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A Short History of Contrails and Contrail Research

Q: When were the earliest contrails observed?

A: The first published reports of contrails appeared during and shortly after World War I when aircraft were finally able to reach the altitudes required for contrail formation. An early example of contrail formation was observed during the flights of the pilot Zeno Diemer in 1919, when he reached altitudes as high as 30,500 ft above Munich, Germany.

Q: When did scientists begin to study contrails?

A: Contrails remained a seldom-studied scientific curiosity until the beginning of World War II when the detectability of aircraft became an important concern. Pilots were able to use contrails to track down enemy aircraft easily; they sometimes could use the contrails to hide from and to sneak up on the enemy! Contrails also caused occasional visibility problems within large aircraft formations. Thick, persistent contrails made it more difficult to stay in formation, and could even lead to aircraft collisions. As a

result of these problems, much research on contrails was conducted by Germany, Britain, and the United States during the war. The researchers wanted to learn exactly how contrails formed, and from this be able to determine the conditions under which they formed.

Q: When did scientists learn how contrails formed?

A: Although some early scientists suspected that the water vapor emitted from aircraft engines was critical in the production of contrails, others believed the outside air was too dry to allow any significant cloud formation, and it was not known for several years how contrails formed. Research during World War II showed that contrails would form at or below a particular temperature (sometimes referred to as the critical temperature), but that this temperature changed over time. Schmidt in Germany (1941) and Appleman in the United States (1953) independently developed the currently accepted theory of contrail formation. Their theory showed that the threshold temperature depended on the ambient pressure, temperature and humidity outside of the aircraft, and on the ratio of water vapor and heat released into the atmosphere by the aircraft exhaust. From this theory, Appleman developed a graphical method to determine when an aircraft would or would not form a contrail. Until recently, this graphical technique formed the basis of the contrail-forecasting algorithm used by the United States Air Force.

Q: Why do scientists study contrails today?

A: Contrails are studied for many reasons today. These man-made clouds impact the climate in many ways; they modify the energy balance between sunlight and infrared energy in the atmosphere, and they may affect the water vapor content and chemistry of the upper troposphere. As the volume of commercial air travel increases, these effects will become more important. Scientists today are trying to learn more about the longevity of persistent contrails and how much they may affect the climate in the future.

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