

Guidelines for Eddy Covariance Method

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1. INTRODUCTION

Guidelines are presented for the Eddy Covariance micrometeorological technique of high-speed flux measurements of water, gas, heat, and momentum within the atmospheric boundary layer. This technique is widely used by micrometeorologists all over the globe. However, a number of scientists from related disciplines outside of micrometeorology may not have been introduced to the information about this method, or may not be familiar enough with it to assess its usefulness within their research. With this in mind, step-by-step instructions were created to introduce a novice to general principles, requirements, applications, and processing steps of the conventional Eddy Covariance technique, to assist in further understanding the method through more advanced references such as textbooks, network guidelines and journal papers, and to help technicians, students and new researchers in the field deployment. Modern instruments and software can potentially expand the use of this method beyond micrometeorology and prove valuable for plant physiology, hydrology, biology, ecology, entomology, and other non-micrometeorological areas of research.

2. METHODOLOGY

The Eddy Covariance method is one of the most direct, defensible ways to measure and calculate turbulent fluxes within the atmospheric boundary layer. However, the method is mathematically complex, and requires significant care to set up and process data. The main challenge of the method for a non-expert is the complexity of system design, implementation, and processing of the large volume of data. In the past several years, efforts of the flux networks (e.g., FluxNet, Ameriflux, CarboEurope, Fluxnet-Canada, Asiaflux, etc.) have led to noticeable progress in unification of the terminology and general standardization of processing steps. The

methodology itself, however, is difficult to unify, because various experimental sites and different purposes of studies dictate different treatments, and site-, measurement- and purpose-specific approaches.

The guidelines are based, to a large degree, on frequently asked questions received from new users of the Eddy Covariance method and relevant instrumentation, and employs non-technical language to be of practical use to those new to this field. Information is provided on theory of the method (including the state of methodology, basic derivations, practical formulations, major assumptions, sources of errors, error treatment and use in non-traditional terrains), practical workflow (*e.g.*, experimental design, implementation, data processing, and quality control; Fig. 1), alternative methods and applications, and the most frequently overlooked details of the measurements.

The following topics are specifically addressed in detail: basics of flux footprint analysis for tower and instrument placement, data pre-processing (units conversion, de-spiking, coordinate rotation, time delay calculations), frequency response and density corrections, etc. References and access to an extended 141-page Eddy Covariance Guideline in three electronic formats are also provided.

3. FORMAT EXPLANATION

There are three formats for these guidelines: (1) On-line lecture to view and listen; (2) Adobe Acrobat text file to print as a book; and (3) PowerPoint presentation to download.

The on-line lecture is a 2-hour slide presentation with detailed voice-over further explaining information on every slide. The lecture text can be seen by clicking the red checkmark titled "Notes" at the bottom of the screen. This section contains text and informal notes along with additional details. Nearly every slide contains references to other web and literature references, additional explanations, and/or examples. Slide "forward" and "backward" buttons are also at the bottom of the screen. This format is most suitable for listening.

The Adobe Acrobat text format is an electronic book-like format. It has the same information as the on-line lecture, but it is more convenient for someone who does not have time to listen to 2 hours of the lecture at once. The Adobe text (141 pages) can be printed out on paper and read as a book and/or could be used in the field as a quick reminder guide.

The PowerPoint presentation is 141-slide presentation containing the same information as the on-line lecture. The voice-over can be activated by using the slide-show mode or by clicking the sound icon at the bottom of each slide. The notes section with the text at the bottom of each slide can be expanded by clicking on the “view->normal” commands located at the top of the frame. This format is most suitable for downloading and using for parts (e-mail me for password), or for viewing on the computer without internet connection.

4. ON-LINE ACCESS

Access to all three formats: [HTTP://WWW.LICOR.COM/EDDYPRESENTATION](http://www.licor.com/eddypresentation)

Specific links:

On-line lecture - http://www.licor.com/env/Products/GasAnalyzers/eddyPresentation/EC_master_Presentation.htm

Adobe PDF file - http://www.licor.com/env/PDF_Files/EddyCovariance_readonly.pdf

MS PowerPoint file - http://www.licor.com/env/Products/GasAnalyzers/EddyCovariance/files/EC_presentation_readonly.zip

Electronic reference: Burba, G.G., and Anderson, D.J. (2007) “Introduction to the Eddy Covariance Method: General Guidelines and Conventional Workflow”. LI-COR Biosciences, <http://www.licor.com>, 141 pp. (download date)

5. CONCLUDING REMARK

Authors intend to keep the content of this document dynamic and current, and we will be happy to periodically incorporate any updated information and literature references. Please feel free to send in your suggestions. Please address e-mail to [george.burba\(at\)licor.com](mailto:george.burba@licor.com) with subject “EC Guidelines”.

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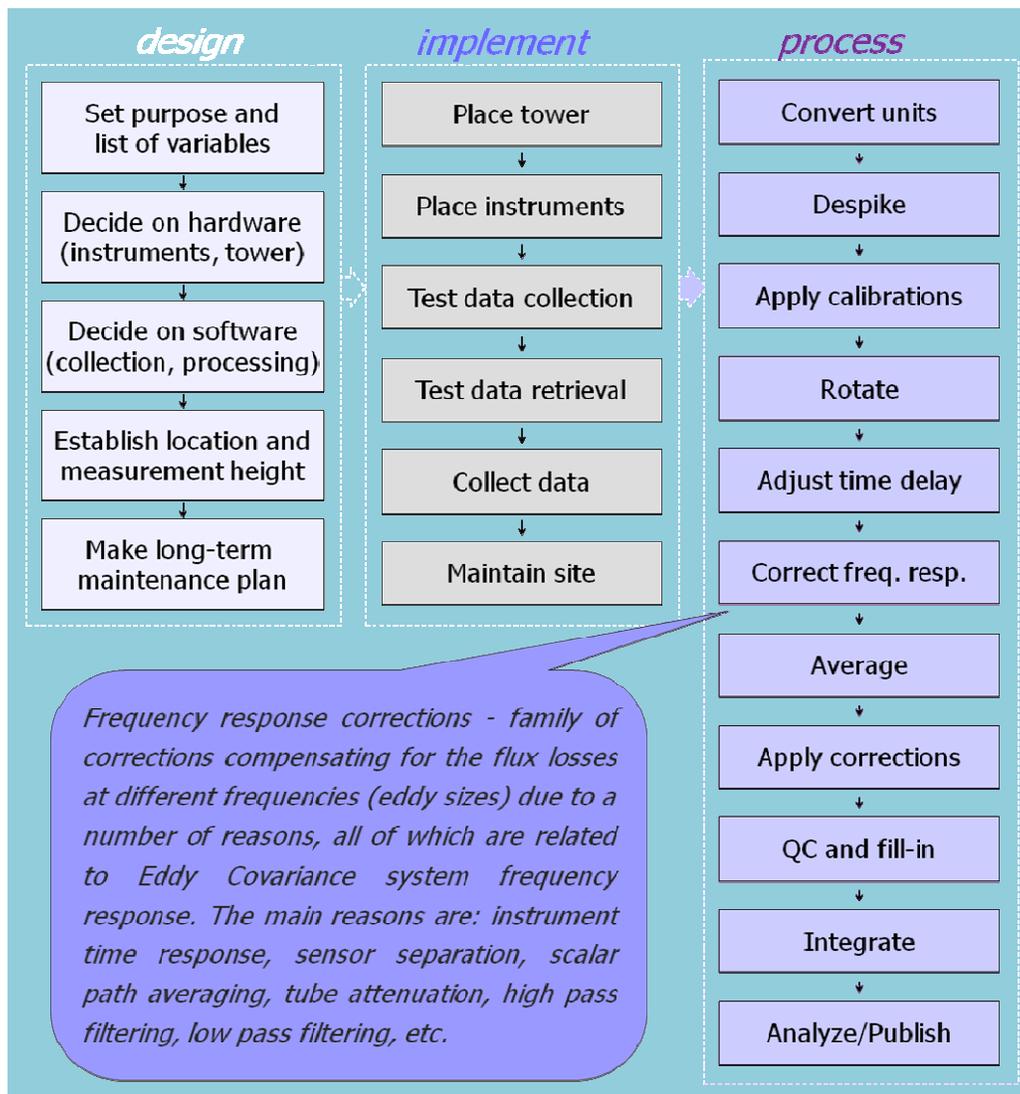


Figure. 1 Example of the typical workflow for Eddy Covariance flux measurements.