



Chapter 1: An Introduction to the Climate Problem

<http://lees.geo.msu.edu/courses/geo103/>

1/21 & 1/26

1.1. What is Climate?

1.2. What is Climate Change?

1.3. A Coordinate System for the Earth

1.4. Why You Should Believe This Book

Terms

Problems



Update

Student Perceptions of Learning Survey (SPLS): <https://my-msu.bluera.com/>

- Opens 12:01AM (Eastern) on April 17, 2026
- Closes at 11:59PM (Eastern) on April 26, 2026

Q: e-access of the textbook?



Correction

Artemis lunch during
Feb 6 - 15, 2026, with
climate as one of many
influencing variables!

<https://www.nasa.gov/mission/artemis-ii/>



5 MIN READ

NASA's Artemis II Mission to Fly Legacy Keepsakes with Astronaut Crew



This image shows NASA's SLS (Space Launch System) and Orion spacecraft rolling out of the Vehicle Assembly Building at NASA's Kennedy Space Center. NASA's massive crawler-transporter, upgraded for the Artemis program, carries the powerful SLS rocket and Orion spacecraft on the Mobile Launcher from the Vehicle Assembly Building to Launch Pad 39B at Kennedy Space Center in preparation for the Artemis II mission.

NASA/Brandon Hancock

1.3. A Coordinate System for the Earth

EQUATOR: line on Earth surface halfway between North and South Poles, dividing Earth into northern hemisphere (NH) and southern hemisphere (SH).

LATITUDE: distance in north-south direction between location and Equator, measured in degrees.

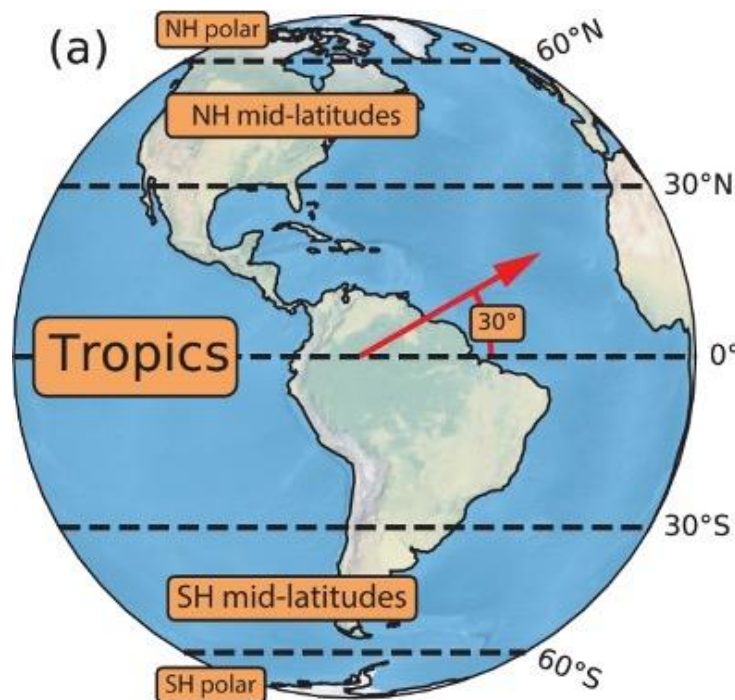


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30 degrees N to 30 degrees S), NH and SH mid-latitudes (30-60 degrees in each hemisphere), and polar regions (poleward of 60 degrees in each hemisphere).

1.3. A Coordinate System for the Earth

Latitude at Equator = 0 degrees (0°).

30° N: point on Earth that is 30° north of Equator.

0 to 90° latitude in each N/S hemisphere.

Unit: degree ($^\circ$), minute ($'$), second ($''$)

Latitude of Lansing (MI): ?

$42^\circ 44'$

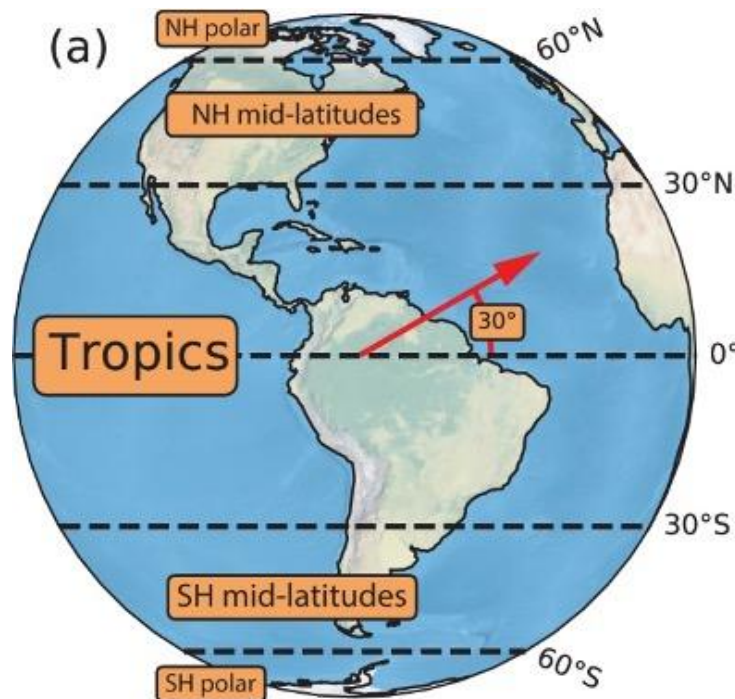


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30 degrees N to 30 degrees S), NH and SH mid-latitudes (30-60 degrees in each hemisphere), and polar regions (poleward of 60 degrees in each hemisphere).

1.3. A Coordinate System for the Earth

TROPICS = region from 30° N to 30° S latitude, covering one-half of Earth surface area.

MID-LATITUDES = region from 30 to 60° latitude in both hemispheres, covering one-third of Earth surface area.

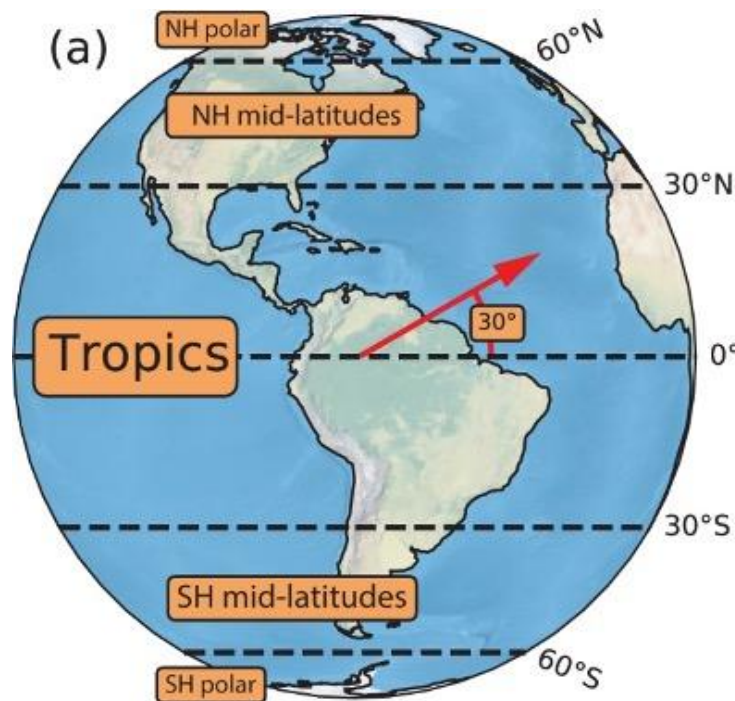


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30° N to 30° S), NH and SH mid-latitudes (30- 60° in each hemisphere), and polar regions (poleward of 60° in each hemisphere).

1.3. A Coordinate System for the Earth

POLAR REGIONS = regions from 60 to 90° latitude (the pole) in both hemispheres, covering one-sixth of Earth surface area.

North and South Poles are 90 degrees N/S.

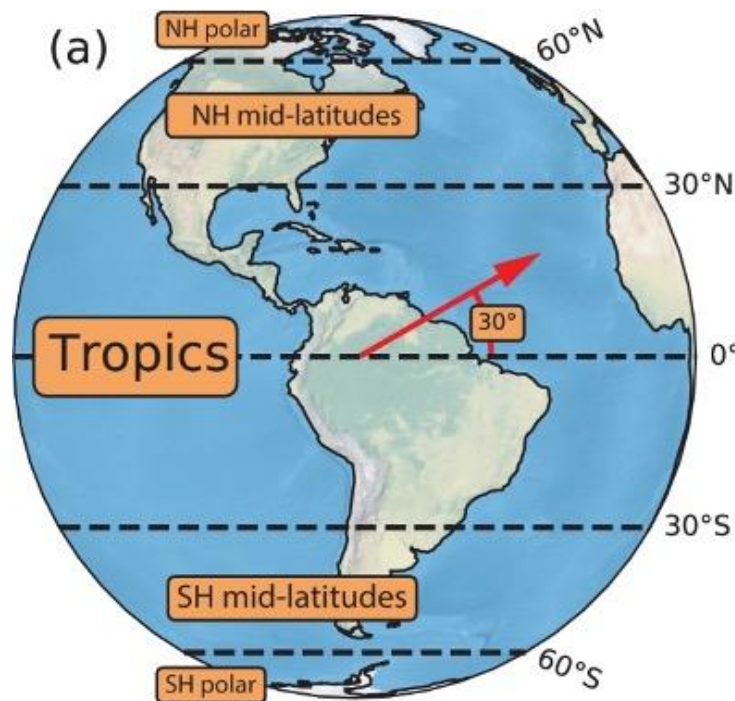


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30 degrees N to 30 degrees S), NH and SH mid-latitudes (30-60 degrees in each hemisphere), and polar regions (poleward of 60 degrees in each hemisphere).



1.3. A Coordinate System for the Earth

Latitude gives N/S location relative to Equator, but to uniquely identify location on Earth, also need E/W location relative to Prime Meridian.

Prime Meridian: 0° longitude, the global reference line for location and time.

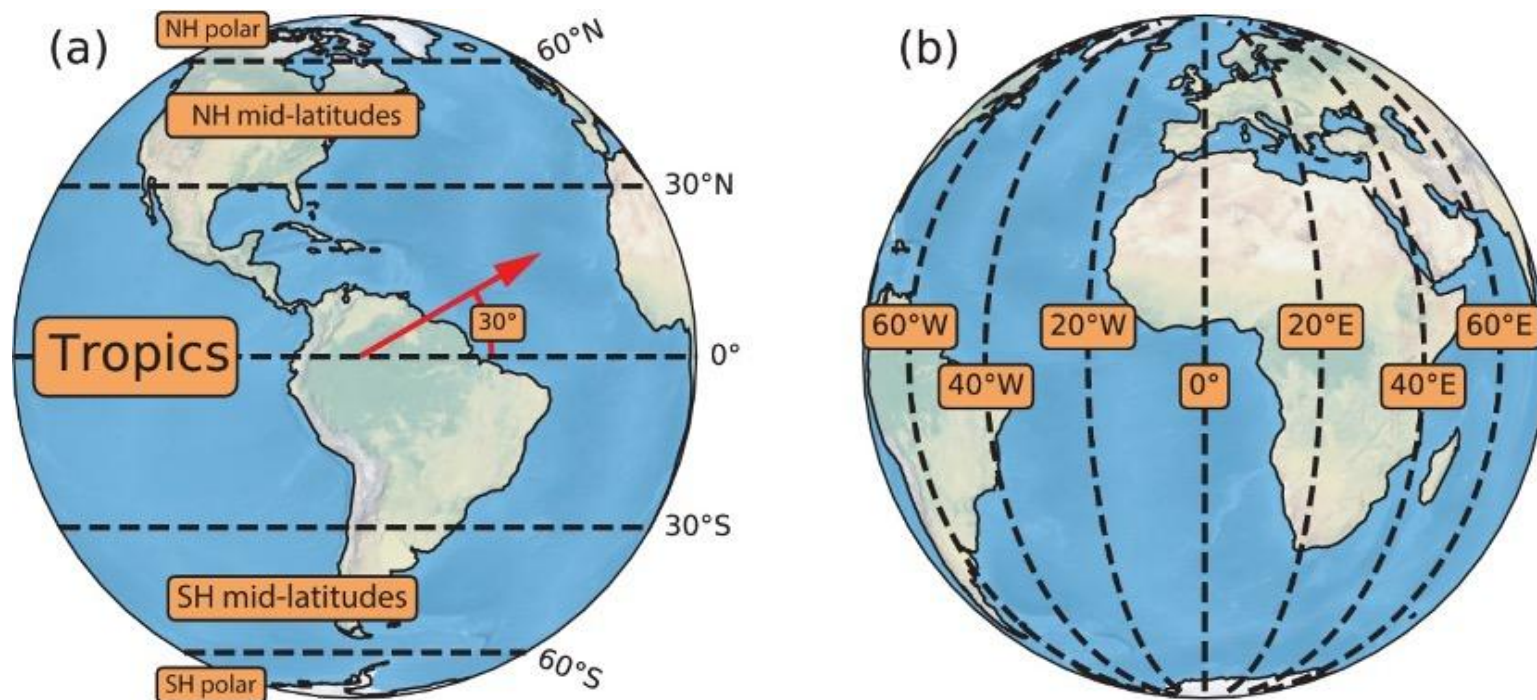


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30 degrees N to 30 degrees S), NH and SH mid-latitudes (30-60 degrees in each hemisphere), and polar regions (poleward of 60 degrees in each hemisphere).

1.3. A Coordinate System for the Earth

LONGITUDE: angle in east or west direction, from Prime Meridian, a line that runs from North Pole to South Pole through **Greenwich, England**, arbitrarily defined as 0 degrees longitude.

0° to 180° longitude in each E/W hemisphere.

Latitude of Lansing (MI): ?
84° 33' W

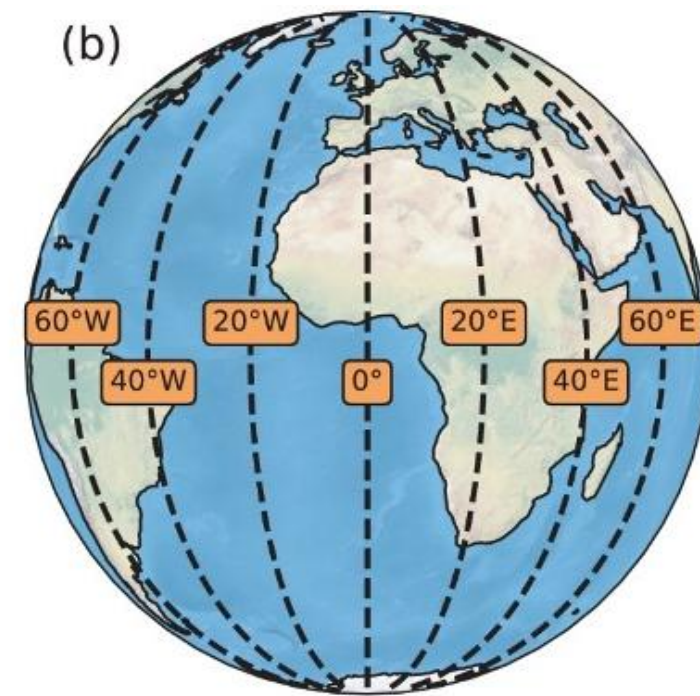


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30 degrees N to 30 degrees S), NH and SH mid-latitudes (30-60 degrees in each hemisphere), and polar regions (poleward of 60 degrees in each hemisphere).



1.3. A Coordinate System for the Earth

- In both directions (east and west), longitude increases to 180° .
- East meets west at International Date Line.
- Global Positioning System (GPS) technology allows us to find accurate locations.
- Google maps (Google Earth Pro) are widely used for GPS locations

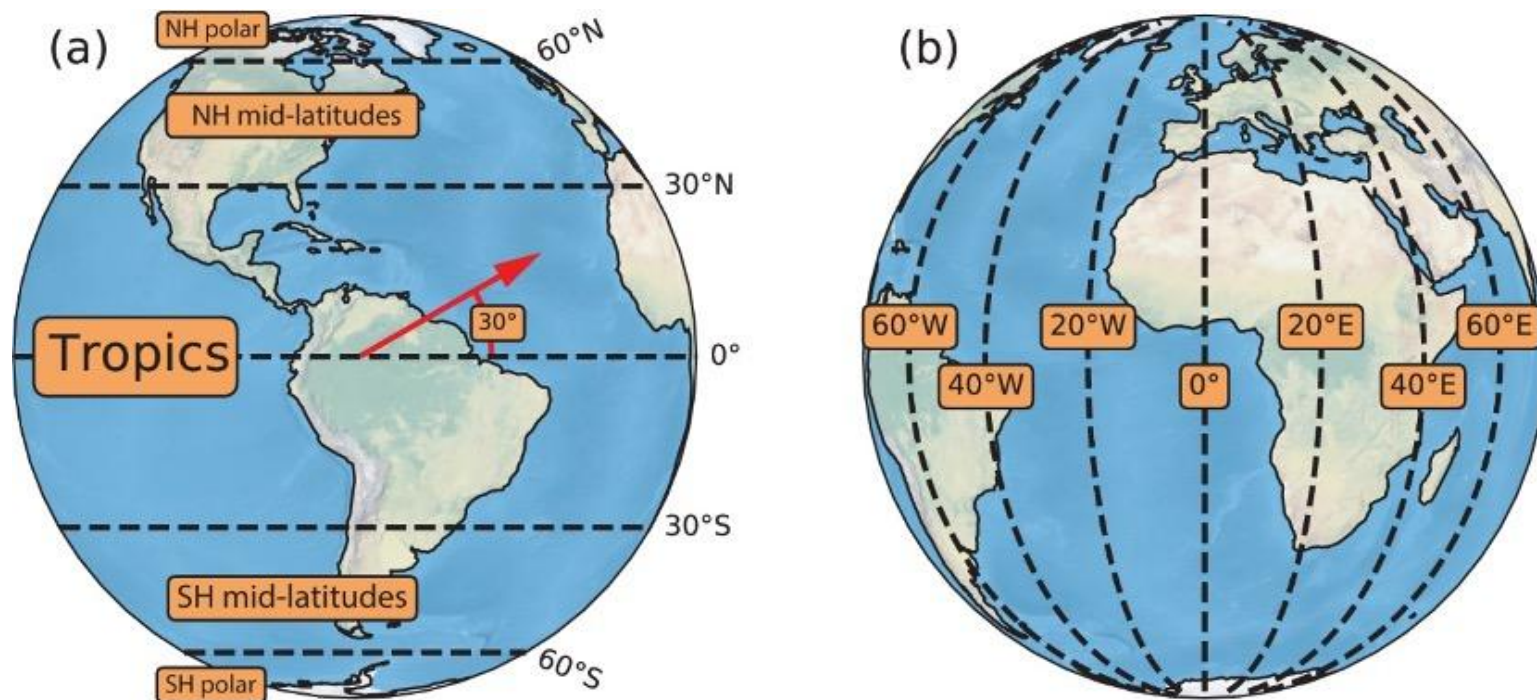


Fig. 1.2. (a) Schematic plot of latitude showing tropics (30°N to 30°S), NH and SH mid-latitudes (30° - 60° in each hemisphere), and polar regions (poleward of 60° in each hemisphere).



1.3. A Coordinate System for the Earth

Using Google Maps, determine the latitude and longitude of the following locations (Columns 2 and 3). Convert these values into degrees–minutes–seconds (Columns 4 and 5). Work in pairs.

Location	Lat	Long	Lat	Long
Cairo, Egypt				
Saigon, Vietnam				
Kyiv, Ukraine				
Seoul, South Korea				

1 degree = 60 minutes

1 minute = 60 seconds



1.3. A Coordinate System for the Earth

Here's a completed table with **latitude and longitude** (in decimal degrees) and their **degree-minute-second (DMS)** equivalents for the cities you mentioned, based on Google Maps/geographic data:

Place	Latitude (Decimal)	Longitude (Decimal)	Latitude (DMS)	Longitude (DMS)
Cairo, Egypt	30.033333° N	31.233334° E	30° 1' 59.9988" N	31° 14' 0.0024" E
Ho Chi Minh City (Saigon), Vietnam	10.762622° N	106.660172° E	10° 45' 45.44" N	106° 39' 36.62" E
Kyiv, Ukraine	50.450001° N	30.523333° E	50° 27' 0.0036" N	30° 31' 23.9988" E
Seoul, South Korea	37.566° N	126.9784° E	37° 33' 57.6" N	126° 58' 42.24" E



1.4. Why You Should Believe this Textbook

Climate change not like many other subjects:

- Sources exist disputing nearly every claim.
- You may not believe that climate change is a serious problem.
- Your friends/family may not believe that climate change is a serious problem.
- There exist many skeptical viewpoints.



1.4. Why You Should Believe this Textbook

How do you determine whether or not to believe a scientific claim?

- Recall how science evolved in real-time during coronavirus pandemic.

We can not be experts on every subject, so we must rely on shortcuts:

- Firsthand experience about how world works.

Over length of human life span may seem to some that climate does not change much.



1.4. Why You Should Believe this Textbook

- ✓ However, geologists know that dramatic climate changes have occurred over Earth history.
- ✓ Problem with relying on firsthand experience about climate that past experience may not be relevant to present or future.
- Another shortcut is to rely on our values:
 - ✓ We may choose to accept claims that fit our worldview while rejecting claims that do not.
 - ✓ Claims of secondhand smoke, vaccines, etc.



1.4. Why You Should Believe this Textbook

- Yet another shortcut is to rely on opinion leader:
 - ✓ **OPINION LEADER** = person who you trust because they appear to be authoritative or because you agree with them on other issues.
 - ✓ Family member, influential friend, media figure, politician.
 - ✓ In absence of strong opinion of your own, can adopt those of opinion leaders, even if those opinions have not been fact-checked.



1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

Where should you turn to find out whether or not science supports a particular claim?

- Scientific method: (1) generate hypothesis, (2) perform experiments to test hypothesis, and then (3) reach conclusion about hypothesis.

Testable hypothesis (e.g., Earth is warming).

- Before conclusion can be considered “true” it must first be reviewed (**validated**) by scientific community.

1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- Scientists write detailed manuscript that includes details about hypothesis, experimental methods, results, and conclusions.
- Manuscript then submitted to scientific journal, where manuscript critically reviewed by journal editor and volunteer expert peer reviewers.
- **PEER REVIEW** = process that looks for errors or weaknesses in analysis that might cast doubt on conclusions.



1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- Peer review is double-blind process, where identity of reviewers not revealed to author(s) and vice versa.
- Peer reviewers each write critical review, then provide suggestion to editor to: (1) publish without revisions, (2) publish after revisions, or (3) reject.
- If published, scientific article continues to be scrutinized by “crucible of science” as methods and conclusions repeatedly tested by scientific community.

1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- Sometimes errors discovered after publishing and errata published or article retracted.
- Other times conclusions confirmed many times over, increasing confidence in conclusions.
- Scientific terminology has included: law, property, theory, fact, truth, etc.
- While 100% confidence impossible, we can get close with well-verified conclusions.



1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- **SCIENTIFIC CONSENSUS** = over time as peer-reviewed literature fills up with replications and other tests of a claim, some claims become well-verified enough that they come to be regarded simply as scientific truth.
 - ✓ double helix structure of DNA.
 - ✓ atoms obeying laws of quantum mechanics.
 - ✓ burning fossil fuels increases abundance of carbon dioxide in atmosphere.



1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- Road to consensus often not a straight line.
- **CLIMATE SKEPTICS** = climate scientists who continue to dispute climate change consensus – and who can not advance a good reason for doing so – become marginalized and ignored by their colleagues.
- Climate deniers = those who actively cast doubt on reality of climate change consensus in a way similar to Holocaust denialism.



1.4. Why You Should Believe this Textbook

1.4.1. How Science Works

- Those aiming to cast doubt often selectively cite out-of-date, discredited, or unrepresentative peer-reviewed studies in attempt to claim that scientists disagree.
 - ✓ Scientific consensus not based on poll or vote, but rather analysis of body of peer-reviewed literature.
 - ✓ Reading every peer-reviewed article impossible by any one person, as there are thousands.



1.4. Why You Should Believe this Textbook

1.4.2. Scientific Assessments

- Scientific articles densely written and full of jargon because they are written by experts, mostly for other experts.
- Thus, we need reliable summary for non-experts, especially policymakers.
- Scientific assessment = reputable summary of peer-reviewed literature.



1.4. Why You Should Believe this Textbook

1.4.2. Scientific Assessments

- Job of scientific assessment not to do new science, but to summarize existing peer-reviewed literature:
 - ✓ Assessment begins with policymakers defining questions they want answered.
 - ✓ Large, expert writing team assembled.
 - ✓ Assessment draft peer reviewed before published.



1.4. Why You Should Believe this Textbook

1.4.2. Scientific Assessments

- Most well-known assessment is **Intergovernmental Panel on Climate Change** (IPCC):
 - ✓ To learn more about this international effort, visit ipcc.ch.
 - ✓ Shared 2007 Nobel Peace Prize.
 - ✓ Scientific organizations routinely publish statements of agreement supporting IPCC (e.g., NASA, NOAA, NSF, AMS, AGU, AAG, and others).



1.4. Why You Should Believe this Textbook

1.4.2. Scientific Assessments: IPCC

- 1988 (start), 1990 (FAR), 1995 (SAR), 2001 (TAR), 2007 (AR4), 2013-14 (AR5), 2021-22 (AR6), 2023- (AR7).
- Working Group I: The Physical Science Basis.
- Working Group II: Impacts, Adaptation, and Vulnerability.
- Working Group III: Mitigation of Climate Change.
- Synthesis Report: Climate Change.
- Summary for Policymakers (SPM).



1.4. Why You Should Believe this Textbook

Key findings from the AR6 Synthesis Report (IPCC):

- **Human-caused warming is unequivocal.** The report concludes that human activities (especially burning fossil fuels) are the dominant cause of recent climate change.
- **Warming continues and is widespread.** Global average temperatures, sea levels and greenhouse gas concentrations are higher than at any time in millennia.
- **Risks are serious and escalating.** Every additional increment of warming increases risks to human health, ecosystems, food and water security, and economic systems.
- **Some changes will last centuries.** Sea-level rise and certain ecological shifts are essentially irreversible on human timescales.
- **To limit warming to ~1.5 °C**, deep and rapid cuts in greenhouse gas emissions (**GHG**) are needed now for emissions being decreasing already and reduce *almost by half* by 2030 to stay on that pathway.



1.4. Why You Should Believe this Textbook

1.4.2. Scientific Assessments

At national level, we have National Climate Assessment (NCA) now in its fifth iteration in 2023: <https://nca2023.globalchange.gov/>. **But terminated in 2025.**

We can now answer the question posed above:

Information in this book (and class) based on assessments from IPCC and other credible organizations, which in turn based on peer-reviewed literature from expert scientific community!



Aside 1.1. The Summary for Policymakers

IPCC reports are summaries but still run into thousands of pages.

SUMMARY FOR POLICYMAKERS (SPM) = more readable summary of full report a few dozen pages long.

- Summarizes in more general language most important conclusions in main report.
- IPCC representatives from each world government review SPM draft written by scientists and vote on every sentence.



Aside 1.1. The Summary for Policymakers

- Each sentence only included after unanimous agreement from all world governments!
- Each country attempts to mold SPM to best suit their negotiating position.
- During process sentences often rewritten to gain unanimous support.
- Sometimes footnotes included to mention dissent.

Purpose of exercise to produce common set of scientific facts to serve as basis for future negotiations on policy.



Aside 1.1. The Summary for Policymakers

In the end, SPM represents good summary of our current scientific understanding of climate:

- But, SPM has unavoidable hint of political influence.
- Such influence nearly always waters down conclusions, weakening assertion of scientific statements.
- Despite these flaws, SPM remains important.

Failed COP30 in 2025

 **United Nations**
Climate Change

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UN Climate Change Conference – Belém, November 2025

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Updates.



 18:39  22 Nov, 2025

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Simon Stiell closing speech: “COP30 showed that climate cooperation is alive and kicking, keeping humanity in the fight for a livable planet”



UN Climate Change Executive Secretary Simon Stiell spoke at the closing of the COP30 plenaries in Belém today.

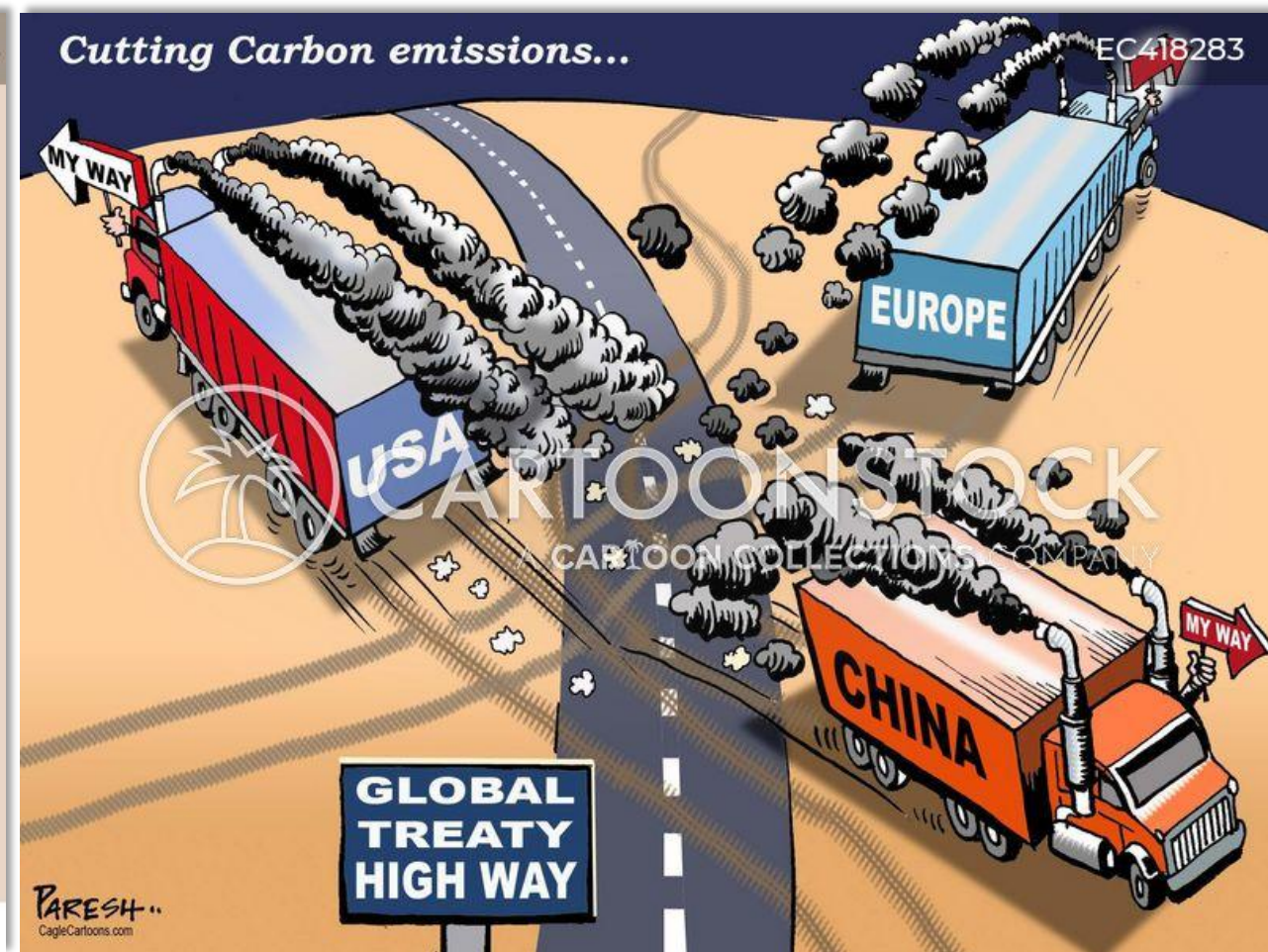
Some notable quotes include:

“We knew this COP would take place in stormy political waters. Denial, division and geopolitics has dealt international cooperation some heavy blows this year.

But friends. COP30 showed that climate cooperation is alive and kicking, keeping humanity in the fight for a livable planet, with a firm resolve to keep 1.5C within reach.

US Policy Shifts on Climate Change

From basic research/education to engineering, implementation and daily life:
a complex process because of too many stakeholders!





Terms & Units from today

Solar constant ()

Energy flux (W/m^2)

Latitude and longitude ($^\circ$, ', ")

Equator

Tropics (0 - 30°)

Mid-latitudes ($>30^\circ$)

Polar region ($>60^\circ$)

Prime Meridian

GPS

IPCC & NCA, [Reports \(SPMs\)](#)

Study question

7

First quiz on Jan 28 (before the lecture)



Chapter 1: An Introduction to the Climate Problem

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1/21 & 1/26

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Chapter 2: Is the Climate Changing?

<http://lees.geo.msu.edu/courses/geo103/>

1/28 & 2/2

2.1. Temperature Anomalies

2.2. Recent Climate Change

2.3. Climate over the Earth's History

Terms

Problems



Questions (examples) for the Quizzes

1. Which parts of the Earth System store the most carbon?

- ☐ The atmosphere
- ☐ Oceans
- ☐ Terrestrial Biosphere
- ☐ Polars

2. What are the two primary methods used to directly measure GHG emissions of a field, such as at Gustafson Farm?

- 1 _____
- 2 _____

3. List four methods used to remove CO₂ from the atmosphere.

- 1 _____
- 2 _____
- 3 _____
- 4 _____

4. Provide two of the three major sources of fossil fuel industries responsible for the rise in atmospheric CO₂ concentrations.

- 1 _____
- 2 _____

5. If a person drives 5,000 miles per year using regular gasoline, how many large oak trees with a DBH of 24 inches would store an equivalent amount of carbon? Select one answer.

- ☐ One tree
- ☐ Two trees
- ☐ Three trees
- ☐ Four Trees