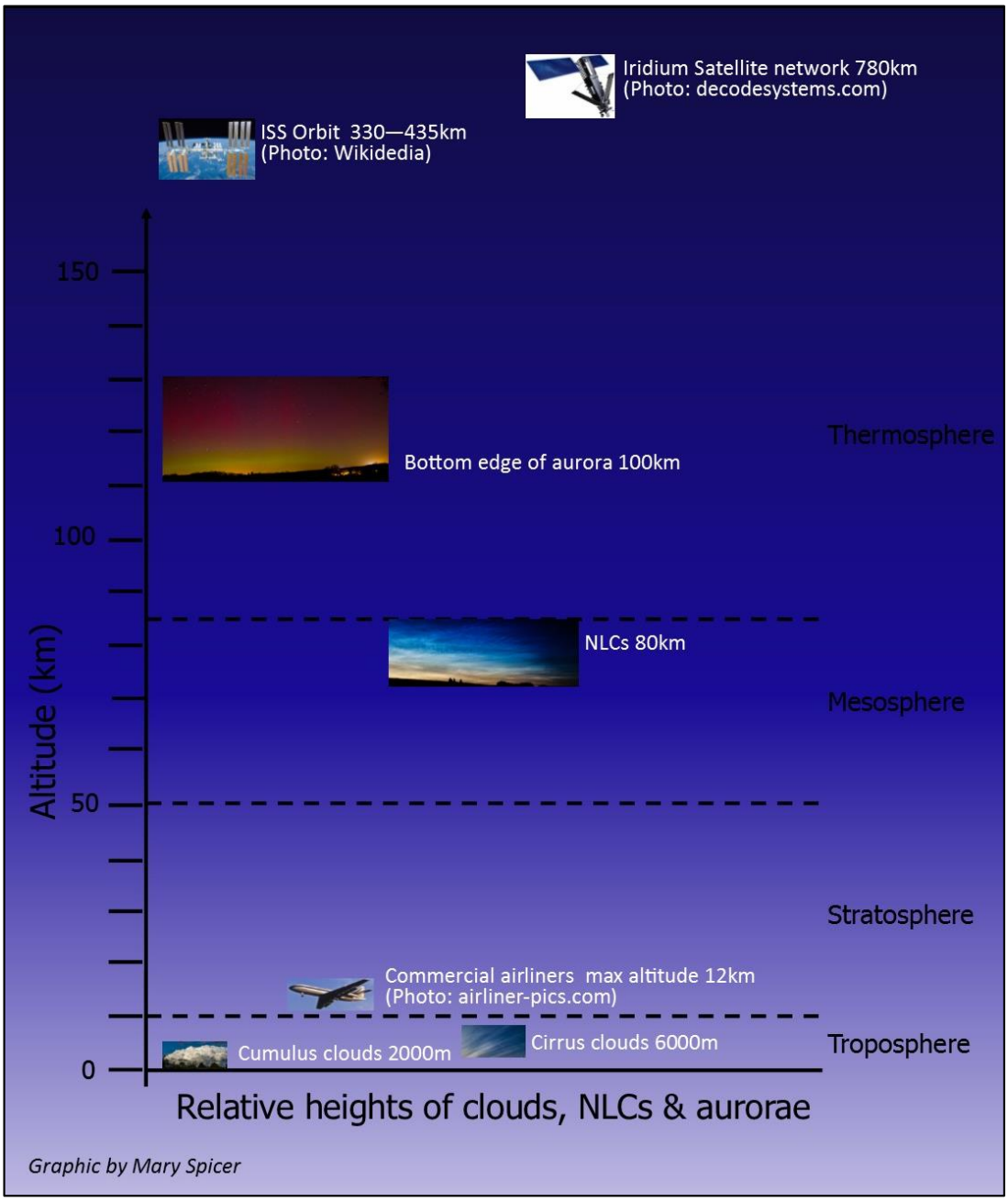
Noctilucent Clouds

June and July are difficult months for astronomers. With so few hours of darkness, observations are restricted. The brighter planets are visible and there are some nice globular clusters to be seen, as well as the usual steady stream of Iridium flares. But other observations are definitely hindered. So does this mean I can spend an evening in the house, or actually finish a meal without diving in and out with my camera? No it doesn't; and the reason? Because it's noctilucent cloud season!

Noctilucent clouds (NLCs), also known as "night shining clouds" are still a bit of a mystery. They are sometimes described as the "ragged edge" of polar mesospheric clouds. They differ from other clouds mainly because of their altitude. Earth's atmosphere is divided into different layers. Directly above the surface is the troposphere, which reaches up to around 10km. The clouds we see each day are all located in this region. Cumulus clouds, those big fluffy cotton ball clouds we all drew as children, are some of the lowest at around 2km above sea level. The highest clouds are those thin and wispy cirrus clouds responsible for solar halos and sundogs, and they're located at around 6km above sea level. Just for comparison, airliners cruise at around 12km. So where do NLCs fit it? We need to go higher up for those; much higher up. Above the troposphere is the stratosphere, a layer which is unique to Earth. This is where the ozone layer is located, formed when UV from the Sun breaks down the oxygen in our atmosphere. The stratosphere reaches up to about 50km. Saturn's moon Titan also has a stratosphere which is similar to Earth's but is formed when methane is broken down by the Sun rather than oxygen. Apart from Titan and the Earth, nowhere else in our solar system has a troposphere. Above that we have the mesosphere, which extends to 85km, and above that is the thermosphere. It is at the boundary between the mesosphere and thermosphere that you will find NLCs. The bottom edge of an aurora display is only 15 km above this, so they really are very high! They are sometimes seen in the very tenuous atmosphere on Mars too, where they reach a

whopping altitude of 100km. This makes them the highest clouds recorded on any planet in the solar system. The graphic below gives you an idea of how they compare.



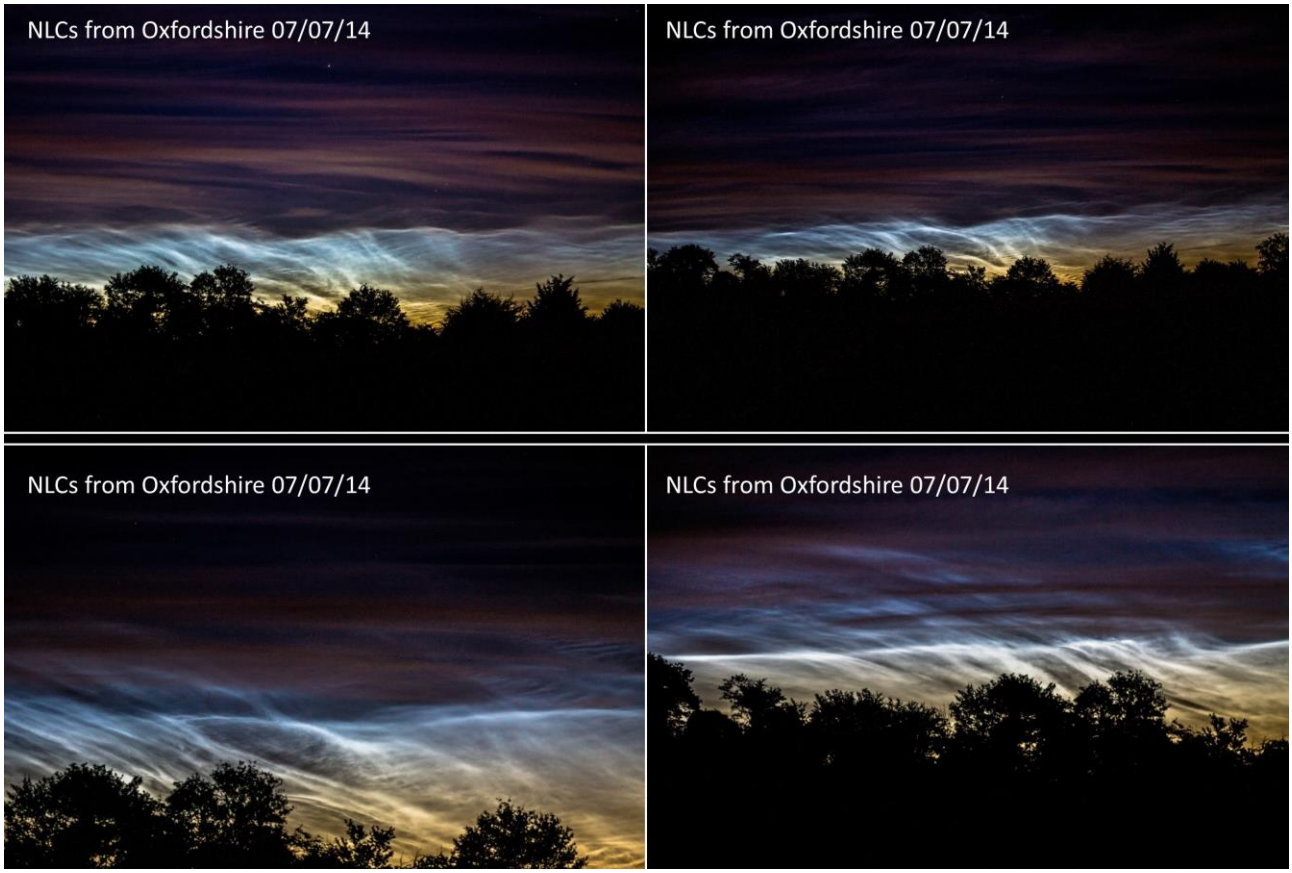
As the name suggests, NLCs are only visible during deep twilight so they can be seen around an hour after sunset or before sunrise, in the north-eastern or north-western sky for us in the northern hemisphere. They are under lit by the Sun when it is between 6 and 16 degrees below the horizon, leaving the lower levels of the atmosphere in Earth's shadow. This gives them a beautiful ethereal quality as they appear to glow in the darkening sky. We still don't know a great deal about them, and there is fierce debate about how and why they form. What we do know is that they were first reported in 1885; prior to this there had been no reported sightings of them. They used to be quite rare but are becoming more frequent. They are only visible during summer months (between mid-

May and mid-August in the northern hemisphere and mid-November to mid-February in the southern hemisphere) and are usually only visible from a latitude of between 50 to 60 degrees. They are not visible from the Polar Regions because during the summer months the Sun doesn't get low enough in the sky to illuminate them. They are reported much more frequently in the northern hemisphere than in the southern hemisphere, but it is unclear whether this is due the southern latitudes being less well populated than the equivalent region in the north. What is clear is that displays in the southern hemisphere are usually much fainter than in the northern hemisphere.

The air in the mesosphere is very thin and very dry. NLCs are made up of tiny crystals of water ice, with the average diameter of each crystal being only 100nm in size (0.0001mm). These crystals will only form if the air temperature is lower than -120^{o}C. The temperature of the mesosphere is actually colder in summer so this is the only time the air is cold enough for NLCs to form. They are usually silvery blue in colour (although they have been reported to appear as red and green) and can take on a variety of structures and patterns. Their brightness is affected by the solar cycle. When the Sun is at its most active, NLCs are usually less bright then when the Sun is quiet. It is thought that this is because when the Sun is more active there is an increase in how much UV light hits the atmosphere. In addition to breaking down oxygen, UV light will also break down water molecules. If there is more UV breaking down water molecules in the mesosphere, there is less water available to form clouds.

There are several theories about how NLCs form and why they are becoming more frequent. For many years it was thought that their frequency was connected to volcanic activity. The first time they were reported back in 1885 was just 2 years after a major eruption from Mount Krakatoa. However, many scientists today do not believe there is a connection between the two. A different theory links NLCs with dust from micrometeorites. Another very interesting observation involved the space shuttle. The water vapour from exhaust fumes following a launch would rapidly move down from the thermosphere into the mesosphere and towards the Polar Regions and cause individual polar mesospheric clouds. But these were isolated displays and not thought to be connected to the main displays that are seen during the summer months. There is, however, strong evidence connecting them to climate change. Whilst an increase in greenhouse gases causes the lower levels of the atmosphere to heat up, it also causes the temperature of the mesosphere to fall, thereby making it more likely that those minute ice crystals will form and produce NLCs. This would explain why the frequency of NLC displays has increased in recent years.

No doubt the debate over exactly how they are formed will continue to rage. One thing is for certain; NLCs are one of the most beautiful things you'll see in the summer sky. And they are the reason why I will still be ducking in and out after sunset and probably having a few early starts too, in my annual quest to capture these beauties on camera!



Sources:

The Cloud Book – How to Understand the Skies by Richard Hamblyn

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http://en.wikipedia.org/wiki/Noctilucent_cloud