1.4 Omega shape: flows pulled and flows pushed.

Observation of pressure lines at a given altitude (isobars) or altitude lines at a given pressure (isohypses) relating to the best wave conditions always shows a midline shaped like an omega- (Ω).

The lines joining the centres of high pressure and those joining the centres of low pressure are practically perpendicular. This configuration is in effect the one that provides maximum energy. Here are some examples. In Figure 1.10, isohypses at 500 hPa over Europe, there is good perpendicularity of these lines. It should be noted that the presence of two high-pressure centres and two low-pressure centres located on either side of the omega is an acceleration factor and thus increases the available energy and improves the quality of wave systems.

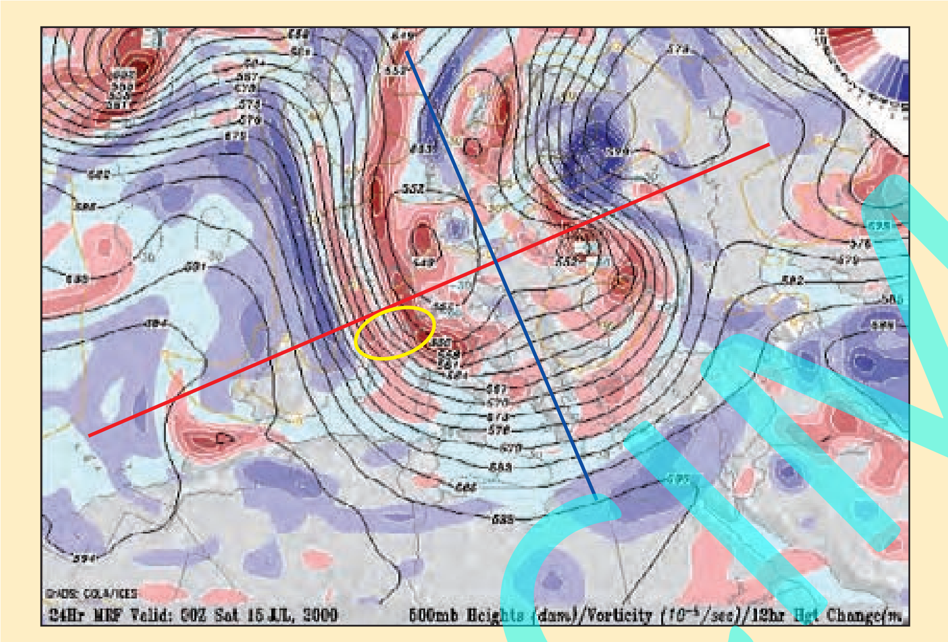


Fig. 1.11 forecast 24-hour isohypses at 500 hPa over Europe July 15, 2000.

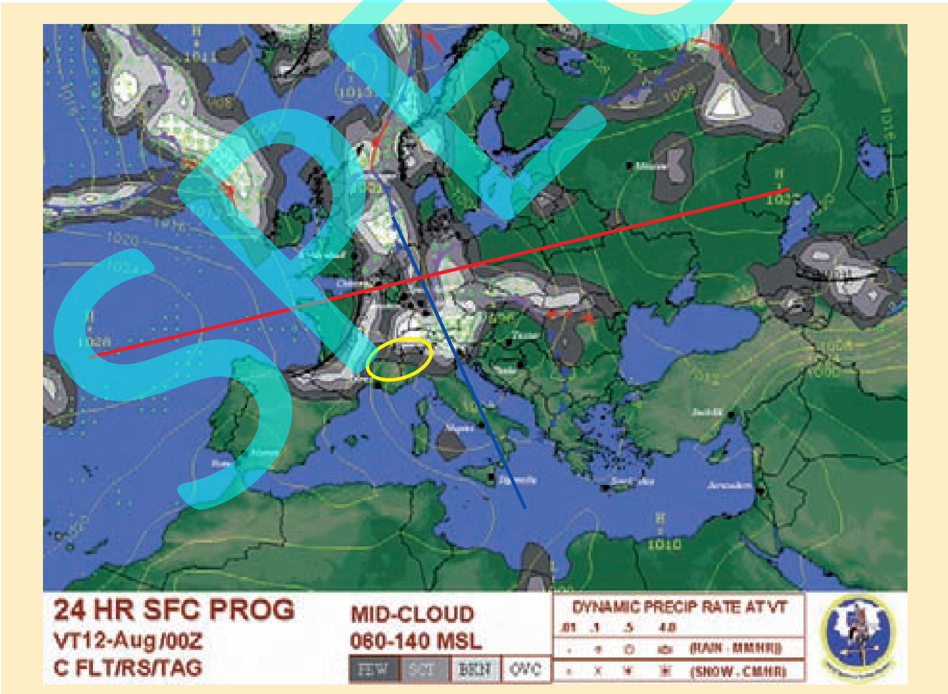


Fig. 1.12 forecast 24-hour contours at 500 hPa over Europe August 12, 2002.

In Figure 1.11, 24-hour forecast isohypses at 500 hPa over Europe July 15, 2000, the day of the first crossing of the Rhone Valley from Varese (Italy), there is much the same perpendicular line joining the centres of pressure and the same omega shape of the isohypses. All the ingredients are thus gathered for this first attempt at a 1,000 km “out and return” flight between Varese and Bédarieux which had to be abandoned because of solid cloud cover in the last 100 km (54 nm).

But this was only a postponement because the forecast for August 12, 2002 appeared to be a photocopy of the previous one and so allowed this time, the flight to be flown as originally planned.

The situation seems very simple indeed to predict, at least as regards the direction and intensity of the wind.

As regards the quality of the wave systems, that is to say, the intensities of the vertical speeds, one must take into account, in addition to all the parameters of temperature, temperature gradient, velocity gradient (as explained later) and the presence or absence of jet-stream, another parameter that I think is important and that nobody talks about: is the position of the flight area in relation to the centres of pressure, or more simply whether we are on the side of the anticyclone or the side of the low pressure relative to the centre line of the isohypses or isobars.

One must keep in mind the fact that at the altitude of the mountains, because

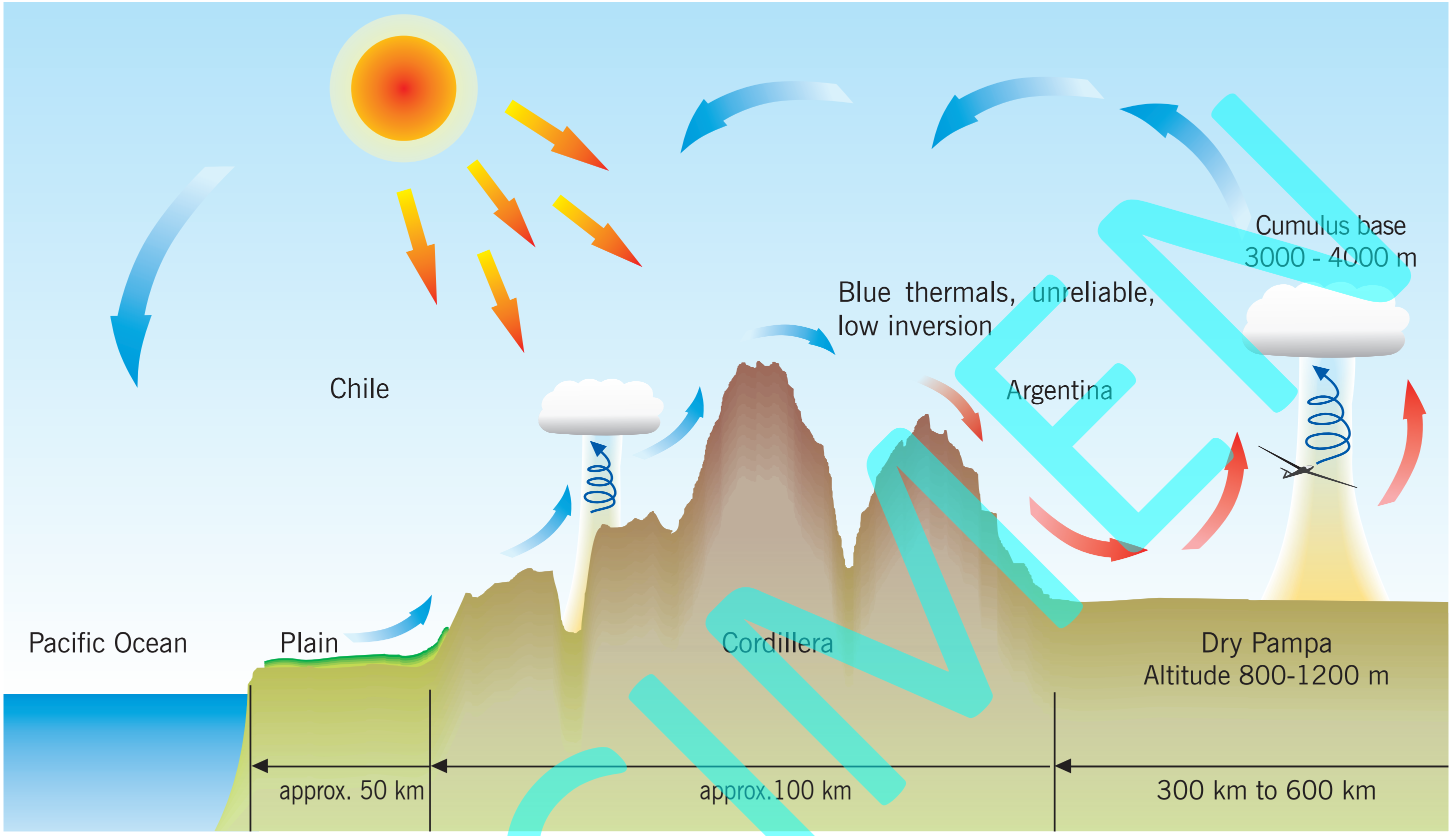


Fig. 2.19 Diagram of the thermal breeze system in the Andean Cordillera at the start of the afternoon.

Fig. 2.20 Convergence front over the Po Valley, April 1994, oriented NE-SW, moving slowly to the SE in a NW wind. The top of lift was about 2,000 m (6,500 ft). Today the airspace in this picture is limited to 600 m or 2,000 ft AMSL (Class A above).

This index (K) is simply an indication of the force required to obtain a certain displacement in compression or in tension.

The stiffer the spring is the more rapidly it will oscillate.

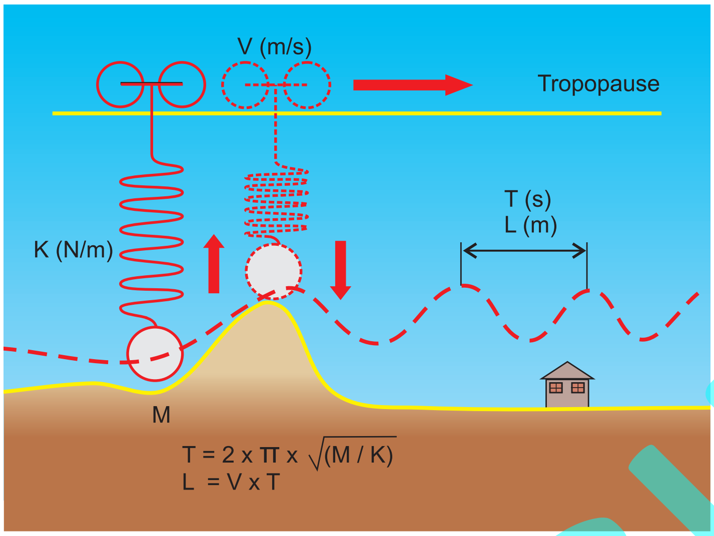


Fig. 5.2.3 The laws of similitude applied to mechanical and wave systems.

V = speed of a mass of air, close to that of the wind
M = mass attached to the spring, the density of the air particle, a function of its temperature
K = stiffness of the spring, that is to say, the air mass stability index
T = period, the time between two peaks, excluding the first.
L = wave length, distance between two peaks, excluding the first.

The movement of the mass on the spring is similar to that of an air particle passing over a mountain. This is more evident when the crossing of the obstacle is fast enough.

The period of oscillation is the one defined in Fig. 5.2.4, which means (and this everyone knows) that the higher the mass or the slacker the spring, the longer the period, thus the oscillation will be slower, and vice versa.

$$T = 2.\pi.\sqrt{\frac{m}{k}}$$

Fig. 5.2.4 Period of oscillation of the mass (M) on the spring of stiffness (K)

But how can we calculate the atmospheric parameters equivalent to the mass and stiffness of our spring? This is where Lyra and Queney become involved, they equated stiffness to relative stability, that is to say, the difference between the actual temperature gradient and adiabatic. The formula of Lyra and Queney 5.2.5 to calculate the period of an atmospheric wave, is thus :

$$T = 2.\pi.\sqrt{\frac{1}{g}.\frac{\theta}{(\gamma * - \gamma)}}$$

5.2.5 Oscillation period of an air particle, according to Lyra and Queney

- Θ is the absolute temperature (°Kelvin = °C + 273)
- is the acceleration of gravity (9.81 m/s^2)
- ϒ*is the adiabatic lapse rate, about 0.01 °/m
- ϒ is the actual lapse rate of the air mass between 0.005 and 0.007 °/m or so, according to the atmospheric sounding of the day.

Here we find the terms of the differential equation 5.2.2.

Consider the flight of 21 March 1999 (details below), we are at 4,200 m (13,770 ft) at a temperature of -11 °C (262 °K), the lapse rate is 1 °C per 100 m (0.01 °C/m) and the actual gradient is 0.65 °C per 100 m (0.0065 °C/m).

The calculation gives a 548 seconds oscillation period thus 9 minutes and 8 seconds. We measured that day 9 min. 56 s. in the first period.

The length of the wave is the elapsed time (period) multiplied by the speed of travel, the formula being L (m) = T (seconds) x V (m/s). In the previous example, the wind speed measured by the onboard computer was 67 km/h =18.6 m/s (36 kt) giving a wavelength of 10.2 km (5.5 nm), against the 9.6 km (5.2 nm) we measured. The correspondence is excellent.

All the special types of waves, with the exception of the hydraulic jump, can be reduced to this situation, we will study them later.

Some popular books offer a simplified formula in which the wavelength is directly proportional to wind speed, neglecting the factors of absolute temperature and the difference of temperature gradients (equivalent to the stiffness of this spring). I will not hold this simplified hypothesis because, firstly, no glider pilot ever calculates the wavelength before take-off, it is now a matter for powerful computers and the Internet to deliver a splendid col-

6. Atypical waves

We have in both cases, verified the existence of wake waves corresponding to the theoretical calculations and observations on satellite photos. While these waves are not violent, they do not allow a stop for a fast climb, if other than only to gain a few hundred metres.
They sometimes allow the making of progress (always slowly) if the waves are well formed. It is important to know how to identify and use them for several reasons :

- if the pilot wants to pass to windward of the volcano, the best energy route is the one that moves from one wave to another, by climbing in a zigzag in the edge of the wake of which the angle is about 20° (internal edge) to 30° (outer edge). When this route can be seen (photo 6.5.8), it is then necessary to jump from one rotor to the other. Otherwise, fly by observing the "netto " variometer and flying "zigzags" along the supposed ideal route.

  The interior of the wake turbulence is usually "dead" so it is useless to go there in search of hypothetical wave climbs. The approach from downwind of the Lanin volcano can be done practically without losing altitude by applying the diagonal approach method described above, by jumping over the waves located on the edge of the wake cone, shown by rotor cumulus; the trajectory converges towards the cone.

Fig. 6.5.8 Wake from the Lanin volcano. The cone of turbulence is devoid of any cloud on the edges, the cumulus show the "Wake waves ", their edges are symmetrically inclined (mirrored) relative to the cone axis. The Vz are low (of the order of m/s), but allow progress towards the volcano without losing altitude.

- If the pilot has to cross the wake cone downwind of the volcano because his route demands this way, he should seek the "wake wave" that is closest to his route, by viewing the angle to the volcano and wind (20° to 30°), which requires careful observation of headings, of the route and bearings. The "netto" never being zero, he will have to choose to move along the edge of the wake cone in search of the best "netto", generally downwind, then immediately resume a convergent route into wind of about 45° to 60°, which is the angle of the "waves" relative to the wind. It should be remembered that these waves are longer the further they are far from the volcano, but crossing the wake cone will also be correspondingly longer.

Lanin volcano behaves identically to those of the Crozet Islands. At a distance of 100 km from the summit, the cone of wake is at least 30 km (16 nm) long and the waves are inclined approx. 45° relative to the axis. See diagram fig. 6.5.9. You have to practice this exercise on blue days when one is not stressed by the stopwatch. I personally had some very pleasant surprises and have been able to tranquilly finish my 1,500 km badge by using this phenomenon in blue sky on the last leg.

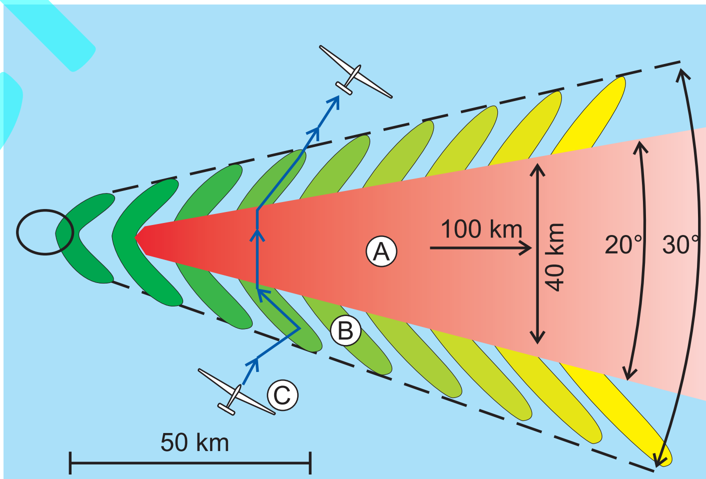


Fig. 6.5.9 Diagram of wake wave, and the path to cross the cone of turbulence, 30 to 50 kt wind:
A: Wake turbulence cone, no organized lift
B: Lateral waves
C: Ideal path of a glider to cross the wake of an isolated peak. Search for the best netto variometer readings starting halfway between crosswind and downwind, turn 90° intowind "surfing" the wave, once in the cone, cross it quickly by the shortest possible path, search for the wave on the other side and repeat the same process.

The most amazing special feature of these isolated peaks is the presence of strong convergence lift that strengthens the lee wave climb, at the foot of the cone; it is almost always

7. The hydraulic jump

In 2009, the World Meteorological Organization published in its brochure No. 1038, “Atmospheric Processes favourable to gliding” a small article on the hydraulic jump, which showed the lack of current theoretical knowledge in this field, writing:

“The atmospheric-jump rotor has no organized branches; these rotors can extend much higher than the mountain top and are usually far more turbulent than the trapped-wave rotors. Atmospheric jumps are much less common than the more familiar trapped-wave systems. Little is known about specific conditions leading to atmospheric jumps rather than the trapped waves. From numerical model studies, we know that they favour environments with strong near-mountaintop inversions and relatively weak vertical shear.”

This commentary is accompanied by the following diagram, fig. 7.4.0.e that accurately reflects both the conditions described above by Steve Fossett’s meteorologist and those we also encountered during our various flights, especially early on, when we had not yet understood all the peculiarities of this flow.
Against this, there is, to this day, no study or explanation for the coexistence between the hydraulic jump and lee wave (sinusoidal rebound) that we have seen and used on several occasions.

Evidences of this phenomenon are visible in photographs 7.3.2, 3, and 4, but it is also possible, even quite common, for there to be no trace on the ground or even intermediate level condensation cloud, against which pseudo-lenticular is almost always present.
If it is not, this does not mean that the jump does not exist. Photo 7.4.1 shows the situation on 28 November 2003.

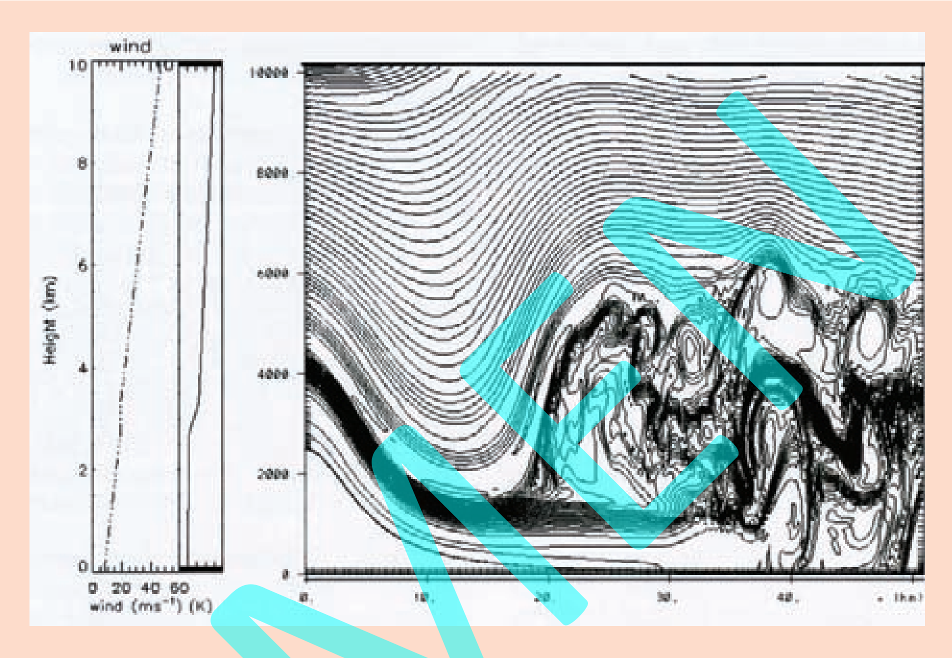
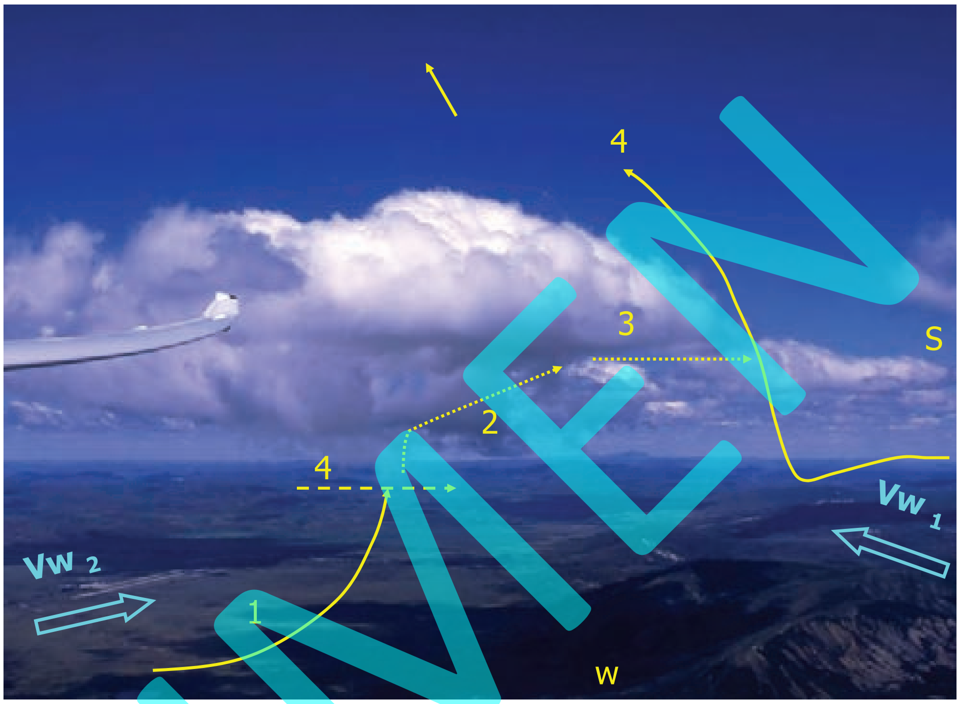


Fig. 7.4.0.e Modelling of an “atmospheric jump” by the World Meteorological Organization, 2009.

Fig. 7.4.1 The hydraulic jump in the Loncopué valley looking towards the south. The glider is at 5,000 m (16,000 ft), the pseudo-lenticular starts around 6,000-7,000 m (20,000-23,000 ft). Note the edge, “fringed” or comb-shaped, characteristic of the hydraulic jump. Also note the presence of rebound waves in the lower layers, with well-marked rotors and low lenticular. We are more than 20 km (11 nm) from the ridgeline.

The contact with the laminar flow happens just at the height of the highest base. It often happens that these clouds are strengthened by a convergence because the upper wind often causes suction at ground level if the plain is unobstructed, which will generate a convergence in synergy with the thermal.



8.4.1 Example of cumulus-rotor in synergy with convergence. The wind at altitude (Vw1) is from 240°, that at ground level (Vw2) is from 300°. The plain is very active with thermals, and it is clear that all the cumulus are combed by a westerly wind. The technique will therefore be (1) thermalling to the first base, about 1,500 m (5,000 ft), (2) climb in the convergence to the highest base, about 2,500 m (8,200 ft), and (3) move to the cloud (4) to enter the wave system.

8.5 Flying downwind of ridges not perpendicular to the wind.

We saw in Chapter 3, fig. 3.4.1, that because of friction as wind crosses a ridge, the wind (or fluid) tends to leave the ridge perpendicular thereto.

This physical law works as well for fluids as for solids and it is used in an industrial environment for angles that normally do not exceed thirty degrees, mainly for mechanical reasons. This does not mean that this law does not apply for higher angles.

Most experts agree that an inclination of 30° with respect to the perpendicularity of the wind vector is not particularly a negative factor for the formation of wave. This is also the view of the excellent Tom Bradbury who indicates in fig. 97 p. 80 of the reference (14) an angle of approximately 30°, see fig. 8.5.1.

The reality is not as categorically entrenched and we were surprised to observe that ridges inclined 45° either side of the wind could generate resonant wave systems.

The satellite photo 8.5.2 shows a beautiful example of herringbone wave to the north of Bolzano that I used regularly during the twenty years that I was flying in the area.

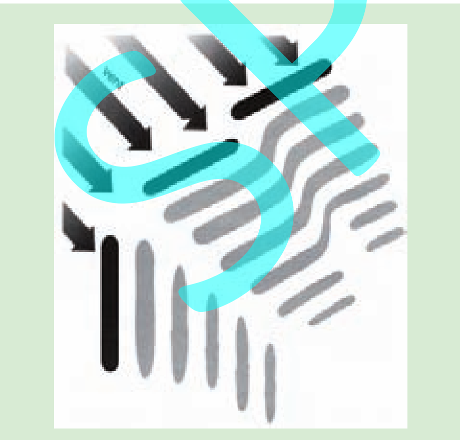
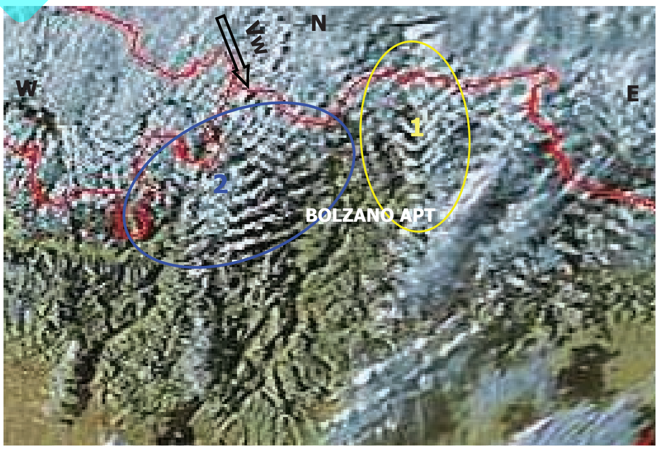
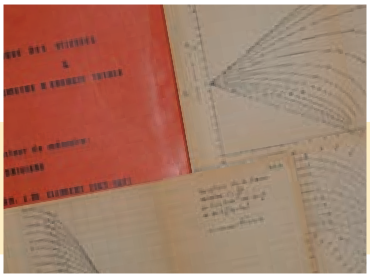


Fig. 8.5.1 According to Tom Bradbury (14), a diagram of the wave system when the peak is not at right angles to the wind. Note that the difference is about 30°.



8.5.2 Satellite photo of an example of wave in 90° chevron-shapes (yellow ellipse), angled at 45° on either side of the wind vector. The classical wave, perfectly perpendicular to the wind, is contained in the blue ellipse. Crossing the yellow area is one of the keys to success to flying towards Austria.



the more the offset along the axis of the Vz will be greater.
The glide ratio goes from 13.3 to 16.7 (+ 25 %), for the record it is 15.8 for an ASH 25.
The speed-to-fly is 194 km/h against 162 km/h, the circuit cross country average speeds are 30 and 40 km/h respectively (+ 33 %). This represents a gain of 15 minutes and 460 m (1,500 ft) above sea level every 30 km (16 nm), it's huge. Recall that it is 37 km/h for the ASH 25, the smaller glider with heavier wing loading thus has better performance.

The Equivalent MacCready setting will be (E) = 3.6 m/s for the light glider and (B) = 3 m/s for the heavy glider, which therefore will fly slower through the air and yet more quickly over the ground.
The pilot of this small glider will always win over the big two seater. The instructor can therefore use these lines to convince his student he has a better glider on the day of his first solo in wave! Provided that he flies it with high wing loading!

From now on, all the studies and their conclusions will refer exclusively to the glider at its maximum permissible load, unless expressly stated otherwise.

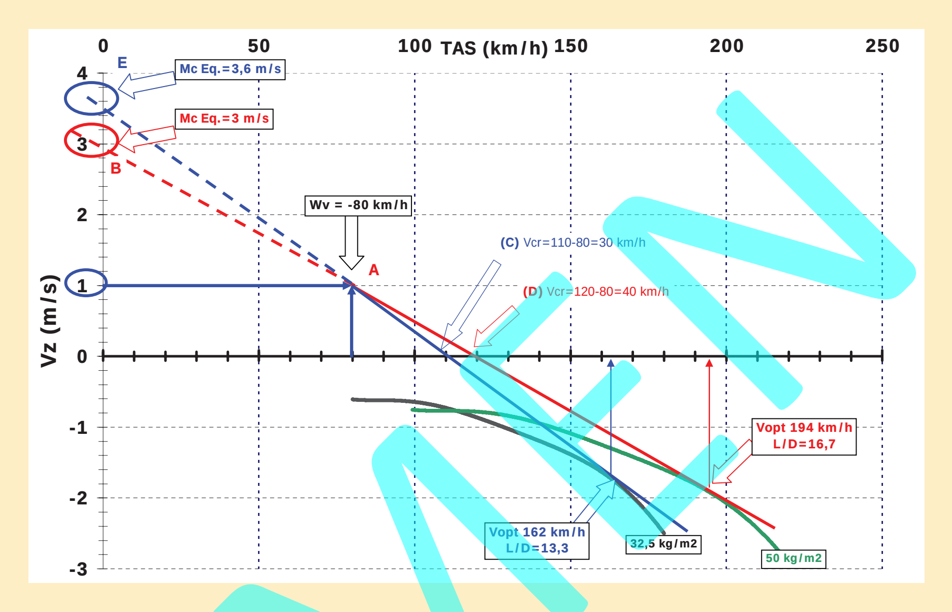


Fig. 9.4.2 Discus 1 Polar at 32.5 and 50 kg/m² (6.7 to 10.2 lb/ft²), headwind 80 km/h, sea level, average lift 1 m/s, looking for the best cross country average speed.

9.5 Direct influence of altitude.

The approach is identical to that described above: the decrease in air density with altitude increases true horizontal and vertical speeds by the same amount roughly proportional to the height, about 5 % every 1,000 m, or about 30 % at 6,000 metres (20,000 ft). The polar undergoes a homothetic translation completely identical to that caused by the increase of the mass, and this starting from the origin of the axes, 0 km/h 0 m/s.

In the absence of wind or when flying in lowland thermals, when considering speed-to-fly through the air and not in relation to the ground, the effect of increased altitude on the glide ratio is zero, neglecting any aerodynamic improvement. Only the true airspeed increases, but so does the sink rate and the benefit in terms of cross country average speed on a task will be more important the more time is spent flying in a straight line.

But when the headwind is significant, the origin point of the tangent is shifted and the glide ratio increases with al-

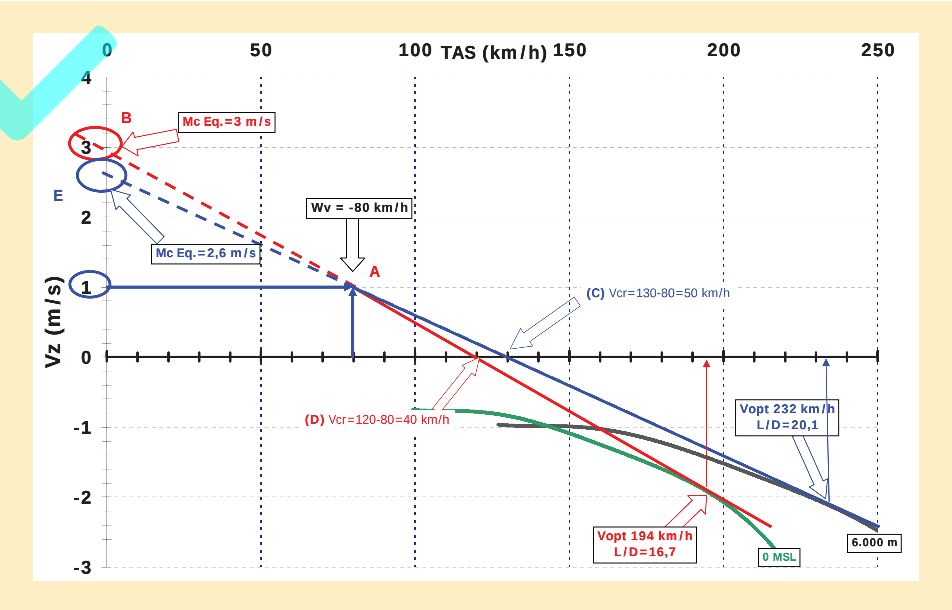


Fig. 9.5 Polar Discus 1 at 50 kg/m²,, headwind 80 km/h, sea level and 6,000 m (20,000 ft), average lift 1 m/s (2 kt), looking for the best speed-to-fly.

Fig. 9.10.3 Vne (indicated airspeed) depending on the altitude, to apply in front of the control stick, (Nimbus 4D modified per TN 868-29)

ALT	Vne
3	285
4	273
5	266
6	260
7	253
8	247
9	241
10	235

source of inaccuracy that can even so be quantified, however, other problems such as air leaks must always be resolved.

The Flight Manual must indicate the correction to be applied to the reading of the ASI that is to say the error in measurement of air pressure depending on the position of the probe (in the nose or on the tail) and of the flaps. See for example the diagrams for correction of Discus 1, fig. 9.10.4 and Nimbus 4D, fig. 9.10.5.

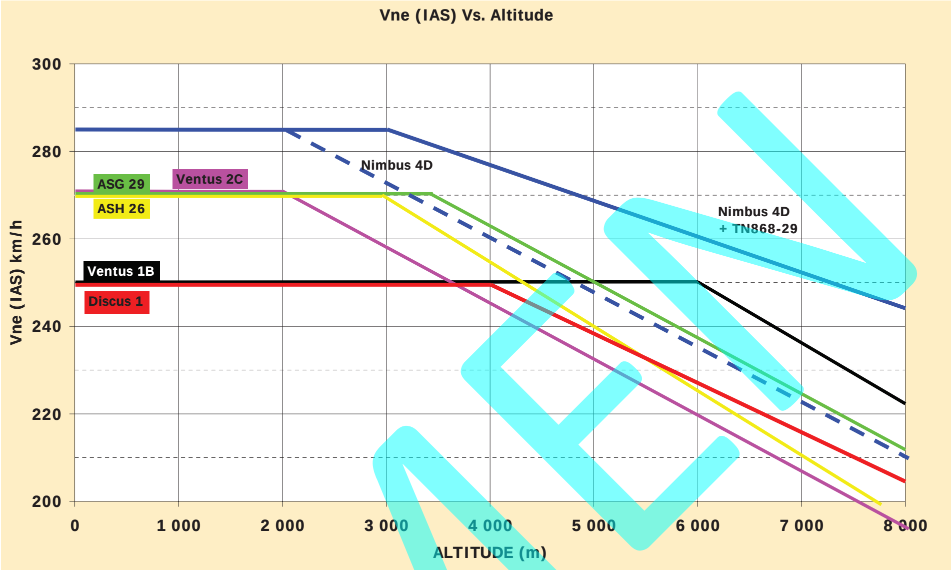
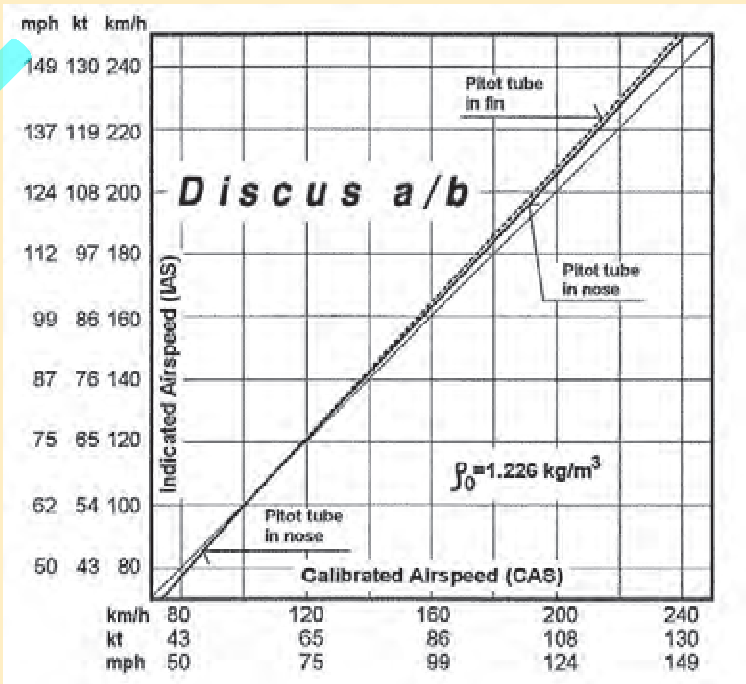
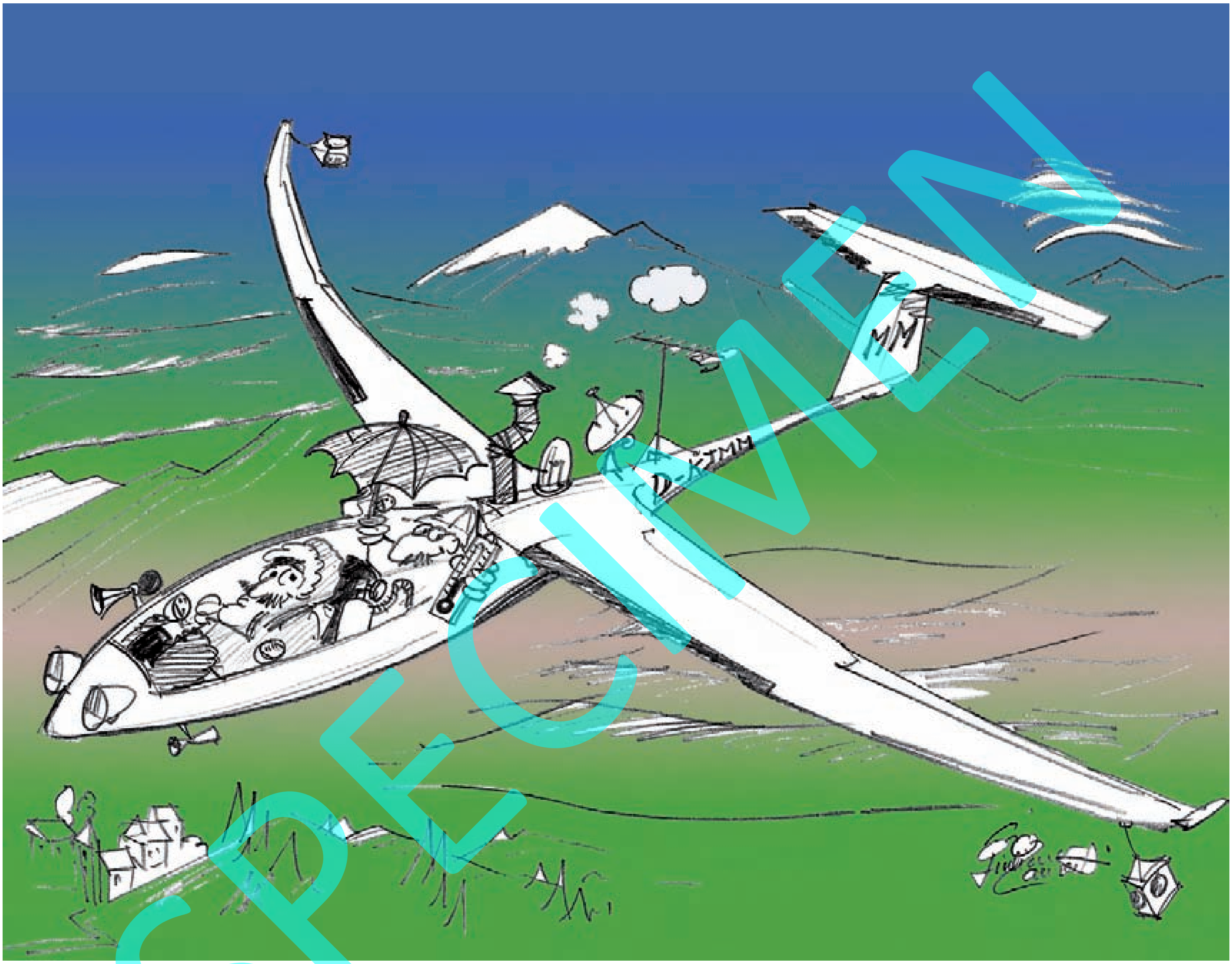


Fig. 9.10.2 Curves Vne (IAS) versus altitude, for a few modern gliders widely used for wave flights.
For the Nimbus 4, modification TN 868-29 is simply balancing the inner ailerons of the outer wing, the gain is extraordinary, 37 km/h at 6,000 m, bringing the ground speed to 360 km/h. I have seen quite often more than 450 km/h on the GPS, with some tailwind. Only to be practiced with caution and sensitivity for any unforeseen weather anomaly can be fatal in seconds.
Note the performance of Ventus 1 which retains its Vne up to 6,000 m, confirming its reputation as an extremely rigid glider. Its successor, the Ventus 2C, much thinner wing profile and more flexible wing, has the worst performance of all these examples.
The ASG 29 (which is actually an extension to 18 m of the ASW 27) seems today the fastest single seater on the market, until the release of the US glider Duck Hawk designed by Greg Cole, who announces a Vne of 405 km/h (219 kt) at sea level.

Fig. 9.10.4 airspeed calibration chart, Discus 1.
The two positions (nose and fin) give exactly the same error. From 110 km/h, the indicated speed is always higher than actual, which is good for Vne since the red line will be about 5 km/h below the actual speed.
The error at low speeds is of opposite sign, of the order of 3 km/h at stall speed.

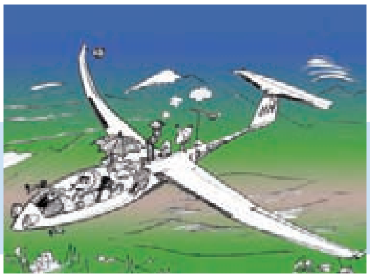


10 Flight planning, problem management



June 4, 2001, the meteorologist Giuliano Laurenti takes the back seat for an Out & Return 1,000 km flight between Varese (Italy) and Koflach (Austria). A few minutes after landing, smiling from ear to ear, he had already drawn the ideal glider for this type of flight.

A beautiful wave flight can not be improvised; man and glider should live in perfect harmony for a whole day in totally unusual conditions for both the pilot and his aircraft. We will have to fly very fast and sometimes very slowly, the start of the flight can be in clear skies with a temperature of 40 °C (104 °F) on the ground and some hours later be at -30 °C (-22 °F), above a solid cloud layer, navigating your way through and with the help of electronic screens plus negotiating clearances in English with an incomprehensible Neapolitan controller. Everything has to work perfectly and if using a club glider, you must prepare it the previous day/s to avoid unpleasant surprises.



presence of an integrated electronic Protection Circuit Module (PCM) is required, all for a very high price of around €1,200 for two units of standard volume, with a rated capacity 280 % higher than lead, which higher capacity will only fall by about 10 % at -20 °C (-4 °F).

We compared the discharge of a group of two new lead batteries of the latest generation, to that of one of our groups of Li-Ion that was three years old, Module SAFT 4S2P MP. All kept in a freezer at -18 °C (0 °F) for 24 hours before the test, almost constant current discharge of 1.5 A (resistive load of 8 Ohm).

See fig. 10.7.4. This test is quite representative of the maximum amount of energy can be arranged with two standard modules of 65 x 151 x 95 mm, lead (€40) or Li-Ion (€1,200). In simple terms, you have to spend 30 times more for 3 times more capacity at high altitude.

The rated capacity of 14 Ah per standard module means 28 Ah installed. This capacity is not yet quite sufficient to provide electrical energy during a 16-hour flight wave in a two seater with all the instrumentation switched on (flight computer, two loggers, transponder, ADSB, radio, PDA's , Flarm, TCAS, EDS, some heating).

One must occasionally resort to load reduction or adding solar cells, which operate well only around midday.

Warning: This Lithium-Ion technology has three major disadvantages:

1- End of charge voltage is 16.8 V. However, almost all of the instrumentation is guaranteed for a maximum voltage of only 15.0 V. None of the interviewed manufacturers wanted to do a test or take any responsibility. So I personally took that risk, and luckily, everything worked. Except for the turn and bank, but this was expected and so I installed a DC/DC converter stabilized to output 12 V.

2- The voltage at end of discharge is about 10.5 V and deep discharge can mean the sudden death of the battery.

We must therefore be equipped not only with an automatic cut-off system, but also by an alarm prior to 11.0 V, which, in our case, leaves about an hour to handle the consequences.

We experienced these automatic power cuts while crossing a TMA and unintentionally caused panic in the control tower. In effect, during radio transmissions, the cut intervened and everything went off, including the transponder; then everything returned to normal a minute later.

After identification of the problem, the problem was solved, first by using the portable radio for communications with the tower, then by switching to the engine battery.

3- Despite all the assurances given by the suppliers, the fire risk when charging is not zero. We know of two cases of ground fire in gliders, but they were of Chinese products "cobbled together".

The GEPTEC are enclosed in steel cases, it is better, but I still do not trust them and remove them for charging. Repeated incidents on the Boeing 787 Dreamliner clearly show the limits of this technology, see fig. 10.7.5.

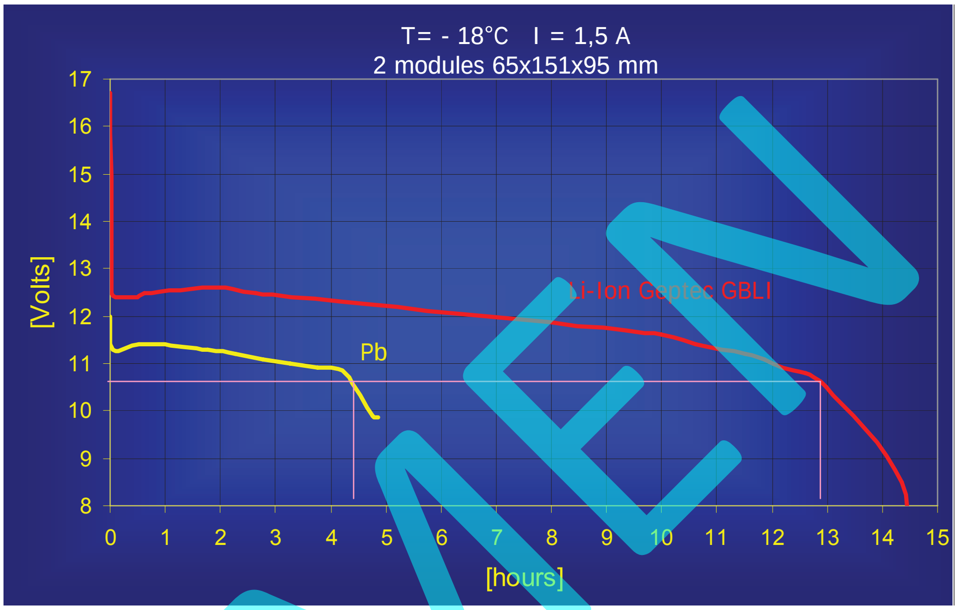


Fig. 10.7.4 discharge characteristics at a current of 1.5 A at -18 °C (=0 °F) of two new latest generation lead batteries (yellow curve) compared to two three year old Li-Ion GEPTEC GBLI (red curve), SAFT elements of the Antares glider.
In Europe, Li-Ion guarantees all of a wave flight from dawn to dusk. In Patagonia, you need additional energy or to carry out load shedding.

pacity rarely reached the ½ litre, and one may need to pass more than double that volume, and they ended up freezing, becoming unusable. Fig. 11.2.1 shows an example of a bag still connected to the penile sheath. There are drainable 2 litre "night use" bags now available. Some pilots re-use these anti reflux 2 litre night bags with a tap on the bottom, laid in the footwell, but check the bag's inlet valve has not stuck.

- Disposable freezer bags are not free of problems, and it took us a long apprenticeship in moving the arm far enough out and down from the window to make sure the bag is thrown well downwards. Fig. 11.2.2 and 11.2.3 show examples of bags that did not follow the desired path.

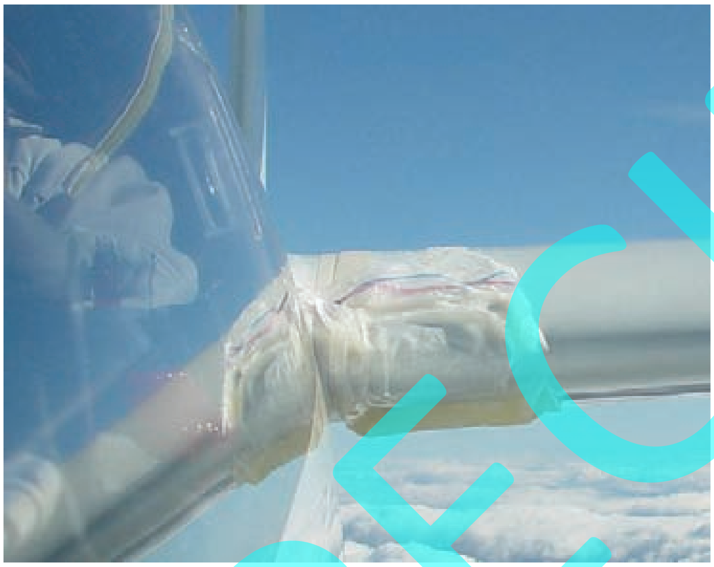


Fig. 11.2.2 This urine bag accompanied us for 1,800 km.

Between the penile sheath (e.g. Penilex®, Peniflow®) and the Ziploc Easy Zipper® bags, the total cost of comfort is of the order of €3 per flight. It's our choice, to try it, is to adopt it!

- Also on the market are small bags containing a powder that reacts with urine immediately forming a gel, which can be disposed of easily. This solution is widely used in the world of light aircraft, it is available in all aeronautical stores under various names such as "TravelJohn ®", "Biffy Bag ®", "Peebol ®", "Roadbag®", "Brief relief®" etc. Variable cost €5-15 per unit. I always have one handy, for difficult cases. Fig. 11.2.4 shows two common examples of general circulation.
- For ladies, there are unfortunately few other solutions than absorbent layers, disposable baby or adult versions.

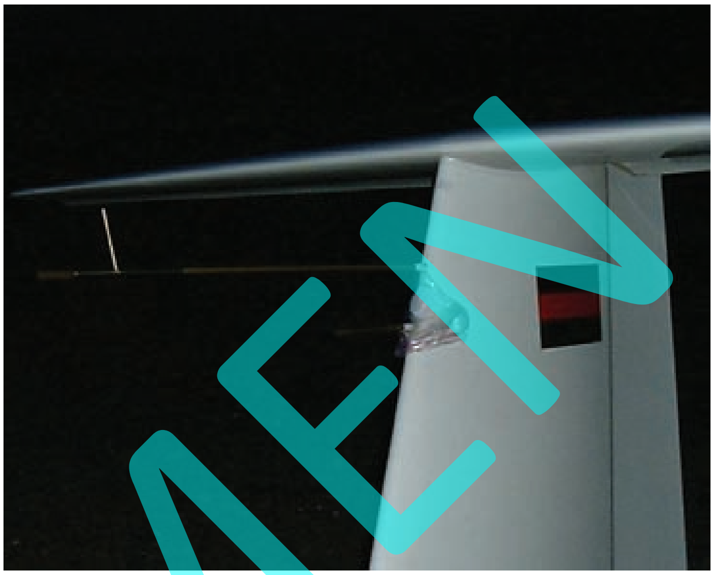


Fig. 11.2.3 We have been very lucky, the bag was pierced by the Pitot tube, which is equipped with a liquid trap. A few centimetres higher and the TE probe could have broken, it would have been the end of the flight.

Fig. 11.2.4

Despite the discomfort, it is definitely out of the question for one to advise the installation of a urinary catheter.

- **Protection against cold, clothing.**
Let's see how the ancients addressed the problem in the 1950s when the aerodrome of Mazet du Romanin (Les Alpilles, Saint Rémy de Provence) was the seat of attempts on the world duration record, slope soaring in

12 Oxygen: basic physiological aspects, applied research, and management of EDS®[1]

Photo 12.0
Dr. Heini Schaffner under real-life conditions experimenting in his flying laboratory. The EDS D1 supplies the nasal cannulae worn under a tight A-14 mask whose flows were reversed, the large corrugated pipe acting as outlet across three successive filters, trapping the exhaled moisture and consequently reducing the icing of the canopy and ensuring positive expiratory pressure (better oxygenation in the lungs, improving pulse oximetry oxygen saturations by 4-5%).
Efficiency and improved safety margin, but difficult to apply to the general public.

[1] ***EDS: Electronic Delivery System for oxygen manufactured by Mountain High E&S Co., 2244 SE Airport Way, Suite 100, Redmond, Or 97756. USA.***

The intelligent use of oxygen seems to have been forgotten in piloting manuals. The French Gliding Manual (11th and last edition) gives only a page and a half (out of 320) on what not to do, but not a line on what to do or how to use oxygen intelligently. Worse, it suggests to the pilot that hypobaric hypoxia would not start until 3,800 m without additional oxygen.

This 50 year-old assessment hardly even guarantees the great vigilance required in flight in the lower levels and proved itself a cause of accidents in the past. This same manual devotes less than a column to hyperventilation, and only five lines on its interaction with hypoxia. Fortunately, the only advice «breathe oxygen and reduce respiratory rate and depth» is accurate but not always applicable, since we must firstly have oxygen and also be aware of what is happening, difficult for an unconscious automatic activity.

We will see that even mild hypoxia in flight is actually a major factor in causing accidents, which is why it must, and happily can be completely eliminated by simple

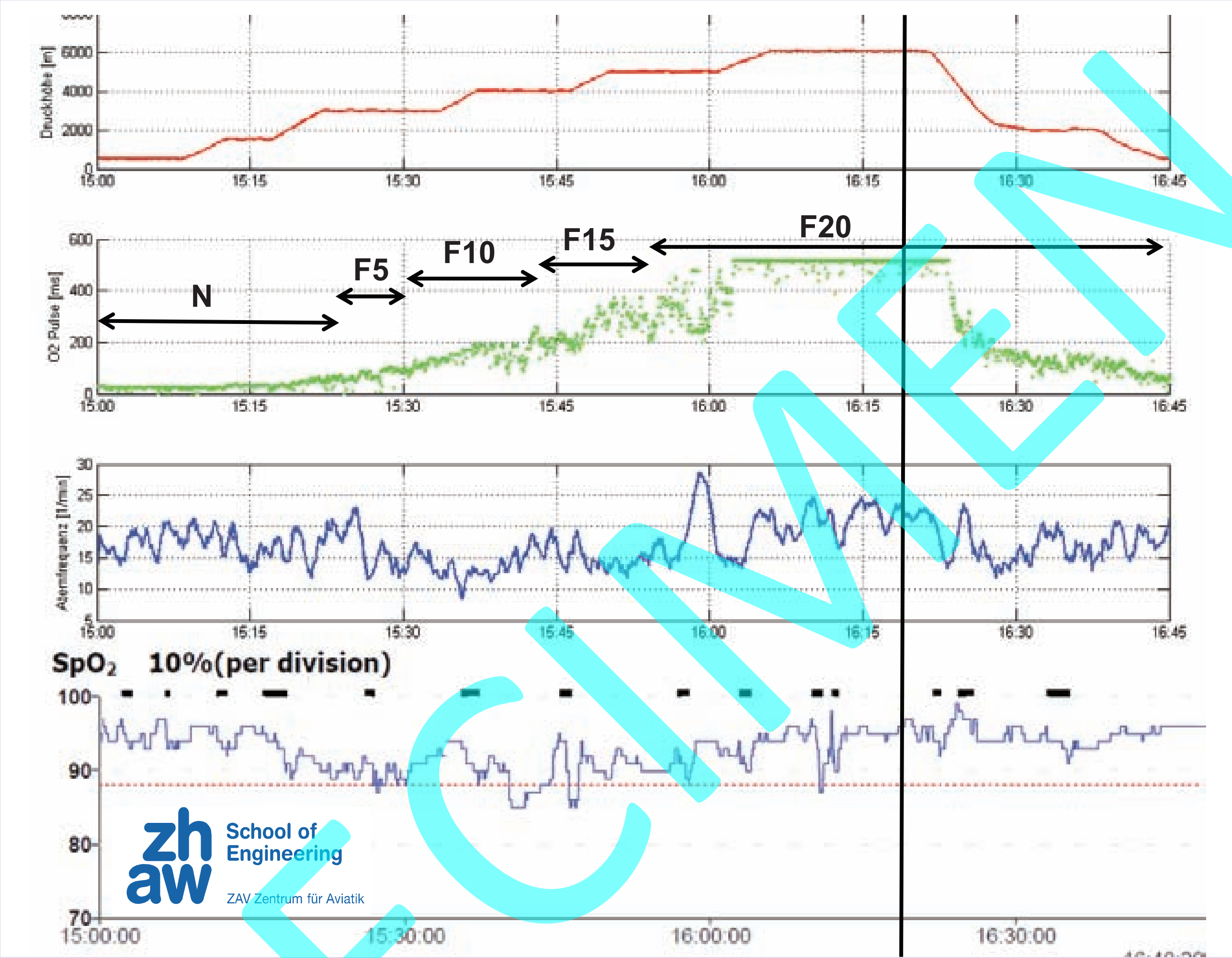


Fig 12.9.3 Male, 69 years old, 1.72 m, 78 kg, BMI 26.3 (almost normal weight), non smoker.
EDS starting in N position, saturation collapsed to 88 % at 3,000 m, so EDS changed to F5 to keep 88 %, then F10 towards 4,000 m with 90 % and then F15 towards 5,000 m to maintain 90 %, and then F20 half way through the 5,000 m increment. Saturation rises to 95 %. Breathing becomes in contrast chaotic at 4,000 and 5,000 m, oscillating between 10 and 28/min, a typical episode of periodic breathing. As also observed in anaesthesiology, lung function invariably decreases with age!

prolonged holding of his breath to make an intense effort, so I decided on an emergency descent to the nearby airport of Chos Mallal.

Around 4,000 m, his brain activity starts slowly, he told me to stop the descent as he was breathing better (EDS R/M position) and he ended his urination. After half an hour, all is well and he decides that we can continue home as there were still 400 km to go and we had to go up to 6,000 m again, with no subsequent problems. In a single seater, this incident would have been fatal for him.“

See in Fig. 12.9.6 the pulsoxygram of another healthy pilot of 70, normal BMI during urination in a Stemme, altitude 6,500 m. In anticipation of effort apnoea, he had set his EDS to R/M (100% oxygen) before starting the manoeuvre. We see that for 4 minutes, the pilot (while passenger) was often holding his breath to exert abdominal pressure (which is also the reason for the horizontal line between 8:37 and 8:39 p.m.) since the SpO2 is equal to that he would have had at 6,000 m without supplemental oxygen, or 75-80% (fig. 12.2.1).

According to Table 12.3.5, he could pass out and lose all piloting capacity as in the previous example. In a single seater, this incident could have serious consequences!