An Introduction To Astro-Photography

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Astro-Photographers Do It In The Dark

Types of Astro-Photography

- There are two types of Astro-Photography:-

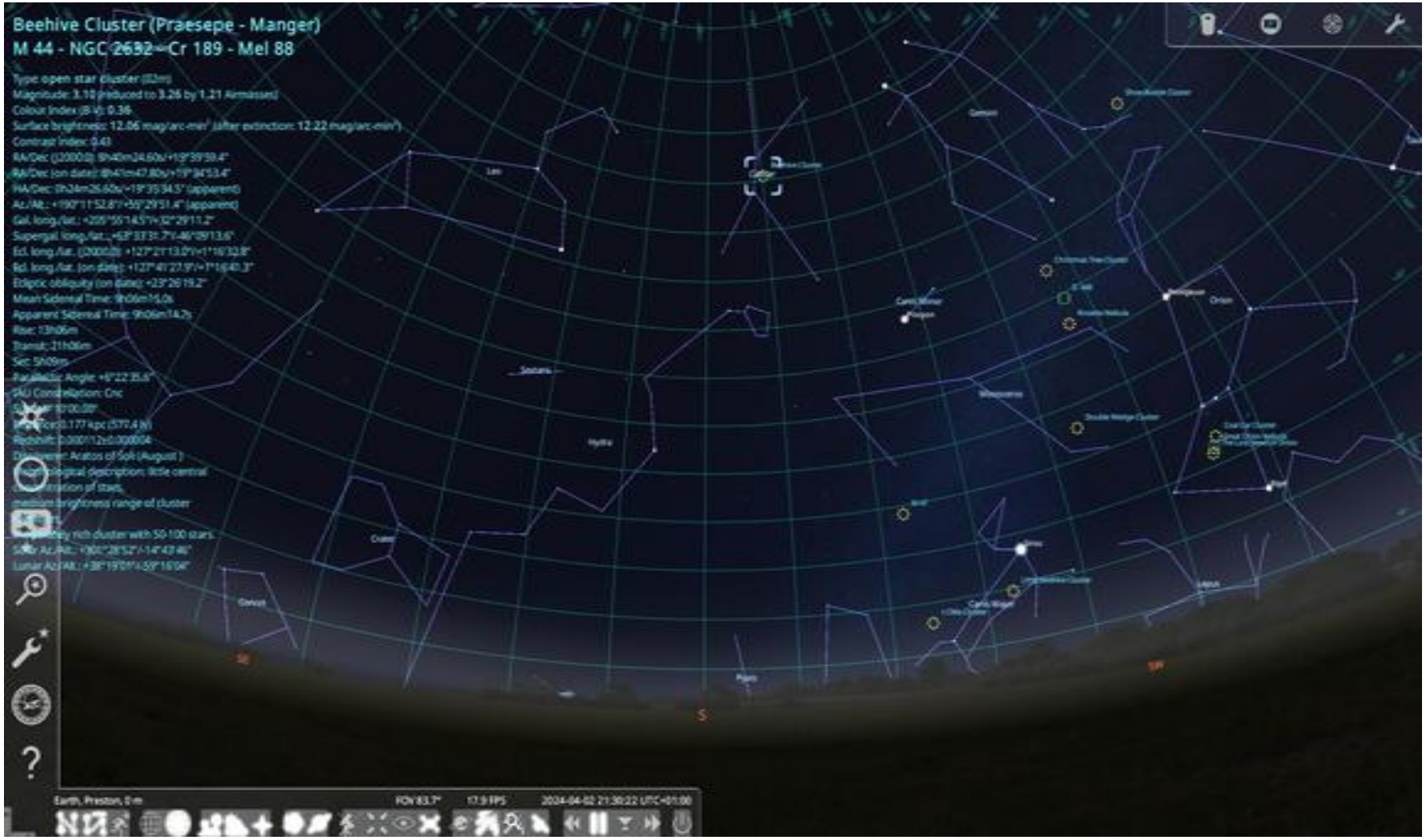
- Landscape Astro-Photography – Star Trails, Milky Way, Aurora.
- ‘Pure’ Astro-Photography – Moon, Planets, DSOs → Galaxies, Nebula.

- All types of Astro-Photography require planning. 4 W’s:-
  - What to photograph.
  - When to photograph.
  - Where to photograph.
  - Weather to bother!!

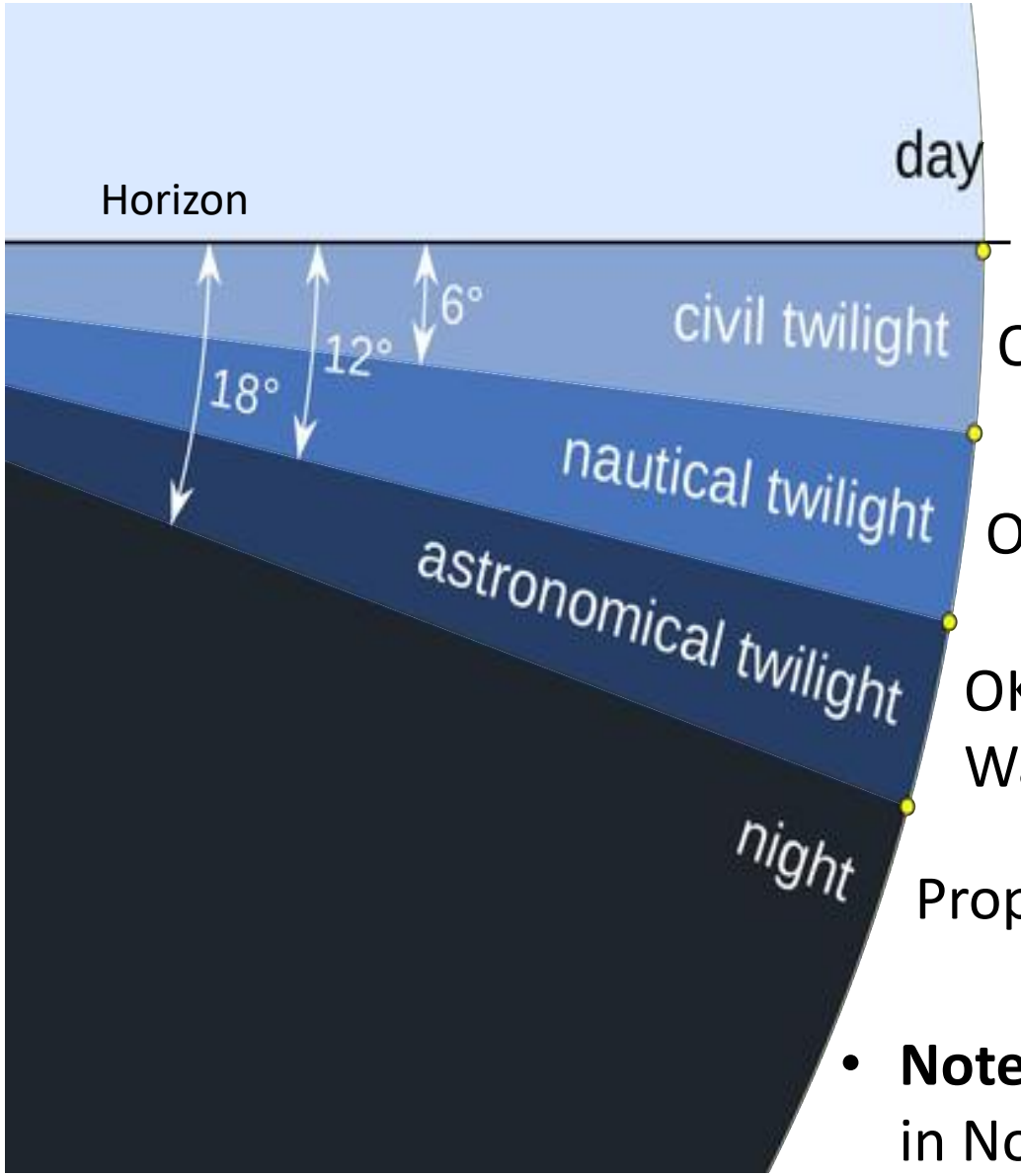
What – Planetarium Software

Stellarium

- Free Download from www.stellarium.org.
- Windows, Mac or Linux – Mobile version also available.
- Shows the night sky for any location/date.
- Shows framing of objects by setting your Focal Length and camera sensor size.
- Shows compass settings – note that objects are highest in the sky when due south.



When – Day, Night and Twilight



OK for Moon, not for stars.

Only Bright stars visible

OK for star trails and Milky Way, but not fully dark.

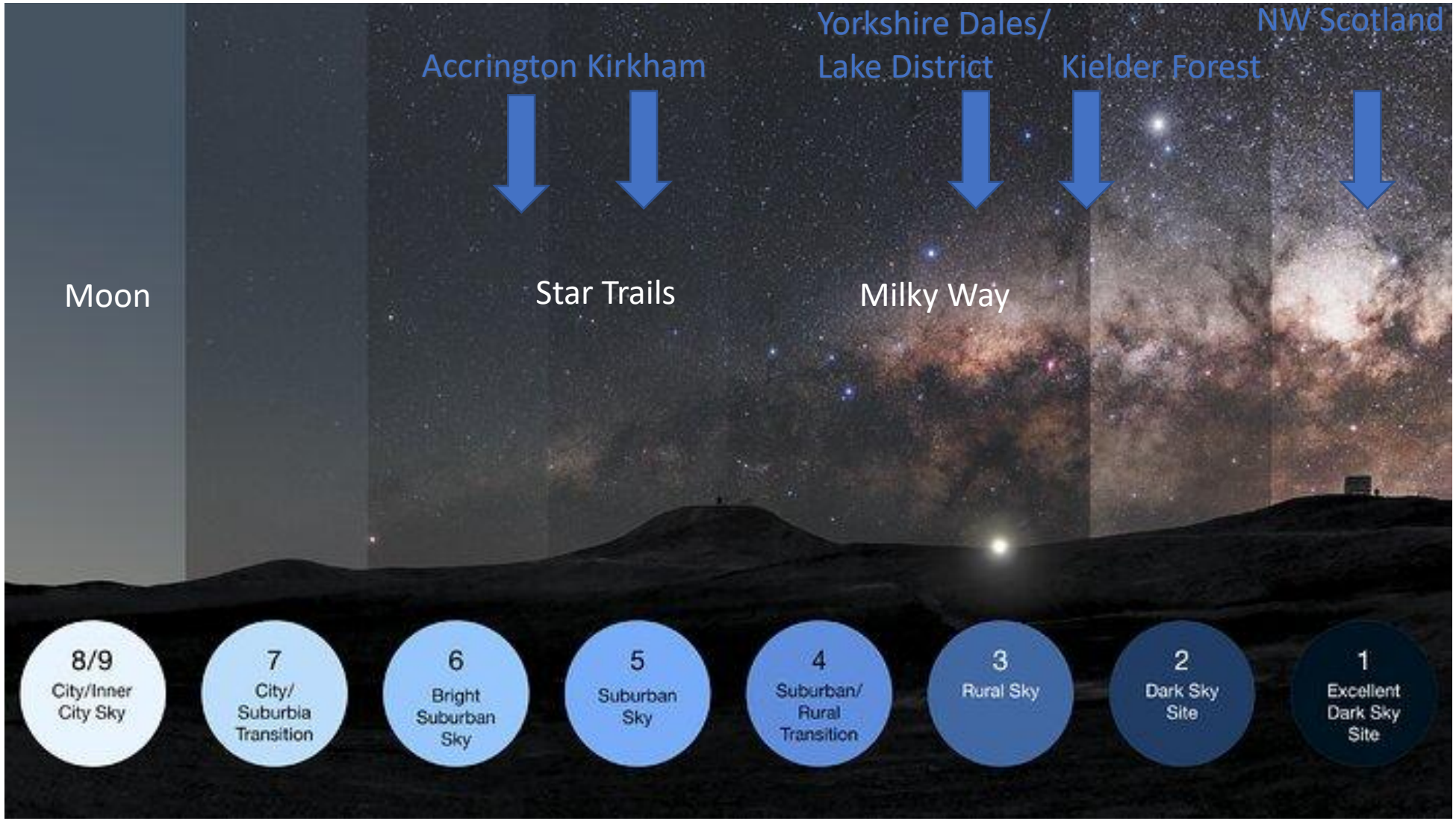
Proper Night.

- Google Search for Twilight Times
- www.clearoutside.com
- Mobile app: Golden Hour

- **Note** – in late May, June and July, we never reach true Night in North-West UK.

Where - Light Pollution

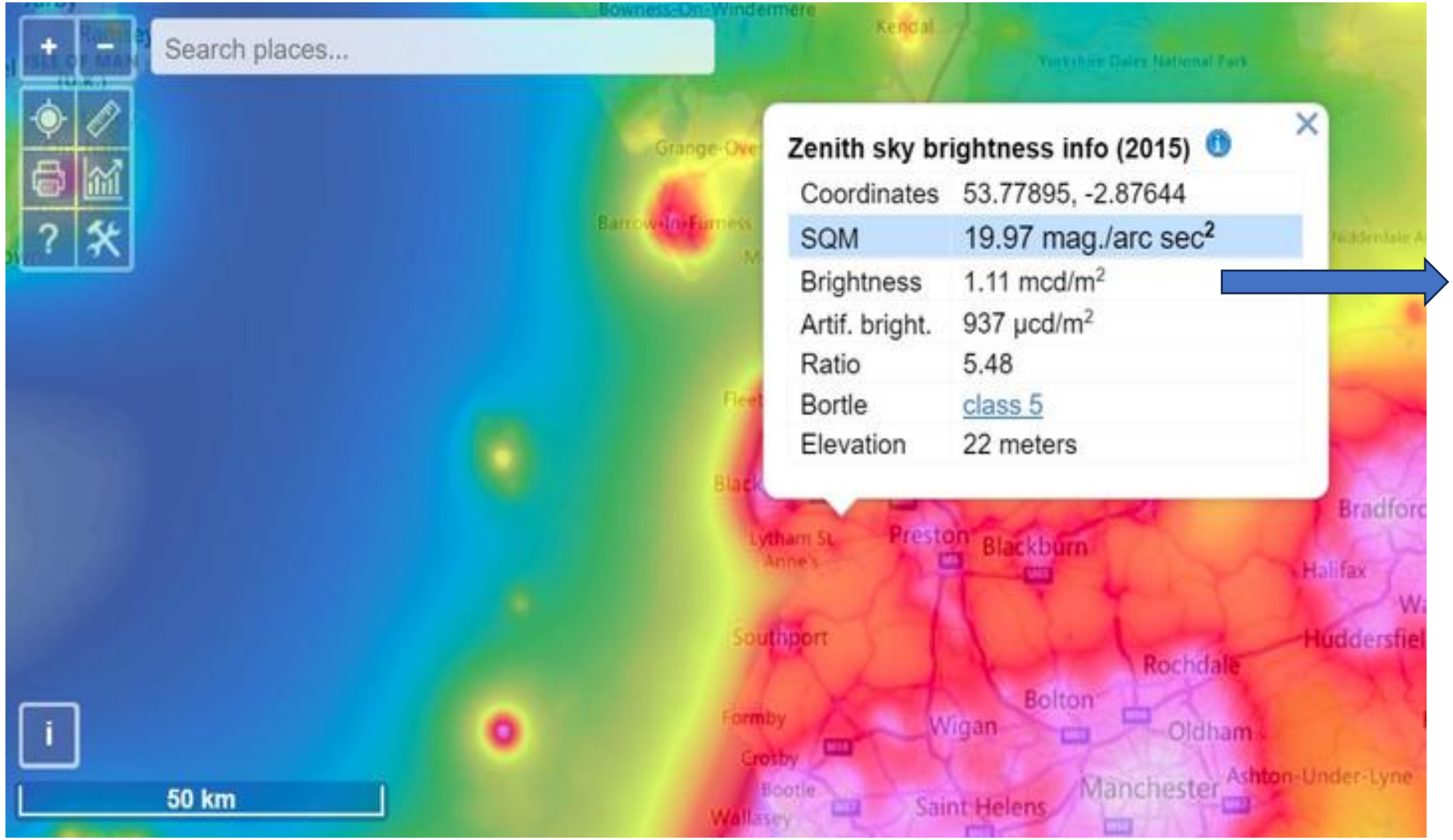
- Light Pollution is measured on the Bortle Scale, or by sky brightness.



Bortle Scale

Where – Light Pollution

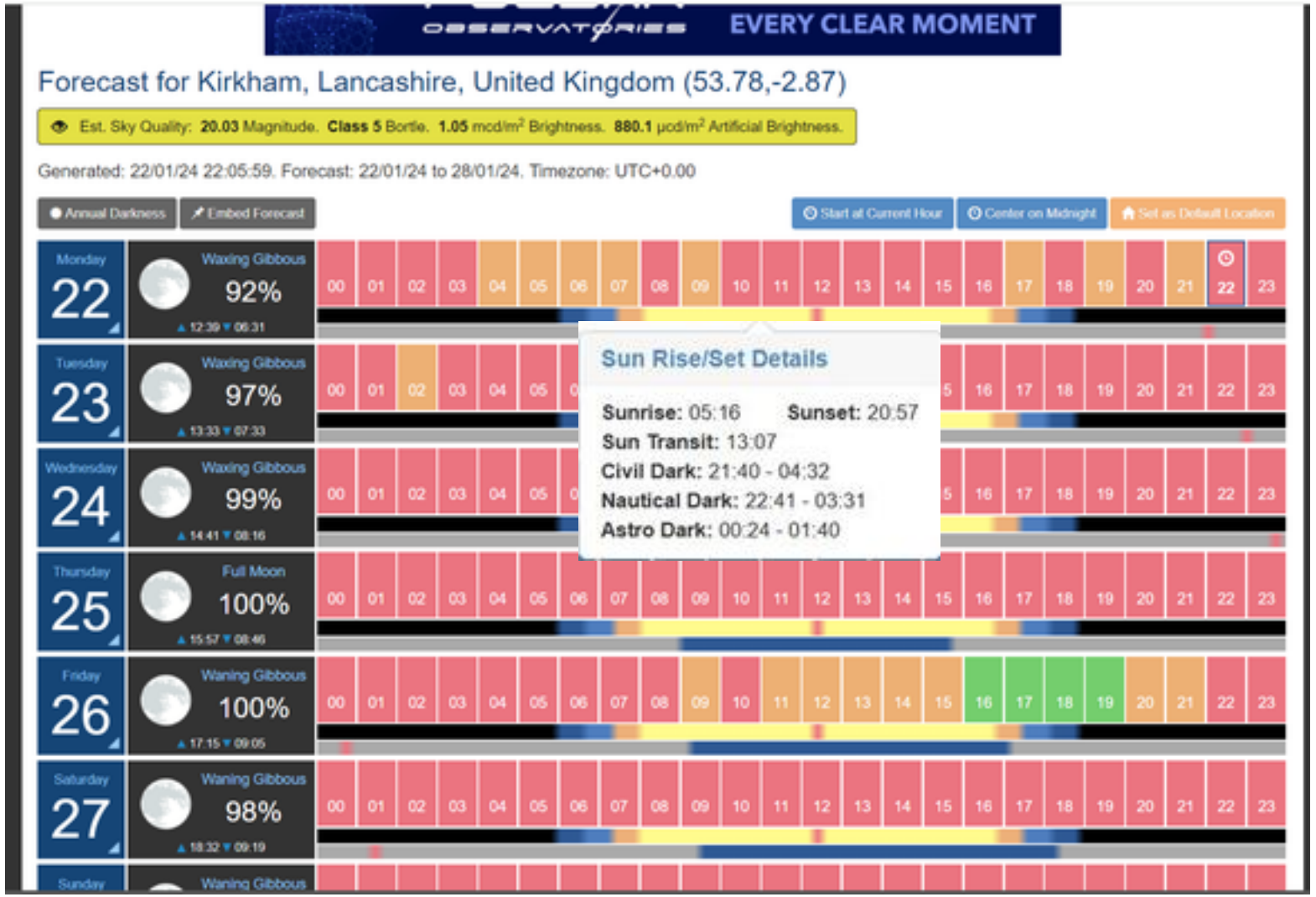
- Light Pollution Map: www.lightpollutionmap.info



- Brightness = 1.11
- Darkest skies have brightness = 0.171, so my sky is ~6 times as bright.
- A Dark Sky site gathers detail 6 times more quickly than at my location.

Weather

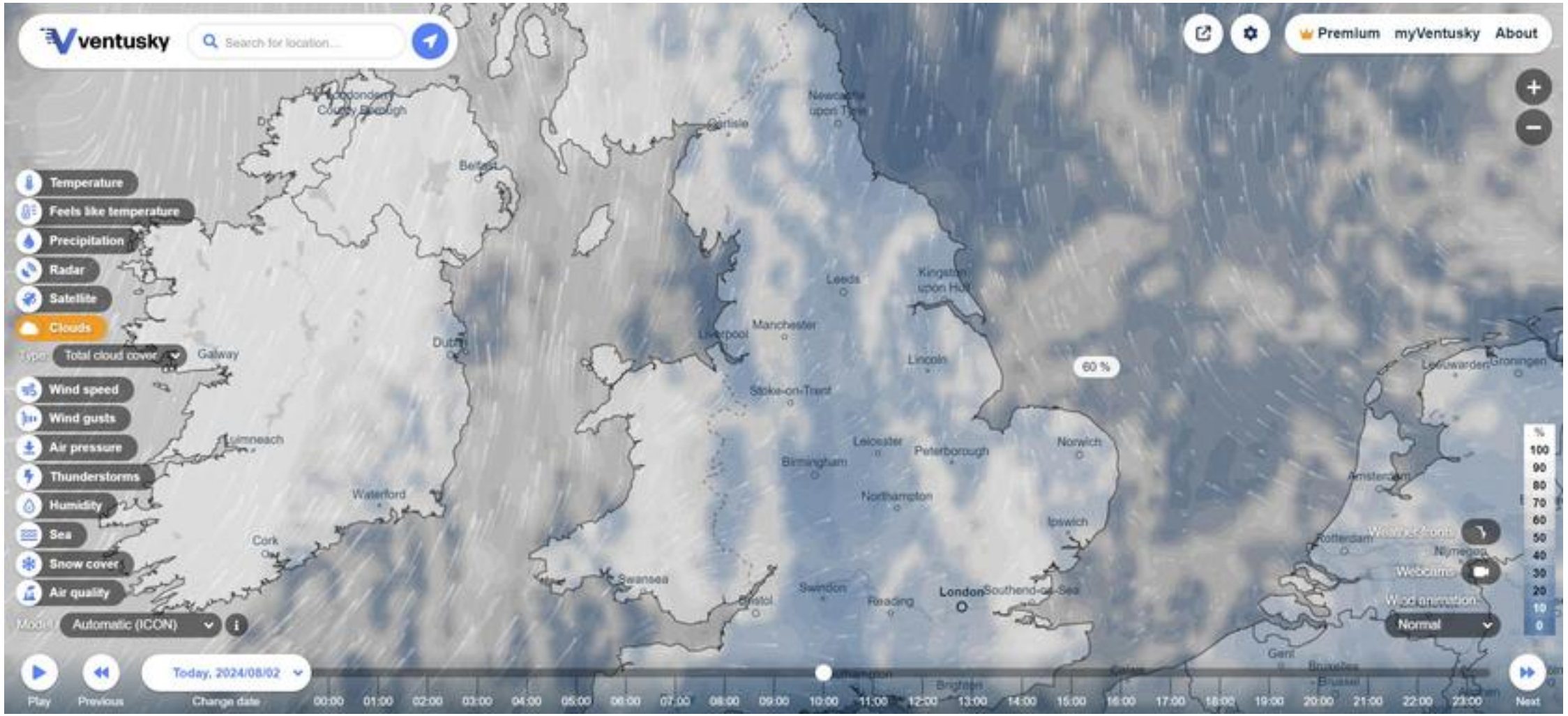
- Clear Outside –
- Astro Weather Forecast
  - On-Line version at www.clearoutside.com. Free phone app also available.
  - Expands for Cloud Cover, Temperature, Rain, Fog, Wind
  - Shows sunrise, sunset, moonrise, moonset, moon phase, Twilight times.
  - Also shows Light Pollution levels



Summary colour shows weather to bother – usually Red in UK!

Weather

www.ventusky.com – shows predicted cloud cover (also wind, rain, temperature etc).
Mobile App also available.



The Moon

- Not affected by light pollution.
- Required equipment – Camera, Long Lens, Tripod.

Stellarium View:-
Full Frame Camera @ 600mm

The Moon - Technique

- Choose a Partial Moon - A Full Moon can look flat and lacking detail.
- Lens mounted on tripod, longest zoom, image stabilisation off.
- Camera Settings – similar to terrestrial settings:-
  - Moderate aperture ~ F8-10 → good depth of field.
  - Fairly short exposure times ~1/50s.
  - Low ISO ~ 100 – 200.
- Manual focus – focus using Live View, zoom in on rear screen and focus on ‘the terminator’.
- Remote shutter release or timer delay (10sec). Lock the mirror up (DSLR) Use electronic shutter if available → Minimise camera shake.
- Take several images→ Increases chance of clear air (Lucky Imaging).

Half Moon

Planets are too small without specialist equipment.

- APS-C Camera.
- 600mm Lens + 1.4 Convertor. → 1344mm Effective Focal Length.
- F9, 1/50s, ISO200

Lunar Eclipse

Total Eclipse ~ Every 2.5 Years → Next one in UK 20th Dec 2029

Eclipse Mosaic – 28th Sep 2015

2:15AM
F5, ISO100, 1/400s

3:30AM
F5, ISO400, 13s

Factor of 20,000 in brightness

Star Trails

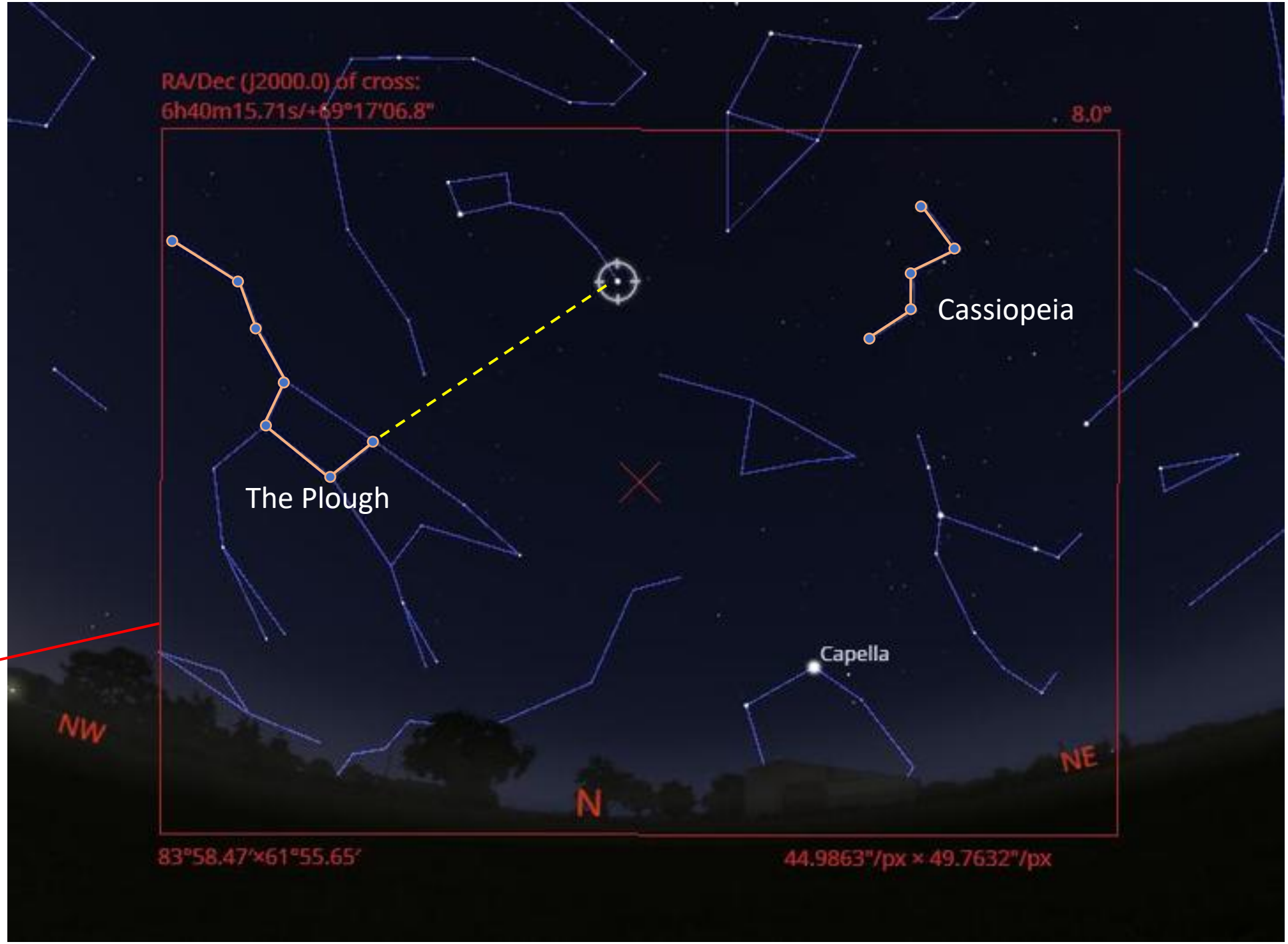
- Very dark skies not essential - Bortle 5 or better.
- Required Equipment – Camera, Wide Angle Lens, Tripod.
- Intervalometer (optional) and Spare Batteries(useful).

- Look north and include the Pole Star for circular star trails.
- Include some foreground interest pointing into the sky – lone tree, isolated building.

Finding Polaris

Find the Plough, then follow a line from the pointer stars.

20mm Lens on Full Frame Camera.



Star Trails Technique

- Take multiple images rather than 1 long image →Avoids over-exposing light pollution.
- 30s Shutter Speed recommended.
- Widest aperture to maximise light gathering.
- Moderate ISO ~ 800-1600 → Stars have colour, high ISO will saturate bright stars.
- Long Exposure Noise Reduction Off.
- Focus manually using Live View →Set high ISO, manually focus at about infinity, point at a bright star, magnify the rear screen view, adjust focus until star size is minimised.
- Re-set ISO and frame the image.
- Take Raw images.
- Take a test shot and check for focus and framing.
- Use an intervalometer with ~ 1sec between exposures, or simply keep pressing shutter release. Do not use the timer delay.
- Take images for ~ 1 hour.

Star Trails Example

Bortle 3/4 Boundary – Single Unprocessed Exposure

14mm Focal Length. 30sec, F4, ISO1600.

1 of 110 images taken over 55 minutes).

Star Trails Processing

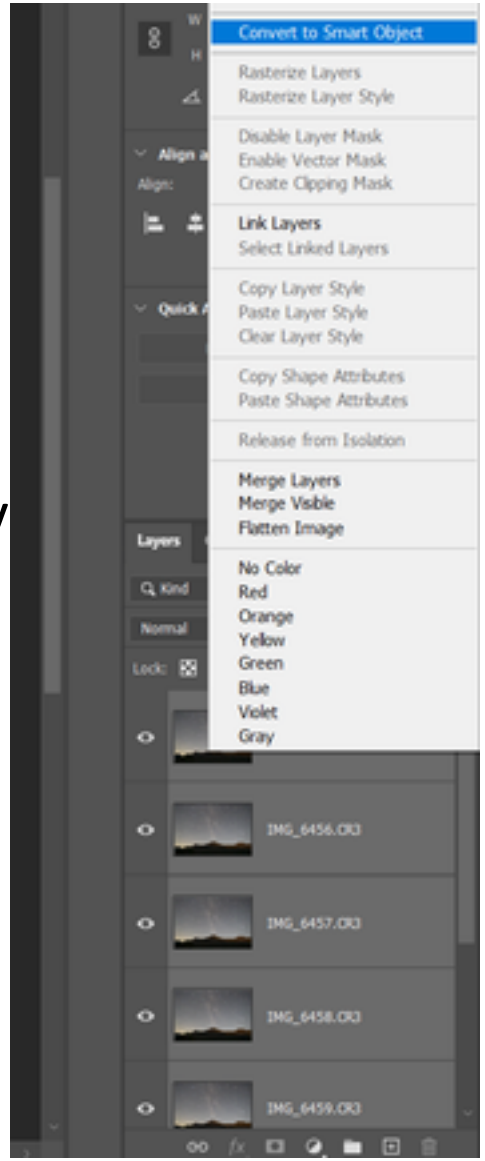
- Open images in Lightroom and apply lens profile (corrects aberrations).

- **1) Foreground Image** - Open images into Photoshop as layers. Select all layers, convert to Smart Object and change the Stack Mode to Mean or Median → Reduces noise.
- **2) Star Trails Image** - Open images again in Photoshop, keep bottom layer blend mode as Normal and set all other layers to Lighten blend mode→ Accumulates the star trails.
- **3) Combine Images** - Flatten Star Trails layers and copy onto the Foreground image using a Lighten blend mode.

Star Trails Processing – Smart Object Blend

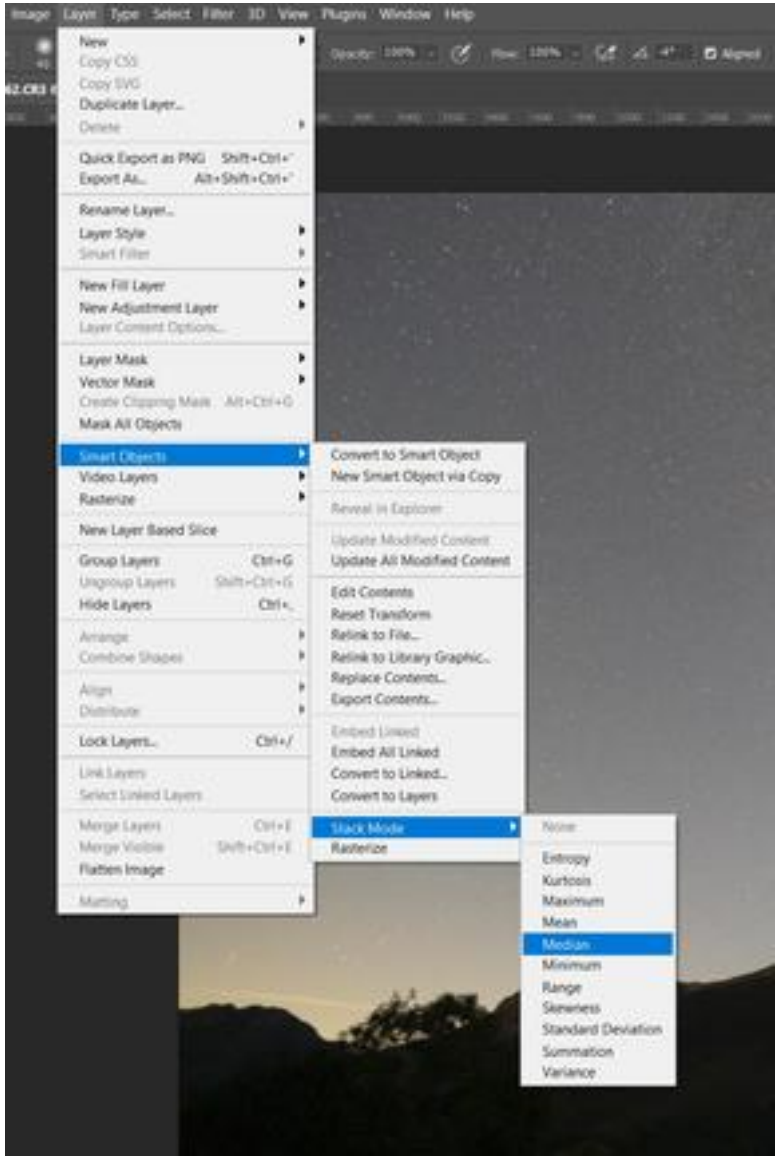
Select All Layers, Right click and select Convert To Smart Object.

This creates a single layer – only the top layer is visible, but data from underlying layers is still present.



From Top Menu, Select
Layer→
Smart Objects →
Stack Mode→
Median or Mean

This produces an image that is the average of all layers.



Noise Reduction By Stacking

- All images contain noise. When we brighten a dark image (high ISO or post processing), we amplify the noise, making it visible.
- To reduce noise we need to expose for longer:-

> - Signal/Noise Ratio improves in proportion to √(Exposure time).

- Several stacked frames gives the same benefit as a single long exposure → it is the TOTAL integration time that matters.

  - Stack 4 Images → Signal/Noise improves by a factor of 2.
  - Stack 16 Images → Signal/Noise ratio improves by a factor of 4.

Benefit Of Stacking

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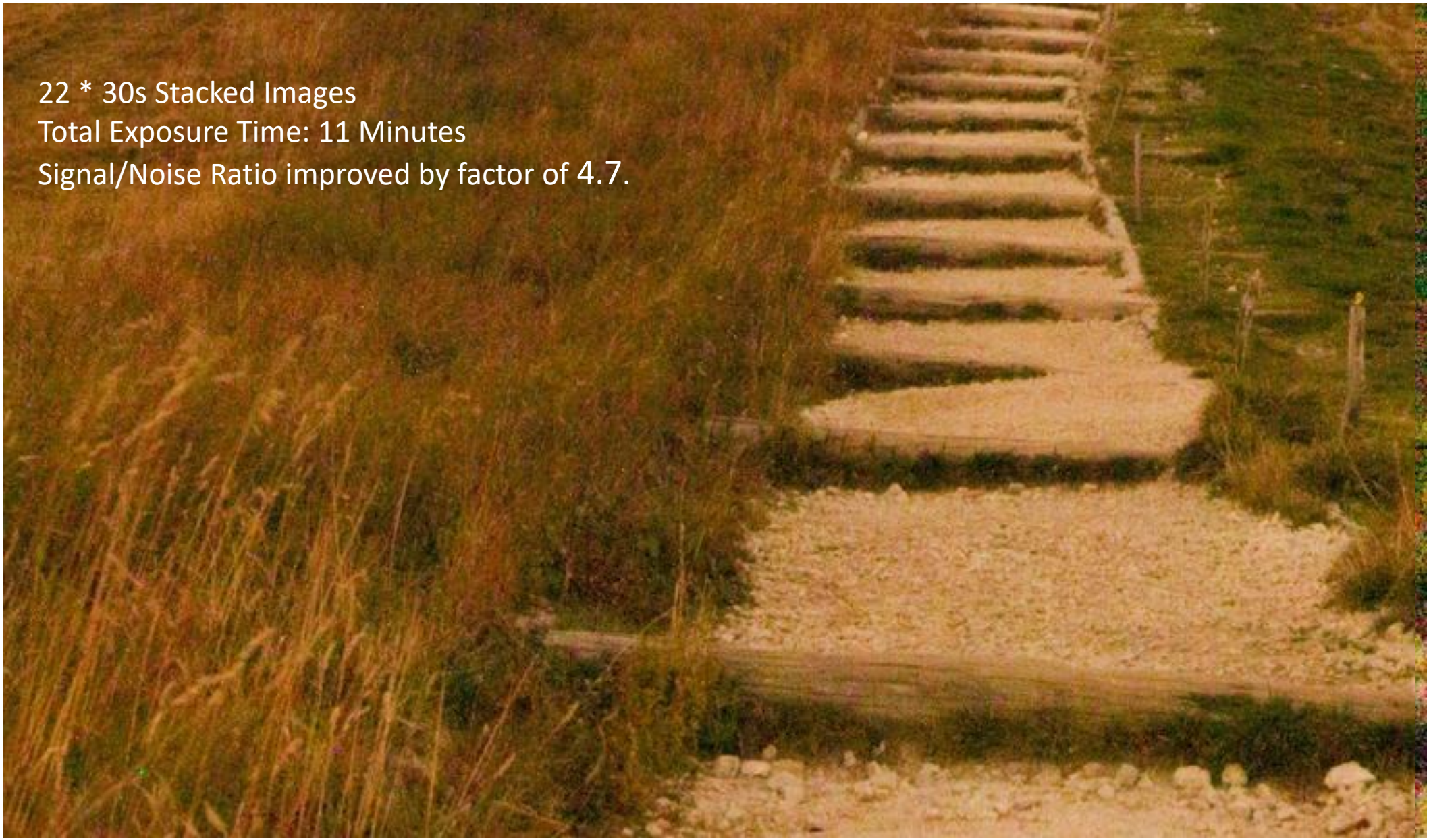

Benefit Of Stacking

Star Trails Processing

- 1) Stacked and averaged Foreground Image.

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- 2) Adjust Colour temperature/brightness in Camera Raw.

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- 3) Lighten Sky/Foreground selectively using masks.

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- 4) Introduce Stacked Star Layer.

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- 5) Change Blend Mode to Lighten.

Star Trails Processing

- 1) Stacked and averaged Foreground Image.
- 2) Adjust Colour temperature/brightness in Camera Raw.
- 3) Lighten Sky/Foreground selectively using masks.
- 4) Introduce Stacked Star Layer.
- 5) Change Blend Mode to Lighten.
- 6) Clone out plane trails and some final adjustments.

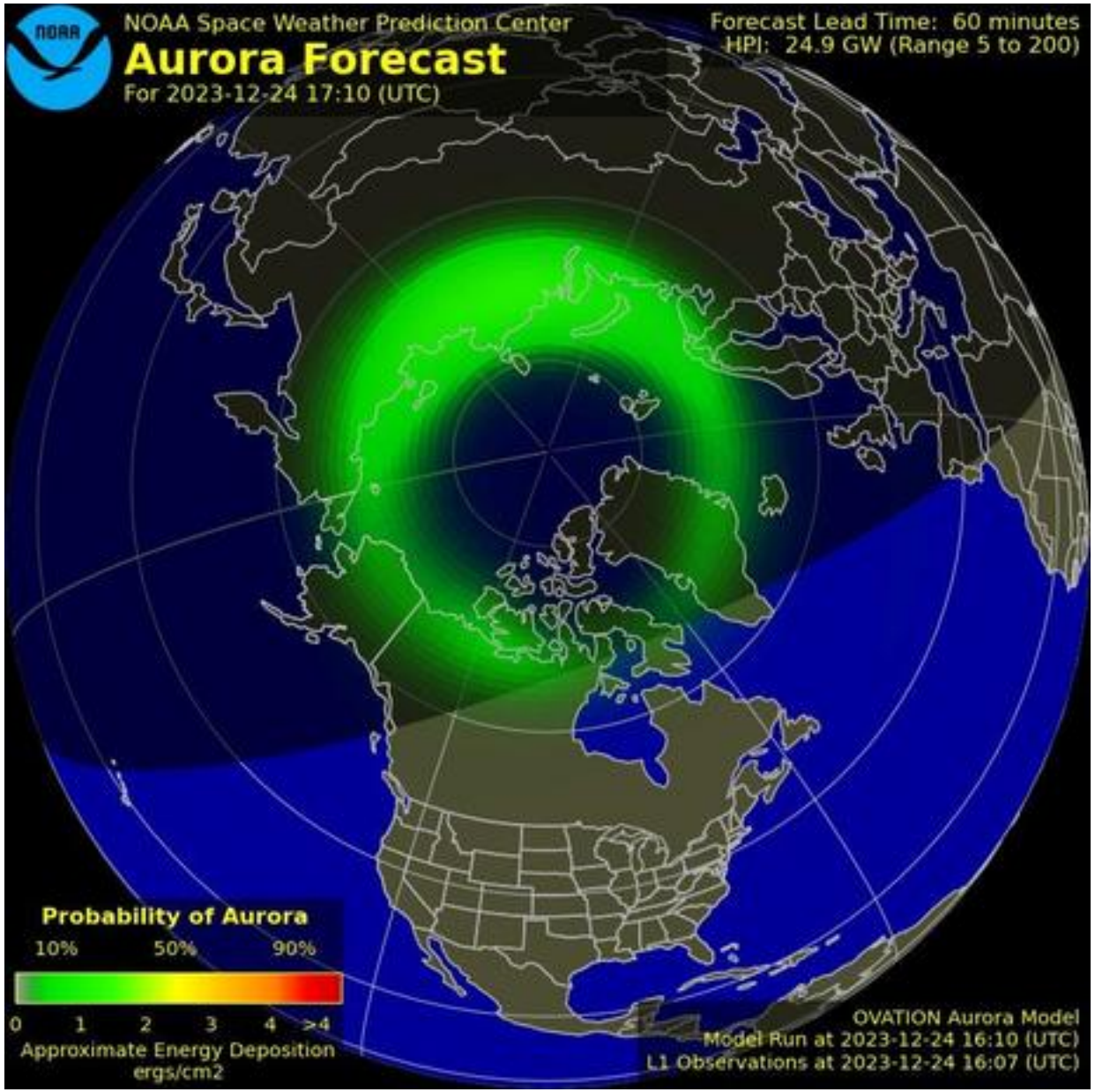
Stairway To Heaven!

The Aurora Borealis

- Aurora - created by high energy charged particles from the sun entering Earth's Atmosphere.
- The particles are guided by Earth's magnetic field and enter the atmosphere close to the poles ~ 60-75deg latitude.
- They interact with the atmosphere at different altitudes producing different colours:-
  - Green→ Oxygen at 60 to 90 miles height
  - Red→ Oxygen at 180-250 miles height
  - Blue/Purple → Nitrogen at 60 miles height
- In UK, we often only see red because it is at the highest altitude.
- The sun's activity varies on an 11 year cycle. The Solar Maximum is occurring 2024/25.

Aurora Forecasts

- Many websites offer Aurora Forecasts or text alerts. Eg For UK:-
  - https://aurorawatch.lancs.ac.uk/alerts/
- Mobile App: Aurora Alert
- The Space Weather Prediction Center gives a very accurate 30-90 Minute Forecast, based on a satellite 1.5 million km closer to the sun:-
  - https://www.swpc.noaa.gov/products/aurora-30-minute-forecast



Aurora Technique

- UK Aurora are likely on the Northern Horizon → Choose a location with a clear view north and low light pollution.
- Photograph over water for ‘twice the value!’
- Remove any Filters – Aurora light creates interference rings between filter and lens.
- Camera on Tripod. Wide Angle lens. Manual exposure. Wide Aperture.
- Exposure times ~5sec to show shapes in the aurora – longer exposures will blur the movement.
- Choice of ISO depends on aurora strength.
- Manual Focus using Live View on a bright star.
- Use 2 sec timer to avoid camera shake.
- Take longer exposure images for foreground if at a very dark location.

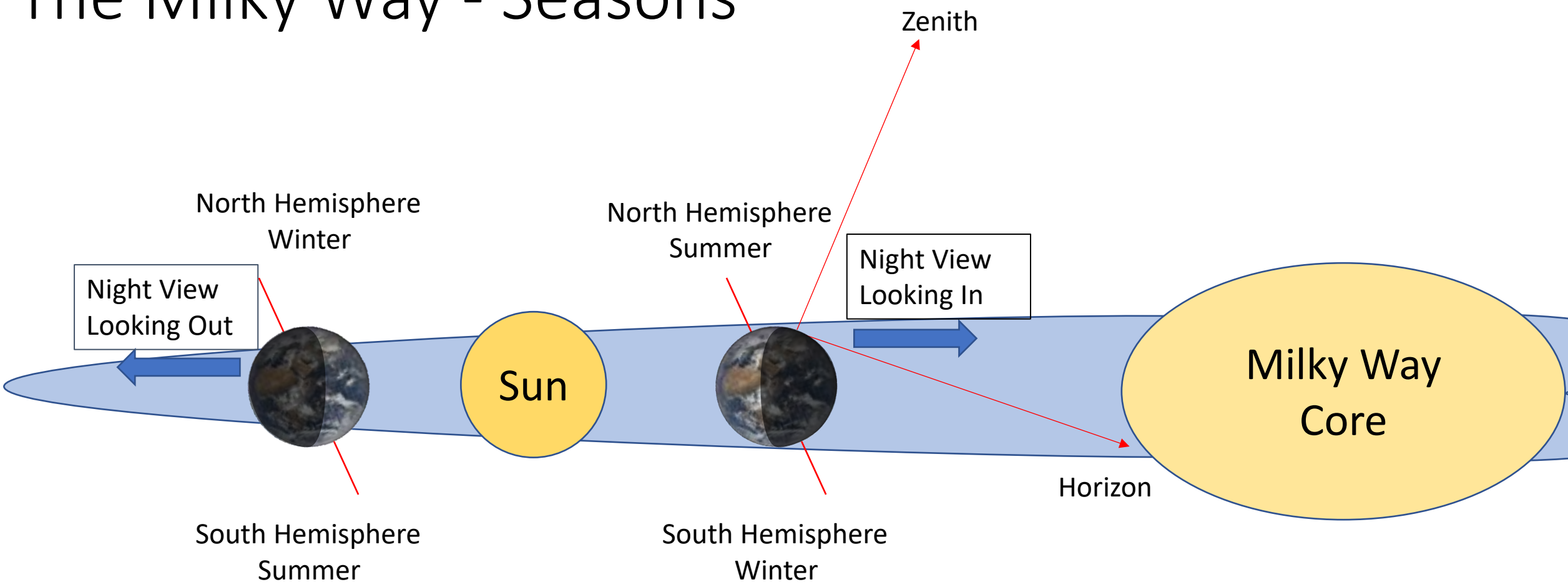
The Milky Way

- The Milky Way is our local spiral galaxy.
- It contains ~ 250,000,000,000 stars and is 100,000 Light Years in diameter.

- Context: Voyager 1 Spacecraft.
  - Would orbit Earth in ~ 40 minutes.
  - Travels ~ 1 Million miles a day.
  - Would take 1.8 Billion Years to cross Milky Way.

- The sun is about mid way out from the centre.
- We only see ~4000 bright stars in our local area. Beyond this, the stars merge into the Milky Way.

The Milky Way - Seasons



- In Northern Hemisphere, we look into the Milky Way core in Summer, out of the Milky Way in Winter.
- In the UK the Core is always low on the horizon – travel south for a better view.
- The Southern Hemisphere gets best view – the core is high in the sky during the dark winter nights.

- Earth's rotation is also inclined into the plane of the diagram, so the angle of the Milky Way disc varies as Earth rotates.

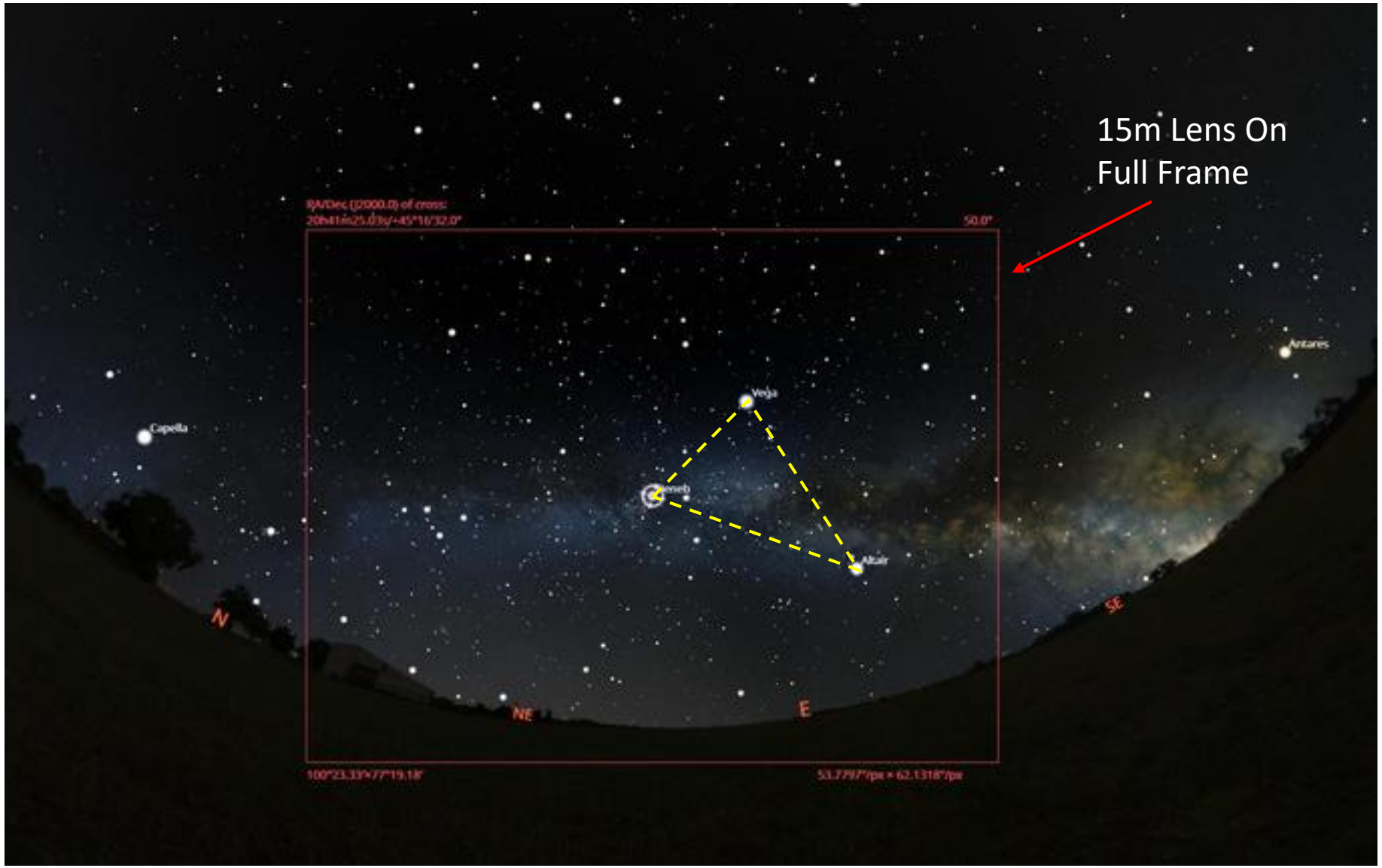
Milky Way – Spring

1st April – 4AM

- Milky Way forms an arc in the East.
- The core is below the horizon towards the SE.
- Look for the ‘Summer Triangle’ stars
  – Vega, Deneb, Altair

- Astronomical Night ends at 4:40am.

- To photograph the full arc requires a stitched panorama.

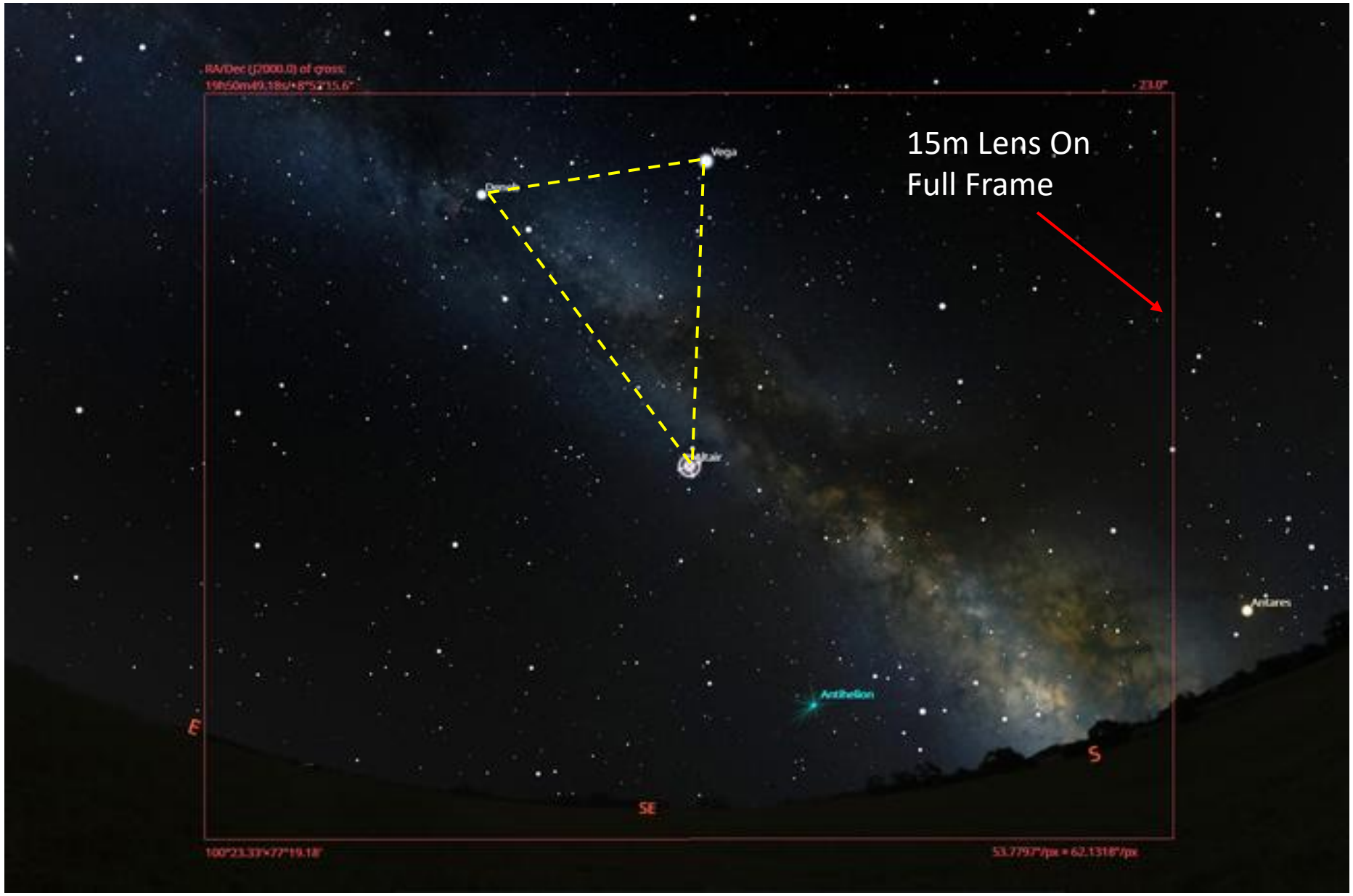


Milky Way – Summer

30th June – 0:30AM

- Milky Way rises from South at ~45deg.
- Best time of year for view of Core from UK - due South, so at its highest.
- Look for the ‘Summer Triangle’ stars
  – Vega, Deneb, Altair

- No astronomical night in UK, but it is darkest at 1am.

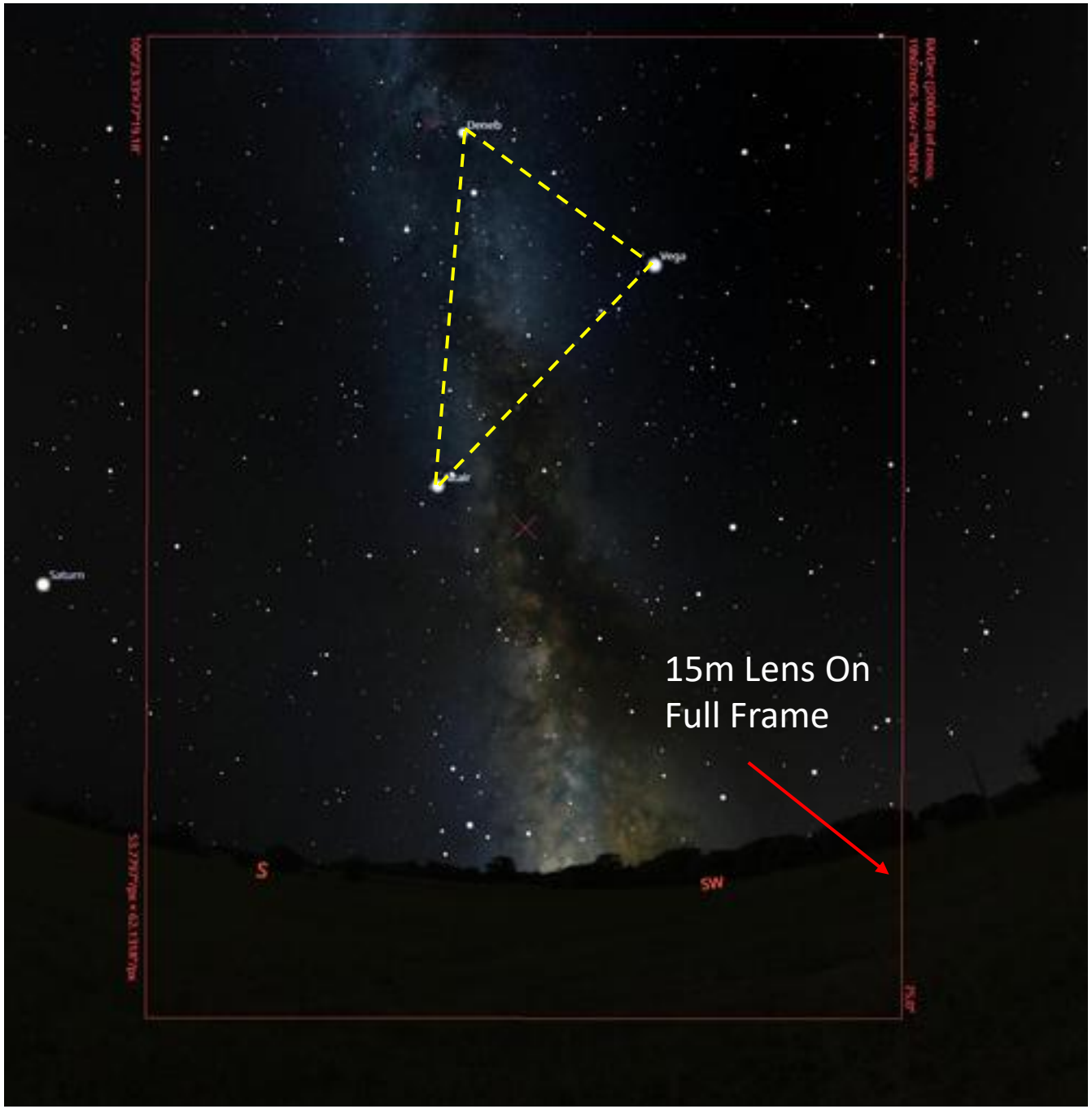


Milky Way - Autumn

15th Sep – 10pm

- Milky Way rises vertically in SW.
- Core is below horizon, but the view remains good.
- Look for the ‘Summer Triangle’ stars
  – Vega, Deneb, Altair

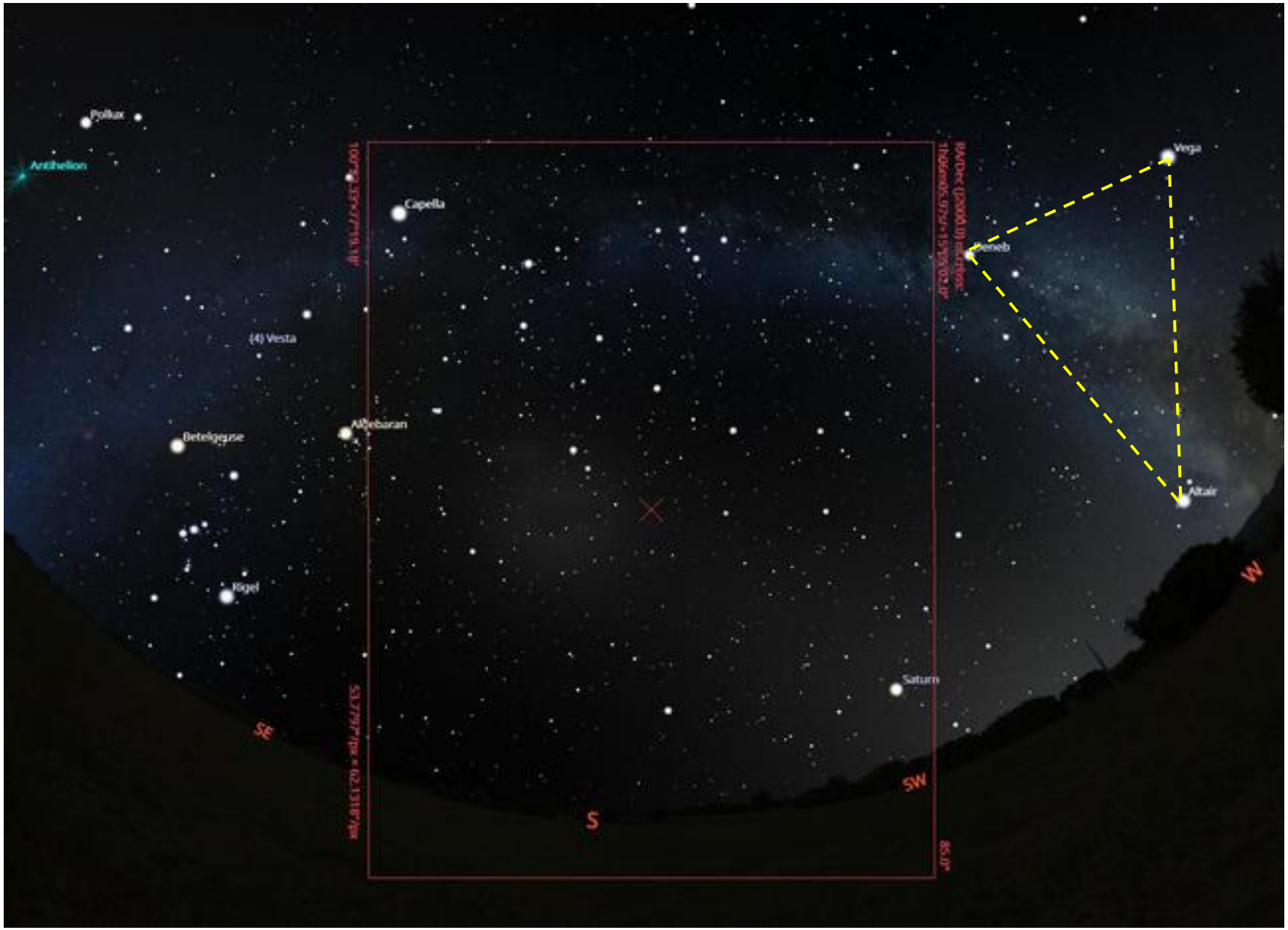
- Astronomical night starts at 9:30pm.



Milky Way - Winter

31st Dec – 7pm

- Due south, we are looking out of the Milky Way, so arc is quite dim.
- Milky Way core to the west – below the horizon.
- Not the best time for Milky Way photography!



Settings - Shutter Speed

- Avoid Star Trails - Use a “300 rule” to set Shutter Speed:-

> ➢ Shutter Speed = 300 /(Focal Length x Crop Factor)

- (NB – A Google search may give a “500” rule → slightly too long).
- The Milky Way can be photographed in a single exposure, but the limited exposure time means noise levels will be high.
- Stacking multiple images helps reduce noise, but stars must be aligned.
- A star tracker follows the stars allowing longer exposures. Also makes stacking much easier → take multiple 30second exposures.

Settings – Aperture/ISO

- Use a ‘fast’ lens and start with maximum aperture – F2.8 is ideal.
- Stars can become deformed in the corners → stopping down may improve star shapes, but reduces light gathering.
- Take a test shot - check star shapes and stop down if necessary.

- ISO is not critical – image will be brightened in post processing.
- Choose an ISO so that you can see the image on the camera screen.
- → ISO 1600-3200. Avoid very high ISO → reduces dynamic range.

Technique – Single Frame (Summer/Autumn)

- Choose a moonless night.
- Camera on tripod, manual focus, image stabilisation off, Long Exposure Noise Reduction off (unless taking just a single image).
- Set maximum aperture, high ISO (~3200). Manually focus on a bright star using Live View.
- Re-frame image. Set shutter speed/ISO/Aperture based on previous slides.
- Use an intervalometer, or 2sec timer to avoid camera shake.
- Take a test shot → Check centre stars for trailing, corner stars for distortion.
  - Adjust Shutter speed or Aperture if necessary.
- Take several images for stacking (~ 5 minutes if possible).
- If tracking, also take a number of untracked images for foreground.

Milky Way Technique

Buttermere – Bortle 3

Untracked Image.

F2.8, 30s, ISO 3200
16mm Lens on Full Frame Camera
Focal Length * Exposure = 480

Milky Way Technique

Buttermere – Bortle 3

Untracked Image.

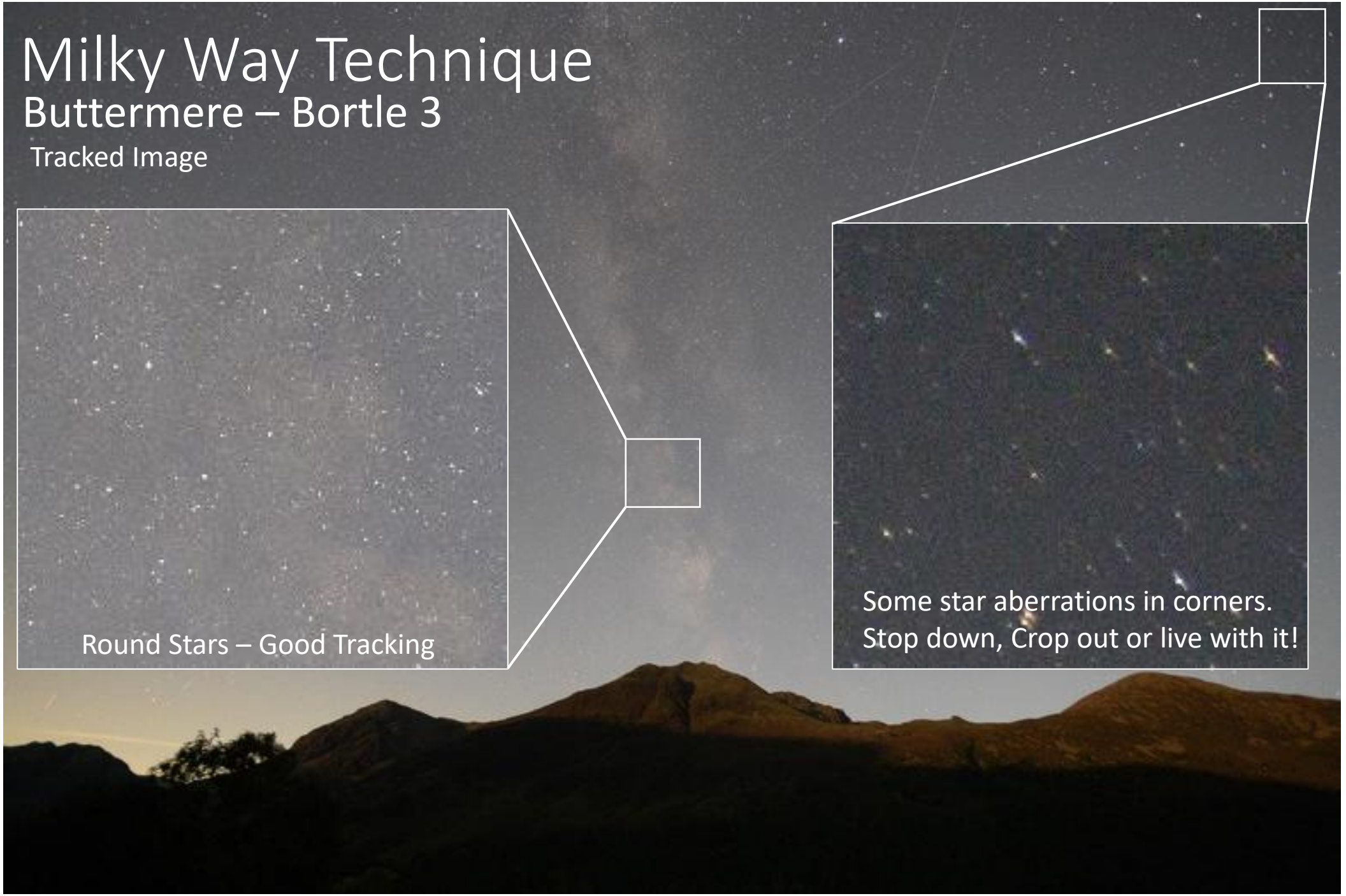
F2.8, 30s, ISO 3200
16mm Lens on Full Frame Camera
Focal Length * Exposure = 480

200% Crop – Some star trailing using 500 Rule

Milky Way Technique

Buttermere – Bortle 3

Tracked Image



Milky Way Stacking Technique

Two stacks will be required – one with stars aligned, the other with foreground aligned.

- Apply Lens corrections in Lightroom, then export as TIFF images for stacking.

- Tracked sky images and untracked foreground images should align automatically in Photoshop → Same approach as Star Trails Foreground (Smart Object→Mean Blend).

- Untracked sky images are difficult to align → use specialist stacking software:-

  - Sequator - https://sites.google.com/view/sequator/download
  - Starry Landscape Stacker (Mac - $40) - https://apps.apple.com/us/app/starry-landscape-stacker/id550326617?mt=12

Milky Way Technique

8 * Stacked Image
Satellite trails have dissapeared

Stars are aligned, but Foreground is blurred
Take separate Untracked stack for foreground.

Milky Way Technique

8 * Stacked Image
Satellite trails have dissapeared

Single Image

8 * Stacked Images

Stars are aligned, but Foreground is blurred
Take separate Untracked stack for foreground.