Sailplanes and Gliding

An introduction to powerless flight.
The history of the sailplane.
Sailplane design.
Getting airborne.
Staying airborne - weather systems and soaring.
Landing.
The sport of gliding - Is it for you?

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An introduction to powerless flight.

This is the closest that mankind has come to flying like a bird

An introduction to powerless flight.

New inventions invariably result from the introduction of new materials or a technological breakthrough and powered flight was no exception.

Being powerless the sailplane wasn’t “on hold” waiting for engines of sufficient power to weight ratio to be developed. The sailplane was therefore able to pre-date all forms of “powered” flight.

As engine development progressed, the fixed-wing aircraft eventually took to the skies but it was some time until a truly vertical take-off and landing aircraft (the helicopter) was realised. An interim form of rotorcraft (the autogyro) was developed and it preceded the helicopter by more than a decade.

There will be a lecture on the autogyro and a lecture on the helicopter later in this course, when the virtues of each of these aircraft will be explained.

Irrespective of the type of aircraft, fundamentally they all have just four forces acting upon them which must be in balance for sustained flight!

An introduction to powerless flight.

Forces on an aircraft:

Aerodynamic forces – **Lift** and **Drag**

Mass forces – Weight (& Inertia)

Propulsive forces – Aerodynamic, Jet Reaction, Gravity (or combinations thereof).

Aerodynamic forces:

Lift – A useful force, always acts perpendicular to the direction of flight.

Drag – An undesirable and unavoidable force associated with generating lift and additionally associated with many non-lift generating elements of the aircraft structure. It always acts in the opposite direction to flight.

Mass forces:

Generally needs to be kept to a minimum so as to reduce the required **Lift** force but this is not always the case!

Propulsion forces:

Must be greater than the aircraft **Drag** force for successful flight.

An introduction to powerless flight.

For efficient flight the power required must be kept to the minimum

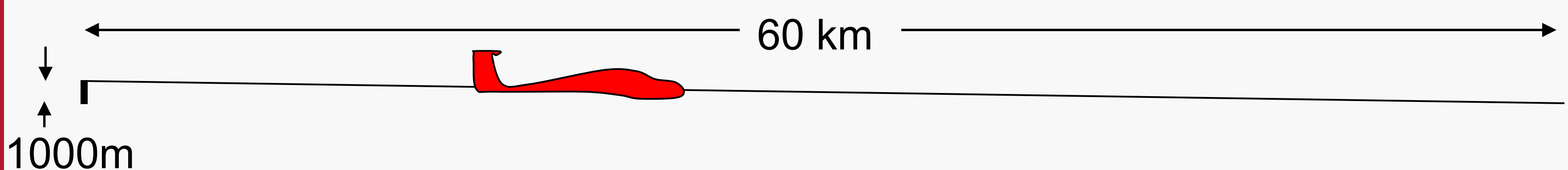
The Propulsive power is the product of the **Drag** force and the aircraft velocity.

Therefore it is essential to generate the required **Lift** with the minimum **Drag**.

As **Drag** is an unavoidable byproduct of **Lift**, the aircraft mass must be as low as possible, (generally speaking).

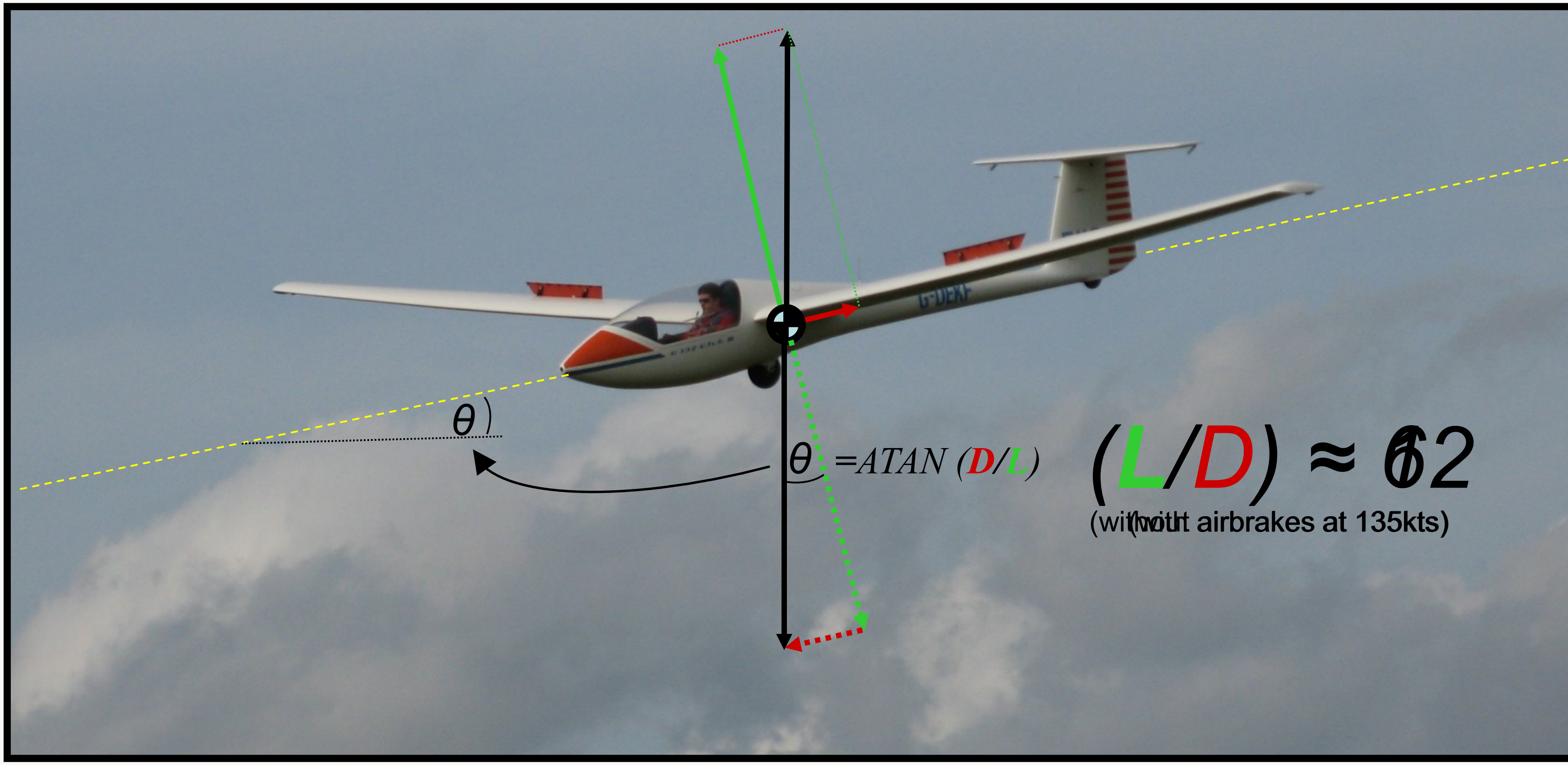
Maximisation of the **Lift** to **Drag** (**L**/**D**) ratio has been and always will be the principal focus of the aircraft designer and more specifically the aerodynamicist.

The sailplane designer leads the way on aerodynamic efficiency and modern sailplanes can now have an overall (**L**/**D**) ratio in excess of 60.



An introduction to engineless flight.

powerless?



An introduction to engineless flight.

The history of the sailplane.

Milestones of flights (in chronological order):

(First flight dates) *(Developments of aircraft dates)* *(Installed power)*

Engine
~~Power~~less flight – ***(1852)*** Cayley's glider ***(1912)*** **60 years later!** ***(0 bhp)***

Powered fixed-wing flight – ***(1903)*** Wright Flyer ***(1904)*** ***(24 bhp)***

Powered rotorcraft (autogyro) – ***(1923)*** Cierva's C4 Autogiro ***(1923)*** ***(80 bhp)***

Powered rotorcraft (helicopter) – ***(1936)*** Focke-Angelis Fa61 ***(1937)*** ***(160 bhp)***

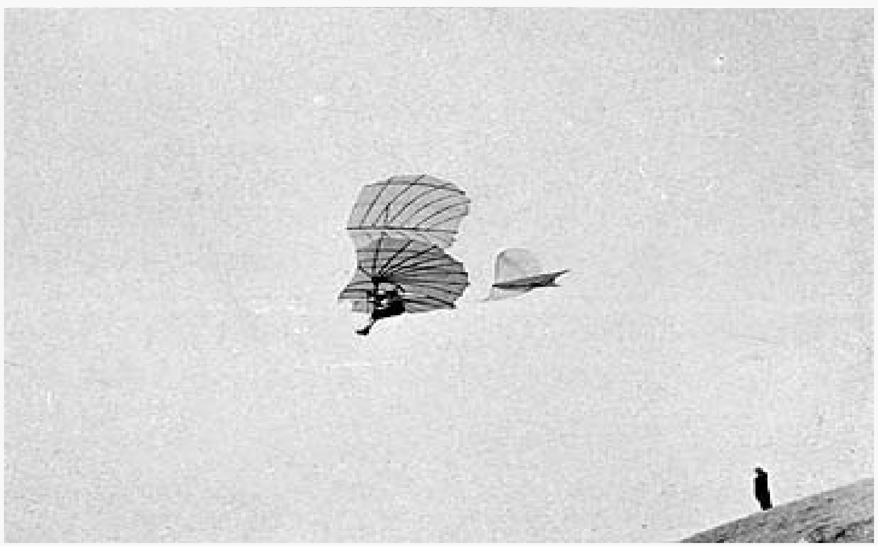
The history of the sailplane.

So, what happened in the mid-nineteenth century?

Models were constructed to imitate bird flight but of all the experimentalists, two are worth mentioning as their models extended into man carrying craft that did fly and were therefore significant.

Sir George Cayley was a Yorkshire man who built his aircraft and then forced his Butler to fly it.

Otto Lilienthal, a German eccentric would run and leap off 250ft cliffs in his gliders But after 2000 flights he died in a crash.



The history of the sailplane.

Both Cayley and Lilienthal were very methodical in their work and gained a good understanding of the mechanics of flight, particularly on stability and control.

Their research was of great benefit to the Wright brothers who pioneered powered flight some half a century later and with their success in 1903 there remained little interest in gliding.

An aside:

This "paving the way to eventual near extinction" was repeated a few years later in the development of rotary winged aircraft. Like the sailplane that preceded the powered aircraft because it didn't need an engine, so the autogyro preceded the helicopter because it didn't need such a powerful one.

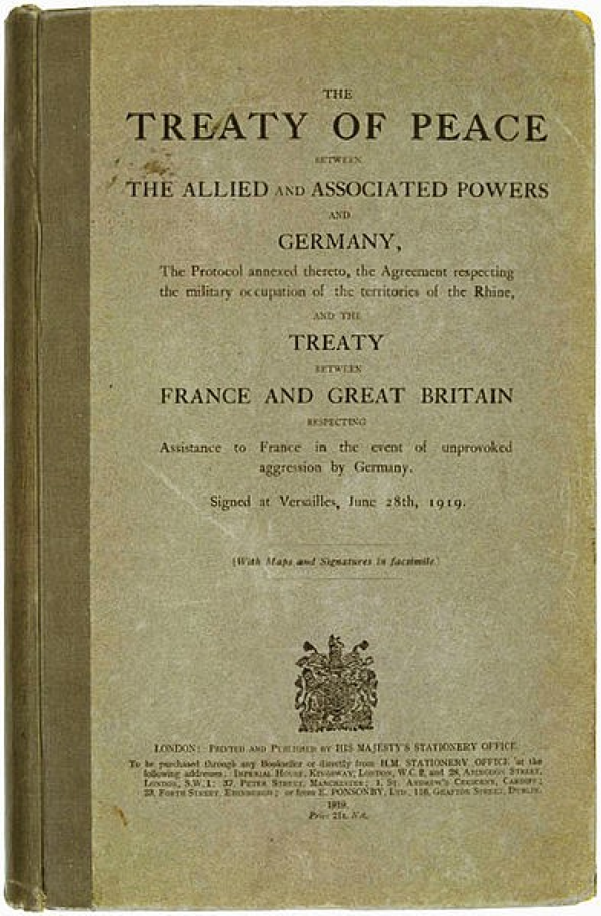
Both the sailplane and the autogyro paved the way for their successors by sorting out all the stability and control problems. They then became discarded as mere stepping stones to a better and more useful craft. It was some time later that they were adopted by enthusiasts in the field of sport aviation, due to their simplicity and low cost.

The history of the sailplane.

So, sixty years after Cayley and Lilienthal, there was a brief resurgence in sailplane design but this really took off after the World War 1 in Germany.

This was due to the Versailles Peace Treaty which stated that Germany could have no Air Force and was forbidden to indulge in any form of powered flight. The no-powered flight condition of the Versailles Treaty, rather than hindering the Germans, stimulated them to investigate the realm of gliders and creating what is known as sport gliding.

Germany dominates high level technology sailplane research, development and manufacturing and the majority of today's sailplanes are still manufactured in Germany.


THE
TREATY OF PEACE
BETWEEN
THE ALLIED AND ASSOCIATED POWERS
AND
GERMANY,
The Protocol annexed thereto, the Agreement respecting the military occupation of the territories of the Rhine,
AND THE
TREATY
BETWEEN
FRANCE AND GREAT BRITAIN
RESPECTING
Assistance to France in the event of unprovoked aggression by Germany.
Signed at Versailles, June 28th, 1919.
(With Maps and Signatures in facsimile.)
LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.
1919.

The history of the sailplane.

From the gliding perspective Cayley's efforts were not in vain as, besides aiding powered flight, a sailplane manufacturing capability did flourish in England, particularly in his native county of Yorkshire for a number of years.

Fred Slingsby formed a sailplane manufacturing company in Kirbymoorside on the Yorkshire Moors which was for fifty years the main, and for most of the time the only, producer of sailplanes in Britain.

Although the company was one of the first to use glass fibre reinforced plastics in production aircraft (as early as 1953) and were probably the first to use carbon fibre composite materials for structural members, it was the German factories and the students who trained in the Akafliegs of German Universities who prevailed. Slingsby stopped building sailplanes in 1980.

Elliotts of Newbury, a furniture factory which built wooden aircraft (including the Mosquito) during the second World War built sailplanes from 1947-65.

The history of the sailplane.

Some gliders from Slingsby Sailplanes

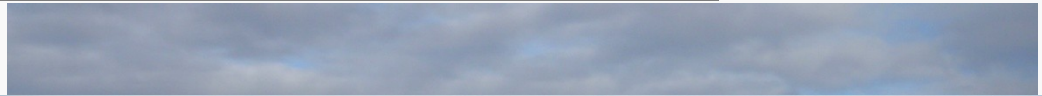
Type 30 – Prefect

The history of the sailplane.

Some gliders from Slingsby Sailplanes

Sailplane design.

Construction:



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Sailplane design.

Controls

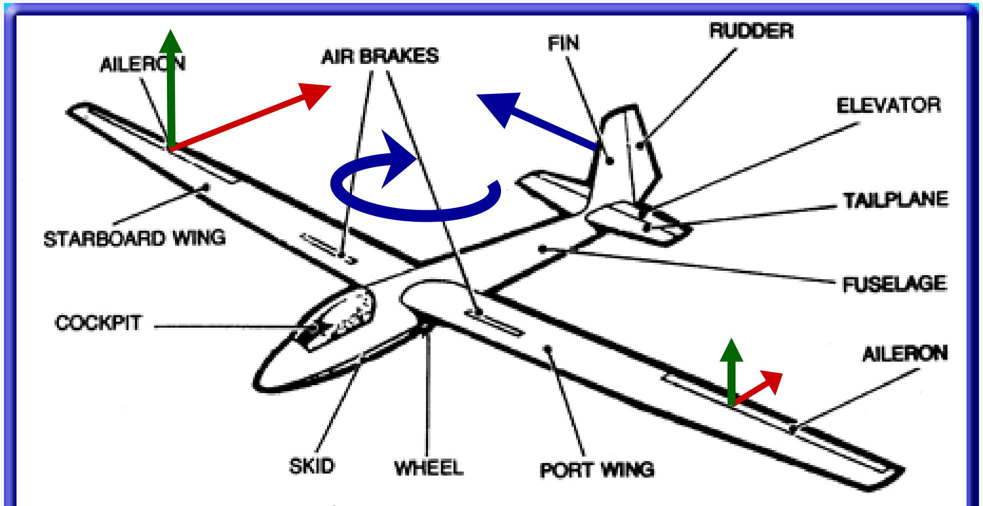
Sailplanes have a normal 3-Axis control system:

a) Tail plane elevator (or just all-moving tail plane) for longitudinal control

b) Ailerons for lateral control

c) Rudder for directional (yaw) control

Because the wing span of a sailplane is so much greater than an equivalent weight engine-powered aircraft, the lateral and directional controls are used together to counteract adverse yaw. *(shown here as rolling to port and therefore yawing to starboard)*



THE GLIDER AND ITS COMPONENTS

Getting airborne.

There are three methods (disregarding self-launching systems) by which the sailplane can become airborne and these are:

- Aerotow
- Wire launch (by drum winch or reverse pulley)
- Catapult launch (also referred to as a “bungee”)

There is generally only one way of landing a sailplane

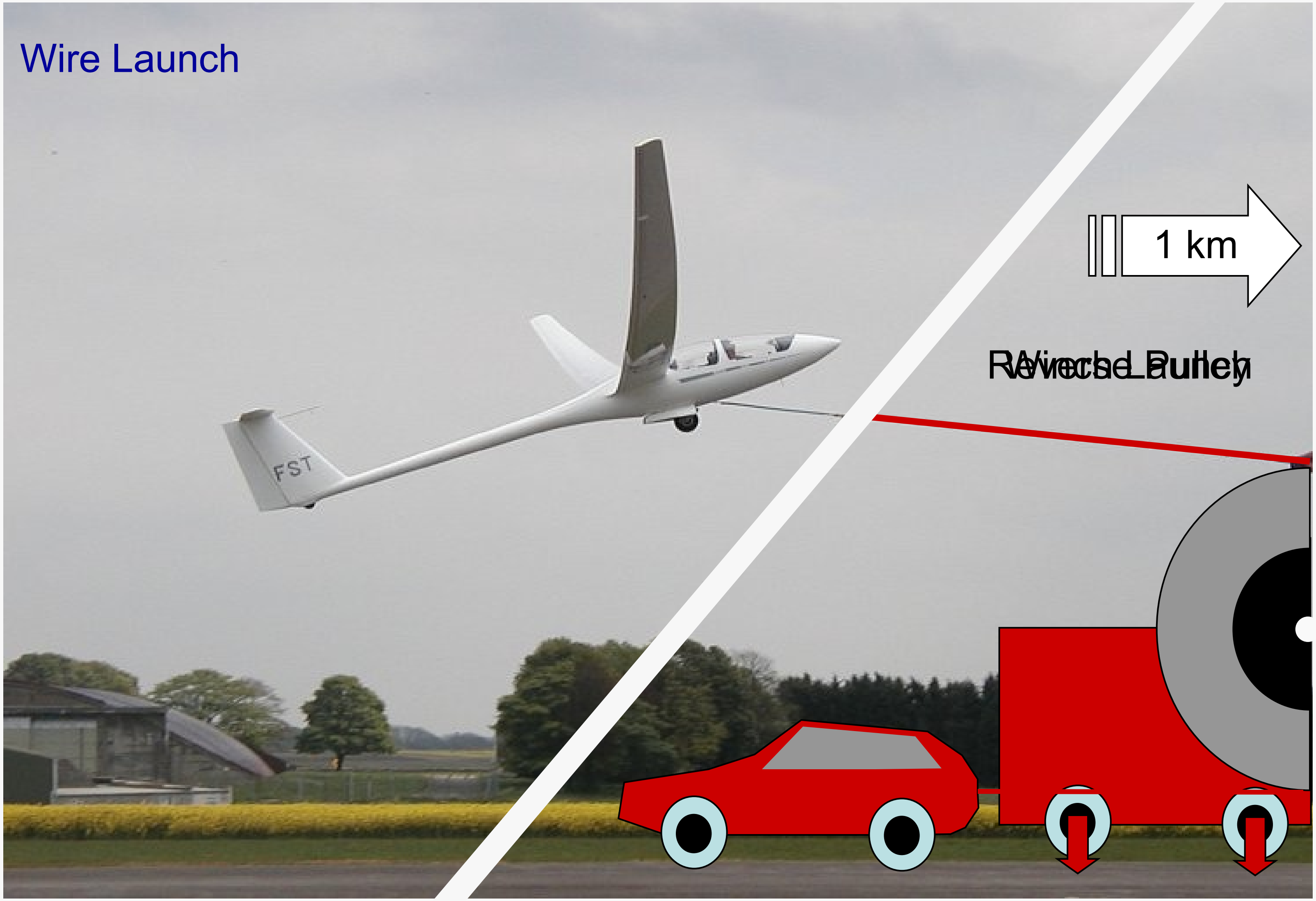
By far the most common method of launch these days is by drum winch as this is the most affordable and also the most efficient time-wise.

Most UK gliding clubs have both Aerotow and Wire launch facilities.

Getting airborne.

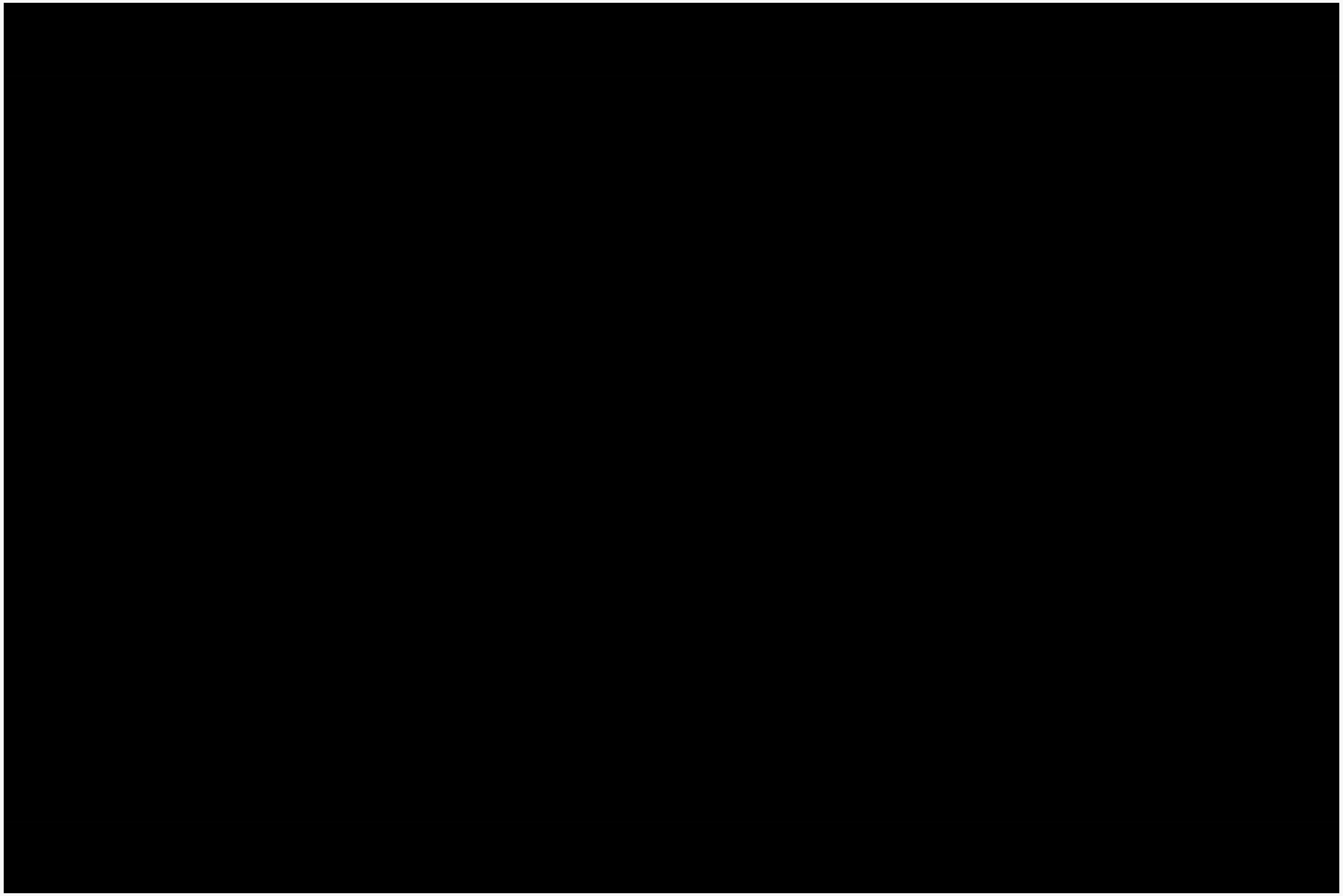
Getting airborne.

Getting airborne.



Back to "The history of the sailplane"

Getting airborne.



Getting airborne.

Getting airborne.

Getting airborne.

Staying airborne - weather systems and soaring.

There are THREE fundamental ways that the skilled glider pilot can sustain flight by using energy in the atmosphere and these are:

- Thermal lift
- Hill lift
- Mountain lee wave lift

A few gliding sites in Britain are so favourably situated that pilots are able to utilise all forms of lift so the art of soaring can be an all-year-round sport.

One must remember that at a constant speed, the glider is always in a descending flight relative to the air mass through which it flies. Thus for sustained flight the air mass must be ascending at a rate equal to, or greater than the rate of descent of the glider.

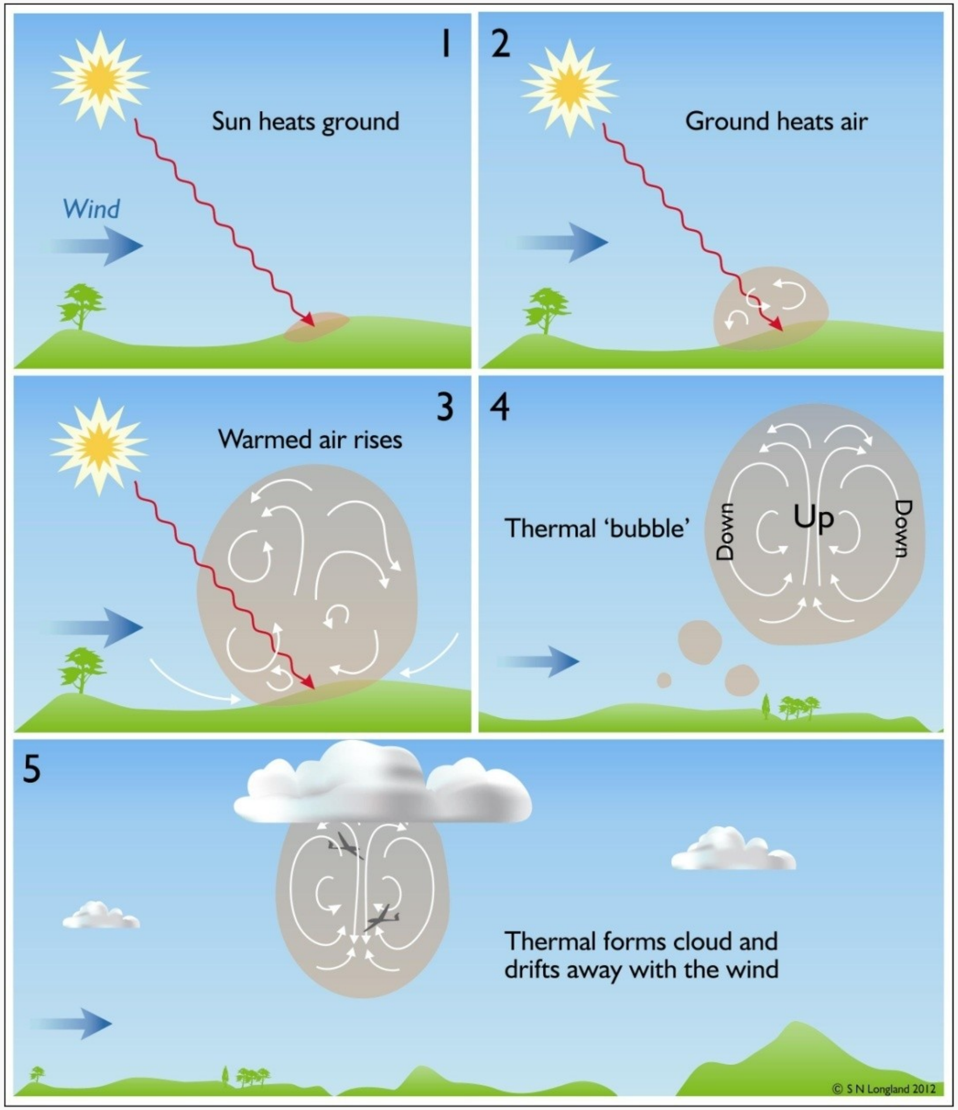
Staying airborne - weather systems and soaring.

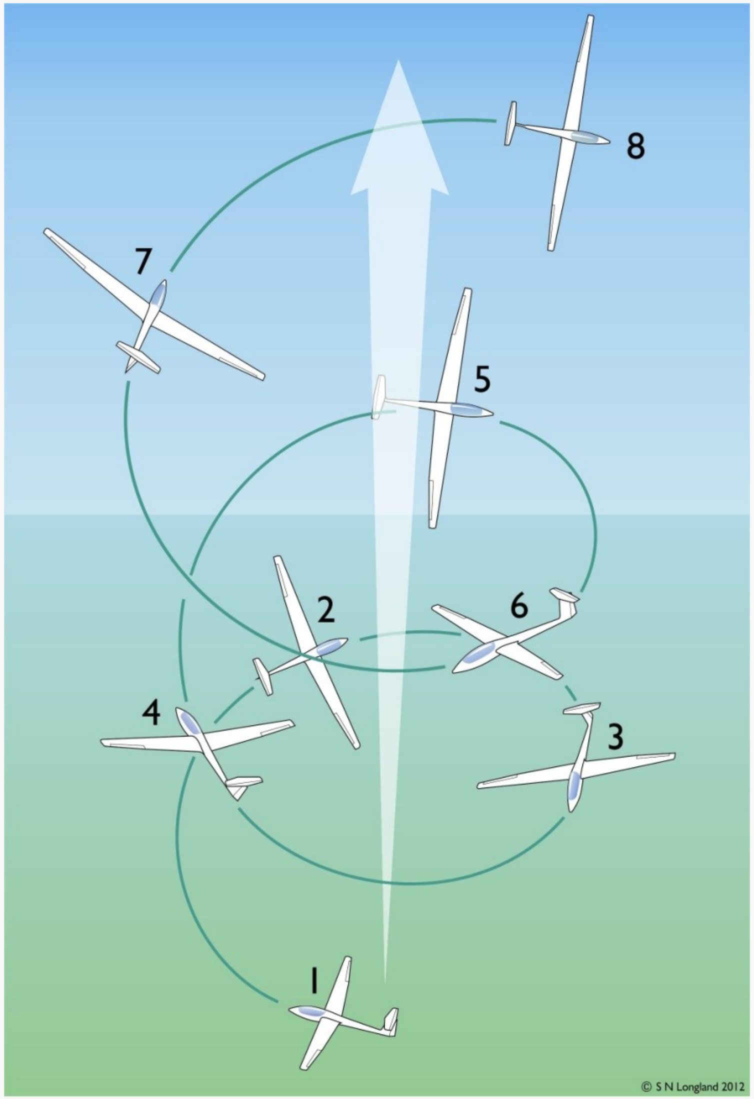
Thermal lift – results from the uneven heating of the earth's surface on local scale with brown fields heating up more rapidly than say, green fields, woodland or lakes. This will cause the air above a brown field to expand more rapidly than surrounding green fields and the air will rise. This is known as a thermal.

The intensity of the energy within a thermal is directly proportional to the sun's heating effect and the thermal instability of the air. Thus the use of thermal is very much seasonal with strong thermal activity in the uk for up to 10 hours per day in the summer.

By using thermals as "fuel stations" pilots are able to cover large distances, frequently in excess of 500km on really good days. Flights of up to 1000km have been made in this country by the best pilots, in the best aircraft on the very best days in a British good summer!

Staying airborne - weather systems and soaring.





AVDASI 1 – Introduction to Sailplanes and Gliding

Staying airborne - weather systems and soaring.

Staying airborne - weather systems and soaring.

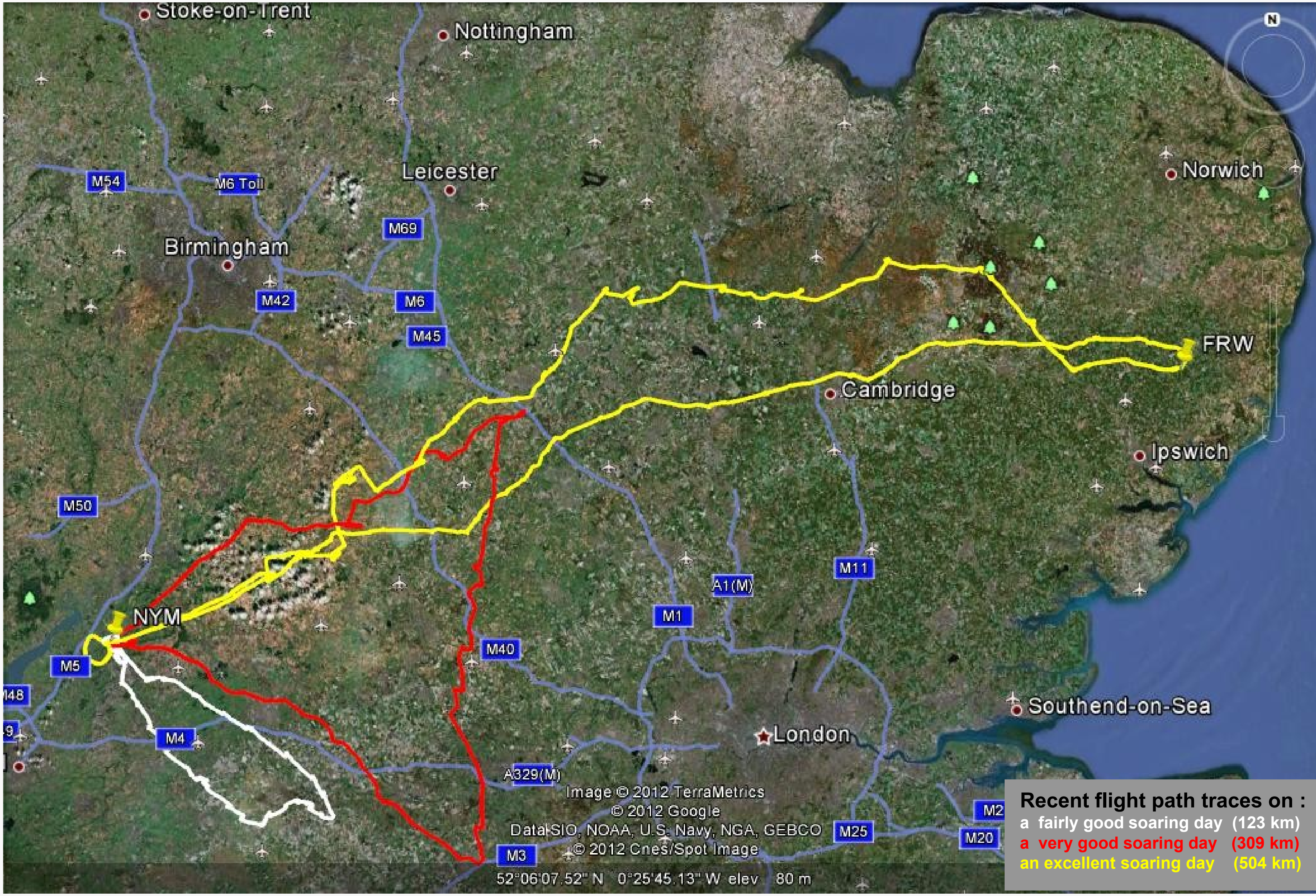

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Image © 2012 TerraMetrics
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52°06'07.52" N 0°25'45.13" W elev 80 m
Recent flight path traces on :
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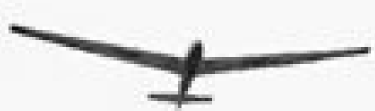
a very good soaring day (309 km)
an excellent soaring day (504 km)



Staying airborne - weather systems and soaring.

Hill Lift – results from that vertical component of air that is forced to rise as the wind blows against a hill or escarpment.

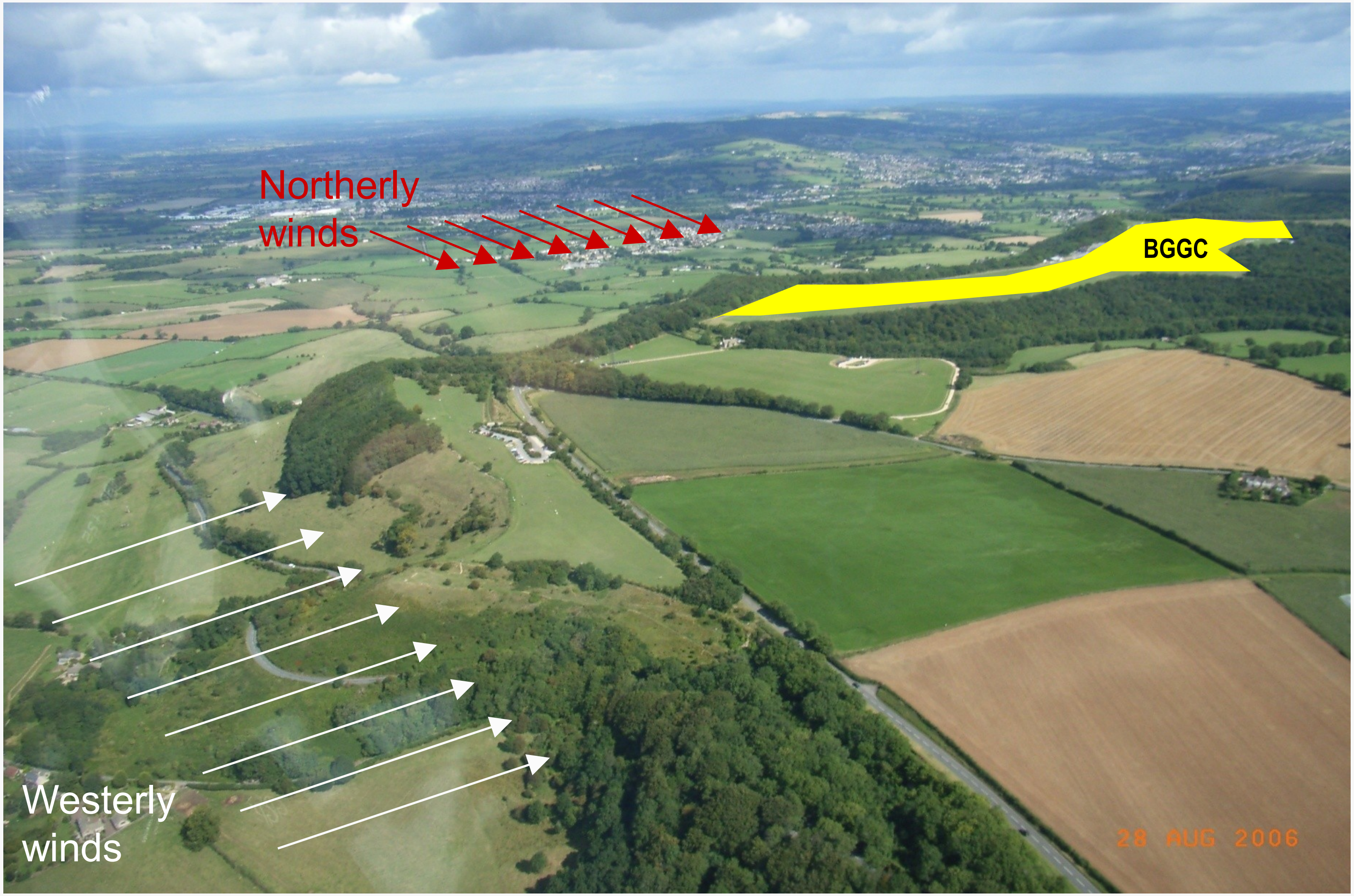
The region of “lifting” air is restricted to a band running parallel with the ridge of the hill and is characterised by the hill shape, wind speed and wind direction.

The Bristol and Gloucestershire Gliding cub is situated at an altitude of 700 ft (above mean sea level) on the Cotswold escarpment which runs from the city of Bath in the south to Cheltenham in the north. If the wind strength and direction are favourable (generally > 10 knots from a north-westerly direction) then the entire ridge will “work” and flying the entire ridge is possible. At heights rarely above 1000 ft, this can be a truly exhilarating experience

These conditions are more common during the autumn and winter seasons when thermal activity is less prevalent.

Staying airborne - weather systems and soaring.

Staying airborne - weather systems and soaring.



Staying airborne - weather systems and soaring.

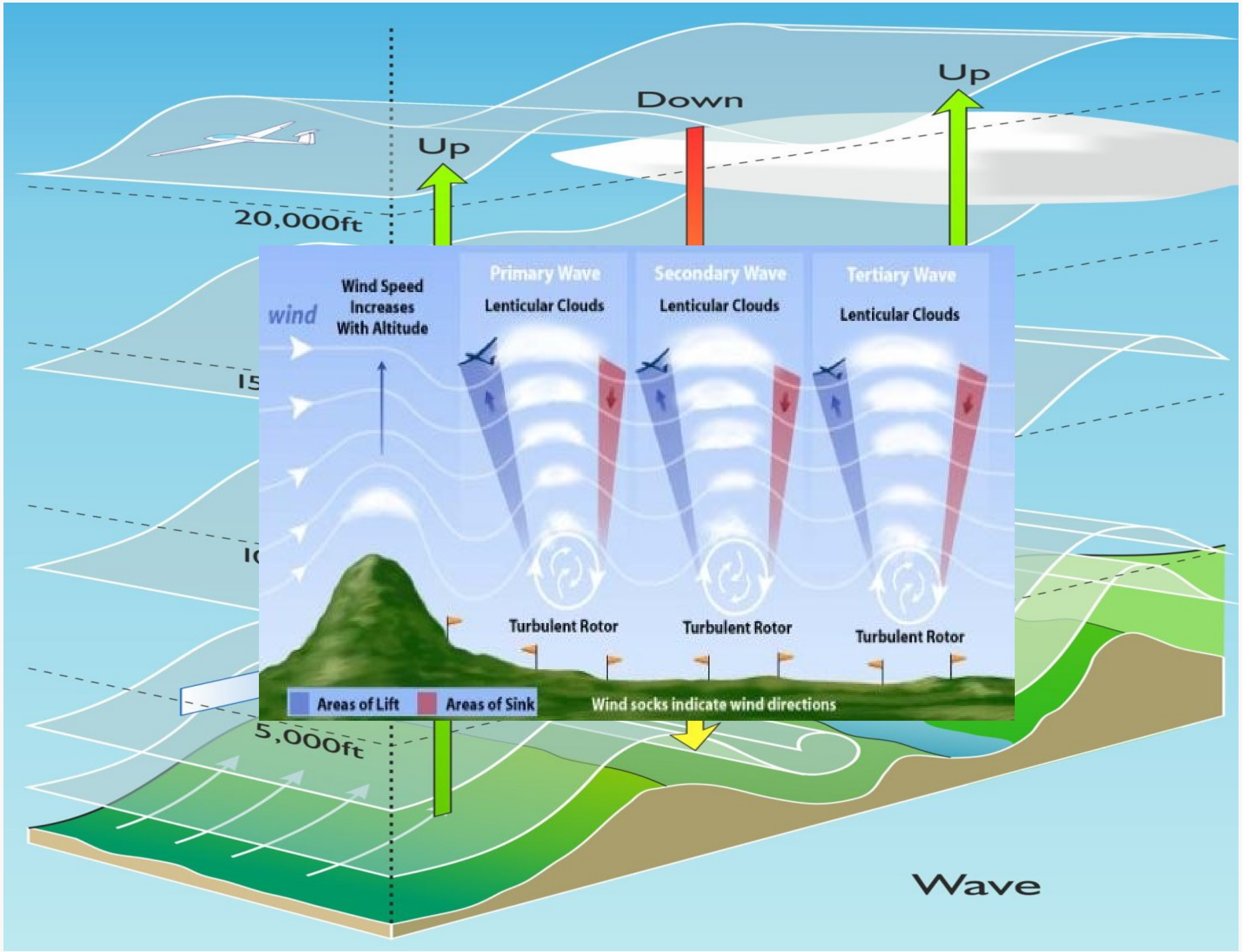
Lee wave lift – results from using the bands of rising air that can (under certain meteorological condition) form in the lee of mountains and large hill ranges.

Like ridge lift, a specific combination of wind strength and direction is required. Once the air has gone over the top of the hill or mountain it cascades down the other side (the leeward side) with considerable energy and “bounces” up again. This process can be repeated and exist for considerable distance downwind of the hill.

The art of wave flying is to position the glider in the up currents, avoiding the equally strong down currents associated with this oscillating air mass.

The tops of the rising air currents are often made visible by cloud formation known as lenticular clouds due to their shape which is like a very thin lens.

Staying airborne - weather systems and soaring.



Landing

Landing a sailplane requires good judgement and skill, more so than for a powered aircraft because the pilot has only one chance to get it right.

Also, the landing may not always be at a designated airfield.

All sailplanes are fitted with “airbrakes” or “spoilers” which increase the rate of descent and more importantly reduce the glide angle. In addition, the old technique of slide-slipping can be utilised to further increase the rate of descent. Some gliders have tail chutes but this is not common.

A good landing is nearly always the result of a good final circuit, during which the pilot positions the aircraft with suitable safety margins to take account of wind direction, wind speed and wind shear.

Wind shear is particularly important aspect when landing on a hilltop site such as Nympsfield, the home of the Bristol & Gloucestershire Gliding Club.

Landing

The sport of gliding - Is it for you?

So what does it offer?

- A sense of achievement
- Excitement
- A competitive spirit both against the weather and fellow pilots
- Camaraderie
- Team work – you cannot launch yourself!
- Healthy exercise in some very beautiful areas of the country
- An opportunity to better understand weather and principles of flight
- Affordable flying, especially through membership of the BUGC

(For further details follow the university link on www.bggc.co.uk)

WARNING – It can become more than just a hobby, there are many pilots in their eightieth year who were younger than you when they started gliding.

Any Questions ?