

## Current Climate Studies 2:

## VISITING GLOBAL CLIMATE CHANGE AND IMPACTS STUDY RESOURCES

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### Do Now:

1. Print this file.
2. Print the *Weekly Climate News* file and answer the two *Concept of the Week* questions in the *Weekly Climate News* File.  
(**Note:** Check the DataStreme Climate *RealTime Climate Portal* website during the week as breaking climate news stories may have been added.)

### To Do Investigation:

1. Read Chapter 2 in the *DataStreme ECS* textbook and respond to the *Chapter Progress Questions* in the *DataStreme ECS Study Guide* binder. [Do **not** complete the *Questions for Review* and *Critical Thinking Questions* appearing in the text].
  2. Complete Investigations 2A and 2B in the *Climate Studies Investigations Manual*.
  3. Go to the *Current Climate Studies* link on the *RealTime Climate Portal* to complete this investigation.
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### AMS Climate Studies Conceptual Structure:

The course *AMS Climate Studies* is uniquely structured. It is organized conceptually along two themes that are carried forward concurrently as the course proceeds. The first and primary theme of the course is a systematic study of climate, climate variability, and climate change, encompassing the fundamentals of modern climate science. These fundamentals include the spatial variations in climate as a response to many interacting forcing agents, or mechanisms, both internal and external to the Earth system. The *AMS Climate Studies* textbook, investigations manual, and the *AMS RealTime Climate Portal* website deliver primary theme learning experiences.

The second theme focuses on climate change and impacts from the perspective of findings reported by the U.S. Global Change Research Program (USGCRP), International Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change (UNFCCC) 2015 *Paris Agreement*, U.S. National Academies, U.S. National Aeronautics and Space Administration (NASA), U.S. National Oceanic and Atmospheric Administration (NOAA), the *AMS/NOAA State of the Climate* reports, and the August 2012 *AMS Information Statement on Climate Change*. *AMS Climate Studies* shares a common foundation with these entities, relying on the latest authoritative scientific information. The ultimate goal of this second theme is to inform decision makers and members of the public (including you) as we strive to develop effective policies in response to vulnerabilities arising from climate variability and climate change.

## Climate Change and Impacts:

**There is unequivocal evidence of global warming.** From NOAA’s National Centers for Environmental Information (NCEI) *Global Analysis – 2015*, [<https://www.ncdc.noaa.gov/sotc/global/201513>], “This year marks the fourth time in the 21<sup>st</sup> century a new record high annual temperature has been set (along with 2005, 2010, and 2014) and also marks the 39<sup>th</sup> consecutive year (since 1977) that the annual temperature has been above the 20<sup>th</sup> century average. To date, including 2015, 15 of the 16 warmest years on record have occurred during the 21<sup>st</sup> century. ... Overall, the global annual temperature has increased at an average rate of 0.07°C (0.13°F) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970.”

NOAA and NASA independently confirmed that Earth’s 2015 average surface temperature was the warmest since modern record keeping began in 1880. NASA reported Earth’s 2015 average global surface temperature shattered the 2014 record by 0.23° F (0.13° C). NASA further stated that since the late-19<sup>th</sup> century, Earth’s average surface temperature has risen about 1.8 degrees F (1.0 C degree), and that “Most of the warming occurred in the past 35 years, with 15 of the 16 warmest years on record occurring since 2001.” For more details by NASA, go to <http://www.giss.nasa.gov/research/news/20160120/> .

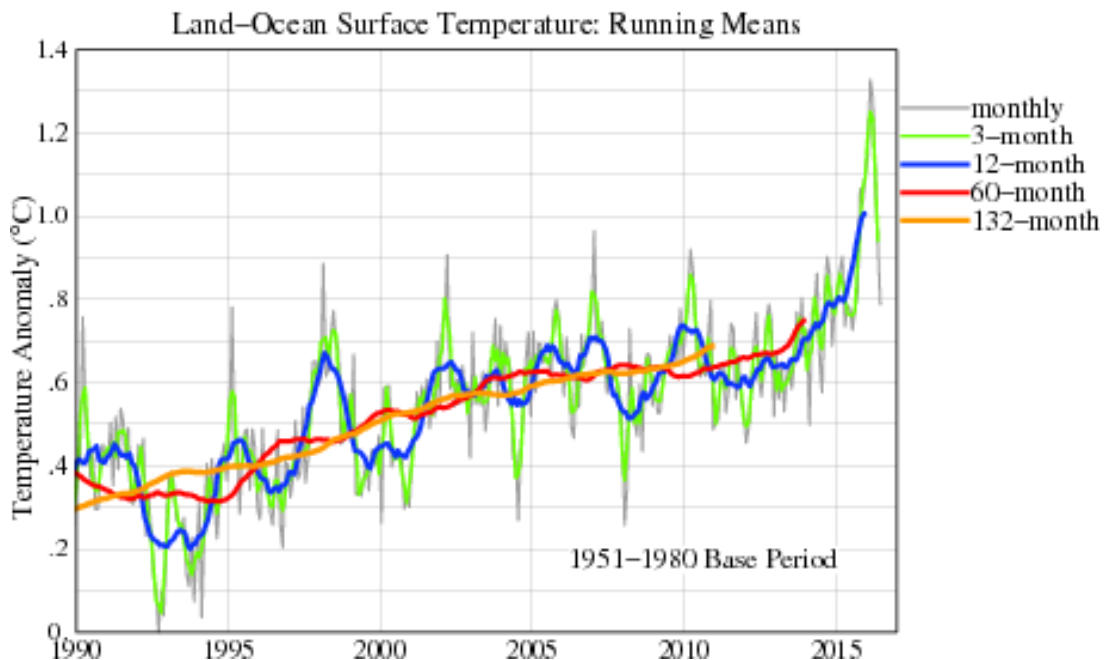


Figure 1. Global land-ocean surface temperature anomalies. Gray curve denotes monthly running mean through June 2016. [NASA GISS]

**Figure 1**, provided by NASA’s Goddard Institute for Space Studies (GISS), shows global surface temperature anomalies relative to the 1951-1980 base period from 1990 through June 2016. The curves of the different running means generally confirm a rising temperature trend over the nearly 26-year period of record.

1. The gray monthly curve (partially masked by the green 3-month running mean curve) reveals record or near-record temperature anomalies throughout most of 2015 and into 2016. According to the graph, June 2016 (at end of gray curve) had a positive temperature anomaly of about \_\_\_\_\_ °C.

0.20

0.78

1.12

The NCEI and NASA findings and those reported by other agencies confirm that the preponderance of climate indicators, including rising temperatures, accumulation of heat energy in the global ocean, rising levels of atmospheric carbon, rising sea levels, and melting of Arctic sea ice, show a warming Earth.

**Climate continually evolves.** There is no doubt that over time climate has changed, is changing, and will continue to change. Against this backdrop, there is a growing sense of urgency arising from the mounting evidence of climate change taking place now, and the impact such change is having, and will have for centuries, on people and ecosystems.

In the scientific community, there is essentially total agreement that the observational evidence showing global warming is undeniable, and there is almost universal consensus it is primarily human induced. There is similar concurrence that the current scientific understanding of climate change justifies taking steps to prepare for climate change and to slow it. The major purpose of this particular *Current Climate Studies* is to introduce you to the most widely-recognized science-based information sources on climate change and its impacts. These sources are firmly based on scientific research findings reviewed, interpreted, and reported by hundreds of independent climate scientists, dozens of non-governmental scientific organizations (including the AMS), and scores of governmental agencies including 13 U.S. federal departments and agencies via USGCRP. The *AMS Climate Studies* course is science based and promotes no political viewpoint. It is left to the informed learner to employ scientific knowledge when considering possible policies and actions directed toward addressing climate and climate change issues.

### **The AMS/NOAA *State of the Climate* Reports:**

The *State of the Climate in 2015* is the 26th edition of NOAA's *State of the Climate* series of observation-based assessments of Earth's climate system. These annual reports, each published midway through the subsequent year, provide the most current overview of what is happening to the world's climate. The information provided helps to advance understanding of the climate system and build confidence in climate projections. The AMS/NOAA *State of the Climate in 2015* can be accessed via the *RealTime Climate Portal* website under the Climate Information heading.

Among the climatic data reported in the AMS/NOAA *State of the Climate* reports is global ocean heat content. The report for 2015 contains information similar to that

contained in **Figure 2**. Ocean heat content is critically important in climate and climate change studies because the major reservoir of added heat in Earth’s climate system, about 93%, is in the world ocean.

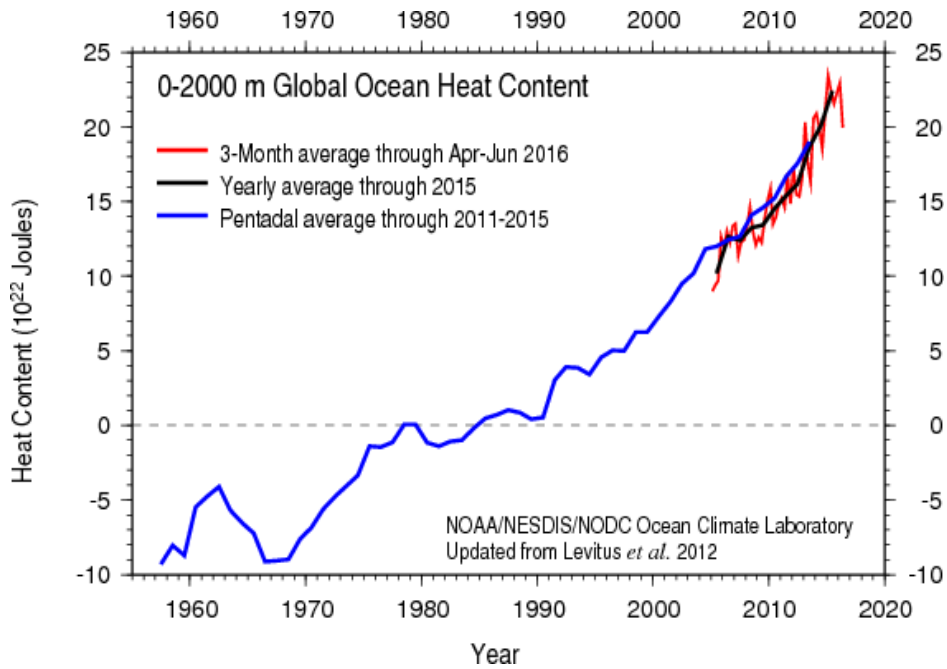


Figure 2. Global Ocean Heat Content in the top 2000 m to June 2016.

2. In Figure 2, the blue curve designates the pentadal (5-year) running average of heat content in the top 2000 m of the ocean measured from the 0 baseline since the mid-1950s. The black yearly-average curve, incorporating detailed Argo float array data starting about 2005, shows curvature indicating that ocean heat content is increasing from year to year and its annual rate of increase appears to be generally \_\_\_\_\_ over time.

- decreasing
- steady
- increasing

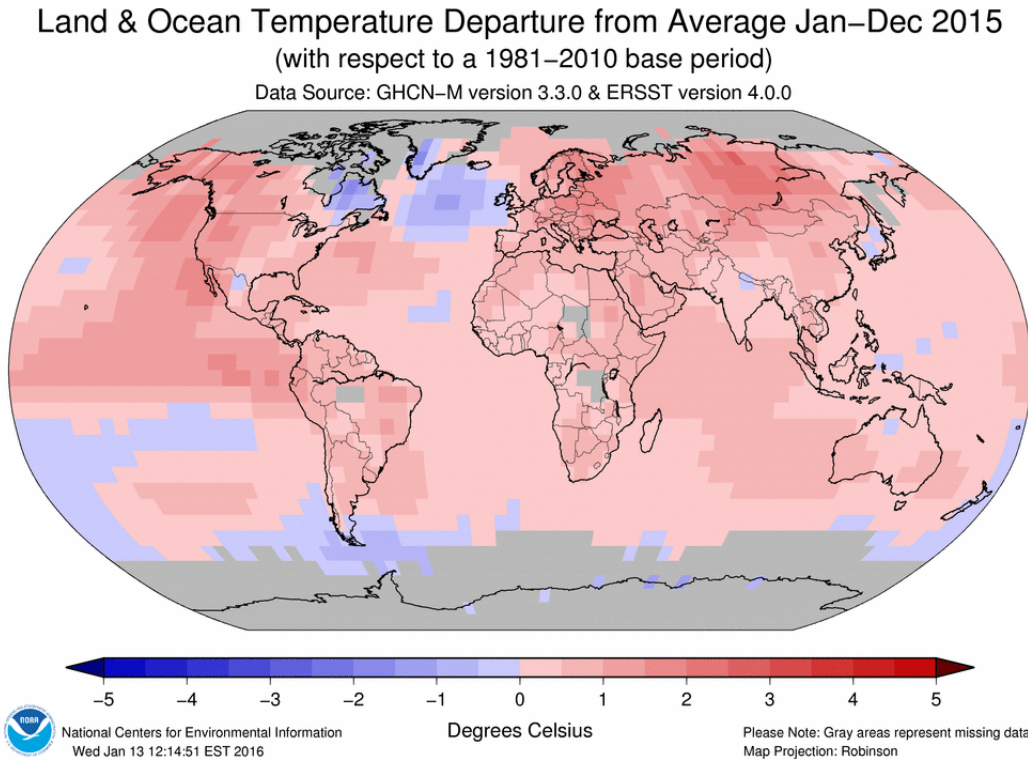


Figure 3. 2015 land and ocean surface temperature anomalies based on 1981–2010 average), deep red represents the warmest and deep blue the coldest. [NOAA]

3. A temperature anomaly is the deviation of temperature from the long-term average value for the same location. **Figure 3** displays land and ocean surface temperature anomalies in 2015. The figure shows that places with the greatest warming in 2015 relative to the 1981–2010 average, with the exception of the eastern and central tropical Pacific, were generally at the \_\_\_\_\_ latitudes.

- higher southern
- tropical
- higher northern

Note in Figure 3 that the 2015 temperature anomaly pattern shows northeastern Canada was the only major primarily land region to experience below-average annual temperatures. This illustrates regional variability within Earth’s climate system.

NOAA’s NCEI also publishes *State of the Climate, National Overview* on monthly and annual schedules. Go to <http://www.ncdc.noaa.gov/sotc/national>. The page that appears describes the U.S. climate for the latest full month reported (or the latest annual report if early in the year). Near the top of the page select the settings for “National Overview” report, “2015”, and “Annual”, and then click on “Submit”.

4. Scroll down to the first paragraph of text; the 2015 Annual report indicated that in 2015 the contiguous U.S. (CONUS) experienced an average annual temperature of 54.4 °F. This was \_\_\_\_\_ Fahrenheit degrees (F°) above the 20<sup>th</sup> century average, and marked the 18<sup>th</sup> consecutive year with an annual average temperature above the 20<sup>th</sup> century average for the CONUS.

- 0.8  
 1.3  
 2.4

5. Scroll through the 2015 Annual Report to survey the kinds of information it contains. The only state with a dedicated section in the report is \_\_\_\_\_.

- Hawaii  
 Texas  
 Alaska

### **The National Academies:**

The **U.S. National Academies** (including the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council) act as advisors to the nation on Science, Engineering, and Medicine. In response to a request from the U.S. Congress, the National Academies have conducted a program called *America's Climate Choices*.

On the course website, go to the Societal Interactions and Climate Policy section and click on “America’s Climate Choices” (or go directly to <http://nas-sites.org/americasclimatechoices/>). There, under Summaries & Booklets, click on the first booklet, “Climate Change: Evidence and Choices”. Then, click on “Download the full booklet.”

6. Peruse the booklet for an objective science-based introduction to climate change. On page 3, it is mentioned that Earth’s average surface temperature has increased by about \_\_\_\_\_ Celsius degrees over the past century.

- 0.8  
 1.4  
 2.8

### **Intergovernmental Panel on Climate Change (IPCC):**

An unprecedented worldwide effort was established in 1989 to face the risks of climate change, particularly those produced by human action. The Intergovernmental Panel on Climate Change (IPCC) is the leading body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on

the current state of climate change and its potential environmental and socio-economic consequences.

The IPCC assesses the most recent scientific, technical, and socio-economic information produced worldwide relevant to understanding climate change. Thousands of scientists from around the world voluntarily contribute to its work. Review is essential to the IPCC process, ensuring an objective and complete assessment of current information. Because of its scientific and intergovernmental nature, the IPCC embodies a unique opportunity to provide rigorous and balanced scientific information to decision makers and the public. The fifth IPCC assessment report (AR5), was completely published by late 2014.

Go to the *RealTime Climate Portal* course website and, under the Climate Change section, click on “WMO/UNEP IPCC, AR5”. Go to information about the *Fifth Assessment Report (AR5)* by clicking on “AR5” in the lower right corner of the upper panel. The *Report* consists of four volumes: three IPCC Working Groups (WG) reports and a Synthesis report. Click on the *Climate Change 2013: The Physical Science Basis* report cover image and then click on “Summary for Policy Makers (SPM)”. This Summary provides a succinct overview of the report’s contents.

7. Go to the SPM’s Section B. Observed Changes in the Climate system. The first highlighted statement indicates the “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.” The statement indicates \_\_\_\_\_.

- the atmosphere and ocean have warmed
- the amounts of snow and ice have diminished
- sea level has risen
- the concentrations of greenhouse gases have increased
- all of these

8. Go to SPM’s Section C. Drivers of Climate Change. There, *radiative forcing (RF)* is further described as changes in energy fluxes (flows) by natural and anthropogenic substances and processes that are drivers altering Earth’s energy budget. The changes are measured relative to 1750, taken as the beginning of the industrial revolution. Positive RF leads to surface warming and negative RF leads to surface cooling. According to the highlighted statement near the beginning of Section C, the total radiative forcing (RF) of the Earth system is \_\_\_\_\_. This has led to an uptake of energy by the climate system, largely due the increase in the atmospheric concentration of carbon dioxide (CO<sub>2</sub>) since 1750.

- positive
- 0
- negative

## **The United Nations Framework Convention on Climate Change (UNFCCC) 2015 *Paris Agreement*:**

The **2015 United Nations Climate Change Conference** was held in Paris, France, from 30 November to 12 December 2015. Recognizing “that climate change is a common concern of humankind”, a total of 195 countries negotiated and signed an historically significant agreement to address climate change.

Among unanimously accepted fundamental understandings stated in the *Paris Agreement* was recognition that

- “climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions,” and,
- “deep reductions in global emissions will be required in order to achieve the ultimate objective of the Convention and emphasizing the need for urgency in addressing climate change”.

Built on the assessments of the IPCC and the findings of other science-based investigations of Earth’s climate system, the *Paris Agreement* is intended to steer all countries away from employing fossil fuels as the primary energy sources for economic sustainability and growth, and to show that governments around the world take climate change seriously. The *Paris Agreement* will be a major reference in the *AMS Climate Studies* course when treating climate change public policy.

[<http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>]

## **U.S. Global Change Research Program:**

The **U.S. Global Change Research Program (USGCRP)**, the combined effort of 13 Federal departments and agencies, is a comprehensive and integrated United States research program that assists the nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change. The USGCRP released its third *National Climate Assessment* (NCA3) in May 2014. This state of knowledge report summarizes the science of climate change and impacts of climate change on the United States, now and in the future. The report presents climate-related impacts for various societal and environmental sectors and regions across the country.

Go to the highlights of the third *U. S. National Climate Assessment* (NCA3) at: [http://www.globalchange.gov/sites/globalchange/files/NCA3\\_Highlights\\_LowRes-small-FINAL\\_posting.pdf](http://www.globalchange.gov/sites/globalchange/files/NCA3_Highlights_LowRes-small-FINAL_posting.pdf). This *Highlights* component of NCA3 will be the primary reference used in the *Current Climate Studies* component of the **AMS Climate Studies** course.

9. NCA3 was produced by more than 300 experts drawing from a large body of scientific peer-reviewed research, technical input reports, and other publically

available sources. According to the first paragraph on page iii of the Highlights report, the overall goal of the publication is to better inform \_\_\_\_\_.

- climate science researchers
- public and private decision making at all levels

10. In the section on *Climate Change and the American People*, at the top of page 3, it is indicated the NCA3 report includes \_\_\_\_\_.

- analyses of impacts on seven sectors
- the interactions among sectors at the national level
- assessments of key impacts on all U.S. regions
- all of these

11. In the *Response Options* section, on page 10, it is pointed out that as the impacts of climate change become more prevalent, Americans face choices. In particular, choices have to be made about emissions of heat-trapping gases into the atmosphere. The choices are actions society should be taking to respond to the climate change challenge. These actions fall into the category(ies) of \_\_\_\_\_.

- mitigation
- adaptation
- both mitigation and adaptation

### **The U.S. Climate Resilience Toolkit:**

*Current Climate Studies* segments will frequently refer to the **U.S. Climate Resilience Toolkit**. The Toolkit is a website developed by NOAA and other Federal agencies to provide access to scientific and technical information to ensure that communities have actionable information they need to better understand climate-related risks and opportunities in order to take steps to improve their resilience to extreme events.

The *Toolkit* builds on the findings of NCA3 and related climate change scientific publications. The *Toolkit* provides guidance through the process of planning and implementing resilience-building projects.

12. Go to <https://toolkit.climate.gov/>. Click on “Steps to Resilience” at the top of the web page. Then click on “Overview” and scroll down to the Getting started section and click on “Steps to Resilience glossary.” *Resilience* is defined as the capacity of a community, business, or natural environment to \_\_\_\_\_ a disruption.

- prevent
- withstand
- respond to
- recover from
- all of these

## AMS Information Statement on Climate Change:

Go to the *RealTime Climate Portal* website. In the Climate Change section, click on “AMS Statement on Climate Change”. The AMS Statement includes sections on how climate is changing, why it is changing, how it can be projected into the future, and how it is expected to change in the future. Please read it as an introduction to climate change and re-read it occasionally as you accumulate climate science knowledge.

### Summary:

We will be returning to these and other information sources as this course progresses. The USGCRP, AMS/NOAA, the National Academies, IPCC AR5, and the UNFCCC 2015 *Paris Agreement* reports will act as the primary references for the conceptual theme of this course as we investigate climate change and impacts. The *Climate Resilience Toolkit* will inform us on ways climate resilience is actually being built throughout the country.

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Record your responses to items in DataStreme ECS Investigations 2A and 2B on the **Investigations Answer Form** and responses for Current Climate Studies items on the **Current Climate Studies Answer Form** for transmission to your course mentor.

### Instructions for Communications with Mentor:

After completing this week's applications, transmit the following work to your LIT mentor by Monday, 12 September 2016, or as coordinated with your mentor:

1. Chapter 2 **Progress Response Form** from the DataStreme ECS *Study Guide*, or the DataStreme *RealTime Climate Portal*.
2. Investigations 2A and 2B **Investigations Answer Form**, from the *Climate Studies Investigation Manual*, or the DataStreme *RealTime Climate Portal*.
3. Current Climate Studies 2, **CCS Answer Form**.

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