



Storm Room: Four Teams, Twelve Lessons

DRIVING QUESTION

How do sunlight, air, and water work together to make our weather, our storms, and our climate, and how can we tell what is coming?

YOUR CHALLENGE

Build it. Make it work. Teach it. Your team is the class expert on three lessons, and your build is how you teach them.

THE PROJECT

The phenomenon

Some afternoons the sky over campus goes from clear to thunder in a few hours. Some winters are mild, and some bring a hard freeze. Out in the Gulf, warm water can help a storm grow much stronger overnight. All of it runs on one engine: the Sun heats Earth unevenly, and air and water carry that heat around a spinning planet. To explain your own sky you need all of Module 3: the air, the weather, the storms, the climate, and the ocean. No one team can learn it all in time, so each team becomes the expert on one part and teaches it.

THE PROJECT

How it works

- Your group forms on your Scholar Dashboard and picks one focus.
- Each focus covers three Module 3 lessons.
- Each teammate leads one of your three lessons.
- In a group of four, the fourth teammate is the Verifier.
- Your team builds something that works.
- It is not a poster.
- It has to do something you can test.
- Your team keeps one shared group note in Note Studio.
- Everyone types in it at the same time.
- You photograph your build.
- When Dr. Ijezie approves the photos, they appear on the Module 3 page.
- On teach-back day your team teaches its three lessons with the build.
- Everyone learns all twelve lessons.
- Each of you turns in the group note to the Assessment Center, like notes homework.

TEAMS

Four teams, four focuses

Three teams of three and one team of four. Every focus is part of the same driving question: how do sunlight, air, and water make our weather, our storms, and our climate?

TEAM	FOCUS QUESTION
Team 1 • Cloud Makers The air, its properties, and clouds	What is the air made of, how does it take in heat, and what makes a cloud and rain appear?
Team 2 • Weather Station Causes of weather, weather data, and forecasts	Why does the wind blow and the weather change, and how can we measure it and forecast what comes next?
Team 3 • Storm and Sea Thunderstorms, hurricanes, and the ocean	What does a storm need to grow, and how does the ocean feed it and move heat around the planet?
Team 4 • Climate Desk Recurrent weather, climate, and feedbacks	What sets the climate of a place, why does some weather keep coming back, and how can one change grow into a bigger one?

TEAMS

Form your group

Groups form on your Scholar Dashboard. First come, first served: once a group takes a focus, no other group can take it.

1. Talk with your partners first and agree on the focus you want, plus a backup.
2. When Dr. Ijezie opens group forming, a pop-up appears on your Scholar Dashboard.
3. Your dashboard shows the opening time before then.
4. One person signs in to the Scholar Dashboard with their alias and PIN.
5. That person adds each partner by typing at least 3 letters of their alias.
6. Then they pick the group's focus and press Create group.
7. Taken focuses are crossed out.
8. Groups are 3 people.
9. One group in the class can have 4.
10. Everyone in the group now sees the group and focus on their own dashboard.
11. To change a group, talk to Dr. Ijezie.

WHO DOES WHAT

Team roles

EVERY TEAM

Lead Investigator

- Runs the lab investigation and the build tests, and records every setting and reading.
- Keeps the team on schedule and checks each day's checkpoint in the group note.
- Leads one of your three lessons.

Hands the raw readings to the Data Analyst by the end of Day 2.

EVERY TEAM

Data Analyst

- Does the team's calculation and checks it with the self-check.
- Builds the data table in the group note, with units on every number.
- Leads one of your three lessons.

Hands a checked table and one finished calculation to the Communicator by the end of Day 5.

EVERY TEAM

Science Communicator

- Leads the build and takes the build photos for approval.
- Plans the teach-back so every lesson gets equal time.
- Leads one of your three lessons.

Uploads at least two approved-quality photos by the test day.

ONLY THE TEAM OF FOUR

Verifier

- Repeats every test and calculation on their own and settles differences.
- Checks every number in the group note against its source.
- Helps each lesson lead and builds the strongest argument against the team's claim before teach-back.

Turns in a one-page verification log with the team's products. In a team of three, the Analyst writes the uncertainty statement and the Lead writes the counter-argument.

WHAT YOU MAKE

What every team makes

- **Working build** (Presented in class · Day 5).
 1. The thing your team builds.

2. It must pass its 'It works when' tests at least twice.
- **Build photos** (Group note · Day 5).
 1. At least two clear photos of the build only (no faces or people), uploaded in your group note.
 2. Approved photos appear on the Module 3 page.
 - **Group note** (Note Studio → Assessment Center · Day 8).
 1. Your shared Note Studio group note: your three lessons, build plan, test data, results, teach-back plan, and each teammate's own contribution and reflection.
 2. Each of you turns in your copy like notes homework.
 - **Teach-back lesson** (Presented in class · Day 8).
 1. A ten-minute lesson: show the build working, then each lesson lead teaches their lesson with it and asks one check question.

Your Note Studio group note

Open Note Studio and choose **ESS Group Project**. Your team types in one shared note at the same time, and nobody can erase a teammate's section.

Build plan and materials

- Sketch description.
- Materials list.
- Who brings what.

What this lesson teaches (one per lesson)

- Two to four key ideas.
- Vocabulary.
- One example.
- The lesson lead writes this; teammates add.

Build log and test data

- Every try:
- Date.
- What you changed.
- Results with units.

What our build shows and what it leaves out

- Claim.
- Evidence from your tests.
- One limit of the build.

Teach-back plan and check questions

- Who teaches what.
- In what order.
- One check question per lesson with the answer.

What I did (each scholar, only you type here)

- Your own work on each day.
- Only you type here.

My reflection (each scholar, only you type here)

- What you learned from another team.
- One thing you would change.

Turn in your copy

Photos: at least two of the build only, no faces or people. Dr. Ijezie approves them before they appear on the Module 3 page. On teach-back day:

1. Each of you presses Update my turn-in copy.
2. Turn it in on the Assessment Center.

THE PLAN

Eight days, eight checkpoints

DAY	WHAT HAPPENS	CHECKPOINT
Day 1 Mon, Oct 12	Form up and plan. Know your three lessons and plan the build. • Form your group on the Scholar Dashboard. • Pick your focus. • Open your group note in Note Studio. • Choose who leads each lesson. • Read the Module 3 slides your team needs. • In the note, write two key ideas for each of your lessons. • Sketch the build. • List the materials.	Group note: lesson leads chosen, two key ideas per lesson, build sketch and materials list.
Day 2 Tue, Oct 13	Learn deeply. Become the expert on your lesson. • Each lesson lead fills in their lesson section: key ideas, vocabulary, one example. • Run your team's Circulation Engine investigation. • Record every setting and reading. • Gather materials.	Every lesson section filled in; lab readings recorded with units.
Day 3 Wed, Oct 14	Build. Build the thing and make it run once. • Build it. • Follow your build steps. • Try it once. • Write what happened and what you will fix. • Take progress photos (build only, no faces). • Before you leave, label your build with your team name. • Store it where Dr. Ijezie says.	Build log in the group note; first try recorded; build stored.

DAY	WHAT HAPPENS	CHECKPOINT
Day 4 Thu, Oct 15	Test and photograph. Prove it works. • Reread your group note. • Check that every part of the build still works. • Run every 'It works when' test at least twice. • Record results with units. • Upload at least two photos of the finished build in the group note. • Before you leave, store your build again. • There is no class on Friday, so it waits until Monday.	Test data with units; two photos uploaded for approval.
Day 5 Mon, Oct 19	Improve and retest. Fix what failed and prove the fix works. • Check that every part of the build still works after the weekend. • Fix one thing that did not work, or one test that was close. • Run that test twice again. • Record the new results. • Do your team's calculation. • Check it.	One fix and its retest recorded; calculation checked.
Day 6 Tue, Oct 20	Plan the lesson. Plan how to teach with your build. • Plan the ten-minute teach-back: two minutes of demo, then each lesson lead teaches with the build. • Write one check question per lesson, with an answer key. • Write what your build shows and one thing it leaves out.	Teach-back plan and three check questions in the group note.
Day 7 Wed, Oct 21	Rehearse. Practise until it runs smoothly. • Rehearse with another team. • They give one strength, one question, one fix. • Every teammate practises every part, not only their own lesson. • Each of you writes your own contribution and reflection in the group note.	Rehearsal feedback written; every teammate's contribution filled in.

DAY	WHAT HAPPENS	CHECKPOINT
Day 8 Thu, Oct 22	Teach-back day. Teach your lessons and learn all the others. • Each team teaches for ten minutes with its build. • Everyone takes learning notes. • Everyone answers every check question. • Press 'Update my turn-in copy' in the group note. • Turn it in to the Assessment Center. • Last-day partner review in the Assessment Center.	Teach-back given; learning notes; group note turned in; partner review done.

Cloud Makers

FOCUS QUESTION

What is the air made of, how does it take in heat, and what makes a cloud and rain appear?

Every other team's weather happens in the air. Your team teaches what the atmosphere is made of and how it heats up, how to measure the water in it, and how that water becomes clouds and rain.

Your lessons

1. Atmospheric Basics

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

2. Properties of the Atmosphere

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

3. Clouds and Precipitation

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

Also read: Module 3 Slides — Atmosphere, Weather & Oceans: The Fluid Earth. Read the slides on solar input and the energy budget, the two knobs on the engine (albedo and greenhouse gases), and the traps about why hot air rises and about warm air 'holding' water. They explain how the Sun heats the air and how a cloud forms.

Big ideas you will use

- The atmosphere is mostly nitrogen and oxygen. It has layers: the troposphere, where weather happens, the stratosphere, which holds the ozone layer, and higher layers above.
- The Sun heats the ground. The ground heats the air touching it (conduction). Denser air around the warm air pushes it up (convection).
- Air has a temperature, a pressure, a density, and a humidity. The dew point is the temperature at which the water vapour in the air starts to condense.
- A cloud forms when air cools to its dew point. Droplets grow until they are heavy enough to fall as rain, snow, sleet, or hail.

Cloud station: make the air show its water

Build a three-part station that shows how air takes in heat, measures the water in the room's air, and then makes a cloud and rain on purpose. Classmates use it to explain when a cloud will form.

Materials

- Two empty plastic bottles of the same size (1 litre or less), each with a balloon (stretched first) over the mouth
- Two tubs: one of ice water and one of warm tap water
- A shiny metal can with the label removed and a smooth rim, ice cubes, a spoon, and a thermometer
- A clear plastic food container, plastic wrap, and a zip bag of ice
- Hot tap water, poured by an adult
- A timer and a dark sheet of paper to hold behind the container

Your model must show

1. Heat moves into the air by conduction.
Warmed air expands, so the same air takes up more space and is less dense.
2. The dew-point can measures the dew point of the room's air, and you compare it with the air temperature.
3. Air cooled below its dew point makes droplets (a cloud), and the droplets grow and fall (precipitation).

Build steps

1. Balloon bottles: stand one bottle in the warm water and one in the ice water.
2. Hold each one down so the water comes up its sides.
3. Watch each balloon for 5 minutes.
4. Dew-point can: half fill the can with room-temperature water and stand the thermometer in it.
5. Add ice one cube at a time and stir gently with the spoon.
6. Record the temperature the moment the outside of the can fogs.
7. That is the dew point.
8. Record the room temperature too.
9. Rain maker: an adult pours about 3 cm of hot tap water into the container.
10. Cover it with plastic wrap and set the bag of ice on top so the wrap sags in the middle.
11. Hold the dark paper behind it and watch.
12. Label each part with its lesson and one sentence on what it shows.

It works when

- The balloon on the warm bottle stands up, and the balloon on the cold bottle droops or pulls into the mouth.
- Two dew-point readings in a row agree within 2 °C, and the dew point is lower than the room temperature.
- Droplets form under the ice, and drops grow big enough to fall back into the water.

Test it: Run each part twice. Record what each balloon did, the room temperature and the dew point in °C, and the minutes until droplets appear and until the first drop falls.

Safety: Adults pour the hot tap water, never boiling water. Stir with the spoon, not the thermometer. Check that the can has no sharp edge. Wipe spills right away. Never taste or drink lab water.

The Circulation Engine: The equator paradox

1. On the Engine tab, press Enter Storm Mode.
2. Keep the start settings and press Front 2.4 km.
3. Record the LCL, LFC, CAPE, CIN, and the Verdict.
4. Set Sea-surface temperature to 31 °C, Surface dew point to 30 °C, and Latitude to 0°.
5. Record what the Verdict says, and what it does not say.
6. Raise Latitude one degree at a time.
7. Record the lowest latitude that gives a FAVORABLE ENVIRONMENT.
8. Set Latitude to 15°.
9. Raise Vertical wind shear to 11 m/s and record the Verdict.
10. Then set it back to 6 m/s.
11. Lower Surface dew point slowly until the parcel stalls.
12. Record the dew point, the LFC, and the CIN at that moment.

Calculate: Energy budget and cloud base

1. Part A: NASA reports about 340 W/m² of sunlight arriving on average, and about 29% reflected to space.
2. How many W/m² are reflected, and how many are left to heat Earth?
3. Part B: Rising air makes a cloud where it cools to its dew point.
4. A quick estimate: the cloud base is 0.125 km higher for every °C between the air temperature and the dew point.
5. The room reads 22 °C and your can gives a dew point of 10 °C.
6. How high would the cloud base be if air like this rose outdoors?

Self-check: Reflected plus remaining must equal 340 W/m². For Part B, your height ÷ 0.125 must give back the difference in °C.

Real data

- **Earth's energy budget** · NASA Earth Observatory, Climate and Earth's Energy Budget. NASA reports about 340 watts per square metre of sunlight at the top of the atmosphere, averaged over the planet. About 29 percent is reflected to space, about 23 percent is absorbed by the atmosphere, and about 48 percent is absorbed by the surface. The tropics have an energy surplus and the poles have a deficit, which drives the air and ocean circulation.

<https://science.nasa.gov/earth/earth-observatory/climate-and-earths-energy-budget> · Read on 2026-09-23.

- **Gulf air and water today** · NOAA National Data Buoy Center, Station 42035, 22 nautical miles east of Galveston, TX. Record the air temperature, dew point, and water temperature. They are in °F, so convert each to °C. Compare the water with 26.5 °C. Then estimate the cloud base: 0.125 km for every °C between the air temperature and the dew point.

https://www.ndbc.noaa.gov/station_page.php?station=42035 · Station name and location read on 2026-09-23. Readings change every hour, so read them yourself and record the time.

The decision to make

1. Deciding when to move an outdoor game or practice inside on a hot, humid afternoon when storms may build.

Two options to compare

- Moving inside ahead of time when the morning forecast calls for afternoon storms
- Watching the sky and moving inside at the first thunder you hear

Your map hotspot

1. On a drawing of the sky over campus, mark the cloud base from Part B and label the layer of the atmosphere it is in.

Trap to avoid

Warm air does not 'hold' water like a sponge. Warmth speeds up evaporation. Cooling air to its dew point makes condensation win, and a cloud forms.

TEACH IT

Show your build working, then teach:

1. The atmosphere is a mix of gases in layers. The Sun heats the ground, the ground heats the air, and convection carries warm air up.
2. Warm air expands and is less dense. The dew point tells you how much water vapour is in the air.
3. When air cools to its dew point, droplets form a cloud. The droplets grow and fall as precipitation.

Check question: Why does water form on the outside of the ice-cold can but not on a can of room-temperature water?

Texas standards

- **ESS.11B** Describe how Earth's atmosphere is chemically and thermally stratified and how solar radiation interacts with the layers to cause the ozone layer, the jet stream, Hadley and Ferrel cells, and other atmospheric phenomena. §112.49(c)(11)(B) *You describe the layers of the atmosphere and how sunlight heats it.*
- **ESS.11F** Explain how the transfer of thermal energy among the hydrosphere, lithosphere, and atmosphere influences weather. §112.49(c)(11)(F) *You explain how heat moving between water and air makes clouds and rain.*
- **ESS.1G** Develop and use models to represent phenomena, systems, processes, or solutions to engineering problems. §112.49(c)(1)(G) *You build a working model of heating, the dew point, and precipitation.*
- **8.10A** Describe how energy from the Sun, hydrosphere, and atmosphere interact and influence weather and climate. §112.28(b)(10)(A) *Grade 6–8 foundation.*
- **7.8A** Investigate methods of thermal energy transfer into and out of systems, including conduction, convection, and radiation. §112.27(b)(8)(A) *Grade 6–8 foundation.*

Word bank: troposphere · stratosphere · conduction · convection · humidity · dew point · condensation · precipitation

Weather Station

FOCUS QUESTION

Why does the wind blow and the weather change, and how can we measure it and forecast what comes next?

Weather is the air on the move. Your team teaches why the air moves and how weather systems form, builds the instruments that measure it, and uses them to make a forecast the class can check.

Your lessons

1. Causes of Weather — and Weather Systems

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

2. Gathering Weather Data

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

3. Weather Analysis and Prediction

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

Also read: Module 3 Slides — Atmosphere, Weather & Oceans: The Fluid Earth. Read the slides on why one loop becomes three cells, on the wind belts and the ITCZ, and the trap about what the Coriolis effect really does. They explain why the air moves and which way weather travels.

Big ideas you will use

- The Sun heats Earth unevenly. That makes areas of high and low pressure, and air moves from high toward low pressure as wind.
- Earth's spin bends moving air to the right in the Northern Hemisphere. This is the Coriolis effect, and it helps shape the global wind belts.
- An air mass is a huge body of air with about the same temperature and humidity. A front is where two air masses meet, and fronts often bring clouds and rain.
- Forecasters use instruments, weather balloons, radar, and satellites. A forecast gets less certain the farther ahead it looks.

Campus weather station and forecast board

Build working weather instruments, read them every class, and use them with the national weather map to make a forecast the class can check.

Materials

- Wind vane: a straw, card for the arrowhead and a bigger tail, a pin, a pencil with an eraser, and a paper cup filled with sand
- Anemometer: four small paper cups (one coloured), two straws, a pin, and a pencil with an eraser
- Rain gauge: a clear, straight-sided cup, a ruler, tape, and a measuring cup marked in mL
- Barometer: a clean jar, a balloon stretched over the mouth with a rubber band, a straw, glue, and a card scale
- A thermometer, a compass (or a phone compass), a timer, and a small battery fan for testing

Your model must show

1. Wind direction and speed from your vane and anemometer, explained with the high and the low on today's weather map.
2. Four instruments that each give a reading with a unit, read at the same time each class.
3. A written forecast for the next class, with how sure you are, checked against what happened.

Build steps

1. Build each instrument.
2. Mark N, E, S, and W on the vane's base and line it up with the compass.
3. Test indoors with the battery fan.
4. Count the anemometer's turns in 30 seconds with the fan 30 cm away, then 100 cm away.
5. Check that the vane's arrow points into the fan.
6. Measure the inside width of your rain gauge.
7. Its base area is $3.14 \times \text{half the width} \times \text{half the width}$.
8. Calculate how deep 100 mL will stand, then pour in 100 mL and read the ruler.
9. Set the station outside in an open spot Dr. Ijezie approves.
10. Read every instrument each class and log the time, the readings, and the units.
11. Read today's national surface map.
12. Write a forecast for the next class, then check it.

It works when

- The vane's arrow points into the fan, within 45° , in both trials.
- The anemometer counts more turns in 30 seconds with the fan 30 cm away than 100 cm away, in both trials.
- The rain gauge reads within 2 mm of the depth you calculated for 100 mL, in both trials.

Test it: Run each indoor test twice. Then read the station on at least three class days. Record wind direction, turns per 30 seconds, rain in mm, temperature in °C, and the barometer straw's position in mm on its card scale, each with the time. Compare the barometer's change with the official pressure on the map.

Safety: Push pins into the erasers with an adult nearby. Keep the fan's batteries dry. Put the outdoor station only where Dr. Ijezie allows.

The Circulation Engine: Break the loop • Feed the engine

1. On the Engine tab, set Rotation to 0× Earth.
2. Record the Cells per hemisphere and the Peak surface wind.
3. Raise Rotation step by step.
4. Record the value where a third cell first appears, and where a fourth appears.
5. Set Rotation back to 1× Earth.
6. Set Solar input to 0.5×, 1×, and 1.5× present.
7. Record the Hadley cell width and the Peak boundary current each time.
8. Move Season • peak heating all the way to each end.
9. Record the ITCZ latitude each time.
10. Explain why Solar input alone never moved it.

Calculate: Pressure gradient and rain-gauge depth

1. Part A: Map 1 has two stations at 1020 hPa and 996 hPa, 600 km apart.
2. Map 2 has two stations at 1016 hPa and 1008 hPa, 400 km apart.
3. Find each pressure gradient in hPa per 100 km.
4. Say which map has the stronger wind and which way the air is first pushed.
5. Part B: A practice rain gauge is a straight-sided cup with a base area of 50 cm².
6. How deep, in mm, will 100 mL of water stand in it?
7. (1 mL = 1 cm³ and 1 cm = 10 mm.) Then do the same for your own cup.

Self-check: Gradient × (distance ÷ 100) must give back the pressure difference. For Part B, depth in cm × 50 cm² must give back 100 cm³.

Real data

- **Today's weather map** • NOAA Weather Prediction Center, surface analysis. Find the high (H) and the low (L) nearest Texas. The pressure is the number printed beside each one. Tick the lat/lon box to see where each sits, then use an online map's distance tool to find the distance between them in km. Work out the gradient the same way as Part A.

<https://www.wpc.ncep.noaa.gov/html/sfc-zoom.php> • The map changes every few hours. Record the map time and the date you read it. Checked on 2026-09-23: the map prints a pressure beside each H and L, and has a lat/lon box but no distance scale.

- **What the cone means** • NOAA National Hurricane Center, Definition of the NHC Track Forecast Cone. NHC says the cone shows the probable track of the centre of a tropical cyclone. Each circle in the cone is sized so that two-thirds of NHC's official forecast errors over a recent five-year sample fall inside it.

<https://www.nhc.noaa.gov/aboutcone.shtml> • Read on 2026-09-23.

- **Why the cone is not the danger zone** · NOAA National Weather Service, The Tropical Cyclone Track Forecast Cone: A conversation with Jamie Rhome. NHC's acting director said that the centre of a storm has historically moved out of the cone about a third of the time. He said impacts on land can extend hundreds of miles outside the cone in all directions.
<https://www.weather.gov/news/101722-jamie-rhyme-cone> · Read on 2026-09-23 (article dated October 17, 2022).
- **Watch or warning** · NOAA National Hurricane Center, Glossary. A hurricane watch means winds of 74 mph or more are possible in the area. It is issued 48 hours before tropical-storm-force winds are expected. A hurricane warning means those winds are expected. It is issued 36 hours before tropical-storm-force winds are expected. Use these for your two actions.
<https://www.nhc.noaa.gov/aboutgloss.shtml> · Read on 2026-09-23.

The decision to make

1. Deciding how early to act on a hurricane alert.
2. Acting early gives people more time, but the storm may still miss.

Two options to compare

- Acting on the hurricane watch, about 48 hours before tropical-storm-force winds
- Waiting for the hurricane warning, about 36 hours before tropical-storm-force winds

Your map hotspot

1. On today's surface map, mark the nearest high, low, and front to campus, and draw the wind direction your vane measured.

Trap to avoid

The cone is not the size of the storm. It shows where the centre will probably go, and places outside the cone can still get wind, rain, and surge.

TEACH IT

Show your build working, then teach:

1. Uneven heating makes highs and lows. Air moves from high toward low pressure, and fronts form where air masses meet.
2. Instruments measure weather in units: wind direction and speed, rain, temperature, and pressure.
3. A forecast combines readings and maps, says how sure it is, and is checked against what really happened.

Check question: The official pressure falls all afternoon, and your barometer straw moves the same way. What kind of weather system is probably coming?

Texas standards

- **ESS.11B** Describe how Earth's atmosphere is chemically and thermally stratified and how solar radiation interacts with the layers to cause the ozone layer, the jet stream, Hadley and Ferrel cells, and other atmospheric phenomena. §112.49(c)(11)(B) *You explain how uneven solar heating builds the Hadley and Ferrel cells that drive the winds.*
- **ESS.1E** Collect quantitative data using the International System of Units (SI) and qualitative data as evidence. §112.49(c)(1)(E) *You collect weather data in SI units with instruments you built.*
- **ESS.2B** Analyze data by identifying significant statistical features, patterns, sources of error, and limitations. §112.49(c)(2)(B) *You find patterns, errors, and limits in your readings and in the forecast cone.*
- **ESS.2C** Use mathematical calculations to assess quantitative relationships in data. §112.49(c)(2)(C) *You calculate a pressure gradient and a rain-gauge depth.*
- **8.10B** Identify global patterns of atmospheric movement and how they influence local weather. §112.28(b)(10)(B) *Grade 6–8 foundation.*

Word bank: air mass · front · high-pressure system · low-pressure system · Coriolis effect · barometer · anemometer · forecast

Storm and Sea

FOCUS QUESTION

What does a storm need to grow, and how does the ocean feed it and move heat around the planet?

Storms are the weather at its most violent, and warm ocean water is a hurricane's fuel tank. Your team teaches how thunderstorms and tornadoes form, how a hurricane runs on warm water, and how the ocean's currents move heat.

Your lessons

1. Thunderstorms — and Severe Weather

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

2. Tropical Storms

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

3. Earth's Oceans

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

Also read: Module 3 Slides — Atmosphere, Weather & Oceans: The Fluid Earth. Read the slides on building a thunderstorm, on scaling up to the hurricane machine, and on gyres, boundary currents, and the deep conveyor. They explain what your tank and your vortex show.

Big ideas you will use

- A thunderstorm needs moisture, unstable air, and a lift such as a front. Condensing vapour gives off heat that keeps the updraft rising.
- Severe thunderstorms can make hail, lightning, damaging winds, and tornadoes. A tornado is a rotating column of air that reaches from the storm to the ground.
- A hurricane needs sea water of at least 26.5 °C, low wind shear, and enough distance from the equator. Even with all of these, many storms never become hurricanes.
- Winds drive surface currents. Cold, salty water is dense and sinks, and it helps drive a slow deep circulation that takes about a thousand years per lap.

BUILD IT

Storm-and-sea tank with a vortex

Build a see-through sea that shows why cold, salty water sinks, how wind moves the surface, and how a storm cools the warm water it runs on. Add a working vortex that shows the spinning column of a tornado.

Materials

- A clear plastic storage box of room-temperature water
- A cup of cold, salty water with blue food colouring (stir in table salt)
- A cup of warm tap water with red food colouring, poured by an adult
- Two thermometers, a spoon, a ruler, and a timer
- A drinking straw and a small square of paper
- Two 2-litre plastic bottles, a metal washer, and strong tape (or a tornado tube)

Your model must show

1. A spinning column (vortex) forms in the bottles and drains the water faster than water with no spin, like the rotating column of a tornado.
2. A warm layer floats on cooler water. Stirring it like storm winds mixes cooler water up and cools the surface, the way a hurricane cools the sea it passes over.
3. Cold, salty water sinks and spreads along the bottom, and blowing across the surface moves the top layer, like wind driving a current.

Build steps

1. Let the box of room-temperature water sit still.
2. Pour the blue water slowly down one side.
3. Then an adult pours the red water slowly over the back of a spoon onto the top at the other side.
4. After 2 minutes, measure each coloured layer's thickness in cm.
5. Blow gently along the surface through the straw for 10 seconds and measure how far the paper square drifts.
6. Record the surface temperature.
7. Stir the top hard with the spoon for 30 seconds, like hurricane winds, and record it again.
8. Vortex: fill one bottle two-thirds with water, tape the washer and the empty bottle on top, and flip it over a tub.
9. Time the draining with no swirl, then with a swirl.

It works when

- The blue water forms a bottom layer and the red water forms a top layer you can measure, in both trials.
- Stirring lowers the surface temperature by at least 2 °C.
- The swirled bottle drains faster than the unswirled bottle in both trials, timed in seconds.

Test it: Run each test twice with fresh water. Record layer thicknesses in cm, the drift distance in cm, surface temperatures before and after stirring in °C, and draining times in seconds.

Safety: Adults pour the hot tap water, never boiling water. Wipe spills right away, because salty water makes floors slippery. Tape the bottles tightly and flip them over a tub.

The Circulation Engine: Ride the belts (Globe)

1. Open the Globe tab.
2. Turn on Surface currents and Labels, then press Atlantic.
3. Name the warm current on the west side of the North Atlantic and say which way it flows.
4. Match each ring of surface arrows to its name and the direction it blows from: trades, westerlies, polar easterlies.
5. Check each one against the zonal-wind profile beside the globe.
6. Turn on Deep conveyor.
7. Name where it sinks and where it comes back up, and explain why a smaller radius on this globe means deeper water.
8. Open the Storm Tracks tab.
9. Find the dashed 26.5 °C line on the map.
10. Say whether the Gulf of Mexico is inside the warm water.
11. Launch a storm and record the Sea surface at the storm as it crosses the Gulf.

Calculate: Condensation energy and seawater density

1. Part A: A storm drops 40 mm of rain over 200 km².
2. Find the mass of that water (1 mm over 1 km² is 10⁶ kg).
3. Then find the energy released when that much vapour condensed (2.5×10^6 J for every kg).
4. Write both answers in scientific notation.
5. Part B: Use $\rho \approx 1027 + 0.78(S - 35) - 0.15(T - 10)$ kg/m³, where S is salinity in ppt and T is temperature in °C.
6. Find the density of Gulf surface water (30 °C, 36 ppt), deep North Atlantic water (3 °C, 35 ppt), and a river plume (26 °C, 30 ppt).
7. Stack them from bottom to top.

Self-check: Divide your energy by 2.5×10^6 . You must get back your mass. In Part B, the densest water goes on the bottom.

Real data

- **What a hurricane needs** · NOAA AOML Hurricane Research Division, How do tropical cyclones form?. NOAA lists what a hurricane needs. Sea water must be at least 26.5 °C (80 °F) down to about 50 m. The storm must be at least 500 km (300 miles) from the equator. Vertical wind shear must be below about 10 m/s. NOAA says these conditions are necessary but not sufficient, because many disturbances in good conditions do not develop.
<https://www.aoml.noaa.gov/hrd/tcfaq/A15.html> · Read on 2026-09-23.
- **A storm that strengthened overnight** · NOAA National Hurricane Center, Tropical Cyclone Report: Hurricane Beryl (AL022024). NHC reports that Beryl became a hurricane again around 0400 UTC on 8 July 2024 as it neared Texas. It then rapidly strengthened to 80 knots before its centre made landfall near Matagorda, Texas, at 0840 UTC. For comparison, the NHC glossary defines rapid intensification as a rise of at least 30 knots in 24 hours.
https://www.nhc.noaa.gov/data/tcr/AL022024_Beryl.pdf · Read on 2026-09-23 from the NHC report and the NHC glossary.

- **Gulf water temperature today** · NOAA National Data Buoy Center, Station 42035, 22 nautical miles east of Galveston, TX. Record the water temperature. It is in °F, so convert it to °C and compare it with 26.5 °C.
https://www.ndbc.noaa.gov/station_page.php?station=42035 · Record the time and the date you read it.
- **Leave or stay** · Fort Bend County Homeland Security and Emergency Management, Hurricane Information/Evacuation. The county's guidance is 'Run from the water, hide from the wind.' It also says few buildings in the area are built to withstand the winds of a category 4 or 5 hurricane. Use it for your two actions.
<https://www.fortbendcountytexas.gov/government/departments/homeland-security-emergency-management/hurricane-informationevacuation> · Read on 2026-09-23.
- **Where to hide from the wind** · FEMA Ready.gov, Hurricanes. Ready.gov says to take refuge in a storm shelter or an interior room for high winds. It says to leave right away if you live in a mandatory evacuation zone and officials tell you to evacuate.
<https://www.ready.gov/hurricanes> · Read on 2026-09-23.

The decision to make

1. Deciding who must leave and who can stay, when a storm may grow much stronger overnight.

Two options to compare

- Evacuation: leave the area before the storm arrives
- Shelter in place: hide from the wind in a storm shelter or an inside room

Your map hotspot

1. Mark the warmest Gulf water you found, and say how far it is from the coast a storm would reach next.

Trap to avoid

Warm water alone does not make a hurricane. The storm also needs low wind shear, enough spin, and moist air, and even then many storms never form.

TEACH IT

Show your build working, then teach:

1. A thunderstorm needs moisture, rising unstable air, and a lift. The strongest ones make hail, lightning, and tornadoes.
2. A hurricane runs on warm sea water. It also needs low wind shear and enough spin, and it cools the sea as it stirs it.
3. Wind drives surface currents. Cold, salty water sinks and drives the slow deep circulation.

Check question: Why can a hurricane that stalls over one spot get weaker, even over warm water?

Texas standards

- **ESS.12B** Analyze the impact on humans of naturally occurring extreme weather events such as flooding, hurricanes, tornadoes, and thunderstorms. §112.49(c)(12)(B) *You analyze how thunderstorms, tornadoes, and hurricanes affect people.*
- **ESS.11F** Explain how the transfer of thermal energy among the hydrosphere, lithosphere, and atmosphere influences weather. §112.49(c)(11)(F) *You explain how heat moving from warm sea water into the air feeds storms.*
- **ESS.10A** Describe how the composition and structure of the oceans leads to thermohaline circulation and its periodicity. §112.49(c)(10)(A) *You describe how temperature and salt drive the deep, slow circulation.*
- **ESS.10C** Analyze how global surface ocean circulation is the result of wind, tides, the Coriolis effect, water density differences, and the shape of the ocean basins. §112.49(c)(10)(C) *You show how wind drives surface ocean currents.*
- **8.10C** Describe the interactions between ocean currents and air masses that produce tropical cyclones, including typhoons and hurricanes. §112.28(b)(10)(C) *Grade 6–8 foundation.*

Word bank: instability · updraft · latent heat · tornado · wind shear · salinity · density · thermohaline circulation

Climate Desk

FOCUS QUESTION

What sets the climate of a place, why does some weather keep coming back, and how can one change grow into a bigger one?

Weather is one day; climate is the pattern over many years. Your team teaches the weather that keeps coming back, what sets a place's climate, and how feedbacks and El Niño change it.

Your lessons

1. Recurrent Weather

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

2. Climate — What Sets It

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

3. Climate — Feedbacks, El Niño, and Change

Publisher lesson: your textbook pages. Dr. Ijezie shares the pages in class.

Also read: Module 3 Slides — Atmosphere, Weather & Oceans: The Fluid Earth. Read the slides on climate versus weather, on why maritime climates are gentle, on rhythms and feedbacks (the Milankovitch cycles and the ice-albedo and water-vapour feedbacks), and on El Niño as one coupled machine. They explain every test on your bench.

Big ideas you will use

- Floods, droughts, heat waves, and cold waves come back again and again. Wind makes cold air feel colder because moving air carries heat away from skin faster.
- Climate is the pattern of weather over many years. Latitude, nearness to the ocean, elevation, and mountains shape it.
- Albedo and greenhouse gases are two knobs on Earth's energy budget. Slow changes in Earth's orbit, the Milankovitch cycles, pace the ice ages.
- Feedbacks make a change bigger. Melting ice uncovers darker ocean that absorbs more sunlight. El Niño warms the eastern Pacific and shifts weather around the world.

BUILD IT

Climate test bench

Build a bench of three fair tests. It shows why wind makes a cold wave feel colder, why places near the ocean have gentler climates, and how melting ice makes warming grow.

Materials

- Two identical plastic cups, dry sand, and room-temperature water
- Two or more thermometers and a timer
- A sunny window or a desk lamp (an old-style bulb warms things more than an LED), and a ruler to set every test the same distance away
- Two ice cubes of the same size, a sheet of white paper, and a sheet of black paper on a tray
- Two cups of warm tap water, poured by an adult, and a small battery fan

Your model must show

1. A warm cup in front of the fan cools faster than a cup in still air, the way wind makes a cold wave feel colder.
2. Sand heats and cools faster than water under the same lamp, which is why places near the ocean have gentler climates.
3. Ice on black paper melts faster than ice on white paper. Less ice means a darker surface and more warming: the ice-albedo feedback.

Build steps

1. Wind test: an adult pours the same amount of warm water into two cups.
2. Put the fan in front of one.
3. Record both temperatures every minute for 10 minutes.
4. Land and water test: fill one cup with sand and one with the same amount of water.
5. Put each thermometer just under the surface, at the same depth.
6. Set both cups the same distance under the lamp.
7. Record both temperatures every 2 minutes for 10 minutes with the lamp on, then 10 minutes with it off.
8. Ice test: put one ice cube on white paper and one on black paper, the same distance under the lamp.
9. Time how long each takes to melt.
10. Label each test with its lesson and the climate idea it shows.

It works when

- The cup in front of the fan loses more degrees in 10 minutes than the cup in still air, in both trials.
- The sand warms at least 2 °C more than the water in 10 minutes under the lamp.
- The ice on black paper melts first in both trials.

Test it: Run each test twice. Record temperatures in °C with the time in minutes, and melt times in minutes.

Safety: Adults set up the lamp and pour the warm water. Keep the lamp and its cord away from water and ice, and never touch the bulb. Use a battery fan only.

The Circulation Engine: Seesaw & steering wheel (ENSO + Tracks)

1. On the ENSO tab, press Normal.
2. Record the Warm-pool centre, the Thermocline depths and tilt, the Rainfall, and the Atlantic shear it sets.
3. Press El Niño.
4. Record the same four readings.
5. By how many metres did the thermocline tilt change?
6. Press La Niña.
7. Record the same four readings, including the basin-mean rainfall.
8. Open the Storm Tracks tab.
9. Leave every Tracks setting as it is.
10. Press ► Launch storm with El Niño set, then again with La Niña set, switching the state on the ENSO tab between launches.
11. Record the peak wind each time and explain it with the shear number.

Calculate: Running averages and sea-level rise

1. Part A: NOAA tracks El Niño with a three-month running average of sea-surface temperature differences from normal.
2. Five monthly values are +0.3, +0.6, +0.9, +1.2, and +1.2 °C.
3. Find the average of months 1–3, months 2–4, and months 3–5.
4. Say which averages are above +0.5 °C, and why that is not yet enough for an official El Niño episode.
5. Part B: If sea level kept rising at 3.6 mm per year, how many mm would it rise in 20 years?

Self-check: Each average $\times 3$ must equal the sum of its three months. For Part B, your answer $\div 20$ must give back 3.6 mm.

Real data

- **The El Niño status right now** · NOAA Climate Prediction Center, ENSO Diagnostic Discussion. On 10 September 2026, NOAA had an El Niño Advisory in place. It said El Niño is strengthening, with a greater than 90% chance of a very strong event during the Northern Hemisphere fall and winter 2026–27. Read the newest discussion and record what has changed.
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml · The 10 September 2026 status was read on 2026-09-23. A new discussion comes out each month, so read the latest yourself.
- **How El Niño is measured** · NOAA Climate Prediction Center, Relative Oceanic Niño Index (RONI). NOAA uses a three-month running average for the Niño 3.4 region (5°N–5°S, 120°–170°W), minus the average for the whole tropical belt. Above +0.5 °C is El Niño; below –0.5 °C is La Niña. A warm or cold period is marked only when the threshold is met for at least five overlapping seasons in a row.
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso/roni/ · Read on 2026-09-23.

- **The 2026 hurricane season outlook** · NOAA Climate Prediction Center, Atlantic Hurricane Season Outlook. Issued 6 August 2026: a 75% chance of a below-normal season, 20% near normal, and 5% above normal, with 7–13 named storms, 2–6 hurricanes, and 0–2 major hurricanes. NOAA gives El Niño as a main reason. NOAA says the outlook is not a landfall forecast and that it only takes one hurricane or tropical storm to cause a disaster.
<https://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml> · Read on 2026-09-23.
- **Heat stored in the ocean** · NOAA Climate.gov, Climate Change: Ocean Heat Content. NOAA reports that the ocean is storing an estimated 91 percent of the extra heat trapped in Earth's climate system by extra greenhouse gases. It reports that global ocean heat content has been above average since the mid-1990s.
<https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content> · Read on 2026-09-23 (page published June 26, 2025).
- **How much the sea has risen** · NOAA Climate.gov, Climate Change: Global Sea Level. NOAA reports that global average sea level has risen 8 to 9 inches (21 to 24 cm) since 1880. It rose 0.14 inches (3.6 mm) per year from 2006 to 2015.
<https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> · Read on 2026-09-23 (page published August 22, 2023).

The decision to make

1. Deciding how hard a city prepares for the season when the outlook says it will be quiet.

Two options to compare

- Preparing to the same standard every year, whatever the outlook says
- Scaling preparation up or down with NOAA's seasonal outlook

Your map hotspot

1. On a world map, mark the Niño 3.4 box (5°N–5°S, 120°–170°W) and draw an arrow to the Atlantic where its effect on shear lands.

Trap to avoid

A quiet season forecast does not mean your coast is safe. It counts storms; it does not say where they hit. One storm is enough.

TEACH IT

Show your build working, then teach:

1. Floods, droughts, heat waves, and cold waves keep coming back. Wind makes a cold wave feel colder by carrying heat away faster.
2. Climate is the long-term pattern of weather. Latitude, the ocean, elevation, albedo, and greenhouse gases set it.
3. Feedbacks make a change bigger: melting ice uncovers darker surfaces that absorb more sunlight. El Niño shifts weather worldwide.

Check question: Why do coastal cities have milder summers and winters than inland cities at the same latitude?

Texas standards

- **ESS.11A** Analyze how energy transfer through Milankovitch cycles, albedo, and differences in atmospheric and surface absorption are mechanisms of climate. §112.49(c)(11)(A) *You analyze how albedo and differences in absorption shape climate.*
- **ESS.11D** Evaluate how the combination of multiple feedback loops alter global climate. §112.49(c)(11)(D) *You model the ice-albedo feedback and how it amplifies warming.*
- **ESS.11G** Describe how changing surface-ocean conditions, including El Niño–Southern Oscillation, affect global weather and climate patterns. §112.49(c)(11)(G) *You describe how El Niño and La Niña change weather and climate far away.*
- **ESS.12C** Analyze the natural and anthropogenic factors that affect the severity and frequency of extreme weather events and the hazards associated with these events. §112.49(c)(12)(C) *You analyze a natural factor that changes how often extreme storms happen.*
- **8.10A** Describe how energy from the Sun, hydrosphere, and atmosphere interact and influence weather and climate. §112.28(b)(10)(A) *Grade 6–8 foundation.*
- **8.11B** Use scientific evidence to describe how human activities, including the release of greenhouse gases, deforestation, and urbanization, can influence climate. §112.28(b)(11)(B) *Grade 6–8 foundation.*

Word bank: climate · albedo · greenhouse gas · feedback · Milankovitch cycles · El Niño · drought · wind chill

Day 8: teach, learn, decide

Teach-back day. Every team teaches its three lessons, so everyone leaves knowing all twelve.

ABOUT 40 MINUTES

Teach-back lessons

Each team teaches for ten minutes: two minutes showing the build working, then each lesson lead teaches their lesson with the build and asks one check question. Every visitor writes an answer.

ABOUT 7 MINUTES

Council

Mixed groups answer the driving question using evidence from all four teams.

ABOUT 8 MINUTES

On your own

Exit ticket, then turn in your group note and do the partner review.

Your learning notes, for every team's lesson

- Team and lessons
- What the build showed
- Key idea from each lesson
- My answers to their check questions
- A question I still have

SCORING

The rubric

One rubric for every ESS team project. Your team is scored together on the first four rows; the last row is scored for you alone. Read it before you start and check your work against it before teach-back day.

STRAND	4 • EXEMPLARY	3 • PROFICIENT	2 • DEVELOPING	1 • BEGINNING
Lesson science Content accuracy across all your lessons • 25% • team	Every lesson is correct and complete, uses the right vocabulary, and connects to the other lessons and the driving question.	Every lesson is correct, with key ideas and vocabulary.	One lesson has errors or gaps, or the ideas are listed without explanation.	Lessons are missing or mostly wrong.
The build works Function, testing, and photos • 25% • team	The build passes every 'It works when' test at least twice, the results have units, one fix improved it, and clear approved photos show it.	The build passes its tests, with recorded results and photos.	The build works only partly, or the tests are not recorded.	The build does not work or was not tested.
Teaching the class Teach-back and check questions • 20% • team	Each lesson lead teaches clearly with the build; most classmates answer the check questions correctly; timing is right.	Every lesson is taught with the build, and check questions are asked.	Some lessons are rushed or taught without the build.	The lesson is missing or unclear.
Group note Note Studio group note and evidence • 20% • team	Every section is complete, data has units and sources, the claim matches the evidence, and it names one limit of the build.	Every section is complete, with data and a claim.	Some sections are thin or missing.	The note is mostly empty.
My contribution Individual work, partner and teacher ratings • 10% • each scholar	You led your lesson well, did your role on time, and made a teammate's work better. Your contribution section, partner ratings, and teacher rating agree.	You led your lesson and did your role on time.	Your part was late or only partly done.	Little evidence of your part.

The first four rows are scored for the team. My contribution, your learning notes, and your exit ticket are scored for you alone.

ON YOUR OWN

Exit ticket

1. Pick a lesson another team taught. Explain its main idea in two or three sentences.
2. Name one test from another team's build and what it proved.
3. Write one number your own build measured, with its unit, and say what it shows.
4. Name the part of your team's work you did yourself, and one thing you would rebuild.

Sentence starters

- *Our team claims that ____ because ____.*
- *We observed _____. From that we infer _____.*
- *The evidence that supports this is _____, which shows _____.*
- *In the Circulation Engine, when we changed _____, the _____ changed from _____ to _____.*
- *The data came from _____, and we read it on _____.*
- *One limit of our model is _____.*
- *Explanation _____ fits the evidence better, because _____.*
- *I agree with _____ because _____. I would add _____.*
- *I have a different idea. The evidence _____ suggests _____.*
- *Can you explain how _____ connects to _____?*

Supports you can use

- Every packet has a word bank. Look up any word in the Ascent Lexicon.
- You may draft in the language you think in best and then write the final version in English.
- Use the sentence starters above in your claim, your lesson, and the council.
- The teach-back lesson can be split between teammates, and it can use the slide's pictures and numbers as notes.
- Ask your teacher for a printed packet, a larger-print copy, or extra time on any checkpoint.

STANDARDS

Standards for the whole project

These are selected connections to the Texas standards for Earth Systems Science (19 TAC §112.49), not a claim that this project fully covers each one. No engineering-design (HS-ETS) standard is claimed.

- **ESS.3B** Communicate explanations and solutions individually and collaboratively in a variety of settings and formats. §112.49(c)(3)(B) *Every team teaches its lessons to the class and explains its build.*
- **ESS.3C** Engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence. §112.49(c)(3)(C) *The council argues from evidence across all four teams.*

SOURCES

Where the numbers come from

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2. NOAA National Data Buoy Center. Station 42035, Galveston, TX. https://www.ndbc.noaa.gov/station_page.php?station=42035 (live data)
3. NOAA Weather Prediction Center. Surface analysis. <https://www.wpc.ncep.noaa.gov/html/sfc-zoom.php> (live data)
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7. NOAA AOML Hurricane Research Division. Tropical Cyclone FAQ A15: How do tropical cyclones form? <https://www.aoml.noaa.gov/hrd/tcfaq/A15.html> (read 2026-09-23)
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15. NOAA Climate.gov. Climate Change: Global Sea Level. <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> (read 2026-09-23)