

Chapter 9

Air Masses and Fronts

Air Masses

- An *air mass* is defined as a large body of air that has a fairly uniform horizontal distribution of temperature and moisture content.
- Air masses are at least around 2000 kilometers in horizontal extent.
- The temperature and moisture content of an air mass are not exactly uniform, but the horizontal gradients of these variables are small.
- The region where an air mass is formed is called the *source region*.
- In order to form, an air mass must remain in its source region for a week or more.
- Source regions must be large and uniform.
- Air masses are associated with anticyclones (areas of high pressure).
- The major source regions for air masses are either found in the tropics or in the polar regions.

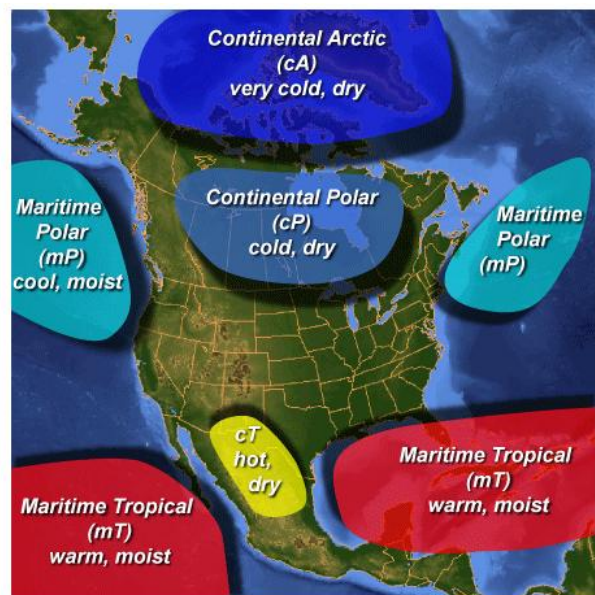
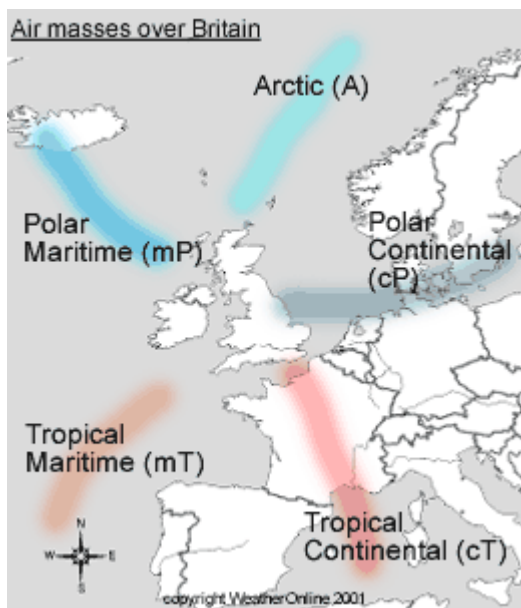
Air mass Classifications

- Air masses are classified according to the latitude of their source region, and according to whether they are formed over land or over water.
- Latitude of source region
 - Arctic
 - Polar
 - Tropical
- Air masses formed over water are called maritime air masses.
- Air masses formed over land are called continental air masses.
 - The five categories of air masses are
 - continental arctic – **cA**
 - continental polar – **cP**
 - continental tropical – **cT**
 - maritime tropical – **mT**
 - maritime polar – **mP**

Air Mass Modification

- Once an air mass moves out from its region of origin, it can become modified by the surface over which it is passing.
- If an air mass is colder than the surface over which it is passing it receives the designation, k.
- If an air mass is warmer than the surface over which it is passing it receives the designation, w.

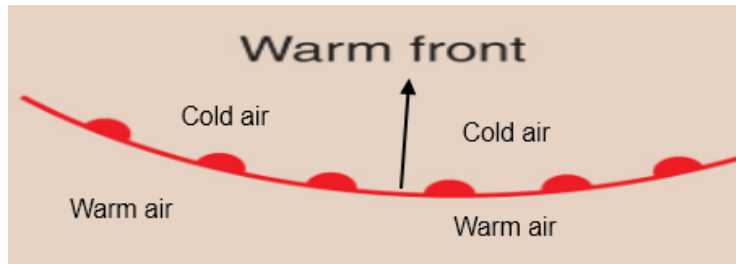
- For example, if a continental polar air mass (cP) moves out over the warm water, it becomes (cPk).
- An air mass's stability can be assessed by whether it is colder or warmer than the surface over which it is passing.
 - Cold air over a warm surface will be unstable
 - Warm air over a cold surface will be stable
- A k air mass will often be associated with cumuliform clouds
- A w air mass will often be associated with stratiform clouds
- An air mass can be modified so much that it becomes an entirely different air mass type.
- A cP air mass moving out over the water will eventually become an mP air mass.



Fronts

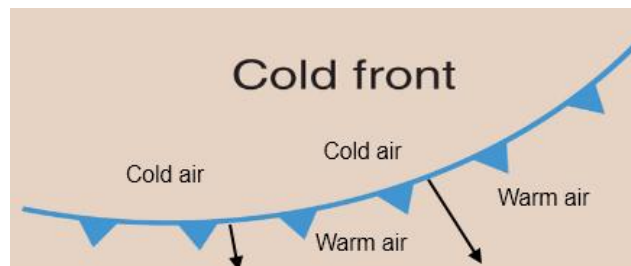
- A *front* is a boundary between two air masses.
- General properties of fronts
 - Sharp temperature contrast
 - Moisture contrast
- Cyclonic wind shift ↓
- Because of the two air masses have different temperatures and different humidities they are of different density.
 - The lighter air mass will *overrun* the denser air mass, which causes lifting along the frontal zone. This is why fronts are associated with clouds and precipitation.
 - Because air masses are associated with areas of high pressure, and fronts separate these air masses, fronts themselves lie in regions of low pressure, or troughs.

Warm Fronts



- Warm air advances into region formerly covered by cold air.
- Weather map symbol is red line with circular teeth.
- Warm air rides up and over cold air.
- The frontal surface slopes very shallowly with height (about 1:200).
- The front moves forward at 20 - 30 km/h.
- Cloud sequence
 - Cirrus
 - Cirrostratus (possibly cirrocumulus)
 - Altostratus
 - Nimbostratus (sometimes with embedded cumulonimbus)
- Precipitation
 - Steady rain, drizzle, or snow
 - Freezing rain or sleet may occur on cold side of front

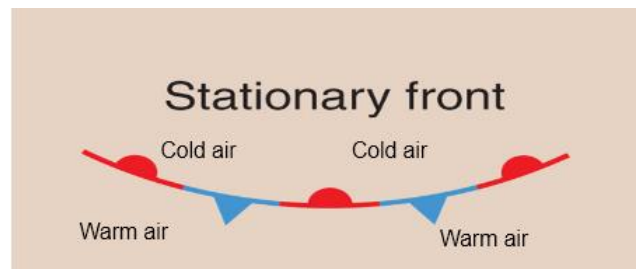
Cold Front



- Cold air advances into region formerly covered by warm air.
- Weather map symbol is blue line with triangular teeth.
- Warm air rides up and over cold air.
- The frontal surface has a steeper slope than a warm front (about 1:100)
- The front moves forward at 30 - 60 km/h (much faster than warm front).
- Cloud sequence
 - Cirrus and cirrostratus (from thunderstorm anvils)

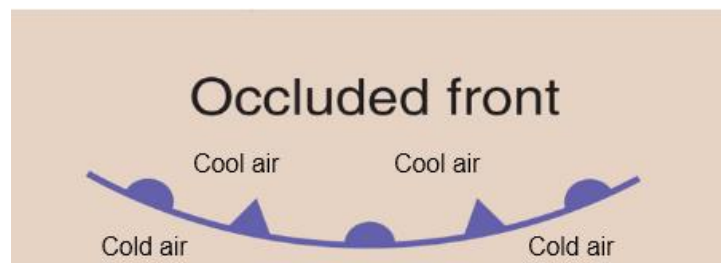
- Altocumulus (sometimes)
- Cumulonimbus
- Precipitation
 - Showers of rain or snow
 - Often thunderstorms
- Precipitation region is much narrower with a cold front than with a warm front.
- Precipitation region can be either ahead of or behind cold front.

Stationary Front



- Boundary between air masses is not moving
- Weather map symbol is alternating red and blue line with alternating warm and cold front teeth pointing in opposite directions.
- Even though frontal boundary itself doesn't move, the warm air is still moving up and over the cold air.
- Clouds associated with stationary fronts are usually stratiform (stratus, nimbostratus, altostratus, cirrostratus).
- Precipitation is usually light to moderate, and steady (rain or snow).
- Stationary fronts can linger for days, causing prolonged periods of dreary weather.

Occluded Front الجبهة المنطبقة



- Occur when a cold front overtakes a warm front
- Weather map symbol is a purple line with both sharp and circular teeth pointing in the same direction.

- Types of occlusions
- cold occlusion – air behind cold front is colder than air ahead of warm front
- warm occlusion – air behind cold front is warmer than air ahead of warm front
- Clouds associated with occluded fronts are a complicated mixture of those associated with warm and cold fronts.

Drylines

Drylines exist at a boundary between a dry and moist air mass (without a temperature gradient)

- Advancing drylines act like cold fronts since dry air is more dense than moist air
- Severe weather is common along drylines
- Drylines can both retreat and advance