D07 FIU Site Characterization
Supporting Data

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See Configuration Management System for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	10/25/2010	NEON.FIU.000256.CRE	Initial Release
B	12/10/2010	NEON.FIU.000278.CRE	UPDATES SEE CRE
C	03/29/2011	ECO-00157	Great Smoky Mtn National Park site added. See ECO for additional changes
D	09/23/2011	ECO-00279	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 in Domain 07. This document presents all the supporting data for FIU site characterization.

1.2 Scope

FIU site characterization data and analysis results presented in this document are for D07 tower locations: Oak Ridge National Labs – Walker Branch (ORNL Walker Branch) site (Advanced), Mountain Lake Biological Station site (Relocatable 1), and Great Smoky Mountains National Park – Twin Creeks site (Relocatable 2). Issues and concerns for each site that need attentions are also addressed in this document according to our best knowledge. Accuracy of our GPS locations are only as good as the methodology used, i.e., GPS units to ~ ±3 m.

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 ORNL WALKER BRANCH (ADVANCED TOWER SITE)

3.1 Site description

NEON Advanced tower site at Oak Ridge is located within The Walker Branch Watershed (Figure 1), which is located on the U. S. Department of Energy's Oak Ridge Reservation in Roane County, Tennessee. Major funding for Walker Branch Watershed research activities comes from the Program for Ecosystem Research (PER) in the DOE Office of Science and Office of Biological and Environmental Research (OBER). The 97.5 ha Walker Branch watershed has been the site of long-term, intensive environmental studies since the late-1960's by staff from the Environmental Sciences Division at Oak Ridge National Laboratory (ORNL), staff from the Atmospheric Turbulence and Diffusion Division, Air Resources Laboratory, National Oceanic and Atmospheric Administration in Oak Ridge, Tennessee, and many visiting university researchers. (Information source: http://walkerbranch.ornl.gov/)

Mean annual precipitation in Walker Branch Watershed is 140 cm and mean temperature is 13.3 ^{o}C. The acidic forest soils (pH 3.5 to 4.6) at this site are primarily typic Paleudults. These ancient residual soils are very cherty, infertile, and highly permeable. They formed over a dolomitic bedrock but retain little evidence of their carbonate parent material. Depth to bedrock at this location is approximately 30 m. Stand basal area averages 20 to 25 m^2 ha^{-1}. The site has relatively uniform slope, consistent soils, and a reasonably uniform distribution of vegetation. The site is dominated by Quercus alba, Quercus pMus and Acer rubrum L. but it contains just under 20 tree species. (Source information: http://www.osti.gov/bridge/purl.cover.jsp?purl=/41269-PjBCZg/webviewable/).

Figure 1. Boundary map of ORNL Walker Branch and NEON candidate tower location

3.1.1 Ecosystem

Major forest types were identified by Grigal and Goldstein (1971) and characterized predominately as upland hardwoods [oak (Quercus spp.), red maple (Acer rubrum L.), hickory (Carya spp.)] dominated by chestnut oak (Q. prinus L.) with some intermixing of pine [shortleaf pine (Pinus echineta Mill.) and Virginia pine (P. virginiana Mill.)] on ridges. Mesic coves and riparian zones are mainly yellow poplar (Lirodendron tulipifera L.) and American beech (Fagus grandifolia Ehrh.). The watershed is at ≈300 to 350 m elevation, has 14.5°C mean annual temperature, and receives ≈151 cm average annual precipitation of which 43–48% is estimated to undergo evapotranspiration (Information source: http://soil.scijournals.org/cgi/content/full/63/5/1436)

Vegetation and land use type at this area can be found on Figure 2 and Figure 3, Table 1 and Table 2 below.

The ecosystem we are interested in is the mixed hardwood forest described above. The tree species around NEON tower site are mainly oak and maple. Candidate tower location was lat 35.964618, long -84.280557. After FIU site characterization, we determine the tower location to be at 35.96412, -84.28260 to avoid measuring the air that is channeled by the valley on the south direction. New tower location is microsited toward southwest direction for ~190 m and toward the hill top. It is next to dirt access road. This is a closed-canopy ecosystem. Canopy height is ~28 m around tower site with lowest branches at ~10 m above ground level. No obvious strata observed at canopy. Seedlings and sapling form understory. Height varies between 5 to 10 meters. This understory canopy layer is more obvious at lower elevation toward valley. Litter layer is very thick. Ferns and new seedling form the understory at ground level with height < 1m (Figure 4).

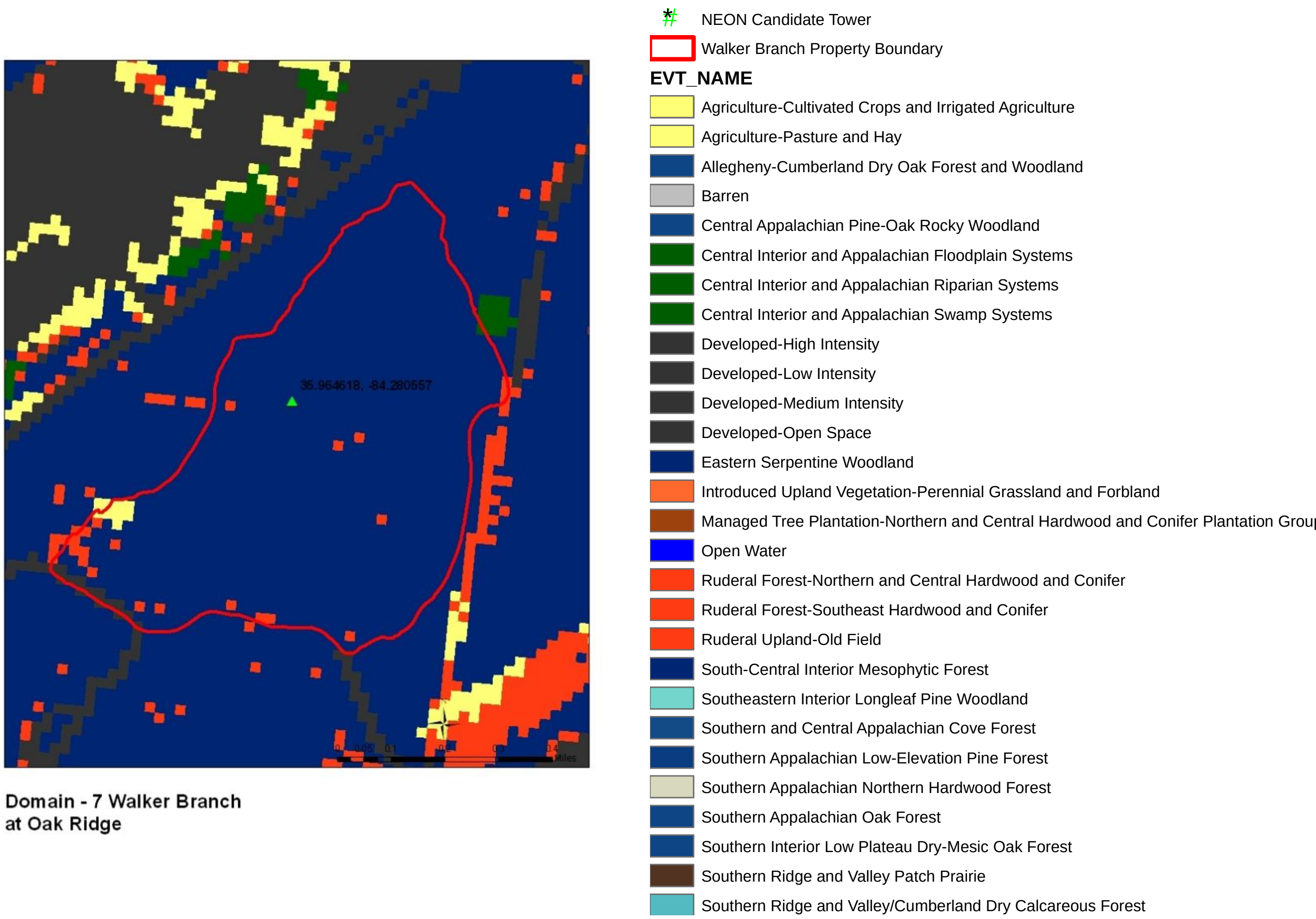


Figure 2. Vegetative cover map of ORNL Walker Branch and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

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

Land cover type	Area	Percentage (%)
Developed-Open Space	0.0072	0.711619
Agriculture-Pasture and Hay	0.00558758	0.552254
South-Central Interior Mesophytic Forest	0.982807157	97.13664
Central Interior and Appalachian Swamp Systems	0.0009	0.088952
Ruderal Upland-Old Field	0.0027	0.266857
Ruderal Forest-Northern and Central Hardwood and Conifer	0.012583236	1.243676
Total	1.011777973	100

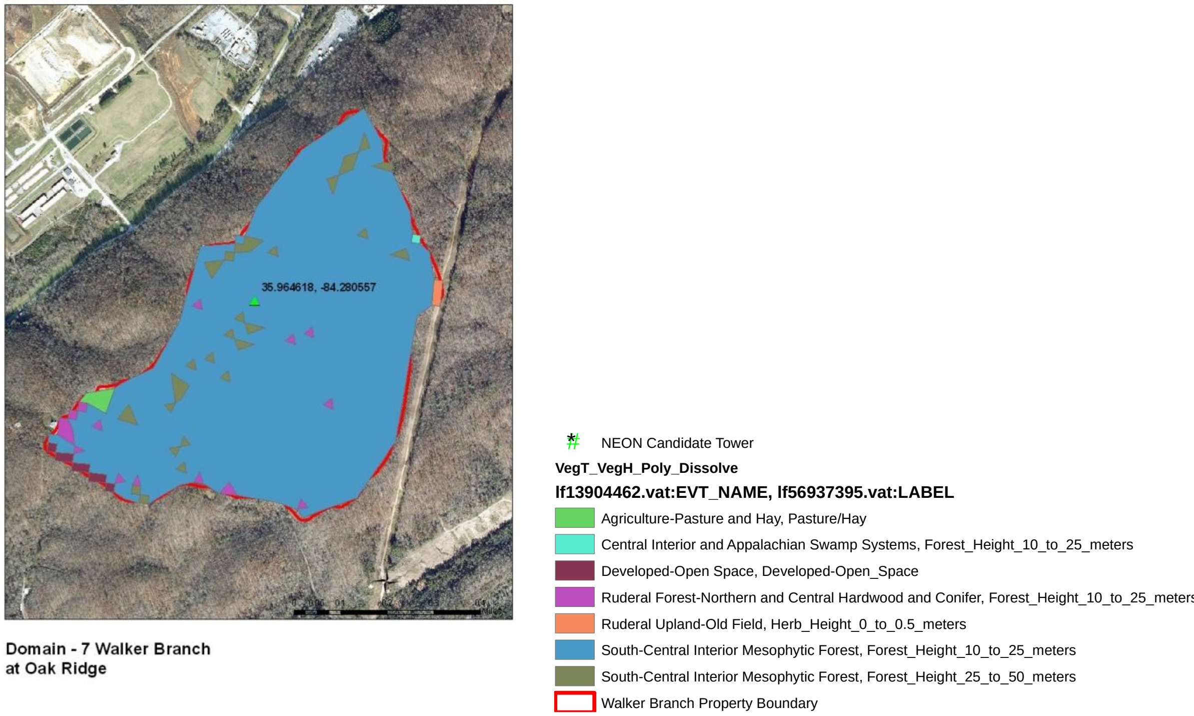


Figure 3. Vegetative height map of ORNL Walker Branch and the surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 2. Percent Land cover by vegetation height type at ORNL Walker Branch (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Height	Vegetation Type	Area	Percentage
Developed-Open_Space	Developed-Open Space	0.0072	0.712734
Pasture/Hay	Agriculture-Pasture and Hay	0.00558758	0.553119
Herb_Height_0_to_0.5_meters	Ruderal Upland-Old Field	0.0027	0.267275
Forest_Height_10_to_25_meters	South-Central Interior Mesophytic Forest	0.951061504	94.14632
Forest_Height_10_to_25_meters	Central Interior and Appalachian Swamp Systems	0.0009	0.089092
Forest_Height_10_to_25_meters	Ruderal Forest-Northern and Central Hardwood and Conifer	0.012543393	1.24168
Forest_Height_25_to_50_meters	South-Central Interior Mesophytic Forest	0.030202592	2.989778
	Total Area Sq Km	1.01019507	100

Figure 4. A photo to show the ecosystem structure at ORNL Walker Branch Advance tower site

3.2 Soils

3.2.1 Soil description

Soil data and soil maps (Figures 5) below for the ORNL Walker Branch Advanced tower site were collected from 2.5 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.

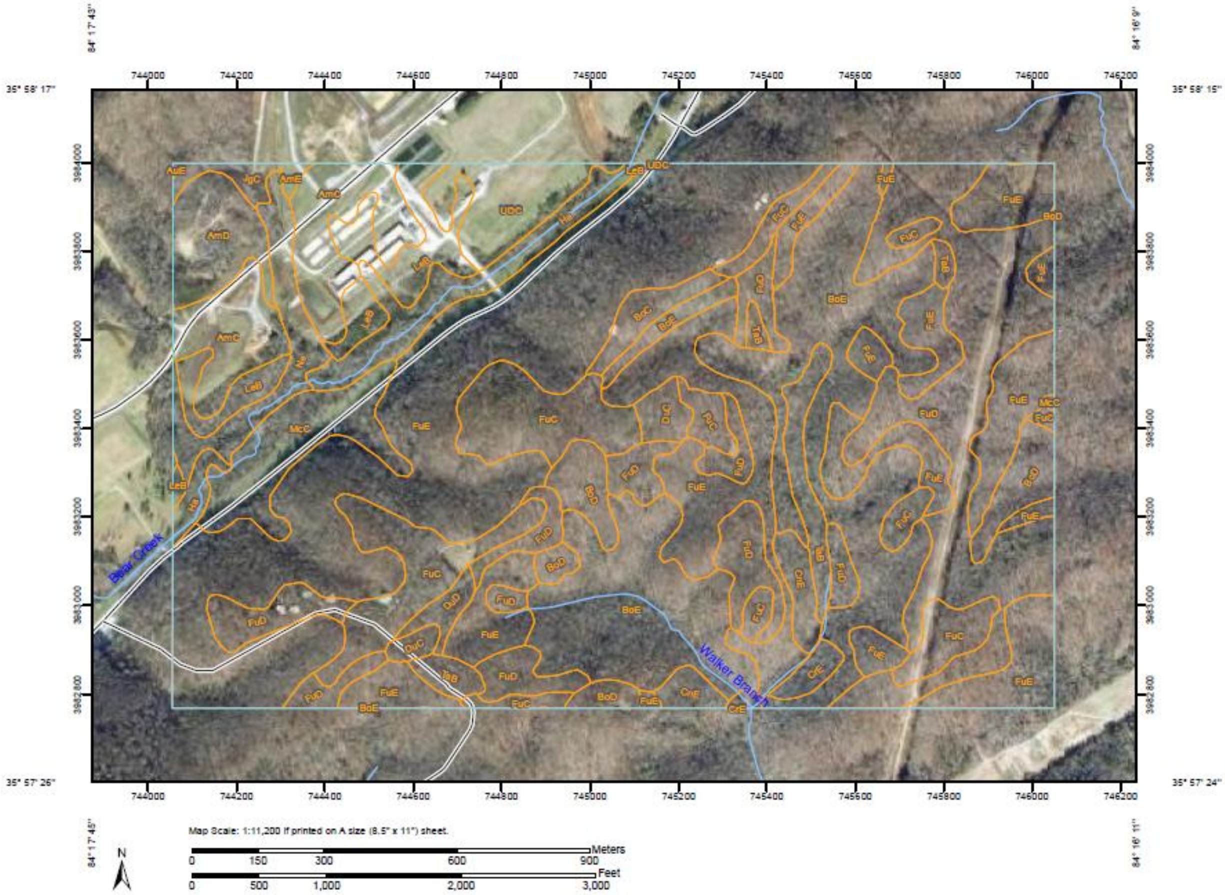


Figure 5. 2.5 km^2 soil map for ORNL Walker Branch NEON advanced tower site, center at tower location.

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, is 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 2.5 km^2 centered on the tower.
Area Object Interest (AOI) is the mapping unit from NRCS.

Anderson County, Tennessee (TN001)

Map Unit Symbol	Soil types	Acres in AOI	% AOI
AmC	Armuchee silt loam, 5 to 12 percent slopes	19.4	3.50%
AmD	Armuchee silt loam, 12 to 20 percent slopes	1	0.20%
AmE	Armuchee silt loam, 20 to 45 percent slopes	2.1	0.40%

Anderson County, Tennessee (TN001)

Map Unit Symbol	Soil types	Acres in AOI	% AOI
AmC	Armuchee silt loam, 5 to 12 percent slopes	27.8	4.60%
AmD	Armuchee silt loam, 12 to 20 percent slopes	12.3	2.00%
AmE	Armuchee silt loam, 20 to 45 percent slopes	0.8	0.10%
AuE	Armuchee-Muskingum complex, 25 to 60 percent slopes	0.1	0.00%
BoC	Bodine cherty silt loam, 5 to 12 percent slopes	4.9	0.80%
BoD	Bodine cherty silt loam, 12 to 25 percent slopes	15.5	2.50%
BoE	Bodine cherty silt loam, 25 to 50 percent slopes	91.7	15.10%
CnE	Claiborne silt loam, 25 to 45 percent slopes	6.7	1.10%
CrE	Collegedale-Rock outcrop complex, 20 to 35 percent slopes	3.2	0.50%
DuC	Dunmore silt loam, 5 to 12 percent slopes	4.9	0.80%
DuD	Dunmore silt loam, 12 to 25 percent slopes	2.8	0.50%
FuC	Fullerton cherty silt loam, 5 to 12 percent slopes	50.7	8.40%
FuD	Fullerton cherty silt loam, 12 to 25 percent slopes	91.7	15.10%
FuE	Fullerton cherty silt loam, 25 to 45 percent slopes	200	33.00%
Ha	Hamblen silt loam	16.7	2.70%
JgC	Jefferson gravelly loam, 5 to 12 percent slopes	2.9	0.50%
LeB	Leadvale silt loam, 2 to 7 percent slopes	19.2	3.20%
McC	Minvale cherty silt loam, 3 to 15 percent slopes	17.3	2.80%
Ne	Newark silt loam	12.4	2.10%
TaB	Tasso silt loam, 2 to 7 percent slopes	11.7	1.90%
UDC	Udorthents, rolling	13	2.20%
Totals for Area of Interest		606.3	100.00%

Note, asterix indicates dominate soil type in airshed

Anderson County, Tennessee: AmC—Armuchee silt loam, 5 to 12 percent slopes. Map Unit Setting *Elevation:* 710 to 1,400 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Armuchee and similar soils:* 100 percent **Description of Armuchee Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Crest *Parent material:* Clayey residuum weathered from acid shale **Properties and qualities** *Slope:* 5 to 12 percent *Depth to restrictive feature:* 20 to 36 inches to bedrock (paralithic) *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Very low (about 3.0 inches) **Interpretive groups** *Land capability (nonirrigated):* 4e **Typical profile** *0 to 6 inches:* Silt loam *6 to 18 inches:* Channery silty clay *18 to 24 inches:* Very channery silty clay *24 to 40 inches:* Weathered bedrock

Anderson County, Tennessee: AmD—Armuchee silt loam, 12 to 20 percent slopes. Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Armuchee and similar soils: 100 percent Description of Armuchee **Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Clayey residuum weathered from acid shale **Properties and qualities** Slope: 12 to 20 percent Depth to restrictive feature: 20 to 36 inches to bedrock (paralithic)

Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 3.0 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 6 inches: Silt loam 6 to 18 inches: Channery silty clay 18 to 24 inches: Very channery silty clay 24 to 40 inches: Weathered bedrock

Anderson County, Tennessee: AmE—Armuchee silt loam, 20 to 45 percent slopes. Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Armuchee and similar soils: 100 percent **Description of Armuchee Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Clayey residuum weathered from acid shale **Properties and qualities** Slope: 20 to 45 percent Depth to restrictive feature: 20 to 36 inches to bedrock (paralithic) Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 3.0 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 6 inches: Silt loam 6 to 18 inches: Channery silty clay 18 to 24 inches: Very channery silty clay 24 to 40 inches: Weathered bedrock

Anderson County, Tennessee: AuE—Armuchee-Muskingum complex, 25 to 60 percent slopes. Map Unit Setting Elevation: 1,200 to 2,500 feet Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Armuchee and similar soils: 50 percent Muskingum and similar soils: 45 percent Minor components: 5 percent **Description of Armuchee Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Clayey residuum weathered from acid shale **Properties and qualities** Slope: 25 to 60 percent Depth to restrictive feature: 20 to 36 inches to bedrock (paralithic) Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 3.0 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 6 inches: Silt loam 6 to 18 inches: Channery silty clay 18 to 24 inches: Very channery silty clay 24 to 40 inches: Weathered bedrock **Description of Muskingum Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Loamy residuum weathered from sandstone and shale **Properties and qualities** Slope: 25 to 60 percent Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic) Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.1 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 5 inches: Silt loam 5 to 26 inches: Channery silt loam 26 to 36 inches: Weathered bedrock **Minor Components** Percent of map unit: 5 percent

Anderson County, Tennessee: BoC—Bodine cherty silt loam, 5 to 12 percent slopes. Map Unit Setting Elevation: 700 to 1,300 feet Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Bodine and similar soils: 100 percent **Description of Bodine Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Crest Parent material: Gravelly residuum weathered from cherty limestone **Properties and qualities** Slope: 5 to 12 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 5.0 inches) **Interpretive groups** Land capability (nonirrigated): 4s **Typical profile** 0 to 11 inches: Gravelly silt loam 11 to 29 inches: Gravelly silt loam 29 to 63 inches: Very gravelly silt loam

Anderson County, Tennessee: BoD—Bodine cherty silt loam, 12 to 25 percent slopes. Map Unit Setting *Elevation:* 700 to 1,300 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Bodine and similar soils:* 100 percent **Description of Bodine Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Side slope *Parent material:* Gravelly residuum weathered from cherty limestone **Properties and qualities** *Slope:* 12 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 5.0 inches) **Interpretive groups** *Land capability (nonirrigated):* 6s **Typical profile** *0 to 11 inches:* Gravelly silt loam *11 to 29 inches:* Gravelly silt loam *29 to 63 inches:* Very gravelly silt loam

Anderson County, Tennessee: BoE—Bodine cherty silt loam, 25 to 50 percent slopes. Map Unit Setting *Elevation:* 700 to 1,300 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Bodine and similar soils:* 100 percent **Description of Bodine Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Side slope *Parent material:* Gravelly residuum weathered from cherty limestone **Properties and qualities** *Slope:* 25 to 50 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 5.0 inches) **Interpretive groups** *Land capability (nonirrigated):* 7s **Typical profile** *0 to 11 inches:* Gravelly silt loam *11 to 29 inches:* Gravelly silt loam *29 to 63 inches:* Very gravelly silt loam

Anderson County, Tennessee: CnE—Claiborne silt loam, 25 to 45 percent slopes: Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Claiborne and similar soils: 100 percent **Description of Claiborne Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Loamy colluvium over clayey residuum weathered from limestone **Properties and qualities** Slope: 25 to 45 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: High (about 10.3 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 16 inches: Silt loam 16 to 42 inches: Silty clay loam 42 to 62 inches: Clay

Anderson County, Tennessee-CrE—Collegedale-Rock outcrop complex, 20 to 35 percent slopes: Map Unit Setting Elevation: 700 to 1,200 feet Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Collegedale and similar soils: 70 percent Rock outcrop: 20 percent Minor components: 10 percent **Description of**

Collegedale Setting Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Clayey residuum weathered from limestone and shale **Properties and qualities** Slope: 20 to 35 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 (0.20 to 0.60 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 8.7 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 5 inches: Silt loam 5 to 64 inches: Silty clay **Description of Rock Outcrop Properties and qualities** Slope: 20 to 35 percent Depth to restrictive feature: 0 inches to bedrock (lithic) **Minor components** Percent of map unit: 10 percent

Anderson County, Tennessee: DuC—Dunmore silt loam, 5 to 12 percent slopes: Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Dunmore and similar soils: 100 percent **Description of Dunmore Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Crest Parent material: Clayey residuum weathered from limestone **Properties and qualities** Slope: 5 to 12 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: High (about 9.5 inches) **Interpretive groups** Land capability (nonirrigated): 3e **Typical profile** 0 to 14 inches: Silt loam 14 to 62 inches: Clay

Anderson County, Tennessee: DuD—Dunmore silt loam, 12 to 25 percent slopes: Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Dunmore and similar soils: 100 percent **Description of Dunmore Setting** Landform: Ridges Landform position (two-dimensional): Summit Landform position (three-dimensional): Side slope Parent material: Clayey residuum weathered from limestone **Properties and qualities** Slope: 12 to 25 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: High (about 9.5 inches) **Interpretive groups** Land capability (nonirrigated): 4e **Typical profile** 0 to 14 inches: Silt loam 14 to 62 inches: Clay

Anderson County, Tennessee: FuC—Fullerton cherty silt loam, 5 to 12 percent slopes. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Fullerton and similar soils:* 100 percent **Description of Fullerton Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Crest *Parent material:* Clayey residuum or creep deposits over clayey residuum weathered from cherty limestone **Properties and qualities** *Slope:* 5 to 12 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 7.5 inches) **Interpretive groups** *Land capability (nonirrigated):* 3e **Typical profile** *0 to 12 inches:* Gravelly silt loam *12 to 27 inches:* Gravelly silty clay loam *27 to 64 inches:* Gravelly clay

Anderson County, Tennessee: FuD—Fullerton cherty silt loam, 12 to 25 percent slopes. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F

Frost-free period: 195 to 209 days **Map Unit Composition** *Fullerton and similar soils:* 100 percent **Description of Fullerton Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Side slope *Parent material:* Clayey residuum or creep deposits over clayey residuum weathered from cherty limestone **Properties and qualities** *Slope:* 12 to 25 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 7.5 inches) **Interpretive groups** *Land capability (nonirrigated):* 4e **Typical profile** *0 to 12 inches:* Gravelly silt loam *12 to 27 inches:* Gravelly silty clay loam *27 to 64 inches:* Gravelly clay

Anderson County, Tennessee: FuE—Fullerton cherty silt loam, 25 to 45 percent slopes. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Fullerton and similar soils:* 100 percent **Description of Fullerton Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Side slope *Parent material:* Clayey residuum or creep deposits over clayey residuum weathered from cherty limestone **Properties and qualities** *Slope:* 25 to 45 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 7.5 inches) **Interpretive groups** *Land capability (nonirrigated):* 7e **Typical profile** *0 to 12 inches:* Gravelly silt loam *12 to 27 inches:* Gravelly silty clay loam *27 to 64 inches:* Gravelly clay

Anderson County, Tennessee: Ha—Hamblen silt loam. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Hamblen and similar soils:* 92 percent *Minor components:* 8 percent **Description of Hamblen Setting** *Landform:* Flood plains *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Talf *Parent material:* Loamy alluvium derived from limestone, sandstone, and shale **Properties and qualities** *Slope:* 0 to 2 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 (0.60 to 2.00 in/hr) *Depth to water table:* About 24 to 36 inches *Frequency of flooding:* Occasional *Frequency of ponding:* None *Available water capacity:* High (about 11.4 inches) **Interpretive groups** *Land capability (nonirrigated):* 2w **Typical profile** *0 to 8 inches:* Silt loam *8 to 34 inches:* Silt loam *34 to 60 inches:* Gravelly silt loam

Anderson County, Tennessee: JgC—Jefferson gravelly loam, 5 to 12 percent slopes: Map Unit Setting Mean annual precipitation: 46 to 63 inches Mean annual air temperature: 47 to 69 degrees F Frost-free period: 195 to 209 days **Map Unit Composition** Jefferson and similar soils: 100 percent **Description of Jefferson Setting** Landform: Hillslopes Landform position (two-dimensional): Summit Landform position (three-dimensional): Base slope Parent material: Loamy colluvium derived from interbedded sedimentary rock **Properties and qualities** Slope: 5 to 12 percent Depth to restrictive feature: More than 80 inches Drainage class: Well 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: Moderate (about 7.5 inches) **Interpretive groups** Land capability (nonirrigated): 3e **Typical profile** 0 to 10 inches: Gravelly loam 10 to 58 inches: Gravelly clay loam 58 to 66 inches: Very gravelly loam

Anderson County, Tennessee: LeB—Leadvale silt loam, 2 to 7 percent slopes. Map Unit Setting *Elevation:* 1,700 to 2,300 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Leadvale and similar soils:* 100 percent **Description of Leadvale Setting** *Landform:* Stream terraces *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Tread *Parent material:* Loamy alluvium over residuum weathered from shale **Properties and qualities** *Slope:* 2 to 7 percent *Depth to restrictive feature:* 16 to 38 inches to fragipan; 40 to 96 inches to bedrock (paralithic) *Drainage class:* Moderately well drained *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.60 in/hr) *Depth to water table:* About 16 to 27 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Low (about 5.2 inches) **Interpretive groups** *Land capability (nonirrigated):* 2e **Typical profile** *0 to 6 inches:* Silt loam *6 to 27 inches:* Silt loam *27 to 42 inches:* Silty clay loam *42 to 50 inches:* Silty clay *50 to 54 inches:* Unweathered bedrock

Anderson County, Tennessee: McC—Minvale cherty silt loam, 3 to 15 percent slopes. Map Unit Setting *Elevation:* 500 to 1,200 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Minvale and similar soils:* 100 percent **Description of Minvale Setting** *Landform:* Ridges *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Base slope *Parent material:* Loamy colluvium derived from cherty limestone **Properties and qualities** *Slope:* 3 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 (0.60 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 8.8 inches) **Interpretive groups** *Land capability (nonirrigated):* 3e **Typical profile** *0 to 13 inches:* Gravelly silt loam *13 to 32 inches:* Gravelly silty clay loam *32 to 62 inches:* Gravelly silty clay

Anderson County, Tennessee: Ne—Newark silt loam. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Newark and similar soils:* 100 percent **Description of Newark Setting** *Landform:* Flood plains *Landform position (three-dimensional):* Talf *Parent material:* Loamy alluvium derived from interbedded sedimentary rock **Properties and qualities** *Slope:* 0 to 2 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 2.00 in/hr) *Depth to water table:* About 6 to 18 inches *Frequency of flooding:* Frequent *Frequency of ponding:* None *Available water capacity:* High (about 11.8 inches) **Interpretive groups** *Land capability (nonirrigated):* 2w **Typical profile** *0 to 8 inches:* Silt loam *8 to 30 inches:* Silt loam *30 to 61 inches:* Silt loam

Anderson County, Tennessee: TaB—Tasso silt loam, 2 to 7 percent slopes. Map Unit Setting *Elevation:* 100 to 600 feet *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Tasso and similar soils:* 100 percent **Description of Tasso Setting** *Landform:* Hillslopes *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Base slope *Parent material:* Loamy colluvium and/or alluvium over residuum weathered from limestone **Properties and qualities** *Slope:* 2 to 7 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 (0.20 to 0.60 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Moderate (about 9.0

inches) **Interpretive groups** *Land capability (nonirrigated):* 2e **Typical profile** *0 to 7 inches:* Silt loam *7 to 22 inches:* Silt loam *22 to 36 inches:* Gravelly silty clay loam *36 to 72 inches:* ravelly clay

Anderson County, Tennessee: UDC—Udorthents, rolling. Map Unit Setting *Mean annual precipitation:* 46 to 63 inches *Mean annual air temperature:* 47 to 69 degrees F *Frost-free period:* 195 to 209 days **Map Unit Composition** *Udorthents and similar soils:* 100 percent **Description of Udorthents Properties and qualities** *Slope:* 2 to 12 percent *Depth to restrictive feature:* More than 80 inches *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None

3.2.2 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 6). 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 6).

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 6), 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.

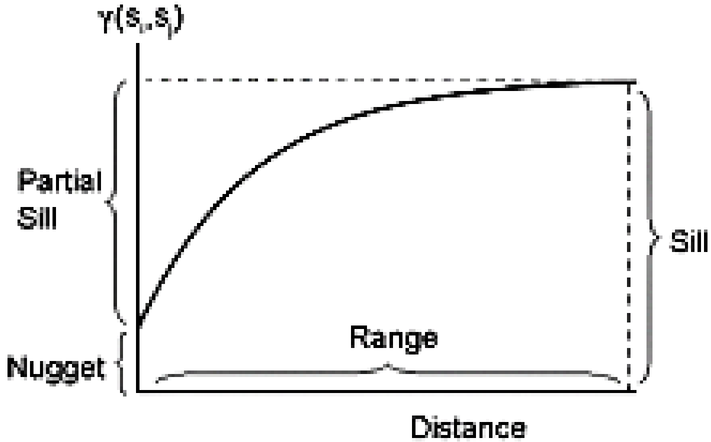


Figure 6. Example semivariogram, depicting range, sill, and nugget.

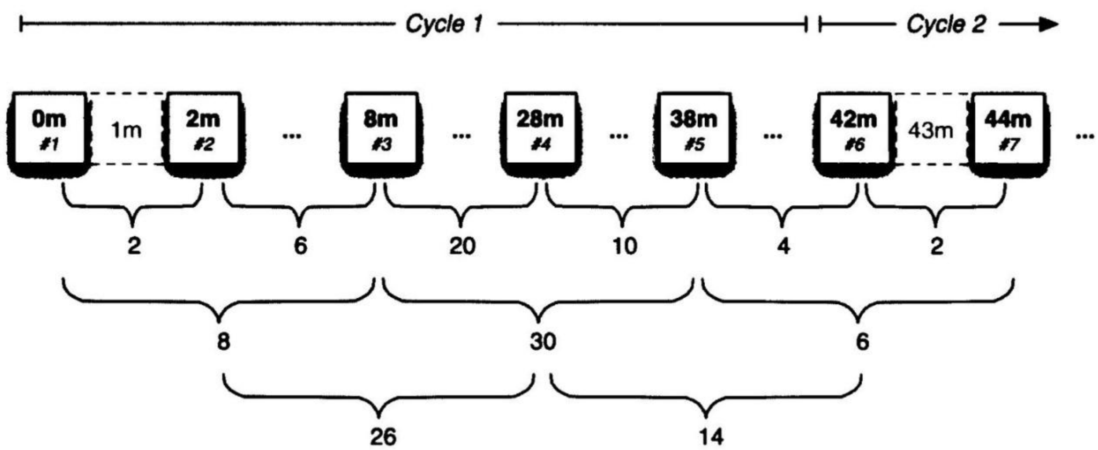


Figure 7. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 19 April 2010 at the Oak Ridge site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 7). Soil temperature and moisture measurements were collected along four transects (all 84 m) located in the expected airshed at Oak Ridge. 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 7, 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).

3.2.3 Results and interpretation

3.2.3.1 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 8). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 9, left graphs) and directional semivariograms do not show any indication of anisotropy (Figure 9, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 9, right graph). The model indicates a distance of effective independence of 30 m for soil temperature.

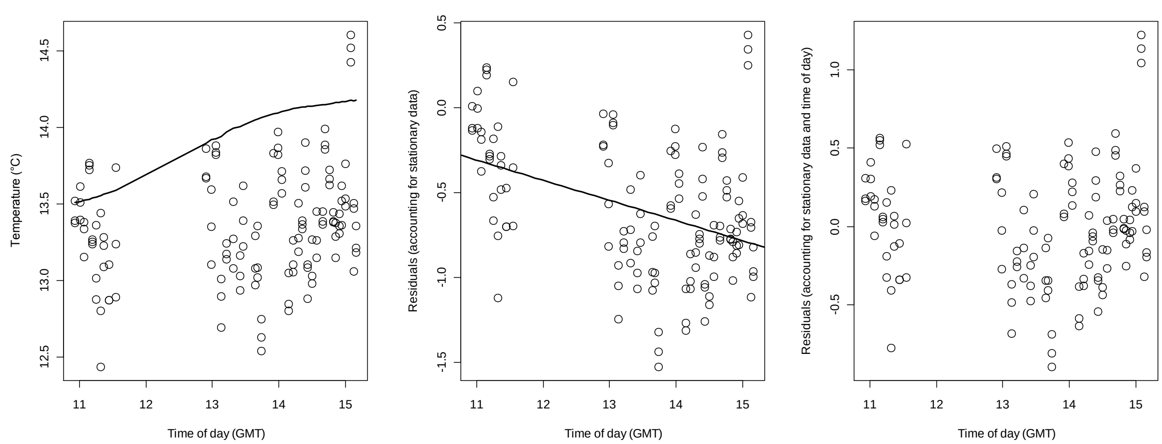


Figure 8. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

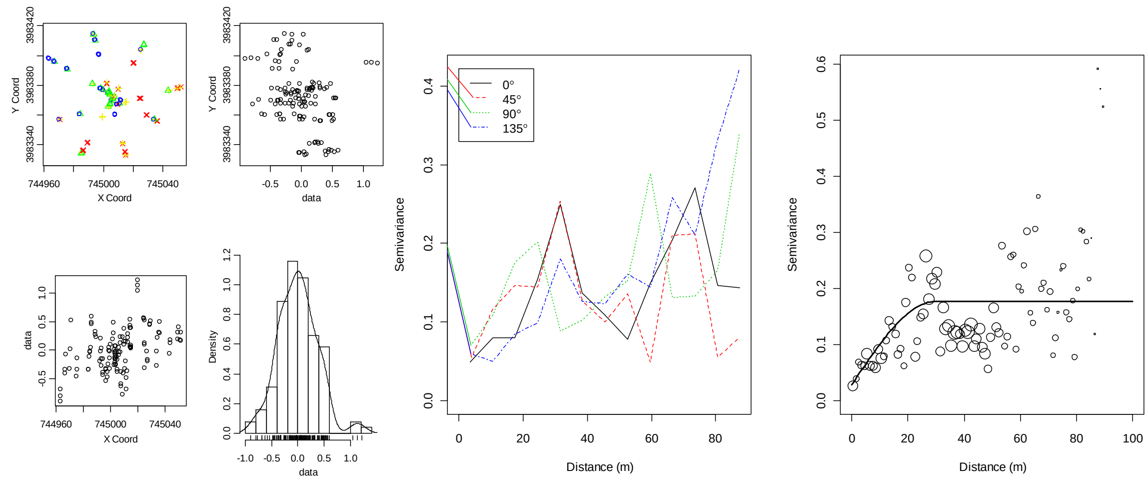


Figure 9. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

3.2.3.2 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 10). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 11, left graph) and directional semivariograms do not show anisotropy (Figure 11, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 11, right graph). The model indicates a distance of effective independence of 122 m for soil water content.

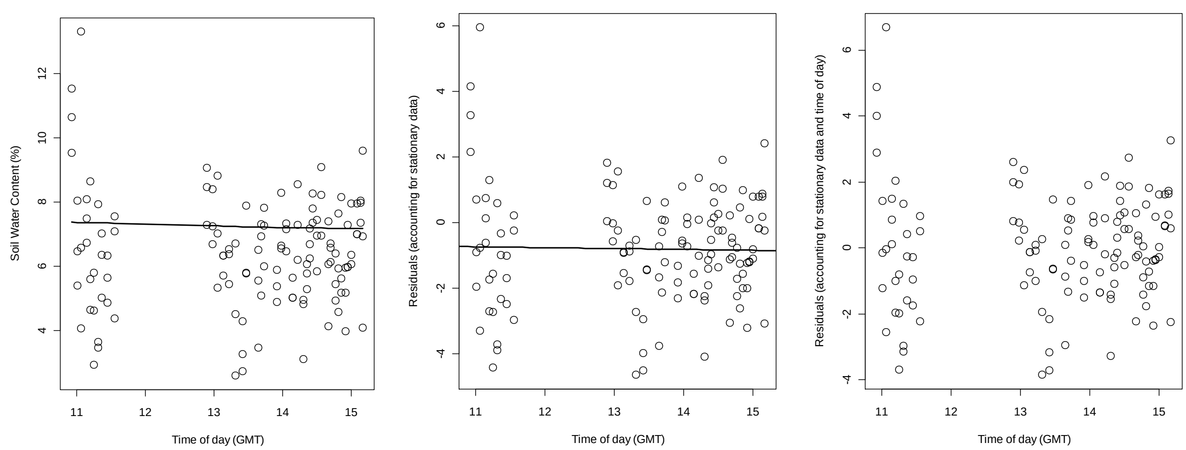


Figure 10. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting 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.

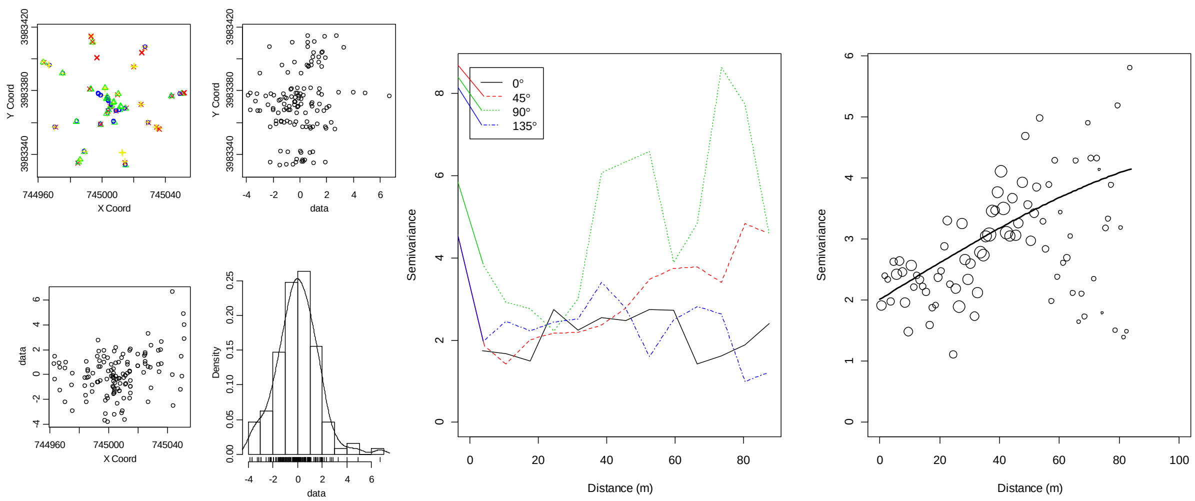


Figure 11. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

3.2.3.3 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 costs. The estimated distance of effective independence was 30 m for soil temperature and 122 m for soil moisture. Based on these results and the site design guidelines the soil plots at Oak Ridge 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 253° from the soil plot nearest the tower (i.e., first soil plot). The location of the first soil plot will be approximately 35.96424°, -84.28266°. 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 35.96414°, -84.28261°. A summary of the soil information is shown in Table 4 and site layout can be seen in Figure 12.

Dominant soil series at the site: Fullerton cherty silt loam, 5 to 12 percent slopes. The taxonomy of this soil is shown below:
Order: Ultisols
Suborder: Udults
Great group: Paleudults
Subgroup: Typic Paleudults
Family: Fine, kaolinitic, thermic Typic Paleudults
Series: Fullerton cherty silt loam, 5 to 12 percent slopes

Table 4. Summary of soil array and soil pit information at Oak Ridge. 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	14 m
Latitude and longitude of 1st soil plot OR direction from tower	35.96424°, -84.28266°
Direction of soil array	253°
Latitude and longitude of FIU soil pit	35.96453°, -84.28276°
Dominant soil type	Fullerton cherty silt loam, 5 to 12 percent slopes
Expected soil depth	>2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.30 m (gravelly silt loam)	0.15 m†
0.30-0.69 m (gravelly silt clay loam)	0.50 m†
0.69-1.63 m (gravelly clay)	1.16 m†
1.63-2.00 m§	1.82 m
2.00 m	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.

†Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)

§Soil description not available at this depth

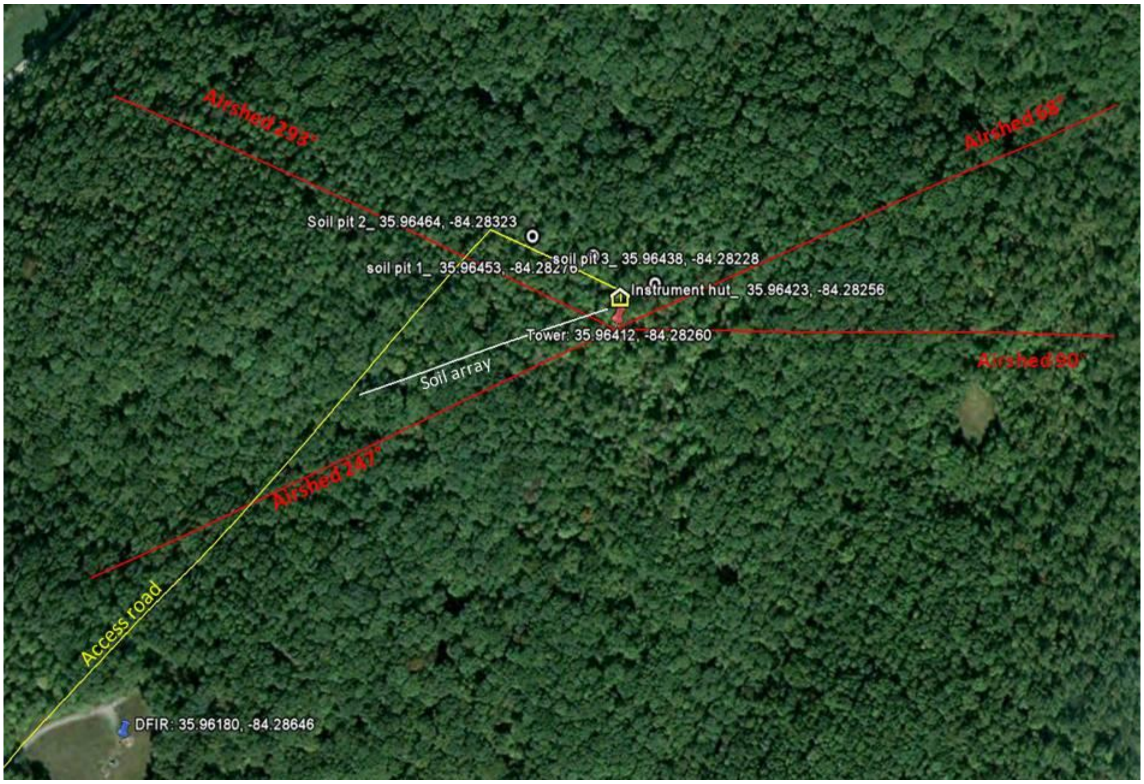


Figure 12. Site layout at ORNL Walker Branch Advanced tower site showing soil array and location of the FIU soil pit.

3.3 Airshed

3.3.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figures 13-14. The weather data used to generate the following wind roses are from AmeriFlux tower site of Walker Branch at Oak Ridge, TN, which is <400 m Northwest of NEON Advanced site at ORNL Walker Branch. 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 16 cardinal directions. Wind roses and wind roses description below were provided by Dr. T. Meyers.

3.3.2 Results (graphs for wind roses)

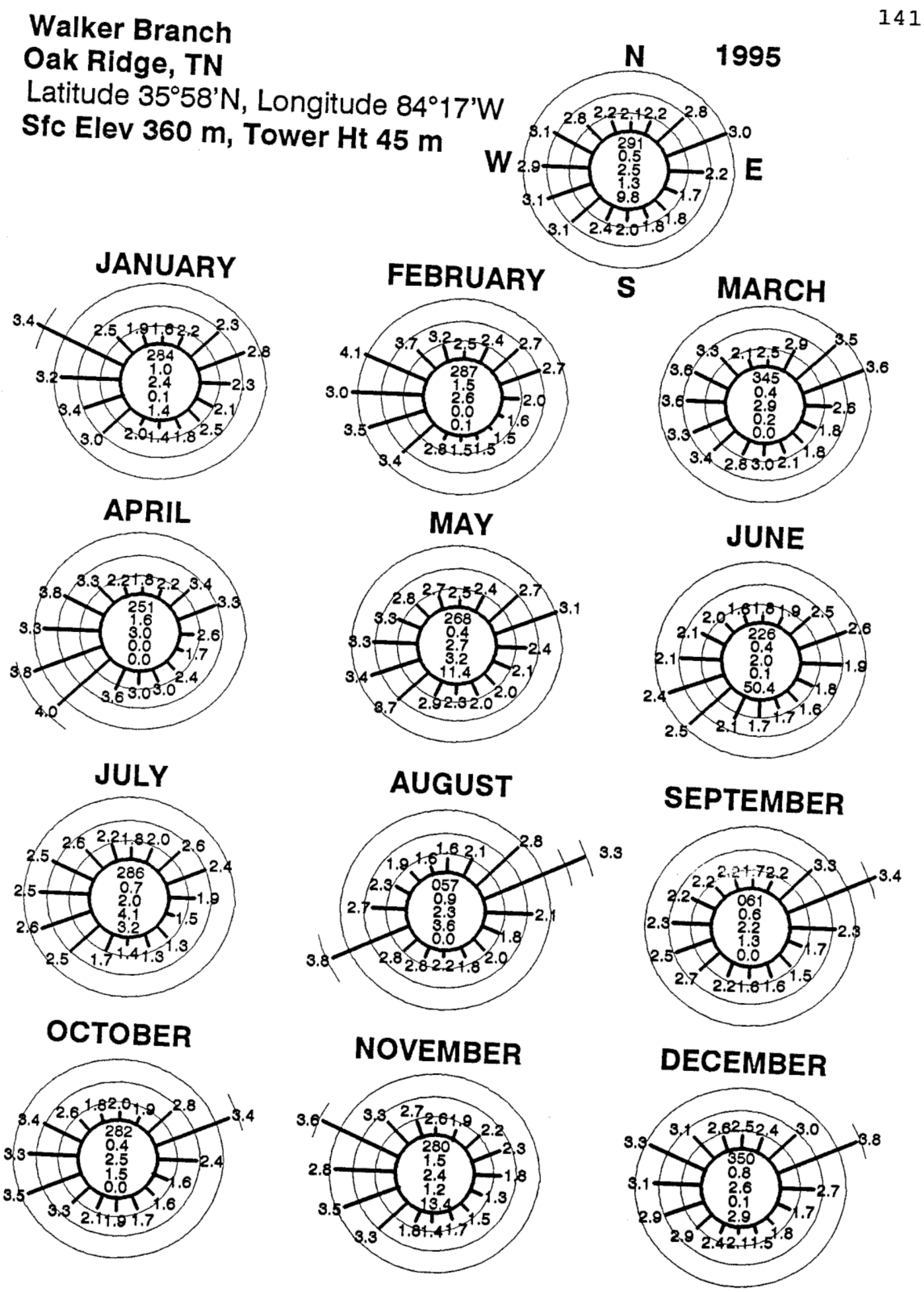


Figure 13. Wind roses for D07 ORNL Walker Branch Advanced Site.
(Provided by Dr T. Meyers)

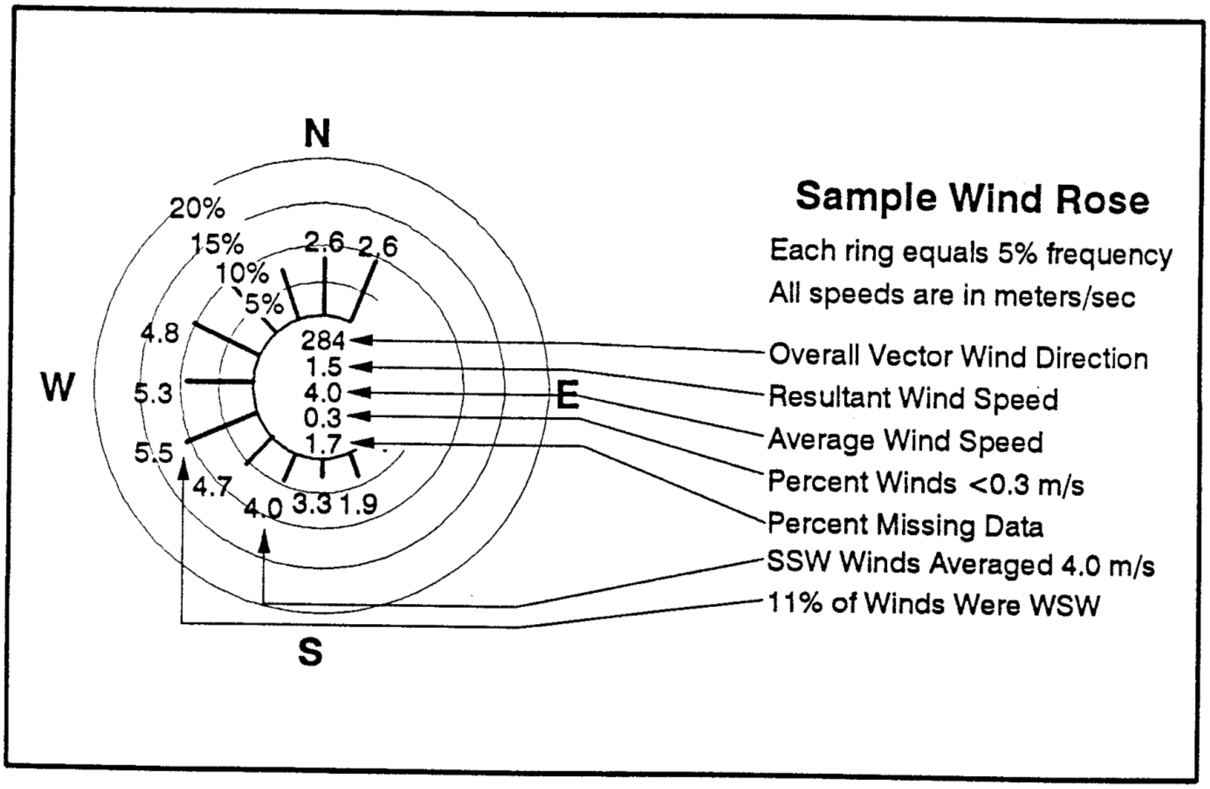


Figure 14. Description of wind roses for D07 ORNL Walker Branch Advanced Site. (Provided by Dr T. Meyers)

3.3.3 Resultant vectors

Table 5. The resultant wind vectors for D07 ORNL Walker Branch Advanced site.

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	N/A	N/A
April to June	N/A	N/A
July to September	N/A	N/A
October to December	N/A	N/A
Annual mean	N/A	N/A

3.3.4 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.

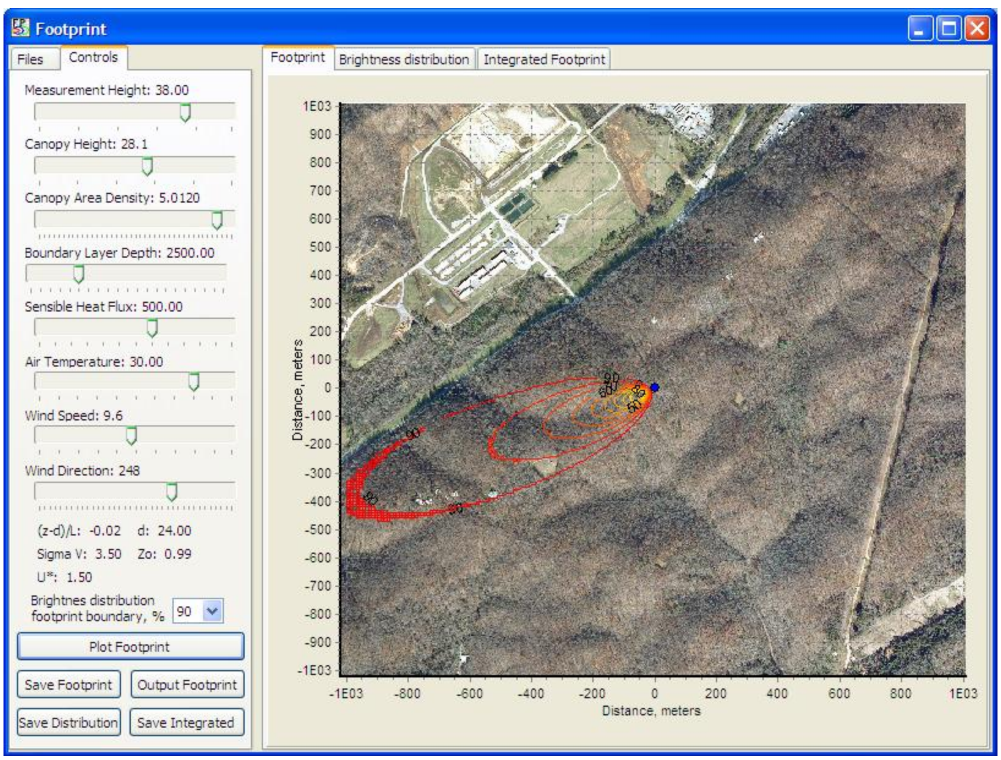
Here, with support from Dr R. Clement, we use a web-based footprint model that made by Micrometeorology Group at University of Edinburgh, UK to determine the footprint area under various conditions (model info: http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/). Winds used to run the model and 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 varify 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 ORNL Walker Branch Advanced 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	38	38	38	38	38	38	m
Canopy Height	28	28	28	28	28	28	m
Canopy area density	5	5	5	2.5	2.5	2.5	m
Boundary layer depth	2500	2500	701	1201	1201	501	m
Expected sensible heat flux	500	500	90	151	151	31	W m^{-2}
Air Temperature	30	30	22	15	15	10	°C
Max. windspeed	9.6	2.8	2.6	9.0	2.6	2.6	m s^{-1}
Resultant wind vector	248	248	78	271	271	57	degrees
Results							

(z-d)/L	-0.02	-0.32	-0.15	-0.01	-0.19	-0.06	m
d	24	24	24	22	22	22	m
Sigma v	3.50	2.30	1.10	3.10	1.50	1	$m^2\ s^{-2}$
Z0	0.99	0.99	0.99	1.40	1.40	1.40	m
u*	1.50	0.62	0.46	1.50	0.53	0.46	$m\ s^{-1}$
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	750	280	450	800	400	700	m
Distance of 80% cumulative flux	450	220	280	480	300	400	m
Distance of 70% cumulative flux	300	180	200	300	200	280	m
Peak contribution	65	35	45	65	45	55	m

3.3.5 Footprint model results (source area graphs)



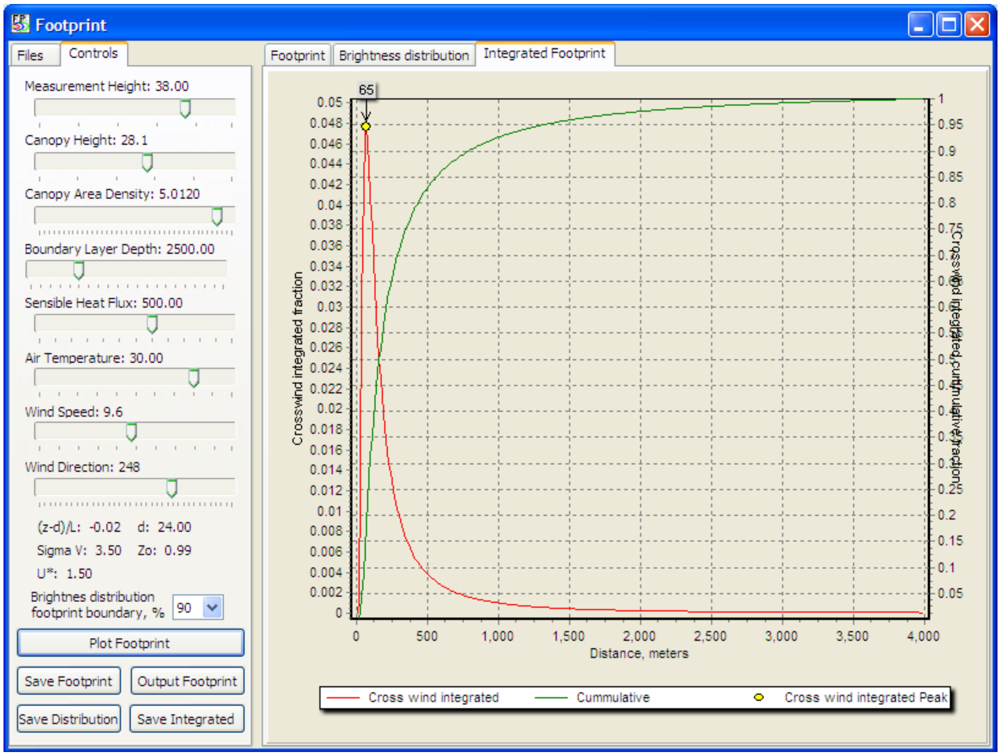
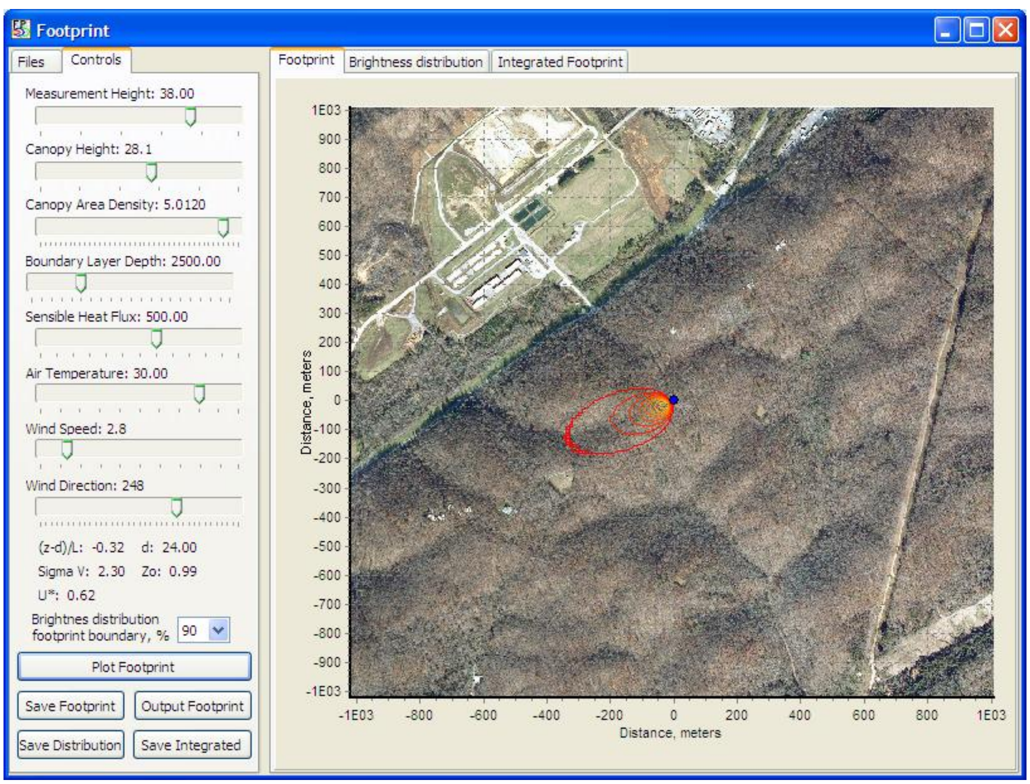


Figure 15. D07 ORNL Walker Branch summer daytime (convective) footprint output with max wind speed.



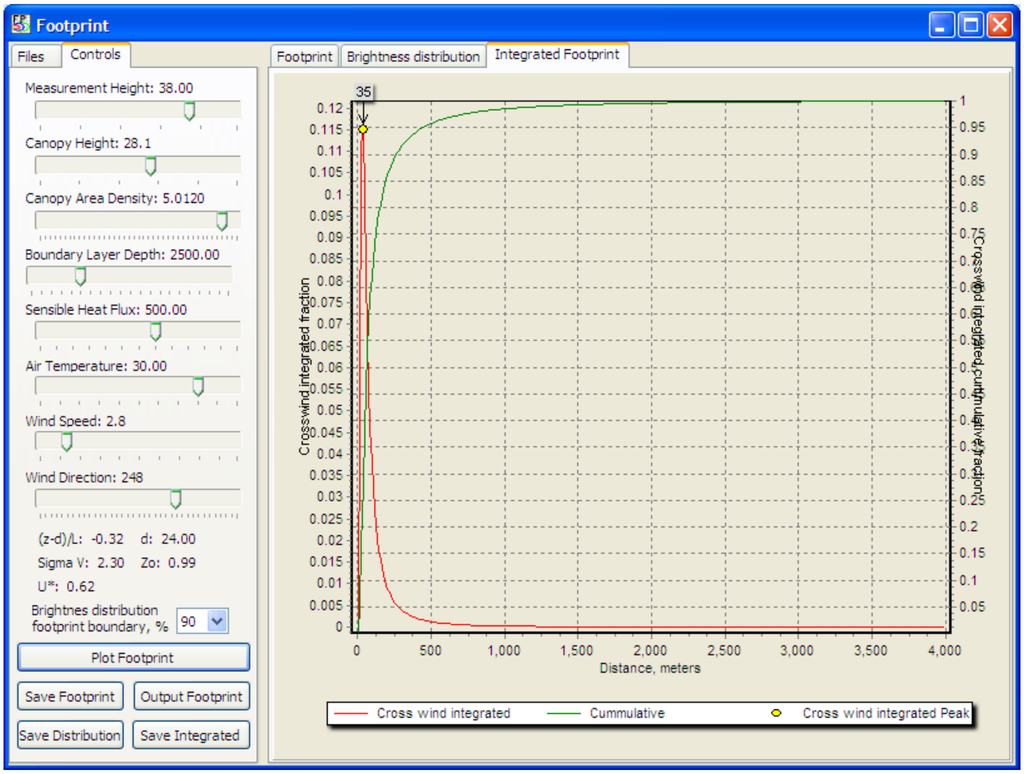


Figure 16. D07 ORNL Walker Branch summer daytime (convective) footprint output with mean wind speed.

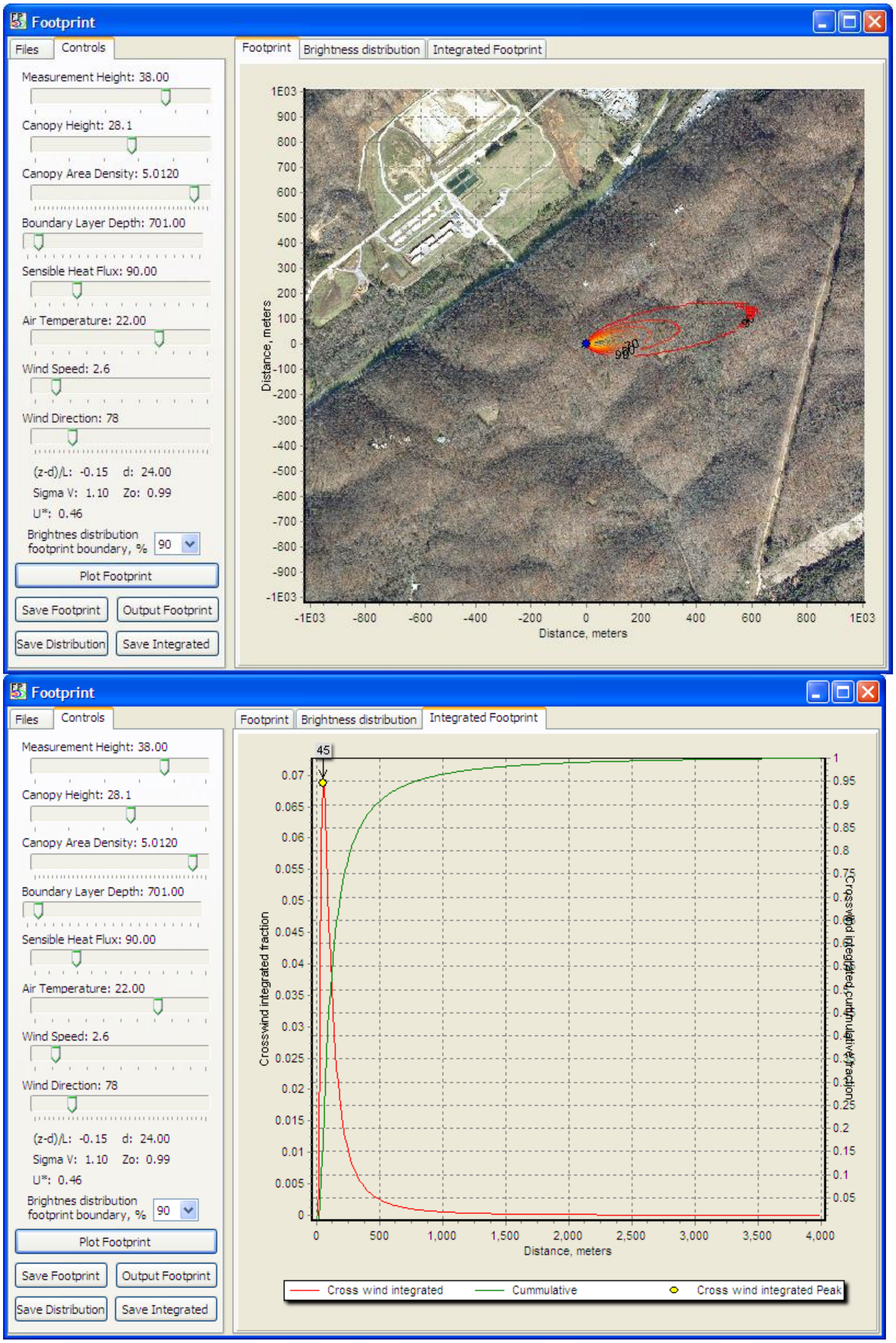


Figure 17. D07 ORNL Walker Branch summer nighttime (stable) footprint output with mean wind speed.

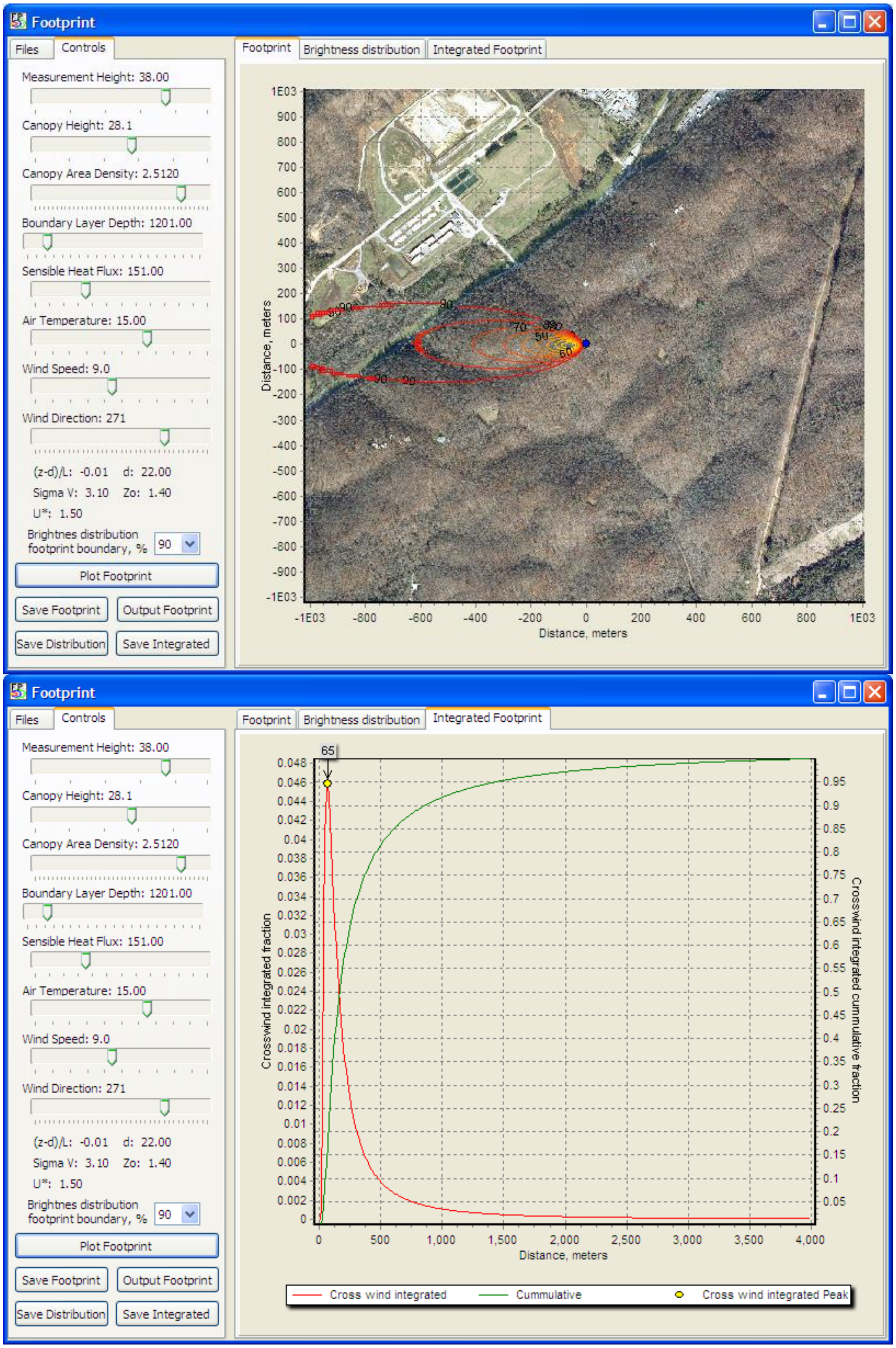


Figure 18. D07 ORNL Walker Branch winter daytime (convective) footprint output with max wind speed.

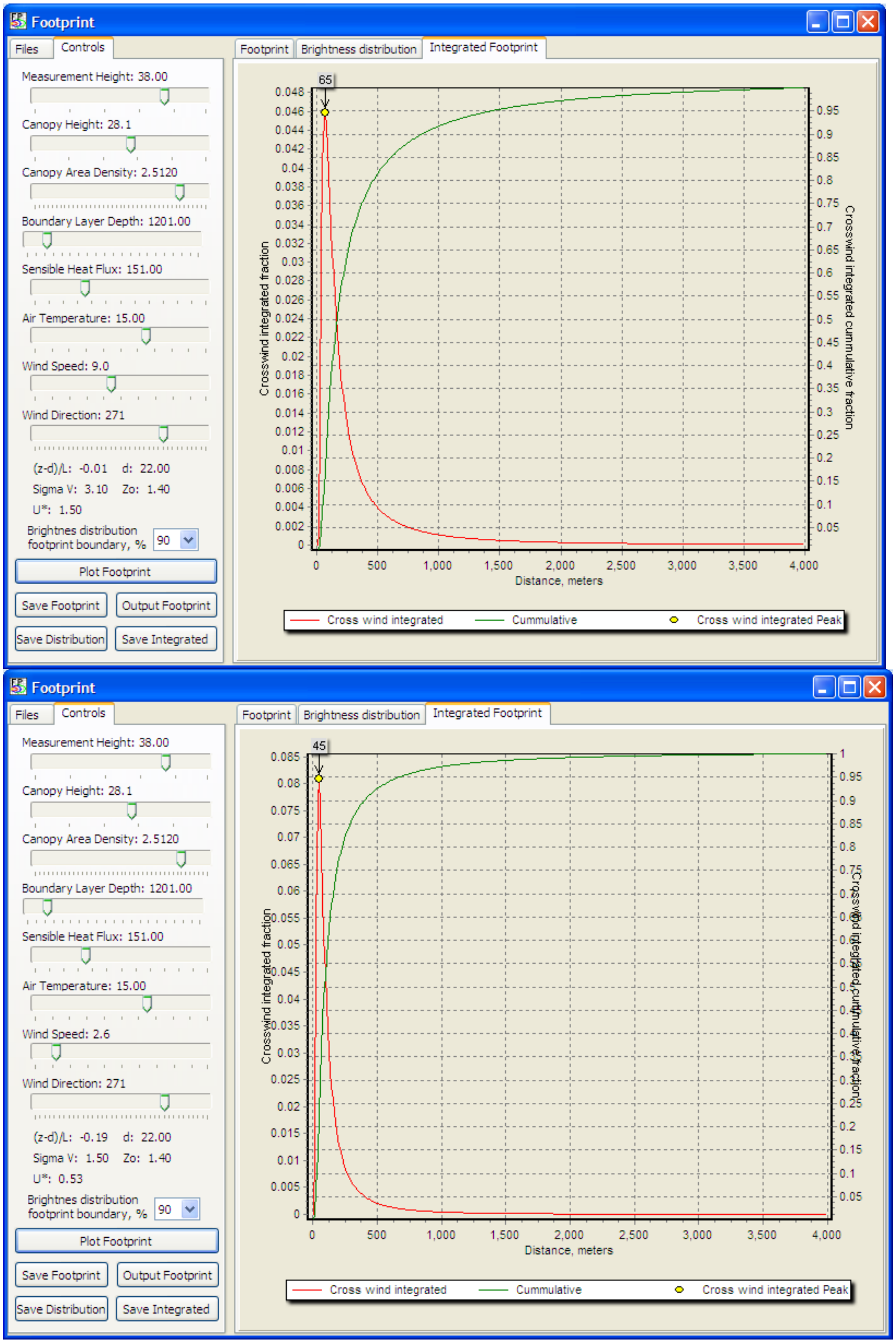


Figure 19. D07 ORNL Walker Branch winter daytime (convective) footprint output with mean wind speed.

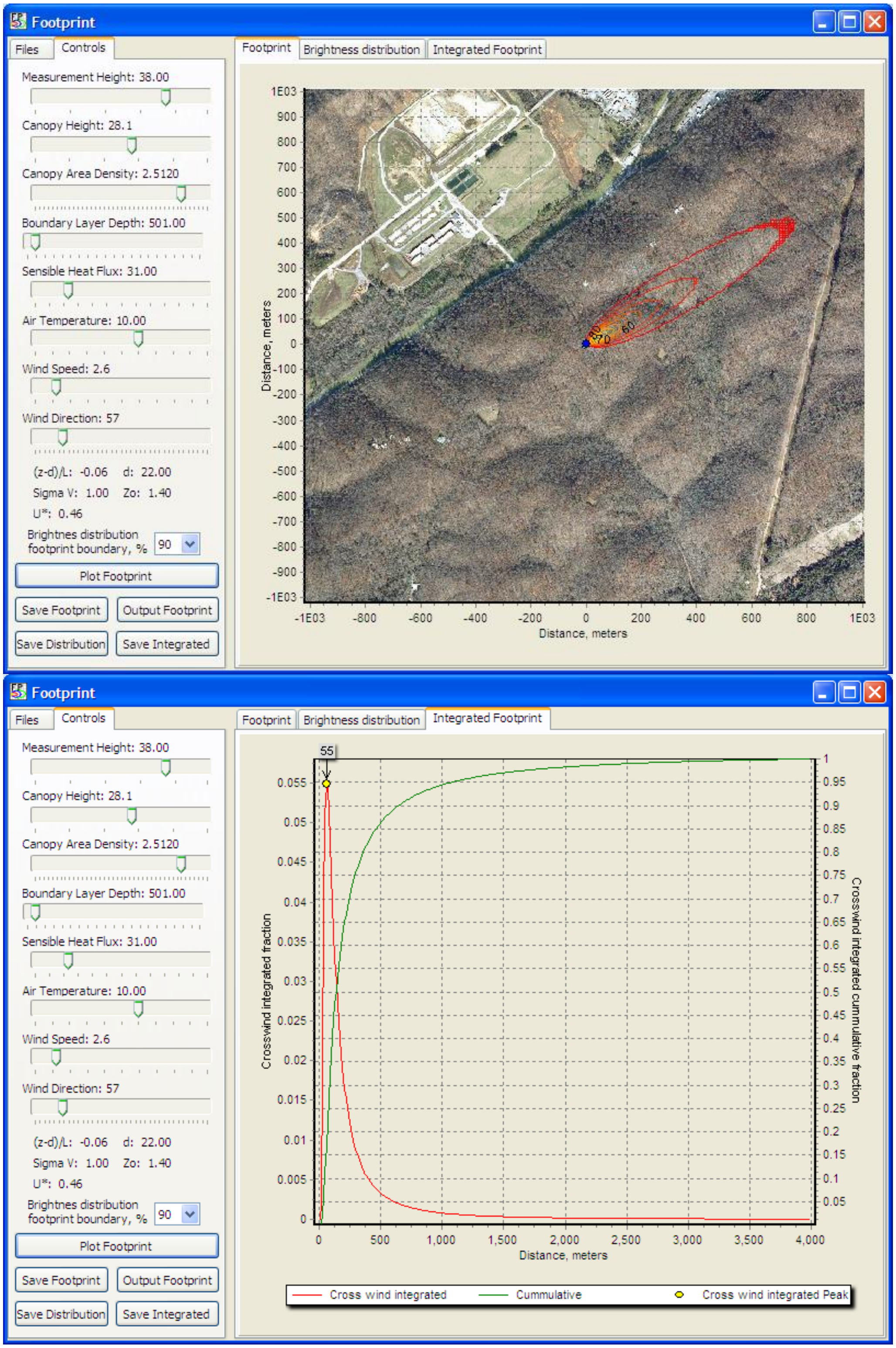


Figure 20. D07 ORNL Walker Branch winter nighttime (stable) footprint output with mean wind speed.

3.4 Site design and tower attributes

According to wind roses, the prevailing wind direction blows from west (247° to 293°, clockwise from 247°) and northeast (68° to 90°, clockwise from 68°) throughout the year. Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is oak and maple dominant deciduous forest at this site. The original tower site was 35.964618, -84.280557. After FIU site characterization, we determine the **tower location** to be at 35.96412, -84.28260 to avoid measuring the air that is channeled by the valley on the south direction. New location is southwest of original tower for ~190 m and closer to the available AC power.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the south 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 north side of tower and have the longer side parallel to E-W direction. Therefore, we require the placement of instrument hut at 35.96423, -84.28256.

Canopy height is ~28 m around tower site with lowest branches at ~10 m above ground level. Seedlings and sapling form understory. Height varies between 5 to 10 meters. Ferns and new seedling form the understory at ground level with height < 1m. We require 6 **measurement layers** on the tower with top measurement height at 38 m, and rest layers are 30 m, 22 m, 16m, 7m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

DFIR (Double Fenced International Reference) for bulk precipitation collection will be located at an existing open clearing, which is used by ORNL as NADP wet/dry deposition collection site and used by ATDD as a test bed for meteorological sensors. DFIR is on the south west side of tower and ~430 m away from tower. Power is available at site. **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 (short-side of instrument hut is perpendicular to the **Instrument hut orientation vector)**. **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, in this case, level 6 being the upper most level at this tower site.

Table 7. Site design and tower attributes for the ORNL Walker Branch 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			247° to 293° and 68° to 90°		Clockwise from first angle
Tower location	35.96412,	-84.28260	--	--	new site
Instrument hut	35.96423,	-84.28256			
Instrument hut orientation vector	--	--	90° - 270°		Short face parallel to 0° - 180°
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	180°	--	
DFIR	35.96180	-84.28646			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				7.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				22.0	m.a.g.l.
Level 5				30.0	m.a.g.l.
Level 6				38.0	m.a.g.l.
Tower Height				38.0	m.a.g.l.

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

Figure 21 below shows the proposed tower location, instrument hut location, airshed area and access road.

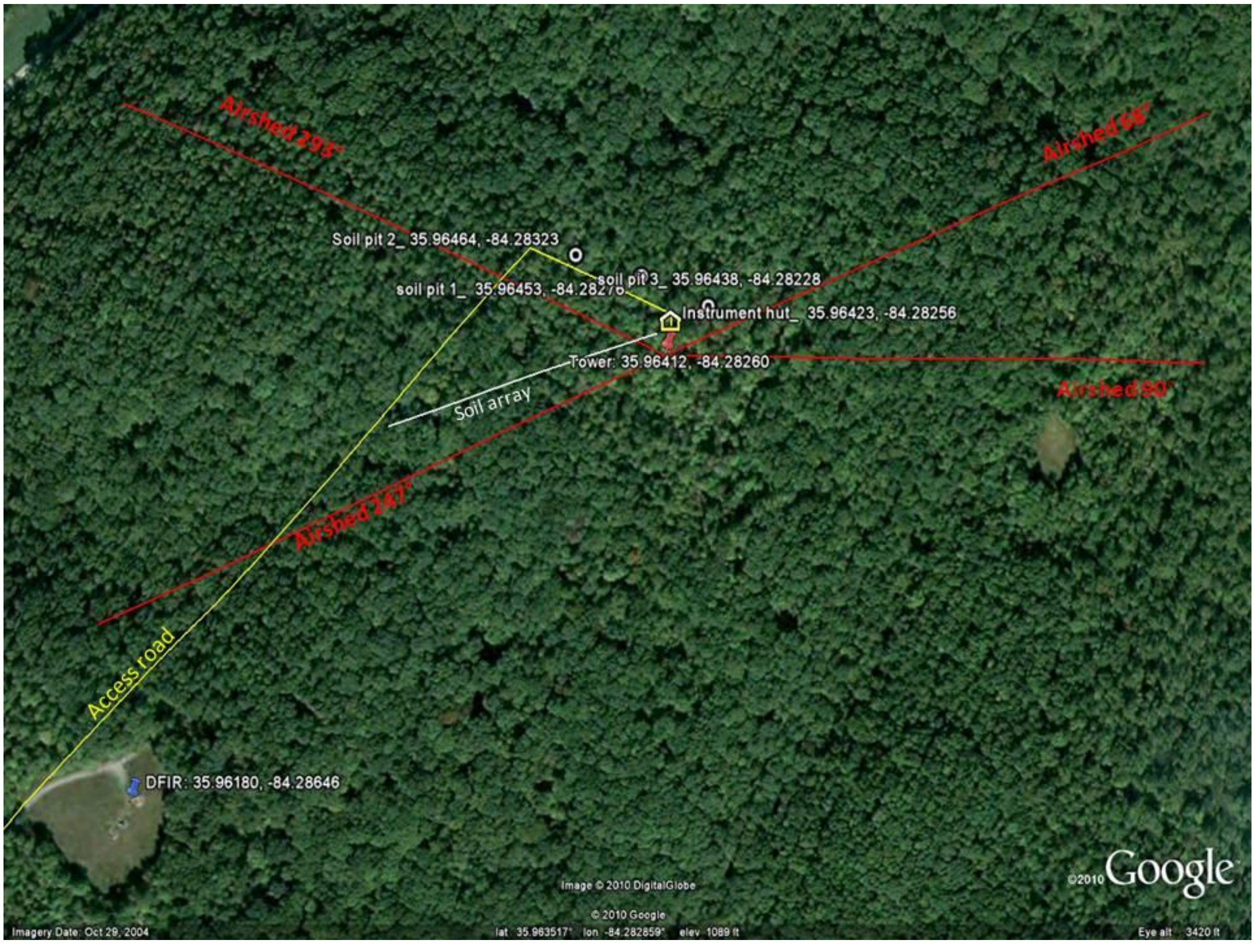


Figure 21. Site layout for ORNL Walker Branch Advanced tower site.

i) New tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 247° to 293° (clockwise from 247°) and 68° to 90° (clockwise from 68°) 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 indicates the 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' 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.

- There is always a boardwalk from the instrument hut to the tower
- If there is a boardwalk on the south side of the tower, it is never underneath the radiation booms, and it is more than 4 m from the side of the tower
- There is never a boardwalk within 4 m of the tower, except where it perpendicularly intersects the tower for access
- The boardwalk to access the tower is not on any side that has a boom.
- There is never boardwalk within 10 m of a soil plot, except where it perpendicularly intersects a soil plot for access.

Specific Boardwalks at ORNL Walker Branch Advanced site

- Boardwalk is from the access dirt road 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 (optional from access road to soil array)
- No boardwalk from the soil array boardwalk to the individual soil plots
- No boardwalk needed at DFIR site

3.5 Information for ecosystem productivity plots

The tower at ORNL Walker Branch Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (deciduous hardwood forest). Airshed areas at this site are from 247° to 293° (clockwise from 247°) and from 68° to 90° (clockwise from 68°), and 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots be placed within the boundaries of 247° to 293° (clockwise from 247°) or 68° to 90° (clockwise from 68°).

3.6 Issues and attentions

According to our communication with Dr. P. Mulholland, the site contact at ORNL, he is ok with NEON micrositting tower to the new location. He said currently there is almost no active experiments at this forest site. The site location should not conflict with other experimental needs.

The DFIR site we picked is in an existing open area, which is the closest clearing to our tower location that we could find. This open area is currently use by ORNL as a NADP wet/dry deposition colletion site and used by ATDD as meteorologiocal sensor test bed. Dr. P. Mulholland expressed interests to let us take over the NADP wet/dry deposition instruments and site if we are doing same measurements. He felt that it is getting more difficult for him to get funding to maintain the measreuments. He also said if the open space is not large enough to meet the class 1 or 2 criteria for DFIR, it is possible to cut down some rows of trees to enlarge the space, but a proposal is required for further discussion with regarding permit and approvals. Dr. J. Kochendorfer from ATDD implied that some unused equipment could be removed from the site to free up space for our DFIR. But that needs to be checked and confirmed by Dr T. Meyers.

Dr. J. Kochendorfer from ATDD mentioend some gas emissions from the buildings on the south or west sides of the forest could potentially affect source area (flux) measurements. He said that could be the reason Ameriflux tower at Walker Branch was relocated to Chestnut Ridge. But he was unclear what the gas species was/is and where the emission sources could be. We will need communicate with Dr T. Meyers about this issue for further information.

One inconvenient issue here is that scientist with foreign nationality need to be escorted all the time. Hopefully, NEON can negotiate a special permit without such restriction for our foreign scientists.

4 MOUNTAIN LAKE BIOLOGICAL STATION, RELOCATEABLE TOWER 1

4.1 Site description

NEON candidate Relocatable tower site at Virginia (37.371796, -80.524488) is located within Mountain Lake Biological Station boundary (see Figure 22). Because the major fetch area for the candidate tower location is over a creek and drainage area to the west, we propose a new tower site at 37.37828, -80.52484 to maximize our measurements over the natural hardwood forest ecosystem. The analysis and results we provide below are based on the new site at 37.37828, -80.52484.

Mountain Lake Biological Station is located on a remote wooded ridge at an elevation of 1,160 meters on the top of Salt Pond Mountain in southwestern Virginia. Its mountaintop location is surrounded by sharp ecological gradients and fine-scale changes in habitat - ideal conditions for the studies of ecology and evolution. Biologists from around the world come to the station each summer to conduct field research based on the diverse flora and fauna of the Southern Appalachians. The station supports a summer population of 60 -100 students, researchers and their families. Visiting scientists conduct research in plant and animal population biology, behavioral ecology, life history evolution, community ecology, ecological genetics, biosystematics, epidemiology, conservation biology, and the physiology of behavior. Many research programs are long-term, resulting in numerous publications, and are often funded by the NSF. Biologists interested in field studies are encouraged to consider Mountain Lake as a home for their research. Some financial assistance is available to assist graduate students and faculty in starting research projects at the Station (Information source: http://mlbs.org/research.html).

Weather summary data for 2005 at this station can be found in the table below (information source: http://www.mlbs.virginia.edu/weatherdata/metsum.htm):

Table 8 MLBS Meteorological Data Summary for 2005

Month	Temperature (deg. C)			Rain (mm)	Humidity (Rel. %)	Wind Speed (m/s)	PAR*
	Maximum	Minimum	Mean	Accumulation	Mean	Mean	Mean
January	14.5	-20.3	-0.8	87	83	2.3	114
February	12.5	-12.5	-0.5	58	78	2.6	193
March	17.0	-13.0	0.6	112	79	2.7	270
April	21.1	-5.5	8.3	111	68	2.6	340
May	23.1	-1.9	11.1	66	71	2.0	412
June	26.4	7.4	16.9	85	86	1.7	373
July	27.5	12.0	19.4	117	91	1.4	360
August	26.8	11.8	19.1	111	90	1.3	323
September	24.7	2.7	16.0	22	85	1.5	345
October	21.2	-2.9	10.4	100	86	1.8	217
November	18.3	-14.4	5.5	124	73	2.3	168
December	11.1	-13.4	-3.0	52	80	2.5	107

The Year	27.5	-20.3	8.6	1044	81	2.1	269

Figure 22. Boundary map of Mountain Lake Biological Station and NEON candidate tower location

4.1.1 Ecosystem

The land use types and ecosystems are diverse at this region (see Figure 23-24, and Table 9-10 below). Appalachian (Hemlock-) Northern Hardwood Forest and Central and Southern Appalachian Montane Oak Forest count for > 95% in area in this region. The ecosystem type that we will measure at the proposed new site is oak forest. The terrain is flat and ecosystem is very uniform around tower site. The mean canopy height around tower is ~18 m with lowest branch at ~8 m above ground. Seedlings and saplings understory varies from 5 to 12 m in height without obvious strata. Ferns and other annual plants form the understory at floor lever with height < 1m. Canopy is closed and canopy area density is estimated to be 5 in summer and 2.5 in winter. Photo below shows a general view of the site (Figure 25.)

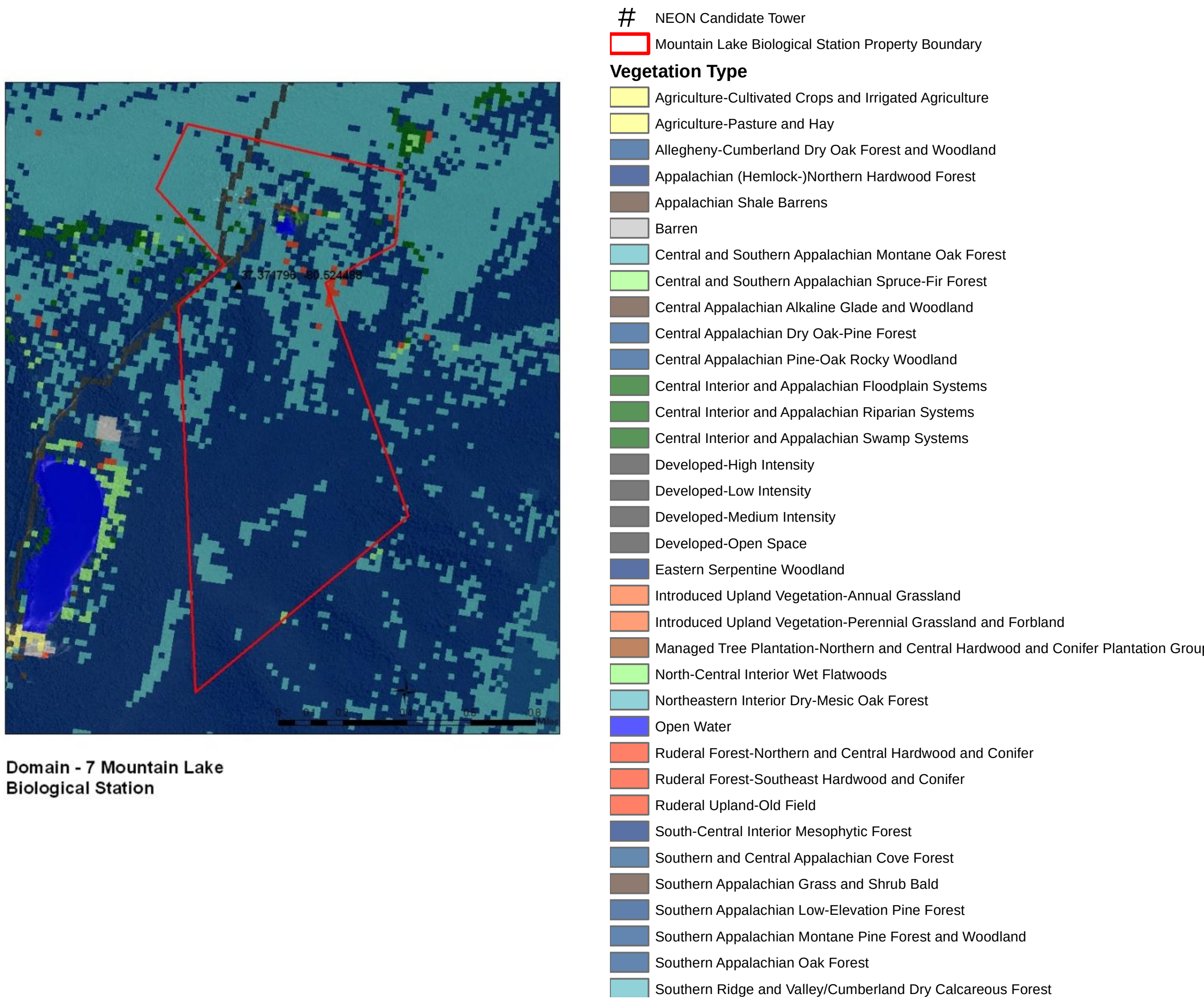


Figure 23. Vegetative cover map of Mountain Lake Biological Station and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Table 9. Land cover information at Mountain Lake Biological Station site (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Land cover types	Area (km^2)	Percentage
Appalachian (Hemlock-)Northern Hardwood Forest	1.458606	64.9206698
Central and Southern Appalachian Montane Oak Forest	0.716664	31.897795
Central and Southern Appalachian Spruce-Fir Forest	0.003597	0.16011028
Central Interior and Appalachian Swamp Systems	0.013868	0.61726274
Developed-Open Space	0.034876	1.55229385
Open Water	0.006295	0.28019292
Ruderal Forest-Northern and Central Hardwood and Conifer	0.0068	0.30267066
Ruderal Upland-Old Field	0.000899	0.04002756

Southern Appalachian Grass and Shrub Bald	0.005145	0.2289772
Total	999973.98	100.00

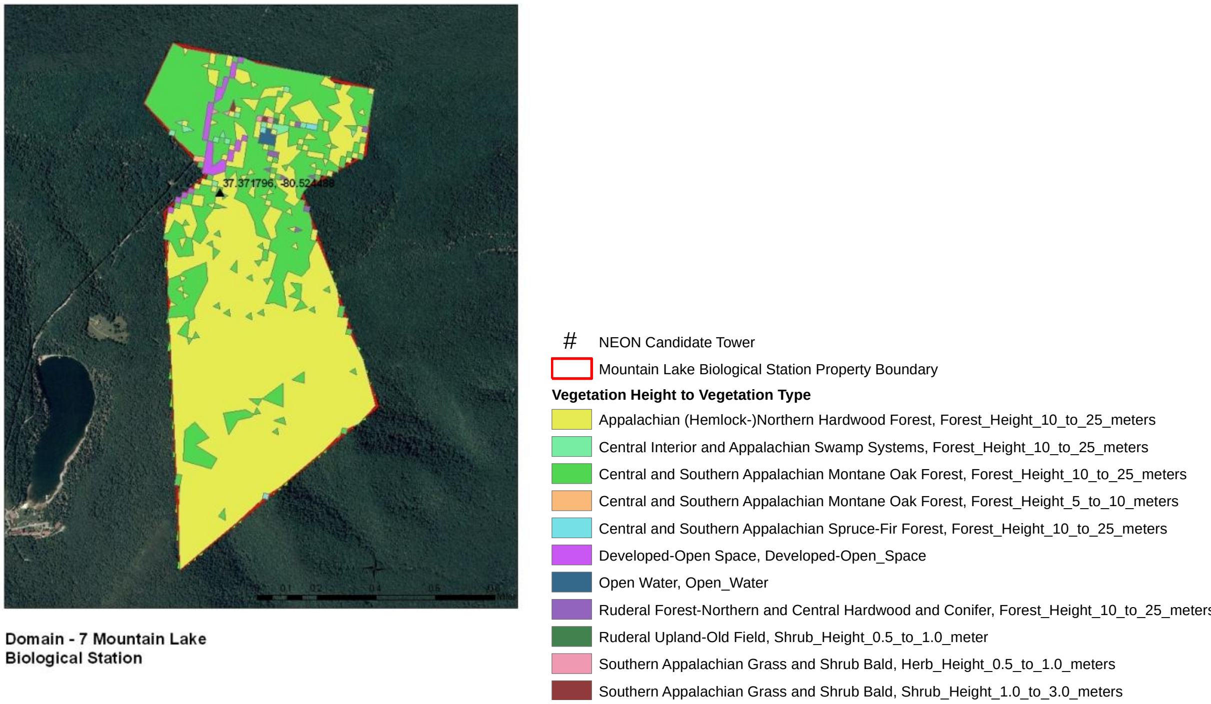


Figure 24. Vegetative height map of Mountain Lake Biological Station and the surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 10. Percent Land cover by vegetation height at Mountain Lake Biological Station (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Height	Vegetation Type	Area	Percentage
Forest_Height_10_to_25_meters	Appalachian (Hemlock-)Northern Hardwood Forest	1.458606	64.9202476
Forest_Height_10_to_25_meters	Central and Southern Appalachian Montane Oak Forest	0.716679	31.8982379
Forest_Height_10_to_25_meters	Central and Southern Appalachian Spruce-Fir Forest	0.003597	0.16010924
Forest_Height_10_to_25_meters	Central Interior and Appalachian Swamp Systems	0.013868	0.61725873
Developed-Open_Space	Developed-Open Space	0.034876	1.55228375
Open_Water	Open Water	0.006295	0.2801911
Forest_Height_10_to_25_meters	Ruderal Forest-Northern and Central Hardwood and Conifer	0.0068	0.30266869
Shrub_Height_0.5_to_1.0_meter	Ruderal Upland-Old Field	0.000899	0.0400273
Herb_Height_0.5_to_1.0_meters	Southern Appalachian Grass and Shrub	0.005145	0.22897571

	Bald		
	Total Area Sq Km	2.246766	100

Figure 25. General view of the ecosystem at Mountain Lake Biological Station Relocatable tower location

4.2 Soils

4.2.1 Description of soils

Soil data and soil maps (Figure 26) below for Mountain Lake Biological Station relocatable tower site were collected from 2.4 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.

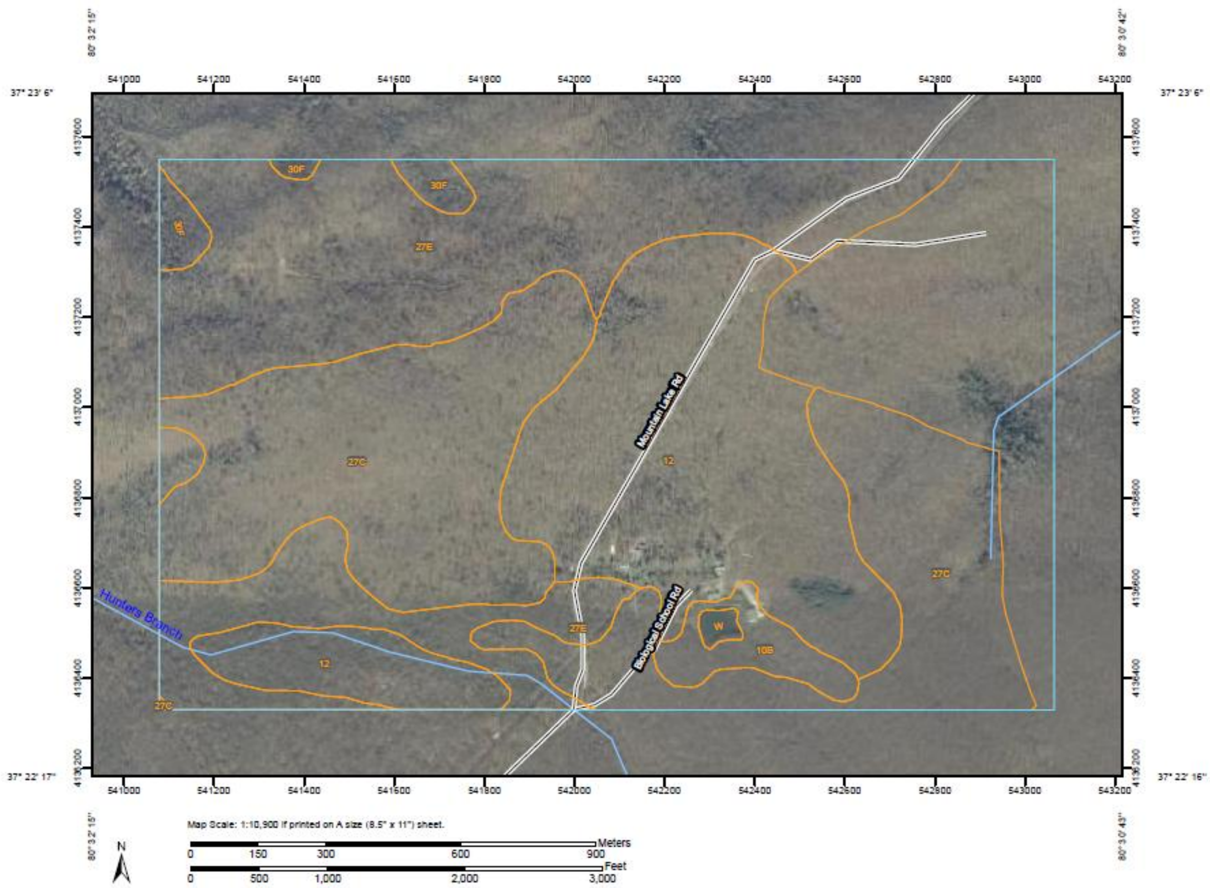


Figure 26. 2.4 km^2 soil map for Mountain Lake Biological Station relocatable site, center at tower location, north is top of map.

Soil Map Units 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. The 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, is 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 11. Soil series and percentage of soil series within 2.4 km^2 centered on the tower, Mountain Lake Biological Station.

Giles County, Virginia (VA071)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10B	Cotaco loam, 2 to 7 percent slopes	12.5	2.10%
12	Fluvaquents, nearly level	142.6	23.80%
27C	Lily-Bailegap complex, very stony, 2 to 15 percent slopes	177.2	29.60%
27E	Lily-Bailegap complex, very stony, 15 to 35 percent slopes	168.7	28.20%
30F	Nolichucky very stony sandy loam, 30 to 65 percent slopes	8.7	1.40%
W	Water	1.6	0.30%
Subtotals for Soil Survey Area		511.2	85.30%
Totals for Area of Interest		598.9	100.00%
Jefferson National Forest, Virginia, Northern Part (VA602)			
No soil data available for this soil survey area.			
Totals for Area of Interest		598.9	100.00%

Giles County, Virginia: 10B—Cotaco loam, 2 to 7 percent slopes. Map Unit Setting *Elevation:* 550 to 1,100 feet *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Cotaco and similar soils:* 85 percent **Description of Cotaco Setting** *Landform:* Stream terraces *Landform position (two-dimensional):* Summit *Landform position (three-dimensional):* Tread *Down-slope shape:* Linear *Across-slope shape:* Linear *Parent material:* Old alluvium derived from sandstone and shale **Properties and qualities** *Slope:* 2 to 7 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 18 to 30 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Moderate (about 7.0 inches) **Interpretive groups** *Land capability (nonirrigated):* 2e **Typical profile** *0 to 8 inches:* Loam *8 to 11 inches:* Loam *11 to 60 inches:* Clay loam

Giles County, Virginia: 12—Fluvaquents, nearly level. Map Unit Setting *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Fluvaquents and similar soils:* 80 percent **Description of Fluvaquents Setting** *Landform:* Flood plains *Landform position (two-dimensional):* Toeslope *Landform position (three-dimensional):* Tread *Down-slope shape:* Linear *Across-slope shape:* Linear *Parent material:* Alluvium derived from sandstone and shale **Properties and qualities** *Slope:* 0 to 3 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:* Frequent *Frequency of ponding:* None *Available water capacity:* Moderate (about 7.9 inches) **Interpretive groups** *Land capability (nonirrigated):* 7w **Typical profile** *0 to 13 inches:* Loam *13 to 41 inches:* Loam *41 to 65 inches:* Fine sandy loam

Giles County, Virginia: 27C—Lily-Bailegap complex, very stony, 2 to 15 percent slopes. Map Unit Setting *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Lily and similar soils:* 55 percent *Bailegap and similar soils:* 35 percent **Description of Lily Setting** *Landform:* Mountains *Landform position (two-dimensional):* Summit, shoulder *Landform position (three-dimensional):* Mountaintop *Down-slope shape:* Convex *Across-slope shape:* Convex *Parent material:* Residuum weathered from sandstone and siltstone and interbedded shale **Properties and qualities** *Slope:* 2 to 15 percent *Surface area covered with cobbles, stones or boulders:* 9.0 percent *Depth to restrictive feature:* 20 to 40 inches to lithic bedrock *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 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 4.3 inches) **Interpretive groups** *Land capability (nonirrigated):* 6s **Typical profile** *0 to 7 inches:* Gravelly sandy loam *7 to 30 inches:* Gravelly loam *30 to 36 inches:* Clay loam *36 to 46 inches:* Bedrock **Description of Bailegap Setting** *Landform:* Mountains *Landform position (two-dimensional):* Summit, shoulder *Landform position (three-dimensional):* Mountaintop *Down-slope shape:* Convex *Across-slope shape:* Convex *Parent material:* Residuum weathered from sandstone and siltstone and interbedded shale **Properties and qualities** *Slope:* 2 to 15 percent *Surface area covered with cobbles, stones or boulders:* 9.0 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock; 40 to 60 inches to lithic bedrock *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Low (about 4.7 inches) **Interpretive groups** *Land capability (nonirrigated):* 6s **Typical profile** *0 to 8 inches:* Flaggy loam *8 to 20 inches:* Gravelly silt loam *20 to 42 inches:* Very cobbly silt loam *42 to 58 inches:* Bedrock *58 to 68 inches:* Bedrock

Giles County, Virginia: 27E—Lily-Bailegap complex, very stony, 15 to 35 percent slopes. Map Unit Setting *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Lily and similar soils:* 70 percent *Bailegap and similar soils:* 20 percent **Description of Lily Setting** *Landform:* Mountains *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Mountainflank *Down-slope shape:* Linear *Across-slope shape:* Convex *Parent material:* Residuum weathered from sandstone and siltstone and interbedded shale **Properties and qualities** *Slope:* 15 to 35 percent *Surface area covered with cobbles, stones or boulders:* 9.0 percent *Depth to restrictive feature:* 20 to 40 inches to lithic bedrock *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 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 4.3 inches) **Interpretive groups** *Land capability (nonirrigated):* 6s **Typical profile** *0 to 7 inches:* Gravelly sandy loam *7 to 30 inches:* Gravelly loam *30 to 36 inches:* Clay loam *36 to 46 inches:* Bedrock **Description of Bailegap Setting** *Landform:* Mountains *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Mountainflank *Down-slope shape:* Linear *Across-slope shape:* Convex *Parent material:* Residuum weathered from sandstone and siltstone and interbedded shale **Properties and qualities** *Slope:* 15 to 35 percent *Surface area covered with cobbles, stones or boulders:* 9.0 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock; 40 to 60 inches to lithic bedrock *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* Low (about 4.7 inches) **Interpretive groups** *Land capability* *(nonirrigated):* 6s **Typical profile** *0 to 8 inches:* Flaggy loam *8 to 20 inches:* Gravelly silt loam *20 to 42 inches:* Very cobbly silt loam *42 to 58 inches:* Bedrock *58 to 68 inches:* Bedrock

Giles County, Virginia: 30F—Nolichucky very stony sandy loam, 30 to 65 percent slopes. Map Unit Setting *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Nolichucky and similar soils:* 90 percent **Description of Nolichucky Setting** *Landform:* Hills *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope, nose slope *Down-slope shape:* Convex *Across-slope shape:* Convex *Parent material:* Colluvium derived from sandstone and shale and minor amounts of limestone **Properties and qualities** *Slope:* 30 to 65 percent *Surface area covered with cobbles, stones or boulders:* 9.0 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 (0.57 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 7.0 inches) **Interpretive groups** *Land capability (nonirrigated):* 7s **Typical profile** *0 to 8 inches:* Gravelly sandy loam *8 to 32 inches:* Clay loam *32 to 43 inches:* Gravelly clay loam *43 to 70 inches:* Clay loam

Giles County, Virginia: W—Water. Map Unit Setting *Mean annual precipitation:* 34 to 46 inches *Mean annual air temperature:* 52 to 55 degrees F *Frost-free period:* 129 to 180 days **Map Unit Composition** *Water:* 100 percent **Description of Water Setting** *Landform:* Perennial streams, lakes

4.2.2 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 27). 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 27).

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 27), 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.

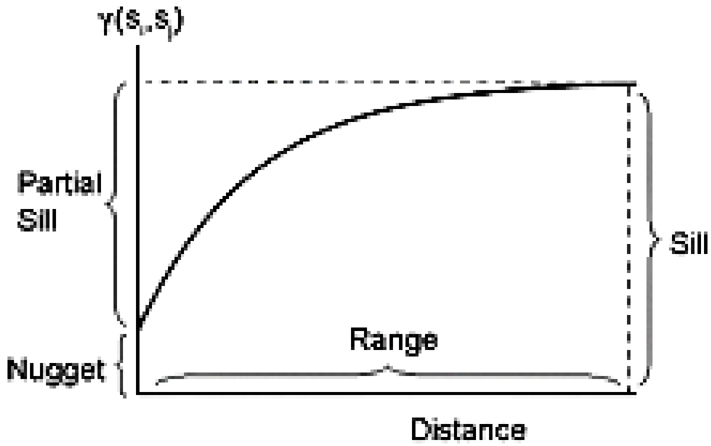


Figure 27. Example semivariogram, depicting range, sill, and nugget.

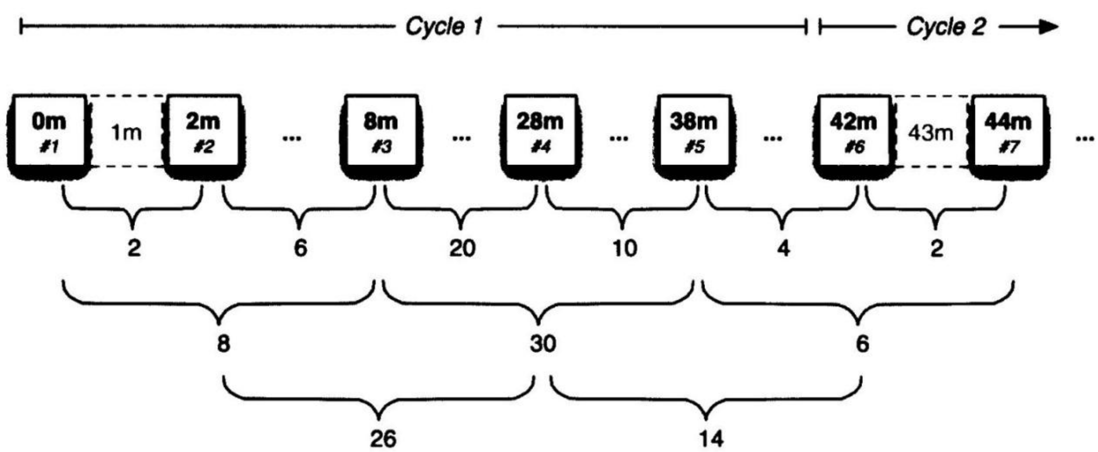


Figure 28. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 22 April 2010 at the Mountain Lake site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 28). Soil temperature and moisture measurements were collected along three transects (168 m, 84 m, and 84 m) located in the expected airshed at Mountain Lake. 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 28, 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).

4.2.3 Results and interpretation

4.2.3.1 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 29). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 30, left graphs) and 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 79 m for soil temperature.

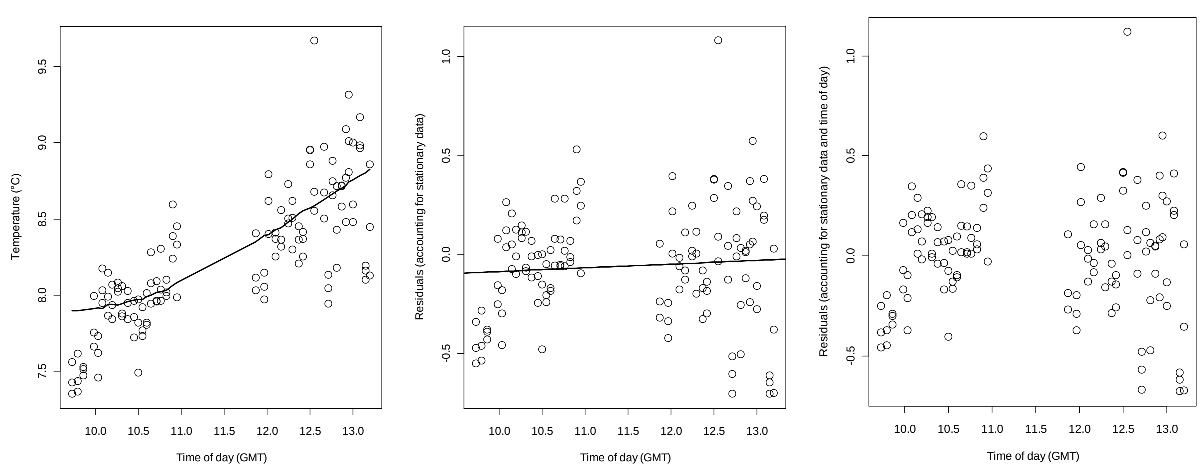


Figure 29. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

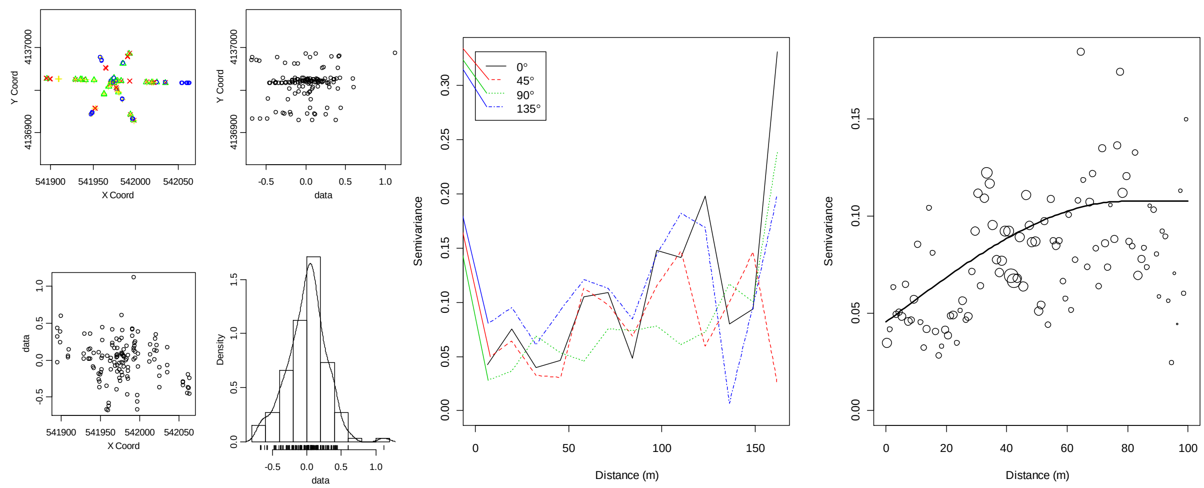


Figure 30. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

4.2.3.2 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 31). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 32, left graph) and directional semivariograms do not show anisotropy (Figure 32, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 32, right graph). The model indicates a distance of effective independence of 70 m for soil water content.

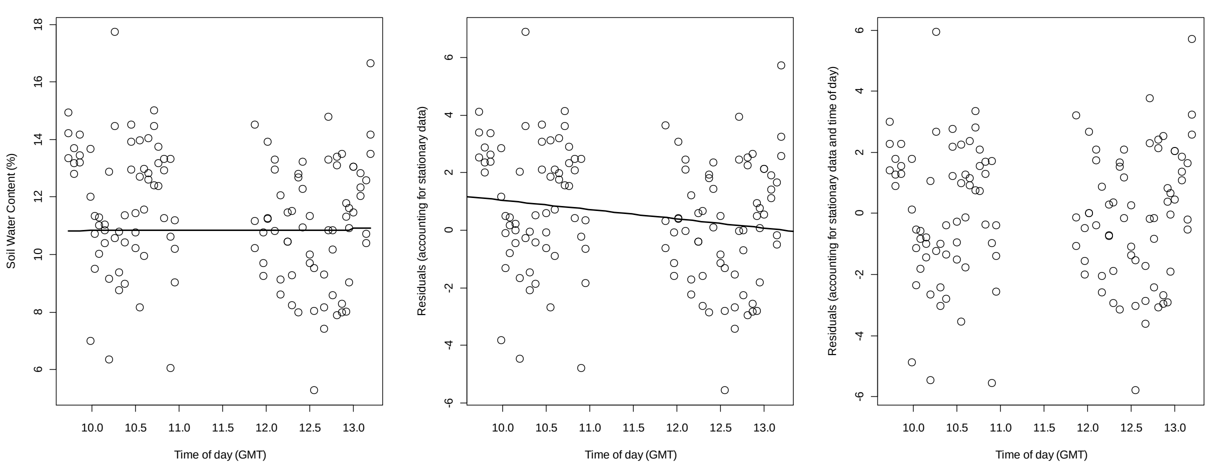


Figure 31. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting 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.

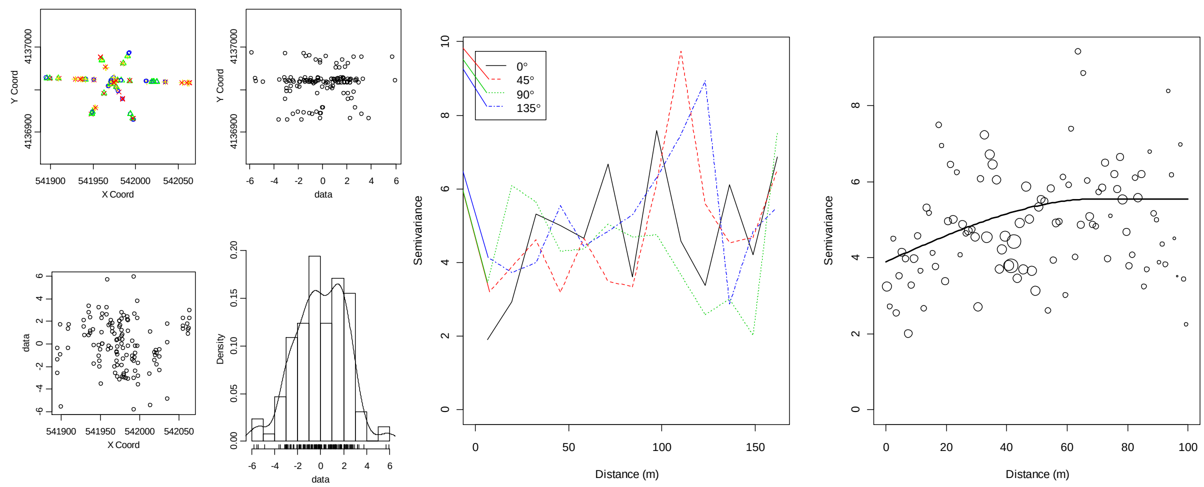


Figure 32. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

4.2.3.3 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 costs. The estimated distance of effective independence was 79 m for soil temperature and 70 m for soil moisture. Based on these results and the site design guidelines the soil plots at Mountain Lake 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 290° from the soil plot nearest the tower (i.e., first soil plot). The location of the first soil plot will be approximately 37.37840°, -80.52515°. 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 37.37835°, -80.52481°. A summary of the soil information is shown in Table 12 and site layout can be seen in Figure 33.

Dominant soil series at the site: Fluvaquents, nearly level. The taxonomy of this soil is shown below:
Order: Entisols
Suborder: Aquents
Great group: Fluvaquents
Subgroup: NA
Family: NA
Series: Fluvaquents, nearly level

Table 12. Summary of soil array and soil pit information at Mountain Lake. 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	30 m
Latitude and longitude of 1st soil plot OR direction from tower	37.37840°, -80.52515°
Direction of soil array	290°
Latitude and longitude of FIU soil pit	37.37778°, -80.52426°
Dominant soil type	Fluvaquents, nearly level
Expected soil depth	>2 m
Depth to water table	0 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.33 m (loam)	0.17 m†
0.33-1.04 m (loam)	0.69 m†
1.04 -1.65 m (fine sandy loam)	1.35 m†
1.65-2.00 m§	1.83 m
2.00 m	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.
†Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)
§Soil description not available at this depth

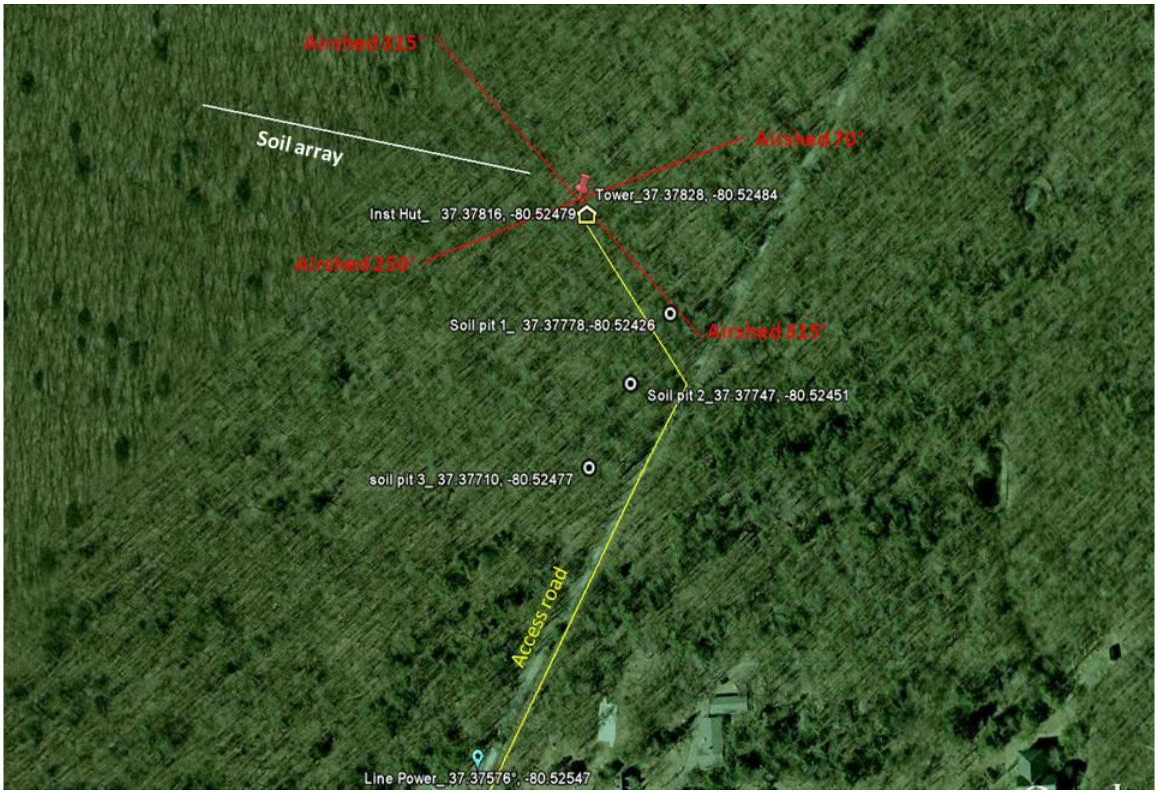


Figure 33. Site layout at Mountain Lake showing soil array and location of the FIU soil pit.

4.3 Airshed

4.3.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figures 34-37. The weather data used to generate the following wind roses are from Virginia Tech airport (37.217, -80.417), VA, which is ~20 km southeast of NEON Relocatable site at Mountain Lake Biological Station. 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. Color bands depict the range of wind speeds. 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.

4.3.2 Results (graphs for wind roses)

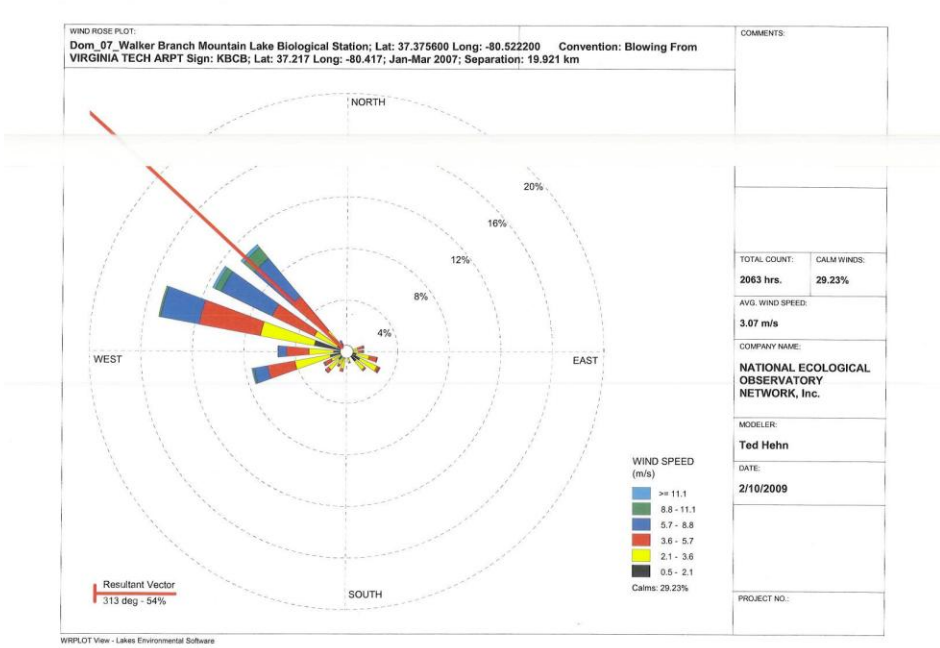


Figure 34. Windroses of January – March for D07 Mountain Lake Biological Station Relocatable site.

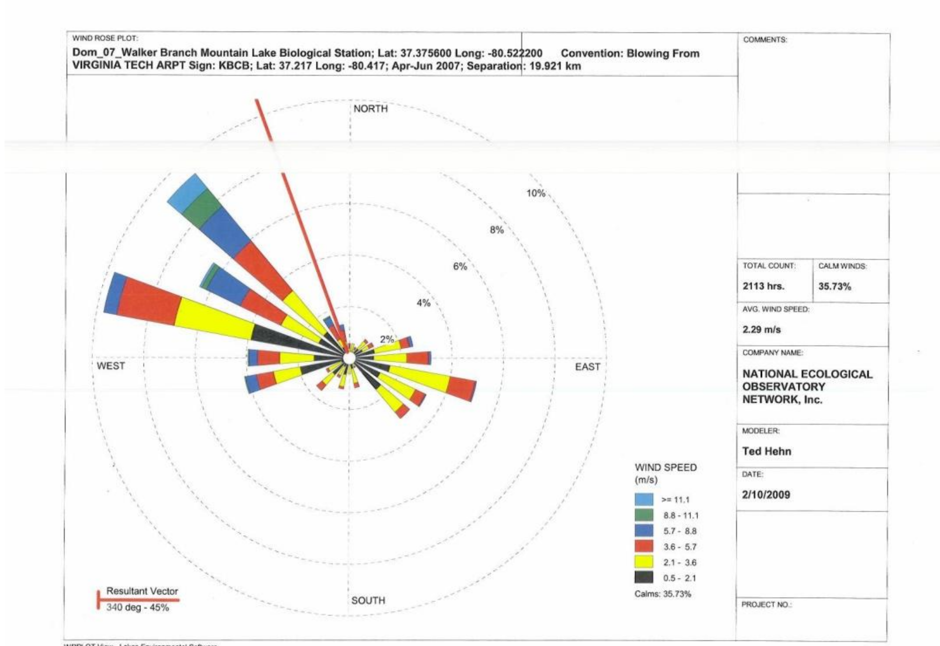


Figure 35. Windroses of April – June for D07 Mountain Lake Biological Station Relocatable site.

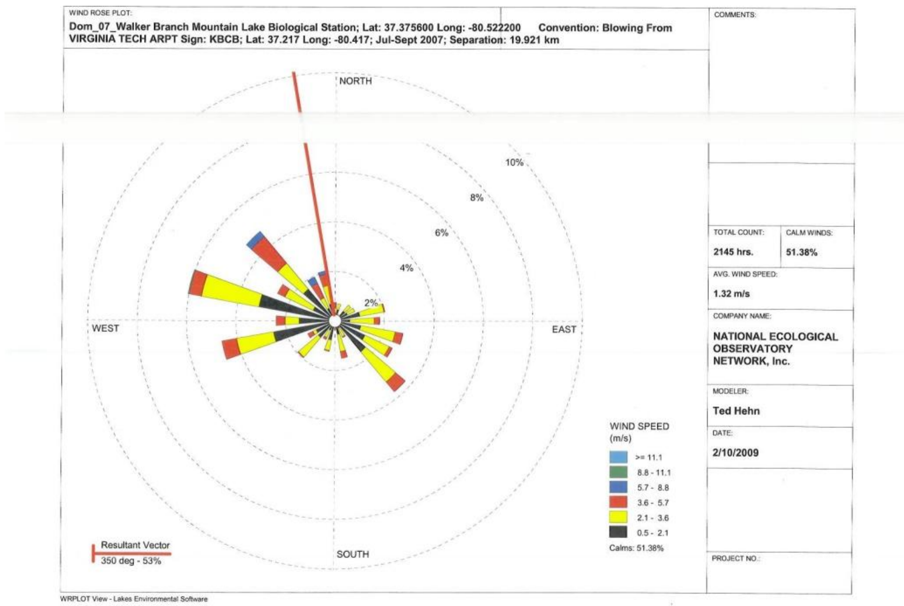


Figure 36. Windroses of July – September for D07 Mountain Lake Biological Station Relocatable site.

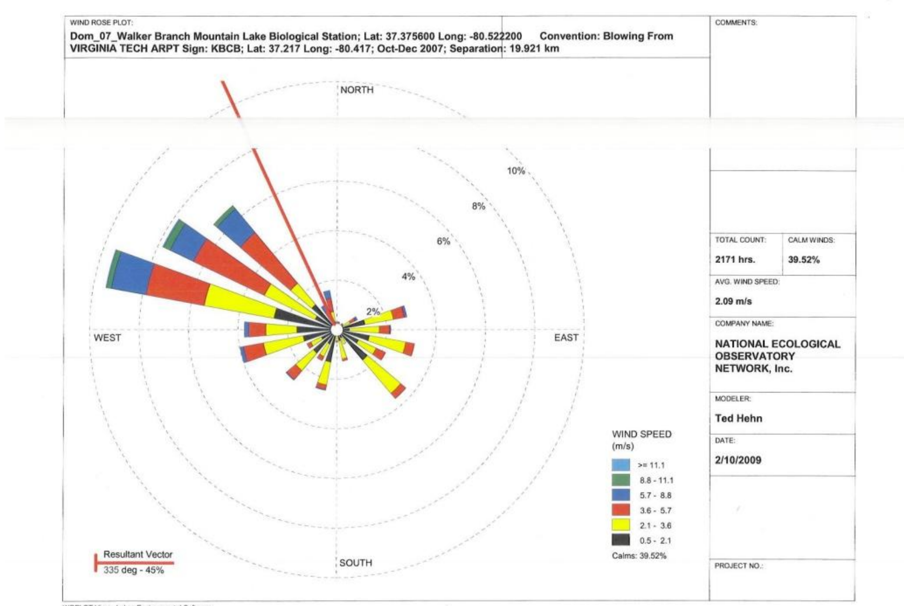


Figure 37. Windroses of October – December for D07 Mountain Lake Biological Station Relocatable site.

4.3.3 Resultant vectors

Table 13. The resultant wind vectors from D07 Mountain Lake Biological Station Relocatable site.

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	313°	54
April to June	340°	45
July to September	350°	53
October to December	335°	45
Annual mean	334.5°	na.

4.3.4 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, with support from Dr R. Clement, we use a web-based footprint model that made by Micrometeorology Group at University of Edinburgh, UK 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 varify 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 14. Expected environmental controls to parameterize the source area model, and associated results from D07 Mountain Lake Biological Station 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	30	30	30	30	30	30	m
Canopy Height	20.2	20.2	20.2	20.2	20.2	20.2	m
Canopy area density	5.0120	5.0120	5.012	2.5120	2.5120	2.5120	m
Boundary layer depth	2001	2001	801.0	900	900	500	m
Expected sensible heat flux	350	350	51	125	125	31	W m^{-2}
Air Temperature	27	27	20	11	11	3	°C
Max. windspeed	8.8	3.4	1.0	13.0	6.6	2.0	m s^{-1}
Resultant wind vector	284	284	105	284	284	105	degrees
				Results			
(z-d)/L	-0.03	-0.25	-0.40	0	-0.02	-0.13	m
d	17	17	17	16	16	16	m
Sigma v	2.90	2.00	0.81	4.00	2.20	0.81	m^2 s^{-2}
Z0	0.71	0.71	0.71	1.00	1.00	1.00	m
u*	1.20	0.59	0.27	2.00	1.00	0.35	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	750	480	200	800	780	500	m
Distance of 80% cumulative flux	400	250	150	490	420	290	m
Distance of 70% cumulative flux	300	200	100	300	300	240	m
Peak contribution	65	45	25	65	65	55	m

4.3.5 Footprint model results (source area graphs)

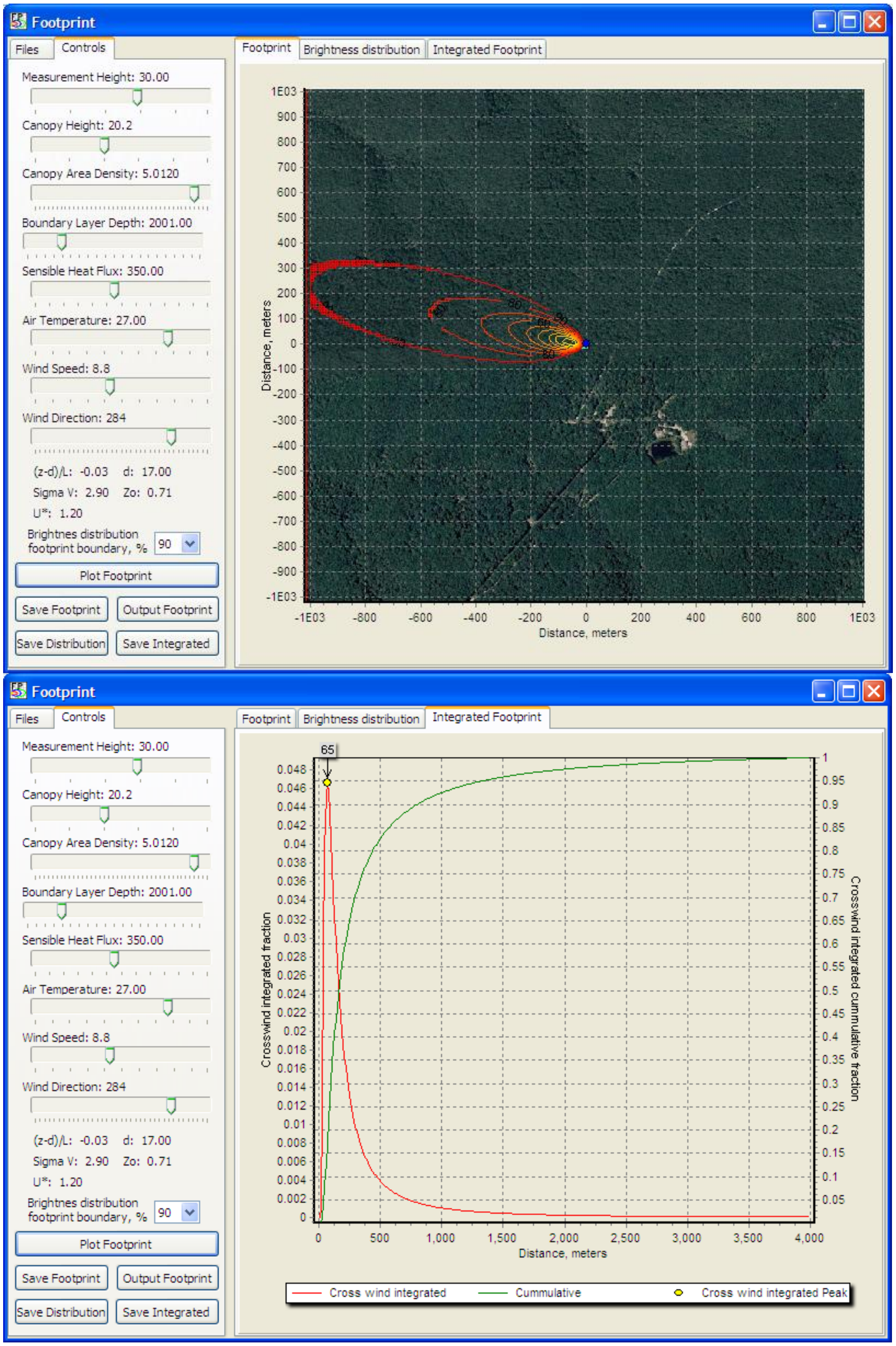


Figure 38. D07 Mountain Lake Biological Station summer daytime (convective) footprint output with max wind speed.

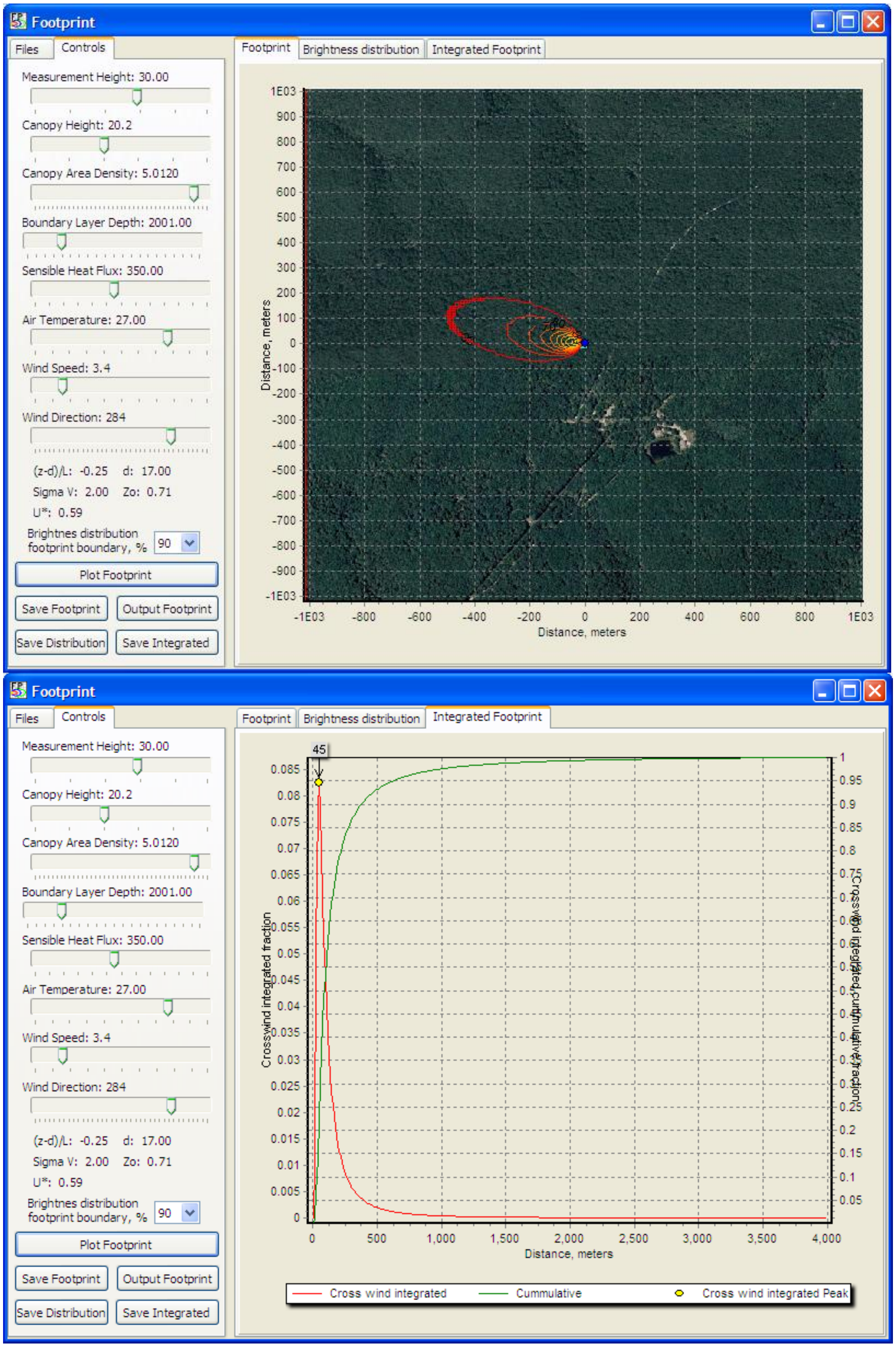


Figure 39. D07 Mountain Lake Biological Station summer daytime (convective) footprint output with mean wind speed.

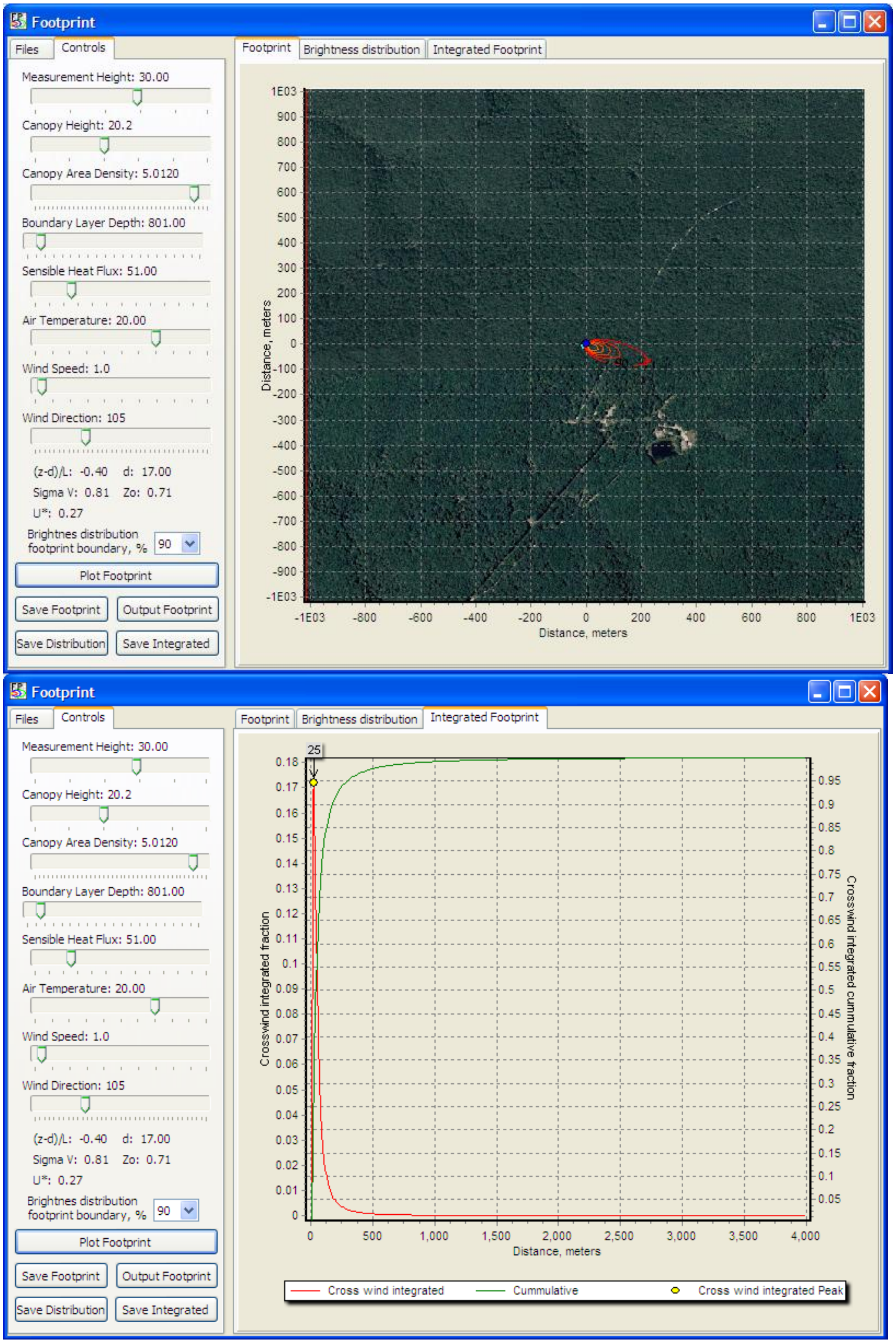


Figure 40. D07 Mountain Lake Biological Station summer nighttime (stable) footprint output with mean wind speed.

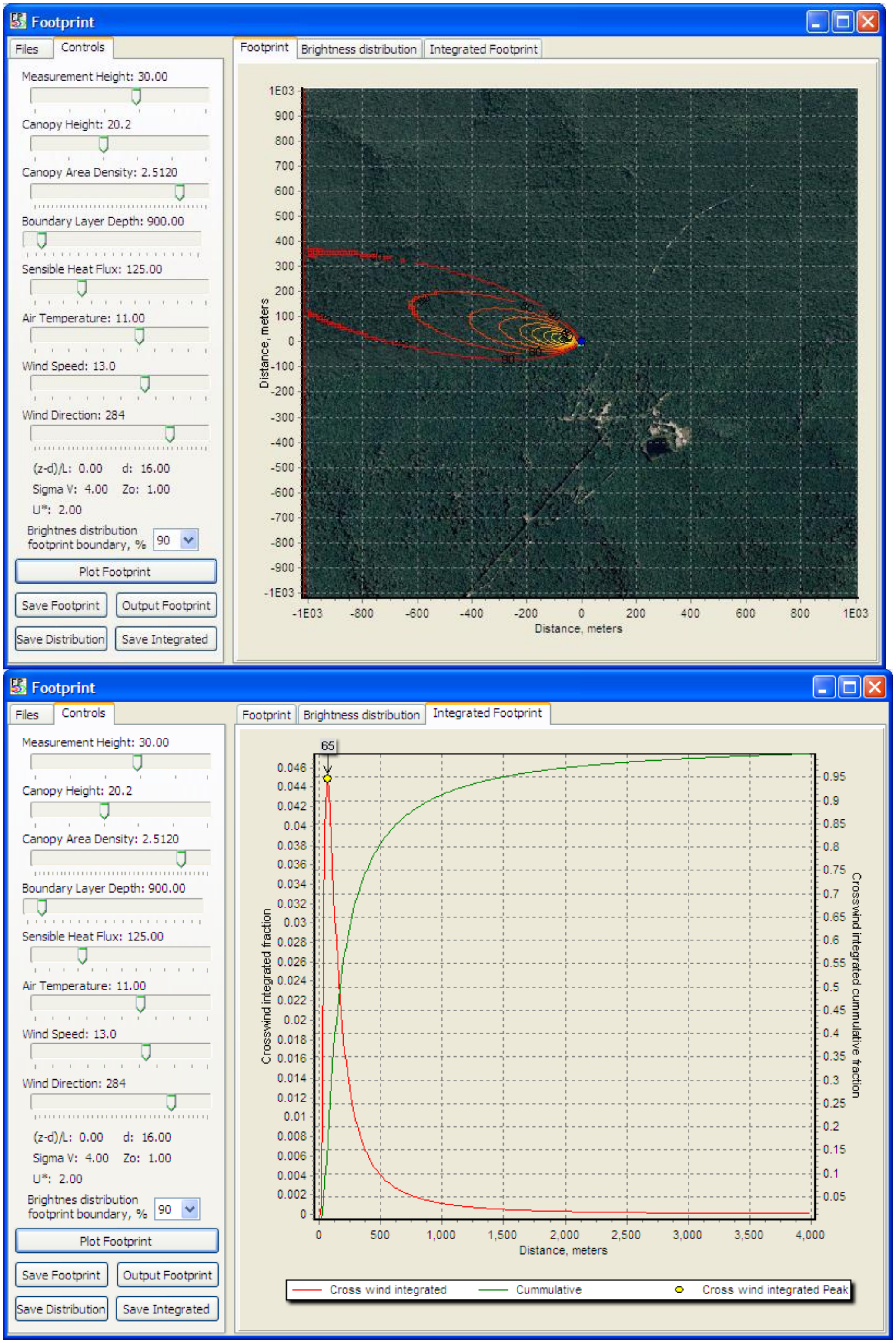


Figure 41. D07 Mountain Lake Biological Station winter daytime (convective) footprint output with max wind speed.

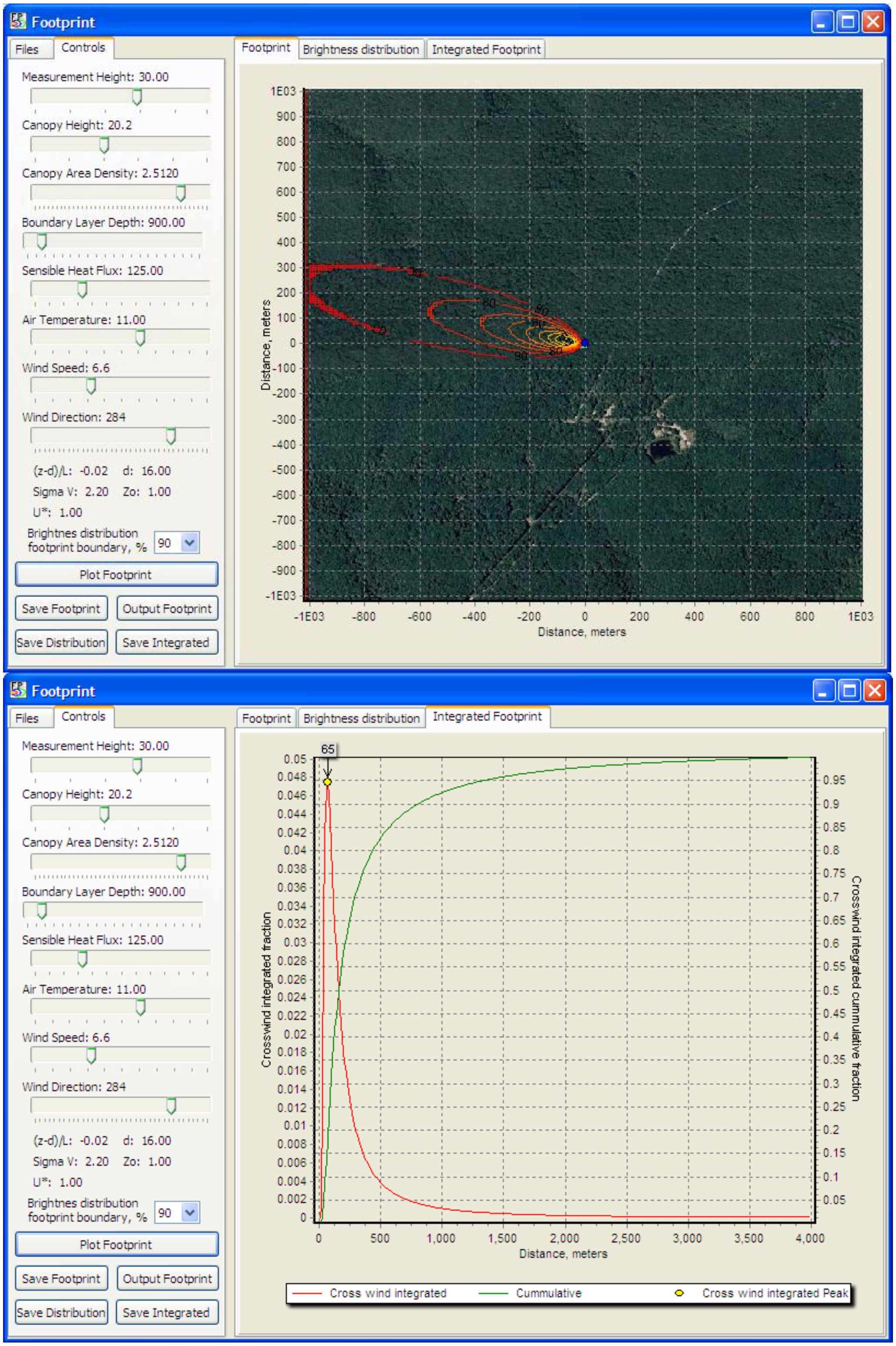


Figure 42. D07 Mountain Lake Biological Station winter daytime (convective) footprint output with mean wind speed.

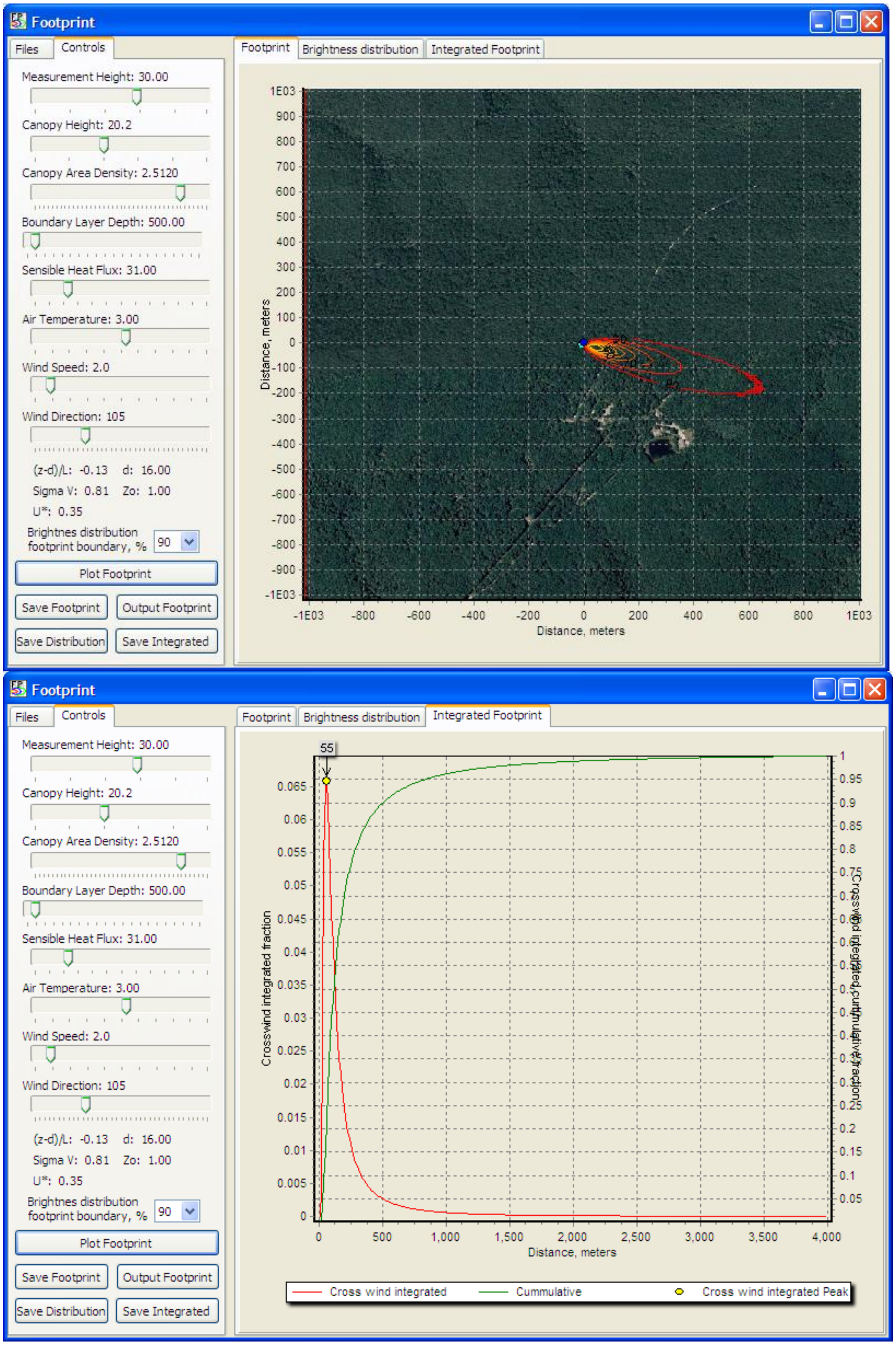


Figure 43. D07 Mountain Lake Biological Station winter nighttime (stable) footprint output with mean wind speed.

4.4 Site design and tower attributes

According to windroses, the prevailing wind direction blows from west (250° to 315° clockwise from 250°, major airshed) or from east (70° to 135° clockwise from 70°, secondary airshed) throughout the year. Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is Oak dominant hardwood forest at this site. The original candidate tower location is 37.371796, -80.524488. Because the major airshed area for this tower location is over a creek and drainage, after FIU site characterization we propose a new tower site at 37.37828, -80.52484 to maximize our measurements over the hardwood forest ecosystem. New tower location is ~700 m north to the original site, and within the same property boundary and EA. It is about 100 m from highway State Route 613.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the north 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 southeast side of tower and have the longer side parallel to W-E direction. Therefore, we require the placement of instrument hut at 37.37816, -80.52479.

The site is a closed hardwood forest. Canopy height is ~18 m with lowest branch ~8 m above ground. Shrub, seedlings and sapling understory varies from 5 m to 12 m in height without obvious strata. Fern and other annual plants at ground level are <1.0 m tall. We require 6 **measurement layers** on the tower with top measurement height at 28 m, and rest layers are 20 m, 14 m, 8 m, 4 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile through forest.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated on the top of 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 (short-side of instrument hut is perpendicular to the **Instrument hut orientation vector)**. **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, in this case, level 6 being the upper most level at this tower site.

Table 15. Site design and tower attributes for D07 Mountain Lake Biological Station 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			250° to 315° (major) and 70° to 135°		Clockwise from first angle
Tower location	37.37828,	-80.52484	--	--	new site
Instrument hut	37.37816,	-80.52479			
Instrument hut orientation vector	--	--	90°-270°		Short face parallel to 180° - 360°
Instrument hut distance z	--	--	--	14	
Anemometer/Temperature boom orientation	--	--	360°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				4.0	m.a.g.l.
Level 3				8.0	m.a.g.l.
Level 4				14.0	m.a.g.l.
Level 5				20.0	m.a.g.l.
Level 6				28.0	m.a.g.l.
Tower Height				28.0	m.a.g.l.

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

Figure 44 below shows the proposed tower location, instrument hut location, airshed area and access road.

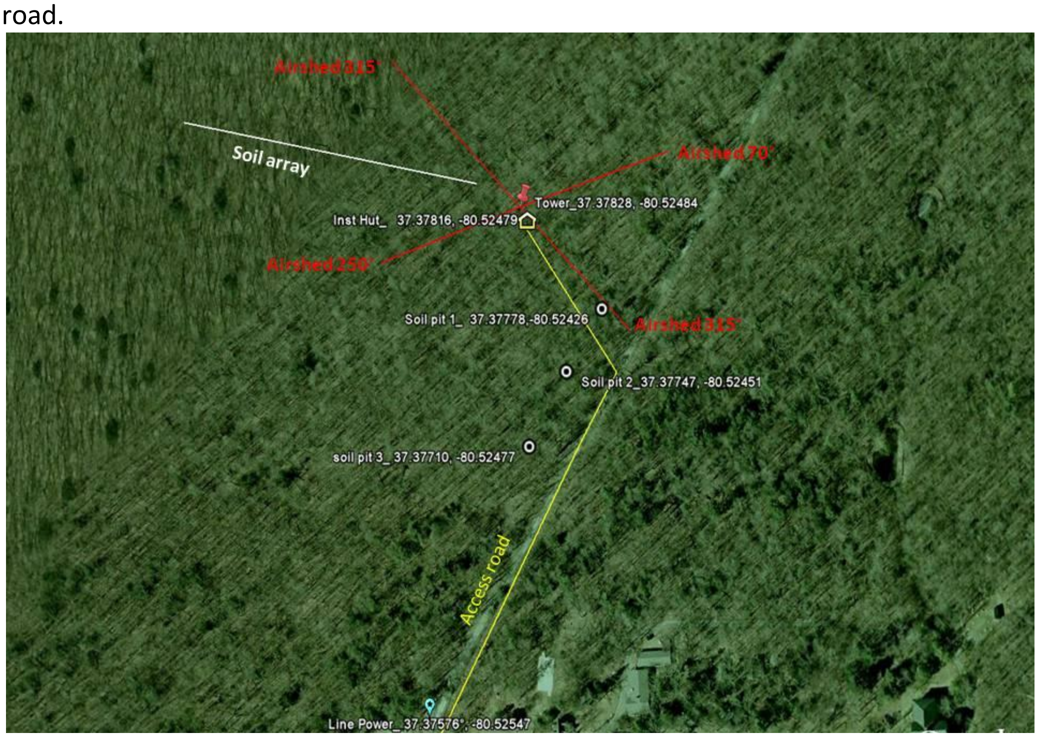


Figure 44. Site layout for Mountain Lake Biological Station Relocatable site.

i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 250º to 315º (clockwise from 250º, major airshed) or from 70º to 135º (clockwise from 70º, secondary airshed) that 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.

- There is always a boardwalk from the instrument hut to the tower
- If there is a boardwalk on the south side of the tower, it is never underneath the radiation booms, and it is more than 4 m from the side of the tower
- There is never a boardwalk within 4 m of the tower, except where it perpendicularly intersects the tower for access
- The boardwalk to access the tower is not on any side that has a boom.
- There is never boardwalk within 10 m of a soil plot, except where it perpendicularly intersects a soil plot for access.

Specific Boardwalks at Mountain Lake Biological Station Relocatable site

- Boardwalk is 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
- Boardwalk to the soil array
- No boardwalk from the soil array boardwalk to the individual soil plots

4.5 Information for ecosystem productivity plots

The tower at Mountain Lake Biological Station Relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (hardwood forest). Airshed at this site is from 250º to 315º (clockwise from 250º, major airshed) and from 70º to 135º (clockwise from 70º, secondary airshed), and 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots be placed within the major airshed boundaries of 250º to 315º (clockwise from 250º).

4.6 Issues and attentions

There are three concerns at this tower site.

First is security. Highway Sate Route 613 is actively used by public for recreation activities in the sourrounding areas. Vandalism or damage of facilities, although rare, remains a concern if the tower structure and instrument hut are visible from the road, which is more likely in winter after leaves fall.

Second concern is boundary lines on the north and west of the tower site. The tower location and instrument hut are inside the Mountain Lake Bioklogical Sation property according to the boundary map. But, during site visit, we found some wooden stake marks on trees on the north side of new tower location that looked like boundary line marks, which is more toward south than the boundary map indicates. Dr E. Nagy, our site contact, tried to identify the boundary lines on north and west, but wasn't sucessful. He said there was no active activities in that area. Most boundaries marks cannot be reconganized anymore. He suggested we should finish this report using the tower location we picked and make him a copy of the report. He will then bring this report to talk with the owners on north and west side of boundary. He doesn't think it will be a problem. The ecosystem is uniform here. The new tower location can be moved south <100 m and east <40 m if adjustment is necessary. But tower location must be at least 60 m from the roadside. Instrument hut should be moved as well to keep its relative location to the tower.

The third concern is that the major airshed area is on the west side of tower and outside boundary. It will require additional negotiation and permits for FSU EP plots.

5 GREAT SMOKY MOUNTAIN NATIONAL PARK (GSMNP), RELOCATEABLE TOWER 2

5.1 Site description

NEON candidate Relocatable tower site at Tennessee is located within Great Smoky Mountain National Park (see Figure 45). The original candidate site was at 36.6847, -83.5000 at the foot of a large mountain. The slopes are steep and long. Cold air drainage along the slope will be concerns at this location and very likely contribute towards uncertainty in NEON FIU data products. After FIU first site characterization, we suggested a new tower location at 35.68604, -83.50494, which was moved toward ridge and is ~470 m northwest of the original tower location. But GSMNP staff considers this tower site at ridge is outside the park development zone, and a tower at ridge will be seen by the visitors on a scenic trail (viewshed issues). FIU (along with other NEON PTs) made a second visit to the park, to work with the GSMNP staff to determine a location that would be mutually beneficial to both parties. A new tower location at 35.68895, -83.50210, used here in this report was chosen by all parties in part i) to limit the construction and operation disturbance, ii) replace an existing tower that was zoned for 'conditional use', so that no new petition or change in land use would be needed, and iii) not affect the current viewshed and maintain the natural the beauty of the area. Data analysis and site design below are based on this location.

Great Smoky Mountains National Park is a United States National Park that straddles the ridgeline of the Great Smoky Mountains, the lower section in latitude of the Blue Ridge Mountains, which divides the larger Appalachian Mountain chain. The border between Tennessee and North Carolina runs northeast to southwest through the centerline of the park. It is the most visited national park in the United States. On its route from Maine to Georgia, the Appalachian Trail also passes through the center of the park. The park was chartered by the United States Congress in 1934 and officially dedicated by President Franklin Delanor Roosevelt in 1940. It encompasses 814 square miles (2,108 km²), making it one of the largest protected areas in the eastern United States. The main park entrances are located along U.S. Highway 441 (Newfound Gap Road) at the towns of Gatlinburg, Tennessee, and Cherokee, North Carolina. Interestingly, it was the first national park whose land and other costs were paid for in part with federal funds; previous parks were funded wholly with state money or private funds (Source information: http://en.wikipedia.org/wiki/Great_Smoky_Mountains_National_Park).

Elevations in the park range from 876 feet (267 m) at the mouth of Abrams Creek to 6,643 feet (2,025 m) at the summit of Clingmans Dome. Within the park a total of sixteen mountains are > 6,000 feet (1829 m). The wide range of elevation mimics the latitudinal changes found throughout the entire eastern United States. Plants and animals common in the country's Northeast have found suitable ecological niches in the park's higher elevations, while southern species find homes in the balmier lower reaches. During the most recent ice age, the northeast-to-southwest orientation of the Appalachian mountains allowed species to migrate southward along the slopes rather than finding the mountains to be a barrier. As climate warms, many northern species are now retreating upward along the slopes and withdrawing northward, while southern species are expanding. The park normally has very high humidity and precipitation, averaging from 55 inches (1,400 mm) per year in the valleys to 85 inches (2,200 mm) per year on the peaks. This area receives more annual rainfall than anywhere else in the United States outside of the Pacific Northwest and parts of Alaska. It is also generally cooler than the lower elevations below, and most of the park has a humid continental climate more comparable to locations much farther north, as opposed to the humid subtropical climate in the lowlands. The park is almost 95 percent forested, and almost 36 percent of it, 187,000 acres (760 km2), is estimated by the Park Service to be old growth forest with many trees that predate European settlement of the area. It is one of the largest stands of deciduous, temperate, old growth forest in North America (Source information: http://en.wikipedia.org/wiki/Great_Smoky_Mountains_National_Park).

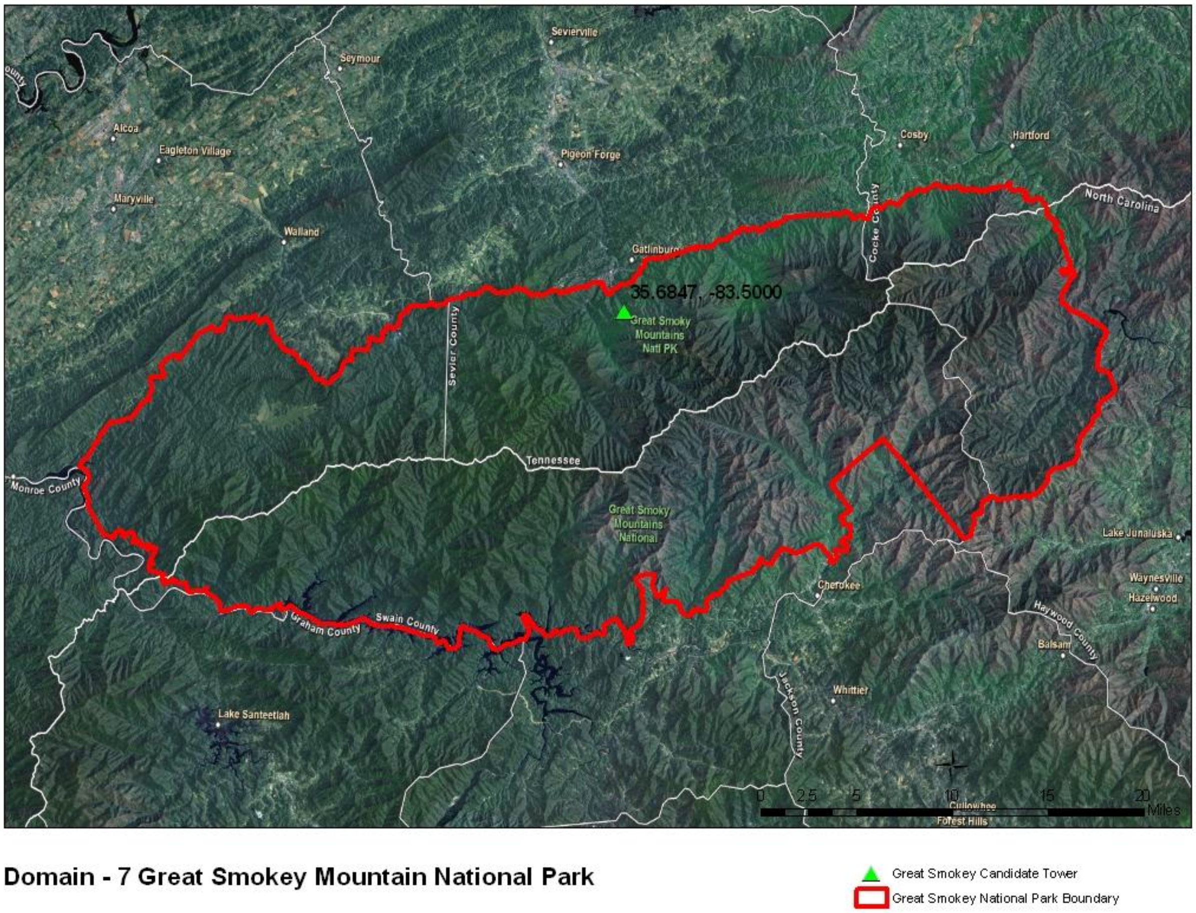


Figure 45. Boundary map of GSMNP Relocatable site and original NEON candidate tower location New tower location can be found below.

5.1.1 Ecosystem

The variety of elevations, the abundant rainfall, and the presence of old growth forests give Great Smoky Mountain Park an unusual richness of biota. About 10,000 species of plants and animals are known to live in the park, and estimates as high as an additional 90,000 undocumented species may also be present. Park officials count more than 200 species of birds, 66 species of mammals, 50 species of fish, 39 species of reptiles, and 43 species of amphibians, including many lungless salamanders. The park has a noteworthy black bear population, numbering at least 1,800. An experimental re-introduction of elk (wapiti) into the park began in 2001. Over 100 species of trees grow in the park. The lower region forests are dominated by deciduous leafy trees. At higher altitudes, deciduous forests give way to coniferous trees like Fraser Fir. In addition, the park has over 1,400 flowering plant species and over 4,000 species of non-flowering plants (Source information: http://en.wikipedia.org/wiki/Great_Smoky_Mountains_National_Park).

The vegetation and land cover information for the park are presented as following:

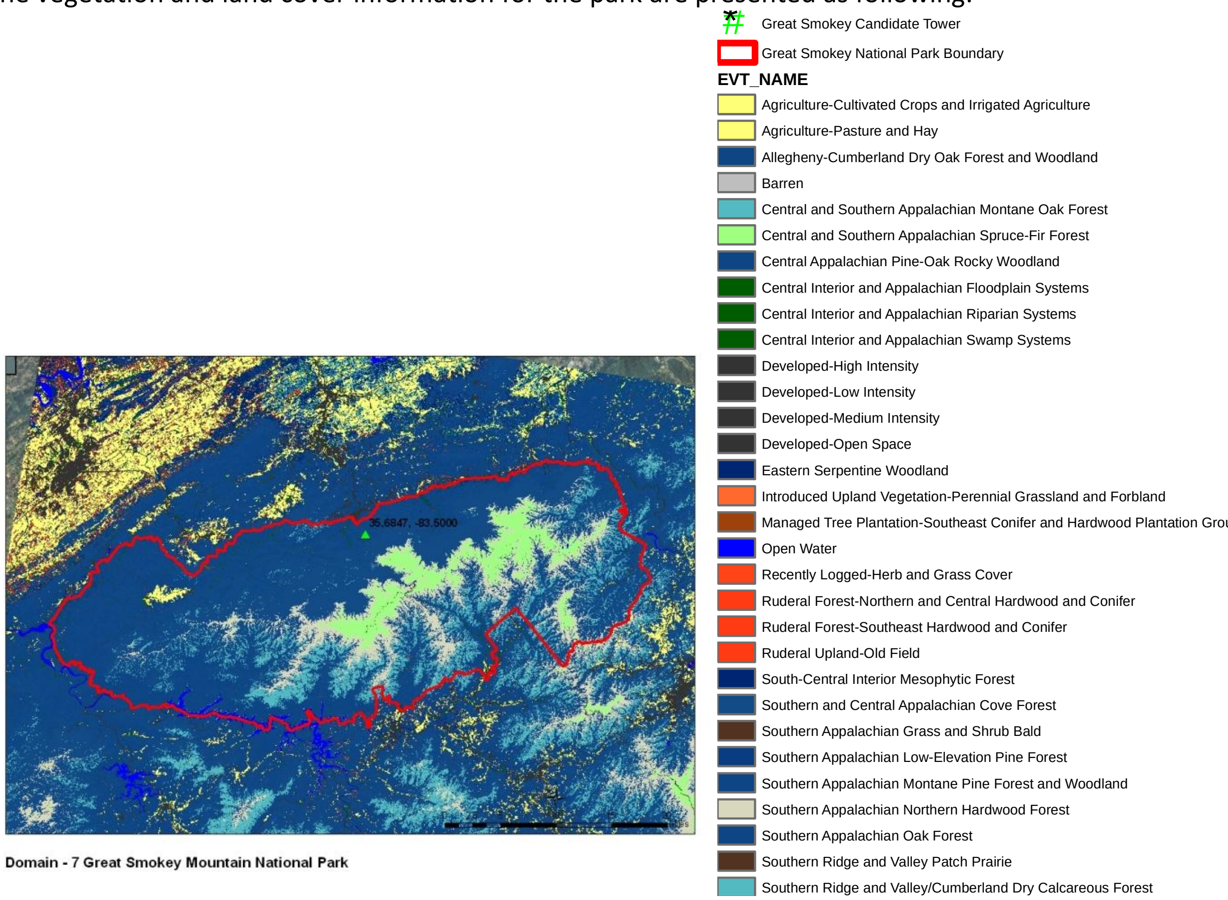


Figure 46. Vegetative cover map of Great Smoky Mountains National Park – Twin Creeks and surrounding areas
(from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Table 16. Percent Land cover information at Great Smoky Mountains National Park – Twin Creeks relocatable site
(from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	Area (km^2)	Percentage
Open Water	17.69	0.86
Developed-Open Space	7.80	0.38
Developed-Low Intensity	0.13	0.01
Developed-Medium Intensity	0.03	0.00
Barren	0.41	0.02
Agriculture-Pasture and Hay	7.91	0.38
Agriculture-Cultivated Crops and Irrigated Agriculture	0.74	0.04

Introduced Upland Vegetation-Perennial Grassland and Forbland	0.03	0.00
Recently Logged-Herb and Grass Cover	0.00	0.00
Southern Appalachian Northern Hardwood Forest	232.66	11.29
Southern Appalachian Oak Forest	503.36	24.43
Allegheny-Cumberland Dry Oak Forest and Woodland	0.01	0.00
Southern and Central Appalachian Cove Forest	894.32	43.41
Central and Southern Appalachian Montane Oak Forest	185.15	8.99
South-Central Interior Mesophytic Forest	0.18	0.01
Central and Southern Appalachian Spruce-Fir Forest	137.61	6.68
Southern Appalachian Montane Pine Forest and Woodland	49.40	2.40
Southern Appalachian Low-Elevation Pine Forest	5.43	0.26
Eastern Serpentine Woodland	3.95	0.19
Southern Ridge and Valley/Cumberland Dry Calcareous Forest	0.00	0.00
Central Appalachian Pine-Oak Rocky Woodland	0.00	0.00
Southern Appalachian Grass and Shrub Bald	0.00	0.00
Central Interior and Appalachian Floodplain Systems	0.86	0.04
Central Interior and Appalachian Riparian Systems	10.45	0.51
Ruderal Forest-Southeast Hardwood and Conifer	1.99	0.10
Total Area Sq Km	2060.09	100.00

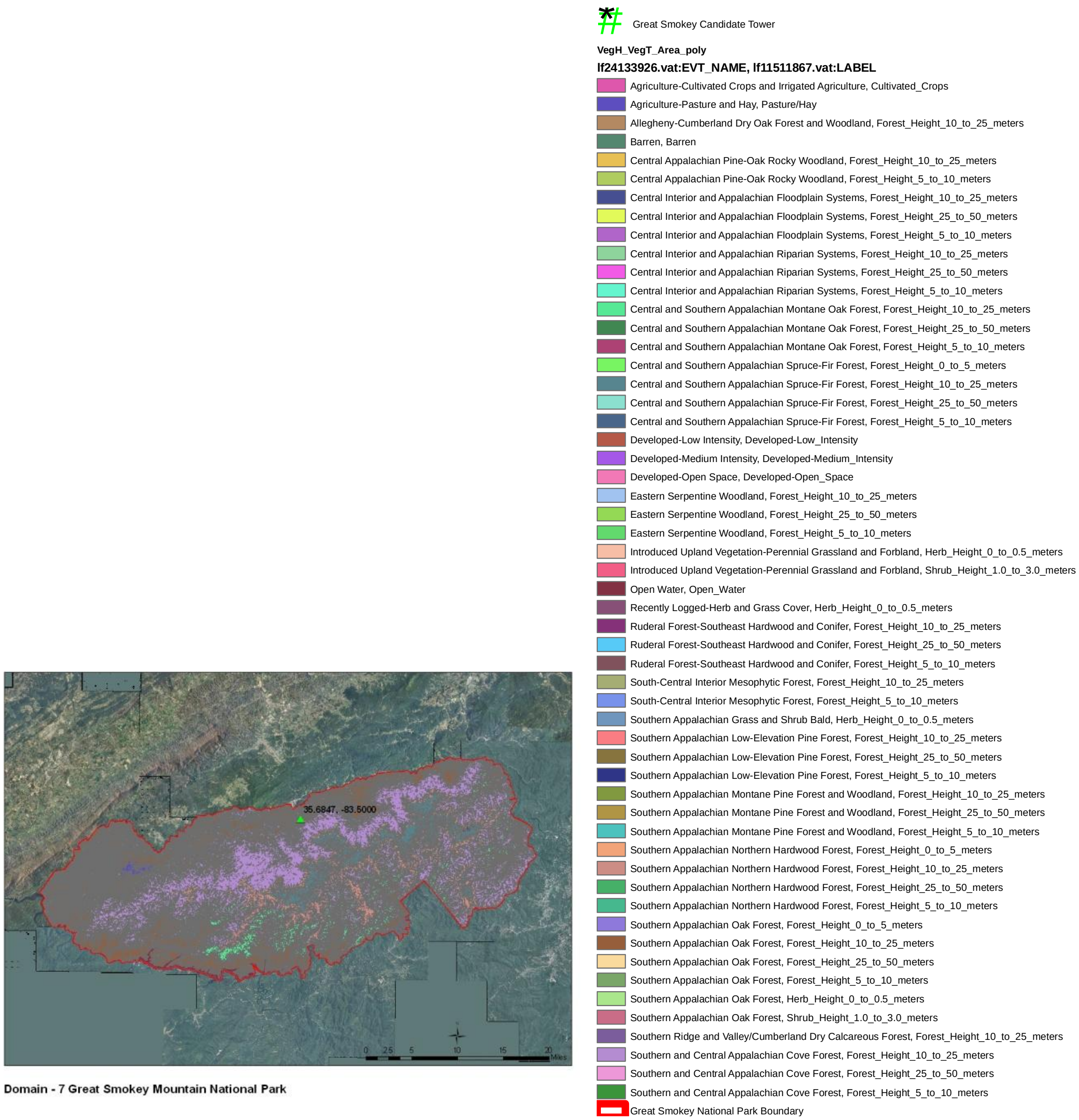


Figure 47. Vegetative height map of Great Smoky Mountain National Park – Twin Creeks site and the surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 17. Percent Land cover by vegetation height at Great Smoky Mountain National Park – Twin Creeks site (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Height	Vegetation Type	Area	Percentage
Open_Water	Open Water	17.68	0.86
Developed-Open_Space	Developed-Open Space	7.84	0.38
Developed-	Developed-Low Intensity	0.13	0.01

Low_Intensity			
Developed-Medium_Intensity	Developed-Medium Intensity	0.03	0.00
Barren	Barren	0.41	0.02
Pasture/Hay	Agriculture-Pasture and Hay	7.92	0.38
Cultivated_Crops	Agriculture-Cultivated Crops and Irrigated Agriculture	0.74	0.04
Herb_Height_0_to_0.5_meters	Introduced Upland Vegetation-Perennial Grassland and Forbland	0.02	0.00
Herb_Height_0_to_0.5_meters	Recently Logged-Herb and Grass Cover	0.00	0.00
Herb_Height_0_to_0.5_meters	Southern Appalachian Oak Forest	0.00	0.00
Herb_Height_0_to_0.5_meters	Southern Appalachian Grass and Shrub Bald	0.00	0.00
Shrub_Height_1.0_to_3.0_meters	Introduced Upland Vegetation-Perennial Grassland and Forbland	0.00	0.00
Shrub_Height_1.0_to_3.0_meters	Southern Appalachian Oak Forest	0.00	0.00
Forest_Height_0_to_5_meters	Southern Appalachian Northern Hardwood Forest	0.03	0.00
Forest_Height_0_to_5_meters	Southern Appalachian Oak Forest	0.01	0.00
Forest_Height_0_to_5_meters	Central and Southern Appalachian Spruce-Fir Forest	0.04	0.00
Forest_Height_5_to_10_meters	Southern Appalachian Northern Hardwood Forest	1.53	0.07
Forest_Height_5_to_10_meters	Southern Appalachian Oak Forest	10.50	0.51
Forest_Height_5_to_10_meters	Southern and Central Appalachian Cove Forest	5.89	0.29
Forest_Height_5_to_10_meters	Central and Southern Appalachian Montane Oak Forest	1.49	0.07
Forest_Height_5_to_10_meters	South-Central Interior Mesophytic Forest	0.00	0.00
Forest_Height_5_to_10_meters	Central and Southern Appalachian Spruce-Fir Forest	10.95	0.53
Forest_Height_5_to_10_meters	Southern Appalachian Montane Pine Forest and Woodland	2.42	0.12
Forest_Height_5_to_10_meters	Southern Appalachian Low-Elevation Pine Forest	0.58	0.03
Forest_Height_5_to_10_meters	Eastern Serpentine Woodland	0.10	0.00
Forest_Height_5_to_10_meters	Central Appalachian Pine-Oak Rocky Woodland	0.00	0.00
Forest_Height_5_to_	Central Interior and Appalachian Floodplain Systems	0.12	0.01

10_meters			
Forest_Height_5_to_10_meters	Central Interior and Appalachian Riparian Systems	1.05	0.05
Forest_Height_5_to_10_meters	Ruderal Forest-Southeast Hardwood and Conifer	0.23	0.01
Forest_Height_10_to_25_meters	Southern Appalachian Northern Hardwood Forest	230.06	11.17
Forest_Height_10_to_25_meters	Southern Appalachian Oak Forest	484.80	23.53
Forest_Height_10_to_25_meters	Allegheny-Cumberland Dry Oak Forest and Woodland	0.01	0.00
Forest_Height_10_to_25_meters	Southern and Central Appalachian Cove Forest	860.55	41.77
Forest_Height_10_to_25_meters	Central and Southern Appalachian Montane Oak Forest	180.46	8.76
Forest_Height_10_to_25_meters	South-Central Interior Mesophytic Forest	0.18	0.01
Forest_Height_10_to_25_meters	Central and Southern Appalachian Spruce-Fir Forest	125.92	6.11
Forest_Height_10_to_25_meters	Southern Appalachian Montane Pine Forest and Woodland	46.30	2.25
Forest_Height_10_to_25_meters	Southern Appalachian Low-Elevation Pine Forest	4.84	0.23
Forest_Height_10_to_25_meters	Eastern Serpentine Woodland	3.84	0.19
Forest_Height_10_to_25_meters	Southern Ridge and Valley/Cumberland Dry Calcareous Forest	0.00	0.00
Forest_Height_10_to_25_meters	Central Appalachian Pine-Oak Rocky Woodland	0.00	0.00
Forest_Height_10_to_25_meters	Central Interior and Appalachian Floodplain Systems	0.74	0.04
Forest_Height_10_to_25_meters	Central Interior and Appalachian Riparian Systems	9.28	0.45
Forest_Height_10_to_25_meters	Ruderal Forest-Southeast Hardwood and Conifer	1.75	0.09
Forest_Height_25_to_50_meters	Southern Appalachian Northern Hardwood Forest	1.30	0.06
Forest_Height_25_to_50_meters	Southern Appalachian Oak Forest	8.10	0.39
Forest_Height_25_to_50_meters	Southern and Central Appalachian Cove Forest	26.90	1.31
Forest_Height_25_to_50_meters	Central and Southern Appalachian Montane Oak Forest	3.47	0.17
Forest_Height_25_to_50_meters	Central and Southern Appalachian Spruce-Fir Forest	0.51	0.02

Forest_Height_25_to_50_meters	Southern Appalachian Montane Pine Forest and Woodland	1.08	0.05
Forest_Height_25_to_50_meters	Southern Appalachian Low-Elevation Pine Forest	0.05	0.00
Forest_Height_25_to_50_meters	Eastern Serpentine Woodland	0.03	0.00
Forest_Height_25_to_50_meters	Central Interior and Appalachian Floodplain Systems	0.01	0.00
Forest_Height_25_to_50_meters	Central Interior and Appalachian Riparian Systems	0.15	0.01
Forest_Height_25_to_50_meters	Ruderal Forest-Southeast Hardwood and Conifer	0.02	0.00
	Total Area Sq Km	2060.09	100.00

The ecosystem around the tower and in the airshed is closed-canopy hardwood deciduous forest that includes oaks and maples. Canopy is closed. Canopy height is ~30 m. Lowest branches are ~15 m above ground. Seedlings and saplings are abundant and dense. They form understory with height varying from 1 m to 15 m without any obvious strata (Figure 48). Understory on floor level is diverse and canopy height is ~0.5 m. Canopy density area is estimated to be 5.0 in summer and 2.5 in winter.

Figure 48. General view of the ecosystem at GSMNP alternative Relocatable tower site

Table 18. Ecosystem and site attributes for GSMNP tower site.

Ecosystem attributes	Measure and units
Mean canopy height	30 m
Surface roughness[a]	3 m
Zero place displacement height[a]	25 m
Structural elements	Closed deciduous hardwood forest, diverse and dense understory
Time zone	Eastern time zone
Magnetic declination	5° 34' W changing by 0° 4' W/year

Note, [a] From field observation.

5.2 Soils

5.2.1 Description of soils

Soil data and soil maps below for Great Smoky Mountains National Park Advanced tower site were collected from 2.4 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.

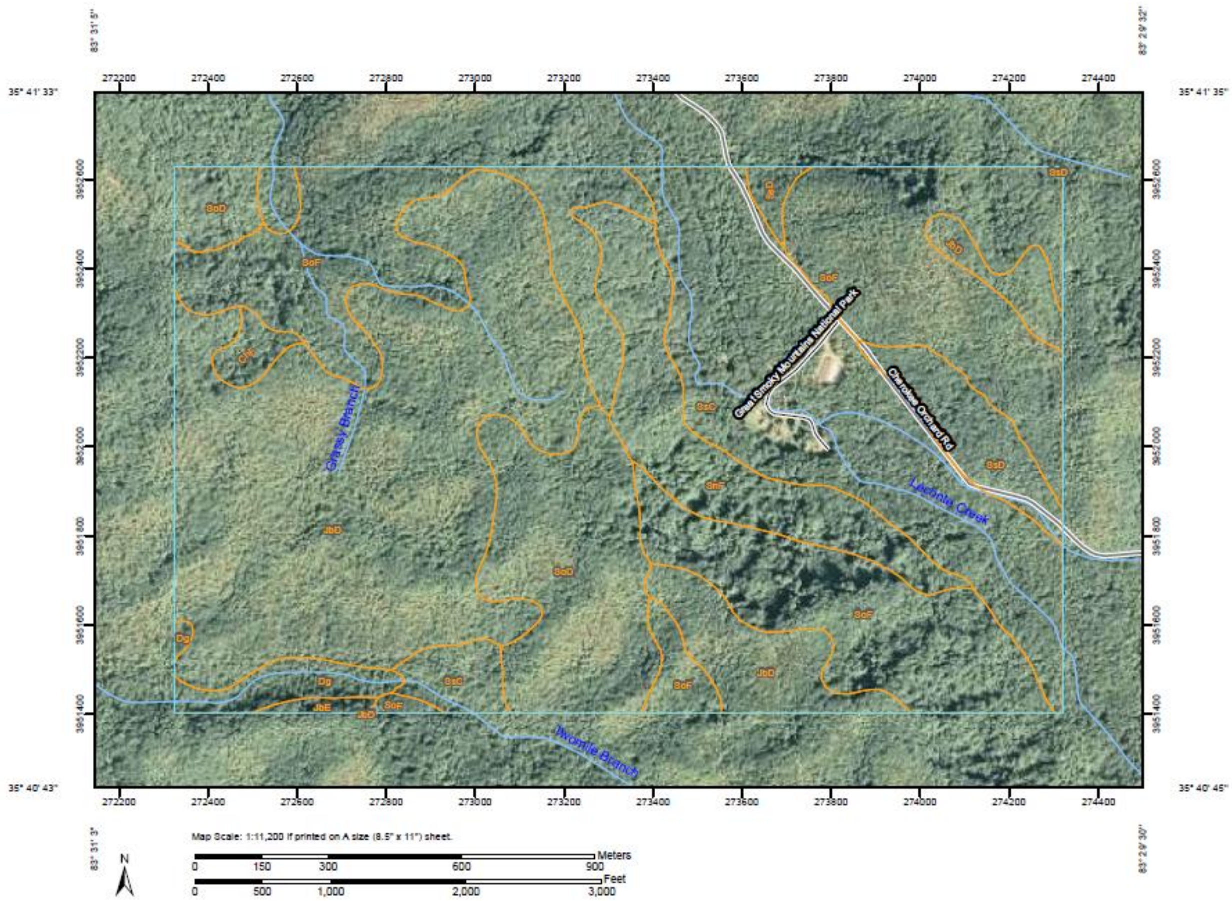


Figure 49. Soil map of the Great Smoky Mountain National Park – Twin Creeks Relocatable site and surrounding areas.

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. 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 19. Soil series and percentage of soil series within 2.4 km^2 at the site

Great Smoky Mountains National Park, Tennessee and North Carolina (TN640)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
ChF	Cheoah channery loam, 30 to 95 percent slopes, stony	4.4	0.7%
Dg	Dellwood-Smokemont complex, 0 to 5 percent slopes, frequently flooded	9.9	1.6%
JbD	Junaluska-Brasstown complex, 15 to 30 percent slopes, stony	191.7	31.8%
JbE	Junaluska-Brasstown complex, 30 to 50 percent slopes, stony	1.9	0.3%
SnF	Snowbird loam, 30 to 95 percent slopes, stony	40.2	6.7%
SoD	Soco-Stecoah complex, 15 to 30 percent slopes, stony	59.6	9.9%
SoF	Soco-Stecoah complex, 30 to 95 percent slopes, stony	173.4	28.7%
SsC	Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony	102.7	17.0%
SsD	Spivey-Santeetlah complex, 15 to 30 percent slopes, very stony	19.4	3.2%
Totals for Area of Interest		**603.2**	**100.0%**

Great Smoky Mountains National Park, Tennessee and North Carolina: ChF—Cheoah channery loam, 30 to 95 percent slopes, stony: Map Unit Setting Elevation: 1,970 to 4,200 feet Mean annual precipitation: 48 to 65 inches Mean annual air temperature: 43 to 68 degrees F Frost-free period: 162 to 176 days **Map Unit Composition** Cheoah and similar soils: 80 percent Minor components: 20 percent **Description of Cheoah Setting** Landform: Mountainsides Landform position (three-dimensional): Head slope Down-slope shape: Concave Across-slope shape: Concave Parent material: Loamy residuum and/or creep deposits derived from metasedimentary rock **Properties and qualities** Slope: 30 to 95 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 40 to 60 inches to paralithic bedrock 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 5.6 inches) **Interpretive groups** Land capability (nonirrigated): 7e Other vegetative classification: Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft Sandstone (Copperhill), mesic temperature regime, rolling hills phase (Model 15), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7) **Typical profile** 0 to 13 inches: Channery loam 13 to 45 inches: Channery sandy clay loam 45 to 56 inches: Channery sandy loam 56 to 64 inches: Weathered bedrock **Minor Components** Minor soils Percent of map unit: 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: Dg—Dellwood-Smokemont complex, 0 to 5 percent slopes, frequently flooded. Map Unit Setting *Elevation:* 980 to 3,020 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Dellwood and similar soils:* 50 percent *Smokemont and similar soils:* 30 percent *Minor components:* 20 percent **Description of Dellwood Setting** *Landform:* Flood plains *Landform position (three-dimensional):* Mountainbase *Down-slope shape:* Concave *Across-slope shape:* Linear *Parent material:* Sandy and gravelly alluvium **Properties and qualities** *Slope:* 0 to 5 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 (1.98 to 5.95 in/hr) *Depth to water table:* About 24 to 47 inches *Frequency of flooding:* Frequent *Frequency of ponding:* None *Available water capacity:* Very low (about 2.9 inches) **Interpretive groups** *Land capability (nonirrigated):* 4s *Other vegetative classification:* Floodplains and Terraces (Model 16), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7) **Typical profile** *0 to 8 inches:* Cobbly loam *8 to 14 inches:* Extremely gravelly sand *14 to 60 inches:* Extremely gravelly coarse sand **Description of Smokemont Setting** *Landform:* Flood plains *Landform position (three-dimensional):* Mountainbase *Down-slope shape:* Concave *Across-slope shape:* Linear *Parent material:* Cobbly alluvium derived from metasedimentary rock **Properties and qualities** *Slope:* 0 to 5 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:* About 48 to 72 inches *Frequency of flooding:* Frequent *Frequency of ponding:* None *Available water capacity:* Low (about 3.1 inches) **Interpretive groups** *Land capability (nonirrigated):* 4s *Other vegetative classification:* Floodplains and Terraces (Model 16), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7) **Typical profile** *0 to 11 inches:* Gravelly sandy loam *11 to 27 inches:* Extremely gravelly sandy loam *27 to 62 inches:* Extremely gravelly loamy coarse sand **Minor Components Minor soils** *Percent of map unit:* 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: JbD—Junaluska-Brasstown complex, 15 to 30 percent slopes, stony. Map Unit Setting *Elevation:* 990 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Junaluska and similar soils:* 45 percent *Brasstown and similar soils:* 35 percent *Minor components:* 20 percent **Description of Junaluska Setting** *Landform:* Ridges *Landform position (three-dimensional):* Crest *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum weathered from metasedimentary rock **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock *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 3.9 inches) **Interpretive groups** *Land capability (nonirrigated):* 6e *Other vegetative classification:* Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15) **Typical profile** *0 to 11 inches:* Loam *11 to 21 inches:* Sandy clay loam *21 to 26 inches:* Sandy loam *26 to 31 inches:* Weathered bedrock **Description of Brasstown Setting** *Landform:* Ridges *Landform position (three-dimensional):* Crest *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum weathered from metasedimentary rock **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock *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 6.6 inches) **Interpretive groups** *Land capability (nonirrigated):* 6e *Other vegetative classification:* Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15) **Typical profile** *0 to 6 inches:* Channery loam *6 to 29 inches:* Channery sandy clay loam *29 to 46 inches:* Channery fine sandy loam *46 to 60 inches:* Weathered bedrock **Minor Components Minor soils** *Percent of map unit:* 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: JbE—Junaluska-Brasstown complex, 30 to 50 percent slopes, stony: Map Unit Setting Elevation: 990 to 4,200 feet Mean annual precipitation: 48 to 65 inches Mean annual air temperature: 43 to 68 degrees F Frost-free period: 162 to 176 days **Map Unit Composition** Junaluska and similar soils: 45 percent Brasstown and similar soils: 35 percent Minor components: 20 percent **Description of Junaluska Setting** Landform: Mountainsides Landform position (three-dimensional): Side slope Down-slope shape: Convex Across-slope shape: Linear Parent material: Loamy residuum weathered from metasedimentary rock **Properties and qualities** Slope: 30 to 50 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 20 to 40 inches to paralithic bedrock 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 3.9 inches) **Interpretive groups** Land capability (nonirrigated): 6e Other vegetative classification: Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty

Metasandstone), mesic temperature regime. (Model 7) **Typical profile** 0 to 11 inches: Loam 11 to 21 inches: Sandy clay loam 21 to 26 inches: Sandy loam 26 to 31 inches: Weathered bedrock **Description of Brasstown Setting** Landform: Mountainsides Landform position (three-dimensional): Side slope Down-slope shape: Convex Across-slope shape: Linear Parent material: Loamy residuum weathered from metasedimentary rock **Properties and qualities** Slope: 30 to 50 percent Surface area covered with cobbles, stones or boulders: 0.1 percent Depth to restrictive feature: 40 to 60 inches to paralithic bedrock 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 6.6 inches) **Interpretive groups** Land capability (nonirrigated): 6e Other vegetative classification: Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7) **Typical profile** 0 to 6 inches: Channery loam 6 to 29 inches: Channery sandy clay loam 29 to 46 inches: Channery fine sandy loam 46 to 60 inches: Weathered bedrock **Minor Components** Minor soils Percent of map unit: 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: SnF—Snowbird loam, 30 to 95 percent slopes, stony. Map Unit Setting *Elevation:* 1,500 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Snowbird and similar soils:* 80 percent *Minor components:* 20 percent **Description of Snowbird Setting** *Landform:* Mountainsides *Landform position (three-dimensional):* Head slope *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:* Loamy residuum weathered from soft metasedimentary sandstone and siltstone **Properties and qualities** *Slope:* 30 to 95 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock *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:* High (about 9.1 inches) **Interpretive groups** *Land capability (nonirrigated):* 7e *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10) **Typical profile** *0 to 6 inches:* Loam *6 to 9 inches:* Sandy clay loam *9 to 37 inches:* Sandy clay loam *37 to 54 inches:* Very gravelly fine sandy loam *54 to 66 inches:* Weathered bedrock **Minor Components Minor soils** *Percent of map unit:* 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: SoD—Soco-Stecoah complex, 15 to 30 percent slopes, stony. Map Unit Setting *Elevation:* 990 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Soco and similar soils:* 50 percent *Stecoah and similar soils:* 35 percent *Minor components:* 15 percent **Description of Soco Setting** *Landform:* Ridges *Landform position (three-dimensional):* Lower third of mountainflank, side slope, crest *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum and/or creep deposits derived from metasedimentary rock **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock *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 5.4 inches) **Interpretive groups** *Land capability (nonirrigated):* 6e *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10) **Typical profile** *0 to 6 inches:* Channery loam *6 to 26 inches:* Fine sandy loam *26 to 37 inches:* Channery fine sandy loam *37 to 62 inches:* Weathered bedrock **Description of Stecoah Setting** *Landform:* Ridges *Landform position (three-dimensional):* Lower third of mountainflank, crest, side slope *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum and/or creep deposits derived from metasedimentary rock **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock *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:* Moderate (about 6.8 inches) **Interpretive groups** *Land capability (nonirrigated):* 6e *Other vegetative classification:* Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7) **Typical profile** *0 to 4 inches:* Channery loam *4 to 28 inches:* Channery loam *28 to 50 inches:* Channery loam *50 to 62 inches:* Weathered bedrock **Minor Components Minor soils** *Percent of map unit:* 15 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: SoF—Soco-Stecoah complex, 30 to 95 percent slopes, stony. Map Unit Setting *Elevation:* 990 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Soco and similar soils:* 50 percent *Stecoah and similar soils:* 30 percent *Minor components:* 20 percent **Description of Soco Setting** *Landform:* Mountainsides *Landform position (three-dimensional):* Lower third of mountainflank, side slope, crest *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum and/or creep deposits derived from metasedimentary rock **Properties and qualities** *Slope:* 30 to 95 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock *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 5.4 inches) **Interpretive groups** *Land capability (nonirrigated):* 7e *Other vegetative classification:* Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10) **Typical profile** *0 to 6 inches:* Channery loam *6 to 26 inches:* Fine sandy loam *26 to 37 inches:* Channery fine sandy loam *37 to 62 inches:* Weathered bedrock **Description of Stecoah Setting** *Landform:* Mountainsides *Landform position (three-dimensional):* Lower third of mountainflank, side slope, crest *Down-slope shape:* Convex *Across-slope shape:* Linear *Parent material:* Loamy residuum and/or creep deposits derived from metasedimentary rock **Properties and qualities** *Slope:* 30 to 95 percent *Surface area covered with cobbles, stones or boulders:* 0.1 percent *Depth to restrictive feature:* 40 to 60 inches to paralithic bedrock *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:* Moderate (about 6.8 inches) **Interpretive groups** *Land capability (nonirrigated):* 7e *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring

Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Soft Sandstone (Copperhill), mesic temperature rgime, rolling hills phase (Model 15) **Typical profile** *0 to 4 inches:* Channery loam *4 to 28 inches:* Channery loam *28 to 50 inches:* Channery loam *50 to 62 inches:* Weathered bedrock **Minor Components Minor soils** *Percent of map unit:* 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: SsD—Spivey-Santeetlah complex, 15 to 30 percent slopes, very stony. Map Unit Setting *Elevation:* 1,500 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Spivey and similar soils:* 50 percent *Santeetlah and similar soils:* 30 percent *Minor components:* 20 percent **Description of Spivey Setting** *Landform:* Coves *Landform position (three-dimensional):* Mountainbase, lower third of mountainflank *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:* Cobbly or stony colluvium derived from metasedimentary rock **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 2.0 percent *Depth to restrictive feature:* More than 80 inches *Drainage class:* Well 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 4.2 inches) **Interpretive groups** *Land capability (nonirrigated):* 7s *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Large basins of colluvium, mesic temperature regime (Model 11), Hard metasandstone (Thunderhead), mesic temperature regime (Model 6) **Typical profile** *0 to 13 inches:* Very bouldery sandy loam *13 to 45 inches:* Very bouldery fine sandy loam *45 to 48 inches:* Extremely bouldery sandy loam **Description of Santeetlah Setting** *Landform:* Coves *Landform position (three-dimensional):* Lower third of mountainflank, mountainbase *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:* Loamy colluvium derived from metasedimentary sandstone, slate, and phyllite **Properties and qualities** *Slope:* 15 to 30 percent *Surface area covered with cobbles, stones or boulders:* 2.0 percent *Depth to restrictive feature:* More than 80 inches *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* High (3.97 to 11.05 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water capacity:* High (about 9.9 inches) **Interpretive groups** *Land capability (nonirrigated):* 6e *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Large basins of colluvium, mesic temperature regime (Model 11), Hard metasandstone (Thunderhead), mesic temperature regime (Model 6) **Typical profile** *0 to 17 inches:* Loam *17 to 39 inches:* Loam *39 to 49 inches:* Channery loam*49 to 65 inches:* Very channery loam **Minor Components Minor soils** *Percent of map unit:* 20 percent

Great Smoky Mountains National Park, Tennessee and North Carolina: SsC—Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony. Map Unit Setting *Elevation:* 1,500 to 4,200 feet *Mean annual precipitation:* 48 to 65 inches *Mean annual air temperature:* 43 to 68 degrees F *Frost-free period:* 162 to 176 days **Map Unit Composition** *Spivey and similar soils:* 50 percent *Santeetlah and similar soils:* 25 percent *Nowhere and similar soils:* 15 percent *Minor components:* 10 percent **Description of Spivey Setting** *Landform:* Coves *Landform position (three-dimensional):* Mountainbase, lower third of mountainflank *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:*

Cobbly or stony colluvium derived from metasedimentary rock **Properties and qualities** *Slope:* 8 to 15 percent *Surface area covered with cobbles, stones or boulders:* 2.0 percent *Depth to restrictive feature:* More than 80 inches *Drainage class:* Well 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 4.2 inches) **Interpretive groups** *Land capability (nonirrigated):* 7s *Other vegetative classification:* Hard metasandstone (Thunderhead), mesic temperature regime (Model 6), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Large basins of colluvium, mesic temperature regime (Model 11) **Typical profile** *0 to 13 inches:* Very bouldery sandy loam *13 to 45 inches:* Very bouldery fine sandy loam *45 to 48 inches:* Extremely bouldery sandy loam **Description of Santeetlah Setting** *Landform:* Coves *Landform position (three-dimensional):* Lower third of mountainflank, mountainbase *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:* Loamy colluvium derived from metasedimentary sandstone, slate, and phyllite **Properties and qualities** *Slope:* 8 to 15 percent *Surface area covered with cobbles, stones or boulders:* 2.0 percent *Depth to restrictive feature:* More than 80 inches *Drainage class:* Well drained *Capacity of the most limiting layer to transmit water (Ksat):* High (3.97 to 11.05 in/hr) *Depth to water table:* More than 80 inches *requency of flooding:* None *Frequency of ponding:* None *Available water capacity:* High (about 9.9 inches) **Interpretive groups** *Land capability (nonirrigated):* 4e *Other vegetative classification:* Large basins of colluvium, mesic temperature regime (Model 11), Hard metasandstone (Thunderhead), mesic temperature regime (Model 6), Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10) **Typical profile** *0 to 17 inches:* Loam *17 to 39 inches:* Loam *39 to 49 inches:* Channery loam *49 to 65 inches:* Very channery loam **Description of Nowhere Setting** *Landform:* Coves *Down-slope shape:* Concave *Across-slope shape:* Concave *Parent material:* Cobbly colluvium derived from metasedimentary rock **Properties and qualities** *Slope:* 8 to 15 percent *Surface area covered with cobbles, stones or boulders:* 2.0 percent *Depth to restrictive feature:* More than 80 inches *Drainage class:* Somewhat poorly drained *Capacity of the most limiting layer to transmit water (Ksat):* High (1.98 to 5.95 in/hr) *Depth to water table:* About 6 to 16 inches *Frequency of flooding:* None *Frequency of ponding:* Occasional *Available water capacity:* Moderate (about 6.3 inches) **Interpretive groups** *Land capability (nonirrigated):* 7w *Other vegetative classification:* Soft metasandstone (Copper Hill, Roaring Fork, Elkmont, Wading Branch, Longarm, and Wehutty Metasandstone), mesic temperature regime. (Model 7), Siltstone and phyllite (Pigeon Siltstone and Phyllite), mesic temperature regime (Model 10), Large basins of colluvium, mesic temperature regime (Model 11), Hard metasandstone (Thunderhead), mesic temperature regime (Model 6) **Typical profile** *0 to 16 inches:* Very cobbly fine sandy loam *16 to 28 inches:* Extremely cobbly fine sandy loam *28 to 62 inches:* Extremely cobbly fine sandy loam **Minor Components Minor soils** *Percent of map unit:* 10 percent

5.2.2 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 50). 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 50).

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 50), 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.

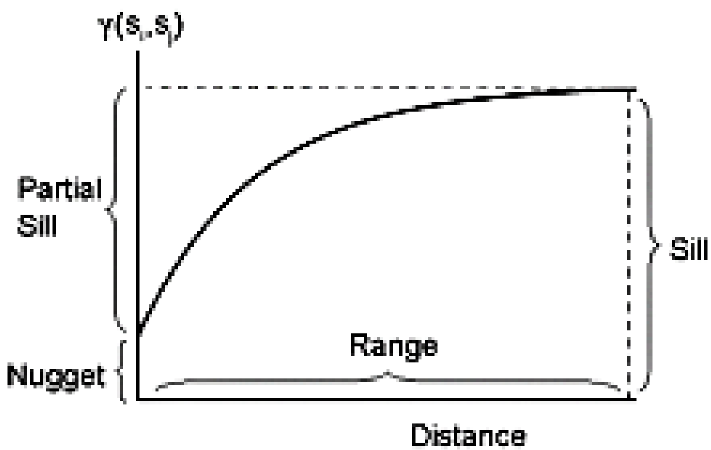


Figure 50. Example semivariogram, depicting range, sill, and nugget.

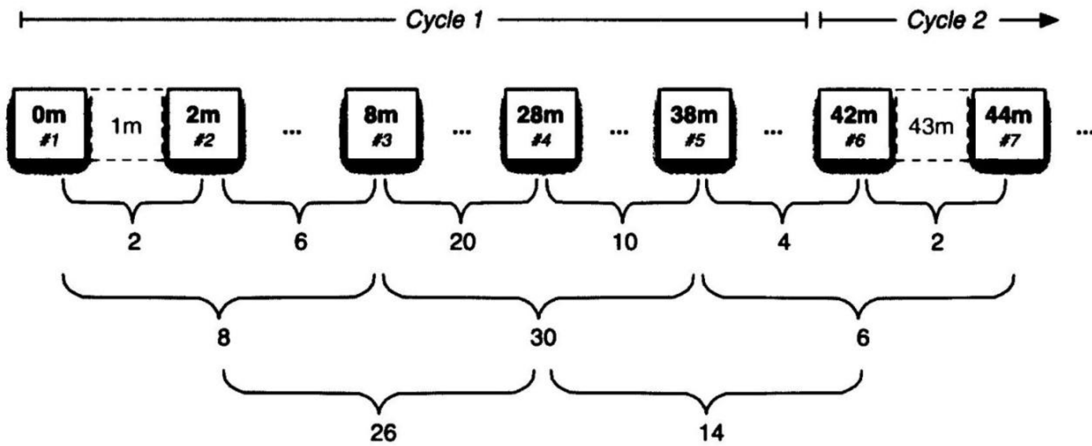


Figure 51. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 20-21 April 2010 at the Great Smoky site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 51). Soil temperature and moisture measurements were collected along three transects (168 m, 84 m, and 84 m) located in the expected airshed at Great Smoky. 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 51, 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. Trends relating to elevation, aspect, and slope were alse removed when significant ($p < 0.05$). 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).

5.2.3 Results and interpretation

5.2.3.1 Soil Temperature

After accounting for changes in temperature in the stationary data, any remaining time of day trend, and trends relating to aspect and slope, soil temperature data residuals were used for the semivariogram analysis (Figure 52). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 53, left graph) and directional semivariograms do not show anisotropy (Figure 53, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 53, right graph). The model indicates a distance of effective independence of 70 m for soil temperature.

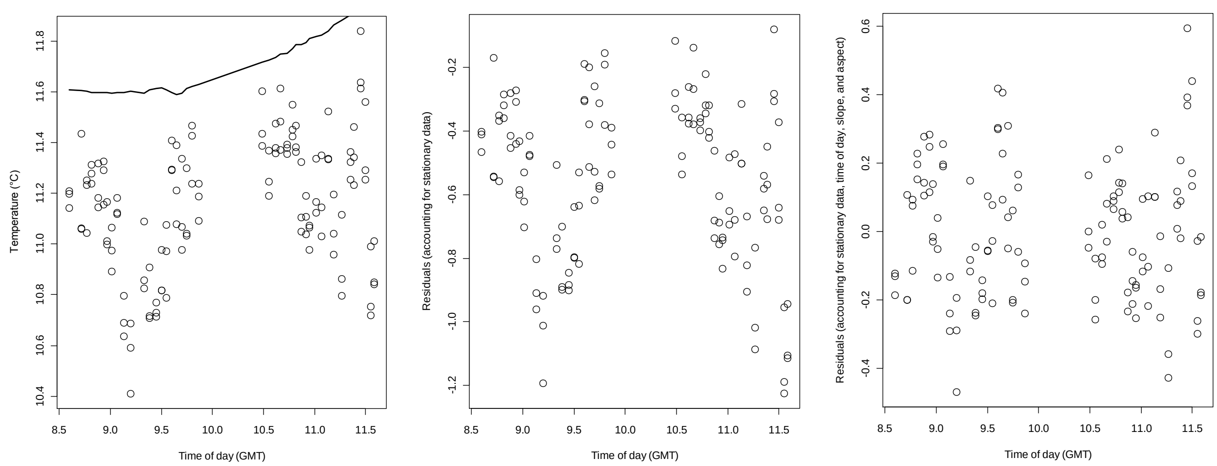


Figure 52. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

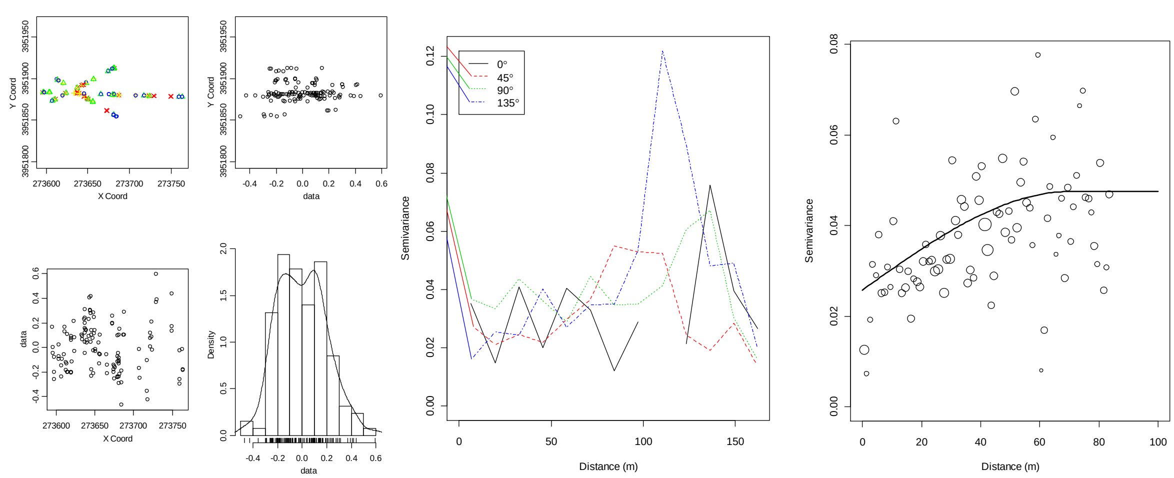


Figure 53. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

5.2.3.2 Soil water content

After accounting for changes in water content in the stationary data, any remaining time of day trend, and trends relating to elevation, aspect, and slope, soil water content data residuals were used for the semivariogram analysis (Figure 54). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 55, left graph) and directional semivariograms do not show anisotropy (Figure 55, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 55, right graph). The model indicates a distance of effective independence of >80 m for soil water content.

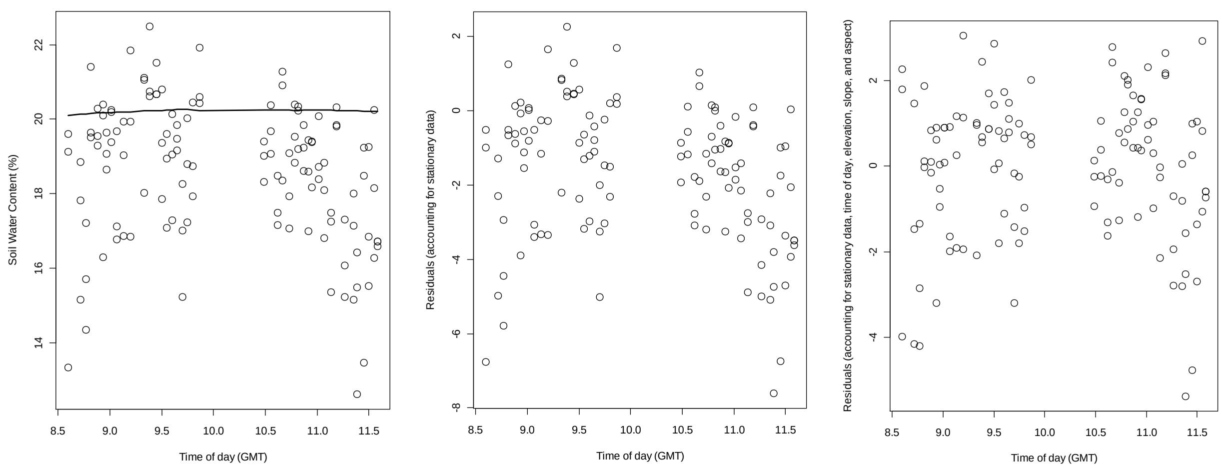


Figure 54. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting 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.

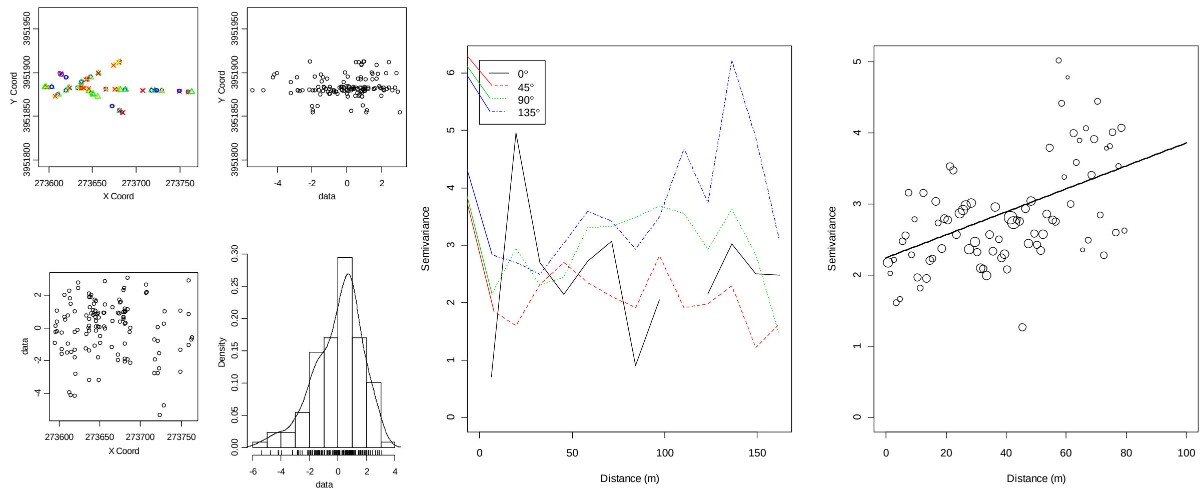


Figure 55. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

5.2.3.3 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 >80 m for soil moisture. Based on these results and the site design guidelines the soil plots at Great Smoky shall be placed 40 m apart. Due to the limited area of land that the landowner would permit instrumenting the soil array does not follow any of the predefined patterns for a soil array. Instead the latitude and longitude is presented for each soil plot (see table below). The soil plots shall be 5 m x 5 m. The exact location of each soil plot may be microsited 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 35.687624°, -83.500381° (primary location); or 35.687965°, -83.500045° (alternate location 1 if primary location is unsuitable); or 35.688301°, -83.499678° (alternate location 2 if primary location is unsuitable). Unfortunately, the soil pit locations were picked using Google Earth and it was difficult to determine exactly how far they are from the road (i.e., ± a few meters). Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it. We fully expect that these soil pit locations will move based on input from the Great Smoky Mtn NP staff. Moreover, we do not know the boundaries of the conditional use area to best place the soil pits. It may be best to place them along the access path to the tower site itself.

A summary of the soil information is shown in Table 20 and site layout can be seen in Figure 56.

Dominant soil series at the site: Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony. The taxonomy of this soil is shown below:

Order: Inceptisols
Suborder: Udepts- Aquepts
Great group: Humudepts- Humaquepts
Subgroup: Typic Humudepts- Typic Humaquepts
Family: Loamy-skeletal, isotic, mesic Typic Humudepts- Fine-loamy, isotic, mesic Typic Humudepts- Loamy-skeletal, isotic, acid, mesic Typic Humaquepts
Series: Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony

Table 20. Summary of soil array and soil pit information at Great Smoky. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	NA (non-standard pattern)
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	25 m
Latitude and longitude of soil plot 1	35.688804, -83.502149
Latitude and longitude of soil plot 2	35.689193, -83.502304
Latitude and longitude of soil plot 3	35.689318, -83.501828
Latitude and longitude of soil plot 4	35.688930, -83.501672
Latitude and longitude of soil plot 5	35.688544, -83.501518
Direction of soil array	NA (non-standard design)
Latitude and longitude of FIU soil pit 1	35.687624°, -83.500381° (primary location)[~]
Latitude and longitude of FIU soil pit 2	35.687965°, -83.500045° (alternate 1)[~]
Latitude and longitude of FIU soil pit 3	35.688301°, -83.499678° (alternate 2)[~]
Dominant soil type	Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony
Expected soil depth	>2 m
Depth to water table	0.15 to >2 m

Expected depth of soil horizons	**Expected measurement depths**[*]
0-0.33 m (Very bouldery sandy loam)	0.17 m[†]
0.33-1.14 m (Very bouldery fine sandy loam)	0.74 m[†]
1.14-1.22 m (Extremely bouldery sandy loam)	1.18 m[†]
1.22 m-2.00 m[§]	1.61 m
2 m	2 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.
[§]Soil description not available at this depth
[†]Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)
[~]Soil pit locations were picked using Google Earth and it was difficult to determine how far they are from the road. Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it.

Figure 56. Site layout at Great Smoky showing soil array and location of the FIU soil pit.

5.3 Airshed

5.3.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figures 58-61. The weather data used to generate the following wind roses are from Franklin Airport, TN (35.223, -83.419), which is ~52 km South of NEON Relocatable site at GSMNP Relocatable site. Because of the complexity of the mountain terrain, the wind pattern at this airport is like not representative the wind patterns at NEON tower location. But, no other wind data at tower location or within a reasonable distance to tower location is available to represent this site by the time this report is written. Therefore, the wind roses presented here is just for reference. Further wind pattern analysis need to be done after NEON tower is established and collects wind data more than a year. By examining the terrain map, it is likely that wind mainly blows from southeast and northwest direction due to the local terrain and valley landscape (see Figure 57 below). We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes. 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. Color bands depict the range of wind speeds. 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.

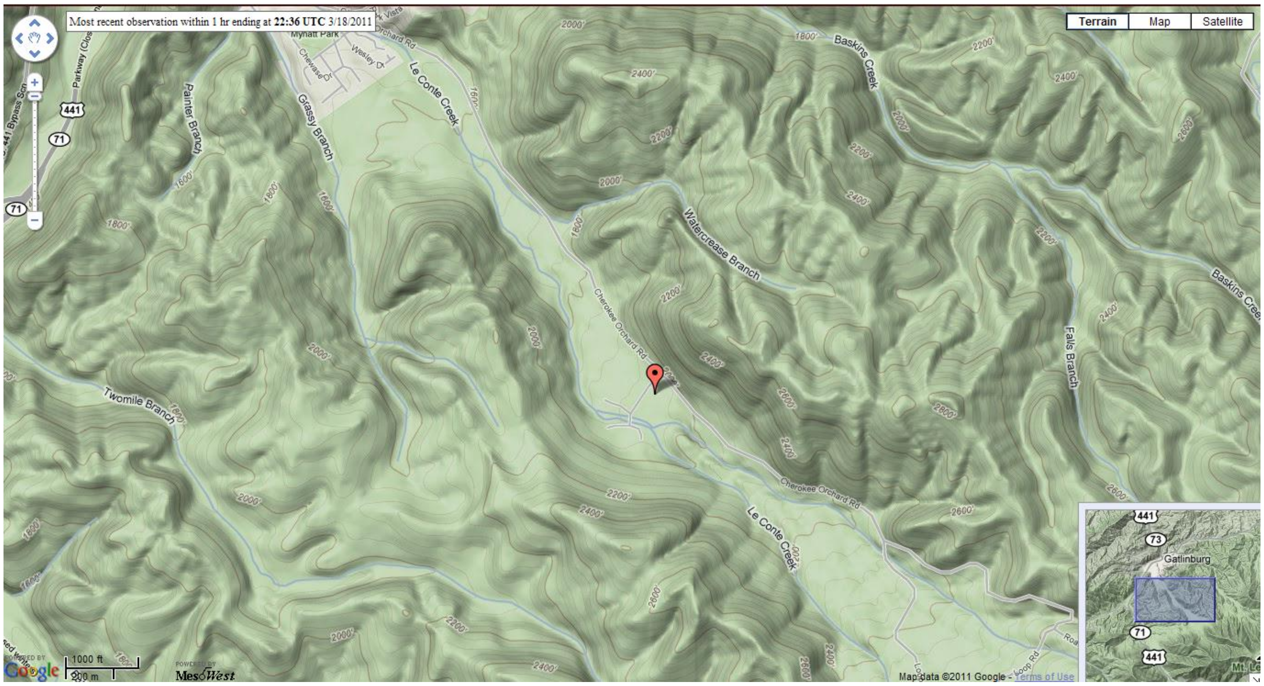


Figure 57. Terrain map for NEON alternative tower location and surrounding area

5.3.2 Results (graphs for wind roses)

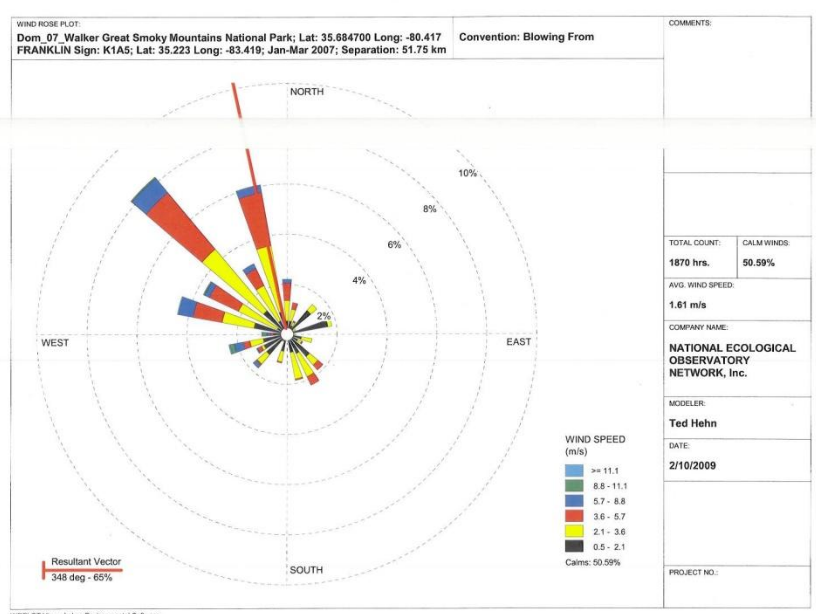


Figure 58. Windroses of January – March for D07 GSMNP Relocatable site.

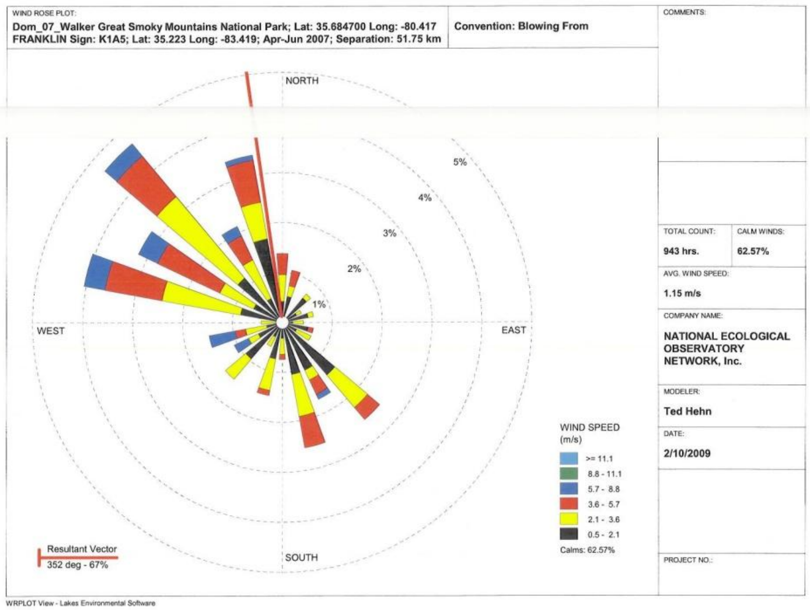


Figure 59. Windroses of April – June for D07 GSMNP Relocatable site.

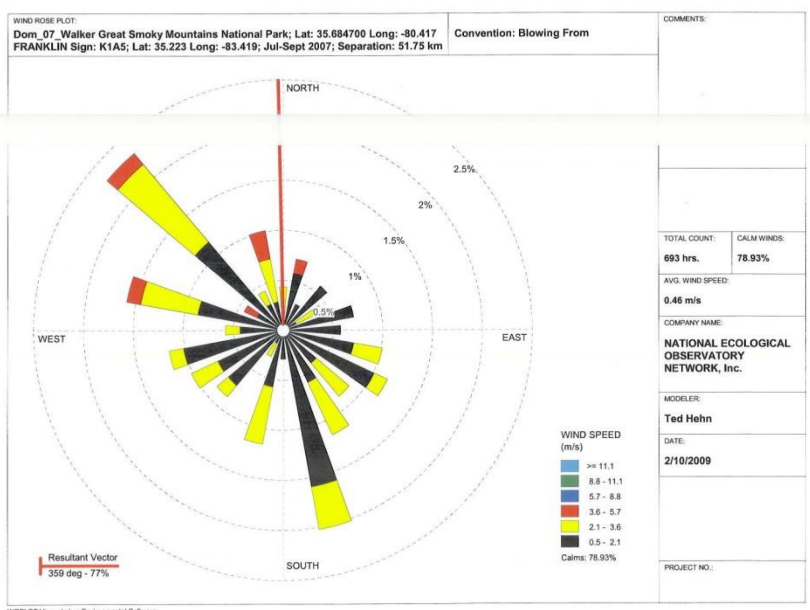


Figure 60. Windroses of July – September for D07 GSMNP Relocatable site.

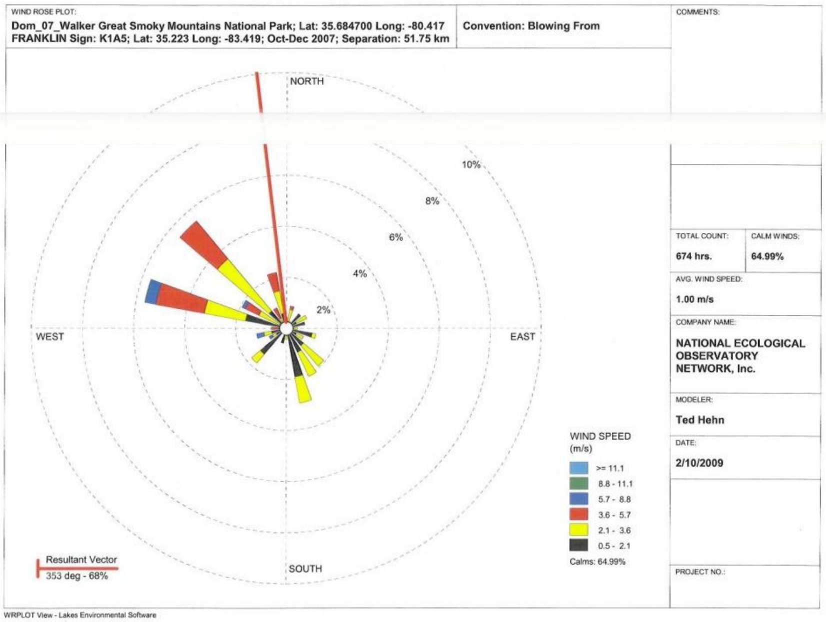


Figure 61. Windroses of October – December for D07 GSMNP Relocatable site.

5.3.3 Resultant vectors

Table 21. The resultant wind vectors from D07 GSMNP Relocatable site based on the windroses above

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	348°	65
April to June	352°	67
July to September	359°	77
October to December	353°	68
Annual mean	353°	na.

5.3.4 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, with support from Dr R. Clement, we use a web-based footprint model that made by Micrometeorology Group at University of Edinburgh, UK 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 22. Expected environmental controls to parameterize the source area model, and associated results from D07 GSMNP alternative 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	38	38	38	38	38	38	m
Canopy Height	28	28	28	28	28	28	m
Canopy area density	5	5	5	2.5	2.5	2.5	m
Boundary layer depth	1801	1801	701	901	901	501	m
Expected sensible heat flux	351	351	50	125	125	31	W m^{-2}
Air Temperature	27	27	20	11	11	3	°C
Max. windspeed	5.8	2.6	0.6	11.2	3.6	1.0	m s^{-1}
Resultant wind vector	316	316	165	316	316	316	degrees
Results							
(z-d)/L	-0.07	-0.32	-0.50	0.00	-0.09	-0.28	m

d	23	23	23	22	22	22	m
Sigma v	2.40	1.90	0.77	3.70	1.60	0.71	$m^2\ s^{-2}$
Z0	0.99	0.99	0.99	1.40	1.40	1.40	m
u*	0.94	0.56	0.25	1.80	0.65	0.28	$m\ s^{-1}$
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	700	300	120	800	600	230	m
Distance of 80% cumulative flux	300	200	90	480	350	180	m
Distance of 70% cumulative flux	250	150	60	400	250	120	m
Peak contribution	55	35	15	65	55	25	m

‡: Model was run based on the wind info extracted from wind roses above. The actual model outputs may be different at the tower location. But currently no wind data from tower location are available for actual assessment.

5.3.5 Footprint model results (source area graphs)

Graphs below were outputted from footprint model based on the wind info extracted from wind roses above. The actual footprint outputs may be different at the tower location. But currently no wind data from tower location are available for actual assessment.

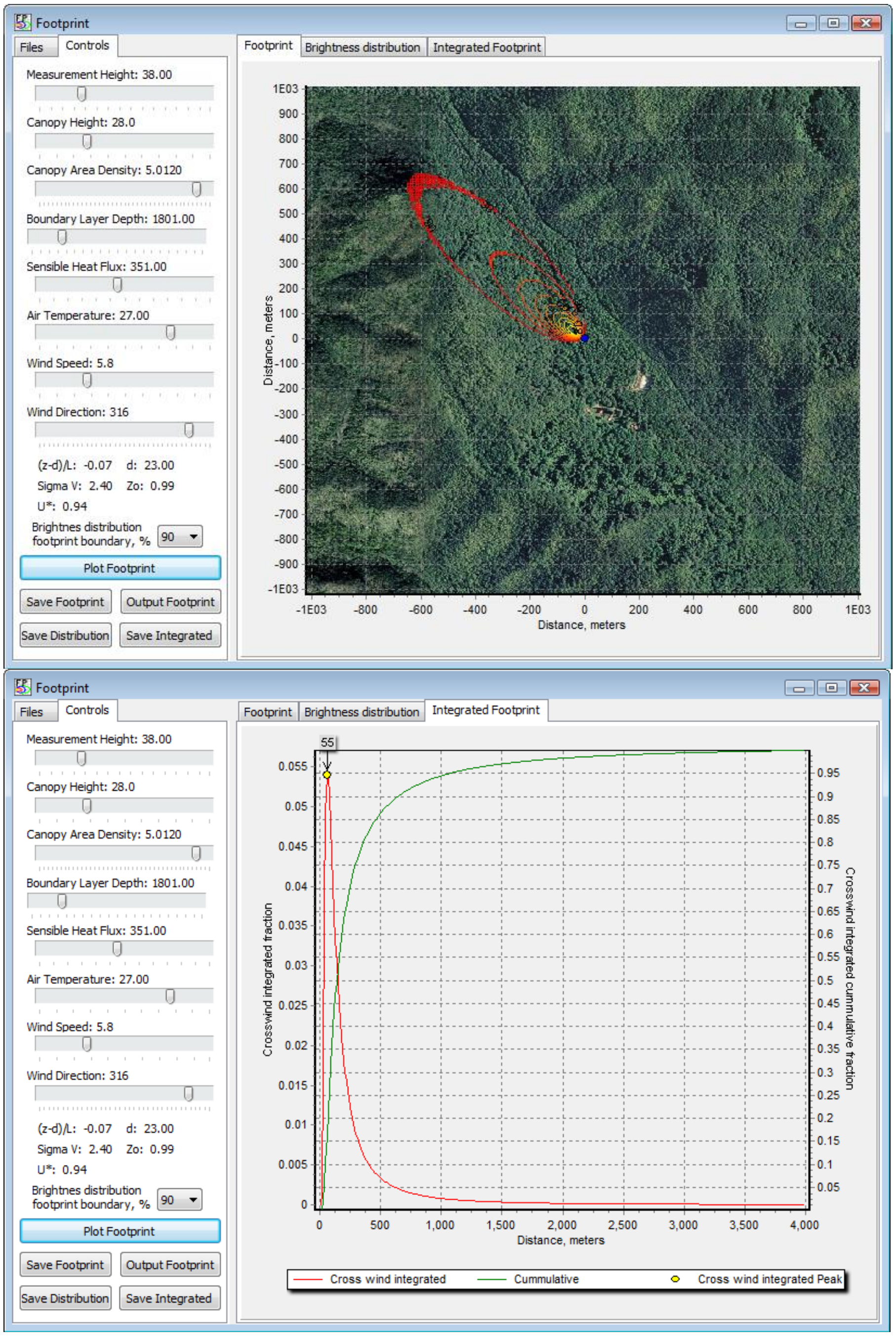


Figure 62. D07 GSMNP alternative site summer daytime (convective) footprint output with max wind speed.

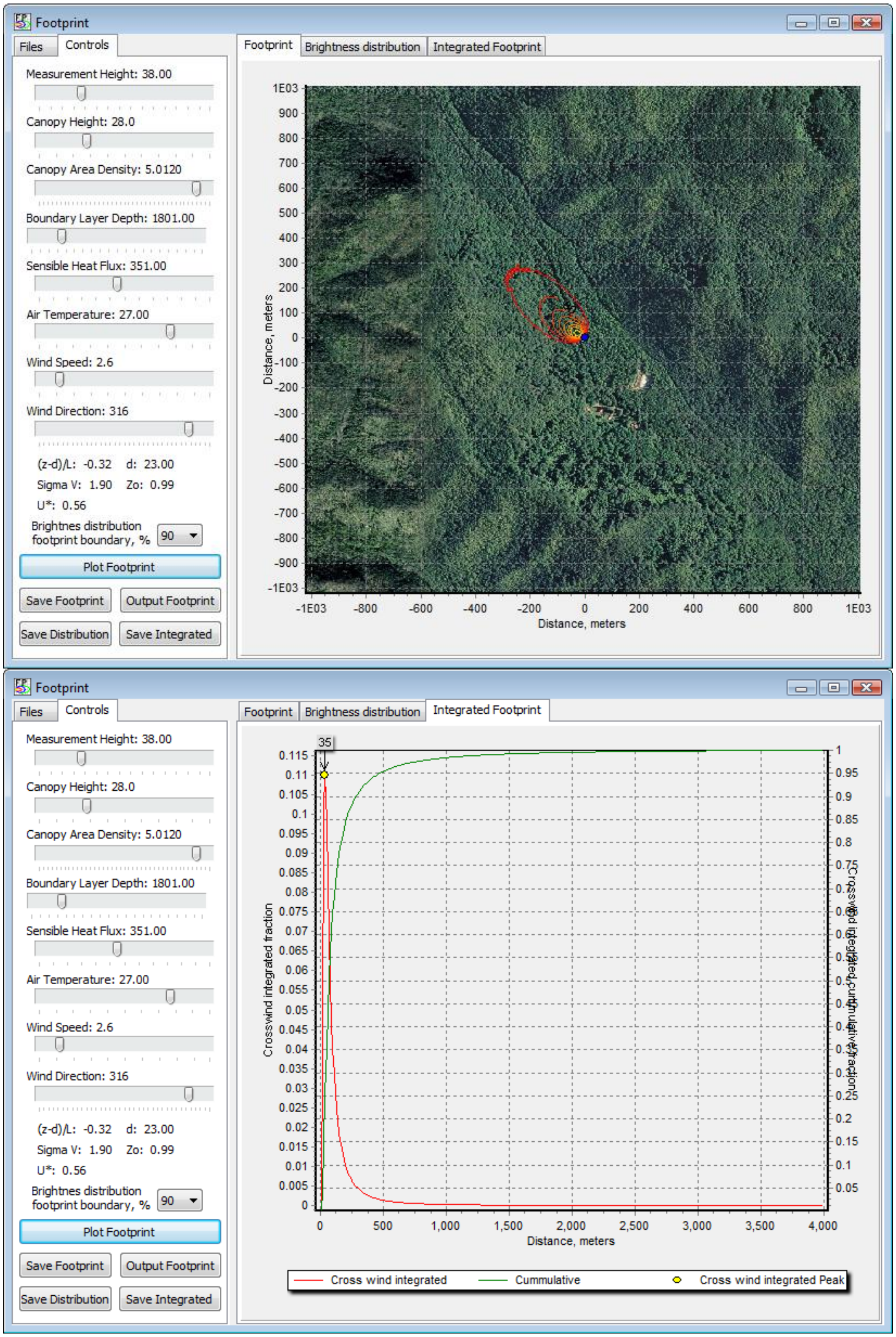


Figure 63. D07 GSMNP alternative site summer daytime (convective) footprint output with mean wind speed.

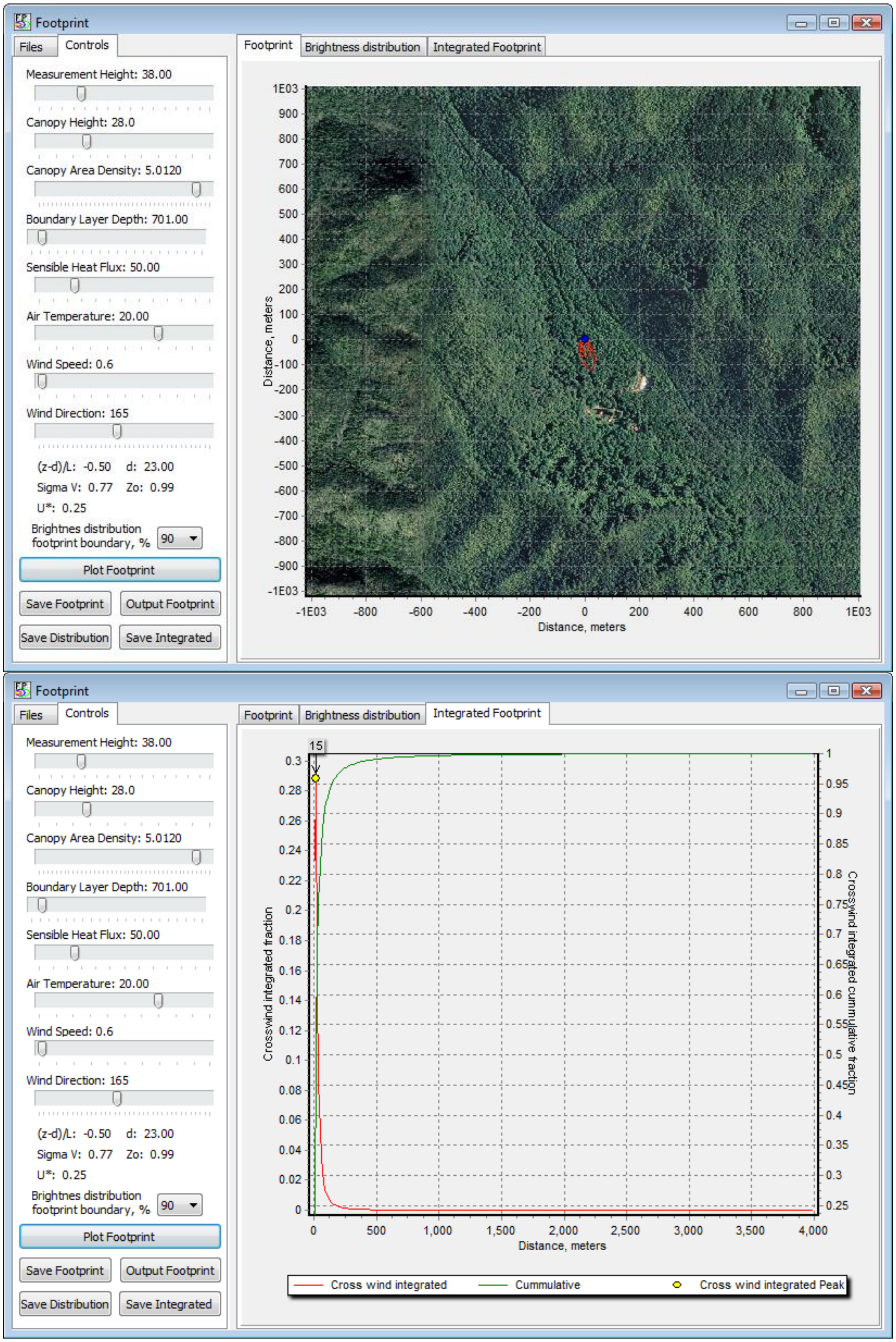


Figure 64. D07 GSMNP alternative site summer nighttime (stable) footprint output with mean wind speed.

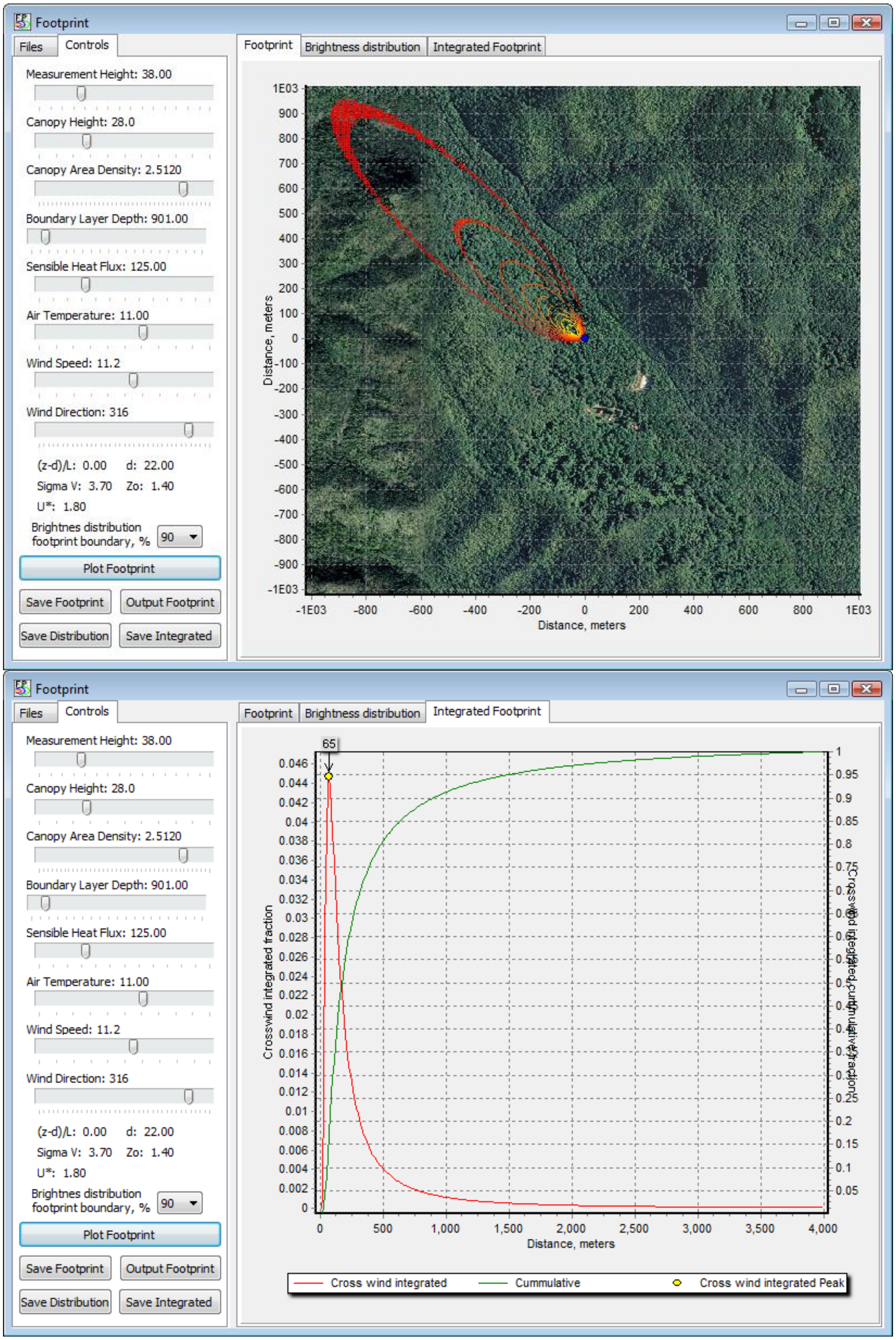


Figure 65. D07 GSMNP alternative site winter daytime (convective) footprint output with max wind speed.

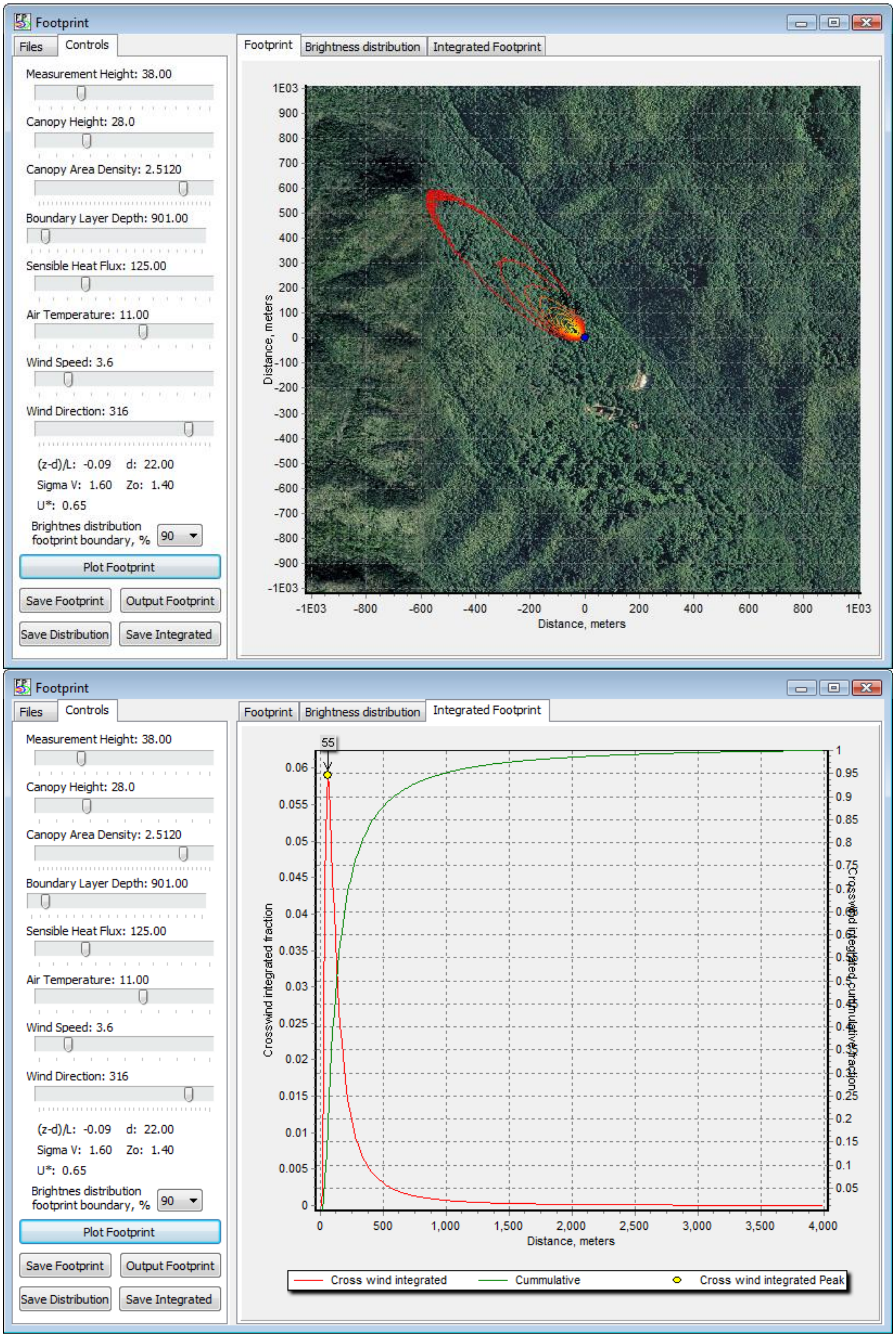


Figure 66. D07 GSMNP alternative site winter daytime (convective) footprint output with mean wind speed.

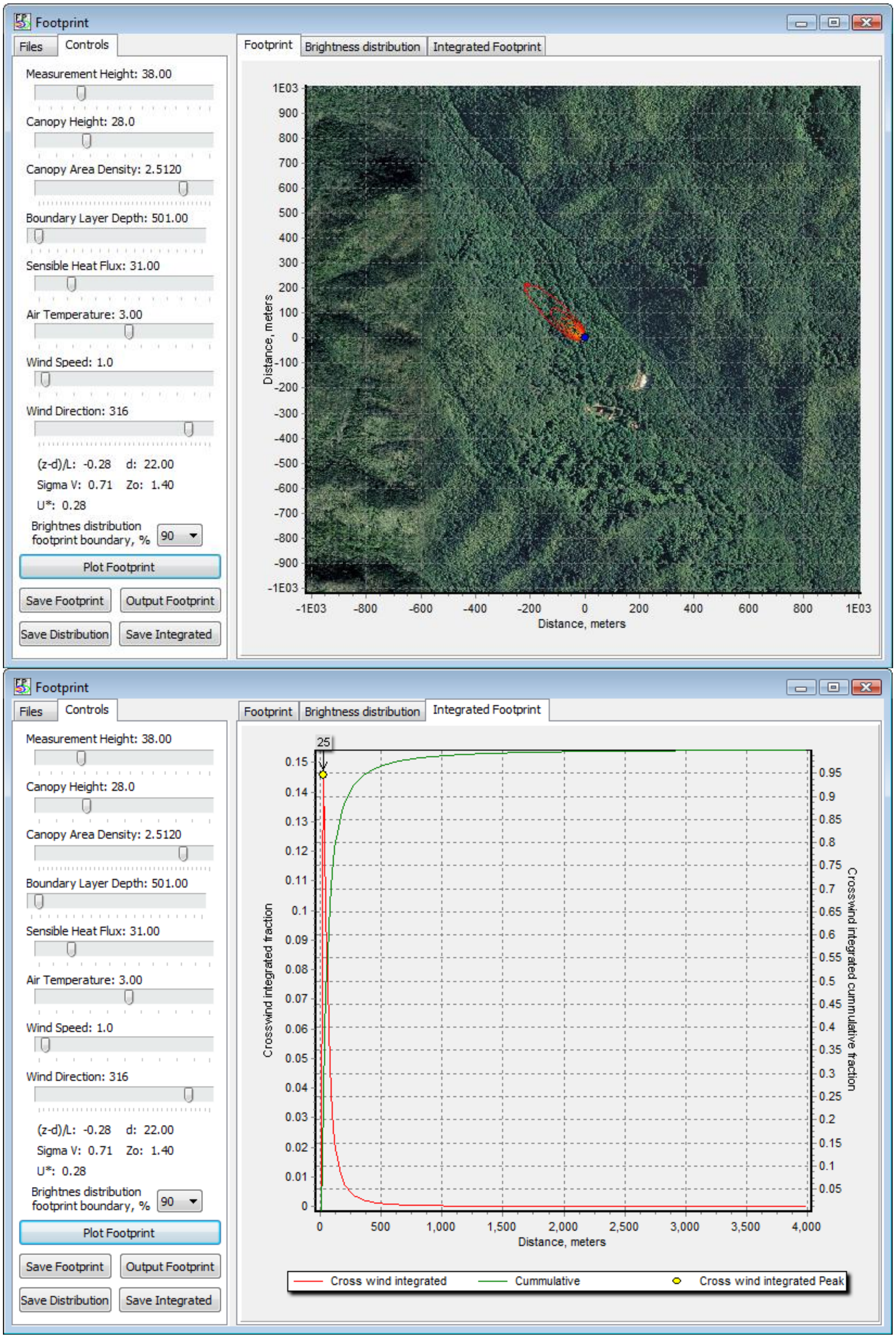


Figure 67. D07 GSMNP alternative site winter nighttime (stable) footprint output with mean wind speed.

5.4 Site design and tower attributes

According to windroses from Franklin Airport, TN (~52 km South of NEON Relocatable site at GSMNP), the prevailing wind direction blows from northwest (280^o to 350^o clockwise from 280^o, major airshed) or from south (100^o to 260^o clockwise from 100^o, secondary airshed) throughout the year. However, because of the complexity of the mountain terrain, the wind pattern at this airport is like not representative for the wind patterns at NEON tower location. But, no other wind data at tower location or within a reasonable distance to tower location is available to represent this site by the time this report is written. Further wind pattern analysis will be needed after NEON tower is established and collects wind data more than a year. By examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140^o-320^o. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes. After rounds of discussion and negotiation with Great Smoky Mountain National Park and site visits, **tower location** was determined to be at 35.68896, -83.50195. An existing tower is currently on this location, but will be decommissioned prior to the establishment of NEON tower. Exact nature and timing of its removal will be discussed with the park service.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture most undistorted 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 east side of tower and have the longer side parallel to NW-SE direction. Therefore, we require the placement of instrument hut at 35.689050, -83.502080. Because there is a public access and a picnic area nearby, the National park would like to have an interpretation platform near NEON tower with interpretive signage (that would have a cursory gate to stop foot traffic) for education purposes. This would also stop foot traffic from entering the immediate research area around the tower site. If this occurs, we suggest this platform to be located at 35.68864, -83.50224, which is ~45 m away from tower.

The ecosystem around the tower and in the airshed is closed-canopy hardwood deciduous forest. Canopy height is ~30 m. Lowest branch is about 15 m above ground. Seedlings and saplings are abundant and form understory, which varies from 1 m to 15 m without obvious strata. Understory on floor level is diverse with height ~0.5 m. We require 6 **measurement layers** on the tower with top measurement height at 45 m, and rest layers are 34 m, 25 m, 16 m, 7 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile through forest.

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 23. Site design and tower attributes for the GSMNP alternative Relocatable tower site.

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

Attribute	lat	long	degree	meters	notes
Airshed			Wind mainly blows from SE and NW approximately along the valley line of 140°-320°.		No local wind data available to define the major airshed boundary. Nighttime drainage flows from S, SW and E along the mountain slopes are also expected.
Tower location	35.68896,	-83.50195	--	--	new site
Instrument hut	35.68905,	-83.50208			
Instrument hut orientation vector	--	--	135°- 315°		longwise
Instrument hut distance z	--	--	--	16	
Anemometer/Temperature boom orientation	--	--	230°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				7.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				25.0	m.a.g.l.
Level 5				34.0	m.a.g.l.
Level 6				45.0	m.a.g.l.
Tower Height				45.0	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 68. Site layout for GSMNP alternative Relocatable site

i) new tower location is presented (Red pin), ii) Airshed boundary lines are not presented. Prevailing winds blow from SE and NW approximately along the valley line of 140^o-320^o. But no local wind data available to define the exact airshed boundary iii) Yellow line is the suggested access road to instrument hut.

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

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 this Relocatable site:

- Gravel path from access point to the interpretation platform (if built)
- Well-defined marked path from the interpretation platform to instrument hut
- Boardwalk from the instrument hut to the tower and intersect tower on north face
- Marked path to the soil array
- No boardwalk or marked path to the individual soil plots

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

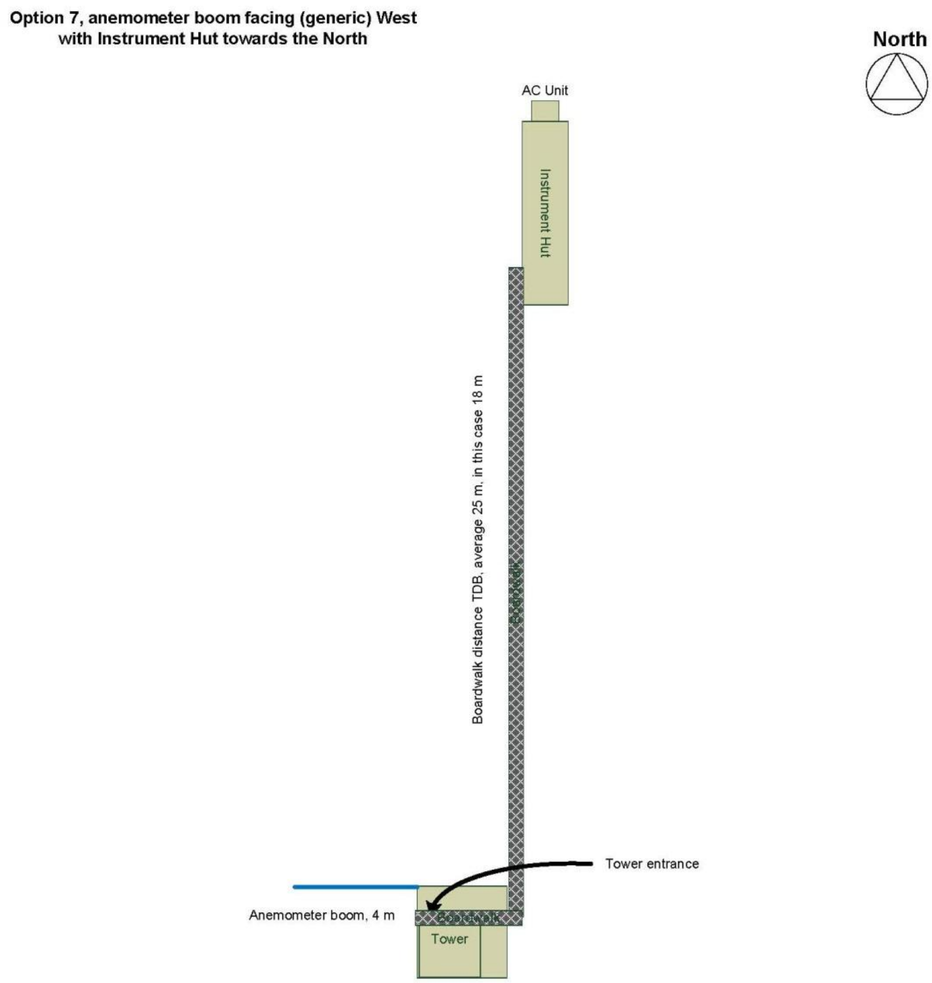


Figure 20. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the north towards the tower.

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 this site, the boom angle will be 230 degrees, instrument hut location is on the northwest toward tower, the distance between instrument hut and tower is 16 m. The instrument hut vector will be SE-NW (135^o-315^o, longwise).

5.5 Information for ecosystem productivity plots

We do not have good wind data for this site to define the airshed area with high confidence. However, by examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140^o-320^o due to the local terrain and valley landscape. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes. The tower at GSMNP relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially for the most undistorted signals. 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots be placed on the southeast and northwest areas of tower.

5.6 Issues and attentions

Weather data used for the windroses in this report are from Franklin Airport, TN (~52 km South of NEON Relocatable site at GSMNP). However, because of the complexity of the mountain terrain, the wind pattern at this airport is likely not representative for the wind patterns at NEON tower location. But, no other wind data at tower location or within a reasonable distance to tower location is available to represent this site by the time this report is written. Further wind pattern analysis will be needed after NEON tower is established and collects wind data more than a year. By examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140^o-320^o. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes.

Tower location is in a valley at the foothill of large steep mountain slopes. Cold air drainage expected here, and likely will cause additional uncertainties in FIU data products. In addition, the GSMNPS building is within tower airshed (~250 m away). Wind will likely pick up the signals from those buildings and parking lot prior to reaching tower when wind blows from southeast.

This site is one of the sites that are designed to monitor the atmospheric chemistry and then scale to up to the region and continent. Because tower locates at the mountain foothill and wind is channeled by the valley, instead of being representative for the whole region, the atmospheric chemicals collected at the location will be mainly from the city of Gatlinburg, which is located on the NW toward tower for ~1.6 miles—making this a non-ideal location of atmospheric chemistry

Because of the complex landscape, valley terrain and large steep mountain slopes, it will be challenge to interpret the flux signals collected at the tower top. Therefore, science goals about atmospheric chemistry and flux measurements may have additional uncertainties at this site

An existing tower structure is currently at our tower location. National park will take it down prior the establishment of NEON tower. Exact nature and timing of its removal will be discussed with the park service.

Soil pit locations were picked using Google Earth and it was difficult to determine exactly how far they are from the road. Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it. We fully expect that these soil pit locations will move based on input from the Great Smoky Mtn NP staff. Moreover, we do not know the boundaries of the conditional use area to best place the soil pits. It may be best to place them along the access path to the tower site itself.

The land owner/representative stated during the site visit that NEON infrastructure had to be placed with a small area around the tower location, because this is located in an existing 'condition use' area. The exact size and shape of the area was undefined, but it is likely to be on the scale of tens of meters, not hundreds of meters. As a result, all of the soil plots could not be placed within the expected tower airshed, which will reduce the linkages between information collected at soil plots and information collected at the tower. Nonetheless, the ecosystem structure at the soil plot locations is similar to the ecosystem structure at the tower site and in the expected airshed, therefore, this is not expected to substantially impact science at this site.

It is very rocky around tower site and location of the soil pits. In addition, it was difficult to see exactly where roads and paths were using Google Earth. As a result, it is possible that soil plots and soil pits will have to be micrposited in order to avoid being too close to paths/roads or being located on rocky outcrops.

While selecting locations to place soil plots and soil pits, we were sensitive to National Park concerns in relation to minimizing disturbance and visibility, while also meeting our science goals. We expect to receive feedback from the National Park about the location of the soil plots and soil pits and we will work with the Park to ensure that their concerns at addressed while also meeting our science goals.

6 APPENDIX A. CONCEPTUAL DESIGN LAYOUT OF SOIL ARRAY PATTERNS.

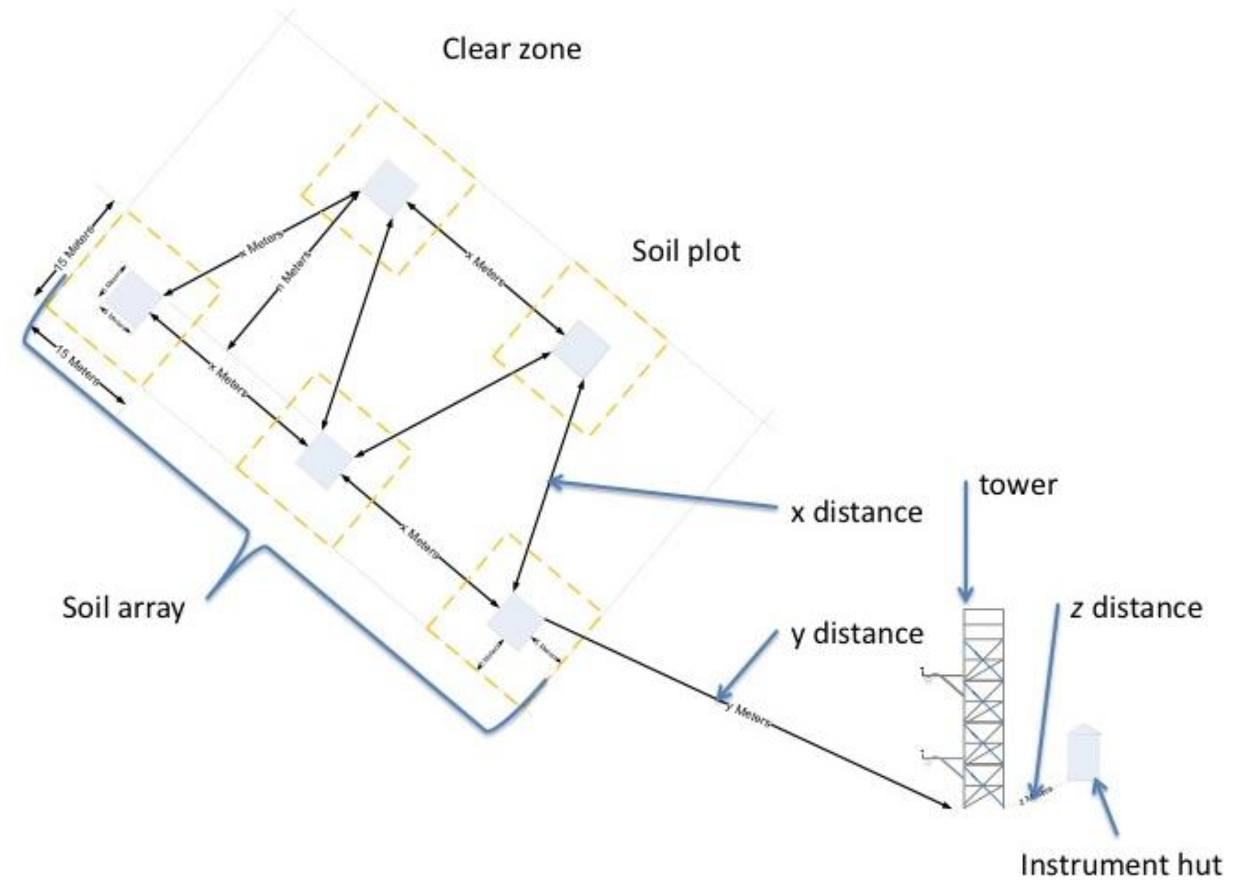


Figure A1. Conceptual diagram of Soil Array Pattern A

Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

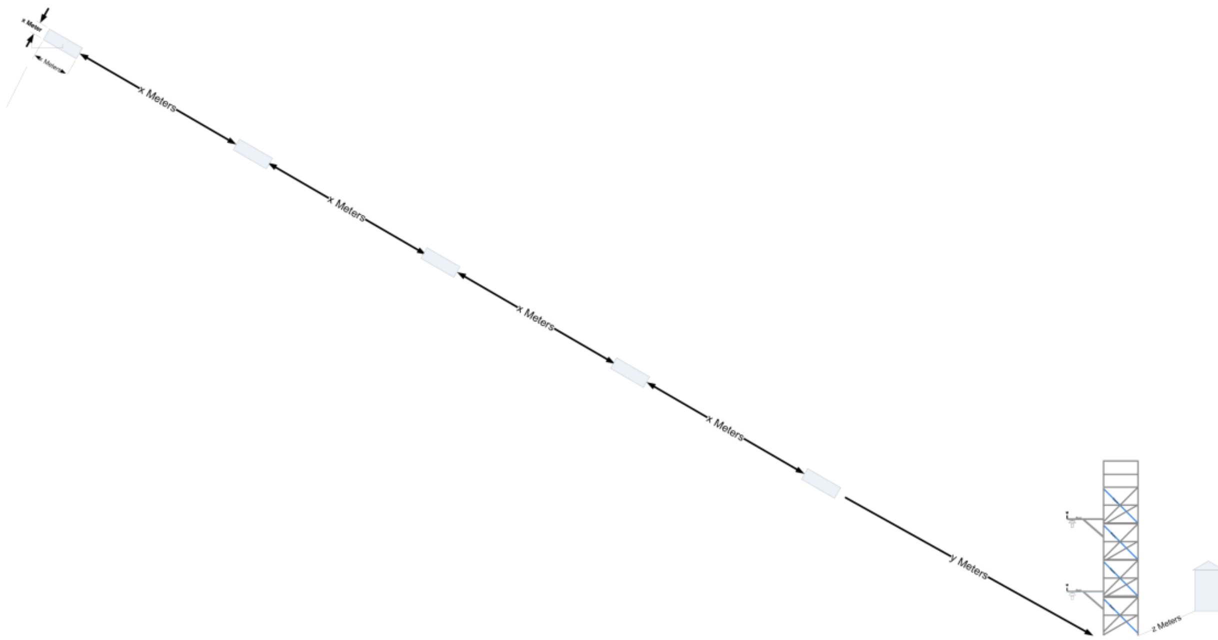


Figure A2. Conceptual diagram of Soil Array Pattern B
Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

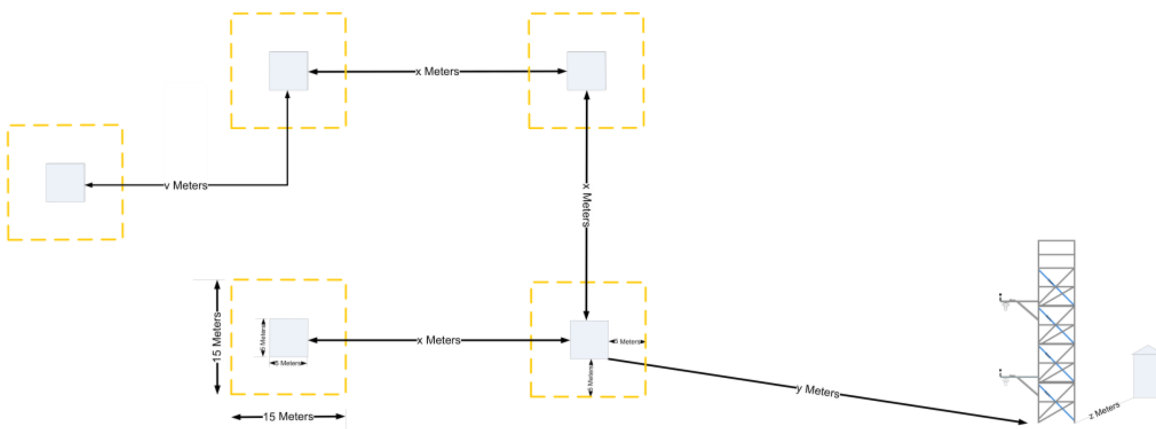
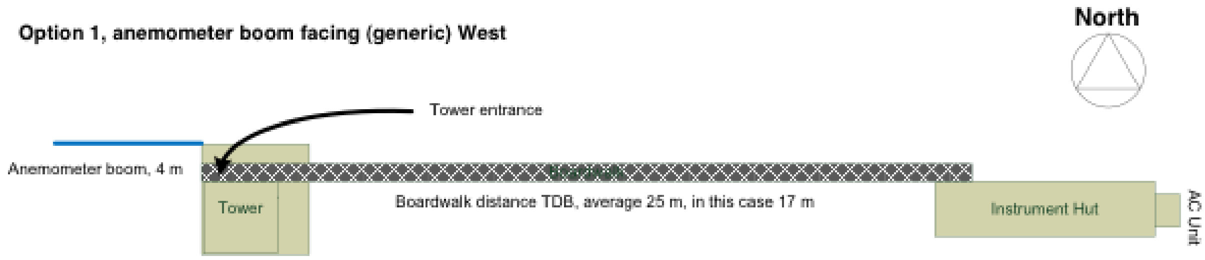
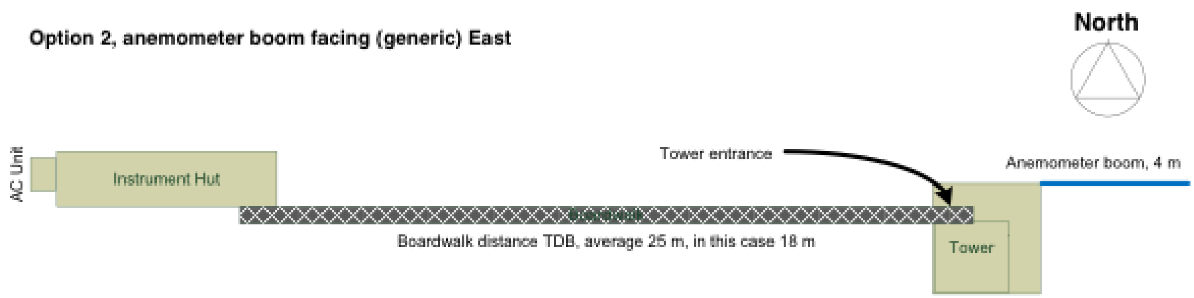
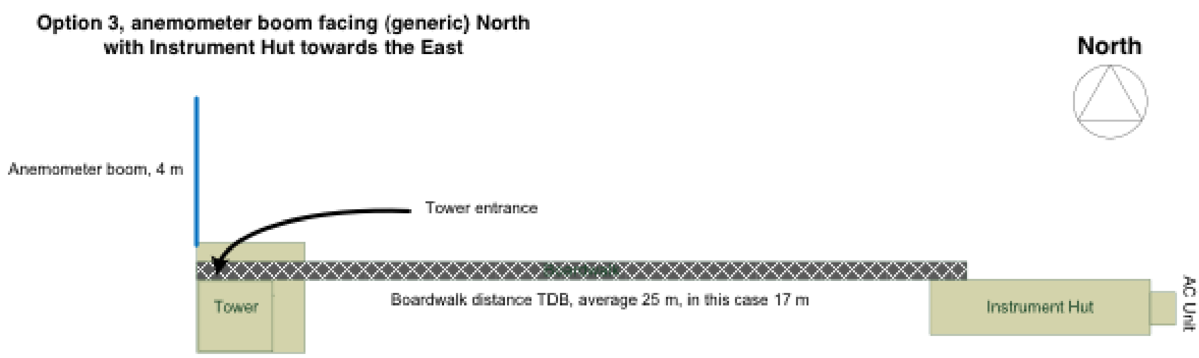


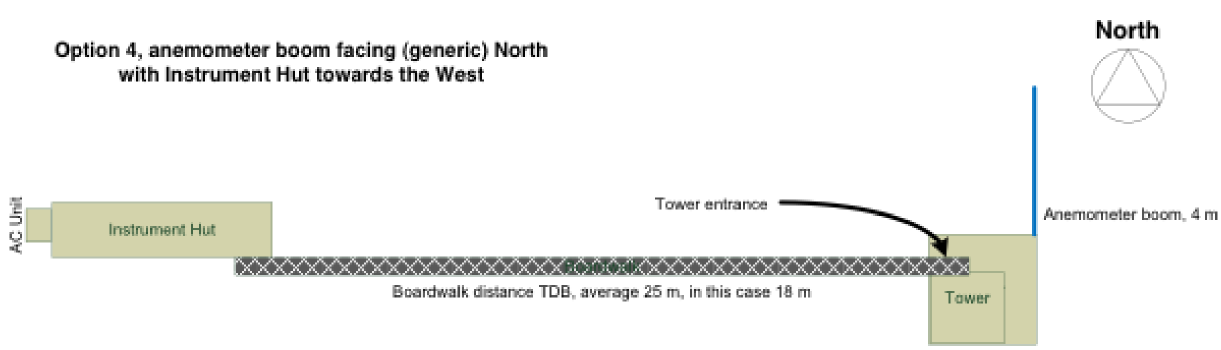
Figure A3. Conceptual diagram of Soil Array Pattern C
Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

7 APPENDIX B. CONCEPTUAL BOARDWALK CONFIGURATION.









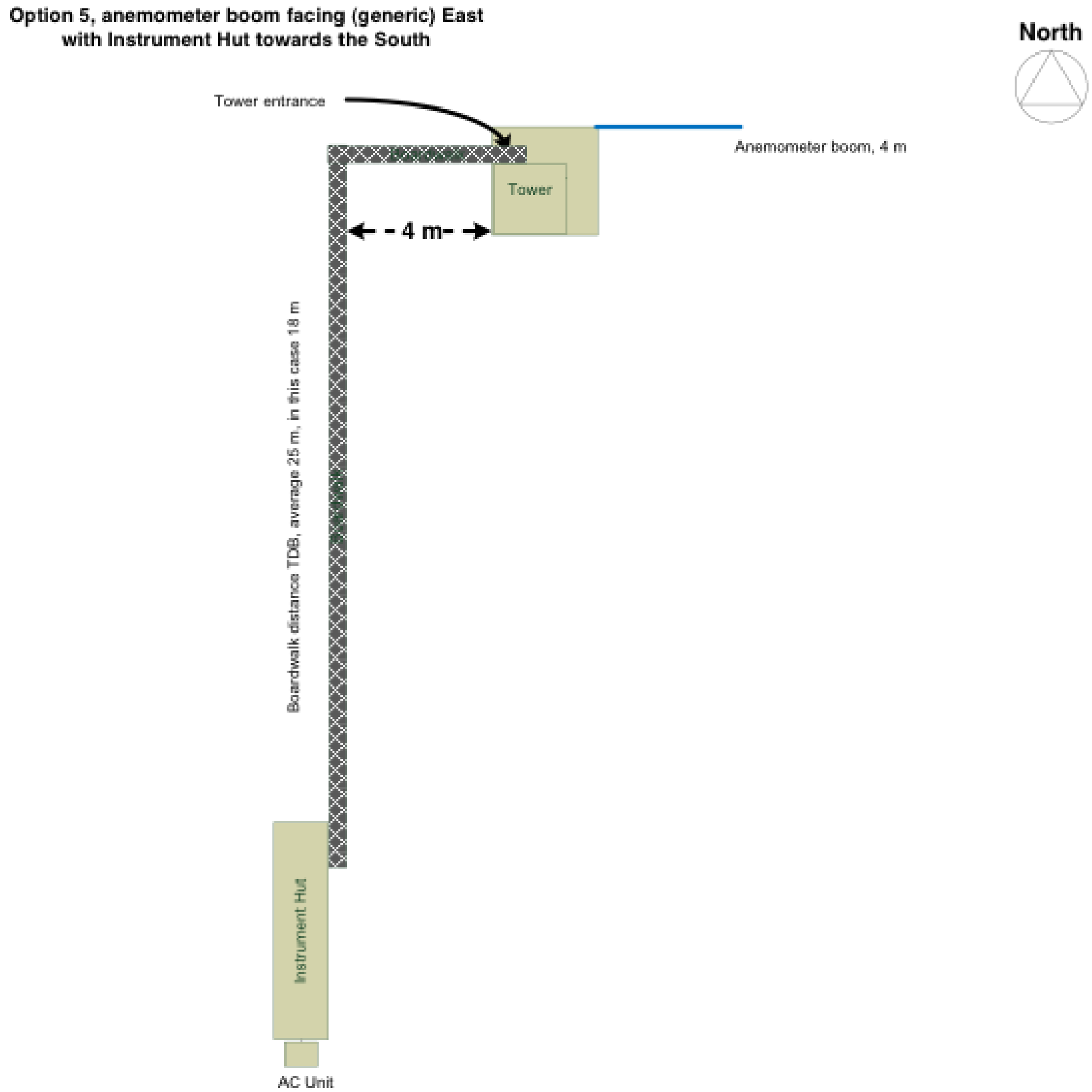


Figure B1. Generic patterns for the boardwalk configuration

8 REFERENCES

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