A Smoother Approach to Elevation Gain Calculation

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During a recent hike on the Tour du Mont Blanc, I noticed a persistent discrepancy between the elevation gain reported by Gaia GPS and my Garmin watch. In some cases, Gaia overstated the gain by as much as 35%. This observation led me to investigate how elevation gain is calculated, and whether there's a more accurate, effort-reflective method. I present a simple approach that smooths the elevation profile and measures only meaningful climbs and descents—helping reconcile differences between platforms and improve route planning.

1 Why Do Gaia and Garmin Disagree?

Table 1 highlights the elevation gain and loss reported by Gaia GPS and Garmin for the same trek. As seen, Gaia's values are significantly higher.

Table 1: Raw elevation statistics reported by each device

Metric	**Gaia**	**Garmin**
Ascent (m)	12,288	9,079
Descent (m)	12,059	8,815

This raised a simple but important question: how can two devices disagree so much about the same physical effort?

Two main factors appear to drive this divergence:

1. **Track misalignment with base elevation data**: If the track recorded in the GPS is slightly offset from the trail, it can intersect different elevation contours, especially on steep slopes. This can lead to artificial spikes in calculated elevation change.
2. **The coastline paradox effect**: A higher-resolution track records more minor ups and downs. When summed, these micro-variations inflate the total gain—even if they have little impact on perceived effort.

2 An Alternative Measure of Elevation

To get a more realistic view of elevation gain, I propose a method based on the cumulative height of major climbs and descents, rather than the sum of small changes between every GPS point.

This method involves:

- Smoothing the elevation profile to remove small fluctuations
- Identifying significant peaks and valleys using local minima and maxima
- Summing the positive and negative elevation changes between these key points

In my view this approach better reflects actual climbing effort and filters out noise that inflates elevation stats.

3 How I Tested the Method

I began by downloading the GPX tracks from both Gaia and Garmin, then aligned them as closely as possible to ensure comparability. These tracks were processed in Python to analyze the elevation profiles.

As shown in Figure 1, while the overall shape of the two profiles is consistent, Gaia's profile includes more minor fluctuations.

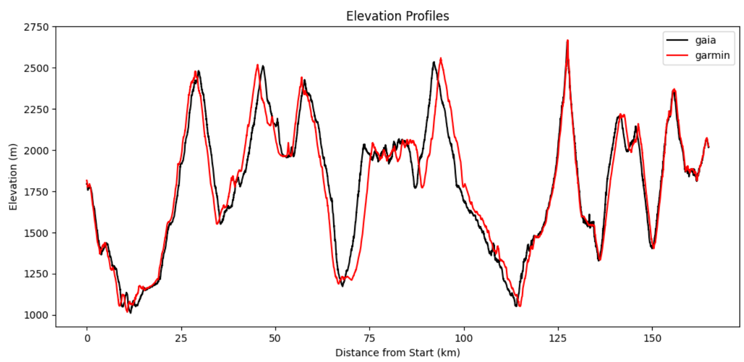

Figure 1: Comparison of elevation profiles recorded by Gaia and Garmin

Using a simple peak-detection algorithm, I smoothed the profile and measured elevation changes only between local maxima and minima, ignoring short, insignificant fluctuations.
Figures 2 and 3 show examples of the input and processed elevation profiles.

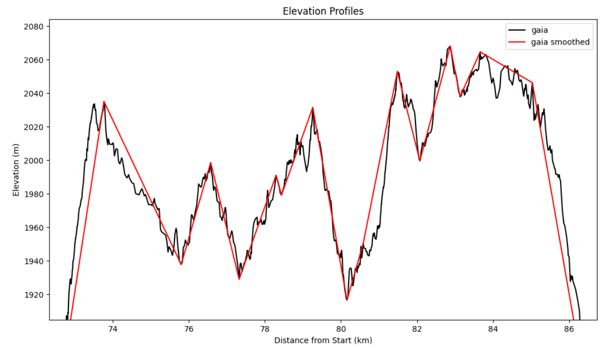

Figure 2: Example A: Original Gaia profile vs. smoothed elevation transitions

4 Does It Work?

Applying the smoothing method to the Gaia data brought the ascent and descent values much closer to Garmin's—but not identical. The results are summarized in Table 2.

Table 2: Elevation statistics after smoothing and processing

Metric	**Gaia (Processed)**	**Garmin (Raw)**
Ascent (m)	9,903	9,079
Descent (m)	9,678	8,815

This suggests that a large portion of the discrepancy can be explained by oversampling and/or misalignment—both of which are reduced through this approach.

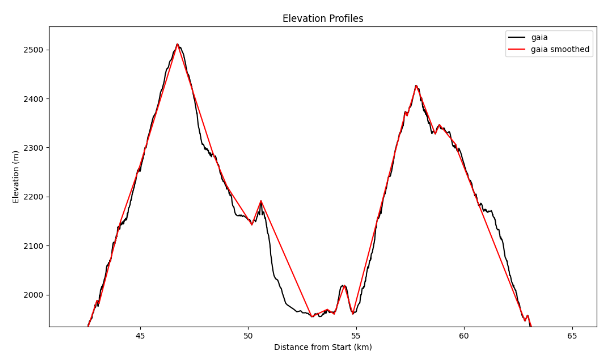

Figure 3: Example B: Smoothed profile with significant elevation changes preserved