PO.156

Recovery rate on measuring masts: What is the acceptable limit?

Marion Jude, Hélène Willis
Eoltech

eoltech Wind resource experts

Abstract

A low recovery rate on a measuring station can be due either to an entire single missing/invalid period or to several punctual blocks of missing/invalid data throughout the campaign. Whether the low recovery rate is associated to the first or the second case, the impact on the energy yield assessment will not be the same.

The aim of this study is to estimate the impact on the average wind speed of recovery rates obtained from different associations of lengths of missing data (i.e. distribution of the missing data). Each association was tested 100 times randomly for a better robustness of the results.

The results indicate that both the recovery rate and the lengths of the missing periods have an impact on the global wind speed. Hence a recovery rate alone is not sufficient to estimate the impact of the missing data on the measuring campaign. The lengths of the missing periods should also be taken into account in the uncertainty on the measuring campaign.

Objectives

The results of this study help to put into perspective the value of the recovery rate (high or low) for a wind measuring campaign, and to qualify the risk of bias on the mean wind speed depending of the length of the gap of data. The lengths of the gaps (missing or invalid data) should also be taken into account to estimate the uncertainty on the measuring campaign.

Methods

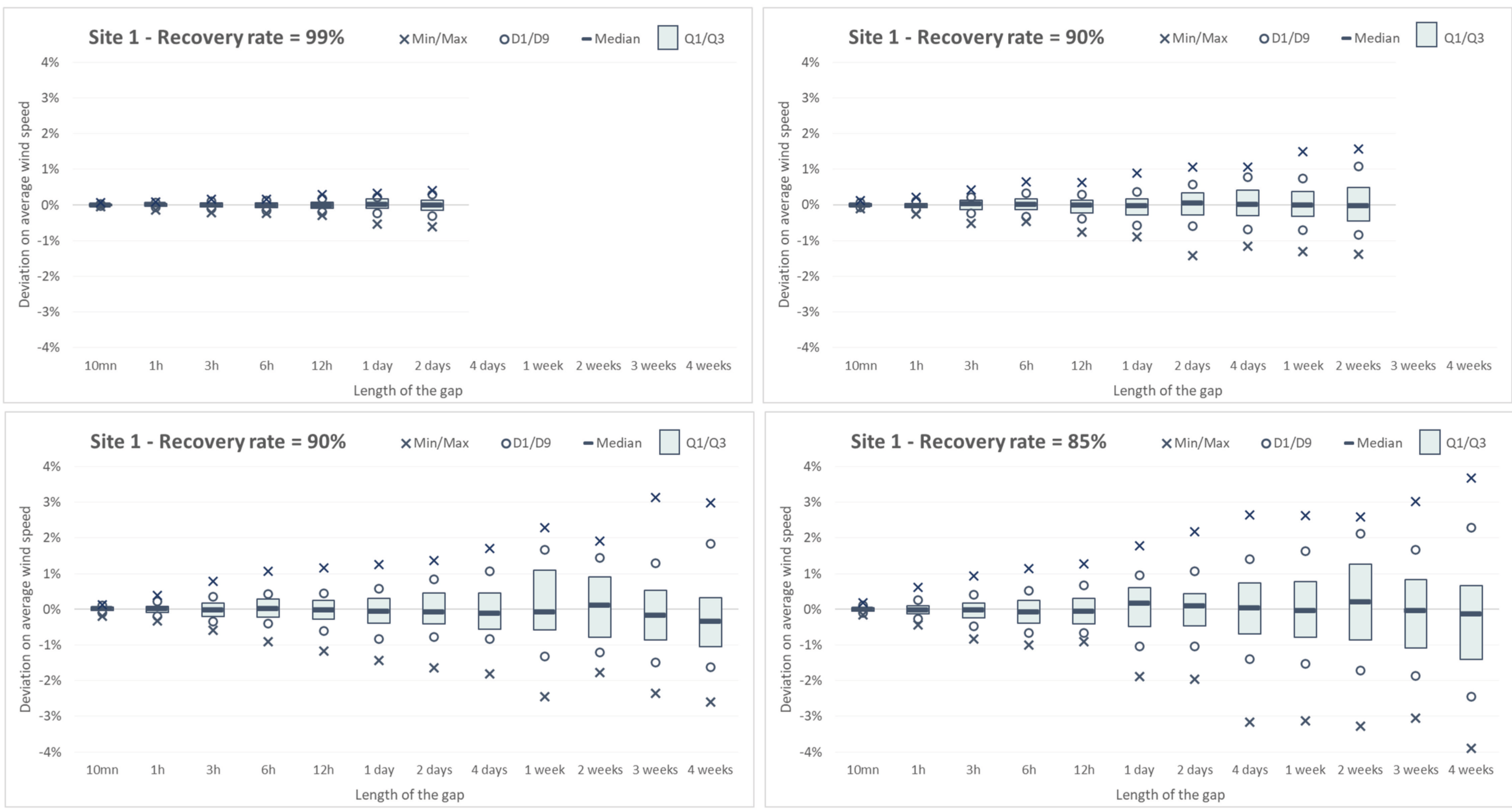
For this study, three 1-year measuring campaigns with 100% recovery rates after data processing were considered (i.e. no missing or invalid data).

Site	Location	Height	Length	Recovery rate *(after data processing)*	Average wind speed
1	France – Rhône Alpes	110 m	12 months	100%	6.6 m/s
2	France – Nouvelle Aquitaine	120 m	12 months	100%	7.1 m/s
3	France – Nouvelle Aquitaine	100 m	12 months	100%	5.1 m/s

Table 1: Main characteristics of the 3 measuring campaigns tests

Different associations of global recovery rate / lengths of gaps were analyzed from these 10-min data series measured on site. Hence the average wind speed was calculated based on incomplete datasets generated by removing randomly several 10-mind data. Each association (one association being one global recovery rate and one maximum length of gaps) was tested 100 times randomly for a better repeatability of the results, leading to 18000 time series tested. The average wind speeds obtained for each case were compared to the average wind speed of the 1-year campaign with 100% recovery rate. Recovery rates from 99% to 85%, and gaps from 10 min to 4 weeks were tested.

For illustration purposes, the figures below display the distributions of the deviations observed on the average wind speed for site 1, for recovery rates of 99%, 90%, 95% and 85%, depending on the length of the gaps. The median value of the deviations obtained from the 100 tests are displayed for each association, as well as the 1st and 9th deciles, the 1st and 3rd quartiles and the extremes deviations observed.



Figures 1 to 4: Deviation on the average wind speed depending on the recovery rate and the length of the gaps for site 1 (100 tests per association)

Results

Maximum deviations observed

The table below displays for each of the three sites, the largest deviations observed on the average wind speeds for each recovery rate (absolute value):

Recovery rate	99%	98%	97%	96%	95%	94%	93%	92%	91%	90%	89%	88%	87%	86%	85%
Site 1	0.6%	0.9%	1.4%	1.4%	1.6%	1.8%	2.1%	2.5%	2.9%	3.0%	3.3%	3.9%	4.0%	3.7%	3.9%
Site 2	0.5%	1.0%	1.6%	2.1%	2.0%	2.4%	2.4%	2.9%	3.0%	3.7%	4.0%	4.3%	4.6%	4.1%	4.8%
Site 3	0.6%	1.0%	1.2%	1.8%	2.0%	2.5%	2.3%	2.8%	2.8%	3.7%	3.0%	3.5%	3.3%	3.3%	4.0%

Table 2: Maximum wind speed deviations observed for each recovery rates (6000 tests per site)

The deviation on the average wind speed can reach 1.0% from 2% of missing data (i.e. recovery rate of 98%). Beyond 10% of missing data the deviation can exceed 4.0%.

Conditions for deviations exceeding 0.5% and 1.0% on the average wind speeds

The table below displays for each of the three sites, the length of the gaps from which deviation on the average wind speed can exceed 0.5% (table 3), and 1.0% (table 4).

Recovery rate	99%	98%	97%	96%	95%	94%	93%	92%	91%	90%	89%	88%	87%	86%	85%
Site 1	1j	12h	12h	6h	3h	3h	3h	3h	3h	3h	3h	3h	3h	1h	1h
Site 2	2j	12h	6h	6h	3h	3h	3h	3h	3h	3h	3h	3h	1h	3h	1h
Site 3	1j	12h	12h	6h	6h	3h	3h	3h	3h	3h	3h	1h	1h	3h	1h

Table 3: Length of the gaps from which the deviation on the average wind speed can exceed ±0.5%

Recovery rate	99%	98%	97%	96%	95%	94%	93%	92%	91%	90%	89%	88%	87%	86%	85%
Site 1	/	/	2d	2d	2d	1d	1d	1d	12h	6h	12h	6h	12h	12h	6h
Site 2	/	2d	1d	2d	1d	1d	1d	12h	6h	12h	6h	6h	12h	6h	6h
Site 3	/	4d	2d	2d	2d	12h	12h	1d	12h	12h	6h	12h	6h	6h	6h

Table 4: Length of the gaps from which the deviation on the average wind speed can exceed ±1.0%

Hence, the previous table indicates that, for instance for Site 1:

- no deviation on the average wind speed above 1.0% was found for a recovery rate of 98%,
- At least one deviation beyond 1.0% was found among the 100 tests run for a recovery rate of 90% and gaps of 6h occurring randomly. However, no deviation exceeding 1.0% was found for a recovery rate of 90% and gaps of 3h or less.

The results on the three sites can be summarized as showed on the graph below:

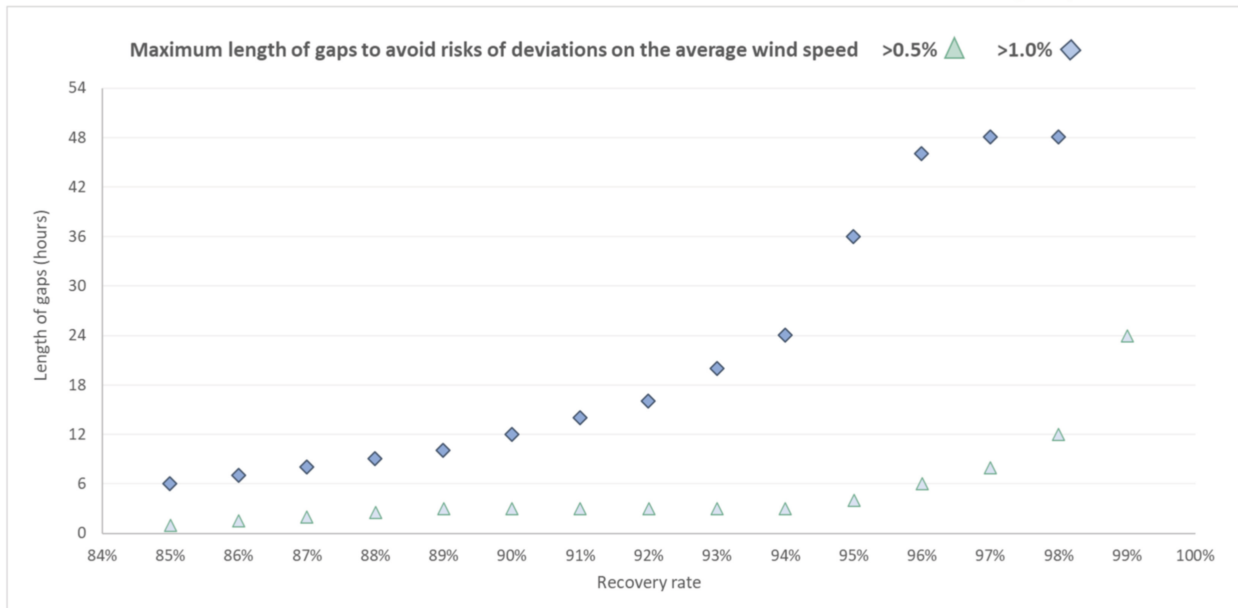


Figure 5: Main outcomes from the 3 sites: Maximum gap length to avoid risks of wind speed deviations exceeding 0.5% and 1%

Thus, for instance:

- for a recovery rate of 96%, the deviation on the average wind speed is not likely to exceed 0.5% if the length of the longest gap is below 6h, and the deviation is not likely to exceed 1.0% if the length of the longest gap is below 48h.
- for a recovery rate of 90%, the deviation on the average wind speed is not likely to exceed 0.5% if the length of the longest gap is below 3h, and the deviation is not likely to exceed 1.0% if the length of the longest gap is below 12h.

These graphs also show that for a given recovery rate, the impact on the average wind speed is significantly dependent on the length of the gaps of data. As expected, numerous short periods randomly distributed should lead to lower impacts on the measuring campaign than larger blocks.

Conclusions

From three one-year measured data, the generation of 100 timeseries with randomly distributed gaps for each association recovery rate / length of gaps has led to 18000 timeseries tested. The analysis carried out on the 3 different sites have shown quite consistent results.

It results from this analysis that the length of the gap of data is a relevant indicator to estimate the risk of bias on the average wind speed, and has to be associated to the recovery rate. And thus, the acceptable limit on recovery rates on a measuring campaign is widely dependent on the length and distribution of the gaps, leading to a case-by-case uncertainty on measurements. For further insight, a focus could be made on the seasonal effect of the distribution of the gaps of data on the wind resource assessment.