ORANSSILUMI

An exploratory journey through atmospheric events

For grades 1-9

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

KONE FOUNDATION

Welcome to Oranssi Lumi!

Are you ready to join a dust particle on its adventure from the Sahara's arid lands all the way to Finland?

This journey is successful only a handful of times a year, and landing on the ground is an even more rare and fascinating phenomenon! The last event in Finland, that took place in 2021, is what inspired us to create these materials.

In the following pages, we will explore together the processes that happen during the dust's journey. We will discover how deserts become deserts, types of interaction between dust and clouds, and how dust can land in such far away regions, among other topics.

Our mission is to bridge the gap between educators and the captivating topic of dust transport and deposition, inspiring them to bring these activities to life in their classrooms, enabling meaningful conversations about climate topics.

Designed with education professionals in mind, these materials are tailored to those instructing **grades 1-9** in both formal and informal learning environments. All the concepts are explored from multiple angles, allowing its implementation by teachers of different disciplines: music, physics, language and more, in an effort to connect scientific and artistic disciplines.

Using an exploratory learning approach, these materials have a **set of ready-made activities**, addressing the students directly. Each activity's background information will support the educator's role in facilitating it.
For an easy implementation, we have included the ***curriculum connections*** according to the Finnish National Education Curriculum.

An extensive list of ***additional resources*** are available for a deeper dive in the concepts explored. To enhance the experience, we added instructions on ***how to make your own notebook*** for documenting observations.
Additionally, the materials include easy ***guidelines for snow sample collection***.

Oranssi Lumi: a journey through atmospheric events is structured in three thematic blocks referring to the stages of the dust's journey: its origin, transport and deposition. The stages connect with an adjacent concept: ***dust***, ***wind*** and ***snow***, respectively. With the **story line marker** on the top part of every page you will always know what stage of the dust's journey you are exploring.

Each block contains a **set of activities** designed to be implemented in the classroom, with **step-by-step instructions**, **key implementation points** (duration, target age, type of activity, needed equipment, …) and **background insights**.

The **Use your notebook** icon indicates when this tool is helpful in the activity.

Other teaching implementation tips or suggestions will be found under the **Tips for Teaching** box .

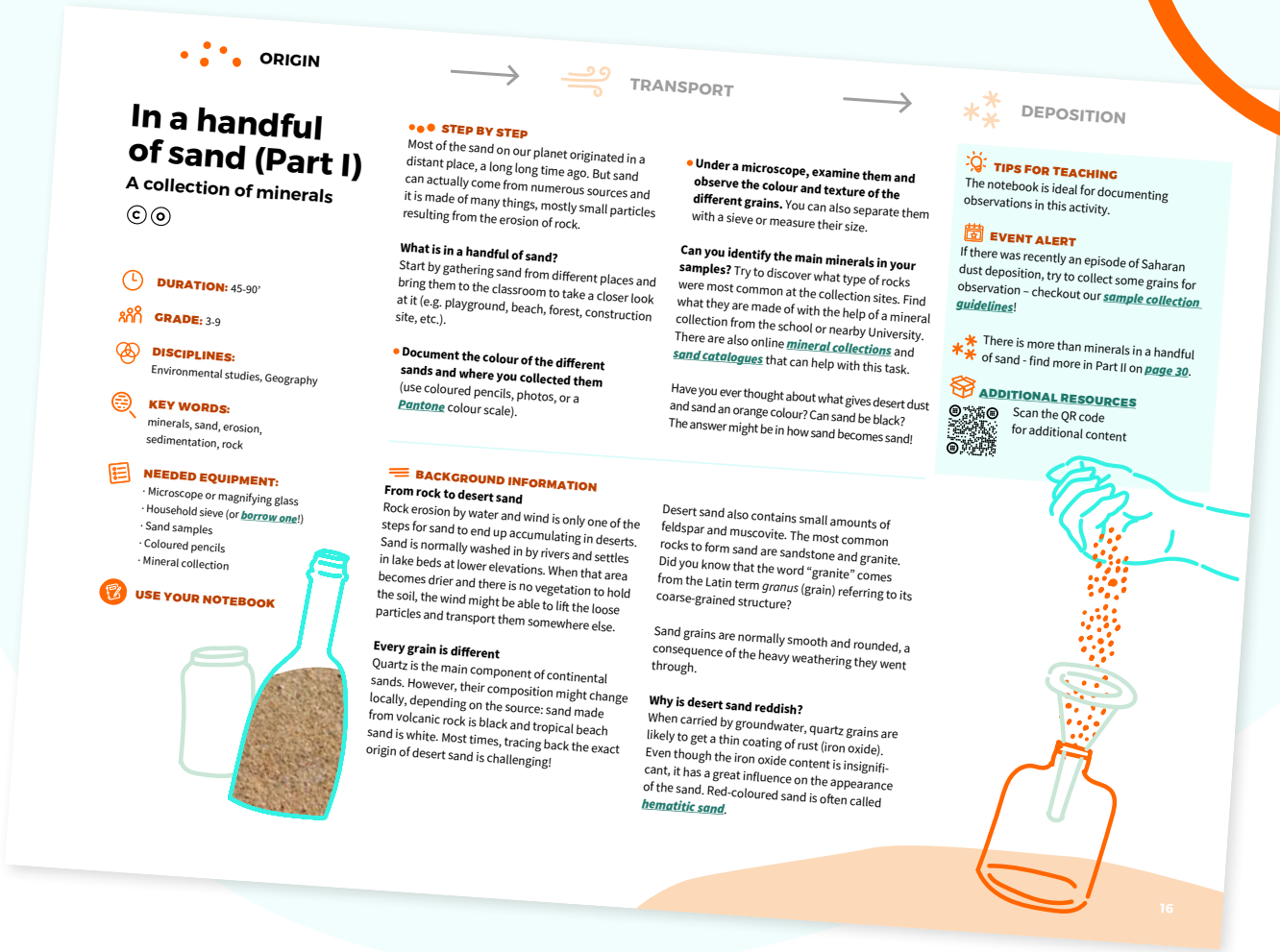
These activities can be explored all-year-round. Look for the **Event alert** box to find activities to do in case of a dust deposition episode.

Both educators and students will find easy access to **additional resources** through a link and QR code within each activity.

We hope that this journey serves as an inspiration beyond the classroom walls. Get ready to explore, share and enjoy!

The adventure awaits…

The Oranssi Lumi Team*


ORIGIN

In a handful of sand (Part I)

A collection of minerals

DURATION: 45-90'

GRADE: 3-9

DISCIPLINES: Environmental studies, Geography

KEY WORDS: minerals, sand, erosion, sedimentation, rock

NEEDED EQUIPMENT:
- Microscope or magnifying glass
- Household sieve (or *borrow one*!)
- Sand samples
- Coloured pencils
- Mineral collection

USE YOUR NOTEBOOK

TRANSPORT

STEP BY STEP

Most of the sand on our planet originated in a distant place, a long long time ago. But sand can actually come from numerous sources and it is made of many things, mostly small particles resulting from the erosion of rock.

What is in a handful of sand?
Start by gathering sand from different places and bring them to the classroom to take a closer look at it (e.g. playground, beach, forest, construction site, etc.).

- **Document the colour of the different sands and where you collected them** (use coloured pencils, photos, or a *Pantone* colour scale).

- **Under a microscope, examine them and observe the colour and texture of the different grains.** You can also separate them with a sieve or measure their size.

Can you identify the main minerals in your samples? Try to discover what type of rocks were most common at the collection sites. Find what they are made of with the help of a mineral collection from the school or nearby University. There are also online *mineral collections* and *sand catalogues* that can help with this task.

Have you ever thought about what gives desert dust and sand an orange colour? Can sand be black? The answer might be in how sand becomes sand!

BACKGROUND INFORMATION

From rock to desert sand
Rock erosion by water and wind is only one of the steps for sand to end up accumulating in deserts. Sand is normally washed in by rivers and settles in lake beds at lower elevations. When that area becomes drier and there is no vegetation to hold the soil, the wind might be able to lift the loose particles and transport them somewhere else.

Every grain is different
Quartz is the main component of continental sands. However, their composition might change locally, depending on the source: sand made from volcanic rock is black and tropical beach sand is white. Most times, tracing back the exact origin of desert sand is challenging!

Desert sand also contains small amounts of feldspar and muscovite. The most common rocks to form sand are sandstone and granite. Did you know that the word "granite" comes from the Latin term *granus* (grain) referring to its coarse-grained structure?

Sand grains are normally smooth and rounded, a consequence of the heavy weathering they went through.

Why is desert sand reddish?
When carried by groundwater, quartz grains are likely to get a thin coating of rust (iron oxide). Even though the iron oxide content is insignificant, it has a great influence on the appearance of the sand. Red-coloured sand is often called *hematitic sand*.

DEPOSITION

TIPS FOR TEACHING
The notebook is ideal for documenting observations in this activity.

EVENT ALERT
If there was recently an episode of Saharan dust deposition, try to collect some grains for observation – checkout our *sample collection guidelines*!

There is more than minerals in a handful of sand - find more in Part II on *page 30*.

ADDITIONAL RESOURCES
Scan the QR code for additional content

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Oranssi Lumi: a journey through atmospheric events, has been created by a multidisciplinary team at the Finnish Meteorological Institute, with financial support of the Kone Foundation.

WHERE TO FIND WHAT

Index

Exploring the activities

CURRICULUM CONNECTIONS: **T** – Transversal competences / **O** – Objectives of instruction / **C** – Content areas

GRADE	ACTIVITY	CATEGORY	CURRICULUM CONNECTIONS					Page	Keywords
			Disciplines	T	O	C	Learning Objectives		
1-2	**Inside a sandstorm**	*Origin*	Music, Crafts	T1	Music: O2, O3 Crafts: O1, O3, O4	Music: C1 Crafts: C2, C4	Multidisciplinary, combining craft skills with music	17	sound, physics, wind, speed, strength
	Let the dust settle	*Transport*	Environmental studies, Mathematics	T1	Environmental studies: O1, O2, O5, O6, O8 Mathematics: O2, O3, O4, O10, O12	Environmental studies: C4 Mathematics: C1, C3	Observation skills, exploratory experiment	23	transport, grain size, wind, speed, weight
	Cloud in a jar	*Transport*	Environmental studies	T1	O1, O5, O6	C4	Doing experimental work, understanding the phenomenon of cloud formation	25	clouds, cloud condensation nuclei, condensation, phase state change
	Orange snow cake	*Deposition*	Environmental studies	T1	O1, O5, O6	C4	Exploring texture, colour, gradients	29	colouring, gradient, texture, mixing
	Practice makes perfect	*Deposition*	Environmental studies	T1	O1, O2, O4, O6, O7, O8	C3, C4	Observation, doing natural science research	31	observation, deposition, sample collection, DIY
	The story of a particle	*Deposition*	Mother tongue and literature, Second national language, Foreign languages	T1, T2, T7	O3, O4, O9, O10, O11	C3	Potential for assessment of what was learned with the educational materials	32	particles, climate change, displacement and migrations, imagination

Exploring the activities

CURRICULUM CONNECTIONS: **T** – Transversal competences / **O** – Objectives of instruction / **C** – Content areas

GRADE	ACTIVITY	CATEGORY	CURRICULUM CONNECTIONS					Page	Keywords
			Disciplines	T	O	C	Learning Objectives		
3-6	**In a handful of sand (Part I)**	***Origin***	Environmental studies	T1, T4, T5	O1, O3, O5, O9, O13, O14, O15	C4	Observation skills, using source materials, exploring, scientific research	16	minerals, sand, erosion, sedimentation, rock
	Inside a sandstorm	***Origin***	Music, Crafts	T5	Music: O5 Crafts: O3	Music: C1 Crafts: C4	Multidisciplinary, combining craft skills or technology with music	17	sound, physics, wind, speed, strength
	Not-so-quick sand	***Origin***	Environmental studies	T5	O1, O6, O7, O11, O12, O13, O16	C4	Using an Earth observation program, understanding effects of desertification better, data visualisation	18	satellites, Earth observation, desertification
	Black T-shirt/ white T-shirt	***Transport***	Environmental studies	T1, T7	O1, O4, O5, O6, O13, O17	C4	Observation skills, exploratory experiment	22	albedo, energy budget, global warming, greenhouse effect, aerosols radiative effect
	Let the dust settle	***Transport***	Environmental studies, Mathematics	T1	Environmental studies: O1, O4, O5, O6, O13 Mathematics: O3, O4, O5,	Environmental studies: C3, C4 Mathematics: C1, C4	Observation skills, exploratory experiment	23	transport, grain size, wind, speed, weight
	Cloud in a jar	***Transport***	Environmental studies	T1	O1, O4,O5, O6, O17	C5	Doing experimental work, understanding the phenomenon of cloud formation	25	clouds, cloud condensation nuclei, condensation, phase state change

Exploring the activities

CURRICULUM CONNECTIONS: **T** – Transversal competences / **O** – Objectives of instruction / **C** – Content areas

GRADE	ACTIVITY	CATEGORY	CURRICULUM CONNECTIONS					Page	Keywords
			Disciplines	T	O	C	Learning Objectives		
3-6	**In a handful of sand (Part II)**	***Deposition***	Environmental studies	T1, T7	O1, O4, O5, O18	C4	Doing natural science research	30	diatoms, soil, iron, phosphorus, fertiliser
	Practice makes perfect	***Deposition***	Environmental studies	T1	O1, O4, O5, O6, O12	C3, C4	Observation, doing natural science research	31	observation, deposition, sample collection, DIY
	The story of a particle	***Deposition***	Mother tongue and literature, Second national language, Foreign languages	T1, T2, T7	O3, O4, O9, O11	C3	Potential for assessment of what was learned with the educational materials	32	particles, climate change, displacement and migrations, imagination
7-9	**In a handful of sand (Part I)**	***Origin***	Geography	T1	O1, O4, O8, O9	C4	Observation skills, using source materials, exploring, scientific research	16	minerals, sand, erosion, sedimentation, rock
	Inside a sandstorm	***Origin***	Music, Crafts	T5	Music: O5, O6, O7 Crafts: O1, O3	Music: C1 Crafts: C4	Multidisciplinary, combining craft skills or technology with music	17	sound, physics, wind, speed, strength
	Not-so-quick sand	***Origin***	Geography	T5	O2, O4, O5, O7, O9	C4	Using an Earth observation program, understanding effects of desertification better, data visualisation	18	satellites, Earth observation, desertification

Exploring the activities

CURRICULUM CONNECTIONS: **T** – Transversal competences / **O** – Objectives of instruction / **C** – Content areas

GRADE	ACTIVITY	CATEGORY	CURRICULUM CONNECTIONS					Page	Keywords
			Disciplines	T	O	C	Learning Objectives		
7-9	**Black T-shirt/ white T-shirt**	*Transport*	Physics	T1	O1, O3, O5, O6, O11	C2	Observation skills, exploratory experiment	22	albedo, energy budget, global warming, greenhouse effect, aerosols radiative effect
	All the way here	*Transport*	Geography	T5	O2, O5, O7, O8, O9	C2	Using an internet-based Earth observation program, understanding its data, understanding Saharan dust phenomena better	24	satellites, Earth observation
	In a handful of sand (Part II)	*Deposition*	Biology, Geography	T1, T7	Biology: O6, O10, O12 Geography: O2, O7, O11	Biology: C2 Geography: C5	Doing natural science research	30	diatoms, soil, iron, phosphorus, fertiliser
	Practice makes perfect	*Deposition*	Biology, Geography	T1	Biology: O6, O7, O10, O12 Geography: O2, O3	Biology: C1 Geography: C3, C4	Observation, doing natural science research	31	observation, deposition, sample collection, DIY
	The story of a particle	*Deposition*	Mother tongue and literature, Second national language, Foreign languages	T1, T2, T7	O3, O10, O11, O12	C3	Potential for assessment of what was learned with the educational materials	32	particles, climate change, displacement and migrations, imagination

Find the Finnish National Curriculum ***here***.

VISUAL INDEX

The journey of a dust particle

Dust

Page 13

Wind

Page 19

Snow

Page 26

Grades 1-2 3-6 7-9 **Page number with link** 13 **Activity type** (C) In the Classroom (O) Outdoor

BEFORE YOU START...

Make your own notebook!

Before starting this journey, create your own notebook for writing your observations, sketching or drawing. Follow the instructions to get it done, and don't forget to decorate it!

The *Use your notebook* icon will appear in the activities whenever it is a good idea to use it!

More ideas for notebooks

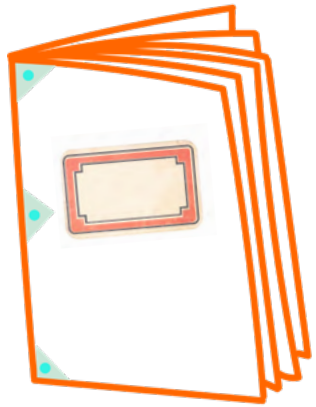
Scan the QR code for additional content

Needed Equipment:

- Pencil
- Ruler
- Scissors
- 8 white or light-coloured A4 sheets of paper
- 1 thicker A4 piece of paper or cardboard for the cover
- Yarn or textile ribbon (ideally 3 times the height of the book)
- Materials for decoration

LET´S DO THIS!

1. Take eight sheets of paper, make a stack and fold them in half. The backside of the scissors can be helpful to fold a precise crease.



2. Make three marks with a pencil on the left side of the folded stack: one in the centre and the other two on the upper and bottom part of the spine. Use the ruler to measure where the middle mark goes.

3. Cut a triangular hole from the middle of the spine with the scissors around the marks (check illustrations). Repeat folding and hole cutting, now for the cover paper. Make sure the cover holes and the paper stack holes are aligned.

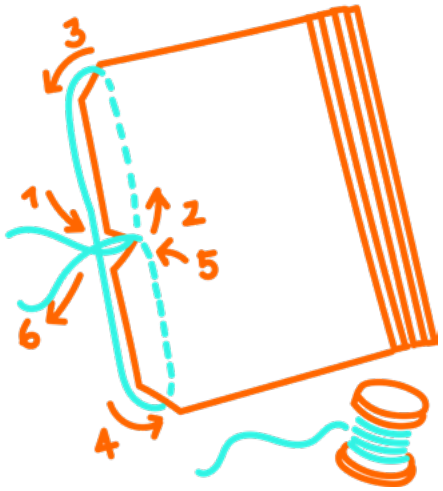
4. Put it all together and open the book from the middle. Thread your ribbon or yarn through the middle hole. Leave a little tail outside.

5. Inside, take the thread up and then to the outside all the way down. Come back inside from the bottom hole and then thread it through the middle hole to the outside.

6. Now make sure the two tails are on both sides of the spine thread and tie a knot around it, in the middle. You can tie it in a bow and even string on some colourful beads.

7. You can decorate the cover however you like. Put your favourite stickers, write your name, draw on it or make a collage.

Your notebook is now ready for collecting observations and thoughts!



What does an aerosol feel, taste and sound like?

More than gases in our air

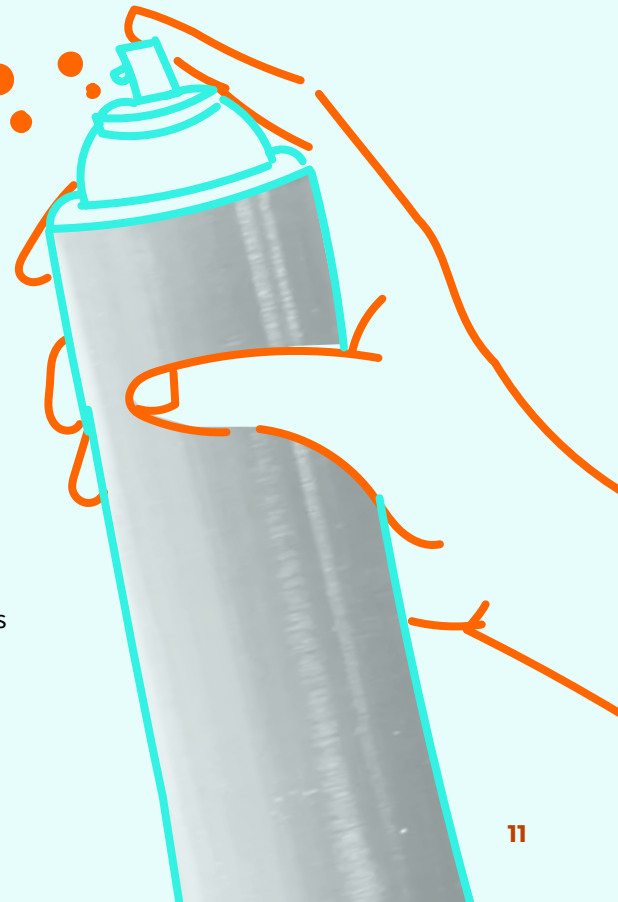
Floating among the nitrogen, oxygen and other gas molecules, there are very small particles called **aerosols** surrounding us everywhere. Aerosols can be solid or liquid, and they are smaller than the thickness of a hair! In a portion of air the size of a dice we can find hundreds or thousands of aerosol particles, even if they are invisible to the naked eye!

A panoply of aerosols

Aerosols differ in shape, size and origin. Some of them are produced by natural processes: sea salt, smoke from volcanic eruptions, wildfires, or dust in deserts. But we, as humans, create and emit a great portion of them, mainly derived from burning wood and predominantly fossil fuels - oil, gas and coal.

They don't come only from a can!

In a normal conversation, we might use the term aerosol (aerosol spray) to describe a dispensing system that creates a mist of tiny droplets - of paint, deodorant, or perfume. When we think about aerosol spray we are not too far from the broader concept of aerosol: in the end, it's all about small particles that float in the air.



INTRODUCTION

What about climate?

Aerosols can influence the amount of energy that the Earth gets from the Sun. Some of them act as a mirror, reflecting away part of the incoming energy in the form of light. Others, instead, trap energy efficiently, which contributes to warming the atmosphere just like an insulating winter jacket.

Aerosols and us

Humans are not only responsible for some of the aerosol emissions, they are also affected by them. Our respiratory system is sensitive to tiny particles. When we breathe, the aerosol-containing air carries particles into our lungs, potentially causing damage. However, the larger the aerosol size, the more likely it will be stopped by our body's filters: sticky mucus and the cilia inside your nose!

Dust

What is in it?
Where does it come from?
Find more dusty business on page 13

The essence of a cloud

Aerosols are key in the process of cloud-making. Most cloud droplets or ice crystals need a "seed" that facilitates the condensation of water or ice. The nature of the aerosol, its location and abundance, will determine the type and properties of clouds formed in their presence. Through the formation of clouds, aerosols also affect climate.

Wind

Discover how wind is made and what it can bring us from far away places on page 19

Snow

Did you know that snow can appear in many colours other than white? Check it out on page 26

Dust

DUST

Did you know that there are dustier places on Earth than under your bed?

Unlike household dust (consisting of pollen, hair, textile and paper fibres, soil minerals…), atmospheric dust is made from the erosion of rock materials. Erosion is a process where natural forces like water or wind wear away and transport rocks and soil.

LET´S TRY THIS!

"Dusty"

Duration: 45'/ multiple sessions

Grade: 1-9

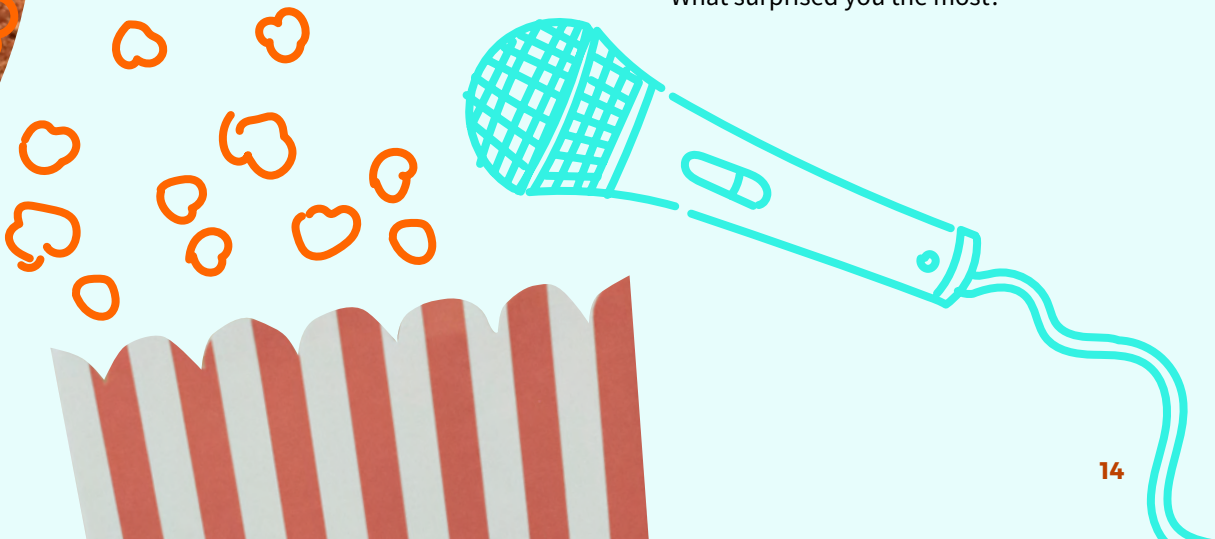
"Dusty", a song by Ed Sheeran, released in 2023, is about spending enjoyable moments together with his daughter while listening to an old album by famous singer Dusty Springfield.

Dust can be found in many places… including pop culture and music.

How many more examples can you discover?
Make a playlist and set up a karaoke session in the classroom!
Don't forget to look for hits in Finnish and other languages!

Dust, sand and deserts have been featured in cinema across different genres from historical and sci-fi to action movies (e.g. classics like Indiana Jones' *Raiders of the Lost Ark*, animation movies like *Rango* and *Aladdin*, the epic *Star Wars* saga or *Dune)*.

Together with the whole class, **search for trailers and prepare a *Sand Film Festival* to watch your favourites at home or school.**
Discuss details you notice in these movies:
- Where was it filmed?
- Were there strong winds or sandstorms?
- What were the most common colours?
- What surprised you the most?



DUST

How does sand become sand? Discover what is in it.

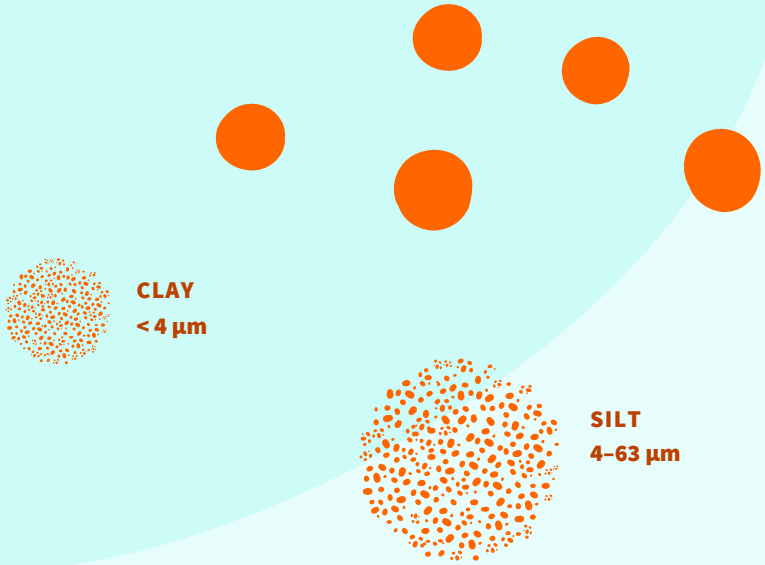
In a handful of sand (Part I) *Page 16*

Curious to know how sand and dust become airborne?

Inside a sandstorm *Page 17*

Were deserts always deserts?

Not-so-quick sand *Page 18*



Additional resources

Mineral dust is one of the most important types of aerosols. It has an influence beyond its sources, it impacts our planet at multiple levels by taking part in physical and biological processes.

Earth's "dust factories"
Mineral dust originates in areas with currently arid and windy climates where there once was a lake or a sea.
The powerful winds blowing over these "dust factories" is the force behind the dust injection into the atmosphere reaching very high altitudes. Once aloft it can be transported worldwide by winds, covering distances of thousands of kilometres.

The Sahara Desert produces far more atmospheric dust than any other region in the world. In its Bodélé depression, where Lake Chad used to be, one can find Earth's largest single source of atmospheric dust. In fact, about half of the dust suspended in the atmosphere originates in North Africa.

Dunes are surprisingly not the main source of airborne dust: their grains are too large and heavy to be transported long distances. Dunes are formed by the accumulation of mineral dust/sand that originates nearby.

Sand, dust or both?
Both sand and dust are present in the desert and can be lifted up and transported. Depending on the context, one term will fit better than the other. Generally, we use dust for particles being transported by air.
Regarding size, dust is quite similar to silt. Grain size is measured by finding the diameter of the particle. The smaller the grain size, the easier the wind can transport the particles.

What is it made of?
Dust is a mixture of fine particles of varying composition, including metal oxides, carbonates, and clay. The exact mineral composition of dust varies depending on the source region and its geological composition.

In a handful of sand (Part I)

A collection of minerals

DURATION: 45-90'

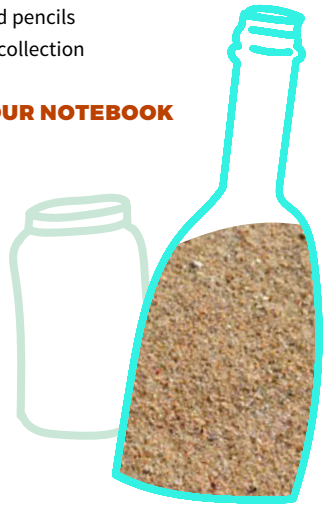
GRADE: 3-9

DISCIPLINES:
Environmental studies, Geography

KEY WORDS:
minerals, sand, erosion, sedimentation, rock

NEEDED EQUIPMENT:
· Microscope or magnifying glass
· Household sieve (or ***borrow one***!)
· Sand samples
· Coloured pencils
· Mineral collection

USE YOUR NOTEBOOK



STEP BY STEP

Most of the sand on our planet originated in a distant place, a long long time ago. But sand can actually come from numerous sources and it is made of many things, mostly small particles resulting from the erosion of rock.

What is in a handful of sand?
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- **Document the colour of the different sands and where you collected them** (use coloured pencils, photos, or a ***Pantone*** colour scale).
- **Under a microscope, examine them and observe the colour and texture of the different grains.** You can also separate them with a sieve or measure their size.

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When carried by groundwater, quartz grains are likely to get a thin coating of rust (iron oxide). Even though the iron oxide content is insignificant, it has a great influence on the appearance of the sand. Red-coloured sand is often called ***hematitic sand***.

TIPS FOR TEACHING

The notebook is ideal for documenting observations in this activity.

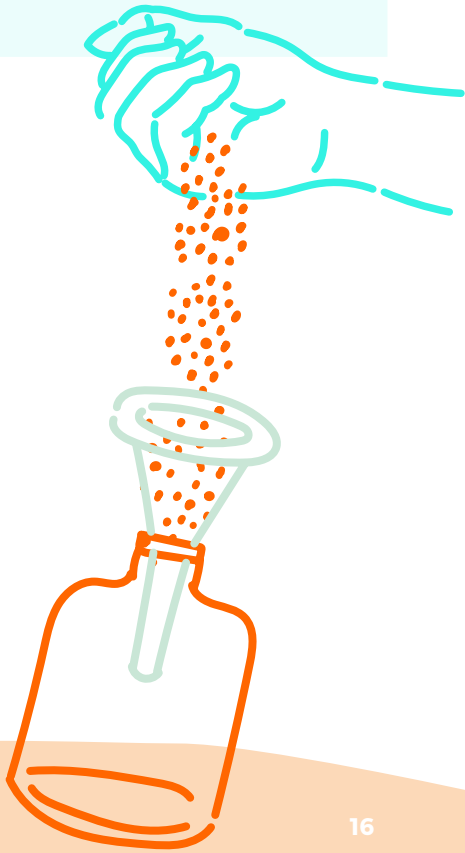
EVENT ALERT

If there was recently an episode of Saharan dust deposition, try to collect some grains for observation – checkout our ***sample collection guidelines***!

There is more than minerals in a handful of sand - find more in Part II on ***page 30***.

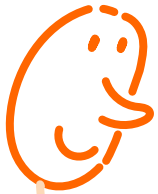
ADDITIONAL RESOURCES

Scan the QR code for additional content



Inside a sandstorm

More layers than you can feel!



DURATION: 45’ / multiple sessions

GRADE: 1-9

DISCIPLINES:
Music, Crafts

KEY WORDS:
sound, physics, wind, speed, strength

NEEDED EQUIPMENT:
· Ready-made instruments
· DIY instruments
· Soundscapes
· Sandstorm videos

STEP BY STEP

How would it feel to be inside a sandstorm?
Close your eyes. Imagine how it would be to stand in a desert dune when strong winds start to increase, blowing large amounts of sand and dust particles.

How can you reproduce the sound of a sandstorm with existing and/or built instruments?
You can also gather online audio clips that resemble the sounds of a sandstorm.

Under the chaos that a sandstorm might look, feel and sound like, there is some structure. There are particles called **reptons** that move close to the ground in the direction of the wind, and others called **saltons** that jump higher above. Saltons move much faster and travel longer distances than reptons. When they fall to the ground, they create a splash effect that makes reptons jump high, turning them into saltons.

Knowing how this process goes, **you can try to recreate the sandstorm effect and sound by making or choosing the best instruments to “play” reptons and saltons!**

Different students can be in charge of separate layers of a sandstorm… The whole classroom acts like a **sandstorm orchestra** - the possibilities are endless!

TIPS FOR TEACHING

Experiment with musical instruments, boxes or tubes with grains inside (rice, couscous, oats, barley). Use also body percussion, blowing, noises, wind soundscapes/videos or ***Musyc*** app.

Split the activity in three 60’ sessions for
1) research sounds and planning,
2) build and test instruments and sounds, and
3) orchestra rehearsal for the “concert”.

ADDITIONAL RESOURCES

Scan the QR code for additional content

BACKGROUND INFORMATION

Stomping air
A sandstorm is like a wall of dust and debris blown into an area by strong winds from thunderstorms.
Inside a thunderstorm, a localised column of sinking air hits the ground and spreads out in all directions, carrying sand or dust at very high speeds. The lifted particles can reach as far as hundreds of metres. Through convection, dust can reach even higher altitudes in the atmosphere.

Sandstorms and dust storms are the same type of phenomenon, the difference resides in the size of the particles carried and the distances that they travel. Did you know that *haboob* was the original Sudanese term for these phenomena? Nowadays we use it to describe any wind-driven sandstorm or dust storm around the world.

***Sisu* in the desert**
People have always settled in deserts, which requires an adapted lifestyle. Clothing covers a person fully, maximising the protection against heat, sand and wind.

Healthy breathing
Dust can be hazardous for humans and have a great impact on transport and other services. Breathing dusty air might cause respiratory problems, including allergy outbreaks.

SIZE MATTERS!

Particle size is key to determine how dangerous dust is for human health. Particles larger than 10 µm (micrometres) are not breathable. For reference, the thickness of a human hair is approximately 70 µm. Particles under 10 µm can get trapped in the upper respiratory tract and affect it (causing asthma or allergies). Finer particles might penetrate the lower respiratory tract and enter the bloodstream.

Not-so-quick sand

Tracking deserts through time

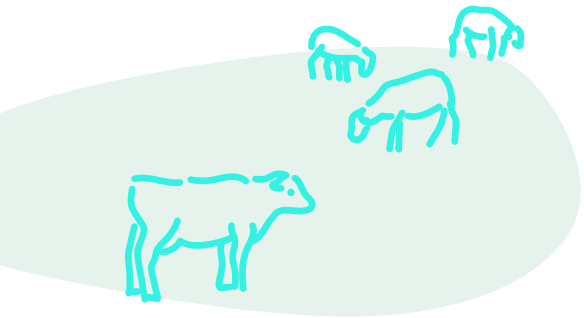
DURATION: 20-60'

GRADE: 3-9

DISCIPLINES:
Environmental studies, Geography

KEY WORDS:
satellites, Earth observation, desertification

NEEDED EQUIPMENT:
- Computer with downloaded version of ***Google Earth Pro***®
- Online or mobile apps for animations or ***GIF-editing***
- Craft materials for cut-outs and analogue animations



STEP BY STEP

Since the first satellite images were taken, we have been able to see ourselves from space. We now have decades of images that help us realise how the surface of the Earth has changed. With **Google Earth Pro®** one can browse easily through historical pictures and **track deserts through time**.

1. **Open Google Earth Pro® and move your view to the Saharan desert** (North Africa).
2. **Click on the clock icon at the top toolbar** (*show historical imagery*).
3. **Use the time slider to move between acquistion dates.** You can click the arrows on both ends of the slider.
4. **Observe changes in the Saharan desert.** Can you notice desertification happening? Are you able to find Lake Chad? Compare it now with how it looked in the 1980s.
5. **Search for other deserts and also the Aral Sea.** What can you observe in those areas?

BACKGROUND INFORMATION

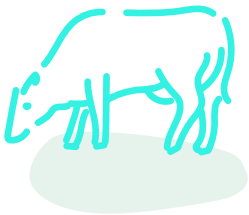
Antarctica is a desert!
Deserts are arid areas where precipitation is scarce. In deserts, living conditions are hostile for most plant and animal life. But deserts are not always in warm climates. Polar or cold deserts exist, the key is their lack of precipitation. Antarctica is one of them! The Sahara is the world's largest hot desert and the third largest desert after Antarctica and the Arctic.

Were deserts always deserts?
Current deserts were not always so dry. The Sahara was not a desert during the African humid period (14000-5000 years ago). Instead, most of northern Africa was covered by grass, trees, and lakes.

The process by which semi-arid lands turn into deserts, reducing their ability to support life, is called **desertification**. Both natural and human causes can be behind this process, but climate change, deforestation, overgrazing, and over-cultivation are key contributing factors. They favour the removal of plants that anchor the soil, making it easier for eroding agents (wind and water) to remove the nutrient-rich soil layer.

Global warming linked to **climate change** can have huge impacts on desert ecosystems: the rate of temperature-rise is higher in those areas, affecting plant life. With rainfall patterns changing, precipitation also becomes scarcer and more unpredictable.

Managing land sustainably can help avoid, reduce, or reverse desertification. The ***Great Green Wall*** in Africa and sustainable farming practices are just some examples. Conscious choices like buying local organic food can have a big impact at a global scale.



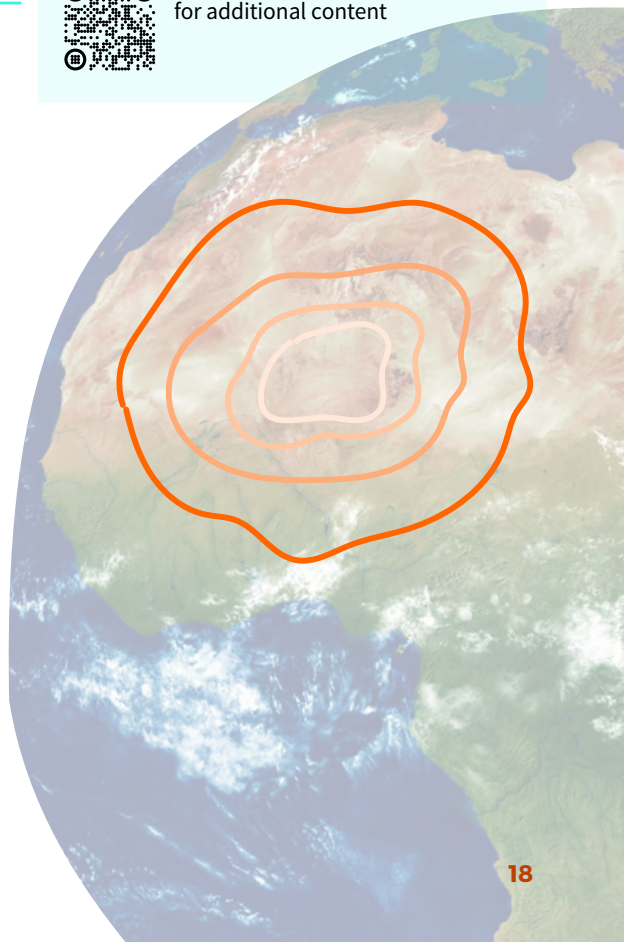
TIPS FOR TEACHING

Turn the pictures retrieved by the students into an animated GIF or explore other animation techniques.
Use Google Earth Pro® to investigate other climate change-related topics: deforestation, urban growth, etc.

A bit of math: quantify desertification using cut-out desert areas from different historical imagery. Fill them with barley pearls (*ohra surimo*) and compare their volume or weight.

ADDITIONAL RESOURCES

Scan the QR code for additional content



Wind

WIND

Aerosols can be transported long distances from where they originated, all thanks to wind!
But only special winds can make aerosols travel longer distances.

Instructions for making paper planes

LET´S TRY THIS!

Ready, set, fly!

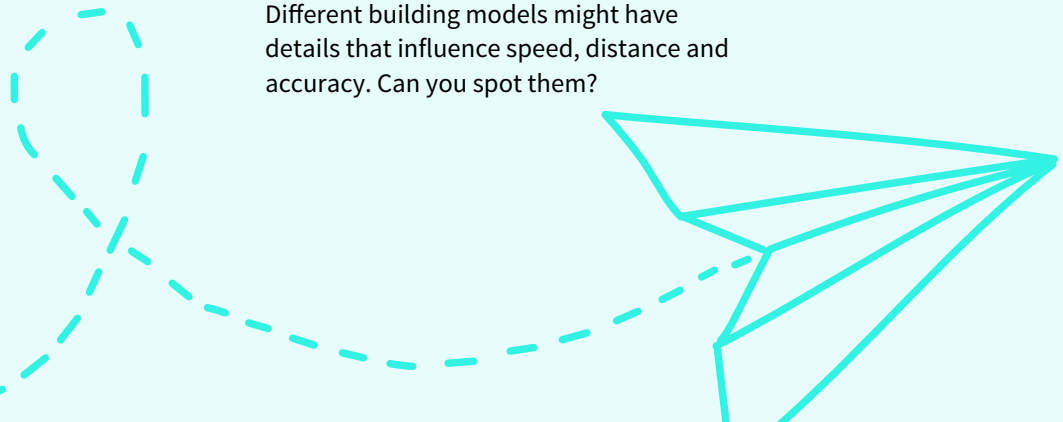
Duration: 30-45’

Grade: 1-9

Not everything that flies needs wind!
Flying or floating on air? These are different mechanisms of air transport.
A hot air balloon needs wind to move in the air but an aeroplane doesn’t. Plant seeds can be transported by wind, but what about a paper plane or a paraglider? We all need a push sometimes!

Build your own paper plane and put it to the test!
After folding and decorating your paper plane, put up some hoops at different heights and distances to challenge the paper planes built in the classroom.
What type of paper plane flies the farthest? Who has the most accurate model when trying to go through the hoops? Which paper plane is the fastest?
Different building models might have details that influence speed, distance and accuracy. Can you spot them?

In flight, there are four major forces in action: lift, weight, thrust and drag. For an aeroplane to fly, there must be a very fine balance between these forces.
For **dust** though, the transport mechanism is actually different. Once dust is lifted up, it gets carried along horizontally with the wind just like a hot air balloon would.



WIND

Global warming - what is happening in the atmosphere?

Black T-shirt / white T-shirt Page 22

How much sand travels every year from the Saharan desert to other places on Earth?

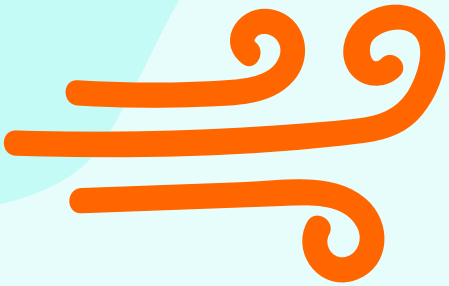
Let the dust settle Page 23

Can we use technology to observe aerosols?

All the way here Page 24

Do-it-yourself clouds: following nature's recipe.

Cloud in a jar Page 25



Additional resources

Air on the move

Wind is no more than a mass of air moving from one place to another. But, what makes a parcel of air do that?
The Sun heats up the Earth unevenly, creating warmer spots, like over the Equator, for example. Warm air heated up by the Sun, rises due to its lower density. When adjacent masses of cooler air move to fill the void left, wind is created! In warmer air masses, gas molecules spread out, spacing themselves if there is room for it. In cold air, the gas molecules stay closer to each other. The more crowded with gas molecules, the higher the air pressure. Winds generally blow from high-pressure areas to low-pressure areas.

An invisible force

One can not hold wind in their own hands, nor see it, but the force wind carries is undeniable. Without wind, we could not have sailed the seas or milled grain. Nowadays, we still use wind as a source of energy, mainly by turning it into electricity with wind turbines. In 2021, 9% of Finland's energy production came from wind power!
Will the wind go on forever? Since the motor behind wind is the Sun, as long as our star shines, there will be wind.

Naming winds

Chinook, *Bora* or *Levante* are names of local winds around the world. You can find more examples and when they happen ***here***.

Are there any names for specific winds in Finland?

Direction and speed

To measure wind one needs to characterise not only how fast it blows, but also the direction it is coming from. We use velocity units to measure speed, like m/s, km/h or knots. Do you know how the unit *knot* was created? To specify the direction of the wind we use the cardinal points - North, East, South, West - and directions in between.

Shaping our climate

Wind is a key element determining weather and climate: wind carries heat, moisture and aerosols to new areas, and also brings rain clouds.
Wind affects weather patterns differently in specific locations. For example, in coastal regions wind direction changes daily because land gets heated by the Sun more quickly than water. Winds also help drive ocean currents around the world, bringing nutrients and warmer waters to other latitudes.

Black T-shirt / white T-shirt

A temperature delicate equilibrium

DURATION: 45’

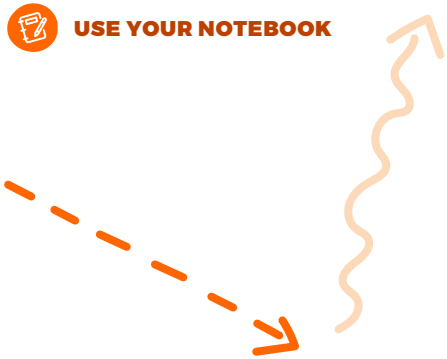
GRADE: 3-9

DISCIPLINES:
Environmental studies, Physics

KEY WORDS:
albedo, energy budget, global warming, greenhouse effect, aerosols radiative effect

NEEDED EQUIPMENT:
· Black T-shirt
· White T-shirt
· 2 metal trays
· 2 incandescent light bulb lamps
· 2 thermometers
· Timer

USE YOUR NOTEBOOK



STEP BY STEP

In Finland, dark roofs are used on buildings so the snow melts faster. In southern countries with warm weather, village homes have white outside walls keeping them cool in the summer.

For this experiment you need some volunteers to bring both white and black T-shirts to school. In the classroom, place each T-shirt on top of two separate metal trays. Put each tray under a desk lamp with an incandescent light bulb. With a thermometer placed between each T-shirt and tray, measure the initial temperature. Grab your notebook and register the temperature from both thermometers in 10 minute intervals during the whole length of the class.

Do temperatures stay the same or do they increase?
If the temperature changed, in which tray did it happen faster?
How do you think darker or lighter surfaces affect the temperature on Earth? Think about what happens on snow versus garden surfaces or highways versus lakes. Try to guess or find ways to test it.
Can aerosols in the atmosphere also behave as a white or black T-shirt to the planet?

TIPS FOR TEACHING

How can we possibly balance the energy input/output on Earth and mitigate the temperature rise? Encourage your students to become young **climate activists**!
Use the black or white T-shirt as a metaphor to trigger a discussion with them or organise a *global warming awareness day*.

ADDITIONAL RESOURCES

Scan the QR code for additional content

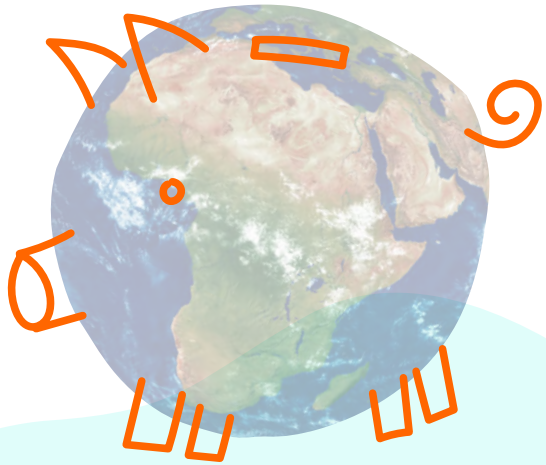
BACKGROUND INFORMATION

The energy budget
The Earth is fueled by energy coming from the Sun in the shape of radiation. Part of it gets reflected back to space together with infrared energy emitted by the planet! When there is a mismatch between the amount of incoming and outgoing energy, the average temperature of the atmosphere changes. Think of it as a piggy bank: if your monthly allowance is higher than your expenses, your savings go up!

Behind the imbalance
The Earth’s energy budget gets out of balance when there is a change in the processes influencing its calculation. For example, if the concentration of certain heat-trapping gases increases, less energy will leave the system, having a warming effect. On the other hand, if the coverage of reflective clouds is higher, a larger amount of solar energy will get bounced back to space, with a cooling effect.

Aerosols also play a role
Aerosols interact with radiation affecting how much energy leaves and gets trapped in the atmosphere. They interact **directly** by reflecting sunlight back to space (cooling effect) or by absorbing it and re-emitting it as heat (warming effect), depending on their “colour”.
Indirectly, aerosols also interact with radiation when they act as “seeds” in the making of clouds. Clouds’ cooling or warming effect is determined by the size and number of their droplets or ice crystals.

A blanket around our planet
Thanks to the *greenhouse effect*, Earth’s atmosphere is warm enough to support life. Without the presence of water vapour, carbon dioxide (CO_2), methane, and nitrous oxide in the atmosphere, the average temperature would be -18 °C, a bit chilly! These gases absorb and re-emit infrared energy down to the surface, acting as a blanket. Greenhouse gases are not harmful by definition. The problem comes when their concentration increases, leading to an enhanced greenhouse effect, resulting in a warmer atmosphere.



Let the dust settle

On how wind transports particles

DURATION: 45’

GRADE: 1-6

DISCIPLINES:
Environmental studies, Mathematics

KEY WORDS:
transport, grain size, wind, speed, weight

NEEDED EQUIPMENT:
- Hair dryer
- Table
- “Rock” (beans, chickpeas)
- “Gravel” (barley pearls, rice, lentils, oat groats)
- “Sand” (brown sugar)
- “Dust” (wheat flour)
- Measuring tape
- Camera

USE YOUR NOTEBOOK

STEP BY STEP

Given that about 20 billion kilograms of dust are suspended in the atmosphere at any given time, how many buckets would you need to collect all this dust?

Can dust particles really travel all the way from the Sahara to Finland?
Grab a handful of four different particles that mimic rock, gravel, sand and dust sediments. Let's test how wind affects them, one at a time. Place your sample on one side of the table and use a hair dryer to blow it horizontally, at a slow speed for 2 seconds. Measure the distance it travelled on the table. Clean the table and do the same for the other particles.

Which particle size travelled the farthest?
What happens if you increase the hair dryer speed? Does it affect the movement of the particles?
You can now test with a mix of particles - analyse and document the pattern it creates with a photo.
Did each of them travel the same in distance?
Make a video and then check it in slow motion!

Real wind testing!
Check the forecast and choose a windy day to do the same experiment outdoors!
Throw a handful of particles and see how their distance and pattern of movement is compared to the indoors experiment.

BACKGROUND INFORMATION

The dust elevator
Dust moves in source areas through saltation (jumps forward in the direction of the wind), or by rolling. Small particles can also move much longer distances through suspension. How does this work? Winds at the surface need to be fast and turbulent enough to make dust not only move but also be lifted up. Eddies and whirls create upward currents that carry the particles up, holding them away from the surface.

Turbulent air
The ground of arid areas can experience extreme daytime heating, warming the air near the surface. The temperature differences in the air will make the warmer air go up and cool air will replace it, creating a sort of circular motion or eddy. Unstable conditions or turbulence can be created by other mechanisms, like the presence of a mountain.

Going with the flow
The dust grains will stay up above for as long as the upward currents are able to support the individual particles’ weight. While suspended, particles can get transported between a few metres to thousands of kilometres. So, how far can dust travel? Two main factors are key: the particle size and the environmental conditions.

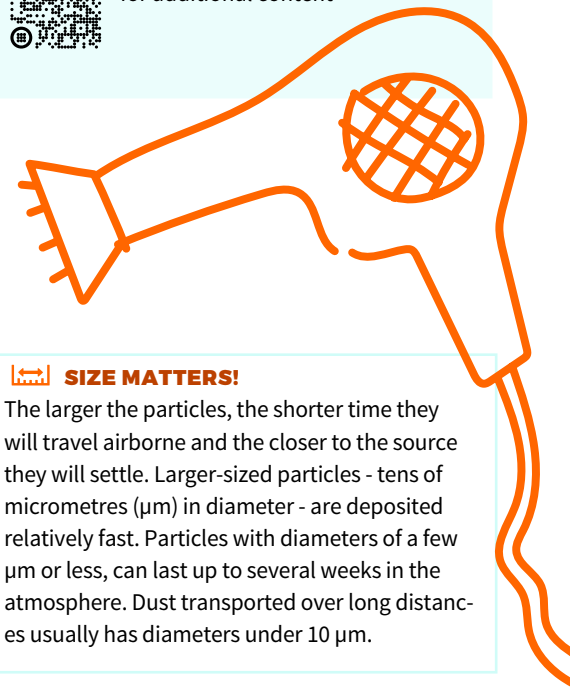
Giant particles?
It sounds unbelievable, but giant Saharan dust particles have been spotted thousands of kilometres from the source: across the Atlantic and as far as Iceland! The mechanism behind this long-range transport is still an open question: exceptionally favourable meteorological conditions or the electrification of the dust layer are possible explanations.

SAFETY MATTERS!

Choose the hair dryer’s cold-air feature and use a mask when blowing at the smallest particles.

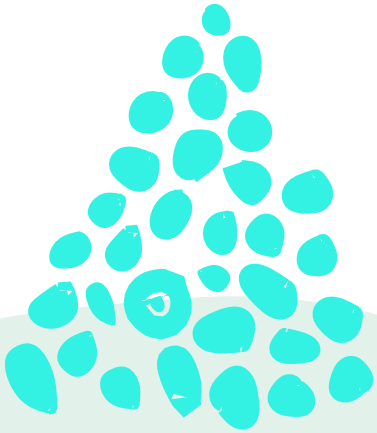
ADDITIONAL RESOURCES

Scan the QR code for additional content



SIZE MATTERS!

The larger the particles, the shorter time they will travel airborne and the closer to the source they will settle. Larger-sized particles - tens of micrometres (µm) in diameter - are deposited relatively fast. Particles with diameters of a few µm or less, can last up to several weeks in the atmosphere. Dust transported over long distances usually has diameters under 10 µm.



All the way here

Observing aerosols from space

DURATION: 60-90'

GRADE: 7-9

DISCIPLINES:
Geography

KEY WORDS:
satellites, Earth observation

NEEDED EQUIPMENT:
· Computer with internet connection
· Sound recorder (optional)

USE YOUR NOTEBOOK

ADDITIONAL RESOURCES
Scan the QR code
for additional content

STEP BY STEP

Search for news online or posts on social media about orange snow or dust in the air in Europe over the last years. Check dates and locations, and write them in your notebook.
Once you know of an event of Saharan dust and its dates, you are ready to use the EO Browser platform and see if you can find any aerosols!

How to use it?

1. **Go to** the ***EO Browser platform*** and change to *Education* mode in the upper right corner (hat icon).

2. **Choose**
   a) A place from the map or search using *Go to place* (magnifying glass icon in the upper right corner).
   b) Theme *Atmosphere and Air pollution*, on the left side menu.
   c) Data source *Sentinel-5P* and *AER AI (Aerosol Index)* in the drop-down menu.
   d) Time range.

3. **Click the *Search* button.**

4. From the available set of pictures, **choose the one you want to see by clicking the *Visualize* button.**

5. **Wait for the image to load.**
   It might take a while.

6. When the picture has loaded, **zoom out for a view over a wider region**, if needed. Can you observe turquoise, yellow, green and red? These colours mean that there are aerosols - like Saharan dust - present in these areas.

7. **To explore more pictures, go back to the *Discover* tab and choose another one.**

   Once you are happy with a picture, use the *Download image* button on the right side menu.

8. **Go back to the beginning and do another search for previous days.** How far can you backtrack the aerosols trajectory? All the way to the Saharan desert? Follow the path of aerosols and download all the pictures along the way.

EO Browser story

Write a news article or make a podcast episode with an interview of a family member, friend or neighbour who remembers an event of Saharan dust (in the snow, during a vacation, etc.). Use the EO Browser to investigate the source point and a picture from it to illustrate your story. How many kilometres did dust travel in your reported event?

BACKGROUND INFORMATION

Destination: everywhere!

Dust originating in the Sahara can reach distant regions, located tens of thousands of kilometres from the source. Dust can travel westwards to the American continent and the Caribbean crossing the Atlantic; and towards the north across the Mediterranean sea and Europe. Saharan dust has been detected even in ***Fennoscandinavia***, Iceland and Greenland! Through this long-range transport, dust can have a worldwide impact.

Dust highways

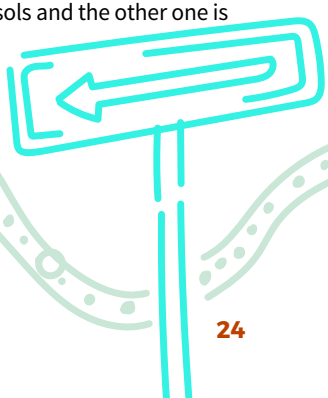
After reaching high enough altitudes dust can be transported long distances by prevailing winds, joining a sort of "wind highway". Dust can be detected and deposited along the defined paths of the blowing winds.

Seen from space

Dust plumes frequently cover huge areas of the Earth, and they are commonly "visible" in satellite images.
Satellites can see dust thanks to the particles' optical properties (the way aerosols interact with light). Dust is efficient at reflecting visible light but is an ultraviolet-absorbing type of aerosol. Do you know how satellites use these properties to detect the presence of aerosols?

The Aerosol Index

This qualitative measure indicates the existence of suspended layers of aerosols in the atmosphere. It can be used to detect ultraviolet-absorbing aerosols such as desert dust and volcanic ash plumes, by using the spectral contrast between two wavelengths, where one is absorbed by the aerosols and the other one is not.



Cloud in a jar

Aerosols, the special ingredient

DURATION: 30'

GRADE: 1-6

DISCIPLINES:
Environmental studies

KEY WORDS:
clouds, cloud condensation nuclei, condensation, phase state change

NEEDED EQUIPMENT:
·Glass jar with a lid
·Boiling water
·Food colouring (optional)
·Hairspray bottle
·Ice cubes

STEP BY STEP

Not all clouds can be found in the sky. Under the right conditions, one can create them ***indoors*** or even in a small jar.

Let's make one!

1. **Pour a cup of boiling water into a glass jar.** Use food colouring to dye the water blue before pouring it into the jar. This helps distinguish the cloud from the water. Plus, it makes the water look like the sky.

2. **Quickly spray hairspray into the jar and close it with the lid.** This step must be performed immediately, so have the lid at hand. It also helps to have multiple people doing the experiment: one with the hairspray and one to put the lid on.

3. **Place 3-5 ice cubes on top of the jar lid.**

4. **Look inside the jar** and you will see a cloud begin to form near the lid.

5. Once the cloud is clearly visible, **remove the lid.** What happens to the cloud?

BACKGROUND INFORMATION

The ancient recipe

Clouds are a key step in the planet's water cycle, and for them to be formed you only need water, a particle, heat and cold. Water is heated and evaporates from the Earth's surface, turning into vapour and rising up into the atmosphere. Up there, the vapour cools and condenses (turning back into liquid form) sticking onto microscopic particles, forming tiny droplets. A cloud is just an accumulation of these droplets. Through rain, water can come back to the surface, closing the cycle.

Have you ever been in a cloud?

Clouds form in the lowermost layer of the atmosphere: the troposphere. We can find low, middle, or high clouds and their properties change with altitude. For example, the higher the clouds the colder they are. *Cirrus* clouds (the highest ones) are made of tiny ice crystals instead of droplets. **Did you know that fog is a *stratus* cloud that rests at ground level?** Walking in the fog is a very easy way to experience how it feels to be inside a cloud!

A particle at the core

Insoluble aerosol particles (dust, ash, dirt, …) are essential for cloud formation. The condensation of the cloud into tiny droplets can only be triggered in the presence of an aerosol. Without them, we would not have clouds: it would require a very high relative humidity in the air which doesn't happen in nature. A particle that helps in making clouds is called a *cloud condensation nuclei*.

Cloud palette

Clouds get their colours from the sunlight. The tiny water droplets (or ice crystals) in them are just the right size to scatter all colours equally. When light contains all colours, we perceive it as white.
Most clouds look white, but on some occasions they can appear grey, orange and even pink.

TIPS FOR TEACHING

How many colours can a cloud have?

Pink clouds may look like cotton candy when they reflect sunset colours. Darker ones seem to often announce rain, but the reason why they look grey depends mainly on the amount of light shining through them.
To test this, fold an A4 paper sheet in four, draw a cloud and then cut out the shape to get 4 copies of your cloud.
Place one cloud in front of a flashlight, and notice what colour comes through the paper.
Add layers (more clouds) in front of the first one.
What colour is your cloud now?

ADDITIONAL RESOURCES

Scan the QR code for additional content

Snow

SNOW

Every journey must come to an end. For dust this happens when it gets deposited onto land or a water body, far away from where it was initially lifted off. Let's explore the last chapter of this dusty story!

LET´S TRY THIS!

Snow...y!

Duration: 60'

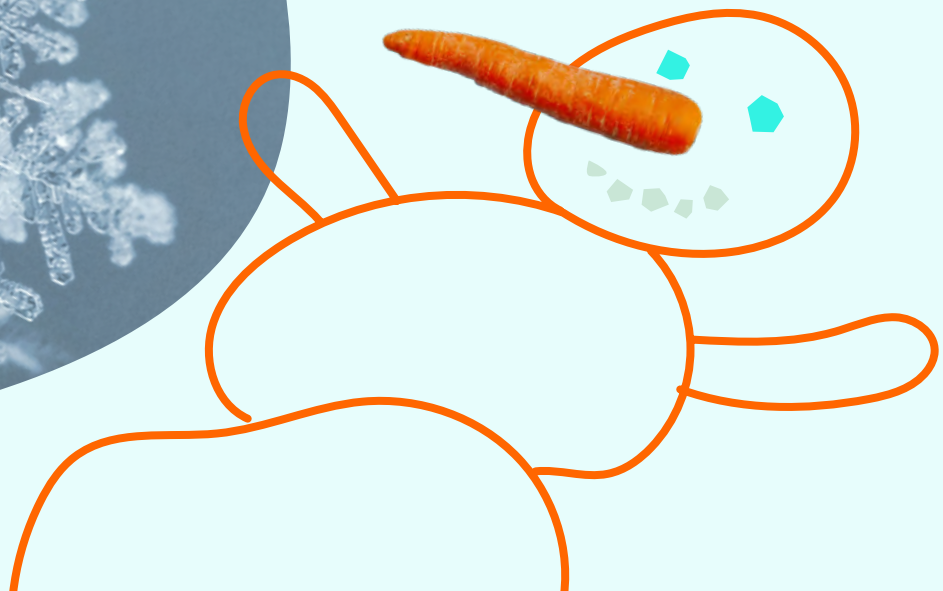
Grade: 1-9

Snowy, snowstorm, snowflake, blizzard, avalanche and Snow White are some examples of words connected with the term "**snow**". How many others come to your mind?

Distribute sticky notes in the classroom and take 5 minutes to write down all the words you can think of. Put them on a wall and make a "snow-word family" display. Remove sticky notes with repeated words. Take a picture!
How many did you gather?

You can also find many sayings, expressions, and **proverbs**.
In Finland you might have heard that "uusi lumi on vanhan surma" (new snow melts the old snow) or in Spain "año de nieves, año de bienes" (which suggests that a year with snow will bring good crops).

Can you think of more examples in these or other languages? You can ask a grownup to help with it.
Share what you found with the rest of the class.



SNOW

Make your own snow and experiment with colour, texture and taste.

Orange snow cake ***Page 29***

What is the secret to an exuberant rainforest?

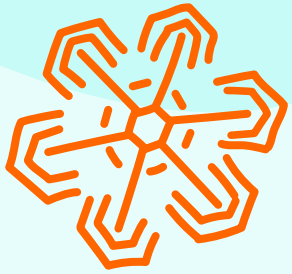
In a handful of sand (Part II) ***Page 30***

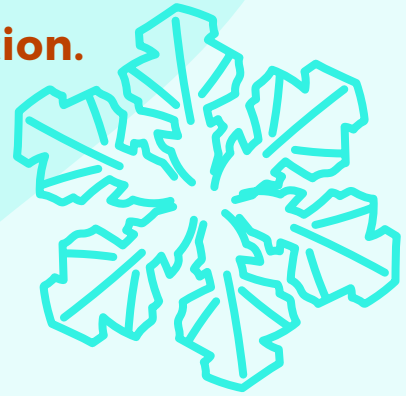
Build your snow collector and be ready for the snow season.

Practice makes perfect ***Page 31***

Travel like dust on a trip powered by your imagination.

The story of a particle ***Page 32***





Additional resources

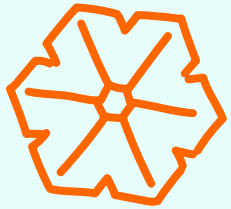
Snow is part of daily life in the Nordic countries, but did you know that half of the world's population has never seen snow in real life?

Snow 101

Snow is just an accumulation of snowflakes. But snowflakes are not frozen raindrops! Instead, they are formed by the transformation of water vapour directly into ice. Where does this happen? Snowflakes are born in clouds, where the temperature is below freezing (0°C). However, small insoluble particles like dust, need to be present for ice crystals to start forming around them. These "seeds" are called *ice nuclei*.
As the ice crystals grow within the cloud, the nice snowflake pattern emerges, becoming heavier and eventually falling towards the ground.

The magical number 6

Every snowflake is different, but they all show a six-fold symmetry, due to how water molecules are arranged in the ice lattice. Temperature and humidity conditions during the snowflake's growth stage will determine its ***shape and design***.



Snow statistics

On average, an immensely huge amount (10^{15}) of snowflakes fall each second, in a typical year. That's enough snow to make one snowman for every person on Earth every ten minutes!
A typical snowflake falls at speeds between 1.5 to 7 km/h, taking around an hour to reach the ground.

Icy precipitation

Snow is not the only type of ice that falls from the sky! Hail, sleet and graupel are other variants.

Dusty snowfall

Snow, rain and other types of precipitation can wash out gases and suspended particles in the air, helping them to make it to the ground, in a process called *wet deposition*. Through this mechanism, dust originating in the Sahara was transported and made it all the way to the Finnish snow-covered grounds in 2021, in a rare ***event***.

Orange snow cake

Playing with all the senses

DURATION: 45'

GRADE: 1-2

DISCIPLINES:
Environmental studies

KEY WORDS:
colouring, gradient, texture, mixing

NEEDED EQUIPMENT:
·2 bowls
·2 spoons
·Corn or potato flour
·Baking soda, Shaving foam
·Lemon juice
·Orange-coloured ingredients (turmeric, food colouring, edible paint, etc.)

USE YOUR NOTEBOOK

STEP BY STEP

No snow outside? No problem, you can prepare your very own snow!
You will need to first find the right texture.
You can try more than one recipe and then pick your favourite.

1. In **bowl number one**, add two tablespoons of corn flour or potato flour. Add about the same amount of shaving foam.

2. In **bowl number two**, add two tablespoons of baking soda. Add about the same amount of shaving foam.

3. **Stir each bowl with a spoon.** Once you have mixed the ingredients well, you can keep doing it by hand. Which one feels more like snow?

4. In the end, **add a small amount of lemon juice** to bowl number two. What happens?

Once you choose the best snow texture, you can make orange snow! **What ingredients can you add to change its colour?**
Try turmeric, edible paint, food colouring,…
What tone of orange fits best your idea of orange snow?

Shape your snow mixes as cakes. Organise them in a colour gradient, from softer to stronger orange.
Take pictures of the different snow cakes made and display them in the classroom. You can also paint them in your Oranssi Lumi notebook.
Was the best ingredient turmeric or food colouring?

TIPS FOR TEACHING

Try real snow to mix in different orange coloured ingredients. Compare the results with the snow made in the classroom.

EVENT ALERT

If there was recently an episode of Saharan dust deposition on snow, you can compare the snow colour to your own orange cakes.

ADDITIONAL RESOURCES

Scan the QR code for additional content

BACKGROUND INFORMATION

Always white?
As surprising as it might sound, snow is not white! Snow is actually translucent but the light reflecting off makes it appear white. The many sides of a snowflake scatter all the colours of the spectrum equally in all directions, making it look white.

Rainbow snow
Snow can appear in other colours besides white: red snow, green snow and brown snow are relatively common phenomena!
When aged snow in glaciers becomes extremely compressed ice, it tends to appear blue due to the loss of air bubbles trapped in it. The presence of naturally occurring *Chlamydomonas nivalis algae* in alpine regions might turn the snow red or green, and even provide a sweet scent reminiscent of watermelon! This phenomenon is commonly known as watermelon snow.

Colourful landing
Snowfall might appear orange, yellow or grey when it washes out suspended particles or pollutants like dust, pollen, soot or ash. In this *wet deposition* process, particles that get included in bulk snow change its apparent colour.
The colour of the snow cover can also be altered through *dry deposition*, when particles suspended in the air settle on the pre-existing snow layer.

The impact of dirty snow
Pure snow has high *albedo* or sunlight reflectivity. Darker snow containing algae, dust or soot has lower albedo, causing the snow to absorb more light, heat up and melt faster. An increase in the rate of snow melting has consequences in agriculture, glacial retreat and nature conservation.

Dry snow?
If snow is made out of water, shouldn't it always be wet? The fact is not all snow contains the same amount of water, determining its texture and how good it is for skiing or making snowballs, for example. Wet snow, with a higher ice to air ratio, holds less air and can be packed into a snowball more easily. Dry snow has a powdery, non-sticky texture and gets easily blown around.

In a handful of sand (Part II)

More than just minerals...

DURATION: 60'

GRADE: 3-9

DISCIPLINES:
Environmental studies, Biology, Geography

KEY WORDS:
diatoms, soil, iron, phosphorus, fertiliser

NEEDED EQUIPMENT:
- 2 pots
- Soil mix
- Seeds or plantlings - e.g. beans, peas
- Commercial biochar
- Measuring tape
- Soil pH measuring-strips

USE YOUR NOTEBOOK

STEP BY STEP

The Sahara Desert and the Amazon rainforest couldn't be more different. Yet, they are tightly connected through the journey of dust from its origin to destination, where it will act as fertiliser. Mineral dust improves soil pH, water retention, microbial activity, and general plant health: better seed germination rates, increased plant height and weight and reduced plant mortality.

Soil health, plan(e)t health!

Thousands of years ago, Amazonian indigenous people developed a technique to create fertile soils, known as *terra preta* (dark earth). These dark soils were key for this civilization to flourish in a region where agriculture would otherwise have been difficult.
Terra preta owes its typical black colour to the charcoal added to a mixture of bones, broken pottery, compost and manure together with the low-fertility soil.
When charcoal (used mainly as a fuel) is produced primarily for improving soil it is called **biochar**. This approach is raising interest again because it could become one of the most effective ways of reducing greenhouse gas emissions, sequestering carbon and thus help mitigate climate change.

How can we have better soils?

1. Use any soil mix available for both pots A and B.
2. Add **biochar** only to **pot B** and mix well.
3. Put the same type of plantlings (small young plants) or seeds into both pots.

For some weeks, compare plant growth in pots A and B by measuring plant height, describing leaf colour and analysing soil pH. Don't forget to water them!

What are the main signs of a healthy plant?

BACKGROUND INFORMATION

A window to the past

In Saharan sand and dust there are more than fragments of eroded rocks, they contain remains of diatoms, unicellular algae that lived in the huge lake that preceded today's desert. Diatoms were the base of the food chain. In the end of their life cycle, diatoms would deposit and accumulate on the lakebed. Diatoms cell walls made it to the present day and can be found in sand in the desert, and also in transported dust!

A fancy glass house

Diatoms are the only organism on the planet that can make cell walls out of glass (silica). Each type of diatom has a unique cell wall design that helps with their identification. One can trace back the source of dust by looking at the diatoms in it.

Saharan gift

Life in the Amazon can only exist thanks to the trans-continental transport of nutrient-rich dust from North Africa. Essential processes for plants (growth, respiration, photosynthesis) depend on the phosphorus and iron brought by dust all the way to the Amazon. The phosphorus in dust comes from diatoms and the iron from the former lake sediments. These minerals were also found in Amazonian fertile soil created by indigenous people.

Fertilising the oceans

Iron-rich dust settling in oceans provides key nutrients for phytoplankton to grow in limited-supply areas. Phytoplankton plays an essential role in carbon dioxide sequestration and oxygen production: almost 50% of the planet's oxygen is produced in the oceans!

TIPS FOR TEACHING

Test other types of soil including a depleted one (used many times) to compare the results or use it as a control in the experiment.

MATERIAL TIP

You can get store-bought **biochar** but also mix it with broken pottery, wood chips and organic matter (e.g. food scraps, leaf and grass mould) and shells.

ADDITIONAL RESOURCES

Scan the QR code for additional content

Practice makes perfect

One snowfall at a time

DURATION: 60’

GRADE: 1-9

DISCIPLINES:
Environmental studies, Biology, Geography

KEY WORDS:
observation, deposition, sample collection, DIY

NEEDED EQUIPMENT:
- Containers (for snow collector)
- Snow or ice chips
- Dark coloured ingredients (cinnamon, black pepper, cocoa powder, etc.)
- Filter paper or coffee filters
- Ruler

USE YOUR NOTEBOOK

STEP BY STEP

Build your own snow collector!
We never know when some (orange) snow might fall so, in order to prepare for it, you can start by planning the best container for gathering your samples.

A bottle, a storage box, a rowboat?
Anything can be used! Remember to consider where you will place your container outdoors, and how much snow you expect to collect each time.

- In groups, start by discussing and drawing what your snow collector will look like.
- Plan the system for all stages: collect, melt and separate.
- Build it together and decorate it too. Check the ***weather forecast*** to find when the next snow day will be.

Let's practise!
Use either real snow or chipped ice and mix in different sized particles to imitate “dusty snow”. For this, use cinnamon, black pepper or cocoa powder (contrasting colours with snow). Collect the mix in the container, let it melt and filter or evaporate following the ***sample collection guidelines***. You can even include the filtering system in your project!

BACKGROUND INFORMATION

On measuring snow
When and how much it snows affects many aspects of our lives, from agriculture and transportation to outdoor recreation and tourism. Measuring them accurately can help us to better predict weather patterns, manage water resources, assess avalanche risks, and monitor the health of ecosystems. But what aspects of snow are usually measured? One can report the **new snowfall** by measuring the height of the fresh snow layer, the **total snow depth** and even the **snow water equivalent** by letting it melt.

Joining efforts
Citizen science is an "umbrella" term that describes a variety of ways in which the public participates in science. Citizens can contribute, for example, with observations or data, helping to answer a specific research question.
A community-supported approach can play a crucial role in snow measurements: by engaging local communities one can gather observations from a broader area. Participating is fun and can contribute to many fields of science! Check what citizen science initiatives are active in your region or holiday destination with focus on snow or other topics.

Wet and dry deposition
Aerosols are removed from the atmosphere via *dry* and *wet deposition*. During **dry deposition**, suspended particles settle mainly due to gravity, while in **wet deposition**, particles get removed through precipitation (like rain or snow). Particle size, shape, density, and atmospheric conditions affect dry deposition, but in wet deposition, the amount and frequency of precipitation are the key factors. These processes determine what is the size and concentration of aerosols that remain in the air.

TIPS FOR TEACHING

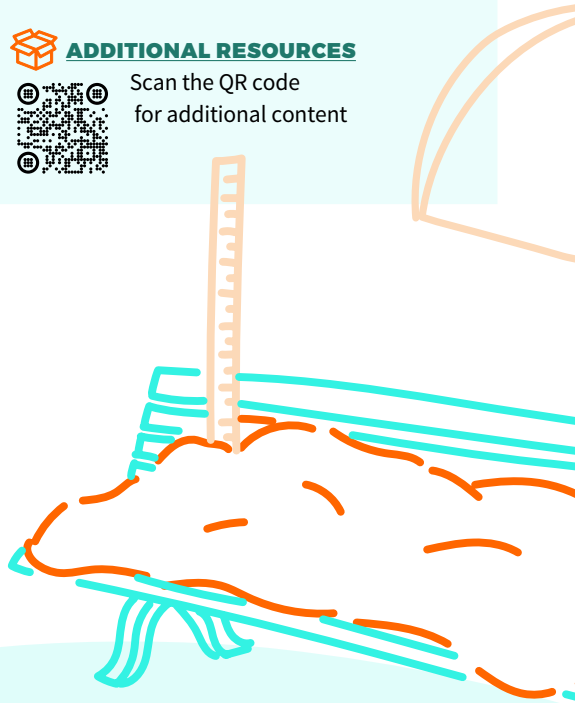
Use this activity to explore simple maths with your students: calculate area and volume for collected samples. They can also measure the **new snowfall** (centimetres of snow accumulated per sampling time) and the **snow depth** (centimetres of piled snow over a longer period of time) and register it in their notebook.

EVENT ALERT

If there was recently an episode of Saharan dust deposition, you should now be all set and ready for it! Don’t forget to follow the ***guidelines*** and check if there is an ongoing citizen science campaign.

ADDITIONAL RESOURCES

Scan the QR code for additional content



The story of a particle

A journey through climate

DURATION: Multiple sessions

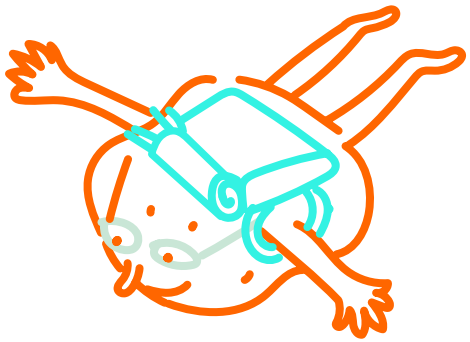
GRADE: 1-9

DISCIPLINES:
Mother tongue and literature,
Second national language,
Foreign languages

KEY WORDS:
particles, climate change, displacement and migrations, imagination

NEEDED EQUIPMENT:
· Imagination
· Creativity

USE YOUR NOTEBOOK

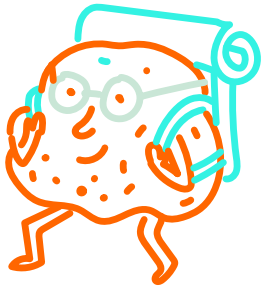


STEP BY STEP

Imagine a… dust particle.
This will be the main character in your adventure - the story of a journey with many thousands of kilometres travelled. From its departing point in the hot Saharan desert, crossing land and seas, this particle will arrive in Finland and paint the snow in an orange dusty tone.

Storytelling ideas
For building the narrative, start by describing and giving a name to your particle. How did it appear in The Sahara? What shape, colour and size does it have? Did it grow little wings to fly or did it just float with the wind for many endless days? Did it have help along the way or some obstacles and challenges to overcome? Did your particle make friends during its travels? Did some of those friends stay behind and land in Spain or Portugal, or did they all make it to Finland? Where in Finland did it land? And how?
There is no limit to your imagination…

Draft your story idea and choose the best way to share it with the class: make a video, write a theatre play to be performed or turn it into fun comic strips.



BACKGROUND INFORMATION

The elephant in the room
Climate change refers to the long-term changes in the Earth's temperature, precipitation, and weather patterns. Earth's climate has constantly been changing for thousands of years oscillating between colder and warmer periods. However, the average temperature of the planet has been recently increasing much more quickly than expected. In 2022, the planet was **1.15 °C** warmer than the pre-industrial (1850-1900) average temperature, making the **last 8 years the warmest** on record.
These changes are largely caused by human activities such as burning fossil fuels that release greenhouse gases into the atmosphere.

Portrait of a warmer Earth
Not all areas on Earth are getting warmer at the same rate nor will the temperature change have the same impact. Polar regions, coastal areas, dry regions and tropical zones are particularly vulnerable. More frequent extreme weather events and severe droughts are some of the consequences that we are starting to experience. Climate change significantly impacts people's health, livelihoods, and quality of life, particularly in vulnerable communities that are already facing social, economic, and political challenges.

The future of dust
The amount of dust in the future climate strongly depends on how the weather patterns will change. For example, if North Africa gets drier, more dust will be produced. But, if rain in Africa increases, the dust plumes might stop reaching far away locations, like the Amazon, affecting the fertility of its soils. However, at the current rates of dispersal, we have Saharan fertiliser for at least a thousand more years.

It's complicated
Variations in the amount of dust suspended in the atmosphere can further impact climate. More or less dust in the air can affect ***how clouds are formed*** and ***how much energy gets bounced back to space***. Understanding the global cycle of dust and all its connections can be complicated!

TIPS FOR TEACHING

This activity can be done without previous knowledge about the dust journey and transport mechanisms involved in getting all the way to Finland. Use this activity to test preconceived ideas: compare the original story created by the students with their knowledge at a later stage.
Choose a medium that suits the resources available or the class interests: text, video, animation, comics, theatre play, etc.
The story can be written in Finnish, Swedish, English or use non-verbal forms of expression; it works as an individual or group task.

ADDITIONAL RESOURCES

Scan the QR code for additional content

Sample collection guidelines

ORANSSI LUMI

An exploratory journey through atmospheric events

For grades 1-9

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

KONE FOUNDATION

Collecting samples: what for?

In the case of a dust deposition event, you can collect samples and look at them yourself, send them for analysis at the **Finnish Meteorological Insitute (FMI)**, or do both! Check out ***Oranssi Lumi's page*** to see if there is any citizen science campaign happening at the moment.

What can I learn from my collected samples?

Find inspiration in the activities ***In a handful of sand (Part I)*** or ***Orange snow cake***. You can prepare yourself by making your own snow collector beforehand, and rehearsing how to collect samples with "fake" dusty snow (see ***activity***). Remember, practice makes perfect!

Can I send my samples to FMI?

Your samples might be also useful for research purposes and contributing to the advancement of aerosol science! Check out ***Oranssi Lumi's page*** to see if there is any citizen science campaign happening at the moment. You will find more information about when and how to send your samples there. Follow these collection guidelines to get them ready. But remember, your samples will be useful only if there is an active campaign taking place!

How can I check if there is a dust deposition event happening?

You can check this from the front webpage of FMI (***in English***) or from these dust forecast products websites (***CAMS***, ***AEMet***) and see if there are any dust plumes expected over your location.

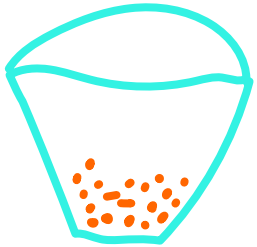
How can I contribute if there is an ongoing citizen science campaign?

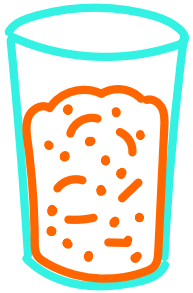
You will find in which ways you can contribute by checking ***Oranssi Lumi's page*** for an active campaign.
If there is one ongoing, the samples you collect and send to FMI can be analysed by researchers.

I want to collect dust-containing snow. What are the steps?

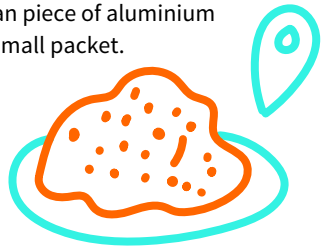
First, you can check if there are any chances that the snow will contain dust (see Resources listed at the end of the guidelines). Then, you can follow these simple guidelines for sample collection. Of course, you can always collect snow following these instructions if you are curious to see what is in it!

Without snow collector





1. **Take a dusty snow sample** (dust-containing snow) by scraping the most superficial layer of recently deposited snow that visibly contains dust. Collecting 2 dL, i.e. one drinking glass, is enough. However, you can collect larger samples or combine several of them.
The closer to deposition time the snow sample is collected, the better! If the dust is deposited by itself or along with precipitation (rain) that has already evaporated, and only dry dust remains, just collect it as it is, no further processing is needed.
You can brush it off carefully and transfer it into a clean piece of aluminium foil to make a small packet.



2. **Write down details about the sample collection**: date and time of collection and place (address or coordinates).
The amount of snow collected in volume (decilitres or litres of snow) and/or sampling area (in square centimetres) are also important information.
You can fill up a container of known volume (a cup, a plastic container) to estimate the total volume of snow collected.
To estimate the sampled area, you can try to collect the snow from a patch with a rectangular shape. By measuring the sides of that rectangle you can get the area: A(cm^2) = side 1 (cm) * side 2 (cm). You can also be more creative with the shape of your patch and find how the area is calculated.

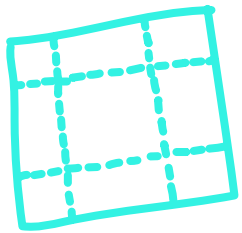
3. **Extract the dust (the solid residue) from the snow sample.** There are 2 methods you can follow.

Method 1: Evaporation
Place the snow on a piece of aluminium foil (usually found in a kitchen) or a container (preferably glass, freshly cleaned) and let the snow melt first, and then let the water evaporate. You can speed up the process by using the sauna heat or an oven (low temperature, preferably under 70°C) for melting and evaporation.

Method 2: Filtering
Let the snow melt in a container and pour the mix of water and dust through a coffee filter. Most of the dust particles should remain in the filter. It is very important to let the filter fully dry before sending the sample (in case of an active campaign, check the status ***here***).

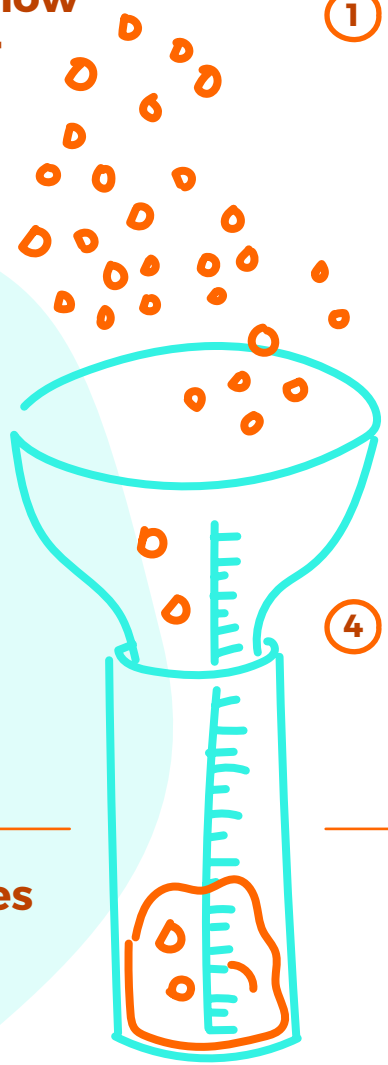
4. **Once the sample is dry, it is ready for analysis!** Check out ***Oranssi Lumi's page*** to see if there is any citizen science campaign at the moment. Follow the instructions there to send your sample or other contributions (photographs, drawings or even poems!) in case of a citizen science campaign. You can always look at your own samples and learn from them. Find inspiration in activities ***In a handful of sand (Part I***), ***Orange snow cake*** or ***Practice makes perfect***.

5. **Don't forget to take pictures of the deposited dust outside and the sample preparation process.** They are very valuable!



When the snow samples are large, one might use the **decantation** technique before applying method 1 or 2. Start by letting the snow melt in a container. Once the dust has settled at the bottom, carefully pour most of the water away and then evaporate (***Method 1***) or filter (***Method 2***) the rest.

With a snow collector



1. **Place your DIY snow collector outside, in an area clear of obstacles. Mark the starting date and time of collection.** Let it collect snow during a snow fall, and mark the **end of the collection** period (date and time).

2. **Make a note of the amount of snow collected (depth).** Since you know the area of your collector, you can calculate the volume of the snow sample. **Write down details about the sample collection:** date and time, duration (time the collector was deployed) and place (address or coordinates). Check the activity ***Practice makes perfect*** to explore how to calculate your collector's area and the volume of your sample. Take the collector inside and retrieve the snow sample. You can let it melt in the collector container and then extract the dust (solid residue) by evaporation (***Method 1***) or filtration (***Method 2***).

3. **Once the sample is dry, it is ready for analysis!** Check out ***Oranssi Lumi's page*** to see if there is any citizen science campaign happening at the moment. Follow the instructions given there to send your sample or other contributions (photographs, drawings or even poems!) in case there is an ongoing citizen science campaign. You can always look at your own samples and learn from them. Find inspiration in activities ***In a handful of sand (Part I)***, ***Orange snow cake*** or ***Practice makes perfect***.

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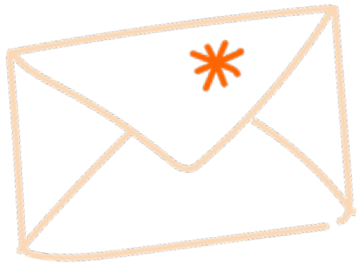

Resources

Finnish Meteorological Institute website (in English).
www.en.ilmatieteenlaitos.fi

Copernicus Atmosphere Monitoring Service (CAMS) aerosol forecast.
www.atmosphere.copernicus.eu/charts/packages/cams/

Daily Dust Products.
Visualisation tool for accessing different dust forecasts and dust-related observational products.
www.dust.aemet.es/products/daily-dust-products

Additional resources

ORANSSI LUMI

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METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

KONE FOUNDATION

Make your own notebook

GET INSPIRED

5 Simple Book Binding Methods
Video about simple bookbinding techniques
Babble Dabble Do

Easy Beginner Bookbinding Ideas for Teaching Groups of Kids
Blog about easy beginner bookbinding ideas for groups of kids of different ages
papercraftpanda.com

Introduction

EXPAND YOUR KNOWLEDGE

What's in the air?
Educational content about air composition
UCAR Center for Science Education

Aerosols: Tiny Particulates in the Air
Educational content about aerosols
UCAR Center for Science Education

Particulate Matter
Air quality teaching box. Includes content and activities. Original and external resources
UCAR Center for Science Education

Aerosols Protocol
Teaching resources
The GLOBE Program, NASA

Sizes of Aerosols, Raindrop and Cloud Droplets
Graphical educational resource about particle sizes
UCAR Center for Science Education

EXPERIMENT MORE

I Breathe WHAT??
Activity for making your own pollution collector
Teach Engineering, University of Colorado Boulder

Sky Conditions
Activity on sky conditions and visibility
NASA

Observing Visibility and Sky Color
Activity on sky colour and visibility
The GLOBE Program, NASA

Sky Scarf
Pattern for documenting sky conditions through knitting
Lea Redmond and Knit The Sky

GET INSPIRED

Weather Misconceptions and Introduction Activity
Game for exploring misconceptions about weather and climate
UCAR Center for Science Education

Dust

Dusty

EXPAND YOUR KNOWLEDGE

The Dirt on Atmospheric Dust
Outreach article about dust and satellite-based dust detection
NOAA

Sand dunes are important desert dust sources
Outreach article about sources of sand and dust
MadGeogNews, University of Wisconsin

EXPERIMENT MORE

Exploring Atmospheric Dust and Climate
Collection of educational activities about atmospheric dust
UCAR Center for Science Education

Dust on the Move
Activity on dust transport and grain size
UCAR Center for Science Education

GET INSPIRED

Dust Tales: The Story of Atmospheric Dust
Educational slide deck about atmospheric dust
UCAR Center for Science Education

In a handful of sand (Part I)

EXPAND YOUR KNOWLEDGE

Sand and Dust Storms
Outreach article about impacts of sand and dust storms
World Meteorological Organization

Sedimentary Rocks
Video about sedimentary rocks
The Good and the Beautiful Homeschool Science

The dustiest place on Earth
Outreach article about dust formation and diatoms
nature.com

African dust keeps Amazon blooming
Outreach article about the fertilising effect of dust
nature.com

Dust in the Wind
Outreach article about the relationship between the Sahara and the Amazon
EarthDate, Bureau of Economic Geology, University of Texas at Austin

EXPERIMENT MORE

Dust on the Move
Activity on dust transport and grain size
UCAR Center for Science Education

Miineralit
Online mineral collection
geologia.fi

Sand Types
Online sand catalogue
sandatlas.org

Desert Sand
Online desert sand catalogue
sandatlas.org

GET INSPIRED

Sand, Singing Dunes and other Types of Sand Dunes
Facts and details about sand and dunes
factanddetails.com

Inside a sandstorm

EXPAND YOUR KNOWLEDGE

What Is a Dust Storm?
Educational content about dust storms
SciJinks, NOAA

Haboob, Sandstorm or Dust Storm?
Outreach article about sand and dust storms
MetMatters, Royal Meteorological Society

Sand and Dust Storms
Outreach article about impacts of sand and dust storms
World Meteorological Organization

Sand and Dust Storms
Outreach video about impacts of sand and dust storms
World Meteorological Organization

The Physics of Sandstorms
Outreach article about the physical mechanisms of a sandstorm
science.org

The impact of sand and dust storms
3D pop-up educational book about the impacts of sand and dust storms
InDust COST Action

The impact of sand and dust storms
Educational video about the impacts of sand and dust storms
InDust COST Action

GET INSPIRED

Microbursts
Outreach article about microbursts
weather.gov

Zooming In: Visualizing the Relative Size of Particles
Particle size infographics
visualcapitalist.com

EXPERIMENT MORE

Storyblocks
Audio and video resources
storyblocks.com

Wind Effect Instrument
Video demonstration about the thunderdrum
Heart-Beats by Mijaelle Dewart

The Thunderdrum!
Video tutorial for building a DIY thunderdrum
kipkay.com

How to Survive a Dust Storm or Sandstorm
Practical guidelines about how to survive a dust storm
wikihow.com

Watch a Man Play 'Sandstorm' on a Potato
Article and video
atlasobscura.com

Not-so-quick sand

EXPAND YOUR KNOWLEDGE

Desert
Educational content about deserts
education.nationalgeographic.org

Desertification, explained
Outreach article about desertification
nationalgeographic.org

Climate change: Land degradation and desertification
Outreach article about land degradation and effects on health
World Health Organization

Special Report on Climate Change and Land - Desertification
Mirzabaev et al., 2019: Desertification. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.*

IPCC: Deserts, Semiarid Areas and Desertification
Mirzabaev et al., 2022: Cross-Chapter Paper 3: Deserts, Semiarid Areas and Desertification. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panelon Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA

What Is Antarctica?
Educational content about Antarctica
NASA

EXPERIMENT MORE

World Atlas of Desertification
Online and printable resources about land degradation in the context of human action, sustainability and solutions. Printed version Cherlet, M., Hutchinson, C., Reynolds, J., Hill, J., Sommer, S., von Maltitz, G. (Eds.), *World Atlas of Desertification*, Publication Office of the European Union, Luxembourg, 2018.
European Union - Joint Research Centre

Shrinking Aral Sea
Outreach article about the desertification of the Aral Sea
Earth Observatory, NASA

GET INSPIRED

The Great Green Wall
Educational content about the Great Green Wall
education.nationalgeographic.org

Wind

Ready, set, fly!

EXPAND YOUR KNOWLEDGE

Wind
Educational content about wind
UCAR Center for Science Education

Wind
Educational content about wind
education.nationalgeographic.org

Why the Wind Blows
Educational video content about wind
UCAR Center for Science Education

The Highs and Lows of Air Pressure
Educational content about high and low pressure systems
UCAR Center for Science Education

Föhn-tuuli Suomessa
Outreach article about Föhn wind in Finland
Finnish Meteorological Institute

Wind Power
Outreach article about wind power
nationalgeographic.org

EXPERIMENT MORE

Modeling Wind Dynamics and Forests
Activity on modelling wind dynamics in forests
UCAR Center for Science Education

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How Do Birds Fly?
Outreach video on the physics of bird flight
The Pendulum Swing

How Airplanes Are Made
Outreach video about airplanes
Minute Physics

Black T-shirt / white T-shirt

EXPAND YOUR KNOWLEDGE

The Energy Budget
Educational content about the energy budget in the Earth system
UCAR Center for Science Education

The Causes of Climate Change
Outreach article about the causes of climate change
NASA

The Problem with Dust
Outreach article about the role of dust in climate
Physical Sciences - UCLA

How Sunshine Warms the Earth
Educational content about albedo and radiation
SkySci - UCAR Center for Science Education

EXPERIMENT MORE

Radiation and Albedo Experiment
Activity on radiation and albedo
UCAR Center for Science Education

The Greenhouse Effect Teaching Box
Greenhouse effect teaching box. Includes content and activities. Original and external resources
UCAR - Center for Science Education.

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Dust and the Earth System
Educational video content about the role of dust in the Earth system
InDust COST Action

Let the dust settle

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Giant Dust Is Spreading Across The World, Defying The Laws of Physics
Outreach article about transport of giant dust particles
sciencealert.com

What Are Trade Winds?
Educational content about trade winds
SciJinks, NOAA

Atmospheric Dust Transport
Outreach article about dust transport
World Meteorological Organization

Atmospheric Dust
Course on atmospheric dust
UCAR - COMET Program

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Dust: a True World Traveller
Educational content and activities about dust transport
Earth Observatory for Kids, NASA

Dust on the Move
Activity on dust transport and grain size
UCAR Center for Science Education

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COMET MetEd
Teaching and Training Resources for the Geoscience Community
UCAR

All the way here

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The Dirt on Atmospheric Dust
Outreach article about dust and satellite-based dust detection
NOAA

Satellites Track Unusual Saharan Dust Plume
Article and video animation using Sentinel-5P data
European Space Agency

Earth Observation
Outreach article about Earth observation satellites
Finnish Meteorological Institute

Circulation of Dust in the Atmosphere
Video animation of circulation of dust in the atmosphere, generated from model data
UCAR Center for Science Education

What Is Desert Dust and How Does It Change Atmosphere and the Air We Breathe?
Outreach article about dust in the atmosphere
EU - The Copernicus Programme

EXPERIMENT MORE

Want to learn more about satellite imagery?
Tutorials, user guides and examples of how you can use satellite imagery
Sentinel Hub

GET INSPIRED

How to Make the Perfect Time-Lapse of the Earth
A detailed guide covering various examples on making animations from satellite imagery
Matic Lubej, Sentinel Hub Blog

Cloud in a jar

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Clouds and How They Form
Educational content about the formation of clouds
UCAR Center for Science Education

Making Clouds
Educational video content about cloud formation
SkySci - UCAR Center for Science Education

Your Cloud Questions Answered
Educational content about clouds with FAQs
SkySci - UCAR Center for Science Education

Making Raindrops With Mindy
Educational content about cloud condensation nuclei
SkySci - UCAR Center for Science Education

In the Clouds with Mindy
Educational game about cloud condensation nuclei
SkySci - UCAR Center for Science Education

The Shape of Raindrops
Educational video about the shape of raindrops
SkySci - UCAR Center for Science Education

EXPERIMENT MORE

Clouds Teaching Box
Clouds teaching box. Includes content and activities. Original and external resources
UCAR - Center for Science Education

Water Cycle Experiment
Activity about the water cycle
The Good and the Beautiful Homeschool Science

Make a Cloud Form in a Jar Science Experiment
Activity on cloud making
Cool Science Experiments HQ

How to Make a Cloud in a Bottle – 3 Easy Methods
Activity on cloud making
sciencenotes.org

Make a Cloud in a Bottle
Activity on cloud making
Jet Propulsion Laboratory - NASA

Cloud in the Bottle
Activity on cloud making
The Spangler Effect

How to make a cloud in a bottle
Activity on cloud making
MetOffice - UK Weather

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Elementary GLOBE: Do You Know That Clouds Have Names?
Digital book about cloud classification for children
SkySci - UCAR Center for Science Education

This artist makes clouds appear in unexpected places
Article about an artist that makes clouds indoors
nationalgeographic.com

Snow

Snow...y

EXPAND YOUR KNOWLEDGE

Snow
Outreach article about snow
National Snow and Ice Data Center, CIRES

17 surprising facts about snow
Outreach article with facts about snow
BBC Earth

What Are Snowflakes?
Educational content about snowflakes
SkySci - UCAR Center for Science Education

What Makes Snowflakes Take Shape?
Educational video about snowflake formation
SkySci - UCAR Center for Science Education

Why are Snowflakes Like This?
Science outreach video about snowflakes with an interview with Dr. Ken Libbrecht
Veritasium

How to Make a Snow Day!
Educational content about weather conditions for snowfall
SkySci - UCAR Center for Science Education

Is it Going to Snow?
Educational video about predicting snowfall
UCAR Center for Science Education

Atmospheric Deposition
Outreach article about atmospheric deposition
World Meteorological Organization

Albedo and Climate
Educational content on albedo
UCAR Center for Science Education

EXPERIMENT MORE

A Century of Glacier Change
Activity on glacier melting
UCAR Center for Science Education

GET INSPIRED

SnowCrystals.com
Online guide to snowflakes, snow crystals and other ice phenomena
Kenneth G. Libbrecht

Growing Snowflakes
Video resources of growing snowflakes
snowcrystals.com

Orange snow cake

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Not All Snow Can Make Snowballs
Educational content about wet and dry snow
SkySci - UCAR Center for Science Education

Difference Between Wet and Dry Snow
Outreach video about wet and dry snow
The Weather Channel

Why the Snow in Parts of Europe Was Orange
Article on Saharan dust affecting Eastern Europe
The New York Times

Why Snow in Eastern Europe Is Turning Orange
Article and video about Saharan dust affecting Eastern Europe
nationalgeographic.org

Dust dampens albedo effect, spurs snowmelt in the heights of the Himalayas
Outreach article about the effect of dust on albedo and snowpack melting
sciencedaily.com

EXPERIMENT MORE

Is Snow White? Maybe, or Maybe Not
Activity on the colour of snow portrayed in paintings
UCAR Center for Science Education

GET INSPIRED

The Surprising Colors of Snow
Outreach article on the colours of snow
JSTOR Daily

The secrets of the Alps' strange red snow
Outreach article about the coloured snow in the Alps
BBC

In a handful of sand (Part II)

EXPAND YOUR KNOWLEDGE

Exploring Atmospheric Dust and Climate with Augmented Reality
Visualisations of dust transport and ocean fertilisation by dust
UCAR Center for Science Education

NASA Satellite Reveals How Much Saharan Dust Feeds Amazon's Plants
Outreach video and article about Saharan dust transported to the Amazon
NASA

Pumping Iron: How Dust Can Change the Climate
Educational game about ocean fertilisation by dust
UCAR Center for Science Education

The dustiest place on Earth
Outreach article about dust formation and diatoms
nature.com

African dust keeps Amazon blooming
Outreach article about the fertilising effect of dust
nature.com

How can adding iron to the oceans slow global warming?
Outreach article about the fertilising effect of dust and role in global warming
howstuffworks.com

What are Diatoms?
Specialised site about diatoms
diatoms.org

These Kaleidoscopic Masterpieces Are Invisible to the Naked Eye
Outreach short video about diatomist Klaus Kemp
National Geographic

Diatom makes Human and All Living things Alive!
Outreach short video about the importance of diatoms
National Geographic

Bio-char
Outreach article about biochar and permaculture
UK Permaculture Association

EXPERIMENT MORE

Experiment-driven sustainability education
Activities and educational resources on soil remineralisation
lets.remineralize.org

GET INSPIRED

Kiss the Ground
Documentary about regenerative agriculture and its impact on the Earth system
Joshua Tickell and Rebecca Harrell Tickell

Dirt Rich
Documentary about regenerative agriculture
Marcelina Cravat

WaterBear
Streaming site for documentaries, films and series with an environmental focus

Practice makes perfect

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How to Measure Snowfall Accurately
Outreach article about how to measure snowfall
weather.gov

What is Citizen Science
European Citizen Science Association website

EXPERIMENT MORE

Measuring Snow
Practical guidelines about how to measure snowfall
weather.gov

How is Snow Measured?
Practical guidelines about how to measure snowfall
weatherworksinc.com

How to Build Your Own Snow Gauge
Video tutorial to build your own snow gauge
The Cape Elizabeth Land Trust

7 Ways to Observe Snow and Ice With Your Students
Teaching box about observing and measuring snow
The Robertson Program for Inquiry-based Teaching in Mathematics and Science, University of Toronto

GET INSPIRED

Talviseuranta
Citizen Science Snow Monitoring in Finland
Luontoliitto-SYKE

Citizen science in Finland - Get involved
Citizen science initiatives in Finland
Tampere University

Finnish Environment Institute (SYKE)
Projects seeking solutions to environmental problems through citizen science
SYKE

Citizen Science University of Oulu
Citizen science initiatives
University of Oulu

Snow sampling Citizen science experiment during Easter 2022
Citizen science experiment in Norway
University of Bergen

SciStarter
Online citizen science hub with projects from all around the world
SciStarter

eu-citizen.science
Platform for sharing citizen science projects, resources, tools, and training

The story of a particle

EXPAND YOUR KNOWLEDGE

A Guide to Climate Change for Kids
Educational content about climate change for children
ClimateKids - NASA

A Kid's Guide to Climate Change (Plus a Printable Comic)
Educational resource about climate change
Life Kit - NPR

Climate change 2021: a Summary for All
Official IPCC report for broader audiences about the state of our climate
The Intergovernmental Panel on Climate Change - World Meteorological Organization

International Teachers' Climate Change Forum
Teacher forum on climate science, climate education and the connection between these two domains
University of Helsinki Science Education and Institute for Atmospheric and Earth System Research Finland

EXPERIMENT MORE

Climate Time Machine
Educational content with visualisations of Earth's key climate indicators changing over time
ClimateKids - NASA

GET INSPIRED

Climate University
Free online courses for universities and everyone who wants to make the sustainability transition in society real
climateuniversity.fi

'If you win the popular imagination, you change the game': why we need new stories on climate
An essay by Rebecca Solnit
The Guardian

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