

The ATPL Cheat Sheet

050 Meteorology

The facts that actually get tested, stripped to the bone: definitions, key numbers, formulas, mnemonics and the classic exam traps for each subject. Built for the night before, the commute, and the last scroll before you walk into the exam hall.

050 Meteorology

59 memory items

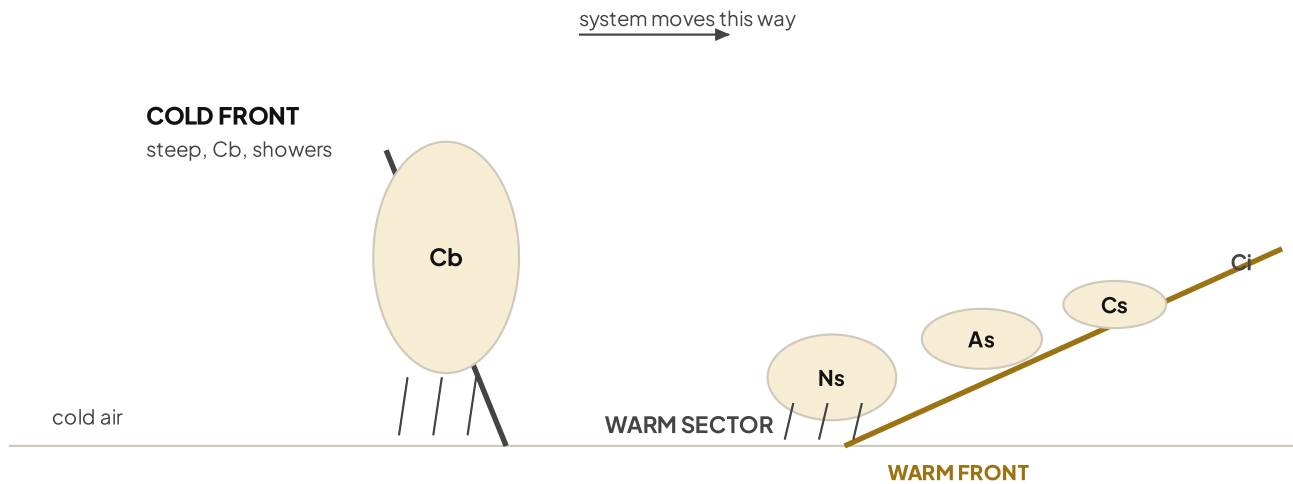
One of 14 subjects; the full set is free at skystudyatpl.com/atpl-cheat-sheet

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ISA, pressure and altimetry, cloud, wind, fronts, icing, thunderstorms.

♦ WARM AND COLD FRONTS IN A DEPRESSION



Cold front (behind): steep slope, cumuliform Cb, showery and squally, passes quickly. **Warm front** (ahead): shallow slope, layered Ns, As, Cs, Ci with prolonged steady rain. Between them lies the mild, moist **warm sector**.

◆ MUST-KNOW DEFINITIONS AND CONCEPTS

- **ISA** is a fixed reference atmosphere for altimetry, performance and calibration; it is not the real atmosphere.
- The **troposphere** is where temperature falls with height (the ELR) and almost all weather occurs; the **tropopause** caps it and is higher/warmer over the tropics, lower/colder over the poles.
- **ELR** (Environmental Lapse Rate) is the actual measured rate on the day; it varies constantly.
- **DALR** (Dry Adiabatic Lapse Rate) is how fast an unsaturated parcel cools when it rises, from expansion alone.
- **SALR** (Saturated Adiabatic Lapse Rate) is less than the DALR because condensation releases latent heat.
- Stability compares ELR to DALR/SALR: a displaced parcel warmer than its surroundings keeps rising (unstable), colder sinks back (stable).
- A **temperature inversion** (temperature rising with height) is very stable and traps moisture, smoke and haze below it.
- **Dewpoint (Td)** is the temperature to which air must cool to become saturated; the **dewpoint spread** (T minus Td) shrinks toward saturation.
- **Geostrophic wind**: balance of pressure gradient and Coriolis force, parallel to straight isobars (above the friction layer).
- **Gradient wind** adds centripetal force for curved isobars; surface **friction** backs and slows the wind, so it crosses isobars toward low pressure.
- **Thermal wind** is the vector difference between geostrophic winds at two levels, from horizontal temperature gradients.
- A **col** is a flat-gradient saddle between two highs and two lows; a **trough** is elongated low pressure, a **ridge** elongated high pressure.

- An **air mass** has fairly uniform temperature and humidity from its source region; a **front** is the boundary between two air masses.
- A **warm front** has a shallow slope: long, gradual cloud (Ci, Cs, As, Ns) and prolonged steady rain. A **cold front** has a steep slope: narrower, vigorous cumuliform cloud with showery, squally rain.
- An **occlusion** forms when the cold front catches the warm front and lifts the warm sector aloft.
- **Radiation fog** forms over land on clear, calm, humid nights; **advection fog** forms when warm moist air moves over a colder surface and needs some wind to persist.
- **Rime ice** (small supercooled droplets, stratiform) is rough and opaque; **clear ice** (large droplets, freezing rain, cumuliform) is smooth, hard and more hazardous.
- A thunderstorm needs **moisture, instability and a trigger**; its life cycle is cumulus (updrafts), mature (up and down drafts, heaviest weather), dissipating (downdrafts).
- A **gust front** is the leading edge of the cold downdraft outflow; a **microburst** is a small, intense downdraft giving sudden severe windshear on takeoff and landing.
- **CAT** (Clear Air Turbulence) occurs in cloud-free air, most often near jet streams and the tropopause; **mountain waves** form downwind of a ridge (lenticular clouds, rotor turbulence).
- The **ITCZ** is a belt of converging trade winds and rising air near the equator; tropical revolving storms need sea temperatures above about 26 to 27 C and enough Coriolis, so none form within about 5 degrees of the equator.

◆ KEY NUMBERS, LIMITS AND VALUES

- ISA MSL: **1013.25 hPa**, **15 C** (288.15 K), density **1.225 kg/m³**.
- ISA lapse rate **1.98 C per 1000 ft** (rounded to 2), equal to 6.5 C per km.
- ISA tropopause: **36,090 ft** (11 km), **-56.5 C**, constant above in the model.
- Real tropopause: roughly 16 km over the equator down to about 8 km over the poles **VERIFY**.
- Pressure change near MSL about **1 hPa per 27 ft**; the height per hPa increases with altitude.
- **DALR = 3 C per 1000 ft** (about 1 C per 100 m).
- **SALR** about **1.5 C per 1000 ft** on average, variable roughly 1.1 to 2.8 depending on temperature and moisture.
- Dewpoint lapse for cloud-base estimation: about **2.5 C per 1000 ft** difference from the DALR.
- Icing is significant roughly between **0 and -40 C**, most severe clear/mixed ice around 0 to -20 C **VERIFY**.
- Jet streams sit near the tropopause, roughly FL300 to FL400, cores commonly 60 to 150+ kt, sometimes over 200 kt **VERIFY**.
- Tropical revolving storms develop about 5 to 20 degrees latitude over sea temperatures above 26 to 27 C.
- METAR is routine (half-hourly or hourly); SPECI is issued on specified changes; TAF validity is commonly 9, 24 or 30 hours **VERIFY**.

◆ FORMULAS AND RELATIONSHIPS

- Convective cloud base (ft AGL) is about (surface T minus surface Td, in C) x 400, i.e. (T minus Td)/2.5 x 1000.
- Stability test: ELR less than SALR = absolutely stable; between SALR and DALR = conditionally unstable; greater than DALR = absolutely unstable.
- Buys Ballot's Law (Northern Hemisphere): back to the wind, low pressure is on your left, high on your right (reversed in the South).
- Thermal wind blows parallel to the thickness lines with cold air to the left in the Northern Hemisphere.
- Coriolis force is proportional to wind speed and the sine of latitude, so it is zero at the equator and maximum at the poles.
- Temperature error rule of thumb: flying from warm/high pressure into cold/low pressure without correction means true altitude is below indicated.

◆ MNEMONICS AND MEMORY ITEMS

- **High to Low, Look out Below:** into lower pressure or colder air, true altitude is below indicated.
- **Dry is faster:** DALR (3 C/1000 ft) is always greater than SALR (about 1.5), because condensation releases latent heat.
- Cold front **CCCC**: Cumuliform cloud, Colder air, Choppy showers, quiCk passage.
- Warm front: **long and slow** (shallow slope, gradual cloud, prolonged rain).
- Fog needs: cool, calm, clear, near-saturated air (light wind still needed to stir radiation fog).
- Thunderstorm ingredients **MIT**: Moisture, Instability, Trigger.
- **Katabatic down at night, Anabatic up by day.**
- **Rime is Rough and Rapid** from small droplets in stratiform cloud; **Clear ice** is denser and more hazardous from big droplets in cumuliform cloud.

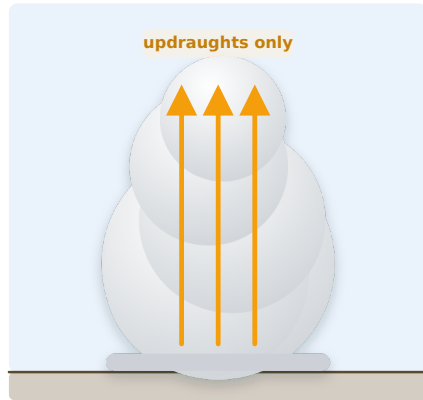
◆ COMMON EXAM TRAPS

- Do not confuse **ELR** (measured on the day) with **DALR/SALR** (parcel rates); stability compares ELR against the adiabatic rates.
- **1 hPa is about 27 ft only near MSL**; the height per hPa increases with altitude.
- Do not swap **QNH** (sea level, altitude) and **QFE** (aerodrome, height); **QNE** is the fixed 1013.25 for flight levels.
- The tropopause is **not constant**; 36,090 ft is the model value, the real one is higher over the tropics.
- **Cold fronts** usually bring the more intense, showery, turbulent weather despite passing faster.
- **Clear ice** (cumuliform, large droplets) is generally more hazardous than **rime** (stratiform, small droplets).
- Icing can persist toward **-40 C** in cloud, not only near 0 C.
- **CAT** is by definition cloud-free turbulence near jet streams, not a thunderstorm phenomenon.
- The **SALR is variable**; only the **DALR** is treated as a constant.
- Use pure Buys Ballot for the **geostrophic/upper** wind; the surface wind is backed and crosses isobars toward low pressure.
- **SIGMET** covers severe en-route hazards; **AIRMET** covers less severe, lower-level phenomena.
- A **METAR** is an observation, a **TAF** is a forecast; they can legitimately disagree.

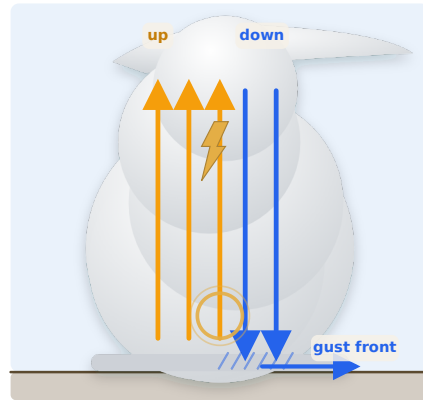
The thunderstorm (CB) life cycle in three stages

050 • METEOROLOGY

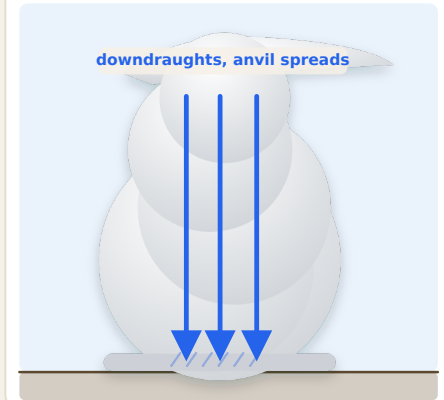
1 Cumulus (building) stage



2 Mature stage



3 Dissipating stage



Each cell lasts 20 to 30 minutes; the mature stage holds the worst hazards.

1 Cumulus stage

Warm moist air rises in updraughts only. The cloud builds rapidly and no precipitation yet reaches the ground.

2 Mature stage

Updraughts and downdraughts now coexist. This is the worst stage: heavy rain and hail, lightning, a gust front, severe turbulence and low-level windshear.

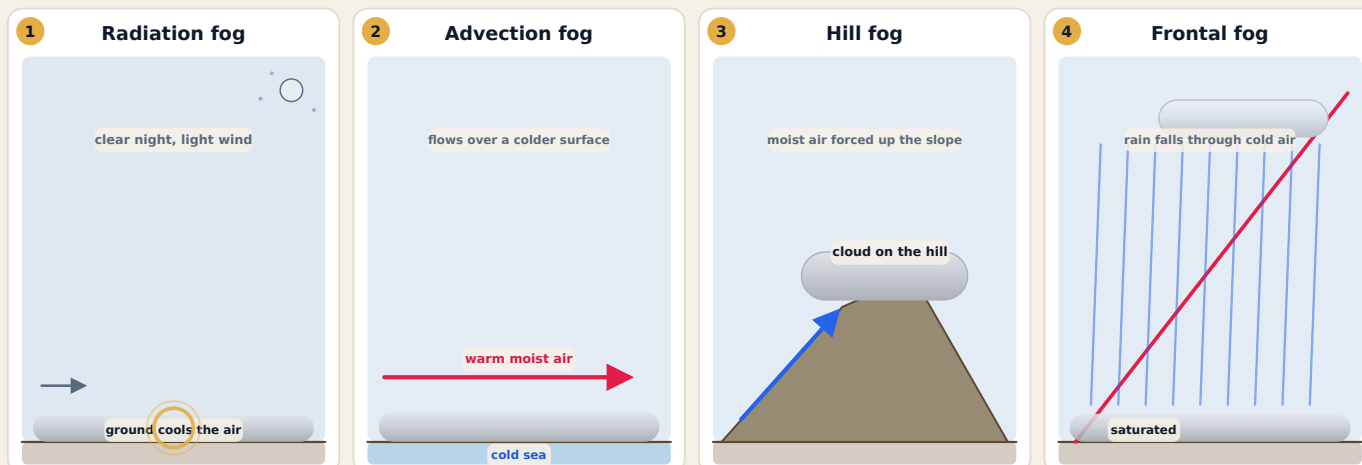
3 Dissipating stage

Downdraughts spread through the whole cell and cut off the inflow. The anvil of ice crystals remains as the rain and turbulence ease.

4 What it needs

A thunderstorm needs unstable air, high humidity and a trigger to lift it (heating, a front or high ground). Remove any one and it cannot grow.

A thunderstorm is worst in the mature stage, where updraughts and downdraughts coexist with hail, lightning, the gust front and severe windshear. Drawn in code.



Fog is cloud on the ground, visibility below 1000 m. Each type reaches saturation differently: by cooling the air, or by adding moisture to it.

1 Radiation fog

Forms on a clear night with light wind over land: the ground radiates heat and cools the moist air to its dew point. Calm gives dew, strong wind gives stratus; it clears with daytime heating.

2 Advection fog

Warm, moist air flows over a colder surface (often the sea) and is cooled to its dew point. It can form and persist in a stronger wind, by day or night. Sea fog is advection fog.

3 Hill (upslope) fog

Moist air is forced up rising ground and cools adiabatically to saturation. It is really stratus cloud sitting on the high ground, clearing the valleys below.

4 Frontal fog

Rain from the warm air aloft falls through the colder air below a front and evaporates, saturating it. It forms in the frontal rain belt (precipitation fog).

Fog forms when air is cooled to its dew point (radiation, advection, upslope) or moistened by evaporating rain (frontal): the result is cloud on the ground with visibility below 1000 m. Drawn in code.

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