Sport Aviation

http://www.drjack.net/fisheye_big_smooth+ultradg400.jpg

Goal

- Find a region where the air is ascending faster than the craft sinks with respect to the air:
  - Where wind blows up the side of a hill
  - Where rising air occurs as a result of surface heating
  - Where atmospheric waves form often in the lee of hills or in the vicinity of convective updrafts

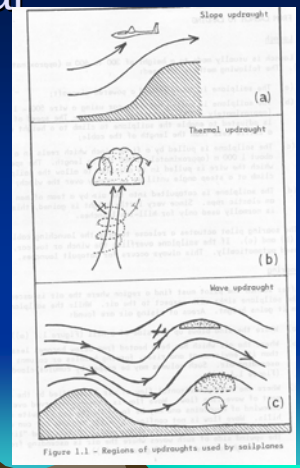


Figure 1.1 – Regions of updraughts used by sailplanes

WMO 1993

Terminology

- Thermal: discrete buoyant element often caused by inequitable distribution of solar heating at the surface
- Convection: Turbulent motion resulting in transport and mixing of fluid

Pilots wish to know:

- When convection will begin
- How long convection will persist
- How high the thermals will extend
- The area where thermals will occur
- The strength of the thermals
- If showers or thunderstorms will develop

- http://www.drjack.net/BLIPMAP/SW/index.html
- http://www.drjack.net/BLIPMAP/SW/first.wfpm.21z.png

Physics of Flight

- Weight- downward directed force due to mass of craft
- Lift- force of the air pushing craft upwards
- Drag- retarding force due to motion of craft through the air

http://ldaps.arc.nasa.gov/Physics/liftdrag.html

Irving 1999

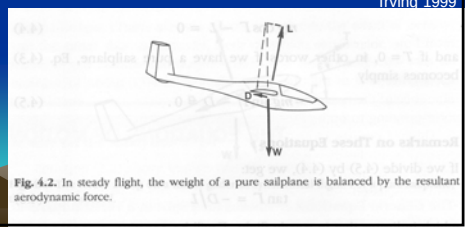
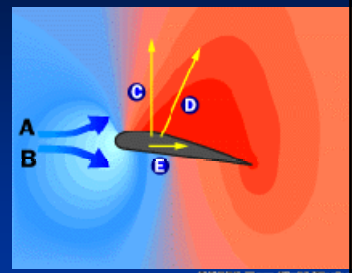


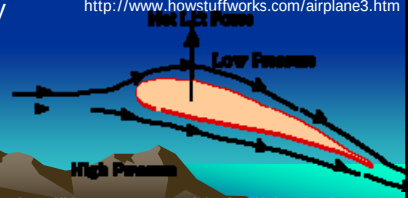
Fig. 4.2. In steady flight, the weight of a pure sailplane is balanced by the resultant aerodynamic force.

Lift

- A: Air approaching wing is compressed, lifted. As wing curves downward, low pressure develops above wing
- B: Air approaching wing is compressed, sinks. Pressure increases slightly
- C: Lift force
- E: Drag
- D: Resultant force



http://www.howstuffworks.com/airplane3.htm



http://ldaps.arc.nasa.gov/Physics/liftdrag.html

Drag

- Turbulence increases drag
- If angle of attack of wing is too large, drag increases

These two airfoils have the same drag

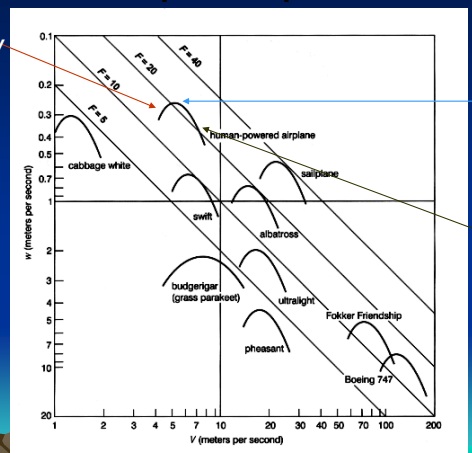
http://ldaps.arc.nasa.gov/Physics/liftdrag.html

Speed polars

Too slow

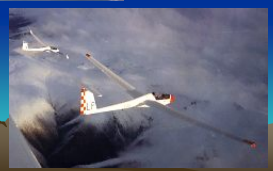
Just right

Too fast



http://hjem.get2net.dk/helmuth/data-diff.html

Gliders



Whiteman

Motorgliders

Whiteman

Gliders

Characteristic	*Range of values*
Wing span	11 - 29 m
Empty weight	80 - 500 kg
Gross weight	200 - 750 kg
Best glide ratio	1:27 at 75 kph (46 mph) to 1:60 at 110 kph (68 mph)
Minimum sink rate	0.45 - 0.75 m/s (1-2 mph)

WMO/OSTIV (1999)

Hang gliders

Whiteman

Hang gliders

Characteristic	*Typical values*
Wing span	10 m
Wing area	15 m^2
Empty weight	30 kg
Loaded weight	70-100 kg
Stalling speed	25 kph
Best glide ratio	1:12
Effective maximum speed	70 kph
Terminal diving speed	90 kph

WMO/OSTIV (1999)

Paragliders

Whiteman

Hot air airships

Whiteman

Hot air balloons

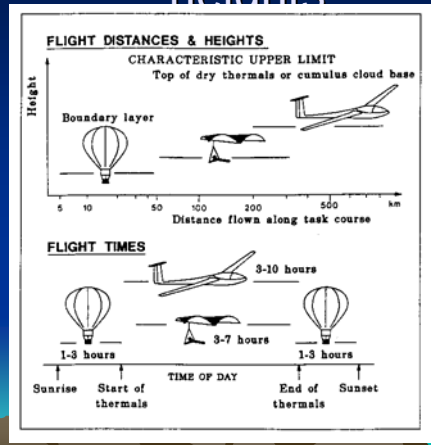
Whiteman

Hot air balloons

Characteristic	*Range of values*
Envelope volume	1600 - 8500 m^3
Height (top to bottom)	20 - 40 m
Weight	1.5 - 10 tonnes (1500 - 10000 kg)
Free lift	850 - 2000 kg
Maximum rate of ascent	5 m s^{-1}
Terminal descent rate	3.5 - 4 m s^{-1}

WMO/OSTIV (1999)

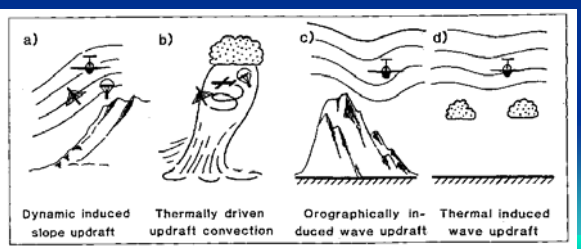
Flight distances, times and heights



WMO (1993)?

Good lift conditions

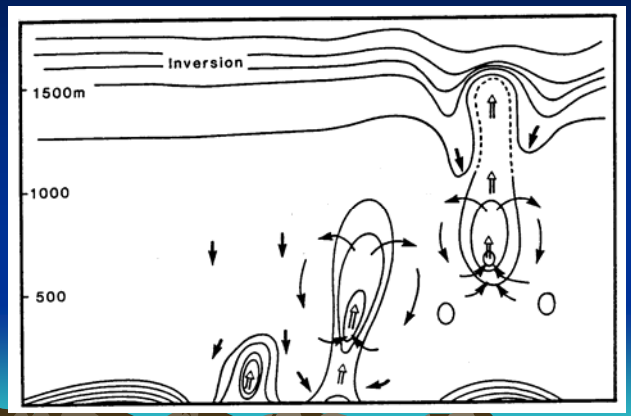
- Dynamically induced slope updraft (slope soaring)
- Thermally driven updraft (convection)
- Orographically induced waves
- Thermally induced waves
- Other forms of convergence



WMO (1993)?

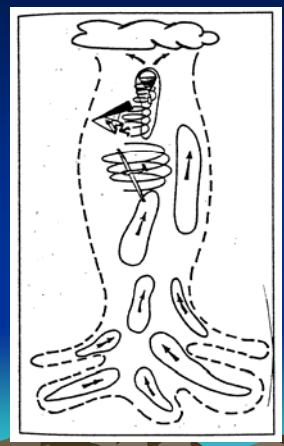
Slope soaring

Convective bubbles



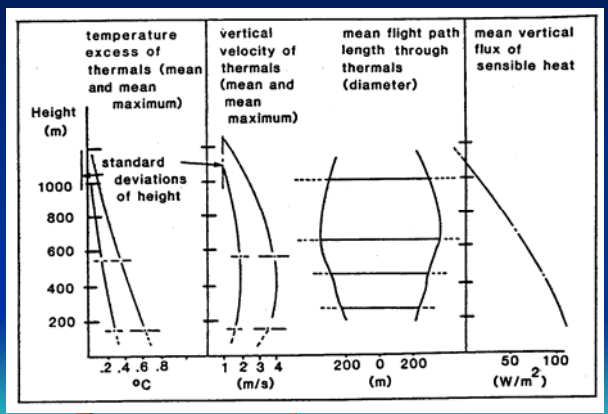
WMO (1993)

Bubbles in the bubble



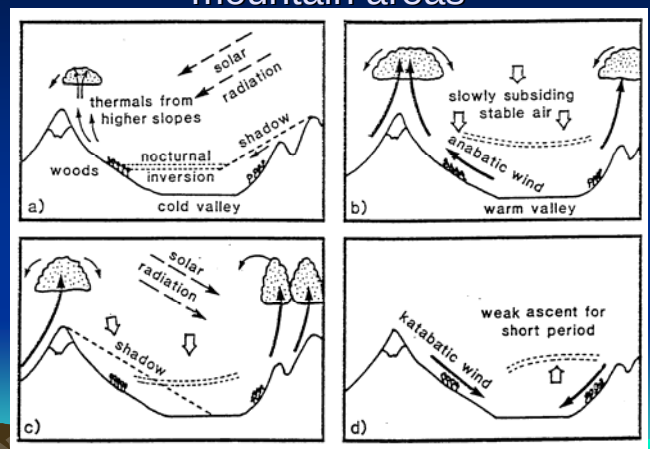
WMO (1993)

Thermal characteristics



Unknown (19xx)

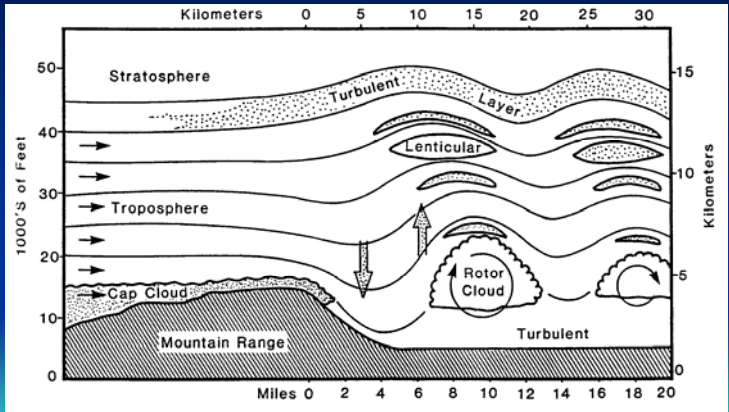
Sequence of thermal activity in mountain areas



a) morning, b) noon, c) afternoon, and d) evening

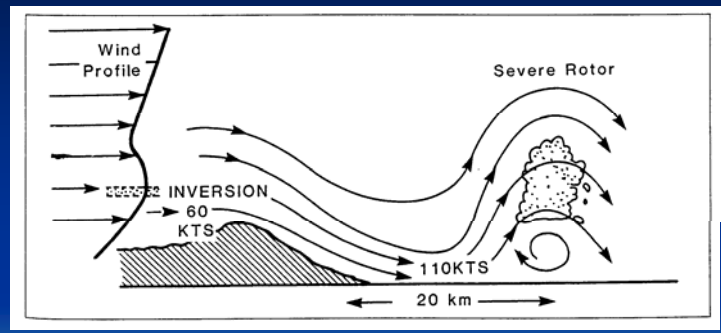
WMO (1993)

Flow over mountains



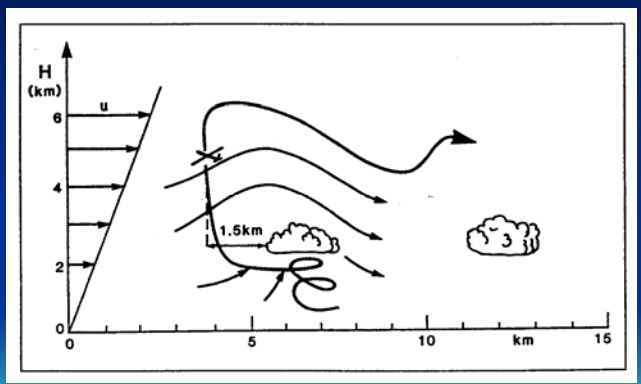
WMO (1993)

Severe rotor



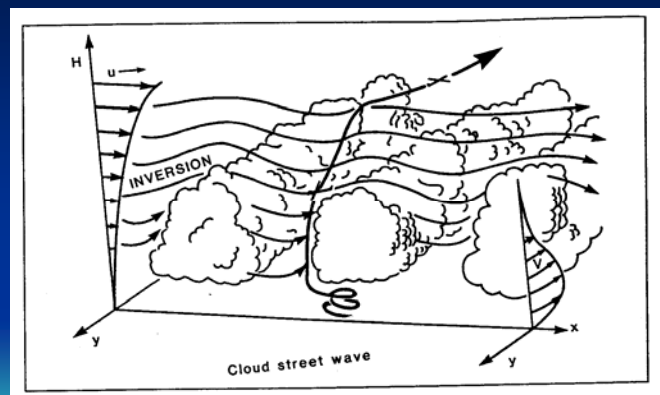
WMO (1993)

Soaring in cumulus waves



WMO (1993)

Wave above convection streets



WMO (1993)

Wind speed component normal to street axis should exhibit shear greater than 3 m/s per 1000 m both above and below the inversion. Then, streets act line a line of mountain ranges and a wave develops above the street.

Sources

- Irving, F., 1999: The Paths of Soaring Flight. Imperial College Press. London. 131 pp. (TL 765 I78 1999)
- Whiteman, David. Class notes.
- World Meteorological Organization, 1993: *Handbook of Meteorological Forecasting for Soaring Flight, Second Edition*. WMO No. 495, Tech. Note 158, Geneva. (QC 851 W6445 no. 495)