THE
ATMOSPHERICRESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

ON THE CONTRARY, THOSE ARE CONTRAILS

By Mark D. Schneider

Spring weather means that we're typically outside more often and have more 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. 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 the clear, cold, humid air." Another common name for a contrail 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 into the air per second. These water vapor droplets freeze almost instantaneously due to the frigid temperatures of -40 degrees or colder (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 45,000 U.S.-based flights per day! Additionally, 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 suitable.

A common misperception about contrails is whether or not they are really condensed jet exhaust or actually other chemicals. In the hours around sunrise or 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 the sun's illumination. A "rainbow" of color can also be seen within contrails (even in the skies overhead) because they contain ice crystals that the sun's light refracts off of them like a prism. Another example of this can be seen within cirrus clouds when sun dogs occur.

Overall, 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 Department of Water Resources | 1200 Memorial Highway, Bismarck, ND 58504
(701) 328-2788 | dwr.nd.gov

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