Advance Pilot Training Lecture Series

Thermalling

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Bacchus Marsh Airfield, Australia
9 July 2005

Lecture Overview

Discovery of thermals and their importance;

Clouds, thermals and their sources;

Life cycle of a thermal;

Structure of thermals;

Finding the centre;

Glide polar fundamentals;

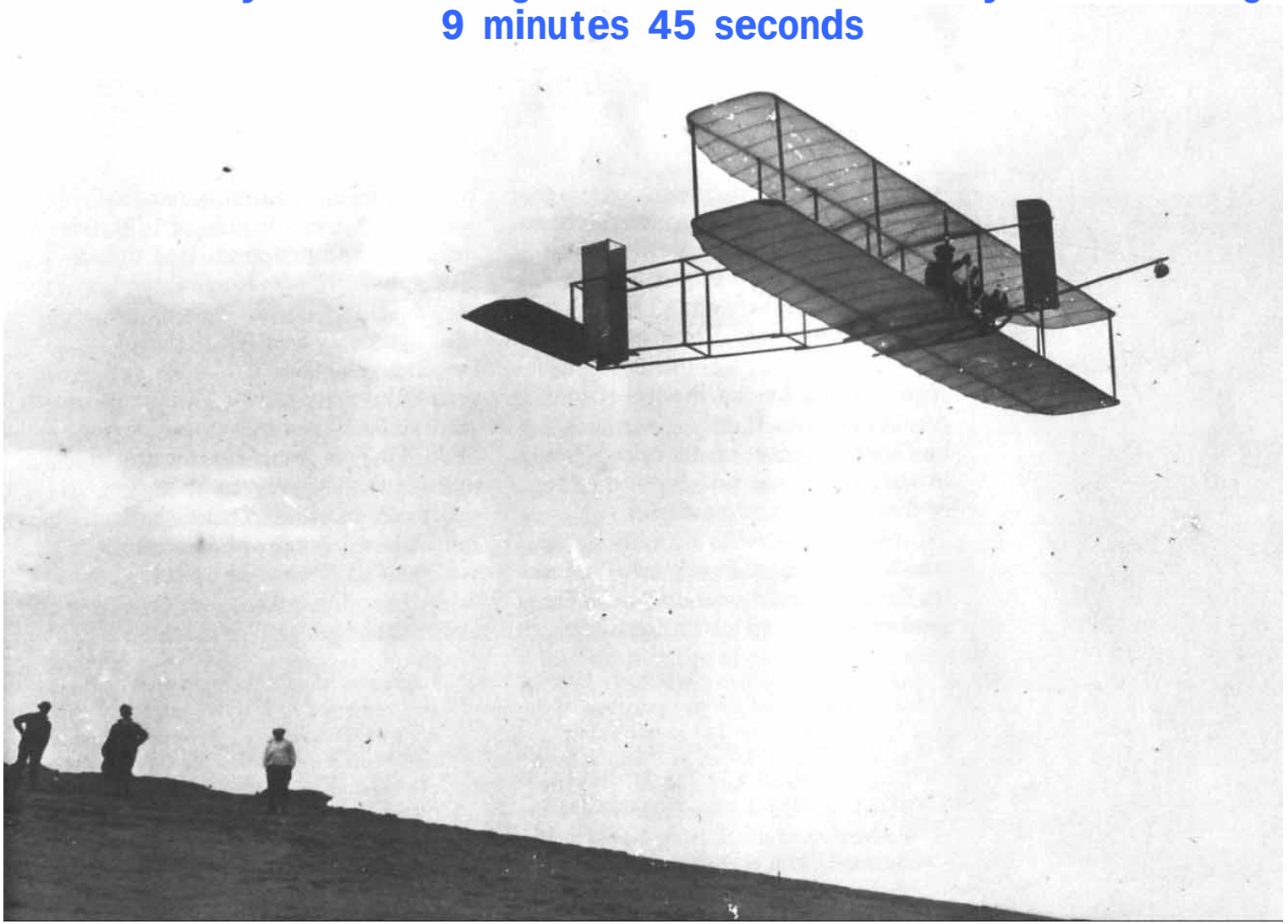
Achieving best climb;

Summary of key points.

Slide # 3

first sustained soaring flight

October 24, 1911, winds of 35knots against the North Carolina sand dunes at Kitty Hawk. Wright Glider No 5 flown by Orville Wright, 9 minutes 45 seconds



When asked why he had returned to Kitty Hawk to fly gliders in 1911 when his powered airplane had been successful since 1903, Orville replied,

"We have given several answers to different people to that question; that it was to experiment with stability and controls. But, you know and we knew then that it was more fun to fly gliders than to fly powered airplanes."

Orville Wright, 1911

from slope to cloud...

. . . to great distances!

a variety of cumulus cloud forms

Sources and Trigger Points

(during best part of day)

Contrasting fields (dark/light, ploughed/crop);

Fields being worked by farmers;

Uneven terrain;

Ridges and lee of hills;

Roadside tree/scrub lines;

Stubble fires;

Towns and airfields.

Sources and Trigger Points
(during latter part of day)

Forested areas (release heat);

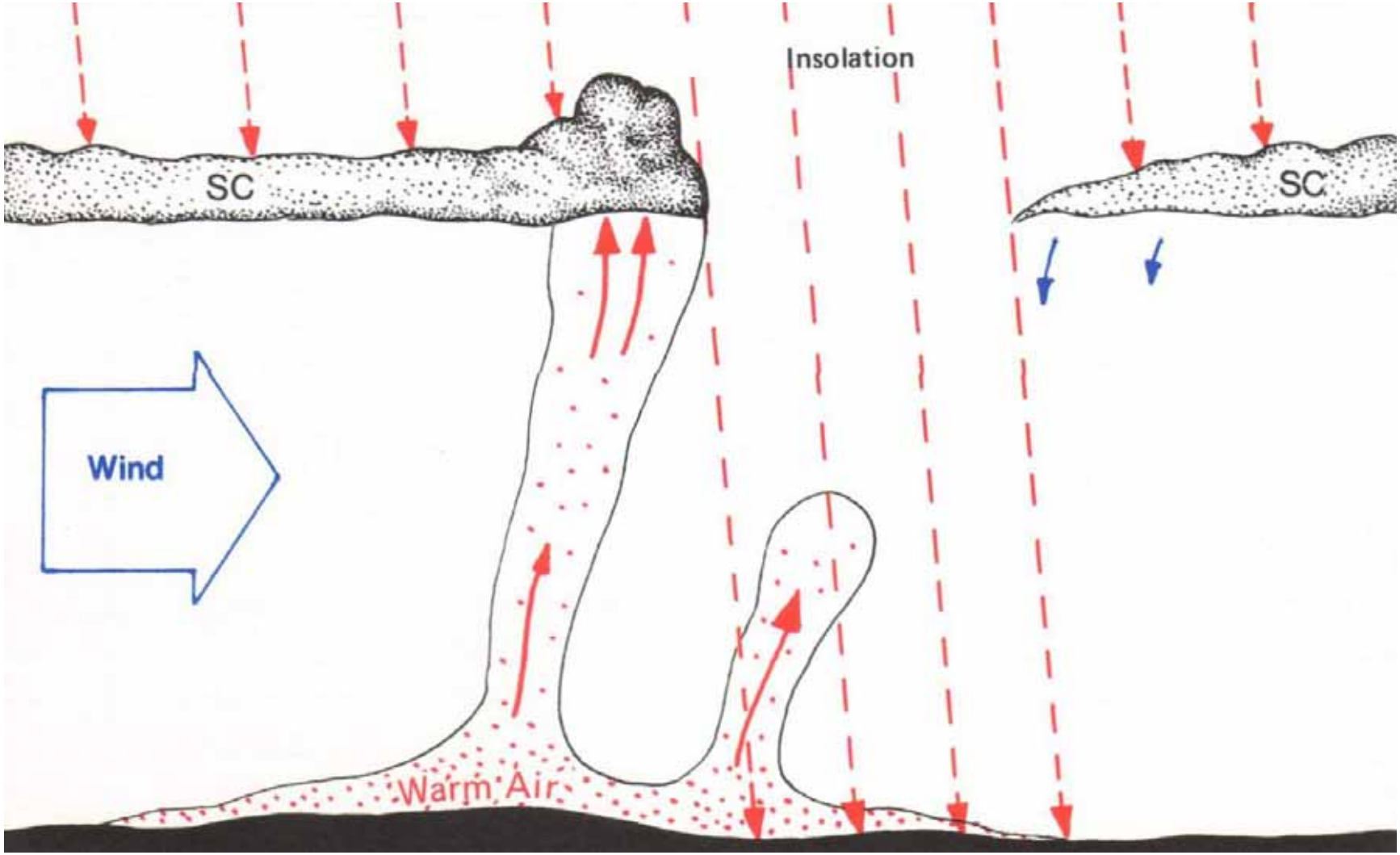
Stubble fields;

Gullies and creek bed surrounds;

Towns (sometimes);

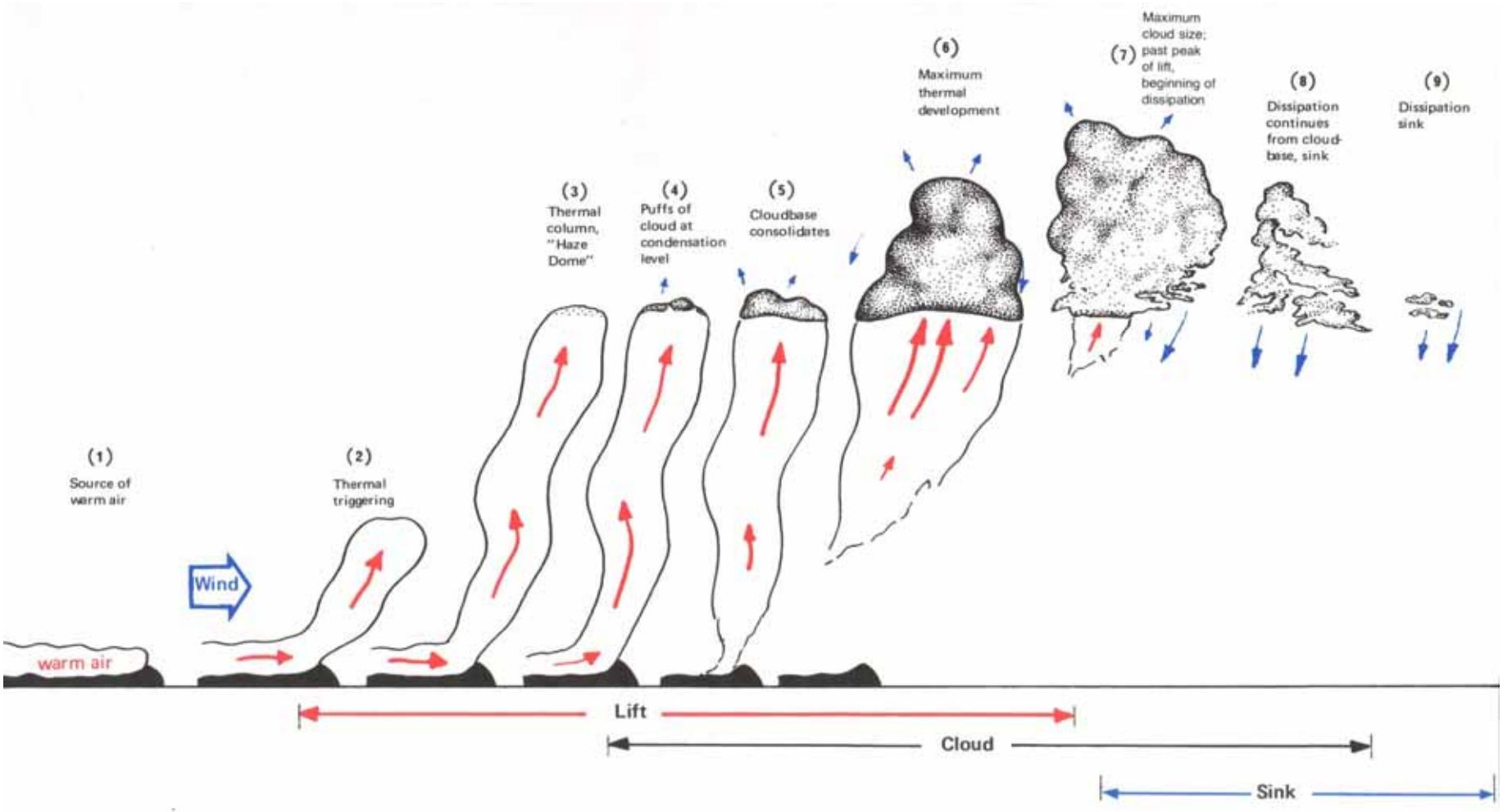
Insolation (can also happen at other times).

gap in cloud cover or over-development

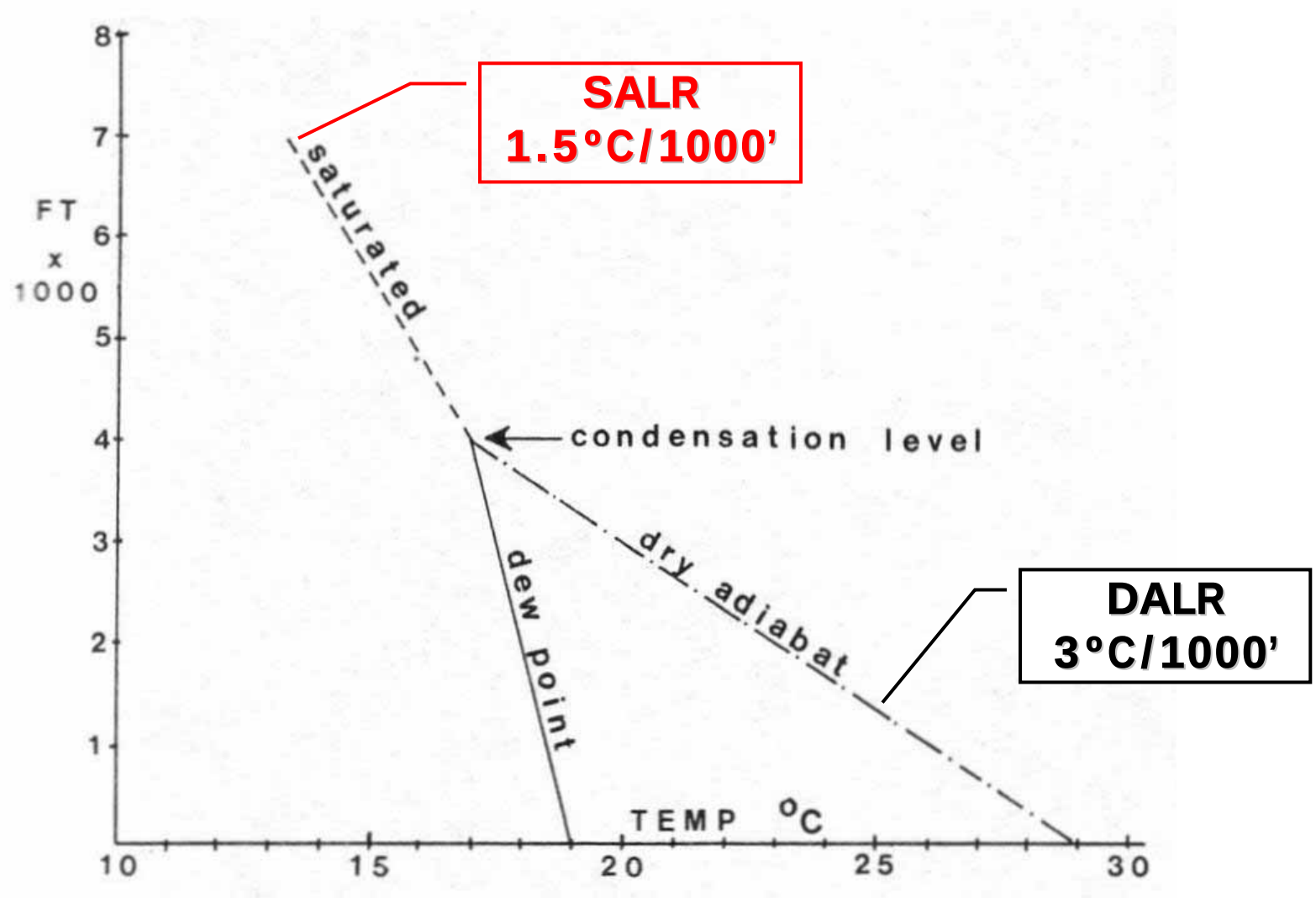


other sources ...

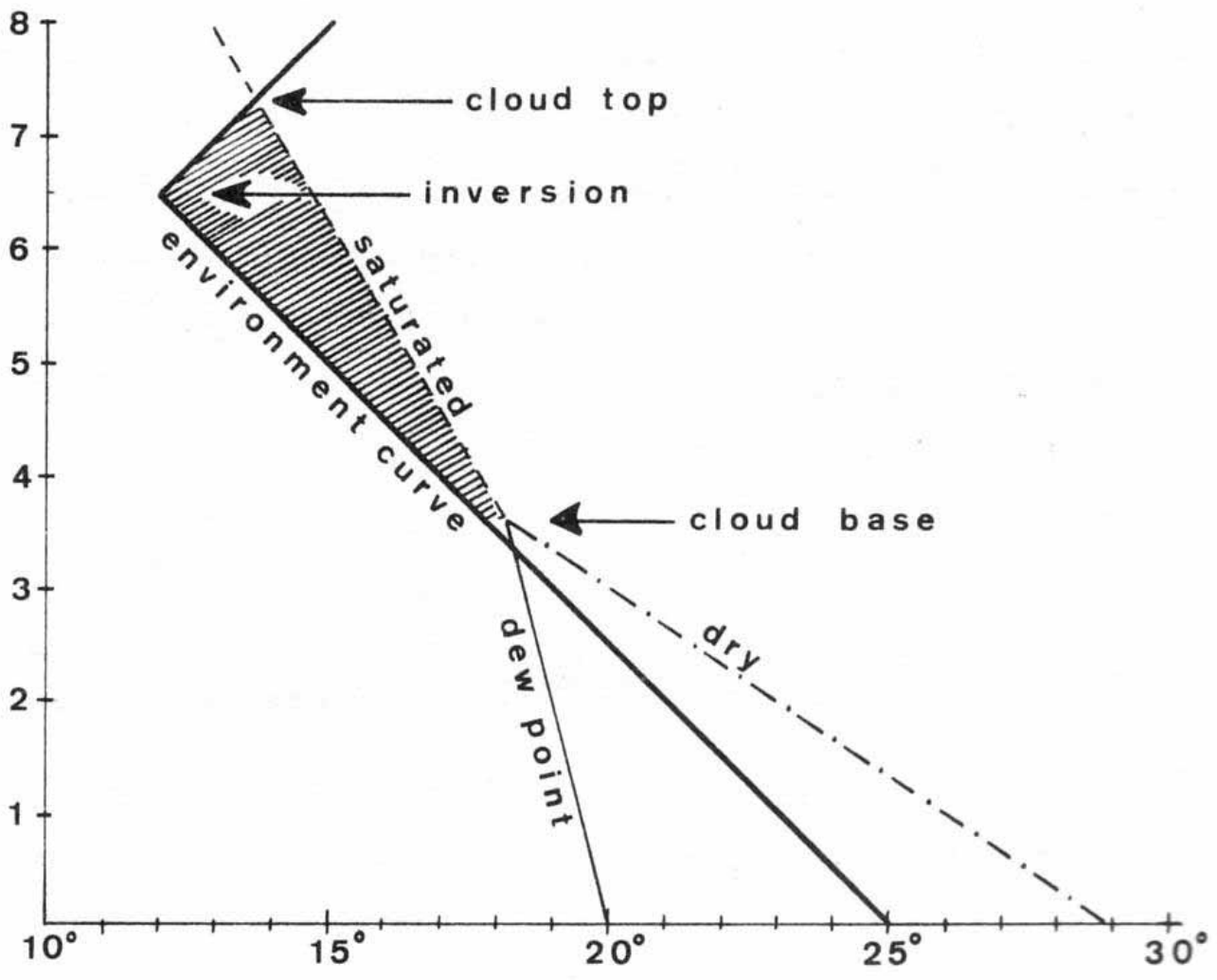
life cycle of a thermal



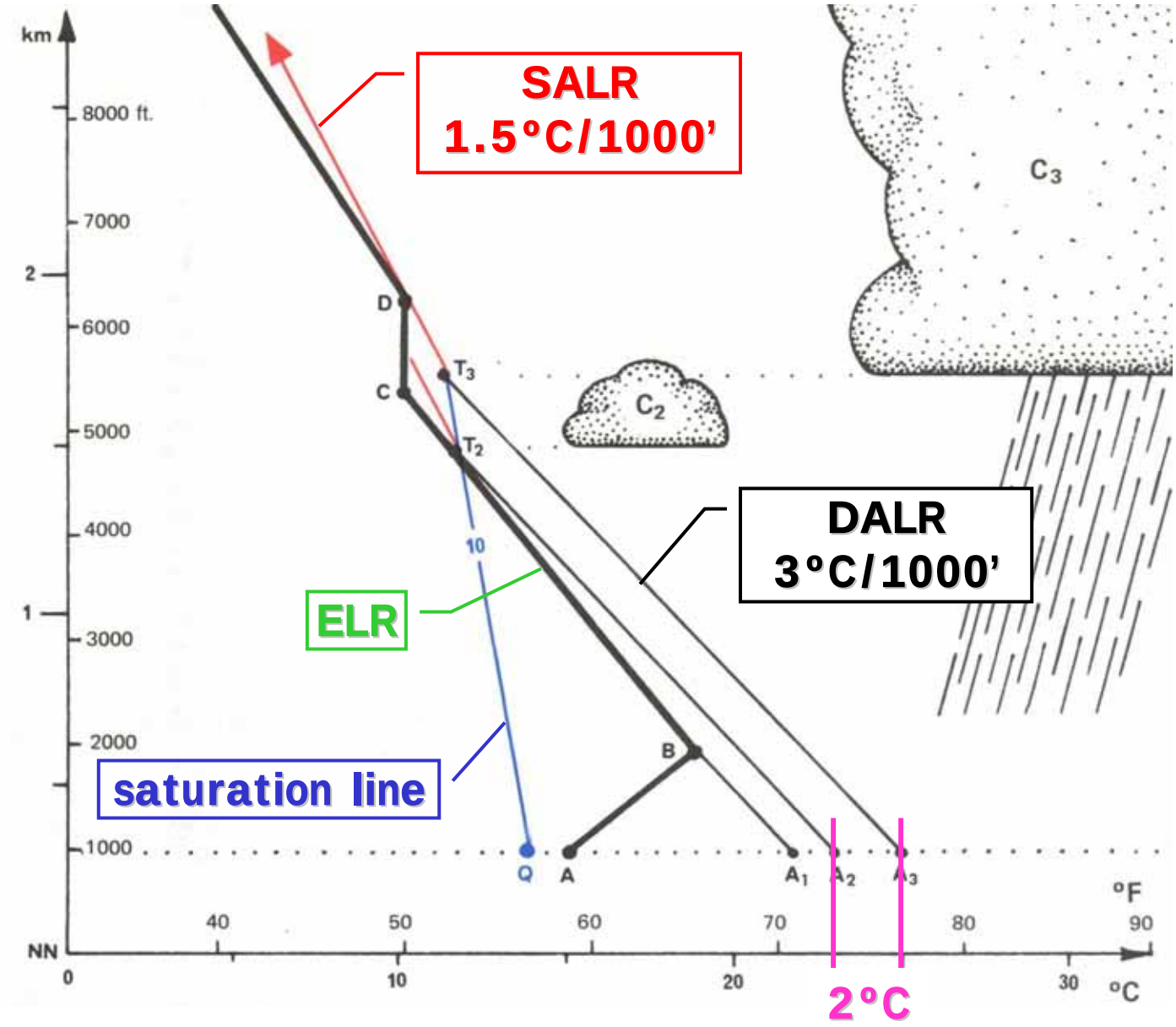
condensation level



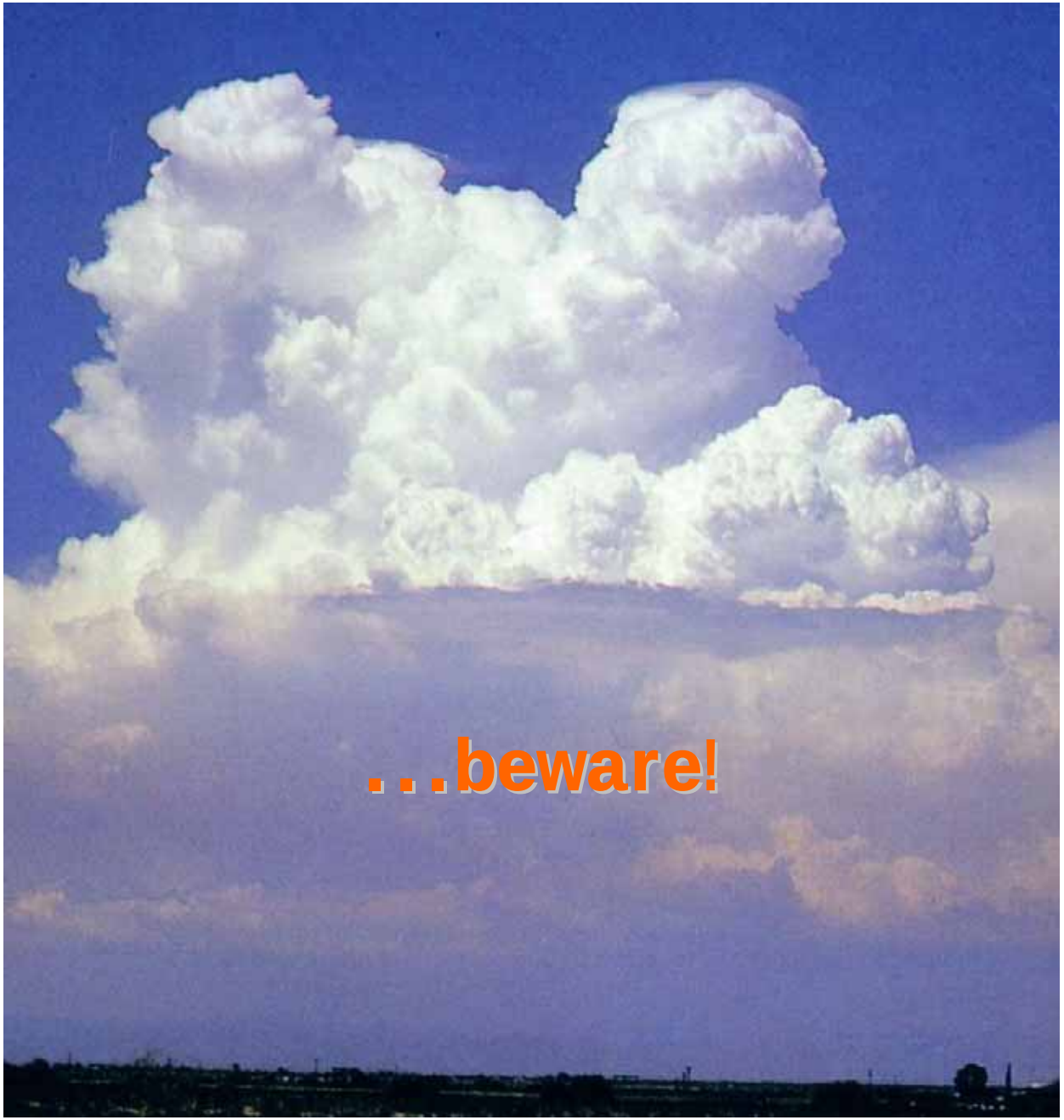
cloud depth


8
7
6
5
4
3
2
1
cloud top
inversion
saturated
environment curve
cloud base
dew point
dry
10°
15°
20°
25°
30°

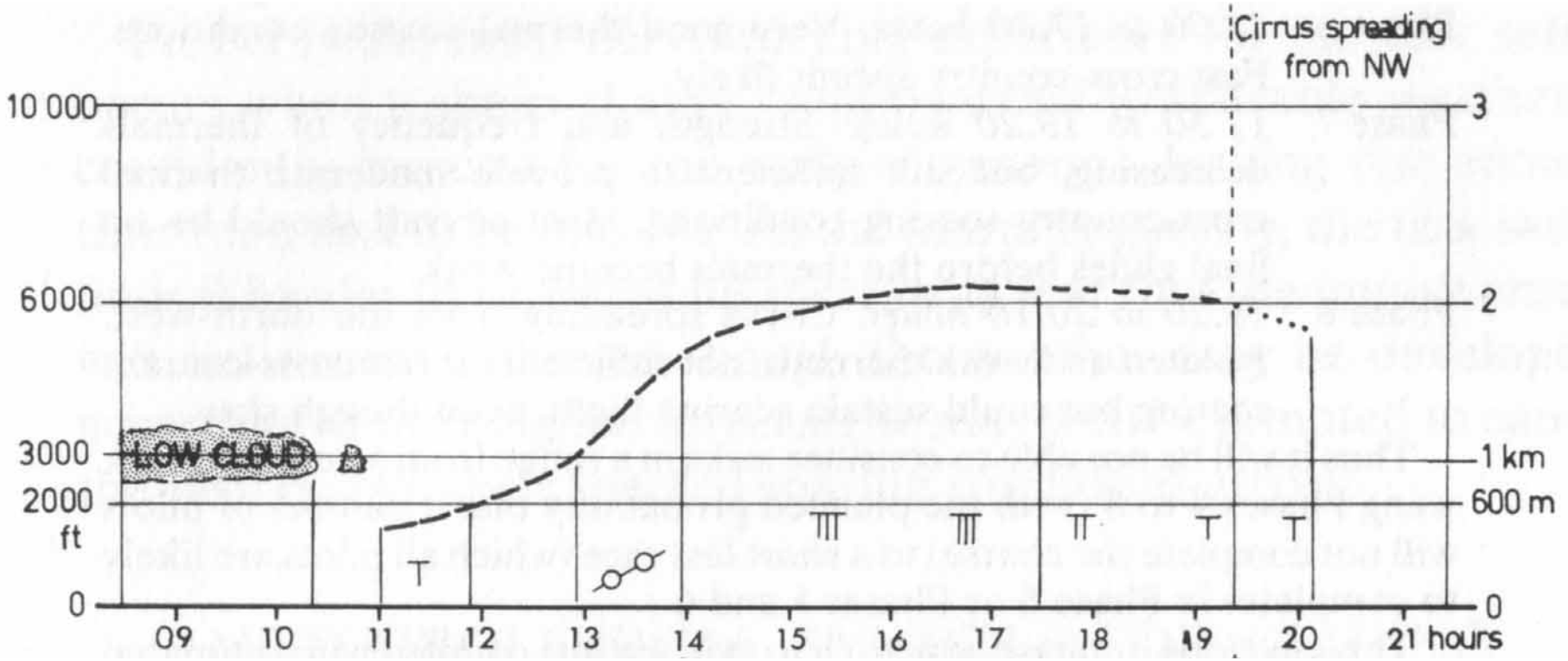
Slide # 15


SALR
1.5°C/1000'
DALR
3°C/1000'
ELR
saturation line
km
8000 ft.
7000
6000
5000
4000
3000
2000
1000
2
1
NN
D
C
T_3
T_2
C_2
C_3
10
B
Q
A
A_1
A_2
A_3
40
50
60
70
80
90
°F
0
10
20
30
°C
2°C

Slide # 16

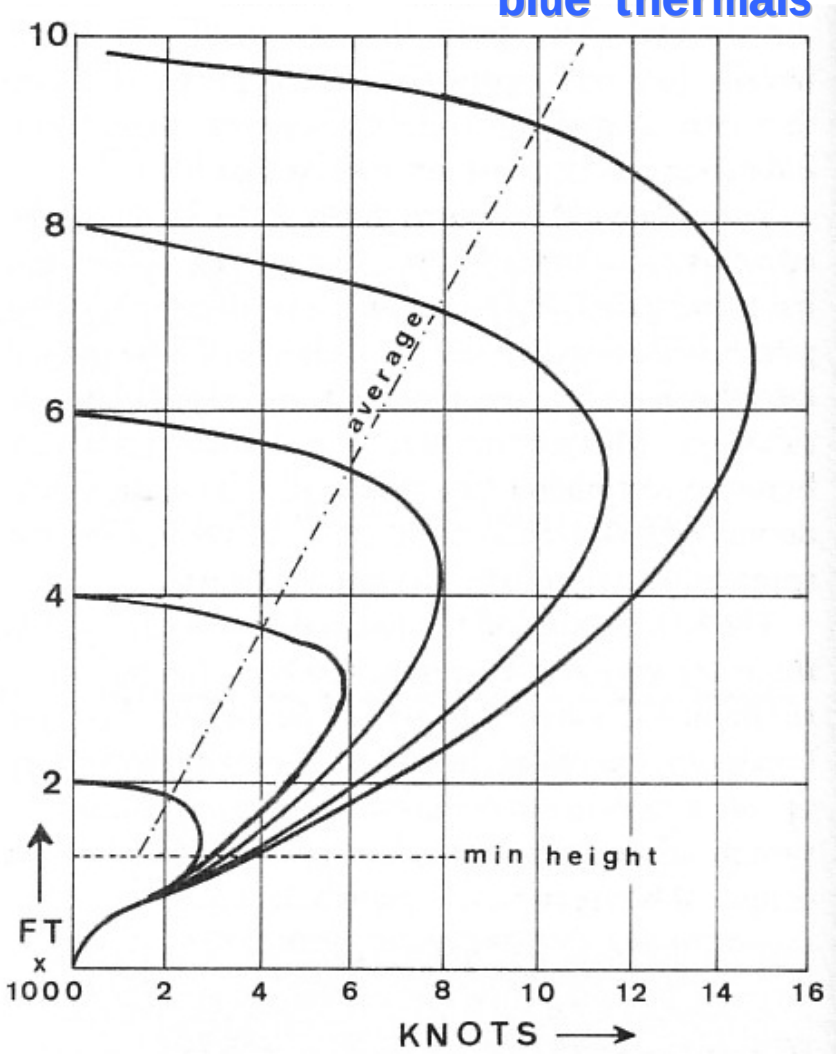


changes in cloudbase with time of day



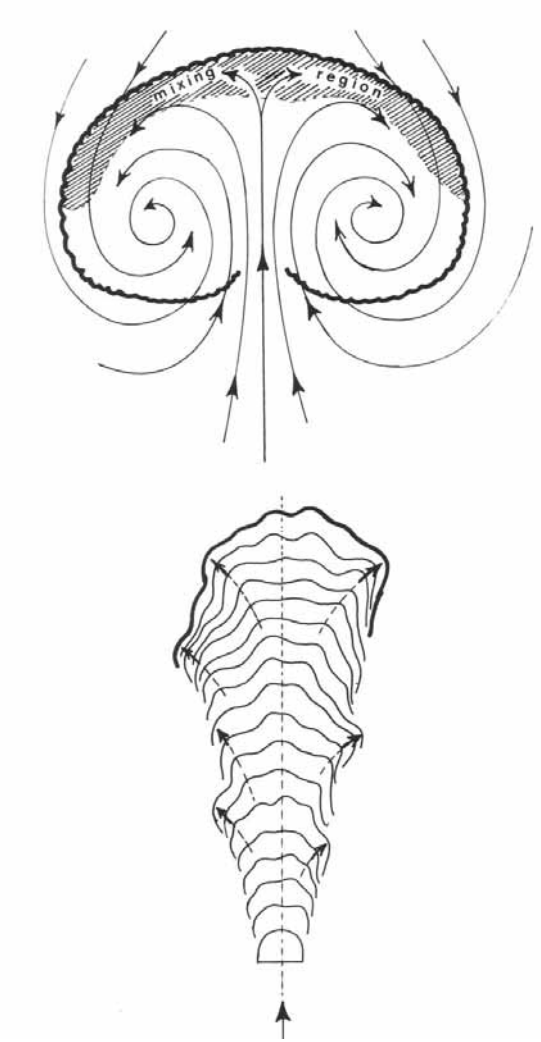
strength and spacing

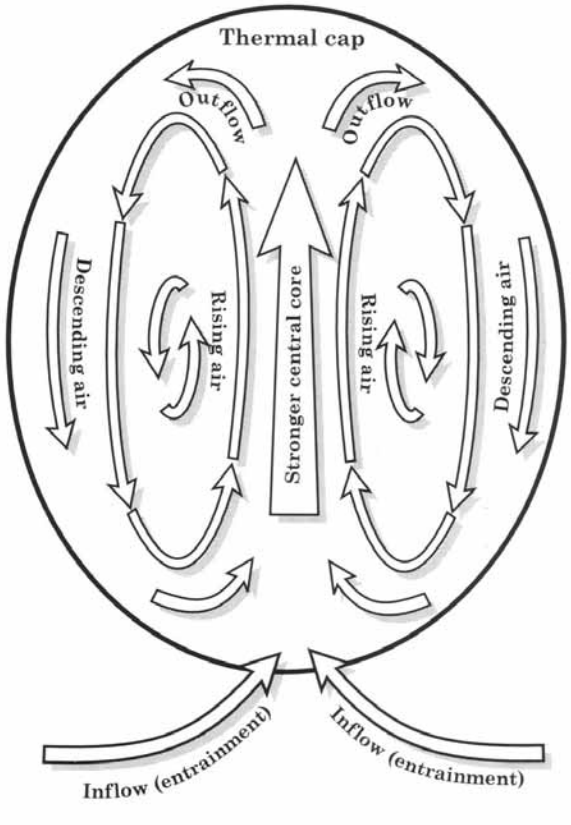
blue thermals



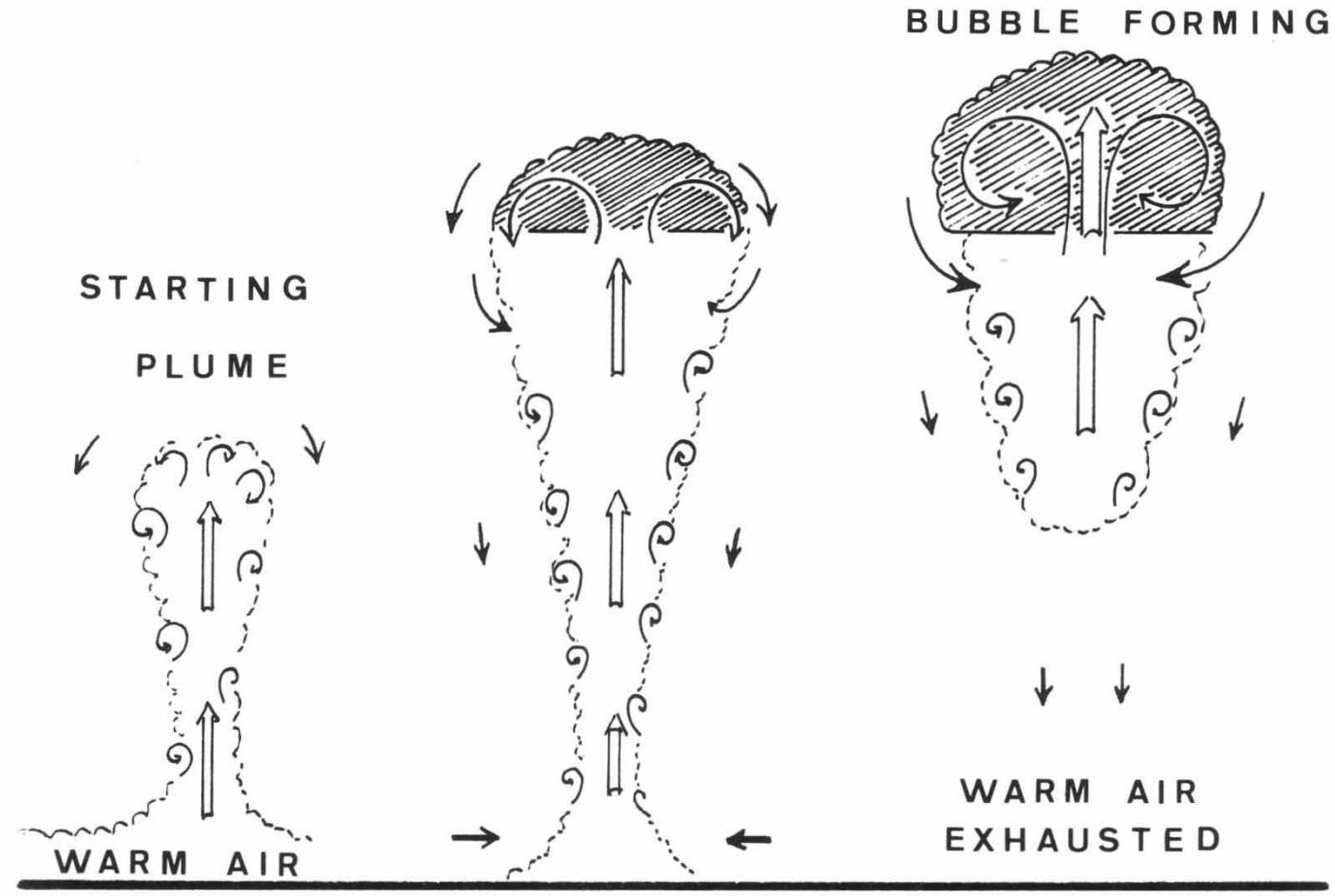
Distance between adjacent thermals is about 1½ to 2½ times the height to which they ascend

basic structure





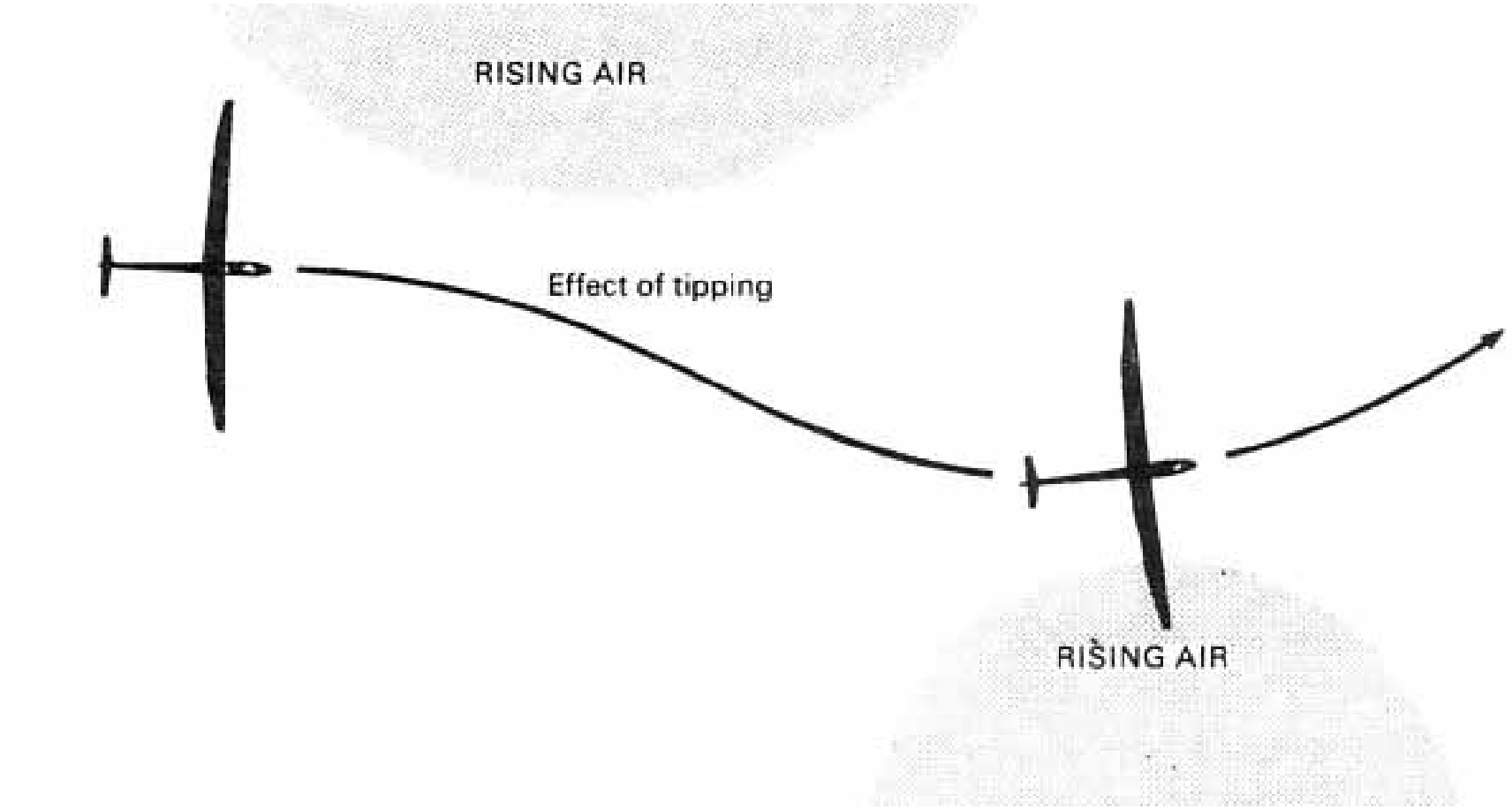
basic structure



signs of the plume at ground level

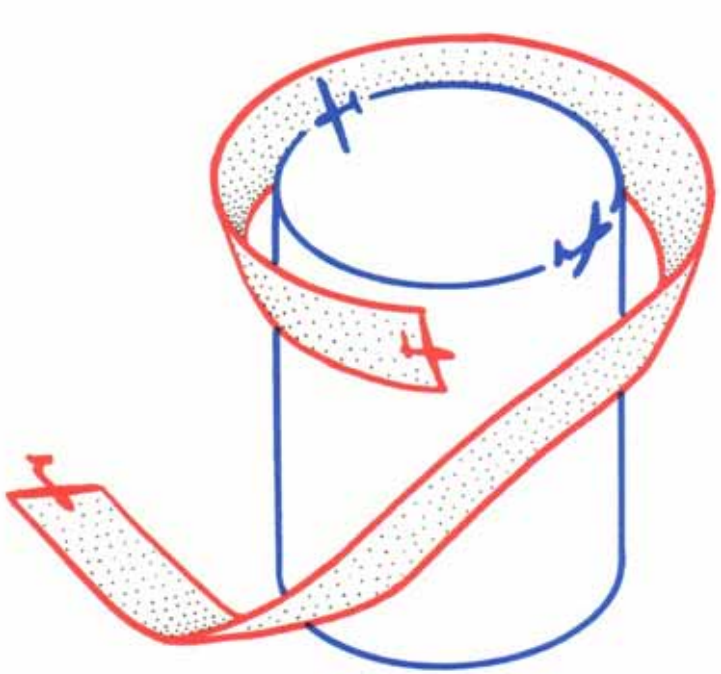
Centring in Thermals

doing nothing = maximum sink



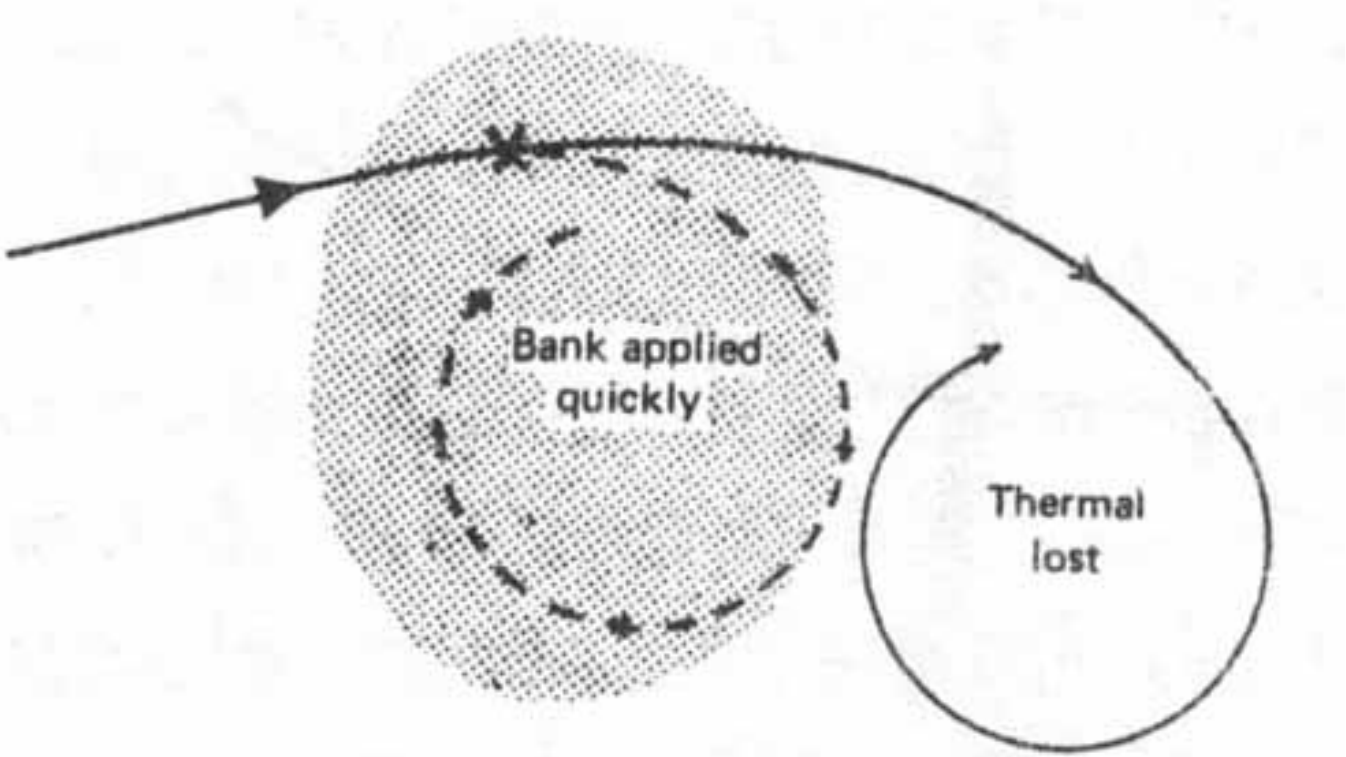
BEFORE YOU TURN...

LOOKOUT +

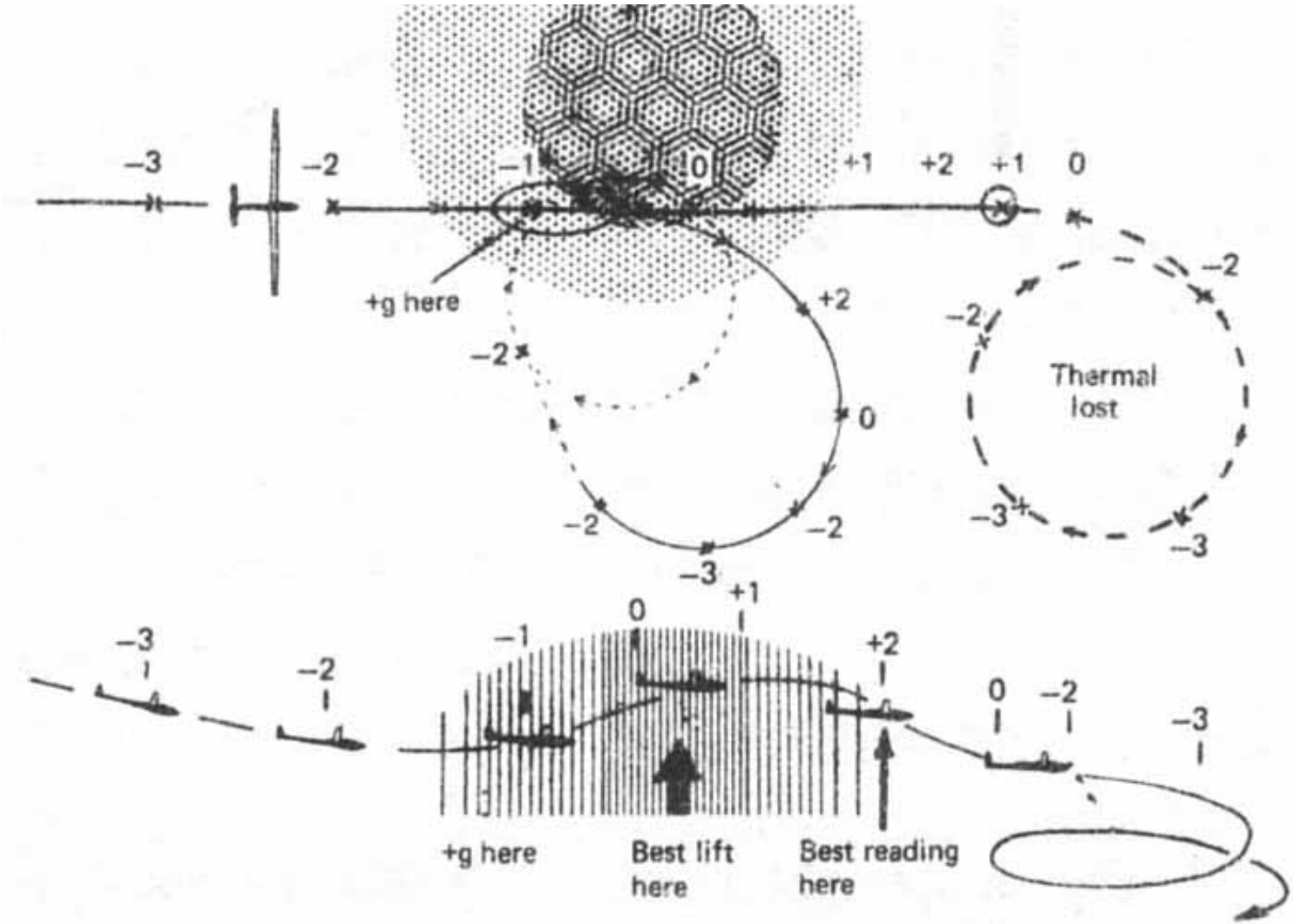


be careful when joining others in a thermal and when leaving a thermal

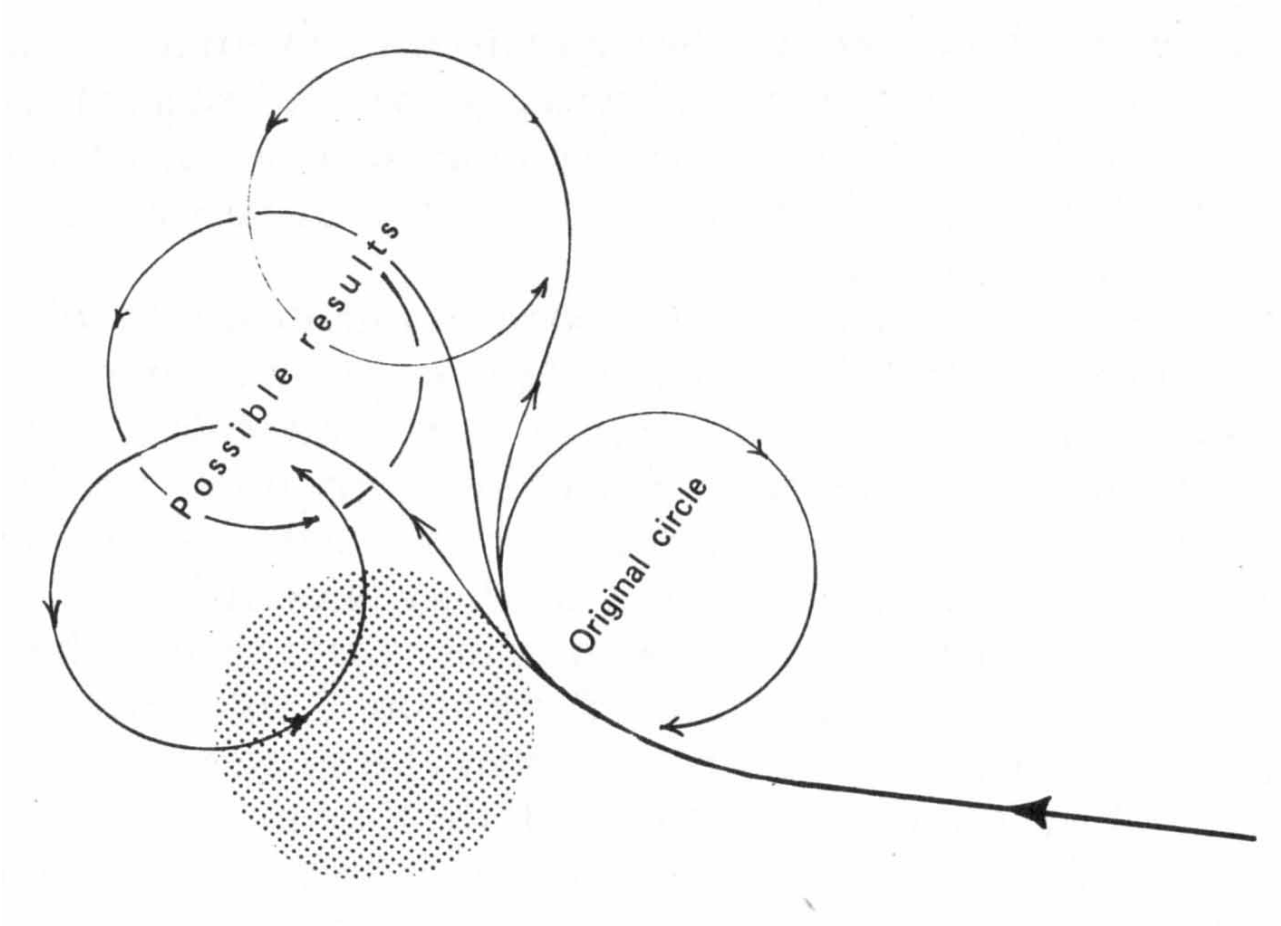
turning too late = missed thermal



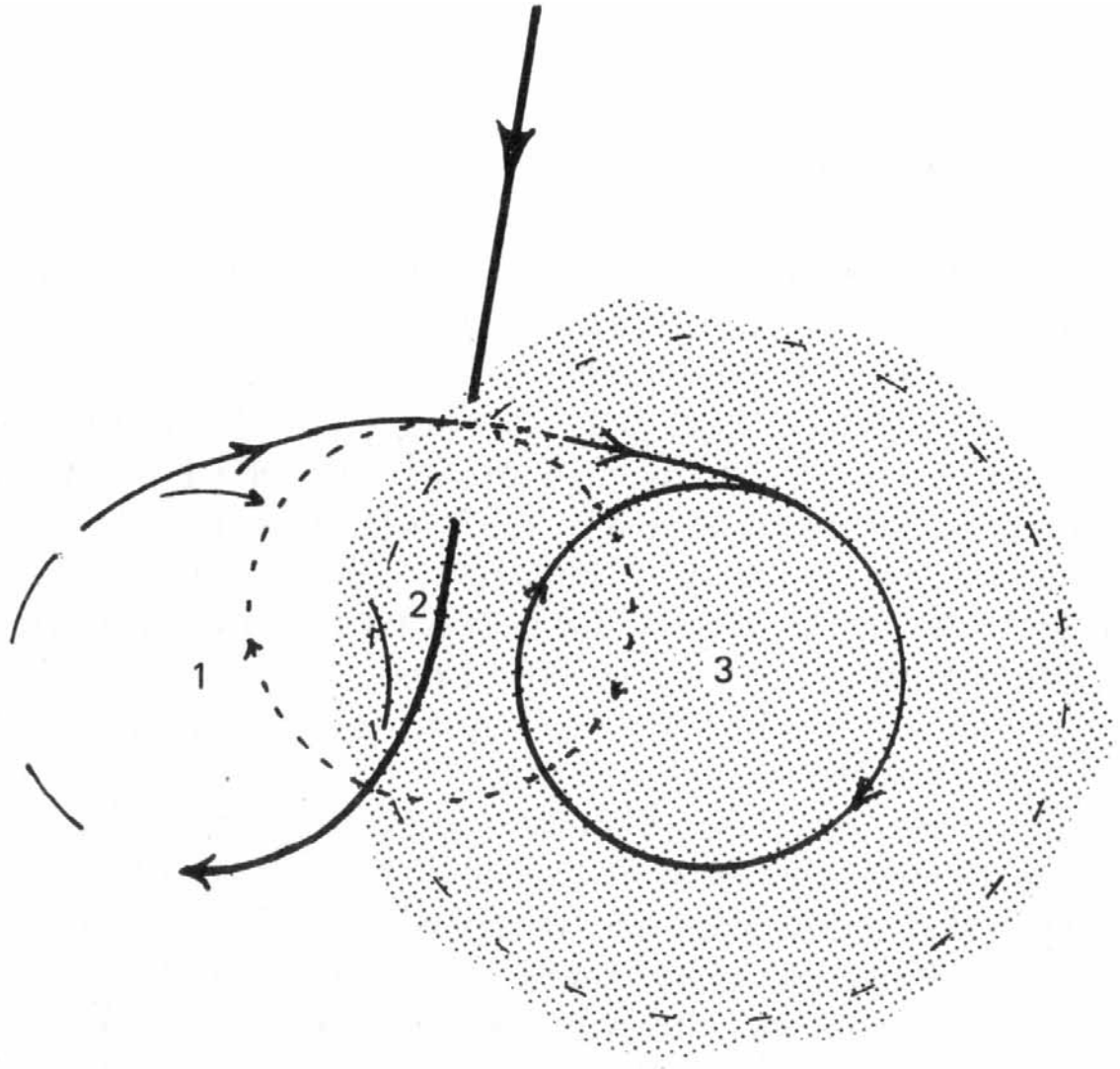
watch for lag in the instruments



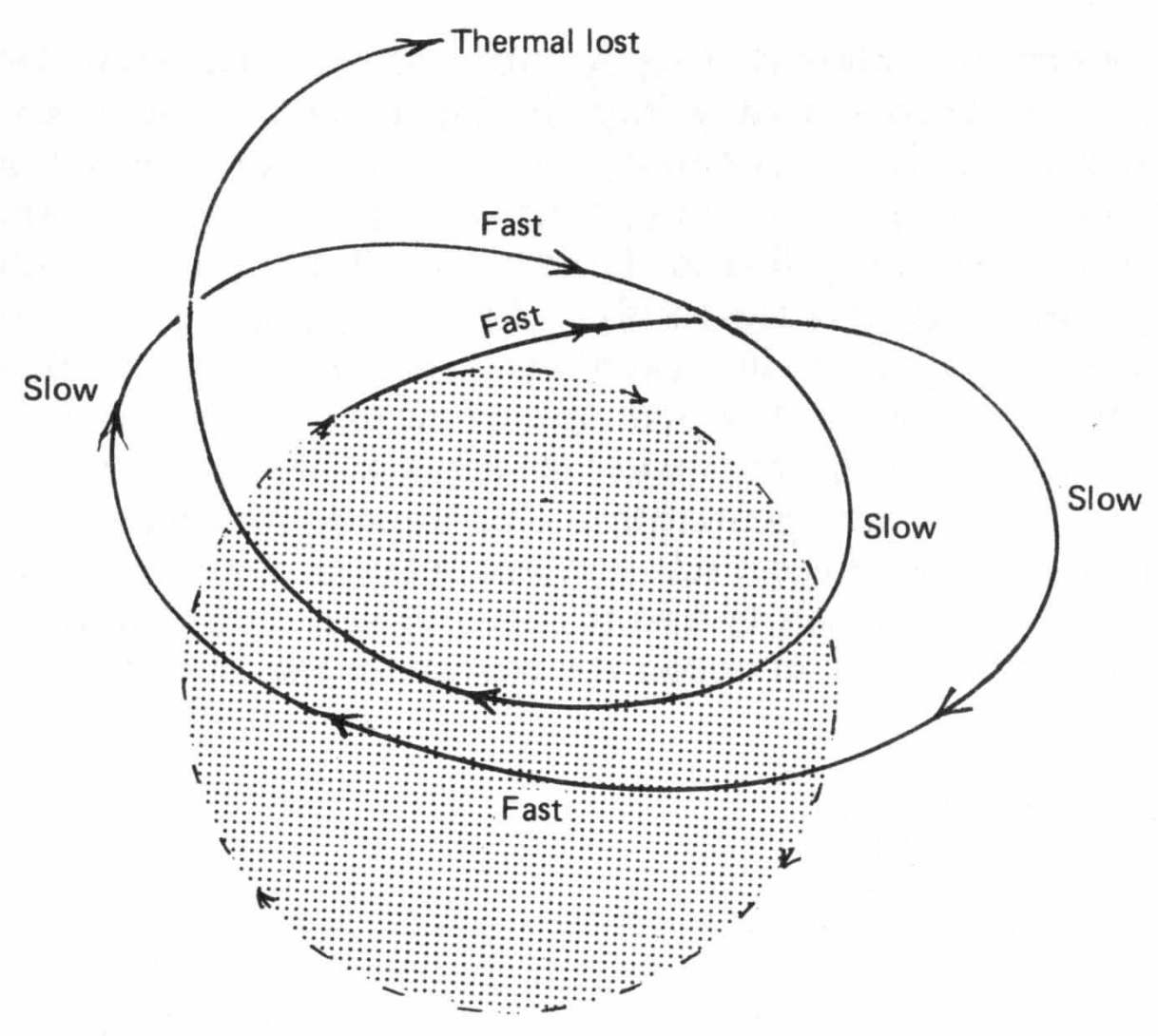
wrong initial turn



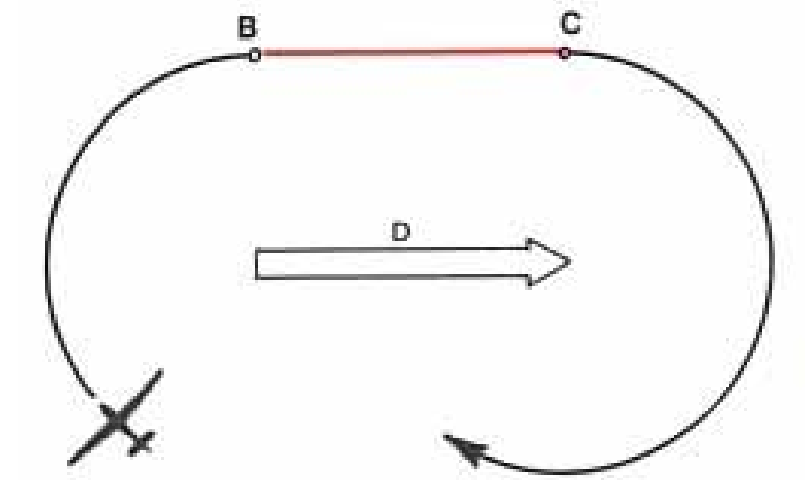
wrong initial turn with corrections



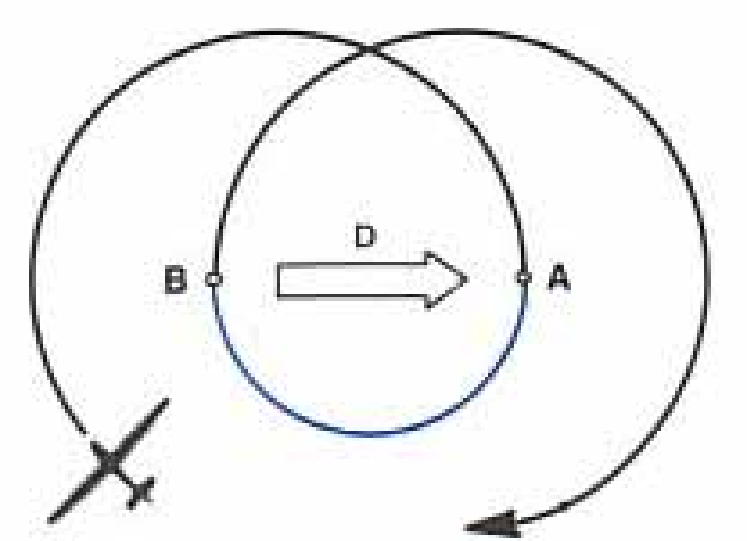
varying speed and bank angle
(unintentionally)



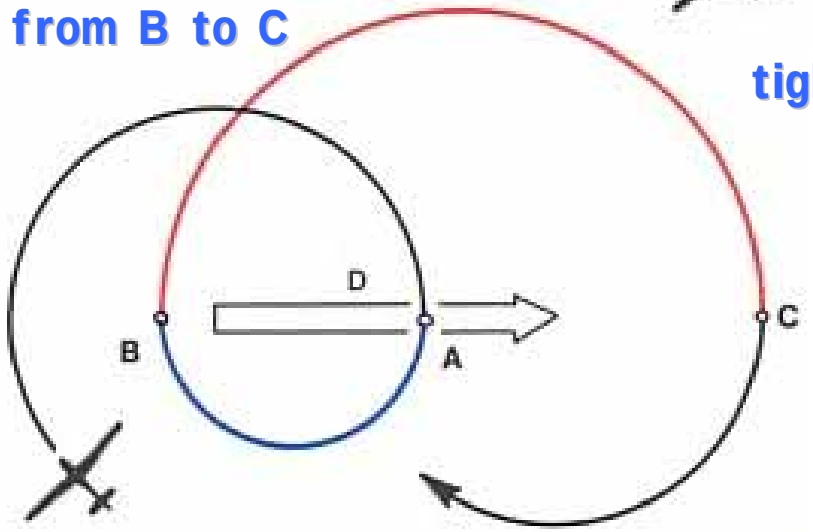
making adjustments (intentionally)



straighten up from B to C

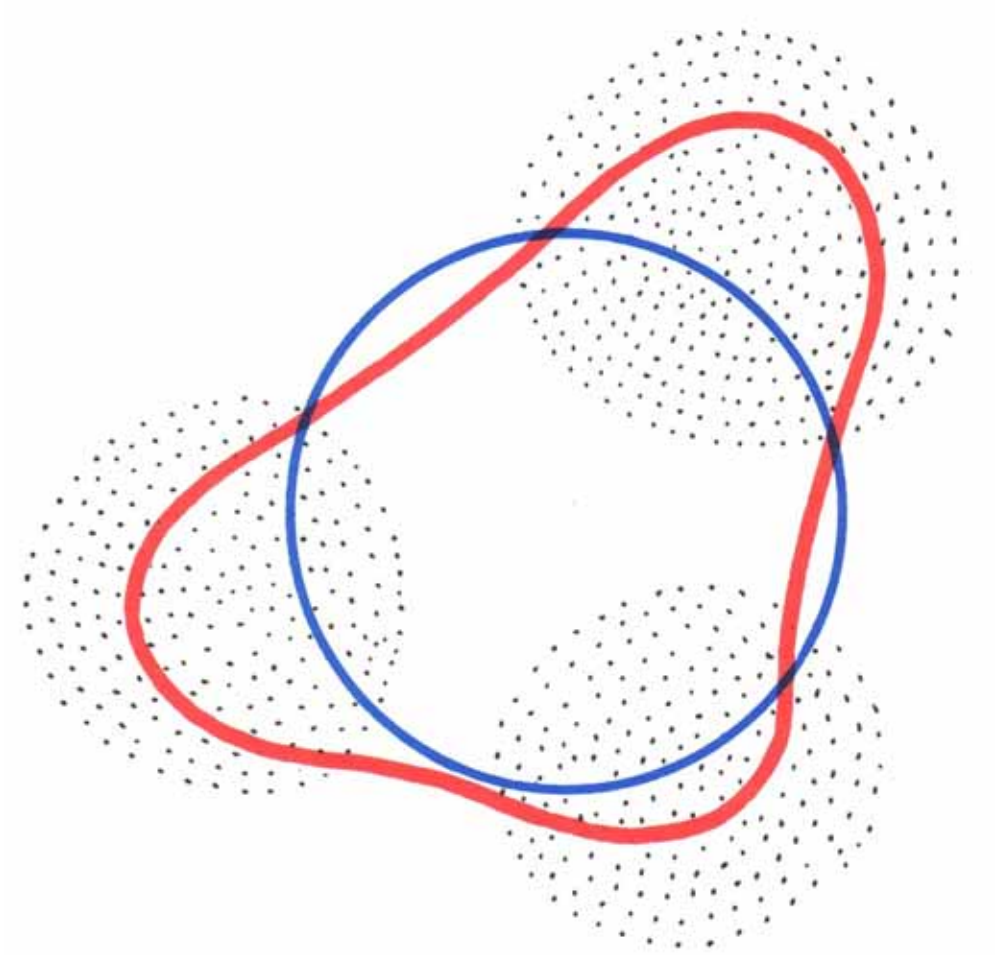


tighten turn from A to B

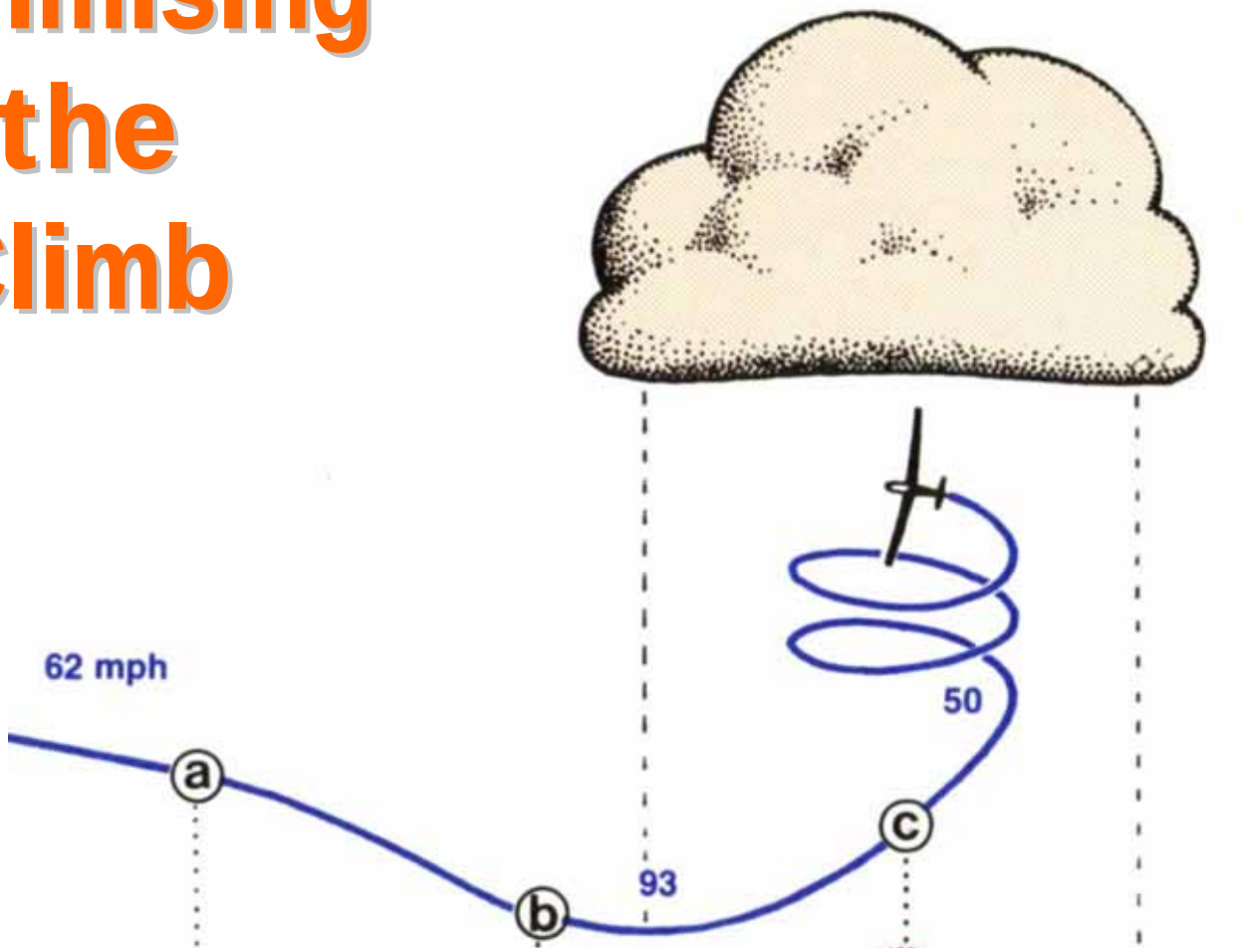


tighten turn from A to B, opening up from B to C

find and follow the core(s)...



Optimising the Climb



first some basics...

The glide polar;

Influence of wing loading;

Circling flight (forces);

Circling polar (glider performance);

Thermal lift profiles;

Achieved climb;

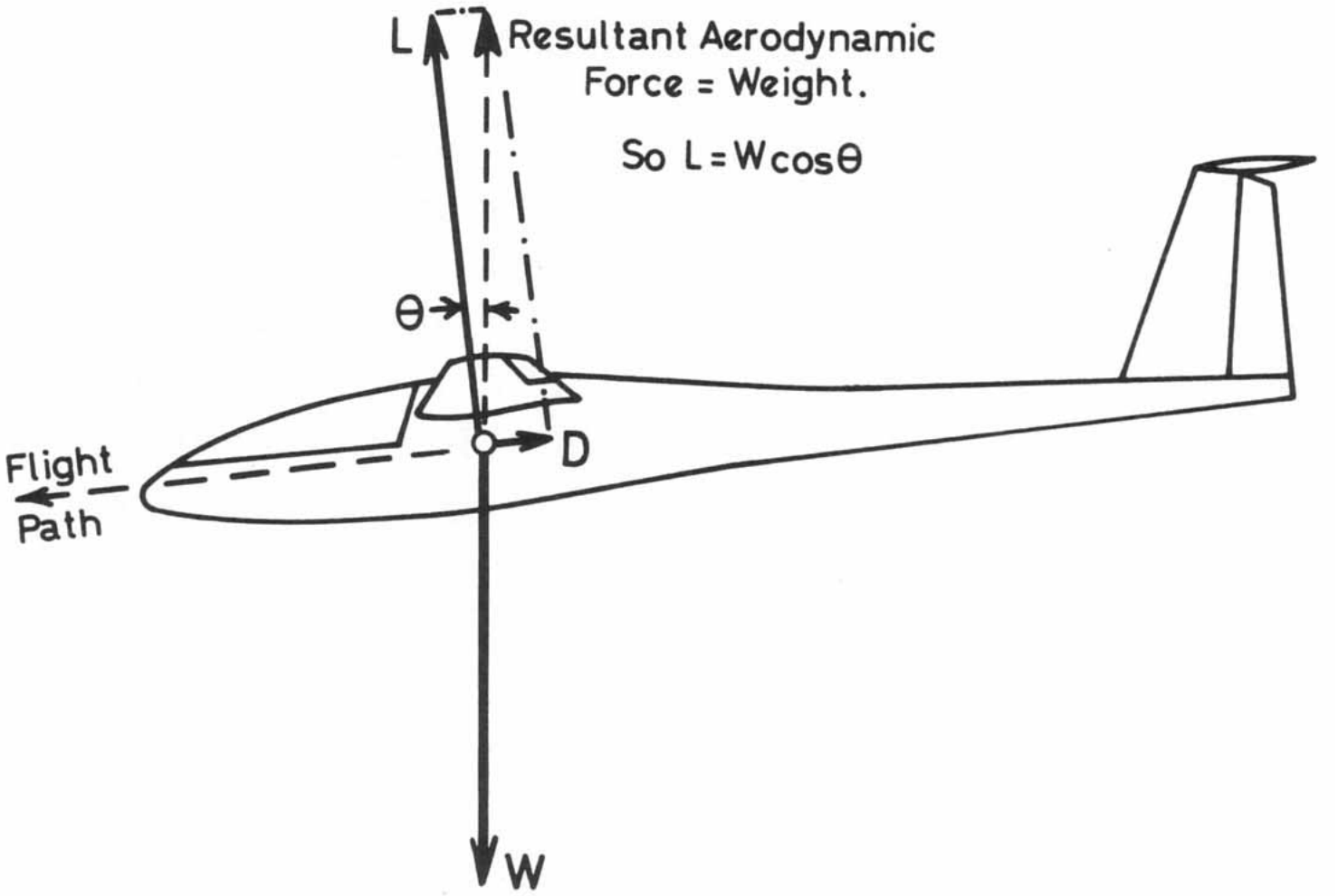
Best climb.

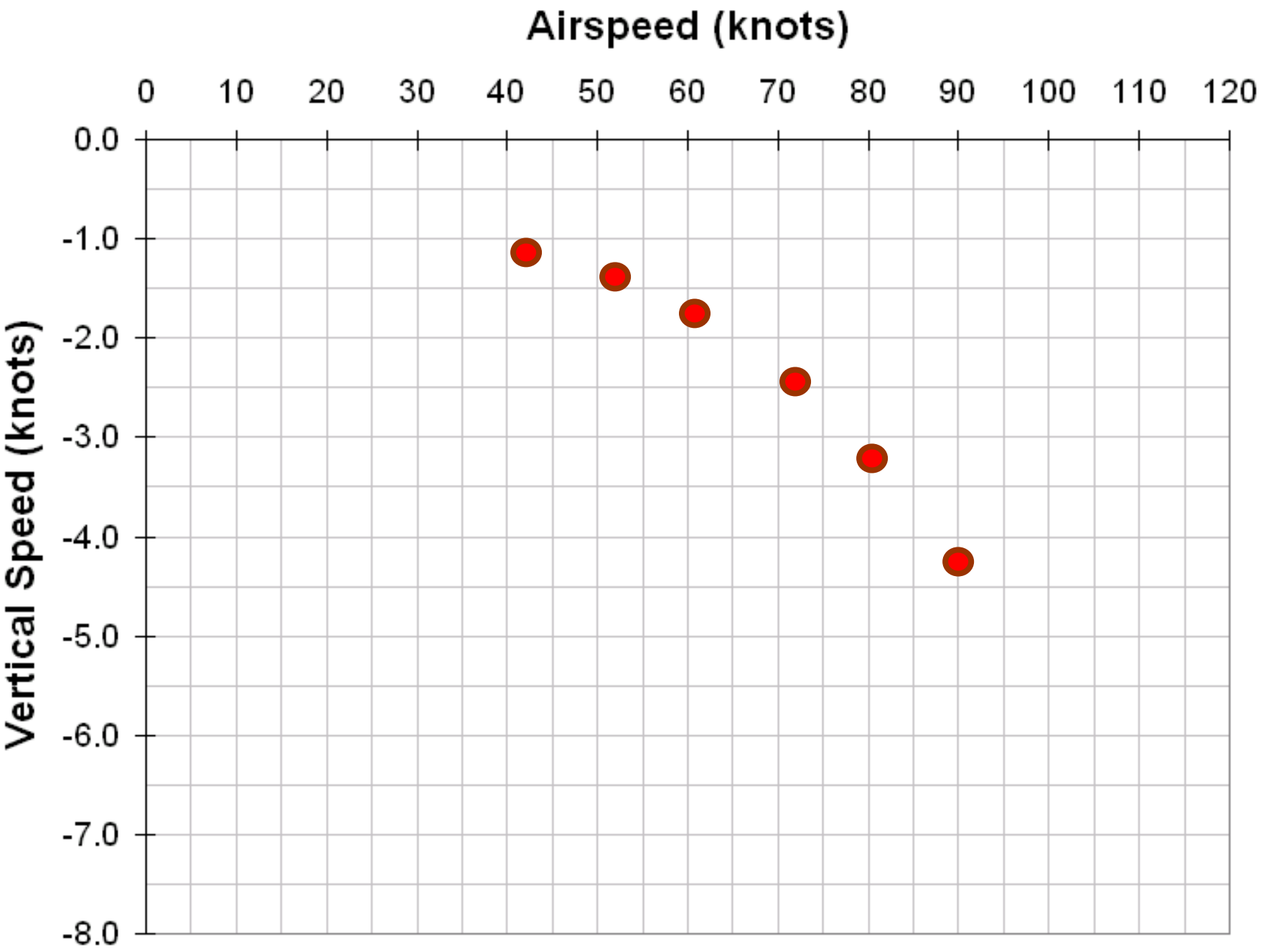
measuring the glide polar

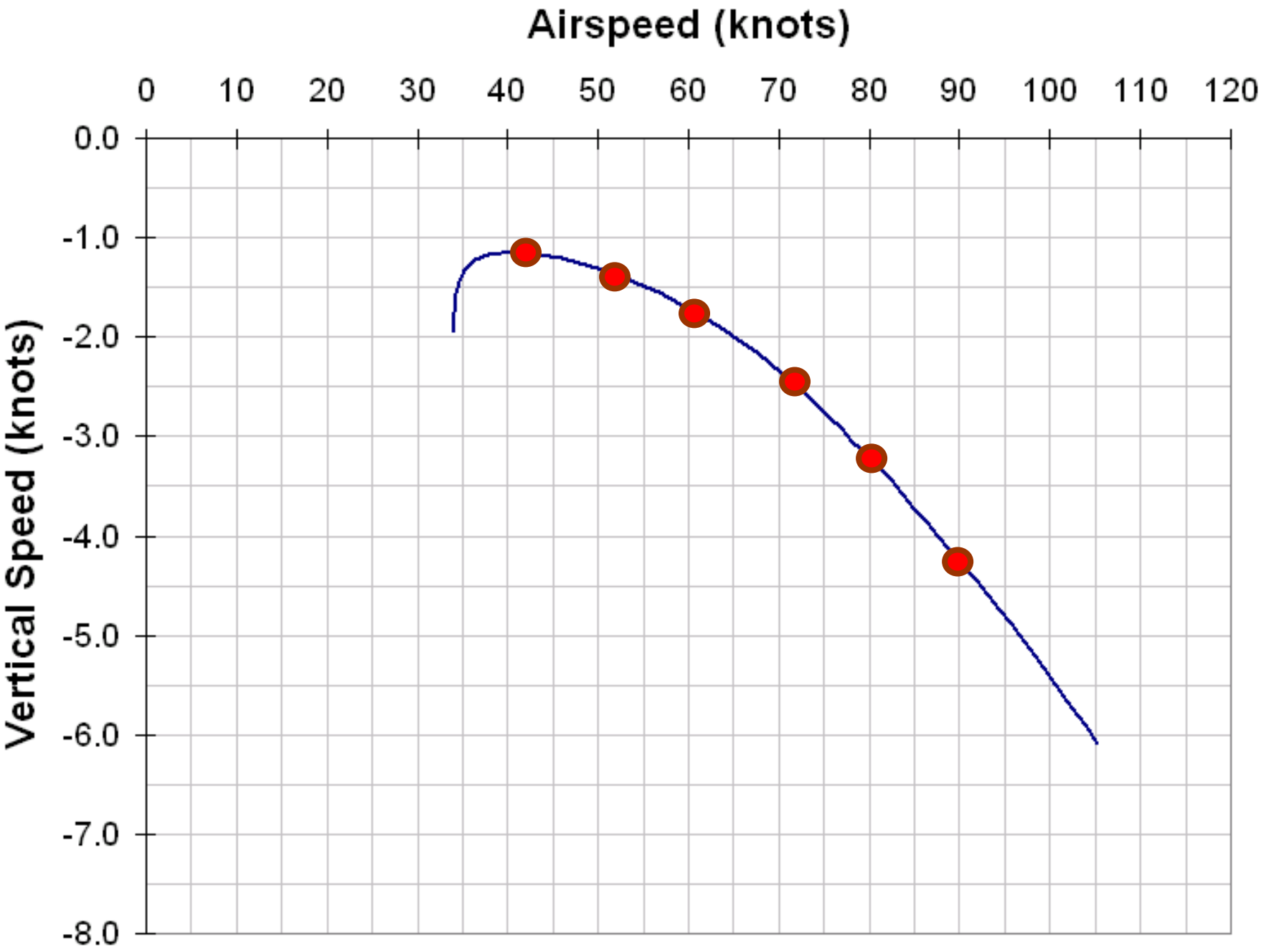
1) rate of climb/sink

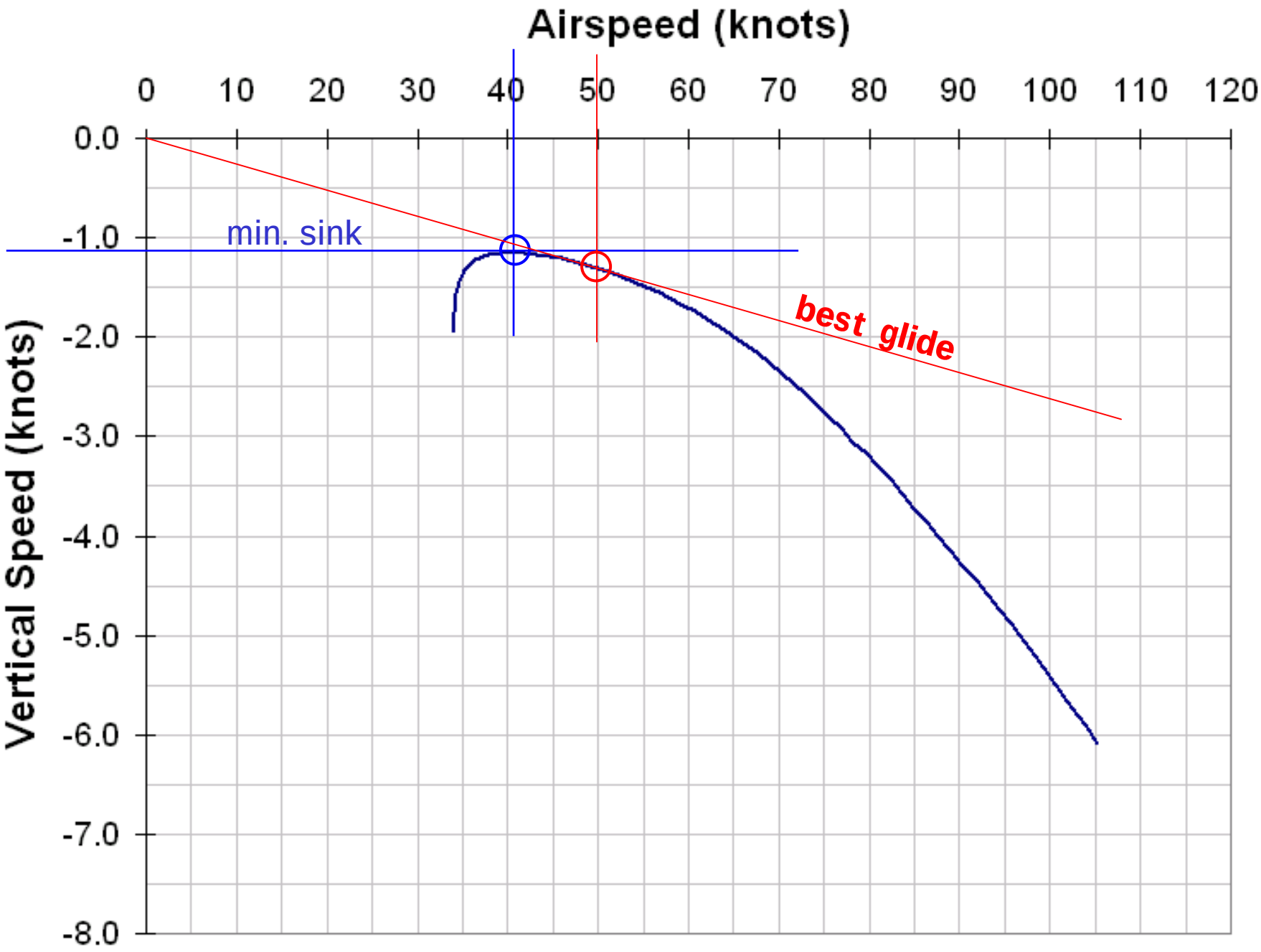
2) air speed

straight and level flight




Airspeed (knots)
0
10
20
30
40
50
60
70
80
90
100
110
120
Vertical Speed (knots)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0


Airspeed (knots)
0
10
20
30
40
50
60
70
80
90
100
110
120
Vertical Speed (knots)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0


Airspeed (knots)
0
10
20
30
40
50
60
70
80
90
100
110
120
Vertical Speed (knots)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
min. sink
best glide

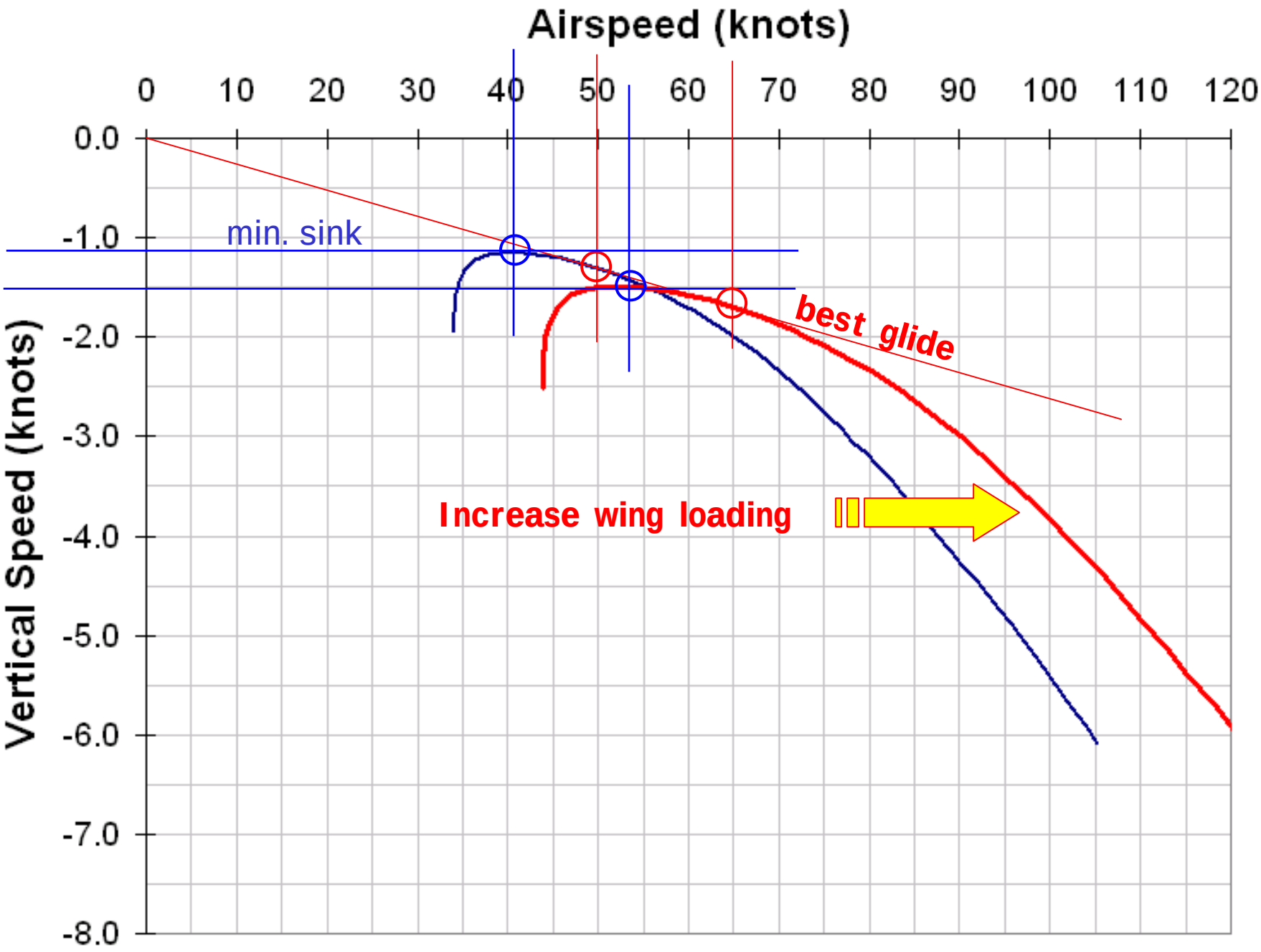
Wing Loading
(straight and level flight)

= Wing Load / Wing Area

= Weight / Area

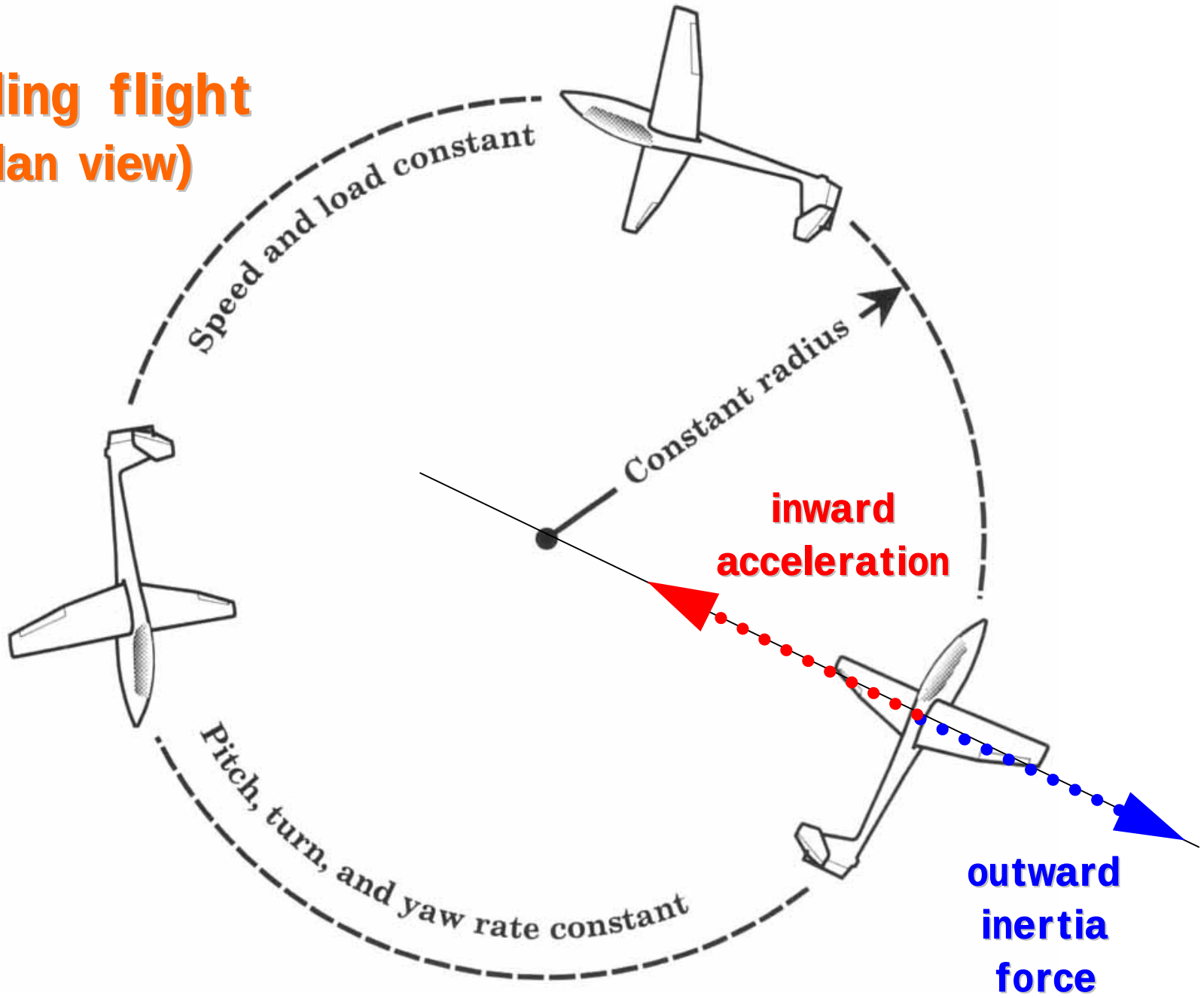
= 300kg / 10m^2

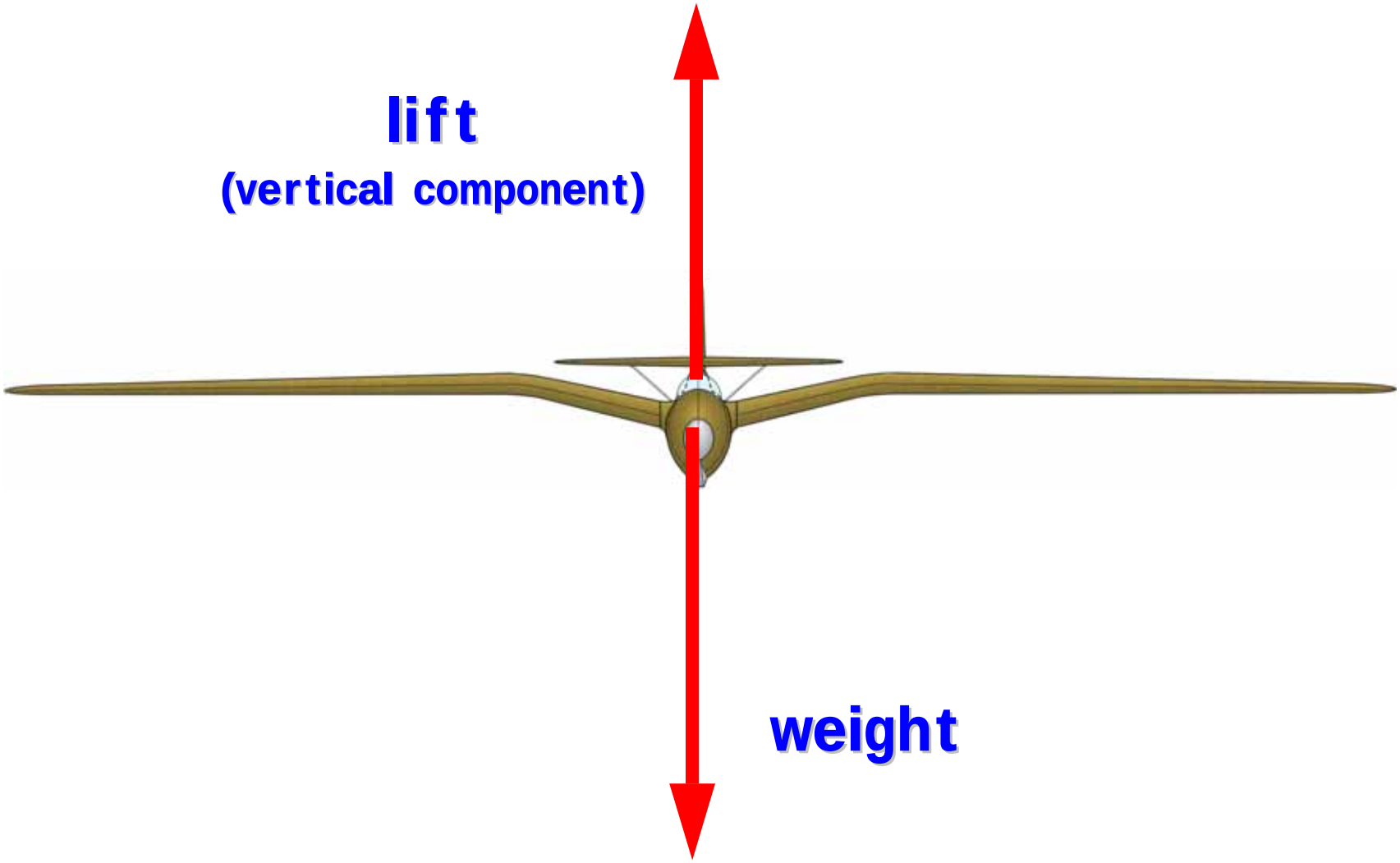
= 30kg/m^2

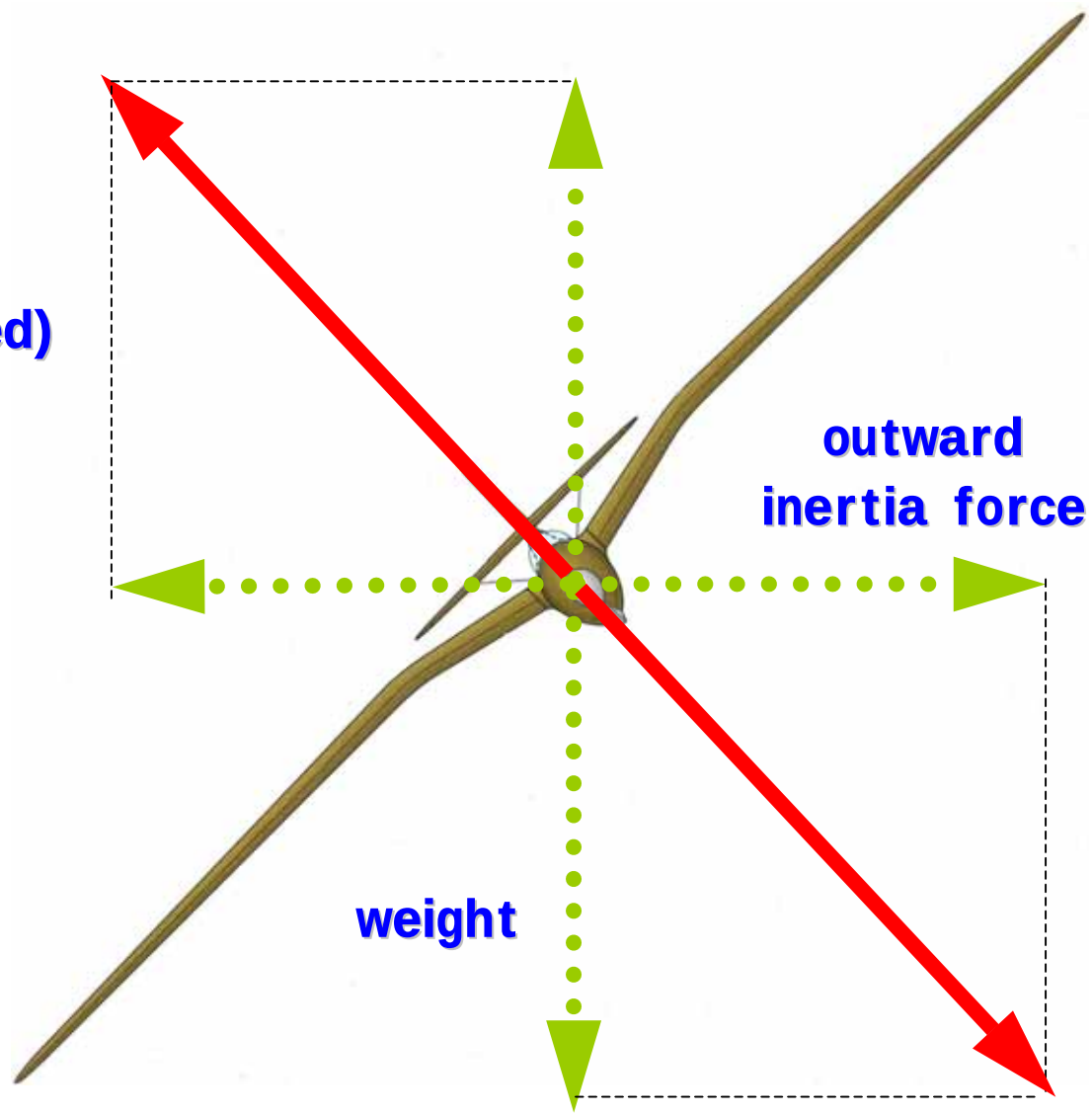

Airspeed (knots)
0
10
20
30
40
50
60
70
80
90
100
110
120
Vertical Speed (knots)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
min. sink
best glide
Increase wing loading

circling flight

circling flight
(plan view)




lift
(vertical component)
weight


lift
(increased)
outward
inertia force
weight
resultant
load
(increased)

Wing Loading
(circling flight)

= Resultant Load / Wing Area

= Weight x Load Factor / Wing Area

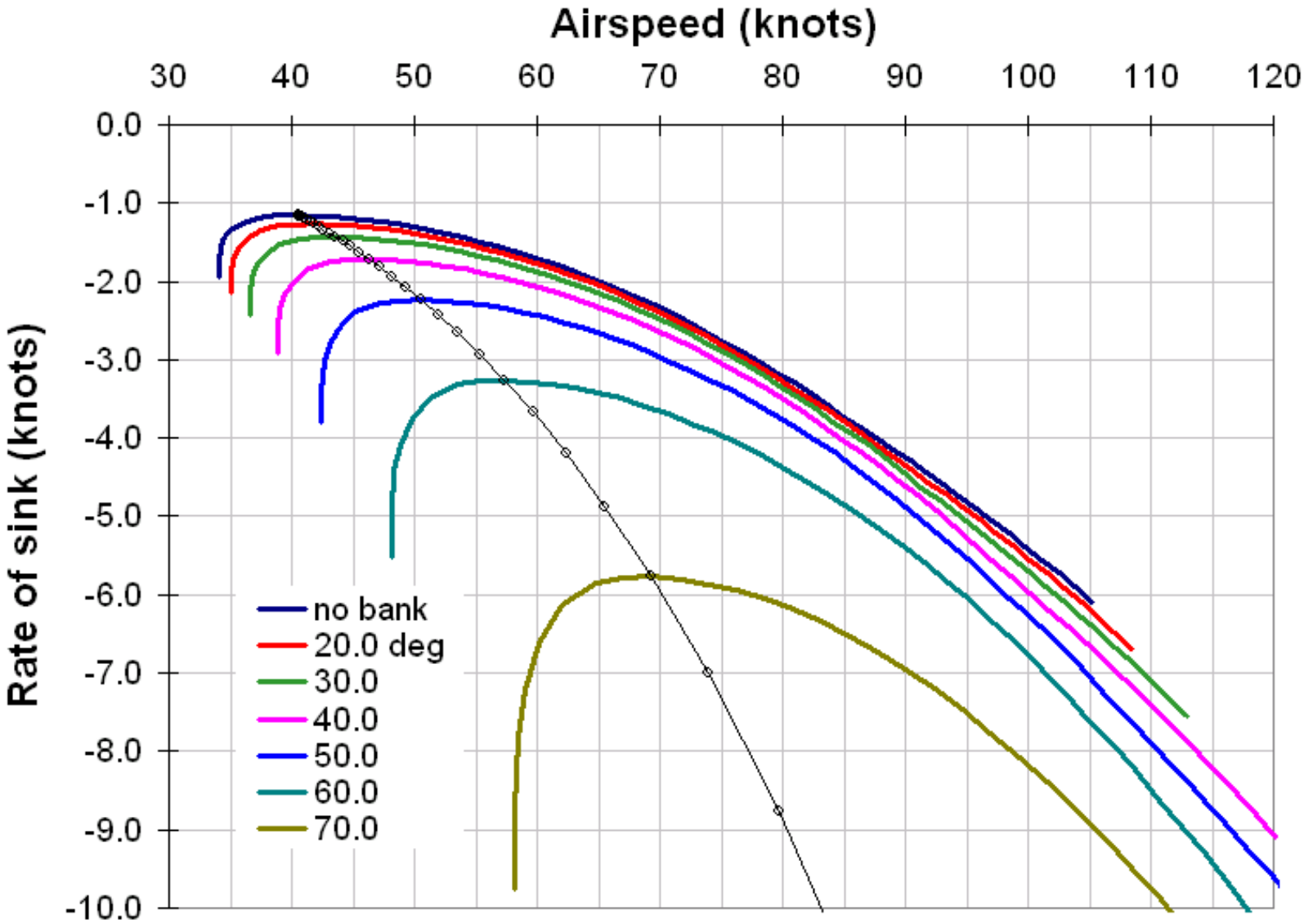
Angle of bank	0°	15°	30°	45°	60°	75°	80°	85°	90°
Load factor	1.0	1.04	1.15	1.41	2.00	3.86	5.76	11.47	∞

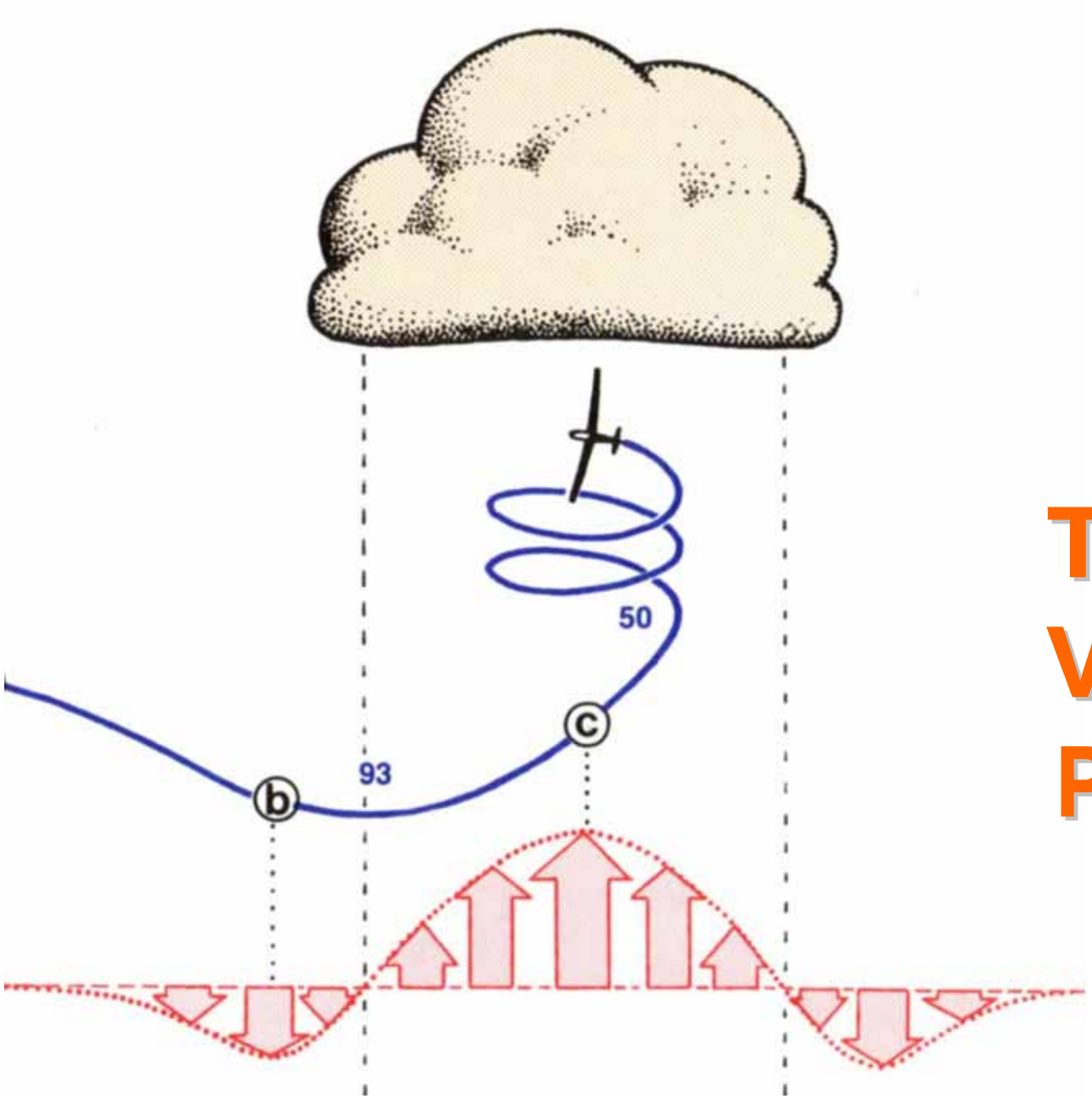
Table 20.1 Variation of load factor with angle of bank.

Key Point to Remember:

wing loading increases with angle of bank

circling glide polar

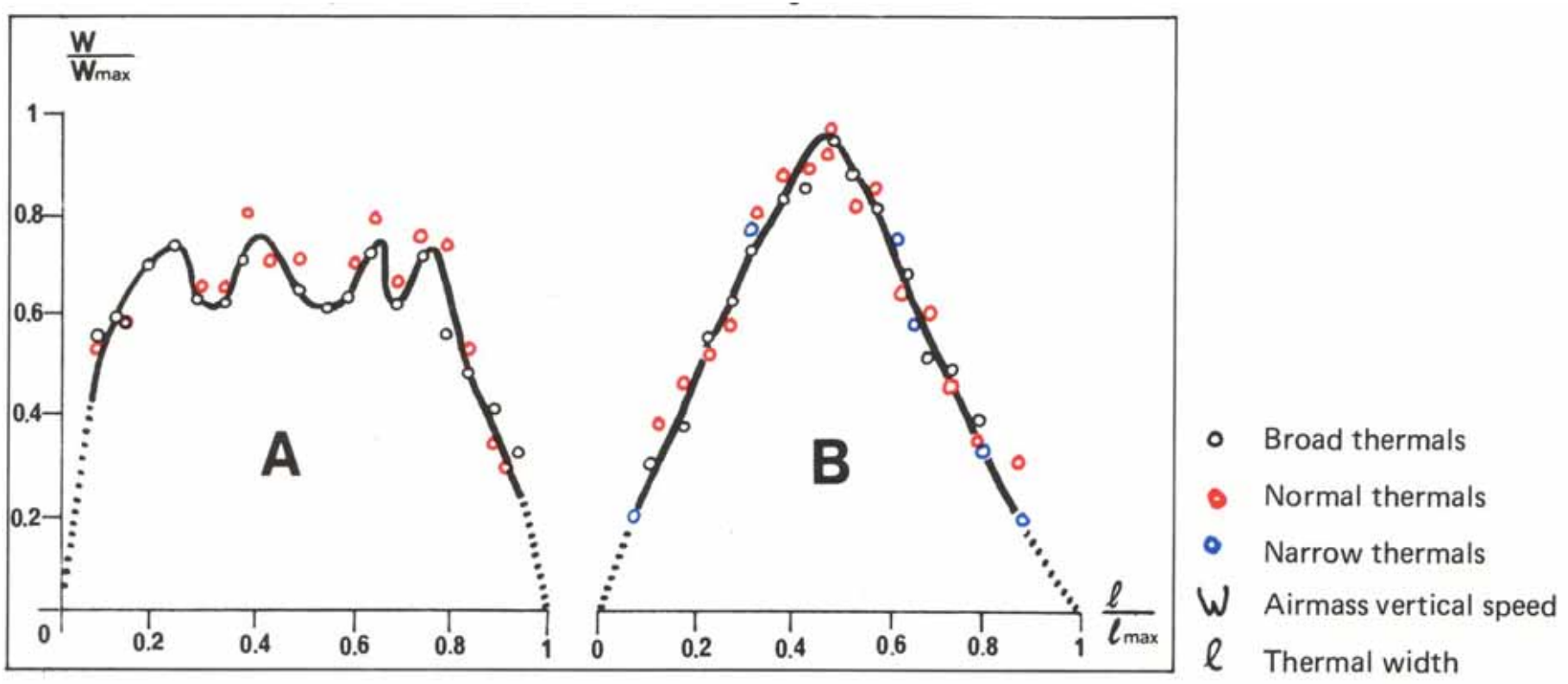




Thermal Velocity Profiles

measured vertical speed through a thermal

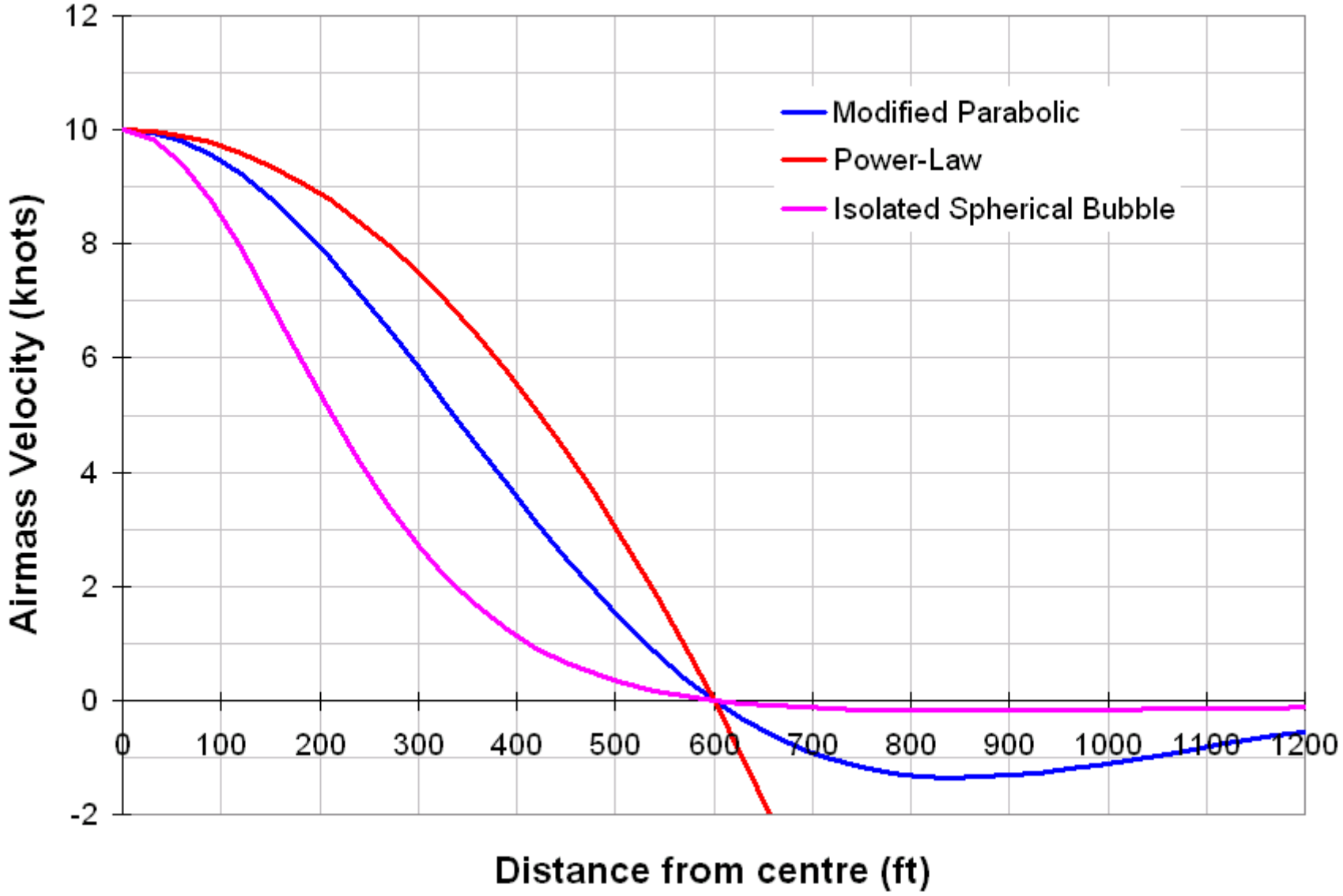
(normalised scales)



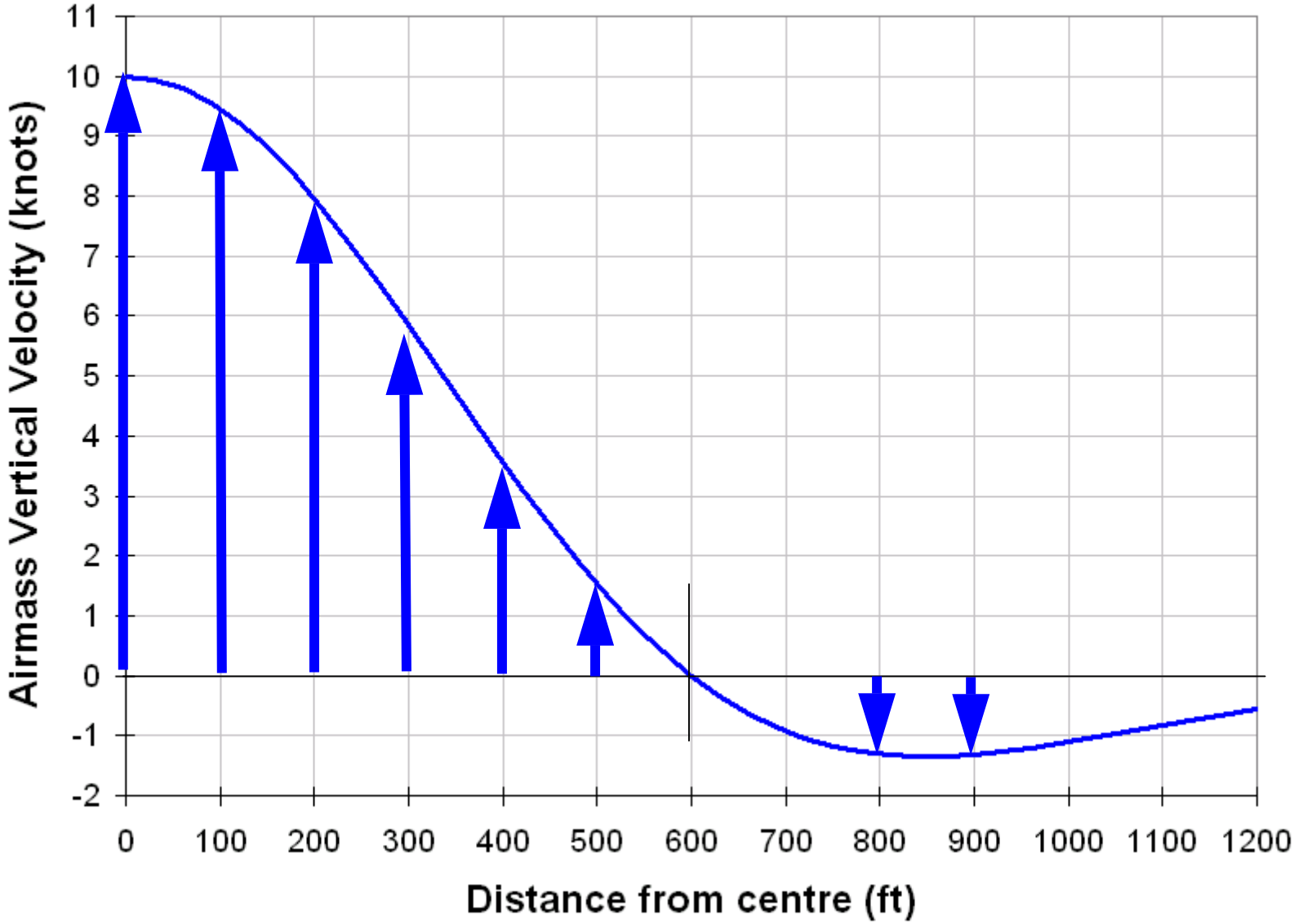
“The thermals that depart from the norm are most likely to be the norm themselves.”

- Helmut Reichmann

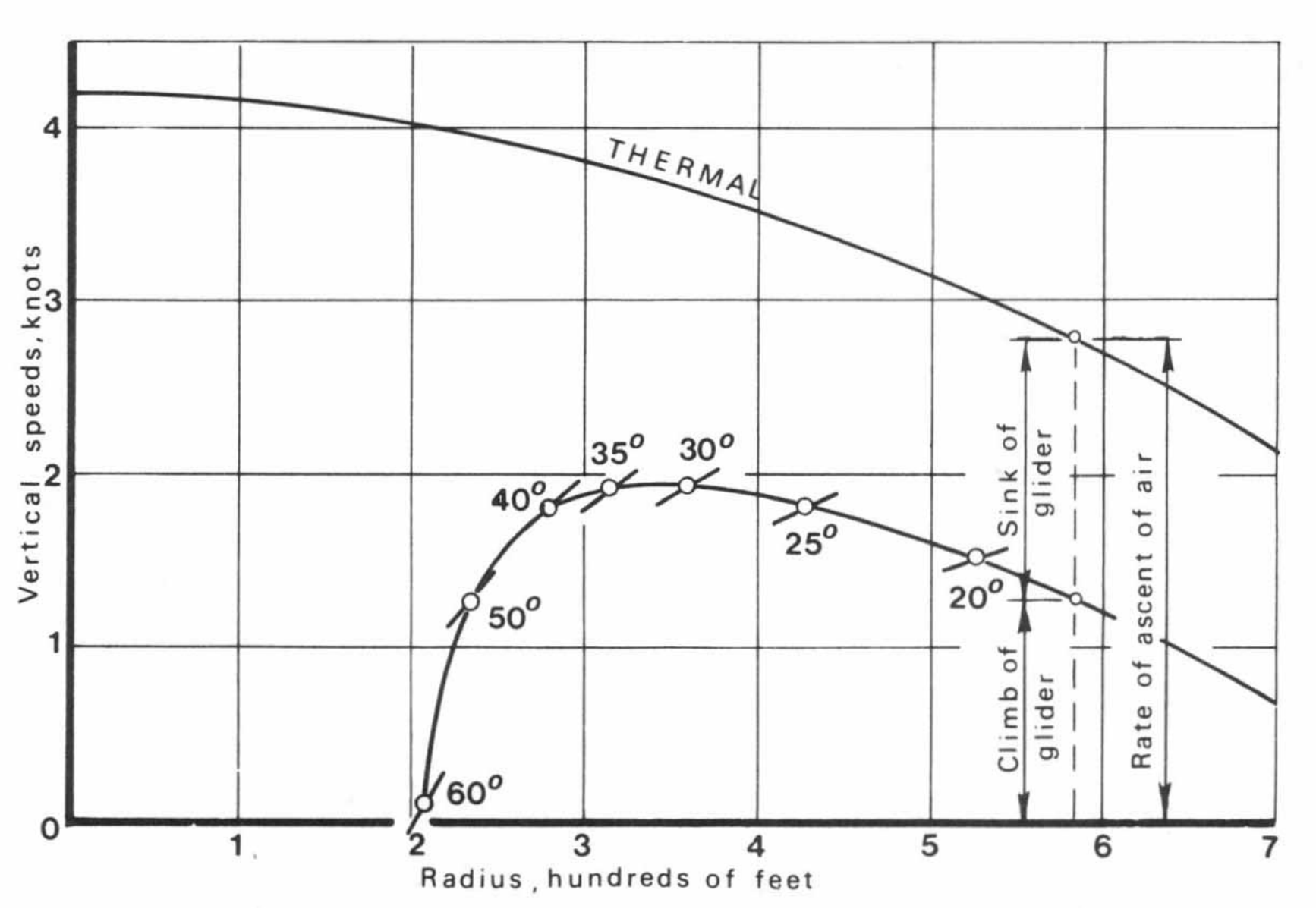
various theoretical profiles



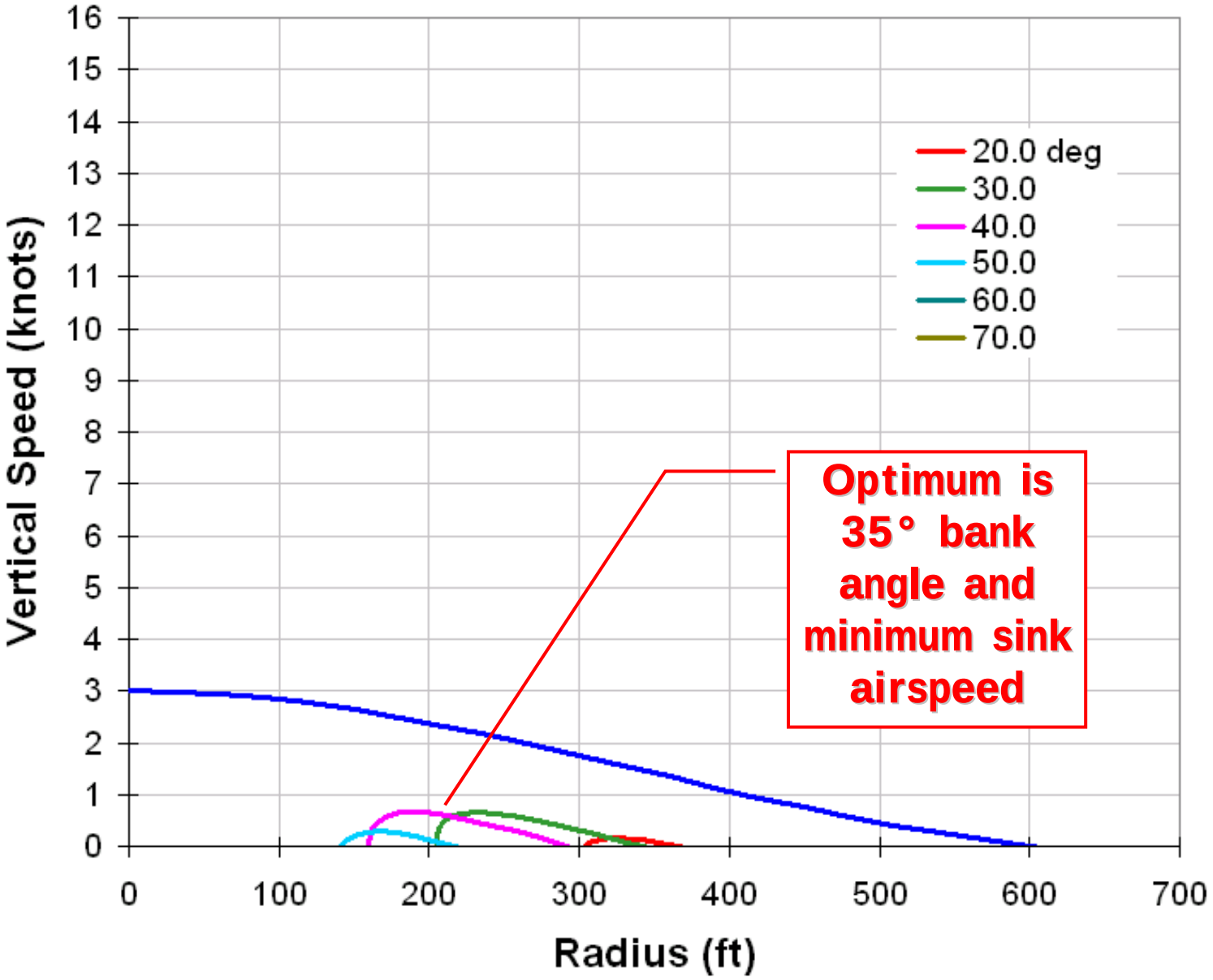
"Aussie thermal"



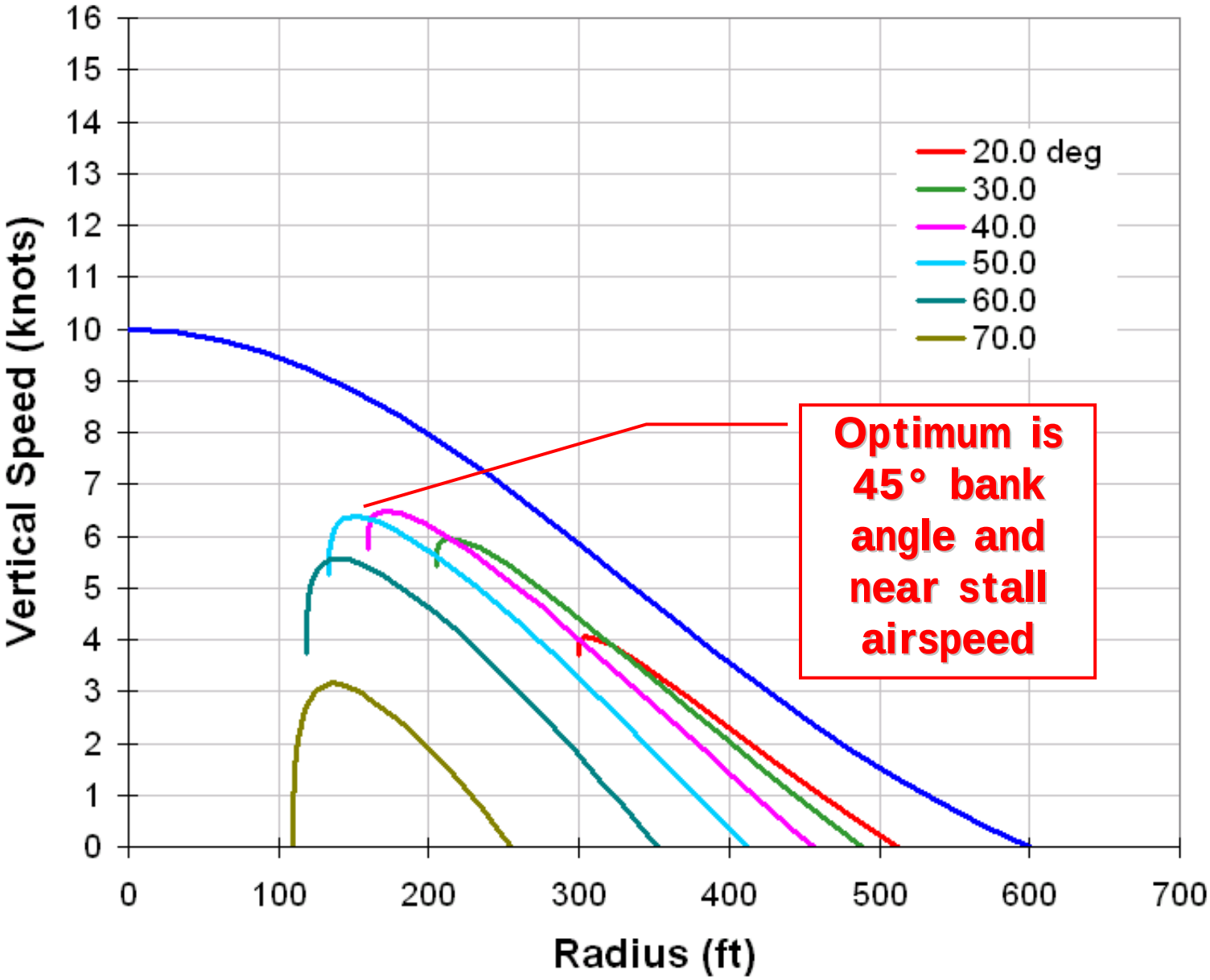
Slide # 53


THERMAL
Vertical speeds, knots
Radius, hundreds of feet
0
1
2
3
4
5
6
7
60°
50°
40°
35°
30°
25°
20°
Sink of glider
Climb of glider
Rate of ascent of air

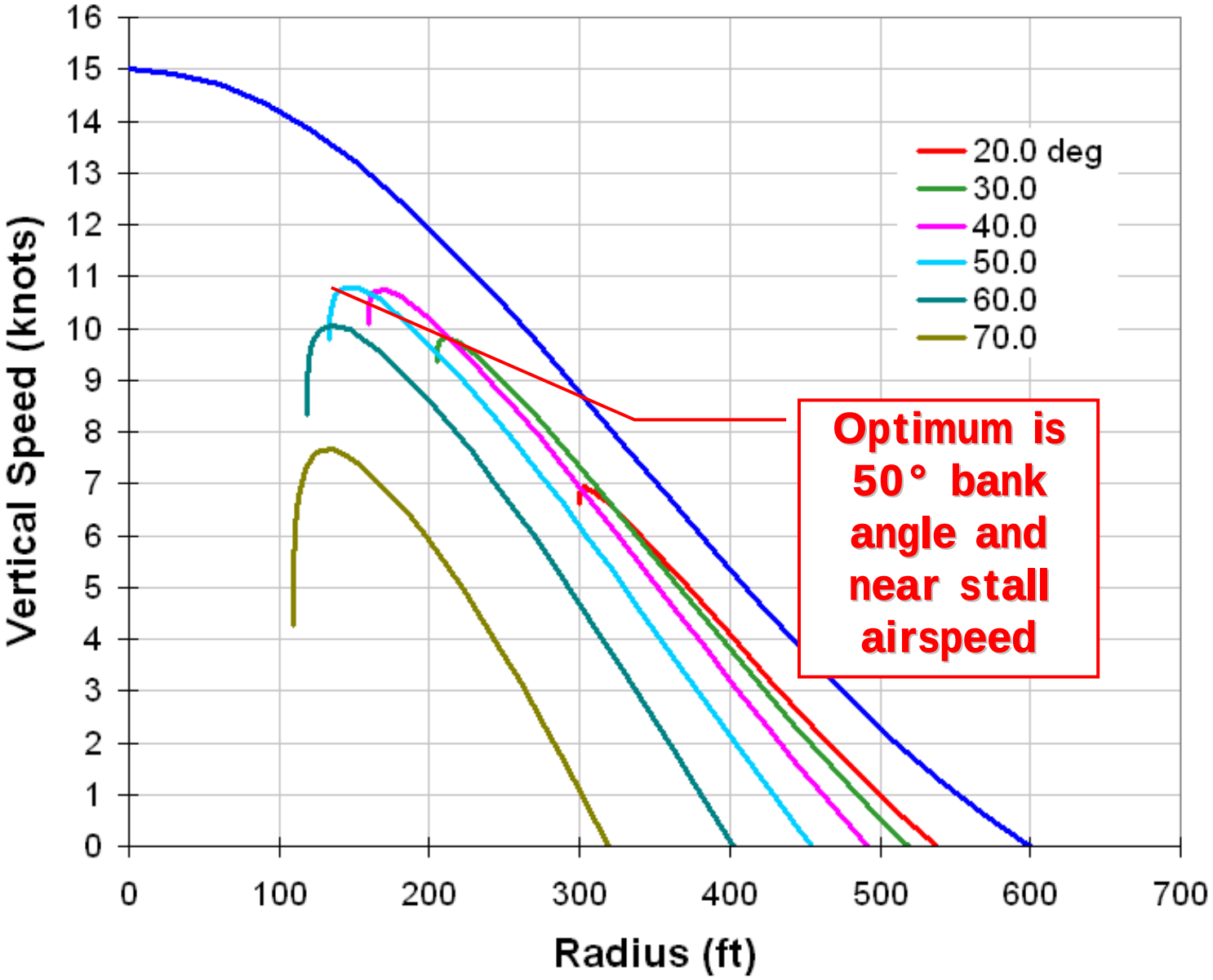
Aussie thermal - weak



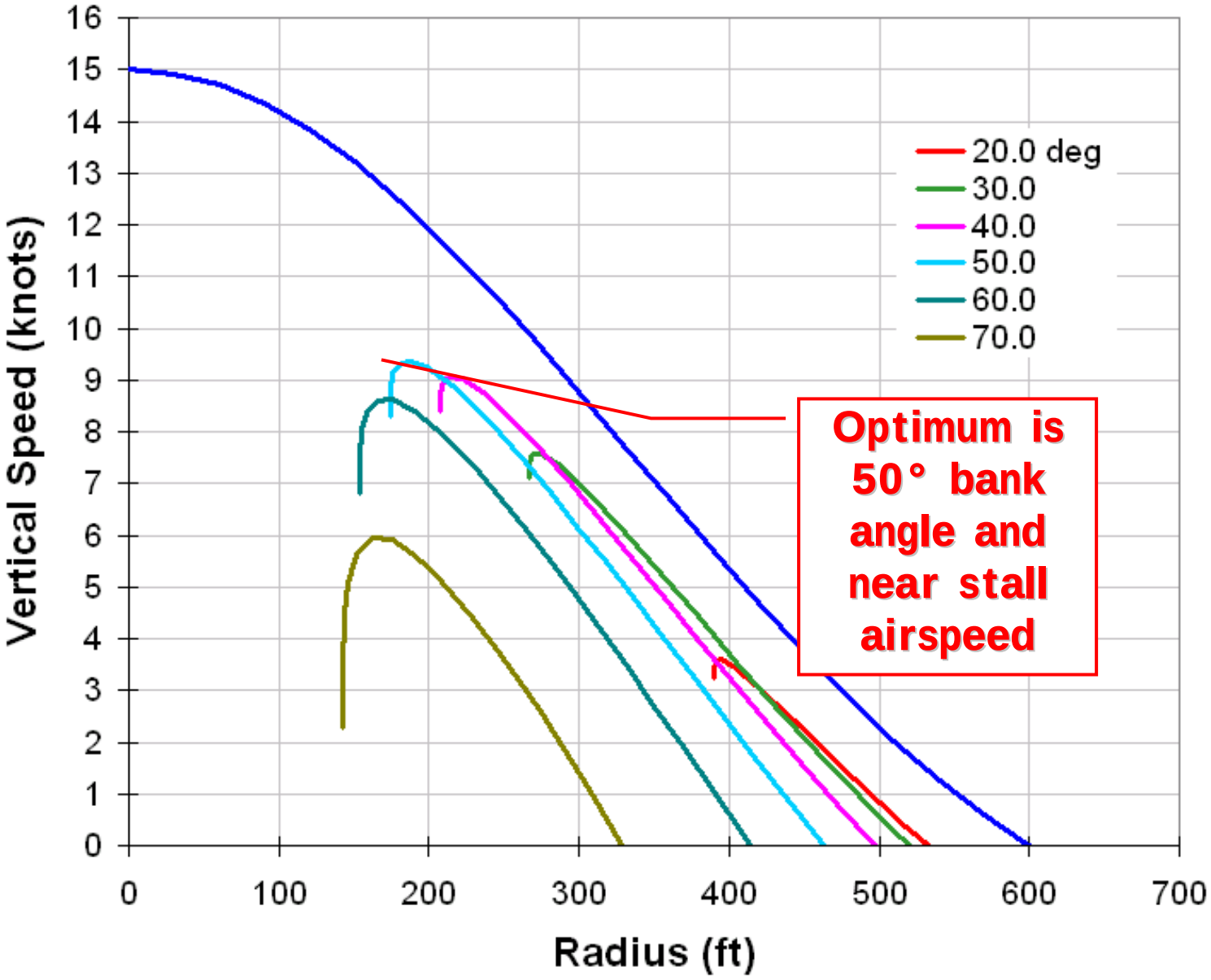
Aussie thermal - typical



Aussie thermal - strong

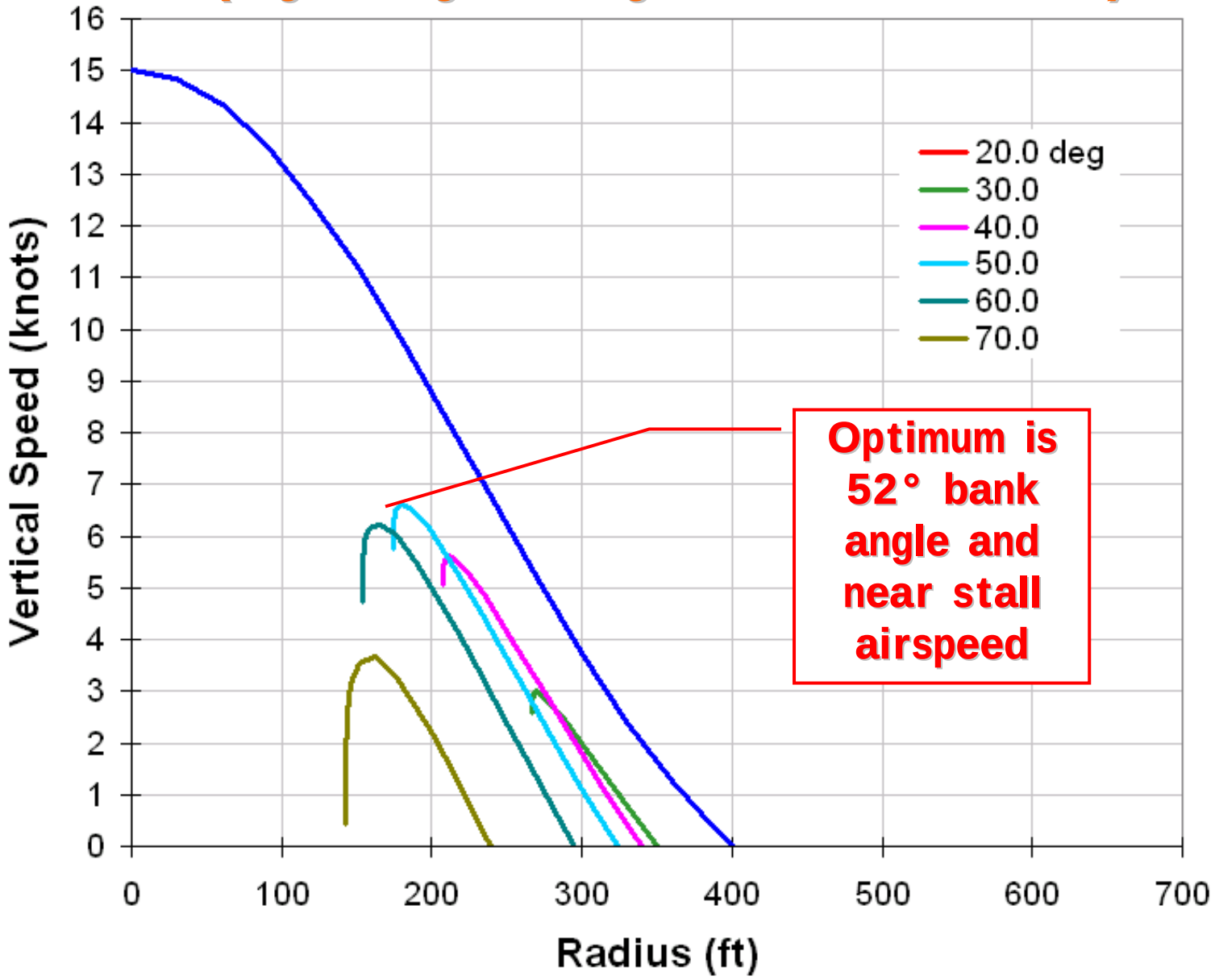


Aussie thermal – strong
(high wing loading)

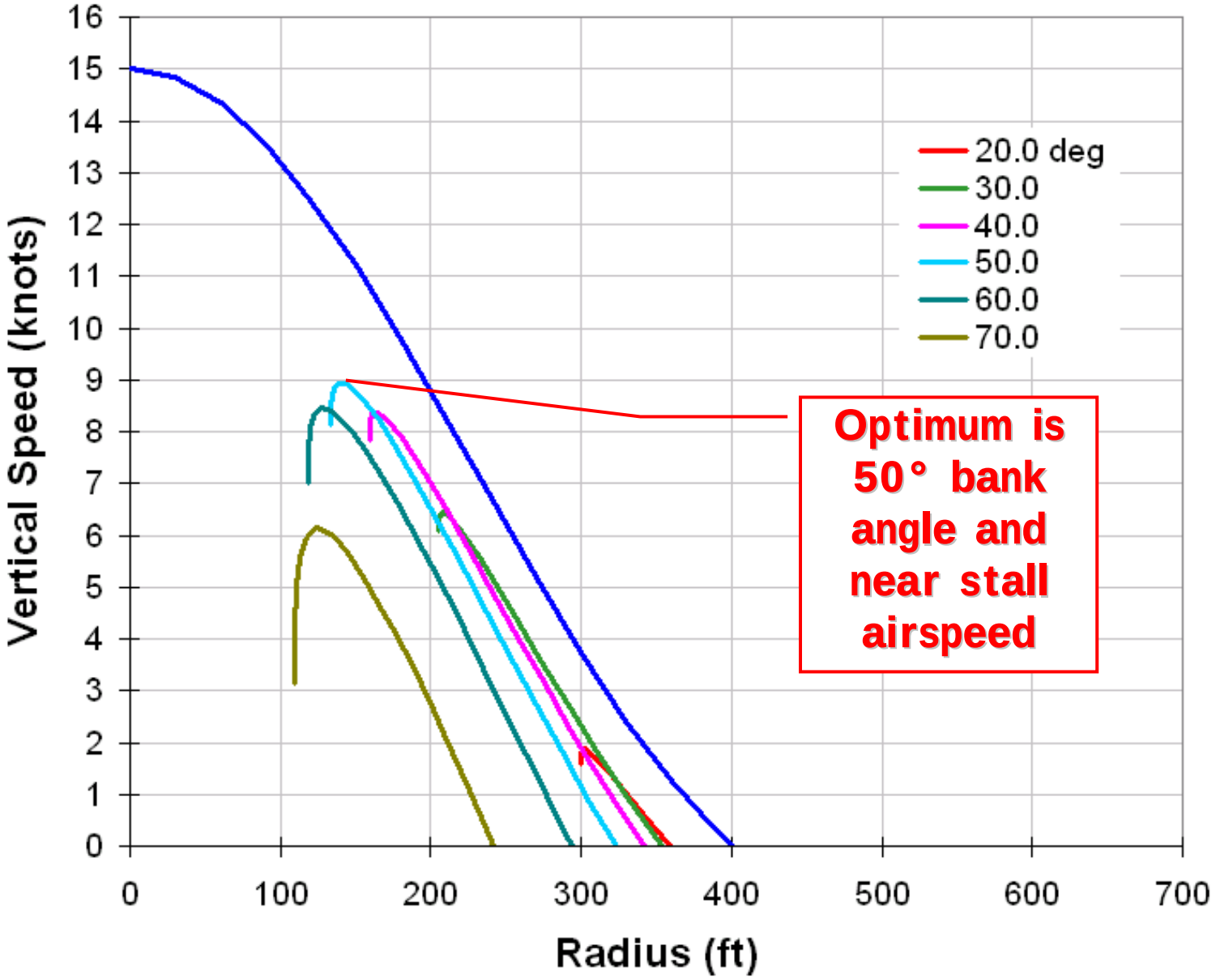


Aussie thermal – strong

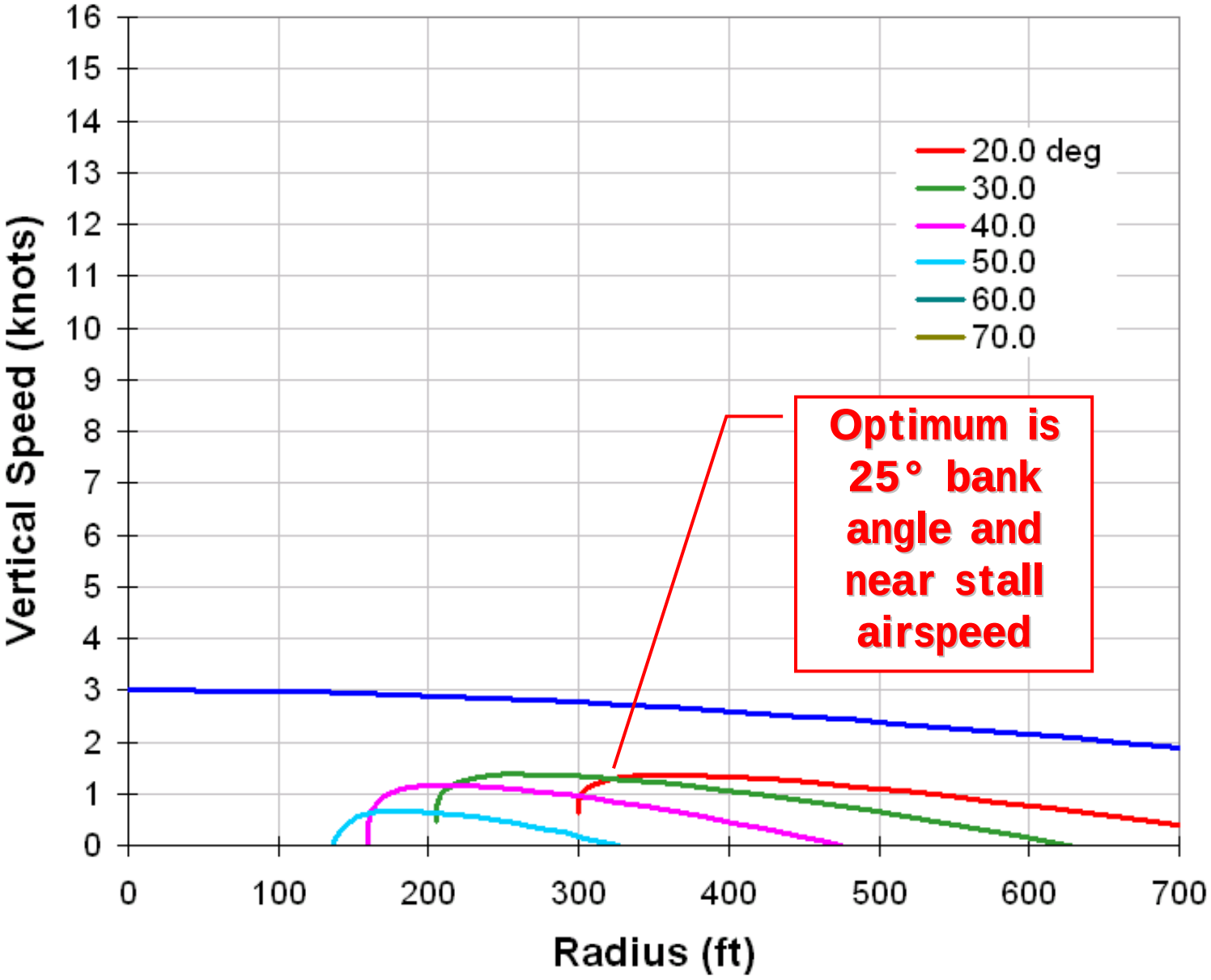
(high wing loading + narrow thermal)



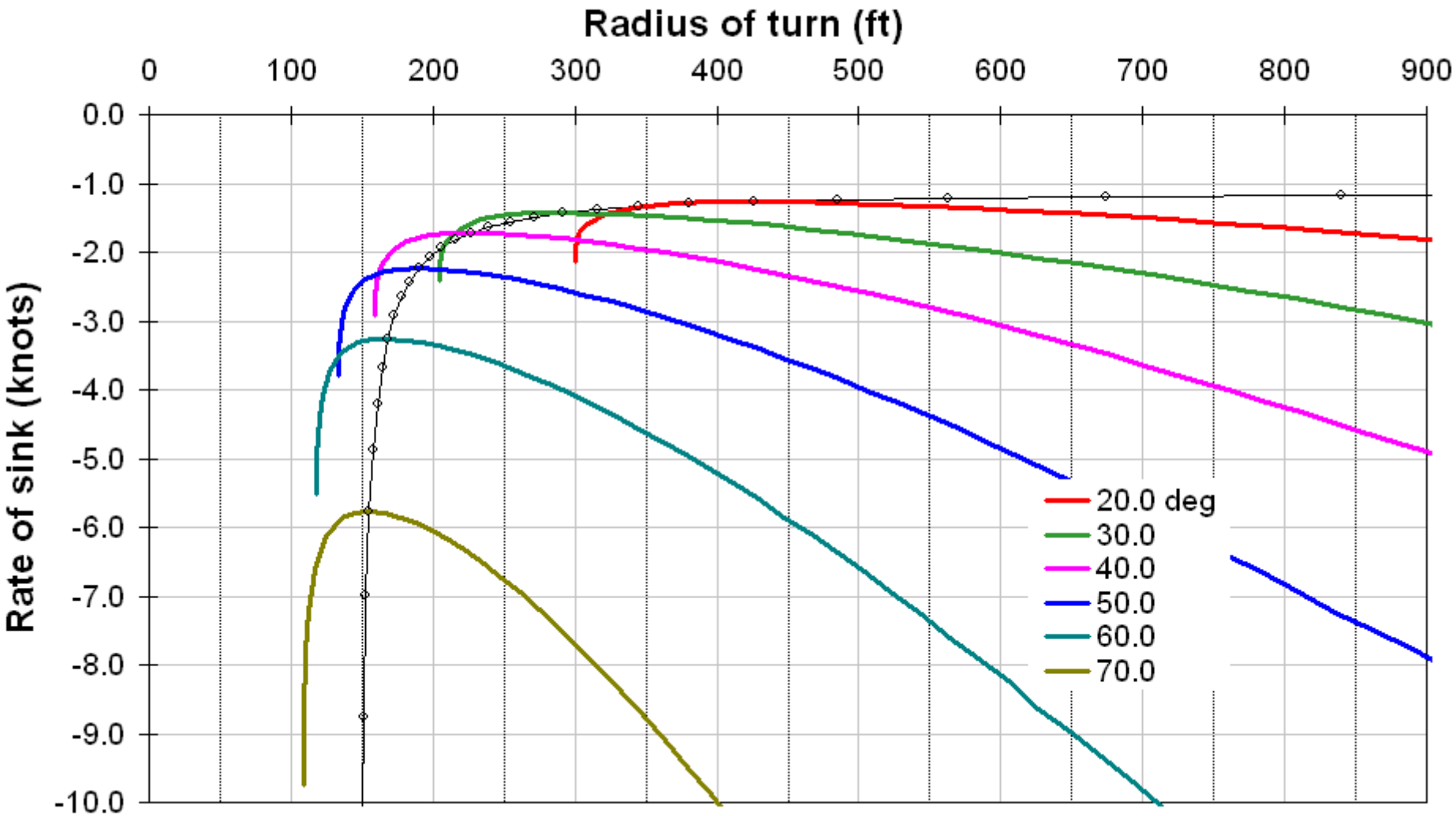
Aussie thermal – strong
(narrow thermal)



Aussie thermal – weak
(broad thermal)



circling performance



Keys Points
(Safety)

Always LOOKOUT BEFORE you start a turn;

When slowing down from cruising to climbing speed - in a climbing turn - lookout AND LOOKUP;

When joining other gliders in a thermal, join on the opposite side and STAY VISIBLE to the other pilots;

Be mindful and careful when flying close to the stall with other gliders below (watch out for gliders above).

Keys Points
(Thermalling)

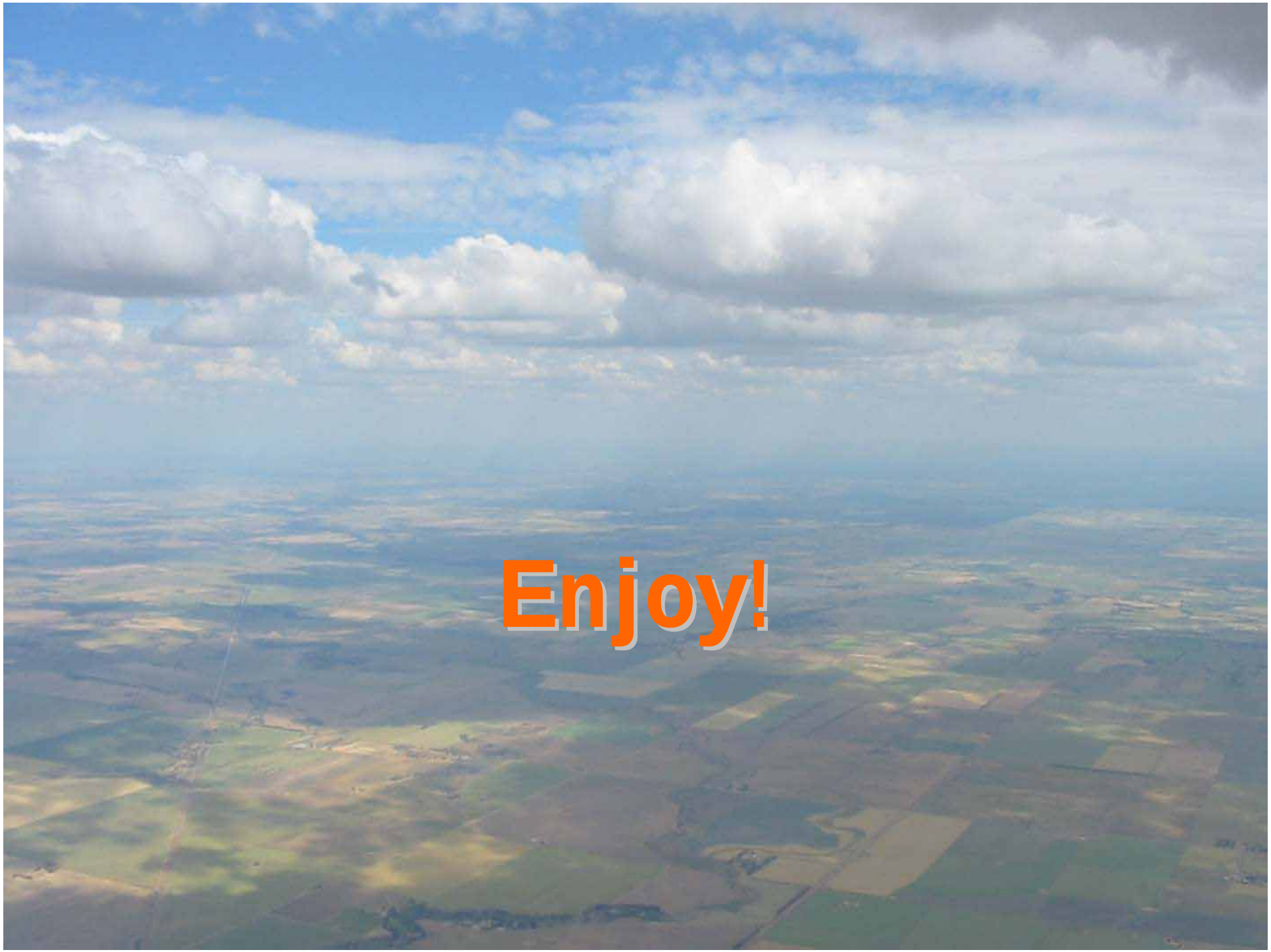
Know your glider's performance;

Maintain constant speed (attitude) and bank angle (approx. 40° to 45°);

Visualise the thermal (broad-weak, narrow-strong, etc.);

Centre, and re-centre, when you have visualised where the core(s) is.


OWL
PUCHACZ


Enjoy!

ACKNOWLEDGEMENT: Material from the following references was used in this presentation.

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