We demonstrate a method for incorporating wind velocity measurements from multiple-point scanning lidars into threedimensional wind turbulence time series serving as input to wind turbine load simulations. Simulated lidar scanning patterns are implemented by imposing constraints on randomly generated Gaussian turbulence fields in compliance with the Mann model for neutral stability. The expected efficiency of various scanning patterns is estimated by means of the explained variance associated with the constrained field. A numerical study is made using the HAWC2 aeroelastic software, whereby the constrained turbulence wind time series serves as input to load simulations on a 10 MW wind turbine model using scanning patterns simulating different lidar technologies—pulsed lidar with one or multiple beams—and continuous wave lidars scanning in three different revolving patterns. Based on the results of this study, we assess the influence of the proposed method on the statistical uncertainty in wind turbine extreme and fatigue loads. The main conclusion is that introducing lidar measurements as turbulence constraints in load simulations may bring significant reduction in load and energy production uncertainty, not accounting for any additional uncertainty from real measurements. The constrained turbulence method is most efficient for prediction of energy production and loads governed by the turbulence intensity and the thrust force, while for other load components such as tower base side-to-side moment, the achieved reduction in uncertainty is minimal.

General information
State: Published
Organisations: Department of Wind Energy, Wind Turbine Structures and Component Design
Contributors: Dimitrov, N. K., Natarajan, A.
Number of pages: 17
Pages: 79–95
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Wind Energy
Volume: 20
Issue number: 1
ISSN (Print): 1095-4244
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.18 SJR 1.051 SNIP 1.834
Web of Science (2017): Impact factor 2.938
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.37 SJR 1.079 SNIP 2.316
Web of Science (2016): Impact factor 2.725
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.06 SJR 1.201 SNIP 2.165
Web of Science (2015): Impact factor 2.891
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.42 SJR 1.209 SNIP 3.688
Web of Science (2014): Impact factor 3.069
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.75 SJR 1.235 SNIP 2.486
Web of Science (2013): Impact factor 2.556
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.36 SJR 1.062 SNIP 2.297
Web of Science (2012): Impact factor 1.436
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.49 SJR 0.892 SNIP 2.582
Web of Science (2011): Impact factor 1.768
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.364 SNIP 2.026
Web of Science (2010): Impact factor 1.716
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.885 SNIP 1.439
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.743 SNIP 1.555
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.942 SNIP 1.42
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.586 SNIP 1.653
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.273 SNIP 0.827
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.525 SNIP 0.845
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
Keywords: Turbulence, Uncertainty, Constrained, Lidar, Load simulations, Wind measurements, Load verification, Random field
Electronic versions:
DOIs:
10.1002/we.1992
Source: PublicationPreSubmission
Source-ID: 123938056
Research output: Research - peer-review – Journal article – Annual report year: 2016