

# Climate Science and One Health

Guide to accompany the Climate Science Foundations Module:

The Science of Global Climate Change

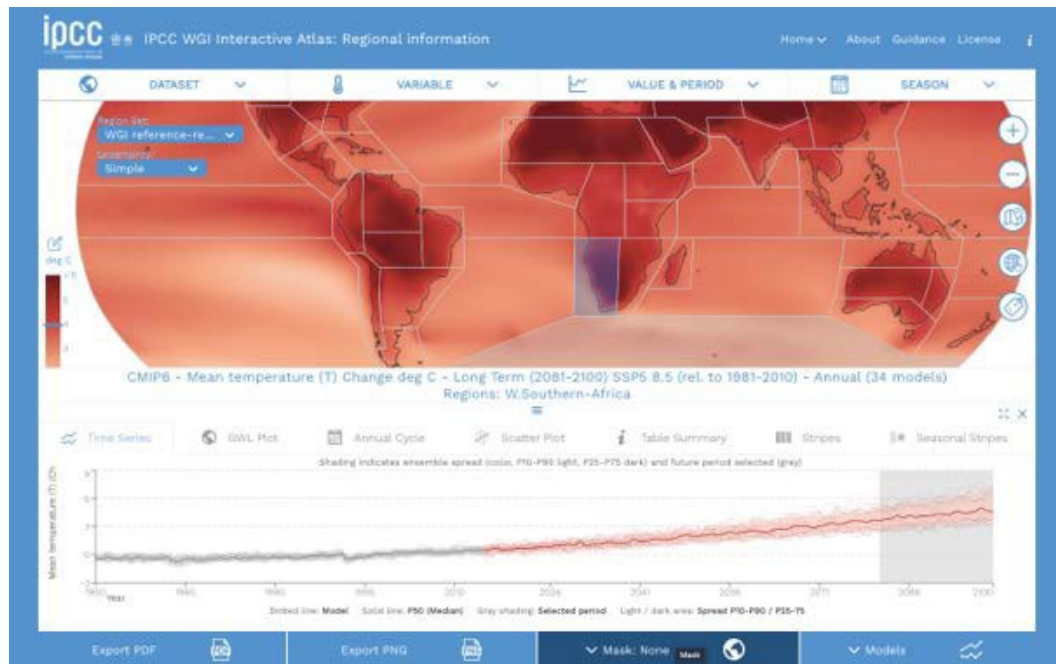


Image from the IPCC Interactive Atlas. <https://interactive-atlas.ipcc.ch/>

## Facilitator's Guide

Authors:

Cheryl Meehan, Ph.D.

One Health Institute, School of Veterinary Medicine

University of California, Davis

Kathryn C. Conlon, Ph.D., M.P.H

School of Medicine and School of Veterinary Medicine

University of California, Davis

*This document was prepared as part of the USAID funded One Health Workforce – Next Generation Project to support activities conducted under One Health Workforce Academies and is intended for an audience of qualified professionals and One Health trainers.*

*The contents of this document are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. USAID and the authors of this guide bear no responsibility for the actions of individuals implementing the material herein.*

*If you have feedback for us after using this guide or would like more information about the contents of this guide, please contact [onehealthnextgen@ucdavis.edu](mailto:onehealthnextgen@ucdavis.edu).*



# Climate Science and One Health: Climate Science Foundations

---

## Summary

---

This guide provides implementation strategies for the delivery of Module 1 of Climate Science and One Health: Climate Science Foundations. It is recommended that facilitators utilize either the accompanying Power Point Presentation and provided transcripts or fully narrated video. Both are available at: <https://www.onehealthworkforceacademies.org>

**One Health Competency Domains:** Ecosystem Health; Environment and One Health; Human Animal Environmental Interactions; One Health Principles and Concepts; Systems Thinking; Risk Assessment & Mitigation; Policy; Communication

---

## Learning Objectives:

---

### Learning Objectives:

1. **Differentiate** weather and climate processes.
  2. **Explain** the relationship between greenhouse gas emissions and global climate change.
  3. **Describe** evidence of global climate change.
  4. **Discuss** how global climate models are used to understand global climate change.
  5. **Utilize** modeling and visualization tools.
  6. **Present** evidence of regionally specific climate change and develop a persuasive presentation.
-

---

## Time for Completion

---

Variable. A minimum of ~ 2 hours is recommended for both the lecture and the group activity. The process may take longer depending on group knowledge level, enthusiasm, integration with other learning concepts, etc.

---

## Audience

---

This module is designed at an introductory level and is intended for an undergraduate or graduate audience. Synchronous delivery of lectures and synchronous group project work, either in person or online, are recommended.

---

## Materials

---

1. The Science of Global Climate Change PowerPoint slides or narrated videos.
2. Whiteboard, blackboard, or flip chart paper and markers (for in person delivery).
3. Jam board or other e-collaboration tool (for online delivery).
4. Printouts or electronic versions of the student activity handouts.
5. Computers with internet access (for both online and in person delivery).

*Facilitator Note:* The information included in this facilitator's guide is not intended for distribution to participants. This is for your use in preparing and facilitating the exercise only. Distributing or verbally disseminating this information directly will take away from the intended experience for the participants.

---

---

## *Instructional Sequence*

---

1. **Opening Questions:** Prior to delivering the Power Point lecture or playing the narrated video, engage the students in a discussion around their current understanding of climate change science. This discussion may be prompted with the use of open-ended questions. You may use the suggested Opening Questions or create your own. Collect responses using a blackboard, whiteboard, flip chart paper or e-collaboration tool.
2. **Direct Instruction:** Deliver the PPT presentation (or a version adapted to your needs) or play the narrated video for your learners.
3. **Reflection:** Following delivery of the lecture material, engage your learners in a discussion around their understanding of the introduced concepts and vocabulary. You may use the suggested Reflection Questions or create your own. Collect responses using a blackboard, whiteboard, flip chart paper or e-collaboration tool.
4. **Application Activity:** Provide learners with the instruction materials for the application activity. The application activity may be conducted by individuals or in small groups (recommended) and may be completed during class time or in out of class time, per your preference.
5. **Presentations and Discussion:** Learners share the results of their application activities and engage in group discussion. Suggested discussion prompts are provided.
6. **Reflection:** Learners complete a post-module written reflection. Suggested prompts are provided.

---

## Opening Questions

---

The goal of opening question is to engage learners in a discussion of topics related to the vocabulary and concepts that will be introduced in the module. These questions should be phrased such that they encourage sharing of perspectives, rather than be oriented toward arriving at a correct answer. Misunderstandings may be communicated during opening questions, and they should not be corrected at this time. Documenting responses to opening questions on a digital whiteboard, blackboard or flip chart paper is recommended.

Opening questions should be broad and open-ended.

**Closed-ended Questions...**have a limited number of acceptable responses or “right answers”.

- Fact-based.
- Often require only a “yes” or “no” answer.
- Begin with who, what, when, where, and name, and sometimes how and why.

*For example: Define the One Health approach.*

**Open-ended Questions/Prompts...** those that can be explored further.

- Do not have a single “right” answer.
- Encourage a full, meaningful answer using the learner’s own words.
- Questions/Prompts that use the terms describe, discuss, interpret, explain, evaluate, compare, if, or what if.

*For example: Explain to me what you understand about the One Health approach.*

After posing Opening Questions, provide ample wait time.



- Wait time provides all students the opportunity to formulate a response. Typically, the first responses encourage others to respond.
- Wait time encourages quieter, more passive learners to engage. Research reveals that more learners respond when ample wait time is provided.

How do I know if what ample wait time is?

- Tip: Try to make eye contact with each person in the room/video conference at least once; in a large lecture hall, scan the room slowly from one side to the other, and back again.

---

## *Suggested Opening Questions:*

---

- Describe what the terms weather and climate mean to you.
- Explain your understanding of how data can be analyzed and interpreted to explain environmental events.
- Share your understanding of what climate models are and how they are used.
- Explain your understanding of how, if at all, human activity has caused the world's climate to change over the past 100 years.
- Explain your understanding of the phrase "greenhouse effect".

---

## *Reflection*

---

Following the delivery of direct instruction, facilitators will engage learners in a discussion reflecting on the content presented. The reflection period will provide an opportunity for learners to share their understanding of the concepts and vocabulary that have been introduced. During the reflection period, the facilitator will pose a series of questions to help assess learners' understanding of current topics and processes.

It is important to identify and address any misunderstandings students might have during the reflection discussion. Facilitators may want to revisit key concepts and vocabulary (see next section) to make sure that learners demonstrate understanding in their responses to reflection questions. Documenting responses to reflection questions on a digital whiteboard, blackboard or flip chart paper is recommended.

---

## *Suggested Reflection Questions:*

---

Using evidence from today's lesson...

- Explain your understanding of the relationship between greenhouse gas emissions and global climate change.
- Describe how climate models are used to study past climate or predict future climate.
- Share your predictions about how the world's climate could change over the next 100 years. What factors do you take into consideration when forming your prediction?
- Describe your understanding of the relationship between climate change and the likelihood of extreme weather events.

---

## *Concepts and Vocabulary*

---

**Weather:** Short-term (i.e., minutes, hours, days, weeks) atmospheric conditions

**Climate Change:** Long-term continuous change (increase or decrease) to average weather conditions or the range of weather

**Climate Variability:** The way climate fluctuates yearly above or below a long-term average value

**Climatological Normal:** 30-year average of a weather variable

**Anomaly:** Departure from a reference value or long-term average

**Positive** –Observed temp higher than the average

**Negative** –Observed temp lower than the average

**Climate Model:** Computer simulation that characterizes the Earth's climate system by using mathematical equations to represent interactions of important climatic drivers like the atmosphere, oceans, land surface, and ice. They are used to study past climate or predict future climate.

**Ensemble:** A group of comparable climate model simulations. Each model is slightly different from another; the ensemble average is expected to perform better than an individual model.

**Downscale:** The process used to estimate higher spatial resolution (i.e., more local) data using coarse resolution data from climate models.

**Radiative Forcing:** The difference between incoming and outgoing energy in Earth's climate.



---

## *Application*

---

The true test of learners' understanding is when they can apply new knowledge and skills to authentic situations. Application activities serve as vehicles for utilizing new knowledge or skills in independent, real-world situations.

In this application, learners will be presented with a challenge relating to interpreting and communicating climate science to stakeholders to inform decision making at the regional level. Working individually or in small groups, they will utilize the IPCC WGI Interactive Atlas to gather evidence to support their case and will present their findings to the larger group who will ask generative questions.

---

## *Instructional Sequence*

---

### Preparation

- Small group work is recommended for this activity. Prior to introducing the scenario, arrange students into groups of 2-4 or allow groups to self-select.
- You may assign scenarios (see page 11) to each group, or allow them to choose their own.
- Each group should have access to a computer with internet access.
- Introduce the scenario to the students and then provide access to printed or online versions of the activity materials.

### Group Work

- Provide time in class or between class meetings for groups to work together.
- Schedule presentations.

### Presentations

- Invite each group to deliver their presentations. Presentations should be 5-7 minutes in length.
- Following each presentation allow for 2-3 minutes of questions from the group.

### Reflection

- Following all presentations allow for a Reflection period. This may be a guided discussion or a written reflection. Possible reflection prompts include:
  - Share how the information provided in the presentations influenced your understanding of climate change related risks.
  - Share how the climate related risks were similar or different across contexts.
  - Explain how regionally-specific information about climate related risks may be useful in policy, planning or other public processes.
  - Describe some of your take-aways regarding effective communication of climate related risks to a non-scientific audience.

---

## Climate Change Mitigation Activity: Student Guide

---

### Background

Climate Change mitigation refers to efforts to reduce or prevent the emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior. To generate sufficient support to advance mitigation efforts, the public, businesses, and government officials must be convinced that the risks posed by the changing climate are relevant and timely. To accomplish this outcome, climate science must be communicated in a clear and credible manner.

Your team has been selected to create a presentation for your region's climate committee that will demonstrate the local risks associated with climate change and provide them with information that will help encourage the adoption of mitigation strategies.

In addition to your knowledge of climate science, your team will utilize the climate modeling and visualization tools provided by the IPCC WGI Interactive Atlas to complete this project.

### IPCC WGI Interactive Atlas

The Intergovernmental Panel on Climate Change (IPCC) Working Group I (WGI) Interactive Atlas is a mapping tool that allows users to choose datasets to output flexible temporal and spatial analyses of trends and changes in key atmospheric and oceanic variables, extreme indices, and climatic impact-drivers. This data was obtained from several global and regional datasets, both observational and model simulated, and is the information underpinning the Working Group I contribution to the Sixth Assessment Report.

The Interactive Atlas has two components – regional information and regional synthesis.

- Regional information allows users to generate global maps, time series, scatter plots, tables, climate stripes, and more, for observed and projected climate change for time periods, emissions scenarios, or global warming levels of interest.
- Regional synthesis provides qualitative information about changes in climatic impact-drivers. Users can select one or more impact-drivers and visualize the regional historical trends and projected changes across regions.

The Interactive Atlas allows users to define which datasets they'd like to look at in the context of more than 25 different climate variables under multiple scenarios/time scales and can be further refined to show data and projections for particular seasons.

To become oriented with the tool, please watch the IPCC WGI Interactive Atlas Tutorial:

[https://interactive-atlas.ipcc.ch/InteractiveAtlas\\_IntroVideo.mp4](https://interactive-atlas.ipcc.ch/InteractiveAtlas_IntroVideo.mp4)

You may also find this article helpful: <https://www.popsci.com/environment/ipcc-interactive-climate-change-atlas/>

## Scenario

Your group will create a presentation that is a) specific to your geographic region and b) provides information that addresses the context specified in one of the scenarios below. If none of the scenarios below is a good fit for your geographic region, you may create your own scenario modeled after the examples provided.

### Scenarios 1: Climate Change and Forest Resiliency

You will be presenting to managers of public and private forestland. Your goal is to educate the audience on climatic and weather event related data for your region and make connections between these trends and predictions as they pertain to the resiliency of forested areas and communities.

### Scenario 2: Climate Change and Coastal Resiliency

You will be presenting to managers of public and private coastal land. Your goal is to educate the audience on climatic and weather event related data for your region and make connections between these trends and predictions as they pertain to the resiliency of coastal areas and communities.

### Scenario 3: Climate Change and Agricultural Resiliency

You will be presenting to managers of public and private agricultural land. Your goal is to educate the audience on climatic and weather event related data for your region and make connections between these trends and predictions as they pertain to the resiliency of agricultural areas and communities.

### Scenario 4: Climate Change and Urban Resiliency

You will be presenting to citizens and government officials representing a city in your region. Your goal is to educate the audience on climatic and weather event related data for your region and make connections between these trends and predictions as they pertain to the resiliency of urban areas.

For all scenarios, you will be comparing data modeled under different Shared Socioeconomic Pathways. Please read: <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/> to familiarize yourself with these pathways and how they impact climate models.

## Building your Presentation

Once you have chosen a scenario to investigate, your team will begin to use the IPCC WGI Interactive atlas to investigate patterns, trends, and predictions relating to the climate and weather events that are most relevant to your scenario. Remember that the aim of your presentation is to demonstrate to stakeholders how climate change related trends and events are relevant to your region and context (forest, coastal, urban, or agricultural) and to convince them that mitigation efforts should be considered and acted upon in a timely manner.

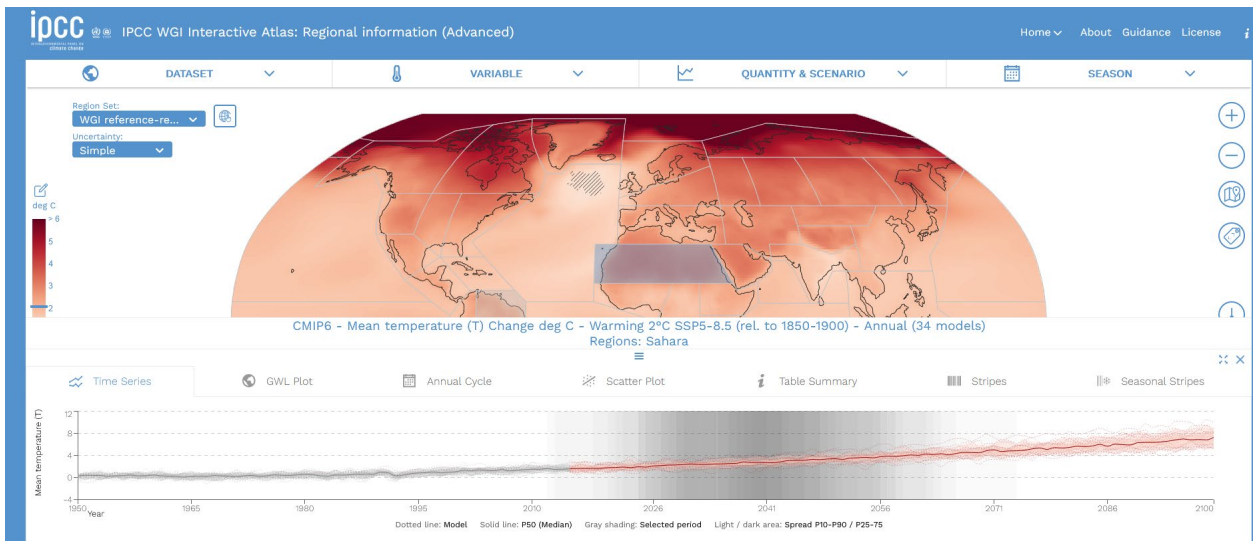
## Presentation Requirements

You may choose the specific information you would like to include in your presentation, but all presentations should include the following elements for your region:

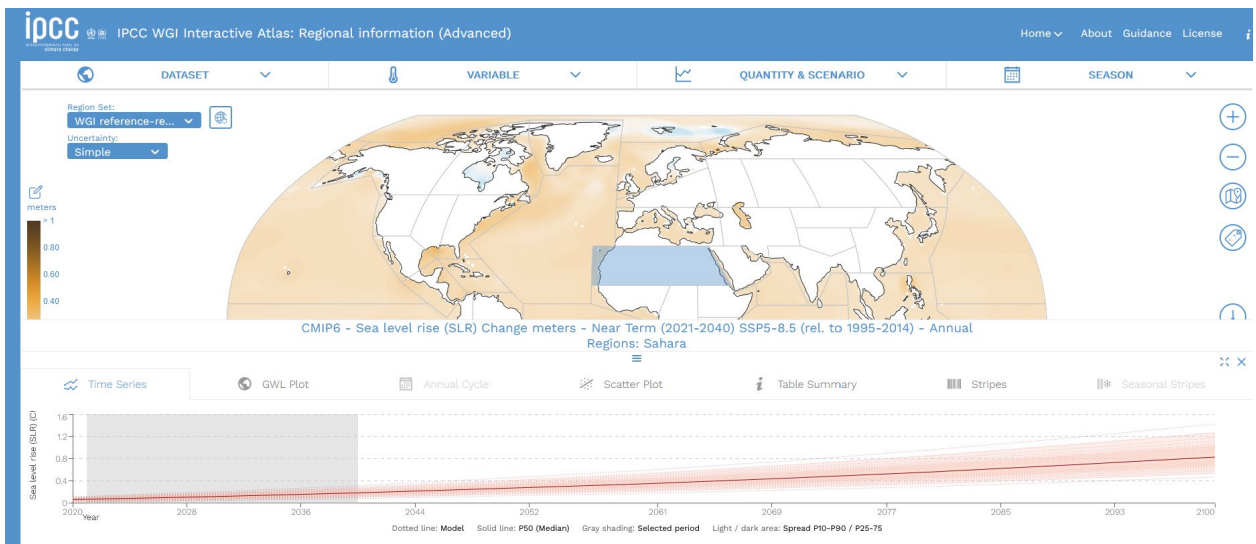
1. Provide a brief introduction of yourselves, your goals for the presentation and the context/scenario you will be presenting.
2. Regional Information
  - a. Present the Mean Temperature (T) Change in the near term (2021-2040) relative to baseline (1850-1900) using the CMIP6 model. This can be visualized using any of the data presentation tools provided, but you must be able to interpret the visualizations for your audience.
    - i. Present and compare these data under two different SSP scenarios.
    - ii. Explain the two SSP scenarios and how they pertain to the Mean Temperature Change predictions.
  - b. Present at least two other Atmospheric, Ocean or Other variables for the same time period using the same model and baseline. These can be visualized using any of the data presentation tools provided, but you must be able to interpret the visualizations for your audience.
    - i. Present and compare these data under two different SSP scenarios.
    - ii. Explain the two SSP scenarios and how they pertain to the variable predictions.
3. Regional Synthesis: Climate Impact Drivers (CIDs) are physical climate system conditions (e.g., averages, and extremes) that affect society or ecosystems. Every sector can be affected by multiple CIDs, each CID affects multiple sectors and can cause different responses in different circumstances.
  - a. For your region, present the future projections for up to 6 CIDs that are of importance to your scenario. Present the projected future changes as well as any trends or attributions.
4. Other notes:
  - a. Your presentation should be between 5-7 minutes in length.
  - b. Your presentation must put the data you gathered from the IPCC WGI Interactive Atlas in context for a non-scientific audience. The goal of your presentation is to share data that will motivate your audience to allocate resources to climate change mitigation strategies. Why are these data relevant to your region and your context, specifically?
  - c. You do not need to present mitigation recommendations, your job is to convince your audience of the need to act rather than to take specific steps.

### Example Outputs from the IPCC WGI Interactive Atlas

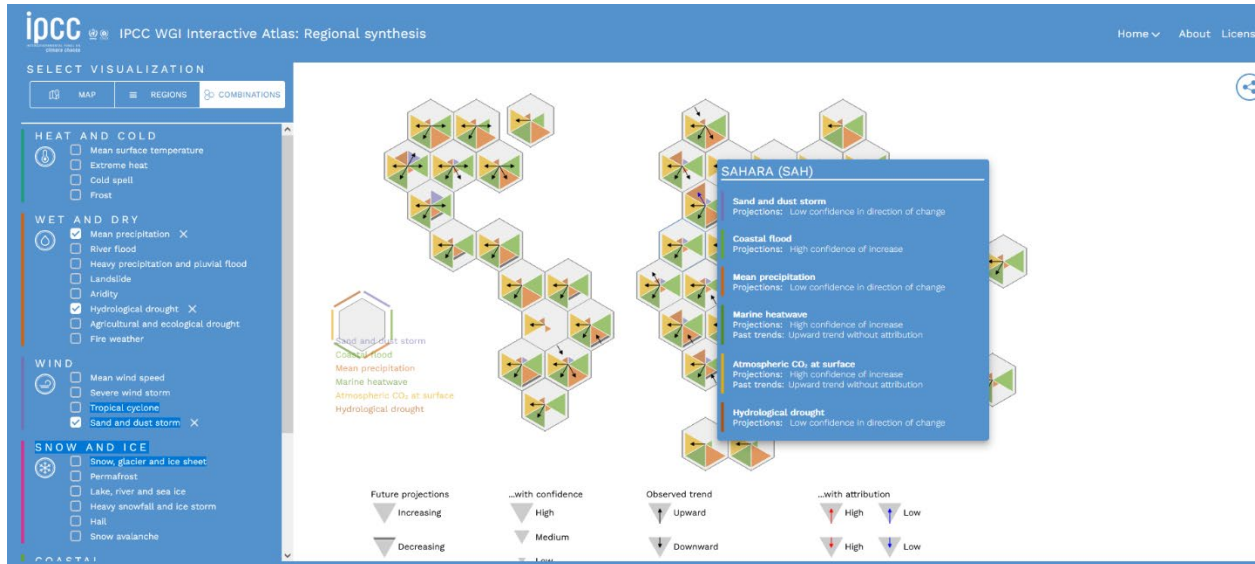
Data visualizations should be included in your presentation. You will need to familiarize yourself with these visualizations so you can interpret them for your audience.



Time series showing Mean temperature (T) Change relative to baseline (1850-1099) under the SSP5-8.5 pathway for the Saharan region of Africa.



Time series showing Sea Level Rise (SLR) Change relative to baseline (1850-1099) under the SSP5-8.5 pathway for the Saharan region of Africa.



Regional synthesis of six CIDs for the Sahara. For each CID, the direction of the projection and degree of confidence are shown. For some CIDs, observed trends and attribution are also shown.

---

## *Additional Reading and Resources*

---

[Center for Climate and Energy Solutions](#)

[CMIP 6: The Next Generation of Climate Models Explained](#). Carbon Brief

[Climate Science Academy](#). Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado Boulder

[Understanding Climate](#). US National Oceanic and Atmospheric Administration (NOAA)

[Earth Observatory](#). US National Aeronautics and Space Administration (NASA)

---

## *References*

---

Gulev, S.K., P.W. Thorne, J. Ahn, F.J. Dentener, C.M. Domingues, S. Gerland, D. Gong, D.S. Kaufman, H.C. Nnamchi, J. Quaas, J.A. Rivera, S. Sathyendranath, S.L. Smith, B. Trewin, K. von Schuckmann, and R.S. Vose, 2021: Changing State of the Climate System. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 287–422, [doi:10.1017/9781009157896.004](https://doi.org/10.1017/9781009157896.004).

Eyring, V., N.P. Gillett, K.M. Achuta Rao, R. Barimalala, M. Barreiro Parrillo, N. Bellouin, C. Cassou, P.J. Durack, Y. Kosaka, S. McGregor, S. Min, O. Morgenstern, and Y. Sun, 2021: Human Influence on the Climate System. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 423–552, [doi:10.1017/9781009157896.005](https://doi.org/10.1017/9781009157896.005).

Szopa, S., V. Naik, B. Adhikary, P. Artaxo, T. Berntsen, W.D. Collins, S. Fuzzi, L. Gallardo, A. Kiendler-Scharr, Z. Klimont, H. Liao, N. Unger, and P. Zanis, 2021: Short-Lived Climate Forcers. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy,

J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 561–605, [doi:10.1017/9781009157896.009](https://doi.org/10.1017/9781009157896.009).



Press, Cambridge, United Kingdom and New York, NY, USA, pp. 817–922,  
[doi:10.1017/9781009157896.008](https://doi.org/10.1017/9781009157896.008).

Forster, P., T. Storelvmo, K. Armour, W. Collins, J.-L. Dufresne, D. Frame, D.J. Lunt, T. Mauritsen, M.D. Palmer, M. Watanabe, M. Wild, and H. Zhang, 2021: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, 923 Cambridge, United Kingdom and New York, NY, USA, pp. 923–1054, [doi:10.1017/9781009157896.009](https://doi.org/10.1017/9781009157896.009).

Eyring, V., Bony, S., Meehl, G.A., Senior, C.A., Stevens, B., Stouffer, R.J. and Taylor, K.E., 2016. Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization. *Geoscientific Model Development*, 9(5), pp.1937-1958.