



Overview

- Mountain and high altitude topics:
 - Physiology
 - Survival
 - Performance
 - Operations
 - Weather
 - But...
 - no time to cover every possible topic in depth;
 - prepare to do some reading on your own!

History

- 2007: Fly Out Group (FOG) formed
 - Bay Area flight instructors
 - Multiple organizations
- 2007: Colorado 5-day trip template established
 - 2–8 Cessna 182s
 - 1st night: Sedona, Santa Fe, or Durango
 - 2nd–3rd nights: Glenwood Springs (Eagle County) touring Leadville, Aspen, Telluride, Kremmling
 - 4th night: Las Vegas McCarran via Grand Canyon tour
 - 5th day: home via Furnace Creek and Yosemite

07 March 2018

Copyright © 2009–2018 My Flight Training

3

Before You Fly

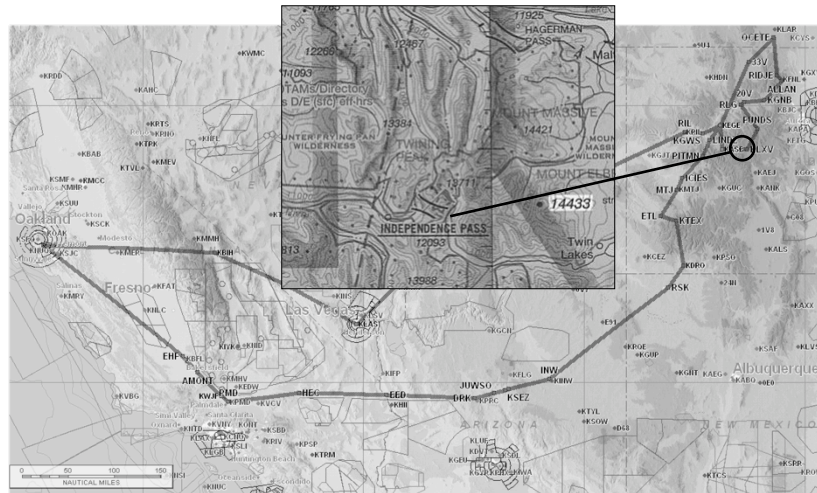
- Planning
 - Route
 - Performance
 - Weather
 - Flight plan
- Supplies
 - Physiological
 - Survival

07 March 2018

Copyright © 2009–2018 My Flight Training

4

Physiology



07 March 2018

Copyright © 2009–2018 My Flight Training

5

Physiology

- Hypoxia
- Hydration
- Vision

07 March 2018

Copyright © 2009–2018 My Flight Training

6

Physiology

- Hypoxia
 - Hypoxic hypoxia
 - Operating at or above oxygen altitudes
 - Operating at night at high altitude
 - Operating for prolonged periods at altitude
 - §91.211 Supplemental oxygen
 - > 12500 MSL Required crew beyond 30 minutes
 - > 14000 MSL Required crew at all times
 - > 15000 MSL Available (but not required) to passengers
 - Non-regulatory, but recommended
 - > 5000 MSL Prolonged night operation

07 March 2018

Copyright © 2009–2018 My Flight Training

7

Physiology

- Oxygen systems
 - Built-in
 - Typically provided only in turbocharged airplanes
 - “Hook-up” (connector, hose, regulator) required
 - No standard for connectors (unfortunately)
 - Pilot outlet may be color-coded for extra flow
 - Portable systems
 - Oxygen cylinder
 - Various capacities
 - Number of simultaneous users (2-place, 4-place)
 - Duration of use
 - Weight
 - Don't forget O₂ system in weight and balance
 - Security
 - Oxygen cylinder secured in cabin against turbulence

07 March 2018

Copyright © 2009–2018 My Flight Training

8

Physiology

- Oxygen systems
 - Familiarity
 - Continuous flow system operation and limitations
 - Masks and cannulas
 - Donning and securing
 - Pre-flight
 - Oxygen cylinder charged (1800–2200 psi)
 - Flow check from oxygen cylinder
 - Flow check at each passenger station
 - Ascending to and cruising at oxygen altitudes
 - Set flowmeter for cruise altitude
 - Regular checking of flowmeter
 - Assist and monitor passengers
- Pulse oximeter
 - Closed feedback loop
 - *Know that you are getting enough O₂: don't depend on flowmeter*



07 March 2018

Copyright © 2009–2018 My Flight Training

9

Physiology

- Hypoxia
 - Hypemic hypoxia
 - Cold at high altitude
 - Use of cabin heat
 - Carbon monoxide from cabin heat
 - Avoidance/remedies
 - Carbon monoxide detector
 - Breath supplemental oxygen
 - Vent cabin
 - Precautionary landing

07 March 2018

Copyright © 2009–2018 My Flight Training

10

Physiology

- Hydration
 - Prolonged flight at high altitudes
 - Air is relatively dry
 - Breathing of oxygen
 - Hot weather
 - Hot cabin
 - Avoid dehydration
 - Carry and consume water in flight

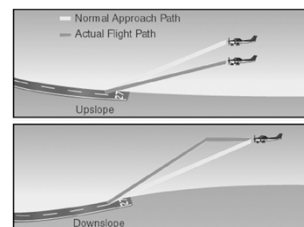
07 March 2018

Copyright © 2009–2018 My Flight Training

11

Physiology

- Vision
 - Illusions
 - Runway slope
 - Mountain airports often sloped, sometimes extremely so ($> 5\%$)
 - Upslope: airplane appears high, is flown low
 - Downslope: airplane appears low, is flown high
 - Obscurements
 - Rain, fog, haze: airplane appears high, is flown low
 - Groundspeed
 - True airspeed higher at high elevation airports
 - Ground rush: airplane appears low, is flown high



07 March 2018

Copyright © 2009–2018 My Flight Training

12

Physiology

- Vision
 - Horizon
 - Irregular terrain (distant ridgeline)
 - Sloping cloud deck
 - Horizon is the base of the mountains 6–8 miles away
 - Crosscheck instruments
 - Night
 - Oxygen use
 - Sparse ground lighting
 - Sloping ground lighting

07 March 2018

Copyright © 2009–2018 My Flight Training

13

Physiology

- Survival tip: don't try to push C-182 uphill at 10000 MSL

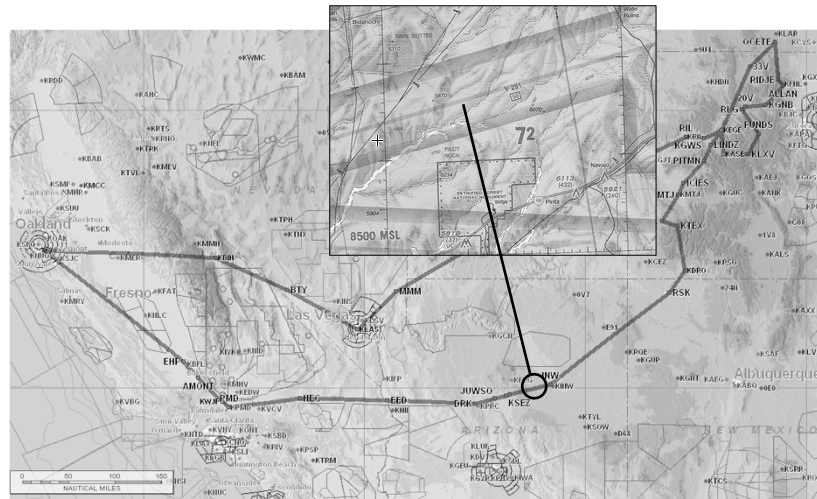


07 March 2018

Copyright © 2009–2018 My Flight Training

14

Survival



07 March 2018

Copyright © 2009–2018 My Flight Training

15

Survival

- Clothing
- Supplies
- After the crash
- Rescue

07 March 2018

Copyright © 2009–2018 My Flight Training

16

Survival

- Appropriate clothing
 - Don't be fooled by departing from California sea level on a summer day
 - In the mountains you may find yourself in high-altitude winter conditions
 - Many have survived a crash only to succumb to the environment

07 March 2018

Copyright © 2009–2018 My Flight Training

17

Survival

- Flight tracking and arrival notification
 - VFR radar advisories (“flight following”) is virtually non-existent in the mountains
 - Expect radar service to be terminated approaching mountainous terrain
 - File and open a VFR flight plan
 - Be sure your en route time, route, aircraft colors, and souls on board are accurate
 - Be sure to close your flight plan upon arrival

07 March 2018

Copyright © 2009–2018 My Flight Training

18

Survival

- Clothing
 - Warm or winter jacket
 - Sturdy or hiking shoes
 - Gloves
 - Waterproofing

07 March 2018

Copyright © 2009–2018 My Flight Training

19

Survival

- Survival kit contents
 - Canadian Aviation Regulations 602.61
 - State of Alaska Statute 02.35.110
 - <http://www.aopa.org/members/files/pilot/1996/survive9604.html>
 - <http://touchngo.com/lglcntr/akstats/Statutes/Title02/Chapter35/Section110.htm>
 - http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/PART6/602.htm#602_61

07 March 2018

Copyright © 2009–2018 My Flight Training

20

Survival

- Sample survival kit contents (non-statutory)
 - Water
 - Food (high-energy)
 - Warmth
 - Sleeping bag
 - Blanket
 - Matches
 - Signaling
 - Mirror
 - Pyrotechnic
 - Radio and cellular phone
 - Whistle
 - Medical
 - First-aid kit
 - Compresses
 - Bandages
 - Tools
 - Knife
 - Multitool
 - Fishing kit
 - Flashlight

07 March 2018

Copyright © 2009–2018 My Flight Training

21

Survival

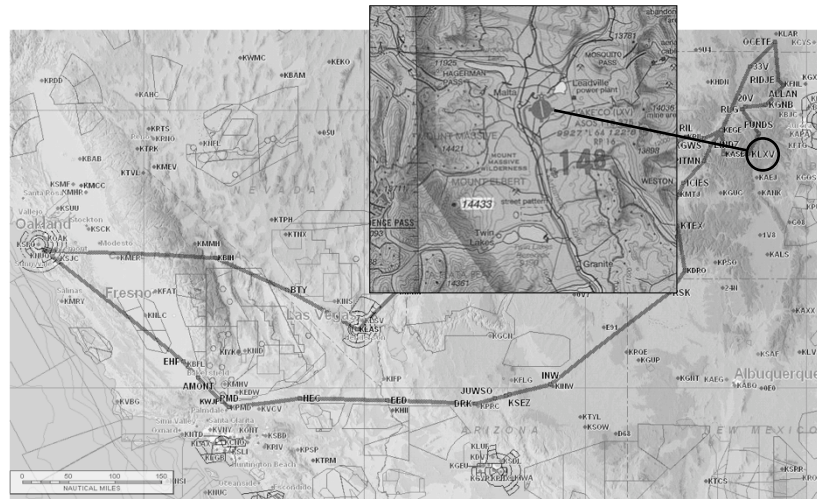
- After the crash
 - Remain near the wreck
 - Your flight plan identified the airplane type and colors—*right?*
 - Search-and-rescue timeliness *only with open* flight plan
 - Signal
 - Bright clothing laid on ground
 - Signal mirror
 - Handheld radio
 - ELT
 - Can typically be removed and operated with standalone antenna
 - 406 MHz preferred for signal quality and satellite detection
 - Conserve
 - Warmth
 - Water

07 March 2018

Copyright © 2009–2018 My Flight Training

22

Performance



07 March 2018

Copyright © 2009–2018 My Flight Training

23

Performance

- Landing Lake County, CO (KLXV)
 - Elevation 9934 MSL



07 March 2018

Copyright © 2009–2018 My Flight Training

24

Performance

- Weight
- Density altitude
 - Pressure altitude
 - Temperature
- Wind
- Slope

07 March 2018

Copyright © 2009–2018 My Flight Training

25

Performance

- Airspeed definitions
 - Indicated airspeed (IAS)
 - Calibrated airspeed with installation errors
 - Calibrated airspeed (CAS)
 - Most important airspeed related to performance
 - True airspeed (TAS)
 - Aircraft's actual linear progress through air
 - Groundspeed (GS)
 - True airspeed adjusted for effects of wind

07 March 2018

Copyright © 2009–2018 My Flight Training

26

Performance

- **Airspeeds**
 - TAS and GS are flight planning quantities
 - They relate to progress over ground and ETE and fuel burn
 - CAS is the most important airspeed for measuring aircraft performance
 - Relates the behavior of aerodynamic surfaces to the relative wind
 - CAS appears directly in formulas for lift
 - CAS responds to changes in air density (σ)
 - CAS adjusts automatically for flight at different altitudes
 - IAS approximates CAS at cruise airspeeds

07 March 2018

Copyright © 2009–2018 My Flight Training

27

Performance

- **Ceiling definitions**
 - Service ceiling
 - Altitude at which aircraft is capable of maximum 100 fpm climb (all engine(s) operating)
 - Absolute ceiling
 - Altitude at which aircraft can sustain 0 fpm climb at V_Y
 - Flying any airspeed other than V_Y at absolute ceiling results in a descent

07 March 2018

Copyright © 2009–2018 My Flight Training

28

Performance

- Airspeeds
 - AFM/POH operating airspeeds (IAS) remain the same at all density altitudes
 - V_S Stall speed
 - V_{REF} Approach speed
 - V_A Maneuvering speed
 - True airspeed (TAS) for a fixed IAS increases with altitude
 - But IAS is the performance speed you fly

07 March 2018

Copyright © 2009–2018 My Flight Training

29

Performance

- True airspeed (TAS)
 - Increases approximately 2% per 1000 ft of altitude for fixed IAS
 - Causes groundspeed to increase
 - Can cause landing visual illusions due to faster apparent motion over runway
 - Solution: Consciously fly indicated airspeed

07 March 2018

Copyright © 2009–2018 My Flight Training

30

Performance

- Performance airspeeds (IAS)
 - V_Y (best rate of climb)
 - Decreases with altitude
 - V_X (best angle of climb)
 - Increases with altitude
 - $V_Y = V_X$ at aircraft's absolute ceiling
- Guidance:
 - Consult AFM/POH for airspeed adjustment
 - Many manufacturers publish SL and 10000 MSL values
 - Fly appropriate climb speed for altitude

07 March 2018

Copyright © 2009–2018 My Flight Training

31

Performance

- Weight adjustment of airspeed
 - Stall speed (angle of attack) depends on weight
 - Performance airspeeds are related to stall speed
 - Approach speed (V_{REF})
 - Maneuvering speed (V_A)
 - Manufacturers publish weight adjustment for maneuvering speed
 - Maximum gross weight
 - Intervals down to minimum typical operating weight
 - With or without AFM/POH guidance, you can compute appropriate airspeeds adjusted for weight

07 March 2018

Copyright © 2009–2018 My Flight Training

32

Performance

- Weight adjustment of airspeed
 - Stall speed decreases as square root of weight decrease
 - Other airspeeds decrease proportionally to stall speed
- Hypothetical airplane example:
 - Maximum gross weight airspeeds:
 - $W_{MTOW} = 3000$ lbs
 - $V_{S1} = 60$ KCAS
 - $V_{S0} = 50$ KCAS
 - $V_A = 117$ KCAS
 - $V_{REF} = 65$ KCAS
 - What are appropriate airspeeds for operation at 2500 lbs?

07 March 2018

Copyright © 2009–2018 My Flight Training

33

Performance

- Example
 - Appropriate airspeeds for operation at 2500 lbs?
 - $W = 2500$ lbs
 - $W/W_{MTOW} = 2500/3000 = 0.83$
 - $\sqrt{W/W_{MTOW}} = \sqrt{0.83} = 0.91$
 - Airspeeds at 2500 lbs (KCAS)
 - $V_{S1} = 55$ KCAS (0.91×60 KCAS)
 - $V_{S0} = 46$ KCAS (0.91×50 KCAS)
 - $V_A = 107$ KCAS (0.91×117 KCAS)
 - $V_{REF} = 59$ KCAS (0.91×65 KCAS)
 - Then convert each KCAS speed to KIAS (AFM/POH)!
 - Position error results in significant KCAS/KIAS divergence at low airspeeds!

07 March 2018

Copyright © 2009–2018 My Flight Training

34

Performance

- Load factor
 - $LF = G's = \text{aerodynamic load} / \text{weight}$
 - Load factor increases with bank angle
- Limit load factor
 - Normal category: -1.52 G, +3.80 G
 - Utility category: -1.76 G, +4.40 G
 - Acrobatic category: -3.00 G, +6.00 G (typically)
 - Flaps deployed substantially penalizes limit load factor
 - Typically: -0.00 G, +2.00 G
- Ultimate load factor
 - Limit load factor + 50% ($\times 1.5$)

07 March 2018

Copyright © 2009–2018 My Flight Training

35

Performance

- Radius of turn
 - Decreases with increased bank angle
 - Load factor increases
 - Stall speed increases
 - Decreases with increased rate of turn
 - Increases with increased airspeed
 - Doubling airspeed quadruples turn radius
 - Tight turn
 - Slow down
 - Bank as steeply as load factor and stall speed allow

07 March 2018

Copyright © 2009–2018 My Flight Training

36

Performance

- Effects of higher weight
 - Higher takeoff speed
 - Longer takeoff run
 - Lower angle of climb
 - Poorer rate of climb
 - Decreased cruise speed
 - Increased stall speed
 - Higher landing groundspeed
 - Longer landing roll

07 March 2018

Copyright © 2009–2018 My Flight Training

37

Performance

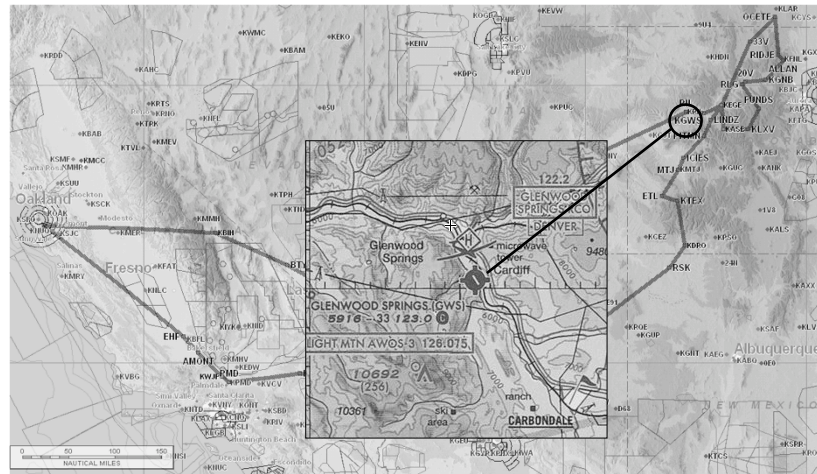
- Effects of higher density altitude
 - Longer takeoff run
 - Longer landing roll
 - Poorer rate of climb
 - Higher landing groundspeed
- Note,
 - *higher density altitude* is
 - *lower density air*

07 March 2018

Copyright © 2009–2018 My Flight Training

38

Operations



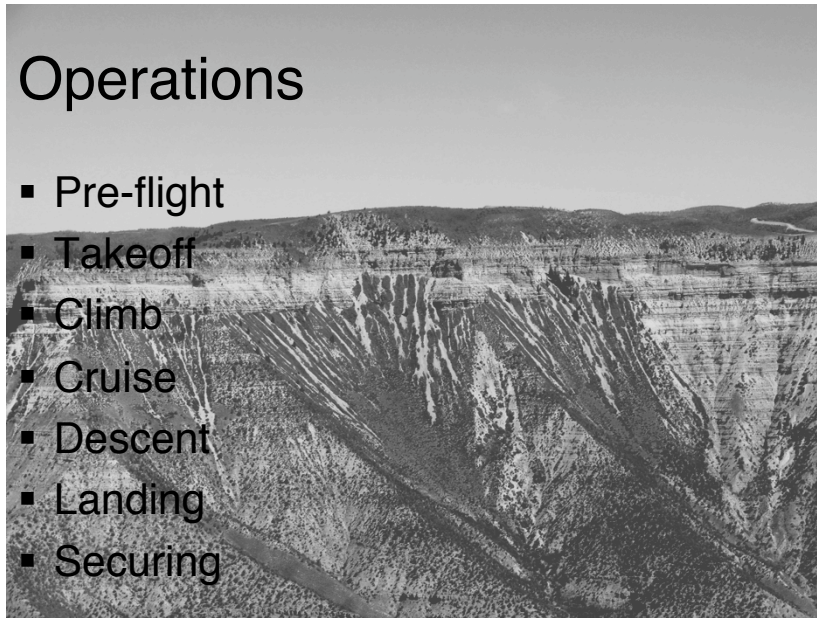
07 March 2018

Copyright © 2009–2018 My Flight Training

39

Operations

- Pre-flight
- Takeoff
- Climb
- Cruise
- Descent
- Landing
- Securing



07 March 2018

Copyright © 2009–2018 My Flight Training

40

Operations

- Pre-flight
 - Weight and balance
 - Performance calculations
 - Fuel
 - Rigging
 - Frost
 - Engine pre-heat
 - Run-up
 - File flight plan

07 March 2018

Copyright © 2009–2018 My Flight Training

41

Operations

- Pre-flight
 - Run-up
 - Normally-aspirated (non-turbocharged) engines
 - Full-rich mixture *not* used for high-altitude takeoff
 - Lean for maximum power per POH and instruments:
 - Fuel flow
 - EGT
 - Maximum smooth RPM
 - Full-power run-up if any uncertainty about mixture setting
 - Choose debris-free, prop-blast-safe location

07 March 2018

Copyright © 2009–2018 My Flight Training

42

Operations

- Takeoff
 - Most critical phase of flight
 - You can land at places you cannot takeoff from
 - Considerations
 - Temperature
 - Proxy for density altitude
 - Runway
 - 1-way in/out, slope, surface, obstructions
 - Weight
 - Ground effect

07 March 2018

Copyright © 2009–2018 My Flight Training

43

Operations

- Takeoff
 - Runway considerations
 - One-way in, one-way out airports
 - Close-in obstructions
 - May need to takeoff with tailwind
 - Runway slope
 - Slope factor rarely appears in small aircraft takeoff performance chart
 - Combinations of
 - Headwind/tailwind
 - Upslope/downslope

07 March 2018

Copyright © 2009–2018 My Flight Training

44

Operations

- Takeoff
 - Technique
 - 70% rule: 70% of takeoff speed at 50% runway distance
 - Short-field takeoff
 - Prescribed flap setting
 - Airspeed milestones
 - These are *always* weight adjusted!
 - Flap retraction schedule
 - Soft-field takeoff
 - Unpaved runway (sod, gravel, dirt) factors in takeoff performance chart
 - Remember to accelerate before climbing out of ground effect

07 March 2018

Copyright © 2009–2018 My Flight Training

45

Operations

- Climb
 - Pitch attitude at V_Y/V_X will be lower than sea level
 - V_X to clear obstacles
 - Monitor engine temperature
 - Limit duration
 - V_Y otherwise
 - Shuttle climb for obstacle clearance
 - Circle over airport
 - Climb in ridge lift (downwind side of valley)

07 March 2018

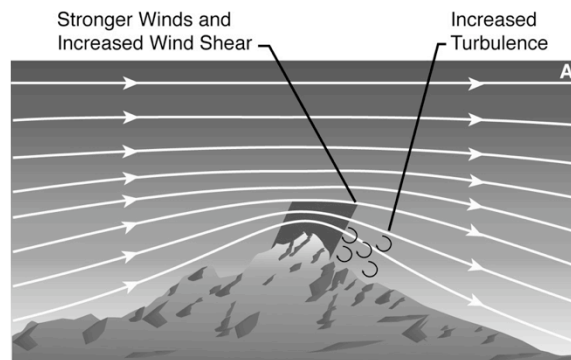
Copyright © 2009–2018 My Flight Training

46

Operations

Visualizing turbulence

- Vertical venturi effect



07 March 2018

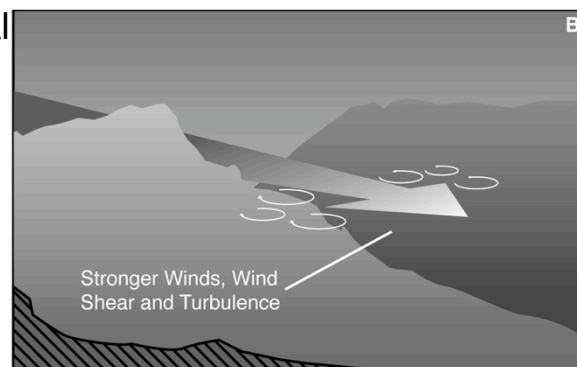
Copyright © 2009–2018 My Flight Training

47

Operations

Visualizing turbulence

- Horizontal venturi effect



07 March 2018

Copyright © 2009–2018 My Flight Training

48

Operations

- Canyon flight safety
 - Principles
 - Aircraft climb gradient rarely exceeds 5%
 - Terrain slope of as little as 10% appears shallow
 - Aircraft cannot out climb even *shallow* terrain slope!
 - Avoid flight up canyon toward higher terrain
 - Enter canyon from high terrain end
 - Maintain airspeed above V_Y to permit instant climb
 - Imeson rule: Altitude and terrain spacing such that gliding descent always allows clearance or turn away!

07 March 2018

Copyright © 2009–2018 My Flight Training

49

Operations

- Canyon flight
 - Visualize wind flow
 - Avoid middle of canyon
 - Even though it offers terrain separation
 - More turbulence
 - Opposite direction traffic
 - Restricted turnaround radius
 - Fly outer third of canyon width
 - Choose updraft (downwind) side
 - Choose sunlit side
 - Ridge lift
 - Only available within 300–1000 feet of canyon wall

07 March 2018

Copyright © 2009–2018 My Flight Training

50

Operations

- Canyon turn
 - Minimize airspeed to minimize turn radius
 - Radius of turn increases with *square* of airspeed!
 - Full power to gain or preserve altitude
 - Trade airspeed for altitude
 - Steep turn without (accelerated) stall
 - Load factor increases with bank angle
 - Stall speed increases with bank angle
 - Unloading wing (descent) relieves load factor
 - Therefore: unload wing (descend) at maximum bank

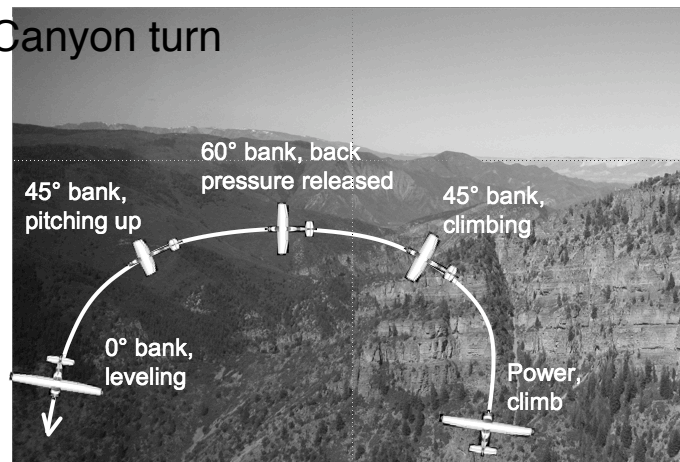
07 March 2018

Copyright © 2009–2018 My Flight Training

51

Operations

- Canyon turn



07 March 2018

Copyright © 2009–2018 My Flight Training

52

Operations

- Cross ridgelines
 - With altitude to spare
 - 2000 feet for the novice
 - 1/2 again of AGL summit elevation
 - With awareness of approaching from upwind or downwind side
 - Expect downdraft from lee side and add altitude
 - At 45° angle to reduce the time to turn away in case of downdraft

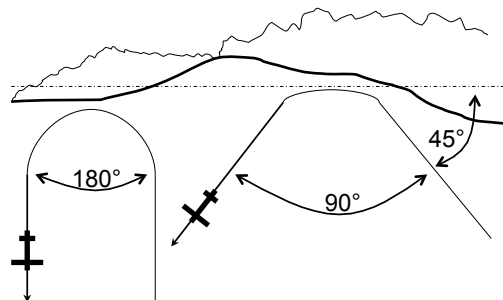
07 March 2018

Copyright © 2009–2018 My Flight Training

53

Operations

- Cross ridgelines
 - 45° approach
 - at 1/2 mile
 - Reduces angle of turn in case need to turn away for downdraft



07 March 2018

Copyright © 2009–2018 My Flight Training

54

Operations

- Updrafts and downdrafts
 - Best angle of climb to clear obstacles
 - V_X decreases in an updraft
 - V_X increases in a downdraft
 - Downdraft rule:
 - Fight instinct to pitch for V_Y
 - Accelerate to escape more quickly
 - Pitch down

07 March 2018

Copyright © 2009–2018 My Flight Training

55

Operations

- Descent
 - Danger in descent is increase in airspeed
 - Exceeding weight-adjusted V_A
 - Expect turbulence when descending below ridge level
 - Flaps not a help since they reduce limit load
 - Adding drag while avoiding idle engine
 - Idle engine results in shock-cooling, counterweight detuning
 - Speed brakes
 - Landing gear (watch V_{LOE})
 - Propeller to high rpm (but MP in green)
 - Forward slip

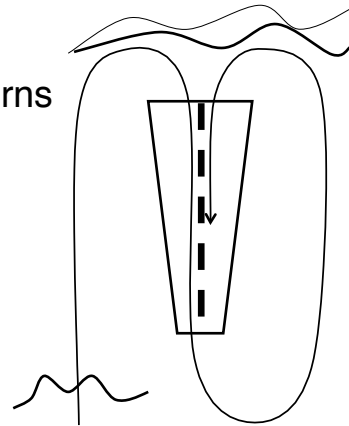
07 March 2018

Copyright © 2009–2018 My Flight Training

56

Operations

- Landing
 - Non-standard traffic patterns
 - Over fly (drag) field
 - Surface hazards
 - Obstacles
 - Wildlife



07 March 2018

Copyright © 2009–2018 My Flight Training

57

Operations

- Landing
 - Stabilized approach
 - Absence of visual glide path aid:
 - 3° glide path: $VS \text{ (fpm)} = 5 \times \text{groundspeed (knots)}$
 - 4° glide path: $VS \text{ (fpm)} = 7 \times \text{groundspeed (knots)}$
 - Weight-adjusted V_{REF}
 - “Spot” method
 - Aim point stationary in windshield
 - “Back side of drag curve” operation
 - Pitch controls airspeed
 - Power controls descent angle
 - Pitch change requires matching power change

07 March 2018

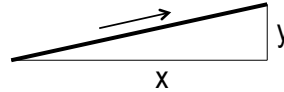
Copyright © 2009–2018 My Flight Training

58

Operations

▪ Runway slope and wind

- Gradient = y/x
- Expressed as % in Chart Supplement (CS)
- Or divide runway end elevations by length
- Landing
 - Adjust ground roll -10% per 1% uphill slope
 - Adjust ground roll +10% per 1% downhill slope



07 March 2018

Copyright © 2009–2018 My Flight Training

59

Operations

▪ Soft-field landing

- Approach at minimum airspeed ($1.3 V_{S0}$)
- Add power immediately before touchdown
- Nose high attitude at touchdown
- Maintain back stick
- Power as needed for surface conditions after touchdown
- Avoid brakes
- Maintain forward motion on ground

07 March 2018

Copyright © 2009–2018 My Flight Training

60

Operations

- Short-field landing
 - Obstacle or no-obstacle
 - Approach speed $1.3 V_{SO}$ maximum or per AFM/POH recommendation
 - Precise airspeed controlled by pitch
 - 10% excess airspeed increases landing distance by 21%
 - Powered stabilized approach
 - No “chopping” power past obstacle or in flare
 - After touchdown
 - Flaps up, *with safety*
 - Braking as appropriate to surface condition

07 March 2018

Copyright © 2009–2018 My Flight Training

61

Operations

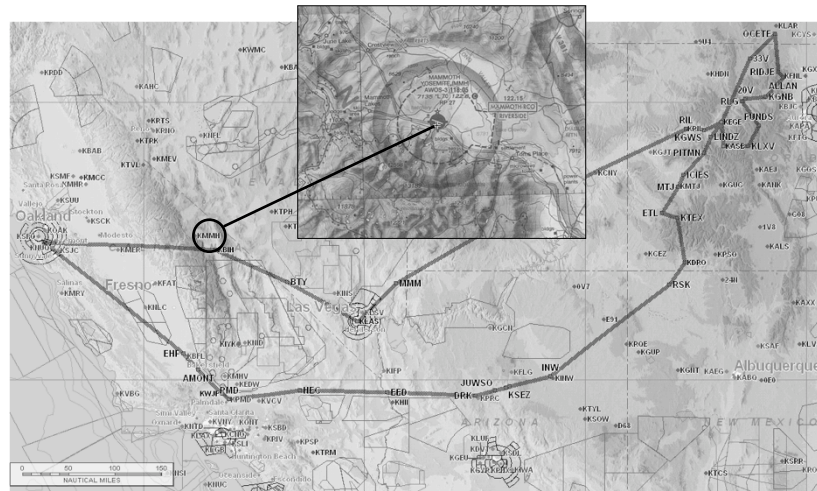
- Securing
 - Park into wind
 - Tie-downs may be deficient or absent
 - Bring securing aids with you
 - Rope
 - Know your knots
 - Screw anchors
 - Chocks

07 March 2018

Copyright © 2009–2018 My Flight Training

62

Weather



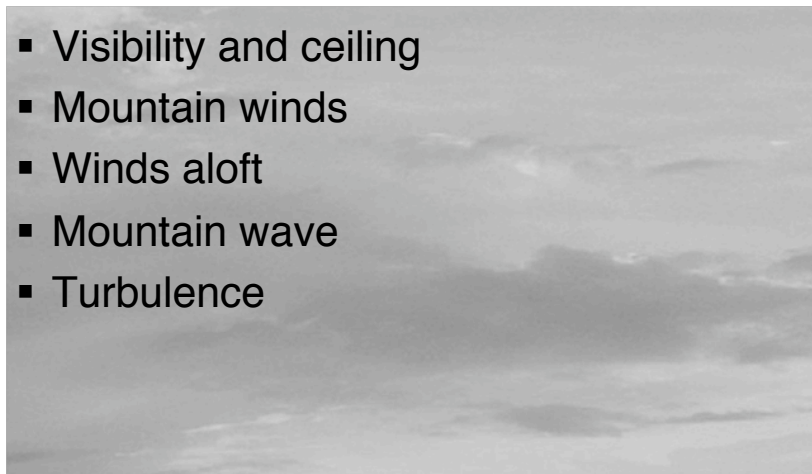
07 March 2018

Copyright © 2009–2018 My Flight Training

63

Weather

- Visibility and ceiling
- Mountain winds
- Winds aloft
- Mountain wave
- Turbulence



07 March 2018

Copyright © 2009–2018 My Flight Training

64

Weather

- Weather report scarcity
 - Mountain airports are widely separated
 - Isolated by terrain
 - Micro-climates
 - Sporadic surface observations (METARs)
 - AWOSs
 - Colorado DOT mountain pass AWOS network
 - METAR typically not generated
 - Radio outlet may be unreadable at distance

07 March 2018

Copyright © 2009–2018 My Flight Training

65

Weather

- Weather report scarcity
 - Consequences
 - Suspect altimeter settings
 - Suspect visibility and ceiling
 - Unreported local wind conditions
 - Mitigation
 - PIREPs
 - Brief them
 - Give them
 - Call FBO, county airport department, sheriff's office

07 March 2018

Copyright © 2009–2018 My Flight Training

66

Weather

- Winds aloft
 - At ridgeline level, winds
 - > 20 knots dictate caution, planning, turbulence tolerance
 - > 30 knots are probably no-go for light aircraft
 - In Sierra Nevadas,
 - FD altitudes
 - 9000 MSL
 - 12000 MSL
 - FD locations
 - FAT (SFO FA area)
 - BIH (SFO FA area)
 - RNO (SLC FA area)

07 March 2018

Copyright © 2009–2018 My Flight Training

67

Weather

- VFR ceiling
 - TAF, METAR cloud bases are reported AGL
 - Airport elevation may be thousands MSL
 - Adjust cloud bases to MSL accordingly
 - FA cloud bases are MSL unless otherwise designated
 - Even generous “VFR” ceiling may place cloud bases below the levels of surrounding peaks
 - AIRMET SIERRA for mountain obscuration issued
 - But probably not that helpful for specific valley or airport

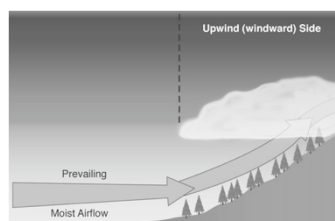
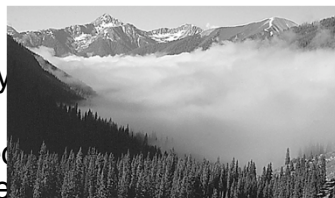
07 March 2018

Copyright © 2009–2018 My Flight Training

68

Weather

- VFR visibility
 - Minimum legal VFR visibility insufficient in mountains
 - Even 5 SM should be limited to expert knowledge of local terrain
- Fog
 - Valley fog
 - Precipitation
 - Radiation cooling
 - Upslope fog
 - Adiabatic cooling



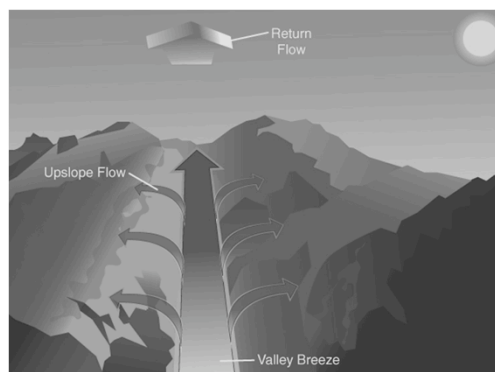
07 March 2018

Copyright © 2009–2018 My Flight Training

69

Weather

- Diurnal wind
 - Valley breeze
 - Daytime
 - Upslope
 - Mountain breeze
 - Nighttime
 - Downslope



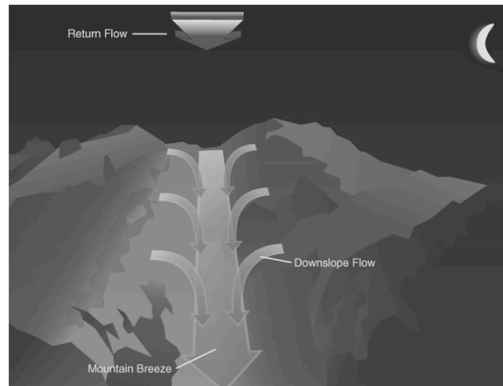
07 March 2018

Copyright © 2009–2018 My Flight Training

70

Weather

- Diurnal wind
 - May dictate takeoff/landing runway
 - With temperature may dictate time of day for 1-way airport



07 March 2018

Copyright © 2009–2018 My Flight Training

71

Weather

- Mountain wave
 - Standing wave of updraft and downdraft extending downwind from mountain chain
 - Marked by clouds in presence of sufficient moisture
 - May extend from tens to hundreds of miles downwind
 - May extend vertically to tropopause

07 March 2018

Copyright © 2009–2018 My Flight Training

72

Weather

▪ Mountain wave

• Preconditions

- Moderate to strong winds at crest elevation
- Approximately perpendicular to crest face wind direction
- Moderately stable air

• Result

- Spring-like upward deflection of air at crest followed by overshooting down flow as stable air seeks its natural altitude

07 March 2018

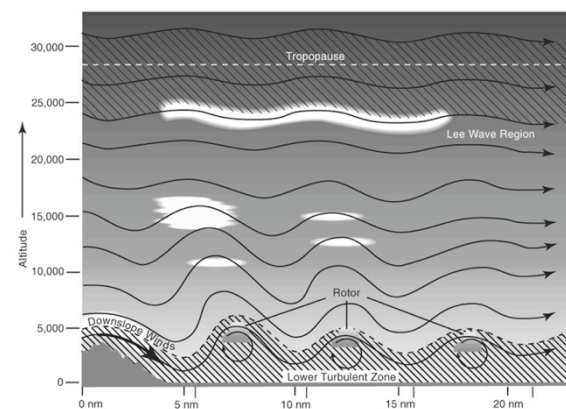
Copyright © 2009–2018 My Flight Training

73

Weather

▪ Mountain wave

- Vertical development to tropopause
- Layered lenticulars



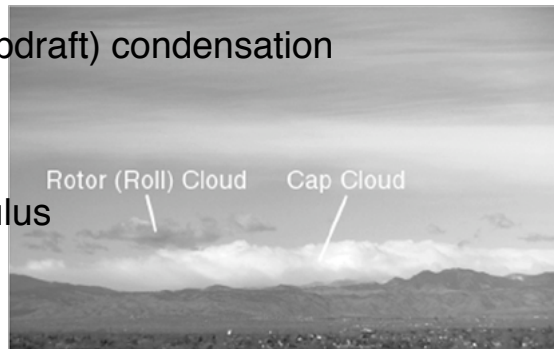
07 March 2018

Copyright © 2009–2018 My Flight Training

74

Weather

- Cap cloud
 - Upslope (updraft) condensation
- Rotor (roll) cloud
 - Stratocumulus fractus



07 March 2018

Copyright © 2009–2018 My Flight Training

75

Weather

- Lenticular cloud
 - Appear to be stationary
 - But actually forming and dissipating continuously
 - May be layered
 - Reported as ACSL



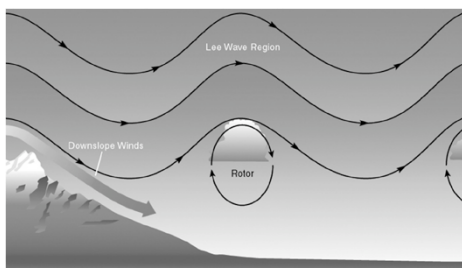
07 March 2018

Copyright © 2009–2018 My Flight Training

76

Weather

- Rotor clouds
 - Rotary motion may be visible as different cloud velocity top and bottom
 - Torn or ragged appearance (fractus)
 - Severe or greater turbulence
- Avoid
 - Detour around
 - Well above
 - Never below



07 March 2018

Copyright © 2009–2018 My Flight Training

77

Weather

- Turbulence
 - PIREP
 - Reporting criteria
 - Intensity
 - Duration
 - Aircraft type

TURBULENCE REPORTING CRITERIA TABLE		
Intensity	Aircraft Reaction	Reaction Inside Aircraft
Light ^	Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, yaw). Report as light turbulence or light CAT. or Turbulence that causes slight, rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as light CHOP.	Occupants may feel a slight strain against belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.
Moderate ^	Turbulence that causes changes in altitude and/or attitude occurs but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Report as moderate turbulence or moderate CAT. or Turbulence that is similar to light CHOP but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as moderate CHOP.	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.
Severe ^	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control. Report as severe turbulence or severe CAT.	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking are impossible.
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as extreme turbulence or extreme CAT.	

07 March 2018

Copyright © 2009–2018 My Flight Training

78

Summary

- This presentation gave only briefest overview of many topics.
- Some topics were omitted.
- Get a mountain checkout.
- Participate in a multi-day mountain trip.
- It's not all serious...
 - Have fun flying in the mountains!

07 March 2018

Copyright © 2009–2018 My Flight Training

79

Resources

- **Web**
 - <http://www.aopa.org/members/files/pilot/1996/survive9604.html>
 - <http://touchngo.com/lglcntr/akstats/Statutes/Title02/Chapter35/Section110.htm>
 - http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/PART6/602.htm#602_61
 - http://www.fepco.com/Bush_Flying.html
 - <http://www.dot.state.ak.us/stwdav/akfly.shtml>
- **Print**
 - Imeson, S. *Mountain Flying*. Airguide Publications, 1987.
 - Imeson, S. *Mountain Flying Bible (Revised)*. Aurora Publications, 2005.
 - Potts, F.E. *Guide to Bush Flying*. ACS Publishing, 1993.
- **Colorado Department of Transportation**
 - Colorado Division of Aeronautics. *Colorado Airport Directory*, revised yearly.
 - http://www.coloradodot.info/programs/aeronautics/co_awos
- **Acknowledgment**
 - Photographs from June 2008 WVFC Colorado Trip by Christine Kelly

07 March 2018

Copyright © 2009–2018 My Flight Training

80