SELECTED MAPS FROM THE CLIMATE ATLAS OF THE UNITED STATES

February 2005

National Climatic Data Center
Asheville, NC

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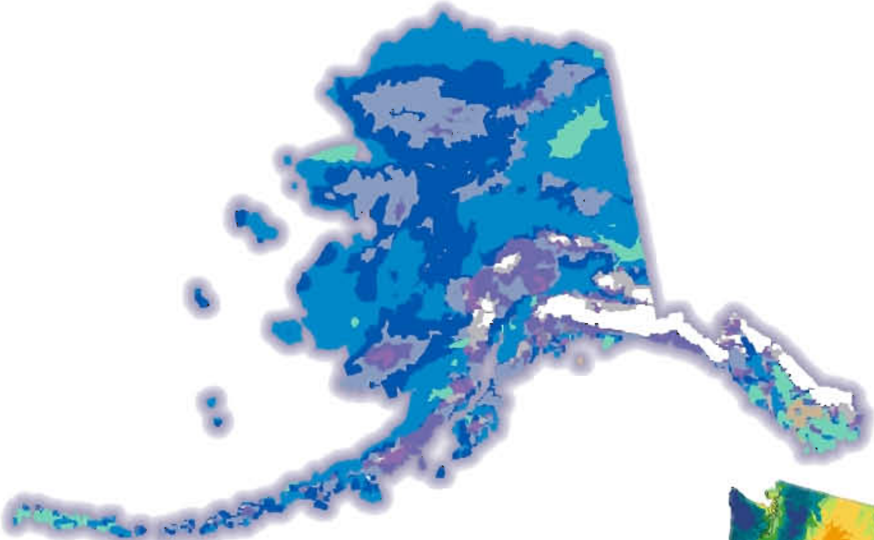

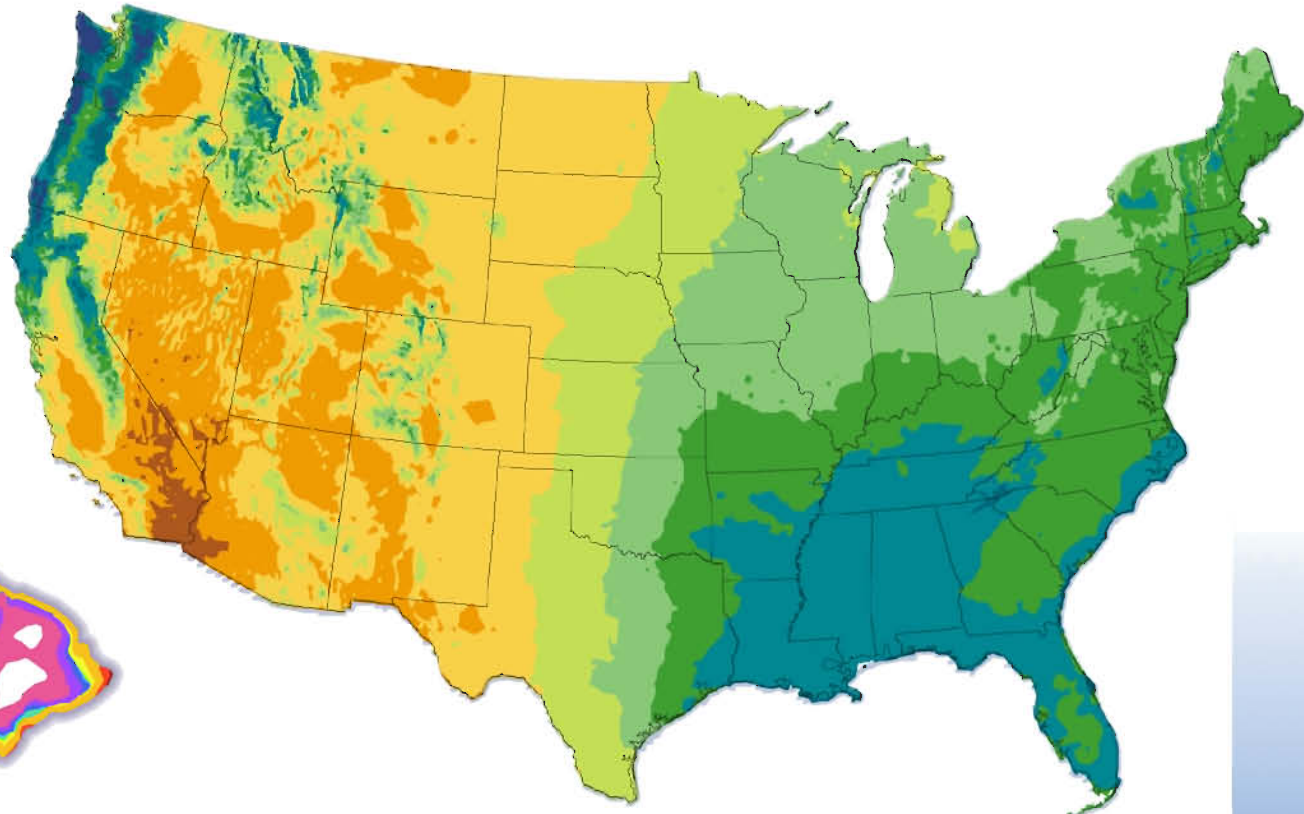

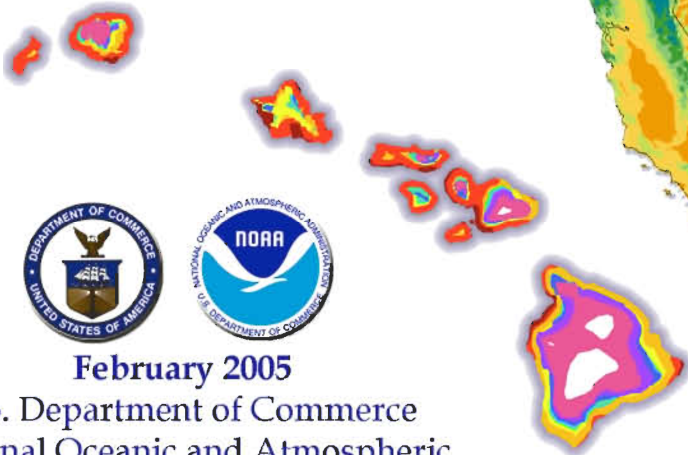

February 2005
U.S. Department of Commerce
National Oceanic and Atmospheric Administration

National Climatic Data Center
Asheville, NC

Editor: S. Elizabeth Love-Brotak

The National Climatic Data Center (NCDC) Climate Atlas team produced the Climate Atlas of the Contiguous United States.

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George Taylor - Oregon Climate Service,
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For more information about Climate Atlas Products
http://www.ncdc.noaa.gov/oa/about/cdrom/climatls2/info/atlasad.html

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Table of Contents

Introduction

The Selected Maps from the Climate Atlas of the United States publication is a subset of maps from the Climate Atlas of the United States Version 2.0 CD-ROM, which was developed by NOAA's National Climatic Data Center. This booklet contains maps for 20 of the more requested products from the Climate Atlas. The CD-ROM version of the Atlas is comprised of 2023 maps that show the spatial distribution (gridded 2-dimensional representation of point data) of major climatic elements. The Climate Atlas will serve the interests of commercial, industrial, agricultural, research, and educational institutions, as well as those from the general public. Its primary purpose is to show the normal spatial patterns for a variety of temperature, precipitation, snow, and other parameters. The CD-ROM version offers many advantages over the previous hardcopy version including over 1700 more maps and some basic interactive mapping tools such as zoom and query features. The new atlas was developed using innovative technology and easy to use Geographic Information Systems (GIS) to objectively generate the maps. The analytical model, PRISM (Parameter-elevation Regressions on Independent Slopes Model), which was developed at the Oregon Climate Service (OCS) at Oregon State University, was used to generate 936 different map products. An additional 1077 maps were generated by NCDC using ESRI's (Environmental Systems Research Institute, Inc.) ArcView 3.1. Most atlas products are derived from the 1961-1990 period of record.

Data Sources

Several data sources were used for generating the atlas maps including Daily Cooperative Summary of the Day (NOAA, 1995), Climatic Data Normals (NOAA, 1994), Snow Climatology (NOAA, 1997), Hourly First-Order Observations (NOAA, 1999), Daily Summaries of Hourly First-Order Observations (NOAA, 1999), Monthly Normals for Atypical Elements (NOAA, 1997), and the Monthly Normals of Temperature, Precipitation, and Degree Days for the U.S. (Clim81) (NOAA, 1994).

Station Selection Criteria

The number of stations used for generating the various grids was dependent on the data source: 3779 stations from the snow climatology data set, 6662 precipitation stations from the Clim81 set, 4775 temperature stations from Clim81, 8198 temperature stations from the cooperative observer data set, and 230 stations from the first-order data set.

Station Selection Criteria for Snow Elements

The snow elements were obtained from the snow climatology (NOAA, 1997). The criteria for handling missing data for computing the mean monthly and annual normal snowfall differed for the coop stations and the first order (WBAN) stations. For the coop stations, the total snowfall had no tolerance for missing data. If even one day was missing in a month, the total snowfall was not computed for that year's month. Consequently, the number of years with non-missing data varied with month. For first order stations, the criteria were not as stringent as for coop stations. The WMO guidelines for computing normals were used. They defined a missing month as having (1) five or more consecutive daily values missing, or (2) a total of eleven or more missing daily values in the month.

The median daily value for a month had no tolerance for missing data. All days in a month had to have data in order for a median daily value to be computed for that year-month. The number of days with snowfall or snow depth parameters had no tolerance for missing data. Data for leap days were included in the analysis. Due to this fact and due to rounding error, the sum of the values for the = 0 or>= 0.1 inch (1.0 inch for snow depth) thresholds may not exactly equal the number of days in the month.

The daily extreme and date of occurrence parameters had a greater tolerance for missing data. Data were analyzed even if a month had up to 5 days missing. This could result in apparent discrepancies between these and other parameters.

In the "number of days with" computations, if a month had fewer than 6 missing days, then the "number of days" tallies were pro-rated by a factor of (pos/obs), where pos = the number of days in the month and obs = the number of non-missing days in the month. Leap days were included in the analysis, but the results were pro-rated as above to conform to a 28-day February. The pro-rating feature and possible rounding errors may result in the following apparent inconsistencies: (1) the sum of the monthly values may not equal the sum of the annual value, and (2) the cross-element sums (e.g., number of days with snowfall [or snow depth] = 0. plus the number of days>= 0.1 inch for snowfall [1.0 inch for snow depth]) may not equal the maximum possible monthly or annual value. In all cases the apparent inconsistencies are minor.

Station Selection Criteria for non-Snow Elements

Generally, no more than 5 missing days in a month of daily values were allowed for that data-month to be valid and no more than 15 missing data-months during the 1961-1990 period for an element-month to be valid. An additional requirement for hourly data sets was that at least three observations were required in the morning hours and three in the evening hours so that a bias was not introduced.

PRISM Methodology

PRISM is a new analytical climate model that distributes point measurements to a regular grid at regional to continental scales. It uses point data, a digital elevation model, and other spatial data sets in conjunction with ESRI's ArcInfo to generate gridded estimates of monthly, yearly, and event-based climatic parameters, such as precipitation, temperature, snowfall, degree days, and dew point, according to Daly, Taylor, and Gibson (1997). PRISM is an expert system written by a meteorologist specifically to address climate. It is uniquely designed to map climate in the most difficult situations, including high mountains, rain shadows, temperature inversions, coastal regions, and other complex climatic regimes. These capabilities were described by Daly, Neilson, and Phillips (1994). It uses a digital elevation model (DEM) to group stations according to topographic facets at spatial scales that reflect the local station density (Gibson, et al., 1997). PRISM estimates precipitation and other parameters at each DEM cell through a weighted regression of the climate parameter with elevation. PRISM has been compared with common objective methods such as kriging, detrended kriging, and cokriging and has shown superior performance both quantitatively and qualitatively. For more information on PRISM, please visit http://www.ocs.orst.edu/prism/.

GIS Methodology

NCDC used ESRI's ArcView to reclassify all the grid files created at OSU and then produce shape files from those grids. Those elements not suitable for treatment by PRISM, for instance because they are reported by fewer stations, or because they lack a topographic or elevation influence that is accounted for in PRISM, were mapped at NCDC using ArcView. Sea-level pressure is an example of such an element. For these elements, ArcView was used to produce the gridded data from the actual station data, and then shape files were created. Discontinuous elements, such as prevailing wind direction, only have point values displayed.

Map Interface and Display

The CD-ROM product uses ESRI's ArcExplorer as the display method, except for 5 maps, which are displayed in PDF format using Adobe Acrobat Reader. ArcExplorer is an ESRI freeware product that allows users to access shape files for display and it provides limited GIS map tools, such as zoom capability. A front-end graphical user interface, written in Visual Basic 6.0, allows users to select the map(s) they wish to view.

General Element Descriptions

Unless otherwise noted, all values were based on normals for the period 1961-1990.

Monthly normals were computed for as many stations as practical. In order to be included, the station had to have at least 10 years of monthly temperature data and 10 years of monthly precipitation data from the period 1961-90. Computation of annual values were made from 12 monthly values, provided that no months were missing.

Documentation for NCDC data sets can be found at http://www4.ncdc.noaa.gov/ol/documentlibrary/datasets.html.

Mean Daily Maximum Temperature:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original data is in whole degrees Fahrenheit. This element is computed to tenths of a degree Fahrenheit.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Daily Minimum Temperature:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original data is in whole degrees Fahrenheit. This element is computed to tenths of a degree Fahrenheit.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Daily Average Temperature:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original data is in whole degrees Fahrenheit. This element is computed to tenths of a degree Fahrenheit.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Last 32 Degree Fahrenheit Temperature in Spring:
This element was computed using data from the National Climatic Data Center's Cooperative Summary of the Day (TD-3200) database (NOAA, 1995). The original data is in whole degrees Fahrenheit. This element is given as a date range.

The date of occurrence of the last 32 degree Fahrenheit temperature observation in spring was based on the median, mean, and extreme dates of such occurrence from 30 years of daily minimum temperature values, respectively. If at least one 32 degree Fahrenheit temperature was observed in the first six months of the calendar year, but a 32 degree Fahrenheit temperature did not occur in at least one-half of the years of available data, then the station was designated "RARE FREEZE." If no 32 degree Fahrenheit temperatures were observed in the first six months of the calendar year, then the station was designated "NO FREEZE." Daily minimum temperatures were the lowest observed temperatures for the 24-hour period ending at the time of observation for a given station.

First 32 Degree Fahrenheit Temperature in Autumn:
This element was computed using data from the National Climatic Data Center's Cooperative Summary of the Day (TD-3200) database (NOAA, 1995). The original data is in whole degrees Fahrenheit. This element is given as a date range.

The date of occurrence of the first 32 degree Fahrenheit temperature observation in autumn was based on the median, mean, and extreme dates of such occurrence from 30 years of daily minimum temperature values, respectively. If at least one 32 degree Fahrenheit temperature was observed in the last six months of the calendar year, but a 32 degree Fahrenheit temperature did not occur in at least one-half of the years of available data, then the station was designated "RARE FREEZE." If no 32 degree Fahrenheit temperatures were observed in the last six months of the calendar year, then the station was designated "NO FREEZE." Daily minimum temperatures were the lowest observed temperatures for the 24-hour period ending at the time of observation for a given station.

Median/Mean Length of Freeze-Free Period:
This element was computed using data from the National Climatic Data Center's Cooperative Summary of the Day (TD-3200) database (NOAA, 1995). The original data is in whole degrees Fahrenheit. This element is given as the number of whole days.

The length of the freeze-free period was based on the difference between the median and mean dates, respectively, of the last 32 degree Fahrenheit temperature in spring (Element TEMP09) and the first 32 degree Fahrenheit temperature in autumn (Element TEMP10). If either element was designated "RARE FREEZE" the station was excluded from the database. If both elements were designated "NO FREEZE," then this element was designated the same. If only one element was designated "NO FREEZE," then the station was excluded. Daily minimum temperatures were the lowest observed temperatures for 24 hours ending at the time of observation for a given station.

Mean Dew Point Temperature:
This element was computed using data from the National Climatic Data Center's Surface Airways Hourly (TD-3280) database (NOAA, 2000a). The original data is in whole degrees Fahrenheit. This element is computed to tenths of a degree Fahrenheit.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Relative Humidity:
This element was computed using data from the National Climatic Data Center's Surface Airways Hourly (TD-3280) database (NOAA, 2000a). The original data and this element are measured as a percentage.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The daily values were computed as the mean of relative humidity values for the 24 hourly observations. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Total Cooling Degree Days:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original data is in whole degrees Fahrenheit. This element is given to whole degree days.

Cooling degree day values were derived from a base of 65 degrees Fahrenheit. Simple arithmetic procedures were not applied to obtain the cooling degree day values. Instead, the rational conversion formulae developed by Thom (1954, 1966) were used. These formulae allow the adjusted mean temperature normals and their standard deviations to be converted to degree day normals with uniform consistency. In some cases this procedure will yield a small number of degree days for months when degree days may not otherwise be expected. This results from statistical considerations of the formulae. The annual degree day normals were calculated by adding the corresponding monthly degree day normals.

Mean Total Heating Degree Days:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original data is in whole degrees Fahrenheit. This element is given to whole degree days.

Heating degree day values were derived from a base of 65 degrees Fahrenheit. Simple arithmetic procedures were not applied to obtain the heating degree day values. Instead, the rational conversion formulae developed by Thom (1954, 1966) were used. These formulae allow the adjusted mean temperature normals and their standard deviations to be converted to degree day normals with uniform consistency. In some cases this procedure will yield a small number of degree days for months when degree days may not otherwise be expected. This results from statistical considerations of the formulae. The annual degree day normals were calculated by adding the corresponding monthly degree day normals.

Mean Total Precipitation:
This element was computed using data from the National Climatic Data Center's U.S. National 1961-1990 Climate Normals (NOAA, 1994b). The original daily data and the element are in hundredths of an inch, with daily trace values designated as zero.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the sum of the daily precipitation values for a given month. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Number of Days with Measurable Precipitation:
This element was computed using data from the National Climatic Data Center's Cooperative Summary of the Day (TD-3200) database (NOAA, 1995). The original data and this element are given in hundredths of an inch. This element is given as number of whole days.

The monthly values were computed by taking the 30-year mean of the number of days with measurable precipitation (at least 0.01 inch) for a given month. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean number of days with measurable precipitation.

Mean Total Snowfall:
This element was computed using data from the National Climatic Data Center's United States Snow Climatology (TD-9641M) database (NOAA, 1999c). The original data and this element are given in tenths of an inch, with daily trace values designated as zero.

The mean monthly values were computed by taking the 30-year mean of the maximum daily snowfall values for a given month. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean maximum daily snowfall values.

Probability of Measurable Snowfall in a Snow Season:
This element was computed using snowfall data from the National Climatic Data Center's United States Snow Climatology (TD-9641M) database (NOAA, 1999c). The original snowfall data is given to a tenth of an inch. This element is given as a percentage.

The probability of measurable snow is the probability that a snowfall of at least 0.1 inch will be observed within a given snow season (August 1 - July 31). The probability is based on the 29 annual periods from August 1 - July 31, with the first period beginning August 1, 1961 and the last period ending July 31, 1990. Daily snowfall measurements were based on the 24-hour period ending at the time of observation for a given station. In computing the probabilities, daily trace values of snowfall were treated as a value of zero.

Probability of a White Christmas:
This element was computed using snow depth data from the National Climatic Data Center's United States Snow Climatology (TD-9641M) database (NOAA, 1999c). The original snow depth data is given to the nearest whole inch. This element is given as a percentage.

The probability of a white Christmas is the probability that a snow depth of at least 1 inch will be observed on December 25. The probability was computed using snow depth observations for December 25, for the full period of record for a given station, not just 1961-1990. Daily snowfall measurements were based on the 24-hour period ending at the time of observation for a given station. In computing the probabilities, daily trace values of snowfall were treated as zero.

Mean Wind Speed and Prevailing Direction:
This element was computed using data from the National Climatic Data Center's Monthly Normals for Atypical Elements (TD-9641) database (NOAA, 1997b). For wind speed, the original data is in knots and this element is in miles per hour. For prevailing wind direction, both the original data and this element are in coded directions, where 1=wind from the NNE and 16=wind from the N. Wind vectors are presented as arrows flying with the prevailing wind.

The monthly values of mean wind speed were computed by taking the 30-year mean of monthly wind speed for a given month. Monthly wind speeds were computed from the mean of daily wind speed observations. Daily wind speeds were computed as the mean of all 1-minute wind speed observations during the 24-hour period ending at the time of observation for a given station. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

The monthly values of prevailing wind direction were computed by taking the 30-year mean of prevailing wind directions for a given month. Monthly prevailing wind directions were computed as the most common daily prevailing wind direction. Daily wind directions were computed as the most common prevailing direction of all 1-minute wind direction observations during the 24-hour period ending at the time of observation for a given station. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Number of Days with Heavy Fog:
This element was computed using data from the National Climatic Data Center's Summary of the Day First Order (TD-3210) database (NOAA, 2000b). The original data and this element are given as whole days.

The monthly values were computed by taking the 30-year mean of the number of days with at least one occurrence of heavy fog for a given month. The daily values included observations for the 24-hour period ending at the time of observation for a given station. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean number of days with heavy fog. Heavy ice fog was considered as heavy fog through 1964. Heavy fog is defined as reducing visibility to 0.25 mile or less.

Mean Sunshine Percentage:
This element was computed using data from the National Climatic Data Center's U.S. Stations 1961-1990 Monthly Normals for the Atypical Climate Elements (TD-9641) database (NOAA, 1997b). The original data and this element are given as a percentage of possible sunshine.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The daily values were computed as the number of hours of sunshine observed out of the hours of sunshine possible for the 24-hour period ending at the time of observation for a given station. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Sunshine Total Hours:
This element was computed using data from the National Climatic Data Center's U.S. Stations 1961-1990 Monthly Normals for the Atypical Climate Elements (TD-9641) database (NOAA, 1997b). The original data and this element are given as the number of hours of observed sunshine.

The mean monthly values were computed by taking the 30-year mean of the total hours of sunshine for a given month. The monthly total hours were computed from the daily values. The daily values were computed as the total number of hours of sunshine observed for the 24-hour period ending at the time of observation for a given station. The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

Mean Sky Cover (Sunrise to Sunset):
This element was computed using data from the National Climatic Data Center's Summary of the Day First Order (TD-3210) database (NOAA, 2000b). The original data is in tenths of sky cover according to the following: clear (0.0 - 0.1); scattered (0.1 - 0.5); broken (0.6 to 0.9); and overcast (1.0). This element is given as a percentage.

The mean monthly values were computed by taking the 30-year mean of the monthly means. The monthly means were computed from the daily values. The daily values were computed as the mean of the hourly daylight sky cover observations where tenths of sky cover were converted to percentages (i.e., 0.1=10%, etc.) The mean annual value was computed by taking the 30-year mean of the yearly means. The yearly means were computed by averaging their 12 monthly mean values.

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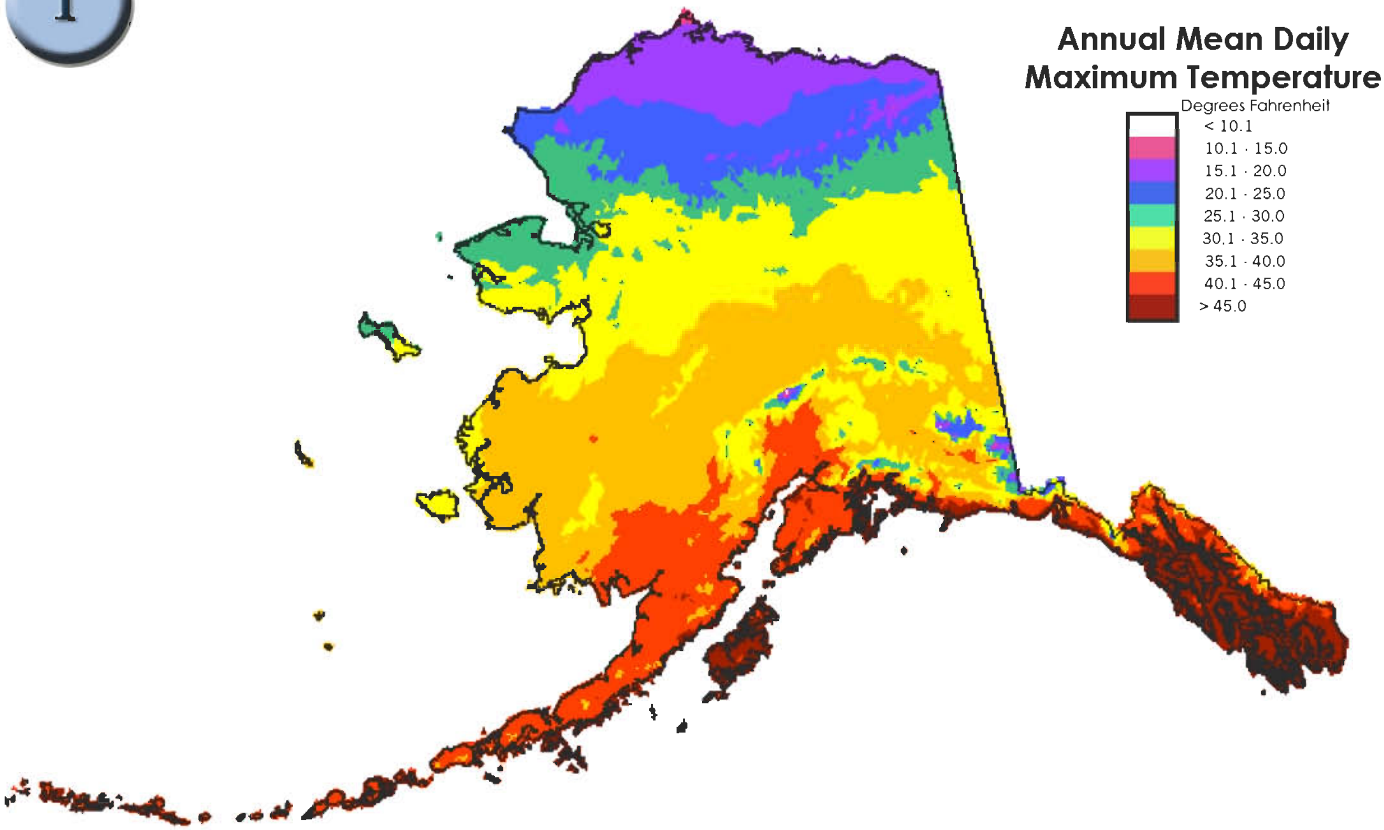
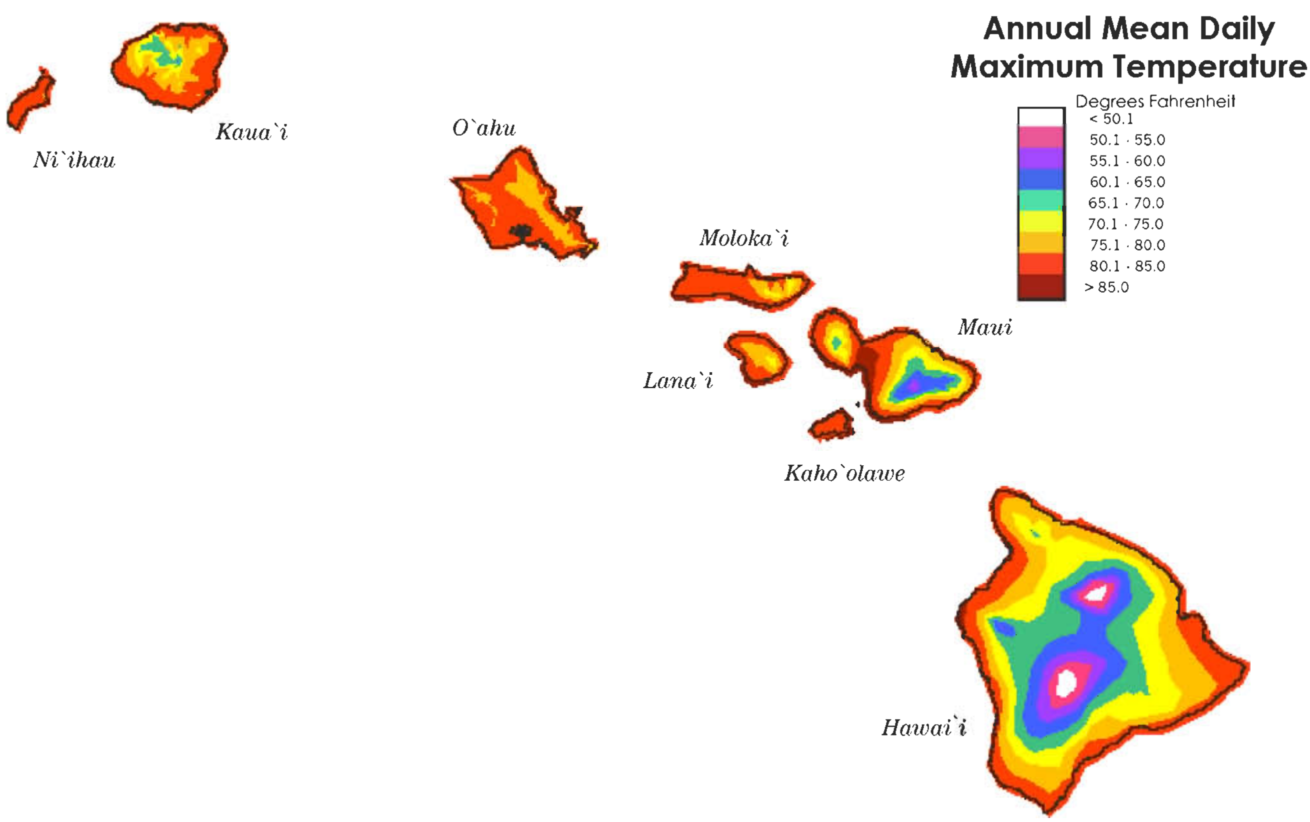
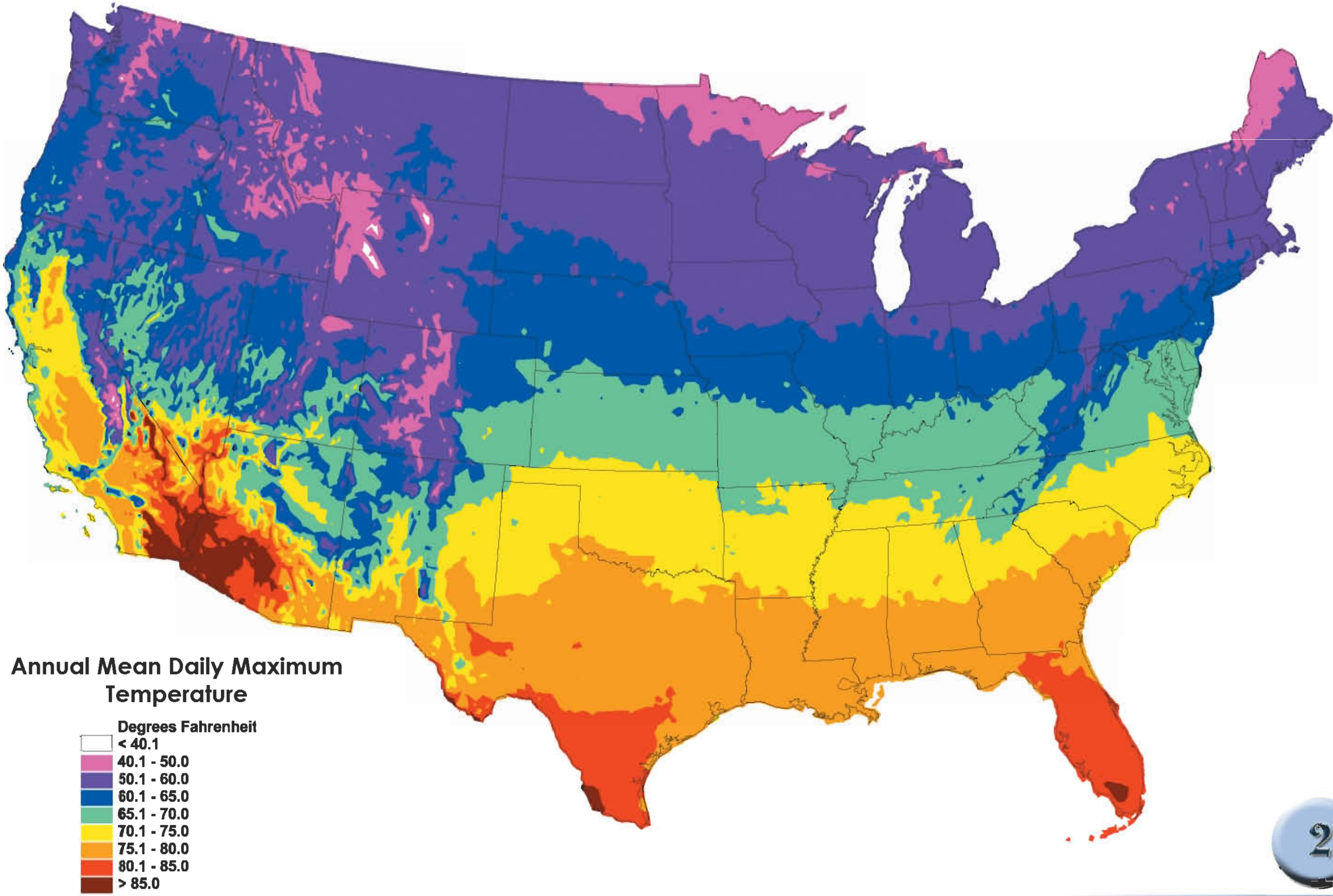
Maximum Temperature

1







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Maximum Temperature

Minimum Temperature

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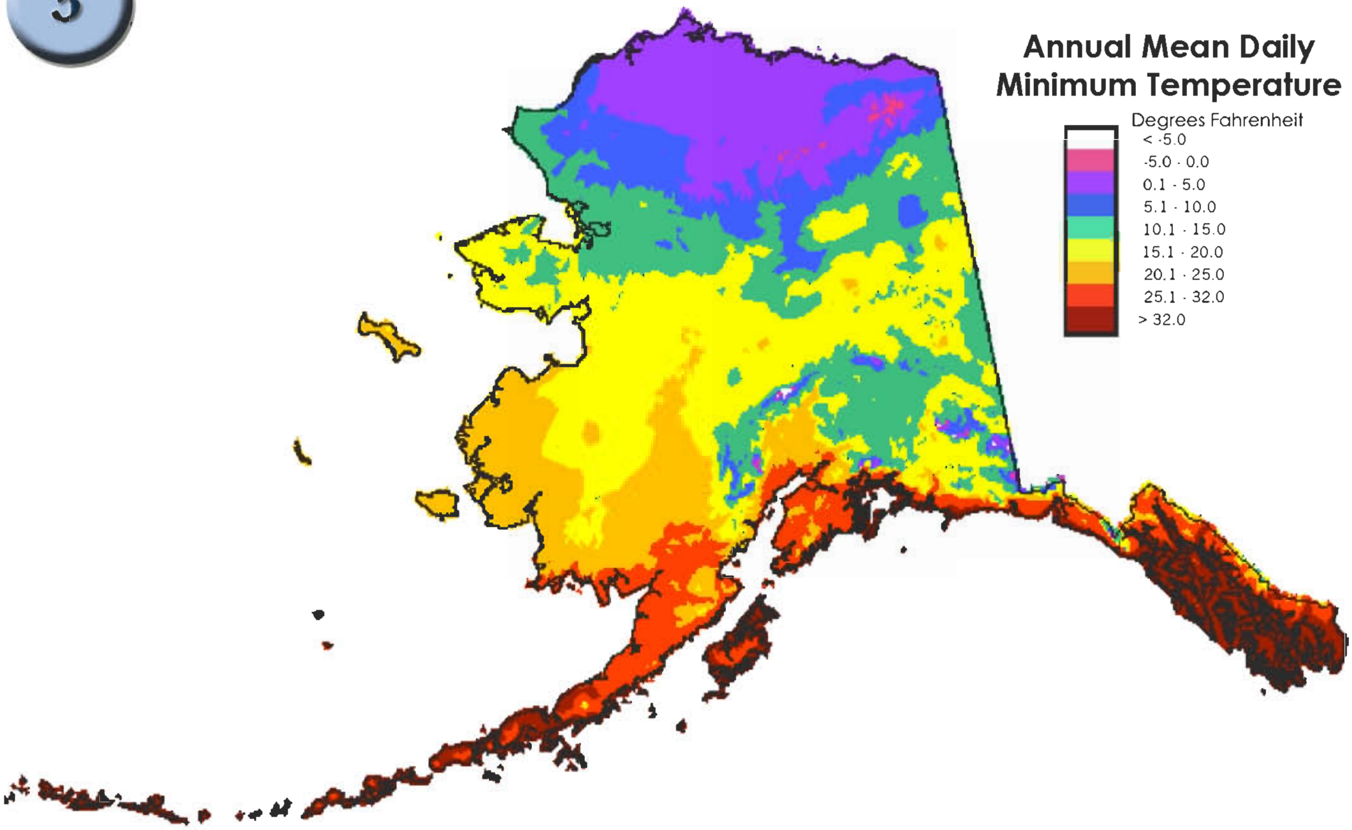
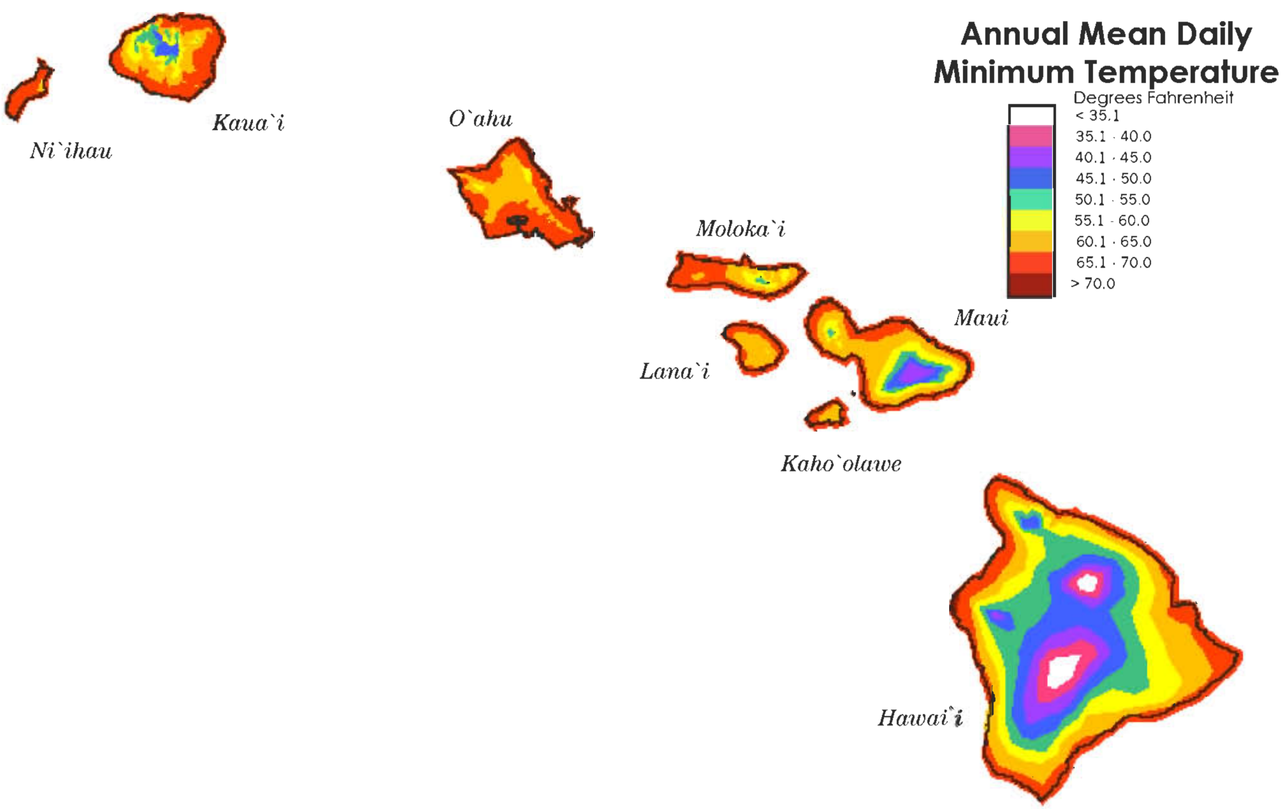
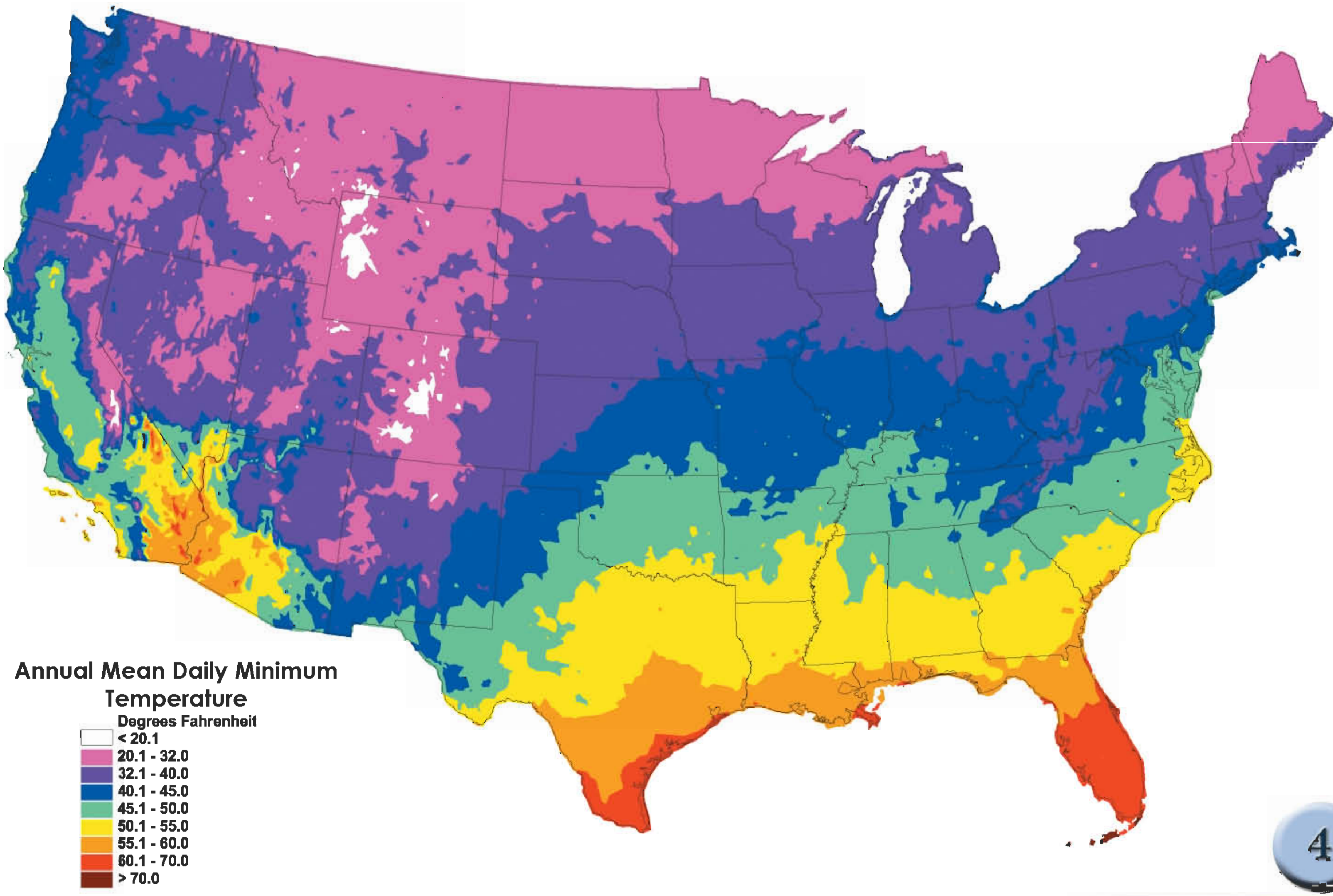


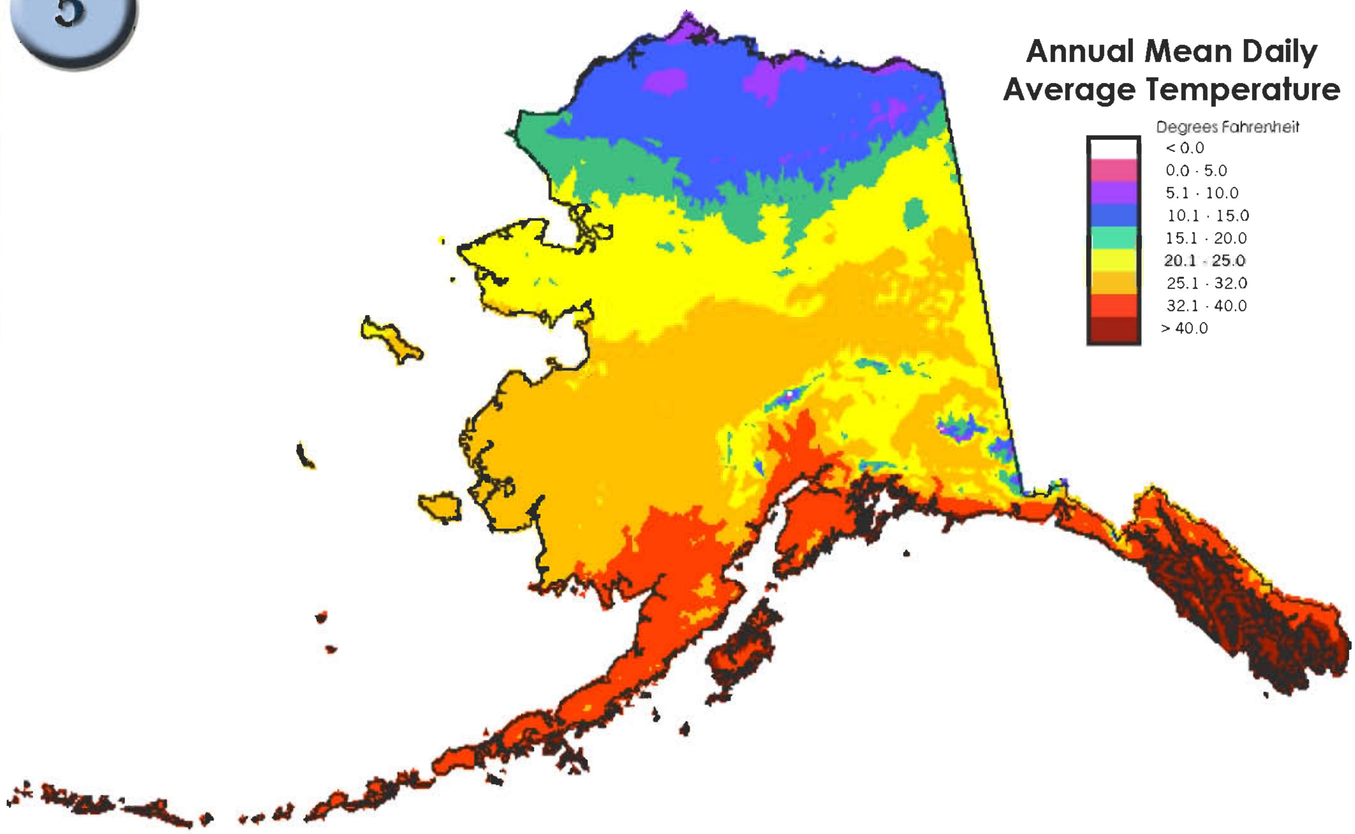


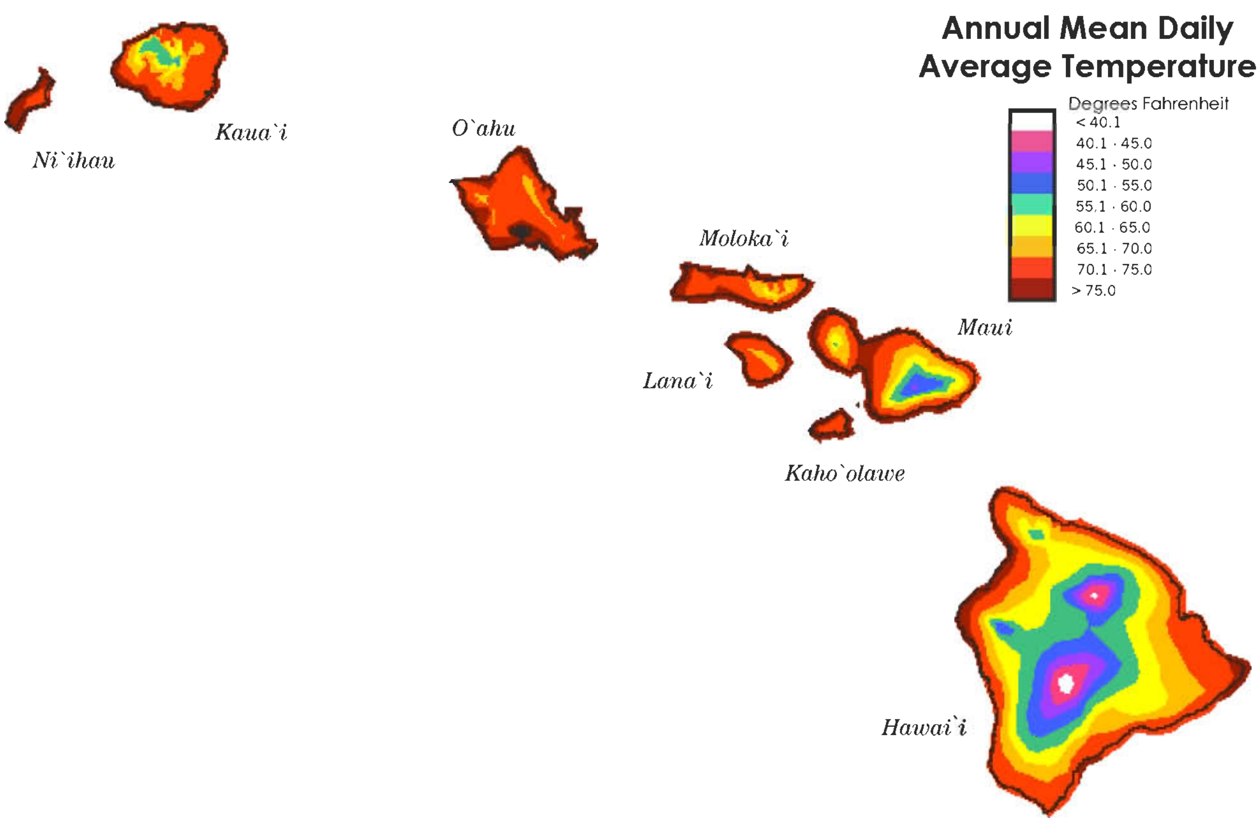


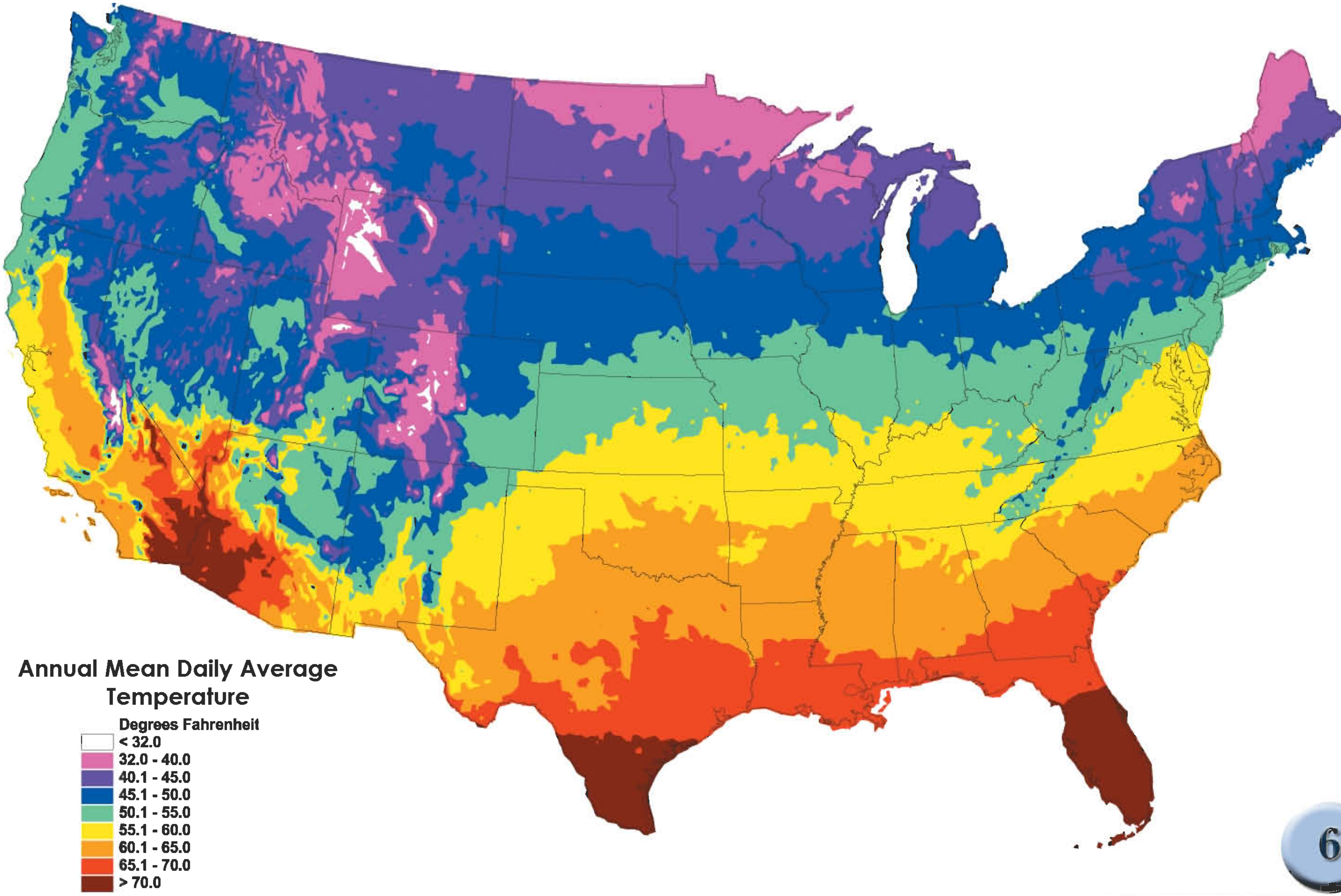
Minimum Temperature

Average Temperature

5





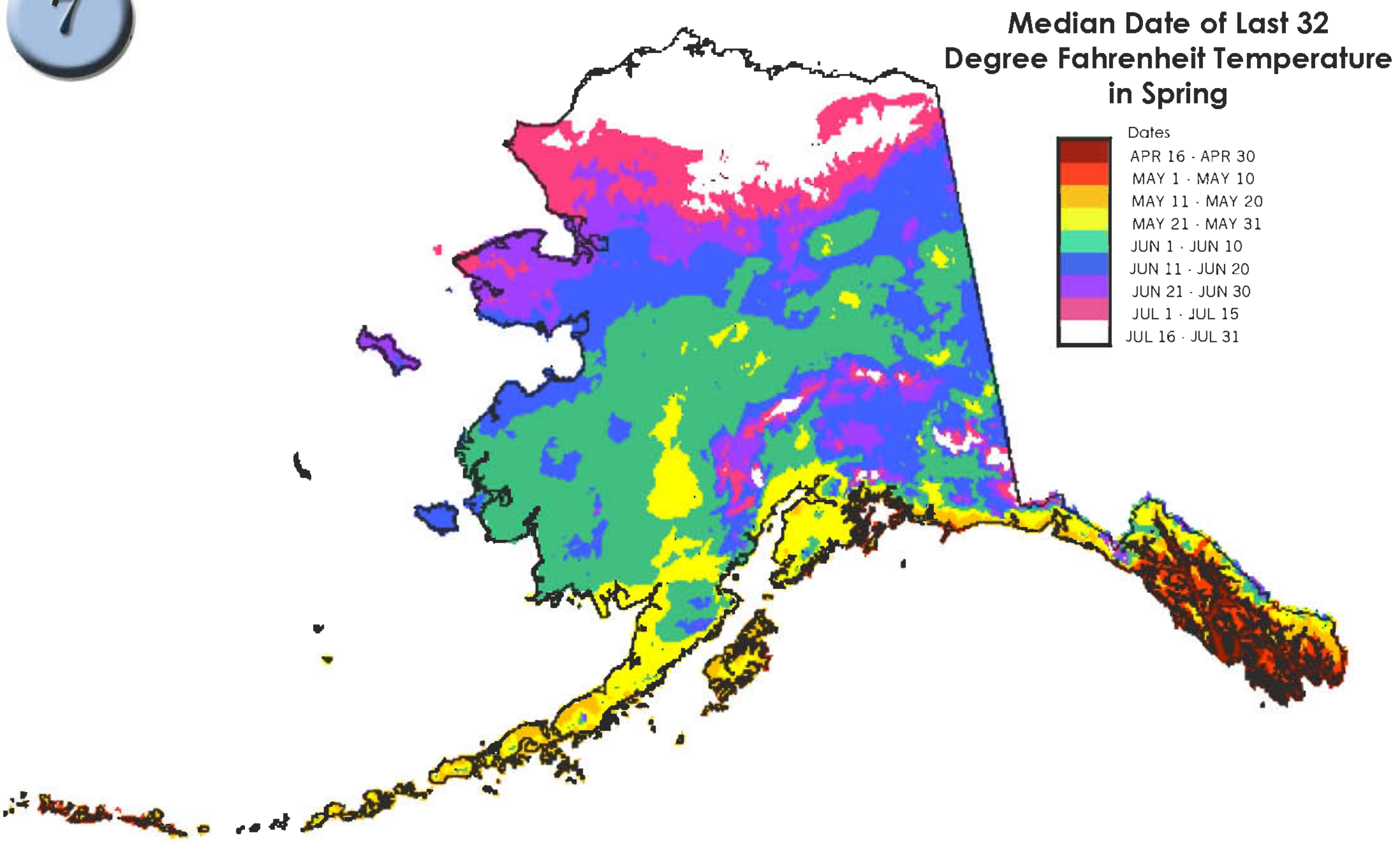


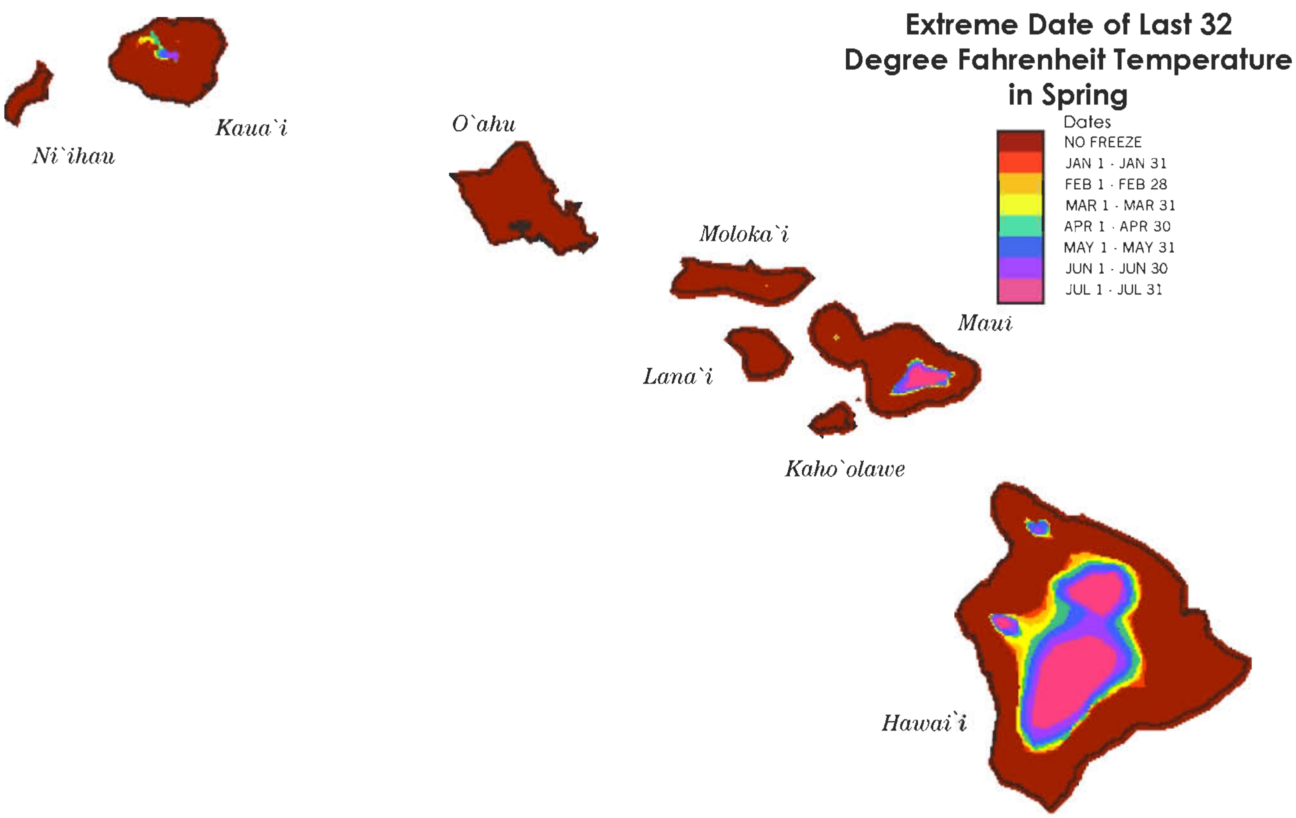
6

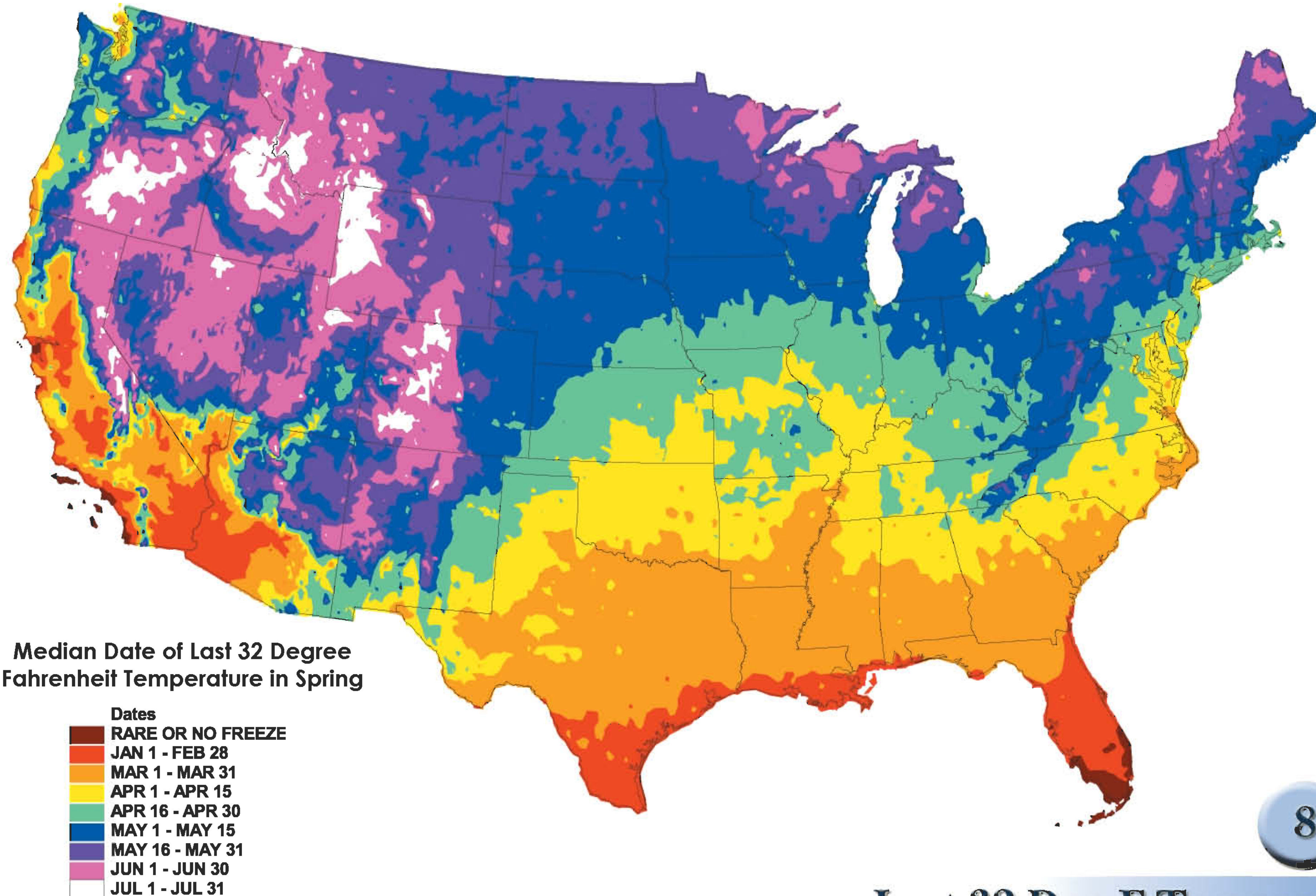
Average Temperature

Last 32 Deg F Temperature

7





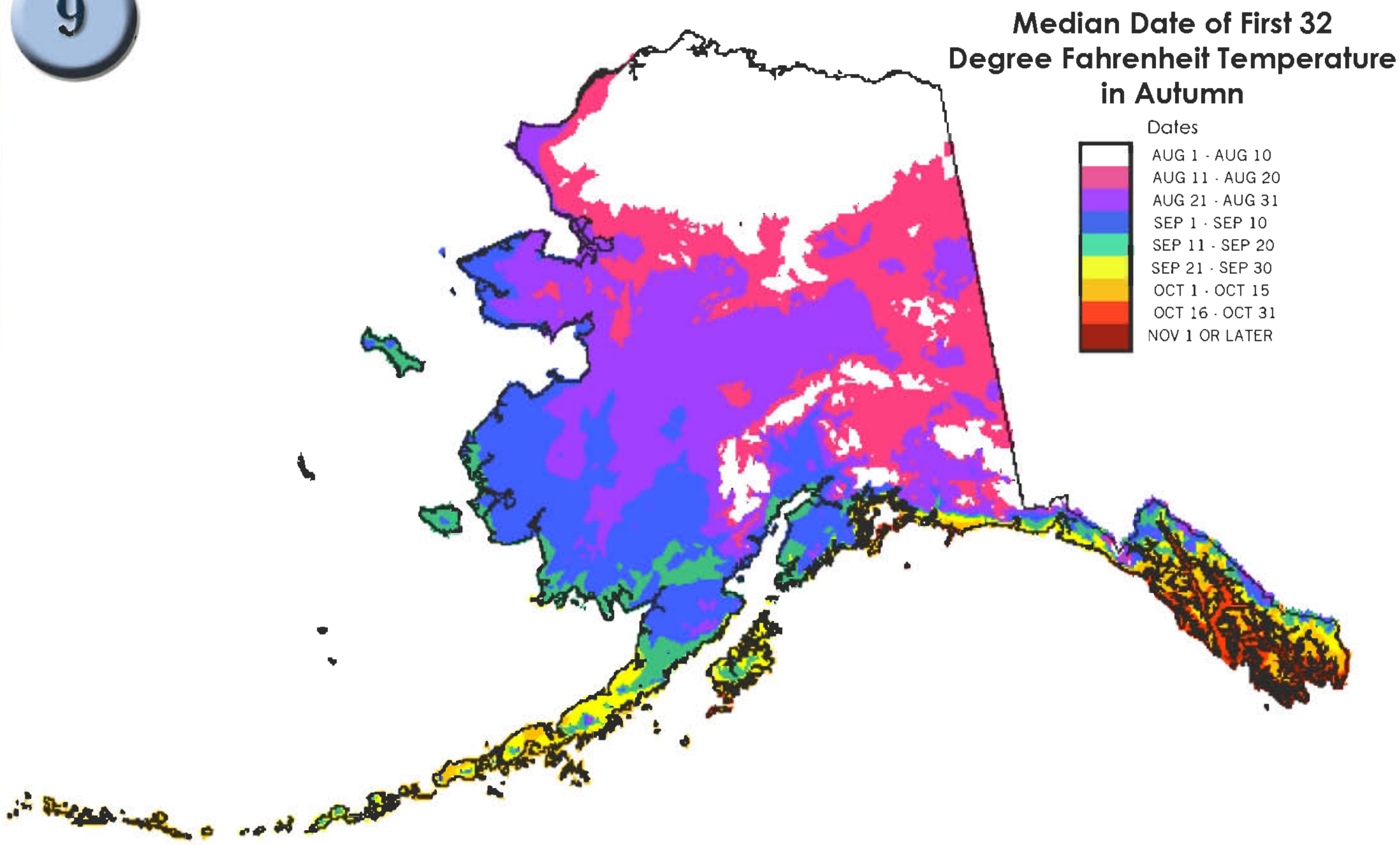


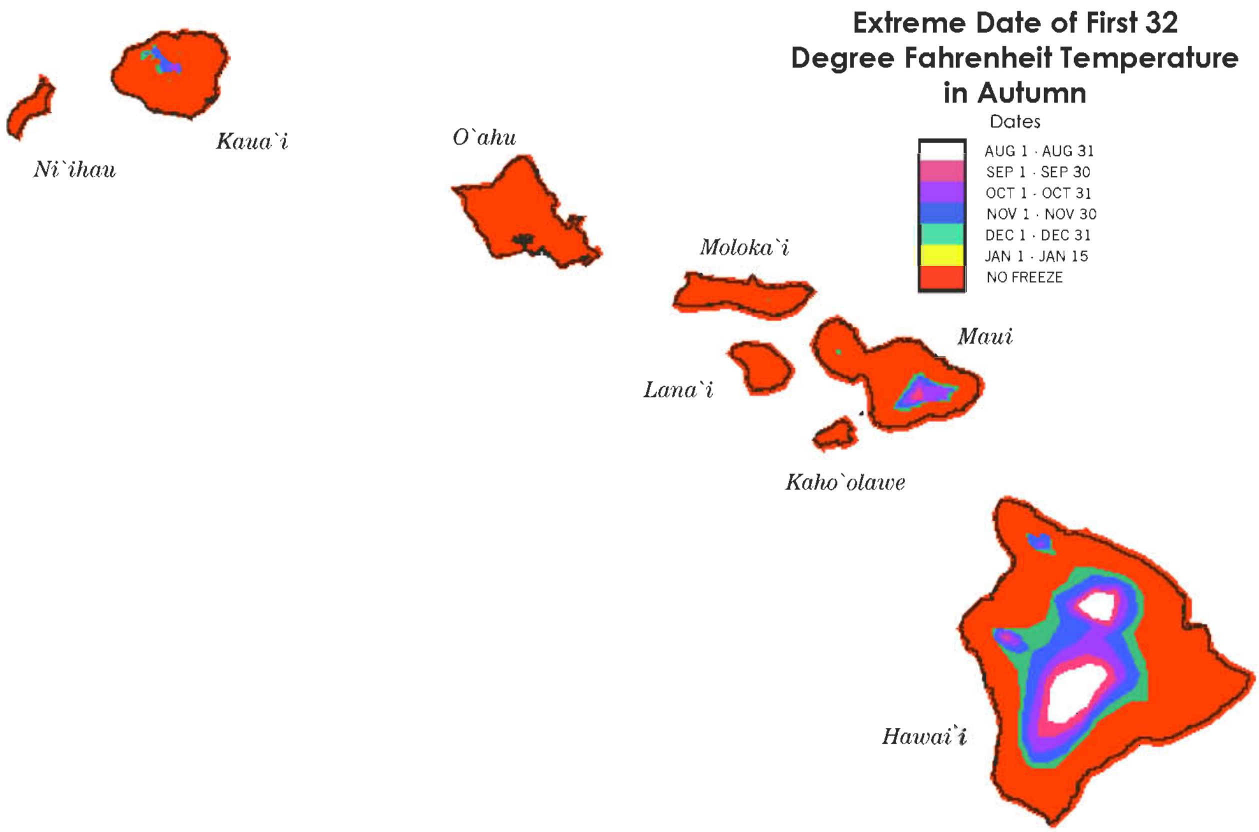
8

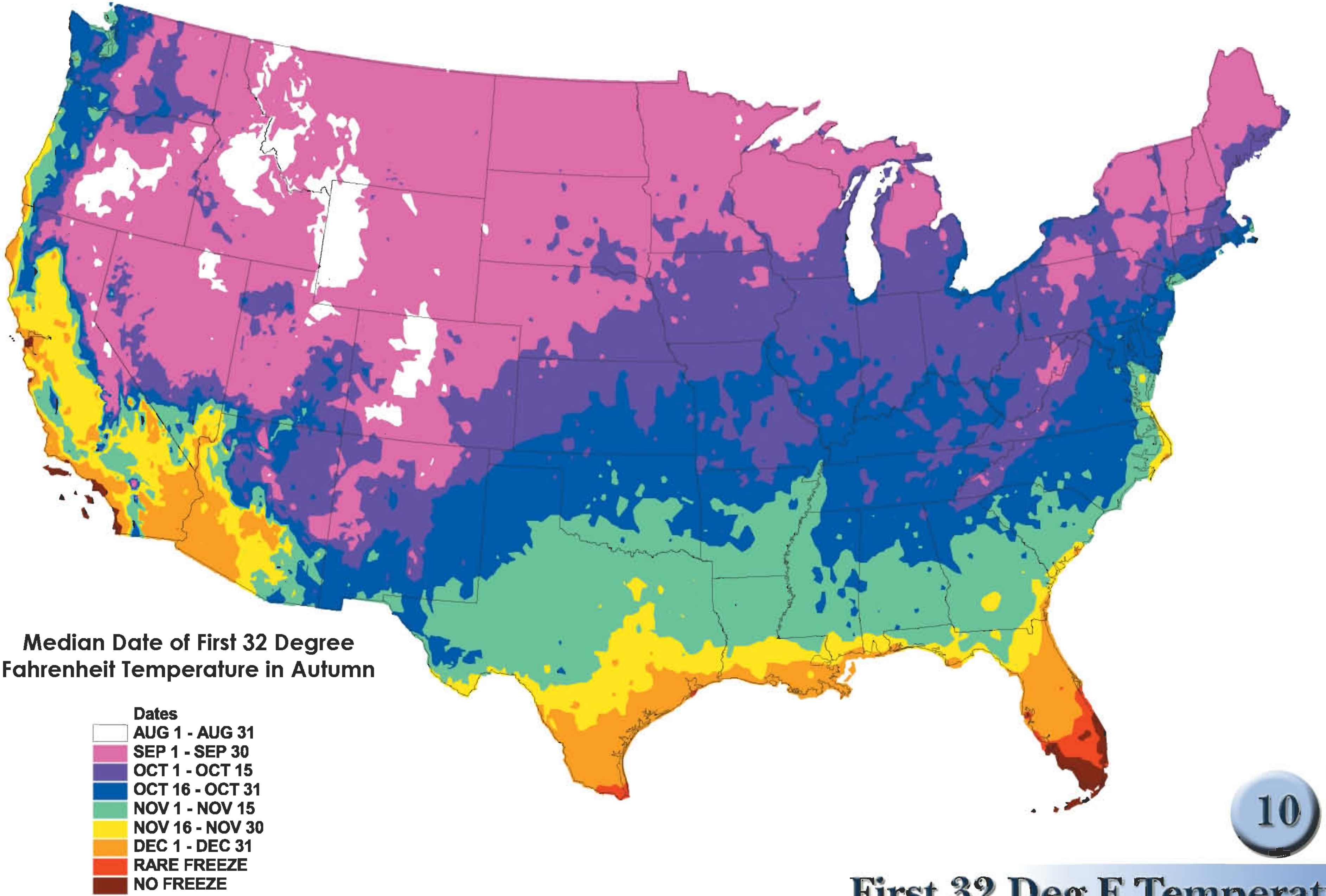
Last 32 Deg F Temperature

First 32 Deg F Temperature

9



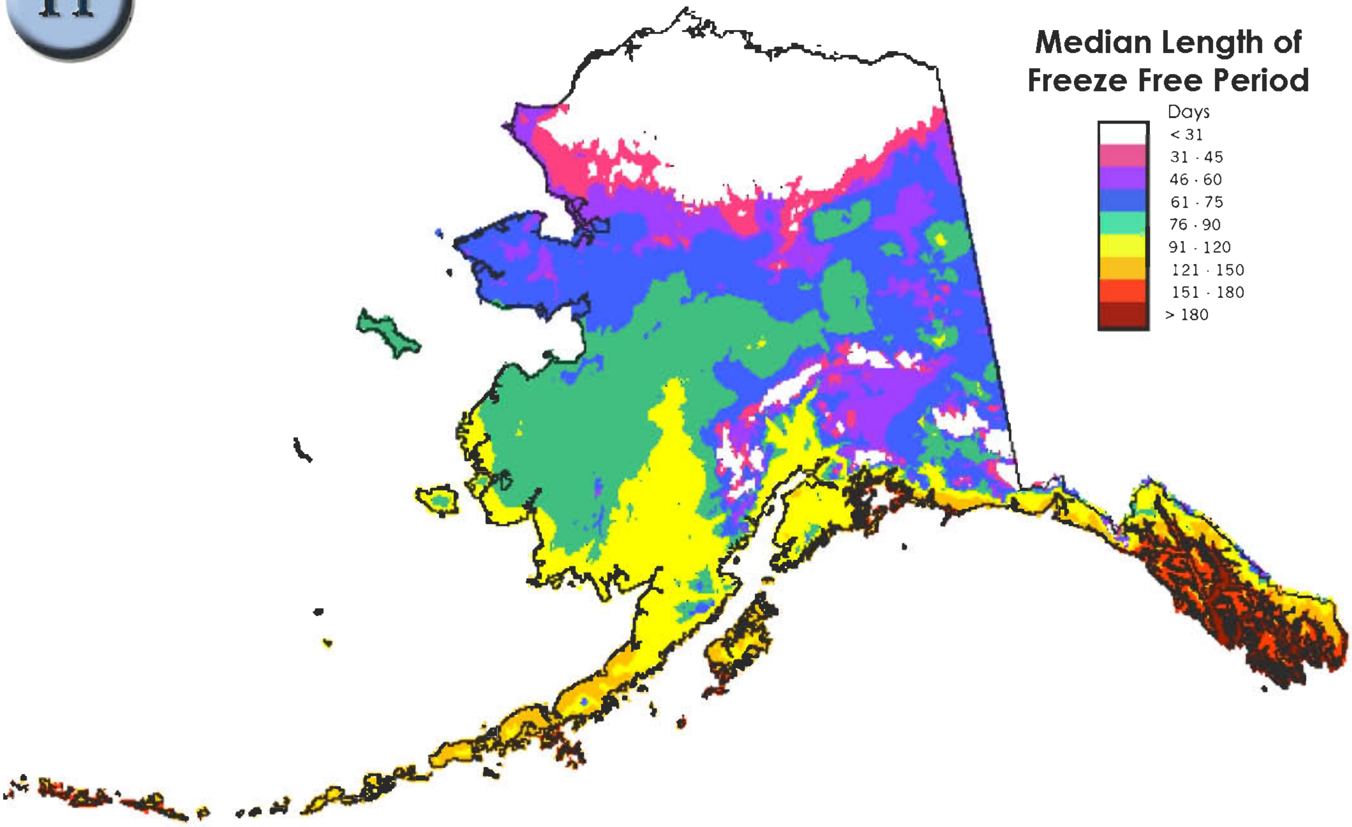


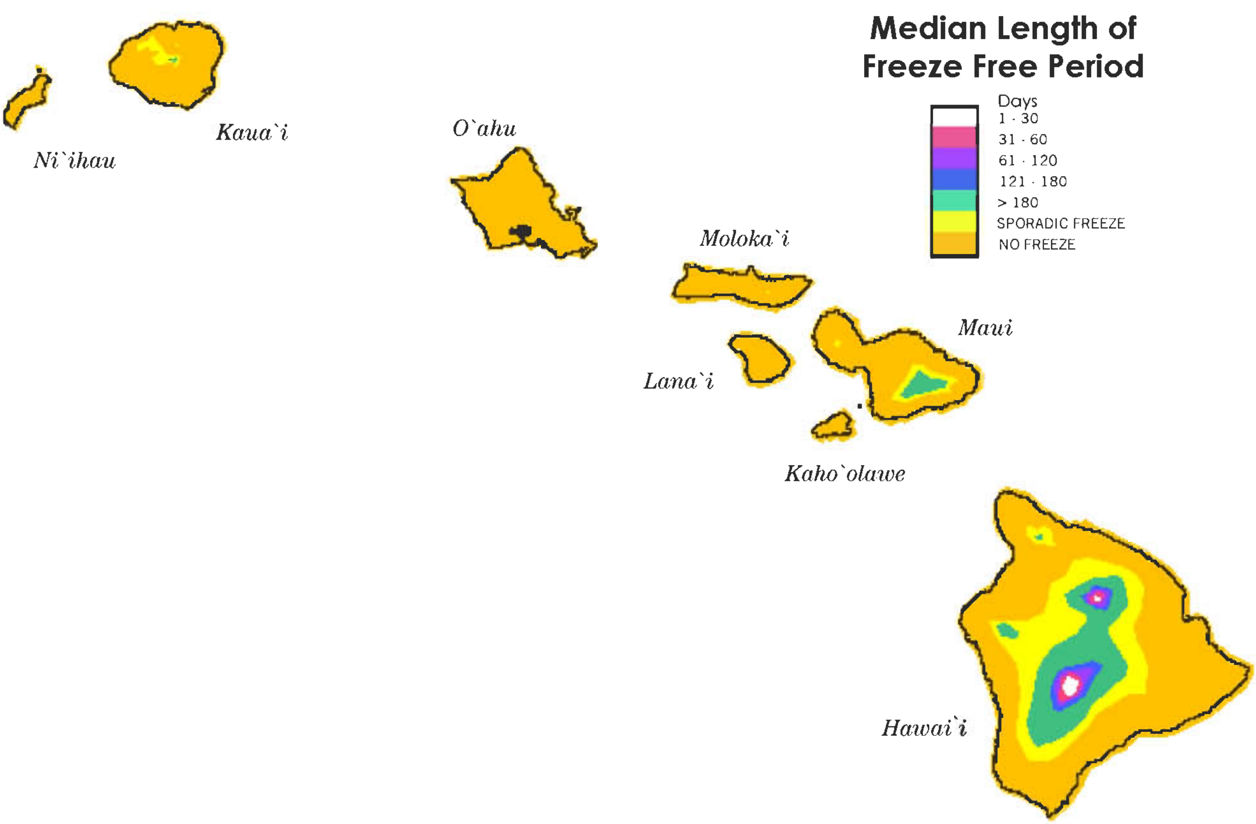


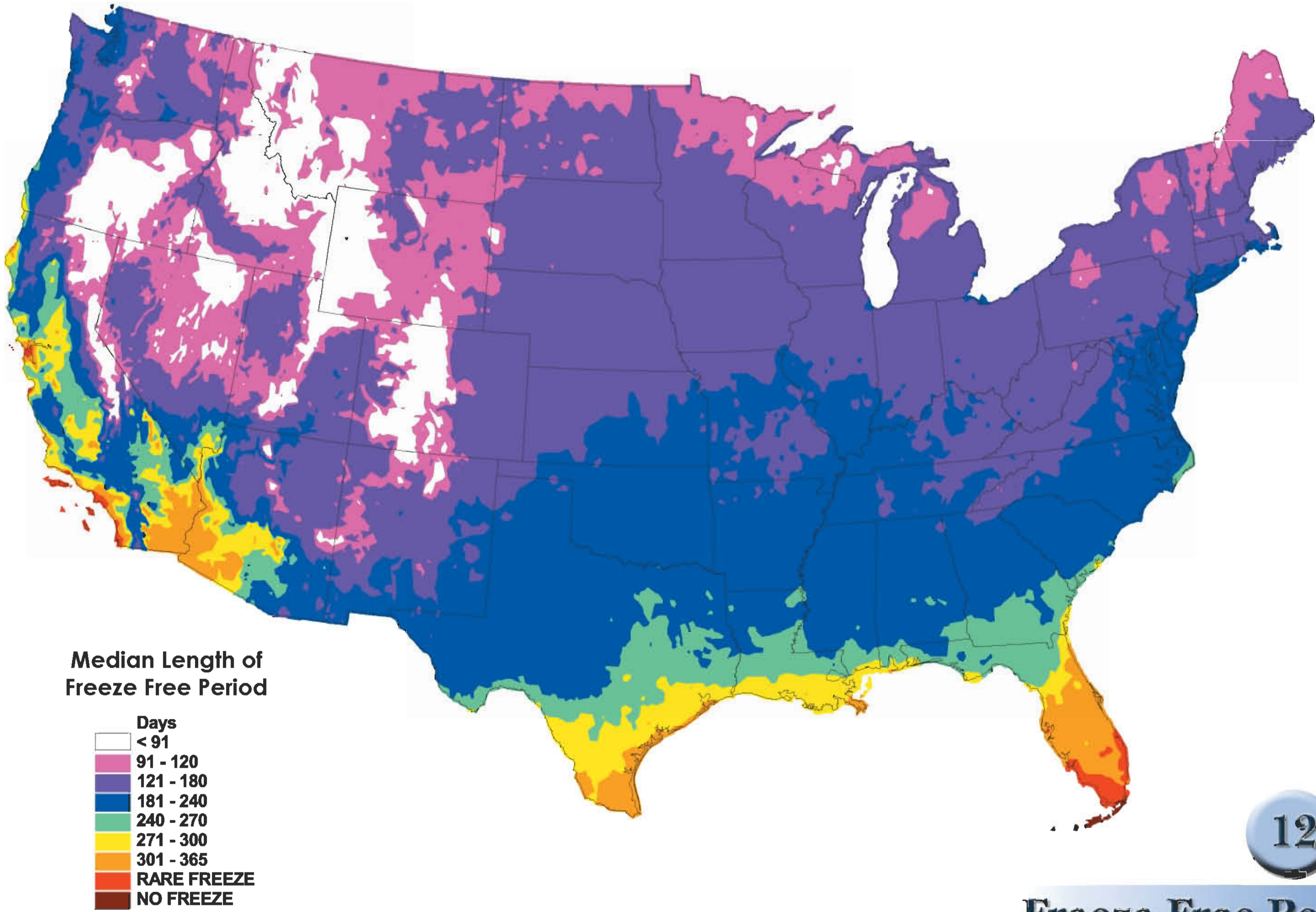
First 32 Deg F Temperature

Freeze Free Period

11





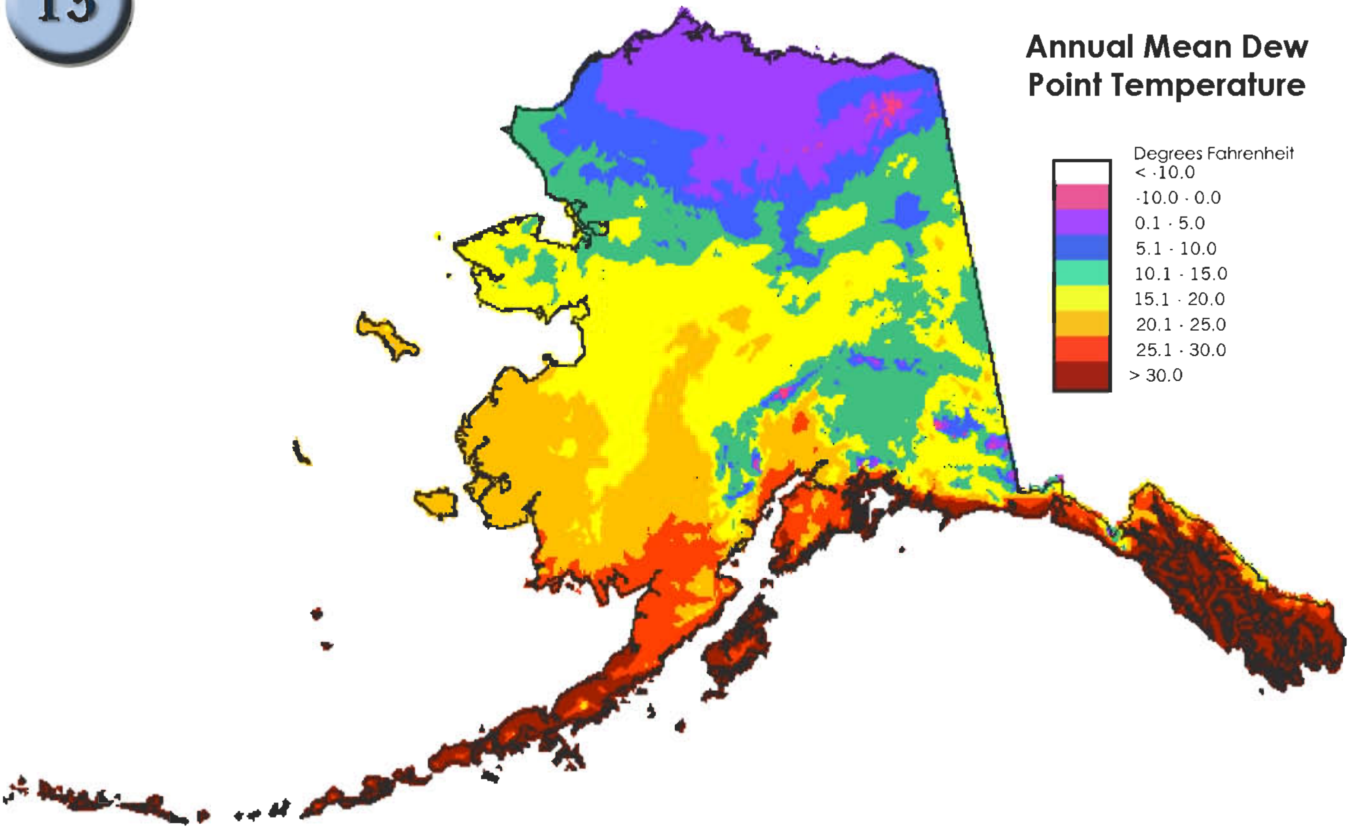


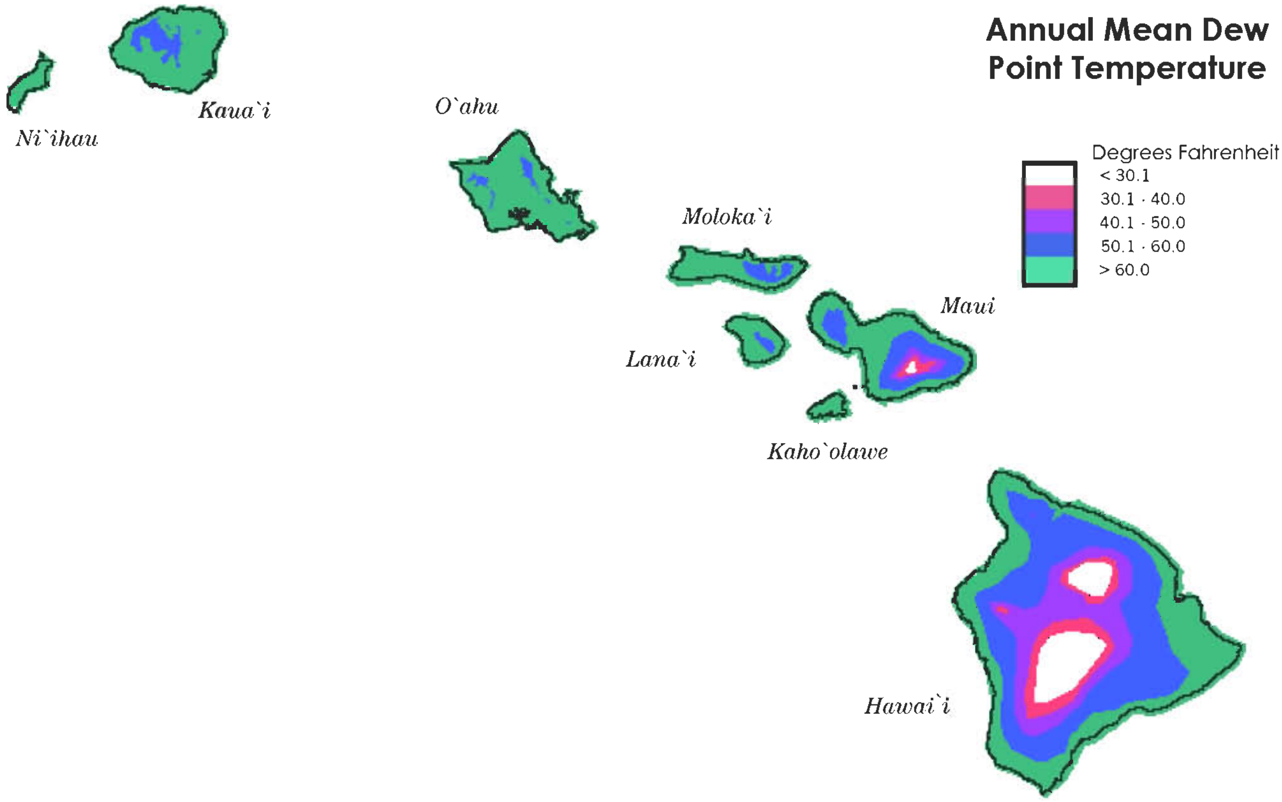
12

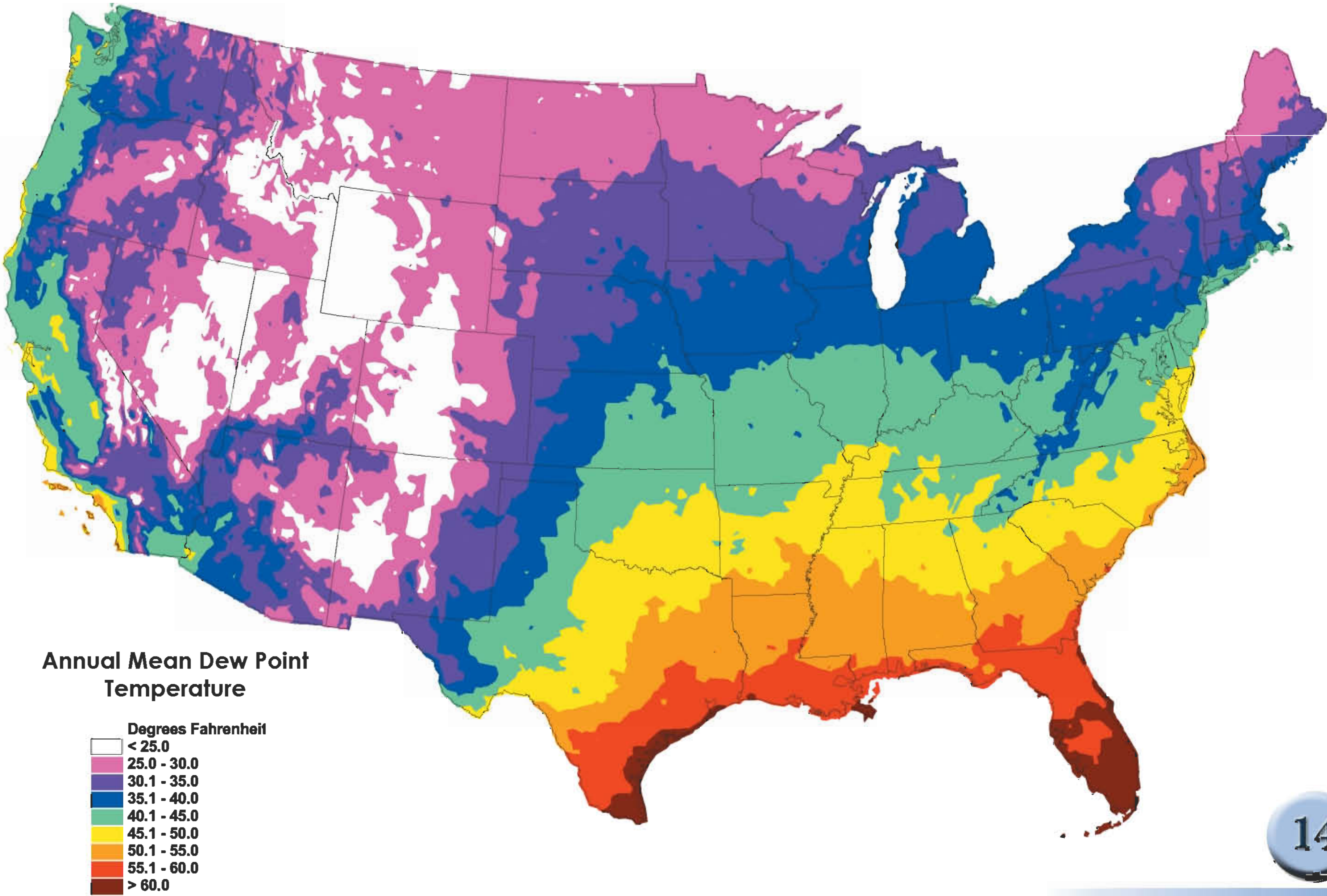
Freeze Free Period

Dew Point Temperature

13



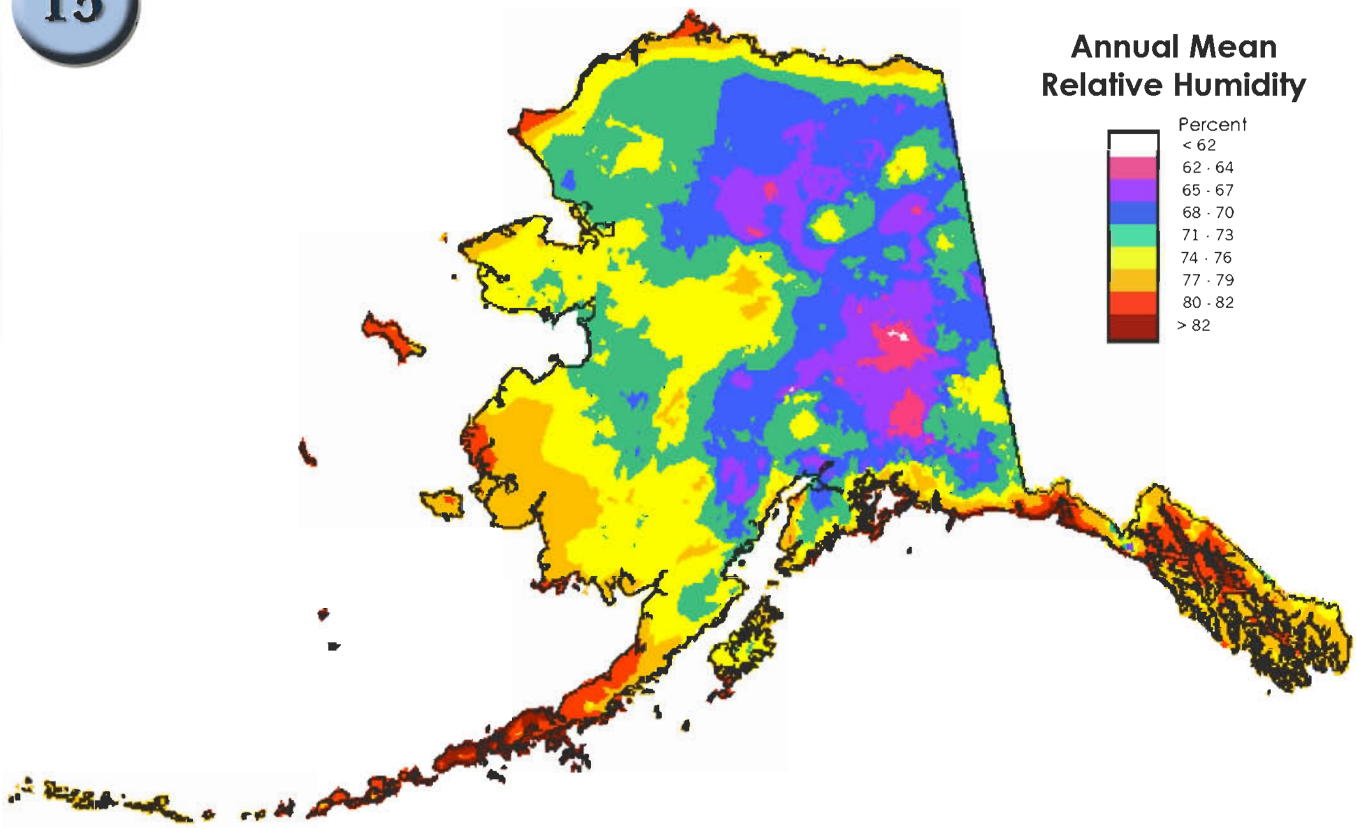


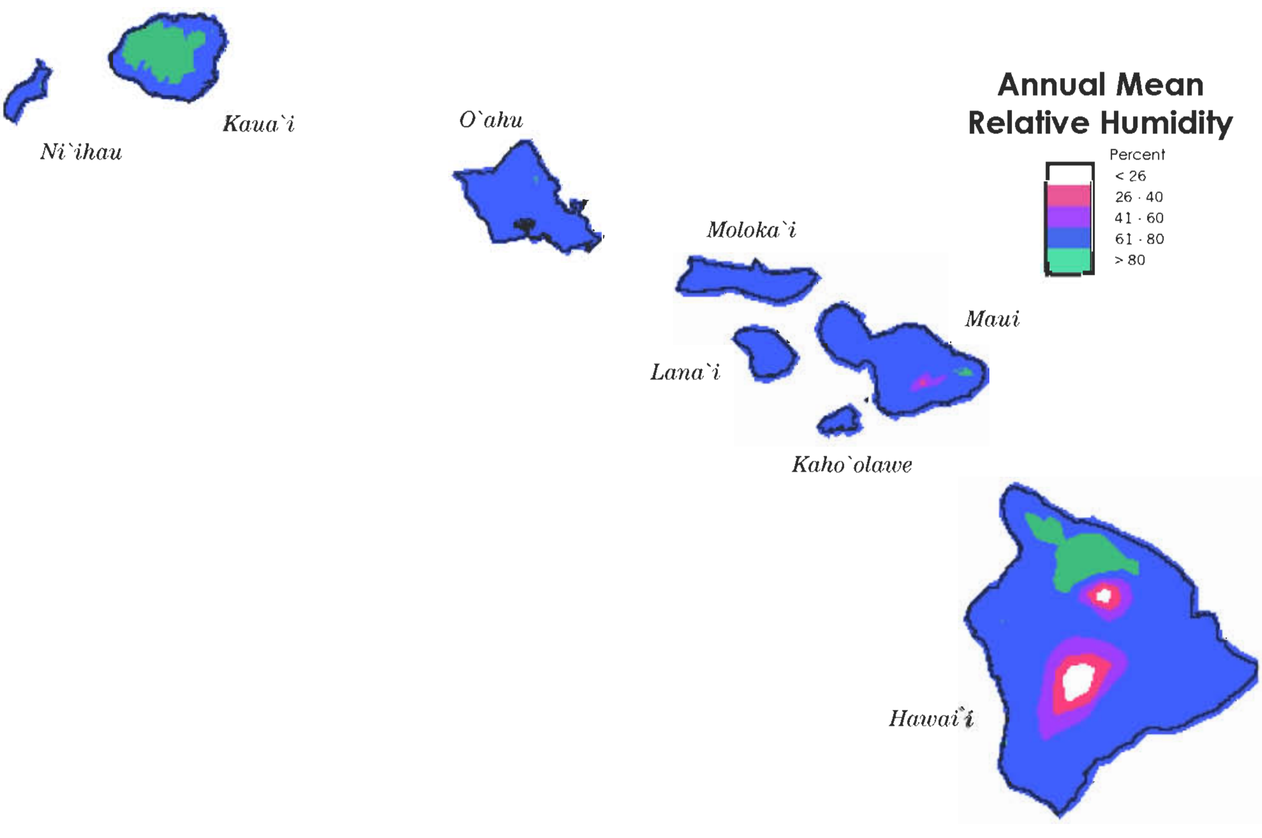


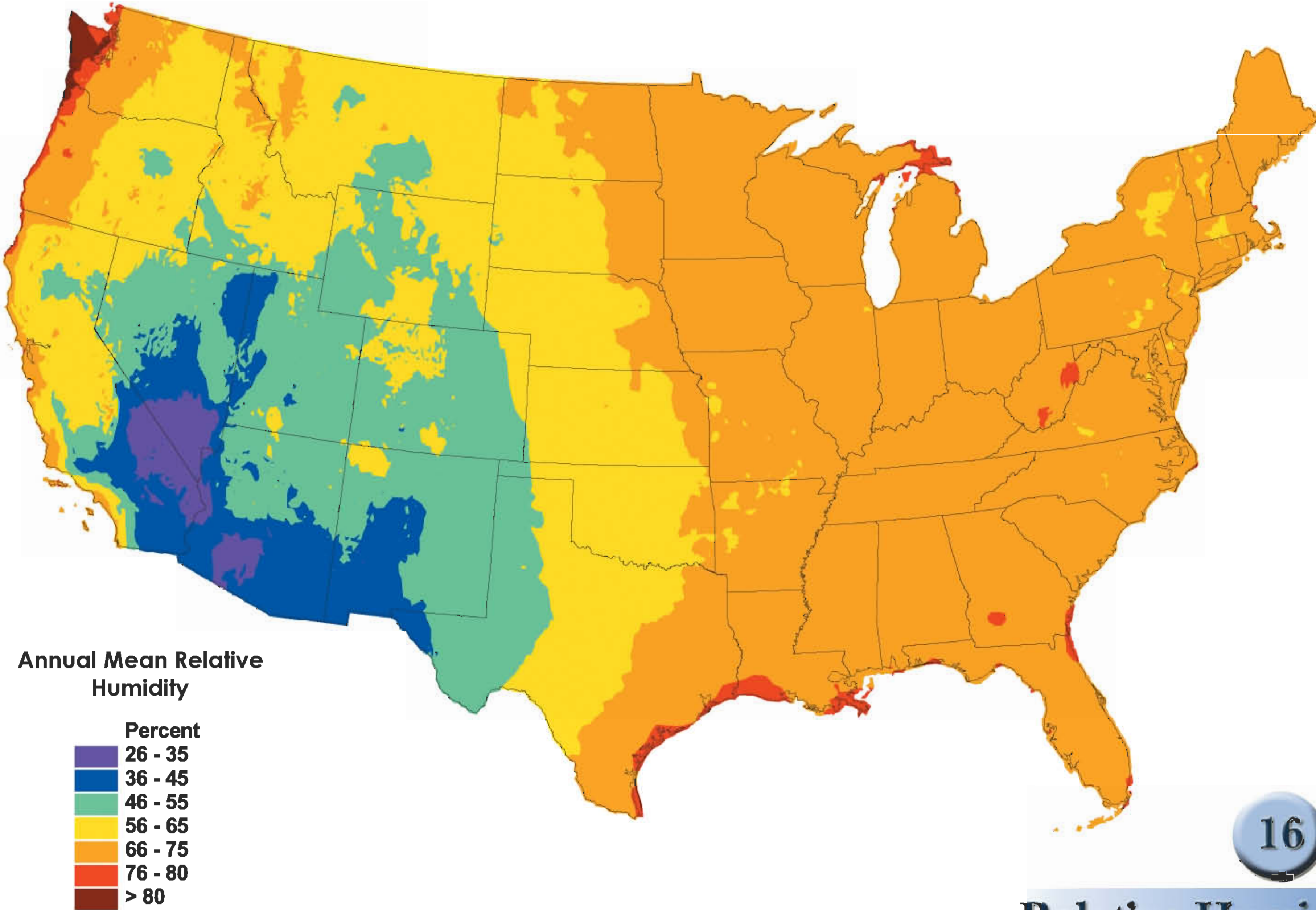
Dew Point Temperature

Relative Humidity

15





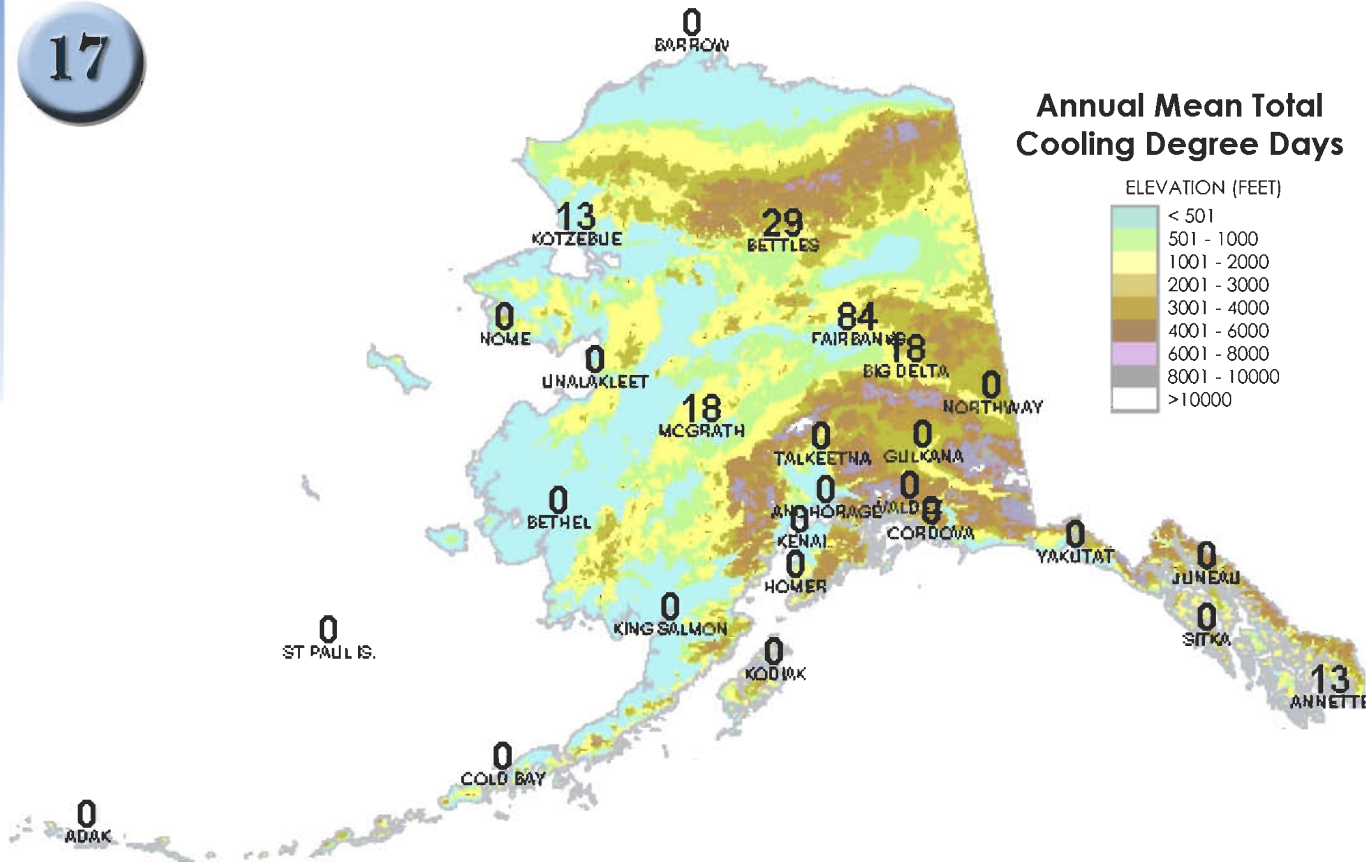


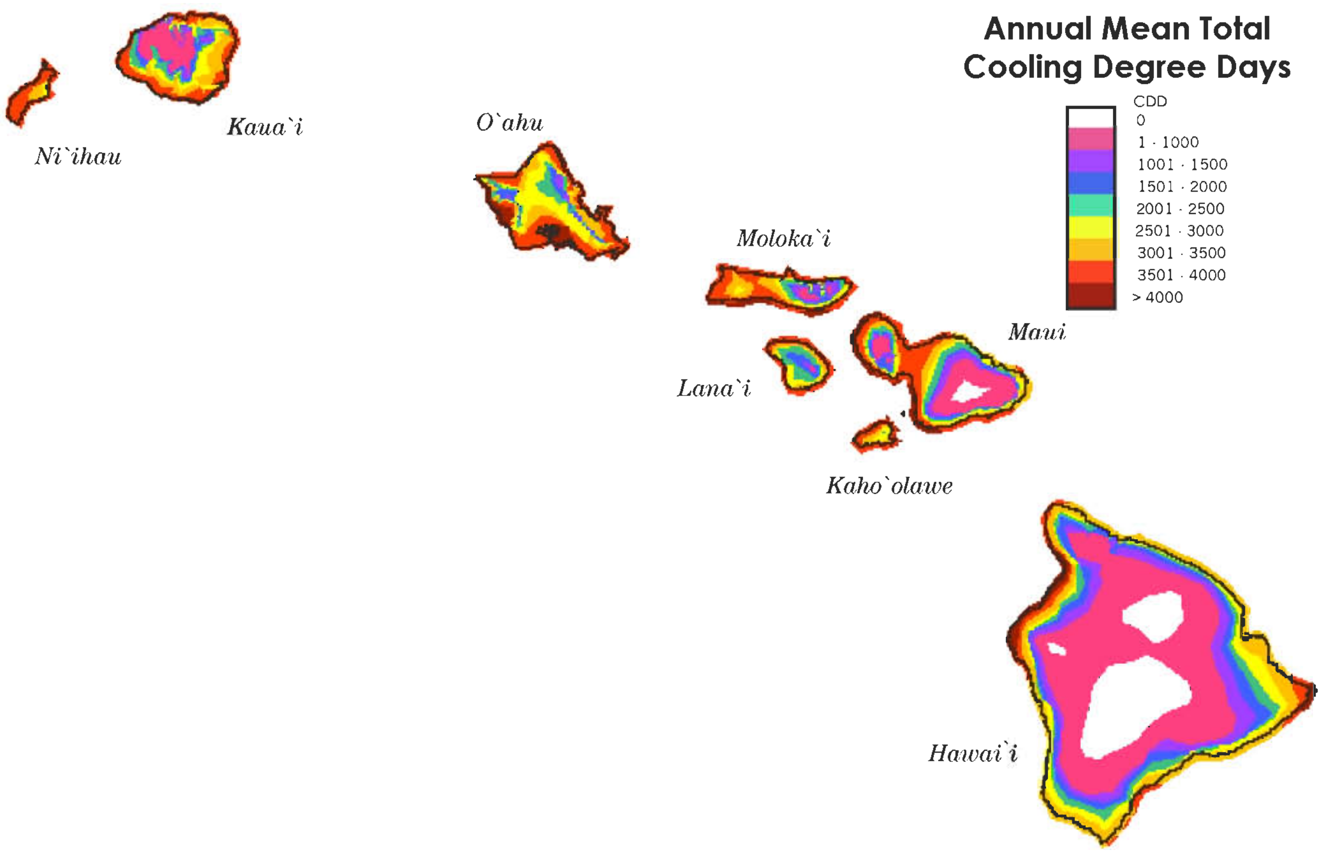
16

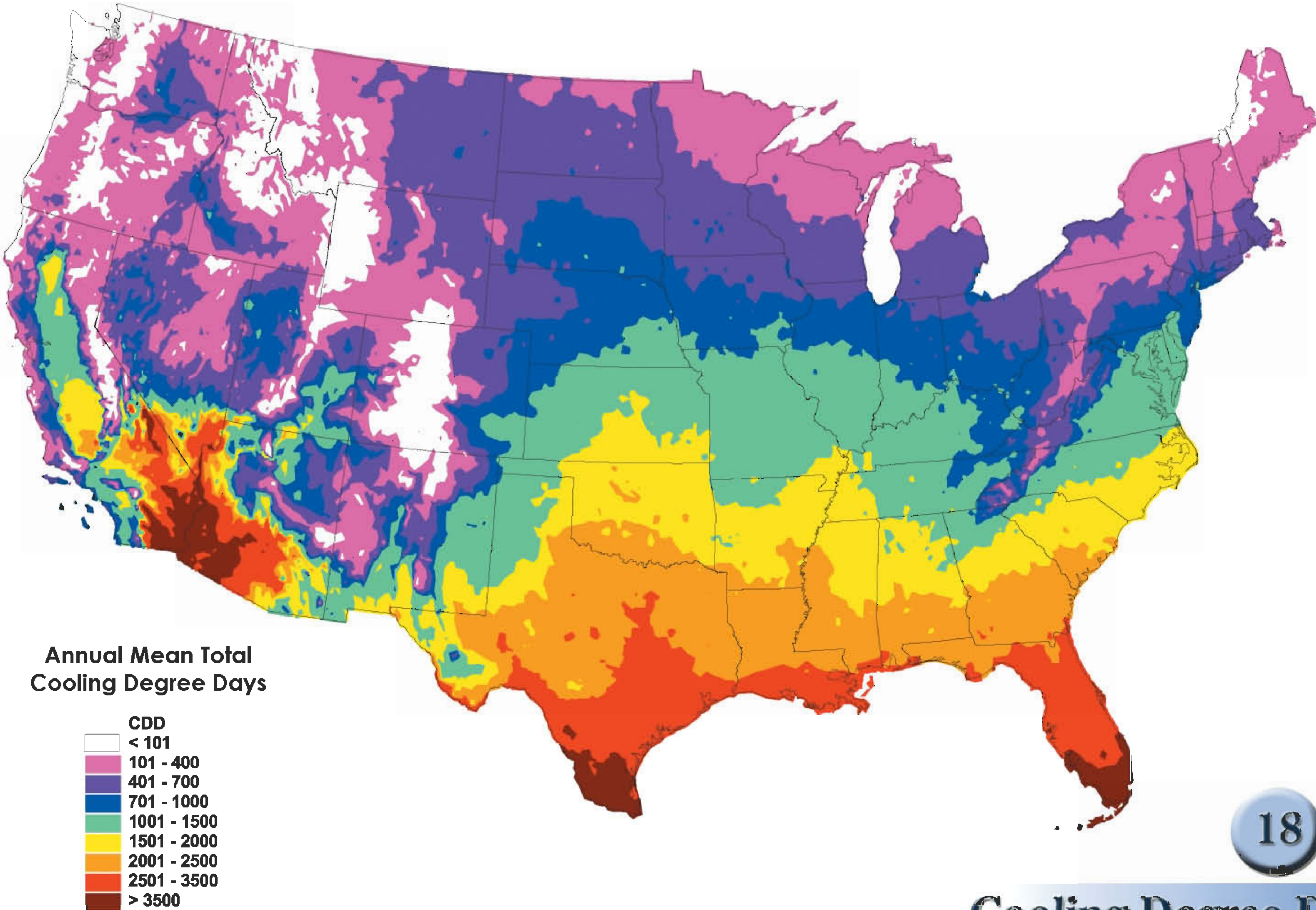
Relative Humidity

Cooling Degree Days

17





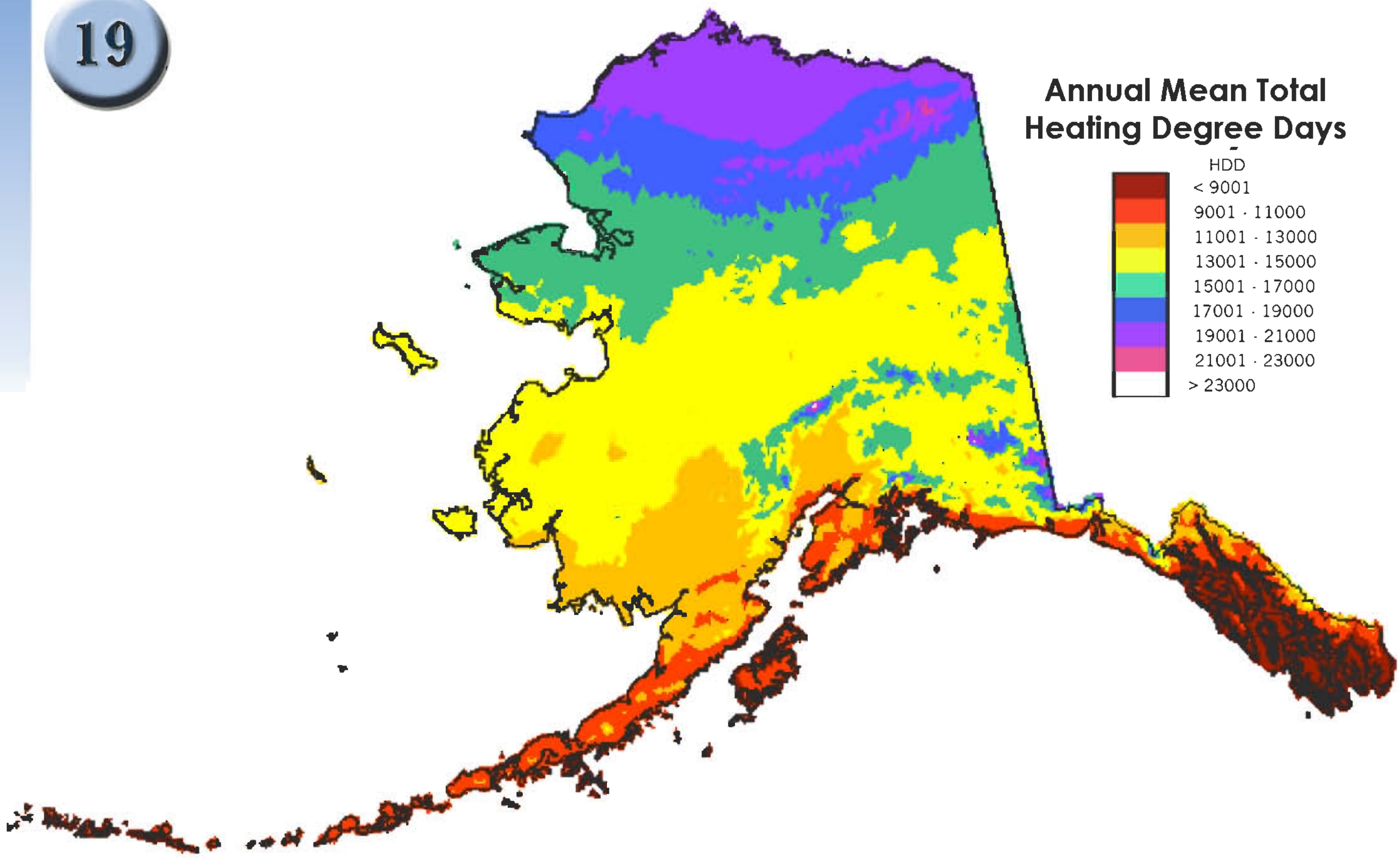


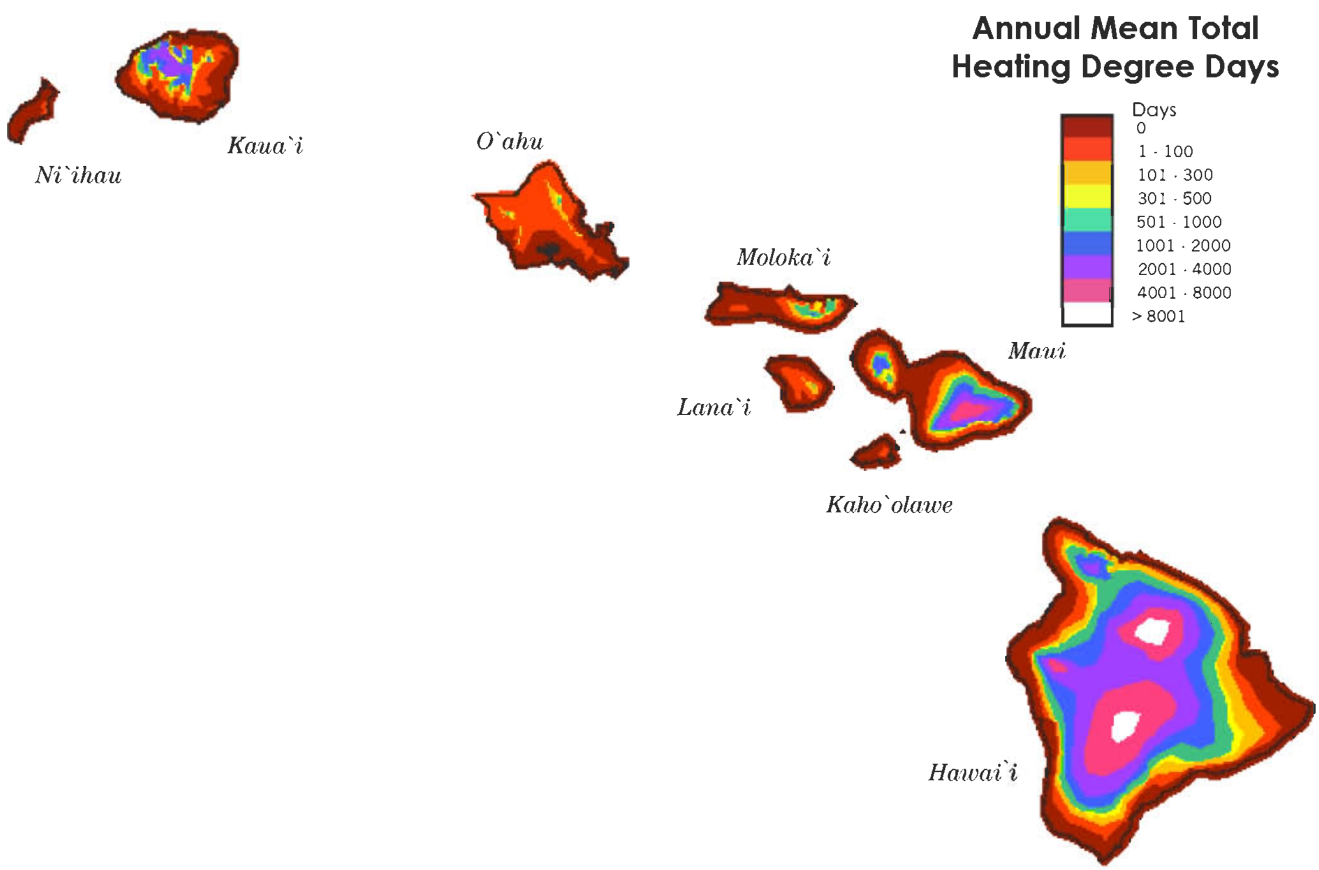
18

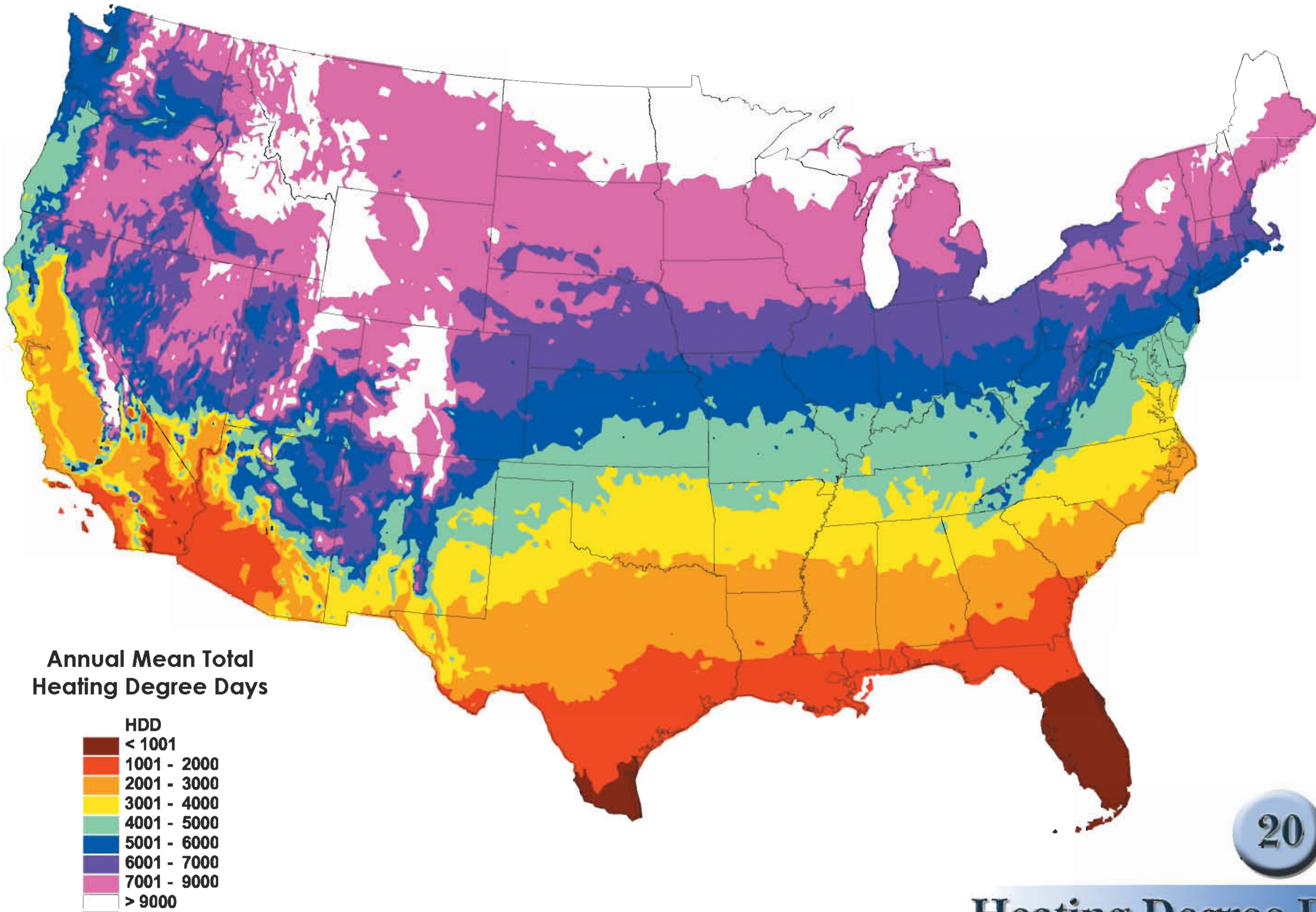
Cooling Degree Days

Heating Degree Days

19



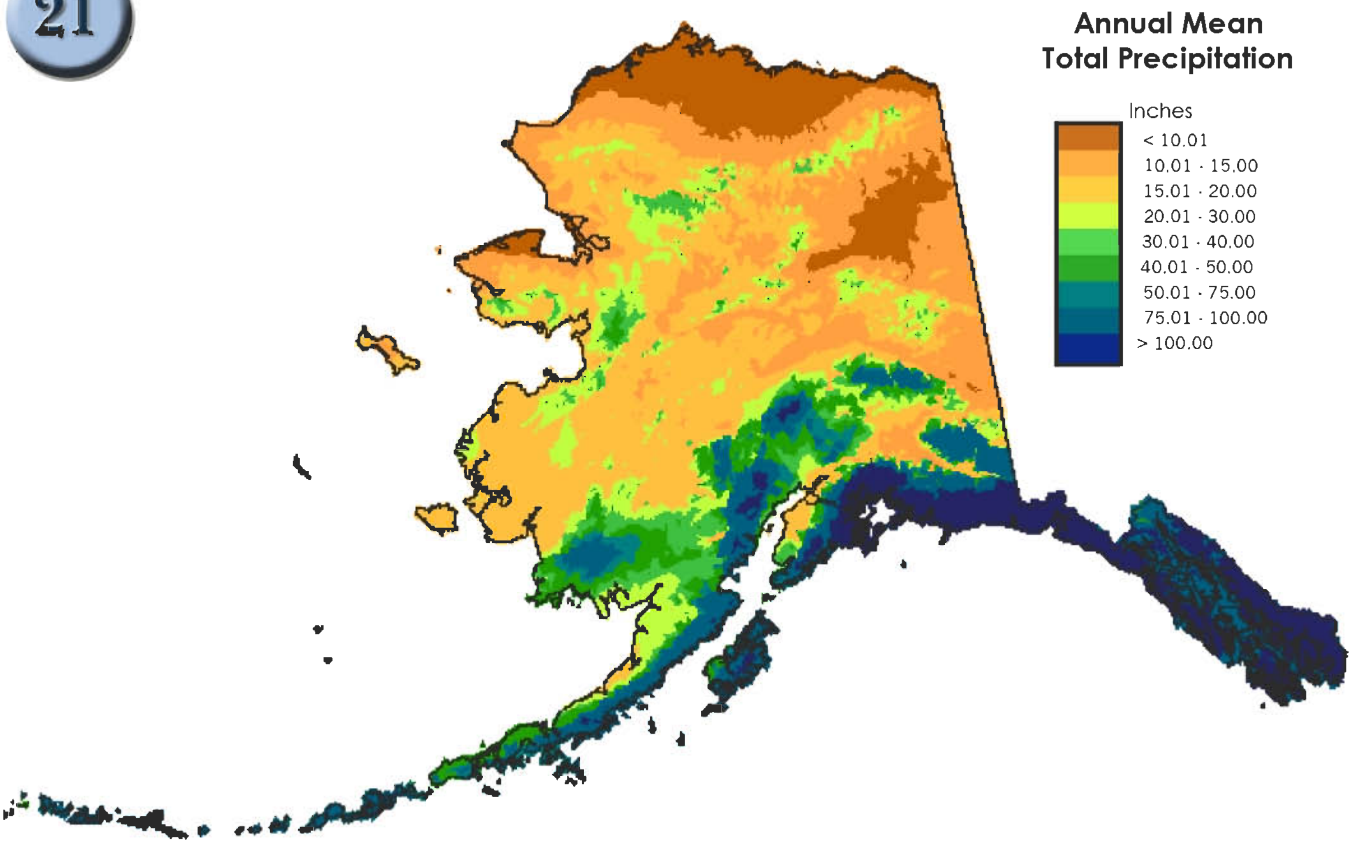


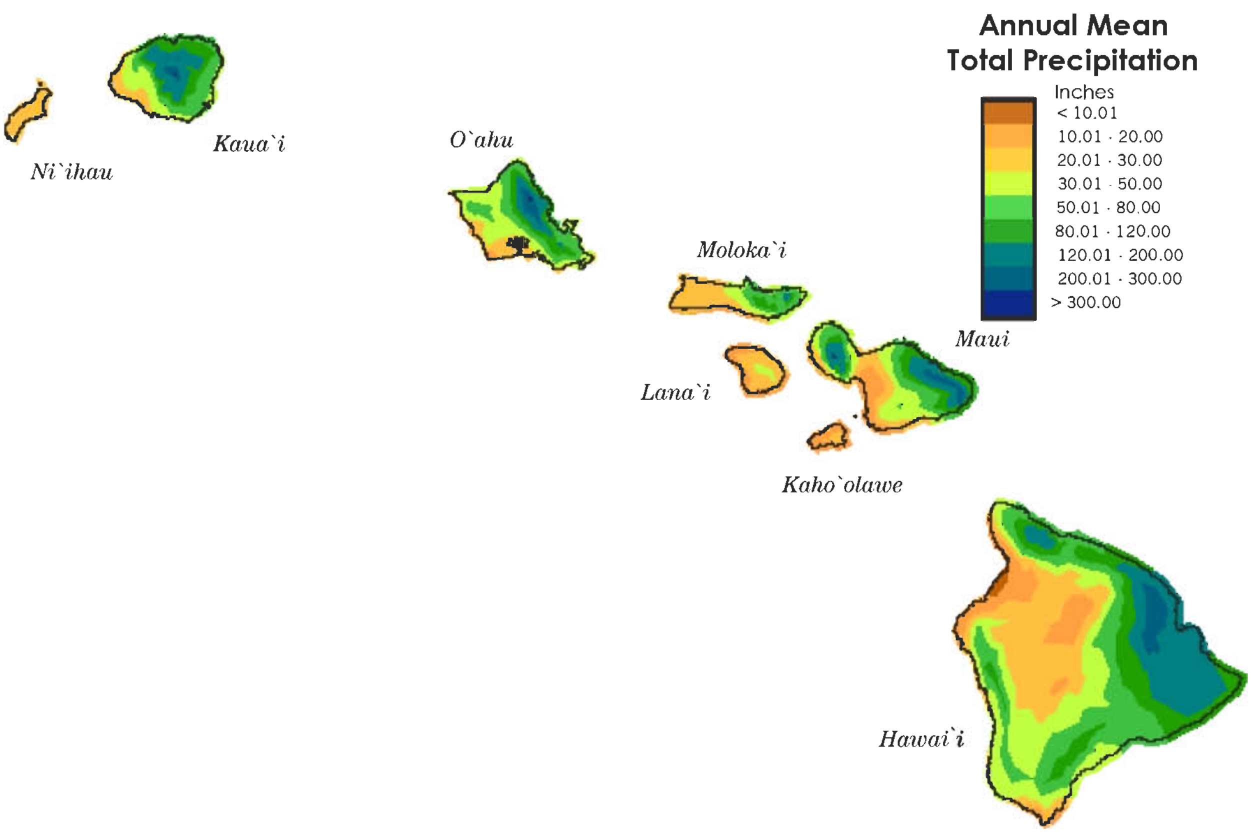


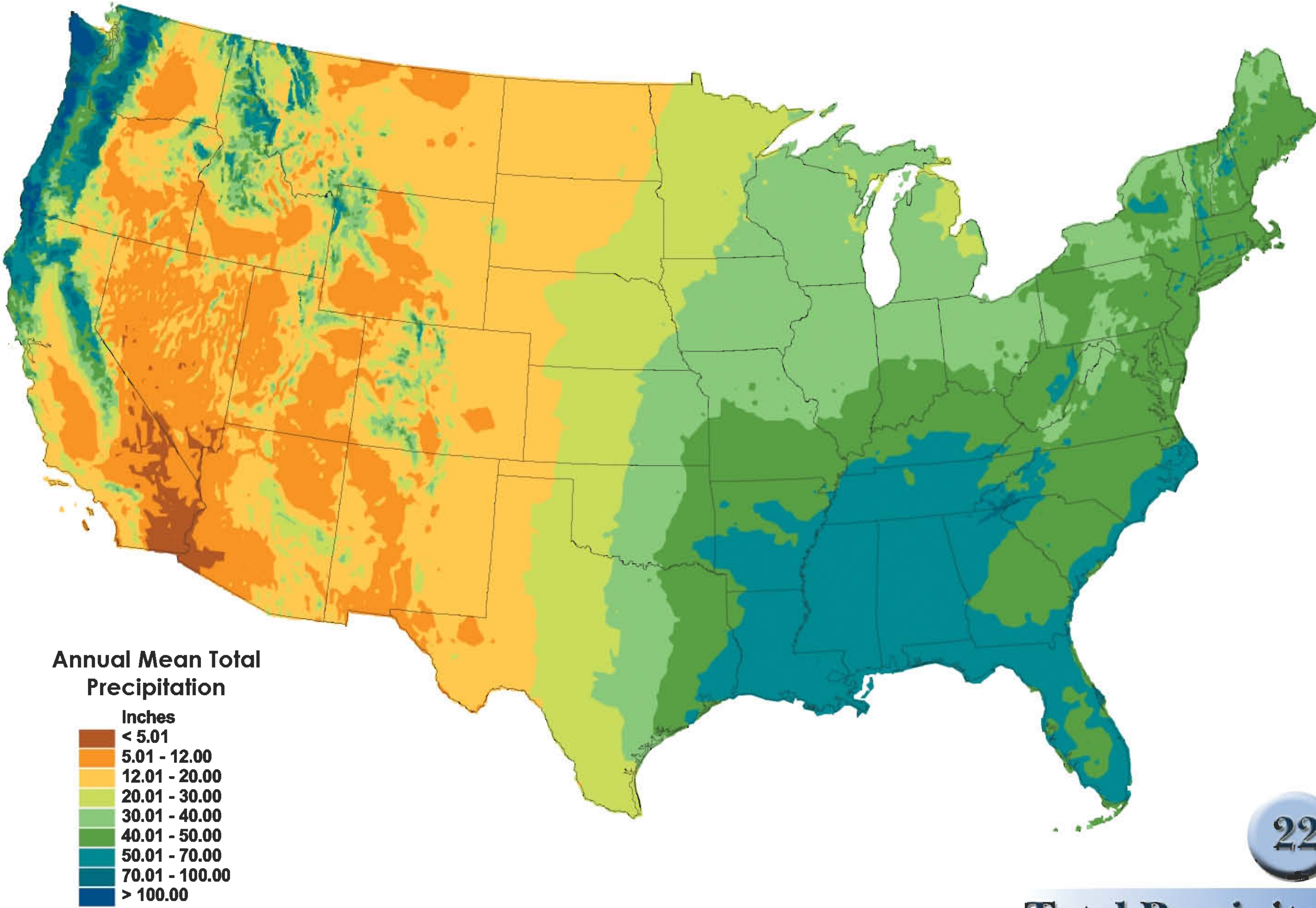
Heating Degree Days

Total Precipitation

21



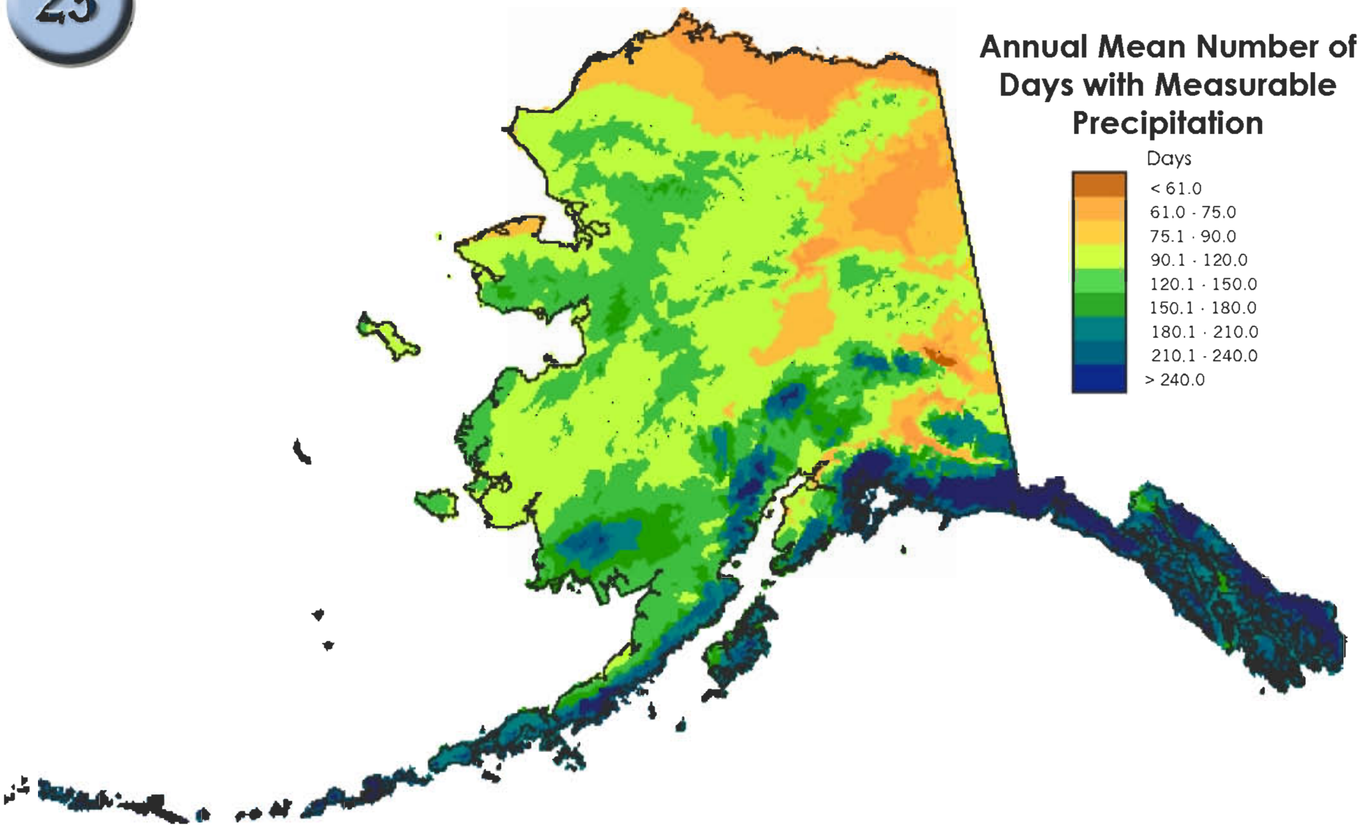


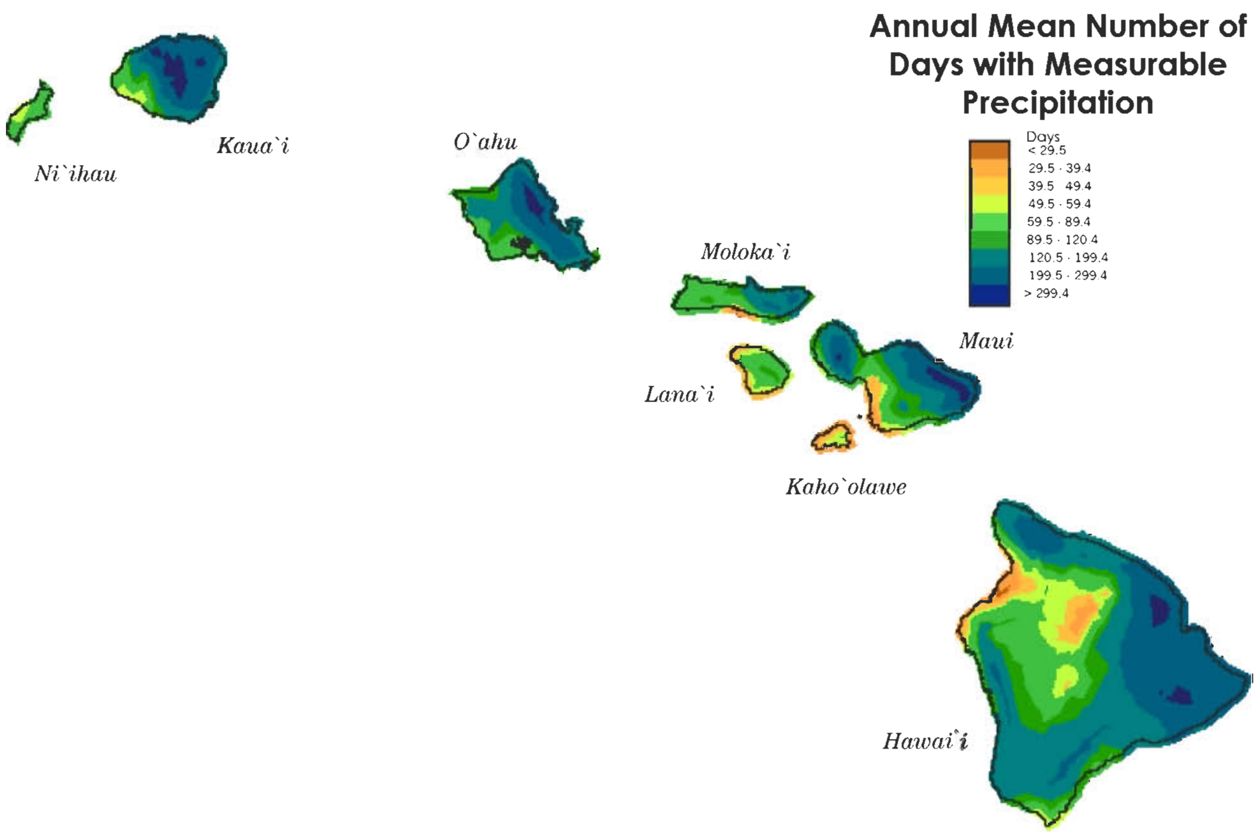


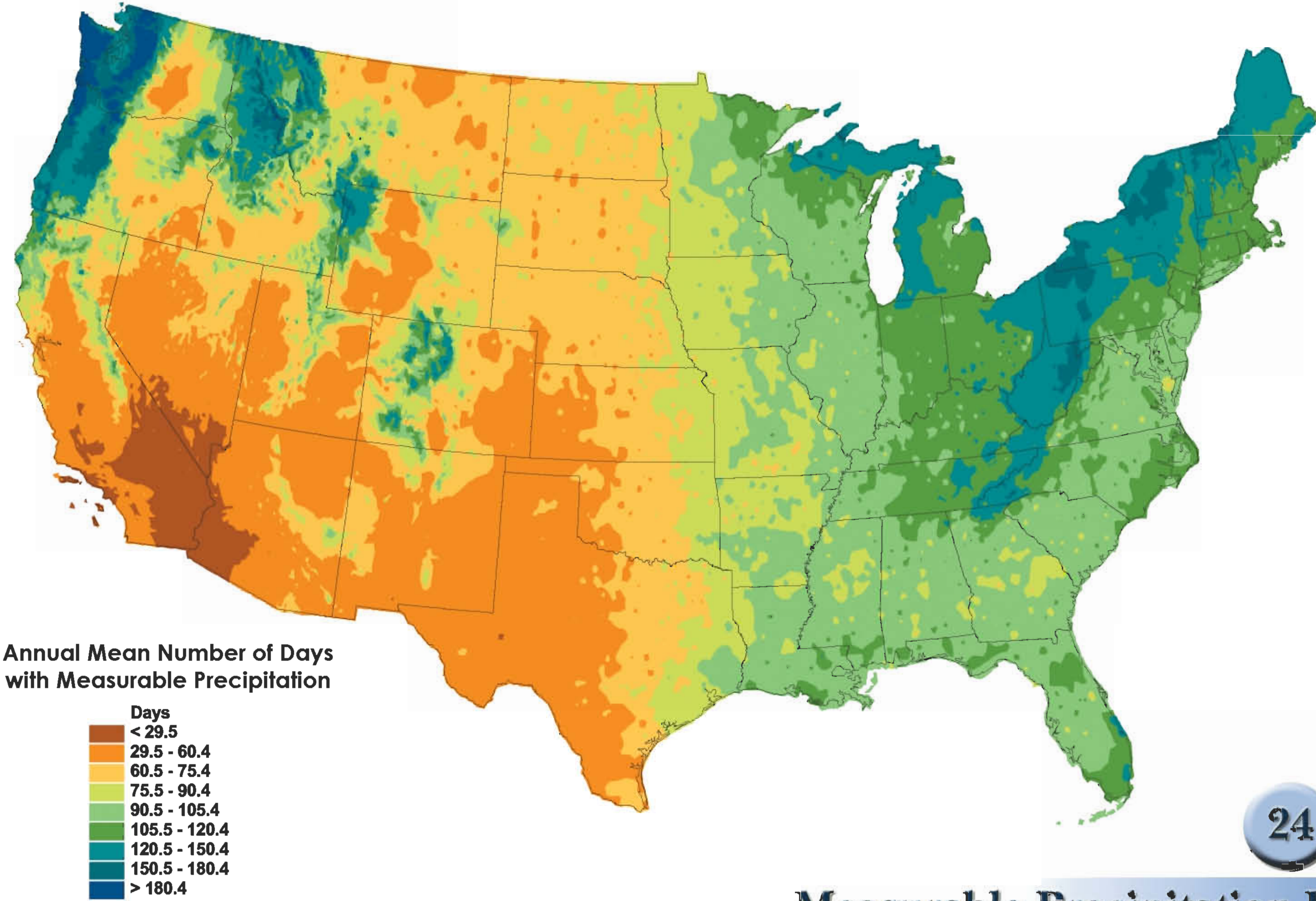
Total Precipitation

Measurable Precipitation Days

23



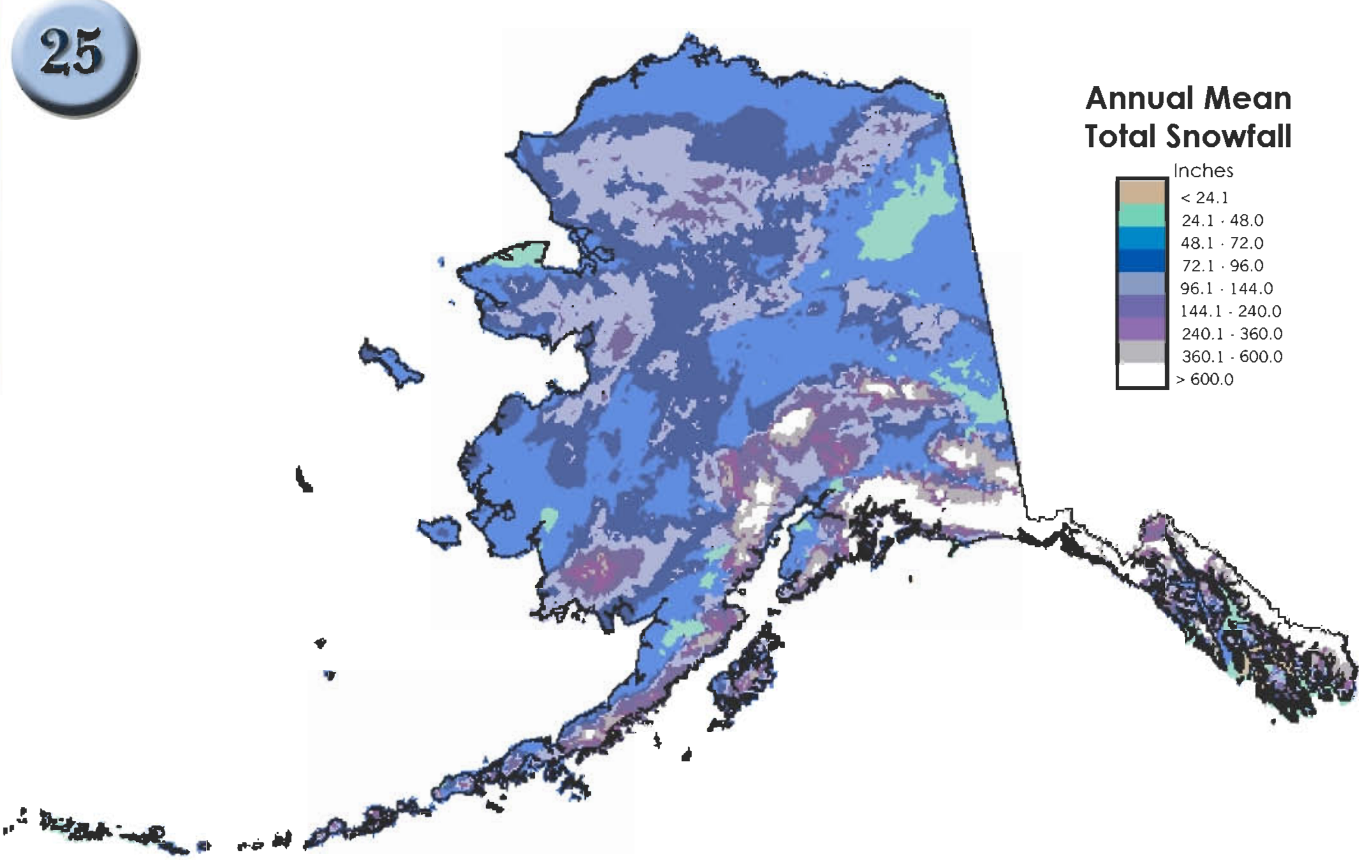




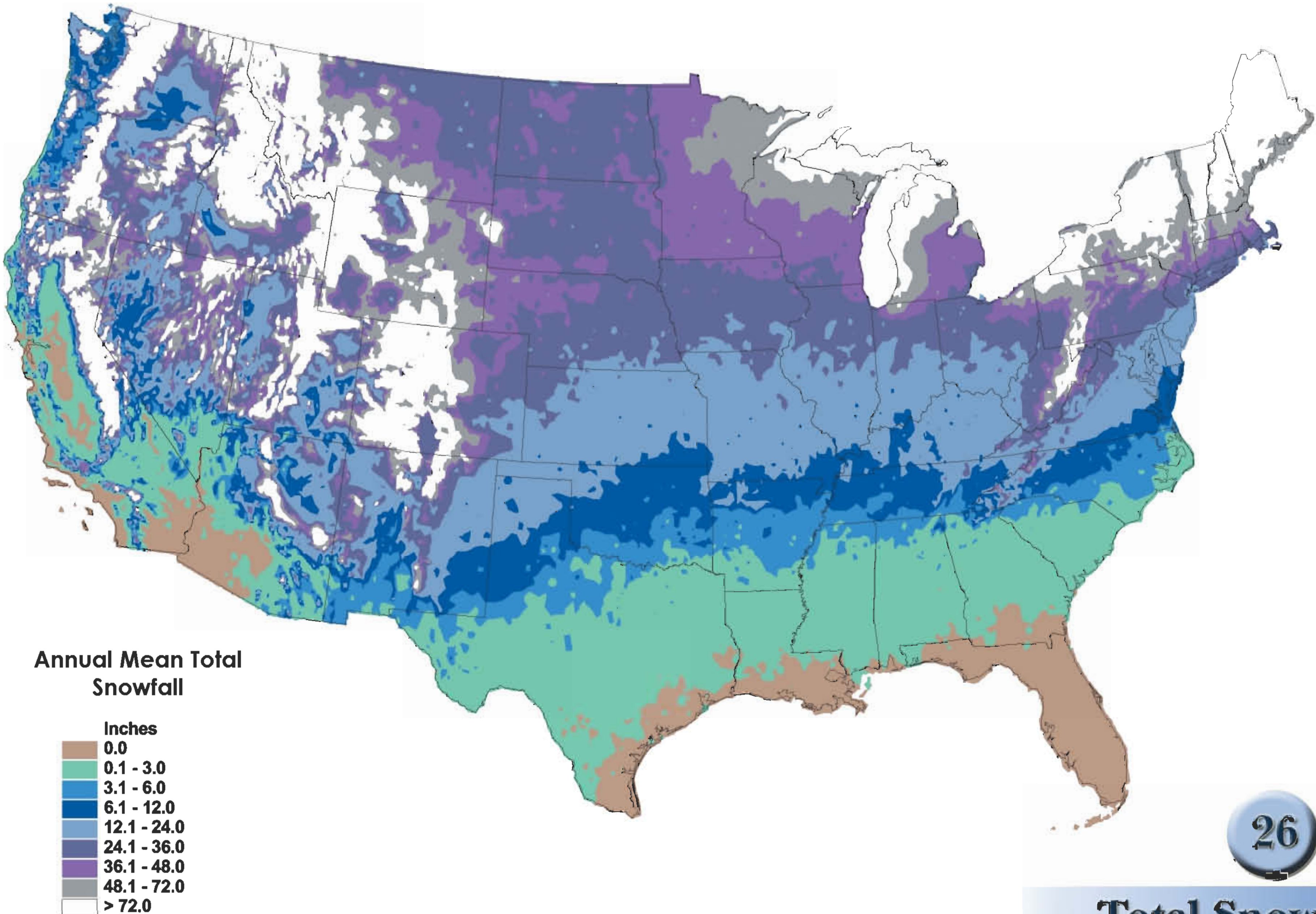
Measurable Precipitation Days

Total Snowfall

25



Map Not Available for Hawaii

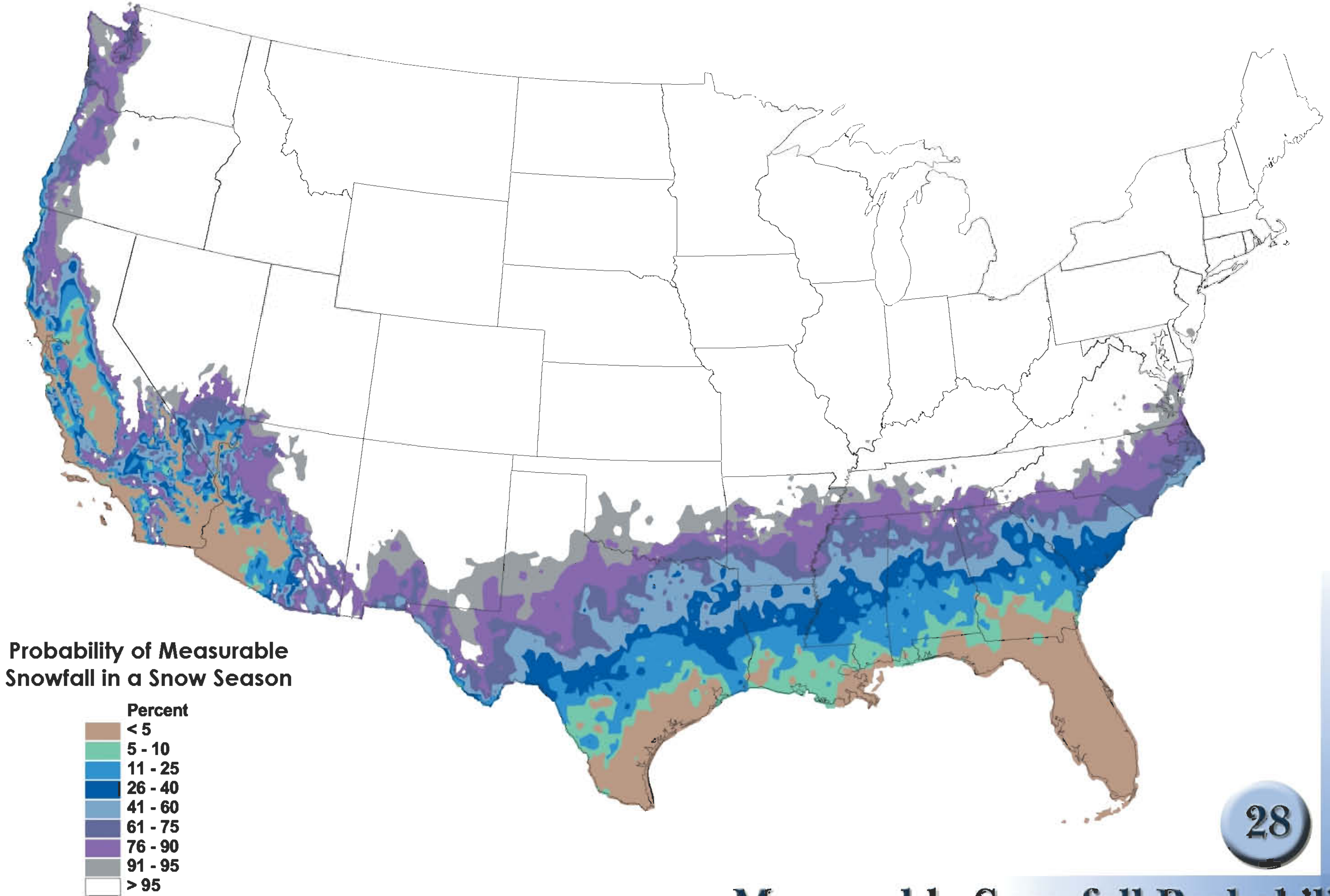


26

Total Snowfall

Map Not Available for Alaska

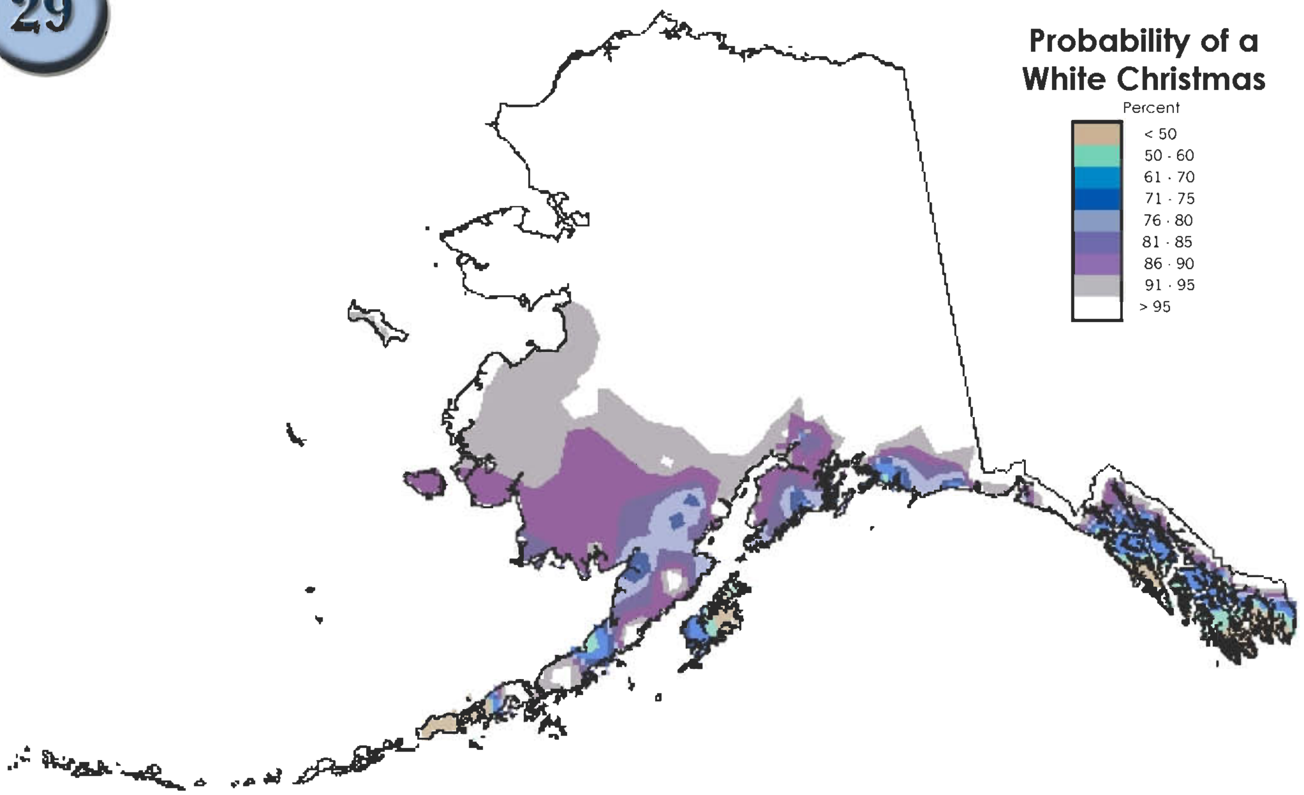
Map Not Available for Hawaii



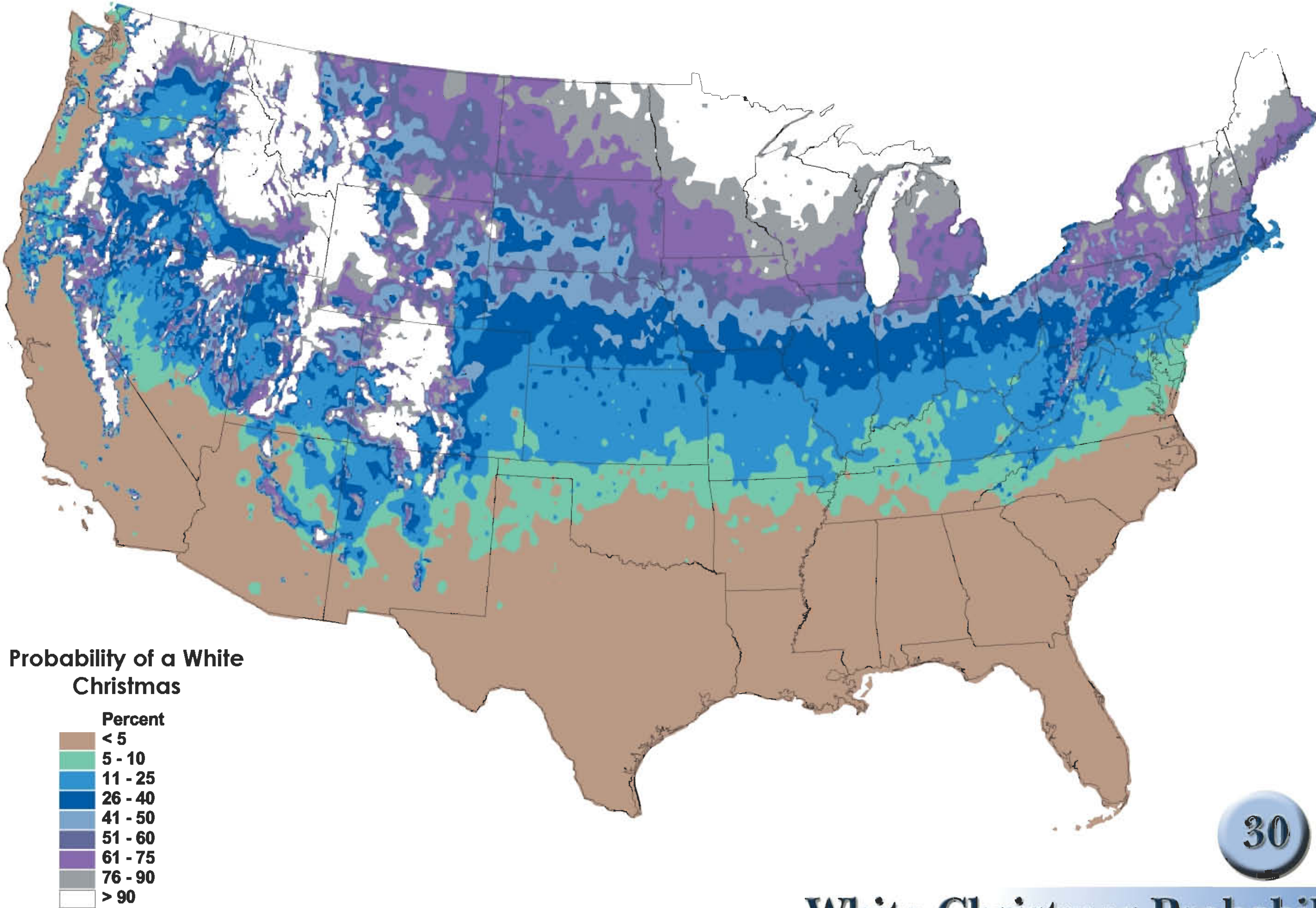
Measurable Snowfall Probability

White Christmas Probability

29



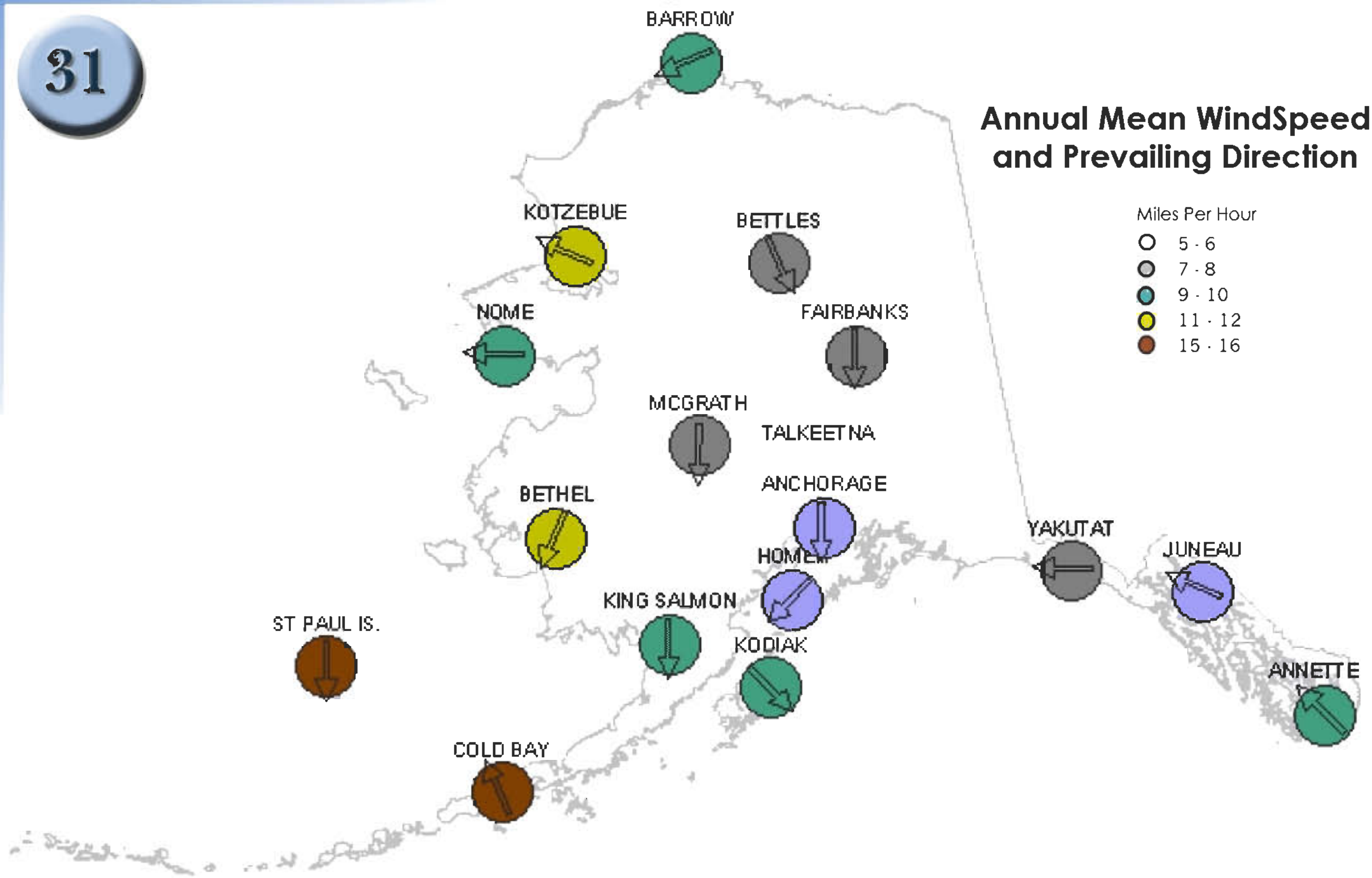
Map Not Available for Hawaii

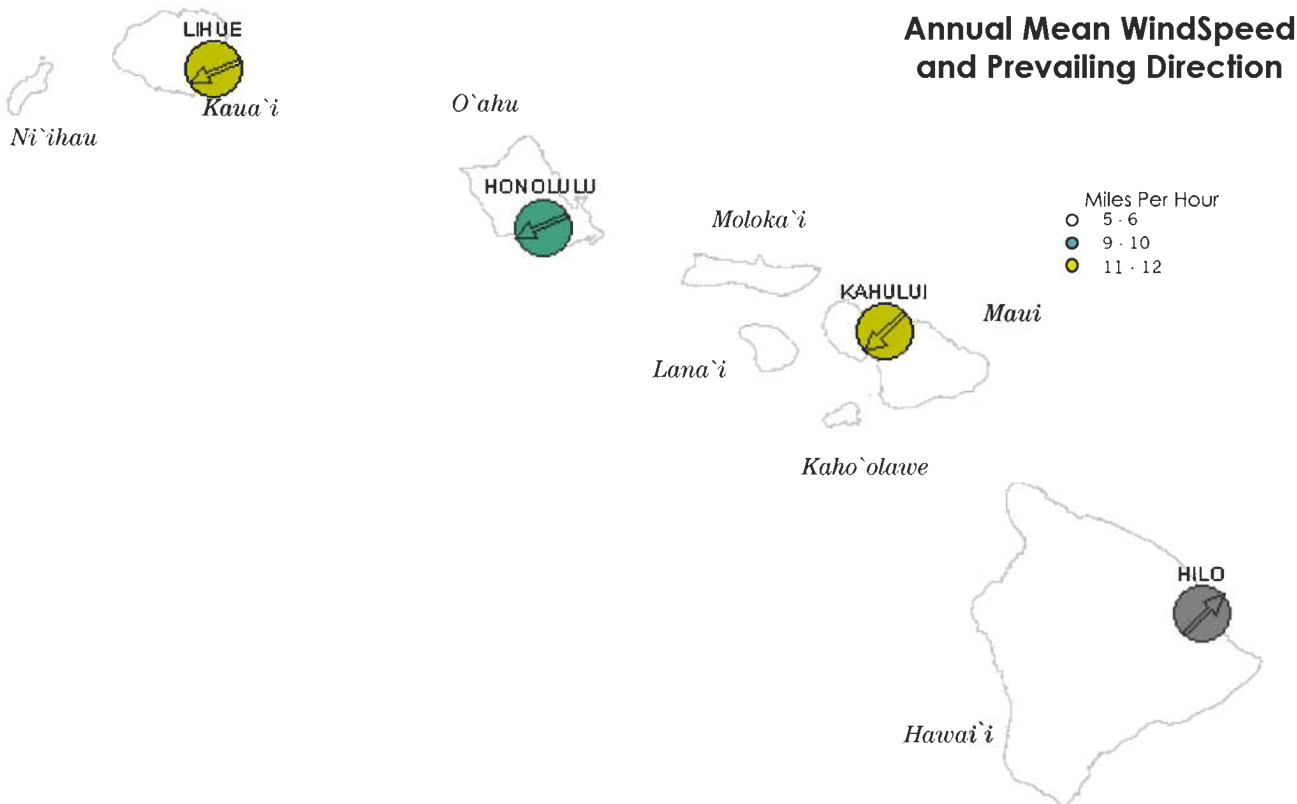


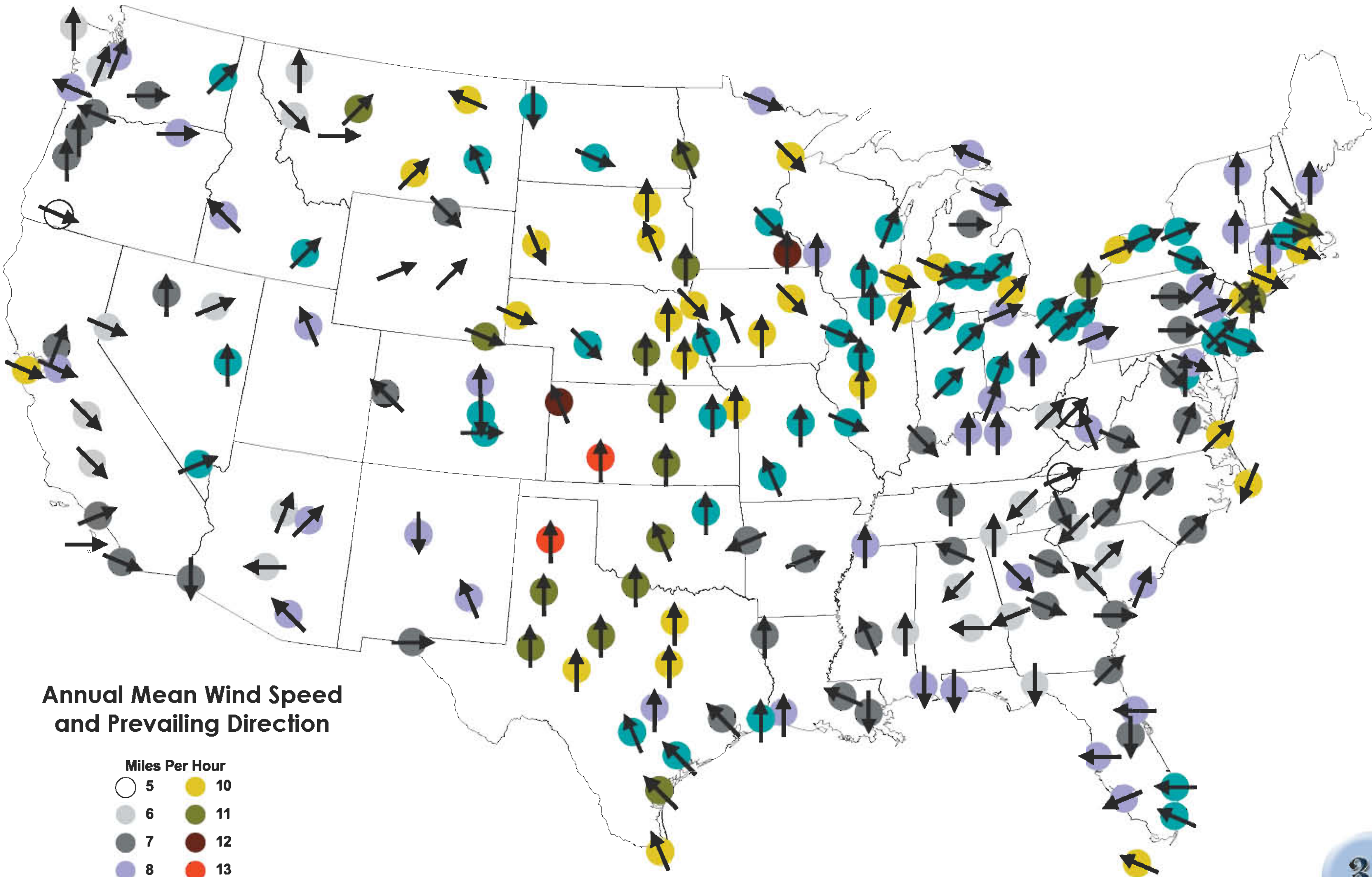
White Christmas Probability

Wind Speed and Prevailing Direction

31



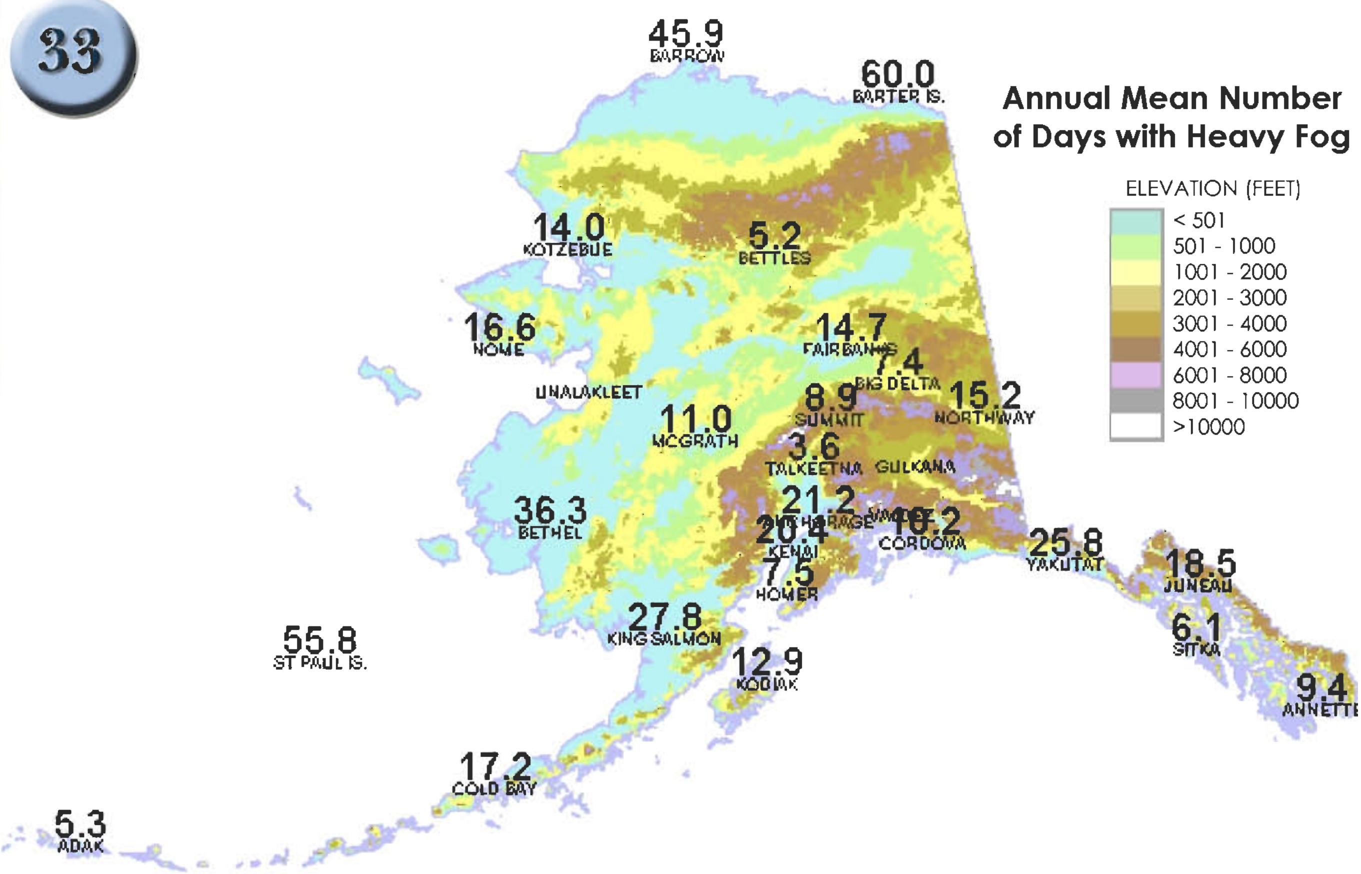


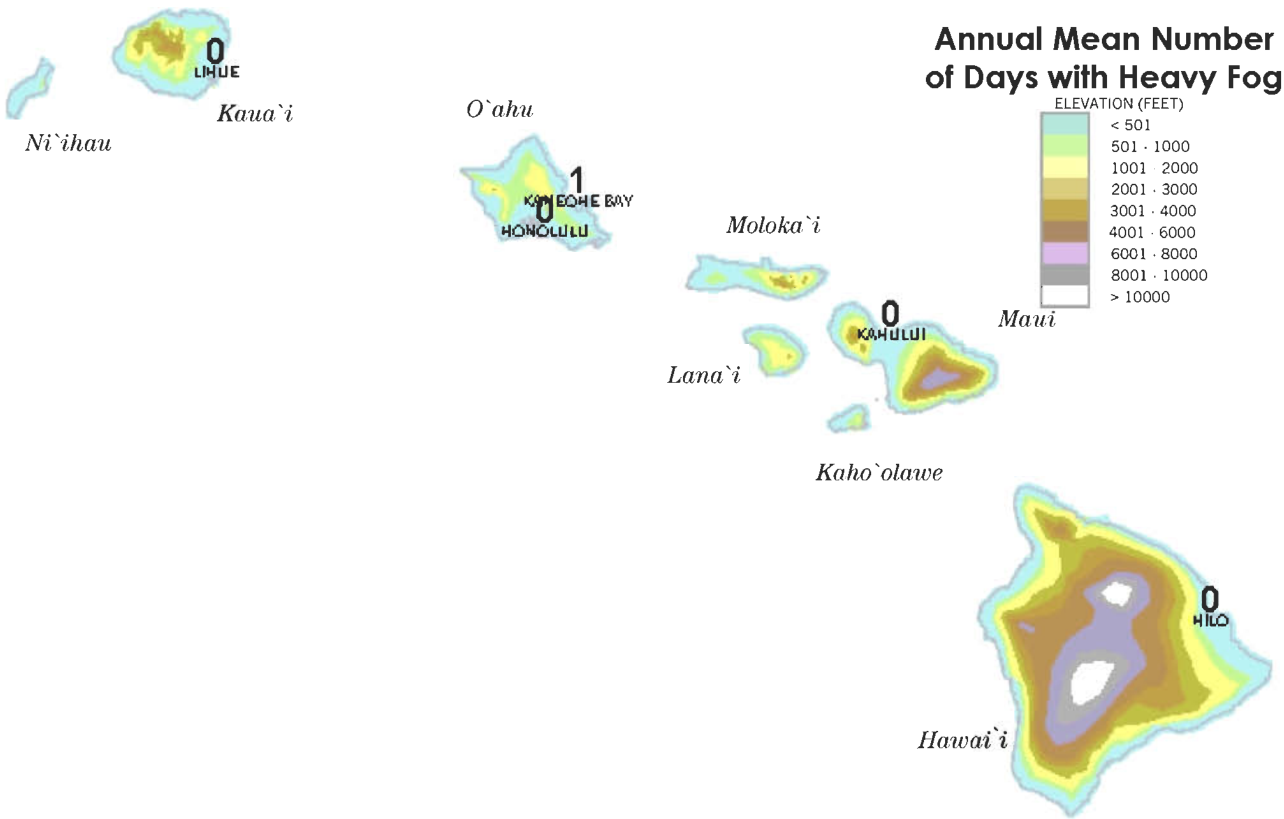


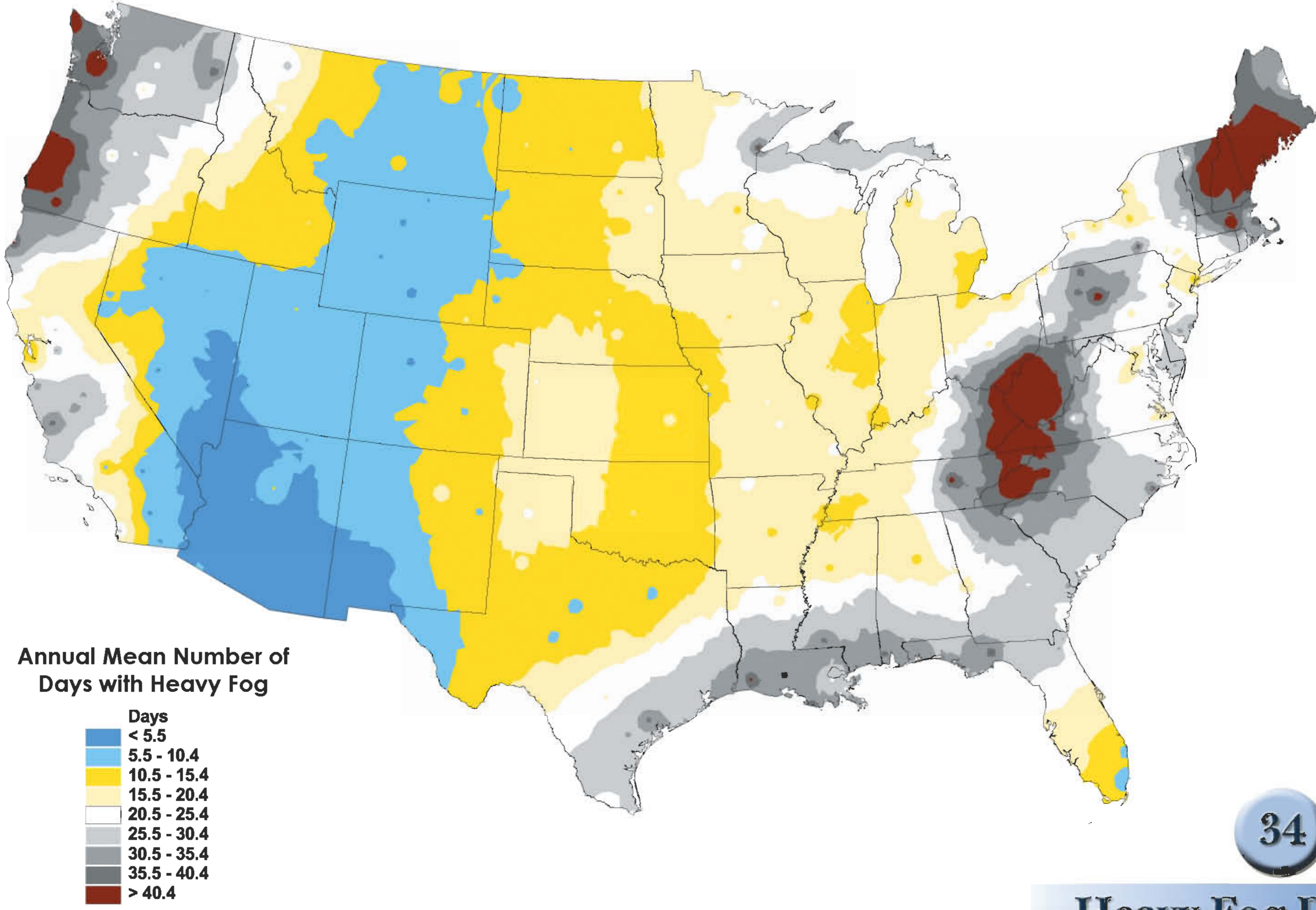
Wind Speed and Prevailing Direction

Heavy Fog Days

33

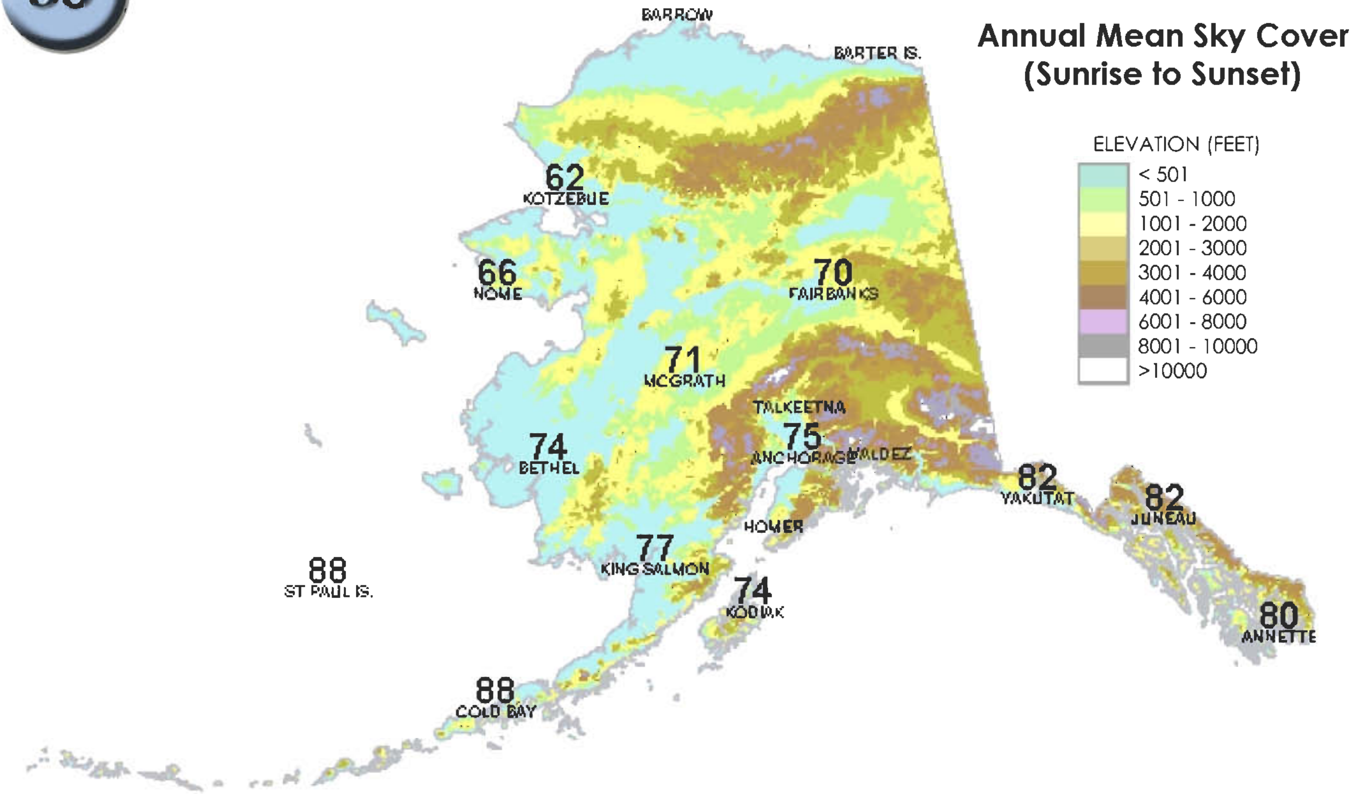




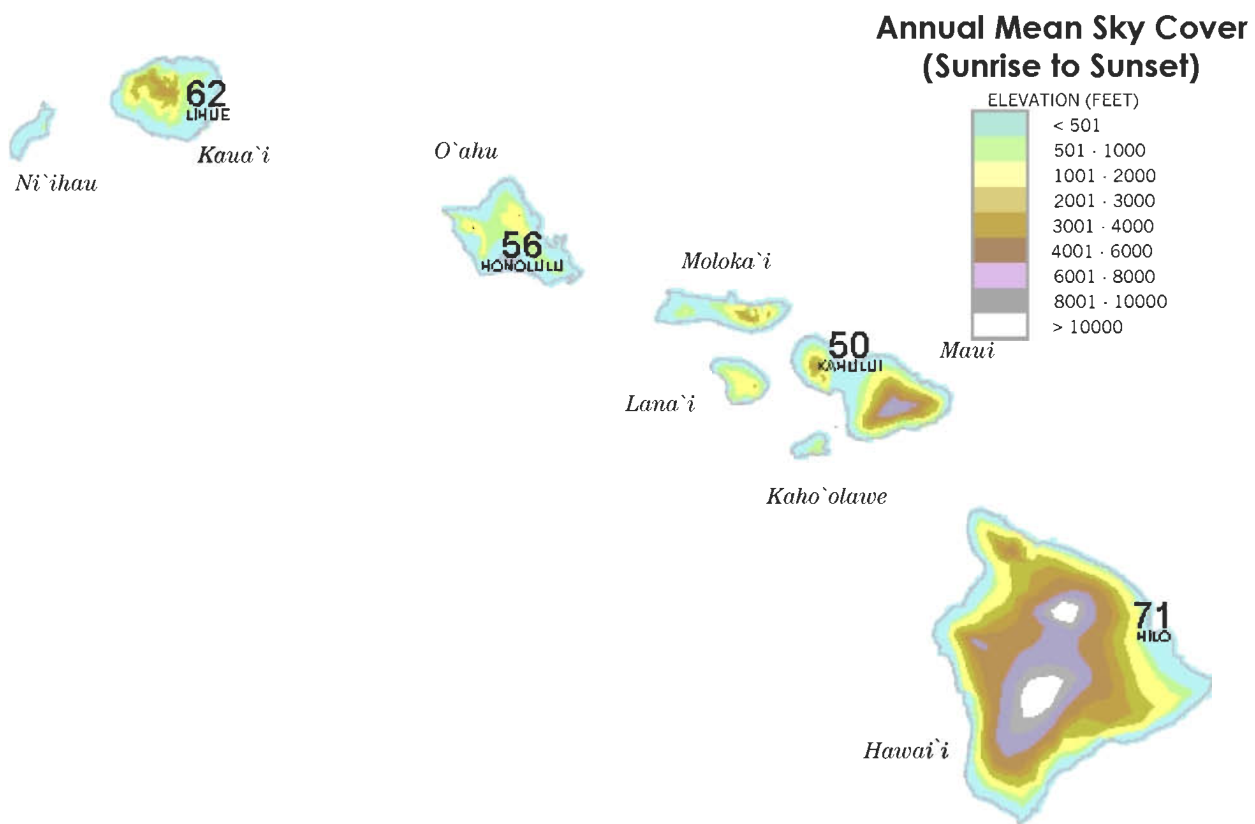

Annual Mean Number of Days with Heavy Fog
Days
< 5.5
5.5 - 10.4
10.5 - 15.4
15.5 - 20.4
20.5 - 25.4
25.5 - 30.4
30.5 - 35.4
35.5 - 40.4
> 40.4

Sky Cover

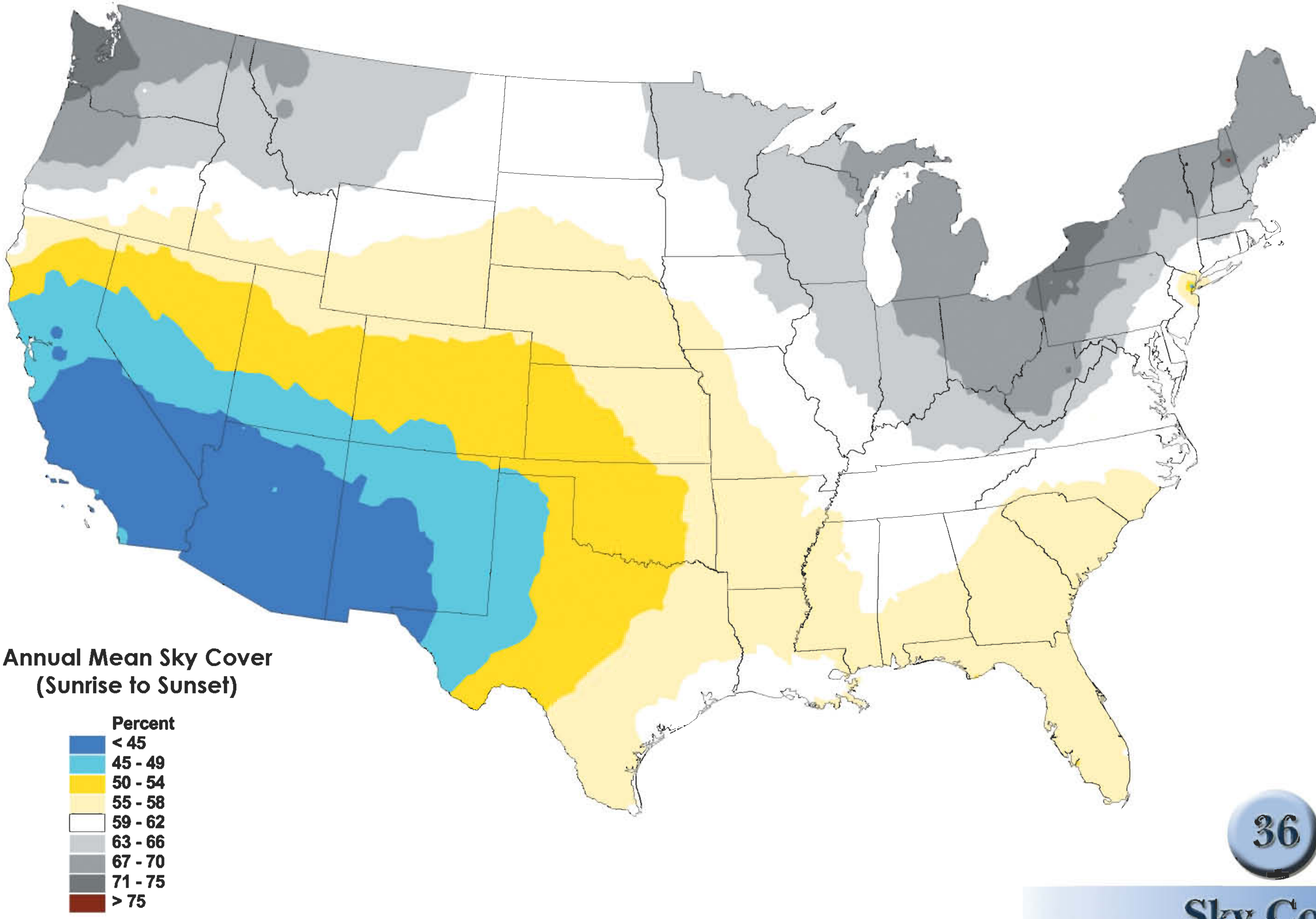
35



Annual Mean Sky Cover
(Sunrise to Sunset)
ELEVATION (FEET)
< 501
501 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 6000
6001 - 8000
8001 - 10000
>10000
BARROW
BARTER IS.
62
KOTZEBUE
66
NOME
70
FAIRBANKS
71
MCGRATH
TALKEETNA
75
ANCHORAGE
VALDEZ
74
BETHEL
82
YAKUTAT
82
JUNEAU
HOMER
77
KING SALMON
88
ST PAUL IS.
74
KODIAK
80
ANNETTE
88
COLD BAY

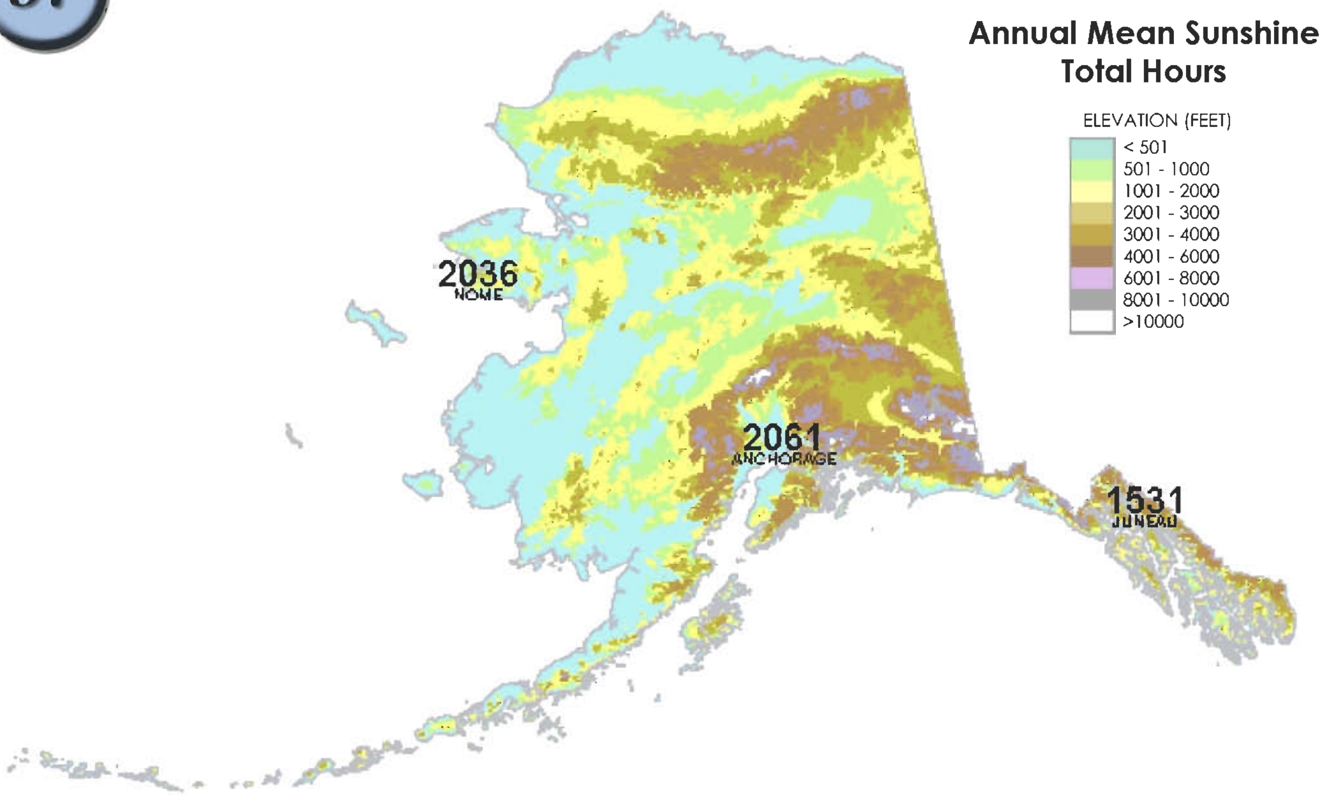


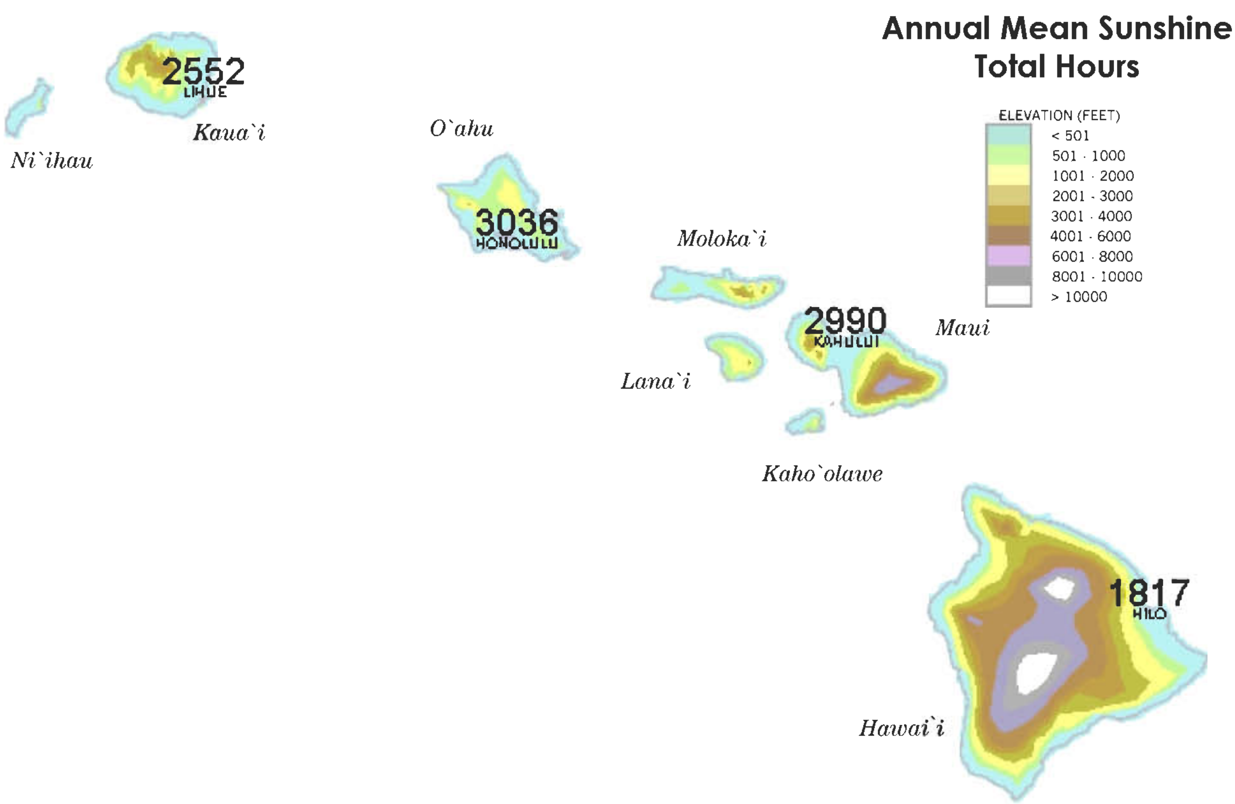
Annual Mean Sky Cover
(Sunrise to Sunset)
ELEVATION (FEET)
< 501
501 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 6000
6001 - 8000
8001 - 10000
> 10000
62
LIHUE
Kaua`i
Ni`ihau
O`ahu
56
HONOLULU
Moloka`i
50
KAHULUI
Maui
Lana`i
Kaho`olawe
71
HILO
Hawai`i

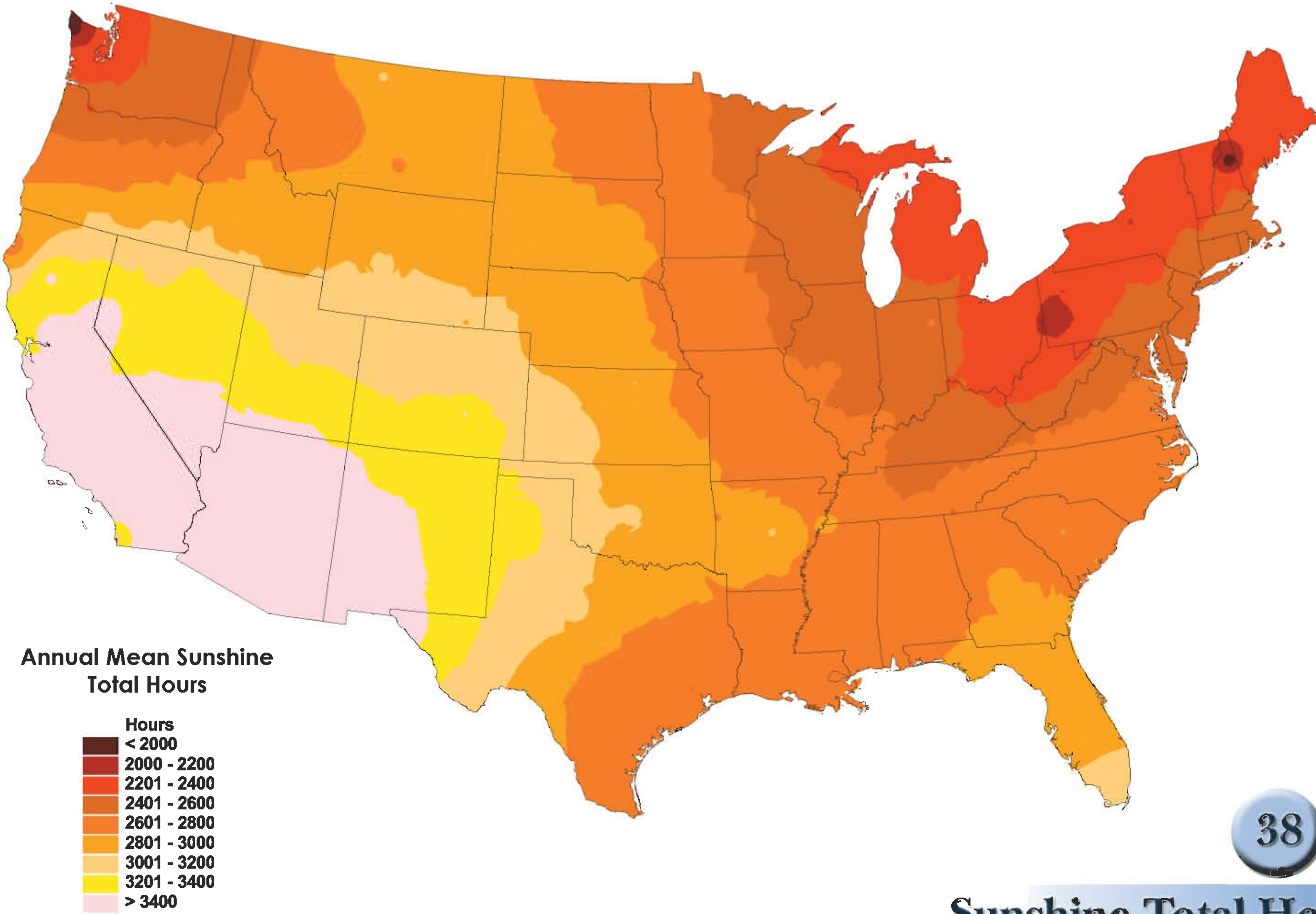

Annual Mean Sky Cover
(Sunrise to Sunset)
Percent
< 45
45 - 49
50 - 54
55 - 58
59 - 62
63 - 66
67 - 70
71 - 75
> 75

Sunshine Total Hours

37



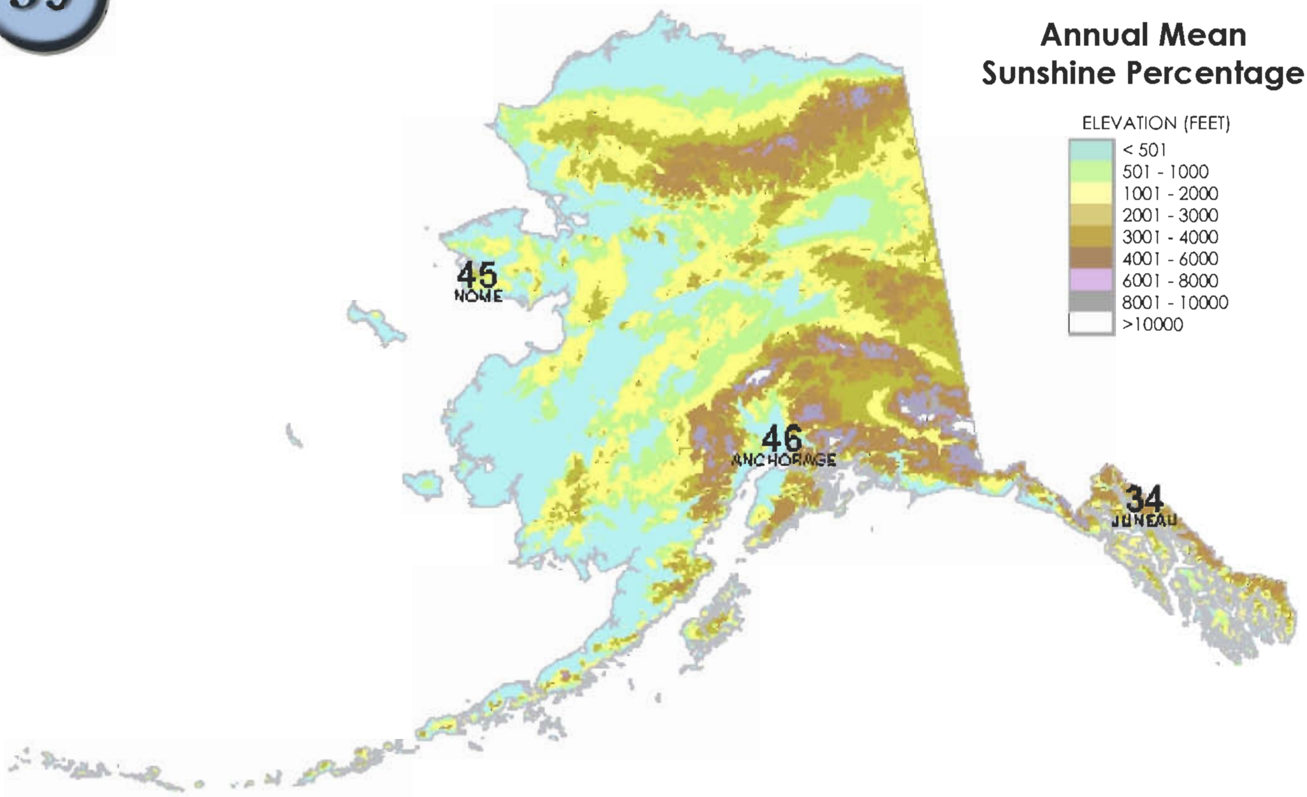


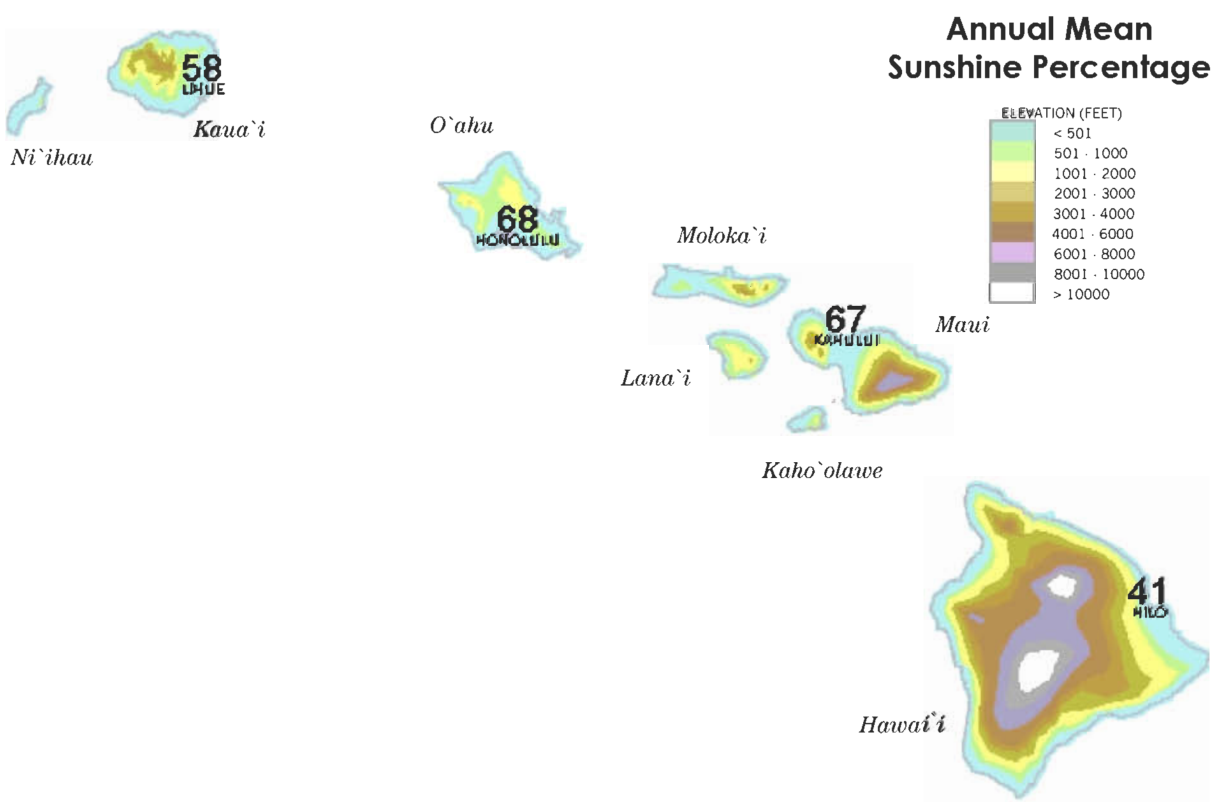


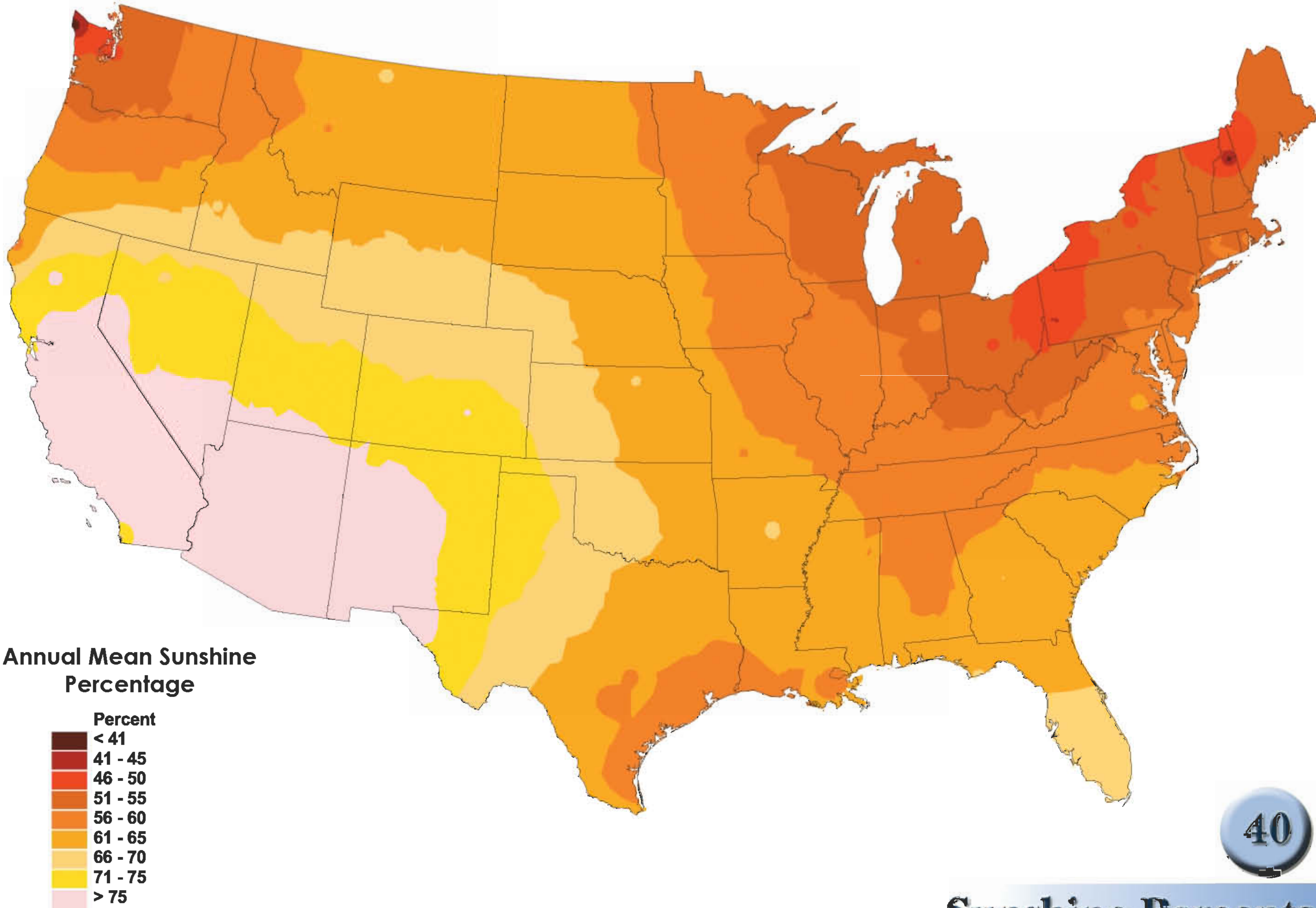
Sunshine Total Hours

Sunshine Percentage

39







Sunshine Percentage