# Accuracy on Suspended Particulate Matter (SPM) concentration estimates

The algorithm applied to estimate the SPM concentrations was previously developed and had the accuracy compared with other classical methods (Távora et al., 2020a). This previous study considered a vast dataset, collected worldwide, encompassing 420 *in-situ* samples, whose environments ranged the SPM concentrations from 0.4 to 3980 g.m$^{-3}$. The high number of assembled materials provided reliable statistical parameters, resulting in a better performance of correlation coefficient (*r*), absolute percentage error (MAPE, %), average relative percentage error bias (BIAS, %) and root mean square error (RMSE, g.m$^{-3}$) in comparison with other trustworthy algorithms (Távora et al., 2020a).

The performance of the algorithm applied to Patos Lagoon region was also assessed in the present work, by comparing SPM in-situ data with the estimated results. The Patos Lagoon has a low number of match-ups, 43 for Guaíba River and 4 for Camaquã River. These match-ups allowed the development of an accuracy assessment, but to reach satisfactory statistical parameters a higher number of match-ups is needed.

Figure 1 represents the comparisons between the in-situ measurements and algorithm-derived, presenting the statistical parameters (i.e., *r*, MAPE, BIAS, and RMSE). Figure 1A is based on the match-ups of the Camaquã River: it represents three match-ups. The linear regressions in Figure 1A and 1B represent the scatter plots of Landsat 5 satellites (red dots) and Landsat 8 (green dots), both lie close to the 1:1 line, evidencing a strong correlation between SPM modeled and in-situ measurements.

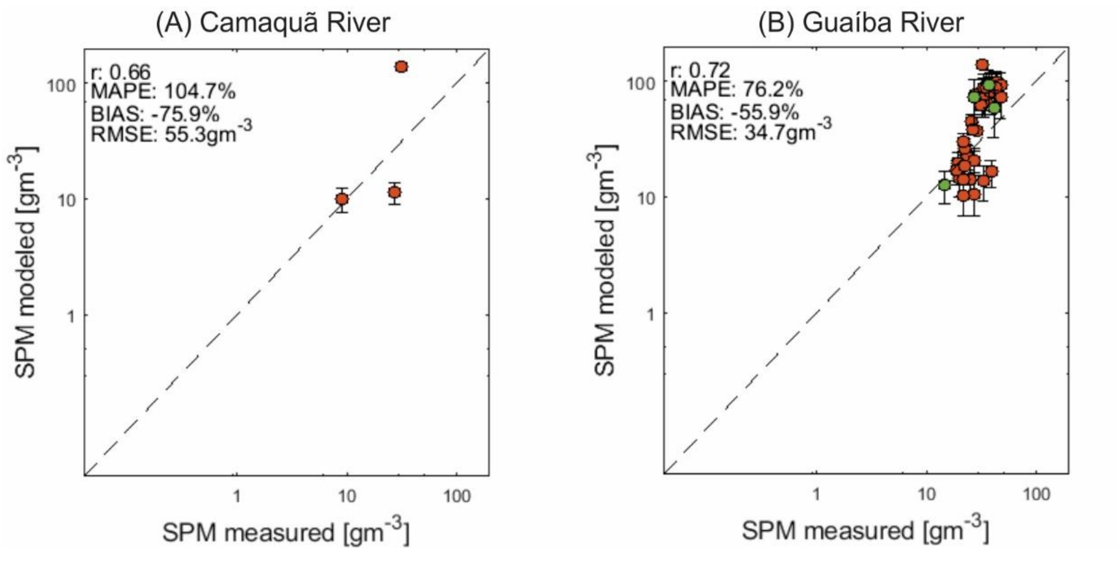


*Figure 1: Comparisons between estimated and in situ measured SPM concentrations, for Camaquã (A) and Jacuí (B) Rivers. The red dots represent the SPM concentrations estimated based on Landsat 5 satellites and the green dots represent the results from the Landsat 8 satellites.*

Higher *r* coefficients represent strong relationships between measured in situ and estimated values. The current study resulted in $r$ = 0.66 (n = 3, p-value = 0.33) and $r$ = 0.72 (n = 44, p-value << 0.001), respectively for Camaquã and Guaíba rivers, these values are better than the results obtained by other classical algorithms (Nechad et al., 2010; Han et al., 2016; Novoa et al., 2017) already applied to Patos Lagoon and compared between themselves in previous studies (Távora et al., 2020b).

The other statistical parameters (MAPE, BIAS, and RMSE) are based on the statistical error, thus lower values indicate satisfactory results. There is an inverse relationship between the sample size and the margin of error, this means that as the sample size increases the margin of errors decreases. The relatively high values obtained for these parameters in the present analysis might be a consequence of the reduced number of match-ups, in this sense, a single point far from the 1:1 linear relationship can generate unsatisfactory results and bias the error statistic. This hypothesis is reinforced by observing both scatterplots because the Camaquã River presented less accurate results in comparison with Guaíba River, which has a higher number of match-ups. The Camaquã correlation did not reveal statistical significance when considered independently, most likely due to the low number of match-ups available (n = 3) which can limit the representativeness of the analysis. Therefore, a larger sample is necessary to develop a consistent relationship. Lastly, the matchups from Camaquã and Guaíba when integrated result in *r* = 0.52 (p-value << 0.001), RMSE = 36.87 g.m$^{-3}$, BIAS = -57.61%, and MAPE = 78.62%.

Accurate validations could be improved based on constrained time-window (Δt) between satellite overpass and the moment of in-situ data acquisition, which is recommended by (IOCCG, 2019) not overpass 4 hours. In the current work, the sampling time of the historical SPM data is unknown, this may develop larger differences between both data sets because significant changes in environmental conditions can occur in this interval (e.g., intensified/reduced river discharge, or sediments can be resuspended by winds). Nonetheless, a range of 30-40% inaccuracy is acceptable to this type of estimates (Távora et al., 2020b). Improvements in the statistical parameters based on error can be achieved by increasing the match-ups number and by aligning the collection time of in-situ samples with the satellites passing during future campaigns.

The São Gonçalo Channel and the Inlet did not present match-ups, thus histograms were developed for comparison between the full time series of satellite-derived SPM concentrations (of each tributary region) and in-situ measurements (Figure 2). The frequency distribution (i.e., shape, center, spread, skewness) for the histograms of both tributaries if similar between the in-situ and estimated SPM concentrations may be mean that the distributions are representative of one-another.

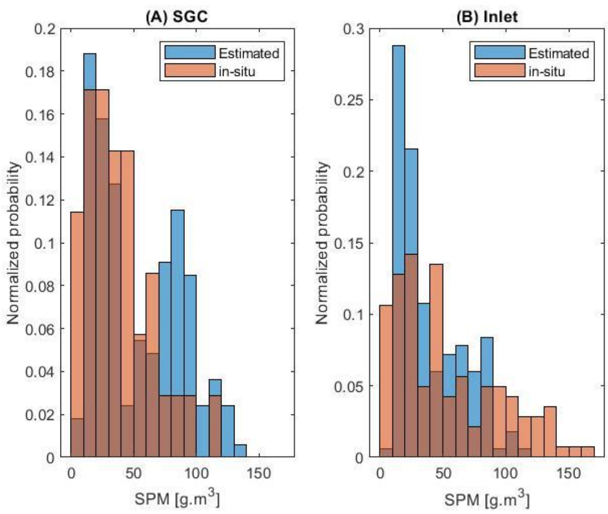


*Figure 2: Histograms representing the frequency distribution of in-situ SPM concentrations (orange bins) and satellite-derived SPM concentrations (blue bins), for São Gonçalo Channel (A pannel) and Inlet (B pannel).*

The favorable results obtained in a previous work when a higher number of samples were analyzed (Távora et al., 2020a), also the good *r* correlation and the tight distribution of points on scatterplots ensure the accuracy of this algorithm, although the error parameters can be improved if more match-ups are obtained in the future. In addition, the histograms also presented a satisfactory relationship between the in-situ and satellite-derived data, reinforcing the accuracy of the algorithm.

## References


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