Fun with Weather Maps!
(no, really… stop laughing)
AOSC 200
Tim Canty

Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

• Observations
• Station Model
• Temperature Maps
• Pressure Maps
• Fronts

Lecture 03
Sep 3 2019

Pressure: Aneroid Barometer

Fig 5-3b Meteorology: Understanding the Atmosphere
Wind Speed and Direction

A wind vane points in the direction the wind is coming from.

A westerly wind means winds are coming from the west.

Can also use degrees from North.

(can you spot the mistake in the figure?)

Wind Speed and Direction

An anemometer measure wind speed.

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Wind Speed and Direction

Beaufort Scale: Devised in 1805 to standardize reporting of wind based on observable conditions. This did not require exact knowledge of wind speed.

<table>
<thead>
<tr>
<th>Beaufort Number</th>
<th>Wind Speed (mph)</th>
<th>Seaman’s term</th>
<th>Effects on Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Under 1</td>
<td>Calm</td>
<td>Caim; smoke rises vertically.</td>
</tr>
<tr>
<td>1</td>
<td>1-3</td>
<td>Light Air</td>
<td>Smoke drift indicates wind direction; cains do not move.</td>
</tr>
<tr>
<td>2</td>
<td>4-7</td>
<td>Light Breeze</td>
<td>Wind felt on face; leaves rustle; waves begin to move.</td>
</tr>
<tr>
<td>3</td>
<td>8-12</td>
<td>Gentle Breeze</td>
<td>Leaves, small flags in constant motion; light flags extended.</td>
</tr>
<tr>
<td>4</td>
<td>13-18</td>
<td>Moderate Breeze</td>
<td>Dust, leaves and paper raised up; small branches move.</td>
</tr>
<tr>
<td>5</td>
<td>19-24</td>
<td>Fresh Breeze</td>
<td>Small trees begin to sway.</td>
</tr>
<tr>
<td>6</td>
<td>25-31</td>
<td>Strong Breeze</td>
<td>Large branches of trees in motion; whistling heard in wires.</td>
</tr>
<tr>
<td>7</td>
<td>32-38</td>
<td>Moderate Gale</td>
<td>Whole trees in motion; resistance felt in walking against the wind.</td>
</tr>
<tr>
<td>8</td>
<td>39-46</td>
<td>Fresh Gale</td>
<td>Large and small branches broken off trees.</td>
</tr>
<tr>
<td>9</td>
<td>47-54</td>
<td>Strong Gale</td>
<td>Slight structural damage occurs; slate blown from roofs.</td>
</tr>
<tr>
<td>10</td>
<td>55-63</td>
<td>Whole Gale</td>
<td>Seldom experienced on land; trees broken; structural damage occurs.</td>
</tr>
<tr>
<td>11</td>
<td>64-72</td>
<td>Storm</td>
<td>Very rarely experienced on land; usually with widespread damage.</td>
</tr>
<tr>
<td>12</td>
<td>73 or higher</td>
<td>Hurricane Force</td>
<td>Violence and destruction.</td>
</tr>
</tbody>
</table>

Rain: rain gauge

Measures total rainfall over a time period but it has to be emptied periodically.

Rainfall less than 1mm is reported as a "trace" amount.
Rain: tipping bucket rain gauge

After the bucket fills and tips, a small signal is sent and recorded.

Meteorological Observations

Automated Surface Observing System (ASOS)
Automated Surface Observing System (ASOS)

Measures:
- cloud height
- visibility
- precipitation
- pressure
- temperature
- dew point
- wind direction
- wind speed
- rainfall amount

http://www.allweatherinc.com/programs/faa-asos/
Meteorological Observations: Meteogram

Radiosondes

Weather doesn’t just happen at the surface!!!
Radiosondes

Position of balloon

Dew Pt.

Temperature

Dew Point Hygrometer

When temperature is above the dew point, observed light is unchanged

(a)

Transmitted light

Observed light

Mirror temperature above dew point

Receiver

Fig 5-3a  Meteorology: Understanding the Atmosphere
Humidity: Dew Point Hygrometer

When temperature reaches dew point, water condenses on surface and observed light is scattered.

Weather Station Model

The weather station model tells you what the conditions are like at the surface.

Temperature (°C)

Significant weather

Dew point temperature (°C)

(See Chapter 5)

Wind speed and direction

Atmospheric pressure

Cloud cover

Fig 5-3b Meteorology: Understanding the Atmosphere

Fig 2-1-1 Weather: A Concise Introduction
Weather Station Model

The central circle indicates cloud cover

Fig 2-1-2  Weather: A Concise Introduction

The symbol located between the air temperature and dew point temperature indicates significant weather

Fig 2-1-3  Weather: A Concise Introduction
**Weather Station Model**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Wind Speed (knots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 knot</td>
<td>1.15 mph</td>
</tr>
<tr>
<td>half barb = 5 knots</td>
<td></td>
</tr>
<tr>
<td>full barb = 10 knots</td>
<td></td>
</tr>
<tr>
<td>full and a half barb</td>
<td>15 knots</td>
</tr>
<tr>
<td>... and so on up to</td>
<td>45 knots</td>
</tr>
<tr>
<td>95 knots</td>
<td></td>
</tr>
<tr>
<td>100 knots, etc.</td>
<td></td>
</tr>
</tbody>
</table>

The line indicates the direction the wind is coming from (in this case from the Northeast) and the “barbs” and “pennants” indicate wind speed.
Reading the pressure can be a little confusing. In the figure above, the pressure is 987 hPa (mbar) at the surface.

Sometimes weather maps use a “shorthand” to represent pressure.
If reported value greater than 500:

Initial 9 is missing. Place it on left, then divide by 10.
For example: 827 becomes 982.7 mb.

If reported value less than 500:

Initial 10 is missing. Place it on left, then divide by 10.
For example: 027 becomes 1002.7 mb.
Temperature maps are often colored based on how warm (red) or cold (blue) the surface temperatures are.

The black lines indicate “isotherms” or lines of constant temperature. These maps help us identify the air masses that are controlling surface conditions and the temperature frontal boundaries between them.
A cold front is a region where cold air is replacing warm air. It’s indicated by a blue line with blue triangles pointing in the direction the air mass is moving.

A warm front is a region where warm air is replacing cold air. It’s indicated by a red line with red half circles pointing in the direction the air mass is moving.
The black lines indicate “isobars” or lines of constant pressure. These maps help us identify regions of high pressure (“H”) and low pressure (“L”). They also give some indication of surface wind speed and direction. The numbers are the actual pressure (no conversion needed).

Generally, isobars are plotted at 4 hPa intervals. If it helps, consider this like a map of surface height and you’ll get an idea of where are is flowing too and how fast it’s moving.
Closed contours define regions of high pressure and low pressure.

Isobars that aren’t closed can still help us define regions of increasing (“ridges”) and decreasing (“troughs”) pressure.
We can combine the different ways of looking at surface data to create what you may recognize as a modern weather map.
We can look at pressure maps at a some particular altitude but the mathematics becomes very complicated 😞

Instead, we look at altitude of a specific pressure level. The figures to the right show the height (in meters) of the 850 hPa surface.

The station model provides slightly different information than at the surface. The height of the pressure surface is in the position where pressure used to be. Maps of this information are called “isobaric” maps.
We can combine the different ways of looking at surface data to create what you may recognize as a modern weather map.

The color contours represent wind speed (in knots). Notice that the fastest winds in the central US are almost above the position of the surface low pressure. Here the black lines are in “decameters”.

Fig 2-2 Weather: A Concise Introduction

Fig 2-10 Weather: A Concise Introduction
Sometimes this information is plotted as the 1000-500 hPa thickness.
Prognostic Charts

850 mb 1500 m (4900 ft)
- High moisture values that can contribute to heavy precipitation
- Convergent winds associated with strengthening low pressure areas
- A low-level jet stream that can help intensify thunderstorm development
- Temperatures that determine whether precipitation will fall as snow, rain, sleet, or a mixture

700 mb 300 m (9800 ft)
- Moisture to feed precipitation and mid-latitude storm systems
- Temperature advection that could strengthen or weaken fronts
- A dry-warm layer that can inhibit thunderstorm development
- Temperatures that help determine ice crystal and snowfall type
**Prognostic Charts**

500 mb  
- General steering flow for mid-latitude storm systems, hurricanes, and tropical cyclones
- Location and motion of ridges, troughs, and short waves that generate and strengthen surface features
- Areas of cold advection that can help increase conditional instability and support thunderstorm development
- Large areas of high or low heights that correspond to unusually warm or cold conditions at the surface, depending on region and time of year

300 mb  
- Location of core of jet stream
- Jet streaks and areas of divergence within jet stream that may correspond to intensifying low pressure at the surface
- Areas of high pressure and light, divergent wind in the tropics and subtropics that can support hurricane development

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Fig 9.5: *Essentials of Meteorology*