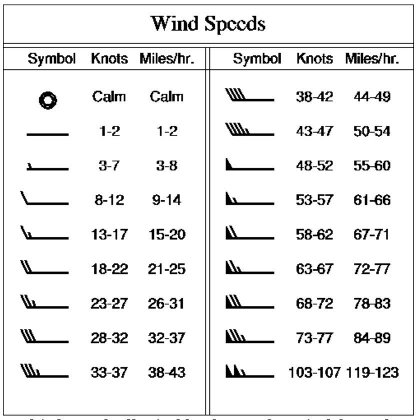
ASP Windgram Reading — soaring forecasts highlights on one diagram.

Winds | Stability | Lift | Clouds and Moisture | Temperature | Altitude | Summary

A windgram is a forecast for a ***single spot on the map*** *over the course of the day* and shows several things about what is expected to happen.
The vertical axis is the *altitude above the ground*, while the horizontal axis is *time of day*.

Wind-Barbs show *wind speed* and *direction*. Color shows the *lapse rate*, or rate of change of temperature with altitude. The numbers at the top show the expected *upward velocity of thermals* at the time where time is on the bottom axis. The little paragliders show *how high* a 225fpm sink rate glider *can expect to get*, while the clouds show where any *cumulus clouds would form* if there is enough moisture.. The *temperature* is shown on contour lines with *freezing level* represented as snowflakes.
All these things are superimposed on the *height by time* graph.
Details below:

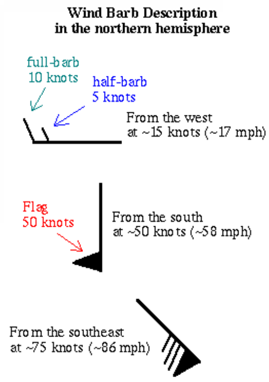


Wind Speeds

Symbol	Knots	Miles/hr.	Symbol	Knots	Miles/hr.
	Calm	Calm		38-42	44-49
	1-2	1-2		43-47	50-54
	3-7	3-8		48-52	55-60
	8-12	9-14		53-57	61-66
	13-17	15-20		58-62	67-71
	18-22	21-25		63-67	72-77
	23-27	26-31		68-72	78-83
	28-32	32-37		73-77	84-89
	33-37	38-43		103-107	119-123

In this legend, all wind barbs are for wind from the West.

Wind-Barbs
show wind speed and direction.
Speed is in knots. The **green color** is given to wind barbs that represent less than 9 knots, so single barbs that range from 7.5-12.5 knots are **green up to 9 knots,** the low end of the range and **white above 9 knots,** in the high end.



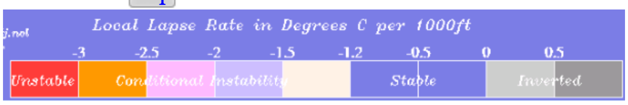
The **f**eathers are where the wind is coming **f**rom the skinny end is where it is going.

The wind IS the arrow.

Conversion factors		Enter known speed on right. Click convert.	
10 mph →	8.7knots →	16 kph →	4.5 mps
10knots →	11.5 mph →	18.5 kph →	5.14 mps
10 kph →	6.2 mph →	5.4knots →	2.78 mps
1 Meters/second (mps) → 197 feet/minute (fpm)			
10 Meters/second (mps) → 36kph → 22.8mph			

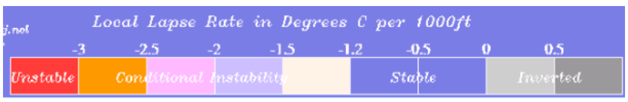
miles (mph)
knots (kt)
kilometers (km/h)
meters/sec (m/s)
(ft/sec)
(ft/min)
Beaufort
Convert
Reset

top



Stability indicated by Background Colors:

We don't need completely unstable air to fly!
- *Backround colors* represent the "local" lapse rate at each time and altitude in C°/1000ft.
  For those familiar with **soundings**, the color represents the ***slope*** of the red temperature line.
- The lapse rate is change in temp / change in altitude as we go up.



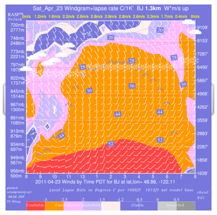
Most foot-launch soaring happens in the range where windgrams are pink or orange.
Although we do often fly when the lowest levels are red.

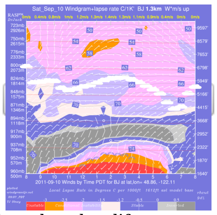
(higher altitude temp) - (lower altitude temp)
(thousands of feet between them).

If it's warmer than *it should be* up high, stable air happens.
If it's lots colder than *it should be* up high and moist enough, thunderstorms happen.
Most flyable days are in between the two extremes.

The ***Standard lapse rate*** is -2.0 C° per 1000 feet — -2 — -3.6F° per 1000 feet, considered the rule of thumb **for marginally stable air**.

In terms of a foot-launch site, if the launch is 2000 feet above the LZ, the standard lapse rate would mean that the air temperature at launch is 4.0C° cooler than at the LZ. If it is cooler than that, you can expect thermals. If it is more than 6C° cooler than the LZ at launch, you can expect strong thermals. During the course of a day, the warm air at the base mixes with the cooler air above. While the sun is out, the surface air keeps getting enough hotter that it still rises through the mixed air. At sites near water, the cooling effect of the water will change the way this happens, decreasing the thermals when the air is warmer than the water, and increasing them when the air is significantly cooler than the water.

 Which resulted in these flights: 

 Compared to a day with a strongly inverted CAP at the same site (Sept 10, 2011) that was reported to have zero wind at launch and no lift.

To view the windgram for any day in the past few years that you flew a NW site, click here.

Unstable The atmosphere is Absolutely Unstable	**Conditional Instability** The atmosphere is Conditionally Unstable Thermal soaring *can* happen	**Stable** The Atmosphere is Absolutely Stable Thermal soaring *will not normally* happen. (see discussion of the CAP below)	**Inverted** The Atmosphere is Inverted Thermal soaring *will not* happen.
When the lapse is more negative than the near constant *dry adiabatic lapse rate* -9.8 C°/km. or -3 C°/1000ft) or -5.5 F°/1000ft	When the lapse rate is between -9.8 C/km and -4 C°/km or between -3 C°/1000ft and -1.2 C°/1000ft or between -5.5 F°/1000' and -2.16 F°/1000'	When the lapse rate is still negative but a smaller magnitude than -4 C°/km or -1.2 C°/1000ft or -2.16 F°/1000ft	When the lapse rate is positive, that is when the higher level air is warmer than the lower air.

We don't need completely unstable air to fly!

Note that when the weather forecasters talk about *unstable air*, they are indicating that it is unstable enough for **rain** to be likely. Overall stability will depend on moisture content. More moisture → less cooling as the air rises → increasing instability.

To think about thermal soaring, remember that the higher the lapse rate the smaller the heating or mechanical trigger required to get air to start rising. It cools as it rises and expands to lower pressure. Once rising, it will rise until it reaches either the level where its temperature matches the surrounding air, or where the temperature has dropped to the dew point and clouds form. Once a cloud forms, the condensation process generates additional heating allowing the clouds to billow up further. These are our favorite cumulus clouds aka Cums, Cus, or Qs and indicate the top of a column of rising air.

Layers of air where the lapse rate becomes stable are called ***caps***. When there is **no cap**, the billowing clouds become self-sustaining and can become rain or thunderstorm clouds. Windgrams do an excellent job of showing where the cap is at any given time of day. In the summer, the cap will typically rise during the hottest part of the day and then descend again later. It is rare to ride a thermal as high as the cap, but it is *possible* for strong thermals to "break through" a cap and soaring can continue to much higher altitudes. There is often considerable turbulence associated with breaking through a cap. Moist thermals that are forming clouds that manage to break through the cap often form rain and thunder clouds.

see JEFF HABY Thermodynamics Q&A
TJ Olney

- **Lift:** top
  - *Numbers* at the top are the W* or the expected Thermal updraft velocity in meters/second (1m/s ~= 200ft/min) without cloudsuck or ridgelift at that time.
  - *Paragliders* show the highest a 225fpm (1.14m/s) sink rate glider can expect to get. (YMMV)
  - *Anomalies:* Sometimes, mid-day, there will be a period where there appears to be no lift while before and after it there is an indication of good lift. This may or may not reflect a real phenomenon. Sometimes it does represent a period of widespread cloudiness that blocks the sun and kills lift. Sometimes the sun is blocked, but there is still lift that was not forecast on the windgram. RASP does NOT forecast cloud suck.
  - *Convergent/Divergent upward velocity* : The windgrams may one day include the spot prediction for non-thermal vertical motion of the air. For now refer to blipspots or the blipmaps themselves for predictions of this phenomenon.
    From Dr. Jack: Note that convergence line dynamics occur on a much smaller scale than is resolved by the model - for example, the actual upward motion has a width on the order of 100 m compared with typical model resolutions of 12-20 km. Model convergence must be spread over a grid cell rather than the actual convergence line width, so the model will greatly under-predict the magnitude of this upward motion (this is depicted in a diagram comparing actual vs. model convergence)."

- **Clouds:** top
  - *Small clouds* represent the expected LCL (Lifted Condensation Level ≈ lowest cloudbase), but do not mean that there will be clouds.. LCL is listed on the Blipspots
  - Areas of ***white*** *cross-hatching* are times and levels where relative humidity > 94% so actual clouds are very likely there. Marine stratus seems to show up nicely. Blanchard morning clouds do as well. This marking doesn't work quite as well for higher stratus clouds and doesn't work at all for cumulus clouds.
  - *Green bars hanging down* tell the expected accumulated rain from the previous hour.

- **Temperature:** top
  - *Numbers* on contour lines are temperature.
  - *Snowflakes* mark the lowest freezing level at that particular time.

- *Horizontal bars* (if present) show the top of the *Boundary layer* , from which BlipMaps™ get their name. This level is often called the *mixing height*.
- *That Blue and/or Gray layer above the little clouds* is known as the the *cap* . It is a layer of stable air that inhibits lift because rising air is no longer warmer than the surrounding air.. When the cap is thin, there is a real possibility that strong thermals can break through it and then the lift can go up much further. When there is no *cap* there is often a possibility of convectively generated showers or thunderstorms, as the condensation/heat engine comes into play.

see Alan Crouse's annotated windgram

- **Altitude and Pressure levels:** top
  - The altitude scale is **at best approximate**. In most conditions, 30ft /1 Hpa. or every 10mb is about 300ft.
    Today the pressure to altitude correspondence looks like this (scroll window):

    Refresh Pressure Readings 60min → last pressure refresh 7:45 PM
    show_forecast_heights(fcstday)

    Forecast heights based on Monday RASP forecast pressure and temps at KBLI .

	07:00	08:00	09:00	10:00	11:00	12:00	13:00
1000mb	-	-	-	-	-	-	-27'
990mb	-	-	-	-	-	-	245'
980mb	-	-	-	-	-	-	521'
970mb	-	-	-	-	-	-	800'

    So 850mb is usually around 5000 feet and Sea Level is 1014mb ish, on average. The correspondence between pressure and altitude can easily change by 300 feet over the course of a day, which explains why we have to adjust our varios so often so that the current pressure corresponds to our known altitude.

  - The white horizontal lines on the windgram are constant pressure lines. The red line is the altitude of that pressure. The lines start the day at the same level. If the red line is below the white line at the end of the day, it means that the pressure is expected fo fall during the day. If the red line is above the white line at the end of the day it means that high pressure is building.
    For a fairly dramatic example, see this during a December 2010 Pineapple Express event.

Summary

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So, just picture yourself standing on launch looking straight up each time column. Because of your incredible visualization ability, you can see the windbarbs in the air floating above your head. You can also see the changing colors that tell you how quickly the temperature is changing overhead. You will stop climbing before you get to the white, gray or blue layers. The little clouds are just like the little clouds you see at launch. The paraglider is the best pilot you know at the limit of available thermal lift. The snowflakes tell you where your water bottle will start to freeze, and the cross-hatches are the major clouds as a ceiling over your head, not the puffy type, but the widespread type. All the way at the top of the column, you see a sign that tells you the vertical speed limit for thermals that hour. Floating between you and the top number are other numbers that tell you the air temperature in F° at the altitude where they appear. They are connected by lines that help you know whether the temperatures are rising, falling, or steady.

The annotated windgram from Alan Crouse in Southern California might help as well.

I developed the windgrams based on two common forms of display often called meteograms or time-height plots. None of the examples that I could find displayed the things that were most relevant to foot-launch soaring or to soaring in general. Dr. Jack Glendenning's RASP system output all the relevant variables and his Blipspots™ are a numerical snapshot of a point in time, but most people seem to respond better to a graphical presentation than to a table of numbers. Hence, I developed the Windgram. They are now in use by RASP operators in many parts of the world. I hope you find them useful. TJ Olney

See the MM5 tutorial at Cascade Paragliding Club
or details about Skew-t diagrams.
A summary of the different ways we try to measure instability.

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Using Windgrams?

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