

Observations

- Two types: “direct” and “indirect”:

direct: measure at the location of the instrument.

indirect: measure remotely from the instrument.

“active”: emit radiation; analyze return (e.g., radar).

“passive”: analyze incoming radiation (e.g., camera).

Instruments

<u>quantity</u>	<u>direct</u>	<u>indirect</u>
temperature	thermometer	satellite (infrared).
pressure	barometer	satellite.
wind	anemometer	satellite (cloud track).
moisture	hygrometer	radar; satellite.
precipitation	rain gauge	radar; satellite.

Direct observation frequency

- **Surface observations** (airports and automated stations): hourly, or more frequent. Dense surface network.

- **Upper-level observations** (rawinsondes): twice daily (00 UTC, 12 UTC). Sparse surface network.

Typical errors

Surface observations

sea level pressure	{ land stations; buoys	$\pm 0.5 - 1.0$ hPa
	{ ships	$\pm 1 - 3$ hPa

temperature: $\pm 1^\circ \text{ C}$.

wind speed and direction: $\pm 2\text{--}4 \text{ m s}^{-1}$; $\pm 10^\circ$.

moisture (relative humidity): $\pm 10\%$.

Rawinsonde observations

geopotential height $\left\{ \begin{array}{ll} 700 \text{ hPa} & 5\text{--}10 \text{ m} \\ 500 \text{ hPa} & 10\text{--}15 \text{ m} \\ 300 \text{ hPa} & 15\text{--}20 \text{ m} \\ 100 \text{ hPa} & 20\text{--}30 \text{ m} \end{array} \right.$

temperature: $\pm 0.5^\circ \text{ C}$.

wind speed and direction: $\pm 5\%$; $\pm 10^\circ$.

Typical contour intervals

temperature: 5° , starting with 0° C .

pressure, geopotential height:

<u>level</u>	<u>contour interval</u>	<u>starting value</u>
mean sea level	4 hPa	1000 hPa.
850 hPa	3 dam (30 m)	150 dam.
700 hPa	3 dam	300 dam.
500 hPa	6 dam	564 dam.
300 hPa	12 dam	948 dam.

Miscellany

pressure units: $1 \text{ bar} = 10^5 \text{ Pa}$. $\rightarrow 1 \text{ mb} = 1 \text{ hPa}$.

wind speed: $1 \text{ m s}^{-1} = 1.95 \text{ knots} = \text{nautical miles/hour}$.

$1 \text{ nautical mile} = 1.15 \text{ statute miles (5280 feet)}$.