



THE ATMOSPHERIC RESERVOIR

Examining the Atmosphere and Atmospheric Resource Management



By Mark D. Schneider

Spring weather means that we're typically outside more often and have the opportunity to observe the sky. The sky is sometimes brilliant blue and clear of clouds. Other times we may see *contrails* like the ones in the included photo at sunrise. The word *contrail* is a contraction for "condensation trail", defined by the American Meteorological Society as "a cloudlike streamer frequently observed to form behind aircraft flying in clear, cold, humid air." Another common name for a condensation trail is a vapor trail.

Commercial aircraft have turbine-type engines that serve as a source of water vapor for contrail development. This means that even when moisture conditions aren't conducive for natural cirrus clouds to develop, contrails can appear. In fact, for every pound of fuel used by an airliner, more than a pound of water vapor is produced. Larger airliners can eject five or more pounds of water vapor a second into the air. These water vapor droplets freeze almost instantaneously due to the frigid temperatures colder than -40 degrees (Fahrenheit and Celsius are equal at this temperature) at flight levels of over 30,000 feet.

Over rural states like North Dakota, it may seem unusual to see contrails so frequently. There are, however, approximately 5,000 aircraft flying over the U.S. at any given moment and roughly 87,000 flights per day! There are international flights originating in Europe that pass over North Dakota due to the curvature of their flight paths. The busier airways of the U.S. have multiple aircraft passing through them at the same time. This is achieved with air traffic control's separation of altitudes. With several aircraft at high altitude producing contrails,

there can be crossing patterns or even grid-like formations in the sky. These may linger for several hours if the atmospheric conditions are conducive.

When looking at contrails on a global-scale, an average of less than 0.2 percent of our planet is covered by them. This includes the contrails that spread out into thin layers much like cirrus clouds due to the wind conditions aloft. Hypothetically, more contrails covering the sky during the daylight hours could actually act to subdue global warming. This isn't realistic, however, because the areal coverage of these clouds would have to be many times greater than that currently being realized.

Primary misperceptions about contrails include whether or not they are really condensed jet exhaust or other chemicals. In the hours around sunrise and sunset, a red hue might be seen highlighting contrails close to the horizon. To the amateur observer, the red contrails have been thought to be nefarious; however, the effect is simply from the sun's illumination. Contrails are very beneficial to pilots and meteorologists alike. Pilots are served by the additional safety that contrails provide in visual identification of other aircraft in their vicinity. This "see-and-avoid" tool, along with air traffic control's altitude separation have made our skies remarkably safe. Meteorologists use contrails as indicators of upper level wind speed, wind direction, and moisture. Sometimes contrails are good indicators of turbulence and this is very apparent when they resemble a curvy or corkscrew shape in the sky. Observe the differences in contrail appearance both in the photo above and in the outside sky and see what you can reveal about atmospheric conditions.

Atmospheric Resource Board | North Dakota State Water Commission | 900 East Boulevard, Bismarck, ND 58505
(701) 328-2788 | <http://swc.nd.gov>

ND Weather Modification Association | PO Box 2599 | Bismarck, ND 58502 | (701) 223-4232