Air Masses
AOSC 200
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Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

Air Masses
Fronts

Lecture 20
Nov 5 2019

Air Masses

What is an air mass?

Large body of air whose temperature and humidity are the same in any horizontal direction

Can cover huge areas (hundreds of thousands sq mi)

Influenced by the surface over which they form (source region)

Longer the air stays over source region the more it takes on characteristics of that region
Characteristics of air mass depends on source region
Air Mass Source Regions

<table>
<thead>
<tr>
<th>SOURCE REGION</th>
<th>ARCTIC REGION (A)</th>
<th>POLAR (P)</th>
<th>TROPICAL (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>cA</td>
<td>cP</td>
<td>cT</td>
</tr>
<tr>
<td>Continental (c)</td>
<td>extremely cold, dry, stable; ice- and snow-covered surface</td>
<td>cold, dry, stable</td>
<td>hot, dry, stable air aloft; unstable surface air</td>
</tr>
<tr>
<td>Water</td>
<td>mP</td>
<td></td>
<td>mT</td>
</tr>
<tr>
<td>Maritime (m)</td>
<td>cool, moist, unstable</td>
<td></td>
<td>warm, moist; usually unstable</td>
</tr>
</tbody>
</table>

Remember: Continental = dry
Maritime = moist

First letter: surface category
Second letter: location category

cT = continental Tropical

Air Masses that Affect North America

Arrows indicate general direction of air flow

Table 8.1: Essentials of Meteorology
Continental Polar (cP) and Continental Arctic (cA) Air

Cold to extremely cold and dry air masses

cP air comes from Canada and can head as far south as Florida

cA forms over frozen Arctic bringing bitterly cold temperatures

Sometimes called “Siberian Express”

Strong winds and blowing snow can lead to blizzards

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Maritime Polar Air (mP)

Form over oceans at high latitudes, cool to cold and humid

In winter, mP from Pacific begin as cP from Siberia

These systems run into west coast mountains and dump lots of snow (orographic forcing)

On East coast, mP brings in moist air from Atlantic over land where it meets with cP air

Can lead to large snowfalls!!!
Fig 6.9 Weather: A Concise Introduction

Table 8.8: Essentials of Meteorology
Maritime Tropical Air (mT)

- Eastern U.S. strongly affected by mT air that forms over Gulf of Mexico, Caribbean Sea, and subtropical western Atlantic Ocean

- Stable air mass leads to oppressive heat wave

- Wintertime precipitation over Central and Eastern U.S. due to uplift of mT air over cold air masses

- Western U.S. strongly affected by mT air from Pacific

“Nor’easter”: cyclone that moves to the Northeast
Maritime Tropical Air (mT)

“Pineapple Express” Jan 1, 1997

March 2012
Heat wave in 1999 led to 232 deaths

Maritime Tropical Air (mT)

Form over tropical and subtropical deserts and plateaus

In North America, formed in southwest and N. Mexico

Air mass is hot and dry

When cT and mT air meet, contrast between systems is called the “dry line”

In summer, large supercell storms often form at dry line, conducive to tornado development
Continental Tropical Air (cT), July 14-22, 2005

Sinking upper level air (Hadley Cell) is shown (H), leading to hot, dry conditions at surface

Lake Effect Snow

Cold Polar or Arctic air blows over warm water and picks up moisture and drops snow on downwind side of lake

Snow can fall in distinct bands
Fronts

Front: transition between two air masses

The upward extension of the front is called the “Frontal Zone”
Fronts

Fig 8.14: Essentials of Meteorology

Warm air flows over cold air mass… why?

Fig 9-11 Meteorology: Understanding the Atmosphere
Cold Fronts

Doppler image of precipitation along a cold front
Cold Fronts

Represented as blue triangles pointing toward warm air

Travels ~25 knots

Warm air forced up, cools, releases latent heat, leads to storms

As cold front moves through, temps. hold steady then drop
Cold Fronts

As cold front moves through, temps. hold steady then drop
Pressure drops then rises after front passes

Precipitation forms along leading edge of front, “squall line”
Cold Fronts

As cold front moves through, temps. hold steady then drop
Pressure drops then rises after front passes
Precipitation forms along leading edge of front, “squall line”
Winds shift from southwest to northwest
Cold fronts generally move to the south, southeast, or east

Fig 9-13  Meteorology: Understanding the Atmosphere

<p>| TABLE 8.2  Typical Weather Conditions Associated with a Cold Front in Winter in the Northern Hemisphere |</p>
<table>
<thead>
<tr>
<th>WEATHER ELEMENT</th>
<th>BEFORE PASSING</th>
<th>WHILE PASSING</th>
<th>AFTER PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winds</td>
<td>South or southwest</td>
<td>Gusty, shifting</td>
<td>West or northwest</td>
</tr>
<tr>
<td>Temperature</td>
<td>Warm</td>
<td>Sudden drop</td>
<td>Steadily dropping</td>
</tr>
<tr>
<td>Pressure</td>
<td>Falling steadily</td>
<td>Minimum, then sharp rise</td>
<td>Rising steadily</td>
</tr>
<tr>
<td>Clouds</td>
<td>Increasing Ci, Cs, then either Tcu* or Cb*</td>
<td>Tcu or Cb</td>
<td>Often Cu, Sc* when ground is warm</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Short period of showers</td>
<td>Heavy showers of rain or snow, sometimes with hail, thunder, and lightning</td>
<td>Decreasing intensity of showers, then clearing</td>
</tr>
<tr>
<td>Visibility</td>
<td>Fair to poor in haze</td>
<td>Poor, followed by improving</td>
<td>Good, except in showers</td>
</tr>
<tr>
<td>Dew point</td>
<td>High; remains steady</td>
<td>Sharp drop</td>
<td>Lowering</td>
</tr>
</tbody>
</table>

*Tcu stands for towering cumulus, such as cumulus congestus; whereas Cb stands for cumulonimbus. Sc stands for stratocumulus.

Table 8.2: Essentials of Meteorology
Warm Fronts

Represented as red semi-circles pointing toward cold air

Travels ~10 knots

Warm air slides over cold air and slowly cools.

Clouds form starting with cirrus, then various layers of stratus
Winds change from south or southeast to south or southwest
Warm Fronts

<table>
<thead>
<tr>
<th>WEATHER ELEMENT</th>
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<th>WHILE PASSING</th>
<th>AFTER PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winds</td>
<td>South or southeast</td>
<td>Variable</td>
<td>South or southwest</td>
</tr>
<tr>
<td>Temperature</td>
<td>Cool to cold, slow warming</td>
<td>Steady rise</td>
<td>Warmer, then steady</td>
</tr>
<tr>
<td>Pressure</td>
<td>Usually falling</td>
<td>Leveling off</td>
<td>Slight rise, followed by fall</td>
</tr>
<tr>
<td>Clouds</td>
<td>In this order: Ci, Cs, As, Ns, St, and fog; occasionally Cb in summer</td>
<td>Stratus-type</td>
<td>Clearing with scattered Sc, especially in summer; occasionally Cb in summer</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Light-to-moderate rain, snow, sleet, or drizzle; showers in summer</td>
<td>Drizzle or none</td>
<td>Usually none; sometimes light rain or showers</td>
</tr>
<tr>
<td>Visibility</td>
<td>Poor</td>
<td>Poor, but improving</td>
<td>Fair in haze</td>
</tr>
<tr>
<td>Dew point</td>
<td>Steady rise</td>
<td>Steady</td>
<td>Rise, then steady</td>
</tr>
</tbody>
</table>

Stationary Fronts

Represented as red semi-circles and blue triangles

Front doesn’t move

Winds blow along front but in opposite directions
Occluded Fronts (cold type occlusion)

Cold front moves faster than warm front, may catch warm front

Warm air is forced up over both cold/very cold air masses

May have mix of clouds similar to both cold and warm fronts

Fig 8.22: Essentials of Meteorology
Occluded Fronts (cold type occlusion)

Cold front moves faster than warm front, may catch warm front
Warm air is forced up over both cold/very cold air masses
May have mix of clouds similar to both cold and warm fronts

Cold front moves faster than warm front, may catch warm front
Cool air is forced up over cold air mass
May have mix of clouds similar to both cold and warm fronts
Occluded Fronts (warm type occlusion)

Cold front moves faster than warm front, may catch warm front

Cool air is forced up over cold air mass

May have mix of clouds similar to both cold and warm fronts

Table 8.4: Typical Winter Weather Most Often Associated with Occluded Fronts in North America

<table>
<thead>
<tr>
<th>WEATHER ELEMENT</th>
<th>BEFORE PASSING</th>
<th>WHILE PASSING</th>
<th>AFTER PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winds</td>
<td>East, southeast, or south</td>
<td>Variable</td>
<td>West or northwest</td>
</tr>
<tr>
<td>Temperature</td>
<td>(a) Cold-type occluded</td>
<td>Cold or cool</td>
<td>Dropping</td>
</tr>
<tr>
<td></td>
<td>(b) Warm-type occluded</td>
<td>Cold</td>
<td>Rising</td>
</tr>
<tr>
<td>Pressure</td>
<td>Usually falling</td>
<td>Low point</td>
<td>Usually rising</td>
</tr>
<tr>
<td>Clouds</td>
<td>In this order: Ci, Cs, As, Ns</td>
<td>Light, moderate, or heavy continuous precipitation or showers</td>
<td>Light-to-moderate precipitation followed by general clearing</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Light, moderate, or heavy precipitation</td>
<td>Light, moderate, or heavy continuous precipitation or showers</td>
<td>Light-to-moderate precipitation followed by general clearing</td>
</tr>
<tr>
<td>Visibility</td>
<td>Poor in precipitation</td>
<td>Poor in precipitation</td>
<td>Improving</td>
</tr>
<tr>
<td>Dew point</td>
<td>Steady</td>
<td>Usually slight drop, especially if cold-occluded</td>
<td>Slight drop, although may rise a bit if warm-occluded</td>
</tr>
</tbody>
</table>

Fig 8.22: Essentials of Meteorology