates during the due diligence phase.*

9. A. Clifton, A. Smith, and M. Fields, “Wind Plant Preconstruction Energy Estimates. Current Practice and Opportunities,” National Renewable Energy Laboratory, NREL/TP–5000-64735 (2016).

The novel aspect of our paper is that it shows for the first time that year-to-year

correlations in wind resource level have a *large* effect on resource assessment uncertainty. The presence of these correlations is largely ignored in current industry practice. Our identification of this effect constitutes a very fundamental advance in the diagnostic understanding of causes of uncertainty in P50 and P90. This finding is also very general: the identified correlations were present at all 60 sites in the present study, and are in our opinion highly likely to present at every wind site in the world. Recognizing the existence of such correlations links wind resource assessment to a wide body of statistical understanding of related natural phenomena in other fields, and thus indeed provides a ‘pathforward,’ as we suggest with regard to references we cite, namely Hurst (1951), Beran (1989, 2003), Haslett and Raftery (1989), Pelletier and Turcotte (1997), Koscielny-Bunde, et al. (1998), Ault (2013), Witt and Malamud (2013), and Tsekouras and Koutsoyiannis (2014).

The concern over the underlying data being “presumably also confounded by instrumentation and other changes” can best be alleviated by referring to the paper accompanying the source data (Wan, 2010), which describes the state-of-the art homogenization techniques employed.