

# Footprint area generating based on eddy covariance records

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**Abstract:** Energy flux and evapotranspiration modeling via the widely used two-source energy balance (TSEB) model at a subfield scale for vineyards based on the high-resolution images gained by the small Unmanned Aerial System (sUAS) is a critical tool for vine-growers and researchers to better understand the water and energy exchange between the land surface and air. The footprint area of the eddy-covariance (EC) tower is a crucial factor that can provide an efficient and effective channel for verification of modeling results (e.g., evapotranspiration and energy components). This project provides an efficient way to search parameters from the available dataset provided by the Grape Remote sensing Atmospheric Profiling and Evapotranspiration eXperiment (GRAPEX) team according to the AggieAir (<https://uwrl.usu.edu/aggieair/>, a type of sUAS) flight time, which can help in footprint area calculation. The list of footprint areas generated are intended to efficiently support research and promote a better understanding of the water and energy exchange. This project is also a part of our pending paper. Other researchers can also consider using this project if the available data are similar.

**Keywords:** Footprint area; EC tower; TSEB model; Energy components; Evapotranspiration partitioning; sUAS; Python

## Brief Introduction

This project supports our pending paper called “LAI estimation across California vineyards using sUAS multi-seasonal multi-spectral, thermal, and elevation information and machine learning.” Details about the concept of the footprint area can be found in this pending paper. This project (manual and/or example) explains how we extracted parameters from the processed eddy covariance (EC) data, a part of the Grape Remote sensing Atmospheric Profiling and Evapotranspiration eXperiment (GRAPEX) research products, and how we generated a list of footprint areas based on the extracted parameters.

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Three folders are included in this project: “1\_Data,” “2\_Script,” and “3\_ Results.” One DOCX file called “ReadME.docx” (the document you are reading now) briefly explained how users can duplicate our processes or even develop the scripts. Users must learn how to use the required libraries successfully on their own. Details about each folder are presented in each section below.

## **1\_Data**

Demo data are listed in 2 EXCEL files in this folder.

Since the original data provided by the GRAPEX team is heavy, only a small part of the processed EC-tower data was clipped and saved in this folder as demo data: “GRAPEX\_EC\_Tower\_Demo.xlsx.”

“Request\_Demo.xlsx” contains the AggieAir small Unmanned Aerial System flight information. Because our research is based on the high-resolution data gathered via the AggieAir platform (<https://uwrl.usu.edu/aggieair/>) and the data provided by the EC tower can be used for validation, the parameters listed in this EXCEL file can be the link for the corresponding script to search the corresponding parameters from the “GRAPEX\_EC\_Tower\_Demo.xlsx” file.

“Time\_flight” is the exact AggieAir flight time, and the “Time\_EC” that is closest to the flight time is recognized as the index to search for corresponding information from the EC-tower processed data (“GRAPEX\_EC\_Tower\_Demo.xlsx”). “Time\_EC” represents the time of the EC-tower records, which can only be on the hour or half hour. Because the EC-tower only provides processed data on the half hour between two neighboring hours, interpretation was done on the hour based on the two neighboring half hours. “Time\_EC” was approximated based on the “Time\_flight,” which represents the AggieAir flight time.

## **2\_Scripts**

This folder contains 2 scripts.

“EC\_Tower\_Extraction\_HYD.ipynb” is used to extract parameters required by the footprint-area calculation from the EXCEL file provided by the GRAPEX project.

“Footprint\_Area\_Calculation\_HYD.ipynb” is used to generate a list of footprint areas based on the result, a CSV file, generated from the previous programming.

Running “Footprint\_Area\_Calculation\_HYD.ipynb” requires a valid account (license) in the ArcGIS organization.

## **3\_Results**

“OUT\_Extracted.csv” is the result from the script, “EC\_Tower\_Extraction\_HYD.ipynb.”

3 TIF files are the footprint areas according to the parameters included in the CSV file calculated through the script, “Footprint\_Area\_Calculation\_HYD.ipynb.”

## **Acknowledgement**

This project was possible thanks to support from NASA Grant NNX17AF51G and the Utah Water Research Laboratory Student Fellowship. The authors are also grateful for the extraordinary support from the Utah State University AggieAir sUAS program staff and E&J Gallo scientific teams for data

collection support and analysis. The authors would like to thank Carri Richards for editing the manual. USDA is an equal opportunity provider and employer.

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Any feedback, comments and suggestions are welcome.