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Terrain depiction in Jeppesen FliteStar

version 1.2

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Introduction

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- Jeppesen FliteStar is the software most widely used by General Aviation pilots for flight planning. It is available in a number of versions (VFR, IFR, Corporate) and configurations for desktop and in-cockpit use.
- The software is very powerful and necessarily quite complex. It integrates a wide range of aviation data
  - "Vector" charts, which are purpose-built computer charts that depict airspace, topographic features and text as individual objects: analogous to a PowerPoint diagram. The user can select the chart display from a range of VFR (US and Europe styles) and IFR (High and Low airways) options
  - Terrain data, which "underlies" the Vector charts and is used to depict a colour-graded elevation on the VFR Vector charts, and the elevation directly below a specified route of flight in the Vertical Profile window
  - Optionally, "Raster" charts, which are scanned Jeppesen 1/2mil VFR charts: analogous to a high-quality photo of paper charts.
- Following a recent accident in which a Piper Seneca crashed into mountains in France, I happened to study the crash area using the terrain features and charts in FliteStar, to try and understand the possible route taken and terrain on that route
- As a result, I found some significant discrepancies and inaccuracies in the way terrain is depicted in FliteStar.
- The vertical profile and terrain features of FliteStar are not formal, legal or official flight planning data, and the Jeppesen manuals for FliteStar are careful to caveat both the underlying data and the meaning of terrain depictions (see Fig 1 below)
- However, my view is that the accuracy of the terrain information is significantly worse than a user might infer from the product and its documentation.

Fig 1: Extract from FliteStar help file

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My selection of text and bold emphasis

Terrain

The terrain data shown on FliteStar's Profile View is depicted from left to right, from departure to destination. The profile window shows the approximate height of the terrain directly under the aircraft's planned flight path.

It is important to understand that **no course width is used in the terrain depiction** and lateral clearance from terrain will not be shown. In areas where terrain data is not known or the accuracy of that data is not acceptable, FliteStar will not depict any terrain in the profile window.

CAUTION **Accuracy of terrain data varies greatly from region to region** and should not be relied upon as the sole source of terrain clearance information for your planned flight.

Example of a route

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- Figs 2 and 3 are cropped screen shots of the FliteStar software, displaying the optional overlay of Jeppesen VFR Raster charts
- In Fig 2, an illustrative flight plan route is depicted as the black line running vertically down the centre of the map. Below it is the Vertical Profile window, which depicts the terrain elevation on the route segment visible in the map. I have added the labels A,B,C and D to clarify the correspondence between the map's plan view of the route and the vertical profile
- Notice how the route in Fig 2 passes close to the 7679' peak between points B and C but the Vertical Profile is 4000'-5000' in this region
- The FliteStar help file does make it clear that "*no course width is used in the terrain depiction and lateral clearance from terrain will not be shown"* so, in principle, it is quite possible that Fig 2 is accurate and consistent with true terrain under the depicted route
- In Fig 3, a user waypoint has been manually placed over the 7679' peak, and the route has been adjusted to pass over that waypoint. This waypoint is labelled "B" in the plan and vertical map views.
- At point B, the Jepp vertical profile terrain height is 6400', compared to the true peak terrain height of 7679': clearly this can not be a result of the "zero lateral route width" used in the vertical profile depiction, and it seemed to me that one or both of the following errors may be present
  - The raster chart overlay was not correctly referenced or aligned with the vector chart terrain data, and thus the terrain data shown did not actually correspond to the terrain data at the 7569' peak
  - The position of the 7569' peak shown on the Raster charts was correctly overlayed on to the Vector charts, but that the Vector chart terrain data was wrong

- Note: The illustrations are from FliteMap IFR European, v9.160; Nav Data Cycle 12-2006; Jeppesen VFR scanned charts 2006. FliteMap is a variant of FliteStar which includes a GPS position input capability.

Fig 2

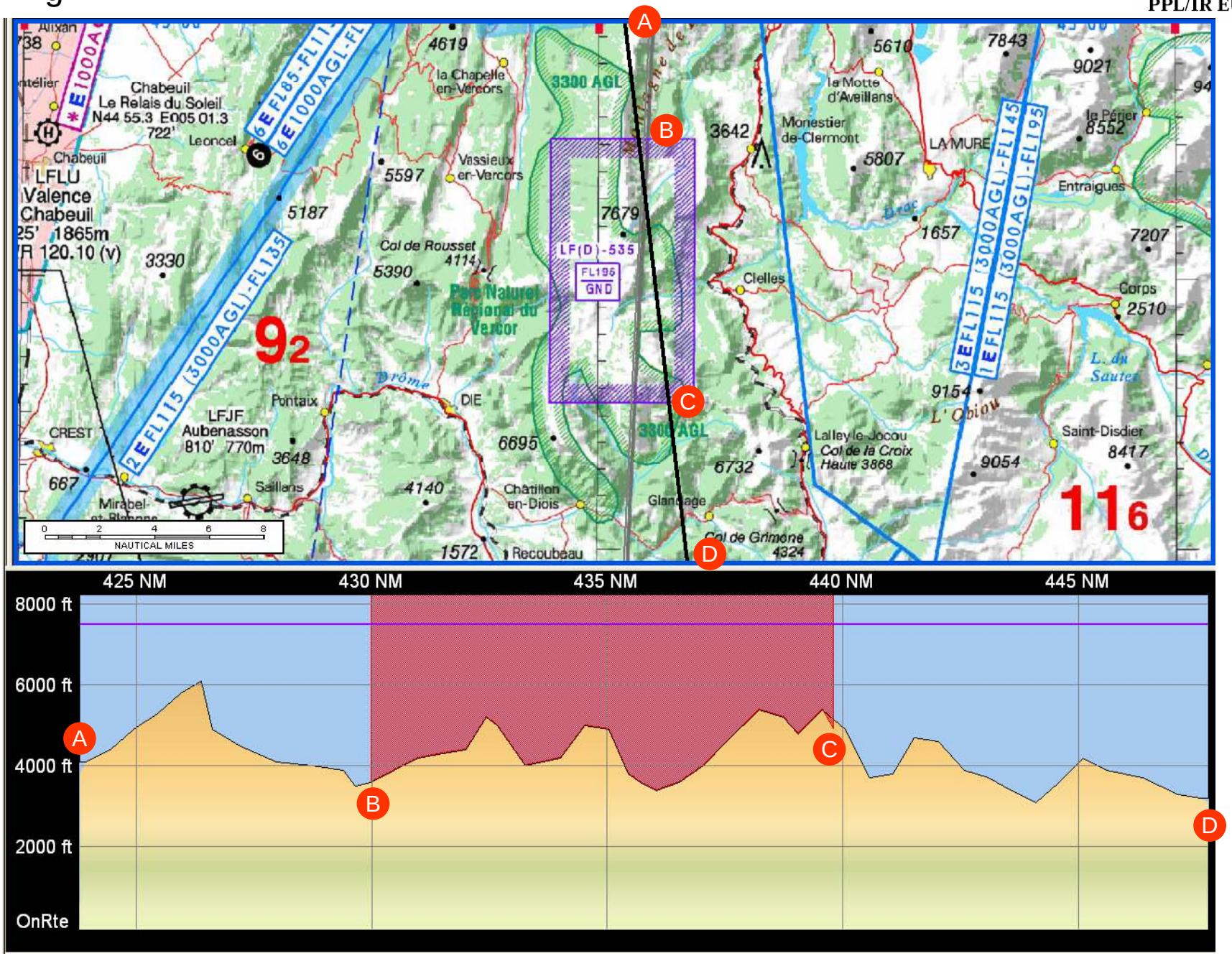
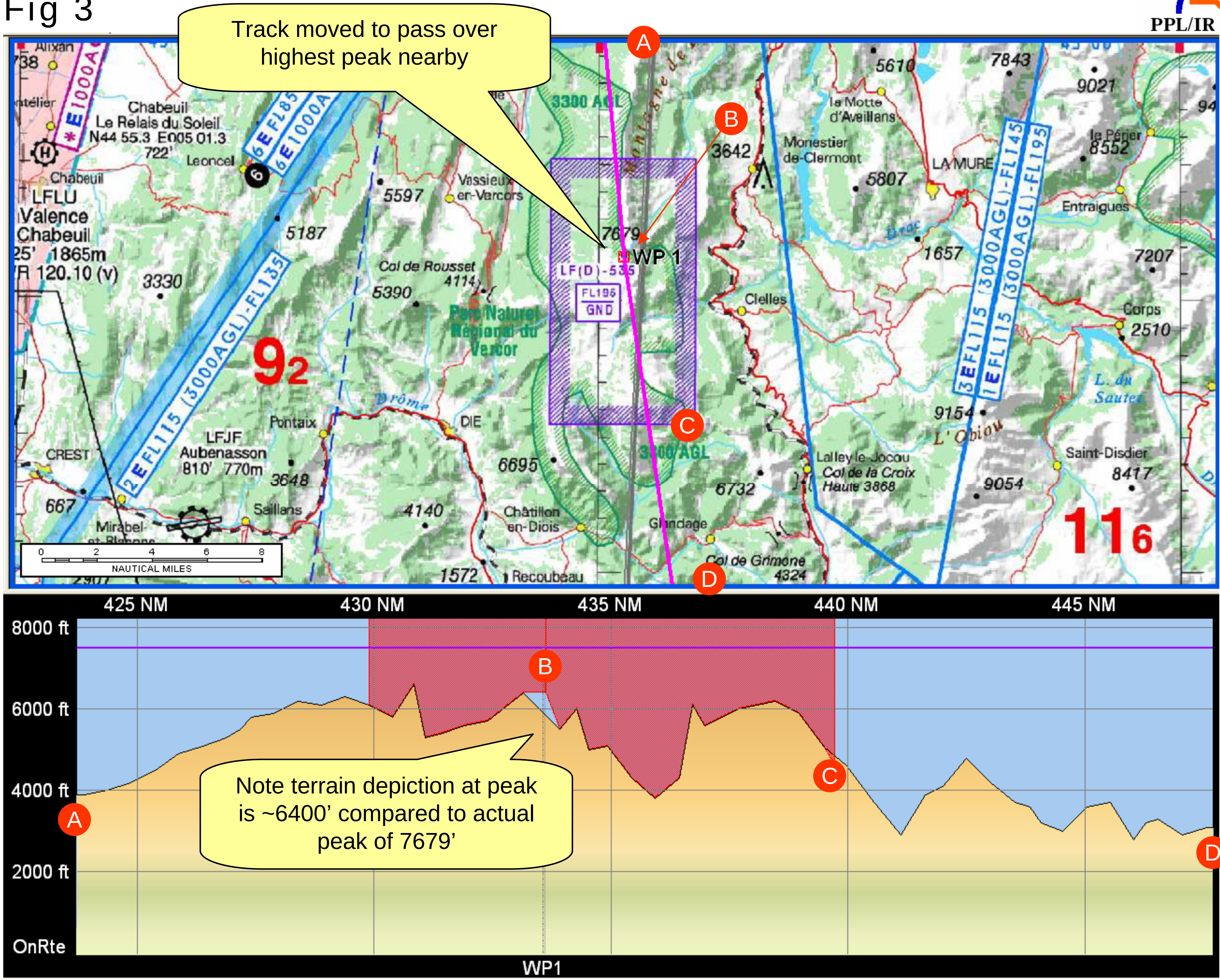

A
B
C
D
Chabeuil
Le Relais du Soleil
N44 55.3 E005 01.3
LFLU
Valence
Chabeuil
1865m
120.10 (v)
Leoncel
la Chapelle en-Vercors
Vassieux en-Vercors
Col de Rousset
4114
Parc Naturel Régional du Vercor
3300 AGL
LF(D)-535
FL195
GND
la Motte d'Aveillans
Monestier de-Clermont
LA MURE
Clelles
Entraigues
le Périer
Corps
2510
Pontaix
DIE
LFJF
Aubenasson
810' 770m
CREST
Saillans
Châtillon en-Diois
Glandage
Col de Grimone
4324
Recoubeau
Lalley le Jocou
Col de la Croix Haute 3868
Saint-Disdier
8417
9154
9054
7207
7679
6695
6732
5187
5597
5390
4619
5610
7843
9021
8552
5807
3642
1657
3330
4140
1572
667
3648
NAUTICAL MILES
425 NM
430 NM
435 NM
440 NM
445 NM
8000 ft
6000 ft
4000 ft
2000 ft
OnRte

Fig 3


Track moved to pass over highest peak nearby
Note terrain depiction at peak is ~6400' compared to actual peak of 7679'
A
B
C
D
WP 1
7679
3642
LF(D)-535
FL195
GND
3300 AGL
Chabeuil
Le Relais du Soleil
N44 55.3 E005 01.3
722'
LFLU
Valence
Chabeuil
Leoncel
Vassieux-en-Vercors
Col de Rousset
4114
5597
5187
5390
3330
Parc Naturel Régional du Vercor
LFJF
Aubenasson
810' 770m
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Saillans
Châtillon-en-Diois
Recoubeau
Glandage
Col de Grimone
4324
6695
6732
4140
3648
1572
667
la Motte d'Aveillans
Monestier de-Clermont
LA MURE
Entraigues
Clelles
Corps
Lalley le-Jocou
Col de la Croix Haute 3868
Saint-Disdier
L'Obiou
L. du Sautet
5610
7843
9021
8552
5807
1657
7207
2510
9154
9054
8417
6 EFL85
6 E1000A
2 EFL115 (3000AGL)-FL135
3 EFL115 (3000AGL)-FL145
1 EFL115 (3000AGL)-FL195
NAUTICAL MILES
0
2
4
6
8
425 NM
430 NM
435 NM
440 NM
445 NM
8000 ft
6000 ft
4000 ft
2000 ft
OnRte
WP1

Nature of Terrain Data in FliteStar

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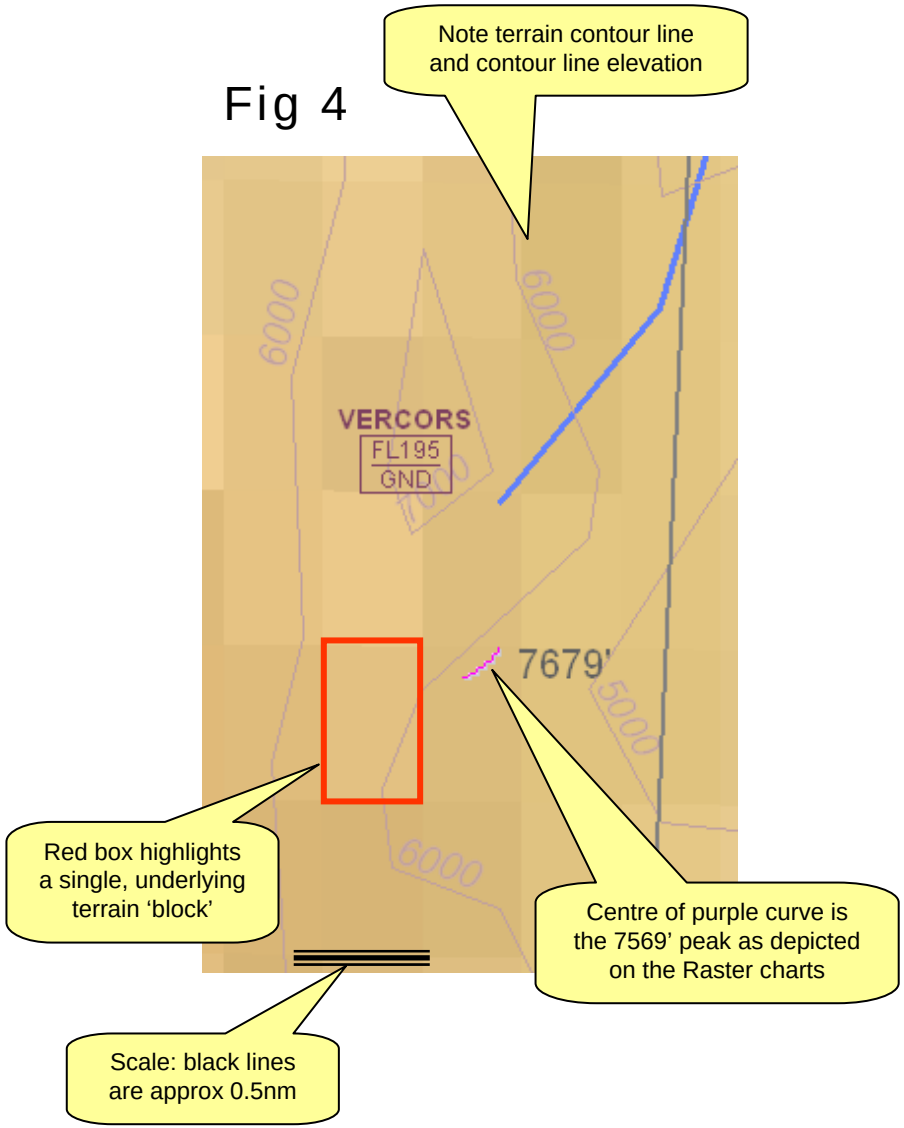
- Terrain data in software charts is “digitised”: the true terrain is broken down into small blocks, and a single elevation is associated with each block – in much the same way that a digital camera would depict a scene in black and white as a single light intensity value associated with each pixel
- Fig 4 is a screen shot of the Flitestar VFR Vector charts, zoomed in to show the nature of the terrain blocks used: they seem to be rectangles about 0.7nm N/S and 0.4nm E/W
- In Fig 4, the European-style VFR chart display is shown, this has the same terrain data as the US-style VFR charts, but includes contour lines and elevations, shown in faint purple
- Fig 4 also has a manual waypoint added at the exact place (to within 0.1nm accuracy, I estimate) the Raster chart overlay depicts the 7596’ peak
- In FliteStar, the user can identify the exact terrain elevation figure associated with each block, by positioning the mouse cursor over the block and reading the elevation figure which appears in a small window in the bottom right of the main screen

Fig 4



Accuracy of Terrain Data

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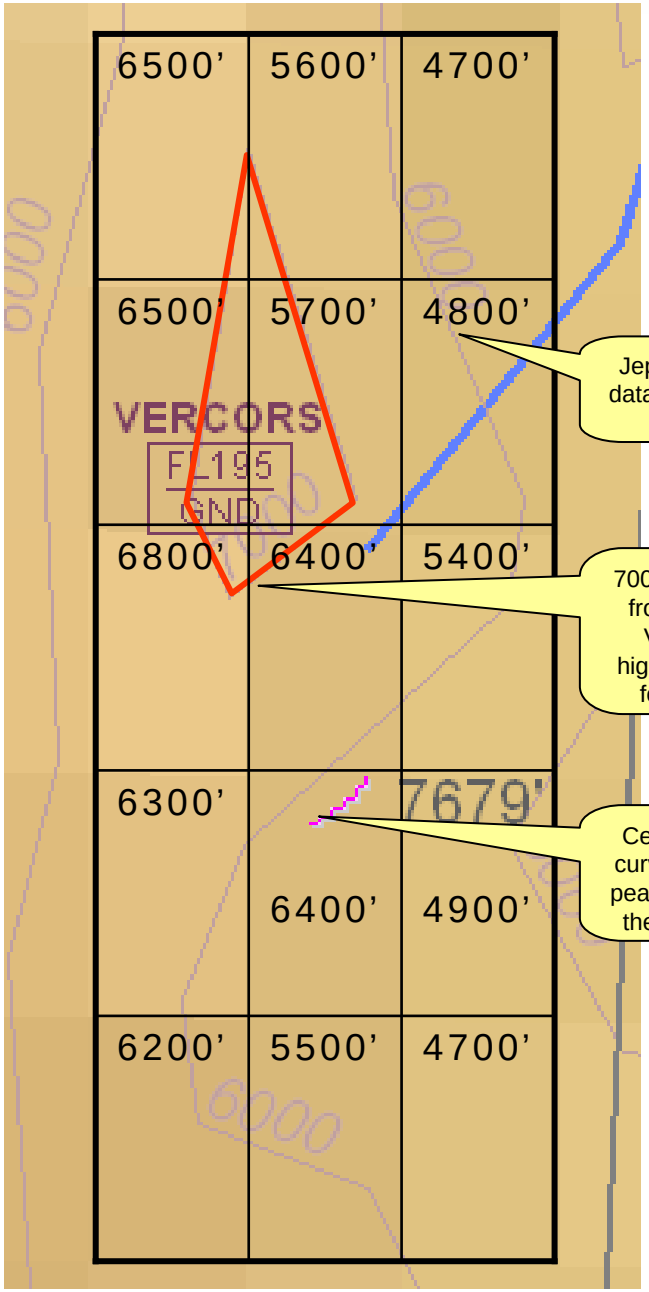
- Fig 5 illustrates the actual terrain elevation used in FliteStar in a 3x5 cluster of terrain blocks around the position of the 7679’ peak
- The vertical profile in FliteStar is drawn by plotting the terrain elevation values of the blocks a route line passes through
- The terrain elevation data appears to be inaccurate, it understates the elevation at the 7679’ peak by 1279’, and no nearby block has an elevation close to the 7679’ true local peak
- The vector chart terrain elevation is also incompatible with the contour lines displayed in the Euro-VFR vector chart – in Fig 5, the 7000’ contour line is depicted in red and passes through 6 terrain blocks – whose elevation is recorded as 5600’-6800’
- It is clear that there are referencing errors between the Raster chart and the Vector chart contour lines. In Fig 5, the Vector chart does not depict peaks, only contours, and one would assume the 7679’ peak is within the 7000’ contour line. This is approximately 1nm from its Raster chart position.
- Irrespective of the referencing errors, the terrain elevation data used for the vertical profile significantly understates the terrain height as depicted by the Raster chart and the Vector chart contour lines
- **There errors are typically 500’-1500’, the worst case observed is 3300’**

Fig 5



Accuracy of colour coding of elevation in VFR Vector charts

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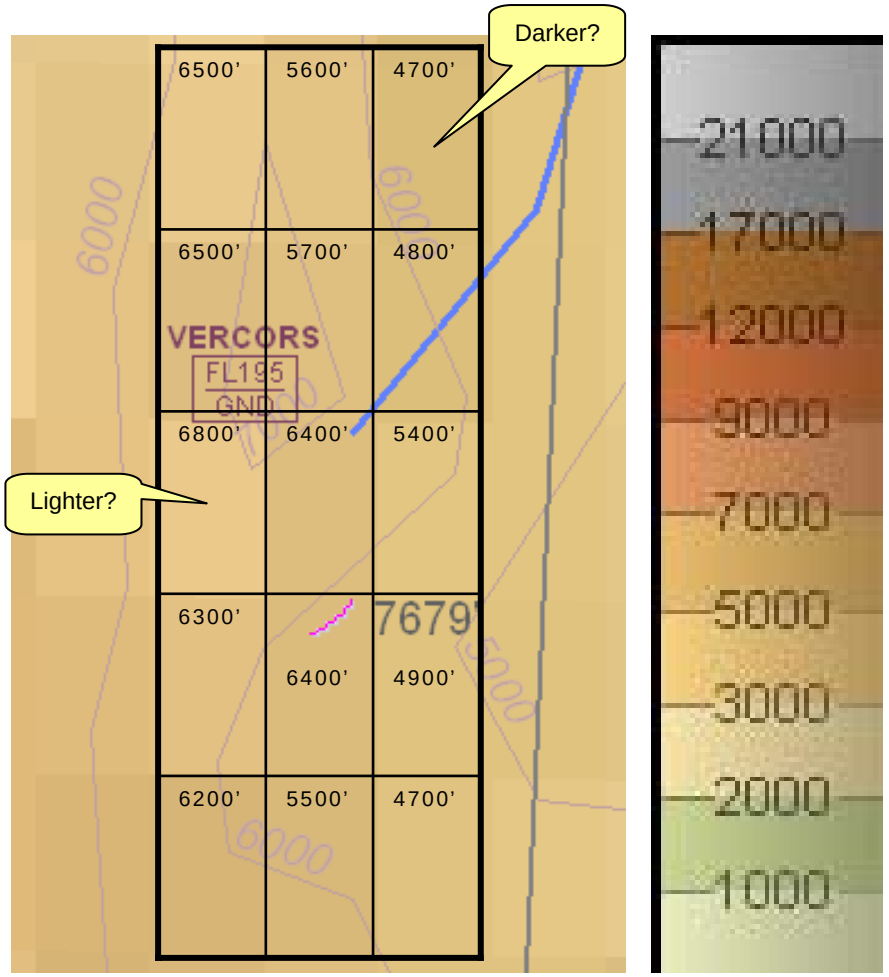
- Figure 6 compares the sample Vector chart region used previously with a close-up of the elevation colour legend that appears in the bottom right-hand corner of all FliteStar VFR vector chart displays
- When the Vector chart is zoomed out, to a scale of 20nm per inch or more, the colour depiction of terrain is helpful and accurate
- At closer zoom levels, the colour gradation, as Fig 6 illustrates, is misleading and difficult to interpret

Fig 6



Is the Vercors peak error an isolated example?

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- Fig 7 illustrates the results of 4 other peaks I picked randomly, 2 near Vercors and 2 in the Pyrenees
- I performed a quick analysis, of the type in Fig 5 above, by dropping a user waypoint on the Raster chart peak and then moving the mouse around that position and noting the elevation displayed. The red numbers are the height of the peak as displayed on the Raster chart and the black numbers are the Jeppesen terrain block elevations (from quick manual inspection)
- It is clear that the errors found in the Vercors 7679' example are systematic in FliteStar's terrain depiction
- This is a small and unscientific sample, but it is genuinely the first 4 points I randomly selected – no samples were discarded because they did not show an error

Fig 7

Two nearby peaks in the French alps

9106' peak @ N44.49 E06.03

8000'	7800'	7200'
7900'	7600' 9106'	5500'
6600'	6800'	5900'

5075' peak @ N45.04 E05.51

4200'	4200'	4500'
4200'	4200' 5075'	4500'
3900'	3900'	2900'

Two peaks in the Pyrenees

10,046'' peak @ N42.36 E00.40

7800'	8700'	8700'
8500'	9000' 10046'	9000'
9400'	9300'	9200'

7458' peak @ N42.41 E00.44

5500'	6200'	7200'
6600'	6500' 7458'	7200'
7100'	7100'	7100'

- Fig 8 is not a random sample, it illustrates a worst-case example found, near Vercors, where the terrain error is 3300'

Fig 8

Peak near Vercors

6722' peak @ N45.03 E05.36

4900'	3100'	3100'
4700'	3400' 6722'	3400'
4700'	3400'	3400'

Conclusions

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- The Jeppesen digitised terrain data in FliteStar is poor. It seems to systematically understate the terrain around mountain peaks by 500-1500’ and, in places, by over 3000’
- Consequently, users of FliteStar are advised to treat the Vertical Profile terrain display with great caution, and to be aware that the terrain elevation very close to the flight planned route may be thousands of feet higher than depicted
- The contour lines in FliteStar’s European style VFR charts are probably accurate, but be aware that small referencing errors (less than 1-2nm) may exist between the contour lines and the aeronautical waypoints and/or the Raster VFR charts
- At some close-up map scales, I also note that the VFR chart colour coding of terrain is not particularly helpful
- These problems should not directly affect flight safety, since the Vertical Profile feature is not appropriate for either IFR or VFR flight planning. Hence, this paper is intended only as an advisory note to users of the FliteStar software.
- It also highlights how non-approved data should not be used for terrain awareness.
  - for example, a number of GPS products offer VFR-style topographic moving maps with colour coded elevation. A pilot who might be tempted to use them for terrain planning and avoidance should be aware that they may not be suitable.
  - “Certification” for flight safety purposes sometimes seems like a formality that adds cost and restrictions, when reasonably safe “non-certified” alternatives are available. This is an example where the “non-certified” product is not a safe alternative.

Notes

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- This paper is not a systematic criticism of FliteStar. I continue to use FliteStar because I find it a great product, that is invaluable in flight planning. The vertical profile feature includes useful and accurate airspace information along a route of flight, and can overlay Jeppesen winds aloft and weather information. My only caveat is that the terrain profile should be treated as a very rough indication. Additionally, almost all of my flying depends on Jeppesen chart and database products, which I continue to have 100% confidence in.

- I intend forwarding this note to Jeppesen Europe, after some of my fellow PPL/IR Europe members have reviewed it

- No inference about the February 2007 Vercors accident should be drawn from this paper. It merely prompted me to look closely at terrain features in FliteStar because I was interested in the area of the accident. Ideally, I should have eliminated any connection by selecting another peak as my main sample. However, given I ended up spending some significant effort understanding how the terrain feature worked based on the Vercors chart, it would have been time-consuming to replicate the work.

- Thanks to my friend and fellow PPL/IR Europe member Peter Holy for input and comment based on his deep knowledge of many IFR and software/technology issues.