THE
ATMOSPHERICRESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

"Smoke Transport"

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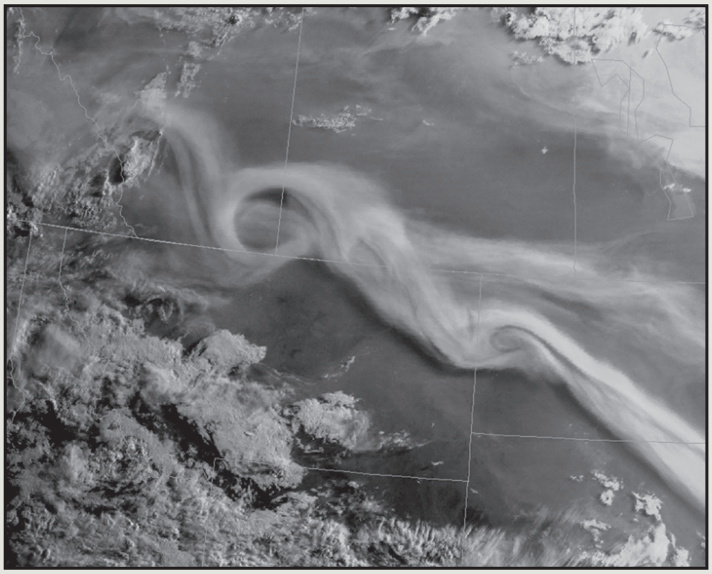

Visible Satellite Image Courtesy of NWS Glasgow/NOAA

This fire season was particularly bad for much of Canada and the Pacific Northwest. North Dakotans experienced many days of poor visibility and reduced air quality due to smoke particles emanating from these fires. What appears to be cloud cover over North Dakota on the included image is actually smoke making its way from Alberta and Saskatchewan southeastward through Montana and North Dakota.

So how does the smoke travel long distances and affect our weather? Imagine a warm summer day when the ground is heated and mixing occurs as the air rises. When smoke particles are introduced into the rising air, they enter the middle and upper levels of the atmosphere where the predominant wind direction is usually from a westerly direction. This process can carry particulates and pollutants many hundreds or even thousands of miles before the concentrations are dispersed enough to reach unnoticeable levels. In fact, smoke from Canadian fires was observed along the eastern coast of the U.S. this season!

Besides reduced visibility, smoke particles and other airborne aerosols can have effects on precipitation. Smoke can reduce or suppress rainfall; however, it can also invigorate or intensify the rainfall that does develop. The explanation involves two very different rain processes. The first process is a warm rain process called Collision-Coalescence. During Collision-Coalescence microscopic water droplets bump into each other and join together. Eventually the droplets that grow large enough will fall or precipitate from a cloud. The process is more efficient when there are different sizes of water droplets available in the atmosphere because this creates different fall speeds and increases the chances for collision. When smoke and aerosol particles are introduced into the atmosphere in high enough concentrations, the air contains many small droplets that are less conducive to colliding and growing into large droplets.

The second rain process is very different and it involves an ice process where freezing occurs within the cloud. This is called the Bergeron-Findeisen-Wegener process and is characterized by ice crystals growing at the expense of water droplets. Additional smoke or aerosol particles in a cloud can serve as nuclei on which droplets can freeze. When the atmosphere is unstable and updrafts begin, this ice process can be enhanced and may result in moderate to heavy rainfall due to the ice particles melting as they fall through warmer air below.

To sum things up: smoke and aerosols can cause reduced precipitation in regions that rely on a warm rain process, while potentially invigorating storms in regions that receive most of their rainfall from thunderstorms sustained by an ice process. Now that the fire season is coming to an end we can be thankful that the spring fires and drought that were prevalent across North Dakota were ended by growing season rains.

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