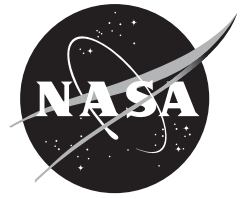


Explore.
Discover.
Understand.

Contrail Education



National Aeronautics and Space Administration

Engaging students in authentic science to advance our knowledge of Earth

CLIMATE CHANGE AND THE FUTURE OF AIR TRAVEL

by Natasha Richardson, Engineering and Physical Sciences Research Council

Inside this issue:

Climate Change...Air Travel	1
Contrail Science	1
NASA Scientists Use Empty...	2
S'COOL Resources	2
Contrail Science	3
Contrails' Worth of Websites	3
Introducing...SCIENCE Players	4
Contrail Wordsearch	5
Climate Change...Air Travel	6
NASA Scientists Use Empty...	6
NASA STEM	7
Contrail Prediction Activity	7
Contrail Website Guide	7
GLOBE Contrail ID Chart	8

A recent investigation focuses on how aircraft can avoid creating vapor trails, also known as contrails. These spindly threads of condensation may not seem important but some persist for hours and behave in the same way as high altitude cirrus clouds, trapping warmth in the atmosphere and exacerbating global warming.

Air travel is currently growing at between 3 and 5% per year and cargo transportation by air is increasing by 7% per year. Researchers at Imperial College London are combining predictions from climate change models with air traffic simulations to predict contrail formation and identify ways of reducing it.

As the climate changes, so will the general condition of the atmosphere and the new work aims to understand how this will affect contrail formation. They have already found that aircraft could generally minimize contrail formation by flying lower in the atmosphere. Their work suggests that in the summer, when the air is warmer, restricting jets to an altitude of 31,000 feet could be beneficial. In winter, when the air cools, and contrail formation becomes more likely, the ceiling should be no more than 24,000 feet.



Contrails behind the engines of a large aircraft.

(continued on page 6)

Contrail Science

by Roberto Sepulveda, SAIC-NASA Langley Research Center

The word “contrails” comes from ‘condensation trails,’ which typically refers to line-shaped clouds produced by jet airplane engine exhaust. This ‘condensation’ event typically occurs at 8-12 km (about 5-7 miles) above the Earth’s surface. Contrails are composed primarily of water in the form of ice. Jet engine exhaust emits water vapor into the surrounding air. The water vapor is a by-product of jet fuel combustion. Tiny particles (aerosols) are also emitted and provide a surface for water droplets to form. Contrails form when the water droplets freeze to form ice particles.

Another factor affecting contrail formation is the humidity (amount of atmospheric moisture) along the airplane’s path. If the humidity is low the contrails will evaporate quickly; these are called ‘short-lived’ contrails. If the humidity is high the contrail will continue to grow; these are called ‘persistent spreading’ contrails. Persistent contrails can last for hours and can grow considerably in width and height. They often spread due to differences in wind speed along the flight path. You’ve probably wondered why contrails don’t appear daily. We have learned how

(continued on page 3)

Well, what exactly are CONTRAILS?



A B-52 mothership drops the X-24A experimental plane for a trial flight. Notice the contrails!