

Vermont Department of Environmental Conservation

Contrails vs. Chemtrails – Fact Sheet

What are Contrails?

Visible contrails are long, thin “condensation trails” composed primarily of tiny ice particles that sometimes form behind aircraft at higher altitudes. Their formation requires water vapor emissions, cold ambient temperatures, and high relative humidity. At lower humidity, contrails may not form or may evaporate quickly. Higher humidity conditions can allow contrails to persist for hours, leading to accumulation of multiple crossing trails. Depending on humidity and other meteorological conditions, contrails may remain as relatively tight thin lines, or may spread over time and space, eventually merging with other contrails to form thin but extensive cirrus clouds, indistinguishable from natural cirrus clouds.

Vermont does not have the legal authority to regulate contrails.

Federal law provides that “no State or political subdivision thereof may adopt or attempt to enforce any standard respecting emission of any air pollutant from any aircraft or engine thereof unless such standard is identical to a standard” adopted by the U.S. Environmental Protection Agency (EPA) pursuant to their authority under the Clean Air Act. (42 U.S.C. §7573)



Contrails and Air Quality

Burning aviation fuel releases atmospheric emissions of carbon dioxide (CO₂) and water vapor (H₂O), with smaller amounts of carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon soot and trace metals. These emissions occur all along the aircraft flight path, but are most concentrated at ground level close to major airports. VOC and NO_x contribute to the formation of ozone pollution; NO_x, SO_x and soot contribute to formation of fine particles (PM_{2.5}); and older piston engine aircraft are a decreasing but significant source of airborne lead (Pb) emissions.

Aviation fuel combustion contributes a relatively small fraction of Vermont emissions of the pollutants indicated above, accounting for less than 2% of VT’s total greenhouse gas emissions and less than 0.5% of VT’s CO, NO_x, and PM_{2.5} emissions in 2011. There are no indications of any substantial increases

in VT aviation traffic or aviation fuel consumption over the past 10 years, and measured VT air quality trends for CO, NO_x, ozone, SO_x, soot, PM_{2.5} and Pb have all been improving in recent years.

What are Chemtrails?

“Chemtrails” is a term sometimes used by those who believe some contrails are indicative of secretive attempts to broadly distribute chemical or biological contaminants in the atmosphere. The various alleged objectives of this chemical distribution range from population control to behavior modification to climate engineering. Some of the chemical contaminants alleged to be distributed by chemtrails include the elements aluminum, barium and strontium.

No unhealthy exposures of aluminum, barium or strontium at any locations in VT have been identified by VT AQCD.

VT AQCD does not have capabilities to measure air quality at the high altitudes where contrails are most often visible, although it might be expected that if chemicals were being distributed by aircraft aloft, they would eventually show up in measurements at the surface. VT AQCD does have long-term 10 to 20-year measurements of the chemical composition of small particles

(PM_{2.5}) at urban, low elevation (Burlington), rural, mid elevation (Underhill) and remote, high elevation (Mt. Equinox) measurement sites in Vermont. None of these measurements indicate unhealthy exposures, increases with elevation, or increases over time in concentrations of aluminum, barium or strontium at any locations in VT.

Contrails and Climate Change

The carbon dioxide, ozone (formed from VOCs and NO_x), carbon soot, SO_x and water vapor (sometimes in the form of contrails) emitted by aircraft can influence climate on regional and global scales. Contrails can spread out in the sky and become cirrus clouds, which can produce a cooling effect by reflecting

incoming sunlight back into space. However, these high clouds also can trap heat energy re-emitted by the Earth's surface that would otherwise escape the atmosphere to space. The

Contact the EPA's Office of Air and Radiation (OAR) with questions and concerns regarding contrails.

current and projected future climate forcing effects of aircraft emissions in general and aircraft contrails in particular have been subjects of extensive research and analysis by the scientific community and remain active areas of ongoing scientific inquiry.

For More Information

We encourage you to contact EPA's Office of Air and Radiation with any further concerns, or consider contacting your U.S. congressperson or senator. There is a wealth of information on aircraft contrails available from reputable academic and government scientific research organizations. Please be advised there is also a large body of poorly documented, unreliable and/or inaccurate information, often specifically relating to the term "chemtrails". We are not aware of any information documenting the presence, deliberately altered chemical or biological composition, or adverse effects of "chemtrails" published in the peer-reviewed scientific literature.

Recommended Resources and References

US EPA (2000) Aircraft Contrails Factsheet, EPA430-F-00-005.

http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/contrails.pdf

USEPA Aircraft Emissions <http://www.epa.gov/otaq/aviation.htm>

Federal Aviation Administration (2005) Aviation & Emissions: A Primer,

http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/AEPRIMER.pdf

NASA, The Contrail Education Project. <http://science-edu.larc.nasa.gov/contrail-edu/>

NASA Contrail Formation Forecast, <http://cloudsgate2.larc.nasa.gov/cgi-bin/site/showdoc?docid=33&cmd=forecast>

Contrail Science - The Science and Pseudoscience of Contrails and Chemtrails, M. West, <http://contrailscience.com/>

Contrail, Wikipedia, <http://en.wikipedia.org/wiki/Contrail>

Chemtrail Conspiracy Theory, Wikipedia, http://en.wikipedia.org/wiki/Chemtrail_conspiracy_theory

Intergovernmental Panel on Climate Change (1999) Aviation and the Global Atmosphere, J.E.Penner, D.H.Lister, D.J.Griggs, D.J.Dokken, M.McFarland (Eds.) <http://www.ipcc.ch/ipccreports/sres/aviation/>

Lee, D. S. *et al.* (2009) Aviation and global climate change in the 21st century. *Atmos. Environ.* 43, 3520–3537.

<http://www.sciencedirect.com/science/article/pii/S1352231009003574>

Burkhardt, U and B. Kärcher (2011) Global radiative forcing from contrail cirrus, *Nature Climate Change J.*, Vol. 1 April 2011

www.nature.com/natureclimatechange

Jacobson, M. Z. *et al.* (2011) The effects of aircraft on climate and pollution. Part I: Numerical methods for treating the subgrid evolution of discrete size- and composition-resolved contrails from all commercial flights worldwide, *Journal of Computational Physics* 230 (2011) 5115–5132.

<https://www.stanford.edu/group/efmh/jacobson/Articles/VIII/JCompPhysPt1.pdf>

Gottelman, A., and C. Chen (2013), *The climate impact of aviation aerosols*, *Geophys. Res. Lett.*, 40, 2785–2788,

<http://onlinelibrary.wiley.com/doi/10.1002/grl.50520/abstract>

Huszar, P. *et al.* (2013) Modeling the present and future impact of aviation on climate: an AOGCM approach with online coupled chemistry, *Atmos. Chem. Phys. Discuss.*, 13, 3817–3858, <http://www.atmos-chem-phys-discuss.net/13/3817/2013/acpd-13-3817-2013.pdf>