D19 FIU Site Characterization
Supporting Data

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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 visits to the 4 NEON candidate sites in Domain 19. This document presents all the supporting data for FIU site characterization at NEON candidate sites of Caribou Poker Watershed (Black Spruce, permafrost) Advance site, Delta Junction Relocatable Site 1 (well drained black spruce forest, non-permafrost), Poker Flats Relocatable Site 2 (black spruce forest, permafrost gradient, burned site), and Eight Mile Lake Relocatable site 3 (alpine tundra, thermokarsting).

1.2 Scope

FIU site characterization data and analysis results presented in this document are for 4 NEON candidate sites in Domain 19: Caribou Poker Watershed (Black Spruce, permafrost) Advance site, Delta Junction Relocatable Site 1, Poker Flats Relocatable Site 2, and Eight Mile Lake Relocatable site 3. Issues and concerns for each site that need further review are also addressed in this document according to our best knowledge.
Disclaimer, accuracy of our latitude and longitude points are subject to the tolerances of our GPS measurement system i.e., ~ ±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 CARIBOU CREEK - POKER FLATS WATERSHED (CARIBOU POKER) ADVANCE TOWER SITE

3.1 Site description

NEON candidate tower location 65.154010°, -147.502581° at this site is located within Caribou Poker Creeks Research Watershed (Figure 1).

Information below about Caribou-Poker Creeks Research Watershed (CPCRW) is from this webpage: http://www.lter.uaf.edu/bnz_cpcrw.cfm).

The Caribou-Poker Creeks Research Watershed (CPCRW) is a 104 km2 basin north of Fairbanks, Alaska. The watershed is reserved for ecological, hydrological, and climatic research. It is owned jointly by the State of Alaska and the University of Alaska Fairbanks. Much of the research is made in conjunction with the Bonanza Creek Long Term Ecological Research Program. The entrance to the Research Watershed is located on the Steese Highway about 31 miles from Fairbanks. Access is restricted.

The Caribou-Poker Creek Research Watershed (CPCRW) is located in the Yukon-Tanana Uplands of the Northern Plateaus Physiographic Province (Wahrhaftig 1965), near the town of Chatanika in interior Alaska. It is centered on 65o10' N latitude and 147o30' W longitude, and can be found on the Livengood A-1 and A-2 USGS 1:63,360 topographic map quadrangles. The Yukon-Tanana Uplands are a region of northeast-trending, round-topped ridges with gentle slopes. The elevations of these ridges range from 450 to 900 meters with rises of 150 to 500 meters above the adjacent valley bottoms. The alluvial-covered valley floors are generally flat.

The CPCRW basin is a northeast-southwest trending oval about 16 kilometers and eight kilometers wide. The total area of the watershed is about 104 km^2, with the Caribou Creek drainage comprising about 40 percent of the area. Elevations within CPCRW range from 210 meters at Poker Creek near the Chatanika River to 826 meters at the northern part of the watershed.

The Caribou-Poker Creeks Research Watershed (CPCRW) is a relatively pristine basin reserved for meteorologic, hydrologic, and ecologic research, with no current human influence (other than scientific research). The Boreal Ecology Cooperative Research Unit and Water and Environmental Research Center have been collecting climate and hydrology data since 1969, as well as ecological studies on a more sporadic schedule. In addition, access to the watershed has been upgraded by the construction of a bridge across the Chatanika River, completed on 5 August 1995. There is a rustic field camp with accommodations for sleeping and eating, and field laboratory with a generator for line power is now over run by mice and is uninhabitable.

The CPCRW is unique among such research areas in the United States in that it is the only one in the zone of discontinuous permafrost, which comprises a large portion of the state of Alaska, including most of interior Alaska. It is fairly representative of upland headwater stream basins in subarctic Alaska. The hydrology of CPCRW is a major driver of the aquatic ecology and biogeochemistry of the basin, while events in the terrestrial portions of the watersheds set the stage. Hydro-biological research in CPCRW has several major thrusts: to assess the role of disturbance in the terrestrial landscape (e.g. wildfire, herbivory, logging) on subarctic stream ecosystems, to assess the influence of discontinuous permafrost on fresh water ecology, and to assess the validity of the River Continuum concept in a subarctic context.

Permafrost is discontinuously distributed within CPCRW, determined by low sun angle at high latitude, local topography, and successional status. The permafrost mosaic of the surrounding taiga forest uplands exerts a powerful influence over hydrological patterns within the watershed. Stream flow is a mixture of highly variable shallow subsurface storm runoff events from permafrost dominated areas and consistent groundwater base flows from permafrost free areas. In addition to physical effects on stream ecology, these two distinct flow regimes have divergent influences on stream biogeochemistry with important ramifications for food webs. Permafrost here may be sensitive to global climate change because of its position close to the southern limit of permafrost in Alaska. In CPCRW, there are first order streams with a range of 4% to 55% of their catchments underlain by permafrost, allowing tests of a number of hypotheses of permafrost effects on stream ecosystems, including patterns of concentrations and export of carbon, nutrients and sediment.

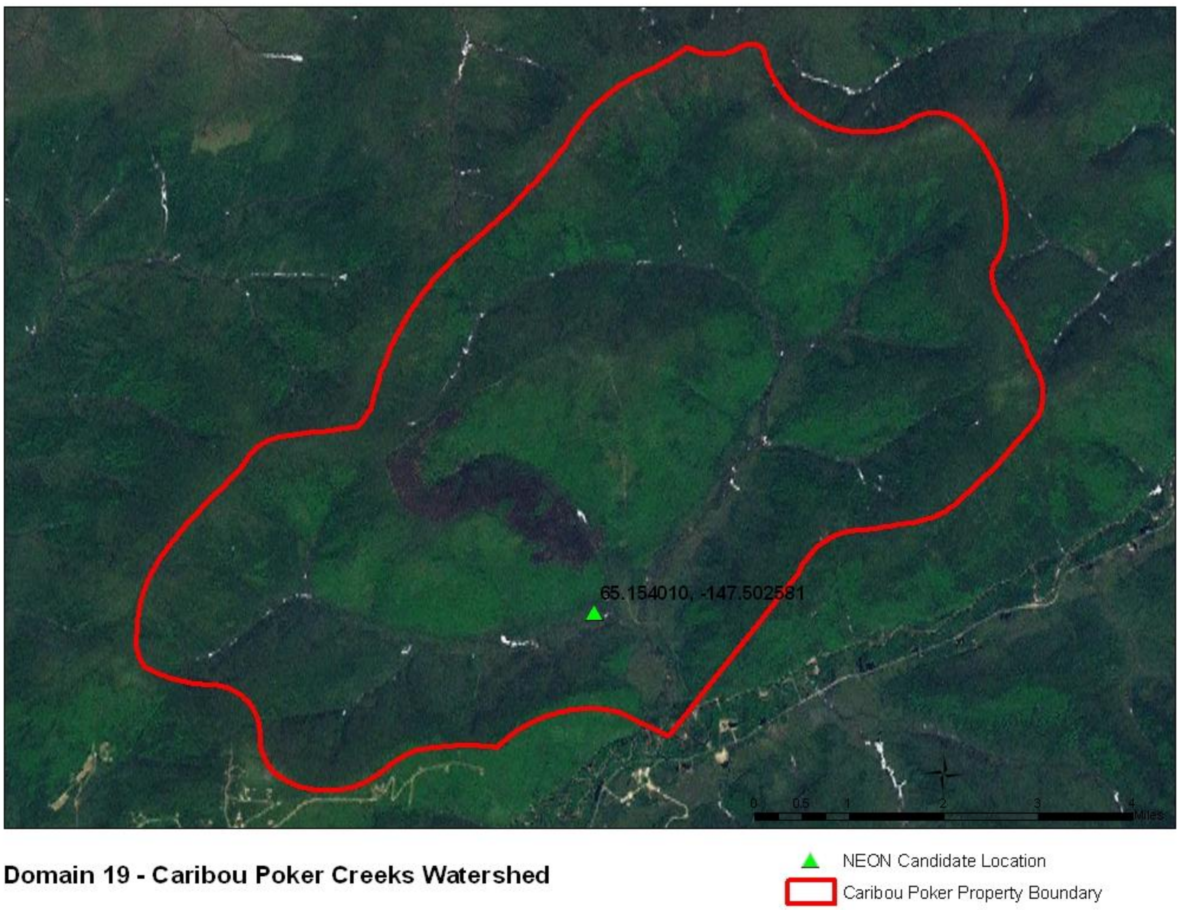


Figure 1. Boundary map for Caribou Poker Advance site and candidate tower location.

3.2 Ecosystem

In CPCRW, the mosaic of plant communities found in the subarctic biome is structured by a number of ecological processes. Wildfire is common in the subarctic uplands, and is the primary reset mechanism for forest succession in terrestrial upland ecosystems. In the lowland floodplains, the meandering of large rivers exposes silt bars, which are then colonized by shrubs and trees, initiating primary forest succession. Local conditions such as hydrology, topography and microclimate determine the path and rate of forest succession in both floodplains and uplands. Superimposed on this forest mosaic are insect and mammalian herbivores that can influence ecosystem properties such as palatability and decomposability of leaves and leaf litter, and indeed can restructure forest succession (e.g. massive tree mortality caused by spruce bark beetles). CPCRW does not contain the full range of these forest types and ages: stand-initiating fires, and perhaps some logging by early settlers, since the turn of the century have resulted in young (i.e. 60-90 year old) stands of birch and aspen on south facing slopes, while older uneven aged (e.g. up to 200 year) black spruce stands dominate on north facing slopes. A fire came through in 2004, burning patches of forest with, at times, cool fires leaving large amounts of live biomass intact and a patchy landscape towards the eastern part of the parcel. This has also resulted in areas of active recruitment. White spruce may be under-represented. Stream valley bottoms are generally treeless. Moose and beaver are common in CPCRW, so it is likely that there are patches of herbivore-impacted vegetation. The tops of the peaks and ridges provide near-alpine habitat (Info source: http://www.lter.uaf.edu/bnz_cpcrw.cfm).

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

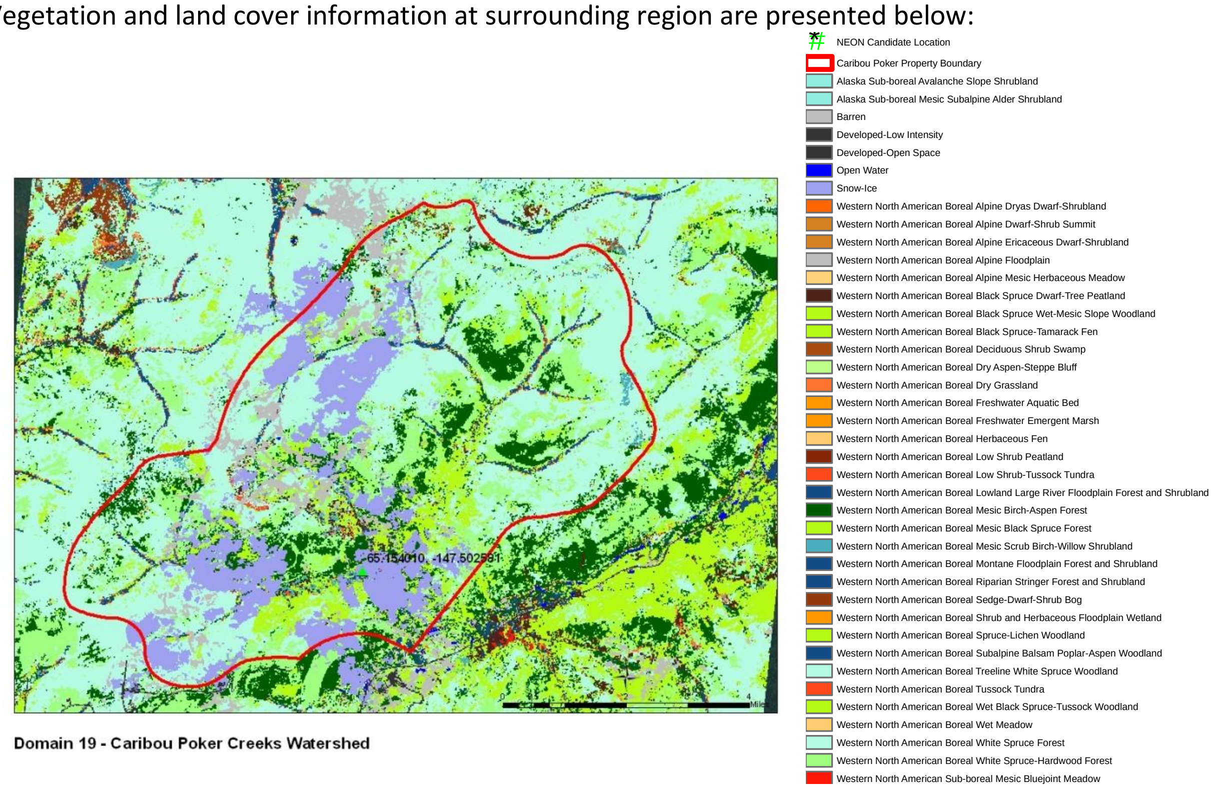


Figure 2. Vegetative cover map of Caribou Poker Advance tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 1. Percent Land cover type at Caribou Poker Advance tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	**Area (km^2)**	**Percentage**
Open Water	0.0072	0.01
Snow-Ice	17.2142447	15.54
Barren	5.8355636	5.27
Western North American Boreal White Spruce Forest	36.6064418	33.05
Western North American Boreal Treeline White Spruce Woodland	7.64661699	6.90

Western North American Boreal Spruce-Lichen Woodland	0.27650443	0.25
Western North American Boreal White Spruce-Hardwood Forest	16.7841059	15.15
Western North American Boreal Mesic Black Spruce Forest	10.3646816	9.36
Western North American Boreal Mesic Birch-Aspen Forest	10.6862024	9.65
Western North American Boreal Subalpine Balsam Poplar-Aspen Woodland	0.01252903	0.01
Alaska Sub-boreal Avalanche Slope Shrubland	0.0053689	0.00
Alaska Sub-boreal Mesic Subalpine Alder Shrubland	0.01193939	0.01
Western North American Boreal Mesic Scrub Birch-Willow Shrubland	1.08670256	0.98
Western North American Boreal Dry Grassland	0.07239998	0.07
Western North American Boreal Montane Floodplain Forest and Shrubland	1.87032514	1.69
Western North American Boreal Lowland Large River Floodplain Forest and Shrubland	0.02892526	0.03
Western North American Boreal Riparian Stringer Forest and Shrubland	0.0108	0.01
Western North American Boreal Herbaceous Fen	0.00892903	0.01
Western North American Boreal Sedge-Dwarf-Shrub Bog	0.03506889	0.03
Western North American Boreal Low Shrub Peatland	0.10577344	0.10
Western North American Boreal Black Spruce Dwarf-Tree Peatland	0.73199914	0.66
Western North American Boreal Black Spruce Wet-Mesic Slope Woodland	0.43116495	0.39
Western North American Boreal Black Spruce-Tamarack Fen	0.12470568	0.11
Western North American Boreal Deciduous Shrub Swamp	0.14677279	0.13
Western North American Boreal Freshwater Emergent Marsh	0.01105269	0.01
Western North American Boreal Wet Meadow	0.01285269	0.01
Western North American Boreal Low Shrub-Tussock Tundra	0.56197663	0.51
Western North American Boreal Wet Black Spruce-Tussock Woodland	0.08112615	0.07
Western North American Boreal Alpine Mesic Herbaceous Meadow	0.00327634	0.00
Western North American Boreal Alpine Dryas Dwarf-Shrubland	0.0009	0.00
Western North American Boreal Alpine Ericaceous Dwarf-Shrubland	0.0009	0.00
Total Area sq km	110.77705	100.00

The ecosystem inside the tower airshed and around tower is dominant by black spruce- tussock tundra woodland (Figure 3). This is black spruce forest on permafrost. Forest canopy is open without the typical conifer cone-shape. Canopy ground projection coverage is ~50% - 60%. Max canopy height is ~12 m, and the mean canopy height is ~10 m. Tree density is 120-200 stems ha^{-1}. LAI is ~ 1 for the black spruce forest. Birch, horsetail and other shrubs form an understory layer with height ~1.2 m. The moss layer (sphagnums, reindeer lichen, etc.) is very thick (can be >40 cm), dense, and forms another understory at ground level (Figure 4). Relief of sphagnum ground cover is ±20 cm without compression of the spongy structure. Tussock tundra grass is also one of the major components at ground level. The height of the individual tussock can be >50 cm. Canopy heights for grass and other annuals is ~ 0.2 m. The LAI is ~1.3 for the understory, making a total LAI of 2.3.

Figure 3 Open black spruce canopy is the dominant vegetation type at Caribou-Poker advance site

Figure 4 Moss layer is very thick and dense at Caribou-Poker advance site

Table 2. Ecosystem and site attributes for Caribou-Poker advance tower site.

Ecosystem attributes	Measure and units
Mean canopy height	8 m
Surface roughness[a]	1.2 m
Zero place displacement height[a]	4.7 m
Structural elements	Open black spruce forest with dense understory at ground level
Time zone	Alaska Standard Time
Magnetic declination	20° 59' E changing by 0° 22' W/year

Note, [a] From field observation.

3.3 Soils

3.3.1 Soil description

Soil data and soil maps (Figure 5 Table 3) below for Coribou Poker tower site were collected from 2.2 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.

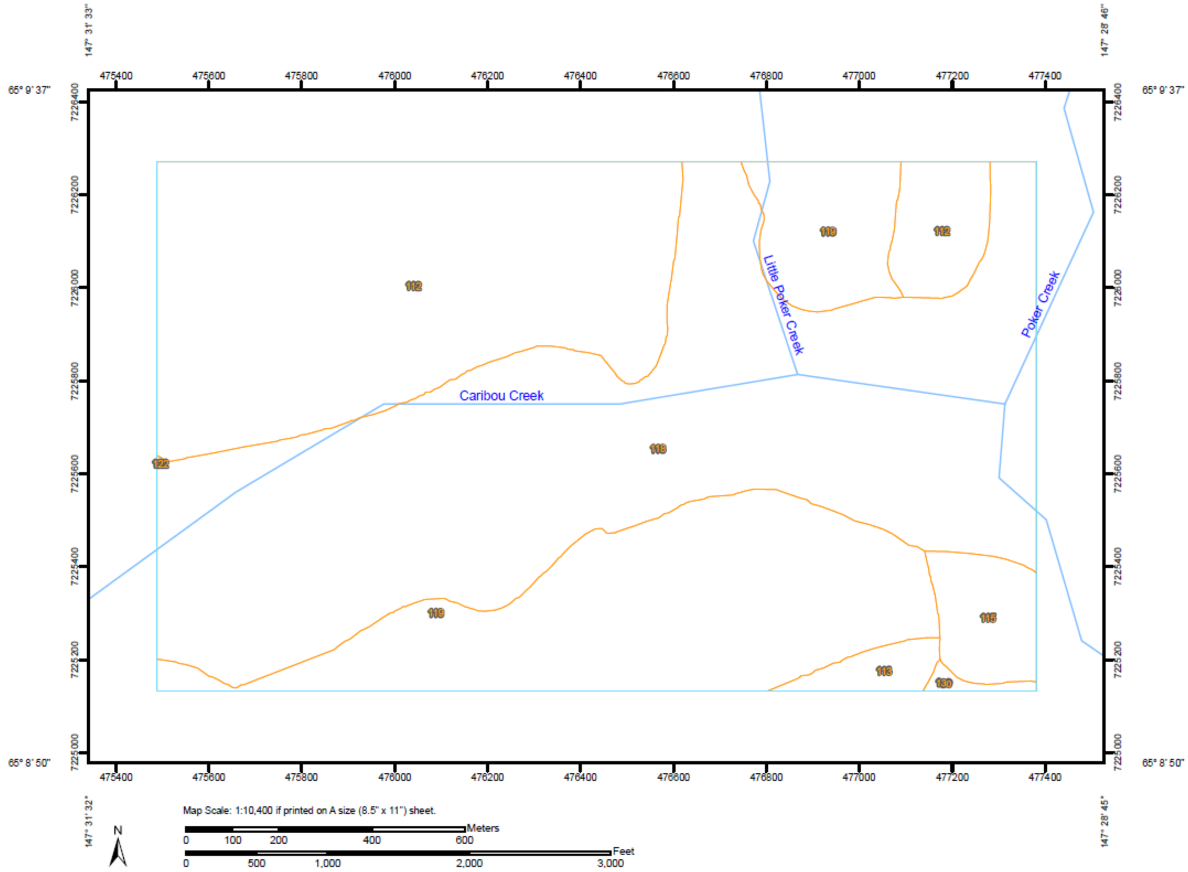


Figure 5. 2.2 km^2 soil map for Caribou Poker NEON advanced tower site. Bottom image shows the same area with a background image, but without a scale bar.

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

North Star Area, Alaska (AK642)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
112	Gilmore silt loam, 12 to 45 percent slopes	155.0	29.1%
113	Gilmore-Ester complex, 15 to 45 percent slopes	6.1	1.1%
115	Goldstream peat, 0 to 3 percent slopes	14.1	2.6%
118	Histic Pergelic Cryaquepts, fans, 1 to 20 percent slopes	239.0	44.9%
119	Histic Pergelic Cryaquepts, 15 to 45 percent slopes	117.1	22.0%
122	Histic Pergelic Cryaquepts-Typic Cryochrepts complex, 15 to 45 percent slopes	0.1	0.0%
130	Saulich peat, 3 to 7 percent slopes	1.5	0.3%
Totals for Area of Interest		**532.8**	**100.0%**

North Star Area, Alaska 112—Gilmore silt loam, 12 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Gilmore and similar soils: 85 percent Minor components: 15 percent **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 12 to 45 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 8 percent Landform: Hills Down-slope shape: Linear

Across-slope shape: Linear **Histic pergelic cryaquepts, 231** Percent of map unit: 7 percent Landform: Hills Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 113—Gilmore-Ester complex, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 30 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Gilmore and similar soils: 50 percent Ester and similar soils: 30 percent Minor components: 20 percent **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Description of Ester Setting** Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Head slope, side slope Down-slope shape: Linear Across-slope shape: Concave, linear, convex Parent material: Mossy organic material over colluvium and/or loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 7 to 30 inches to permafrost; 14 to 39 inches to paralithic bedrock Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 1.3 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 9 inches: Peat 9 to 12 inches: Mucky silt loam 12 to 21 inches: Very channery silt loam 21 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 4 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear **Fairbanks** Percent of map unit: 4 percent Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Interfluve, head slope, side slope Down-slope shape: Convex, linear Across-slope shape: Linear, convex **Histosols, permafrost** Percent of map unit: 4 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Steese** Percent of map unit: 4 percent Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear **Rock outcrop** Percent of map unit: 4 percent Landform: Hills, ridges

North Star Area, Alaska 115—Goldstream peat, 0 to 3 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Goldstream, non flooded, and similar soils: 90 percent Minor components: 10 percent **Description of Goldstream, Non Flooded Setting** Landform: Alluvial flats Down-slope shape: Concave, linear Across-slope shape: Concave, linear Parent material: Organic material over loess **Properties and qualities** Slope: 0 to 3 percent Depth to restrictive feature: 14 to 24 inches to permafrost Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6w **Typical profile** 0 to 9 inches: Mucky peat 9 to 12 inches: Mucky silt loam 12 to 20 inches: Silt loam 20 to 72 inches: Material **Minor Components Aquepts** Percent of map unit: 4 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histosols, permafrost** Percent of map unit: 3 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histic pergelic cryaquepts, 229** Percent of map unit: 3 percent Landform: Alluvial flats Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 118—Histic Pergelic Cryaquepts, fans, 1 to 20 percent slopes Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Histic pergelic cryaquepts, 231, and similar soils: 90 percent Minor components: 10 percent **Description of Histic Pergelic Cryaquepts, 231 Setting** Landform: Alluvial fans Down-slope shape: Concave Across-slope shape: Concave Parent material: Loess over colluvium **Properties and qualities** Slope: 1 to 20 percent Depth to restrictive feature: 8 to 39 inches to permafrost; 16 to 72 inches to paralithic bedrock Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 to 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.4 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 13 inches: Peat 13 to 19 inches: Silt loam 19 to 26 inches: Silt loam 26 to 72 inches: Material 72 to 72 inches: Bedrock **Minor Components Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histic pergelic cryaquepts, 231 moderately steep** Percent of map unit: 5 percent Landform: Alluvial fans Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 119—Histic Pergelic Cryaquepts, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Histic pergelic cryaquepts, 231, and similar soils: 90 percent Minor components: 10 percent **Description of Histic Pergelic Cryaquepts, 231 Setting** Landform: Hills Down-slope shape: Concave Across-slope shape: Concave Parent material: Loess over colluvium **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 8 to 39 inches to permafrost; 16 to 72 inches to paralithic bedrock Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 to 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.4 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 13 inches: Peat 13 to 19 inches: Silt loam 19 to 26 inches: Silt loam 26 to 72 inches: Material 72 to 72 inches: Bedrock **Minor Components Cryaquepts, permafrost substratum** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Concave Across-slope shape: Concave **Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 122—Histic Pergelic Cryaquepts-Typic Cryochrepts complex, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Histic pergelic cryaquepts, 231, and similar soils: 55 percent Typic cryochrepts and similar soils: 35 percent Minor components: 10 percent **Description of Histic Pergelic Cryaquepts, 231 Setting** Landform: Hills Down-slope shape: Concave Across-slope shape: Concave Parent material: Loess over colluvium **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 8 to 39 inches to permafrost; 16 to 72 inches to paralithic bedrock Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 to 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.4 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 13 inches: Peat 13 to 19 inches: Silt loam 19 to 26 inches: Silt loam 26 to 72 inches: Material 72 to 72 inches: Bedrock **Description of Typic Cryochrepts Setting** Landform: Hills Down-slope shape: Linear Across-slope shape: Linear Parent material: Loess over colluvium **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 16 to 47 inches to paralithic bedrock Drainage class: Well drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 5.9 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 2 inches: Silt loam 2 to 26 inches: Silt 26 to 32 inches: Very channery silt loam 32 to 60 inches: Weathered bedrock **Minor Components Cryochrepts, wet** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Concave Across-slope shape: Concave **Rock outcrop** Percent of map unit: 5 percent Landform: Hills, ridges

North Star Area, Alaska 130—Saulich peat, 3 to 7 percent slopes Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Saulich and similar soils: 90 percent Minor components: 10 percent **Description of Saulich Setting** Landform: Valley sides Landform position (two-dimensional): Toeslope, footslope Landform position (three-dimensional): Base slope, side slope Down-slope shape: Linear, concave Across-slope shape: Linear Parent material: Colluvium and/or loess **Properties and qualities** Slope: 3 to 7 percent Depth to restrictive feature: 14 to 24 inches to permafrost Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6w **Typical profile** 0 to 16 inches: Peat 16 to 21 inches: Mucky silt loam 21 to 72 inches: Material **Minor Components Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histic pergelic cryaquepts, 231** Percent of map unit: 5 percent Landform: Alluvial fans Down-slope shape: Concave Across-slope shape: Concave

3.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 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.

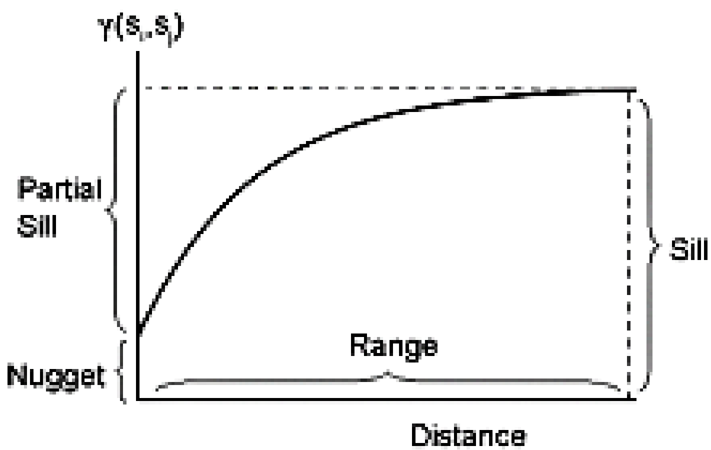


Figure 6. Example semivariogram, depicting range, sill, and nugget.

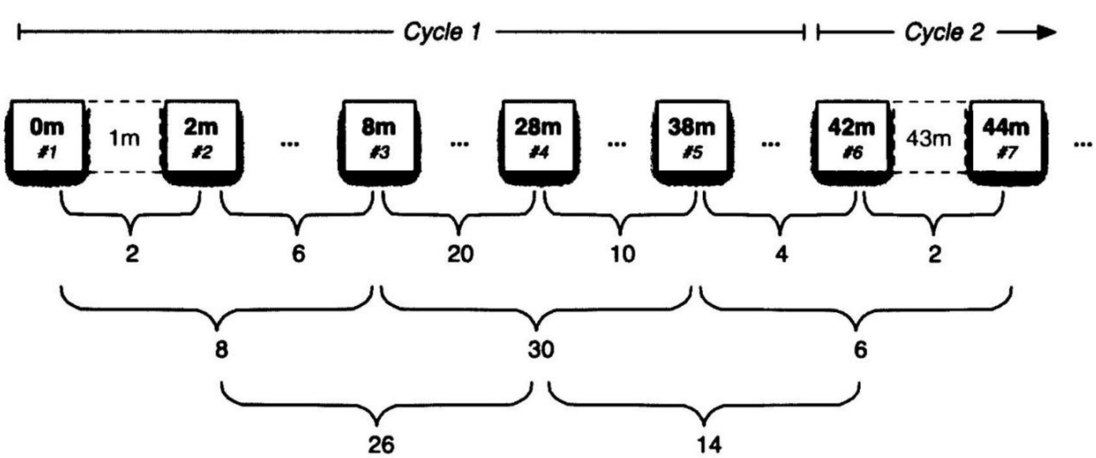


Figure 7. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 22 June 2010 at the Caribou Poker Core 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 three transects (210 m, 84 m, and 84 m) located in the expected airshed at Caribou Poker Core site. 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. Soil temperature and moisture were not continuously recorded at a single fixed location (stationary data) throughout the sampling time at this site due to lack of available memory in the data logger.

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. In many instances a time of day trend was still apparent in the data. This time of day trend was corrected for by fitting a linear regression and using the residuals for the semivariogram analysis. Soil temperature and moisture data, R code, graphs, and R output can be found at: P:\FIU\FIU_Site_Characterization\DXX\YYYYYYY_Characterization\Soil Measurements\Soil Data Analysis (where XX = domain number and YYYYYYY = site name).

3.3.3 Results and interpretation

3.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 8). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 9, left graph) and directional semivariograms do not show 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 6 m for soil temperature.

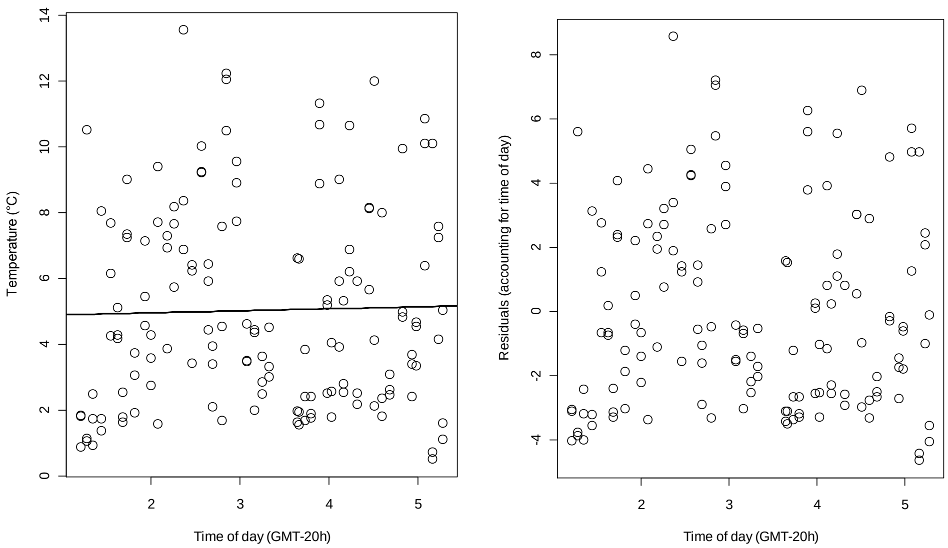


Figure 8. Left graph: mobile soil temperature data (circles) and time of day regression (line). Right graph: temperature data after correcting for time of day regression (circles). Data in the right graph were used for the semivariogram analysis.

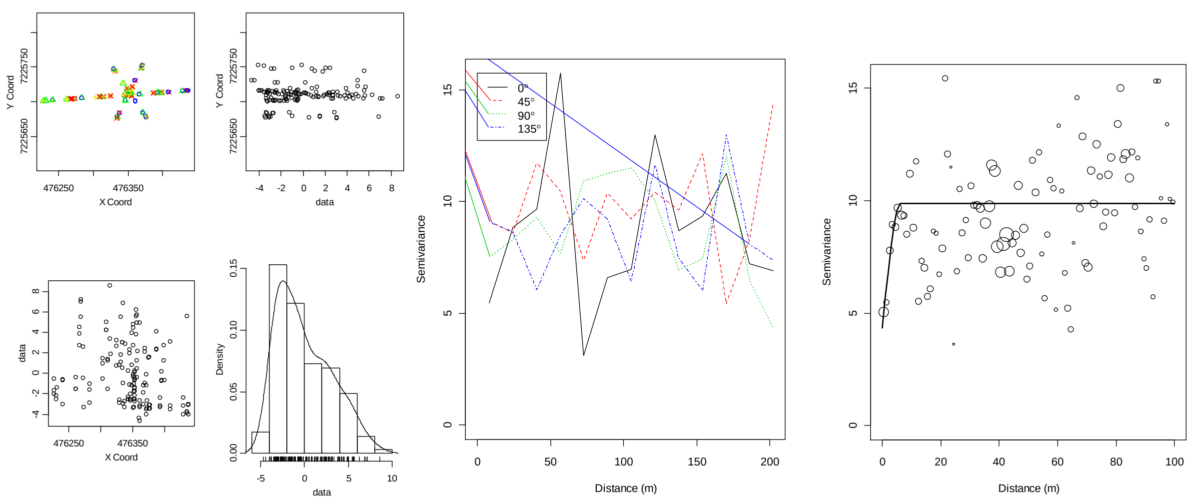


Figure 9. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

3.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 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 7 m for soil water content.

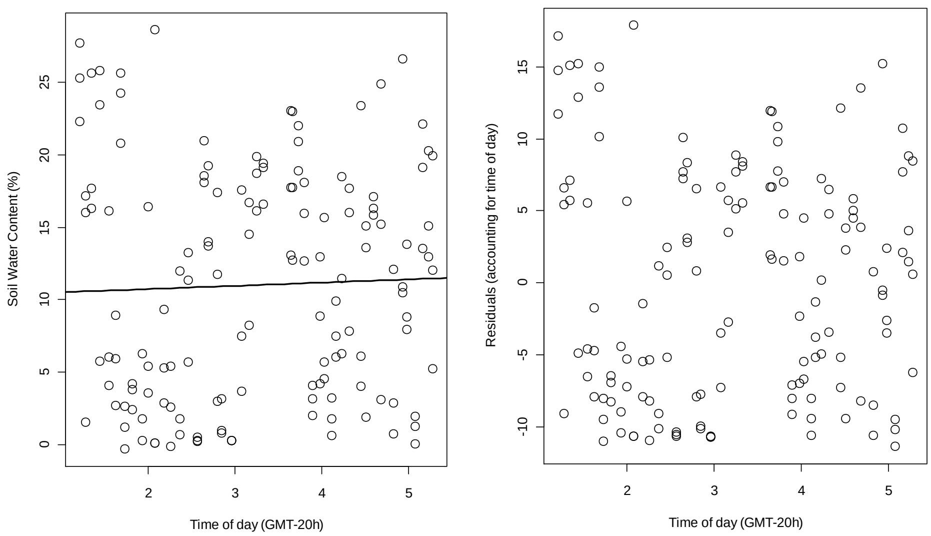


Figure 10. Left graph: mobile soil water content data (circles) and time of day regression (line). Right graph: water content data after correcting for time of day regression (circles). Data in the right graph were used for the semivariogram analysis.

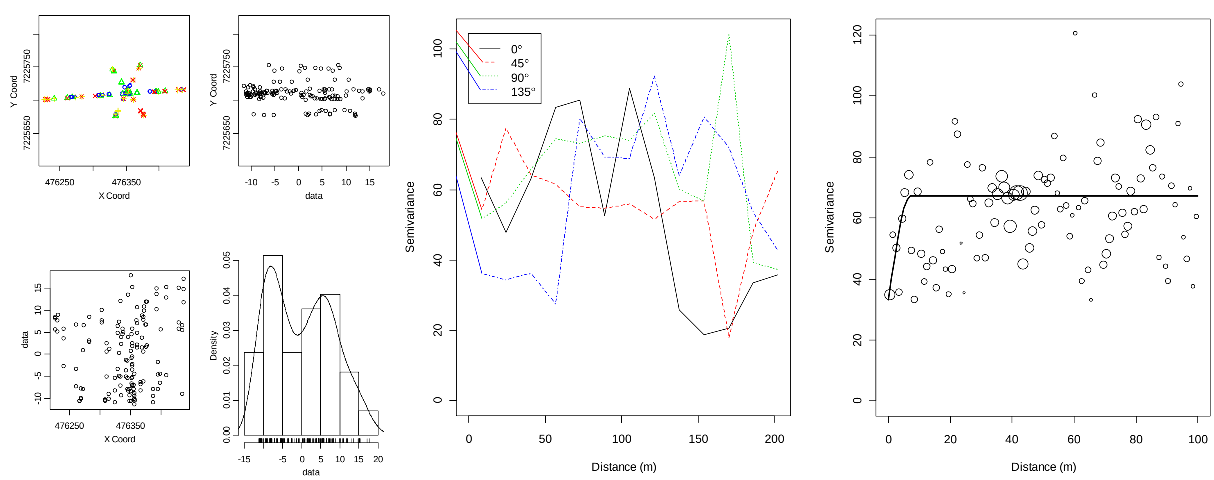


Figure 11. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

3.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was 6 m for soil temperature and 7 m for soil moisture. Based on these results and the site design guidelines the soil plots at Caribou Poker Core site shall be placed 25 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 250° from the soil plot nearest the tower to avoid crossing the wet area that is not representative of the habitat being studied by FIU at this site. The location of the first soil plot will be approximately 65.15402°, -147.50293°. 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 65.155557°, -147.489651° (primary location); or 65.155110°, -147.489810° (alternate location 1 if primary location is unsuitable); or 65.155907°, -147.490067° (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 4 and site layout can be seen in Figure 12.

Dominant soil series at the site: Histic Pergelic Cryaquepts, fans, 1 to 20 percent slopes. The taxonomy of this soil is shown below:
Order: Inceptisols
Suborder: Aquepts
Great group: Cryaquepts
Subgroup: Histic Pergelic Cryaquepts
Family: Not available from NRCS
Series: Histic Pergelic Cryaquepts, fans, 1 to 20 percent slopes

Table 4. Summary of soil array and soil pit information at Caribou Poker Core. 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	25 m
Distance from tower to closest soil plot: y	16 m
Latitude and longitude of 1st soil plot OR direction from tower	65.15402°, -147.50293°
Direction of soil array	250°
Latitude and longitude of FIU soil pit 1	65.155557°, -147.489651° (primary location)
Latitude and longitude of FIU soil pit 2	65.155110°, -147.489810° (alternate 1)
Latitude and longitude of FIU soil pit 3	65.155907°, -147.490067° (alternate 2)
Dominant soil type	Histic Pergelic Cryaquepts, fans, 1 to 20 percent slopes
Expected soil depth	0.20-0.99 m
Depth to water table	0-0.15 m
Expected depth of soil horizons	**Expected measurement depths**[*]
0-0.33 m (Peat)	[a]0.17 m
0.33-0.48 m (Silt loam)	0.41 m
0.48-0.66 m (Silt loam)	[a]0.57 m
0.66-1.83 m (Silt loam)	1.25 m

1.83-1.83 m (Bedrock)	1.83 m
1.83-3.00 m	[a]3.00 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. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to characterize permafrost dynamics. [a]Notes the current understanding of the measurement depths to be applied by the soil array.

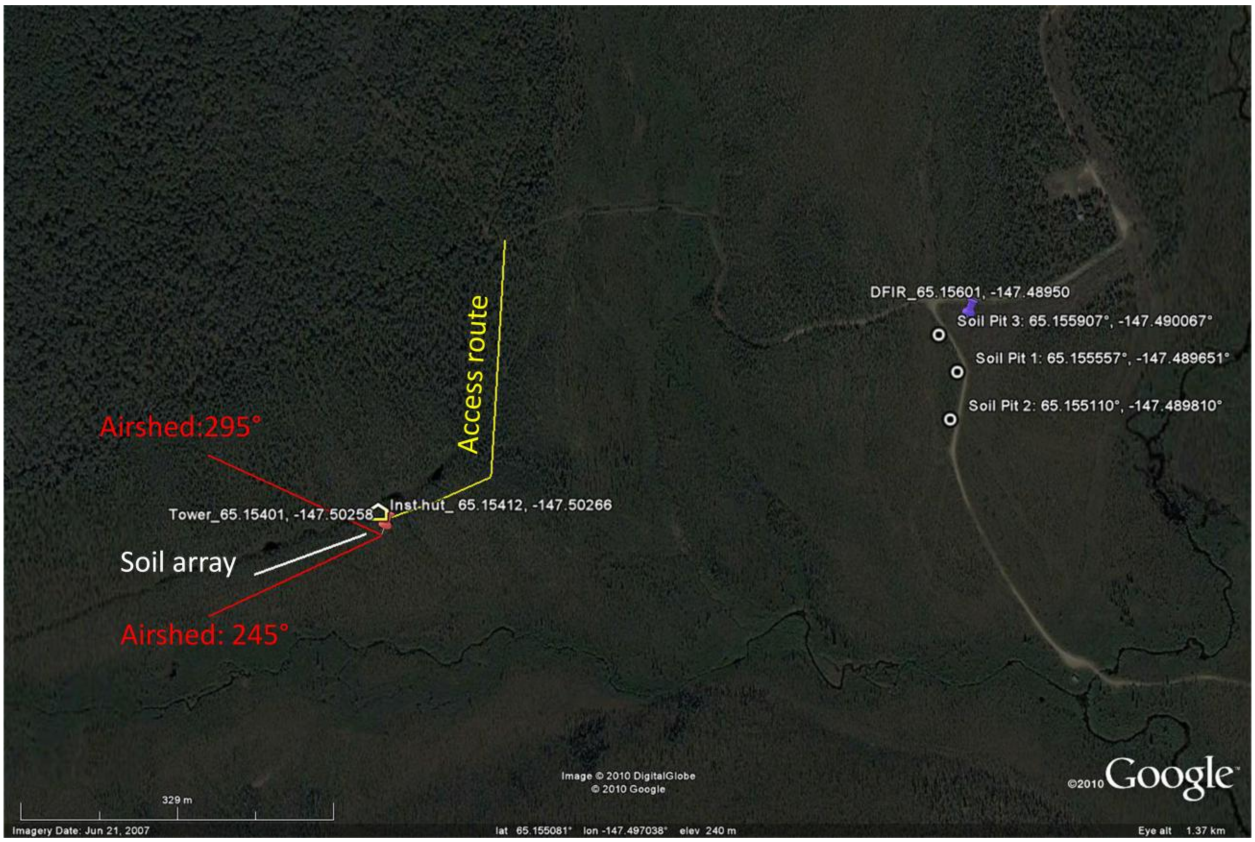


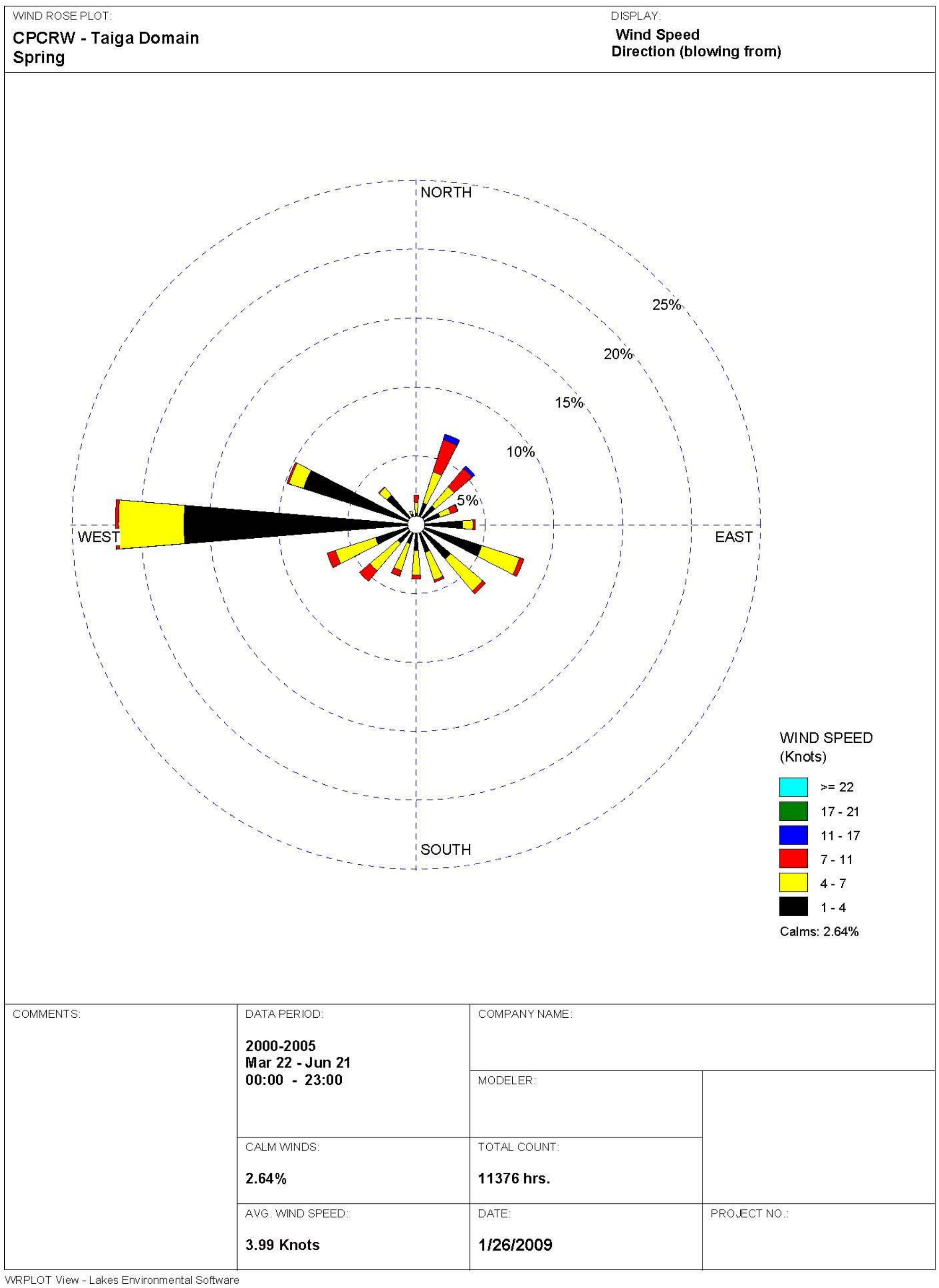
Figure 12. Site layout at Caribou Poker Core showing soil array and location of the FIU soil pit.

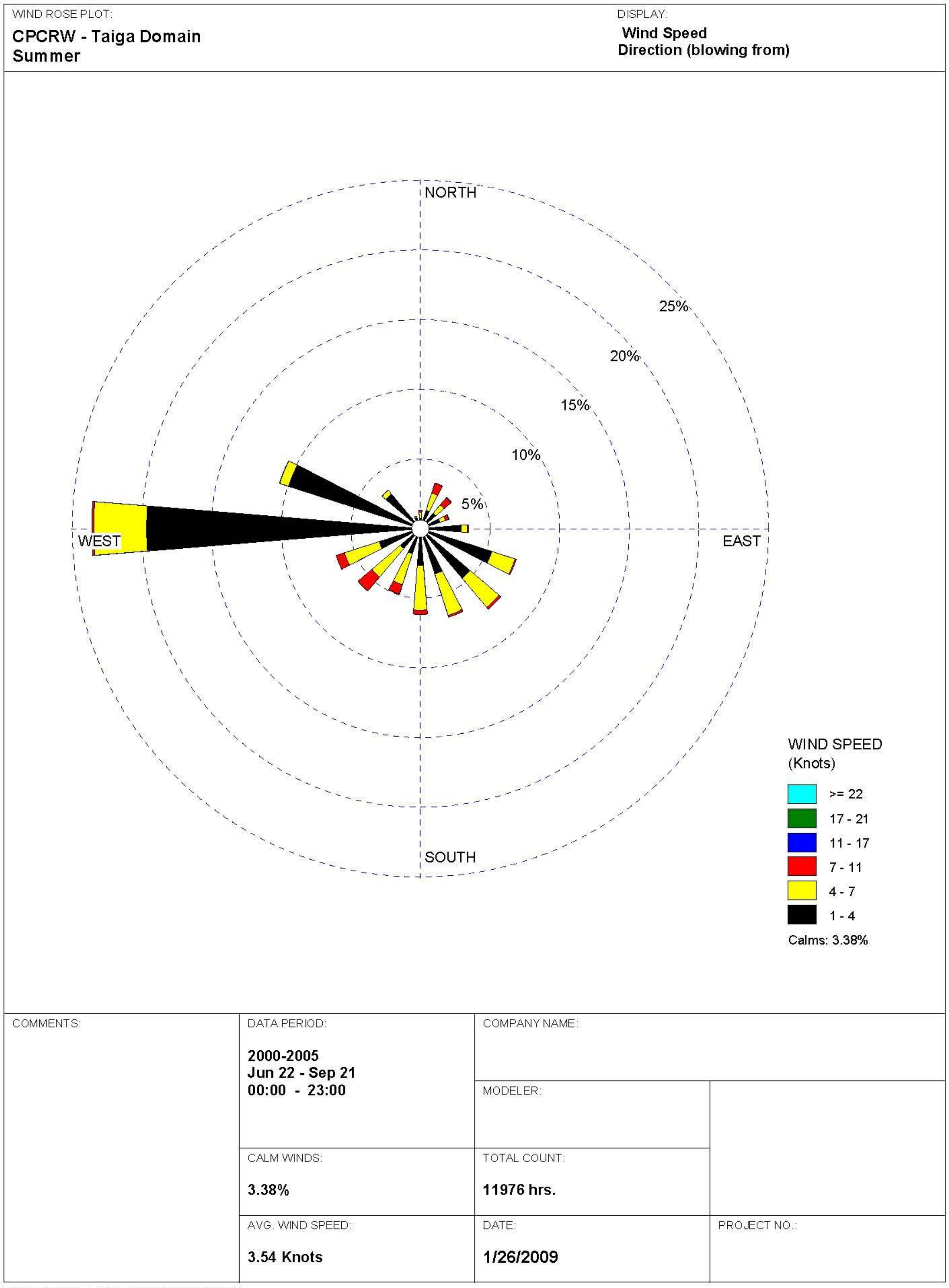
3.4 Airshed

3.4.1 Seasonal windroses

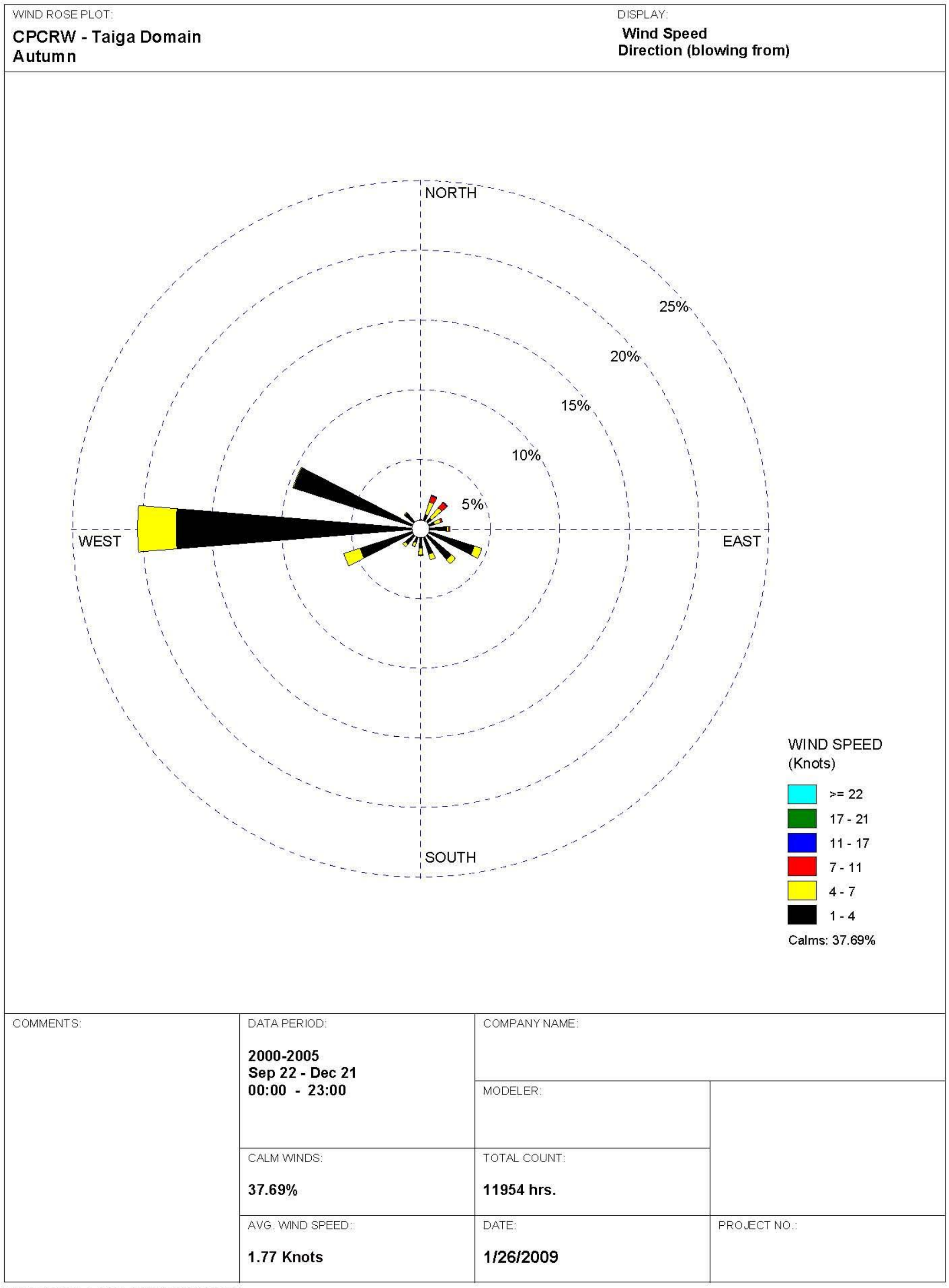
Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figure 12. The weather data used to generate the following wind roses using data from a weather station at approximately 65.15265, -147.48705 maintained by University of Fairbanks, which is ~ 750 m on the ESE to NEON tower site. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

3.4.2 Results (graphs for wind roses)





WIND ROSE PLOT:
CPCRW - Taiga Domain
Summer
DISPLAY:
Wind Speed
Direction (blowing from)
NORTH
SOUTH
WEST
EAST
5%
10%
15%
20%
25%
WIND SPEED
(Knots)
>= 22
17 - 21
11 - 17
7 - 11
4 - 7
1 - 4
Calms: 3.38%
COMMENTS:
DATA PERIOD:
2000-2005
Jun 22 - Sep 21
00:00 - 23:00
COMPANY NAME:
MODELER:
CALM WINDS:
3.38%
TOTAL COUNT:
11976 hrs.
AVG. WIND SPEED:
3.54 Knots
DATE:
1/26/2009
PROJECT NO.:
WRPLOT View - Lakes Environmental Software


WIND ROSE PLOT:
CPCRW - Taiga Domain
Autumn
DISPLAY:
Wind Speed
Direction (blowing from)
NORTH
SOUTH
WEST
EAST
5%
10%
15%
20%
25%
WIND SPEED
(Knots)
>= 22
17 - 21
11 - 17
7 - 11
4 - 7
1 - 4
Calms: 37.69%
COMMENTS:
DATA PERIOD:
2000-2005
Sep 22 - Dec 21
00:00 - 23:00
COMPANY NAME:
MODELER:
CALM WINDS:
37.69%
TOTAL COUNT:
11954 hrs.
AVG. WIND SPEED:
1.77 Knots
DATE:
1/26/2009
PROJECT NO.:
WRPLOT View - Lakes Environmental Software

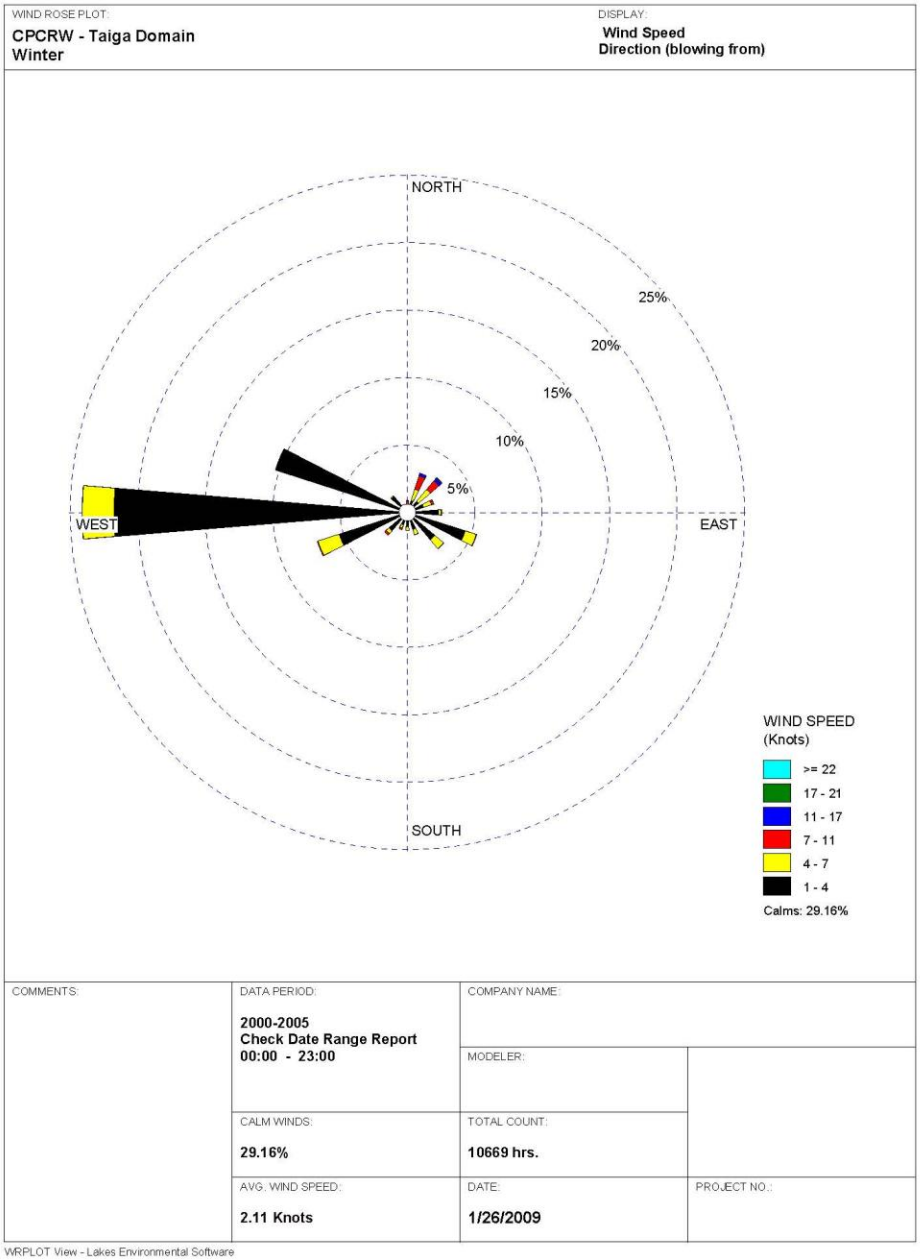


Figure 13. Windroses for the Caribou-Poker Advance tower site.
Data used here are hourly data from 2000-2005. Data was collected and obtained are from a weather station at approximately 65.15265, -147.48705, which is maintained by University of Fairbanks and ~ 750 m on the ESE to NEON tower site. It is assumed that the wind data was corrected for declination. Panels are (from top to bottom), Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

3.4.3 Resultant vectors

Not available, though we fully expect the constrained wind flows are due to local orographic effects, and remain consistent in time.

3.4.4 Expected environmental controls on source area

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

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

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

Table 5. Expected environmental controls to parameterize the source area model, and associated results from Caribou Poker advanced site.

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

	(max WS)	(mean WS)		(max WS)	(mean WS)		
Atmospheric stability	Convective	convective	Stable	Convective	convective	Stable	qualitative
Measurement height	18	18	18	18	18	18	m
Canopy Height	8	8	8	8	8	8	m
Canopy area density	2.2	2.2	2.2	2.1	2.1	2.1	m
Boundary layer depth	900	900	900	300	300	300	m
Expected sensible heat flux	180	180	100	-25	-25	-25	W m^{-2}
Air Temperature	4	4	2	-20	-20	-20	°C
Max. windspeed	3.6	2.6	1	3.6	2.6	1.0	m s^{-1}
Resultant wind vector	271	271	271	271	271	271	degrees
Results							
(z-d)/L	-0.2	-0.39	-1.10	0.06	0.31	3	m
d	6.3	6.3	6.3	6	6	6	m
Sigma v	1.4	1.3	0.94	1.7	1.7	1.6	m^2 s^{-2}
Z0	0.4	0.4	0.40	0.45	0.45	0.45	m
u*	0.5	0.4	0.23	0.40	0.23	0.02	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	500	350	200	1200	1750	3500	m
Distance of 80% cumulative flux	350	200	150	700	1000	3200	m
Distance of 70% cumulative flux	200	150	100	450	700	2750	m
Peak contribution	55	45	15	75	105	1645	m

3.4.5 Results (source area graphs)

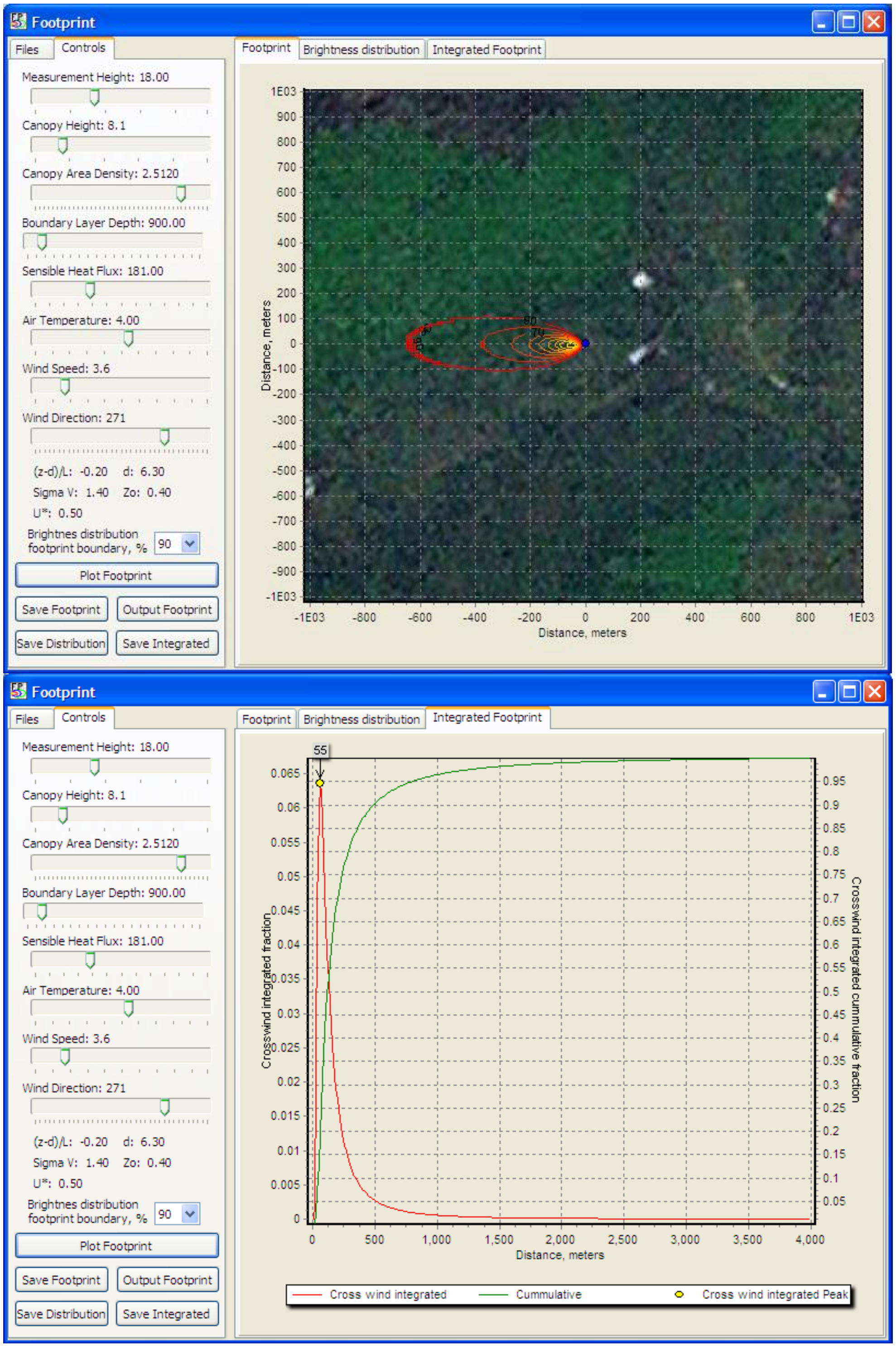


Figure 14. Caribou-Poker Core site Forest summer daytime (convective) footprint output with max wind speed.

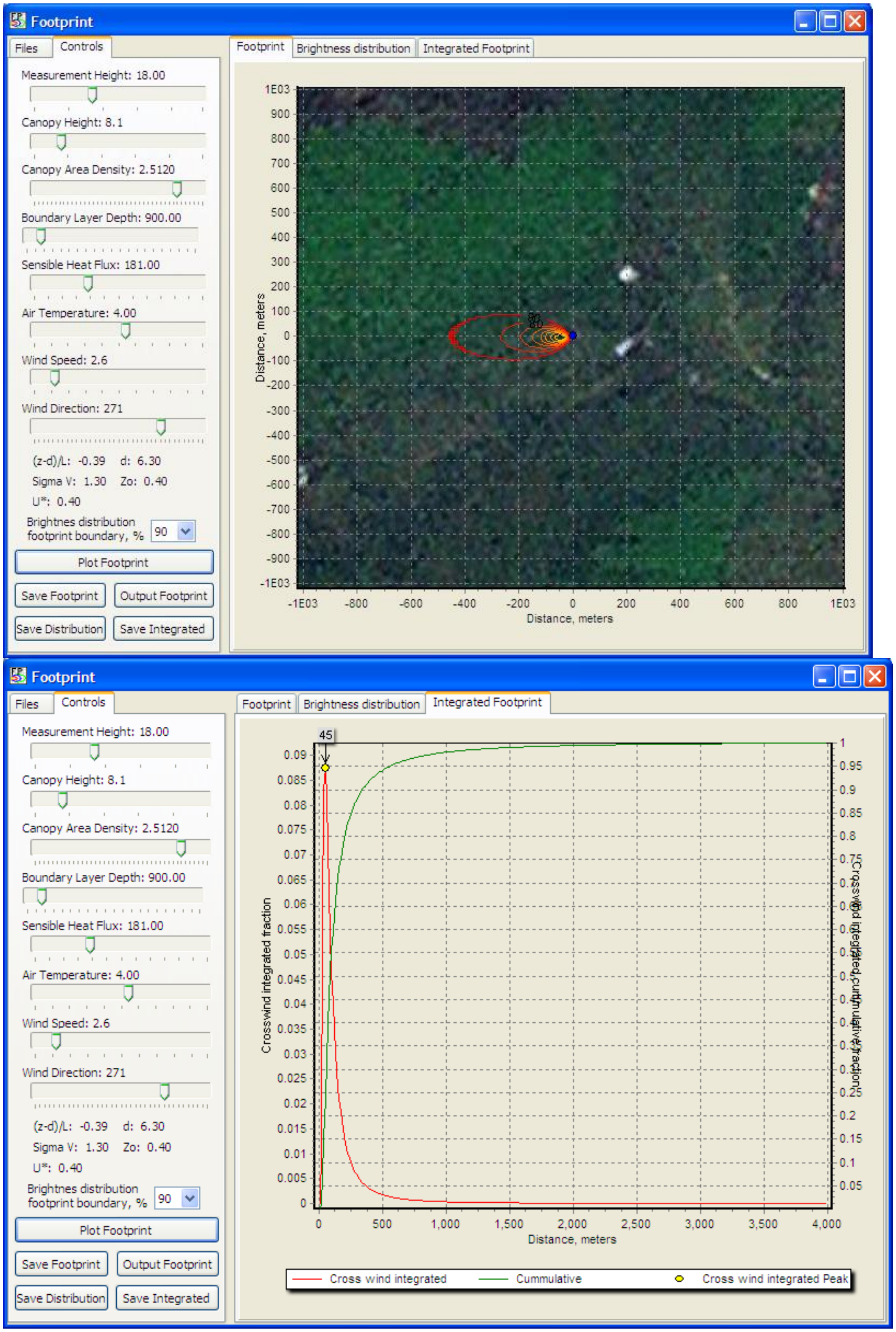


Figure 15. Caribou-Poker Core site summer daytime (convective) footprint output with mean wind speed.

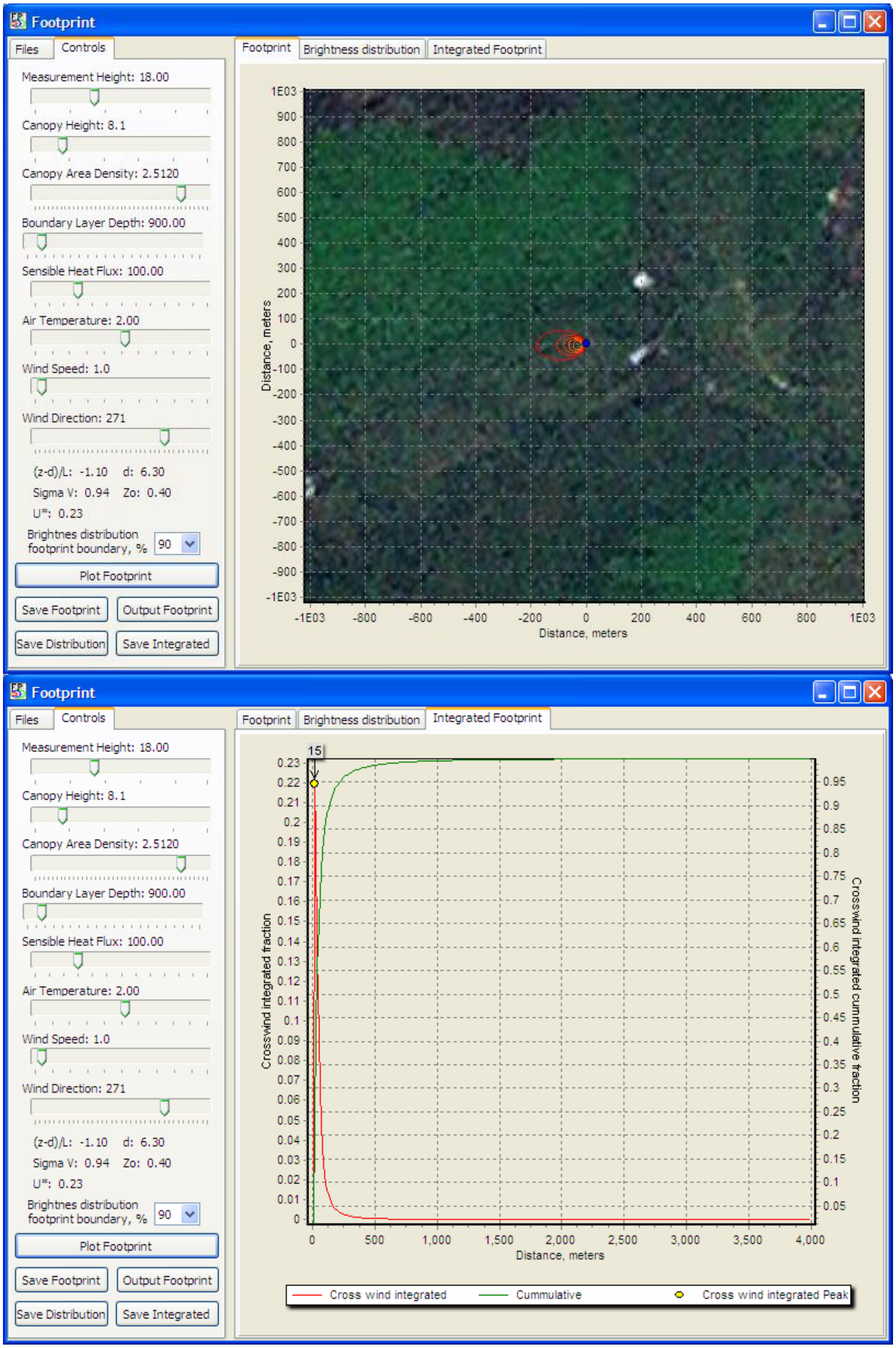


Figure 16. Caribou-Poker Core site summer nighttime (stable) footprint output with mean wind speed.

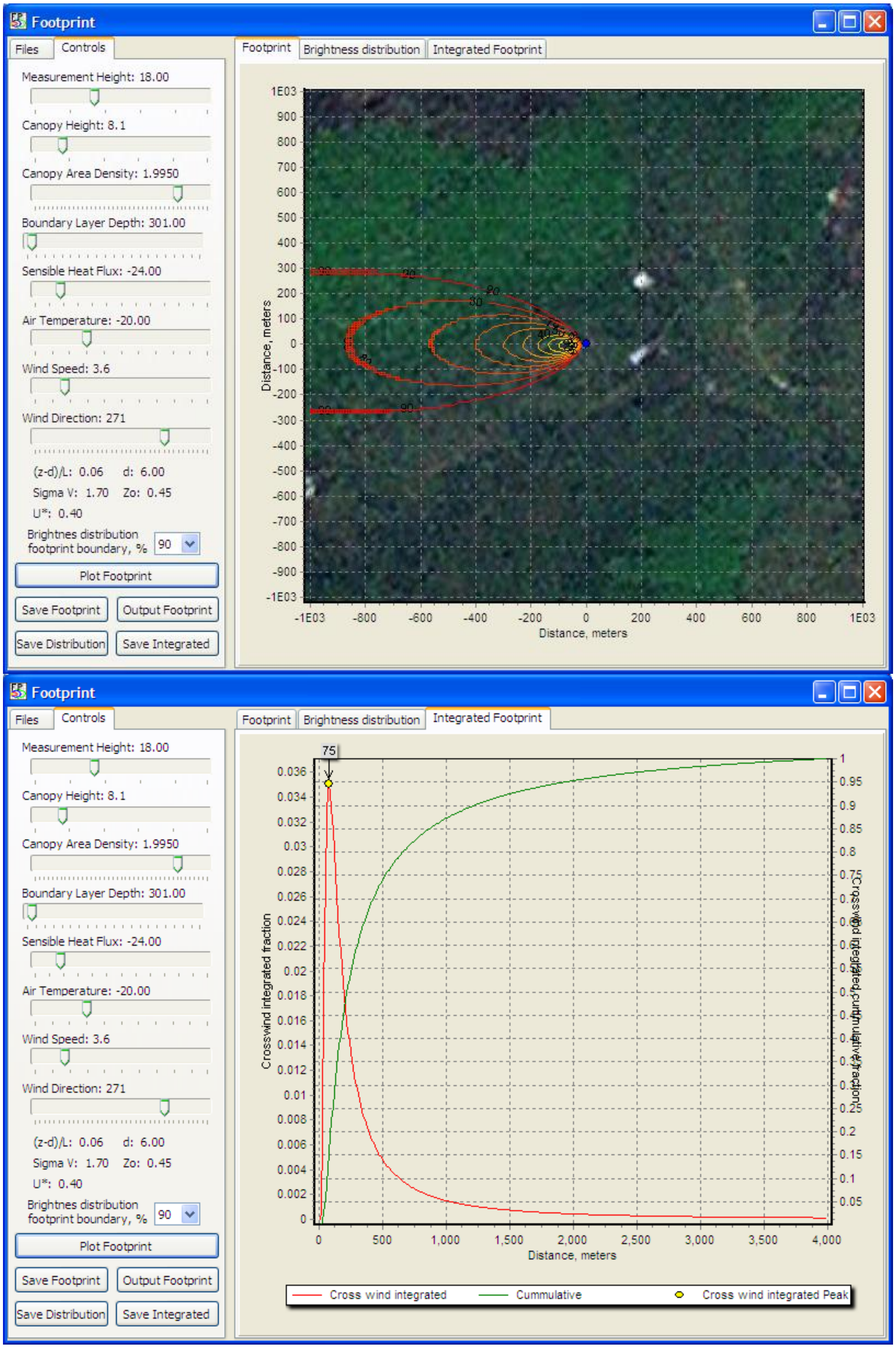


Figure 17. Caribou-Poker Core site winter daytime (convective) footprint output with max wind speed.

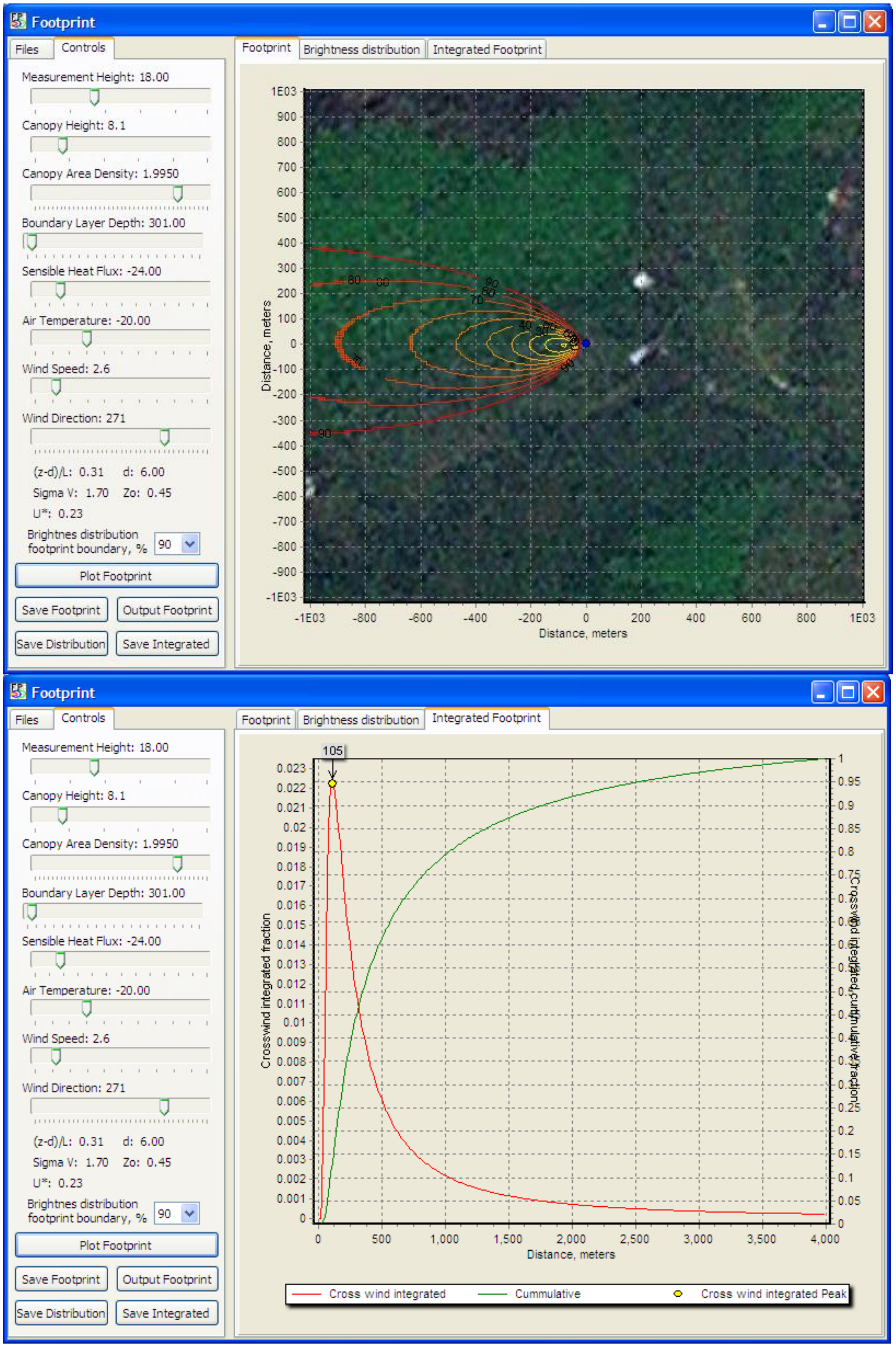


Figure 18. Caribou-Poker Core site winter daytime (convective) footprint output with mean wind speed.

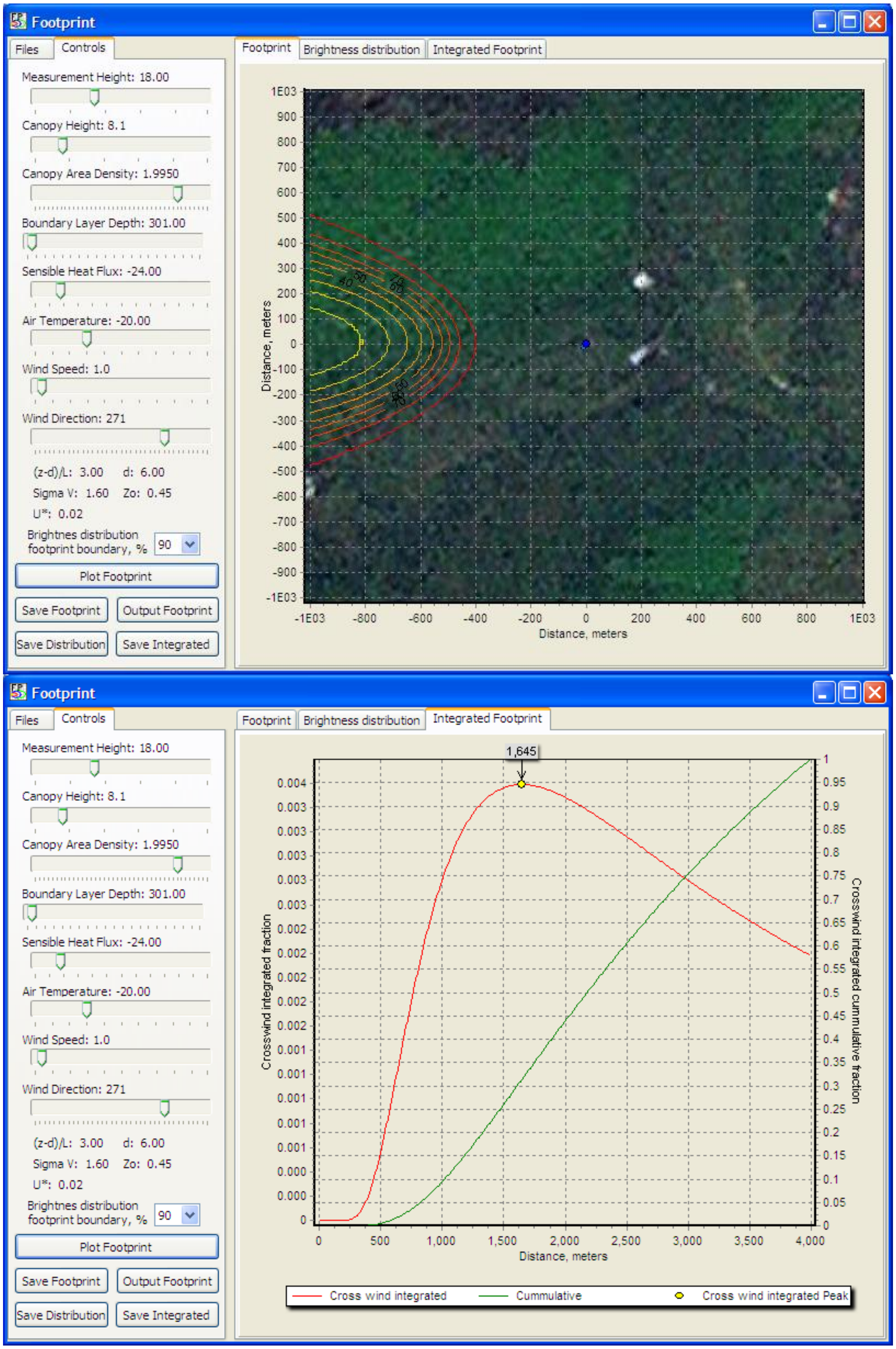


Figure 19. Caribou-Poker Core site winter nighttime (stable) footprint output with mean wind speed.

3.4.6 Site design and tower attributes

According to wind roses, the winds could come from any direction between 10º and 315º (clockwise from 10º). However, the prevailing wind is dominantly from west throughout the year. The major airshed, however, is from 245º to 295º (major airshed, clockwise from 245º). Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is black spruce on permafrost. Original candidate tower location is at 65.15401°, -149.50258°. We confirmed that it meets our requirements after FIU site characterization. Terrain is relatively flat and homogenous at the tower site and airshed areas.

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 and similar to the setup at other NEON sites, even it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circles the sky > 20 hours a day. 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 W-E direction. We require the placement of instrument hut at 65.15412°, -147.50266°, thus, the distance between the tower and the instrument hut is ~ 13 m.

The ecosystem inside the tower airshed and around tower is dominant by black spruce. Mean canopy height is ~ 8 m. Birch, horsetail and other shrubs forms top understory layer with height ~1.2 m. Canopy height for moss, grass and other annuals is ~ 0.2 m. We require 5 **measurement layers** on the tower with top measurement height at 18 m, and remaining measurement levels are 10.0 m, 4.0 m, 1.5 m and 0.15 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

DFIR (Double Fenced International Reference) will be used for bulk precipitation collection. We cannot find any adequate open area within 500 m radius from tower location that can meet USCRN class 1 or 2 criteria. The location we proposed is at 65.15601, -147.48950, which is ~650 m on northeast to tower. It is currently a clear cut open area. It will need to be maintained open in the whole life time of DFIR to meet USCRN criteria. This location is next to access dirt road, and should be close to power is NEON will bring line power along access dirt road to tower 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. **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 6. Site design and tower attributes for Caribou-Poker 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			245° to 295°		Clockwise from first angle
Tower location	65.15401°	-147.50258°	--	--	
Instrument hut	65.15412°	-147.50266°			
Instrument hut orientation vector	--	--	90° - 270°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	180°	--	
DFIR	65.15601°	-147.48950°			
Height of the measurement levels					
Level 1				0.15	m.a.g.l.
Level 2				1.5	m.a.g.l.
Level 3				4.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				18.0	m.a.g.l.
Tower Height				18.0	m.a.g.l.

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

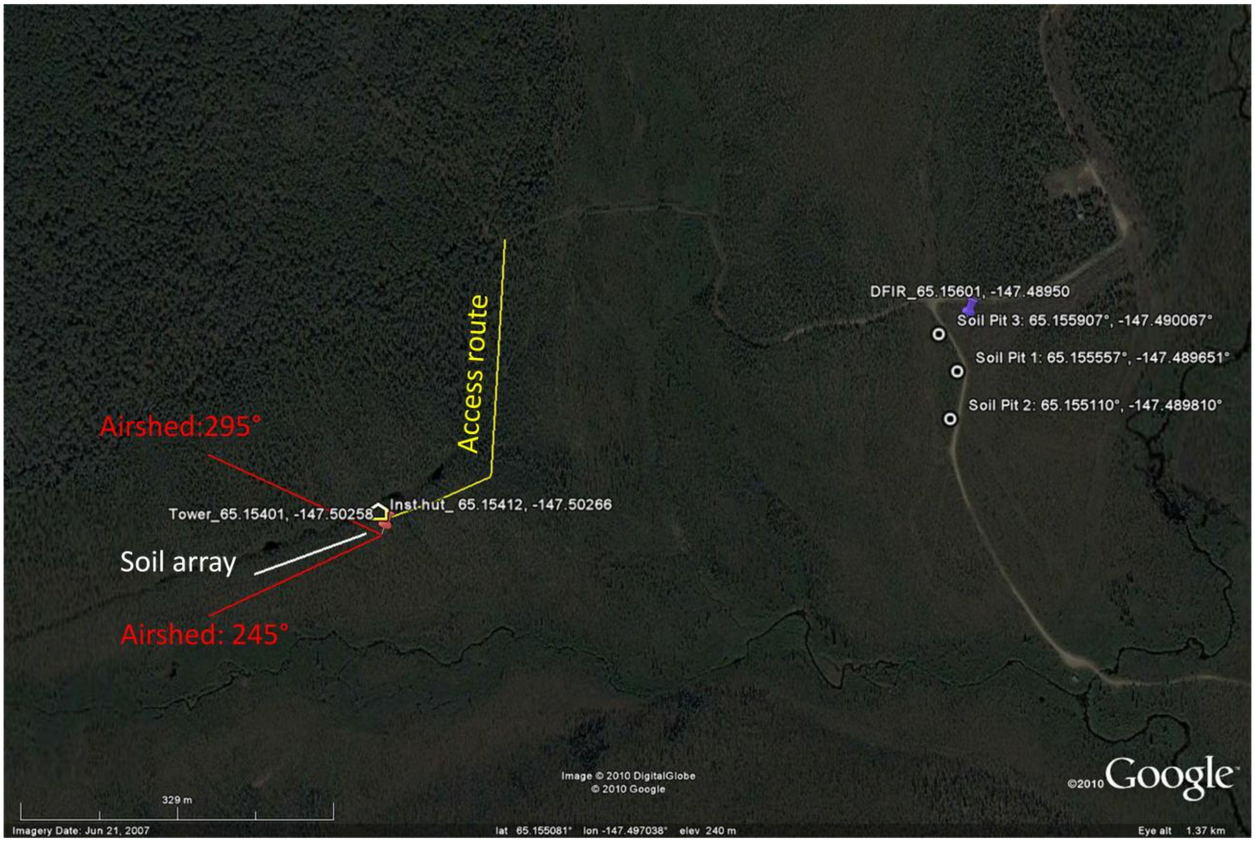


Figure 20. Site layout for Caribou Poker Advance tower site.
i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 245^{o} to 295^{o} (major airshed, clockwise from 245^{o}) is the airshed areas that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut. iv) Purple pin is 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" (0.914 m). wide footprint. The boardwalk to access the tower is not on any side that has a boom.
Specific Boardwalks at this site:

- Boardwalk from access dirt road to instrument hut. Boardwalk need to be wide enough only for ATV.
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array
- Boardwalk from soil array boardwalk to individual soil plots
- Boardwalk from access road to DFIR site

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

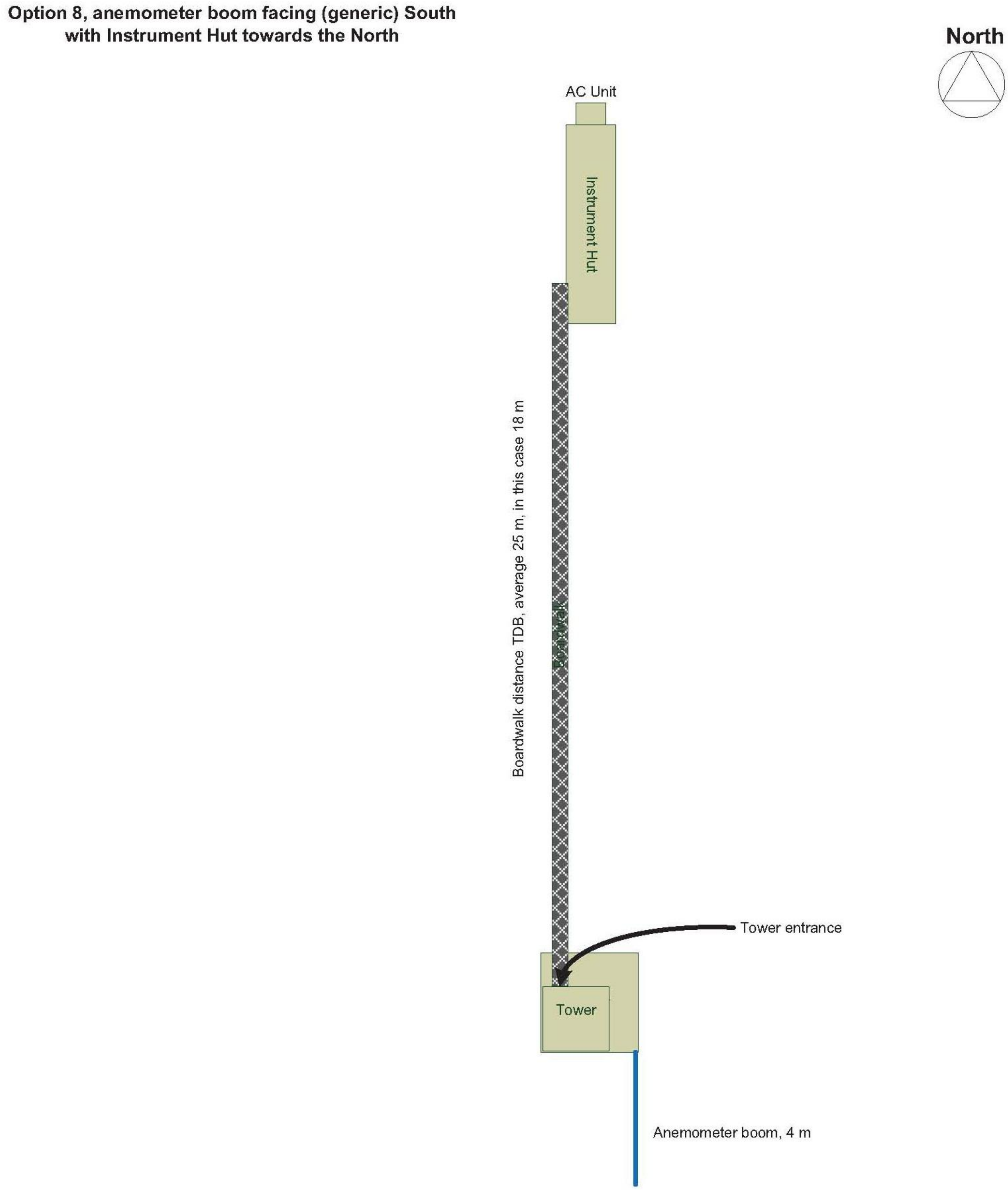


Figure 21 Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is 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 180°, instrument hut will be on the north towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be E-W (90° - 270°, longwise).

3.4.7 Information for ecosystem productivity plots

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (black spruce on permafrost). Tower airshed areas are from 245º to 295º (major airshed, clockwise from 245º), and 90% signals for flux measurements are in a distance < 500 m from tower during summer and >1200 m during the winter, and 80% within 350 m during the summer and >700 m during the winter. We suggest FSU Ecosystem Productivity plots be placed within the boundaries of 245º to 295º (major airshed, clockwise from 245º) from tower.

3.5 Issues and attentions

Power is ~ 3.22 km (2 miles) from tower site.
Tower site is at a foothill valley that conjoin the mountain slopes on north, south and east directions (Figure 22). Mountain terrain is complex. Cold air drainages converge at tower site area, making this site very appropriate for an advection study. Caribou Creek runs east-west direction next to tower site. The airflow is channeled by the north-facing and south-facing slopes and blows dominantly along the creek from west to east. These make it not ideal , but workable for flux measurements here, but will be still valid to catch inter-seasonal trend and inter-annual variation. Additional experimentation with advection measurements may be appropriate here.

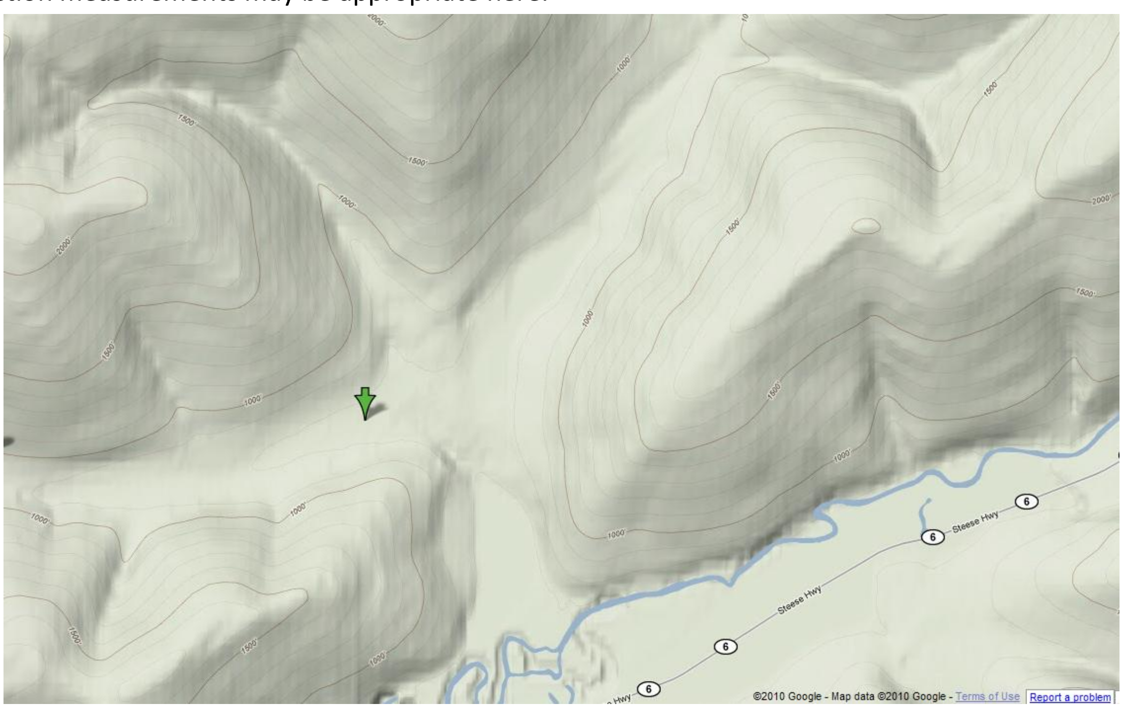


Figure 22. Caribou Poker advance tower site locates at a foothill valley that conjoin the mountain slopes on north, south and east directions

4 DELTA JUNCTION RELOCATEABLE TOWER 1

4.1 Site description

NEON candidate relocatable site (63.88112°, -145.75136°) at Delta Junction, Alaska is inside BLM lands and ~ 10 miles south of Delta Junction city (Figure 23) and about 100 miles south of Fairbanks.

NEON candidate site locates at "Big Delta, which lies at the intersection of the Delta River and the Tanana River. Three mountain ranges—the White Mountains to the north, the Granite Mountains to the southeast, and the Alaska Range to the southwest—and the Delta River to the west. Terrain is flat.

As it is not near the ocean, this area is drier than coastal Alaska and experiences seasonal extremes typical of subarctic areas. The annual precipitation is only 30.5 cm (12 inches), including 94 cm (37 inches) of snow. The average low temperature in January is -23°C (-11°F). The average high during July is +20°C (+69°F). Temperature extremes have been recorded from -53°C to +33°C (-63°F to +92°F).

Delta Junction is mostly sunny in the summer and split between clear and overcast days in the winter. On clear winter nights, the aurora borealis can often be seen in the winter sky. Like all subarctic regions, the months from May to July in the summer have no night, only twilight during the night hours. The months of November to January have 4 to 5 daylight and twilight hours.

Delta Junction was known as the "Windy City" and "Little Chicago" by many soldiers on Fort Greely, a reference to Chicago in the lower 48 United States. In Delta Junction itself, but not in the nearby areas, wind blows many days from the south up the Delta River from the Gulf of Alaska, bringing river silt in the summer and snowdrifts in the winter. There are usually several days in the winter when the temperature is in the range of -40° (C or F) when a wind (known as a Chinook wind) begins to blow. A few minutes later, the temperature climbs to above 0°C (+32°F). When the wind stops, the temperature returns to its colder value. Delta Junction's prevailing winds are from the east and south east (info source: http://en.wikipedia.org/wiki/Delta_Junction,_Alaska).

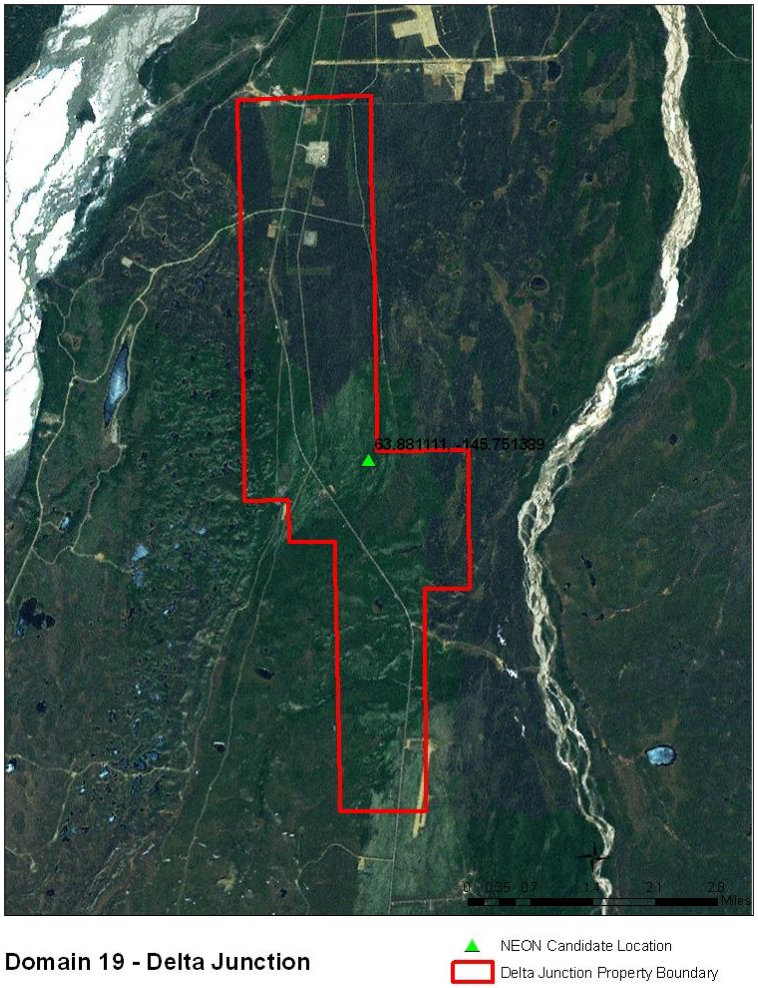


Figure 23. Boundary map for Delta Junction Relocatable site and candidate tower location.

4.2 Ecosystem

Vegetation and land cover information at NEON candidate site and surrounding area can be found below:

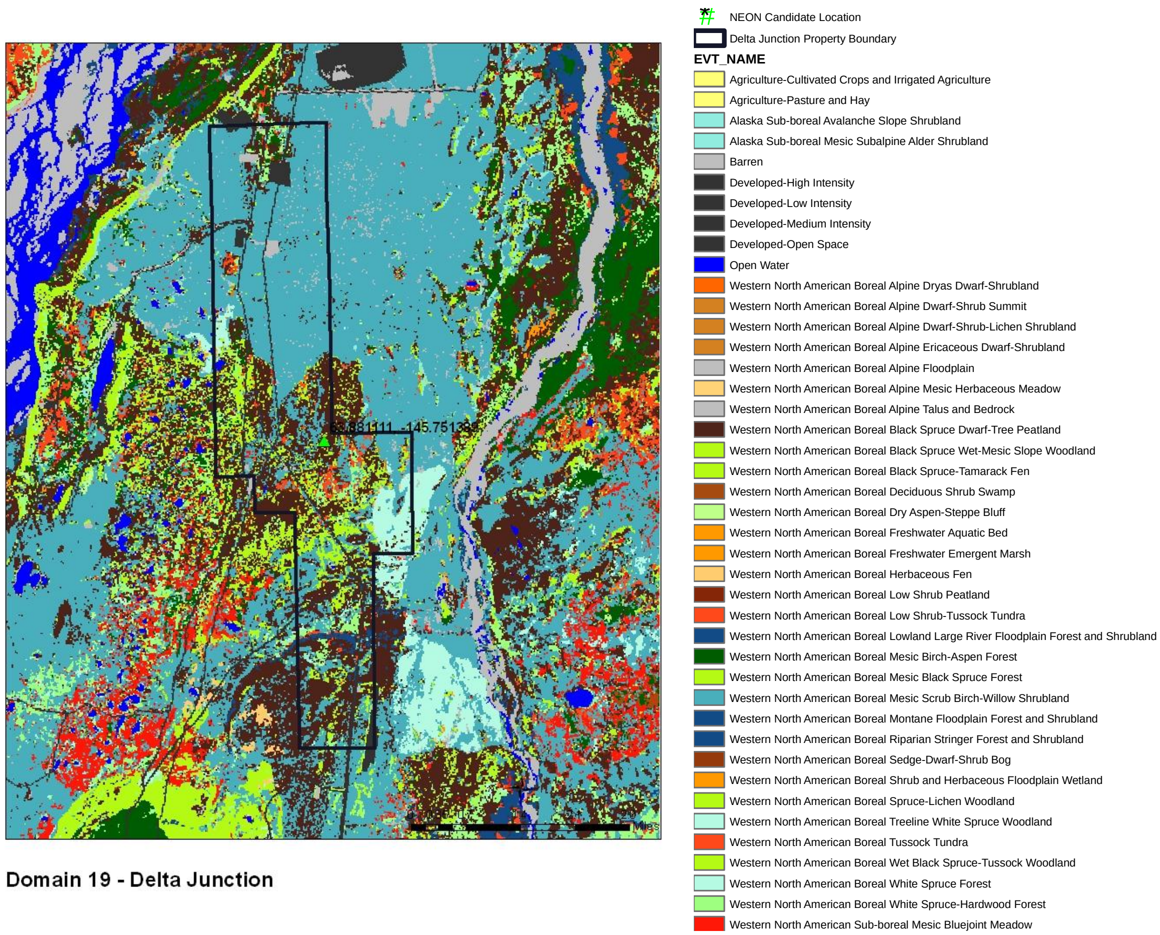


Figure 24. Vegetative cover map of Delta Junction Relocatable tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 7. Percent Land cover type at Delta Junction Relocatable tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Type	Area (km^2)	Percentage
Open Water	0.055830024	0.19
Developed-Open Space	0.152746895	0.51
Developed-Low Intensity	1.218892486	4.07
Developed-Medium Intensity	0.07466172	0.25
Developed-High Intensity	0.0171	0.06
Barren	0.469232776	1.57
Western North American Boreal White Spruce Forest	0.061433508	0.21
Western North American Boreal Treeline White Spruce Woodland	1.1127939	3.72
Western North American Boreal Spruce-Lichen Woodland	0.106293404	0.36
Western North American Boreal White Spruce-Hardwood Forest	0.826087535	2.76
Western North American Boreal Mesic Black Spruce Forest	2.104298434	7.03
Western North American Boreal Mesic Birch-Aspen Forest	0.270371889	0.90

Western North American Boreal Dry Aspen-Steppe Bluff	0.101141676	0.34
Alaska Sub-boreal Avalanche Slope Shrubland	0.0009	0.00
Alaska Sub-boreal Mesic Subalpine Alder Shrubland	0.049289184	0.16
Western North American Boreal Mesic Scrub Birch-Willow Shrubland	13.44375719	44.94
Western North American Sub-boreal Mesic Bluejoint Meadow	0.085906488	0.29
Western North American Boreal Montane Floodplain Forest and Shrubland	0.237082597	0.79
Western North American Boreal Herbaceous Fen	0.032368901	0.11
Western North American Boreal Sedge-Dwarf-Shrub Bog	0.012529049	0.04
Western North American Boreal Low Shrub Peatland	0.122615762	0.41
Western North American Boreal Black Spruce Dwarf-Tree Peatland	7.974438885	26.66
Western North American Boreal Black Spruce Wet-Mesic Slope Woodland	0.086650141	0.29
Western North American Boreal Deciduous Shrub Swamp	0.0009	0.00
Western North American Boreal Freshwater Emergent Marsh	0.0018	0.01
Western North American Boreal Freshwater Aquatic Bed	0.010166975	0.03
Western North American Boreal Low Shrub-Tussock Tundra	0.582721755	1.95
Western North American Boreal Wet Black Spruce-Tussock Woodland	0.644228553	2.15
Western North American Boreal Alpine Dryas Dwarf-Shrubland	0.0081	0.03
Western North American Boreal Alpine Ericaceous Dwarf-Shrubland	0.050471306	0.17
Total Area Sq Km	29.91481104	100.00

The representative ecosystem around NEON site is black spruce on well drained non-permafrost. This ecosystem is semi-open forest (Figure 25). Canopy height is ~ 10 m (mean), and max at 14 m around tower site and in airshed. Stem diameter is ~ 10 cm. Black spruce canopy has nice, typified healthy cone-shape at this site than the one found on permafrost. Recruitment of black spruce and birch form an understory with height ~ 1.5 m. Moss and lichen form the understory at ground level with height ~ 20 cm. Moss and lichen layer is thick (>20 cm without compression). Terrain is flat and ecosystem is homogenous.

Table 8. Ecosystem and site attributes for Delta Junction Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	10 m
Surface roughness[a]	1.2 m
Zero place displacement height[a]	7.0 m
Structural elements	black spruce on well drained non-permafrost, homogenous
Time zone	Alaska standard time
Magnetic declination	21° 10' E changing by 0° 22' W/year

Note, [a] From field survey.

Figure 25. Variable densities of black and white spruce is the dominant ecosystem at Delta Juntion Relocatable site

4.3 Soils

4.3.1 Description of soils

Soil data and soil maps (Figure 26, Table 9) below for Delta Junction tower site were collected from 5.8 km^2 NRCS soil maps(http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) to determine the dominant soil types in the larger tower foot print. This was done to assure that the soil array is in the dominant (or in the co-dominant) soil type present in the tower footprint.

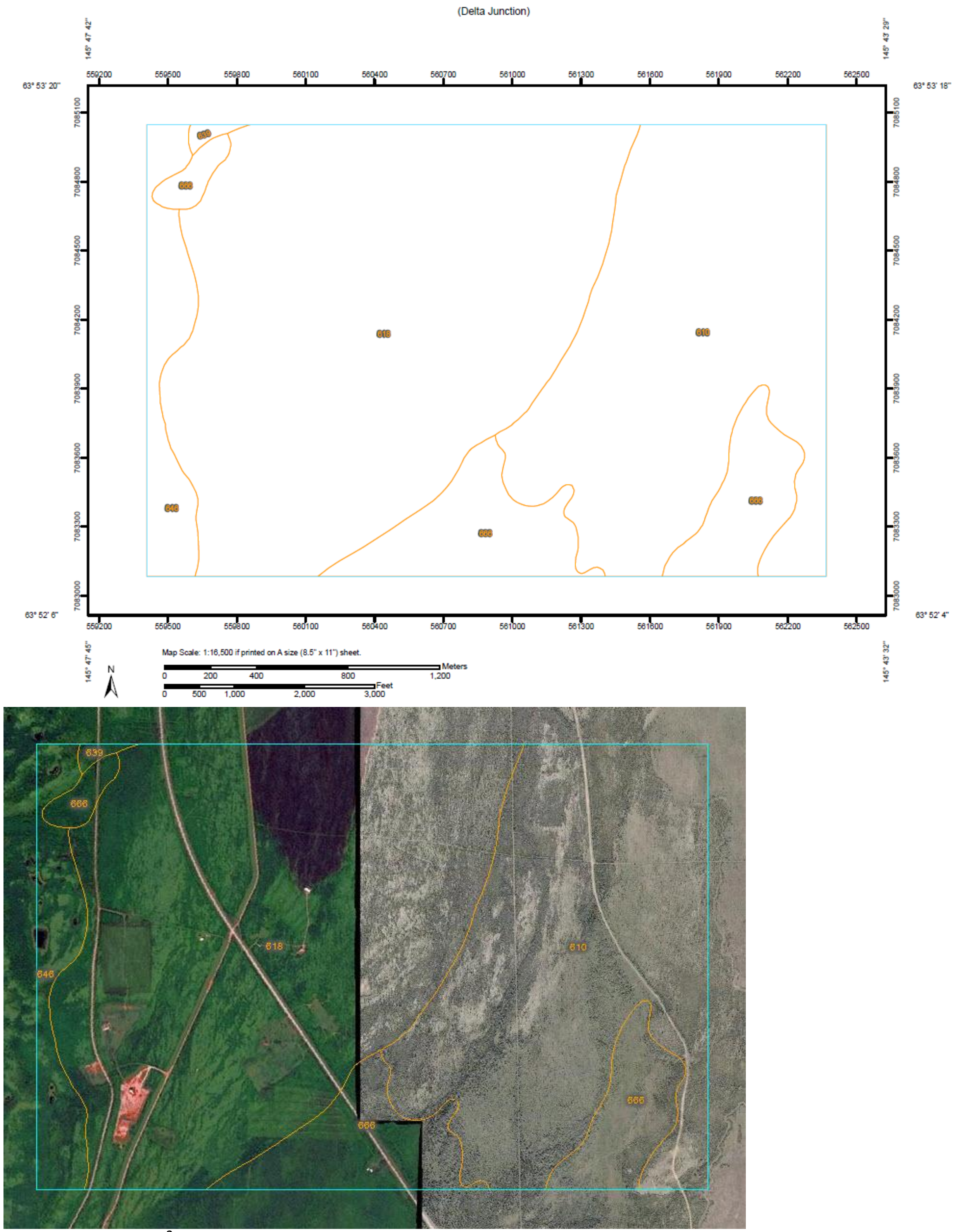


Figure 26. 5.8 km^2 soil map for Delta Junction NEON advanced tower site. Bottom image shows the same area with a background image, but without a scale bar.

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 9. Soil Series and percentage of soil series within 5.8 km^2 centered on the tower.
Area Object Interest (AOI) is the mapping unit from NRCS.

Fort Greely and Donnelly Training Area, Alaska (AK683)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
610	Butchlake-Southpaw complex, 0 to 12 percent slopes	474.5	33.0%
618	Donnelly-Nenana complex, 0 to 3 percent slopes	726.4	50.5%
639	Nenana silt loam, 0 to 3 percent slopes	3.7	0.3%
646	Nomercy Lake-Butchlake-Water complex, 0 to 35 percent slopes	75.5	5.3%
666	Typic Aquiturbels, 0 to 7 percent slopes	157.3	10.9%
Totals for Area of Interest		**1,437.3**	**100.0%**

Fort Greely and Donnelly Training Area, Alaska 610—Butchlake-Southpaw complex, 0 to 12 percent slopes: Map Unit Setting Elevation: 1,270 to 2,220 feet Mean annual precipitation: 16 to 22 inches Mean annual air temperature: 24 to 28 degrees F Frost-free period: 75 to 104 days **Map Unit Composition** Butchlake, gently sloping, and similar soils: 50 percent Southpaw and similar soils: 40 percent Minor components: 10 percent **Description of Butchlake, Gently Sloping Setting** Landform: Hills on moraines Landform position (two-dimensional): Backslope, shoulder, summit, footslope Down-slope shape: Linear, convex Parent material: Loess over till **Properties and qualities** Slope: 0 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 (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.9 inches) **Interpretive groups** Land capability (nonirrigated): 6s **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 4 inches: Mucky silt loam 4 to 9 inches: Extremely gravelly coarse sandy loam, cobbly sandy loam 9 to 60 inches: Very cobbly sandy loam **Description of Southpaw Setting** Landform: Hills on moraines Landform position (two-dimensional): Summit, shoulder, backslope, footslope Down-slope shape: Linear, concave, convex Parent material: Loess over glacial till **Properties and qualities** Slope: 0 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 (0.57 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 7.2 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 4 inches: Slightly decomposed plant material 4 to

13 inches: Silt loam 13 to 22 inches: Fine sandy loam 22 to 36 inches: Gravelly sandy loam 36 to 60 inches: Very gravelly loamy sand **Minor Components Butchlake, moderately steep** Percent of map unit: 5 percent Landform: Hills on moraines Landform position (two-dimensional): Backslope, shoulder, summit, footslope Down-slope shape: Linear, convex **Typic aquiturbels** Percent of map unit: 5 percent Landform: Depressions on moraines, hills on moraines Landform position (two-dimensional): Toeslope, footslope, backslope Down-slope shape: Linear, concave, convex

Fort Greely and Donnelly Training Area, Alaska 618—Donnelly-Nenana complex, 0 to 3 percent slopes: Map Unit Setting Elevation: 1,390 to 2,040 feet Mean annual precipitation: 16 to 20 inches Mean annual air temperature: 19 to 37 degrees F Frost-free period: 75 to 104 days **Map Unit Composition** Donnelly and similar soils: 65 percent Nenana and similar soils: 35 percent Minor components: 0 percent **Description of Donnelly Setting** Landform: Stream terraces Down-slope shape: Linear Parent material: Loess over sandy and gravelly alluvium **Properties and qualities** Slope: 0 to 3 percent Depth to restrictive feature: More than 80 inches Drainage class: Somewhat excessively drained Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 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 3.5 inches) **Interpretive groups** Land capability (nonirrigated): 6s **Typical profile** 0 to 2 inches: Slightly decomposed plant material 2 to 6 inches: Gravelly silt loam 6 to 12 inches: Gravelly silt loam 12 to 60 inches: Very gravelly sand **Description of Nenana Setting** Landform: Stream terraces Down-slope shape: Linear Parent material: Loess over alluvium **Properties and qualities** Slope: 0 to 3 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: Occasional Available water capacity: Low (about 5.9 inches) **Interpretive groups** Land capability (nonirrigated): 3s **Typical profile** 0 to 2 inches: Moderately decomposed plant material 2 to 15 inches: Silt loam 15 to 21 inches: Gravelly silt loam 21 to 60 inches: Extremely gravelly sand **Minor Components Volkmar** Percent of map unit: 0 percent Landform: Stream terraces Down-slope shape: Linear

Fort Greely and Donnelly Training Area, Alaska 639—Nenana silt loam, 0 to 3 percent slopes: Map Unit Setting Elevation: 1,190 to 1,760 feet Mean annual precipitation: 12 to 16 inches Mean annual air temperature: 19 to 37 degrees F Frost-free period: 75 to 104 days **Map Unit Composition** Nenana and similar soils: 85 percent Minor components: 15 percent **Description of Nenana Setting** Landform: Stream terraces Down-slope shape: Linear Parent material: Loess over alluvium **Properties and qualities** Slope: 0 to 3 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: Occasional Available water capacity: Low (about 5.9 inches) **Interpretive groups** Land capability (nonirrigated): 3s **Typical profile** 0 to 2 inches: Moderately decomposed plant material 2 to 15 inches: Silt loam 15 to 21 inches: Gravelly silt loam 21 to 60 inches: Extremely gravelly sand **Minor Components Donnelly** Percent of map unit: 10 percent Landform: Stream terraces Down-slope shape: Linear **Volkmar** Percent of map unit: 5 percent Landform: Stream terraces Down-slope shape: Linear

Fort Greely and Donnelly Training Area, Alaska 646—Nomercy Lake-Butchlake-Water complex, 0 to 35 percent slopes: Map Unit Setting Elevation: 1,300 to 2,830 feet Mean annual precipitation: 17 to 21 inches Mean annual air temperature: 24 to 28 degrees F Frost-free period: 50 to 104 days **Map Unit Composition** Nomercy lake and similar soils: 35 percent Butchlake and similar soils: 25 percent Water:

20 percent Minor components: 20 percent **Description of Nomercy Lake Setting** Landform: Hills on moraines Down-slope shape: Linear, convex, concave Parent material: Loess over till **Properties and qualities** Slope: 0 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 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 6.0 inches) **Interpretive groups** Land capability (nonirrigated): 6s **Typical profile** 0 to 2 inches: Moderately decomposed plant material 2 to 4 inches: Silt loam 4 to 13 inches: Gravelly fine sandy loam 13 to 60 inches: Very gravelly fine sandy loam **Description of Butchlake Setting** Landform: Hills on moraines Landform position (two-dimensional): Backslope, shoulder, summit, footslope Down-slope shape: Linear, convex Parent material: Loess over till **Properties and qualities** Slope: 0 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 to high (0.57 to 1.98 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Low (about 3.9 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 4 inches: Mucky silt loam 4 to 9 inches: Extremely gravelly coarse sandy loam, cobbly sandy loam 9 to 60 inches: Very cobbly sandy loam **Description of Water Setting** Landform: Lakes **Interpretive groups** Land capability (nonirrigated): 8 **Minor Components Typic cryaquepts** Percent of map unit: 10 percent Landform: Depressions on pitted outwash plains, depressions on moraines Down-slope shape: Concave **Typic aquiturbels** Percent of map unit: 5 percent Landform: Depressions on moraines, hills on moraines Landform position (two-dimensional): Toeslope, footslope, backslope Down-slope shape: Linear, concave, convex **Butchlake, very steep** Percent of map unit: 3 percent Landform: Hills on moraines Landform position (two-dimensional): Backslope, shoulder, summit, footslope Down-slope shape: Linear, convex **Terric hemistels** Percent of map unit: 2 percent Landform: Depressions on moraines Down-slope shape: Concave

Fort Greely and Donnelly Training Area, Alaska 666—Typic Aquiturbels, 0 to 7 percent slopes: Map Unit Setting Elevation: 1,320 to 2,250 feet Mean annual precipitation: 15 to 19 inches Mean annual air temperature: 24 to 28 degrees F Frost-free period: 50 to 104 days **Map Unit Composition** Typic aquiturbels and similar soils: 90 percent Minor components: 10 percent **Description of Typic Aquiturbels Setting** Landform: Depressions on moraines, hills on moraines Landform position (two-dimensional): Toeslope, footslope, backslope Down-slope shape: Linear, concave, convex Parent material: Loess over till **Properties and qualities** Slope: 0 to 7 percent Depth to restrictive feature: 14 to 31 inches to permafrost Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Low (about 5.1 inches) **Interpretive groups** Land capability (nonirrigated): 6w **Typical profile** 0 to 7 inches: Moderately decomposed plant material 7 to 15 inches: Very fine sandy loam 15 to 33 inches: Very fine sandy loam 33 to 41 inches: Very fine sandy loam 41 to 60 inches: Gravelly very fine sandy loam **Minor Components Audrey** Percent of map unit: 5 percent Landform: Hills on moraines Landform position (two-dimensional): Shoulder, summit, footslope, backslope Down-slope shape: Linear, concave, convex **Terric hemistels** Percent of map unit: 5 percent Landform: Depressions on moraines Down-slope shape: Concave

4.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 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.

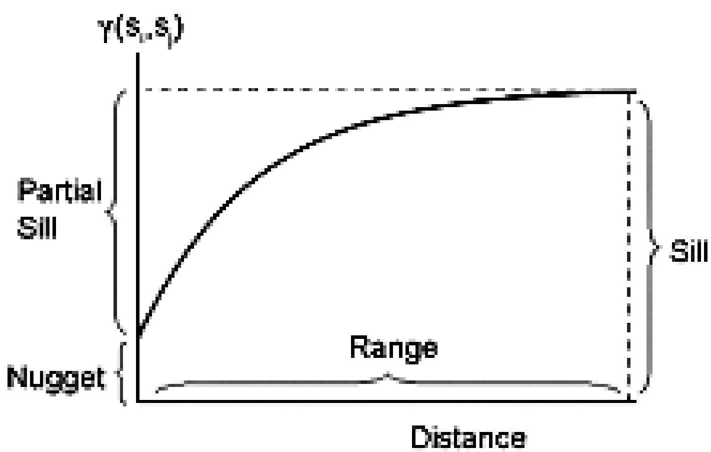


Figure 27. Example semivariogram, depicting range, sill, and nugget.

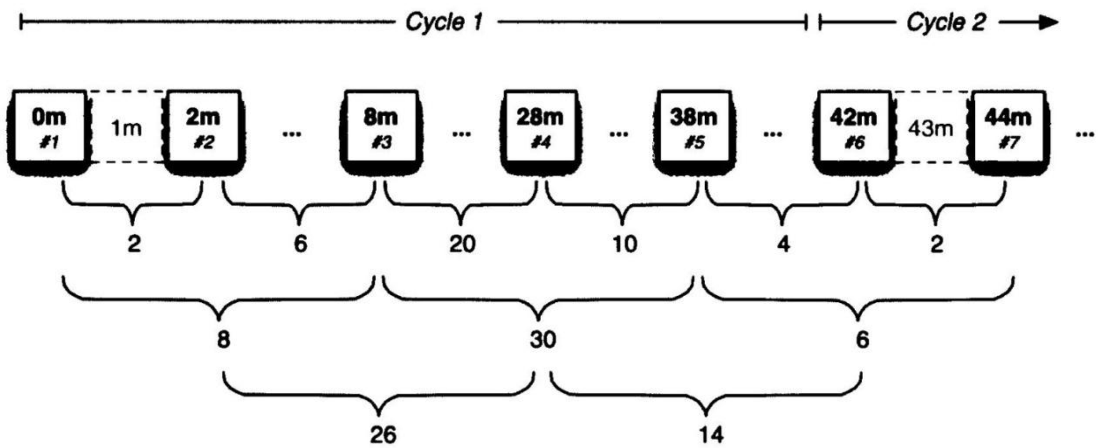


Figure 28. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 23 June 2010 at the Delta Junction 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 (210 m, 84 m, and 84 m) located in the expected airshed at Delta Junction. 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).

4.3.3 Results and interpretation

4.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day 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 graph) 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 44 m for soil temperature.

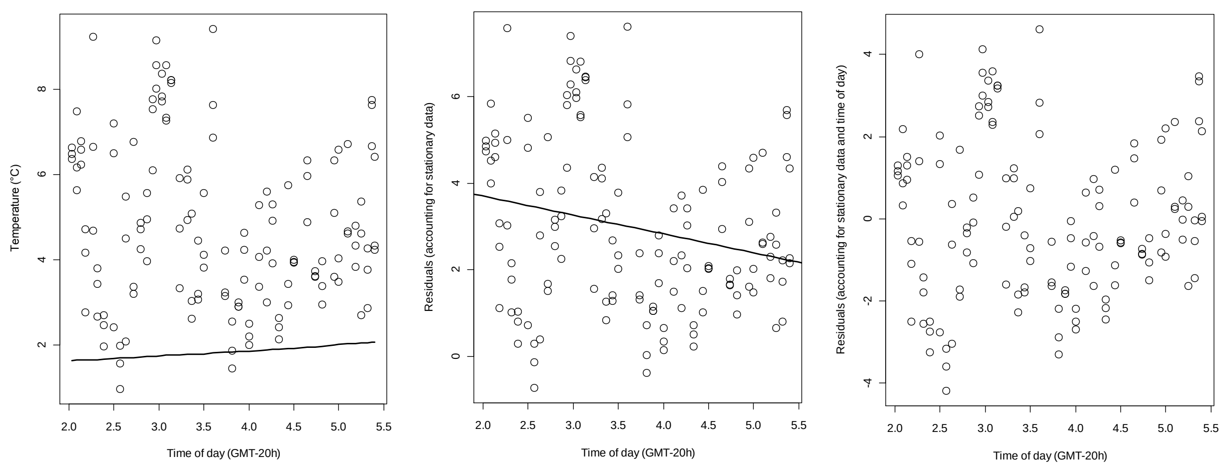


Figure 29. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting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

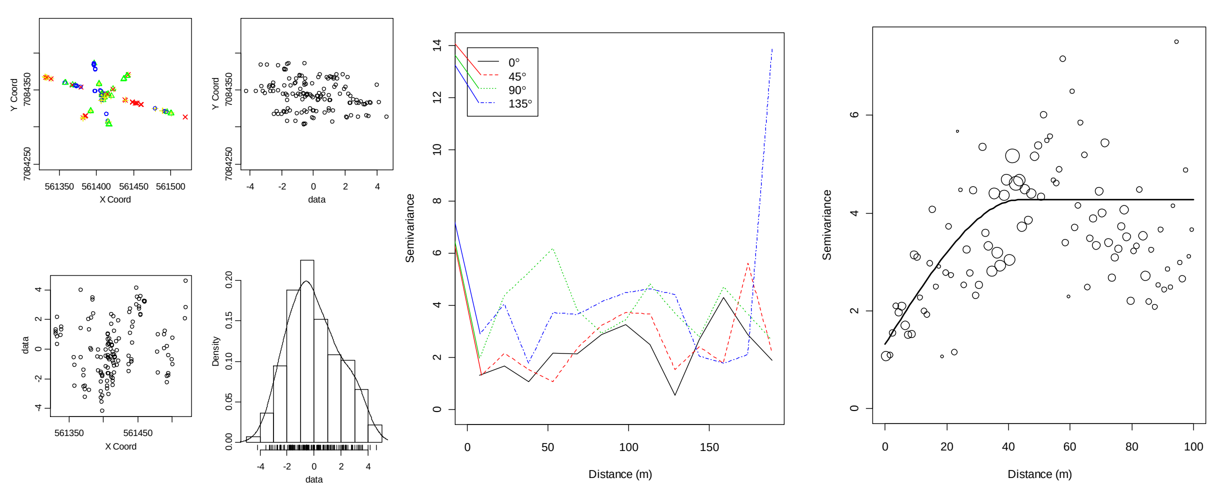


Figure 30. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

4.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 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 6 m for soil water content.

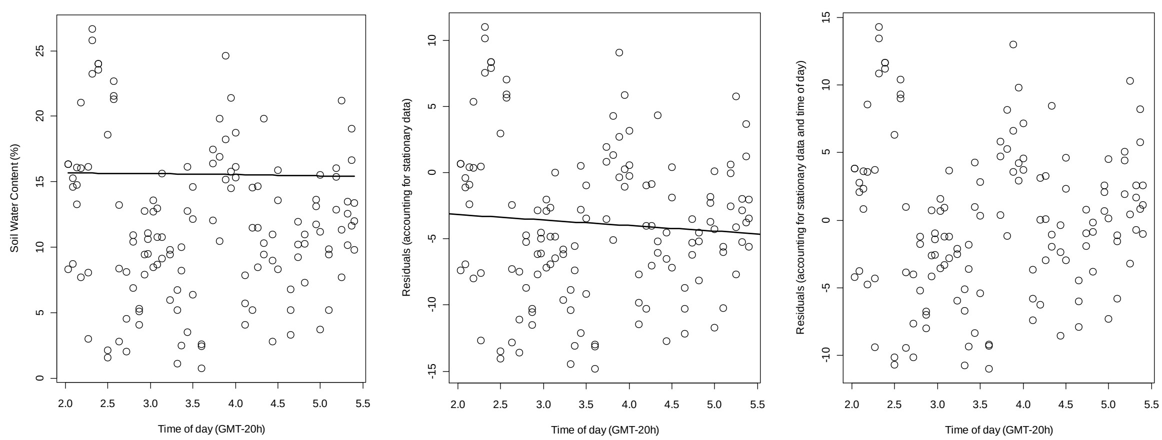


Figure 31. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting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

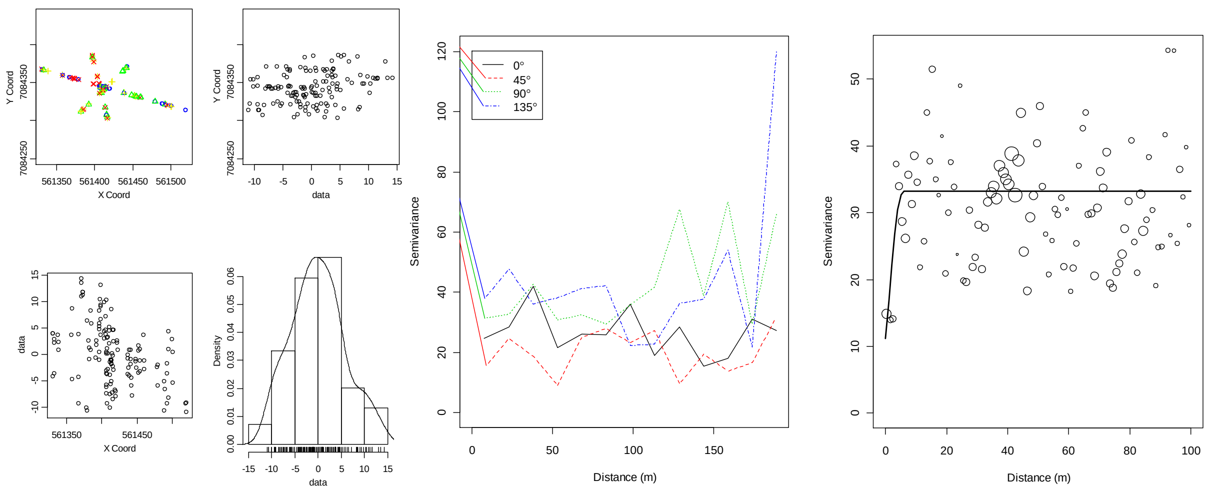


Figure 32. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

4.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was 44 m for soil temperature and 6 m for soil moisture. Based on these results and the site design guidelines the soil plots at Delta Junction 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 125° from the soil plot nearest the tower. The location of the first soil plot will be approximately 63.881148°, -145.751020°. 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 63.879713°, -145.747663° (primary location); or 63.879242°, -145.747665° (alternate location 1 if primary location is unsuitable); or 63.878762°, -145.747669° (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 10 and site layout can be seen in Figure 33.

Dominant soil series at the site: Butchlake-Southpaw complex, 0 to 12 percent slopes. The taxonomy of this soil is shown below:
Order: Inceptisols
Suborder: Cryepts
Great group: Haplocryepts
Subgroup: Typic Haplocryepts
Family: Loamy-skeletal, mixed, superactive Typic Haplocryepts-Coarse-loamy, mixed, superactive Typic Haplocryepts
Series: Butchlake-Southpaw complex, 0 to 12 percent slopes

Table 10. Summary of soil array and soil pit information at Delta Junction. 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	17 m
Latitude and longitude of 1st soil plot OR direction from tower	63.881148°, -145.751020°
Direction of soil array	125°
Latitude and longitude of FIU soil pit 1	63.879713°, -145.747663° (primary location)
Latitude and longitude of FIU soil pit 2	63.879242°, -145.747665° (alternate 1)
Latitude and longitude of FIU soil pit 3	63.878762°, -145.747669° (alternate 2)
Dominant soil type	Butchlake-Southpaw complex, 0 to 12 percent slopes
Expected soil depth	>2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths[*]**
0-0.10 m (Slightly decomposed plant material)	0.05 m
0.10-0.33 m (Silt loam)	[a]0.22 m
0.33-0.56 m (Fine sandy loam)	0.43 m
0.56-0.91 m (Gravelly sandy loam)	[a] 0.74 m
0.91-1.52 m (Very gravelly loamy sand)	1.23 m
1.52-3.00 m	[a] 3.00 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. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to characterize permafrost dynamics. [a]Notes the current understanding of the measurement depths to be applied by the soil array.

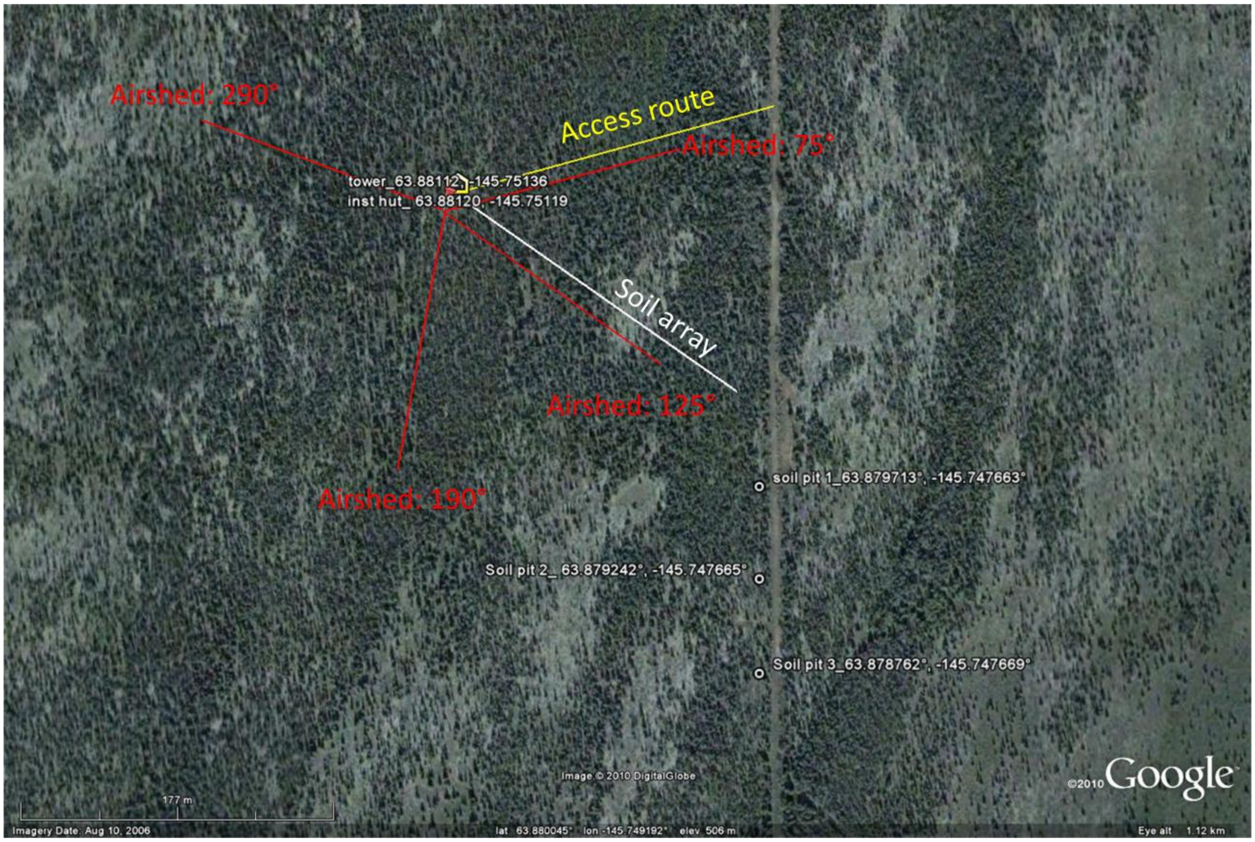


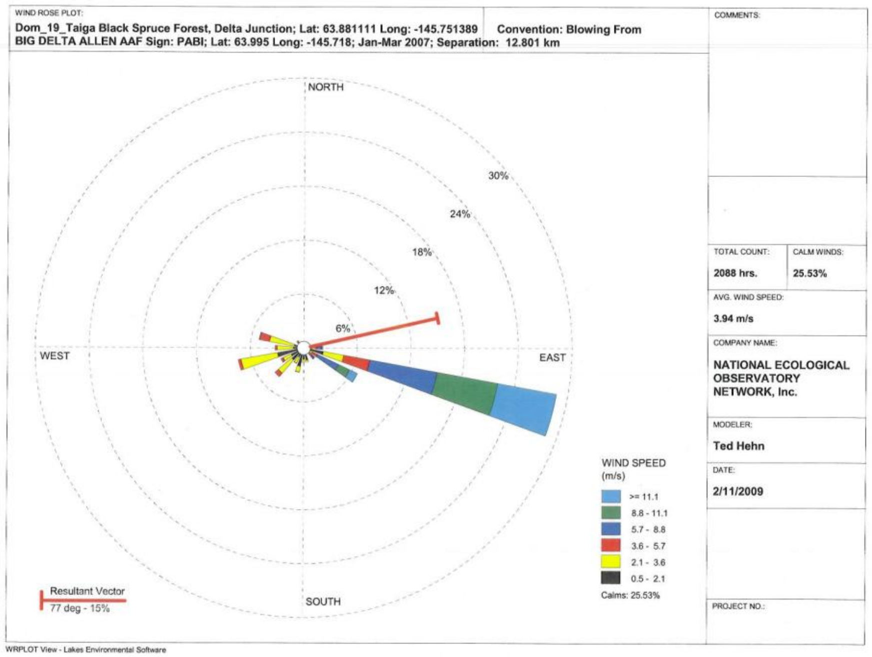
Figure 33. Site layout at Delta Junction showing soil array and location of the FIU soil pit.

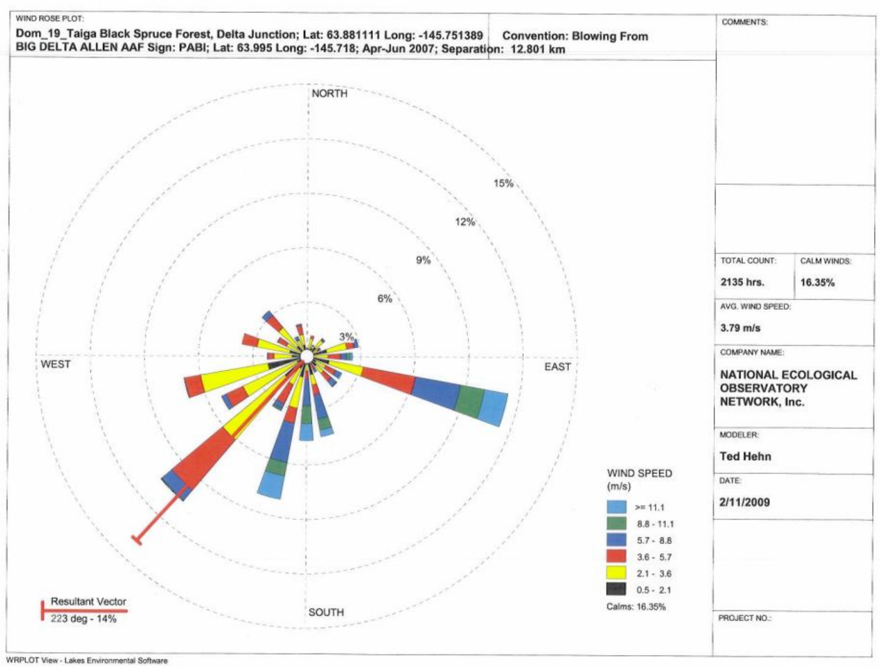
4.4 Airshed

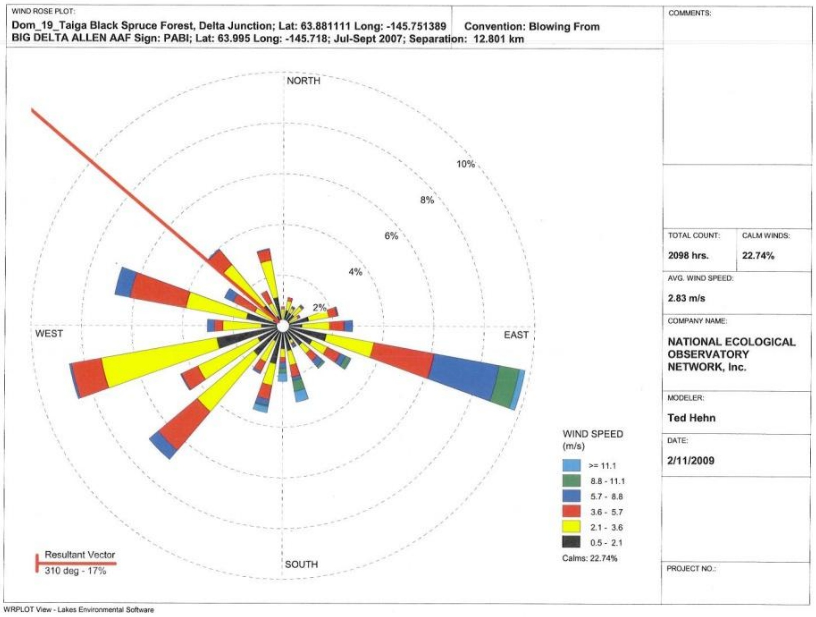
4.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figure 32. The weather data used to generate the following wind roses are from Allen Army Airfield (AAF) airport at 63.995, -145.718, which is ~ 13 km on the north to NEON tower site. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

4.4.2 Results (graphs for wind roses)







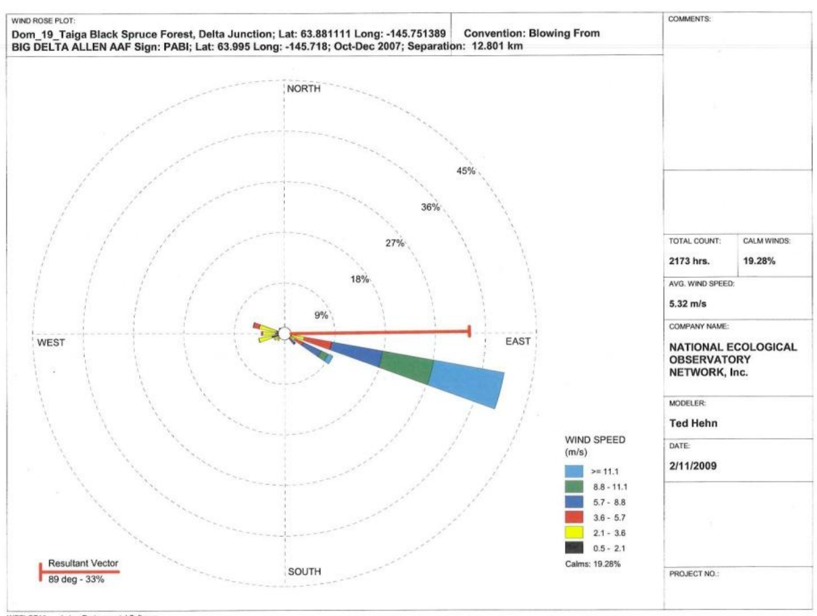


Figure 34. Windroses for Delta Junction relocatable site.
Data used here are 2007 wind data from from Allen Army Airfield (AAF) airport at 63.995, -145.718, which is ~ 13 km on the north to NEON tower site. It is assumed that the wind data was corrected for declination. Panels (from Top to bottom), are from Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

4.4.3 Resultant vectors

Table 11. The resultant wind vectors from Delta Junction relocatable site using hourly data in 2007

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	77°	15
April to June	223°	14
July to September	310°	17
October to December	89°	33
Annual mean	84.75°	na.

4.4.4 Expected environmental controls on source area

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

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

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

Table 12. Expected environmental controls to parameterize the source area model, and associated results from Delta Junction 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	18	18	18	18	18	18	m
Canopy Height	8	8	8	8	8	8	m
Canopy area density	2.0	2.2	2.2	1.8	1.8	1.8	m
Boundary layer depth	900	900	900	300	300	300	m
Expected sensible heat flux	180	180	100	-25	-25	-25	W m^{-2}
Air Temperature	4	4	2	-20	-20	-20	°C
Max. windspeed	13	3.6	2.4	11	5.6	2	m s^{-1}
Resultant wind vector	105	105	255	105	105	255	degrees
Results							
(z-d)/L	-0.01	-0.19	-0.3	0	0.01	3	m
d	6	6	6	5.8	5.8	5.8	m
Sigma v	3.3	1.4	1.1	1.7	1.7	1.6	m^2 s^{-2}
Z0	0.45	0.45	0.45	0.49	0.49	0.49	m
u*	1.6	0.51	0.36	1.4	0.69	0.06	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	950	480	400	1000	1000	3250	m
Distance of 80% cumulative flux	500	350	250	520	600	2750	m
Distance of 70% cumulative flux	400	200	200	400	350	2300	m
Peak contribution	75	55	45	75	65	895	m

4.4.5 Results (source area graphs)

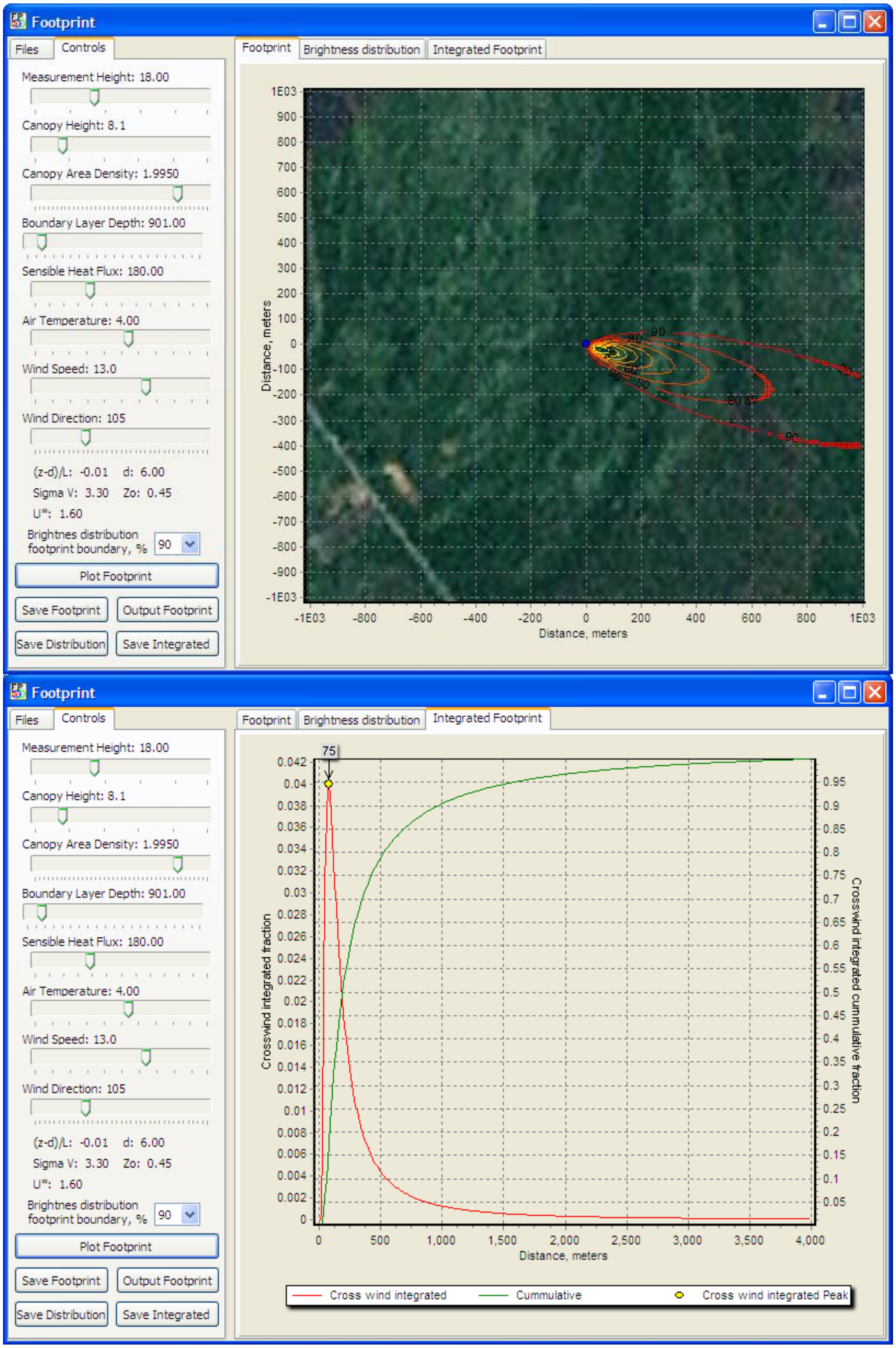


Figure 35. Delta Junction summer daytime (convective) footprint output with max wind speed.

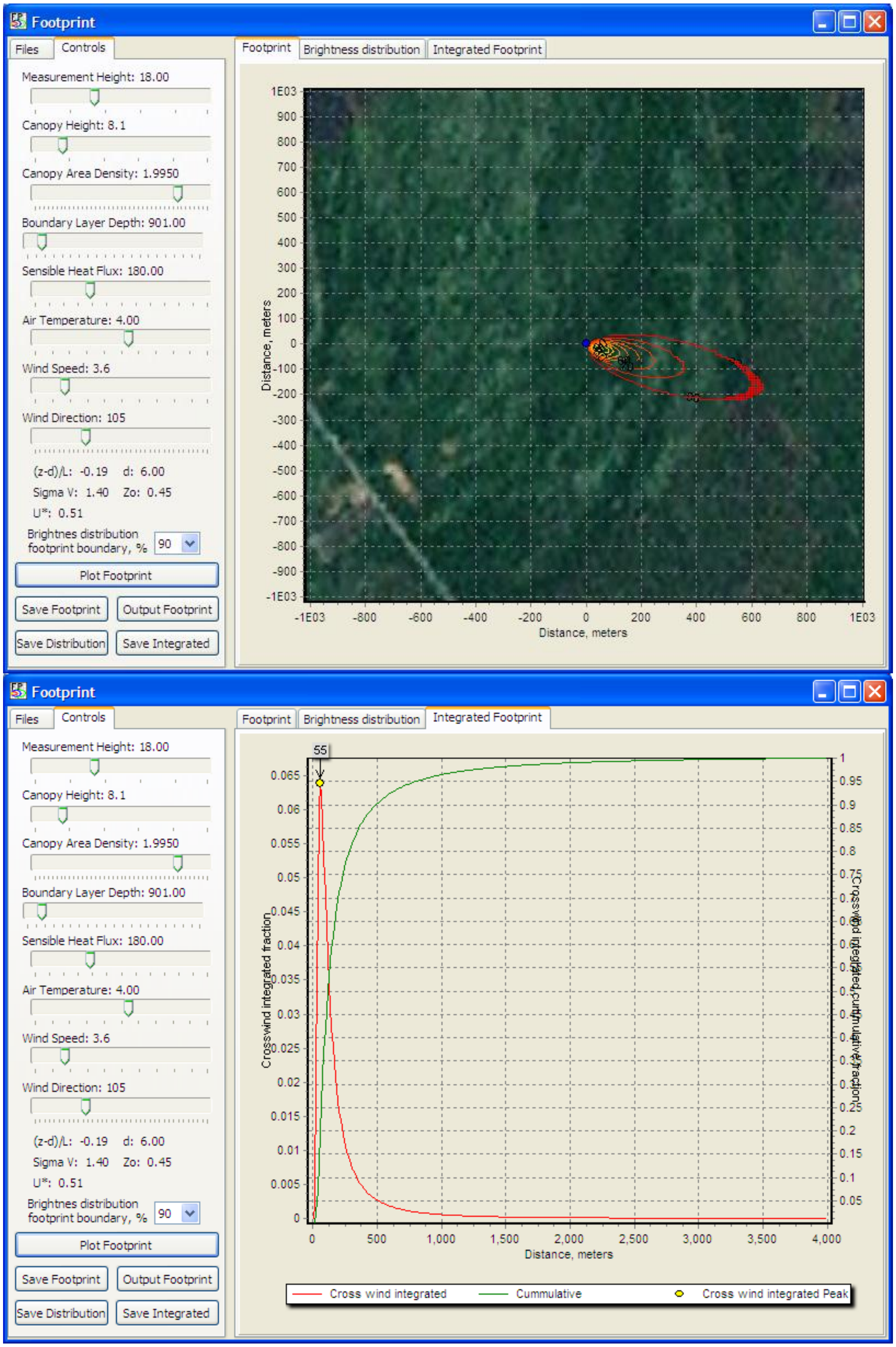


Figure 36. Delta Junction summer daytime (convective) footprint output with mean wind speed.

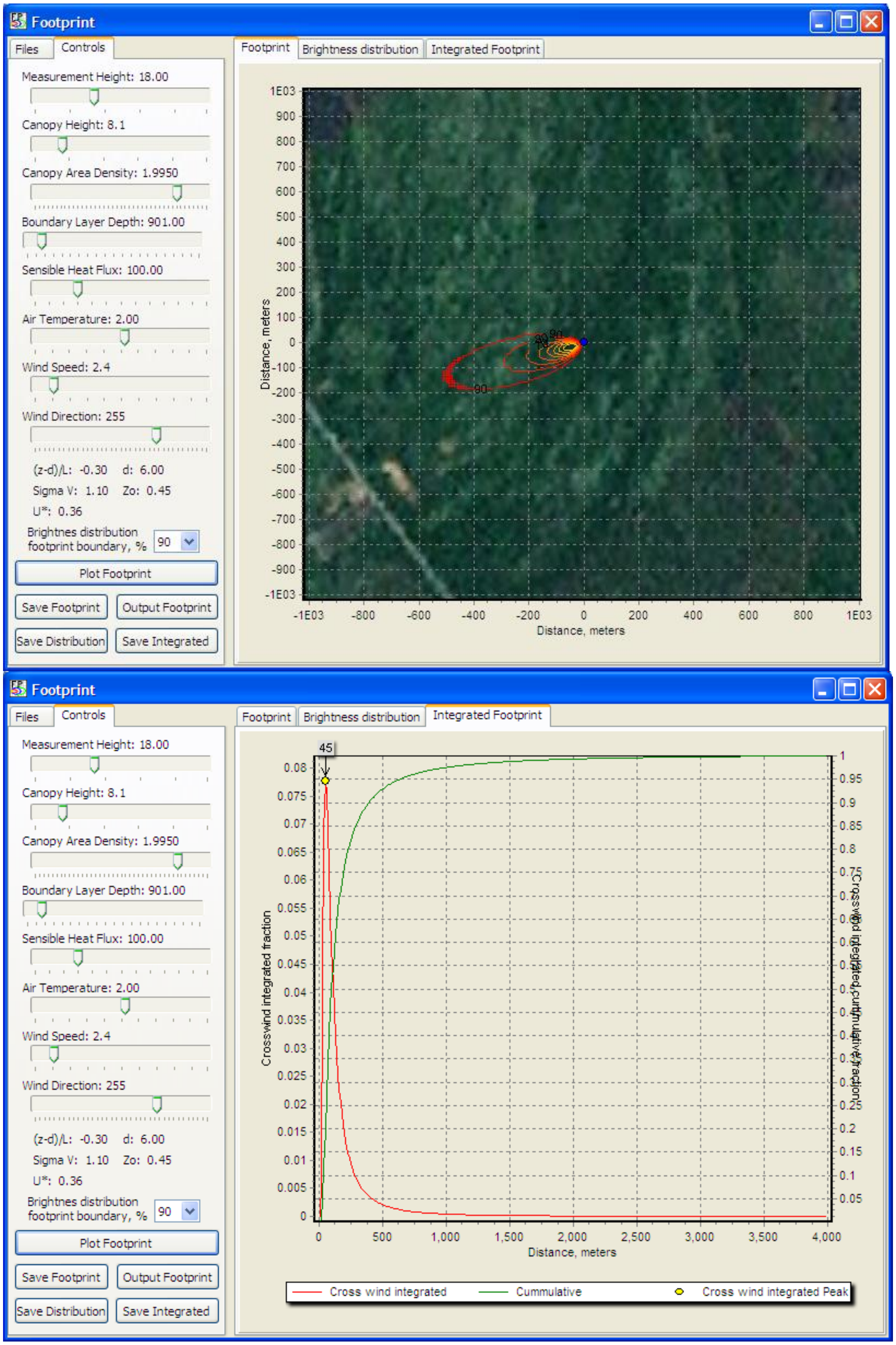


Figure 37. Delta Junction summer nighttime (stable) footprint output with mean wind speed.

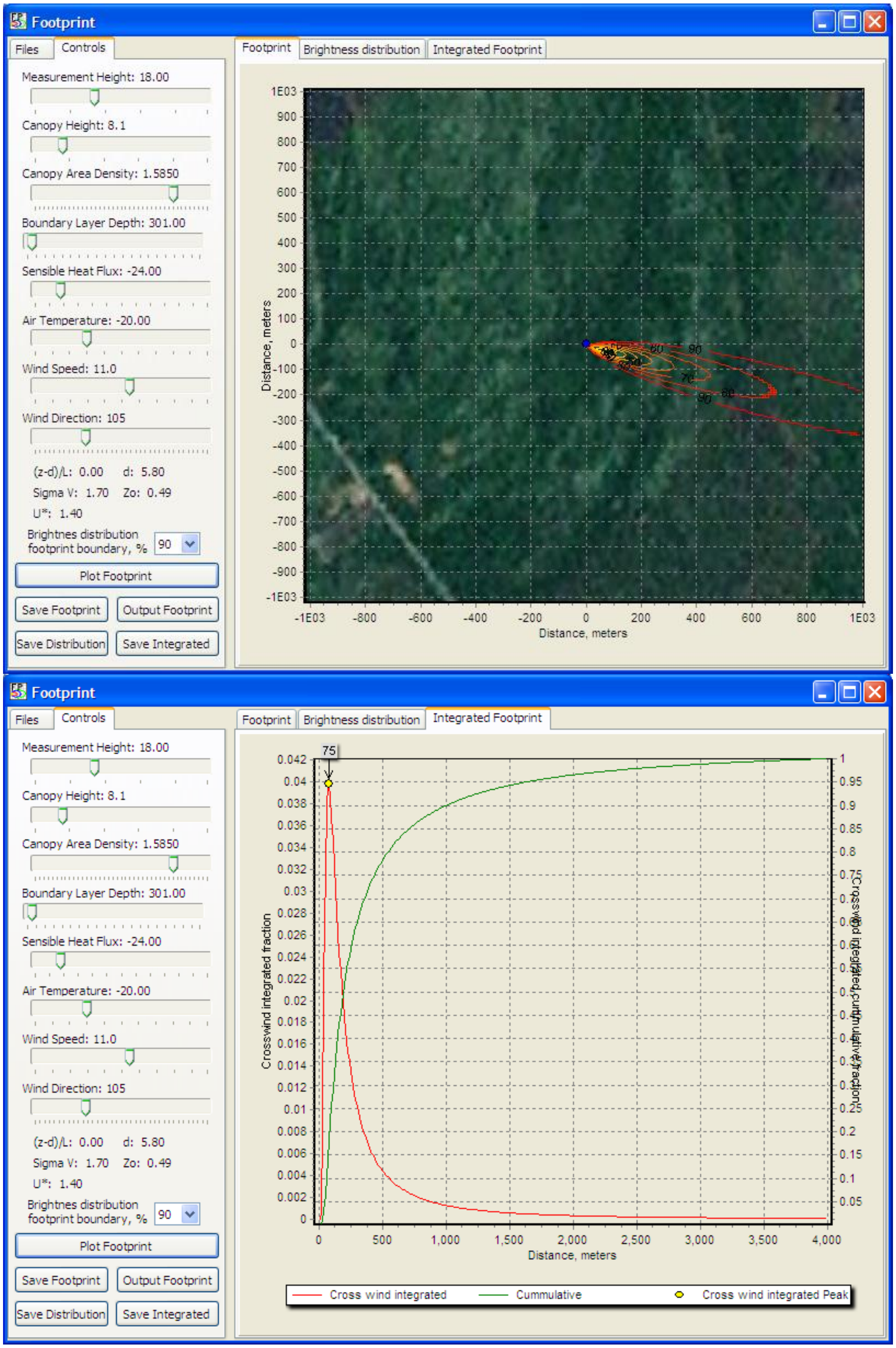


Figure 38. Delta Junction winter daytime (convective) footprint output with max wind speed.

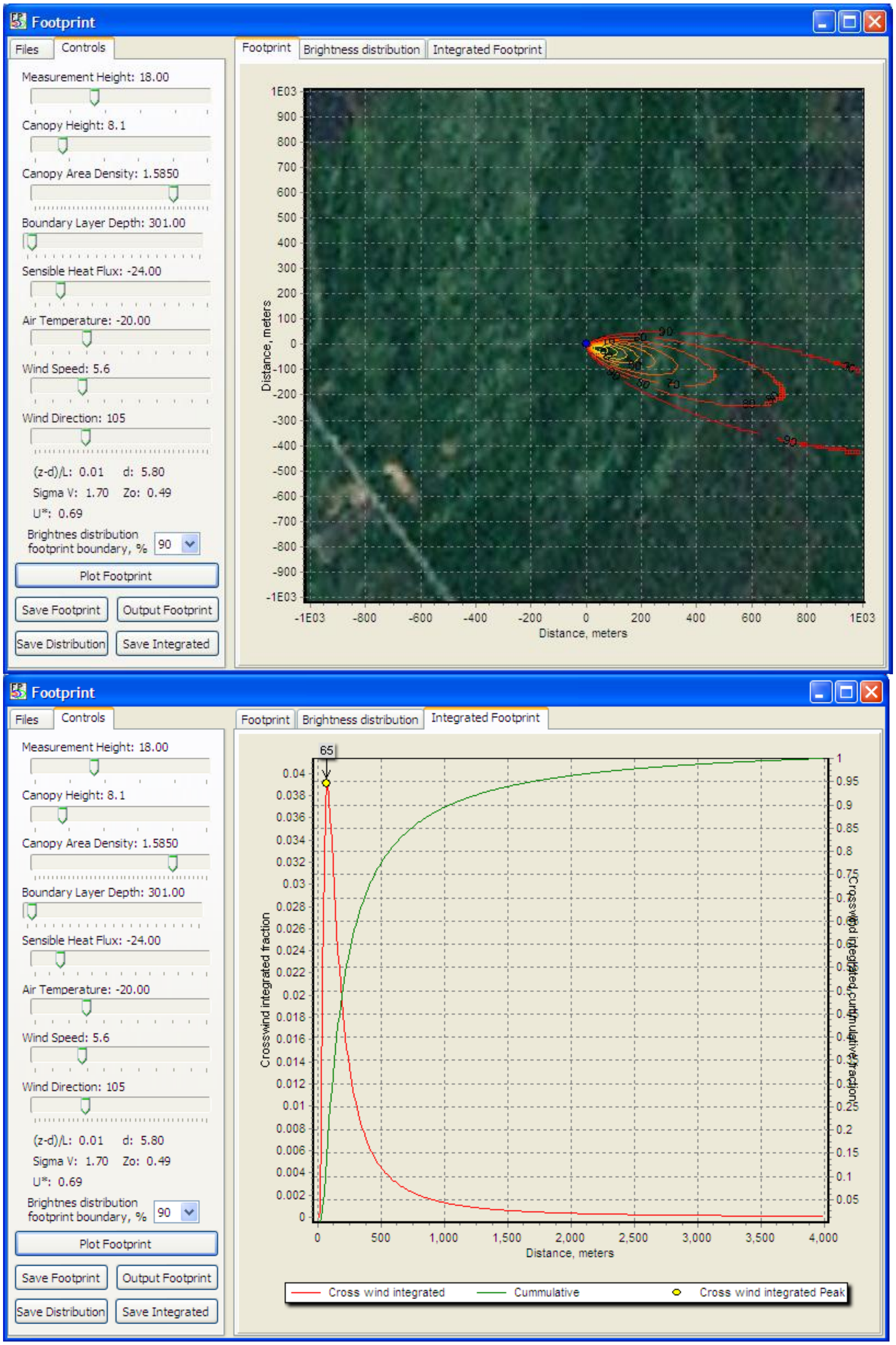


Figure 39. Delta Junction winter daytime (convective) footprint output with mean wind speed.

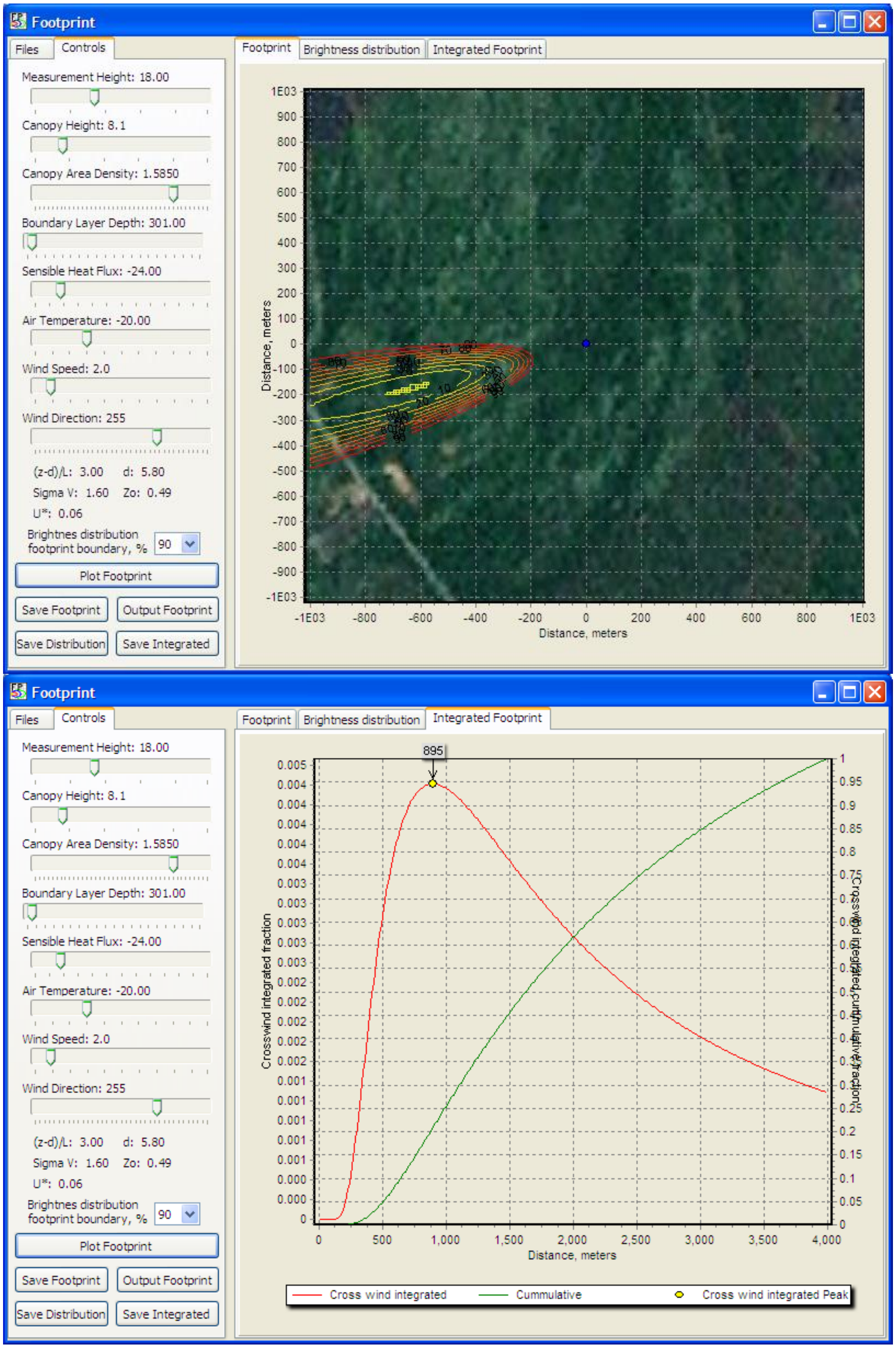


Figure 40. Delta Junction winter nighttime (stable) footprint output with mean wind speed.

4.4.6 Site design and tower attributes

According to wind roses, winds can blow from all directions during the year. The prevailing wind consistently blows from 75° to 125° (clockwise from 75°, major airshed) throughout the year. However, during the warmer seasons (April to September), winds also blow between south and northwest with higher frequency from 190° to 290° (clockwise from 190°, secondary airshed). Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is black spruce ecosystem. Tower location was determined to be 63.88112, -145.75136 during FIU site characterization.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the SSE will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south similar to the setup at other NEON sites, even it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circles at the sky >20 hours a day. 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 northwest side of tower and have the longer side parallel to ESE-WNW direction. We require the placement of instrument hut at 63.88120°, -145.75119°. The distance between the tower and the instrument hut is ~ 13 m at this site.

At this site, the representative ecosystem around NEON site is black spruce forest. Canopy height is ~ 10 m. Recruit black spruce and birch form an understory with height ~ 1.5 m. Moss and lichen form the understory at ground level with height ~ 20 cm. We require 5 **measurement layers** on the tower with top measurement height at 19 m, and remaining measurement levels are 13 m, 6 m, 1 m and 0.15 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

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

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

Table 13. Site design and tower attributes for Delta Junction 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			75° to 125°(major) and 190° to		Clockwise from first angle

			290°(secondary)		
Tower location	63.88112,	-145.75136	--	--	
Instrument hut	63.88120,	-145.75119			
Instrument hut orientation vector	--	--	105°-285°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	200°	--	
Height of the measurement levels					
Level 1				0.15	m.a.g.l.
Level 2				1.0	m.a.g.l.
Level 3				6.0	m.a.g.l.
Level 4				13.0	m.a.g.l.
Level 5				19.0	m.a.g.l.
Tower Height				19.0	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.

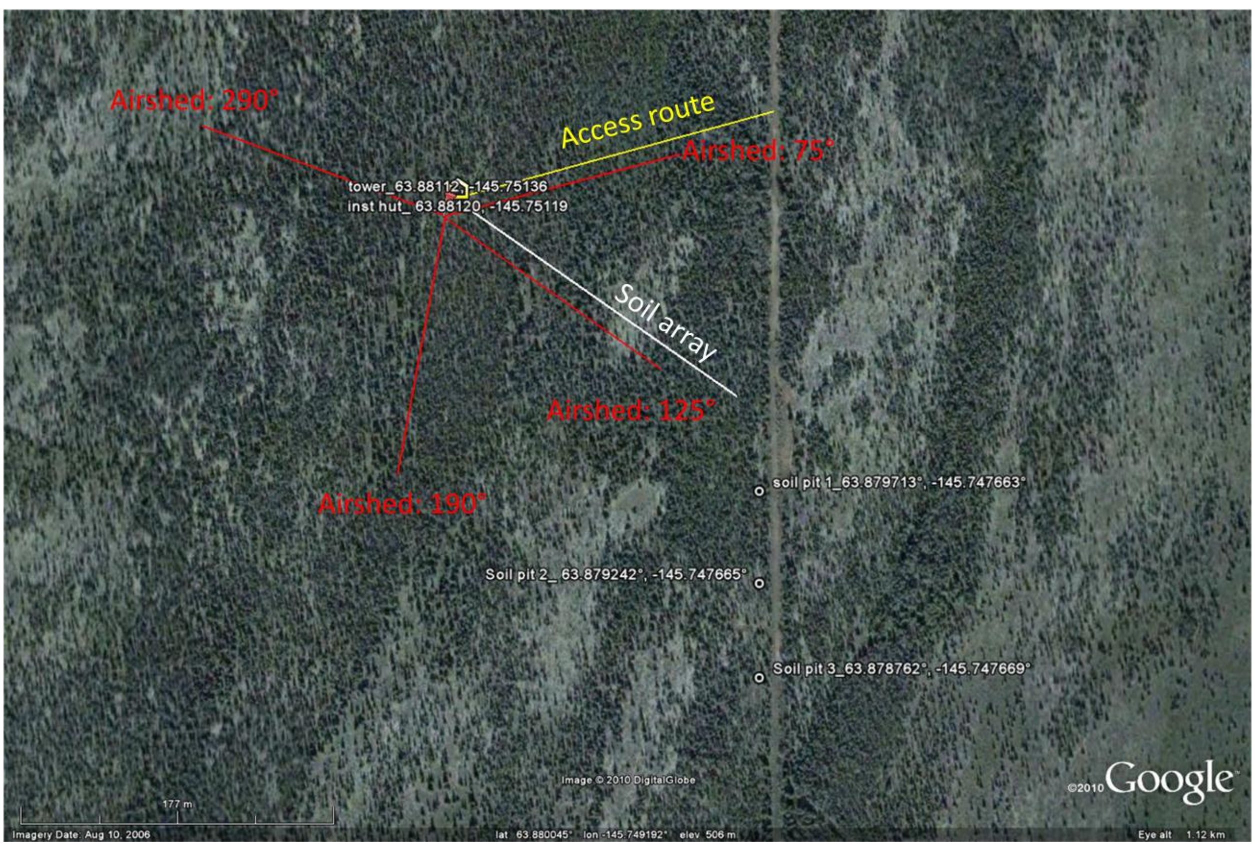


Figure 41. Site layout for Delta Junction Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 75° to 125° (major airshed, clockwise from 75°) and 190° to 290° (secondary, clock wise from 190°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

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

- Boardwalk from access dirt road to instrument hut.
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array.
- Boardwalk from soil array boardwalk to individual soil plots

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

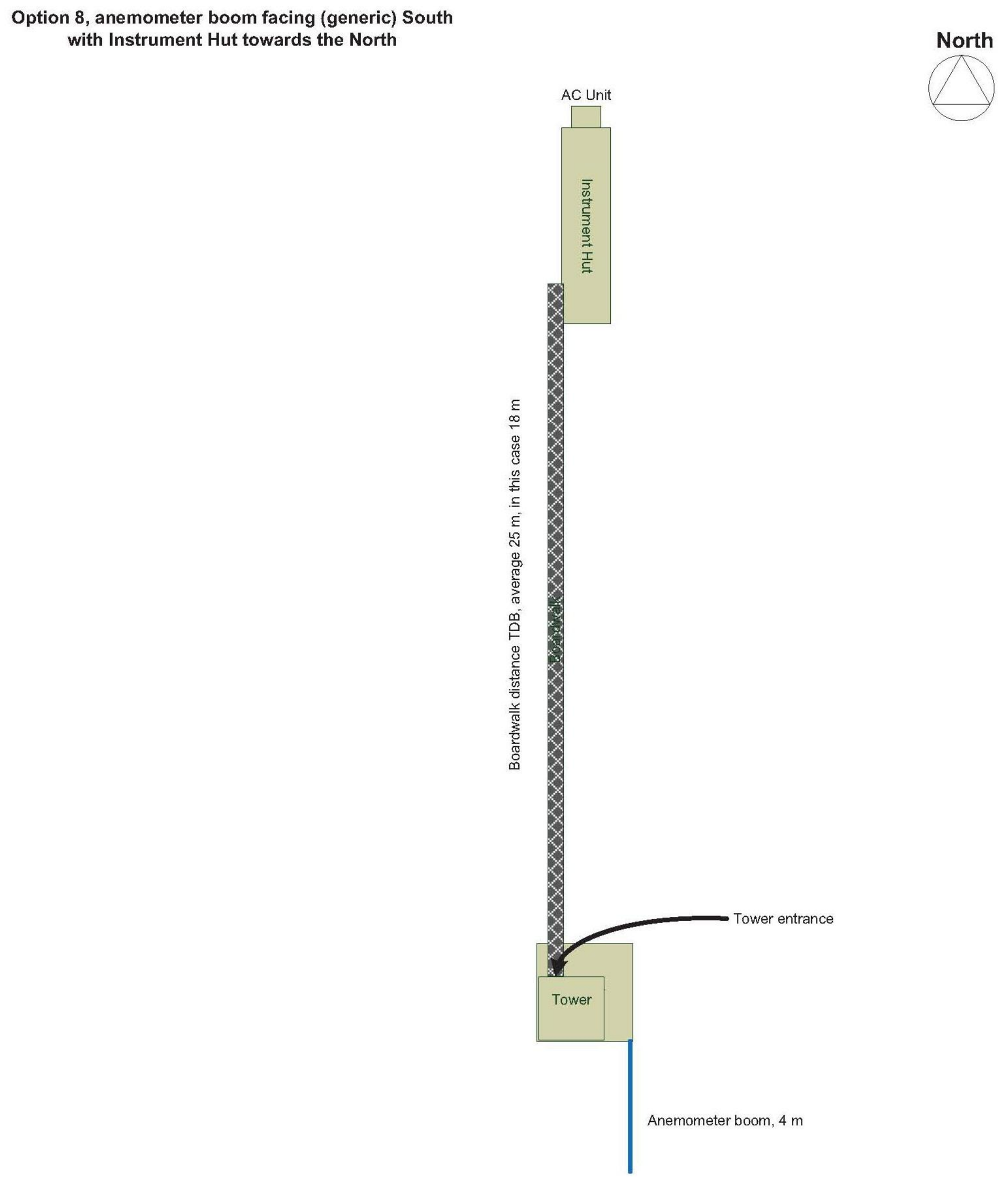


Figure 42. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be the responsibility of FCC following FIU's guidelines. At this site, the boom angle will be 200 degrees. Instrument hut will be on the northeast towards the tower, and boardwalk will access tower on north. The distance between instrument hut and tower is ~13 m. The instrument hut vector will be ESE-WNW (105^{o}-285^{o}, longwise).

4.4.7 Information for ecosystem productivity plots

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (black spruce forest on well drained non-permafrost). The prevailing wind consistently blows from 75° to 125° (clockwise from 75°, major airshed) throughout the year. However, during the warmer seasons (April to September), winds also blow between south and northwest with higher frequency from 190° to 290° (clockwise from 190°, secondary airshed). 90% signals for flux measurements are within a distance of 1000 m from tower, and 80% within 600 m from tower. We suggest FSU Ecosystem Productivity plots to be placed within the major airshed boundaries of 75° to 125° (clockwise from 75°) from tower.

4.5 Issues and attentions

Access dirt road can be very muddy and soft during summer storms and snow melt seasons. Either good road maintenance or powerful 4 –wheel drive vehicle will be required for field visit.

Power and communication cable are < 200 m from tower site along the dirt road.

Military training is conducted nearby. NEON personnel must be informed which areas have restricted access. Sometimes the access road has tank maneuvers.

5 POKER FLATS RELOCATEABLE TOWER 2

5.1 Site description

Original NEON candidate relocatable site (65.16361°, -147.45972°) at Caribou Poker is a burned black spruce forest on permafrost inside Caribou Poker Creek Research Watershed (CPCRW, Figure 43), and ~ 1.4 miles on the northeast to Caribou Poker Advanced tower site. This site was design to measure burned black spruce at permafrost terrain. The original candidate site was at a foothill of a large mountain slope, which doesn't meet FIU micrometeorological measurement requirements. It was difficult to microsite the tower location around candidate site because of patches of burned and unburned forests, extremely long distance to power, and we could not find a location that met our minimum site requirements, e.g., without edge effects. The alternative site is about 3.7 km from the original candidate site inside Poker Flat Research Range at 65.11298, -147.42274 (Figure 44), which is on a relative flat area on a ridge line, consists of a complete, extensive, hot burn site (and better for science). This site retains the goal to study the burned black spruce forest at permafrost terrain. Access road and power are <700 m away (compared to 2.5 miles for original site). Lab, office space, clean room, storage room and other local supports are potentially available at alternative site. Electronically controlled gate access provides excellent security.

Information about Poker Flat Research Range below is fromhttp://www.pfrr.alaska.edu/pfrr/index.html.

Poker Flat Research Range (PFRR) is the only non-federal, university owned and operated range in the world and the only high-latitude, auroral-zone rocket launching facility in the United States of America. The name *Poker Flat* was taken from an old Bret Harte rags-to-riches short story, *The Outcasts of Poker Flat*; the name may have been suggested by the nearby Poker Creek, or perhaps by the way in which the original launch site was constructed from begged and borrowed materials.

Owned and operated by the University of Alaska's Geophysical Institute since 1968, the range has been primarily dedicated to the launch of sounding rockets for the purpose of auroral and middle to upper atmospheric research. Range operations are funded through contracts with the National Aeronautics and Space Administration (NASA) and the range has been operating under a cooperative agreement between NASA and the Geophysical Institute since 1979.

A small group of university employees work year-round at the facility to maintain the physical plant, to provide launch support, and to obtain the various waivers, approvals and agreements necessary to the operation. Past funding sources include the Defense Nuclear Agency, the U.S. Air Force Geophysics Laboratory, the National Science Foundation, and the National Oceanic and Atmospheric Administration.

The 5,132-acre site located about 30 miles northeast of Fairbanks, Alaska, is the world's largest, land-based rocket range and has an established chain of downrange flight and observing facilities from inland Alaska to Spitzbergen in the Arctic Ocean for monitoring and recovery purposes.

More than 1,500 meteorological missiles and 236 major high-altitude sounding rocket experiments have been launched from the range by scientists and technicians from a variety of federal agencies and from universities throughout the world to conduct atmospheric research, including studies on the aurora, ozone layer, solar protons, the electric and magnetic fields, and ultraviolet radiation.

The Federal Aviation Administration approves requested rocket flight zones and coordinates air space use during rocket launches. Permission to impact rockets and payloads on some 26 million acres of land is authorized by the Bureau of Land Management, the U.S. Fish and Wildlife Service, the State of Alaska Division of Lands, Doyon, Ltd., and the Village Traditional Councils of Venetie and Arctic Village. The research range launch site is owned by the University of Alaska.

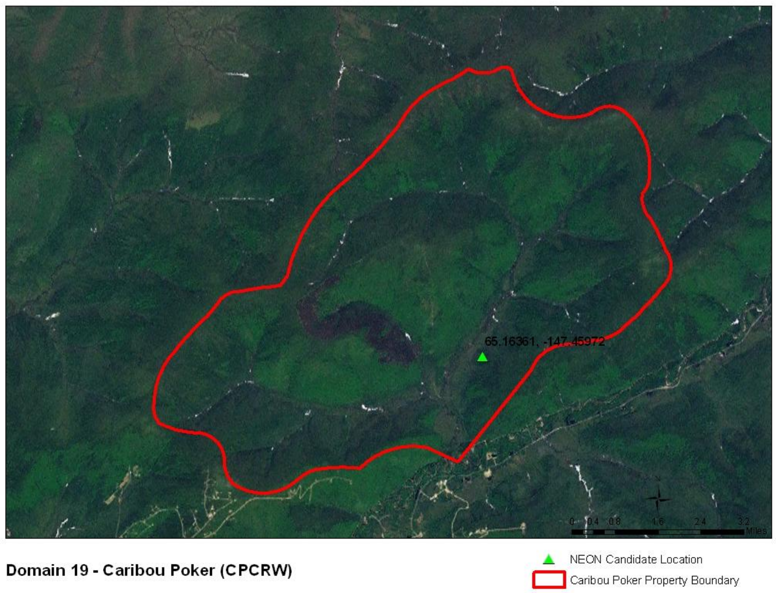


Figure 43. Boundary map for original Caribou Poker Relocatable site. Tower was moved to new location (see text for current location)..

Figure 44. 2 km × 2 km map to indicate alternative Poker Flats Relocatable tower location

5.2 Ecosystem

Property boundary is currently not available for us yet. Therefore, vegetation and land cover information at NEON this alternative site and surrounding area is showed in the 2 km × 2km map below:

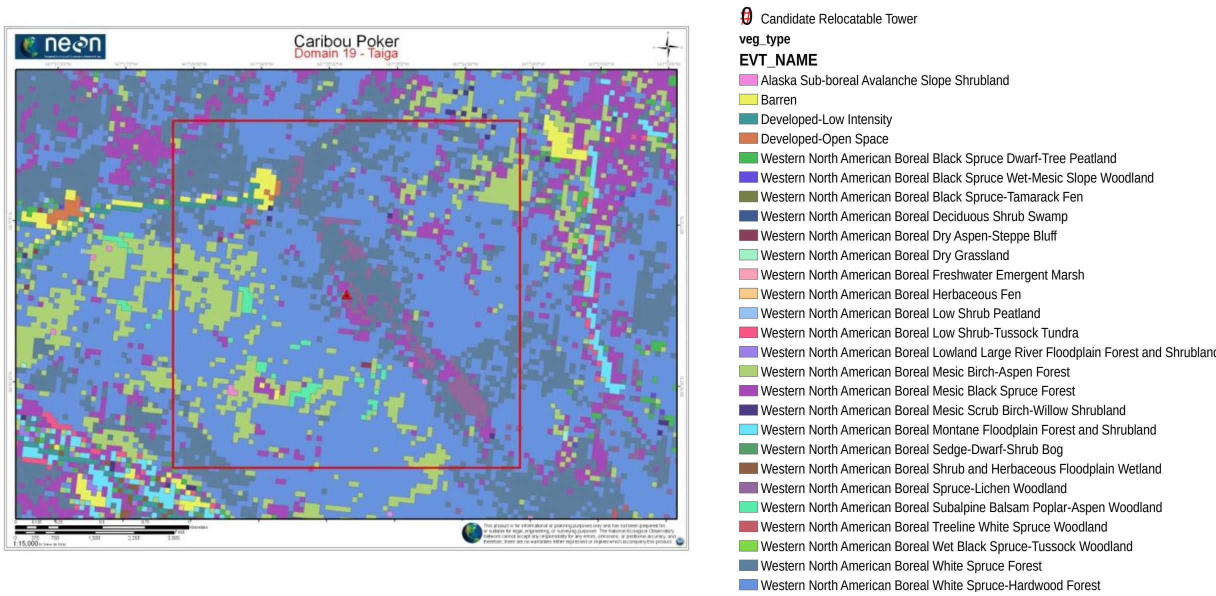


Figure 45. Vegetative cover map of the alternative Poker Flats Relocatable tower site and surrounding areas
(information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 14. Percent land cover type at the alternative Poker Flats Relocatable tower site and surrounding areas
(information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation_Type	Area_km^2	Percentage
Alaska Sub-boreal Avalanche Slope Shrubland	0.0045	0.11
Barren	0.0333	0.83
Developed-Low Intensity	0.0190	0.47
Developed-Open Space	0.0045	0.11
Western North American Boreal Black Spruce Dwarf-Tree Peatland	0.0009	0.02
Western North American Boreal Black Spruce Wet-Mesic Slope Woodland	0.0009	0.02
Western North American Boreal Dry Aspen-Steppe Bluff	0.0027	0.07
Western North American Boreal Herbaceous Fen	0.0009	0.02
Western North American Boreal Mesic Birch-Aspen Forest	0.4509	11.27
Western North American Boreal Mesic Black Spruce Forest	0.2180	5.45
Western North American Boreal Mesic Scrub Birch-Willow Shrubland	0.0054	0.13

Western North American Boreal Spruce-Lichen Woodland	0.1104	2.76
Western North American Boreal Subalpine Balsam Poplar-Aspen Woodland	0.0423	1.06
Western North American Boreal Treeline White Spruce Woodland	0.0027	0.07
Western North American Boreal White Spruce Forest	0.8242	20.60
Western North American Boreal White Spruce-Hardwood Forest	2.2799	56.99
TOTAL	4.0005	100.00

The representative ecosystem around this alternative site is burned black spruce forest on permafrost terrain. The forest was burned in 2004. It was a hot burn. The motility of black spruce was 100%. ~ 60 % burned stems are still standing (mean height 8-9 m, density ~ 400 ha^{-1}). Top soil was burned as well. This site has active recruitment during FIU site characterization in June, 2010. The recruitment is currently dominant by birch, mixed with some willows. Mean height is currently ~ 1.5 m, and are expected to increase ~ 0.3 m per year with the rapid growth of birch. Black spruce recruitment is rarely found. Moss, forbs and grass form understory at ground level with height ~ 40 cm. They are patchy and shallow.

Table 15. Ecosystem and site attributes for Poker Flats Relocatable site.

Ecosystem attributes	Measure and units
Spruce stems:	
Mean canopy height*	**8.0 m**
Surface roughness[a]	1.5 m
Zero place displacement height[a]	4.0 m
Mean canopy height (Recruitments)	1.2 m
Structural elements	Burned standing spruce stems, active birch recruitments, homogenous
Time zone	Alaska standard time
Magnetic declination	20° 59' E changing by 0° 22' W/year

Note, [a] From field survey.

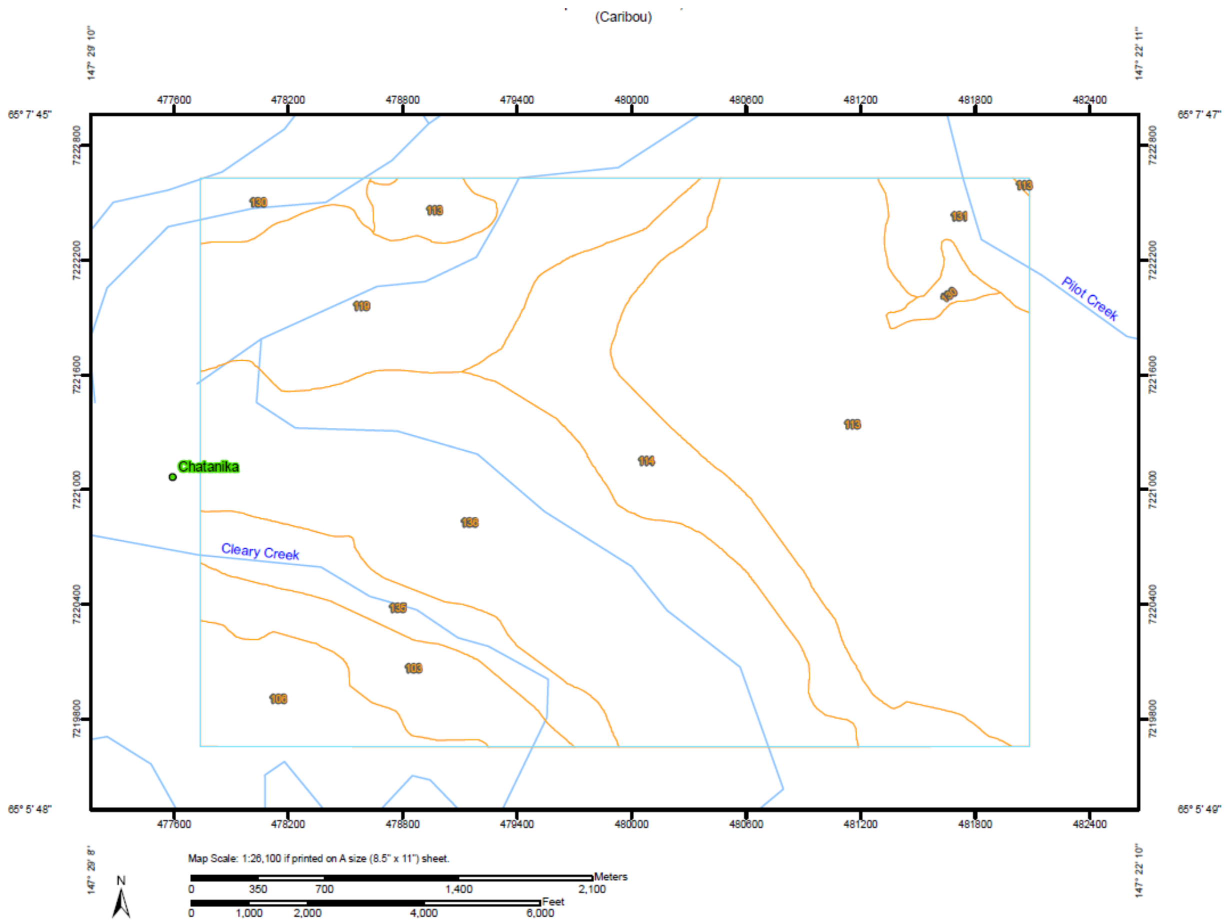
*: Although the recruitment of birch is currently the living dominant ecosystem type at this site, the standing burned spruce stems have large influence on the surface roughness with regarding to aerodynamics at this site. Therefore, canopy height of the standing burned spruce stems will be used when design the tower at this site.

Figure 46 Burned spruce forest is the ecosystem in interest at Poker Flats Relocatable site

5.3 Soils

5.3.1 Description of soils

Soil data and soil maps (Figure 47 Table 16) below for Poker Flats Relocatable tower site were collected from 12.9 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.



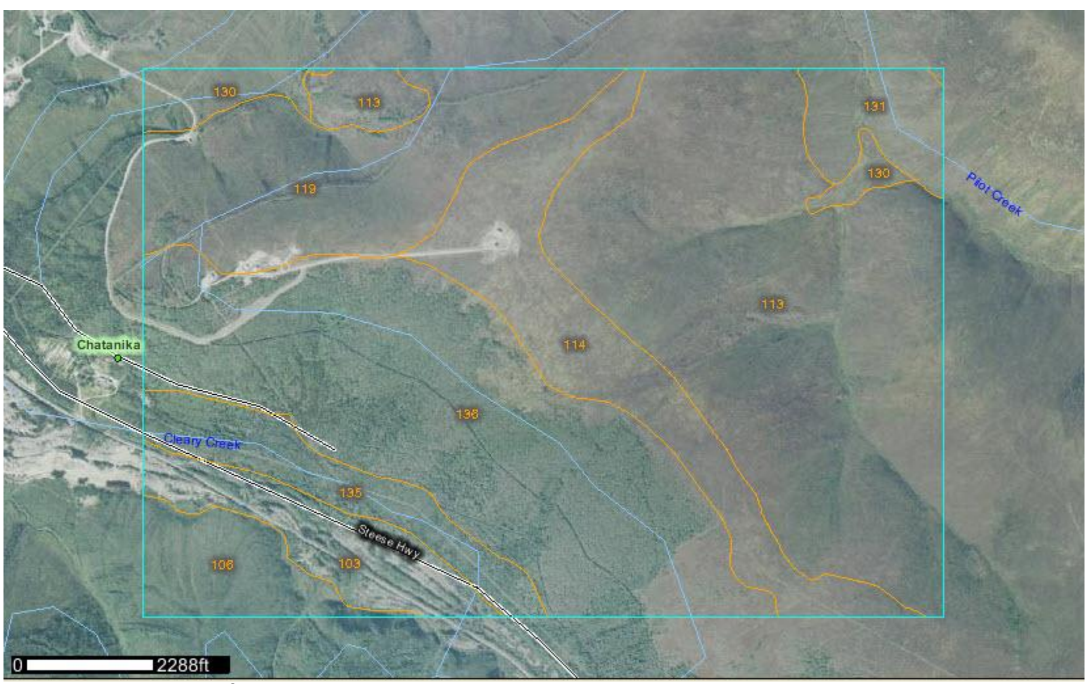


Figure 47. 12.9 km^2 soil map for Poker Flats Relocatable NEON advanced tower site. Bottom figure show the same area with the background image, but without a metric scale bar.

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 16. Soil Series and percentage of soil series within 12.9 km^2 centered on the tower. Area Object Interest (AOI) is the mapping unit from NRCS.

North Star Area, Alaska (AK642)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
103	Dumps, mine	156.8	4.9%
106	Ester-Gilmore complex, 15 to 45 percent slopes	130.1	4.1%
113	Gilmore-Ester complex, 15 to 45 percent slopes	1,022.2	31.9%
114	Gilmore-Steese complex, 3 to 15 percent slopes	344.8	10.8%
119	Histic Pergelic Cryaquepts, 15 to 45 percent slopes	395.4	12.4%
130	Saulich peat, 3 to 7 percent slopes	75.2	2.3%
131	Saulich peat, 7 to 12 percent slopes	101.0	3.2%
135	Steese silt loam, 12 to 45 percent slopes	155.5	4.9%
136	Steese-Gilmore complex, 10 to 45 percent slopes	818.8	25.6%
Totals for Area of Interest		**3,199.8**	**100.0%**

North Star Area, Alaska 103—Dumps, mine: Map Unit Setting Mean annual precipitation: 10 to 14 inches **Map Unit Composition** Dumps, mine: 95 percent Minor components: 5 percent **Description of Dumps, Mine Setting** Landform: Flood plains **Interpretive groups** Land capability (nonirrigated): 8 **Minor Components Aquepts** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 106—Ester-Gilmore complex, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 30 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Ester and similar soils: 50 percent Gilmore and similar soils: 30 percent Minor components: 20 percent **Description of Ester Setting** Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Head slope, side slope Down-slope shape: Linear Across-slope shape: Concave, linear, convex Parent material: Mossy organic material over colluvium and/or loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 7 to 30 inches to permafrost; 14 to 39 inches to paralithic bedrock Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 1.3 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 9 inches: Peat 9 to 12 inches: Mucky silt loam 12 to 21 inches: Very channery silt loam 21 to 72 inches: Weathered bedrock **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear **Fairbanks** Percent of map unit: 5 percent Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Interfluve, head slope, side slope Down-slope shape: Convex, linear Across-slope shape: Linear, convex **Steese** Percent of map unit: 5 percent Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear **Rock outcrop** Percent of map unit: 5 percent Landform: Hills, ridges

North Star Area, Alaska 113—Gilmore-Ester complex, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 30 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Gilmore and similar soils: 50 percent Ester and similar soils: 30 percent Minor components: 20 percent **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 7e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Description of Ester Setting** Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Head slope, side slope Down-slope shape: Linear Across-slope shape: Concave, linear, convex Parent material: Mossy organic material over colluvium and/or loess over residuum weathered from schist **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 7 to 30 inches to permafrost; 14 to 39 inches to paralithic bedrock Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Very low (about 1.3 inches)

Interpretive groups Land capability (nonirrigated): 7w **Typical profile** 0 to 9 inches: Peat 9 to 12 inches: Mucky silt loam 12 to 21 inches: Very channery silt loam 21 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 4 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear **Fairbanks** Percent of map unit: 4 percent Landform: Hills Landform position (two-dimensional): Backslope Landform position (three-dimensional): Interfluve, head slope, side slope Down-slope shape: Convex, linear Across-slope shape: Linear, convex **Histosols, permafrost** Percent of map unit: 4 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Steese** Percent of map unit: 4 percent Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear **Rock outcrop** Percent of map unit: 4 percent Landform: Hills, ridges

North Star Area, Alaska 114—Gilmore-Steese complex, 3 to 15 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Gilmore and similar soils: 50 percent Steese and similar soils: 35 percent Minor components: 15 percent **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 3 to 15 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 4e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Description of Steese Setting** Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 3 to 15 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): Very low (0.00 to 0.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.1 inches) **Interpretive groups** Land capability (nonirrigated): 4e **Typical profile** 0 to 2 inches: Slightly decomposed plant material 2 to 5 inches: Silt loam 5 to 27 inches: Silt loam 27 to 33 inches: Very channery silt loam 33 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear **Aquic cryochrepts** Percent of map unit: 5 percent Landform: Depressions on hills Down-slope shape: Concave Across-slope shape: Concave **Typic cryochrepts** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear

North Star Area, Alaska 119—Histic Pergelic Cryaquepts, 15 to 45 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Histic pergelic cryaquepts, 231, and similar soils: 90 percent Minor components: 10 percent **Description of Histic Pergelic Cryaquepts, 231 Setting** Landform: Hills Down-slope shape: Concave Across-slope shape: Concave Parent material: Loess over colluvium **Properties and qualities** Slope: 15 to 45 percent Depth to restrictive feature: 8 to 39 inches to permafrost; 16 to 72 inches to paralithic bedrock Drainage class: Poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 to 6 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.4 inches) **Interpretive groups** Land capability (nonirrigated): 7w **Typical profile** 0 to 13 inches: Peat 13 to 19 inches: Silt loam 19 to 26 inches: Silt loam 26 to 72 inches: Material 72 to 72 inches: Bedrock **Minor Components Cryaquepts, permafrost substratum** Percent of map unit: 5 percent Landform: Hills Down-slope shape: Concave Across-slope shape: Concave **Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 130—Saulich peat, 3 to 7 percent slopes Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Saulich and similar soils: 90 percent Minor components: 10 percent **Description of Saulich Setting** Landform: Valley sides Landform position (two-dimensional): Toeslope, footslope Landform position (three-dimensional): Base slope, side slope Down-slope shape: Linear, concave Across-slope shape: Linear Parent material: Colluvium and/or loess **Properties and qualities** Slope: 3 to 7 percent Depth to restrictive feature: 14 to 24 inches to permafrost Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6w **Typical profile** 0 to 16 inches: Peat 16 to 21 inches: Mucky silt loam 21 to 72 inches: Material **Minor Components Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histic pergelic cryaquepts, 231** Percent of map unit: 5 percent Landform: Alluvial fans Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 131—Saulich peat, 7 to 12 percent slopes: Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Saulich and similar soils: 90 percent Minor components: 10 percent **Description of Saulich Setting** Landform: Valley sides Landform position (two-dimensional): Toeslope, footslope Landform position (three-dimensional): Base slope, side slope Down-slope shape: Linear, concave Across-slope shape: Linear Parent material: Colluvium and/or loess **Properties and qualities** Slope: 7 to 12 percent Depth to restrictive feature: 14 to 24 inches to permafrost Drainage class: Very poorly drained Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr) Depth to water table: About 0 inches Frequency of flooding: None Frequency of ponding: Frequent Available water capacity: Low (about 3.6 inches) **Interpretive groups** Land capability (nonirrigated): 6w **Typical profile** 0 to 16 inches: Peat 16 to 21 inches: Mucky silt loam 21 to 72 inches: Material **Minor Components Histosols, permafrost** Percent of map unit: 5 percent Landform: Depressions Down-slope shape: Concave Across-slope shape: Concave **Histic pergelic cryaquepts, 231** Percent of map unit: 5 percent Landform: Alluvial fans Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 135—Steese silt loam, 12 to 45 percent slopes Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Steese and similar soils: 85 percent Minor components: 15 percent **Description of Steese Setting** Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 12 to 45 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): Very low (0.00 to 0.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.1 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 2 inches: Slightly decomposed plant material 2 to 5 inches: Silt loam 5 to 27 inches: Silt loam 27 to 33 inches: Very channery silt loam 33 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 8 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear **Histic pergelic cryaquepts, 231** Percent of map unit: 7 percent Landform: Hills Down-slope shape: Concave Across-slope shape: Concave

North Star Area, Alaska 136—Steese-Gilmore complex, 10 to 45 percent slopes Map Unit Setting Elevation: 750 to 1,300 feet Mean annual precipitation: 10 to 14 inches Mean annual air temperature: 25 to 28 degrees F Frost-free period: 80 to 120 days **Map Unit Composition** Steese and similar soils: 50 percent Gilmore and similar soils: 40 percent Minor components: 10 percent **Description of Steese Setting** Landform: Hills Landform position (two-dimensional): Shoulder, backslope Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, crest Down-slope shape: Convex, linear Across-slope shape: Linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 10 to 45 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): Very low (0.00 to 0.00 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water capacity: Moderate (about 6.1 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 2 inches: Slightly decomposed plant material 2 to 5 inches: Silt loam 5 to 27 inches: Silt loam 27 to 33 inches: Very channery silt loam 33 to 72 inches: Weathered bedrock **Description of Gilmore Setting** Landform: Hills Landform position (two-dimensional): Backslope, summit Landform position (three-dimensional): Crest, interfluve, head slope, nose slope, side slope Down-slope shape: Linear, convex Across-slope shape: Convex, linear Parent material: Loess over residuum weathered from schist **Properties and qualities** Slope: 10 to 45 percent Depth to restrictive feature: 13 to 24 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: Very low (about 2.9 inches) **Interpretive groups** Land capability (nonirrigated): 6e **Typical profile** 0 to 3 inches: Slightly decomposed plant material 3 to 6 inches: Silt loam 6 to 12 inches: Silt loam 12 to 19 inches: Very channery silt loam 19 to 72 inches: Weathered bedrock **Minor Components Cryochrepts** Percent of map unit: 10 percent Landform: Hills Down-slope shape: Linear Across-slope shape: Linear

5.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 48). 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 48).

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 48), 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.

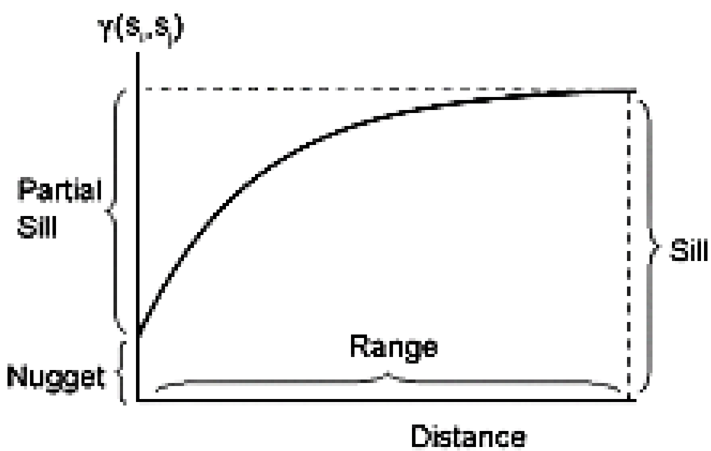


Figure 48. Example semivariogram, depicting range, sill, and nugget.

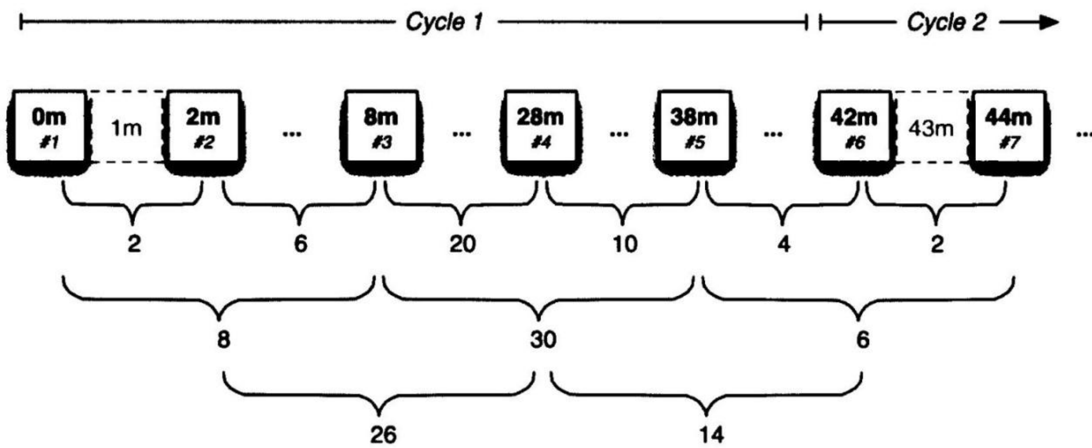


Figure 49. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 28 June 2010 at the Caribou Poker Relocatable site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 49). Soil temperature and moisture measurements were collected along three transects (210 m, 84 m, and 84 m) located in the expected airshed at Caribou Poker Relocatable. 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 49, 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).

5.3.3 Results and interpretation

5.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 50). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 51, left graph) and directional semivariograms do not show anisotropy (Figure 51, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 51, right graph). The model indicates a distance of effective independence of 3 m for soil temperature.

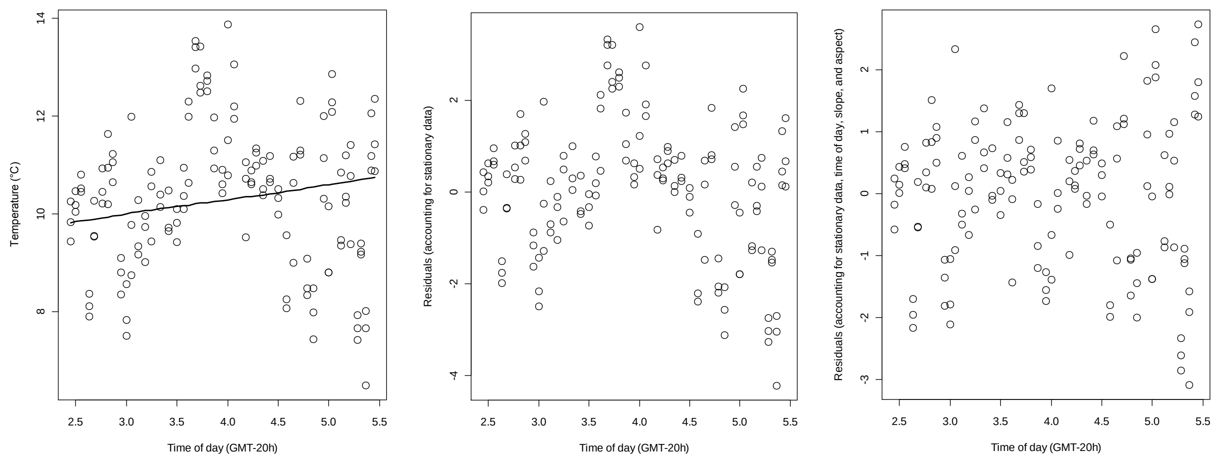


Figure 50. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

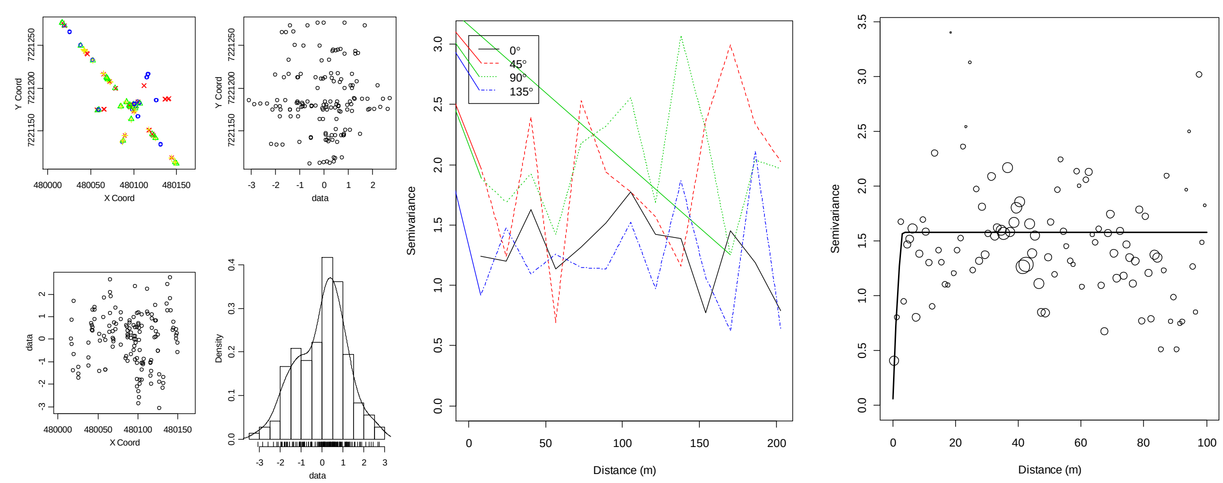


Figure 51. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

5.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day trend, 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 8 m for soil water content.

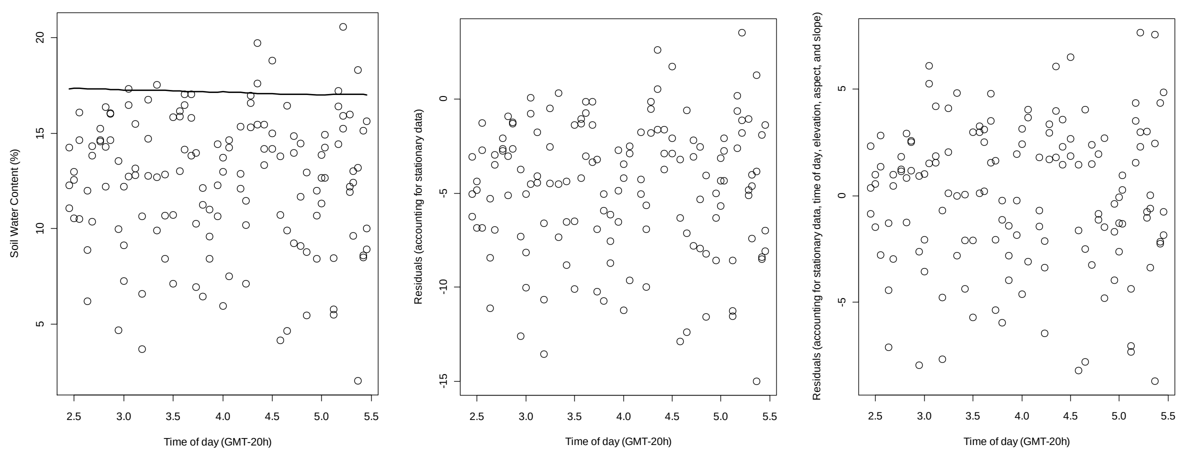


Figure 52. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting 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.

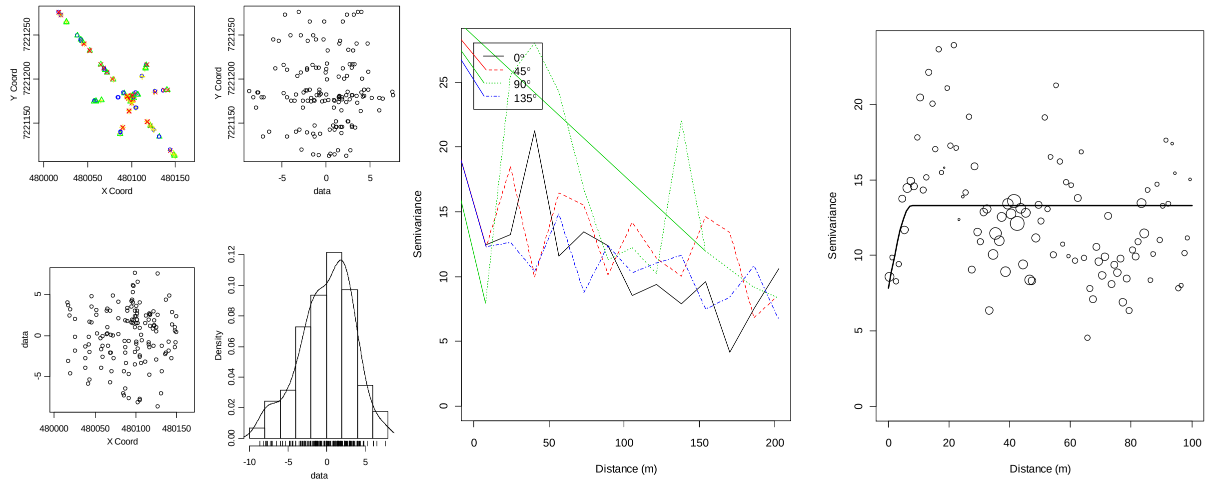


Figure 53. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

5.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was 3 m for soil temperature and 8 m for soil moisture. Based on these results and the site design guidelines the soil plots at Caribou Poker Relocatable shall be placed 25 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 270° from the soil plot nearest the tower. The location of the first soil plot will be approximately 65.112980°, -147.423166°. 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 65.117221, -147.433286 (primary location); or 65.117270, -147.431916 (alternate location 1 if primary location is unsuitable); or 65.117596°, -147.430765° (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 17 and site layout can be seen in Figure 54.

Dominant soil series at the site: Gilmore-Steese complex, 3 to 15 percent slopes. The taxonomy of this soil is shown below:
Order: Inceptisols
Suborder: Udepts-Cryepts
Great group: Dystrocryepts-Haplocryepts
Subgroup: Typic Dystrocryepts-Typic Haplocryepts
Family: Loamy-skeletal, mixed, superactive, shallow Typic Dystrocryepts-Coarse-loamy, mixed, superactive Typic Haplocryepts
Series: Gilmore-Steese complex, 3 to 15 percent slopes

Table 17. Summary of soil array and soil pit information at Caribou Poker Relocatable. 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	25 m
Distance from tower to closest soil plot: y	20 m
Latitude and longitude of 1st soil plot OR direction from tower	65.112980°, -147.423166°
Direction of soil array	270°
Latitude and longitude of FIU soil pit 1[†]	65.117221, -147.433286 (primary location) [†]
Latitude and longitude of FIU soil pit 2[†]	65.117270, -147.431916 (alternate 1) [†]
Latitude and longitude of FIU soil pit 3[†]	65.117596°, -147.430765° (alternate 2) [†]
Dominant soil type	Gilmore-Steese complex, 3 to 15 percent slopes
Expected soil depth	0.33-1.02 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths**[*]
0-0.08 m (Slightly decomposed plant material)	0.04 m
0.08-0.15 m (Silt loam)	0.12 m
0.15-0.30 (Silt loam)	[a]0.23 m
0.30-0.48 m (Very channery silt loam)	0.39 m
0.48-1.83 m (Weathered bedrock)	[a]1.16 m
1.83-3.00 m	[a]3 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. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to characterize permafrost dynamics. [a]Notes the current understanding of the measurement depths to be applied by the soil array.
[†]Soil pit locations should be away from obvious sign of disturbance relating to the Poker Flat Research Range.

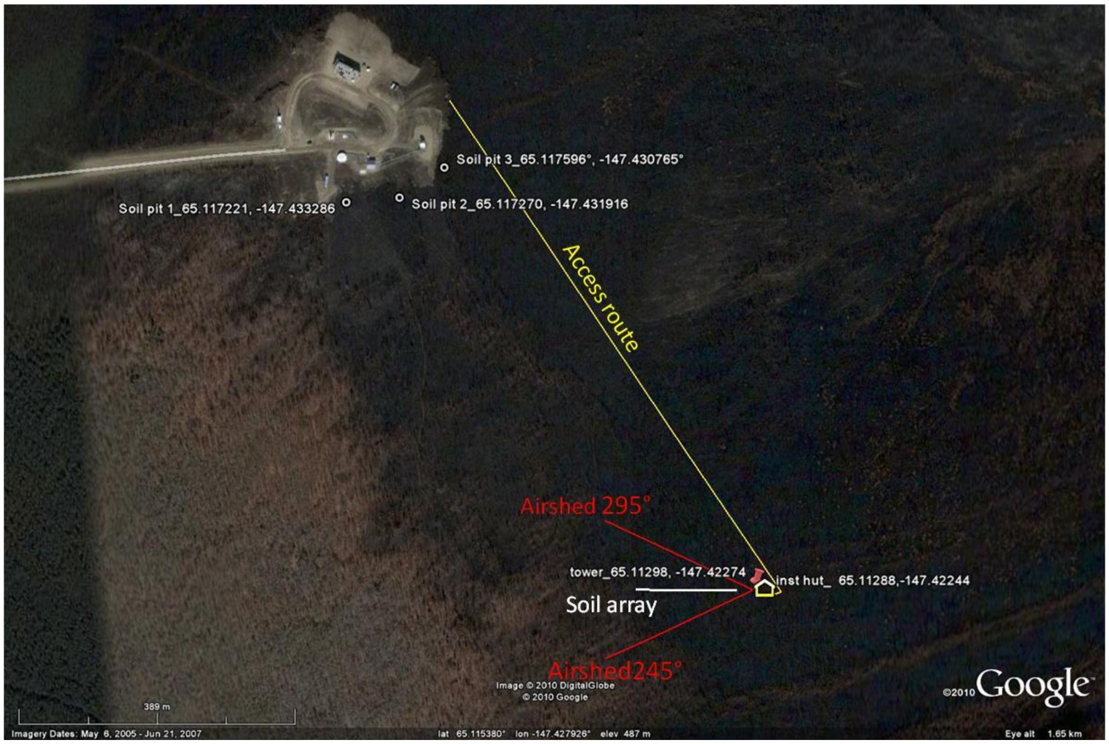


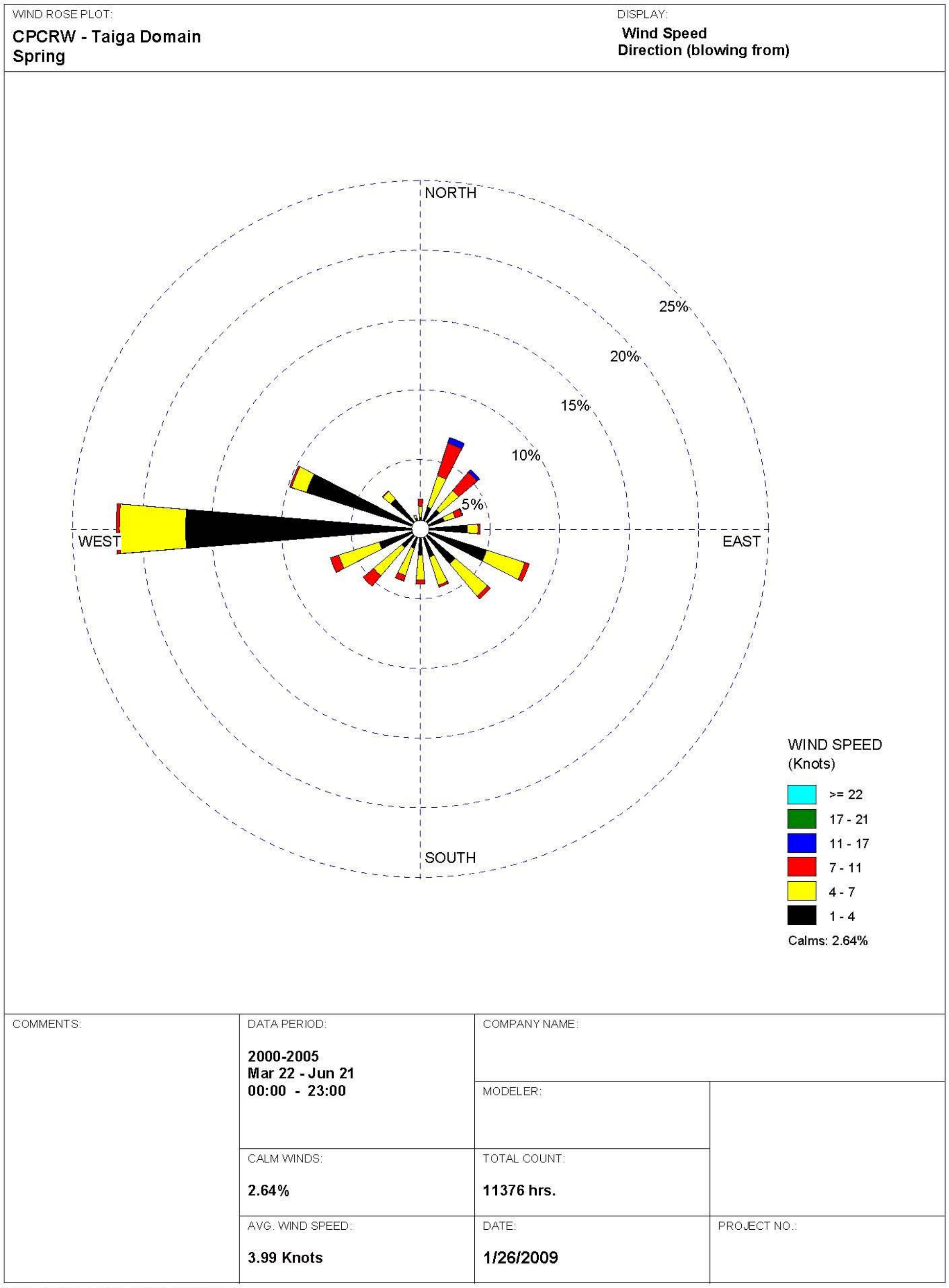
Figure 54. Site layout at Poker Flats Relocatable showing soil array and location of the FIU soil pit.

5.4 Airshed

5.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figure 32. We used the closest available wind data nearby for wind and footprint analysis at this site. The weather data used to generate the following wind roses are from a weather station at approximately 65.15265, -147.48705 maintained by University of Fairbanks, which is ~ 3.5 miles on the NW to this relocatable tower site. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

5.4.2 Results (graphs for wind roses)

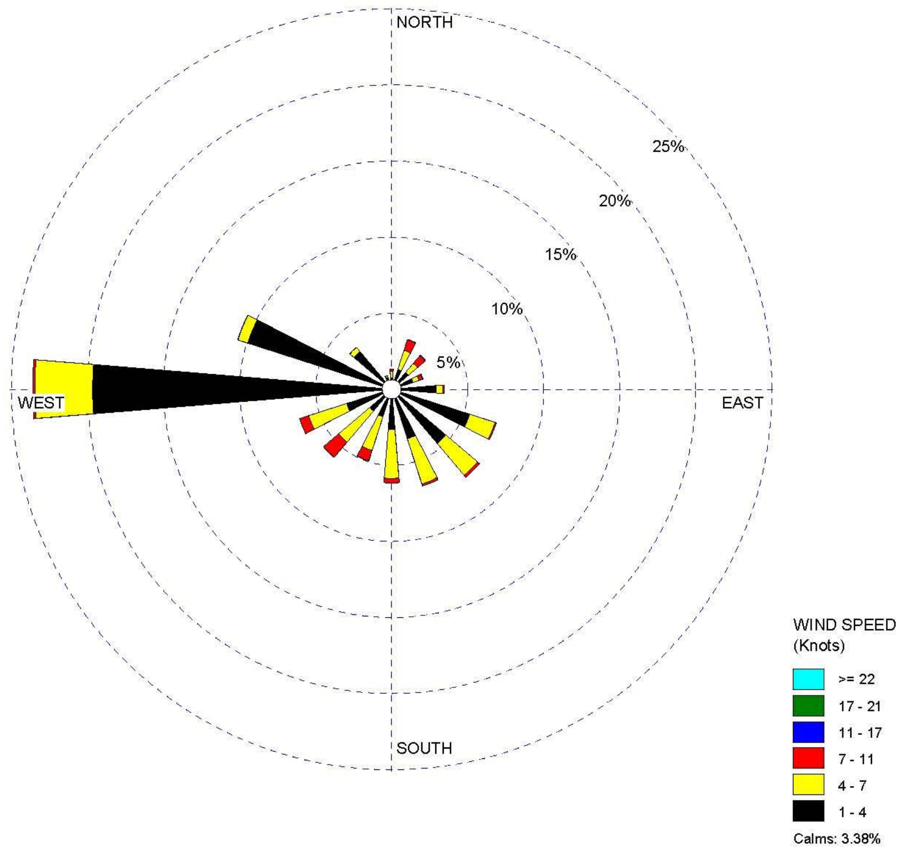


WIND ROSE PLOT:

CPCRW - Taiga Domain
Summer

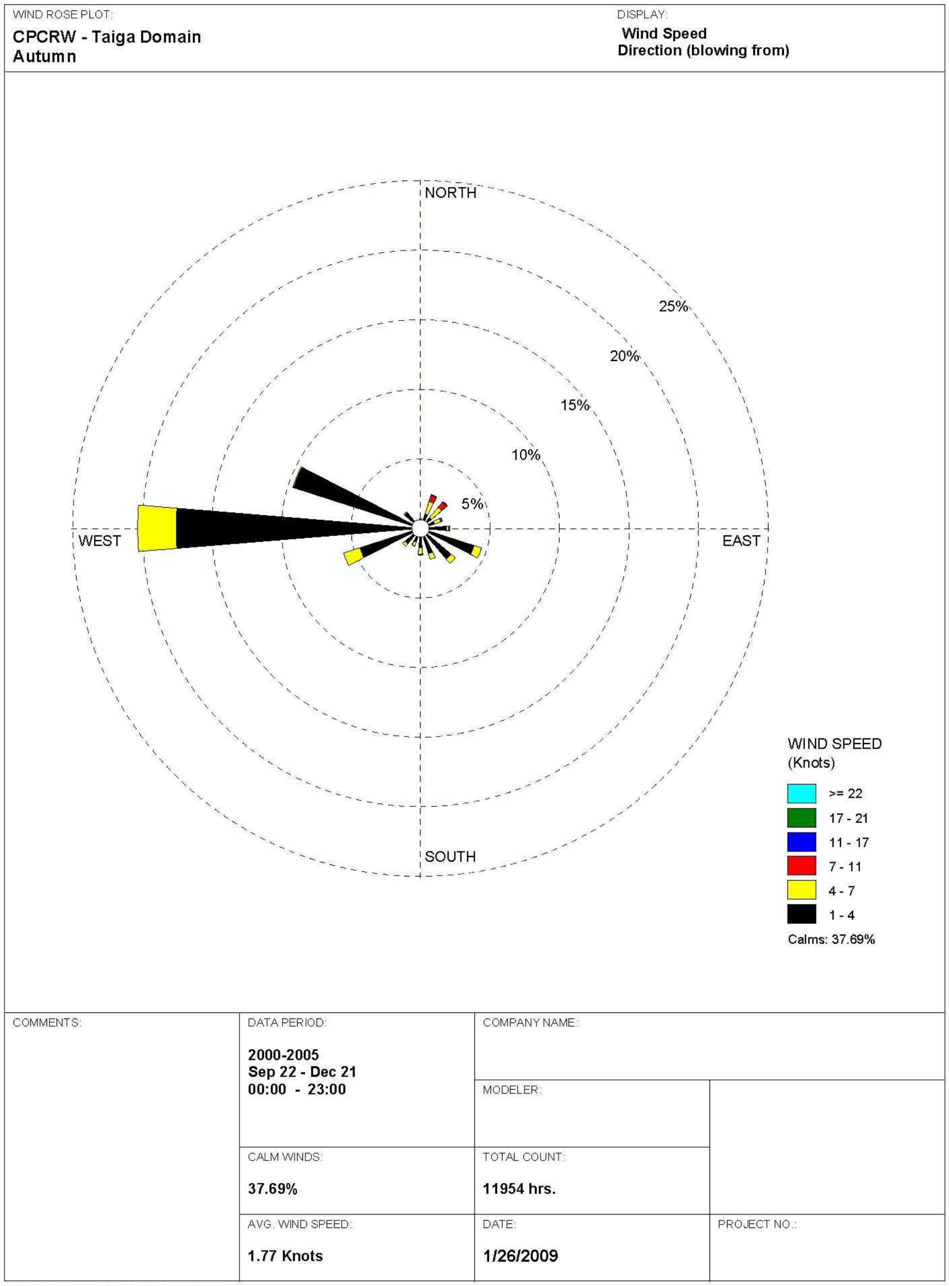
DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **2000-2005** **Jun 22 - Sep 21** **00:00 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **3.38%**	TOTAL COUNT: **11976 hrs.**	
	AVG. WIND SPEED: **3.54 Knots**	DATE: **1/26/2009**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software



WIND ROSE PLOT:
CPCRW - Taiga Domain
Autumn
DISPLAY:
Wind Speed
Direction (blowing from)
NORTH
SOUTH
WEST
EAST
5%
10%
15%
20%
25%
WIND SPEED
(Knots)
>= 22
17 - 21
11 - 17
7 - 11
4 - 7
1 - 4
Calms: 37.69%
COMMENTS:
DATA PERIOD:
2000-2005
Sep 22 - Dec 21
00:00 - 23:00
COMPANY NAME:
MODELER:
CALM WINDS:
37.69%
TOTAL COUNT:
11954 hrs.
AVG. WIND SPEED:
1.77 Knots
DATE:
1/26/2009
PROJECT NO.:
WRPLOT View - Lakes Environmental Software

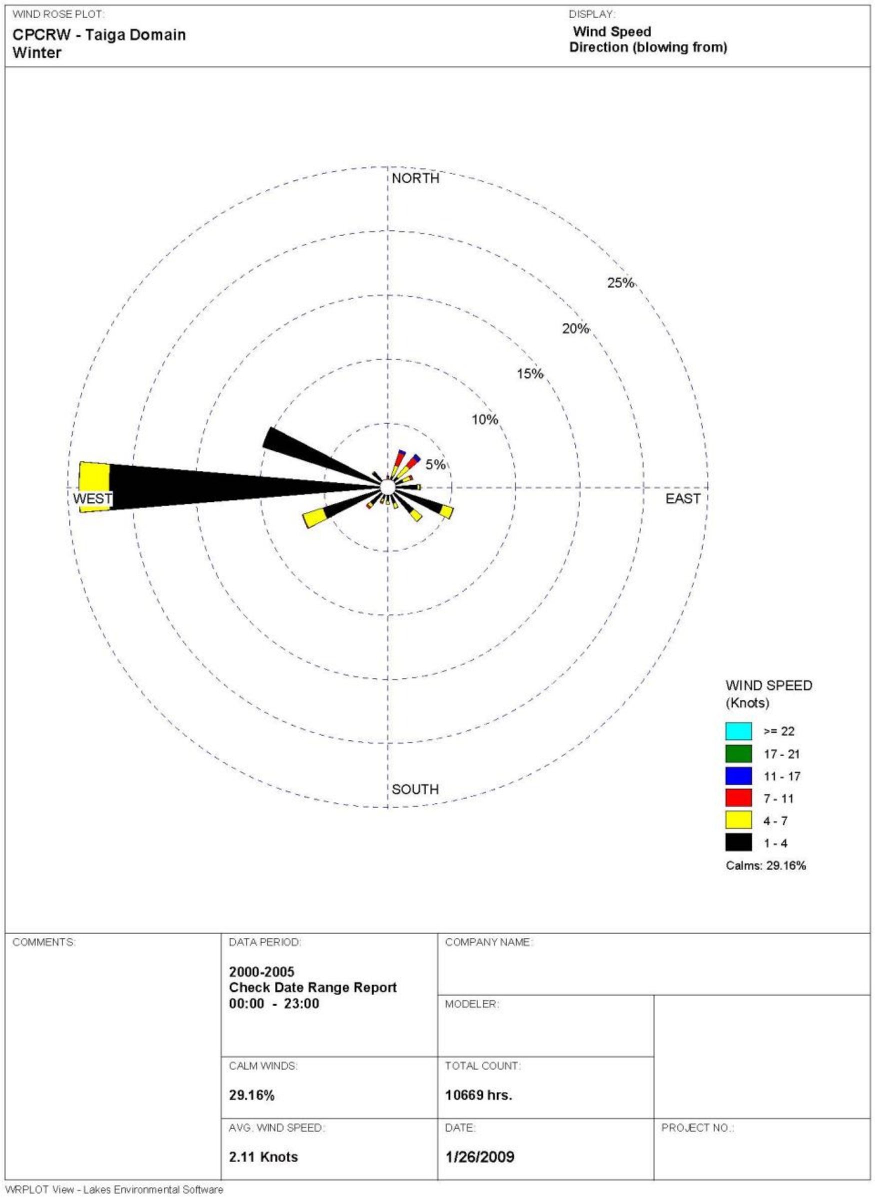


Figure 55. Windroses for Poker Flats Relocatable site.

Data used here are 2000-2005 wind data from a weather station at approximately 65.15265, -147.48705 maintained by University of Fairbanks, which is ~ 3.5 miles on the NW to this relocatable tower site. It is assumed that the wind data was corrected for declination. Panels (from Top to bottom), are from Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

5.4.3 Resultant vectors

Not available.

5.4.4 Expected environmental controls on source area

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

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

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

Table 18. Expected environmental controls to parameterize the source area model, and associated results from Caribou Poker 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	18	18	18	18	18	18	m
Canopy Height	8	8	8	8	8	8	m
Canopy area density	2.0	2.0	2.0	2.0	2.0	2.0	m
Boundary layer depth	900	900	900	300	300	300	m
Expected sensible heat flux	180	180	100	-25	-25	-25	W m^{-2}
Air Temperature	4	4	2	-20	-20	-20	°C
Max. windspeed	3.6	2.6	1	3.6	2.6	1.0	m s^{-1}
Resultant wind vector	270	270	270	270	270	270	degrees
Results							
(z-d)/L	-0.20	-0.39	-1.10	0.06	0.35	3.00	m
d	5.90	5.90	5.90	5.90	5.90	5.90	m
Sigma v	1.40	1.30	0.95	1.70	1.70	1.60	m^2 s^{-2}
Z0	0.43	0.43	0.43	0.43	0.43	0.43	m
u*	0.51	0.41	0.24	0.40	0.22	0.02	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	500	350	200	1200	1750	3500	m
Distance of 80% cumulative flux	350	200	150	700	1000	3200	m
Distance of 70% cumulative flux	200	150	100	450	700	2750	m
Peak contribution	55	45	15	75	115	1675	m

5.4.5 Results (source area graphs)

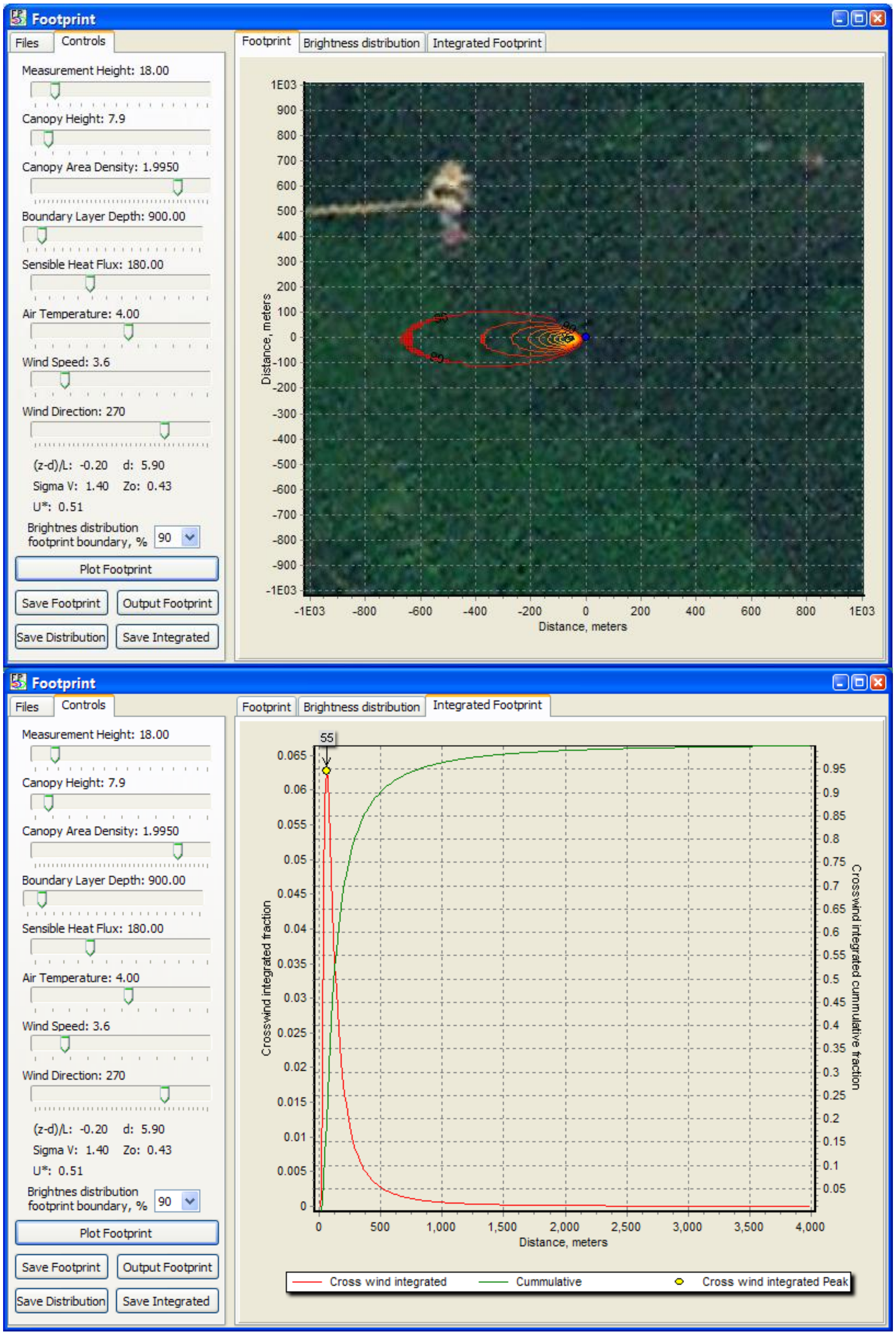


Figure 56. Caribou Poker Relocatable site summer daytime (convective) footprint output with max wind speed.

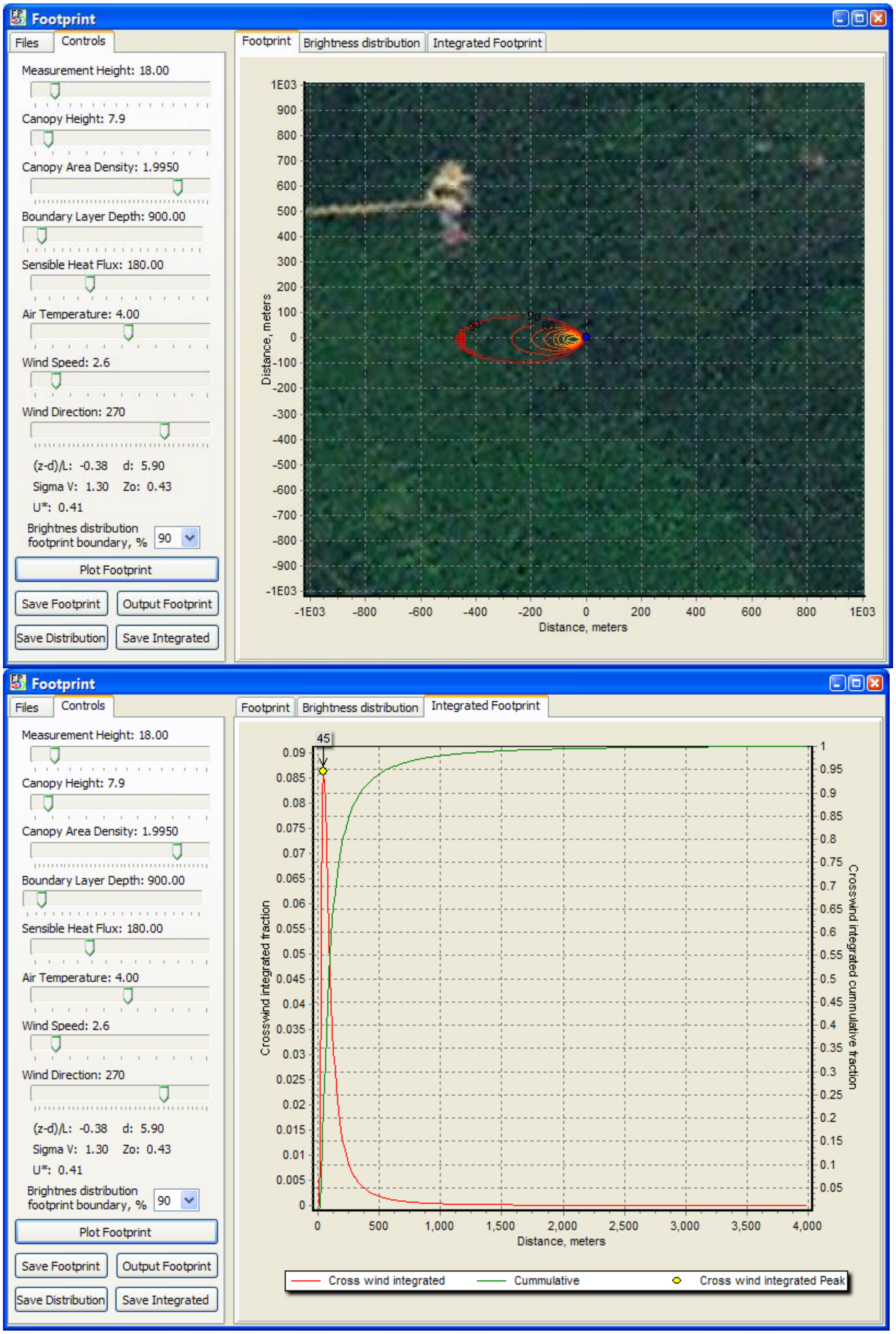


Figure 57. Caribou Poker Relocatable site summer daytime (convective) footprint output with mean wind speed.

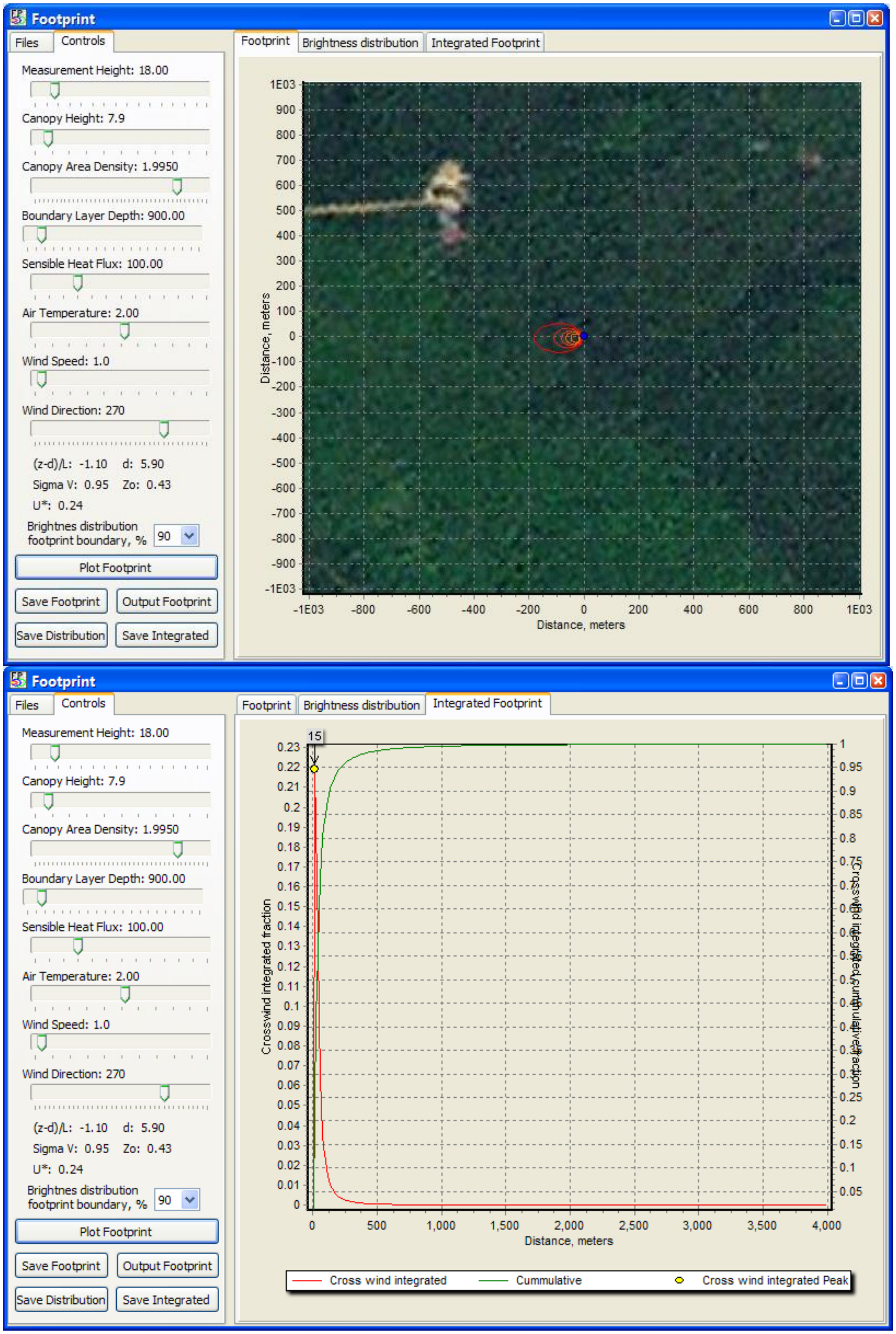


Figure 58. Caribou Poker Relocatable site summer nighttime (stable) footprint output with mean wind speed.

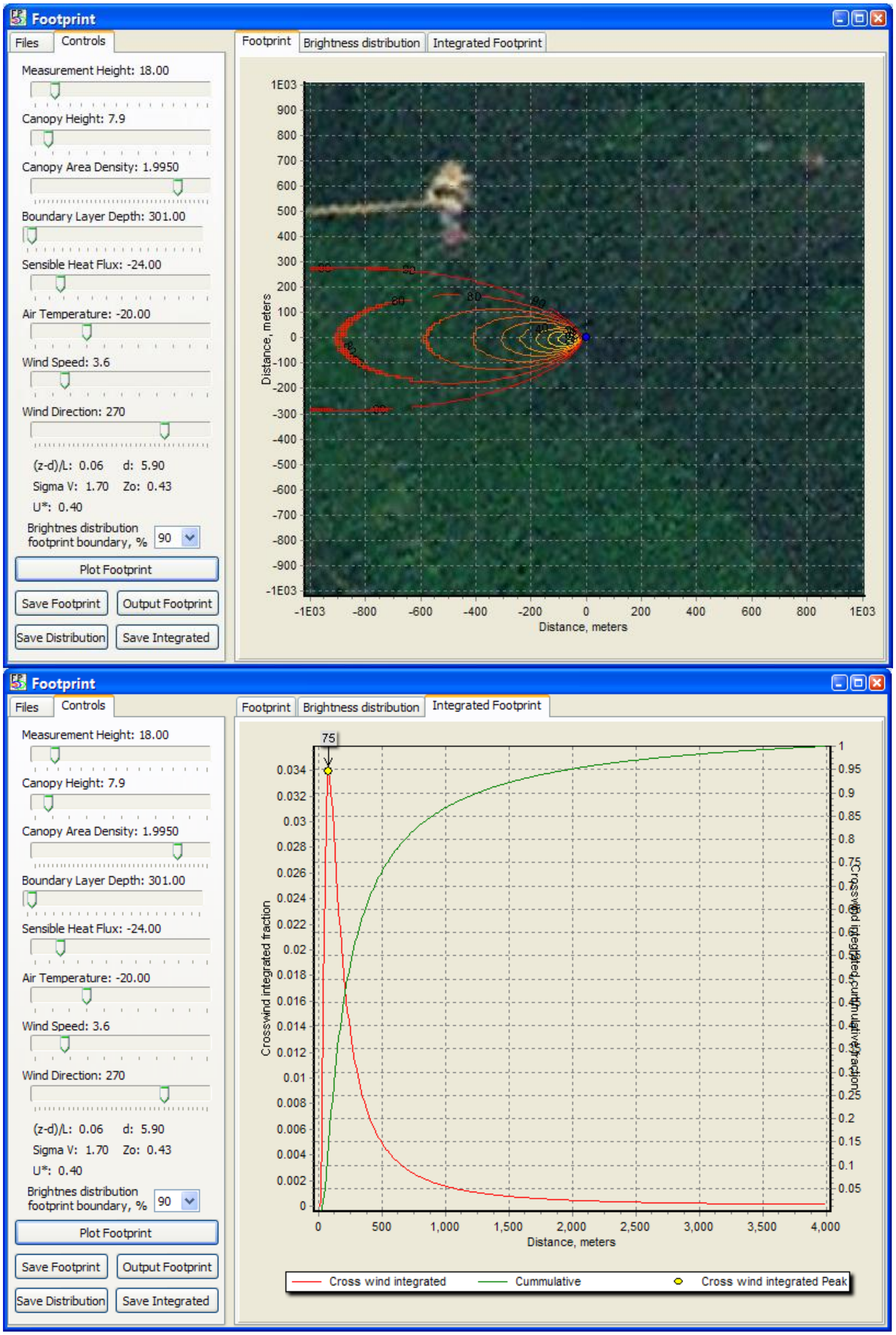


Figure 59. Caribou Poker Relocatable site winter daytime (convective) footprint output with max wind speed.

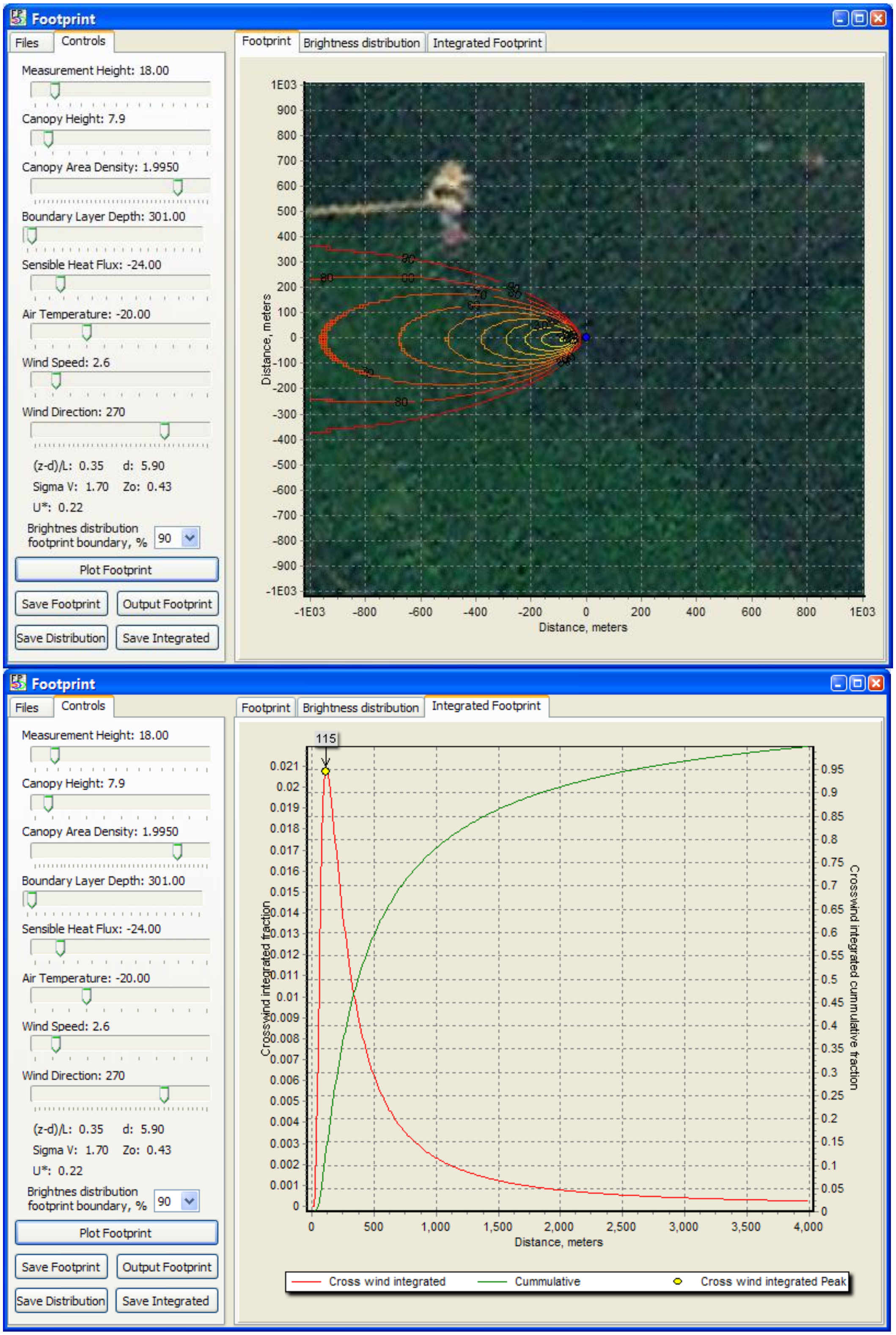


Figure 60. Caribou Poker Relocatable site winter daytime (convective) footprint output with mean wind speed.

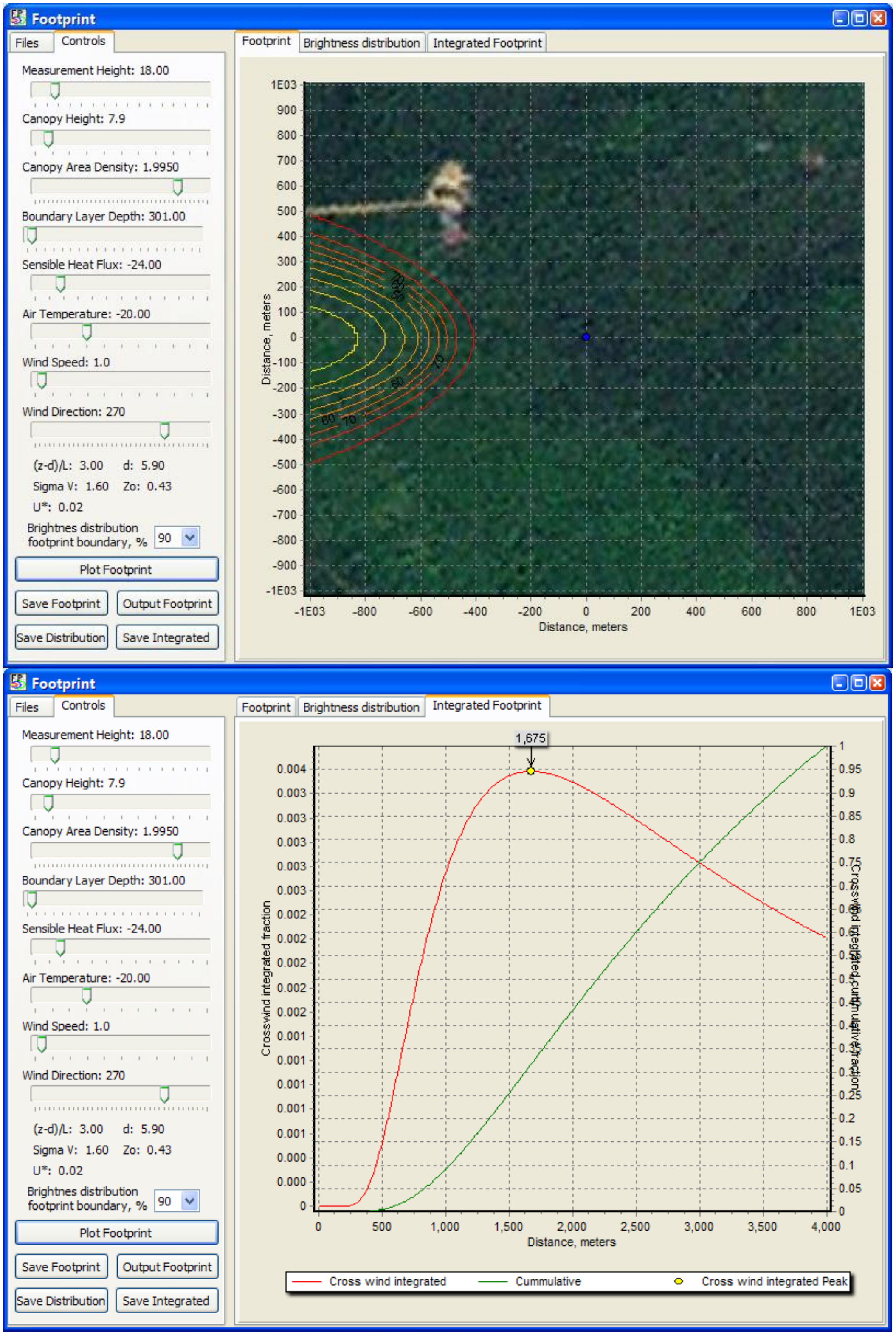


Figure 61. Caribou Poker Relocatable site winter nighttime (stable) footprint output with mean wind speed.

5.4.6 Site design and tower attributes

We used the closest available wind data nearby for wind and footprint analysis at this site. The weather station is at approximately 65.15265, -147.48705 maintained by University of Fairbanks, which is ~5.64 km (3.5 miles) on the NW to this relocatable tower site. According to wind roses, the winds could come from any direction from 10° to 315° (clockwise from 10°). However, the prevailing wind is dominantly from west throughout the year. The major airshed is from 245° to 295° (major airshed, clockwise from 245°). Because the weather station is at a valley and our tower location is on a mountain ridge. We will expect some difference in the wind pattern. By examining the topography of this region, the terrain and tower location will likely support the dominant wind of northeast-southwest direction (along the river and valley, 60°-240°). Therefore, we should keep wind path clear on the northeast, west and southwest side of the tower to ensure quality wind measurements. Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is burned spruce ecosystem. Tower location was determined to be 65.11298, -147.42274 during FIU site characterization.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the N will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south similar to the setup at other NEON sites, even it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circles at the sky >20 hours a day. 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 NNW to tower and have the longer side parallel to NE-SW direction. We require the placement of instrument hut at 65.11288°,-147.42244°. The distance between the tower and the instrument hut is ~ 17 m at this site.

The representative ecosystem around this alternative site is burned black spruce forest on permafrost terrain. The forest was burned in 2004. It was a hot burn. The motility of black spruce was 100%. ~ 60 % burned stems are still standing (mean height 8-9 m, density ~ 400 ha^{-1}). This site has active recruitments during FIU site characterization in June, 2010. The recruitment is currently dominant by birch, mixed with some willows. Mean height is currently ~ 1.5 m, and expected to increase ~ 0.3 m per year with the rapid growth of birch. Although the recruitment of birch is currently the living dominant ecosystem type at this site, the standing burned spruce stems have large influence on the surface roughness with regarding to aerodynamics at this site. Therefore, canopy height of the standing burned spruce stems will be used when design the tower at this site. We require 5 **measurement layers** on the tower with top measurement height at 20 m, and rest layers are 10 m, 5 m, 1.5 m and 0.2 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

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

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

Table 19. Site design and tower attributes for Caribou Poker 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			245° to 295° (airshed from windroses)		Clockwise from 245°, but likely dominant by NE-SW wind direction, and see some winds from west
Tower location	65.11298,	-147.42274	--	--	
Instrument hut	65.11288,	-147.42244			
Instrument hut orientation vector	--	--	60°-240°		
Instrument hut distance z	--	--	--	17	
Anemometer/Temperature boom orientation	--	--	360°	--	
Height of the measurement levels					
Level 1				0.2	m.a.g.l.
Level 2				1.5	m.a.g.l.
Level 3				5.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				20.0	m.a.g.l.
Tower Height				20.0	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.

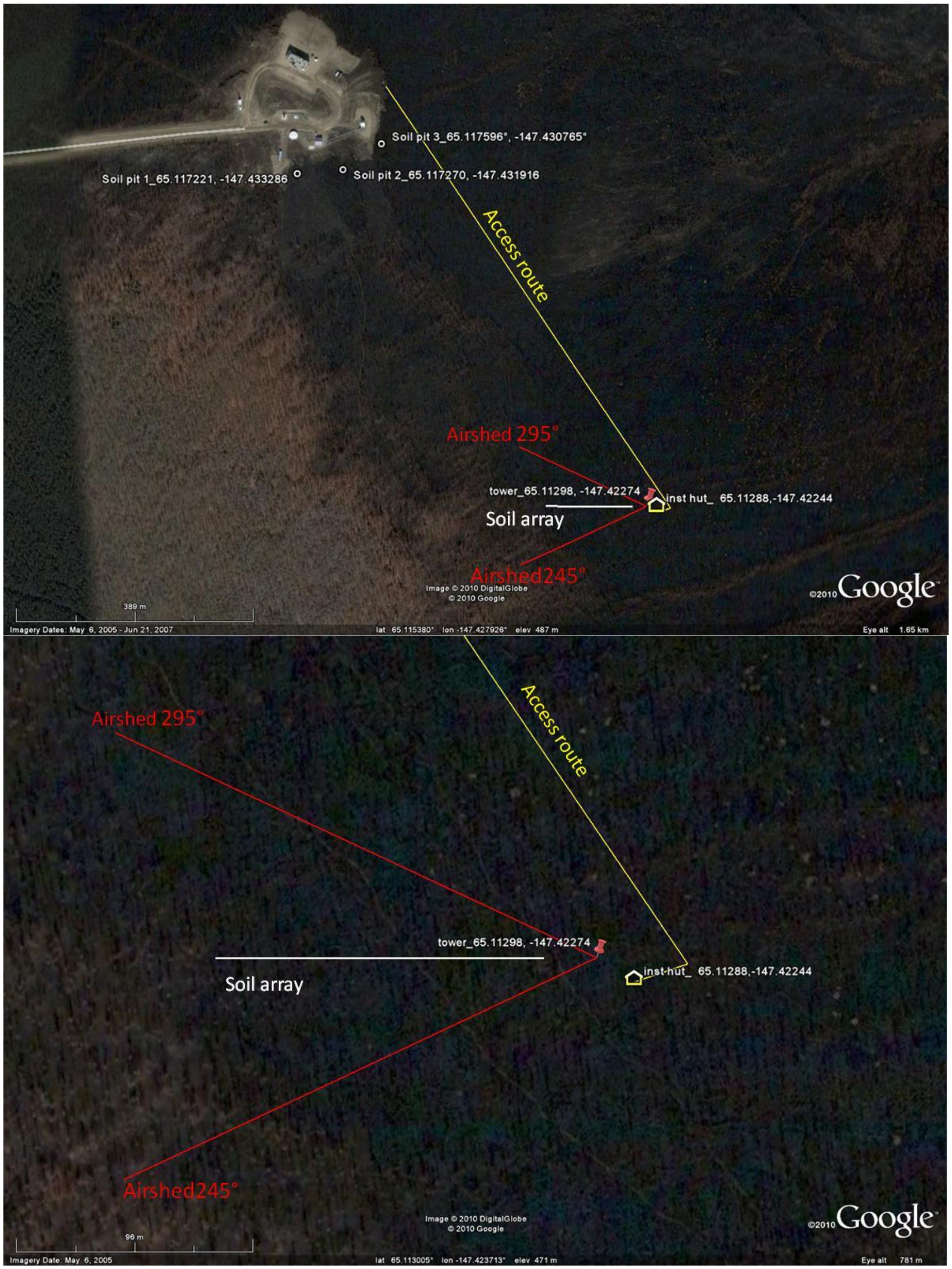


Figure 62. Site layout for Poker Flats Relocatable site.

Top panel shows the general site layout. Lower panel shows detailed information for tower, instrument hut, soil array and access boardwalk. i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 245° to 295° (major airshed, clockwise from 245°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

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

- Boardwalk from access point at Davis Science Operation center to instrument hut. This boardwalk should be only wide enough for ATV to access instrument hut.
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array.
- Boardwalk from soil array boardwalk to individual soil plots

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

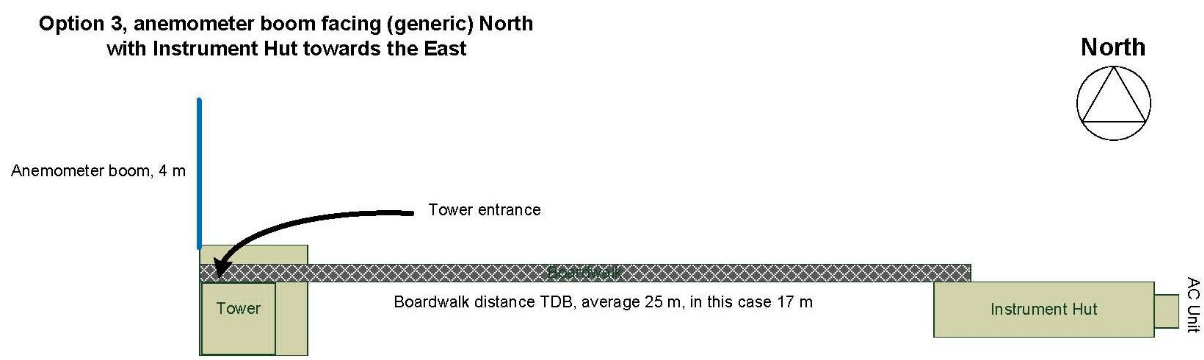


Figure 63. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing north and instrument hut on the south towards the tower.
This is just a generic diagram. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At this site, the boom angle will be 360°. Instrument hut will be on the southeast towards the tower, and boardwalk will access tower on north. The distance between instrument hut and tower is ~17 m. The instrument hut vector will be NE-SW (60°-240°, longwise).

5.4.7 Information for ecosystem productivity plots

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (burned spruce forest). Airshed at this site is from 245^o to 295^o (major airshed, clockwise from 245^o) according to windroses from a weather station at a nearby valley. Our site is at a mountain ridge, which may have different wind pattern compared to the valley windroses. According to the experience, we also expect to see winds from NE and SW along the river and valley direction (~ 60° and 240°), and some winds from west direction. 90% signals for flux measurements are within a distance of 500 m from tower, and 80% within 350 m from tower during summer season. While in winter, 90% flux signals are from a footprint with distance >1200 m, and 80% signals are from a footprint with distance > 700 m from tower. Since above airshed is from the only available data set for us, we suggest FSU Ecosystem Productivity plots to be placed within the major airshed boundaries of 245^o to 295^o (clockwise from 245^o) from tower.

5.5 Issues and attentions

Available wind data is from a weather station ~ 5.64 km (3.5 miles) away in a valley, which may not be representative for our site at ridge. But this is the only available data we can get by the time we analyze data and write this report. Risk identified, but minimized.

Power, communication cable and access point are ~ 700 m from tower location along the ridge, where Poker Flat Research Range facility Davis Science Operations Center location.

Electronically controlled gate access provides excellent security.

Poker Flat Research Range launch rockets to study aurora between September to next April. Site access may be restricted on the launch dates.

Range Operation Manager K. Rich expressed great interests in having NEON site inside Poker Flat Research Range and willing to provide lab, office space, clean room, storage room and other local supports.

6 EIGHT MILE LAKE RELOCATEABLE TOWER 3

6.1 Site description

NEON candidate relocatable site (63.874°, -149.211°) at Eight Mile Lake (Figure 64) is about 6.5 miles west of Healy. Because this site is located on land which Department of Natural Resources (DNR) is transferring to the Denali Borough soon. NEON can no longer get permission to use this location. The boundary is not valid anymore. We were suggested move tower site > 100 feet toward west on adjacent state land. Based on FIU site characterization field survey and data analysis, we determined the new tower location at 63.87569°, -149.21334°.

NEON site at Eight Mile Lake is design to study thermokarsting. Climate change scenarios predict that the greatest magnitude of warming will occur at high latitudes. This predicted warming is supported by observational evidence over the last 25 years and is associated with warmer ground temperatures, permafrost (permanently frozen soil) thawing, and thermokarst (ground subsidence as a result of ground ice thawing) (ACIA 2004). Permafrost thawing and thermokarst have the potential to alter ecosystem carbon cycling by changing the vegetation structure and growth rates, and by altering soil microbial decomposition rates. Together, these changes in plant and soil processes can alter the balance of carbon cycling processes in these ecosystems and cause feedbacks to climate change (info source: http://www.lter.uaf.edu/pdf/1242_Schuur_Vogel.pdf).

Site description below is from Dr Schuur's article http://www.lter.uaf.edu/pdf/1242_Schuur_Vogel.pdf for his research site, which is < 1.5 miles west and northwest toward NEON site. We can consider the description below is also true for NEON site.

Site Description This summary describes measurements made in the Eight Mile Lake Watershed (63º 52'42.1" N, 149º 15'12.9"W) on the north slope of the Alaska Range. Ground temperature in a borehole has been monitored for several decades at this site, before and after the permafrost was observed to thaw (Osterkamp and Romanovsky 1999*).* In this watershed, our study has defined three sites that represent differing amounts of disturbance from permafrost thawing based on observations of the vegetation and the borehole measurements: 1) tussock tundra typical of arctic ecosystems, dominated by the sedge *Eriophorum vaginatum* and *Sphagnum spp* mosses, 2) a site near the borehole used for permafrost temperatures where the vegetation composition has been shifting to include more shrub species, such as *Vaccinium uliginosum* and *Rubus chamaemorus,* and 3) a site located where permafrost melted more than several decades ago, now largely dominated by shrub species *(Schuur et al. in press).* These three sites are a natural experimental gradient representing the long-term effects of permafrost melting on carbon loss.

The mean annual temperature (1976–2005) was -1.0°C in Healy, with large differences between the coldest month (December, -16°C) and warmest month (July, 15°C). The total annual average precipitation was 378 mm (National Climate Data Center, NOAA). The study site was located at 700 m elevation on a gently sloping (~4%), north facing glacial terminal moraine that dates to the Early Pleistocene. An organic horizon, 0.45–0.65 m thick, covered cryoturbated mineral soil that was a mixture of glacial till (small stones and cobbles) and windblown loess. Soil organic C pools to 1 m depth averaged between 55 and 69 kg C m^2 across all three. Permafrost was found within 1 m of the soil surface, and therefore the soils were classified in the soil order Gelisol. Permafrost temperatures have been monitored in a 30 m deep borehole in the study area since 1985 maximum temperature range = -0.7 to -1.2°C at 10 m). During this time frame, researchers recorded rapidly increasing deep permafrost temperatures (by -0.6°C at 10 m) from 1990 until 1998, followed by a slight cooling (by -0.2°C) between 1998 and 2004 (info source: http://www.lter.uaf.edu/pdf/1443_Vogel_Schuur_2009.pdf).

Some other research data and results at Dr. Schuur's site can be found here http://www.lter.uaf.edu/data_detail.cfm?datafile_pkey=453, which may provide some helpful initial information for NEON science groups.

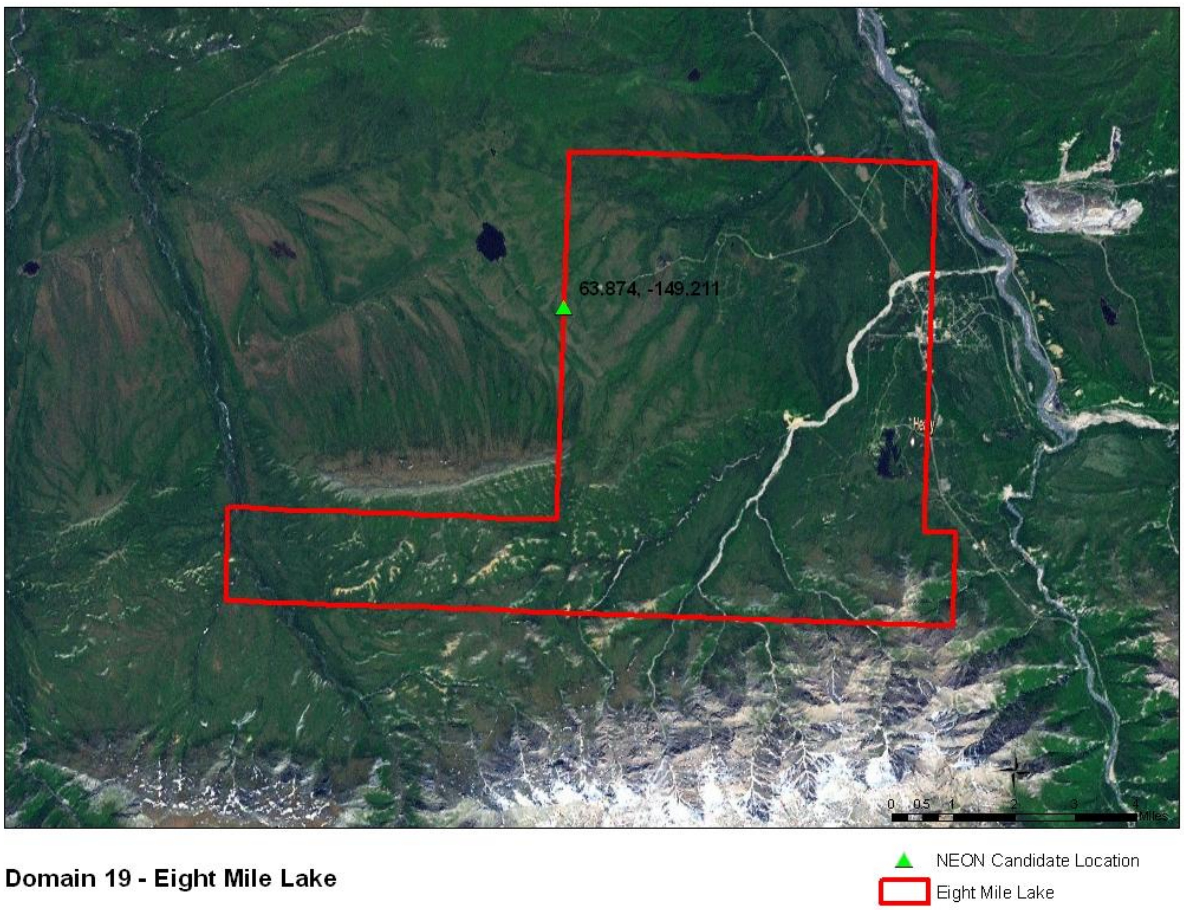


Figure 64. Boundary map for Eight Mile Lake Relocatable site and original candidate tower location.

Figure 65. New tower location at Eight Mile Lake, Healy, Alaska

6.2 Ecosystem

Vegetation and land cover information at this new NEON tower site and surrounding area can be found in the 2 km x 2km map below (centered at tower location):

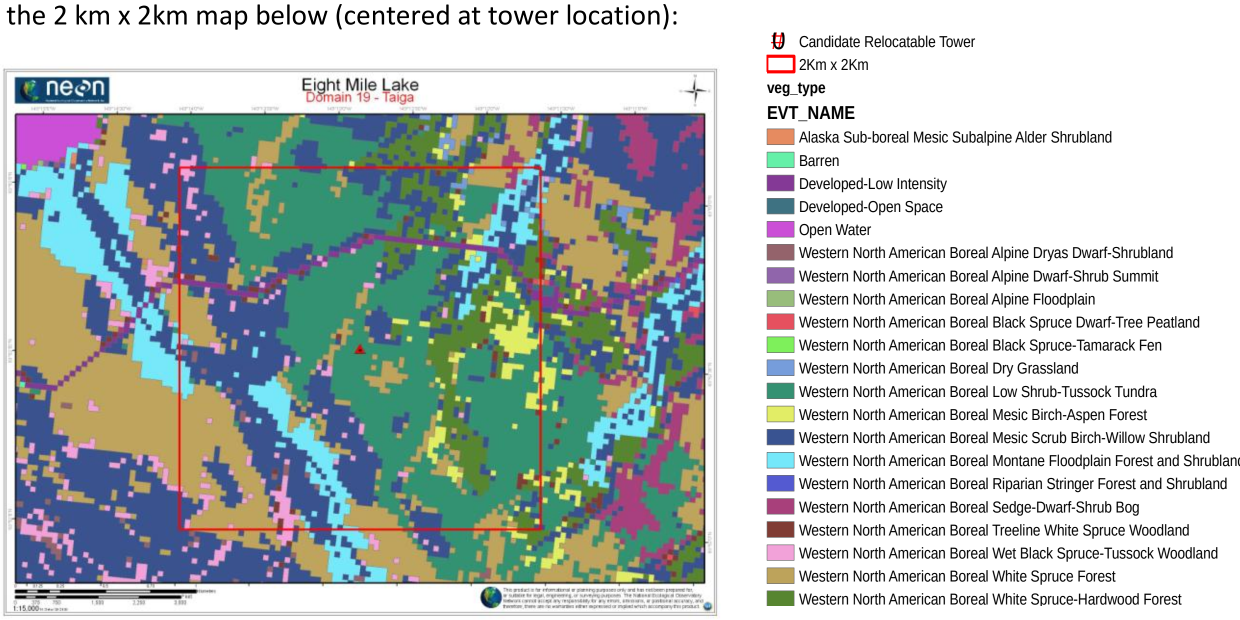


Figure 66. Vegetative cover map of Eight Mile Lake Relocatable tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 20. Percent Land cover type at Eight Mile Lake Relocatable tower site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation_Type	Area_km^2	Percentage
Developed-Low Intensity	0.0614	1.53
Developed-Open Space	0.0014	0.03
Western North American Boreal Alpine Dryas Dwarf-Shrubland	0.0117	0.29
Western North American Boreal Black Spruce Dwarf-Tree Peatland	0.0009	0.02
Western North American Boreal Dry Grassland	0.0114	0.28
Western North American Boreal Low Shrub-Tussock Tundra	1.4614	36.53
Western North American Boreal Mesic Birch-Aspen Forest	0.1330	3.32
Western North American Boreal Mesic Scrub Birch-Willow Shrubland	1.0419	26.04
Western North American Boreal Montane Floodplain Forest and Shrubland	0.2178	5.44
Western North American Boreal Sedge-Dwarf-Shrub Bog	0.0108	0.27
Western North American Boreal Treeline White Spruce Woodland	0.0404	1.01
Western North American Boreal Wet Black Spruce-Tussock Woodland	0.1035	2.59
Western North American Boreal White Spruce Forest	0.5813	14.53
Western North American Boreal White Spruce-Hardwood Forest	0.3237	8.09
TOTAL	4.0006	100.00

The representative ecosystem around NEON site is dominant by tussock alpine tundra on thermokasting and discontinued permafrost terrain (Figure 67). Besides tundra grass, other plants include salmon berry, dwarf birch, etc. The canopy height for the tundra grass is 30 cm. The height of the tussocks is ~ 20 cm. Moss layer is thick and reaches 30-40 cm. Water table is shallow and close to surface. Some water pits appear at site. Scrub birch-Willow shrub islands are distributed on the tundra with height < 1.5 m. Islands of Black spruce are scattered across the landscape with height < 8 m. Terrain is flat and ecosystem is homogenous.

Table 21. Ecosystem and site attributes for Eight Mile Lake Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	0.3 m
Surface roughness[a]	0.04 m
Zero place displacement height[a]	0.2 m
Structural elements	Tussock tundra on thermokarsting terrain, homogenous
Time zone	Alaska standard time
Magnetic declination	19° 54' E changing by 0° 20' W/year

Note, [a] From field survey.

Figure 67 Tussock tundra meadow is the dominant ecosystem at Eight Mile Lake Relocatable site

6.3 Soils

6.3.1 Description of soils

No soil data available from NRCS (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx).

6.3.2 Soil semi-variogram description

The goal of this aspect of the site characterization is to determine the minimum distance between the soil plots in the soil array such that data farther apart can be considered spatially independent. The collected field data will be used to produce semivariograms, which is a geostatistical technique to characterize spatial autocorrelation between mapped samples of a quantitative variable (*e.g.*, soil property data in our case). In an empirical semivariogram, the average of the squared differences of a response variable is computed for all pairs of points within specified distance intervals (lag classes). The output is presented graphically as a plot of the average semi-variance versus distance class (Figure 68). 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 68).

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 68), 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.

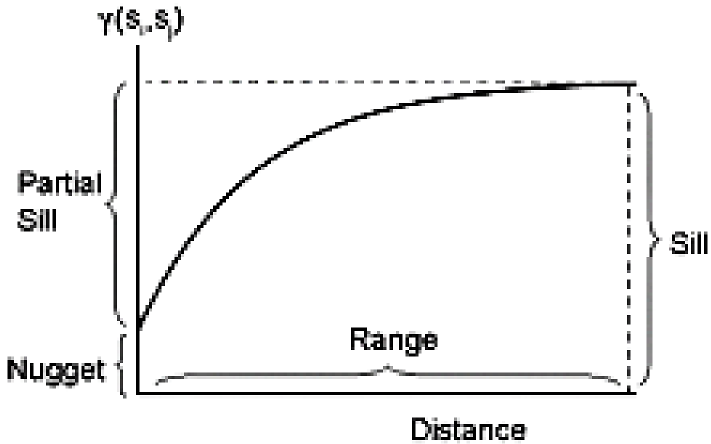


Figure 68. Example semivariogram, depicting range, sill, and nugget.

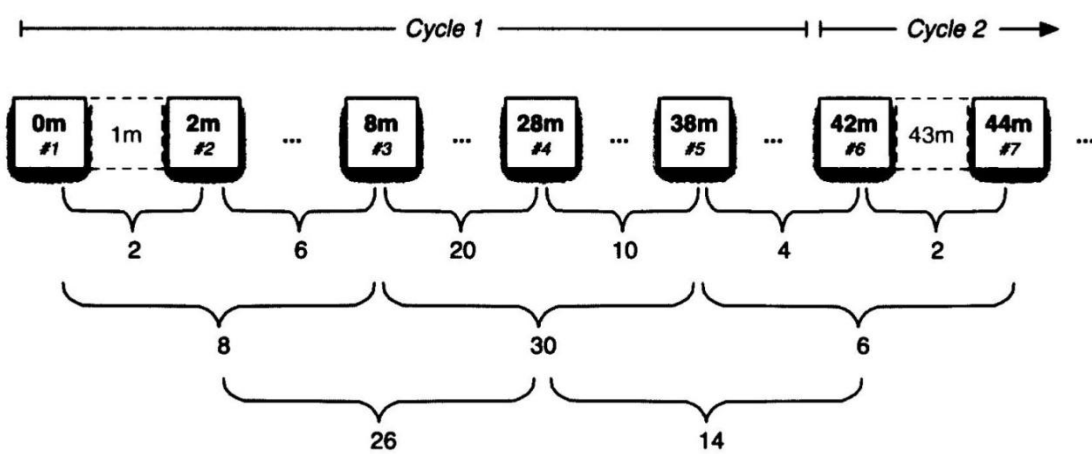


Figure 69. Spatially cyclic sampling design for the measurements of soil temperature and soil water content.

Field measurements of soil temperature (0-12 cm) and moisture (0-15 cm) were taken on 29 June 2010 at the Eight Mile site. The sampling points followed the spatially cyclic sampling design by Bond-Lamberty et al. (2006) (Figure 69). Soil temperature and moisture measurements were collected along three transects (196 m, 84 m, and 84 m) located in the expected airshed at Eight Mile. 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 69, 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).

6.3.3 Results and interpretation

6.3.3.1 Soil Temperature

Soil temperature data residuals, after accounting for changes in temperature in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 70). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 71, left graph) and directional semivariograms do not show anisotropy (Figure 71, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 71, right graph). The model indicates a distance of effective independence of 72 m for soil temperature.

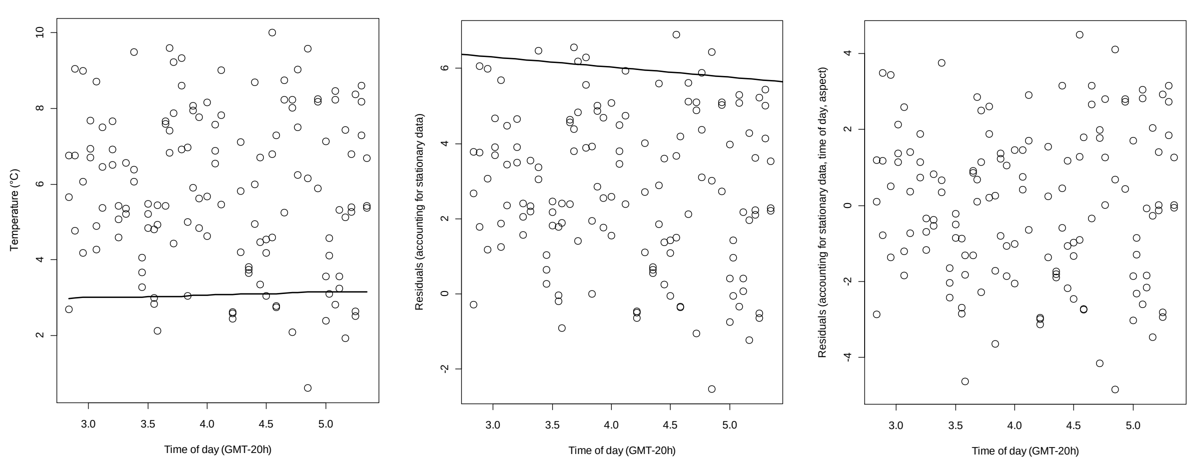


Figure 70. Left graph: mobile (circles) and stationary (line) soil temperature data. Center graph: temperature data after correcting for changes in temperature in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual temperature data after correcting for changes temperature in the stationary data and the time of day regression. Data in the right graph were used for the semivariogram analysis.

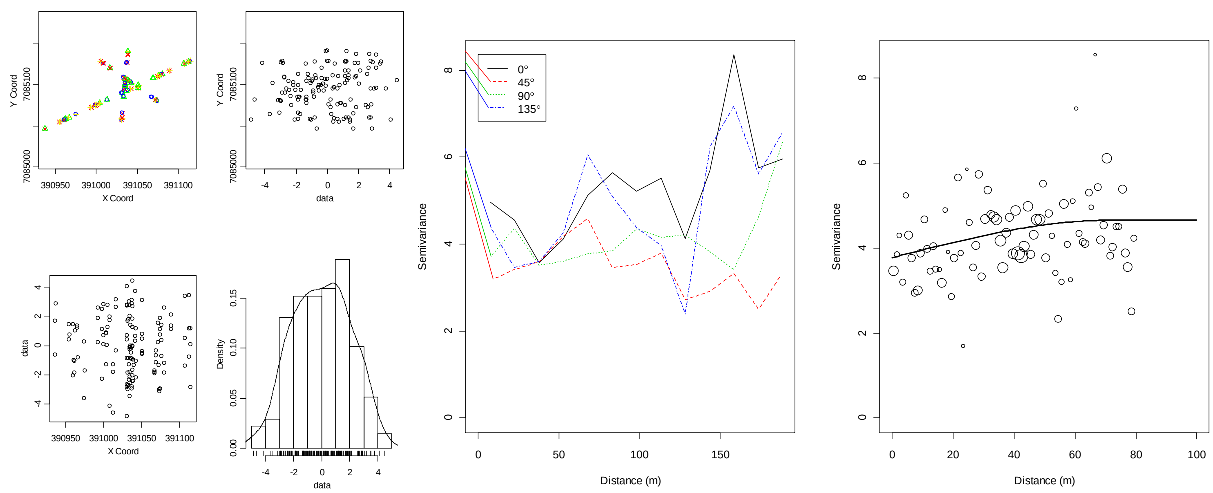


Figure 71. Left graphs: exploratory data analysis plots for residuals of temperature. Center graph: directional semivariograms for residuals of temperature. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of temperature.

6.3.3.2 Soil water content

Soil water content data residuals, after accounting for changes in water content in the stationary data and any remaining time of day trend, were used for the semivariogram analysis (Figure 72). Exploratory data analysis plots show that there was no distinct patterning of the residuals (Figure 73, left graph) and directional semivariograms do not show anisotropy (Figure 73, center graph). An isotropic empirical semivariogram was produced and a spherical model was fitted using Cressie weights (Figure 73, right graph). The model indicates a distance of effective independence of 14 m for soil water content.

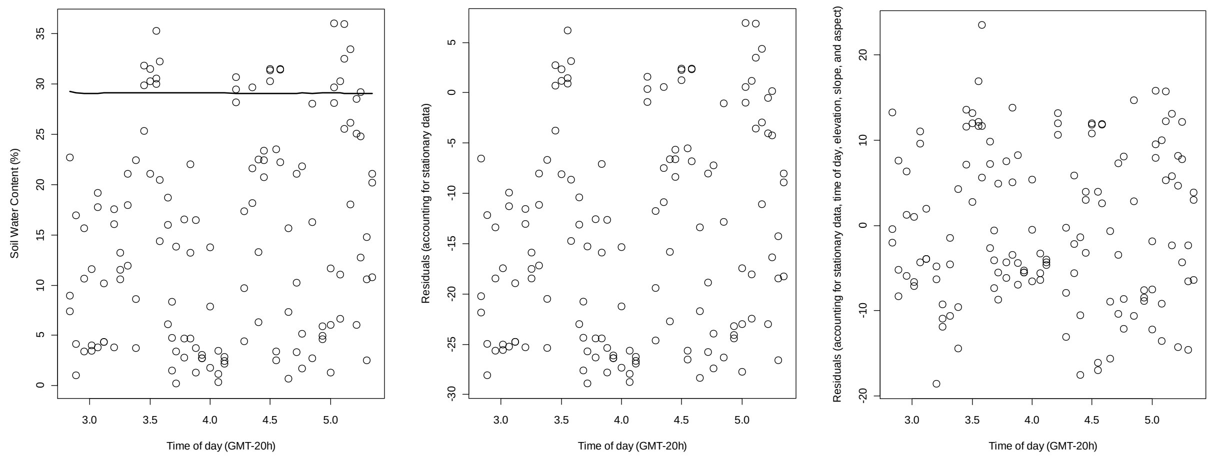


Figure 72. Left graph: mobile (circles) and stationary (line) soil water content data. Center graph: water content data after correcting for changes in water content in the stationary data (circles) and a linear regression based on time of day (line). Right graph: residual water content data after correcting 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.

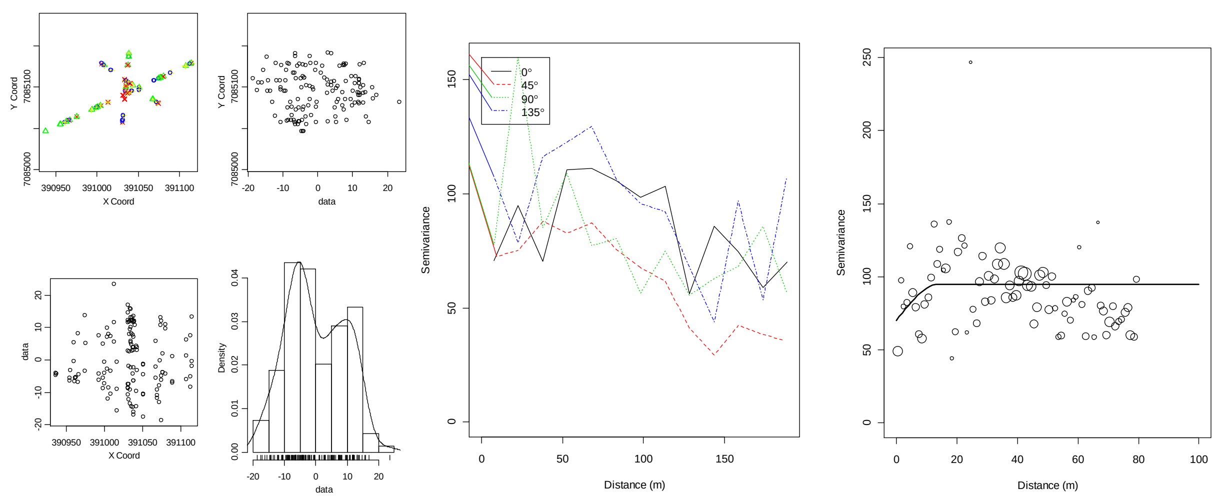


Figure 73. Left graphs: exploratory data analysis plots for residuals of soil water content. Center graph: directional semivariograms for residuals of water content. Right graph: empirical semivariogram (circles) and model (line) fit to residuals of water content.

6.3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. The estimated distance of effective independence was 72 m for soil temperature and 14 m for soil moisture. Based on these results and the site design guidelines the soil plots at Eight Mile 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 225° from the soil plot nearest the tower. The location of the first soil plot will be approximately 63.875569°, -149.213614°. 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 63.880318°, -149.216824° (primary location); or 63.880765°, -149.215347° (alternate location 1 if primary location is unsuitable); or 63.881145°, -149.213840° (alternate location 2 if primary location is unsuitable). A summary of the soil information is shown in Table 22 and site layout can be seen in Figure 74.

Dominant soil series at the site: Not available from NRCS. The taxonomy of this soil is shown below:
Order: Not available
Suborder: Not available
Great group: Not available
Subgroup: Not available
Family: Not available
Series: Not available

Table 22. Summary of soil array and soil pit information at Eight Mile. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	19 m
Latitude and longitude of 1st soil plot OR direction from tower	63.875569°, -149.213614°
Direction of soil array	225°
Latitude and longitude of FIU soil pit 1	63.880318°, -149.216824° (primary location)
Latitude and longitude of FIU soil pit 2	63.880765°, -149.215347° (alternate 1)
Latitude and longitude of FIU soil pit 3	63.881145°, -149.213840° (alternate 2)
Dominant soil type	Not available
Expected soil depth	Unknown
Depth to water table	Unknown

Expected depth of soil horizons	**Expected measurement depths***
Unknown	0.10 m
	[a] 0.35 m
	[a] 1.00 m
	[a] 3.00 m

* Currently, there are no data on the expected soil depth of soil horizons from NRCS. However, we fully expect to be measuring (at least) 4 different horizons, i.e., the top and bottom of the active layer, at 3 m and other TBD layers. The 3 m depth is below the biologically active layer, but provides a link between the active layer dynamics and the temperature regime of the deep permafrost, V. Romanofsky, pers. Comm. 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. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to measure long-term permafrost dynamics. [a]Notes the current understanding of the measurement depths to be applied by the soil array.

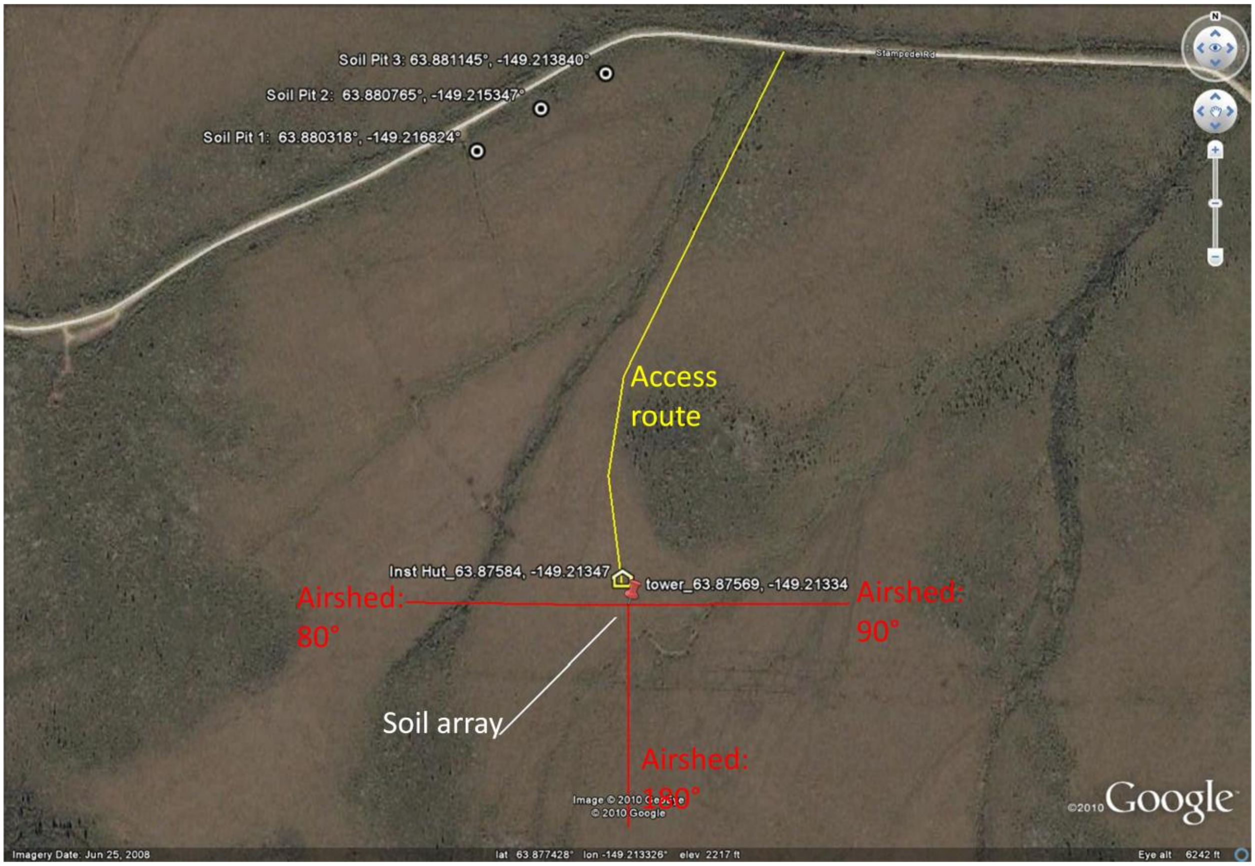


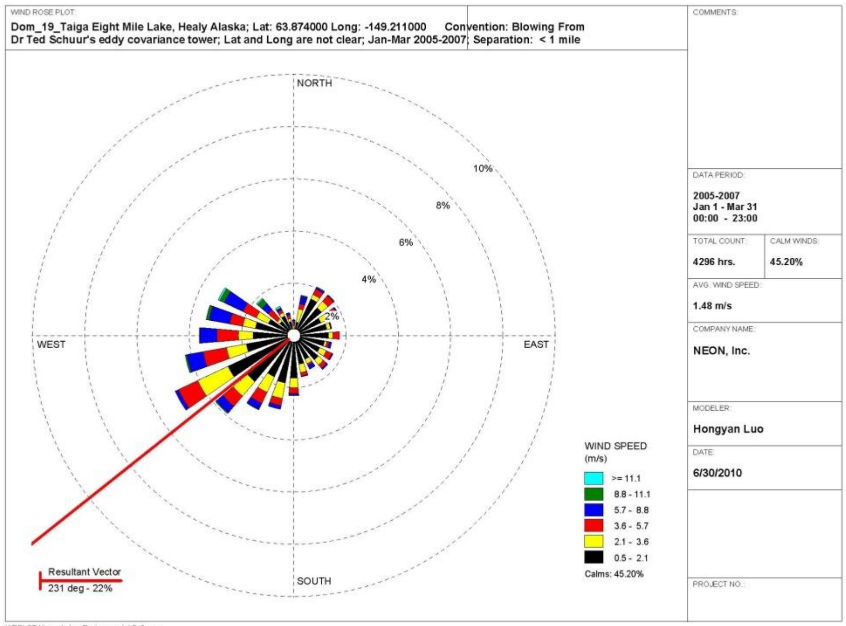
Figure 74. Site layout at Eight Mile showing soil array and location of the FIU soil pit.

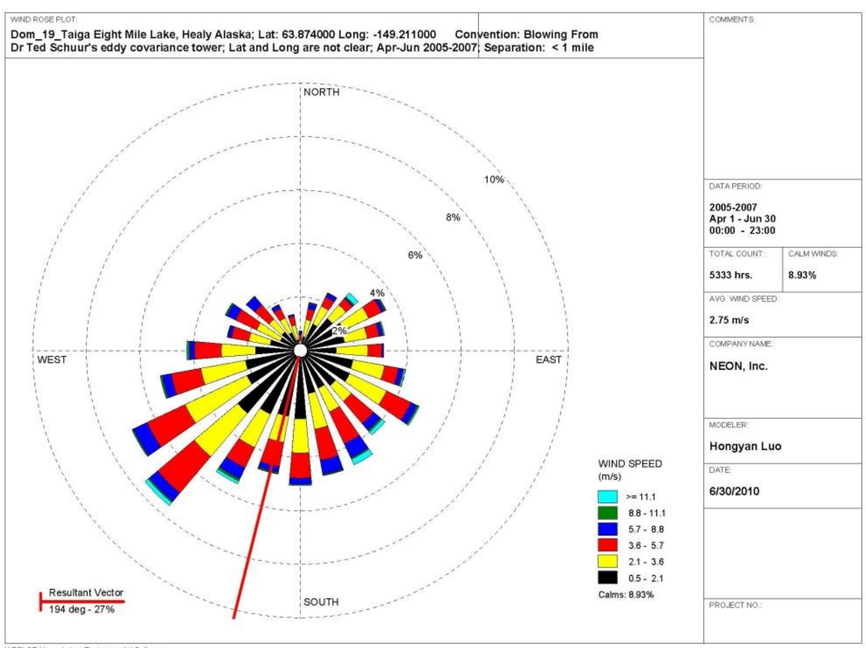
6.4 Airshed

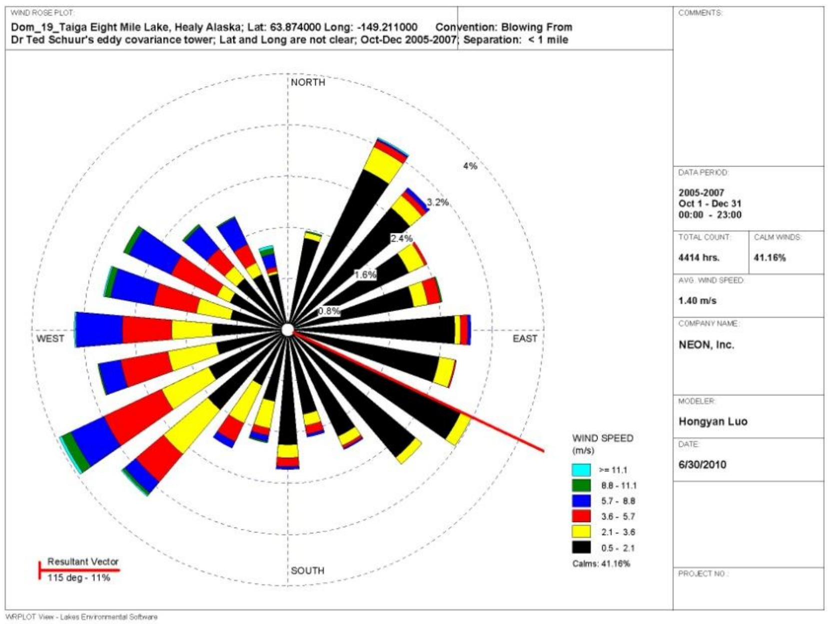
6.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries, Figure 32. The weather data used to generate the following wind roses are from Dr T. Schuur's eddy covariance tower, which is ~ 1.3 mile on the west to NEON tower site. The orientation of the wind rose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions.

6.4.2 Results (graphs for wind roses)







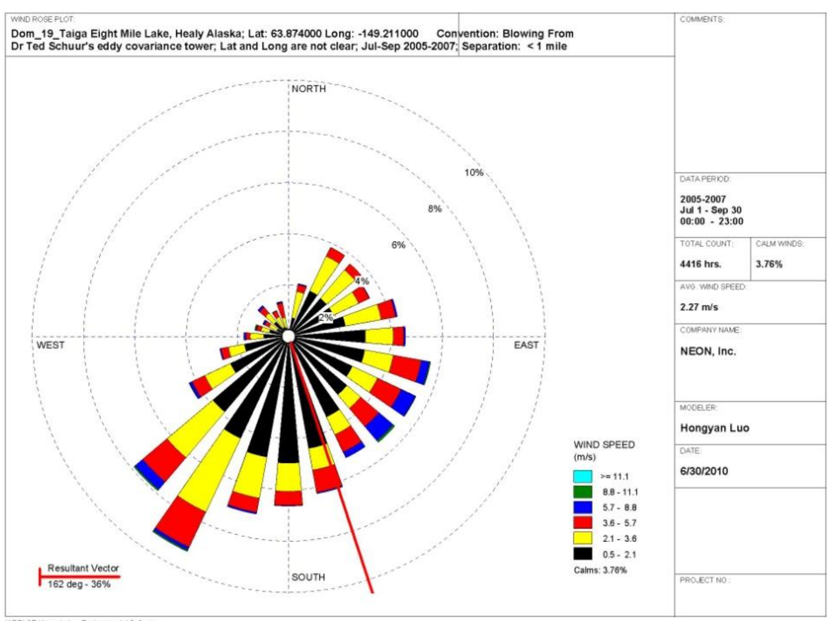


Figure 75. Windroses for Eight Mile Lake relocatable site.
Data used here are 2005-2007 wind data from Dr Schuur's Eddy Covariance tower site, which is ~ 1.3 miles on the west to NEON tower site. It is assumed that the wind data was corrected for declination. Panels (from Top to bottom), are from Jan-Mar, Apr-Jun, Jul-Sept, and Oct-Dec.

6.4.3 Resultant vectors

Table 23. The resultant wind vectors from Delta Junction relocatable site using hourly data in 2007

Quarterly (seasonal) timeperiod	Resultant vector	% duration
January to March	182°	20
April to June	231°	22
July to September	194°	27
October to December	162°	36
Annual mean	192.25°	na.

6.4.4 Expected environmental controls on source area

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

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

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

Table 24. Expected environmental controls to parameterize the source area model, and associated results from Eight Mile Lake 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	6	6	6	6	6	6	m
Canopy Height	0.3	0.3	0.3	0.3	0.3	0.3	m
Canopy area density	1.3	1.3	1.3	1.1	1.1	1.1	m
Boundary layer depth	800	800	800	400	400	400	m
Expected sensible heat flux	150	150	80	-75	-75	-75	W m^{-2}
Air Temperature	4	4	2	-20	-20	-20	°C
Max. windspeed	8.6	3	1	11	3.6	1.6	m s^{-1}
Resultant wind vector	76	76	316	76	76	316	degrees
Results							
(z-d)/L	-0.04	-0.63	-3	0.01	3.00	3.00	m
d	0.21	0.21	0.21	0.20	0.20	0.20	m
Sigma v	1.5	1	0.76	1.8	1.6	1.6	m^2 s^{-2}
Z0	0.02	0.02	0.02	0.02	0.02	0.02	m
u*	0.62	0.25	0.10	0.78	0.11	0.03	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	750	300	200	1000	2500	3300	m
Distance of 80% cumulative flux	400	200	150	500	1650	2800	m
Distance of 70% cumulative flux	350	150	100	350	1200	2350	m
Peak contribution	65	45	15	65	245	935	m

6.4.5 Results (source area graphs)

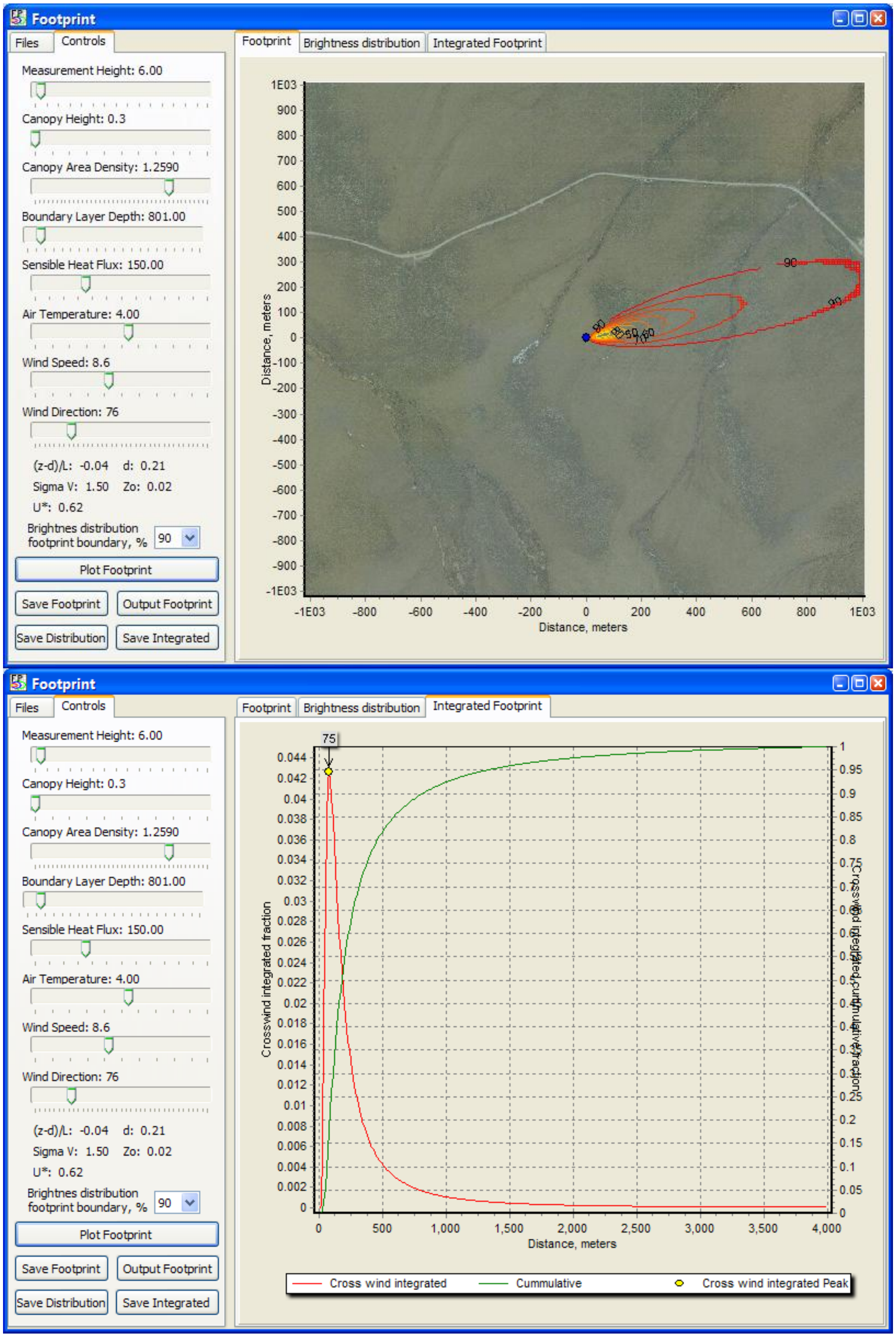


Figure 76. Eight Mile Lake summer daytime (convective) footprint output with max wind speed.

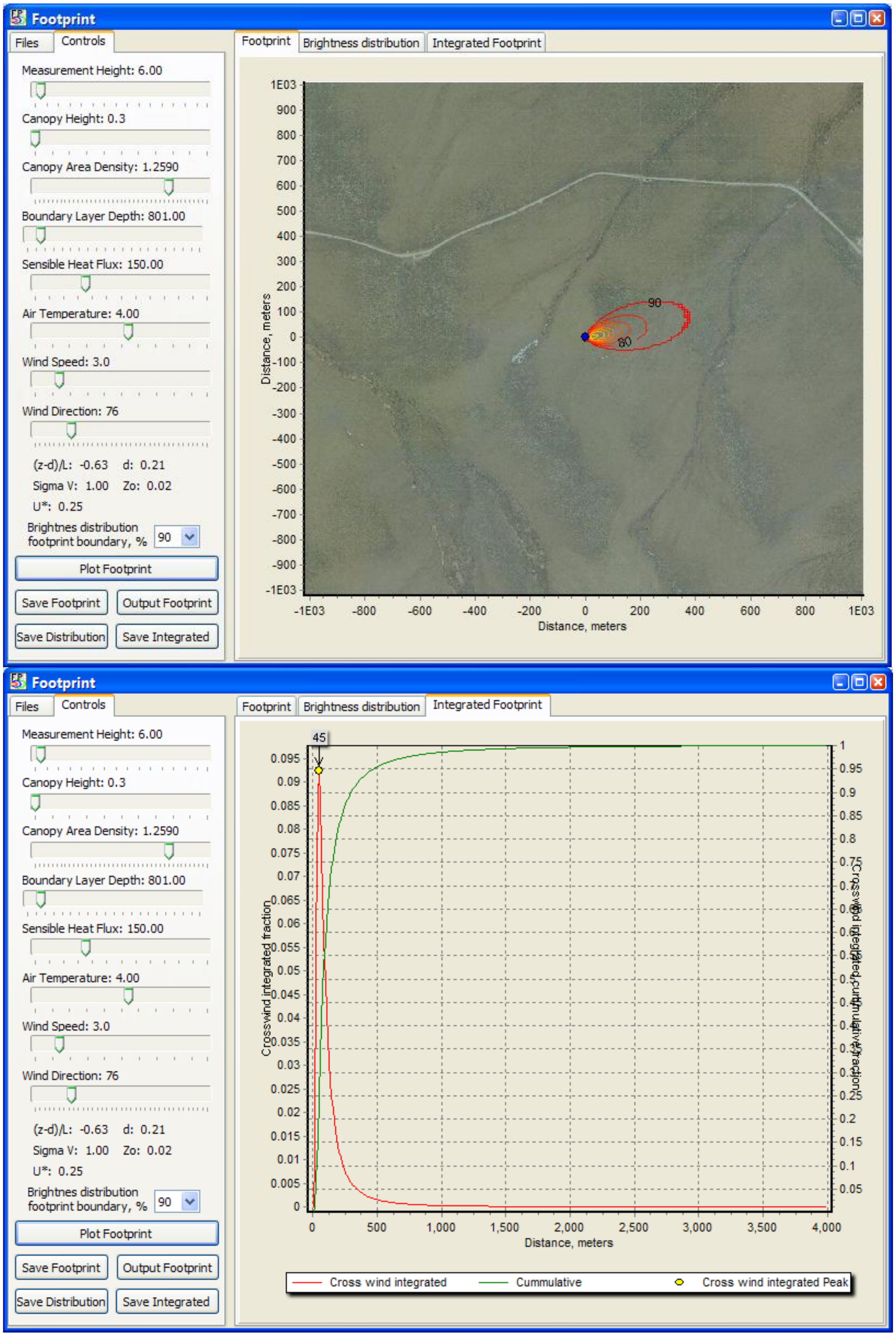


Figure 77. Eight Mile Lake summer daytime (convective) footprint output with mean wind speed.

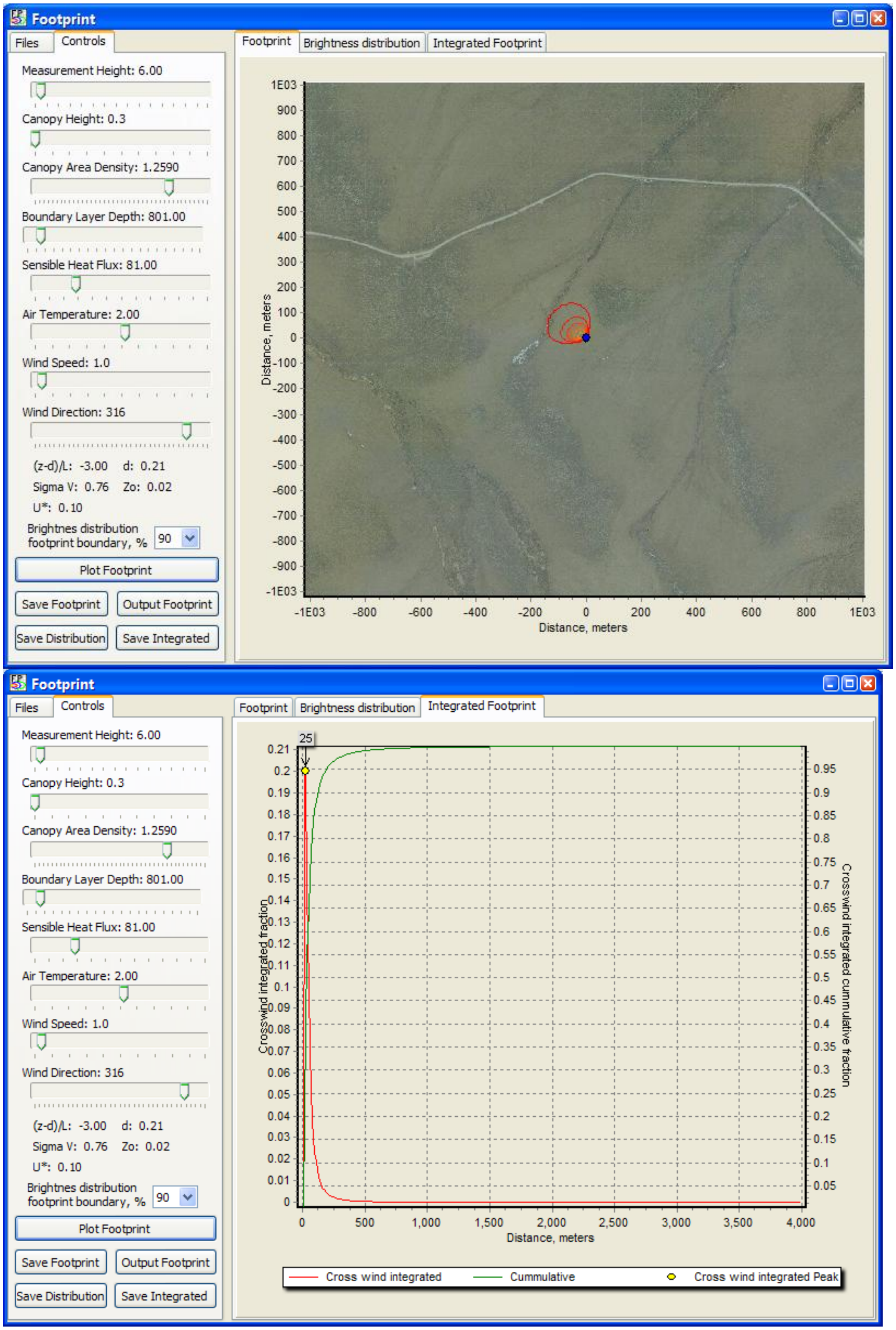


Figure 78. Eight Mile Lake summer nighttime (stable) footprint output with mean wind speed.

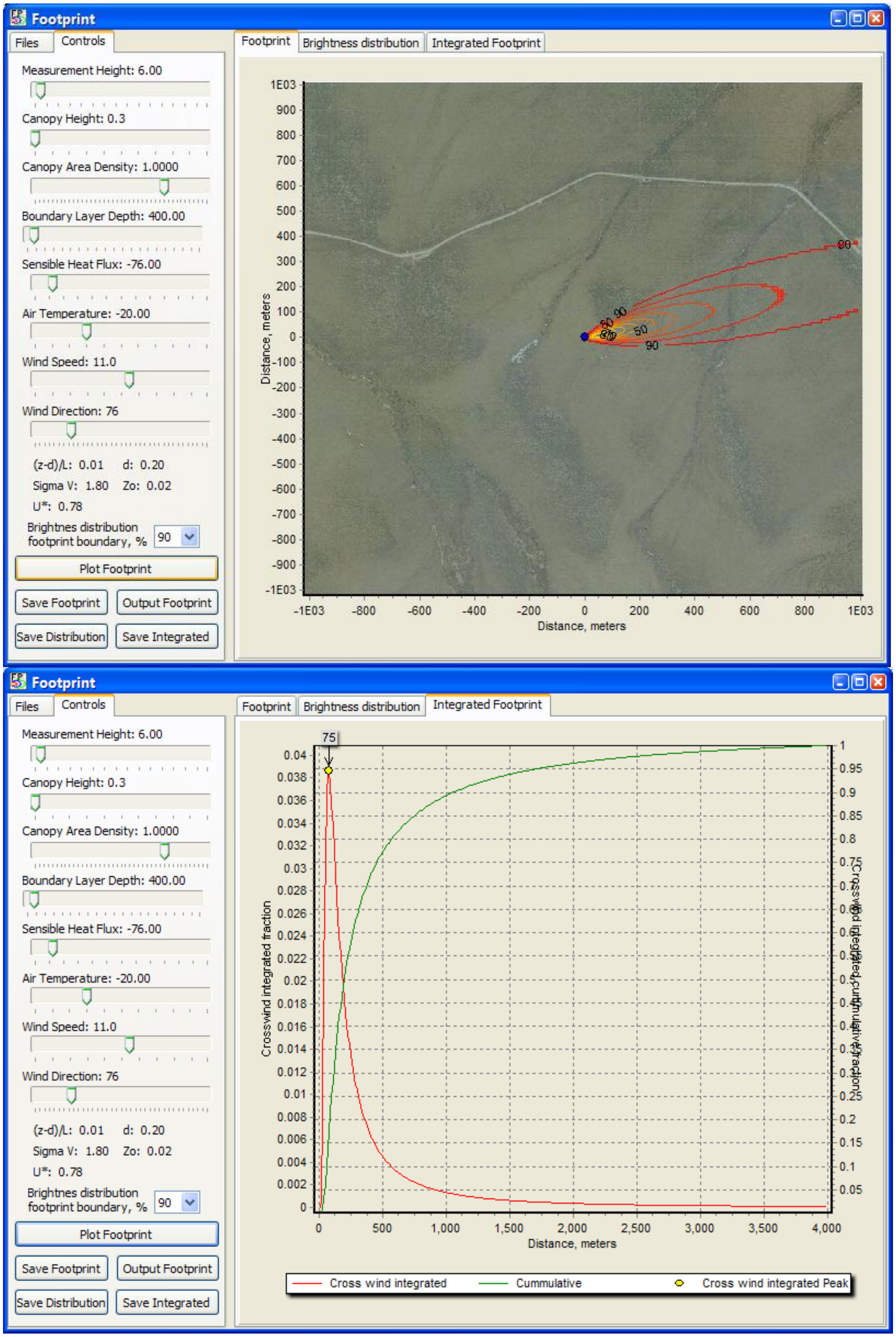


Figure 79. Eight Mile Lake winter daytime (convective) footprint output with max wind speed.

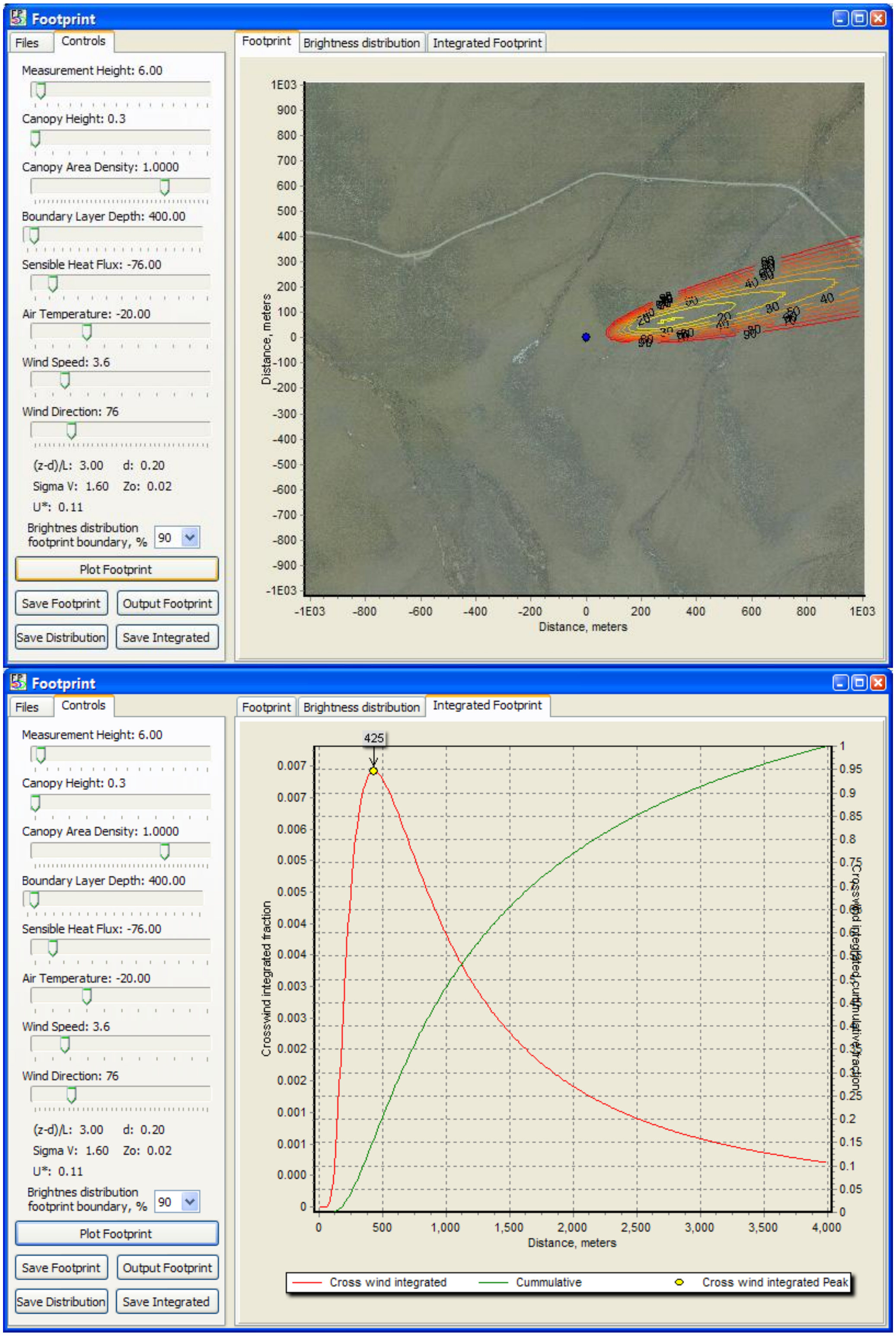


Figure 80. Eight Mile Lake winter daytime (convective) footprint output with mean wind speed.

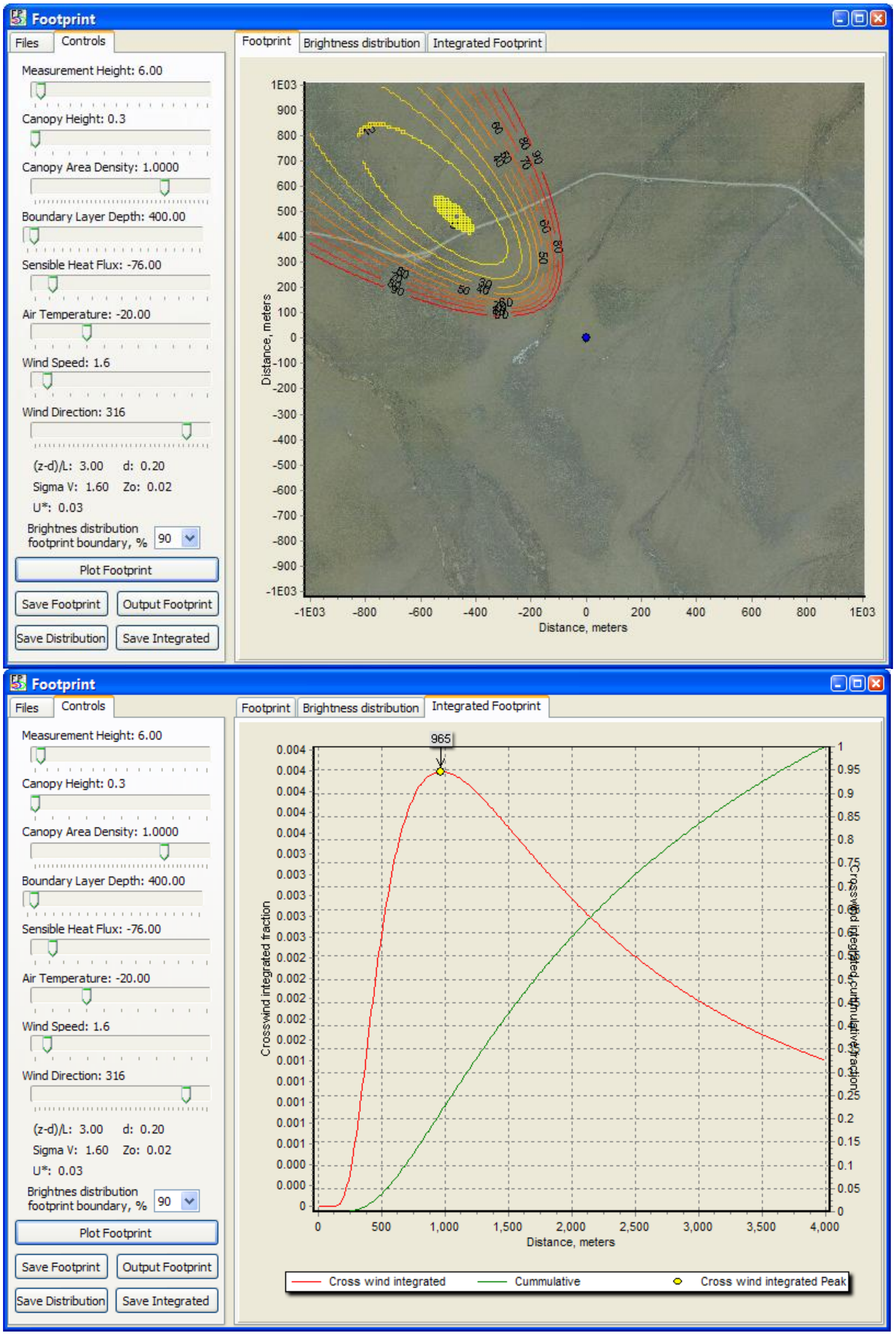


Figure 81. Eight Mile Lake winter nighttime (stable) footprint output with mean wind speed.

6.4.6 Site design and tower attributes

According to wind roses, winds can blow from any direction from 20° to 340° (clockwise from 20°). The prevailing wind direction changes from season to season, with slightly higher frequency from 180° to 270° (clockwise from 180°). Airshed from 90^{o} to 180^{o} (clockwise from 90^{o}) have secondary high frequency. Tower should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is tussock tundra ecosystem on thermokarsting terrain. Tower location was determined to be 63.87569, -149.21334 after FIU site characterization.

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 similar to the setup at other NEON sites, even it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circles at the sky >20 hours a day. 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 northwest side of tower and have the longer side parallel to NE-SW direction. We require the placement of instrument hut at 63 63.87584°, -149.21347°. The distance between the tower and the instrument hut is ~ 19 m at this site.

The ecosystem we are interested in at this site is tussock tundra on thermokasting and discontinued permafrost terrain. Besides tundra grass, salmon berry, dwarf birch, etc area commonly found at this tundra. The canopy height is ~30 cm. Scrub birch-Willow shrub islands are distributed on the tundra with height < 1.5 m. The distance between Black Spruce islands varies from 100 m to > 1000 m, with a mean distance ~ 500 m. Black spruce scatters at some islands with height < 8 m. We require 4 **measurement layers** on the tower with top measurement height at 8 m to avoid the effects of possible stand waves created by scrub shrub islands, and remaining measurement levels are 4.5 m, 1 m and 0.2 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

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

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

Table 25. Site design and tower attributes for Eight Mile Lake 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			180° to 270° (major) 90° to 180° (secondary)		Clockwise from first angle
Tower location	63.87569,	-149.21334	--	--	
Instrument hut	63.87584,	-149.21347			
Instrument hut orientation vector	--	--	45º-225º		
Instrument hut distance z	--	--	--	18	
Anemometer/Temperature boom orientation	--	--	180°	--	
Height of the measurement levels					
Level 1				0.2	m.a.g.l.
Level 2				1.0	m.a.g.l.
Level 3				4.5	m.a.g.l.
Level 4				8.0	m.a.g.l.
Tower Height				8.0	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.

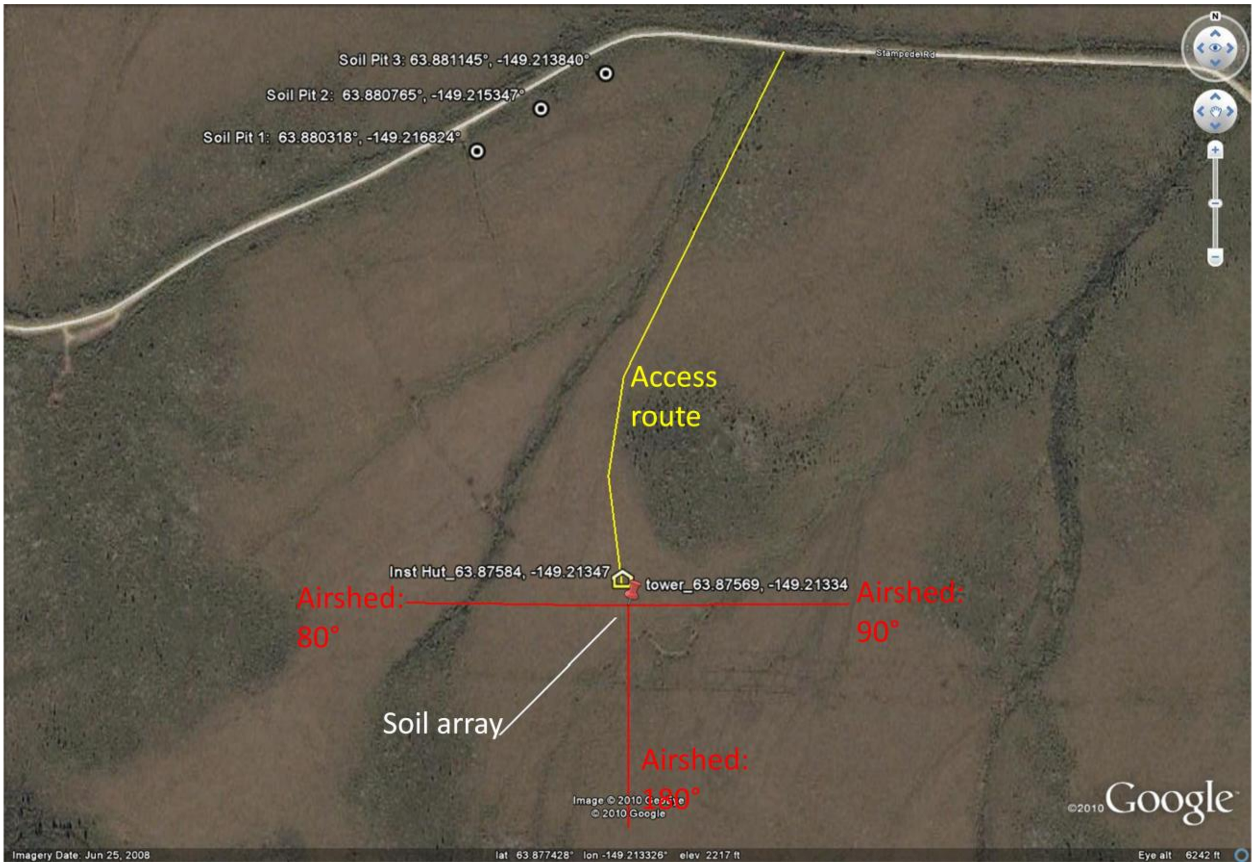


Figure 82. Site layout for Eight Mile Lake Relocatable site.

i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 180° to 270° (major airshed, clockwise from 180°), 90° to 180° (secondary airshed, clockwise from 90°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

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

Specific Boardwalks at this site:

- Boardwalk from access dirt road to instrument hut. Boardwalk should be only wide enough for ATV to access instrument hut.
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array.
- Boardwalk from soil array boardwalk to individual soil plots

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

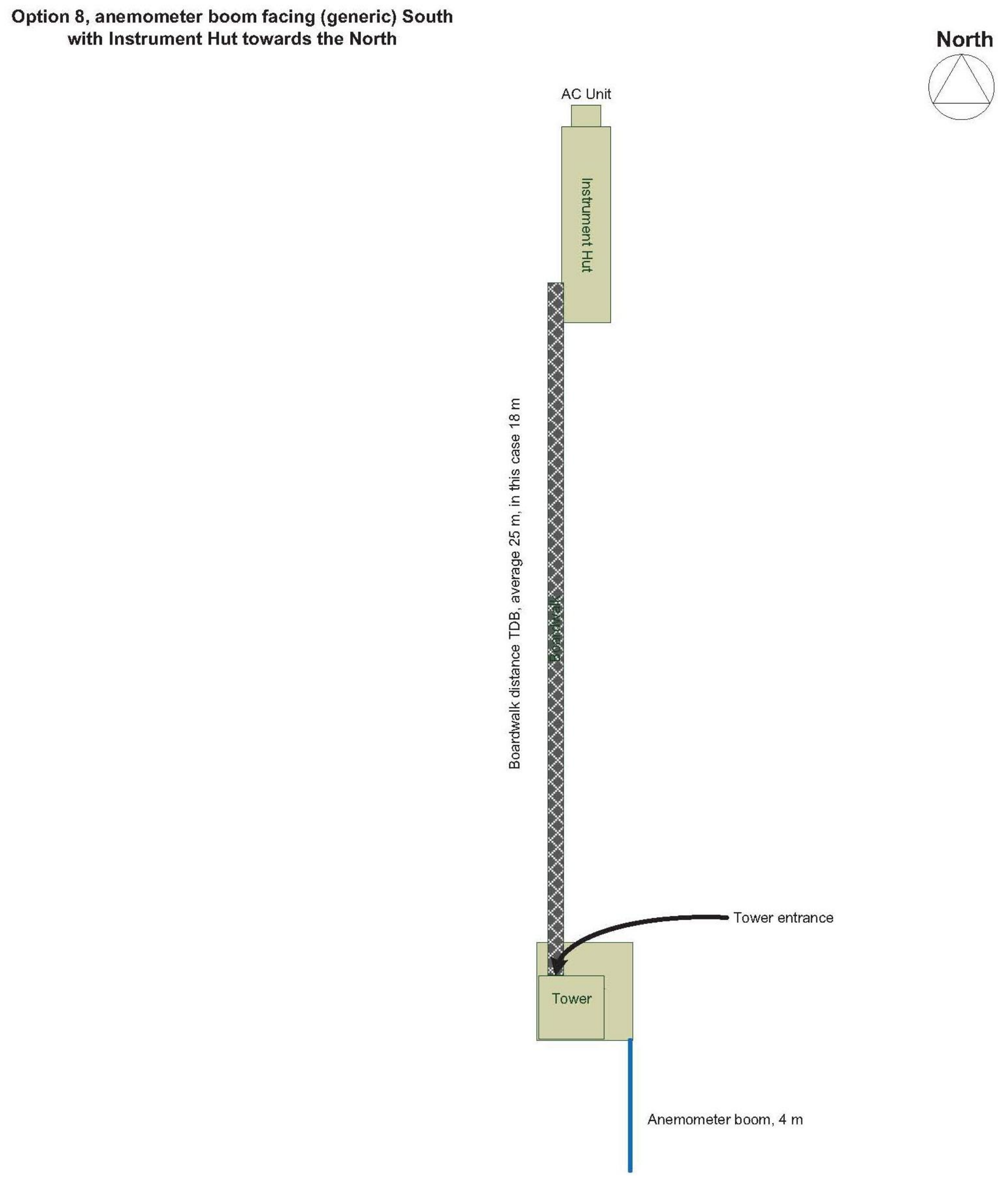


Figure 83. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be joint responsibility of FCC and FIU. At this site, the boom angle will be

180°. Instrument hut will be on the northwest towards the tower, and boardwalk will access tower on north. The distance between instrument hut and tower is ~18 m. The instrument hut vector will be NE-SW (45º-225º, longwise).

6.4.7 Information for ecosystem productivity plots

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (tussock tundra on thermokasting terrain). Winds blow from all directions throughout the whole year. Prevailing wind direction changes from season to season. Winds from 180º to 270º (clockwise from 180º) have relatively higher frequency through the year. Airshed from 90º to 180º (clockwise from 90º) have secondary high frequency throughout the whole year. 90% signals for flux measurements are from a distance of < 800 m from tower during summer while over 1000 m during the winter, and 80% within 450 m from tower during summer while 500 m during the winter. We suggest FSU Ecosystem Productivity plots to be placed within the major airshed boundaries of 180º to 270º (clockwise from 180º) from tower. EHS indicates that the lands in the secondary airshed belongs to different owner and may not be available for NEON use.

6.5 Issues and attentions

The tower location we selected during FIU site characterization is no longer able to us due to changes in land ownership. We changed tower site design to current location. Flux measurements may see some influence from a scrub shrub island (~ 80 m away from tower) when wind comes from northeast to the tower. There is another shrub island on the ~ 300 m southwest to tower location. Therefore, only 70% signals from the major airshed of southwest will be contributed by tussock tundra. There will be better fetch area on south and southeast for the measurements on tundra ecosystem.
We miscrosited the tower site ~150 meters closer to road than original candidate site to optimize the source area and provide measurements with confidence. The original site was too close to ridge where no permafrost presents, which doesn't fit in our design to measure tundra ecosystem on discontinued permafrost with thermokarst features (second reason to re-locating the tower location).
Because it is hard to predict the direction and growth rate of thermokarst features, deeper (tower and instrument hut) foundations into permafrost will be required at this site.
Line power is quite far away (~2.75 km (1.6 mile) straight line, and 3.22 km (~ 2 miles) along the dirt road).
Moose is commonly found around shrub islands. It was said that the rate people attacked by moose is much higher than bears and other animals at this region.

7 REFERENCES:

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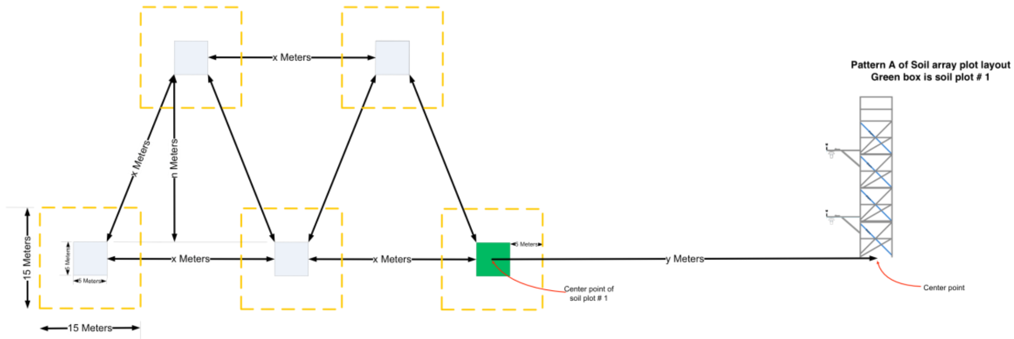
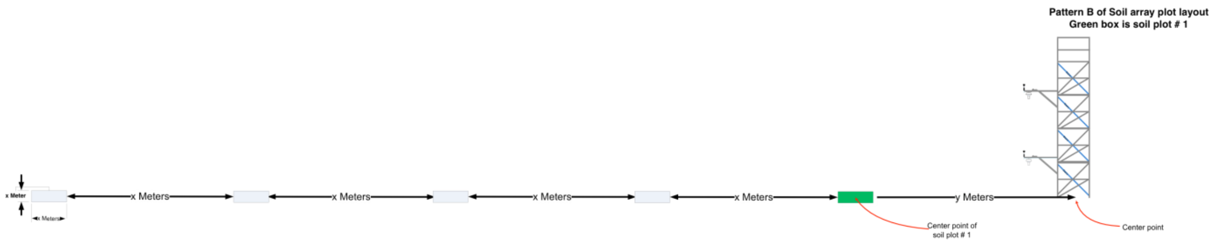
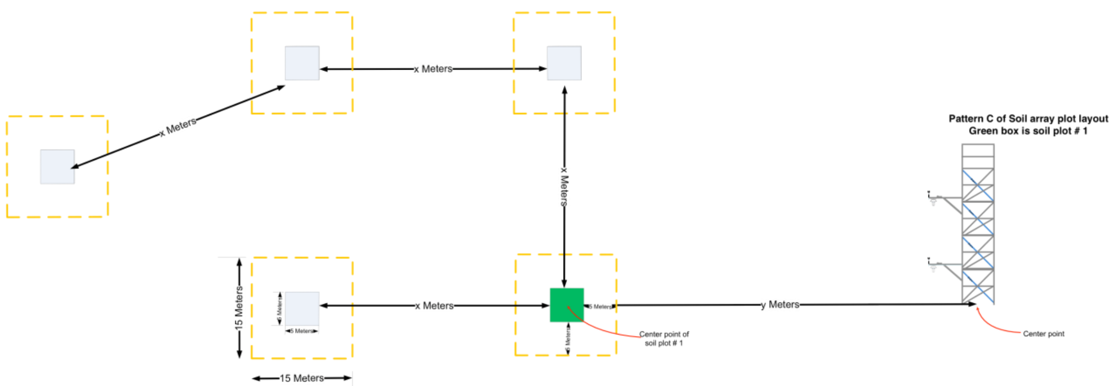
Webster R. & Oliver M.A. (1989). Optimal interpolation and isarthmic mapping of soil properties: VI Disjuctive kriging and mapping the conditional probability. *Journal of Soil Science*, 40, 497-512

8 APPENDIX A. OPTIONAL SOIL ARRAY PATTERNS.







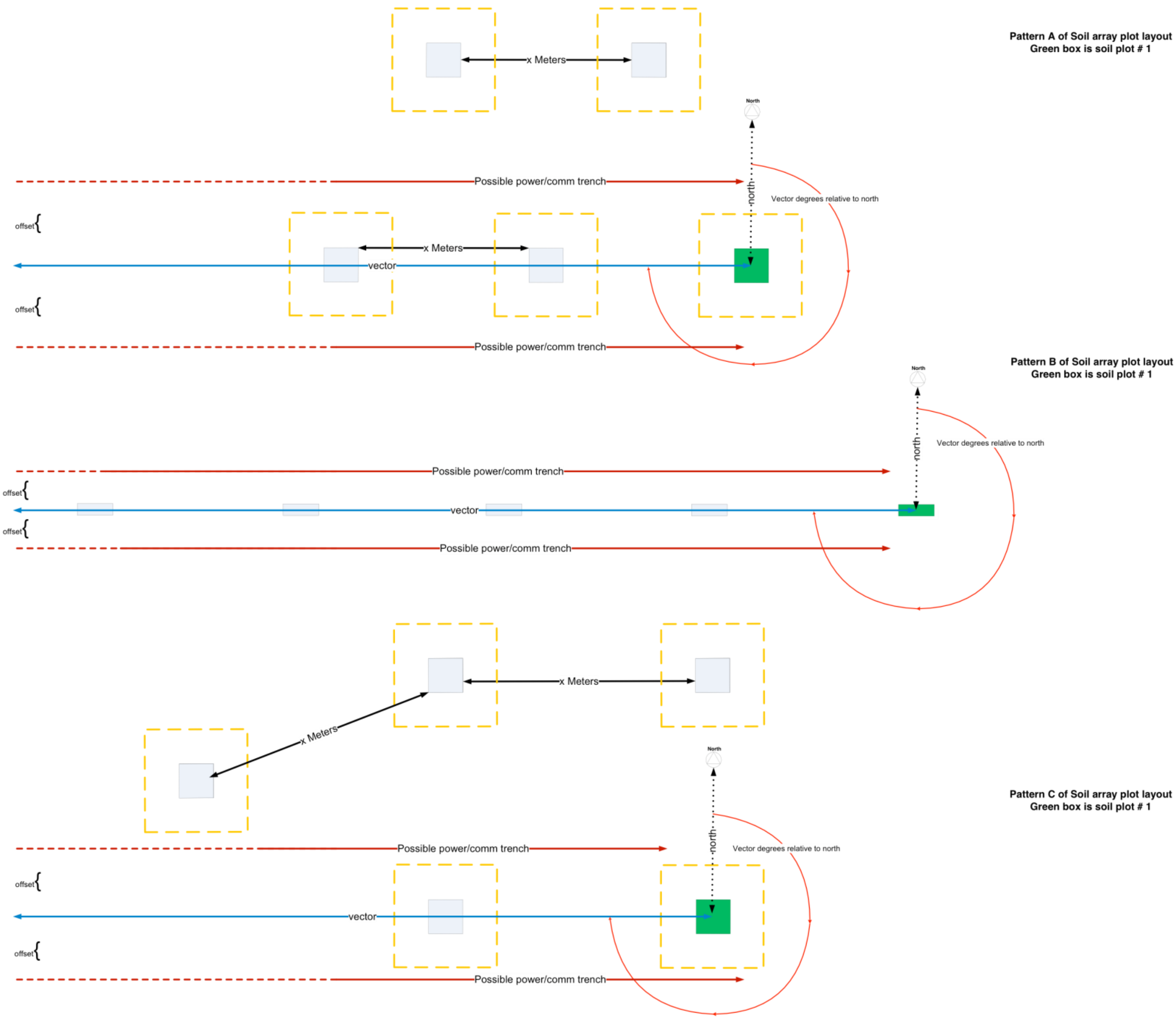


Figure A1. Conceptual diagram of Soil Array Patterns

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.