Biking in the Wind

Anyone who does much biking must be conscious of the effect of wind on forward progress. On the seven Elderhostel bike trips that Mary and I have taken in Europe, the daily rides to the next lodging were all fixed in advance, regardless of headwind or tailwind, rain or shine. On our trip through northern Holland in the spring of 1996, for the first week we faced strong headwinds blowing right off the North Sea. How well we recall one trying day biking 40 miles from Makkum to Dokkum with wind and mist in our face. But later on that trip, we easily biked the 50 miles from Witteveen to Zwartsluis with a tailwind. Then there was the day in Denmark when we biked from Nyborg to Svendborg in the strongest headwind of all, even by Danish standards, as evidenced by downed branches to be dodged all along the way. We often found ourselves using the lowest of our five gears even on the level. (Mary wondered how we could be going uphill the whole way along the coast.)

One day on our Loire Valley trip in 2003 we were biking with a strong wind that, for a while at least, was directly from our side. I noticed that a strong gust from the side seemed to slow me down. How could that be, I wondered. Just psychological? No, I became convinced that it was actual. To pass the time, I ran the problem through my head, and by the end of the day I figured I had the explanation. So, for those few who might be interested in such things, that is what the rest of this paper is about.

To begin with, one of the basic laws of aerodynamics states that the force of the wind varies with the square of the velocity. When it blows twice as hard, the force is four times as much. To put it another way, when you bike twice as fast on a calm day, the wind resistance is four times as strong. When biking fast, most of your effort goes into overcoming wind resistance, as opposed to mechanical friction.

Now let's assume you are biking leisurely along on a calm day at, say, 10 miles an hour, and the wind resistance amounts to 5 pounds of force, which exactly balances the 5 pounds of effort you are exerting. Now along comes a 10 mile per hour gust directly from the side. A fundamental principle of physics is that all motion is relative. Thus, if you prefer, you can think of yourself as fixed, experiencing a wind that comes at you from a 45-degree angle. The velocity of that wind, by simple vector analysis, is $10\sqrt{2}$ or slightly over 14 miles per hour. But the force of that wind varies with the square of the velocity. Thus, if a 10 mile per hour wind exerts 5 pounds of force, this new wind will exert 10 pounds of force. Again by simple vector analysis, this force can be broken into two components of slightly over 7 pounds each ($10/\sqrt{2}$), one from the side and one from the front. It is the one from the front that concerns us, two pounds more of force to be overcome because of the side wind. I mentioned all this to one of our companions who was an engineer, and he thought there must be some flaw in my calculations, but he did not say what it was. I believe they are correct, and careful observation tends to bear them out.

While we are at it, let's not overlook that side component of force. For a given velocity of wind directly from the side, by the same logic the side force will necessarily increase as the speed of the vehicle increases. I believe you can notice this when driving a light car like ours at highway speed, especially with a canoe on the roof. In the news just a few days ago were severe wind storms in the Pacific Northwest. Several vehicles were shown blown over on the interstate highway, even including large trailer trucks. If my theory is correct, this probably happened when they were driving at high speed in a side wind, probably oblivious of the increased hazard.

STC, January 2008