I BET YOU DIDN'T KNOW...

There is a storm coming and it is not going away

Prof. Dudley Shallcross, PSTT CEO, links **cutting-edge research** with the **principles of primary science**

dudley.shallcross@pstt.org.uk

Around 30 years ago, the Voyager 2 spacecraft gave us 'extraordinary' information about Neptune, *now* the furthest planet from the Sun in our Solar System.

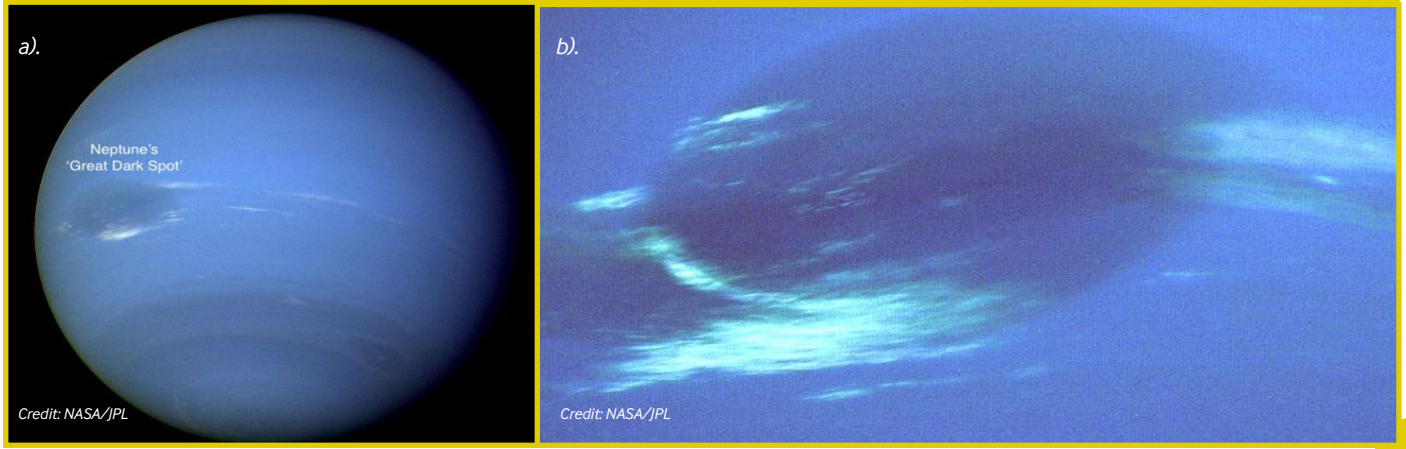
Discussion: Why would you consider this information to be 'extraordinary'? Why is the term *now* used? What was the furthest planet and why is it not now?

The Voyager 2 fly-past of Neptune lasted days and during that time it observed a large dark blue spot, called the 'Great Dark Spot' (GDS; Figure 1) which is a huge storm that could be seen to be rotating in the atmosphere and not going away.

What happened to that storm and what has the weather been like on the planet since the images were taken? The Hubble space telescope, named after Edwin Hubble, has since provided improved observation of the outer planets. It is a very powerful telescope and it is also located outside the Earth's atmosphere. This is important as the light it collects and analyses from the Solar System and beyond is not compromised by clouds, ice surfaces, the ocean etc. in the Earth's system that can modify the light being received, making it harder to analyse. In order to see these storms on Neptune from so far away, you need a telescope that can detect blue light and even though these storms are large, when viewed from a long way away, the contrast between the darker storm and the background atmosphere requires a high resolution image (many pixels). Therefore, the Hubble space telescope is unique in its ability to observe these storms. In a recent paper, scientists Andrew Hsu and colleagues looked back over 25 years of Hubble telescope images to track these giant storms. Their analysis provides some very interesting information that we will discuss later.

Storms on the Earth last hours to days, extreme storms (hurricanes and typhoons) last many days. On Earth, clouds and storms form from water, but on Neptune storms seen in the dark spots are from clouds of frozen *methane*. On Earth, the violent storms are generated by rapid evaporation of water. The heat needed comes from the Sun shining on the Earth's surface. **Why do you think there are more storms near the Earth's equator?** Neptune is 30 times further away from the Sun than the Earth and it receives 1/900 times the heat we receive. This means that solar heating cannot explain the violent storms as the Sun's energy is too weak, and that is why the GDS was such a surprise when it was discovered.

Figure 1. a) location of Neptune's 'Great Dark Spot' and b) enhanced image of the GDS, both captured by Voyager 2.



So where does the heat come from that drives these great storms? Scientists assume that the core of Neptune contains *radioactive material* that is still generating a lot of heat to create storms that then cause *convection currents* (as we see on Earth) within the atmosphere of Neptune and gives rise to these great storms.

So, what did Andrew Hsu and his colleagues find? They looked at 256 images from the Hubble space telescope and looked for dark spots on Neptune from 1994 to 2018. There were issues that they had to deal with that you may wish to discuss:

- The storm (dark spot) would be moving across the surface.
- The planet was rotating (spinning).
- The images were infrequent, just 10-11 a year.
- They could see from the South Pole to around 50° N only.
- The telescope could only view/take images of one side of the planet.

Questions to discuss with children:

- **What happens if the storm is still going, but on the other side of the planet from the telescope?**
- **If they wanted to know how long the storm lasted, how could they know when it started and when it finished?**

However, after analysis of data, the scientists found out that:

- Storms last for a maximum of six years and a minimum of one to two years, depending on their location.
- There were no storms detected in 2002, 2005, 2006, 2008 and 2011.
- There were no observations of Neptune from 2012-2014 (i.e. no data was obtained, so they could not tell whether there was a storm or not).

The Teacher Guide that accompanies this series of *I bet you didn't know...* articles on planets includes activities that enable children to learn more about the Earth and space, the processes of science research and to develop their own enquiry skills.

Activities that are relevant to this article include:

- How to make a simple telescope
- How to investigate the science behind a storm
- How to investigate convection currents
- How to track previous hurricanes and typhoons to see where they develop and how long they last
- How children could mirror the scientists' methods to investigate changes in their local environment

GLOSSARY

convection current
a process of the movement of heat energy from one place to another in liquids and gases (fluids) due to a difference in temperature. Hot fluids tends to rise and cold fluids tend to sink, creating a current within the fluid

methane
a colourless, odourless, flammable gas consisting of carbon and hydrogen

radioactive material
materials that are composed of atoms that naturally break apart (decay), and as they do so, they give out energy. We have radioactive elements on Earth, e.g. uranium and we use these to generate energy (nuclear power)

The paper that inspired this work was:

Lifetimes and Occurrence Rates of Dark Vortices on Neptune from 25 Years of Hubble Space Telescope Images.

By Andrew I. Hsu,[1] Michael H. Wong,[1] and Amy A. Simon,[2].

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1. *University of California, Astronomy Department, Berkeley CA 94720-3411, USA.*
2. *NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA.*