Are red skies at night a shepherd's delight? An astronomer's view

October 31 2017, by Daniel Brown

Be warned? Credit: C. P. Ewing, CC BY-SA

Humans have always used simple observations of nature to try to understand our complex environment and even the wider cosmos. One such example is: "Red sky at night, shepherd's delight" and "Red sky at morning, shepherd's warning". These sayings – which date back to the Bible (Matthew 16:2b–3) – suggest that a particularly red sunset means clear weather is coming and a particularly red sunrise means it's going to be bad weather or possibly a stormy day.

There is a rich heritage of interpreting dusk and dawn sky colours, with different cultural groups and peoples having different traditions and sayings. For example, "shepherd's delight" is typically replaced with "sailor's delight" in the US version of the rhyme. But is there any truth behind such forecasting?

In mid latitudes such as Europe and the US, weather systems mostly move in from the west. It is this particular feature that can help us understand how the colour of the sky is linked to future weather patterns – and whether shepherds should bother paying attention to red skies.

Shades of red

During sunset or sunrise, the light from the sun will travel through a signficant fraction of the atmosphere and ultimately the troposphere – a region that contains clouds. There, sunlight interacts with gas molecules that are much smaller than the wavelength of light, a process physicists call Rayleigh scattering. In this interaction, light is dispersed more effectively if its colour is blue rather than red. The reason the sun looks red at sunset or sunrise is because most of its blue light has been scattered away during the extra long journey through the atmosphere.

You can test this at home. Shine a torch through water that has one or two drops of milk added. Milk scatters light in a similar way to the gas molecules in the atmosphere, leaving the torch light looking red.

But sunset or sunrise don't necessarily mean a bright, red sky. If there's a lot of water vapour in the air this can make the sunset look more pink and orange – muting the bright red colours. This is an effect caused by water droplets being comparable or larger in size to the wavelength of light, which means they scatter all colour of light similarly.

An intensively red colour sky requires a particularly dry and clear

troposphere along the path of the sunlight – so the air consists mostly of molecules smaller than water droplets, dust or pollutants. Such clear atmospheric conditions are usually linked to the leading side of a high pressure weather front moving in from the west – a phenomenon that usually means the next day will be dry and sunny. So it seems there is indeed some truth to the saying about red skies at night.

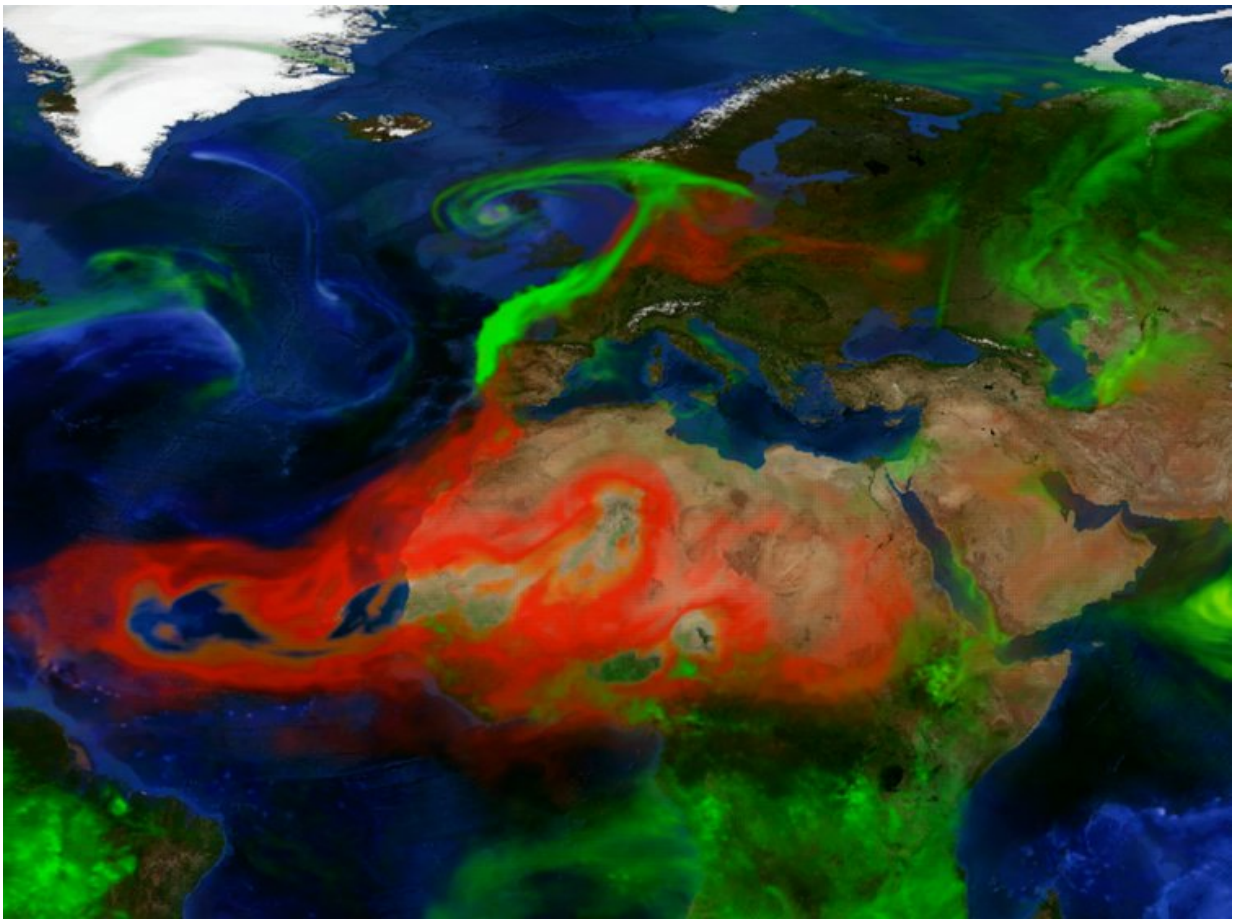
Strange skies over Nottingham, UK, as a result of fine dust within the weather

system linked to the passing hurricane Ophelia. Credit: Nottingham Trent Observatory: D Brown

If the high pressure system is moving away to the east these atmospheric conditions are encountered by the light of the rising sun reaching us instead. As a result, red sky in the morning indicates a change in weather is imminent. Any light reaching us during sunset from the west would have to pass through more humid air. In addition, the atmosphere on the trailing side of a high pressure system is usually also higher in pollutants, which also helps scatter blue light.

But the colours of the sunset or sunrise can be far more complex and a result of events much further away from the observer other than weather. The air can contain not only water, but more complex pollutants and small dust particles. If these are all similar in size, the sun and the sky can take on orange-red colours, as well as lilac or purple. These particles can be picked up from wild fires and dust-storms.

Only recently this resulted in a phenomenon in the UK dubbed the hurricane sun. A weather system linked to the hurricane Ophelia had transported dust from North-Africa and the Iberian wild fires in its clouds over the UK. As a result the noon sun was turned into a deep orange, tinging the landscape with an eerie light. Another example was the 2010 eruption of Eyjafjallajökull, a volcano in Iceland, that generated fine ash as well as Sulphate aerosols in the high atmosphere.



Smoke is green in the image above. This image is produced using aerosol sensors on polar-orbiting satellites. Credit: NASA

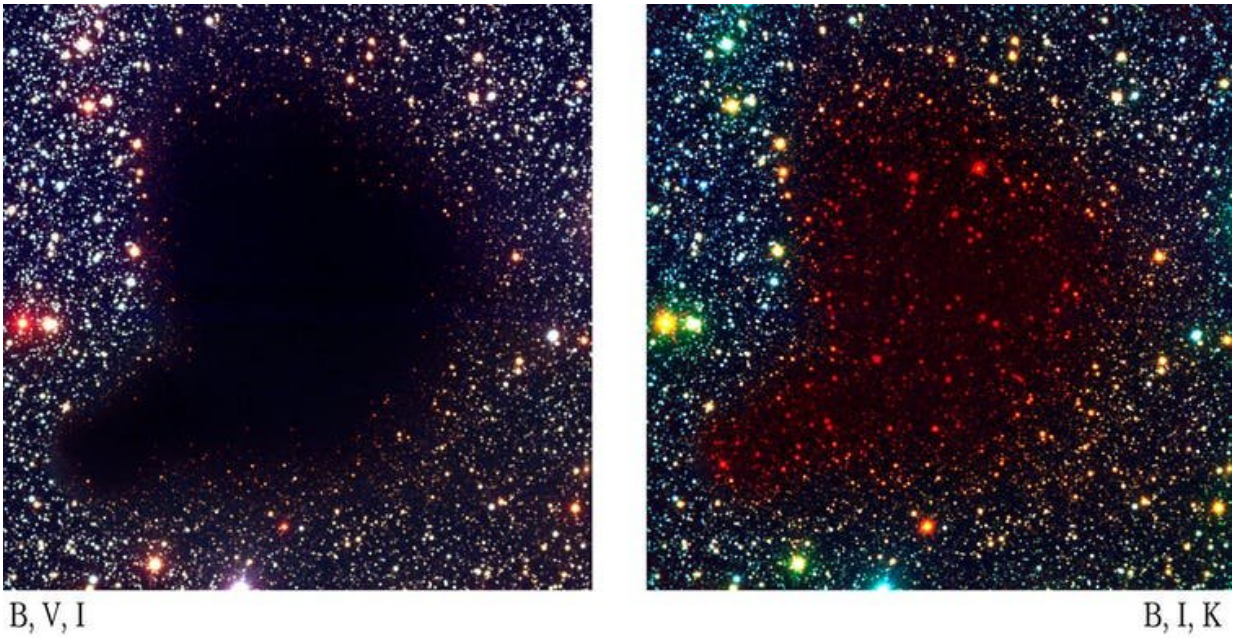
Interstellar sunsets

Red skies are far more than nice opportunities for a photo. They offer moments to contemplate how basic observations can reveal insights into future weather and even volcanic eruptions many thousands of miles away. Perhaps more surprisingly, they also help us to understand what lies outside our own planet.

Space known as the "interstellar medium" is filled with dust and gas.

Sometimes that can be bunched up in clouds and cause the light of distant stars to be significantly dimmed and reddened. When we look at this, it's like we see hundreds of suns at the same time being turned into a redder colour. Understanding these "interstellar sunsets" is allowing us to explore what lies between us and other stars.

That's because particles near stars or in star-forming clouds can be present in or among the dust, helping to cause the red starlight. Ultimately, by studying these interstellar sunsets, we could work out exactly what these particles are. That means we could understand what elements help form stars and planets with their own atmospheres and sunsets and sunrises. So red skies not only bring shepherds' delight – they bring astronomers delight as well.



Two images of a dense cloud in space absorbing the light of background stars. The left shows the visual range and the right includes infra red. Overall, stars become reddened similar to the sun during sunset or sunrise. Credit: ESO