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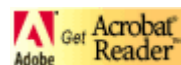
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Man-Made Clouds

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There are many different types of clouds in the sky, but did you know that some of them are man-made? "Contrails" are the long, thin clouds that are left by airplanes as they fly past.

Contrails (short for "condensation trails") are line-shaped clouds that are sometimes formed by airplane exhaust, usually at high altitudes. Even though contrails have a high-tech origin, they have a very down-to-Earth cousin that almost everyone has seen. Have you ever gone outside on a cold day and been able to see your breath when you exhale? That little

cloud is formed by the water vapor in your breath, which is normally invisible. In cold weather, however, the vapor condenses into a visible cloud.

Contrails are formed in much the same way. Aircraft engine exhaust contains water vapor, and since temperatures are colder at higher altitudes, that water vapor condenses into a visible form as ice crystals, leaving the streaks across the sky behind airplanes. The water vapor from the aircraft engine may also be joined by moisture already existing in the air, contributing to the size of the contrail. Contrails may occur as one of two different types, depending on atmospheric temperature and humidity. If the humidity is low, then a short-lived contrail will form. Short-lived contrails are visible only for a short distance behind the airplane and dissipate quickly.

In higher humidity environments, a persistent contrail will occur. Ice particles formed by the condensation of the water vapor from the engine exhaust will be joined by water in the atmosphere, creating a contrail that extends a long distance behind the airplane, and can remain visible long after the airplane has gone. Persistent contrails can last for hours and can even continue to



grow, spreading to several miles in width, and becoming as tall as the length of two to four football fields. These contrails can even continue to spread until they turn into cirrus clouds indistinguishable from naturally occurring clouds.

Since contrails are made up of water vapor, they do not pose any direct health risks for humans. However, some NASA researchers are looking into whether contrails may have a negative impact in another way. Contrails are man-made clouds. They contribute to the Earth's cloud coverage, and as a result might affect the atmospheric temperature and climate. Persistent line-shaped contrails are estimated to cover, on average, 0.1 percent of the Earth's surface, not including the cirrus clouds that can evolve from contrails. Since contrails are most common in areas with heavy airplane traffic, however, the cloud cover they create is also much heavier in those areas, covering 3.8 to 5.5 percent of the sky in some places.



If air traffic and contrail formation continue to increase, NASA researchers believe that they could have a significant impact on the environment by the year 2050, although they are still looking into what effects contrails actually have. If it is determined that they have a negative impact on the environment, then ways would have to be found to reduce that impact. One solution would be to plan flights along paths that would reduce contrail formation in problem areas. Researchers at NASA's Glenn Research Center are also working with industry partners on the creation of more efficient jet engines. These engines would greatly reduce the emissions

created by air travel, which might help reduce contrail formation.

Courtesy of NASA's Aeronautics Mission Directorate

Published by NASAexplores: October 31, 2002

Information in this article was accurate as of the publication date. For the latest updates about this project, visit the NASA homepage (<http://www.nasa.gov>).