

Weather forecasting

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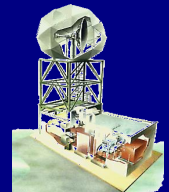
Radiosonde

Satellites

Radar

Weather ships

Supercomputers



Pressing Weather forecasting on any slide will bring you back to this menu

During the last two decades the Met Office has used state-of-the-art **supercomputers** for numerical weather prediction and more recently, also for predictions of global climate.



This is a picture of a supercomputer

Weather forecasters are helped by several things. These include:-

- 1. The computer's advice**
- 2. Information from radar**
- 3. Information from satellite pictures**

The computer makes millions of calculations.

The sums are called differential equations

Before the computer can do the calculations, data has to be collected first.

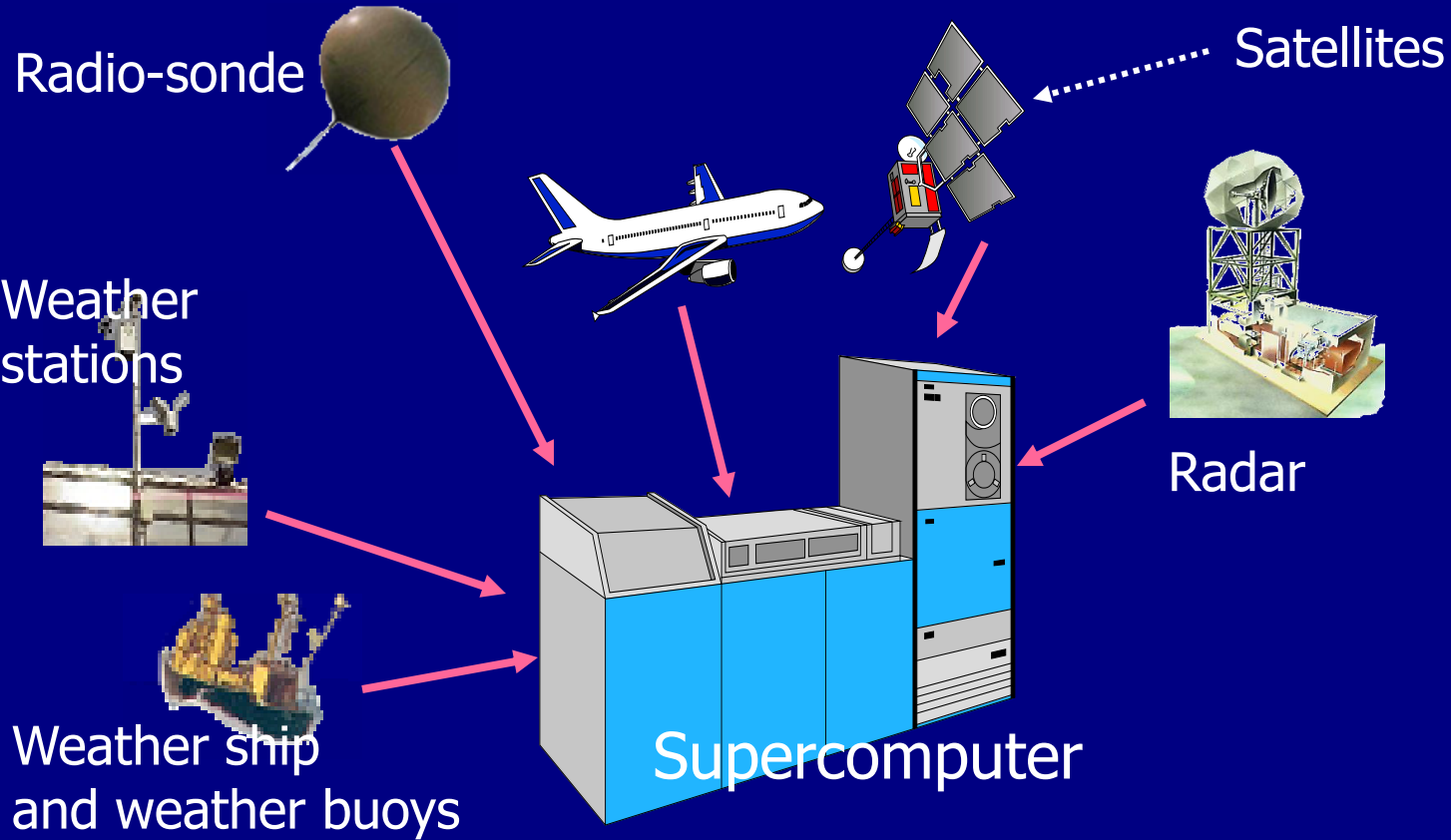
Collecting data on the weather is very important.

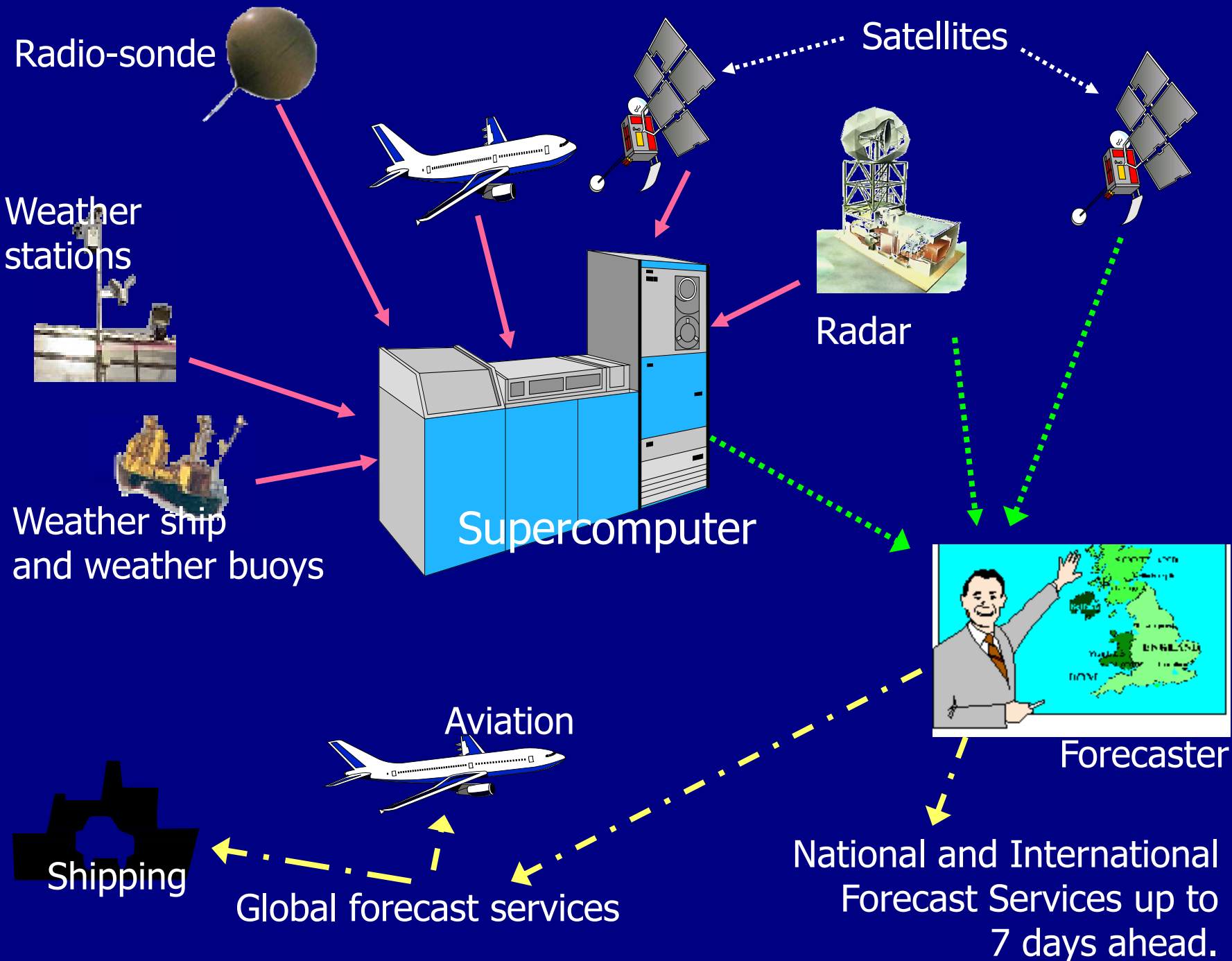
Without the data, the computer could not do the calculations that enable it to make weather predictions.

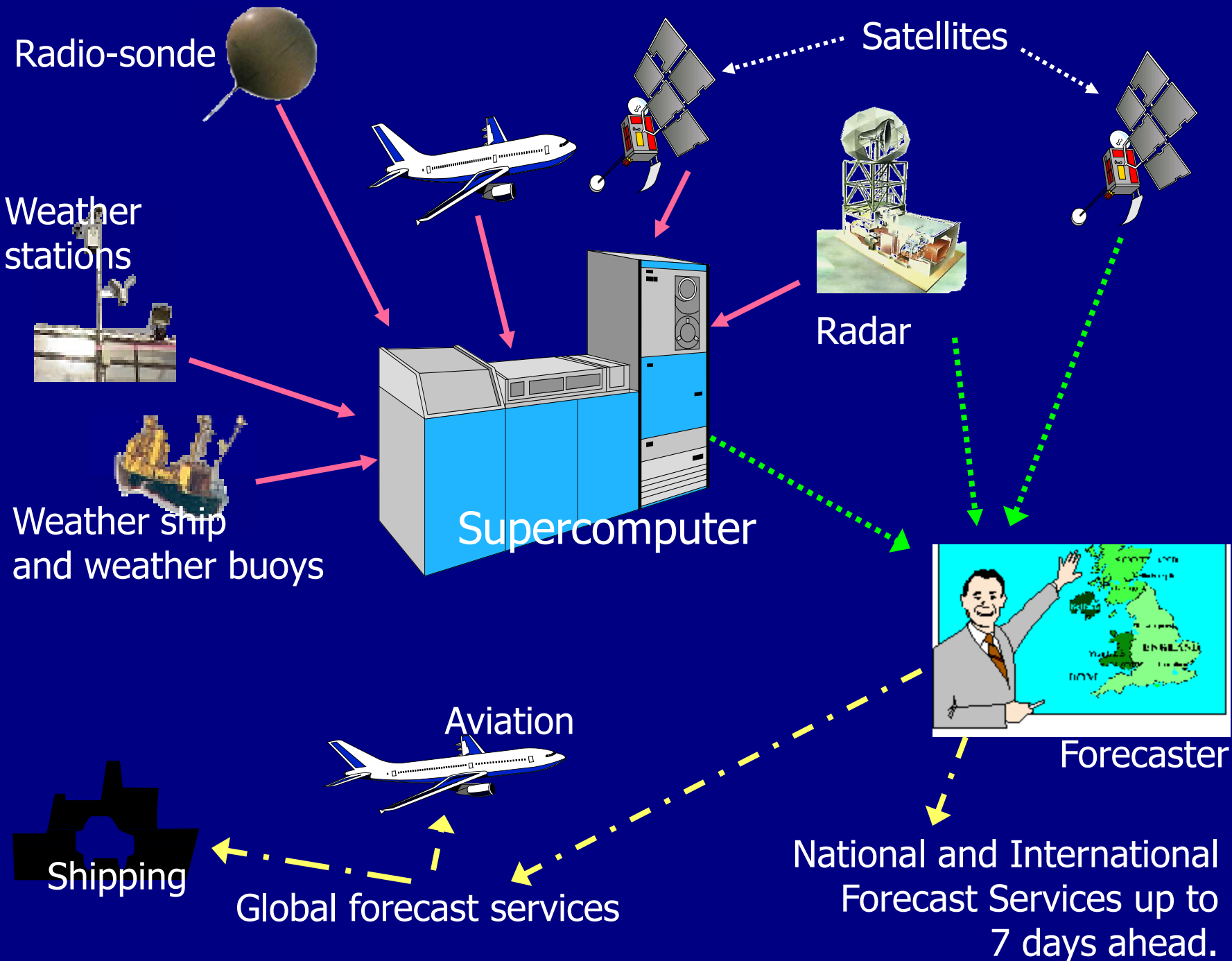
The next slide shows where the data comes from.

It also shows where the forecasts are sent.

Always remember that the forecasters are highly trained people and they use their judgement and expertise to make their forecast based on the information the computer gives them and the information from the radar and the satellite pictures.







Data is collected continuously for the computer from the following:-

1. Weather stations
2. Automated weather stations
3. Satellites
4. Radar
5. Radiosondes
6. Weather ships
7. Mini-radiosondes
8. Radar
9. Aeroplanes
10. Drifting buoys



The data measurements are made by sensors

A **sensor is a transducer which responds to some physical property such as pressure, temperature, rate of flow.**

A **transducer is an electronic component which converts energy from one form to another.**

We want the transducers to send signals to the computer in the Met. Office.

The measurements needed include:-

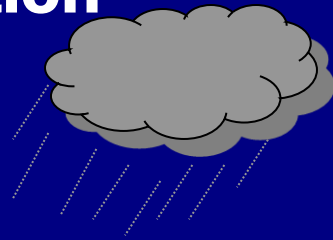
1. Temperature .. Air, surface and subsurface temp.

2. Atmospheric Pressure

3. Wind speed

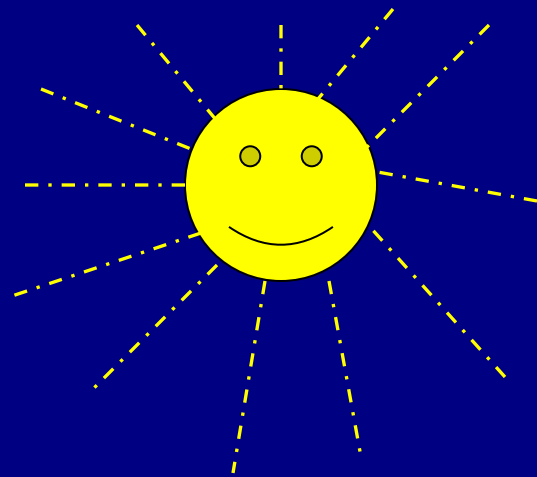
4. Wind direction

5. Humidity



6. Rainfall

7. Sunshine



A Digital Computer
Weather Logging
Station
WLS-8000

Display Console



Wind Sensor



Rain Collector



Temperature & Humidity



Solar Sensor



Texas Weather
Instruments, Inc.

These are some of the **sensors** used to collect data.

Data logging is the capture and storage of data for future use.

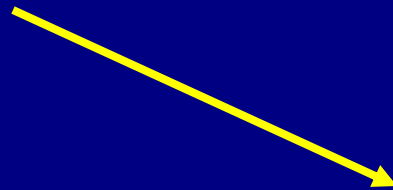
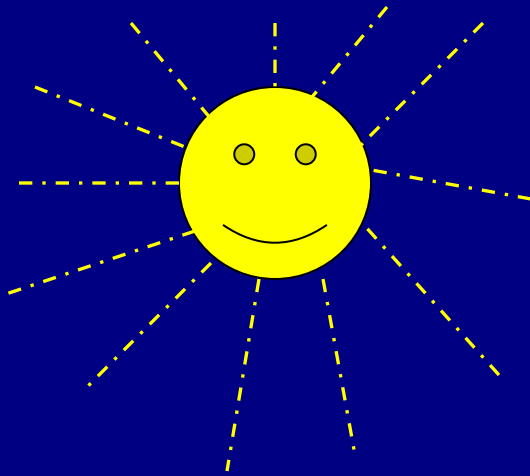
All the measurements from the sensors are stored because:-

- The computer processes the data in batches
- People need to refer back to weather data for many reasons

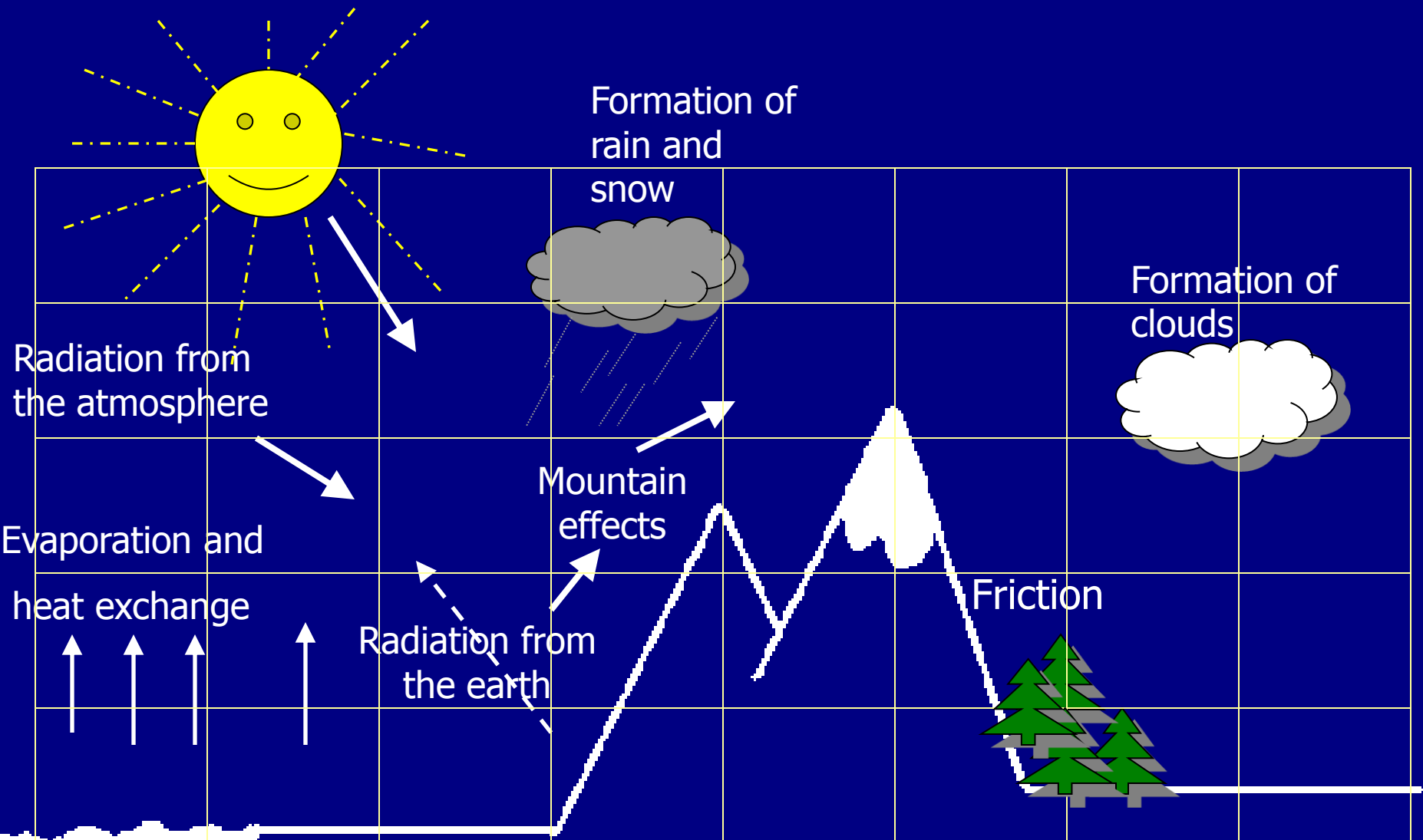
So data logging is used in weather forecasting.

The next slides explain more about data collection.

To jump to the details of the computers, click on the computer.



Radiation from the sun



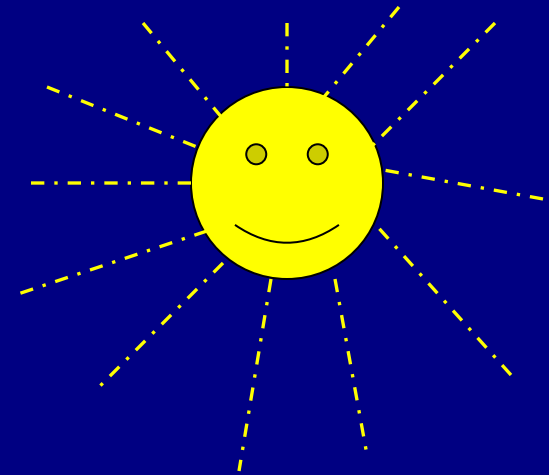
The atmosphere is split up into a 3-D grid. Each land based grid is about 60km.

The vertical grid you just saw only had 5 levels.

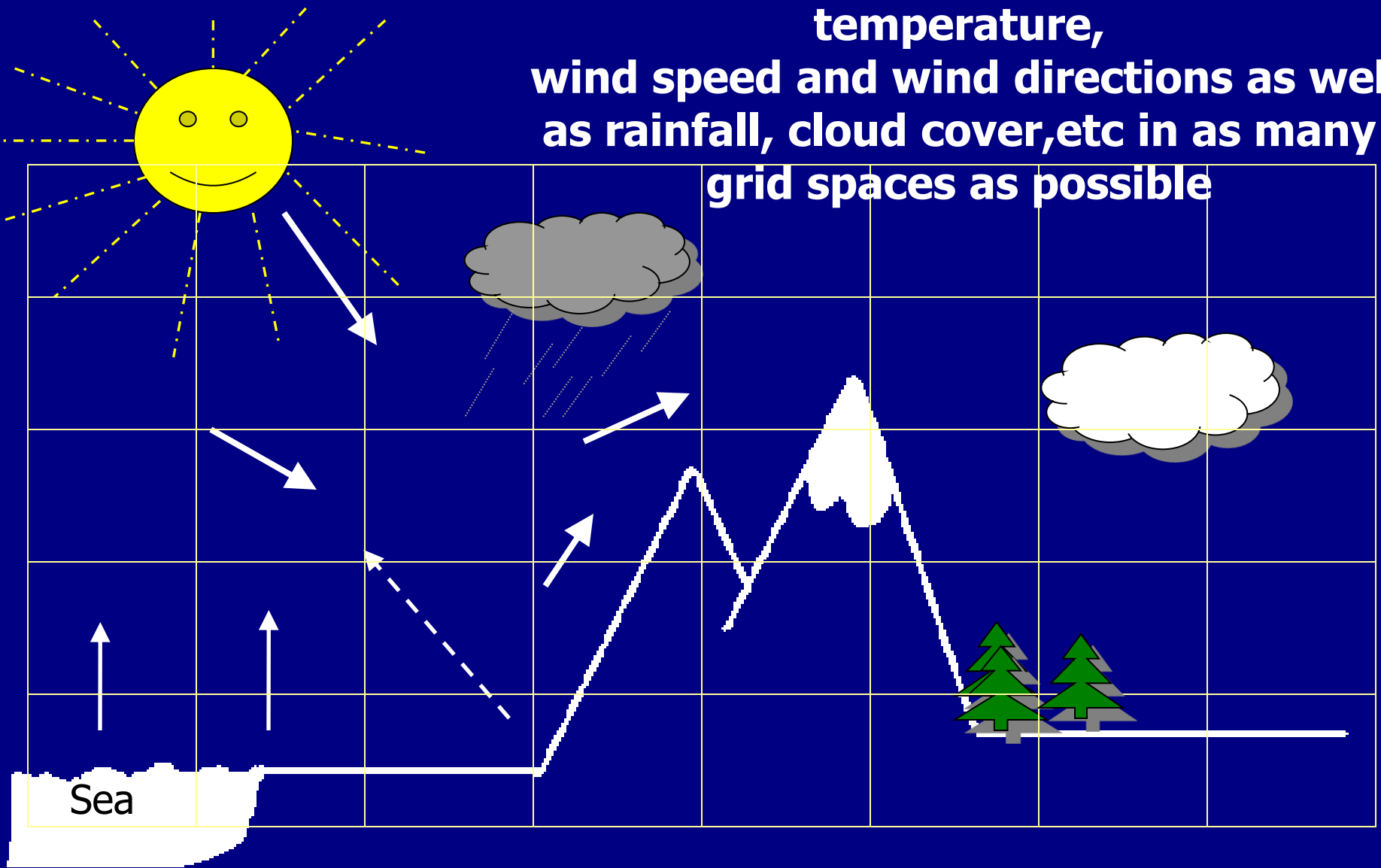
The Met Office uses far more, some computer models work on 40 vertical levels.

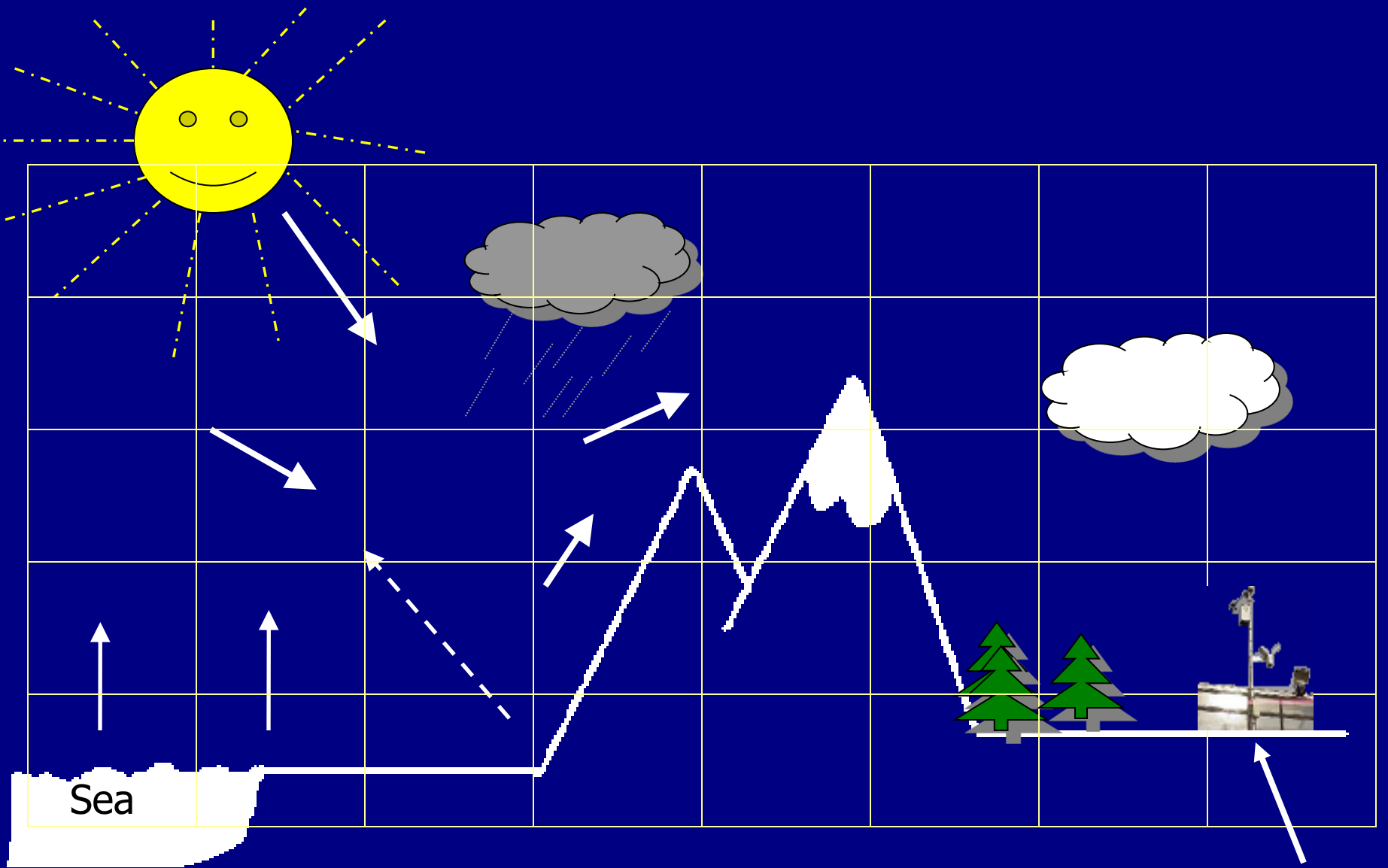
For the global forecasts the horizontal grid is 60km

For UK forecasts the horizontal grid is 15km.



**We need to measure pressure,
temperature,
wind speed and wind directions as well
as rainfall, cloud cover, etc in as many
grid spaces as possible**





Weather stations are used here.

A **weather station** sends signals back to the Met Office computer.

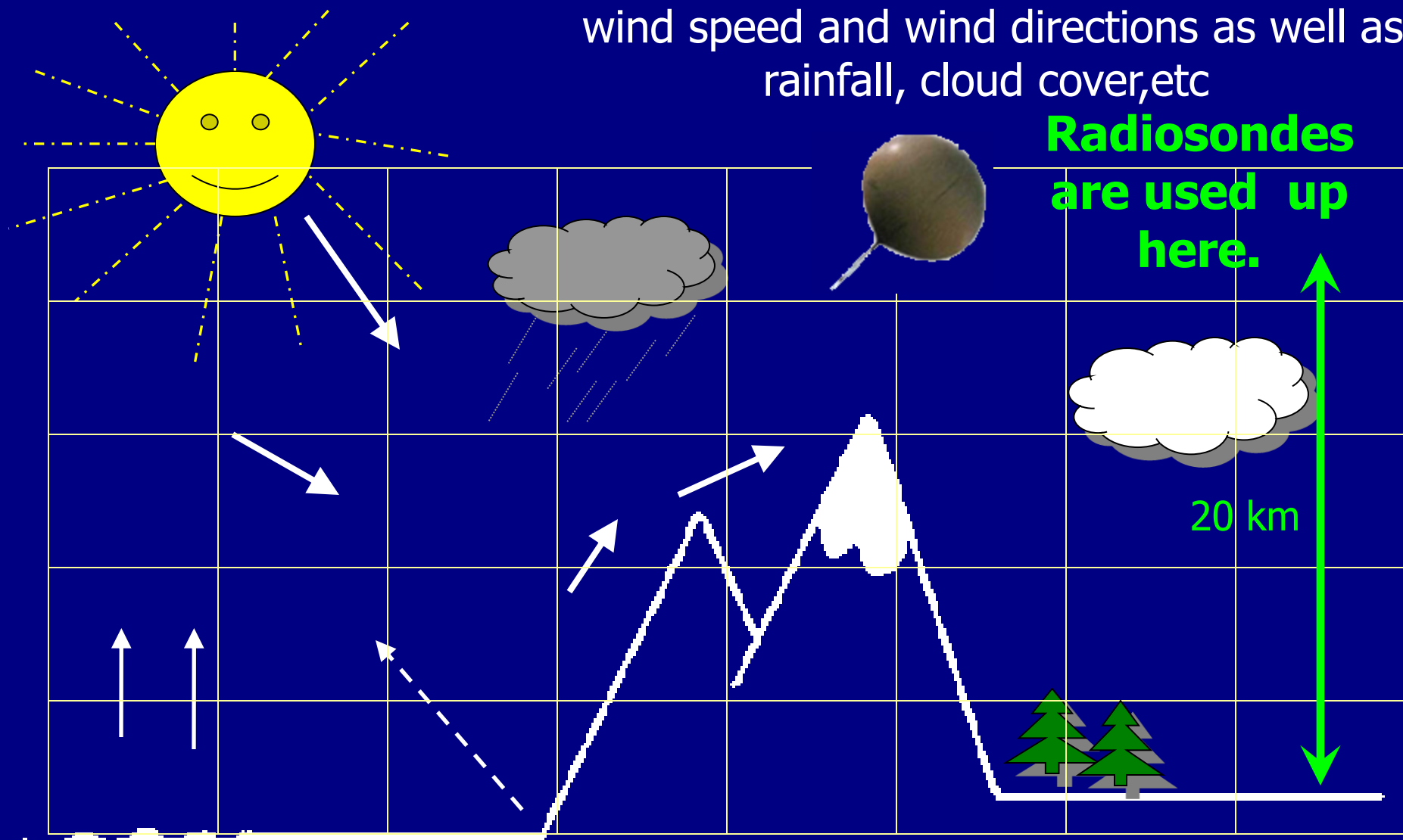


The instruments measure pressure, temperature and humidity.

Some weather stations are automated. These send their measurements back to the computer directly.

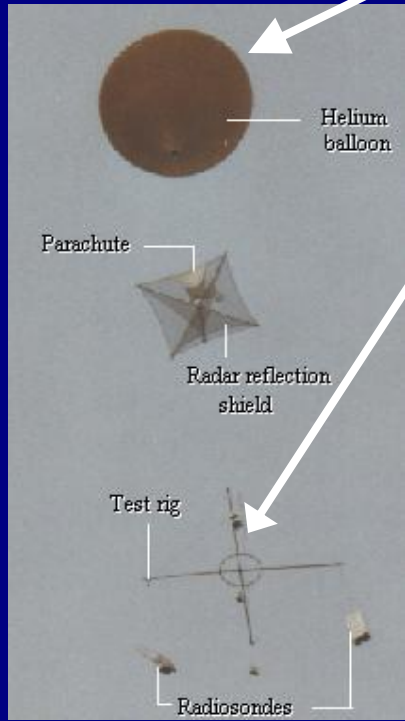
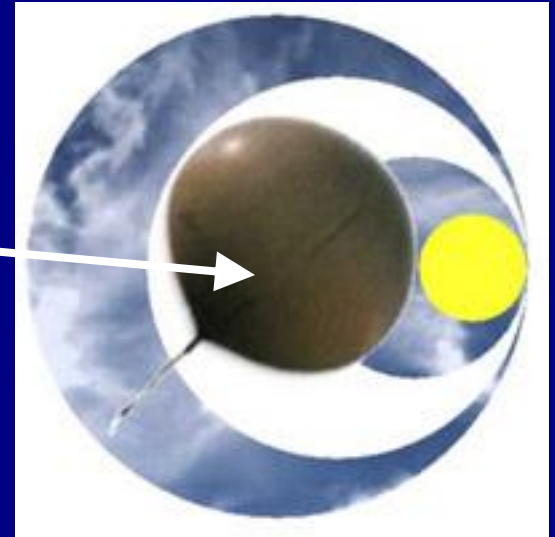
We need to measure pressure, temperature, wind speed and wind directions as well as rainfall, cloud cover, etc

Radiosondes
are used up
here.



Sea

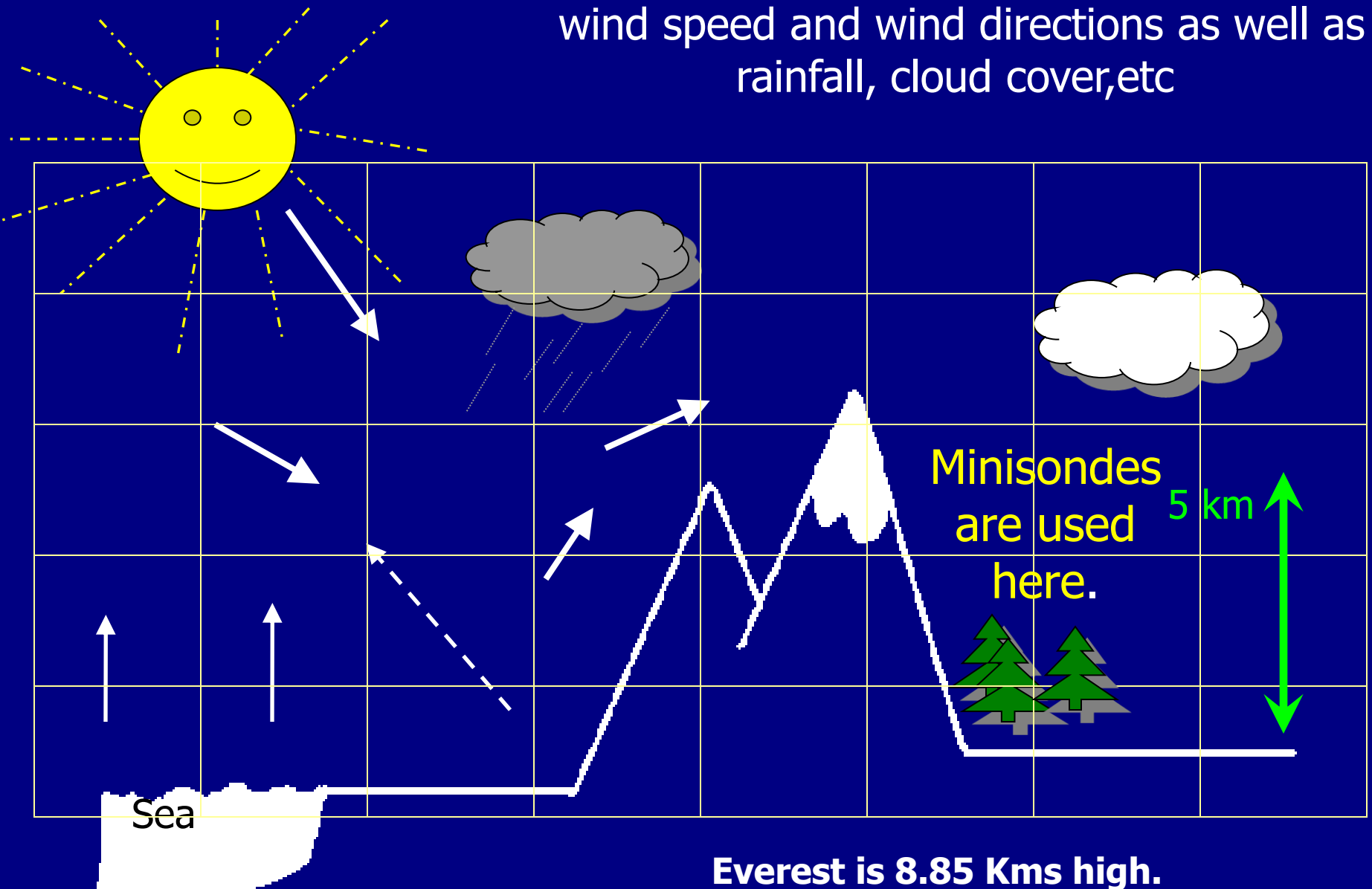
A **radiosonde** sends signals back to the Met Office computer. They are attached to a balloon carrying instruments.



The instruments measure pressure, temperature and humidity.

By measuring the track of the radiosonde, the wind direction and speed can be calculated.

We need to measure pressure, temperature, wind speed and wind directions as well as rainfall, cloud cover, etc



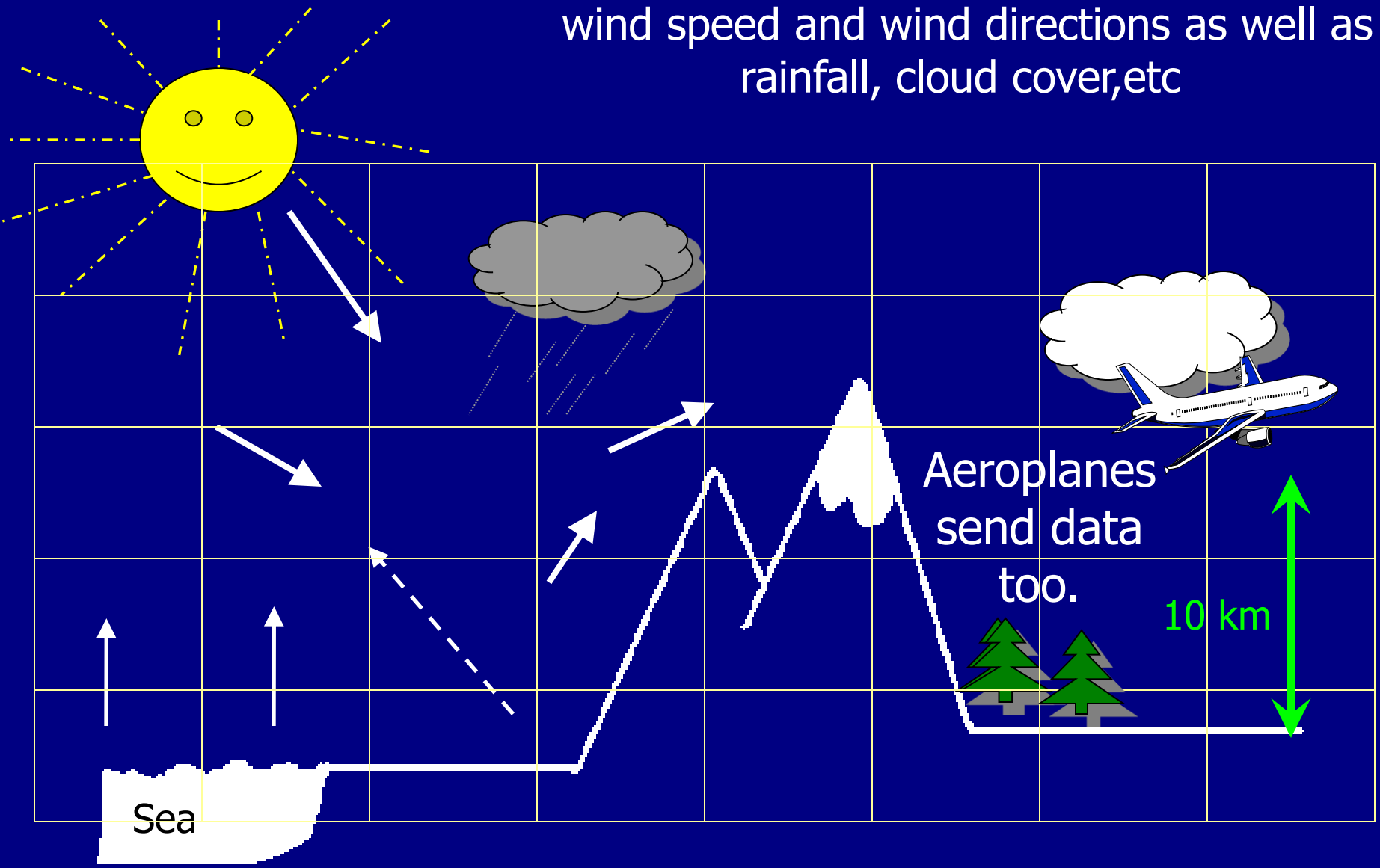
**Everest is 8.85 Kms high.
So we have shown you a very high mountain!**



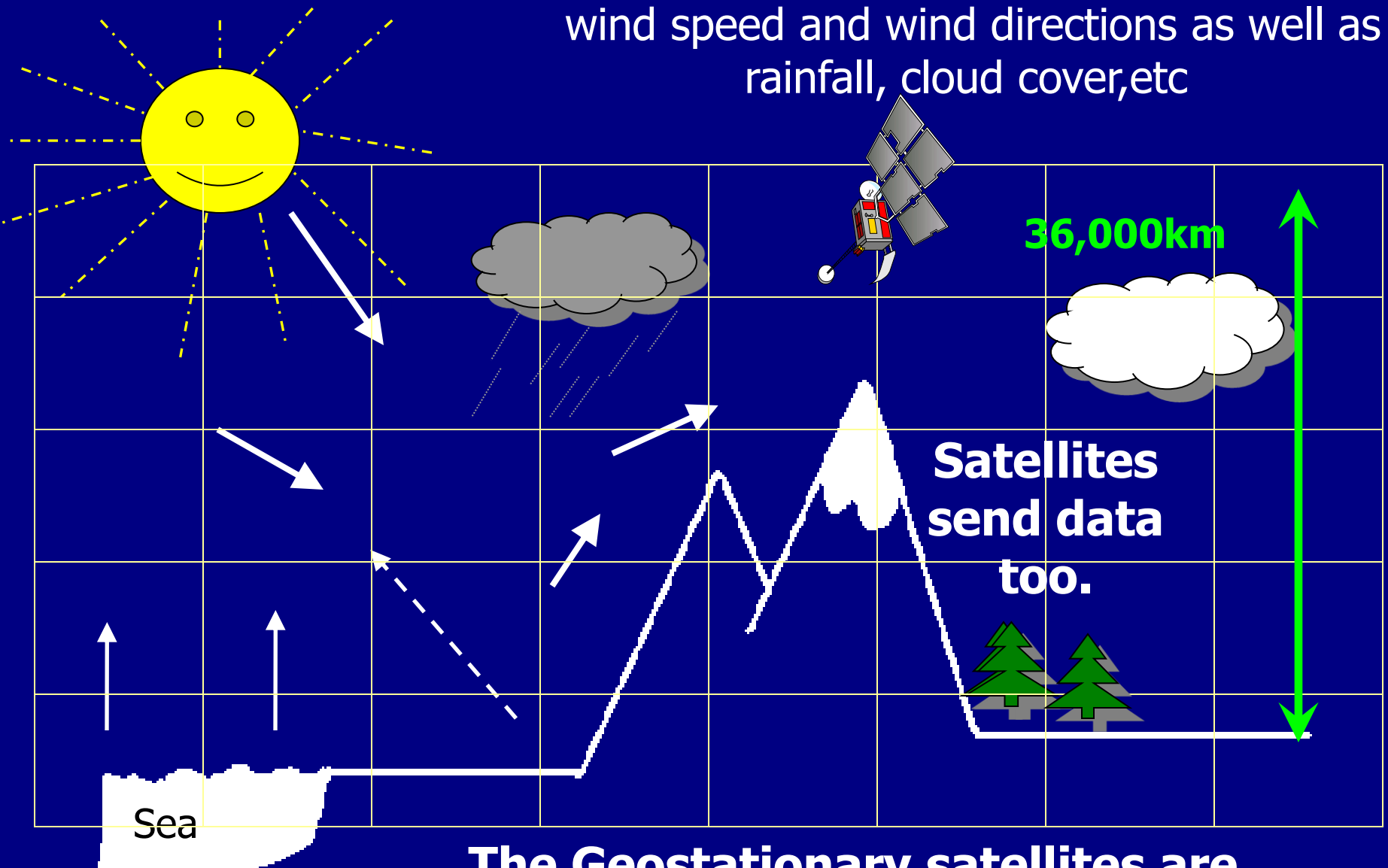
A minisonde system takes measurements at 5Km above sea level.

Both radiosondes and minisondes use radio waves to transmit the data readings to the computers

We need to measure pressure, temperature, wind speed and wind directions as well as rainfall, cloud cover, etc



We need to measure pressure, temperature, wind speed and wind directions as well as rainfall, cloud cover, etc



36,000km

Satellites
send data
too.

Sea

The Geostationary satellites are
36,000 Km above earth.

There are two types of satellites.

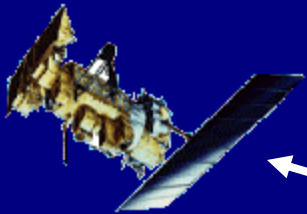
- **Geostationary.** These stay in the same spot. They orbit the earth at exactly the same speed as the earth rotates. They are very high above earth - **36,000 km.**

5 geostationary satellites are enough to give global coverage.

- **Polar orbiting.** These orbit the earth about 14 times a day. They orbit at **1000 km** above the earth.



A Geostationary satellite stays in the same place with respect to earth all the time



A Polar orbiting satellite moves above the earth's surface



©Eumetsat 2003

Meteosat: a geostationary satellite. It sends microwave signals back to earth.

The satellite's signals are received by antennae.



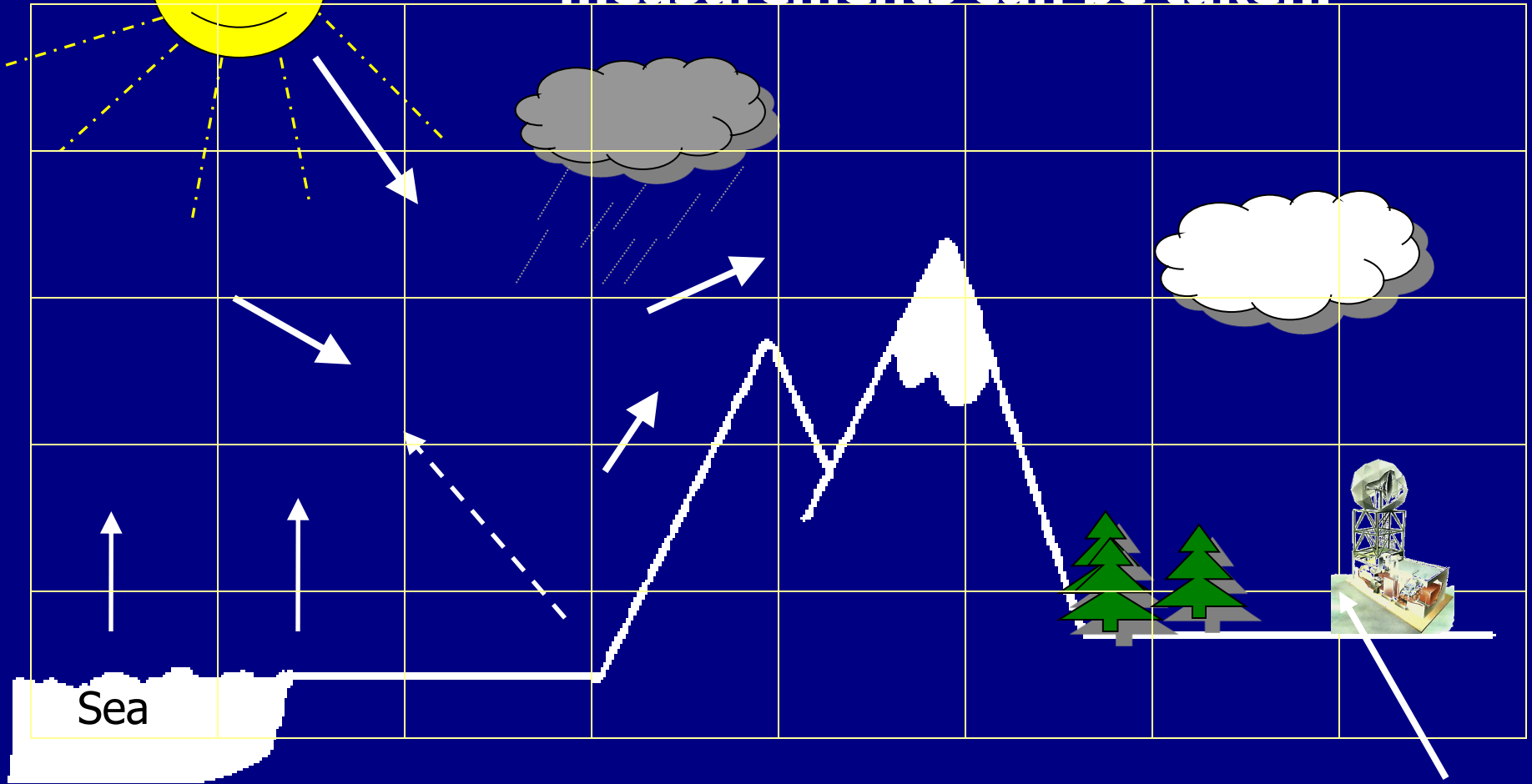
The URL (**Uniform Resource Locator**)
www.sat.dundee.ac.uk/tour.html

This is a **Polar Orbiting** Satellite



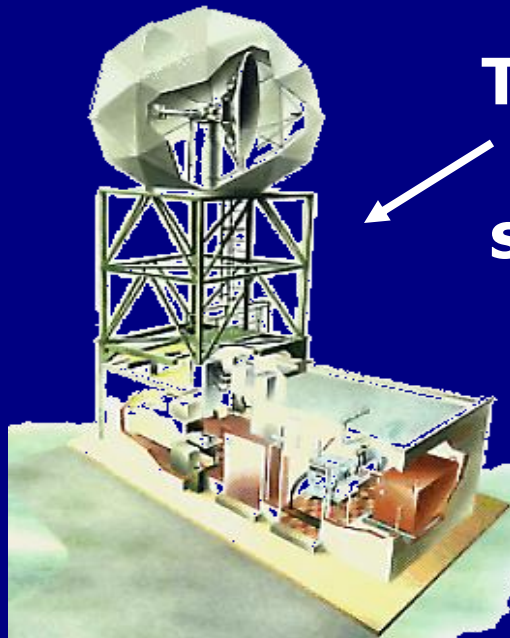
The satellite can take readings across the entire earth during the course of one day.

Radar stands for **radio detection and ranging**. Radio waves are transmitted, when they hit a rain cloud they bounce back to earth and measurements can be taken.



Radar systems are used here.

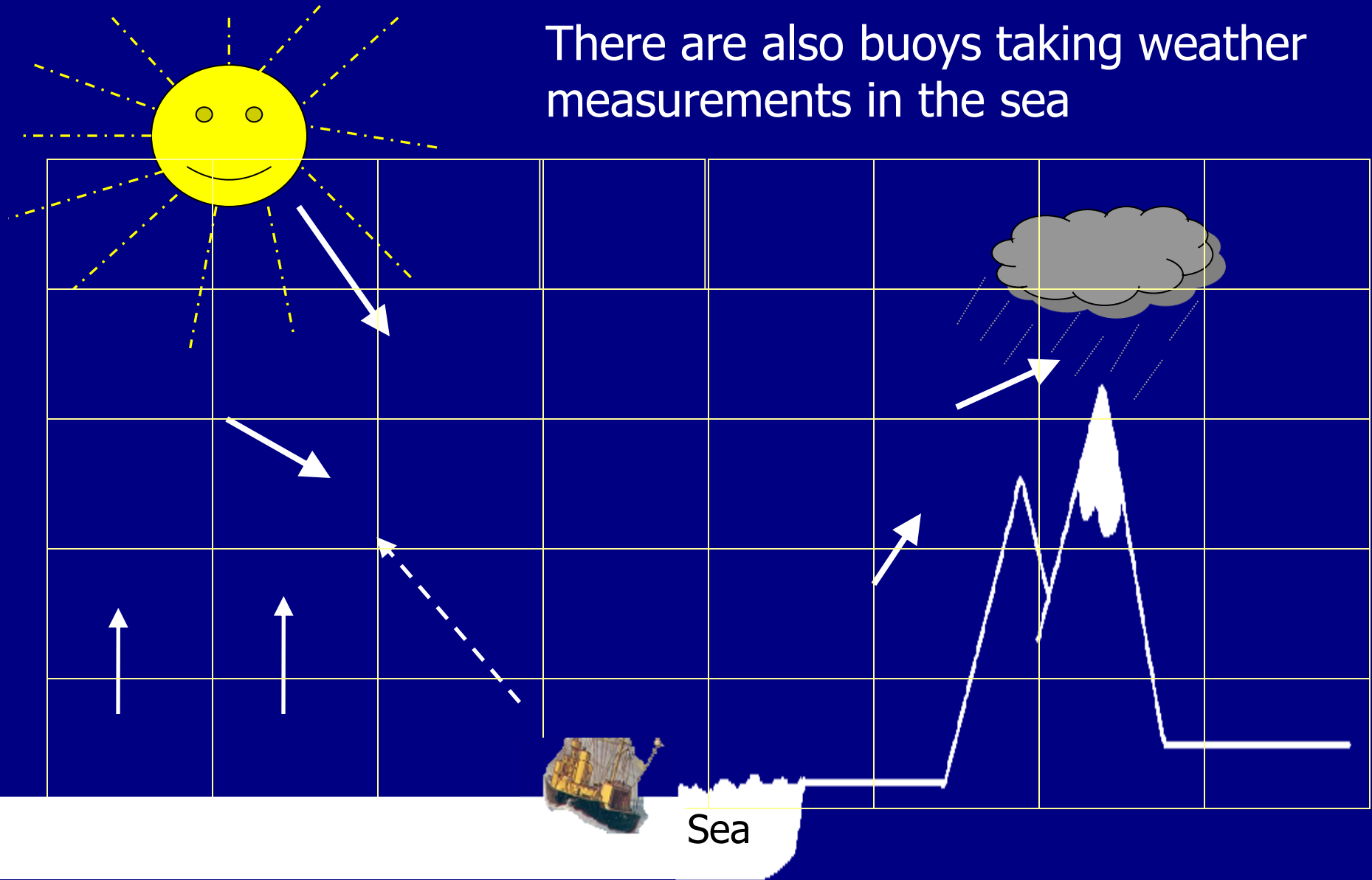
Radar measurements let the forecaster and the computer know if the radar has seen rain clouds.



**This is a
radar
station.**

The computer and the forecaster receive data from the radar systems.

There are also buoys taking weather measurements in the sea



There are weather ships out to sea

This is a Weather ship.



Thanks to www.gdfcartophily.co.uk

Buoys are used at sea more than weather ships these days. They send their data automatically back to the computer.



A supercomputer is a very large computer, which works very, very fast. It is about 1000 times more powerful than a PC.

It also has an enormous store (memory).



We store Gigabytes (one thousand million bytes 10^9) of data on the Hard drives in our school. Supercomputers have stores for **Terabytes of data.**

A Terabyte is one million, million bytes, 10^{12} bytes.

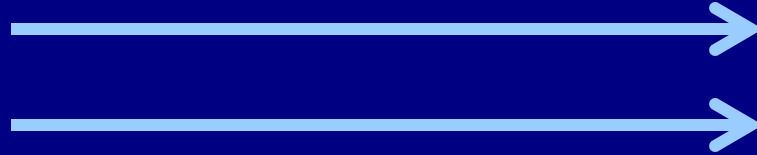
A supercomputer is a very large computer, which works very, very fast. It is about 1000 times more powerful than a PC

It usually has many processors working in parallel to achieve the fast processing time.



The Met Office supercomputers are **Massively Parallel Processor machines.**

Massively Parallel Processor machines use **Parallel processing**



Parallel processing is the simultaneous use of several processors to perform a single job. A job may be split into a number of tasks each of which may be processed by any available processor.

**When a computer uses
several processors in parallel
it is known as
parallel processing.**



**Parallel processing splits jobs up and gives
different processors tasks. These all have to be
brought together.**

Parallel processing is difficult to program

How does parallel processing work?

A

$$1*7$$

B

$$2*7$$

C

$$3*7$$

D

$$4*7$$

Let's give four processors A, B, C, D a sum each

7

14

21

28

If processor A did all four sums it would take longer.

Parallel processing is very complicated to program but it does make it faster to do loads and loads of sums.