

In the thick of the series, thin air may toss Sox a curve

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At 5,280 feet above sea level, fastballs will possess more zip but less lift as they streak toward home plate.

Curveballs, meanwhile, will fly less curvaceously, while sliders will lose snap - tending to fly straighter than pitchers would wish.

Baseball is about physics as much as physical coordination and conditioning. And the atmospheric physics of mile-high Denver are markedly different from those of Boston-by-the-Sea.

"There will be a definite effect" on World Series games played in Denver, said Alan M. Nathan, a physicist at the University of Illinois at Urbana-Champaign, Maine native, and ardent citizen of Red Sox Nation. "It probably won't be a decisive effect, but it will be a real factor."

It's well known that Colorado's thinner air makes for longer hits, although scientists disagree over how much farther a ball walloped in Coors Field will travel than would the same slam at Fenway Park. Baseballs used at the Rockies' home field are these days stored in humidors to prevent drying that would make them even more defiant of gravity, but oft-cited calculations claim the gain remains on the order of 10 percent - meaning a ball slugged 400 feet at Fenway would travel 440 feet in Denver.

Maybe.

Nathan believes a 5 percent gain is more accurate. "That's a lot, but not as much as they like to say out there," he said.

It's in the pitching game, however, that the Red Sox are most likely to feel Rocky Mountain lows.

Physicists say the reduced air pressure will give a slight edge to batters because fewer molecules in the air mean a pitched ball will have less substance on which to "bite," causing it to break, or swerve, less dramatically. The milder the break, the more easily a batter can read the ball's speed and trajectory.

That could spell trouble for pitchers used to the denser air of the Atlantic seaboard - the Red Sox have rarely played at nosebleed altitude (three Denver games in 2004, an exhibition in 1999). Rockies players face the same physics, of course, but are used to thinner air.

"For the Red Sox, it's going to feel different playing in Denver than other major league stadiums," said Barry Zink, a physicist at the University of Denver and a Rockies partisan.

"I expect the difference will be most felt by [Boston] pitchers," Zink said. "Breaking pitches will break less. Fastballs will pick up a little speed, but rise less . . . because they are moving through a thinner fluid," or air.

The difficulty of pitching in Denver is hardly news. "It's a tough place to pitch," said the Red Sox' Curt Schilling. "I don't know that anybody comes and pitches in Coors Field on a consistent basis and has good numbers."

For pitches short on pizzazz, blame the high altitude reduction in an aerodynamic effect called the Magnus force. Scientific aficionados of the national pastime can, and do, fill whole chalkboards - and papers - with Magnus calculations tied to velocity, trajectory, and the 216 raised red stitches on a baseball. It's those stitches and the ball's cowhide surfaces that snag the air and control flight.

But the bottom line is fairly simple: Magnus force, which acts only on balls with spin, is directly proportional to atmospheric pressure. In the wispy air of Denver, the Magnus force is 20 percent less than in Boston. Thicker atmosphere provides greater grab that pitchers exploit to shape the arc of the ball.

The reduced force will affect any pitch with spin - fastballs, curveballs, sliders, cutters, and sinkers.

Still, don't expect a game of "moon ball," with balls flying surreal distances and otherwise behaving freakishly, as if in ultralow gravity. Denver remains firmly rooted on planet Earth.

"A ball that moves at 95 miles per hour in Boston might move a mile or two faster in Denver," said Nathan. "A good fastball that drops 18 inches before crossing the plate [at Fenway] will drop 22 inches at Coors."

These are the calculable differences. But baseball's greatest allure, perhaps, lies in complexities that could tax the mightiest brains. As Yale physicist Robert K. Adair, author of "The Physics of Baseball," once noted, even "Einstein, if he were interested in baseball, could still not . . . calculate the flight of the ball."

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