

Night Photography

December 2011



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<http://www.tawbaware.com>

Agenda

- Photography at different times of night
- Moon
- Stars
- Software and technology
- Tips, Tricks and Equipment



Blue Hour

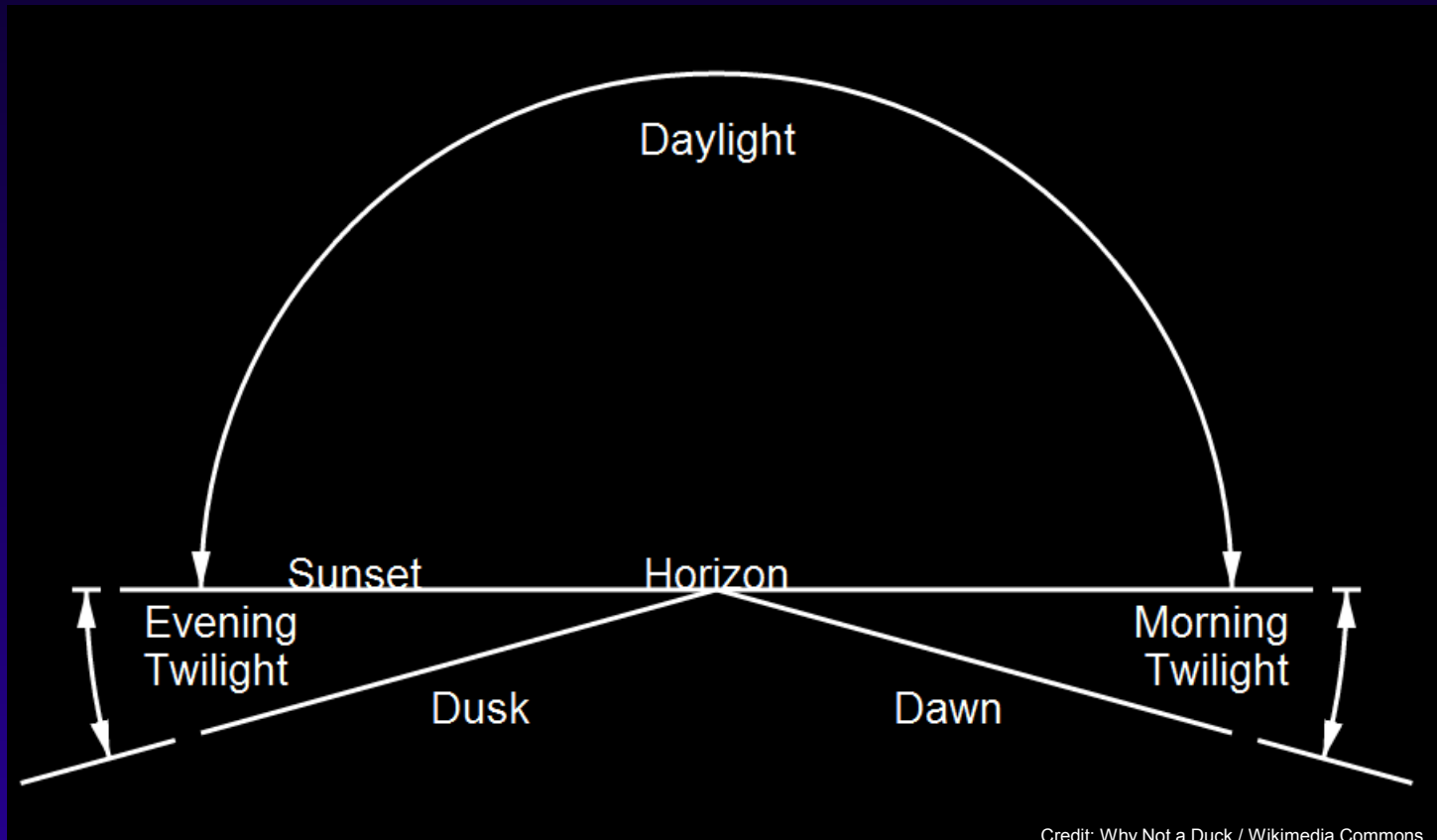
- Blue Hour: “The period of twilight each morning and evening where there is neither full daylight nor complete darkness. The time is considered special because of the quality of the light at this time of day.”



35 minutes after sunset, sun about 7 degrees below horizon

Twilight

- Twilight: “the period between sunset and sunrise during which there is natural light provided by the upper atmosphere, which receives direct sunlight and scatters part of it towards the earth's surface”

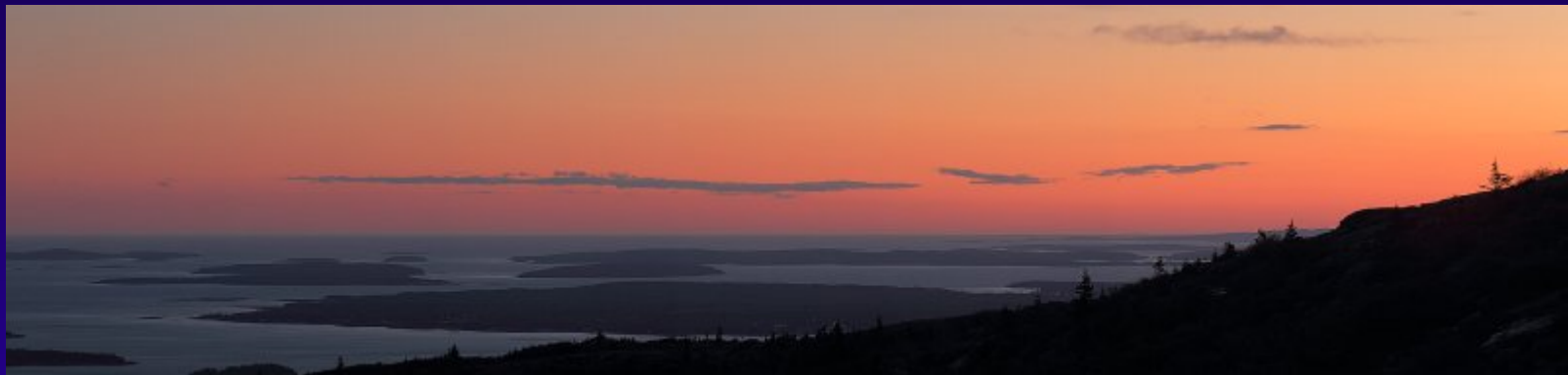


Light After The Sun Sets

- Civil Twilight: Sun is 0 to 6 degrees below horizon
- Nautical Twilight: Sun is 6 to 12 degrees below horizon
- Astronomical Twilight: Sun is 12-18 degrees below horizon
- Night: Sun is more than 18 degrees below horizon

Blue Hour

- Some of the best “sunset” shots happen after most of the photographers have packed up their gear and gone home!



Top: 1 minute before sunset, sun on horizon
Bottom: 30 minutes after sunset, sun about 6 degrees below horizon

Blue Hour

- If conditions are right, clouds “light up” just after sunset



10 minutes after sunset, sun about 2 degrees below horizon

Blue Hour

- Clouds take on pink glow just after sunset



10 minutes after sunset, sun about 2 degrees below horizon

Blue Hour

- Twilight provides even, soft illumination...and the opportunity for longer exposures



15 minutes after sunset, sun about 3.5 degrees below horizon
ISO 100, F11, 2 seconds

Blue Hour

- Great time to shoot objects illuminated by artificial light: buildings, statues, monuments, etc.
- When light in sky is balanced by artificial light, the sky takes on a rich, saturated color, but not black



32 minutes after sunset, sun about 6 degrees below horizon

Blue Hour

- “Best” light for shooting artificially illuminated objects is usually when sun is about 4-8 degrees below horizon...at transition from civil to nautical twilight
- Exact time varies on lighting, location and time of year...but is about 20-40 minutes after sunset or before sunrise



25 minutes after sunset, sun about 5 degrees below horizon

Blue Hour

- Exposure times at twilight are usually between 1-20 seconds (ISO 100-400, F5.6-F11)...depends on light



38 minutes after sunset, sun about 7.5 degrees below horizon
ISO 200, F7.1, 8 Seconds

Blue Hour

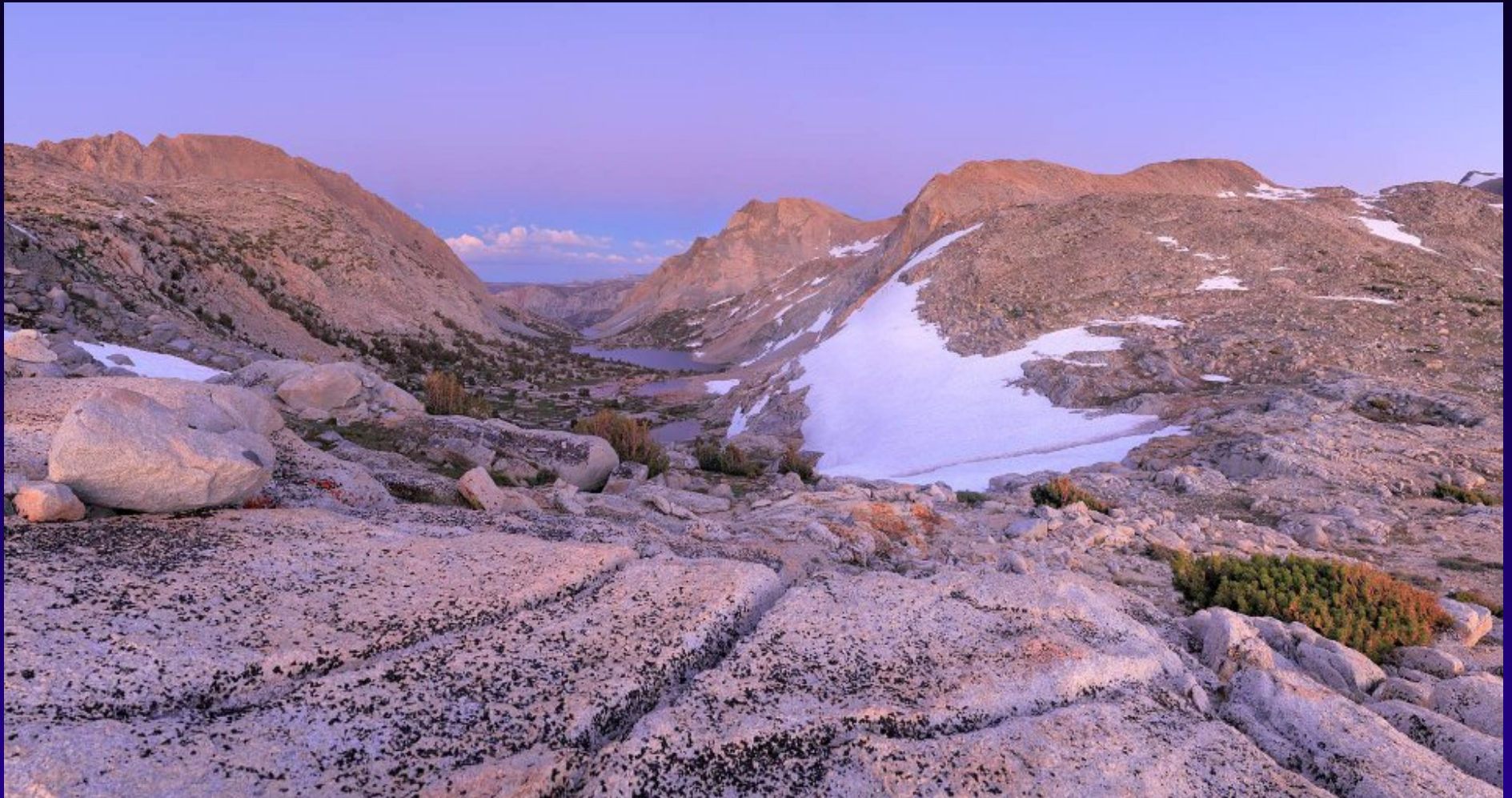
- Look for balance between artificial and natural light
- Exposure times change rapidly...can change by one stop in just a few minutes



45 minutes after sunset, sun 9 degrees below horizon, moon (4%) 4 degrees above horizon
ISO 200, F7.1, 3 Seconds

Blue Hour

- After sunset and before sunrise, the horizon 180 degrees from sunset/sunrise takes on a soft, rosy light: “Alpenglow”



20 minutes after sunset, sun about 4 degrees below horizon

Blue Hour

- Alpenglow provides even, soft illumination with a warm color



15 minutes before sunrise, sun about 3.5 degrees below horizon
ISO 200, F22, 5 seconds

Blue Hour

- The Belt of Venus...is the Victorian-era name for an atmospheric phenomenon seen at sunrise and sunset. Shortly after sunset or shortly before sunrise, the observer is...surrounded by a pinkish glow...that extends roughly 10° – 20° above the horizon.



5 minutes before sunrise, sun about 2 degrees below horizon

Blue Hour

- The light rose (pink) color is due to backscattering of reddened light from the rising or setting Sun...Often, the glow is separated from the horizon by a dark layer, the Earth's shadow or "dark segment". The light rose (pink) color is due to backscattering of reddened light from the rising or setting Sun.
(http://en.wikipedia.org/wiki/Belt_of_Venus)



7 minutes before sunrise, sun about 2 degrees below horizon, moon about 7 degrees above horizon

Twilight

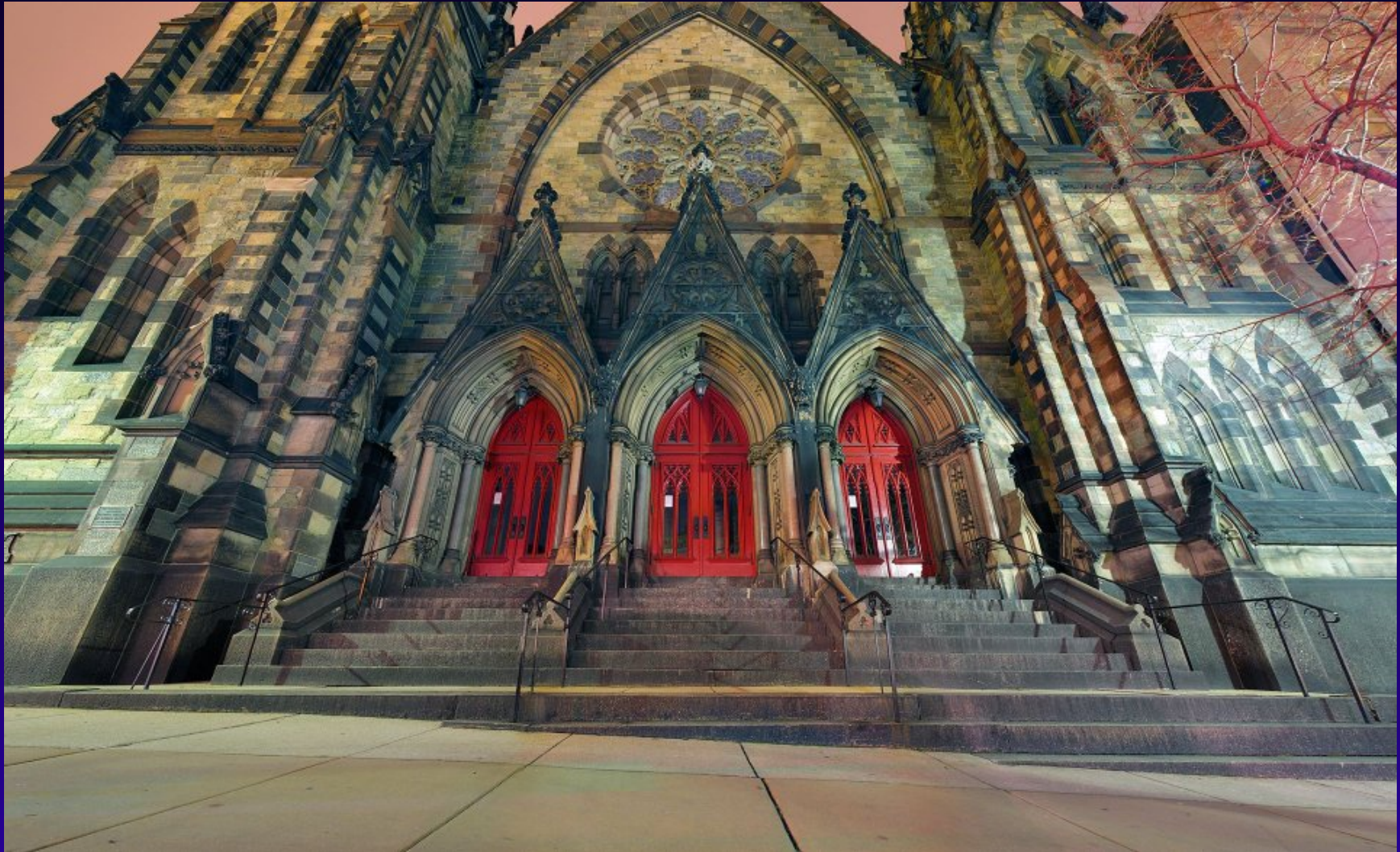
- After sun drops below about 7 or 8 degrees beneath horizon (about 45 minutes after sunset), skies start to become black



40 minutes after sunset, sun about 8 degrees below horizon
ISO 200, F8, 6 Seconds

Night

- Moonlight or artificial light are main sources of light at night
- In urban environments, artificial light predominates



Night

- Indirect light provides even illumination at night



Night

- Counterintuitive tip: look for subjects that aren't directly illuminated at night



Sun about 10 degrees below horizon
ISO 200, F8, 25 seconds

Night

- Almost impossible to avoid over-exposure of bright light sources



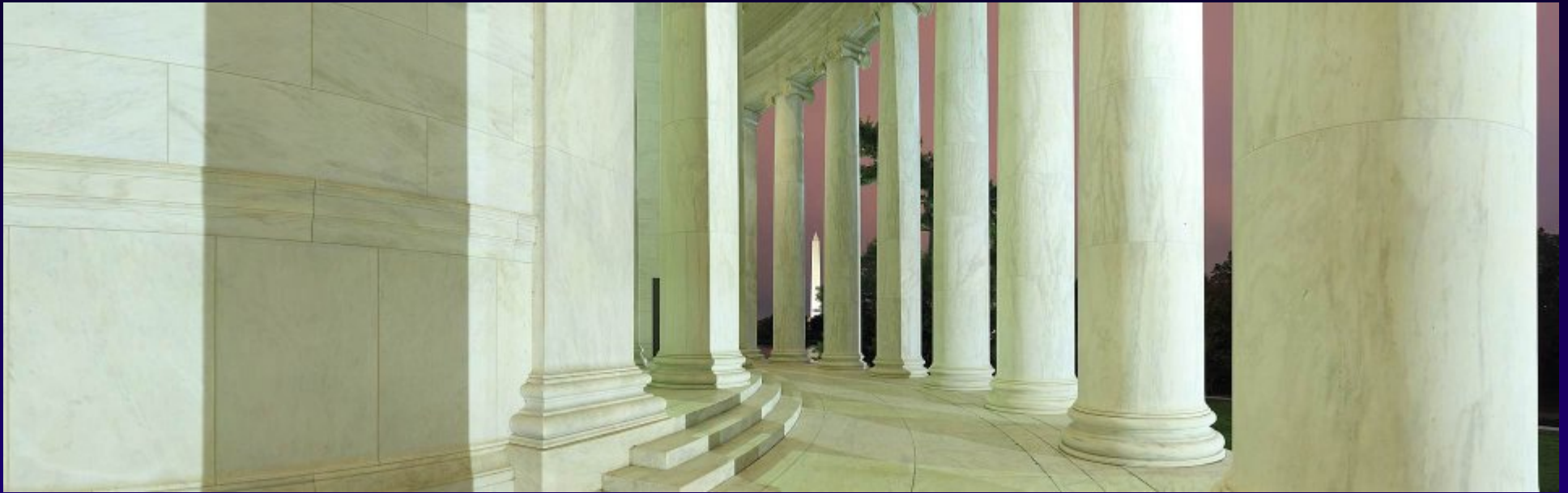
Night

- Clouds can reflect artificial light at night...white balance can be tricky, or offer artistic possibilities



Night

- In urban areas, clouds reflect artificial light and show unusual colors



Night

- A little artificial light can go a long way...scene is predominantly illuminated by three street lamps



90 minutes after sunset, sun about 18 degrees below horizon, moon (80% full) about 50 degrees above horizon.
Blended exposure: Exposure 1=ISO 400, F 7.1, 5 seconds, Exposure 2=ISO 400, F 7.1, 30 seconds

Night

- Motion of clouds and water becomes apparent with longer exposures at night



Moon (53% full), 43 degrees above horizon, 65 minutes after sunset
ISO 400, F4.5, 60 seconds

Night

- A little moonlight can go a long way...your eyes can't see colors at night, but your camera can!



Moon (96% full), 50 degrees above horizon, 4.5 hours after moonrise
ISO 800, F5.6, 60 seconds

Moon

- Great subject for night photography
- Great source of illumination for night photography



Full Moon Rising over Half Dome
10 minutes after sunset, sun about 2.5 degrees below horizon

Moon

- When moon is full, it rises at sunset, and sets at sunrise
- When moon is new, it sets at sunset, and rises at sunrise



Crescent Moon Setting over Bisti Badlands

30 minutes after sunset, sun about 7 degrees below horizon, moon about 7 degrees above horizon

Moon

- When moon is full, it is 180 degrees opposite sun at sunrise/sunset
- When moon is new, it is in same location as sun at sunrise/sunset



28 minutes after sunset, sun: 6 degrees below horizon, moon: 2 degrees above horizon
ISO 400, F8, 1.6 seconds

Moonlight

- A full moon provides about 18 or 19 stops less light than the sun



Full moon 22 degrees above horizon
ISO 400, F4.5, 60 seconds

Moonlight

- Apart from exposure length, not too different from shooting with sunlight



Moon (90%) about 44 degrees above horizon
ISO 800, F5.6, 60 seconds

Moonlight

- Colors, contrast and white-balance can be tricky
- Scene is often illuminated by a combination of sources (moonlight, man-made light, light pollution)
- Shooting in “raw” format allows for easy color adjustment



Default camera settings
Color Temp: 5500K



Increased exposure by
0.5, reduced contrast,
boosted shadows



Color Temp: 4800K



Color Temp: 4000K

Light Pollution

- Almost impossible to avoid anywhere near a city
 - Right side of picture: Gaithersburg/Germantown
 - Middle: Herndon/Reston
 - Left: Tysons Corner



Stars

- Stars appear to “move” as the night progresses due to the rotation of the earth
- Longer exposures capture the motion of the stars, producing “star trails”

Stars

- Shorter exposures show stars as points
- The wider the lens, the longer the exposure can be used before trails are visible



Moon (22% full), 7 degrees above horizon
ISO 3200, F2.8, 20 seconds

Stars

- The brighter the moon, the more stars are “washed out”, but moon provides illumination for ground



Moon (99 % full), 4 degrees above horizon
ISO 1600, F3.2, 16 seconds

Stars

- Fewer stars are visible in urban areas, but some are still visible, and can be enhanced by careful image processing



Moon (50 % full), 16 degrees above horizon
ISO 400, F3.5, 60 seconds

Stars

- Some stars are still visible despite urban location and thin clouds



Moon (4 % full), 4 degrees above horizon
ISO 800, F4, 20 seconds

Stars

- Longer exposures show stars as “trails”
- Earth rotates 15 degrees per hour (360 degrees each day)
- Starlight provides faint, but visible illumination of ground



ISO 400, F3.2, 240 seconds

Stars

- The longer the lens, the longer the trails appear for any given exposure length



Moon (99% full), 22 degrees above horizon
ISO 200, F5, 200 seconds

Stars

- Comparison of short (20 seconds) and long (4 minutes) exposures



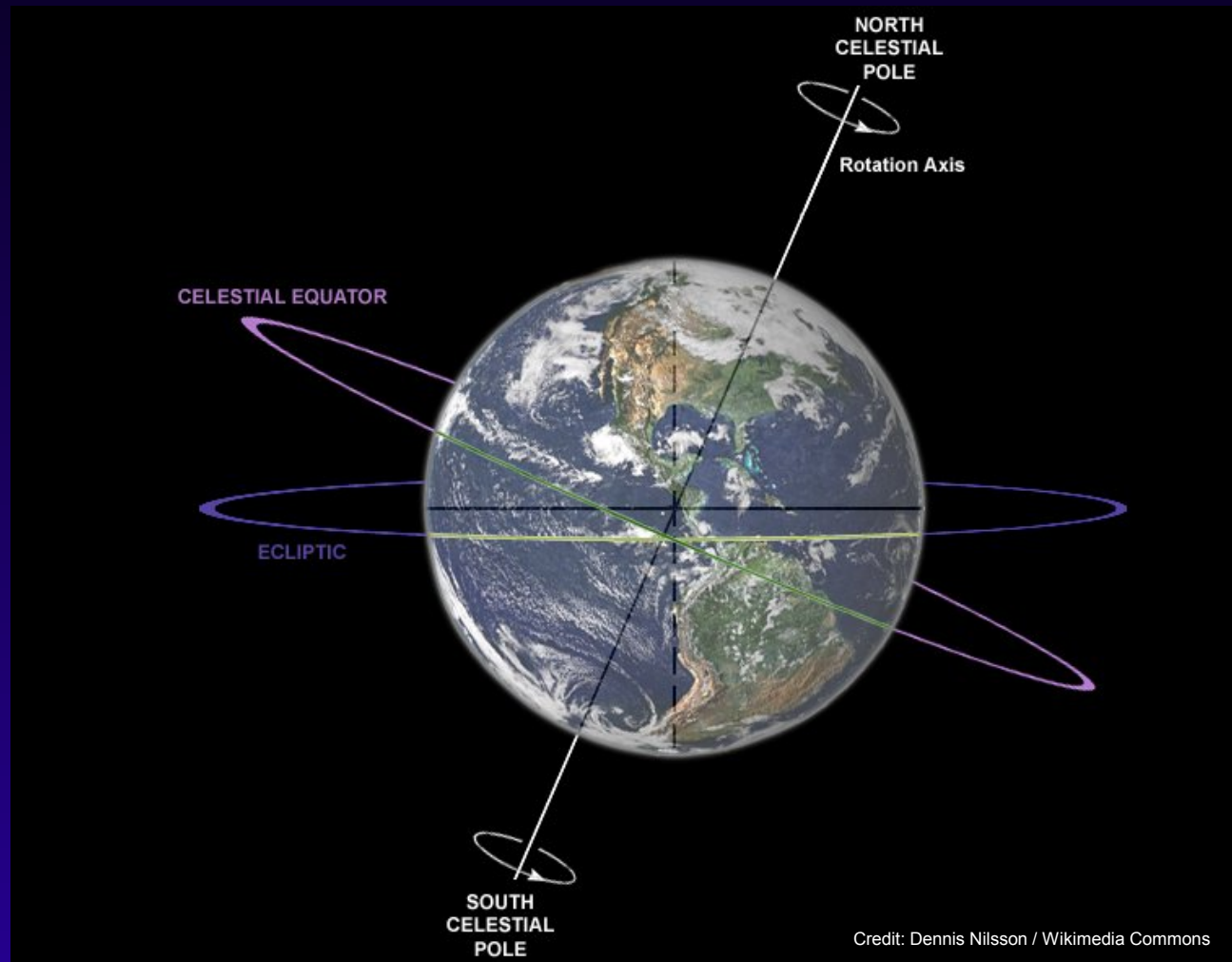
ISO 3200, F2.8, 20 seconds



ISO 400, F3.2, 240 seconds

Stars

- As Earth spins on its axis, the stars appear to rotate around the visible celestial pole



Stars

- Stars rotating around the north celestial pole



Stars

- Panoramic image (more than 180 degree field of view), showing stars rotating around north celestial pole



Stars

- Panoramic image (about 160 degree field of view), showing stars rotating around south celestial pole (below horizon)



Stars

- Choice of projection changes shape of star-trails, similar to wide angle lens “stretching” objects at the edge of the picture



Stars: Image Stacking

- Problem: Capturing star trails in urban areas is impossible with conventional photography because lights and light pollution makes it impossible to take a long enough exposure to capture the motion of the stars
- Solution: “Image Stacking”
 - Capture multiple images in sequence using short exposures
 - Use software to “stack” these images into a single composite
 - Different stacking methods can produce different results

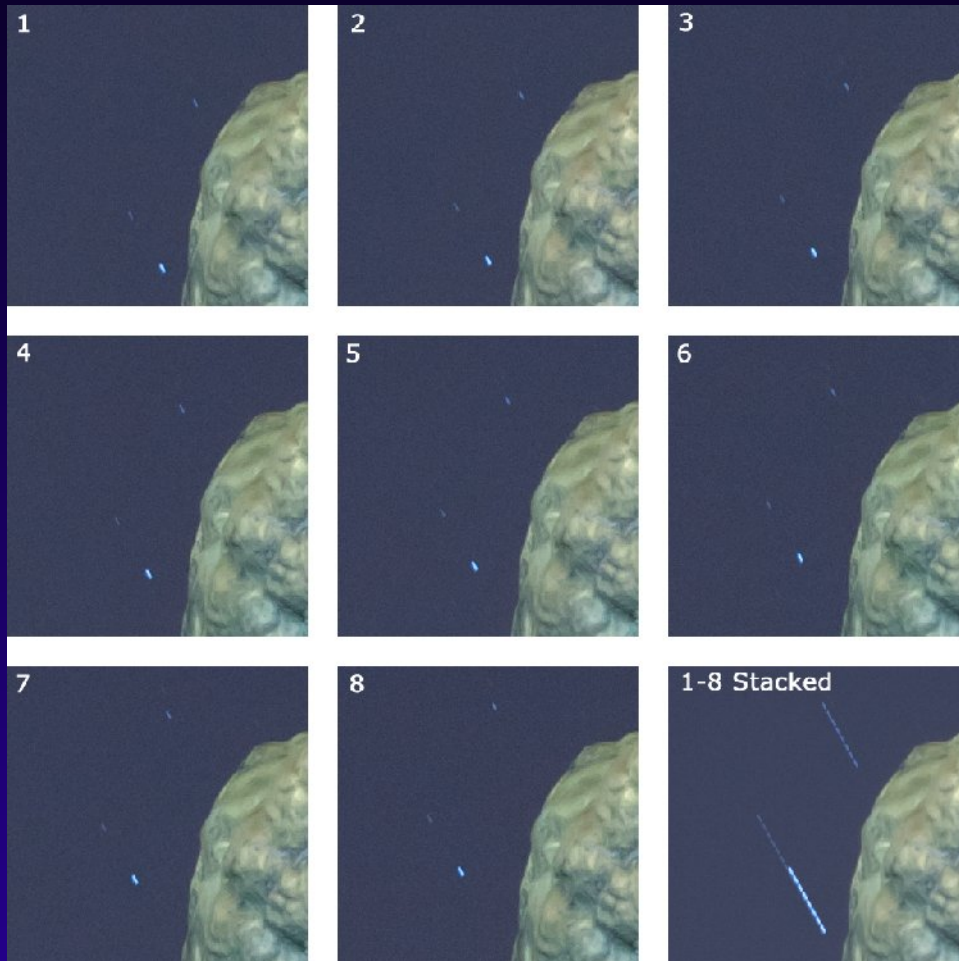
Stars: Image Stacking

- Single exposure (ISO 400, F5, 12 seconds) is exposed correctly for subject and sky. A longer exposure would overexpose.
- Stars are visible at full size:



Stars: Image Stacking

- Multiple images (all ISO 400, F5, 12 seconds) are taken in sequence, and stacked to create composite



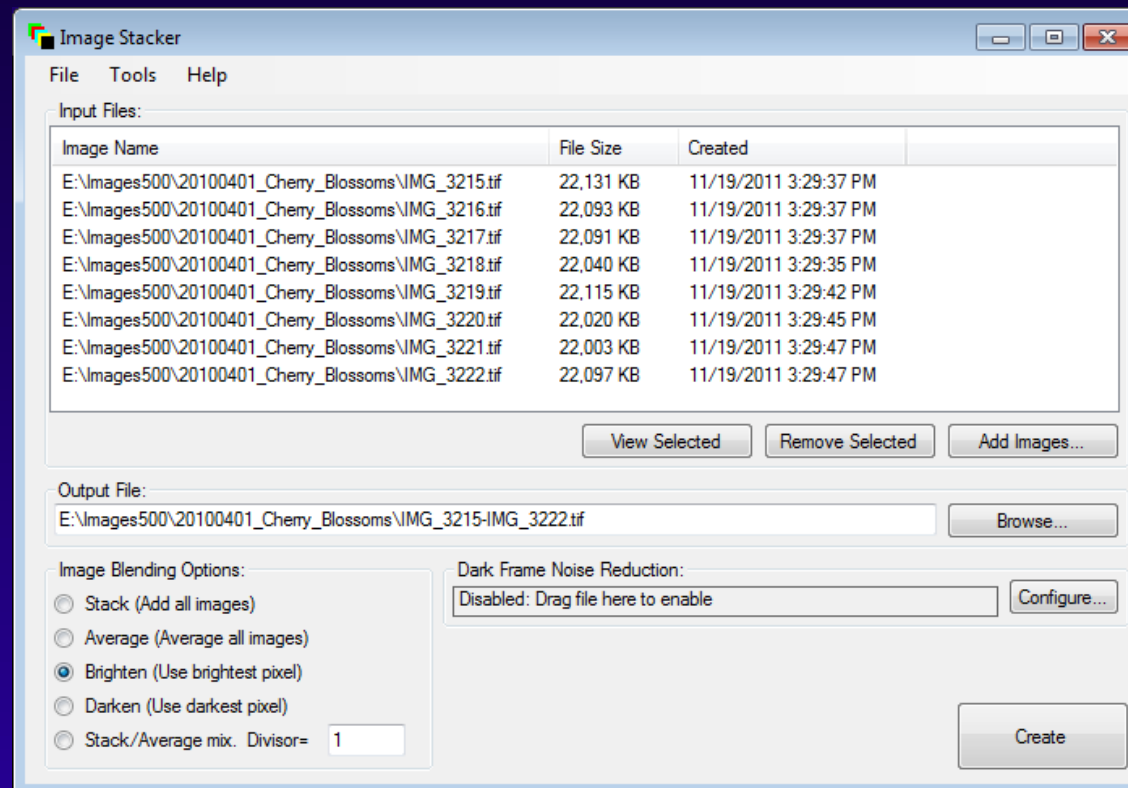
Cropped region from 8 images, and stacked composite image (bottom right)



Stacked composite image

Stars: Image Stacking

- Image Stacking can be done using software that handles image layers, or a specialized program like Image Stacker
- Image Stacker's “Brighten” blending mode picks the brightest pixel in each source image which allows star-trails to form, without overexposing the rest of the image



Stars: Image Stacking

- One problem with stacking is the appearance of “gaps” in star trails corresponding to the time elapsed between images when photographing
- Even a pause of a second may be long enough to reveal “gaps”



A two second pause between images caused this stacked image to show “gaps”

Stars: Star Tracer

- “Gaps” can be filled effectively using Star Tracer
- Star Tracer can be used to determine the trajectory of each star in the image, and fill in the gaps



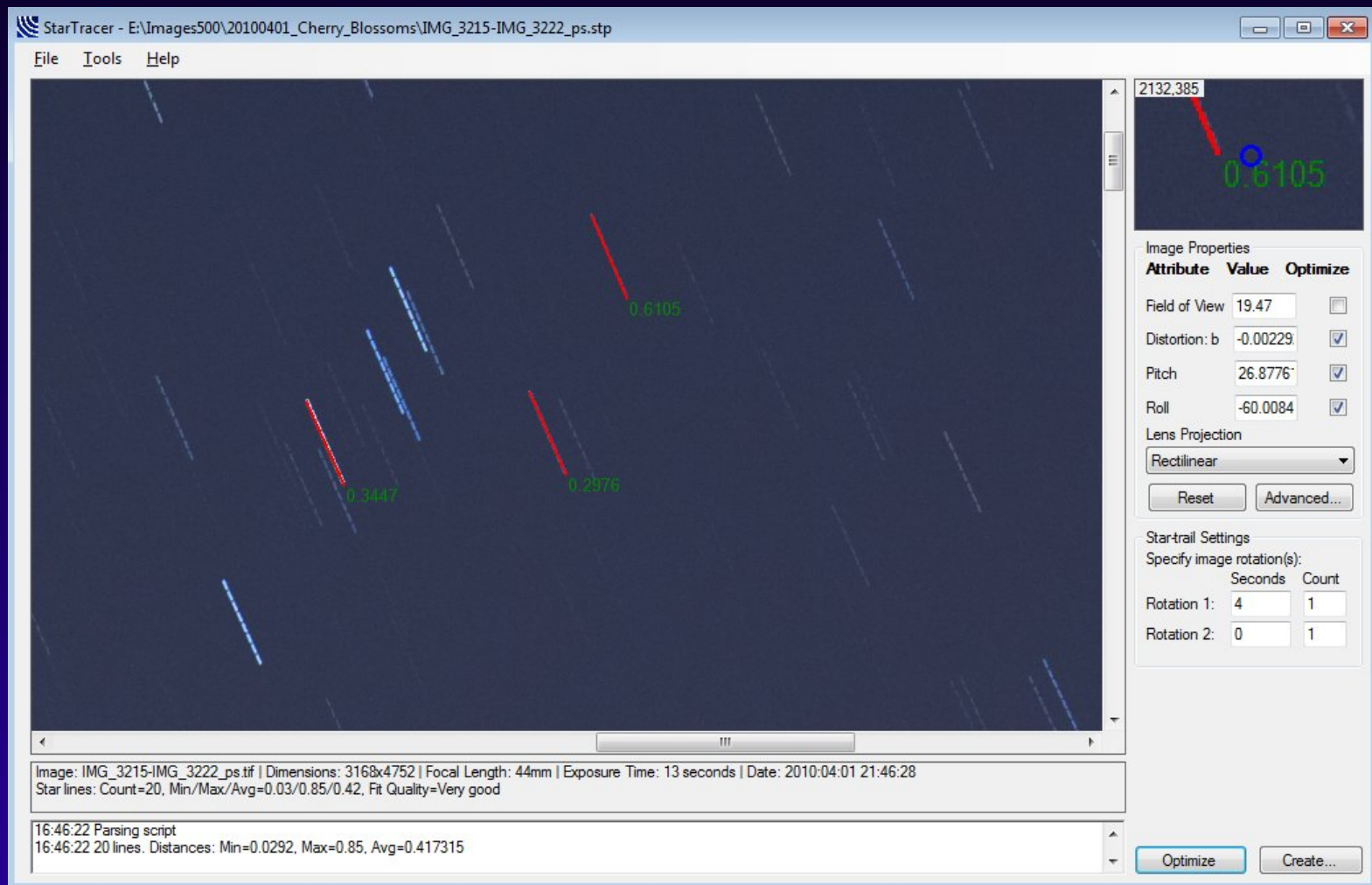
Two second “gaps” in stacked image



“Gaps” filled by Star Tracer

Stars: Star Tracer

- You tell Star Tracer some information about your images, and draw a few “star lines” indicating the trajectory of some stars in your image



Stars: Star Tracer

- “Optimizing” the project allows Star Tracer to determine the trajectory of all the stars in the image
- Output image is created by “rotating” the image a number of times by a specified amount
 - “Rotation” is a simplification of what actually happens to the image, but simulates the rotation of the earth
- In this example, one 4 second rotation was enough to fill in the 2 second gap between trail segments

The screenshot shows the Star Tracer software interface. It has two main sections: 'Image Properties' and 'Star-trail Settings'.

Image Properties

Attribute	Value	Optimize
Field of View	19.47	<input type="checkbox"/>
Distortion: b	-0.00229	<input checked="" type="checkbox"/>
Pitch	26.8776	<input checked="" type="checkbox"/>
Roll	-60.0084	<input checked="" type="checkbox"/>

Lens Projection: Rectilinear (dropdown menu)

Buttons: Reset, Advanced...

Star-trail Settings

Specify image rotation(s):

	Seconds	Count
Rotation 1:	4	1
Rotation 2:	0	1

Buttons: Optimize, Create...

Stars: Star Tracer

- Star Tracer isn't limited to just filling in short gaps
- Some cameras pause for a long time to perform noise-reduction between images, and the resulting stacked images show much larger gaps...these can also be filled



Fifteen second “gaps” in stacked image



“Gaps” filled by Star Tracer

Stars: Star Tracer

- In fact, once Star Tracer has calculated the trajectory of each star, it isn't limited to just filling in gaps...it can be used to “extend” the length of trails



Star-trail Settings		
Specify image rotation(s):		
	Seconds	Count
Rotation 1:	90	5
Rotation 2:	0	0

Star Tracer “rotates”
the image by an
amount of 90
seconds, five times

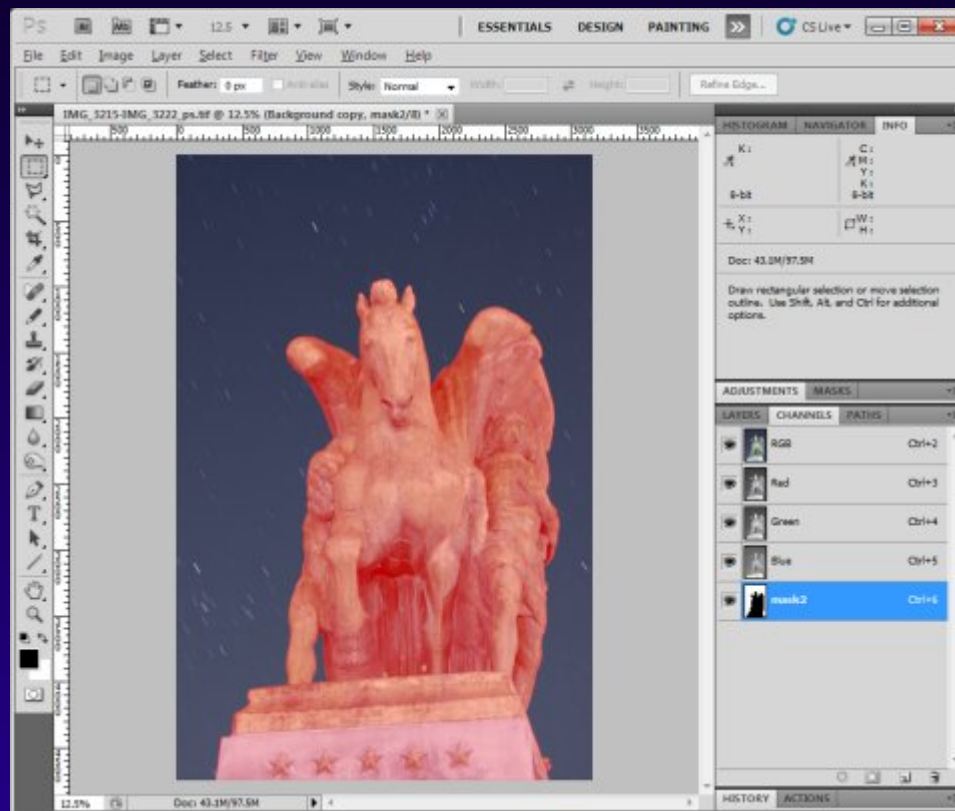


Eight 12 second exposures stacked to create a
“synthetic 100 second” (approx) exposure

Trails extended by Star Tracer to create a
“synthetic 9 minute” (approx) exposure

Stars: Star Tracer

- Star Tracer can't determine what is and isn't a star...by default it rotates the entire image. You can create a “mask” layer in the input image to prevent “non-star” areas from being rotated.



Using Photoshop to draw a mask on input image,
prior to processing in Star Tracer

Stars: Star Tracer

- Shooting panoramas at night takes time
- Five images (4 minutes each) combined into one image: 20 minutes of total image capture



Sun: 28 degrees below horizon, Moon (7%): 16 degrees below horizon
3 hours after sunset, 80 minutes after moonset
ISO 400, F4, 240 seconds

Stars: Star Tracer

- Panoramic image consisting of five images (4 minute exposures for each image): 20 minutes of total image capture



Sun: 28 degrees below horizon, Moon (7%): 16 degrees below horizon
3 hours after sunset, 80 minutes after moonset
ISO 400, F4, 240 seconds

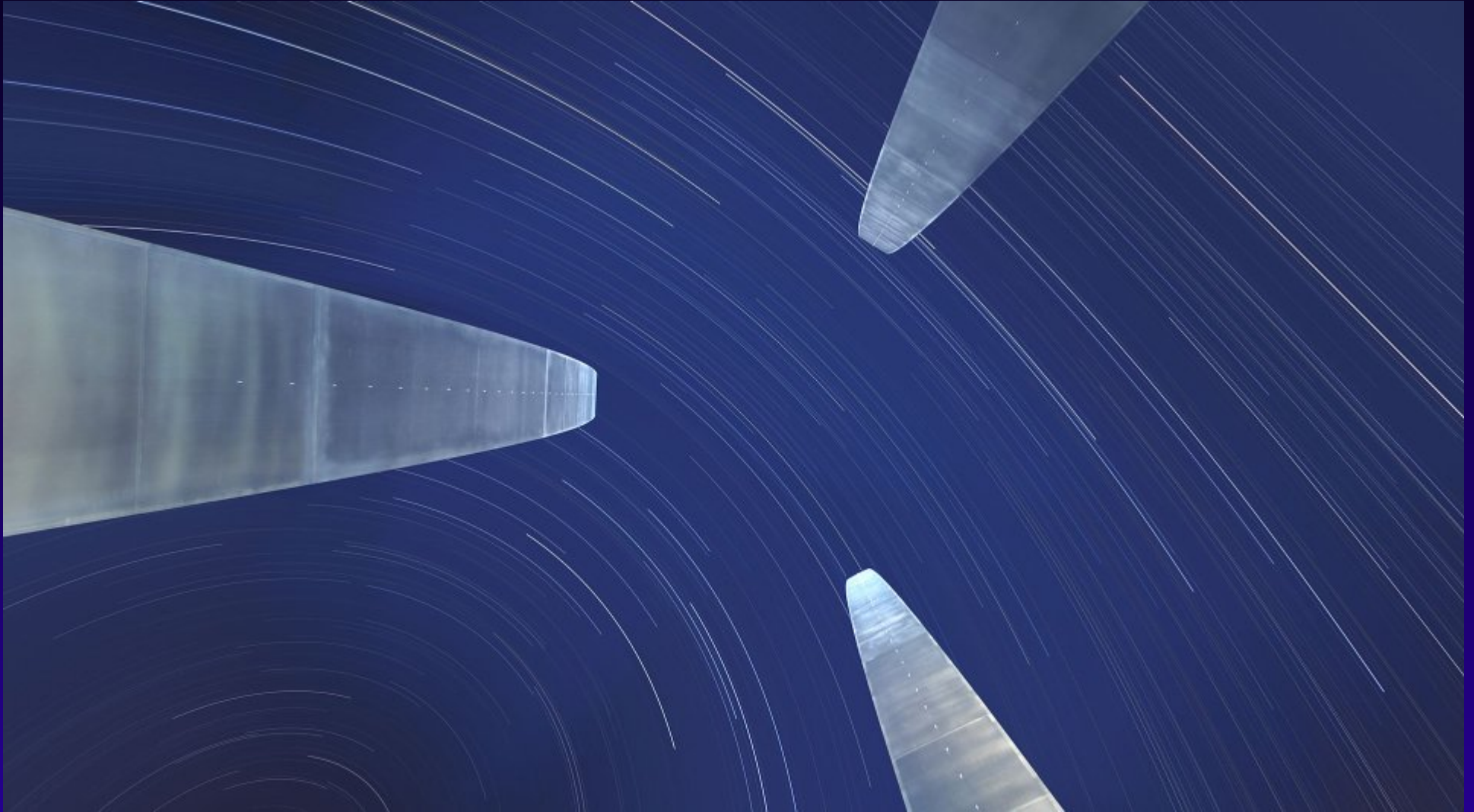
Stars: Star Tracer

- Star Tracer used to extend trails
- Not sure there would have been enough night hours to create this panoramic image using conventional approach



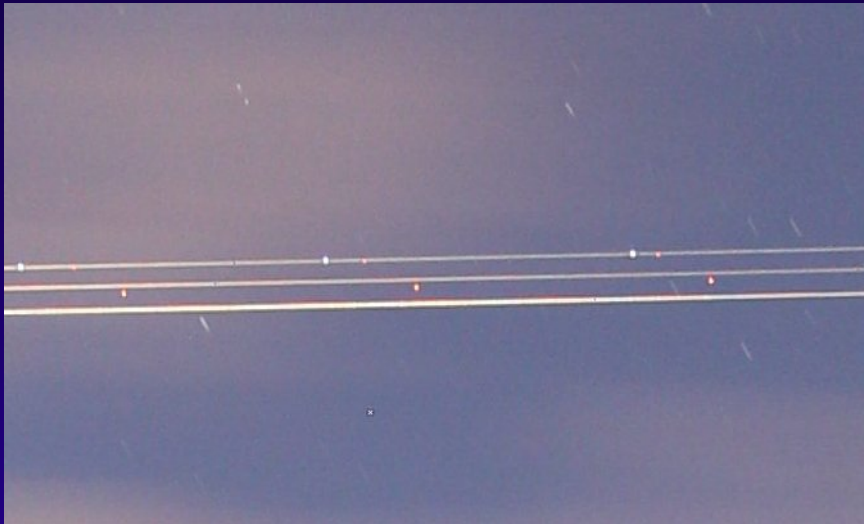
Stars: Star Tracer

- Is it cheating? Does it matter?!



Things That Move in the Night

- Airplanes
 - Almost impossible to avoid in urban areas
 - Surprisingly difficult to avoid in remote areas
 - Airplane lights can be “removed” using photo editing software
 - Or...airplane lights can be the subject of the photograph!



Streaks left by airplanes flying through scene

Things That Move in the Night

- Meteors (Shooting Stars)
 - Usually show as streaks with gradual start/end
 - Can move in any direction
 - Can happen any time of year, but most frequently during meteor “showers”
- Moon
 - appears elongated in exposures longer than a few seconds



Top: Perseid Meteor; Bottom: Setting moon

Things That Move in the Night

- Satellites
 - Usually show as bright streaks
 - Are illuminated by sun below horizon, and are only visible in hours near sunrise and sunset
 - Are very predictable!



International Space Station

70 minutes after sunset, sun about 12 degrees below horizon
ISO 400, F5.6, 90 seconds

Tips and Techniques: Exposure

- Determining correct exposure is much easier with digital than film: instant feedback and no reciprocity failure
- Use a high ISO setting (e.g. ISO 3200 or ISO 6400) and short exposure to take test shot(s), review image(s), then adjust ISO and exposure length to desired setting
- Exposure remains constant if ISO is doubled and exposure is halved.

ISO	Exposure (seconds)
100	240
200	120
400	60
800	30
1600	15
3200	8
6400	4

Tips and Techniques: Exposure

- Exposure (shutter/aperture/ISO) is a complicated tradeoff

Longer exposures	Shorter exposures
Moon becomes elongated	Moon is rendered as round
Creates Star Trails	Renders stars as points
More planes	Fewer planes
More meteors/satellites	Fewer meteors/satellites
Allows for lower ISO	Requires higher ISO

Low ISO	High ISO
Fewer stars appear in image	More stars appear in image
Creates Star Trails	Renders stars as points
Less noise	More noise
Typically requires larger aperture	Typically allows for smaller aperture
Typically requires longer exposure	Typically requires shorter exposure

Larger Aperture	Smaller Aperture
More light...more stars	Less light...less stars
Shorter exposure	Longer exposure
More vignetting	Less vignetting
Softer image	Sharper image
Less depth of field	More depth of field

Tips and Techniques: Exposure

- “Light Painting” with a flashlight can be used to illuminate portions of a scene



Tips and Techniques: Exposure

- Exposure blending can be used to balance exposure of bright and dim objects in “contrasty” scenes
- Can be used to blend two images taken with different exposures
- Can be used to blend one raw image processed differently (once for shadows, once for highlights)
- I use TuFuse and/or TuFuse Pro for Exposure blending:
 - <http://www.tawbaware.com/tufuse.htm>
 - <http://www.tawbaware.com/tufusepro.htm>

Tips and Techniques: Exposure

- One raw file, processed into two images (once for sky, once for statue), and then combined using TuFuse into a single image



Raw file processed to
retain detail in statue



Raw file processed to show
sky color and stars



“Exposure blended”
combination of two files

Tips and Techniques: Focus

- Auto focus can give inaccurate results in low light
- In low light, look for a light source at (or close to) the desired focus distance (e.g. moon, distant street light, etc.)
- Manual focus, in conjunction with live view (particularly with a camera that allows for a magnified image) can be useful
- A laser pointer with live view and manual focus can be used to perform accurate focus in totally dark situations

- Photographer's Ephemeris



Planning

- Heavens Above: Shows position of satellites
- Website (<http://www.heavens-above.com>) and Android app

Heavens Above

Upcoming: **Cosmos 1005 Rocket**
Start: 20:36:44 10° N 46s

Magnitude	Name	Date	Start Time	Start Az.	End Time	End Az.
3.6	Cosmos 1500 Rocket	26 Nov	20:27:07 10° S	20:31:35 89° S	20:36:07 10° N	
1.7	Lacrosse 4	26 Nov	20:28:26 10° SSW	20:33:17 86° ESE	20:37:18 15° NE	
4.4	Cosmos 1023 Rocket	26 Nov	20:35:15 10° S	20:40:22 66° ESE	20:44:53 13° NNE	
3.5	ATLAS 3B R/B	26 Nov	20:35:29 10° NW	20:42:23 39° NNE	20:46:45 22° E	
3.3	Cosmos 1184 Rocket	26 Nov	20:35:43 10° N	20:39:31 50° ENE	20:43:14 10° SSE	
2.5	Cosmos 1005 Rocket	26 Nov	20:36:44 10° N	20:40:11 53° ENE	20:43:37 10° SSE	
3.8	Cosmos 2082	26 Nov	20:36:49 10° NNW	20:42:20 52° NE	20:47:50 10° SE	
4.2	FengYun 1-2 T	26 Nov				

Daily predictions for brighter satellites

Home | Prev. PM | Next PM | Prev. Day | Next Day

Ads by Google | Soccer Predictions | Satellites | 2012 Predictions | Psychic Predictions

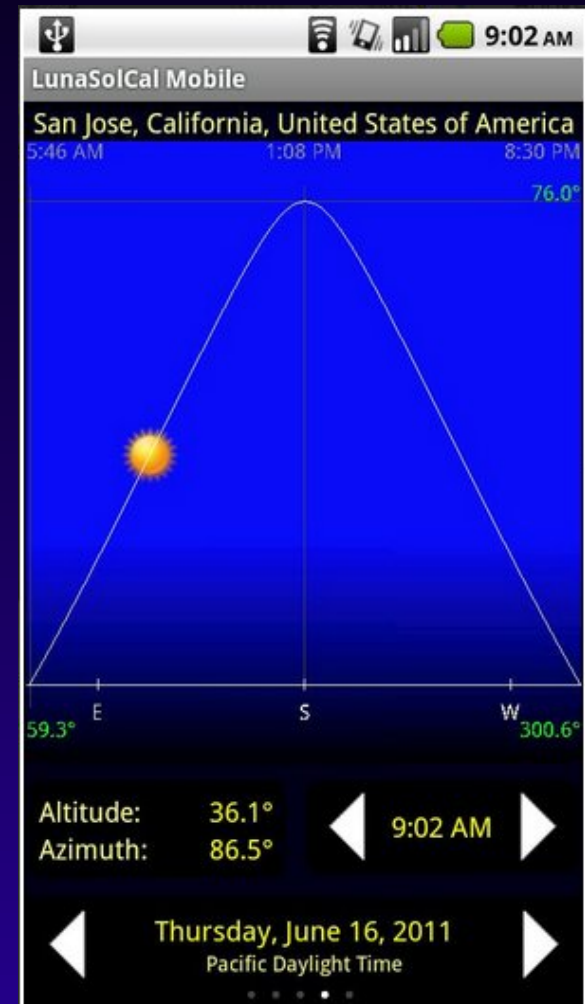
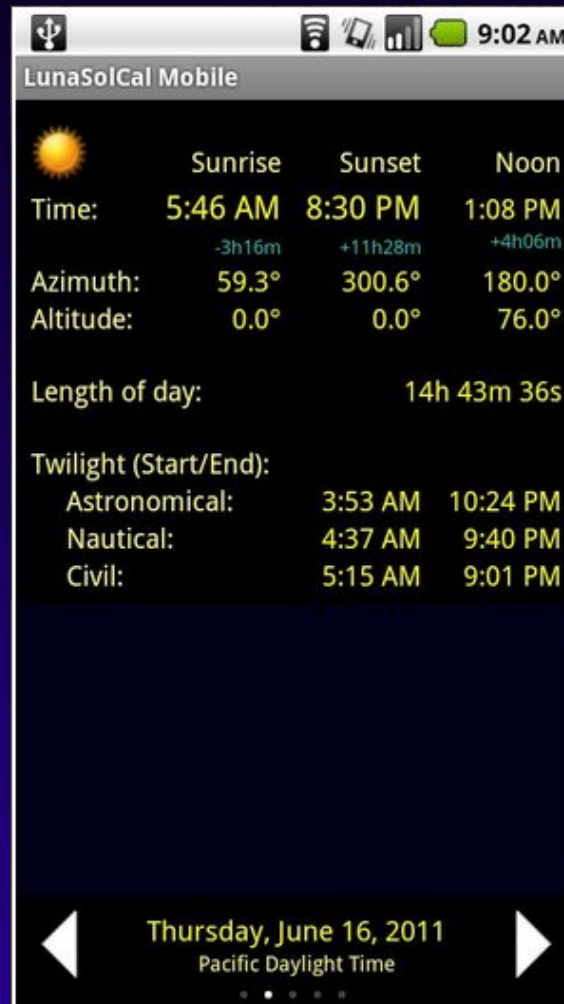
Search Period Start: 12:00 Saturday, 19 November, 2011
 Search Period End: 01:00 Sunday, 20 November, 2011
 Observer's Location: Unspecified (0.0000°N, 0.0000°E)
 Local Time: Central European Time (GMT + 1.00)
 Limiting magnitude: 3.5

NEW! Click on the time of max. altitude to get a star chart and other pass details.

Satellite		Starts			Max. Altitude			Ends		
Name	Mag	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
Cosmos 2322 Rocket	3.1	19:01:26	10°	SSE	19:06:20	30°	ESE	19:11:13	10°	NE
Abrixas	3.2	19:03:58	10°	NW	19:07:49	88°	SW	19:11:40	10°	SE
Cosmos 1980 Rocket	2.4	19:06:31	10°	S	19:11:59	53°	ESE	19:17:24	10°	NNE
SL-16 R/B	3.0	19:11:38	10°	NE	19:17:22	40°	ESE	19:23:05	10°	S
GPS 2-17 Rocket1	3.1	19:12:15	10°	WNW	19:16:55	68°	NNE	19:21:25	10°	ESE
UNKNOWN OBJECT B	3.2	19:20:58	10°	S	19:24:52	71°	WSW	19:28:49	10°	NNW
Atlas Centaur 2	2.5	19:25:03	10°	NW	19:30:41	61°	NE	19:37:55	10°	ESE
Cosmos-2242	3.1	19:28:42	10°	N	19:33:07	86°	WNW	19:37:38	10°	S
Ariane 4 3rd Stage Rocket	3.3	19:30:21	10°	WSW	19:33:48	48°	SSE	19:39:16	13°	E
Centaur AC-65	2.8	19:30:24	10°	WNW	19:33:00	90°	SW	19:40:24	10°	ESE
ATLAS 2AS CENTAUR R/B	2.9	19:31:41	10°	NNW	19:39:25	65°	ENE	19:46:53	10°	SSE
Cosmos 2227 Rocket	2.2	19:37:35	10°	N	19:43:08	58°	ENE	19:48:42	10°	SSE
Meteor 1-31 Rocket	3.2	19:46:51	10°	SSE	19:50:31	38°	ENE	19:53:48	12°	NNE
SL-16 R/B	2.1	19:51:44	10°	S	20:00:23	73°	ESE	20:04:25	20°	NNE
Lacrosse 5	3.4	19:59:50	10°	N	20:01:32	18°	NNE	20:01:32	18°	NNE
Ariane H10	3.3	20:10:11	10°	W	20:25:15	61°	S	20:26:40	41°	SE
Cosmos 44	2.8	20:13:45	10°	NNW	20:18:02	87°	WSW	20:22:18	10°	SSE
ARIANE 3 DEB	3.0	20:25:51	10°	W	20:33:09	82°	WSW	20:33:09	82°	WSW
Ariane H10	2.7	20:26:26	10°	WNW	20:29:01	62°	N	20:29:01	62°	N
Cosmos 2360 Rocket	2.9	20:41:08	10°	S	20:44:58	40°	SSE	20:44:58	40°	SSE
COSMOS 2428	3.2	20:57:11	10°	SSW	21:01:32	54°	SSW	21:01:32	54°	SSW

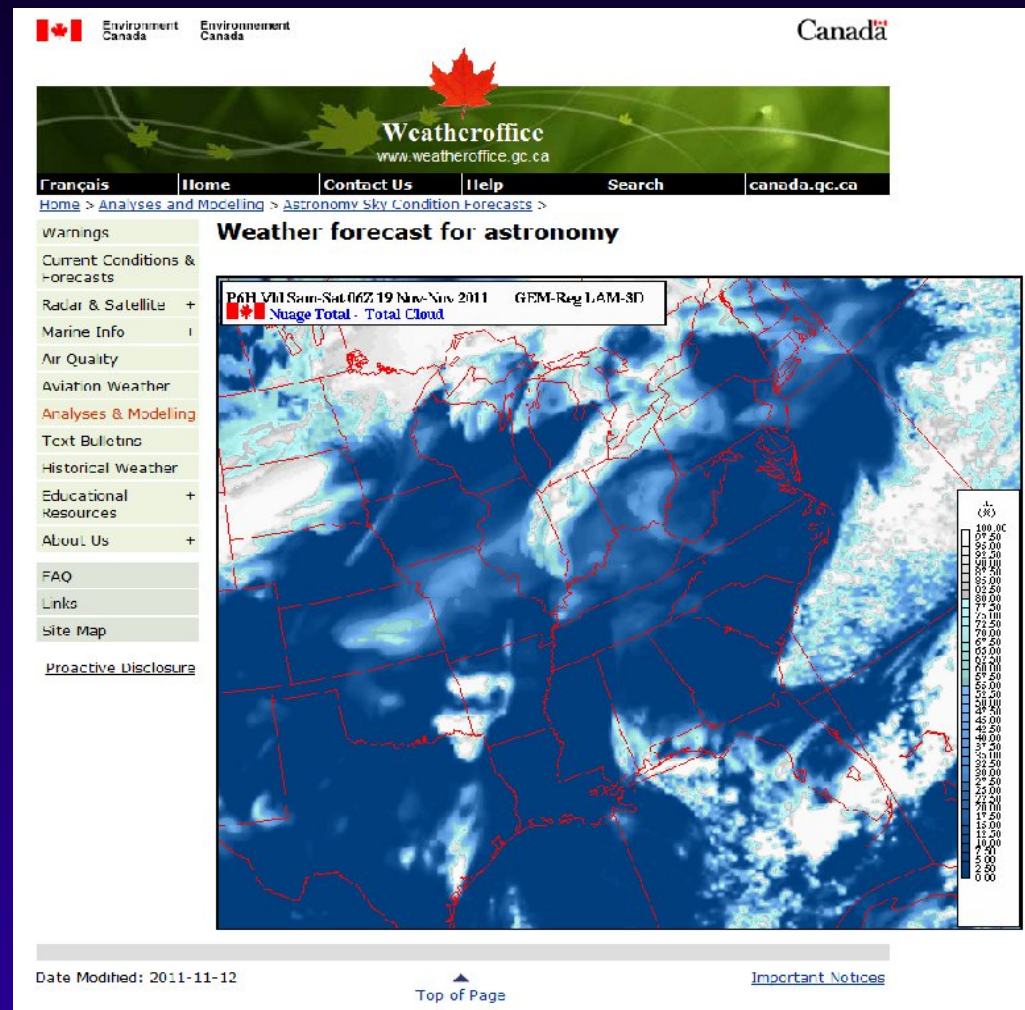
Planning

- Many smart-phone apps (e.g. LunaSolCal)



Planning

- Canadian Meteorological Center:
http://www.weatheroffice.gc.ca/astro/index_e.html

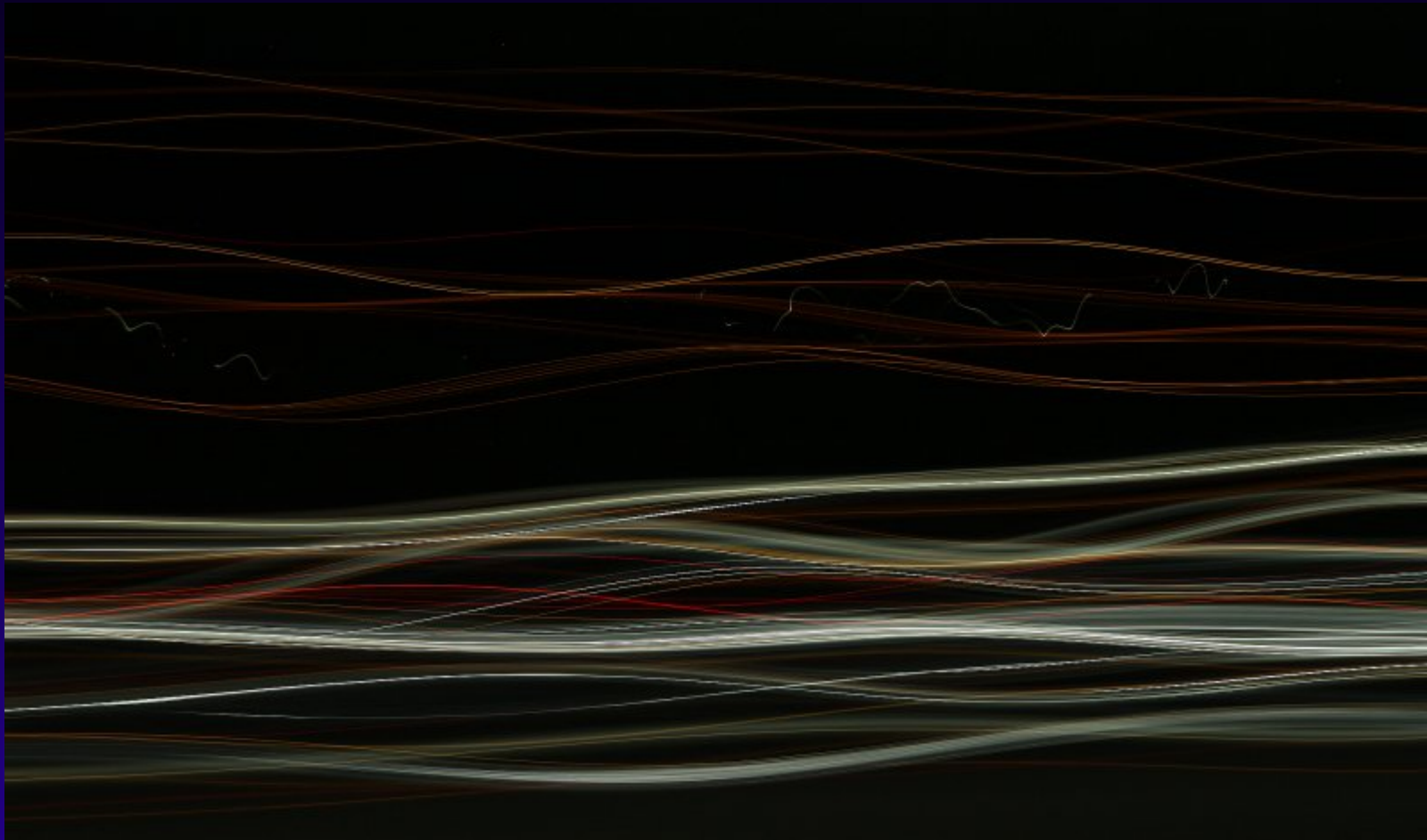


Equipment

- Tripod
 - Very few possibilities for night photography without one!
- Cameras
 - Most DSLRs have a “bulb” mode allowing unlimited exposures
 - Most digicams are limited to maximum exposures of under 30 seconds
 - Modern DSLRs produce usable images at very high ISOs (e.g. ISO 3200)
 - Shooting in RAW format allows for processing after capture
- Lenses
 - Variety of focal lengths can be used
 - Look for lenses that perform well at wide apertures. Vignetting and distortion can be easily fixed with software, but blurry corners cannot. Be willing to compromise...no lens is perfect wide open.

Tripod

- Night photography without a tripod!



30 second exposure through the window of a moving vehicle at night

Equipment

- Cable Releases/Remote

- Allows triggering of camera shutter without touching/moving camera
- Allows shutter to be locked open in bulb mode for exposures longer than 30 seconds



- Intervalometers/Timer Remote Controllers

- Can be programmed to shoot a specified number of exposures in sequence, with a specified exposure length, a specified delay between shots, and a delay before starting
- Costs vary wildly despite the fact they all do pretty much the same thing (Canon=\$150, Generic=\$15)



Equipment

- Laser Pointer
 - Useful for assisting in focusing
- Flashlight
 - Small, low-power key-chain type flashlights are useful for setting up, looking in bag, etc.
 - Higher power flashlights are useful for navigation and “light painting”
- Timer/watch
 - Useful for timing long exposures without an intervalometer
- Compass
 - Useful for estimating position of sun/moon at different times of day
- Patience!

RAW Converters

- Shooting in RAW format allows you to correct:
 - White Balance
 - Vignetting
 - Distortion
 - Noise Reduction
- Not all converters perform equally well
 - Some offer better vignetting correction
 - Some automatically detect and remove noise and “hot pixels”

RAW Converters

- Canon Digital Photo Professional vs Adobe Camera Raw
- Adobe Camera Raw “automagically” removes hot pixels



Canon Software: Digital
Photo Professional



Adobe Software: Adobe
Camera Raw

Conclusion

- Don't put the camera away just because the sun isn't up!



Links and More Reading

- Software
 - Image Stacker: <http://www.tawbaware.com/imgstack.htm>
 - Star Tracer: <http://www.tawbaware.com/startracer.htm>
 - PTAssembler: <http://www.tawbware.com/ptasmbldr.htm>
- Photographs
 - Gallery: <http://www.tawbaware.com/maxlyons>
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- Discussion Forum: <http://www.tawbaware.com/forum2/>
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http://www.tawbaware.com/maxlyons/max_lyons_night_photography.pdf
- Contact: maxlyons@tawbaware.com



Sierra Nevada before Sunrise



C&O Canal at Night



National Colonial Farm Fishing Pier



Pan American Health Institute



Highway 395 at Night



14th Street Bridges



Kennedy Center



Arena Stage



National Gallery of Art



Volta Bureau



Washington Monument



Cannon Beach

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