

RESPONSE LETTER

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Paper Title: “Quality aspects of the measurements of a wind profiler in a complex topography”
by M. Maruri et al.

We've tried to answer to all the suggestions from the referees and respond to the improvements aspects pointed out by them.

We've highlighted comments from the referees in bold font while our responses to reviewers are in regular font.

Answer to Anonymous Referee #1:

The authors would like to thank the referee 1 all the comments. The authors recognize that to answer the referee is needed more explanations of the methodology content.

The duration of the work was three years, and the authors have omitted details to emphasize the results.

Regions with complex topography as the Basque Country need many observations to describe meteorological events. Remote techniques using many beams require a homogeneity test for the lower layers to calculate wind profiles.

This reviewer outlines the following suggestions to improve the paper:

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- **Introduction: It defines the main objective of the study: deviation and evaluation of the systematic initial homogeneity assumption (lines 9-10) which could be added as metadata: great idea, but the results do not show a real quantitative usable output....:**

Answer:

At product level (wind profiles), the wind profiler system has a column labeled as “MET_QC” in which service operator could include quality information using a flag code. This column uses a quality control value from 0 to 9 as qualitative quality information (0 means that the data pass all the quality control algorithms, 9 means that failed the consensus filter, 8 is an invalid data and 7 is suspect data defined by the service operator). Others value could be used as qualitative quality metadata information by the service operator (inhomogeneity detection in the radial velocities could be assigned a value between 1 and 6). This column is stored in the consensus files and in the consensus database. The end user uses this column to reject or not the data according to the application.

The first objective of the authors is the detection and labeling of inhomogeneties correlated with the meteorological data. The identification of homogeneity is easy to implement at consensus level operation.

The quantitative evaluation of the uncertainties should be done at spectral level. The interaction in the signal process is not easy at this level on an operational system as Punta Galea.

A reference of the software documentation, including format description of different types of data, could be included if the referee considers it is appropriate.

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- **System description: Because the complex topography of the area is of first importance for the study, a much better description of the area is mandatory (including a better Figure 1).**

Answer:

We agree with the reviewer's comment.

The authors have included a paragraph with a better description of the area and improved the Figure 1.

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- **Methodology: Module 1, database selection. I have the impression that the selection of cases was based on empirical criteria: "statistical and visual inspection" (line 8). A better explanation on how this selection was made would help.)**

Answer:

The module 1 is the core of the methodology.

In this module the authors decided which input data of the signal processing system would be analyzed.

The authors would include some references of flows of the signal processing system (Strauch et al 1984, Ecklund et al 1988, May et al 1989, Wilfong et al 1999, Morse et al 2002 ...).

The Punta Galea wind profiler stores data from time series to consensus. The authors evaluated in this module the advantages and disadvantages of working with each one. The amount of data to analysis, the complexity of the identification of groups and the easy implementation of the results in operation are some of the reasons why the authors decided to work at consensus level.

The "Exploratory Data Analysis-EDA" is the statistical method used in this study (Tukey J.W. 1977). It is a first look at the data. It is a critical module, as the statistical model of the method is influenced by daily monitoring observation of data and severe meteorology events where the quality of the observations is crucial for making decisions.

In this module, the authors work with a subsample to decide and choose between the different statistical tools of the EDA module of IBM-SPSS software. Selected tools must give good representations of the data, control the transformations of the data and the behavior of three vertical velocities along time and height. Simple plots that take into account statistical descriptive of the population associated to each vertical velocities are selected to the study.

Finally the groups are defined using meteorological criterion, type of targets, and recurrent patterns identified in the exploratory data analysis.

- **Methodology: Testing periods. I did not get very well the connection of this paragraph with the previous one. What do you mean with “previous analysis ...” (line19). It is quite confusing to me.**

Answer:

A database of sample of three years (from 2009 to 2011), was used in this study.

The testing period is identified with a subsample used in the module 1 to design the statistical methodology applied in subsequent modules.

The authors worked with all available data at consensus level. Noisy data associated with low consensus numbers were displayed by the statistical tools.. Data with low signal noise ratio are correlated with low consensus numbers. This is the reason that “a cleaning process” is included by the authors in this module.

- **Methodology: Module 3: pre-analysis and interpretation. Once again, I am confused: why do we have to proceed to a “cleaning process”.. and how (line 13) + what is the “criterion of usefulness” (line 20). It is really not easy to keep track of the various steps .**

Answer:

In order to clarify the text, all comments related to the cleaning process will be removed from this module and included in module 1.

To clarify the text, all the comments related to the criterion of usefulness of the EDA tools will be removed from this module and included in module 1.

Authors consider that the decisions of cleaning and identifying the best statistical tools for data analysis are crucial to identify the structures and therefore the groups..

Control of transformations of module 2 and the identification of groups are the focus of this module. This is why the module name “pre-analysis and interpretation”.

- **Methodology: Module 4: homogeneity. Once again, it seems to me that we have a mix of statistical tools and of empirical methods (visual) in order to get the appropriate set of data : “The tool was supported by visual and numerical descriptive analyses” (line 22) .**

Answer:

This module analyzed the homogeneity features associated to each group. This module looks for a correlation between homogeneity and quality. In this module will be included the meaning of hqp and its uses in operation.

- **Results: The explanation of Figure 16 (which are Tables!) should be better formulated: what trend means and what Results:0 – (-,0,+) means, and what are the first column’s numbers, ..).**

Answer:

This is a mistake. In a previous review of the paper, Figure 16 was substituted by table 1 and 2.

The first column is the name of the consensus file. Consensus Files are daily files that use Julian day format as denotation of the file name. This is the reason why the authors added day identification.

Radial velocities, including vertical velocities, are measured in m/s. This is the reason why velocities are close to zero. The authors ranged the values in the following groups:

- 0 = measurements around 0 m/s, with a tolerance of $\pm 0.25\text{m/s}$
 - plus (+) if the measurements are above 0 m/s (bigger than 0.25m/s)
 - minus (-) if the measurements are below 0 m/s (lower than -0.25m/s).
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- **Results: To me, clear quantitative results are missing: what can we gain from such a technique to check the quality of the Basque wind profiler. Thinkers are quite confused.**

Answer:

The authors have defined a threshold, which is a quantitative value, to flag as valid homogeneity cases. In contrast non homogeneity cases are flagged with a qualitative quality flag. This threshold which is defined in the paper as “hqp” is an empirical value based on the results of the breeze case. This value is set to 0.5 m/s, as explained in page 5225 (lines 10 to 14). This value could be set as default value for other boundary layer wind profiler or it could be changed by the operator, in the same way as other algorithms implemented by the system.

- **Conclusions: The fact that uncertainties are almost not described in this work (as mentioned) remains a weakness of the study.**

Answer:

The authors made some approaches of the theoretician uncertainties including empirical values of the deviation in a particular meteorological situation at consensus level. Nevertheless the authors consider that the uncertainties must be calculated at spectral level where the sequence of the five beams are closed in time and time intervals are lower than 30 minutes. The inhomogenities due to the site impact are of the order of 1 m/s, very large values for vertical velocities but small values in comparison to the radial velocities of the oblique beams (in the order of 20 m/s).

- **General comments: English is not my mother language, but I think that the English wording needs substantial improvement before to have this paper accepted.**

Answer:

I would like to thank the reviewer the effort to try to understand the contents of the paper. The authors consider two relevant points in this study:

- The complex methodology could be useful to other research works
- Regions with complex topography need more system observations to describe the local meteorology The homogeneity hypothesis should be tested in this complex terrain.

The manuscript has once more revised and the detected errors have been corrected.

- **General comments: Mathematical and statistical bases seem to be often used and presented in the background instead of, maybe, being explicitly described.**

Answer:

Agreed. The authors have included references and definitions of background concepts in the answers.

- **General comments: The description of several filtering steps gives the impression to the reader that the method can only be used by the authors on their system at its location. A paragraph on the possibility of a generalization of the method to other systems would be very welcome.**

Answer:

The authors hope that the above explanations answer this general comment.

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- **Minor comments: Page 5220, line 9 : E-Winprof : need a reference.**

Answer:

This reference will be included.

- **Minor comments: Page 5220, line 25 : the authors mention 5 modules, Figure 2 shows 4 modules!**

Answer:

It is a mistake. The modules are four.

- **Minor comments: Page 5221, line 6 : lower layers of the atmosphere instead of lower layers atmosphere.**

Answer:

Agreed. Changes included.

- **Minor comments: Page 5221, line 9 : (.spc files) → to be deleted.**

Answer:

Agreed. Changes included.

- **Minor comments: Page 5221, line 26-6 : this paragraph is not clear to me.**

Answer:

The authors decided to work with consensus data as mentioned above.

“The amount of data to analysis, the complexity of the identification of groups and the easy implementation of the results in operation are some of the reason the authors decided to work at consensus level”

- **Minor comments: Page 5229, line 22 : Jordan → 1995 or 1997 ?**

Answer:

Jordan is correct in the references-1997.

The year will be corrected in the paper.

- **Minor comments: Page 5232, line 13 : Ralph → 2012 or 1996 ?**

Answer:

Ralph is 1996. The year will be corrected in the references. In the paper is ok.

- **Minor comments: Page 5232, line 28 : Wilfong et al : not found in text.**

Answer:

This reference was considered by the authors at the beginning to explain the flow of the signal process. Later the authors omitted this paragraph in the paper.

At this moment the authors is going to include a paragraph as background to clarify the text.

- **Minor comments: Figure 1 : should be improved with, for exemple, a E-W crossection showing the topography (see comment above).**

Answer:

Agreed.

- **Minor comments: Figure 3 : what are the lines + improve the legend.**

Answer:

The lines are layers identified by the authors to help in the analysis.

- **Minor comments: Figure 4, 8, 9, 12, 15 : what are the colors on top (not seen on the plots) + improve the legend. These plots are important and must be easily readable.**

Answer:

The authors will work to improve all the figures to a better understanding.

- **Minor comments: Figure 5, 13 : the legend on top of right plot not clear.**

Answer:

- Agreed. Changes included.

Minor comments: Figure 7, 11 : what are the colors on top + improve the legend.

Answer:

Agreed. Changes included.

- **Minor comments: Figure 10 : what 0.1 and 0.2 mean in the plot ?**

Answer:

It is not a number. It is a capital letter, "O", (Observations). The authors will substitute the labels.

- **Minor comments: Figure 16 : Figure or table ? + improve the legend.**

Answer:

Figure 16 was substituted by tables 2 and 3

In general, all the tables have been revised by the authors. The authors have improved the quality of figures.

In table 1 an error has been detected 25th percentile of the South case in the Wns column.

-0.5 m/s was substitute by -0.05 m/s

Answer to Anonymous Referee #2:

We would like to thank the referee for the suggestions. We really appreciate the effort to help the authors clarify the text.

The work has involved a revision of a large database. Many details and secondary results were omitted by the authors to try to emphasize the main result and to simplify the complex methodology.

This reviewer outlines the following suggestions to improve the paper:

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- **Page 5217: Title: Suggest rewording the title to read “Aspects of quality control of wind profiler measurements in complex topography”.**

Answer:

We agree with the reviewer’s comment. The suggested changes have been introduced in the title.

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- **Page 5218: Line 13: Replace “is useful to look for” with “provides useful indicators for” Line 24: Omit “Besides” and replace “were” with “have been” (so that the sentence reads: “Several quality studies have been proposed ...”)**

Answer:

Agreed. Changes included.

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- **Page 5219: Line 6: break up this sentence. Eg, “... derived from the oblique beams Wns and Weo). The study also classified ...” Line 10: replace “had to be” with “were” and replace “as” with “along with” Line 13: replace “must” with “should”**

Answer:

Agreed. Changes included.

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- **Page 5220: Line 2: replace “sends microwave pulses towards the sky” with “transmits microwave pulses upwards”**

Agreed. Changes included.

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- **Page 5220: Line 8: Omit “In spite of the fact”, instead note how long the system has been used by E-Winprof.**

We have replaced the paragraph:

“In spite of the fact that the system has been working since 1996, the most recent database is controlled by E-Winprof”

with the following:

“The Punta Galea Wind Profiler was incorporated to the European Network in September 2006. Since then, the data is quality monitored by the owner “the Basque Meteorological Service” and by the Eumetnet wind profile program, Winprof”.

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- **Page 5220: Line 9: Omit “Aside from this” Line 10: Add “also” after “has” Line 11: replace “know” with “monitor”**

Agreed. Changes included.

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- **Page 5221: Line 8: Omit “Besides” Line 9: replace “was” with “were” Line 16: replace “was” with “were” and omit “a” Line 17: use “episodes” and replace “was” with “were” Line 18: omit “allowed” and replace “defining” with “defined” Line 19: add “multiple” after “of” and replace “episode” with “analysis” Line 21: omit “one”**

Answer:

Agreed. Changes included.

Additionally we have replaced the subtitle “Testing period (7 days from December, 2009)” with “Testing period”.

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- **Page 5222: Line 1: not clear what is meant here**

Answer:

Module 1 (database selection) is the core of the statistical method applied.

The main objectives pursued with the development of the study have been:

- Search data persistent behaviors that could be correlated with patterns detected during visual inspection of the data.
- High reliability and accuracy of the obtained results.
- Easy implementation of statistical processing.
- Simplicity of implementation to be easily used in the operation of the wind profiler

Taking into account these premises, the following aspects of the study were decided in module I:

1. The level of the data processing
2. The best statistical tools to examine the data
3. The evaluation of if a cleaning module is required or not.

In operational mode, wind profiler systems register information in different levels of data processing: time, spectral, and consensus series data.

Time series data provide the most detailed information from a wind profiler. However, the analysis of a very large amount of data is extremely complex and unworkable in practice.

Spectral series data register information very useful for a statistical study of homogeneities. In the same way the spectral analysis of large series is complex in practice, causing operational problems in the implementation of operating results.

The consensus data is a user product. It provides information about wind velocity in the five directions during the consensus interval time. This product is used in operational systems to monitor the evolution of severe weather episodes. For example, the Weber and Wuertz algorithm uses the consensus information for continuity and pattern recognition checks. This algorithm uses a column to flag the data. The flag is a numerical code and it could be considered as the metadata quality information for the users. Apply this quality index in a digital quality flag in the metadata (yes or not) is a first step. But in many applications is enough to reject the data.

In operational systems, the accurate detection of deviations of the homogeneity hypothesis is determinant. Therefore, in this study the exploratory data analysis, EDA (Tukey J.W, 1977), was applied to the database of the testing period, analyzing all the available consensus data in a first stage.

EDA techniques include visual exploration of the data (plots of the time series, stem and leaf displays, box-plots, bar tables, scatterplots) and descriptive statistical analysis of the sample and subsamples. These are tools for looking in the data structures, or for the lack of it.

A severe weather episode, with shifting winds and storms, during seven days in December 2009, was selected in this study (subsample). Furthermore a visual inspection of all data is performed trying to find patterns of behavior.

In this stage, the authors worked with this subsample to make decision about the relevant information obtained by each tool, about the bests plot to check the transformations of the data or the best box plot to explore the evolution of the homogeneity along time and height. This is a required step in order to further implement the same statistical tools within the two-year database.

The results obtained at this stage showed noisy data structures. This was due to poor consensus associated with non-persistence patterns during the consensus time interval or with low signal to noise ratios (as described in line5, page 5222).

To detect main structures and behaviors a cleaning process was applied: data with less than 100% of consensus data was removed to avoid transitional changes during the consensus time interval. Therefore the cleaning process is a statistical concept used to remove noisy data, which are not representative of the time interval. Full samples throughout the test period thus become a subsample with less data but with greater consistency, trying to seek persistent behaviors in the data which are correlated with patterns detected during visual inspection of the data and trying to get good mean descriptive values (data inconsistency with deviations greater than the thresholds values).

Based on the foregoing, the following decisions were taken in the Module 1 of the study:

- The study was done at consensus level. The temporal resolution is 30 minutes. Each data (radial component of the wind velocity) has a consensus value, indicative of the number of samples used to build the wind vector. Only data with higher consensus number were used in the study. This decision means that data studied were consistent in the time interval.
- The spectral data was only used in this study for verification of the results. The authors consider that persistent patterns should be identified as consensus level while spectral level is a second level of work, to validate the results. This decision is a limitation because only qualitative results are possible to obtain at the consensus level. Additionally it is necessary to note the noisy amount of data incorporated into the study in the spectral analysis and the performance problems of the implementation of the results in operation. The cleaning process used (subsamples generation) ensures that if a pattern of inhomogeneity is identified at the level of consensus, will also be identified spectrally.

Page 5222: Line 2: instead of “convenient”, perhaps you mean “thorough”

Answer:

Agreed. Change included.

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- **Page 5223: Line 6: omit “Besides” and swap the sentence around so that it reads “The differences between these three vertical velocities ($W_v - W_{ns}$, $W_v - W_{eo}$, $W_{ns} - W_{eo}$) were calculated.” Line 17: Omit “In spite of this”**

Answer:

Agreed. Changes included.

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- **Page 5223: Line 21: Omit “Besides this”. I’m not sure what this sentence is saying – perhaps reword to “The predominance of the low mode produced biases in the results”**

Answer:

We agree with the referee's suggestion. Changes have been included.

The impact of the surroundings is stronger in lower mode of operation (short pulses). The first gate is closer to the surface and finest meteorological structures of wind field are described with these pulses.

- **Page 5223: Line 22-23: replace "On the other hand, during certain periods ..." with "There were certain periods ..."**

Answer:

Agreed. Changes included.

- **Page 5224: Line 3: Perhaps insert "sorted", ie: "sorted according to" Line 17: perhaps replace "repetitive" with "typical" or "predominant"**

Answer:

Agreed. Changes included.

- **Page 5225: Line 8: It's not clear what this sentence means – perhaps reword along the lines of "This technique provided a means to identify standard features associated with a particular meteorological process or characteristic signal pattern".**

Answer:

We agree with the referee's suggestion. Changes have been included.

There are two ideas behind this paragraph:

- First one is the suggested by the referee: "This technique provided a means to identify standard features associated with a particular meteorological process or characteristic signal pattern".
 - The second idea concerns the velocity resolution associated to each mode, which is taken into account in this study. In the low mode, the velocity resolution is 0.174 m/s and in the high mode is 0.188 m/s. The ratio between the spacing between the vertical velocities and the velocity resolution is calculated. The consistency case associated to the breeze case (0.5 m/s) has a ratio less than 3. This is the lowest empirical value obtained in the study and it is consider as a reference value of consistency. For this reason the Homogeneity quality parameter "hqp" is set to 0.5m/s. The difference values that are greater than hqp are considered flag, while values less than or equal are considered homogeneous.
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- **Page 5225: Line 16: Omit “At this stage” Line 17: replace “were” with “are” and replace “corresponded” with “correspond” Line 22: omit “occurrence of”**

Answer:

Agreed. Changes included.

- **Page 5226: Line 23: replace the phrase from “which ...” with “which is more consistent with the behavior of Wv ”.**

Answer:

Agreed. Changes included.

- **Page 5226: Line 24: “This pattern had a correlation with it ...” is unclear it appears to refer to a correlation between variability the different vertical velocities and wind speed and direction.**

Answer:

The north pattern shows a direct dependency with the wind speed. The case presented, surface winds higher than 10m/s (see Figure 5), shows an inhomogeneity pattern up to 700m. The pattern is recurrent, and inhomogeneities of the Wns decrease with height (see Figure 8, 9). In the south case, figure 12 shows a gauss curve with a similar pattern. South cases are analysed taking into account other factors such as virga precipitation.

North pattern also shows a dependence with directions. All cases are north cases but NNE components show larger bias than NNW. The authors consider that the orientation of the coast respect to the wind direction is another factor to be considered in the analysis.

The authors have detected inconsistency in the tables 2 and 3. The west component are displayed in these tables with “O” and it will be substituted with “W”.

- **Page 5227: Line 9: Replace “outstanding peak of the mismatch” with “greatest mismatch : : :” Line 22: replace “surrounding signals (clutter) prevailed over the echo sounds” with “clutter signals dominated over atmospheric signal”. Also omit “On the contrary”**

Answer:

Agreed. Changes included.

- **Page 5228: Line 4: Replace these two sentences with something like “Precipitation case produced the most inhomogeneous situations because the nature of precipitation varies greatly in both time and space.” Line 19: Omit “Besides” Line 24: Replace “were parts of this section” with “were required” since this section implies just this section of the paper, whereas these topics were discussions of the whole work.**

Answer:

Agreed. Changes included.

- **Page 5229: Line 2: replace “these two cases are the only ones included in this section” with “these two situations were the focus of this work”. Answer:**

Agreed. Changes included.

- **Page 5229: Line 4: figure 16 appears to be missing – although perhaps this is just tables 1 & 2. Answer:**

Agreed. Changes included. This is a mistake and the comment of the referee is correct

- **Page 5229: Line 11: confirmed by? Line 19: omit “Besides”**

Answer:

Agreed. Changes included.

- **Page 5230: Line 8: Rearrange the sentence “Under different” to read something like “Data should be examined under different wind regimes in both low and high modes to test if the homogeneity assumption is valid”. Lines 18 – 21: this could be more concisely stated – something like: “Comparisons of the vertical velocity measured directly by the vertical beam with vertical velocities derived from opposing oblique beams were found to be useful diagnostics in this study. Differences in the vertical velocities were taken to indicate inhomogeneous conditions.”**

Answer:

Agreed. Changes included.

- **Table 2: The notation for the H_{qp} parameter is not used in the paper, it would be useful to include it in the relevant section (eg, 3.4.)**

Answer:

We agree with the referee's suggestion. The notation for the H_{qp} parameter is included in section 3.4. It is a mistake of the authors do not use this notation in the methodology.

- **Almost all figures have labels that are too small.**

Answer:

We agree with the referee's suggestion. The authors will try to improve the size of the labels of the figures.

- **Figure 1: The maps are not well chosen. It is not useful to show a map of much of Europe, just the Bay of Biscay is sufficient. The other two maps are okay, although a 3D map or a terrain map would be more useful.**

Answer:

We agree with the referee's suggestion. The map of the site will be substitute taking into account the suggestion of the referee.

- **Figures 3, 4, 7, 8, 9, & 12: note in the captions what the over-plotted lines indicate.**

Answer:

Agreed. Meteorological information of the over-plotted lines will be added.

- **Figures 4, 7, 8, 9, 11, & 15: label the vertical axes.**

Answer:

Agreed. Label of the vertical axes will be included
