



Synoptic Meteorology 1

Lecture 2

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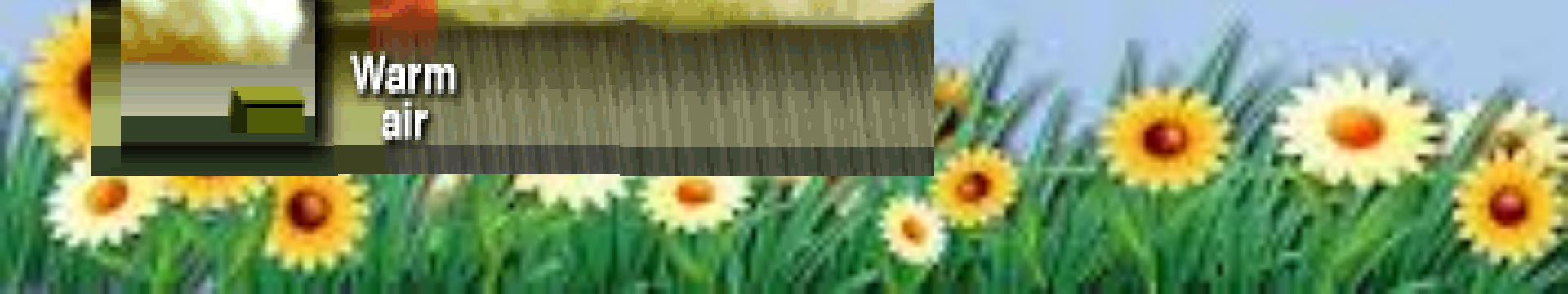
The Forecast Funnel

The forecast funnel visualizes the analysis and forecast process as a "funnel" from the planetary to local scales.

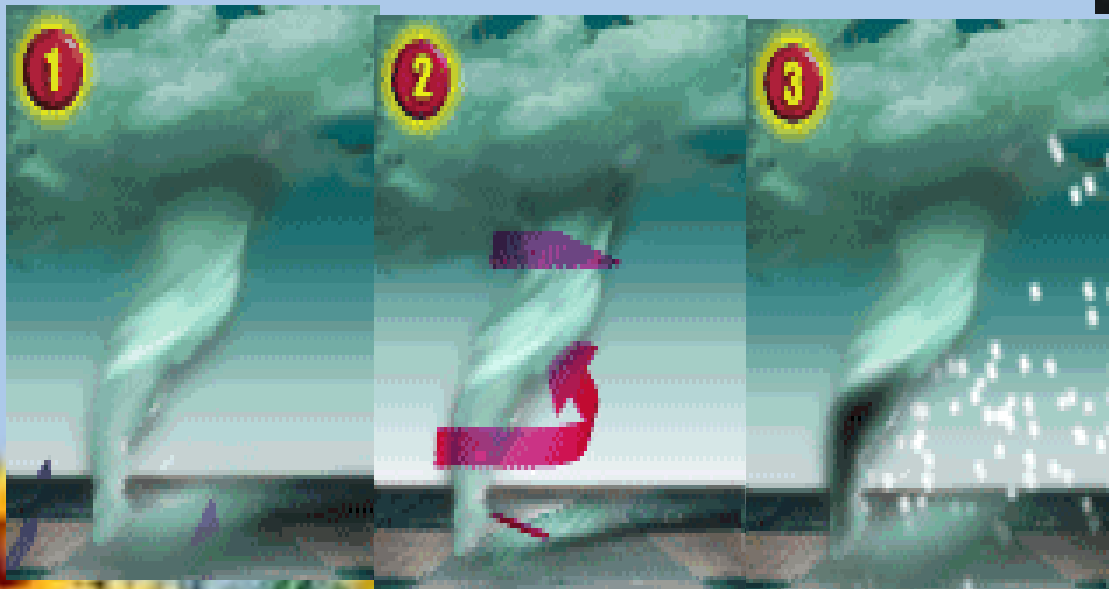
The idea is as shown in the figure: Always understand the planetary scale (waves) background first, then go to synoptic scale (such as frontal cyclones), **then mesoscale (such as Thunderstorms)**, and finally local scale (such as, tornadoes).



Thunderstorm



Tornadoes



Weather impact on daily lives

Hurricane Charley
August 13, 2004



A Blizzard in
Boston 2005



Winter Rains Trigger
Mudslides in California
2005



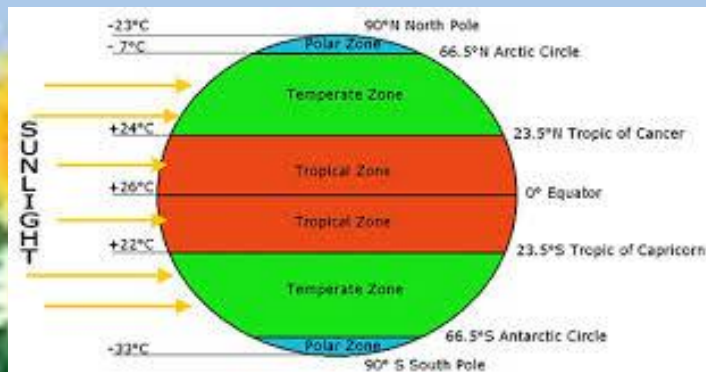
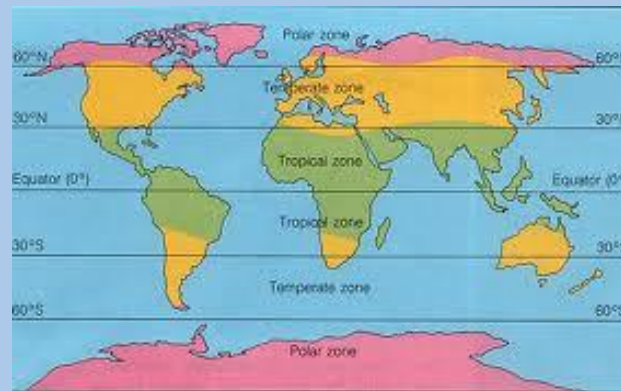
Applied Meteorology

Applied meteorologists deal with the application of meteorological and climatological knowledge to such areas as **agriculture**, **architecture**, **ecology**, and **air pollution**.



Climate: The climate of a region is the condition of the atmosphere over many years.

Described by long-term averages of atmospheric conditions such as temperature and precipitation.



What is the atmosphere?

A fluid

A thin layer surrounding the Earth

Mainly a mixture of invisible gas with some solid and liquid particles that stays in place on account of the force of gravity.

What's in the atmosphere?

Invisible gases

- Some are permanent gases, some variable
- Some are abundant, some not (trace gases)
- Some are greenhouse gases, some not
- Some pollutants, some not

Liquids

- Water: cloud droplets, raindrops, fog, Pollutants

Solids

- Water: ice crystals in clouds, snow
- Soil, sand, acid, pollen, other substances



Composition of the Atmosphere

Major Permanent Gas	Symbol	Percentage by Volume (%)
Nitrogen	N ₂	78.08
Oxygen	O ₂	20.95
Argon	Ar	0.93

Variable Gas

Water vapor	H ₂ O	0 to 4
Carbon dioxide	CO ₂	0.039
Methane	CH ₄	0.00018
Nitrous oxide	N ₂ O	0.00003
Ozone	O ₃	0 to 7 × 10 ⁻⁶
CFCs	CFCs	2 × 10 ⁻⁹ to 5 × 10 ⁻⁸

Meteorology and Atmospheric Science

Usually used interchangeably

Atmospheric science includes not only meteorology but some other topics as well

- Charged particles and electricity in the ionosphere, parts of the upper atmosphere
- Atmospheres of other planets
- Includes the study and simulation of climate
- Includes the study of climate change

The Station Model

The weather conditions at each individual station can be represented on a surface chart by means of a station circle plot.

The land station circle plot can represent all the elements reported from that station, typically examples are:

Air temperature

Dew-point temperature

Wind speed

Wind direction

Visibility

Cloud amounts

Cloud types

Cloud heights

Present weather

Past weather

Atmospheric pressure and

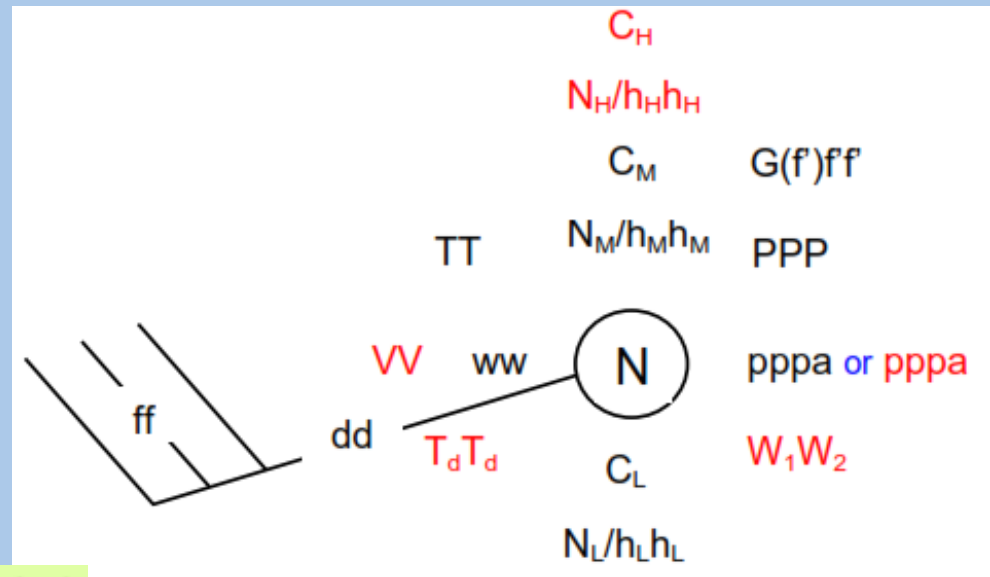
3-hour tendency



Land station circle plot

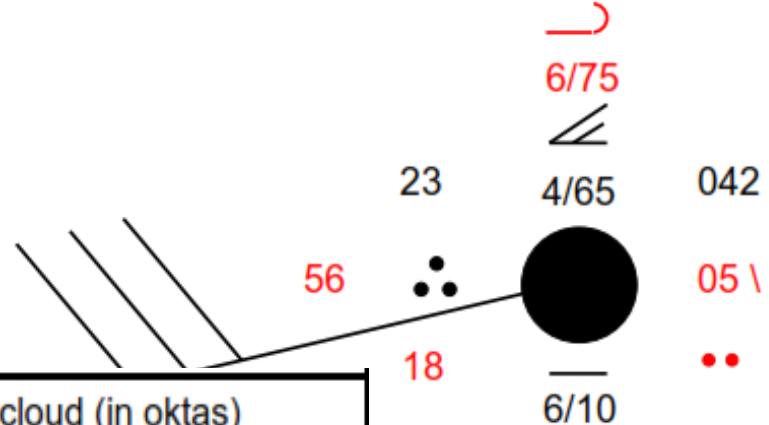
Each element of the observation, with the exception of wind, is plotted in a fixed position around the station circle so that individual elements can be easily identified.

N	Total amount of cloud (in oktas)
C_L	Type of low cloud
N_L	Amount of low cloud (in oktas)
h_Lh_L	Height of low cloud (in feet)
C_M	Type of medium cloud
N_M	Amount of medium cloud (in oktas)
h_Mh_M	Height of medium cloud (in feet)
C_H	Type of high cloud
N_H	Amount of high cloud (in oktas)
h_Hh_H	Height of high cloud (in feet)
TT	Dry-bulb air temperature (in degrees Celsius)
ww	Present weather
dd	Wind direction (in degrees)
ff	Wind speed (in knots)
VV	Visibility (in metres or kilometres)
T_dT_d	Dew point temperature (in degrees Celsius)
W₁W₂	Past weather
pppa or pppa	Pressure tendency and trend (black: rising, red: falling) (in millibars)
PPP	Atmospheric pressure (in millibars)
G(f')ff'	Wind gust (in knots)



Example of synoptic elements plotted on a typical land station report

The decode of the above station plot is as follows:



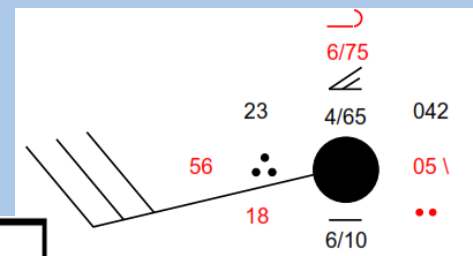
8 oktas	N	Total amount of cloud (in oktas)
23 °C	TT	Dry-bulb air temperature (in degrees Celsius)
Continuous moderate rain	ww	Present weather
260 °	dd	Wind direction (in degrees)
30 knots	ff	Wind speed (in knots)
6 km	VV	Visibility (in metres or kilometres)
18 °C	T_dT_d	Dew-point temperature (in degrees Celsius)
Stratus (6 oktas at 1000 feet)	C_L or C	Type of low cloud
Rain	W₁W₂	Past weather
Falling 0.5mb in last 3 hours	pppa or pppa	Pressure tendency and trend (black: rising, red: falling) (in millibars)
1004.2mb	PPP	Atmospheric pressure (in millibars)
Dense altostratus (4 oktas at 15000 feet)	C_m or C	Type of medium cloud
Cirrus (6 oktas at 25000 feet)	C_H or C	Type of high cloud

1 knot = 0.514 m/s

1 knot = 1.852 km/h

1 km/h = 0.539 knot



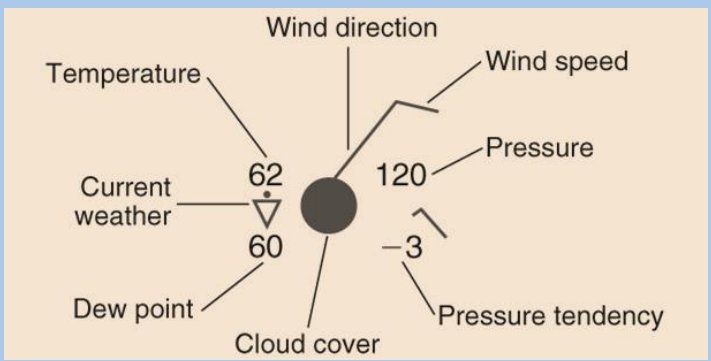


Weather as observed	Code group	Description
8 oktas	N	Total amount of cloud (in oktas)
23 °C	TT	Dry-bulb air temperature (in degrees Celsius)
Continuous moderate rain	ww	Present weather
260 °	dd	Wind direction (in degrees)
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Oktas	Definition	Category
0	Sky clear	Fine
1	1/8 of sky covered or less, but not zero	Fine
2	2/8 of sky covered	Fine
3	3/8 of sky covered	Partly Cloudy
4	4/8 of sky covered	Partly Cloudy
5	5/8 of sky covered	Partly Cloudy
6	6/8 of sky covered	Cloudy
7	7/8 of sky covered or more, but not 8/8	Cloudy
8	8/8 of sky completely covered, no breaks	Overcast



The station model



RAIN

- • Light
- • • Moderate
- • • • Heavy
- ◂ Light shower
- ◂ • Moderate shower
- ◂ ◂ Thunderstorm
- ◂ ◂ Heavy T-storm

DRIZZLE

- • Light
- • • Moderate
- • • • Heavy

FREEZING RAIN

- ◂ • Light
- ◂ • • Moderate

OTHER

- ∞ Haze
- == Fog

SNOW

- * * Light
- * * * Moderate
- * * * • Heavy
- ◂ * Light shower
- ◂ * • Moderate shower

Ice crystals

- ↔

Ice pellets (sleet)

- ◂ •

WIND SPEED
km / h

	Calm
	1-3
	4-13
	14-19
	20-32
	33-40
	41-50
	51-60
	61-69
	70-79
	80-87
	88-96
	97-106
	107-114
•	
•	
	182-190
	191-198

CLOUD COVER

	0% Cloud cover—clear skies
	10% Cloud cover—few clouds
	25% Cloud cover—few clouds
	40% Cloud cover—scattered clouds
	50% Cloud cover—scattered clouds
	60% Cloud cover—broken clouds
	75% Cloud cover—broken clouds
	90% Cloud cover—broken clouds
	100% Cloud cover—overcast
	Vision obscured
	Missing data

Surface weather map

