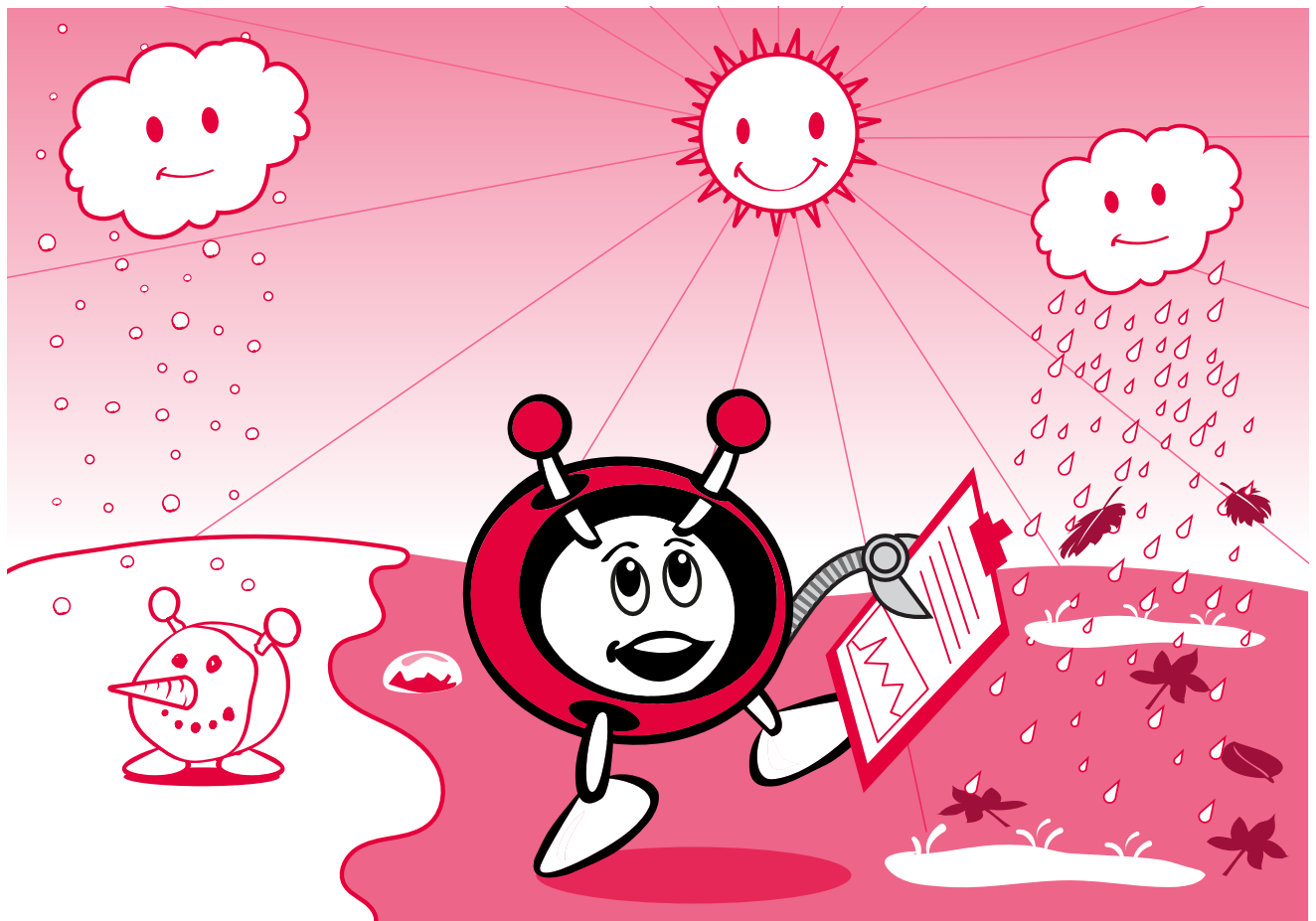


teach with space

→ NOSE UP HIGH IN THE SKY

Observing and measuring weather conditions





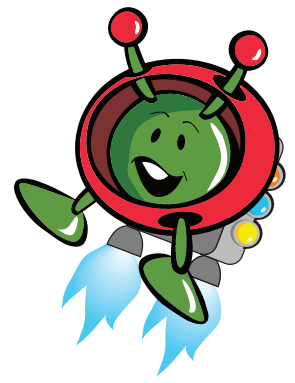
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→ NOSE UP HIGH IN THE SKY

Observing and measuring weather conditions

Fast facts

Subject: Geography, Mathematics, Science

Age range: 8-10 years old

Type: student activity

Complexity: easy

Lesson time required: 90 minutes

Cost: low (0-10 euros)

Location: indoors and outdoors

Includes the use of: craft material

Keywords: Geography, Mathematics, Science, Weather, Weather observations, Wind, Air Temperature, Rain

Brief description

In this set of activities, students will learn how their senses and instruments can be used to describe and measure weather conditions. As an introductory activity, students will analyse local proverbs related to the weather. Then, they will use their senses to make weather observations and to learn how to describe the weather.

Students will also build a small meteorological station and take weather measurements of rain, wind speed and air temperature.

Learning objectives

- Identify the weather elements (wind, temperature, precipitation).
- Observe and record weather conditions.
- Identify local weather processes.
- Learn that satellites, computers and scientific instruments are used to make weather forecasts.
- Learn how to take weather measurements.
- Represent and interpret data.



→ Summary of activities

<i>activity</i>	<i>title</i>	<i>description</i>	<i>outcome</i>	<i>requirements</i>	<i>time</i>
1	Talking about the weather	To analyse local proverbs related to the weather.	To understand the reasoning behind local weather proverbs and how in the past weather forecasting had to rely less on scientific measurements and more on human experience.	None	30 minutes
2	Sensing the weather	To make sensory weather observations.	Students learn how senses can be used to describe weather and that scientists need to have access to scientific instruments to make precise and reliable weather forecasting.	None	30 minutes
3	Build your weather station	To take weather measurements of wind speed, rain fall and air temperature.	To understand how to take weather measurements with their own weather station.	None	30 minutes

→ Introduction

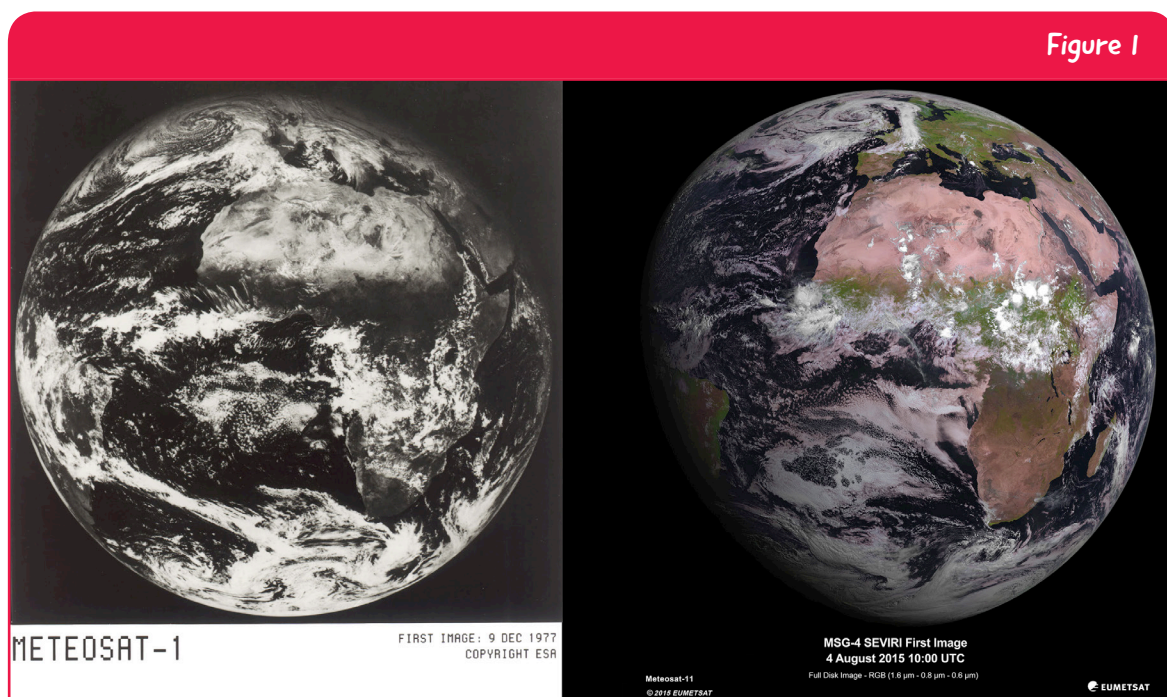
For thousands of years, humans have looked up to the skies trying to predict what the weather might bring. Nowadays, we can get a weather forecast with just a few clicks on the internet, by listening to the news, or in a daily newspaper.

Helping to predict the weather is the longest-running application of Earth observation. Over the last four decades, satellite data have radically improved the accuracy of weather forecasts.

Satellites allow us to monitor large areas of the globe and give us the big picture of what processes are in the atmosphere. The data provided by weather satellites is complemented by data from a global network of weather stations, weather balloons, radar systems, ocean monitoring buoys, and other instruments that help to improve weather forecasting. All these data is processed by powerful supercomputers using mathematical models of the atmosphere and oceans that are used to predict weather based on current conditions.

The European Space Agency (ESA) has been dedicated to observing Earth from space since the launch of its first Meteosat weather satellite in 1977. Since then, three different families of weather satellites have been operated by ESA: Meteosat first generation; Meteosat Second Generation (MSG); and Meteorological Operational satellite programme (MetOp).

Europe's satellites are part of a global weather watch; many different countries and institutions share information from their satellites in order to provide reliable weather forecasts all around the globe.



↑ The first image taken by ESA's first meteorological satellite, Meteosat-1, launched on 23 November 1977 (left). The first image taken by Meteosat-11, launched on 15 July 2015 (right).

→ Activity 1: Talking about the weather

In this activity, pupils will be introduced to the topic by analysing some local proverbs related to the weather. Pupils will discuss the reasoning behind the proverbs with empirical knowledge.

Equipment

- Printed student worksheet for each pupil
- A list of local proverbs related to the weather
- Information sources, such as the internet or an encyclopedia

Exercise

As a starting point, teachers can ask pupils if they know old sayings or proverbs about the weather. Pupils should register at least two. They can use the information sources to find some weather proverbs.

In groups, pupils should try to interpret the reasoning behind one proverb of their choice. They should then present their conclusions to the class.

We suggest that teachers prepare a possible explanation for some local proverbs. There are several online sources where it is possible to find information about the science behind weather proverbs. Below teachers can find three examples of popular sayings about the weather.

“Red sky at night, sailors delight; red sky at morning, sailors take warning.”

The colours we see in the sky are caused by sunlight being refracted into almost all the colours of the visible spectrum as they pass through our atmosphere. The Sun's rays pass through a greater length of atmosphere at sunrise and sunset than at any other time of day. The reddish colour results from scattering of blue light by particles in the atmosphere, leaving only red light to give the sky its beautiful appearance. In addition, dust and small particles are trapped in the lowest layers of the atmosphere when the atmosphere is dominated by sinking air (high air pressure areas).

Weather systems generally travel from west to east in the mid latitudes. Because the Sun rises in the east and sets in the west a red sky at sunset means high pressure is moving in from the west so the next day will usually be pleasant. A red sunrise means the Sun is reflecting from dust particles and clouds that have passed from the west, and a storm may be following in from the east.

“A ring around the Moon or Sun, and rain approaches on the run.”

A ring around the Sun or Moon is caused by the refraction of the Sun's light due to ice crystals formed in high clouds. These high clouds, or Cirrus clouds, are made up completely of ice crystals and often form in advance of a warm front, indicating a change in the weather is on the way. In summer months mainly, the ring may be a sign of approaching storms.

“Seagull, seagull sit on the sand. It's never good weather when you're on land.”

Seagulls are usually flying or on a flat, calm sea. If the weather gets worst and the sea is not very calm they will fly to land in order to avoid strong winds. Another reason may be that some birds prefer not to fly during low pressure systems which are associated with bad weather. This may be due to the air being thinner which makes flying harder.



→ Activity 2: Sensing the weather

In this activity, pupils will make sensory weather observations to learn how to describe weather conditions. They will conclude that to describe weather we can use wind, rain, temperature and clouds.

Equipment

- Printed student worksheet for each pupil

Exercise

Start this activity by first asking pupils how they would describe the weather using their senses (what can they see, feel or hear).

Discuss with the pupils which key words they would use to describe the weather. Example: there was more or less heat, more or fewer clouds, more or less wind, more or less rain, etc. Pupils will then describe the weather today through a text, a table, or drawing. Guide students to conclude that to describe the weather we can use the wind, rain, temperature and clouds.

Depending on the level of the students, teachers can conclude this activity by analysing a weather forecast and asking students to compare their observations with the daily forecast. Ask students what is necessary to produce reliable weather forecasts. Students should understand that modern weather forecasting makes use of different instruments and applies scientific knowledge to predict future weather conditions across the globe from observations made from land, at sea, in the air, and from space.



→ Activity 3: Build your weather station

In this activity, students will make weather measurements with their own weather station. They will use a thermometer to measure air temperature. They will build an anemometer to measure the wind speed and a rain gauge to measure how much rain has fallen.

Exercise

Organise pupils into groups to carry out the practical experiment. Explain that they will use and build different instruments in order to make weather measurements. Ask students if they know any instruments that do these kinds of measurements.

Students should record all the measurements from their weather station in a weather diary (see Annex) so that they can conclude how the weather changes over the week. The measurements should be done at least once a day and more or less at the same time every day.

Younger students may only use their senses to describe the weather and fill the weather description in the weather diary using the weather and temperature stamps (see Annex).

Exercise 1 – Measuring air temperature

Equipment

- Thermometer
- Weather diary and printed students worksheet

Exercise

Start this exercise by demonstrating how to take a reading on the thermometer in the classroom. You can then go outside and demonstrate how to take measurements outside. It is important to wait a few minutes before taking a reading. This allows the thermometer to adjust to the outside air temperature. When recording the temperature, students should follow some simple instructions:

- Place the thermometer a few centimetres above the ground (to make sure that the thermometer is not reading the heat from the ground) and out of direct sunlight;
- The thermometer should be protected from rain (or snow);
- When recording the temperature the thermometer should be close to eye level.

Exercise 2 – Measuring wind speed

Equipment

- 5 plastic cups (per group)
- 1 straw
- 3 wooden sticks
- Weather diary and students worksheet



Exercise

Start this exercise by explaining to the students that they will build an instrument to measure the wind speed. Hand out the equipment and ask pupils to follow the instructions on their activity sheets.

Students should make the measurements outside in an open area. Before measuring, students should test and become familiar with the instrument. When all the groups have finished building the anemometer, ask students to suggest ideas of how to use this model to calculate the wind speed. For example, students can count how many times the anemometer rotates in a given time interval, and use this method to measure the wind speed in cycles per time.

Exercise 3 – Measuring rain

Equipment

- Plastic bottle (1,5l - 2l)
- Ruler
- Paper clips
- Marker
- Pebbles
- Weather diary and students worksheet

Exercise

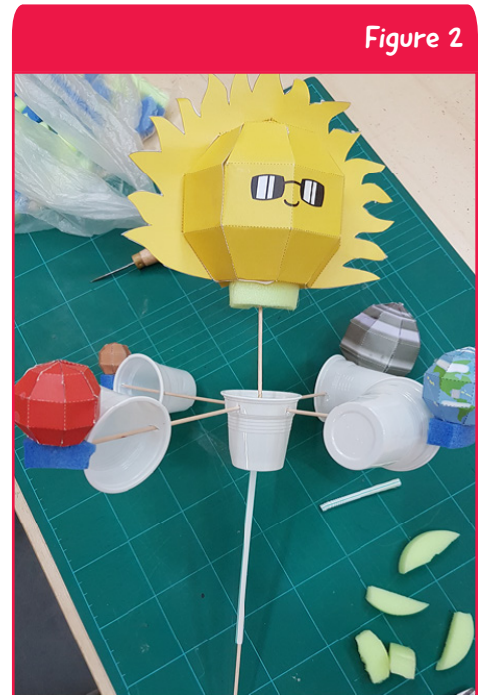
Start by explaining students that they will build an instrument to measure rain – a rain gauge. Hand out the equipment and ask pupils to follow the instructions on their activity sheets.

Pupils should take their rainfall measurements at least once per day during a week. After each measurement, pupils should empty the rain gauge until the water level is again at omm.

Discussion

Once groups have completed their first readings of temperature, wind speed and rain, discuss the results as a class. Ask students to explain possible different results among the groups (different locations, different collecting areas, any differences in the instruments built).

Once groups have completed their weather diary, they should compare their results with the other groups.



↑ Anemometer to measure wind speed.

→ Conclusion

Nowadays, we refer to technology when we need a weather forecast, however, if we find ourselves outdoors and out of touch with technology, there are many signs that we can look for to help us infer something about the weather and avoid getting completely wet or blown about by the wind.

Where do all the data that are used to predict the weather come from? Pupils should understand that numerous satellites provide us with the most useful data for weather forecasting. They continuously observe the Earth and communicate the data back to Earth. The analysis of those data combined with data from meteorological stations on Earth allow meteorologists to predict the weather.

→ NOSE UP HIGH IN THE SKY

Observing and measuring weather conditions

→ Activity 1: Talking about the weather

Long before people could measure the weather scientifically, they told stories to explain the weather. Do you know any weather proverbs? In this introductory activity, you will explore the meaning of some of these old sayings.

Exercise

1. Write down two weather proverbs.

2. Choose one of the proverbs that you listed before and try to interpret the reasoning behind it .

Did you know?

For thousands of years, humans have looked up to the skies trying to predict what the weather might bring. Nowadays, we can get a weather forecast anytime! Where do all the data that are used to predict the weather come from? There are numerous satellites that provide us the most useful data for weather forecasting. They continuously observe the Earth and communicate what they see back to our planet. The analysis of that data combined with the information obtained from meteorological stations here on Earth allows meteorologists to predict the weather.



→ Activity 2: Sensing the weather

To create a weather forecast we need to make observations. In this activity, you will make weather observations using your senses.

Exercise

1. Observe and describe the weather today (you can use a list of words or drawings).

Insert your weather description here:

2. Which senses did you use to make your description?
-
-

Did you know?

While the weather can change over a few hours, climate is measured over many years. Scientists are worried about the climate changes induced by us on our planet that are responsible for global warming. A large team of scientists works in the ESA Climate Change Initiative to understand what influences the changes in our climate and to identify ways to lessen them. You can also make a difference, for example, by walking or using your bike instead getting a ride in a car and by recycling paper, plastic, glass and aluminum.



→ Activity 3: Build your weather station

In this activity, you will make weather observations using different instruments and create your own weather forecast. You will learn how to build a small meteorological station with an anemometer to measure the wind speed and a rain gauge to measure the rainfall.

Exercise 1: Measuring air temperature

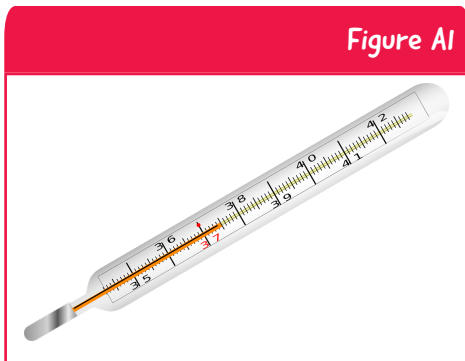


Figure A1

↑ Thermometer to measure air temperature.

- To measure the air temperature you will use a thermometer.
1. Start by measuring the air temperature in the classroom. When recording the temperature the thermometer should be close to your eye level.
 2. Go outside and wait two minutes before you take a reading.
 3. Register the temperature in your weather diary.

Exercise 2: Measuring wind speed

To measure the wind speed, you will construct an anemometer with the help of your teacher, similar to the one in figure A2.

1. Pierce two holes in four of the plastic cups on opposite sides, as shown in the image.
2. On the remaining plastic cup, pierce two holes on opposite sides of the cup and two more perpendicular to those. Also, pierce the bottom of the cup and stick a straw through it.
3. Place a wooden stick inside the straw so that it is free to rotate.
4. Put the other wooden sticks through the cup holes as in the images to complete the anemometer.
5. Place the anemometer outside where it is exposed to the wind and test your anemometer.
6. How could you calculate the wind speed with this anemometer?

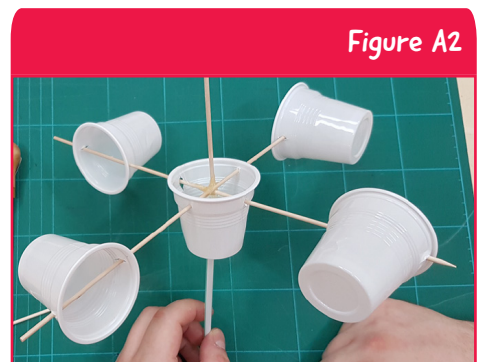


Figure A2

↑ Anemometer to measure wind speed.

7. Write your calculations below:

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8. Repeat the measurements with the anemometer and register the wind speed in your weather diary.

Did you know?

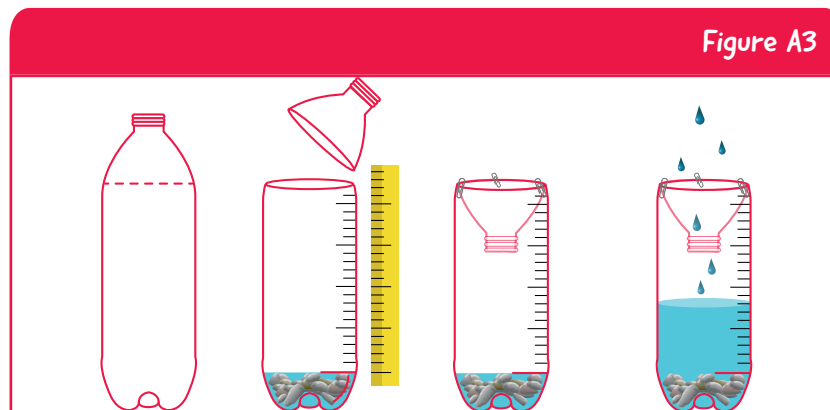
Weather satellites make use of very special instruments in order to measure and predict the weather conditions on Earth. ESA's Aeolus wind mission, the first space mission to measure wind on a global scale, carries just one large instrument – a laser called ALADIN that will probe the lowermost 30km of the atmosphere to measure the winds sweeping around our planet. Meteorologists need reliable wind- measurements to improve the accuracy of weather forecasts.



Exercise 3: Measuring rain

To complete your meteorological station, you will build your own rain gauge to measure how much rain has fallen.

1. Take an empty plastic bottle and cut off its top (see Figure A3).



↑ How to build a rain gauge to measure the rain.

2. If the bottle has an uneven bottom, place pebbles inside to even it and to keep it from tipping over if there is wind.
3. Place the top of the bottle upside down into the bottom part, without the cap. Use paper clips to hold it in place.
4. Add a scale to it by drawing a vertical line on the bottle. Take a ruler and mark a scale every 5mm or more often, depending how precise you want your scale to be. Label those measurements “0mm, 5mm, 10mm, 15mm...”.
5. Place the gauge outside and fill it with water until it reaches the 0mm mark. Make sure that there is nothing overhead your rain gauge (like a tree) that could give you wrong readings.
6. Register the amount of rainfall in your weather diary.
7. Empty your rain gauge after each reading until the water reaches the 0mm mark.

Discussion

Compare your results with the results of your colleagues. If they are very different, what could be causing those differences?



→ LINKS

ESA resources

ESA classroom resources

esa.int/Education/Classroom_resources

ESA Kids

esa.int/esaKIDSen

ESA space projects

ESA's Earth Observation missions

esa.int/Our_Activities/Observing_the_Earth/ESA_for_Earth

Meteorological missions

esa.int/Our_Activities/Observing_the_Earth/Meteorological_missions

Aeolus mission

esa.int/Our_Activities/Observing_the_Earth/Aeolus

ESA's Climate Change Initiative

<http://cci.esa.int/>

Extra information

List of national meteorological services

en.wikipedia.org/wiki/List_of_meteorology_institutions

MeteoEarth- An app weather that displays various weather indicators

www.meteoearth.com

Earth: a global map of wind, weather, and ocean conditions

<https://earth.nullschool.net>

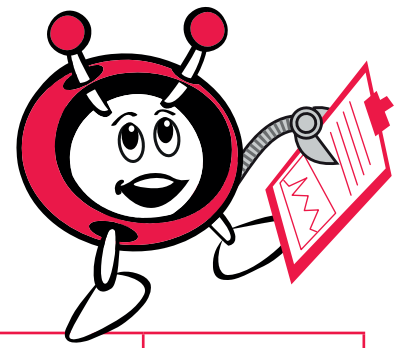
EUMETSAT video: How do we monitor the weather from space?

youtube.com/watch?v=zfVeB4s8WWk

ESA, space in videos: Why measure wind?

esa.int/spaceinvideos/Videos/2018/08/Why_measure_wind



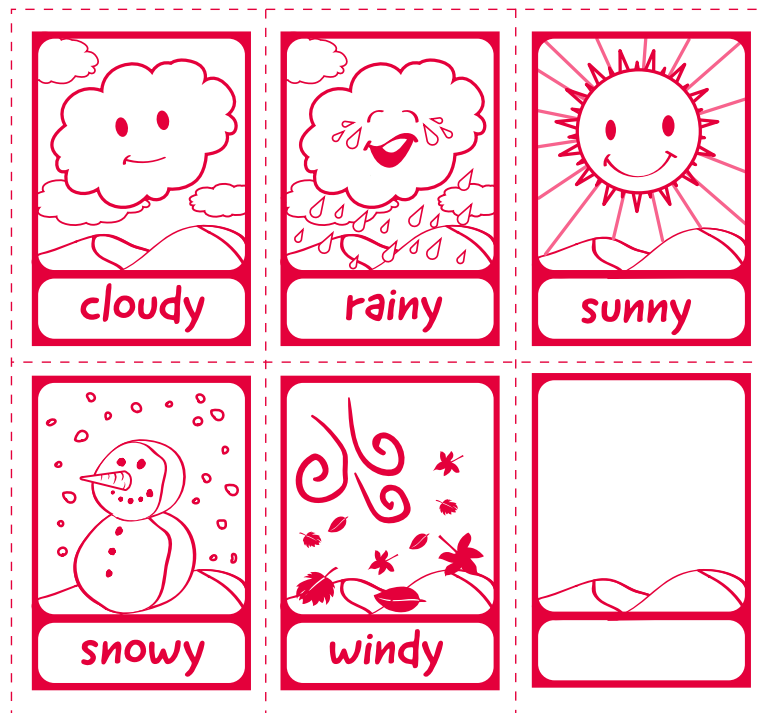


→ ANNEX

Weekly Weather Diary

	Date & Time	Description	Air temperature	Wind Speed	Rainfall
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					

Weather stamps



Temperature stamps

