The power of collisions

Collisions between grains is the main driver of sandstorms

Igor Zolnerkevic

PUBLISHED IN SEPTEMBER OF 2013

The basic ingredients of a sandstorm are, obviously, strong wind and lots of sand. Still, until recently, no researcher had ever managed to create a physical model based on these two elements that was able to fully explain the strength of these storms. An article written by Brazilian and foreign physicists and published in the August 2013 issue of the journal Physical Review Letters (PRL) now allows us to understand why these storms reach colossal dimensions in regions near the great deserts of the Earth, such as the Gobi in Asia and the Sahara in Africa. Millions of tons of sand and dust can be blown thousands of kilometers, blocking roads, impeding air traffic, burying structures and eroding topsoil.

Before, researchers thought that computer simulation of the trajectory of each grain of sand in a storm would be impossible. Therefore, the models used simplified assumptions. One was that when blown by the wind, the virtual grains never collided with each other. This assumption was applied because it was believed that collisions between grains in the air hindered the progress of a storm, shortening the trajectory of the grains. Now, an international team led by Brazilian physicist Marcus Carneiro of the Swiss Federal Institute of Technology Zurich (ETH) has concluded otherwise. By comparing simulations with and without collisions between the grains, the researchers have shown that air collisions are key to the increase in the number of particles involved in a storm.

DAVID EAST / SCIENCE PHOTO LIBRARY

"To take the collisions into account, one must develop very efficient mathematical programs and use advanced computing power," says Portuguese physicist Nuno Araújo, also at ETH and the second author of the PRL paper describing the results. The new simulations followed the trajectory of only a handful of grains of sand – approximately 4,000 grains blown by wind using a simplified model – but they were the first to describe the air collisions realistically.

Stormy weather: dust storm on the road connecting the cities of Melbourne and Geelong, in Australia

SALTONS

The results of the new simulations demonstrate that collisions more than double the wind's capacity to transport sand. It was already widely known that a storm begins when the wind lifts a layer of sand several centimeters above the ground. Some of these grains – known as saltons – fly much higher than the others, gaining more energy from the wind, whose speed increases with height. Sometimes, saltons fall and create more saltons when they collide with the grains in the layer closer to the ground. The new simulations indicate, however, that before approaching the ground, a salton may collide with several other grains that are flying just slightly above average height, transferring some of its energy to them. These collisions in midair generate additional saltons, thickening sandstorm clouds.

In addition to more accurately predicting the intensity of storms, the new model should change what is understood about the formation and movement of sand dunes. According to Araújo, the theory can be verified in laboratory tests by observing the movement of artificial grains with different elastic properties. ■

Scientific article

CARNEIRO, M.V. *et al.* Midair collisions enhance saltation. **Physical Review Letters**. v. 111, n. 5. 2013.