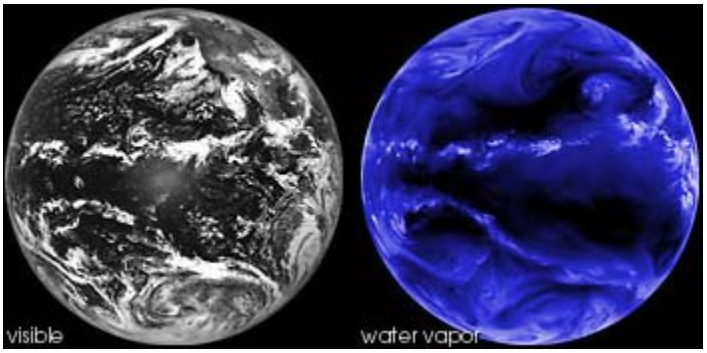
"For the Earth's atmosphere to form clouds at all, you need particles for the water vapor to condense on," said Michael King. He is an atmospheric scientist at NASA's Goddard Space Flight Center who has studied cloud formation for more than ten years. He explained that when water evaporates into the atmosphere, it does not move together on its own to form water droplets, but spreads evenly throughout the atmosphere. Airborne particles (aerosols) that dissolve easily in water, such as ammonium sulfate and sea salt, break up this otherwise even distribution and give the water molecules something to cling to. The particles provide nuclei for cloud droplets to condense around, and together these droplets form clouds. Were it not for particles in our atmosphere, the sky would always be clear and the air around us, thick and humid (King et al. 1995).



Many areas of the globe with high water vapor concentrations (bright blue and white in the image at left) do not form clouds (white in the visible light image at far left.) (Images by Robert Simmon & the GOES Project Science Office, based on NOAA GOES data)

King said, "A greater number of aerosol particles in a cloud will lead to the production of more cloud droplets, albeit smaller in size, than would otherwise be the case. This in turn increases the brightness of the cloud." Additional particles give the water vapor more nuclei to cling to, so more smaller drops form in the cloud. These smaller drops in turn make the cloud more reflective to sunlight. The same phenomenon can be seen when ice cubes are crushed. As the ice is broken up, the once smooth surface is shattered into many tiny surfaces at varying angles to one another. These additional surfaces reflect incoming light in all directions and cause the crushed ice to appear white and opaque. Water droplets do not contain all these ridged surfaces, but their fragmentation has a similar effect on sunlight.

Whole ice cubes transmit more light than they scatter, (clear ice, top)

A majority of cloud-creating aerosols arise from natural sources, ranging from volcanoes to microscopic ocean plants. Yet, scientists speculate that an ever growing number originate from our need for electricity and transportation. Each time we burn fossil fuels, sulfur dioxide, a gas that leads to the formation of sulfate aerosols, is released. The particles often rise into the atmosphere and create more and brighter clouds. Though no one is certain what effect this extra cloud cover may have on the environment, many scientists believe it may be cooling the atmosphere. "By modifying clouds we make them brighter," King said. "This has a cooling effect on the climate, because the clouds are reflecting more solar radiation than they normally do back into space." Any light that is reflected cannot heat the ground or the atmosphere.

Proving this hypothesis is much more difficult than measuring the brightness of the clouds over a smokestack. Above land, where most industry is located, the wind currents and convection are too tumultuous to measure cloud formation from individual pollution sources. The clouds break up and change so often that scientists have trouble monitoring the aerosols, let alone determining the precise amount of fossil fuel needed to create clouds. What the researchers needed was a pollution source that spilled contaminants continuously into a calm and relatively pristine air mass (King et al. 1995).

compared to crushed ice which scatters light very well (white opaque ice, above.) This is analagous to the bright white clouds formed with high amounts of aerosols, which are composed of many very small water droplets. (Photographs by Robert Simmon, NASA Earth Observatory)

For more information, see What Are Aerosols?

▶ Searching for Ship Tracks
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