Introduction to Aviation Weather

Session Time: One, 50-minute session

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Understanding how weather affects flight is one of the essential skills required of pilots.

Wind, clouds, precipitation, and thunderstorms are the common weather phenomena that have the greatest impact on flight safety.

Weather is caused by the sun's uneven heating of the earth and the resulting effect on moisture.

Pilots must know how to use available weather services to help form an understanding of the weather situation and make better flying decisions.

ESSENTIAL QUESTIONS

1. What do I need to know about weather to safely fly an airplane?

LEARNING GOALS

Students Will Know

- Why the study of weather is important to pilots
- That wind, clouds, precipitation and thunderstorms are the common weather phenomena that affect flying
- That pilots have tools to help them better understand and navigate hazardous weather

Students Will Be Able To

- *Define* select aviation weather terms (DOK-L1)
- *Infer* that weather tools are critical to safe and comfortable flight but have limitations (DOK-L2)

ASSESSMENT EVIDENCE

Warm-up
Students will hypothesize answers to questions about the importance of weather in flying and the impact of weather on flight decisions. They will then watch a video that suggests answers to these questions.

Formative Assessment
Students will define important aviation weather terms and answer questions in which they analyze the role that weather played in an accident shown in a video.

Summative Assessment
Students will explain why weather is important to pilots.

LESSON PREPARATION

MATERIALS/RESOURCES

- Introduction to Aviation Weather Presentation
- Introduction to Aviation Weather Student Activity 1
- Introduction to Aviation Weather Teacher Notes 1
- Student Daily Weather Diary

LESSON SUMMARY

The lesson will begin with a brief discussion about why students think that weather is important to flying and what weather phenomena they have experienced.

During the next part of the lesson, students will learn about common aviation weather terms and apply this knowledge to a case study of an aircraft accident. Students will then provide their thoughts on familiar weather phenomena and participate in a guided discussion with the instructor about these phenomena's likely effects on aircraft and their operators and passengers.

Finally, students will be introduced to a student activity that will span the entire unit. Students will create a daily weather diary in which they record specific weather information for their local area. They will also consider their own personal limitations for flying, relevant to weather.

BACKGROUND

This lesson provides an introduction and overview to this unit on the flying environment. All topics in the lesson will be covered in more detail as the Unit progresses.

Weather is something most of us take for granted. We generally have a sense of the day's weather and may use basic weather information to determine what to wear or what type of activities to conduct. Often, it's only during extraordinary weather conditions like floods, hurricanes, or droughts, that we give deeper thought to the weather around us.

But weather is a critical consideration in all flight operations. Since the earliest days of aviation, pilots have sought ways to minimize the hazards of weather and take advantage of its benefits. Early experiments with flying in the clouds frequently ended in disaster. By contrast, glider pilots learned early on how to take advantage of thermal radiation to stay in the air.

Today, pilots have many tools to help them fly safely in a wide range of weather conditions. But they still must understand weather, know how to find and interpret weather information, and use what they learn to make decisions about when, where, and whether or not to fly. Pilots also need to understand that their capabilities, and the capabilities of their aircraft, can have a significant effect on the weather decisions they make. To help students grasp the importance of weather in aviation, they will consider a dramatic weather-related accident that cost the lives of a pilot and his passengers.

The lesson will require students to think about their interpretation of and experiences with common weather terminology and phenomena. The student activities will provide a foundation for later lessons by having students research common terms related to weather and begin a personal weather log that they will maintain and update each day of the unit.

MISCONCEPTIONS

Students may confuse weather and climate. Weather can be thought of as the day-to-day state of the atmosphere. It's what you see when you look outside on any given day: sunny, rainy, etc. Climate is the long-term state of the

atmosphere in a particular location. The earth has many climate zones in which different types of weather phenomena are considered “normal.”

DIFFERENTIATION

To help students integrate the information they receive from the video with the weather terms in the EXPLORE section, provide students with a notes sheet that lists the weather terms. As they watch the video, have the students make notes about the context in which each term is used to help them infer its meaning.

LEARNING PLAN

ENGAGE

Teacher Material: Introduction to Aviation Weather Presentation

Slides 1-3: Introduce the topic and learning objectives of the lesson.

Slide 4: Conduct the **Warm-Up**.

Warm-Up

Ask students why they believe weather is important to flying.

Anticipated answers include hazards that come with weather, such as storms including lighting, hail, and reduced visibility.

More advanced answers may include pros and cons of winds: e.g., tailwinds allow an aircraft to go faster over the ground, while headwinds can make an aircraft fly slower and require additional fuel.

Continue the discussion by asking students to identify some weather phenomena they have witnessed. Briefly have students elaborate on the pros and cons they believe these events create for aircraft and pilots.

Finally, show students the following video; ask which weather hazard they believe has the greatest impact on flight.

- “Intro to Weather Hazards” (Length 1:12)
  https://video.link/w/Twpp

[DOK-L2; *description*, *hypothesis*]

EXPLORE

Teacher Materials: Introduction to Aviation Weather Presentation, Introduction to Aviation Weather Teacher Notes 1
Student Material: Introduction to Aviation Weather Student Activity 1

Slide 5: Post the following quote for students to read: “It’s better to be on the ground wishing you were in the air, than in the air wishing you were on the ground.”

Questions

What do you think this old aviation saying means?

Answers will vary, but students may suggest that it is better to be safe than sorry, especially when it comes to flying. Most weather-related mishaps are attributed to human error (e.g., poor planning, flying outside of limitations). "Pushing weather" is never a good option, and a smart pilot must always balance the urgency of getting to the destination with the need to get there safely.

Weather is defined as the state of the atmosphere. All flying takes place in the atmosphere, so flying and weather are inseparable. Pilots must understand the weather in order to make good decisions about when it is and is not safe to fly.

Teaching Tips

Remind students that VFR stands for "Visual Flight Rules," and refers to flight that is guided by what the pilot actually sees outside. IFR stands for "Instrument Flight Rules," and refers to flight that is guided by reference to the aircraft's instruments, often in situations when there is little or no outside visibility.

Slide 6: Instruct students to read the aviation weather terms listed on the slide. (These terms are defined in **Introduction to Aviation Weather Teacher Notes 1**. However, students should not attempt to define these terms now.) Over the next few activities, students will learn about these terms: first by watching a video, then by completing an assessment. Emphasize that understanding these terms will lay the necessary foundation for the rest of the unit.

Slide 7: Distribute **Introduction to Aviation Weather Student Activity 1**, which lists the terms from the previous slide. Students will complete this activity for the Formative Assessment, but first they should watch the following video. As students watch, they should listen for the aviation weather terms but they should not attempt to define them yet. Students should also think about how weather caused the accident shown in the video and how the accident might have been avoided; students will answer questions as part of the Formative Assessment.

- "Accident Case Study: Time Lapse" (Length 12:35)
  https://video.link/w/5xpp

Slide 8: Complete the **Formative Assessment**.

Formative Assessment

Now, students will define the aviation weather terms listed in Part 1 of **Introduction to Aviation Weather Student Activity 1**. Students will also analyze the "Accident Case Study" video by answering the questions in Part 2 of the activity worksheet. Sample answers are provided in **Introduction to Weather Aviation Teacher Notes 1**.

[DOK-L2; *define, explain*]

EXPLAIN

Teacher Material: [Introduction to Aviation Weather Presentation]

Slide 9: Discuss with students the positive and negative qualities of flying in both good and bad weather. The discussion should also focus on how weather affects flying conditions.

Questions

What kind of weather conditions are good for flying? What kind of weather conditions are bad for flying?

Possible responses: Answers will vary but students may suggest that clear days with little wind, few clouds, and no precipitation are good for flying. Students may also mention the positive attributes of tailwinds, stable atmospheric conditions that don't produce turbulence, and other phenomena they perceive as positive.

By contrast, students may suggest that days with strong winds, heavy precipitation, extreme weather phenomena like thunderstorms or hurricanes, and heavy convective activity are bad for flying. They may also consider weather phenomena like haze, clouds, or smoke that can affect visibility.

As students discuss different phenomena, point out that in some cases, the same conditions can be both good and bad. For example, flying when the atmosphere is very stable can mean a smooth ride, but it may also mean poor visibility. Strong winds aloft can be good or bad depending on your direction of travel—tailwinds speed your travel and help save fuel, headwinds can slow you down and require greater fuel burn.

Slide 10: Weather is important to flying because it affects:

- Visibility
- Comfort
- Safety

Slide 11: Specific weather conditions can affect these aspects of flying in different ways.

- The presence of clouds, haze, or smoke in the atmosphere can reduce visibility. Pilots typically must rely on their instruments (IFR) when flying through clouds.
- Winds can have positive and negative effects on flying, depending on their direction and speed. A strong tailwind can help a plane move more quickly while burning less fuel, while a strong headwind can have the opposite effect. Winds can also cause turbulence, creating a bumpy, uncomfortable ride for passengers.
- Precipitation (rain, snow, hail) can negatively affect visibility. The low temperatures that produce snow and hail can also cause ice to form on the aircraft, which could lead to a loss of control.
- Thunderstorms produce precipitation and turbulence severe enough to break up an aircraft in flight.

Teaching Tips

Having a working knowledge of the different types of cloud formations will help pilots better understand what is happening in the earth's atmosphere. While an obstacle to visibility, clouds can

also be a key predictor of anticipated weather patterns; their presence can be a precursor to thunderstorms, rain, hail, and turbulence. Clouds will be explained in further detail in a later lesson.

Slide 12: Students should begin to think about the causes of weather events and phenomena, such as the ones shown in this graphic.

Questions

What causes weather phenomena such as clouds, winds, and precipitation to occur?

Possible response: Answers will vary but students could mention atmospheric pressure and the exchange of heat. Proximity to water or mountains, climate, and season of the year can also have an impact on local weather patterns.

Explain that all weather on Earth is driven by the sun and involves the exchange of heat. The remaining lessons in the unit will explain these and related processes, as well as connect them to flight safety.

EXTEND

Teacher Material: Introduction to Aviation Weather Presentation
Student Material: Student Daily Weather Diary

Slide 13: A great deal of money and effort has been spent to create special weather products and information to help pilots complete their flights safely. Modern technology has provided us with numerous services, websites, and applications that compile weather data and provide accurate and timely weather briefings. In upcoming lessons, students will learn more about these tools, including how to access and use them to get a much deeper understanding of weather than is provided by the typical forecasts that students might see on the news.

Teaching Tips

1-800-WX-BRIEF is both a phone number and website to obtain weather briefings. By calling, a pilot can have a one-on-one discussion with a weather briefer. In an upcoming lesson, students will have the opportunity to hear a formal pilot weather briefing.

In addition, pilots visit many different websites for aviation-specific weather information. (The AOPA site requires a login.)

- https://www.aviationweather.gov/
- 1-800-WX-BRIEF
- https://www.aopa.org/travel/flight-tools/weather

If time permits, visit one or two of these websites as a class. This will provide students with the opportunity to view the type of information that pilots receive before making weather-related decisions. They will learn much more about the available products and how to use them in upcoming lessons.

Slide 14: Weather tools and information exist to help pilots make decisions about whether to fly and what route to take. Weather information will be weighed against such factors as the pilot's training and ability, the type of aircraft and equipment being used, and the mission to be accomplished.

Weather that might be of little or no concern to an airliner could cause serious problems for a small single-engine aircraft. By the same token a pilot who is rated to fly under instrument flight rules and has many hours of experience has different capabilities than a new IFR pilot or a VFR-only pilot. It is important for the pilot to take these factors into account when maker weather-related flying decisions.

When thinking about weather and making informed decisions to fly, it is beneficial to ask oneself the following questions:

- What are the risks if I fly?
- Can I reduce or avoid the risks? If so, how?
- Should I fly or not?

Slide 15: Students will now begin a weather diary that will span Units 1 and 2. Provide each student with the blank **Student Daily Weather Diary**. Each day, beginning today, students should track the following weather data:

- Temperature
- Dew Point
- Air Pressure
- Wind direction and velocity
- Precipitation type and amount (over the previous 24 hours)
- Cloud type and coverage
- Height of cloud base
- Visibility

Students will also note whether Visual Flight Rules (VFR) apply.

Based on all these data, students will determine each day whether it is a good day to fly. Students should be free to use any reliable sources they prefer (one option is via text, through www.wxbytxt.com). A 1,000' ceiling with 3 miles of visibility is the minimum weather considered to be VFR, though a 3,000' ceiling with 5 miles visibility is more reasonable for actually flying VFR.

Teaching Tips

In future lessons, students will typically record their daily weather data during the Warm-Up or maintaining the weather diary may be assigned as homework. For multi-day lessons, students should record data for later days on their own. In addition to compiling daily weather data, students will use their data to complete two broader analyses:

- At the end of Unit 1, students will draw conclusions about weather patterns, based on their observations (e.g., Winds from the southwest one day result in higher temperatures the next day).

- At the end of Unit 2, students will use their data to make predictions for the coming week.

EVALUATE

Teacher Material: Introduction to Aviation Weather Presentation

Slide 16: Conduct the **Summative Assessment**.

Summative Assessment

Students should write a paragraph explaining, in their own words, why it is important for pilots to understand weather and how they think weather phenomena like clouds, winds, precipitation, and thunderstorms can affect flight.

Based on the presentation, answers may include:

- *Because aircraft fly in the atmosphere, atmospheric conditions such as weather impact every aspect of a flight.*
- *Weather can affect visibility, comfort, and safety.*
- *Weather reporting and equipment has limitations—for example the delay in radar information received by the aircraft in the Accident Case Study video.*
- *Clouds can negatively impact visibility, making flight difficult or impossible for VFR aircraft and pilots.*
- *Winds can be good or bad. Tailwinds can make a flight faster, while headwinds can slow it down. Winds can also result in turbulence that can be uncomfortable or even unsafe.*
- *Precipitation can affect visibility and may result in icing.*
- *Thunderstorms can produce dangerous turbulence and precipitation, including icing.*

[DOK-L2; *identify*, *explain*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Postings show evidence of one or more of the following:
  - Knowledge of weather terminology
  - Provides details about the factors that can affect flying in various weather conditions
- Contributions show understanding of course of the concepts covered in the lesson
- Contributions show in-depth thinking including analysis or synthesis of lesson objectives

Points **Performance Levels**

9-10 Thoroughly explains why weather considerations are important for the pilot; Lists and describes the effects of various weather phenomena on flying; correctly uses weather terminology from the lesson
7-8 Sufficiently explains how weather considerations are important for the pilot; Lists and describes the effects of most weather phenomena on flying; correctly uses most of the related terminology from the lesson
5-6 Partially explains how weather considerations are important for the pilot; Lists and describes the effects of one or two weather phenomena on flying; Uses limited terminology from the lesson or uses some terminology incorrectly
0-4 Fails to explain how weather considerations are important for the pilot; Fails to list and describe the effects of various weather phenomena on flying; Uses little or no terminology from the lesson

GOING FURTHER

Students may continue to review some of the pilot planning websites mentioned in this lesson to gain familiarity with these tools and compare additional data to the weather information captured in the daily weather diary.

STANDARDS ALIGNMENT

COMMON CORE STATE STANDARDS

- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - 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 9-10 texts and topics.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

Intro to Weather Hazards: https://youtu.be/QC1nhSow948, https://video.link/w/Twpp
Accident Case Study: Time Lapse: https://youtu.be/83uvKWJS2os, https://video.link/w/5xpp
https://www.faa.gov/training_testing/training/fits/guidance/media/personal%20minimums%20checklist.pdf
http://rgl.faa.gov/Regulatory_and_Guidance_Library%5CrgFAR.nsf/0/8FF69D2EEBA22CF9852566CF00613B69?OpenDocument