Survey of Muncaster Fell

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1) Introduction

Muncaster Fell (Hill Number 2694, Section 34D, OS 1:50000 Map 96, OS 1:25000 Map OL6N, Grid Ref SD112983) is currently listed in the Database of British and Irish Hills as a Marilyn, HuMP, TuMP, Wainwright Outlying Fell and Fellranger. The accepted summit position is marked with a trig point (231m) on the 1:50k map. The 1:25k and 1:10k maps, however, show a 230m contour on ground 500m to the North-East which therefore could be higher than the currently accepted summit. One of the authors visited Muncaster Fell in 2007 and found, using an Abney level, the highest ground in the vicinity of the trig point to be an outcrop 35m to the North of it. A forward and back sighting of the summit to the North-East showed it to be greater than 230m in height, but the instrument was unable to confirm which of the two summits was the higher. More recently, Mark Jackson has studied LIDAR (Light Detection and Ranging) data which gave heights of 231.0m for the SW Top and 231.5m for the NE Top, thus suggesting that a change of summit position was likely. The purpose of this survey was to measure accurately the height of the two Tops of Muncaster Fell to determine the true summit position.

2) Equipment used and Conditions for Survey

The ground surveys to locate the position of the summits were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is dual-frequency and multi-channel, which means it is capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receiving two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As a stand-alone instrument it is capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite "fix". Despite the on-board features of the Viva GS15 receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from the Ordnance Survey which were post-processed using Leica Geo Office 8.3 software.

Conditions for the survey, which took place between 11.00hr and 15.00hr BST, were excellent. Visibility through the optics was clear, the wind was light at between 5 and 10mph and the temperature was between 20 and 25 degrees Celsius.

3) The Survey

3.1) Character of Hill

Muncaster Fell forms a long ridge that rises above the hamlet of Ravenglass and the nearby Muncaster Castle (see map in Appendix). The undulating ridge is about 4km in length and its

summit is hidden by forestry on approach by road from the South. It is more readily seen from the North where the Ravenglass and Eskdale light railway runs at the foot of the hill finally terminating at Dalegarth. The railway can only be glimpsed from the summit of Muncaster Fell due to the proximity of the line to the steep sides of the hill, but the sound of its whistle carries easily to the summit and announces its presence. The route to the trig point on the South West top starts from the car park for Muncaster Castle and leaves the main A595 road after about 300m at a sharp bend where a forest road climbs gently in a North East direction for 1.5km. Just before the termination of the forest the road which then continues as a rough track, there is a small lake with, on our visit, flowering water lilies. The track now follows a forestry boundary fence for 0.5km and then strikes immediately up hill to the prominent trig point. For such a small hill the views are extensive with the Isle of Man visible to the West across Morecombe Bay. To the North West is Sellafield and to the North the Pillar group, while Scafell dominates the North East. Finally, Harter Fell and the complex of rocky hills in its environs to the East complete a remarkable view. The summit area around the trig point is relatively flat with a few protruding rocks and a couple of small rock outcrops and it was the northerly one of these that had been identified previously as the highest point on this top. The North East top appears to the naked eye to be much lower.

3.2) Survey of SW Top

Once at the summit, the first task was to confirm the earlier work by locating the highest point on the South West top. The Leica NA730 level was set up at a convenient position and readings taken at various locations around the trig point on several rocks and the two outcrops. The highest point was confirmed to be the outcrop that is about 35m North of the trig point. A staff reading was also taken on the flush bracket of the trig point.

Staff readings:

Summit outcrop (bearing 10 degrees from trig point and 35m away) = 0.275m

Highest rock by trig point (bearing 60 degrees from trig point and 2m away) = 0.463m

Two rocks (bearing 336 degrees from trig point and 7m away) = 0.346m & 0.332m

Flush bracket of trig point = 0.288m

Highest rock by trig point is 0.463 – 0.275 = 0.188m lower than summit outcrop

Rocks 7m from trig point are 0.346 – 0.275 = 0.071m lower and 0.332 – 0.275 = 0.057m lower than summit outcrop

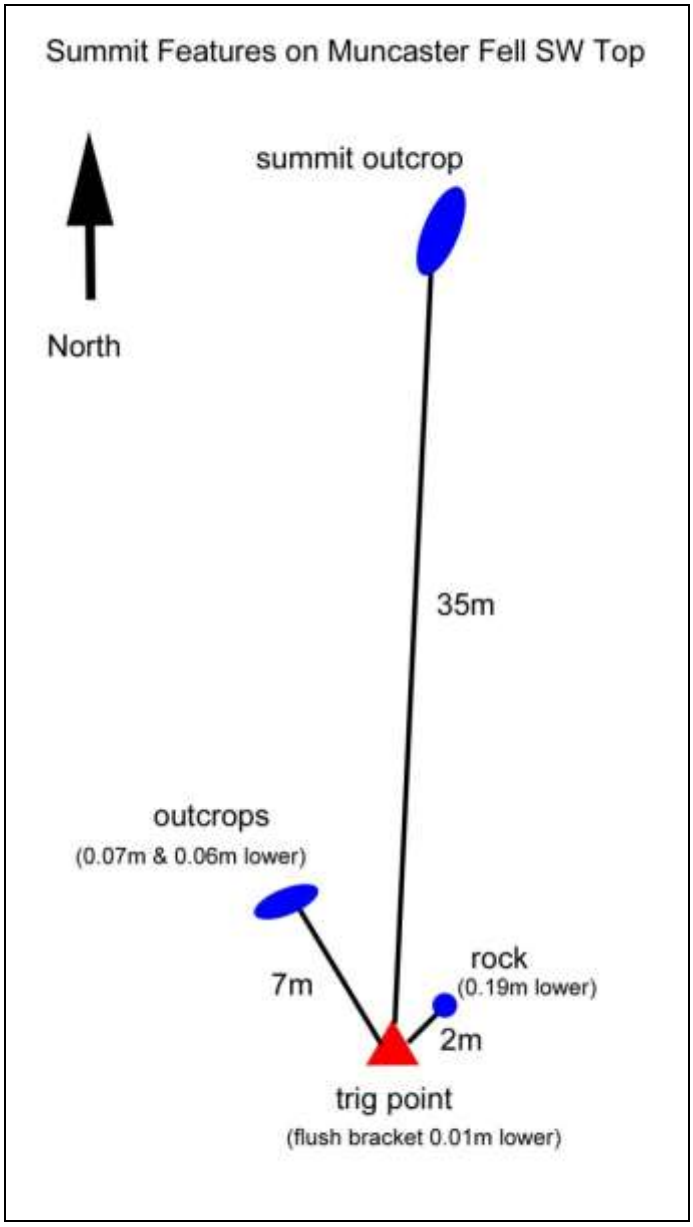
The ten figure grid references recorded by hand-held Garmin GNSS receivers for the trig point were:-

Garmin Oregon 450	SD 11207 98318	Accuracy: averaged	Height = 236m
Garmin Montana 600	SD 11208 98316	Accuracy: averaged	Height = 231m
Garmin Etrex 20	SD 11208 98317	Accuracy: averaged	Height = 236m

The ten figure grid references recorded by hand-held Garmin GNSS receivers for the summit outcrop were:-

Garmin Oregon 450	SD 11212 98354	Accuracy: averaged	Height = 236m
Garmin Montana 600	SD 11212 98353	Accuracy: averaged	Height = 231m
Garmin Etrex 20	SD 11212 98351	Accuracy: averaged	Height = 233m

The diagram below shows the geography of the summit area with the height differences of the various features relative to the summit outcrop.



Prior to collecting data with the Leica Viva GS15, we set the Leica NA730 level with the summit outcrop and then observed the summit of the NE Top. The summit feature there was an outcrop which we later measured to be about 0.7m high when we visited the NE Top. The level line was passing below this feature thus enabling us to give an estimate that the NE Top was about 0.8m higher. Regrettably heat haze prevented us obtaining useful photographs that would have enabled us to give a more quantitative answer by this method.

Next the tripod was set-up over this position and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.333m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 1hr with an epoch time of 15 seconds. A photograph of the GS15 over the summit position is also shown in the Appendix.

The results are shown below.

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	311209.541	0.003	498351.777	0.002	231.392	0.004

The height of Muncaster Fell SW Top is 231.39m.

The height of the flush bracket of the trig point is measured as 231.392 – 0.288 + 0.275 = 231.379m

The height of the flush bracket in the OS database is 231.346m.

3.3) Survey of NE Top

After completing our work on the South West top we made our way over to the North East top. The ground between the two tops is rough and in many places very wet, but fortunately there was a narrow, but clear, path across this ground that passed just beneath the North East top's summit. From there it was a short walk through thick heather to the summit area. It was clear by eye that the summit itself was likely to be a small outcrop under a metre high. In order to be certain the level was set up and several candidate high points checked, but all were lower.

The ten figure grid references recorded by hand-held Garmin GNSS receivers for the summit outcrop were:-

Garmin Oregon 450	SD 11554 98671	Accuracy: averaged	Height = 237m
Garmin Montana 600	SD 11555 98671	Accuracy: averaged	Height = 237m
Garmin Etrex 20	SD 11556 98669	Accuracy: averaged	Height = 239m

We also set the NA730 level to the height of the summit outcrop and then focussed on the trig point of the SW Top. Although the quality of the photograph suffers from heat haze it may be clearly seen that the level line runs just below the top of the trig point, thus giving visual confirmation that the NE top is the higher of the two tops (see photograph in Appendix). Given that the summit outcrop was 0.01m higher than the flush bracket and that flush brackets are usually set between 0.3m and 0.4m above the ground, our best estimate of height difference between the SW Top and the NE Top is 0.85m in agreement with the observation made from the SW Top. Note that had we been able to obtain better photographs that included one of the stadia lines of the level then a more quantitative measurement could have been obtained by this method.

Next the tripod was set-up over this position and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.260m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 1hr with an epoch time of 15 seconds. A photograph of the GS15 over the summit position is also shown in the Appendix.

The results are shown below.

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	311551.824	0.002	498668.033	0.002	232.130	0.001

The height of Muncaster Fell NE Top is 232.13m

4) Summary of Operating and Processing Conditions

	SW Top	NE Top
Data collection summit (min)	62	64
Number of Base Stations used in Processing for all points	8	8
Epoch Time (sec)	15	15
Troposphere Model	Computed	Computed
Cut off Angle (degs)	15	15
Geoid Model	OSGM36(15)	OSGM36(15)

5) Discussion of Results

The measurement uncertainty in height associated with location of the summit position is better than 2mm, since both summits were well defined outcrops, while that for the measurement itself is +/-0.06m. Therefore the height of Muncaster Fell SW Top is 231.4+/-0.06m and the height of Muncaster Fell NE Top is 232.1+/-0.06m. The LIDAR results are 231.0m and 231.5m respectively as calculated by Mark Jackson. In this instance it may be seen that LIDAR has determined the heights to within 0.4m, but a more extensive study by C Crocker will be reported in the near future. This survey shows that the summit of Muncaster Fell is the NE Top which is 0.7m higher than the SW Top. Consequently, the NE Top becomes the Marilyn, HuMP and TuMP while the SW Top retains its status as the Wainwright Outlying Fell.

The height of the flush bracket on the trig point that is given in the Ordnance Survey database is just 0.03m lower than our measured value. The two values are in excellent agreement.

We noted in our preparation for the survey that the LIDAR data files indicate the drop between the two tops to be close to 30m and consequently both summits may be TuMPs. The ground between the SW and NE tops is boggy and extensive and there was insufficient time on our visit to determine the position of the col or collect data for it.

6) Summary and Conclusions

The **summit** of **Muncaster Fell** is an outcrop on the NE Top at Grid reference *** SD 11555 98671** and this has a height of 232.1m. The respective hill list authors have agreed the summit change and so the NE Top becomes the Marilyn, HuMP and TuMP.

The summit of the SW Top is an outcrop 35m N of the trig point at grid reference ***SD 11212 98353** and this has a height of 231.4m. The SW Top retains its status as the Wainwright Outlying Fell.

- NB average hand-held Garmin GNSS grid references are quoted in the summary.

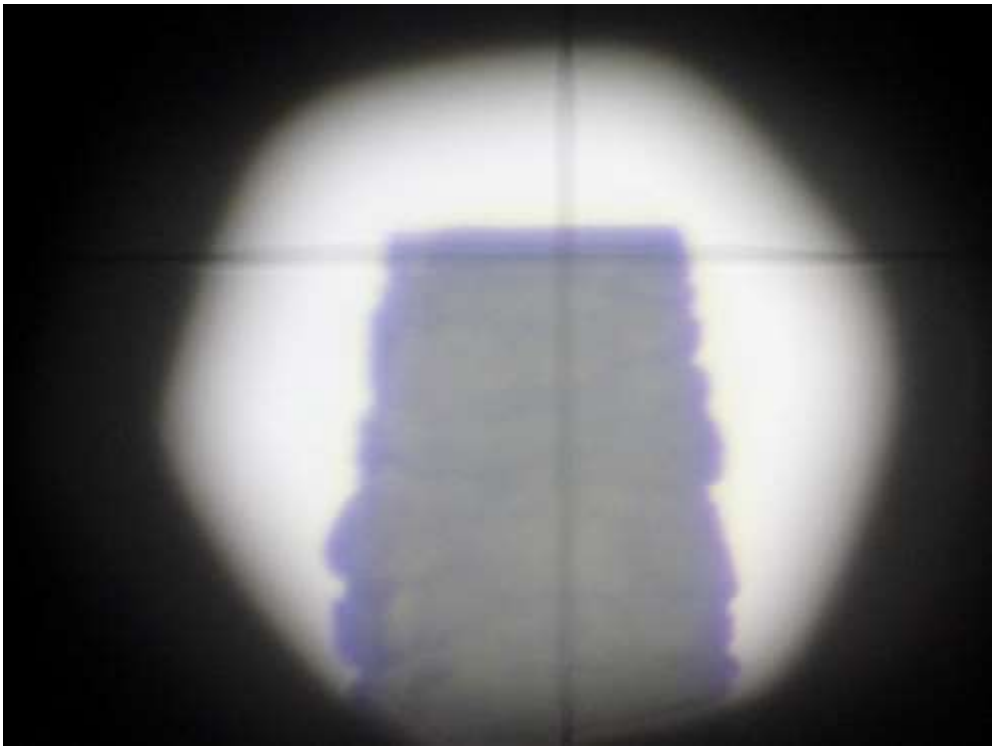
John Barnard & Graham Jackson 11 September 2016.

Appendix 1

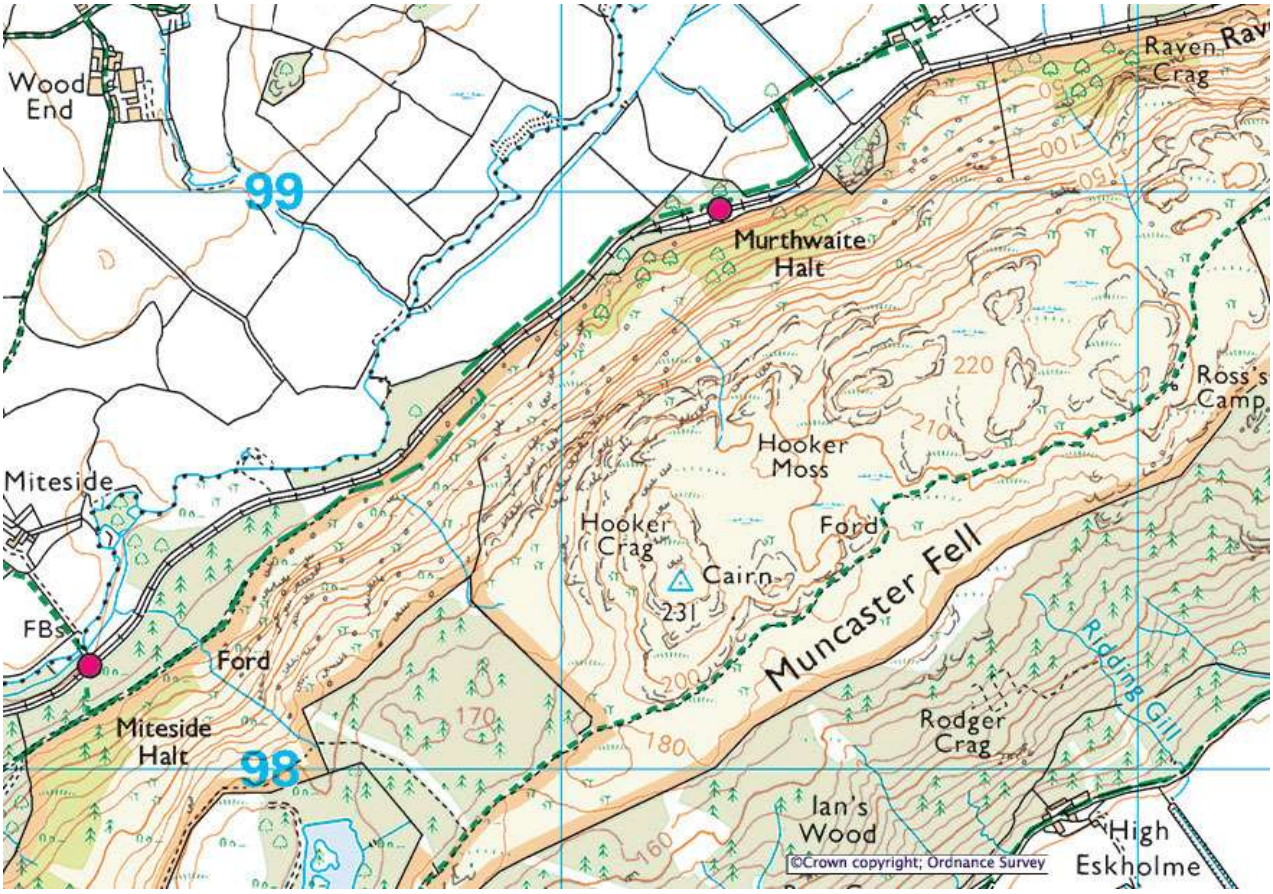
Tape reading for Leica Viva GS15 on SW Top

Tape reading for Leica Viva GS15 on NE Top

Leica Vivia GS15 set up over summit of NE Top



Trig point on SW Top as seen through the level set up on NE Top



1:25k map of summit ridge (courtesy Ordnance Survey)