Today:
5 minutes Team Time
Clouds from orographics and weather systems

Cloud image submission: Include
1) your edited image
2) your original (unedited) image
3) the appropriate Skew-T diagram
4) a short statement of cloud type and stable or unstable atm.

Admin stuff:
• Please sit with your team
• Mac users, in submitted filenames: letters and numbers only, NO SYMBOLS please.
• Don’t forget UNCOMPRESSED edited final image, not jpg.
• Please no zips, many steps to put in workflow.
  You can upload as many files as you need to.
• Clouds 1 due Weds Feb 19
• Team First image due Weds March 5.

Clouds = droplets or ice MOVING UPWARDS

Lift mechanisms:
1. Instability: creates Cumulus clouds
2. Orographics: terrain, mountains
3. Synoptic scale weather systems; local instability. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences and cyclonic uplift

2: Orographic clouds, caused by topography, i.e. mountains

Most common interesting cloud in spring is the

*standing*

Altocumulus lenticularis (higher than 6500 ft above local ground level)  \( AC SL \)
or
\( ^{\wedge} \)
Stratocumulus lenticularis (lower) or Mountain Wave Cloud, trapped or lee requires STABLE atmosphere: note exception to unstable/cumulus pairing.

Clouds that sit right on the Divide = FOEHN cloud wall. From air being forced up over the mountains.

Altocumulus lenticularis. Typically 1 to 5 wave crests.

Clouds stay stationary, but may move off and reform periodically.

If there's more wave crests, or short wavelengths, it's probably NOT a mountain.


Ben Britton, FV 2010
wave cloud; more likely altocumulus undulatus, from gravity waves in the atmosphere, like ripples on a liquid surface.

http://www.colorado.edu/MCEN/flowvis/galleries/2007/assignment2.html

Could also be from wind shear, via the Kelvin Helmholtz instability

http://cloudappreciationsociety.org/collecting/terry-robinson/

Tracy Eliasson FV 2007

Rare to be able to see cross section like this

Minute paper: Which way is the wind going?
Where is it faster?

Foehn clouds suggest winds coming over the mountains: the presence of a CHINOOK (pre-cold-front, warm, strong, downslope winds, or a BORA (post-cold-front, cold, strong, downslope winds). Also called cap clouds.

3: Synoptic uplift = weather system clouds.

Weather system progressions; 'synoptic scale' uplifts (1000 km across).

Any type of cloud is possible.

Inserted from: <file://C:/Users/hertzber/Documents/01CLASSES/FlowVis/Content/Scanned images/TypWeatherSystem.tif>
The whole system tends to move toward the east...

Warmer air gently overriding the colder air (known as a warm front).

Colder air pushing underneath the warmer air (known as a cold front).

Warmer air rises suddenly.

Warmer, moister air (which is less dense).

Warmer, moister air (which is more dense).

Large areas lift all together = stratus clouds.

... and as it moves over, an observer will tend to see the following cloud types:

Cirrus

Cirrostratus

Altostratus

Cirrostratus

Altostratus

Altocumulus

Nimbostratus

Cirrocumulus

Altostratus

Cumulus

Cumulonimbus

Stratus

Stable stratus

STABLE

STABLE

How cloud formations can develop as a region of low pressure, or ‘depression’, passes over. Those who think this looks complicated will be depressed to learn that it is in fact a very simplified diagram of a weather system.
Low Pressure System: Air tries to move into low. Coriolis makes it turn right = counterclockwise circulation. Typically unstable.

High pressure system: Air tries to move out. Coriolis makes it turn right = clockwise circulation. Weak or nonexistent fronts, so no instability.
Convergence uplift along shorelines warms quickly, air rises, pressure drops. Divergence aloft creates convergence and lift at surface. Pumping action. Cool sea breeze is pulled in. Land or shore breeze happens at night, when land cools more rapidly than the water.

CloudClassificationTable.pdf; Copyrighted, but available in D2L. Also see Cloud types for observers (PDF, 4 MB) - Met Office 45 pgs
The Clump Antennas Guide

CLOUDPW CLASSIFICATION TABLE

Gavin Pretor-Pinney, Perigee Press 2006

Clouds are divided into five basic groups, known as “shapes.” They are further divided into one of five basic groups, known as “shapes.” The classification of clouds is based on their size and appearance. The following table shows the different types of clouds and their characteristics. Each type of cloud has a unique shape, size, and appearance. The table also includes a description of the cloud’s behavior and the weather conditions that are associated with it.

<table>
<thead>
<tr>
<th>Type</th>
<th>Shape</th>
<th>Size</th>
<th>Appearance</th>
<th>Behavior</th>
<th>Weather Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratus</td>
<td>Sheet</td>
<td>Small</td>
<td>Flat, even</td>
<td>Generally stable</td>
<td>Clear skies</td>
</tr>
<tr>
<td>Cumulus</td>
<td>Tower</td>
<td>Large</td>
<td>Fluffy, billowy</td>
<td>Typically follows a cold front</td>
<td>Showers, thunderstorms</td>
</tr>
<tr>
<td>Cirrus</td>
<td>Feather</td>
<td>Medium</td>
<td>Fine, wispy</td>
<td>Generally stable</td>
<td>Clear skies</td>
</tr>
<tr>
<td>Alteus</td>
<td>Veil</td>
<td>Medium</td>
<td>Gray, wispy</td>
<td>Typically follows a warm front</td>
<td>Showers, thunderstorms</td>
</tr>
<tr>
<td>Nimbata</td>
<td>Bullet</td>
<td>Large</td>
<td>Dark, rounded</td>
<td>Typically follows a cold front</td>
<td>Showers, thunderstorms</td>
</tr>
</tbody>
</table>

Note: The above information is based on the “Clouds of the Gods” guide by Gavin Pretor-Pinney.
HOW TO SPOT CUMULUS CLOUDS

Cumulus are low, detached, fluffy clouds that develop vertically in rising currents, domes or towers, and have generally flat bases. These appear puffy and resemble cauliflower and they appear bright white when reflecting high sunlight, but can look dark when the sun is behind them. Cumulus tend to be scattered across the sky.

**CUMULUS SPECIES**

1. **Cumulus humilis**: Small, flat topped, vertical stratus. They look sunken and appear whiter than they are due to the sun's angle.
2. **Cumulus mediocris**: Medium vertical stratus. They show gradual transitions and movement at the top. Appears as tall as they are wide. Do not cause downbursts.
3. **Cumulus congestus**: Nests with many vertical currents. The nests look like cauliflower. Appears taller than they are wide. Causes downbursts.
4. **Cumulus-fractus**: Rugged edges and broken up. Can form in the midst of other clouds.

**CUMULUS MODIFICATION**

**Albocumulus**: When cumulus have turned into cirrus, or Visual steaming, which are roughly parallel to the wind direction. Due to perspective, the nests appear to converge toward the horizon.

**NOTE ON CUMULUS INCLUSION...**

**STRATUSCUMULUS**: Cumulus clouds are detached, not joined onto a layer like Stratuscumulus.

**Albocumulus**: Cumulus are not usually as regularly spaced as a layer of the Higher Albstatus. The clouds also look larger than for the layer of the Albstatus. When they are above the albstatus, cumulus appear larger than the width of these figures, held at one's length.

**CUMULUS** which often develops from a large Cumulus congestus. A little is still a Cumulus when its upper region has a sharp outline, compared with the other type of the Cumulonimbus.

*These appearances are altitudes (from the surface) on the real cumulus shapes.*
HOW TO SPOT CUMULONIMBUS CLOUDS

Cumulonimbus clouds are characterized by their enormous height, They are typically tall enough to reach the top of the troposphere, where they spread out in flattened form, creating smooth, wavy patterns. These clouds produce heavy showers, often accompanied by thunder and lightning.

NOT TO BE CONFUSED WITH...

UNSTABLE DURATION: These clouds are distinguished by their appearance near the top. When the upper region becomes well defined, these clouds are marked by a rounded, dome-like form called a cumulonimbus. When the upper region is not defined, these clouds are referred to as cumulus congestus, which is a less stable type of cloud.

CUMULONIMBUS FEATURES:

- These clouds are usually visible at a distance.
- They produce heavy showers, often accompanied by thunder and lightning.
- These clouds are often associated with severe weather conditions.

CUMULONIMBUS WEATHER:

- Heavy showers, often accompanied by thunder and lightning.
- These clouds are often associated with severe weather conditions.

* These cumulonimbus areas are often associated with severe weather conditions.
HOW TO SPOT

STRATUS CLOUDS

Stratus are grey layers or patches of cloud with very diffuse edges. They are the lowest forming of all the cloud genera, sometimes appearing at ground level, when they are called fog or mist.

TYPICAL CHARACTERISTICS:

- Low altitude
- Grey appearance
- Diffuse edges

WHERE THEY FORM:

- Worldwide
- Most commonly around front and fronts

PRECURSOR TO:

- No more than occasional cirrus, rare in some cases

FORMS:

- Stratus
- Stratus clouds

NOTE FOR PRACTITIONERS:

- Clouds which are low in height may look similar to one another. Being made of ice, however, it is a helpful note to remember:

- **A**lternating **C**larity which is a high layer cloud that can look similar to a very thin stratus. Being made of ice, however, it is a helpful note.

- **N**otice which is a mid-level layer cloud, which consists of droplets, like stratus. Through a layer of stratus, the surface of the earth is discernible in high detail, compared to the "glimpsed" appearance of the Nutschelinites.

- **S**tratus which is a thick, dark layer of precipitation cloud that might be confused with a thick Stratus. But the line is Sometimes high in the mind Shcumatis and produces lighter precipitation.

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STRATOCUMULUS CLOUDS

Stratocumuli are low layers or patches of cloud, with well-defined bases. They are usually composed of cumulus or nimbostratus clouds, often with strong variations in size and shape. The cloud elements may be joined into continuous, uniform layers or have gaps between them.

Stratocumuli are:
- **Streaky**: When the layer is thick enough to completely obscure the base of cumulus.
- **White-Covered**: When the layer is thin enough to allow the base of the cumulus to be seen.
- **Fog-Layered**: When there are gaps between the cloud elements.
- **Banded**: When these are banded at different altitudes, sometimes poorly defined.
- **Compact**: When the elements are arranged in a more vertical structure.

Stratocumuli are:
- **On Top**: When few of the lower cloud elements appear to penetrate the base of the cumulus.
- **Over Base**: When the layer shows gaps between the layers of clouds.

These appearances often indicate the environment for mid-latitude regions.
HOW TO SPOT ALTOCUMULUS CLOUDS

Altostratus are mid-level layers or patches of clouds, in the shape of rounded clumps, rolls or altostratus masses. These are white or gray, and the sides away from the Sun are shaded. Altostratus are usually composed of droplets, but may also contain ice crystals.

**HOW TO SPOT ALTOCUMULUS CLOUDS**

- **Appearance:** Most formations, when the clouds are replaced by a large mass.
- **Lighting:** When it is thin enough, the cloud can be seen in the background.
- **Formation:** When there are gaps between the clouds.

**TYPICAL FEATURES:**

- **COLOR:** Light gray
- **TEXTURE:** Very characteristic, cumulus-like roundings.

**DETECTING CHANGES:**

- Very common in summer, light rain.

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**ALTOCUMULUS LENTICULARIS**

- **Clouds:** Long, thin, lenticular clouds that appear like a pair of clouds, that appear like a pair of wings.
- **Lighting:** Bright, white, and white.
- **Formation:** When there are gaps between the clouds.

**CHROMOSPHERE:** Clouds appear like a pair of wings, that appear like a pair of wings.

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**ALTOCUMULUS LENTICULARIS**

- **Appearance:** Long, thin, lenticular clouds that appear like a pair of wings, that appear like a pair of wings.
- **Formation:** When there are gaps between the clouds.

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How to Spot Altostratus Clouds

Altostratus are mid-level layers of grey cloud, which are often featureless or fibrous in appearance, and typically extend over an area of several hundred square miles. Usually composed of both water droplets and ice crystals, they are often thin enough in parts to reveal the position of the sun, which appears as if through ground glass. Altostratus can cause a white or blue-grey halo (referred to as a 'sundog') around the sun or moon.

Altostratus handlers:

- Breaks: When the cloud layer is generally thick enough to mask the position of the sun or moon.
- Translucence: When it is generally fine enough to show the position of the sun or moon.
- Promotion: When there is more than one layer at different altitudes, these often being nearly merged. This is generally only visible when, by the light of a low sun, the higher layer is lit and the lower one is in shadow, or when looking north over the mountains of the lower to higher regions. When the layer shows length parallel undulations, it is known as a wave cloud when it is caused by convection or a wave moving over the topography.
- Wobbling: If the layer shows a wobbling phenomenon, it is known as a wave cloud when it is caused by convection or a wave moving over the topography.
- Sun dogs: When caused by a white disc of light, called a 'sundog' or 'sun pillar', which appears around the sun or moon. Generally, this is produced by small, but occasionally large, ice crystals in the sky.

How to Be Comfortable With...

Altostratus with a thin layer of ice crystals that looks like a thin, white, fibrous cloud. These clouds are often fibrous and的样子 to describe them. Altostratus can cause a white or blue-grey 'sundog' around the sun or moon.

Altostratus without ice crystals that are white, fibrous, or have a white disc of light around the sun or moon.

* These approximate altitudes above the surface are for real-time weather conditions.
HOW TO SPOT NIMBOSTRATUS CLOUDS

Nimbostratus are thick, grey, featureless layers of cloud that cause prolonged, continuous, often heavy, rain, snow or ice pellets. They tend to have very diffuse bases, as a result of all the falling precipitation.

Nimbostratus are the deepest of all the layer clouds - sometimes extending from 2,000 ft up to around 18,000 ft - and generally extend over many thousands of square miles. As well, other precipitating clouds, the falling precipitation can cause Nimbostratus to form in the air below Nimbostratus cloud. These are known as 'passive' and appear as streaks of cloud, looking similar to the underside of the Nimbostratus. When they rise together, they tend to lower the base of Nimbostratus clouds even further. They are invisible at night, as they have no edge for the sun or moon.

TO BE CONSIDERED WHEN:

- ASPRETTEN: which is a variant - though the distinct layer of cloud. Nimbostratus is always visible that it and, by definition, produces precipitation. Altocumulus only then sometimes, and this will generally be light. With the position of the sun it can generally be distinguished through a layer of Nimbostratus, a tail of Nimbostratus, which, absent by evening, should appear to be a very dark, long, covering the whole sky. The precipitation falling from a Nimbostratus will not generally be so heavy and will be more plentiful and continuous, compared with the usually denser, at the surface.

NIMBOSTRATUS SIGNATURES:

- Nimbostratus often produce heavy rain and thunderstorms.
- Nimbostratus often produce heavy snow and snowstorms.
- Nimbostratus often produce heavy ice pellets and hail.
- Nimbostratus often produce heavy fog and low visibility.

*Nimbostratus are a type of clouds that are known for their characteristic greyish appearance and their ability to cause prolonged, continuous precipitation.
HOW TO SPOT

CIRRUS CLOUDS

Cirrus are the highest of the six main cloud types. In the form of delicate, white, wispy, or bands of falling ice crystals, they are detached from each other, and have fibrous or silky appearances. Cirrus rarely appear very thick. They are often seen with the other high clouds, Cirrostratus and Altostratus, and, like these, can show halo phenomena around the sun or moon.

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**TYPICAL ALTITUDES:**
- 13,000-20,000 ft
- Mostly free from freezing

**AURORA BOREALIS**

CIRRUS CLOUDS

**CIRRUS CLOUDS:**

**FORMATION:** When it is in the form of straight or curved filaments that are smoothly distinct from each other and do not remain in bands or columns.

**UNUSUALLY:** Those closer to the sun appear in patches that often form in the form of the sun — which tend to originate from the area of a Coronariaimbus.

**Cirrus:** When it is in the form of small distinct groups, small rounded tops, or columns, which are often part of a larger pattern of cloud formation.

**CIRRUS MOTIONS:**

When the filaments are in parallel bands, usually aligned with the wind at high altitudes, which converge towards the horizon, due to precipitation.

**ORIENTATION:**

When the filaments are in parallel bands, usually aligned with the wind at high altitudes, which converge towards the horizon, due to precipitation.
HOW TO SPOT CIRROCUMULUS CLOUDS

Cirrocumulus are high patches of cloud or layers of tiny clouds that appear in white names. These show on slides, some in the form of clouds. These clouds are generally regularly spaced, and often arranged in layers, known as the cumulus variety.

**Distinctive features:**
- When they are at a higher altitude, they appear as a patch. A few clouds are larger than the others, appearing in a box shape.
- When they are in the form of one or more clouds, they are well defined, clasped on less shaped shapes, which have smooth outlines. But are much larger than the precipitating clouds of the other species.
- Characteristic: When, on careful inspection, in clouds have small circulations and circular bases, quickly. When, on careful inspection, its clouds are Cirrus-like, with ragged bases.

**Occurrence:**
- When the sun has been limbed with clouds, like a set of honeycomb.

**NOT TO BE CONFUSED WITH:**
- Cirrus and cirrocumulus, which are smaller and smooth/flat-like layers high in the cloud. Cirrocumulus layers, by contrast, are embedded into many genera-like cirrocumulus.
- Precipitation: Which is a smaller layer of large cumulus. Looking down 30° from the horizon, the smaller clouds appear larger than the width of one finger, held at arm's length.

*Their appearance above shows the weather for the next 2 days.*