



# Arctic Network Climate Monitoring Site Evaluation 2009



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# Introduction

The Inventory and Monitoring Program is the result of the National Parks Omnibus Management Act, which was passed by Congress in 1998. This act directs the National Park Service to establish baseline [resource] information and to provide information on the long-term trends in the condition of National Park System resources.” To accomplish this task, the NPS has grouped parks into 32 networks which are characterized by their ecological similarities. Four of these networks are in Alaska. Bering Land Bridge National Preserve, Noatak National Preserve, Cape Krusenstern National Monument, Kobuk Valley National Park, and Gates of the Arctic National Park and Preserve have been organized into the Arctic Network (ARCN). Weather and climate ranked as a high priority “vital sign” to be monitored as part of ARCN. The objective of the climate program is to monitor and record weather conditions at representative locations in order to identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts.

The five park units of the ARCN span an enormous area stretching from the Chukchi Sea to the heart of the Brooks Range, measuring approximately 350 km (220 miles) from north to south and 800 km (500 miles) from east to west, encompassing more than 19 million acres, or roughly 25% of the land area managed by the National Park Service (NPS). Elevations range from sea level to 2,594 m (8,510’); much of the network lies north of the Arctic Circle with the northern boundaries of the parks reaching above 68 degrees north latitude. The ARCN parks contain a broad array of the ecosystems typical to the subarctic and arctic biomes (Figure 1). Temperature and precipitation patterns are extremely variable, from steep elevation gradients and proximity to the coast (Figure 2).

Natural resource monitoring provides site specific information needed to understand and identify changes in complex, variable, and little understood natural systems (Lawler et al, 2009). In order to better understand climate variation as well as possible long-term changes in ecosystems, new long-term climate monitoring stations are being proposed for the five ARCN parks. In 2008 and 2009, numerous sites were visited to obtain specific information on the suitability of each site for climate station installation. The initial site selection process involved a scoping meeting with park staff and climate experts. This report presents an evaluation of climatologically valuable sites identified within each of the five parks.

The Arctic Network climate monitoring program is proposing to install 17 new weather stations in the ARCN park lands: 4 in BELA; 2 in CAKR; 6 in NOAT; 1 in KOVA; 4 in GAAR (Figure 3).

# Ecoregions of Alaska

Arctic Network Park Units

National Park Service  
U.S. Department of the Interior

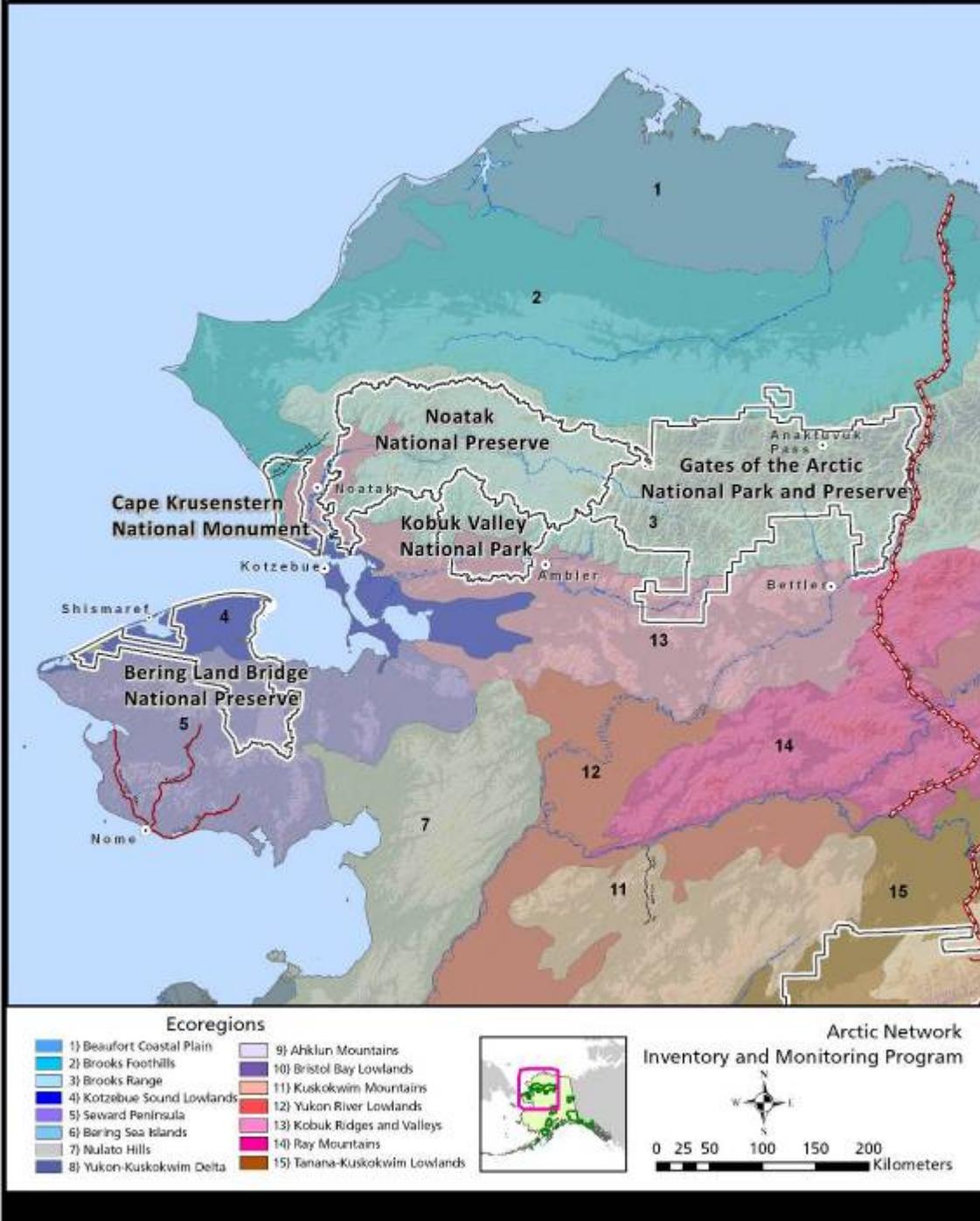


Figure 1. Ecoregions of Alaska with Arctic Network park boundaries

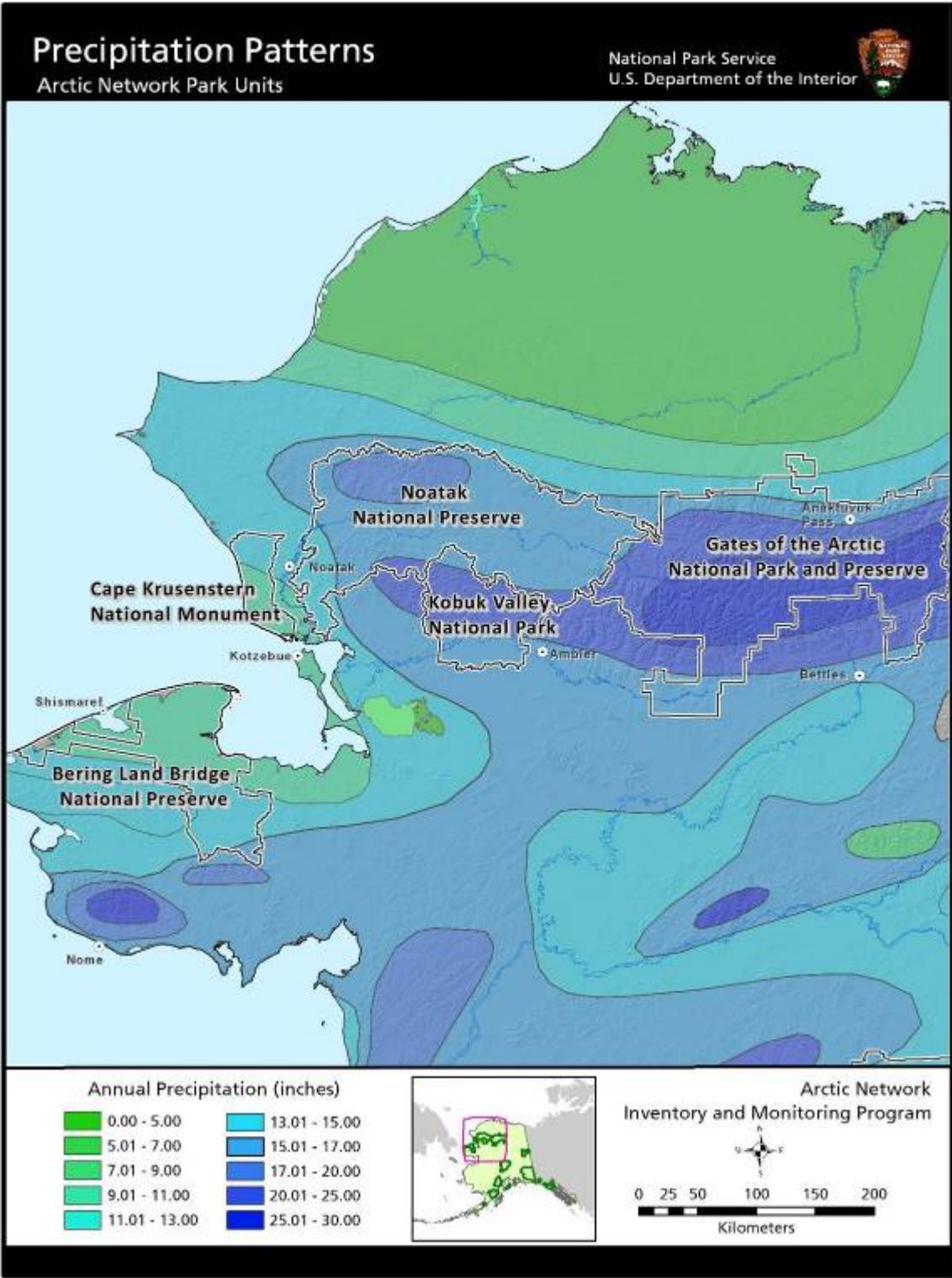


Figure 2. Precipitation Map of Alaska with Arctic Network park boundaries

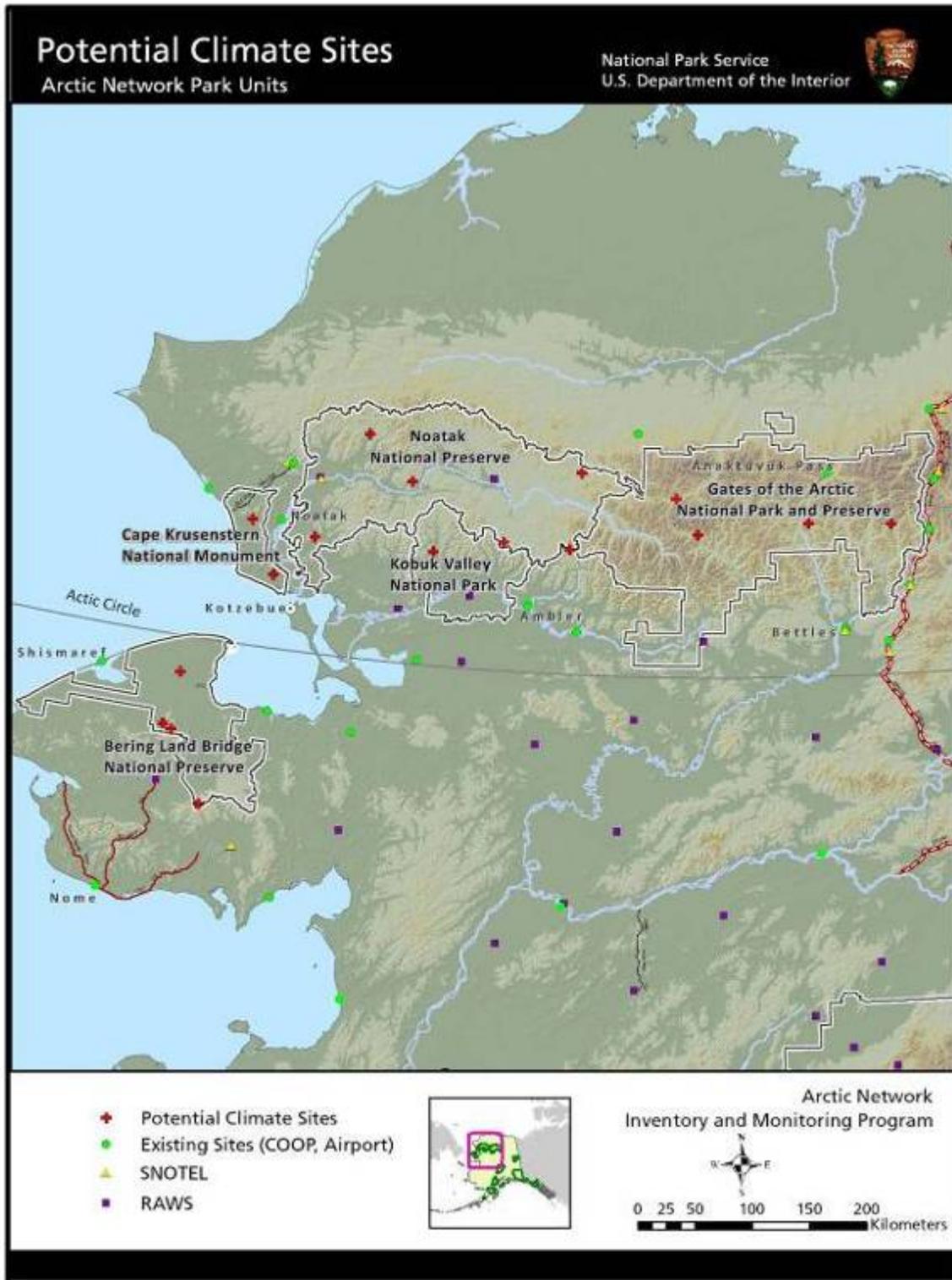


Figure 3. Map of potential new locations for climate stations with existing sites.

## **Importance of Climate as a Vital Sign**

Ecosystem processes in the Arctic parklands are driven by climate characteristics. Climatic stressors may be the foremost issues that Arctic park managers will deal with in the few decades. Global climate models indicate that subtle climate changes will have the most dramatic effect in arctic regions. These changes will be observable in many arctic system characteristics, such as permafrost dynamics, snowpack persistence, variations in timing of wildlife migrations, plant phenology, albedo, and sea ice extent and duration.

The parks encompass large areas of mountainous terrain, including a major portion of the Brooks Range, and major river drainages, and the two western park lands are influenced by sea ice patterns in the Chukchi Sea. The climate of the ARCN parks varies from the extreme continentality of interior Alaska to the more maritime coastal areas of the parks bordering the Chukchi Sea. The maritime climate is influenced by the presence of pack ice, which minimizes the moderating effect of the sea during the six to nine months it is present. Thus winters, even in coastal areas, are intensely cold and have relatively moderate precipitation and snow cover.

Numerous studies describe the effects of climate change on selected ecosystems, but it is important to quantitatively monitor meteorological conditions directly so that a reliable record of long term change can be established. These data will be used by a myriad of researchers and park staff to understand other research and monitoring questions, it is the foundation data for understanding changes in the arctic parks.

## **Existing Climate Monitoring Sites**

A network of climate monitoring sites currently exists in and around the ARCN parks. The sites that do exist provide the only record of Arctic climate available and are extremely valuable. An objective of the ARCN climate monitoring program will be to ensure that these existing sites keep operating. Sites include National Weather Service Cooperative Observer sites, automated airport weather stations, and the Remote Automated Weather Stations (RAWS) run by the interagency fire programs. Most of these existing sites are located at relatively low elevations, along major rivers, and in towns and villages surrounding the parks. There are currently six weather stations operating within the boundaries of the ARCN network. These include one in BELA, 3 in NOAT, 1 in KOVA and 1 in GAAR (Table 1).

## **Potential New Sites**

According to the 2006 Climate Inventory Report, there are large portions of the ARCN park units that have no station coverage, including western GAAR, northern KOVA, far eastern and west-central portions of NOAT, all of CAKR, and northwestern areas of BELA (Davey et al, 2006). In general there are very few observations from the interior of the Seward Peninsula, and there are no climate stations that adequately characterize the higher elevation of the Brooks Range, the upland areas of the Noatak River drainage or the northern mountainous areas of Kobuk Valley. There is also a lack of weather observations as you move from the coast of the Chukchi Sea to the inland areas of Cape Krusenstern. These are the areas of focus that could help characterize the changing arctic climate.

In an effort to fill some of the holes in the existing climate monitoring network and increase our knowledge of climate variability across the ARCN parks, a number of potential new sites were

identified and evaluated (Table 2). The main criteria in locating sites was to 1) get the best possible coverage across each park, 2) to sample different ecoregions within each park, and 3) to get observations from higher elevations within the mountainous areas of the ARCN parks. Additionally, we considered the issue of access, although the remote nature of these parks makes access an undeniable additional logistic expense. Where possible an effort was made to co-locate new stations with existing infrastructure or other disturbances such as airstrips, repeater sites, and buildings.

**Table 1. Existing sites within park boundaries**

Park	Site Name	Elev (ft)	Latitude DM_NAD 83	Longitude DM_NAD83	Access for Maintenance	Land Status & (Wilderness)	Con-current Land Uses	Co-location with Other Monitoring
BELA	Hoo Doo Hills	1475	65°35.586	163° 24.402	Helicopter	Preserve	RAWS	Add soil, snowpack
NOAT	Kelly RAWS	413'	67°55.980'	162° 18.000'	Fixed- wing	Preserve (wilderness)	RAWS	Add soil, snowpack
NOAT	Kelly SNOTEL	302'	67° 55.980	162° 16.980'	Fixed-wing	Preserve (wilderness)	SNOTEL	
NOAT	Noatak RAWS	1200'	68° 08.136'	159° 02.034'	Helicopter	Preserve (wilderness)	RAWS	Add soil, snowpack
NOAT	Asik	277'	67° 28.407'	162° 12.492'	Helicopter or fixed-wing	Preserve	Research site	Fire, upgrade existing equipment
KOVA	Kavet Creek RAWS	293'	67°08.253'	159°02.764''	Helicopter or boat	Park	RAWS	Add soil, snowpack
GAAR	Anaktuvuk Pass	2057'	68° 10.020'	151° 46.020'	Fixed-wing	Preserve	Town	

**Table 2. Potential new weather station sites**

<b>Park</b>	<b>Site Name</b>	<b>Elevation (ft)</b>	<b>Latitude DM_NAD83</b>	<b>Longitude DM_NAD83</b>	<b>Access for Maintenance</b>	<b>Land Status &amp; (Wilderness)</b>	<b>Concurrent Land Uses</b>	<b>Required Site Preparation</b>
GAAR	Chimney Mountain	3,100	67° 45.3454'	150° 29.6020'	Helicopter or float plane	Park (Wilderness)	None	None
GAAR	Pamichtuk Lake	2,700	67° 46.3160'	152° 11.7000'	Helicopter or float plane	Park (Wilderness)	None	None
GAAR	Ram Creek	3,000	67°41.1110'	154° 28.3870'	Helicopter	Park (Wilderness)	None	None
GAAR	Killik Pass	3,000	67° 58.2210'	154° 55.4500'	Helicopter or float plane	Park (Wilderness)	None	None
NOAT	Kaluich Creek	2,486	67° 34.4030'	158° 25.9030'	Helicopter	Preserve (Wilderness)	None	None
NOAT	Imelyak	3,620	67°32.6890'	157° 04.6460'	Helicopter	Preserve (Wilderness)	None	None
NOAT	Howard Pass	2,062	68° 09.3610'	156° 53.7490'	Helicopter	Preserve (Wilderness)	None	None
NOAT	Sisiak	1,823	67° 59.7020'	160° 23.7390'	Helicopter	Preserve (Wilderness)	None.	None
NOAT	Kugururok	1,028	68° 19.9870'	161° 22.5530'	Helicopter	Preserve (Wilderness)	None	None
NOAT	Asik (High elevation)	1329	67° 28.4930'	162° 15.9860'	Helicopter	Preserve	None	None
KOVA	Salmon River	1,262	67° 27.5940'	159° 50.4750'	Helicopter	Park	None	None
CAKR	Mt. Noak	809	67° 08.4860'	162° 59.6720'	Helicopter	Monument	None	None
CAKR	Rabbit Creek	966	67° 33.0090'	163° 34.0310'	Helicopter	Monument	None	None
BELA	Midnight Mountain	2,267	65° 49.2200'	164° 32.5645'	Helicopter	Preserve	NPS Radio Repeater	None
BELA	Serpentine Hot Springs	518	65° 51.1380'	164° 42.4690'	Fixed-wing to Serpentine Hot Springs Airstrip	Preserve	None	None
BELA	Devil Mountain	285	66° 16.5530'	164° 31.851'	Helicopter	Preserve	None	None
BELA	Ella Creek	2258	65° 16.2890'	163° 48.6810'	Helicopter	Preserve	None	None

## Climate Monitoring Program Station Design

There are two Alaska Inventory and Monitoring networks that have developed climate monitoring programs, the Central Alaska Network (CAKN) and the Southwest Alaska Network (SWAN). The ARCEN will use foundation documents drafted by the Western Regional Climate Center (Davey 2006) and the Central Alaska Network (Sousanes 2006) to design and develop a strategy that will focus on high latitude climate issues and remote operations.

The climate stations were specifically designed for remote, high latitude, extreme cold conditions. Special consideration was taken to minimize visual and physical impacts by making the stations as compact as possible to fit in with the wilderness values within national park lands. The stations have a small footprint and low-impact anchoring systems. Stations are powered year-round by a solar panel and two sealed lead-acid batteries that are enclosed in an insulated cargo container

The standard tower is a ten-foot mast on a tripod base, and utilizes a Campbell Scientific, Inc. CR1000 datalogger and a high data rate GOES satellite transmitter. The tripod sits on the surface and requires three rebar pegs to anchor the station; if the station were to be removed in the future there would be no evidence that it had been there. Basic instrumentation includes air temperature, relative humidity, wind speed and direction, and incoming solar radiation, rainfall, soil temperatures, and snow depth (Figures 4 and 5).



**Figure 3. Sites at Gates Glacier in Wrangell-St. Elias (left) and Upper Charley River in Yukon-Charley Rivers (right).**

Co-location of other monitoring components at climate sites could vary the configuration of the basic station design. Exceptions to this basic station design include the substitution of a 20' mast for measuring wind speeds in certain locations that are deemed valuable for fire weather indices. Another exception would be in locations where permafrost and soil monitoring could be augmented by placing a satellite datalogger and soil temperature probe in an area where permafrost degradation is occurring – these locations ideally are not where the tripod would sit, for obvious reasons. These satellite systems would be no more than a 15 minute walk from the site and be imperceptible if looking from the site or from the air. The additional instrumentation at certain locations would be a good faith effort to monitor multiple vital signs at one location, with the priority being the basic suite of climate data.

One other exception would tie in the snowpack vital sign, which is inextricably linked to weather, but is inherently more difficult to measure. The Natural Resource Conservation Service Snow Survey program runs the most effective monitoring program in Alaska, and currently the NPS is engaged in multiple interagency cooperative agreements across the state to obtain this information for other parks. A Snow Telemetry (SNOTEL) site was in operation near the Kelly Ranger station in Noatak from 1991-1996. The ARC staff and NRCS have discussed refurbishing the site as part of the ARC climate program to provide year round precipitation information from western Noatak. Figure 6 shows the Kelly SNOTEL site in disrepair. These sites are quite intensive and require more infrastructure than the basic tripod site; therefore, given the remote nature of the park and the wilderness values that characterize them, the ARC is not proposing to install any additional SNOTEL sites within park boundaries.



**Figure 4. Kelly SNOTEL site just east of Kelly Ranger Station**

## **Installation, Operation and Maintenance**

These are robust automated systems that require minimum hands-on maintenance. Once installed, the sites will only need to be accessed once a year for routine maintenance and data downloads. In the event that a system goes down, additional trips may be necessary, but these situations do not occur very often. The initial installation will require about 4-5 hours at the site. Most of the sites that were evaluated require helicopter access due to the remote nature of the ARCN parklands and the type of ecosystem and area being targeted for climate monitoring. The installation will require 2-3 trips, with internal loads, to transport the equipment and field crew to the site. The logistics will be coordinated in such a way that the helicopter ferry distance, between a base location and the site, will be kept to a minimum. For example, one site being proposed is in the Kugururok River drainage in north central NOAT. For the installation we would transport the equipment and passengers via fixed-wing to the Kelly Ranger Station and stage out of that location to reduce the helicopter ferry time. The base locations for these operations would include Nome/Quartz Creek, Kotzebue/ Kelly Ranger Station, Dahl Creek, and Bettles.

The following pages offer detailed site descriptions of our preferred sites by park unit. Sites that were considered, but are not preferred are included in Appendix A.

## Bering Land Bridge National Preserve Site Evaluation

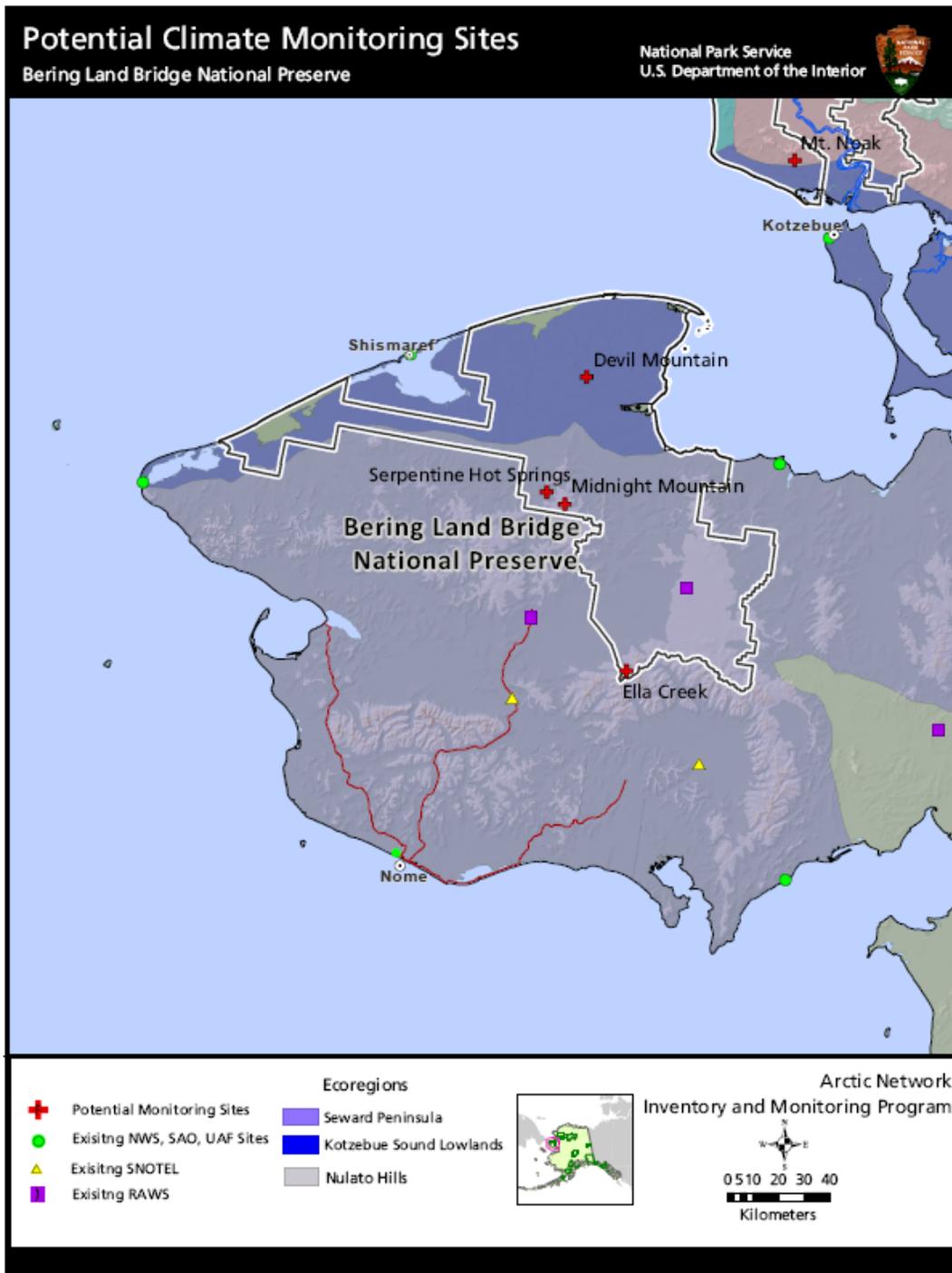


Figure 5. Location of existing and potential climate monitoring sites in relation to Alaska Ecoregions, Bering Land Bridge National Preserve

In Bering Land Bridge the strategy was to fill in some of the data gaps between the coastal stations at Nome, Shismaref, and Wales with some interior peninsula sites. The strategy involved a north to south transect through the park starting with the Devil Mountain Lakes area in the north and ending with a site in the mountains along the southern boundary of the preserve. The middle of the transect would include a paired high and low elevation site near Serpentine Hot Springs and Midnight Mountain. Midnight Mountain has a repeater site and would require no additional structure. These new locations will complement the existing Remote Automated Weather Station (RAWS) at Hoo Doo Hills near Imuruk Lake within the Preserve and the Quartz Creek RAWS located to the west of the Preserve boundary.

Ear Mountain: Site is off the north-south transect and is not representative of the area. The site was considered because it was in the western “corridor” of the Preserve and was located near an existing airstrip that could be used for access.

Arctic Inventory and Monitoring Network  
Bering Land Bridge National Preserve  
Potential Climate Monitoring Sites

Site: Midnight Mountain

Area: Serpentine Hot Springs – High Elevation site

Coordinates: 65° 49.2200' N, 164° 32.5645' W (NAD 83)

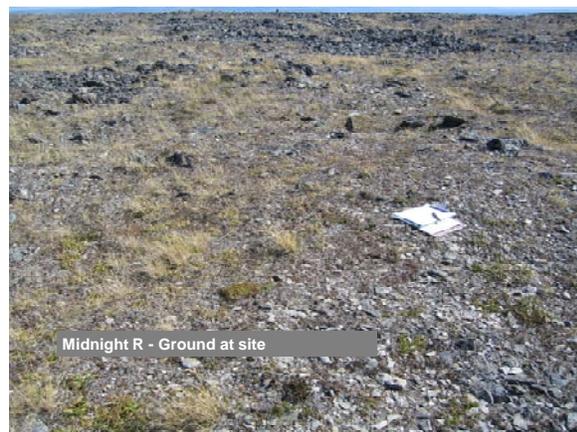
Elevation: 2267'

Description: Large, flat open plateau east of Serpentine Hot Springs. Dry, rocky and flat expanse with 360° views. Sparse alpine vegetation.

Access: ~5 miles SE of Serpentine Hot Springs Airstrip, helicopter access

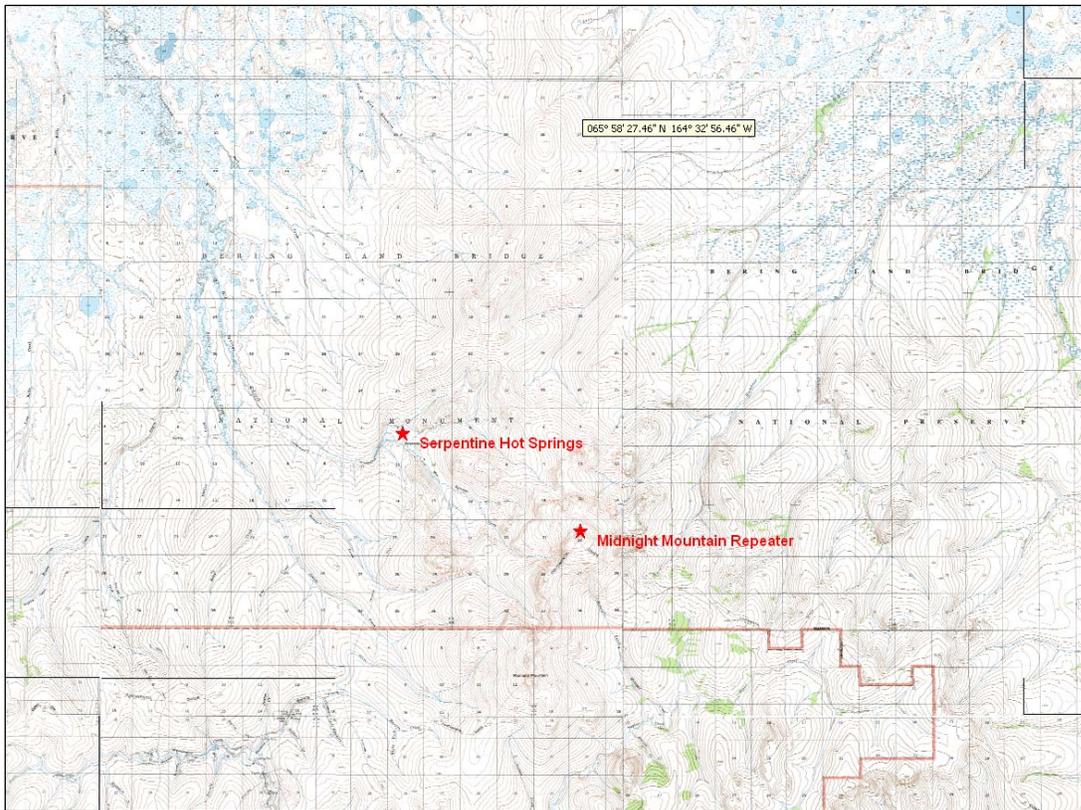
Notes:

- Radio repeater at site at northwest end of very broad mountain top
- Co-location; no additional structure necessary
- Good high elevation counterpart to Serpentine Hot Springs site
- Good regional wind patterns
- Can see north to Devil Mountain
- Very windblown
- Snow and precipitation data, if collected, would be marginal





**Looking towards Midnight Mountain (flat ridge in distance)**



Arctic Inventory and Monitoring Network  
Bering Land Bridge National Preserve  
Potential Climate Monitoring Sites

Site: Serpentine Hot Springs

Area: Serpentine Hot Springs – Low Elevation site

Coordinates: 65° 51.138' N, 164° 42.469' W

Datum: NAD 83

Elevation: 518'

Description: Gentle, rolling hills surrounded by granite tors. Slightly sloping open area on tundra. Vegetation: Dwarf birch, lichens, low tundra (*Betula*, *Arctous*, *Empetrum*)

Access: Fixed-wing access into Serpentine Hot Springs Airstrip.

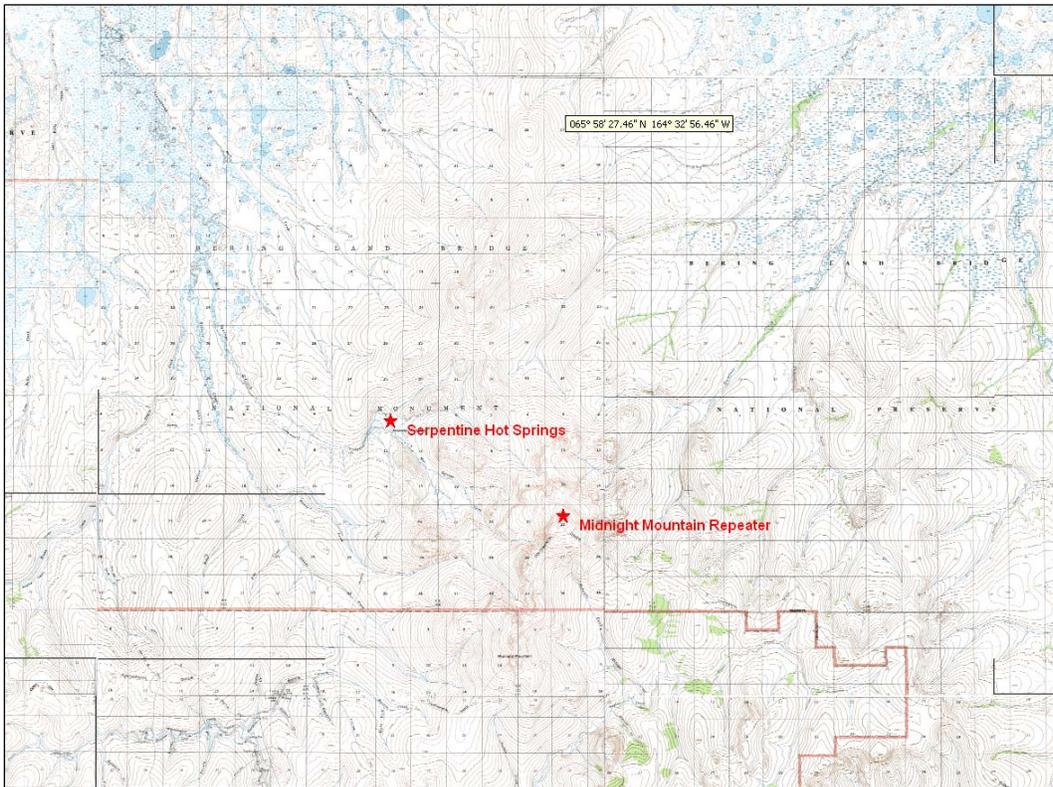
Notes:

- Airstrip location blocks the southeast horizon and winter sun
- Location is out of site of airstrip and Serpentine Hot Springs buildings.
- Trail from Nome to Shishmaref runs just south of location
- Easy access from airstrip
- Nice high and low paired combination with Midnight Mountain site in north central region of the Seward Peninsula
- Could site station across river and out of Hot Springs area for aesthetic purposes





**Figure 6 Serpentine Hot Spring Setting**



Arctic Inventory and Monitoring Network  
Bering Land Bridge National Preserve  
Potential Climate Monitoring Sites

Site: Devil Mountain (2009)

Area: Devil Mountain Lake area. Tundra expanse directly southeast of Devil Mountain

Coordinates: 66° 16.553' N, 164° 31.851' W                      Datum: NAD 83

Elevation: 285'

Description: Low-lying tundra expanse representative of the northern area of BELA. Gentle slope off the southeast side of Devil Mountain. Vegetation: Tussock tundra with Labrador Tea and saturated mosses. Silty, saturated soils, wet in low elevations (*Ledum*, *Rubus chamaemorus*, *Spagnum*).

Access: Helicopter

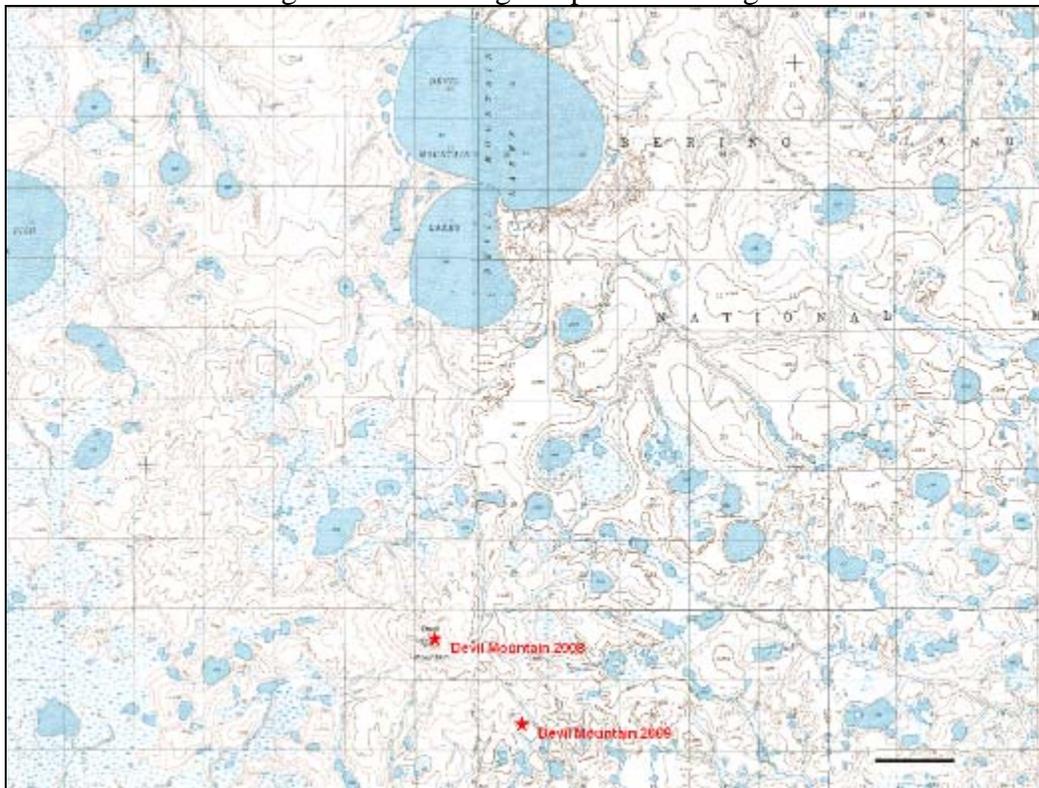
Notes:

- Just off of Devil Mountain proper, a higher rocky area that may be of archaeological significance.
- Good representation of the upper Seward Peninsula lake area
- Tussocky, but anchorable ground
- Windy location
- Plenty of caribou sign in area
- On north-south transect with Serpentine, Quartz Creek and Nome





View flying northeast towards Devil Mountain in distance. Potential site would be off the right side of the highest point to the right.



Arctic Inventory and Monitoring Network  
Bering Land Bridge National Park and Preserve  
Potential Climate Monitoring Sites

Site: Ella Creek

Area: SW Preserve Boundary; 25 miles ESE of Quartz Creek

Coordinates: 65° 16.289' N, 163° 48.681' W      datum: NAD 83

Elevation: 2258'

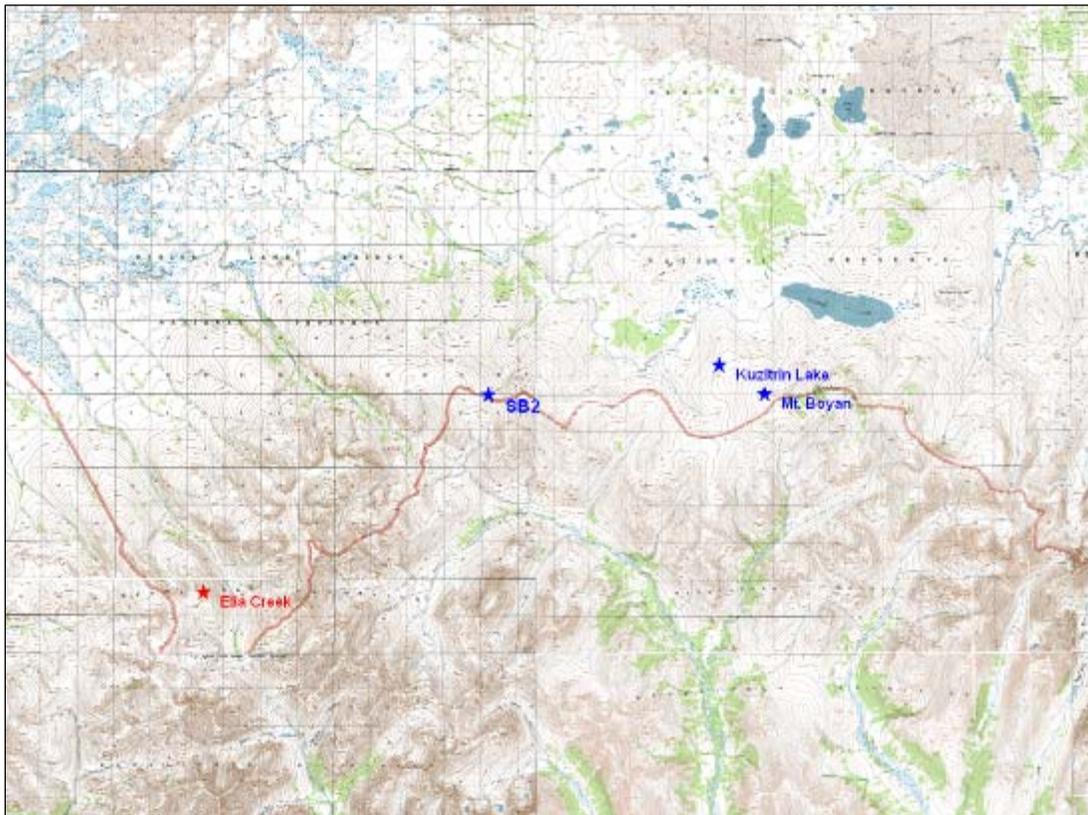
Description: Located at pass between Ella Creek and Pargon Creek in Bendlebeen Mountains. Broad, flat-top expanse with little vegetation. Vegetation: Sparse at site, but surrounded by prostrate shrub just off the high spot (*Loiseleuria*, *Diaspensia*, *Therorhodium*, *Empetrum*, *Dryas*, *Salix*, *Hierchloe alpine*).

Access: Helicopter

Notes:

- Good southern exposure
- Flat, rocky ground; need good anchor system
- Good representation of high elevation areas in Bendlebeen Mountains
- Good for wind, temperatures marginal for precipitation and snow





# Cape Krusenstern National Monument Site Evaluation



Figure 7. Potential sites in Cape Krusenstern National Monument

The strategy in Cape Krusenstern was to locate sites at higher elevations and inland from the coast. Red Dog Mine operates a weather station at the port site and there are National Weather Service or Federal Aviation Administration (FAA) sites at Kivalina and Kotzebue.

Arctic Inventory and Monitoring Network  
Cape Krusenstern National Monument  
Potential Climate Monitoring Sites

Site: Mt. Noak (2009)

Area: Western end of Igichuk Hills in southern CAKR

Coordinates: 67° 08. 486' N, 163° 59.672' W      Datum NAD 83

Elevation: 809'

Description: Broad sloping hills oriented southeast, 2 miles SE of Mt. Noak. Western edge of spruce forest in area. Vegetation: Dwarf shrub tundra. Channery metamorphic rock in loamy soil (*Dryas integrifolia*, *Potentilla biflora*, *Salix arctica*, *Arctous*).

Access: Helicopter

Notes:

- Site is not as scoured and exposed as the top of Mt. Noak
- Good representation of gentle slopes of mountains just inland from coast
- Good site to help characterize tree expansion (latitude and elevation)
- Pair with temperature probe at Mt. Noak for temperature elevation gradient between sites
- Short flight from Kotzebue
- Excellent southern exposure





Mt. Noak Setting



Arctic Inventory and Monitoring Network  
Cape Krusenstern National Monument  
Potential Climate Monitoring Sites

Site: Rabbit Creek

Area: Central CAKR, Mulgrave Hills.

Coordinates: 67° 33.009' N, 163° 34.031' W Datum NAD 83

Elevation: 966'

Description: Broad sloping hills just north of Rabbit Creek drainage. Hills surrounding site are a bit higher but more rocky and exposed. About 5.5 miles SE of Igarich site evaluated in 2008.

Vegetation: Dwarf shrub tundra with hummocks. (*Lupinus*, *Betula nana*, *Empetrum*, *Arctous alpine*, *Arternisia arctica*, *Ledum*, *Hierchloe alpine*).

Access: Helicopter

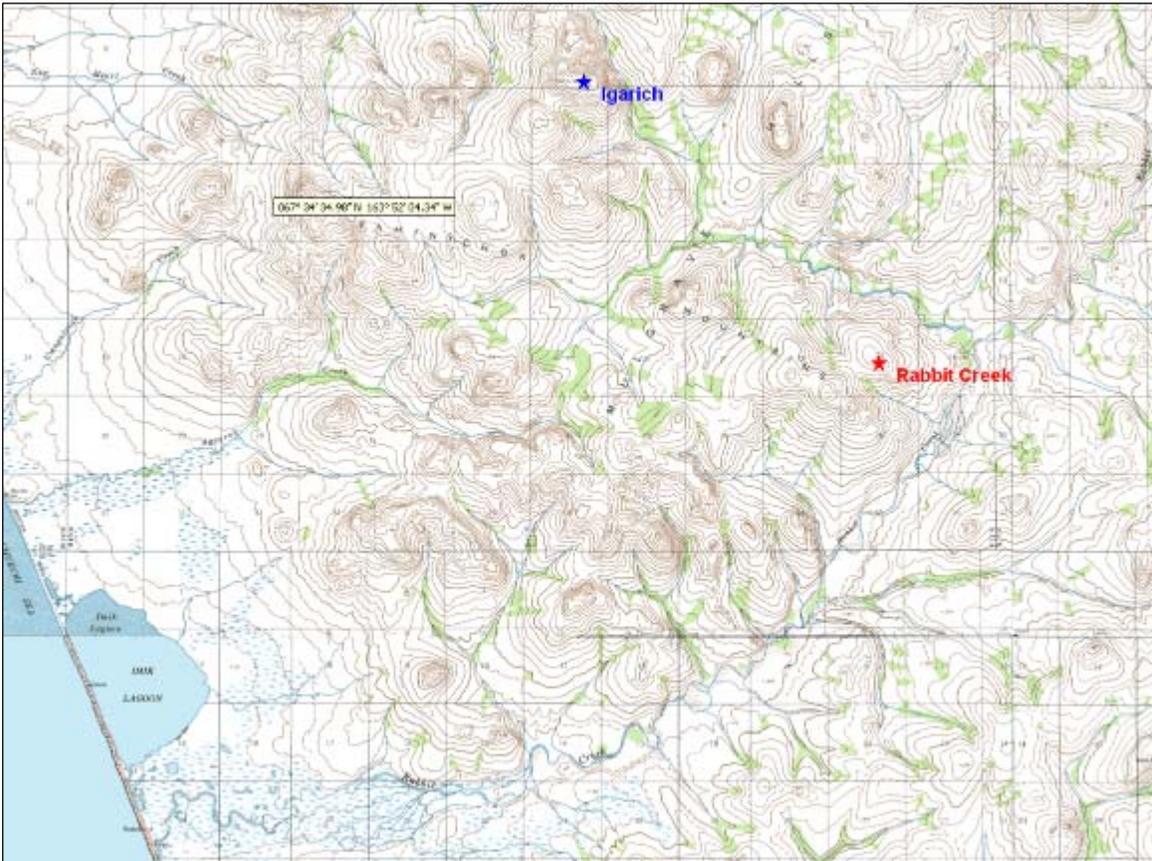
Notes:

- Representative of extensive low mountains and plateaus in region
- Good southern horizon for GOES and solar
- Located in central hilly region of CAKR
- Better site for all measurements as exposed to higher scoured sites
- Rabbit Creek is a major drainage in the Monument





Rabbit Creek Setting



# Noatak National Preserve Site Evaluation



Figure 8. Potential monitoring locations in Noatak National Preserve

In Noatak the strategy was to locate sites in upland areas on both the north and south side of the Noatak River corridor, especially the far eastern and west central areas as suggested by WRCC. The Asik site is a research intensive area and the objective would be to upgrade the current weather station with new sensors and satellite telemetry. There was a SNOTEL site at the Kelly Ranger Station that operated between 1991 and 1996; most of the equipment is still at the site. ARCN and the NRCS would like to rehabilitate the station and include it as part of the ARCN climate monitoring program. There are two existing RAWS sites one at Kelly and one on Makpik Creek at the confluence with the Noatak. Snow depth sensors would be added to these sites and included as part of the ARCN network.

Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Asik - Low elevation

Area: Agashashok River drainage in the SW corner of NOAT.

Coordinates: 67° 28' 40.7' N, 162° 12' 49.0' W      Datum: NAD 83

Elevation: 277'

Description: Existing 10 meter tower at site for Stottlemeyer research. Propose upgrade of sensors – would require minor brushing at base of tower. Riparian site with alder and willow and interspersed white spruce (*Salix*, *Oxytropus*, *Hedysarum*, *Potentilla fruticosa*)

Access: Fixed-wing on gravel bar or helicopter

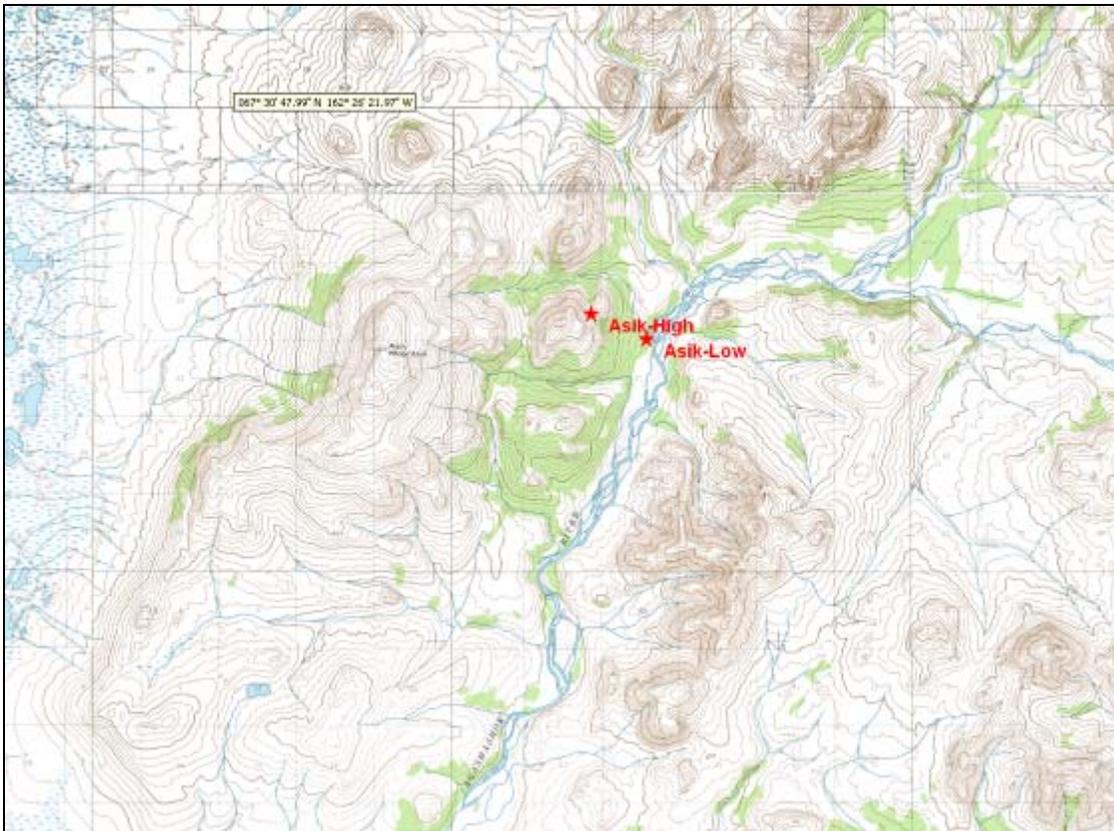
Notes:

- Existing 10 m tower at site (Stottlemeyer)
- Propose to upgrade sensors and brush around base of tower
- Hobo set up attached to tower. Old cotton shelter and Belfort at site. Unsure of which instrumentation is still being used.
- Lovely site in beautiful river valley
- Good site for precipitation and snow measurements





Asik-Low existing weather station



Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Asik - High elevation

Area: Agashashok River drainage in the SW corner of NOAT.

Coordinates: 67° 28.493' N, 162° 15.986' W      Datum: NAD 83

Elevation: 1329'

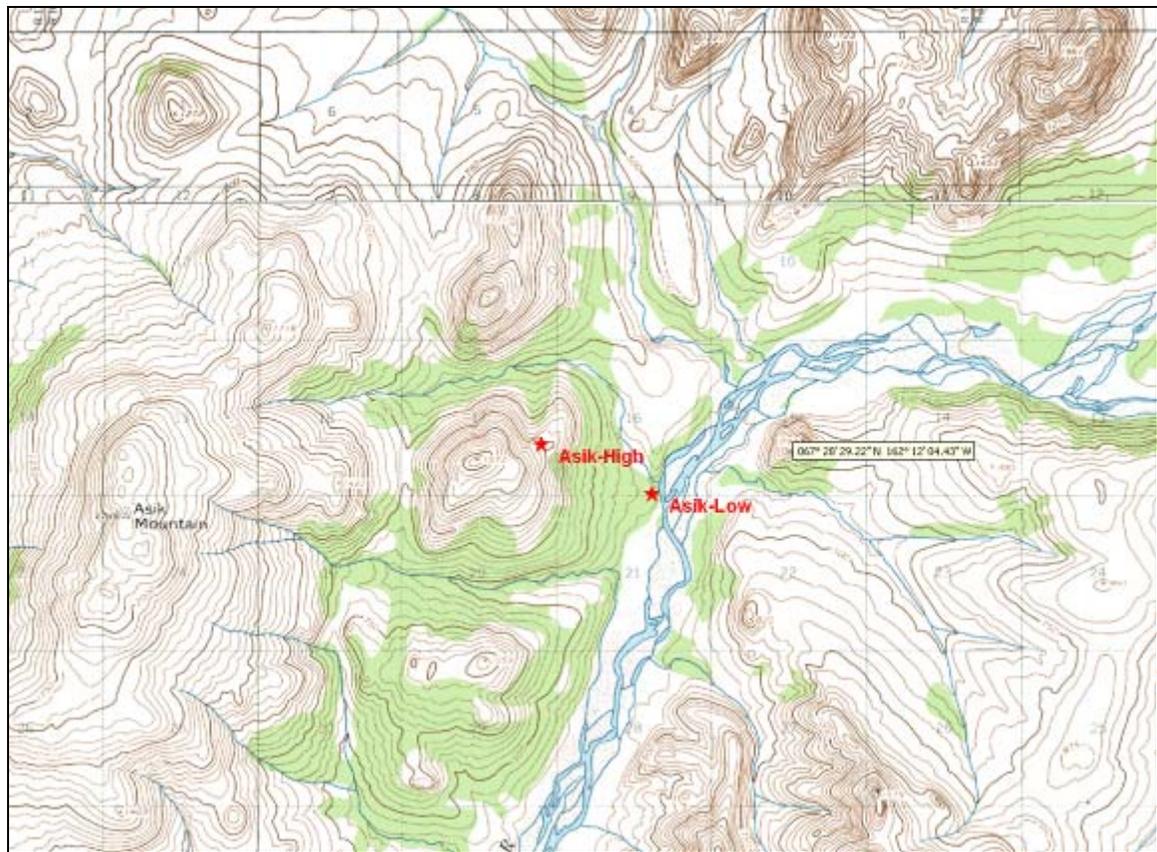
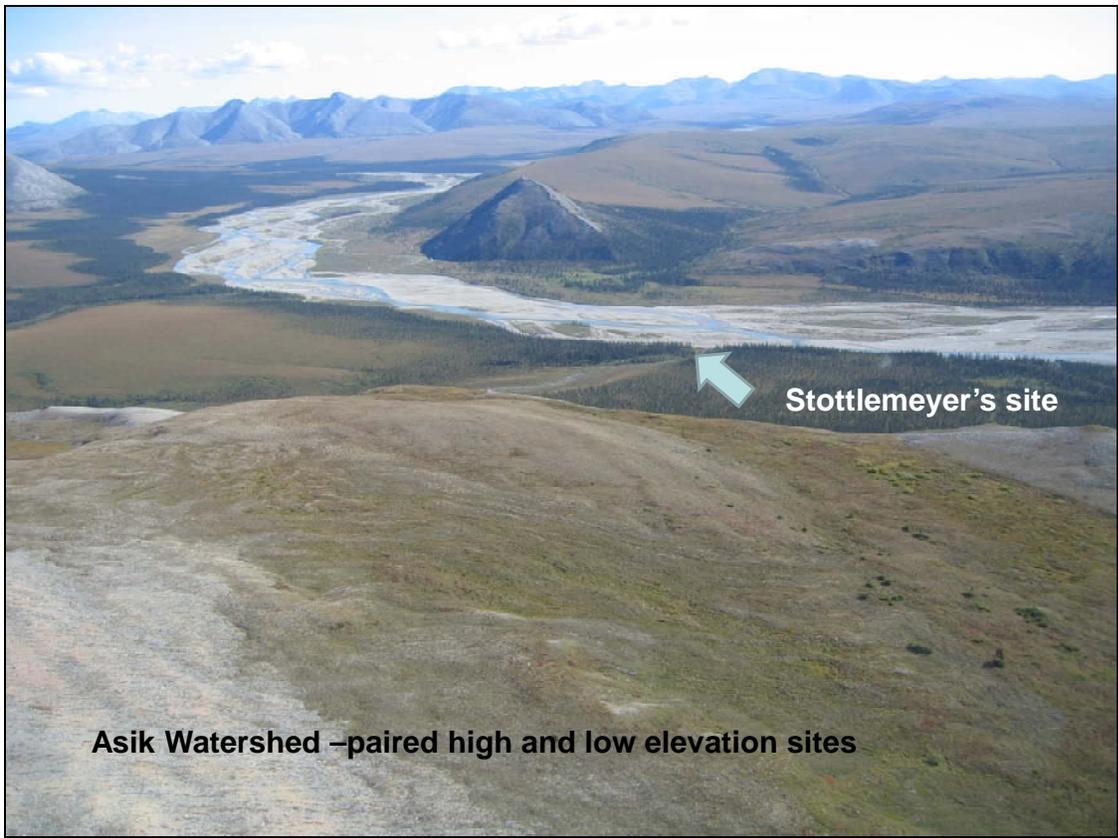
Description: Asik Mountain northwest of Asik low elevation site in river drainage. Gentle rounded hills with low alpine tundra. Near a geologic contact between limestone and non-calcerous metamorphic rock. Trees reach nearly to the site as krumholz. Vegetation: sparse alpine tundra (*Dryas octapetala*, *Lupine*, *Calamagrostis purpurascens*)

Access: Helicopter

Notes:

- Good high and low elevation paired site with Asik-low
- Good site to look at future tree expansion
- Other research in area
- Great southern exposure





Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Kugururok

Area: Kugururok River drainage,

Coordinates: 68° 19.987' N, 161° 22.553'

Datum: NAD 83

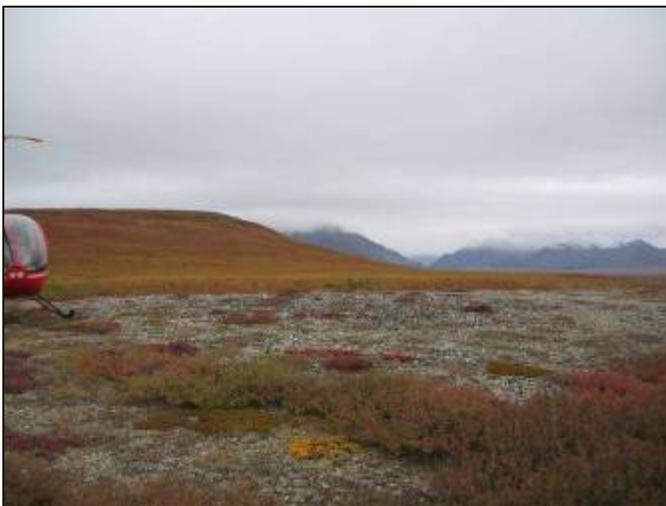
Elevation: 1028'

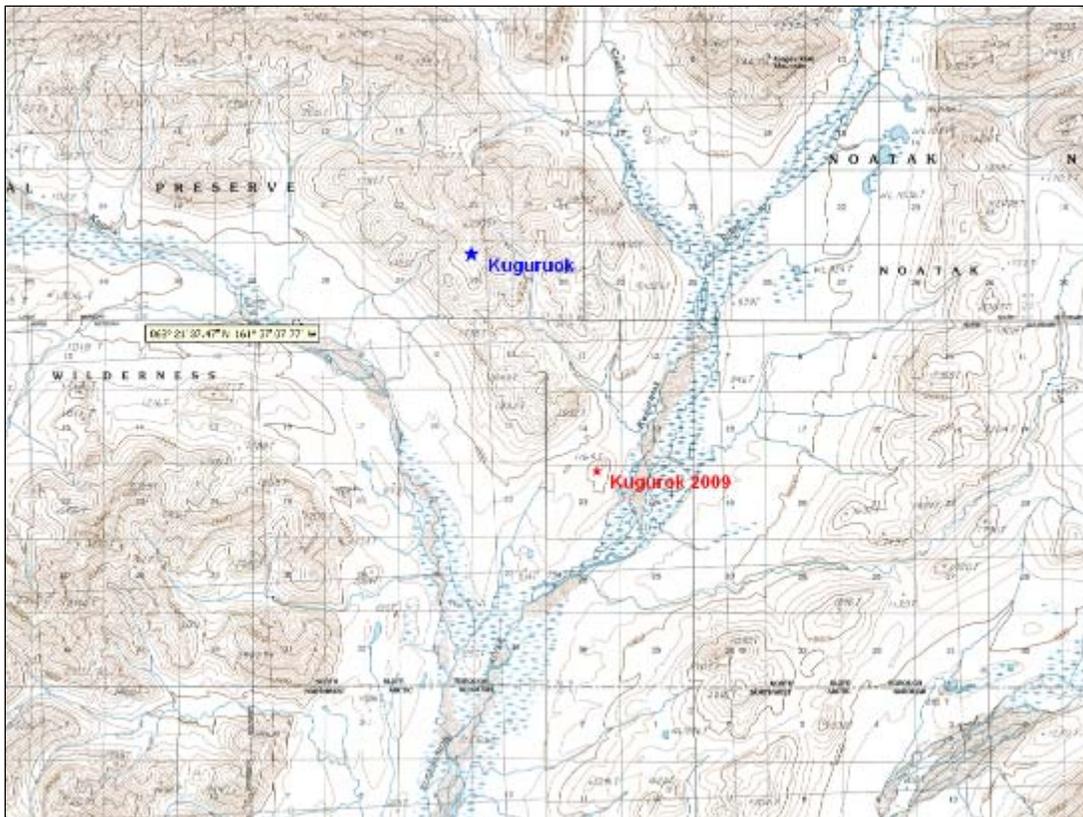
Description: Knob above river drainage, south of high exposed peaks to the north, sweeping view to the south down river. Little vegetation on knob, gravel and cobble sized blocky chert. Tussock tundra surrounds knob (*Betula nana*, *Carex bigelowii*, *Eriophorum vaginatum*, *Sphagnum* moss, *Ledum*).

Access: Helicopter

Notes:

- No other weather stations anywhere near this area
- Open tundra; wide valley; slightly elevated area
- Not as exposed or scoured as 2008 site
- Interesting site for tree expansion; young poplar near floodplain, but no spruce yet.
- Good solar and GOES potential
- Wilderness





Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Sisiak

Area: Hills north of Noatak River in west-central NOAT.

Coordinates: 67° 59.702" N, 160° 23.739"

Datum: NAD 83

Elevation: 1823'

Description: Rolling tundra hills just north of the Noatak River just before the river turns to the west. Expansive low plateaus extend in every direction, some higher peaks to the north. Dwarf shrub tundra with channery metamorphic rock. Vegetation: Dwarf shrub (*Dryas octapetala*, *Betula nana*, *Vaccinium*)

Access: Helicopter

Notes:

- No other weather stations anywhere near this area
- Open expansive tundra plateaus in west central NOAT
- A few caribou near site
- Good solar and GOES potential
- Precipitation measurements would be marginal
- Wilderness





Sisiak Setting



Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Kaluich Creek

Area: East of Akiak Mountains, south of Noatak River on boundary between NOAT and KOVA

Coordinates: 68° 34.403' N, 158° 25.903'

Datum: NAD 83

Elevation: 2486'

Description: High plateaus in southern NOAT on boundary of KOVA. Excellent 360° views of both parks. Rocky substrate, sparse vegetation. Alpine flower mats, interspersed mosses, lichen. Just down slope is a good area for a satellite soil site with willow and alder (*Salix richardsonii*, *Carex bigelowii*, *Equisetum*).

Access: Helicopter

Notes:

- No other weather stations anywhere near this area
- Broad open plateaus – good representation of high elevation area south of main NOAT drainage
- Good solar and GOES potential
- Exposed site – wind scour
- Wilderness





Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Imelyak

Area: SE area of NOAT, in Imelyak River headwaters; valley west of Ambler River

Coordinates: 67° 32.689' N, 157° 04.646' W      Datum: NAD 83

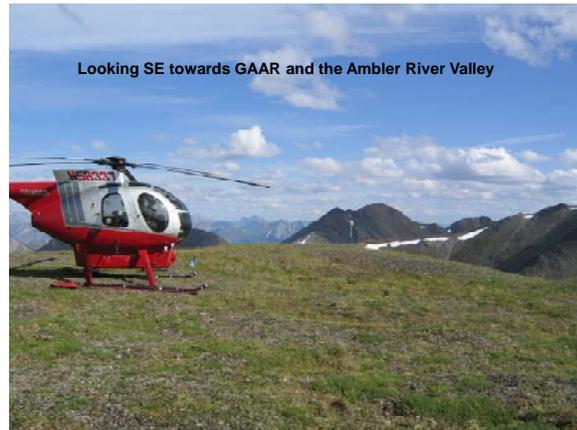
Elevation: 3569'

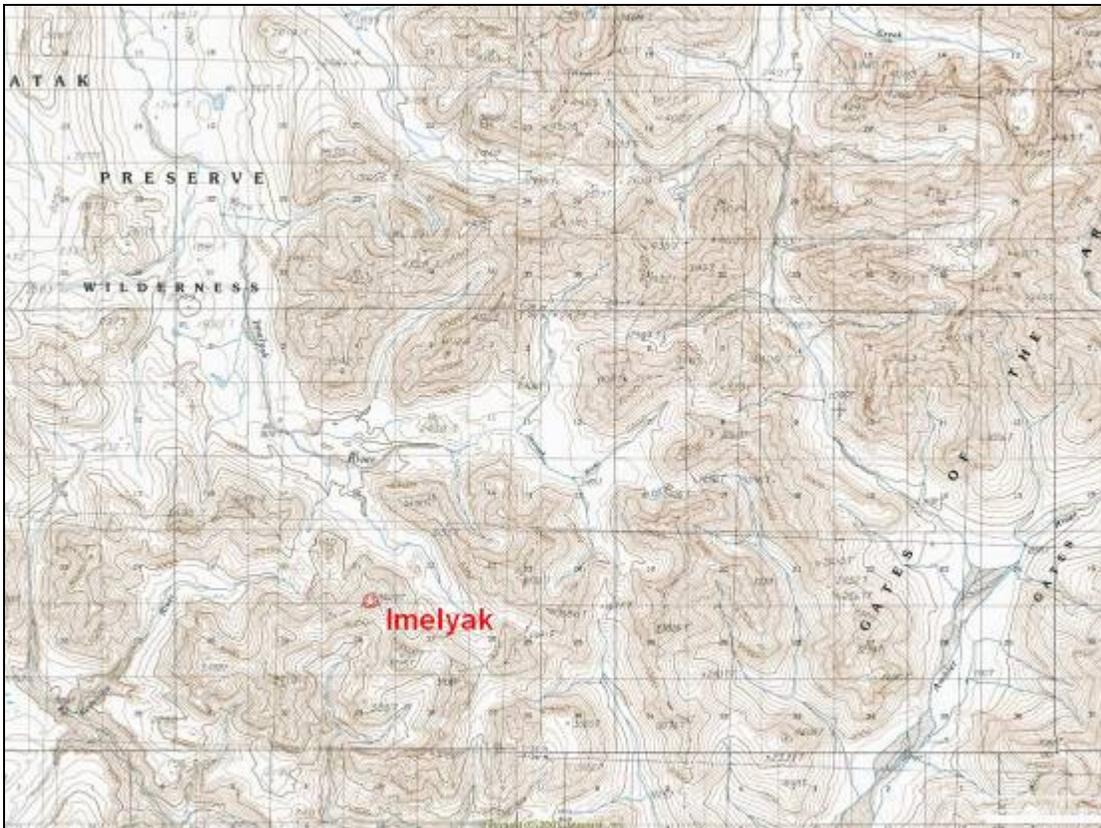
Description: Broad, flat-top exposed mountain top just inside preserve boundary. Imelyak River valley runs northwest. Low *Dryas* tundra, loamy-skeletal soil

Access: Helicopter from Dahl Creek

Notes:

- No other weather stations anywhere near this area
- Good representative high elevation site
- Close to Dahl Creek
- Good solar and GOES potential
- Wilderness designation





Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Howard Pass

Area: NE area of NOAT, in rolling hills south of Howard Pass, north of Noatak River

Coordinates: 68° 09.361' N, 156° 53.749'

Datum: NAD 83

Elevation: 2062'

Description: Rocky tor outcrop on rolling hills southeast of Howard Pass. *Dryas* tundra near top, *Carex*, *Salix*, *Cassiope* just down slope – good satellite soil site. Expansive views in all directions, some higher peaks to the east.

Access: Helicopter

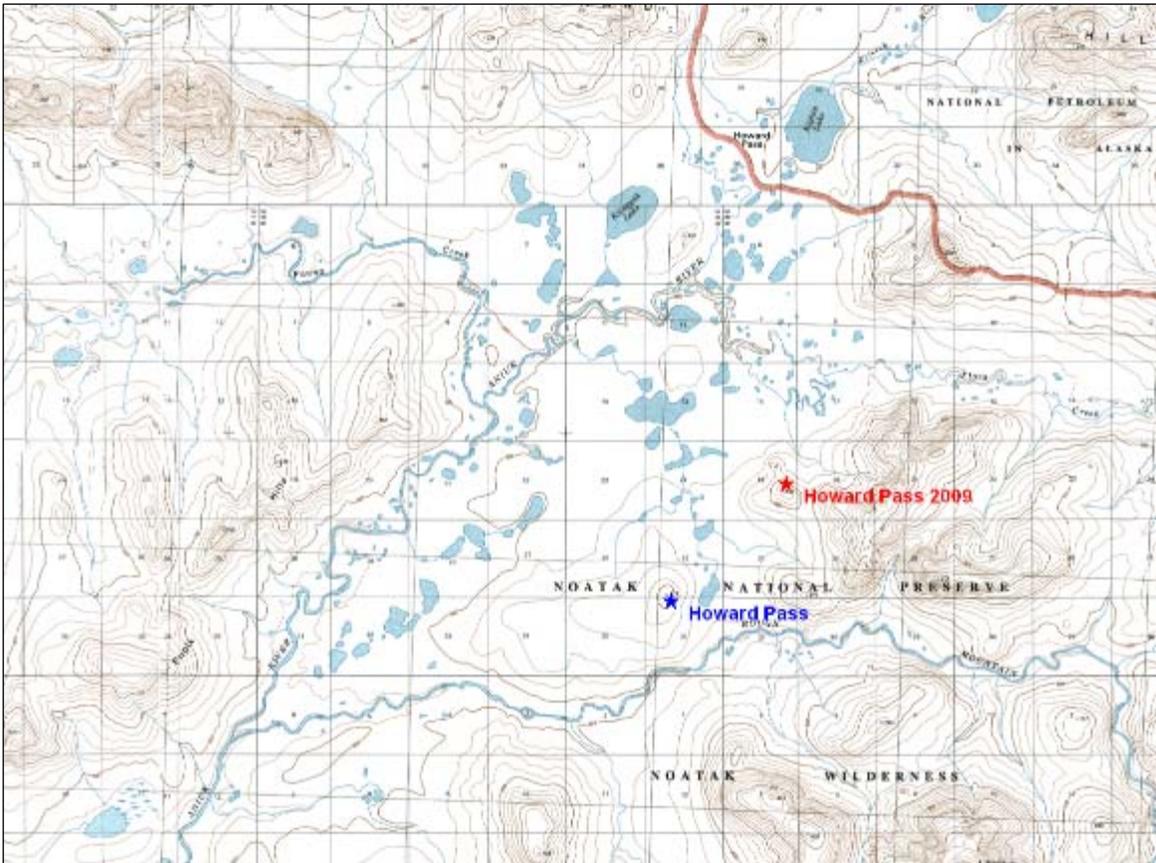
Notes:

- No other weather stations anywhere near this area
- Open tundra; wide valley; slightly elevated area
- Caribou tracks in area – can position station near tors so station is less visible when caribou come through the pass from the north
- Significant cultural site to the south, could be archaeological sites on any of these hills
- Area dotted with small lakes
- Good solar and GOES potential





Howard Pass Setting



# Kobuk Valley National Park Site Evaluation



Figure 9. Potential monitoring locations in Kobuk Valley National Park

In Kobuk Valley the goal was to look for a location up in the mountainous areas of the upper watersheds. There is good coverage of the lowland areas between Ambler, Kavet Creek RAWS, and Kiana. The middle valleys around treeline were recommended as important sites by fire ecologists, meteorologists, and park staff. We also looked at the repeater site known as “Old Man” for possible co-location. At this site we could add some weather instrumentation without adding additional structures. Kaluich Creek on the boundary of Noatak and Kobuk Valley is another option for this high elevation area.

Arctic Inventory and Monitoring Network  
Kobuk Valley National Park  
Potential Climate Monitoring Sites

Site: Salmon River

Area: Upper Salmon River in KOVA

Coordinates: 67° 27.594' N, 159° 50.475' W Datum: NAD 83

Elevation: 1262'

Description: Hills north of Nikok Creek and Salmon River confluence. Bald ridge with alder and encroaching spruce. Dryas tundra and dwarf birch at tripod site. Loamy skeletal soils, good satellite soil site off ridge to east.

Access: Helicopter from Dahl Creek

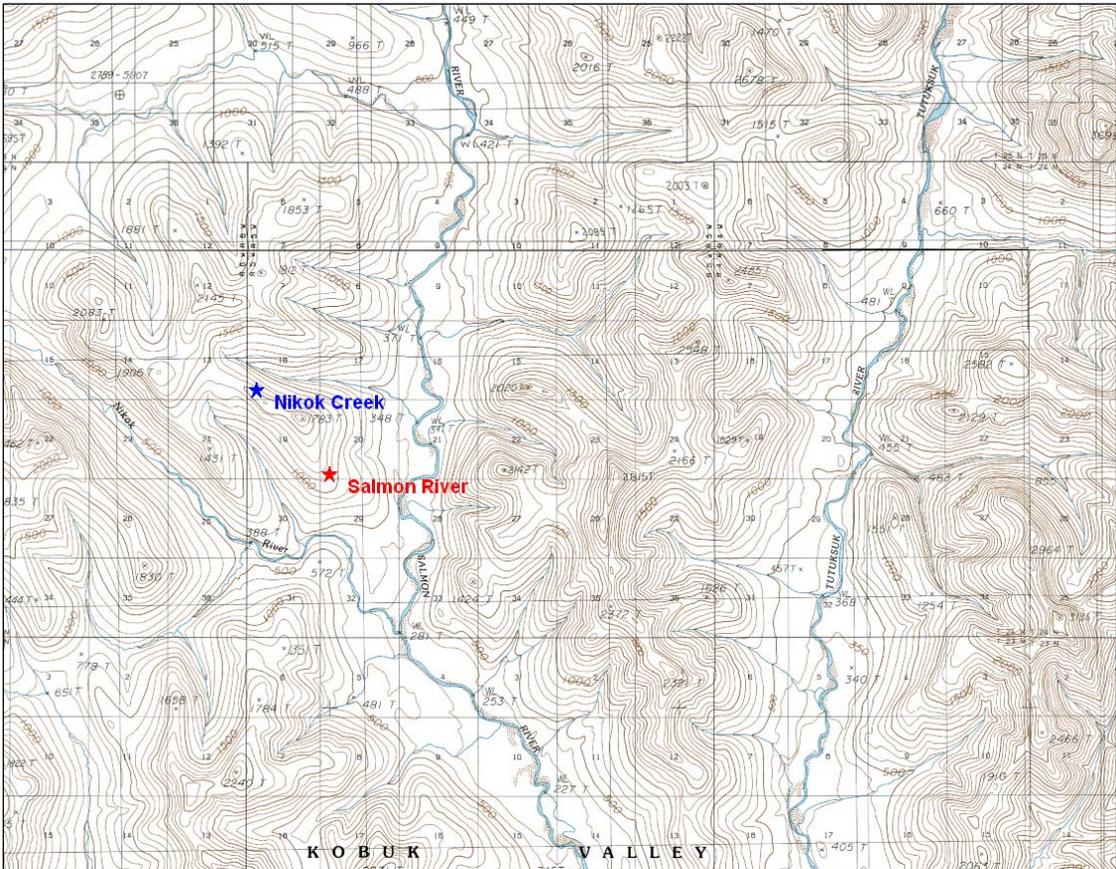
Notes:

- Good representation of mid elevation drainages in KOVA
- Site is an interesting site for future tree expansion
- Was recommended by fire ecologist/fire staff as particularly useful site
- Above main river valley – out of viewshed
- Good southern exposure





Salmon River Setting



## Gates of the Arctic National Park and Preserve Site Evaluation

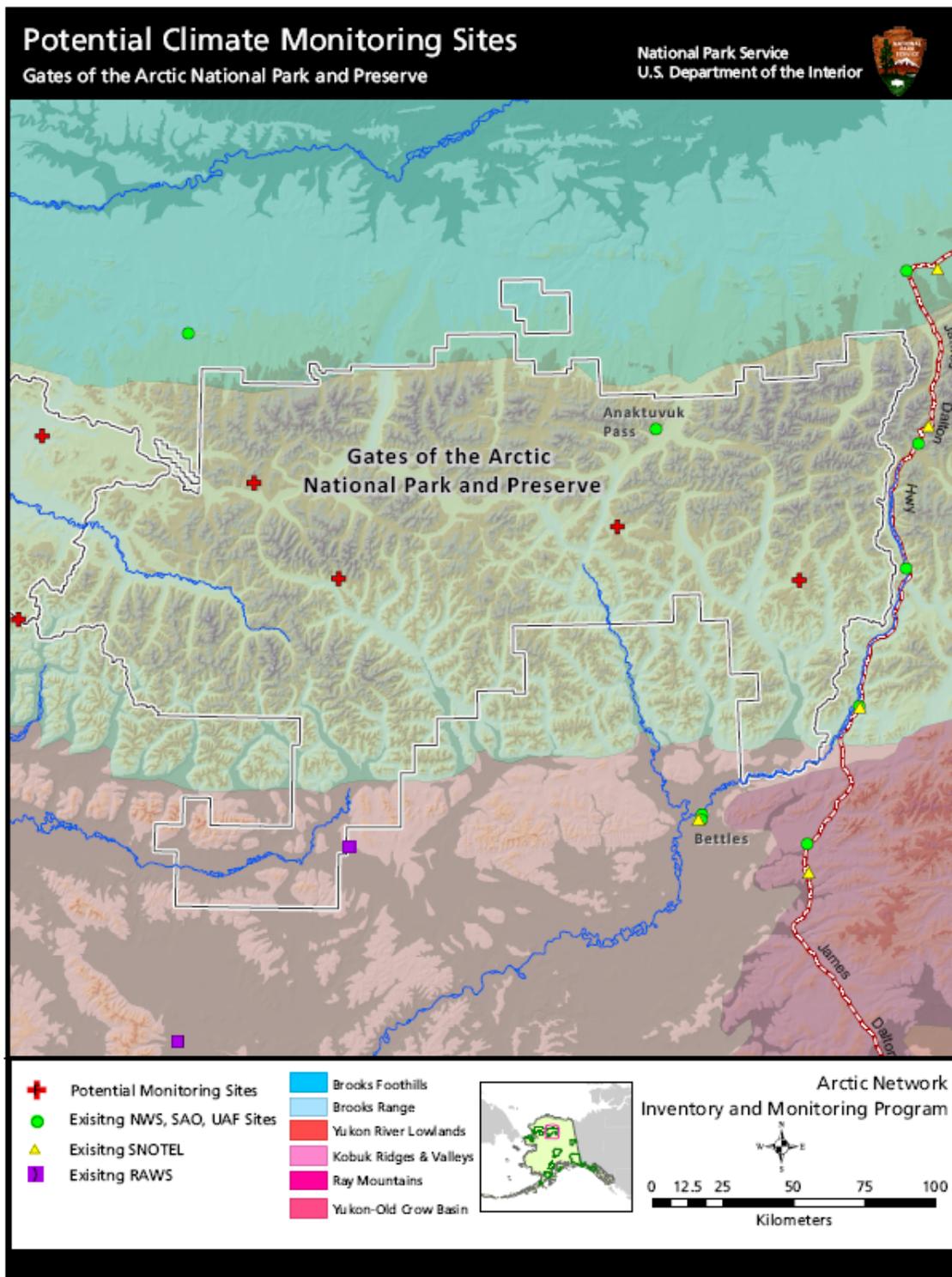


Figure 10. Potential climate monitoring locations in Gates of the Arctic National Park and Preserve

The upper elevations of the Brooks Range ecoregion is lacking in climate data. There are sites along the Dalton highway to the east of the park, sites in the lowlands to the south, no existing sites in the adjacent Noatak Preserve to the west, and few sites to the north. An east west transect going through the heart of the Brooks Range targeting elevations above 1000' would provide the much needed data from the mountainous areas within the park. Three of the sites evaluated could be accessed by floatplane, although it would involve a hike to get to the stations, since the goal would be to site them in the upper elevation areas and not in the bottom of a valley. The other site would be accessible via helicopter. All of the sites are within the Wilderness area of GAAR.

Arctic Inventory and Monitoring Network  
Gates of the Arctic National Park and Preserve  
Potential Climate Monitoring Sites

Site: Chimney Lake

Area: Eastern GAAR. Clear River drainage off the North Fork of the Koyukuk.

Coordinates: 67° 45.345' N, 150° 29.602' W      Datum: NAD 83

Elevation: 3100'

Description: Rolling hills southwest of Chimney Lake. Open expansive views in all directions; Open tundra with dwarf shrub just above treeline. Dry alpine tundra, rocky substrate.

Access: Floatplane to Chimney Lake

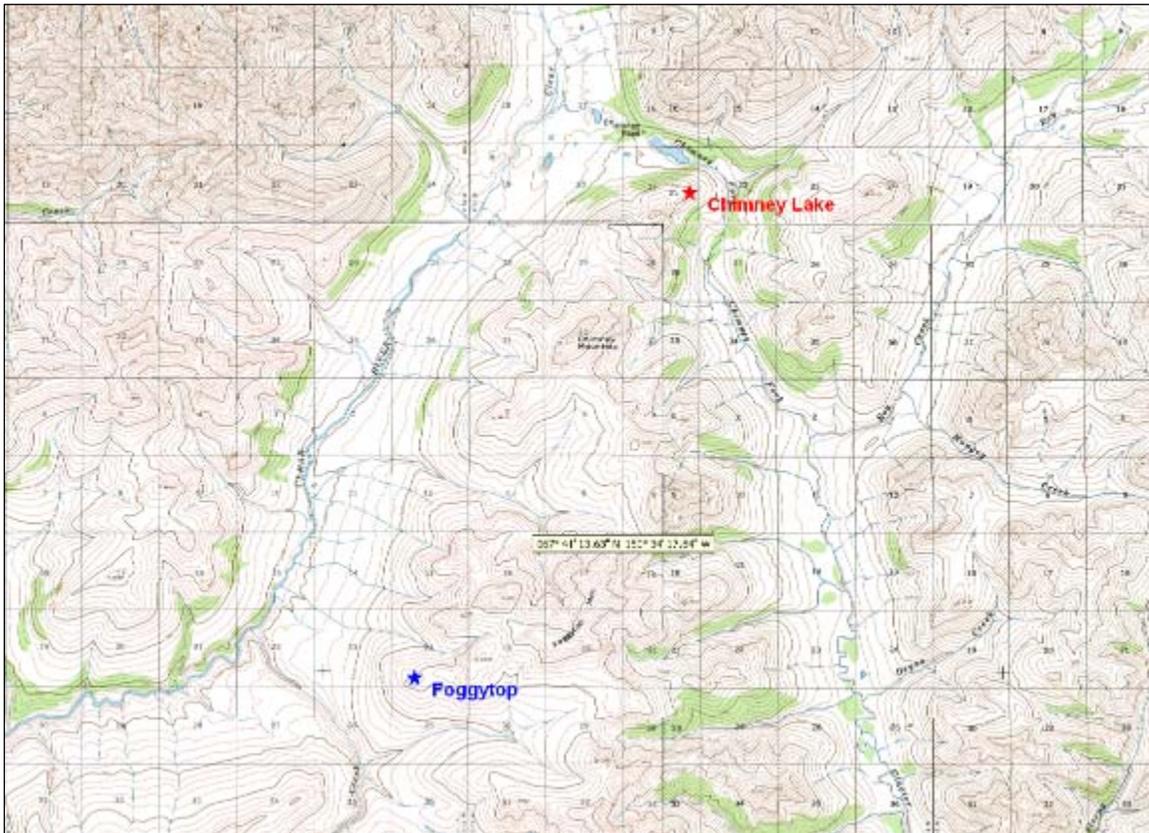
Notes:

- Would require a hike from Chimney Lake to site on top of hills
- Good site for observation of tree line migration
- Gentle rolling hills at a higher elevation
- Good 360° views from this area
- Good high elevation area that is not a rocky exposed summit/ridge
- Wilderness





Chimney Lake Setting



Arctic Inventory and Monitoring Network  
Gates of the Arctic National Park and Preserve  
Potential Climate Monitoring Sites

Site: Pamichtuk Lake

Area: Upper Mashshooshalluk Creek between John and Tinayguk Rivers.

Coordinates: 67° 46.316' N, 152° 11.700' W      Datum: NAD 83

Elevation: 2700'

Description: Hills to the northeast rising up from Pamichtuk Lake. Open tundra areas with exposed rock. Dry ground, above wetter areas near lake. Alders in wet, low areas sloping down towards lake.

Access: Floatplane access to Pamichtuk Lake. Hike up hill to station location.

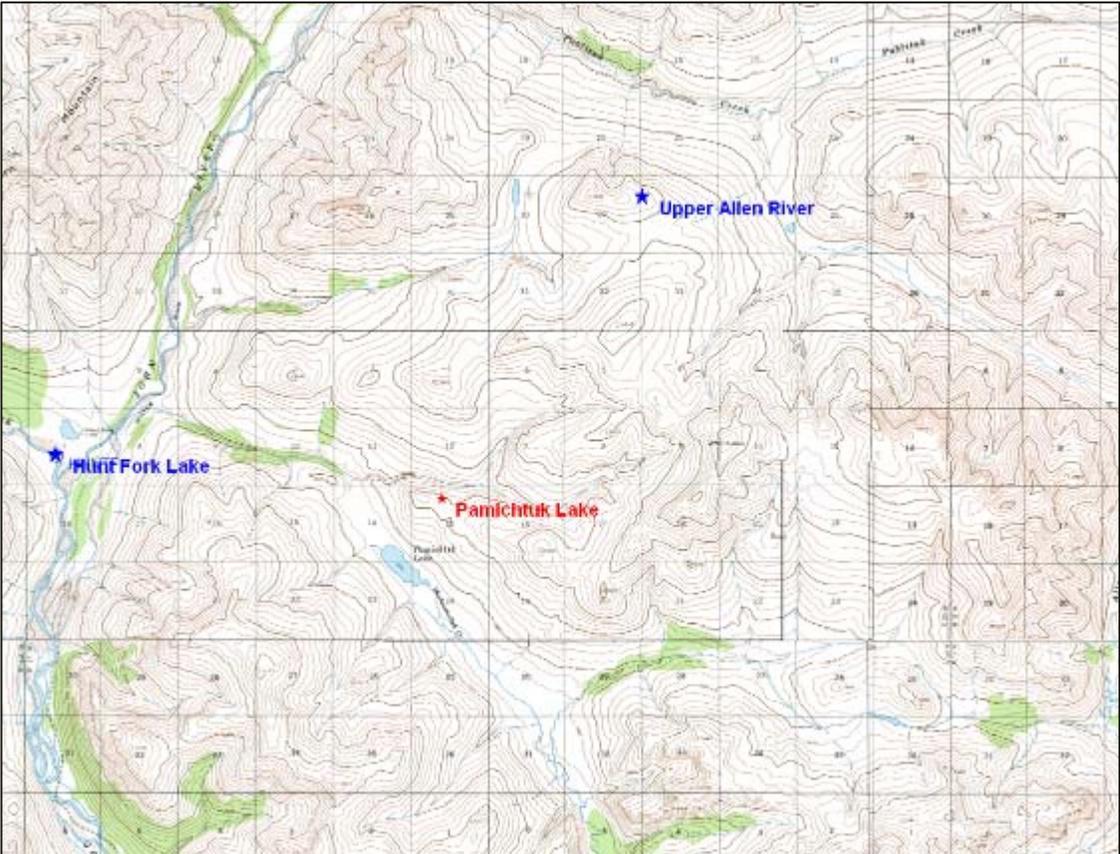
Notes:

- Exposed open bench above Pamichtuk Lake
- Would require hike from lake
- Higher elevation area representative of Brooks Range ecoregion
- Good southern exposure
- Away from popular river corridors
- Wilderness





Pamichtuk Lake Setting



Arctic Inventory and Monitoring Network  
Gates of the Arctic National Park and Preserve  
Potential Climate Monitoring Sites

Site: Killik Pass

Area: Killik Pass, northwestern GAAR

Coordinates: 67° 58.221' N, 154° 55.450' W      Datum: NAD 83

Elevation: 3000'

Description: Hills rising just north of broad Killik Pass area. Site above obvious lake with small island. Expansive views in all directions. Vegetation: Low, wet, tussocky tundra giving way to drier ridges to the north.

Access: Floatplane

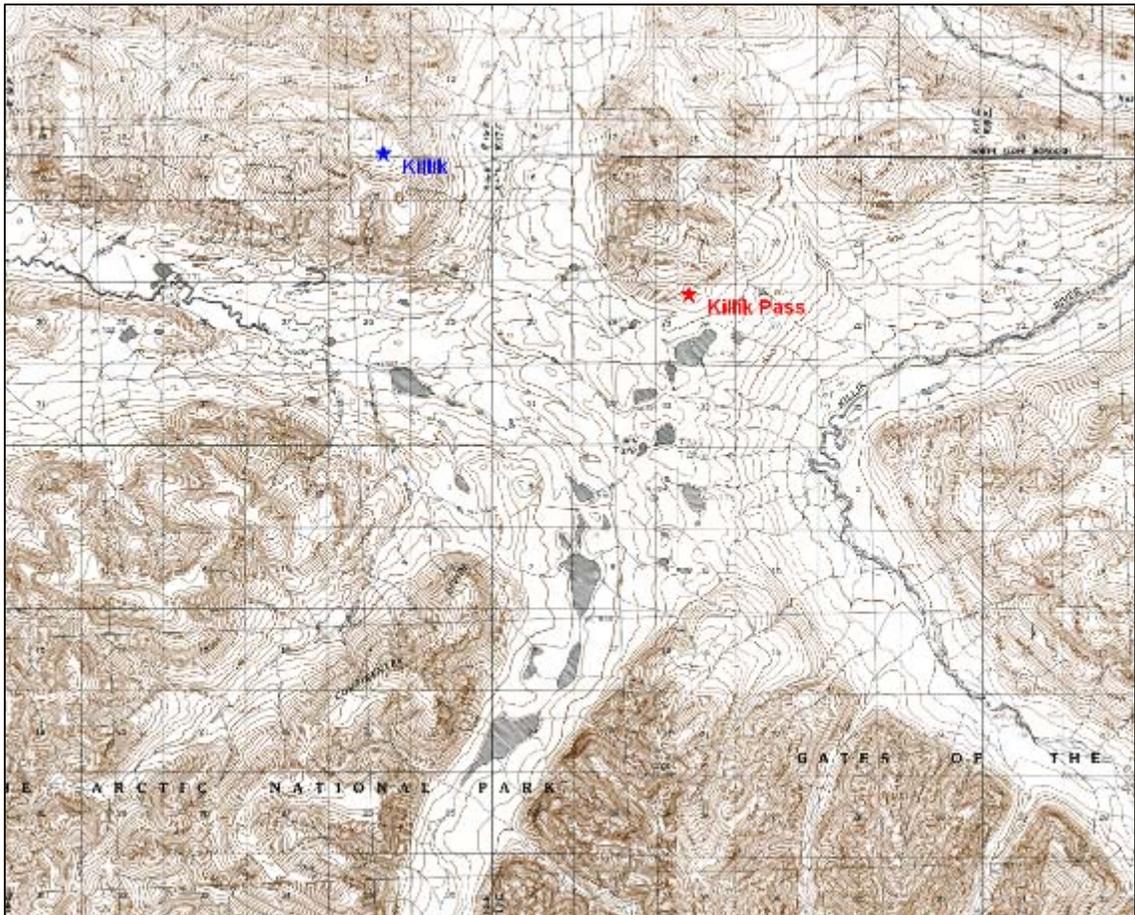
Notes:

- Good high elevation site in northwestern area of park
- Great southern exposure and GOES capabilities
- Accessible via floatplane with short hike
- Looked at lake to the south (in holding) - too close to steep hills to south for solar and GOES
- Wilderness
- Representative of high pass in central Brooks Range





Killik Pass Setting



Arctic Inventory and Monitoring Network  
Gates of the Arctic National Park and Preserve  
Potential Climate Monitoring Sites

Site: Ram Creek

Area: Alatna River drainage

Coordinates: 67° 41.111' N, 154° 28.387' W      Datum: NAD 83

Elevation: 3000'

Description: Mountainous region in Alatna River valley. Difficult area for siting because of all the high peaks. Gentle slopes south of Ram Creek. Area represents open ridge with expansive views to the south-southeast. Dry shrub tundra on ridges, willow and alder below. Spruce is present in river valley below.

Access: Helicopter from Dahl Creek

Notes:

- Representative site in mountainous region of central Brooks Range
- Good southern exposure for solar and GOES
- Dry high ridge good for instrumentation
- Wilderness – helicopter access
- Well above Alatna River – station would be out of viewshed of river users
- Good location to observe tree migration





Ram Creek Setting



Appendix A: Other sites evaluated in each park unit

Arctic Inventory and Monitoring Network  
Bering Land Bridge National Park and Preserve  
Potential Climate Monitoring Sites

Site: Mt. Boyan

Area: Along southern boundary of preserve in Bendlebeen Mountains on eastern flank of Mt. Boyan

Coordinates: 65° 21.006" N, 163° 17.196" W      Datum: NAD 83

Elevation: 2176'

Description: In Bendlebeen Mountains on divide between interior peninsula and southern peninsula. High mountains to the south and flat open Imuruk Lake valley to the north. Rocky, with tussocky tundra

Access: Helicopter

Notes:

- Good high elevation location in southern preserve
- Representative of Bendlebeen Mountain area
- Good regional winds





Looking at site from the northwest



Arctic Inventory and Monitoring Network  
Bering Land Bridge National Park and Preserve  
Potential Climate Monitoring Sites

Site: Ear Mountain

Area: NW area of preserve in narrow section near ear Mountain Airstrip

Coordinates: 65° 57.819 N, 166° 09.026" W Datum NAD 83

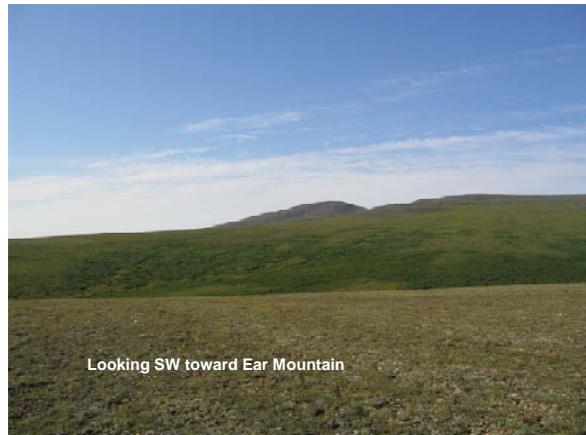
Elevation: 671'

Description: NW flank of ear Mountain. Broad sloping plain down towards Shishmaref and Devil Mountain area. Gentle rolling hills to the south. Site is adjacent to Ear Mountain Airstrip

Access: Small fixed-wing or helicopter

Notes:

- Good western area of park, higher elevation
- Flat with rocky substrate
- Low tundra, sparse vegetation
- Shelter cabin just south of site
- Good regional representation



# Ear Mountain



Arctic Inventory and Monitoring Network  
Bering Land Bridge National Preserve  
Potential Climate Monitoring Sites

Site: Devil Mountain (2008)

Area: Devil Mountain Lake area. Tundra expanse directly southeast of Devil Mountain

Coordinates: 66° 17.749" N, 164° 31.476" W                      Datum: NAD 83

Elevation: 753'

Description: Highest point in area, surrounded by low-lying saturated lake areas in all directions. Site offers somewhat stable ground for siting, but is a bit anomalous. Volcanic rocks interspersed with tundra mat vegetation. Lower on hillside are grasses, Labrador Tea, tussocky tundra.

Access: Helicopter

Notes:

- Just off of Devil Mountain proper, a higher rocky area that may be of archaeological significance.
- Good representation of the upper Seward Peninsula lake area
- Drier, anchorable ground
- Windy location
- Plenty of caribou sign in area
- On north-south transect with Serpentine, Quartz Creek and Nome
- VABM and other miscellaneous equipment at site (pvc pipes, bucket)





View flying northeast towards Devil Mountain in distance. Potential site would be off the right side of the highest point to the right.

Arctic Inventory and Monitoring Network  
Cape Krusenstern National Monument  
Potential Climate Monitoring Sites

Site: Mt. Noak

Area: Western end of Igichuk Hills in southern CAKR

Coordinates: 67° 09. 950" N, 163° 02.982" W

Datum NAD 83

Elevation: 1983'

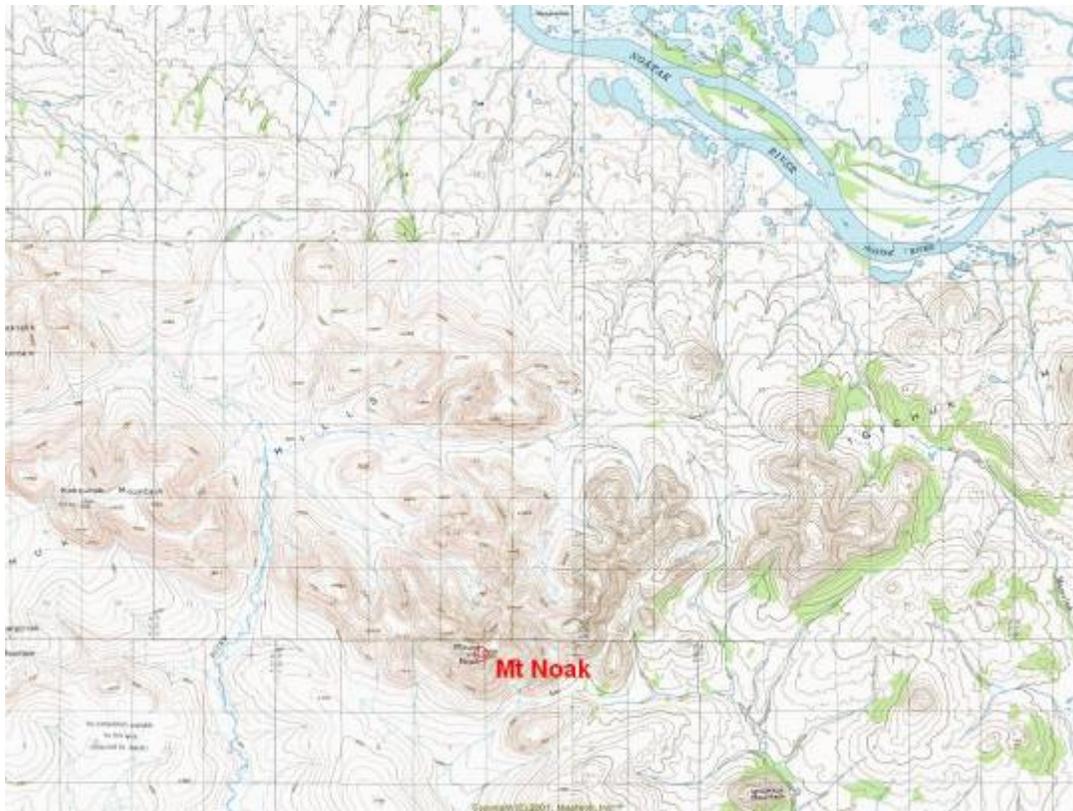
Description: Broad flat top of Mt. Noak. Commanding view of Kotzebue Sound, Chukchi Sea, up to red Dog Port and up the Noatak Valley. Rocky, sparse vegetation. Repeater at site.

Access: Helicopter

Notes:

- Co-location good – repeater at site
- Windy location; not good for precip or snow measurements
- Old repeater still up at site can be used as storage
- Good for solar and GOES
- Representative of inland area off of the coast at elevation





Arctic Inventory and Monitoring Network  
Cape Krusenstern National Monument  
Potential Climate Monitoring Sites

Site: Igarich

Area: Tahinichock Mountains; east of Red Dog Port in northern CAKR

Coordinates: 67° 36.199" N, 163° 42.658" Datum NAD 83

Elevation: 1602'

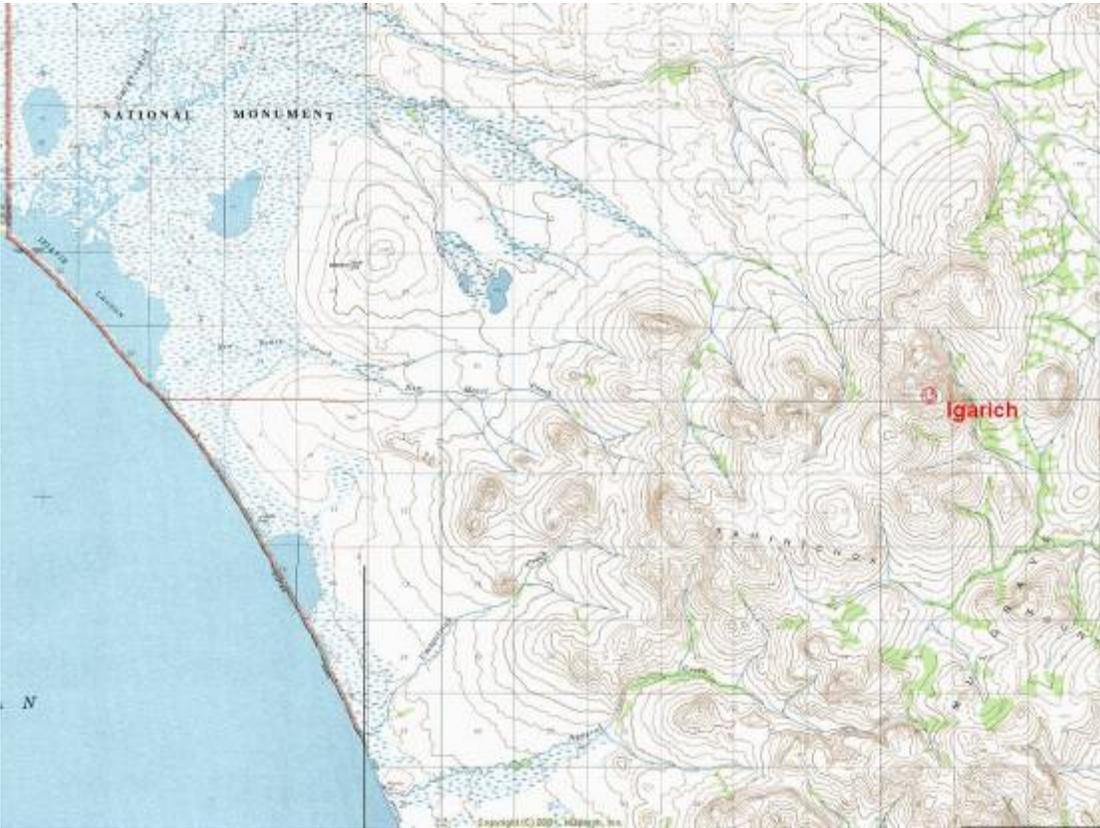
Description: Large plateau feature with sparse vegetation. Slight rise on north end of plateau.

Access: Helicopter

Notes:

- Representative of higher elevations in northern CAKR
- Low tundra; rocky
- Compliments the low elevation site at Red Dog Port
- Good for solar and GOES
- Igarich VABM at site
- 360° views from site





Arctic Inventory and Monitoring Network  
Cape Krusenstern National Monument  
Potential Climate Monitoring Sites

Site: Tasaychek Lagoon

Area: Small lagoon on central coast of CAKR

Coordinates: 67° 16. 558” N, 163° 46.281” W Datum NAD 83

Elevation: 2'

Description: Barrier beach between Chukchi Sea and Tasaychek Lagoon. Area extremely vulnerable to storm surges. Beach grasses and waterfowl abound. Driftwood covers entire area. Beach berm is sandy-skeletal material, unfrozen gravel. Vegetation: Beach grasses and coastal plants , very different from interior sites. (*Leymus arenarius*, *Angelica lucida*, *Senecio pseudo-arnica*, *Festuca sp.*, *Epilobium latifolium*, *Artemisia tilesii*, *Lathyrus maritimus*).

Access: Helicopter

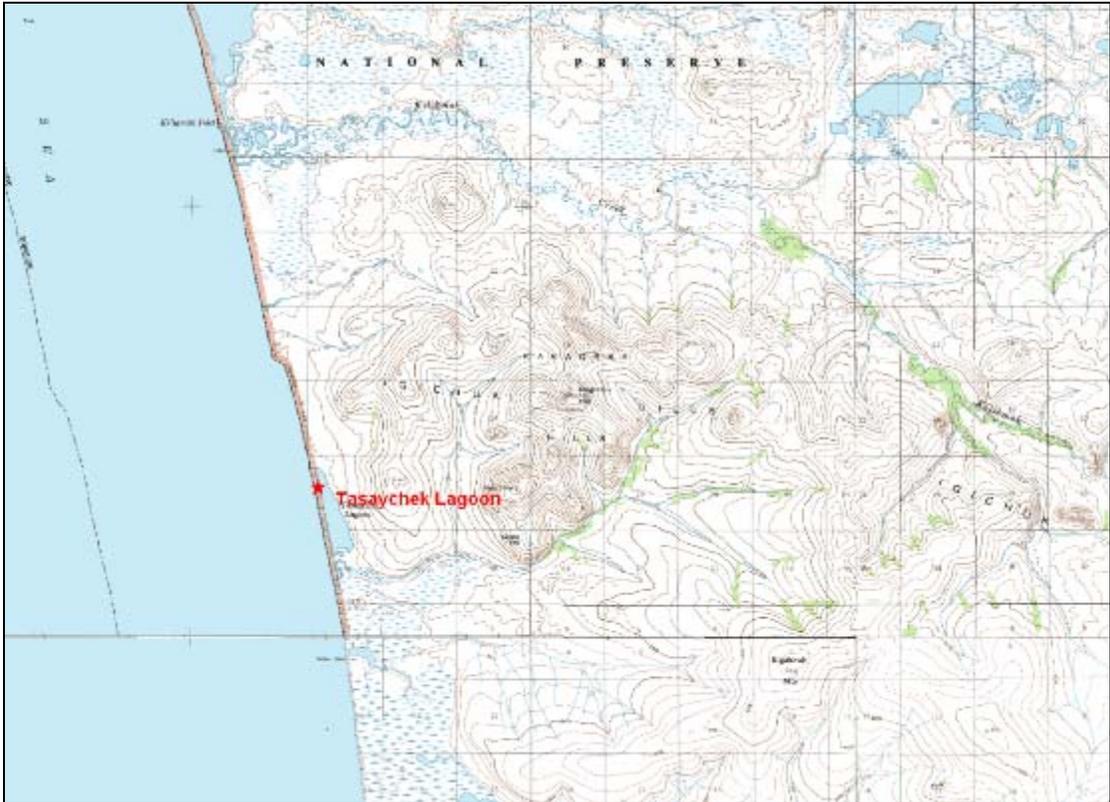
Notes:

- Representative of lagoon systems in CAKR
- Vulnerable location for station – would need to move it inland
- Between Red Dog port site and Kotzebue





Tasaychek Lagoon Setting



Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Kugururok 2008

Area: NW NOAT – Hills between Kingaviksak and Kagvik creek

Coordinates: 68° 22.293” N, 161° 25.578”

Datum: NAD 83

Elevation: 2038’

Description: Rolling Hills up the Kuguruok River valley; north of Noatak River. Last of the gentle rolling hills before the craggy peaks along the northern border of NOAT.

Access: Helicopter

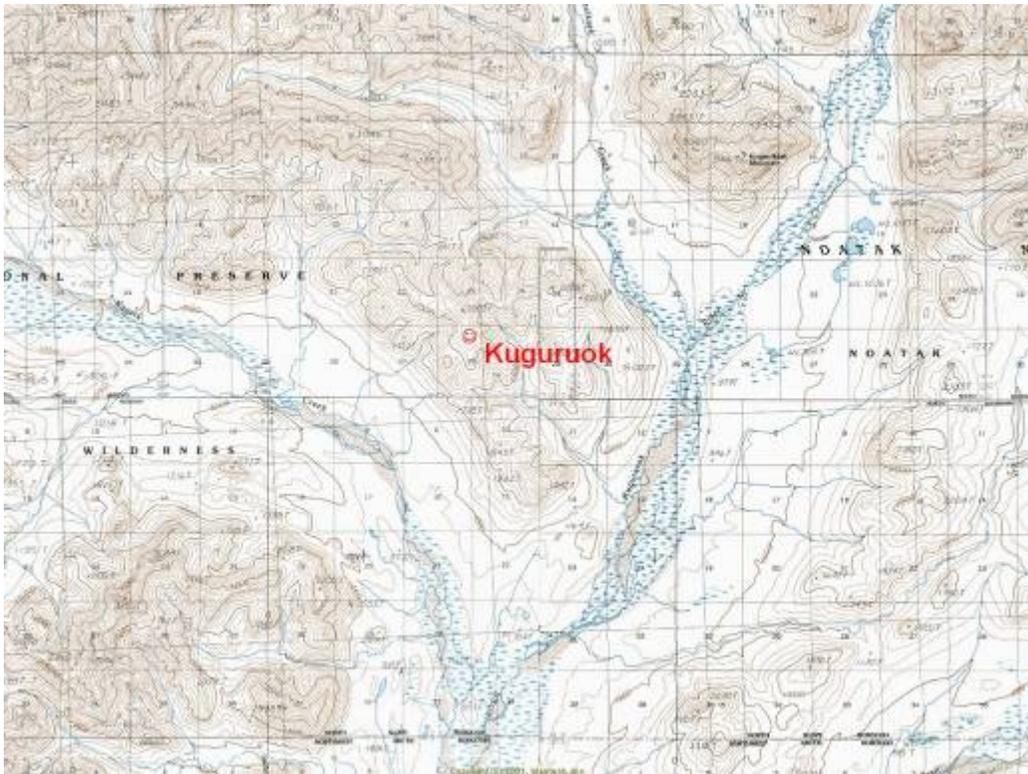
Notes:

- Nice site in mountains north of Noatak River at higher elevation
- No other weather stations anywhere near this area
- Alpine tundra, small mats interspersed with rocks.
- Approx 25 min flight from Kelly Bar





Kuguruok site looking west



Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Imikneyak

Area: North central NOAT; North of Noatak River in rolling hills before Imikneyak Mountains

Coordinates: 68° 02.607" N, 160° 29.475"

Datum: NAD 83

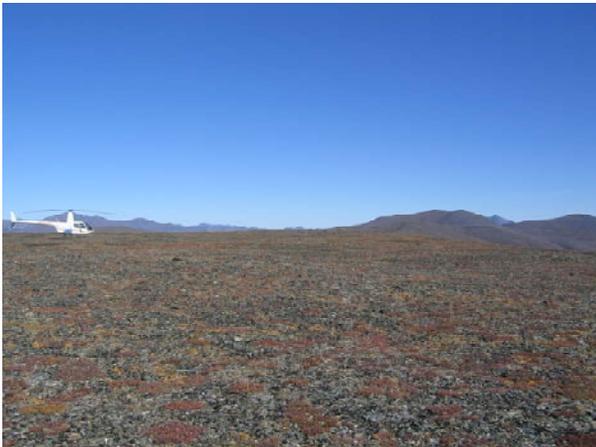
Elevation: 2408'

Description: Gentle rolling slopes

Access: Helicopter

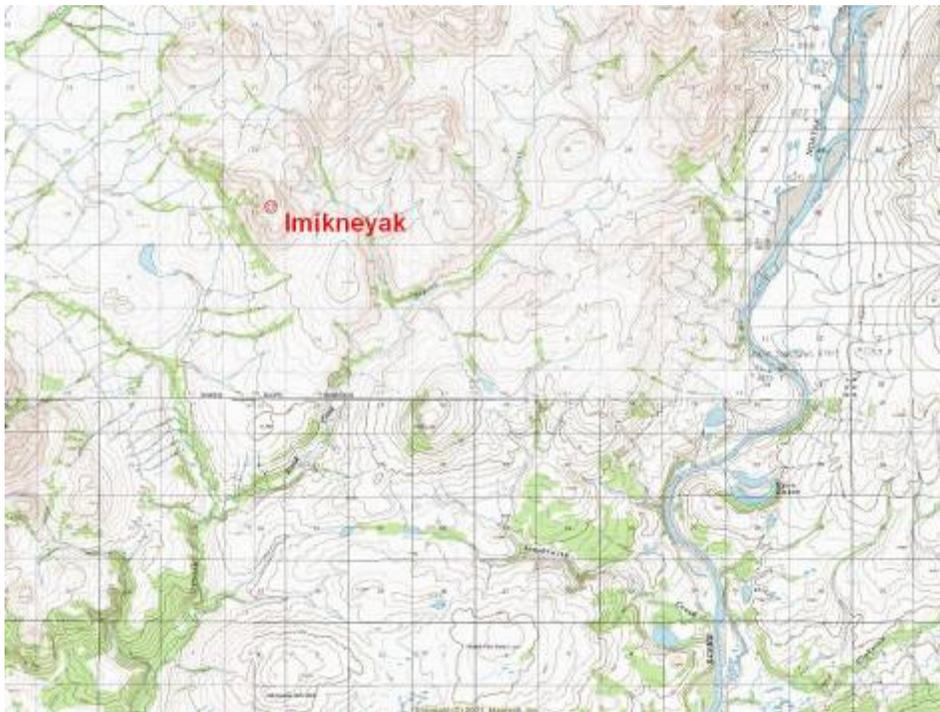
Notes:

- Nice site in mountains north of Noatak River at higher elevation
- No other weather stations anywhere near this area
- Alpine tundra, small mats interspersed with rocks.
- 36 miles NW of Old Man repeater site in KOVA





Looking south from Imikneyak site



Arctic Inventory and Monitoring Network  
Noatak National Preserve  
Potential Climate Monitoring Sites

Site: Howard Pass 2008

Area: NE area of NOAT, in rolling hills south of Howard Pass, north of Noatak River

Coordinates: 68° 08.109" N, 156° 57.079"

Datum: NAD 83

Elevation: 1988'

Description: Small hills south of Howard Pass; open tundra; rocky substrate, poor soils

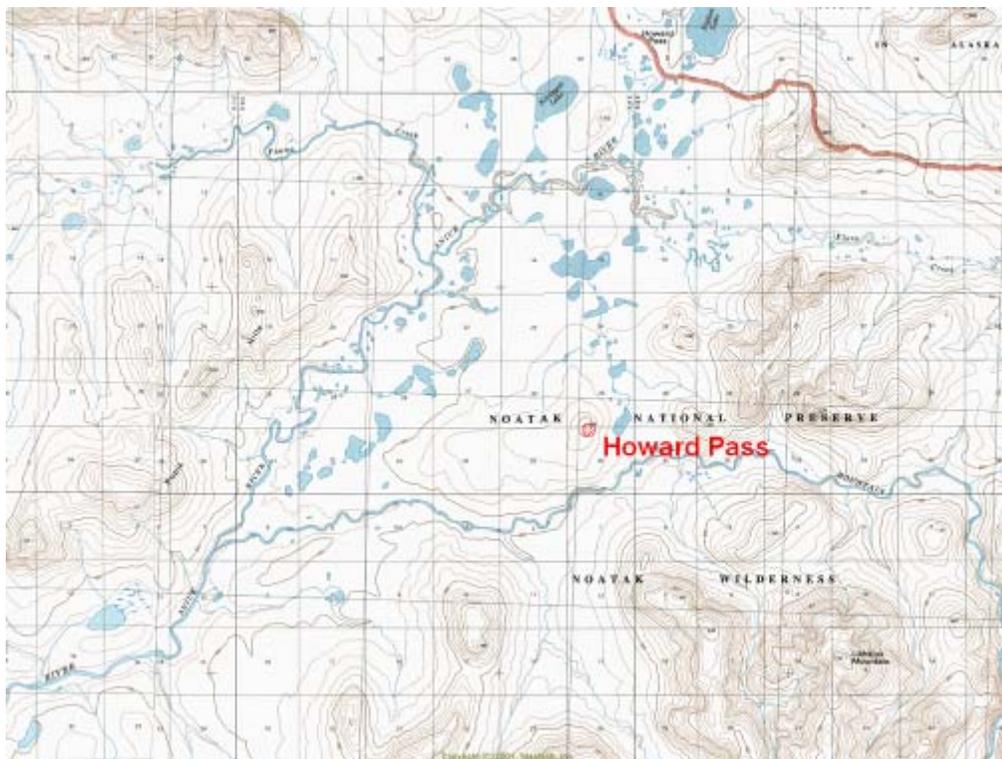
Access: Helicopter

Notes:

- No other weather stations anywhere near this area
- Open tundra; wide valley; slightly elevated area
- Caribou tracks in area – can position station on south facing slope so station is less visible when caribou come through the pass from the north
- Area dotted with small lakes
- Good solar and GOES potential



Howard pass looking South



Arctic Inventory and Monitoring Network

Noatak National Park and Preserve  
Potential Climate Monitoring Sites

Site: Kaluich Creek 2008

Area: South Central area of NOAT; South of Noatak River, in hills separating KOVA and NOAT.

Coordinates: 67° 35.553' N, 158° 33.033' W      Datum: NAD 83

Elevation: 2833'

Description: Exposed knob with good exposure in all directions. Looks south over broad sweeping Noatak Valley to the north and into the upper drainages of KOVA; low arctic tundra, rocky substrate

Access: Helicopter from Dahl Creek

Notes:

- No other weather stations anywhere near this area
- Good representative high elevation site in south central NOAT
- South of Noatak RAWS and north of KAVET Creek RAWS
- Good solar and GOES potential





Arctic Inventory and Monitoring Network  
Kobuk Valley National Park  
Potential Climate Monitoring Sites

Site: Old Man

Area: Northern boundary of KOVA; Mt Angyakaqraq – high peak where “Old Man” repeater site is located

Coordinates: 67° 42.349” N, 159° 25.675” W Datum: NAD 83

Elevation: 4551’

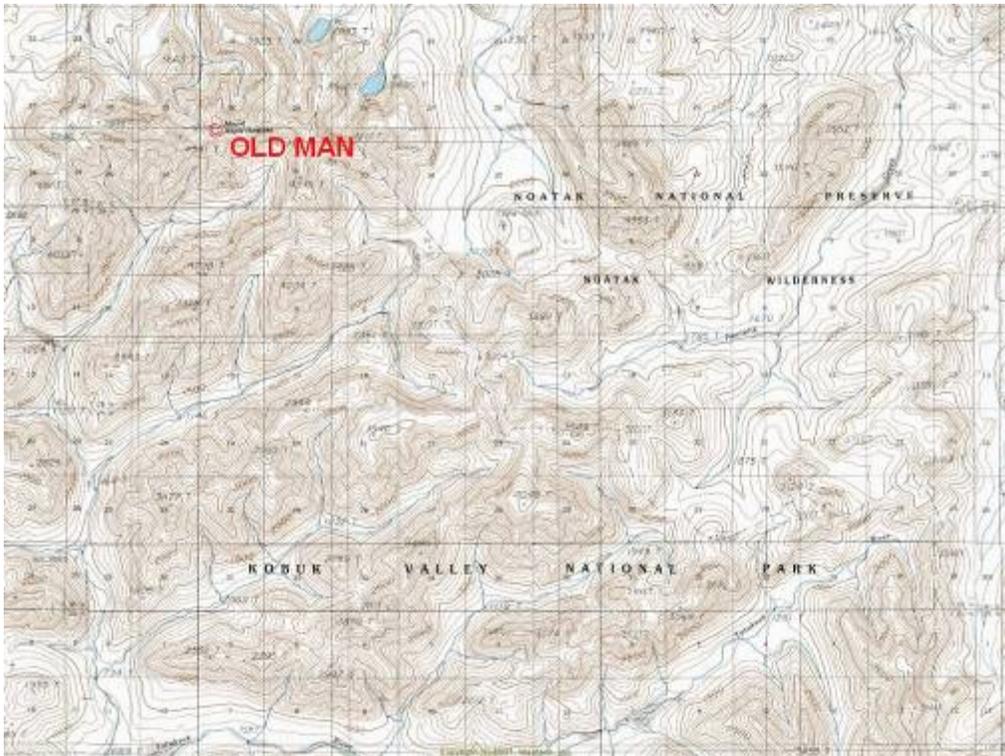
Description: High peak w/ broad flat are where repeater towers are located; large rock cobbles – no vegetation. Looks south over KOVA and north to Noatak Valley.

Access: Helicopter from Dahl Creek

Notes:

- Co-location with repeater site; existing towers for mounting sensors
- Good representative high elevation site in KOVA
- Alternative site to Kaluich site
- Good solar and GOES potential





Arctic Inventory and Monitoring Network  
Kobuk Valley National Park  
Potential Climate Monitoring Sites

Site: Nikok Creek

Area: Upper Salmon River in KOVA

Coordinates: 67° 28.621' N, 159° 55.138' W      Datum: NAD 83

Elevation: 1861'

Description: Hills north of Nikok Creek and Salmon River confluence. Broad sweeping ridges – good views in all directions. Dwarf shrub tundra and dwarf birch (*Betula*). Some spruce krumholz in hollows.

Access: Helicopter from Dahl Creek

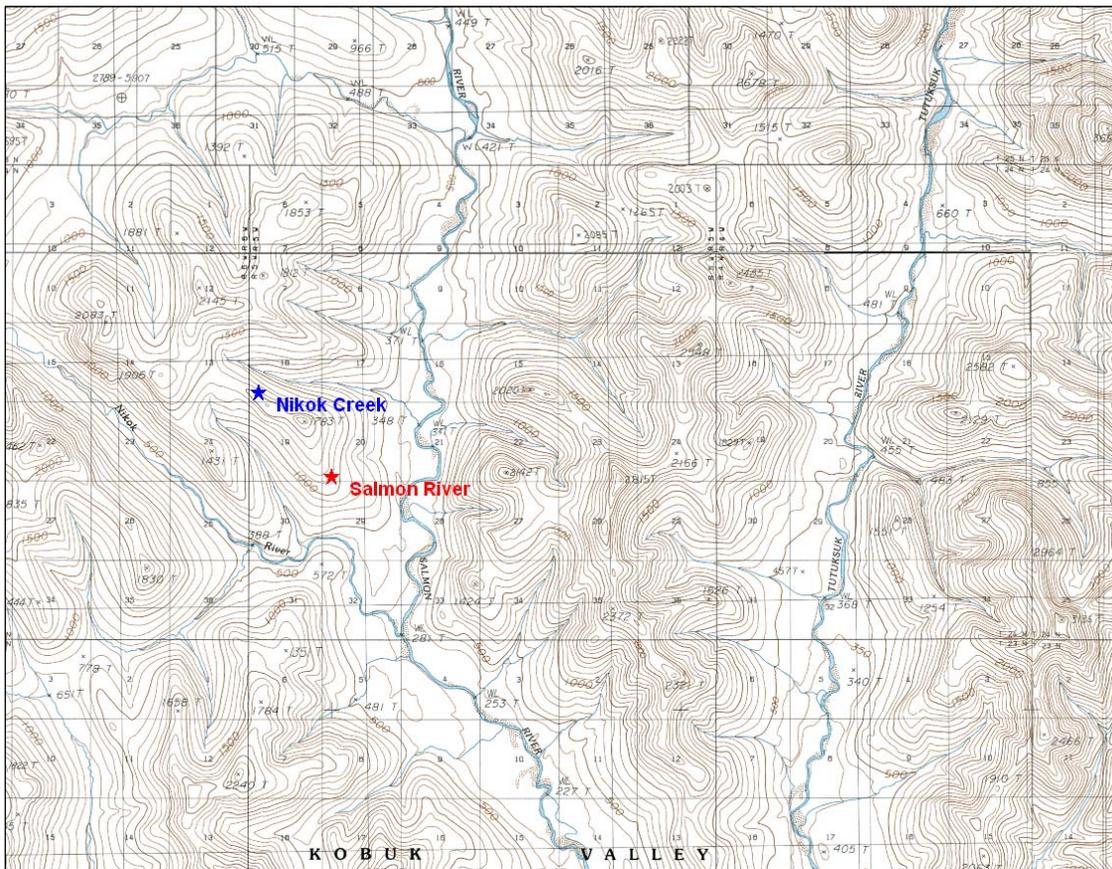
Notes:

- Good representation of mid elevation drainages in KOVA
- Good satellite site off the ridge to the southeast
- Was recommended by fire ecologist/fire staff as particularly useful area
- Above main river valley – out of viewshed
- Good southern exposure





Nikok Setting



Arctic Inventory and Monitoring Network  
Gates of the Arctic National Park and Preserve  
Potential Climate Monitoring Sites

Site: Agiak Lake

Area: Area SW of Agiak Lake,

Coordinates: 68° 05.178' N, 152° 56.243' W Datum: NAD 83

Elevation: 3000'

Description: Area around Agiak Lake. Southern exposure blocked by high peaks. Open tundra area, above treeline. Wide open valley with lakes. Low alpine tundra, wet around lakes giving rise to dry alpine tundra.

Access: Floatplane

Notes:

- Representative site in high broad pass in central Brooks Range
- Southern exposure blocked, not good for GOES transmission or solar power
- Wilderness





Agiak Lake Setting

