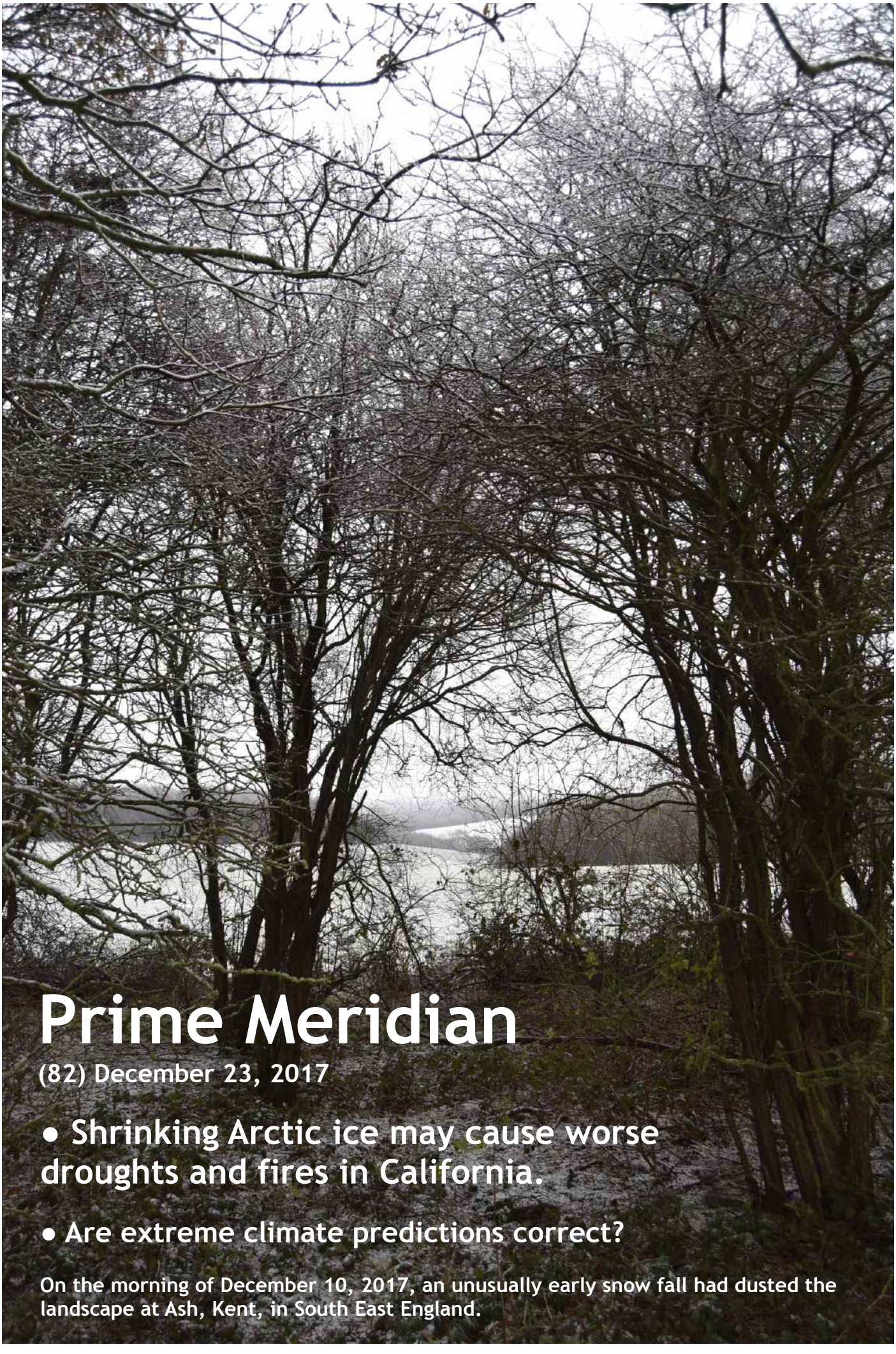
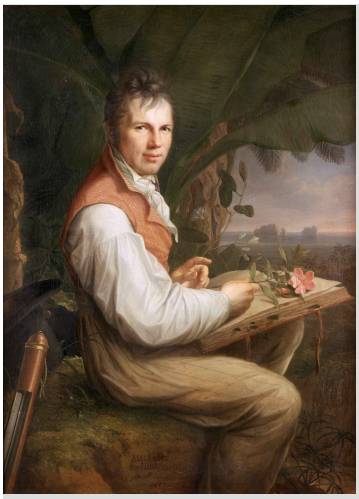


Prime Meridian

(82) December 23, 2017

- Shrinking Arctic ice may cause worse droughts and fires in California.
- Are extreme climate predictions correct?

On the morning of December 10, 2017, an unusually early snow fall had dusted the landscape at Ash, Kent, in South East England.



Editorial: Seeing the bigger picture.

In the last issue, we outlined why we draw together multiple disciplines in both our campaigning work and also in our research into what it is that makes a planet habitable. This is not a new approach and among those historical authors whom we credited with laying the foundations for treating the natural world as an integrated whole was explorer Alexander von Humboldt (1769-1859). His brother Wilhelm von Humboldt (1767-1835) pioneered a system of education and academic freedom in which the individual is free to plot their own course through study and research. At his prompting, Friedrich William III of Prussia (1770 - 1840) established the University of Berlin in 1811. After World War II, this was renamed as the Humboldt University of Berlin.

Upper left: Friedrich Wilhelm Heinrich Alexander von Humboldt. Portrait by Friedrich Georg Weitsch in 1806. Lower left: Friedrich Wilhelm Christian Karl Ferdinand von Humboldt. Lithograph by Franz Krüger, probably before 1835.

Our cross-disciplinary approach is very much in the spirit of the Humboldt model and by no means unique to the Ecospheres Project. Our article "The cosmos and the ecosystem" (PM 81) prefigured a stance that would emerge at The American Geophysical Union Fall Meeting (Dec. 11-15, 2017) New Orleans, Louisiana. Quoted in Science Daily, Giada N. Arney of NASA's Goddard Space Flight Center explained: "In our quest for life on other worlds, it is important for scientists to consider exoplanets from a holistic sense -- that is, from the perspective of multiple disciplines . . . We need these multi-disciplinary studies to examine exoplanets as the complex worlds shaped by multiple astrophysical, planetary and stellar processes, rather than just distant points in the sky."

NASA/Goddard Space Flight Center. "Spanning disciplines in the search for life beyond Earth." ScienceDaily. ScienceDaily, 13 December 2017. <www.sciencedaily.com/releases/2017/12/171213124739.htm>.

We highlight here a couple of papers that raise important issues for climate campaigners and the political establishment alike. The first is the inter-dependence of natural systems and the way in which events in one part of the world can have an intimate effect on those in another. This is illustrated by a new study which indicates that the continuing loss of sea ice in the Arctic Basin may modify weather systems so as to promote drought in California. The second concerns the implications for our civilisation of uncertainties in predictions of climate change - and therefore about how we should mitigate the threat or adapt.

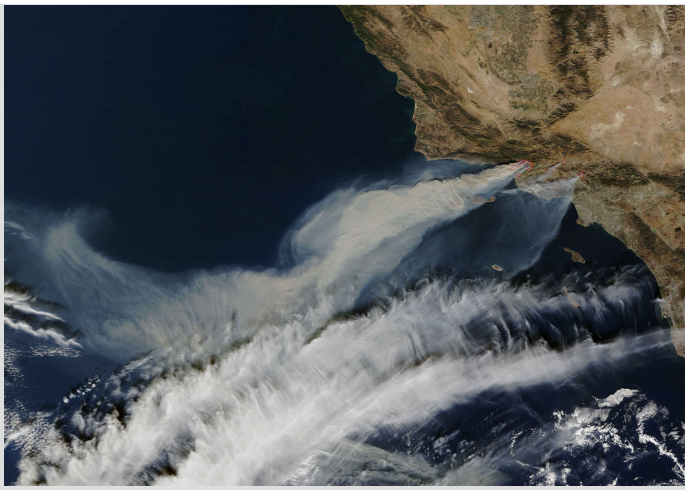
Wildfires and distant connections: California droughts may get 10 - 15% worse as sea ice in the Arctic shrinks away.

Scenes from the late 2017 California wildfires were broadcast around the world. Ecospheres collaborator Laurance Doyle, a Californian, was, thankfully, not personally caught up in the fires. However, he did witness burning areas from the air, while returning from Illinois by plane. He and his family also knew people who lost their homes.

When I called him on the phone in mid-December, he described looking out of the window in the vicinity of Bodega Bay and seeing a spectacular sunset, with the Sun gleaming reddish-orange through a smoke-laden atmosphere, even though it was still about 15 degrees above the horizon. The Sun set early as it descended into obscuring smoke. This was to be the last evening of the wildfire sunsets, but fires continued to burn as we went to print.

Wildfires have posed a problem in this state since time immemorial and whilst he was at high school, Laurance served as a volunteer fire fighter. In this role, he protected both human communities and areas of prime ecological interest.

A major factor in the ignition of fires are the strong Santa Ana winds that emerge from a high pressure area in the Great Basin and warm as they descend down-slope, sweeping hot and dry over the coastal zone of Southern California and northern Baja California. Dry vegetation, however, is another scene-setter for the initiation and spread of fires. If intense droughts become more common, so, one fears, will fires.



The image above right was obtained by NASA's Terra Satellite on Dec. 5 and it shows a massive plume of smoke headed out over the Pacific. Many wildfires broke out in Southern California in December, but the Thomas fire (over 1,100 km^2) in Ventura County accounted for most of the total area affected (over 1,200 km^2) and became the largest fire in Californian history.

A significant new study published on December 5, 2017, highlights a long-distance connection between the ongoing loss of Arctic sea ice and the intensity of droughts in California. The lead author was Ivana Cvijanovic of Climate Modeling and Analysis at the Lawrence Livermore National Laboratory. Cvijanovic, I. *et al*. (2017). NATURE COMMUNICATIONS | 8: 1947 | DOI: 10.1038/s41467-017-01907-4 | www.nature.com/naturecommunications.

> "From 2012 to 2016, California experienced one of the worst droughts since the start of observational records. As in previous dry periods, precipitation-inducing winter storms were steered away from California by a persistent atmospheric ridging system in the North Pacific."

The ridge of high pressure that dominated at this time caused the tracks of storms to swing further to the north. This meant that more rain arrived in the North West (Alaska and Canada) and less in the South West (California).

Information provided by the LLNL emphasises that the new study has not blamed the 2012-2016 drought on the ongoing loss of sea ice. However, their climate simulation does suggest that continuing loss of sea ice could encourage these kinds of conditions in future.

The loss of sea ice would allow warming to penetrate southwards changing the air circulation in the tropics. This, in turn, would modify climate to the north.

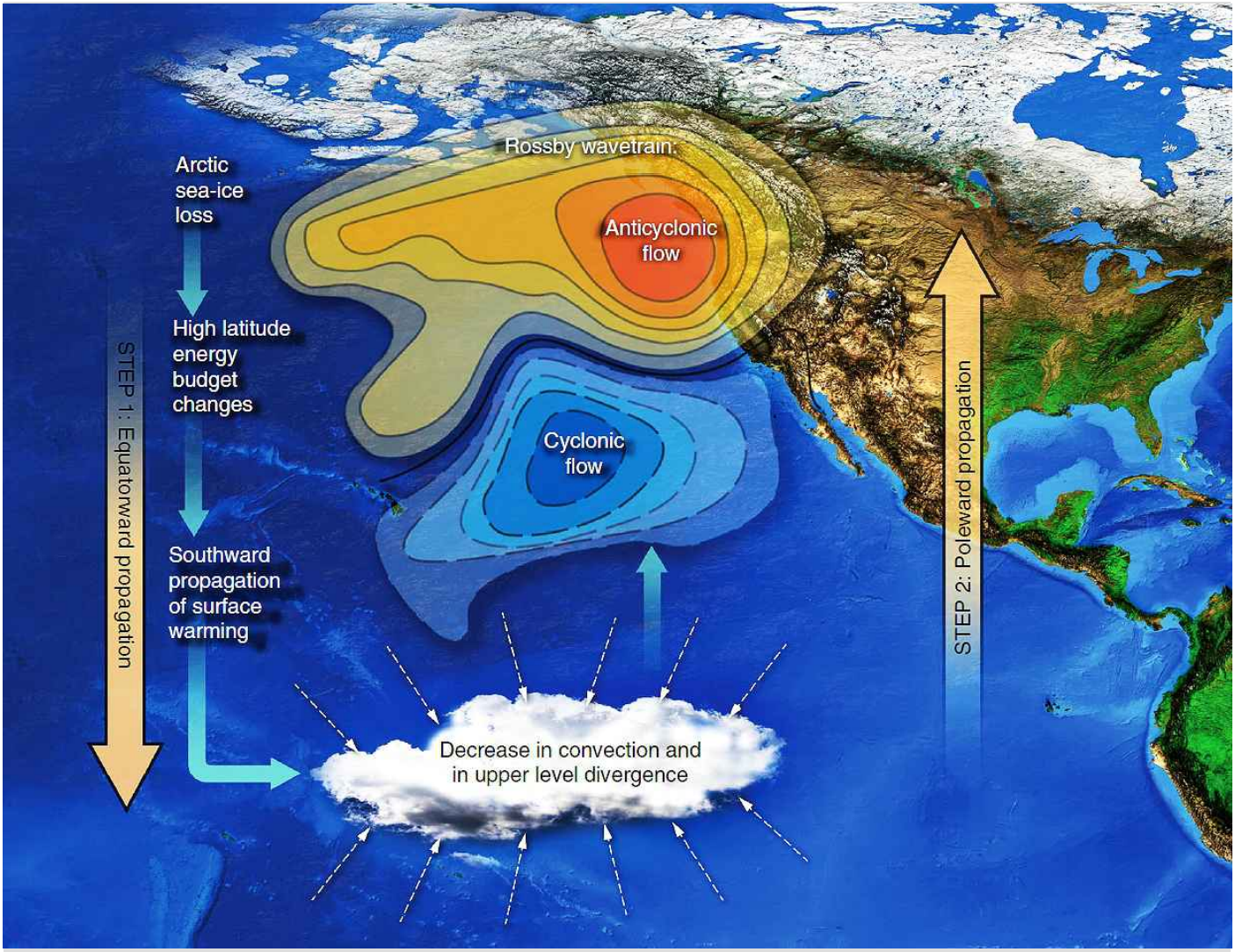
> **"We conclude that sea-ice loss of the magnitude expected in the next decades could substantially impact California's precipitation, thus highlighting another mechanism by which human-caused climate change could exacerbate future California droughts."**

The LLNL statement quoted Cvijanovic:

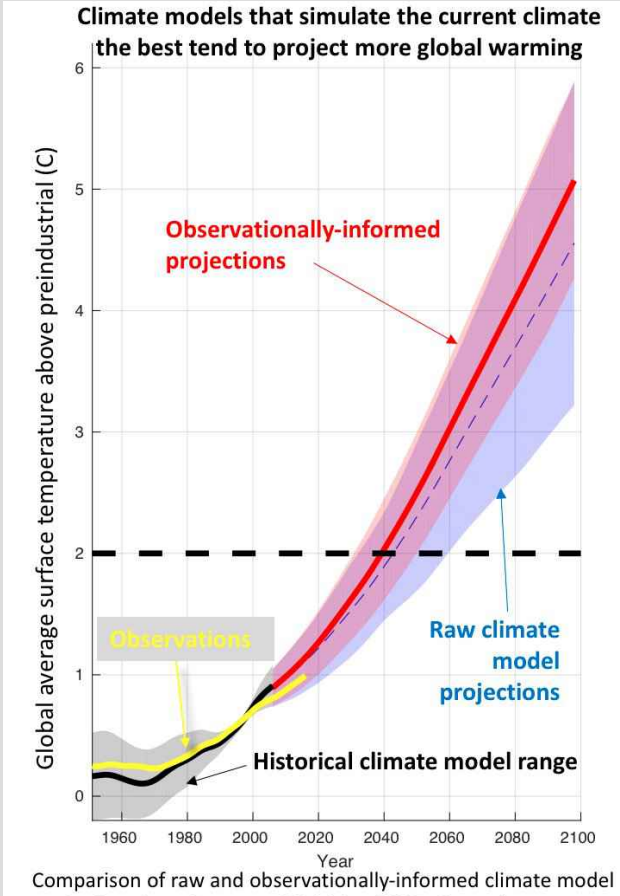
> "While more research should be done, we should be aware that an increasing number of studies, including this one, suggest that the loss of Arctic sea ice cover is not only a problem for remote Arctic communities, but could affect millions of people worldwide. Arctic sea ice loss could affect us, right here in California."

Various other factors may complicate this simple picture, including the potential loss of sea ice around the continent of Antarctica:

> "This assumes that Antarctic sea-ice continues to expand or remains stationary over the next several decades. As Antarctic sea-ice cover begins to decrease, the competing influences of Arctic and Antarctic sea-ice loss will weaken or even reverse the sign of the sea-ice driven component of California's precipitation changes."



Above: Graphic by Kathy Seibert/LLNL outlining the relationship between loss of Arctic sea ice cover and drought in California (this study did not investigate fire).



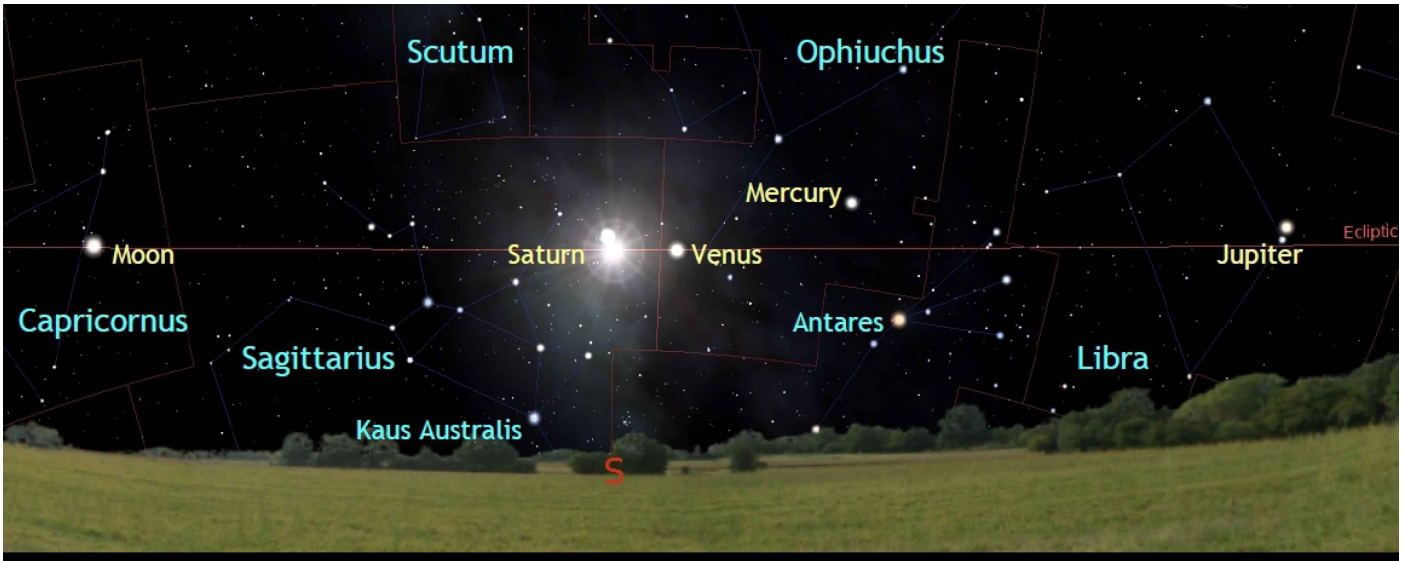
Comparison of raw and observationally-informed climate model projections from Brown and Caldeira (2017, *Nature*)

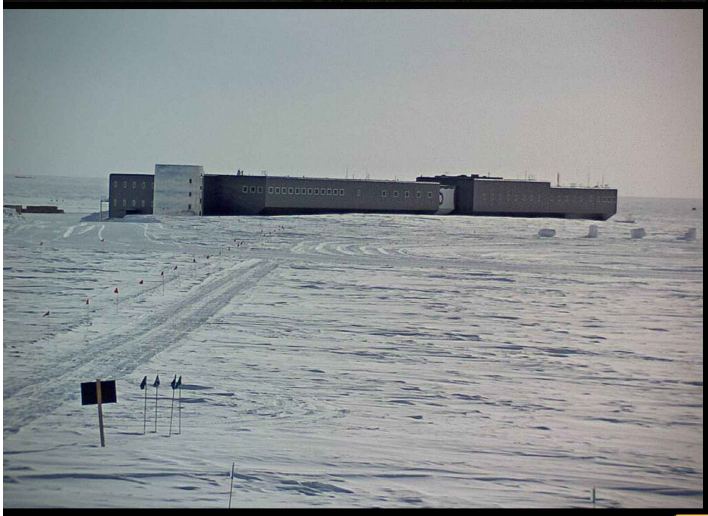
Warming could be more extreme.

In another study that has received a great deal of interest, two scientists at the Carnegie Institution for Science, Stanford University, CA, have laid out the case for global warming during the 21st C being near the more extreme end of predictions. They noted that: "estimates of warming vary by a factor of approximately two even under the same radiative forcing scenarios."

Patrick T. Brown and Ken Caldeira compared predictions across climate models with data from actual observations. They narrowed the error bars on estimates by about a third and concluded that warming would be 15% (0.5°C) greater than often assumed (left). We ask planners to take note of their conclusions:

"achieving any given global temperature stabilization target will require steeper greenhouse gas emissions reductions than previously calculated."





The winter solstice 2017.

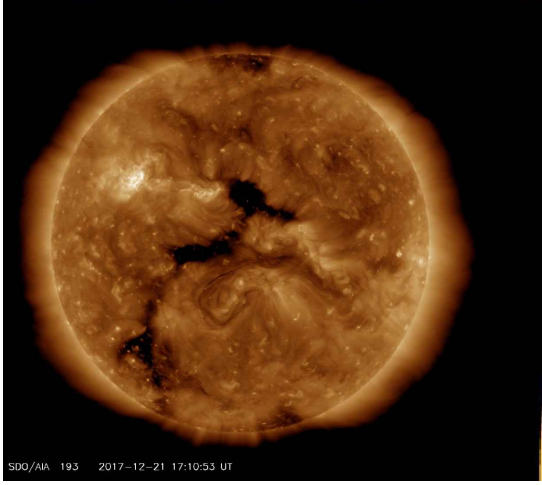
The Northern Hemisphere passed through its winter solstice on December 21, 2017.

The re-labelled *Stellarium* image above shows what the sky around mid-day would look like without Earth's obscuring atmosphere. The planets to the west (right) of the Sun are morning stars and Saturn, to the east, an evening star (although the planets close to the Sun in the sky will be lost in its glare).

During the previous night, a heavy hill fog had swallowed the countryside around NW Kent. It had largely dissipated by morning, but from high ground around West Kingsdown, mistiness still obscured distant views of London.

In the early afternoon, stark and leafless branches stood against an almost featureless overcast on a grey December day.

It was mid-summer's day in the Southern Hemisphere, with continuous daylight at the South Pole (left). The view of the the Amundsen-Scott South Pole Station was from a webcam of the United States Antarctic Program.



Two views of the Sun from NASA's Solar Dynamics Observer on the day of the solstice. The 193 Å (UV) image (left) shows a coronal hole (dark), where the Sun's magnetic field lines open into interplanetary space and the fast solar wind of particles escapes. Sunspot AR2692 and its fellow spots relieved the general blankness of the Sun's disk.

Seasons in South East England

November 2017

Above: A view from the high ground of Ash, Kent, across a valley and over a woodland of bare and yellow trees.

A sunny and dry, yet cool November.

Our region saw almost a fifth more sunshine than normal and less than 60% of its usual rainfall, but this was not a warm month. At 5.8°C, the UK's mean temperature was 0.4°C lower than the 1981-2010 norm. England, at 6.6°C was 0.2°C colder than the norm. Met Office region England SE and Central S, which contains Greenwich, the home of the Prime Meridian, was significantly warmer at 7.1°C, which was 0.3°C below the norm. The warmest UK region was England SW and Wales S, whose mean temperature was 7.4°C (0.1° C below the norm).

Left: Dawn breaks on the first day of the month, which was also the warmest day of the month at Heathrow, at around 16°C. New Ash Green, Kent. A row of limes, losing their yellowed leaves edge a field at Ash, Kent. Nov. 5, 2017. Below: Last year, it was a crescent Moon that peered through the smoke of bonfires on the traditional Nov. 5 fireworks night. This year, it was a Moon just a day past Full. New Ash Green.

Above: An All Souls service, a remembrance of the departed, held in the chapel at King's College, London, not on the traditional date for All Hallows (Nov. 1), but to coincide with choral evensong on Nov. 7. In a poignant reminder of the passage of time, a fallen and moss-encrusted tombstone in the churchyard of St Peter and St Paul at Ash, is being encroached by a drift of autumn's leaves. Remembrance Day (Nov. 11), focussing on the fatalities of two World Wars, is another annual event that prompts us to recall history (tree decorated with poppies at Castle Hill, Hartley, Kent). The view below (Nov. 11) is of a woodland (Hartley Bottom), dripping with recent rain and becoming ever more forlorn. This was Heathrow's rainiest day (9 mm).

The Met Office reported that the month opened with “relatively quiet weather” thanks to a ridge of high pressure in the south. Frontal systems swept repeatedly over Britain punctuating the dry and sunny episodes and “most of the month had a mobile westerly type interspersed with short-lived northerlies.” There was mild spell from Nov. 20 to 22, but snow fell on the closing day of November. Out in the countryside at New Ash Green, Kent, it was thawing no sooner than it had fallen, but repeated falls left the landscape dusted white.

Above: Autumn colours in a hedgerow near West Kingsdown, Kent. The prominent tree whose leaves have turned a russet brown is a beech (*Fagus sylvatica*). Nov. 17, 2017.

Left: A broad, deep puddle near Brand hatch, Kent on Nov. 12, after the rainy spell. A sycamore leaf, tugged from a tree by autumn's winds, has caught in a bare branch (Nov. 19). Below left: A rural lane on the edge of woodland at Ash, Kent (Nov. 19). It is early afternoon. Already, the Sun (from left) is throwing long shadows. Below right: The leaves of this hazel (*Corylus avellana*) are about to fall, but catkins remained. West Kingsdown (Nov. 17).

Monthly means for SE and central S England. Max. temp.: 10.7ºC (0.1ºC); min. temp.: 3.4ºC (-0.8ºC). Hours of sunshine: 84.2 (118%). Rain: 50.4 mm (58%). Anomalies re. 1981-2010 norm in brackets. Date obtained from Met Office on-line monthly reports. Heathrow data is obtained from *WeatherOnline*.

Above: The end of a chilly November day. North Field, New Ash Green. Nov. 19. Left: The leaves of oak trees linger on the branches after many other trees are losing theirs. Churchyard St Peter's & St Paul's, Ash. Nov. 17. Right: A hailstone is caught in a spider's web. Nov. 28. New Ash Green. Below: Snow falls in a lane beside Saxten's & Cage's Wood, Kent on Nov. 30, 2017.

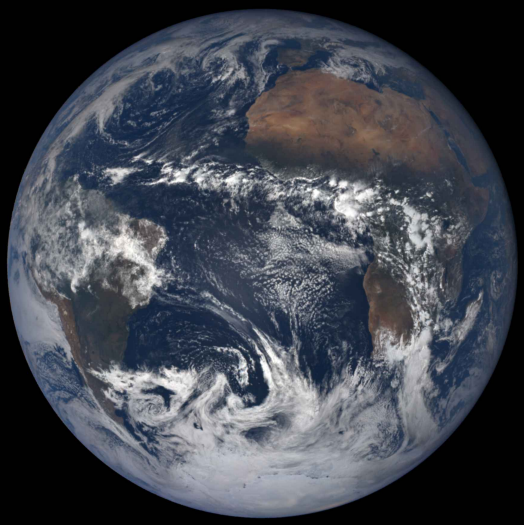
The UK's warmest day, with 16.8°C was at Chivenor, (SW England) on Nov. 2. Nov. 25 was Heathrow's coldest, (not quite as low as -2°C). The UK's coldest day (-6.9°C) was at Bewcastle in Cumbria (NW England) on the last day of the month.

Global climate: The fifth warmest November (tied with November 2016).

At first sight, the fifth warmest November on record may not sound impressive, but in the context of a data set that begins in 1880, it adds to the mountain of evidence for a climbing temperature. Analysis by the USA's National Oceanic and Atmospheric Administration found that:

> "November 2017 marks the 41st consecutive November and the 395th consecutive month with temperatures at least nominally above the 20th century average. The 10 warmest Novembers have occurred during the 21st century. The global land and ocean temperature during November has increased at an average rate of +0.07˚C (+0.13˚F) per decade since 1880; however, the average rate of increase is twice as great since 1980"

The global mean temperature was 0.75 ± 0.15ºC above the 20th Century mean of 12.9ºC (2015 was warmest).



The oceans were 0.62 ± 0.15ºC above the norm (4th warmest; 2015 was warmest), while the land (1.1 ± 0.21ºC above the mean), was its 9th warmest (2010 was warmest).

In the N. Hemisphere, the combined land and ocean temperature was 0.95 ± 0.17ºC above the mean (5th warmest; 2015 was warmest). The oceans were 0.81 ± 0.14ºC above the mean (2nd warmest after 2015). Meanwhile, temperatures on land in this hemisphere were 1.18 ± 0.20ºC above the norm (10th warmest; 2010 was warmest).

In the S. Hemisphere, the combined land and ocean temperature was 0.55 ± 0.15ºC above the mean (8th warmest; 2015 was warmest). The oceans were 0.48 ± 0.15ºC above the mean (10th warmest, with 2015 as warmest). Meanwhile, temperatures on land in this hemisphere were 0.87 ± 0.16ºC above the norm (13th warmest; 2009 was warmest).

Above left: Halfway through the month. Our planet on November 15, 2017 at 13:03:33 GMT. DSCOVR mission. NASA/NOAA.

Source: *NOAA National Climatic Data Center, State of the Climate: Global Analysis for November 2017.* Published online. Data is provisional.

Prime Meridian

Prime Meridian is published by the Ecospheres Project, a trans-Atlantic research and media collaboration. It follows global environmental issues alongside the cycle of the seasons in South East England. It steps back to look at the Earth in its astronomical context and it pursues the search for other habitable worlds.

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