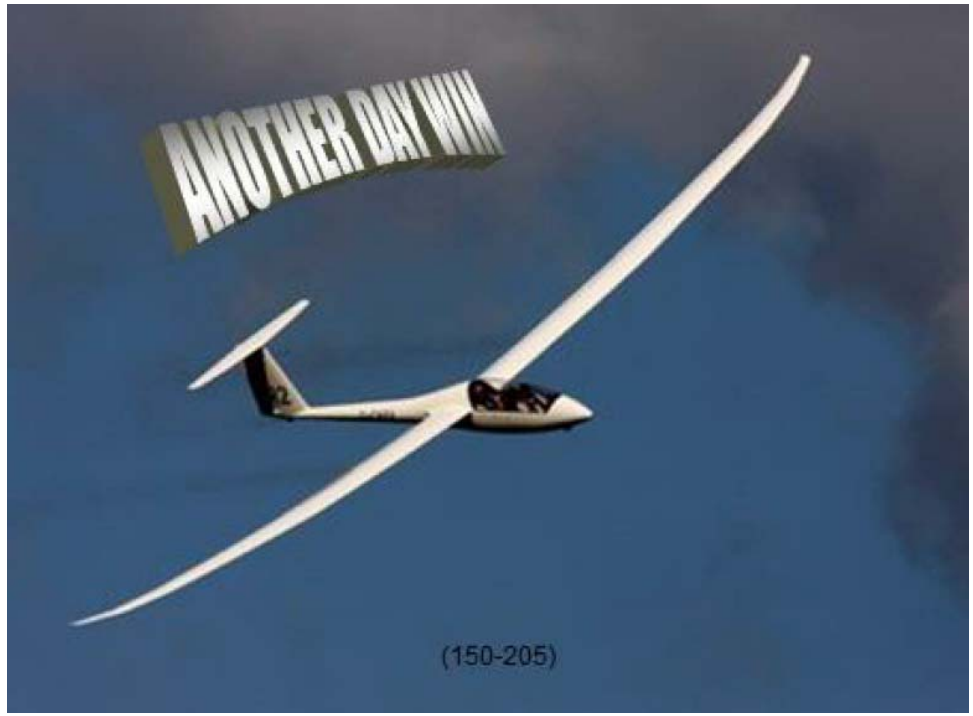
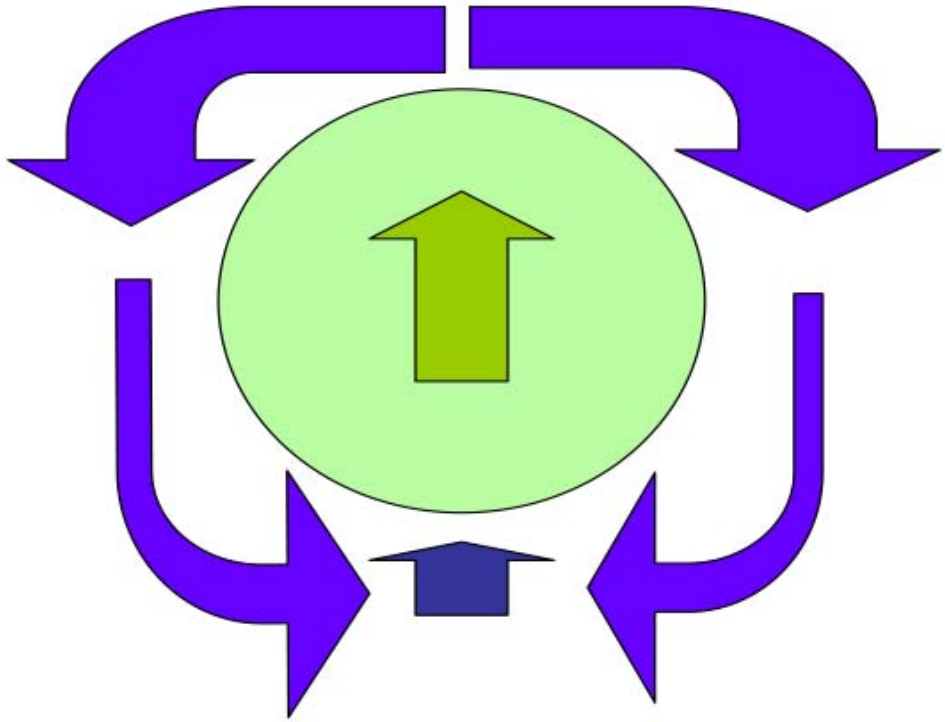


BGA Advanced Gliding Training Notes

Compiled by Kevin R Atkinson BGACCL

Thermal Structure, Vortex

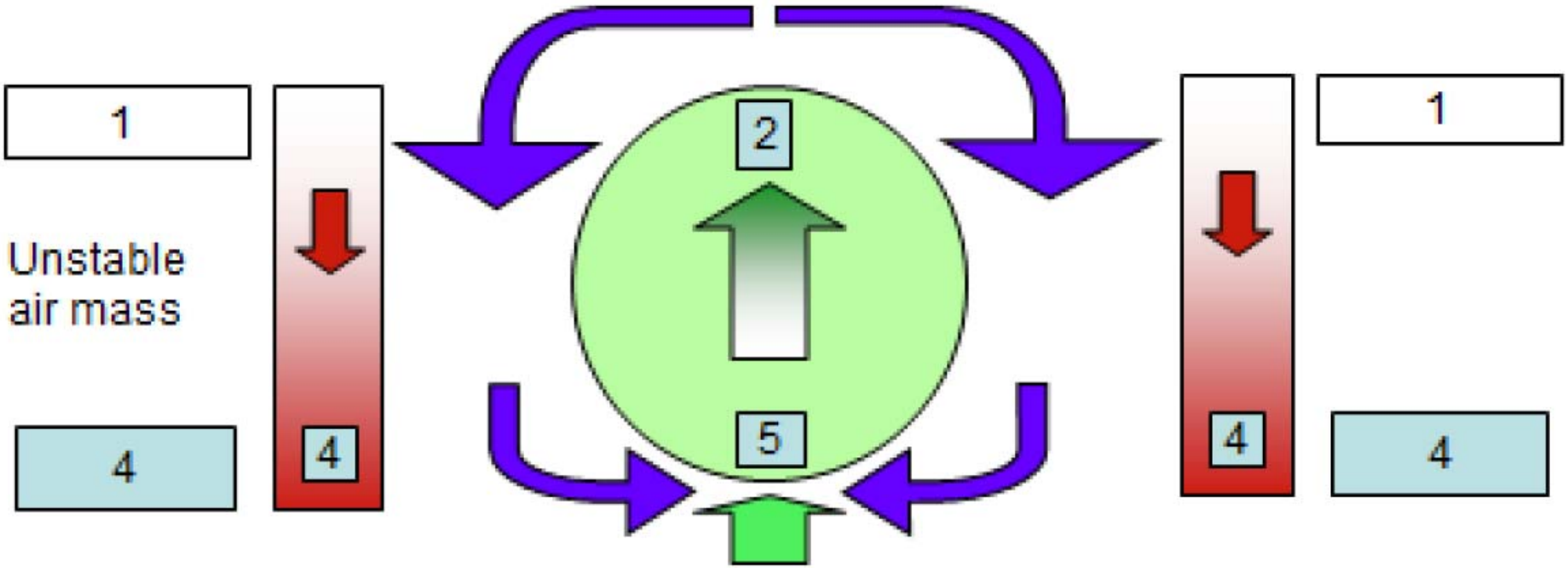
First to the vortex ring. Imagine a solid ball or balloon going through the air, an eddy will be set up which must generate a vortex motion. However, the faster the thermal rises, the stronger the vortex, therefore the stronger the sink around the bubble.



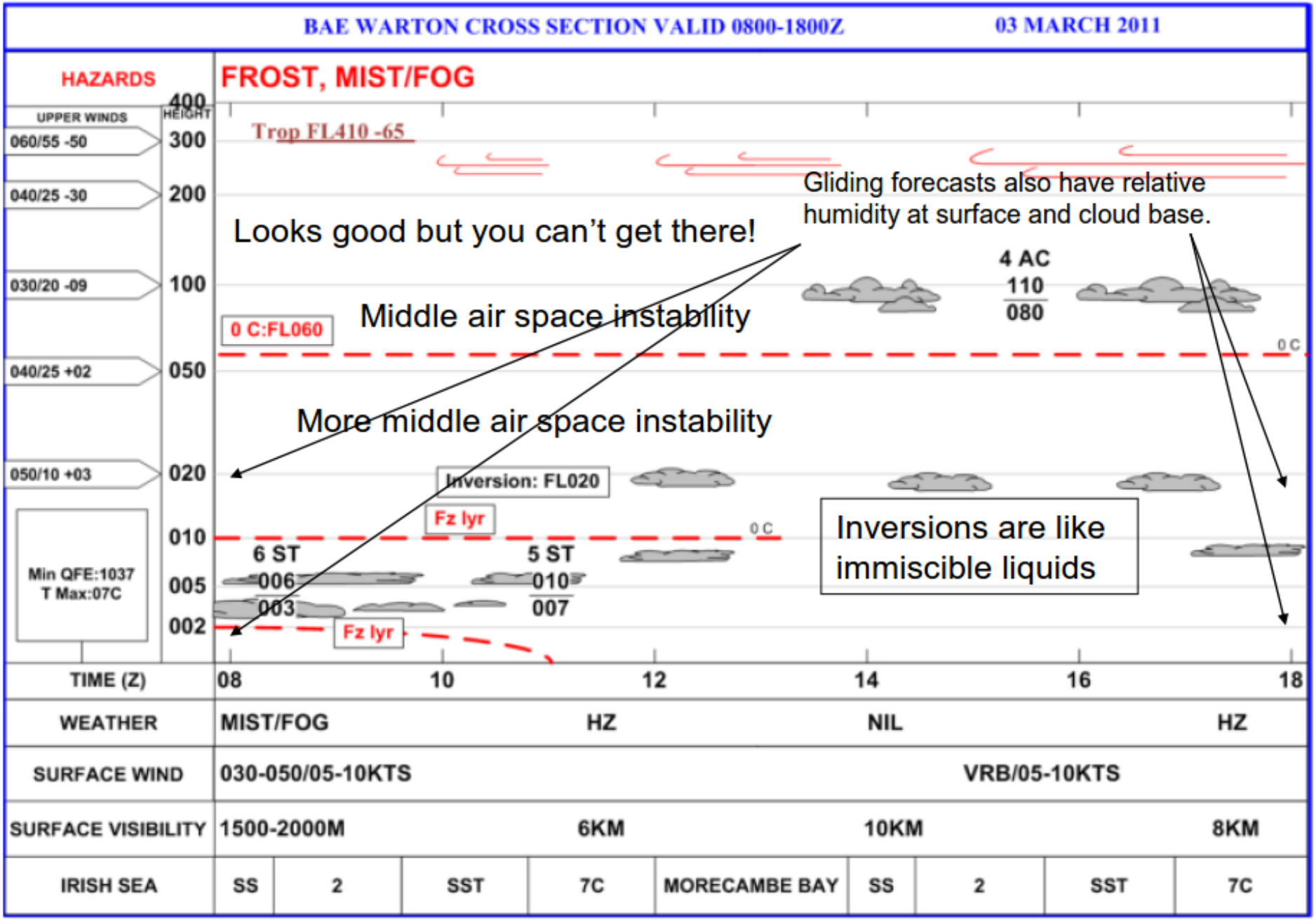
CKA

Thermal Structure, Sink - Bubble

We are very familiar with the concept that as air rises it cools – at 3 degrees per thousand feet. But warming happens to the descending air. Consider the bubble below being 1000' high. The air above the bubble descends and warms at 3 degrees, therefore the bubble continues to rise steadily. Below is the bubble thermal.

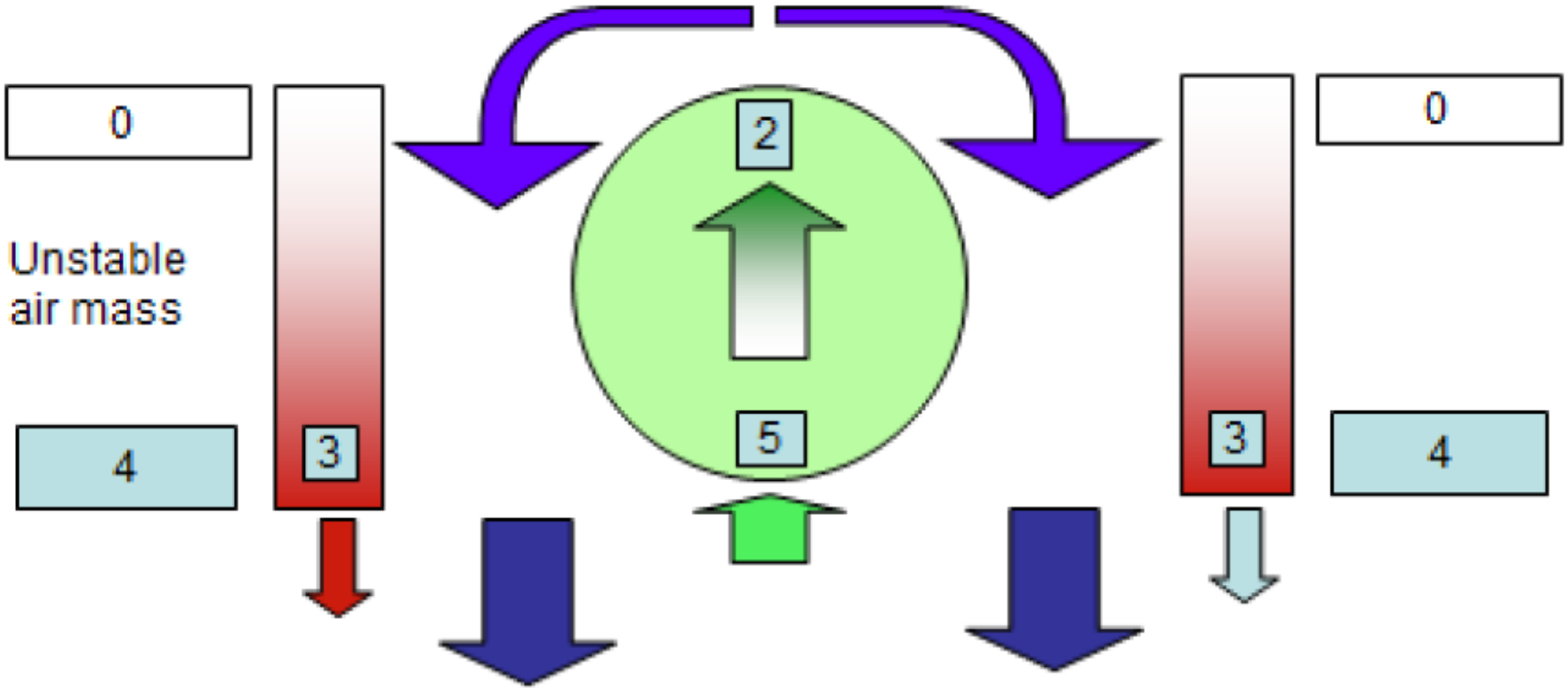


Temperature does not always reduce with height



Thermal Structure, Sink – Column Development

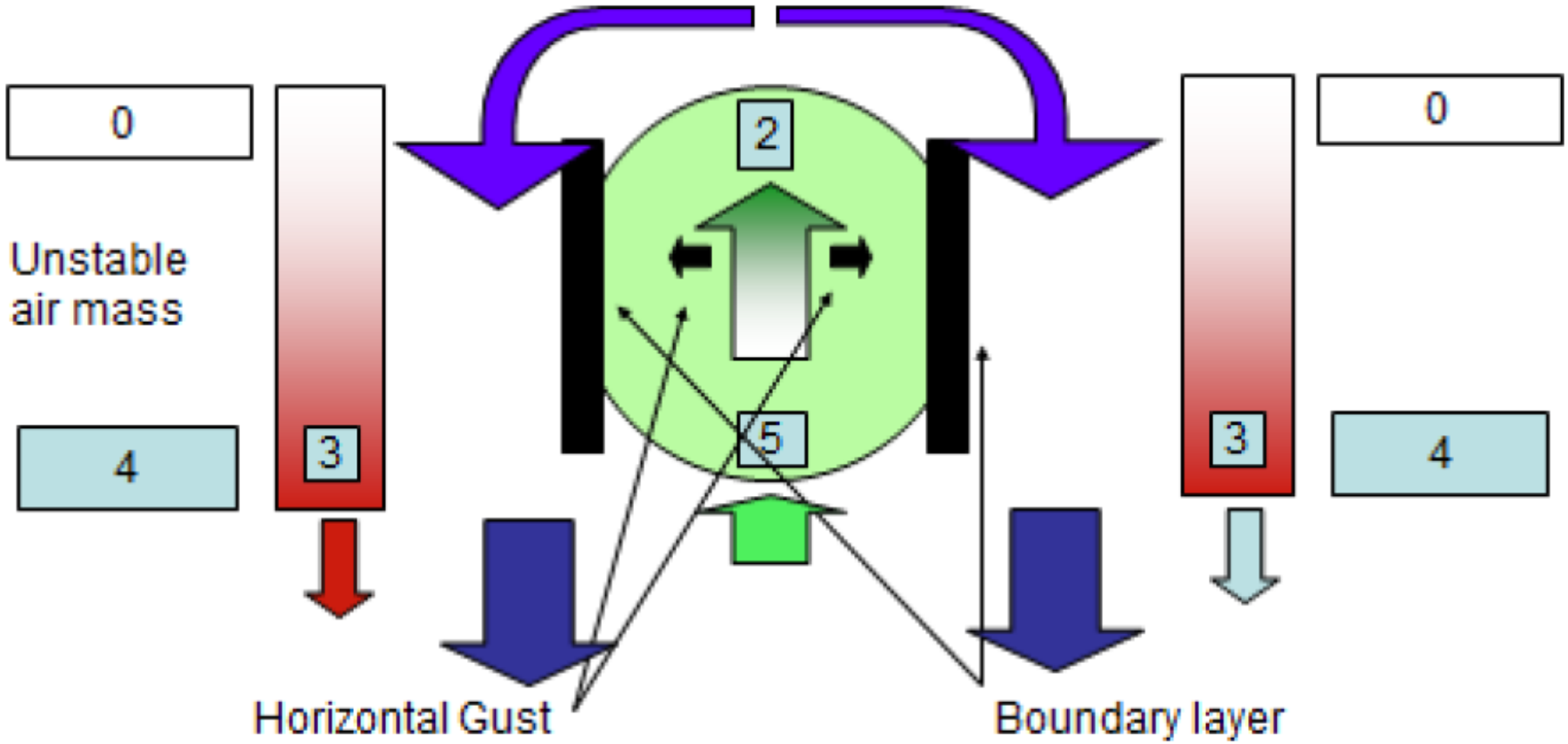
We are very familiar with the concept that as air rises it cools – at 3 degrees per thousand feet. But warming happens to the descending air. Consider the bubble below being 1000' high. The air above the bubble descends and warms at 3 degrees, and becomes heavier and therefore continues to descend reinforcing the thermal beneath. The thermal 'grows' downwards.



Thermal Structure, Expansion

Between the rising and descending air there will be an interference boundary layer which feels like flying over cobbles stones.

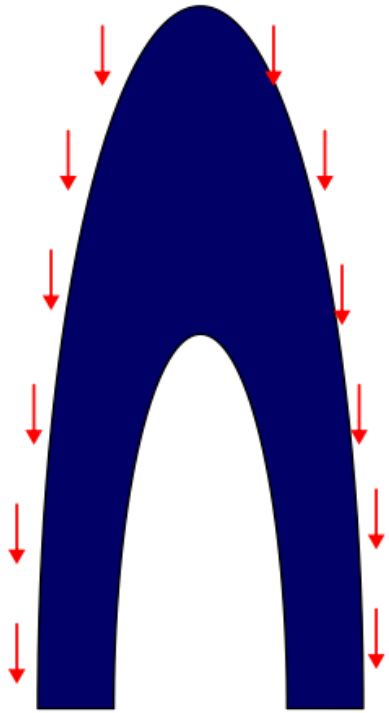
The warmer air within the thermal will be at a slightly higher pressure than the air around and therefore the bubble will try to expand outwards into the descending air. This horizontal gust is only close to the central core where there is the largest change of temperature.



Formation of column thermals, in an unstable layer from a constant heat source. Notice how the volume of the thermal is increases vertically by extending down, not horizontally

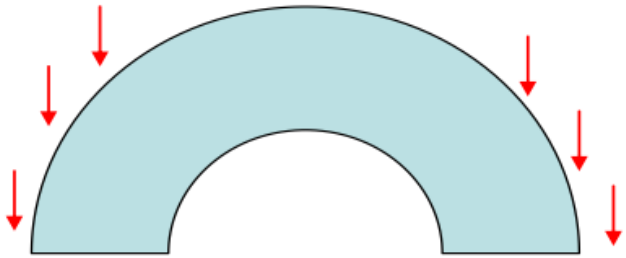
SINK!

The air where the cloud is, can not hold any more moisture so it condenses out as water droplets. The air surrounding the cloud is drier so the water evaporates, cooling the air.



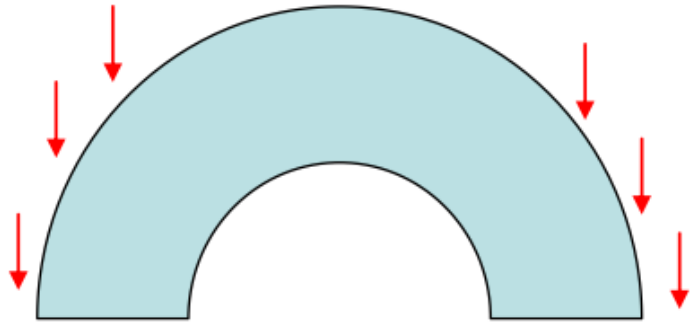
Tall Cloud therefore 'strong' band of sink

Broad Cloud therefore broad area of 'moderate sink'



The higher the cloud/s, the stronger the developing sink

No Sink Vortex



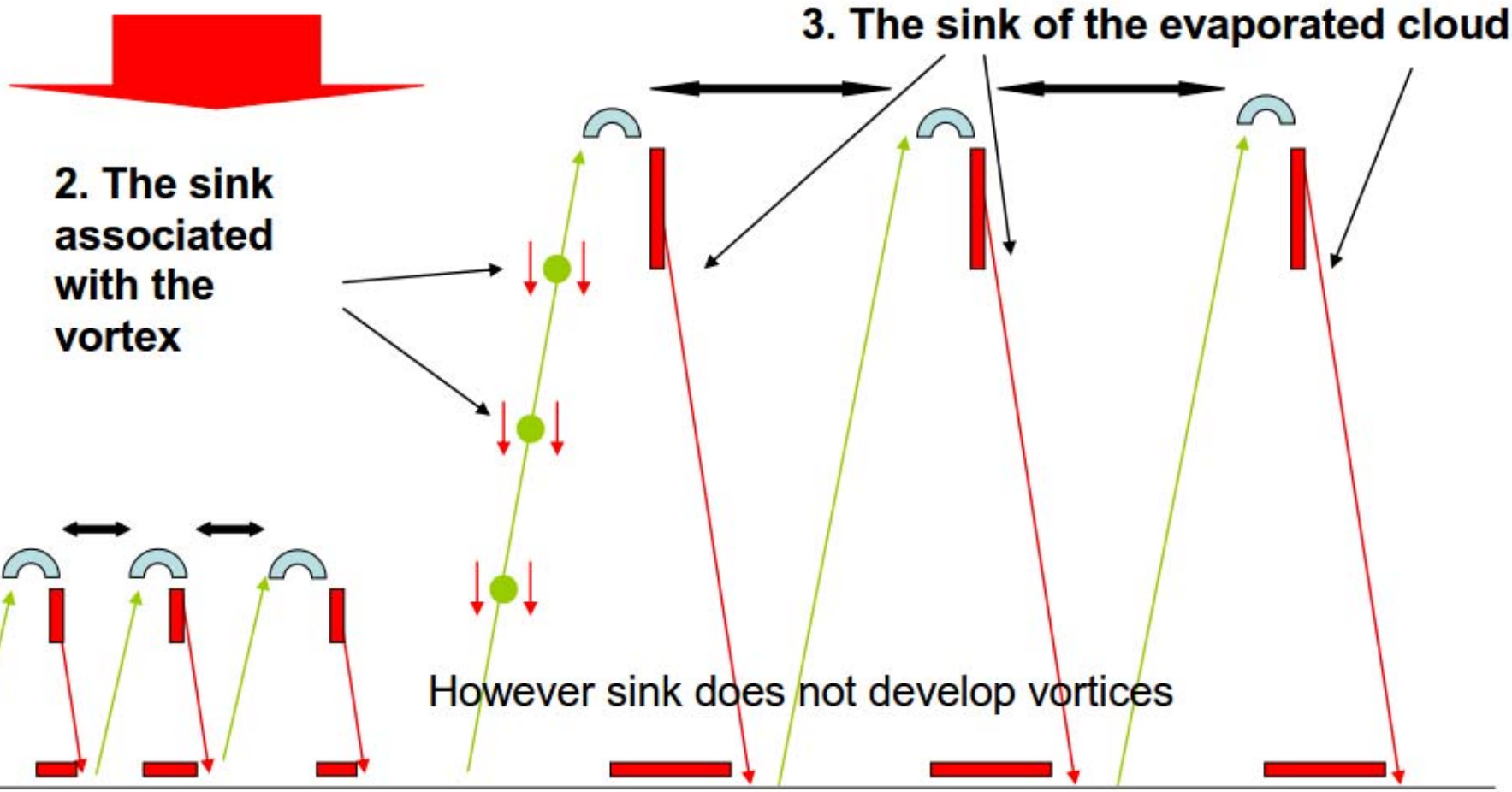
Because the evaporation of the water vapour takes place around the edges of the cloud first, and from the centre last there is no formation of a descending vortex and it lacks any kind of rigidity unlike a rising thermal, which is the important difference.

The exception to this rule is when there is precipitation. Rain, hail or snow all generate a central down flow of air like a column thermal in reverse.

Why the higher the cloud base, the further between thermals?

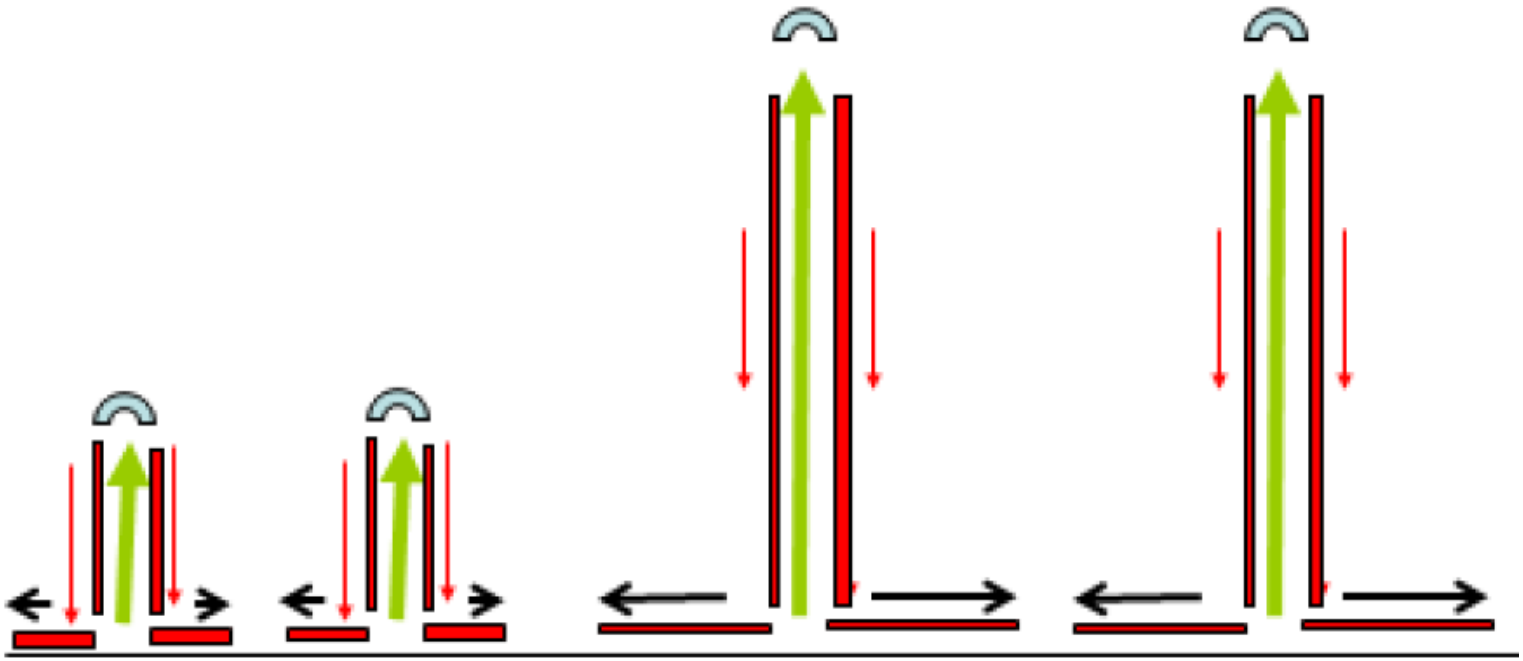
- The controlling force is the sink.
- Ignoring wave, there are three types of sink.

1. Mass sink, subsidence



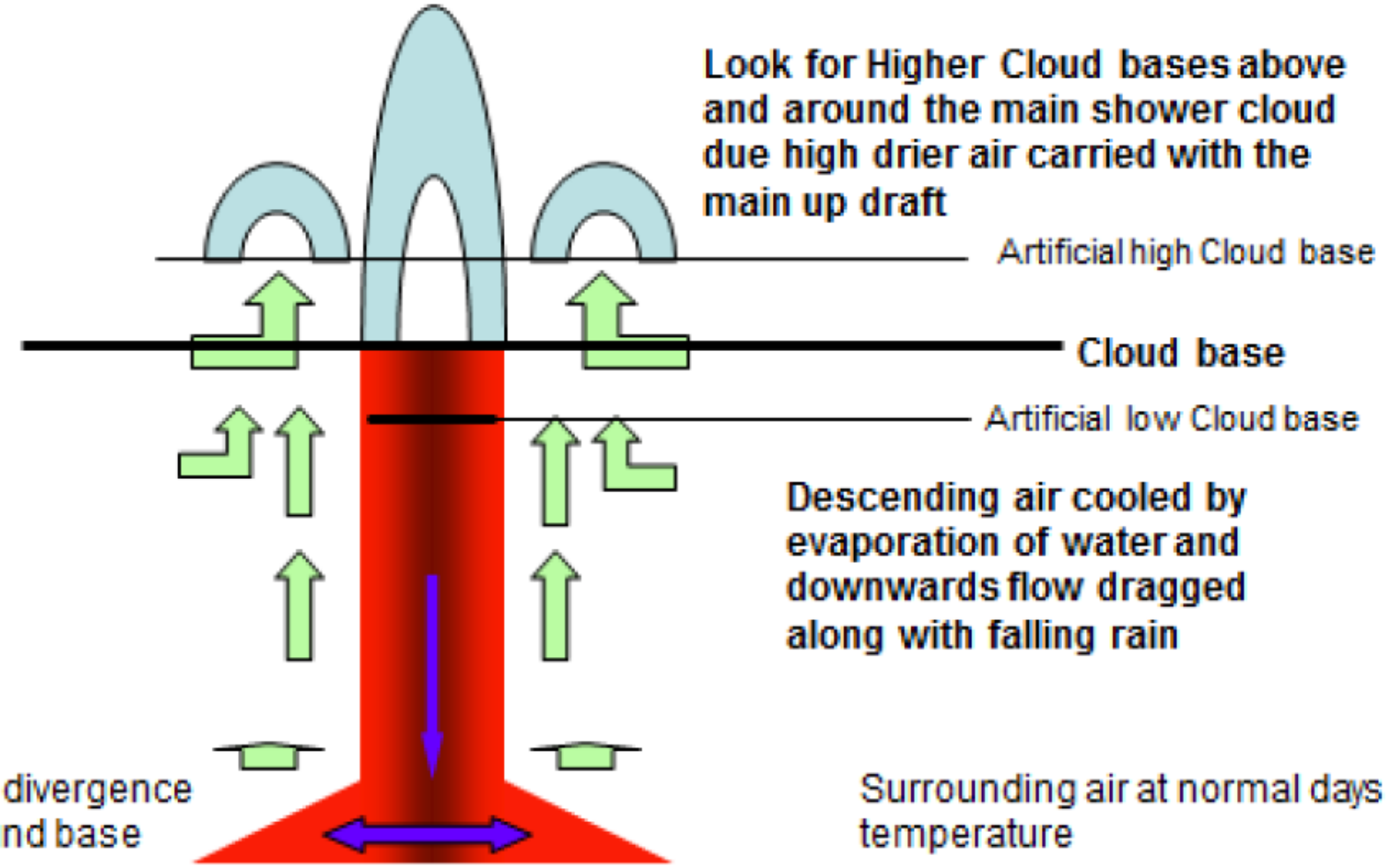
Why the higher the cloud base, the further between thermals?

- The controlling force is the huge volume of descending air.
- The higher the cloud base the greater volume of rising air, therefore the greater volume of descending air.



Rain/storms and reverse thermals

A Reverse Thermal: Theory; Heavy Shower (Rain, hail, snow.) Local ground divergence



Molngator… men undvik flyga på röda pilen

Streeting

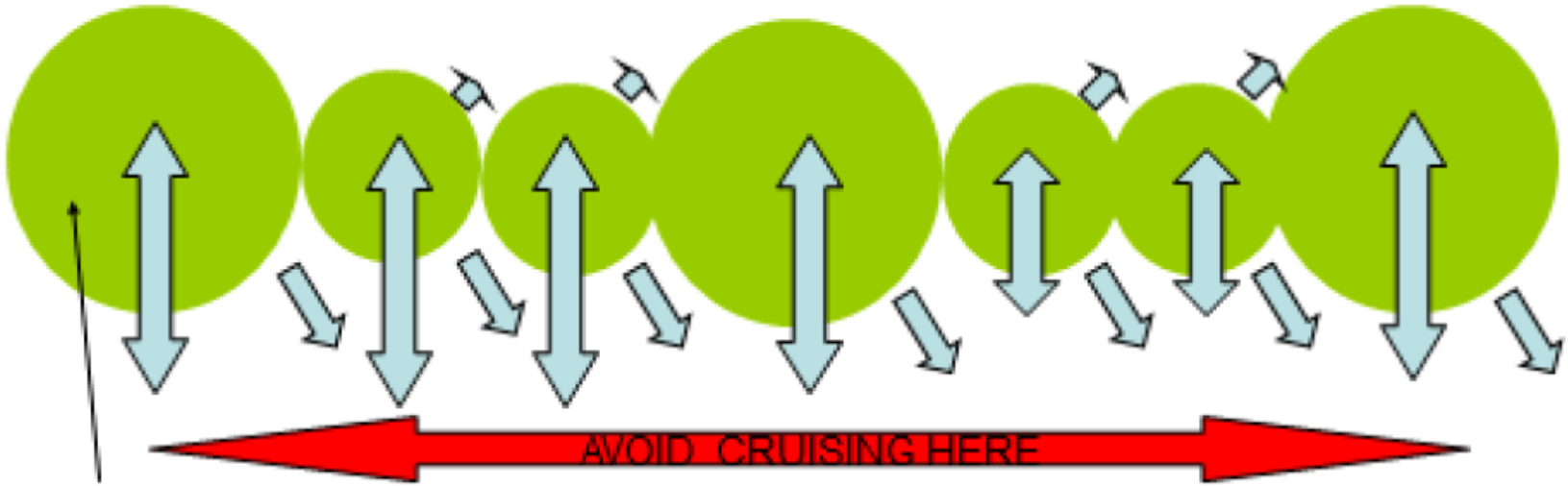
Vortex Streeting top view

WIND at Cloud Base

WIND near cloud tops

Vortex ring formation

Note: Wind veers and increases with height

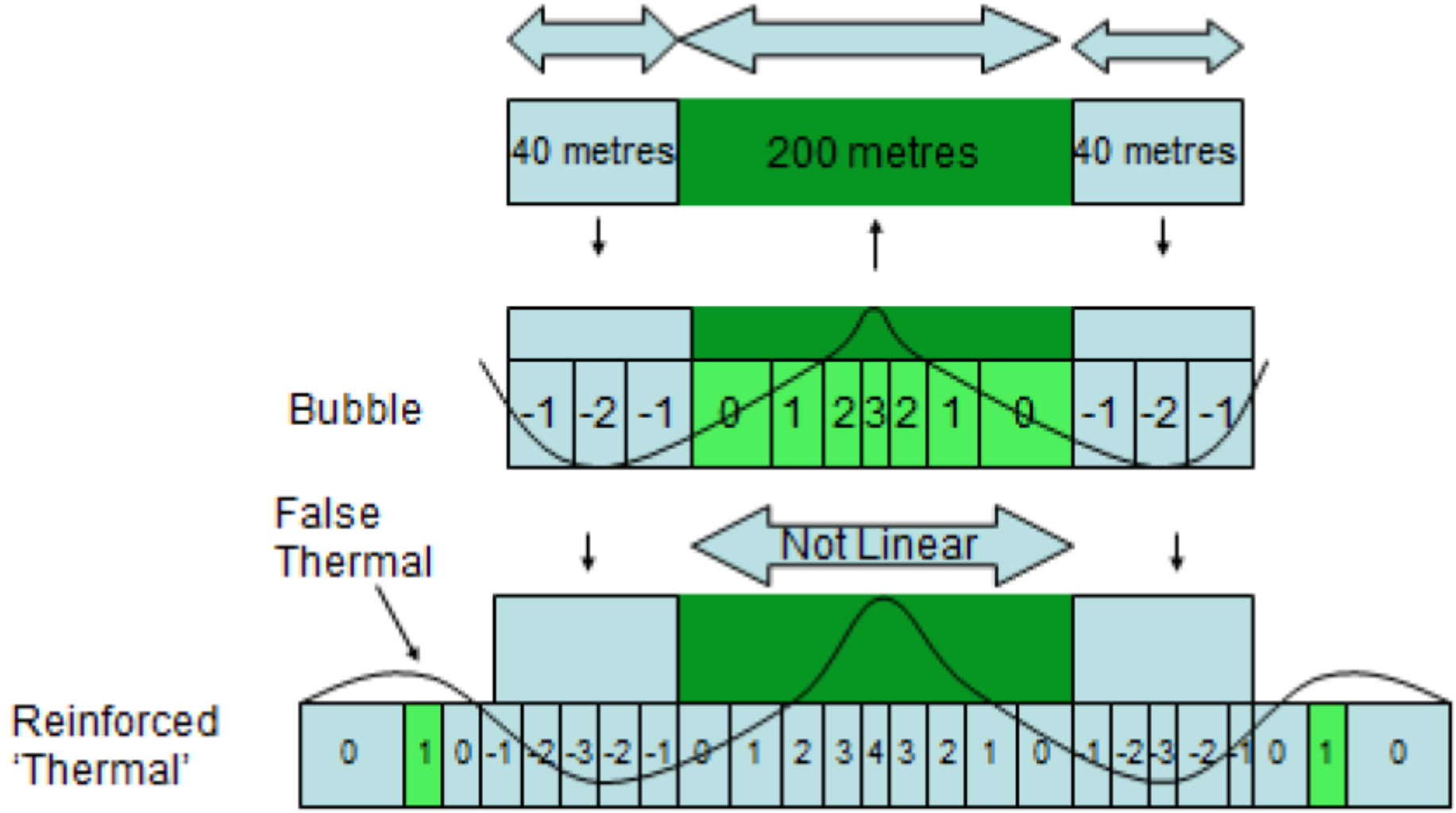


Sett uppifrån

The leading strong thermal punches highest and prevents the downdraft up wind coupled with any significant increase and change in direction of the wind above the inversion

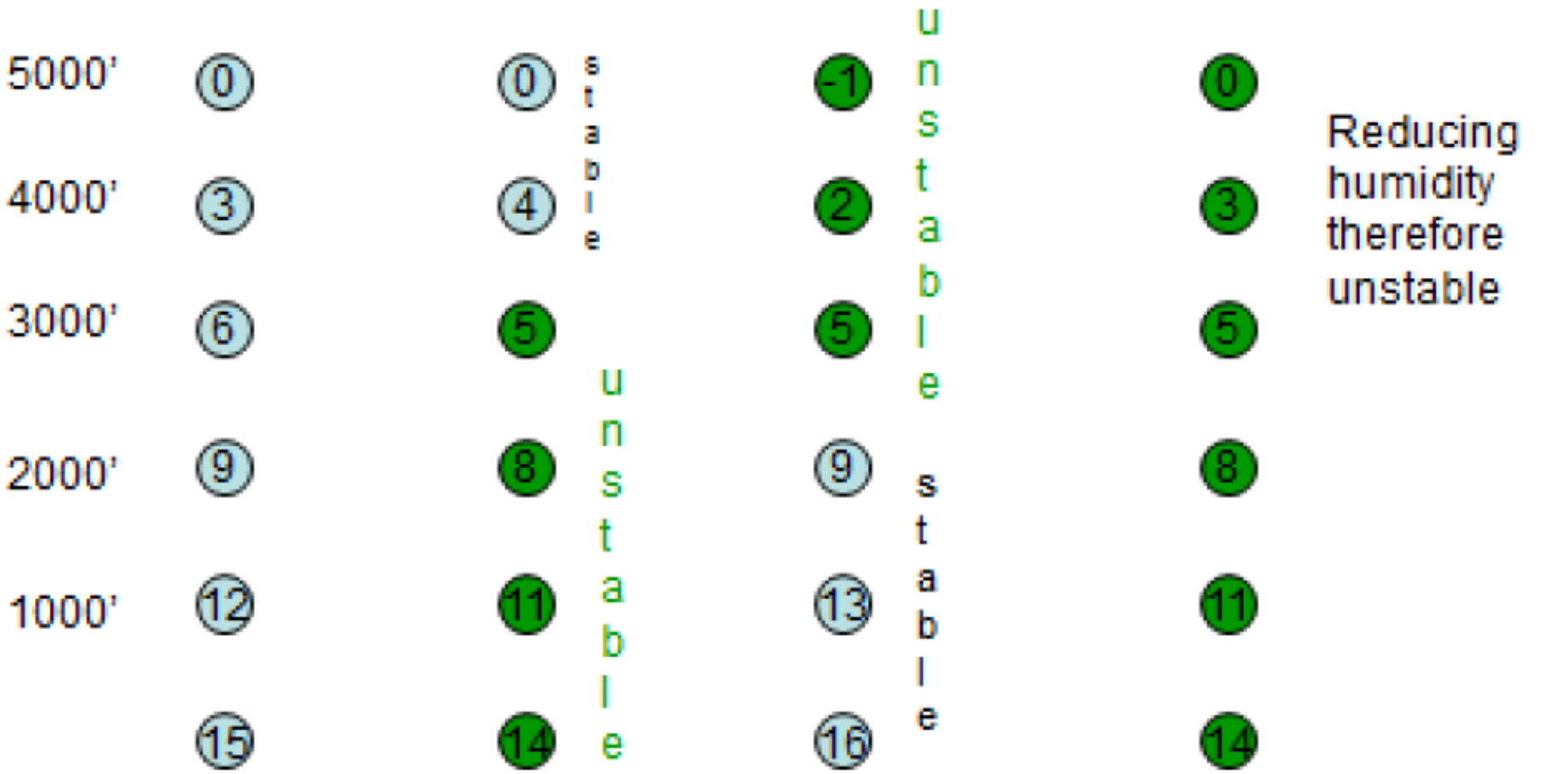
Thermal Cross Section

Consider what the cross section of a thermal is likely to be rather than just up and down. If we consider for simplicity that a 1 degree temperature difference equates to 1 knot of lift or sink.

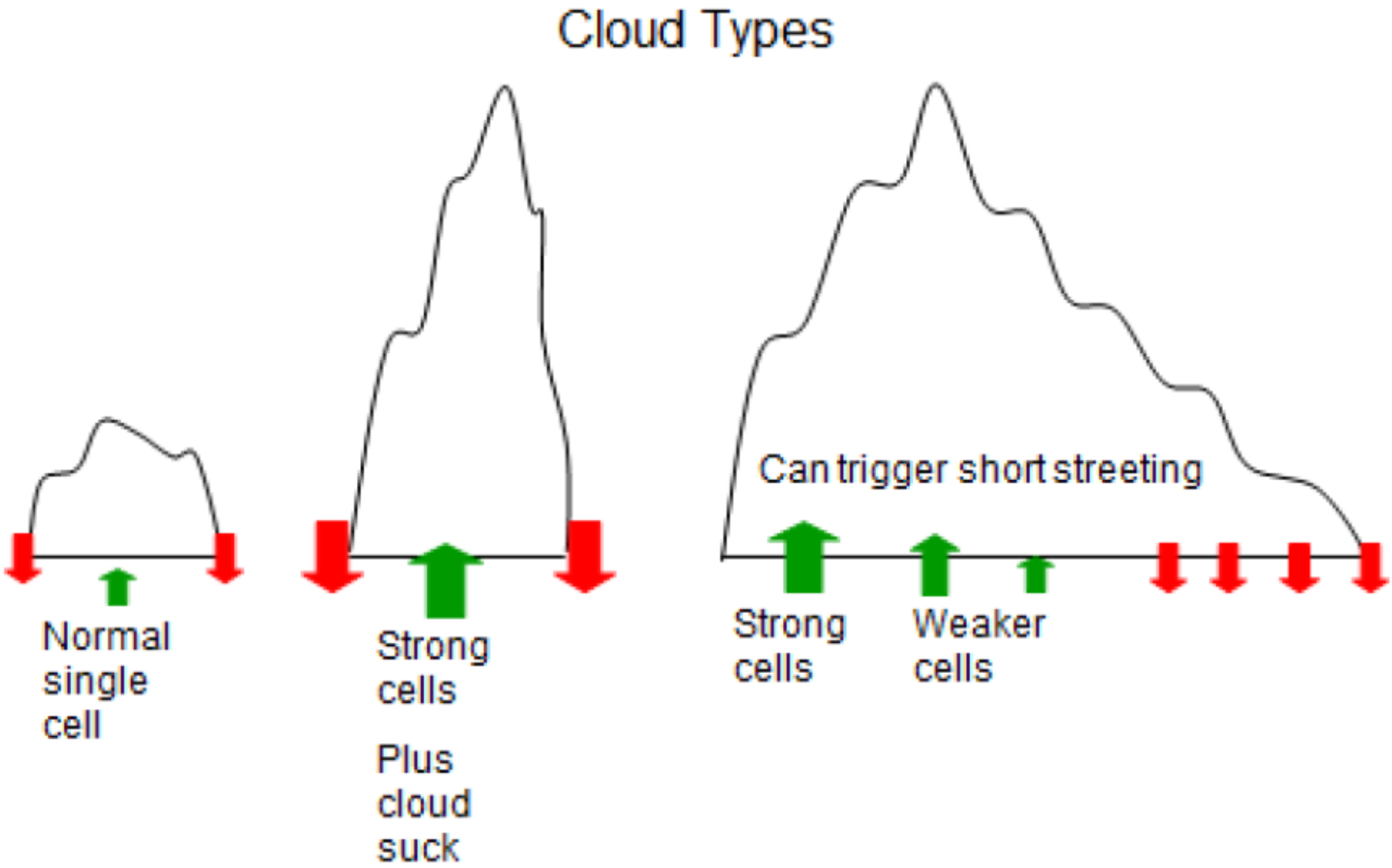


Instability

Assuming that any bubble of 'warm' air will cool at 3 degrees per 1000' as it climbs then its relative buoyancy will depend purely on the surrounding air at that height. The actual temp change of the natural atmosphere is **rarely 3/1000**'.

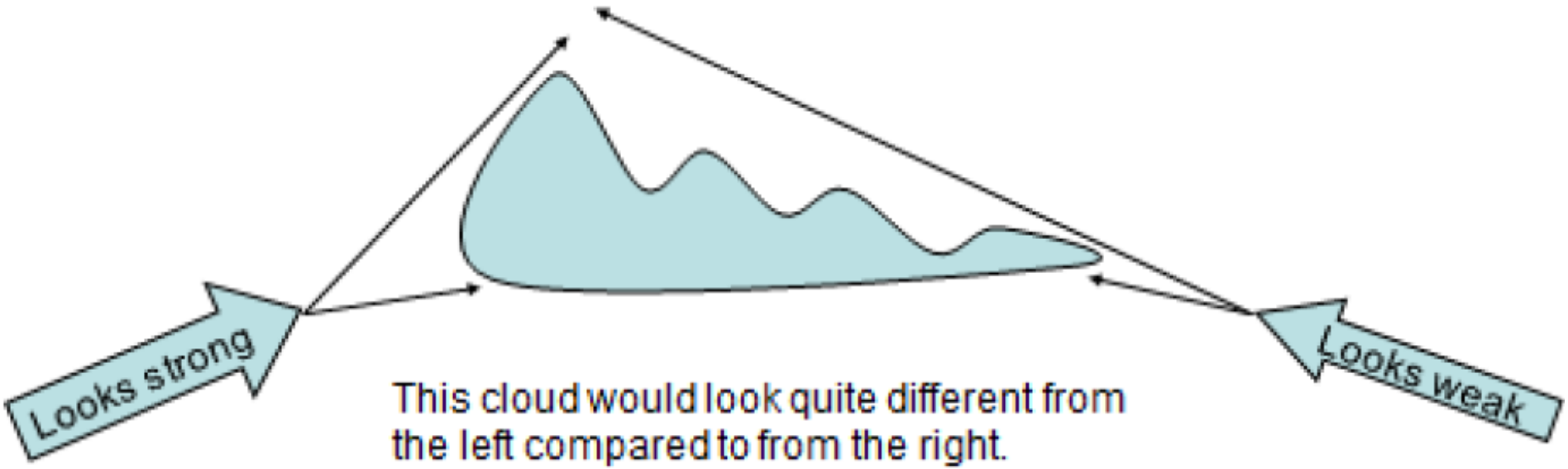


Cloud appreciation



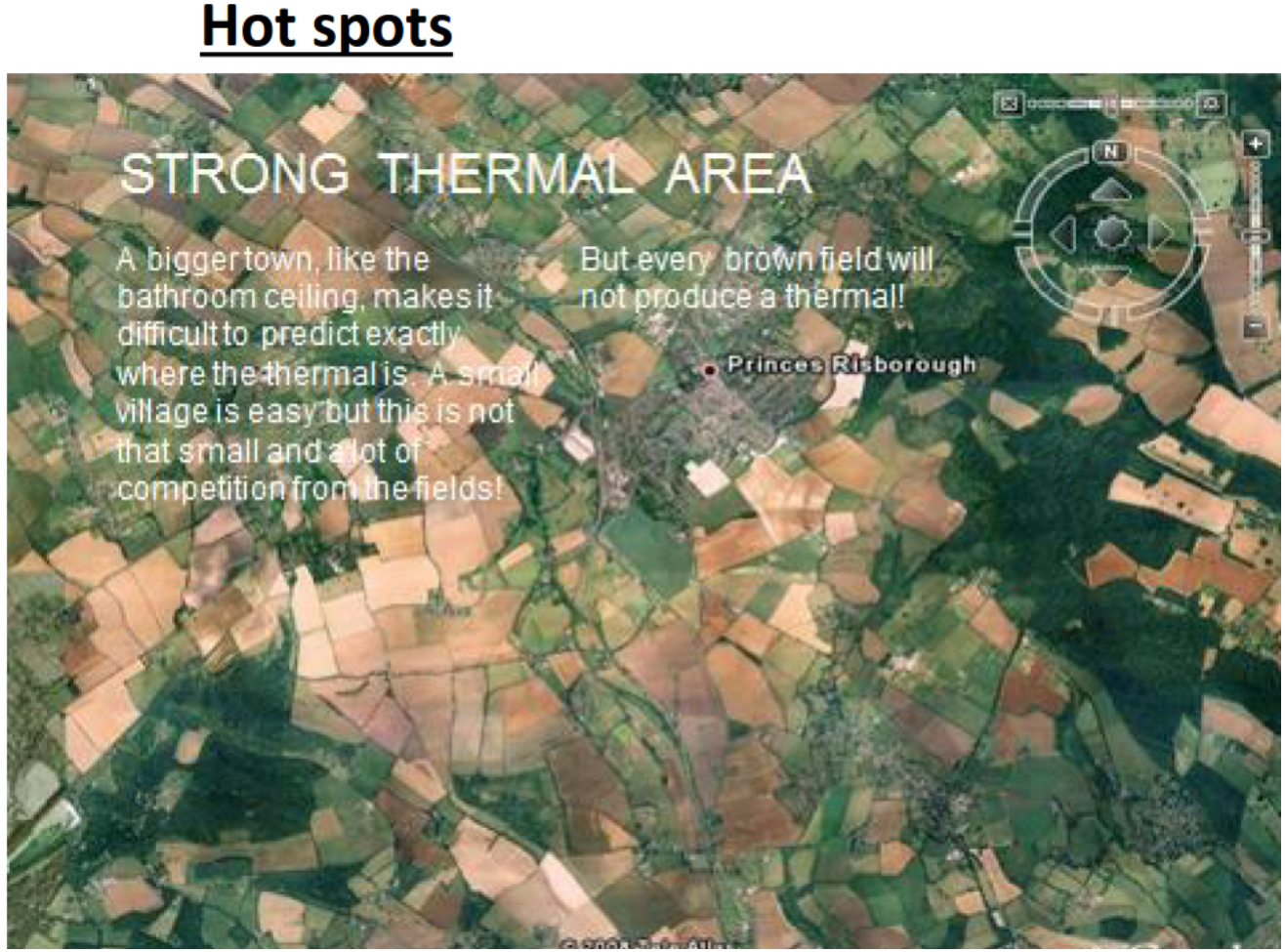
Before the Turning Point

- Have a good look down the next leg.
- The clouds may be just the same but once on the new leg they appear different.

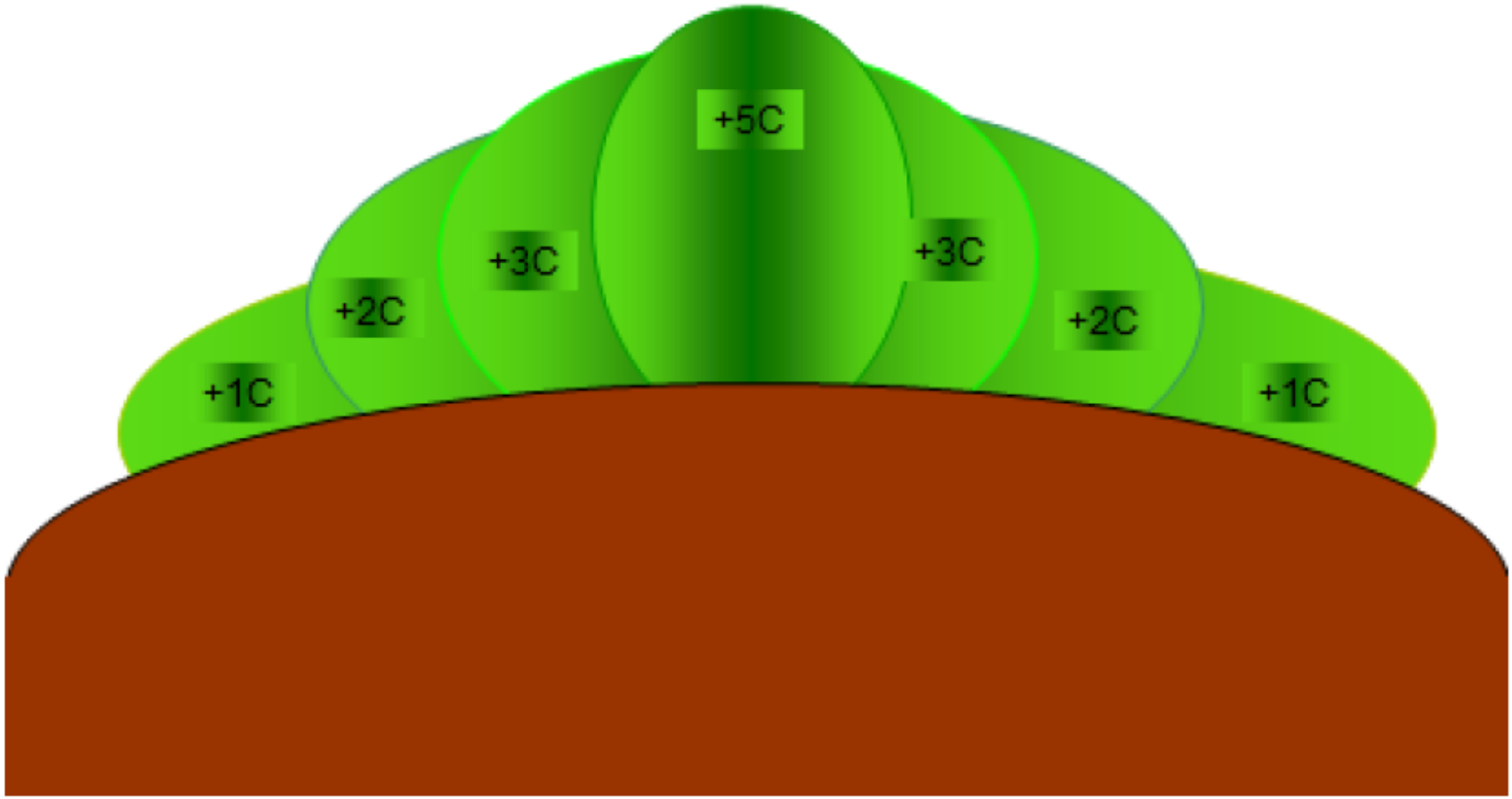


Stora bruna fält med läskydd runtom bör ge termik, men…

- Stor stad → svårt att förutse var termiken bildas
- Småbyar kan ge termik
- Många stora bra fält här konkurrerar som källor
- Inta alla bruna fält ger termik



Stronger Thermals!
Big ground area
Greater than 200 metres wide



Strong Thermals!
Big ground area
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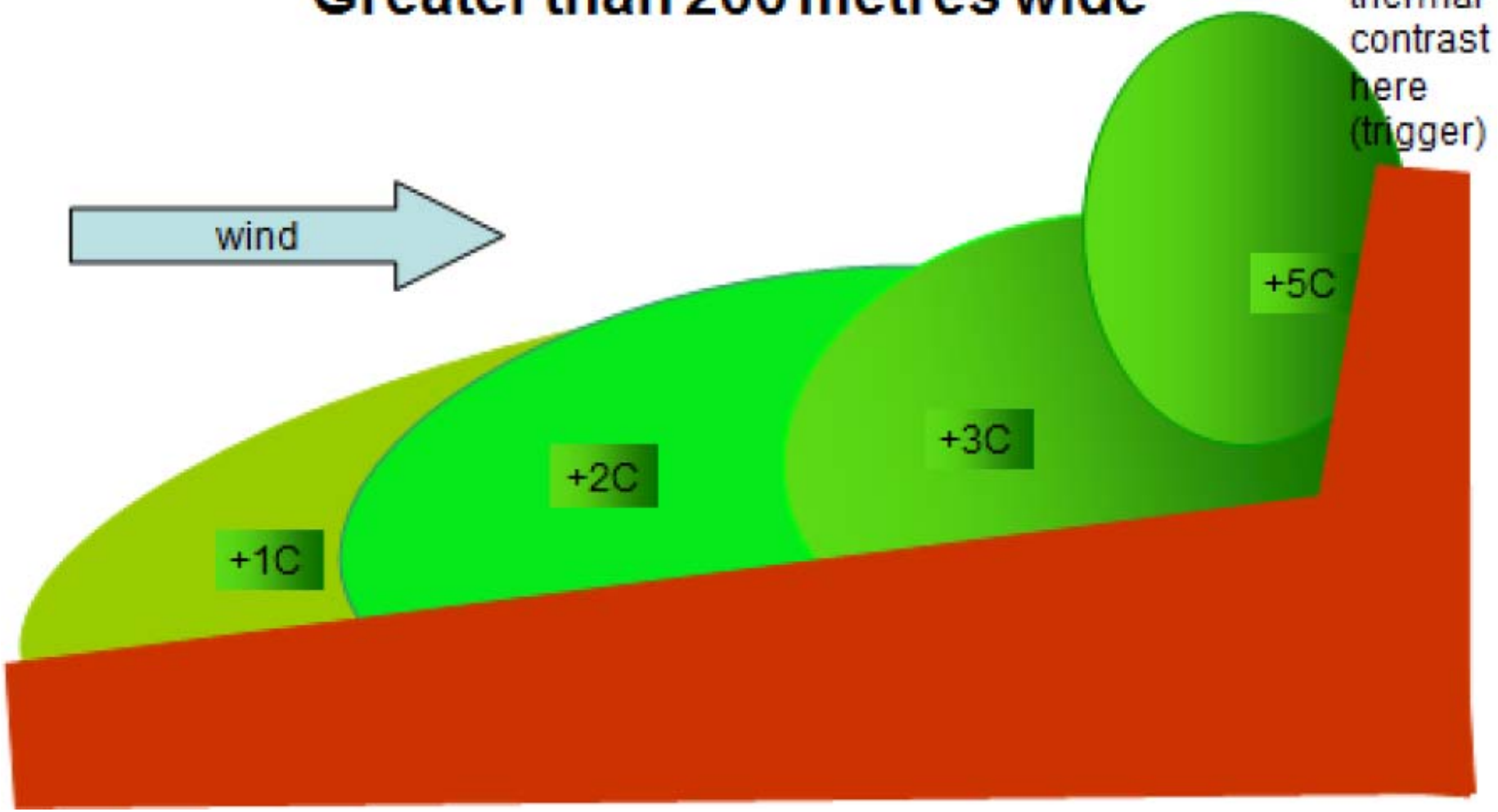
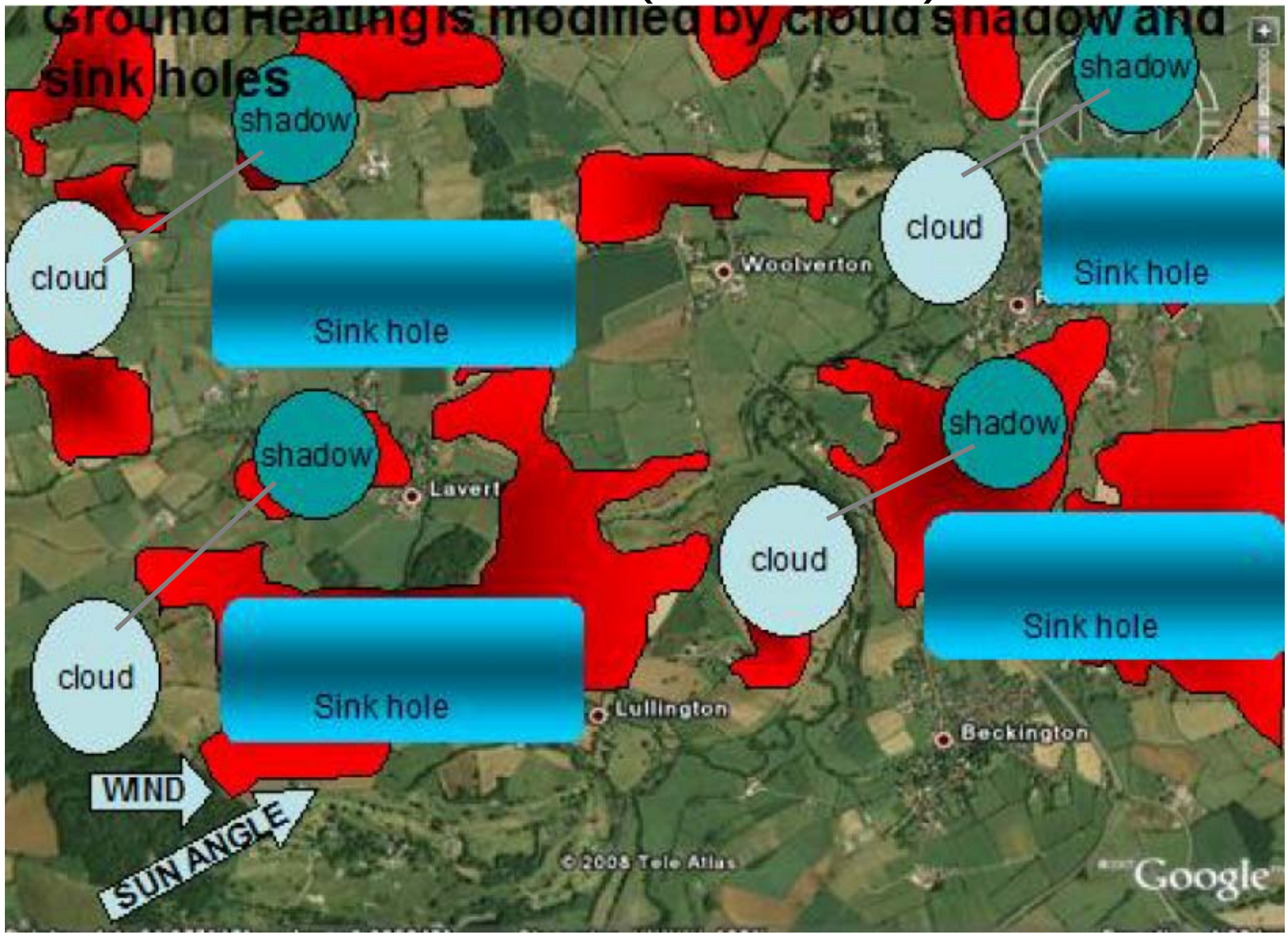


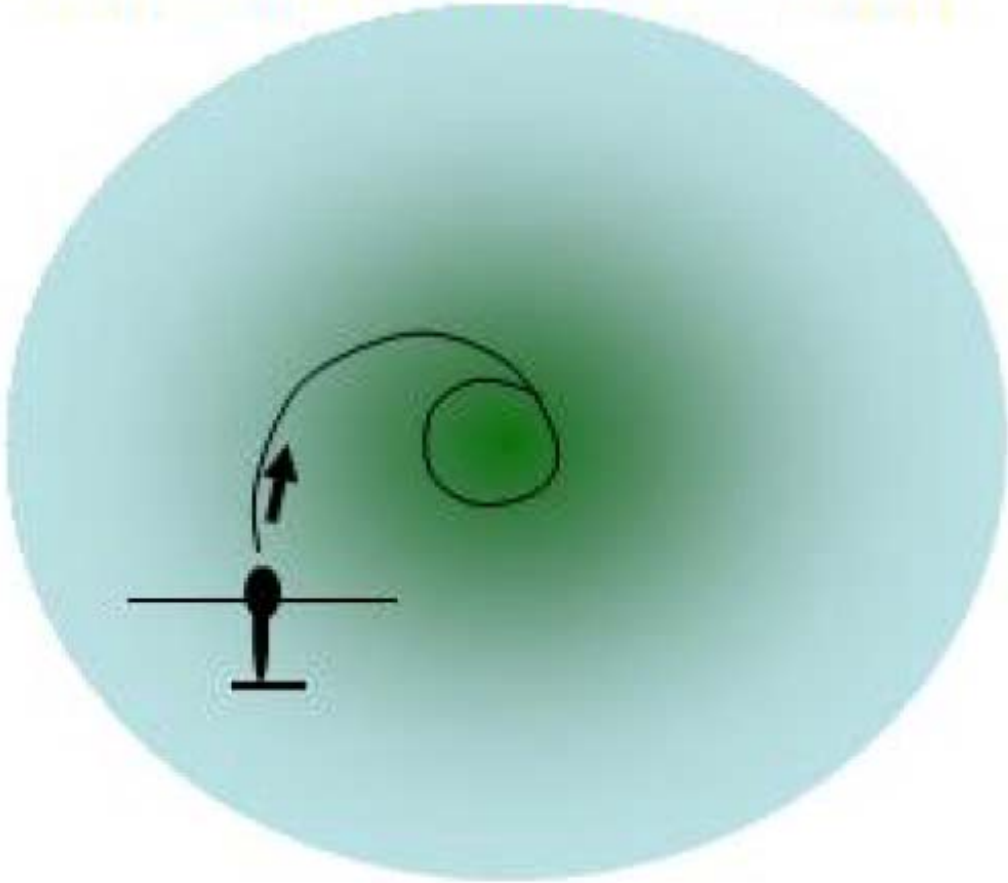
Uppvärmning av marken påverkas av molnskugga och termikdöda områden (sink holes) i lä av moln



Flygteknik

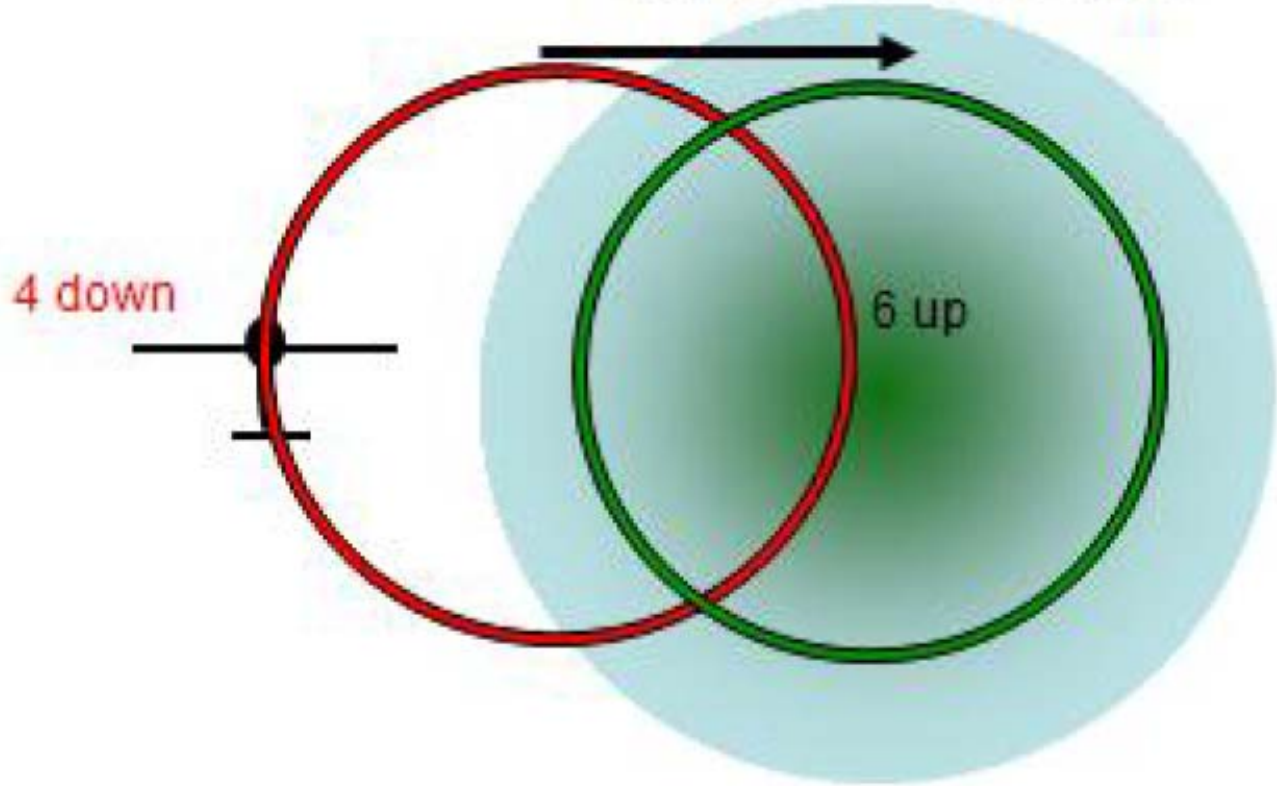
Centeringstekniker m m

Conventional Centreing
Weak Thermal and Vario Peak



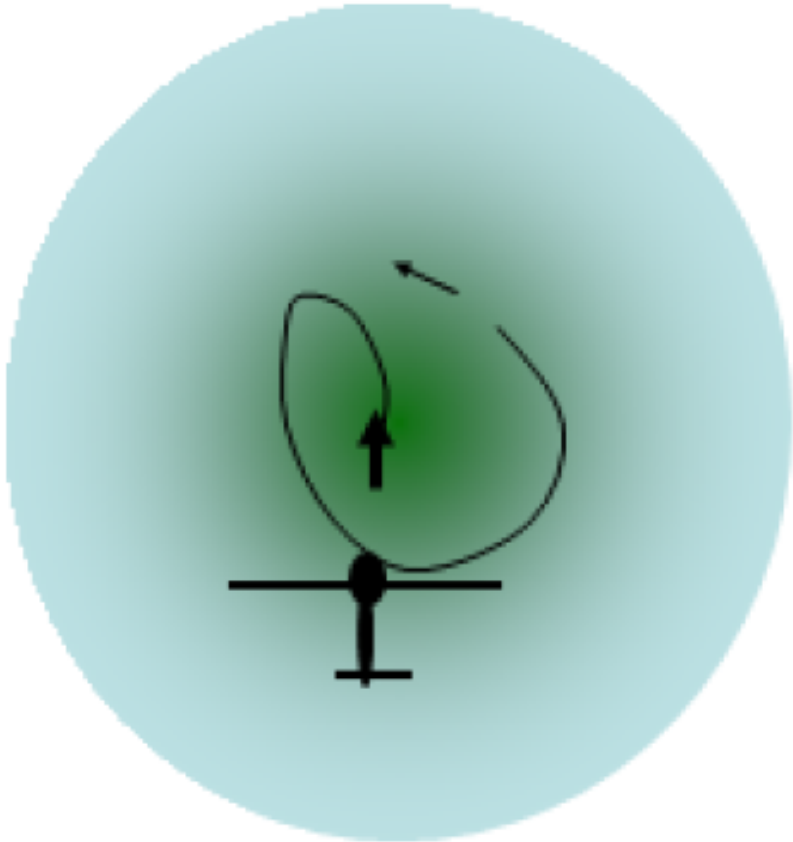
Right Wing Lifts therefore turn right with increasing bank (keep tightening the turn) until a maximum turn is achieved.

Conventional Centreing
Vario Minimum



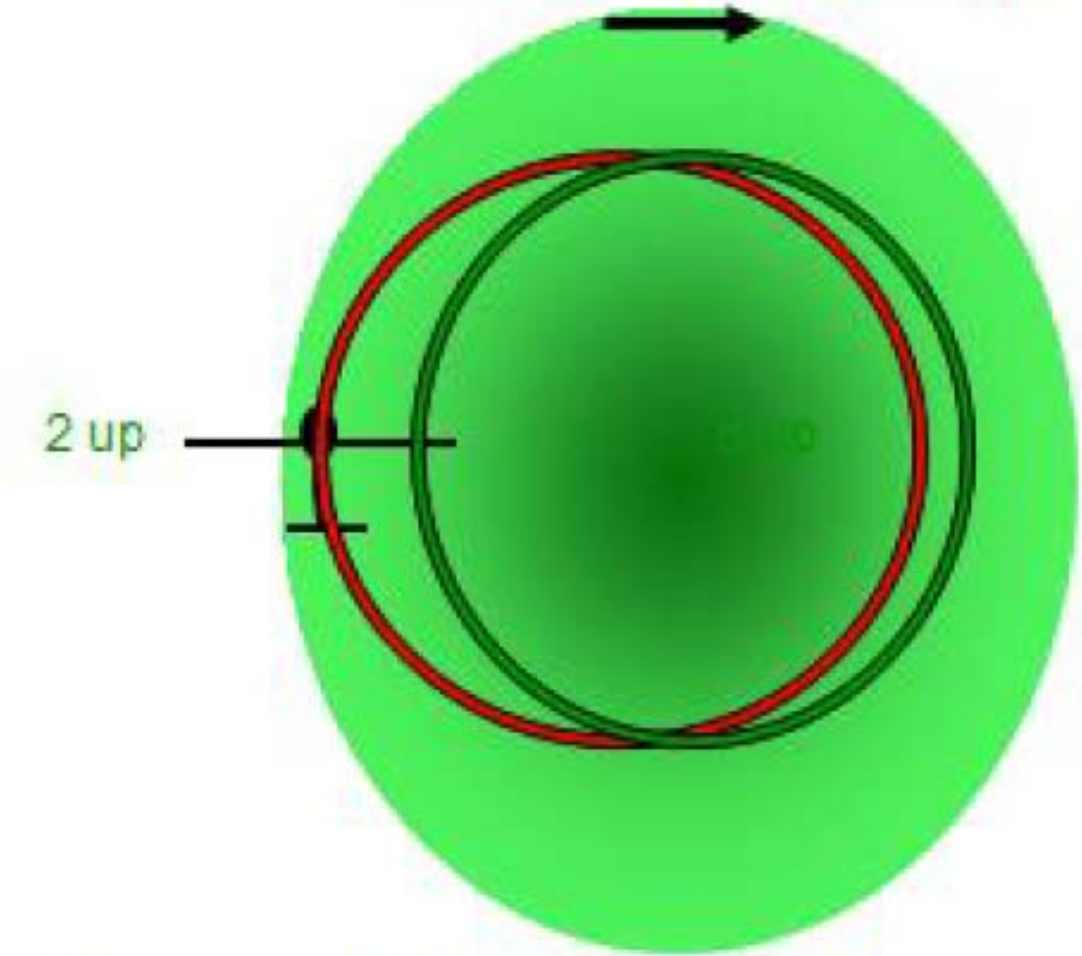
The one thing you can say about the vario is that it will tell you that you are in sink! Therefore 90 degrees after the highest sink value, roll out and after a pause, roll back in.

Conventional Centreing
Approaching the Vario Peak
No wing lift and no string



When the vario has been giving an increasing climb for 3 seconds turn using full aileron and rudder – it does not matter which way you turn –so long as you turn! You anchor the wing tip at that point.

Conventional Centreing
Vario Minimum



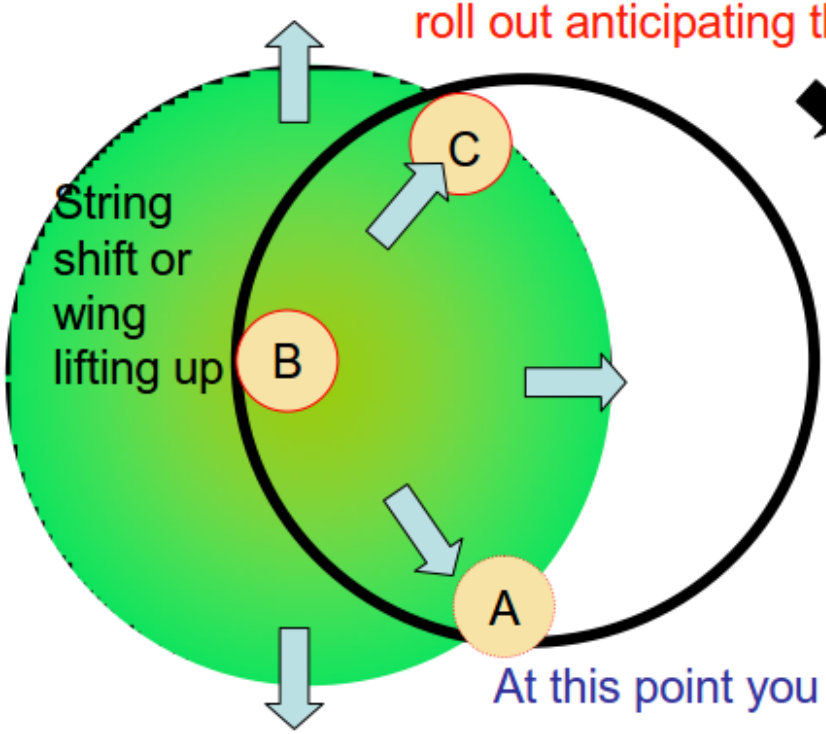
The same technique can be used in the established turn using the weakest part of the climbing turn as a reference.

Basic Thermalling
ASI and String Theory

Just avoid the sink!

C

At this point you will get a **gust speed DECREASE.**
You now know the thermal is exactly behind you.
Turn hard nearly 180 to keep out of the sink, and
roll out anticipating the gust increase



The ASI gusts are proportional to the strength of the thermal

At this point you will get a **gust speed INCREASE**

A

You now know the thermal is in front of you

Either roll out or progressively increase bank to a steep turn

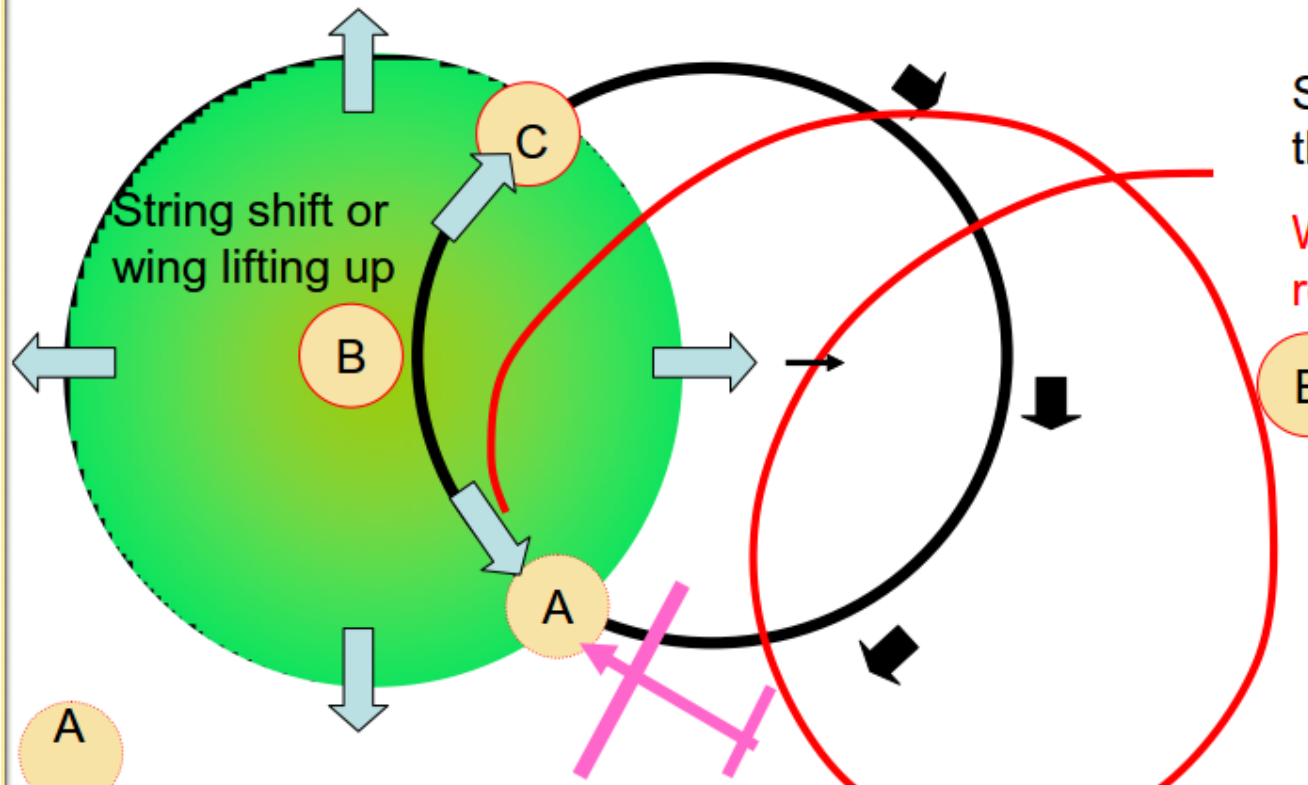
Avoid the sink!

Basic Thermalling

C

At this point you will get a **gust speed DECREASE. (on the ASI) (+TE Vario down)**

You will be **pushed out** away from the thermal



At this point you will get a **gust speed INCREASE (on the ASI) (+TE Vario up)**

Here you will get a head wind, **slowing** your progress towards the lift

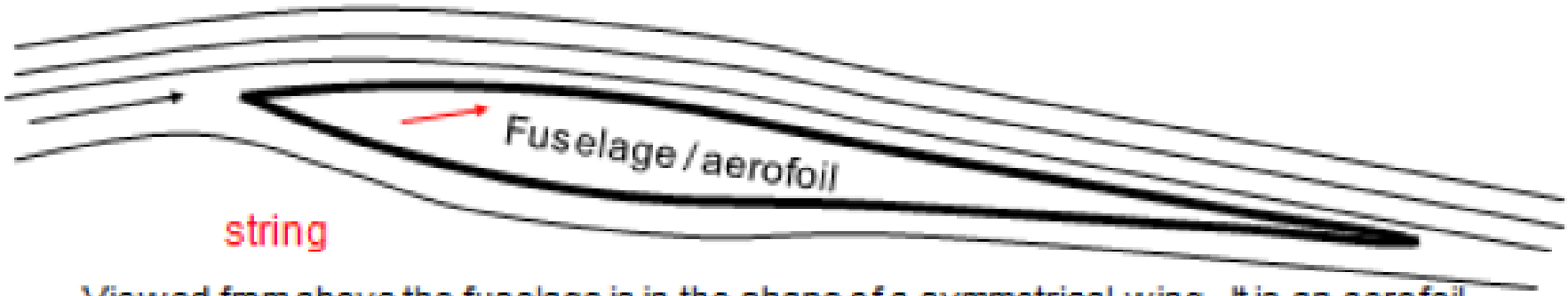
So this is what we are feeling if we fly through a thermal!

- 1. Feel, and Hear on the audio the sink.
- 2. Feel cobble stones.
- 3. Hear and See the speed increase.
- 4. Hear the audio vario up.
- 5. See the string deflection and wing lift.
- 6. Hear and See the speed decrease.
- 7. Feel the sink.

And this is what we are feeling for whilst turning within the thermal!

- 1. Feel, and Hear on the audio the lift.
- 2. Hear and See the speed increase.
- 3. See the string deflection and wing lift.
- 4. Hear the change in audio vario up.
- 5. Feel the tail go up (or nose yawing down).
- 6. Hear and See the speed decrease.
- 7. Audio indicates lift values reducing.
- 8. Feel the sink.

Wasted Opportunity Climbing
In a left hand turn viewed from above

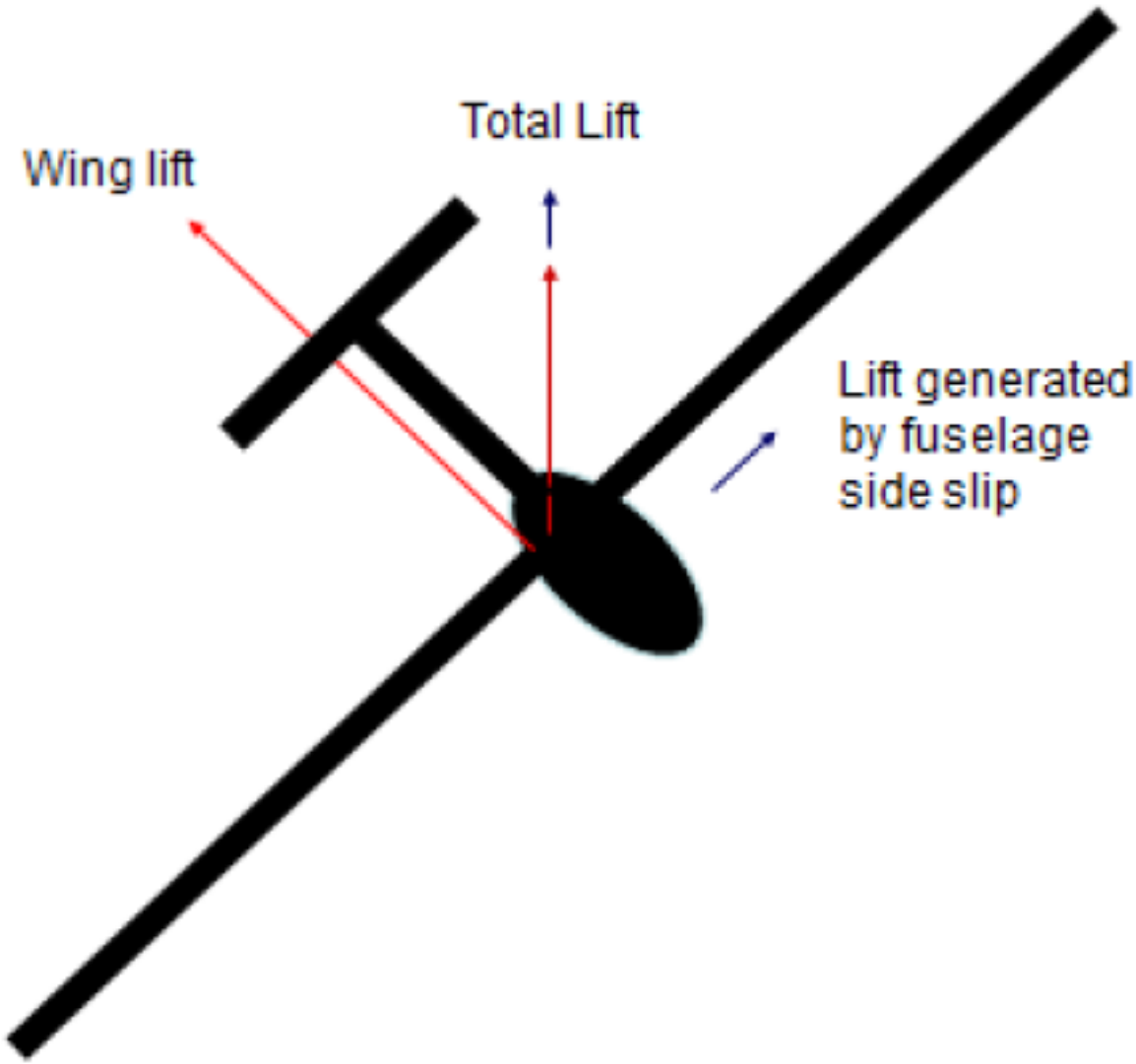


Viewed from above the fuselage is in the shape of a symmetrical wing. It is an aerofoil viewed at any angle. Therefore if we apply a positive angle of attack to it, it will produce lift off the fuselage, which actually has about two thirds the surface area of a wing (but sadly not that efficient!)

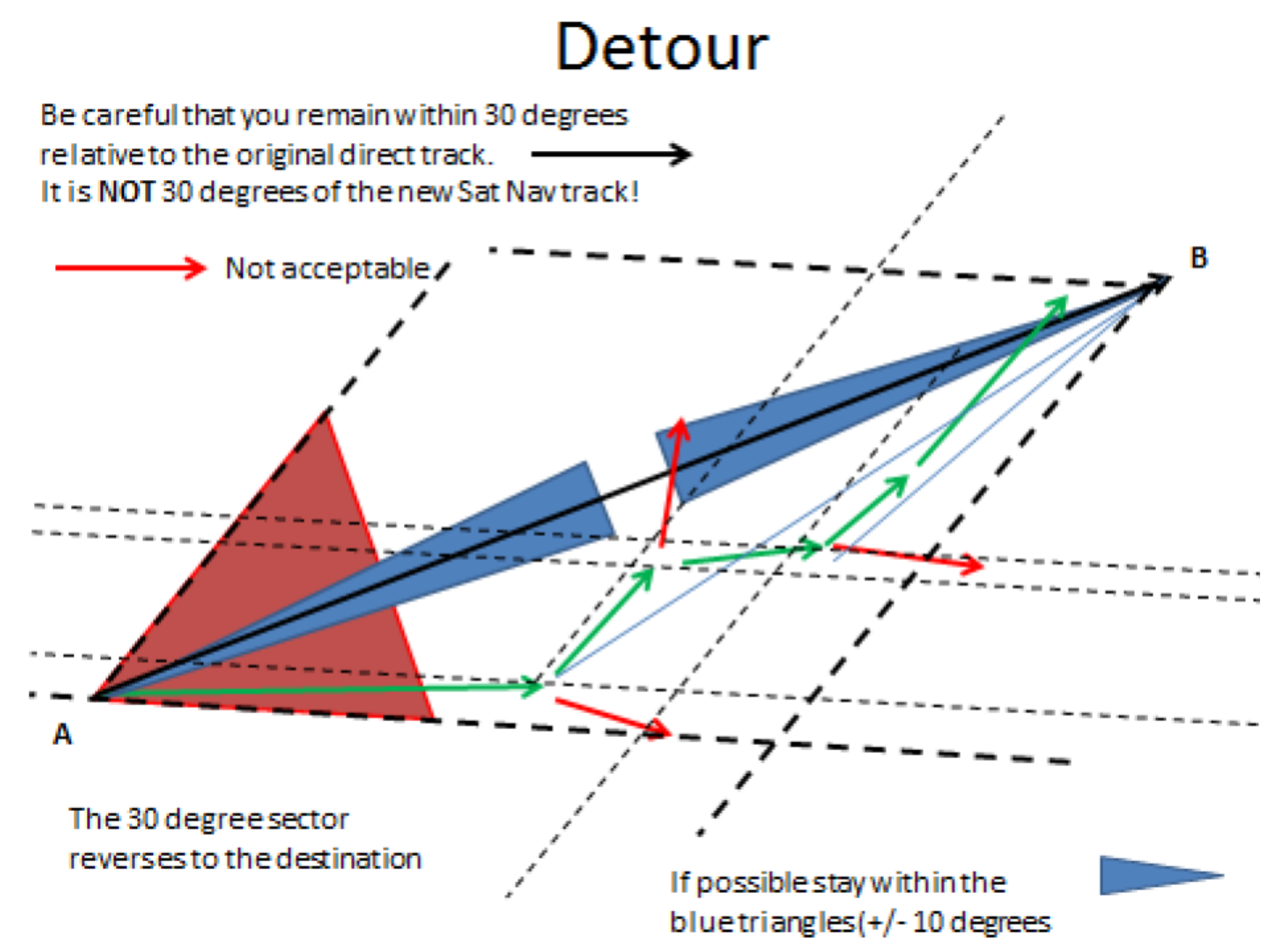
So the question is how much side slip should we use? This depends on a few things but a simple rule of thumb is the tighter you turn (the fuselage is more on its side) and the stronger the thermal, the more sideslip, but not beyond the limit of efficiency. The actual optimum is 15 degrees but the string will exaggerate this.

To find out just how far we can go on a smooth flat day simply fly straight and monitor the increase rate of descent on the vario as you fly more and more out of balance. The 'limit' will be obvious and the same right or left. Now practice turning with the string held just short of the limit towards the top wing.

Wasted Opportunity Climbing
In a left hand turn viewed from behind

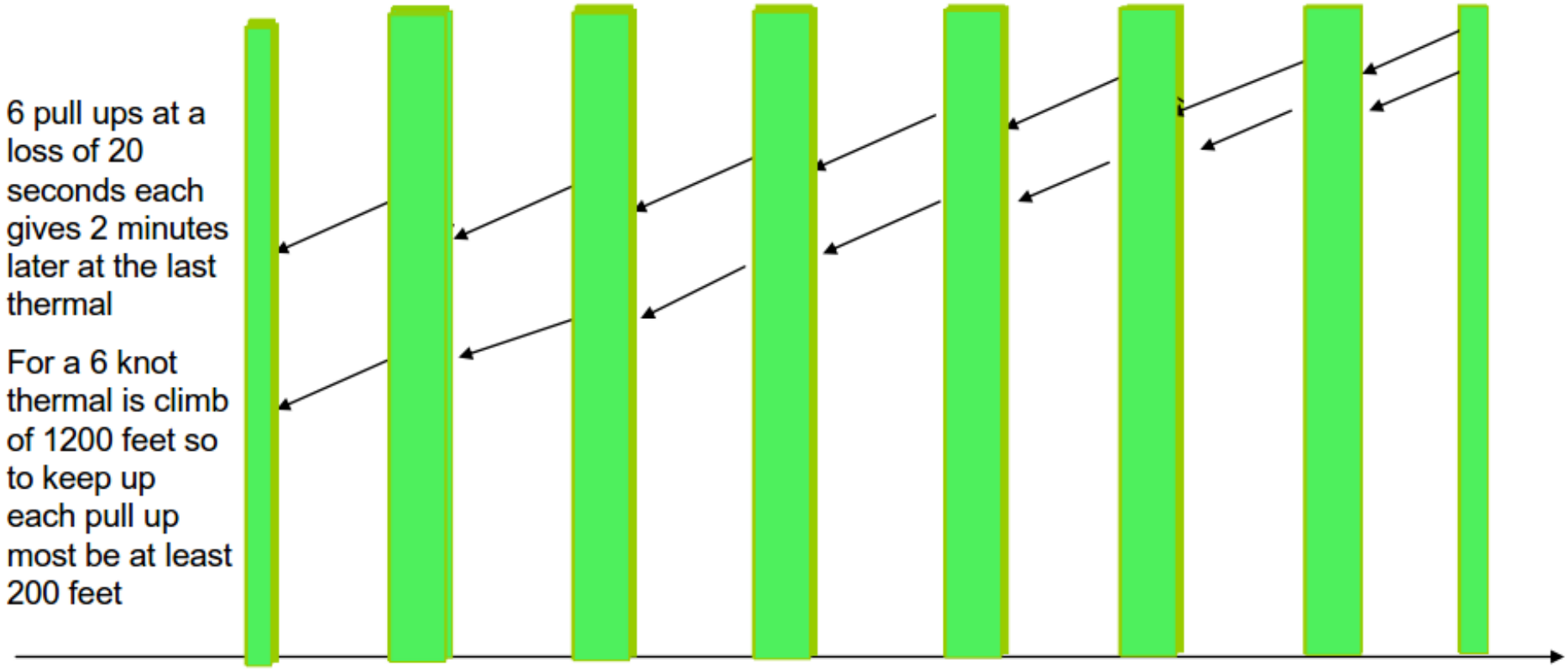


Detour


Be careful that you remain within 30 degrees
relative to the original direct track.
It is NOT 30 degrees of the new Sat Nav track!
Not acceptable
B
A
The 30 degree sector
reverses to the destination
If possible stay within the
blue triangles (+/- 10 degrees

Dolphin

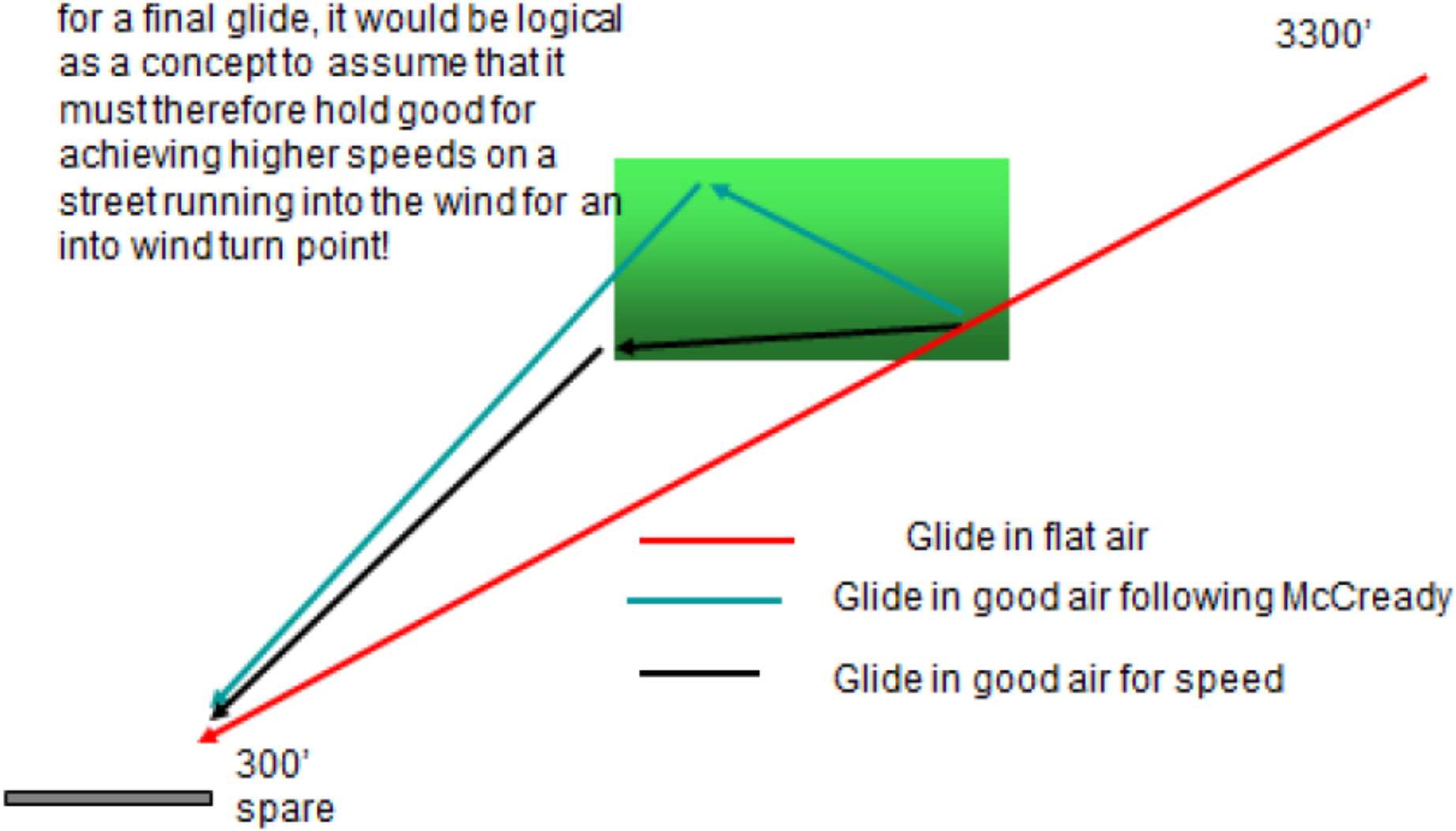
- **Another misnomer**
- **Following the MacCready religiously, it is efficient but slow. Like driving a formula one car for best fuel efficiently does not win races. All these little climbs are at nearly half the cruise speed and if any accelerations are late then it is a case of accelerating in sink – huge mistake. Simply use the lift as a gymnast uses a spring board. A gentle short pull up and bounce to maintain never less than 20 knots slower than cruise. More commonly only about 10 knots.**



If you want to think about how much time is lost, try driving down the motorway and slowing down from 80 to 40 every couple of minutes! Hopeless!

Final Glides

Whilst this argument holds good for a final glide, it would be logical as a concept to assume that it must therefore hold good for achieving higher speeds on a street running into the wind for an into wind turn point!



Final Glide

- One such danger is the reality and what the LX is actually telling you.
- The LX is simply a computer and you must understand the short falls.
- It assumes that you have entered the current QNH, correct weight, that the air ahead is standard, that the glider is really polished and it tries to give you a realistic compensation for the wind on the final glide, but it is only a simple calculator and does not (it can not) give you the full picture in terms of height needed to get in. Look out of the canopy and Bring back the John Willy!
- How accurate is the altimeter at height and how much lag do you get on the run in. A slight tap 'by' the altimeter can make an okay looking final glide into a loss of most of your safety height in a blur!
- The LX does not know the sea breeze is now blowing in your face.
- To simply set a lower MacCready so the numbers appear to work and slow down so that it infers that you can make it is simply not good enough.
- So a confident start to the final glide is a must and not become oops!

Motvind

Duo Discus

Speed to Fly and Final Glide

Head Wind - Zero on the MacCready

DRY (utan vatten)

knop

glidtal (stiltje, motvind (knop))

IAS	ROD	L/D	WIND 10	WIND 15	WIND 20	WIND 25
50	1.2	41.6	33.3	29.1	25	20.8
53	1.3	40.7	33	29.2	25.4	21.5
55	1.4	39.3	32	28.6	25	21.4
60	1.7	35.3	29.4	26.5	23.5	20.6
65	2.0	32.5	27.5	25	22.5	20
70	2.25	31.0	26.6	24.4	22.2	20
75	2.78	27	23.4	21.6	19.8	18
80	3.25	24.6	21.5	20	18.5	16.9
85	4.25	20.0	17.6	16.5	15.3	
90	5.2	17.0	15.4	14.4	13.5	

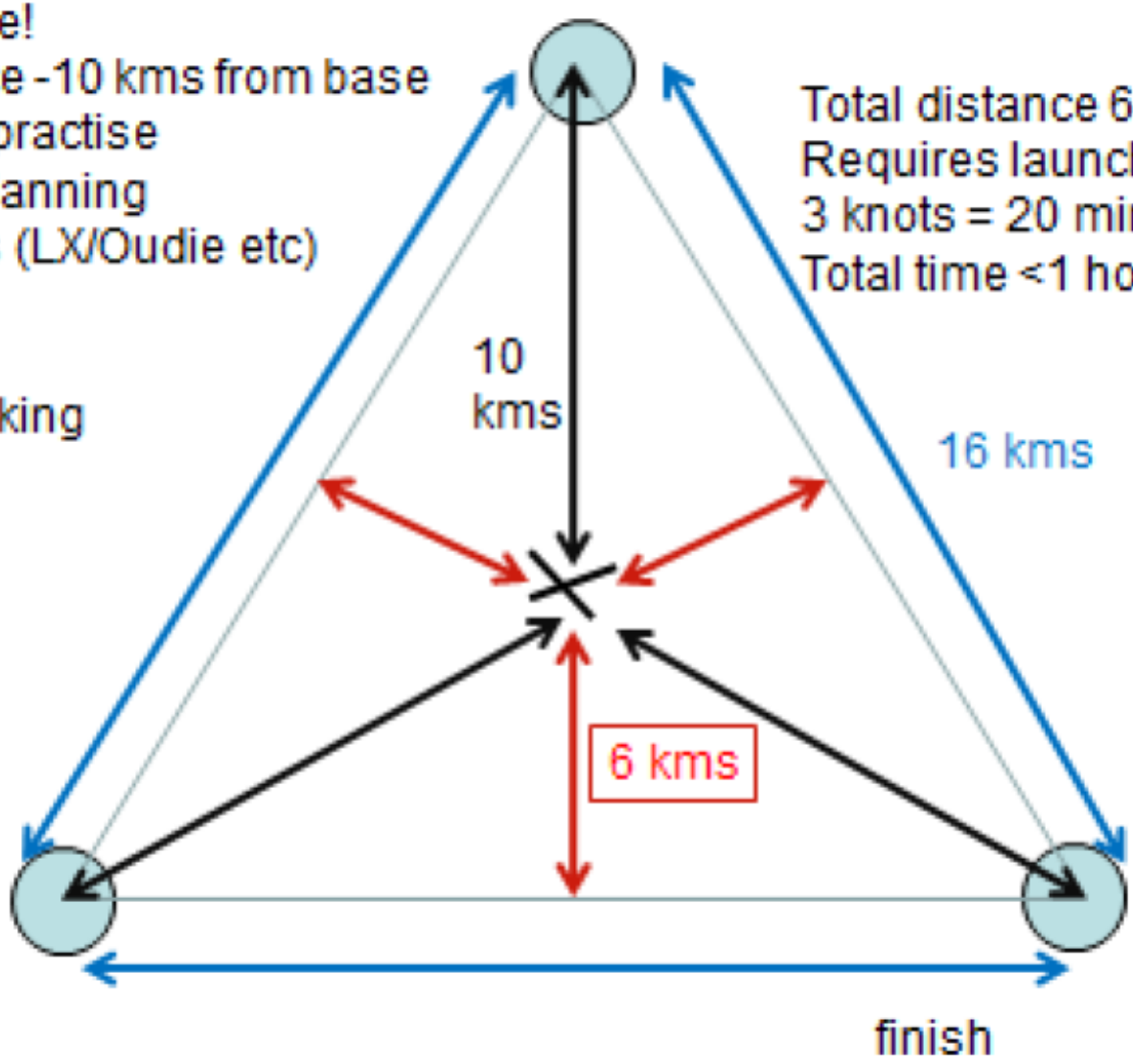
WET Vattenbarlast

IAS	ROD	L/D	WIND 10	WIND 15	WIND 20	WIND 25
50	1.25	40	32	28	24	20
55	1.3	42.3	34.6	30.7	26.9	23
60	1.5	40	33.3	30	26.6	23.3
65	1.7	38.2	32.3	29.4	26.4	23.5
70	1.9	36.8	31.6	28.9	26.3	23.7
75	2.2	34	29.5	27.3	25	22.7
80	2.5	32	28	26	24	22
85	2.85	29.8	26.3	24.6	22.8	21.1
90	3.3	27.2	24.2	22.7	21	19.7
95	4	23.75	21.25	20	18.7	17.5

Träning

The 48km Triangle Trainer Task
10 km radius

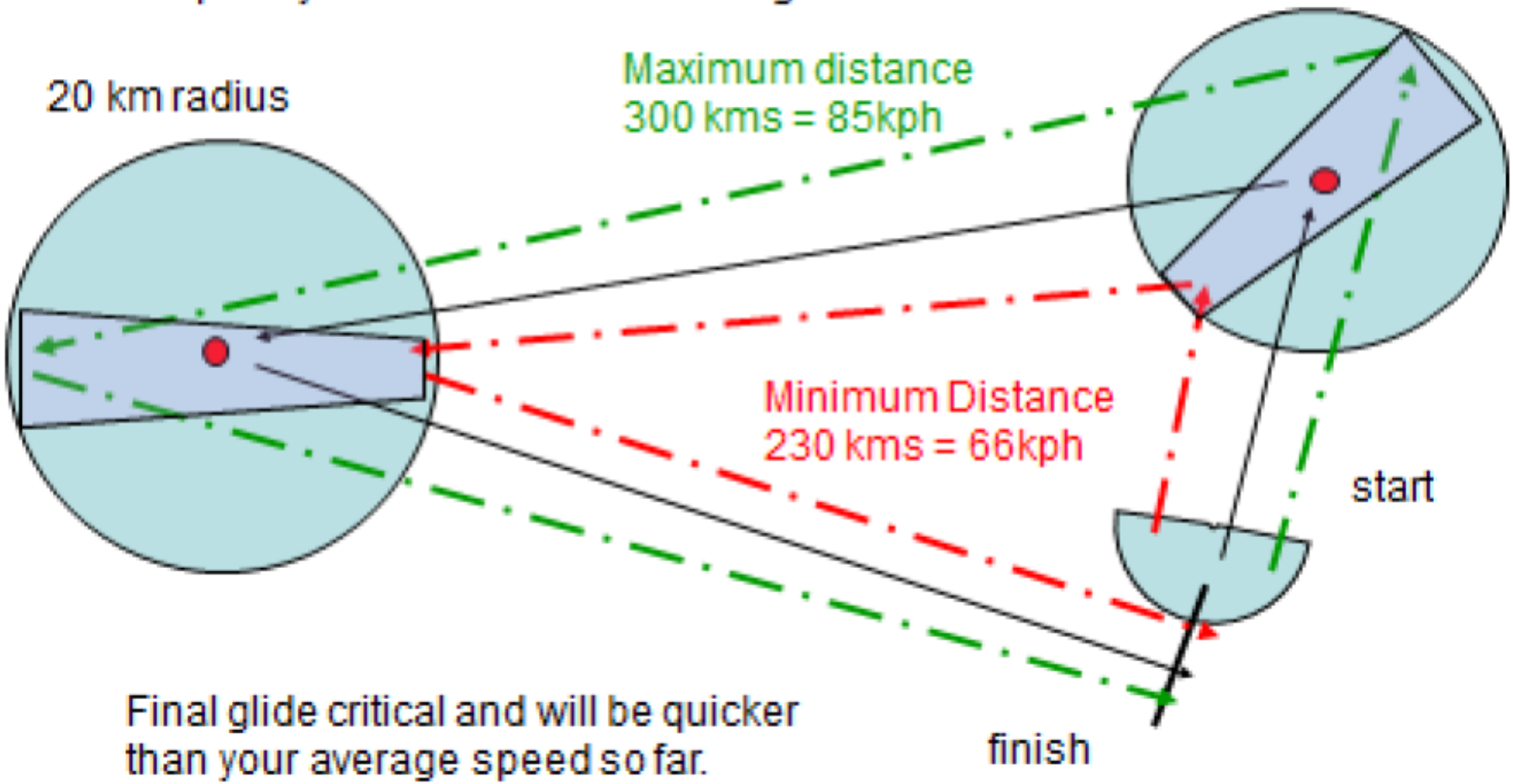
Fixed Course!
Max Distance -10 kms from base
To Teach or practise
Map route Planning
Sat Nav Aids (LX/Oudie etc)
Start
Turn Points
Decision Making
Into wind
Cross Wind
Down Wind
Final Glide



Total distance 68 kms
Requires launch + 6000'.
3 knots = 20 minutes climbing
Total time <1 hour

Assigned Area Task

Task may be a set time (3 ½ hours seems common). Must not arrive early or penalties as you are scored for a 3 ½ hour duration! This also means that assuming the crew know when you started then they know when you are going to finish – hopefully. Look/Plan far ahead to get minimum detour.



Lead and Follow

Where to follow?

Not exactly behind, as you will lose performance flying in the leaders downwash.

2 SHIP FLYING

Mutual Benefit.

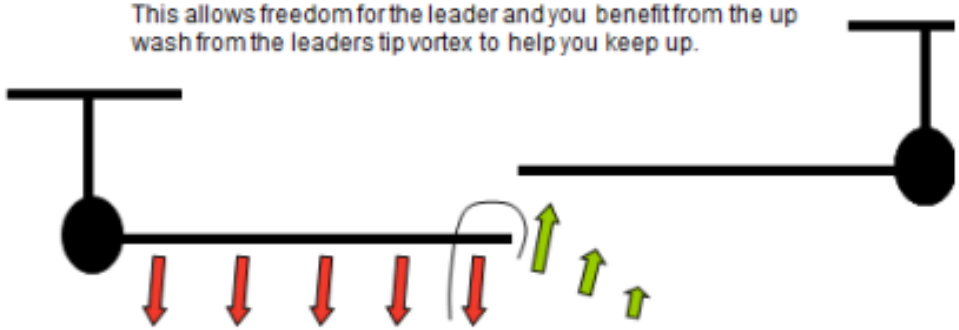
Less than 250 metres.

Lead and follow.

Lead and Follow

About 10 to 20 seconds behind and half a wing span out is good.

This allows freedom for the leader and you benefit from the up wash from the leaders tip vortex to help you keep up.



Lead and Follow

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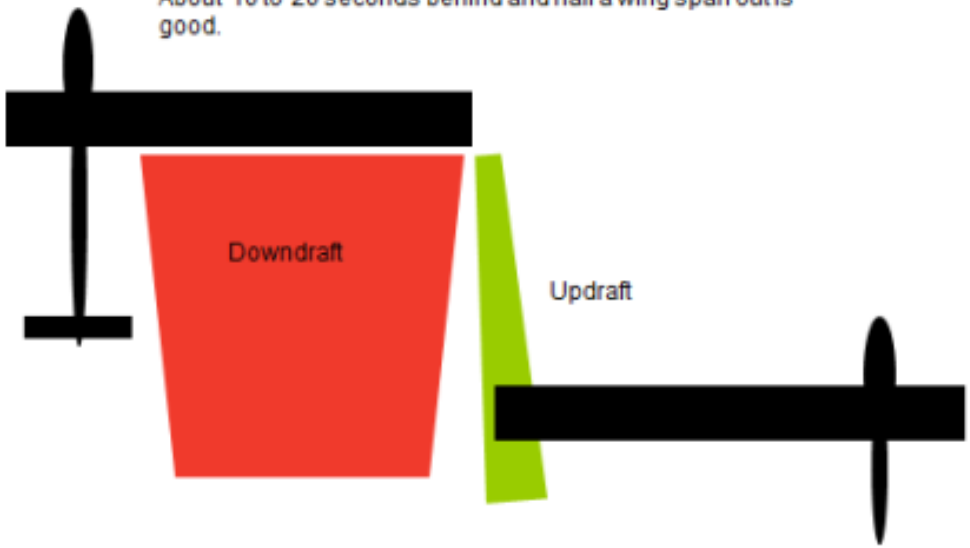
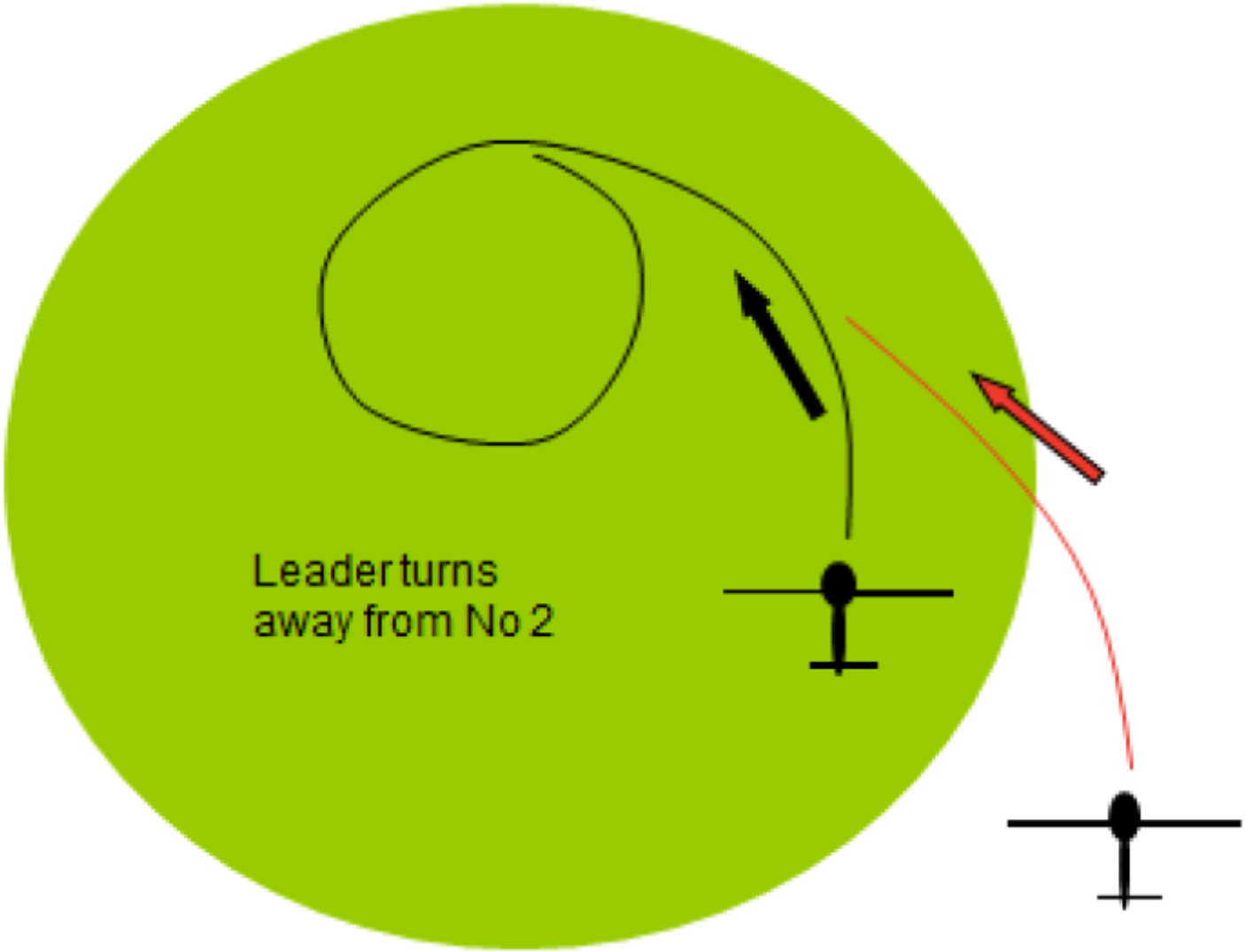


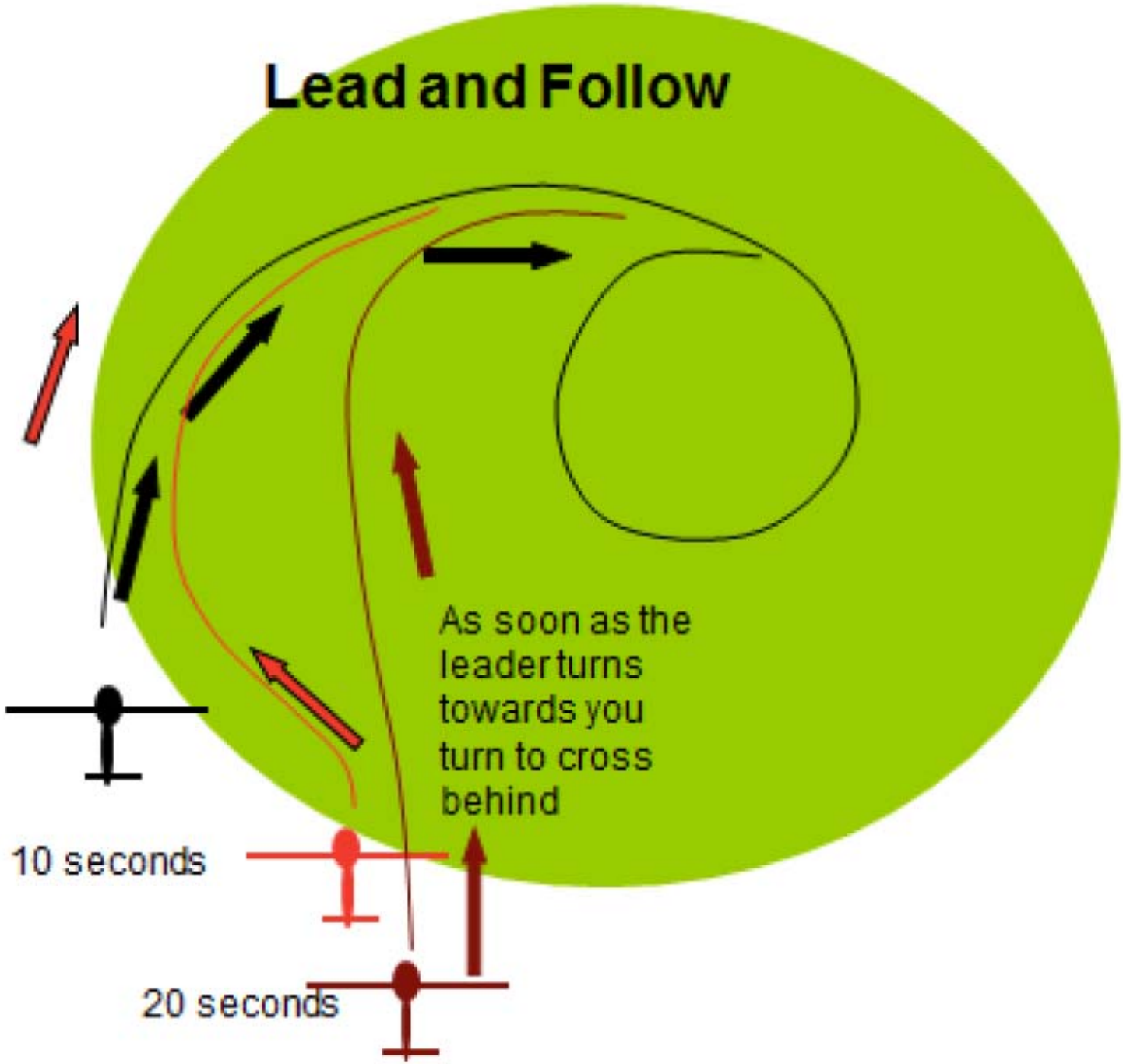
Spacing

- The reason for 10-20 seconds is simple. Firstly it hopefully means that you won't lose sight of him.
- It takes about 25 seconds to do a 360 once established in a thermal so cutting the corner slightly when turning in behind the leader means that you end up directly opposite so each are both in sight.
- It also becomes clear whether you are going to climb or 'S' turn.

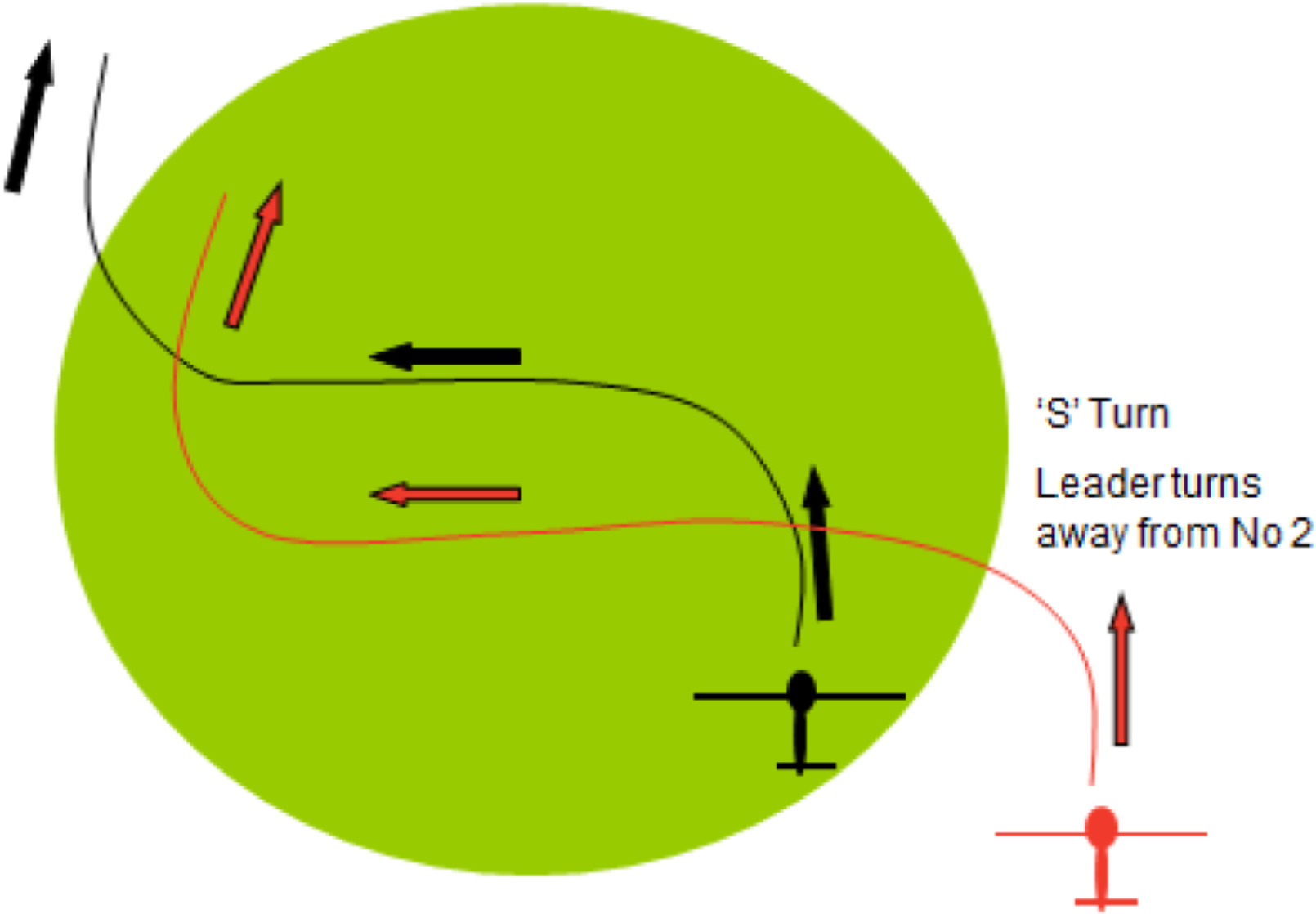
Lead and Follow



Lead and Follow



Lead and Follow



Lead and Follow