European Commission

ALL U NEED IS SPACE

in cooperation with

esa
European Space Agency

Internal market, Industry, Entrepreneurship and SMEs

You can find this booklet online at: http://ec.europa.eu/growth/sectors/space/learning_en

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ALL U NEED IS SPACE

Photo: ESA/NASA
During her "Futura" mission for the Italian Space Agency, Samantha Cristoforetti took a copy of this brochure into space. The photo shows the Italian ESA astronaut in the "cupola" observatory module on the International Space Station.

Original idea and concept by Didier Schmitt and Elena Ron Diaz

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Storyboard: Simon Leysen

Photos: European Commission, European Space Agency, iStock Photo

Information boxes: text by Directorate-General for Internal market, Industry, Entrepreneurship and SMEs in cooperation with the European Space Agency

CONTENT

This is what you can learn with Elena in the 'space' of one day!

Today is a normal day in Elena's life: she goes to school, *meets her friends,* makes fun of her father and little *brother, visits her* daydreaming grandmother… *But during the course* of the day, Elena will discover that *so many of the little* things she does are made possible or *easier thanks to space* technology and science. *Elena has a lot of* imagination. She loves sci-fi films, *especially those* related to space. On each page, you'll find *at least one reference* to a famous film or TV series. See *how many you can spot.*

So let's go and explore space… from Earth!

Did you know?

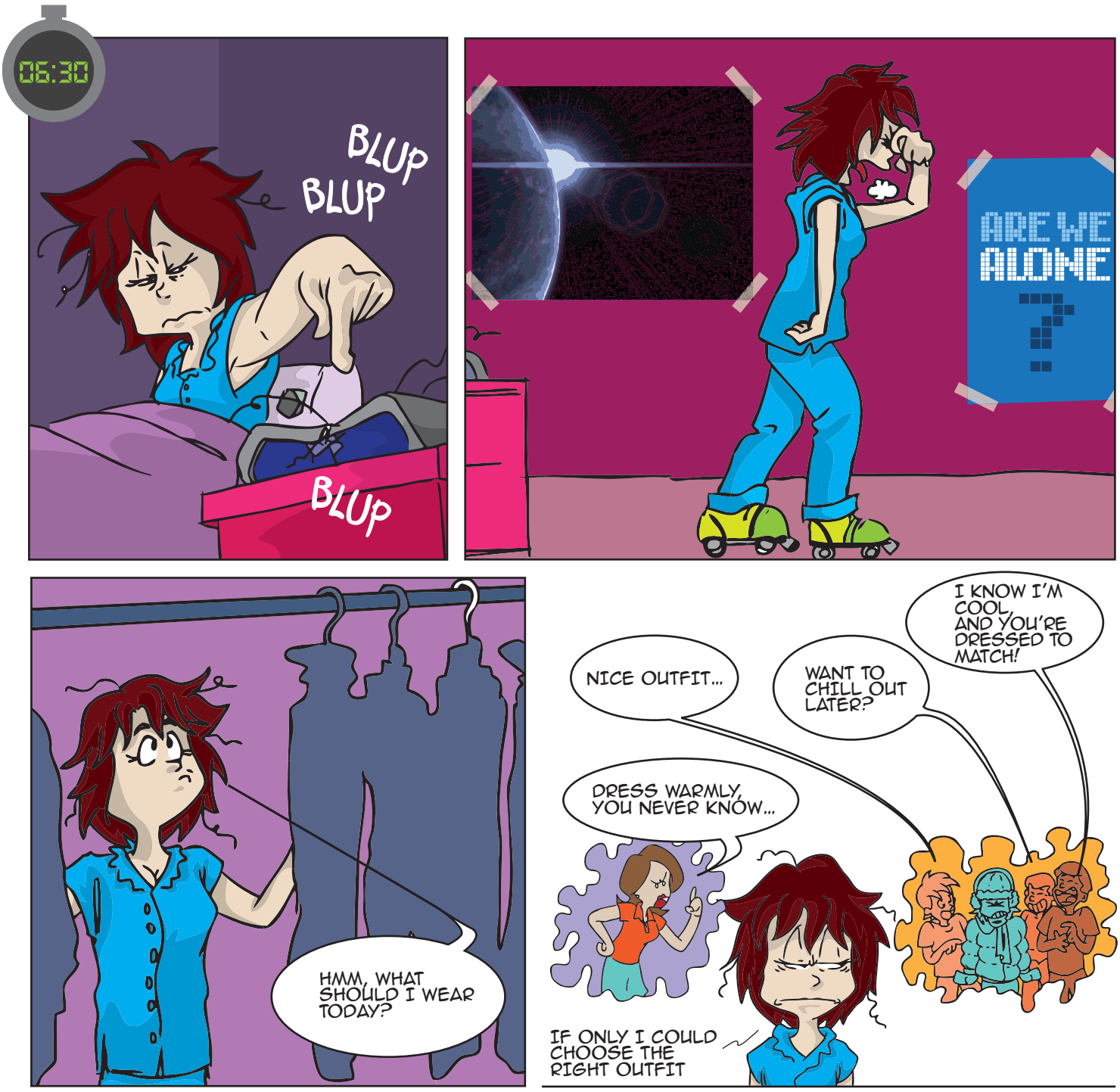
Atomic clocks in Galileo satellites are accurate to within one second in three million years. Such precision is needed so that signals from the satellites are sent out at the same time. The satellites can then get position accuracy down to a few centimetres on the Earth's surface, despite being at an altitude of 23 000 km.

The more satellites are in sight, the better the accuracy. An error of only a few nanoseconds (billionths of a second) in Galileo measurements would produce an error of several metres in our position on Earth!

What are we doing?

The Galileo programme of the European Union (EU) will have up to 30 satellites in orbit by 2020. Engineers at the European Space Agency (ESA) are the architects of this project and oversee its deployment.

Photo: ESA–J. Huart



Fantastic!

To help us predict the weather many days in advance, millions of measurements (temperature, wind, and many more parameters) are taken both on the ground and from satellites.

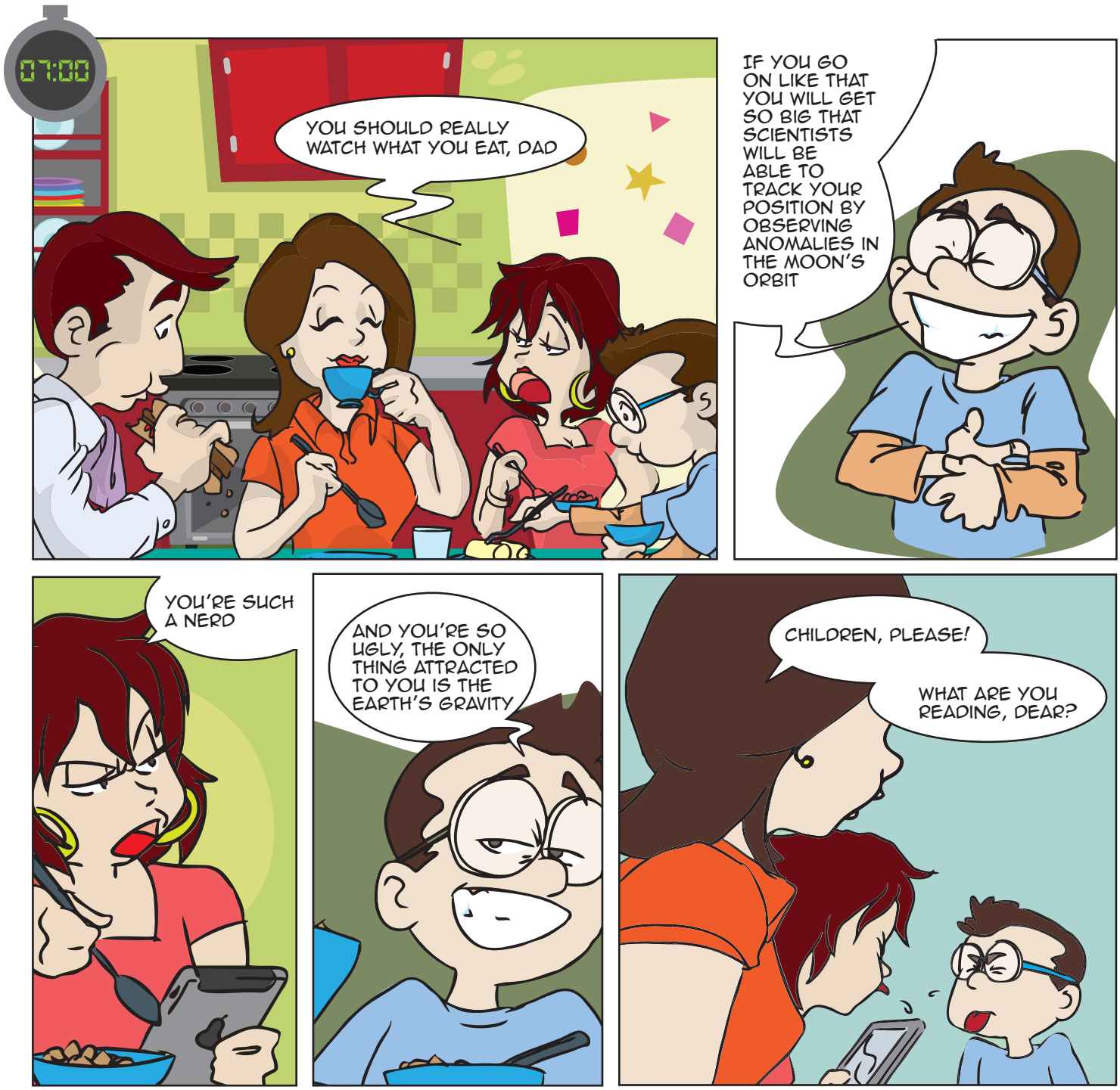
Meteorological satellites must be in geostationary orbit at 36 000 km, so that they always remain above the same spot.

The weather is not only important for us to know what clothes to wear. Every time a plane leaves an airport, it needs to know what the weather will be like on the way. The same is true of ships, to warn them if a heavy storm is approaching. Farmers also need to know if they can expect good weather to harvest their crops.

What are we doing?

The European Organisation for the Exploitation of Meteorological Satellites (Eumetsat) uses meteorological satellites to deliver the most accurate information.

Photo: Sandarosa Studio - iStockphoto



Fantastic!

The highest resolution of a civilian Earth observation satellite at 700 km altitude is 34 cm. Onboard cameras are so precise that if you used them from the top of the Eiffel Tower in Paris, you could see a silhouette of a person in Berlin.

What are we doing?

European satellites contribute to detecting ships at sea in order to rescue them, identify drug smuggling, and protect them from pirates.

Satellites can also help in case of a flood, and to locate oil slicks polluting the sea and find the ship they came from.

Photo: ESA

Fantastic!

You will see automated cars in the not-so-distant future. They will be part of an 'intelligent transport system' developed thanks to remote-sensing, telecommunication and navigation satellites.

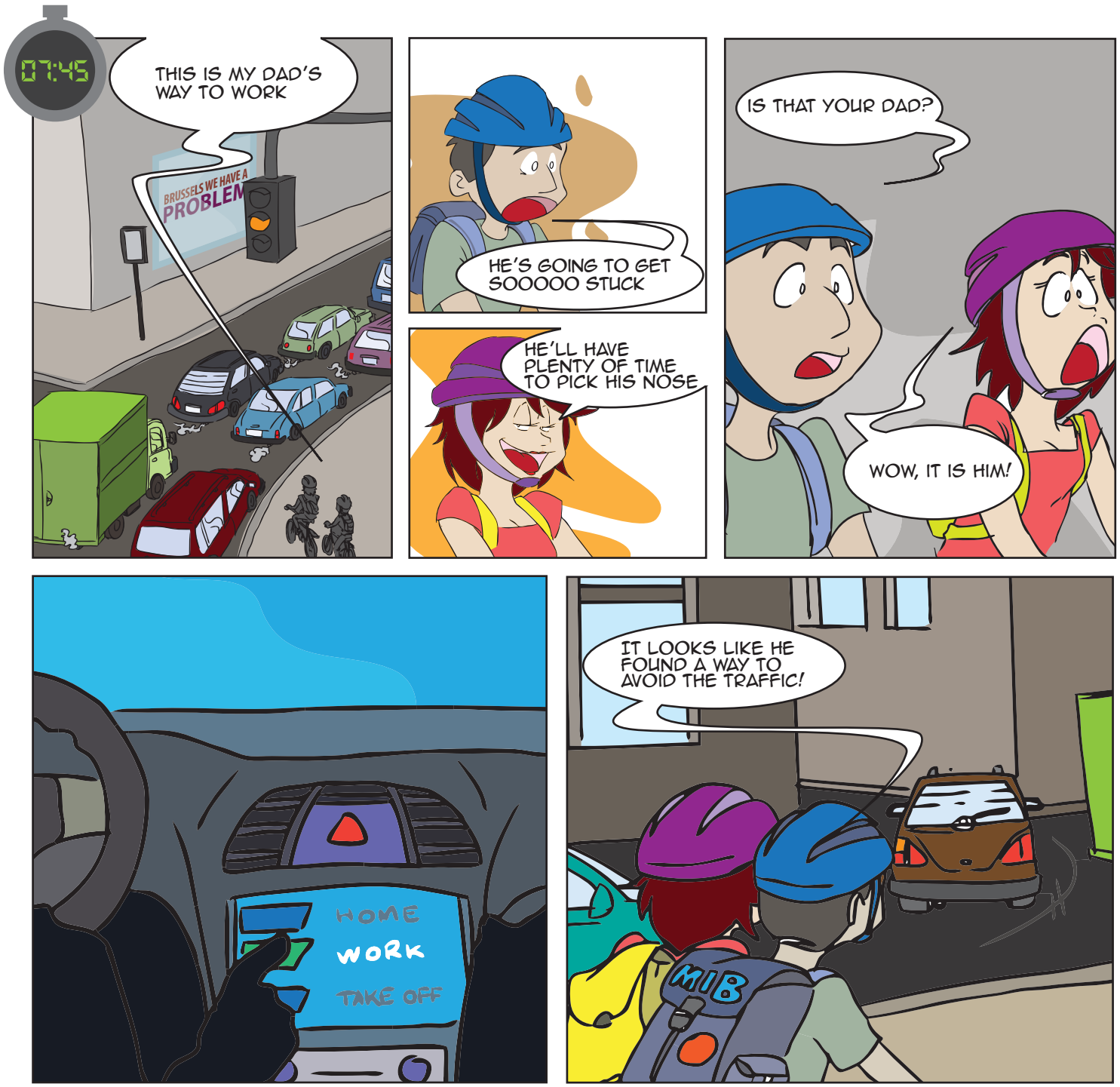
ESA will land its own 'astromobile' on Mars in 2020 and drive it remotely from Earth!

What are we doing?

Steering ESA's ExoMars 'astromobile', called a rover, in real time by remote control from the ground is not possible. Radio signals can take up to 14 minutes to get to Mars. However, using a stereoscopic camera and onboard computer instruments, we simply need to tell the 'astromobile' where to go and it will drive there by itself, cleverly avoiding obstacles such as rocks.

The rover will drill small holes to search for signs of past or present life. Mars is a promising target because it is known to have contained large amounts of surface water in the past, which is a very important ingredient of life as we know it. Because Mars has almost no atmosphere to protect it from the radiation of the Sun or cosmos, we will need to drill at least 1.5 metres deep to find any possible current or ancient life forms.

Photo: ESA–AOES Medialab



Did you know?

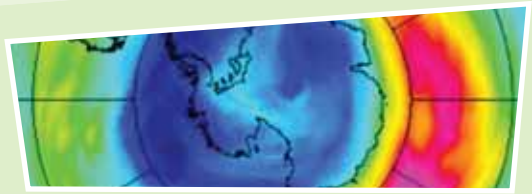
A high level of positioning accuracy via satellites is vital to ensure a reliable modern transport sector, be it cars, trucks, planes or ships. It helps prevent collisions, enforce speed limits, assist with delicate manoeuvres and locate shipment containers.

If you want to guarantee a non-stop service all year round, day and night, you need many satellites. This is why we talk about a global navigation satellite system.

What are we doing?

Galileo is Europe's own high-accuracy global navigation satellite system. Galileo satellites and numerous ground stations are being developed in collaborative efforts between the EU and ESA. The first Galileo satellites were launched in 2011 on a Russian Soyuz rocket from French Guiana.

Photo: Rafal Olechowski - iStockphoto



Amazing!

If you live in an urban area, your life expectancy is reduced by almost two years due to air pollution.

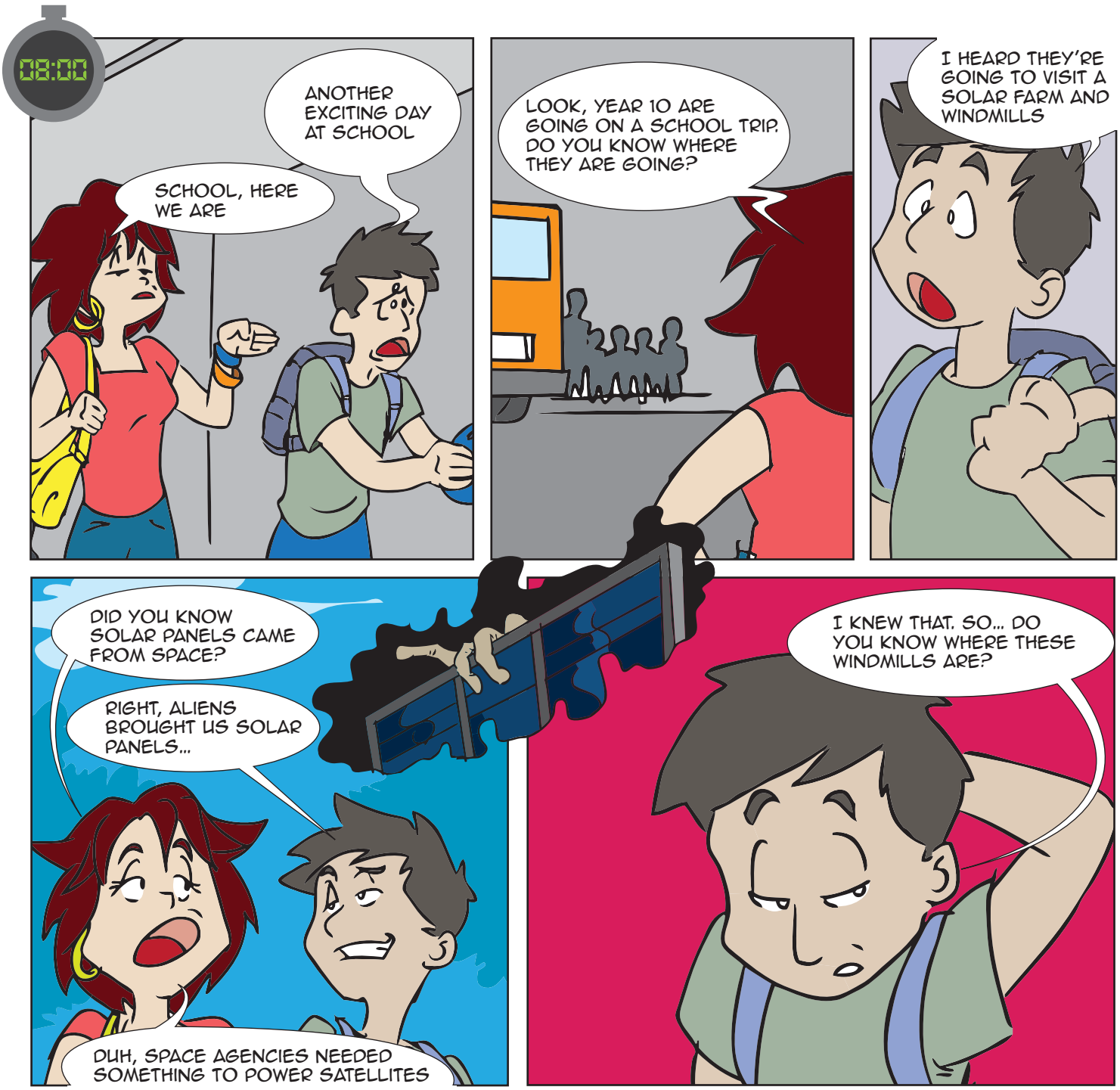
Satellites are able to determine concentrations of pollutants in the atmosphere, like ozone (O_3) from heat waves, sulphur dioxide (SO_2) from industry, nitric oxide (NO_2) and small particles from car exhausts.

By the way, ozone high up in the atmosphere is something very useful to protect us from UV radiation.

What are we doing?

European satellites are able to measure a wide range of gases to help us better understand what is in the air we breathe.

Photo: ESA–AOES Medialab



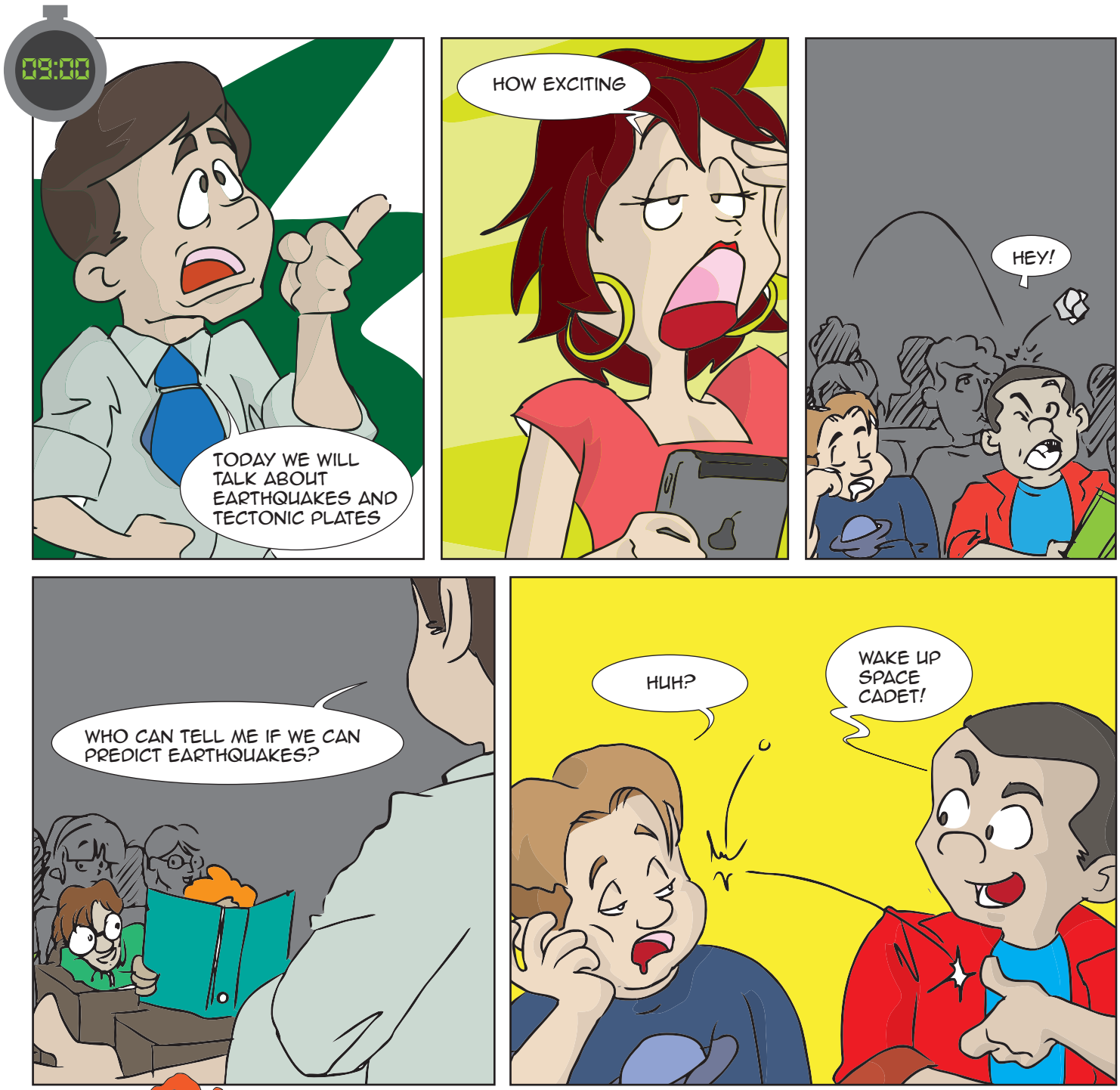
Did you know?

The International Space Station gets all its energy from the Sun by using solar panels. These solar panels permanently support six astronauts, life-support systems and all kinds of experiments.

What are we doing?

European engineers are constantly trying to increase the performance of solar panels by making them more efficient and lighter. Earth observation allows us to find the best spots for solar and wind farms.

Photo: Janusz B - iStockphoto



Did you know?

The accuracy of land movements measured by satellite imagery is precise to within a few millimetres. You can even see a volcano 'breathing' by the expansion and retraction resulting from its state of activity.

What are we doing?

Earth observation satellites (from ESA and the EU) are crucial to predict or assess the risk of catastrophic events such as floods, storms, earthquakes, landslides and volcanic eruptions.

Photo: Anmit - iStockphoto

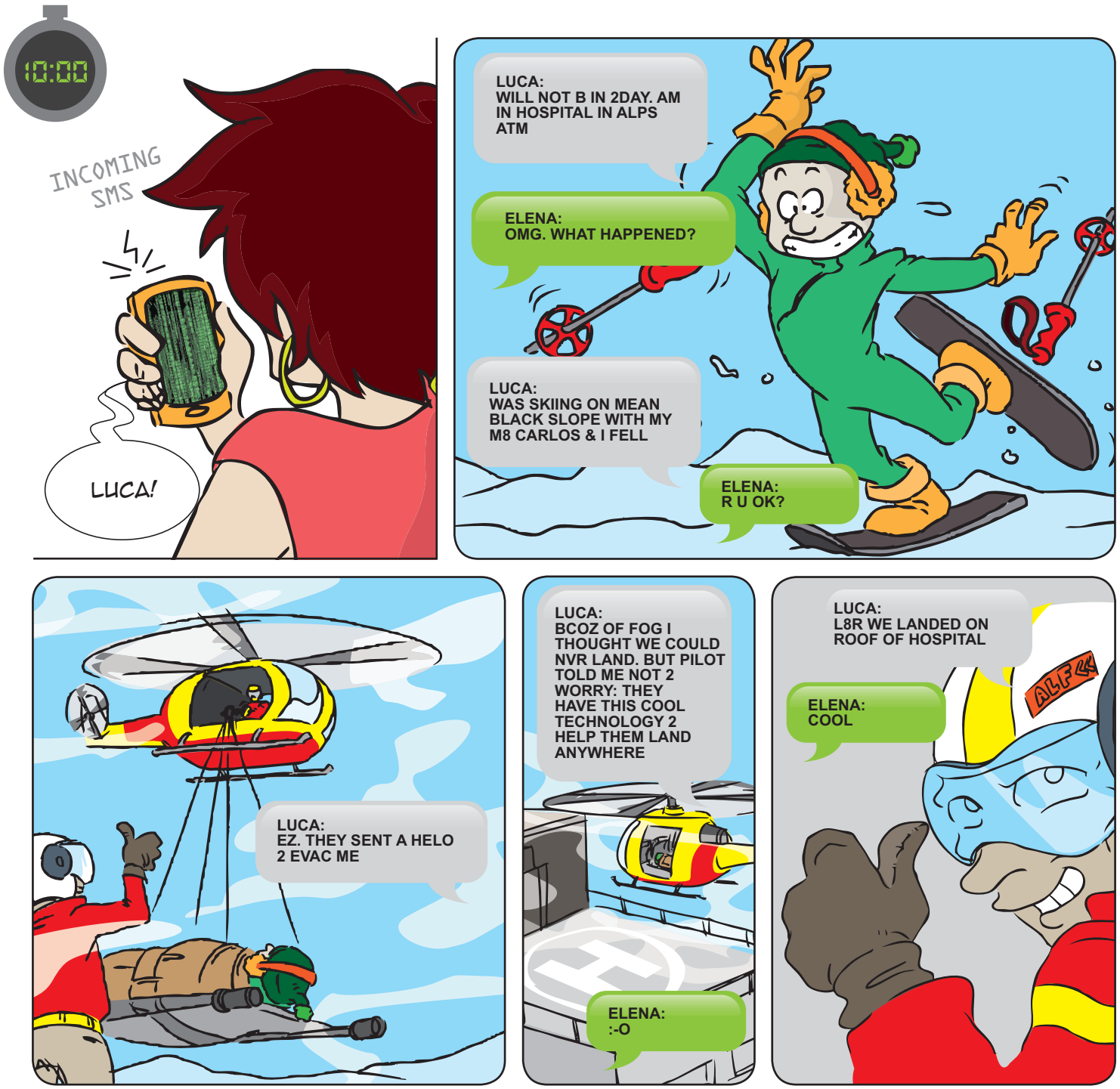
Did you know?

Following a catastrophic event like a severe flood or tsunami, only satellites can immediately replace destroyed ground-based communication infrastructures. Satellites can see if a road is still acceptable to drive on and can identify areas where aid agencies can build refugee camps and land helicopters.

What are we doing?

Satellites for earth observation, telecommunication and navigation help to assess damage and plan as well as guide rescue operations. The EU and many space agencies give their data to rescue teams free of charge and help in generating maps. In the future, new satellites will be built that will deliver even better and more accurate information. The EU is the world's largest contributor of foreign aid.

Photo: John Barnett - iStockphoto



Did you know?

The first commercial plane landing assisted by a satellite took place in southern France in 2011. Nowadays, pilots can land planes regardless of weather conditions thanks to permanent and reliable measurements coming from satellites.

What are we doing?

The European Geostationary Navigation Overlay System (EGNOS) is constantly looking to improve the accuracy and integrity of Global Positioning System (GPS) signals across Europe. EGNOS is composed of a network of ground stations and three geostationary satellites. EGNOS makes GPS much more accurate and reliable and therefore suitable for critical safety applications such as flying aircraft or navigating ships through narrow channels.

Photo: Online Creative Media - iStockphoto

Did you know?

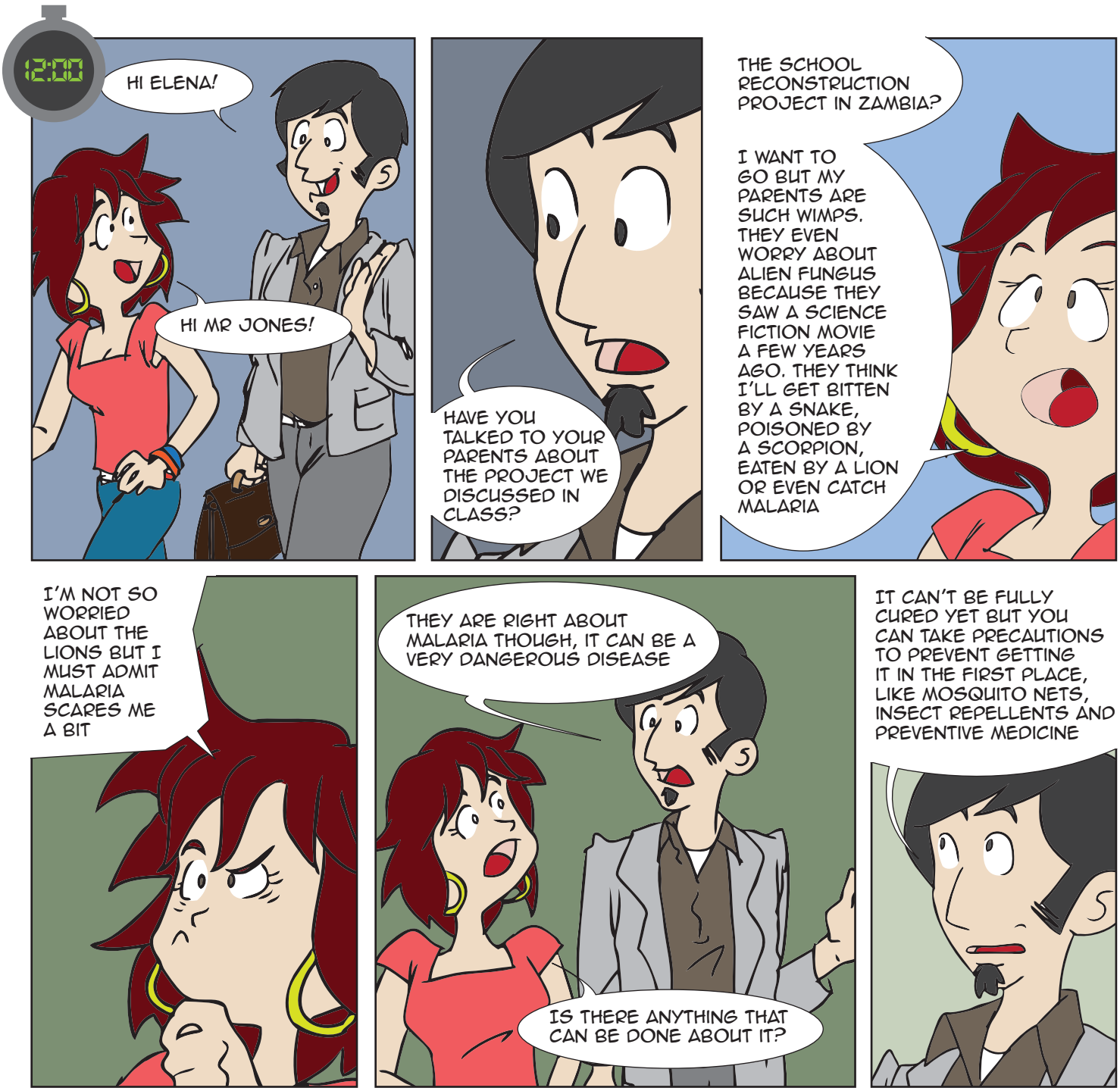
Satellite telecommunications and technologies used to support astronauts during space flight can also help to improve healthcare here on Earth.

What are we doing?

ESA has already supported over 150 health projects. Examples include advanced diagnosis and treatment devices, remotely-controlled-surgery, and robotic-assisted echography.

The main benefits are the reduction of unnecessary travel for doctors and patients as well as better access to quality healthcare.

Photo: Tomasz Wyszolmirski - iStockphoto



Did you know?

Remote-sensing satellites and navigation satellites combined with other local information can help identify the source and predict the spread of some diseases. For example, mosquitoes that spread malaria or other dangerous diseases need warm water to lay eggs. Satellites can detect water and measure the temperature to help locate breeding grounds.

What are we doing?

Satellite data are used to support these development efforts and give countries access to information that contributes to setting up warning systems for diseases. European satellites also help to produce risk maps for malaria and other communicable diseases.

Europe supports projects to ensure that water is safe to drink and that there is enough water available for urban development.

Photo: HAYK/IRDI - iStockphoto

Did you know?

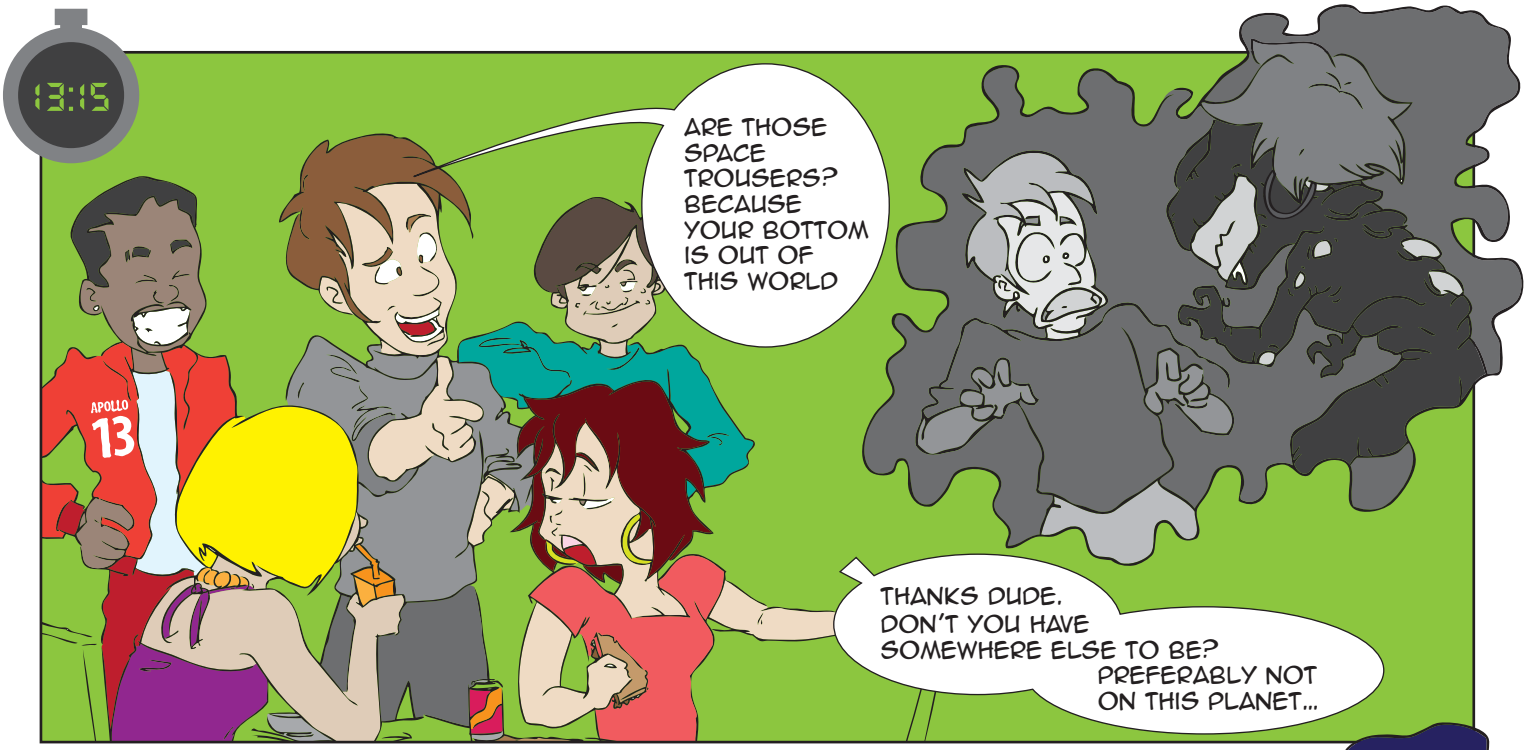
Satellites help guarantee better food quality and food safety, whilst protecting the environment.

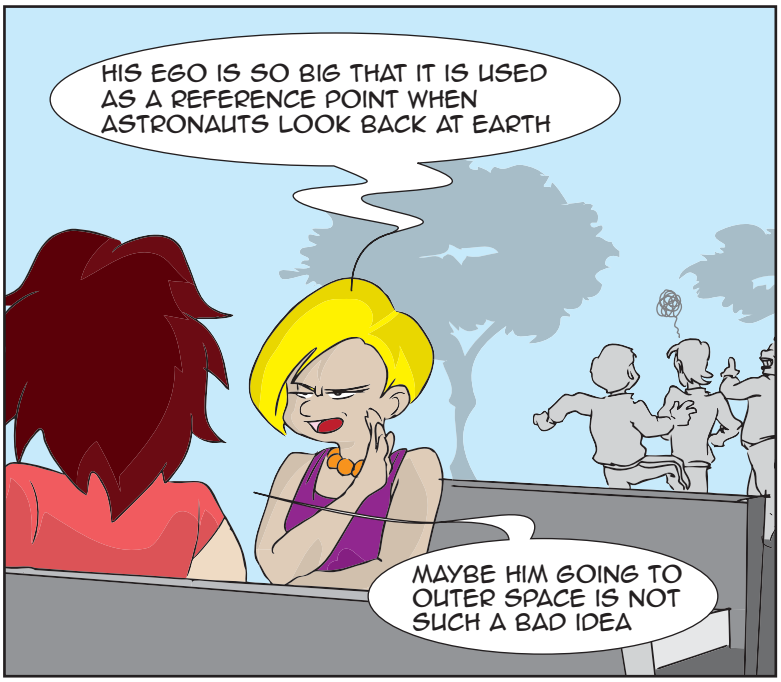
Harvests can be predicted several months ahead using satellite images to make sure we have enough food.

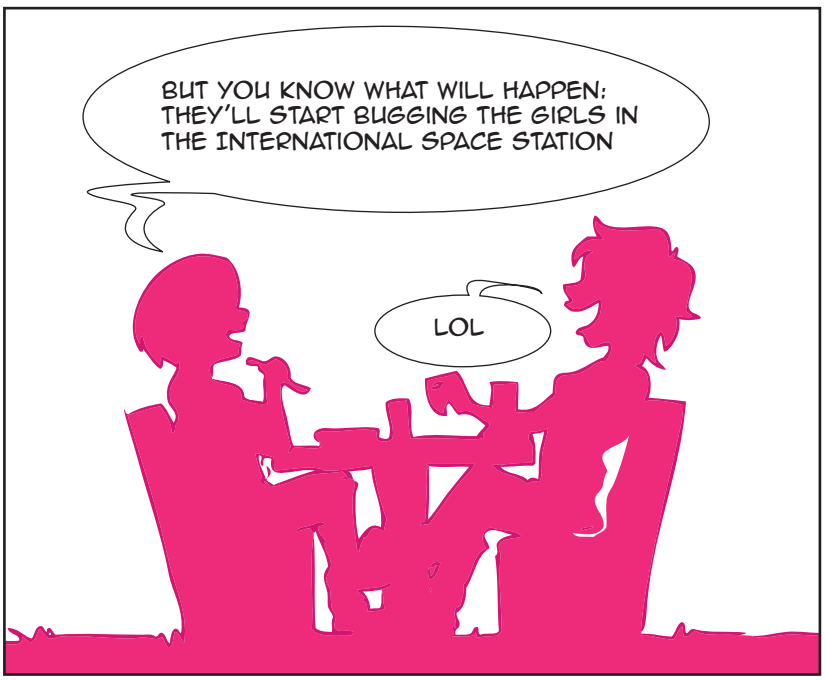
What are we doing?

European satellites can improve the use of farm land. When producing maps of their fields, farmers know exactly if and where water or fertilisers should be applied. But satellites can help forecast the expected harvest quantity well in advance. They are also very helpful to optimise sustainable forestry practices.

Photo: ESA







Did you know?

Europe has a spaceport in Kourou in French Guiana near the equator in South America. The Ariane 5 launcher has a total mass of about 770 tonnes. Only 1 % of this mass is the satellite payload, but it could easily send a school bus to the International Space Station!

More than 300 satellites have been launched from Europe's spaceport.

What are we doing?

ESA developed the Ariane 5 heavy launcher and also a smaller launcher called Vega. The Russian Soyuz rocket lifted off for the first time from Europe's spaceport in French Guiana on 21 October 2011, carrying the first operational Galileo satellites.

Photo: ESA/CNES/ARIANESPACE–Optique Photo Video CSG

Did you know?

Environmental monitoring from space provides us with crucial information on vegetation, ocean currents, water quality, natural resources, atmospheric pollutants, and greenhouse gases. It allows us to better predict the effects of climate change in different regions and countries.

What are we doing?

European industry is building satellites that keep track of changes in sea levels with very high accuracy of only a few millimetres. The satellites record changes in ice coverage in the Arctic, in ocean currents, and in temperature. They also help monitor deforestation.

Photo: Mayumi Terao - iStockphoto

Fantastic!

The International Space Station, the result of cooperation between the USA, Russia, Japan, Canada and Europe, is the largest object ever built in space – it's the size of a football pitch! It took over 10 years to assemble and cost about €100 billion.

What are we doing?

International cooperation is vital for space activities, so that humans can build spaceships more complex than any single country could do alone. Europe's contribution to the International Space Station comes from the provision of cargo ships, the Columbus laboratory and European astronauts.

The EU seeks to promote better international relations by encouraging political cooperation for future robotic and human exploration of the solar system.

Photo: ESA

Did you know?

Huge icebergs break off ice fields in the Arctic and Antarctic each spring; the most famous ship sunk by an iceberg was the Titanic in 1912. Nowadays, with the help of satellites, very precise maps are being produced and sent to ships to help them navigate through large ice fields.

What are we doing?

European satellites provide data free of charge to ice breakers, so that they know where their help is most needed and where icecaps are the thinnest. The Baltic Sea is the most travelled sea in the world and, thanks to satellite data, maritime routes can be safely negotiated by a huge number of ships.

Photo: Lee Sutterby - iStockphoto

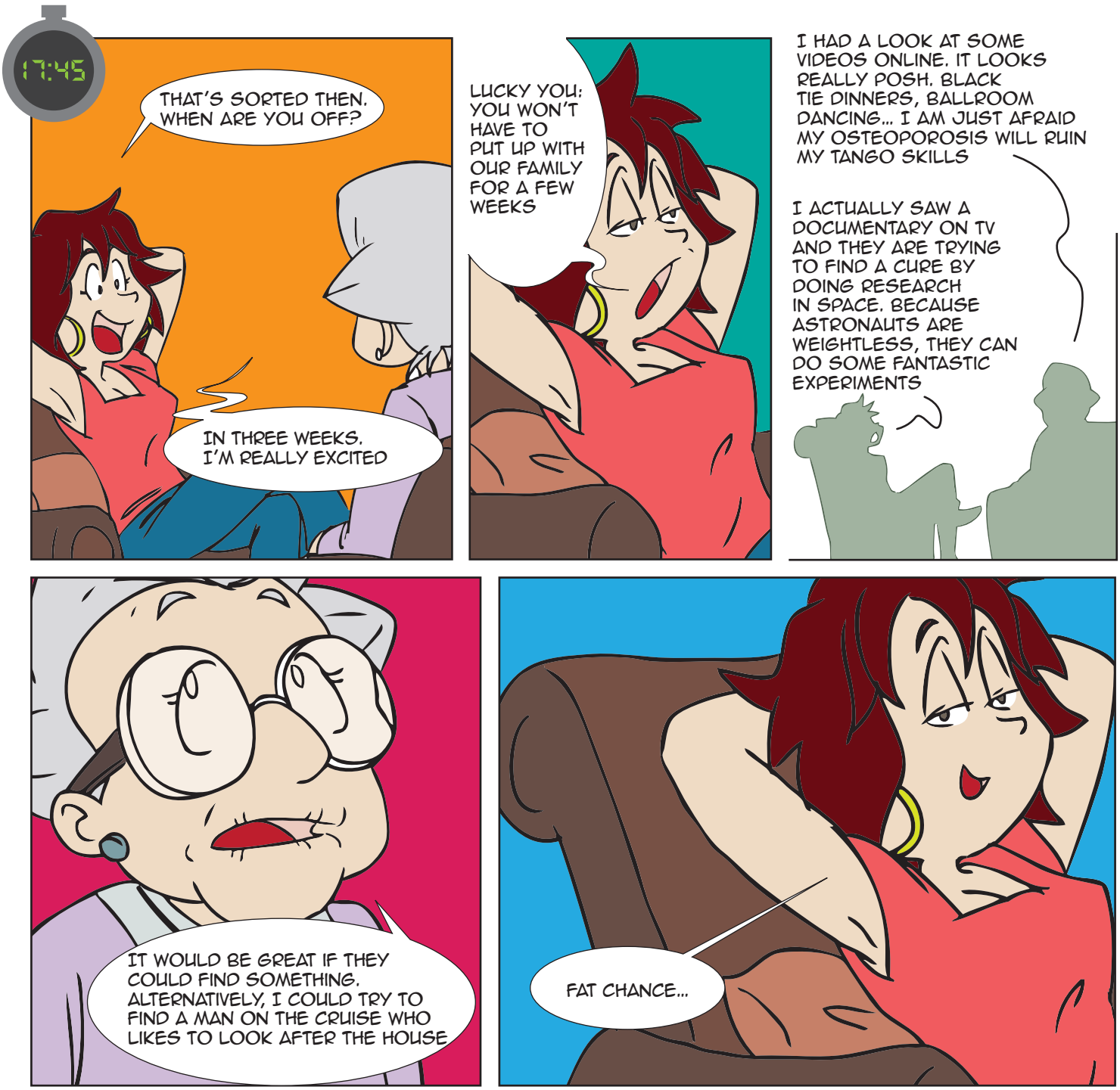


Photo: ESA

Did you know?

Scientists use the International Space Station to create new technologies to better understand our world. Space technology spin-offs are everywhere (in car airbags, aeroplane engines, etc.) and can even help us understand and cure health problems like osteoporosis.

What are we doing?

ESA helps companies create new products derived from space technology that can be used in our daily lives. Experiments are performed in space, but also in Antarctica, in special 'spacecraft' on Earth, and on aeroplanes.

Did you know?

Allergies due to pollens in the air are becoming more and more of a public health burden. The rate of asthma is increasing mostly in young children because of the combination of allergens and other air pollutants.

Different space-derived technologies can now be integrated, making it possible to record jogging routes and monitor basic medical parameters.

What are we doing?

European satellites help evaluate air quality. Sensitive individuals can find out the level of air allergen risk a few days in advance thanks to space-based weather and pollution prediction, together with pollen occurrence probability.

All these services are possible thanks to the combination of space and non-space applications.

Photo: Jasmina - iStockphoto

Did you know?

'Science of space' answers all kinds of questions about the origin of life and our place in the universe, ranging from fundamental physics of particles and forces, to observing giant galaxies and looking for asteroids and meteoroids that could collide with the Earth.

What are we doing?

ESA's comet chaser Rosetta has started its space travel in 2004. It flew by asteroid Lutetia and landed a probe on a comet for the first time ever on 12 November 2014. Detailed automated scientific experiments were conducted to understand the composition of this this comet called Churyumov-Gerasimenko. Already 25 years ago, the Giotto probe swept within 600 km of Halley's Comet, obtaining the first close-up images of a comet.

The EU is currently financing research on potential methods to avoid collision of asteroids with the Earth.

Photo: Sébastien Decoret - iStockphoto

Did you know?

There will be more than 1 000 000 pieces of space junk bigger than 1 cm orbiting the earth by 2020, all travelling at 8 km/second. At that speed, even a small screw can completely destroy a satellite.

In our daily lives, we all make constant use of satellite communications. Just think of telephones, the Internet, online banking… or how much you enjoy watching live sport from around the world!

Amazing!

More than 3 000 TV broadcast channels are available via European satellite operators!

What are we doing?

The new generation of telecommunication satellites that ESA is developing is able to handle more than a billion voice calls or transmit hundreds of TV channels at a time. Thanks to this advanced technology, European telecom providers are world leaders.

Photo: ESA

Did you know?

Most online maps and itineraries are based on satellite imagery. In addition, raw space imagery can be processed in many ways, for example to decide on future motorways, preferred housing areas, preservation of small ecosystems or sewage management. It can even be done in 3D! It's also useful for long-term planning of resilience measures, such as protecting against sea erosion, flood zones or heat waves in big cities.

What are we doing?

Satellite imagery is either sold or given to small companies that specialise in satellite-based services. This highly skilled economic activity is expected to grow rapidly in the coming years, especially for decision-making in land use, urban development and all kinds of risk prediction.

Photo: Sébastien Decoret - iStockphoto

WHAT ABOUT THE FUTURE?

The surface of our planet has a rather complex biosphere. It is characterised in recent history by the dominance of the human species and our peculiar infatuation with technology. Hence, we have become unavoidably dependent on science and technology due to significant population growth, globalisation, an ageing population, urbanisation, scarcity of resources, relations between individuals and between humans and nature, and the way that we organise our societies in general.

According to several estimates, by 2050:

The world population will have increased by
2 billion
mostly in Asia and Africa.

Source: OECD (environmental outlook to 2050)

70%
of people will live in cities, so in the coming decades, the equivalent of a city of 1 million inhabitants will be created every week.

Source: UN-Habitat

The number of people over 80 will have reached
400 million

Source: WHO

There will be over
150 million
'climate refugees', mostly due to the rise in sea levels.

Source: International Organization for Migration

The number of cars will have doubled, reaching
2 billion

Source: OECD; International Energy Agency

Imagine the consequences just on resources like clean water, food and energy!

Can space technology help? It is rocket science after all!

Space technologies will be increasingly needed to address a wide variety of societal challenges. Anticipating such challenges and their possible scientific and technological solutions will be key for the EU. After all, the wellbeing of citizens on a healthy planet is what matters most.

What can you do?

Wouldn't you like to play a part in this? Why not consider a career in science or technology and help shape a better future?

Remember, the Earth is your space too...

WATCH THIS SPACE!

Go to our website to find more fun material and test what you've just learned – games, videos, posters, links... You can also find an electronic version of this comic so you can share it with your friends!

On our website, you'll find which sci-fi films and TV series were referenced in the comic. Check if you found them all!

http://ec.europa.eu/growth/sectors/space/learning_en

DO YOU WANT TO EXPLORE EVEN FURTHER?

Ask your teacher to tell you more about each of the topics in this comic. You can then talk in class about general issues such as climate change, pollution, transport, resources (energy, food, water, land and oceans), health, safety and security, development aid, etc.

IN ADDITION, MANY TOPICS ARE SUITABLE FOR LESSONS IN:

- **Geography:** Weather conditions, volcanoes, landslides, earthquakes, urban mapping, agriculture and harvest prediction, pollution monitoring, green energies, diseases and environment, climate change consequences, etc.
- **History:** Extinction of dinosaurs, history of space flight in the Cold War context, old and new 'space powers', etc.
- **Physics:** Speed, acceleration, angular velocity and kinetic energy, gravity, orbits, vacuum, air friction, atomic clocks, electromagnetic spectrum for astronomy, wavelengths for remote-sensing instruments, etc.
- **Biology:** Origin of life, gravity and its effect on the evolution of living organisms, conditions for life, effects of weightlessness on humans, etc.
- **Chemistry:** Formation and reactivity of ozone (O_3), pollutants from industry (SO_2) or cars (NO_2), etc.
- **Mathematics:** Exponentials in rocket acceleration, angular velocity of satellites, etc.
- **Philosophy:** Possible life forms on exoplanets: are we alone in the universe?
- **Ethics:** Should we use resources from outer space (e.g. asteroid mining)? Are we facing a technology divide?
- **Languages:** Why not read the comic in one of the other 23 available languages?

USEFUL LINKS

Find this comic and much more fun material related to space
http://ec.europa.eu/growth/sectors/space/learning_en

European Commission

Galileo and Egnos: http://ec.europa.eu/growth/sectors/space/galileo_en
http://ec.europa.eu/growth/sectors/space/egnos_en

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European Space Agency (ESA)

http://www.esa.int

More games, quizzes and online fun to learn about the European Union (EU):

http://europa.eu/kids-corner/index_en.htm
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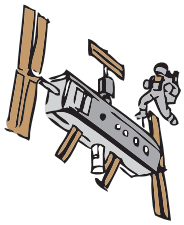
MEET SOME OF OUR EUROPEAN SCIENTISTS AND EXPLORERS



Anne Glover (UK), Claudie Haigneré (France), Frank De Winne (Belgium) and André Kuipers (Netherlands) all studied and followed different careers in science, which led them to the fascinating jobs they now have.
Studying science offers many fantastic and creative career prospects and means you contribute to a better future!

As you can see, our four European scientists also like Elena's adventures ...

Frank studied engineering. In the course of his career, he has been an engineer and experimental test pilot. He is also a General in the Belgian Air Force and was the Commander of the International Space Station in 2009.

André studied medicine. As an ESA astronaut, he performed a lot of scientific experiments in space and currently holds the European long-term spaceflight record of 194 days.

Photo: Elena Ron Diaz

Anne studied biology and had a very important job in the EU as the First Chief Scientific Advisor to the former European Commission President Barroso. She is one of our best science ambassadors and is also passionate about space.

Photo: European Union

Claudie studied medicine and neurosciences. As an astronaut she flew on board the Russian Mir space station and the International Space Station. As a decision-maker she was French Minister of Research and New Technologies and then Minister of European Affairs. She is now adviser to the European Space Agency (ESA) Director General.

Photo: Planète Science

ALL U NEED IS SPACE

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Space is not just about adventurous space travel of robots and humans, or studying astronomy and astrophysics. It can also be very down to Earth!

The European Commission, European Space Agency and several national programmes are developing more and more space applications that can be used in our daily lives.

You'll find many examples in this comic by joining Elena and her family and friends in their activities in the course of a 'normal' day.

Follow Elena and enjoy the trip!

Go to our website http://ec.europa.eu/growth/sectors/space/learning_en

You'll find lots of fun material to test your knowledge!

Publications Office

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