

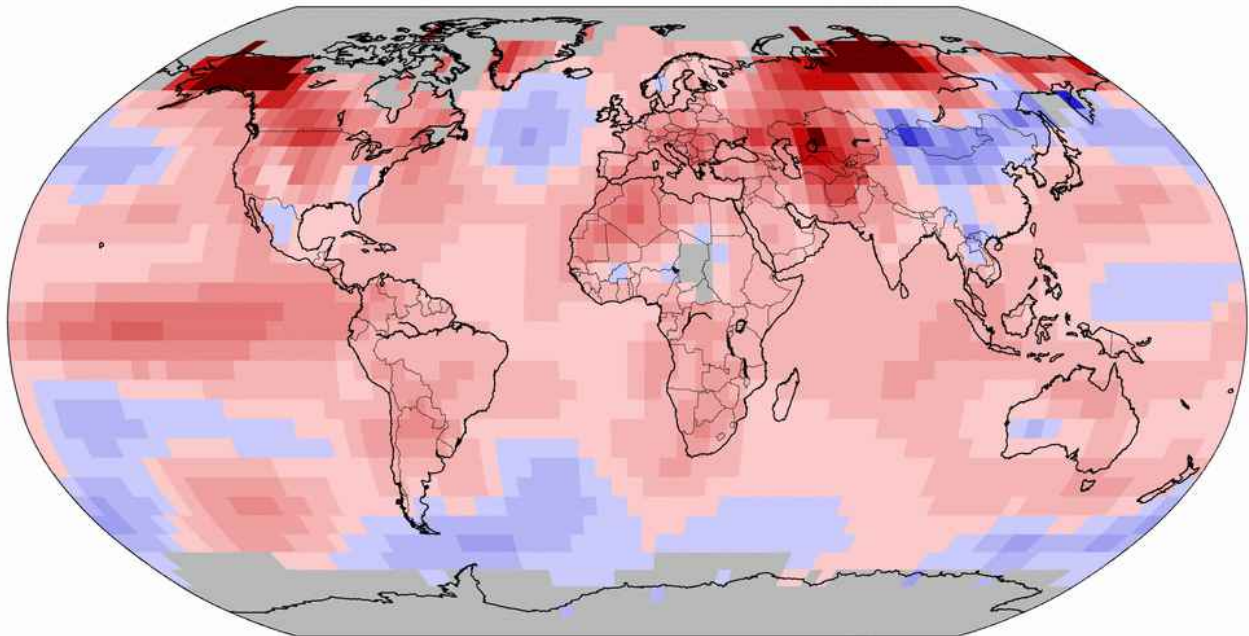
Prime Meridian (51) March 29, 2016

Symptoms of a warming world

2016 opened with the warmest January and February in a record extending back to 1880. Data published by US science agencies reveal the extent and impact of global warming, attributed by climate scientists to our emission of greenhouse gases.

Land & Ocean Temperature Departure from Average Jan–Feb 2016 (with respect to a 1981–2010 base period)

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0



National Centers for Environmental Information
Mon Mar 14 07:22:03 EDT 2016

Degrees Celsius

Please Note: Gray areas represent missing data
Map Projection: Robinson

This chart, from the National Oceanic and Atmospheric Administration, shows how, across large swathes of our planet, temperatures exceeded the long-term mean during January and February 2016. We cannot expect every month and every year to follow on with higher average temperatures than the year before, but the overall upward trend is unmistakable.

According to NOAA, taken together: “The first two months of 2016 were the warmest such period on record across the world’s land and ocean surfaces, at 1.13°C (2.03°F) above the 20th century average of 12.1°C (53.8°F), surpassing the previous record set in 2015 by 0.29°C (0.52°F).”

The smallest Arctic sea ice maximum on record.

The Arctic sea ice expanded its coverage during the long Arctic winter, as it always does during this season. It shrinks back in the spring. The Arctic sea ice appears to have reached its greatest annual extent a few days ago on March 24. The DSCOVR image (NASA/NOAA) at top left looks over the Arctic on March 24 at 16:53:27 GMT.

Its area, 14.52 million km², was the smallest in the satellite record. It occurred 12 days later than the 1981-2010 average. According to the USA's National Snow and Ice Data Center, ice extent was below average everywhere except for the Labrador Sea, Baffin Bay, and Hudson Bay.

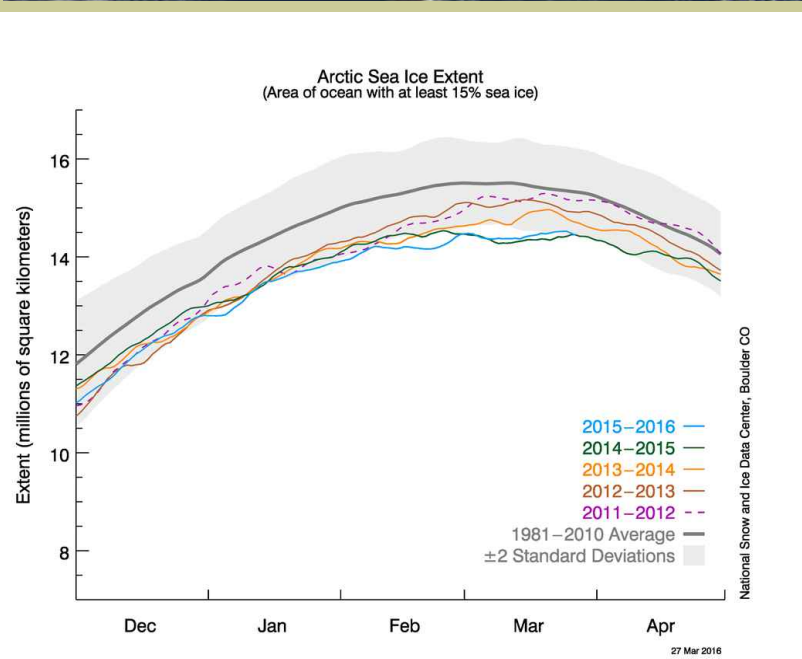
In 2014, the maximum occurred on March 21, the day after the spring equinox. In 2015, it was observed on February 25, with a re-growth to a smaller peak on March 26. The chart at centre left compares sea ice extent for the period December to end April for at maximum for onwards.

It's too early yet to know whether or not summer 2016 will see the smallest recorded floating ice cap, but we may well see one of the smallest areas in the record.

News from the Antarctic.

In the Southern Hemisphere, where summer ended on March 20 with its autumnal equinox, the floating sea ice around Antarctica shrank away to its seasonal minimum on February 19, 2016. With an average area of 2.6 million km², this was the 9th lowest minimum in the satellite record.

Left: Antarctica, Southern and Pacific Oceans on February 19, 2016. DSCOVR image (NASA/NOAA) 20:48:18 GMT.





A study published online in *Nature Climate Change* on March 14, 2016 has concluded that sea level rise during this Century may displace millions of people living in the coastal areas of the USA.

Mathew E. Hauer, Jason M. Evans and Deepak R. Mishra of the University of Georgia, Athens, Georgia, estimated that by the year 2100, “a SLR [sea level rise] of 0.9 m places a land area projected to house 4.2 million people at risk of inundation, whereas 1.8 m affects 13.1 million people – approximately three times larger than indicated by current populations.”

They concluded that “using the example of the cost for relocating some Alaskan coastal villages [Huntington *et al.*, 2012] of US\$ 1 million per resident, the cost of relocation could exceed US\$ 14.0 trillion (2014 values).”

Refs: Hauer, M. E. *et al.* (2016). ADVANCE ONLINE PUBLICATION | www.nature.com/natureclimatechange. Huntington, H. P. *et al.* (2012). *Ambio* 41: 6674 (2012).

Awaited asteroid missed us by a very wide margin, posing no danger.

It was always thought that the 17 to 54 m asteroid 2013TX68 would miss the Earth during its close approach in early March 2016. There was a possibility, however, that it might skim by us so close that it would pass inside the ring of geosynchronous satellites (located 35,786 km above the Earth's surface around the equator). There had been some doubt about the date of its arrival, because there had been few observations between its discovery in 2013 and astronomers losing it again, and the details of its orbit remained hazy. In the event, it shot by safely on March 7 at 13:42 Universal Time Coordinated (essentially GMT) at the substantial distance of almost 4.1 million km. This was 10.64 times the average distance between the Earth and the Moon. As seen from Earth, 2013TX68 arrived from the general direction of the Sun, which made its approach unobservable in the day time sky. There are fears that a dangerous object might approach us in this way which would mean that Earth-bound observatories would not be able to provide warnings about its arrival which would otherwise enable evacuation of endangered areas or attempts to deflect it.

Biggest fireball since the Chelyabinsk blast.

Meanwhile, a major fireball on February 6, at about 14:00 UTC, was estimated to have been caused by the burn up of a 7 m object travelling at 15.5 km relative to the Earth as it hit our atmosphere. It burned out 31 km up and 1,850 km off the coast of Brazil, over the southern Atlantic Ocean. With an explosive force equivalent to around 12,000 kilotons of TNT, this was the second most intense fireball burst since the February 2013 Chelyabinsk (Siberia) event (but it produced only 2.7% the force of that explosion, which caused widespread damage, notably broken windows, and injuries from flying glass).

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Our thanks to Belair House Ltd (UK) for generous provision of community and internet facilities and to Laura Elworthy for valuable assistance.

March 9, 2016 solar eclipse.

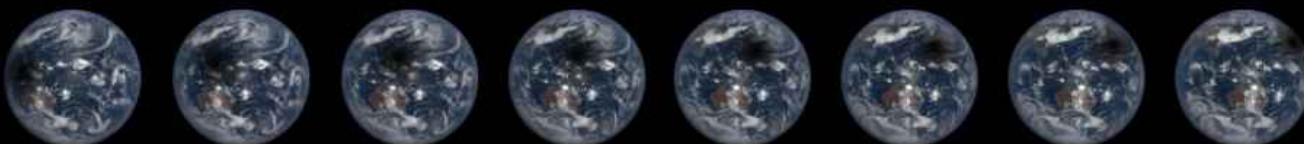
DSCOVR followed the Moon's shadow as it swept across the Earth in an arc that took in Palembang on Sumatra, Indonesia and Honolulu, Hawaii.



Above: An image taken during totality by Ezagren March 9 2016 from Balikpapan, East Kalimantan, Indonesia CC BY 1.0 Ezagren



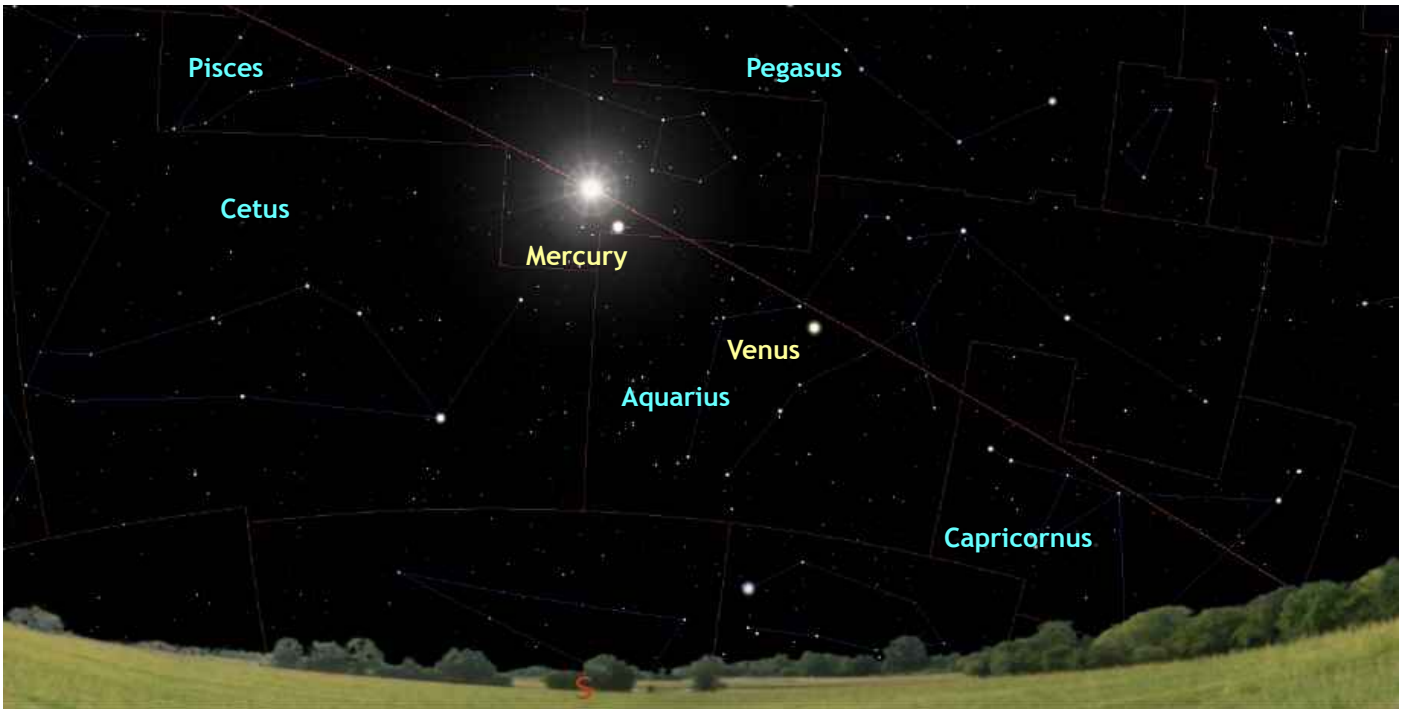
Right: The Moon's shadow and, just to the south, a bright area of specular (literally "mirror"-like - but helpfully thought of, perhaps, as "billiard ball"-type) reflection from the ocean with a bright sun-glint at its centre (01:41:31 GMT).



Above: Images returned by the NASA/NOAA DSCOVR satellite between 00:41:31 and 03:21:31 GMT on March 9, 2016. Located in the vicinity of the L1 point of gravitational stalemate between the Earth and the Sun, DSCOVR (Deep Space Climate Observatory) always sees a nearly full Earth. This is a great vantage point to witness an eclipse in progress and a testimony to Al Gore's vision of a satellite that could allow everyone to appreciate the beauty of their home world.

Right: The view from closer to home. The Moon's shadow crossing the South Pacific at 03:05 UTC (essentially equivalent to GMT for most purposes). This image was obtained by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's Aqua satellite on March 9, 2016. Image Credit: Jeff Schmaltz, MODIS Land Rapid Response Team. NASA GSFC.





Spring Equinox March 20, 2016.

As seen from the vicinity of West Dulwich, South London, clouds obscured the Sun for much of the day, but cleared in time for sunset.



Above: Mercury and Venus, the planets inside the Earth's orbit, are visible in the morning sky. Mercury will return to the evening sky next month and Venus will become a prominent evening star by the end of the year. Re-labelled *Stellarium* image.

Meanwhile, at the South Pole (below, right), where the Sun was setting until late September, the NOAA/NSF webcam (14:20:02 GMT) caught a blizzard that obscured almost all the detail of signs and buildings at the Amundsen-Scott South Pole Station and the distinction between ground and sky.





Seasons in South East England
January, 2016



Above: Snow dusts fields in the vicinity of West Kingsdown, Kent. Jan. 17, 2016.

With the SE in the grip of winter, cold spells were not unexpected, but the month was warmer than normal.

For the UK as a whole, the mean January temperature was 4.5°C, 0.9°C above the 1981-2010 mean. England at 5.2°C, was warmer at 1.1°C above the mean, and SE and S central England (see Met Office website for details of how they define these regions) had a mean temperature of 5.7°C (also 1.1°C above the mean). Overall, the UK had 152% and England, 156% normal rainfall in the 4th wettest January in a record from 1910.



Left: TV viewers saw London fireworks ushering in the New Year. Jan. 3 was a grey day with flooding at Fawkham Green, Kent. Sundog - an effect caused by sunlight passing through ice crystal clouds. S. London, Jan. 16. Below: Gulls flock against a brooding sky. Belair Park, S. London. Jan. 10. Right: Almond blossoms on Jan. 10, Belair Park.





Above: Jan. 16. Ice had formed in a flooded willow coppice in Belair Park, South London. Jan. 17. In the early hours, cars in a South London street received a light dusting of snow.

The January freeze.

Left: Snow lies on fields near West Kingsdown, Kent on Jan. 17. Broken ice on South London street. Jan. 19. Frosted plants along a gutter, South London, Jan. 21. Below: *Clematis* gone to seed and the snow give skeletal woodland a ghostly appearance. Near West Kingsdown, Kent Jan. 17.



There was fog lingering along the Thames Valley on Jan. 5. Heathrow saw its highest rainfall of 10 mm on Jan. 7 and it was wet throughout England on Jan. 9, with a gust of wind approaching 137 km per hour at the Needles Old Battery, Isle of Wight. Jan. 10 saw its heaviest showers in the Home Counties. On Jan. 11, 10 mm of rainfall was repeated at Heathrow. On Jan. 14, gusts nearly 108 km per hour were recorded at Weybourne in Norfolk. On Jan. 16, a low of -5.7°C was recorded at Benson in Oxfordshire and 4mm of rain fell at Heathrow. Jan. 20 saw the highest temperature at Heathrow just manage 4°C . The UK's lowest temperature was felt at Kinbrace (Sutherland, Highlands of Scotland) on Jan. 19. Jan. 20 was also cold. In SE England, Benson suffered -8.8°C and Heathrow a minimum of -5°C . Jan. 24 saw the UK's highest temperature, not in the SE, but at Achnagart in the Scottish Highland; 16.5°C . Meanwhile, at Heathrow, London, the temperature climbed to over 15°C , the highest temperature recorded at that location during January. On Jan. 25 and 27, the highest temperatures at Heathrow were in excess of 10°C and exceeded 13°C on the final day of the month. 3 mm of rain were recorded at Heathrow on Jan. 22, 26 and 27.





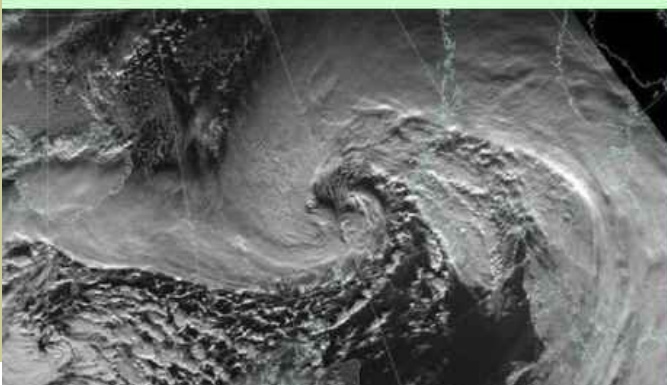
Above: Jan. 23. Looking along a bare hedgerow near West Kingsdown, Kent. Seeds of Old Man's Beard (*Clematis vitalba*). Hedgerow dotted with early appearing white flowers of the blackthorn (*Prunus spinosa*). A woodland floor with last autumn's leaf fall. The growth of *Arum maculatum* was well underway on the woodland floor and the leaves of bluebells (*Hyacinthoides non-scripta*) were poking through the ground. Snowdrops (*Galanthus nivalis*) were out in the churchyard of St. Peter's and St. mPaul's at Ash, Kent.

Regional weather data from online reports from UK Met Office. Heathrow data from WeatherOnline.

SE and central S England, mean max. temp.: 8.9°C (1.5°C); mean min. temp.: 2.4°C (0.7°C). Hours of sunshine: 59.2 (101%). Rain: 136.4 mm (170%). Anomalies re. 1981-2010 norm in brackets. Source UK Met Office.



Above: Sunny afternoon of Jan. 30. Near West Kingsdown. Below: Storm Gertrude. Seen here on Jan. 29, as a deepening depression to the N of Scotland in this infra-red satellite image (UK Met Office) Gertrude caused disruption mainly in Northern Ireland and Scotland. Open Government Licence v1.0.





Global climate: January 2016 - this year opened with record-breaking warmth.

The USA's National Oceanic and Atmospheric Administration reported that: *“The January 2016 globally-averaged temperature across land and ocean surfaces was 1.04°C (1.87°F) above the 20th century average of 12.0°C (53.6°F), the highest for January in the 137-year period of record, breaking the previous record of 2007 by 0.16°C (0.29°F). This departure from average is the second highest among all months in the historical record, second only to December 2015, which was 1.11°C (2.00°F) above average.”* NOAA uses a record which began in 1880.

Planet Earth in mid-January. The DSCOVR image of the Earth was taken on January 15 2016 at 06:14:35 GMT. NASA/NOAA. The South Pole was still more than two months away from sunset.

Only the land masses of the Northern Hemisphere lagged behind the trend for record warmth. The combined mean for land and ocean taken together was $1.11 \pm 0.07^\circ\text{C}$ higher than the 20th Century average. The oceans were $0.86 \pm 0.15^\circ\text{C}$ warmer than their mean, whilst land areas were $1.56 \pm 0.24^\circ\text{C}$ warmer (2nd warmest after 2007).

In the N. Hemisphere, the combined mean temperature for land and ocean was $1.23 \pm 0.07^\circ\text{C}$, joint first with 2007 and the oceans $0.96 \pm 0.14^\circ\text{C}$ above the January norm. The land on the other hand, all the warmest ever recorded. The land areas, $1.67 \pm 0.34^\circ\text{C}$ above the norm managed only to be the 3rd warmest on record, with 2007 the warmest. In the S. Hemisphere, all three values broke records. The mean combined land and ocean temperature was $0.86 \pm 0.15^\circ\text{C}$, the ocean $0.79 \pm 0.15^\circ\text{C}$ and the land $1.27 \pm 0.12^\circ\text{C}$, above their January norms.

NOAA reported that *“Record warmth was observed in all major ocean basins: various regions of the eastern and western Atlantic, particularly near coasts, part of the Barents Sea in the Arctic; the Southeast Indian Ocean to the south of Australia; most of the North Indian Ocean; parts of the eastern and central equatorial Pacific; and the western Mediterranean Sea. Near record strong El Niño conditions prevailed in the central and eastern equatorial Pacific Ocean during the month”*. The El Niño warm phase conditions are expected to die away by late spring or early summer.

Source: NOAA National Climatic Data Center, *State of the Climate: Global Analysis for January, 2016*. Published online. Data provisional.



Water droplets from recent rainfall on blades of grass, field margin, West Kingsdown, Kent. Jan. 23, 2016.