Alpe d'Huez, Famous Climb in France.

Cycling up Alpe d'Huez is comparable to cycling into a 59 km/h headwind, for an amateur road biker. The famous climb up the Alpe d'Huez, with its many hairpin curves, is an almost 14 km climb with an average grade of 8.1%.

These numbers that are almost meaningless for a lot of people in the world!
Why you ask?
Well, because not everybody lives near the mountains. For those people, there is now a solution. Instead of cycling up a hill, we can now express the same effort as if we are cycling against the wind (thanks to this study). Our question is:

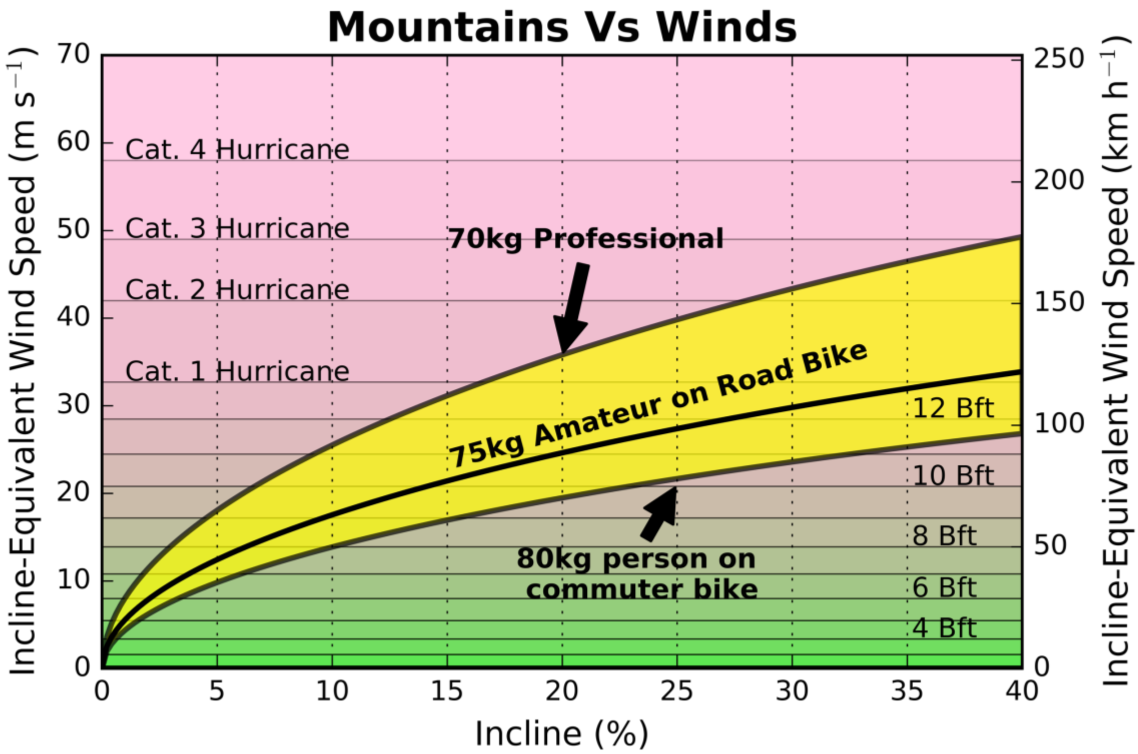
How does cycling uphill with no wind, compare to cycling against the wind on a flat road?

The answer to that question is the following equation (based on this study),

$$v_{\alpha} \approx \frac{2mg}{\rho C_{\mathrm{d}} A}\sqrt{\alpha}.$$

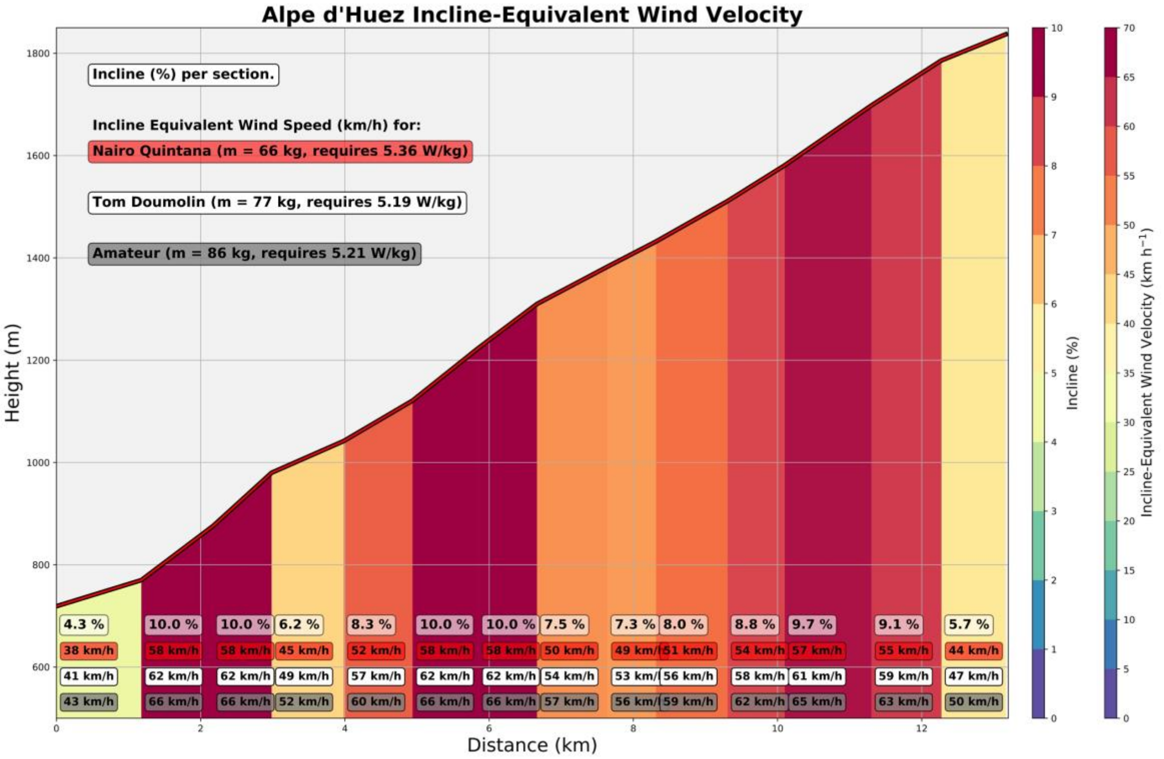
In this formula m is the mass (kg) of the rider and bike, ρ is the density of air (in kg/m^3), g is the gravitational acceleration (m/s^2), A is the frontal area of the cyclist and bike (m^2), C_d is the drag coefficient and α is the incline. The "Incline-Equivalent Wind Speed" v_{α} calculated in this equation, is the head wind a rider needs to overcome on a flat road, in order to compare its efforts to riding up a hill with given incline of α.

From this equation we learnt that, the heavier a person is, the more power it costs to ride up a hill (because of gravity), hence the larger the incline-equivalent wind speed. Also, more aerodynamic bikes and position on the bike, reduce the area (A) x drag (C_d). This also increase the incline-equivalent wind speed, as the wind has less "grip" on the rider and therefore needs to push harder to bring a rider to a standstill. Hence, the incline-equivalent wind speed mainly depends on the aerodynamics (A x C_d) and mass. The following diagram compares different combinations of these factors, ranging from a time trail specialist to a Dutch biker doing groceries in Amsterdam:

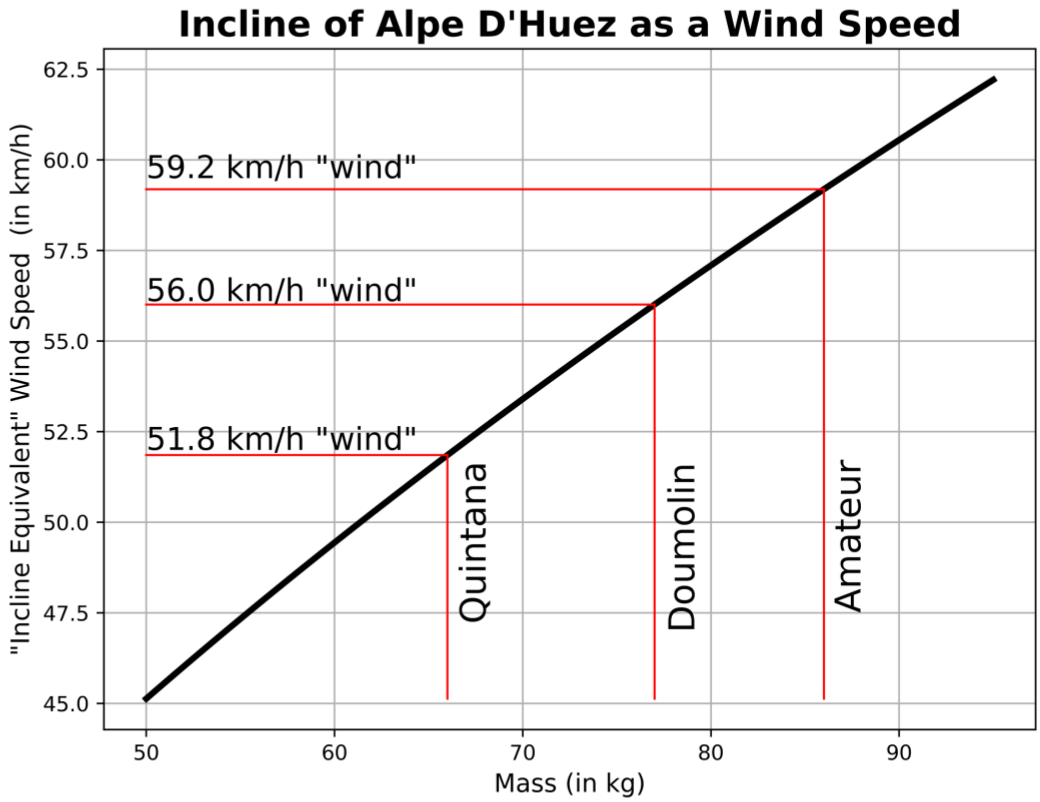


Incline Equivalent Wind Speed for Alpe d'Huez

Now let us get back to Alpe d'Huez. How does climbing up Alpe d'Huez differ for different riders? Below we compare Tom Dumoulin (70 kg) and Nairo Quintana (59 kg) with professional bikes (7 kg) to an amateur rider (77 kg) with an amateur bike (9 kg). The Profile then looks like:



Here we have expressed the sections of Alpe d'Huez as an incline -equivalent windspeed for the different riders (boxes at the bottom, with the colors corresponding to the riders above). When look at the mean incline, we can also calculate the mean incline-equivalent wind speed:



From this we conclude that, Nairo Quintana needs to ride against lower mean incline-equivalent wind speeds (51.8 km/h) than Tom Doumulin (56.1 km/h), while amateurs are even more disadvantaged (59.2 km/h). At first, we would think that therefore Quintana would have a large advantage over Doumulin, when it comes to riding uphill. However, it is not that simple. If we assume an average speed of 18 km/, and no head-wind, the W/kg body weight is actually in Doumulin's advantage (5.19 vs 5.36 W/kg), meaning that he needs less W/kg. There are a few assumptions included, of which the biggest one is perhaps that the kinetic energy is considered to be zero. This is valid as long as the speed does not change. However, in irregular climbs the average speed of the rider does change and therefore also the kinetic energy. This would be in Doumulin disadvantage, because kinetic energy is proportional to mass.

At least, using the incline equivalent wind speed, people from flat countries like myself, now also understand how hard it is to ride against a mountain like Alpe d'Huez. So ask yourself, what is your incline equivalent wind speed for Alpe d'Huez, and understand the tremendous effort it is to ride up that mountain.