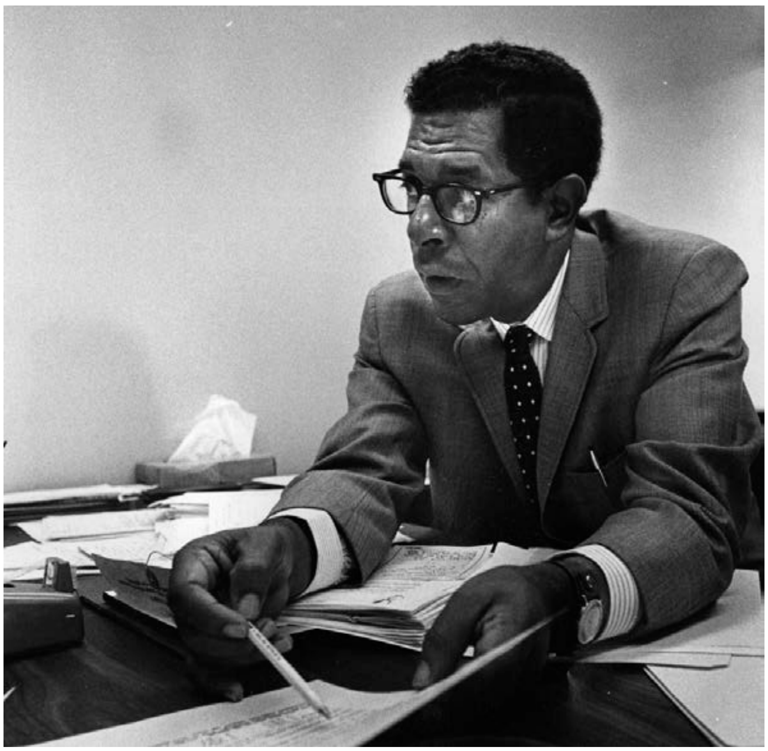
Lesson Plan

Meteorological Forecasting like a Tuskegee Airman



Charles E. Anderson, Tuskegee Airman Meteorologist.
Image courtesy of [The University of Wisconsin—Madison Archives](#).

Grade Level(s): 6-8

Subjects: History, Physics, Earth Science

Supplements: Meteorology, Atmospheric Science

In-class Time: 45-55 minutes

Prep Time: 10-15 minutes

Materials

- Lesson Plan (this document)
- Projector and connected computer, or Internet access for each student
- Colored pencils, crayons, or markers
- Supplemental Materials
  - Explain PowerPoint
  - Student handout with map, discussion questions, and weather map creation key
  - Handout answers/prompts
  - Resource links

Objective

This single-period lesson will introduce students to an interesting historical figure in the field of meteorology and give students a chance to try their hand at meteorological forecasting. The lesson first focuses on Charles E. Anderson, Tuskegee Airman, then gives an overview of some physics and Earth science topics related to his work, before discussing how weather forecasts are conducted. Students then create a weather map based on radar, similar to the "new" style of forecasting that Anderson did in his time working with the Tuskegee Airmen. Students will learn how the Earth's atmosphere works th mrough an introduction to Charles Anderson.

Introduction

This section includes history about the Tuskegee Airmen's involvement in World War II, biographical and career information for Charles Anderson, the relevance of meteorology to the war as a whole, and a brief summary of forecasting, weather vocabulary, and how to read radar maps. The information contained in this introduction will help to present the supplemental PowerPoint Presentation.

Aerial surveillance and combat played a major role in World War II. The United States Air Force needed pilots to fly the new military planes, as well as never-before-needed specialists: meteorologists. Meteorology is the study of weather and how our atmosphere causes, changes, and affects it. The more accurate meteorological information is, the better our predictions for the future weather will be.[1] Meteorology is used by civilians, when we want to check the weather before a day at the beach, and by the government—especially where the Air Force is concerned, to ensure the safety of planes in combat.

[1] "Weather Analysis and Forecasting." American Meteorological Society, Dec. 2021, www.ametsoc.org/index.cfm/ams/about-ams/ams-statements/statements-of-the-ams-in-force/weather-analysis-and-forecasting2/.

In 1941, the US military was still fully segregated, so Black recruits were not trained alongside their white counterparts. Instead, they were only able to receive proper training at one place: Tuskegee University, located in Alabama. The Tuskegee Airmen were the first specialized military program in the US to intentionally recruit all-Black classes for training and combat. Running from the late 1930s until the military was desegregated following 1948, over 1,000 men were trained to be pilots, navigators, and eventually, meteorologists in the Tuskegee program.

Despite segregating them fully from the rest of the military, it was still controversial for African Americans to even receive military training; many civilians and government officials alike thought that Black individuals were not smart or skilled enough to understand airplane machinery or successfully pilot a plane. In fact, the squadrons made up of Tuskegee Airmen, despite acting as protectors and escorts for Allied bomber planes, had one of the lowest plane loss rates of any in all of the war.[2]

With the increasing need for planes to fly safely over the ocean, which offered no opportunities for emergency landings except in water, the US needed to advance its meteorological technologies to ensure the safety of Air Force pilots and crew. As the war ramped up, Charles Anderson was recruited to join the Air Force as a cadet and meteorologist.[3]

Charles Edward Anderson (1919-1994) was born near St. Louis, Missouri, on a farm in University City. From childhood, his family valued education, reading, and knowledge. Anderson's father was raised under Jim Crow laws in Mississippi and sought betterment for his children; Anderson and his three older sisters were all successful students. He graduated valedictorian of the local Sumner High School, and was accepted to Lincoln University for chemistry in 1937.[4] As wartime tensions escalated, he was asked to join the meteorology program at the University of Chicago in preparation for work with the military. He set aside his chemistry work with the atmosphere to tailor his studies towards meteorology. During his time at Chicago, he studied how clouds formed, specifically how the structure of clouds was influenced by the atmosphere they formed in, and different methodologies for meteorological forecasting. His studies showed many new connections between tangible, scientific observations and the patterns that the weather follows—never-before-studied up until this point. In addition to his rigorous meteorology course work, he was also a full-time Air Force cadet, undergoing military training in preparation for his graduation from the program.[5]

Following his work on cloud dynamics and new methods of forecasting, Anderson received a Master's in meteorology and orders to move to Tuskegee, Alabama, to join the new training program for Black Air Force recruits in 1943. After a brief return to his hometown to marry his college sweetheart, Marjorie, Anderson joined the Tuskegee Airmen as an expert in the field of atmospheric dynamics, more specifically the motion and formation of clouds.[6]

During WWII, Anderson traveled around the country working as a military meteorologist. His expertise on clouds and the dynamics that control the atmosphere led to an overall improvement of the forecasting capabilities of the US. Prior to Anderson's stint with the Air Force, most forecasting was done by looking at past weather patterns

[2] "Tuskegee Airmen Facts." Tuskegee University, http://www.tuskegee.edu/support-tu/tuskegee-airmen/tuskegee-airmen-facts.
[3] Droessler, Earl, and Charles E. Anderson. "Interview of Charles E. Anderson." Tape Recorded Interview Project, American Meteorological Society University Corporation for Atmospheric Research, 24 June 1992. https://opensky.ucar.edu/islandora/object/archives%3A7575/datastream/OBJ/view.
[4] Zhong, Michelle. "Charles Edward Anderson (1919-1994)." Black Past, https://www.blackpast.org/african-american-history/anderson-charles-e dward-1919-1994/.
[5] Droessler.
[6] Droessler.

and making a guess towards what would happen next. Anderson pioneered a new technique, using his knowledge of clouds and connections with other atmospheric scientists to begin observing the atmosphere from above the ground, giving insight to the dynamics in the air. He remained in military service for two years after the war ended, developing methods for a technique called “cloud seeding” in which aerosolized chemicals are added to clouds to reduce the freezing point.[7]

After Anderson’s departure from service, he shifted his focus towards peacetime applications of atmospheric sciences.

He attended the Massachusetts Institute of Technology and became the first Black American to earn a Ph.D. in meteorology, completing his studies in 1960. Following his Ph.D., Anderson chose to research meteorology full-time, foregoing his former field of chemistry. His previous studies of radiation and aerosol technology from a chemical perspective proved relevant to his new meteorological studies. Despite beginning his transition from chemistry to meteorology with cloud seeding—a practice where aerosolized chemicals are sprayed into clouds to modify weather patterns—Anderson quickly switched to researching forecasting improvements when the negative environmental impacts of cloud seeding were discovered.[8] He first worked with the Douglas Aircraft Company’s atmospheric science department before transitioning into government work, where he sought to improve environmental protections in the U.S. Department of Commerce.[9]

His later years, from around 1948 until the end of his life,[10] were spent in academia, filling several positions in meteorological and space science at the University of Wisconsin, Madison, before being selected as Associate Dean and becoming the first tenured Black professor at the university. He spent nearly ten years in the role before finishing out his long and successful career at North Carolina State University, where he was a professor in the Department of Marine, Earth, and Atmospheric Sciences.[11] There, he continued his work in improving storm forecasting, adding to the already-significant reputation of North Carolina State in meteorological forecasting. Anderson retired in North Carolina with his wife Marjorie before passing away in 1994[12] after a long career in meteorology and chemistry.

Anderson’s work improving forecasting continues to inform the field. Modern forecasting now uses analyses of weather data to come up with statistical models that predict the next weather events, and Anderson’s publication *Cumulus Dynamics* remains in regular circulation as a landmark text in the development of forecasting technologies.[13]

Instructions/Activities

Engage: 2-5 Minutes

Teachers will introduce students to the core components of weather with a brainstorming session, aiming to coax the seven elements of weather from the students.

[7] Droessler.
[8] Droessler.
[9] Hill.
[10] Zhong.
[11] Hill.
[12] “Charles Edward Anderson Sr.” Find A Grave. https://www.findagrave.com/memorial/81892560/charles-edward-anderson.
[13] Droessler.

What is the teacher doing?	What are the students doing?
Prompting students to think about what they consider "weather" and "the atmosphere" to be. Make a list as a group of what elements count as "weather," seeking specifically:[14] 1. Wind 2. Temperature 3. Atmospheric pressure 4. Humidity 5. Clouds 6. Precipitation 7.Storms As students talk about things that they consider "weather," prompt them with how those elements are related. For example, do storms usually come with precipitation and/or wind? Is it usually humid and hot at the same time, or is it just as frequently humid and cold?	At teacher's prompting, attempting to figure out the seven elements of weather, listed to the left. When asked for relations between the elements, brainstorming as a class to come up with some (see examples to the left).

Explain: 15-20 Minutes

The teacher will explain the life and work of Charles Anderson, the basics of meteorology, and the basics of weather forecasting.	
What is the teacher doing? (Background) Using the information from the lesson's Introduction and the PowerPoint presentation in the Supplemental Materials, teachers will guide students through Charles Anderson's life as a Tuskegee Airman, his work studying clouds, clouds and meteorology in general.	**What are the students doing? (Background)** Listening (and taking notes).
What is the teacher doing? (Forecasting) PowerPoint, continued. Teachers will summarize the information given in the handout, including the basics of forecasting and the symbols used to notate weather.	**What are the students doing? (Forecasting)** Familiarizing themselves with the weather map creation key, which will be used in the Explore section.

Explore: 10-15 Minutes

[14] Encyclopedia Britannica.

Students will now attempt to draw a map of weather over the United States, using real-time radar animations and the notation discussed in the Explain section and the student handout.

What is the teacher doing?	What are the students doing?
Teachers will either direct students to the Current Radar Animation (https://radar.weather.gov/) or display it for the class via a projector. The site defaults to showing a paused radar map for the whole US. This shows just the precipitation radar. For a static cloud-cover satellite image (which gives better definition to the current boundaries of warm and cold fronts), see the Aviation Cloud Cover Image (https://aviationweather.gov/satellite/plot?region=us&type=irbw&date=). Students should be given the ability to look at both or either of these. When students are prepared with the blank map and drawing utensils, teachers should press the play button on the animation for the Current Radar to Loop (https://radar.weather.gov) while students draw. Some elements to include in their maps: • High- and low-pressure spots • Fronts (where is the air moving?) • Precipitation forecasts (where will it rain today?) • Wind direction (where is the wind flowing?) For an example of how the maps might look, students can see this image: June 21st Weather Map (https://www.wpc.ncep.noaa.gov/noaa/noaa_archive.php?month=06&day=21&year=2023), which is also included in the student handout. It is a real NOAA forecast from a day in the past, and is **not** the same as today's weather! The radar map shows the current motion of precipitation, which gives the lower pressure areas, and the cloud cover map gives all the cloud cover currently over the US, which will help to define their maps.	Using the skills they learned in the Explain section and given in the student handout, students are drawing where they think the current pressure systems, fronts, and wind directions are across the country on the blank map. The students should use the notation discussed to try to draw a map of the current atmospheric state above the US. They should seek to include the elements listed to the left.

Elaborate: 10-15 Minutes

The Elaborate section is built to check students' understanding of the material covered. The teacher will guide by showing weather maps or directing students to them, and leading Discussion Questions.

What is the teacher doing? (Answers)	What are the students doing? (Answers)
The teacher should either display the Current Pressure and Precipitation Map (http://www.wpc.ncep.noaa.gov/noaa/noaa.gif) via a projector or direct students to the link. Students should be given time to compare their maps to the "real" map, noting any significant similarities or differences. If they have questions about what a	Students are comparing their maps to the displayed "correct" map, comparing what they absorbed from the motion of clouds on the radar to the real pressure map.

notation on the map means, feel free to elaborate based on the Introduction or Explain sections.	
What is the teacher doing? (Discussion) The teacher is prompting students through some of the discussion questions, given in the separate section below.	**What are the students doing? (Discussion)** Students are responding to the teacher, comparing map correctness with each other, and considering their answers to the open-ended discussion questions.

Evaluate:

The main opportunity for evaluation emerged during the Elaborate section of the lesson, when reviewing students' maps.

Required/Recommended Reaching and Resources

Further resources, including printable PDF files and the PowerPoint for the Explain section, are located in the Resources section of the Teaching Guide homepage. The links below are referenced in the Explore section of this Teaching Guide.

- Current Radar Animation (for Explore)
  - https://radar.weather.gov
- Current Pressure and Precipitation Map (for Explore)
  - http://www.wpc.ncep.noaa.gov/noaa/noaa.gif

Discussion Questions

Discussion Questions can be found as a Handout with a corresponding Answer Key in the Supplemental Materials to this lesson plan.

1. How similar was your drawn map to the real pressure map?
2. How effective was observing the clouds at mapping atmospheric pressure systems?
3. Think about pressure. What are some other examples of things flowing from high to low pressure?

Further Reading and Additional Resources

Related AIP Teacher's Guides on the History of the Physical Sciences:

- The Tuskegee Weathermen: African-American Meteorologists during World War II
- "The Physicist's War:" Dr. Herman Branson and the Scientific Training of African Americans during World War II
- Eunice Foote: Climate Scientist

More Information on Charles E. Anderson:

- Oral History Interview with Charles Anderson

    - https://opensky.ucar.edu/islandora/object/archives%3A7777
- The Charles E. Anderson Award
    - https://www.ametsoc.org/index.cfm/ams/about-ams/ams-awards-honors/awards/awards-for-outstanding-contributions/the-charles-e-anderson-award/
- Note: Charles E. Anderson and Charles A. Anderson were both Tuskegee Airmen; this Teaching Guide covers only Charles E. Anderson, the meteorologist, and not Charles A. Anderson, the pilot.

More Information on the Tuskegee Airmen:

- War Documentary: Red Tails
    - https://en.wikipedia.org/wiki/Red_Tails
- Place: The Tuskegee Airmen National Historic Site
    - https://www.nps.gov/tuai/index.htm
- References in popular media: Night at the Museum: Battle of the Smithsonian
    - https://en.wikipedia.org/wiki/Night_at_the_Museum:_Battle_of_the_Smithsonian

Common Core Standards

For more information on Common Core Standards, visit http://www.corestandards.org/.

Science and Technical Subjects	
CCSS.ELA-LITERACY.RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.
CCSS.ELA-LITERACY.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
Speaking and Listening	
CCSS.ELA-LITERACY.SL.6.2	Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
Language	
CCSS.ELA-LITERACY.L.6.6	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression

Next Gen Science Standards

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.

Earth Sciences	
MS-ESS2-5: Weather and Climate	Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
MS-ESS3-2: Earth and Human Activity	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.