Current Climate Studies 11:

CLIMATE CHANGE IMPACTS ON U.S.: BY REGIONS

1. Print this file. Also answer the "Concept of the Week" questions in the *Weekly Climate News* File. (Check for additional *News* updates during the week.)

2. Complete the Investigation by responding to the *Chapter Progress Questions* (*Study Guide*) and the Investigations 11A and 11B from the *Climate Studies Investigations Manual*, and this *Current Climate Study*.

Introduction

The third *U.S. National Climate Assessment* (*NCA3*) summarizes the state of knowledge about what is known concerning the observed and projected consequences of climate change on the U.S. It presents climate-change assessments from the perspectives of **sectors** and geographical **regions**. Having looked at U.S. climate change impacts by sectors, we now examine climate change impacts by regions.

There are important climate-related issues and consequences faced everywhere around the U.S., but there are also significant and unique sets of issues and consequences that merit regional attention. The USGCRP has described climate change impacts in eight regions of the nation, as well as the country's rural communities and coasts. The regions are identified in **Figure 1**.

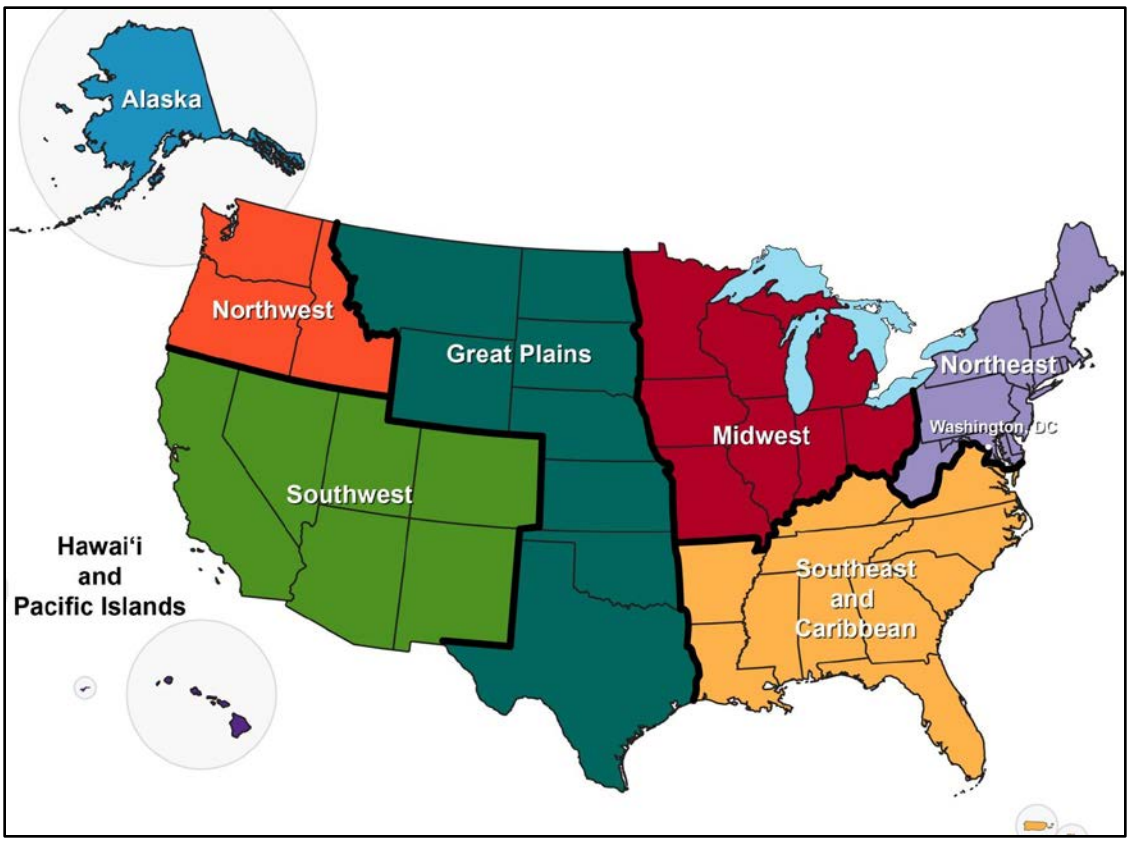

Figure 1. USGCRP Climate Change Regions [USGCRP]

Access *NCA3 Highlights* by going to your bookmarked *Highlights* address, to the *AMS RealTime Climate Portal* website and click on "National Climate Assessment (NCA3) Highlights", or go directly to http://www.globalchange.gov/sites/globalchange/files/NCA3_Highlights_LowRes-small-FINAL_posting.pdf. Go to page 69, on which the ***Regions*** section begins. This introductory page starts with the statement, "Evidence of climate change can be found in every region, and impacts are visible in every state."

Northeast Region: The introductory page is followed by summaries of changes and impacts that are observed and anticipated in the different regions of the U.S., beginning with the **Northeast** region on page 70. As seen in Figure 1, the Northeast region stretches from New England and New York State to West Virginia, Maryland, and Delaware. From Washington, DC to Boston stretches one of the most developed environments in the world.

1. According to the first Key Message at the top of page 70, the Northeast's environmental, social and economic systems will be subjected to growing challenges by all of the following except _____.

   [ ] coastal flooding
   [ ] drought
   [ ] river flooding

[ ] heat waves

2. On the same page, it is mentioned that the Northeast experienced a greater increase in extreme precipitation (defined as the amount falling in the heaviest 1% of all daily events) than any other U.S. region. From 1958 to 2010, the Northeast received more than a _____% increase in the amount of precipitation falling in very heavy events. Extreme precipitation events are projected to increase this century.

   [ ] 30
   [ ] 50
   [ ] 70

3. The coastal cities in the Northeast are highly vulnerable to hurricanes, as demonstrated by Hurricanes Irene and Sandy. The increasing threat of hurricanes due to climate change is partly due to the rising sea levels, which have elevated the base above which storm surges, flood waters, and high tides rise. According to the caption to the upper figure on page 71, while global average sea level increased 8 inches over the past century, the observed sea level rise in Philadelphia increased slightly more than _____ ft. Ocean levels are projected to rise another 1 to 4 feet this century due to warming of seawater and melting of glaciers and ice sheets.

   [ ] 0.8
   [ ] 1.0
   [ ] 1.2

4. One way of visualizing climate change impacts is to imagine "climate on the move." **Figure 2**, from the second *U.S. National Climate Assessment (NCA2)*, page 107, projects the impact of climate change in the Northeast as exemplified by the "Climate on the Move" figure. It shows that in New Hampshire, summers towards the end of this century, assuming the IPCC Lower CO_2 Emissions Scenario, will be more like today's summers in parts of northern Virginia and surrounding areas, and under the higher emissions scenario (red arrows) they will be more like current summers in _____. It is evident from Figure 2 that it is not a question of whether climate "moves" (changes), but how much it "moves" (changes) under lower and higher emissions scenarios. [USGCRP *NCA2*]

   [ ] eastern Maryland
   [ ] southern Virginia and north-central North Carolina
   [ ] Pennsylvania

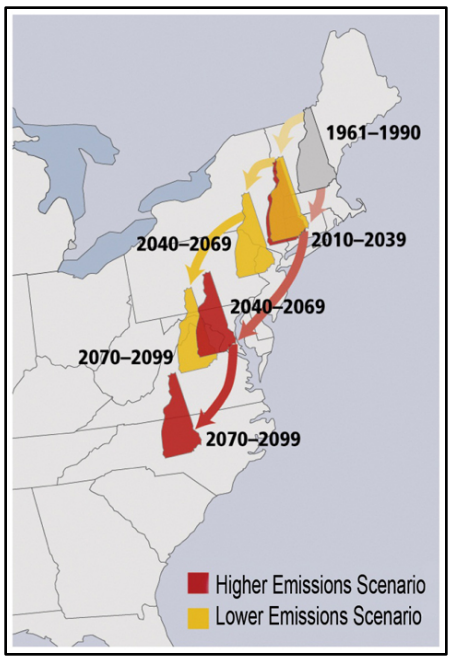

Figure 2. Climate on the Move: Changing Summers in New Hampshire. Tracks that summers are projected to feel like in New Hampshire

Sections describing the rest of USGCRP climate regions follow in the report, with each delivering Key Messages concerning the region being addressed. Note that water is a key issue in virtually all regions.

Southeast and Caribbean Region: The Key Messages on page 72 reflect the fact that the region is facing challenges due to sea level rise, extreme heat events, hurricanes and decreased water availability.

5. The top figure on page 73 shows the relative risk of sea level rises using a Coastal Vulnerability Index. All the cities identified on the map are vulnerable, with _____ perhaps most at risk because, according to text on the same page, roughly half of its inhabitants lives on land below sea level. The color coding in the figure generally confirms this heightened vulnerability.

   [ ] Virginia Beach
   [ ] Charleston
   [ ] Miami
   [ ] Tampa
   [ ] New Orleans

Midwest: The Key Messages on page 74 indicate that climate change will deliver both negative and positive impacts on the region, although, on the long term, the stresses associated with climate change are projected to lower agricultural productivity.

6. According to text on page 75, among these climate changes, _____ are projected to influence future Midwest crop yields the most.

   [ ] extreme weather events
   [ ] changes in average temperature
   [ ] changes in annual precipitation

Great Plains: Key Messages on page 76 describe a region in which climate change is superimposed on weather variability that includes multiple climate and weather hazards which can be dramatic and challenging. In much of the Great Plains, particularly the Southern Plains, too little precipitation falls to replenish that needed by people, plants, and animals.

7. According to the text on page 76, the trend toward more dry days and higher temperatures across the Southern Plains will result in all the following except _____.

   [ ] increased evaporation
   [ ] decreased water supplies
   [ ] reduced electricity transmission capacity
   [ ] increased cooling demands
   [ ] reduced downpours

Southwest: Key Messages presented on page 78 define the Southwest, the hottest and driest region of the U.S., as a place where climate changes are projected to make it hotter and, in its southern half, significantly drier. Referring back to *NCA2*, page 129, its major message is that "Water supplies are projected to become increasingly scarce, calling for trade-offs among competing uses, and potentially leading to conflict." It goes on to say that "Water is, quite literally, the lifeblood of the Southwest."

8. Among the *NCA3* Key Messages is that increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems. According to page 79, between 1970 and 2003, warmer and drier conditions increased burned area in western U.S. mid-elevation conifer trees by _____ %.

   [ ] 150
   [ ] 350
   [ ] 450
   [ ] 650

Although it has great vulnerability to climate change impacts, the Southwest has advantageous adaptation options, as described in the lower part of page 79. Relative to most of the country, it has abundant geothermal, wind and solar energy resources. The use of renewable energy would also lead to large reductions in the emission of greenhouse gases.

Northwest: This region's Key Messages, appearing on page 80, describing climate-change risks reflect the variety of impacts that will emerge quite differently in largely natural environments compared to urban areas, such as Greater Seattle, or among the many Native American tribes in the region.

9. As one of the Key Messages describes, forested areas of the region are already experiencing widespread tree die-off that will cause additional forest mortality by the 2040s, resulting in the long term transformation of forest landscapes. The tree die-off is due primarily to the impacts of all of the following except _____ related to climate change.

   [ ] increasing wild fires
   [ ] later spring peak stream flows
   [ ] increasing insect outbreaks
   [ ] increasing tree diseases

Alaska: Alaska faces particularly unique climate-change consequences because of its high-latitude location. Alaska has seen a temperature increase over the past 60 years more than twice the increase of the rest of the U.S. This is consistent with the generally observed *polar amplification* - an increase in the magnitude of a temperature change with increasing latitude. Strongly related to the temperature increase are climate change impacts that are embodied in the Key Messages listed on page 82. Arctic summer sea ice is receding at a rate greater than previously projected, most glaciers are shrinking, permafrost temperatures are rising with a thawing trend that is likely to continue, ocean temperatures are rising, and ocean chemistry is expected to be altered. Particularly vulnerable to these impacts are Native communities, which make up 40% of the federally recognized tribes in the U.S

10. According to the text on page 82, Alaska's average annual temperature has increased 3 F degrees over the past 60 years, with considerable year-to-year and regional variability. During the same time period, the average winter temperature rose _____F degrees.

    [ ] 1
    [ ] 6
    [ ] 9

Hawaii and Pacific Islands: On page 84, it is stated that, "The U.S. Pacific islands are at risk from climate changes that will affect nearly every aspect of life." The Key Messages on the same page summarize the unique set of impacts that face the U.S. Pacific islands and islanders. Among the impacts are warmer ocean, diminishing freshwater resources, increasing temperatures, reduced rainfall in some areas, and rising sea levels and storm surges.

11. One of the Key Messages describes mounting threats to food and water security, infrastructure, health, and safety which are expected to lead to increasing human migration. This will make it _____ difficult for Pacific Islanders to sustain their unique customs, beliefs, and languages.

[ ] more
[ ] less

The *NCA3 Highlights* report also examines the impacts of climate change on the oceans (page 58), rural communities (page 86), and coasts (page 88) to more comprehensively identify the challenges we face now and in the many decades to come. It is recommended that you read and consider the Key Messages focusing on oceans, rural communities and coasts.

Visiting the *Climate Resilience Toolkit*: Go to the *Toolkit* web site at https://toolkit.climate.gov/case-studies. The *Toolkit* is organized around topics, such as Water and Food, as we have already investigated. Additionally, it has the capability of accessing regionally-focused case studies of resilience in action. Near the top of the *Toolkit* web site on the same line where the Case Studies title is located, scroll over to the right and hover on "Filter by region". Scroll down and click on "Northwest", a region in which we are selecting a project as an example.

12. On the Case Studies webpage displaying Northwest region climate resilience projects, scroll down and click on "An Integrated Plan for Water and Long-Term Ecological Resilience". This project centers on the need for water to meet diverse needs in the _____ River Basin in south-central Washington State.

    [ ] Snake
    [ ] Skykomish
    [ ] Yakima

13. Under the heading Tools:, the tool specifically mentioned as employed in the project is _____.

    [ ] Climate Outlooks
    [ ] State of the Climate
    [ ] U.S. Drought Portal

14. The project describes how a working group including the Yakama Nation, irrigation districts, environmental organizations, and federal, state, county, and city governments developed and released a climate adaptation strategy, called the Yakima Basin Integrated Water Resource Management Plan, after approximately _____ of effort. The project demonstrates the power of stakeholders working together.

    [ ] six months
    [ ] one year
    [ ] two years

Water and National Security

The importance of water has been highlighted time and again in the *NCA3* regional climate change analysis. It is important to note that the role of this valuable natural resource in terms of its impact on our national well-being and security extends far beyond our borders. The U.S. Defense Intelligence Agency released on 22 March 2012 a National Intelligence Council assessment entitled ***Global Water Security***, available at http://www.dni.gov/files/documents/Newsroom/Press%20Releases/ICA_Global%20Water%20Security.pdf. This report, requested by the Department of State, was designed to answer the question: How will water problems (shortages, poor quality, and floods) impact US national security over the next 30 years?

The report's "Bottom Line" is "During the next 10 years, many countries important to the United States will experience water problems—shortages, poor water quality, or floods—that will risk instability and state failure, increase regional tensions, and distract them from working with the United States on important US policy objectives. Between now and 2040, fresh water availability will not keep up with demand absent more effective management of water resources. Water problems will hinder the ability of key countries to produce food and generate energy, posing a risk to global food markets and hobbling economic growth."

Summary: There are important climate-related issues and consequences faced at global and national levels. There are also significant and unique sets of issues and consequences that require consideration on local and regional bases. The *U.S. Climate Resilience Toolbox* is a valuable centralized and science-based source of easy-to-use information, tools, and best practices to help communities of stakeholders to prepare for and boost resilience to climate change impacts, particularly on local and regional levels.

Instructions for Communications with Mentor:

Transmit this week's work to your LIT mentor by Monday, 21 November 2016, or as coordinated with your mentor. Include:

- **Chapter Progress Response Form** from the *Study Guide* or the *RealTime Climate Portal* course website.
- **Investigations Answer Form** for 11A and 11B from the *Study Guide* or *RealTime Climate Portal* website.
- **Current Climate Studies Answer Form** from *RealTime Climate Portal* website.

At the completion of your DataStreme course, we ask you to respond to an evaluation of your course experience. We are also gathering data for evaluation purposes of our programs by our funding agencies. As preparation for that survey, we request that you familiarize yourself with some background for those questions to save time when you complete the forthcoming survey:

Introduction: The AMS *DataStreme* Program receives major support from the National Oceanic and Atmospheric Administration (NOAA). **NOAA's mission** of science, society, and stewardship includes the goals of understanding, predicting, and responding to changes in climate, weather, oceans, and coasts (the Earth system), sharing that knowledge and information, and the conservation and management of marine ecosystems and resources. Each *DataStreme* course website, textbook, and Investigation Manual is rich with NOAA (and NASA) real-world and real-time data and visualizations.

Evaluation Format: The model employed by NOAA evaluates program impact based on participant knowledge (what you learned), attitude (what you think about it), skill (ability to use what you've learned), influence on aspirational goals (i.e. educational and career choices), and changes in overall environmental literacy. We are seeking data to assist their evaluation.

Atmospheric Science Essential Principles and Fundamental Concepts (online at http://eo.ucar.edu/asl)

SUMMARY: People who are literate in atmospheric science understand the "big ideas" of the relevant scientific knowledge. Armed with this understanding, they will have the basis to communicate about the Earth's atmosphere in a meaningful way, and be equipped to make informed and responsible decisions about activities that impact the Earth's atmosphere.

Key Principles:

- Earth has a thin atmosphere that sustains life.
- Energy from the Sun drives atmospheric processes.
- Atmospheric circulation transports matter and energy.
- Earth's atmosphere changes over time and space, giving rise to weather and climate.
- Earth's atmosphere continuously interacts with the other components of the Earth System.
- We seek to understand the past, present, and future behavior of Earth's atmosphere through scientific observation and reasoning.
- Earth's atmosphere and humans are inextricably linked.

Ocean Essential Principles and Fundamental Concepts (online at http://eo.ucar.edu/asl/pdfs/OceanLitChart.pdf and http://greatlakesliteracy.net/)

SUMMARY: Ocean literacy is an understanding of the ocean's influence on you and your influence on the ocean. An ocean-literate person: understands the Essential Principles and Fundamental Concepts about the functioning of the ocean; can communicate about the ocean in a meaningful way; and is able to make informed and responsible decisions regarding the ocean and its resources.

Key Principles:

- The Earth has one big ocean with many features.
- The ocean and life in the ocean shape the features of the Earth.
- The ocean is a major influence on weather and climate.

- The ocean makes Earth habitable.
- The ocean supports a great diversity of life and ecosystems.
- The ocean and humans are inextricably interconnected.
- The ocean is largely unexplored.

Climate Essential Principles and Fundamental Concepts (online at http://www.globalchange.gov/browse/reports/climate-literacy-essential-principles-climate-science-high-resolution-booklet)

SUMMARY: You are climate literate if you understand the influence of climate on yourself and society and your influence on climate. A climate-literate person: understands the essential principles of all aspects of the Earth system governing climate patterns that are presented in this document; knows how to gather information about climate and weather, and how to distinguish credible from non-credible scientific sources on the subject; communicates about climate and climate change in a meaningful way; communicates about climate and climate change in a meaningful way; and is able to make informed and responsible decisions with regard to actions that may affect climate.

Key Principles:

- The Sun is the primary source of energy for Earth's climate system.
- Climate is regulated by complex interactions among components of the Earth system.
- Life on Earth depends on, is shaped by, and affects climate.
- Climate varies over space and time through both natural and man-made processes.
- Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
- Human activities are impacting the climate system.
- Climate change will have consequences for the Earth system and human lives.

Earth Science Essential Principles and Fundamental Concepts (online at http://www.earthscienceliteracy.org/es_literacy_6may10_.pdf)

SUMMARY: Earth Science Literacy is an understanding of Earth's influence on you and of your influence on Earth. Earth Science Literacy is an ongoing process, continually reshaped and rewritten by new discoveries in the areas of Earth science and learning theory. An Earth-science-literate person understands the fundamental concepts of Earth's many systems, knows how to find and assess scientifically credible information about Earth, communicates about Earth science in a meaningful way, and is able to make informed and responsible decisions regarding Earth and its resources.

Key Principles:

- Earth scientists use repeatable observations and testable ideas to understand and explain our planet.
- Earth is 4.6 billion years old.
- Earth is a complex system of interacting rock, water, air, and life.

- Earth is continuously changing.
- Earth is the water planet.
- Life evolves on a dynamic Earth and continuously modifies Earth.
- Humans depend on Earth for resources.
- Natural hazards pose risks to humans.
- Humans significantly alter the Earth.

Thank you!