LOOKING FORWARD, LOOKING BACK

Building Resilience Today

Community Report

Iliamna, AK

November 12-14, 2019

Native Village of Iliamna
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ALEUTIAN PRIBILOF ISLANDS ASSOCIATION

AK CASC
Alaska Climate Adaptation Science Center

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ACKNOWLEDGEMENTS

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This report describes the results of a community visit to Iliamna that included multiple meetings. The *Looking Forward, Looking Back: Building Resilience Today* (LFLB BRT) project leaders would like to thank the community partners, community leaders, and community meeting participants for their participation and contribution to this project and for sharing their knowledge and wisdom. We would also like to thank them for their time and support during the community visits and meetings that were central to the success of this work.

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COMMUNITY DESCRIPTION*

Iliamna is located on the northwest side of Iliamna Lake, the largest lake in Alaska located in the Bristol Bay region, 260 miles southwest of Anchorage. Prior to 1935, "Old Iliamna"; was located near the mouth of the Iliamna River, a traditional Deni'ana Athabascan village. Around 1935, villagers moved to the present location, approximately 40 miles from the old site.

Iliamna is known for its fresh-water seals, annual salmon runs, immense natural beauty, fresh clear water and Iliamna Lake monster fish. The community is powered by hydropower, and there are several small businesses, including fishing and hunting lodges, along with a subregional health clinic that serves the Iliamna Lake communities. Community members actively fish and hunt, and maintain subsistence. The Village of Iliamna is the federally recognized tribal government, and Iliamna Natives Limited is the local corporation established under the 1971 Alaska Native Claims Settlement Act. With a warming climate, Iliamna is experiencing increased winds, temperatures, precipitation and extreme weather events that are impacting food security, safety, access to and availability of subsistence resources,the practice of local traditions, and pose complex interactions on development options.

*Compiled from L. Anelon's draft community description during the LFLB BRT Intensive Work Session, March 5, 2020. Anchorage, AK and the State of Alaska Division of Community and Regional Affairs Community Database Informational Portal

PROJECT DESCRIPTION

The Alaska Climate Adaptation Science Center (AK CASC), in partnership with the Aleutian Pribilof Islands Association (APIA), designed the Looking Forward, Looking Back: Building Resilience Today (hereafter 'BRT') project as a series of trainings and workshops with tribal community leadership and members. The overarching goal of the project was to collaboratively develop the Indigenous knowledge and western science knowledge for adaptation planning. We worked with five community teams consisting of up to four leaders from communities that chose to participate in the project: Iliamna, Kotlik, Kwigillingok, Quinhagak, and St. Michael. Community teams were developed through the application process and the project duration. Community teams were encouraged to have involvement from multiple governing bodies within the community that could include the Tribal Council, the city government, and the village corporation. The project title, with its references to the future (Looking Forward), past (Looking Back), and present (Building Resilience Today), refers to the idea that adaptation planning relies on all three perspectives. Equally important, however, is the dialogue to exchange past and present information, context, and what we expect in the future. Accordingly, two training sessions held at the International Arctic Research Center in Fairbanks, Alaska at the beginning and near the end of the project were developed to provide community team interaction with each other and with university and federal science partners. The project team also traveled to the partner communities and held a series of onsite events with community members to document locally-relevant information and share climate science tailored to the needs and conditions of each community. This report represents the community information shared during those onsite events. The Meeting Announcement (page 5) shows the date and description of the outreach events.

The purpose of these events was to: 1) facilitate mapping of a Traditional Use Area to refine an area for climate projections; 2) construct current and past seasonal Subsistence Calendars to identify important species and times of the year; 3) document Indigenous and local knowledge from current community members about environmental changes they have observed over their lifetimes; and 4) assist with documenting what the community perceived to be climate-related issues through photos and interviews. The agenda of the visits was co-produced with the community team. In each community, the community team and the project team co-hosted an open-to-the-public meeting and met with various groups. The community team advertised the meetings by posting community fliers, making announcements on the community radio, and reaching out to individuals that would contribute to the engagement discussions. Each community meeting focused on activities to develop seasonal Subsistence Calendars, map Traditional Use Areas, and document observed environmental changes. Community members spent time at stations dedicated to each of these activities working with project team members. The project team also met with various groups of individuals that included village corporation, tribal council, and city representatives where additional information about observed environmental changes was gathered. This community report presents some of the information developed in these activities.

CLIMATE CHANGE IN ILIAMNA

Share your experiences.

A team of Iliamna community leaders, along with the Aleutian Pribilof Islands Association and the Alaska Climate Adaptation Science Center, invites you to attend a series of community events on **November 12th-14th** to discuss climate change impacts and gather information on changes to local lands, waters, and fish and wildlife.

Schedule

Event	Time & Location	Description
Work Session with local community team	Tuesday, Nov. 12th Time: after 2pm Location: Community Center	Review activities and finalize facilitation and site visit.
Dinner meeting with Tribal Council	Tuesday, Nov. 12th Time: 5:15pm Location: Community Center	Meet Council members and review focus of community meeting over dinner.
School outreach	Wednesday, Nov. 13th Time: 3:30-5pm Location: TBA	Youth will explore the impacts of a warming Arctic through interactive activities. Target grade: 7-12th
Potluck & community meeting	Wednesday, Nov. 13th Time: 5:30-8pm Location: Community Center	Hear about future climate change impacts projected for the Iliamna area and share information on community change.

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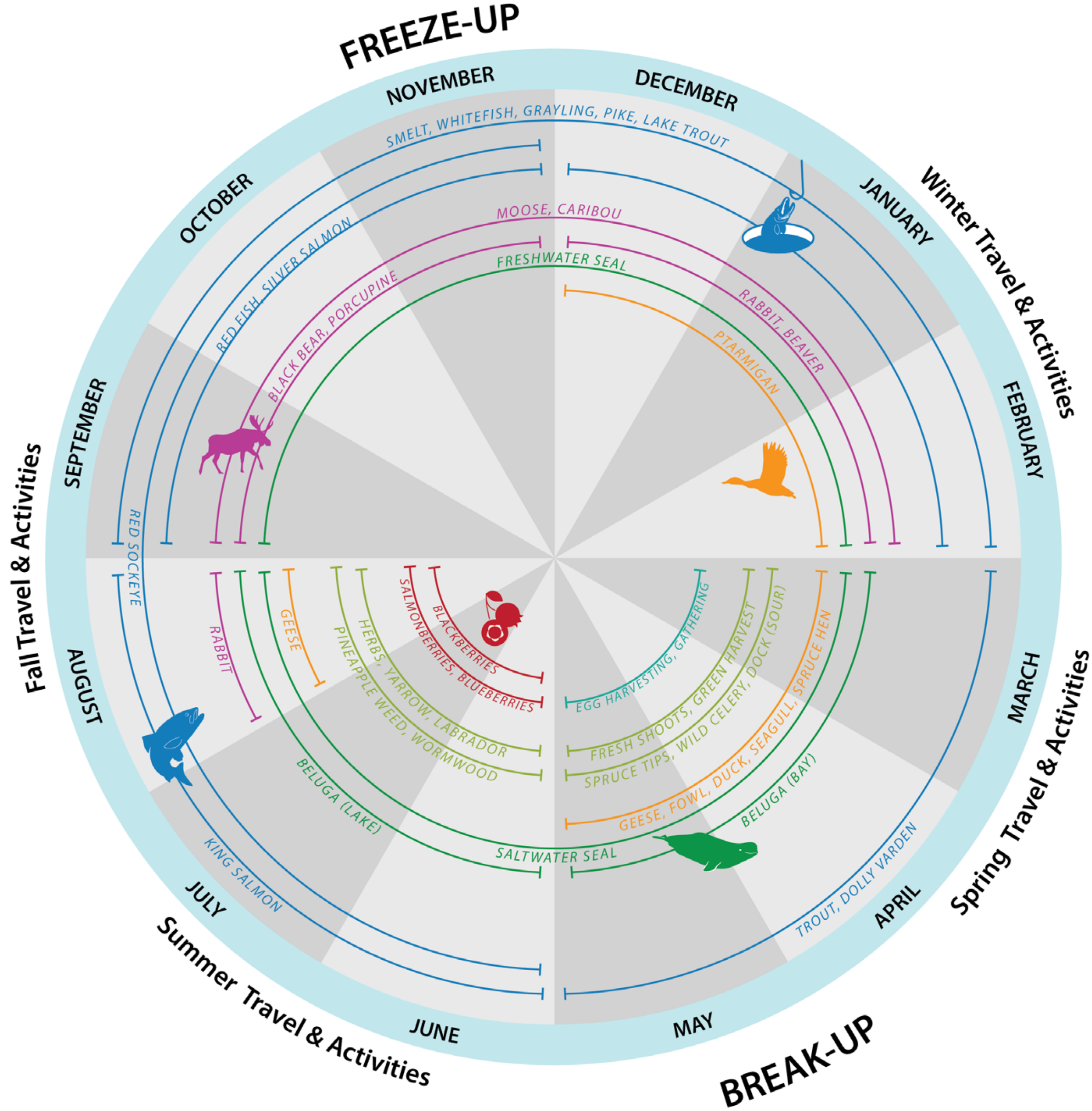


SUBSISTENCE CALENDAR

At the Subsistence Calendar station participants worked on two separate sheets of paper to list the many plant, marine mammal, fish, bird and animal species they rely on and harvest. One list focused on the current subsistence species while the other list focused on subsistence species in the past. After the list of species had been completed, participants then placed the species on a circular calendar during the time of year the species were harvested. In order to document observed changes, participants were asked to list past and current subsistence hunting or gathering practices, identifying any observed changes in the arrival, harvesting or hunting time of key species. This exercise provided an opportunity to recognize the variety of species that each community depends on and has concerns about. Participants also had further opportunities to share brief stories and observations of change.

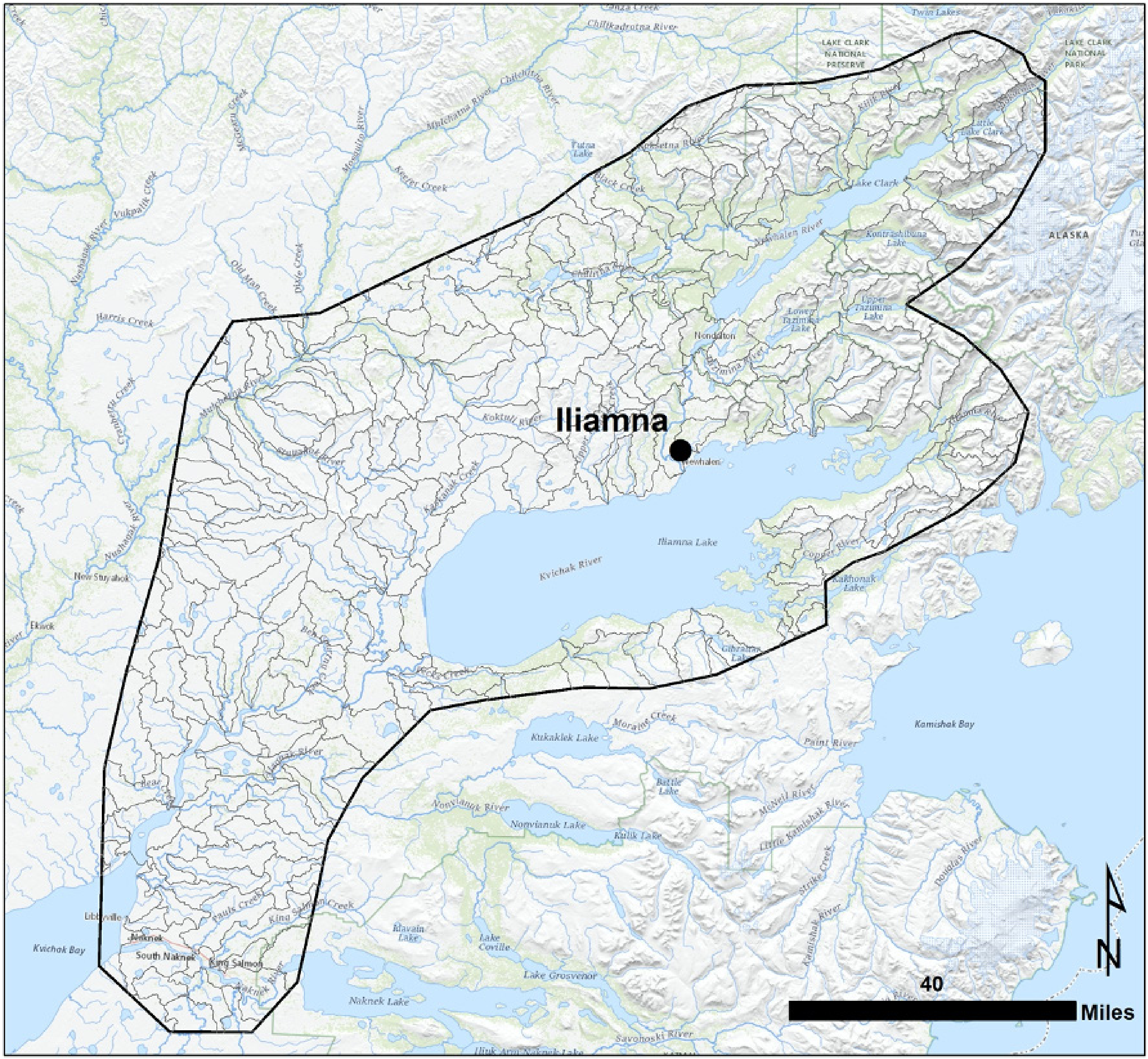
Participatory mapping of Traditional Use Area by some community members of Iliamna.

ILIAMNA COMMUNITY MAP

Iliamna community members mapping the Traditional Use Area.

Each Alaska Native community in Alaska historically had a Traditional Use Area, or traditional territory, prior to the 1971 passage of the Alaska Native Claims Settlement Act (ANCSA). Alaska Native communities still have common use areas that may be based on current land use and ownership, or historical land use. For this exercise, we asked communities to identify these areas. In addition, we asked communities to identify anywhere they traveled by foot, boat, ATV, or snow machine for purposes beyond subsistence that included potlatches, basket-ball tournaments, and other travel.

At the Traditional Use Area activity station, the project team provided the community teams and participants with large scale maps of the land and area around their villages (United States Geological Survey topographic maps) and various colored markers. Working in their teams, they identified a use area by drawing directly on the large paper maps. Each community constructed their own legend that described the map they drew. The project team then used these maps to develop detailed regional climate projections for each community. Many communities identified general subsistence areas and routes taken to access these areas and other communities.



Footprint of the Traditional Use Area identified by participating Iliamna community members.

DIGITIZED COMMUNITY MAP

The community members outlined a Traditional Use Area during community meetings. Areas and trails were drawn on a printed USGS map. These were transferred to a digital representation using computer Geographical Information System (GIS) software (ESRI ArcMap within the GIS). A 'footprint' of the area was also created that encompassed the entire Traditional Use Area. Participants have a digital version of their Traditional Use Area for future purposes. These digitized 'footprints' were then used to refine the spatial extent of the climate projections averaged for the region of interest.

ENVIRONMENTAL OBSERVATIONS

During the public community meetings and the smaller group meetings during the community visits, participants were asked if they had observed any environmental changes throughout their lifetime. These observations were documented and attributed by the project team during the community visit. After the community visit, project team member R. Toohey organized observations into themes by one or more topics (traditional methods, subsistence, weather and climate, etc. – see below, pages 10-16) using a process called 'coding'. The same observation could belong to several different themes as long as it pertained to the theme in some way. These themes were developed from the observations so that community members could quickly find Indigenous and local knowledge that pertained to a certain subject. The community teams reviewed and agreed on these themes when they reviewed the draft documented observations during the second team training (see Project Description above, page 3).

Notes on observations were taken rapidly by hand in a necessarily informal form and were reviewed and appoved by the community. In the interest of preserving the words of the community as closely as possible to this original form, editing in the following section was kept to a minimum and only utilized to preserve space and increase readability.

"As a council, we need to think about how we're going to deal with this. Our smaller lakes are full of weeds now. The birds that used to stop on those lake don't stop anymore. The food's not there anymore." - Lary

Iliamna community members developing the subsistence calendars.

QUESTIONS

Community members raised the following questions during the community meeting activities:

Do you have any idea how long the warming is going to occur? When I was young, the lake did not freeze one year, but the Elders said its ok. It will get cold again. - Ethel

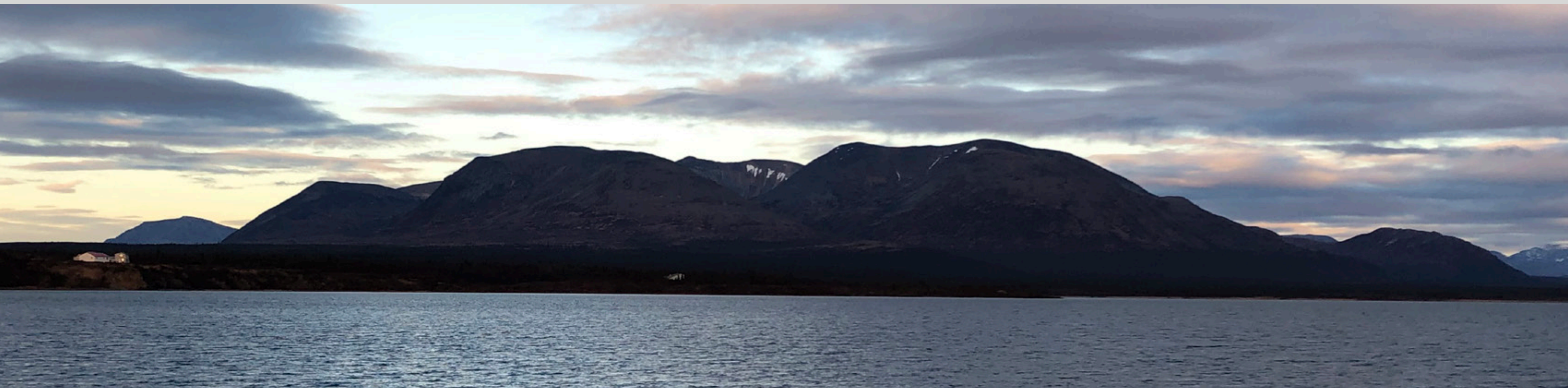
Do you think we're too late? I enjoy the warm temperatures, I love it. - Tref

Do you think that Lake Iliamna is going to start raising? Pedro bay used to be underwater. - Ethel

How are we in Alaska going to change anything? - Louise

Why does it warm up differently throughout the state? - Scotty

OBSERVATIONS



Weather & Climate

Snow

- First snows used to come in October, When I was younger, we used to dig tunnels through the snow drifts. They were as high as the roof of the Green building. I told my sons not to waste their money on snowmachines. They bought them anyway. - Louise
- Last winter, we had a foot of snow in one day. I picked the kids up, the kids want to play in the snow. Parents say its getting too late, you can play tomorrow. Woke up the next morning and it was gone. - Tim
- Its wetter snow too. (Louise nodded).
- Treeline has gone up about 500 feet in 50-60 years. I think that will help to hold the snow. - Lary
- Snow would be from October up to April. Now we don't really get snow until January if we're lucky. - Sue

Ice

- Should be ice in the bays (nearby) by now (11/12), favorite thing to do is to go ice fishing for Dolly Varden during the winter. - Louise
- This time of the year, small lakes should be frozen. This year they are not safe to travel on. - Lary
- Main lake didn't freeze last year. - Clint
- In March running around with boats seal hunting. Never was like that before. - Tim
- When I was young, the lake did not freeze one year, but the Elders said its ok. It will get cold again - Ethel
- Back in the 50s, we used to have lots of glaciers. There's no glaciers anymore. Its all river and tundra, We we're told by the Elders that the temperatures were going to change and the animals are going away. - Myrtle
- No more exciting icebreak – used to be big event. "Pogghkkkghhkkkk pogghkkkghkkkkk". Happening from the ocean and river now. Melts in before melts down. - Unattributed
- Easier to pick ice – to break through - Unattributed

Wind

- Windier than in the past. So much so, we're nervous to burn at the landfill or light the saunas. - Louise
- Constant switch from east to west wind. It makes it really hard to get out on the lake. With a wind storm, sometimes you can only have 4-5 hour window on the lake. - Lary
- We used to say fall time was the worst time to be on the lake. We can't say that anymore, its changes all the time. - Clint
- The wind is really changing. Wind is just 'smoking' (blowing hard). I know people out in Bristol Bay that posted on Facebook the winds hitting the canneries. Dillingham, boat harbor was getting flooded. 80-90 mph winds. - Tim
- That storm [that Tim mentioned] was a big storm surge. – Louise
- I was talking to my godson today and looking at his house. I said, man you better start putting more screws in your roof. He didn't build his house. He has more screws in his sauna than in his house. - Tim
- The wind is changing building practices. We're using hurricane straps and blocking. - Lary
- No more north winds. We get the north winds in the summer and the west winds. East winds in the winter. Where is that weather coming from? - Tim and Louise
- Wind patterns are changing all over. We're building stronger roofs. - Lary

Rain

- We didn't get any rain…then it wouldn't quit raining. - Tim and Rhonda
- You used to be able to see the weather change coming, now its all mixed up..raining and sunny. - Tim

Vegetation

- Lots more grass and weeds in the lake than before. All around dog island. Near six mile lake. - Tim
- The weather is so warm. The grass is green again. Pussy willows are growing again. Its getting brushier too. - Tim
- Snow, rain, get warm again in January, pussy willows blow again. - Clint
- As a council, we need to think about how we're going to deal with this. Our smaller lakes are full of weeds now. The birds that used to stop on those lake don't stop anymore. The foods not there anymore. - Lary
- All the grass and weeds in the big lake are going to make it hard for the salmon - Tim

- Treeline has gone up about 500 feet in 50-60 years. I think that will help to hold the snow. - Lary
- Tim was talking about brush everywhere now. When I was a kid, that big building by the airport. You could stand on a box of milk, you could see Newhalen. Now there's too much brush and evergreens. Lots of alder and birch. Tamarack spruce tree, black eyed timber. You'd think the brush would bring more moose in, but they don't last too long. Although a lot of trees this summer died due to lack moisture and rain.
- Brush is getting green in May instead of June. Trees are dying faster in the fall. - Tim
- Trails are growing in. I dog mush, my trail is growing in. - Tim
- 4 wheelers leaving tracks all over the place filled in with Alder. - Lary
- There used to be nothing but tundra here. Now there are trees. - John
- [There is] increased willow growth - Unattributed
- Willow trees are taking over and growing big. Alders too. - Unattributed
- Used to be only shrubs – all the spruce came in in the last ~40yr - Unattributed

Water

- I'm a certified diver. When it gets hot, the glaciers melt faster. Turn the water green. The glacier water goes down 20 feet, but at 25 feet, its clear. The glacier water doesn't get down to the bottom anymore. - Tim
- I do a lot of subsistence fishing here. Water was really warm this summer. - Clint
- You'd think the water would be cooler up here because of the glaciers (as opposed to Naknek), but its not. - Tim
- Water was warmer than the air. - Lary
- I've got a thermometer; water was 68 degrees last summer in the lake (Bristol Bay) - Tref

Subsistence

Salmon

- In the fall, we don't see salmon carcasses anymore for some reason. - Tim
- We're getting fish a lot less places than they used to be. - Clint
- Fish are becoming bottom spawners. Dieoffs up in Kusha Bay, because the water was too warm (two years ago). Same thing happened this year. Best day for nets this year was 15. Should be like 70. All the fish are in the deep water. I don't know how many years its going to happen like that. - Lary
- Normally our main big runs are right around the July 4th. They were 1.5 weeks late this year. - Clint
- Theory was that Bristol Bay and the ocean was so warm that our fish went up way around. - Lary
- Another village, the water was so warm, didn't freeze up. They caught salmon in April. - Tim
- Last time the bay froze up, we got three salmon through the ice. We were so happy. - Lary
- The Natives in Lake Clark didn't get their quotas. - Tim
- In Knudsen, it was so dry, the salmon were stuck in one little area. We were in a helicopter. We flew all over the place in helicopter. You can tell its changing. Everybody has to go further for caribou too, we have to go all the way almost to the Nushagak. - Chastity
- Meats is getting softer - Tref
- My wife and I, salmon is 30% of our diet. - Lary
- Beaches used to be covered deep and lake surface would have floaters, with spawned out fish. Now you don't even see the floaters. - Unattributed

Other Fish

- Not as many pike, no suckers anymore. - Sue
- We used to catch trout, more from the beach. Now you can't do that. - Sue

Trapping

- Mice and owls are not surviving because there is not enough snow cover. Its hard to trap, because there's no food. - Lary
- If they are here, their fur is not good quality. - Tyler
- No muskrats. We'd eat the muskrats-my grandmother would let us. - Sue
- Wolves have gone – migrated away with caribou. - Sue
- Lynx right up next to houses now. - Unattributed
- Don't see weasels anymore. Ermine, not as much either. - Unattributed

Caribou

- Now our young boys have to go a long ways for caribou. Now you have to have a machine to subsist. - Tim
- Almost seems like the sun is coming up in different place in spring time. We're going to need more roads and bridges just to get around. All tundra. Now they have to go 20 miles (90 miles Louise) to get Caribou. - Lary
- Everybody has to go further for caribou too, we have to go all the way almost to the Nushagak. - Chastity

Berries

- My wife and I were out picking blueberry raisins this year. - Lary
- Cloud berries are not the same. There is not as many. You need to go a long ways even just to find some. - Clint
- Cranberries dried out too. - Lary
- They were small too. - Tim
- More high bush currants now. - Sue

Moose

- Moose population is increasing…with more moose, there is more brown bear. I've probably seen a thousand bear here. - Clint

Ground Squirrels

- May to August in the past, but we don't get them now. Elders ate them. One of the ladies would make parkas out of them, 80 for a parka. Squirrels have been gone for at least 3 years. - Sue

Birds

- This year, first time I ever seen a humming bird - Tim
- I've seen humming birds the last 5 years. - Louise
- Fewer sea gulls and arctic terns around. They used to be out on the beach in the thousands, now you're luck to see 50. - Lary
- They're used to be a lot shags too (commorants). - Clint
- We don't get ptarmigan like we used to. We got like 7 or 8 this fall. - Tim
- Fish and Game has put limits on ptarmigan now. - Lary
- When we were kids we used to see ptarmigan, now we don't. - Sue
- Common mures blew over here from Anchorage, some big wind storm. They wouldn't eat the sticklebacks here. They ate the salmon. - Tim
- Seabirds died and floated in lake. - Unattributed
- Swans are still here (today). Seagulls are too. Normally leave in late October. - Unattributed

Beaver

- I've been beaver hunting, now I have to go an hour out to find one. You have to by boat now. - Tyler
- Don't see as many beaver as we used to. They would be building their houses all year round. - Unattributed

Traditional Methods

- Blowfies were on the fish while they were cutting them. Yellow jackets were eating the fish. - Tim

Sharing

- People don't share anymore. If they don't use, they throw it away. - Tim
- King heads and bellies…that's the best stuff.
- We go around to the canneries and ask them for their heads. - Louise
- Lots of waste, nobody uses the heads, doesn't get a clean filet. - Clint
- Our resources are shrinking. Sometimes if you're not going to have full meal, are you going to share? - Lary
- Lots of waste in hunting and fishing these days. - Myrtle
- All that makes me so upset seeing people shooting animals from town. - Unattributed

Public Health

- Local pilots were getting hoarse throats because of all the smoke they had to fly through. - Lary
- Elders need a cool place to rest during the summer. - Louise
- Lots of smoke, people with asthma had real problems. - Tim
- Peoples allergies to certain things. I was never allergic to nothing. Now, I have asthma, cats and dogs, the cold, the dust. - Clint
- Me too. I have lot more allergies. - Tim
- I'm seeing a lot more fireweed now. - Tyler
- We worked with ANTHC to learn how to improve air quality in people's houses. - Louise
- Seems like every year we get smoke now. - Clint
- "Cool clinics" is a temporary fix, once they leave breathing problems return. I think we should look into getting people air conditioners. - Tim
- Sometimes I go out my car and turn on the air conditioners. - Lary
- I was doing that too. - Tim
- Or go out on the lake. - Lary

Bears

- Moose population is increasing…with more moose, there is more brown bear. I've probably seen a thousand bear here. - Clint
- If it's a warm winter, bears are denning up high. If its warm spring, their dens flood, they get hypothermia and die. - Lary
- Bears are eating whatever they can. No fish laying on the beach anymore. - Tim
- Bears then get really bold, break-ins happen. Bears get into fish totes. - Lary
- Bears now come around and look for food scraps, and are out longer. They didn't used to do that. - Unattributed
- Rarely see black bear. A lot up by lake Clarke, in the mountains. - Unattributed

The Tazimina Hydroelectric Project

Infrastructure

- Almost seems like the sun is coming up in different place in spring time. We're going to need more roads and bridges just to get around. All tundra. Now they have to go 20 miles (90 miles said Louise) to get caribou. - Lary
- I was talking to my godson today and looking at his house. I said, man you better start putting more screws in your roof. He didn't build his house. He has more screws in his sauna than in his house. - Tim
- The wind is changing building practices. We're using hurricane straps and blocking. - Lary
- Wind patterns are changing all over. We building stronger roofs. - Lary
- I think a lot of people are clearing brush away from their home throughout AK. - Tim

Fire

- So dry, all summer long, smoky, fires all over the place. Big fire last year across the river, 2003 big landfill fire. - Louise
- Local pilots were getting hoarse throats because of all the smoke they had to fly through. - Lary
- Seems like every year we get smoke now. - Clint
- I think a lot of people are clearing brush away from their home throughout AK. - Tim

Adaptations

- Put an air conditioner in the shed, insulate it. Keeps it cool. - Tim
- My brother did that too for smoking fish. - Lary
- People use conexes for that. - Clint
- People were trying to put their fish in their smoker before it was dry because of all the bugs. Fish went sour. Too hot, needs more air flow in there. Tim, it needs to be screened off too. - Louise
- Elders need a cool place to rest during the summer. - Louise
- We worked with ANTHC to learn how to improve air quality in people's houses. - Louise
- "Cool clinics" is a temporary fix, once they leave breathing problems return. I think we should look into getting people air conditioners. - Tim
- Sometimes I go out my car and turn on the air conditioners. - Lary
- I was doing that too. - Tim
- Or go out on the lake. - Lary
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- Wind patterns are changing all over. We building stronger roofs. - Lary
- I think a lot of people are clearing brush away from their home throughout AK. - Tim

Insects

- A crazy Japanese bug. They are big and black, big antennae and kind fly (some kind of beetle). All over the place. - Clint
- I had an Elder today asked me if I've seen the wood bug. I said yeah (spruce beetle bug?). - Tim
- There are ants in there too, one to two inch in size. - Clint
- Weird looking bugs. - Unattributed

Permafrost

- Permafrost is disappearing. Down in Newhalen there used to [be] a cold room that was dug into the ground so people could bring their meat down. More frost heaves, more rain, more erosion. If there's one advantage, you save a lot on heating oil. - Lary

Miscellaneous

- Lots more earthquakes. - Tim
- Louise was saying it too. Everything is connected, it's just faster now. - Lary
- I enjoy the warm temperatures, I love it. - Tref
- Over the years, I've watched the dead fish, piles on the beach everywhere. You don't see any fish anymore. The fox, the crows are hungry. - Myrtle
- Used to get fresh water smelt. - Myrtle
- Pedro Bay gets fresh water clams. My mom always used to say don't eat them they're poisonous. But another family used to eat them all the time. - Ethel

Project team member, Jeremy Littell, reviews climate projections with Iliamna Tribal Council. Photo: Malinda Chase

SNAP ONLINE TOOLS

Overview

The second Fairbanks training (see project description, page 4) introduced community teams to online climate information tools developed by The Scenarios Network for Alaska and Arctic Planning (SNAP) at University of Alaska Fairbanks, where the training was held. The goal of these sessions was to introduce community team members to how they might use these tools to develop information for their planning efforts and to learn more about potential impacts in their regions. For this report, the region around each community was considered and a specific narrative for that region was developed to illustrate the potential changes and impacts indicated by each tool. The following pages illustrate the results from each tool for Iliamna.

To explore how climate change might affect you, use the SNAP web tools at https://www.snap.uaf.edu/tools to get a hands-on, user-friendly overview of how climate change may affect regions or resources of concern to you. Many of these tools were introduced during the BRT Training 2 in Fairbanks. All of them can be freely shared. The summaries below help explain the results from each tool for Iliamna.

Questions & Feedback

SNAP is always seeking feedback about the usefulness of our online tools, and about the way we share climate change information. As you read through this document and explore these online tools, it may help to keep following questions in mind – and to think about how your feedback might help us improve:

1. How do changes in average temperatures affect your experience on the land in both the short-term and the long-term? Are short-term effects such as extremely hot days more important, or are long-term trends such as loss of permafrost and river ice more important?
2. What effects that you are experiencing can be linked to changes in vegetation? Which aspects of climate (e.g. hotter summers, fewer cold winter days, drying soils) do you think are most important in causing these changes in vegetation?
3. Is loss of sea ice important to your community? Directly, or only indirectly? What do you think would happen if sea ice almost entirely disappeared in the Bering Sea?
4. What would you like to measure and track in your community (e.g. water temperature, berry crops, dates of seasonal events, numbers of animals sighted) in order to get better data on climate change?

About SNAP

The Scenarios Network for Alaska and Arctic Planning (SNAP) is a climate change research group in UAF's International Arctic Research Center (IARC). Since 2007, SNAP has used climate data to create and share ideas of what a future Northern climate could look like. SNAP works with people, communities, and organizations to plan for a changing climate. To learn more about climate models, methods and projects in Alaska visit SNAP's website at www.snap.uaf.edu. Some of these data were used to create climate projections for the BRT project.

Community Climate Charts

https://snap.uaf.edu/tools/community-charts

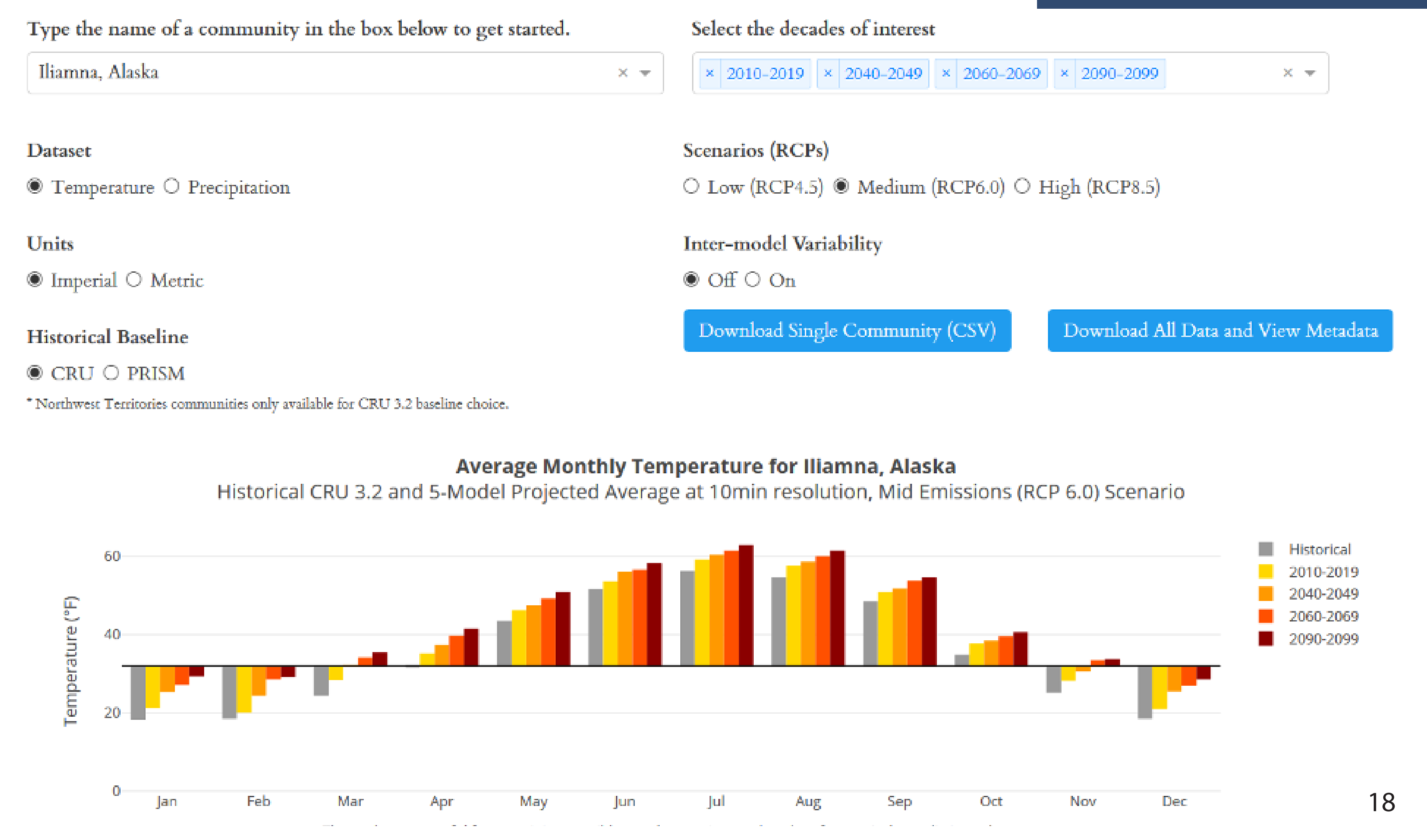
The Community Climate Charts tool allows users to select their own community, and view a graph of temperature or precipitation projections by decade, as compared to historical baseline values. In this case, Iliamna has been selected, and the graph shows temperature for the past, for the approximate present, and for future decades.

Note that overall changes in temperature tend to be greatest in winter, but shifts in fall and spring freeze and thaw may prove to have the greatest impacts. For example, although historically the months of November and March both had average temperatures well below freezing, by the end of this century both these months are projected to average well above freezing.

Connections to changes described in Iliamna BRT community meetings and activities:

- Later snow in fall, affecting usefulness of snowmachines
- Later ice on bays, affecting ice fishing for Dolly Varden, affecting ability to be on the lake
- Heat and insects affecting drying of fish

CRU (Climatic Research Unit, University of East Anglia, UK) and PRISM (http://www.nacse.org/prism/) refer to historical climate estimates made using weather station data and computer modeling of what climate would be between weather stations. RCPs refer to pathways of future climate that would likely occur under different concentrations of greenhouse gases (see page 24 for explanation).



Community Permafrost Data

https://snap.uaf.edu/tools/permafrost

The Community Permafrost Data tool allows users to select one community or multiple communities, and to see relative conditions for several permafrost characteristics including: massive ice, thaw susceptibility, existing problems, permafrost occurrence, permafrost temperature, rating score, and risk level. Here, the project team selected all the communities that participated in the BRT project so that community team members can see the differences.

Note that variables are linked. For example, where permafrost has already been lost, risks are generally considered low. This is the case in Iliamna, where overall risk level is ranked as "none". Although permafrost was present in the area in the past, it has been gone for long enough that changes in soil temperature do not pose a community threat as they do for many of Iliamna's neighbors.

Connections to changes described in Iliamna BRT community meetings and activities:

- Permafrost disappearing, affecting food storage

Community Permafrost Data

Explore community risk to permafrost.

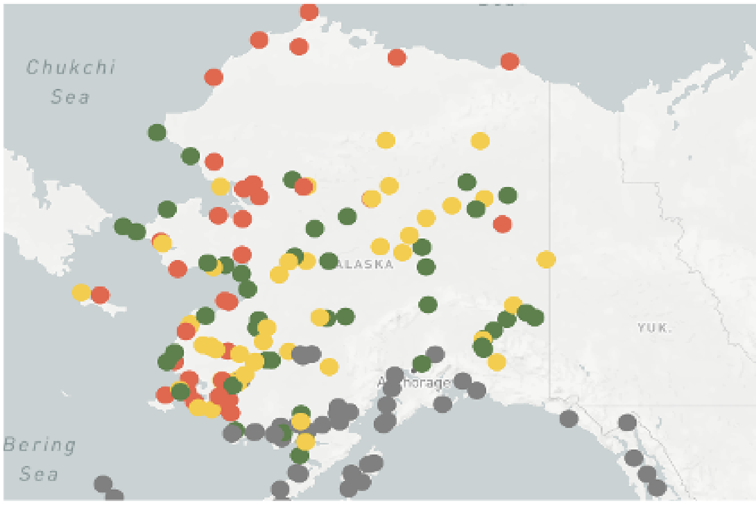
Explore permafrost risks and hazards for rural communities in Alaska based on massive ice, thaw susceptibility, existing infrastructure problems, permafrost occurrence and temperature. Detailed explanations for these variables can be found below. These are tallied to create a cumulative rating score and risk level.

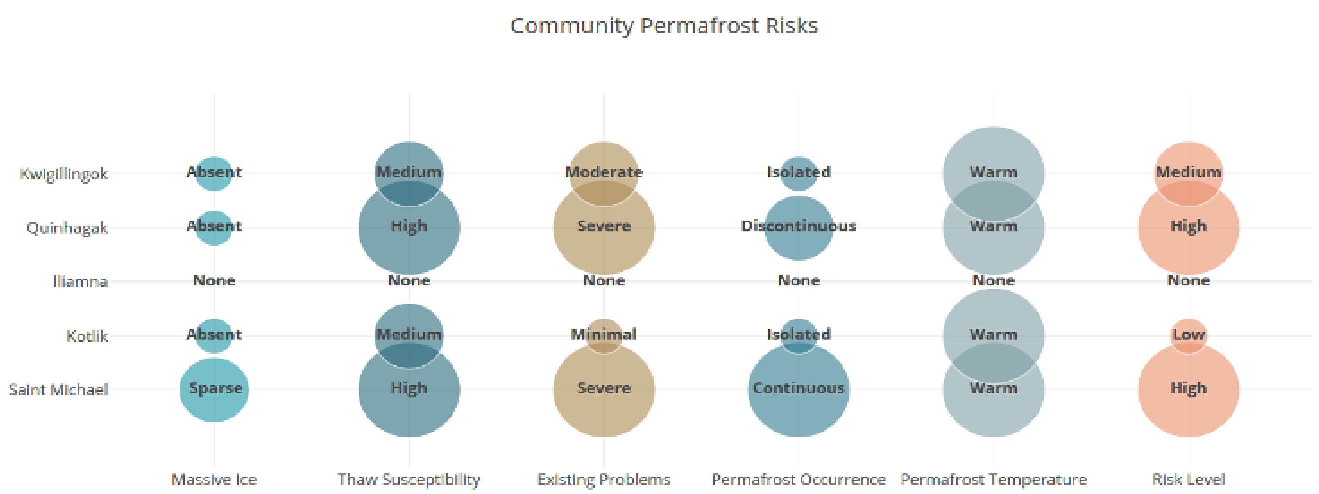
Select a category to visualize on the map

Risk Level

Type the name of one or more communities in the box below to get started.

× Saint Michael × Kotlik × Iliamna × Quinhagak × Kwigillingok



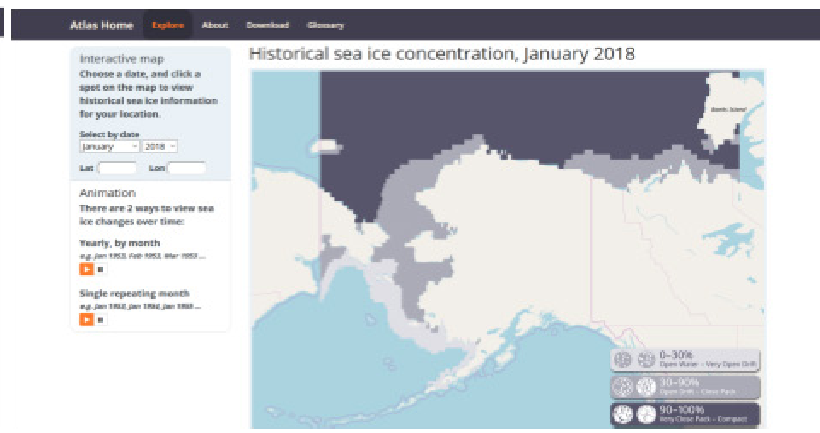


Historical Sea Ice Atlas

http://seaiceatlas.snap.uaf.edu/explore

The Historical Sea Ice Atlas shows historical sea ice for any month of any year from 1850 to the present. It can be animated to show change over time by month or by year. This tool does not provide future projections, but can be a useful visualization for showing trends that are expected to continue.

As shown in the figure and supported by local observations and memories, ice coverage used to be consistent, decade after decade. Declines started in the 1970s, and have continued thereafter. Although Iliamna is not a coastal community, changes in sea ice affect ecosystem dynamics across the region. Areas that reliably had substantial or total ice coverage are now seeing poor ice coverage or open water. Seasons are becoming shorter in both spring and fall. Shorter ice seasons disrupt many species and many traditional activities.



Alaska Garden Helper

https://snap.uaf.edu/tools/gardenhelper

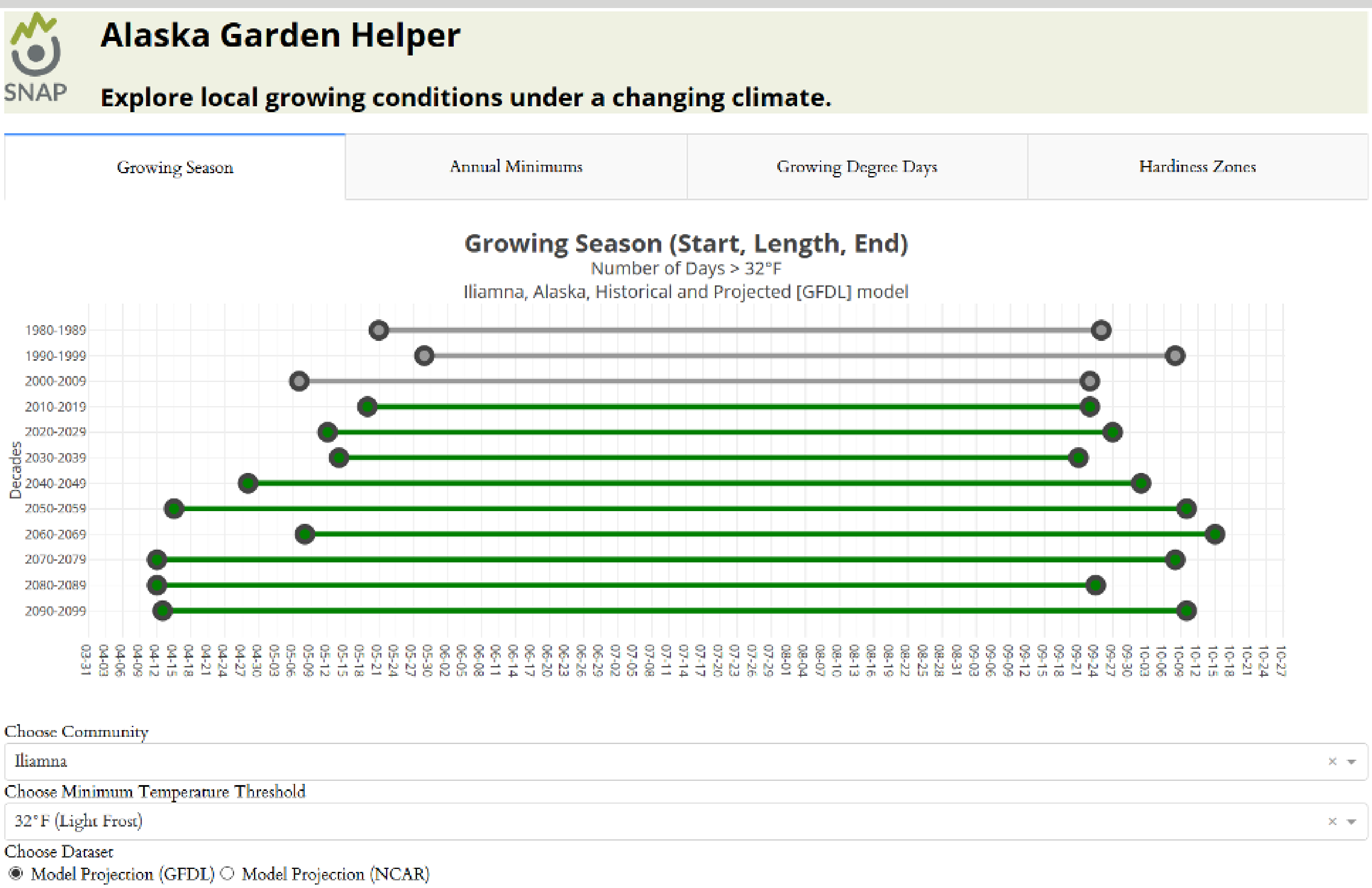
Though designed for gardeners and farmers, this Alaska Garden Helper tool provides useful projections of warm season length and extreme winter cold – variables that also affect natural ecosystems. Longer summers, hotter summers, and loss of limiting cold in winter can greatly change the plants and animals on the land and in the water – changes that community members are already reporting in Iliamna.

Users can select their community and can choose from several tools and temperature thresholds, including 28°F, 32°F, 40°F, and 50°F. Each selection will generate a new graph.

Summer season length in Iliamna, as measured by the precise dates of last frost and first frost, will continue to be highly variable, since a difference of one degree can register as a large shift. However, on average the summer season will expand greatly into the spring and fall. Coldest winter temperatures will become much warmer, as shown by the "Annual Minimums" and "Hardiness Zones" tabs within this tool.

Connections to changes described in Iliamna BRT community meetings and activities:

- Warm weather leading to greener grass, more shrubs, treeline up 500 ft., trails growing in

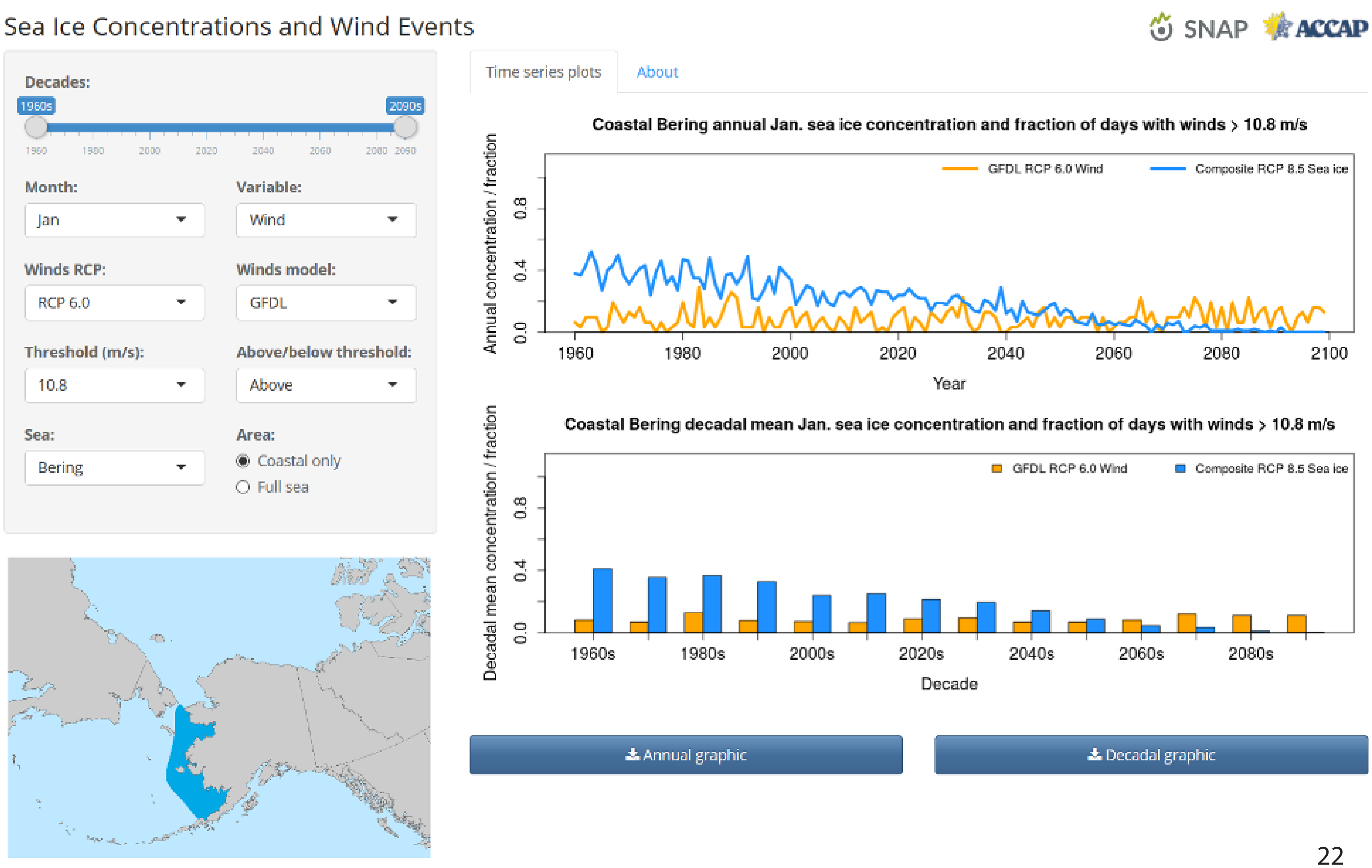


Sea Ice and Wind

https://://uasnap.shinyapps.io/sea_ice_winds/

This Sea Ice and Wind tool explores the interactions of wind and ice. Users can select a sea – in this case, the Bering Sea – and generate graphs for selected months and time periods.

Outputs for wind are highly variable, and may not indicate clear patterns of change, but outputs for ice show obvious severe declines, ongoing and into the future. These results are averaged across the area of the Bering Sea shown in the map, and thus are not specific to any one community. However, strong predicted trends in loss of sea ice suggest large ecosystem changes both on the coast and further inland.



Wildfire in Alaska

http://mapventure.org/#/map/fires

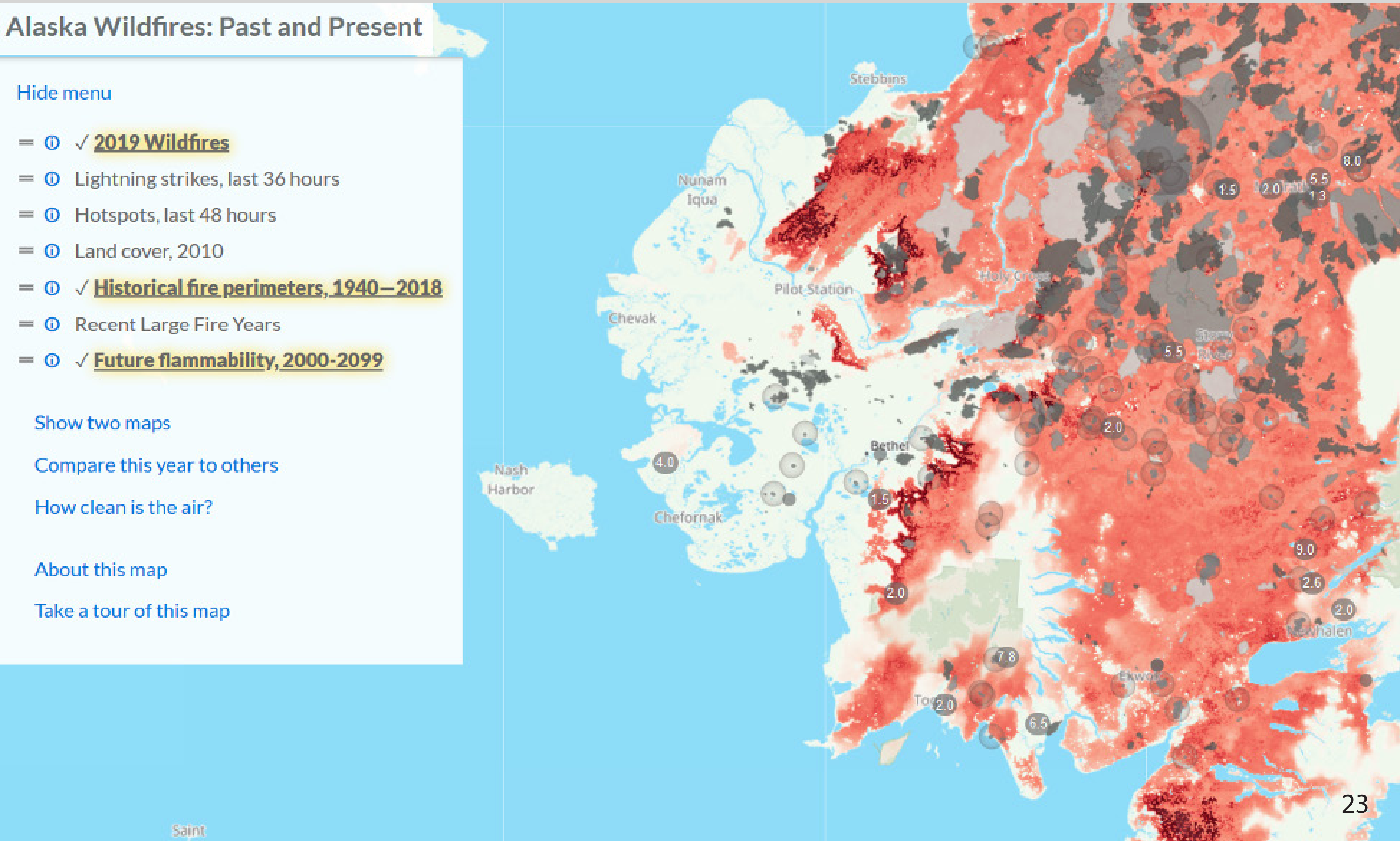
This Wildfire in Alaska map tool explores past and future fires statewide. The map is zoomable, and offers multiple features that can be turned on or off.

The map below shows eighty years of past fire scars, shown as gray patches. The summer fires of 2019 are shown as small gray circles. Note that many 2019 fires occurred in areas much farther southwest and much closer to the coast than typical historical fires. This map also shows modeled future flammability, with darker reds indicating larger changes in future flammability. See page 45 for traditional use area scenarios for changes in flammability. Due to hotter temperatures and expansion of shrubs and trees, flammability is spreading closer to areas such as Iliamna that have little or no history of fires.

Smoke from fires can affect areas that are not themselves on fire or fire-prone. Thus, an increase in fires – particularly fires that are relatively close -- can affect the health, activities, and quality of life of community members in Iliamna.

Connections to changes described in Iliamna BRT community meetings and activities:

- Smoke from fire affecting health



CLIMATE CHANGE AND IMPACTS PROJECTIONS

Overview

In each community workshop, we reviewed potential future climate conditions and some changes in the environment that we would expect from those conditions. These future conditions are called "scenarios" because we don't know exactly what the weather and climate will be like, so we look at a range of possibilities from some warming to more warming. We also use two time ranges for these futures, 2040-2069 and 2070-2100, because different climate effects might take different lengths of time to happen. We learned in the Fairbanks trainings how scientists use complicated computer climate models to work out what the climate might be and how it affects fire, plants, and permafrost. We also learned that there are a lot of these models, and while all of them are scientifically reasonable, the future climates they project vary. So we also use the average of five different climate models for future climate scenarios. For the fire, land, and permafrost changes, two different climate models (a warmer one and one with less change) were used. At the community visits, we brought maps of these changes for the region and talked about them with community members.

For temperature, precipitation, and snow, the historical and future climate used to map changes came from University of Alaska Fairbanks Scenarios Network for Alaska and Arctic Planning (SNAP). Climate models simplify the real world, and this computer version of the world can be too simple for community planning because the model can only see detail for larger areas (like a square with 50 or more miles on a side). The climate for this project has been mapped to smaller areas (like squares less than a mile on a side). This information is available for five climate models that work well in the Arctic – they describe sea ice and the atmosphere in ways that look like historical weather we know occurred.

The average changes from these five models are shown for two futures: one where there is moderate warming, but eventually it slows down because of less coal, oil and gas use (which cause an increase of climate warming gasses in the atmosphere) and one where there is higher warming that continues to increase. These are called "representative concentration pathways" or RCPs for short - RCP4.5 is medium warming and RCP8.5 is higher warming. Lower rates of warming are possible with large changes in global policy and changes in coal, oil, and gas use, but we are currently heading for the moderate or high warming future so we did not choose a low warming scenario (RCP 2.6). The climate changes in the maps are compared to the 1970-1999 historical climate. The numbers in the upper left of each map page are the scenario averages for the four panels over the community-defined Traditional Use Area.

During the Fairbanks training we talked about when climate models do a pretty good job and when and why they are more uncertain. The scenarios that result in the maps in the next section address three main kinds of uncertainty. Using several climate models accounts for differences in climate models. Using a medium warming future and a high warming future addresses the uncertainty in how much change from climate warming gasses we think may happen. Using thirty-year averages decreases the effect of warmer or cooler, wetter or drier decades that happen for natural reasons. Together, these three things (using 5 climate models, using a medium and high warming scenario, using multiple decades) give us a more reliable range of future climates we can expect.

Permafrost futures (average yearly ground temperature at 3 feet deep) were available for two climate models under an older scenario (called A1B), which is in between the medium and high warming futures for the climate, fire, and land changes. The fire and land changes were available for two climate models used to provide temperature and precipitation to a land model that simulates vegetation and fire under the higher warming future.

Specific questions about any of the projections mapped here? Contact Jeremy Littell, Alaska Climate Adaptation Science Center, jlittell@usgs.gov. Further details on variables can be found in the SNAP data archives:

http://ckan. snap.uaf.edu/dataset

Iliamna Projected Climate Changes and Impacts

For the near future, about 2040-2069, Iliamna Traditional Use Area average annual temperatures are expected to increase +5.5 °F under medium warming and +7.2 °F under higher warming compared to 1970-1999. For the later future, about 2070-2099, Iliamna average annual temperatures are expected to increase +7.0 °F under medium warming and +10.5 °F under higher warming compared to the period 1970-1999. Warming will probably be greater in autumn and winter than spring and summer. Annual average precipitation (rain and snowfall) is expected to increase about +14% under medium warming and about +16% under higher warming for the near future 2040-2069 relative to 1970- 1999. Annual average precipitation is expected to increase about +17% under medium warming and about +26% under higher warming for the later future 2070-2099 relative to 1970-1999.

Precipitation increases will probably be greater in autumn and winter than spring and summer. However, in northern forests like those in Alaska, it has been found that about 15% more precipitation is needed to keep up with the increase in water demand of about 2 degrees F. So it is possible that even with more rainfall, water in plants during the warm season could decrease because precipitation increases would not be enough to keep up with the amount of water the heat can evaporate from the land and plants.

For 2040-2069, the amount of water available in April 1 snowpack (October to March snowfall water) is expected to decrease 20% under medium warming and 31% under higher warming, compared to 1970-1999. For 2070-2099, the amount of water available in April 1 snowpack is expected to decrease 27% under medium warming and 46% under higher warming, compared to 1970-1999. Averaged across the Iliamna region, and for all futures, these changes are expected to be large enough to push the region from winters that mostly had snow that melted in spring to a future where mixed rain and snow are more common and affect the timing and amount of water flows in streams. Some areas of permafrost might stay until the 2050s under a lower warming climate model (called ECHAM5), but decrease under all other scenarios.

Areas to the west of Iliamna become good for spruce growth, mostly in places that were shrub tundra. More spruce growth is expected under the moderate climate model (called CGCM3) than the warmer climate model (called CCSM4). Future computer model land changes suggest spruce could become more common to the east of Iliamna and south of Iliamna lake. In the north central part of the region, some shrub tundra and birch/willow/alder forest may become grass tundra. Some mountain tundra in the northeast part of the region near current treeline also could begin to become spruce forest. Except for the mountainous region east of Iliamna Lake and near the southwest (Kvichak Bay), fire could become more common, with the number of fires per century on each part of the landscape increasing. Both models indicate faster landscape changes, especially for the moderate climate model and a higher warming scenario.

Descriptions of variables

Temperature

Annual averages (12 months) as well as four seasons (Spring – March to May; Summer – June to August; Autumn – Septem¬ber to November; Winter – December to February). Maps (pages 29-32) show "deltas", or future projected changes, in surface air temperature from climate models compared to the same historical months or three-month seasons. The mapped changes are averages of 5 climate models and are displayed for two time periods as well as for both moderate and high warming scenarios.

Precipitation

Annual totals (12 months) as well as four seasons (Spring – March to May; Summer – June to August; Autumn – Septem¬ber to November; Winter – December to February). Maps (pages 34-38) show future percent change in precipitation (rain and snow) projected by climate models compared to the same historical months or three-month seasons. The mapped changes are averages of 5 climate models and are displayed for two time periods as well as for both moderate and high warming scenarios.

Snowfall, or snowfall water equivalent

October to March amount of snowfall, measured by the amount of water it contains. Maps (page 39) show future percent change in total snowfall derived from climate model projections compared to the same historical months or three-month seasons. The mapped changes are averages of 5 climate models and are displayed for two time periods as well as for both moderate and high warming scenarios.

Snow Index

October to March amount of total precipitation that is snowfall, measured by the amount of water it contains. These are displayed as a percent; a value of 55% would mean that 55% of the total precipitation falls as snow between October and March. 55% means that 55% of the precipitation was snow, while 45% was rain. Values greater than 40% are snow dominated; values between 10% and 39% are transitional; values between 0% and 9% are rain dominated.

Ground temperature at 1m (3.3ft) depth

Annual average ground temperature at 1 meter (3.3 feet) deep in the ground. This is an index of permafrost stability or thaw. The colder it is, the more likely permafrost is to persist. Near freezing (0 °C or 32 °F), the permafrost is more likely to thaw. Above freezing, it is unlikely to persist into the future.

Changes in fires per century

The times an area burned under simulated historical (1901 – 2000) conditions is compared to the number of times an area burned under simulated future (2001-2100) conditions. Numbers over 0 mean an increase in fire (e.g., 2 would mean a doubling of fire frequency); numbers less than 0 mean a decrease in fire.

Changes in vegetation per century

The times the dominant vegetation in an area changed under simulated historical (1901 – 2000) conditions is compared to the number of times vegetation changes under simulated future (2001-2100) conditions. Numbers over 0 mean an increase in landscape change (e.g., 2 could mean a change from shrub tundra to spruce followed by a change to deciduous forest).

Descriptions of variables (Continued)

Current probability of permafrost

This map shows the current probability that the area has permafrost under it. Darker blue indicates a higher probability of permafrost.

Thermokarst predisposition

Thermorkarst occurs where permafrost thaws and causes the ground to slump or cave in. Dark blues indicate areas where a model designed to predict thermokarst potential indicates it is likely. **If the graphic is absent, the model indicated no thermokarst predisposition in the region, so the map was not printed.**

Change in months of reliable snow

For this map, a month with "reliable snow" was defined as a month where, on average, more than 70% of the precipitation arrived as snow. The historical (1970-1999) months of reliable snow were compared to the future (2040-2069) months of reliable snow for RCP 8.5 (higher emissions), and the change calculated as future minus historical.

Map picture file abbreviations

All maps in this file are also in a folder with each map by itself. There are "small" maps that you can use in Word or PowerPoint (or other software) documents for reading. There are also "big" high resolution maps that could be printed off as posters or zoomed in on the screen and keep higher detail. The file names are abbreviations– here is what they mean:

dPann – change in annual (January to December) precipitation
dPdjf – change in winter (December, January, February) precipitation
dPjja – change in summer (June, July, August) precipitation
dPmam – change in spring (March, April, May) precipitation
dPson – change in autumn (September, October, November) precipitation

dTann – change in annual (January to December) temperature
dTdjf – change in winter (December, January, February) temperature
dTjja – change in summer (June, July, August) temperature
dTmam – change in spring (March, April, May) temperature
dTson – change in autumn (September, October, November) temperature

dswe – change in snowfall water amount, October to March
dFireCen – changes in numbers of fires per century
dVegCen – changes in vegetation per century
sno – snow index, the range between rain dominated and snow dominated
t1 – temperature at 1m ground depth

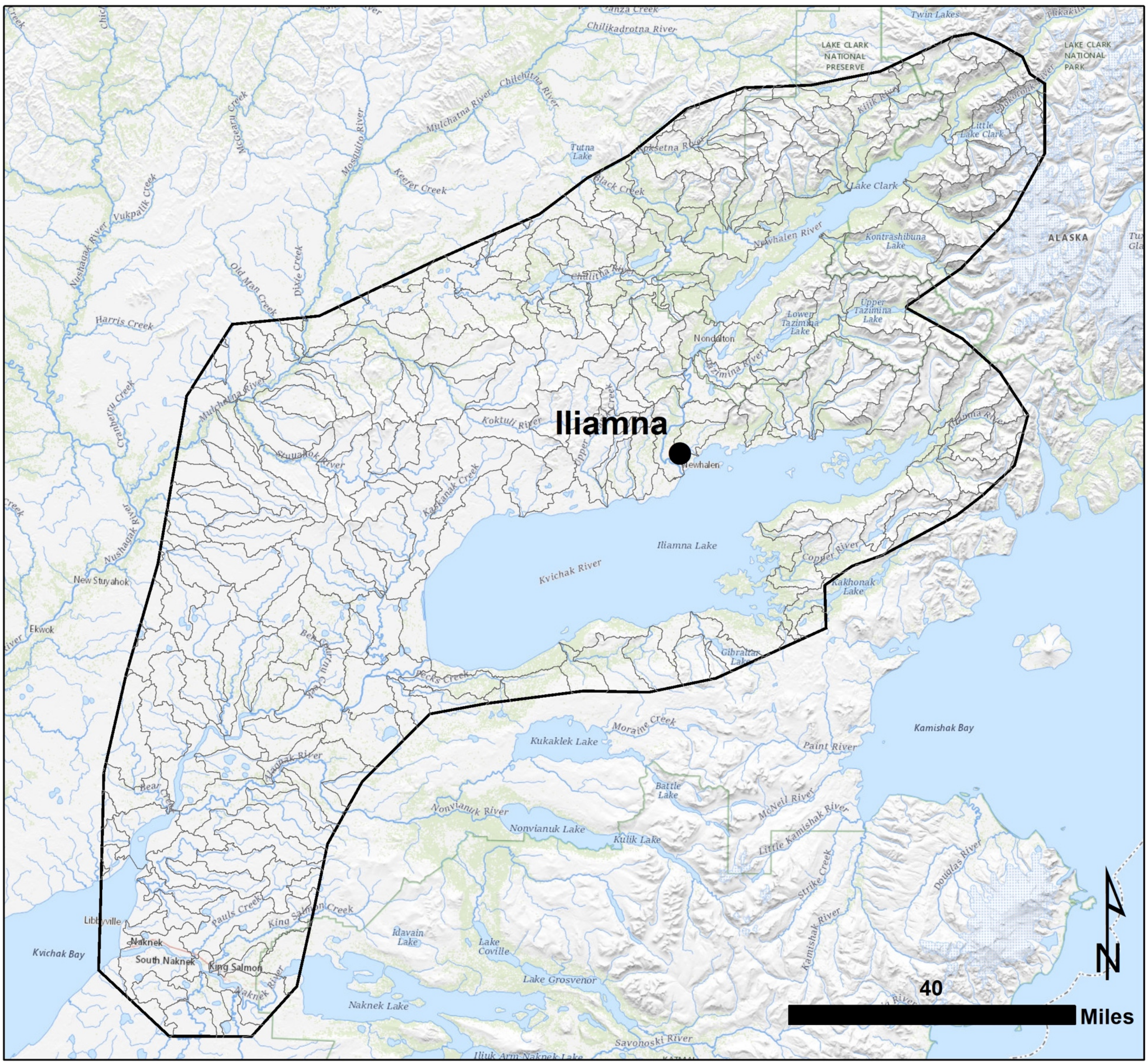
5045 – 2050s (2050-2069), RCP 4.5 (mid century, medium emissions)
5085 – 2050s (2040-2069), RCP 8.5 (mid century, higher emissions)
8045 – 2080s (2050-2069), RCP 4.5 (late century, medium emissions)
8085 – 2080s (2040-2069), RCP 8.5 (late century, higher emissions)

CCMA and ECHAM5 refer to climate models used in permafrost work. CGCM3, GFDL CM3, GISS E2R, IPSL CM5A LR, and CCSM4 refer to climate models used in the projections of temperature, precipitation, and snow. CGCM3 and CCSM4 are used in the vegetation and fire projections.

Iliamna region and watershed boundaries

Iliamna region outlined includes the areas defined by community workshop participants as important. The many lines within the region show watershed boundaries (called hydrologic units or HUC12s). Many of the following maps show average conditions for climate change and its effects within each watershed.

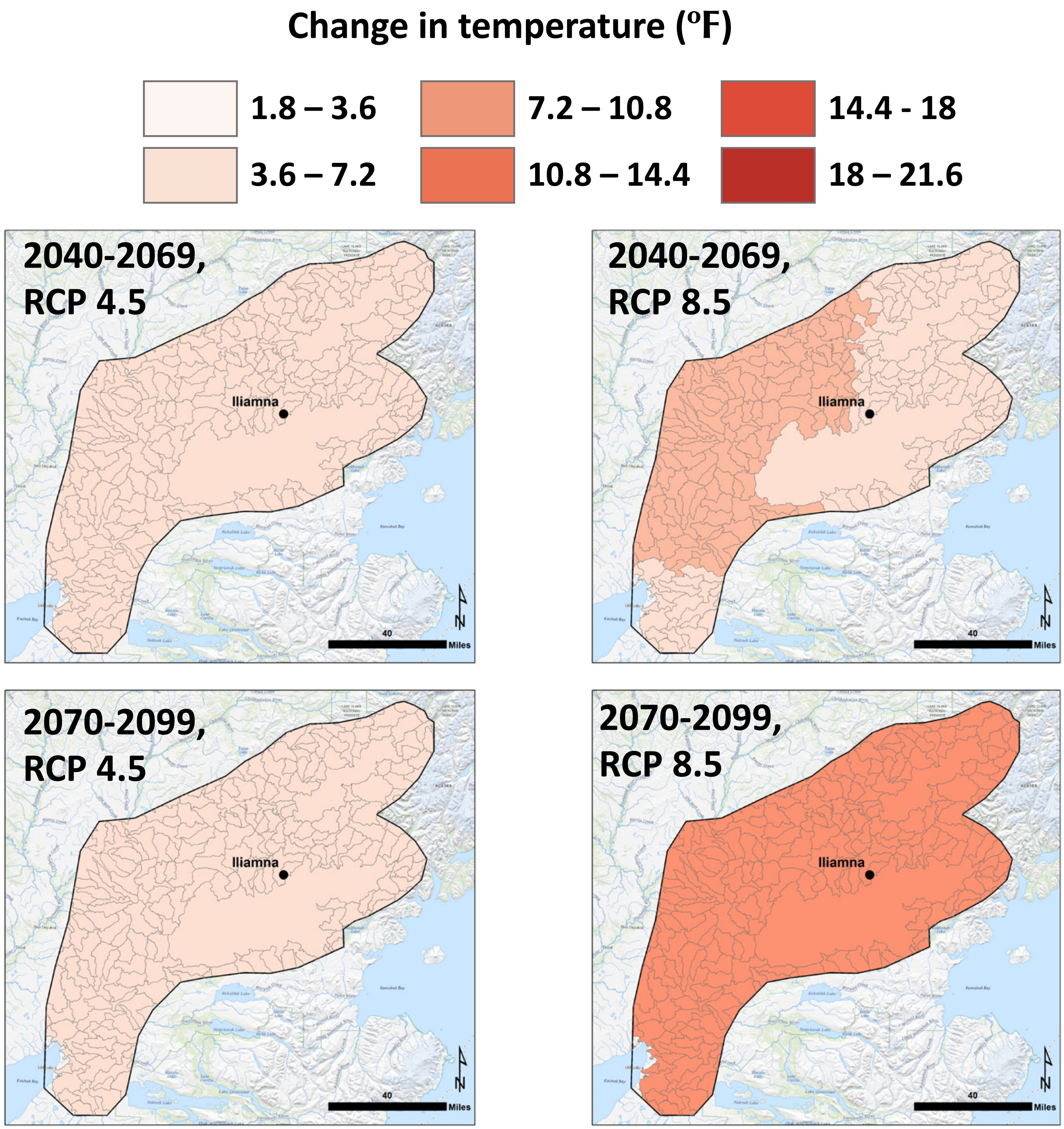
Background map: United States Geological Survey National Map



Annual temperature change, relative to 1970 - 1999

Annual temperature is projected to increase under all scenarios:

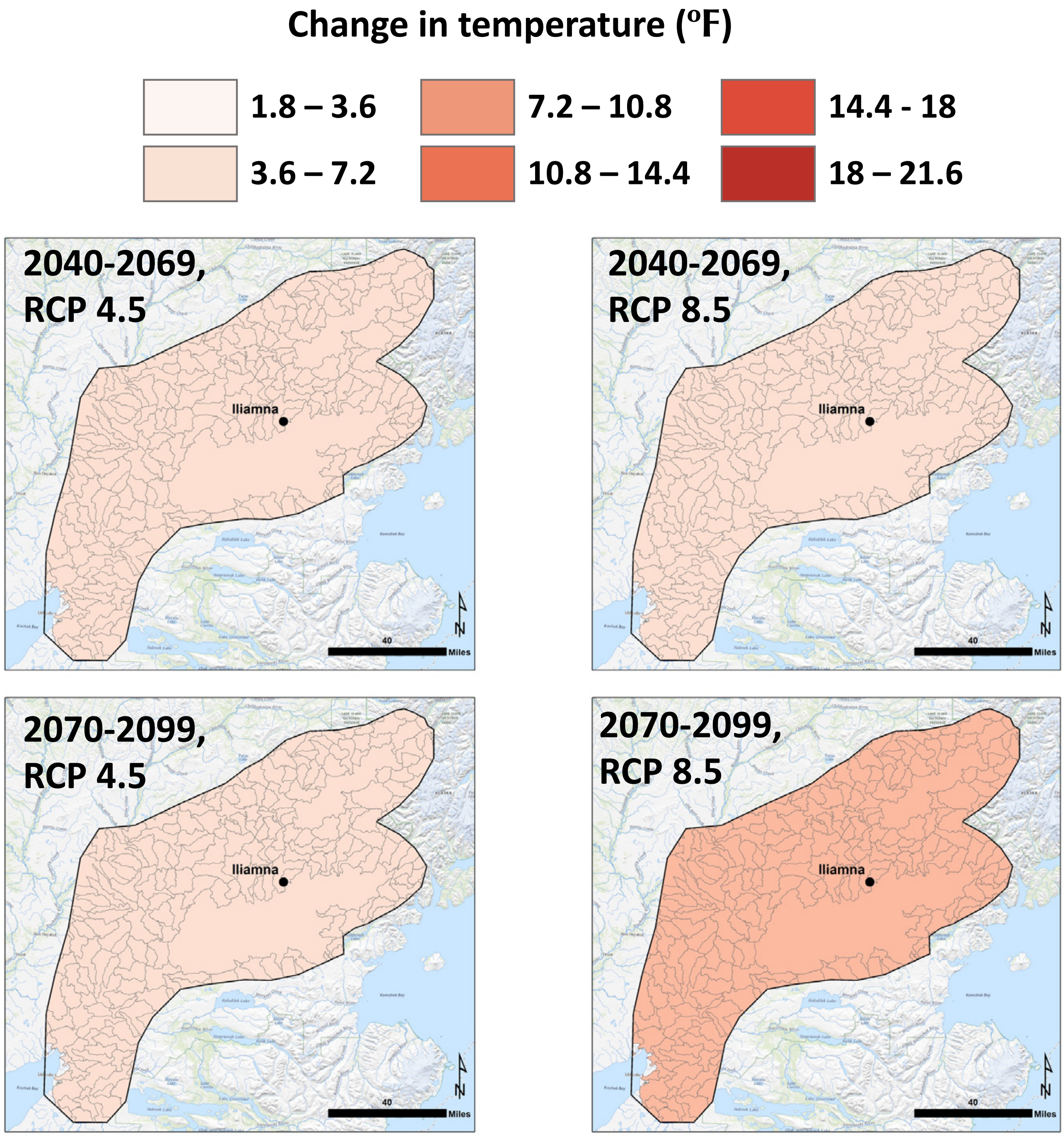
+ 5.5 °F (2050s, RCP 4.5)
+ 7.2 °F (2050s, RCP 8.5)
+ 7.0 °F (2080s, RCP 4.5)
+ 10.5 °F (2080s, RCP 8.5)



Spring (Mar - May) temperature change, relative to 1970 - 1999

Spring temperature is projected to increase under all scenarios:

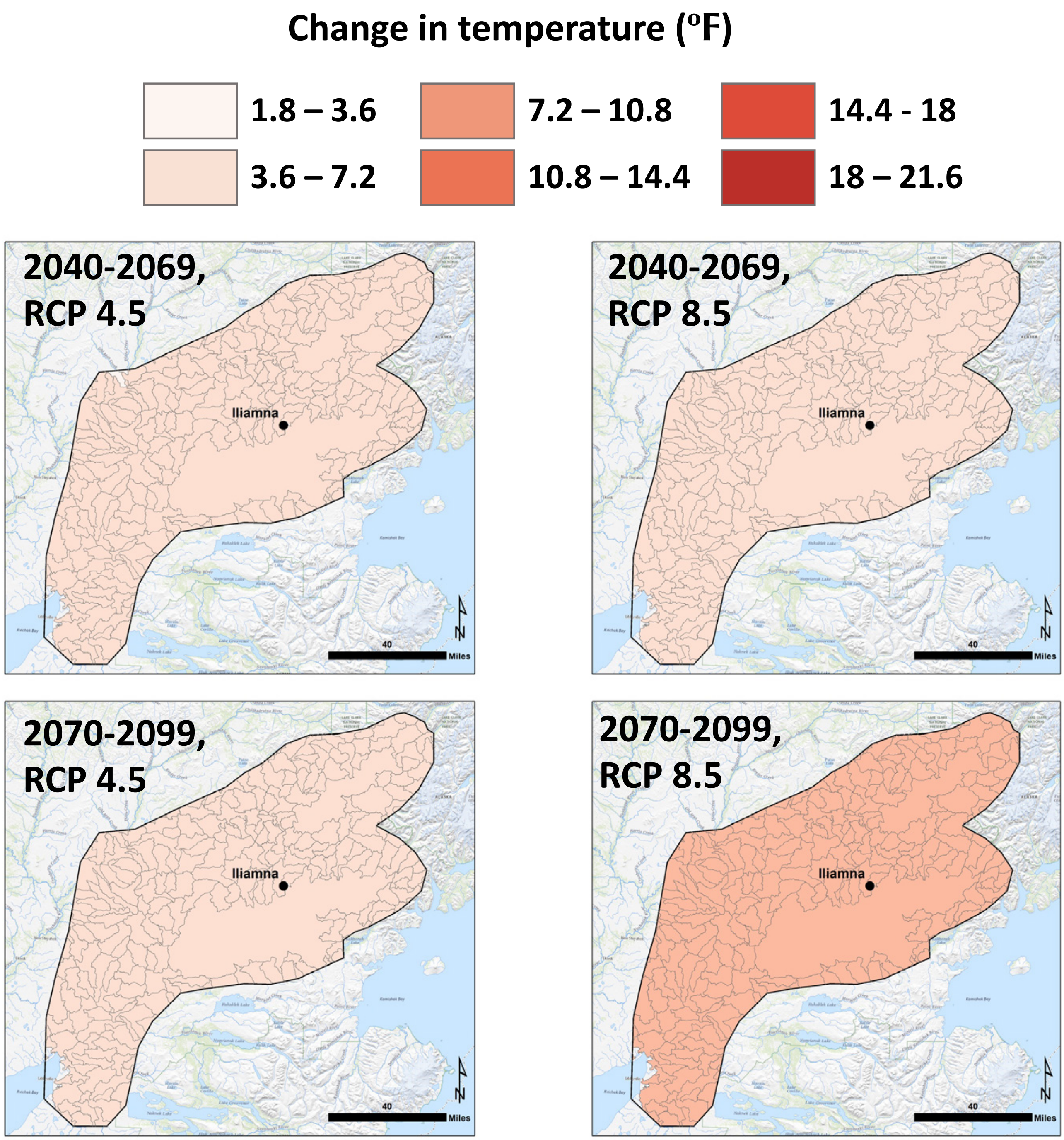
+ 4.9 °F (2050s, RCP 4.5)
+ 6.4 °F (2050s, RCP 8.5)
+ 6.0 °F (2080s, RCP 4.5)
+ 9.1 °F (2080s, RCP 8.5)



Summer (June - Aug) temperature change, relative to 1970 - 1999

Summer temperature is projected to increase under all scenarios:

+ 3.8 °F (2050s, RCP 4.5)
+ 5.0 °F (2050s, RCP 8.5)
+ 5.0 °F (2080s, RCP 4.5)
+ 8.1 °F (2080s, RCP 8.5)



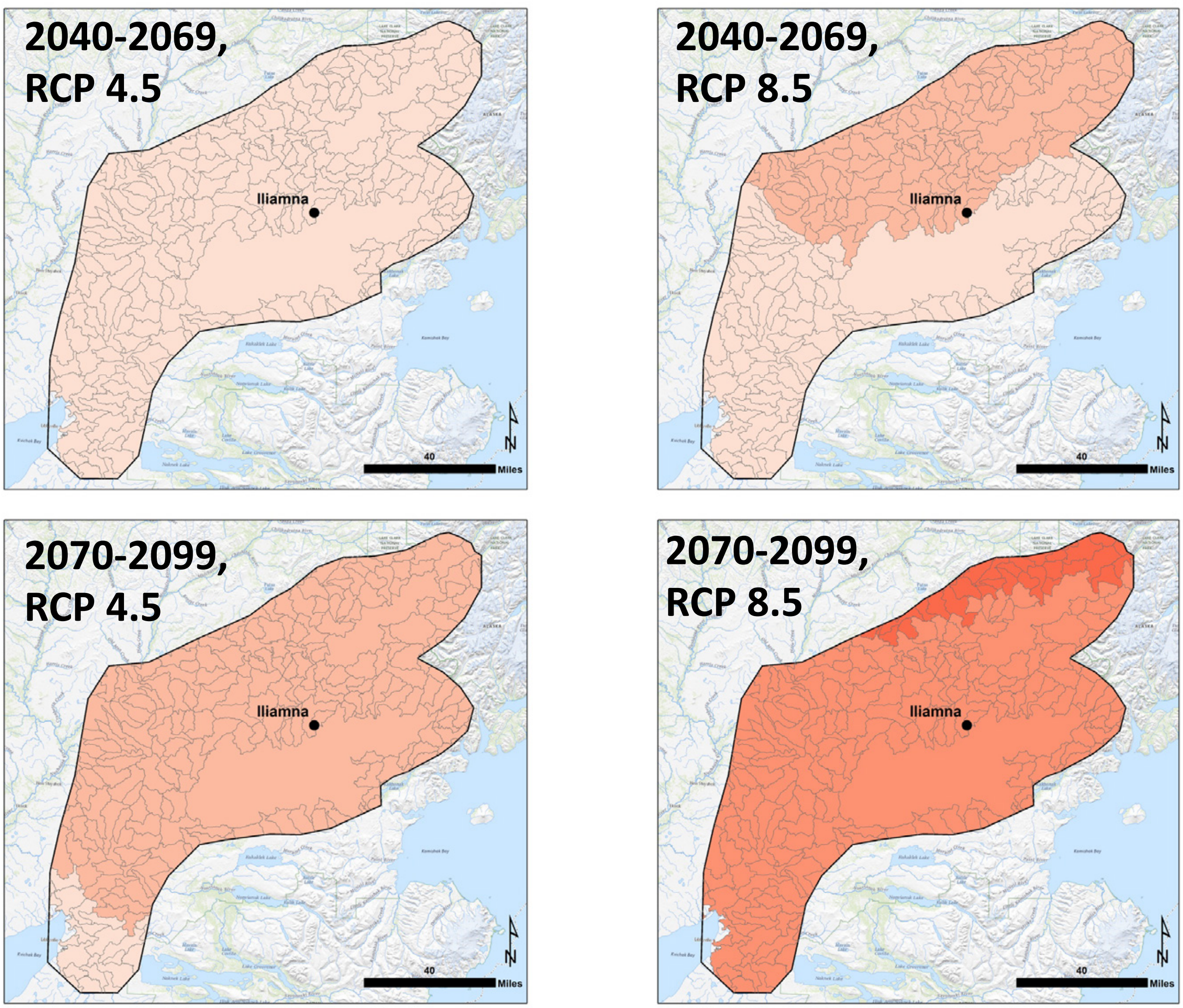
Autumn (Sep - Nov) temperature change, relative to 1970 - 1999

Autumn temperature is projected to increase under all scenarios:

+ 5.8 °F (2050s, RCP 4.5)
+ 7.2 °F (2050s, RCP 8.5)
+ 7.4 °F (2080s, RCP 4.5)
+ 10.6 °F (2080s, RCP 8.5)

Change in temperature (°F)

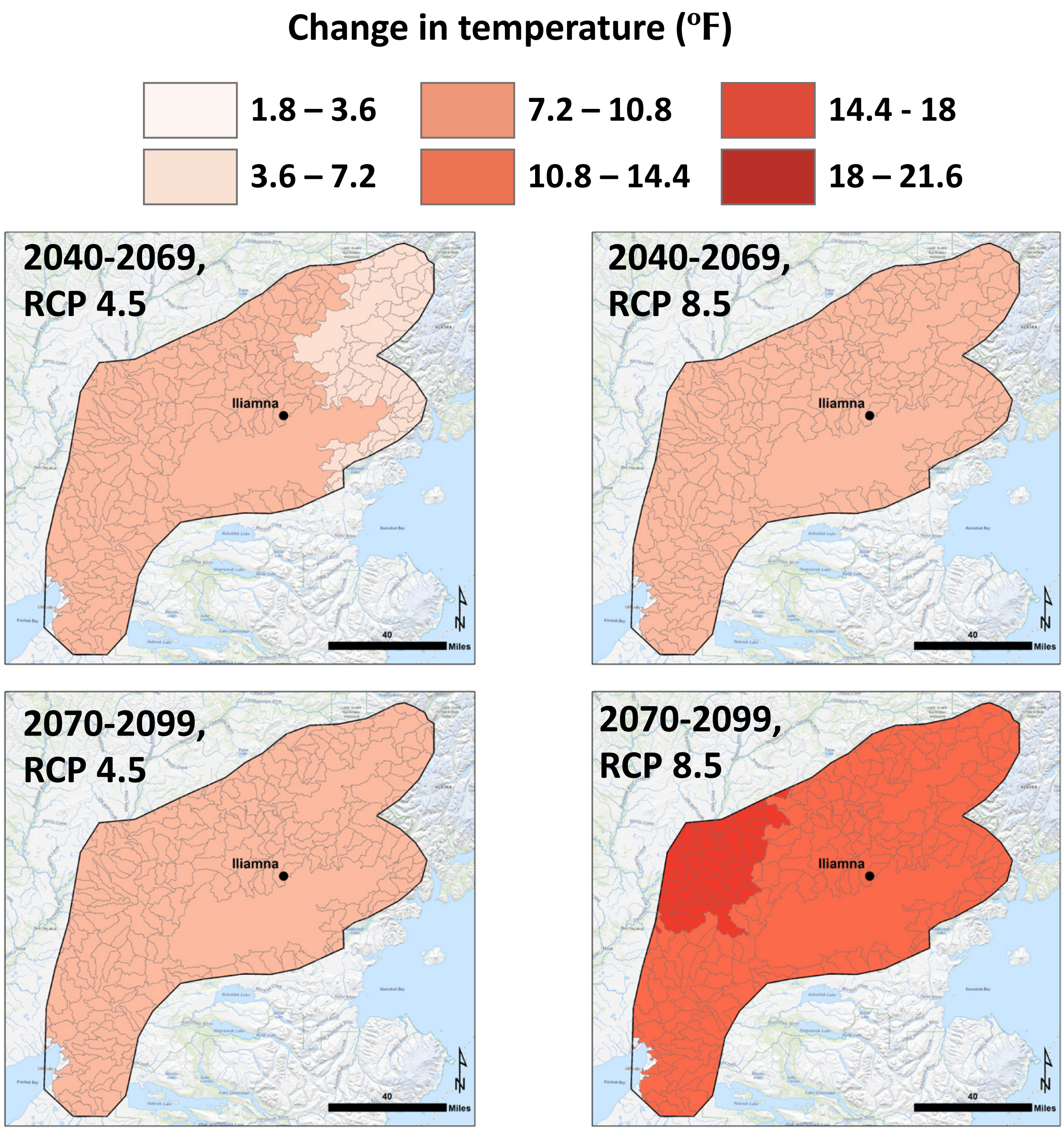
1.8 – 3.6
3.6 – 7.2
7.2 – 10.8
10.8 – 14.4
14.4 - 18
18 – 21.6



Winter (Dec - Feb) temperature change, relative to 1970 - 1999

Winter temperature is projected to increase under all scenarios:

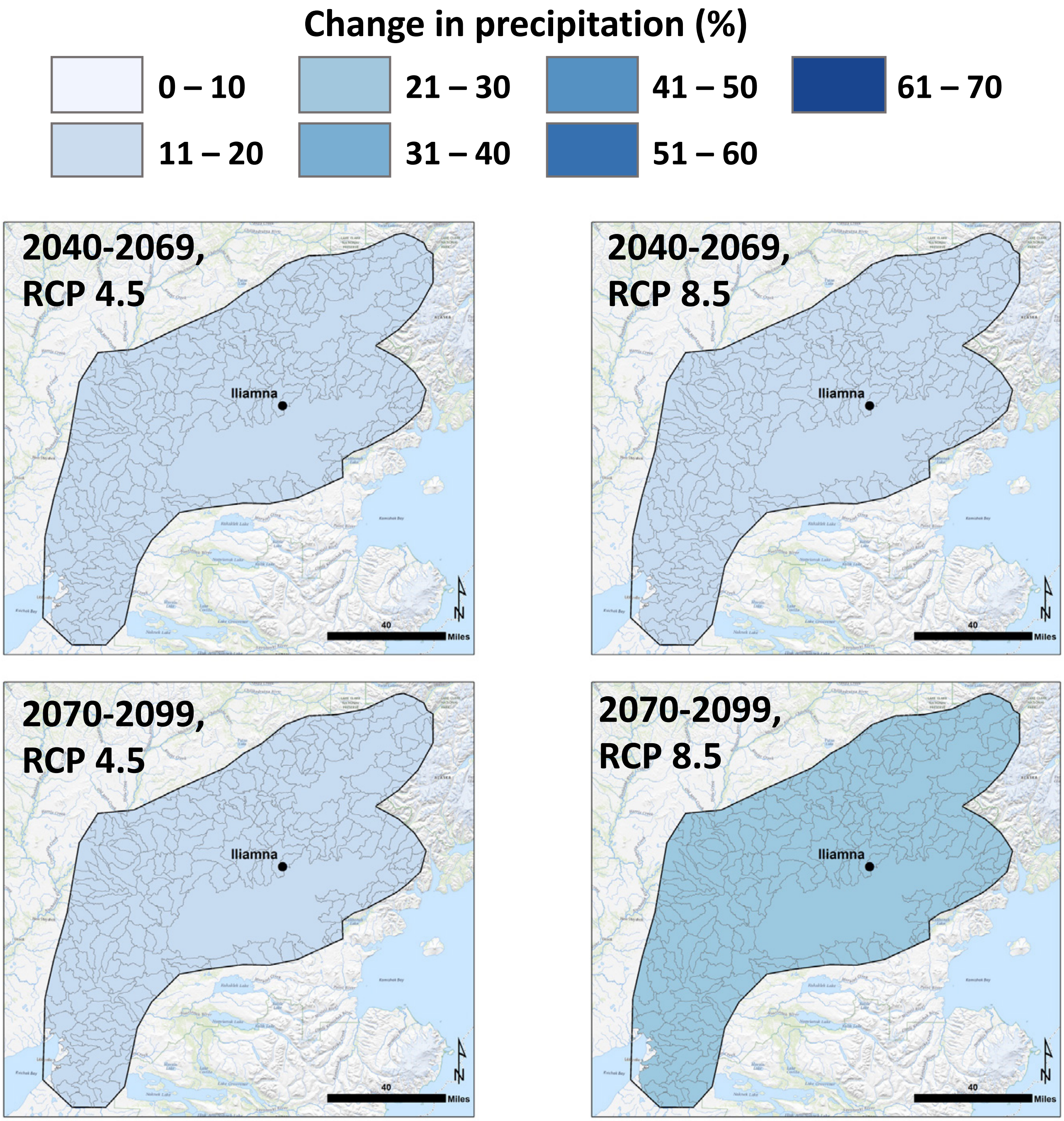
+ 7.4 °F (2050s, RCP 4.5)
+ 9.9 °F (2050s, RCP 8.5)
+ 9.4 °F (2080s, RCP 4.5)
+ 13.9 °F (2080s, RCP 8.5)



Annual precipitation change, relative to 1970 - 1999

Annual precipitation is projected to increase under all scenarios:

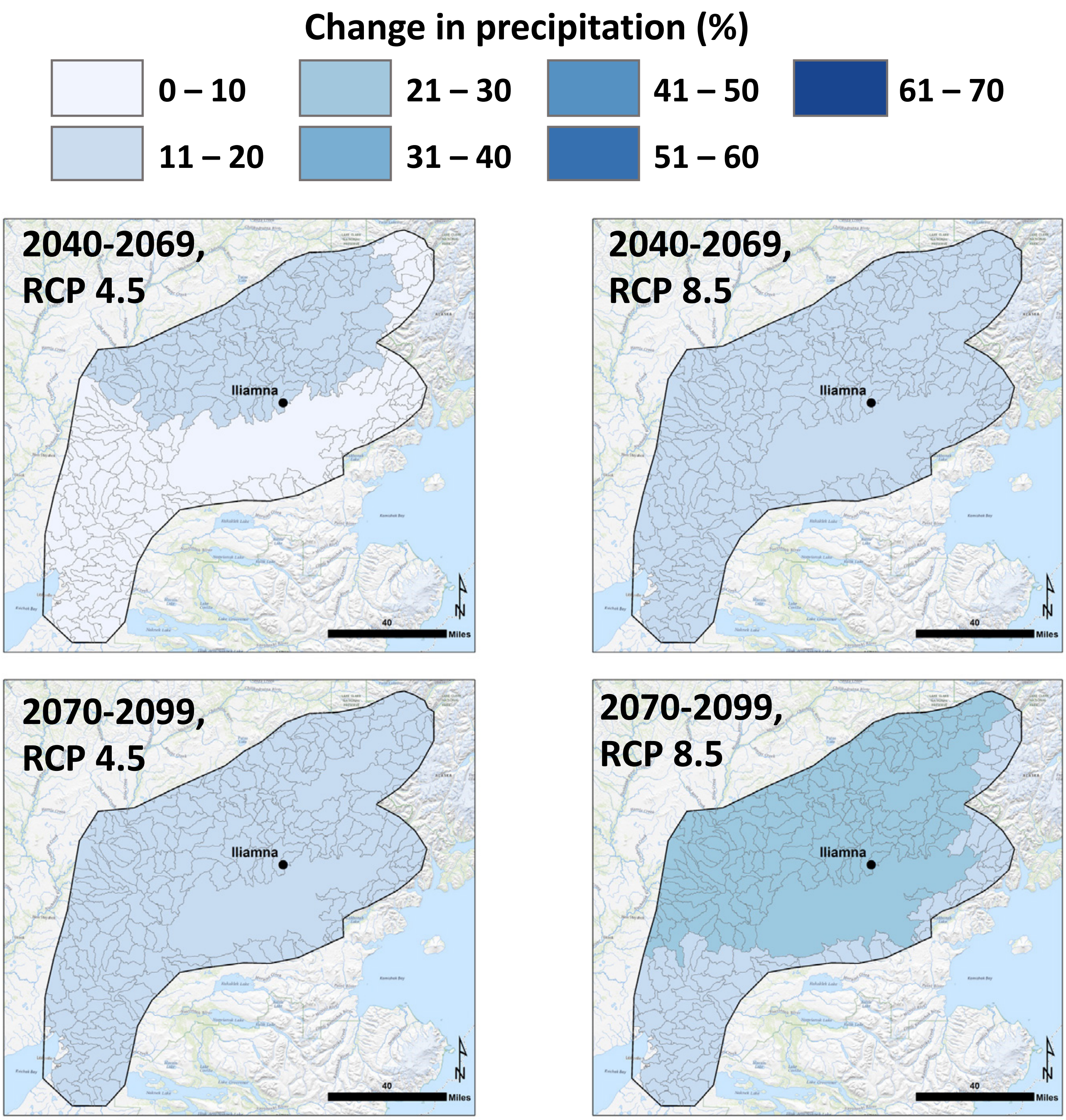
+ 14 % (2050s, RCP 4.5)
+ 16 % (2050s, RCP 8.5)
+ 17 % (2080s, RCP 4.5)
+ 26 % (2080s, RCP 8.5)



Spring (Mar - May) precipitation change, relative to 1970 - 1999

Spring precipitation is projected to increase under all scenarios, with slightly larger increases in the northern part of the region:

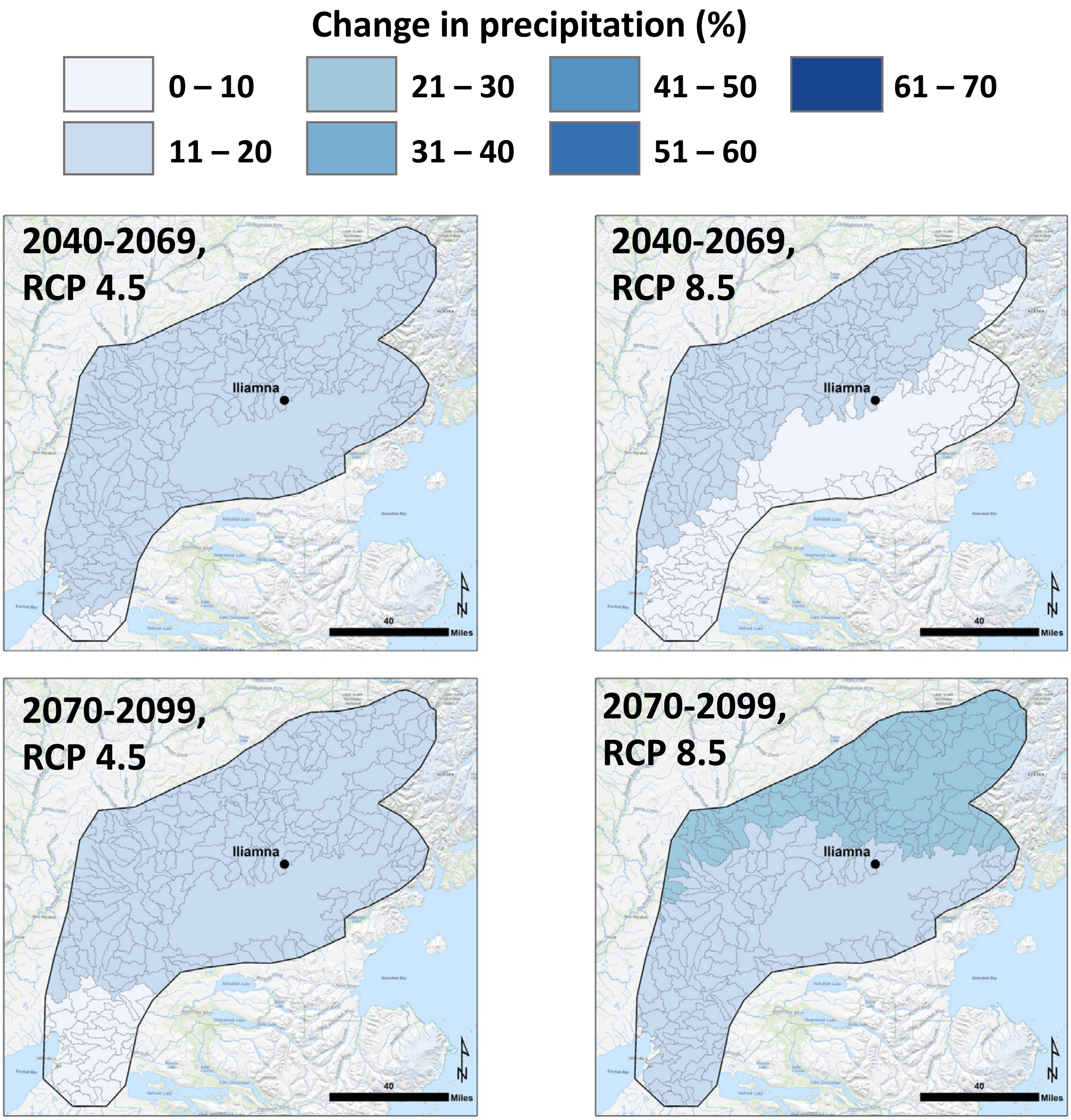
+ 10 % (2050s, RCP 4.5)
+ 16 % (2050s, RCP 8.5)
+ 15 % (2080s, RCP 4.5)
+ 21 % (2080s, RCP 8.5)



Summer (June - Aug) precipitation change, relative to 1970 - 1999

Summer precipitation is projected to increase under all scenarios, with slightly larger increases in the northern part of the region:

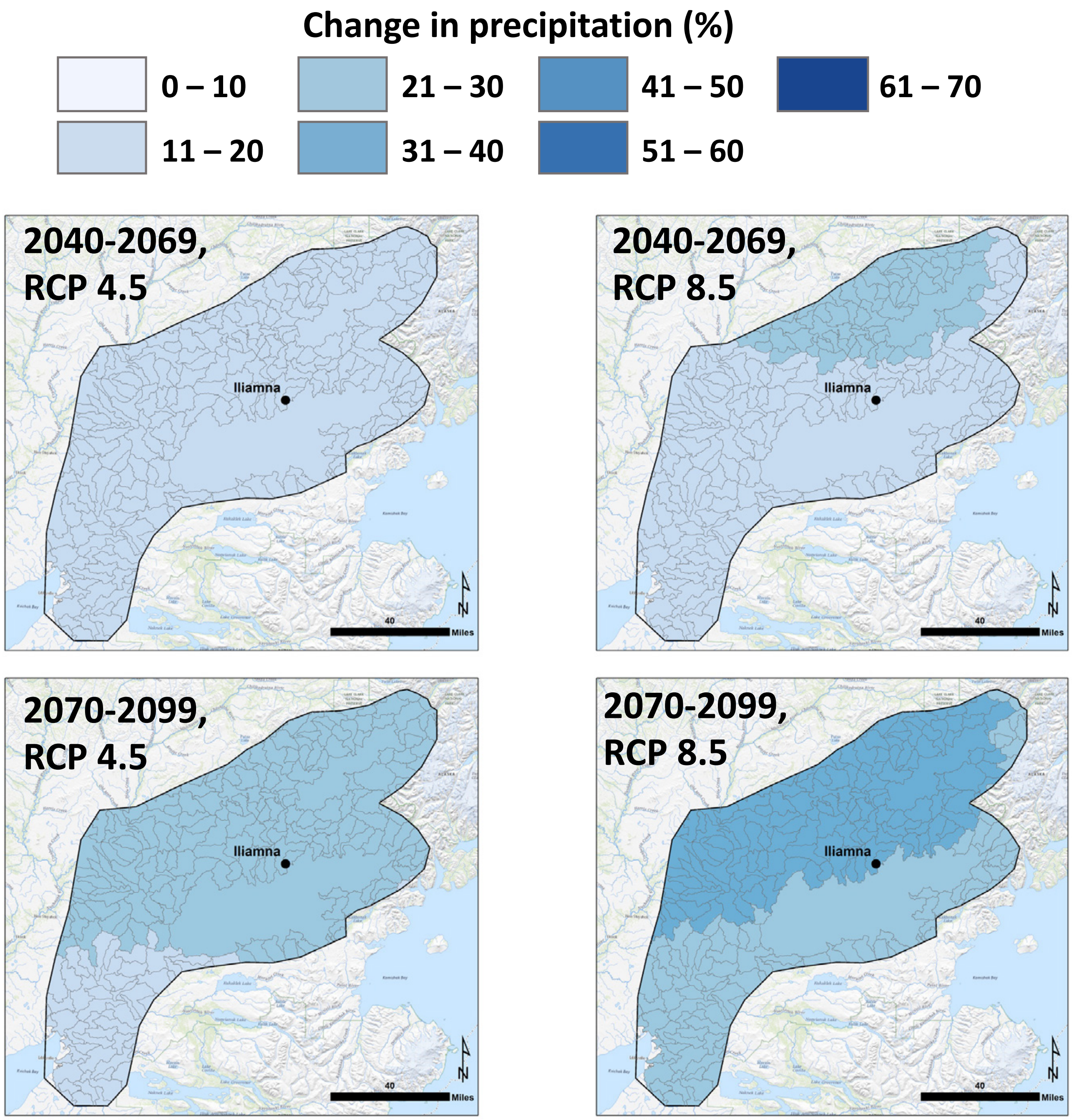
+ 13 % (2050s, RCP 4.5)
+ 10 % (2050s, RCP 8.5)
+ 12 % (2080s, RCP 4.5)
+ 20 % (2080s, RCP 8.5)



Autumn (Sep - Nov) precipitation change, relative to 1970 - 1999

Autumn precipitation is projected to increase under all scenarios, with slightly larger increases in the northern part of the region:

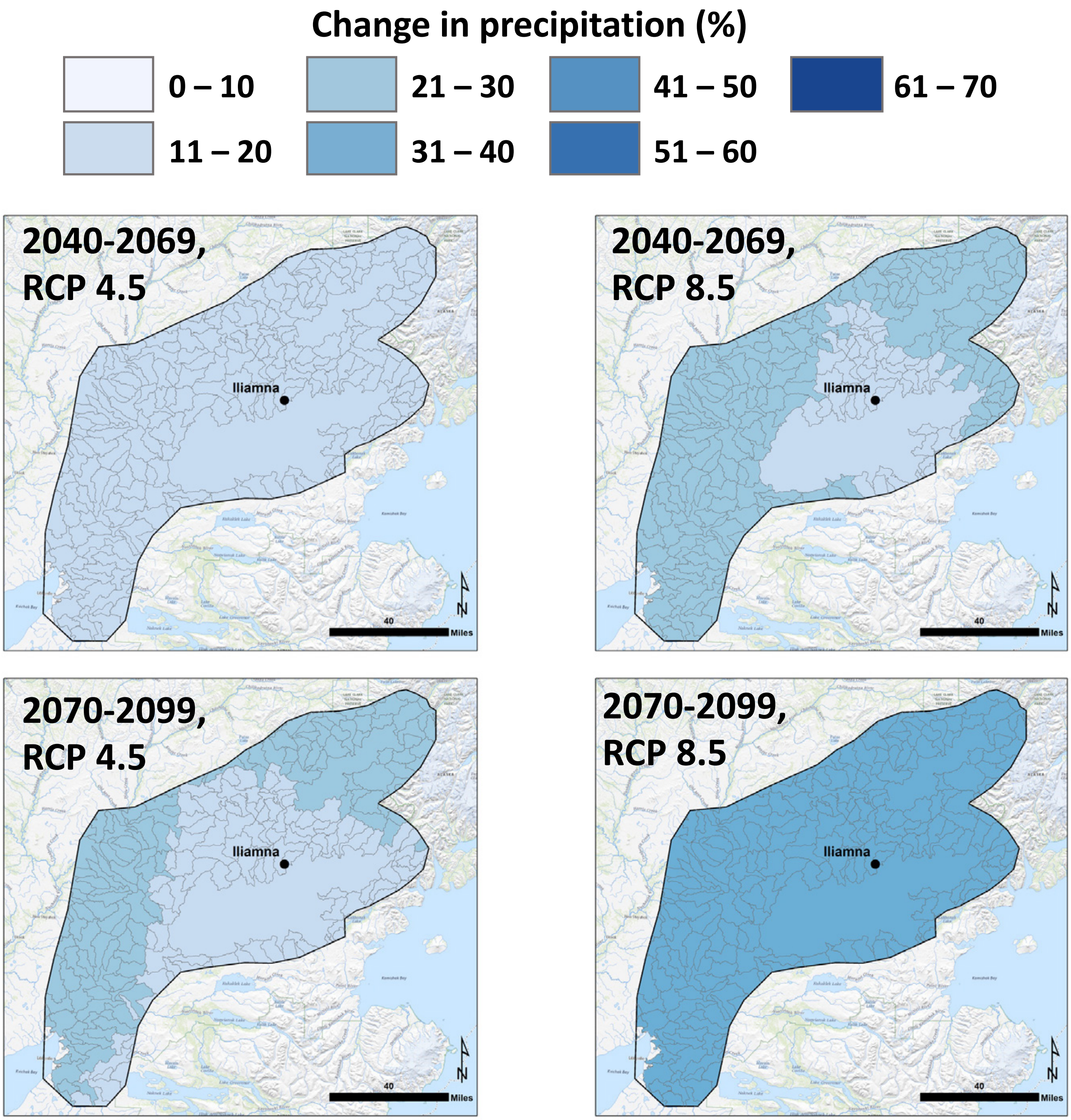
+ 15 % (2050s, RCP 4.5)
+ 19 % (2050s, RCP 8.5)
+ 21 % (2080s, RCP 4.5)
+ 30 % (2080s, RCP 8.5)



Winter (Dec - Feb) precipitation change, relative to 1970 - 1999

Winter precipitation is projected to increase under all scenarios, with slightly larger increases in the northern part of the region:

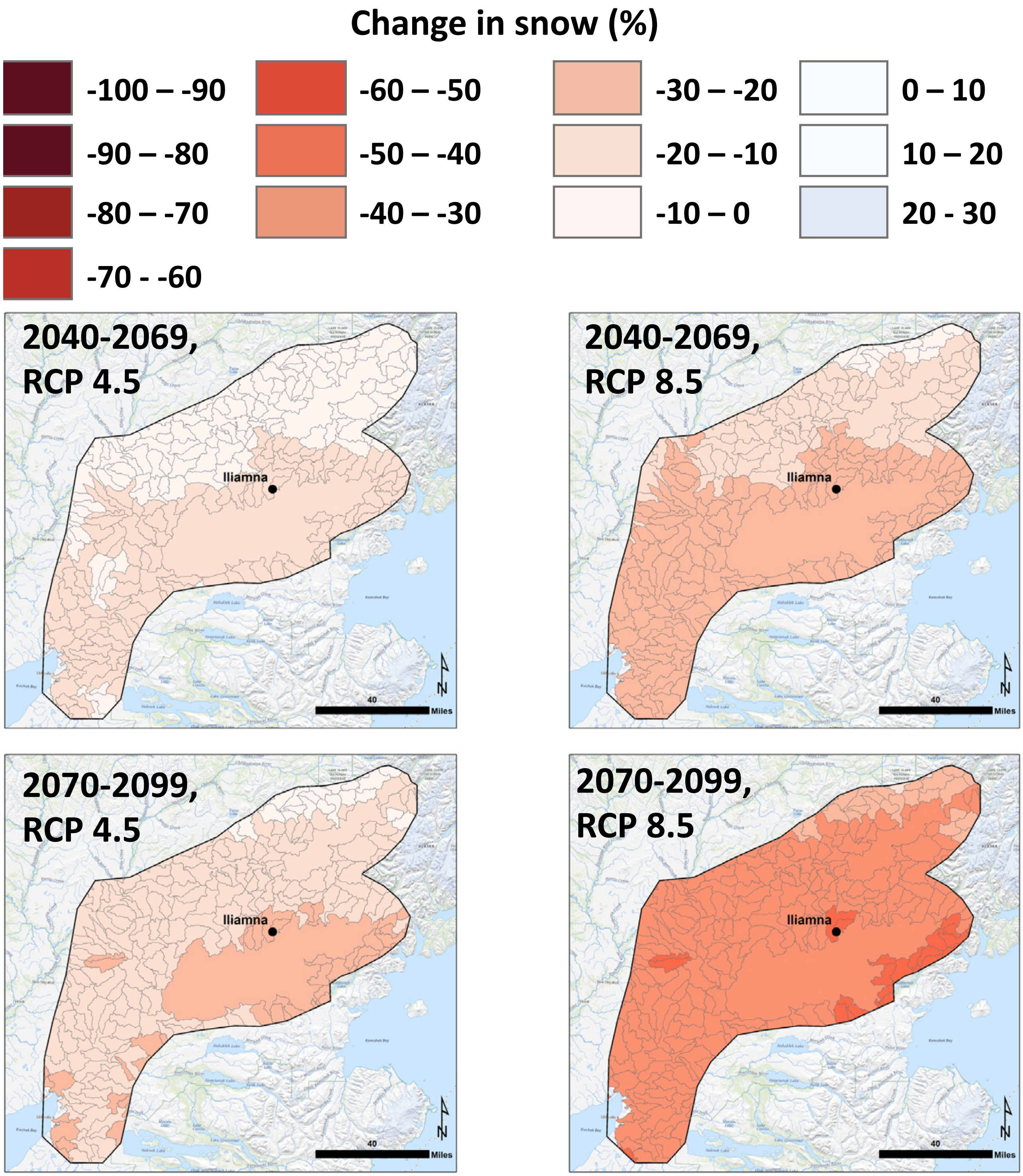
+ 17 % (2050s, RCP 4.5)
+ 21 % (2050s, RCP 8.5)
+ 20 % (2080s, RCP 4.5)
+ 35 % (2080s, RCP 8.5)



Snowfall water equivalent (snowfall) change in October to March, relative to 1970 - 1999

This is the change in the amount of snow that falls.

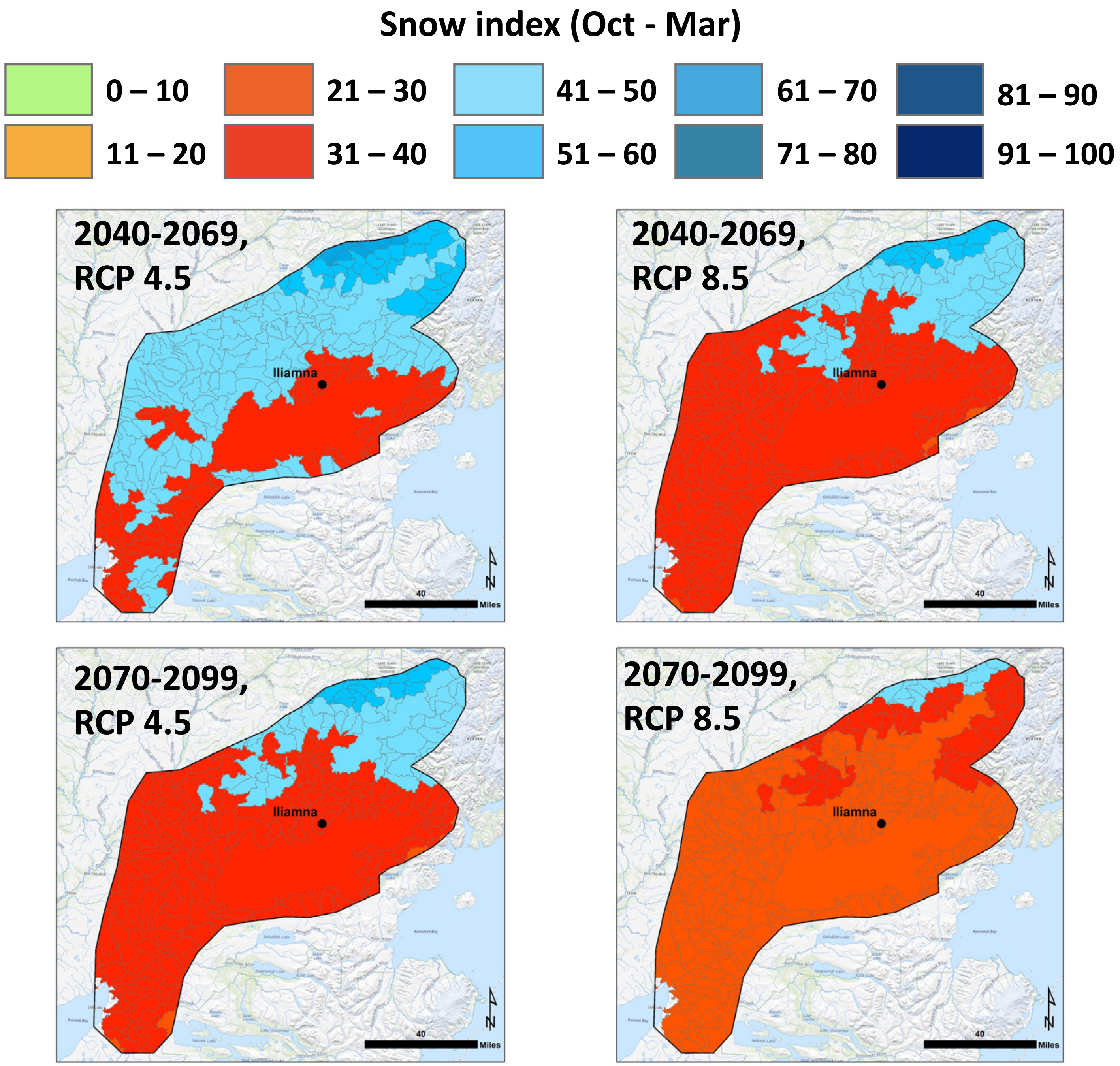
-20 % (2050s, RCP 4.5)
-31 % (2050s, RCP 8.5)
-27 % (2080s, RCP 4.5)
-46 % (2080s, RCP 8.5)



Snow index, October to March % of precipitation in April 1 snow, relative to 1970 - 1999

This is a measure of how snow-dominated the climate is. Blues indicate snow dominated, reds and oranges are in between snow dominated and rain dominated. Greens represent rain dominated. Iliamna was historically snow dominated. Under all scenarios, the area that is snow dominated decreases, and the region is projected to become entirely transitional, or in between, by the end of the 21st century.

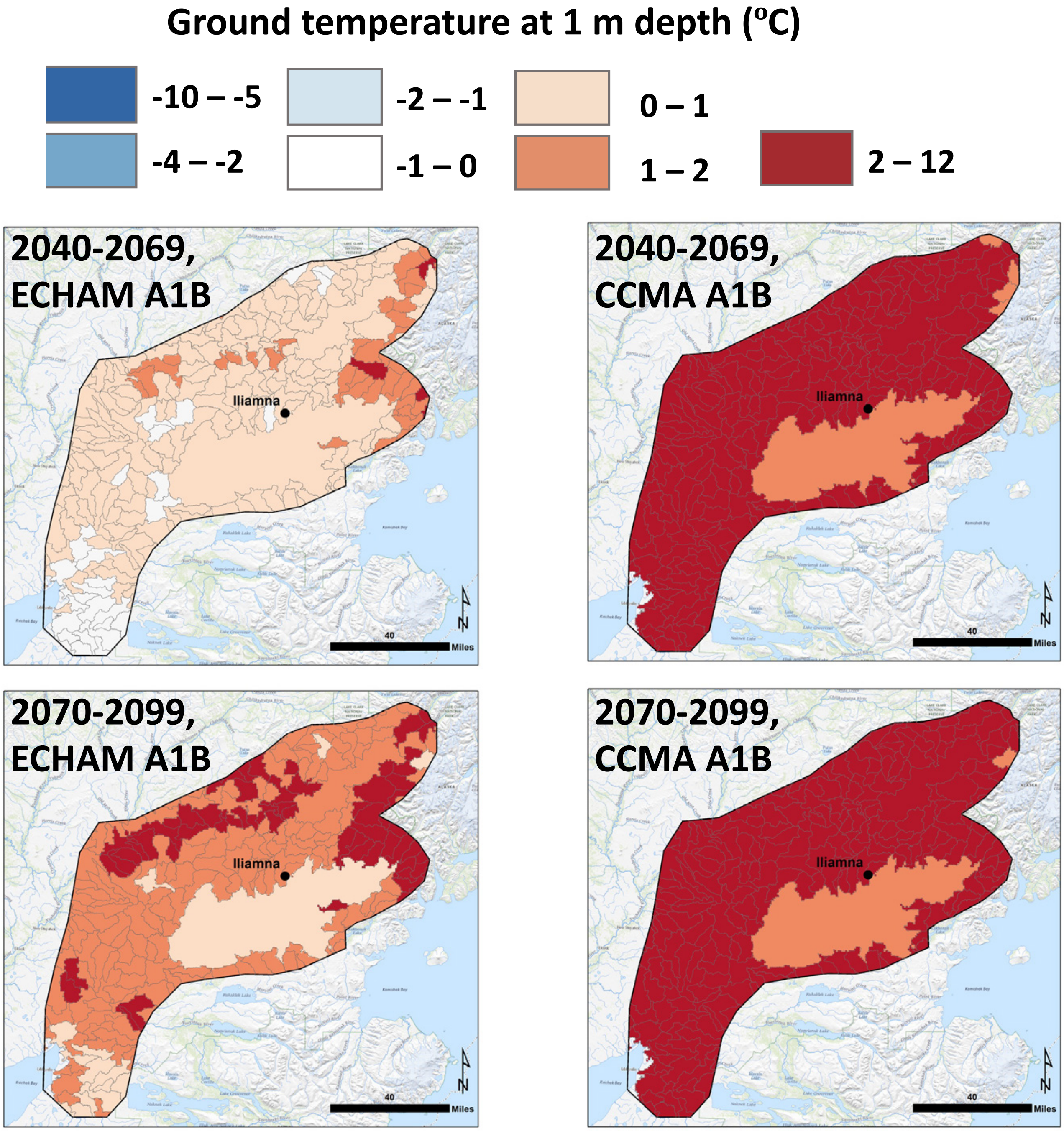
43% (2050s, RCP 4.5)
37% (2050s, RCP 8.5)
37% (2080s, RCP 4.5)
27% (2080s, RCP 8.5)



Annual average ground temperature at 1m (3.3ft) deep

This is an index of how likely permafrost is to remain under climate change. Once annual average temperatures in the ground rise above freezing (0°C) permafrost thaw likely increases. Some small areas of permafrost might persist until the 2050s under the ECHAM model, but decrease under all others.

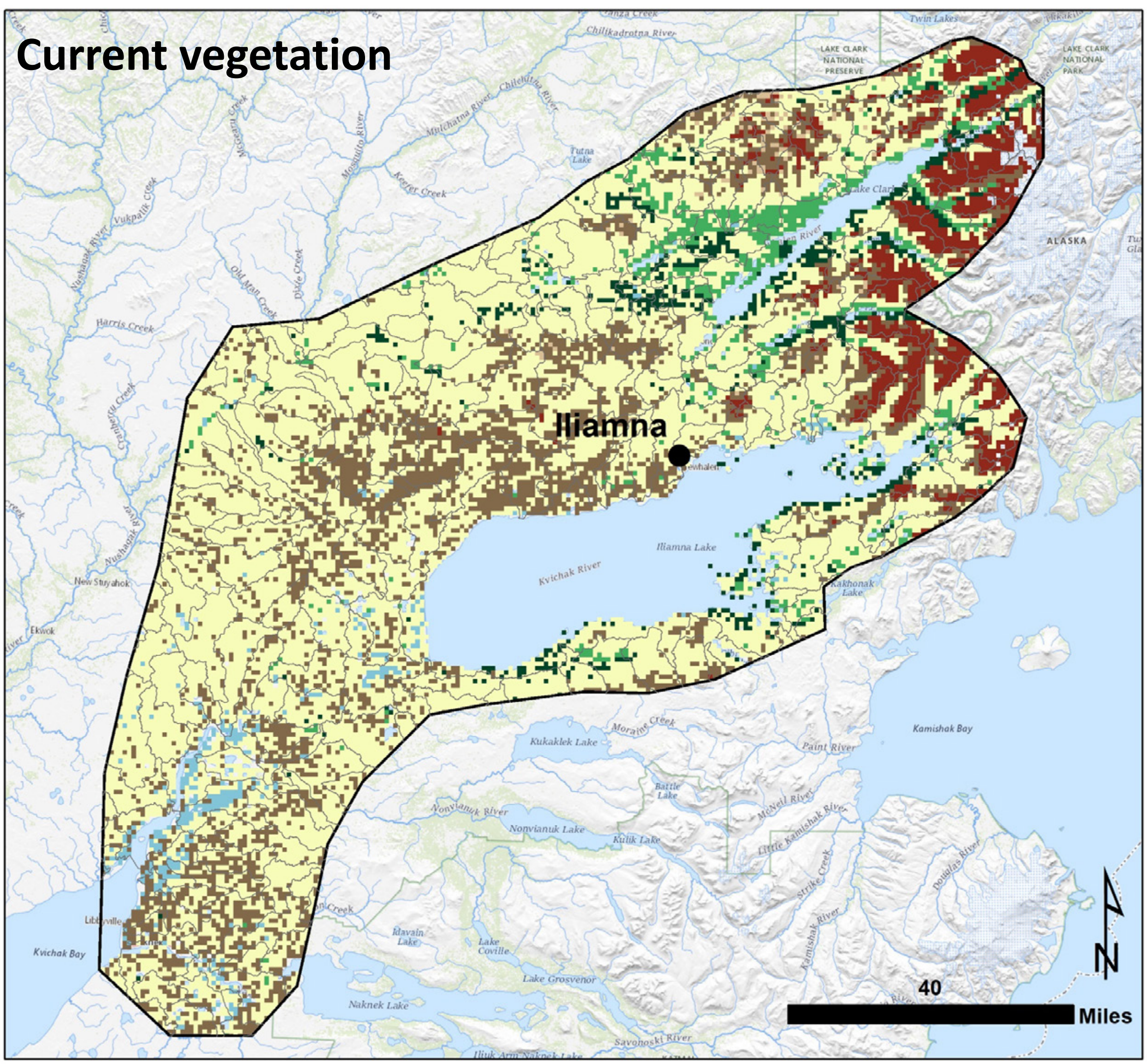
0.6°C, 33°F (2050s, ECHAM A1B)
4.6°C, 40°F (2050s, CCMA A1B)
1.7°C, 35°F (2080s, ECHAM A1B)
5.4°C, 42°F (2080s, CCMA A1B)



Current vegetation

Deciduous forest is birch, aspen, willow, cottonwood and/or alder.

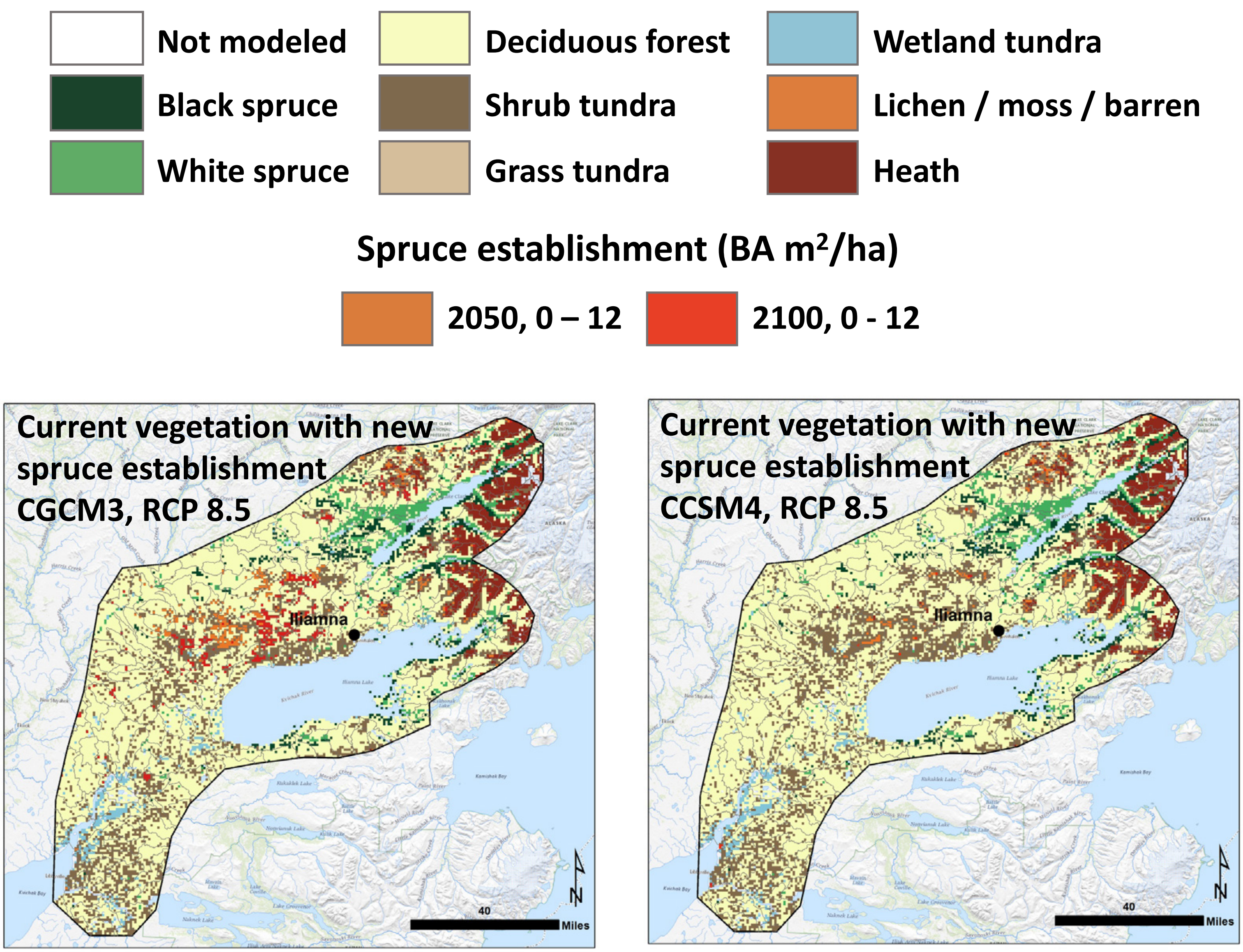
- Not modeled
- Black spruce
- White spruce
- Deciduous forest
- Shrub tundra
- Grass tundra
- Wetland tundra
- Lichen / moss / barren
- Heath
- Maritime upland forest
- Maritime forested wetland
- Maritime fen
- Maritime alder shrubland



Current vegetation with 2050 and 2100 spruce establishment

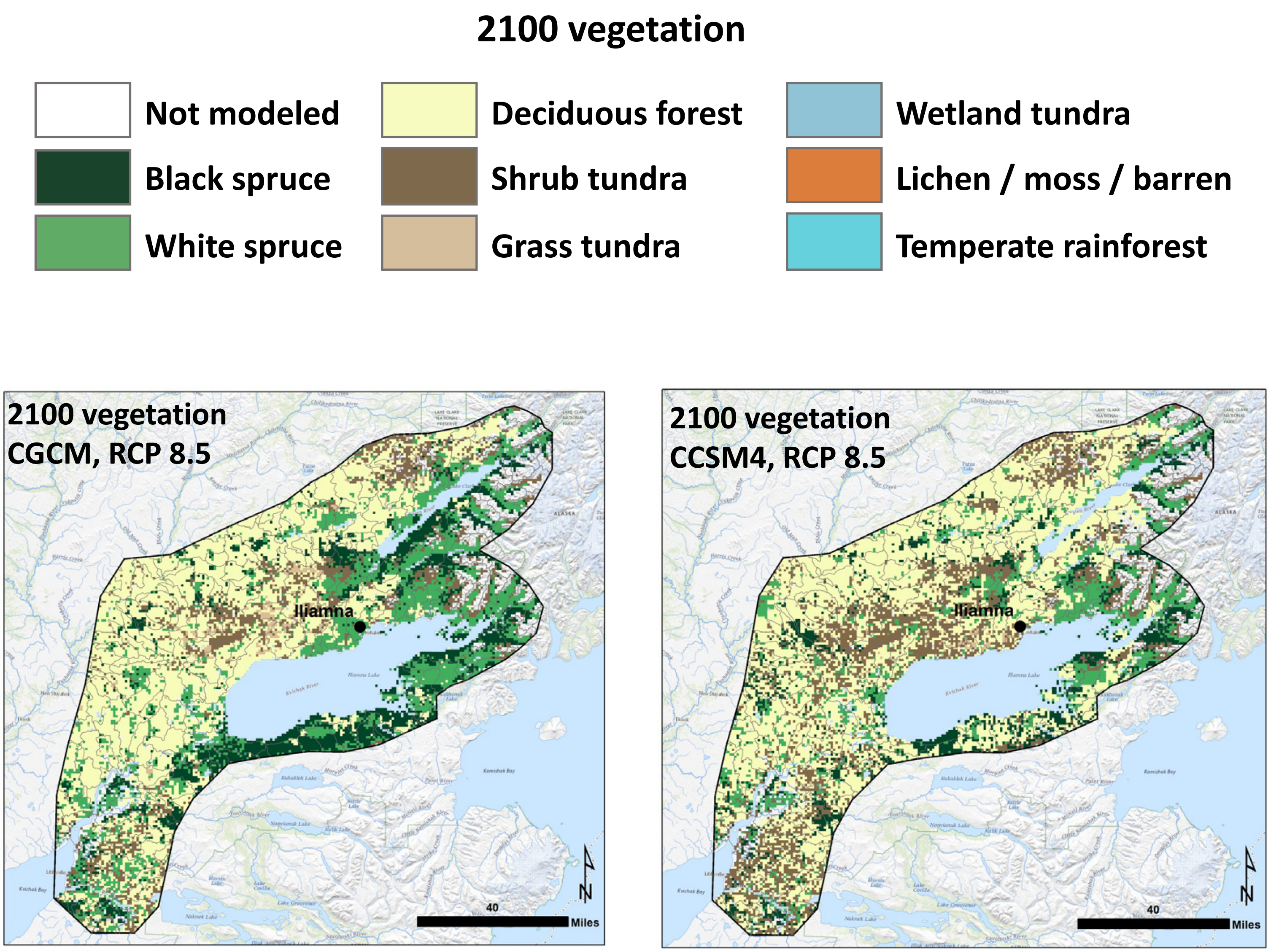
Areas (in red) to the west of Iliamna become favorable for spruce establishment, generally in what was historically shrub tundrya. More establishment is projected under the CGCM3 climate model than the CCSM4 climate model.

Current vegetation with 2050 and 2100 spruce establishment



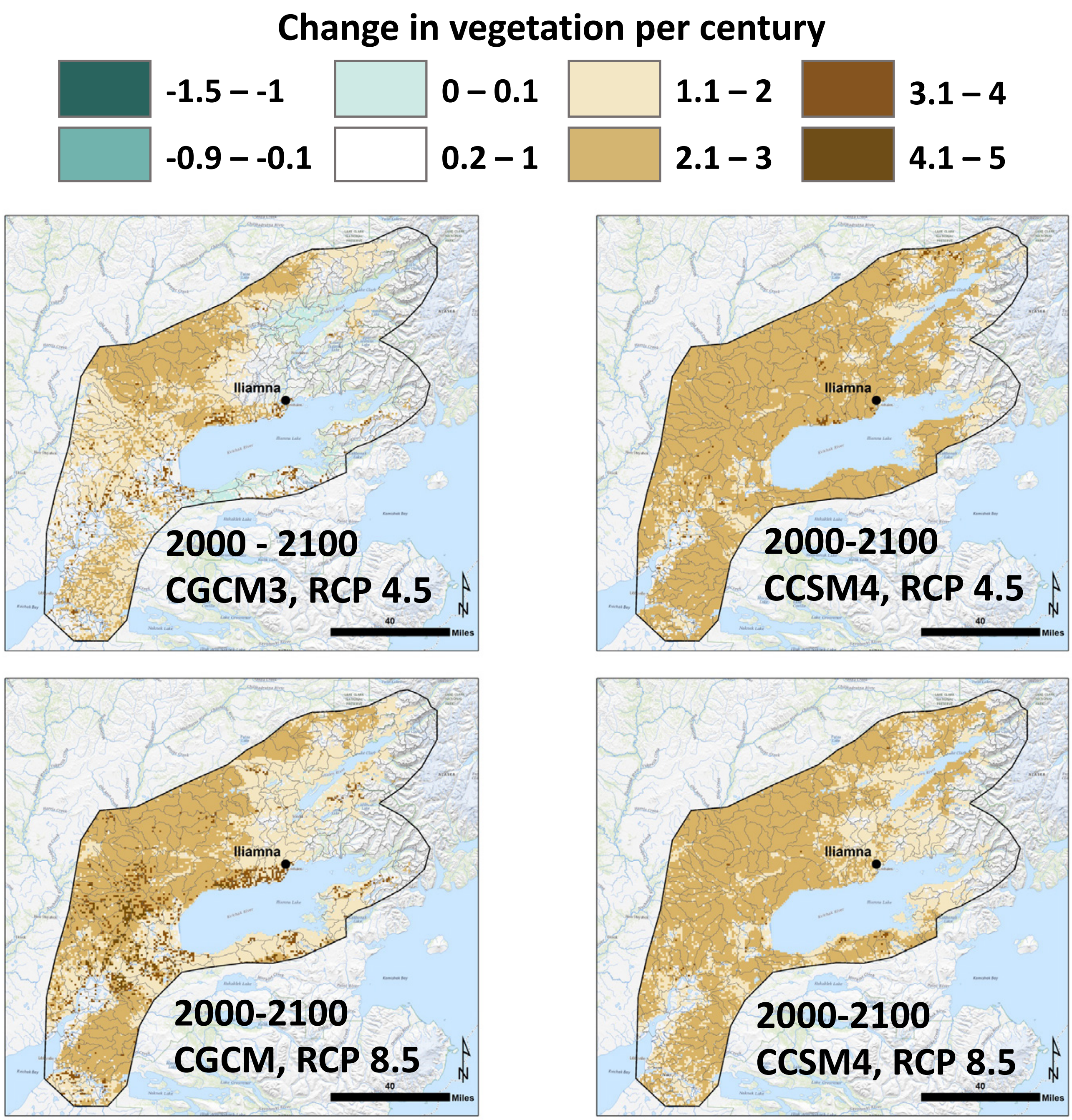
2100 vegetation

Future vegetation changes simulated by a vegetation model project spruce will establish to the east of Iliamna and south of Iliamna lake. More establishment is projected under the CGCM3 climate model than the CCSM4 climate model. In the north central part of the region, some shrub tundra and deciduous forest transitions to grass tundra. Former mountain tundra in the northeast part of the region also becomes spruce forest.



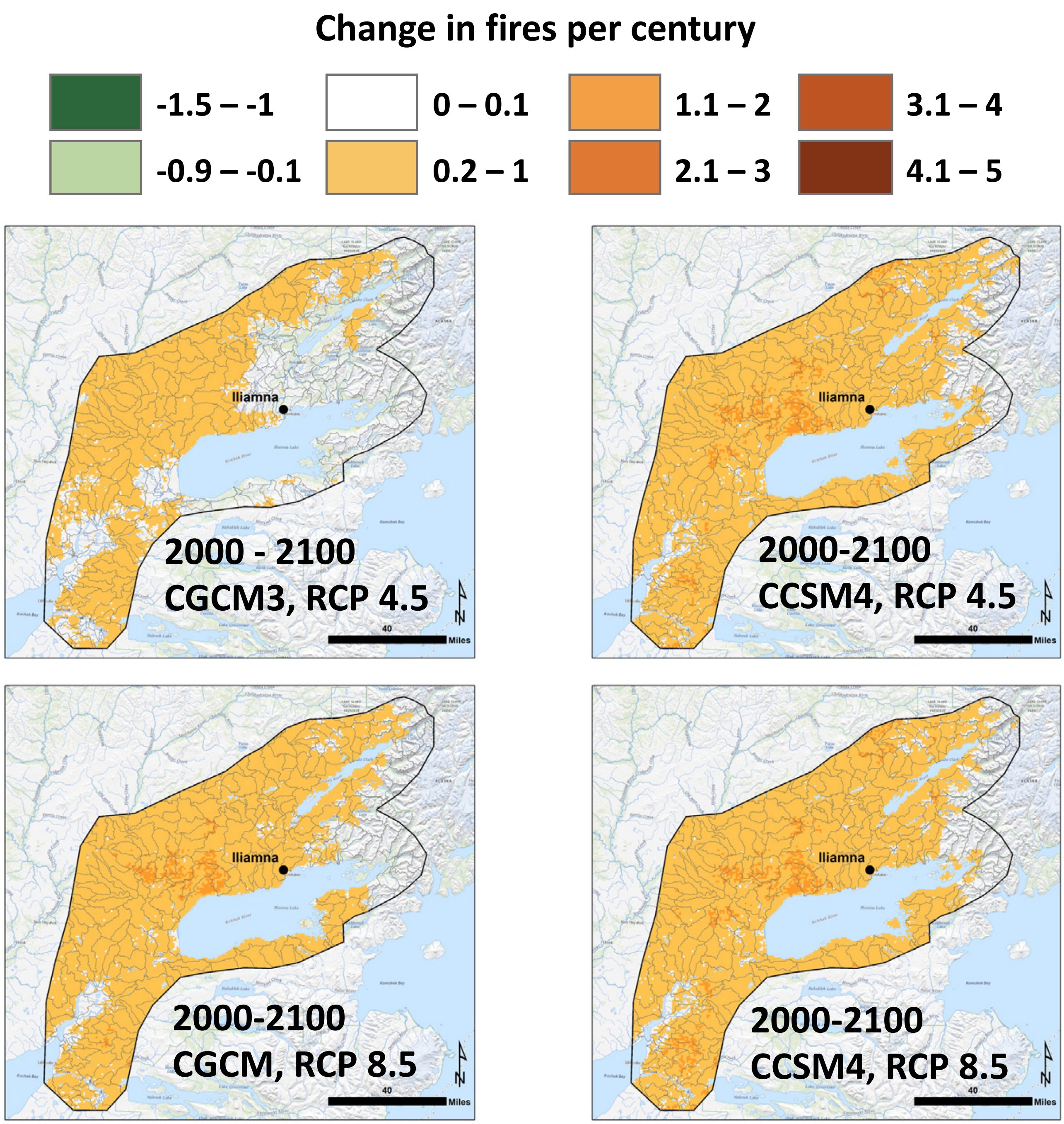
Change in vegetation per century, relative to 20th century

Changes in vegetation are new kinds of plants establishing where different plants used to be. These changes happen as new areas become favorable to plants, either due just to climate changes or after fire or other disturbance. Both models project significant landscape changes , especially under the CGCM climate model under high concentrations of atmospheric greenhouse gases.



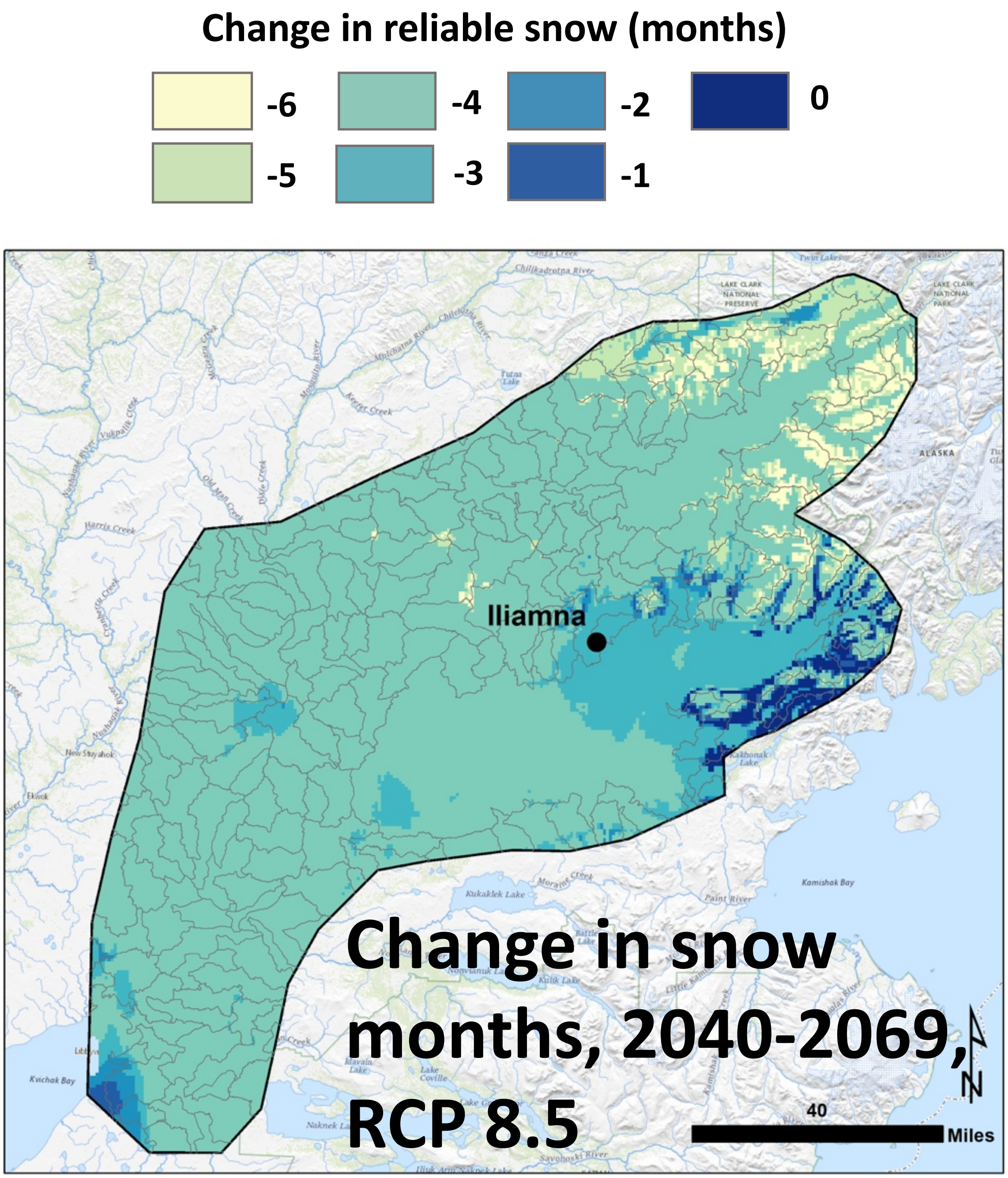
Change in fires per century, relative to 20th century

Except for the mountainous region east of Iliamna Lake and near the southwest (Kvichak Bay), the number of fires per century is projected to increase by 1 (lighter orange) to 2 (darker orange) fires per century on average. The darker orange areas indicate areas of greater increase.



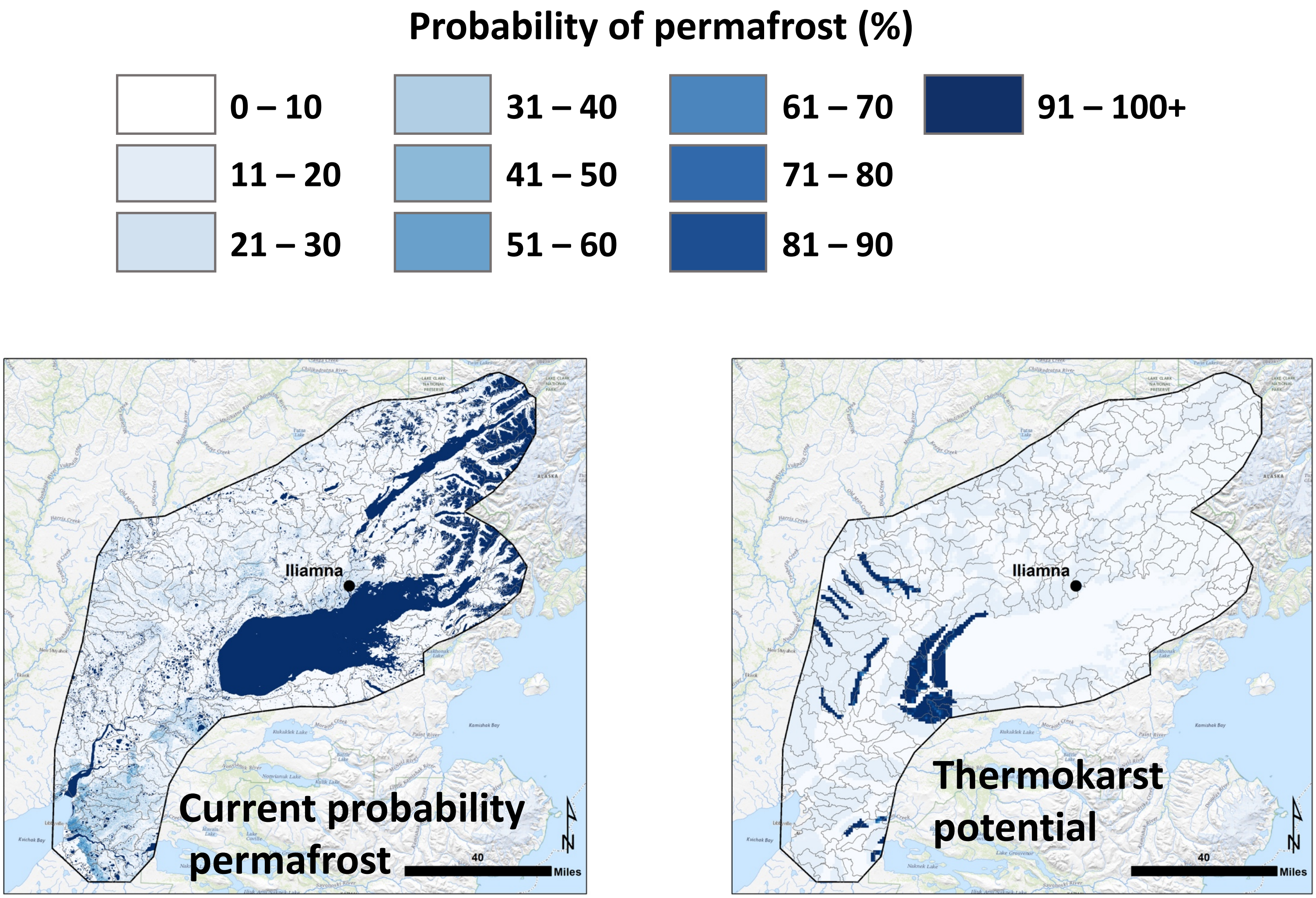
Change in reliable snow (months)

Snow months decrease by 3 to 4 months across much of the region, with largest decreases in the northeast of the region.



Probability of permafrost (%)

Left: Currently, permafrost in the region is thought to be patchy but locally important. Right: the potential for thermokarst is considerable near the west end of Iliamna lake and in the northwest part of the region.



Data tables

PRECIPITATION CHANGES – Percent (%) change averaged over the Iliamna region

	2040 - 2069				**2070 - 2099**			
	RCP 4.5		**RCP 8.5**		**RCP 4.5**		**RCP 8.5**	
	Average	Range	Average	Range	Average	Range	Average	Range
Annual	**14**	**11 - 16**	**16**	**13 - 19**	**17**	**14 - 20**	**26**	**22 - 30**
Spring	10	7 - 12	16	11 - 20	15	11 - 18	21	15 - 27
Summer	13	9 - 16	10	7 - 15	12	8 - 16	20	15 - 24
Autumn	15	12 - 18	19	16 - 22	21	18 - 24	30	26 - 35
Winter	17	15 - 18	21	20 - 22	20	19 - 21	35	33 - 37

TEMPERATURE – Change (in °F) averaged over the Iliamna region

	2040 - 2069				**2070 - 2099**			
	RCP 4.5		**RCP8.5**		**RCP 4.5**		**RCP 8.5**	
	Average	Range	Average	Range	Average	Range	Average	Range
Annual	**5.5**	**5.4 - 5.6**	**7.2**	**6.9 - 7.3**	**7.0**	**6.7 - 7.2**	**10.5**	**10.1 - 10.7**
Spring	4.9	4.6 - 5.0	6.4	6.1 - 6.6	6.0	5.7 - 6.2	9.1	8.5 - 9.3
Summer	3.8	3.6 - 4.0	5.0	4.9 - 5.2	5.0	4.8 - 5.1	8.1	8.0 - 8.4
Autumn	5.8	5.4 - 6.0	7.2	6.8 - 7.4	7.4	7.0 - 7.6	10.6	10.0 - 10.9
Winter	7.4	6.7 - 7.8	9.9	9.0 - 10.4	9.4	8.5 - 9.9	13.9	12.8 - 14.6

SNOWPACK - Percent (%) change (snowfall) and percent (%) (snow index) averaged over the Iliamna region

	2040-2069				**2070 - 2099**			
	RCP 4.5		**RCP 8.5**		**RCP 4.5**		**RCP 8.5**	
	Average	Range	Average	Range	Average	Range	Average	Range
Snowfall water	-20	- 28 - -6	-31	-39 - -14	-27	-35 - -11	-46	-55 - -28
Snow index	43	33 - 64	37	28 - 59	37	28 - 59	27	20 - 47

*Averages are for five climate models. Ranges are across HUC 12 (12 digit Hydrologic Unit Code) watersheds. See the PowerPoint with the regional maps file for descriptions of the variables.

ILIAMNA VILLAGE COUNCIL
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RESOLUTION 2020-004

WHEREAS, the Iliamna Tribe, partnered and participated in the recent *Looking Forward, Looking Back: Building Resilience Today* Project, referred to as the BRT Project, which resulted in three reports: BRT Iliamna Community Report, Training One Report and Training Two Report.

NOW THEREFORE BE IT RESOLVED the Iliamna Tribal Council reviewed these reports and specifically approves the final draft of the BRT Iliamna Community Report.

This resolution was duly considered and adopted at the General Meeting of the Iliamna Village Council called and convened on this 15th day of April, 2020 by a vote of 5 in favor 0 against 0 abstain.

Timothy Anelon Sr.-President

Chasity Anelon-Secretary/Treasurer