Boost your observing and imaging productivity

By adapting the famous Drake equation, **Ron Brecher** shows us how we can spend more time enjoying the beauty of the night sky

The Drake Equation came about in 1961, when Dr Frank Drake formulated it to estimate the number of active and communicative civilisations that might be present in the Milky Way. The formula takes a probabilistic approach, multiplying different factors, such as the number of stars born every year, the fraction of stars that have planets, the length of time that a civilisation might survive, and so on. Drake's original motivation for crafting his famous equation was not to estimate the number of civilisations, but rather to frame the discussion during the first scientific meeting on the Search for Extraterrestrial Intelligence, or SETI. The SETI Institute provides lots more information about the Drake Equation at **www.seti.org/drake-equation-index**.

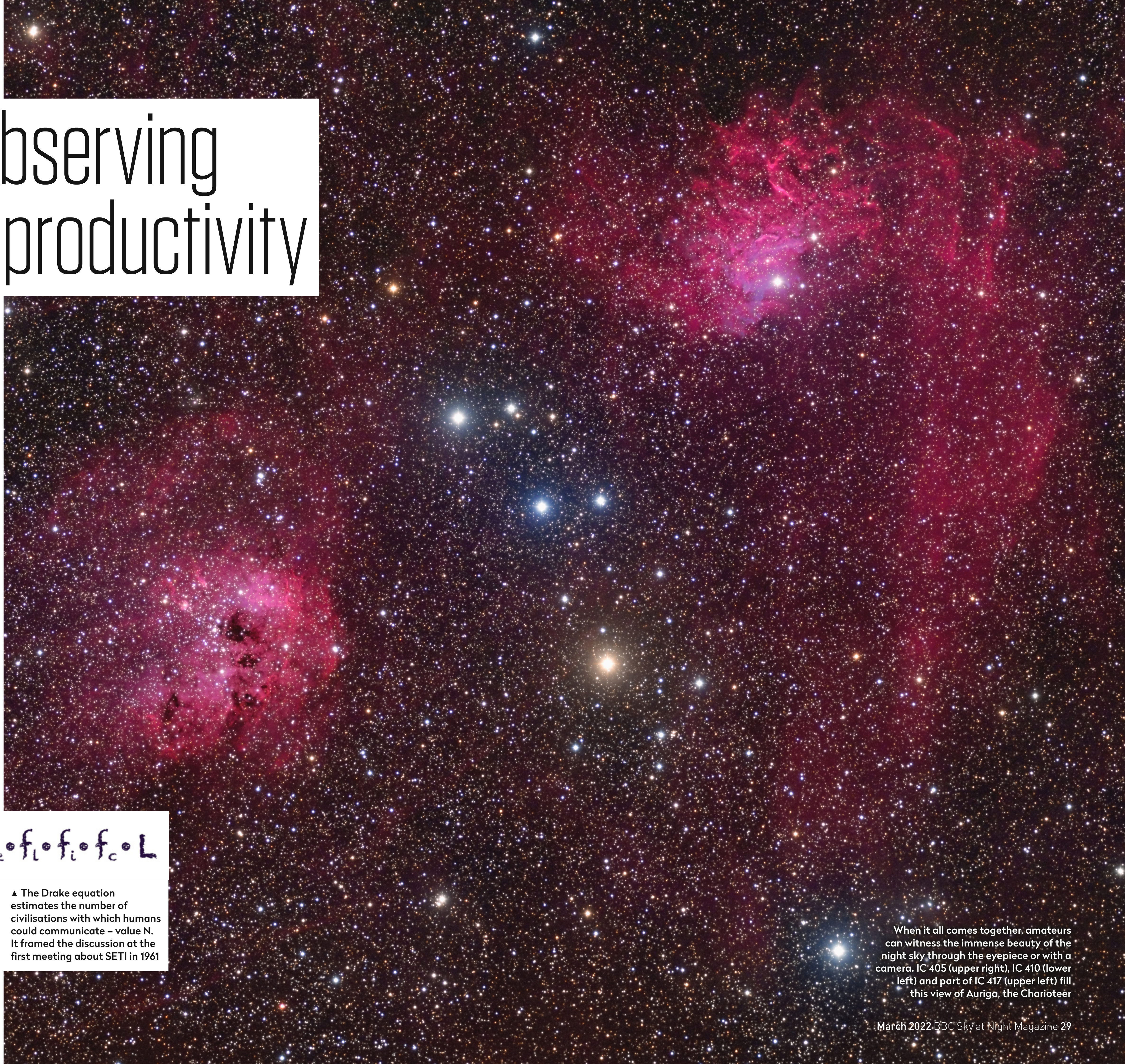
One feature of the Drake equation is that it can be adapted to address other big questions of great importance to readers of this magazine, such as 'How productive am I likely to be as an imager or observer of the night sky?' The answer to this simple question is surprisingly complicated. In fact, I've identified six factors that can affect an astronomer's productivity, which will all be discussed in this article. As you'll see, some are well within your control, while others are just a fact of life (*your* life), but their impacts on backyard astronomy can nevertheless be minimised. ▸

Frank Drake, here at Cornell University in 2017, is a pioneer of SETI – the Search for Extraterrestrial Intelligence

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

▲ The Drake equation estimates the number of civilisations with which humans could communicate – value N. It framed the discussion at the first meeting about SETI in 1961

AMALEXS, SETI, RON BRECHER



When it all comes together, amateurs can witness the immense beauty of the night sky through the eyepiece or with a camera. IC 405 (upper right), IC 410 (lower left) and part of IC 417 (upper left) fill this view of Auriga, the Charioteer

◂ The author's Doghouse Observatory makes all-night imaging comfortable, even in the depths of winter. The walls also provide a wind break for the telescope, for steadier views

▾ Dress for a much colder temperature than it is, with a hat and gloves, and warm socks and boots. Also add a hot drink and some heating pads. An extra sock (lower left) over your finderscope can keep dew off

The opportunities for remote observing and imaging are often more numerous. This image of the Silver Dollar Galaxy, NGC 253, was captured from a remote observatory in Australia and processed by the author

RON BRECHER X 3, NGC 253 RAW DATA COURTESY OF BRETT SOAMES

The Make-or-Break equation

▸ To begin to answer that question, 'How productive am I likely to be as an imager or observer of the night sky?', let's look at the 'Make-or-Break equation', adapted from the Drake equation. We can use this to estimate the number of productive nights per year for an amateur astronomer, denoted by N:

$$N = Y \times f_c \times f_m \times f_{fr} \times f_{bw} \times f_{bt} \times f_e$$

Where the various variables represent these factors:

- Y = total number of nights in a year
- f_c = fraction of nights that are clear
- f_m = fraction of nights that are more or less Moon-free
- f_{fr} = fraction of 'free' nights
- f_{bw} = fraction of nights with bearable wind
- f_{bt} = fraction of nights with a bearable temperature
- f_e = fraction of time that all equipment works properly

Let's look at understanding how these factors can influence productivity estimates and identify ways to mitigate factors that reduce productivity. I'll discuss both imaging and visual observing, as I enjoy both.

Managing the weather

The number of nights in a year (represented by the Y value of 365.25 nights) is an example of one factor that is beyond your control. Similarly, the Moon is up and interferes with deep-sky observing and imaging about half the time (f_m = 0.5), between first and last quarter, like it or not. Of course, visual observers, and planetary and lunar imagers are less bothered by moonlight – they may even relish it – so their f_m value is higher, perhaps 0.8. Imagers with narrowband filters can still image in moonlight, so a narrowband approach can increase overall productivity.

You only need to practise astronomy for a short time to conclude that you can't control the weather, and that is true: manipulating local cloud cover (f_c) is, of course, still beyond our grasp. However, other aspects of the weather – like intense cold, stifling heat and humidity – can be mitigated.

Visual observers and portable imagers are more affected by weather than those who use permanent setups, whether local or remote. The best way to increase the value of f_{bt} is to dress for the weather. On clear nights, our bodies radiate heat away into space, so dress for a temperature that is about 10–15°C cooler than the thermometer says it is. Warm socks, boots, gloves and a hat will keep your extremities warm. On the coldest nights (about –28°C for me) I use disposable chemical heater packs in gloves and boots, and an extra heater in my pocket to defrost the eyepiece. It's also a good idea to have somewhere warm for battery-powered accessories like a flashlight or a laser pointer. Lastly, an insulated mug containing a piping-hot drink can help extend your observing or imaging session.

> *Astrophotographers who purchase time or host their equipment at a remote observatory can achieve the highest values for f_c. After all, it's always clear somewhere*

At the other extreme, summer nights can be warm and humid, and with them can come a plague of biting insects. I wear lightweight long-sleeved clothes and trousers, and spray my clothes with bug repellant, avoiding getting any on my hands or around my eyes – I have heard that they can damage optical coatings. If there's no breeze, a small fan can help keep you cool, too.

Wind is an important determining factor – not only for comfort, but also productivity, particularly when it comes to imaging. So how can we increase the value of f_{bw}? The more solidly mounted your telescope, the less you'll be affected by wind. An observing tent can help to mitigate the impact of any breezes on portable visual or photographic observing. Even better is a permanent setup with walls to block the wind; I've never had to interrupt an imaging session from my Doghouse Observatory because of wind.

Astrophotographers who purchase time or host their equipment at a remote observatory can achieve the highest values for f_c. After all, it's always clear somewhere. Commercial remote observatories are situated under some of the best skies in both hemispheres, including the southern United States, Chile, Spain and Australia. They're still affected by moonlight, of course, but you don't need to worry about temperature, wind or biting insects.

Planning pays off

Many of us come to astronomy in middle age or later. By this time in our lives, we usually have a lot of responsibilities, whether family, work or both. It can be hard to make time for astronomy. And it's not just acquiring imaging data that takes time, we also need time for other things, like planning an observing session, or processing raw data to make stunning photos. How can we maximise productivity for that little bit of free time (f_{fr}) when the stars align in a clear, moonless sky?

Portable gear needs to be set up and taken down for every imaging session. This process usually involves waiting until you can see enough stars to polar align, troubleshooting equipment issues along the way and then having to take down the gear when clouds roll in, only to start over again the next clear night. Anything you can do to increase the amount of ▸

◂ With cameras, filter wheels, focusers and a mount to control, it's important to ensure that drivers and software – and the computer they're installed on – are up to date and working reliably, and that equipment is set up properly. Try and make any checks before a session

▴ Even if you have top of the range equipment, a pair of binoculars can increase the productivity of your visual observing

▸ imaging vs setting up time is helpful here. Practise getting efficient and accurate at setting up your equipment so that you're ready to go at dusk. If you can safely leave all or part of your portable rig fully set up to use over multiple nights, that will reduce the set up and take down time. It will also make imaging or observing much more productive, assuming the weather cooperates. If you are using permanent setups for imaging or observing, these take almost no time to get up and running, provided conditions are good, and all the equipment is working.

When it comes to portability, the best solution for visual observers is a pair of binoculars. These require virtually no set up time and can hugely increase the number of evenings you can spend at least a few moments stargazing. Sometimes a few minutes of binocular therapy between broken clouds can help tide you over until the next clear, moonless night.

Hardware, software and drivers

Keeping the value of f_e near a value of 1 means that when conditions are right, your gear will work properly. The key to success is to do as much setting up, maintenance and testing as possible outside of prime imaging or observing time.

For visual observers, this means becoming efficient at setting up and taking down equipment. With a little practice, tasks like collimation or aligning your finder can be performed quickly, before it's dark enough for serious viewing. If you use a computerised, or Go-To, mount for observing, learn how it works during the day and practise using it on mediocre nights. That will make those prime sessions more rewarding, because you won't be fiddling with any kit.

Compared to visual observing setups, imaging setups contain a lot more components that have the potential to reduce the value of f_e. While I use an electronics-free 10- or 20-inch Dobsonian-mounted reflector – along with a red flashlight and a map – for most of my visual observing, my imaging rig is much more complicated. It includes a heavy-duty mount carrying two telescopes, each with a cooled camera, an electronic filter wheel and an electronic focuser. There's also a guide camera, a couple of dew heaters and a PC to control all the imaging equipment. Problems with the operation of any piece of equipment, such as its ability to connect to the computer (via its driver) or a software problem, can all end a night of imaging. And little things like cables hanging off your scope can cause big problems. Balance can change as the mount tracks, or worse, a cable can snag and cause damage to equipment.

Astrophotographers can practise the same good habits mentioned above for visual observers. Permanent setups should have their polar alignment checked periodically (mine changes slightly when the ground freezes or thaws). In addition, it is important to keep software and equipment drivers up to date. Note, however, that it is never necessary to do this right before a prime night of imaging, or during an expected stretch of good weather. Instead, do it when the forecast is poor if you can. I regularly back up my PC so I can easily switch back to a setup that worked, if needed. An advantage of imaging remotely is that there's little you need to do to keep the value of f_e close to 1, as the observatory host is expected to keep all the equipment running smoothly.

If you use a computer for astronomy, you have probably experienced an unexpected shutdown. Operating system (OS) updates that automatically reboot the computer will stop an imaging run in its tracks. Fortunately, this is often easily solved by disabling automatic updates. If you can't disable these, you may be able to specify that they only occur during the day, when you aren't imaging. Applications (apps, programs) can crash, too. Again, testing during non-prime time will expose any problems, giving you a chance to fix them before your next session.

Visual observers usually don't need to worry about unplanned shutdowns due to electronics. But they can have other unplanned issues, such as dew on the optics. A dew shield and/or electric dew heaters are a must in dew-prone locations. I keep a sock over my red-dot finder to stop the front glass fogging up; without it, I can't find my visual targets.

Ron Brecher observes deep-sky objects from his driveway in Ontario, Canada, while simultaneously imaging from his observatory. See **astrodoc.ca**

FACTOR	PORTABLE VISUAL	PORTABLE IMAGING	PERMANENT IMAGING	REMOTE IMAGING
Y	365	365	365	365
f_c	0.6	0.4	0.4	1.0
f_m	0.8	0.5	0.5	0.5
f_{fr}	0.5	0.5	0.8	0.9
f_{bw}	0.9	0.7	0.9	0.9
f_{bt}	0.7	0.7	0.9	1.0
f_e	0.9	0.8	0.9	1.0
N (night/year)	**50**	**14**	**43**	**148**

◂ In this table the author has applied the variables of the Make-or-Break equation to give examples of how many productive nights of astronomy per year might be achieved with different setups

▾ The Moon brightens the sky about half the time, making deep-sky objects harder to see. Embracing the Moon as a photographic or visual target can boost the number of nights you enjoy astronomy

Productivity estimates

When you throw all of the factors discussed above into a pot and assign values for different scenarios, it's possible to estimate productivity, in nights per year. I've tabulated estimates for my own observing situations (see, table, left); your results may vary.

Eyepiece observers can expect four or five good viewing sessions a month, if they're not too bothered about moonlight. For astro imagers, there are big differences depending on your setup. Remote imaging can be done on any relatively Moon-free night, or about 148 nights per year. But, if like me, you enjoy hands-on time with your own equipment then a local permanent or portable setup may be a better, if less productive, choice. My productivity increased about threefold when I transitioned from a portable setup to a home observatory for imaging. I also observe with a portable setup, and sometimes access southern skies via remote observatories; truly the best of all worlds.

Enjoy the view

Viewed through the lens of the Make-or-Break equation, the obstacles amateur astronomers must surmount come into sharp focus. Fortunately, there are practical ways to adapt to our own unique circumstances and interests to maximise productivity. As in most things, success usually boils down to being well-prepared when opportunities present themselves and being able to recognise problems and implement solutions quickly. For me, the beauty of the sky, through the eyepiece and through the camera, makes it all worthwhile. To paraphrase the singer Miley Cyrus, astronomy's a climb, but the view is great. Enjoy the view as often as you can!