APanel Documentation

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Introduction

APanel (Astroweather Panel) is a numerical weather product which is especially designed for astronomical purpose. The forecast data is extracted and refined from NCEP/GFS model. A description of the GFS model may be read at http://www.emc.ncep.noaa.gov/gmb/moorthi/gam.html.

APanel updates four times a day (generally around 05 UTC, 11 UTC, 17 UTC and 23 UTC, may be delayed under bad network quality), the forecast graph is generated in real-time.

APanel is a product of 7Timer!.

How to use

To use APanel, select a site from the web-based database, or enter the longitude/latitude value of a specific site. You may need to wait for a few seconds until the graph to be generated. On the graph, each column represents a time, and each row represents forecast for an element. Refer to the legend section at the bottom of the page for the meaning of different symbols and colors.

☑ Select a site in GNS database

7Timer! has provided a database that covers over 2 millions of cities, towns and villages in every countries over the world. The site data is obtained from National Geospatial-Intelligence Agency (NGA) for non-United States areas (including Dependent areas) and U. S. Geological Survey (USGS) for U. S. areas. Before using the GNS database, you may to read a statement of NGA at http://earth-info.nga.mil/gns/html/index.html; technical description of GNS service may also be found at this site. To use the GNS database, select the administration region and sub-administration region (if any), then select the specific site.

☑ Enter coordinates

You may enter site coordinates for a forecast graph instead of selecting a site in GNS database. Please make sure that the coordinates are entered as (+/-)DD.DDD, other formats such as DD MM SS or DD MM.M are not supported at the moment. There is an option called Altitude Correction, in most occasions you do not need to modify it. But if your site is much higher than nearby area (such

as high peaks), you may select a correction that is closest to the altitude of your site. For details, please refer to the next paragraph.

☑ Altitude Correction

To understand how it works with the Altitude Correction option, we should first take a look at the properties of forecast data. The resolution of the forecast data is 0.5 arc deg (about 35 kilometers), this roughly means that every data point stand for an average data value of a square area of 35km× 35km. In most cases, the average value applies to the data value of any given point in that square area, as the terrain of a 35km×35km area does not vary much. An example of situation of a common terrain is shown as Fig. 1.
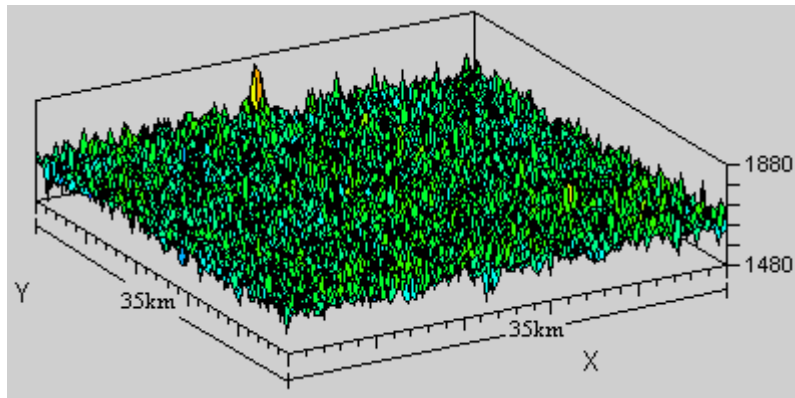

Fig. 1: An example of situation of a common terrain

Taken Z-axis as elevation, we may note that the elevation does not change much in this area, generally around 1600m to 1800m. Thus, the equivalence of the "average" data value to any given point in this area is acceptable. In this situation, the Altitude Correction shall be retained at the "default" option. By contrast, we may take a look of Fig. 2 as below.
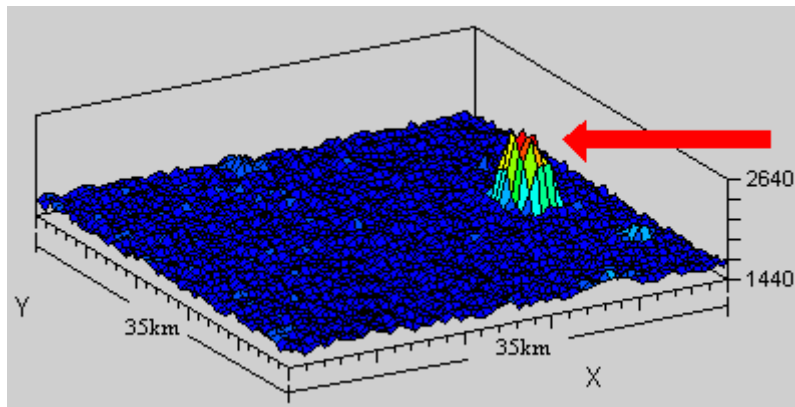

Fig. 2: An example of situation of a complex terrain

Taken Z-axis as elevation, we may note a high "peak" (the area that a red arrow points at) is presented in this area. As the altitude of this area is roughly around 1700m, the "average" data value of this 35km×35km area is not applicable to the top of the peak (which is at an elevation of about 2600m). In such a case, an Altitude Correction is needed.

You may ask, "When should I use the Altitude Correction?" Past experience shows that if your site is several hundred meters higher than your surrounding area (or "surrounding 35km×35km square area"), you may consider to use the Altitude Correction. There are three options available besides

retaining at the default value, "2000m above MSL", "3000m above MSL" or "4000m above MSL". Please note that these values stand for the mean-sea level altitude of your site, not your relative altitude to your surrounding area. In the example above, an option of "3000m above MSL" may be selected. Sometimes a "nearby" option turns out to be unsuitable for a site, then other options may be selected and kept that is most consistent to the actual weather. In the example above, if the "3000m above MSL" does not bring a satisfying performance, we may try for "2000m above MSL" or even retain at the default option.

☑ Read the forecast

You should be able to see something like Fig. 3 after selecting a site fron the GNS database or manually enter a valid coordinates. Brief explanations of each sections are given in Fig. 3.
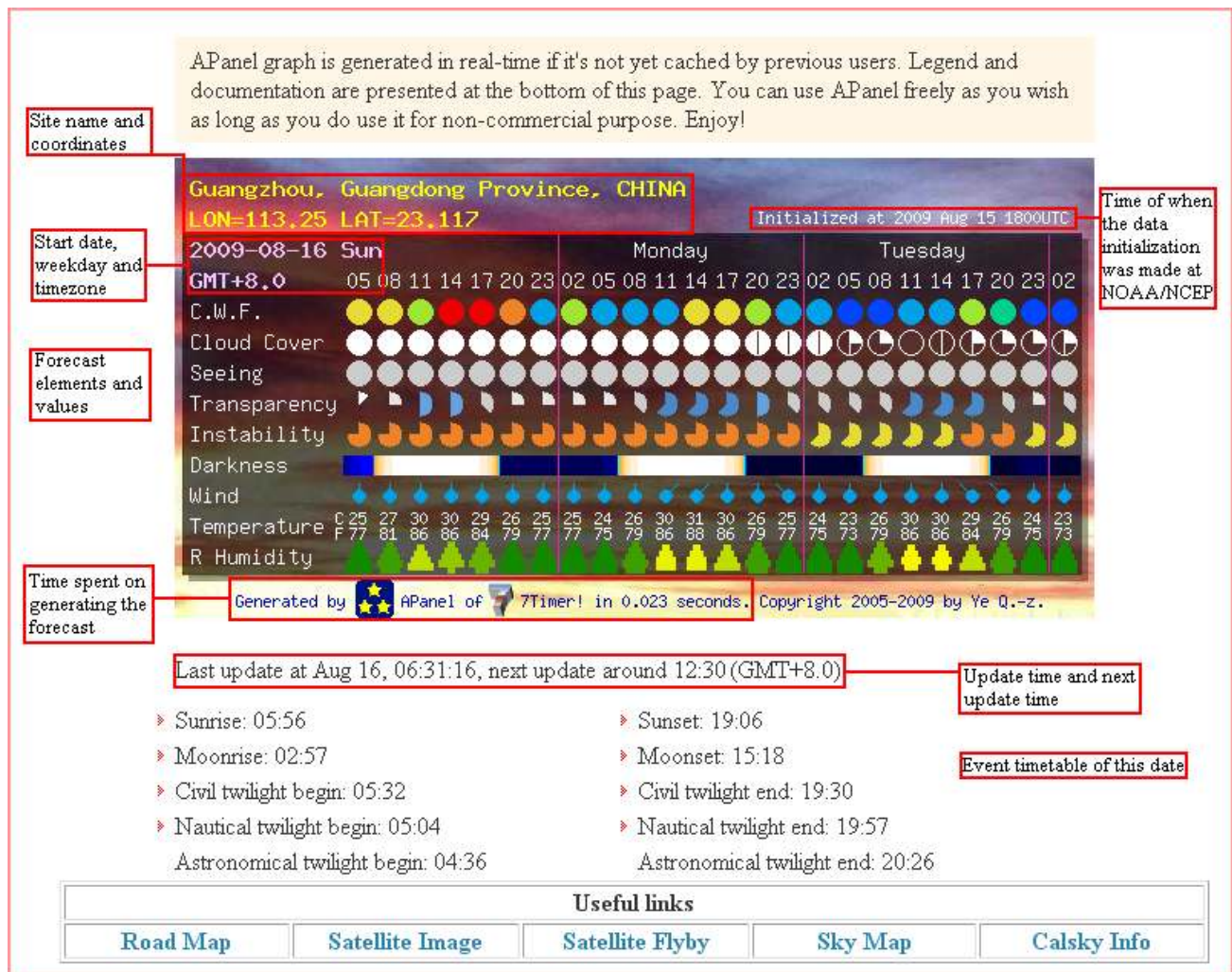

Fig. 3: Interface of APanel forecast page

Please read the image from left to right. Each column represents a time, and each row represents forecast for an element. Then refer to the legend at the bottom of the page for the meaning of different symbols and colors. For example, if we would like assess the observing environment at Guangzhou (Lon. 113.25E; Lat. 23.117N) of 2009 August 17/18, we may do as 1) Find the columns that stand for August 17 20h CST to August 18 05h CST (as Fig. 4); 2) compare the symbols and colors with the legend. Don't worry, the symbols and colors are carefully designed to make users read then quick and easy.
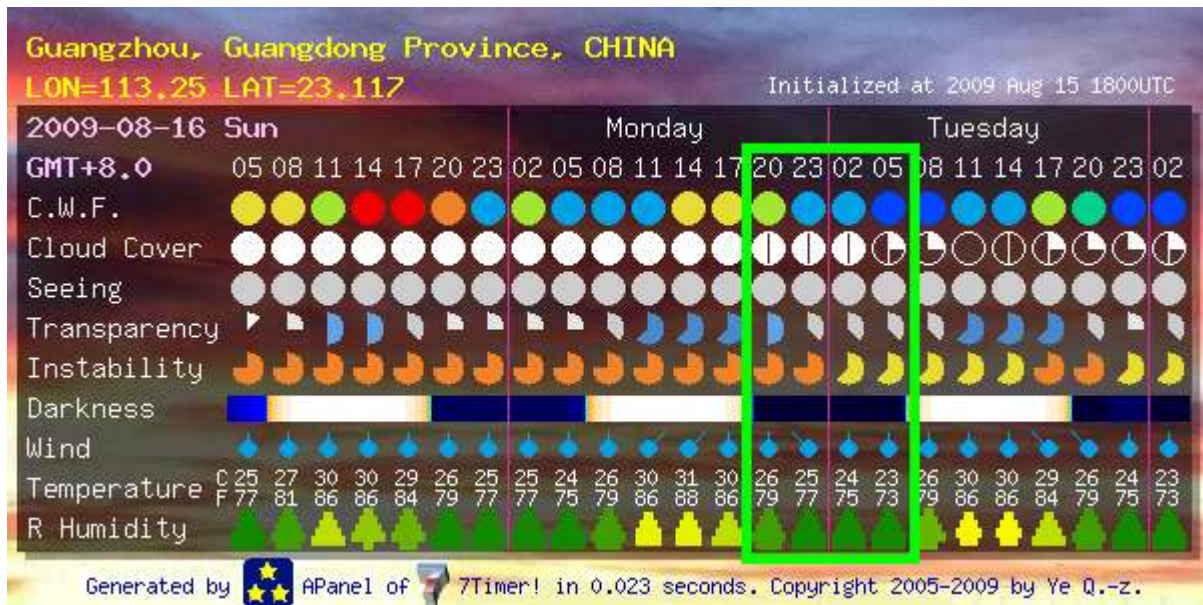
Fig. 4: Tutorial of getting APanel forecast

So now we may get the forecast for 2009 August 17/18, initialized at 2009 August 15 18h UTC, as below: clouds are likely to grow at the beginning of the night (moderate C.W.F. at 20h CST), mostly cloudy (7/8 covered) until morning and may become partly clear toward dawn (3/8 covered at 05h CST); poor seeing over the night (1.5"-2"), generally poor transparency over the night, light northerly wind; instability is moderate, and the temperature is 26-23 Centigrade or 79-73 Fahrenheit; very humid over the night (above 90%).

You are welcome to put the graph on your pages, for details please refer to the instruction at the bottom of the page.

☑ Performance and tips

APanel was opened in 2005 (previously known as Panel). In fall 2005 several colleagues and I had monitor its performance from several cities in eastern China for about a month, the cloud cover accuracy for 48 hours is 67% (Ye, 2005). Another performance study that covers 7 months and over half a dozen places over the world is in progress. Generally speaking, although there have been some disputes about the reliability of cloud cover forecast from a computer model, the performance of APanel is satisfying. As the developer of APanel, I have monitored its performance almost everyday. I summarized my experience into the tips below, and I hope they can help you take best use of APanel and make best decisions when necessary.

1) Keep in mind that APanel is a fully automatic forecast; it's just guesses made by computers. If you are familiar with the weather of a site (especially a site on highland or mountainous area), be confident. I had work for three weeks for the weather of 2009 July 22 total solar eclipse, relying both on personal or predecessors' experience and APanel's indication. The final result proved again that although computer sometimes makes exceptional guesses, human minds are more important in many cases those with a complex situation.

2) Forecast for inland is of better accuracy. For comparison, staffs of Xingming Observatory (near Urumqi, Xinjiang Region, China) figured the accuracy to be 90% or even better for 120h forecast, although the observatory is located on a flat highland; however the forecast accuracy of

Guangzhou (the city I live, at the coast of South China Sea) is no more than 70% for 48h forecast, as mentioned earlier. Forecast accuracy for Lulin Observatory (located at central Taiwan, a mountainous area with very complex terrain surround by sea) is no more than 20%.

3) Cirrus is difficult to predict because some cirrus are thin enough for observations; but the forecast may says the sky is 8/8 covered. When you see many thin cirrus in the afternoon and the forecast says tonight will be 7/8 or 8/8 covered, be aware. It can still be observable.

4) Sometimes APanel makes excellent guesses about when the cloud patch arrives or departs, but there may be an uncertainty of a few hours. When you see such an indications on the forecast, check satellite images if available, locates the cloud patch, and make preparations accordingly. Also, in many occasions, the forecast of cloud cover percentage is not exactly correct, but the trend matches.

5) In mountainous area (or when the Altitude Correction is needed), the cloud cover may not be correct. You may check relative humidity forecast instead of the cloud cover's. When the humidity is high, it is possible that your site to be surrounded by clouds.

6) As mentioned earlier, the forecast value is an "average" value of surrounding 35km×35km area, deviation of a few degrees of the temperature forecast is possible.

7) Local clouds caused by convection are hard to predict; however you may assess the chance reading C.W.F. and instability forecast. Instability forecast is widely used on assessing the possibility of bad or violent weather – such as thunderstorms. However, a low C.W.F. value doesn't mean that the sky will be clear – the clouds can as well to move in instead of grow over your head. A high C.W.F. value does not promise a cloudy weather either.

Technical information of elements

☑ Cloud work function (CWF)

The cloud work function (CWF) is defined as a vertical integration of work by buoyancy per unit mass flux (Arakawa and Schubert, 1974), it represents the stability of the atmosphere with respect to each cloud type by the amount of work done per unit cloud base mass flux for that cloud type (Emanuel, 1994). It can be written in as:

$$A \equiv \int_{z_B}^{z_T} B\eta\, dz = \int_{z_B}^{z_T} \frac{g}{\bar{T}}\left[(T^c - \bar{T}) + \bar{T}(\epsilon(q^c - \bar{q}) - l^c)\right]\eta\, dz$$

Generally speaking, the cloud work function is the vertical integral of the buoyancy term; it is a function of the cloud base vertical motion. Cloud work function can be roughly treated as the indicator that how much energies are there for cloud production to consume, the cloud here generally refers to cumulus since they are much more often produced by convection than other clouds.

<0	0-25	25-50	50-100	100-200	200-300	300-500	>500

(Unit: J/kg)

☑ Cloud Cover

Cloud cover refers to the fraction of the sky obscured by clouds when observed from a particular

location (Huschke, 1959), it is expressed either in oktas (in eighths) or in tenths. APanel adopts the same display mode as the station model on weather maps, which represents the cloud cover with a filled circle. The legend below spans the entire spectrum of cloud cover symbols and cloud cover reports.

Clear	1/8	2/8	3/8	4/8	5/8	6/8	7/8	Overcast
Clear Skies		Scattered Clouds				Broken Clouds		Overcast

As the description of GFS introduced, the cloud cover for a grid point is computed diagnostically following the approach of Xu and Randall (1996) using the formula

$$C = \max\left[R^{0.25}\left(1 - \exp\left\{ - \frac{2000 \times (q_c - q_{cmin})}{\min[\max\{[(1-R)q^*]^{0.25}, 0.0001\}, 1.0]} \right\}\right), 0.0 \right]$$

where R is the relative humidity, q^* is the saturation specific humidity and q_{cmin} is a minimum threshold value of q_{min}.

☑ Seeing

The astronomical seeing conditions on a given night at a given location describe how much the Earth's atmosphere perturbs the images of stars as seen through a telescope. The seeing here is a reference to the best possible angular resolution which can be achieved by an optical telescope. The computation of seeing in APanel is described below.

To start with, we defined

$$C_N^2 = C_T^2 \left(\frac{7.9 \times 10^{-5} P}{T^2}\right)^2$$

Where P is the pressure in hPa, T is the temperature in K, and the temperature structure coefficient C_T^2 is defined as

$$C_T^2 = \frac{(T(x) - T(x+r))^2}{r^{\frac{2}{3}}}$$

Where r is the separation vector and T is temperature. Seeing quality is therefore related to high-frequency temperature fluctuations associated with atmospheric turbulence.

In our seeing model, we convert the coordinate system from z to p, thus,

$$C_T^2 = \frac{(T(p) - T(p+dp))^2}{(dp)^{\frac{2}{3}}}$$

From 1000hPa to 750hPa, the separation vector is 50hPa; and from 700hPa to 200hPa, the separation vector is 100hPa. Pressure reductions due to various height is considered.

When C_N^2 is deduced, seeing parameter r_0 (also called Fried parameter) can be calculated by

$$r_0 = \left(16.7\lambda^{-2}(\cos\gamma)^{-1} \int_0^\infty dh C_N^2(h) \right)^{-3/5}$$

Then we can convert r_0 to the well-known "seeing" in arcsec by

$$SI = 0.98 \times \frac{\lambda}{r_0}$$

In the chart, seeing is scaled as followed:

<0.5"	0.5"-0.75"	0.75"-1"	1"-1.25"	1.25"-1.5"	1.5"-2"	2"-2.5"	>2.5"

Generally the actual seeing is slightly worse than the prediction as of the contribution of the turbulence near the ground.

☑ Transparency

The transparency here is an integrated measure of the extinction of sky objects. The extinction is generally caused by the moisture of atmosphere. In this forecast, both moisture and ozone are taken into account but industrial pollutants or aerosols (although they are big contributors for starlight extinction as well), because they are hard to be measured and predicted by far. The transparency model can be expressed in the following manner:

$$\varepsilon = 0.1066e^{-\frac{9}{820}} + 0.12e^{-\frac{3}{50}} \times \left(\frac{0.68}{\lg(R/100)}\right)^{\frac{4}{3}} + 0.0001OZ + 0.031 \times 0.0094R \times e^{\frac{T}{15}} \times e^{-\frac{9}{820}}$$

Where R is the average 0-30mb (about a few hundred meters) above ground relative humidity, T is the average 0-30mb above ground temperature, and OZ is the ozone density in entire atmospheric column. The result is in V magnitude per air mass.

The forecast of transparency is displayed by colors and in eighths; the symbol can be converted into values with the chart below.

<0.3	0.3-0.4	0.4-0.5	0.5-0.6	0.6-0.7	0.7-0.85	0.85-1	>1
○	◔	◕	◑	◗	◗	▯	▷

(Unit: magnitude/air mass)

☑ Instability (Lifted Index)

The lifted index (LI) is the temperature difference between an air parcel lifted adiabatically Tp(p) and the temperature of the environment Te(p) at a given pressure height in the troposphere (lowest layer where most weather occurs) of the atmosphere, usually 500 hPa (mb). When the value is positive, the atmosphere (at the respective height) is stable and when the value is negative, the atmosphere is unstable. The forecast of instability is displayed by colors and in eighths as below:

>11K	8K~11K	4K~8K	0K~4K	-3K~0K	-5K~-3K	-7K~-5K	<-7K

LI and the condition of instability can be scaled as followed (Blanchard, 1998):

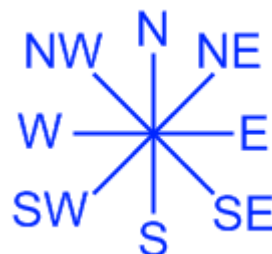| Range (K)	Amount of Instability	Thunderstorm Probability
more than 11	Extremely stable conditions	Thunderstorms unlikely
8 to 11	Very stable conditions	Thunderstorms unlikely
4 to 7	Stable conditions	Thunderstorms unlikely
0 to 3	Mostly stable conditions	Thunderstorm unlikely
-3 to -1	Slightly unstable	Thunderstorms possible
-5 to -4	Unstable	Thunderstorms probable
-7 to -6	Highly unstable	Severe thunderstorms possible
less than -7	Extremely unstable	Violent thunderstorms, tornadoes possible

☑ Darkness

The darkness here shows the visual limiting magnitude in zenith. It takes into account sun's and moon's position, moon phase, atmospheric moisture condition (transparency/starlight extinction), ozone thickness, and meteorological conditions near the surface, but light pollution is not yet included. The darkness model is modified from the model of Sugerman (2000), more technical details can be read at http://www.cleardarksky.com/others/BenSugerman/star.htm.

-4 -3 -2 -1 0 1.0 2.0 3.0 3.5 4.0 4.5 5.0 5.2 5.4 5.6 5.8 6.0

☑ Wind

The wind forecast here shows the average wind direction and speed at a height of 10 meters above the ground. The line points to the direction where the wind is blowing from.

Calm	Light	Moderate	Fresh	Strong	Gale	Storm	Hurricane

The conversion table of Beaufort Class and different wind speed units is shown below (Huler, 2004).

Beaufort Number	Description	General Description	Wind Speed			
			knots	km/h	mph	m/s
0	Calm	Calm	0	0-1	0-1	0-0.2
1	Light	Light air	1-3	2-6	1-3	0.3-1.5
2		Light breeze	4-6	7-11	4-7	1.6-3.3
3	Moderate	Gentle breeze	7-10	12-19	8-12	3.4-5.4
4		Moderate breeze	11-15	20-29	13-18	5.5-7.9
5	Fresh	Fresh breeze	16-21	30-39	19-24	8.0-10.7
6	Strong	Strong breeze	22-27	40-50	25-31	10.8-13.8
7		Near gale	28-33	51-62	32-38	13.9-17.1
8	Gale	Gale	34-40	63-75	39-46	17.2-20.7
9		Severe gale	41-47	76-87	47-54	20.8-24.4
10	Storm	Storm	48-55	88-103	55-63	24.5-28.4
11		Violent storm	56-63	104-117	64-72	28.5-32.5
12	Hurricane	Hurricane	64+	118+	73+	32.6+

☑ Temperature

The temperature here gives that on 2 meters above ground in both Centigrade and Fahrenheit (indicates by "C" and "F"). Celsius and Fahrenheit can be converted from/to each other by

$$[°F] = [°C] \times \tfrac{9}{5} + 32$$

$$[°C] = ([°F] - 32) \times \tfrac{5}{9}$$

☑ Relative Humidity

Relative humidity (RH) is a term used to describe the amount of water vapor that exists in a gaseous mixture of air and water.

<29%	30%-35 %	35%-40%	40%-45%	45%-50%	50%-55%	55%-60%	60%-65%	65%-70%	70%-75%	75%-80%	80%-85%	85%-90%	90%-95%	95%-99%	100%
▫	▫	▯	⊞	⊕	⊞	⊞	⊞	⊞	⊞	⊞	⊞	⊞	⊞	⊞	⊞