D05 FIU Site Characterization
Supporting Data

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See Configuration Management System for approval history.

Change Record

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B	09/26/2011	ECO-000279	Update to new document number's/template throughout document.

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1 DESCRIPTION

1.1 Purpose

Data collected, analyzed and described here are used to inform the site design activities for NEON project Teams: EHS (permitting), FCC, ENG and FSU. This report was made based on actual site visit to the 3 NEON sites in Domain 05. This document presents all the supporting data for FIU site characterization at D05.

1.2 Scope

FIU site characterization data and analysis results presented in this document are for the three D05 tower locations: University of Notre Dame Environmental Research Center (UNDERC, Advanced), Steigerwaldt Land Services Relocatable site (Relocatable 1), and Tree Haven Relocatable site (Relocatable 2). Issues and concerns for each site that need further review are also addressed in this document according to our best knowledge.

Disclaimer: all latitude and longitude points are subject to the tolerances of our measurement system, i.e., GPS.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.011008 _ FIU Tower Design Science Requirements
AD[02]	NEON.DOC.011000 _ FIU Technical and Operation Requirements
AD[03]	
AD[04]	NEON.DOC.011029 _ FIU Precipitation Collector Site Design Requirements

2.2 Reference Documents

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]		
RD[04]		

2.3 Acronyms

2.4 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 UNIVERSITY OF NOTRE DAME ENVIRONMENTAL RESEARCH CENTER (UNDERC, ADVANCED TOWER SITE)

3.1 Site description

NEON UNDERC candidate advanced tower site (46.23259389°, -89.54531065°) was located within University of Notre Dame Environmental Research Center (UNDERC) property (Figure 1). After FIU site characterization, we microsited the tower location for ~635 m toward Northeast at 46.23388°, -89.53725° to maximize the tower fetch area from the same forest type (sugar maple dominant forest) and avoid the impacts of the Roach Lake on the local microclimate measurements. The microsited tower location is immediately west of a large snag.

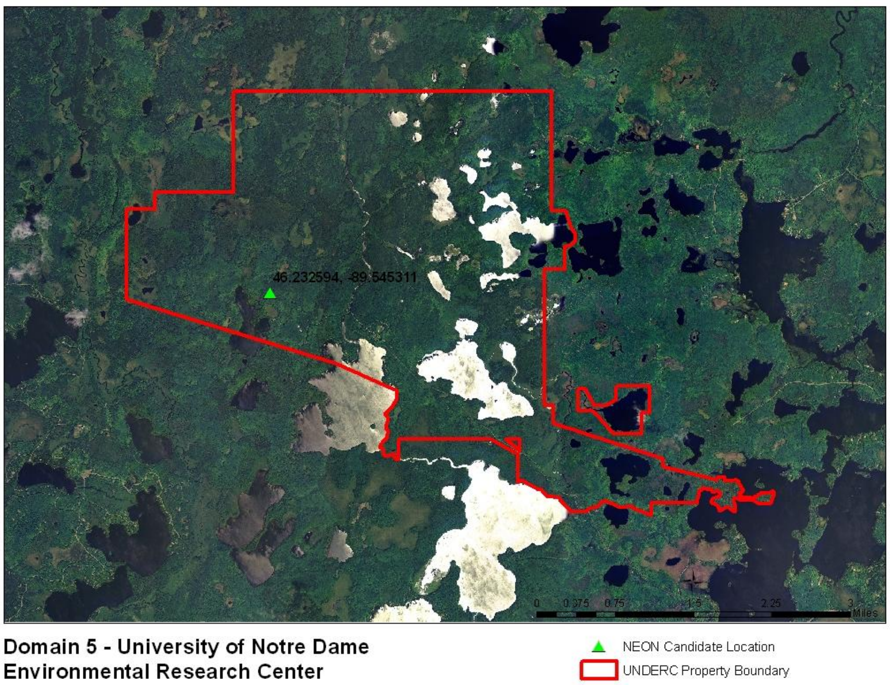


Figure 1. NEON candidate site tower location and boundary map

According to http://www.nd.edu/~underc/east/about/, "The University of Notre Dame Environmental Research Center encompasses approximately 7500 acres on both sides of the state line between Wisconsin and Michigan's Upper Peninsula in Vilas County (Wisconsin) and Gogebic County (Michigan). It includes a land area of 6150 acres and 30 lakes and bogs with a combined surface area of 1350 acres. Open water within the preserve accounts for about 16% of the total area. Twenty-six of the aquatic habitats lie entirely on the property. The center of the UNDERC site is at 46' 13' North by 89' 32' West. The altitude of the area ranges between 1640 ft (500 m) and 1700 ft (520 m)."

"To avoid disturbance to ongoing research operations and the many sensitive habitats on the property, access is strictly controlled. Locked gates protect all roads into the property and unauthorized entry by foot or vehicle is prohibited"

"Among the aquatic habitats that lie wholly on the property are nine dystrophic bogs, many permanent ponds and small lakes, and several marsh habitats. During May and June, many vernal ponds exist on the property. Mosquito populations in many of these ponds have been surveyed annually for more than 20 years by students and researchers associated with the Notre Dame Vector Biology Laboratory. This great diversity of habitats makes UNDERC an excellent location for both aquatic and terrestrial studies."

"The UNDERC property is bounded on three sides by units of the Ottawa National Forest. In addition to hiking and camping, the national forest includes many riverine and lacustrine habitats available for collecting. Aquatic insects are particularly abundant both on and off the property. Three streams traverse the property, Tenderfoot Creek for 3 miles (4.8 km), Brown Creek for 1.1 miles (1.7 km), and Orchard Creek for 0.25 miles (0.4 km). Brown and Tenderfoot creeks are within the Ontonagon River drainage basin. Orchard Creek is part of the Presque Isle River drainage. On the property, these are mostly headwater streams. However, to the north, on their descent to Lake Superior, these streams become torrents that provide a great diversity of both rapids and pool habitats."

According to http://www.nd.edu/~underc/east/about/visitors_guide.shtml: "Climatological maps classify the region as "humid microthermal" which is no dry season with cold winters and cool, long summers. Average temperatures in January range from -4°F (-20°C) to 14°F (-10°C). In general, the lakes on the property are clear of ice by the last week of April, but ice can remain as late as May 15."

"Average temperatures in July range from 61°F (16°C) to 70°F (21°C), although it may get quite warm in protected, low lying areas. The relative humidity during July averages 60 to 70%. Dominant winds come out of the west."

"Annual precipitation ranges between 20" (50 cm) and 40" (100 cm) of snow and rain. The region has more than 1" (2.5 cm) of snow cover for over 120 days in an average year. The first frost of the fall usually occurs around September 21, although frosts can occur during any month of the year. During late October or early November, the lakes freeze over until the following May. Ice may attain thicknesses in excess of 32" (82 cm)."

Additional information about UNDERC can be found at: http://www.nd.edu/~underc/east/

3.2 Ecosystem

Vegetation and land cover information at surrounding region are presented below:

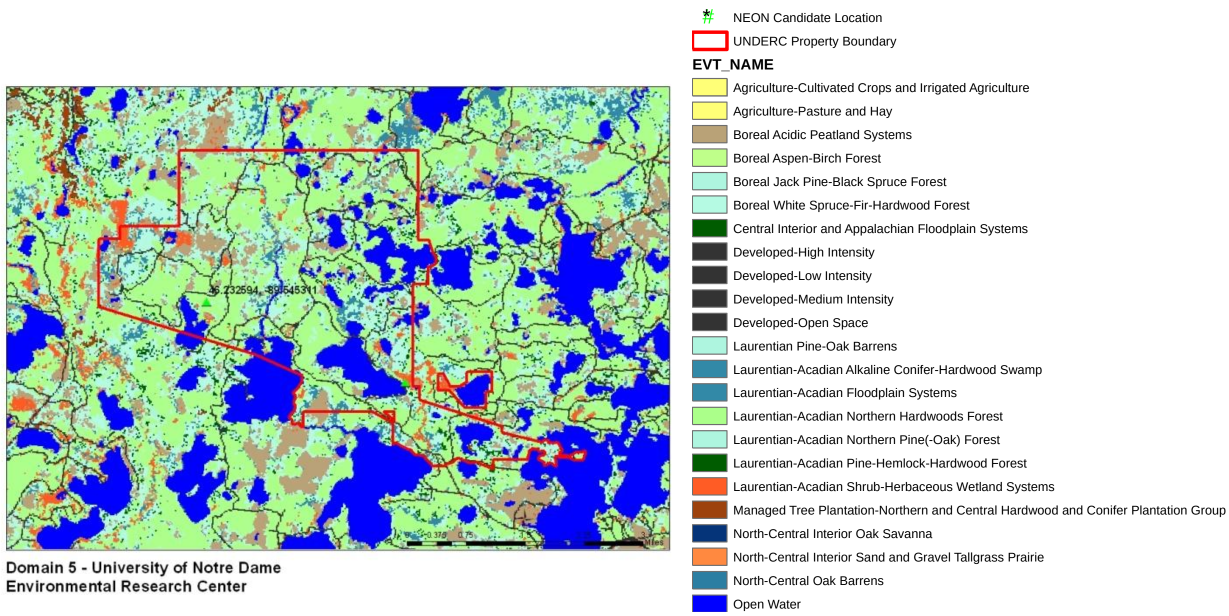


Figure 2. Vegetative cover map of UNDERC tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 1. Percent Land cover type at UNDERC Advance site
(information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	Area (km^2)	Percentage
Open Water	4.24	14.43
Developed-Open Space	1.57	5.33
Boreal Aspen-Birch Forest	0.08	0.27
Laurentian-Acadian Northern Hardwoods Forest	10.92	37.17
Boreal Jack Pine-Black Spruce Forest	0.00	0.00
Laurentian-Acadian Northern Pine(-Oak) Forest	0.23	0.77
Boreal White Spruce-Fir-Hardwood Forest	6.63	22.56
Laurentian-Acadian Pine-Hemlock-Hardwood Forest	0.65	2.20
Laurentian Pine-Oak Barrens	0.04	0.12
Laurentian-Acadian Floodplain Systems	0.14	0.48
Boreal Acidic Peatland Systems	3.03	10.30
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	1.15	3.92
Laurentian-Acadian Shrub-Herbaceous Wetland Systems	0.70	2.38
Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group	0.02	0.06
total area sq km	29.38	100.00

The ecosystem around and in the NEON tower airshed at this site is northern hardwood forest dominated by sugar maple (Figure 3). Sugar maple forest is uniform in age and height, and is distributed in most of the area from SSE to west of the tower. The terrain is relatively flat, although several small drainage channels exist and it may experience some cold air drainage. Sugar maple forest canopy height is ~ 24 m. Dense sugar maple seedlings cover forest floor with height ~ 0.3 m. Very few trees/shrubs are found between this seedling understory and tree canopy. There was some course woody debris on the forest floor, but not so much to make walking around difficult.

There are a large number of ponds and vernal ponds in the vicinity of the tower. In addition, a small wetland (50 m in diameter) lies NE ~100 m to tower with standing water, which contains spruce and/or hemlock. East area and partial southeast airshed areas are wetter. Forest is less dense and tree composition changes to conifer dominated. Ferns are commonly found on the forest floor of these wetter areas.

Figure 3. Sugar maple forest is the dominated ecosystem at UNDERC Advanced site

Table 2. Ecosystem and site attributes for UNDERC Advanced tower site.

Ecosystem attributes	Measure and units
Mean canopy height	24 m
Surface roughness[a]	2 m
Zero place displacement height[a]	20 m
Structural elements	Closed deciduous forest, uniform
Time zone	central time zone
Magnetic declination	2° 44' W changing by 0° 5' W/year

Note, [a] From field observation.

3.3 Soils

3.3.1 Soil description

Soil data and soil maps (Figures 4) below for the UNDERC Advanced tower site were collected from 2.9 km^2 NRCS soil maps(http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm), which centered at the tower location, to determine the dominant soil types in the larger tower foot print. This was done to assure that the soil array is in the dominant (or in the co-dominant) soil type present in the tower footprint.

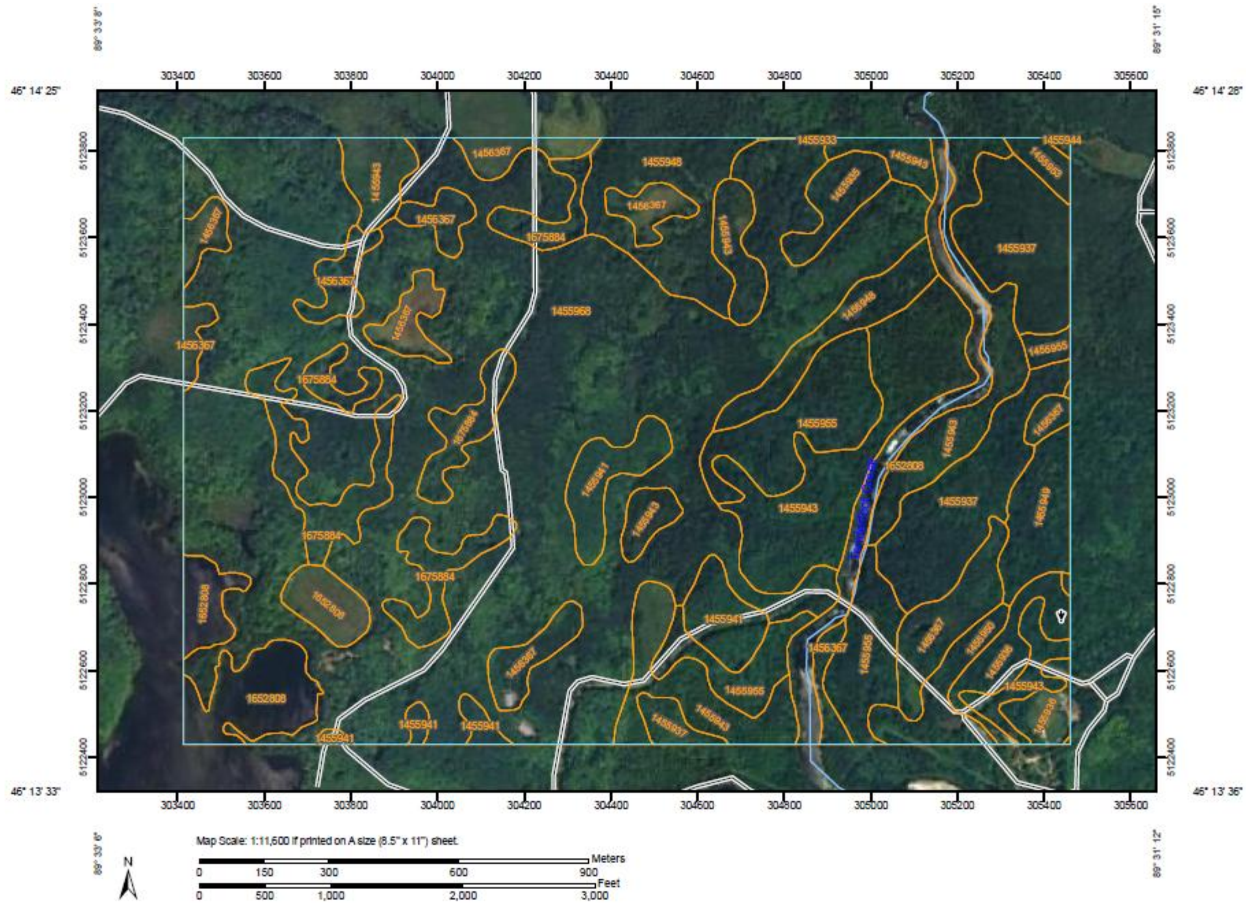


Figure 4. 2.9 km^2 soil map for the UNDERC NEON advanced tower site.

Map Unit Description The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils. Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called non-contrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soil types or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas. An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a soil series. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series. Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups. A complex consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example. An association is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example. An undifferentiated group is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, are an example. Some surveys include miscellaneous areas. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Table 3. Soil Series and percentage of soil series within 2.9 km^2.
Area Object Interest (AOI) is the mapping unit from NRCS.

Gogebic County Area, Michigan, and Gogebic County, Michigan			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1455933	Beechwood muck, 0 to 4 percent slopes	0.2	0.0%
1455935	Gogebic-Tula-Lupton complex, 0 to 6 percent slopes	7.2	1.0%
1455936	Gogebic fine sandy loam, sandy substratum, 1 to 6 percent slopes, stony	13.0	1.8%
1455937	Gogebic fine sandy loam, sandy substratum, 6 to 18 percent slopes, stony	44.6	6.3%
1455941	Gogebic silt loam, sandy substratum, 18 to 35 percent slopes, stony	19.1	2.7%
1455943	Lupton-Pleine-Cathro complex, 0 to 1 percent slopes	92.4	13.1%
1455944	Ausable, frequently flooded-Tawas complex, 0 to 1 percent slopes	0.4	0.1%
1455948	Karlin-Keweenaw-Sarona, dense substratum, complex, 1 to 6 percent slopes	32.0	4.5%
1455949	Karlin-Keweenaw-Sarona, dense substratum, complex, 6 to 25 percent slopes	11.4	1.6%
1455950	Karlin-Keweenaw-Sarona, dense substratum, complex, 25 to 50 percent slopes	9.0	1.3%
1455953	Amasa-Karlin complex, esker, 35 to 55 percent slopes	2.8	0.4%
1455955	Karlin, very deep water table-Noseum-Gay complex, 0 to 6 percent slopes	40.9	5.8%
1455967	Gogebic, sandy substratum-Pence-Cathro complex, 0 to 6 percent slopes	0.0	0.0%
1455968	Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes	314.5	44.4%
1456367	Dawson, Greenwood, and Loxley soils, 0 to 1 percent slopes	47.4	6.7%
1652808	Water	40.6	5.7%
1675884	Gay-Pleine complex, 0 to 1 percent slopes, stony	32.8	4.6%
Totals for Area of Interest		**708.2**	**100.0%**

Gogebic County, Michigan 46E—Amasa-Karlin complex, esker, 35 to 55 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Amasa and similar soils: 52 percent Karlin and similar soils: 38 percent **Description of Amasa Setting** Landform: Eskers Landform position (two-dimensional): Backslope, shoulder, summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Coarse-loamy glaciofluvial deposits over sandy and gravelly glaciofluvial deposits **Properties and qualities** Slope: 35 to 55 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.3 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 1 inches: Moderately decomposed plant material 1 to 4 inches: Cobbly silt loam 4 to 7 inches: Silt loam 7 to 23 inches: Very fine sandy loam 23 to 28 inches: Fine sandy loam 28 to 41 inches: Sand 41 to 80 inches: Very gravelly sand **Description of Karlin Setting** Landform: Eskers Landform position (two-dimensional): Summit, shoulder, backslope Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 35 to 45 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.8 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Tsuga Maianthemum (TM_1), Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 29 inches: Sand 29 to 80 inches: Sand

Gogebic County, Michigan 42—Ausable, frequently flooded-Tawas complex, 0 to 1 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Ausable and similar soils: 70 percent Tawas and similar soils: 25 percent **Description of Ausable Setting** Landform: Flood plains Landform position (three-dimensional): Dip Down-slope shape: Linear Across-slope shape: Linear Parent material: Organic material over sandy alluvium **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: Frequent Frequency of ponding: None Available water capacity: Moderate (about 6.0 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Fraxinus Mentha Carex - Caltha (FMC-C) **Typical profile** 0 to 8 inches: Muck 8 to 16 inches: Sand 16 to 25 inches: Stratified muck to sand to loamy fine sand 25 to 36 inches: Very gravelly sand 36 to 45 inches: Very gravelly sand 45 to 80 inches: Very gravelly coarse sand **Description of Tawas Setting** Landform: Swamps on till plains Landform position (three-dimensional): Dip Down-slope shape: Linear Across-slope shape: Linear Parent material: Highly decomposed organic material over sandy drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: High (about 11.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Fraxinus Mentha Carex - Caltha (FMC-C) **Typical profile** 0 to 22 inches: Muck 22 to 42 inches: Sand 42 to 80 inches: Gravelly sand

Gogebic County, Michigan 35A—Beechwood muck, 0 to 4 percent slopes Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Beechwood and similar soils: 85 percent **Description of Beechwood Setting** Landform: End moraines, ground moraines, interdrumlins Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Modified loamy eolian deposits over coarse-loamy till **Properties and qualities** Slope: 0 to 4 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr) Depth to water table: About 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: High (about 10.1 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Tsuga Maianthemum Coptis - Dryopteris (TMC-D_1), Tsuga Maianthemum Coptis (TMC_1) **Typical profile** 0 to 6 inches: Muck 6 to 8 inches: Silt loam 8 to 10 inches: Loam 10 to 20 inches: Fine sandy loam 20 to 28 inches: Fine sandy loam 28 to 42 inches: Fine sandy loam 42 to 80 inches: Fine sandy loam

Gogebic County, Michigan 28—Dawson, Greenwood, and Loxley soils, 0 to 1 percent slopes Map Unit Setting Elevation: 590 to 1,800 feet Mean annual precipitation: 25 to 34 inches Mean annual air temperature: 37 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Dawson and similar soils: 40 percent Greenwood and similar soils: 35 percent Loxley and similar soils: 20 percent **Description of Dawson Setting** Landform: Depressions on outwash plains, depressions on moraines, depressions on lake plains Down-slope shape: Concave Across-slope shape: Concave Parent material: Hemic organic material over sapric organic material over sandy glaciofluvial deposits **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 16.6 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Picea Chamaedaphne Sphagnum (PCS_2) **Typical profile** 0 to 4 inches: Peat 4 to 9 inches: Mucky peat 9 to 34 inches: Muck 34 to 36 inches: Loamy sand 36 to 39 inches: Sand 39 to 50 inches: Sand 50 to 62 inches: Sand **Description of Greenwood Setting** Landform: Depressions on outwash plains, depressions on moraines, depressions on lake plains Down-slope shape: Concave Across-slope shape: Concave Parent material: Herbaceous organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 31.8 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Picea Chamaedaphne Sphagnum (PCS_2) **Typical profile** 0 to 8 inches: Peat 8 to 11 inches: Muck 11 to 65 inches: Mucky peat 65 to 80 inches: Mucky peat **Description of Loxley Setting** Landform: Depressions on outwash plains, depressions on moraines, depressions on lake plains Down-slope shape: Concave Across-slope shape: Concave Parent material: Herbaceous organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 26.5 inches) **Interpretive groups** Land capability classification (irrigated): 7w Land capability (nonirrigated): 7w Other vegetative classification: Picea Chamaedaphne Sphagnum (PCS_2) **Typical profile** 0 to 5 inches: Peat 5 to 26 inches: Muck 26 to 45 inches: Muck 45 to 80 inches: Mucky peat

Gogebic County, Michigan 36—Gay-Pleine complex, 0 to 1 percent slopes, stony: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Gay and similar soils: 58 percent Pleine and similar soils: 30 percent **Description of Gay Setting** Landform: Depressions on till plains Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties**

and qualities Slope: 0 to 1 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Moderate (about 8.1 inches) **Interpretive groups** Land capability (nonirrigated): 5w Other vegetative classification: Fraxinus Impatiens (FI_1) **Typical profile** 0 to 4 inches: Muck 4 to 7 inches: Fine sandy loam 7 to 11 inches: Sandy loam 11 to 16 inches: Sandy loam 16 to 30 inches: Sandy loam 30 to 80 inches: Sandy loam **Description of Pleine Setting** Landform: Drainageways Landform position (three-dimensional): Dip Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties and qualities** Slope: 0 to 1 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: High (about 11.7 inches) **Interpretive groups** Land capability (nonirrigated): 5w Other vegetative classification: Fraxinus Impatiens - Caltha (FI-C), Fraxinus Impatiens (FI_1) **Typical profile** 0 to 9 inches: Very cobbly muck 9 to 20 inches: Very fine sandy loam 20 to 33 inches: Fine sandy loam 33 to 80 inches: Gravelly sandy loam

Gogebic County, Michigan 5172B—Gogebic, sandy substratum-Pence-Cathro complex, 0 to 6 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 27 to 43 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 145 days **Map Unit Composition** Gogebic, sandy substratum, and similar soils: 60 percent Pence and similar soils: 15 percent Cathro and similar soils: 15 percent **Description of Gogebic, Sandy Substratum Setting** Landform: Till plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 2 to 6 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 4s Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Fine sandy loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly sand **Description of Pence Setting** Landform: Moraines Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy alluvium underlain by sandy and gravelly glacial outwash **Properties and qualities** Slope: 0 to 6 percent Surface area covered with cobbles, stones or boulders: 1.5 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.1 inches) **Interpretive groups** Land capability classification (irrigated): 2e Land capability (nonirrigated): 4s Other vegetative classification: Tsuga Maianthemum Vaccinium (TMV_1), Acer Quercus Vaccinium (AQV_1) **Typical profile** 0 to 2 inches: Moderately decomposed plant material 2 to 6 inches: Fine sandy loam 6 to 9 inches: Fine sandy loam 9 to 13 inches: Fine sandy loam 13 to 16 inches: Loamy coarse sand 16 to 31 inches: Coarse sand 31 to 80 inches: Stratified gravelly coarse sand to sand

Description of Cathro Setting Landform: Depressions on disintegration moraines, drainageways on disintegration moraines Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Herbaceous organic material 16 to 51 inches thick underlain by loamy deposits **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 30 percent Available water capacity: Very high (about 16.5 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Tsuga-Thuja-Mitella (TTM_2), Fraxinus Impatiens (FI_1) **Typical profile** 0 to 6 inches: Muck 6 to 31 inches: Muck 31 to 80 inches: Fine sandy loam

Gogebic County, Michigan 5172C—Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 27 to 43 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 145 days **Map Unit Composition** Gogebic, sandy substratum, and similar soils: 60 percent Cathro and similar soils: 15 percent Pence and similar soils: 15 percent **Description of Gogebic, Sandy Substratum Setting** Landform: Till plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 6 to 18 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6s Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Fine sandy loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly sand **Description of Cathro Setting** Landform: Depressions on disintegration moraines, drainageways on disintegration moraines Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Herbaceous organic material 16 to 51 inches thick underlain by loamy deposits **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 30 percent Available water capacity: Very high (about 16.5 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Fraxinus Impatiens (FI_1), Tsuga- Thuja-Mitella (TTM_2) **Typical profile** 0 to 6 inches: Muck 6 to 31 inches: Muck 31 to 80 inches: Fine sandy loam **Description of Pence Setting** Landform: Moraines Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy alluvium underlain by sandy and gravelly glacial outwash **Properties and qualities** Slope: 6 to 18 percent Surface area covered with cobbles, stones or boulders: 1.5 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.1 inches) **Interpretive groups** Land capability classification (irrigated): 2e Land capability (nonirrigated): 6s Other vegetative classification: Tsuga Maianthemum Vaccinium (TMV_1), Acer Quercus Vaccinium (AQV_1) **Typical profile** 0 to 2 inches: Moderately decomposed plant material 2 to 6 inches: Fine sandy loam 6 to 9 inches: Fine sandy loam 9 to 13 inches: Fine sandy loam 13 to 16 inches: Loamy coarse sand 16 to 31 inches: Coarse sand 31 to 80 inches: Stratified gravelly coarse sand to sand

Gogebic County, Michigan 38B—Gogebic fine sandy loam, sandy substratum, 1 to 6 percent slopes, stony: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Gogebic, sandy substratum, and similar soils: 95 percent **Description of Gogebic, Sandy Substratum Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 1 to 6 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 4e Other vegetative classification: Acer Viola Osmorhiza (AVO_1), Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Fine sandy loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly sand

Gogebic County, Michigan 38C—Gogebic fine sandy loam, sandy substratum, 6 to 18 percent slopes, stony: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Gogebic, sandy substratum, and similar soils: 95 percent **Description of Gogebic, Sandy Substratum Setting** Landform: Till plains Landform position (two-dimensional): Summit, toeslope, shoulder, backslope, footslope Landform position (three-dimensional): Nose slope, side slope, interfluve, base slope, head slope, crest Down-slope shape: Linear Across-slope shape: Convex, linear Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 6 to 18 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Fine sandy loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly sand

Gogebic County, Michigan 39D—Gogebic silt loam, sandy substratum, 18 to 35 percent slopes, stony: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Gogebic, sandy substratum, and similar soils: 85 percent **Description of Gogebic, Sandy Substratum Setting** Landform: Till plains Landform position (two-dimensional): Summit, toeslope, shoulder, backslope, footslope Landform position (three-dimensional): Interfluve, base slope, head slope, crest, nose slope, side slope Down-slope shape: Convex, linear Across-slope shape: Concave, convex Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 18 to 35 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Silt loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly sand

Gogebic County, Michigan 37B—Gogebic-Tula-Lupton complex, 0 to 6 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Gogebic and similar soils: 51 percent Tula and similar soils: 31 percent Lupton and similar soils: 15 percent **Description of Gogebic Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Modified loamy eolian deposits over loamy till over sandy till **Properties and qualities** Slope: 1 to 6 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: 18 to 36 inches to fragipan Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 12 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Tsuga Maianthemum Coptis - Dryopteris (TMC-D_1), Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 1 inches: Slightly decomposed plant material 1 to 5 inches: Silt loam 5 to 8 inches: Silt loam 8 to 12 inches: Silt loam 12 to 20 inches: Fine sandy loam 20 to 33 inches: Gravelly fine sandy loam 33 to 49 inches: Fine sandy loam 49 to 54 inches: Fine sandy loam 54 to 68 inches: Fine sandy loam 68 to 80 inches: Gravelly fine sandy loam **Description of Tula Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Modified loamy eolian deposits over loamy till **Properties and qualities** Slope: 0 to 3 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: 15 to 30 inches to fragipan Drainage class: Somewhat poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: About 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.9 inches) **Interpretive groups** Land capability (nonirrigated): 2w Other vegetative classification: Tsuga Maianthemum Coptis (TMC_1), Acer Viola Osmorhiza - Circaea Impatiens (AVO-CI_3) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 5 inches: Cobbly very fine sandy loam 5 to 8 inches: Cobbly very fine sandy loam 8 to 20 inches: Cobbly very fine sandy loam 20 to 28 inches: Gravelly sandy loam 28 to 37 inches: Gravelly sandy loam 37 to 62 inches: Gravelly loam 62 to 80 inches: Gravelly sandy loam **Description of Lupton Setting** Landform: Swamps on till plains Landform position (three-dimensional): Dip Down-slope shape: Linear Across-slope shape: Linear Parent material: Highly decomposed organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about

23.9 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Tsuga Thuja Sphagnum (TTS_1), Tsuga Thuja Mitchella (TTM_1) **Typical profile** 0 to 20 inches: Muck 20 to 80 inches: Muck

Gogebic County, Michigan 47B—Karlin, very deep water table-Noseum-Gay complex, 0 to 6 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Karlin, very deep water table, and similar soils: 41 percent Noseum and similar soils: 35 percent Gay and similar soils: 16 percent **Description of Karlin, Very Deep Water Table Setting** Landform: Outwash plains, moraines Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 0 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: About 94 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.8 inches) **Interpretive groups** Land capability (nonirrigated): 3s Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 29 inches: Sand 29 to 80 inches: Sand **Description of Noseum Setting** Landform: Outwash plains, moraines Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Loamy outwash over sandy outwash **Properties and qualities** Slope: 0 to 3 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: About 24 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.3 inches) **Interpretive groups** Land capability (nonirrigated): 4s Other vegetative classification: Tsuga-Maianthemum-Coptis Vaccinium phase (TMC-Vac_2) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Fine sandy loam 4 to 6 inches: Fine sandy loam 6 to 14 inches: Fine sandy loam 14 to 24 inches: Loamy sand 24 to 37 inches: Sand 37 to 63 inches: Fine sand 63 to 80 inches: Sand **Description of Gay Setting** Landform: Depressions on till plains Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties and qualities** Slope: 0 to 2 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Moderate (about 8.1 inches) **Interpretive groups** Land capability (nonirrigated): 5w Other vegetative classification: Tsuga Maianthemum Coptis (TMC_1) **Typical profile** 0 to 4 inches: Muck 4 to 7 inches: Fine sandy loam 7 to 11 inches: Sandy loam 11 to 16 inches: Sandy loam 16 to 30 inches: Sandy loam 30 to 80 inches: Sandy loam

Gogebic County, Michigan 44B—Karlin-Keweenaw-Sarona, dense substratum, complex, 1 to 6 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Karlin and similar soils: 36 percent Keweenaw and similar soils: 30 percent Sarona, dense substratum, and similar soils: 25 percent **Description of Karlin Setting** Landform: Outwash plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.8 inches) **Interpretive groups** Land capability (nonirrigated): 3s Other vegetative classification: Tsuga Maianthemum (TM_1), Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 29 inches: Sand 29 to 80 inches: Sand **Description of Keweenaw Setting** Landform: Ground moraines Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 1 to 6 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.7 inches) **Interpretive groups** Land capability classification (irrigated): 3e Land capability (nonirrigated): 2e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 2 inches: Highly decomposed plant material 2 to 4 inches: Loamy sand 4 to 6 inches: Loamy fine sand 6 to 25 inches: Loamy fine sand 25 to 45 inches: Stratified sand to fine sand to loamy fine sand to loamy very fine sand 45 to 56 inches: Stratified loamy fine sand to fine sand to fine sandy loam 56 to 71 inches: Stratified loamy fine sand to fine sand to fine sandy loam 71 to 90 inches: Stratified loamy fine sand to fine sandy loam **Description of Sarona, Dense Substratum Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: 61 to 79 inches to dense material Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 8.3 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 3 inches: Sandy loam 3 to 6 inches: Fine sandy loam 6 to 14 inches: Fine sandy loam 14 to 21 inches: Fine sandy loam 21 to 28 inches: Sandy loam 28 to 47 inches: Loamy sand 47 to 75 inches: Loamy sand 75 to 90 inches: Loamy sand

Gogebic County, Michigan 44C—Karlin-Keweenaw-Sarona, dense substratum, complex, 6 to 25 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Karlin and similar soils: 36 percent Keweenaw and similar soils: 30 percent Sarona, dense substratum, and similar soils: 25 percent **Description of Karlin Setting** Landform: Outwash plains Landform position (two-dimensional): Footslope, summit, toeslope, shoulder, backslope Landform position (three-dimensional): Head slope, crest, nose slope, side slope, interfluve, base slope Down-slope shape: Linear Across-slope shape: Convex, linear Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 6 to 25 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.8 inches) **Interpretive groups** Land capability (nonirrigated): 6e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 29 inches: Sand 29 to 80 inches: Sand **Description of Keweenaw Setting** Landform: Ground moraines Landform position (two-dimensional): Footslope, summit, toeslope, shoulder, backslope Landform position (three-dimensional): Nose slope, side slope, interfluve, base slope, head slope, crest Down-slope shape: Linear Across-slope shape: Convex, linear

Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 6 to 25 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.7 inches) **Interpretive groups** Land capability classification (irrigated): 3e Land capability (nonirrigated): 6e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 2 inches: Highly decomposed plant material 2 to 4 inches: Loamy sand 4 to 6 inches: Loamy fine sand 6 to 25 inches: Loamy fine sand 25 to 45 inches: Stratified sand to fine sand to loamy fine sand to loamy very fine sand 45 to 56 inches: Stratified loamy fine sand to fine sand to fine sandy loam 56 to 71 inches: Stratified loamy fine sand to fine sand to fine sandy loam 71 to 90 inches: Stratified loamy fine sand to fine sandy loam **Description of Sarona, Dense Substratum Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties and qualities** Slope: 6 to 25 percent Depth to restrictive feature: 61 to 79 inches to dense material Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 8.3 inches) **Interpretive groups** Land capability (nonirrigated): 6e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 3 inches: Sandy loam 3 to 6 inches: Fine sandy loam 6 to 14 inches: Fine sandy loam 14 to 21 inches: Fine sandy loam 21 to 28 inches: Sandy loam 28 to 47 inches: Loamy sand 47 to 75 inches: Loamy sand 75 to 90 inches: Loamy sand

Gogebic County, Michigan 44D—Karlin-Keweenaw-Sarona, dense substratum, complex, 25 to 50 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Karlin and similar soils: 36 percent Keweenaw and similar soils: 30 percent Sarona, dense substratum, and similar soils: 25 percent **Description of Karlin Setting** Landform: Outwash plains Landform position (two-dimensional): Toeslope, footslope, summit, shoulder, backslope Landform position (three-dimensional): Nose slope, side slope, interfluve, base slope, head slope, crest Down-slope shape: Convex, linear Across-slope shape: Concave, convex Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 25 to 45 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.8 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 1 inches: Highly decomposed plant material 1 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 29 inches: Sand 29 to 80 inches: Sand **Description of Keweenaw Setting** Landform: Ground moraines Landform position (two-dimensional): Footslope, summit, toeslope, shoulder, backslope Landform position (three-dimensional): Nose slope, side slope, interfluve, base slope, head slope, crest Down-slope shape: Convex, linear Across-slope shape: Concave, convex Parent material: Sandy glaciofluvial deposits **Properties and qualities** Slope: 25 to 50 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.7 inches) **Interpretive groups** Land capability classification (irrigated): 7e Land capability (nonirrigated): 7e Other vegetative classification: Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1) **Typical profile** 0 to 2 inches: Highly decomposed plant material 2 to 4 inches: Loamy sand 4 to 6 inches: Loamy fine sand 6 to 25 inches: Loamy fine sand 25 to 45 inches: Stratified sand to fine sand to loamy fine sand to loamy very fine sand 45 to 56 inches: Stratified loamy fine sand to fine sand to fine sandy loam 56 to 71 inches: Stratified loamy fine sand to fine sand to fine sandy loam 71 to 90 inches: Stratified loamy fine sand to fine sandy loam **Description of Sarona, Dense Substratum Setting** Landform: Till plains Landform position (three-dimensional): Rise Down-slope shape: Linear Across-slope shape: Linear Parent material: Coarse-loamy till **Properties and qualities** Slope: 25 to 50 percent Depth to restrictive feature: 61 to 79 inches to dense material Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 8.3 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Tsuga Maianthemum (TM_1), Acer Tsuga Dryopteris (ATD_1) **Typical profile** 0 to 3 inches: Sandy loam 3 to 6 inches: Fine sandy loam 6 to 14 inches: Fine sandy loam 14 to 21 inches: Fine sandy loam 21 to 28 inches: Sandy loam 28 to 47 inches: Loamy sand 47 to 75 inches: Loamy sand 75 to 90 inches: Loamy sand

Gogebic County, Michigan 41—Lupton-Pleine-Cathro complex, 0 to 1 percent slopes: Map Unit Setting Elevation: 590 to 1,970 feet Mean annual precipitation: 30 to 34 inches Mean annual air temperature: 39 to 43 degrees F Frost-free period: 80 to 140 days **Map Unit Composition** Lupton and similar soils: 60 percent Pleine and similar soils: 23 percent Cathro and similar soils: 15 percent **Description of Lupton Setting** Landform: Depressions on till plains, drainageways on till plains Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Highly decomposed organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 23.9 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Tsuga Thuja Sphagnum (TTS_1), Tsuga Thuja Mitchella (TTM_1) **Typical profile** 0 to 20 inches: Muck 20 to 80 inches: Muck **Description of Pleine Setting** Landform: Depressions on till plains, drainageways on till plains Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Coarse-loamy till **Properties and qualities** Slope: 0 to 1 percent Surface area covered with cobbles, stones or boulders: 0.0 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: High (about 11.7 inches) **Interpretive groups** Land capability (nonirrigated): 5w Other vegetative classification: Fraxinus Impatiens (FI_1), Tsuga Thuja Sphagnum (TTS_1) **Typical profile** 0 to 9 inches: Very cobbly muck 9 to 20 inches: Very fine sandy loam 20 to 33 inches: Fine sandy loam 33 to 80 inches: Gravelly sandy loam **Description of Cathro Setting** Landform: Depressions on till plains, drainageways on till plains Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Herbaceous organic material over loamy drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 30 percent Available water capacity: Very high (about 16.5 inches) **Interpretive groups** Land capability classification (irrigated): 6w Land capability (nonirrigated): 6w Other vegetative classification: Tsuga Thuja Sphagnum

(TTS_1), Fraxinus Impatiens (FI_1) **Typical profile** 0 to 6 inches: Muck 6 to 31 inches: Muck 31 to 80 inches: Fine sandy loam

Gogebic County, Michigan W—Water: Map Unit Composition Water: 100 percent

3.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 5). For the theoretical variogram models considered here, the semivariance will converge on the total variance at distances for which values are no longer spatially auto-correlated (this is referred to as the range, Figure 5).

For the theoretical variograms considered here, three parameters estimated from the data are used to fit a semivariogram model to the empirical semivariogram. This model is then assumed to quantitatively represent the correlation as a function of distance (Figure 5), the range, the sill (the sill is the asymptotic value of semi-variance at the range), and the nugget (which describes sampling error or variation at distances below those separating the closest pairs of samples). The range, sill and nugget are estimated from theoretical models that are fitted to the empirical variograms using non-linear least squares methods.

The variogram analysis will be used, to determine the spatial scales at which we can consider soil measurements spatially independent. This characterization will directly inform the minimum distance between *i*) soil plots within each soil array, *ii*) the soil profile measurements, *iii*) EP plots, and *iv*) the microbial sampling locations. These data will directly inform NEON construction and site design activities.

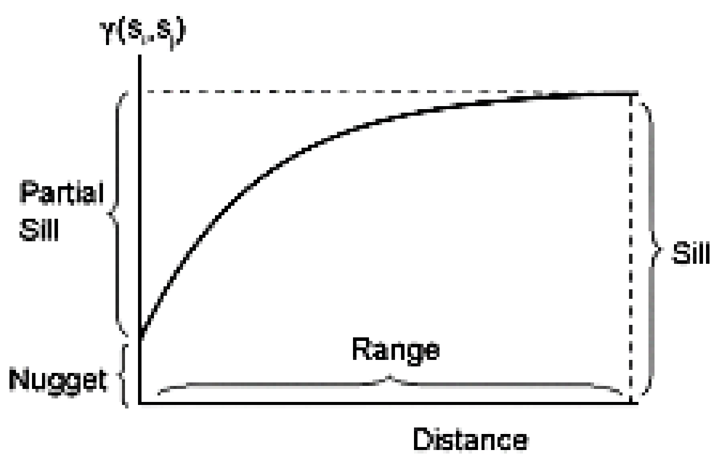


Figure 5. Example semivariogram, depicting range, sill, and nugget.

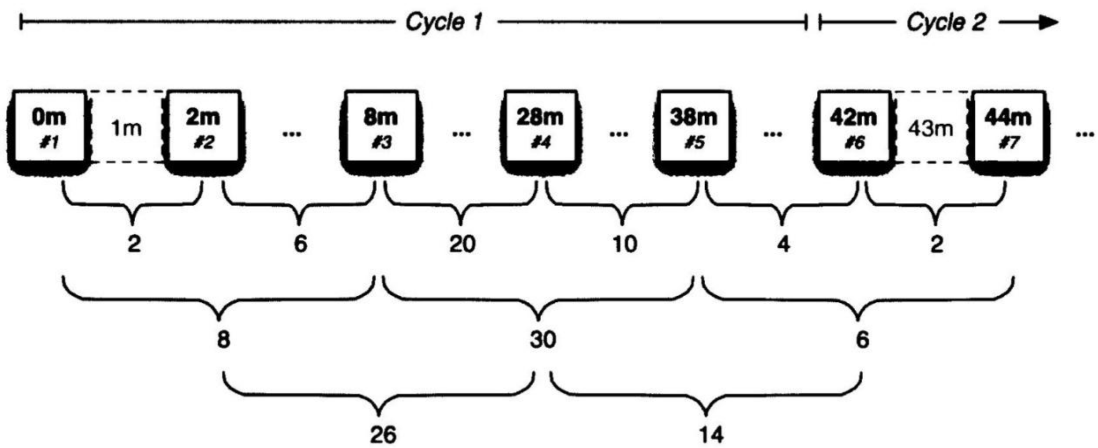


Figure 6. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 10 August 2010 at the UNDERC site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 6). Soil temperature and moisture measurements were collected along three transects (210 m, 84 m, and 84 m) located in the expected airshed at UNDERC. Details of how the airshed was determined are provided below. Soil temperature was measured with platinum resistance temperature sensors (RTD 810, Omega Engineering Inc., Stamford CT) and soil moisture was measured with time domain diaelectric sensors (CS616, Campbell Scientific Inc., Logan UT).

As well as measuring soil temperature and moisture at each sample point in Figure 6, measurements were also taken 30 cm in front and behind the sampling point along the axis of the transect. For example, at the 2 m sampling point, soil temperature and moisture was measured at 1.7 m, 2 m, and 2.3 m; this data is referred to as mobile data, since the measurements were taken at many different locations. In addition, soil temperature and moisture were continuously recorded at a single fixed location (stationary data) throughout the sampling time to correct for changes in temperature and moisture throughout the day.

Data collected were used for geospatial analyses of variograms in the R statistical computing language with the geoR package to test for spatial autocorrelation (Trangmar *et al.* 1986; Webster & Oliver 1989; Goovaerts 1997; Riberiro & Diggle 2001) and estimate the distance necessary for independence among soil plots in the soil array. To correct for changes in temperature and moisture over the sampling period, the stationary data was subtracted from the mobile data. In many instances a time of day trend was still apparent in the data even after subtracting the stationary data from the mobile data. This time of day trend was corrected for by fitting a linear regression and using the residuals for the semivariogram analysis. Soil temperature and moisture data, R code, graphs, and R output can be found at: P:\FIU\FIU_Site_Characterization\DXX\YYYYYYY_Characterization\Soil Measurements\Soil Data Analysis (where XX = domain number and YYYYYYY = site name).

3.3.3 Results and interpretation

3.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 7). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 8, left graph) and directional semivariograms do not show anisotropy (Figure 8, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 8, right graph). The model indicates a distance of effective independence of 70 m for soil temperature.

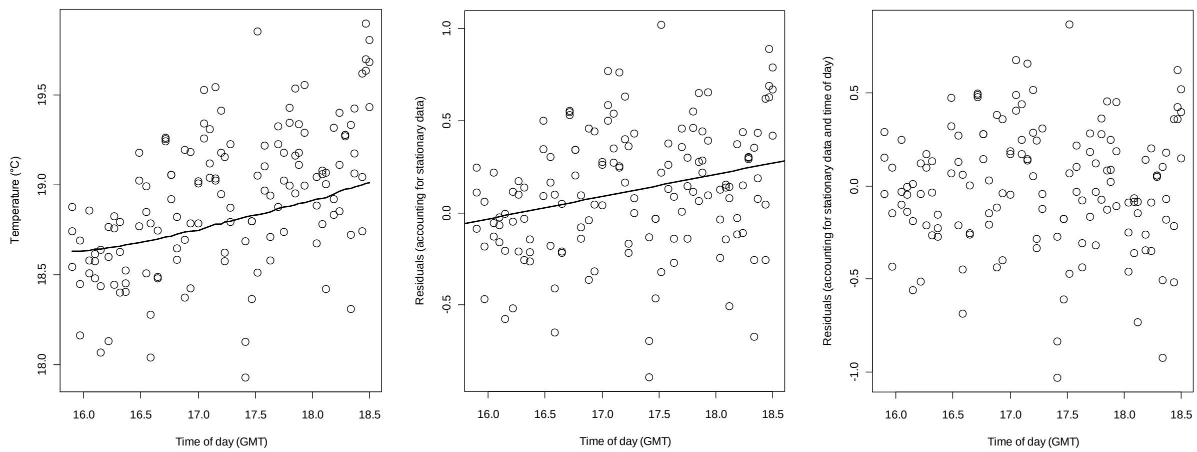


Figure 7. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

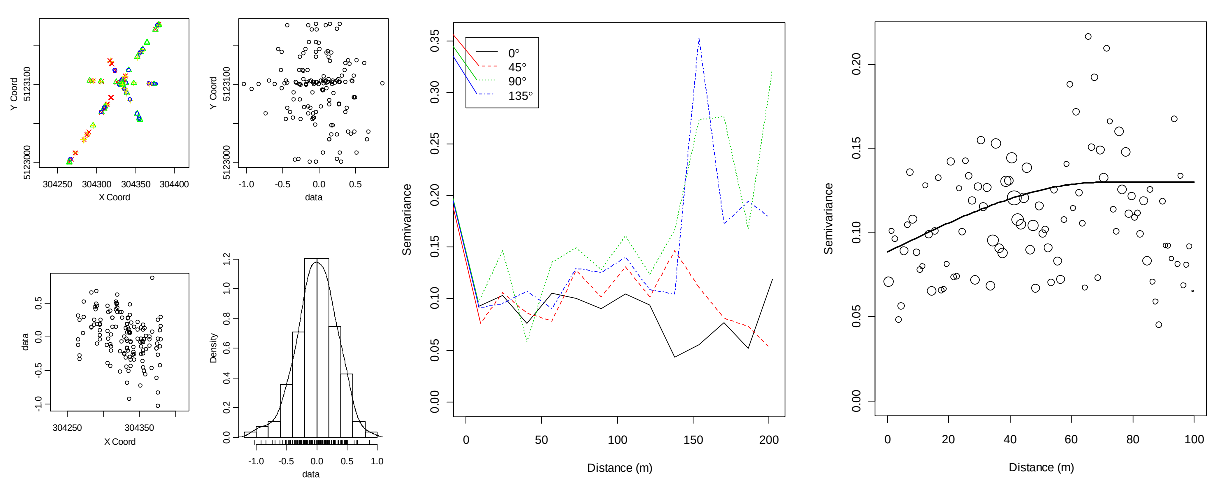


Figure 8. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

3.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 9). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 10, left graph) and directional semivariograms do not show anisotropy (Figure 10, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 10, right graph). The model indicates a distance of effective independence of 20 m for soil water content.

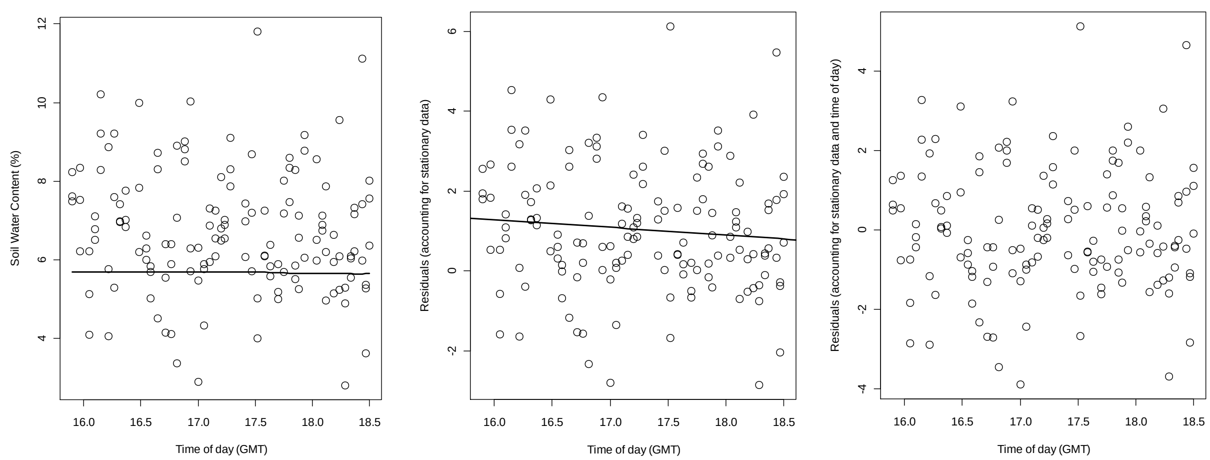


Figure 9. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting for changes water content in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

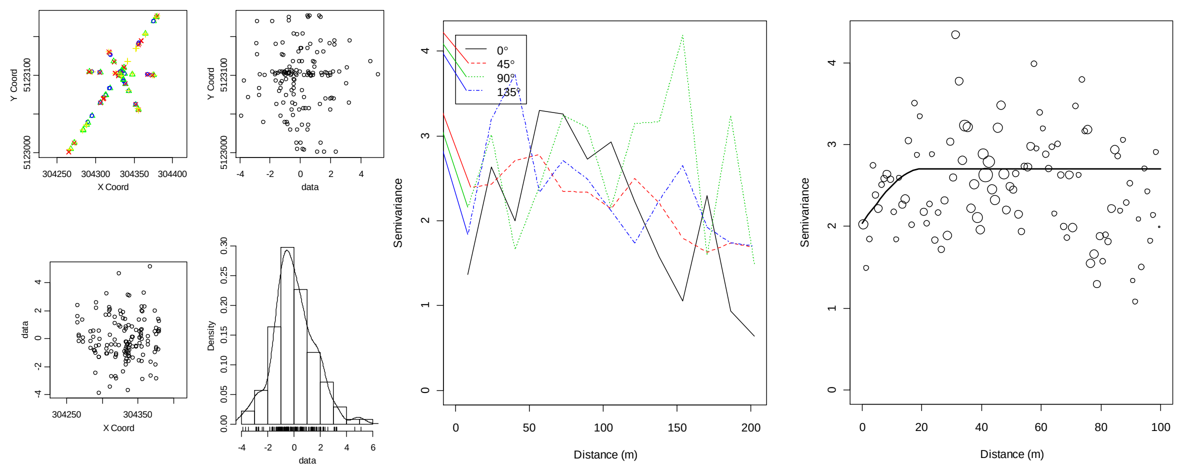


Figure 10. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

3.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was 70 m for soil temperature and 20 m for soil moisture. Based on these results and the site design guidelines the soil plots at UNDERC shall be placed 40 m apart. The soil array shall follow the linear soil array design (Soil Array Pattern B) with the soil plots being 5 m x 5 m. The direction of the soil array shall be 205° from the soil plot nearest the tower (i.e., first soil plot). The location of the first soil plot will be approximately 46.23366, -89.53738. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc). The FIU soil pit for characterizing soil horizon depths, collecting soil for site-specific sensor calibration, and collecting soil for the FIU soil archive will be located at 46.23560, -89.53976 (primary location); or 46.236227°, -89.539159° (alternate location 1 if primary location is unsuitable); or 46.237156°, -89.539036° (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 4 and site layout can be seen in Figure 11.

Dominant soil series at the site: Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Orthods
Great group: Fragiorthods
Subgroup: Alfic Oxyaquic Fragiorthods
Family: Coarse-loamy, isotic, frigid Alfic Oxyaquic Fragiorthods
Series: Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes

Table 4. Summary of soil array and soil pit information at UNDERC. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	26 m
Latitude and longitude of 1st soil plot OR direction from tower	46.23366, -89.53738
Direction of soil array	205°
Latitude and longitude of FIU soil pit 1	46.23560, -89.53976 (primary location)
Latitude and longitude of FIU soil pit 2	46.236227°, -89.539159° (alternate 1)
Latitude and longitude of FIU soil pit 3	46.237156°, -89.539036° (alternate 2)
Dominant soil type	Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes
Expected soil depth	0.46-2 m
Depth to water table	0-2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.03 m (Slightly decomposed plant material)	0.07 m[A]
0.03-0.13 m (Fine sandy loam)	
0.13-0.20 m (Silt loam)	0.17 m[A]
0.20-0.30 m (Silt loam)	0.25 m
0.30-0.51 m (Fine sandy loam)	0.57 m[A]
0.51-0.84 m (Gravelly fine sandy loam)	
0.84-1.24 m (Fine sandy loam)	1.29 m
1.24-1.37 m (Fine sandy loam)	
1.37-1.73 (Fine sandy loam)	
1.73-2.00 m (Gravelly sand)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.

[A] Expected depth of soil CO_2 sensors (subject to soil horizon depths)

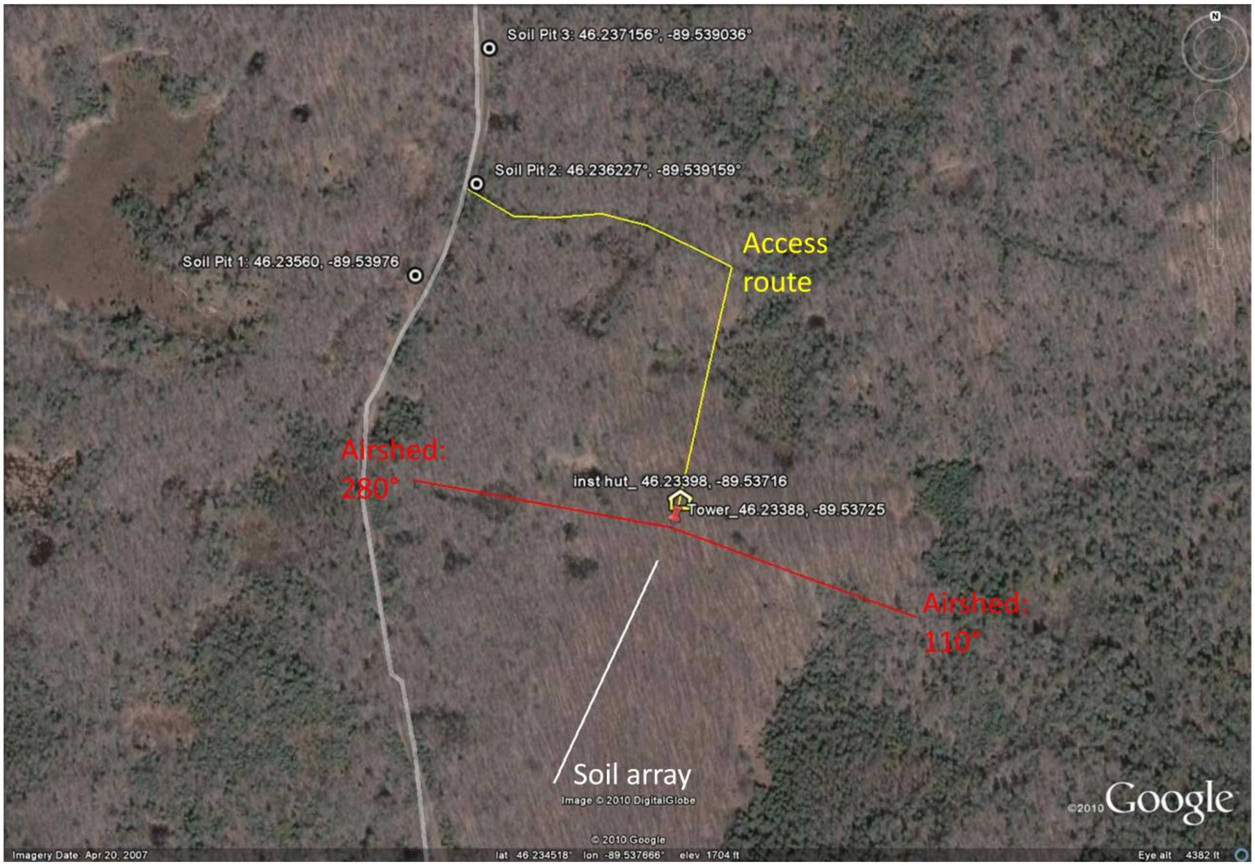


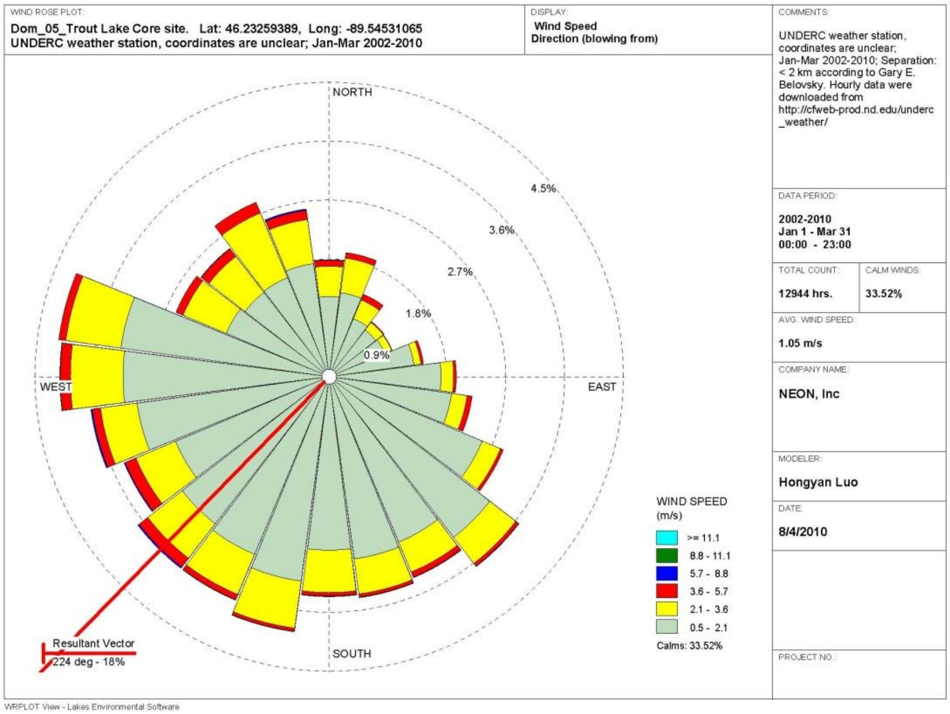
Figure 11. Site layout at UNDERC showing soil array and location of the FIU soil pit.

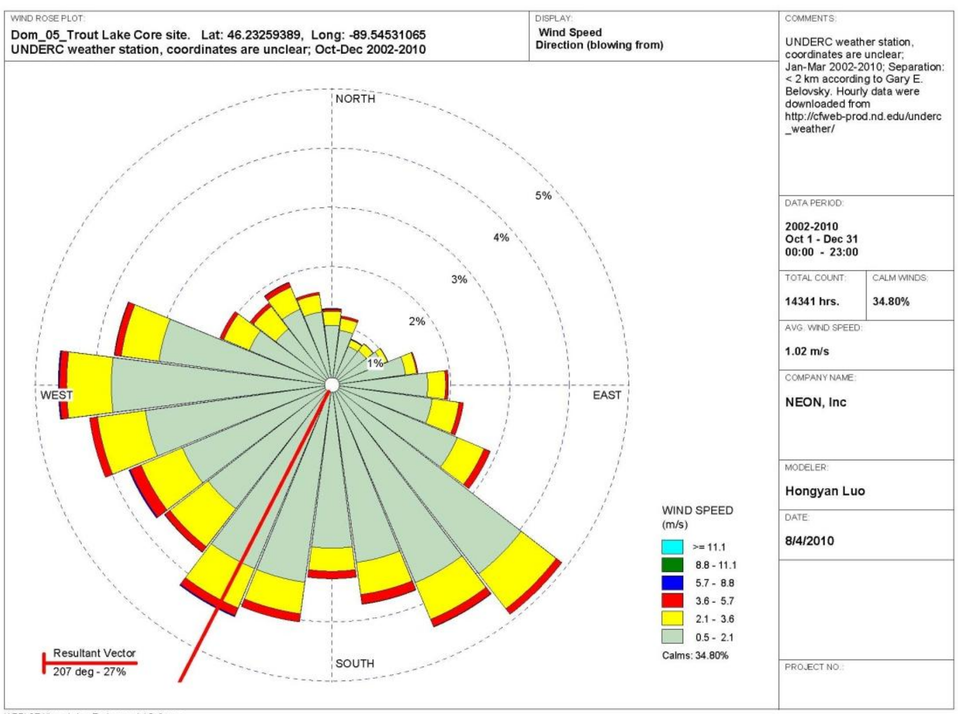
3.4 Airshed

3.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries. The weather data used to generate the following wind roses are 2002-2010 hourly data downloaded from UNDERC website http://cfweb-prod.nd.edu/underc_weather/. Coordinates are unclear. According to G. E. Belovsky, the separation between weather station and NEON tower is < 2 km. The orientation of the windrose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

3.4.2 Results (graphs for wind roses)





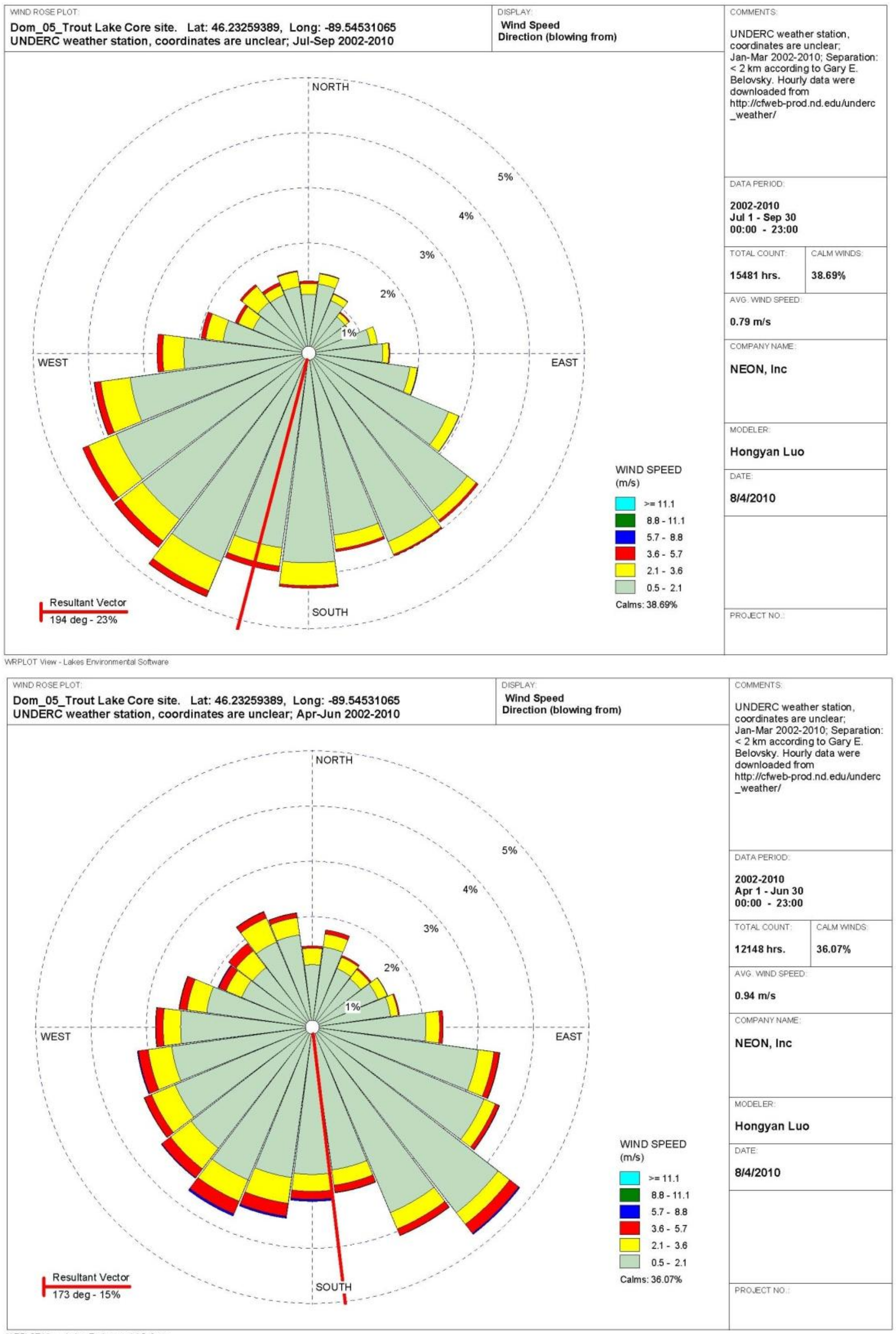


Figure 12. Windroses from UNDERC.
Data used here are hourly data from 2002-2010 from UNDERC weather station, which is < 2 km from NEON tower site. It is assumed that the wind data was corrected for declination. Panels are (from top to bottom) Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

3.4.3 Resultant vectors

Table 5. The resultant wind vectors from UNDERC using hourly data in 2002-2010.

Quarterly (seasonal) timeperiod	**Resultant vector**	**% duration**
January to March	173°	15
April to June	224°	18
July to September	194°	23
October to December	207°	27
Annual mean	199.5°	na.

3.4.4 Expected environmental controls on source area

Two types of models were commonly used to determine the shape and extent of the source area under different and contrasting atmospheric stability classes. An inverted plume dispersion model with modeled cross wind solutions were used for convective conditions (Horst and Weil 1994). For strongly stable conditions, and Lagrangian solution was used (Kormann and Meixner 2001). The source area models where bounded by the expected conditions depict the extreme conditions. Convective conditions typically have strong vertical mixing between the ecosystem and atmosphere (surface layer). Stable conditions typically have long source area and associated waveforms. Convective turbulence is often characterized by short mixing scales (scalar) and moderate daytime wind speeds, *e.g.,* 1-4 m s^{-2}. Higher wind speeds, like those experienced over the Rockies, are often the product of mechanical turbulence with long waveforms. Because thermal stratification is very efficient in suppressing vertical mixing, stable conditions also have typically very long waveforms.

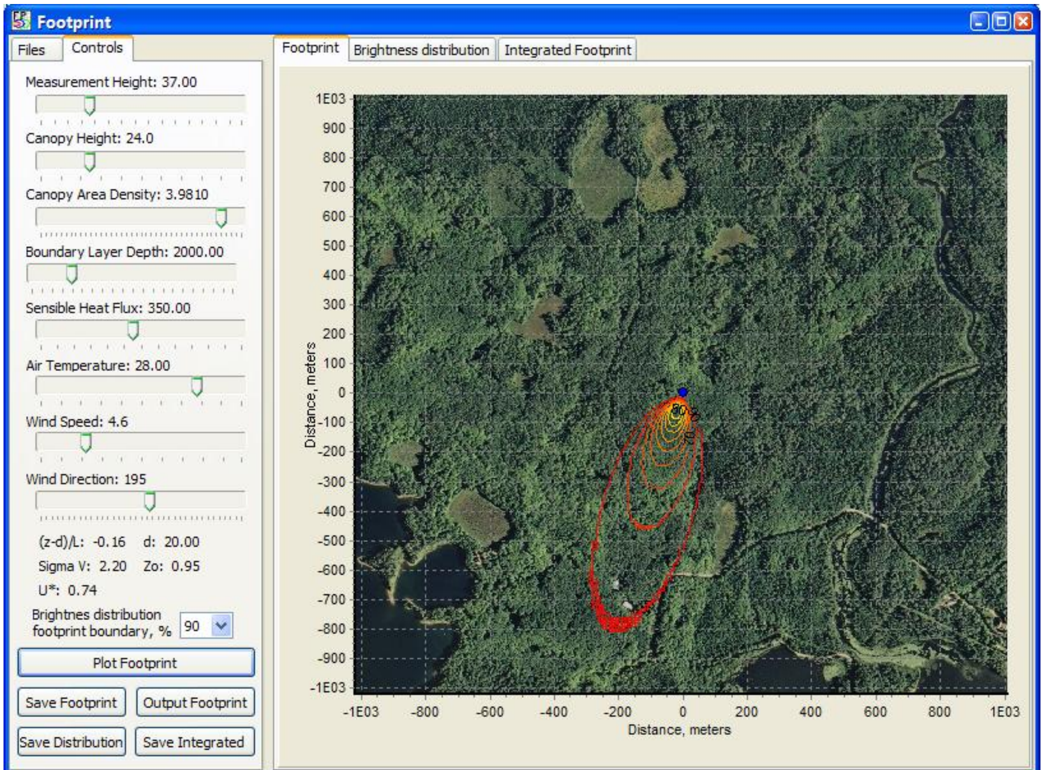
As a general rule, shorter and less structurally complex ecosystems have good vertical mixing during all atmospheric stabilities. Taller and more structurally complex ecosystems have well mixed upper canopies during the daytime, and can be decoupled below the canopy under neutral and stable conditions. The type of turbulence (mechanical verse convective) and the physical attributes of the ecosystem control the degree of mixing, and the length and size of the source area.

Here, we used a web-based footprint model to determine the footprint area under various conditions (model info: http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/). Winds used to run the model and generate following model results are extracted from the wind roses. Vegetation information, temperature and energy information were either from the RFI document, previous site visit report, available data files or best estimated from experienced expert. Measurement height was determined from the Tower Height Info document provided by ENG group, then verify according to the real ecosystem structure after FIU site characterization at site. Runs 1-3 and 4-6 represents the expected conditions for summer and winter conditions, respectively, with maximum and mean windspeeds (daytime convective) and nighttime (stable atmospheres) conditions. The wind vector for each run was estimated from wind roses and is placed as a centerline in the site map included in the graphics. The width of the footprint was also estimated using the length between the isopleth of 80% cumulative flux and center line to calculate the angle from centerline. This information, along with distance of the cumulative flux isopleths and wind direction, will define the source area for the flux measurements on the top of the tower.

Table 6. Expected environmental controls to parameterize the source area model, and associated results from UNDERC advanced site.

Parameters	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	
Approximate season	summer			winter			Units
	Day (max WS)	Day (mean WS)	Night	Day (max WS)	Day (mean WS)	night	qualitative
Atmospheric stability	Convective	convective	Stable	Convective	convective	Stable	qualitative
Measurement height	36	36	36	36	36	36	m
Canopy Height	24	24	24	24	24	1.6	m
Canopy area density	4	4	4	1.6	1.6	1.6	m
Boundary layer depth	2000	2000	900	900	900	-70700	m
Expected sensible heat flux	350	350	-2	180	180	-10-70	W m^{-2}
Air Temperature	28	28	20	-5	-5	0.6-10	°C
Max. windspeed	4.6	1.6	0.6	4.6	2.0	2250.6	m s^{-1}
Resultant wind vector	195	195	195	225	225	225	degrees
			Results				
(z-d)/L	-0.16	-0.47	3.00	-0.08	-0.30	3.00	m
d	20.00	20.00	20.00	17	17.00	17.00	m
Sigma v	2.20	1.90	1.60	1.90	1.40	1.60	m^2 s^{-2}
Z0	0.95	0.95	0.95	1.50	1.50	1.50	m
u*	0.74	0.52	0.01	0.80	0.51	0.01	m s^{-1}
Distance source area begins	10	0	600	10	0	650	m
Distance of 90% cumulative flux	600	200	3700	700	300	3650	m
Distance of 80% cumulative flux	400	100	3300	400	200	3400	m
Distance of 70% cumulative flux	280	70	3000	300	100	3100	m
Peak contribution	65	15	2165	65	35	2405	m

3.4.5 Results (source area graphs)



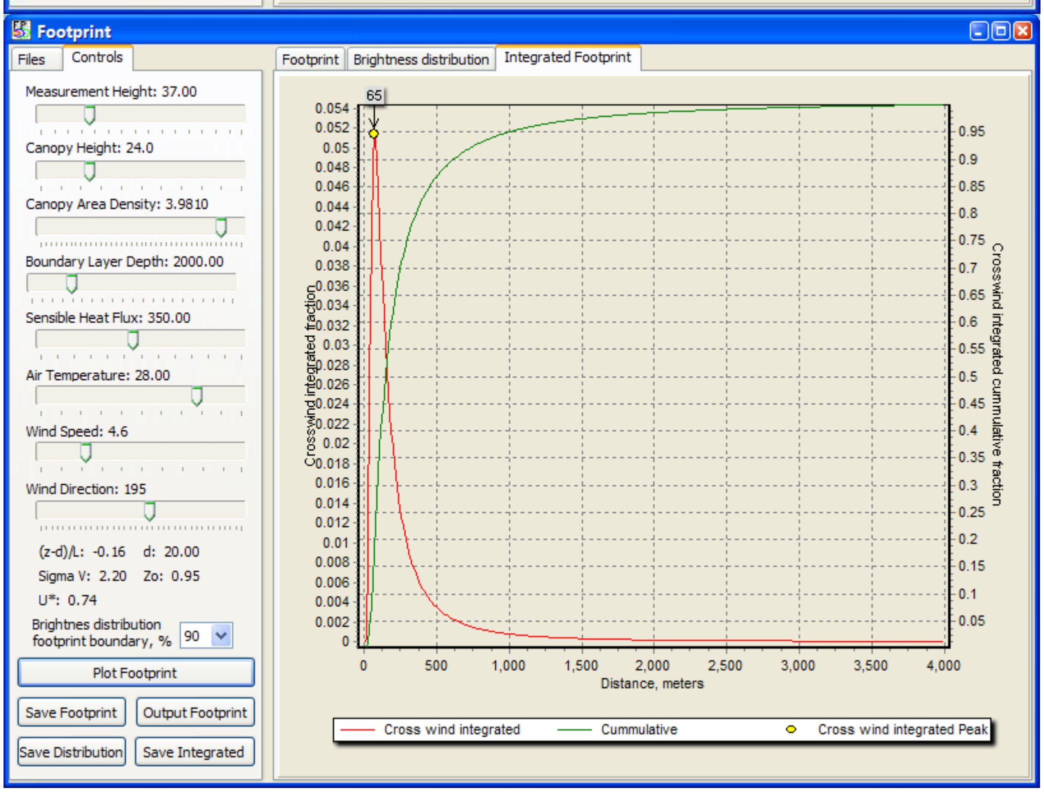


Figure 13. summer, daytime, max wind speed

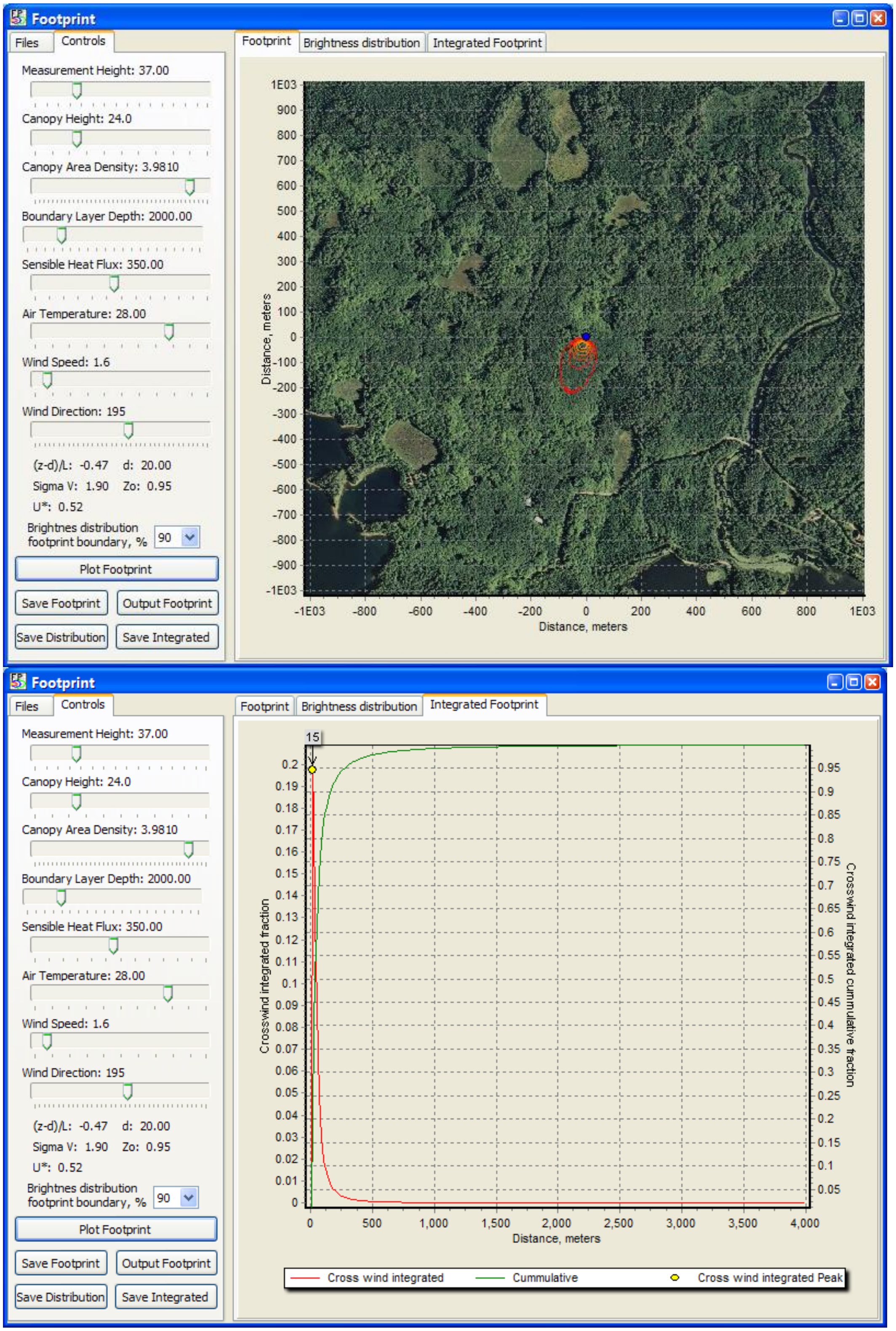


Figure 14. summer, daytime, mean wind speed

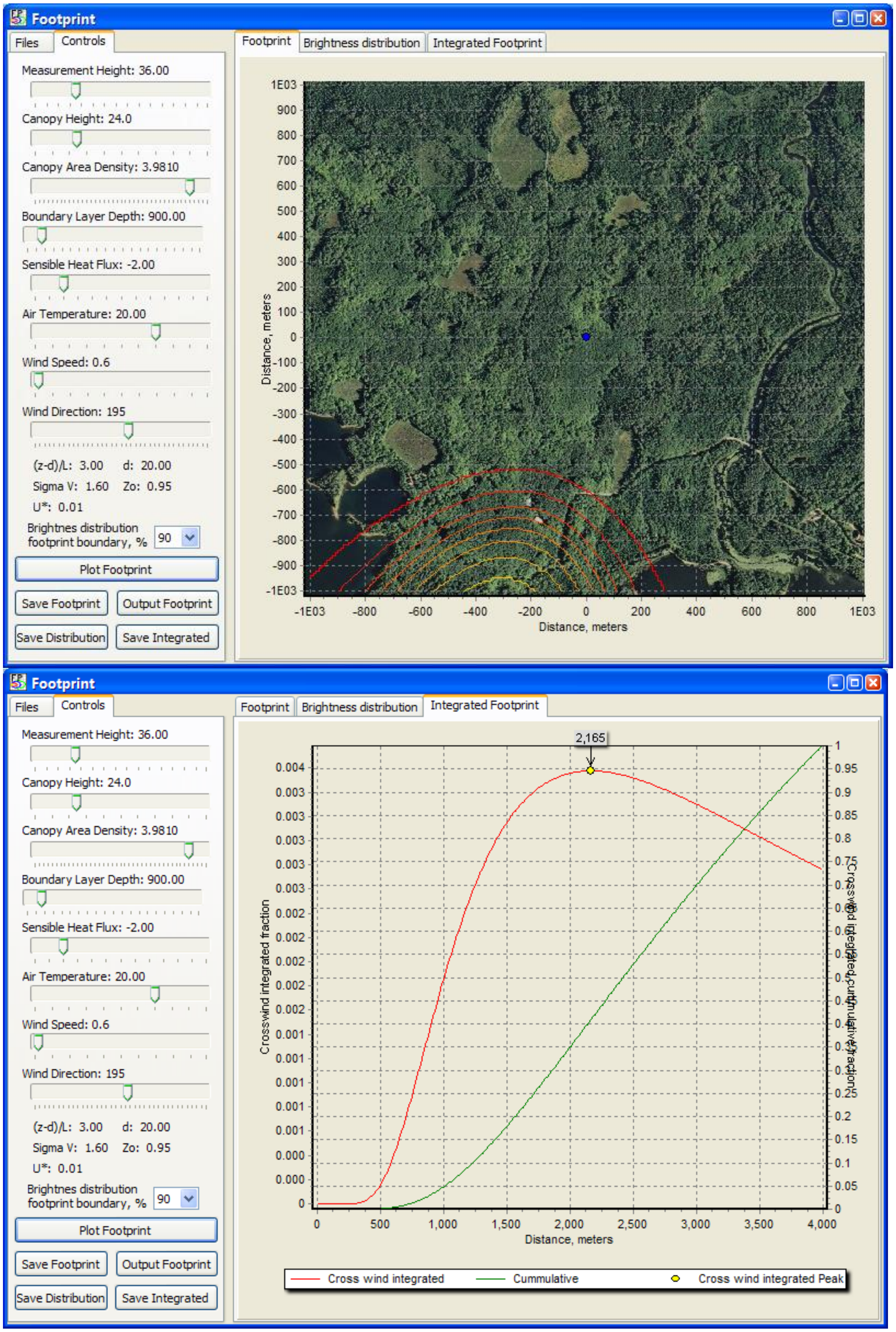


Figure 15. summer, nighttime, mean wind speed

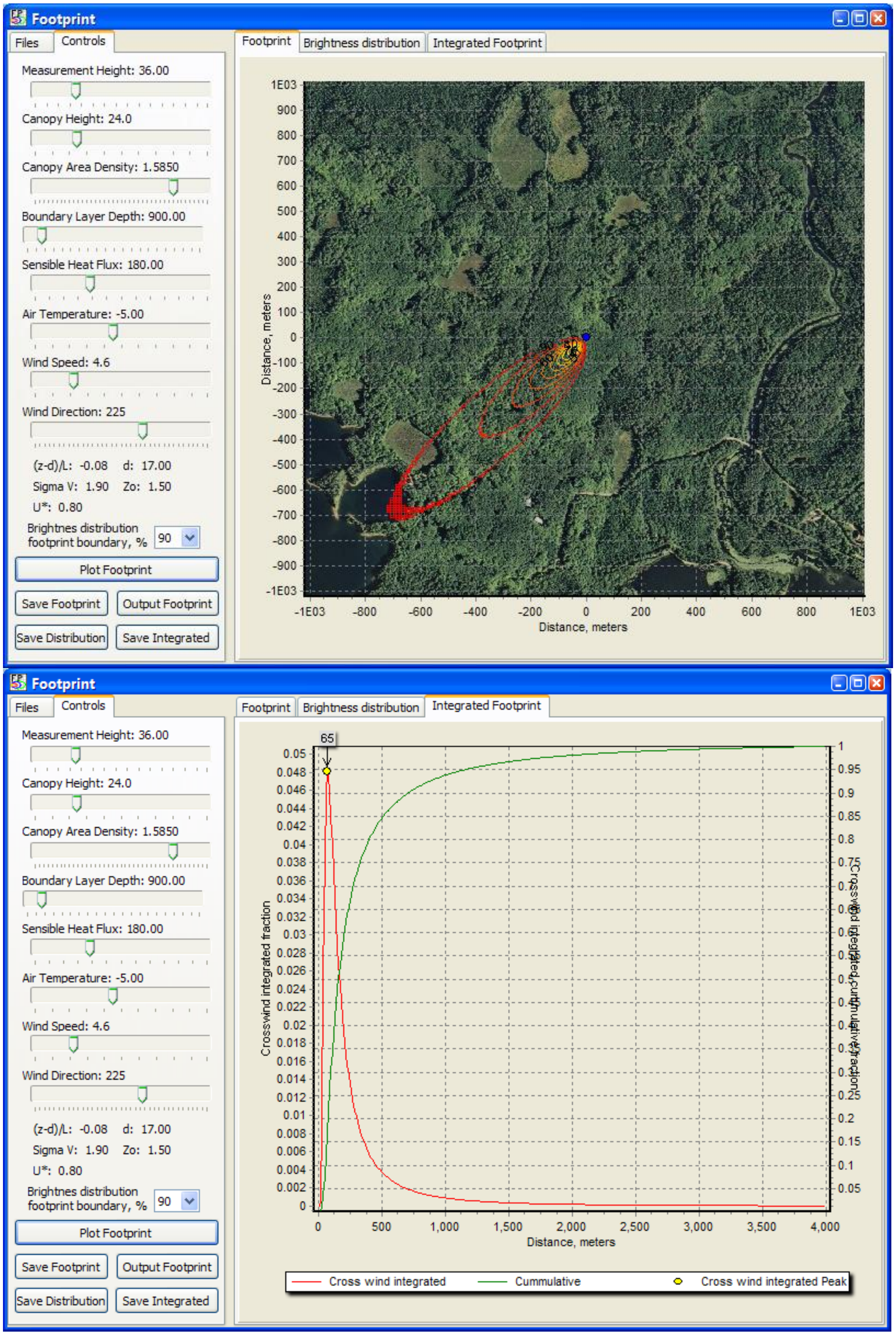


Figure 16. winter, daytime, max wind speed

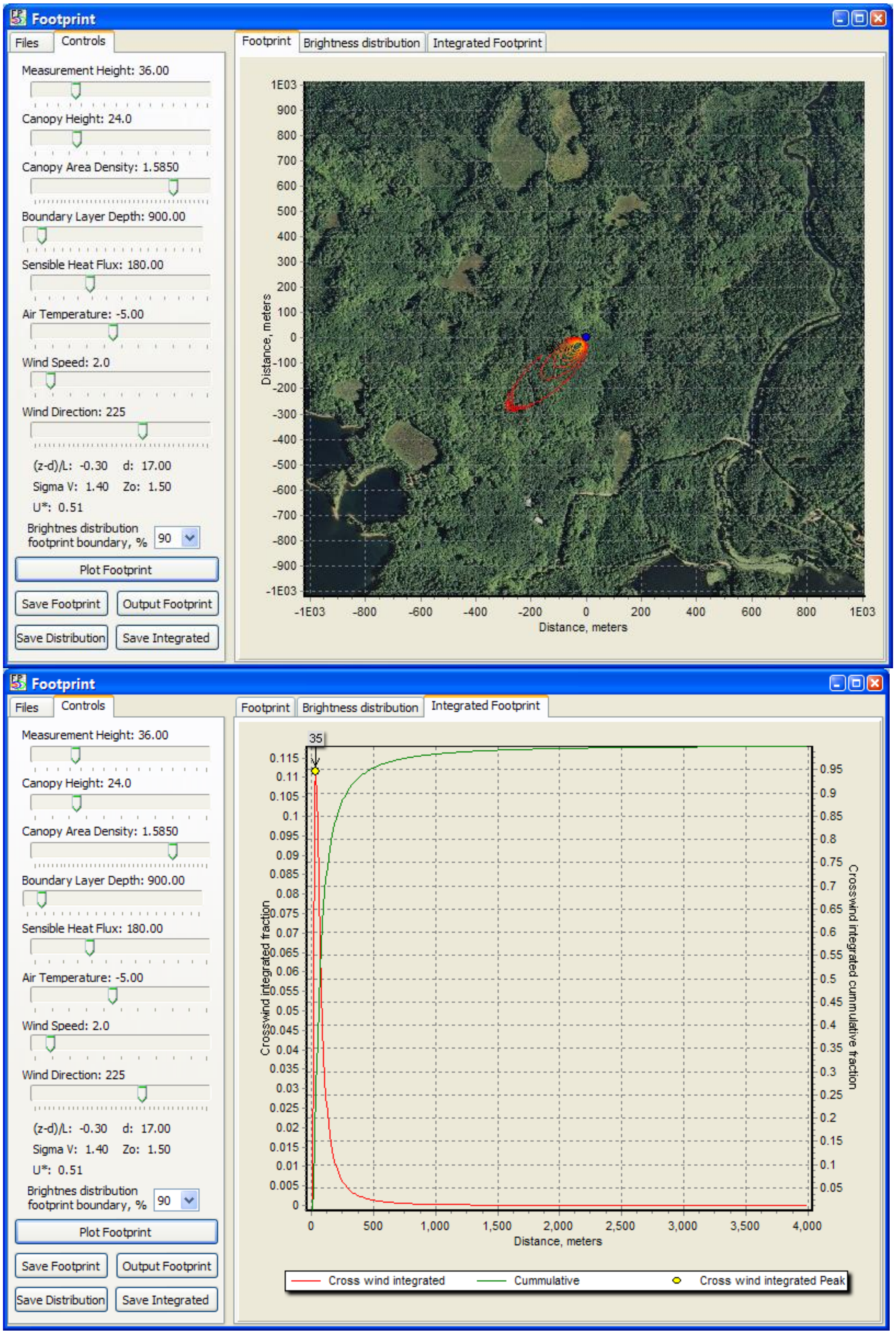


Figure 17. Winter daytime, mean wind speed

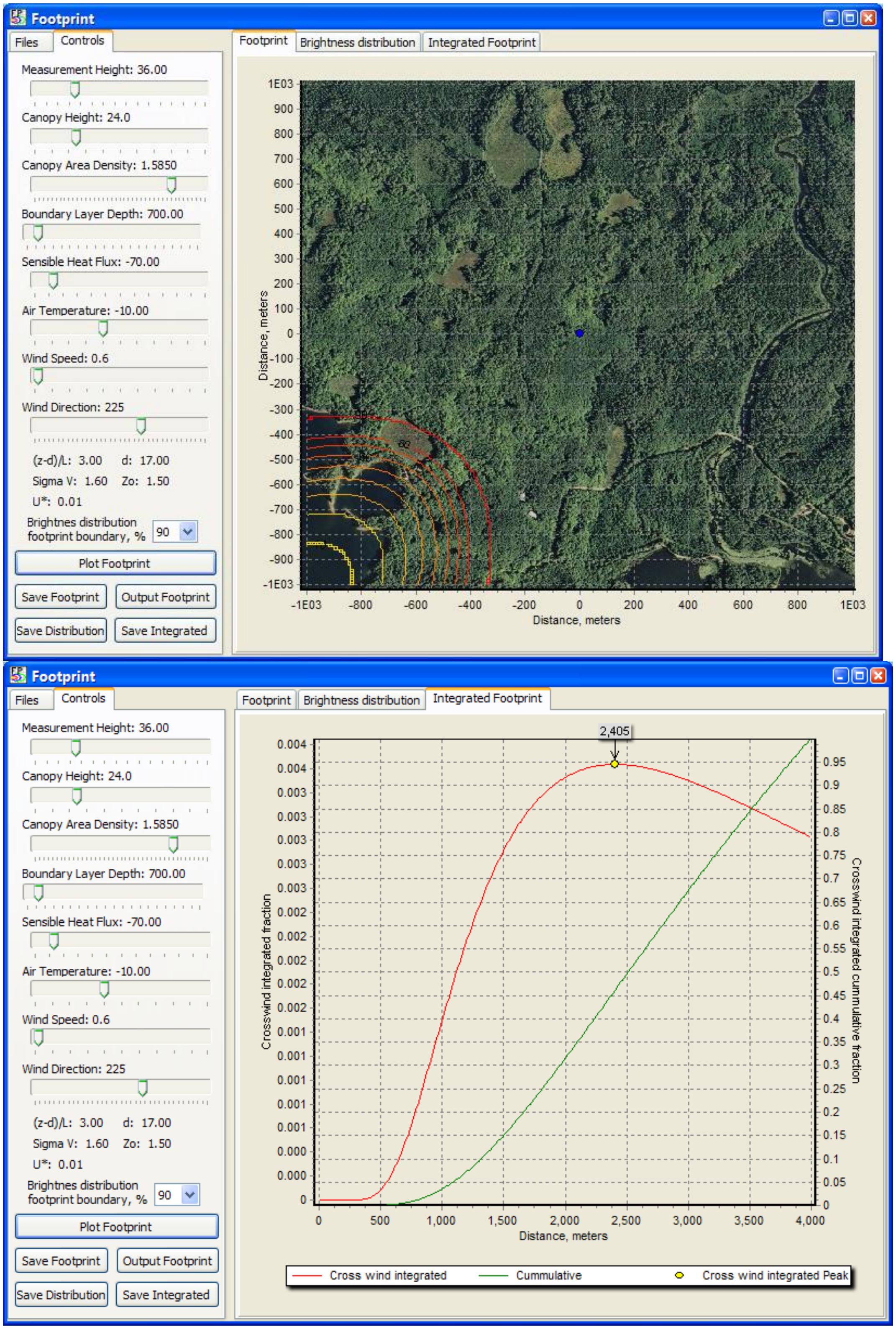


Figure 18. winter, nighttime, mean wind speed

3.4.6 Site design and tower attributes

According to wind roses, wind come from all directions, but the prevailing wind direction blows between southeast and northwest (110^o to 280^o, clockwise from 110^o, **major airshed**), which is fairly consistent throughout the whole year. Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is restored native prairie. The candidate tower site was at 46.23259389°, -89.54531065°. After site visit, we microsited the tower location for ~635 m toward Northeast at 46.23388°, -89.53725° to maximize the tower fetch area from the same forest type (sugar maple dominant forest) in the major tower airshed and avoid the impacts of the Roach Lake on the local microclimate measurements. The new **tower location** is at 46.23388°, -89.53725°.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the SSW will be best to capture signals from all wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure. An **instrument hut** should be outside the prevailing wind airshed to avoid disturbance in the measurements of wind and should be positioned to have the longer side parallel to frequent wind direction to minimize the wind effects on instrument huts and to minimize the disturbances of wind regime by instrument hut, and in this case, instrument hut should be positioned on the northeast side of tower and have the longer side parallel to SW-NE direction. The location of instrument hut is at 46.23398, -89.53716.

Sugar maple forest in tower airshed is uniform in age and height and canopy height is ~ 24 m. Dense sugar maple seedlings cover forest floor with height ~ 0.3 m. Very few trees/shrubs are found between this seedling understory and tree canopy. Course wood debris is thick on the forest floor. We require 6 **measurement layers** on the tower with top measurement height at 36 m, and remaining levels are 27 m, 24 m, 16m, 8 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

Because of the dense forest, we cannot find any open area within 500 m from tower that is large enough to meet USCRN criteria 1 and 2 for **DFIR** (Double Fenced International Reference) location. The closest adequate open area is ~2.33 km away on the southeast toward tower at 46.21704, -89.51931. Because the terrain is relatively flat at this region and few strong convective cells are expected during summer, we assume the precipitation collected at this DFIR location will be representative at tower location as well. DFIR location is ~550 m away from power line on northeast and ~90 m from the Tenderfoot Lake on the west. This DFIR location lies in the state of Wisconsin, while the tower location is inside state of Michigan. But site manager indicated UNDERC owns property in both states. **Wet deposition collector** will collocate at the top of the tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 7. Site design and tower attributes for UNDERC Advanced site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			110° to 280°		Clockwise from first angle
Tower location	46.23388,	-89.53725	--	--	new site
Instrument hut	46.23398,	-89.53716			
Instrument hut orientation vector	--	--	20° - 200°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	200°	--	
DFIR	46.21704,	-89.51931			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				8.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				24.0	m.a.g.l.
Level 5				27.0	m.a.g.l.
Level 6				36.0	m.a.g.l.
Tower Height				36.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Figure below shows the proposed tower location, instrument hut location, DFIR, airshed area and access road.

Figure 19. Site layout for UNDERC Advanced tower site.

i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 110° to 280° (clockwise from 110°) are the airshed areas that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut. iv) Purple pin is DFIR location

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here, FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36" (0.914 m). The boardwalk to access the tower is not on any side that has a boom. M. Cramer suggested that it is probably best to use boardwalk to access NEON equipment at this site in order to minimize disturbance.

Specific Boardwalks at UNDERC Advance site:

- Boardwalk is from the access point to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to the soil array
- No boardwalk from the soil array boardwalk to the individual soil plots
- No boardwalk needed at DFIR site

The relative locations between tower, instrument hut and boardwalk can be found in the Figure below:

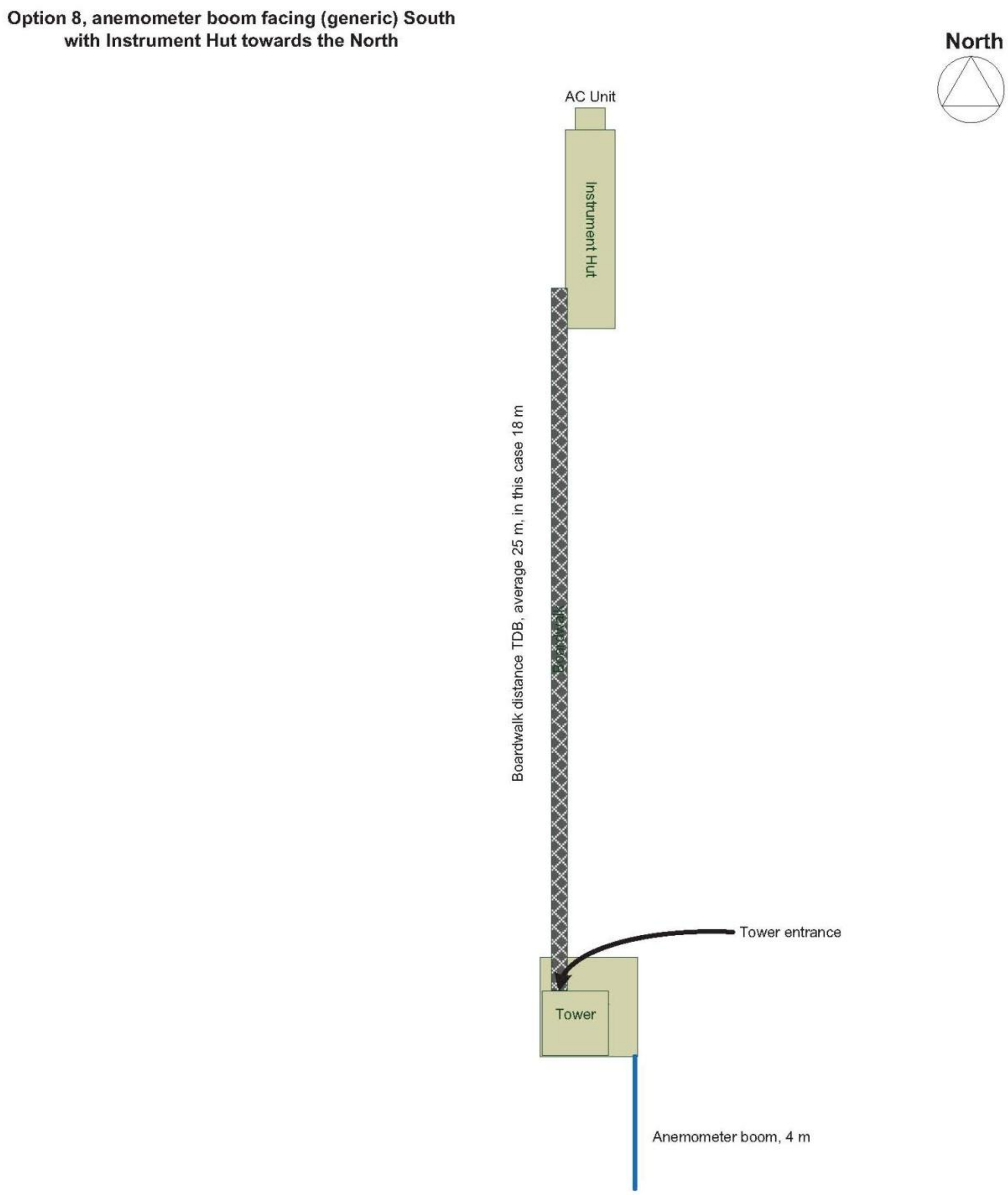


Figure 20. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At UNDERC Advanced site, the boom angle will be 200 degrees, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be SW-NE (20^{o}-200^{o}, longwise).

3.4.7 Information for ecosystem productivity plots

The tower at UNDERC Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (sugar maple forest). Major airshed area at this site are from 110º to 280º (major, clockwise from 110°), and 90% signals for flux measurements during the daytime are within a distance of 700 m from tower, and 80% within 400 m, while during nighttime, some signals collected at tower can be from very far away, beyond 3 km . We suggest FSU Ecosystem Productivity plots are placed within the major airshed boundaries of 110° to 280° (clockwise from 110º) from tower.

3.5 Issues and attentions

The site commonly experiences ~1 m snow pack between September and May (very likely between October and March). A vehicle weight restriction is enforced each spring due to snow melt (typically ending around May) and it may not be possible to start construction until after this restriction is lifted. Operations should take this into account.

Boardwalk should not cross vernal pools/ponds.

Dirt road can be very muddy and difficult to access after heavy rain, and during mud season (the fifth season between spring and summer)

The DFIR is ~2.3 km from the tower. It was not possible to locate the DFIR closer to the tower due to the lack of forest clearings in this area. UNDERC site personnel would not allow the DFIR to be located in open wetland areas that were closer to the tower.

4 STEIGERWALDT, RELOCATEABLE TOWER 1

4.1 Site description

The candidate relocatable tower site (45.50488889, -89.58811111) is located within the property of Steigerwaldt Land Services (Figure 21). After FIU site characterization, we moved tower location ~590 m toward NE to the location of 45.50969, -89.58498 to maximize the fetch area in the major airshed on southwest of tower. The new location is still close to the road and power lines.

Forest management blocks have been shrinking in northern Wisconsin in recent decades. The property that the NEON tower will be located on is considered relatively large and Steigerwaldt Land Services currently do not own any larger management units.

Figure 21. Property boundary of the Steigerwaldt site and original (OLD) candidate tower location. Note that tower location has been changed since this map was made. See site layout map for the new tower location. Please do not be confused.

4.2 Ecosystem

Vegetation and land cover around tower site and surrounding area are presented below:

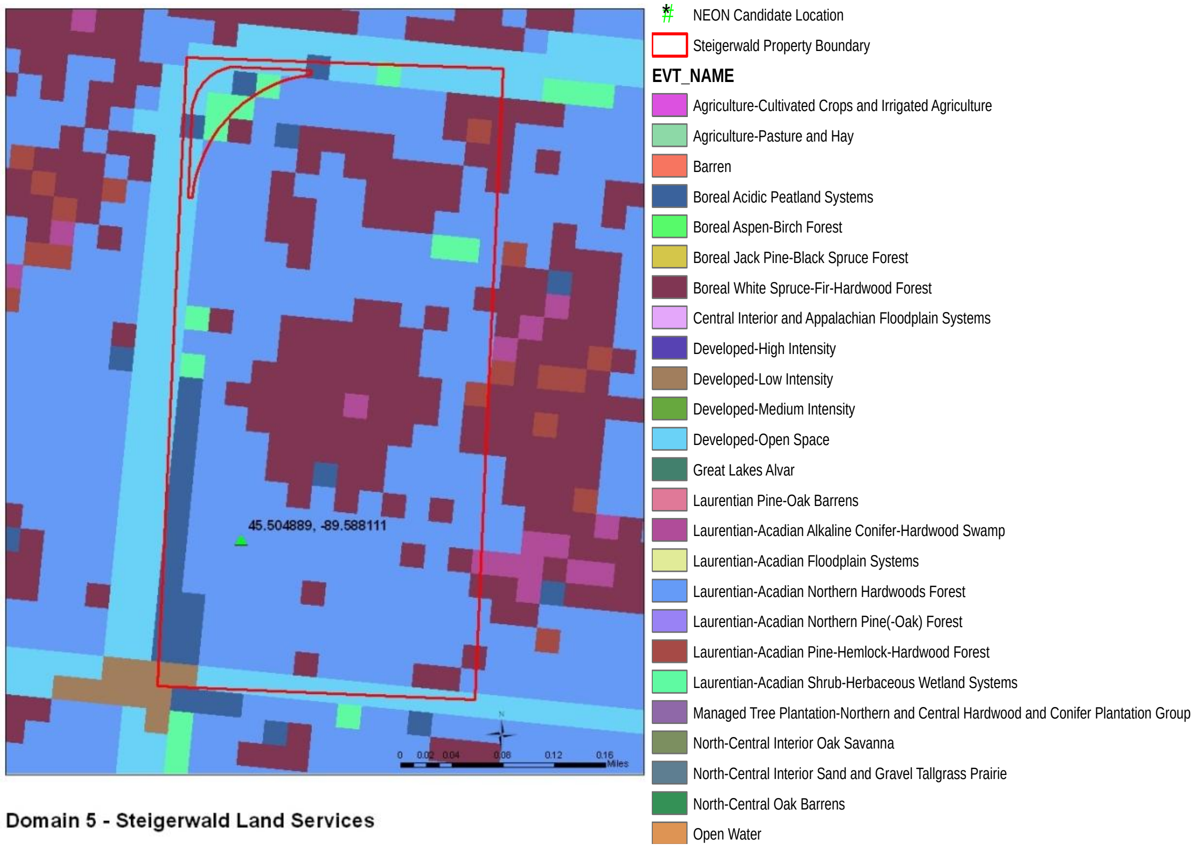


Figure 22. Vegetative cover map of the Steigerwaldt relocatable site and surrounding areas (from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Note that tower location has been changed since this map was made. See site layout map for the new tower location. Please do not be confused.

Table 8. Percent Land cover information at the Steigerwaldt relocatable site (from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	Area (km^2)	Percentage
Developed-Open Space	0.02	6.23
Developed-Low Intensity	0.00	0.29
Laurentian-Acadian Northern Hardwoods Forest	0.19	60.27
Boreal White Spruce-Fir-Hardwood Forest	0.08	26.37
Laurentian-Acadian Pine-Hemlock-Hardwood Forest	0.00	0.49
Boreal Acidic Peatland Systems	0.01	4.61
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	0.00	0.49
Laurentian-Acadian Shrub-Herbaceous Wetland Systems	0.00	1.26
Total Area Sq Km	0.31	100.00

The ecosystem around tower and inside the major airshed is aspen dominated regenerating forest. Trees are mainly regenerating saplings from the near clear-cut 10 years ago. Mean height is ~5.5 m and trees grow actively (~0.6 m per year). Assume the construction at this site will be in 2012 or 2013, which will give canopy height ~ 7 m. The mean canopy height will be expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. Stem density is very high and estimated to be ~4000 ha^{-1}, but this is likely to decrease as the forest stand matures. It is very difficult to walk through. Some trees at the south end of the site were not harvest in last harvest, and a few mature single trees (~20 m) are dotted around site. The height of seedlings and sapling ranges from 1 m to 5.5 m without obvious strata. The shrubs at the site are ~2 m tall. Grass forms the understory on the forest floor level with height ~0.3 m. The soil had few small stones, but some boulders were present.

Steigerwaldt site is small (only <400 m E-W direction and <800 m S-N direction). Forest management plots are shrinking at north Wisconsin and Steigerwaldt is considered relatively large in the region. Aspen trees are harvested every 40 years and used to make paper. The northeast corner of the property was the driest area and the site became wetter towards the south and west.

Table 9. Ecosystem and site attributes for the Steigerwaldt Relocatable site.

Ecosystem attributes	**Measure and units**
Mean canopy height at construction [a]	7.0 m
Surface roughness at construction [a]	1.0 m
Zero place displacement height at construction [a]	5.0 m
Mean canopy height at 8^{th} year of operation [b]	12.0 m
Surface roughness at 8^{th} year of operation [b]	2.0 m
Zero place displacement height at 8^{th} year of operation [b]	9.0 m
Structural elements	Regenerating young trees, actively grow
Time zone	Central time zone
Magnetic declination	2° 32' W changing by 0° 5' W/year

Note, [a] From field survey and best estimates for the time at the construction, which will require top measurement level at 13 m above ground.

[b] Best estimates by the time that NEON tower is decommissioned at the end of the 8 years' services, which will require top measurement level at 21 m above ground, therefore, FCC should design and budget adequate tower height ahead and allow the increase of the top measurement level to 21 m.

Figure 23. Regenerating northern hardwood forest is the dominant ecosystem type at Steigerwaldt Relocatable site

4.3 Soils

4.3.1 Description of soils

Soil data and soil maps below for Steigerwaldt tower site were collected from 4.8 km^2 NRCS soil maps (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) to determine the dominant soil types in the larger tower foot print. This was done to assure that the soil array is in the dominant (or in the co-dominant) soil type present in the tower footprint.

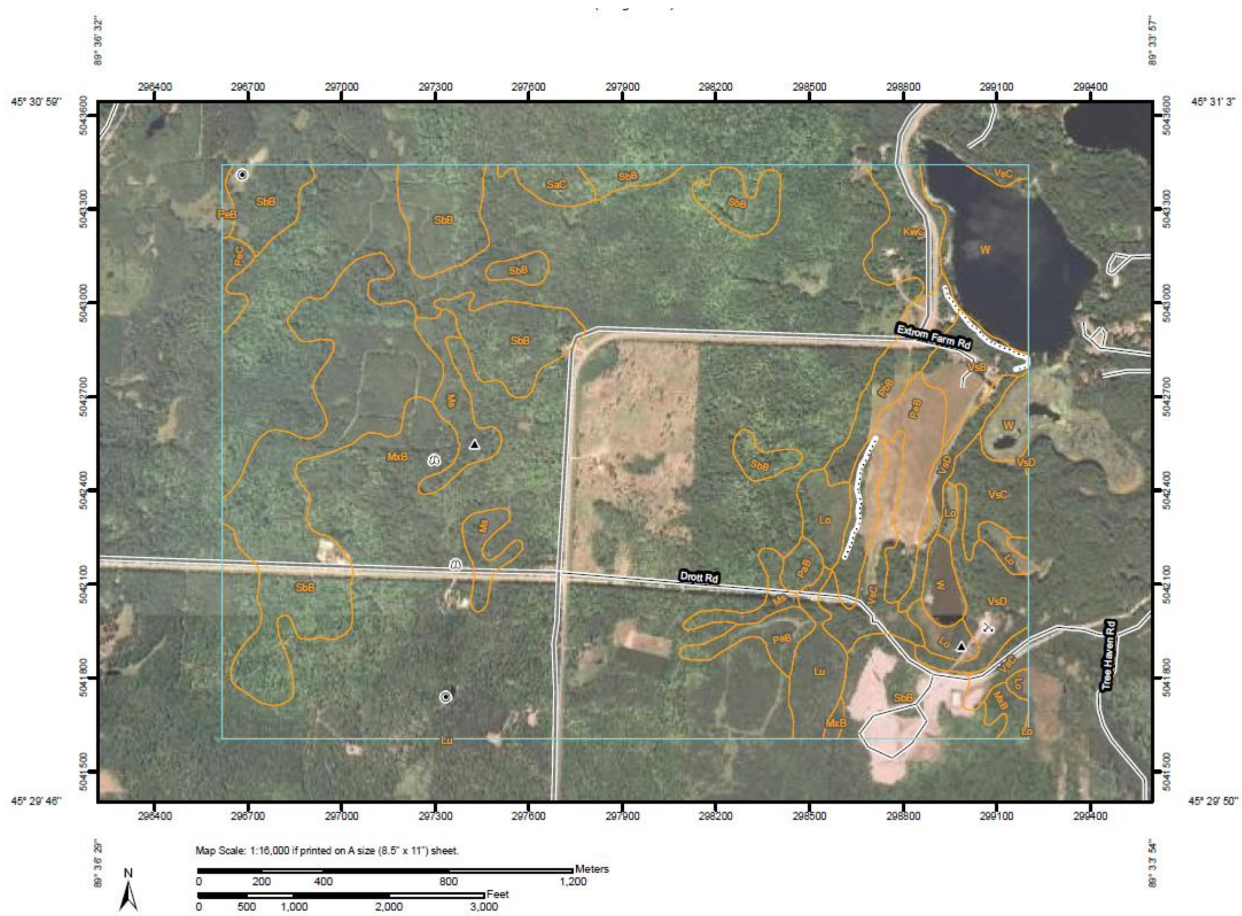


Figure 24. Soil map of the Steigerwaldt Relocatable site and surrounding areas.

Soil Map Units Description: The map units delineated on the detailed soil maps in a soil survey represents the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils. Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called non-contrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas. An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series. Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example. An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example. An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, are an example. Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Table 10. Soil series and percentage of soil series within 4.8 km^2 at the Steigerwaldt site

Lincoln County, Wisconsin (WI069)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
KwC	Keweenaw sandy loam, 6 to 15 percent slopes	18.2	1.6%
Lo	Loxley and Dawson peats, 0 to 1 percent slopes	21.1	1.8%
Lu	Lupton, Cathro, and Markey mucks, 0 to 1 percent slopes	14.7	1.3%
Ms	Minocqua and Capitola mucks, 0 to 2 percent slopes	26.1	2.2%
MxB	Moodig sandy loam, 0 to 4 percent slopes	681.8	58.1%
PaB	Padwet sandy loam, 1 to 6 percent slopes	12.8	1.1%
PbB	Padwood sandy loam, 1 to 6 percent slopes	18.1	1.5%
PeB	Pence-Padus sandy loams, 1 to 6 percent slopes	33.0	2.8%
PeC	Pence-Padus sandy loams, 6 to 15 percent slopes	4.5	0.4%
SaC	Sarona-Pence sandy loams, 6 to 15 percent slopes	6.8	0.6%
SbB	Sarwet sandy loam, 2 to 6 percent slopes	202.4	17.2%
VsB	Vilas-Sayner loamy sands, 1 to 6 percent slopes	15.9	1.4%
VsC	Vilas-Sayner loamy sands, 6 to 15 percent slopes	39.7	3.4%
VsD	Vilas-Sayner loamy sands, 15 to 35 percent slopes	29.7	2.5%
W	Water	49.3	4.2%
Totals for Area of Interest		**1,173.9**	**100.0%**

Lincoln County, Wisconsin KwC—Keweenaw sandy loam, 6 to 15 percent slopes: Map Unit Setting Elevation: 600 to 1,300 feet Mean annual precipitation: 26 to 33 inches Mean annual air temperature: 41 to 45 degrees F Frost-free period: 100 to 140 days **Map Unit Composition** Keweenaw and similar soils: 100 percent **Description of Keweenaw Setting** Landform: Moraines Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy drift **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.7 inches) **Interpretive groups** Land capability (nonirrigated): 3e Other vegetative classification: Acer saccharum/Vaccinium- Viburnum (AVVb) **Typical profile** 0 to 4 inches: Sandy loam 4 to 20 inches: Loamy fine sand 20 to 43 inches: Sand 43 to 60 inches: Fine sandy loam

Lincoln County, Wisconsin Lo—Loxley and Dawson peats, 0 to 1 percent slopes: Map Unit Setting Elevation: 600 to 1,800 feet Mean annual precipitation: 22 to 34 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 60 to 140 days **Map Unit Composition** Loxley and similar soils: 75 percent Dawson and similar soils: 25 percent **Description of Loxley Setting** Landform: Depressions on outwash plains, depressions on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave Across-slope shape: Concave Parent material: Organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Occasional Available water capacity: Very high (about 25.9 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Not Assigned (acid organic soils) (Naor) **Typical profile** 0 to 20 inches: Peat 20 to 60 inches: Muck **Description of Dawson Setting** Landform: Depressions on outwash plains, depressions on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave Across-slope shape: Concave Parent material: Organic material over sandy drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Occasional Available water capacity: Very high (about 19.0 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Not Assigned (acid organic soils) (Naor) **Typical profile** 0 to 8 inches: Peat 8 to 40 inches: Muck 40 to 60 inches: Sand

Lincoln County, Wisconsin Lu—Lupton, Cathro, and Markey mucks, 0 to 1 percent slopes: Map Unit Setting Elevation: 600 to 1,400 feet Mean annual precipitation: 22 to 44 inches Mean annual air temperature: 39 to 46 degrees F Frost-free period: 60 to 140 days **Map Unit Composition** Lupton and similar soils: 45 percent Cathro and similar soils: 35 percent Markey and similar soils: 20 percent **Description of Lupton Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 23.9 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 24 inches: Muck 24 to 60 inches: Muck **Description of Cathro Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material over loamy and/or silty drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 1.98 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 25 percent Available water capacity: Very high (about 18.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 15 inches: Muck 15 to 28 inches: Muck 28 to 60 inches: Loam **Description of Markey Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material over sandy outwash **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 5 percent Available water capacity: Very high (about 15.8 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 36 inches: Muck 36 to 60 inches: Sand

Lincoln County, Wisconsin Ms—Minocqua and Capitola mucks, 0 to 2 percent slopes: Map Unit Setting Elevation: 800 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 130 days **Map Unit Composition** Minocqua and similar soils: 65 percent Capitola and similar soils: 35 percent **Description of Minocqua Setting** Landform: Depressions on outwash plains, depressions on moraines, drainageways on moraines, drainageways on outwash plains Landform position (two-dimensional): Toeslope Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Loamy and/or silty drift over sandy and gravelly outwash **Properties and qualities** Slope: 0 to 2 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 5 percent Available water capacity: Moderate (about 7.0 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (wet mineral soils) (Nmin) **Typical profile** 0 to 4 inches: Muck 4 to 33 inches: Silt loam 33 to 37 inches: Gravelly loamy coarse sand 37 to 60 inches: Coarse sand **Description of Capitola Setting** Landform: Depressions on outwash plains, depressions on moraines, drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Loamy and/or silty drift over loamy till **Properties and qualities** Slope: 0 to 2 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 10 percent Available water capacity: High (about 9.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (wet mineral soils) (Nmin) **Typical profile** 0 to 5 inches: Muck 5 to 7 inches: Silt loam 7 to 22 inches: Silt loam 22 to 33 inches: Fine sandy loam 33 to 60 inches: Fine sandy loam

Lincoln County, Wisconsin MxB—Moodig sandy loam, 0 to 4 percent slopes: Map Unit Setting Elevation: 700 to 1,950 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 135 days **Map Unit Composition** Moodig and similar soils: 95 percent Minor components: 5 percent **Description of Moodig Setting** Landform: Moraines Landform position (two-dimensional): Footslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Loamy till **Properties and qualities** Slope: 0 to 4 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 7.9 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Tsuga/Maianthemum-Coptis (TMC), Acer saccharum/Hydrophyllum (AH), Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum-Tsuga/Maianthemum (ATM) **Typical profile** 0 to 3 inches: Sandy loam 3 to 5 inches: Gravelly sandy loam 5 to 22 inches: Gravelly sandy loam 22 to 53 inches: Sandy loam

53 to 73 inches: Gravelly sandy loam 73 to 95 inches: Gravelly sandy loam **Minor Components Capitola** Percent of map unit: 5 percent Landform: Depressions

Lincoln County, Wisconsin PaB—Padwet sandy loam, 1 to 6 percent slopes: Map Unit Setting Elevation: 700 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 120 days **Map Unit Composition** Padwet and similar soils: 100 percent **Description of Padwet Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 30 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.2 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum/Viola-Osmorhiza (AViO), Acer saccharum-Tsuga/Maianthemum (ATM) **Typical profile** 0 to 2 inches: Sandy loam 2 to 30 inches: Sandy loam 30 to 39 inches: Sandy loam 39 to 60 inches: Sand

Lincoln County, Wisconsin PbB—Padwood sandy loam, 1 to 6 percent slopes Map Unit Setting Elevation: 700 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 120 days **Map Unit Composition** Padwood and similar soils: 100 percent **Description of Padwood Setting** Landform: Lake plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over stratified loamy lacustrine deposits and/or sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr) Depth to water table: About 30 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.4 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 4 inches: Sandy loam 4 to 15 inches: Sandy loam 15 to 27 inches: Sandy loam 27 to 36 inches: Gravelly loamy sand 36 to 50 inches: Sand 50 to 70 inches: Stratified very fine sand to silt loam

Lincoln County, Wisconsin PeB—Pence-Padus sandy loams, 1 to 6 percent slopes: Map Unit Setting Elevation: 600 to 2,000 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 135 days **Map Unit Composition** Pence and similar soils: 65 percent Padus and similar soils: 35 percent **Description of Pence Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability classification (irrigated): 2e Land capability (nonirrigated): 3e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 4 inches: Sandy loam 4 to 16 inches: Sandy loam 16 to 34 inches: Gravelly coarse sand 34 to 60 inches: Gravelly coarse sand **Description of Padus Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties**

and qualities Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.1 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 3 inches: Sandy loam 3 to 4 inches: Sandy loam 4 to 11 inches: Sandy loam 11 to 29 inches: Sandy loam 29 to 60 inches: Gravelly coarse sand

4.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 25). For the theoretical variogram models considered here, the semivariance will converge on the total variance at distances for which values are no longer spatially auto-correlated (this is referred to as the range, Figure 25).

For the theoretical variograms considered here, three parameters estimated from the data are used to fit a semivariogram model to the empirical semivariogram. This model is then assumed to quantitatively represent the correlation as a function of distance (Figure 25), the range, the sill (the sill is the asymptotic value of semi-variance at the range), and the nugget (which describes sampling error or variation at distances below those separating the closest pairs of samples). The range, sill and nugget are estimated from theoretical models that are fitted to the empirical variograms using non-linear least squares methods.

The variogram analysis will be used, to determine the spatial scales at which we can consider soil measurements spatially independent. This characterization will directly inform the minimum distance between *i*) soil plots within each soil array, *ii*) the soil profile measurements, *iii*) EP plots, and *iv*) the microbial sampling locations. These data will directly inform NEON construction and site design activities.

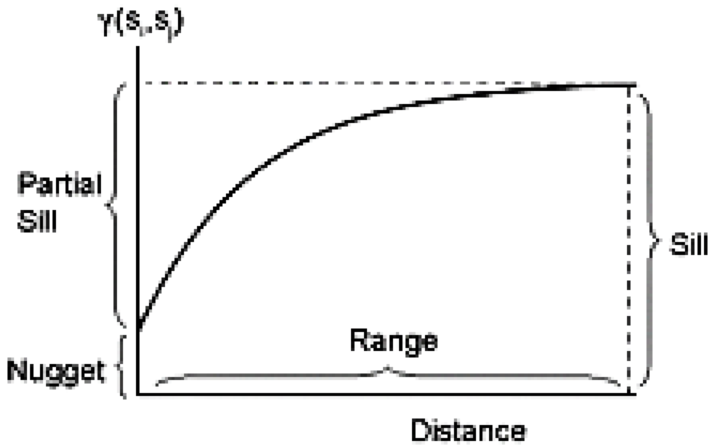


Figure 25. Example semivariogram, depicting range, sill, and nugget.

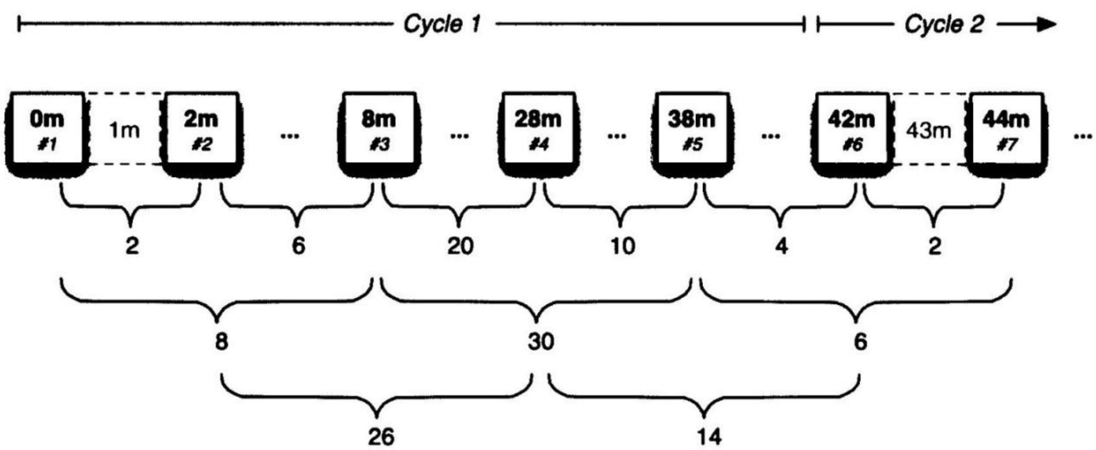


Figure 26. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 12 August 2010 at the Steigerwaldt site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 26). Soil temperature and moisture measurements were collected along three transects (210 m, 84 m, and 84 m) located in the expected airshed at Steigerwaldt. Details of how the airshed was determined are provided below. Soil temperature was measured with platinum resistance temperature sensors (RTD 810, Omega Engineering Inc., Stamford CT) and soil moisture was measured with time domain diaelectric sensors (CS616, Campbell Scientific Inc., Logan UT).

As well as measuring soil temperature and moisture at each sample point in Figure 26, measurements were also taken 30 cm in front and behind the sampling point along the axis of the transect. For example, at the 2 m sampling point, soil temperature and moisture was measured at 1.7 m, 2 m, and 2.3 m; this data is referred to as mobile data, since the measurements were taken at many different locations. In addition, soil temperature and moisture were continuously recorded at a single fixed location (stationary data) throughout the sampling time to correct for changes in temperature and moisture throughout the day.

Data collected were used for geospatial analyses of variograms in the R statistical computing language with the geoR package to test for spatial autocorrelation (Trangmar *et al.* 1986; Webster & Oliver 1989; Goovaerts 1997; Riberiro & Diggle 2001) and estimate the distance necessary for independence among soil plots in the soil array. To correct for changes in temperature and moisture over the sampling period, the stationary data was subtracted from the mobile data. In many instances a trend was still apparent in the data even after subtracting the stationary data from the mobile data. This trend was corrected for by fitting a linear regression based on time of day, elevation, slope, and/or aspect and using the residuals for the semivariogram analysis. Soil temperature and moisture data, R code, graphs, and R output can be found at: P:\FIU\FIU_Site_Characterization\DXX\YYYYYYY_Characterization\Soil Measurements\Soil Data Analysis (where XX = domain number and YYYYYYY = site name).

4.3.3 Results and interpretation

4.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day, elevation, slope, and aspect trend, were used for the semivariogram analysis (Figure 27). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 28, left graph) and directional semivariograms do not show anisotropy (Figure 28, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 28, right graph). The model indicates a distance of effective independence of >100 m for soil temperature.

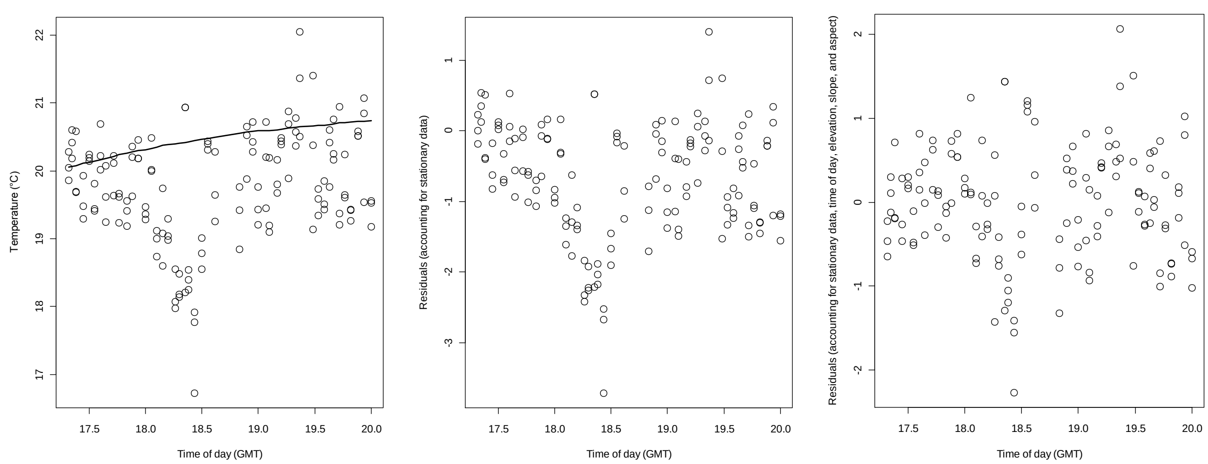


Figure 27. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

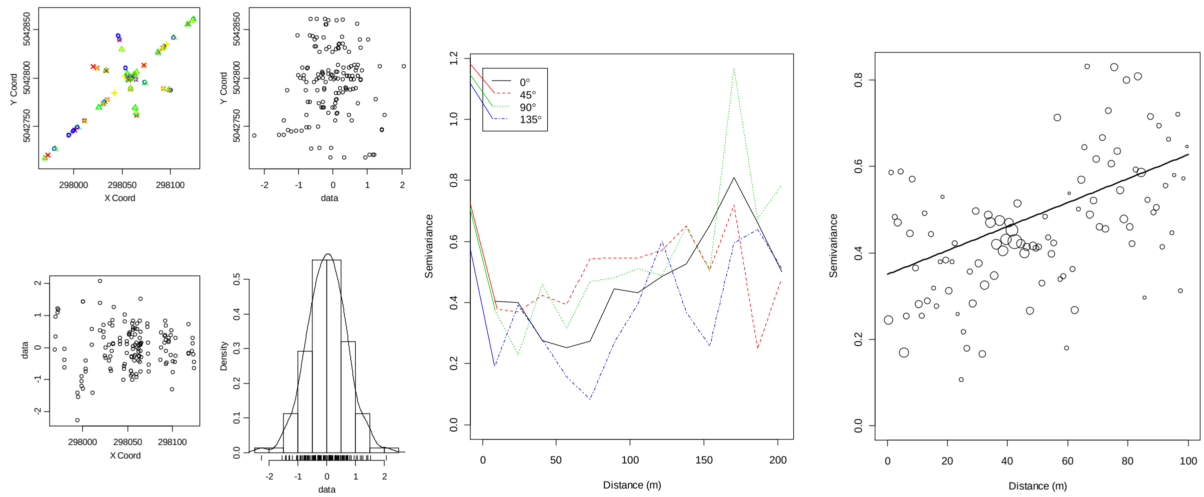


Figure 28. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

4.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day, elevation, and aspect trend, were used for the semivariogram analysis (Figure 29). Exploratory data analysis plots show that there was still some patterning of the residuals, which is not desirable for semivariogram analysis (Figure 30, left graph), but directional semivariograms do not show anisotropy (Figure 30, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 30, right graph). The model indicates a distance of effective independence of >100 m for soil water content.

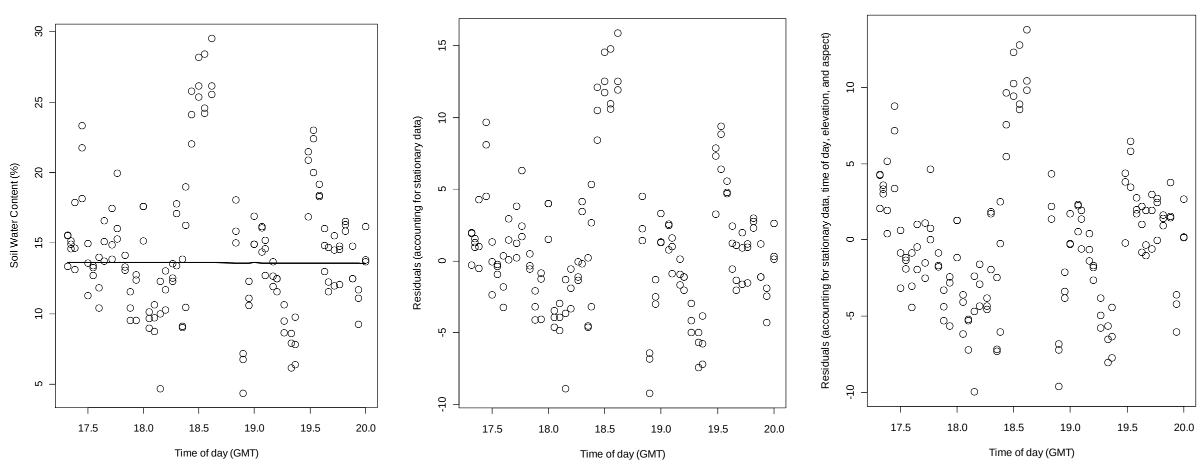


Figure 29. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear

regression based on time of day (line). Right graph: residual water content data after correcting for changes water content in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

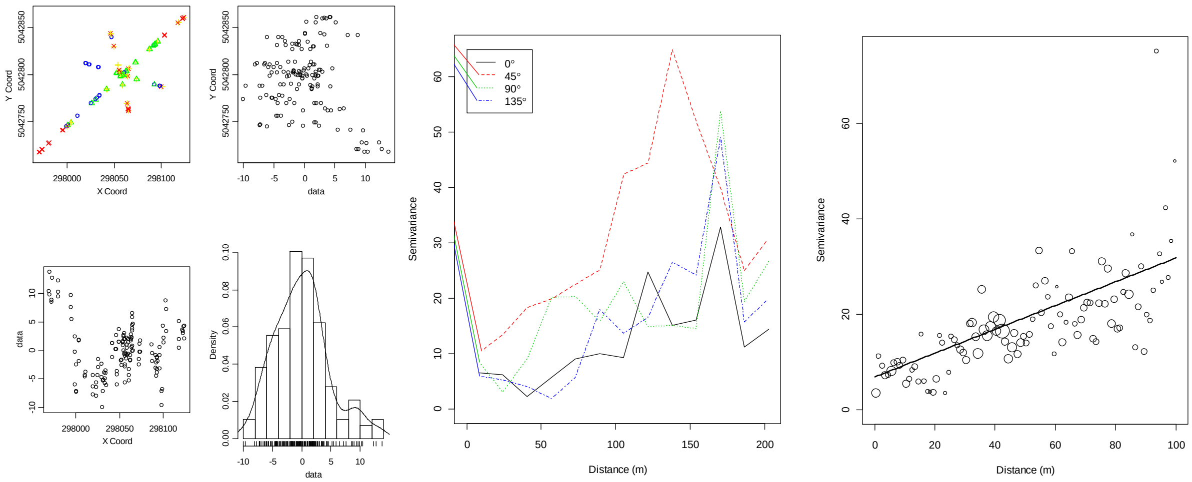


Figure 30. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

4.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was >100 m for soil temperature and >100 m for soil moisture. Based on these results and the site design guidelines the soil plots at Steigerwaldt shall be placed 40 m apart. The soil array shall follow the linear soil array design (Soil Array Pattern B) with the soil plots being 5 m x 5 m. The direction of the soil array shall be 240° from the soil plot nearest the tower (i.e., first soil plot). The location of the first soil plot will be approximately 45.509590, -89.585164. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc). The FIU soil pit for characterizing soil horizon depths, collecting soil for site-specific sensor calibration, and collecting soil for the FIU soil archive will be located at 45.51011, -89.58440 (primary location); or 45.51010, -89.58476 (alternate location 1 if primary location is unsuitable); or 45.510109, -89.585372 (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 11 and site layout can be seen in Figure 31.

Dominant soil series at the site: Moodig sandy loam, 0 to 4 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Aquods
Great group: Epiaquods

Subgroup: Alfic Epiaquods
Family: Coarse-loamy, mixed, superactive, frigid Alfic Epiaquods
Series: Moodig sandy loam, 0 to 4 percent slopes

Table 11. Summary of soil array and soil pit information at Steigerwaldt. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	18 m
Latitude and longitude of 1st soil plot OR direction from tower	45.509590, -89.585164
Direction of soil array	240°
Latitude and longitude of FIU soil pit 1	45.51011, -89.58440 (primary location)
Latitude and longitude of FIU soil pit 2	45.51010, -89.58476 (alternate 1)
Latitude and longitude of FIU soil pit 3	45.510109, -89.585372 (alternate 2)
Dominant soil type	Moodig sandy loam, 0 to 4 percent slopes
Expected soil depth	>2 m
Depth to water table	0.15 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.08 m (Sandy loam)	0.04 m
0.08-0.13 m (Gravelly sandy loam)	0.11 m [A]
0.13-0.56 m (Gravelly sandy loam)	0.35 m [A]
0.56-1.35 m (Sandy loam)	0.96 m
1.35-1.85 m (Gravelly sandy loam)	1.60 m [A]
1.85-2 m (Gravelly sandy loam)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
[A] Expected depth of soil CO_2 sensors (subject to soil horizon depths)

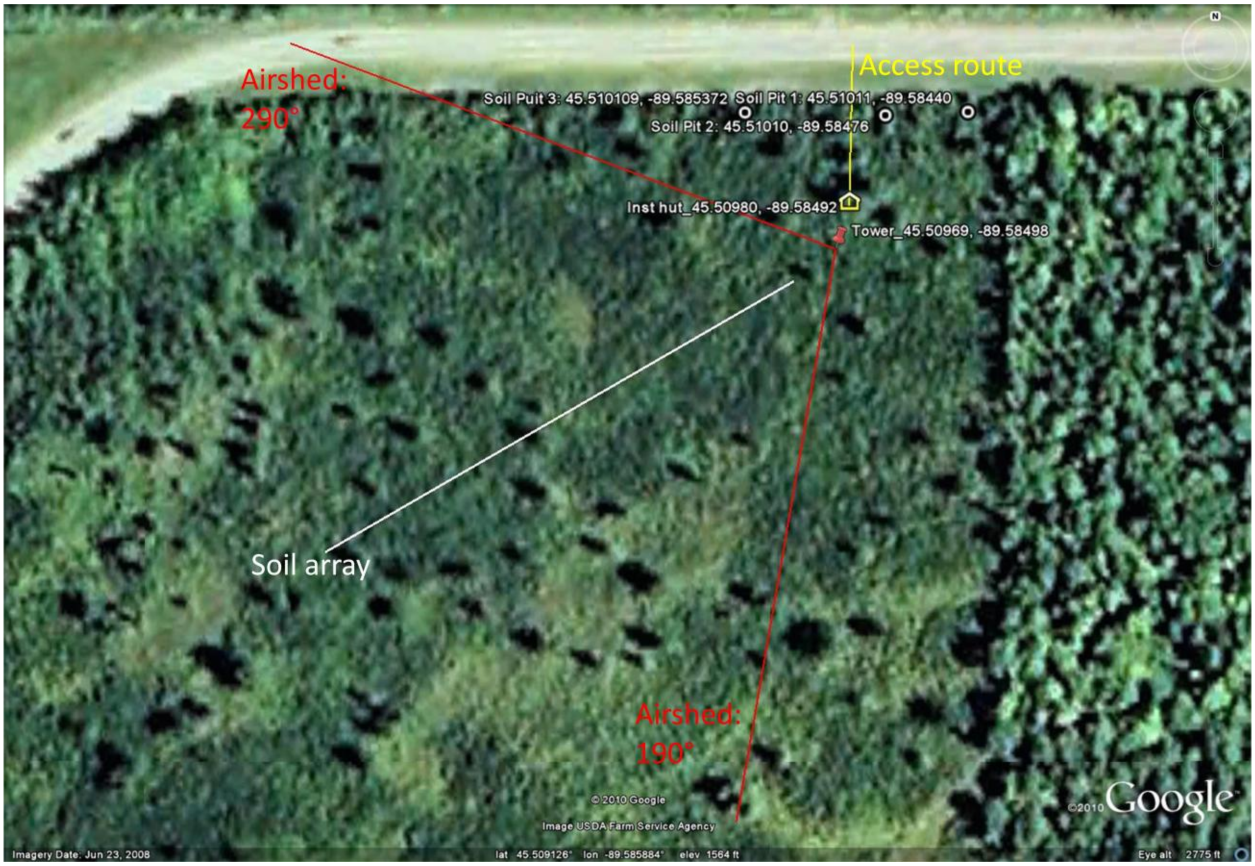


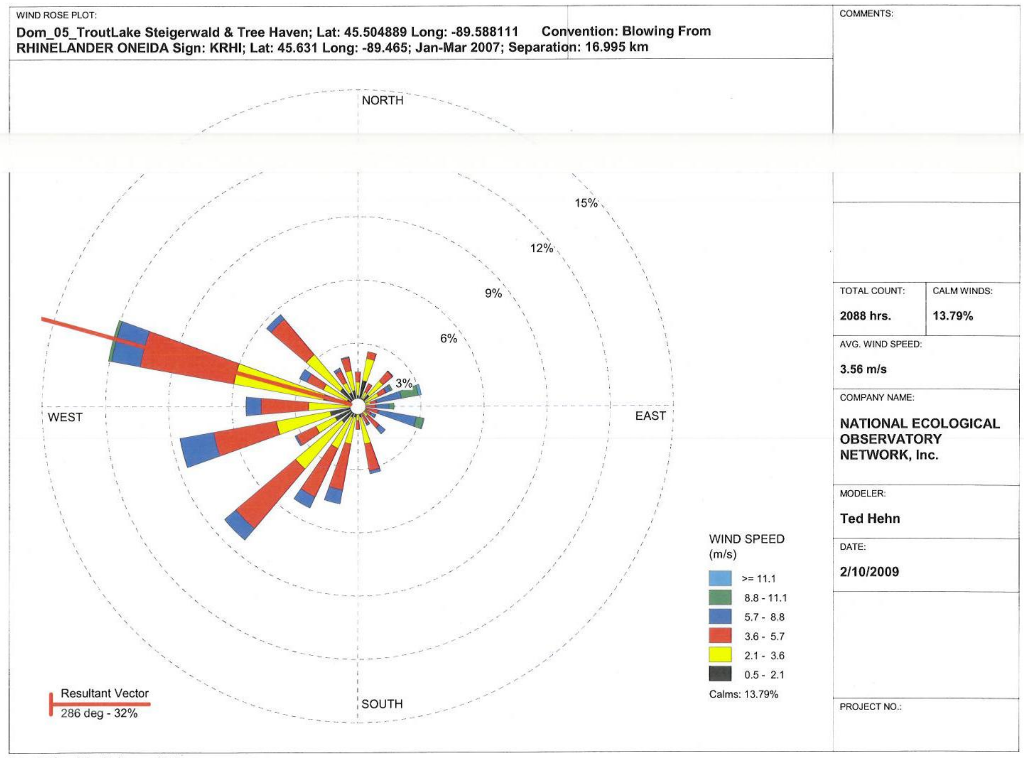
Figure 31. Site layout at Steigerwaldt showing soil array and location of the FIU soil pit.

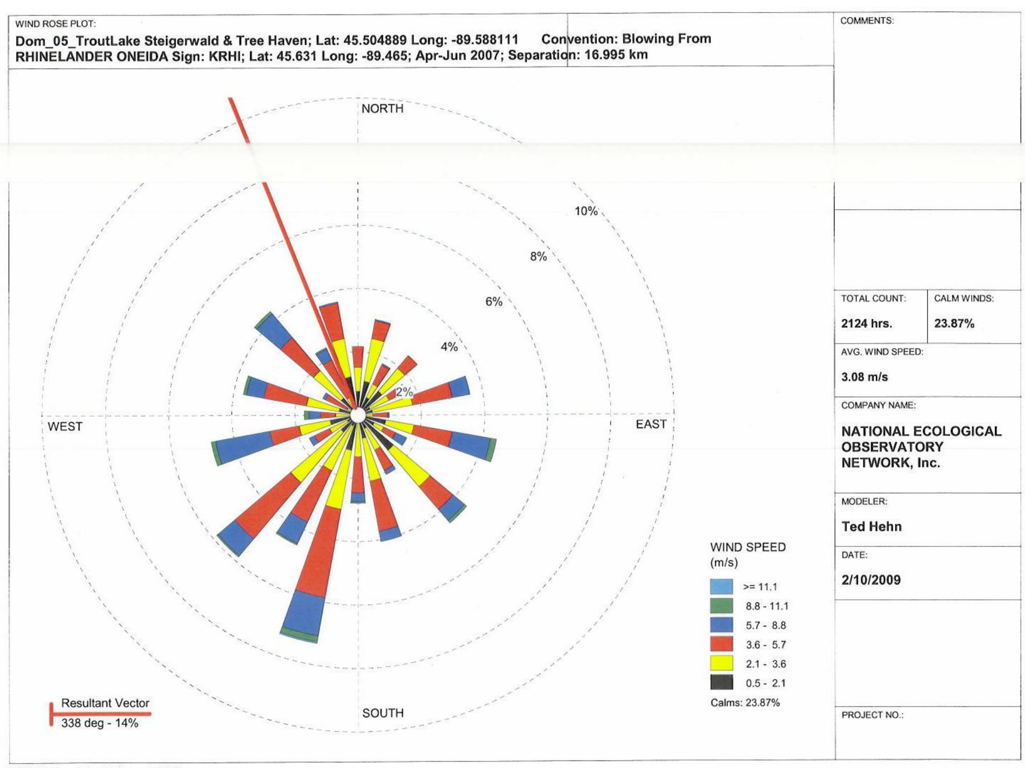
4.4 Airshed

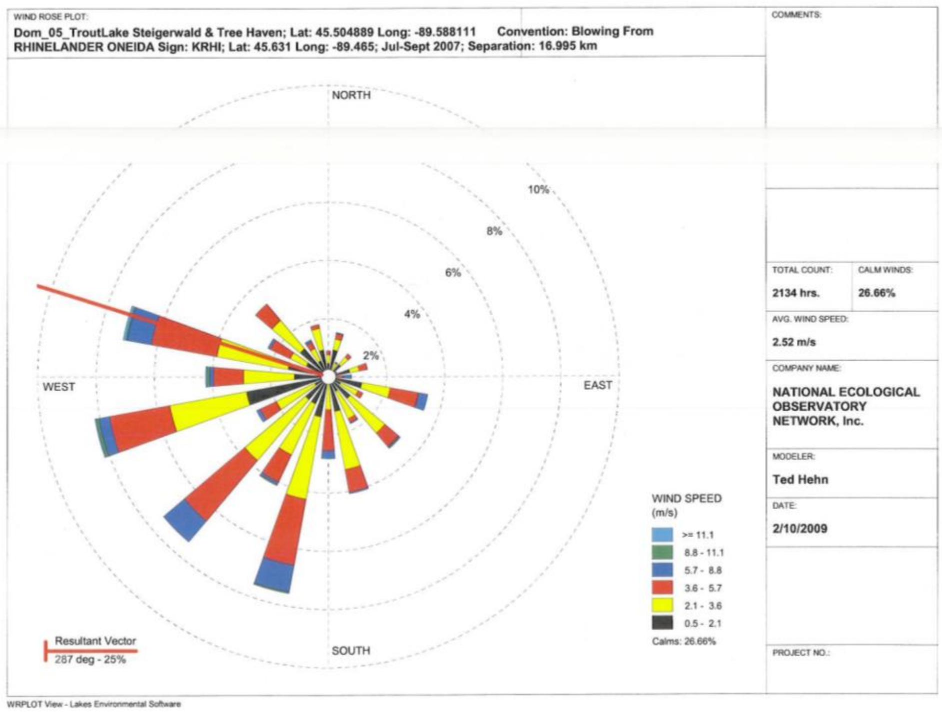
4.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries. The weather data used to generate the following wind roses are from Rhinelander Oneida County (RHI) airport (45.631, -89.465), which is ~17 km from tower site. Terrain is flat in this region. We assume that the wind patterns at RHI are similar to the ones at our sit. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

4.4.2 Results (graphs for wind roses)







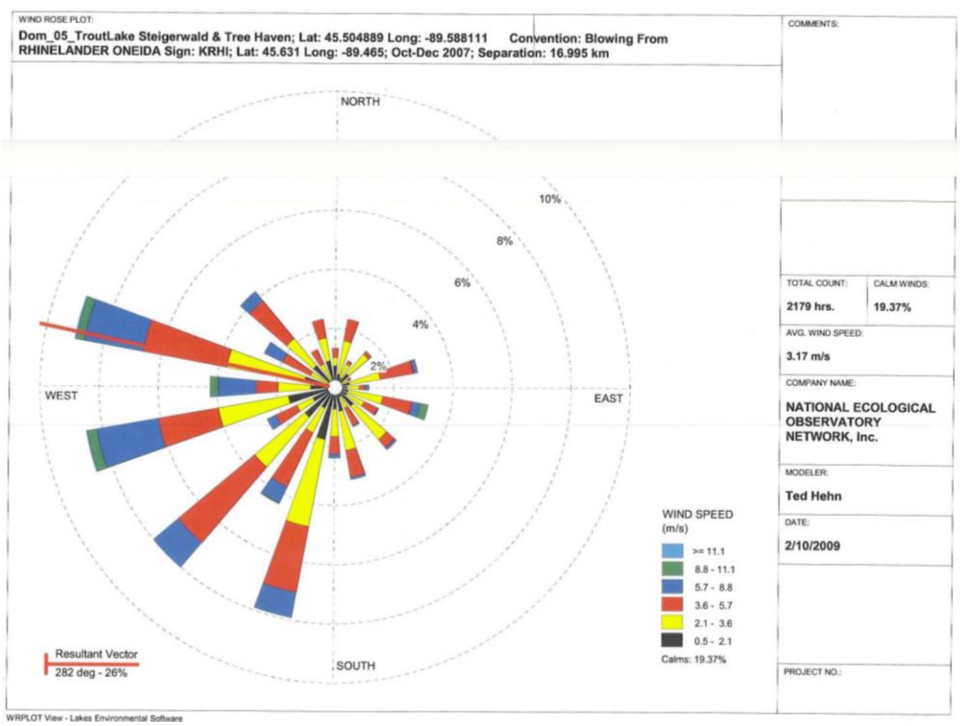


Figure 32. Windroses from Steigerwaldt.
Data used here are 2007 data from Rhinelander Oneida County (RHI) airport (45.631, -89.465), which is ~17 km from NEON tower site. It is assumed that the wind data was corrected for declination. Panels are (from top to bottom) Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

4.4.3 Resultant vectors

Table 12. The resultant wind vectors from Steigerwaldt Relocatable site using hourly data in 2007.

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	286°	32
April to June	338°	14
July to September	287°	25
October to December	282°	26
Annual mean	298.25°	na.

4.4.4 Expected environmental controls on source area

Two types of models were commonly used to determine the shape and extent of the source area under different and contrasting atmospheric stability classes. An inverted plume dispersion model with modeled cross wind solutions were used for convective conditions (Horst and Weil 1994). For strongly stable conditions, and Lagrangian solution was used (Kormann and Meixner 2001). The source area models where bounded by the expected conditions depict the extreme conditions. Convective conditions typically have strong vertical mixing between the ecosystem and atmosphere (surface layer). Stable conditions typically have long source area and associated waveforms. Convective turbulence is often characterized by short mixing scales (scalar) and moderate daytime wind speeds, *e.g.,* 1-4 m s^{-2}. Higher wind speeds, like those experienced over the Rockies, are often the product of mechanical turbulence with long waveforms. Because thermal stratification is very efficient in suppressing vertical mixing, stable conditions also have typically very long waveforms.

As a general rule, shorter and less structurally complex ecosystems have good vertical mixing during all atmospheric stabilities. Taller and more structurally complex ecosystems have well mixed upper canopies during the daytime, and can be decoupled below the canopy under neutral and stable conditions (e.g., Harvard Forest, Bartlett Experimental Forest, and Burlington Conservation Area). The type of turbulence (mechanical verse convective) and the physical attributes of the ecosystem control the degree of mixing, and the length and size of the source area.

Here, we use a web-based footprint model to determine the footprint area under various conditions (model info: http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/). Winds used to run the model and generate following model results are extracted from the wind roses. Vegetation information, temperature and energy information were either from the RFI document, previous site visit report, available data files or best estimated from experienced expert. Measurement height was determined from the Tower Height Info document provided by ENG group, then verify according to the real ecosystem structure after FIU site characterization at site. Runs 1-3 and 4-6 represent the expected conditions for summer and winter conditions, respectively, with maximum and mean windspeeds (daytime convective) and nighttime (stable atmospheres) conditions. The wind vector for each run was estimated from wind roses and is placed as a centerline in the site map included in the graphics. The width of the footprint was also estimated using the length between the isopleth of 80% cumulative flux and center line to calculate the angle from centerline. This information, along with distance of the cumulative flux isopleths and wind direction, will define the source area for the flux measurements on the top of the tower.

Because the forest is actively growing at this site, the canopy height and required measurement height will change over time. We present two sets of footprint analysis outcome below for the time during construction (or at the beginning of operation) and for the time at the end of 8th year of operation, which is approximate the time to decommission NEON tower at this site.

Table 13. Expected environmental controls to parameterize the source area model based on the wind roses for Rhinelander Oneida County (RHI) airport, and associated results for Steigerwaldt Relocatable tower site at construction.

Parameters	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	
Approximate season	summer			winter			Units
	Day (max WS)	Day (mean WS)	Night	Day (max WS)	Day (mean WS)	night	qualitative
Atmospheric stability	Convective	convective	Stable	Convective	convective	Stable	qualitative
Measurement height	13	13	13	13	13	13	m
Canopy Height	7	7	7	7	7	7	m
Canopy area density	3	3	3	1.5	1.5	1.5	m
Boundary layer depth	2000	2000	900	900	900	700	m
Expected sensible heat flux	350	350	-9	180	180	-76	W m^{-2}
Air Temperature	28	28	20	-5	-5	-10	°C
Max. windspeed	11.6	3.6	1.6	11.6	4.6	2.6	m s^{-1}
Resultant wind vector	255	255	255	287	287	287	degrees
Results							
(z-d)/L	-0.01	-0.19	0.18	0.00	-0.06	1.80	m
d	5.60	5.60	5.60	5.00	5.00	5.00	m
Sigma v	3.30	1.90	1.80	3.30	1.70	1.70	m^2 s^{-2}
Z0	0.31	0.31	0.31	0.43	0.43	0.43	m
u*	1.50	0.53	0.16	1.60	0.67	0.16	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	600	300	1100	600	450	2000	m
Distance of 80% cumulative flux	300	200	600	300	300	1300	m
Distance of 70% cumulative flux	200	150	400	250	200	850	m
Peak contribution	45	35	55	45	35	155	m

Table 14. Expected environmental controls to parameterize the source area model based on the wind roses for Rhinelander Oneida County (RHI) airport, and associated results for Steigerwaldt Relocatable tower site at the end of 8th year of operation.

Parameters	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	
Approximate season	summer			winter			Units
	Day	Day	Night	Day	Day	night	qualitative

	(max WS)	(mean WS)		(max WS)	(mean WS)		
Atmospheric stability	Convective	convective	Stable	Convective	convective	Stable	qualitative
Measurement height	21	21	21	21	21	21	m
Canopy Height	12	12	12	12	12	12	m
Canopy area density	3	3	3	1.5	1.5	1.5	m
Boundary layer depth	2000	2000	900	900	900	700	m
Expected sensible heat flux	350	350	-9	180	180	-76	W m^{-2}
Air Temperature	28	28	20	-5	-5	-10	°C
Max. windspeed	11.6	3.6	1.6	11.6	4.6	2.6	m s^{-1}
Resultant wind vector	255	255	255	287	287	287	degrees
Results							
(z-d)/L	-0.01	-0.25	0.52	-0.01	-0.08	3.00	m
d	9.80	9.80	9.80	9.00	9.00	9.00	m
Sigma v	3.40	1.90	1.70	3.30	1.70	1.60	m^2 s^{-2}
Z0	0.48	0.48	0.48	0.66	0.66	0.66	m
u*	1.50	0.56	0.13	1.60	0.69	0.06	m s^{-1}
Distance source area begins	10	0	50	0	0	450	m
Distance of 90% cumulative flux	800	400	1900	800	600	3500	m
Distance of 80% cumulative flux	480	250	1100	480	350	3100	m
Distance of 70% cumulative flux	300	120	750	300	250	2700	m
Peak contribution	65	45	125	65	55	1425	m

4.4.5 Results (source area graphs)

By the time of construction:

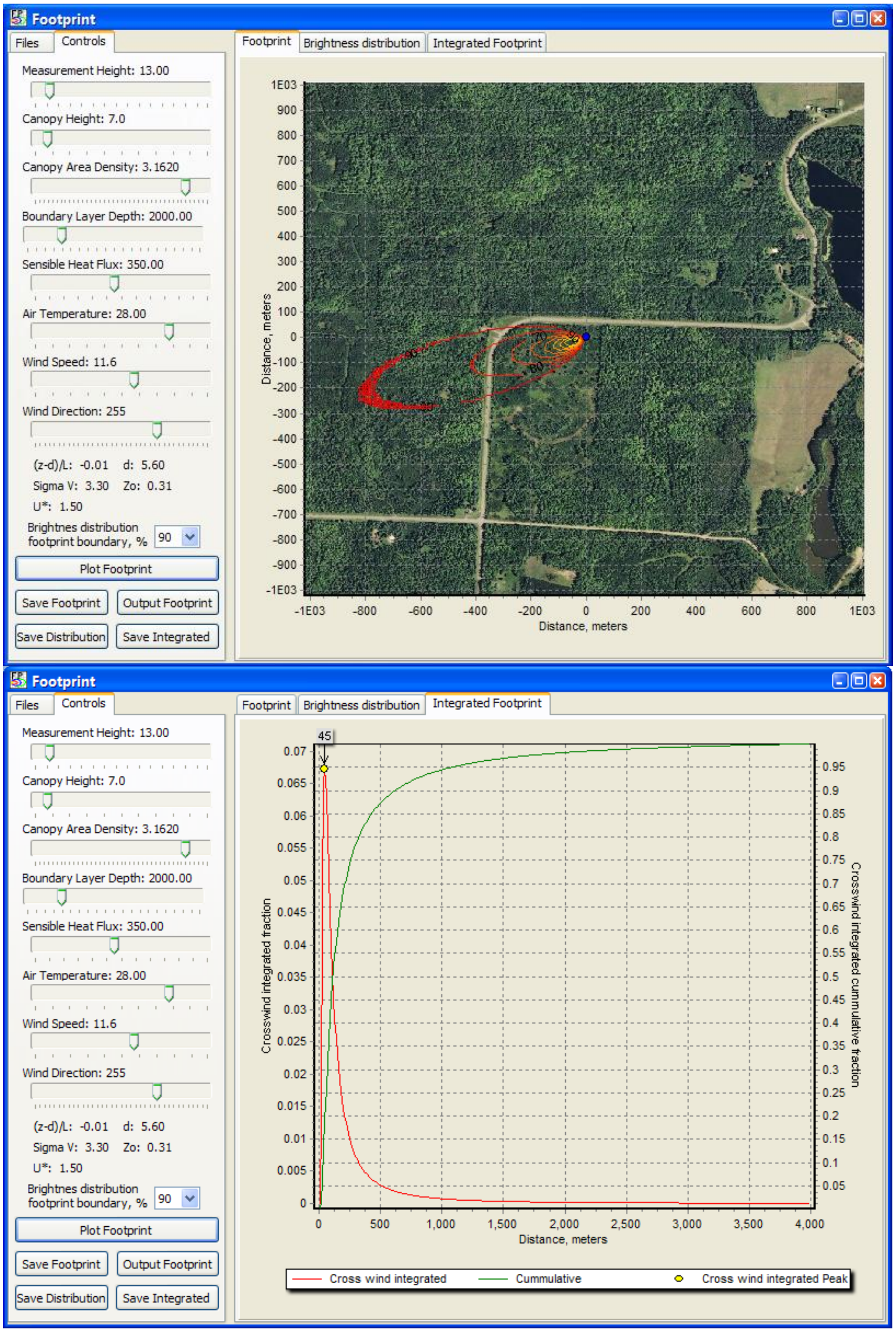


Figure 33. Steigerwaldt Relocatable site summer daytime (convective) footprint output with max wind speed at construction

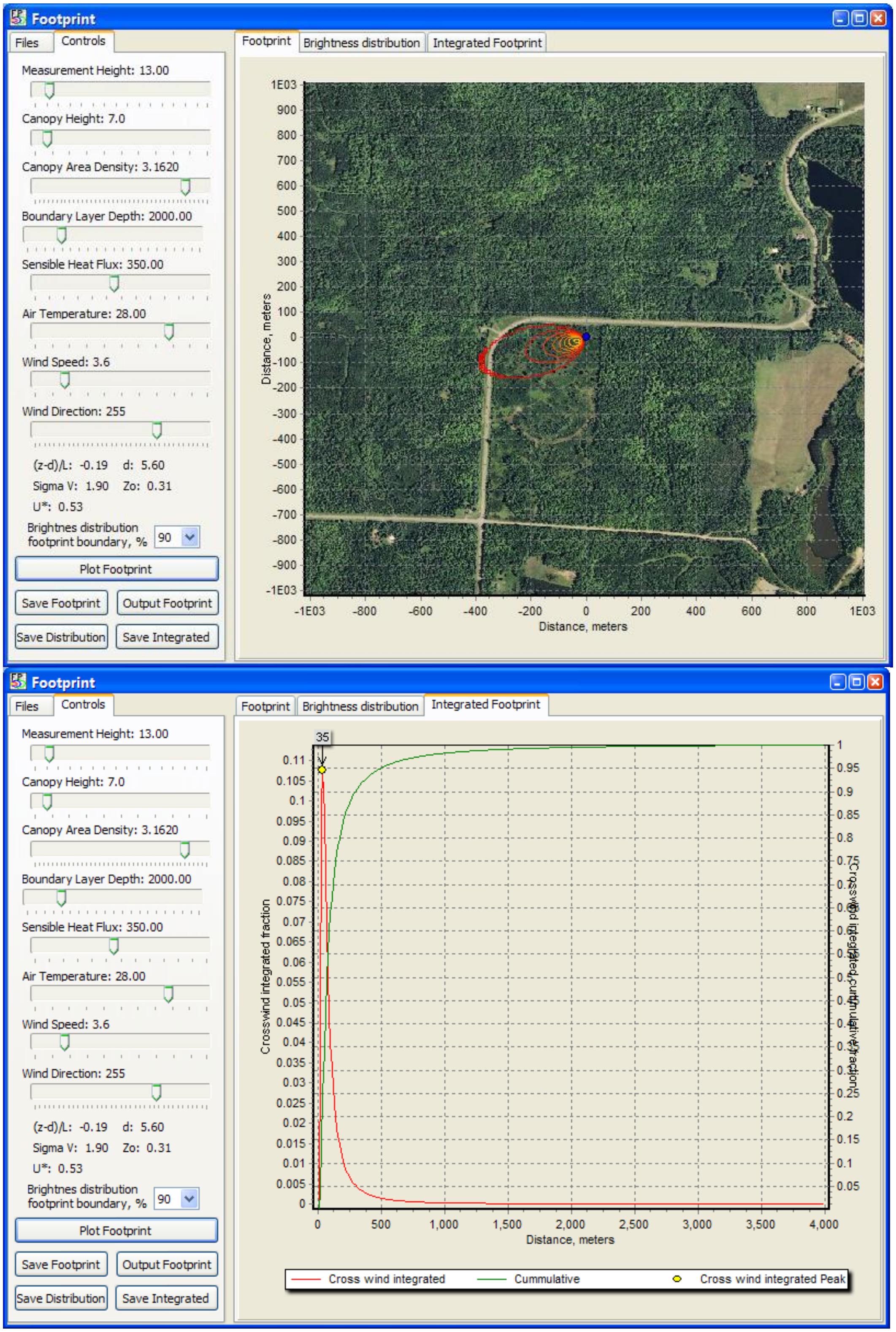


Figure 34. Steigerwaldt Relocatable site summer daytime (convective) footprint output with mean wind speed at construction

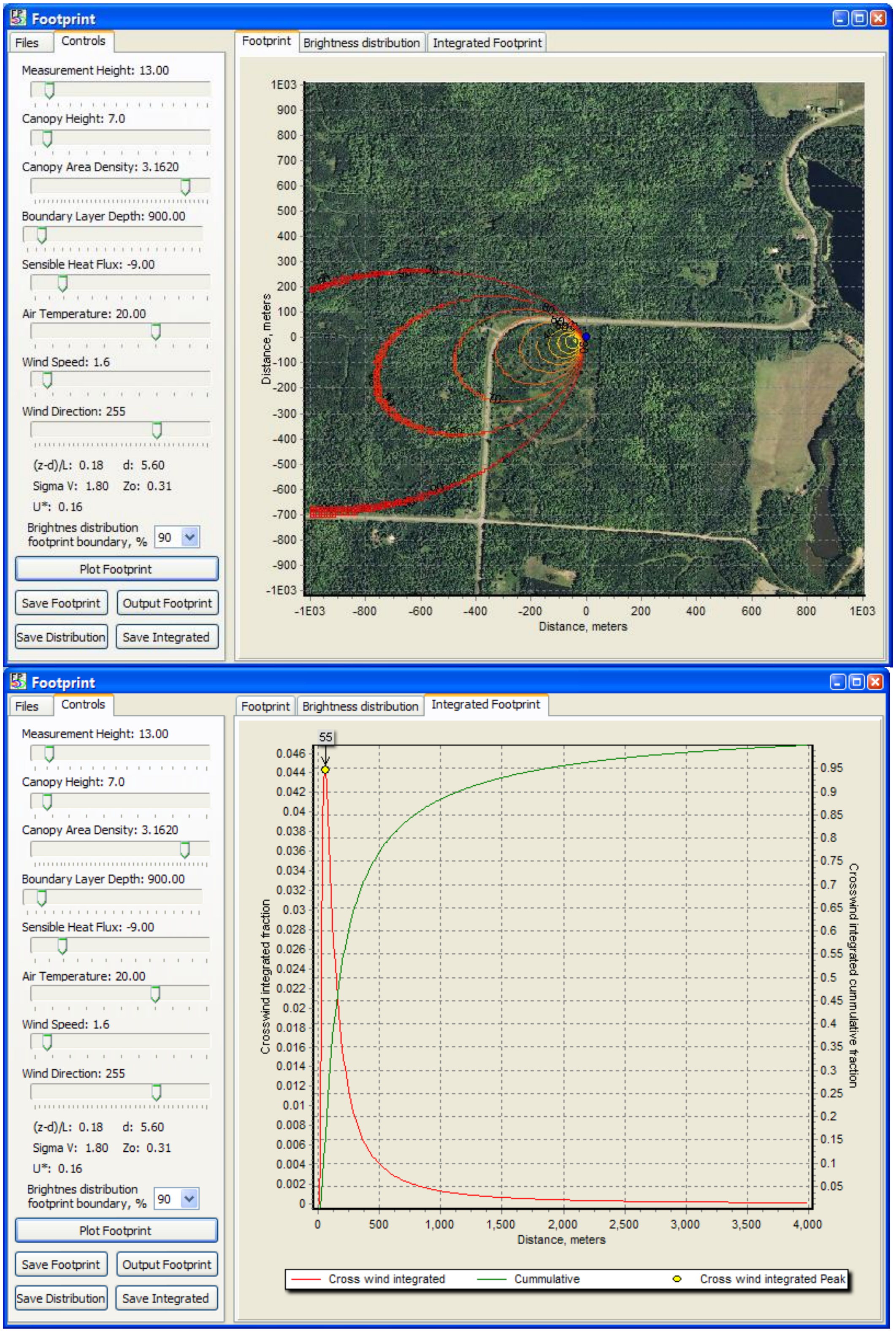


Figure 35. Steigerwaldt Relocatable site summer nighttime (stable) footprint output with mean wind speed at construction

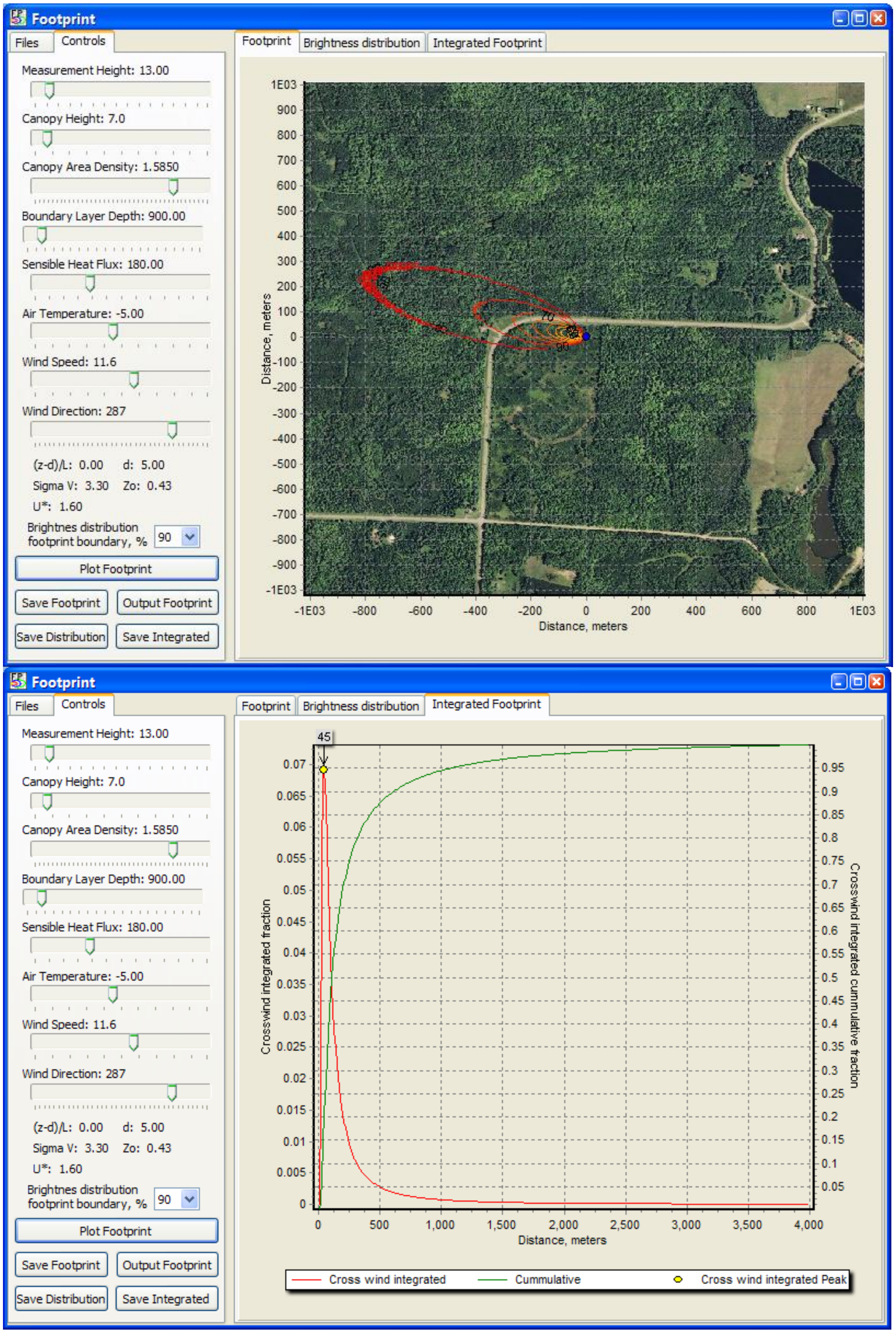


Figure 36. Steigerwaldt Relocatable site winter daytime (convective) footprint output with max wind speed at construction

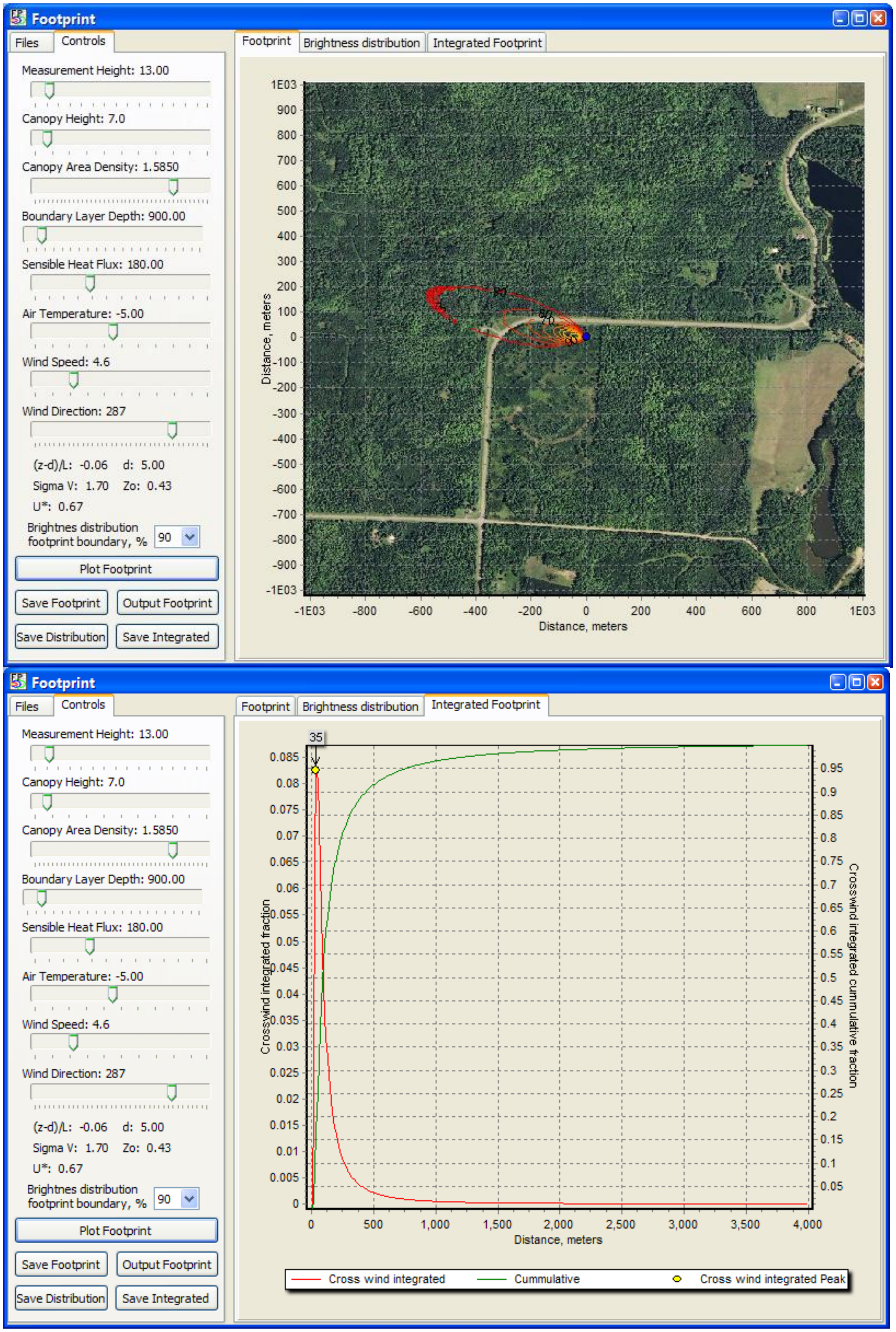


Figure 37. Steigerwaldt Relocatable site winter daytime (convective) footprint output with mean wind speed at construction

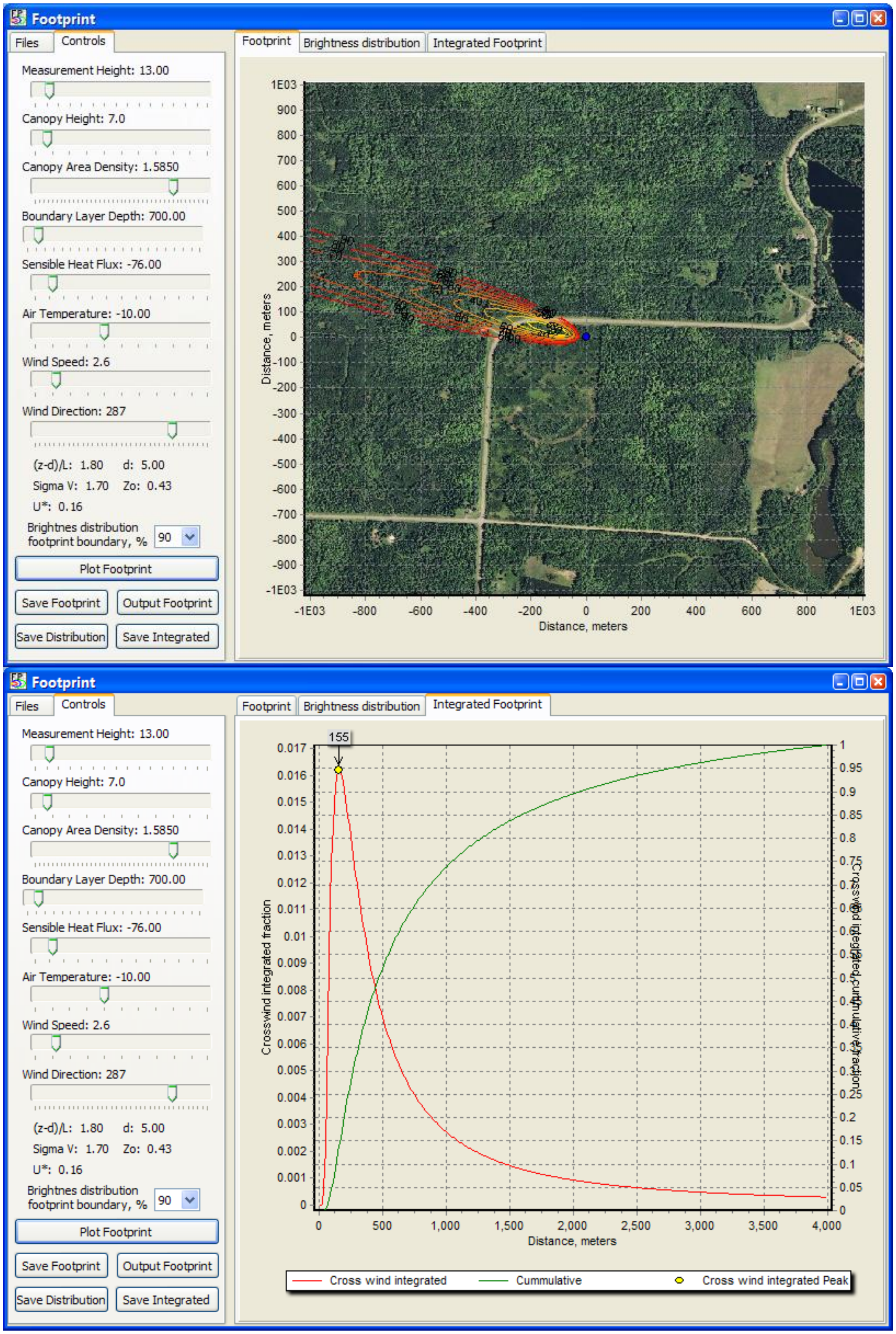


Figure 38. Steigerwaldt Relocatable site winter nighttime (stable) footprint output with mean wind speed at construction

By the time NEON tower operates for 8 years:

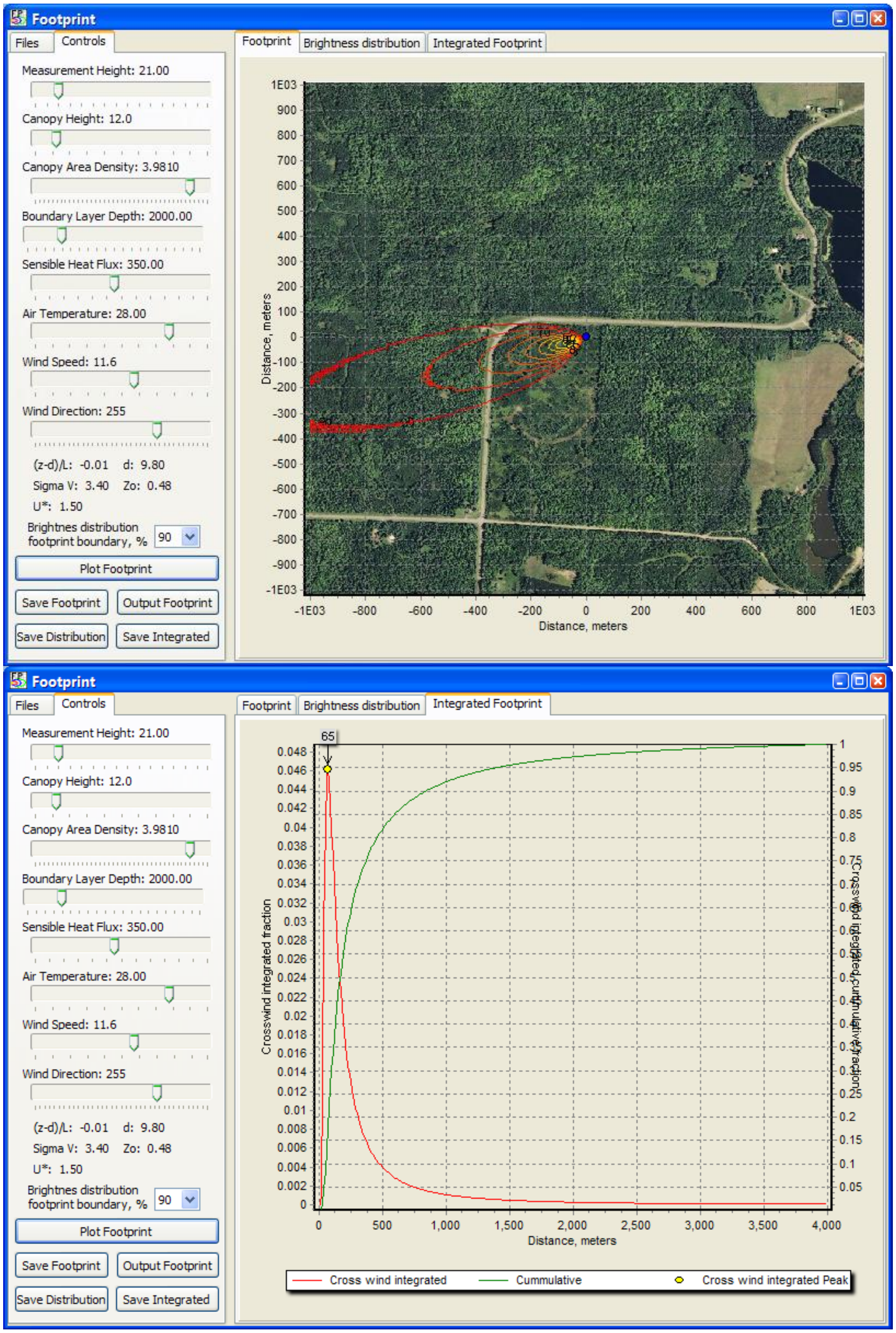


Figure 39. Steigerwaldt Relocatable site summer daytime (convective) footprint output with max wind speed at the end of operation

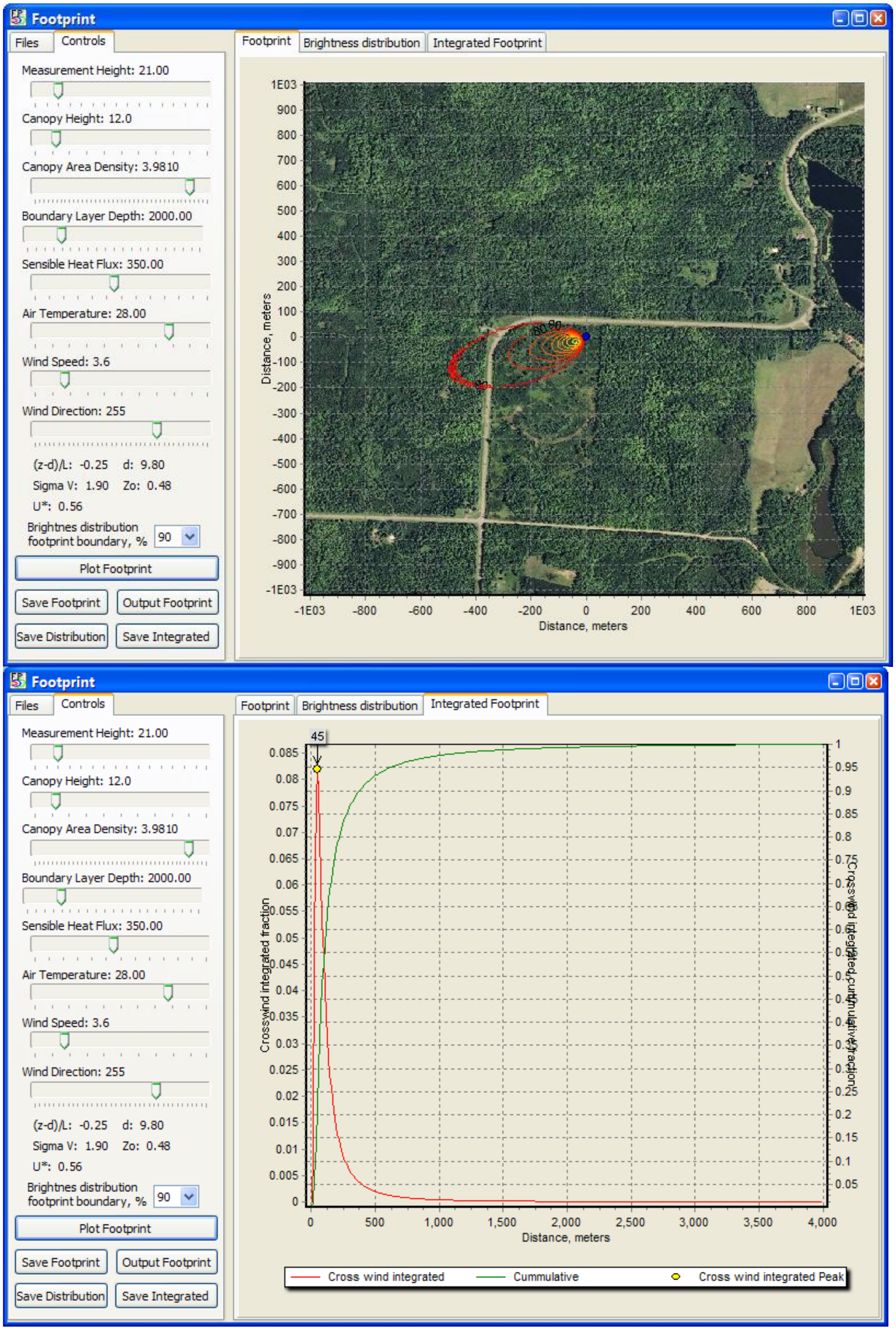


Figure 40. Steigerwaldt Relocatable site summer daytime (convective) footprint output with mean wind speed at the end of operation

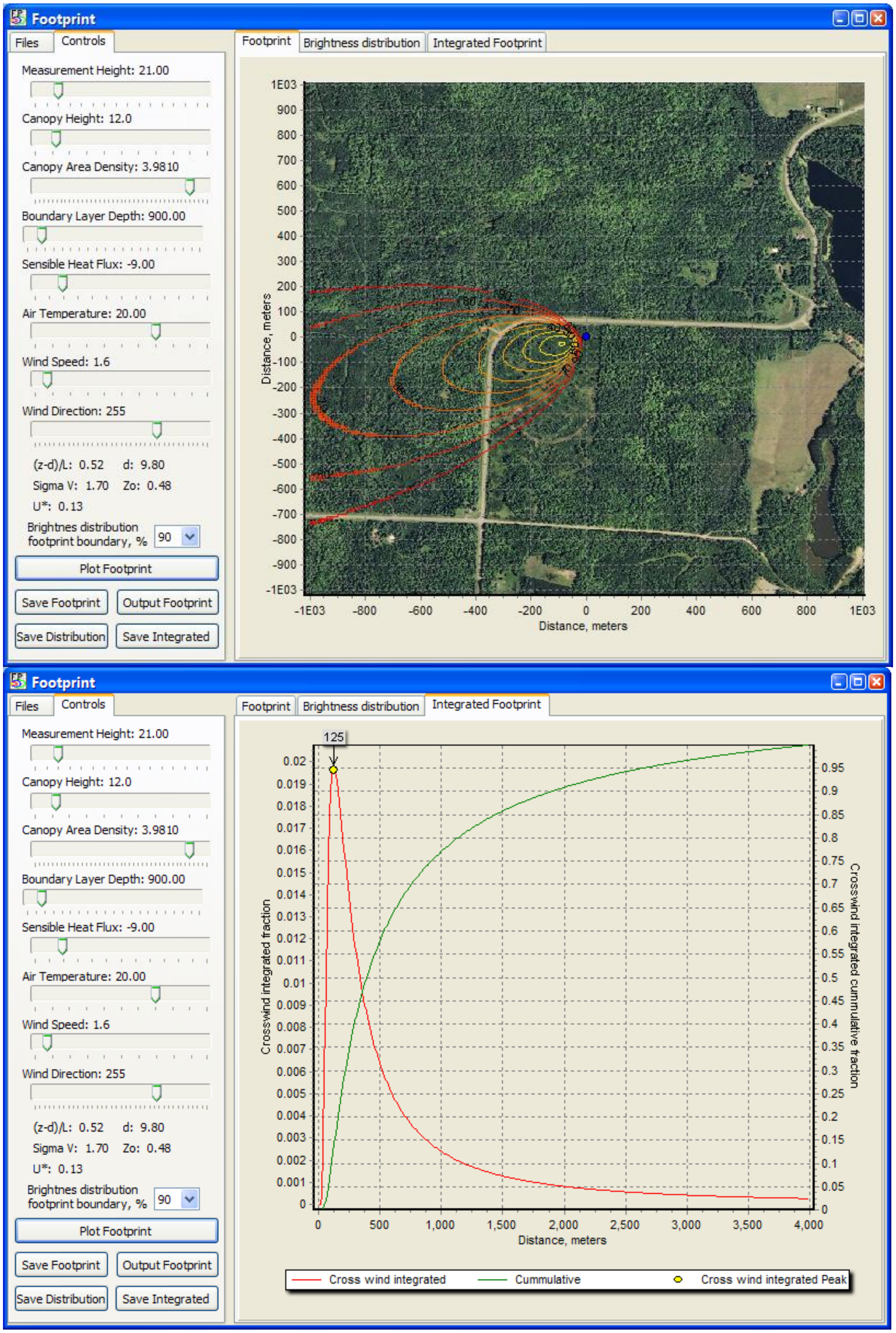


Figure 41. Steigerwaldt Relocatable site summer nighttime (stable) footprint output with mean wind speed at the end of operation

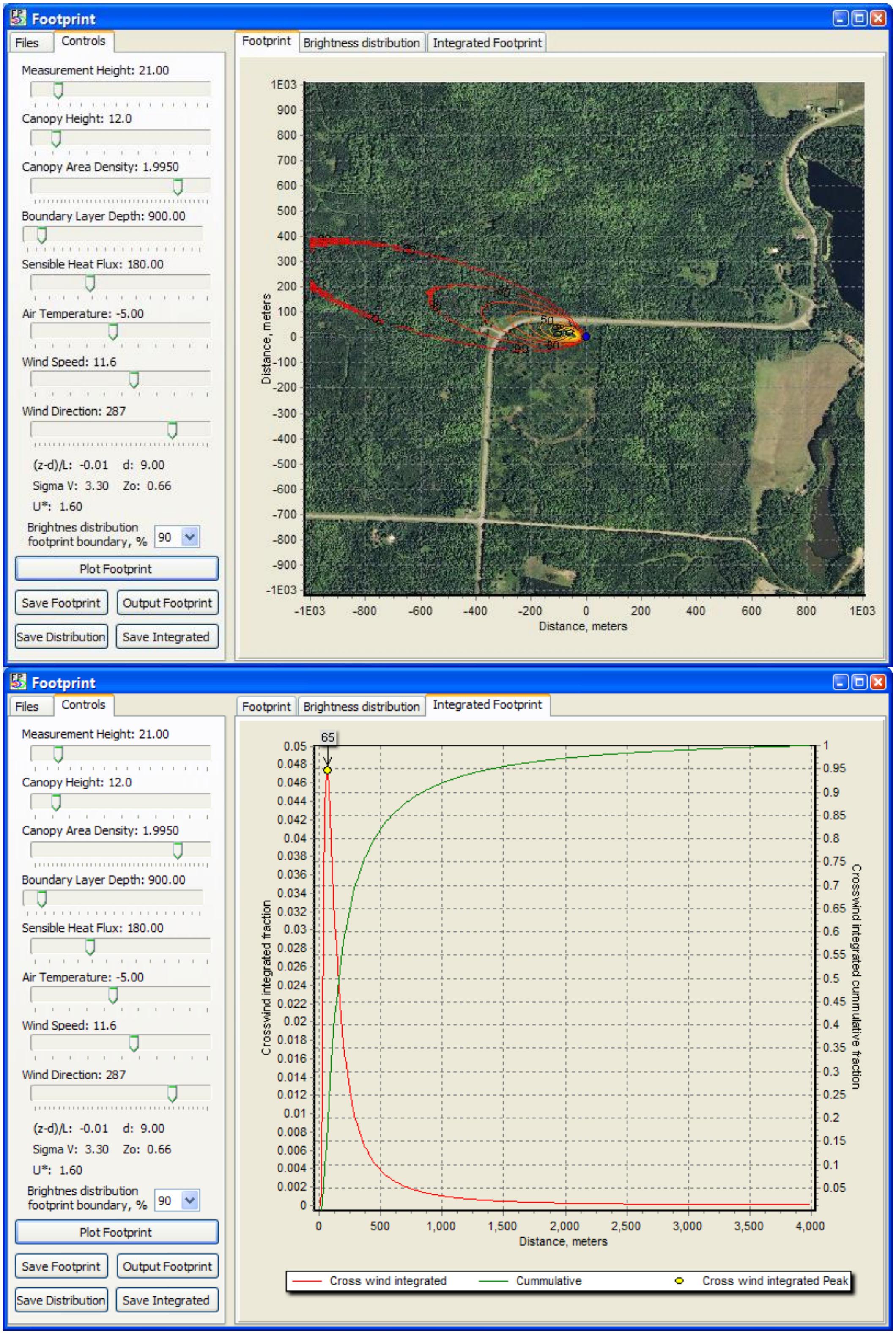


Figure 42. Steigerwaldt Relocatable site winter daytime (convective) footprint output with max wind speed at the end of operation

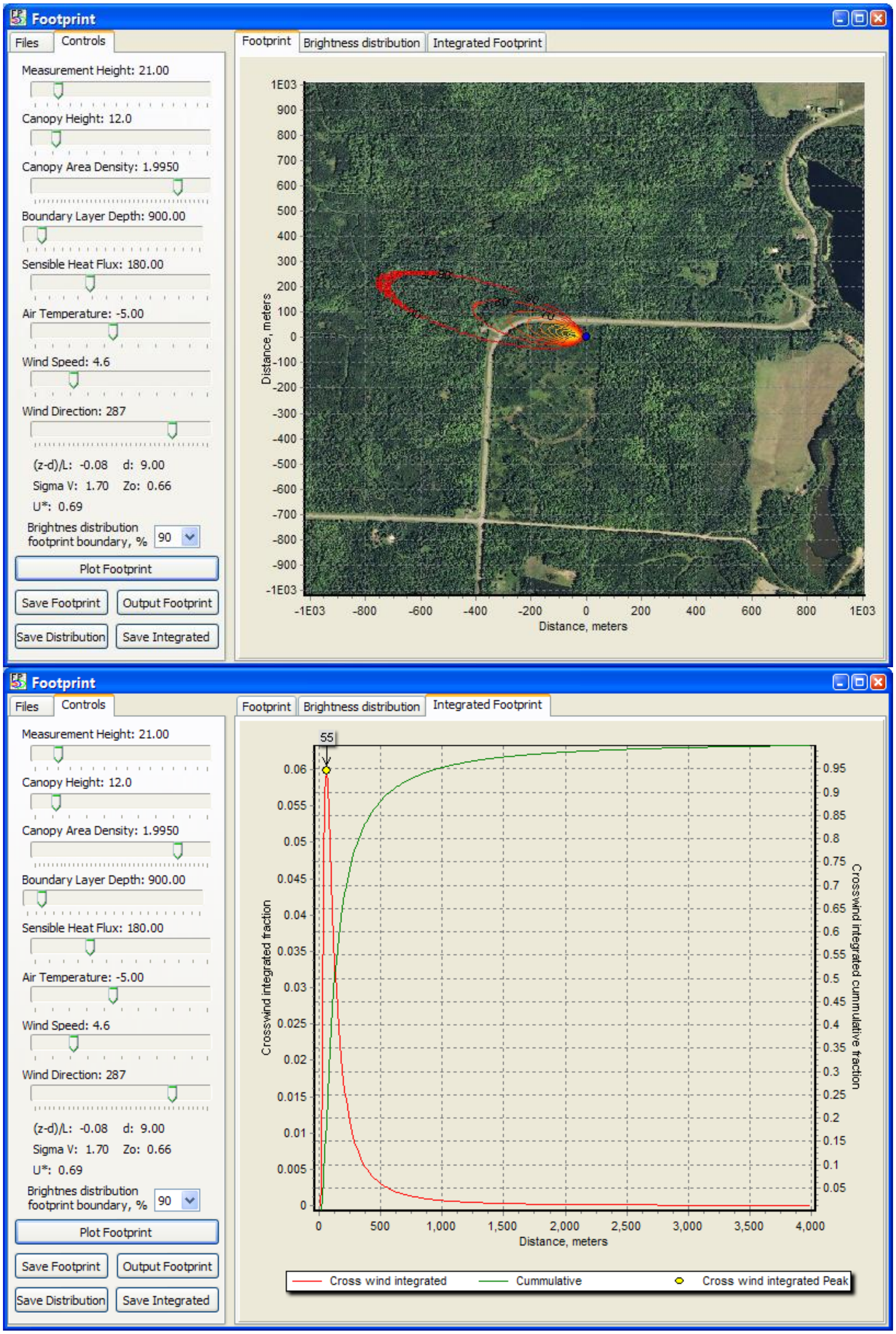


Figure 43. Steigerwaldt Relocatable site winter daytime (convective) footprint output with mean wind speed at the end of operation

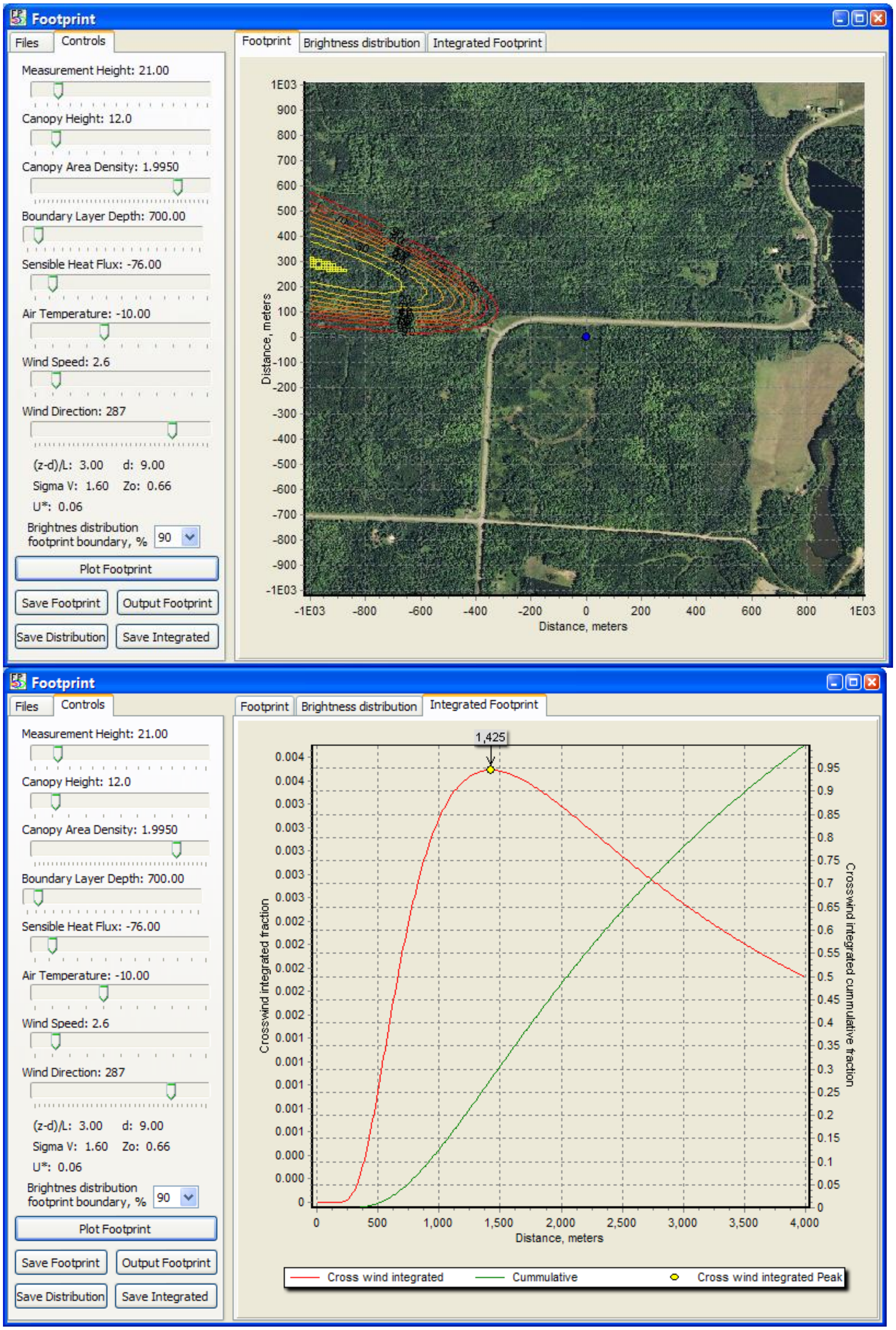


Figure 44. Steigerwaldt Relocatable site winter nighttime (stable) footprint output with mean wind speed at the end of operation

4.4.6 Site design and tower attributes

According to wind roses, wind comes all directions, but the relative higher frequency blows between south and WNW (190^o to 290^o, clockwise from 190^o, major airshed). **Tower** should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is regenerating northern hardwood forest. The candidate relocatable tower site was at 45.50488889, -89.58811111. After FIU site characterization, we moved tower location ~590 m toward NE to the location of 45.50969, -89.58498 to maximize the fetch area in the major airshed on southwest of tower. Power and access road is < 100 m from tower.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure. An **instrument hut** should be outside the prevailing wind airshed to avoid disturbance in the measurements of wind and should be positioned to have the longer side parallel to frequent wind direction to minimize the wind effects on instrument huts and to minimize the disturbances of wind regime by instrument hut, and in this case, instrument hut should be positioned on the northeast toward tower and have the longer side parallel to NE-SW direction. Therefore, we decide the placement of instrument hut at 45.50980, -89.58492. The distance between the tower and the instrument hut is ~ 13 m.

The ecosystem around tower and inside the major airshed is aspen dominated northern hardwood forest. Trees are mainly regenerating saplings from the clear cut 10 years ago. Mean height is ~5.5 m and trees grow actively (~0.6 m per year). Assume the construction at this site will be in 2012 or 2013, which will give canopy height ~ 7 m. The mean canopy height will be expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. The height of seedlings and sapling ranges from 1 m to 5.5 m without obvious strata by the time of FIU site characterization in 2010. The shrub at the site is ~ 2 m tall. Grass forms the understory on the forest floor level with height ~ 0.3 m.

Because this is a young tree plantation, the tree height will change prior to construction, and during our operational period. This plant canopy is rapidly accruing height and will continue to grow for several decades. If the tower was to be built today (12/03/10), the tower height would be 11 m.a.g.l. If we assume construction will occur 2 years from now, i.e., late 2012, then the top measurement level shall be 13 m.a.g.l., During operations the tower height will also need to be increased according to the FIU Science Requirements, for example at the end of 8 years of operation (late 2020) the top measurement level will need to be 21 m.a.g.l. For the remainder of this site characterization, we assume the site will be constructed in 2012, and require a tower height of 13 m.a.g.l. ***If the schedule changes for whatever reason, this height will have to be re-calculated.***

The determination of the exact top measurement level height and when to adjust the boom arm over time will be joint responsibility of FIU and ENG. In the tower attribute table below, we will only list the height of top and profile measurement levels at this assumed construction period. However, FCC (in contruction) and Field OPS (in operations) should design and budget accordingly to allow the ability to increase the top measurement level height to 21 m. Therefore, during construction, we require 5 **measurement layers** on the tower with top measurement height at 13 m, and remaining levels are at 10 m, 7 m, 4 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated at the tower top. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 15. Site design and tower attributes for Steigerwaldt Relocatable site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed			190° to 290° (major)		Clockwise from first angle. Winds are from all direction.
Tower location	45.50969,	-89.58498	--	--	new site
Instrument hut	45.50980,	-89.58492			
Instrument hut orientation vector	--	--	45°-225°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	225°	--	
Height of the measurement levels*					
Level 1				0.3	m.a.g.l.
Level 2				4.0	m.a.g.l.
Level 3				7.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				13.0	m.a.g.l.
Tower Height				13.0	m.a.g.l.

* These dimensions assume a late 2012 construction, see text above. Any change to this schedule the heights would have to be re-calculated.
See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Figure below shows the proposed tower location, instrument hut location, airshed area and access road.

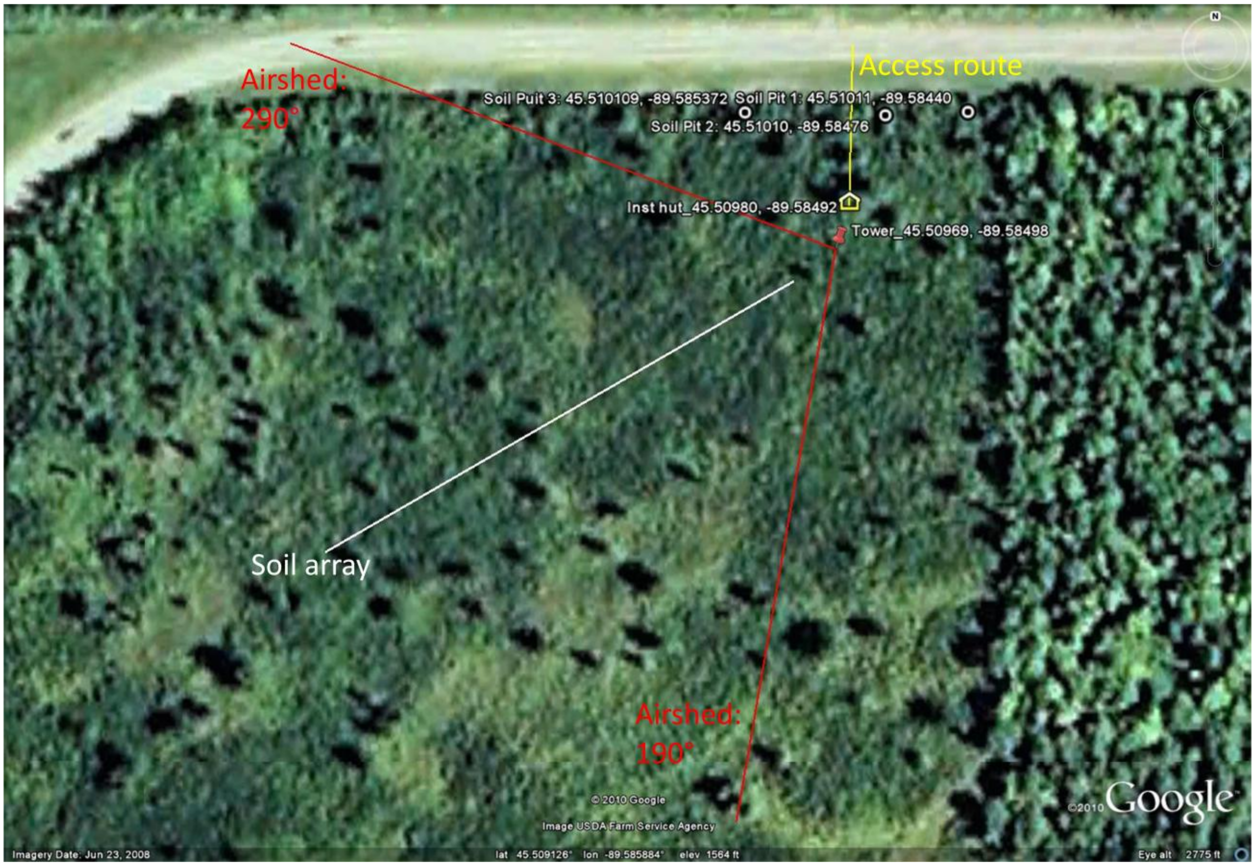


Figure 45. Site layout for Steigerwaldt Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 190^{o} to 290^{o} (major airshed, clockwise from 190^{o}) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access way to instrument hut.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done. Ed Steigerwaldt indicated that it would be ok to use boardwalk at this site.
Specific boardwalks at this site:

- Boardwalk from the access road to instrument hut, pending landowner decision

- Boardwalk from the instrument hut to the tower to intersect on north face of the tower, pending landowner decision
- Boardwalk to soil array
- No boardwalk from soil array boardwalk to individual soil plots.

The relative locations between tower, instrument hut and boardwalk can be found in the diagram below:

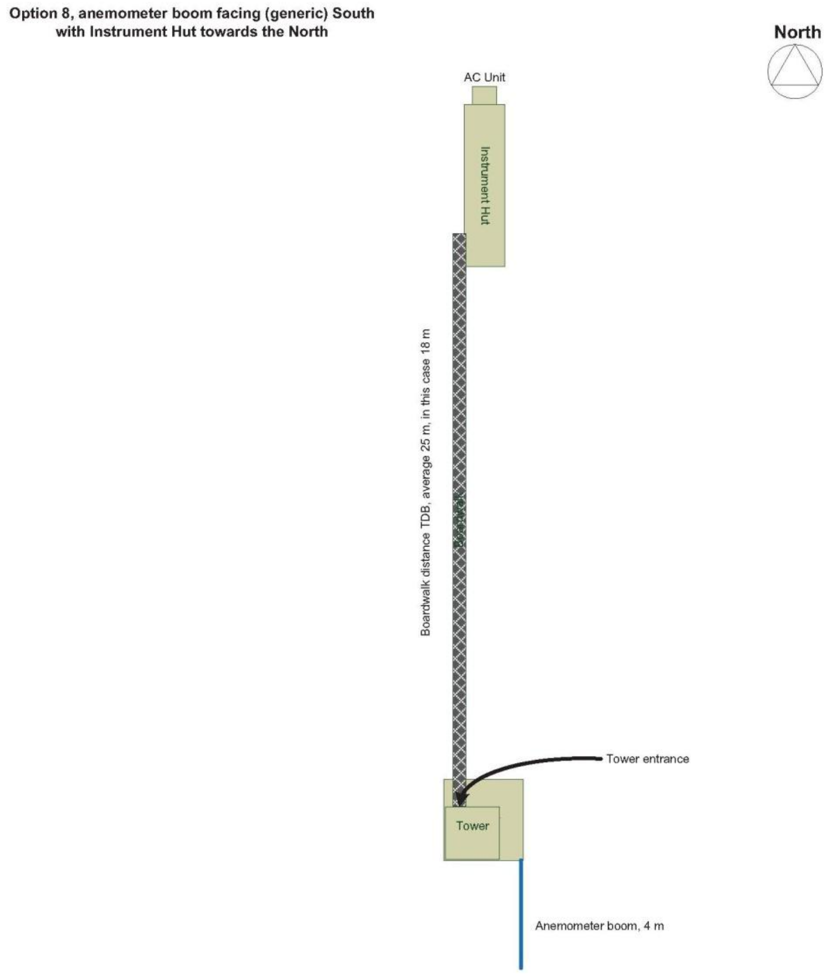


Figure 46. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram when boom facing south and instrument hut on the north towards the tower. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be joint responsibility of FCC and FIU. At Steigerwaldt Relocatable site, the boom angle will be 225 degrees, instrument hut will be on the NNE towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be NE-SW (45°-225°, longwise).

4.4.7 Information for ecosystem productivity plots

The tower has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (aspen dominated regenerating northern hardwood forest). Wind can blow from any direction, but has relatively higher frequency from 190^o to 290^o (major airshed, clockwise from 190°). Due to the actively growing ecosystem and adjustment of the height of top measurement level over time, tower fetch area will change accordingly. We expect that 90% signals for flux measurements during daytime are within a distance of 600 m – 800 m from tower over the operation period of 8 years, and 80% within 300-500 m. But during nighttime stable calm wind conditions, flux sensor on tower can detect signals beyond 2-3 km from tower. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 190^o to 290^o (major, clockwise from 190°) from tower.

4.5 Issues and attentions

Site is very small. Only ~70% flux signals during daytime are within the same management plot of aspen dominated regenerating forest; ~ 30% daytime signal and some nighttime signals will be from the neighboring mature northern hardwood forest in the major airshed between southwest to northwest of the tower, as well as from north and east of the tower. It will be challenging to intepret the measurement results. However, this cannot be easily avoided in this region, because landownership and forest management practices are from small parcels of properties in this region. Even so, this property is considered to be a relatively large management unit in N Wisconsin.

The plant canopy is actively and rapidly accruing height. Design, construction and operations need to take this into account. During the site characterization visit mean canopy height wass ~5.5 m. We assume the construction at this site will be in 2012 or 2013 and that the tree grow ~0.6 m/yr, which will give canopy height ~ 7 m at construction. The mean canopy height is expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. For any change to this schedule the heights would have to be re-calculated.

Power and road access is < 100 m from tower.

5 TREE HAVEN, RELOCATEABLE TOWER 2

5.1 Site description

The original Tree Haven candidate Relocatable site was at 45.493139°, -89.562028° (Figure 47) within the property of University of Wisconsin. After FIU site characterization, we microsited it toward west for ~1800 m at 45.49457°, -89.58505° to avoid the effects from the bog and pond in the major airshed at the old location, and maximize the tower fetch area over the deciduous forest on the west to tower. The new location is closer to power and easy access along the forest roads.

Tree Haven is owned by the University of Wisconsin-Stevens Point, College of Natural Resources. It is used for natural resource education. Additional information about the site can be found at: http://www.uwsp.edu/cnr/treehaven/index.aspx

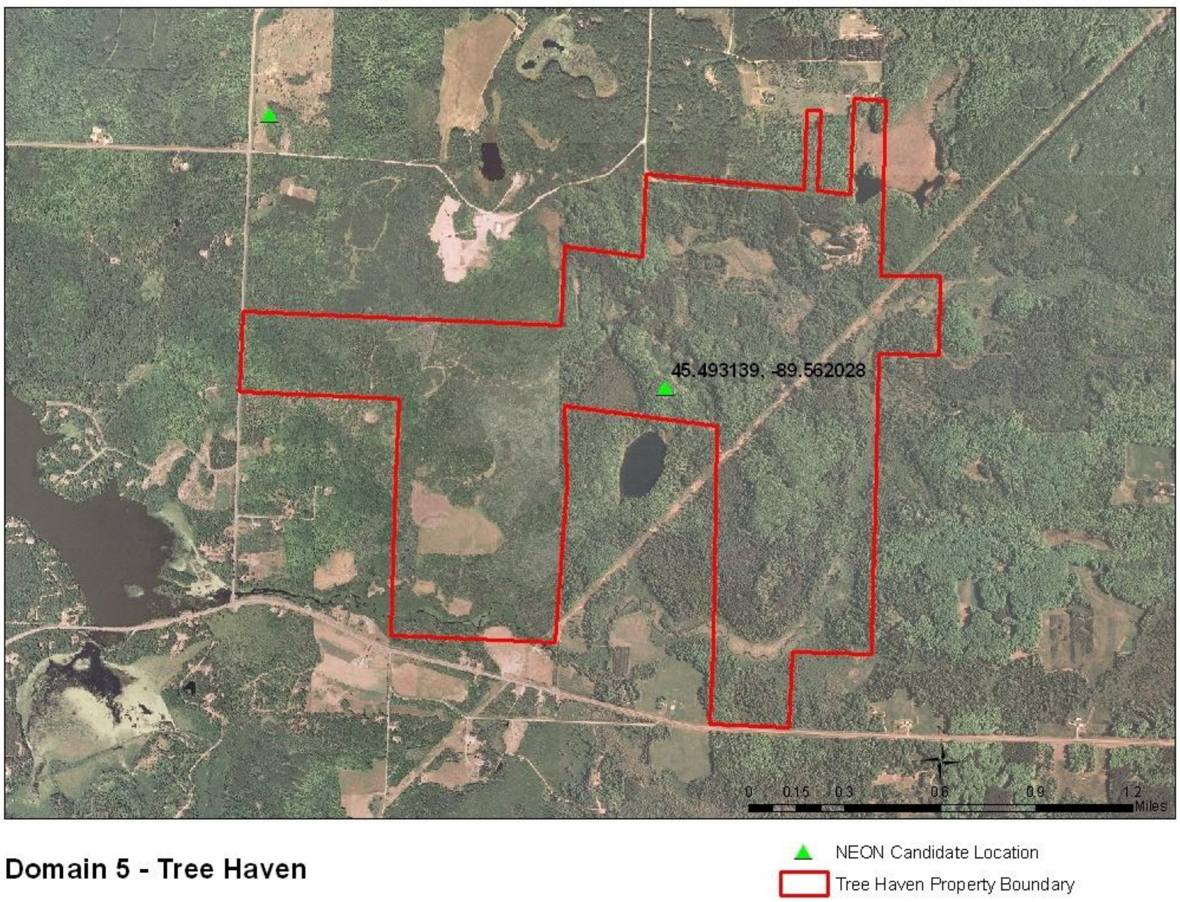


Figure 47. Property boundary of the Tree Haven and original candidate tower location.
Note that the tower was micro-sited since this graph was made, actual tower location indicated below.

5.2 Ecosystem

Vegetation type and land cover information at this relocatable site are presented below:

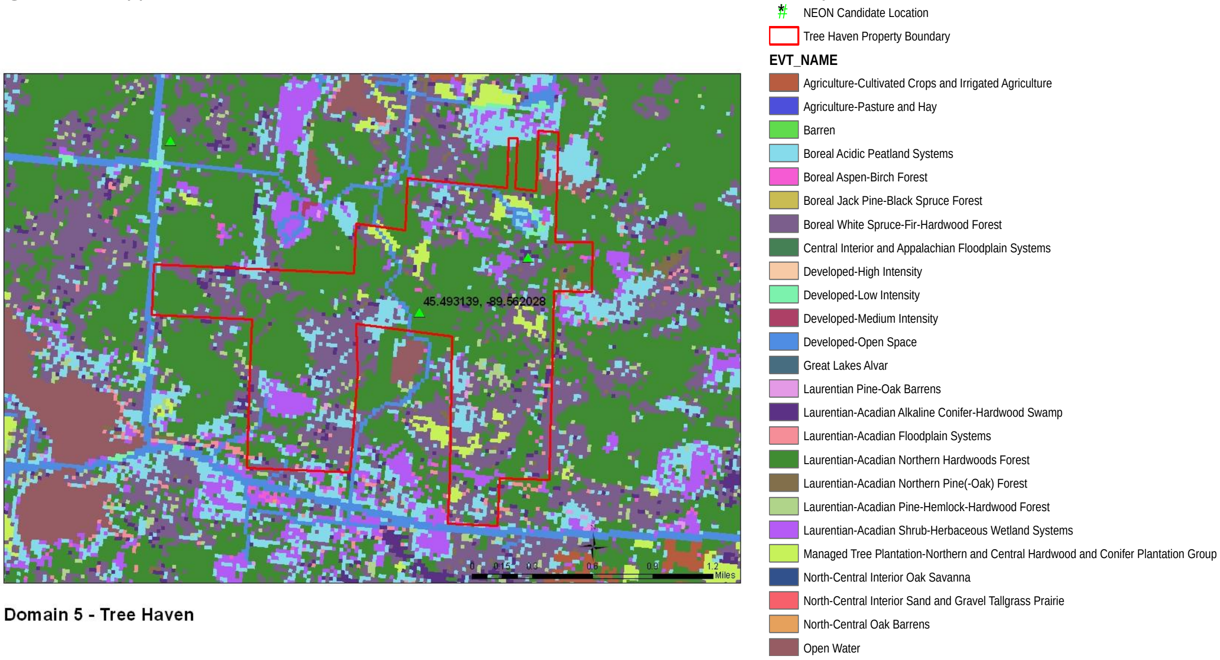


Figure 48. Vegetative cover map of Tree Haven relocatable site and surrounding areas (from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm), note that the tower was micro-sited since this graph was made, actual tower location indicated below.

Table 16. Percent Land cover information at Tree Haven relocatable site (from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	Area	Percenta
Open Water	0.0155	0
Developed-Open Space	0.0912	1
Developed-Low Intensity	0.0099	0
Boreal Aspen-Birch Forest	0.0103	0
Laurentian-Acadian Northern Hardwoods Forest	2.1220	45
Laurentian-Acadian Northern Pine(-Oak) Forest	0.0480	1
Boreal White Spruce-Fir-Hardwood Forest	1.3533	28
Laurentian-Acadian Pine-Hemlock-Hardwood Forest	0.0750	1
Laurentian Pine-Oak Barrens	0.0117	0
North-Central Interior Sand and Gravel Tallgrass Prairie	0.0009	0
Laurentian-Acadian Floodplain Systems	0.0275	0
Boreal Acidic Peatland Systems	0.4518	9
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	0.1139	2
Laurentian-Acadian Shrub-Herbaceous Wetland Systems	0.2175	4
Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group	0.1505	3
Total Area Sq Km	4.6988	

The terrain is relatively flat at this site with vernal pools/ponds in low areas. Bogs also exist, being dominated by black spruce and moss understory. The ecosystem at around tower site and in the major tower airshed is restored northern hardwood forest including maple, hemlock, birch, and aspen with an understory of ferns and tree seedlings. North and east of the tower, i.e. outside the major airshed, is a bog dominated by spruce with a think moss understory.

The forest is being managed to return it to a northern hardwood forest, which is the typical natural ecosystem in this region. Management activities include selective logging, and around the NEON tower site the selective logging is primarily aimed at removing aspen. The forest around the NEON tower is closer to the historical natural forest in this region than most of the other forest on the Tree Haven property.

Mean canopy is ~23 m. Young trees form the upper understory with height around 10 m, while smaller seedlings and saplings form the lower understory with height ~ 4 m. Ferns, grasses and herbs are commonly found at the ground level with a mean height ~ 0.8 m. Forest is managed by selective logging. Many stumps and coarse woody debris were found on the ground.

Figure 49. Ecosystem and surrounding environment at Tree Haven relocatable site.

Table 17. Ecosystem and site attributes for Tree Haven Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	23 m
Surface roughness [a]	3 m

Zero place displacement height [a]	19 m
Structural elements	Northern hardwood deciduous, multiple layers of understory
Time zone	Central time zone
Magnetic declination	2° 32' W changing by 0° 5' W/year

Note, [a] From field survey.

5.3 Soils

5.3.1 Description of soils

Soil data and soil maps below for Tree Haven tower site were collected from 5.7 km^2 NRCS soil maps (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) to determine the dominant soil types in the larger tower foot print. This was done to assure that the soil array is in the dominant (or in the co-dominant) soil type present in the tower footprint.

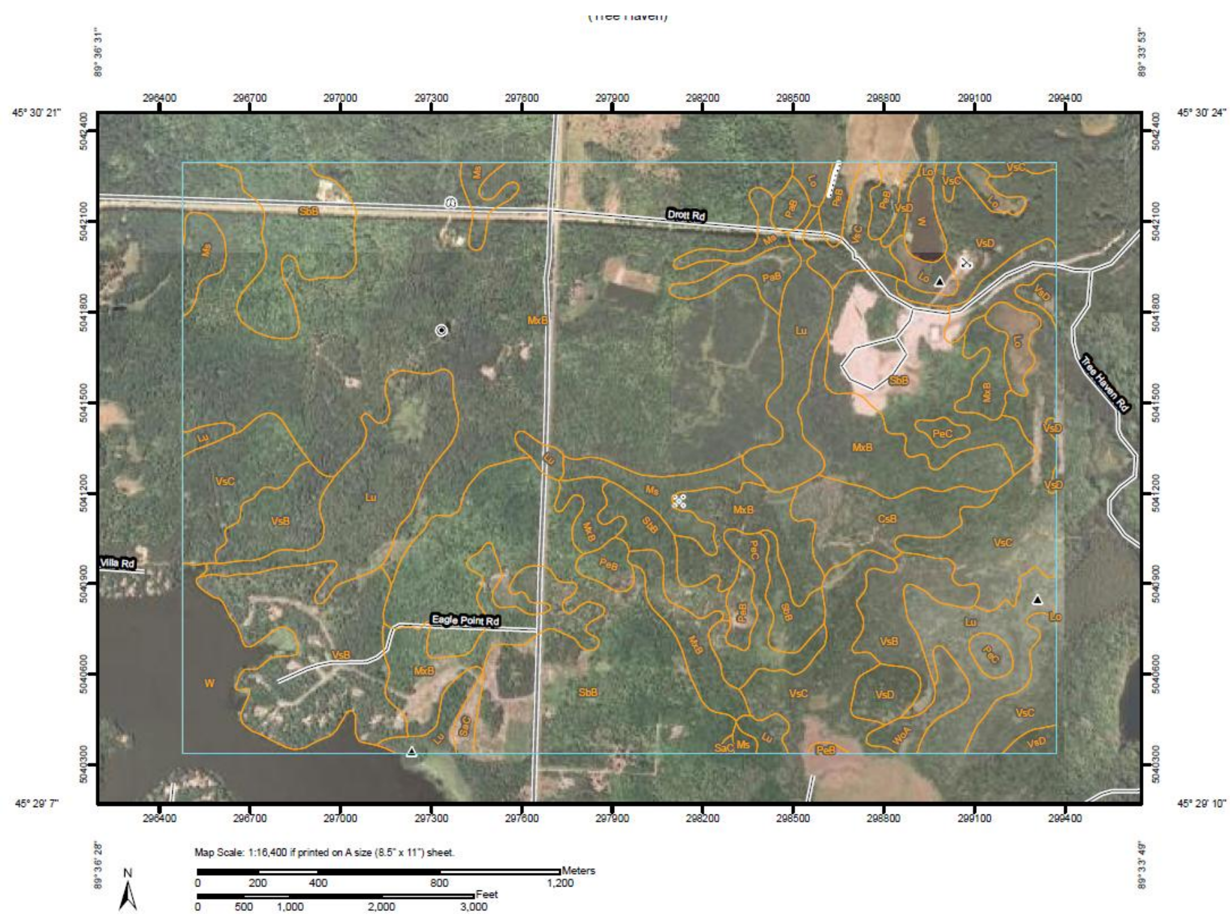


Figure 50. Soil map of the Tree Haven site and surrounding areas.

Soil Map Units Description: The map units delineated on the detailed soil maps in a soil survey represents the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils. Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called non-contrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas. An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. T he name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series. Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example. An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example. An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, are an example. Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Table 18. Soil series and percentage of soil series within 5.7 km^2 at the Tree Haven site

Lincoln County, Wisconsin (WI069)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CsB	Croswood loamy sand, 1 to 6 percent slopes	28.0	2.0%
Lo	Loxley and Dawson peats, 0 to 1 percent slopes	20.1	1.4%
Lu	Lupton, Cathro, and Markey mucks, 0 to 1 percent slopes	123.9	8.8%
Ms	Minocqua and Capitola mucks, 0 to 2 percent slopes	36.8	2.6%
MxB	Moodig sandy loam, 0 to 4 percent slopes	526.2	37.5%
PaB	Padwet sandy loam, 1 to 6 percent slopes	12.8	0.9%
PeB	Pence-Padus sandy loams, 1 to 6 percent slopes	21.8	1.6%
PeC	Pence-Padus sandy loams, 6 to 15 percent slopes	22.1	1.6%
SaC	Sarona-Pence sandy loams, 6 to 15 percent slopes	3.9	0.3%
SbB	Sarwet sandy loam, 2 to 6 percent slopes	252.9	18.0%
VsB	Vilas-Sayner loamy sands, 1 to 6 percent slopes	105.4	7.5%
VsC	Vilas-Sayner loamy sands, 6 to 15 percent slopes	149.7	10.7%
VsD	Vilas-Sayner loamy sands, 15 to 35 percent slopes	46.0	3.3%
W	Water	42.8	3.1%
WoA	Worcester sandy loam, 0 to 3 percent slopes	9.5	0.7%
Totals for Area of Interest		**1,402.0**	**100.0%**

Lincoln County, Wisconsin CsB—Croswood loamy sand, 1 to 6 percent slopes: Map Unit Setting Elevation: 700 to 1,700 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 120 days **Map Unit Composition** Croswood and similar soils: 100 percent **Description of Croswood Setting** Landform: Moraines, drumlins Landform position (two-dimensional): Footslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Sandy outwash over loamy till **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr) Depth to water table: About 24 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.3 inches) **Interpretive groups** Land capability (nonirrigated): 4s Other vegetative classification: Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 4 inches: Loamy sand 4 to 6 inches: Sand 6 to 22 inches: Loamy sand 22 to 55 inches: Sand 55 to 80 inches: Gravelly sandy loam

Lincoln County, Wisconsin Lo—Loxley and Dawson peats, 0 to 1 percent slopes: Map Unit Setting Elevation: 600 to 1,800 feet Mean annual precipitation: 22 to 34 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 60 to 140 days **Map Unit Composition** Loxley and similar soils: 75 percent Dawson and similar soils: 25 percent **Description of Loxley Setting** Landform: Depressions on outwash plains, depressions on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave Across-slope shape: Concave Parent material: Organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Occasional Available water capacity: Very high (about 25.9 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Not Assigned (acid organic soils) (Naor) **Typical profile** 0 to 20 inches: Peat 20 to 60 inches: Muck **Description of Dawson Setting** Landform: Depressions on outwash plains, depressions on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave Across-slope shape: Concave Parent material: Organic material over sandy drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Occasional Available water capacity: Very high (about 19.0 inches) **Interpretive groups** Land capability (nonirrigated): 7w Other vegetative classification: Not Assigned (acid organic soils) (Naor) **Typical profile** 0 to 8 inches: Peat 8 to 40 inches: Muck 40 to 60 inches: Sand

Lincoln County, Wisconsin Lu—Lupton, Cathro, and Markey mucks, 0 to 1 percent slopes: Map Unit Setting Elevation: 600 to 1,400 feet Mean annual precipitation: 22 to 44 inches Mean annual air temperature: 39 to 46 degrees F Frost-free period: 60 to 140 days **Map Unit Composition** Lupton and similar soils: 45 percent Cathro and similar soils: 35 percent Markey and similar soils: 20 percent **Description of Lupton Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Very high (about 23.9 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 24 inches: Muck 24 to 60 inches: Muck **Description of Cathro Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material over loamy and/or silty drift **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 1.98 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 25 percent Available water capacity: Very high (about 18.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 15 inches: Muck 15 to 28 inches: Muck 28 to 60 inches: Loam **Description of Markey Setting** Landform: Drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Organic material over sandy outwash **Properties and qualities** Slope: 0 to 1 percent Depth to restrictive feature: More than 80 inches Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 5 percent Available water capacity: Very high (about 15.8 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (non-acid organic soils) (Nnor) **Typical profile** 0 to 36 inches: Muck 36 to 60 inches: Sand

Lincoln County, Wisconsin Ms—Minocqua and Capitola mucks, 0 to 2 percent slopes: Map Unit Setting Elevation: 800 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 130 days Map Unit Composition Minocqua and similar soils: 65 percent Capitola and similar soils: 35 percent **Description of Minocqua Setting** Landform: Depressions on outwash plains, depressions on moraines, drainageways on moraines, drainageways on outwash plains Landform position (two-dimensional): Toeslope Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Loamy and/or silty drift over sandy and gravelly outwash **Properties and qualities** Slope: 0 to 2 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 5 percent Available water capacity: Moderate (about 7.0 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (wet mineral soils) (Nmin) **Typical profile** 0 to 4 inches: Muck 4 to 33 inches: Silt loam 33 to 37 inches: Gravelly loamy coarse sand 37 to 60 inches: Coarse sand **Description of Capitola Setting** Landform: Depressions on outwash plains, depressions on moraines, drainageways on outwash plains, drainageways on moraines Landform position (two-dimensional): Toeslope Down-slope shape: Concave, linear Across-slope shape: Concave Parent material: Loamy and/or silty drift over loamy till **Properties and qualities** Slope: 0 to 2 percent Depth to restrictive feature: More than 80 inches Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Calcium carbonate, maximum content: 10 percent Available water capacity: High (about 9.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w Other vegetative classification: Not Assigned (wet mineral soils) (Nmin) **Typical profile** 0 to 5 inches: Muck 5 to 7 inches: Silt loam 7 to 22 inches: Silt loam 22 to 33 inches: Fine sandy loam 33 to 60 inches: Fine sandy loam

Lincoln County, Wisconsin MxB—Moodig sandy loam, 0 to 4 percent slopes: Map Unit Setting Elevation: 700 to 1,950 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 135 days **Map Unit Composition** Moodig and similar soils: 95 percent Minor components: 5 percent **Description of Moodig Setting** Landform: Moraines Landform position (two-dimensional): Footslope Down-slope shape: Linear Across-slope shape: Concave Parent material: Loamy till **Properties and qualities** Slope: 0 to 4 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 7.9 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Tsuga/Maianthemum-Coptis (TMC), Acer saccharum/Hydrophyllum (AH), Acer saccharum-Tsuga/ Maianthemum (ATM) **Typical profile** 0 to 3 inches: Sandy loam 3 to 5 inches: Gravelly sandy loam 5 to 22 inches: Gravelly sandy loam 22 to 53 inches: Sandy loam 53 to 73 inches: Gravelly sandy loam 73 to 95 inches: Gravelly sandy loam **Minor Components Capitola** Percent of map unit: 5 percent Landform: Depressions

Lincoln County, Wisconsin PaB—Padwet sandy loam, 1 to 6 percent slopes: Map Unit Setting Elevation: 700 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 120 days **Map Unit Composition** Padwet and similar soils: 100 percent **Description of Padwet Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 30 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.2 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum/Viola-Osmorhiza (AViO), Acer saccharum-Tsuga/Maianthemum (ATM) **Typical profile** 0 to 2 inches: Sandy loam 2 to 30 inches: Sandy loam 30 to 39 inches: Sandy loam 39 to 60 inches: Sand

Lincoln County, Wisconsin PeB—Pence-Padus sandy loams, 1 to 6 percent slopes: Map Unit Setting Elevation: 600 to 2,000 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 135 days **Map Unit Composition** Pence and similar soils: 65 percent Padus and similar soils: 35 percent **Description of Pence Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability classification (irrigated): 2e Land capability (nonirrigated): 3e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 4 inches: Sandy loam 4 to 16 inches: Sandy loam 16 to 34 inches: Gravelly coarse sand 34 to 60 inches: Gravelly coarse sand **Description of Padus Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.1 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 3 inches: Sandy loam 3 to 4 inches: Sandy loam 4 to 11 inches: Sandy loam 11 to 29 inches: Sandy loam 29 to 60 inches: Gravelly coarse sand

Lincoln County, Wisconsin PeC—Pence-Padus sandy loams, 6 to 15 percent slopes: Map Unit Setting Elevation: 600 to 2,000 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 135 days **Map Unit Composition** Pence and similar soils: 70 percent Padus and similar soils: 30 percent **Description of Pence Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability classification (irrigated): 3e Land capability (nonirrigated): 4e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 4 inches: Sandy loam 4 to 16 inches: Sandy loam 16 to 34 inches: Gravelly coarse sand 34 to 60 inches: Gravelly coarse sand **Description of Padus Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.1 inches) **Interpretive groups** Land capability (nonirrigated): 3e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 3 inches: Sandy loam 3 to 4 inches: Sandy loam 4 to 11 inches: Sandy loam 11 to 29 inches: Sandy loam 29 to 60 inches: Gravelly coarse sand

Lincoln County, Wisconsin SaC—Sarona-Pence sandy loams, 6 to 15 percent slopes: Map Unit Setting Elevation: 600 to 2,000 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 70 to 135 days **Map Unit Composition** Sarona and similar soils: 65 percent Pence and similar soils: 35 percent **Description of Sarona Setting** Landform: Drumlins Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy till **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 7.1 inches) **Interpretive groups** Land capability (nonirrigated): 3e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 3 inches: Sandy loam 3 to 5 inches: Fine sandy loam 5 to 18 inches: Fine sandy loam 18 to 77 inches: Sandy loam 77 to 99 inches: Loamy sand **Description of Pence Setting** Landform: Drumlins Landform position (two-dimensional): Shoulder, backslope Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability classification (irrigated): 3e Land capability (nonirrigated): 4e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 4 inches: Sandy loam 4 to 16 inches: Sandy loam 16 to 34 inches: Gravelly coarse sand 34 to 60 inches: Gravelly coarse sand

Lincoln County, Wisconsin SbB—Sarwet sandy loam, 2 to 6 percent slopes: Map Unit Setting Elevation: 700 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 130 days **Map Unit Composition** Sarwet and similar soils: 100 percent **Description of Sarwet Setting** Landform: Drumlins Landform position (two-dimensional): Shoulder, summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Loamy till **Properties and qualities** Slope: 2 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Moderately well drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 24 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 7.6 inches) **Interpretive groups** Land capability (nonirrigated): 2e Other vegetative classification: Acer saccharum-Tsuga/ Maianthemum (ATM), Acer saccharum/Viola-Osmorhiza (AViO) **Typical profile** 0 to 5 inches: Sandy loam 5 to 6 inches: Sandy loam 6 to 22 inches: Sandy loam 22 to 58 inches: Sandy loam 58 to 84 inches: Gravelly sandy loam 84 to 90 inches: Gravelly sandy loam

Lincoln County, Wisconsin VsB—Vilas-Sayner loamy sands, 1 to 6 percent slopes: Map Unit Setting Elevation: 600 to 1,950 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 90 to 135 days **Map Unit Composition** Vilas and similar soils: 65 percent Sayner and similar soils: 35 percent **Description of Vilas Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability classification (irrigated): 3e Land capability (nonirrigated): 4s Other vegetative classification: Acer rubrum-Quercus/Vaccinium (ArQV), Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 3 inches: Loamy sand 3 to 15 inches: Loamy sand 15 to 30 inches: Sand 30 to 60 inches: Sand **Description of Sayner Setting** Landform: Outwash plains Landform position (two-dimensional): Summit Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy and gravelly outwash **Properties and qualities** Slope: 1 to 6 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 2.9 inches) **Interpretive groups** Land capability classification (irrigated): 2s Land capability (nonirrigated): 4s **Typical profile** 0 to 2 inches: Loamy sand 2 to 5 inches: Loamy sand 5 to 19 inches: Loamy sand 19 to 32 inches: Gravelly sand 32 to 60 inches: Error

Lincoln County, Wisconsin VsC—Vilas-Sayner loamy sands, 6 to 15 percent slopes: Map Unit Setting Elevation: 600 to 1,950 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 90 to 135 days **Map Unit Composition** Vilas and similar soils: 60 percent Sayner and similar soils: 40 percent **Description of Vilas Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy outwash **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about

4.4 inches) **Interpretive groups** Land capability (nonirrigated): 6s Other vegetative classification: Acer rubrum-Quercus/Vaccinium (ArQV), Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 3 inches: Loamy sand 3 to 15 inches: Loamy sand 15 to 30 inches: Sand 30 to 60 inches: Sand **Description of Sayner Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy and gravelly outwash **Properties and qualities** Slope: 6 to 15 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 6s Other vegetative classification: Acer rubrum-Quercus/Vaccinium (ArQV), Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 2 inches: Loamy sand 2 to 5 inches: Loamy sand 5 to 19 inches: Loamy sand 19 to 32 inches: Gravelly sand 32 to 60 inches: Error

Lincoln County, Wisconsin VsD—Vilas-Sayner loamy sands, 15 to 35 percent slopes: Map Unit Setting Elevation: 600 to 1,950 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 36 to 45 degrees F Frost-free period: 90 to 135 days **Map Unit Composition** Vilas and similar soils: 55 percent Sayner and similar soils: 45 percent **Description of Vilas Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy outwash **Properties and qualities** Slope: 15 to 35 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 4.4 inches) **Interpretive groups** Land capability (nonirrigated): 7s Other vegetative classification: Acer rubrum-Quercus/Vaccinium (ArQV), Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 3 inches: Loamy sand 3 to 15 inches: Loamy sand 15 to 30 inches: Sand 30 to 60 inches: Sand **Description of Sayner Setting** Landform: Outwash plains Landform position (two-dimensional): Backslope, shoulder Down-slope shape: Convex Across-slope shape: Convex Parent material: Sandy and gravelly outwash **Properties and qualities** Slope: 15 to 35 percent Depth to restrictive feature: More than 80 inches Drainage class: Excessively drained Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 7s Other vegetative classification: Acer rubrum-Quercus/Vaccinium (ArQV), Pinus/Maianthemum-Vaccinium (PMV) **Typical profile** 0 to 2 inches: Loamy sand 2 to 5 inches: Loamy sand 5 to 19 inches: Loamy sand 19 to 32 inches: Gravelly sand 32 to 60 inches: Error

Lincoln County, Wisconsin W—Water: Map Unit Setting Elevation: 660 to 980 feet Mean annual precipitation: 30 to 33 inches Mean annual air temperature: 37 to 55 degrees F Frost-free period: 145 to 165 days **Map Unit Composition** Water: 100 percent **Description of Water Interpretive groups** Other vegetative classification: Not Assigned (water) (Nwat)

Lincoln County, Wisconsin WoA—Worcester sandy loam, 0 to 3 percent slopes: Map Unit Setting Elevation: 700 to 1,900 feet Mean annual precipitation: 28 to 33 inches Mean annual air temperature: 39 to 45 degrees F Frost-free period: 90 to 120 days **Map Unit Composition** Worcester and similar soils: 98 percent Minor components: 2 percent **Description of Worcester Setting** Landform: Drainageways on outwash plains, depressions on outwash plains Landform position (two-dimensional): Footslope Down-slope shape: Linear, concave Across-slope shape: Concave Parent material: Loamy drift over sandy and gravelly outwash **Properties and qualities** Slope: 0 to 3 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat poorly drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr) Depth to water table: About 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.5 inches) **Interpretive groups** Land capability (nonirrigated): 2w Other vegetative classification: Tsuga/Maianthemum-Coptis (TMC) **Typical profile** 0 to 3 inches: Sandy loam 3 to 16 inches: Sandy loam 16 to 32 inches: Sandy loam 32 to 39 inches: Gravelly loamy sand 39 to 60 inches: Gravelly sand **Minor Components Minocqua** Percent of map unit: 2 percent Landform: Depressions

5.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g*., soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 51). For the theoretical variogram models considered here, the semivariance will converge on the total variance at distances for which values are no longer spatially auto-correlated (this is referred to as the range, Figure 51).

For the theoretical variograms considered here, three parameters estimated from the data are used to fit a semivariogram model to the empirical semivariogram. This model is then assumed to quantitatively represent the correlation as a function of distance (Figure 51), the range, the sill (the sill is the asymptotic value of semi-variance at the range), and the nugget (which describes sampling error or variation at distances below those separating the closest pairs of samples). The range, sill and nugget are estimated from theoretical models that are fitted to the empirical variograms using non-linear least squares methods.

The variogram analysis will be used, to determine the spatial scales at which we can consider soil measurements spatially independent. This characterization will directly inform the minimum distance between *i*) soil plots within each soil array, *ii*) the soil profile measurements, *iii*) EP plots, and *iv*) the microbial sampling locations. These data will directly inform NEON construction and site design activities.

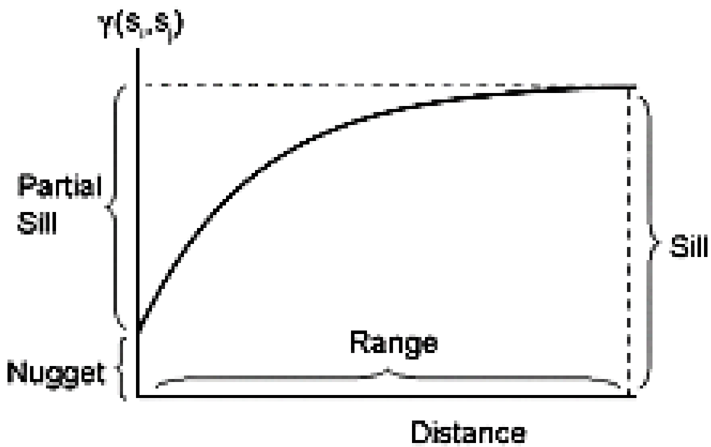


Figure 51. Example semivariogram, depicting range, sill, and nugget.

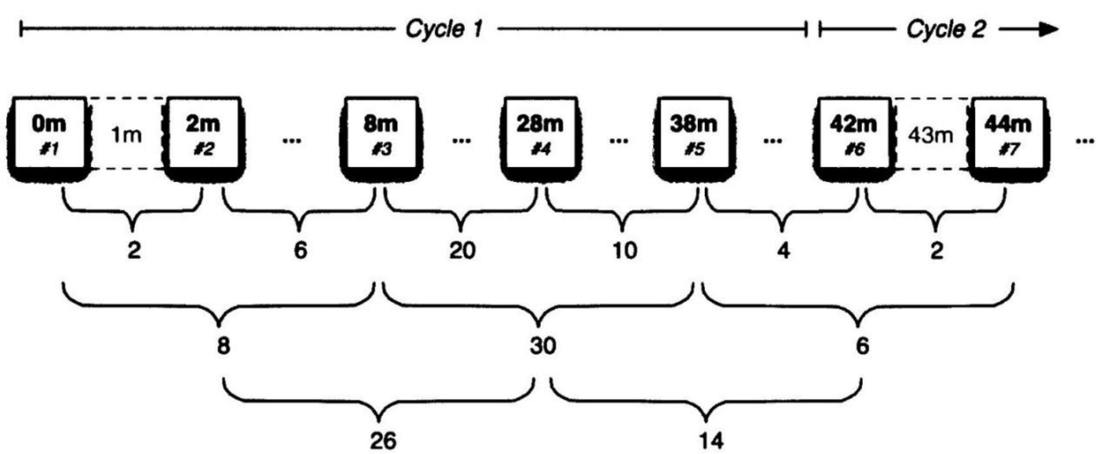


Figure 52. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 11 August 2010 at the Tree Haven site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 52). Soil temperature and moisture measurements were collected along three transects (168 m, 84 m, and 84 m) located in the expected airshed at Tree Haven. Details of how the airshed was determined are provided below. Soil temperature was measured with platinum resistance temperature sensors (RTD 810, Omega Engineering Inc., Stamford CT) and soil moisture was measured with time domain diaelectric sensors (CS616, Campbell Scientific Inc., Logan UT).

As well as measuring soil temperature and moisture at each sample point in Figure 52, measurements were also taken 30 cm in front and behind the sampling point along the axis of the transect. For example, at the 2 m sampling point, soil temperature and moisture was measured at 1.7 m, 2 m, and 2.3 m; this data is referred to as mobile data, since the measurements were taken at many different locations. In addition, soil temperature and moisture were continuously recorded at a single fixed location (stationary data) throughout the sampling time to correct for changes in temperature and moisture throughout the day.

Data collected were used for geospatial analyses of variograms in the R statistical computing language with the geoR package to test for spatial autocorrelation (Trangmar *et al.* 1986; Webster & Oliver 1989; Goovaerts 1997; Riberiro & Diggle 2001) and estimate the distance necessary for independence among soil plots in the soil array. To correct for changes in temperature and moisture over the sampling period, the stationary data was subtracted from the mobile data. In many instances a trend was still apparent in the data even after subtracting the stationary data from the mobile data. This trend was corrected for by fitting a linear regression based on time of day, elevation, slope and/or aspect and using the residuals for the semivariogram analysis. Soil temperature and moisture data, R code, graphs, and R output can be found at: P:\FIU\FIU_Site_Characterization\DXX\YYYYYYY_Characterization\Soil Measurements\Soil Data Analysis (where XX = domain number and YYYYYYY = site name).

5.3.3 Results and interpretation

5.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day, elevation, and slope trend, were used for the semivariogram analysis (Figure 53). Exploratory data analysis plots show that there was little distinct patterning of the residuals (Figure 54, left graph) and directional semivariograms do not show anisotropy (Figure 54, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 54, right graph). The model indicates a distance of effective independence of >100 m for soil temperature.

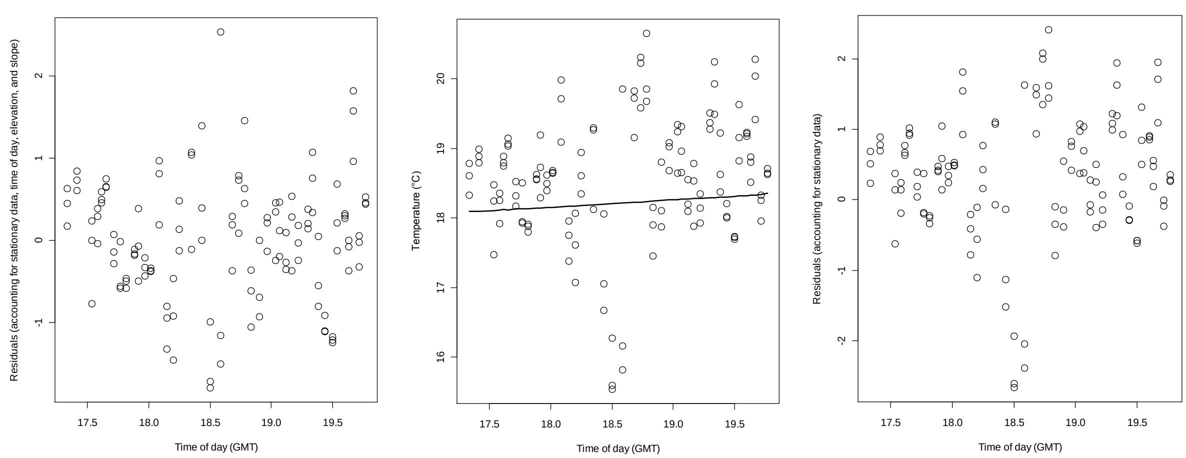


Figure 53. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

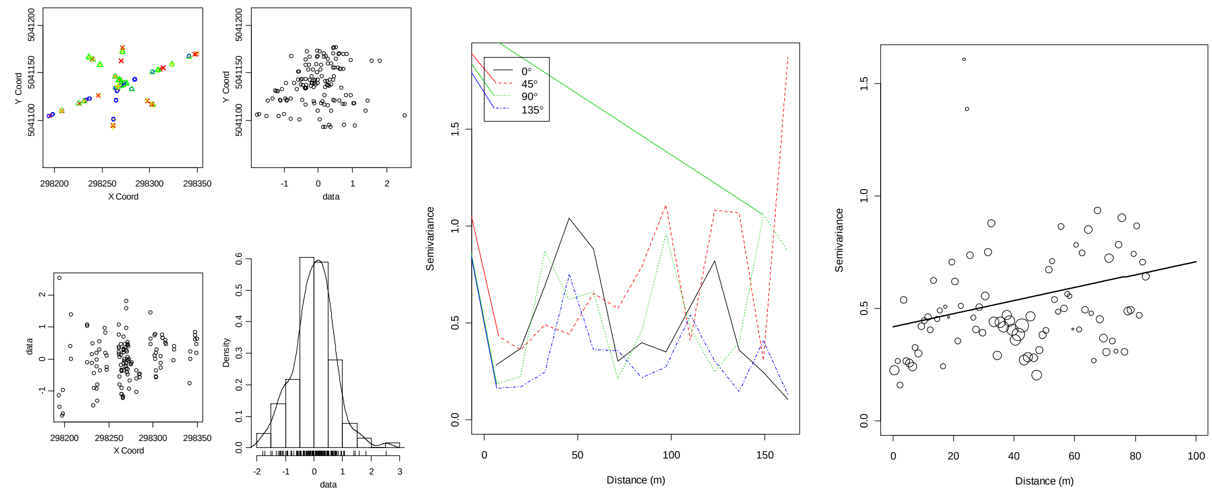


Figure 54. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

5.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day, elevation, slope, and aspect trends, were used for the semivariogram analysis (Figure 55). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 56, left graph) and directional semivariograms do not show anisotropy (Figure 56, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 56, right graph). The model indicates a distance of effective independence of 12 m for soil water content.

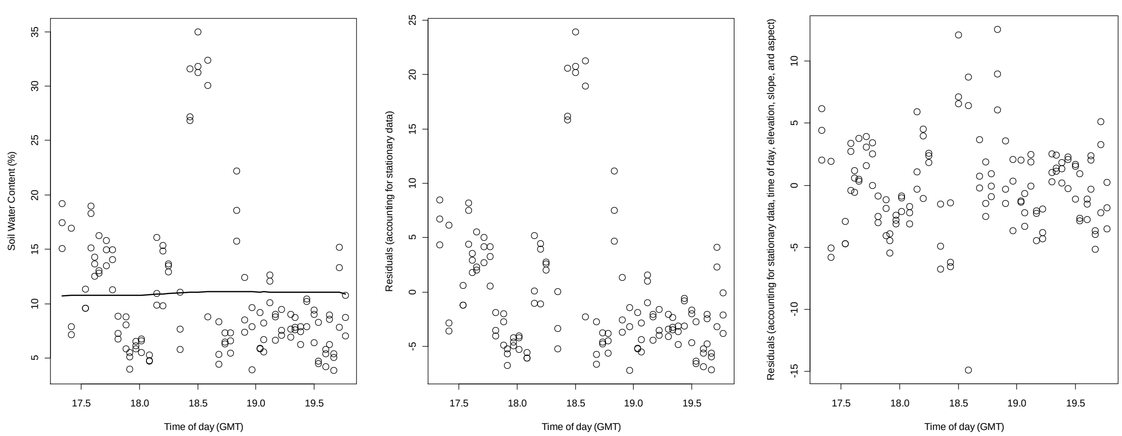


Figure 55. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting for

changes water content in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

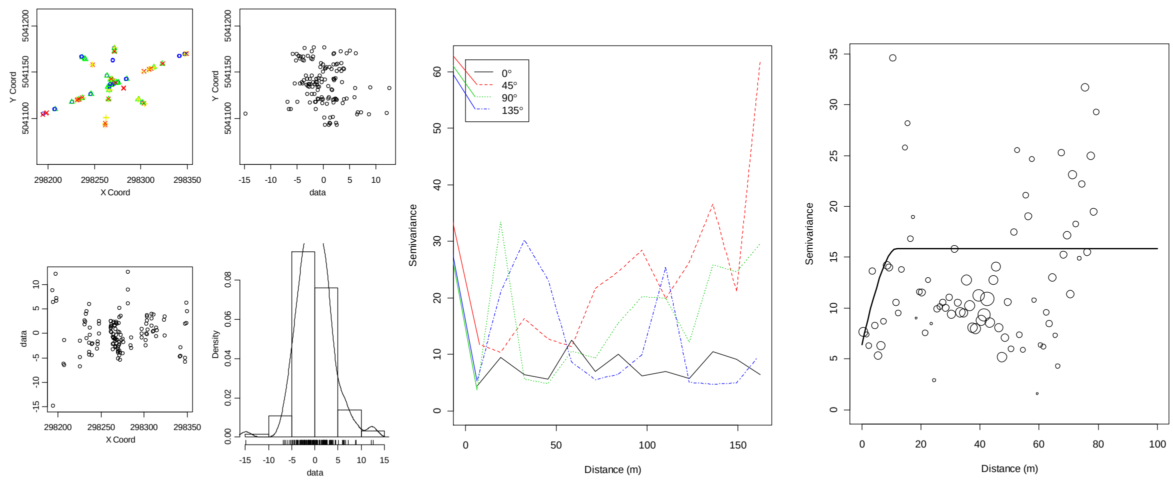


Figure 56. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

5.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was >100 m for soil temperature and 12 m for soil moisture. Based on these results and the site design guidelines the soil plots at Tree Haven shall be placed 40 m apart. The soil array shall follow the linear soil array design (Soil Array Pattern B) with the soil plots being 5 m x 5 m. The direction of the soil array shall be 240° from the soil plot nearest the tower (i.e., first soil plot). The location of the first soil plot will be approximately 45.494485, -89.585261. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc). The FIU soil pit for characterizing soil horizon depths, collecting soil for site-specific sensor calibration, and collecting soil for the FIU soil archive will be located at 45.492550, -89.584079 (primary location); or 45.492656, -89.583484 (alternate location 1 if primary location is unsuitable); or 45.492435, -89.584697 (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 19 and site layout can be seen in Figure 57.

Dominant soil series at the site: Sarwet sandy loam, 2 to 6 percent slopes- Moodig sandy loam, 0 to 4 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Orthods -Aquods
Great group: Haplorthods -Epiaquods
Subgroup: Alfic Oxyaquic Haplorthods -Alfic Epiaquods

Family: Coarse-loamy, mixed, superactive, frigid Alfic Oxyaquic Haplorthods -Coarse-loamy, mixed, superactive, frigid Alfic Epiaquods
Series: Sarwet sandy loam, 2 to 6 percent slopes- Moodig sandy loam, 0 to 4 percent slopes

Table 19. Summary of soil array and soil pit information at Tree Haven. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	19 m
Latitude and longitude of 1st soil plot OR direction from tower	45.494485, -89.585261
Direction of soil array	240°
Latitude and longitude of FIU soil pit 1	45.492550, -89.584079 (primary location)
Latitude and longitude of FIU soil pit 2	45.492656, -89.583484 (alternate 1)
Latitude and longitude of FIU soil pit 3	45.492435, -89.584697 (alternate 2)
Dominant soil type	Sarwet sandy loam, 2 to 6 percent slopes-Moodig sandy loam, 0 to 4 percent slopes
Expected soil depth	>2 m
Depth to water table	0.15-0.61 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.08 m (Sandy loam)	0.04 m [A]
0.08-0.13 m (Gravelly sandy loam)	0.12 m [A]
0.13-0.56 m (Gravelly sandy loam)	0.35 m [A]
0.56-1.35 m (Sandy loam)	0.96 m
1.35-1.85 m (Gravelly sandy loam)	1.60 m
1.85-2 m (Gravelly sandy loam)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
[A] Expected depth of soil CO_2 sensors (subject to soil horizon depths)

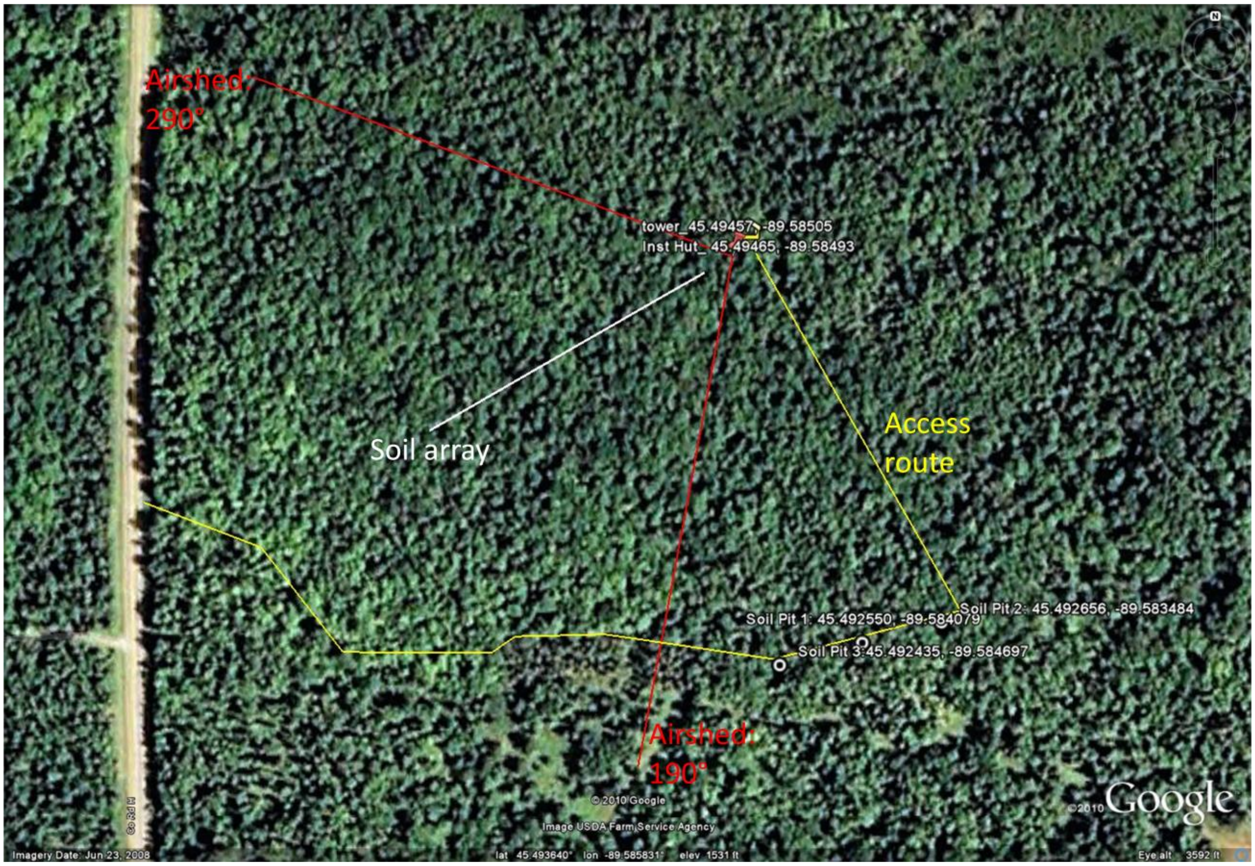


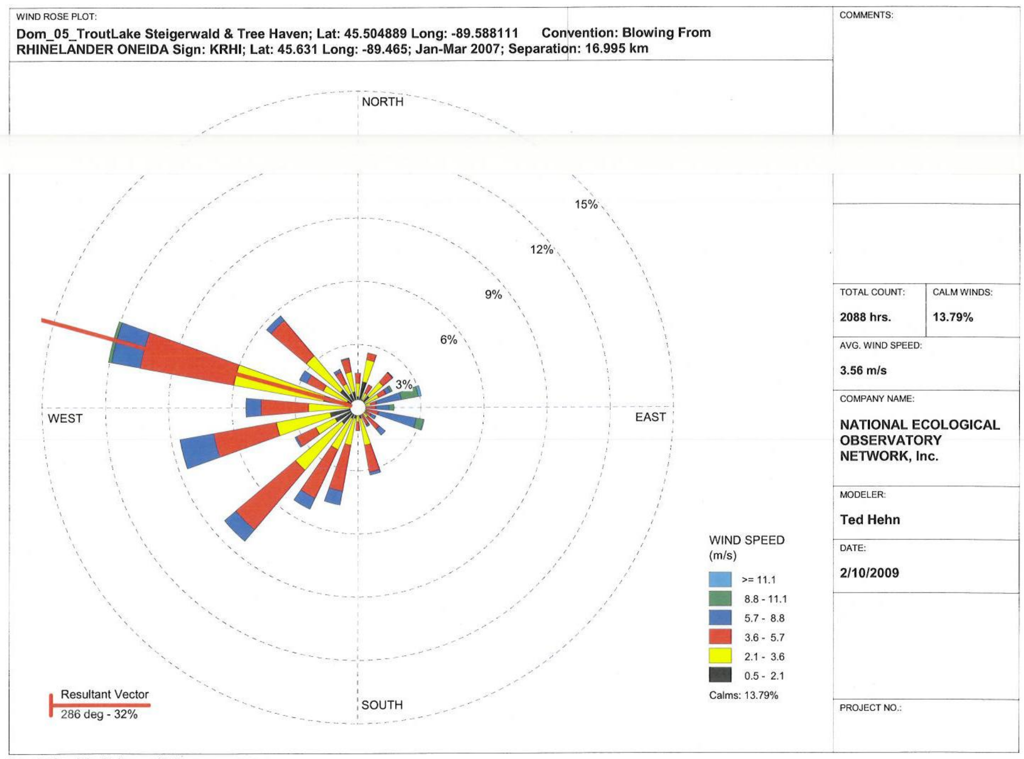
Figure 57. Site layout at Tree Haven showing soil array and location of the FIU soil pit.

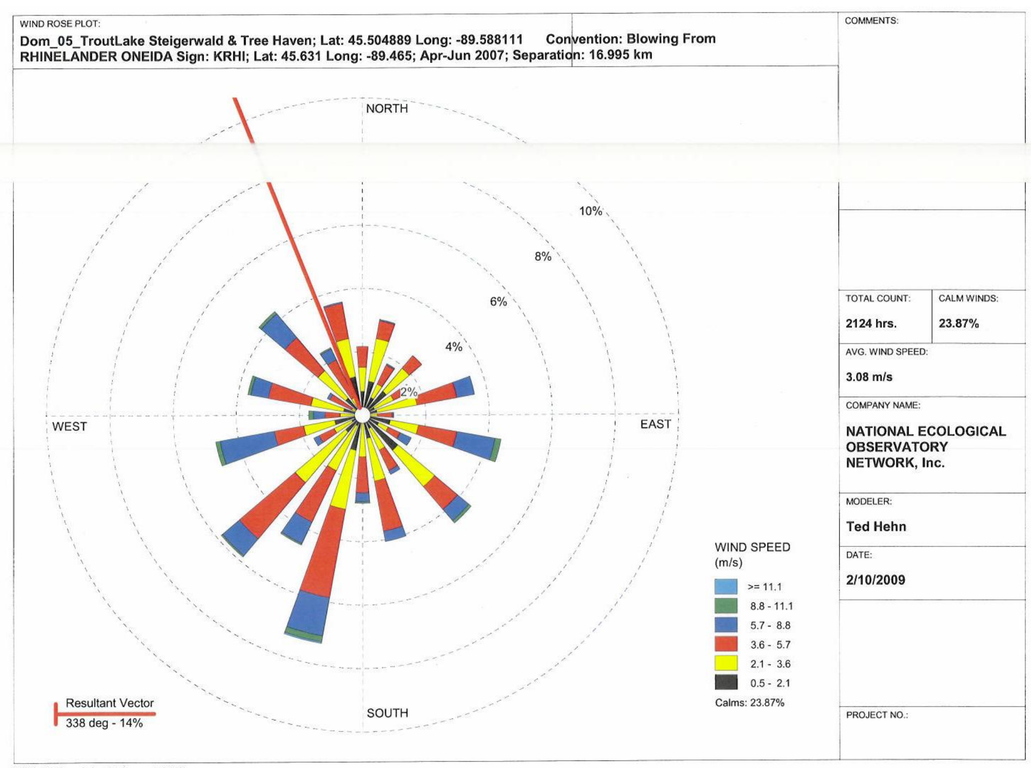
5.4 Airshed

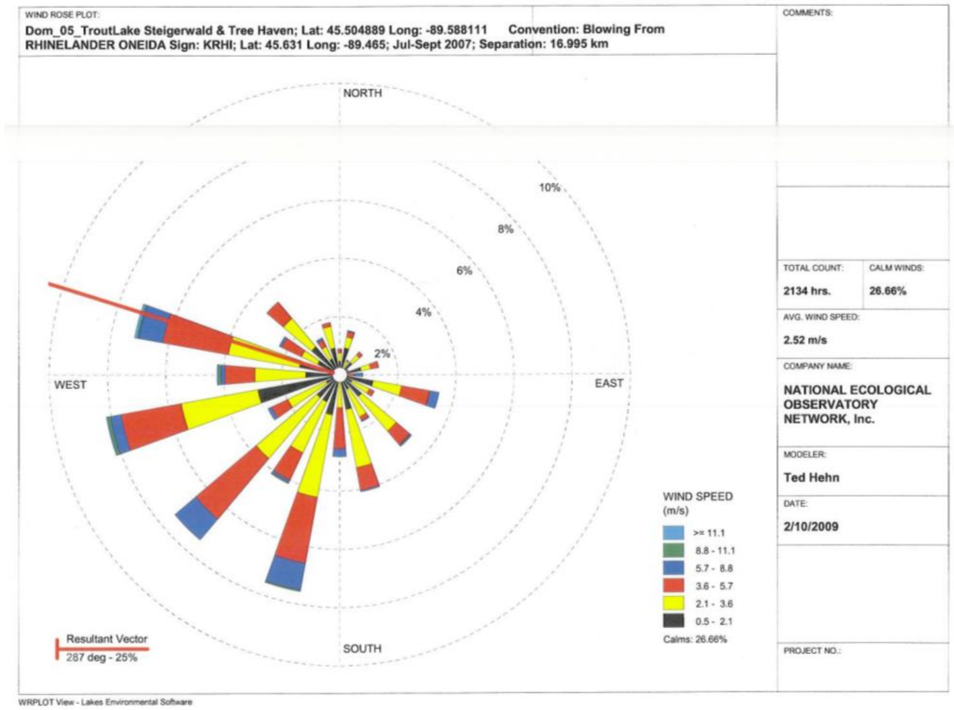
5.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries. The weather data used to generate the following wind roses are from Rhinelander Oneida County (RHI) airport (45.631, -89.465), which is ~17 km from tower site. Terrain is flat in this region. We assume that the wind patterns at RHI are similar to the ones at our sit. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

5.4.2 Results (graphs for wind roses)







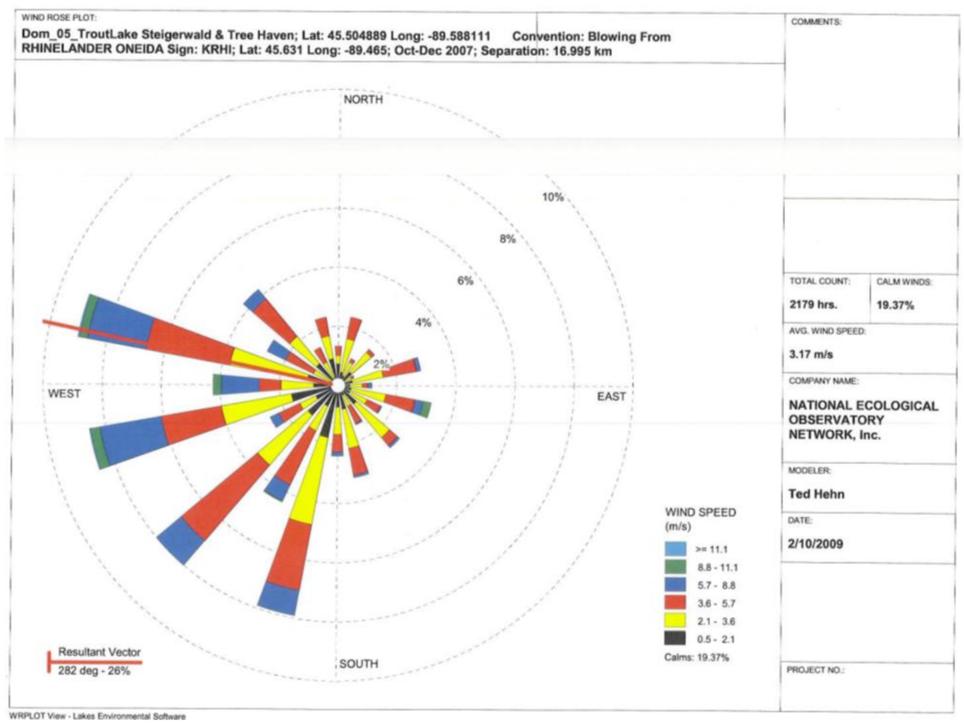


Figure 58. Windroses from Tree Haven.
Data used here are 2007 data from Rhinelander Oneida County (RHI) airport (45.631, -89.465), which is ~17 km from NEON tower site. It is assumed that the wind data was corrected for declination. Panels are (from top to bottom) Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

5.4.3 Resultant vectors

Table 20. The resultant wind vectors from Tree Haven using hourly data in 2007.

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	286°	32
April to June	338°	14
July to September	287°	25
October to December	282°	26
Annual mean	298.25°	na.

5.4.4 Expected environmental controls on source area

Two types of models were commonly used to determine the shape and extent of the source area under different and contrasting atmospheric stability classes. An inverted plume dispersion model with modeled cross wind solutions were used for convective conditions (Horst and Weil 1994). For strongly stable conditions, and Lagrangian solution was used (Kormann and Meixner 2001). The source area models where bounded by the expected conditions depict the extreme conditions. Convective conditions typically have strong vertical mixing between the ecosystem and atmosphere (surface layer). Stable conditions typically have long source area and associated waveforms. Convective turbulence is often characterized by short mixing scales (scalar) and moderate daytime wind speeds, *e.g.,* 1-4 m s^{-2}. Higher wind speeds, like those experienced over the Rockies, are often the product of mechanical turbulence with long waveforms. Because thermal stratification is very efficient in suppressing vertical mixing, stable conditions also have typically very long waveforms.

As a general rule, shorter and less structurally complex ecosystems have good vertical mixing during all atmospheric stabilities. Taller and more structurally complex ecosystems have well mixed upper canopies during the daytime, and can be decoupled below the canopy under neutral and stable conditions (e.g., Harvard Forest, Bartlett Experimental Forest, and Burlington Conservation Area). The type of turbulence (mechanical verse convective) and the physical attributes of the ecosystem control the degree of mixing, and the length and size of the source area.

Here, we use a web-based footprint model to determine the footprint area under various conditions (model info: http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/). Winds used to run the model and generate following model results are extracted from the wind roses. Vegetation information, temperature and energy information were either from the RFI document, previous site visit report, available data files or best estimated from experienced expert. Measurement height was determined from the Tower Height Info document provided by ENG group, then verify according to the real ecosystem structure after FIU site characterization at site. Runs 1-3 and 4-6 represents the expected conditions for summer and winter conditions, respectively, with maximum and mean windspeeds (daytime convective) and nighttime (stable atmospheres) conditions. The wind vector for each run was estimated from wind roses and is placed as a centerline in the site map included in the graphics. The width of the footprint was also estimated using the length between the isopleth of 80% cumulative flux and center line to calculate the angle from centerline. This information, along with distance of the cumulative flux isopleths and wind direction, will define the source area for the flux measurements on the top of the tower.

Table 21. Expected environmental controls to parameterize the source area model and associated results from Tree Haven Relocatable tower site.

Parameters	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	
Approximate season	summer			winter			Units
	Day (max WS)	Day (mean WS)	Night	Day (max WS)	Day (mean WS)	night	qualitative
Atmospheric stability	Convective	convective	Stable	Convective	convective	Stable	qualitative
Measurement height	35	35	35	35	35	35	m
Canopy Height	23	23	23	23	23	23	m
Canopy area density	3	3	3	2	2	2	m
Boundary layer depth	2000	2000	900	900	900	700	m
Expected sensible heat flux	400	400	-9	180	180	-70	W m^{-2}
Air Temperature	28	28	20	-5	-5	-10	°C
Max. windspeed	11.6	3.6	1.6	11.6	4.6	2.8	m s^{-1}
Resultant wind vector	255	255	255	288	288	288	degrees
Results							
(z-d)/L	-0.01	-0.25	0.85	-0.01	-0.09	3.00	m
d	18	18	18	17	17.00	17.00	m
Sigma v	3.70	2.10	1.70	3.60	1.80	1.60	m^2 s^{-2}
Z0	1.00	1.00	1.00	1.30	1.30	1.30	m
u*	1.70	0.66	0.13	1.80	0.77	0.10	m s^{-1}
Distance source area begins	10	0	50	10	0	350	m
Distance of 90% cumulative flux	1000	400	2300	1050	650	3350	m
Distance of 80% cumulative flux	600	250	1500	600	400	2800	m
Distance of 70% cumulative flux	400	180	1100	400	300	2400	m
Peak contribution	75	55	205	75	65	1015	m

5.4.5 Results (source area graphs)

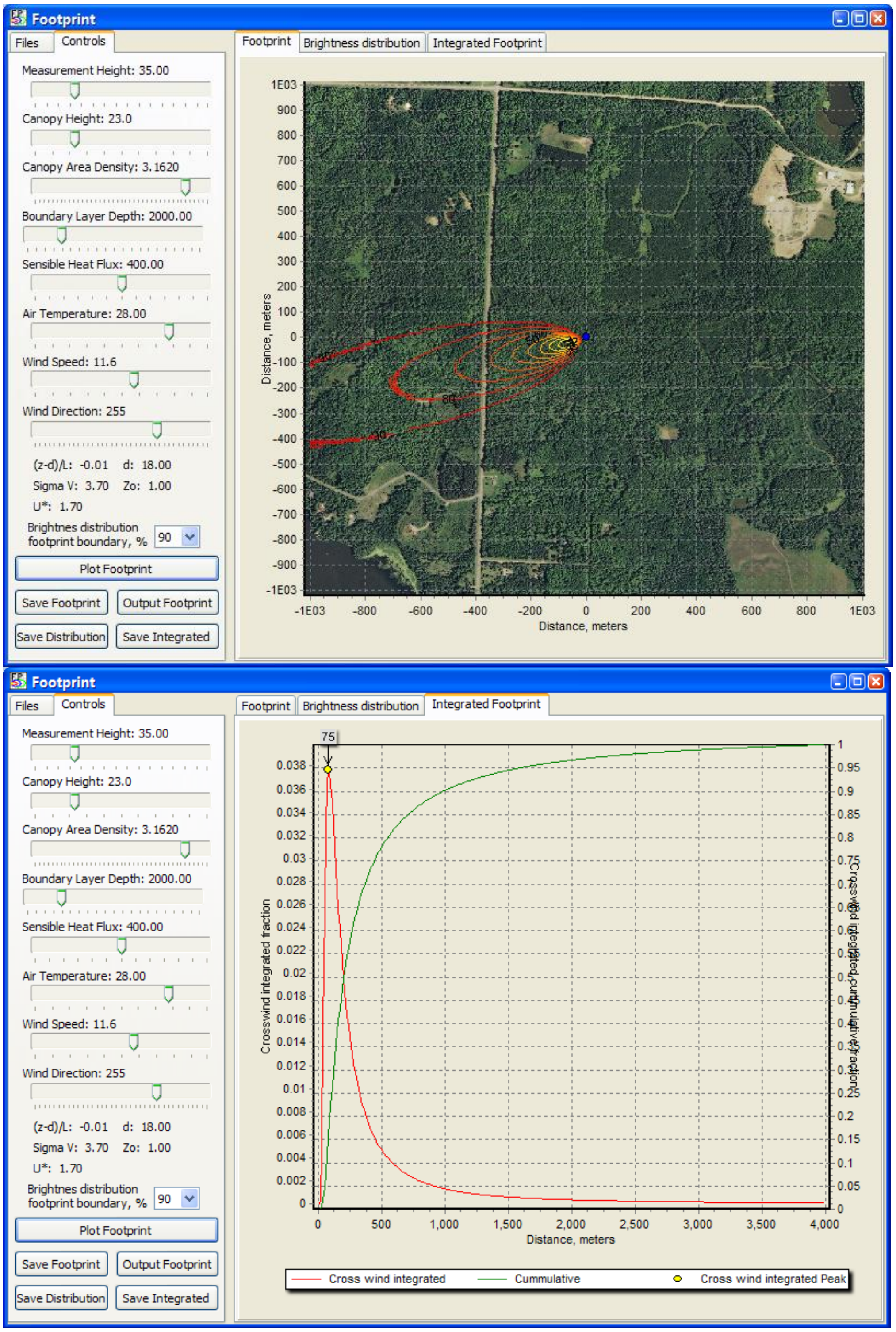


Figure 59. Tree Haven Relocatable site summer daytime (convective) footprint output with max wind speed

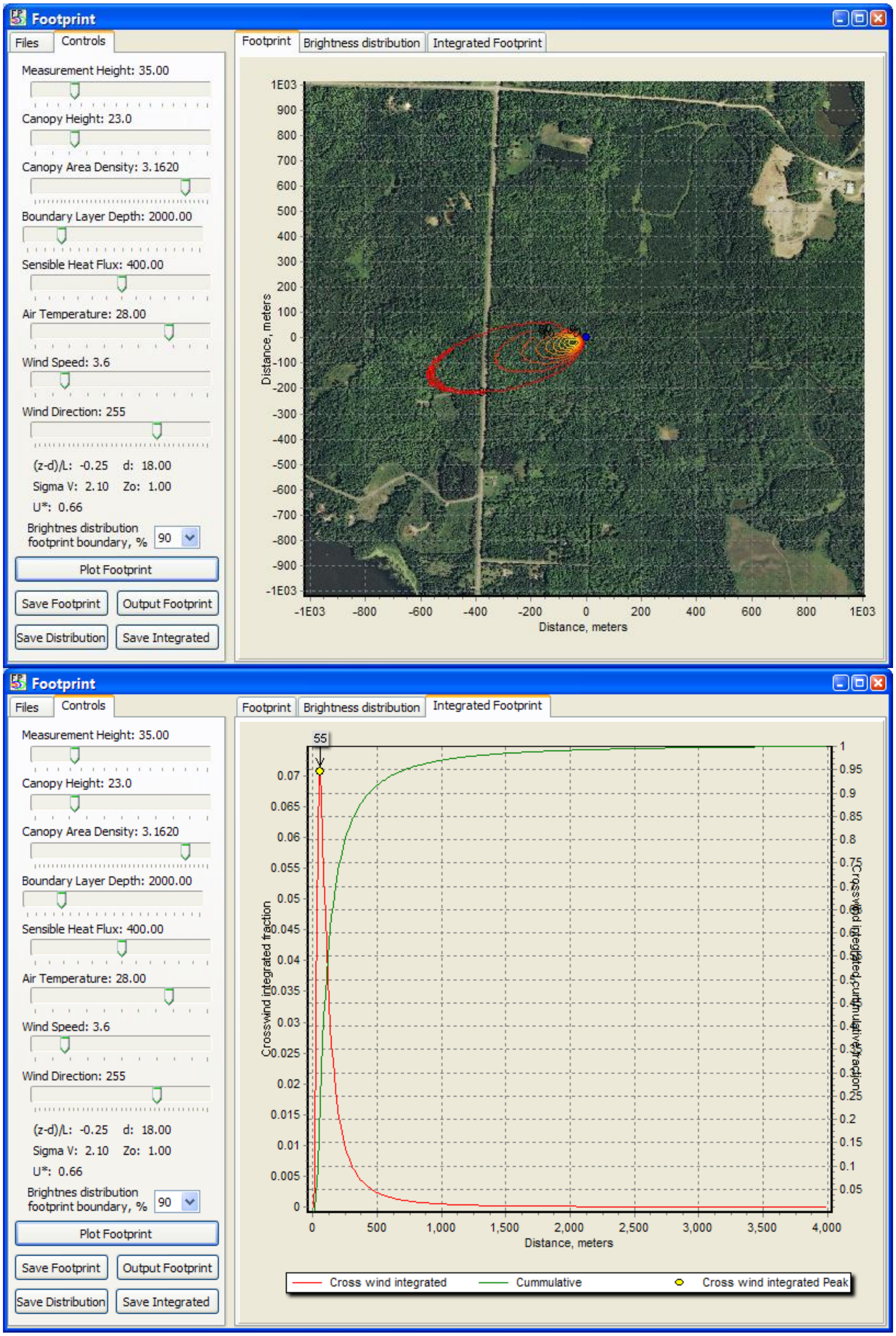


Figure 60. Tree Haven Relocatable site summer daytime (convective) footprint output with mean wind speed

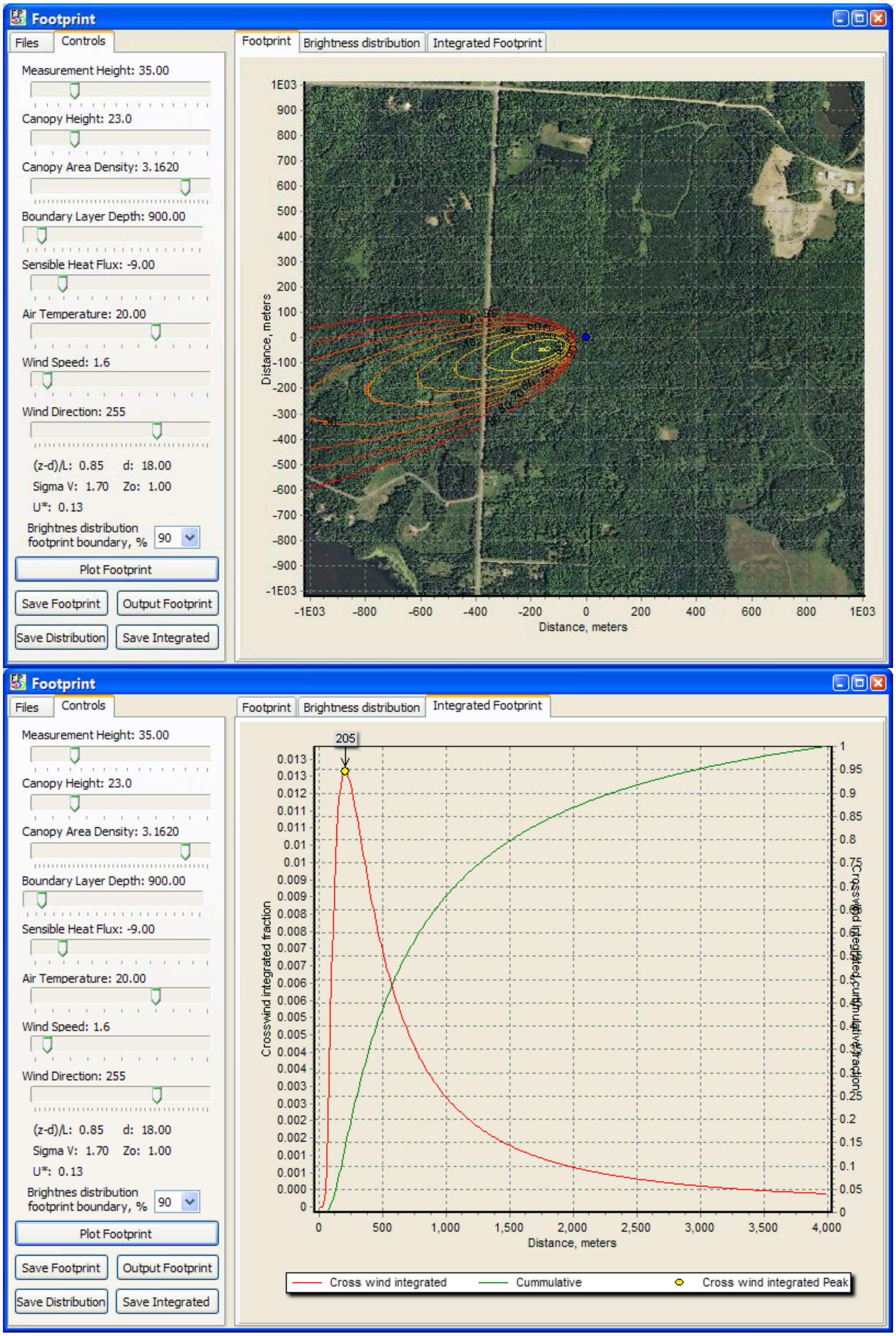


Figure 61. Tree Haven Relocatable site summer nighttime (stable) footprint output with mean wind speed.

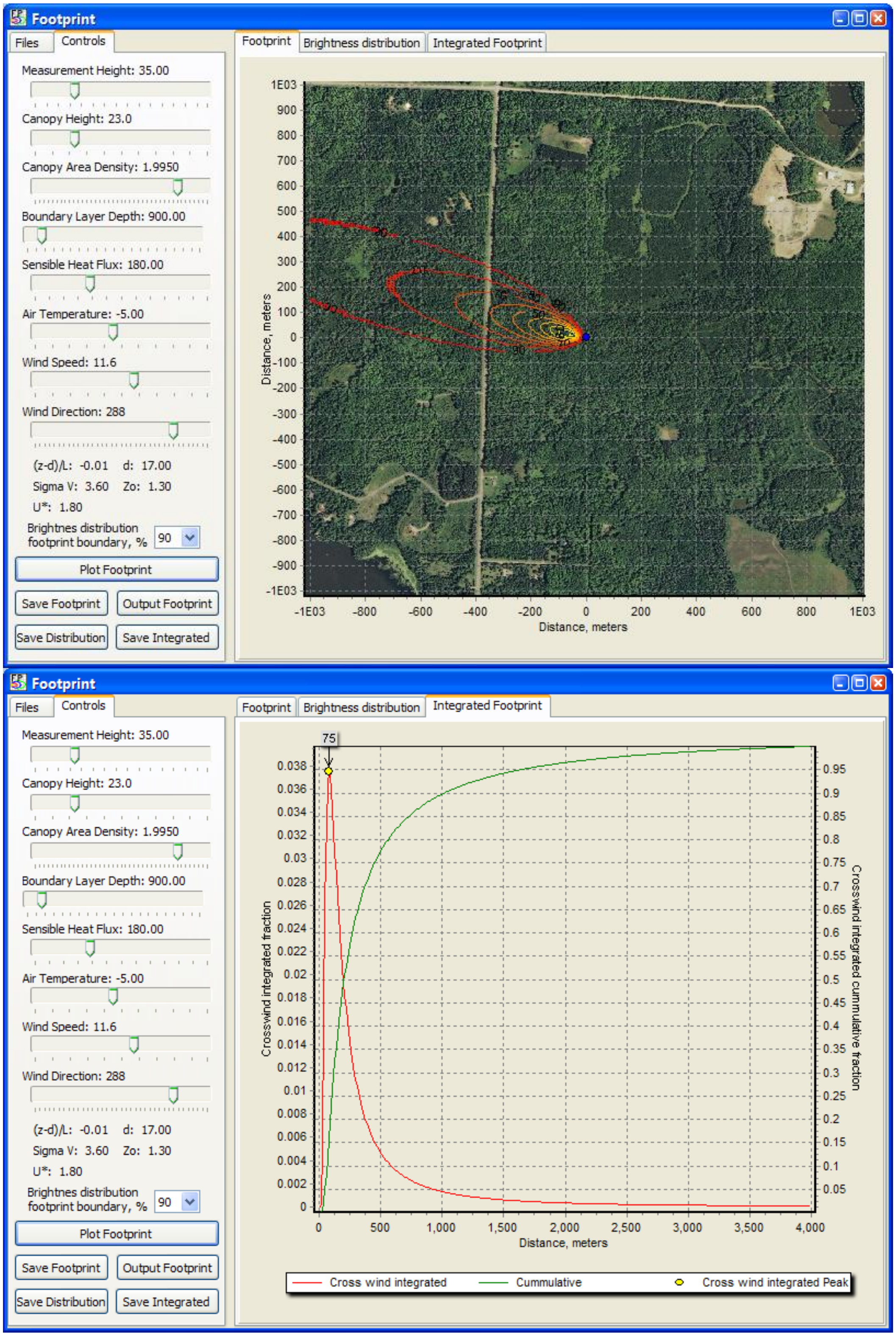


Figure 62. Tree Haven Relocatable site winter daytime (convective) footprint output with max wind speed

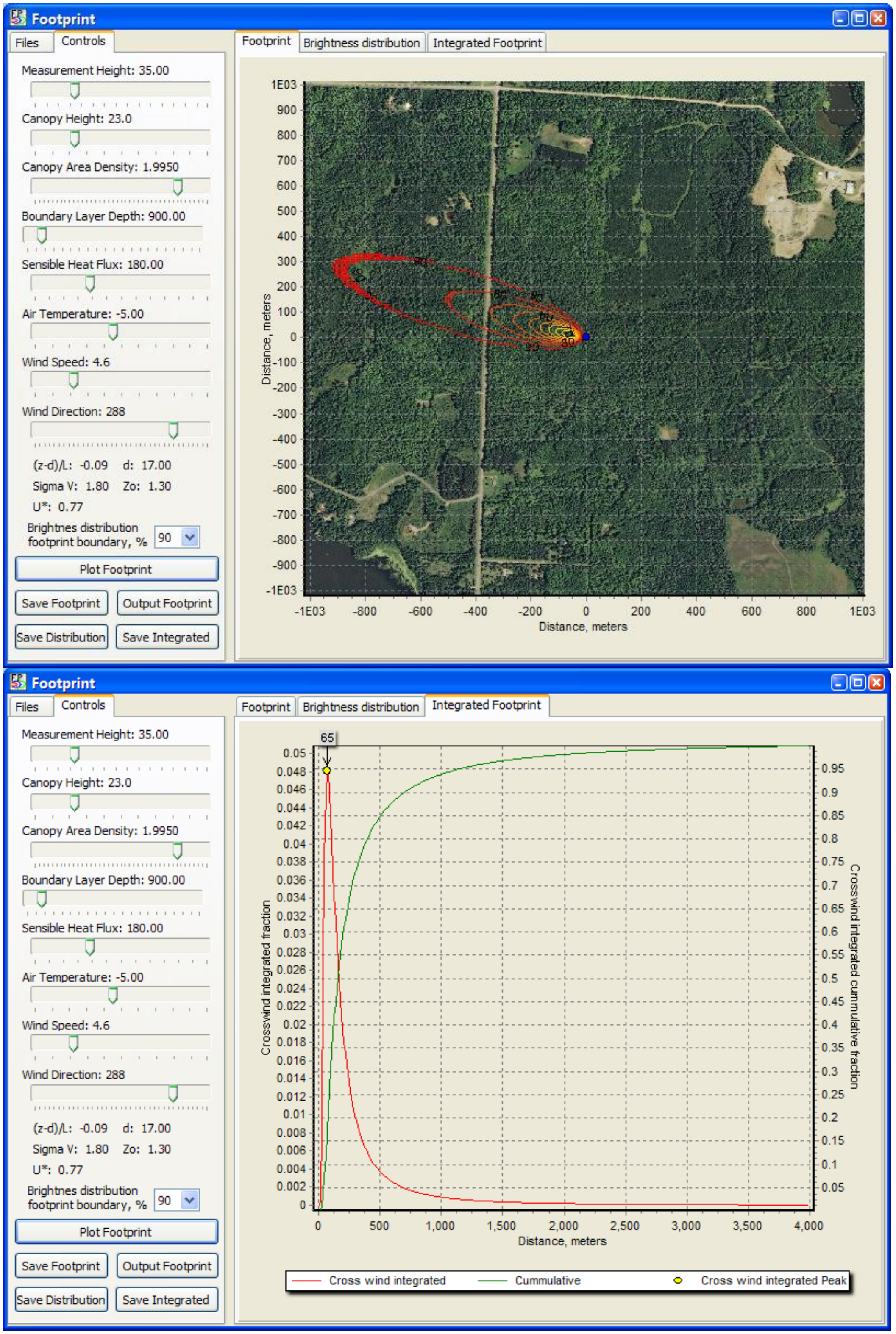


Figure 63. Tree Haven Relocatable site winter daytime (convective) footprint output with mean wind speed.

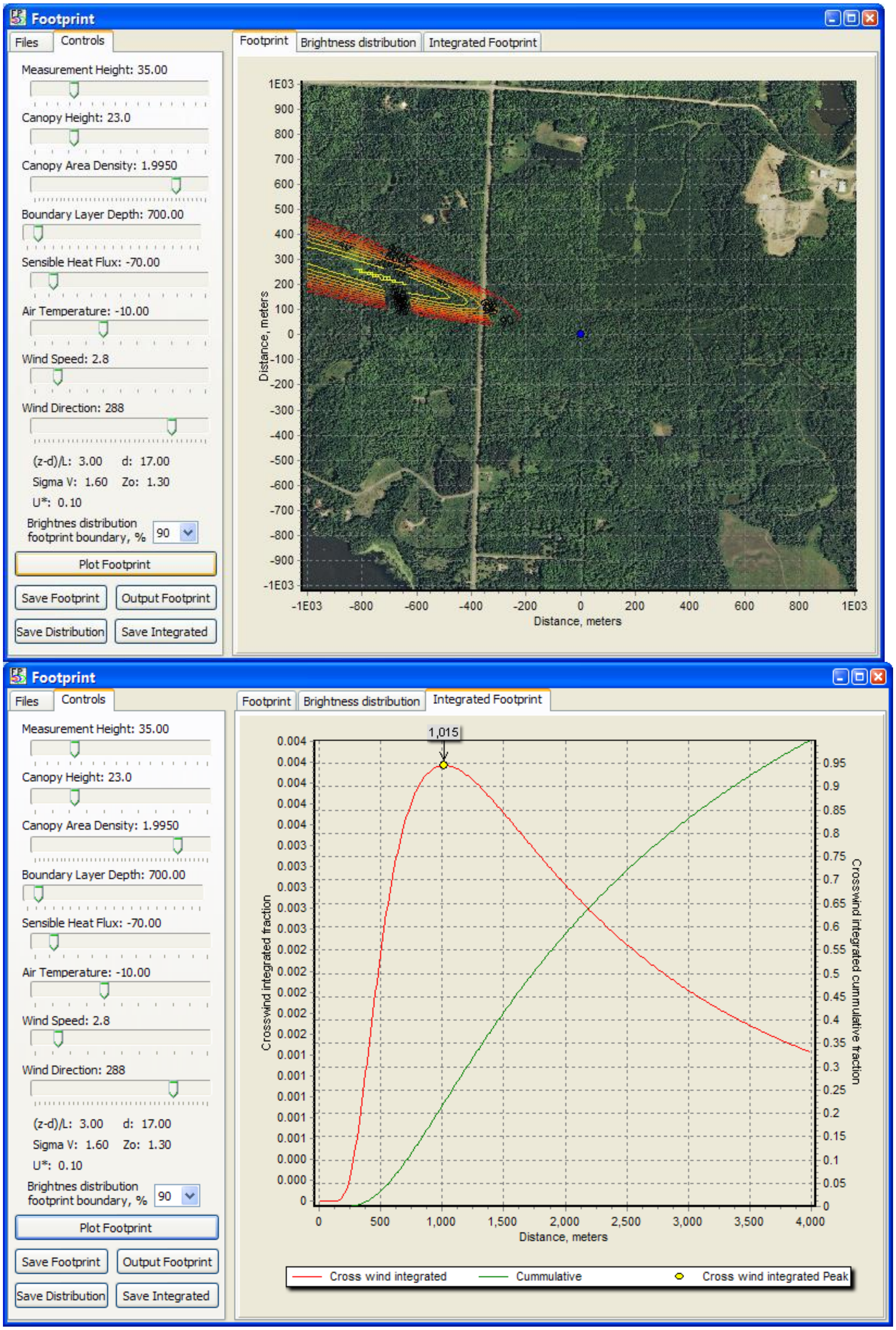


Figure 64. Tree Haven Relocatable site winter nighttime (stable) footprint output with mean wind speed.

5.4.6 Site design and tower attributes

According to wind roses, wind comes all directions, but the relative higher frequency blows between south and WNW (190° to 290°, clockwise from 190°, major airshed). **Tower** should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is Northern hardwood deciduous forest. The candidate tower site was at 45.493139°, -89.562028°. To avoid the effects from the bog and pond in the major airshed, and to maximize the tower fetch area over the deciduous forest on the west to tower, after FIU site characterization, we microsited it toward west for ~1800 m at 45.49457°, -89.58505°. The new location is closer to power and easy access along the forest roads.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure. An **instrument hut** should be outside the prevailing wind airshed to avoid disturbance in the measurements of wind and should be positioned to have the longer side parallel to frequent wind direction to minimize the wind effects on instrument huts and to minimize the disturbances of wind regime by instrument hut, and in this case, instrument hut should be positioned on the northeast toward tower and have the longer side parallel to NE-SW direction. Therefore, we decide the placement of instrument hut at 45.49465, -89.58493.

The ecosystem at around tower site and in the major tower airshed is hardwood forest. Mean canopy is ~23 m. Young trees form the upper understory with height around 10 m, while smaller seedlings and saplings form the lower understory with height ~ 4 m. Ferns, grasses and herbs are commonly found at the ground level with a mean height ~ 0.8 m. Forest is managed by selective logging. Many stumps and coarse woody debris were found on the ground. We require 6 **measurement layers** on the tower with top measurement height at 35 m, and the remaining levels are 27 m, 23 m, 10 m, 0.8 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. No **wet deposition collector** will be deployed at this site. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 22. Site design and tower attributes for Tree Haven Relocatable site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			190° to 290°		Clockwise from

					first angle
Tower location	45.49457,	-89.58505	--	--	new site
Instrument hut	45.49465,	-89.58493			
Instrument hut orientation vector	--	--	45° - 225°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	225°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				1.5	m.a.g.l.
Level 3				0.8.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				23.0	m.a.g.l.
Level 6				27.0	m.a.g.l.
Tower Height				35.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Figure below shows the proposed tower location, instrument hut location, airshed area and access road.

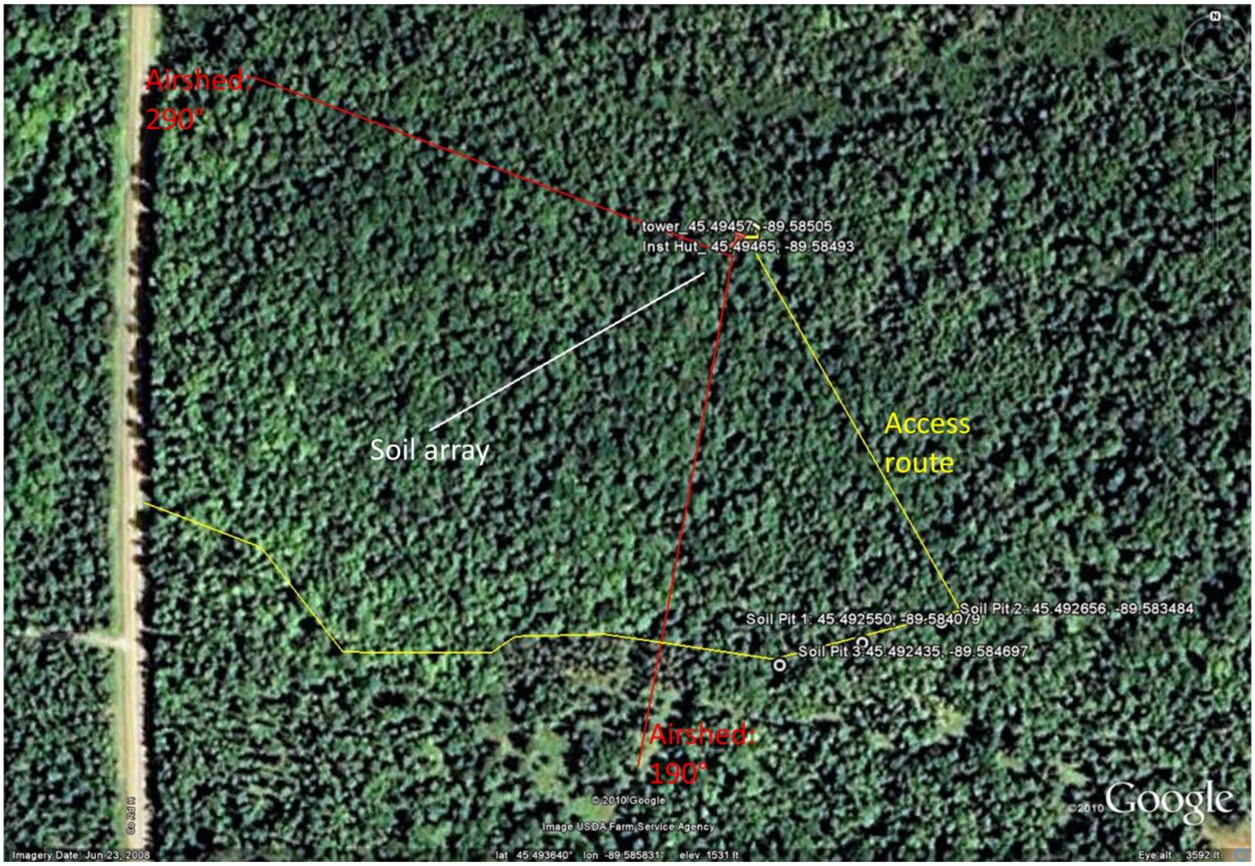


Figure 65. Site layout for Tree Haven Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 190^o to 290^o (major, clockwise from 190°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done.
Specific boardwalks at the Tree Haven Relocatable site

- Boardwalk is from the access forest road to instrument hut

- Boardwalk is required from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array is required, pending landowner decision.
- No boardwalk from the soil array boardwalk to the individual soil plots

The relative locations between tower, instrument hut and boardwalk can be found in the diagram below:

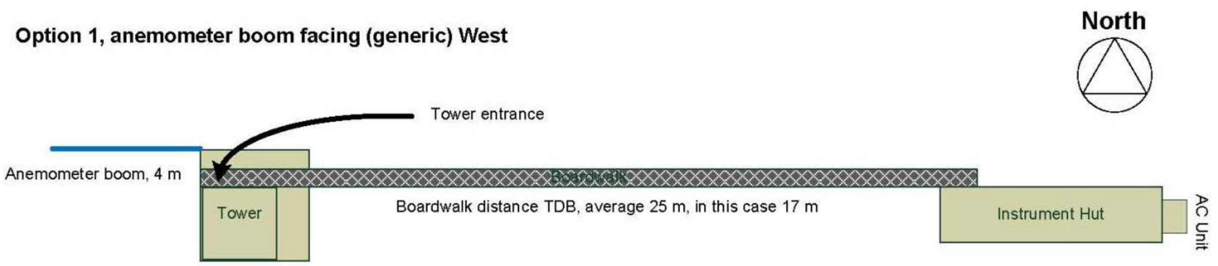


Figure 66. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the east towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At Tree Haven Relocatable site, the boom angle will be 225^o, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be NE-SW (45^o-225^o, longwise).

5.4.7 Information for ecosystem productivity plots

The tower at Tree Haven relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (mixed northern hardwood forest). Wind can blow from any direction, but has relatively higher frequency from 190^o to 290^o (major airshed, clockwise from 190°), and 90% signals for flux measurements during daytime are within a distance of 1000 m from tower, and 80% within 600 m. But during nighttime stable calm wind conditions, flux sensor on tower can detect signals beyond 3 km from tower. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 190^o to 320^o (major, clockwise from 190°) from tower.

5.5 Issues and attentions

The tower location is close to the northern, western, and southern property boundary. Approximatly 70% flux signals during daytime are within the same management unit on the east side of the road, and ~ 30% daytime signal will be from the forest on the west side of the road. However, the forest on the property to the north and west of the tower are similar to the forest in Tree Haven (i.e. northern hardwood). The forest on the property to the south was harvested in ~2002 and is regenerating northern hardwood forest and is unlikely to be harvested for decades. The county highway, ~350 m west of the tower, is not heavily used and vehicle emissions are not expected to be high.

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