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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "A comparison of gap-filling algorithms for eddy covariance fluxes and their drivers" *by* Atbin Mahabbati et al.

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General comments

The paper by Mahabbati et al. presents an updated comparison of gap-filling algorithm, which are an important tool in the analysis of data from eddy-covariance sensors and understanding the ecosystem functioning. Their methodology is oriented at the Australian version of the data processing chain taking into account information in addition to the eddy-stations from weather forecasting models and from BIOS2 model data integration environment. For gap-filling of meteorological drivers, they corroborate previous findings of complex methods being not much better than simple methods. Contrary, for the carbon fluxes itself they find a better performance of the machine learning (ML)

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Discussion paper

based approaches.

This study is a valuable contribution to the Australian setup. However, their findings are difficult to transfer to other processing setups and other sites. Hence, the paper is a quite special application and in the current form better suited for an Australian journal. I encourage the authors for a major revisions to extent their study to setups that are also applicable at other sites for submission to GI.

I have several major concerns, which I state here and explain below. First, I propose to add a comparison with fitting the models to only data that are commonly available at other sites. Second, the methodology needs to be updated to introduce gaps at random positions in time instead of all starting at 1st of January to avoid confounding of gap-length with seasonality. Third, I propose to include the MDS algorithm that was simple but well performing at previous gap-filling comparisons and a "business as usual" for gap-filling NEE at many sites.

Specific comments

In order to be usable at other sites, the methods should be compared in addition to the presented setup by using only data commonly available at eddy-covariance sites, which are the measurements themselves (Fc, Fh, Fe) together with ancillary measurements (Rg, VPD, rH, Tair, Tsoil, Ustar, precip, wind speed, and wind direction), and maybe another comparison using in addition more detailed radiation measurements and ground heat flux and soil water storage (Table 2).

In the current comparison setup, the larger gap-lengths comprise a larger proportion of other seasons, while the short gap-lengths only comprise summer records. Hence, the conclusions on gap-lengths are confounded with seasonality. I suggest to randomly distribute gaps in the portion of the entire data series with sufficiently high proportion of non-missing original data. Moreover, most data-processing setups will not fit a model for each gap tailored at the gap-length. Hence, I suggest to introduce several gaps (of a given length) across the entire dataset (say of proportions of 40% and 70% of the

data according to p6L215) and let each methods fill all these gaps and compute the statistics across all the gaps but also of the aggregated annual value. In this way a recommendation can be presented that is closer to the gap-filling as applied at many sites. The decision to adjust the training window to the gap-length is very difficult to compare to other gap-filling of real time series where gap-lengths vary. Most investigators will not effort to fit a model around each gap. I suggest training the methods on a shifting window and filling all gaps inside this window, and for efficiency use only few increasing window lengths of the training.

Moffat et al. (2007) concluded that the quite simple and widely applied MDS algorithm for filling Fc, i.e. NEE time series, which is using only the common variables NEE, Rg, Tair, and VPD as predictors. What are the reasons to omit this for many sites "business as usual"-algorithm? The computation can even be outsourced to the online-tool provided by the MPI-BGC Jena.

P7L226: Were all the eight drivers used or a subset of them, maybe different by method? What is q? The formulation "by trial and error" needs more explanation.

P10L308: Here it does not become clear what cross-sections have been used. I imaged some categories based on similar environmental conditions or day/night time. This only becomes clear in the discussion, in that data from other sites have been used with site as cross-section. This cross-site gap-filling is hard to transfer to other studies. In what respect does the PD model differ from a classical mixed effects models?

P27L720 Conclusions 4 and 5 are mere speculations given the results presented in the paper. They should be moved to the discussion. Contrary to the suggestion 4, I hypothesize that using net radiation as a predictor should handle this case already well (at least with RF). Otherwise, I suggest first trying to add a nighttime/daytime flag to the set of predictors before splitting the dataset.

P1L35: Currently, I was confused reading the abstract. It was hard for me to spot the distinction between filling of environmental drivers and filling of fluxes. This can be

formulated more clearly.

Technical corrections

P2L43: This formulation does not become clear to me.

Tab 2: I suggest indicating the commonly used abbreviation for the fluxes in parentheses in addition to the notation of the paper (NEE, LE, H).

P11L331: typo: “non-periodic”

eq 12: one bar too much.

P23L583: I suggest to provide another table with method abbreviations or repeat the abbreviations at the beginning of the discussion. By this way you do not force your readers to study the methods section first.

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