

# Preface

Ever since the humble beginnings of micrometeorology over 50 years ago, micrometeorologists have pondered over ways in which to best measure surface-atmosphere exchange at non-ideal sites. In setting up their instrumentation to ensure the highest integrity of data quality, micrometeorologists went to great lengths seeking to eliminate upwind obstacles suspected to adversely degrade the quality of their dataset. Constantly present in the mind of these early pioneers, the problematic determination of the range of the upwind coverage covered by an atmospheric measurement was an ever present concern on their mind. Pasquill however, in his groundbreaking work of 1961 developed a series of empirical guidelines aimed at identifying the source area.

While *a priori* this may appear to be a moot point for non-micrometeorologists, a sensor in the atmosphere does not measure the properties at the point where the sensor is located. Indeed, the sensor measurement reflects the scalar and dynamic properties of eddies embedded in the flow advected past an atmospheric sensor, while an atmospheric flux represents the correlation of the properties of eddies going past the flux system and their vertical wind velocity. Both concentration and flux measurements are the product of a spatial average over the path length of the sensor/flux system and a temporal average dictated by the measurement period (typically 30-min period).

Since the inception of micrometeorological research up until the 1980s, experimentalists limited the scope of their measurements to smooth, flat terrain covering extending homogeneous areas. This state-of-affairs was then to undergo a profound transformation in the mid-1980s with the arrival of a fortuitous combination of cheap computers, the production of affordable data acquisition systems and data loggers and, above all, with the arrival of affordable, fast response sonic anemometers/thermometers that the common use as we know it today surfaced. These modern measurement systems then opened the door to a vast and rapid expansion of the field of micrometeorology, leading experimentalists to move into forays of considerable challenge: the scientific community relaxed their restrictions of limiting their efforts to quasi-idealized terrain to then shift their focus to frequently encountered terrain or over surfaces presenting much need in assessing atmosphere-exchange. It is then that, for the first time, measurements over tall forested canopies and over mosaic-like terrain grew to become the norm rather than the exception.

Furthermore, these techniques were soon adopted by scientists outside the meteorological community: the deceptive ease of use of the eddy-covariance technique opened the door to a myriad of experiments in the field of ecology and became extensively used at difficult sites. The footprint concept was developed in an attempt to provide leadership in this rapidly expanding field.

Why are we writing this book, the reader might well ask: With the recent and rapid proliferation of papers in the field of eddy-covariance essential, either pertaining to or resorting to the use of eddy-covariance, there has yet to be a full comprehensive ‘manual’ summarizing from the ground up the plethora of ways estimating footprints. We have wanted to provide a comprehensive yet easy-to-use guide to those unfamiliar with the concept. We have thus included the rudiments of micrometeorology along with measurement methods. Furthermore, the present book also offers a fresh insight into practical applications like tall tower measurements, wind power investigations, and air pollution issues.

The idea of writing this ‘field manual’ was spurred by the preparation of the special issue of *Agricultural and Forest Meteorology* in 2004 edited by Timo Vesala, Ullar Rannik, and colleagues including but not limited to John Finnigan, Dennis Baldocchi, Xuhui Lee, and many others; this special issue, along with the recent productions of three overviews by Vesala et al. (2008, 2010) and Rannik et al. (2012) into non-traditional readership further demonstrated the relevance of the present endeavor. This manual on footprints should provide a solid well-rounded foundation establishing the basis for robust flux experiments (tower positioning, height of measurements, difficulties with upstream inhomogeneous surfaces, and related errors) and their subsequent interpretation especially when used with the *Handbook on Micrometeorology* (Lee et al. 2004) and the recently published book on *Eddy-Covariance* (Aubinet et al. 2012).

The reader should forgive a personal note of [Chap. 1](#). These views have formed after more than 25 years in the field. Despite this, one point should be emphasized: Writing this book was only possible thanks to the wonderful cooperation of many scientists in common projects and in the preparation of joint papers, overview papers, and book chapters. We want to thank them all; the list is extremely long as the references sections will attest.

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