ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 4

EO C436.02 – DESCRIBE SEVERE WEATHER CONDITONS

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-804/PG-001, *Proficiency Level Four, Qualification Standard and Plan*, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Prepare slides located at Attachment A.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for this lesson to introduce the cadet to severe weather conditions and to generate interest.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall be expected to describe severe weather conditions.

IMPORTANCE

It is important for cadets to describe severe weather conditions as knowledge of this material is essential for future aviation training and potential instructional duties at the squadron.

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Teaching point 1 **Describe thunderstorms.**

Time: 10 min Method: Interactive Lecture

THUNDERSTORMS

Formation

The requirements for the formation of a thunderstorm are the following:

- unstable air,
- high moisture content, and
- some form of lifting agent.

The intensity of these conditions is the difference between a harmless cumulus cloud and a violent thunderstorm. Such unstable atmospheric conditions may be brought about when air is heated from below (convection), forced to ascend the side of a mountain (orographic lift), or lifted over a frontal surface (frontal lift).



Show slide of Figure A-1.

There are three distinct stages of a thunderstorm:

1. cumulus,
2. mature, and
3. dissipating.

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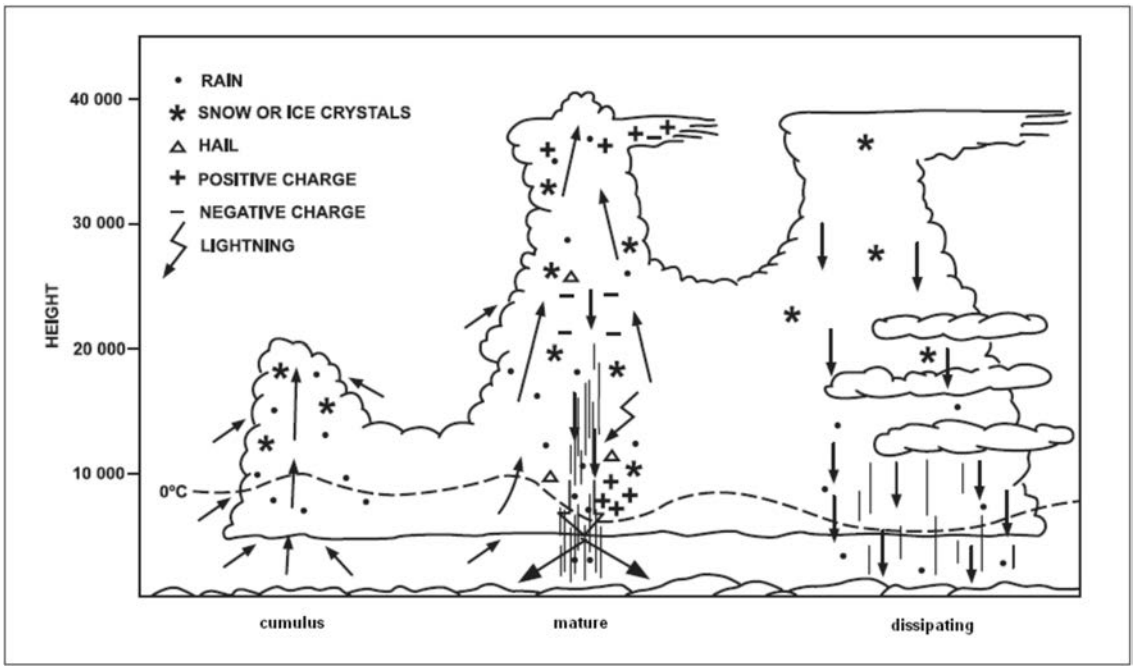

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Figure 1 Stages of a Thunderstorm

Every thunderstorm begins as a cumulus cloud. Strong updrafts, due to the unstable air and lifting agent cause the cloud to build rapidly into a towering cumulus and then cumulonimbus cloud. There is usually no precipitation in this stage as the water droplets and ice crystals are kept suspended in the cloud by the strong updrafts.

In the mature stage, the cumulonimbus cloud may reach heights up to 60 000 feet, with updrafts of 6 000 feet per minute and downdrafts of 2 000 feet per minute. Precipitation, violent turbulence, and thunder and lightning are all associated with thunderstorms in their mature stage.

The precipitation tends to cool the lower region of the cloud causing the thunderstorm cell to dissipate. The downdrafts spread throughout the whole cell except for a small portion at the top where updrafts still occur. The rainfall gradually ceases and the top of the cell spreads out into an anvil shape.

Dangers



Show slide of Figure A-2.

The dangers of flying in or close to a thunderstorm are:

- severe turbulence,
- lightning,
- hail,
- icing,
- unreliable altimeter readings due to rapid changes in pressure,

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- strong wind gusts, and
- heavy rain.

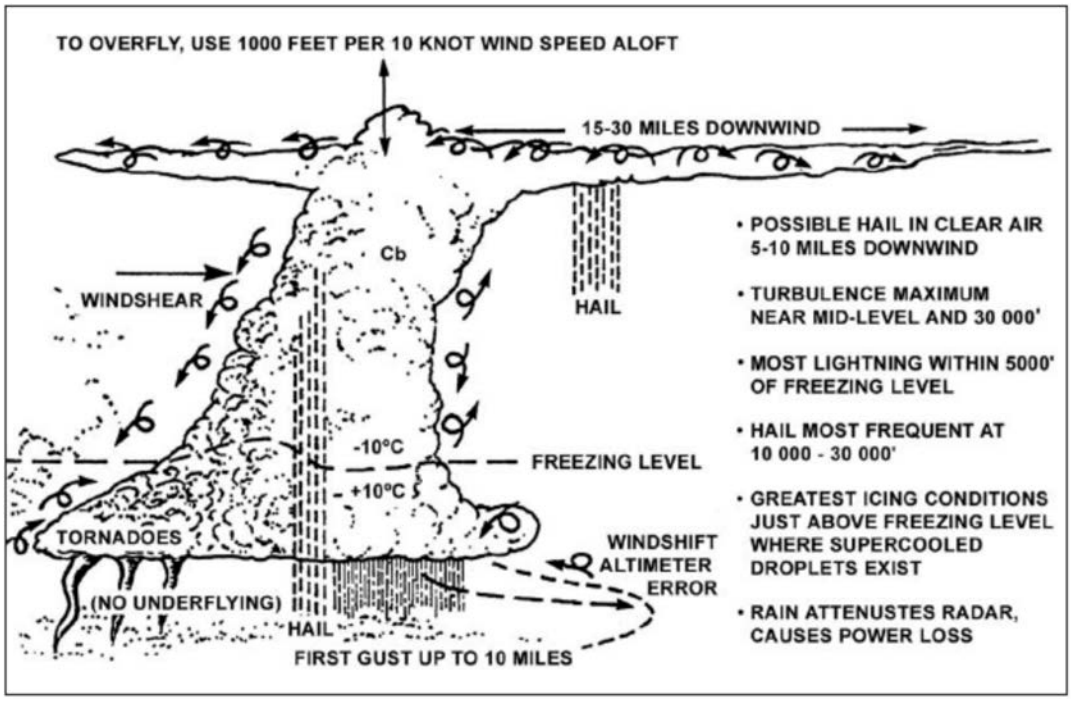

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Figure 2 Thunderstorm Dangers

Avoidance

Stay at least five miles away from a thunderstorm. When flying around a thunderstorm, fly to the right side of it as the wind is circulating counter-clockwise around the low pressure area. Never fly through a thunderstorm in a light aircraft.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What are the requirements for the formation of a thunderstorm?

Q2. In which stage of a thunderstorm will the top of the cumulonimbus cloud take on an anvil shape?

Q3. What are three of the dangers associated with thunderstorms?

ANTICIPATED ANSWERS:

A1. Unstable air, high moisture content, and some form of lifting agent.

A2. The dissipating stage.

A3. Cadets may give any three of the following answers:

- severe turbulence,
- lightning,

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- hail,
- icing,
- unreliable altimeter readings due to rapid changes in pressure,
- strong wind gusts, and
- heavy rain.

Teaching point 2 **Describe icing.**

Time: 5 min Method: Interactive Lecture

ICING

When an airplane flies at an altitude where the outside air temperature is at or below freezing and strikes a supercooled water droplet, the droplet will freeze and adhere to the airplane. This can occur in cloud, freezing rain, or freezing drizzle. Icing can also occur in clear air through sublimation.

Types of Icing

There are three main types of icing:

- clear ice,
- rime ice, and
- frost.



Show slide of Figure A-3.

Clear ice is a heavy coating of glassy ice which forms when flying in dense cloud or freezing rain. It forms when only a small part of the supercooled water droplet freezes on impact, with the rest of the droplet spreading out and freezing slowly. Clear ice is the most dangerous form of icing because of the following:

- loss of lift due to the altered camber of the wing,
- increase in drag due to the enlarged profile area of the wings,
- increase in weight due to the large mass of ice, and
- the vibration caused by the unequal loading on the wings and propeller blades.

Rime ice is an opaque (milky white) deposit of ice. Rime ice forms when the aircraft skin is at a temperature below zero degrees Celsius, causing the water droplet to freeze completely on contact. Although rime ice is light, it is dangerous due to the aerodynamic alteration of the wing camber and the interference it causes with the carburetor and pitot static system.

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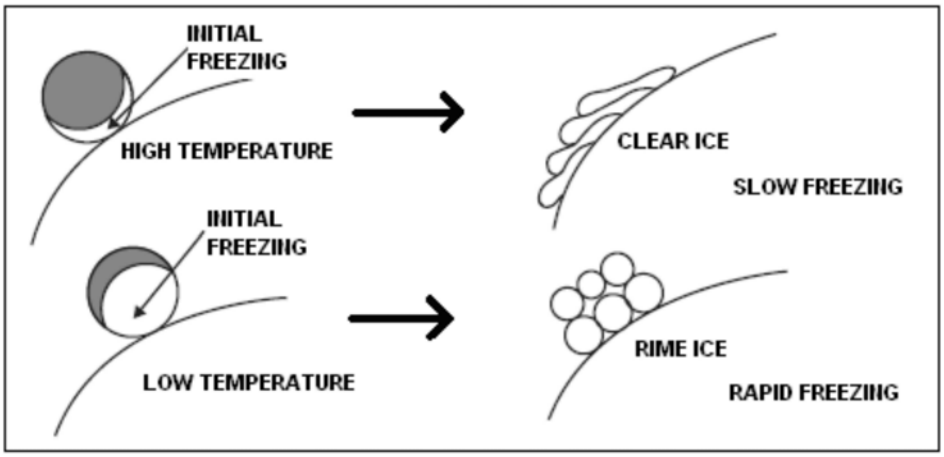

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Figure 3 Clear Ice and Rime Ice

Frost is a white semi-crystalline form of icing which forms in clear air by the process of sublimation. It generally forms on two occasions:

- when a cold aircraft enters warmer and damper air during a steep descent; and
- when an aircraft parked outside on a clear cold night cools by radiation to a temperature below that of the surrounding air.

Frost should be removed before takeoff as it will reduce lift and increase the stall speed of the aircraft.



Show slide of Figure A-4.

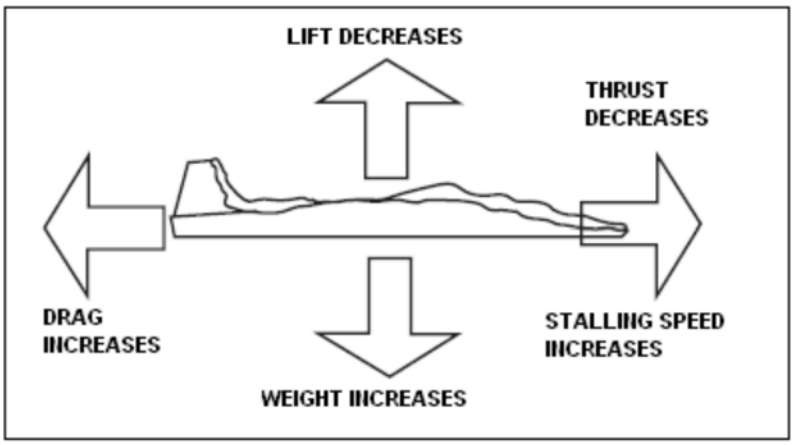

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Figure 4 Effects of Icing

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Protection From Icing

Many modern airplanes are fitted with various systems designed to prevent ice from forming or to remove ice after it has formed. Three of these systems are:

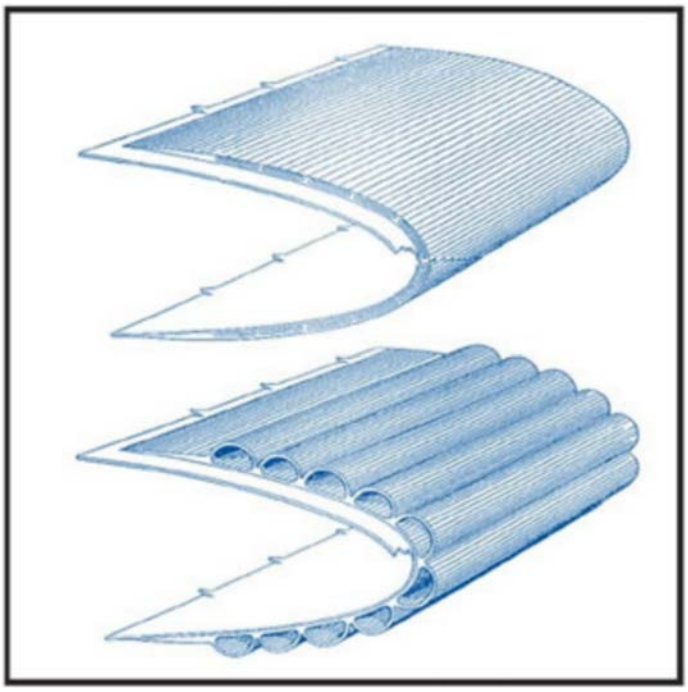
- fluids,
- rubber boots, and
- heating devices.

Fluids with a low freezing point are released over the blades of the propellers and the surfaces of the wings to prevent icing.



Show slide of Figure A-5.

Rubber boots are membranes of rubber attached to the leading edges that can pulsate in such a way that ice is cracked and broken off after it has formed.



Note. From "Icing Conditions in Flight", Pilot Friend. Retrieved October 22, 2008, from http://www.pilotfriend.com/safe/safety/icing_conditions.htm

Figure 5 Rubber Boots

Heating vulnerable areas with hot air from the engine or special heaters prevents the buildup of ice.

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CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. How can a pilot tell the difference between clear ice and rime ice?

Q2. How does frost form?

Q3. What are three methods of protection from icing?

ANTICIPATED ANSWERS:

A1. Clear ice is glassy while rime ice is opaque.

A2. Frost forms through sublimation.

A3. Fluids, rubber boots, and heating devices.

Teaching point 3 **Describe types of turbulence.**

Time: 10 min Method: Interactive Lecture

TYPES OF TURBULENCE

Turbulence is an irregular motion of the air resulting from eddies and vertical currents. It is one of the most unpredictable of all the weather phenomena.

There are four types of turbulence:

- mechanical turbulence,
- thermal turbulence,
- frontal turbulence, and
- wind shear.



Show slides of Figures A-6 and A-7.

Mechanical Turbulence

Mechanical turbulence is caused by friction between the air and the ground. The intensity of mechanical turbulence depends on the strength of the surface wind, the nature of the terrain, and the stability of the air. Strong winds, rough terrain, and very unstable air create greater turbulence. Mountain waves produce some of the most severe mechanical turbulence.

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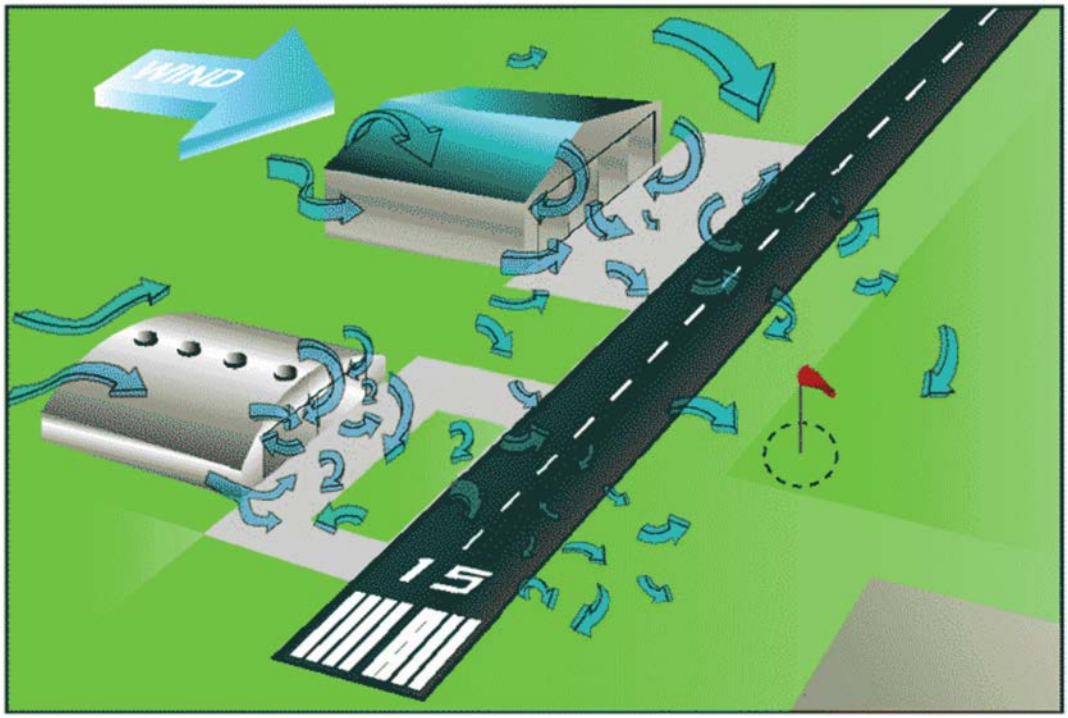

Note. From "Aviation Weather", Free Online Private Pilot Ground School. Retrieved October 22, 2008, from http://www.free-online-private-pilot-ground-school.com/Aviation-Weather-Principles.html

Figure 6 Mechanical Turbulence

Thermal Turbulence

Thermal turbulence is caused by the uneven heating of the ground. Certain surfaces, such as plowed fields and pavement, are heated more rapidly than others, such as grass-covered fields and water. This causes isolated convective currents that are responsible for bumpy conditions as an airplane flies in and out of them. These convective currents can have a pronounced effect of the flight path of an airplane approaching a landing area, causing it to either overshoot or undershoot.

Rising convective currents are commonly referred to as "thermals" or "lift". Glider pilots use their knowledge of the terrain to find thermals and soar for extended periods of time. They also learn to recognize and avoid sinking convective currents (commonly known as "sink").

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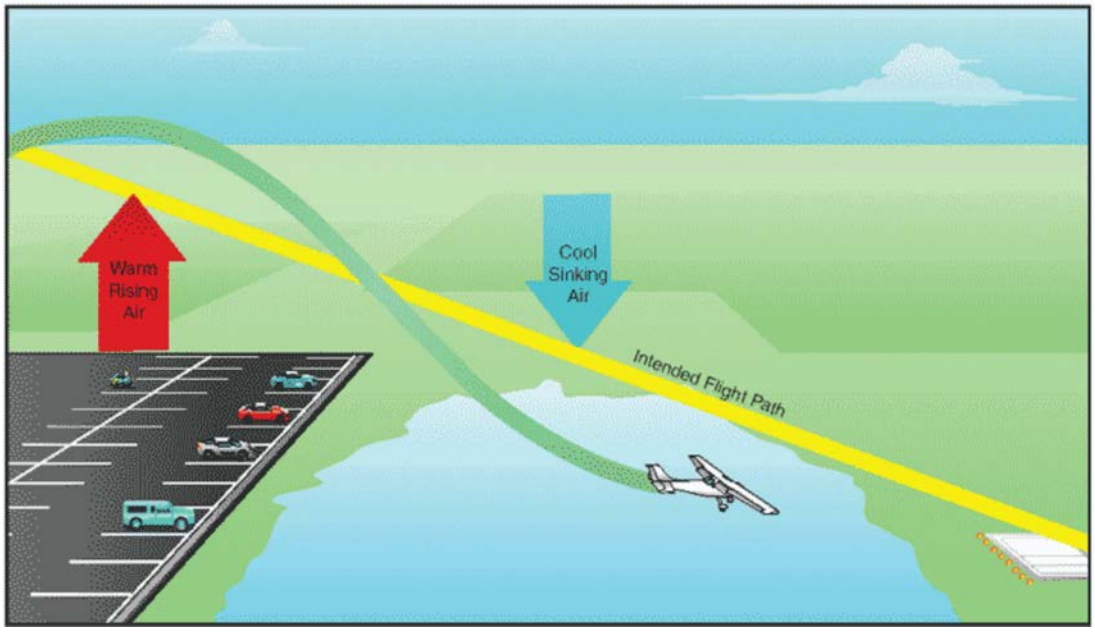

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Figure 7 Thermal Turbulence

Frontal Turbulence

Frontal turbulence is caused by the lifting of warm air by the sloping frontal surface and the friction between the two opposing air masses. This turbulence is strongest in cold fronts, especially when the warm air is moist and unstable.

Wind Shear

Wind shear is caused when there are significant changes in wind speed and direction with height.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. What causes mechanical turbulence?

Q2. Name two examples of terrain that heat more rapidly than water.

Q3. In which type of front is turbulence more pronounced?

ANTICIPATED ANSWERS:

A1. Mechanical turbulence is caused by friction between the air and the ground.

A2. A plowed field and pavement.

A3. Cold front.

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END OF LESSON CONFIRMATION

QUESTIONS:

Q1. What are the three stages of a thunderstorm?

Q2. What are the three main types of icing?

Q3. What are the four types of turbulence?

ANSWERS:

A1. Cumulus, mature, and dissipating.

A2. Clear ice, rime ice, and frost.

A3. Mechanical turbulence, thermal turbulence, frontal turbulence, and wind shear.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Severe weather conditions can adversely affect a flight and ruin a pilot's day. Knowing how to recognize and deal with these conditions is essential for future aviation training.

INSTRUCTOR NOTES / REMARKS

Cadets who are qualified Advanced Aviation may assist with this instruction.

REFERENCES

C3-116 ISBN 0-9680390-5-7 MacDonald, A. F., & Peppler, I. L. (2000). *From the ground up: Millennium edition*. Ottawa, ON: Aviation Publishers Co. Limited

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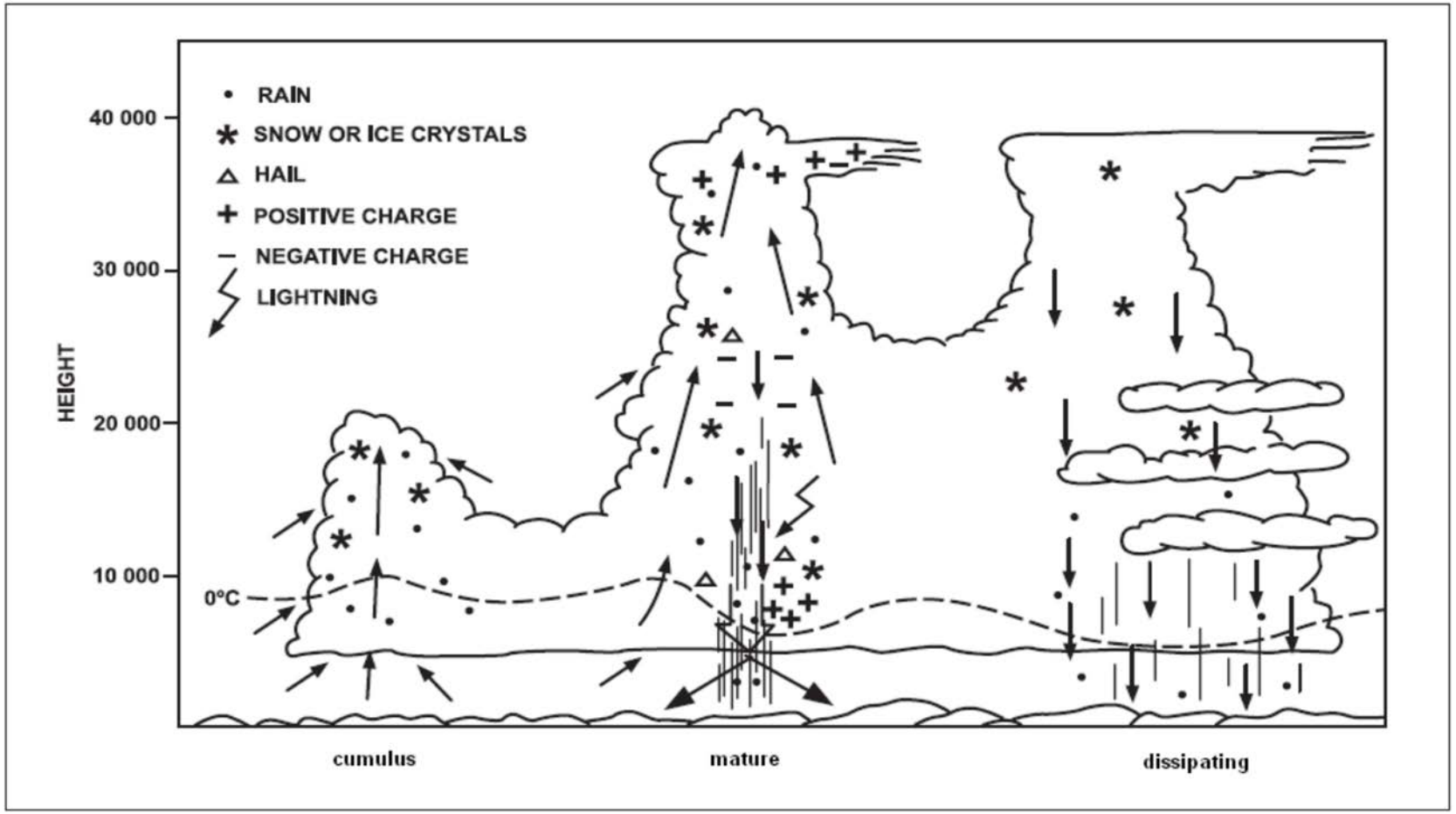

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Figure A-1 Stages of a Thunderstorm

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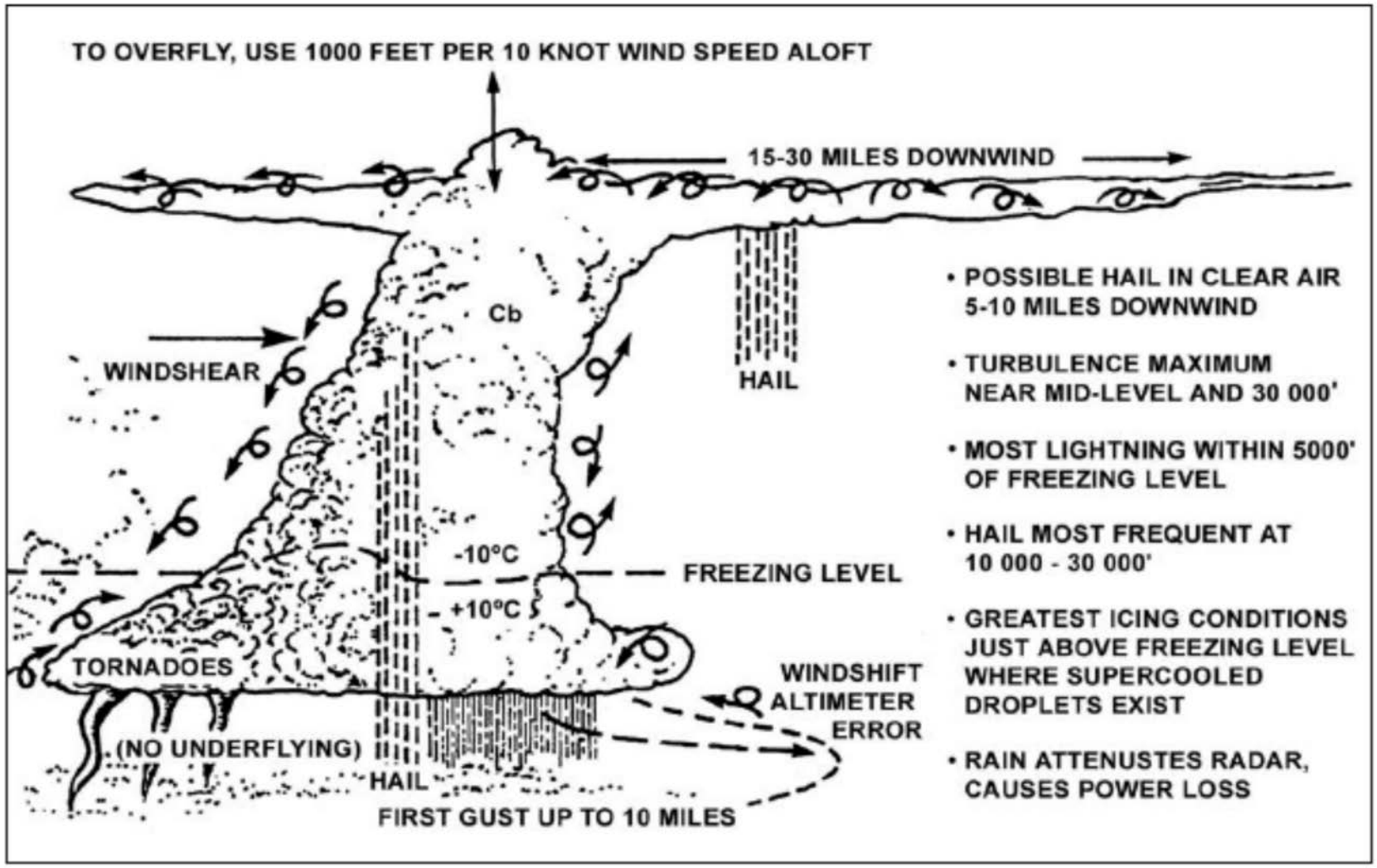

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Figure A-2 Thunderstorm Dangers

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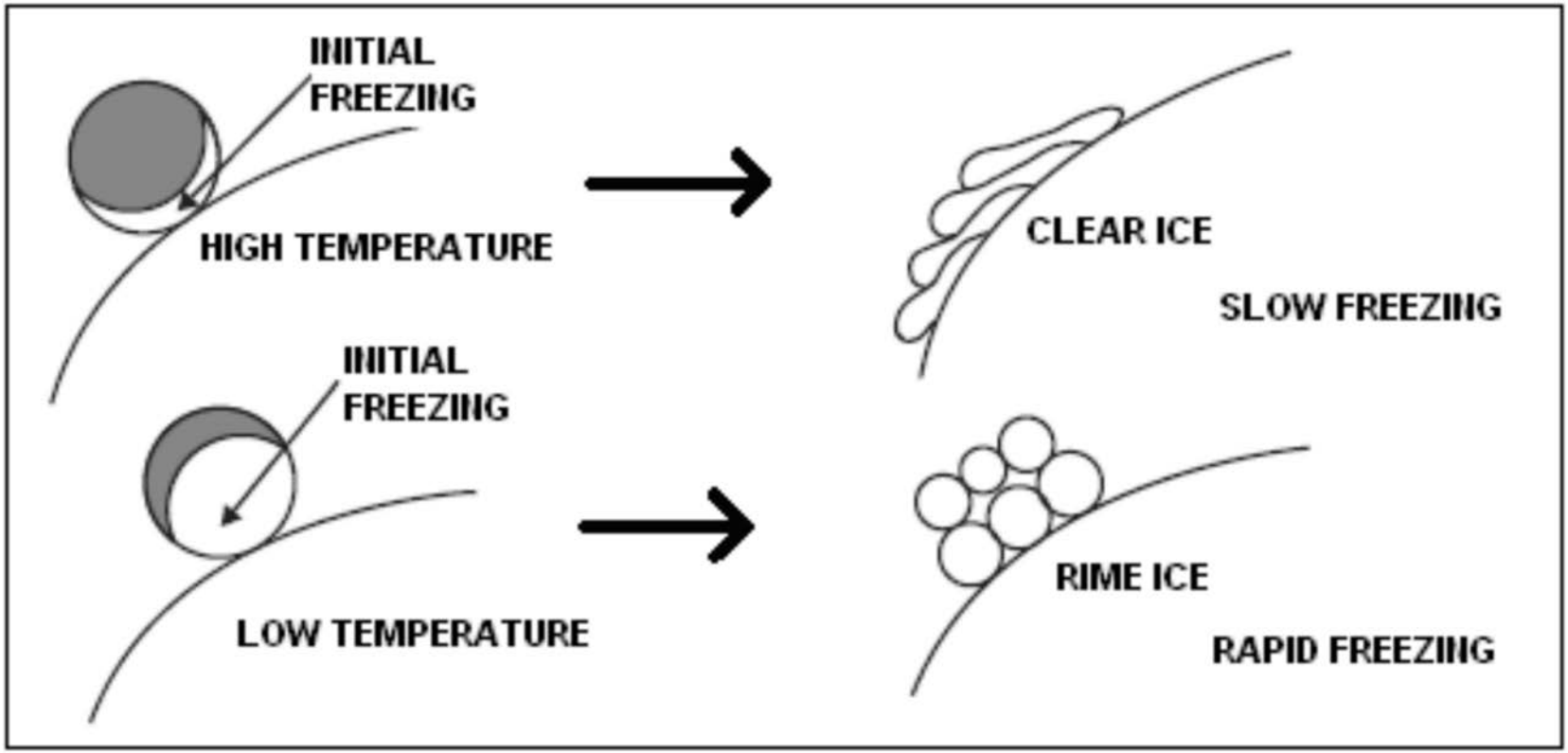

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Figure A-3 Clear Ice and Rime Ice

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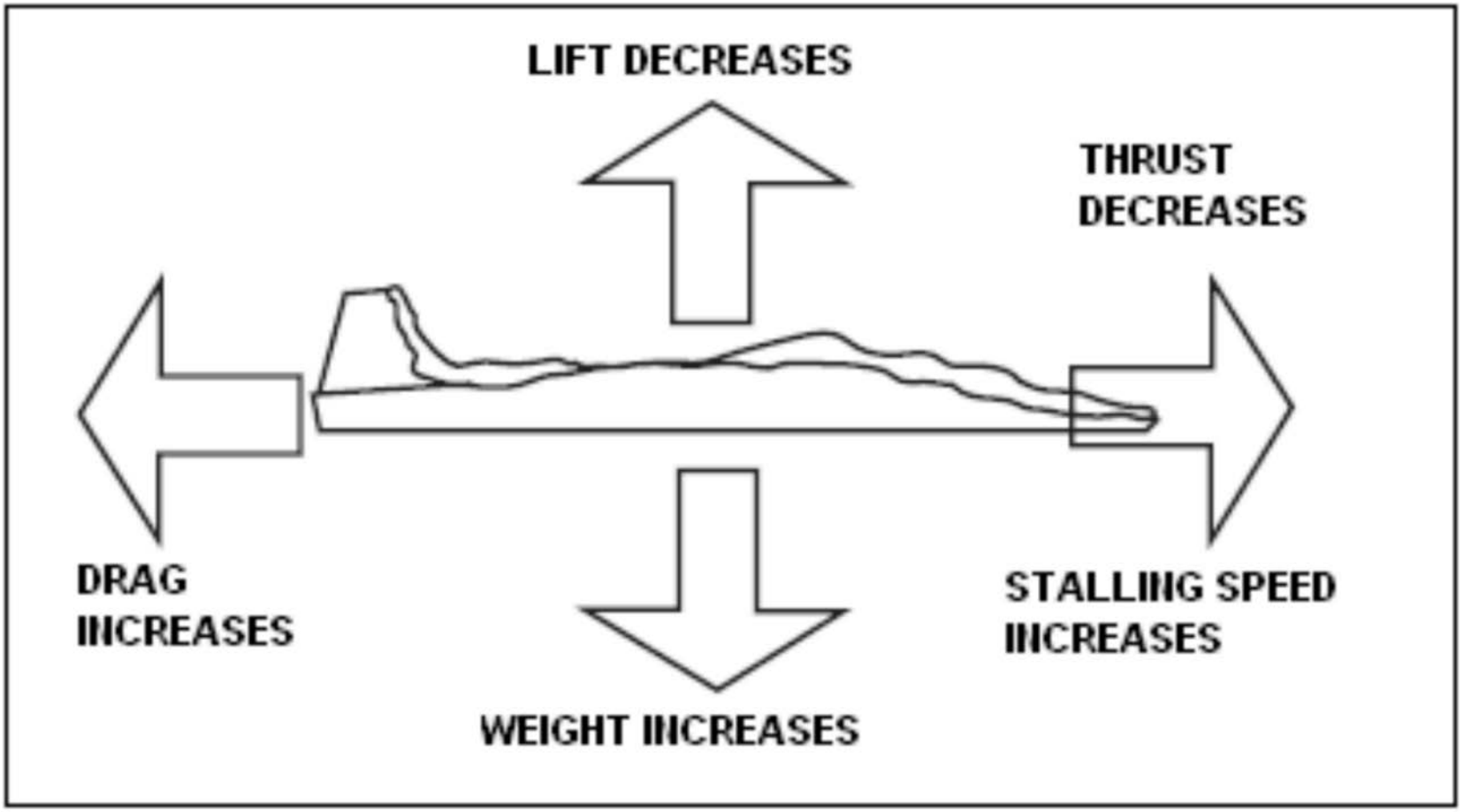

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Figure A-4 Effects of Icing

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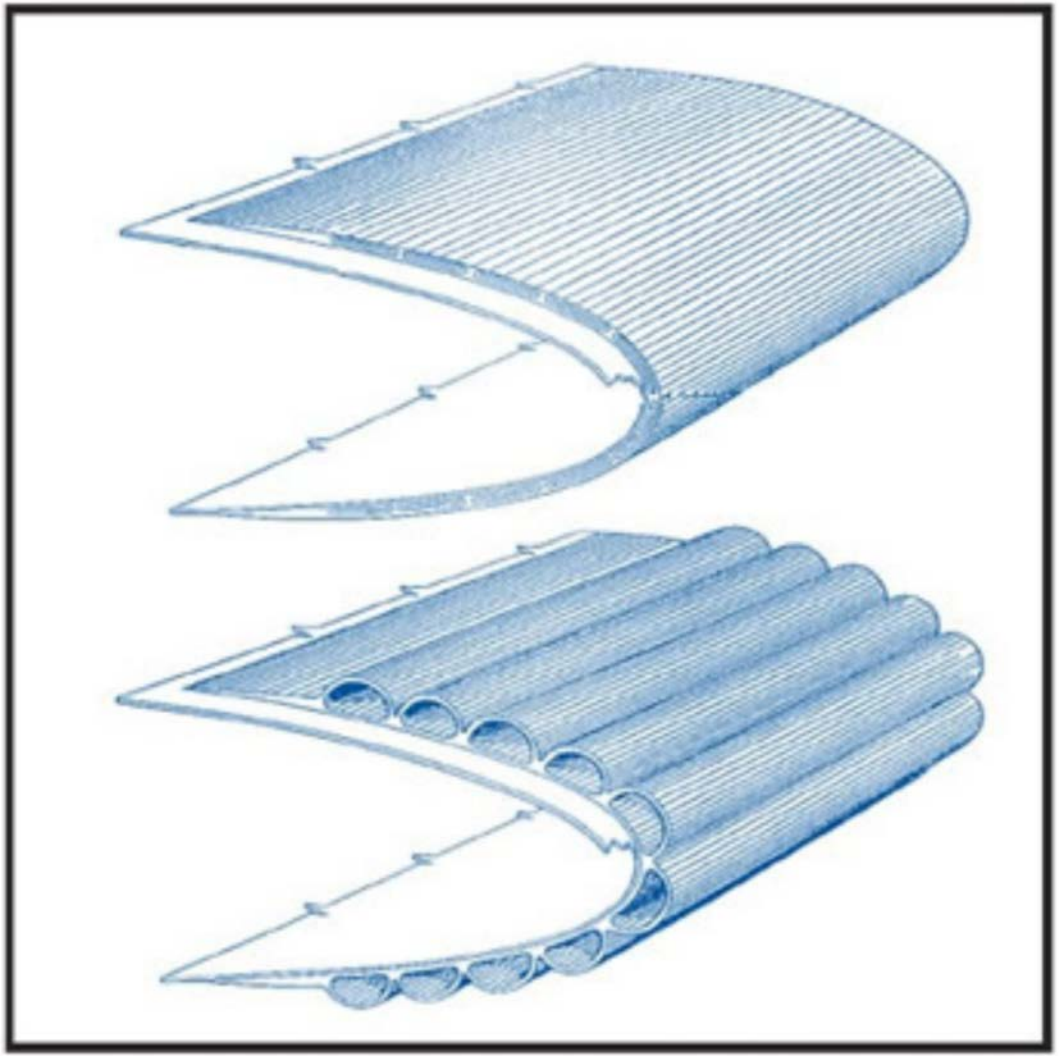

Note. From "Icing Conditions in Flight", Pilot Friend. Retrieved October 22, 2008, from http://www.pilotfriend.com/safe/safety/icing_conditions.htm

Figure A-5 Rubber Boots

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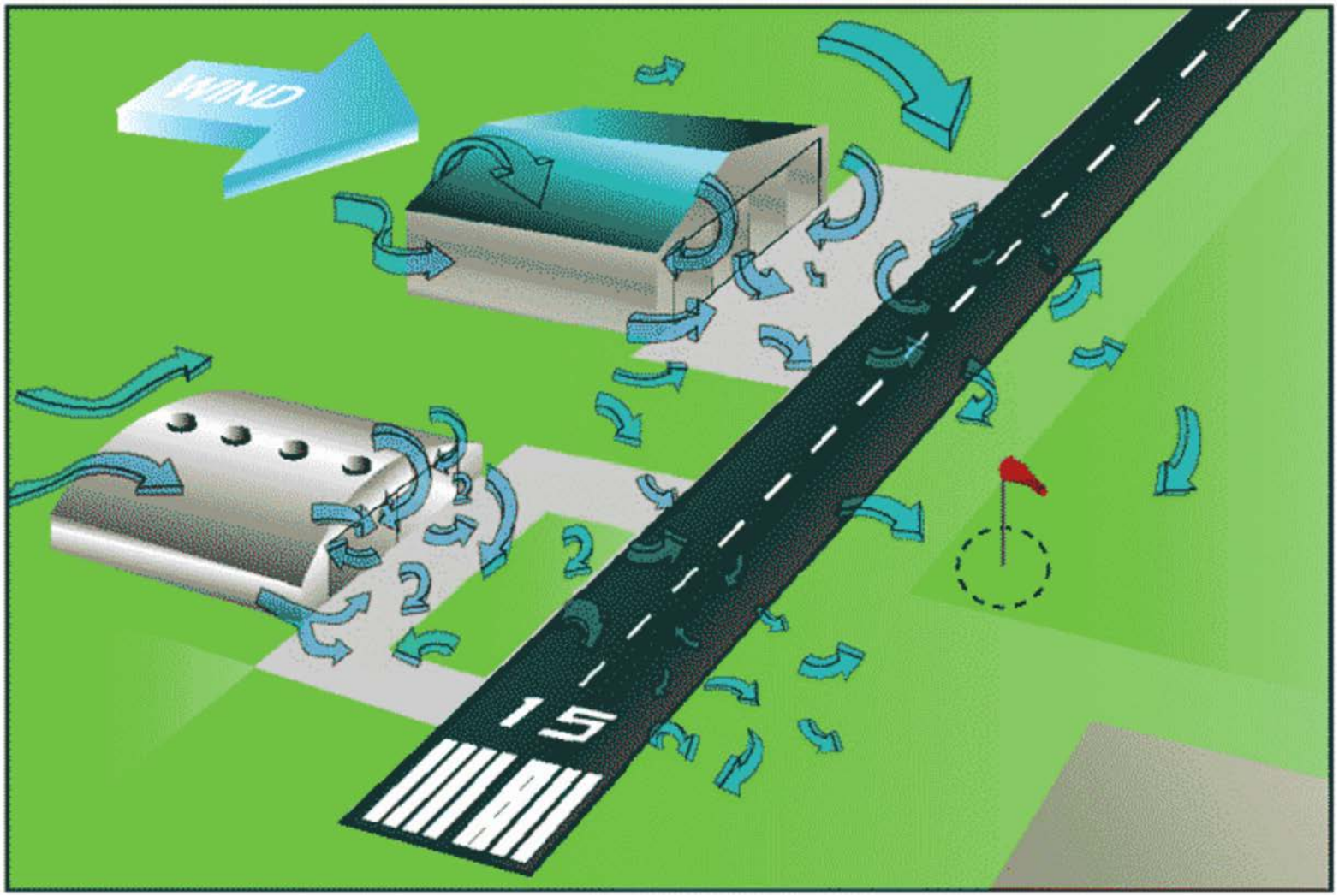

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Figure A-6 Mechanical Turbulence

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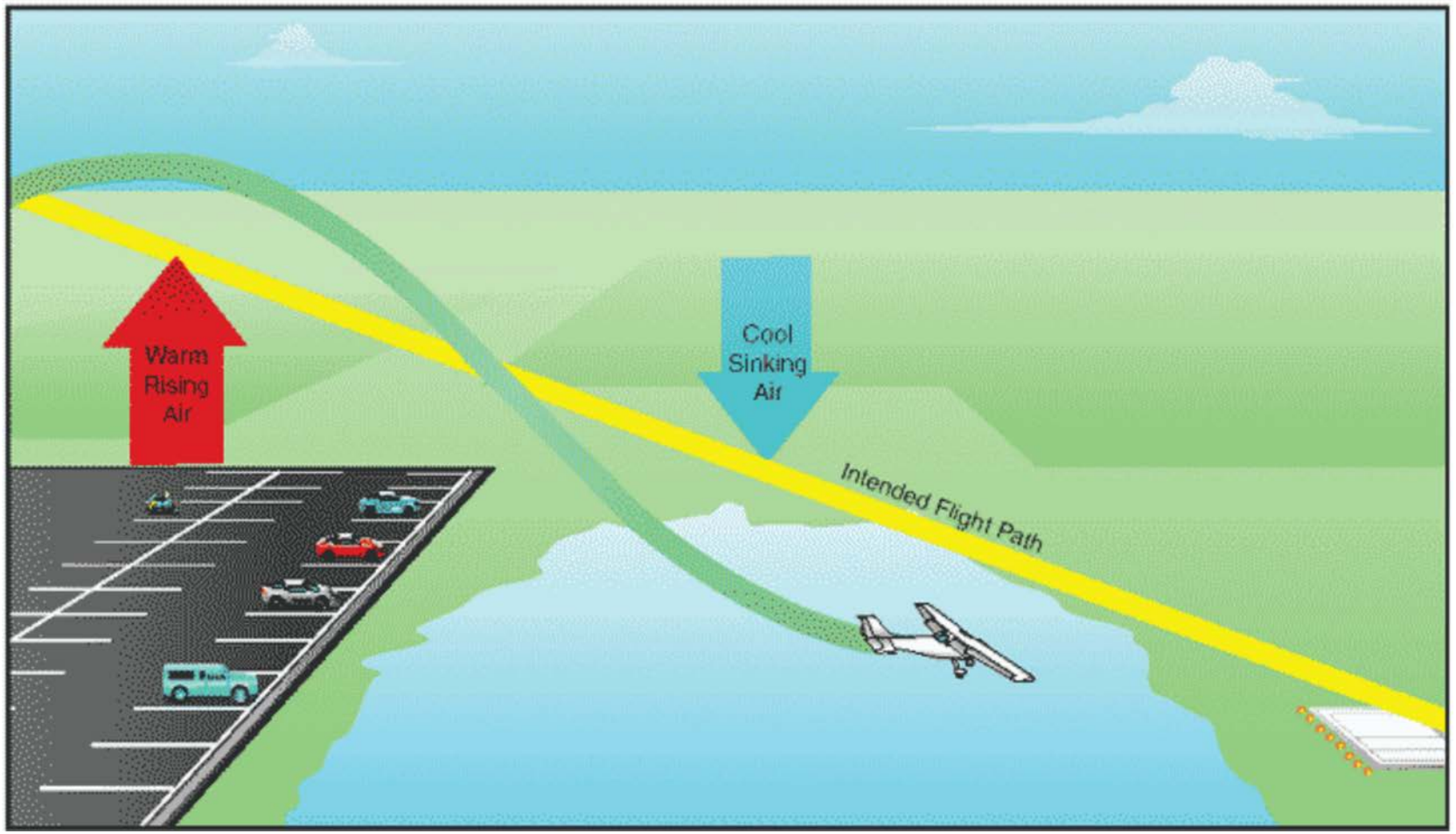

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Figure A-7 Thermal Turbulence

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