Response to Referee # 2

The paper applies POD and Barycentric color map to analyze the wake field in an array of wind turbines with different spacing. The paper is generally well-written (though some grammatical errors do exist). The POD analysis provides insights into the dominant structures in the wake field, which ultimately will be valuable for finding reduced order models for the wakes. The barycentric map highlights the specific anisotropic features in the wakes, which again will be useful for gauging models for the wakes. The analysis is sound and reasonably complete. I recommend publication with minor corrections. Some specific comments are listed below:.

The authors thank the reviewer for reviewing the paper and making valuable comments about the work. We have revised the manuscript according to the comments, and as a consequence, the paper has been significantly strengthened. Below, point-by-point answers to the comments are provided:

A: Specific comments

- ***A.1: Line 89: From this line, am I correct to understand that the POD is applied to the fluctuating velocity only, meaning the mean velocity is subtracted first? Some clarifications are needed.***

  Response A.1: Thanks for the suggestion. The statements read as shown below.

  The flow field, taken as the fluctuating velocity after subtracting time average mean velocity from instantaneous velocity, can be represented as $u = u(\vec{x}, t^n)$*, where* $\vec{x}$ *and* t^n *refer to the spatial coordinates and time at sample* n*, respectively.*

- ***A.2: Page 5: Eq (2) contains typo. In the next sentence (line 94) R(x,x) was referred to as if it appeared in Eq. (2). However it is not there. Also, the locations x and x should have an arrow on the top to be consistent.***

  Response A.2: This has been modified in the revised manuscript. Thank you.

- ***A.3:Line 97: it would be more helpful to explain the relation between G and the coefficients A in Eq. (1).***

  Response A.3: Thanks for pointing this out. The authors have added an explanation in revised paper.

  The matrix $[G]$ *is related to the time coefficient as* $[G] = [A(t^1), A(t^2), \cdots, A(t^N)]^T$.

- ***A.4: Line 102: the running index in the summation on the top should be different from n, as n is the upper bound of the summation.***

  Response A.4: Thanks for pointing this out. The authors have changed the indices of the equations.

  $\eta_n = \sum_{j=1}^{n} \lambda_n / \sum_{j=1}^{N} \lambda_n$ and $\xi_n = \lambda_n / \sum_{j=1}^{N} \lambda_n$.

- ***A.5: Line 108: Please give the definition of k.***

  Response A.5: Thanks. The definition is added in the revised manuscript.
  k represents the turbulence kinetic energy and is defined by $k = 0.5 \sum_{i=1}^{3} \langle u_i u_i \rangle$

- ***A.6: Line 115: to additional promote the study of...? It does not quite make sense.***

  Response A.6: This has been modified. Thanks.
  In an attempt to further facilitate the study of turbulence anisotropy,

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- ***A.7: Line 129: I suspect that the*** $C*_{ic}$ ***inside the parentheses should not have the asterisk. Also, the coefficients 5 and 0.65 are different from those in Emory and Iaccarino. Some explanation is needed.***

  Response A.7: Thanks. The reviewer is correct and the asterisk is removed. There are many values suggested via Emory and Iaccarino, see page 136; one of these values is the coefficients 5 and 0.65. It is chosen because it provides a better visualization than the other coefficients. The statement reads as shown below.
  The coefficient with value of (0.65 and 5) is applied as it provides the optimal visualization; other coefficients were tested with less success in terms of marking differences.

- ***A.8: Line 162: represent aligned wind farms and is not considered.***

  Response A.8: This sentence has been removed for clarity. Thanks.

- ***A.9: Line 173: the typesetting of the expression 0.2m x 0.2m is a bit awkward, thought I suppose this can be fixed by the publisher.***

  Response A.9: Thanks.

- ***A.10: Line 239: reduction of the streamwise spacing.***

  Response A.10: Thanks. This sentence has be modified.
  These results are attributed to the reduction on the streamwise spacing.

- ***A.11: Fig. 8: It seems that, apart from case C3X3, the upstream structure is very much different from the downstream one. Can the authors please comment? This part represents a main contribution of the article. It is important to give an in-depth analysis.***

  Response A.11: Thanks for pointing this. An explanation as added to the revised manuscript. The statements read as shown below.

The upstream of cases $C_{6\times3}$ and $C_{6\times1.5}$ is located at the recovering part of the flow, in contrast to the downstream that presents the wake region. This contradictory is interpreted in the first POD modes that show the discrepancy in the coherent structures between the upstream and downstream. In the $C_{3\times3}$ arrangement, upstream and downstream both are located at the wake flow, thus pointing to the resemblance in the structure. The same conclusion can be extracted from case cases $C_{3\times1.5}$; the difference only in the sign of the eigenvectors, which is one of the POD properties.

- ***A.12: Line 279: Should be 'the intermediate modes are associated with the inflow characterizations'?***

  Response A.12: Thank you. This sentence has been modified as suggestion via the reviewer.

- ***A.13: Line 354: Fig 12 should be Fig 13.***

  Response A.13: Thanks.

- ***A.14: Line 422: '...streamwise spacing exceeds and reconstruct faster...'? Something is missing here. It does not quite make sense.***

  Response A.14: Thanks. This sentence is rewritten in the revised paper.

  Reconstructed profiles display the effects of the spacing, where the array of large streamwise spacing reconstruct faster than the other cases due to the coherent structures embedded within the flow.

In closing, we thank the referee again for the useful feedback and thorough review of the manuscript.
