ASSOCIATION FRANÇAISE DES PILOTES DE MONTAGNE
AFPM
Depuis 1973

Awareness briefing to flying in mountainous environment

Scenario

"After taking off from the airfield, the pilot started the climb towards the massif. He flew over the city and then entered a cirque in the direction of a pass near the fort. ***He realized late****, as he approached the pass while still climbing,* ***that the altitude of the aircraft would not be sufficient to cross it.*** *Judging that he could not turn around because of the terrain,* ***the pilot tried to gain altitude by increasing the aircraft's attitude further****. This resulted in the* ***airspeed decreasing and approaching the stall speed****. He then began a* ***left turn*** *to fly parallel to the ridge line,* ***decreasing the margin to the stall****. He then found himself facing the west side of the second ridge line.* ***The aircraft collided with the fir trees*** *and ended up in the snow.*

Contributing factors to approaching a pass with insufficient altitude were:
- ***Insufficient knowledge of mountain flying techniques.***
- Insufficient consideration by the pilot of the aircraft's performance in the choice of the trajectory."

https://www.bea.aero/fileadmin/user_upload/BEA2021-0120.pdf

Purpose of this training

*"Even if the regulations do not require any specific training, **mountain flying has its own particularities due to the environment**: unusual visual cues due to the loss of the natural horizon, reduced operational performance, complex and changing aerology, and limited space.*

***Specific knowledge and techniques are required to fly safely** in this hostile and demanding environment. **Awareness flights, conducted with instructors** having the necessary skills for this type of flight, would allow pilots to better understand the risks of flying in mountainous areas."*

https://www.bea.aero/fileadmin/user_upload/BEA2020-0405.pdf

Awareness to flying in mountainous environment

1. Aircraft performance
2. Physiology and human factors
3. Basic piloting
4. Weather and aerology
5. Relevant documentation
6. Valley routing - pass and ridge crossing
7. Organization of the flight training

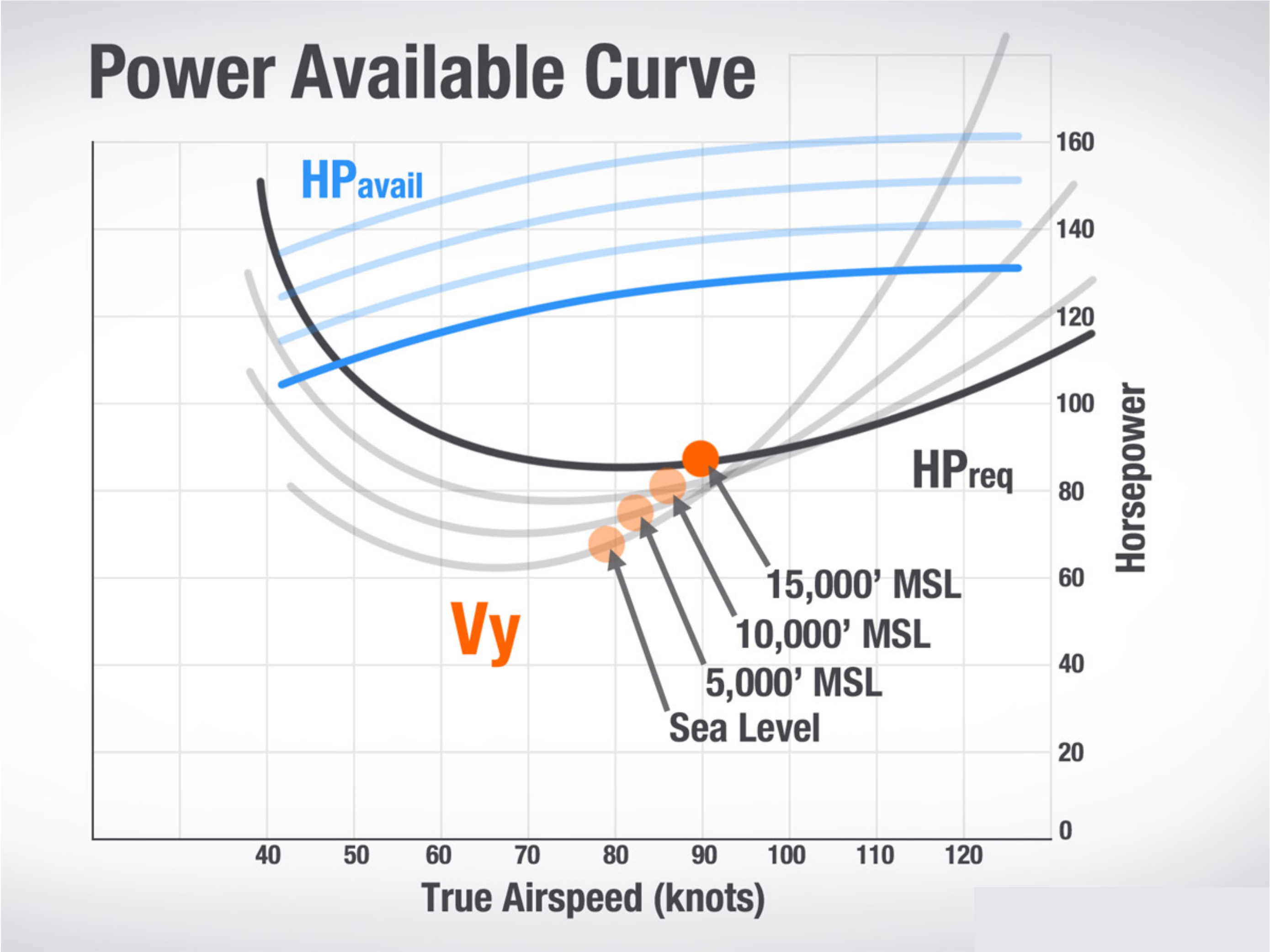
1. Aircraft performance

1. Aircraft performance

Power decreases by 10% for every 3000ft of elevation

At 6000ft, the engine power is reduced by 18% and the minimum power required increases by 10%.

You will be surprised by the performance of the aircraft at high altitude, because you are less used to it.....



1. Aircraft performance

Power decreases by 10% for every 3000ft of elevation

- ➢ **Vertical speed decreases with increasing altitude**

Any aircraft has, at best, a climb gradient of of 6%.

An uphill slope of 6% corresponds to:

1. Aircraft performance

Power decreases by 10% for every 3000ft of elevation

- **Vertical speed decreases with increasing altitude**

Any aircraft has, at best, a climb gradient of of 6%.

An uphill slope of 6% corresponds to:

- 6m (18ft) elevation for 100m
- 60m (180ft) elevation for 1000m (0,5 NM)
- 600m (1800ft) elevation for 10000m (5NM)

1. Aircraft performance

Power decreases by 10% for every 3000ft of elevation

- ➢ **Vertical speed decreases with increasing altitude**

Any aircraft has, at best, a climb gradient of of 6%.

This represents about 350ft per NM

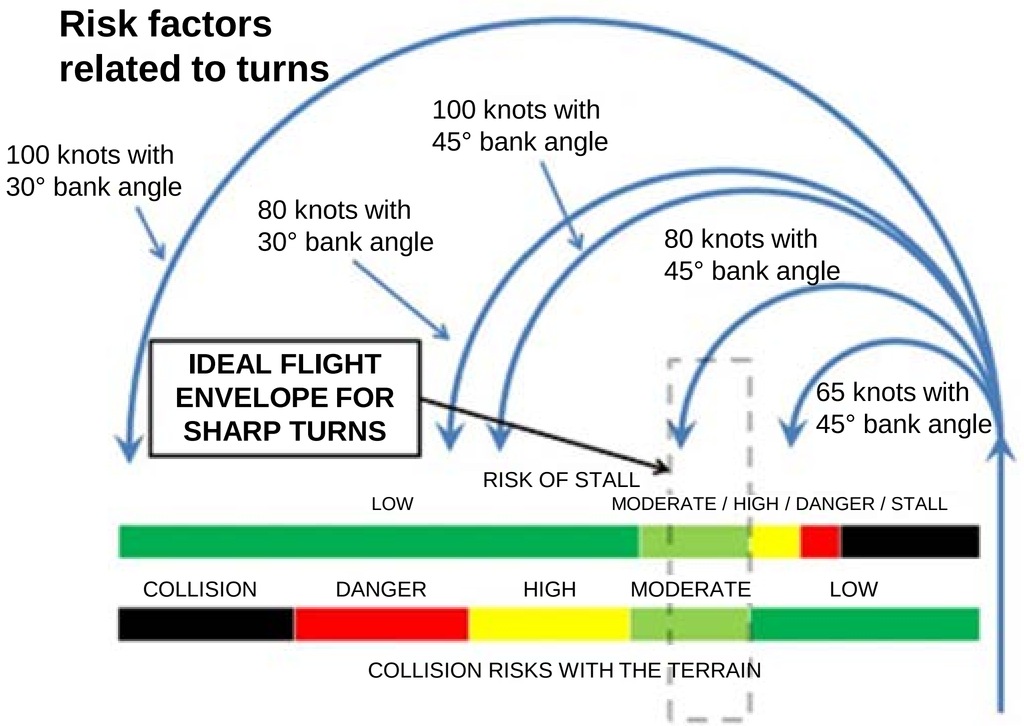
An uphill slope of 6% corresponds to:

1. Aircraft performance

- Speed (true airspeed TAS) increases by 1% per 600ft of pressure altitude (Zp) and +5°C over standard temperature (ISA).

- Turning radius increases by 20% every 6000ft

$$R = \frac{V_p^{\,2}}{g \cdot \tan(\varphi)}$$



2. Physiology and human factors

2. Physiology of mountain flying

- Hypoxia: high altitude (O2 if flight over 30 min > 10 000ft), insidious
- Dehydration: at 6000ft, half as much humidity in the air as at sea level
  -> more dehydration by evaporation from the surface of the epidermis
- Very high luminosity: 40%-90% of light reflected by the snow, less filtration of the atmosphere
- High UV: +10% UV index per 3000ft. UV index can be 12 in summer at 9000ft!
- Very high contrast between sun and shadow
- Optical illusions: difficulties to estimate distances, slopes, horizon
- Turbulences: lack of horizon, more sudden phenomena
- Fatigue linked to the above conditions.

2. Physiology of mountain flying - Hypoxia

- It is commonly accepted that from 9000 ft the human body can no longer compensate for all the external stresses of hypoxia, but the altitude of onset of symptoms depends on each person. Alcohol, smoking and medication increase the symptoms and decrease the altitude of onset.

- The more one advances in the phenomenon of hypoxia, the more the central nervous system will be altered with its procession of secondary effects:
  - Euphoria
  - Difficulty of concentration
  - Illogical thinking
  - Neuromuscular difficulties
  - The visual system will be affected: reduced visual field, difficult to accommodate, hearing affected around 15000 ft

- If symptoms appear, there is only one solution: DESCEND to a lower altitude

2. Physiology of mountain flying – O_2

NCO.OP.190 Use of supplemental oxygen Regulation (EU) 2016/1119

(a) The pilot-in-command shall ensure that all flight crew members engaged in performing duties essential to the safe operation of an aircraft in flight use supplemental oxygen continuously whenever he/she determines that at the altitude of the intended flight the lack of oxygen might result in impairment of the faculties of crew members, and shall ensure that supplemental oxygen is available to passengers when lack of oxygen might harmfully affect passengers.

(b) In any other case when the pilot-in-command cannot determine how the lack of oxygen might affect all occupants on board, he/she shall ensure that:

(1) all crew members engaged in performing duties essential to the safe operation of an aircraft in flight use supplemental oxygen for any period in excess of 30 minutes when the pressure altitude in the the passenger compartment will be between 10 000 ft and 13 000 ft; and

(2) all occupants use supplemental oxygen for any period that the pressure altitude in the the passenger compartment will be above 13 000 ft.

2. Physiology of mountain flying – O_2

AMC1 NCO.OP.190(a) Use of supplemental oxygen - DETERMINATION OF SUPPLEMENTAL OXYGEN NEED

When determining the need for supplemental oxygen carriage and use, the pilot-in-command should:

(a) **in the preflight phase:**

(1) be aware of hypoxia conditions and associated risks;

(2) consider the following objective conditions for the intended flight: (i) altitude; (ii) duration of the flight; and (iii) any other relevant operational conditions.

(3) consider individual conditions of flight crew members and passengers in relation to: (i) altitude of the place of residence; (ii) smoking; (iii) experience in flights at high altitudes; (iv) actual medical conditions and medications; (v) age (vi) disabilities; and (vii) any other relevant factor that may be detected, or reported by the person; and

(4) when relevant, ensure that all flight crew members and passengers are briefed on hypoxia conditions and symptoms, as well as on the usage of supplemental oxygen equipment.

(b) **during flight:**

(1) monitor for early symptoms of hypoxia conditions; and

(2) if detecting early symptoms of hypoxia conditions: (i) consider to return to a safe altitude, and (ii) ensure that supplemental oxygen is used, if available.

2. Physiology of mountain flying – O_2

GM1 NCO.OP.190 Use of supplemental oxygen

GENERAL

(a) The responsibility of the pilot-in-command for safety of all persons on board, as required by NCO.GEN.105(a)(1), includes the determination of need for supplemental oxygen use.

(b) The altitudes above which NCO.OP.190(b) requires oxygen to be available and used are applicable to those cases when the pilot-in-command cannot determine the need for supplemental oxygen. However, if the pilot-in-command is able to make this determination, he/she may elect in the interest of safety to require oxygen also for operations at or below such altitudes.

(c) The pilot-in-command should be aware that flying below altitudes mentioned in NCO.OP.190(b) does not provide absolute protection against hypoxia symptoms, should individual conditions and aptitudes be prevalent.

GM2 NCO.OP.190 Use of supplemental oxygen
DETERMINATION OF OXYGEN NEED — BEFORE FLIGHT

Detailed information and guidance on hypoxia conditions and symptoms, content of the briefing on hypoxia and assessment of individual conditions may be found in the EASA leaflet 'Hypoxia'.

DETERMINATION OF OXYGEN NEED — IN FLIGHT

Several methods for monitoring hypoxia early symptoms may be used and some methods may be aided by personal equipment, such as finger-mounted pulse oximeters. Detailed information and guidance on entering hypoxia conditions, on hypoxia symptoms early detection, and on use of personal equipment such as finger-mounted pulse oximeters or equivalent may be found in the EASA leaflet 'Hypoxia'

3. Basic piloting

3. Basic piloting

In the mountains, the horizon
is not which usable, which disturbs
the perception of the attitude:

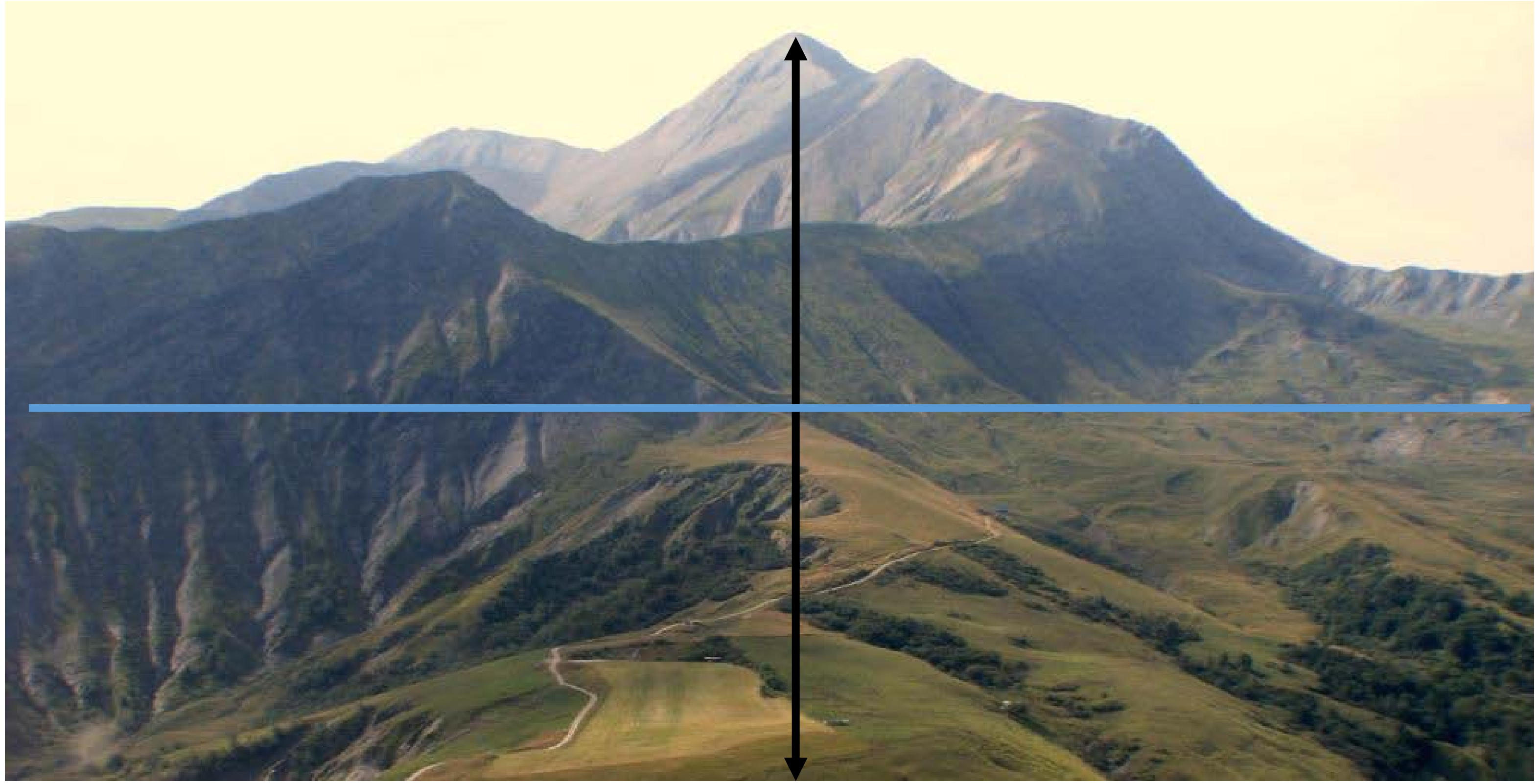
- Difficulty in maintaining straight and level flight

- Difficulty in making turns in level flight

3. Basic piloting

How to find a horizon reference in the mountains?

Take the height of the highest mountain and divide by 2 to have a horizon reference



3. Basic piloting - **Beware of false horizons**

What seems "horizontal" is not necessarily, so:

possibility of an insidious inclination of the aircraft related to that of the terrain

3. Basic piloting - **Beware of false horizons**

On the plains, the pilot has been used to to control the level flight by maintaining a maintaining a constant distance between the horizon and the engine cowling

3. Basic piloting - **Beware of false horizons**

In the mountains, maintaining such a constant constant distance between the horizon (terrain) and the cowling, leads to:

- **Decrease the attitude towards descending terrain**
- **Increase the attitude towards rising terrain**

3. Basic piloting - **Beware of false horizons**

**Faced with rising terrain,
the pilot tends to gradually and insidiously increase the attitude.**

This phenomenon often leads to the progressive transition to the second regime, close to the terrain

Feedback

"[The pilot] took the direction of the Vars pass and stabilized the flight at an altitude of 6,000 ft. When he arrived near the pass, he realized that his altitude did not allow him to cross the terrain. He started again to climb.

The aircraft collides with trees and then the terrain west of the pass, passes through a pylon position and catches fire. (...)

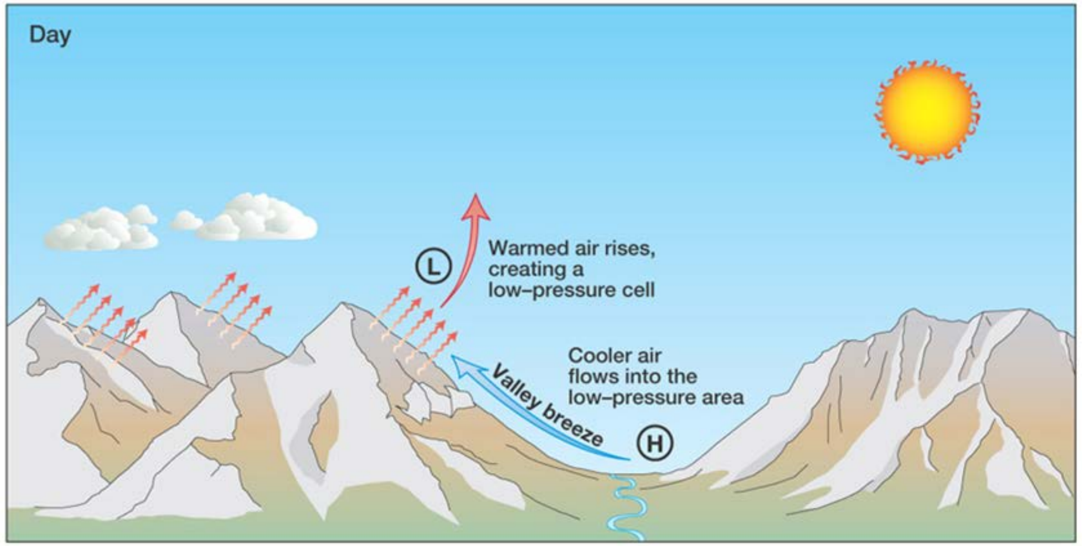
When flying in the mountains, the horizon represented by a ridge line or by uneven terrain can lead the pilot to continue his flight with an increasingly nose-up attitude and at a lower and lower speed leading progressively to a flight in the second regime up to the stall."

https://www.bea.aero/fileadmin/documents/docspa/2014/f-sq140609/pdf/f-sq140609_05.pdf

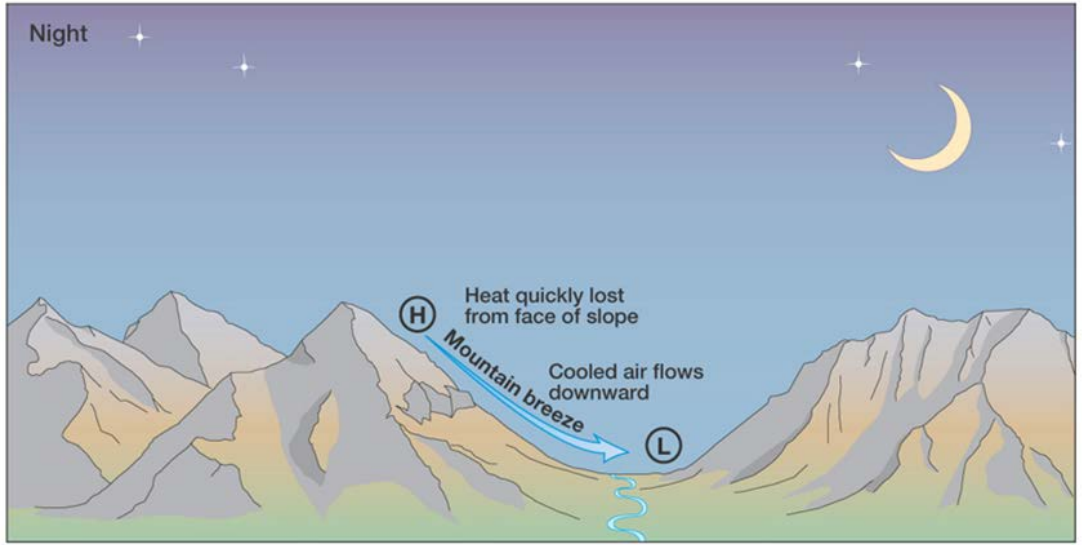
4. Weather and aerology

4. Weather and aerology

Valley wind

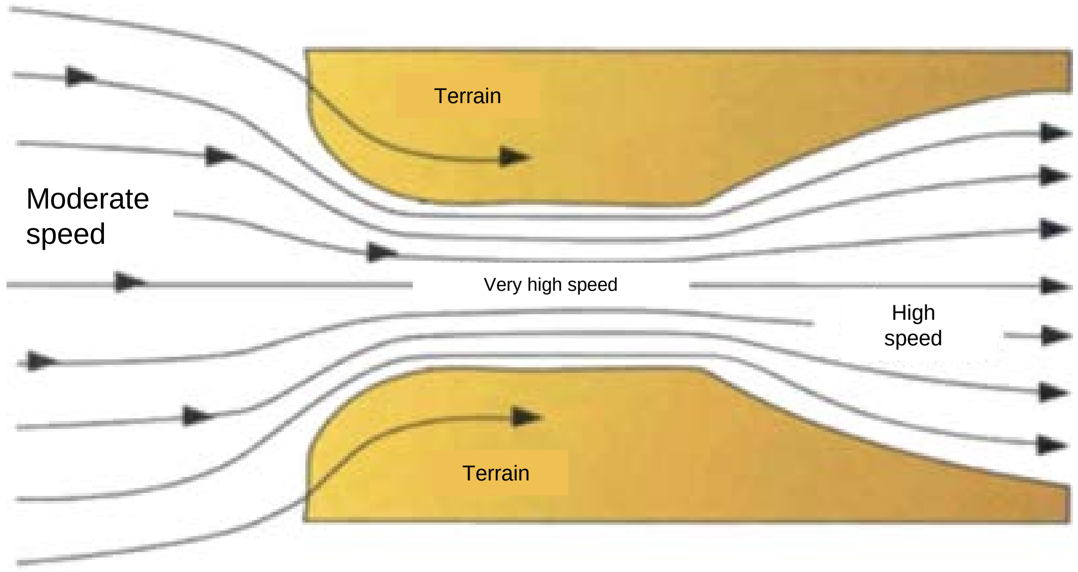


Mountain wind



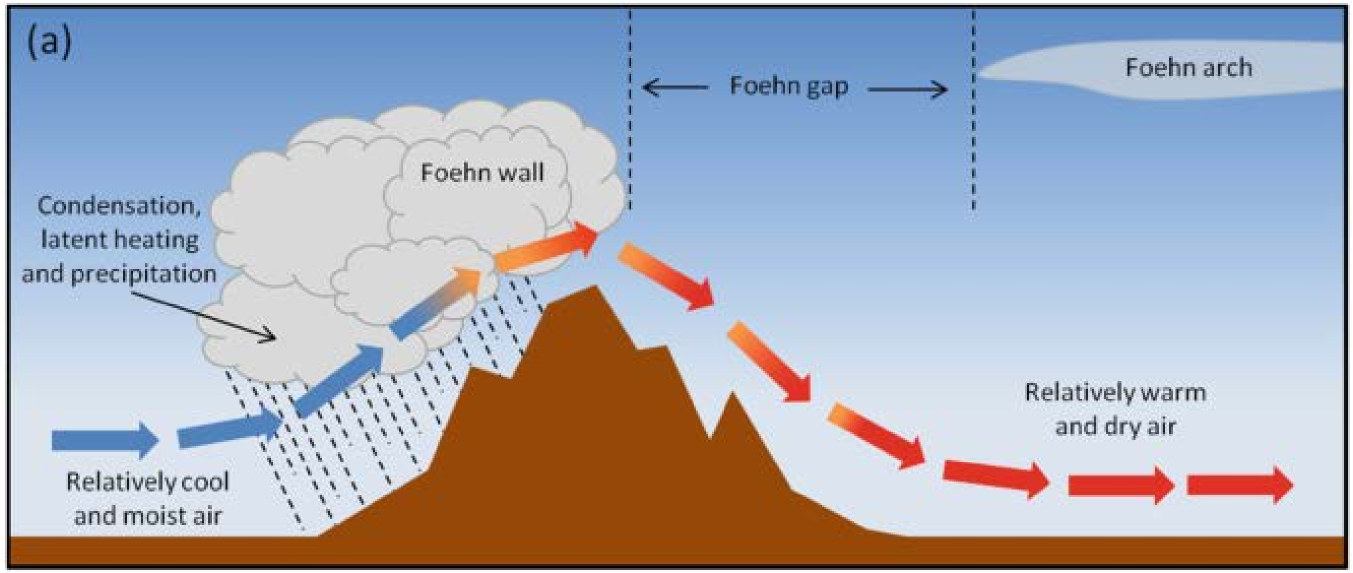
4. Weather and aerology

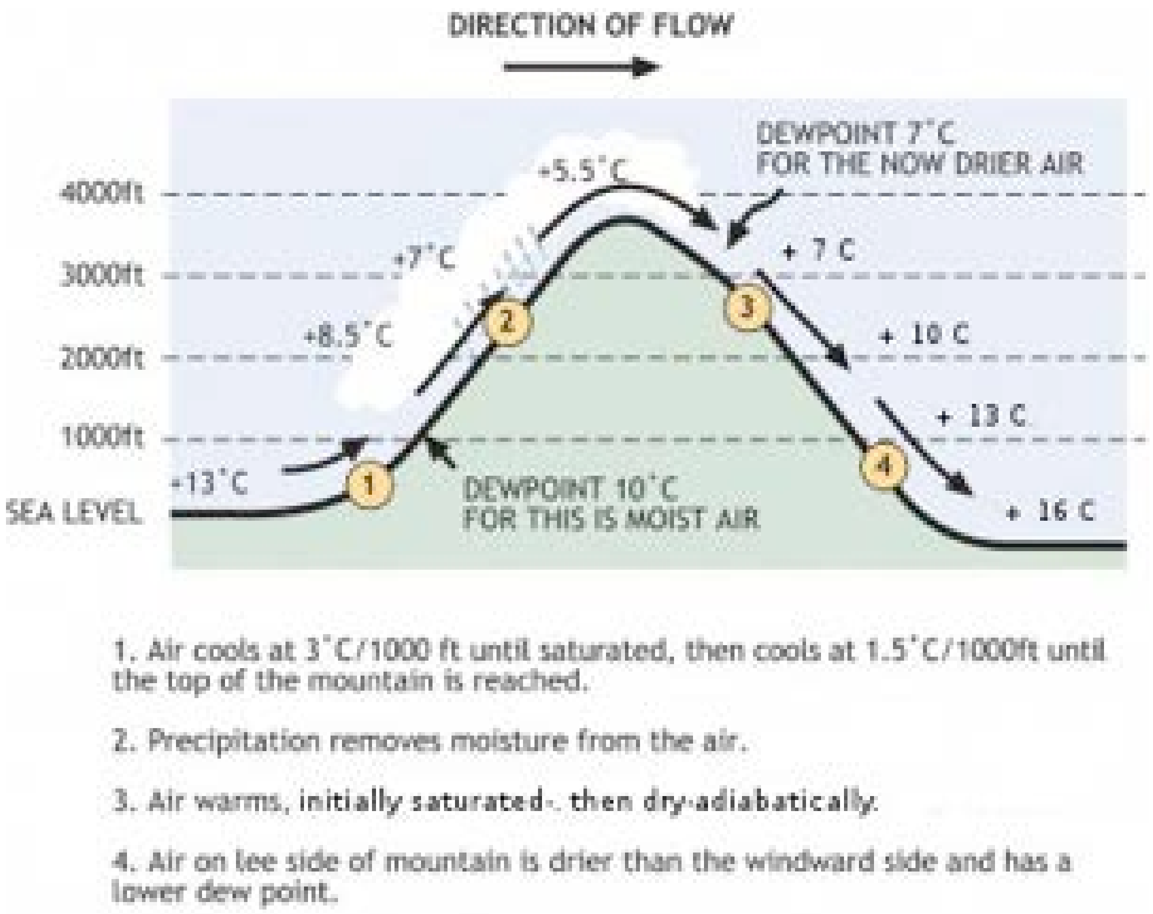
Venturi effect (valley floor, proximity of ridges in strong winds…)



4. Weather and aerology

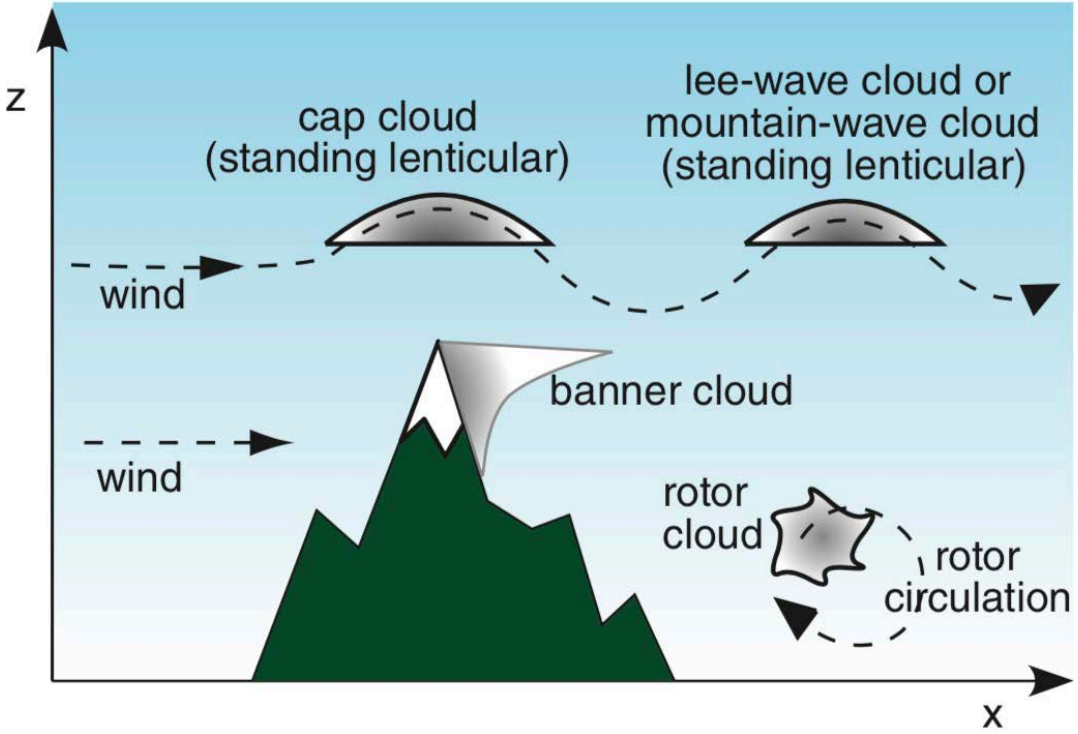
Foehn effect





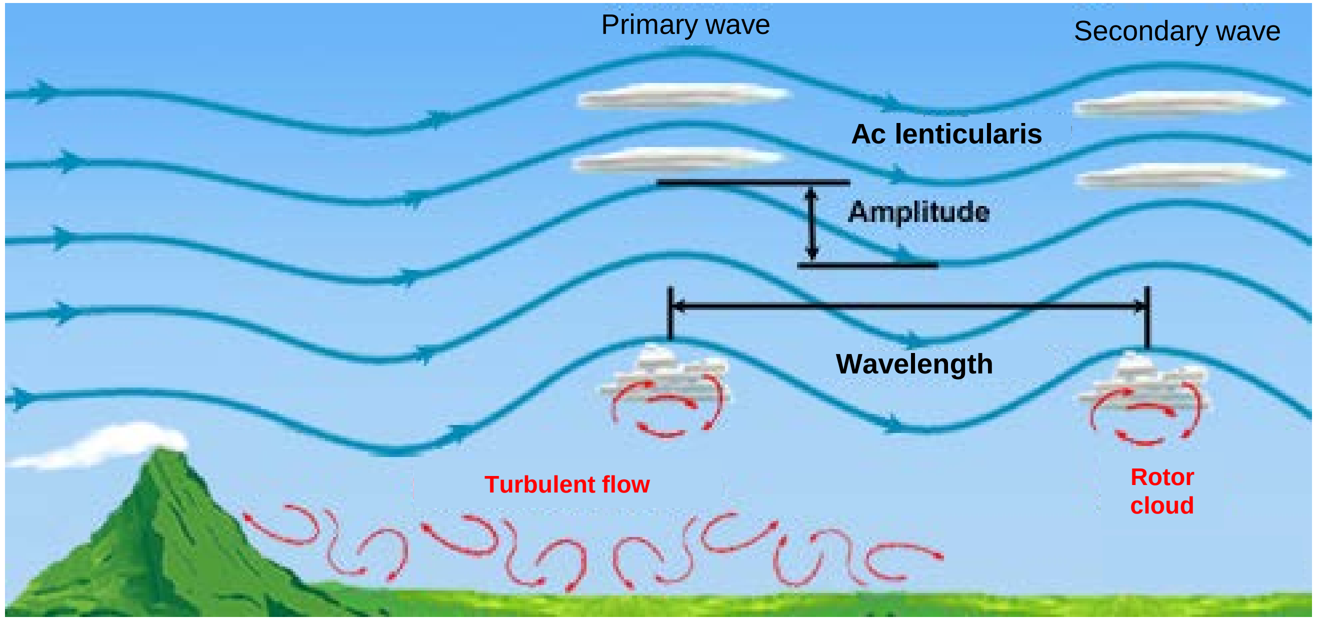
4. Weather and aerology

High altitude wind / waves / lenticular clouds



4. Weather and aerology

Rotors



4. Weather and aerology

In the mountains, convective weather phenomena are amplified by the terrain: the weather can therefore change **very quickly.**

If convective phenomena are expected, it is important to avoid being 'locked' in a valley:

- **Blocked on one side by clouds stuck to the relief**
- **Blocked on the other side by a very developed convective phenomenon**

4. Weather and aerology

The absence of a usable horizon, coupled with the intensity of solar radiation, the low humidity in the air and the altitude, makes flying in convective conditions **very uncomfortable.**

It is therefore advisable to avoid periods of strong winds and high atmospheric instability.

Favour a flight in the morning when the amplitude and the thermal and dynamic phenomena are less developed.

5. Relevant documentation

Feedback

"When the pilots encountered clouds in the vicinity of the town of Susa, they made the decision to ***descend to stay below the cloud base and continue the flight*** *(...) Nevertheless, although unaware of the extent of the cloud mass, they still had the plan to gain altitude once passed the clouds.* ***At this moment, the turnaround had not been considered by either pilot.*** *(...)*

When they made the decision to turn right to the north and enter the valley toward the Col du Mont Cenis, ***they entered an area that had not been prepared. They were unaware of the elevation profile of the valley, the obstacles that might be encountered, the distance to the obstacles, and the climbing performance required to clear the obstacles.*** *(…)*

When they came within sight of the dam, it was no longer possible to cross it due to the flight altitude and climb performance. As they approached the dam, turning back seemed the only option.

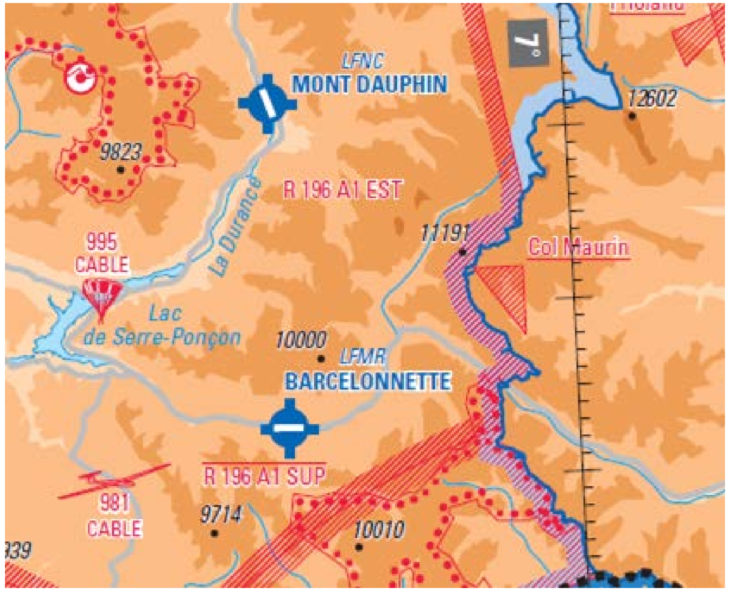
As the aircraft approaches the dam, the pilot leaves the controls to the more experienced right seat pilot. The latter started a left turn to turn back. During this turn, ***the stall warning sounded****, the aircraft stalled, struck trees and collided with the ground."*

https://www.bea.aero/fileadmin/uploads/tx_elydbrapports/BEA2017-0451_septembre_2019.pdf

5. Relevant documentation

There are few relevant aids in the mountains:

Reduced range of radio means
(VHF, VOR, NDB), due to the terrain



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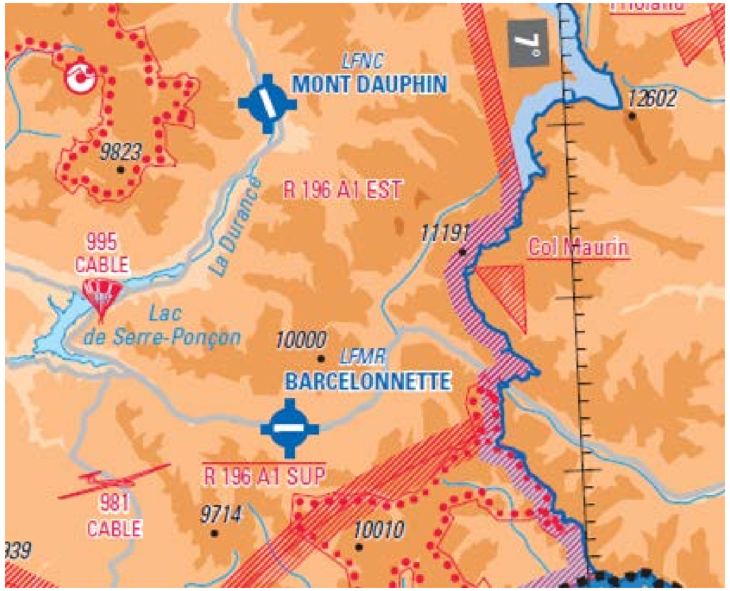

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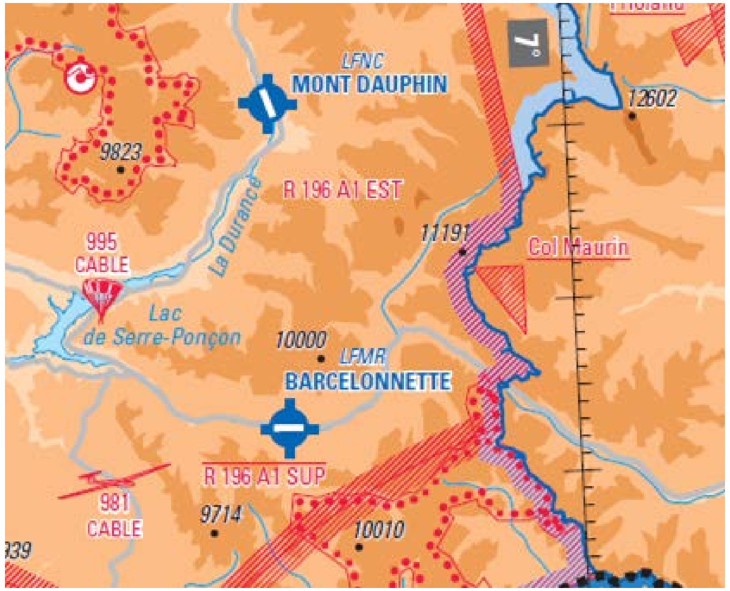
Nevertheless, it is necessary to inform regularly on 130.000 MHz of your position and direction

Beware of the routes in the GPS
(base map used, points chosen
mask of the satellites by the terrain)

The pilot will therefore mainly use maps to prepare and carry out his flight.

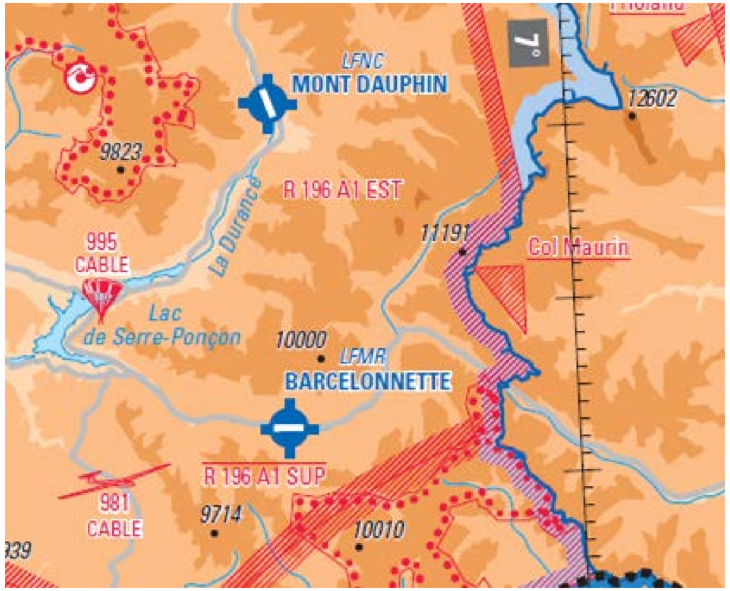


5. Relevant documentation

The pilot is used to navigating with aeronautical charts. However, these maps are not precise enough to navigate in the terrain because the details of the valleys, peaks and passes are not shown.

These maps are nevertheless useful for:

- Learn about the airspace
- Locate the national natural parks
- Locate the main power lines



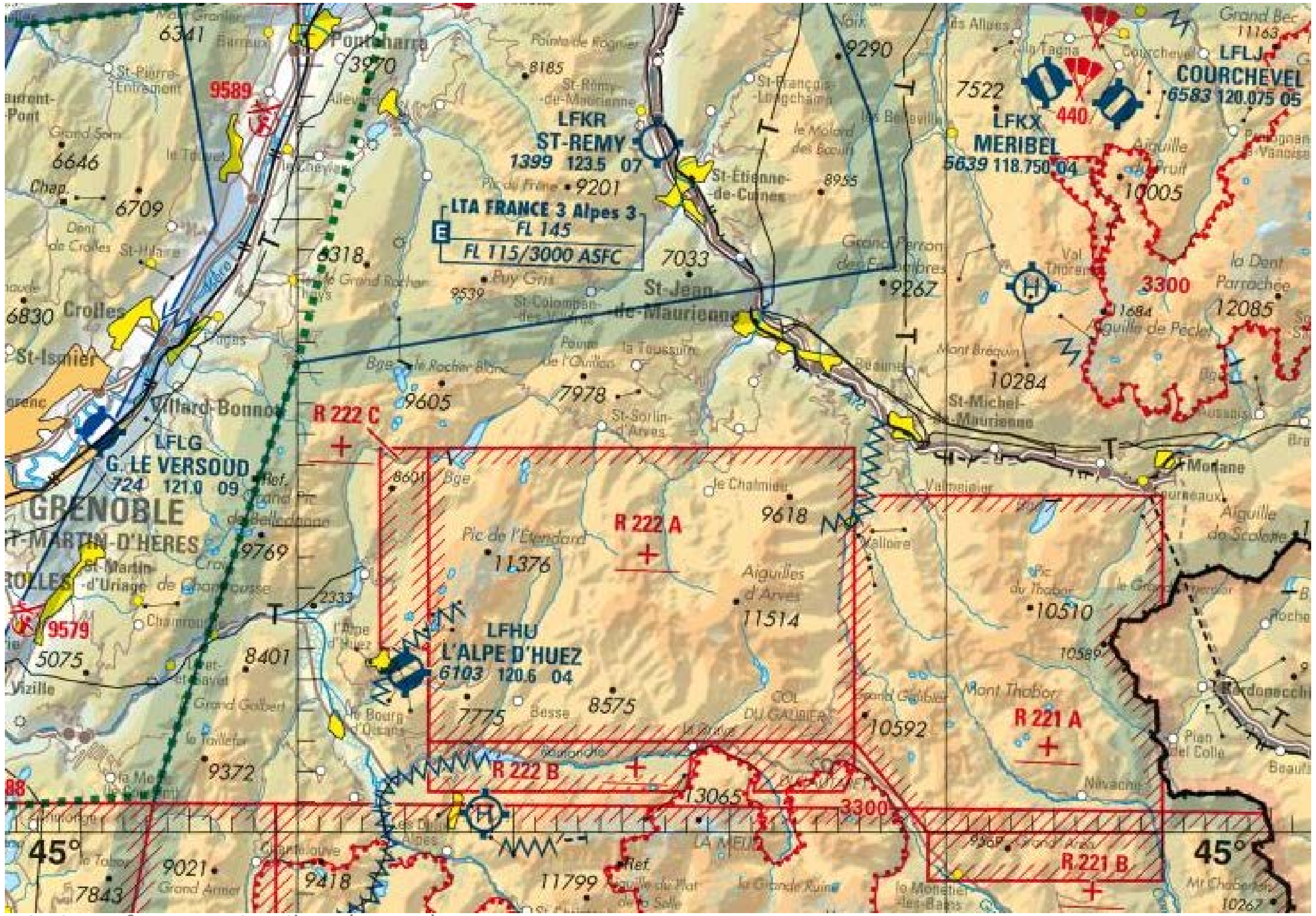
5. Relevant documentation

Little air space

compared to the plain

Beware of military zones

(firing ranges)



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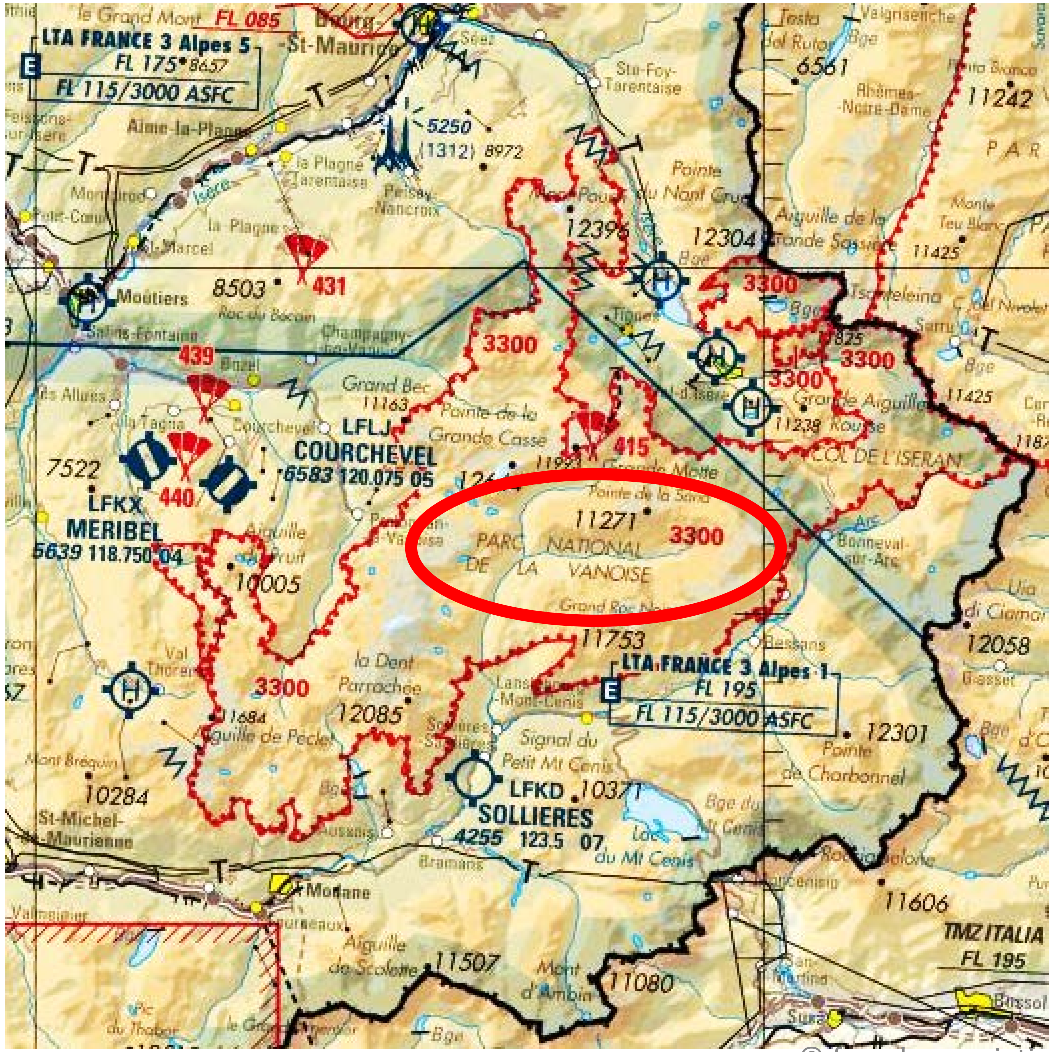


Beware of the national natural parks (3300ft AGL!!)

5. Relevant documentation

Beware of power lines in the valleys

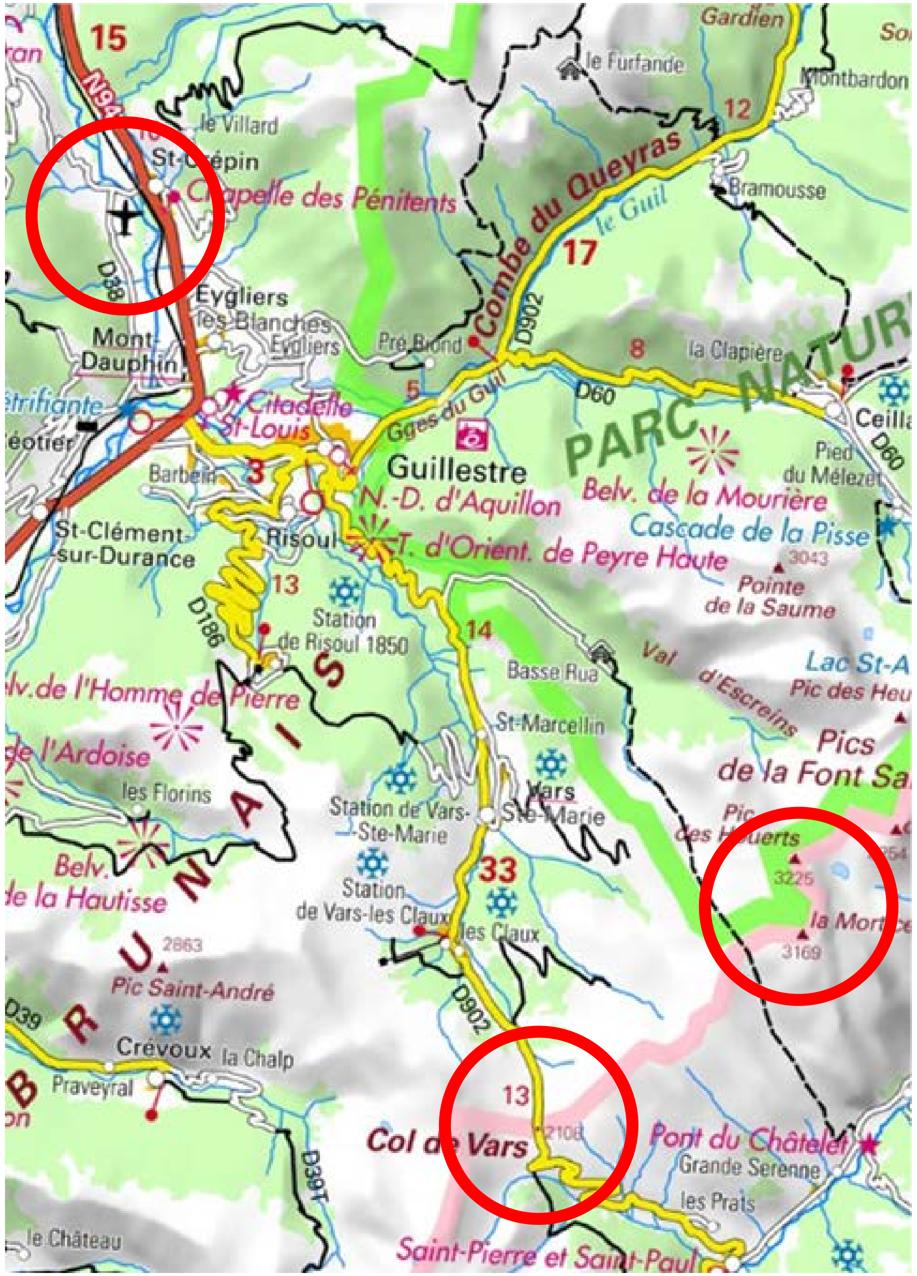
Ligne électrique de 225 kV et plus (hauteur pouvant dépasser 150 pieds)
Power lines at least 225 kV (sometimes more than 150 ft high)

Câble suspendu, traversée de vallée (à 330 pieds AGL et plus)
Suspended cable crossing valley (at least 330 ft AGL high)

5. Relevant documentation

To determine a course in the mountains, 1/200,000° or 1/100,000° road maps are more suitable.
WARNING:

- No mention of airspace or aeronautical specificities (obstacles, aerodromes, national parks...)
- Altitude mentioned in **meters 'm'**
- Non-conforming Mercator projection for the measurement of true roads and distances



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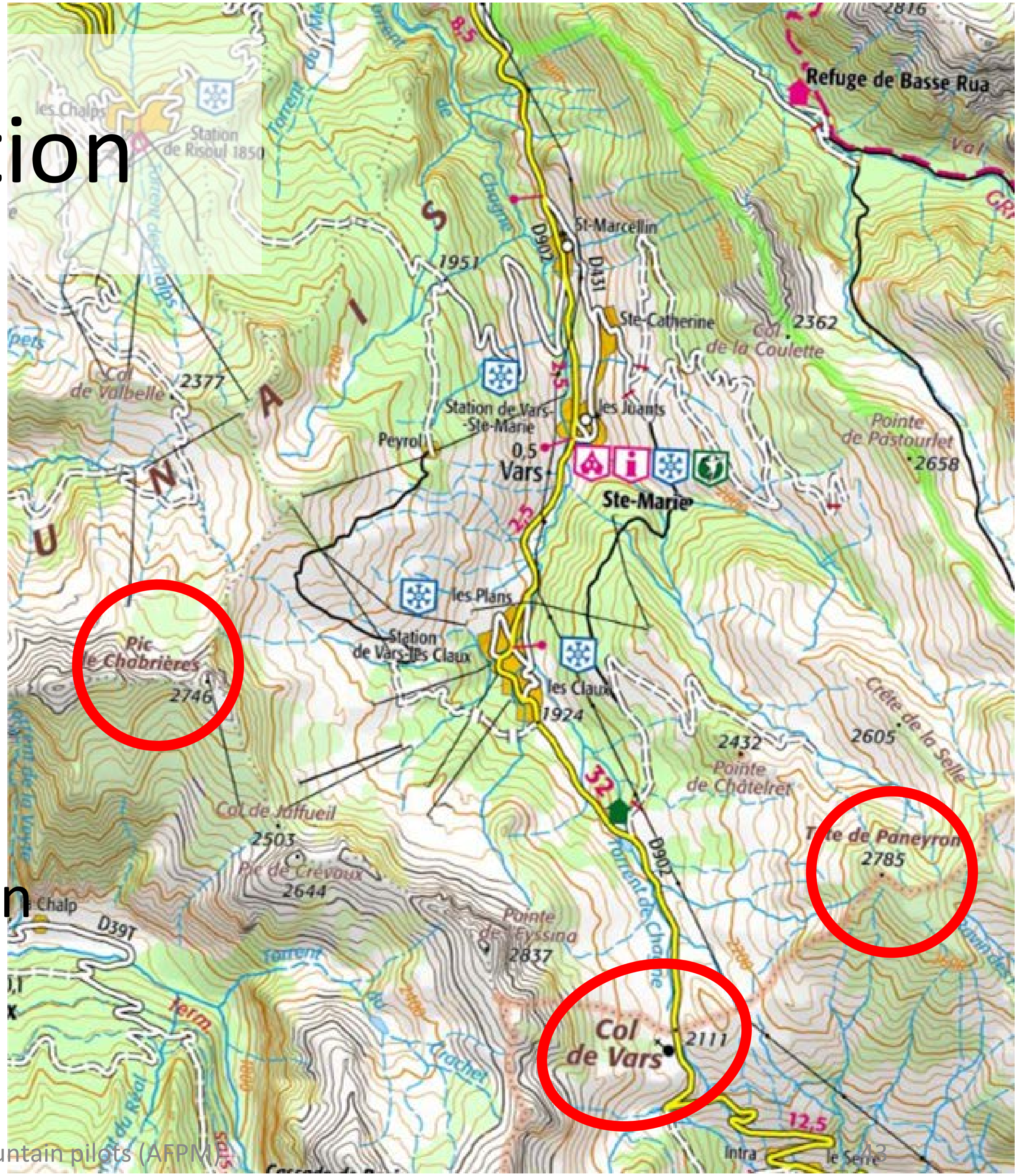
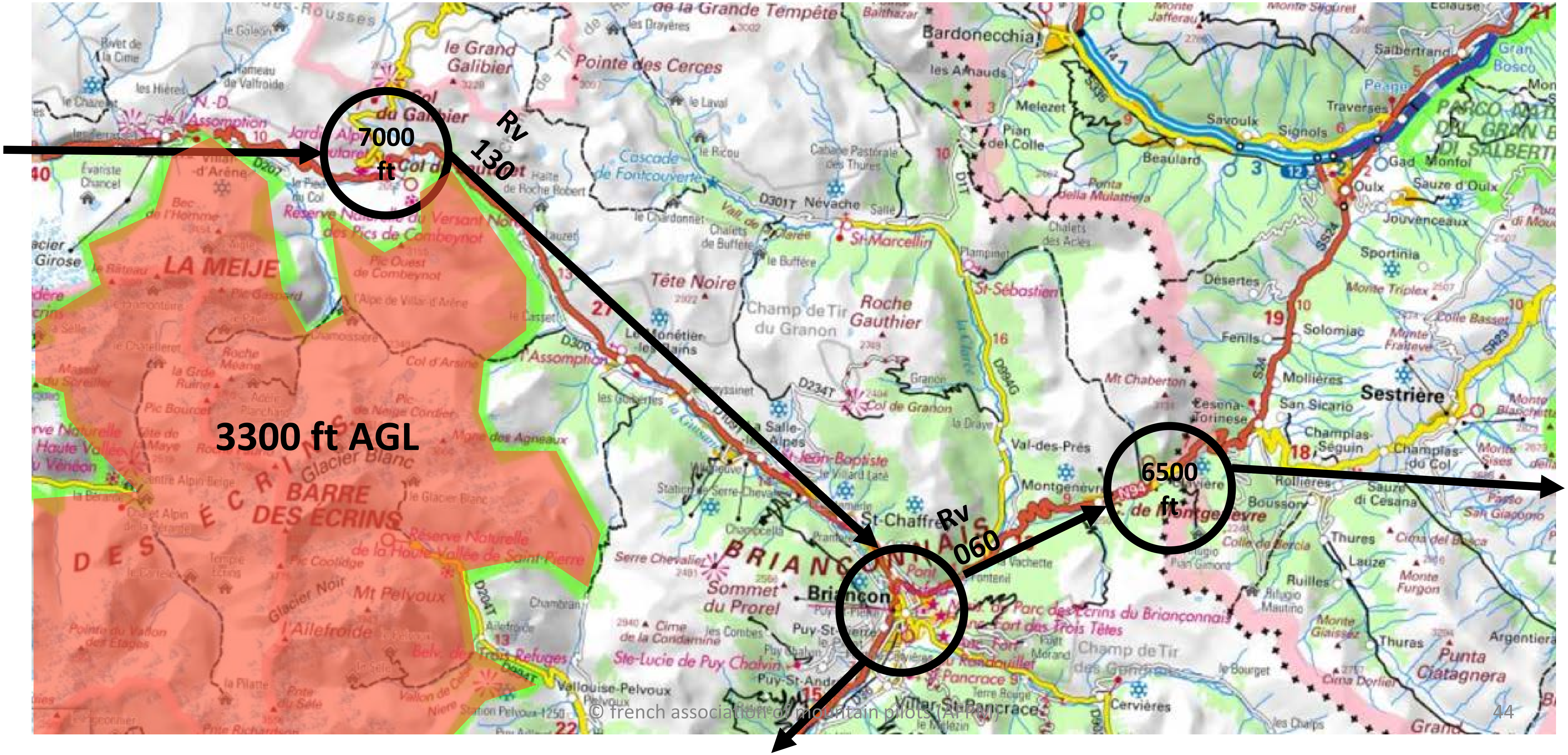


Example of preparation



5. Relevant documentation

- Have on board the necessary maps to follow the route:
  - ✓Aeronautical map
  - ✓Adapted road / topographic map

NB: Using Google Maps in 3D can give you an idea of the itinerary, but this tool is not precise enough to get an exact idea of the situation (wrong morphology of the summits, seasonality of the photos, no 3D representation of obstacles...)

- Check NOTAM and Sup AIP
  - ✓For possible airfields on the planned route
  - ✓For the activation of military zones

5. Relevant documentation

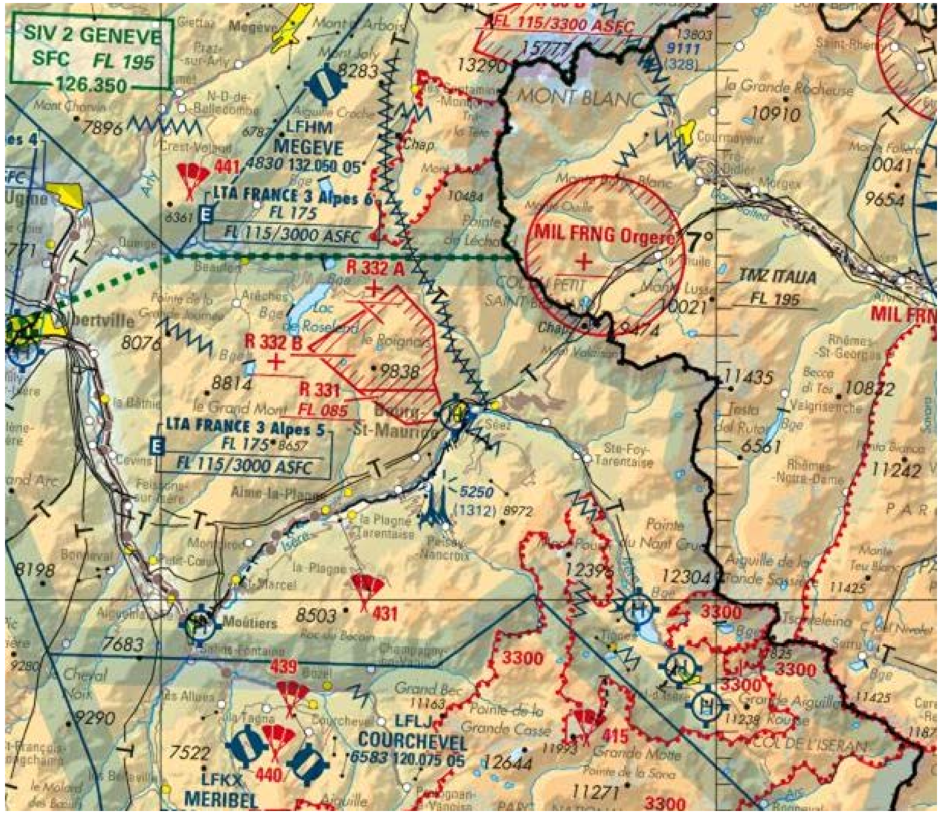
- Weather:
  - ✓ standard briefing (TEMSI, Wintem)
  - ✓ check SIGMET
  - ✓ in case of doubt about the cloud cover, you can use Windy's webcam (cloud cover webcam). This 'help' does not guarantee the success of the flight, because the situation will change between the consultation and the moment when the plane will be at this position.

6. Valley routing
Crossing passes and ridges

6. Valley routing
Pass and ridge crossing

Very high terrain:

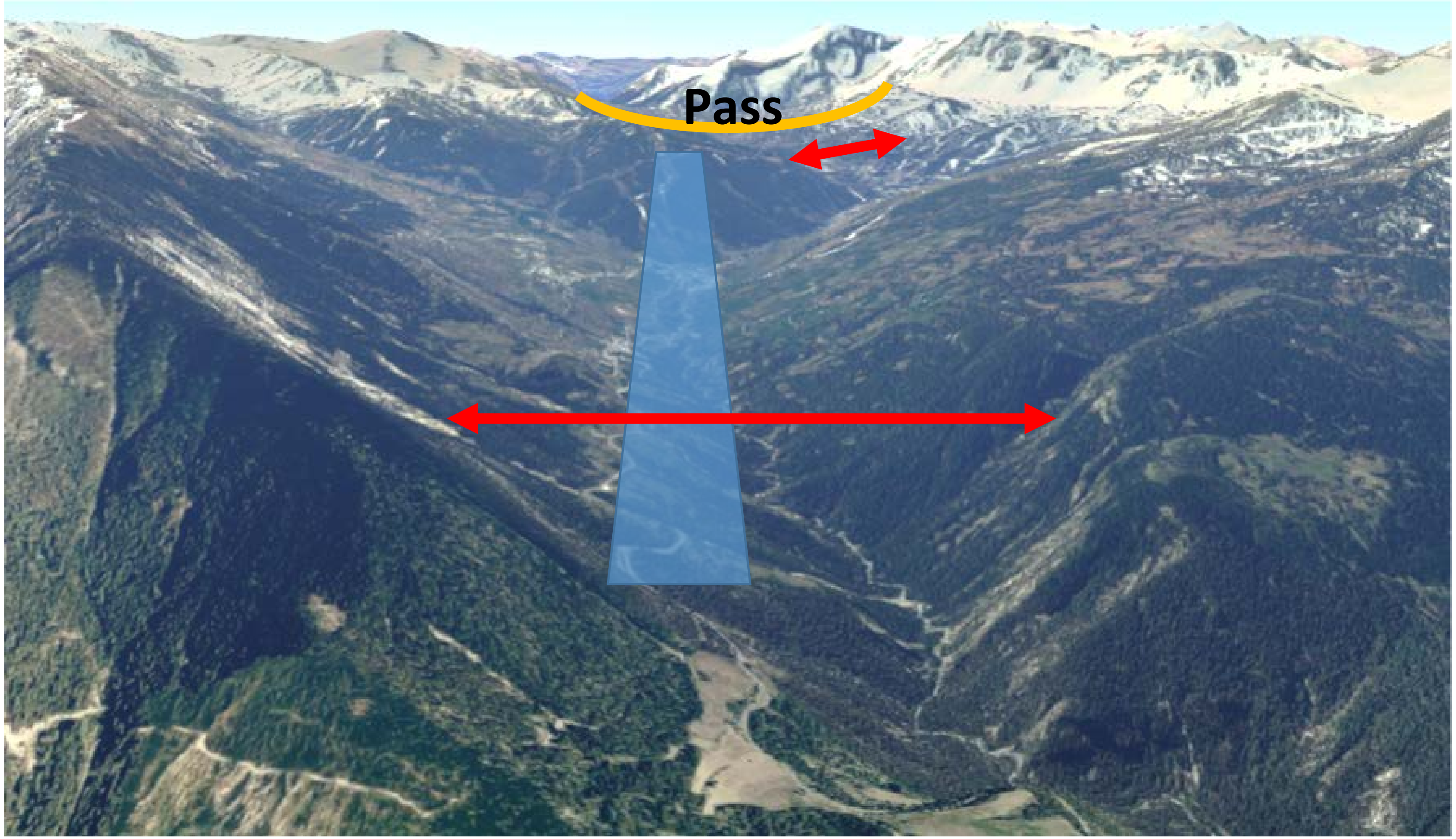
- Impossible to trace direct routes as in the plains
- Need to fly in the valleys



6. Valley routing
Pass and ridge crossing

Morphology of a valley:

- **Floor of the valley going up to the pass** (the closer you are to the pass, the more important the slope is)
- **Width of the valley narrows** as the pass is approached



6. Valley routing
Pass and ridge crossing

Example:

Takeoff from Mont-Dauphin to Barcelonnette via the Col de Vars.

From LFNC to Col de Vars:

- 16,5 km
- 1100m of vertical drop

That is 6,6% of rising slope

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Pass and ridge crossing

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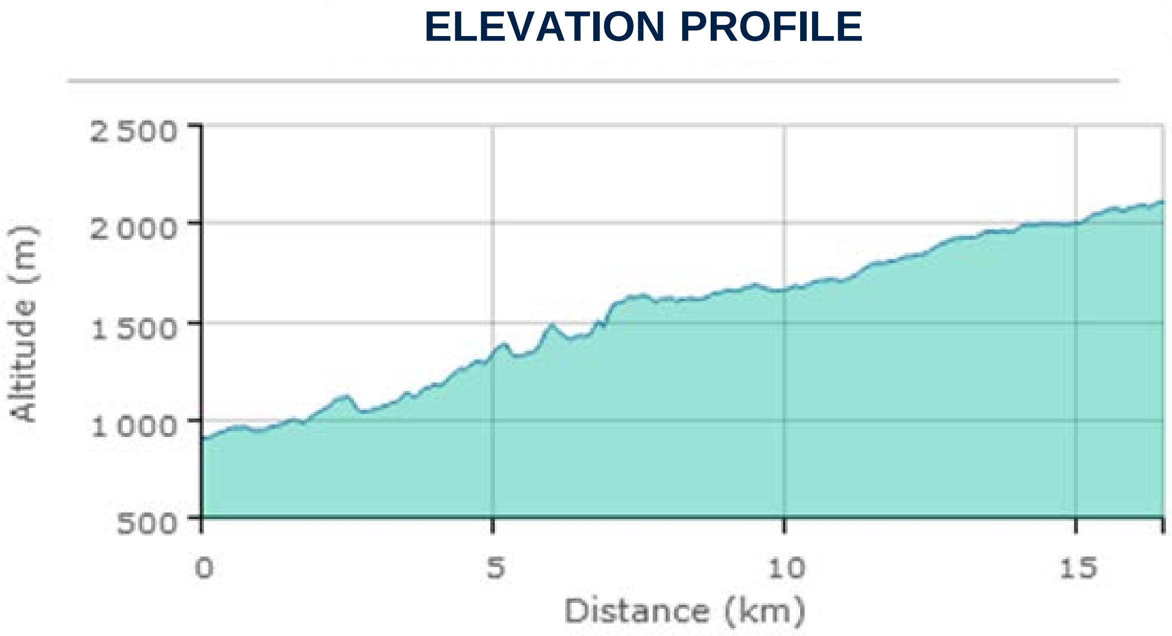

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6. Valley routing
Pass and ridge crossing

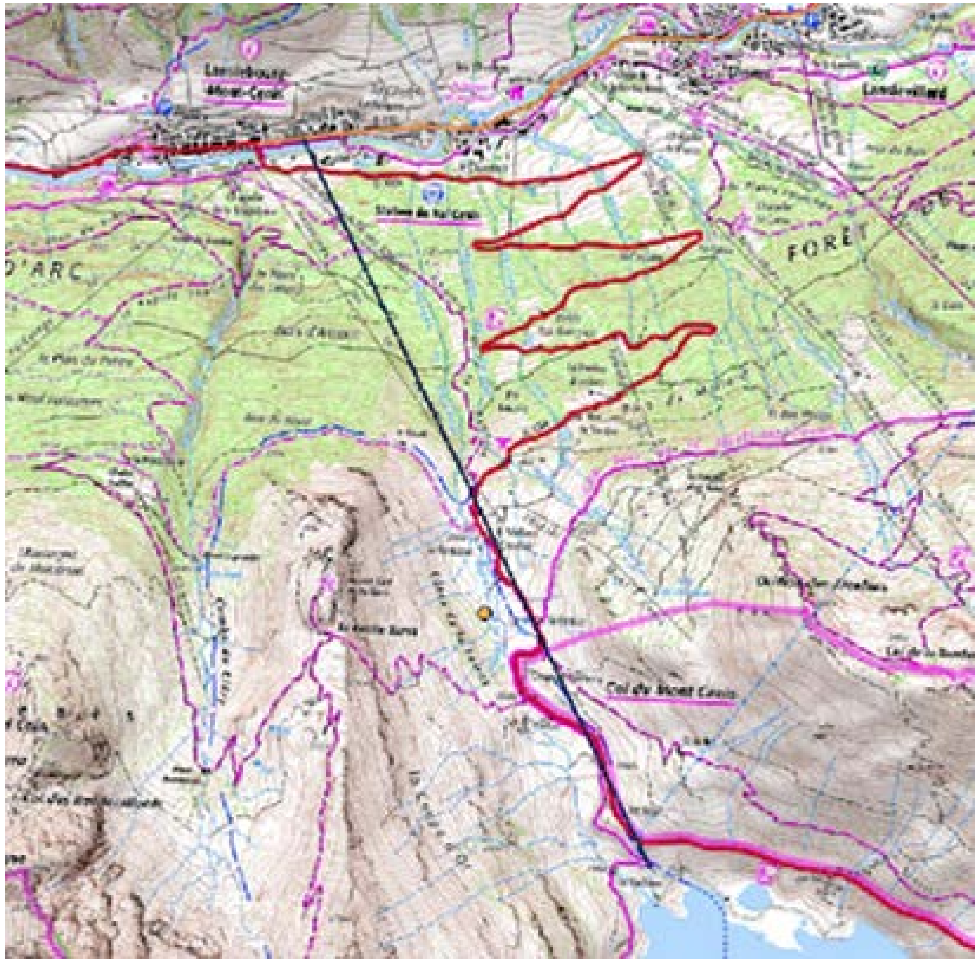
Example:

Flight in the Maurienne valley to Italy via Col du Mont Cenis

From Lanslebourg to the pass:

- 3,2 km
- 700m of vertical drop

That is 21% of rising slope



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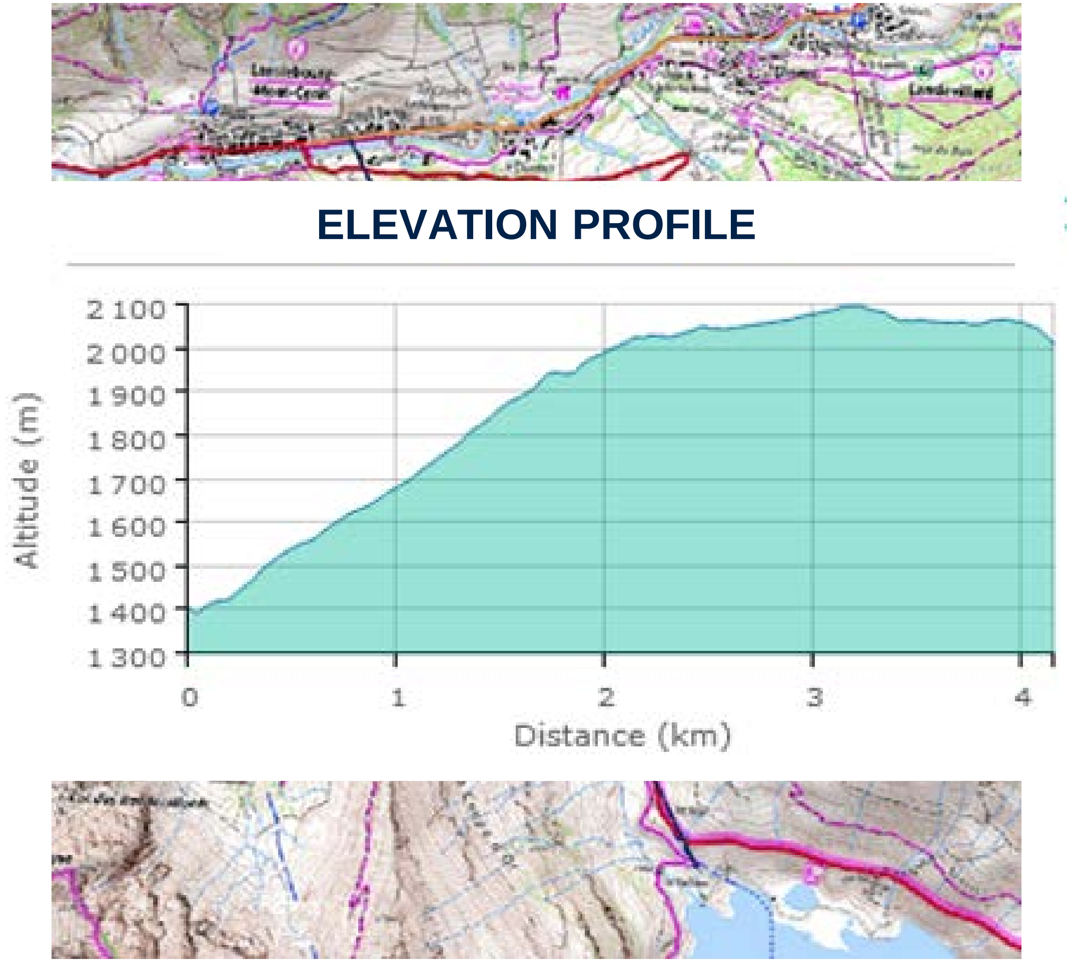


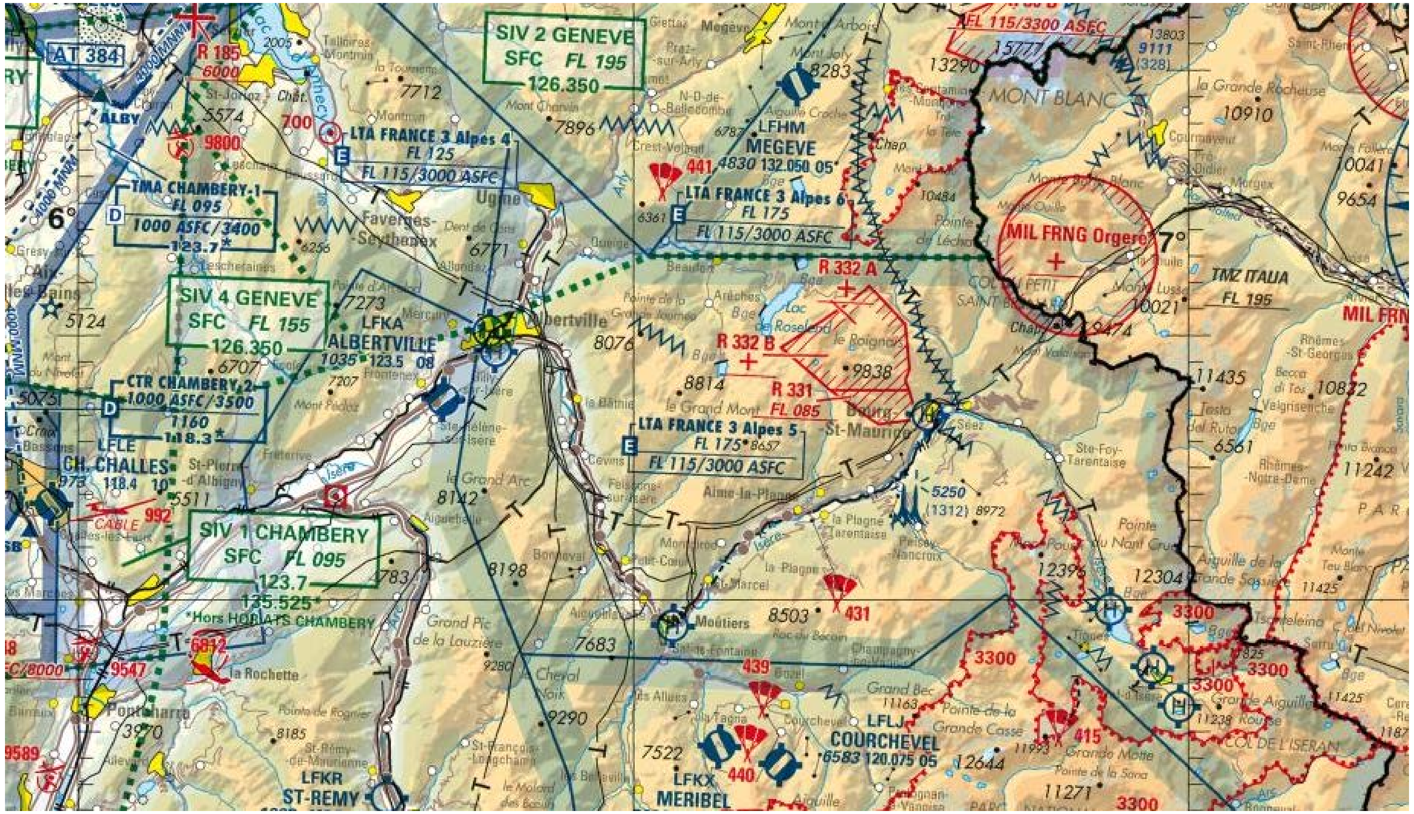
6. Valley routing
Pass and ridge crossing

It is necessary to be wary at the entrance of the valleys, by the false feeling of security offered at the same time by:

- **The width of the valley**
- **The height of the aircraft above the valley floor.**

As the plane ‘goes up’ the valley towards a pass or a ridge, **the valley narrows** and **the valley floor rises steeply**. It is therefore necessary to detect early on whether it is necessary to turn back (valley error, or to climb again), in order to be able to perform the maneuver safely.

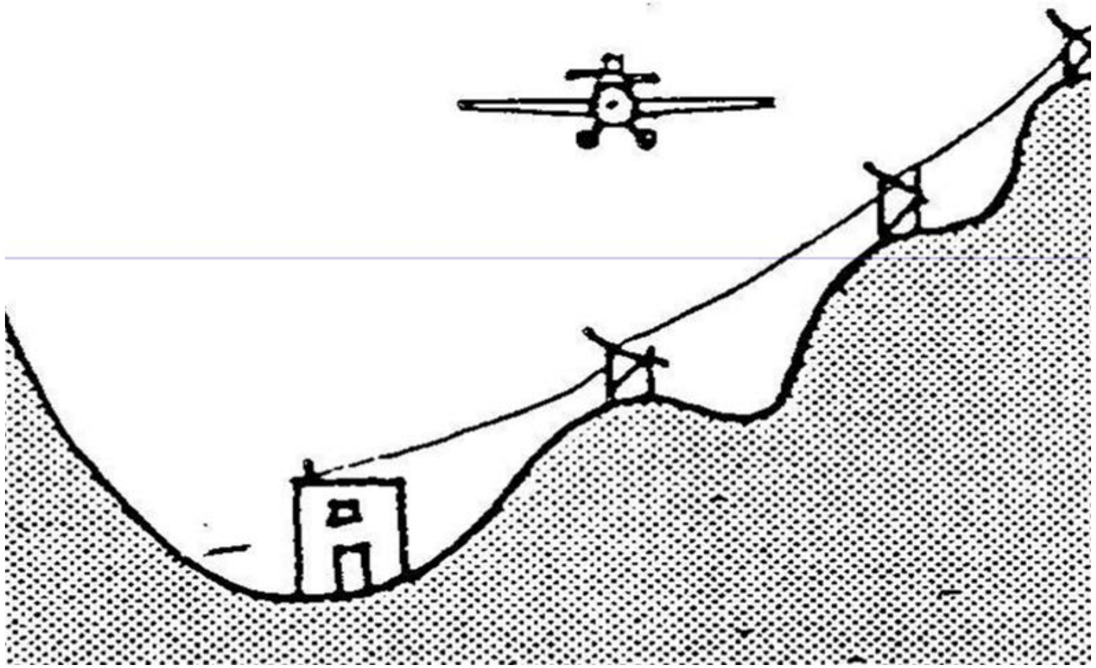
6. Valley routing
Pass and ridge crossing

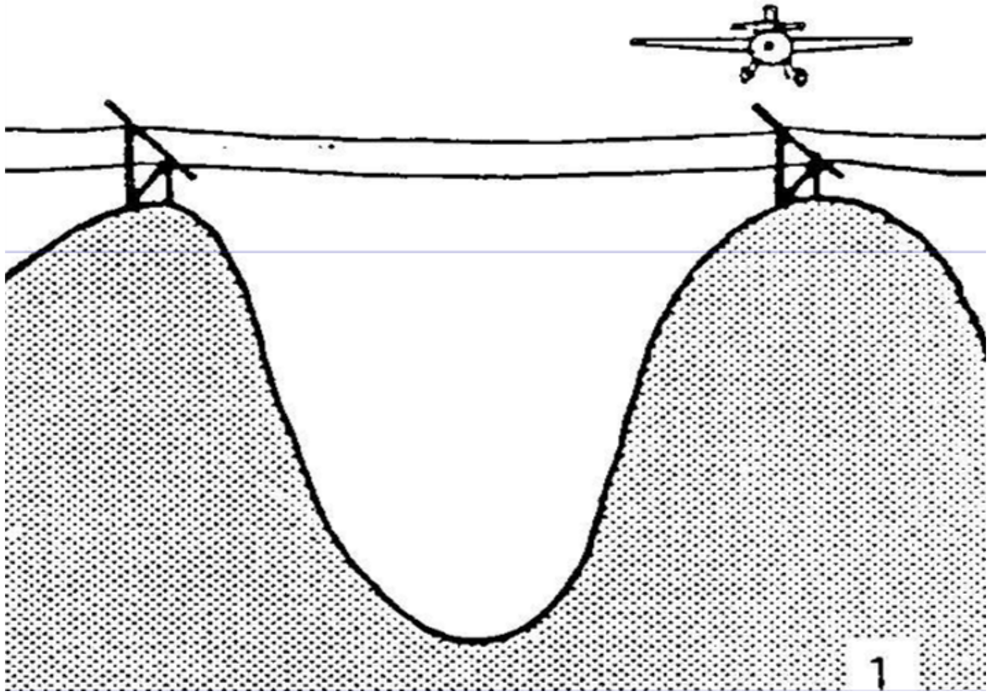


Beware of power lines in the valleys

6. Valley routing
Pass and ridge crossing

Crossing a power line in complete safety, by passing overhead of a pylon.





6. Valley routing
Pass and ridge crossing

Circulation in the valleys by **squeezing the terrain on the right of the plane**: possibility of turning around on the left at any time.

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Pass and ridge crossing

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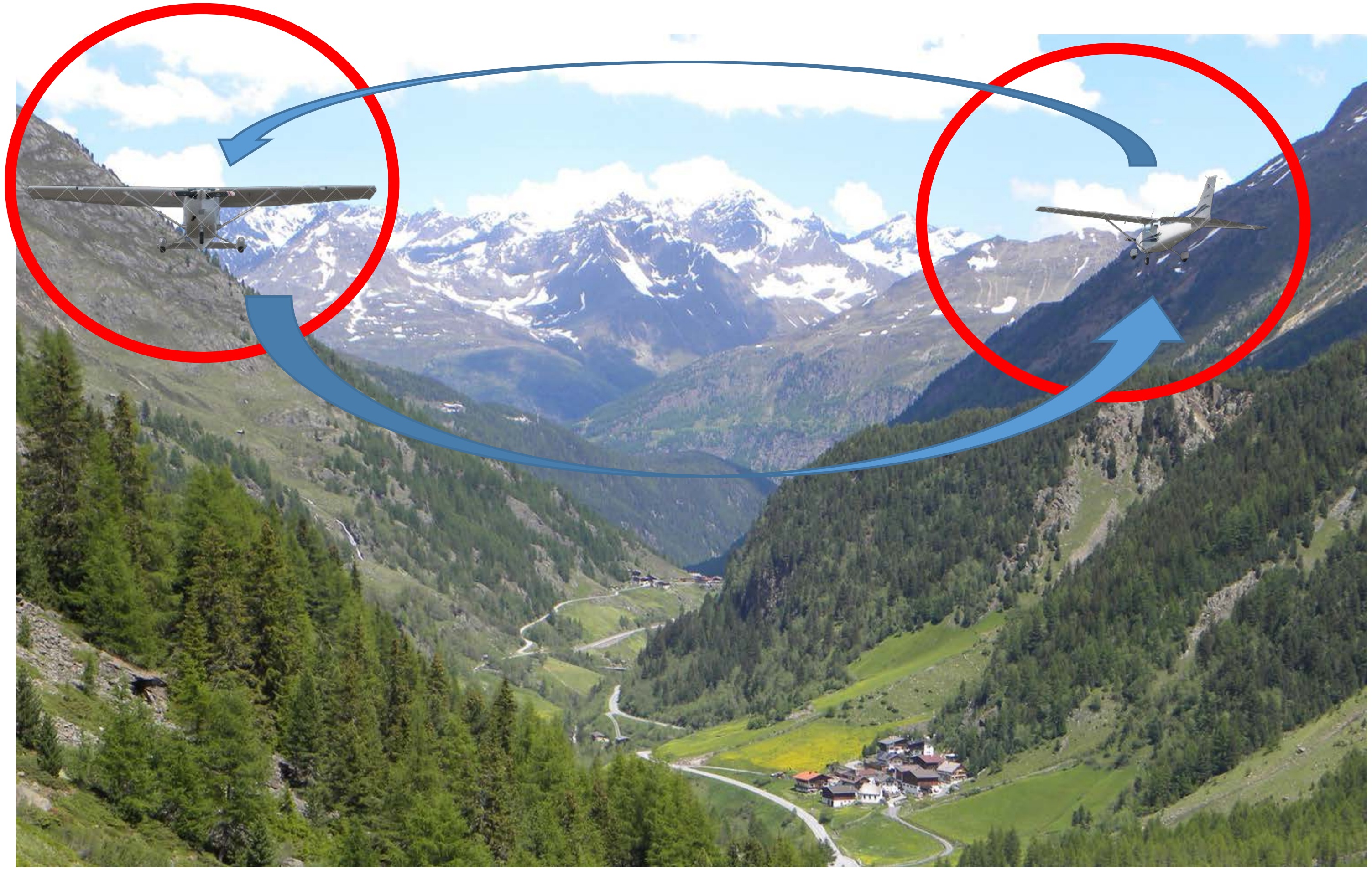
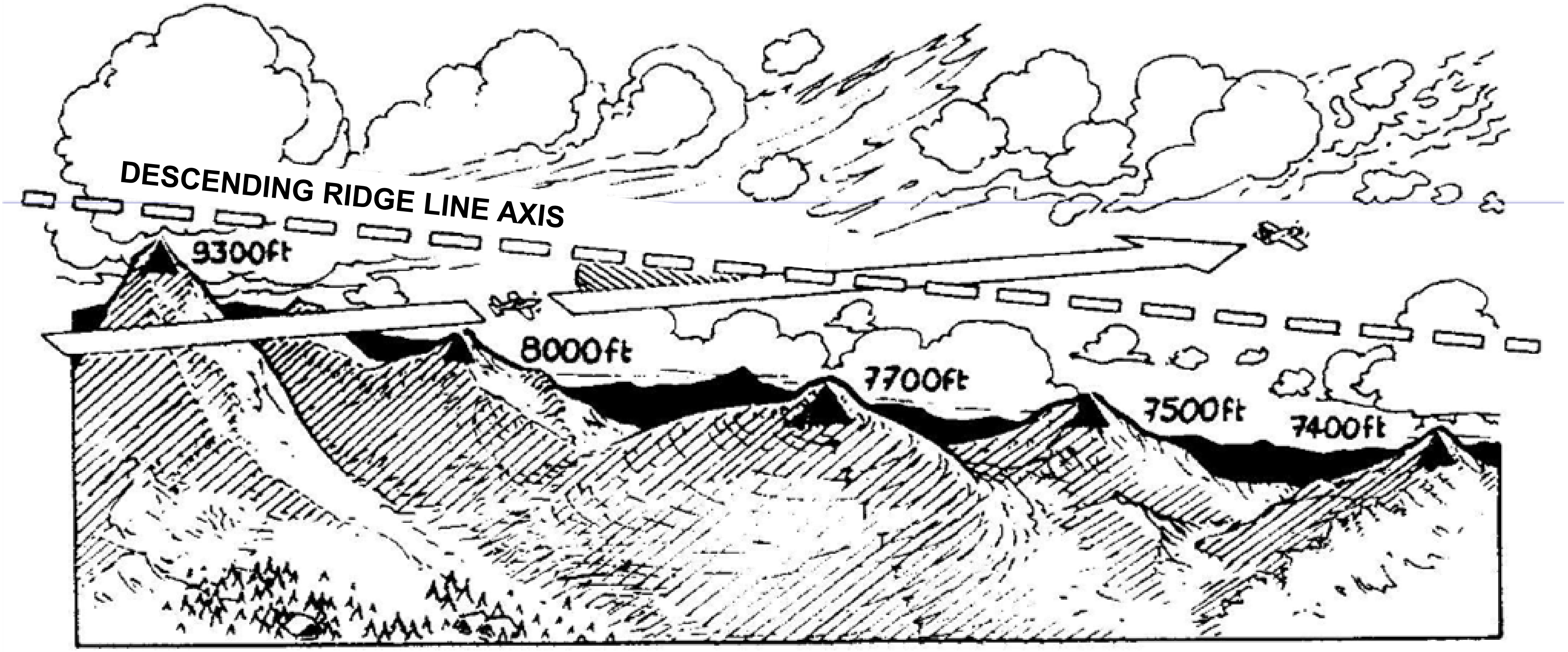


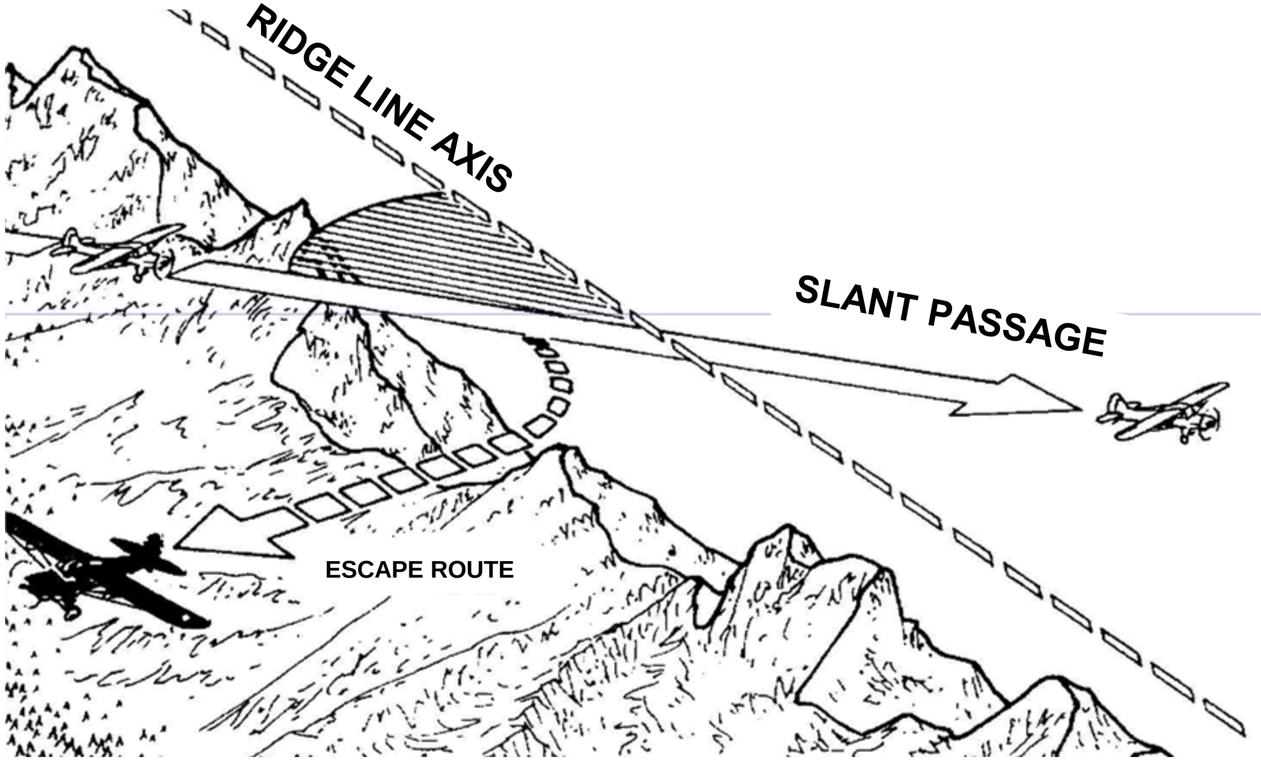
6. Valley routing
Pass and ridge crossing

Ridge crossing: **NEVER FACE DOWN,** ALWAYS in the direction of descending ridges



6. Valley routing
Pass and ridge crossing

Ridge crossing : **NEVER FACE DOWN, always by 45°**



Feedback

*"The pilot had prepared the flight with other pilots. The altitude of the Vars pass was not shown on the aeronautical charts, so another pilot had looked on an IGN map and indicated an altitude of 2,100 m(2). The pilot converted this altitude into feet and **used 6,000 ft as a safe altitude** taking into account the margins.*

The pilot indicates that he put the power back on full throttle when he realized that his altitude did not allow him to cross the Vars pass but that the rate of climb was too low to gain the desired altitude. He then started a U-turn to the left."

(2) ***6 900ft***

https://www.bea.aero/fileadmin/documents/docspa/2014/f-sq140609/pdf/f-sq140609_05.pdf

6. Valley routing
Pass and ridge crossing

Altimetry:

- **The altimeters are calibrated for a standard atmosphere**, and therefore have some deviations when used in real atmosphere
- When flying in a mountainous region with a 'flat' terrain, **the QNH of the departure terrain is often different from the one in the mountains** and the absence of ATS services does not allow for a recalibration
- Aeronautical charts are not accurate enough to establish mountain navigations. The use of other charts, on which the coordinates are given in meters, very often implies **conversion errors from 'm' to 'ft'.**
- All documentation is useful to prepare the flight, but when flying in mountainous areas **it is essential to follow a well established method to cross any pass or ridge safely.**

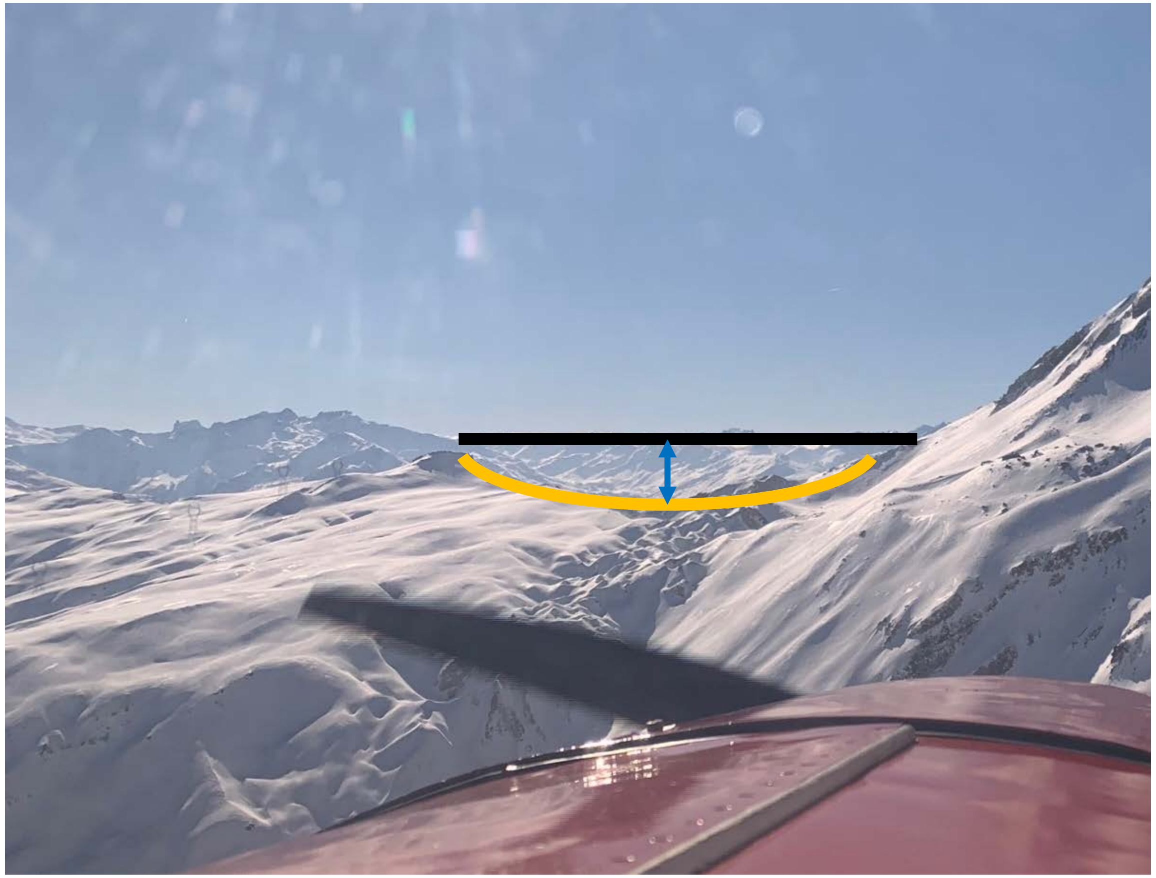
6. Valley routing
Pass and ridge crossing

On any path in the mountains, it is necessary to make sure you have:

- Sufficient space to turn around
- A sufficient height in relation to the bottom of the valley

Practical example of a pass or ridge crossing in 3 steps

6. Valley routing
Pass and ridge crossing

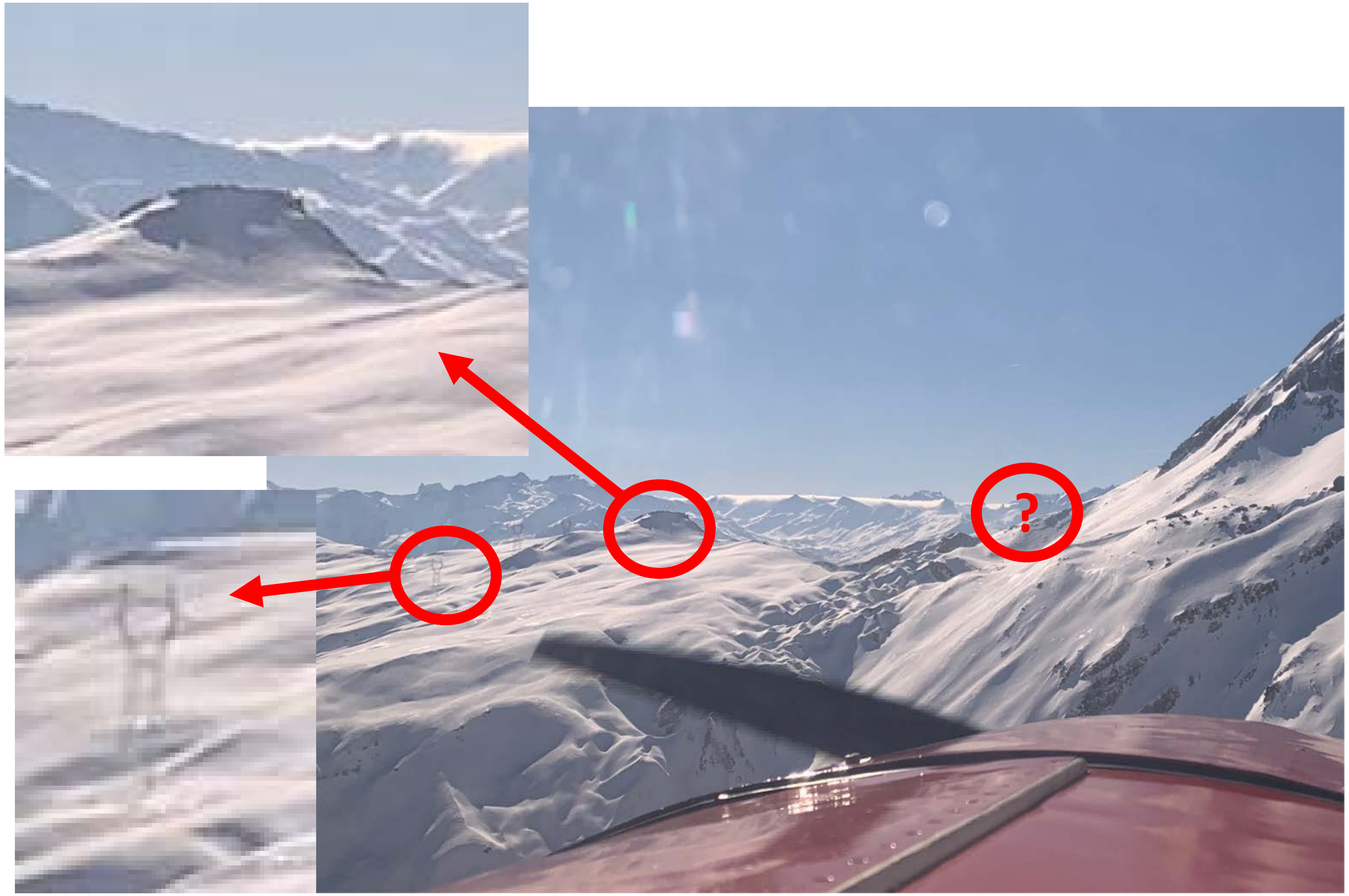


When approaching a ridge or a pass:

1. **Look at the terrain in the background behind the ridge or pass. If, as you approach this ridge or pass, the terrain in the background:**

- **Decreases or disappears: turn around, the plane is lower than the pass or ridge**
- **neither decreases nor increases: turn around, the plane is exactly at the altitude of the ridge or pass**
- **Increases or grows: the plane is higher than the ridge or pass**

6. Valley routing
Pass and ridge crossing



When approaching a ridge or a pass:

2. By squeezing the terrain to the right of the aircraft, identify obstacles near the pass (avoidance strategy) and confirm that the terrain in the background is 'growing'.

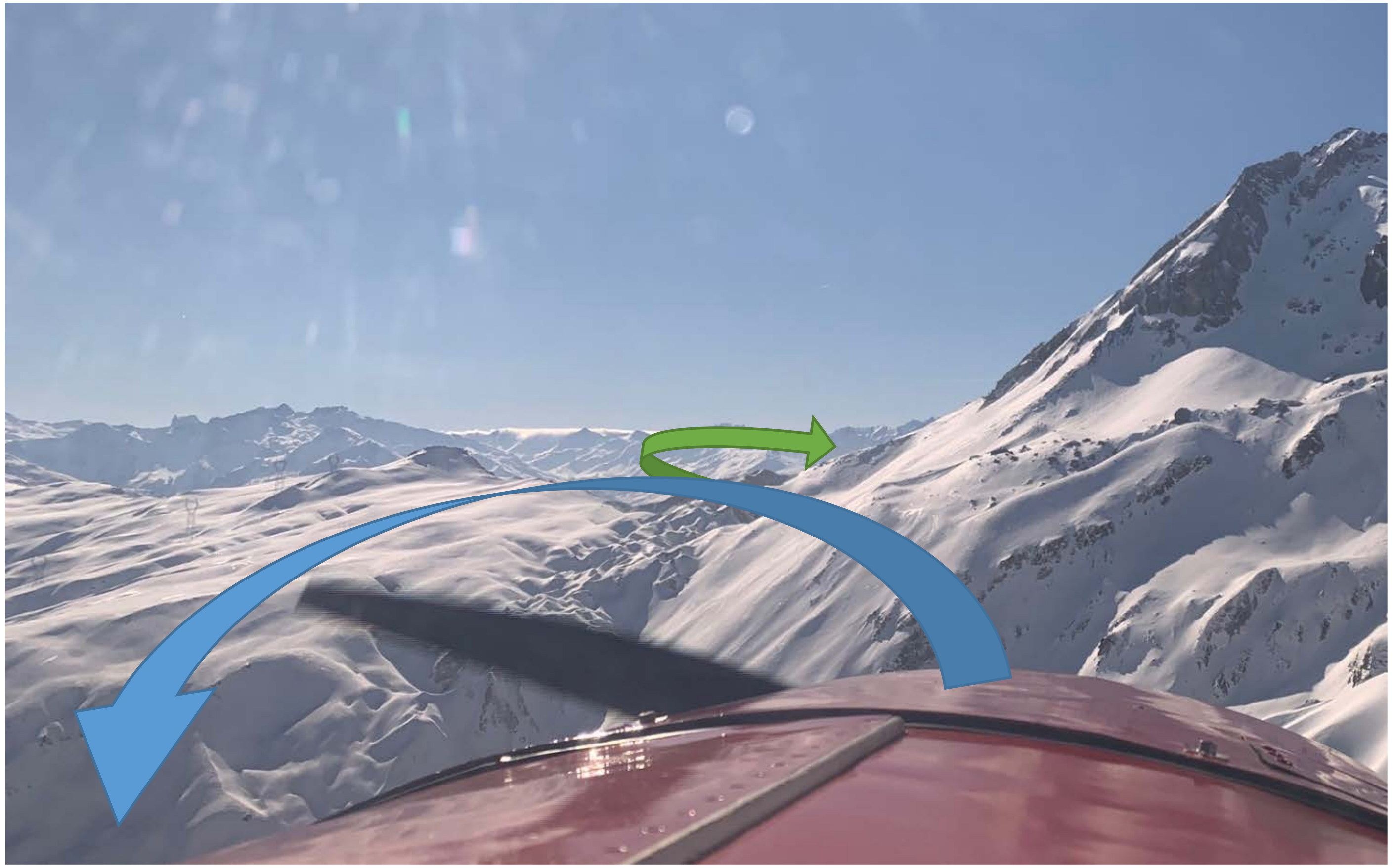
6. Valley routing
Pass and ridge crossing

When approaching a ridge or a pass:

3. Ensure the trajectory of crossing the pass, bringing the aircraft over the ridge, parallel to the ridge, and then decide:

- **to continue the U-turn**
-

6. Valley routing
Pass and ridge crossing



When approaching a ridge or a pass:

3. Ensure the trajectory of crossing the pass, bringing the aircraft over the ridge, parallel to the ridge, and then decide:

- **to continue the U-turn**
- **to make an opposite turn to pass the ridge or the pass**

Feedback

May have contributed to the accident:

- **an inadequate analysis during the preparation of the flight**, of the available weather forecasts consistent with those observed and estimated during the accident flight, as well as of the possible diversions according to the weather conditions encountered in flight;
- **the continuation of the flight towards the highest mountains of the Alps in unfavorable**/incompatible weather conditions for VFR flight.

Decision making is a complex process, which depends on the diagnosis of the situation and the evaluation of possible solutions, and must respect the time constraint. **On the ground, flight preparation should be done using meteorological and aeronautical information, with as little time pressure as possible.**

In flight, when approaching unfavorable weather conditions, diversion is an essential alternative to consider.

https://www.bea.aero/fileadmin/uploads/tx_elydbrapports/BEA2018-0641.pdf

IN PRACTICE

Long term flight preparation:

- Choice of route, suitable documentation, airspace, usable airfields near the route
- Forecast of the flight schedule, according to the light conditions and the aerology anticipated according to the season
- Altitude of transit, taking into account the crossing of passes and ridges
- Oxygen supply
- Fuel estimate (without wind), weight and balance estimate, aircraft performance (take-off, landing **and also climb performance**)

Short term flight preparation

- Weather conditions
  - beware of cloud cover, even a few, at an altitude close to that of the planned transit
  - wind
  - Air mass instability (convection)
- NOTAM, Sup AIP, airspace
- Update of the itinerary if necessary
- Update of fuel balance, weight and balance
- Update of performance according to the day's conditions
- Oxygen

IN PRACTICE

Announce regularly (position and direction) on the mountain self-information frequency 130,000MHz

Vigilance:

- **Light when flying** (low sun on the horizon is a hindrance if it is head-on, but also if it is side-on by valley sides totally in shadow)
- **Wind & aerology**: the more turbulent the atmosphere or the stronger the winds, the greater the height from the pass or ridge to be crossed.
- **Cloud cover:**
  - Does the planned route allow one to remain in VMC conditions while having sufficient height from the valley floor and pass to be crossed?
  - Is an alternative route (lower obstacles) ready in case of lower than expected cloud cover?
  - Are the characteristic points clearly identified in the absence of landmarks by the surrounding peaks masked by clouds?
- **If you decide to go on top:**
  - Certainty of being able to go back under the layer if necessary?
  - Pay attention to the vertical extension of the clouds, which can change very quickly with the orographic lift.

IN ANY CASE:

Make sure you leave yourself ALL the possibilities to turn back at any time

When in doubt, there is no doubt: TURN BACK!

7. Organization of the flight training

Need for flight training

*"The previous year, [the pilot] had attended a mountain flying presentation by the club's chief pilot...and had flown several flights **as a passenger**. This was his first mountain flight as a captain.*
(...)

*When he arrived near the pass, he realized that his altitude did not allow him to cross the terrain. He starts climbing again. **The plane collides with trees** and then the terrain west of the pass, goes into a pylon and catches fire."*

https://www.bea.aero/fileadmin/documents/docspa/2014/f-sq140609/pdf/f-sq140609_05.pdf

7. Organization of the flight training

- Flight n°1: basic mountain flying
  - ✓360° level at 30° inclination with a mountainous horizon
  - ✓360° level at 45° inclination with a mountainous horizon
  - ✓See the approach of the stall in climb, full throttle

  - ✓See the importance of flying on one side of the valley and perform a medium banked turn, in leve flightl
  - ✓Carry out the passage of the pass following the 3-step method
  - ✓Once the pass is crossed, continue the route with different ridge and pass crossings, always applying the same 3 step method.

7. Organization of the flight training

- Flight n°2: navigation in mountainous regions
  - ✓Prepare a round trip navigation to an airfield in a mountainous area that is neither an altiport nor an altisurface. Prepare a return itinerary different from the one planned for the outbound flight.
  - ✓Briefing on the itinerary, the TEM and the flight.
  - ✓A full landing will be made at the destination aerodrome, to allow a short debriefing of this first leg and prepare the return flight.

ASSOCIATION FRANÇAISE DES PILOTES DE MONTAGNE
AFPM
Depuis 1973

Thank you for your attention
Questions?

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