Detailed example of a radar measurement zone.

Mont Ventoux climb, in three parts.

A CLIMB LIKE THAT OF THE MONT VENTOUX CAN BE DIVIDED IN THREE PARTS (SEE MAP), APPROACHED DIFFERENTLY DEPENDING ON RACING AND WEATHER CONDITIONS: :

1) From Bédoin to Saint Estève = 1
2) From Saint Estève to Chalet Reynard = 2
3) From Chalet Reynard to the summit = 3

In part 1, power measurement accuracy has a margin of error of 10 % in the case of a single line race as riders can draft when they ride as a peloton or one behind the other. The average grade is less 4 %: the riders draft and follow one another. They also ride at speeds approaching 30 km/h. This 10 % variation is due the significance of aerodynamic forces of drag and draft in relation to the force of gravity. These aerodynamic forces cannot be determined exactly using the indirect method. However, the average power can be determined in this first segment with significant accuracy on the overall climb in instances of a time trial with little wind (2004 Dauphiné and Iban Mayo record), where there was no drafting effect.

In part 2, power measurement accuracy has 2 % margin of error. The average grade is close to 10 %. The riders are travelling at speeds of approximately 20 km/h and the forest diminishes the impact of the wind. The riders are mostly fighting gravity.

In part 3, power measurement accuracy has a 5 % margin of error. The grade remains relatively high at 8 %, but wind speed at ground level is far from negligible. The Mont Ventoux is located near the Rhône Valley where the mistral often blows. There is no vegetation to diminish the effect of the wind at ground level and, the higher one goes (1900 m at the Ventoux's peak), the stronger the wind.

In racer profiles, average power is therefore generally estimated on the second segment between Saint Estève and the Chalet Reynard. Are some of these calculations intellectually dishonest?

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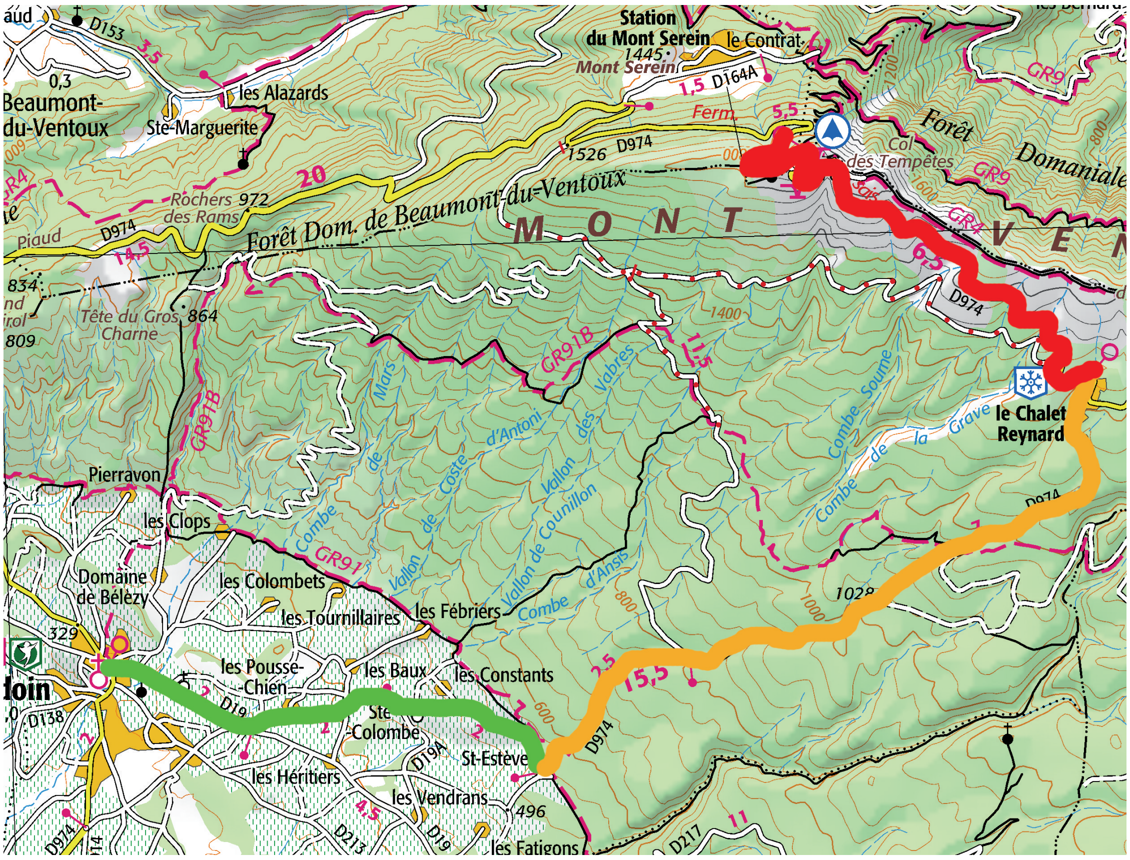

NO,

Based on this study:

Miguel Indurain set a new world hour record on track at Bordeaux on September 2nd 1994 with 53.04 km. His power was estimated at 509.5 watts (ref. 8). Nineteen days prior his attempt at a world record, Indurain performed a laboratory test on an ergocycle with mechanical braking (Monark 818 E, Varberg, Sweden). His power at the lactate threshold (point at which lactate starts to accumulate in the blood stream - 4 mmol /l) was 505 watts (6,23 watts/kg). This exercise intensity was chosen because it has been reported to be sustainable for a maximum amount of time over a prolonged period of time.

In July 1994, Miguel Indurain won his fourth Tour de France. He performed incredibly on the Hautacam stage. We estimate his power (cf. Indurain pages) to have been 530 watts (6.6 watts/kg) over 35 minutes. We also estimate his power during the Avoriaz climb after a prolonged time trial (1 hour 30 minutes) to have been 490 watts (6.13 watts/kg).

On average, Indurain generated 490 watts (6.13 watts/kg) on the last climb of mountain stages. This value is slightly lower than his power at the lactate threshold (505 watts). Our power estimates are therefore entirely within the realm of realistic projections.

Ref: Scientific approach to the 1-h cycling world record: a case study. Sabino Padilla, Iñigo Mujika, Francisco Angulo and Juan Jose Goiriena 89:1522-1527, 2000. ; J Appl Physiol

YES,

Based on this study:

1 : The Michele FERRARI (the "Dottore") Method
Michele Ferrari uses a simple formula to determine relative power in watts/kg based on a climber's Mean Ascent Velocity when he climbs a col.

Relative Power (watts/kg) = MAV (meters/hour)/(grade factor)

The correction factor, the "grade factor", equals 200+10*P, where P is the average grade.

For example, if a rider climbs a col with an average grade of 6 % at 1500 m/h, his relative power in watts/kg will be: 1500/(200+10*6) = 5,77 w/kg

Michele Ferrari made this

connection by measuring MAV on different grades for a 64 kg rider generating 300 watts, for a relative power of 4.69 w/kg.
http://www.53x12.com/do/show?page=article&id=48 and http://www.53x12.com/do/show?page=article&id=74

Our view: In all reality, in road cycling, on a given grade, there is no simple (linear) connection between relative power and ascent velocity. This formula would be appropriate on a given slope if a cyclist only had to overcome forces proportional to his weight on col climbs. Let us consider a cyclist who must only overcome gravity. M*G*H represents the energy he must expend to bring his mass to a height H. (M=rider mass, G=9.81 m/s2)

If the rider expends this energy over time T, his power will be equal to M*G*H/T or even M*G*VAM/3600. His relative power will be equal to g*VAM/3600

We obtain the following correlation: relative power (watts/kg) = VAM / (grade factor), with grade factor = 3600/g = 367. Practically speaking, the rider must overcome not only wind resistance, but also rolling friction, chain transmission energy loss, and inertia in order to accelerate. It is clearly impossible to establish such a simple correlation.

Ferrari's formula can nevertheless obtain correct results if the analyzed rider weighs around 64 kg and generates approximately 4.7 w/kg. The relative power of professional riders on the last cols of mountain stages is very often above 5.8 watts/kg. At this level of power, the interaction between the different forces are not the same as at 4.7 w/kg. The correction factor of Ferrari's formula between MAV and relative power is no longer valid.

If we take into account all the forces at play, the greater the aerodynamic forces (non-linear term) the more Ferrari's formula becomes questionable.
The greater the level of power, the more Ferrari's formula will yield power that is inferior to our models. For example, on an 8 % grade, at 6 watts/kg, Ferrari's formula yields power that is 2 % lower than our estimates. At 6.5 w/kg, the difference will be approximately 3.5 %.

Ferrari's formula is an approximation compared to ours. It has no real value, except perhaps disinformation, favoring athletes «prepared» by the doctor himself or with whom he had a relationship, from Moser to Armstrong, even Jalabert.

2: Analysis of Fred Grappe's calculation in "Cycling and Power Optimization in Cycling"
In his book "Cycling and Power Optimization in Cycling", Frédéric Grappe, who works with the Française des Jeux cycling team, analyzes Lance Armstrong's climb at the Alpe d'Huez time trial in 2004. He estimates the American cyclist's power to have been 435 watts, in other words, 46 watts lower than our estimate. How is such variation (9 %) possible? Fred Grappe provides all the details to arrive at 435 watts.
Fred Grappe's model differs mostly around one point compared to ours: chain transmission output is ignored. This decreased the result by approximately 2.5%.
In addition, the rolling resistance coefficient he uses, Crr, is modulated by the cosine of the grade (projection of weight based on an axis perpendicular to the road). Our simulation simplifies taking into account Crr by supposing it depends on the grade. This barely affects the result. The friction due to rolling resistance remains weak compared to the effect of gravity. There is some uncertainty regarding this parameter. Finally, the grades are smaller than 5°, cos (5°) = 0,996.
The difference in estimated power also comes from model variables.
1)Average percentage
The starting altitude is actually 725 m and not 760 m as he writes (ref. IGN map), which alters the average percentage from 7.9 % to 8.11 %.
2)Rolling Resistance Coefficient
Fred Grappe suggests using a rolling resistance coefficient of 0.0025. This value is close to what one finds in scientific texts for a velodrome. The author of the book evaluated the rolling resistance coefficient on a velodrome to be 0.003 (cf. pg 305). Why did he use a smaller rolling resistance coefficient for col climbs? Mountain roads are far from having a perfectly smooth surface.
3) Scx underestimated at 0.35:
Lance Armstrong has a relatively significant frontal surface in climbs given his build and his tendency to pedal standing up, with his torso straight. His coefficient of air penetration is therefore higher than 0.35 when he climbs a col. We estimated his Scx to be 0.39 during climbs.
4)Total mass
In his calculation, mass is 74 kg plus 7 kg, totaling of 81 kg. It fails to take into account clothing, shoes, and equipment mounted on the cycle.
These 4 differences in model variables as well as the ignored chain transmission output help explain the 9 % difference between our model and Fred Grappe's: 481 watts (6.5 watts/kg) versus 435 watts (5.9 watts/kg).
A short time before the start of the 2004 Tour de France, Lance Armstrong performed a stress test with Michele Ferrari. He generated 493 watts (cf. source) at the lactate threshold for a body mass of 74 kg, or 6.66 w/kg. There is a theoretically strong correlation between this power threshold and maximum effort over 30 to 40 minutes. We are also much closer in our calculation than Fred Grappe to Michele Ferrari's "magic number": 6.7 w/kg. According to Michele Ferrari, this level of power at the threshold was necessary in order to win the Tour de France during the Armstrong years.
Source : "Lance Armstrong's war", Daniel Coyle, page 209
Generally speaking, our power estimations are, for equivalent col climb times, 5 % to 10 % greater than those estimated by Fred Grappe.
In the September 2005 issue of Vélo Magazine, Fred Grappe attempts to explain Lance Armstrong's domination. The article's title: A physiology bordering on supernatural.
He attempts to "humanize" Lance Armstrong by using a power value of 5.9 w/kg generated during the 2004 Alpe d'Huez time trial, which we believe to be underestimated by 9 %.
In addition, he uses the scientifically contested article by Edward F. Coyle which presents an evolution of Armstrong's energy output between 1993 and 1999. No such evolution ever occurred. (http://www.sportsscientists.com/2008/09/coyle-armstrong-research-installment-2.html).

No one has called into question the author of this book. Was he simply naive, blinded by the light, or was he fully cognizant, using his calculations to justify the «normalcy» of the era's idol and his «scientistic» performances? If science is served by interests instead of convictions, then the question no longer remains. The answer likely lies in an implication the author makes, in the conditional tense, that by increasing his output 6.9 %, as Lance Armstrong did between 1992 and 1999, David Moncoutié could have delivered a similar performance at the Alpe d'Huez in 2004. The reality is that Lance Armstrong developed excessive power of 6.5 w/kg in 2004 and that his performance had nothing to do with energy output optimization.