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Characterization of Eddy Covariance flux errors due to data synchronization issues during data acquisition

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Modern Eddy Covariance (EC) systems collect high-frequency data (10-20 Hz) solely via digital communication, thereby overcoming limitations of transmission reliability, data quality and completeness of the datasets typical of traditional, mixed analog/digital EC systems. However, fully-digital acquisition introduces the problem of guaranteeing data synchronicity when the clocks of the involved devices cannot themselves be synchronized, which is often the case with instruments providing data via serial or Ethernet connectivity in streaming mode.
Here we present the results of a a simulation study and show that, while random timing errors can usually safely be neglected, systematic timing errors (STEs) can instead lead to significant flux underestimations which, under realistic circumstances, can get as large as 10% and should therefore be avoided. We show that STEs act as low-pass filters and hence characterize their transfer function, finding realistic cut-off frequencies as low as 1 Hz, which potentially makes STEs one of the strongest sources of high-frequency attenuation in open- or enclosed-path EC systems.
In most cases, STE can neither be detected nor be characterized a-posteriori. Therefore, it is important to test the ability of prospective EC data logging systems to assure the required synchronicity. This is most notably the case with "in-house" solutions adopted when assembling EC systems for applications, for which industrial grade systems are not available, e.g. when addressing less investigated trace gas species. We therefore propose a procedure to implement such a test, which rely on readily available equipment.