# SEASON'S GREETINGS

Welcome to *Science of Christmas* 2015.

This is such a special time, full of magic and mystery.

These weeks may be the darkest days of the year, but winter brings its own joys and wonderment, with the celebration of Christmas the central focus.

This is our third *Science of Christmas*, in a partnership with the Irish Research Council (IRC), a Government-funded organisation that supports scientists who work in pursuit of ever higher levels of knowledge for the benefit of society.

The work of scientists helps us to understand the natural world, while they also use their expertise to develop new ideas in all areas of life.

Thanks to IRC-funded researchers in third-level colleges, along with some of their colleagues, this supplement answers many seasonal questions and, in the process, provides insights into the role that science plays in popular phenomena.

Putting *Science of Christmas* together has been both a fun and fascinating experience. I have learned things about spiders' webs that I wouldn't have thought possible. What do cobwebs have to with Christmas? I wondered about that too. Find out on page 5.

Science is all around us. Physics, chemistry and fields such as astronomy, are what are known as the "hard" sciences. We can credit chemistry for the comforting smells and tastes we associate with the season, while physics lies behind the science of snowflakes. They are but two examples; through these pages, we explore many more.

But, the real spirit of Christmas is wrapped up in the "soft", social and behavioural sciences, the ones that involve caring and giving. Among the themes we touch on is one that has a particular resonance in 2015.

Home and homelessness are central to the biblical Christmas story. For many, Christmas is, more than anything, about home, but, sadly, not everyone enjoys that choice.

*Happy Christmas*
**Katherine Donnelly**
**Education Editor**

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# Will we have a White Christmas?

**EOGHAN HARNEY**

Are you dreaming of a White Christmas? Maybe you have watched too many Hollywood films or have a particular Bing Crosby song stuck in your head. But what do we mean by a White Christmas? That depends on who you ask.

While Met Éireann doesn't have a definition, the UK Met Office defines a White Christmas as a single snowflake falling at any of their weather stations during the 24 hours of Christmas Day. That is hardly what many would think of as a White Christmas, which is snow lying on the ground.

With bookmakers, Paddy Power currently giving odds of 3/1 on a White Christmas, what do past records show?

According to Met Éireann, snow fell at any one of their weather stations on 17 Christmas Days in the 50 years up to 2012, which is 1 in 3. Snow lying on the ground at 9am on Christmas Day was recorded nine times in the same period, giving about 1 in 5.

If you were to place a bet on snow at Dublin Airport, snow fell there on 12 Christmas Days since 1941, but 2010 was the only year that had lying snow. Then, Dublin had a White Christmas roughly every six years or only once in over 70.

Before you place that bet, make sure you look at the small print. Some bookmakers use the snow on the ground definition as opposed to snow falling, making those 3/1 odds for a Dublin White Christmas either quite reasonable or really very poor.

If we were to have a White Christmas, when is the earliest we could know with some certainty?

Weather forecasts presented on TV and radio, are based on complex computer programmes which model the behaviour of the atmosphere. The atmosphere, like any physical system, can be described by a set of equations. Combining these with a good knowledge of the weather at the starting time, we can solve the equations to give a weather forecast.

Monthly and seasonal forecasts are performed by many meteorological centres, but on the whole have little skill compared to the climate average. They are likely to give the same prediction, of a 1/6 chance of snow falling on Christmas Day at Dublin, as the historical record.

The problem with long term predictions is that the atmosphere is a chaotic system. Small errors in the weather at the starting time, can lead to vastly different forecasts. For predicting snow, this means that if the temperature is a degree lower than forecast, then rain may fall instead as snow.

The skill of forecasts has improved year on year, due to developments in satellite technology, increased computer power and better methods of solving the equations. However we'll still need to wait until about a week before Christmas to know if there is any substantial chance of snow.

Personally I would prefer a mild and dry Christmas Day, hopefully that will help me beat my time in the local Goal Mile charity run. It would also help Santa traversing all those rooftops.

**Eoghan Harney, is an Irish Research Council scholar at UCD's School of Mathematics and Statistics, where he researches numerical methods used in weather forecasts**

# These snowy branches are actually gold?

**XINXIN XIAO**

What, at first glance, might appear to be pretty snow covered branches of the Christmas tree, are actually crystals of gold. I used a very high powered microscope, called a Scanning Electron Microscope (SEM) to take this picture.

I make my own Christmas cards using these "snowy tree" images. The length of any branch here is no more than one eighth the width of a human hair, while each branch is about 1/250th the width of a human hair.

But why do these gold crystals look like the branches of a Christmas tree? They have what scientists refer to as, a dendritic shape. This means that they look like trees, because the crystals grow lots of different branches. The word 'dendrite' comes from the Greek 'dendron,' which means tree. We see this type of crystal growth and formation a lot in nature, with my particular favourite being snowflakes! Window frost patterns are another example.

Snowflakes are created by a process known as crystallisation, whereby solid crystals form from a liquid or a gas, in this case water vapour in the air, when the temperature is low. It happens when a tiny particle of dust or pollen in the air comes into contact with water vapour, which coats the particle and freezes into a tiny crystal of ice. This tiny crystal is the seed from which a snowflake will grow.

As more water vapour in the air reaches the crystal it also freezes on it. If there are any tiny bumps or protrusions on the crystal then that bump or protrusion sticks out a bit farther than the rest and so the "branches" grow.

The gold crystals in my picture have been placed, using electricity, onto an electrode, a conductor of electricity that allows electric current to flow through non-metal objects.

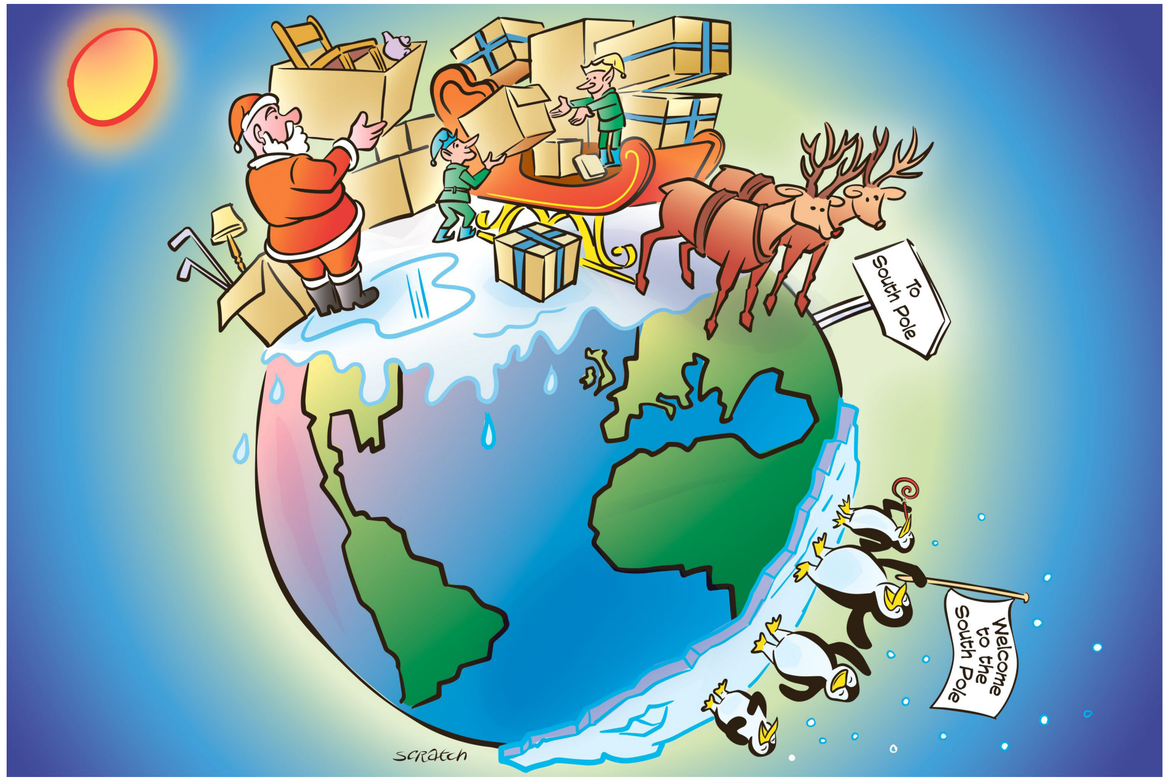
Understanding how to grow these branch-like crystals is very important to my work, because I want to make electrodes that are really small, but that also have a high-surface area. So, I am using these branching crystals to increase the actual surface area of the electrode.

To make these, I use electricity to place gold in this dendritic crystal form onto the electrode. This allows me to produce porous and interconnecting structures similar to birds' nests, which, of course, are made from twigs.

Understanding how to do this properly has lots of implications and uses for society, including in the important area of medical diagnosis and monitoring and maintaining health. The process could, for instance, be used to provide us with information about physiological processes, such as the blood glucose concentration of diabetics.

*Xinxin's image has just been selected as the Christmas card image for the UK Royal Microscopy Society.*

**Xinxin Xiao is an Irish Research Council scholar at the Materials and Surface Science Institute, University of Limerick**




# Could global warming force Santa to move to the South Pole?

**SABRINA RENKEN**

The traditional picture of a white Christmas is disappearing because of increasing temperatures on Earth. In many places snow has become very rare. What will this mean for Santa Claus?

Since the Industrial Revolution, which started in the late 18th century, humans have been releasing large amounts of greenhouse gases into the atmosphere. This is pollution from burning oil, gas and coal, to fuel cars and produce electricity, which, in the atmosphere, traps heat and causes temperatures to rise.

While planet Earth has always heated or cooled naturally over thousands of years, human activities have speeded up the heating process dramatically. Over a few decades we have not only seen a decrease in snowfall, but also the disappearance of mountain glaciers and sea ice.

Scientists report that the Arctic sea ice around the North Pole will be particularly affected by rising temperatures. By the middle of the 21st century the Arctic summer ice could be gone. This would not only leave the polar bears without home, but also Santa Claus and his elves.

However, a new home for Santa and his friends might be found on the other side of the world, at the South Pole, in the Antarctic. Even though Earth is warming and ice is disappearing, snow still falls in Antarctica. In fact, in recent decades snowfall has even increased. Scientists forecast that with every additional degree Celsius temperature increase on Earth, Antarctica could experience 5pc more snowfall. The increased snowfall is possible, as the Antarctic continent is exclusively surrounded by ocean waters. With rising temperatures more water vaporizes into the atmosphere, a process by which it converts from its liquid form into a gas.

At the same time, the heated air has a bigger volume and, therefore, the atmosphere can store more water vapour for a longer time. This means that the water vapour can travel longer distances and reach the Antarctic continent, where, because of the still very low temperatures, it falls down as snow.

Although Antarctica will face more snowfall in the future, it will not be spared from partial snow and ice melt. East Antarctica is already experiencing sea ice melting and glacial ice retreat. However, in contrast with the North Pole, where many animals are losing their place to live, at the South Pole some animals actually profit from the melting.

For example, Adélie penguins need ice free terrain on which to build their nests and breed their chicks. Easy access to water, as well as a steady food supply, is also essential. Thus, the rising temperatures improve their living conditions. The statistics speak for themselves: their population has doubled over the last 30 years with about 1.14 million breeding pairs now living in Antarctica.

So, with Arctic sea ice likely gone in a few decades, Santa may have to move to the colder, partly snowy and ice-covered Antarctica. This way he will also make many new penguin friends!

**Sabrina Renken is an Irish Research Council scholar and PhD student in the Geology Department, Trinity College Dublin**