What is a constant pressure chart. How to read a constant pressure analysis chart. Constant flow vs constant pressure. Constant pressure analysis chart legend. Constant pressure analysis chart aviation. Hatching on a constant pressure analysis chart indicates. What is constant pressure. Constant pressure analysis chart awc. Constant pressure analysis chart hatching. Constant pressure analysis charts are being replaced by.

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It has many features similar to what you might see on the surface analysis chart. There are H's and L's that represent highs and lows and there are lines that resemble lines of constant pressure or isobars. However, those H's and L's are not marking the position of high and low pressure centers and the lines are not lines of constant pressure or isobars. So why is this different from the surface analysis chart? The surface analysis chart like the one shown below depicts the pressure that is recorded by barometers located at the surface. However, if we plotted the surface pressure strictly from these observations of pressure it would look a lot like a surface relief map or topographic map. That is, higher elevation terrain generally has a lower pressure. So you would simply be plotting the difference in pressure due to the height of the terrain and not due to the relative differences in the pressure.Consequently, meteorologists adjust the observed pressure at the surface to a height we know as mean sea level. This depicts the surface pressure as if there were no terrain features higher or lower than sea level.
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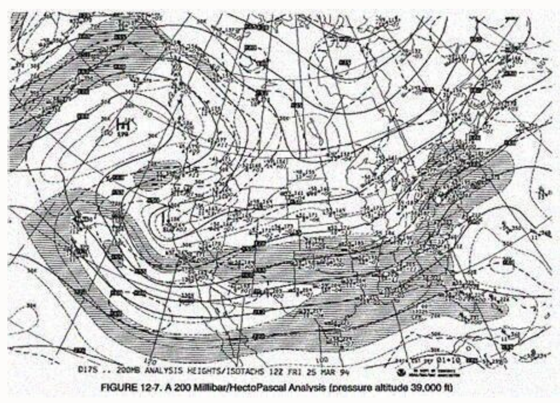

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What varies on this chart is the height of that specific pressure surface. For example, the solid lines on the constant pressure chart below depict the height of the 500 mb surface. So, why use constant pressure instead of "constant altitude" to depict the weather aloft? It would seem more intuitive to depict how the pressure varies at 10,000 feet instead of the how the height varies at 700 mb.   For the last 50+ years, meteorologists have drawn weather maps describing upper air conditions using constant pressure surfaces.
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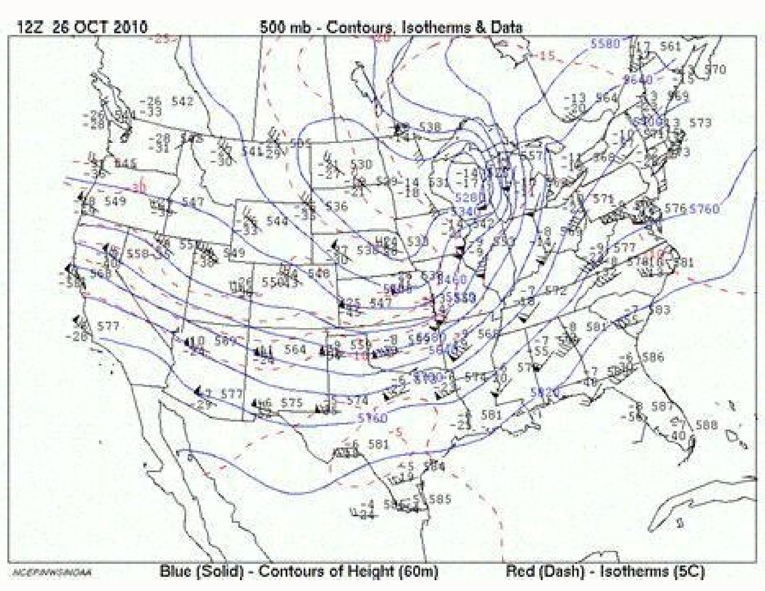

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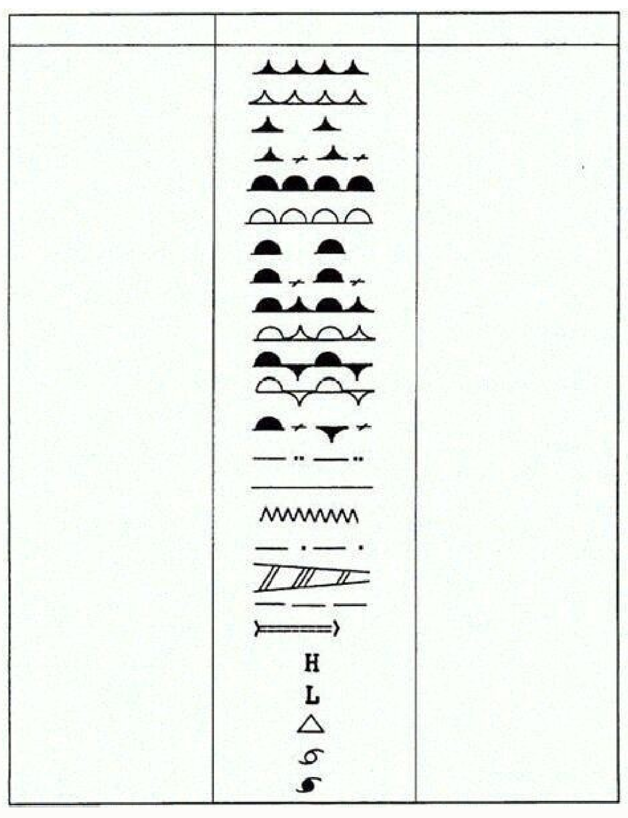

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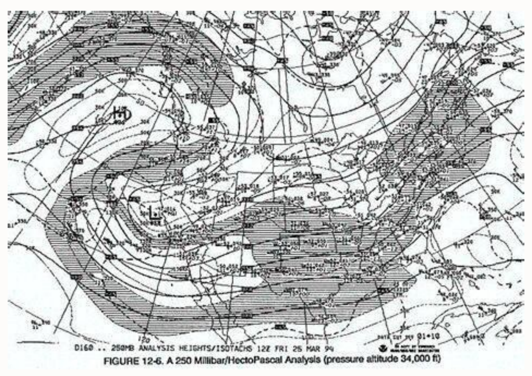

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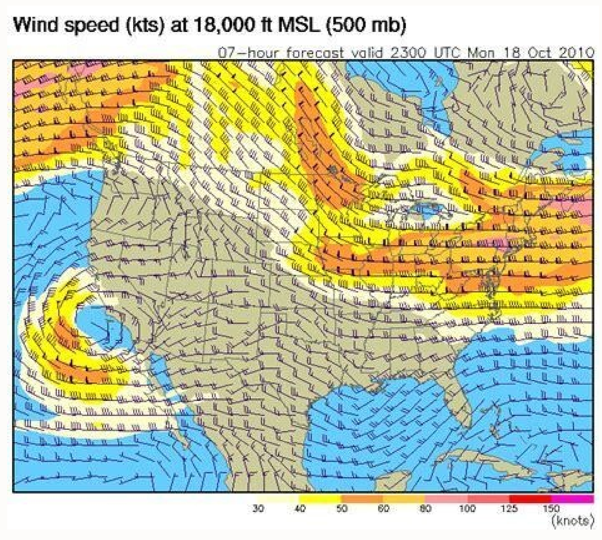

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1. Since most aircraft of the time used pressure altimeters, most "constant altitude" flights were actually flown on constant pressure surfaces. Aircraft today still fly constant pressure surfaces at altitudes at or above 18,000 feet (also known as the flight levels). This is done by using a constant altimeter setting of 29.92. As the pressure changes while en route, the pilot does not adjust the altimeter setting. Instead, they adjust their true altitude up or down in order to fly a constant pressure surface. 2. The radiosonde telemetry data from which the charts are prepared are reported in terms of pressure. As the balloon ascends, temperature, dew point temperature and wind are measured and reported as a function of pressure, not altitude.   3.

Use of pressure as the vertical coordinate simplifies many of the thermodynamic equations and computations used in numerical weather prediction models. In other words, when you hold pressure constant it makes these equations easier to solve. And that was real important when computing power wasn't as good as it is today. Therefore, in addition to the charts made from the radiosonde data, forecast data is also depicted on constant pressure charts.   Meanwhile, we're stuck seeing these charts since most forecasters have adapted to them over the years. In addition to the height of the pressure surface, many constant pressure charts available online will also depict the actual or forecast wind speed and direction. Therefore, many pilots do examine these charts for the winds. The Aviation Weather Center provides the winds on constant pressure surfaces without displaying the height contours as shown above. Even though the chart is labeled with a specific mean sea level height (such as 18,000 feet MSL), please be aware that this is only an approximation. This is still a constant pressure chart (note the pressure in parentheses following the altitude). As a result, the true altitude of the winds can vary by 2,000 feet or more. This Aviation Weather Center rendition is best used for aircraft flying at 18,000 feet and higher since they are truly flying a constant pressure surface.   Most pilots are weatherwise, but some are otherwise™ CFI & former NWS research meteorologist In addition to surface weather maps, maps showing conditions at various altitudes above the ground are also routinely made. We'll spend some time learning about these upper level charts. Upper level conditions can affect the development and movement of surface features (and vice versa). We'll start with some basic features then have a more careful and detailed look at upper level charts.   First the overall appearance is somewhat different from a surface weather map. The pattern on a surface map can be complex and you generally find circular (more or less) centers of high and low pressure. You can also find closed high and low pressure centers at upper levels, but mostly you find a relatively simple wavy pattern like sketched below. The u-shaped portion of the pattern is called a trough. The n-shaped portion is called a ridge. Troughs are produced by large volumes of cool or cold air (the cold air is found between the ground and the upper level that the map depicts). The western half of the country in the map above would probably be experiencing colder than average temperatures. Large volumes of warm or hot air produce ridges. The winds on upper level charts blow parallel to the contour lines (on a surface map the winds cross the isobars slightly, spiralling into centers of low pressure and outward away from centers of high pressure). The upper level winds generally blow from west to east. Now on to a little more in depth look at upper-level charts. By the end of this section you should better understand what the title "850 mb Chart" on the upper level map above refers to. You should also understand what the numbers on the contour lines represent and what their units are. On a surface map contours of pressure, isobars, are normally drawn. That is usually not the case on upper level charts. You'll also have a better idea of where the names trough and ridge come from and why they are associated with cold and warm air masses, respectively. Note that the values on the contours decrease as you move from the equator toward higher latitude.   You should be able to explain why that happens. You really only need to remember two things from earlier in the course: (1) pressure decreases with increasing altitude, and (2) pressure decreases more rapidly in cold high-density air than it does in warm low density air. Pressure drops from 1000 mb to 800 mb, a 200 mb change, when moving upward 1500 meters in the cold air in the picture above. It decreases from 1000 mb to 900 mb, only 100 mb, in the same distance in the warm low density air. Isobars on constant altitude upper level charts One way of depicting upper level conditions would be to measure pressure values at some fixed altitude above the ground.

This approach is shown above. Pressures range from 800 mb to 900 mb at 1500 meters altitude. The pressure pattern could then be plotted on a constant altitude chart using isobars (figure below). Note the lowest pressures are found in the cold air, higher pressures would be found in the warm air. That would seem to be a logical way of mapping upper level atmospheric conditions. Unfortunately that isn't how things are done. Height contours on constant pressure (isobaric) upper level charts Just to make life difficult meterologists do things differently. Rather than plotting conditions at a constant altitude above the ground, meterologists measure and plot conditions at a particular reference pressure level above the ground. In the picture above you start at the ground (where the pressure is 1000 mb) and travel upward until you reach 850 mb pressure. You make a note of the altitude at which that occurs. In the cold dense air at the left pressure decreases rapidly so you wouldn't need to go very high, only 1200 meters. In the warm air at right pressure decreases more slowly, you would have to go quite a bit higher, to 1800 m. Every point on the sloping surface above has the same pressure, 850 mb. The altitude above the ground is what is changing. You could draw a topographic map of the sloping constant pressure surface by drawing contour lines of altitude or height. The L and H on this map represent low and high altitude, respectively. The two kinds of charts (constant altitude or constant pressure) are redrawn below. The numbers on the contour lines have been left off in order to clearly see that both types of maps have the same overall pattern (they should because they're both depicting the same upper level atmospheric conditions). In the example above temperature changed smoothly from cold to warm as you move from left to right (west to east). See if you can figure out what temperature pattern is producing the wavy 850 mb constant pressure surface below. This shouldn't be too hard if you remember that the 850 mb level will be found at relatively high altitude in the warm air where pressure decreases slowly with increasing altitude. The 850 mb level will be found closer to the ground in cold air where pressure decreases rapidly with increasing altitude. The temperature pattern is shown below.

Temperatures change from average, to warm, back to average, to cold, and then to average again at the eastern edge of the picture. If you imagine hiking along the 850 mb surface you can begin to understand where the term ridge comes from. In a ridge the reference pressure is found at higher than average altitude above the ground. A trough is in effect a valley where the reference pressure is found at lower altitude, closer to the ground. In the next figure we will add south to north temperature changes in addition to the west to east temperature gradient. Here's what the temperature pattern will look like. Temperature drops as you move from west to east (as it did in the previous pictures) and now it drops as you move from south to north. What will the wavy 850 mb constant pressure surface look like now? It's the wavy surface that we had in the previous example (where there was just a west to east temperature change) with the northern edge tilted downward because there is colder air in the north.   That's not much of a change. But look at how the map has changed. We now see an "n" shaped ridge and a "u" shaped trough. The highest point on the 850 mb surface (1800 meters or so) is found above the hot air near the SW corner of the picture. The lowest point (a little less than 1000 meters) is found in the coldest air near the NE corner of the picture. Now let's go back to the figure that we started this section with. 1. The title tells you this is a map showing the altitude of the 850 mb constant pressure level in the atmosphere. 2. Height contours are drawn on the chart. They show the altitude, in meters, of the 850 mb pressure level at different points on the map. 3. The numbers get smaller as you head north because the air up north is colder. The 850 mb level is closer to the ground in the north where the air is colder, denser, and where pressure decreases more rapidly with increasing altitude. Here's a figure with some questions to test your understanding of this material.

This is a 500 mb constant pressure chart not an 850 mb chart like in the previous examples. The 500 mb pressure is found higher in the atmosphere than the 850 mb level. Is the pressure at Point C greater than, less than, or equal to the pressure at Point D (you can assume that Points C and D are at the same latitude)? How do the pressures at Points A and C compare? Which of the four points (A, B, C, or D) is found at the lowest altitude above the ground, or are all four points found at the same altitude? The coldest air would probably be found below which of the four points? Where would the warmest air be found? What direction would the winds be blowing at Point C? You'll find the answers to these questions at the end of this lecture. Here is a quick comparison of upper level charts in the northern and southern hemispheres. The contour values get smaller as you move toward colder air. The cold air is in the north in the northern hemisphere and in the south in the southern hemisphere (the pattern is effectively flipped in the southern hemisphere compared to the northern hemisphere). The winds blow parallel to the contour lines and from west to east in both hemispheres. We'll finish this lecture by looking, in a little more detail, at how upper level winds can affect the development or intensification of a surface storm. This material might be a little difficult and confusing at this point. Don't worry if that is the case. Surface and upper level maps are superimposed in the figure above. On the surface map you see centers of HIGH and LOW pressure. The surface low pressure center, together with the cold and warm fronts, is a middle latitude storm. Note how the counterclockwise winds spinning around the LOW move warm air northward (behind the warm front on the eastern side of the LOW) and cold air southward (behind the cold front on the western side of the LOW). Clockwise winds spinning around the HIGH also move warm and cold air. The surface winds are shown with thin brown arrows on the surface map.

Note the ridge and trough features on the upper level chart. We learned that warm air is found below an upper level ridge. Now you can begin to see where this warm air comes from. Warm air is found west of the HIGH and to the east of the LOW.   This is where the two ridges on the upper level chart are also found. You expect to find cold air below an upper level trough. This cold air is being moved into the middle of the US by the northerly winds that are found between the HIGH and the LOW. Note the yellow X marked on the upper level chart directly above the surface LOW. This is a good location for a surface LOW to form, develop, and strengthen (strengthening means the pressure in the surface low will get even lower; this is also called "deepening"). The reason for this is that the yellow X is a location where there is often upper level divergence. Similary the pink X is where you often find upper level convergence. This could cause the pressure in the center of the surface high pressure to get even higher. This figure shows a cylinder of air positioned above a surface low pressure center. The pressure at the bottom of the cylinder is determined by the weight of the air overhead. The surface winds are spinning counterclockwise and spiraling in toward the center of the surface low. These converging surface winds add air to the cylinder. Adding air to the cylinder means the cylinder will weigh more and you would expect the surface pressure at the bottom of the cylinder to increase with time (the low would be "filling"). We'll just make up some numbers, this might make things clearer. We will assume the surface low has 960 mb pressure.   Imagine that each of the surface wind arrows brings in enough air to increase the pressure at the center of the LOW by 10 mb. You would expect the pressure at the center of the LOW to increase from 960 mb to 1000 mb. This is just like a bank account. You have $960 in the bank and you make four $10 dollar deposits. You would expect your bank account balance to increase from $960 to $1000. But what if the surface pressure decreased from 960 mb to 950 mb as shown in the following figure? Or in terms of the bank account, wouldn't you be surprised if, after making four $10 dollar deposits, the balance went from $960 to $950. The next figure shows us what could be happening. There may be some upper level divergence (more arrows leaving the cylinder at some point above the ground than going in). Upper level divergence removes air from the cylinder and would decrease the weight of the cylinder (and that would lower the surface pressure) We need to determine which of the two (converging winds at the surface or divergence at upper levels) is dominant. That will determine what happens to the surface pressure. Again some actual numbers might help The 40 millibars worth of surface convergence is shown at Point 1. Up at Point 2 there are 50 mb of air entering the cylinder but 100 mb leaving. That is a net loss of 50 mb. At Point 3 we see the overall result, a net loss of 10 mb. The surface pressure should decrease from 960 mb to 950 mb. That change is reflected in the next picture. The surface pressure is 950 mb. This means there is more of a pressure difference between the low pressure in the center of the storm and the pressure surrounding the storm. The surface storm has intensified and the surface winds will blow faster and carry more air into the cylinder (the surface wind arrows each now carry 12.5 mb of air instead of 10 mb). The converging surface winds add 50 mb of air to the cylinder (Point 1), the upper level divergence removes 50 mb of air from the cylinder (Point 2). Convergence and divergence are in balance (Point 3). The storm won't intensify any further. Now that you have some idea of what upper level divergence looks like (more air leaving than is going in) you are in a position to understand another one of the relationships between the surface and upper level winds. One of the things we have learned about surface LOW pressure is that the converging surface winds create rising air motions. The figure above gives you an idea of what can happen to this rising air (it has to go somewhere). Note the upper level divergence in the figure: two arrows of air coming into the point "DIV" and three arrows of air leaving (more air going out than coming in is what makes this divergence). The rising air can, in effect, supply the extra arrow's worth of air. Three arrows of air come into the point marked "CONV" on the upper level chart and two leave (more air coming in than going out). What happens to the extra arrow? It sinks, it is the source of the sinking air found above surface high pressure. Here are the answers to the "test your understanding" question found earlier in this lecture. 1. This is a constant pressure chart. The pressures at Points A, B, C, and D are all the same - 500 mb. 2. Point A is found at the lowest altitude - 5400 meters. Point D is found at the highest altitude - 5640 meters. 3. The coldest air is found below Point A, the warmest air is below Point D. 4.

The winds blow parallel to the contours from west to east as shown on the map above. The winds at Point C are blowing from the west. For the last 50 years, meteorologists have drawn weather maps of upper air conditions using constant pressure surfaces. These charts are prepared for several mandatory pressure levels twice daily (0000 Z and 1200 Z) from the temperature, humidity and wind data provided by the operational radiosonde network, supplemented with data from aircraft reports and satellite-derived wind data in data sparse regions. Meteorologists use these constant pressure charts rather than constant altitude charts for several reasons. Since most aircraft of the time used pressure altimeters, most "constant altitude" flights were actually flown on constant pressure surfaces. Furthermore, the radiosonde data (from which the charts are prepared) are reported in terms of pressure. Finally, use of pressure as the vertical coordinate simplifies many of the thermodynamic equations and computations.

THREE CHARTS FOR THREE LEVELS In this section, upper air charts will be studied at three separate levels of the atmosphere - one in the lower troposphere at an altitude of approximately 5000 ft (1.5 km), a second in the mid troposphere at approximately 18,000 ft (5.5 km) and the third in the upper troposphere, near the tropopause, at approximately 30,000 ft (10 km). Each level furnishes a slightly different perspective of the atmosphere; hence, the meteorologist looks for certain features in each.

The atmospheric variables typically plotted on these isobaric maps include (1) the height of the pressure surface; (2) the air temperature; (3) the wind speed and direction; and (4) when applicable, the dewpoint, an indicator of atmospheric humidity. Essentially all these charts can be produced with analyses that include height contours (lines connecting all points on the surface having the same altitude) and isotherms (lines of each temperature). Some charts, primarily the 300 mb chart, may have "isotachs", which are lines of equal wind speed.

An optional background discussion of the salient features of an isobaric chart appears below. The 850 mb chart The 850 mb chart, representing weather conditions in the lower troposphere, is at a level that is above approximately 15 percent of the atmosphere in terms of mass. At an altitude of approximately 1500 meters (5000 feet), this level is above most of the influences of surface friction in the many sections of the country. Unfortunately, the 850 mb intersects and goes below the terrain in the Rocky Mountains. For example, the "Mile High City" of Denver, CO usually has a surface pressure - a measured value not corrected to sea level - of approximately 830 mb, which places it at a higher altitude than the 850 mb surface. Meteorologists often look at the analyzed temperature field of this level, because over the non-mountainous regions, the diurnal temperature cycle is much less than at the surface. They can frequently tell correctly that precipitation falling in regions with an 850 mb temperature of 0 degrees Celsius will probably fall as snow, while rain would more than likely fall at warmer temperatures. The 500 mb chart The 500 mb chart represents weather conditions in the mid- troposphere, at a level where approximately half the mass of the atmosphere lies below this level. This level is at an altitude of approximately 5,500 meters (18.000 ft). This level is often used to represent upper level flow conditions because the level is well above the effects of topography and friction and the level is below the region in the upper troposphere where the air flow may experience strong accelerations and decelerations when in the vicinity of the upper jet streams.

Since many weather systems tend to follow the wind flow at this level, this level is often considered to symbolize the steering level of these systems. The 300 mb chart The 300 mb chart is in the vicinity of the tropopause, at the top of the troposphere. Only 30 percent of the mass of the atmosphere lies above this level.

The altitude of the 300 mb surface is near 9000 meters (30,000 ft) - at a level where many long-distance commercial jet aircraft fly. This level also corresponds the level of the upper tropospheric jet stream, a region of very fast winds that move across the country. Inspection of the isotach patterns at these levels not only reveal the location of the jet streams, but aid the meteorologist in locating the regions of largest acceleration, deceleration and wind shear (rapid changes in wind speed and/or direction); these regions contribute to the upper level horizontal divergence and convergence patterns that influence surface weather systems. FEATURES OF THE ISOBARIC SURFACES The constant pressure charts differ slightly from the constant altitude charts, such as the surface analysis, which display weather information at the same geometric altitude.

A constant pressure surface (or "isobaric surface") can be visualized as a reasonably horizontal, but undulating, three- dimensional surface in the atmosphere, where all points on the surface have the same reported atmospheric pressure. The altitude of the isobaric surface above sea level depends upon the density, and hence the temperature, of the intervening air column.

In regions where the air in that column is cold and dense, the altitude of that isobaric surface will stand lower than over a region where the air is warmer and less dense. Since isobaric surfaces are three dimensional surfaces, "height contours" (or simply, "contours") drawn upon an isobaric chart represent the topography of that pressure surface in identical fashion as isopleths of the same name drawn by cartographers upon topographic maps to depict the terrain. Contours separate regions of high valued height for a given region from lower altitude regions. Because of the contour patterns, the higher altitude regions representing poleward intrusions of warm air, are identified as "height ridges" or simply, "ridges". On Northern Hemisphere upper air charts, these ridges can be identified as regions where the height contours deviate far to the north.

Strong ridges are usually associated with warm and dry surface weather. On the other hand, the lower altitude portions of the pressure surface are "height troughs", or "troughs", with equatorward intrusions of cold polar air.

Troughs can be identified on a upper air chart as regions where height contours are deflected far to the south. Stormy weather and cold temperatures at the surface are often found under upper level troughs. The isotherms and the resultant analyzed temperature field on many of the upper air charts often supports the above relationships. Typically, the best agreement occurs in the lower to mid troposphere. Some displacement of the isotherms away from the ridges and troughs may occur especially in the upper troposphere. On the upper tropospheric charts isotachs are often drawn to identify the jet stream. Typically, a region of winds are considered to be a part of the jet if the winds were at least 70 knots (where a knot is the unit used for upper air charts, which is equivalent to one nautical mile per hour). These regions as highlighted by the isotachs may be elongated and frequently found near the southern excursion of a trough. Last revision 10 June 1996 hopkins@meteor.wisc.edu Master

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