Soaring Training Program

- Meteorology
- Air Reading
- Model Set-up Process
- Competition Strategy
- Landing pattern
- Training Process

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Blah

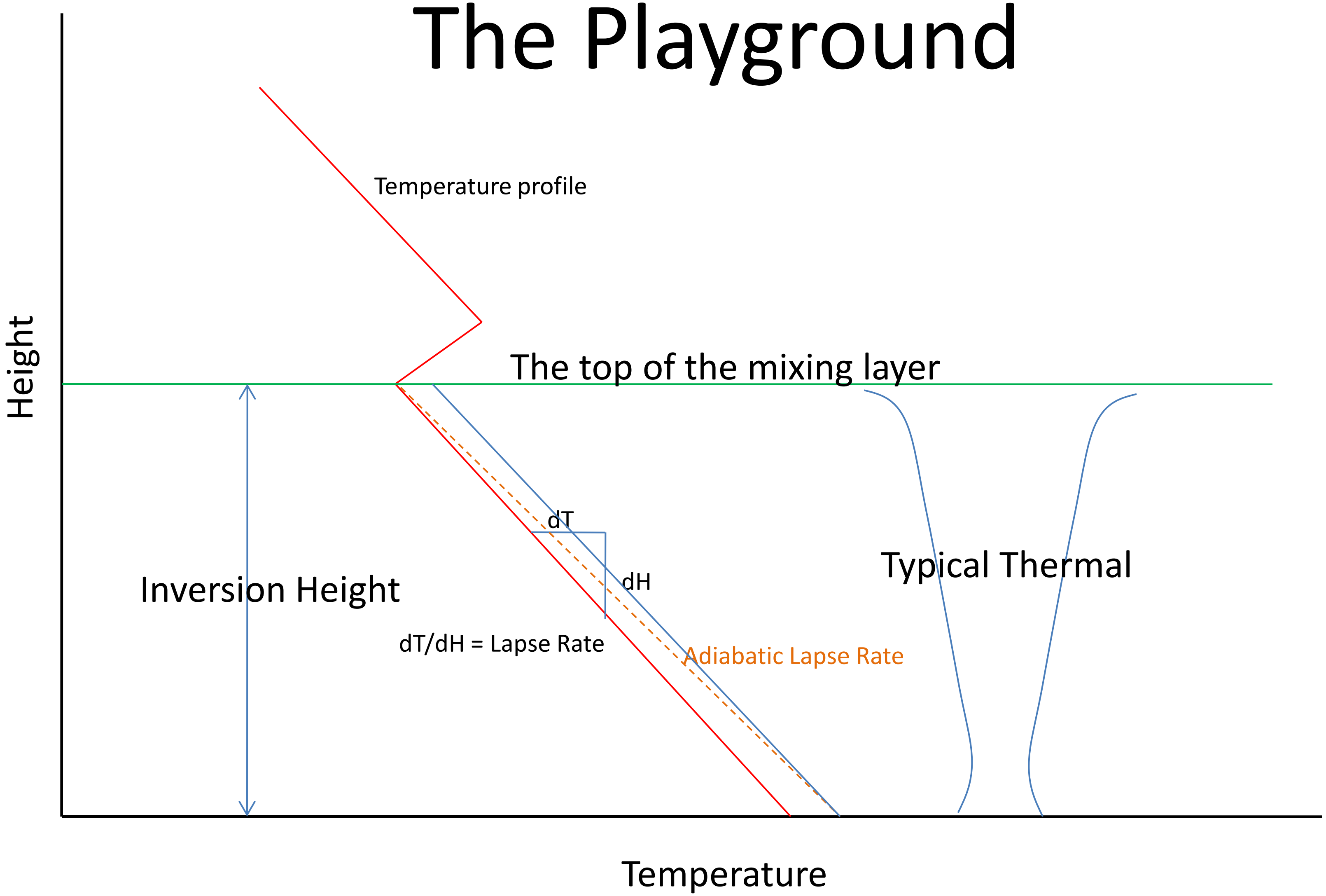
- Blah, blah, blah…
- More blah, blah, blah…

METEOROLOGY

Meteorology Overview

- Solar radiation, our source of energy
- What is an inversion
- Understanding the mixing layer
- A typical day cycle
- Local influences
- Inland vs coastal conditions
- What is a lapse rate
- Influence of wind
- Typical condition types

The Playground

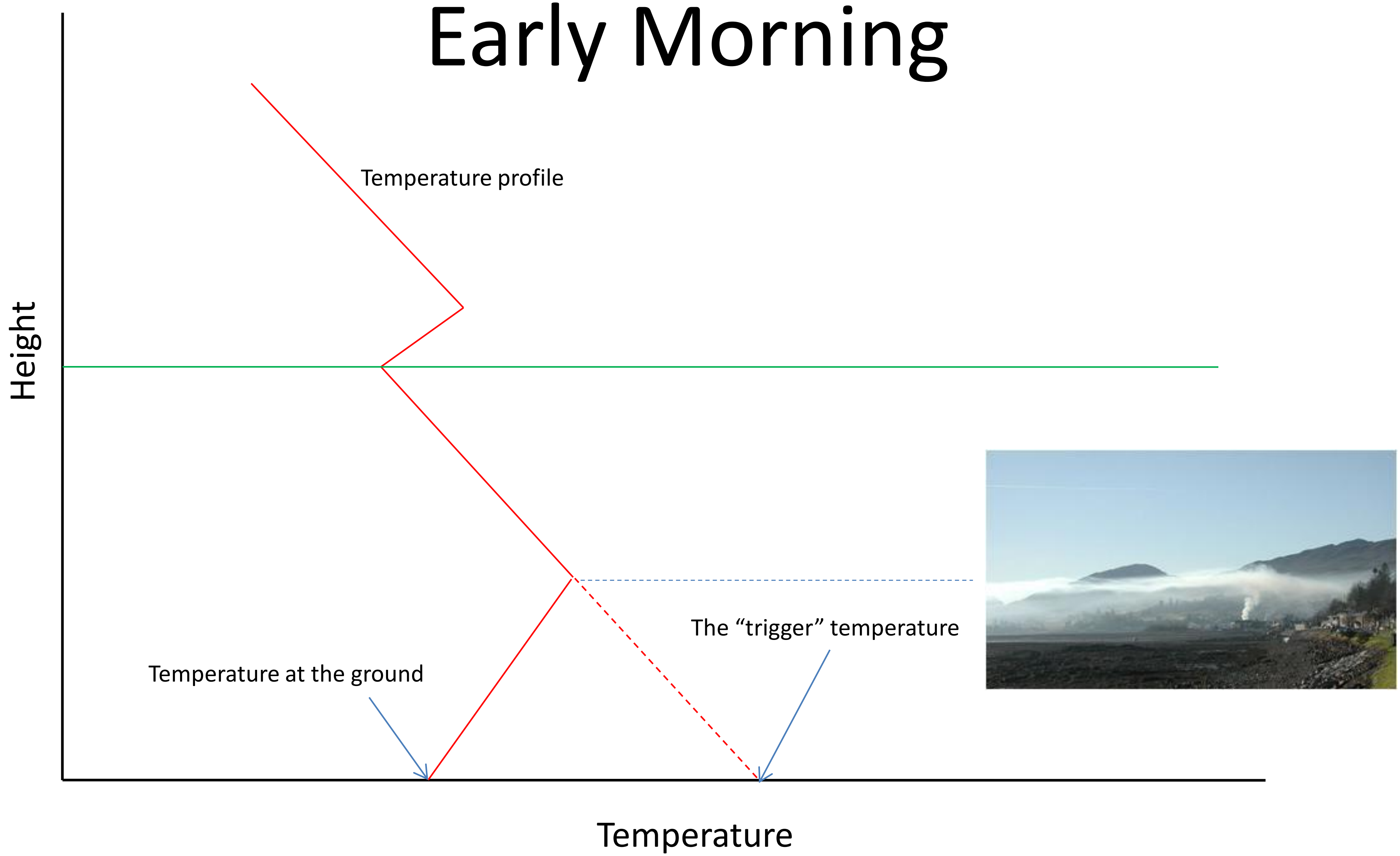


The Lapse Rate defines the potential for thermals. If the lapse rate is near the adiabatic lapse rate then the thermals can be strong. If the lapse rate is lower then thermals are weaker and fewer (farther apart)

Typical Daily Cycle

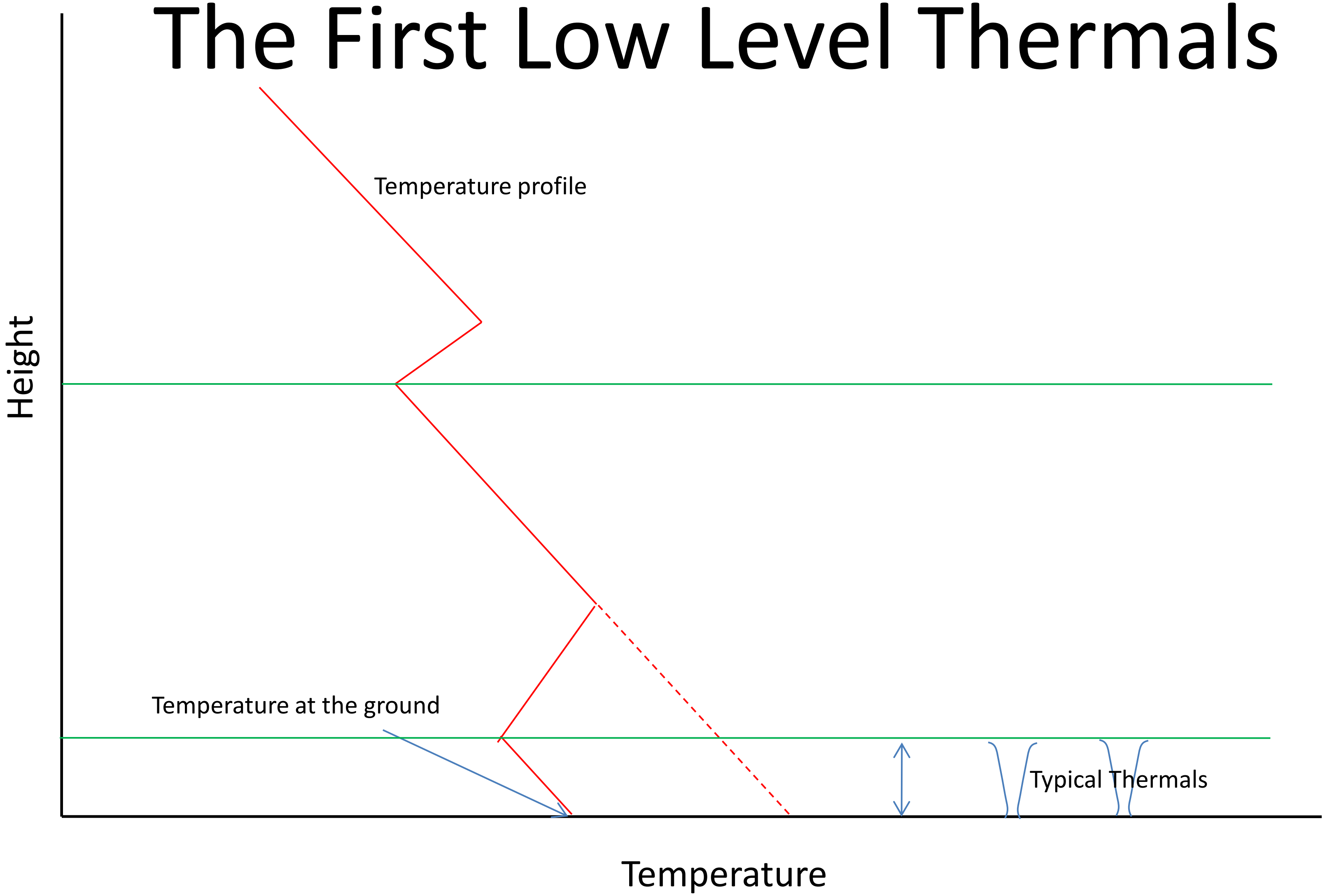
- Early Morning
- The First Thermal
- Late morning mixing
- Mid-day activity
- Late Afternoon

Early Morning



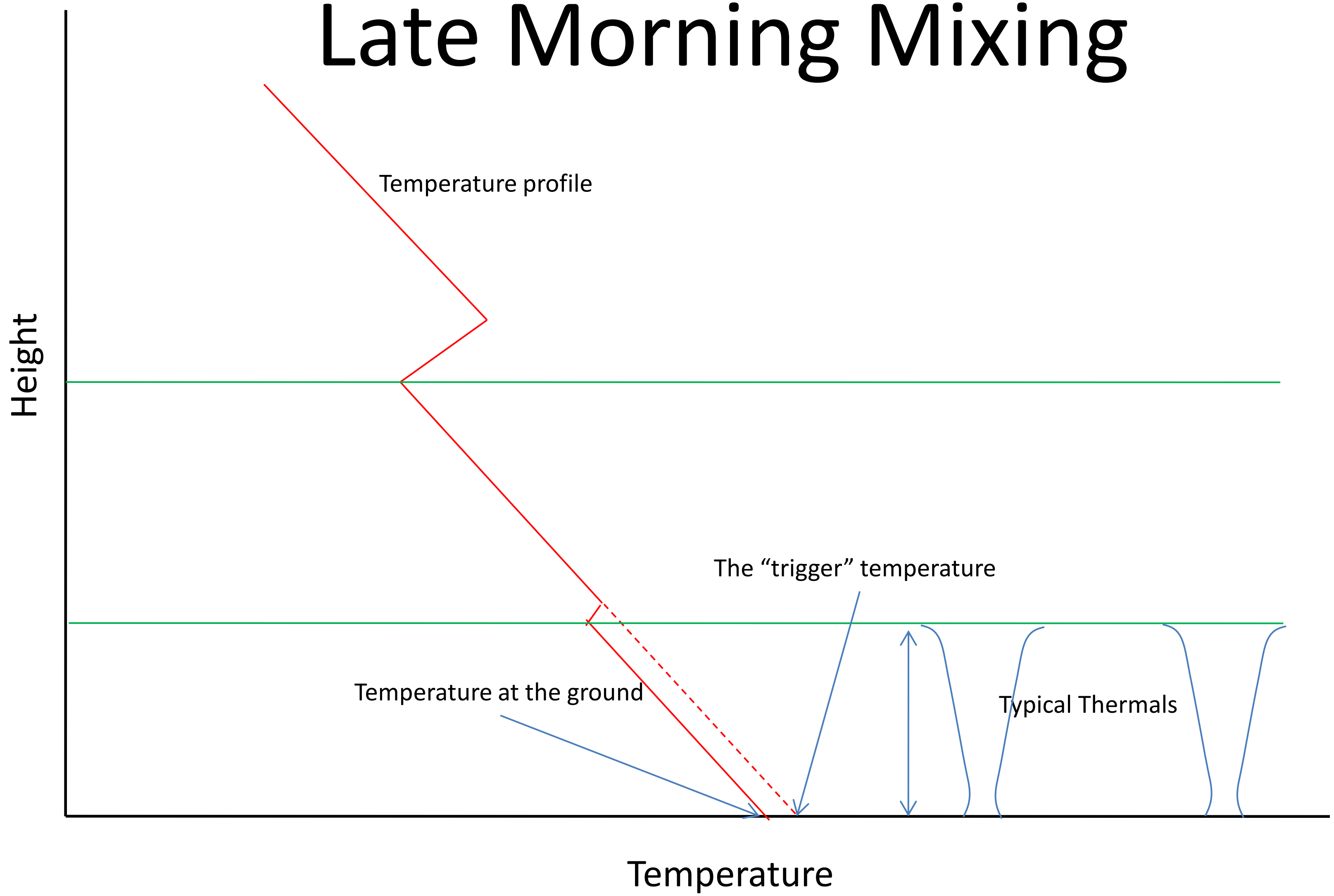
The positive lapse rate near the ground early in the morning results in flat and stable air (no thermals!)

The First Low Level Thermals



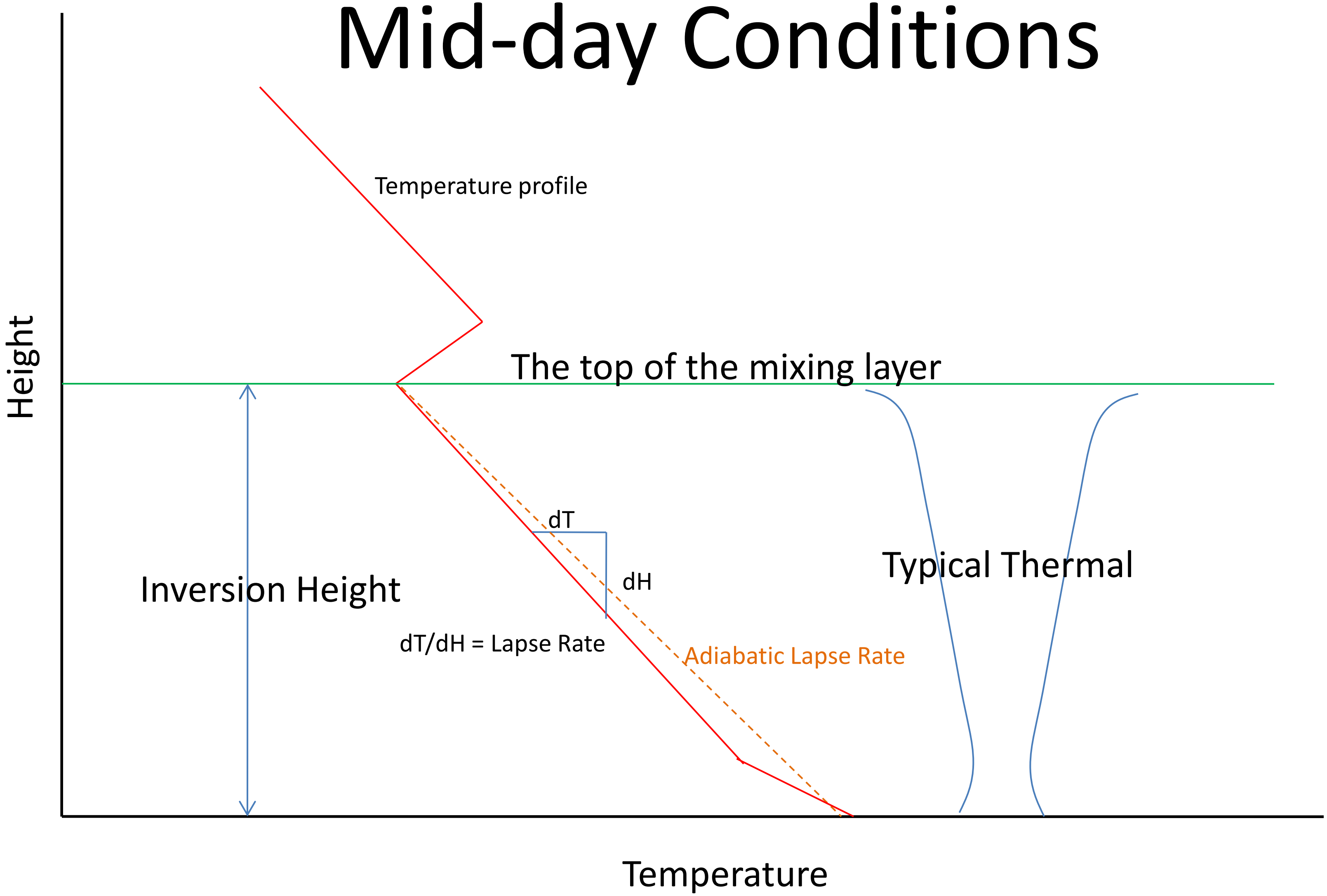
The low level inversion caps the thermal height.
The thermal spacing and size is associated with the inversion height.
Thermals are small, short lived, and numerous.

Late Morning Mixing



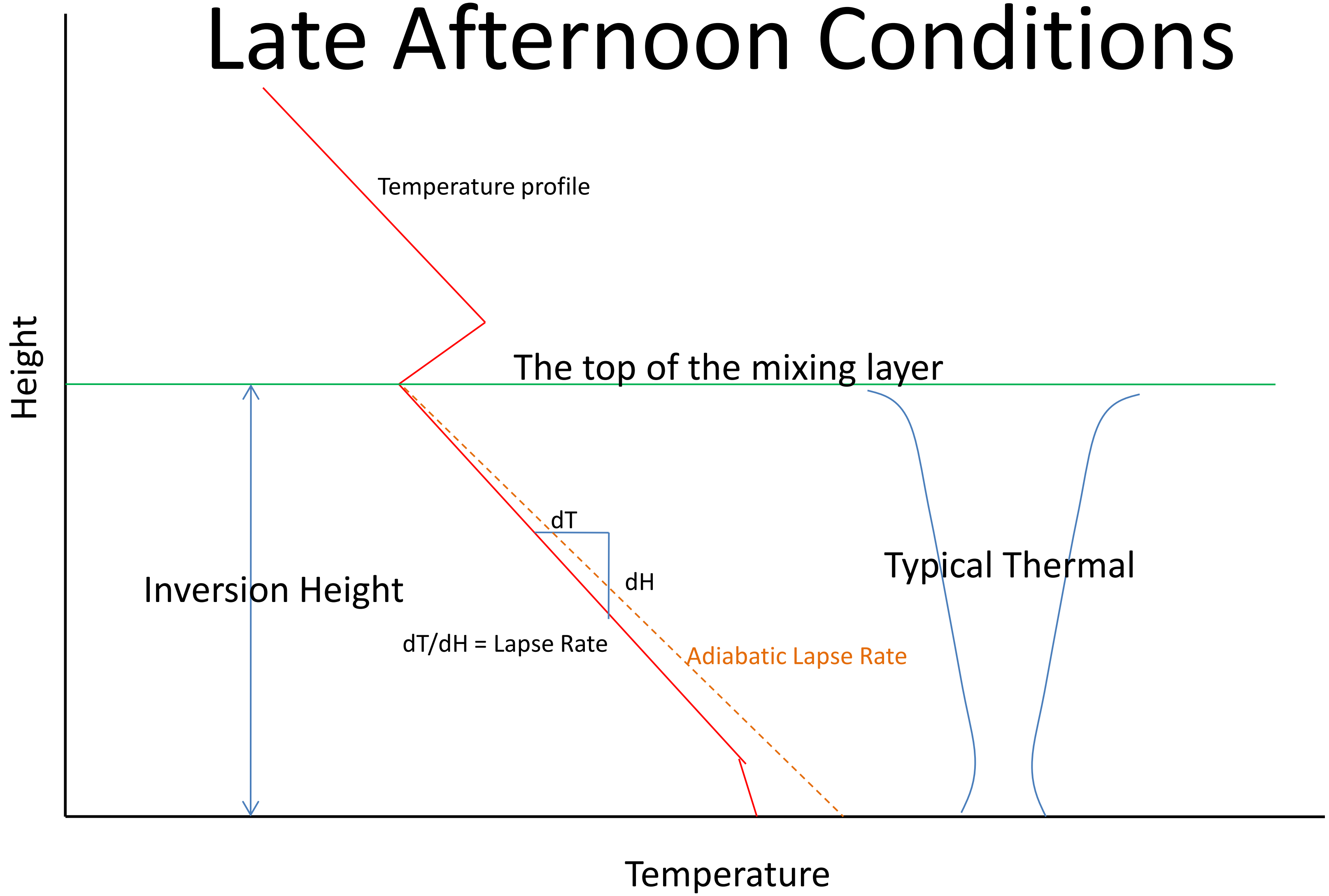
The low level inversion caps the thermal height.
The thermal spacing and size is associated with the inversion height.
When the air temperature at the ground reaches the trigger temperature, the conditions can change dramatically.

Mid-day Conditions



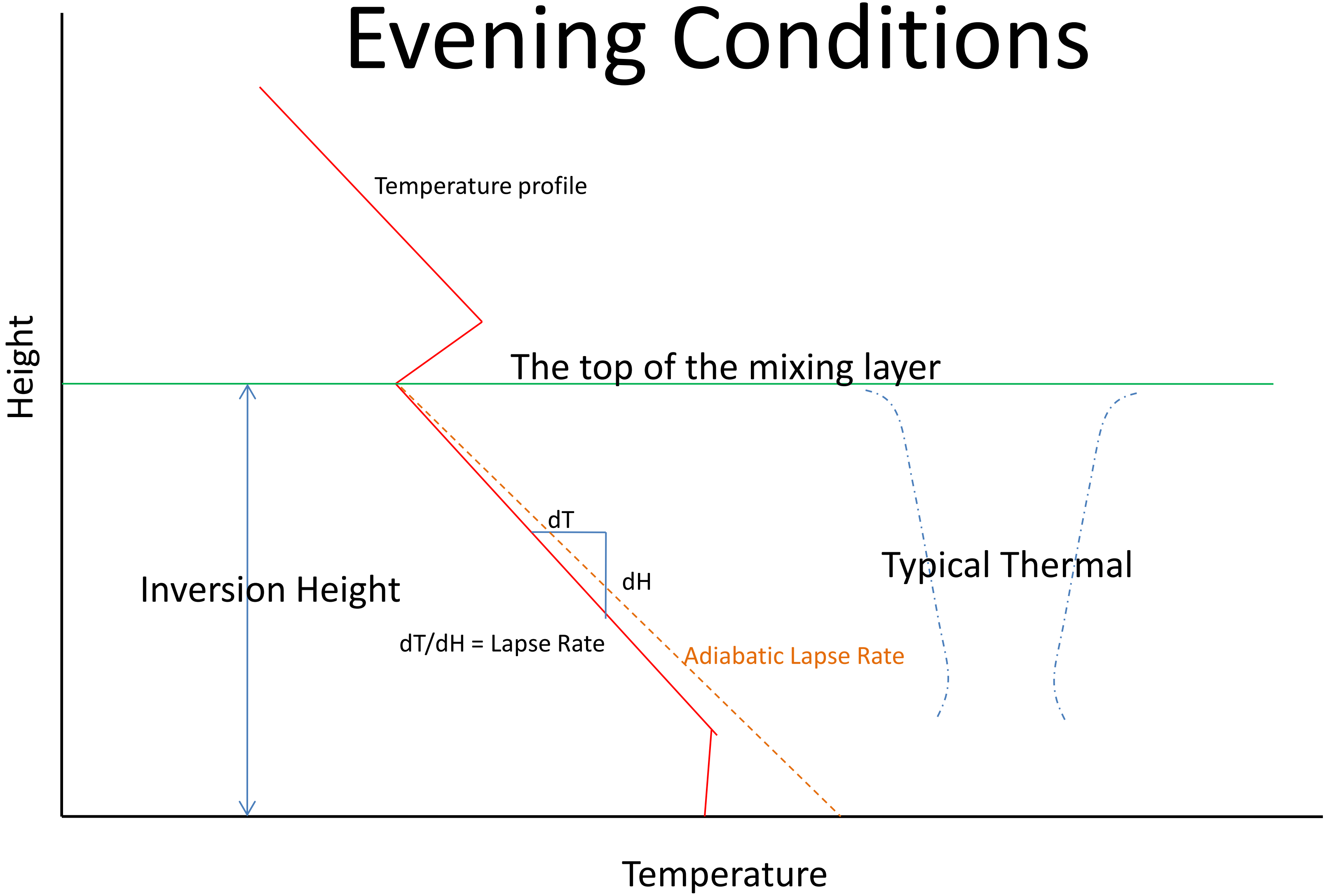
Thermals are big and spaced far apart (dependent on the inversion height).
Low level thermals merge to make the big thermals that go to the top of the inversion
The unstable lapse rate near the ground results in very active and changeable conditions

Late Afternoon Conditions



The air is starting to cool down near the ground.
Weaker thermals near the ground. Still big thermals at altitude, but not as strong. The thermals are smooth and long lived.

Evening Conditions



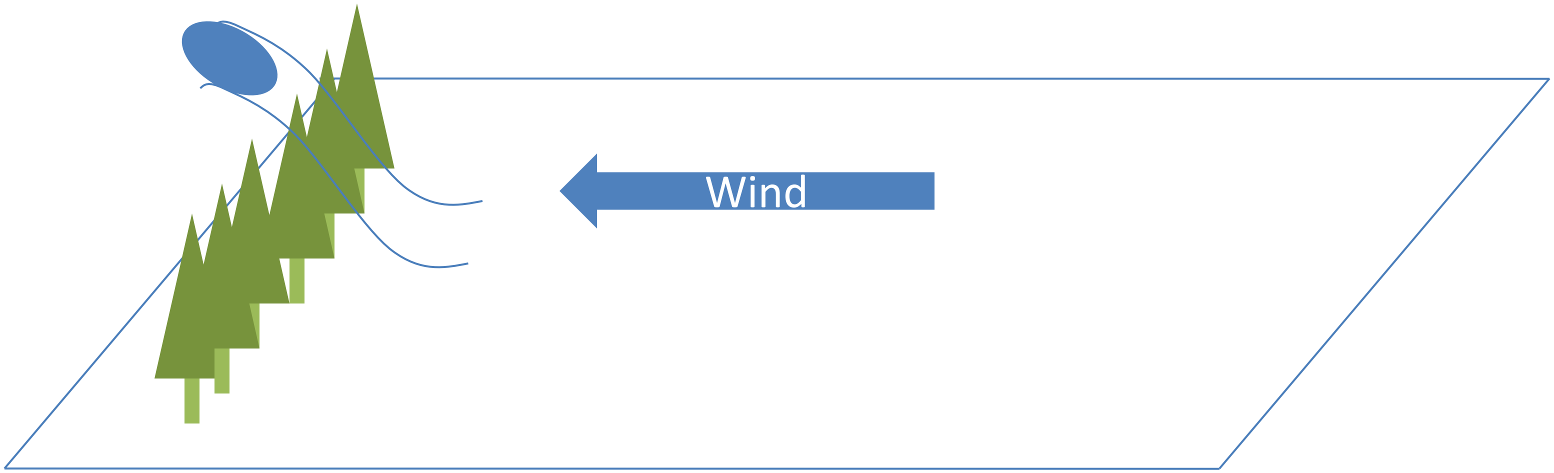
Almost no thermals near the ground. Weak air can still be found at altitude sometimes.

Geographical Influences

- Obstructions (hills, buildings, tree lines) help thermal formation
- The terrain type defines the amount of air heating
  - green crops = little air heating
  - Plowed fields, buildings, tarmac are good thermal generators
- Forests heat slowly and retain heat in the evening
  - Mornings – mostly sink
  - Evenings – thermals over the trees
- Anabatic and Catabatic air movement
  - Mountains heat up first in the morning and cool down quickest in the evening
- Bodies of water tend to minimize thermals nearby

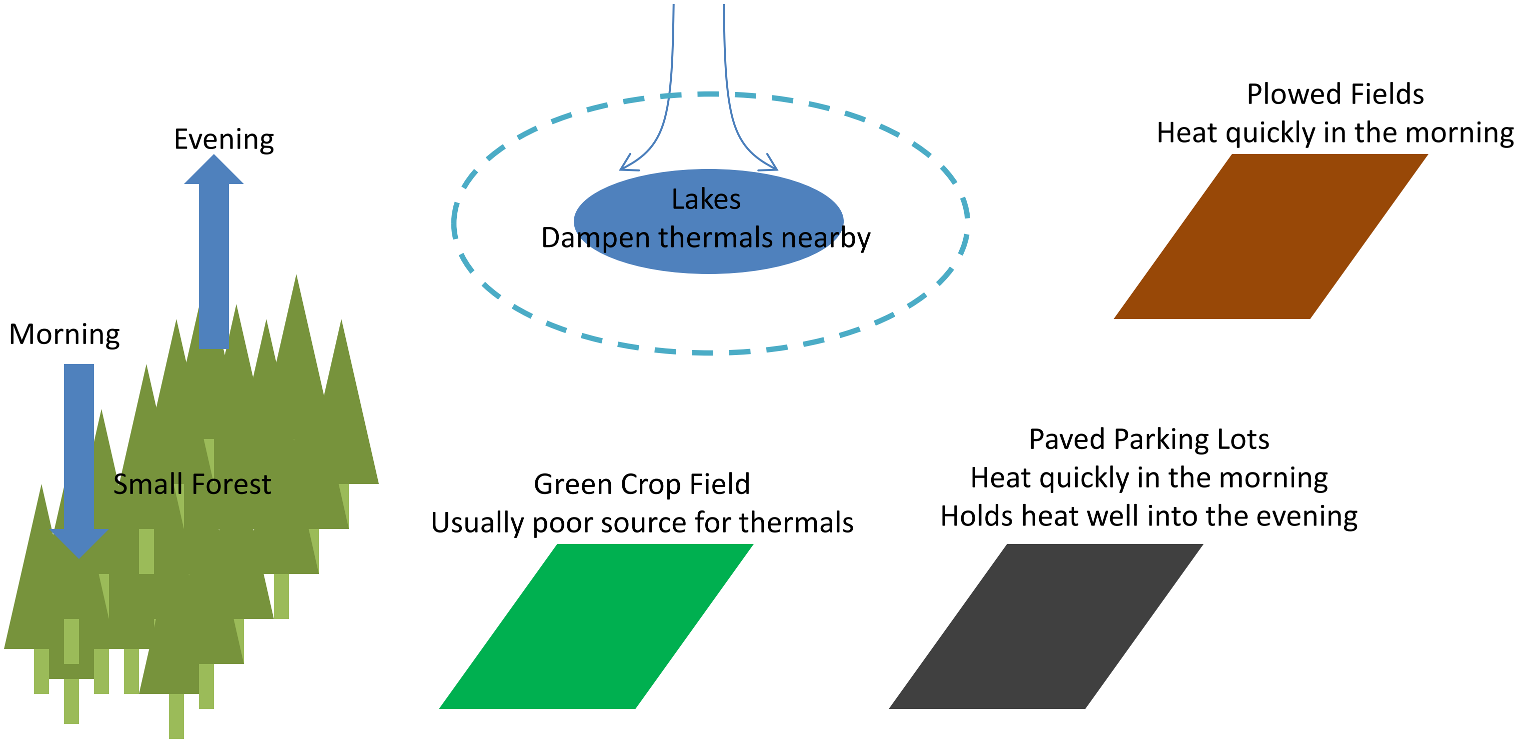
The Effect of Obstructions

Typical obstruction (tree line in this instance)



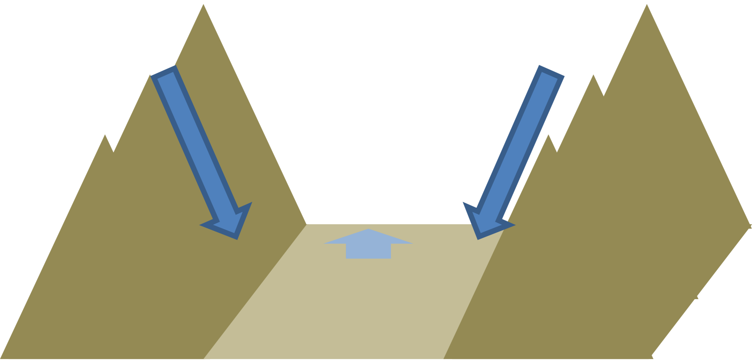
Obstructions can kick-start a thermal if the air near the ground is already warm.
Searching downwind of buildings/hills/treelines has a higher probability for thermal contact than over flat terrain

Terrain Type Effects

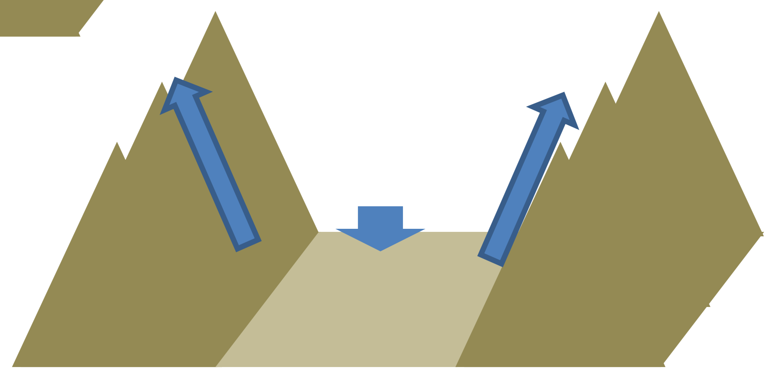


Understanding how various terrain heat up and cool down during the day can provide clues to thermal locations

Anabatic and Catabatic flow

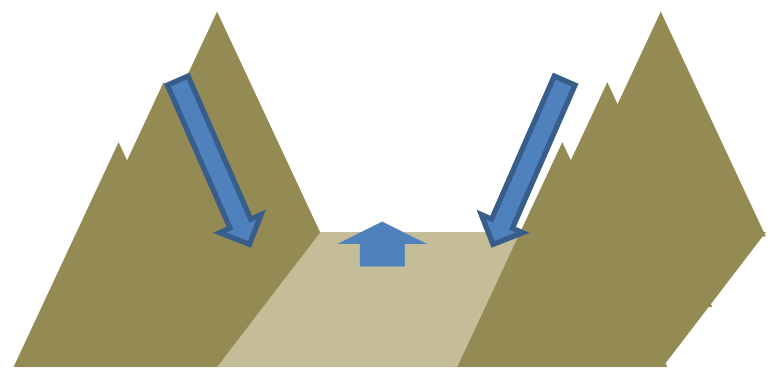


Early morning catabatic flow



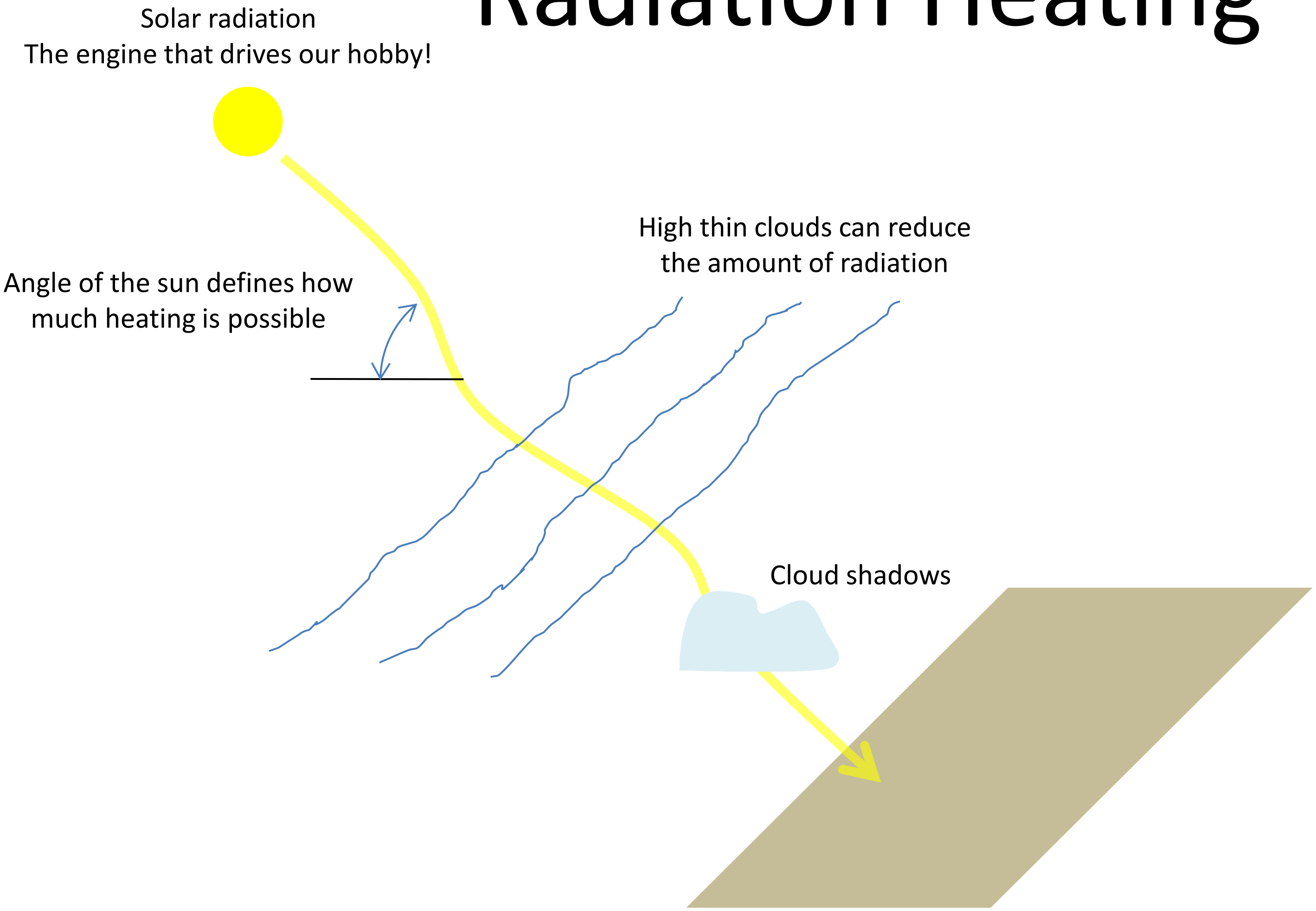
Mid day anabatic flow

Cool air flows down mountains in the evening and night time (catabatic flow). The cool air pools in the valley producing a low level inversion. The cool air goes to the valley floor, providing a gentle lift the the air higher in the valley.
Mountains heat quickly in the day and warm air flows up the mountains (anabatic flow). The cool air in the valley gets drawn to the mountains. Mid day, the valley thermals are difficult to work due to the stable lapse rate in the valley (but low level can have "interesting" air)



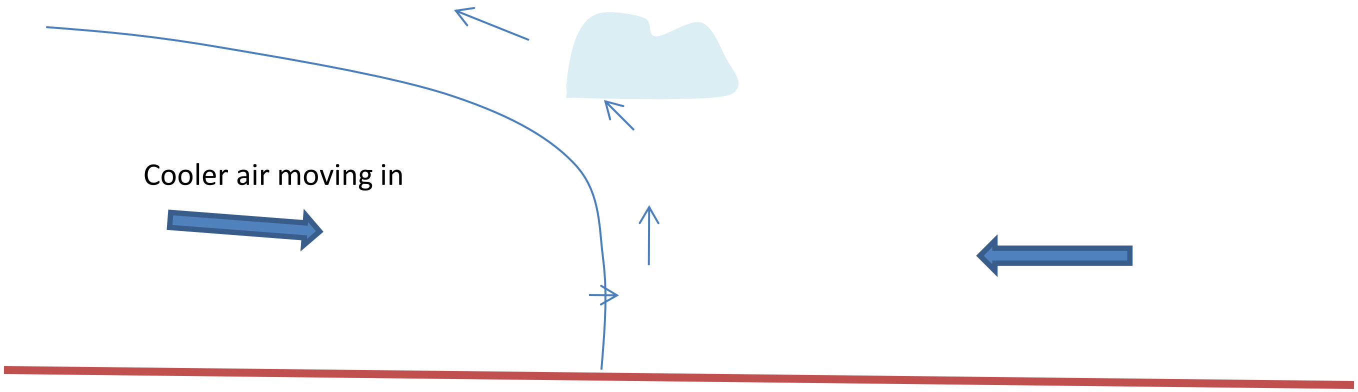
Evening catabatic flow

Radiation Heating



The amount of solar radiation reaching the ground has a very strong influence!
Understanding the power from the engine helps to understand what the thermal conditions will be
The thermal strength expected is a function of the energy reaching the ground, how the ground absorbs that heat, and the atmospheric conditions.

Wind Changes (shear line)



A shear line passing by results in a period of very strong thermals with a well defined wind change.
For a period after the shear line passage, the air will be stable with mostly sink.
Can be caused by a marine layer moving inland, or a different air mass moving into the region.

AIR READING AND THERMALS

Air Reading Overview

- Review of the basics
- What to look for
- Ground signs vs aircraft interaction
- Understanding the local geography
- Wind effects on thermal formation
- Local influences
- Micro vs macro thermals
- The inversion height helps to define the thermal size and spacing

Thermal Theory - Basics

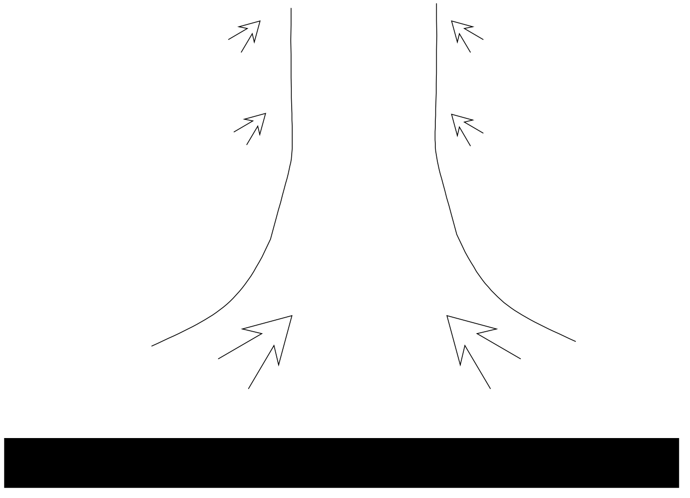
- Basic definition: lighter than the surrounding air
- Thermal shapes
  - Column
  - Bubble (the boiling water pot!)
  - Disorganized blob
  - Streets
- See link below for discussion
  - http://www.rcsoaring.com/docs/thermals_2006.pdf

Thermal Theory - Climate Influences

- Humidity
- Ground moisture
- Lapse rate
- Inversion height
- Cloudiness

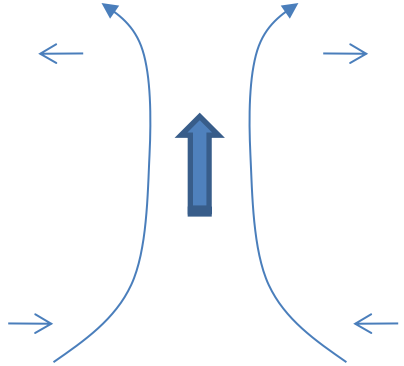
Thermal Theory - Characteristics

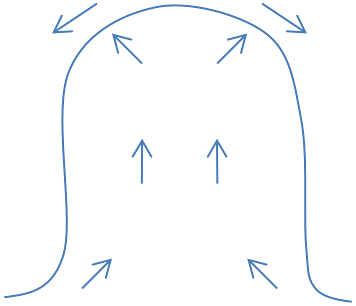
- Feeds from warm air near the ground
- Drifts with the wind
- Attraction to other thermals
- Thermal aspect ratio



Near the Top vs Base of a Thermal

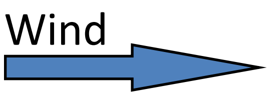
- Near the base, the air is being pulled towards the thermal
- Near the top, the air is pushed away from the thermal
- A new thermal is difficult to stay centered, as the top is low

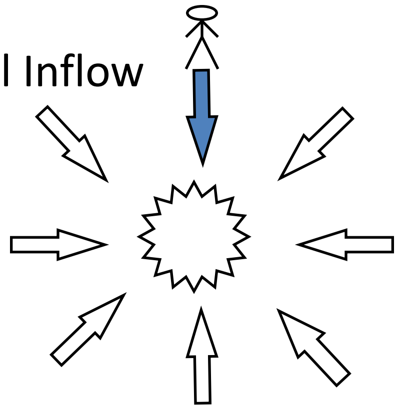


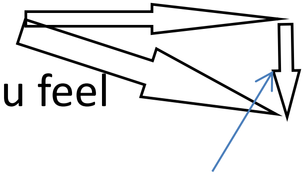


Application - Clues to Finding Thermals

- Detecting thermal inflow
  - Inflow signs
  - Wind lulls, changes
  - Wind shifts
    - Do not confuse with thermal inflow
- Ground signs
  - Look to figure out the “third vector”
- Airplane signs
  - The plane can tell you far more than just whether it is climbing or sinking





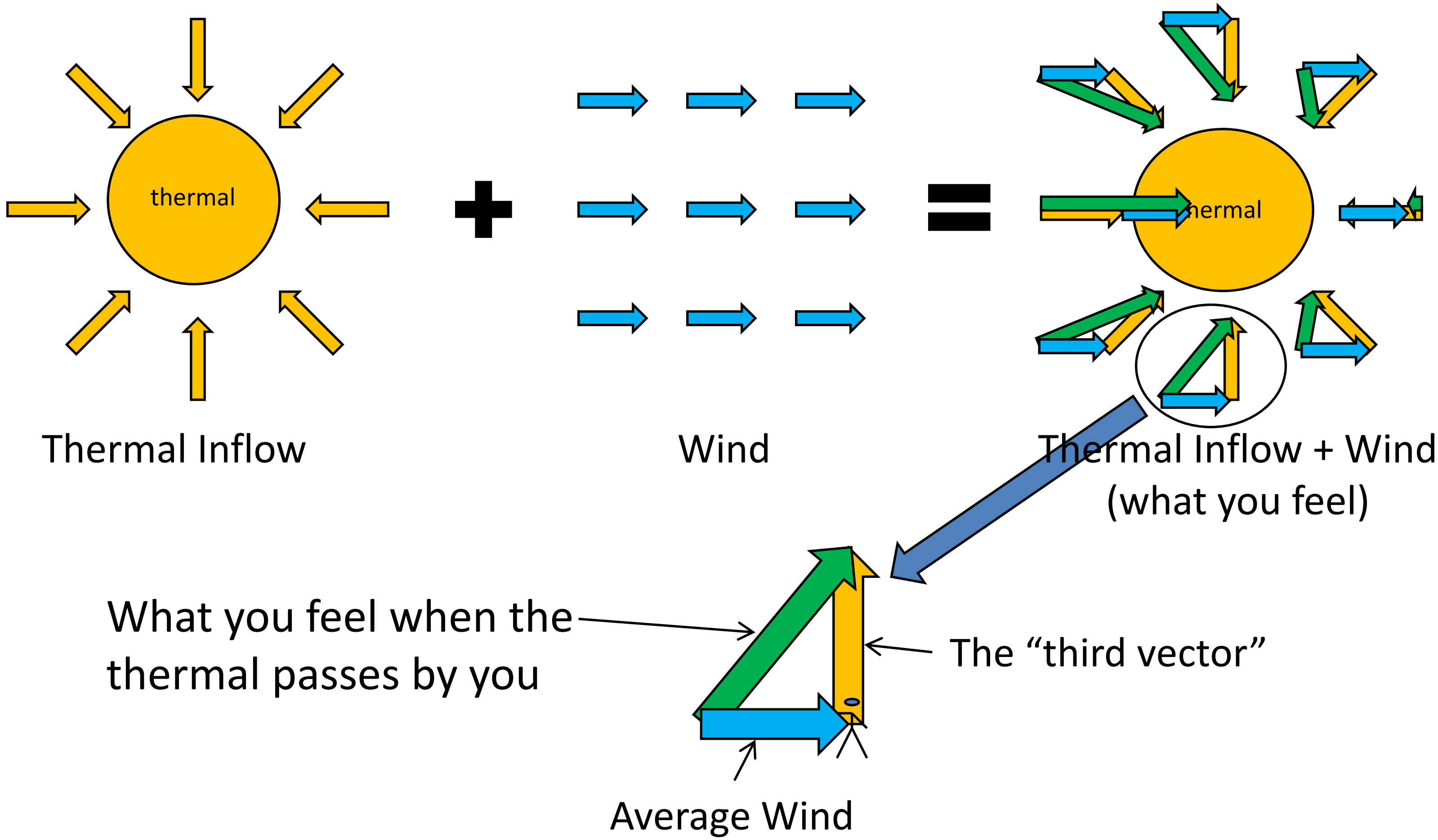


Thermal Signal Prioritization

1. Airplanes, birds, or debris climbing
2. Airplane relative wind change
3. Ground wind signs
4. Terrain type
5. Ground obstruction (at lower height, the priority may increase)

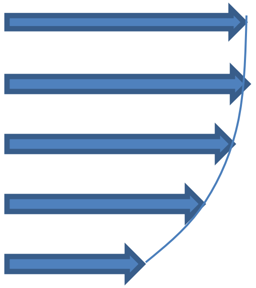
If you see something going up, it is a rather high confidence indication of lift!
Frequently, you get multiple types of thermal indication signals, which increases the thermal read confidence.

Application - The Third Vector



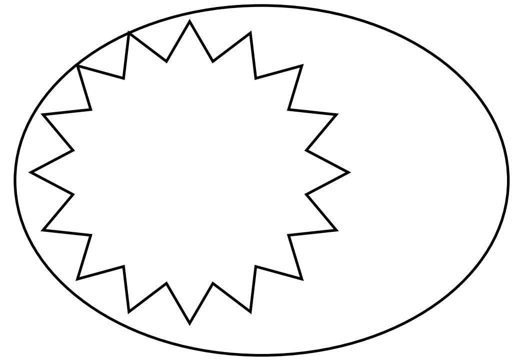
The Influence of Wind

- Strong wind mixes the air and reduces the chance for air near the ground to warm up
  - Weak thermals that break up more easily
- The change in wind strength with altitude changes the character of the thermal shape
  - The upper thermal gets sheared off
  - Lift (and sink) tend to organize into corridors if the terrain is flat

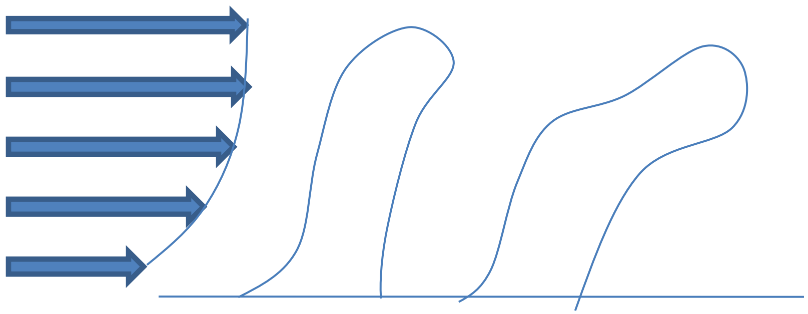


Application - Practical Guidelines

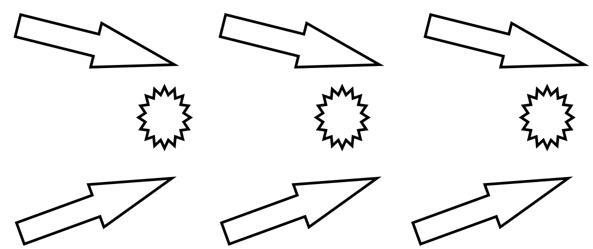
- Sharply defined upwind edge
- Diffuse downwind edge
- Convergence zones



Typical wind profile

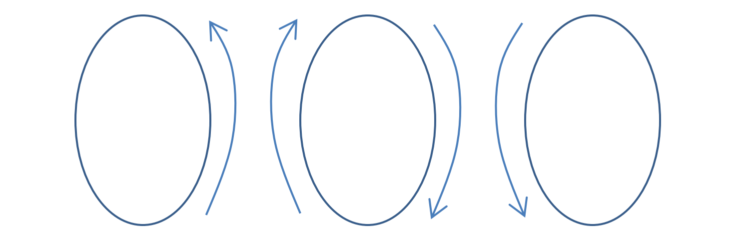


Side View



Top View

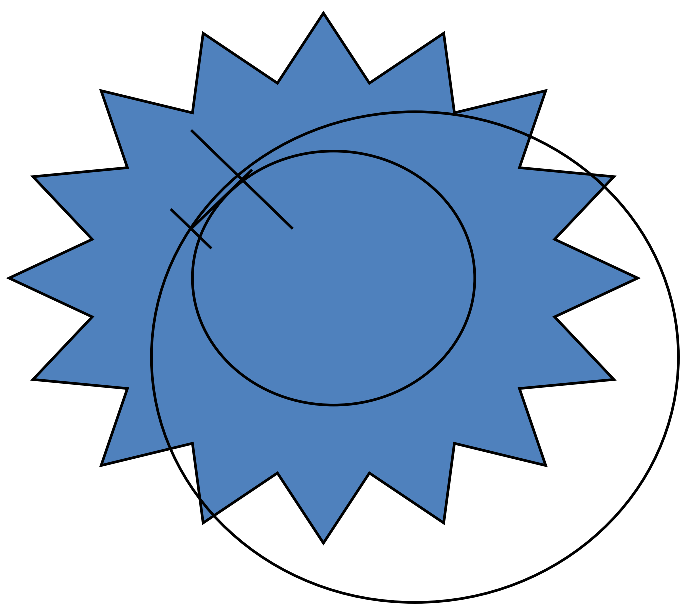
Thermals are influenced by the changes in wind with altitude. The thermal top gets pushed downwind compared the the base of the thermal. Over time, this can organize the thermals into corridors aligned with the wind.

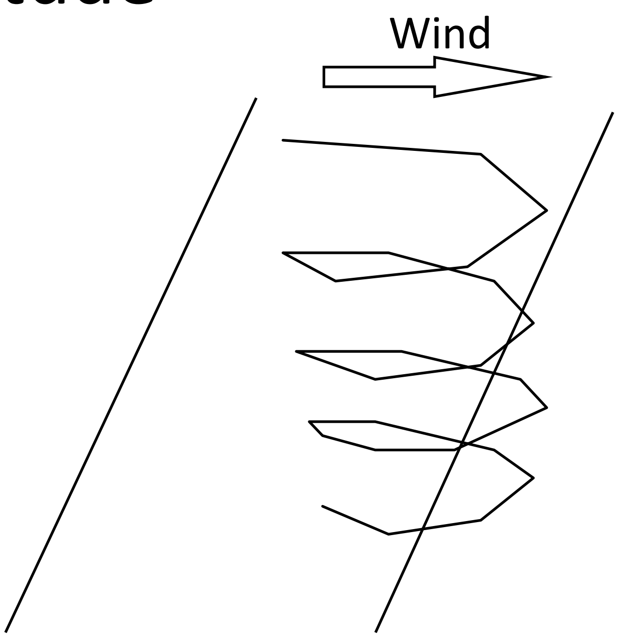


Front View

Application -
Hints on Recentering

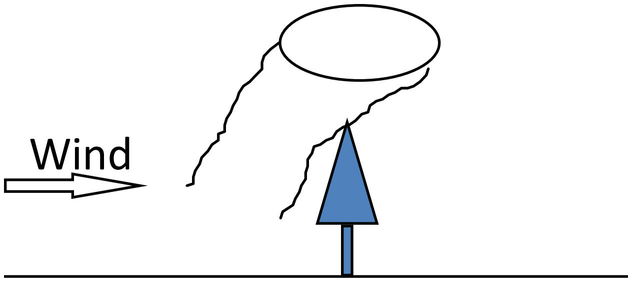
- Turn tighter in the stronger lift
- Constantly reevaluate on each circle
- Be wary of subconscious upwind drift
- Effects of wind shear with altitude





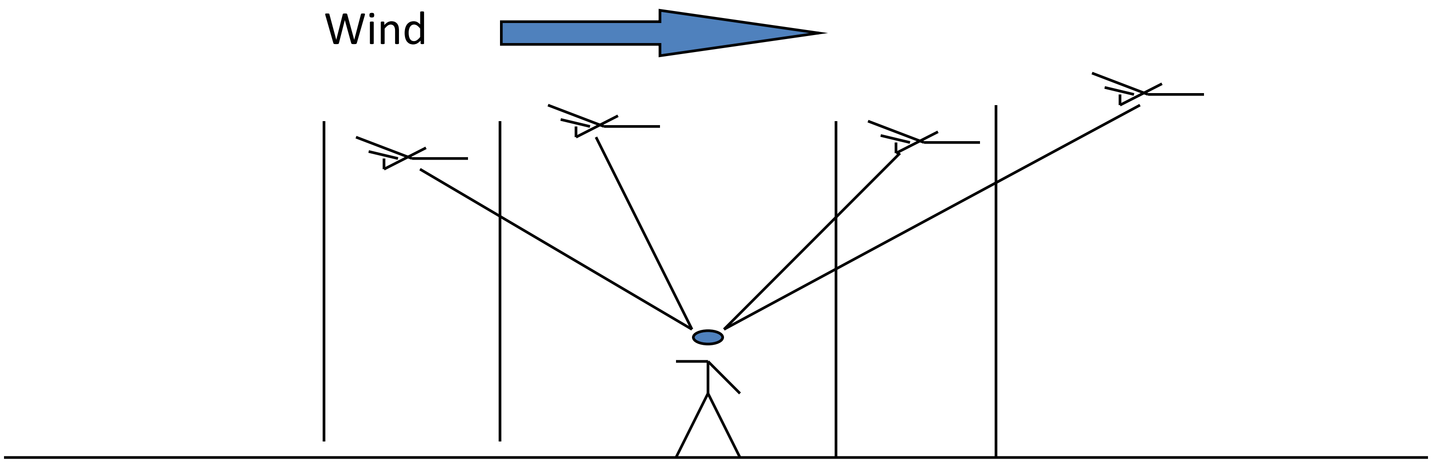
Thermal Sources

- Heating sources
  - Drier ground
  - Radiation sources
- Terrain influences
  - Tree lines
  - Hills



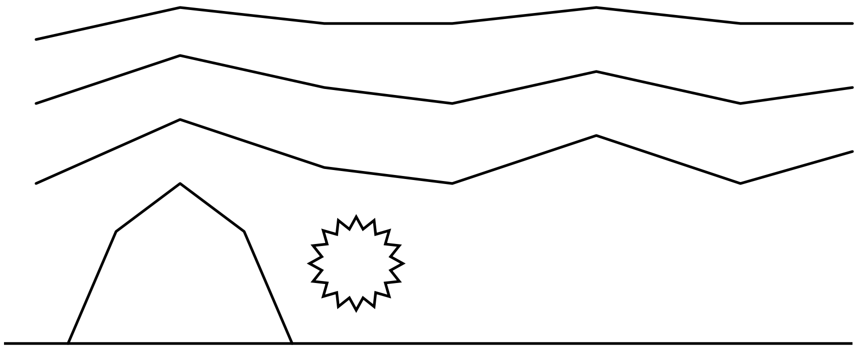
Application - Perspective Challenges

- Confusion between range and altitude
- Elevation angle confusion



Non-Thermal Lift

- Wave
  - Conditions necessary
  - When likely
- Shear line
- Hydraulic wave
- Dynamic soaring



AIRPLANE SETUP

Airplane Set-up Overview

- Philosophy for the pre-sets and mixes used
- Flight Modes used
- Mix and pre-set details

Airplane Program Philosophy

- Ease of Control
  - Use the capability of the radio programming to reduce pilot workload
- Optimum Performance
  - Use appropriate flight modes to get the most performance out of the plane
- Separate flight modes for the various phases of flight
  - Launch
  - Landing
  - Cruise
  - Thermal
- Amount of throw for Aileron/Elevator/Rudder is defined by personal preference

Basic Mixes

- Flap (crow) to Elevator
  - Eliminate pitch change with flap input
- Aileron to Flap
  - Optimizes roll efficiency
  - Best around 1/3 of aileron movement on flap
  - Minimum differential on the flap to not have any pitch response (flap deflection puts downwash on elevator)
- Elevator to Camber
  - Maximize lift with respect to drag with any elevator input
- Aileron to Rudder
  - Lowest drag method for minimizing adverse yaw (challenging to provide the correct amount!)

Flight Modes

- Launch
- Cruise
  - Fast cruise (upwind or in sink)
  - Efficient cruise (best L/D)
- Thermal
  - Active (turbulent) conditions
  - Mild conditions
  - Minimum sink
- Landing

The "in-flight" flight modes (cruise/thermal) are used for to optimize the drag and handling for the various flight speeds.

Flight Modes (Launch)

- Motor power should have at least 2 power settings available, low and maximum.
  - I use 3 power settings, high, medium, and low
  - Medium power should be set to get to 200m at around 30 seconds
  - Low power should be set to have just enough power to have the prop turning without generating much thrust
  - High power should be enough to go several hundred meters upwind with full ballast and reach 200m in 30 seconds

Low power is used to investigate thermals while under power
Best to use the full 30 seconds with power, even if only low power to reduce risk

Flight Modes (Cruise)

- Fast Cruise
  - Slight reflex on trailing edge typically
  - Low aileron differential
  - Low Aileron>Rudder mix amount
- Slow Cruise
  - Neutral trailing edge
  - "A bit more" differential and Ail>Rud mix

Fast cruise for flying through sink, or for penetrating upwind
Slow cruise for flying at maximum glide ratio (L/D)

Flight Modes (Thermal)

- Comments for all thermal modes
  - Aileron differential unchanged
  - Elevator preset to meet target airspeed (cg and airframe dependent)
- Active Thermal (thermal 1)
  - +1 to +2 degrees camber preset
    - Minimum camber is used to provide margin for control movement
  - Moderate Aileron to Rudder mix
- Mild Thermal (thermal 2)
  - Around +3 degrees camber
    - Reduced margin on the trailing edge for control movement
  - "A bit more" aileron to rudder mix
- Minimum Sink (thermal 3)
  - Around +4 to +5 degrees camber
    - No margin for control movement, used when control deflections are minimal
  - Even more aileron to rudder mix possibly
  - Elevator trim to "very slow" flight

The thermal 2 and thermal 3 flight modes can be done via separate flight modes, or via a slider to add camber

Flight Modes (Landing)

- Good to have a little deadband on the flap stick
- Flap to aileron mix (typically maybe 5 degrees up aileron at full flap)
  - Helps to preserve proverse yaw response with a roll input
- Flap to elevator mix is non-linear (pitch up with flap movement occurs strongly at small deflection)
- Good to remove Aileron to flap mix when the flaps are deflected
- Moderate aileron to rudder mix

Goal of the aileron>rudder and flap>aileron mixes is slightly proverse yaw response with a roll input.
Flap to elevator mix should keep the airspeed unchanged with flap movement

COMPETITION STRATEGY

Preliminary vs Flyoff Strategy

- Preliminary strategy is conservative
  - Goal for the preliminary round performance:
    - In the top XX pilots to make the flyoff
    - Best team score is very important, so minimize the risk of large point losses (quick tow = high risk!)
  - Discard score may change strategy with a long contest dependent on scores recorded prior to discard
- Flyoff strategy is aggressive
  - Only individual score matters
  - Need for a small improvement in raw score to beat the best pilots

Preliminary Rounds Strategy

- Conservative Flying!!!
  - Ignore relative results in the early rounds
  - Do not attempt to push for winning the flight group, but to put in a consistent score relative to the conditions
  - A full launch is almost always appropriate
- Landing time may be a bit early to maximize the total score (landing position vs time error)

Flyoff Strategy

- Flyoff strategy is dependent on the air conditions (risk vs reward)
- No team score, so the individual pilot can take more risk without affecting a team score
- Unless the lift is challenging, quick towing is typical
- Being capable of landing at the end of the working time window boundary is important!

TRAINING METHODOLOGY

Training Overview

- Three flight phases
  - Launch
  - Thermal optimization
  - Landing
- How to practice for each phase
- When to practice each phase
  - When the thermals are easy, place a priority on landings
  - When thermals are difficult, place a priority on thermal performance
  - Every flight should end in a practice landing

Training for Launching

- Practice with launching to target altitudes
- Every launch, estimate your launch height and then compare your estimate to the readout when you land
- Practice running at low level to distant locations
- Practice using low throttle to explore thermals prior to motor cutoff

Training for Thermal

- The difference between low level thermal and high thermal technique
- Always practice with your air reading (pick your desired position prior to the launch, and check whether you were correct)
- Understand the varied conditions (windy vs light vs calm, etc.) and practice in all conditions that contests are flown

Training for Landing

- Every flight should end in a measured landing
- Practice a “standard” approach until the timing is reflexive
- After the landing position with respect to time is well understood, practice variations
  - Add “straight-in” landings (no landing pattern)
  - Practice landings from long distance (how far away can you be and still make it back to the landing in time for a good landing)
- Recording landing and time error scores during practice sessions help to understand what is needed for improvement

LANDING METHODOLOGY

Landing Methodology Overview

- A “typical” landing pattern is important to learn and practice
- Understand how to modulate the aircraft energy during the descent