Fogs

ATM 210 – Fall, 2023 – Fovell

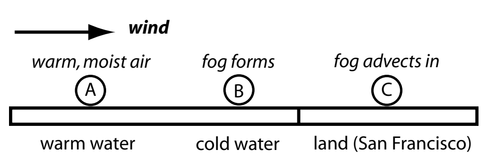
A fog is simply a cloud at or very near the ground. Thus, one person's fog is another person's cloud; it's all a matter of perspective. There are four kinds of fog, representing different routes to saturation. These are *radiation*, *advection*, *upslope*, and *mixing* fogs. These basic types can be combined as well for hybrid situations.

Radiation fog: The infamous California Central Valley wintertime ("Tule") fogs are a classic example of radiation fog. Particularly over low thermal inertia surfaces, the air can be cooled by radiation (and conduction) to its dew point over a relatively deep layer. This often forms on clear, calm nights, when (other things being equal) maximum cooling occurs to the air very near the ground. The longer the night, the more cooling can occur, so radiation fogs are most common over land in the winter. This represents the dew point approach to saturation.

Some points regarding radiation fogs. They are

- induced by radiative/conductive cooling of air near the surface, especially at night
- most common in winter: longer nights and colder air that is easier to saturate
- calm conditions favor this fog, windy conditions destroy it
- clear conditions favor this fog, since the atmospheric window isn't closed
- these fogs like to form in valleys, owing to cold air drainage
- particularly dense examples can persist for days (e.g., California Tule fogs)

Advection fog: San Francisco's famous summertime fogs are an example of advection fog. Advection implies air movement (especially in the horizontal), so this fog forms somewhere else and then "rolls in" (i.e., it is advected).



Refer to the graphic above. Warm moist air originating over the warm central Pacific ("A") is carried by the winds over colder waters off the California coast ("B"). There, the air is chilled from below down to its dew point, and a fog is produced. Then, the winds blow the fog inland over San Francisco. This is also the dew point approach to saturation.

Advection fogs also form over land in the winter. In the southern states, warm moist air originating from over the Gulf of Mexico gets blown over cold land and chilled from below.

Since this is a combination of horizontal air movement (advection) and radiative cooling (that's how the land got cold), this example is often referred to as "advection-radiation fog". This is not to be confused with pure radiation fogs, which tend to dissipate when the winds kick up.

Upslope fog: Lift air up a mountainside and it can be cooled to saturation via adiabatic expansion. If the resulting cloud is in contact with the ground, it is also a fog, and represents the adiabatic expansion approach to saturation.

Mixing fog: The mixing of two subsaturated air parcels can result in a fog, and this is due to the very strong dependence of vapor capacity (VC) on temperature. The classic example of this is when you can "see your breath" on cold days. Neither the air in your mouth nor in the environment is saturated, but the mixture of the two is.

Example: Take two air samples. The sample from your mouth has T = 30°C (VC = 28 g/kg). Say the vapor supply VS = 16 g/kg, making the relative humidity (RH) about 57%. Take the sample from the environment to have T = -10°C, and further pretend it contains no moisture at all, so VS = RH = 0.

Now mix together 1 kg from each source. The new temperature is the average of the original sample temperatures, or 10°C. The new VS is 8 g/kg. (The breath sample had 16 g of vapor in 1 kg, the 1 kg of environment air had no moisture, so the 2 kg mixture that resulted had 16 g per 2 kg of air, or 8 g/kg.) The VC of 10°C air is also 8 g/kg, so the air is saturated. Note that you cannot average the original samples' relative humidities.

This particular fog does not fit any approach to saturation very neatly. However, another type of mixing fog is the steam fog, which occurs when cold air moves over warm water, is easier to classify. The air picks up water through evaporation, and that saturates the air. This produces the effect of "steam" rising from the water surface. This is suggestive of the wet bulb approach to saturation.