BBC

From the makers of FOCUS SCIENCE AND TECHNOLOGY

SPECIAL EDITION

EARTH FROM SPACE

YOUR HOME AS YOU'VE NEVER SEEN IT BEFORE

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ANCIENT SITES
RIVERS DESERTS
ISLANDS FARMING
HURRICANES CITIES
OCEANS CLOUDS REEFS

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SPECIAL EDITION

No subject is too mind-bending for *Focus* to tackle. You'll find 20 of the biggest ideas covered in this special issue

WELCOME

FOR MOST OF recorded history, people have wondered what Earth would look like from up high. Socrates imagined something not a million miles away from a football: "The world, when viewed from above, resembles a ball sewn from twelve pieces of skin," he wrote around 2400 years ago.

It wasn't until 1946 that a camera at last captured views of Earth from space. It was mounted on a V-2 – a missile developed by the Germans in World War II and captured by the Americans. Launched from New Mexico, it took its picture from an altitude of 105km.

Before long, rockets were regularly carrying payloads into orbit and 1959 saw the first satellite image taken from space. A blurred, black-and-white picture of the Pacific Ocean, the Explorer 6 photo is a far cry from the colourful, high-resolution images you'll find in this special issue of *Focus*. From volcanoes, storms and rivers to cities and the remarkable extent of human impact, these images reveal a panoply of activity on Earth.

My favourite photos show Earth at night; whole continents that never sleep. It's a reminder of just how much of the globe we've covered with infrastructure in order to sustain intelligent life on our planet.

I often wonder what Earth will look like in 50 years' time. Will even more of the planet's surface glow and twinkle with artificial light? Or will our desire to conserve energy plunge us into darkness once more? Only time will tell, but for now, sit back and enjoy what only astronauts have seen with their own eyes: our home, whole.

Graham Southorn, Editor

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FRONT COVER PHOTO: ALAMY BACK COVER PHOTO: NASA

Sunrise

THIS DRAMATIC IMAGE of a sunsrise was taken by astronauts travelling at over 27,000km/h. At these speeds it only takes 90 minutes to orbit the planet, allowing them to see 16 sunrises and 16 sunsets every day.
PHOTO: KEVIN KELLEY/GETTY

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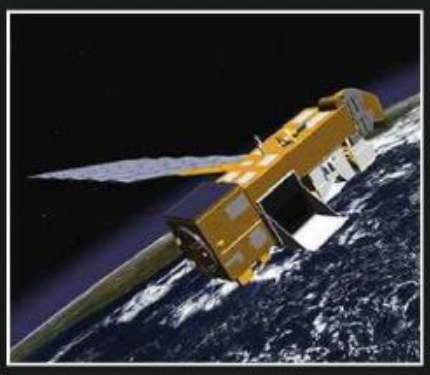


TERRA

GeoEye-1

IKONOS

International Space Station

ON CHRISTMAS EVE 1968, Apollo 8 astronaut Bill Anders took a photo of an 'Earthrise' from the Moon's orbit. As the first image showing how Earth appeared from deep space, it awakened a huge interest in photographing our planet.

In 1972, NASA launched the first satellite that had the sole intent to monitor Earth's landmasses. It was called Landsat 1, and although it retired in 1978, the mission continues. Landsats 5, 7 and 8 all contribute images to *Earth From Space*. With the fleet's focus being on Earth's resources, their pictures provide great insight into the impact of human society.

Satellites allow us to study and analyse many of Earth's previously unexplained processes. It's no coincidence that advances in weather prediction and natural disaster aversion all align with the rise of these orbiting devices. As technology has rocketed, so too has the quality and variety of recordings that satellites take. The complex images are far more than just colour photos – the sensor onboard NASA's Suomi NPP satellite, for instance, measures electromagnetic radation. Orbiting between the poles, Suomi NPP provides data essential to understanding climate change.

Another of NASA's research missions is its TERRA satellite. It has five different image sensors, three of which provide spectacular pictures for this collection. The cameras each have different roles. One captures images of the surface, while another focuses on recording the atmosphere, clouds and land in a three-dimensional manner. Meanwhile a third instrument – the Moderate-Resolution Imaging Spectroradiometer (MODIS) – picks up atmospheric, land surface, and cryospheric features across the globe. There's another MODIS sensor on NASA's Aqua satellite, which observes Earth's water,

The blue planet

▲ ONE OF THE first photos of the Earth in a single image. Shot by an Apollo 8 astronaut, it shows the planet at a distance of about 30,000km, with Antarctica at the top of the picture. PHOTO: NASA

Great divide

California and Nevada, USA

THE SIERRA NEVADA mountains trap moist sea air as it blows in off the Pacific Ocean, creating a lush green haven along the west coast, and an arid landscape in the eastern interior.

PHOTO: ESA

monitoring seas, rivers, ice, clouds and even soil.

Photos from two of the planet's most cutting-edge imaging satellites also feature in this collection – GeoEye-1 and IKONOS. The high-resolution images from GeoEye-1 are the most detailed views of Earth that exist, while IKONOS captures multispectral images – showing data from beyond the visible light range – and black-and-white, or panchromatic, images.

With a rise in commercial satellites like GeoEye-1, the costs attached to these monitors have reduced, but still, the minimum price tag on a launch is £33m. So, when a satellite makes it into orbit, it is worth taking advantage of. Launched in 2000, NASA's Earth Observing-1 (EO-1) satellite was only intended for a year-long mission. But the device proved so successful that it still runs today. EO-1 provides a wealth of pictures, from wide-angle land shots to hyperspectral images that scientists use to classify complex ecosystems.

It's not only satellites that watch us – permanently onboard the International Space Station (ISS) is a rotating crew of six astronauts, plus a host of Earth-monitoring instruments. Thanks to its low Earth orbit, the ISS looks down at a shallow angle, so its images provide a rare view of our world.

Those Apollo astronauts set off on their missions in the bold spirit of exploration. In the half century since, the ISS has taken shape, while thousands of satellites watch the globe. The spirit of Apollo lives on and, thanks to the amazing images in this special edition, we can all enjoy an astronaut's eye view.

The Colosseum

Rome, Italy

▲ THOUGH IT WAS built nearly 2100 years ago, this ancient amphitheatre stands tall. The 20,000m² site sits in the top left of this picture, surrounded by the modern city.
PHOTO: DIGITALGLOBE/GETTY

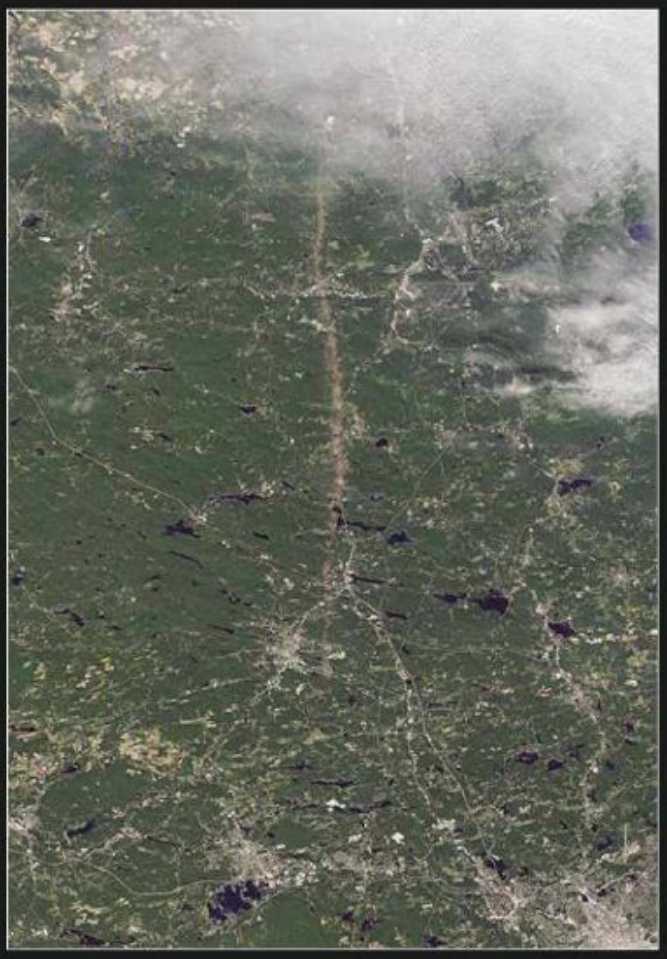
Island paradise

The Bahamas

▶ THE VIVID BLUE waters of The Bahamas owe their practically luminous quality to the shallow depths of their seas.
PHOTO: NASA/JEFF SCHMALTZ

Fort Bourtange
The Netherlands

▲ THIS UNIQUE STAR fortress lies near the German border. The original structure was built in 1593 and served defensively for nearly two centuries. After a 25-year reconstruction project, the fort is now a museum.
PHOTO: DIGITALGLOBE



Tornado track
Massachusetts, USA

▶ ON 1 JUNE 2011, a 63km track of destruction – the pale-brown line that runs through the middle of this picture – was carved out by a single twister. At about 800m wide, the tornado ravaged residential and forest areas.
PHOTO: NASA/JESSE ALLEN

WATER

With water covering over 70 per cent of Earth's surface, it's easy to see why it's called the 'blue planet'. Meandering streams and serene lagoons can be inviting, but the unpredictability of water makes it a dangerous opponent

The Sundarbans

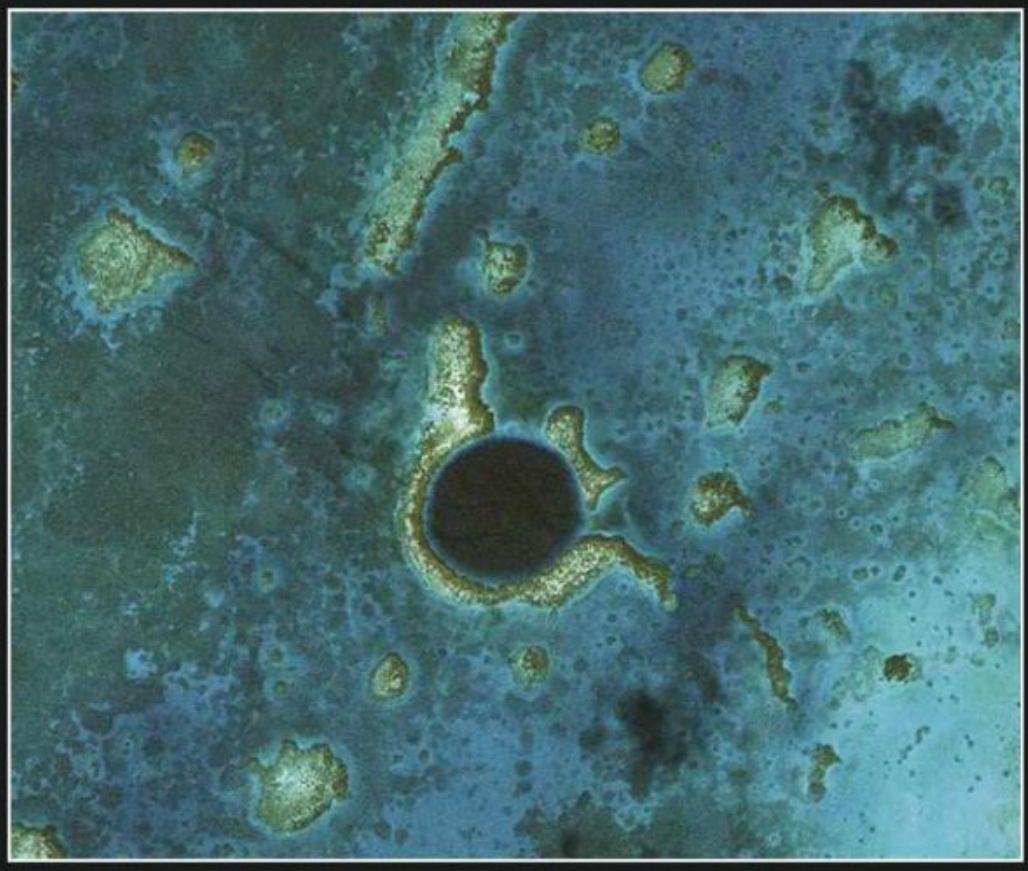
Bangladesh

SPANNING AN AREA the size of 170,000 football pitches, the Sundarbans is one of the largest mangrove forests in the world. The forest lies just west of the main outflow of the Ganges, Brahmaputra and Meghna rivers. The area to the north of the forest is heavily farmed to support the large human population.

PHOTO: NASA/JESSE ALLEN

Great Blue Hole

Belize

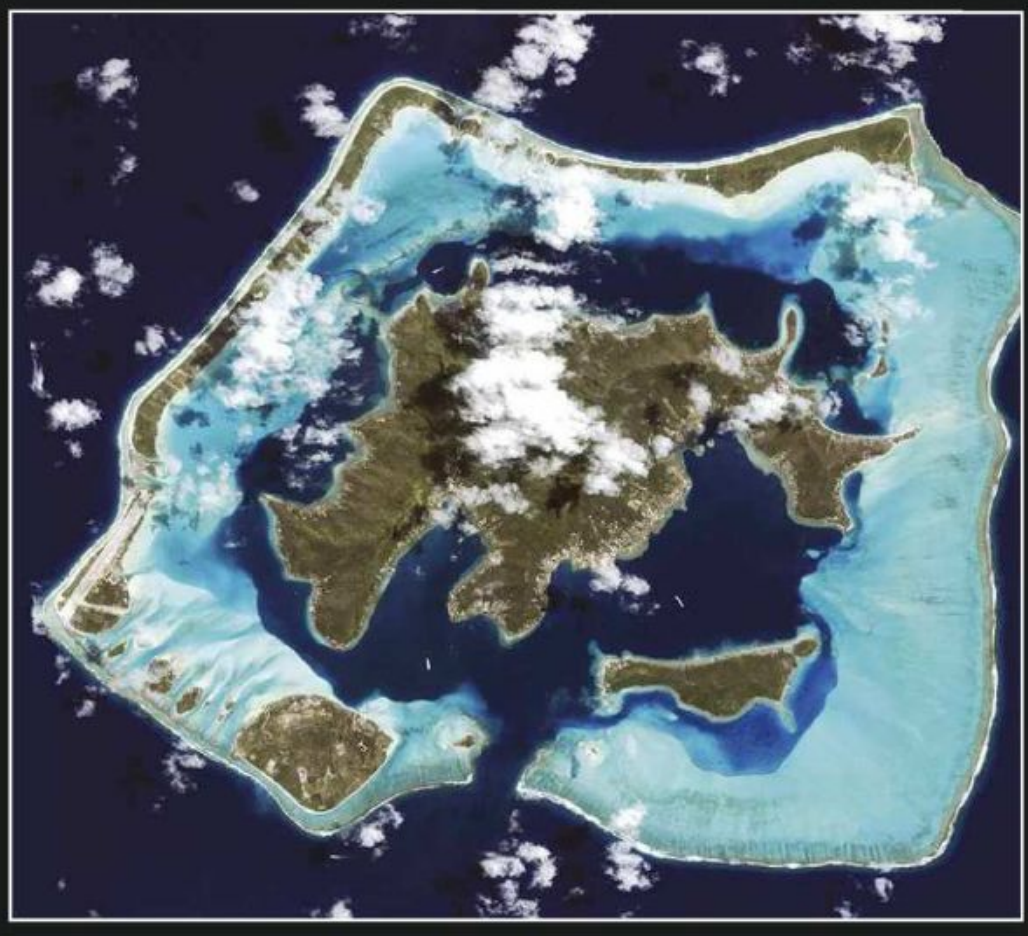


▶ THIS SPECTACULAR underwater sinkhole is part of the Belize Barrier Reef Reserve System. A favourite among scuba divers, the circular cave is 300m wide and 124m deep. In the last Ice Age, sea levels were up to 120m lower than today. Rain eroded the limestone surface creating a cave. As the ocean began to rise again, the cave was flooded, resulting in the Great Blue Hole.

PHOTO: DIGITALGLOBE

Bora Bora

French Polynesia



▶ IN THE MIDDLE of the Pacific Ocean, surrounded by a lagoon and barrier reef, Bora Bora's volcanic land rises from the sea. After the volcano became extinct, the island started to subside. Coral grew, building a fringing reef around the island and creating the lagoon. As the island continued to sink, the barrier reef grew bigger.

PHOTO: DIGITALGLOBE/GETTY

Lagoons

New Caledonia

OVER 1000KM EAST of Australia lie the stunning lagoons and reefs of New Caledonia. The shallow waters are home to a large array of species including humpback whales, sea snakes and dugongs.

PHOTO: NASA

Amazon River

Brazil

THE SOURCE OF the Amazon River is highly contested. However, at around 6400km long there can be no denying its enormity. With over 1000 tributaries, its drainage basin covers 40 per cent of South America. It accounts for one fifth of the world's river flow and the fresh water it carries dilutes the ocean's saltiness for 160km from the shore.

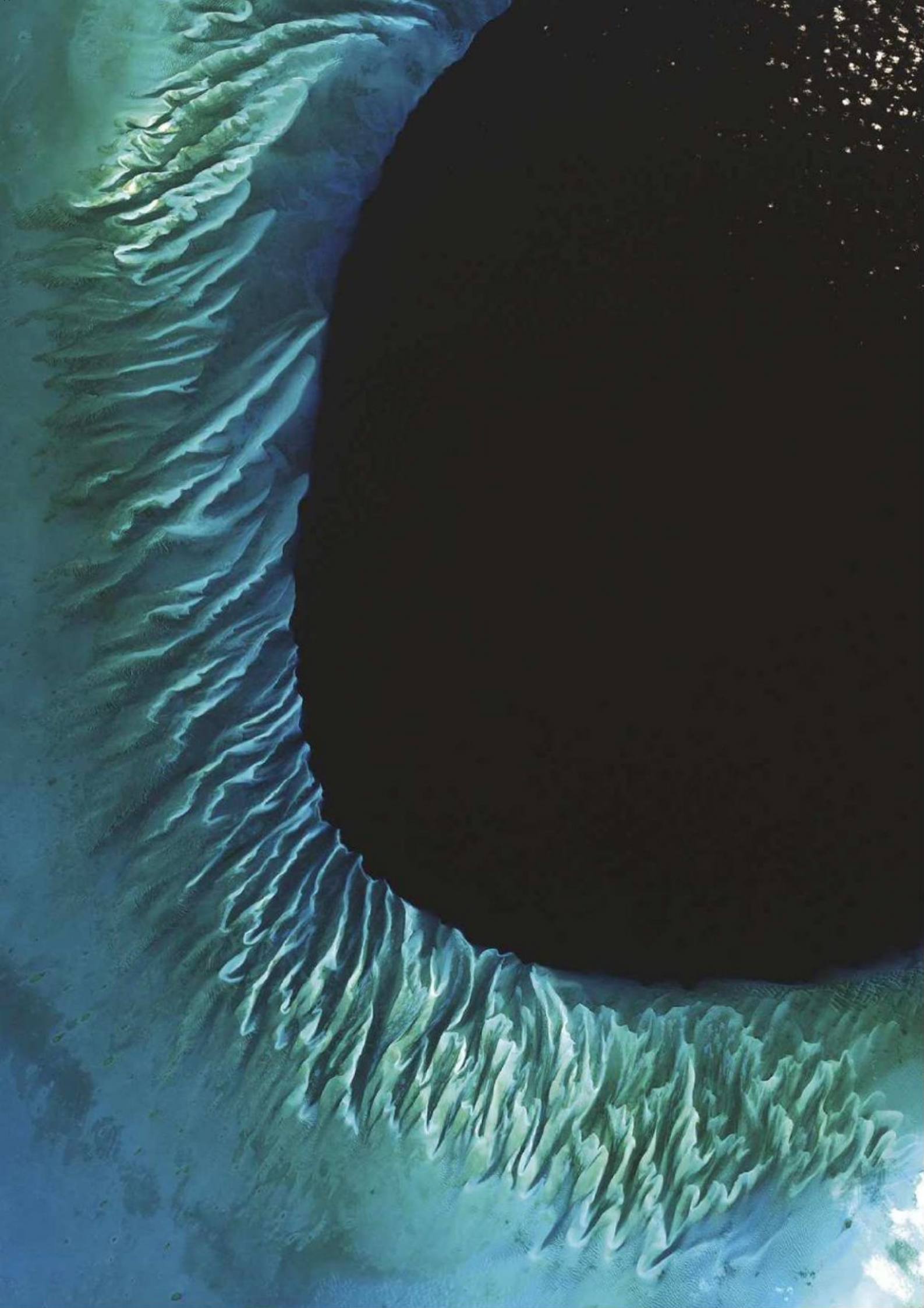
PHOTO: NASA/GSFC/JACQUES DESCLOITRES

Khor Al-Adaid

South Qatar

AMIDST TOWERING SAND dunes lies Khor Al-Adaid, known to locals as the Inland Sea. It is connected to the Persian Gulf by a deep, narrow channel. Here, the ebb and flow of the tide causes the deeper waters to swirl the Arabian sand, which forms this spectacular tree-like pattern.

PHOTO: DIGITALGLOBE



Sand and seaweed

Bahamas

◀ THE 'TONGUE OF The Ocean' is a deep oceanic trench separating the islands of Andros and New Providence in The Bahamas. The blackness of the trench highlights the depth of the water in contrast with the turquoise sand and seaweed beds surrounding it. Ocean tides and currents have sculpted the sand into these mesmerising formations.
PHOTO: NASA/SERGE ANDREFOUET

Aftermath

Sendai, Japan

▼ THE BEAUTY OF water is undeniable, but its inner beast is never far away. This image shows the devastation caused by the 9.0 magnitude earthquake on 11 March 2011, which triggered the destructive tsunami, claiming the lives of over 15,000 people.
PHOTO: DIGITALGLOBE

LANDMARKS

There are many sites that define our landscape, both natural and human-made. While they're breathtaking from the ground, viewing them from above gives a whole new perspective

Uluru

Northern Territory, Australia

RISING UP FROM the arid Australian Outback is Ayers Rock, or Uluru as it's known to the Aboriginal people. At 348m high and 3.6km long, it is claimed by many to be the largest rock in the world. At dawn and sunset, Ayers Rock appears to glow a deep red shade.

PHOTO: NASA

Giza Necropolis

Near Cairo, Egypt

▶ THREE HUGE PYRAMIDS and the Great Sphinx make up the Giza Necropolis. The Great Pyramid (top), is the oldest of the Seven Wonders of the Ancient World. It was also the world's tallest human-made structure for over 3800 years.
PHOTO: DIGITALGLOBE/GETTY

Nazca Lines

Ica region, Peru

▼ THEY WERE CREATED nearly 2000 years ago, yet the meaning behind these ancient designs remains unknown. The lines were made by removing the reddish pebbles that covered the surface to expose the pale ground below.
PHOTO: NASA/GSFC/ASTER

Taj Mahal

Agra, India

COMPLETED IN 1653, the Taj Mahal was commissioned by Emperor Shah Jahan as a mausoleum for his third wife. Legend has it that he wanted to create a mirror image of it in black marble across the river but died before it was built.

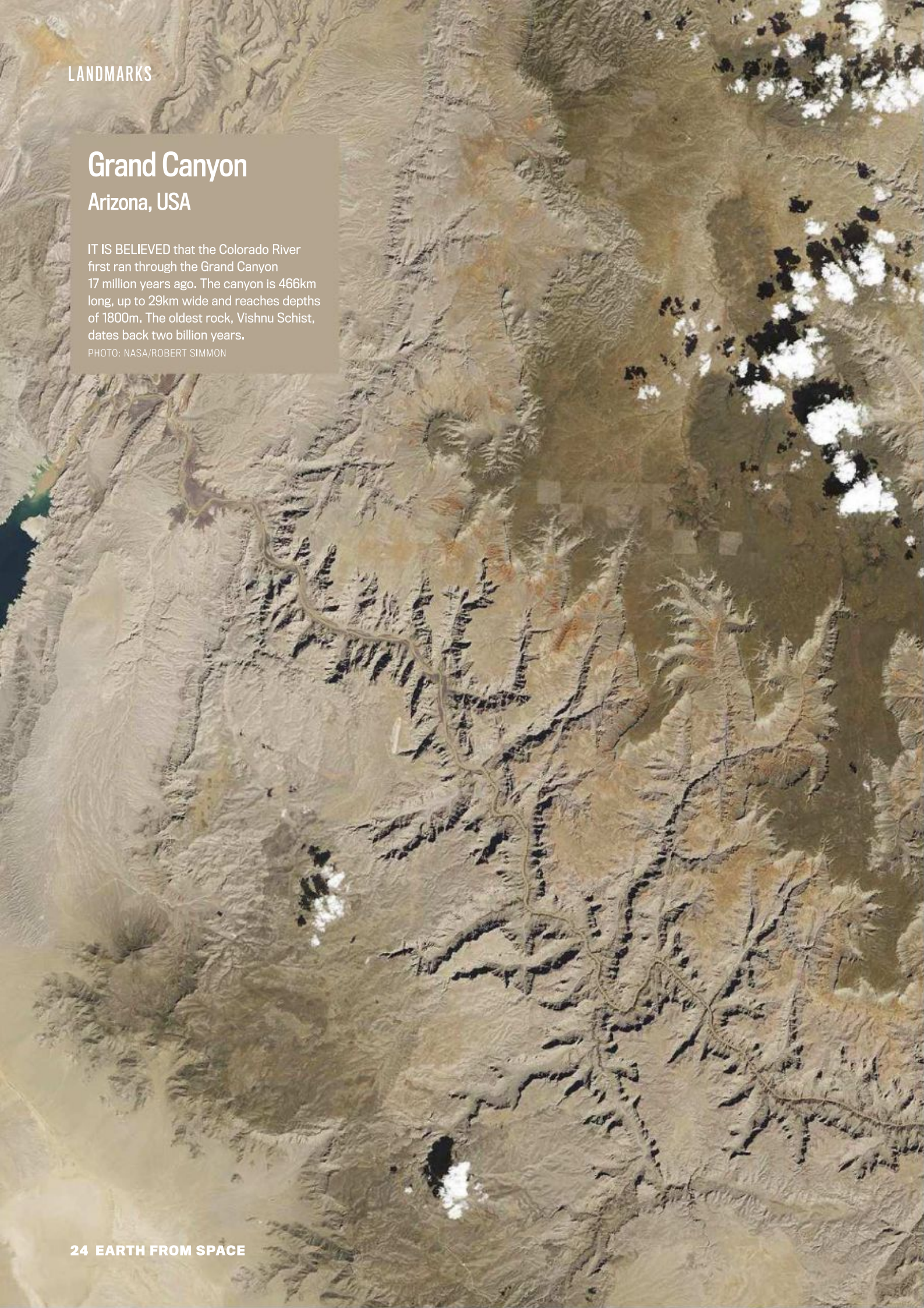
PHOTO: DIGITALGLOBE/GETTY

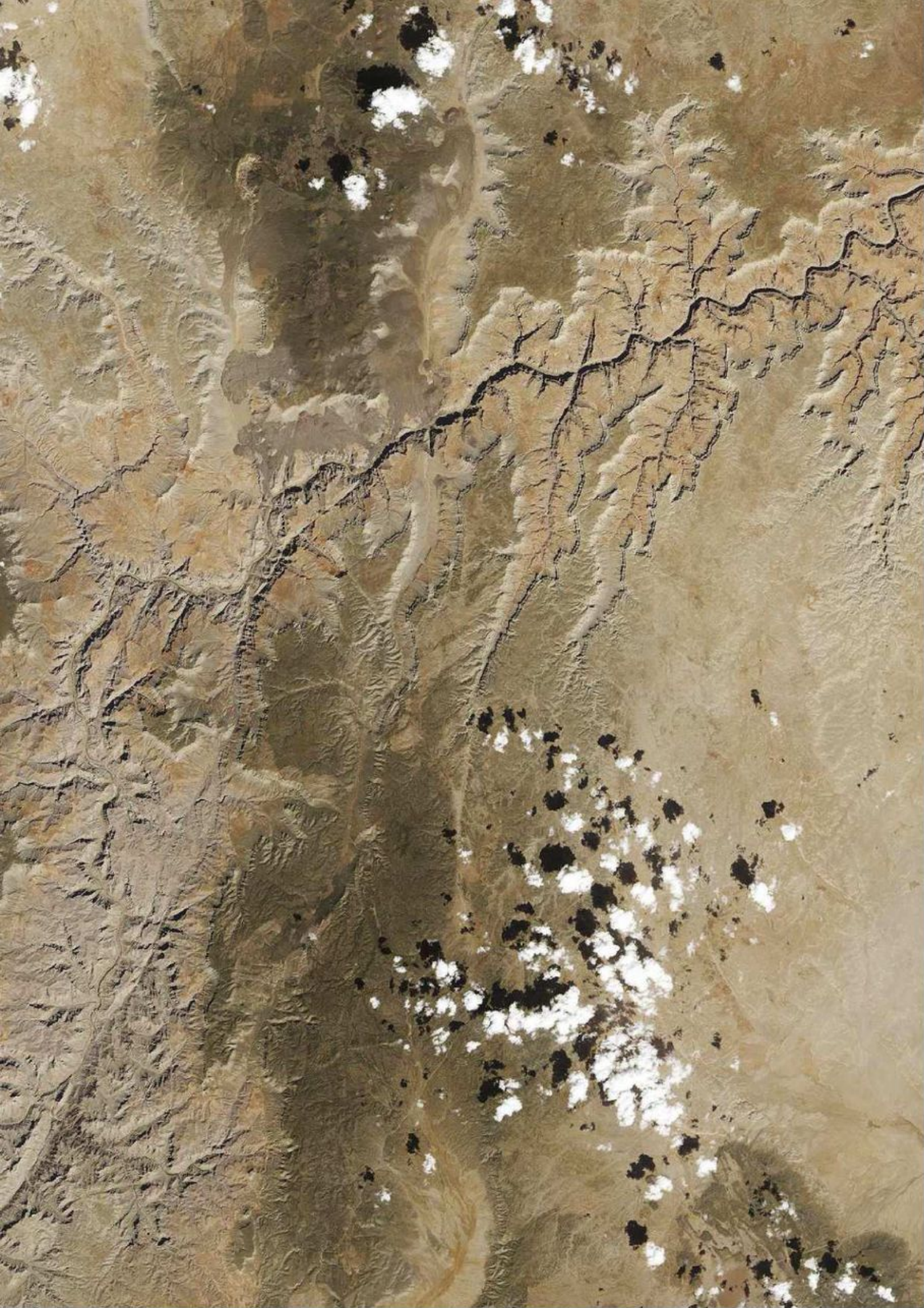
Grand Canyon

Arizona, USA

IT IS BELIEVED that the Colorado River first ran through the Grand Canyon 17 million years ago. The canyon is 466km long, up to 29km wide and reaches depths of 1800m. The oldest rock, Vishnu Schist, dates back two billion years.

PHOTO: NASA/ROBERT SIMMON





Machu Picchu

Cusco region, Peru

BUILT IN THE 15th Century at an altitude of 2430m, Machu Picchu remains one of the most famous Incan cities in the world. Yet the site was abandoned just 100 years after it was built. Known only to the locals for centuries, it was rediscovered by the American explorer Hiram Bingham in 1911.

PHOTO: SATELLITE IMAGING CORP/GEOEYE

Chichen Itza

Yucatán, Mexico

◀ EL CASTILLO, THE towering, stepped pyramid, is the most famous of the Mayan city's ruins. It has 365 steps – 91 on each side plus one on the top – one for each day of the year.
PHOTO: SATELLITE IMAGING CORP

Stonehenge

Wiltshire, UK

▼ NOBODY KNOWS HOW or why Stonehenge was built. Using radiocarbon dating, archaeologists believe it dates from between 3000–2000 BC.
PHOTO: SATELLITE IMAGING CORP

Niagara Falls

USA and Canada

WITH A VERTICAL drop of 50m, Horseshoe Falls is the biggest of the three waterfalls that make up Niagara Falls. At its peak, a combined total of 5700m^3 of water flows over the falls every second.

PHOTO: NASA

Burj Khalifa

Dubai, UAE

▶ STANDING AT 829.8m, the Burj Khalifa is the tallest building in the world. It took over five years to build and cost just under $1.5bn. It holds many world records, including the world's highest nightclub (144th floor).

PHOTO: DIGITALGLOBE/GETTY

Inauguration

Washington, DC, USA

20 January 2009

▼ ON A COLD winter's day, over one million people gather to witness the first inauguration of Barack Obama, the 44th President of the United States of America.

PHOTO: DIGITALGLOBE/GETTY

The Forbidden City

Beijing, China

FOR ALMOST 500 years, the Forbidden City was home to the Chinese Emperor. At 961m long and 753m wide, it is the world's largest palace complex. Nobody was allowed in without the Emperor's permission, hence its name.

PHOTO: DIGITALGLOBE/GETTY

THE COLD EARTH

The poles are melting faster than ever before, but now there's snow in the desert – both signs that our planet's climate is changing rapidly

Kenai Fjords
Alaska, USA

BEAR GLACIER IS the largest of over 30 glaciers in Kenai Fjords. Once, ice would have covered the entire area. Since the 1940s, the glacier has been slowly retreating, which has created Strohn Lake at its base.

PHOTO: NASA/GEOEYE

South Pole

Antarctica

Antarctica is the world's largest desert, with some areas almost never seeing precipitation. It's twice the size of Australia and 98 per cent of it is covered in ice, at an average thickness of 1.6km. The continent has 90 per cent of the world's ice, which if melted, would raise sea levels by about 60m.

PHOTO: NASA/GSFC

Beaufort Sea

Alaska, USA

▼ THE IMAGE BELOW shows ice and snow off the coast of Alaska in May 2012. The bottom image is of the same area one month later. Ice retreat is common in June. However, this summer it was particularly rapid – up to 150,000km² of ice melted each day, double the normal rate.

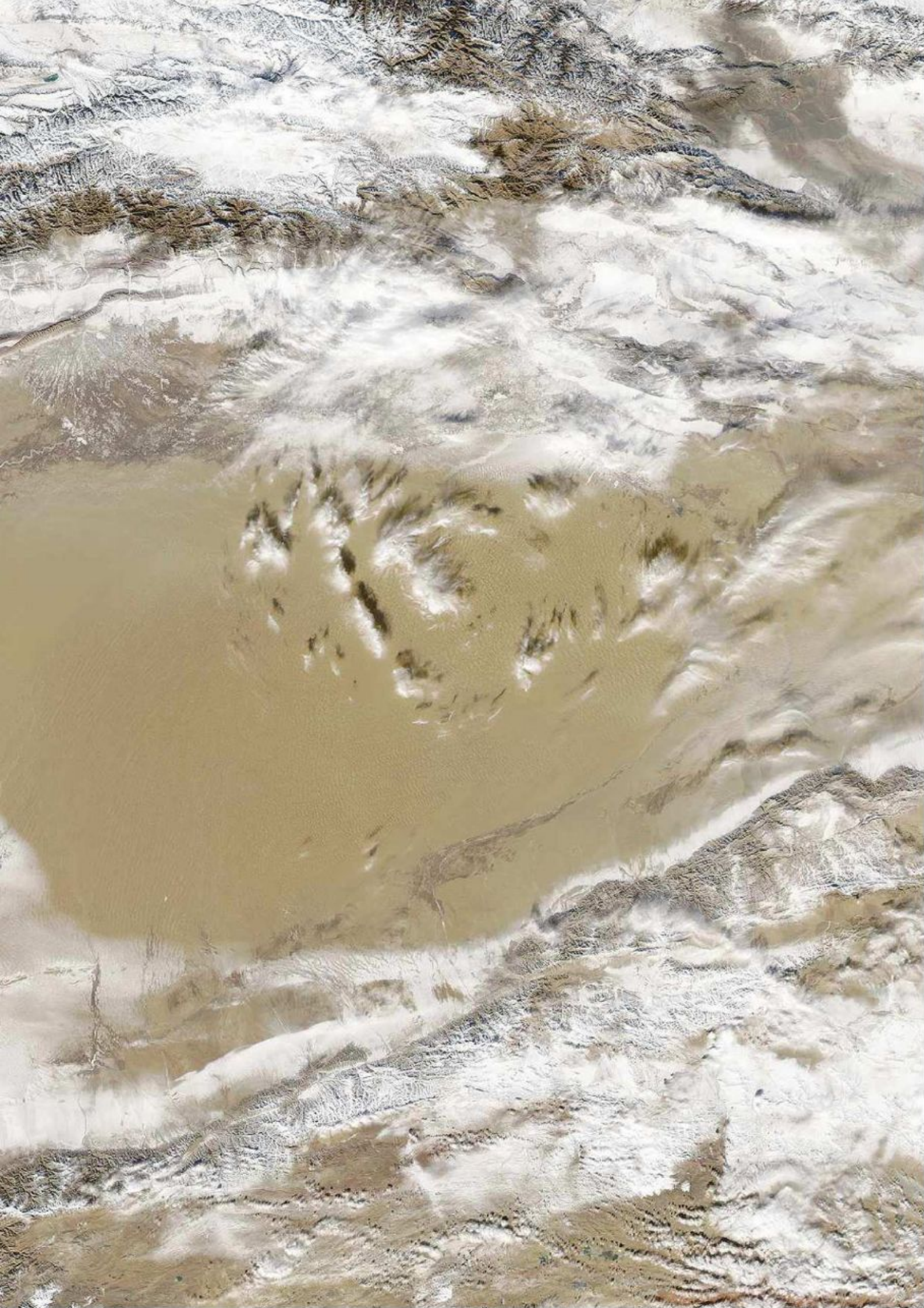
PHOTO: NASA/JESSE ALLEN (LAADS)

Taklimakan Desert

China

THE WINTER OF 2007/2008 saw snow recorded in the Taklimakan Desert for the first time. While this was record breaking, elsewhere the harsh weather damaged buildings, destroyed crops and claimed hundreds of lives.

PHOTO: NASA/JEFF SCHMALTZ



British Isles

7 January 2010

THE UK CAME to a halt when temperatures reached -18°C and snow covered the majority of the country. The cold snap started back in November, with December being the coldest for 100 years.

PHOTO: NASA/JEFF SCHMALTZ

Petermann Glacier

Greenland

◀ ON 5 AUGUST 2010, a chunk of ice larger than Washington, DC, broke off the Petermann Glacier. It produced the largest iceberg in nearly 50 years and reduced the 70km long glacier by a quarter.
PHOTO: NASA/JESSE ALLEN/ROBERT SIMMON (LAADS)

Mountains

Kyrgyzstan

▼ SNOW HIGHLIGHTS THE Tian Shan and Pamir Alay mountains that surround Lake Issyk-Kul. Mountains cover 95 per cent of this Central Asian country.
PHOTO: NASA/GSFC/JEFF SCHMALTZ

Mt. Everest
Himalayas

WITH OVER 100 mountains exceeding 7200m, the Himalayas are the world's highest mountain range. Topping them all is Mount Everest, at a staggering 8848m – the equivalent height of 1600 stacked London buses.

PHOTO: NASA

HUMAN IMPACT

The planet has been evolving and changing since before humans existed. However, there can be no doubt of the effect that people have had on Earth's surface. Civilisation, farming and mining are just a few of the activities that have left their mark

Gulf of Montijo

Panama

THE SAN PABLO river runs through Panama into the Gulf of Montijo. This image of the ecological transition zone shows the dramatic change in landscape from the protected wetlands surrounding the river to the farms and pastures further out.

PHOTO: NASA/BURGESS HOWELL

Deforestation 2000

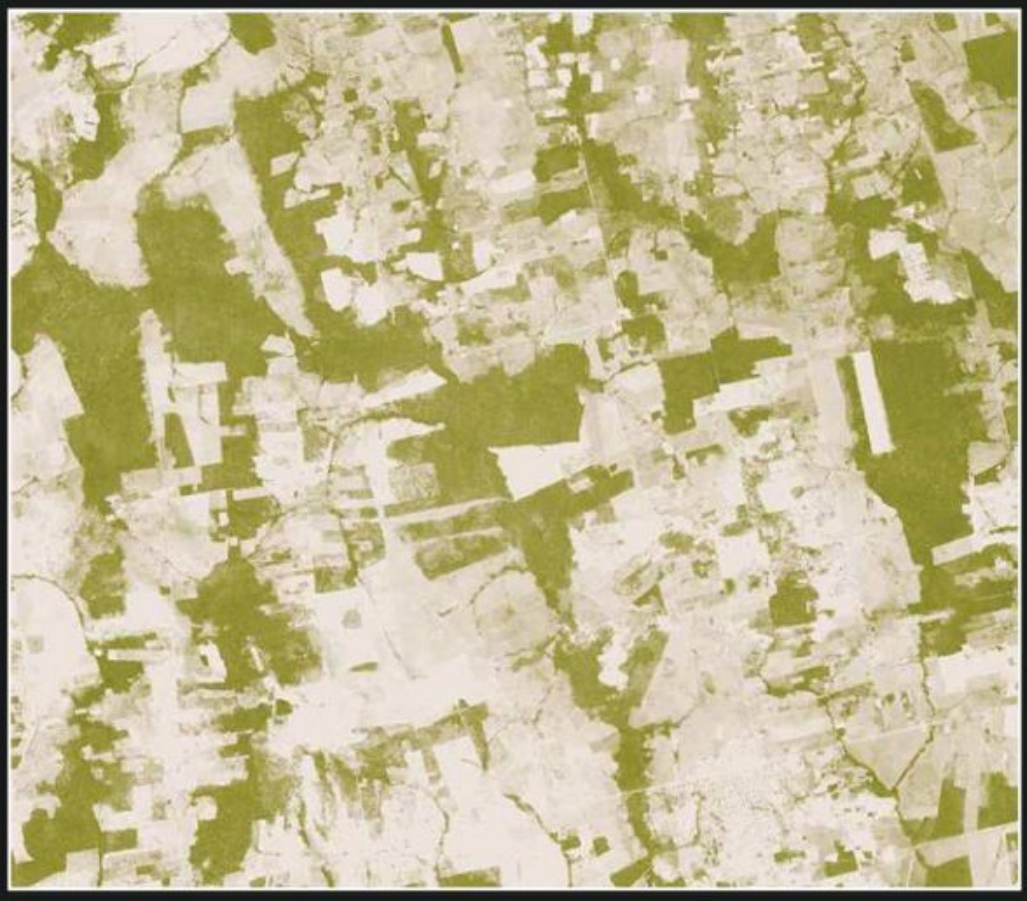
Rondônia, Brazil

► SINCE THE 1970s, the state of Rondônia has undergone rapid change. Initially, areas of the Amazon Rainforest were cleared for roads. Farmers migrated and cleared small areas for crops. Over time the farms grew and industrial scale agriculture became the main reason behind the deforestation.

PHOTO: NASA/ASTER/ROBERT SIMMON

Deforestation 2006

Rondônia, Brazil



► IN JUST SIX years, Brazil lost nearly 150,000km² of forest, an area larger than Greece. Even though the rate of deforestation has decreased, if it maintained its current level, 40 per cent of the Amazon Rainforest will have been destroyed by 2030.

PHOTO: NASA/ASTER/ROBERT SIMMON

Harvesting shrimp

Gulf of Fonseca, Honduras and Nicaragua

SHRIMP FARMING IS the third largest export from Honduras and is estimated to provide over 18,000 jobs. The green rectangles are algae-rich active shrimp ponds, whereas the grey areas show drained ponds. The farms are bordered by dark green wetlands.

PHOTO: NASA/JESSE ALLEN/ROBERT SIMMON

Alluvial fan

Southern Iran

A SEASONALLY DRY river channel carves its way through the valleys of the Zagros Mountains. Even though the surface is dry for most of the year, water still runs underground. At the bottom of the mountain, the stream loses its speed and fans out across the valley floor, where it is used to irrigate the crops.

PHOTO: NASA/ASTER/JESSE ALLEN

San Gorgonio Pass Wind Farm

California, USA

WITH 3218 TURBINES, this is one of the largest wind farms in California. The state currently produces enough energy through wind farms to power five per cent of its electricity needs. By 2020, however, California aims to have 33 per cent of its energy supplied by sustainable sources.

PHOTO: NASA/SPACE IMAGING

Gujarat Solar Park

Gujarat, India

◀ ASIA'S LARGEST SOLAR park is being constructed in western India. The park generates two-thirds of India's solar power and is estimated to save 8 million tonnes of carbon dioxide emissions per year.
PHOTO: DIGITALGLOBE

Solar power

Near Seville, Spain

▼ THE PLANTA SOLAR 20 is the world's most powerful solar power tower. It consists of 1255 mirrors that reflect the solar radiation onto a receiver. This produces steam, which is then converted into electricity.
PHOTO: NASA/GSFC/ASTER

Deepwater Horizon oil spill

Gulf of Mexico

20 April 2010

THE EXPLOSION OF the Deepwater Horizon oil rig claimed 11 lives and resulted in approximately 774.2 million litres of oil pouring into the Gulf of Mexico for 87 days. It is estimated that 6000 birds, 600 sea turtles and 100 mammals died as a result.

PHOTO: NASA/GODDARD

Sunrise Dam Gold Mine

Western Australia

► GOLD WAS DISCOVERED at Sunrise Dam in 1988 and mining began in 1995. Originally, it was an open pit mine, but in 2003 underground mining started as well. Its remote location means miners frequently have to be flown to and from the site.
PHOTO: NASA EO-1 TEAM/JESSE ALLEN

Open pit mines

Arizona, USA

▼ ARIZONA IS THE United States' largest source of copper. As the mineral deposits are found near the surface, most of the mining is open pit. The Asarco Mission mine, on the left, processes over 48,000 tonnes of ore per day.
PHOTO: NASA/EXPEDITION 22 CREW

Suez Canal

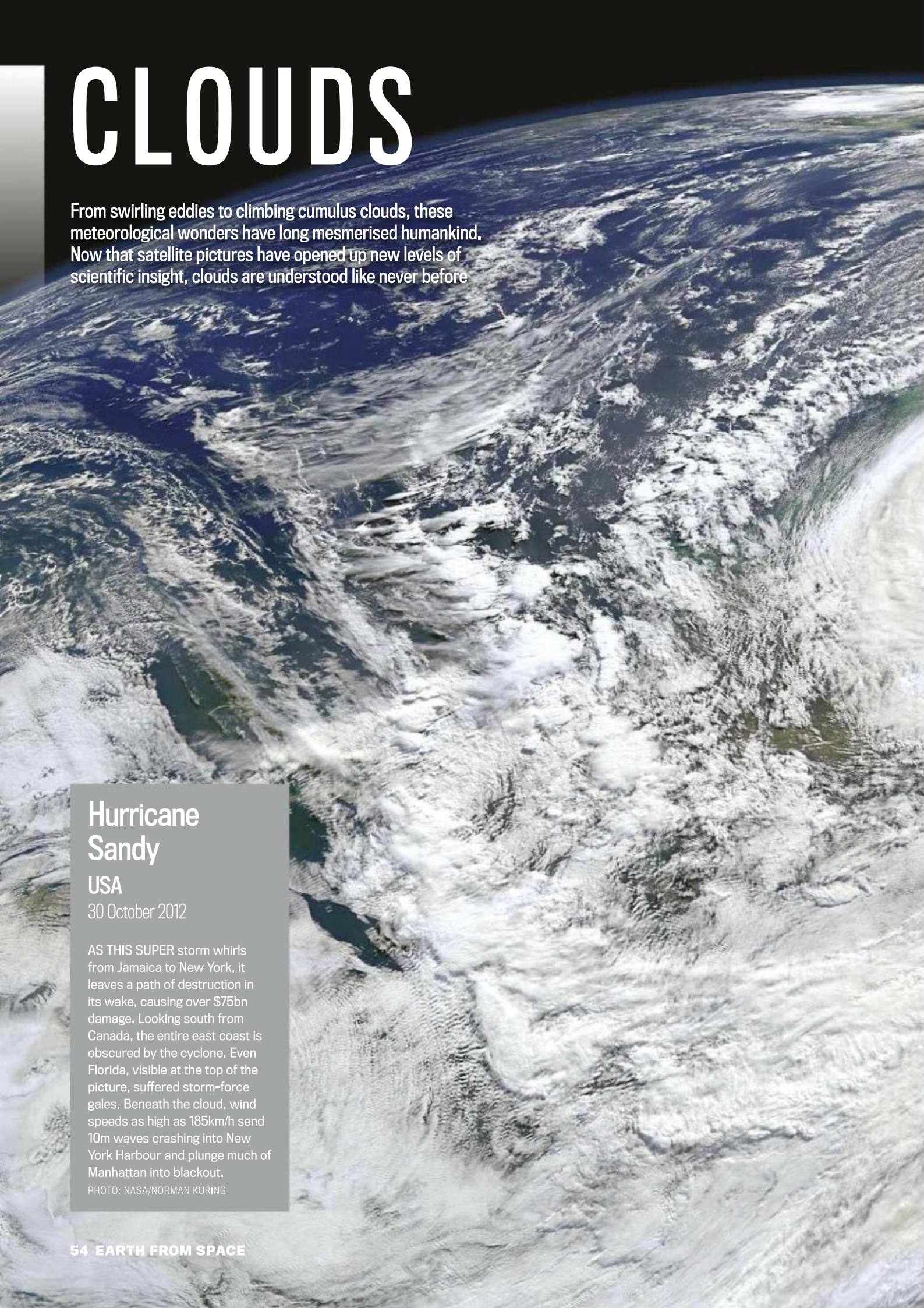
Egypt

TO THE RIGHT of the River Nile lies the Suez Canal. It was completed in 1869 to allow goods to be transported from Asia to Europe without having to sail around Africa. This shortcut to the Mediterranean saves an oil tanker en route from Saudi Arabia to the USA approximately 4385km.

PHOTO: NASA/GSFC/JPL,MISR TEAM

CLOUDS

From swirling eddies to climbing cumulus clouds, these meteorological wonders have long mesmerised humankind. Now that satellite pictures have opened up new levels of scientific insight, clouds are understood like never before



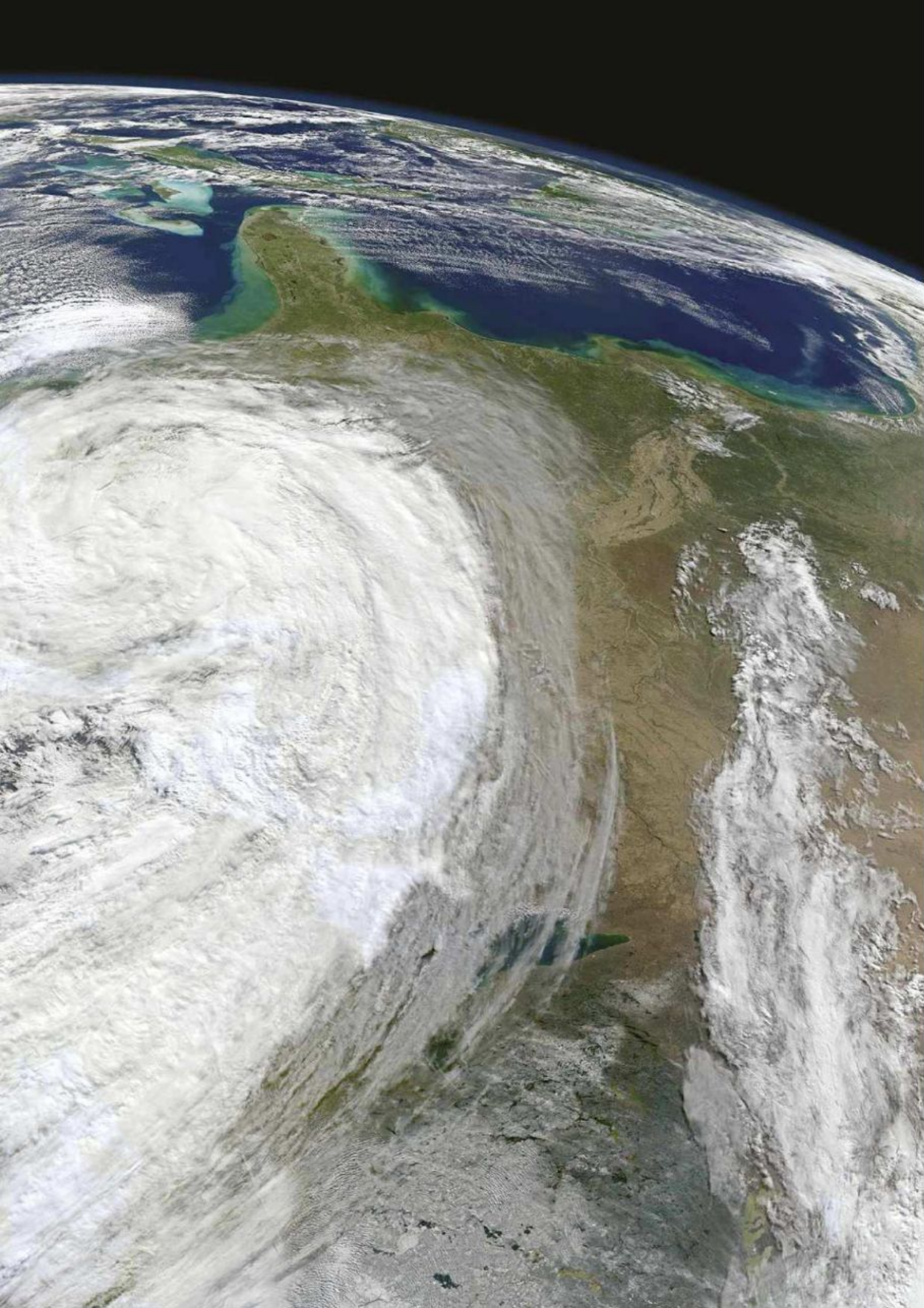
Hurricane Sandy

USA

30 October 2012

AS THIS SUPER storm whirls from Jamaica to New York, it leaves a path of destruction in its wake, causing over $75bn damage. Looking south from Canada, the entire east coast is obscured by the cyclone. Even Florida, visible at the top of the picture, suffered storm-force gales. Beneath the cloud, wind speeds as high as 185km/h send 10m waves crashing into New York Harbour and plunge much of Manhattan into blackout.

PHOTO: NASA/NORMAN KURING



Stratocumulus clouds

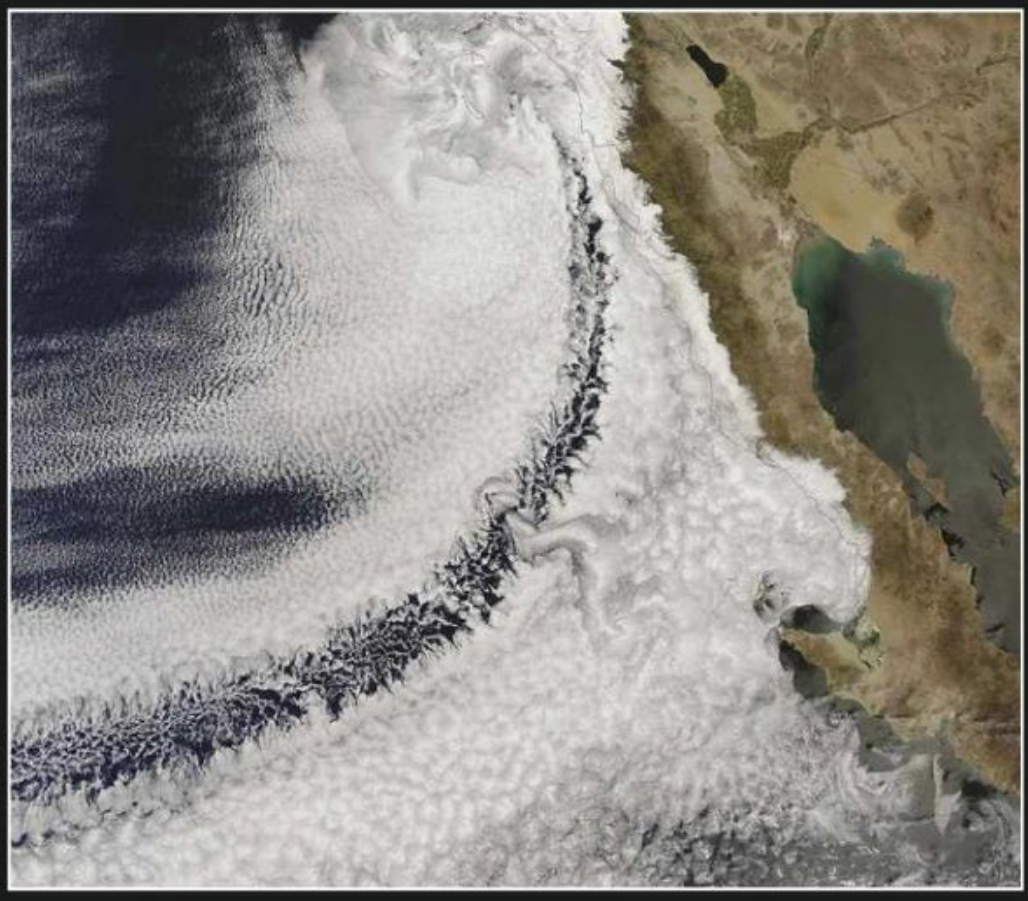
Pacific Ocean

▶ THE SKY OVER the Pacific – the planet's largest ocean – plays host to many spectacular cloud displays. In the centre of this massive stratocumulus sheet lie two different phenomena. Von Karman vortices – spiralling eddies that form in a line – dance about just south of Guadalupe Island. In addition, two feint rainbow-like lines called 'glories' stretch across the cloud.

PHOTO: NASA/JEFF SCHMALTZ

Ahead of the curve

Pacific Ocean



▶ AGAIN, ABOVE THE Pacific, a sheet of stratocumulus cloud hugs the Baja California Peninsula shoreline. But here, an arc over 1000km long slices through its centre. This curve emerged as the cloud bank parted over San Clemente Island, which lies beneath the thicker area of cloud in the top of the photo.

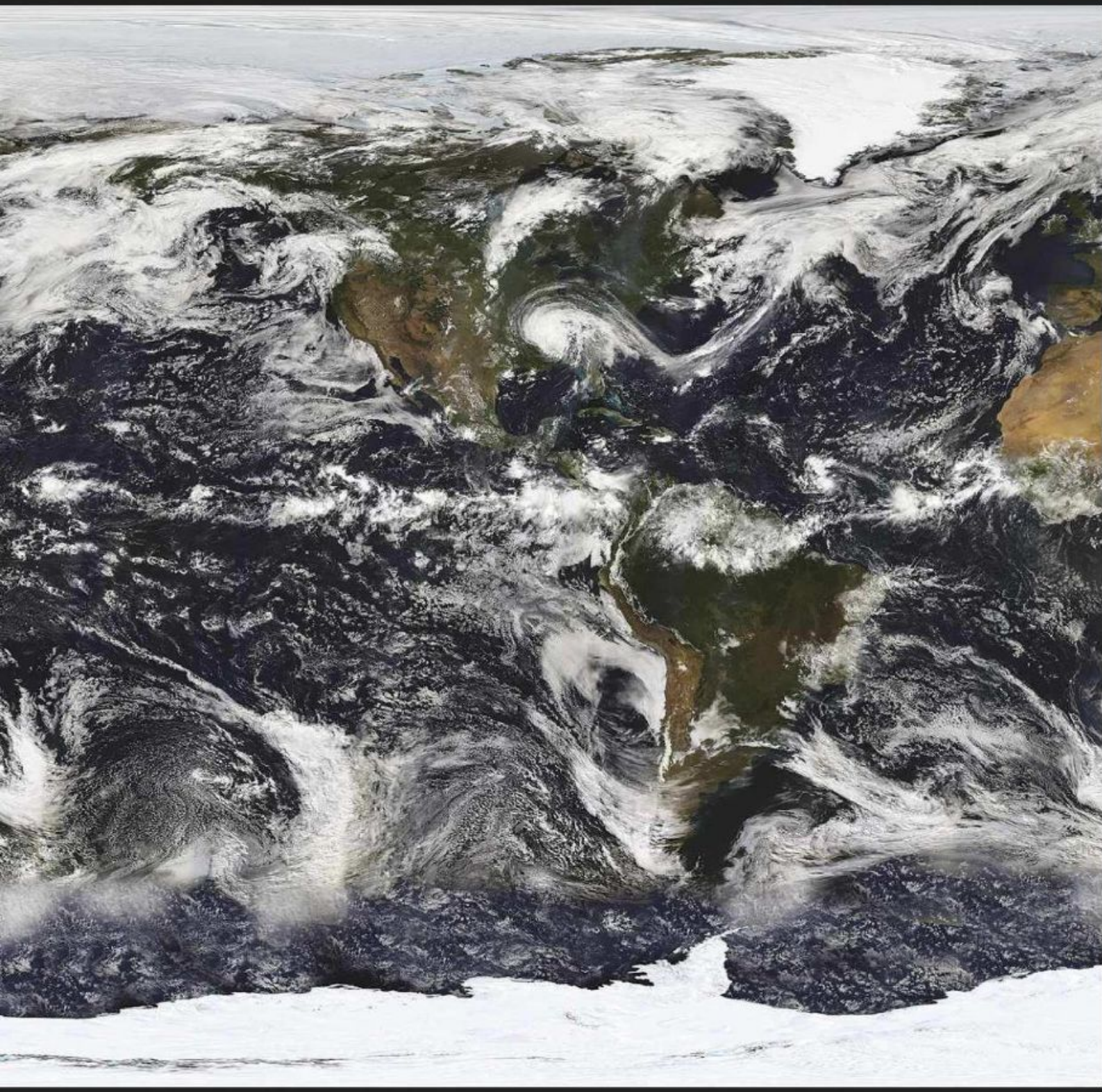
PHOTO: NASA/JEFF SCHMALTZ

Cloud streets

St Matthew Island, Bering Sea

THIS LONELY ISLAND, situated between Alaska and Russia, bears witness to a beautiful meteorological event – 'cloud streets'. As cold air from the icy land sweeps over the ocean, it chills the moist sea air and freezes it into neat, narrow, parallel plumes.

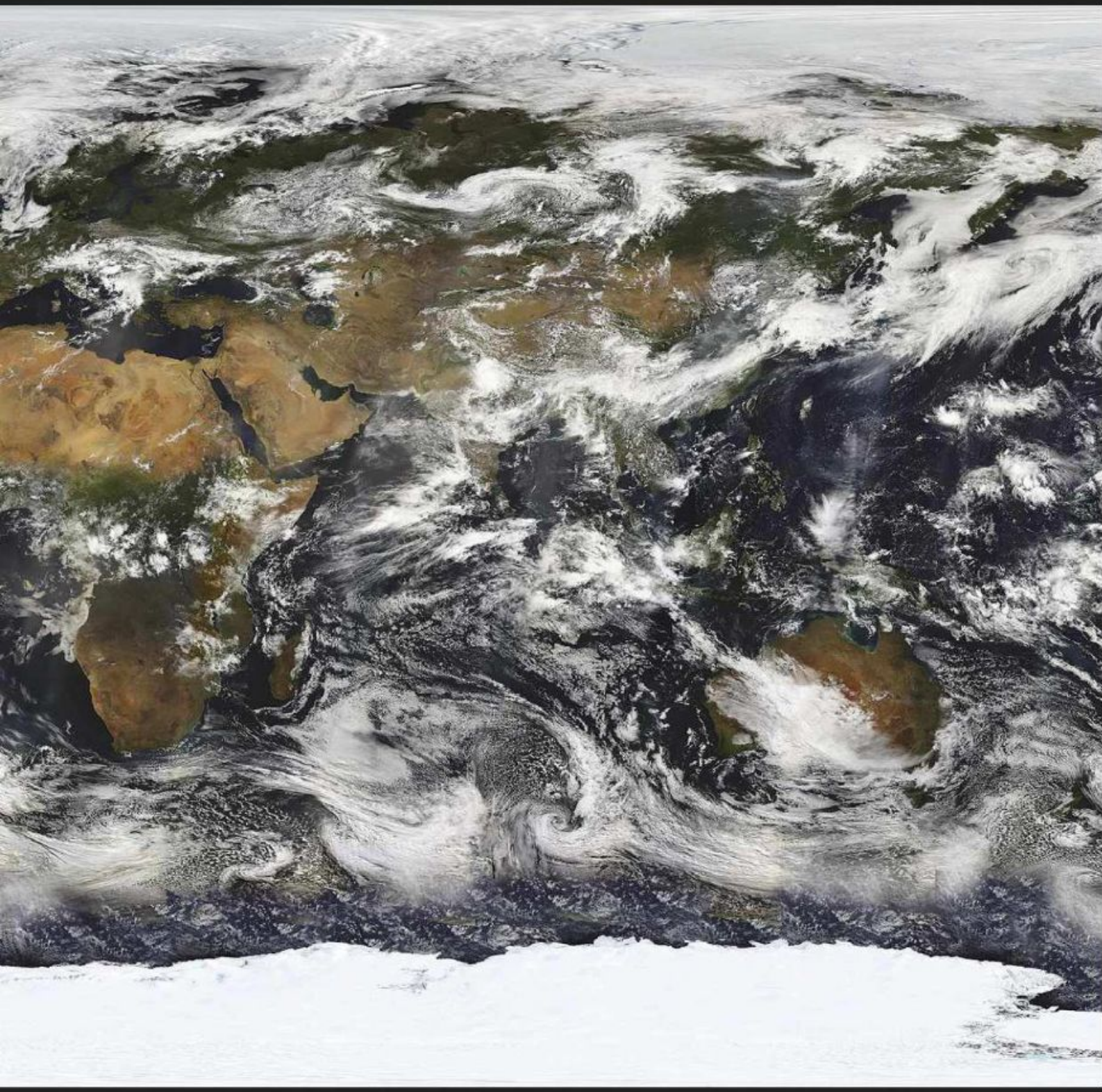
PHOTO: NASA/GSFC/LANCE



State of flux

COMPOSED FROM SEVERAL different satellites' observations, this image shows that Earth's atmosphere is in constant circulation. Air rises at hot points around the equator and sinks where it cools. As land masses interrupt its flow and different weather fronts collide, clouds alter and intertwine in complex, ever-changing movement.

PHOTO: NASA/MARIT JENTOFT-NILSEN/ROBERT SIMMON



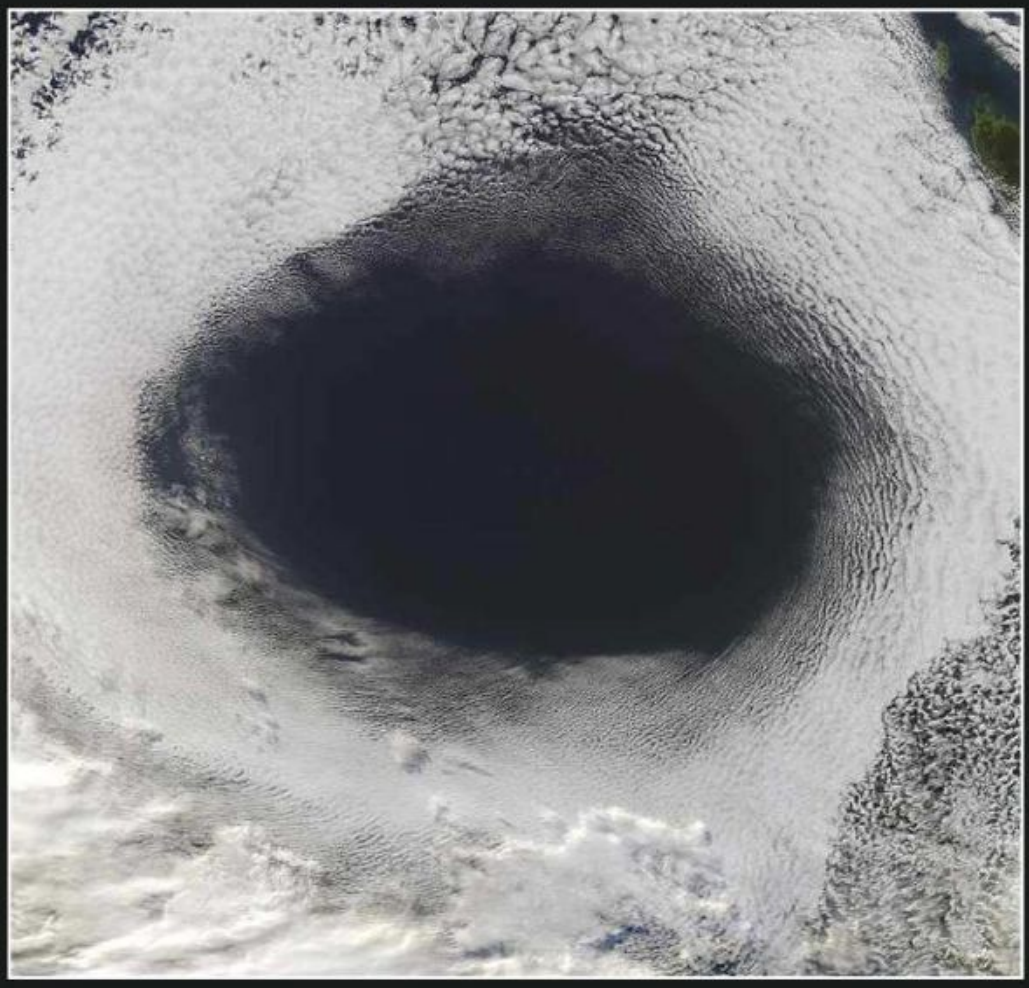
Hurricane Katrina

Gulf of Mexico

28 August 2005

AS THIS CYCLONE whips up waters over the Gulf of Mexico, a deceptively pure white spiral of cloud forms above. Making its move toward New Orleans, gusts of 280km/h circumnavigate Katrina's clearly defined eye, with storm-force winds stretching out to 370km away. When Katrina reaches Louisiana, it will claim over 1500 lives.

PHOTO: NASA/GSFC/JEFF SCHMALTZ



Pressure point

Tasmania, Australia

◀ OFF THE WEST coast of Tasmania, a high-pressure system creates this spectacular chasm in the clouds. Over 1000km wide, this oval-shaped hole has been carved out as high pressure forces a pocket of air to sink down through the stratocumulus cloud blanket.

PHOTO: NASA/JEFF SCHMALTZ

High and dry

Senegal and Mali

▼ A CUMULONIMBUS CLOUD towers over the African sky in this image taken from the International Space Station. As the massive cloud expands vertically, it meets a dry layer of the atmosphere that obstructs its rise. The still-growing cloud is forced to spread out, developing a distinct anvil shape.

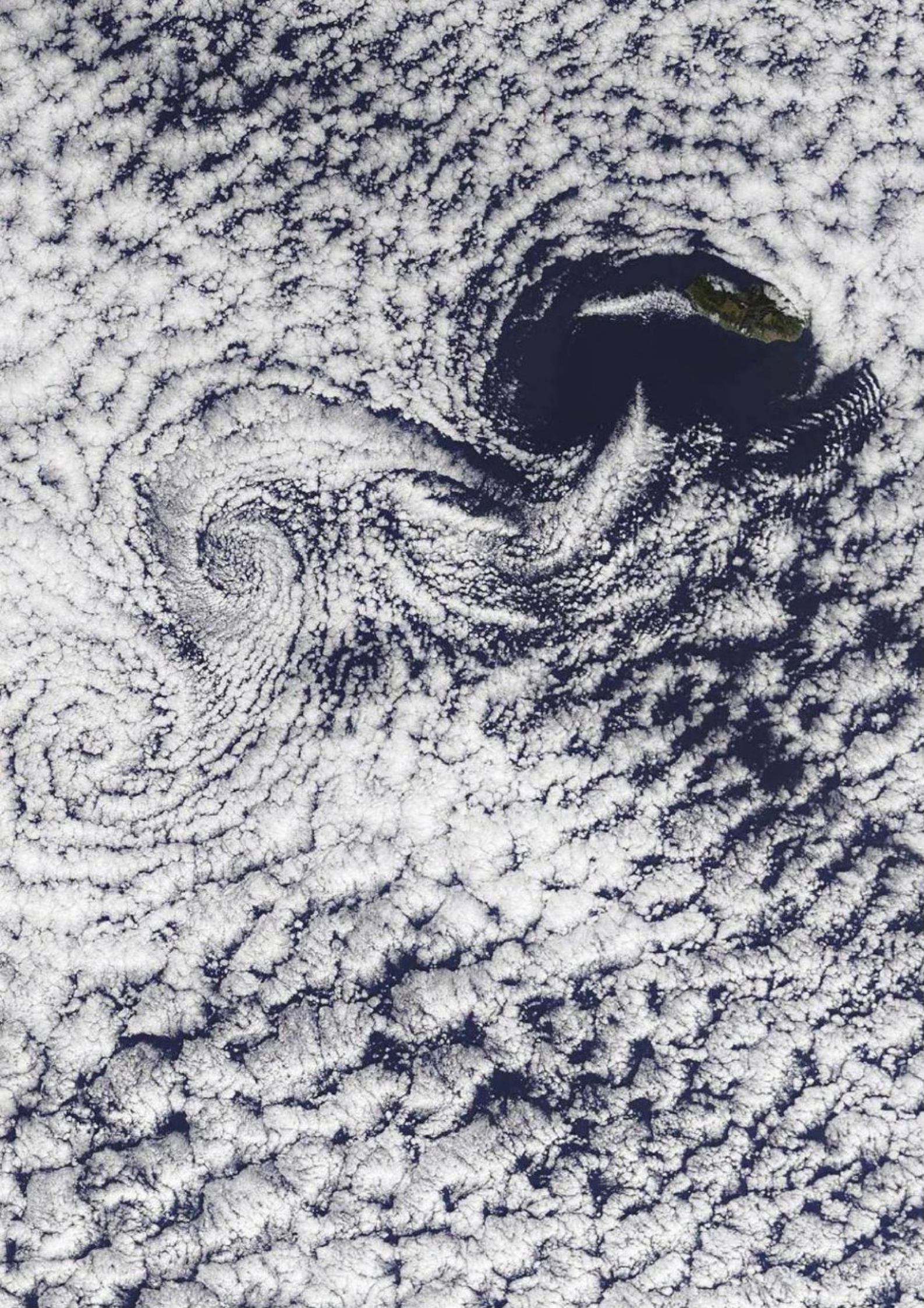
PHOTO: NASA/EXPEDITION 16 CREW

Vortex street

Madeira

THE WINDS OF the North Atlantic Ocean part over Madeira, and a rippling effect occurs in the clouds above. Swirling vortices emerge in an almost honeycomb formation knows as a 'vortex street'. Each individual spiral is bigger than the island that caused the disruption.

PHOTO: NASA/GSFC/JEFF SCHMALTZ



On the horizon

Pacific Ocean

▶ EVER WONDERED WHAT a sunset looks like from the International Space Station? As the Sun sinks, huge anvil-topped thunderclouds cast long shadows over the Pacific and a golden pool of reflected sunlight appears in the sea.

PHOTO: NASA/EXPEDITION 7 CREW

Thunderstorms

Brazil

▼ A PICTURESQUE ROW of storm clouds rain down over the Amazon, forming circular patterns. The cumulonimbus clouds' arc-like structures reveal that they're near the end of their cycles – soon their centres will collapse entirely.

PHOTO: NASA/GOES PROJECT

Wave clouds

Amsterdam Island

THIS TINY VOLCANIC island in the Indian Ocean has the power to make waves in the clouds. As moist and dry layers of air move in turn over the remote volcano's summit, they react differently – the moist air forms lenticular clouds, while the dry air does not – creating a wave-like pattern in the skies above.

PHOTO: NASA/GSFC/JEFF SCHMALTZ

CITIES

In 1800, only three per cent of the world's inhabitants lived in a city. Today, there are more than 400 cities with a population over one million and half the global population is city-based

San Francisco
USA

FOG IS A common sight for all San Franciscans, especially in summer. Cold air blows in from the Pacific Ocean, colliding with the warm Californian air and forming fog. San Francisco is the second most densely populated city in the USA, with 6632 people per km².

PHOTO: NASA EO-1 TEAM

Venice

Italy

▼ FAMED FOR ITS gondolas, the Grand Canal is the main thoroughfare in Venice, snaking through the centre of the city. The white dashes on this image are boats transporting people around. Founded in the fifth century, Venice is spread over 118 islands, linked by canals and more than 400 bridges.

PHOTO: NASA/ROBERT SIMMON

Tokyo

Japan

▶ ORIGINALLY A SMALL fishing village, Tokyo has grown into a metropolis with a population of 13.2 million. It increases by 2.5 million during the day as workers and students commute into the city. However, the population is expected to halve by 2100 as over 46 per cent of Tokyo's residents are past retirement age.

PHOTO: NASA/GSFC/ASTER

Athens

Greece

INHABITED FOR NEARLY 7000 years, Athens is one of the oldest cities in the world. Ancient Athens was founded in 508 BC and is best-known for the Acropolis. The name means 'edge city' as it was built on a rocky outcrop above the main city.

PHOTO: NASA EO-1 TEAM

Dubai

UAE

THE LARGEST OF the seven emirates that make up the country, Dubai has become known for its skyscrapers, malls and human-made islands, including Palm Jumeirah and The World.

PHOTO: NASA/GSFC/ASTER

Brasilia

Brazil

◀ BUILT IN 1956 and designed to look like an airplane, Brasilia is the largest city founded in the 20th Century. However, even though it's the capital, Brasilia is only the fourth largest city in Brazil.

PHOTO: NASA EO-1 TEAM

Versailles

France

▼ WITH OVER 2000 rooms, the Palace of Versailles dominates the surrounding Parisian suburb. The gardens were designed in the 18th Century and completed before the French Revolution.

PHOTO: DIGITALGLOBE/GETTY

El Paso and Juárez

USA and Mexico

▼ FROM ABOVE, EL Paso and Juárez seem to be one city. Rio Grande, running diagonally across the image, is the border separating the USA and Mexico. In this false-colour image, vegetation is shown in red. The brightest shades are in El Paso, showing parks and gardens sustained by residents, in contrast with the barren land surrounding the cities.

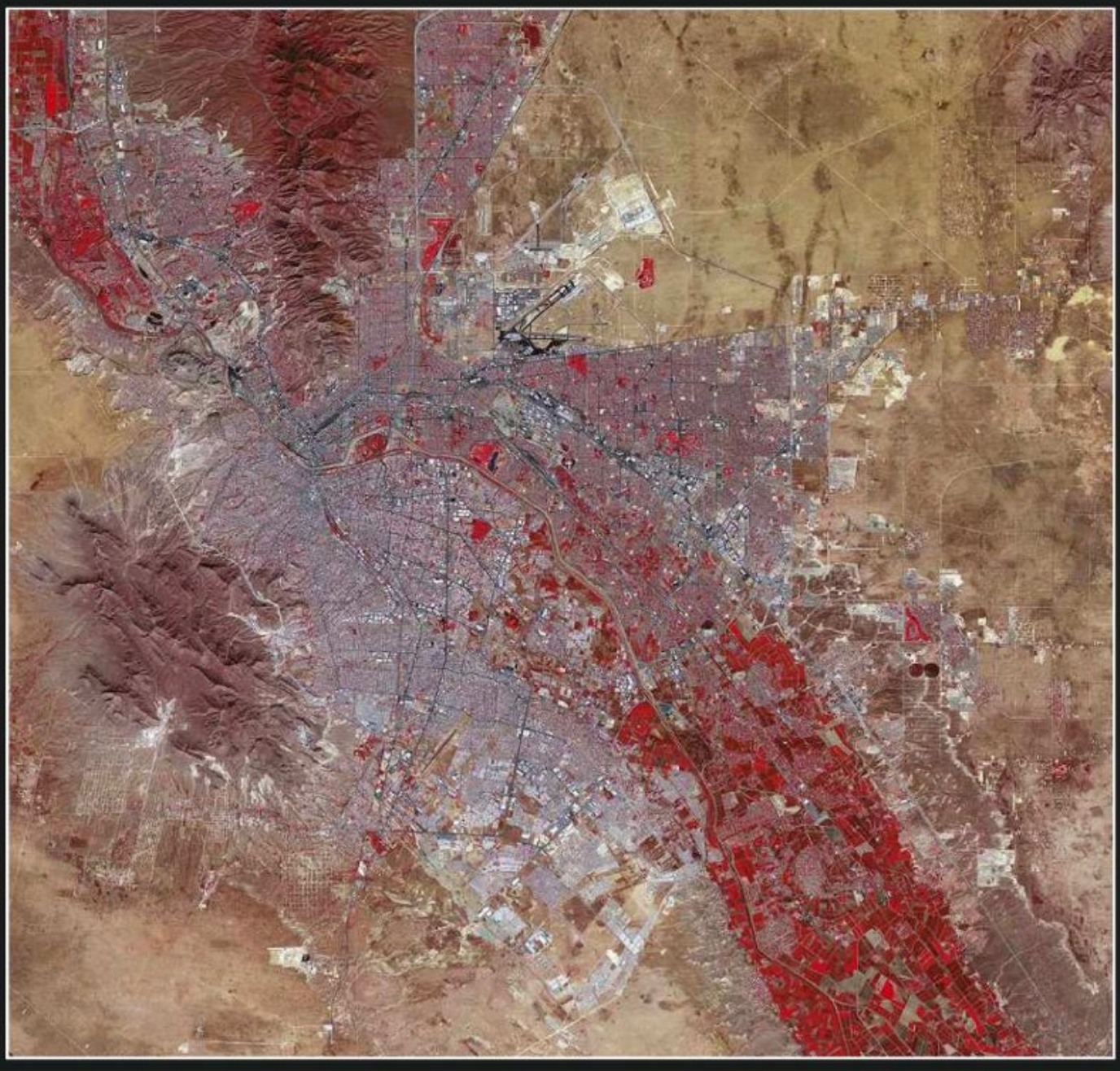
PHOTO: NASA/GSFC/ASTER

Karachi

Pakistan

▶ 'CITY OF LIGHTS', as it's also known, is the largest city in Pakistan. The oldest buildings are in the centre and a street grid system covers the rest of the city. Mangrove forests in the Arabian Sea bring some greenery to the otherwise heavily built up city.

PHOTO: NASA EO-1 TEAM



THE HOT EARTH

Our planet runs on incredible amounts of heat – enough to constantly reshape its surface. From volcanoes powered by the Earth's molten-hot core, to the vast deserts dried out by the Sun, heat is as destructive as it is creative

Sarychev Peak volcano

Kuril Islands, Russia

12 June 2009

SARYCHEV PEAK ERUPTS, spewing massive plumes of ash into the sky. The smooth white ball is steam, created as water vapour in the air rapidly condenses above the rising hot ash. This phenomenon will last only a few moments, before the explosion engulfs the little round cloud.

PHOTO: NASA

Grand Prismatic Spring

Yellowstone Park, USA

▶ THE THIRD LARGEST hot spring in the world, this geothermal pool can reach up to 87°C. Its vivid colours come from bacteria and algae that thrive in the warm, mineral-rich water.

PHOTO: DIGITALGLOBE/GETTY

Valley of Geysers

Kamchatka, Russia

▼ DISCOVERED IN 1941, this remote basin contains around 90 geysers, as well as hot springs. Several years ago, a massive landslide inundated the valley, covering half of the geysers and causing a natural lake to form.

PHOTO: DIGITALGLOBE

Tassili n'Ajjer

Algeria

THIS OTHER-WORDLY landscape is in fact a vast section of the Sahara Desert. The rocky platforms were carved by water around 12,000 years ago – when the area was filled with lakes – and have since been softened by the scorching heat and harsh desert winds.

PHOTO: DIGITALGLOBE

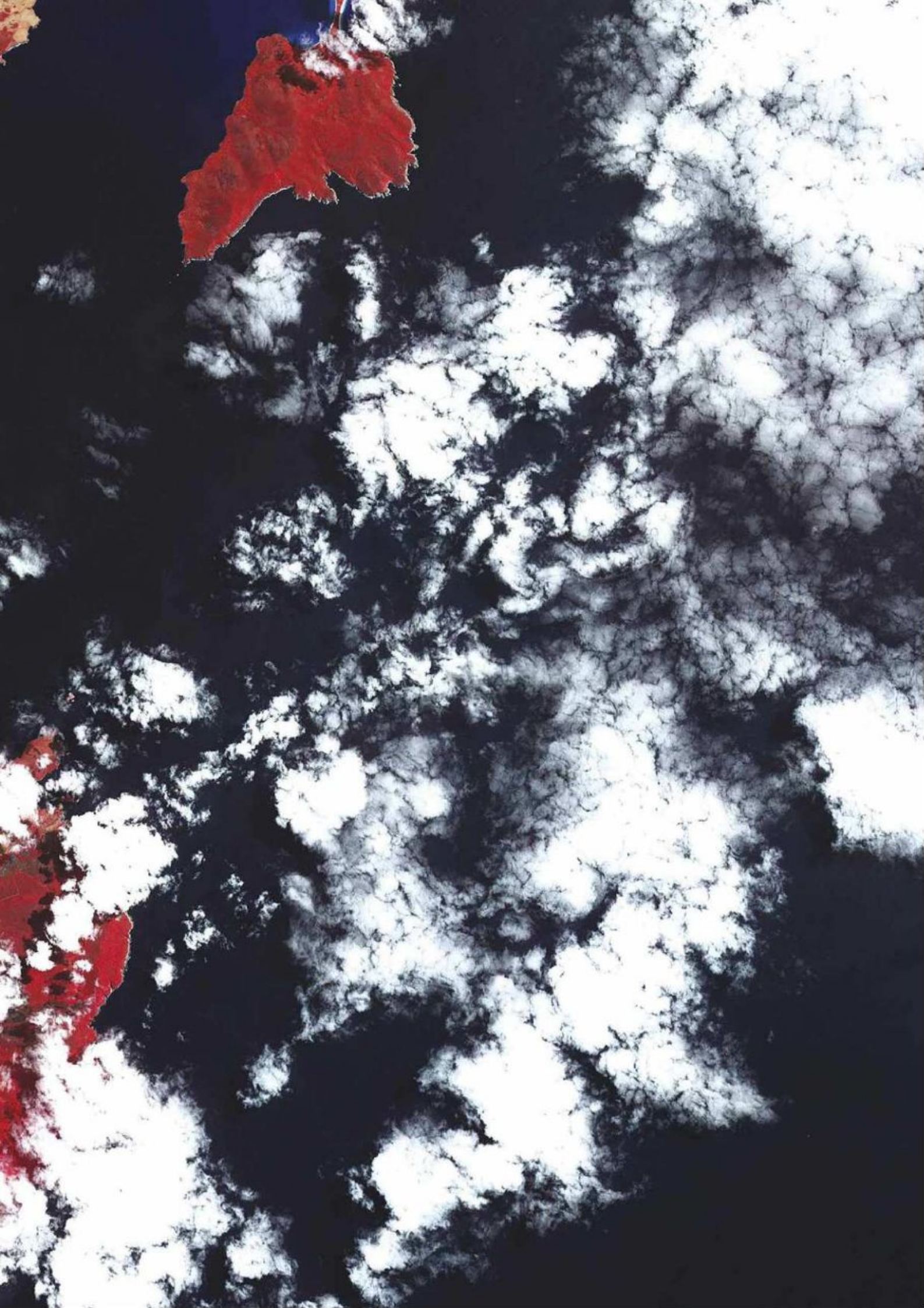
Forest fires

Tasmania, Australia

January 2013

TASMANIA'S LANDSCAPE BURNED during its so-called 'angry summer'. This false-colour image highlights the damage – red areas represent untouched forest, while brown shows severely burnt land. In total, an area of bushland larger than the ciy of Amsterdam was charred and over 100 homes were razed to the ground.

PHOTO: NASA/GSFC/ASTER



Dust storms

Mexico

THE ATMOSPHERE IS constantly reshaping our environment. Here, strong winds have stirred up massive dust storms, carrying tonnes of fine sand across the mainland and the Baja California peninsula into the Pacific.

PHOTO: NASA/OCEANCOLORTEAM

Desert treasure

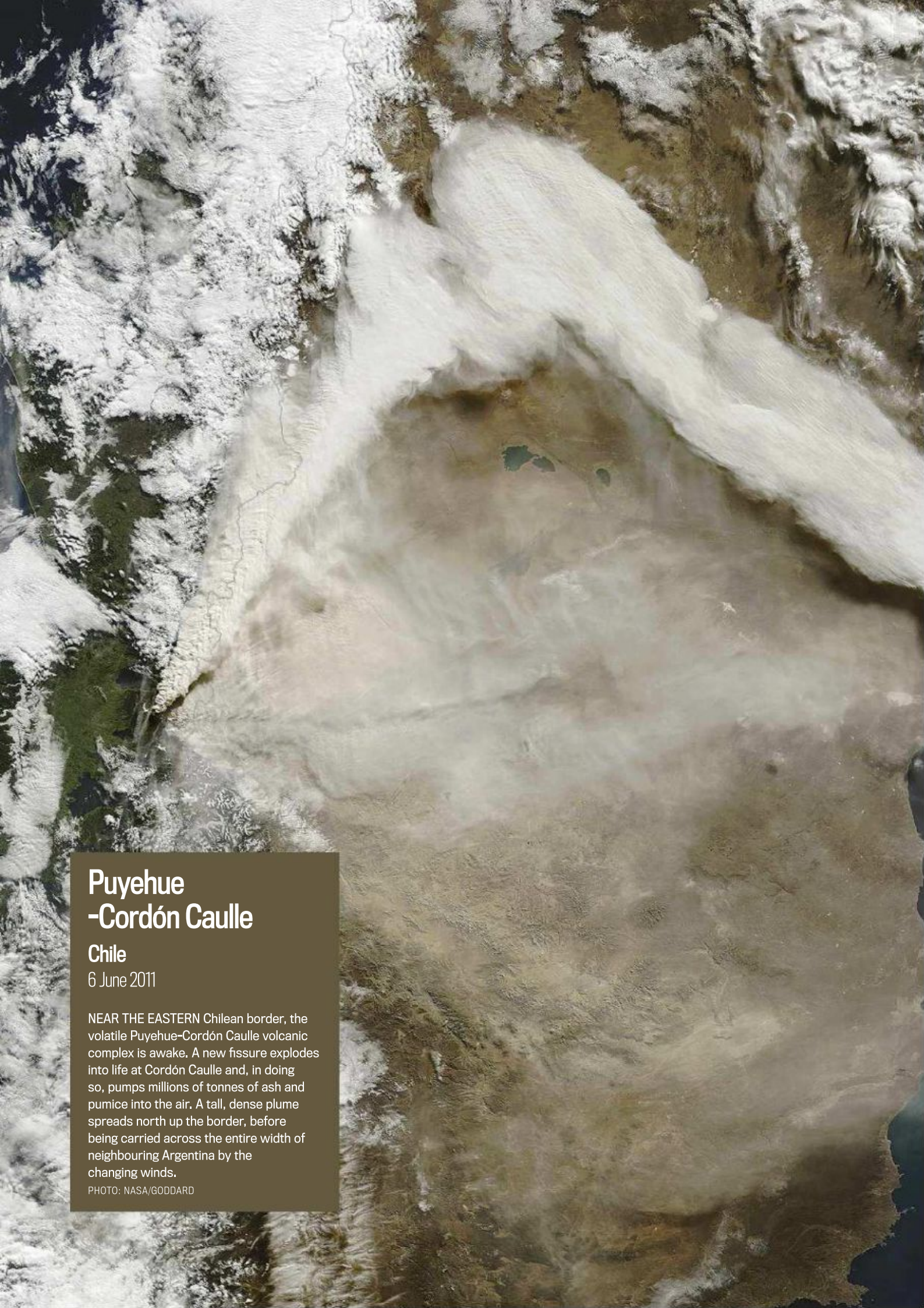
Libya

◄ RICH WITH MINERALS, these Saharan dust plumes will land in the Mediterranean – feeding phytoplankton at the start of the food chain – and across Europe.
PHOTO: NASA/JEFF SCHMALTZ

Catch the drift

Iran and UAE

▼ TRAPPED IN THE Persian Gulf by a southwesterly wind, a thin veil of dust lingers over the Iranian shore, while a larger cloud escapes in the east.
PHOTO: NASA/GSFC/JEFF SCHMALTZ



Puyehue -Cordón Caulle

Chile

6 June 2011

NEAR THE EASTERN Chilean border, the volatile Puyehue-Cordón Caulle volcanic complex is awake. A new fissure explodes into life at Cordón Caulle and, in doing so, pumps millions of tonnes of ash and pumice into the air. A tall, dense plume spreads north up the border, before being carried across the entire width of neighbouring Argentina by the changing winds.

PHOTO: NASA/GODDARD

Mount Etna

Sicily, Italy

27 October 2002

▶ AFTER A SERIES of small earthquakes, Europe's most active volcano – located in the northeast corner of Sicily – erupts. Streams of lava flow down the summit's slopes, forest fires ignite and an ash cloud pours into the atmosphere, with volcanic matter falling as far away as Libya.

PHOTO: NASA/GSFC/JEFF SCHMALTZ

Nabro Volcano

Eritrea

30 June 2011

▼ SEVENTEEN DAYS INTO its eruption, Nabro's ash cloud clears to reveal hot lava running down the volcano's side. The molten rock oozes along the Ethiopian border, until it finally slows and cools when it hits level ground – over 7km west of the summit.

PHOTO: NASA/ROBERT SIMMON

Tata Sabaya

Bolivia

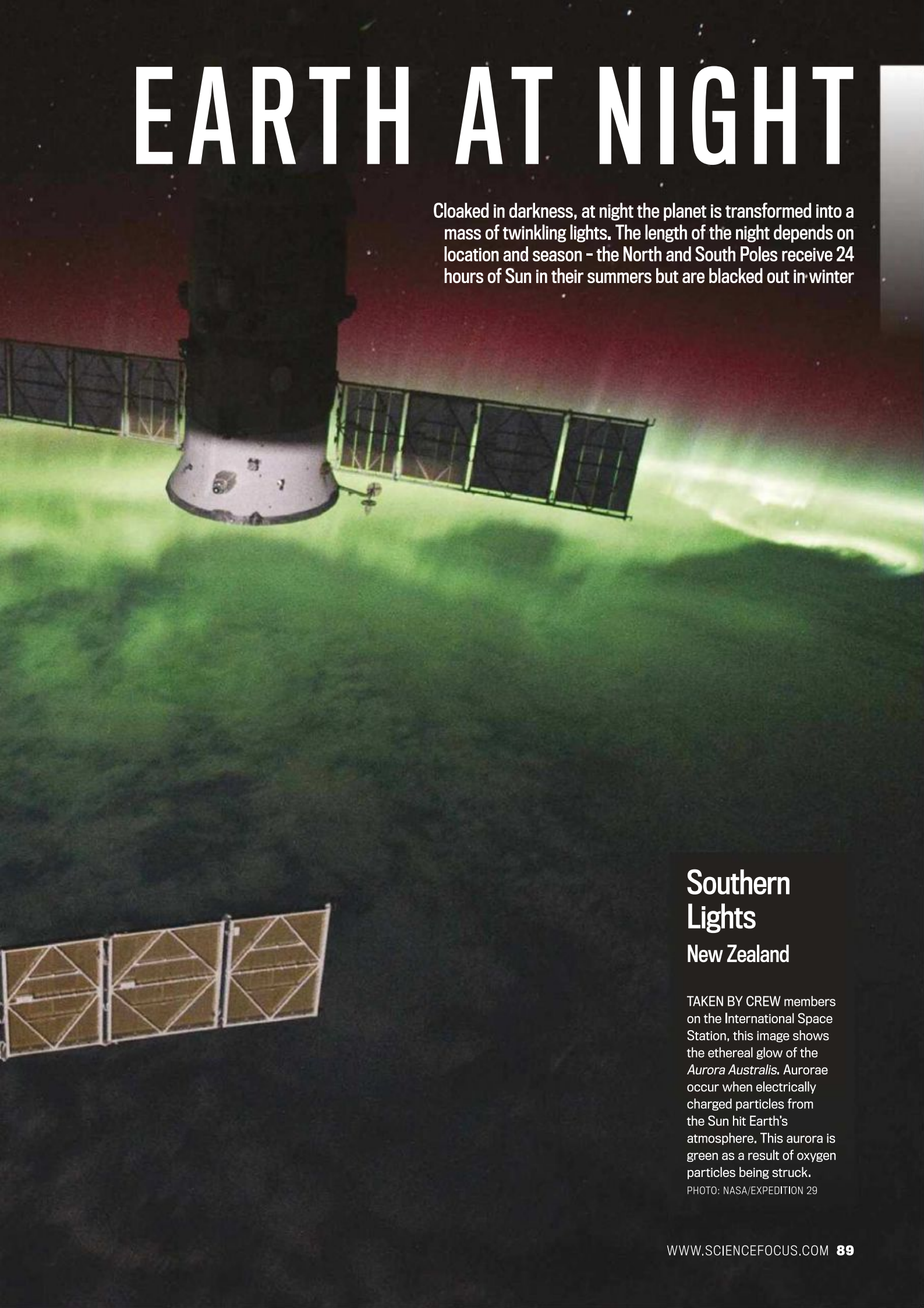
MANY PLACES ON Earth hide catastrophic pasts. Tata Sabaya, seen in the centre, is now a slumbering, inactive volcano. But sometime over 12,000 years ago, its predecessor collapsed, creating an avalanche of debris that covered 300km^2 – that's almost twice the size of Washington, DC. This event left its mark, scarring the ground south of the peak and scattering it with rocks and boulders.

PHOTO: NASA/EXPEDITION 35 CREW

ЮЗ

EARTH AT NIGHT

Cloaked in darkness, at night the planet is transformed into a mass of twinkling lights. The length of the night depends on location and season – the North and South Poles receive 24 hours of Sun in their summers but are blacked out in winter



Southern Lights

New Zealand

TAKEN BY CREW members on the International Space Station, this image shows the ethereal glow of the *Aurora Australis*. Aurorae occur when electrically charged particles from the Sun hit Earth's atmosphere. This aurora is green as a result of oxygen particles being struck.

PHOTO: NASA/EXPEDITION 29

Shining cities

Europe

AT NIGHT, EUROPE is ablaze with lights and the capital cities shine out like beacons. Northern Italy, central England and Belgium are all bright because of the concentration of big cities in these areas. In stark contrast, inland Africa is almost completely dark.

PHOTO: NASA/DMSP

Moscow

Russia

◀ PEERING OUT FROM behind a solar panel of the International Space Station is Europe's second largest city, Moscow, with a population of 11.5 million. On the horizon, daybreak meets the *Aurora Borealis*.

PHOTO: NASA/EXPEDITION 30

Phoenix

USA

▼ THE STREET GRID pattern of Phoenix is especially evident at night. The city is illuminated by more than 88,500 street lights at a cost of $10m a year.

PHOTO: NASA/EXPEDITION 35

Thunderstorm

LIGHTNING FLASHES OVER Earth during this night-time thunderstorm. Lightning is caused by a build up of electrical energy within a cloud. When the charge becomes great enough, it causes lightning to spark out. Earth sees approximately 100 lightning flashes every second.

PHOTO: NASA ISS

Korean Peninsula

Asia

NEVER HAS THE contrast between two countries been more noticeable. In the centre of the image is the brightly-lit South Korea. Above it lies North Korea, enveloped in almost complete darkness.

PHOTO: NASA/JESSE ALLEN/ ROBERT SIMMON

Darkness

◀ WHILE AMERICA IS waking, the rest of the world sleeps. The larger cities across Europe and Asia are instantly recognisable. With the exception of the Nile, which is densely populated, the rest of Africa has only a smattering of lights.

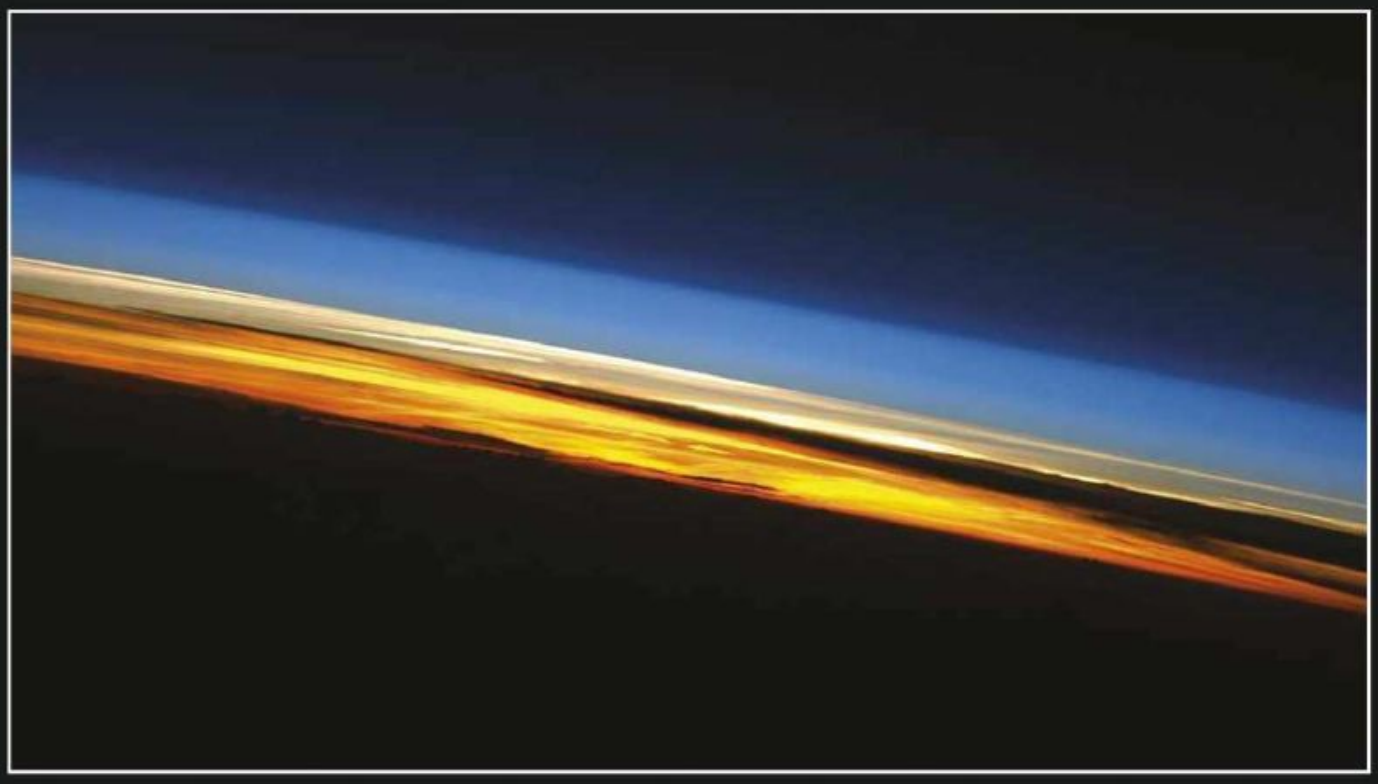
PHOTO: NASA/ROBERT SIMMON

Sunset

Indian Ocean

▼ THIS IMAGE HIGHLIGHTS the different layers of the Earth's atmosphere. The bright orange appears in Earth's troposphere, which extends up to 20km above the surface of the planet. Beyond that is the stratosphere and the blue layers above mark the transition through the upper atmosphere into the blackness of outer space.

PHOTO: NASA/EXPEDITION 23



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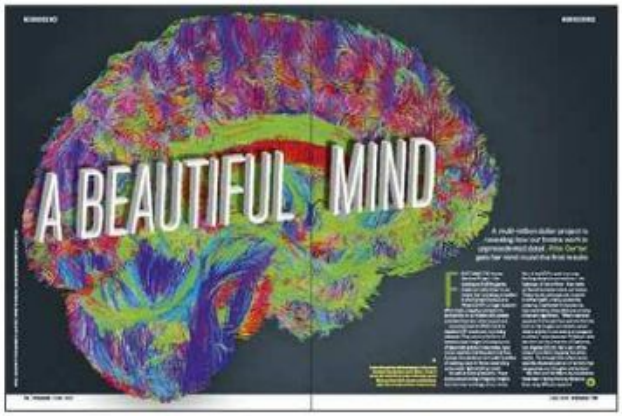

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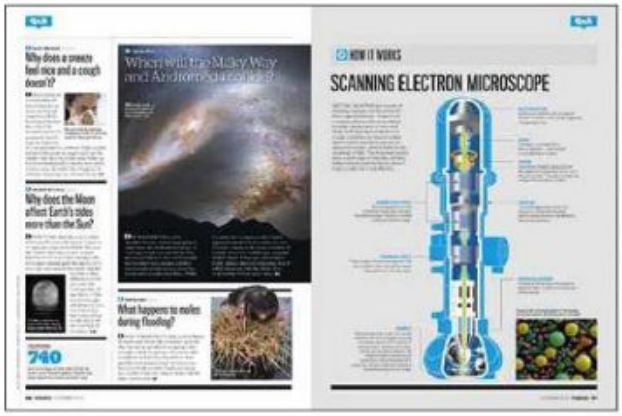

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Moonset

Russia

AS THE MOON dips below the horizon, it appears to be floating in Earth's atmosphere. It is believed that when the Moon was formed it was 14,000km from Earth. However, it moves away from Earth at a rate of 3.8cm per year – roughly the same speed that fingernails grow. Today, our closest companion is over 400,000km from Earth and still moving.

PHOTO: NASA ISS

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