High Altitude Training

Required for Pressurized Aircraft With Service Ceiling Greater Than 25,000’

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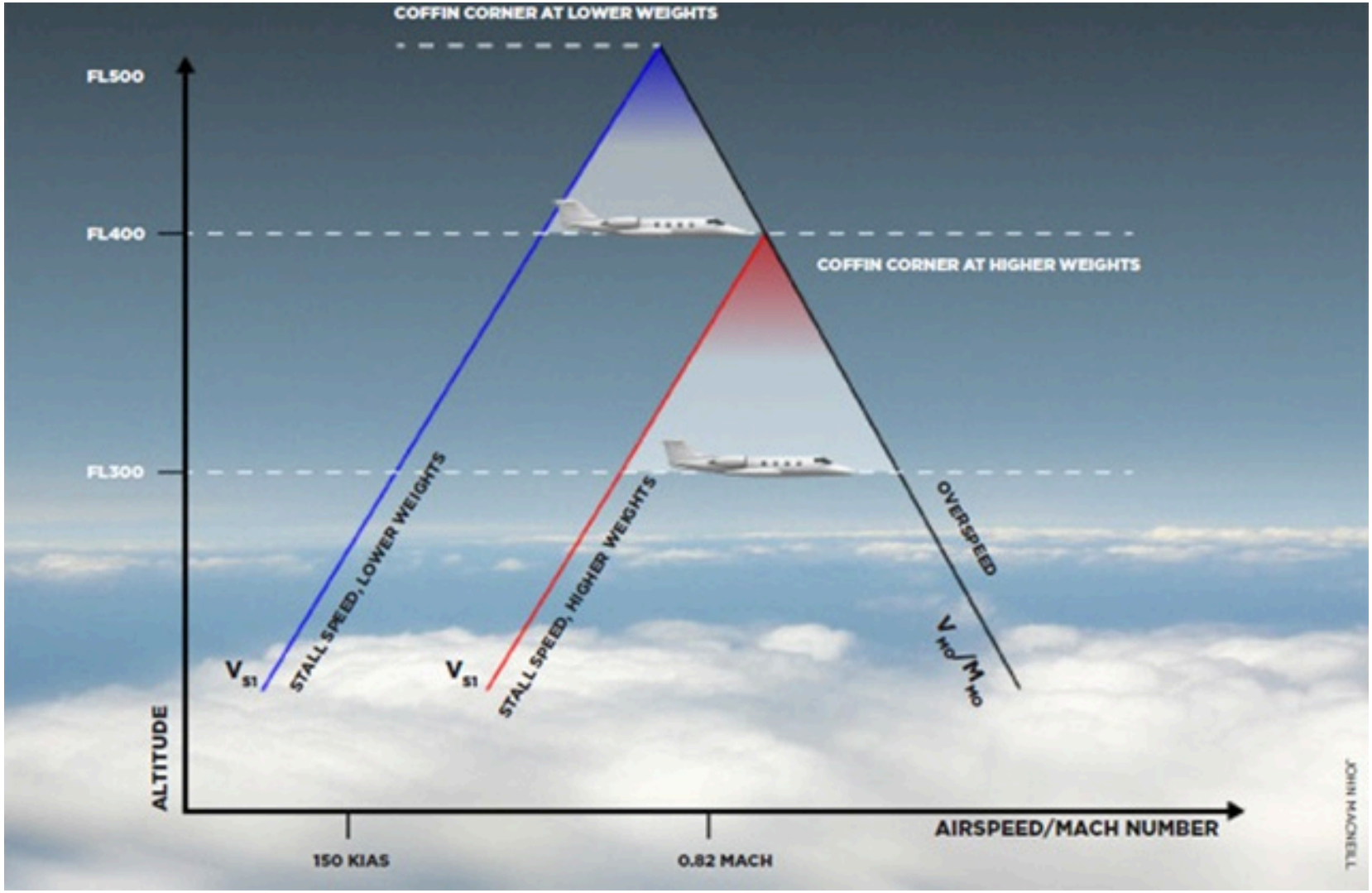
Outline

- Aerodynamics
- Weather
- Physiological
- Aircraft Specific – Conducted in Either Aircraft or Approved Flight Simulator
  - Cruise Ops
  - Emergency Procedures for Decompression
  - Emergency Descent

Aerodynamics



Aero (cont.)

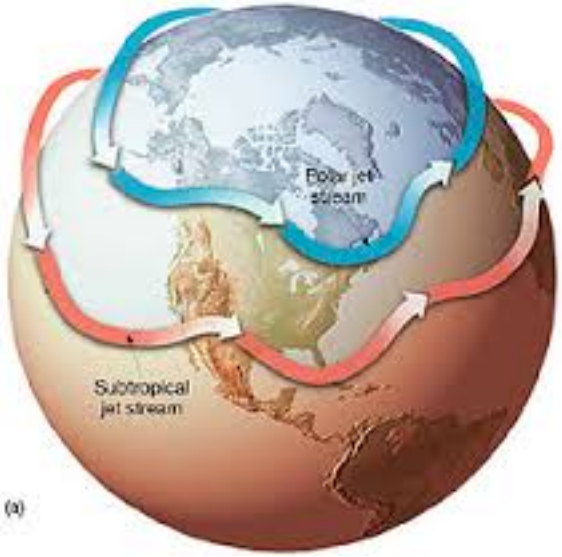
- Pilots of Air France 447 Failed to Recognize Stall
- Factors Regarding Coffin Corner:
  - Load (maneuvering)
  - Weight
  - Turbulence
  - Air Density

Some High Altitude Terms

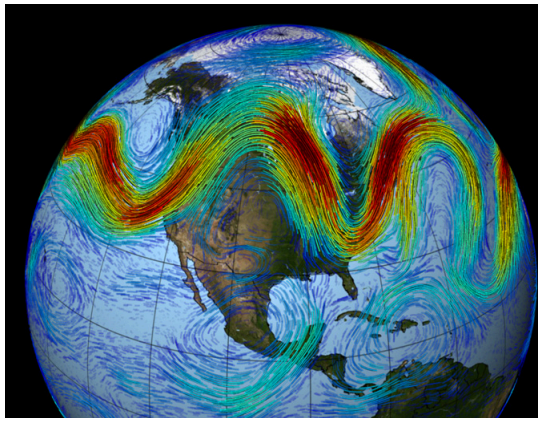
- Mach Number M
  - M = Velocity/Local Speed of Sound
- Critical Mach Number Mmo
  - Highest Mach Number for Which Airflow Remains Laminar
- Coffin Corner
  - Vs1 = Mmo
- Angle of Attack AOA
  - Angle Between Relative Wind and Chord

High Altitude Weather

- For a Thorough Review – See AC 00-06
- Jet Streams
- Clouds
- Turbulence and CAT
- Icing
- Thunderstorms



Jet Stream



Meandering Core of Strong Winds > 50 knots

Usually Between Polar – Artic – Tropical Air masses

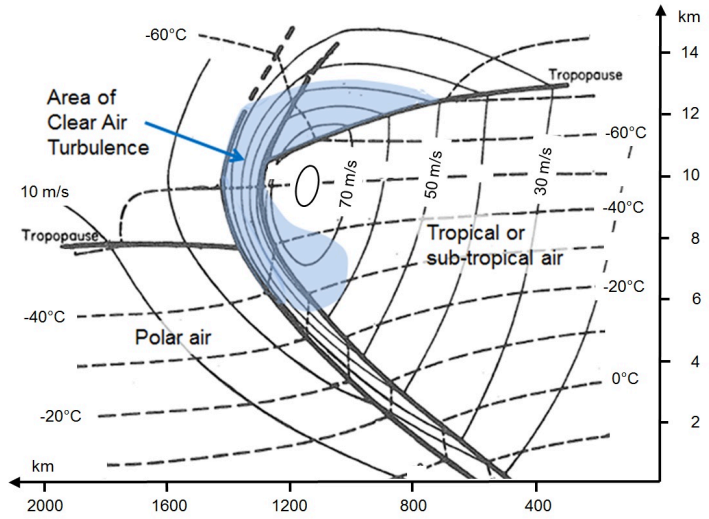
Varies in Height Between 18,000 to 60,000’

Typically West to East with Northerly and Southerly Flow Patterns

Sometimes a ‘Regression’ Jet – East to West Flow

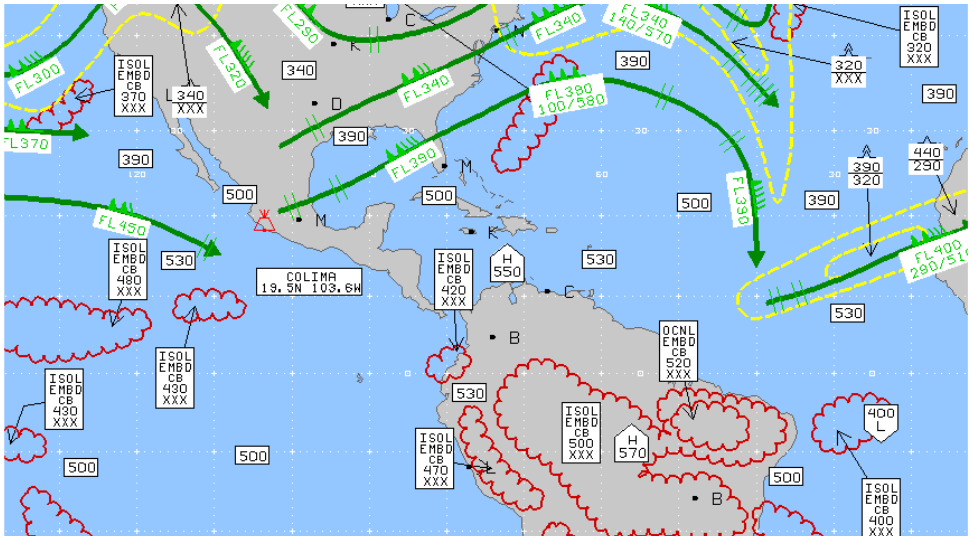
Strongest Wind at Core

Reduced Winds Occurs Fastest on North Side



Weather Products

- Winds Aloft – up to 53,000’
- AIRMETS/SIGMETS
- Turbulence
- Freezing Layers
- Satellite (IR and Visible)
- Significant WX (see below)
  - *Typical Displays of Jets, Turbulence, Convective Activity*
  - *CB Implies TS, and Moderate to Severe Icing and Turbulence*



High Altitude Clouds

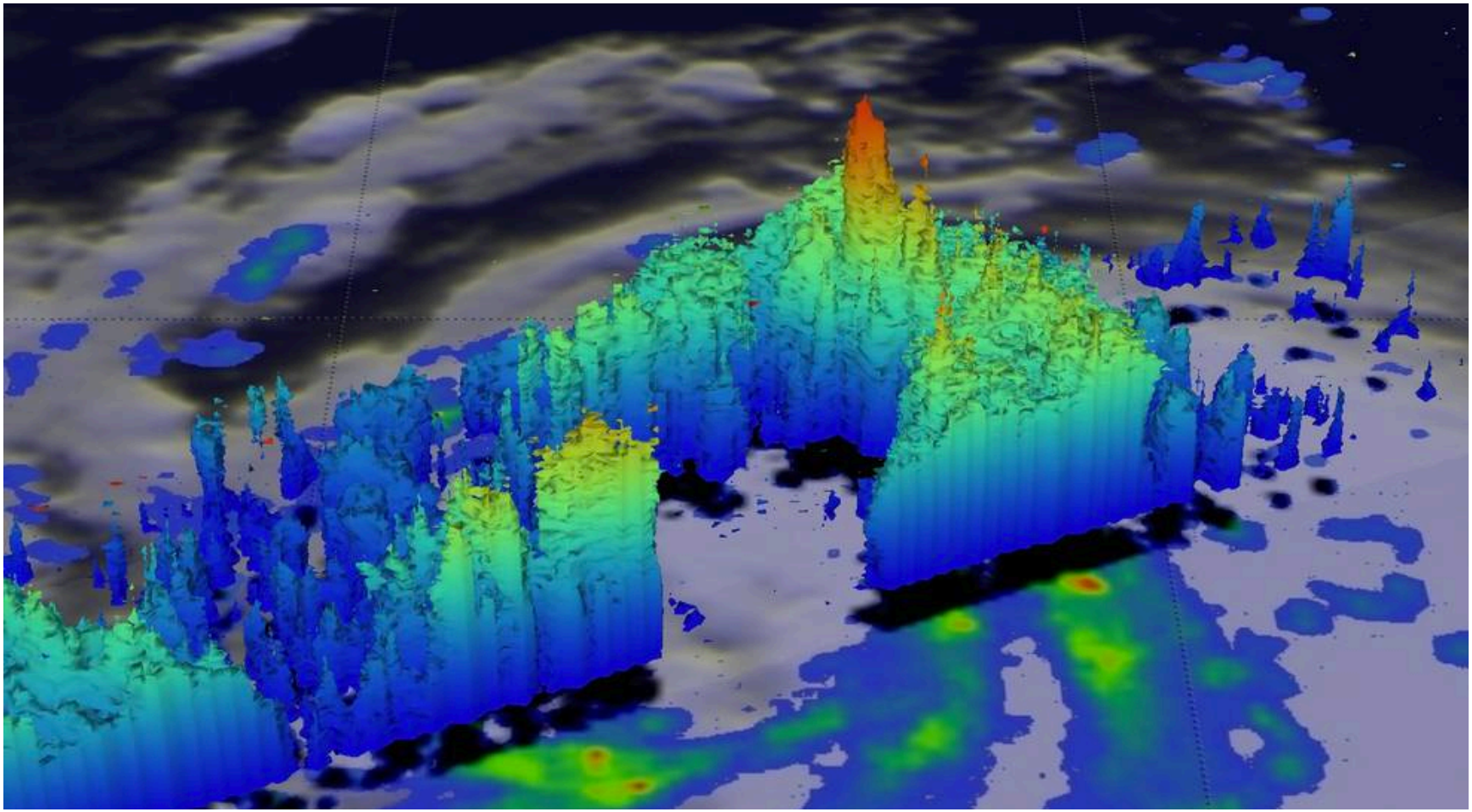
- Cirrus
  - Ice Crystals
- Form on Equatorial Side of Jet
- May be in ‘Bands’ or Layers
- Associated With Turbulence

Icing and Associated Issues

- Prolonged Flight in Cirrus or Tops of Towering Cumulus
- More Likely Over Mountainous Areas
- Slower Forming – Typically Rime, But Clear and Mixed
- Static Discharge on Aircraft – Dust and Ice Impinging on Airframe and Canopy
- Haze – Concentrated Areas (Layers or Bands) of Less Dense Cirrus

Thunderstorms

(this tropical storm had tops to nearly 60,000’)



Physiological
(Supplemental Oxygen)

What We Learned as Private Pilots

§ 91.211 Supplemental oxygen.
(a) General. No person may operate a civil aircraft of U.S. registry—
(1) At cabin pressure altitudes above 12,500 feet (MSL) up to and including 14,000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen for that part of the flight at those altitudes that is of more than 30 minutes duration;
(2) At cabin pressure altitudes above 14,000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen during the entire flight time at those altitudes; and
(3) At cabin pressure altitudes above 15,000 feet (MSL) unless each occupant of the aircraft is provided with supplemental oxygen.

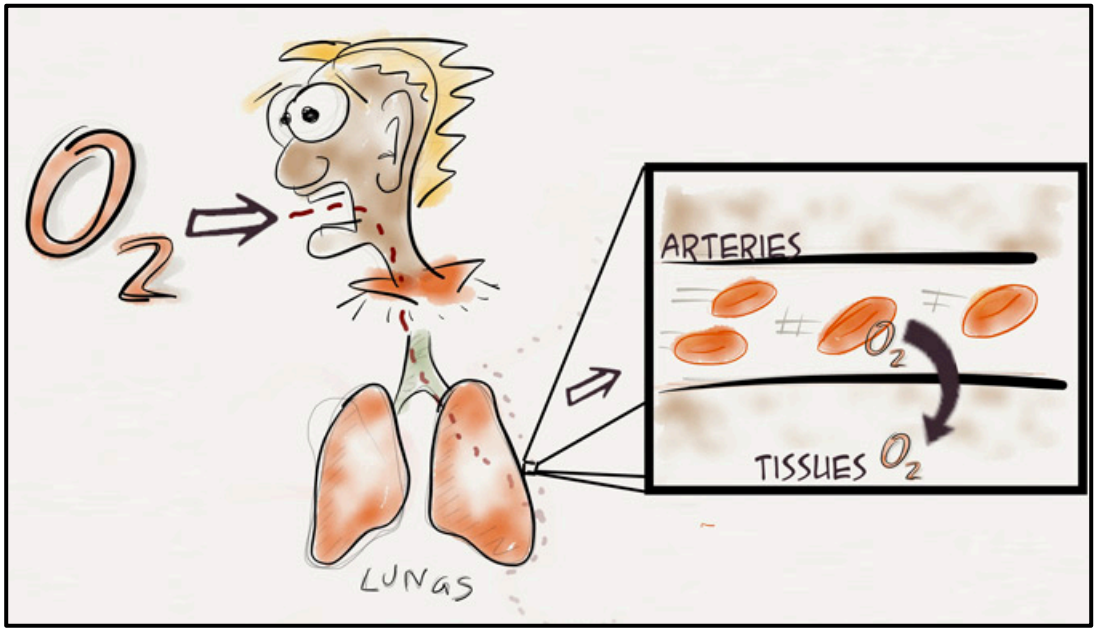
Physiological (Supplemental Oxygen)

But Wait – There's More

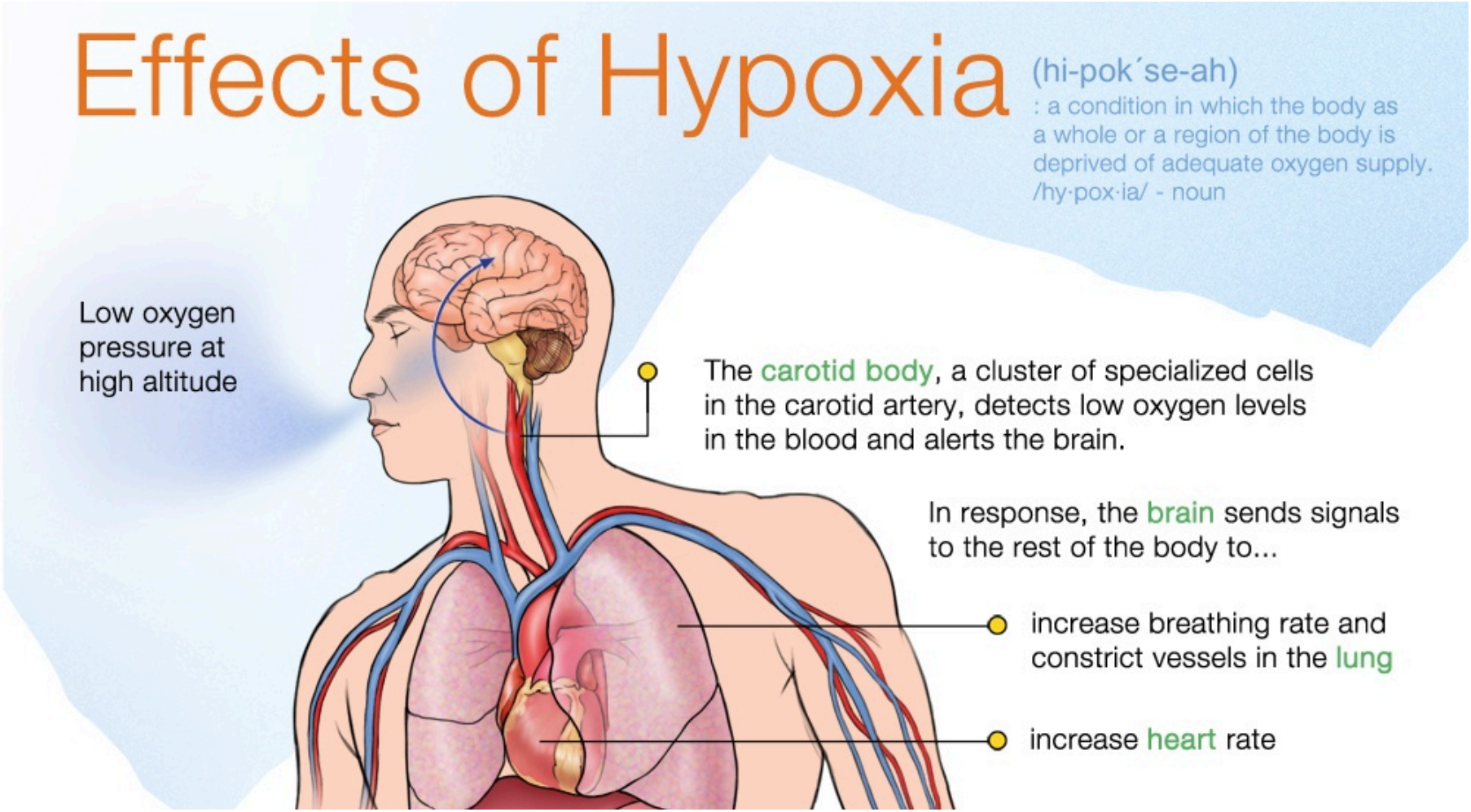
(b) Pressurized cabin aircraft.
(1) No person may operate a civil aircraft of U.S. registry with a pressurized cabin—
(i) At flight altitudes above flight level 250 unless at least a 10-minute supply of supplemental oxygen, in addition to any oxygen required to satisfy paragraph (a) of this section, is available for each occupant of the aircraft for use in the event that a descent is necessitated by loss of cabin pressurization; and
(ii) At flight altitudes above flight level 350 unless one pilot at the controls of the airplane is wearing and using an oxygen mask that is secured and sealed and that either supplies oxygen at all times or automatically supplies oxygen whenever the cabin pressure altitude of the airplane exceeds 14,000 feet (MSL), except that the one pilot need not wear and use an oxygen mask while at or below flight level 410 if there are two pilots at the controls and each pilot has a quick-donning type of oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed.
(2) Notwithstanding paragraph (b)(1)(ii) of this section, if for any reason at any time it is necessary for one pilot to leave the controls of the aircraft when operating at flight altitudes above flight level 350, the remaining pilot at the controls shall put on and use an oxygen mask until the other pilot has returned to that crewmember's station.

Respiration

A metabolic process – At High Altitudes O2 is displaced (the air is thinner) – thus more volume must be processed – also air pressure is reduced so lungs are not as efficient in performing gas exchange through the alveolar capillary membrane



Hypoxia


Effects of Hypoxia
(hi-pok´se-ah)
: a condition in which the body as a whole or a region of the body is deprived of adequate oxygen supply.
/hy·pox·ia/ - noun
Low oxygen pressure at high altitude
The carotid body, a cluster of specialized cells in the carotid artery, detects low oxygen levels in the blood and alerts the brain.
In response, the brain sends signals to the rest of the body to...
increase breathing rate and constrict vessels in the lung
increase heart rate

Time Useful Conscientious or Effective Performance Time

ALTITUDE	TUC/EPT
18,000	20 - 30 Min
22,000	10 Min
25,000	3 - 5 Min
28,000	2.5 - 3 Min
30,000	1 - 2 Min
35,000	.5 - 1 Min
40,000	15 - 20 Sec
43,000	9 - 12 Sec
50,000	9 - 12 Sec

Aviation Physiology

- Other Problems, Such as Rapid Decompression, Rate of Ascent/Descent, Decompression Sickness, etc. Can Occur in Unpressurized Aircraft
- For Further Information Read the FAA's *Aviation Physiology* Manual at
  - https://www.faa.gov/pilots/training/airman_education/media/IntroAviationPhys.pdf

Conclusion

- This Completes the Ground Portion of Your High Altitude Endorsement Training
- A 10 Question Quiz Follows

Quiz

1. The Coffin Corner Altitude Can Be Decreased by:
   A. Decreasing Weight
   B. Performing Aggressive Control Inputs
   C. Flying at a Lower Density Altitude
2. You Must Have a High Altitude Endorsement
   A. For IFR Above 18,000’
   B. Flight Above 25,000’
   C. Flight in Any Pressurized Aircraft

Quiz

3. The Effects of Atmosphere Above 25,000’ May Result in:
   A. Clear Visibility
   B. Smooth Air
   C. Strong Winds
   D. All of Above
4. Cirrus Clouds Are Formed When
   A. Water Molecules Evaporate
   B. Water Gasses Go to Liquid Molecules
   C. Super Cooled Water Droplets that Freeze

Quiz

5. The Jet Stream Begins With Winds Greater Than:
   A. 50 knts
   B. 30 knts
   C. 75 knts
6. The Jet Stream Always Has
   A. An Inner Core of the Strongest Winds
   B. Strong Gradient on the Equatorial Side That Causes a Split Jet
   C. Turbulence Well Above the Jet

Quiz

8. The Metabolic Process is Best Described As:
   A. A Gas Exchange Mechanism
   B. A Blood Transfer Process
   C. A Blockage by the Alveolar Capillary Membrane

9. Without an Adequate Atmosphere, a Human Can Lose Consciousness at or Above 25,000’ in
   A. 3 min
   B. 7 min
   C. 10 min

Quiz

10. Thunderstorms That Have High Tops Indicate
    A. Storms That Have Reached the Mature or Dissipating Stages
    B. Storms That Are Only Embedded in Cirrus Clouds
    C. Stronger Storms With a Higher Likelihood of Extreme Turbulence