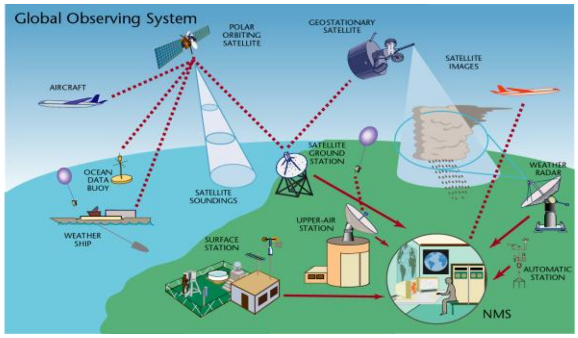
The Course of
Meteorological Instrumentation and Observations



MUSTANSIRIYAH UNIVERSITY
COLLEGE OF SCIENCES
ATMOSPHERIC SCIENCES DEPARTMENT
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SECOND STAGE

Welcome Students! ☺

TO LECTURE ONE

Observing System

World Weather Watch Program

To predict the weather, modern meteorology depends upon near instantaneous exchange of weather information across the entire globe. Thus , **the World Weather Watch Program** - the core of the WMO Programes - comprises the design, implementation, operation and further development of the three interconnected, and increasingly integrated, **core components** to make available meteorological and related environmental information needed to provide efficient services in all countries.

Global Observing System (GOS)

- Consisting of facilities and arrangements for making meteorological observations (including climatological observations) and other related environmental observations at stations on land and at sea, and from aircraft, meteorological environmental satellites and other platforms.

Global Telecommunication System (GTS)

- Consisting of integrated networks of telecommunications facilities and services for the rapid, reliable collection and distribution of observational data and processed information.

Global Data-processing and Forecasting System (GDPFS)

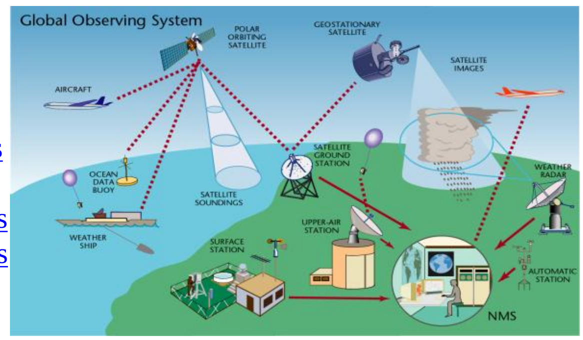
- Consisting of World, Regional Specialized, and National Meteorological Centres that provide quality-assured, processed data, analyses, and forecast products on a wide range of temporal and spatial scales.

Global Observing System (GOS) and its components

The WMO (GOS) comprised of operationally reliable surface- and space-based subsystems.

Its components are :

- Surface observations
- Upper-air observations
- Marine observations
- Aircraft-based observations
- Satellite observations
- Weather Radar observations
- Other observation platforms



For more information, visit this website
http://www.wmo.int/pages/prog/www/OSY/Gos-components.html

OBSERVING SYSTEMS

There are two main types of the observations:

Surface observations

- **Conventional (un-automated) observing systems.**
- **Modern (automated) observing systems.**

Upper air observations

- **Radiosondes**
- **Remote surface-based instruments, e.g. wind profiler radars, SODAR, etc.**
- **Upward-looking ground-based instruments using microwave radiometers, ex. SODAR-RASS.**

CONVENTIONAL OBSERVING SYSTEMS

- It consist of observer and some instruments for some essential parameters. Those systems can be described in general as follows:
- Observation of certain parameters such as wind, temperature, relative humidity, air pressure, precipitation, clouds and visibility
- Conventional instruments with dependency on observer for reading with subjectivity in observations
- Limited observation frequency due to the number of the observers at the station and limited observation parameters.
- Mechanical instruments recording on charts

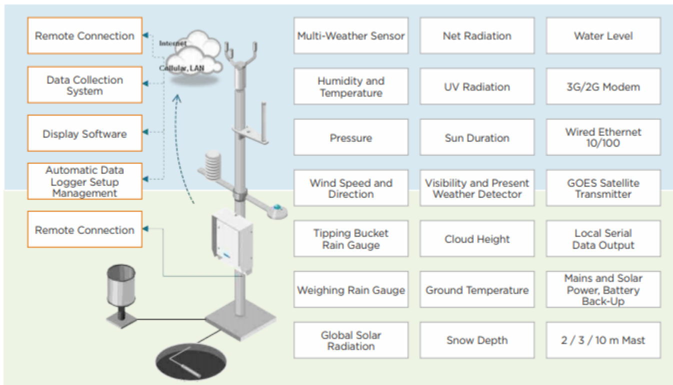
MODERN OBSERVING SYSTEMS AWOS

- Automated Weather Observing Systems (AWOS) is defined as:

  any system which creates and archives a digital (computer-readable) record of one or more weather 'elements', such as air temperature, precipitation, sunshine, wind speed or other parameters.
- It can only observe the atmosphere ***continuously*** by recording all significant changes and phenomena.
- It is able to collect and maintain a greater volume of continuous data, report or log data at much higher resolution rates.
- AWOSs can take samples and report messages every second indefinitely if required, as compared with manual observations, which are restricted to a set observation program, which may not include observations at weekends or overnight.

MODERN OBSERVING SYSTEMS AWOS

- In its simplest form, an AWS can be a single **sensor** integrated with a small, inexpensive electronic data **recorder** (a ‘data logger’ or simply ‘logger’). Loggers that can record only one input signal, or ‘channel’, are therefore ‘single-channel loggers’; those that can handle two or more are ‘multi-channel’.



MODERN OBSERVING SYSTEMS

sensors and sensor interfaces: sense the certain changes in the meteorological parameters; measuring range, resolution, uncertainty, response time can be defined in accordance with the requirements.

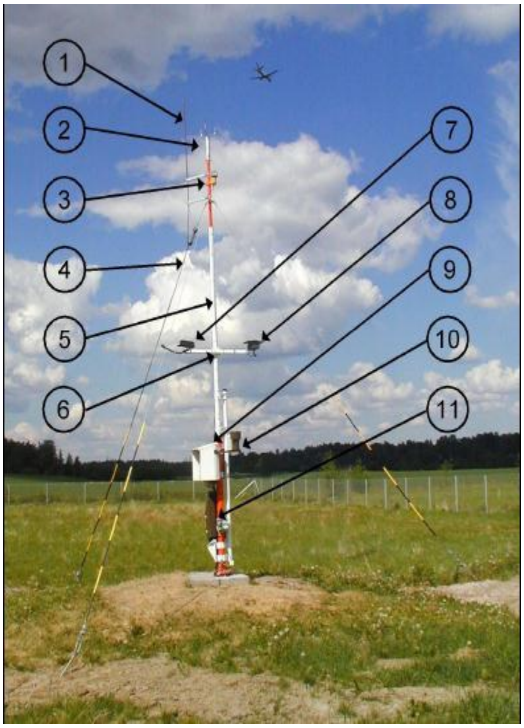
data collection unit: collect the data from the sensor outputs in the form of the engineering units e.g. Ohm, ampere, and converts them to the meteorological units e.g. Degree, Celsius, m/sec.

central control and processing unit: receives data from data collection unit, generates meteorological reports & messages, transmit to the local or remote terminals, archives all data and log files

display unit: displays the meteorological data and reports where it is required

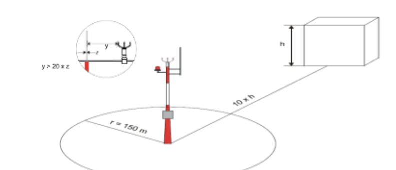
communication interfaces: performs the communication between data collection unit, central processing unit and remote and local terminals

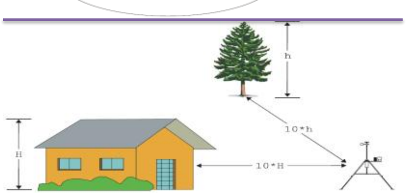
power supplies: supply the power for the system

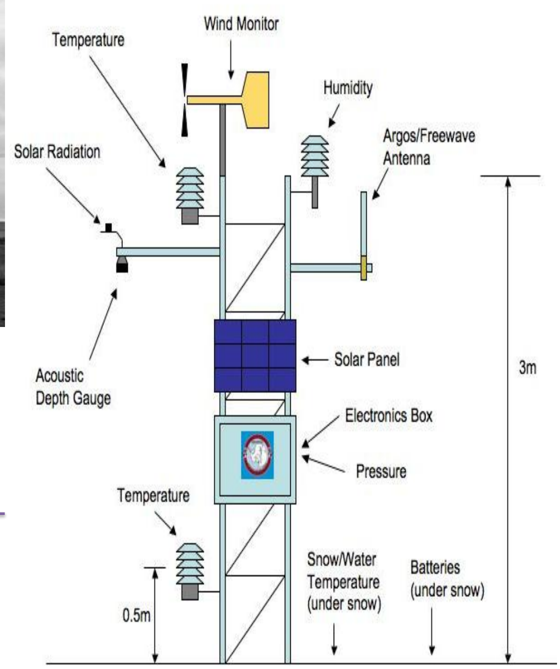


1 = Lightning rod
2 = Heated Ultrasonic Wind Sensor
3 = Obstruction light
4 = Guy wires
5 = Tiltable mast
6 = Sensor arm
7 = Present Weather Sensor
8 = Lightning Detector
9 = Radiation shield protecting the logger tube and Power Supply and Connection Unit
10 = Sensor Arm with Rain Gauge and Air Temperature and Relative Humidity Sensor
11 = Ceilometer

Compact and Lightweight Basic System



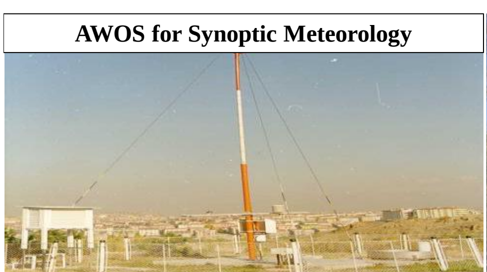


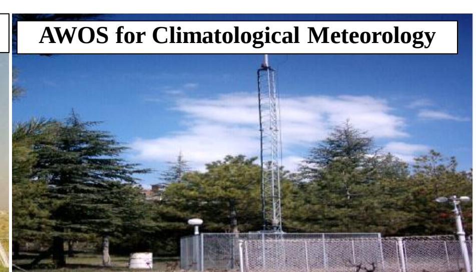


Although the main components are almost same, AWOS can be classified as follows by considering the **purpose** of their use:

- **AWOS for Synoptic Meteorology**: observes and calculates the parameters and generates the reports for weather forecast analysis
- **AWOS for Climatological Meteorology**: observes and calculates the parameters and generates the reports for climate and research studies
- **AWOS for Agricultural Meteorology (Agrometeorology)**: observes and calculates the parameters including soil and plants to support agricultural activities
- **AWOS for Aviation Meteorology**: observes and calculates the parameters required for supporting flight security and aviation
- **AWOS for Marine Meteorology**: observes and calculates the parameters required for supporting navigation and maritime
- **AWOS for Road Meteorology**: observes and calculates the parameters required for supporting road administration and security
- **AWOS for Hydrology**: observes and calculates the parameters required for hydrology and irrigation

Types of Automated Weather Observing Systems (AWOS)





Site selection

Determination of the correct locations to install AWOSs is the first and the most important step for overall success of an AWOS network. These locations should be determined by considering WMO recommendations. During that determination study following criteria should be considered:

- types of meteorological parameters to be measured
- purpose of obtaining those parameters
- variability of parameters according to the other places around the station
- the size of the area presented by the station
- suitability for meteorological observation
- infrastructure and communication facilities

Advantages of automated weather observing systems

As it is expected, automated observations have a great advantages over manual ones. Advantages of automated systems can be summarised as follows:

- Standardisation of observations (both time and quality)
- Real-time continuous measuring of parameters daytime and night-time
- More accurate
- More reliable
- Automatic data archiving
- Higher resolution
- Collection of data in a greater volume
- Adjustable sampling interval for different parameters
- Free from reading errors
- Free from subjectivity
- Automatic QC in both collection and reporting stages
- Automatic message generation and transmission
- Monitoring of meteorological data
- Access of archived data locally or remotely
- Data collection from harsh environments

Disadvantages of automated observations

- Limited represented area of 3-5 km of sensor site
- It is not possible to observe all parameters automatically, e.g. Cloud coverage and types
- Ongoing periodic maintenance
- Periodic test and calibration
- Well trained technicians and specialists
- Well trained operators
- High cost of instrumentation and operation

Even with today's most sophisticated technology and sensors, human observers are still required for many weather observing tasks; for example, ***AWSs are still very poor at telling the difference between rain and wet snow, nor can they report shallow fog just starting to form across the low lying parts of an airfield or see distant lightning flashes on the horizon which warn of an approaching thunderstorm. Human weather observers will continue to be required for a long while to come!***

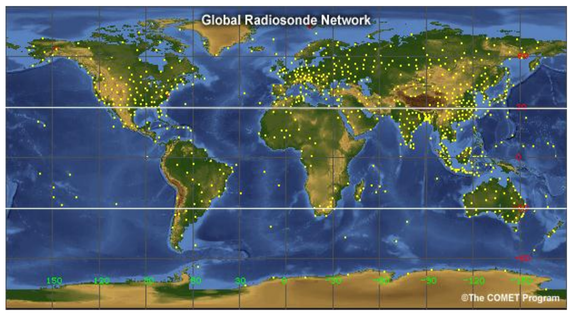
Types of Observations

Current weather information for a location includes observations recorded by:

1. Humans through visual observation.
2. Automated systems such as sensors at airports.
3. A combination of human and automated data gathering.

Once collected, the observations from both human and automated data sources are reported using symbols, codes, and written text. They can then be plotted on maps for a view of conditions and patterns across various spatial scales.

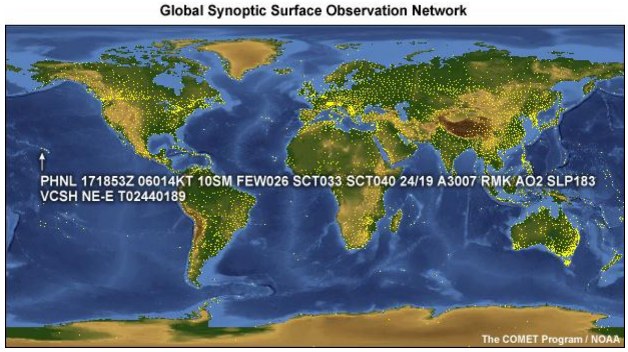
Many routine observations are collected using weather balloons, which rely on both a human observer and an automatic-reporting technology. Once or twice per day, observers at locations around the world release large balloons to carry lightweight sensors upward through the atmosphere. These sensors, called radiosondes, can sometimes be launched more frequently during severe weather or focused observation campaigns. The resulting radiosonde observations **(RAOBs)** provide vertical profiles of temperature, moisture, and winds in the atmosphere. Radiosondes are launched from over 800 locations around the world, represented by the yellow dots on the map.



One of the most commonly reported weather observations is the **METAR**. METAR is not an acronym. Rather, it refers to the format for standardized weather reports used primarily by meteorologists and pilots. <u>METARs are hourly observations taken at numerous airports or official observing stations around the globe, providing fairly good coverage over land areas</u>. Pilots worldwide depend on METARs because these observations represent the most current conditions for an area.

If conditions change significantly before the next METAR, a special report (**SPECI**) will be issued. METARs and SPECIs use a particular format for presenting weather information.

Global Synoptic Surface Observation Network



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At six hour intervals, a more comprehensive set of weather observations called a **synoptic observation** is reported manually by an observer or transmitted directly from an automated observing system. These synoptic observations include: Precipitation, temperature, cloud base and type, visibility, wind, barometric pressure, climate, sea conditions

Synoptic observations are reported in **SYNOP**, or SHIP, format. This format accommodates more information than the METAR, including additional codes to help abbreviate the information.

METARs are likely to be the most common observation format used by meteorological technicians and forecasters, but familiarity with SYNOP, SHIP, and CLIMAT formats is also useful.

A land-based meteorological station transmits a **CLIMAT** report typically once per month. The **CLIMAT** format is used to summarize the average values computed from daily observations and typically includes monthly mean temperature and pressure, mean daily maximum and minimum temperatures for the month, and monthly totals for precipitation and sunshine.

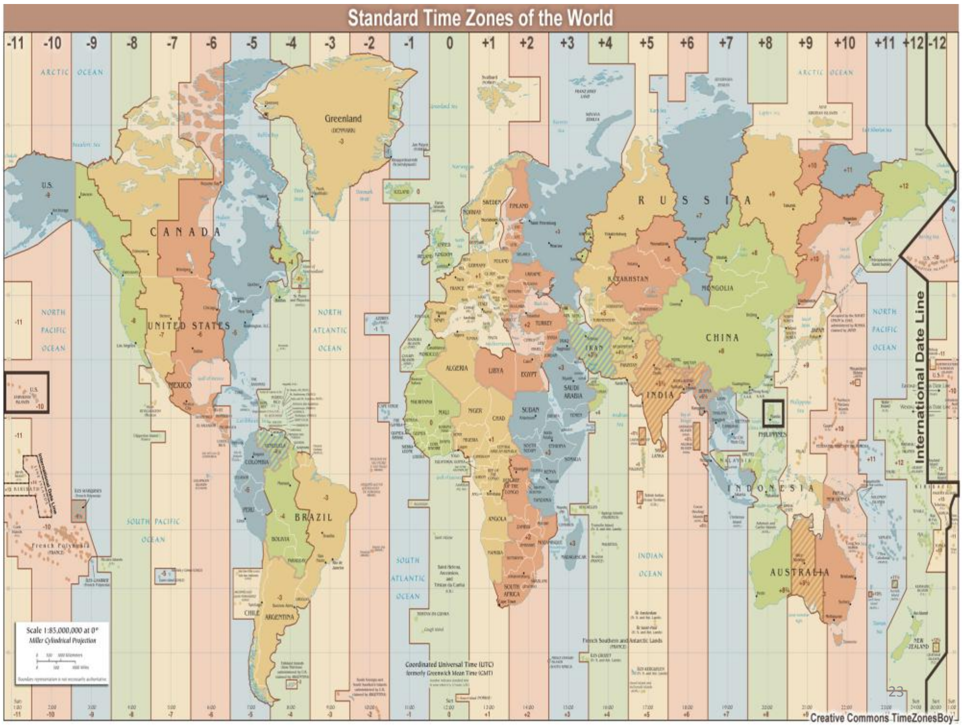
Universal Time

To ensure that the observations are taken and reported at the correct times, and to ensure that the radiosondes are launched simultaneously, a common time system is required. This provides a view of atmospheric conditions for broad areas of the world.

To work within a common time system, weather communities use a 24-hour clock based on the 0° longitude meridian, known as the Greenwich Meridian.

On this clock, 00:00 UTC is 12:00 a.m. local Greenwich time and the hours and minutes increment through the course of the day so that 23:59 UTC is 11:59 p.m. local Greenwich time.

Before 1972, this universal clock was referred to as Greenwich Mean Time (GMT), but is now known as **Universal Time Coordinated** (UTC) or **Coordinated Universal Time**. It is also sometimes referred to as **Zulu Time** or Z time.



UTC is used to specify the set times that observations are taken and reported worldwide:

METARs: hourly, with SPECIs as conditions change

Balloon-borne radiosondes: 00:00 UTC and 12:00 UTC

Synoptic observations: 00:00 UTC, 06:00 UTC, 12:00 UTC, 18:00 UTC

Working with UTC takes some practice. You can determine your local time by adding or subtracting a set number of hours from UTC. The number of hours you add or subtract corresponds to the number of time zones you would cross if you were to travel from Greenwich, England to your local location. You will need to consider if you cross the international date line (shown in black toward the right edge of the image) or if your location has special time considerations such as daylight saving time, which might require that you add or subtract an additional hour depending on the time of year. How and when these special circumstances affect your local time will be specific to your location.

Let's look at an example.

If you are located in Manila in the Philippines, what local time would correspond to 09:00 UTC? The Philippines are located in the South China Sea, directly north of Indonesia. From the map, Manila is +8 hours from UTC, so eight hours ahead of UTC or Greenwich Mean Time. To find the local time, add the UTC conversion to the current time:

Local time = UTC + offset

PHT (Philippine Standard Time) = UTC + 8

PHT = 09:00 UTC + 8 hours (UTC conversion) = 17:00 hours

The local time is 17:00, or 5:00 p.m.