Chapter 9: Weather Patterns

Mid Latitude Cyclones: extratropical cyclones, Nor’easters

Region southern FL to Alaska

Lifecycle and associated weather

Regional Influence

**Polar Front Theory:**

- Norwegian Cyclone Model

- WWI

-describes birth, growth and decay of cyclones

Generates cyclone at the surface
**Midlatitude Cyclone:**
- primary weather producers
- low pressure systems, 1000 km dia.
- counterclockwise circulation toward center
- warm and cold fronts
- upward flow initiates precipitation

**Fronts:**
- boundary surfaces that separate air masses of different densities
  - temperature
  - moisture
- 15-200km wide
- line on the weather map
**Fronts:**

- Surface slope is gradual
- Warm air overlies cold air
- Air masses move at different speeds
- One air mass will **advance**
- Clashing produces weather

**Fronts:**

- Warm air is always forced **aloft**
- **Overrunning:** Warm air gliding on top of cold air
5 Types of Fronts:
- warm
- Cold
- Stationary
- Occluded
- Dryline

Warm Front:
- warm air mass is advancing, displaces colder air at the surface
- red line with half circles
- gradual slope (1:200)
- speed = 25-35 km/hr
**Warm Front:**  
- adiabatic cooling  
- cloud sequence  
- **gradual slope & slow advance:** widespread, light precip. long duration  
- precipitation precedes front  
- E to SW wind shift

**Cold Front:**  
- cold air mass is advancing, displaces warmer air at the surface  
- cold air more dense forces warm air aloft  
- **blue line with triangles**  
- steeper frontal boundary (1:100)  
- speed = 35-50 km/hr
**Cold Front:**
- precipitation follows the passage of the front
- steeper frontal boundary & speed: more violent weather
- altocumulus and cumulonimbus

**Cold Front:**
- same lifting of warm air, only quicker over a shorter distance
- heavy downpours, short duration, narrow band of precipitation
- passage of front temperature drops, polar air, clear skies
- SW to NW wind shift
**Stationary Front:**
- little to no horizontal movement across the front by either air mass
- lateral motion
- **overrunning**, light precipitation

**Occluded Front:**
- rapid moving **cold front** overtakes a **warm front**
- warm air driven aloft
- precipitation from wedging
- strong temperature gradients
- intense weather
Occluded Front:
- cold type occluded front
  advancing air is colder than air mass it is overtaking
  common east of the Rockies (cP overtakes mP)

(a) Cold-type

Occluded Front:
- warm type occluded front
  advancing air is warmer than air mass it is overtaking
  Pacific coast (mP overtakes cP)

(b) Warm-type
**Drylines:**
- fronts based on moisture content
- not necessarily a difference in temperature
- dry air forces moist air aloft
- cT (southwest US) displaces mT (Gulf) spring and summer
- severe T-storms from Texas to Nebraska

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**Life of a Midlatitude Cyclone (2-10 days)**

6 basic stages

Front develops
Wave develops
Cyclonic circulation established
Occlusion begins
Occluded front developed
Cyclone dissipates
Cyclogenesis = cyclone formation

**Front develops**

Stationary front

cP on the North (easterlies)
mT on the South (westerlies)

Life of a Midlatitiude Cyclone

**Wave develops**

wavelength (O 100 km)

wave steepens
Cyclonic circulation established
Warm air invades north (warm front)
Cold air advances south (cold front)
Low pressure at the crest

Life of a Midlatitiude Cyclone

Occlusion: beginning of the end
Cold front advances past the warm front
Strong temperature gradients, storm intensifies
Life of a Midlatituide Cyclone

**Occluded front developed**
blizzards, strong winds
energy is being exhausted
within a few days warm front driven aloft

![](image1)

**Cyclone dissipates**
cold air mass surrounds the low at the surface
horizontal temperature gradient eliminated

![](image2)
Idealized Weather of a Midlatitiude Cyclone

Cyclone generally move from west to east
Steered by the general westerly circulation
Right side of the storm passes first

A) Cirrus clouds
   Front ~1200 km away
   Warm front advances, cloud base lowers (cirrostratus, altostratus, stratus)
Idealed Weather of a Midlatitiude Cyclone

B) Nibostratus clouds
   Light precipitation, gets heavier as front advances
   Temperatures increase
   Winds shift from an easterly direction to a southerly direction

C) mT Air mass
   Warm, moist
   Clear skies
   Southerly winds
**D) Cumulonimbus Clouds**

- Heavy rains
- Violent weather as cold front approaches

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**E) Temperatures Drop**

- cP Air mass
- Descending air
- Clear skies
- Low precipitation
- Wind shifts from southerly to westerly.
**Idealized Weather of a Midlatitude Cyclone**

F-G)

- Occluded front region
- Temperature remains cool
- Precipitation beneath the front
- Type of precipitation depends on the lower temperature profile
- OF moves slower than the warm or cold fronts
- System rotates

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**Veering:** winds rotate/shift in a clockwise direction

- South of the storm
- Skies will clear as you move into the mT region or cP region
**Backing:** winds rotate/shift in a counterclockwise direction

North of the storm, pass through the occlusion

Cold with precipitation
TABLE 9-A Wind, barometric pressure, and impending weather

<table>
<thead>
<tr>
<th>Changes in Wind Direction</th>
<th>Barometric Pressure</th>
<th>Pressure Tendency</th>
<th>Impending Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any direction</td>
<td>1023 mb and above</td>
<td>Steady or rising</td>
<td>Continued fair with no temperature change</td>
</tr>
<tr>
<td></td>
<td>(30.20 in.)</td>
<td></td>
<td>Clearing within 12 to 24 hours and colder</td>
</tr>
<tr>
<td>SW to NW</td>
<td>1013 mb and below</td>
<td>Rising rapidly</td>
<td>Clearing within a few hours and fair for several days</td>
</tr>
<tr>
<td></td>
<td>(29.92 in.)</td>
<td></td>
<td>Clearing and warmer, followed by possible precipitation</td>
</tr>
<tr>
<td>S to SW</td>
<td>1013 mb and below</td>
<td>Rising slowly</td>
<td>In summer, with light wind, rain may not fall for several days; in winter, rain within 24 hours</td>
</tr>
<tr>
<td></td>
<td>(29.92 in.)</td>
<td></td>
<td>In summer, rain probable within 12 to 24 hours; in winter, rain or snow with strong winds likely</td>
</tr>
<tr>
<td>SE to SW</td>
<td>1013 mb and below</td>
<td>Steady or slowly falling</td>
<td>Rain will continue for 1 to 2 days</td>
</tr>
<tr>
<td></td>
<td>(29.92 in.)</td>
<td></td>
<td>Stormy conditions followed within 36 hours by clearing and, in winter, colder temperatures</td>
</tr>
<tr>
<td>E to NE</td>
<td>1019 mb and above</td>
<td>Falling slowly</td>
<td>Steady or slowly falling</td>
</tr>
<tr>
<td></td>
<td>(30.10 in.)</td>
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Source: Adapted from the National Weather Service

Polar Front Theory developed from surface observations

Wave develops

1. Topographic irregularities (Mnts)
2. Temperature contrasts (land/sea)
3. Ocean current influence (hurricanes)
**Conditions aloft**

Surface cyclones are preceded by intensification of airflow aloft

Zonal airflow (W-E) little cyclonic activity

Longitudinal airflow (N-S) increase cyclonic activity

**Surface cyclone:** centered below the jet stream
downwind of a upper level trough
**Cyclonic & Anticyclonic Circulation**

Cyclones and anticyclones are typically found together.

Surface divergence under an anticyclones feeds surface convergence under the cyclone.

Divergence aloft must be greater than convergence at the surface under a cyclone.

**Regions of Cyclogenesis**

- Topographic irregularities (Mnts)
- Temperature contrasts (land/sea)
- Ocean current influence (hurricanes)
Storm Tracks: Patterns of Movement

In general east to northeast track

Most of the north Pacific storms that influence the west coast do not make it over the Rockies in tact (redevelop)
Modern View: The Conveyor Belt Model

3 intersecting air streams (belts)
2 belts originate at the surface and ascend
1 belt originates aloft and descends

Warm Conveyor Belt:
mT air moves toward the middle of cyclone, north over mP or cP air
Ascends to middle troposphere (JS) joins the general westerly flow
Primary producer of precipitation
**Cold Conveyor Belt:**
Originates at surface ahead of the warm front
Flows westerly around the center and ascends, precipitation
Air joins the general westerly circulation aloft
**Nor’easter,** mP air is entrained from the North Atlantic

**Dry Conveyor Belt:**
Originates at the uppermost troposphere
Cold and dry
Splits and descends behind the cold front