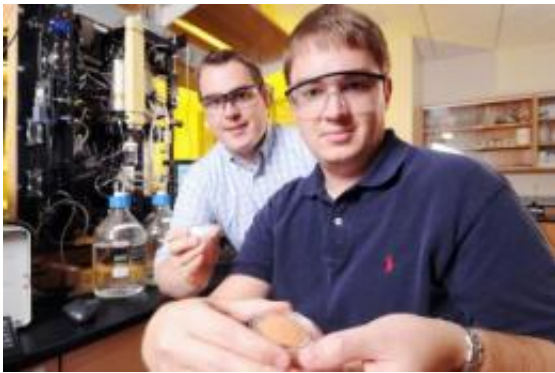


# Insoluble dust particles can form cloud droplets affecting global and regional climates

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Georgia Tech graduate students Richard Moore and Terry Lathem work with equipment used to study the formation of cloud droplets from insoluble dust particles. Credit: Georgia Tech Photo: Gary meek

New information on the role of insoluble dust particles in forming cloud droplets could improve the accuracy of regional climate models, especially in areas of the world that have significant amounts of mineral aerosols in the atmosphere. A more accurate accounting for the role of these particles could also have implications for global climate models.

Cloud properties can have a significant impact on climate, yet the effects of aerosols like dust is one of the more uncertain components of climate change models. Scientists have long recognized the importance of

soluble particles, such as sea salt and sulfates, in creating the droplets that form [clouds](#) and lead to precipitation. But until now, the role of insoluble particles – mostly dust swept into the [atmosphere](#) from such sources as deserts – hasn't figured significantly in climate models.

Using a combination of physics-based theory and laboratory measurement of droplet formation, researchers at the Georgia Institute of Technology have developed a model that can be added to existing regional and global climate simulations. The impacts of these refinements on cloud condensation nuclei (CCN) activity and droplet activation kinetics are still being studied.

"Understanding that insoluble dust forms more droplets than we thought it could, and that those droplets form close to the sources of the particles, could change our picture of how precipitation is formed in areas like the Mediterranean, Asia and other climate-stressed regions," said Athanasios Nenes, a professor in the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology.

The research was supported by the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA) and NASA. The findings were described at the Fall 2011 meeting of the American Chemical Society in Denver, and reported in the journals *Geophysical Research Letters*, *Journal of Geophysical Research* and *Atmospheric Chemistry and Physics*. A new paper on the global modeling impacts has been accepted for publication by the *Journal of Geophysical Research*.

Soluble particles nucleate droplets by absorbing water under conditions of high humidity. Insoluble materials such as dust cannot absorb water, so it was thought that they played little role in the formation of clouds and precipitation.

However, Nenes and collaborators realized that these [dust particles](#) could nucleate droplets in a different way – by adsorbing moisture onto their surfaces, much as moisture condenses on window glass during temperature changes. Some insoluble particles containing clay materials may also adsorb moisture, even though they don't dissolve in it.

Working with Irina Sokolik, also a professor in the School of Earth and Atmospheric Sciences, Nenes and graduate student Prashant Kumar studied aerosol particles created from samples of desert soils from several areas of the world, including Northern Africa, East Asia/China and North America. In laboratory conditions simulating those of a saturated atmosphere, these insoluble particles formed cloud droplets, though the process was slower than the one producing droplets from soluble materials.



Containers hold samples of mineral dust studied by Georgia Tech scientists as part of research into the role played by insoluble dust particles in the formation of cloud droplets. Credit: Georgia Tech Photo: Gary Meek

"We generated particles in the laboratory from materials we find in the atmosphere," explained Nenes, who also holds a faculty appointment in Georgia Tech's School of Chemical and Biomolecular Engineering.

"These particles take up water using a mechanism that had not been considered before in models. It turns out that this process of adsorption soaks up enough water to form [cloud droplets](#)."

The laboratory work showed that smaller particles were more likely than expected to generate droplets, and that their effectiveness as cloud condensation nuclei was affected by the type of minerals present, their size, morphology and processes affecting them in the atmosphere. The dust particles ranged in size from 100 nanometers up to a few microns.

These mineral aerosols may consist of iron oxides, carbonates, quartz and clays. They mainly originate from arid and semi-arid regions, and can remain suspended in the atmosphere for as long as several weeks, allowing them to be transported long distances from their original sources. In the atmosphere, the dust particles tend to accumulate soluble materials as they age.

"We can simulate what is happening to the particles as they get slowly coated with more and more soluble materials," said Nenes. "As they get more and more soluble coatings on them, they become more hygroscopic."

The researchers are now working with collaborators in Germany to incorporate their new theories into existing climate models to see how they may change the predictions. They also hope to carry out new field work to measure the activity of these insoluble aerosols in real-world conditions.

"We now need to study the cloud [particles](#) in the atmosphere and their ability to form droplets to verify our theory using real atmospheric data,"

Nenes said. "We also need to look at dust and clouds from more regions of the world to make sure that the theory works for all of them."

Clouds play an important role in governing climate, so adding new information about their formation could improve the [accuracy](#) of complex climate models.

"The reason that we care about particle-cloud interactions is that they introduce a lot of uncertainties in climate model predictions," Nenes said. "Anything that can be done to improve these predictions by providing more specific cloud information would be helpful to projecting [climate change](#)."

Provided by Georgia Institute of Technology

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