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Driver Ball Flight in the Rain: an Analysis of the Effect of Water on Lift, Drag and Resultant Trajectory

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- Playing Equipment
- Instruction and Coaching
- Analytics and Strategy

Purpose: Golf is played in all kinds of environmental conditions, including the rain. Observations from elite players have suggested that while hitting driver in heavy rain the ball appears to "squirt" off the face, or "fall out of the air" leading some players to ask for grooved drivers and higher lofted drivers to play in these conditions. This study aimed to understand more about the influence of water on ball flight by testing in controlled conditions and quantifying any differences.

Methods: A player test was conducted with a 9-degree PING G400 driver and five elite golfers with handicaps between +3 and 2. Each golfer was asked to warm up before starting the test. 10 shots were hit by each player with a dry ball and a wet ball, switching conditions every 5 shots. Players were asked to hit full swing drives toward a target. Conditions were identical for the two groups of shots except the test operator soaked the golf ball before each shot for the wet condition. A Trackman 4 radar was used in R&D mode to capture full ball flight data including lift and drag coefficients. All shots were hit over 2 days in sunny conditions with low wind and temperature between 60 and 70 degrees Fahrenheit.

Results: The table below captures the initial speed, angular direction and spin rate in the dry and wet conditions and the resulting maximum height, carry distance and offline carry distance. All five players in the test had an average club head speed between 110mph and 116mph. The ball speed, launch angle, launch direction, spin axis and offline are all statistically similar. The spin rate in the wet is statistically higher, maximum height and carry distance in the dry are both statistically higher.

	Ball Speed *(mph)*	Launch Angle *(deg)*	Launch Direction *(deg)*	Spin Rate *(rpm)*	Spin Axis *(deg)*	Maximum Height *(yards)*	Carry *(yards)*	Offline *(yards)*
Dry Average	168.1	12.5	1.0	2771	-0.9	39.1	285.2	0.4
Dry 90% Confidence	0.9	0.4	0.6	107	1.3	0.9	2.5	3.8
Wet Average	167.9	12.0	1.1	3215	-2.9	36.5	269.3	-2.9
Wet 90% Confidence	1.0	0.4	0.6	120	1.1	0.9	2.7	3.4

Figure 1 shows the average ball flight in dry and wet conditions. The ball follows a very similar trajectory until near the apex of flight. In the latter part of the trajectory there is a noticeable and dramatic difference between dry and wet balls. Figures 2(a) and 2(b) show the lift and drag coefficients in the dry and wet, indicating a significantly higher lift and drag coefficient throughout the whole flight in wet conditions.

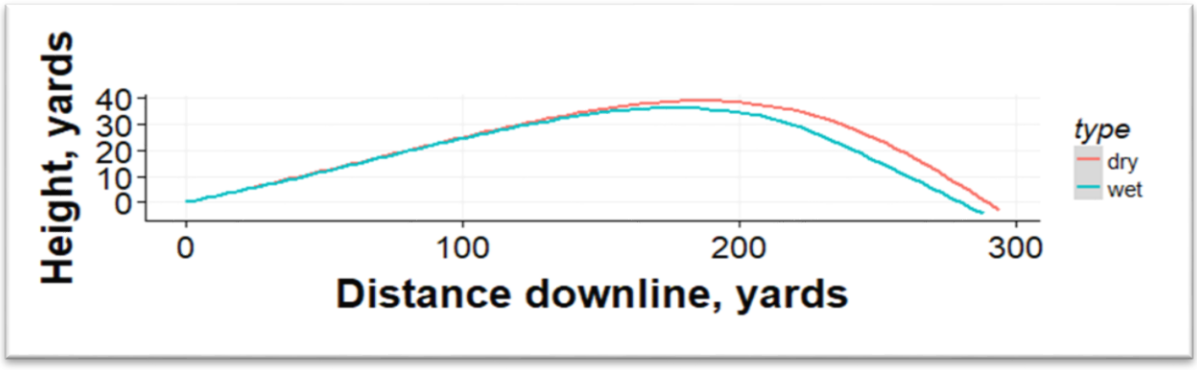
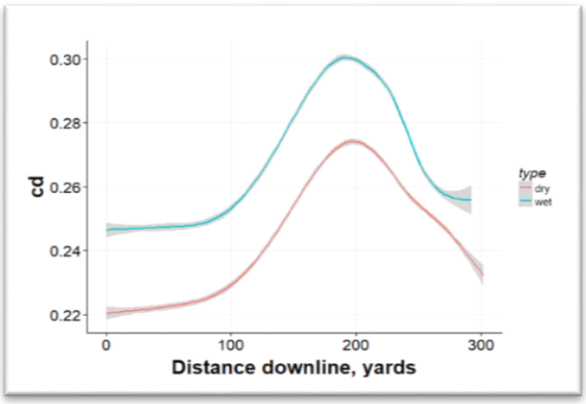


Figure 1: Average trajectory for dry shots and wet shots



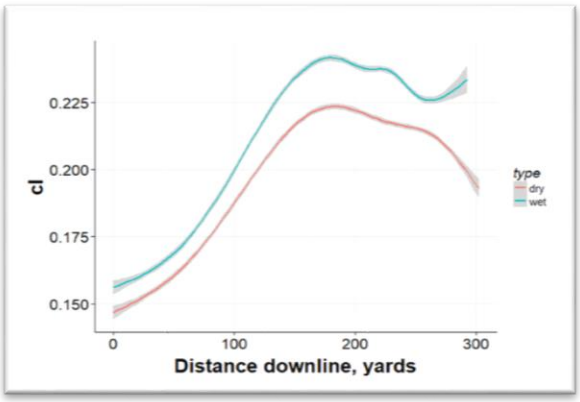


Figure 2(a): Average drag coefficient for dry and wet shots

Figure 2(b): Average lift coefficient for dry and wet shots

Discussion: The results show a dramatic difference in carry distance for balls hit on a dry day in Phoenix, with water on the ball being the only variable changed in the test. While there is a significant difference in initial spin on the ball, this would by no means explain a difference of over 15 yards in ball flight. Analysis using PING's proprietary trajectory model suggest that the difference in launch conditions accounts for only 5 of the 15 yards difference. The increased lift and drag coefficient throughout the whole flight can explain golfers' observations rather well. The ball flies shorter, but follows a similar trajectory during the initial part of the flight. The increased lift will serve to keep the ball in the air while the increased drag is slowing the ball down more quickly and these forces seem to roughly balance out their effect on the height of the ball. From the golfer's viewpoint, the ball goes through the same visual window but it is getting there more slowly. From the apex the ball then really does fall out of the sky more quickly when it is wet. This result was produced on a dry day, so the logical conclusion is that moisture stays on the ball through the entire flight, altering the aerodynamic forces enough to manifest in increased lift and drag. This result was repeated with robot driver testing in a similar format and both player and robot 3 wood testing.

Practical Application: This information can be used by golfers of all ability levels to better understand what to expect on the course in wet conditions. As a practical consideration, keeping the club and ball as dry as possible will likely minimize this effect.