MATH MATTERS

Apply It.

The math behind…

SAND & DUNE MOTION

Some technical terms used:

Geophysical modeling, geomorphology, granular motion, fluid/continuum mechanics

Uses and applications:

Dunes are found in many places on Earth, Mars, and the Saturnian moon Titan. Understanding how dunes form and move can help scientists figure out what these different environments were like at the time and place that the dunes formed and also predict how they might change in the future.

How it works:

Dunes are made of billions of small particles of materials, like sand or ice, called grains. As wind or water flows over the surface of a dune, it exerts a force on the grains, causing them to jump and bounce. The moving grains impact stationary grains, causing them to move too. All of these individual grain motions added together slowly change and move the entire dune.

Models of the motion of a dune can't consider the individual movements of billions of individual grains; instead they approximate these very quick, discrete, small motions by moving large connected "slabs" of sand over larger distances and time periods or by considering the moving grains as a continuous "fluid" layer. These simplified models use environmental parameters such as wind conditions, grain types, and topography. Analysis of these simulations can show fairly accurately how dunes change with varying environmental parameters. In addition, by comparing how the simulated dunes form and move with observed dunes, scientists can get an idea of what the environment looked like when the actual dunes formed. The model can also be used to yield predictions about how the dunes will move or change next.

Interesting facts:

In some places in Africa and Asia, city-sized dunes are moving over buildings, roads, and pipes, creating air pollution problems for people and machines. Knowing how dunes form and move can help engineers divert or stop this sand motion.

On Titan, a moon of Saturn, a dense methane atmosphere moves water ice particles into stripes 330 feet high and 60 miles long — longitudinal dunes. On Earth, similar features can be seen in the Saharan desert — a very different environment, but the physics is similar enough to generate similar shapes.

For more information see:

http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17168
http://saturn.jpl.nasa.gov/multimedia/images/image-details.cfm?imageID=2116
http://www.obspm.fr/actual/nouvelle/may06/dunes.en.shtml)

Submitted by Serina Diniega, University of Arizona, first place, Math Matters, Apply It! contest, January 2008.

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