1. **MAST Upgrade's year in review | 24/12/2015**

   The momentum is building on the MAST Upgrade project at CCFE, as the UK’s new tokamak experiment heads into the final phase of assembly in 2016. Take a look at the progress during 2015 in the latest MAST-Upgrade video diary below.

   Project Leader Joe Milnes thanked the MAST-U team for their efforts during the year and commented:

   "It has been a hugely productive year for MAST-U and, given the need to finish the construction in 2016, it needed to be. Whilst this machine still has the ability to throw up unexpected challenges, I continue to be blown away by the team’s ability to pull together to tackle these and keep us on track.

   "I personally can’t wait to get back from the well-earned Christmas break to start the final phase of construction when we’ll really be able to see the finished machine taking shape and start to connect up the various individual sub-systems to see how they start talking to each other – hopefully they’ll get on OK!"

2. **PPPL physicists simulate innovative method for starting up tokamaks without using a solenoid**

   By Raphael Rosen
   January 4, 2016

   Scientists at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) have produced self-consistent computer simulations that capture the evolution of an electric current inside fusion plasma without using a central electromagnet, or solenoid. The simulations of the process, known as non-inductive current ramp-up, were performed using TRANSP, the gold-standard code developed at PPPL. The results were published in October 2015 in Nuclear Fusion. The research was supported by the DOE Office of
In traditional donut-shaped tokamaks, a large solenoid runs down the center of the reactor. By varying the electrical current in the solenoid scientists induce a current in the plasma. This current starts up the plasma and creates a second magnetic field that completes the forces that hold the hot, charged gas together.

But spherical tokamaks, a compact variety of fusion reactor that produces high plasma pressure with relatively low magnetic fields, have little room for solenoids. Spherical tokamaks look like cored apples and have a smaller central hole for the solenoid than conventional tokamaks do. Physicists, therefore, have been trying to find alternative methods for producing the current that starts the plasma and completes the magnetic field in spherical tokamaks.

One such method is known as coaxial helicity injection (CHI). During CHI, researchers switch on an electric coil that runs beneath the tokamak. Above this coil is a gap that opens into the tokamak's vacuum vessel and circles the tokamak's floor. The switched-on electrical current produces a magnetic field that connects metal plates on either side of the gap. Researchers next puff gas through the gap and discharge a spark across the two plates. This process causes magnetic reconnection — the process by which the magnetic fields snap apart and reconnect. This reconnection creates a magnetic bubble that fills the tokamak and produces the vital electric current that starts up the plasma and completes the magnetic field. This current must be nurtured and fed. According to lead author Francesca Poli, the new computer simulations show that the current can best be sustained by injecting high-harmonic radio-frequency waves (HHFWs) and neutral beams into the plasma.

HHFWs are radio-frequency waves that can heat both electrons and ions. The neutral beams, which consist of streams of hydrogen atoms, become charged when they enter the plasma and interact with the ions. The combination of the HHFWs and neutral beams increases the current from 300 kiloamps to 1 mega amp.

But neither HHFWs nor neutral beams can be used at the start of the process, when the plasma is relatively cool and not very dense. Poli found that HHFWs would be more effective if the plasma were first heated by electron cyclotron waves, which transfer energy to the electrons that circle the magnetic field lines.

"With no electron cyclotron waves you would have to pump in four megawatts of HHFW power to create 400 kiloamps of current," she said. "With these waves you can get the same amount of current by pumping in only one megawatt of power."

"All of this is important because it's hard to control the plasma at the start-up," she added. "So the faster you can control the plasma, the better."
PPPL, on Princeton University’s Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. Results of PPPL research have ranged from a portable nuclear materials detector for anti-terrorist use to universally employed computer codes for analyzing and predicting the outcome of fusion experiments. The Laboratory is managed by the University for the U.S. Department of Energy’s Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov.

3. Won Namkung takes helm of the ITER Council

SAINT-PAUL-LEZ-DURANCE, France (12 January 2016). On 1 January 2016, Korean Professor Emeritus Won Namkung began his term as Chair of the ITER Council, the highest governing board of the ITER Project. Namkung succeeds Robert Iotti from the US, who reached the end of his two-year term in December 2015.

Won Namkung is professor emeritus of physics at Pohang University of Science and Technology (POSTECH) in southeast Korea and executive advisor at the Pohang Accelerator Laboratory. He received his Bachelor of Science in physics from Seoul National University and his PhD on radio-frequency heating systems in tokamaks from the University of Tennessee, US. During the course of his career, Namkung worked with both accelerators and tokamaks, directing the Pohang Accelerator Laboratory and contributing to the construction of Korea’s first all-superconducting tokamak KSTAR.

He has also been involved in Korea’s contribution to ITER, serving as the project’s first Management Assessor in 2009. In 2014, he was part of the search committee that resulted in the recommendation of Bernard Bigot as the third Director-General of the ITER Organization.

Robert Iotti’s term as Council Chair was a time of profound change for the ITER Organization. He took up the position in January 2014 not long after the 2013 Management Assessment Report had urged changes in both project management and governance.

Iotti worked tirelessly to see the recommendations implemented and conducted a number of challenging reforms, including the succession planning process that led to the appointment of Mr Bigot in March 2015. He also led the ITER Council to support the implementation of Director-General Bigot’s action plan that included, among other actions, the update of the project’s long-term schedule, the establishment of a Reserve Fund to implement the most cost effective solutions to arising problems, and the tight integration of the ITER Organization’s Central Team and the Domestic Agencies.

“The ITER Council expresses its gratitude for the enormous personal engagement of Robert Iotti during his time as Council Chair as well as for a long history of involvement with ITER that dates back to the early engineering phase for ITER,” says ITER Council Chair Won Namkung. “I am aware of the huge challenge that lies...
ahead, but I will do my best—together with the ITER Members—to continue to drive ITER along the right track and to have it ready for First Plasma as early as possible.”

“On behalf of the ITER Organization, I want to express my deep appreciation for the immense impact Bob Iotti has made on the course of the project during his tenure as ITER Council Chair,” said ITER Director-General Bernard Bigot. “The transformation of the ITER Project is now well underway, with a reformed organization, a newly proposed schedule and resource plan based on an integrated review, construction and manufacturing moving forward at full pace, and confident relations between the ITER Organization and the ITER Council as the Council continues to review our plans to have an updated reliable and consistent baseline before the end of June 2016. None of this would have been possible without Chairman Iotti’s vision, commitment and diplomatic skill. With ITER on the path to success, we look forward to continued progress and achievement under the strong leadership of Professor Won Namkung.”

BACKGROUND TO THE PRESS RELEASE

ITER—designed to demonstrate the scientific and technological feasibility of fusion power—will be the world’s largest experimental fusion facility. Fusion is the process that powers the sun and the stars: when light atomic nuclei fuse together to form heavier ones, a large amount of energy is released. Fusion research is aimed at developing a safe, abundant and environmentally responsible energy source.

ITER is also a first-of-a-kind global collaboration. Europe will contribute almost half of the costs of its construction, while the other six Members to this joint international venture (China, India, Japan, the Republic of Korea, the Russian Federation and the USA), will contribute equally to the rest. The ITER Project is under construction in Saint-Paul-lez-Durance, in the south of France.

For more information on the ITER Project, visit: https://www.iter.org/

4. Nuclear industry stands ready to help tackle climate change

World Nuclear Association Press Release

9 December 2015


Agneta Rising, Director General of the World Nuclear Association, speaking at
the International New York Times Energy for Tomorrow conference in Paris on December 9, said; "The nuclear industry stands ready to deliver more to help tackle climate change. Nuclear generation could provide 25% of the world's electricity with low carbon generation by having 1000 gigawatts of new build by 2050." Speaking at the same event Fatih Birol, Executive Director, International Energy Agency, said that if governments are serious about nuclear they should find the right frameworks for investors, because of the challenges of large investments in liberalised markets.

The IEA's Two Degree Scenario requires a major shift to low carbon generation by the middle of this century to prevent dangerous climate change. This scenario includes 18% of global electricity being supplied by nuclear energy by 2050, the largest contribution from any low carbon option. To reach this target global nuclear capacity would need to more than double. Rising said, "Sixty-five reactors are currently under construction around the world, the highest number for 25 years. However rates of nuclear construction are not yet high enough to meet the expansion required to hit the IEA target. To grow faster nuclear will need markets with level playing fields, harmonised regulatory processes and an effective safety paradigm."

Rising noted that nuclear energy is the second largest low carbon electricity source in the world. In Europe it is the largest with 27%. However, Rising said that nuclear is taken for granted by governments that fail to communicate about it. This silence on nuclear energy in discussions on climate change is misleading the public. Rising said that support was needed both for current proven nuclear plant and new nuclear technologies. Rising said, "We need to invest into development of smaller reactors that are more flexible in terms of where they can be deployed, better able to work in partnership with intermittent renewables, able to burn used fuel to reduce wastes and have the potential to be more economic."

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The World Nuclear Association is the industry organisation that represents the global nuclear industry. Its mission is to promote a wider understanding of nuclear energy among key international influencers by producing authoritative information, developing common industry positions, and contributing to the energy debate, as well as to pave the way for expanding nuclear business. We are joining with more than 140 societies and associations on the Nuclear for Climate initiative

5. **CGN to build floating reactor**

13 January 2016


China General Nuclear (CGN) expects to complete construction of a demonstration small modular offshore
multi-purpose reactor by 2020, the company announced yesterday.

CGN said development of its ACPR50S reactor design had recently been approved by China's National Development and Reform Commission as part of the 13th Five-Year Plan for innovative energy technologies. The company said it is currently carrying out preliminary design work for a demonstration ACPR50S project. Construction of the first floating reactor is expected to start next year, it said, with electricity generation to begin in 2020. The 200 MWt (60 MWe) reactor has been developed for the supply of electricity, heat and desalination and could be used on islands or in coastal areas, or for offshore oil and gas exploration, according to CGN.

The Chinese company said it is also working on the ACPR100 small reactor for use on land. This 450 MWe reactor would be suitable for providing power to large-scale industrial parks or to remote mountainous areas. CGN said the development of small-scale offshore and onshore nuclear power reactors will complement its large-scale plants and provide more diverse energy options.

Last October, Lloyd's Register of the UK announced it had signed a framework agreement with the Nuclear Power Institute of China - a subsidiary of China National Nuclear Corporation (CNNC) - to support the design and development of a floating nuclear power plant utilizing a small modular reactor. That plant would be based on a marine version of CNNC's ACP100 SMR design, known as the ACP100S. This 100 MWe design with passive safety features has been under development since 2010 and its preliminary design was completed in 2014.

The only floating nuclear power plant today is the Akademik Lomonosov, under construction in Russia, where two 35 MWe reactors similar to those used to propel ships are being mounted on a barge to be moored at a harbour. The Baltic Shipyard in St Petersburg is on schedule to deliver the first floating nuclear power plant to its customer, Russian nuclear power plant operator Rosenergoatom, in September 2016. It could start operating in Chukotka as early as in 2017.

Floating plants offer various advantages: construction in a factory or shipyard should bring efficiencies; siting is simplified; environmental impact is extremely low; and decommissioning can take place at a specialised facility. However, the offshore environment brings important considerations, such as access for personnel and equipment and the need to ensure radioactive materials never enter the sea.

Researched and written
Global nuclear generating capacity increased slightly in 2015 as 10 new reactors began supplying electricity and eight were permanently shut down, according to World Nuclear Association data.

Last year saw new reactors with total capacity of 9497 MWe connected to the grid, up from the 4763 MWe added in 2014. China added eight units, which were, in month order: Fangjiashan 2, Yangjiang 2, Hongyanhe 3, Ningde 3, Fuqing 2, Yangjiang 3, Fangchenggang 1 and Changjiang 1. South Korea and Russia added Shin Wolsong 2 and Beloyarsk 4.

Up rates saw a further 484 MWe added. South Korea, the USA and Sweden accounted for 19 MWe, 290 MWe and 175 MWe of this total. There were two downrates, of 19 MWe each, at South Korea’s Wolsong 3 and 4.

As of 31 December 2015, there were 439 reactors in operation, with a total 382.2 GWe. For comparison, at the start of 2015 there were 437 operable reactors and a total nuclear generating capacity of some 377.7 GWe.

China started construction of the 1080 MWe Hongyanhe 5 in March, the 1161 MWe Fuqing 5 in May, the 1080 MWe Hongyanhe 6 in July, and the 1161 MWe Fuqing 6, the 1150 MWe Fangchenggang 3 and the 1080 MWe Tianwan 5 in December. The United Arab Emirates started construction of the 1400 MWe Barakah 4 in September.

As of 1 December 2015, there were 64 units under construction, with a combined total generating capacity of 67.8 GWe. Since then, China has launched construction of the second Hualong One reactor at the site of the Fuqing nuclear power plant – the 1161 MWe Fuqing 6 – on 22 December. In recent days, China has also poured first concrete for the 1150 MWe Fangchenggang 3 and the 1080 MWe Tianwan 5 – on 24 and 27 December, respectively.

Eight units in four countries were closed permanently last year: Germany’s 1345 MWe Grafenrheinfeld in June; Japan’s 529 MWe Genkai 1, the 320 MWe Mihama 1, the 470 MWe Mihama 2, the 439 MWe Shimane 1 and the 341 MWe Tsuruga 1 – all in March; Sweden’s 638 MWe Oskarshamn 2 in October; and the UK’s 490 MWe Wylfa 1 in December.

Researched and written
7. **German fusion reactor achieves first plasma**

16 December 2015


*After more than a year of technical preparations and tests, the Wendelstein 7-X stellarator has produced its first helium plasma.*

Assembly of the Wendelstein 7-X - the world's largest stellarator-type fusion device - at the Max Planck Institute for Plasma Physics (IPP) in Greifswald, Germany, began in April 2005 and was completed in April 2014. The operational preparations have been under way ever since.

Each technical system - the vacuum in the vessels, the cooling system, the superconducting coils and the magnetic field they produce, the control system, as well as the heating devices and measuring systems - has been tested in turn.

On 10 December, the operating team in the control room started up the magnetic field and initiated the computer-operated experiment control system. It fed around one milligram of helium gas into the evacuated plasma vessel and switched on the microwave heating for a short 1.3 MW pulse. The first plasma could be observed by the installed cameras and measuring devices.

The first plasma in the machine had a duration of one-tenth of a second and achieved a temperature of around one million degrees Celsius.

The next task will be to extend the duration of the plasma discharges and to investigate the best method of producing and heating helium plasmas using microwaves.

Project leader Thomas Klinger said, "We're starting with a plasma produced from the noble gas helium. We're not changing over to the actual investigation object, a hydrogen plasma, until next year."

He added, "This is because it's easier to achieve the plasma state with helium. In addition, we can clean the surface of the plasma vessel with helium plasmas."

Wendelstein 7-X will allow IPP researchers to study high energy plasma under stable conditions.

Wendelstein is a stellarator fusion reactor - different to a tokamak fusion reactor such as the Joint European Torus in the UK or the Iter device under construction in France. A tokamak is based on a uniform toroid shape, whereas a stellarator twists that shape in a figure-8. This gets around the problems tokamaks face when
magnetic coils confining the plasma are necessarily less dense on the outside of the toroidal ring.

Wendelstein 7-X is to operate for two years without active cooling, during which time it will be able to operate for about 50 seconds at 1 MWT, or at 8-10 MW for 5-10 seconds. The machine will then undergo an 18-month shutdown when it will be fitted with an actively cooled divertor for heat fluxes of up to 10 MWT per meter squared. This will bring Wendelstein 7-X to its full steady state capacity.

Some €370 million ($408 million) has been invested in the Wendelstein 7-X project, with funding from federal and state governments and the European Union.

Researched and written by World Nuclear News

8. Enhanced Southern Ocean marine productivity due to fertilization by giant icebergs

Luis P. A. M. Duprat, Grant R. Bigg & David J. Wilton

Primary productivity is enhanced within a few kilometres of icebergs in the Weddell Sea\textsuperscript{1,2} owing to the input of terrigeneous nutrients and trace elements during iceberg melting. However, the influence of giant icebergs, over 18km in length, on marine primary production in the Southern Ocean is less well studied\textsuperscript{1,3}. Here we present an analysis of 175 satellite images of open ocean colour before and after the passage of 17 giant icebergs between 2003 and 2013. We detect substantially enhanced chlorophyll levels, typically over a radius of at least 4–10 times the iceberg’s length, that can persist for more than a month following passage of a giant iceberg. This area of influence is more than an order of magnitude larger than that found for sub-kilometre scale icebergs\textsuperscript{2} or in ship-based surveys of giant icebergs\textsuperscript{1}. Assuming that carbon export increases by a factor of 5–10 over the area of influence, we estimate that up to a fifth of the Southern Ocean’s downward carbon flux originates with giant iceberg fertilization. We suggest that, if giant iceberg calving increases this century as expected\textsuperscript{4}, this negative feedback on the carbon cycle may become more important.
9. ‘Adiabat-shaped’ Pulse Design Improves NIF Implosions
https://lasers.llnl.gov/news/papers-presentations

In a Physics of Plasmas paper published online on Dec. 10, LLNL researchers reported on integrated hohlraum simulations and experiments showing that minimal changes in the pcket drive of the NIF laser pulse can substantially improve the hydrodynamic stability of high-compression implosions. This “adiabat-shaped” pulse is tailored to achieve resistance to ablation-front hydrodynamic instability growth, similar to the recent “high-foot” pulses which produced record neutron yields on NIF, but with a low fuel adiabat (internal capsule energy) to achieve high compression. The adiabat-shaped pulse designs were evaluated in a dedicated NIF campaign that included all aspects of inertial confinement fusion implosions, from laser propagation and hohlraum x-ray conversion to capsule implosion and burn. “Keyhole” targets were used in preparatory tuning experiments to infer the implosion adiabat by performing shock-timing measurements. The hydro-growth radiography (HGR) platform was used to measure and verify the reduction in ablation-front instability growth comparable to that achieved in the high-foot experiments. Finally, low-mode shape distortions were measured through in-flight 2D radiography experiments. This series was followed by a layered DT implosion experiment that demonstrated a significant improvement in yield over all low-foot shots. The new pulse designs produced a factor of 3-10x improvement in the neutron yield (>40% of predicted 2D simulated yield) over similar implosions conducted during the National Ignition Campaign, the researchers said, while maintaining a relatively high fuel compression of >1g/cm². There are a number of other pulse-shaping technique ideas that can now be explored to further improve the stability of high convergence implosions.
Lead author Jose Milovich was joined on the paper by LLNL colleagues Harry Robey, Dan Clark, Kevin Baker, Dan Casey, Charlie Cerjan, John Field, Andy MacPhee, Arthur Pak, Prav Patel, Luc Peterson, Vladimir Smalyuk, and Chris Weber.

10. NEWS | January 11, 2016

2015 second
warmest year on record for U.S.

From the National Oceanic and Atmospheric Administration

http://climate.nasa.gov/news/2386/

The 2015 annual average U.S. temperature was 54.4°F, 2.4°F above the 20th century average, the second warmest year on record. Only 2012 was warmer for the U.S. with an average temperature of 55.3°F. This is the 19th consecutive year the annual average temperature exceeded the 20th century average. The first part of the year was marked by extreme warmth in the West and cold in the East, but by the end of 2015, record warmth spanned the East with near-average temperatures across the West. This temperature pattern resulted in every state having an above-average annual temperature.

The average contiguous U.S. precipitation was 34.47 inches, 4.53 inches above average, and ranked as the third wettest year in the 121-year period of record. Only 1973 and 1983 were wetter. The central and southeastern U.S. was much wetter than average, while parts of the West and Northeast were drier than average. The national drought footprint shrank about 10 percent during the course of the year.

In 2015, there were 10 weather and climate disaster events in the U.S. each with losses exceeding $1 billion. These events included a drought, two floods, five severe storms, a wildfire event, and a winter storm. Overall, these resulted in the deaths of 155 people and had significant economic effects. Further cost figures on individual events in 2015 will be updated when data
are finalized later this year. This annual summary from NOAA’s National Centers for Environmental Information is part of the suite of climate services NOAA provides to government, business, academia, and the public to support informed decision making. For extended analysis of regional temperature and precipitation patterns, as well as extreme events, please see our full report that will be released on January 13, 2016.

11. Power sector carbon emissions jumped 3.8 million tonnes in 2015: Pitt & Sherry


Australia's greenhouse gases from its power sector jumped by 3.8 million tonnes in 2015, potentially making it harder to meet the country's international promises to cut total emissions. Pollution from power stations - which account for about a third of Australia's total carbon emissions - was up 2.4 per cent compared with 2014, according to data compiled by Pitt & Sherry and The Australia Institute. Emissions from electricity production, which was the prime target of the carbon tax, are now 5.1 per cent higher than in June 2014 - just before the scheme was scrapped by the Abbott government:

The rise in emissions is being driven in part by a switch back to coal-fired power as more gas gets diverted to offshore markets. The share of gas in the National Electricity Market, which supplies about 80 per cent of Australia's population, fell to 11.2 per cent in December, its lowest proportion since mid-2010. Australia's total emissions rose 1.3 per cent in the year to June 2015, the first full year after the carbon tax's demise, the government reported just before Christmas. An increase in electricity use is also nudging emissions higher, with demand for power notching the first annual increase since 2010.
A stalling in new renewable energy investments because of political uncertainty over the 2020 Renewable Energy Target has also curbed the rise of wind power. Its share in December was unchanged from a year earlier at 5.7 per cent.

In December, black and brown coal accounted for 75.9 per cent of the NEM’s output.

Australia is likely to meet its 2020 target of cutting greenhouse gas emissions by 5 per cent of 2000 levels in large part because of surplus credits from a reduction in land clearing, particularly in Queensland and NSW.

The longer-term goal of reducing emissions by 19 per cent of 2000 levels by 2030 - as committed by the Turnbull government at the Paris climate summit late last year - will require an average annual reduction of about 11 million tonnes of carbon-dioxide equivalent emissions from now.

Comparing with 2005 levels, the cut is 26-28 per cent. That target will be increasingly difficult without a change in policy, particularly towards curbing emissions from the energy sector, Hugh Saddler, Pitt & Sherry's principal consultant, said.

"Australia is still largely dependent on coal for its electricity supply and, assuming electricity demand continues to rise, Australia's carbon emissions will continue to rise," Dr Saddler said.

The 2015 increase in emissions might have been higher but for a slight rise in hydro electricity towards the end of the year. The extra hydro input, though, will probably be hard to sustain without good rains, particularly for Hydro Tasmania.

"Tasmania ... is now facing a significant challenge as energy storage levels fell to below 24 per cent at the end of December as a consequence of an abnormally dry winter," Pitt & Sherry said in its latest Cedex report.

12. **El Niño effect leads to 2015 being world’s hottest year ever and**
IT MAY seem hard to believe with the deluge of rain currently hitting the east coast, but new data has confirmed that Australians are sweltering under the heat with above average temperatures.

And more hot days are set to come with the world in the grips of one of the strongest El Niño events ever recorded.

The Bureau of Meteorology (BoM)’s annual climate statement, released this morning, said a combination of El Niño and climate change led 2015 to be one of Australia’s hottest years on record and will almost certainly be the globe’s warmest ever.

The BoM’s acting assistant director for climate information services, Dr Scott Power, said the last 12 months were the country’s fifth hottest since records began.

“The national mean temperature was 0.83°C above average, with a number of notable heatwaves during the year and record-breaking temperatures from October to December.”

Nationally, Australian temperatures have warmed
approximately 1 °C since 1950, consistent with global climate trends, according to the BoM.

**HOTTEST ON RECORD**

University of Melbourne climate scientist Professor David Karoly told news.com.au there was now enough evidence to say 2015 was the hottest year since records began more than 100 years ago.

“The reason is primarily due to human-caused climate change with a combination of El Niño.”

The El Niño, which was declared in early May, has developed into the most significant and largest for nearly two decades, ranking alongside those in 1997-98 and 1982-83.

The phenomenon is caused by warmer sea temperatures in the Pacific sucking warm, moist air over North America while leaving Australia hot and dry.

“Sydneysiders may not have got out of their gumboots, and the cricketers certainly haven’t, but if you go west of the divide it’s still quiet dry, South Australia and Victoria have been hot and almost all of eastern Australia had below average rainfall,” he said.

Long-term drought conditions continued in Queensland with the dry weather also hitting parts of Victoria, South Australia and southwest Western Australia throughout 2015.

Rainfall was five per cent below average for the year, at 443.7mm and while January 2015 was wetter than average for large areas, the rain dried
up for the rest of the year with September 2015 being third-driest September on record nationally. Rainfall was well below average in southwest Western Australia, southeast South Australia, western to central Victoria, much of Tasmania and large areas of inland Queensland. Notable weather events last year included seven tropical cyclones including the category five cyclone Marcia in February. Severe thunderstorms caused widespread damage in Melbourne in the same month while a tornado hit Sydney’s southern suburbs in December. A record autumn hot spell occurred across large parts of northern and central Australia during March.

The rain wasn’t completely absent, however, with the Indian Ocean Dipole weather event accounting for much needed downpours in Western Australia while an east coast low in April caused severe weather and flooding throughout the Sydney, Hunter and Central Coast regions of NSW. Cold flurries even reached southern Queensland in July turning the sunshine state in to the snowy state.

MORE EXTREMES
But Prof Karoly said summer rains in Sydney and snow storms in Queensland didn’t mean climate change wasn’t occurring. “Natural variability in the weather is still very important so while you will get occasions of cold extremes and climate change that doesn’t mean cold temperatures suddenly
disappear, it just means there will be a reduced frequency of cold extremes and an increased number of hot extremes and that’s what we’ve seen over the last 50 years.”

Ten years ago in Melbourne around nine days a year could be expected to be above 35C, said Prof Karoly. The average for the last decade was 12 days and the last 12 months have been higher still.

**EL NIÑO ON THE WAY OUT**

An imminent weakening of the current El Niño is likely to see cooler, wetter conditions later in the year, said Prof Karoly. “An El Nino typically starts in autumn and builds during winter so it is now at its peak and will likely wane in the early part and disappear by April or May and a return to more traditional weather patterns which will be welcome.”

The heat isn’t in retreat just yet though, in fact globally this year could ever surpass 20-15 in the record books, he said.

“We often find maximum global warming associated with El Niño happens three to six months after the peak and that means that 2016 is very likely to be even hotter and have record high global temperatures.”

So beach lovers, don’t pack away your swimmers just yet. With months to go until El Niño is gone, hot days and drought conditions are probably just around the corner. Once all this rain clears, that is.
13. **Climate change disaster is biggest threat to global economy in 2016, say experts**

Global warming heads top economists’ concerns for first time but large-scale forced migration seen as most likely risk to materialize


A catastrophe caused by climate change is seen as the biggest potential threat to the global economy in 2016, according to a survey of 750 experts conducted by the World Economic Forum.

The annual assessment of risks conducted by the WEF before its annual meeting in Davos on 20-23 January showed that global warming had catapulted its way to the top of the list of concerns.

A failure of climate change mitigation and adaptation was seen as likely to have a bigger impact than the spread of weapons of mass destruction, water crises, mass involuntary migration and a severe energy price shock – the first time in the 11 years of the Global Risks report that the environment has been in first place.

The report, prepared by the WEF in collaboration with risk specialists Marsh & McLennan and Zurich Insurance Group, comes a month after the deal signed in Paris to reduce carbon emissions. The WEF said evidence was mounting that inter-connections between risks were becoming stronger. It cited links between climate change and involuntary migration or international security, noting that
these often had “major and unpredictable impacts”. Cecilia Reyes, Zurich’s chief risk officer, said: “Climate change is exacerbating more risks than ever before in terms of water crises, food shortages, constrained economic growth, weaker societal cohesion and increased security risks. “Meanwhile, geopolitical instability is exposing businesses to cancelled projects, revoked licences, interrupted production, damaged assets and restricted movement of funds across borders. These political conflicts are in turn making the challenge of climate change all the more insurmountable – reducing the potential for political cooperation, as well as diverting resource, innovation and time away from climate change resilience and prevention.” The WEF said the broad range of risks – from environmental to geopolitical and economic – was unprecedented. It added that risks appeared to be rising, with global average surface temperatures increasing by more than 1°C over pre-industrial levels for the first time, and the number of forcibly displaced people at 59.5 million – almost 50% more than in 1940 when the second world war was being fought. “Data from the report appears to support the increased likelihood of risks across the board, with all 24 of the risks continuously measured since 2014 having increased their likelihood scores in the past three years,” the WEF said. When asked which risk was most likely to materialise in 2016, respondents chose large-scale involuntary migration. This follows last year’s refugee crisis, in which hundreds of thousands of people arrived in Europe fleeing conflicts in the Middle East and North Africa. This was followed by extreme weather events, climate change, interstate conflict with regional consequences, and major natural catastrophes. “Events such as Europe’s refugee crisis and terrorist attacks have raised global political instability to its highest level since the cold war,” said John Drzik, president of Marsh Global Risk and Specialties.
“This is widening the backdrop of uncertainty against which international firms will increasingly be forced to make their strategic decisions. The need for business leaders to consider the implications of these risks on their firm’s footprint, reputation and supply chain has never been more pressing.”

14. Global warming 'delays next ice age by 50,000 years'
Man-made carbon emissions mean the world is unlikely to see another ice age for 100,000 years - 50,000 years later than without human influence.


By Emily Gosden
7:24PM GMT 13 Jan 2016

Man-made global warming has delayed the next ice age by 50,000 years, researchers have claimed.
The next ice age is not likely to begin until 100,000 years from now - 50,000 years later than would otherwise have been expected, according to a study by the Potsdam Institute for Climate Impact Research (PIK)
The researchers said that ice ages were brought on by a combination of long-term shifts in the Earth's orbit around the sun, and the concentration of carbon dioxide in the atmosphere.
The carbon emissions produced by humans burning fossil fuels would be sufficient to radically delay the timing of the next ice age, they predicted.
Andrey Ganopolski, lead author of the study, published in the journal Nature, said that over the past million years the world had gone through glacial cycles, lasting about 100,000 years each.
In each cycle, roughly 80,000 to 90,000 years were an "ice age" in which large ice sheets covered North America and Eurasia.
The remaining 10,000 to 20,000 years were "interglacials" - warmer periods such as now, when no ice sheets over northern continents. Although the last ice age ended about 10,000 years ago, the study found that even without man-made climate change, there would be "an unusually long period in between ice ages" and the next ice age would not begin until 50,000 years from now. Mr Ganopolski said this was due to "very peculiar combinations of the parameters of Earth orbit, namely, that the Earths orbit will remain almost perfectly circular for very long time". But with the added impact of carbon emissions, the next ice age would not be expected until 100,000 years from now. "Our study shows that relatively moderate additional anthropogenic CO2-emissions from burning oil, coal and gas are already sufficient to postpone the next ice age for another 50,000 years," he said. "If the next glacial inception will occur in 100,000 years from now, the entire glacial cycle will be skipped, which never happened during the past million years. "It is mind-boggling that humankind is able to interfere with a mechanism that shaped the world as we know it." Prof Andrew Watson of the University of Exeter said the study confirmed that humans had "cancelled the next ice age". "Humans now effectively control the climate of the planet," he said. "If only we were wise enough to be able to use that power responsibly, this might be a good thing, as a planet that avoided major ice ages would probably be better for most of the species living on it. "Unfortunately, I don't think we've reached that level of wisdom yet." Prof Richard Allan, of the University of Reading, said the benefit of global warming in delaying the distant prospect
of the next ice age was irrelevant compared with the imminent dangerous impacts of climate change. "The many tens of thousands of years after which the next ice age may commence is very long compared to the appearance of modern human societies and is therefore not worth worrying about compared to immediate concerns about damaging human-caused climate change expected over the coming decades if no action is taken to mitigate this likelihood."