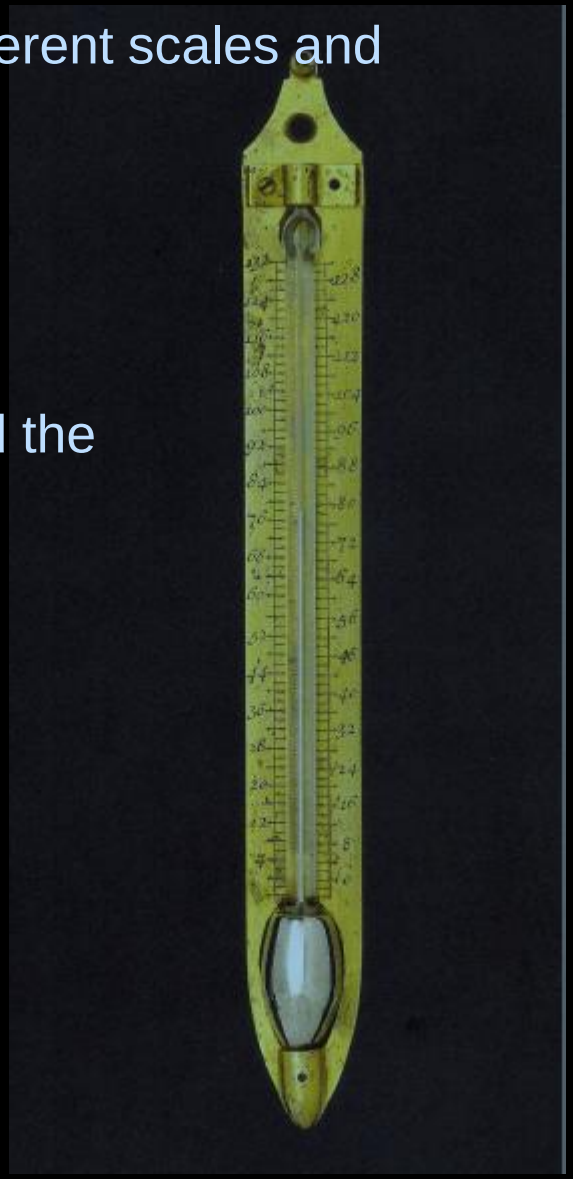
Understanding weather and the weather forecast

Week 11 Observing the Weather (2)

Terry Hart

Temperature measurement

Liquid in glass tubes developed in 1630s with different scales and reference points



Daniel Fahrenheit (1686-1736)

- 1714 Made alcohol in glass thermometers – choosing chilled brine solution for 0 degrees and the boiling point of water as 212.

Anders Celsius (1701-44) in 1742 decided on a 100-point scale (centigrade) but chose freezing and boiling points of water as the reference points. He initially chose 100 for freezing and 0 for the boiling point, but later reversed it.

1948 – **Celsius scale** adopted by most countries as the standard unit of measurement for temperature

Temperature measurement

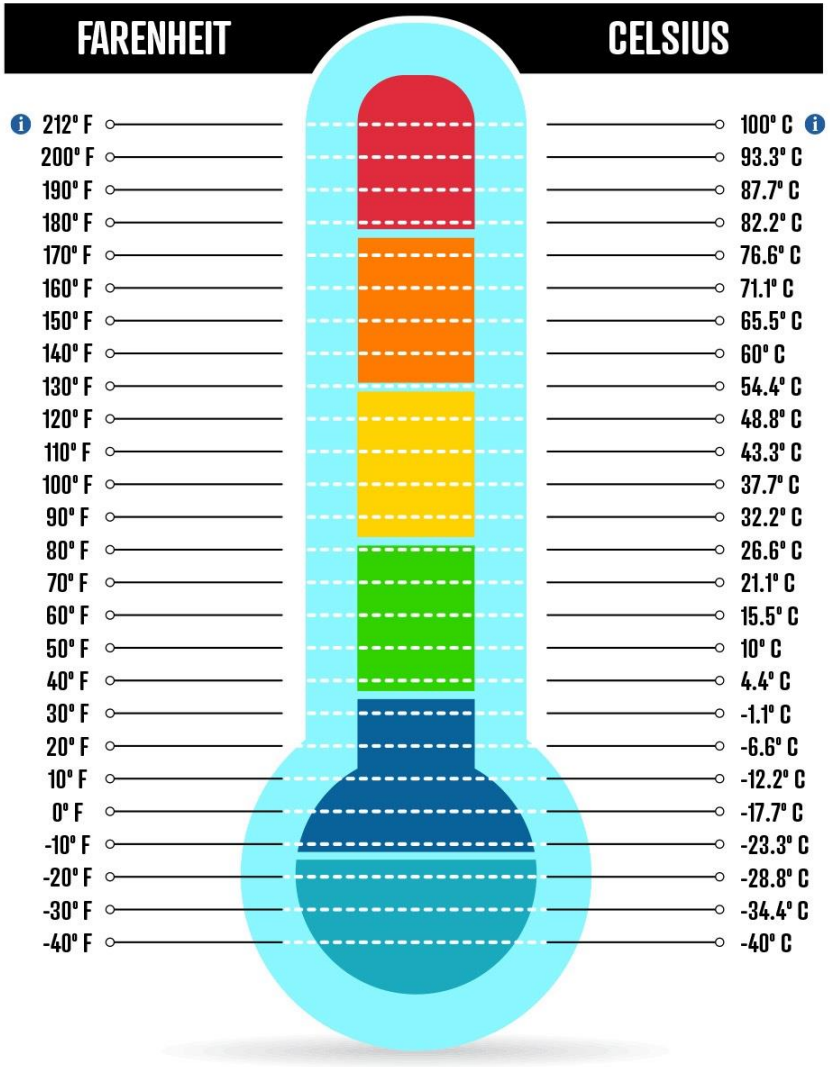
Stevenson screen

Louvred sides

YOUR DICTIONARY

CONVERSION CHART

Farenheit to Celsius



Celsius To Fahrenheit

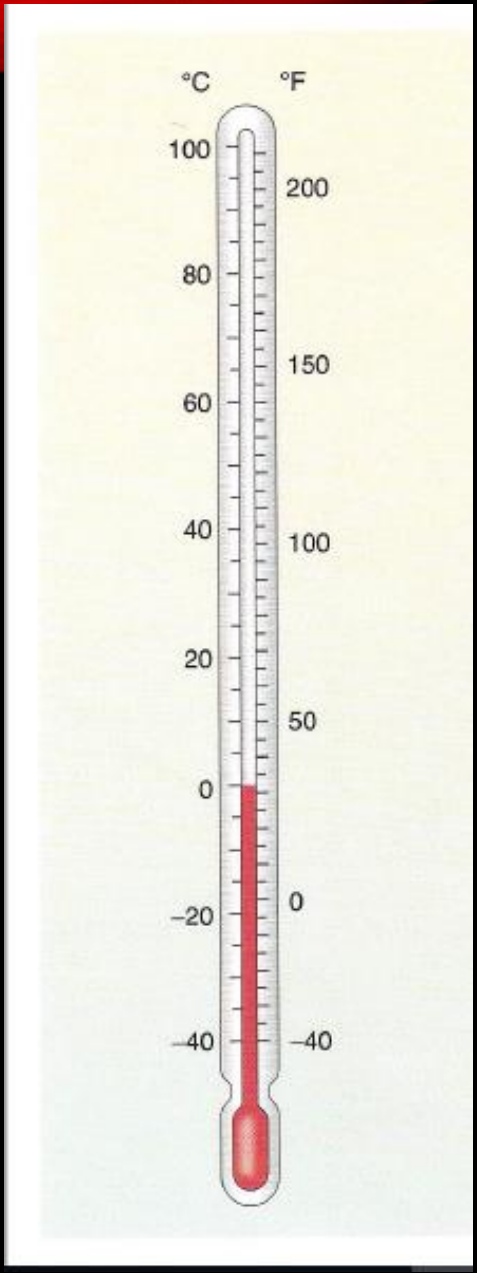
$$F = \frac{9}{5}C + 32$$

Fahrenheit To Celsius

$$C = \frac{5}{9}(F - 32)$$

Fahrenheit And Celsius Conversion

Temperature measurement



Converting Fahrenheit to Celsius and vice versa

$32^oF = ?\,^oC$
$0^oF = ?\,^oC$
$100^oF = ?\,^oC$
$68^oF = ?\,^oC$

$20^oC = ?\,^oF$
$40^oC = ?\,^oF$
$-40^oC = ?\,^oF$

Moisture in the atmosphere

Several quantities are used to report the amount of water vapour in the air:

(a) Wet bulb depression:

- wet muslin over the bulb of the thermometer
- air flow leads to a lower temperature called the wet bulb depression

(b) Dew point

- the temperature to which air would need for it to become saturated, and dew to start forming

(c) Relative humidity

- the ratio (expressed as a percentage) of the water vapour in the air to the amount of water vapour necessary for the air to be saturated

Measurement of wind speed and direction

- Surface wind speeds and directions are measured by an anemometer (propeller, cup, ultrasonic, pressure tube).
- a continuous record of wind speed and direction is recorded on an anemograph

Propeller anemometer

Cup anemometer

Ultrasonic

Cup and pressure tube (Dines) anemometer

Measurement of wind speed and direction

Wind Direction	Direction from which the wind is coming, relative to true North	16 compass points
(Average) Wind speed	Wind observations averaged over 10 minutes	Knots (marine) Kilometres per hour (km/h) for land purposes
Wind Gust	Wind observations averaged for 3 seconds	Knots (marine) Kilometres per hour (km/h) for land purposes

For marine users wind is usually expressed in knots

(1 knot = 1.85 kilometer/hour)

What is wind?

"Some say that what is called air, when it is in motion and flows, is wind, and that this same air when it condenses again becomes cloud and water, implying that the nature of wind and water is the same. So they define wind as a motion of the air.

"It is absurd that this air that surrounds us should become wind when in motion, whatever be the source of its motion."

Aristotle, Meteorologica, (about 350 BC)

Quoted in *"And soon I heard a roaring wind – a natural history of moving air", Bill Streever (2016)*

Even during the eighteenth century there was no successful scientific explanation of wind. It was a rushing stream of vapour, each wind distinct from the next. All that could be done was to note its characteristics, often in colourful prose such as:

- A dashing breeze
- A galloping gale
- A Shakespearean tempest.

1806 Francis Beaufort – captain of HMS Woolwich started a systematic approach in his ship's log:

0 calm

1 Faint Breeze just not a calm

.

6 Fresh breeze

7 Gentle steady gale

.

1838 – Beaufort scale adopted officially for naval use.

Peter Moore: The Weather Experiment.

Beaufort Scale

Beaufort Force	Wind Speed (kts)	Description	Sea Condition
0	0	Calm	Sea is like a mirror
1	1 – 3	Light air	Ripples but without foam crests
2	4 – 6	Light breeze	Small wavelets. Crests do not break
3	7 – 10	Gentle breeze	Large wavelets, perhaps scattered white-caps
4	11 – 16	Moderate breeze	Small waves. Frequent white-caps
5	17 – 21	Fresh breeze	Moderate waves. Many white-caps
6	22 – 27	Strong breeze	Large waves begin to form. White foam crests, perhaps some spray
7	28 – 33	Near gale	Sea heaps up. White foams blown in streaks along wind
8	34 – 40	Gale	Moderately high waves. Crests begin to break into spindrift
9	41 – 47	Strong gale	High waves. Dense foam along the direction of the wind. Crests of waves begin to roll over. Spray may affect visibility
10	48 – 55	Storm	Very high waves with long overhanging crests. The surface of the sea takes a white appearance. The tumbling of the sea becomes heavy and shock like. Visibility affected
11	56 – 63	Violent storm	Exceptionally high waves. The sea is completely covered with long white patches of foam lying in the direction of the wind. Visibility affected
12	64+	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray. Visibility very seriously affected.

Defined by Admiral Sir Francis Beaufort (1774-1857)

Force 0: Wind Speed less than 1 knot
Sea: Sea like a mirror

Force 1: Wind Speed 1-3 knots
Sea: Wave height .1m (.25ft); Ripples with appearance of scales, no foam crests

Force 2: Wind Speed 4-6 knots
Sea: Wave height .2-.3m (.5-1 ft); Small wavelets, crests of glassy appearance, not breaking

Force 3: Wind Speed 7-10 knots
Sea: Wave height .6-1m (2-3 ft); Large-wavelets, crests begin to break, scattered whitecaps

Force 4: Wind Speed 11-16 knots
Sea: Wave height 1-1.5m (3.5-5 ft); Small waves becoming longer, numerous whitecaps

Force 5: Wind Speed 17-21 knots
Sea: Wave height 2-2.5m (6-8 ft); Moderate waves, taking longer form, many whitecaps, some spray

Force 6: Wind Speed 22-27 knots
Sea: Wave height 3-4m (9.5-13 ft); Larger waves forming, whitecaps everywhere, more spray

Force 7: Wind Speed 28-33 knots
Sea: Wave height 4-5.5m (13.5-19 ft); S heaps up, white foam from break-ing waves begins to be blown in streaks along direction of wind

Force 8: Wind Speed 34-40 knots
Sea: Wave height 5.5-7.5m (18-25 ft):

Force 9: Wind Speed 41-47 knots
Sea: Wave height 7-10m (23-32 ft); High

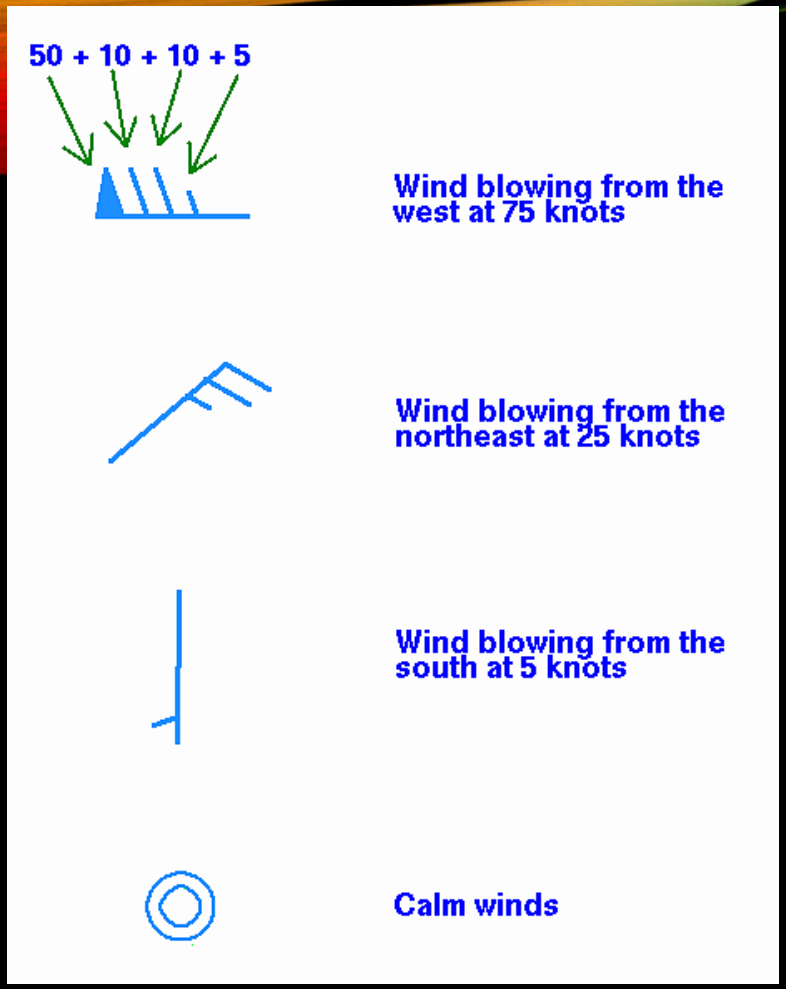
Force 10: Wind Speed 48-55 knots (storm)
Sea: Wave height 9-12.5m (29-41 ft); Very

Force 11: Wind Speed 56-63 knots
Sea: Wave height 11.5-16m (37-52 ft);

Plotting symbol for wind

(wind speed in knots)

Northern hemisphere version



The flags and pennants point to the low pressure.

The barbs in the figure are for the **Northern Hemisphere**, because the wind is circling anticlock-wise around a low-pressure area.

The flags and pennants are plotted on the opposite side in the Southern Hemisphere.

The wind barb shows the speed using "flags" on the end.

- Each half of a flag depicts 5 knots (9.3 km/h; 5.8 mph)
- Each full flag depicts 10 knots (19 km/h; 12 mph)
- Each pennant (filled triangle) depicts 50 knots (93 km/h; 58 mph)

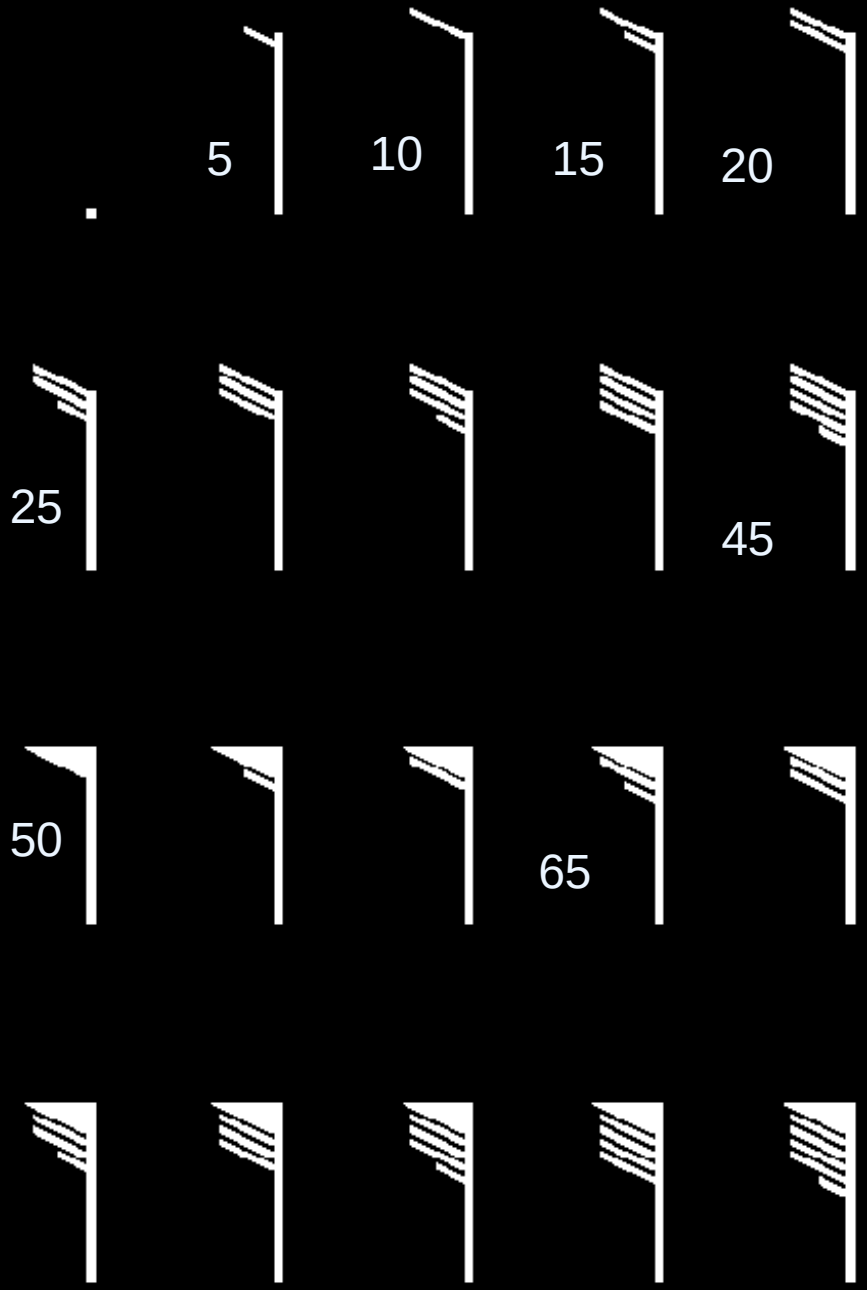
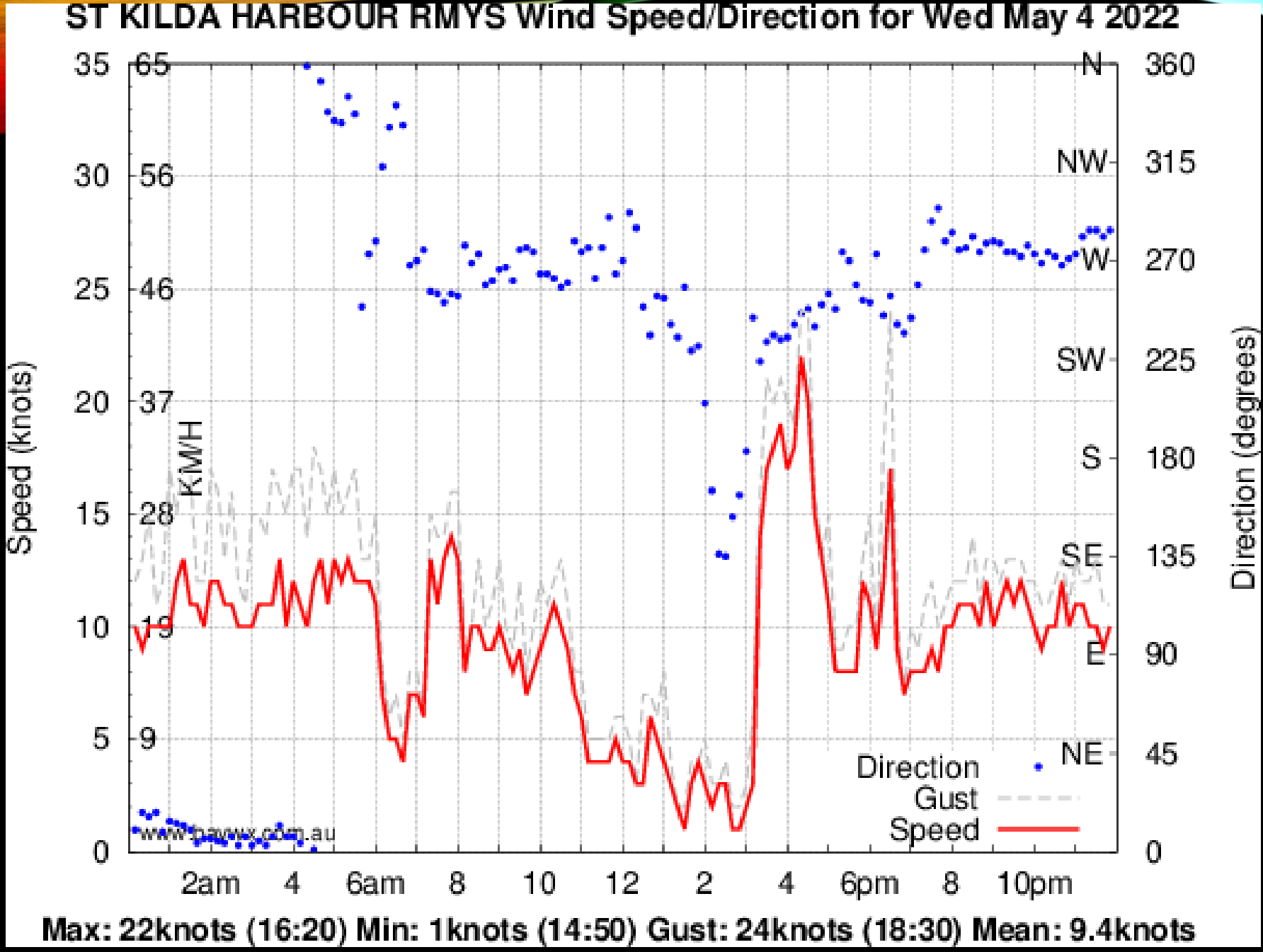


Diagram shows a northerly wind in the southern hemisphere.

Wind speeds are in knots.


ST KILDA HARBOUR RMYS Wind Speed/Direction for Wed May 4 2022
Speed (knots)
KM/H
Direction (degrees)
35
30
25
20
15
10
5
0
65
56
46
37
28
19
9
N
NW
W
SW
S
SE
E
NE
360
315
270
225
180
135
90
45
0
2am
4
6am
8
10
12
2
4
6pm
8
10pm
Direction
Gust
Speed
www.bawwx.com.au
Max: 22knots (16:20) Min: 1knots (14:50) Gust: 24knots (18:30) Mean: 9.4knots

Precipitation

- **Precipitation** - any product of condensation of atmospheric vapour that descends through the atmosphere under the influence of gravity.
  - includes rain, drizzle, snow, sleet and hail.
- **Virga** is precipitation that evaporates before reaching the ground.
- precipitation follows growth of raindrops or snowflakes within a cloud.
- approximately 500,000 km^3 of water falls as precipitation annually.
- average global precipitation is 990mm.
- Melbourne has an average annual rainfall of about 600mm/year; Tully in Queensland has an average annual rainfall exceeding 4000mm.

Measuring rainfall

- Daily rainfall totals measured using a rain gauge

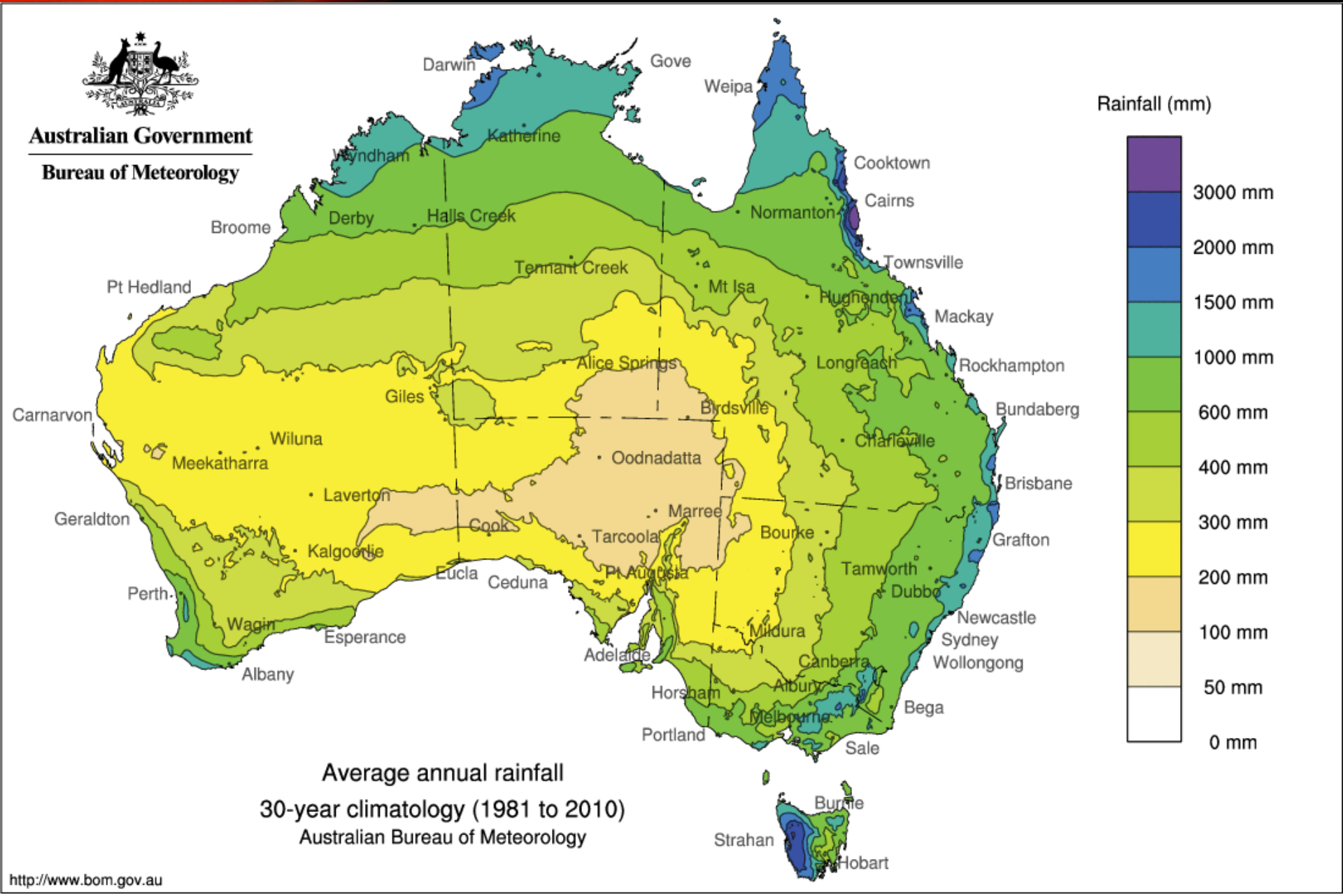
- a continuous record of rainfall (allowing for the measurement of rainfall rates) is recorded on a pluviograph.

Rain gauge

Pluviograph

The internal mechanism of a tipping bucket rain-gauge

Average annual rainfall distribution, Australia 1981-2010



 ID code: AnalyserRen Issued: 28/08/2020

Queensland Rainfall and River Conditions

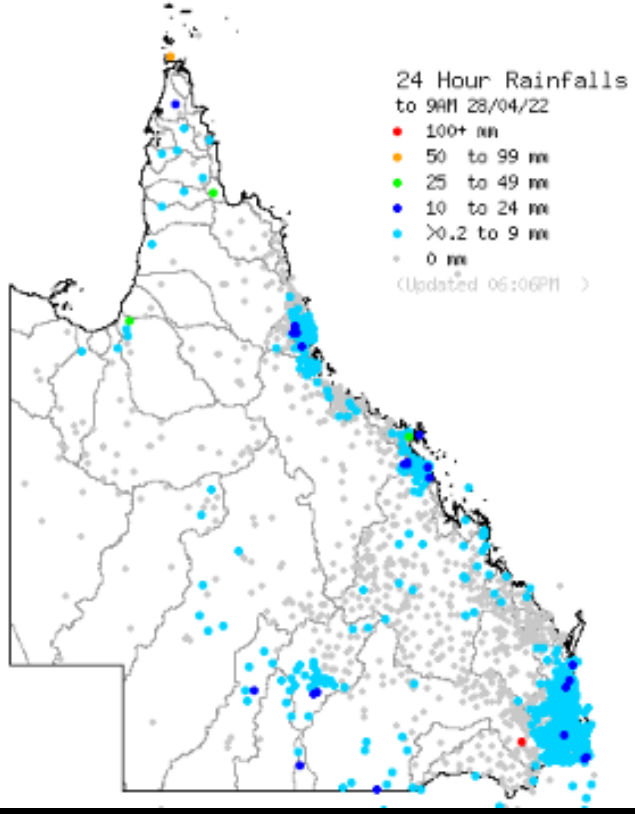
⚠ View the current warnings for Queensland

Display on map

- ○ River Conditions
- ○ Rainfalls Since 9am
- ◉ 24 Hour Rainfalls
- ○ Last 1 Hour Rainfalls

ⓘ About Map

Note: Map contains unchecked data from automatic equipment.
Please remember to refresh page so the data is up to date.



Zoom in to:

- Gulf & Peninsula
- Daintree to Townsville
  - Cairns to Ingham
  - Townsville
- Central Coast
  - Townsville to Mackay
- Mackay to Maryborough
- Maryborough to Gold Coast
  - Albert/Logan Rivers
  - Brisbane River
  - Mary River
  - Greater Brisbane
- South West
- Border Rivers
  - Macintyre River

Zoom out to:

- Queensland
- Australia

Other Links:

- Rain & River Data
- Forecast Rainfall
- Recent Rainfall Maps
- Queensland Service Level Specification
- About Flood Warning in Queensland
- About Flood Watch in Queensland
- Flood Gauge Information
- Queensland Flood History
- Heaviest Reported Rainfalls
- River Brochures
- Catchment Maps

Pan evaporation

- net evaporation combines the effects of temperature, rainfall, humidity and wind
- evaporation highest on hot windy days
- data vital for agricultural management

Sunshine recording

- Duration of daily sunshine ➔ measured by Stokes-Campbell sunshine recorder
- glass sphere focuses the Sun's rays onto a card ➔ burning a trace
- modern sunshine recorders use electronics to measure sunshine

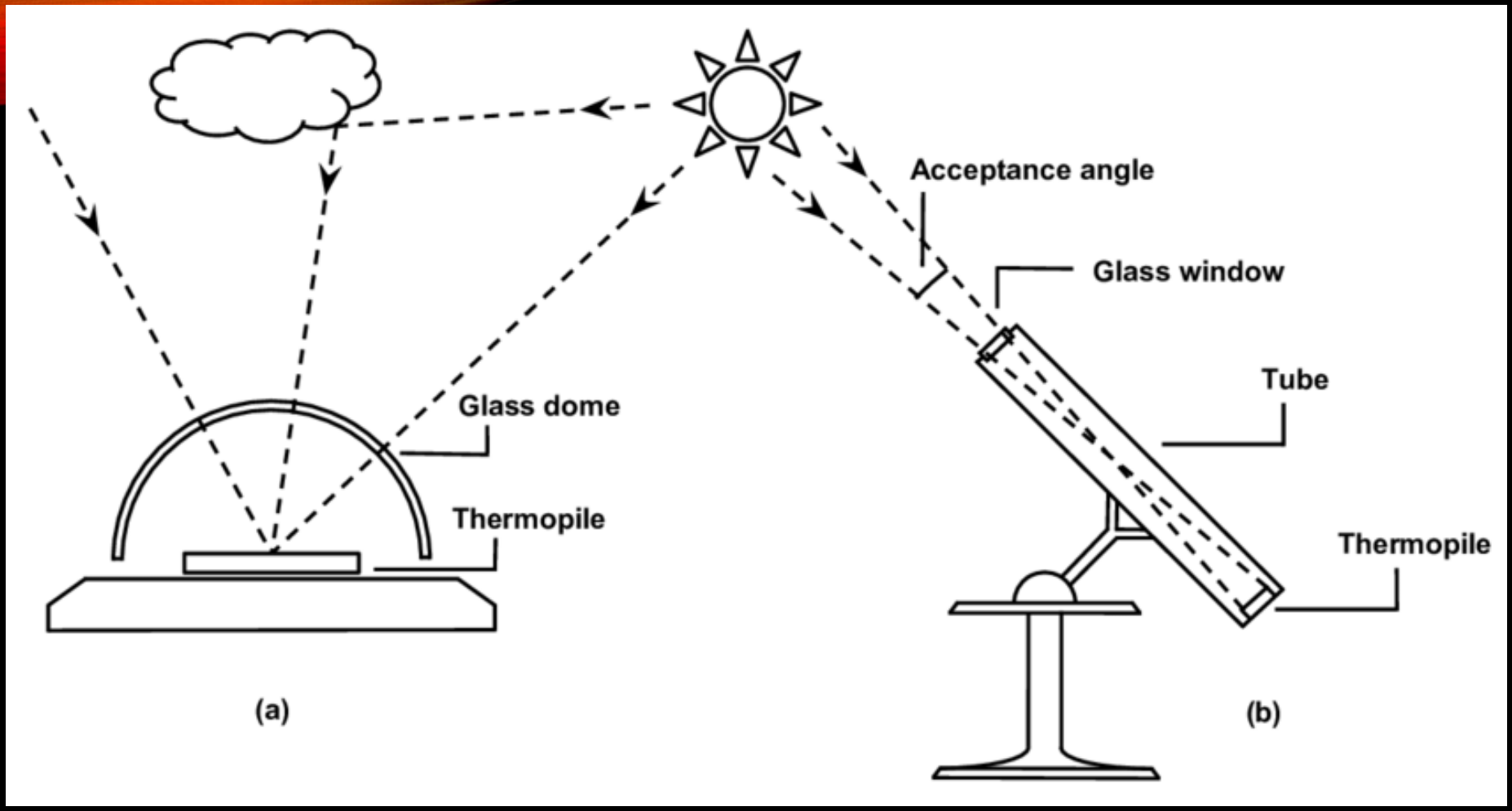
Stokes – Campbell sunshine recorder

Sunshine recording

Measuring the incoming energy from the sun: Pyranometers and Pyrheliometers

A **pyranometer** measures the incoming energy from the sun from all angles – both the direct beam and the scattered light.

A **pyrheliometer** measures has a tube so that only the direct beam is measured



Pyranometer

Pyrheliometer

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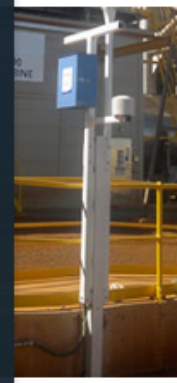
- Tipping Bucket Rain Gauge
- Ambient Air Temperature Sensor
- Relative Humidity Sensor
- Solar Radiation Sensor
- Barometric Pressure Sensor
- Black Globe Temperature Sensor
- Laser Precipitation Monitor
- Flood Warning Sensor
- Vaisala Relative Humidity Sensor
- Grass Temperature Sensor
- Pyranometers
- Dust Monitor
- Ceilometer
- Lightning Electric Field Sensor
- Visibility Sensor
- Leaf Wetness Sensor
- Wind Warning Alarm Systems
- Ultrasonic Wind Sensor
- Class A Evaporation Pan
- Soil Temperature Sensor



- Integrated, multi-parameter **Weather Stations**
- **Modular Weather Stations**
- Full range of individual **Weather Sensors**
- **Data Loggers**
- **Telemetry and Software**
- **Installation Hardware and Infrastructure** (including 10m instrument masts to meet Australian Standards)

Environdata are the Australian Weather Station Specialists

We can provide weather station solutions capable of meeting your needs from small systems to Australian Standard weather stations. We are happy to offer advice on your specific project helping you to discover an appropriate solution and the needs of your project.

We can Deliver, Install, Operate & Maintain your Weather Stations anywhere in Australia