Understanding Night Sky Resources and the Impacts of Light Pollution

February 6th 2018

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Light Pollution Research and Management

NPS Natural Sounds and Night Skies Division

CSU Sound and Light Ecology Team

- The Natural Photic Environment
- Describing and Quantifying Light Pollution
- Local Night Sky Conditions
- Impacts of Light Pollution – Human and Ecological
- Local Conditions
- Fully sustainable outdoor lighting

The Natural Photic Environment

Illuminance from the Whole Sky

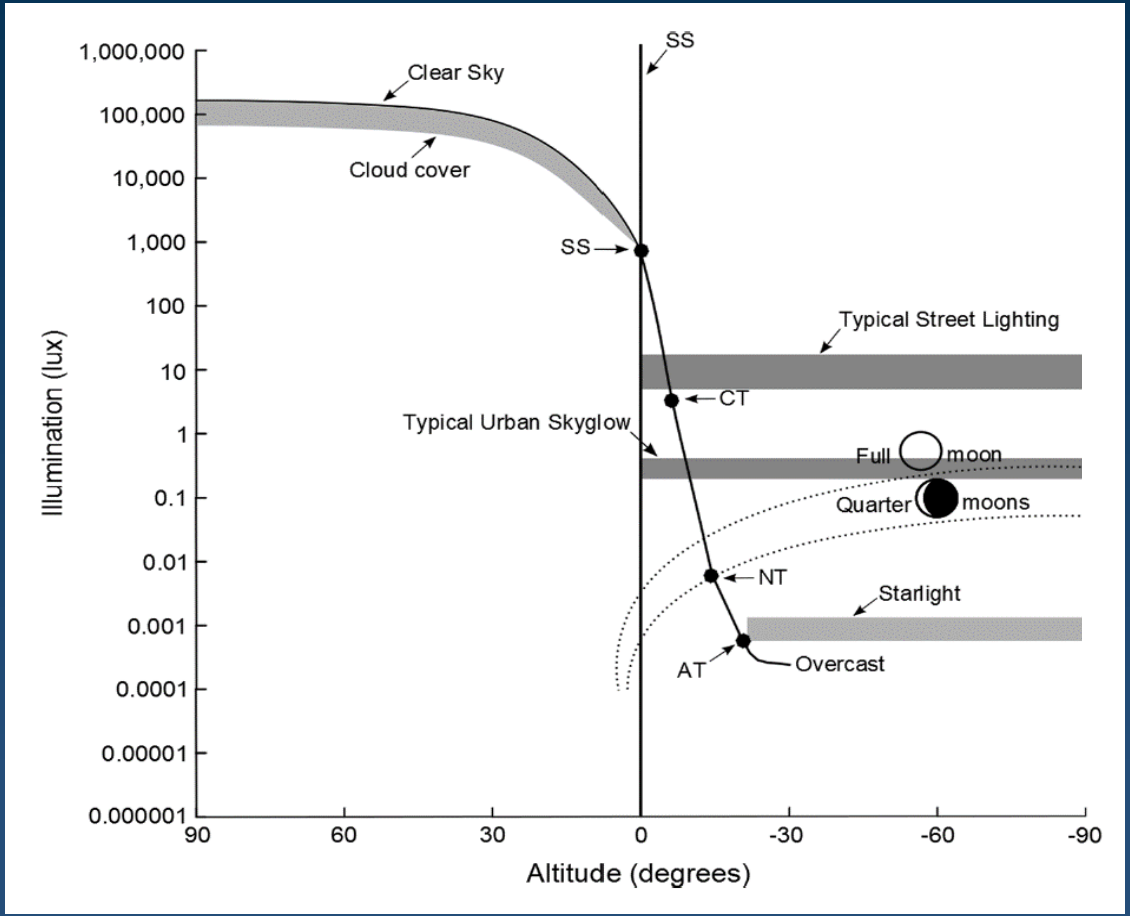
Horizontal
0.8 mlux

Vertical
0.3-0.7 mlux

All-sky
1.6 mlux

The Natural Photic Environment

The Natural Photic Environment

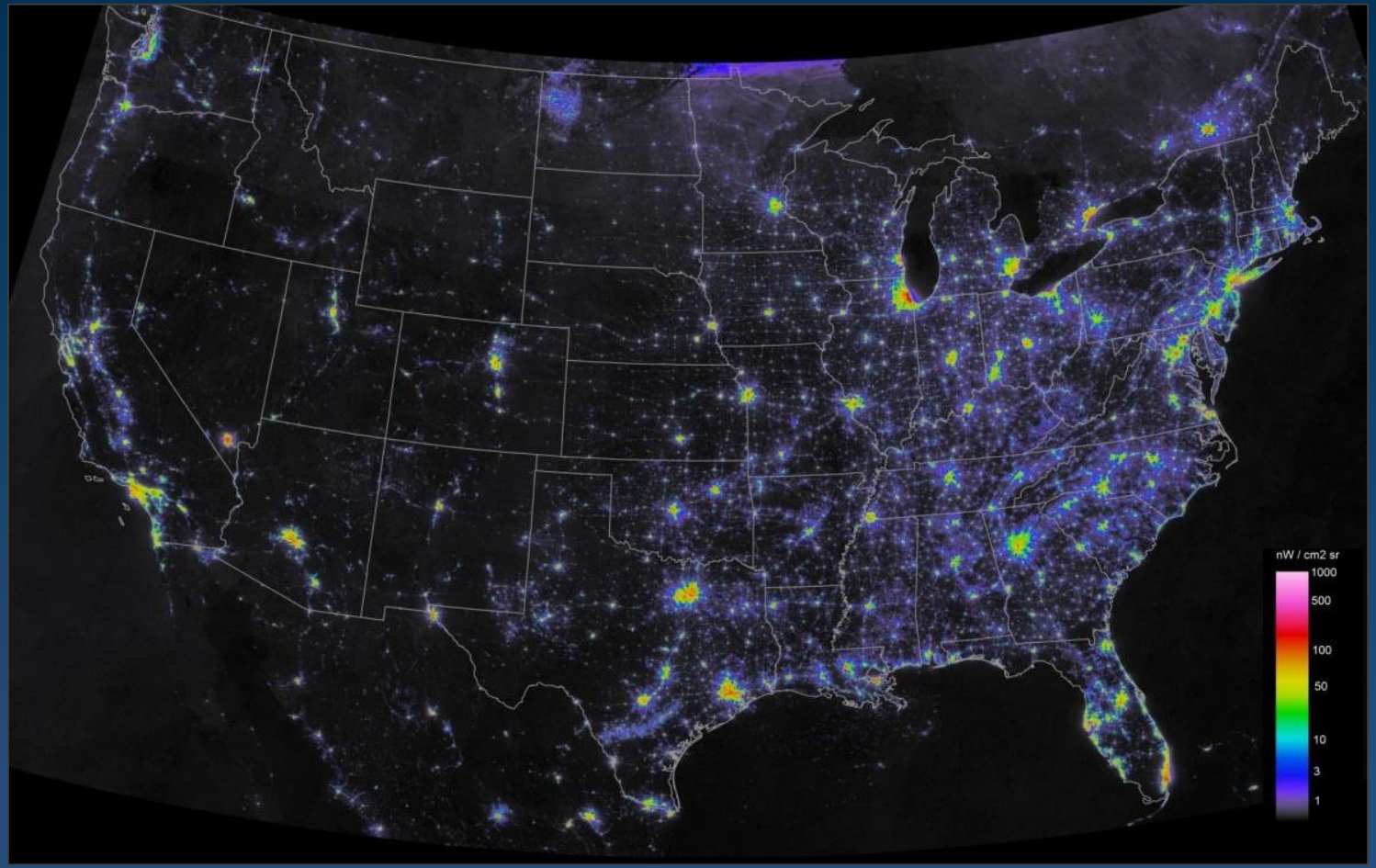


What is Light Pollution

The inappropriate or excessive use of artificial light which brightens the natural sky and surrounding environment. Light Pollution is primarily composed of:

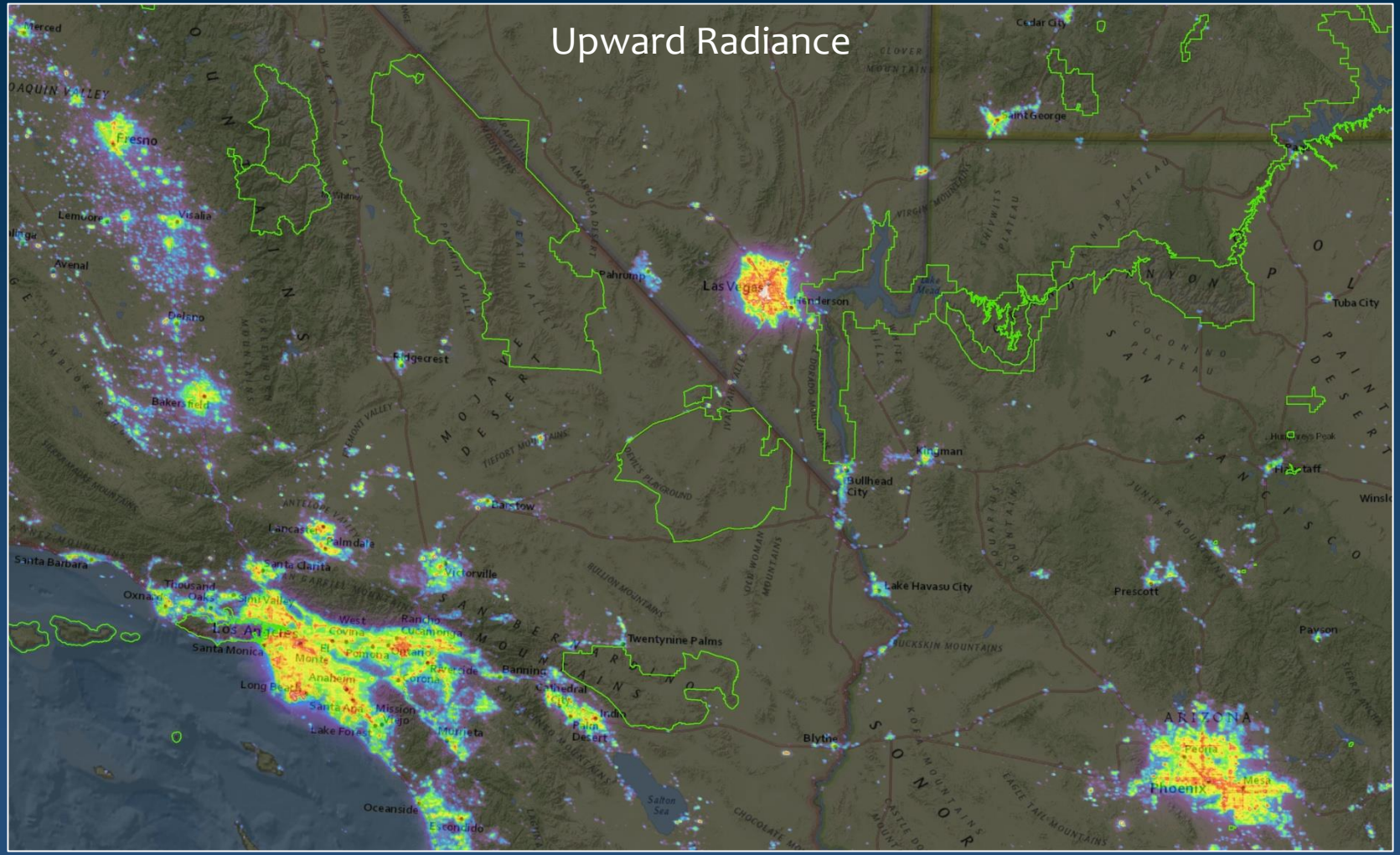
- Glare - excessive brightness that causes visual discomfort
- Skyglow - light scattered and reflected off of air molecules and atmospheric aerosols
- Light Trespass - light falling where it is not intended or needed


Skyglow
Glare
Skyglow
Light Trespass

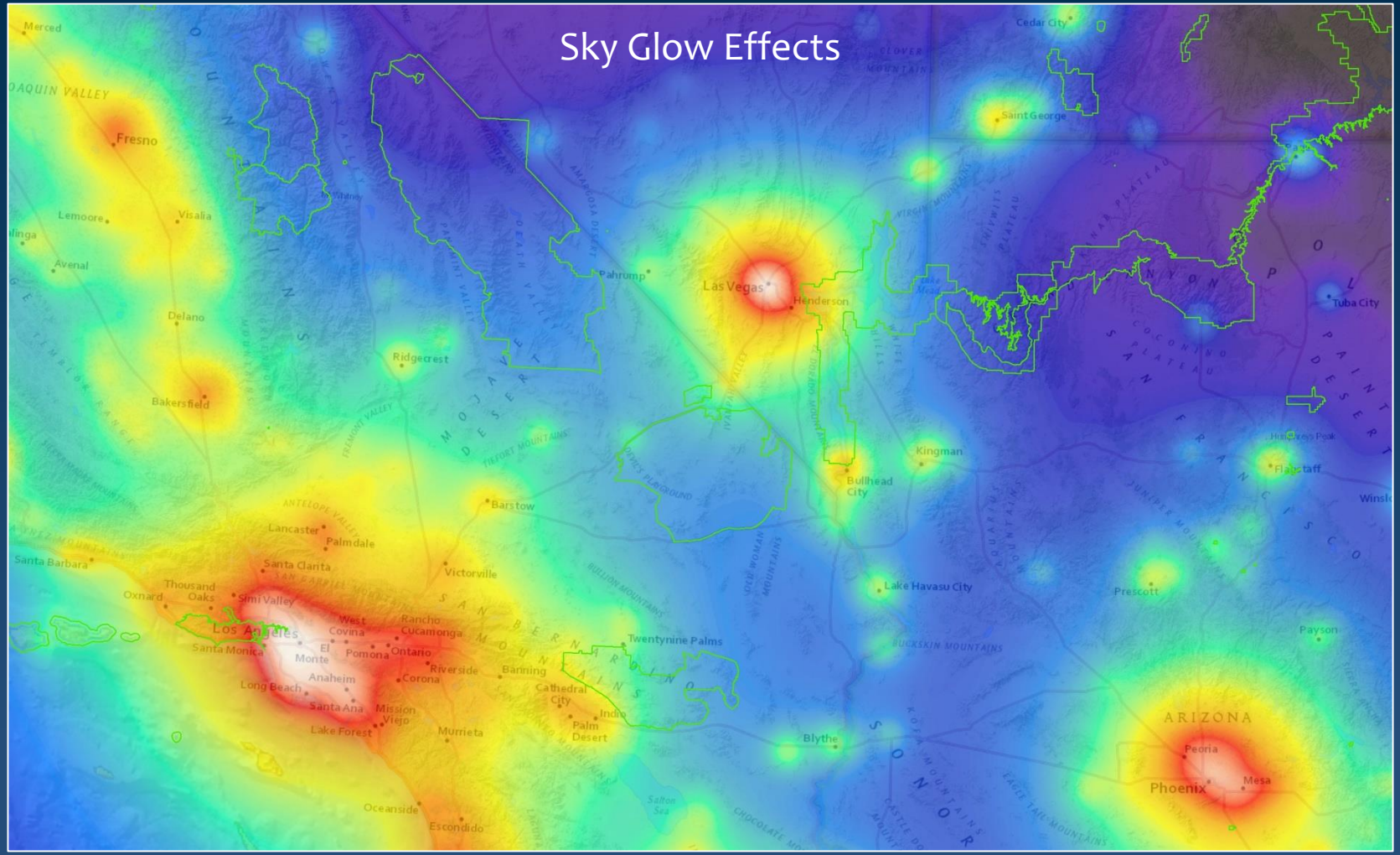


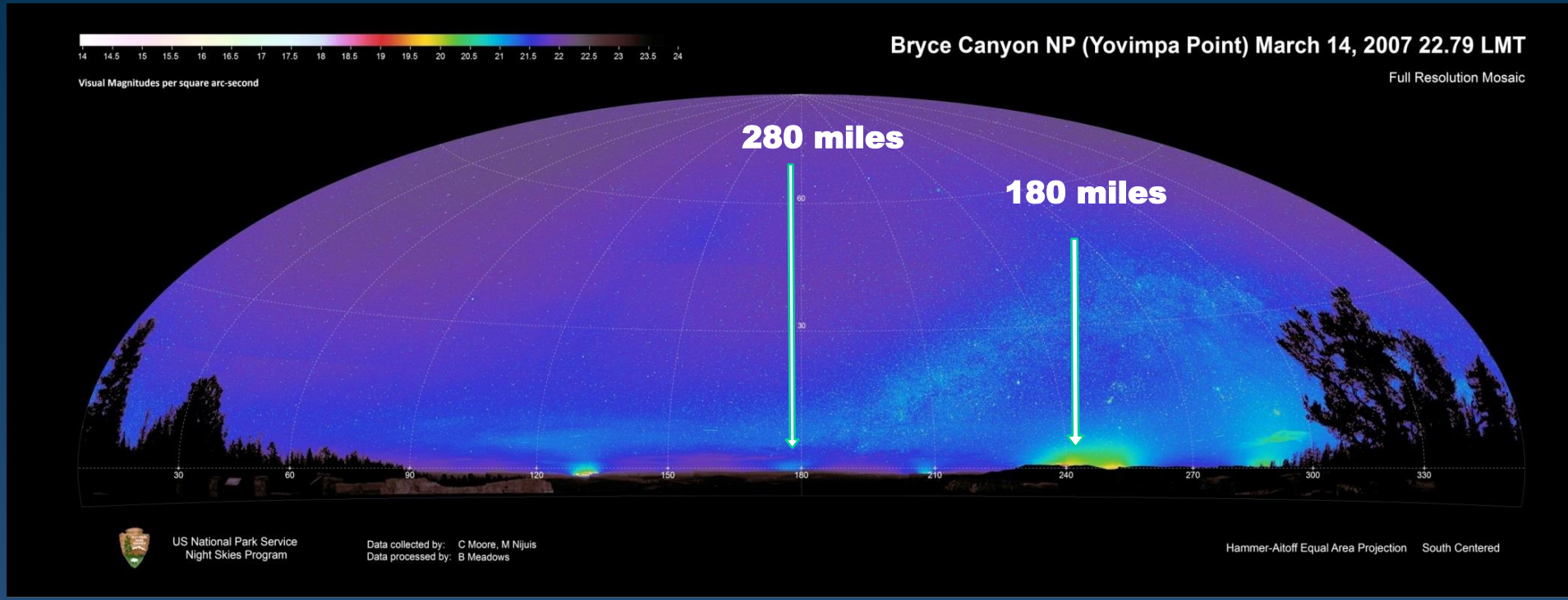
VIIRS Day / Night Band Radiance Data

Upward Radiance

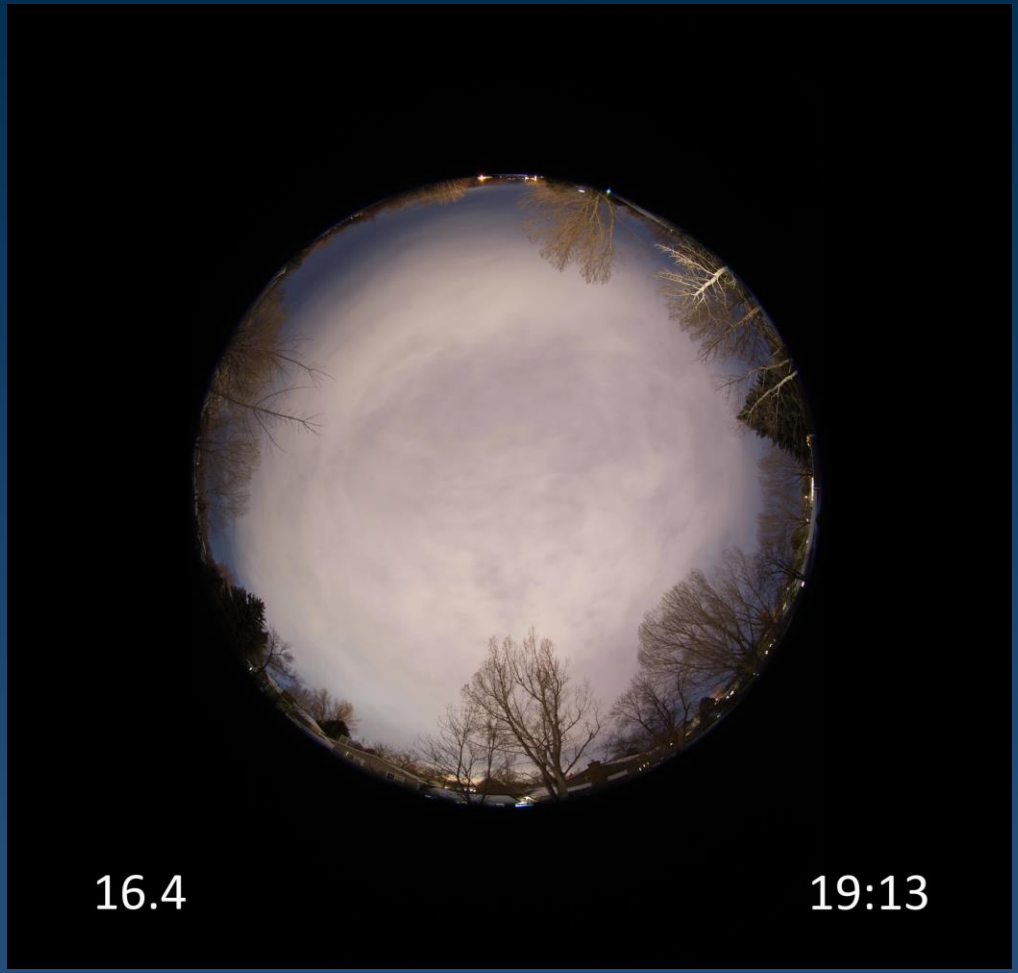


Sky Glow Effects





Bryce Canyon National Park, UT



Light pollution is amplified locally from cloud cover, fog, and haze.

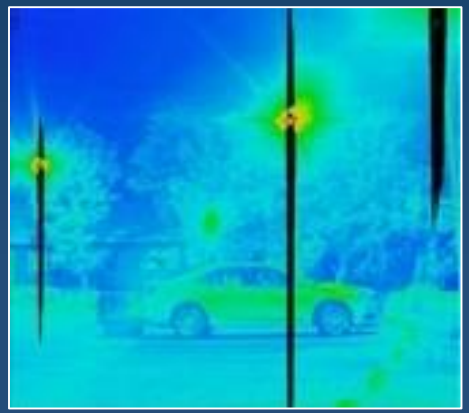
This low cloud bank increased overhead sky brightness by 15x

Measuring the Night Sky

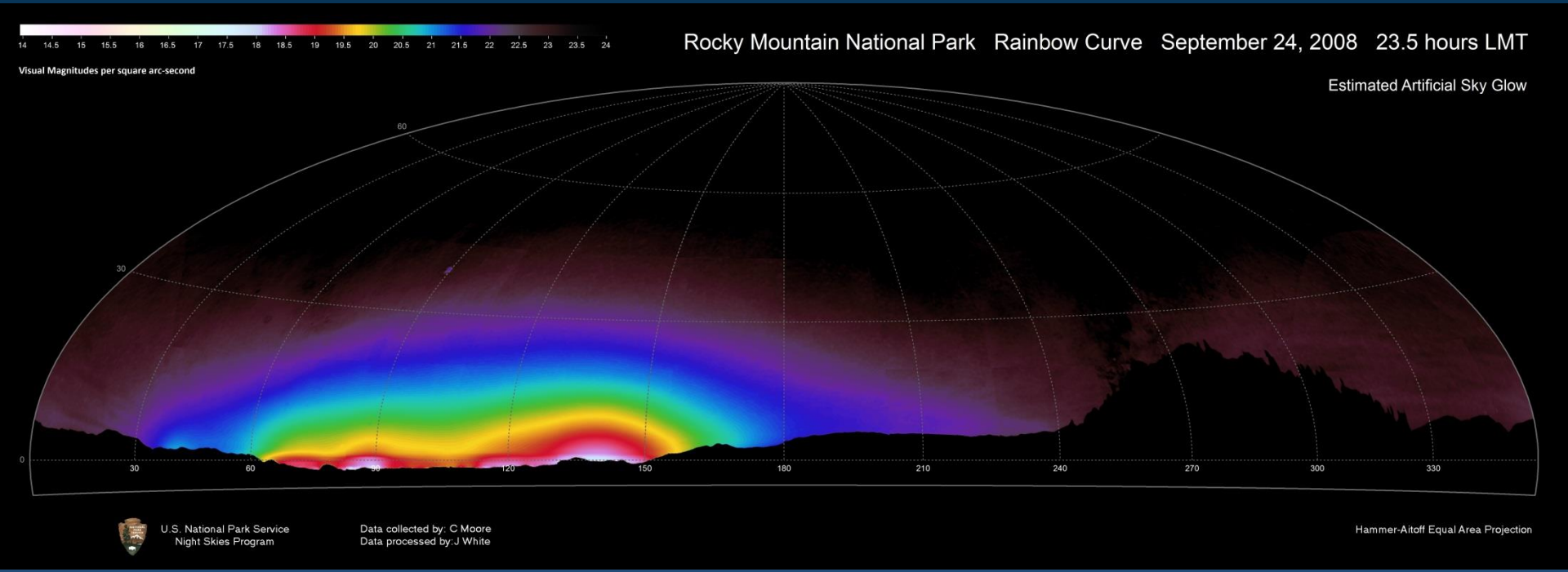
16 bit monochrome image, photometric calibration from standard stars

Calibration applied to each pixel gives brightness measurement (luminance)

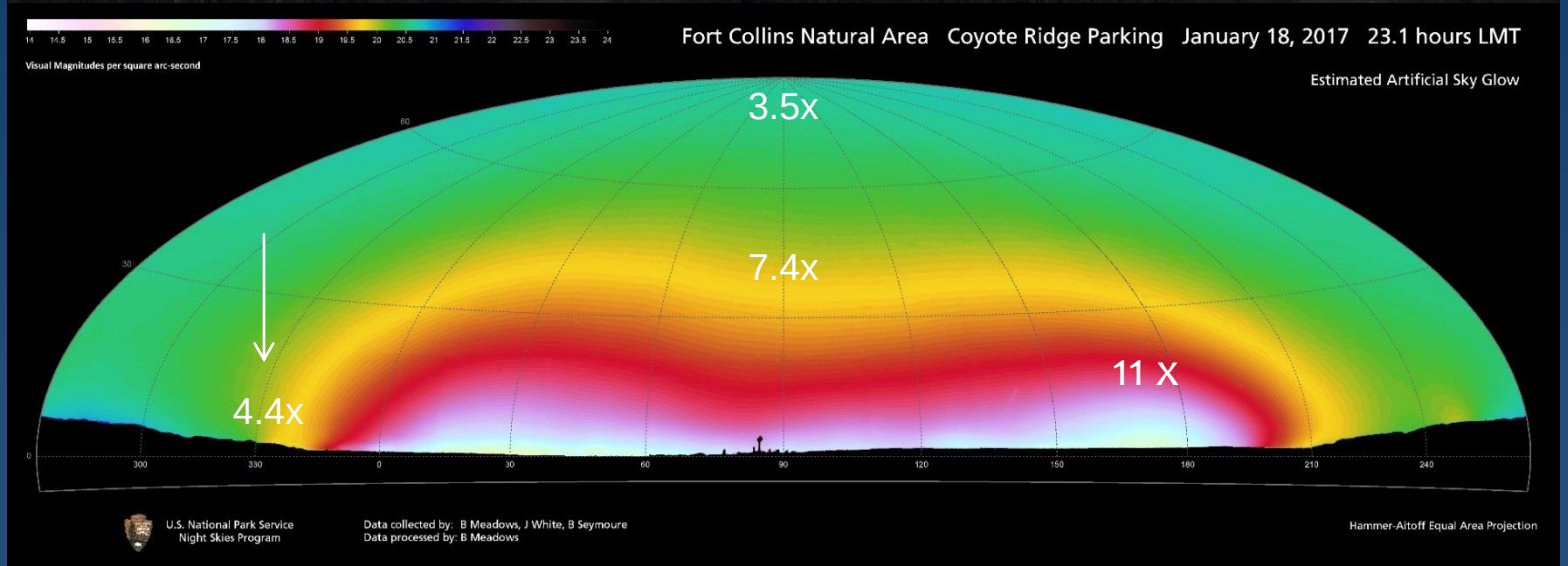
Same system to measure local scene luminance



Measuring the Night Sky



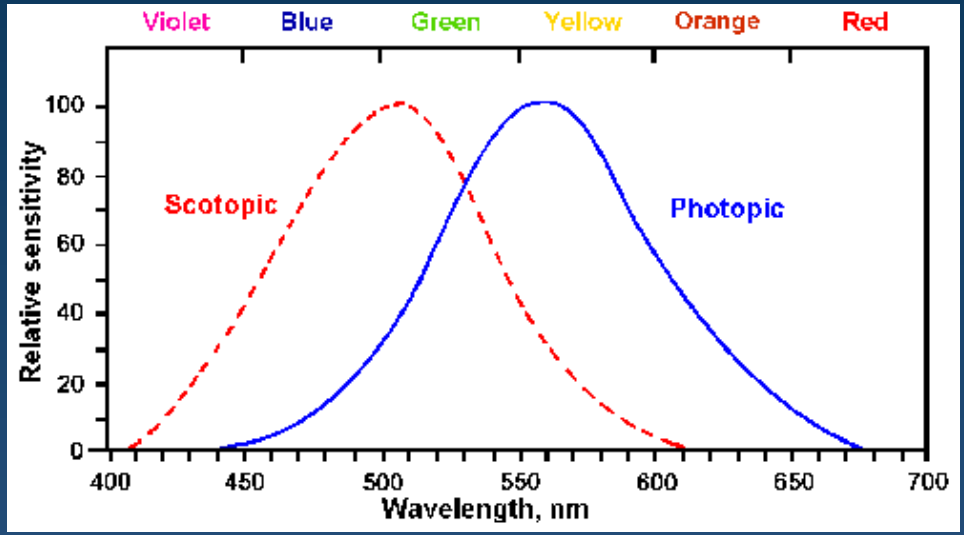

3.5x
7.4x
4.4x
11 X


Visual Magnitudes per square arc-second
Fort Collins Natural Area Coyote Ridge Parking January 18, 2017 23.1 hours LMT
Estimated Artificial Sky Glow
3.5x
7.4x
4.4x
11 X
U.S. National Park Service
Night Skies Program
Data collected by: B Meadows, J White, B Seymoure
Data processed by: B Meadows
Hammer-Aitoff Equal Area Projection

Measuring the Night Sky

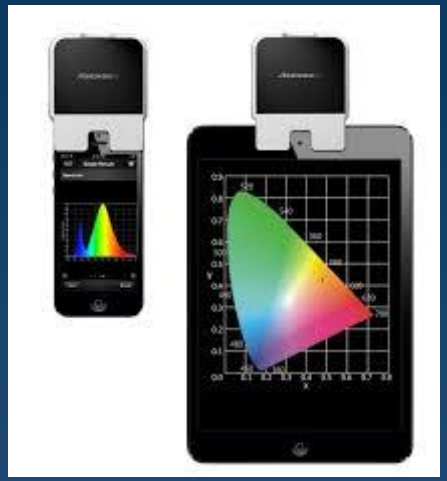
Sky Quality Meter

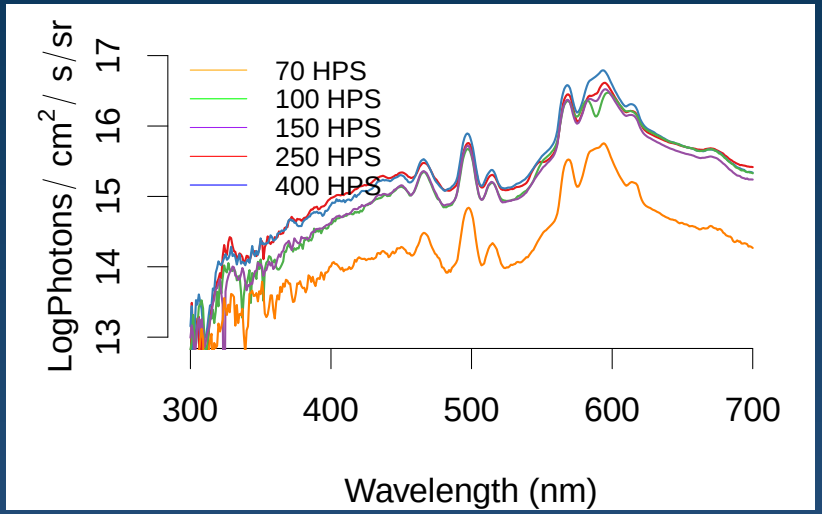
Lux Meter



Human Vision (Photopic = Color Vision)

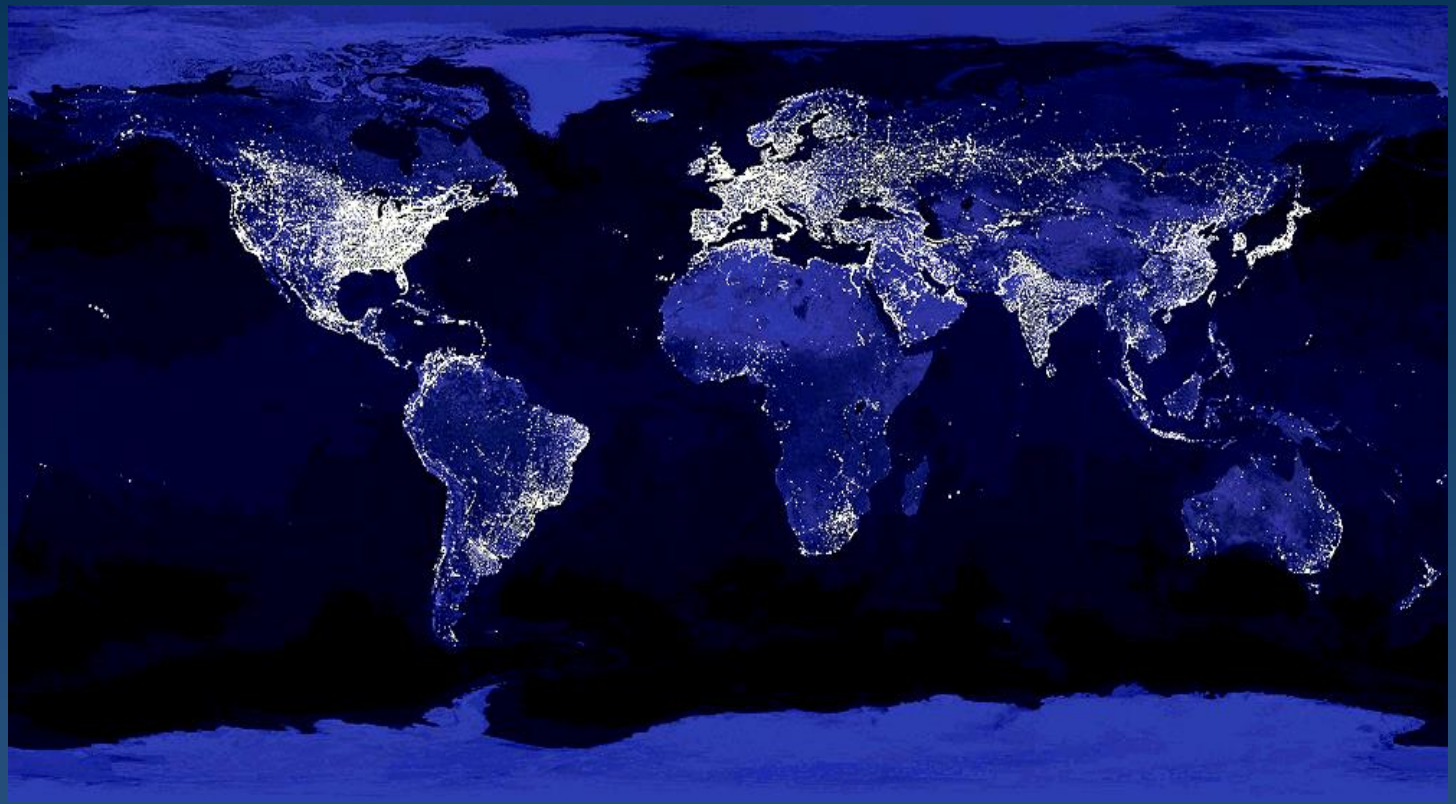
Measuring the Night Sky

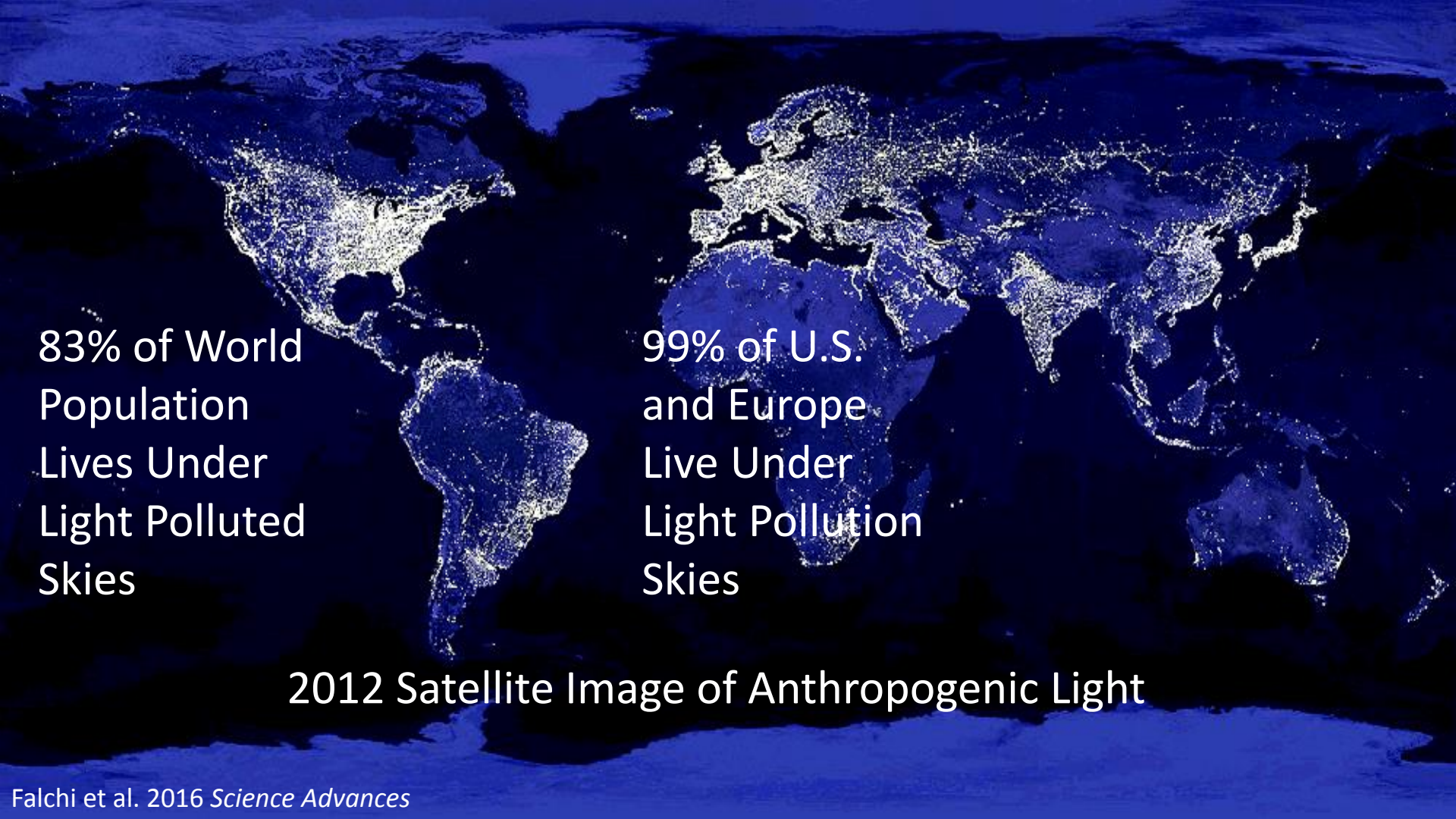




Spectrometers

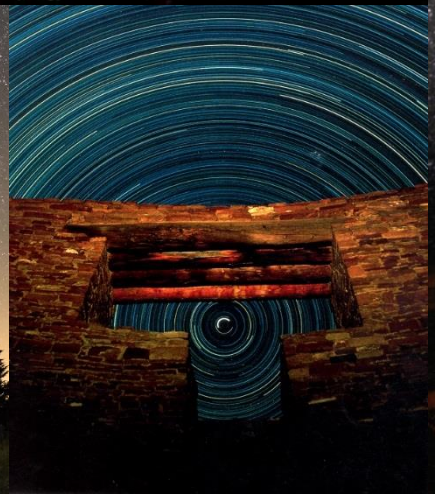
Impacts of Light Pollution

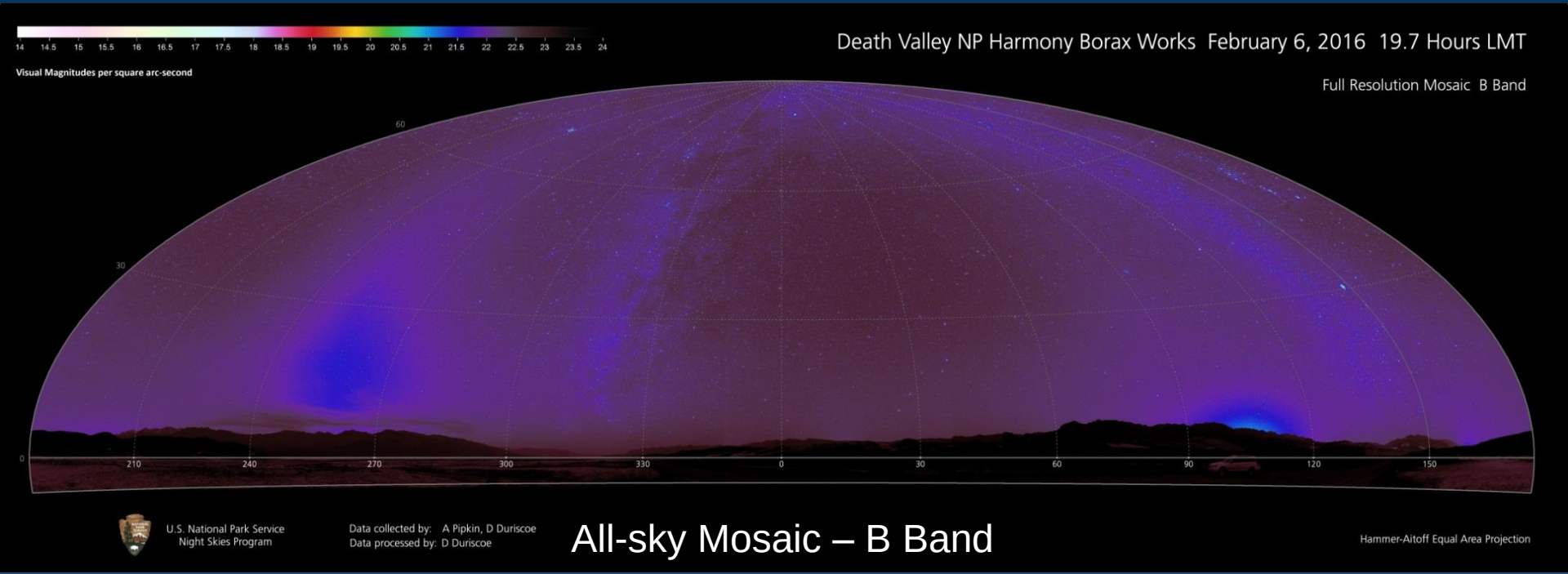




Falchi et al. 2016 *Science Advances*

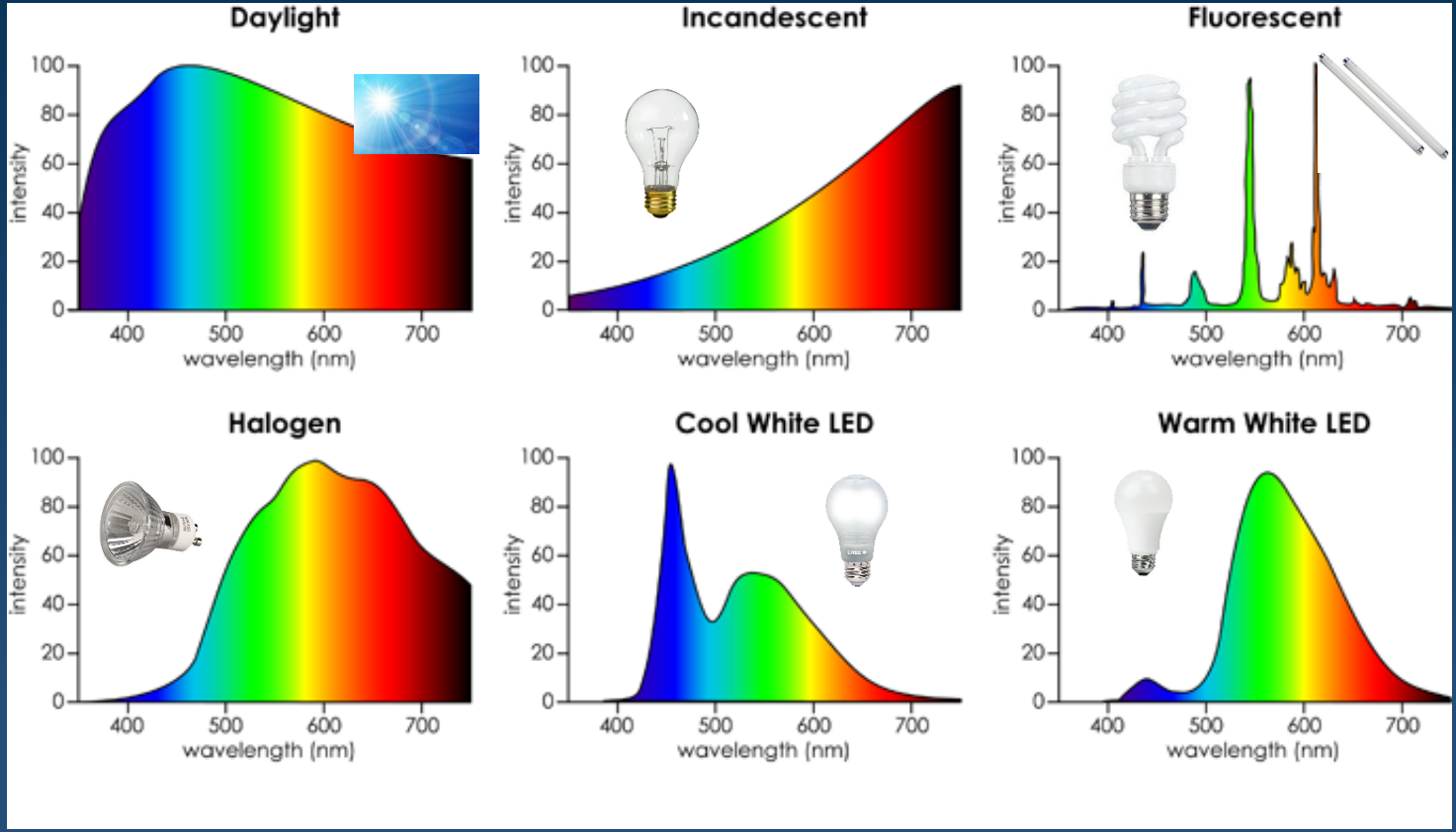
Impacts of Light Pollution



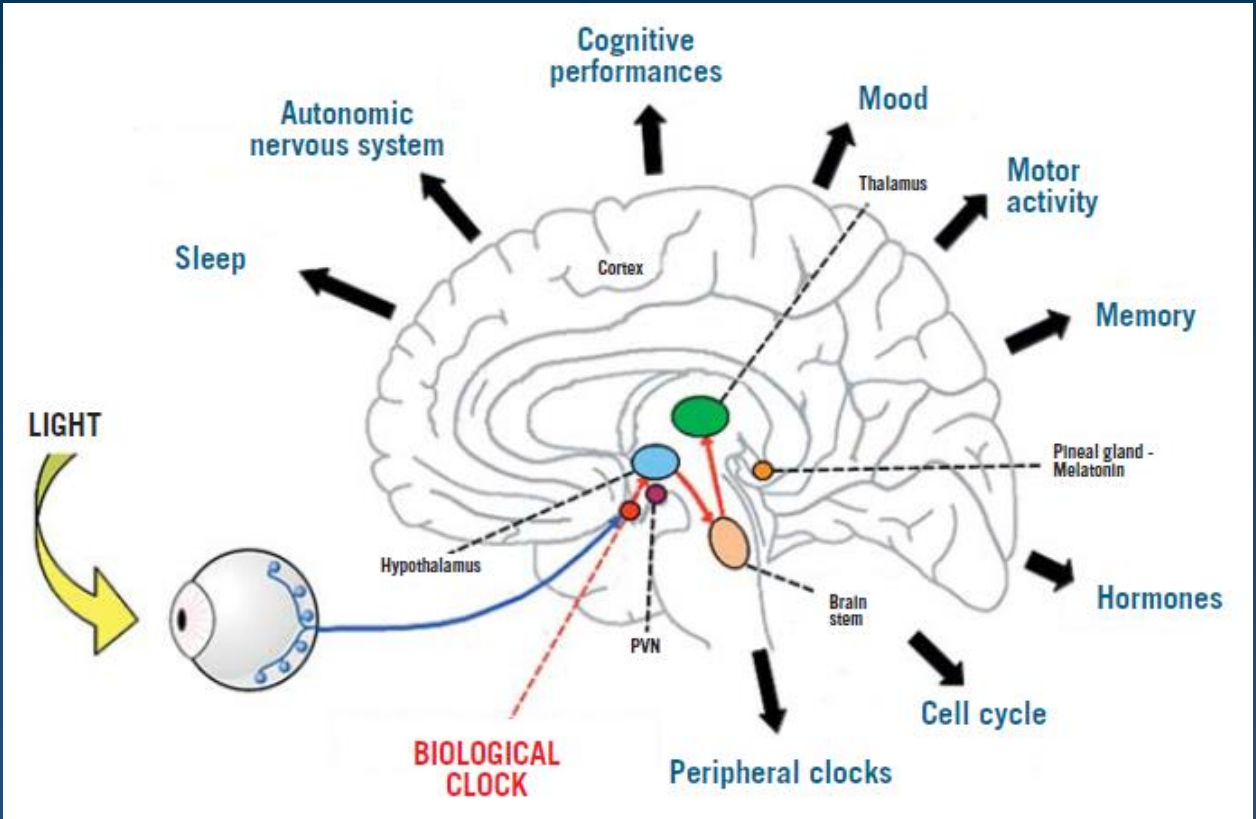


All-sky Mosaic – B Band

All Lights Are NOT Created Equally

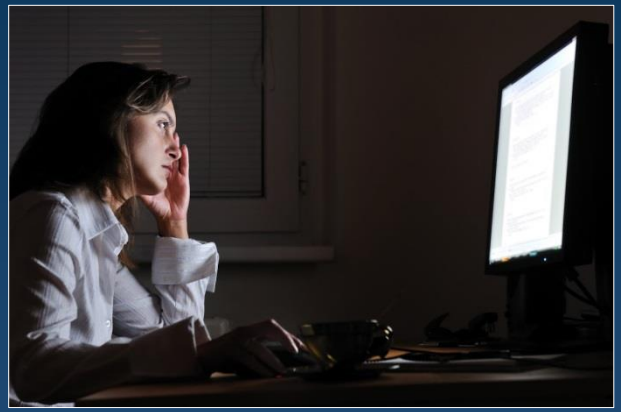


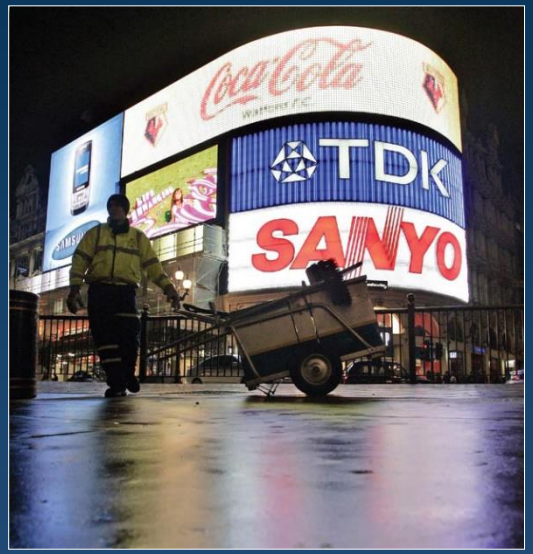
Human Health



Claude Gronifer. Points de Vue, International Review of Ophthalmic Optics, N68, Spring, 2013

Human Health



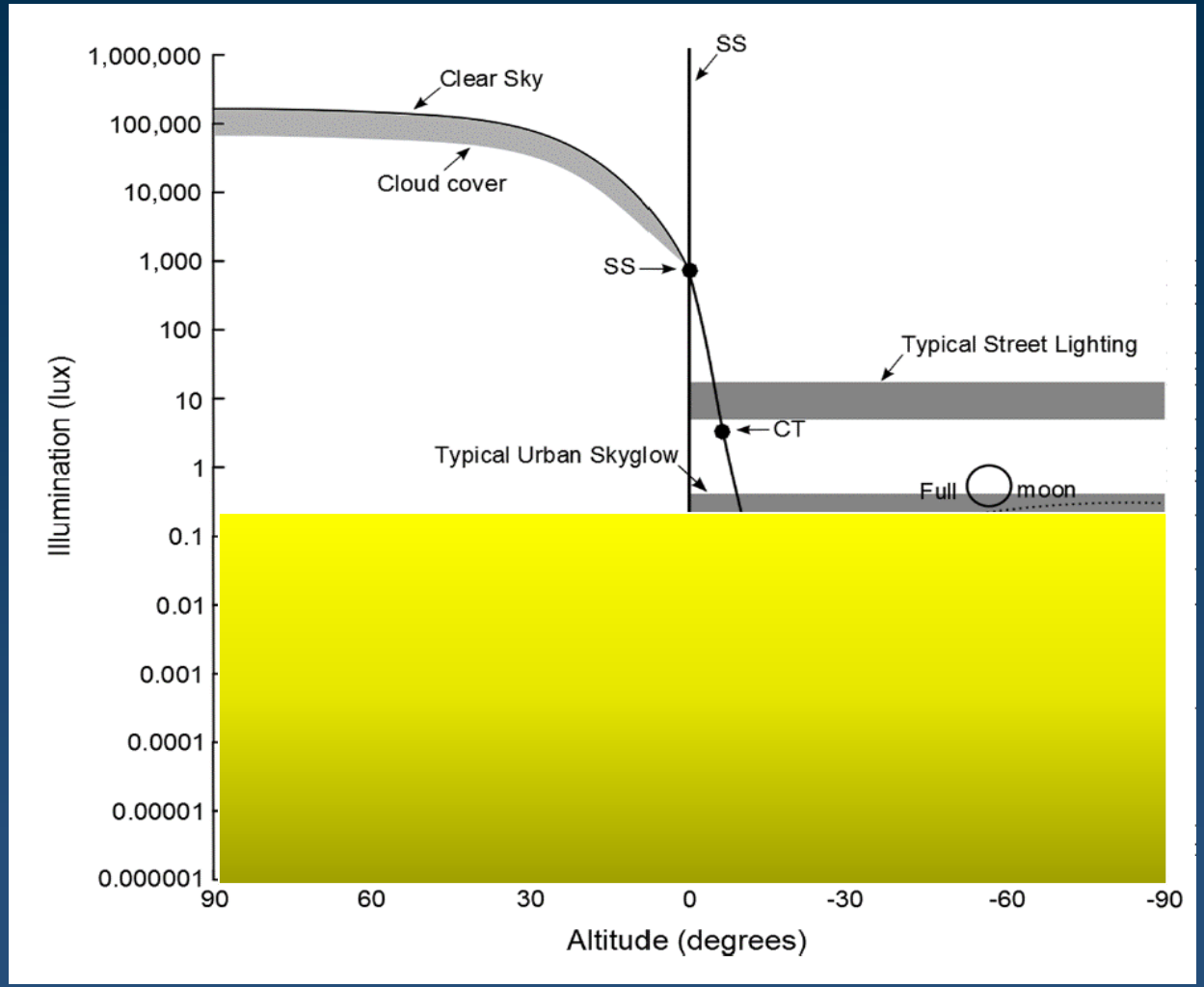


International Agency for Research on Cancer

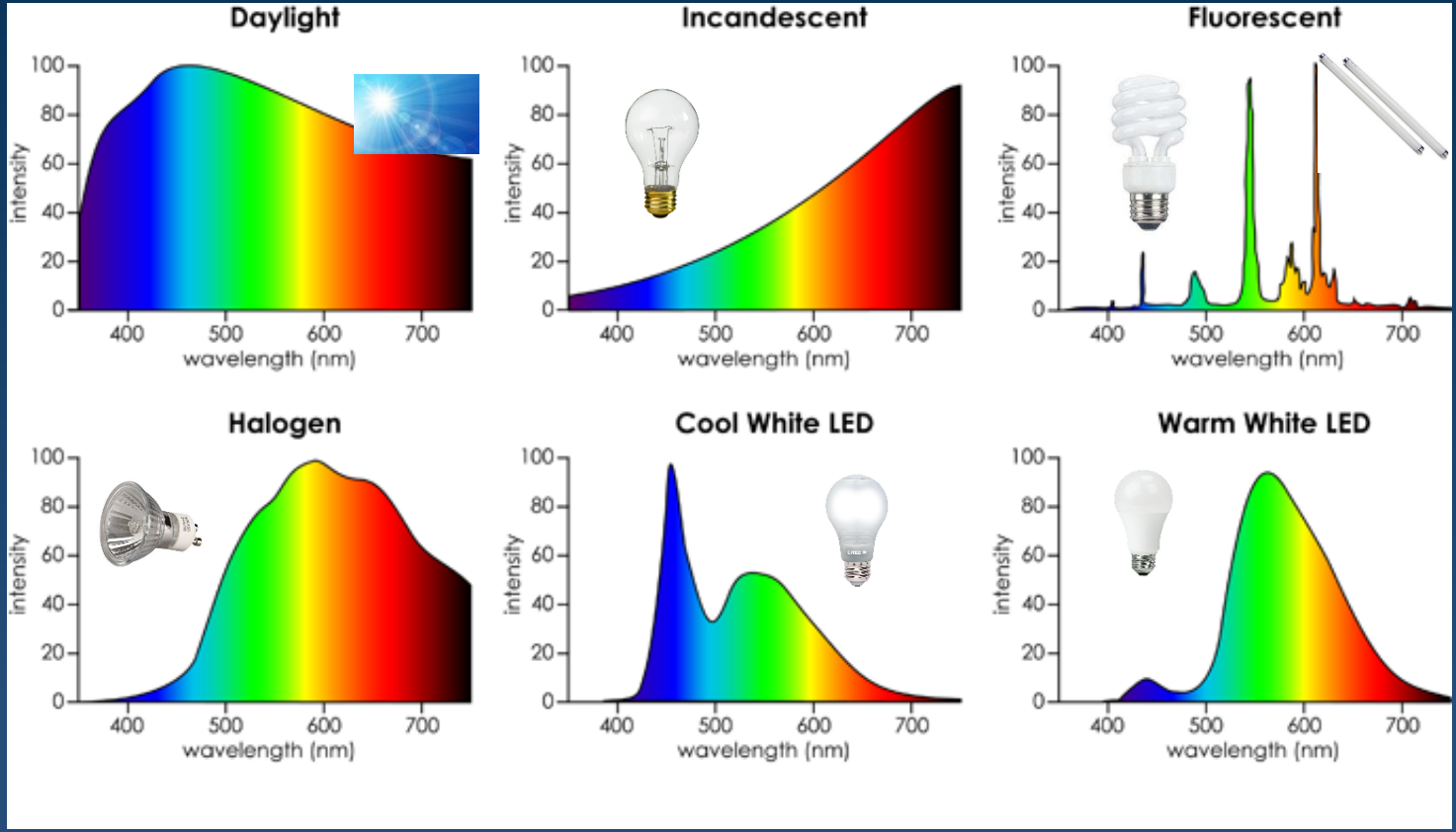
World Health Organization

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

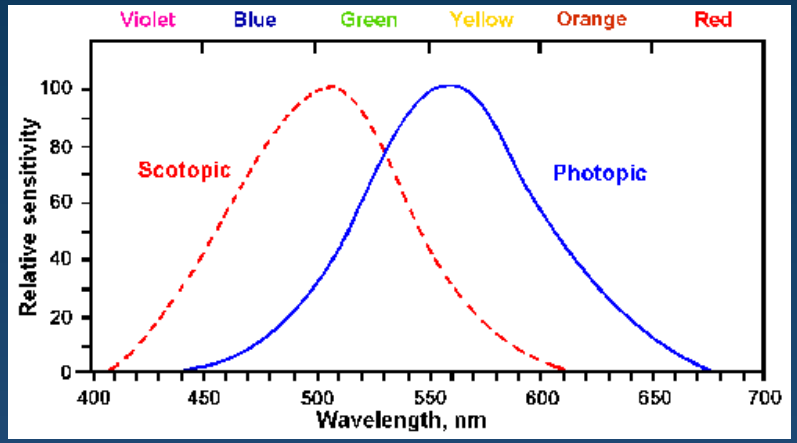
Ecological


1,000,000
100,000
10,000
1,000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
Illumination (lux)
SS
Clear Sky
Cloud cover
SS
Typical Street Lighting
CT
Typical Urban Skyglow
Full
moon
90
60
30
0
-30
-60
-90
Altitude (degrees)

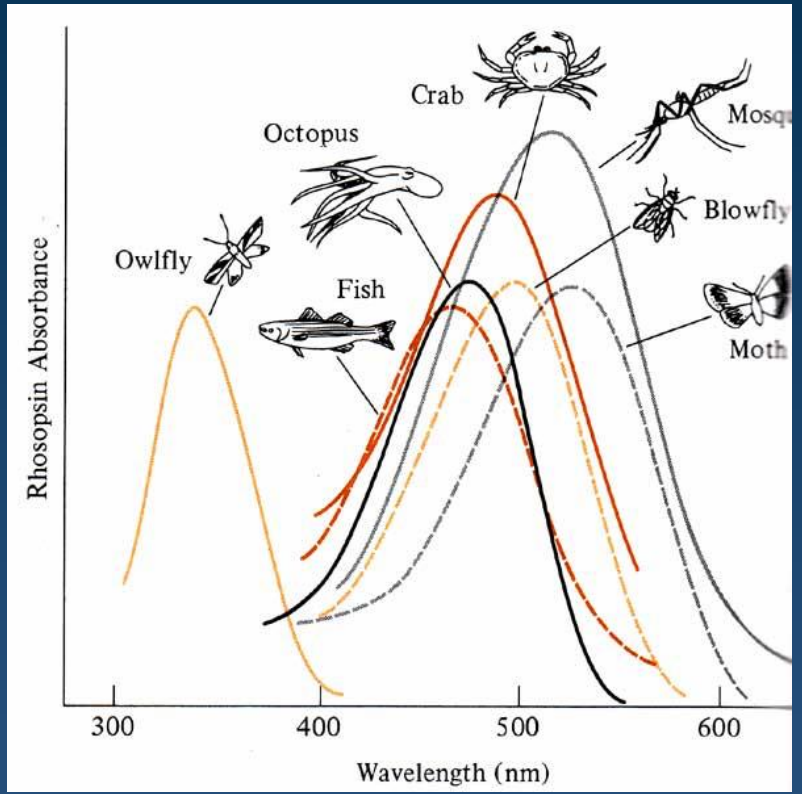
Ecological


Daylight
Incandescent
Fluorescent
Halogen
Cool White LED
Warm White LED
intensity
wavelength (nm)
0
20
40
60
80
100
400
500
600
700

Ecological



Human Vision (Photopic = Color Vision)



Ecological

Movement

Migration

Fragmentation

Foraging

Predator Prey

Competition

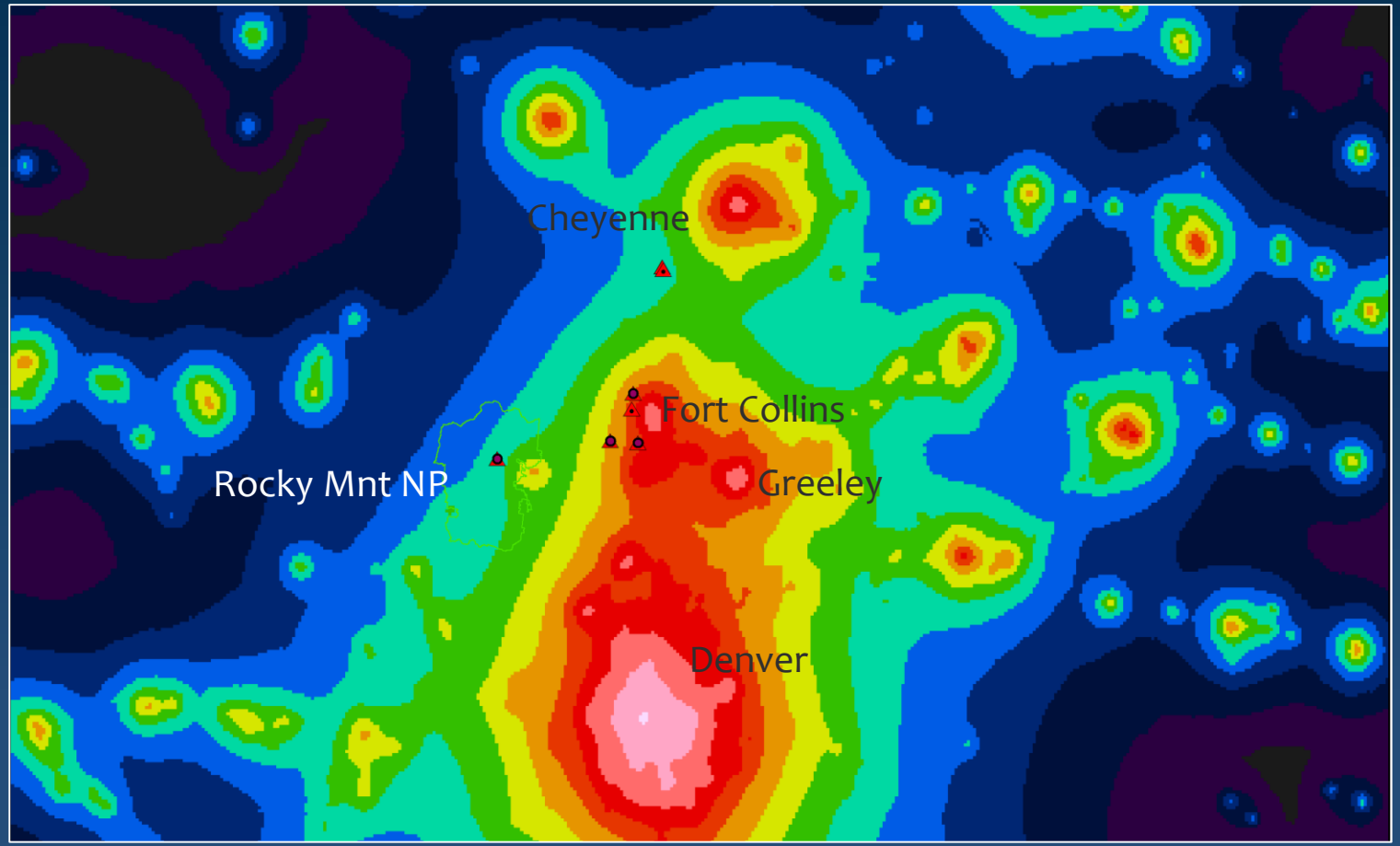
Community Structure

Communication

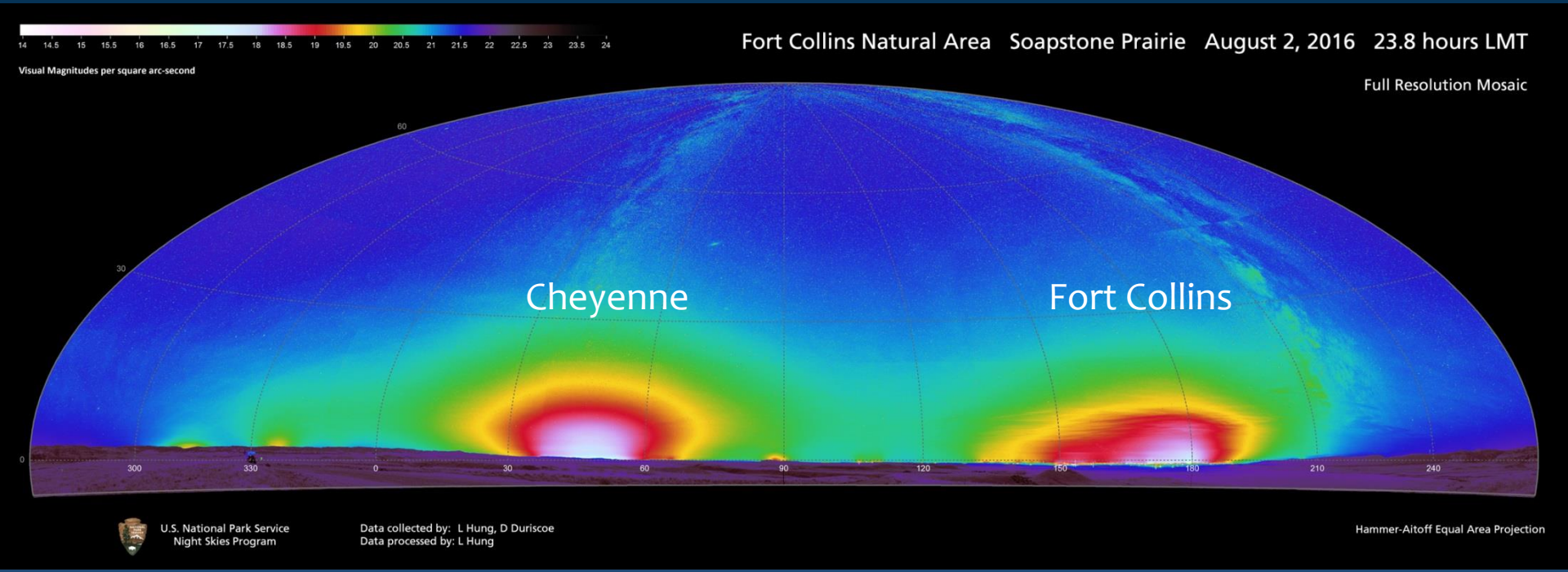
Reproduction

Physiology

Local Conditions

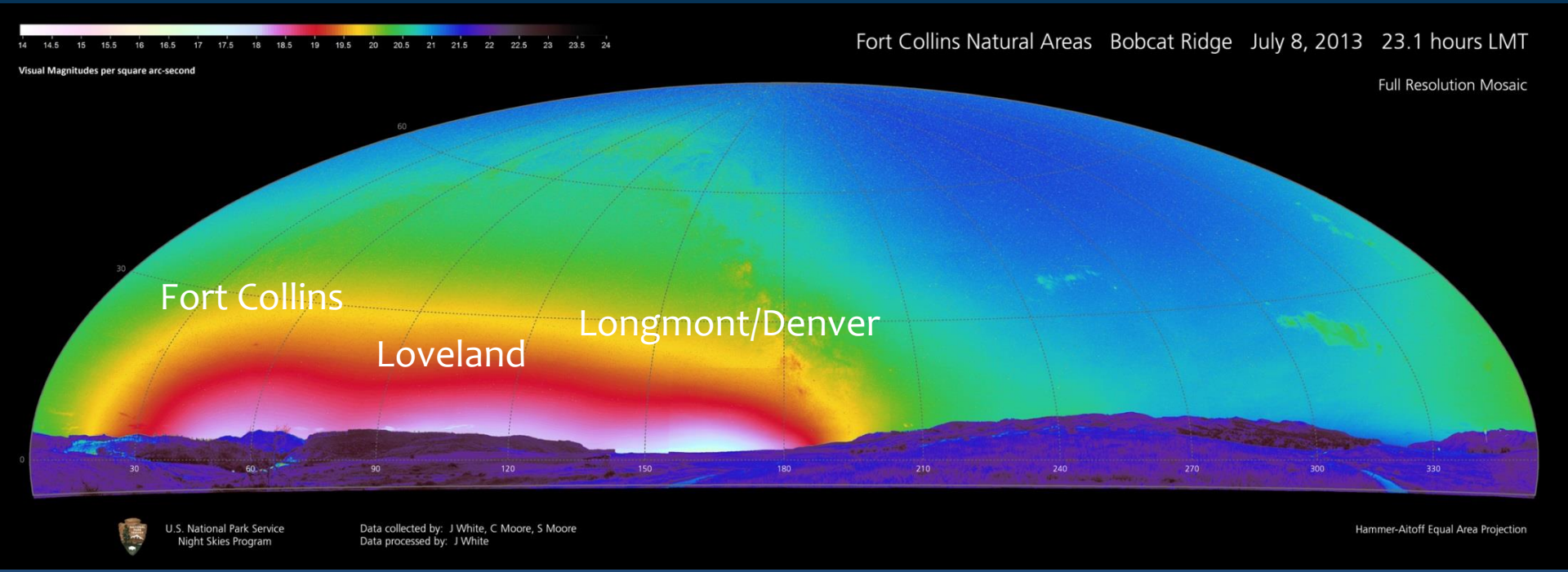


Soapstone Prairie



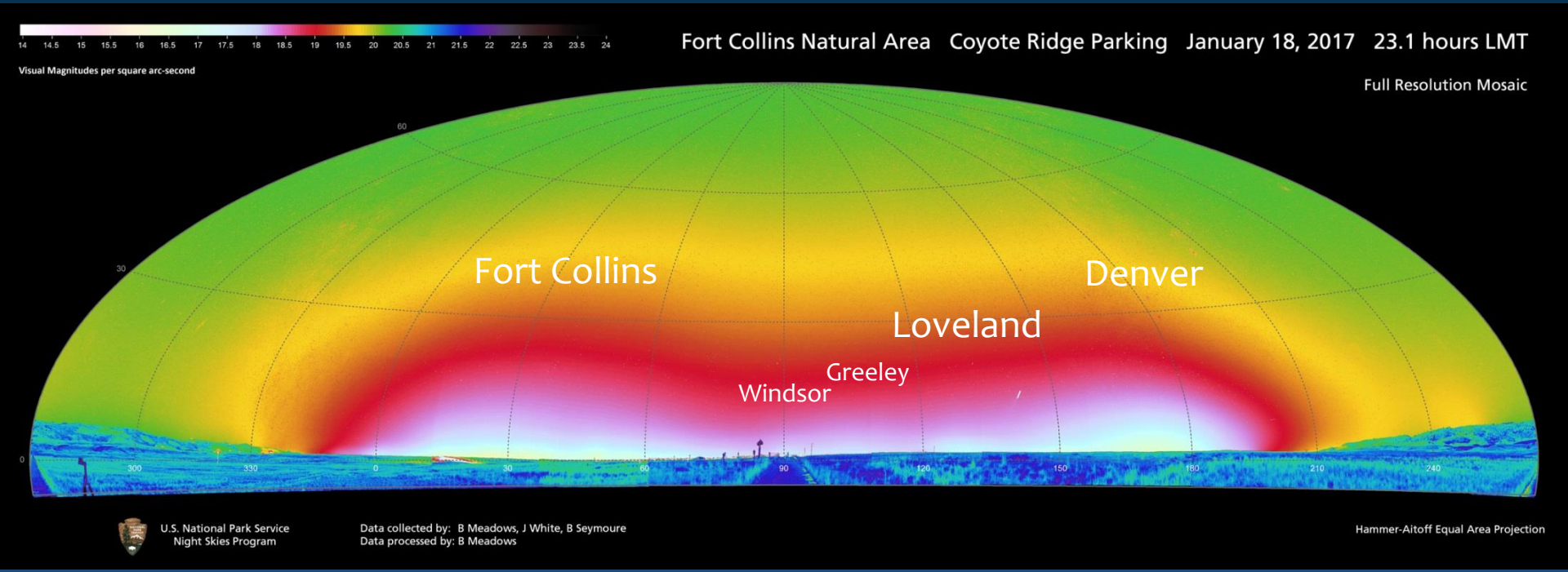
1.4x brighter than natural
.7x zenith brightness
1.7x vertical illuminance
0.6x horizontal illuminance
78% stars visible

Bobcat Ridge



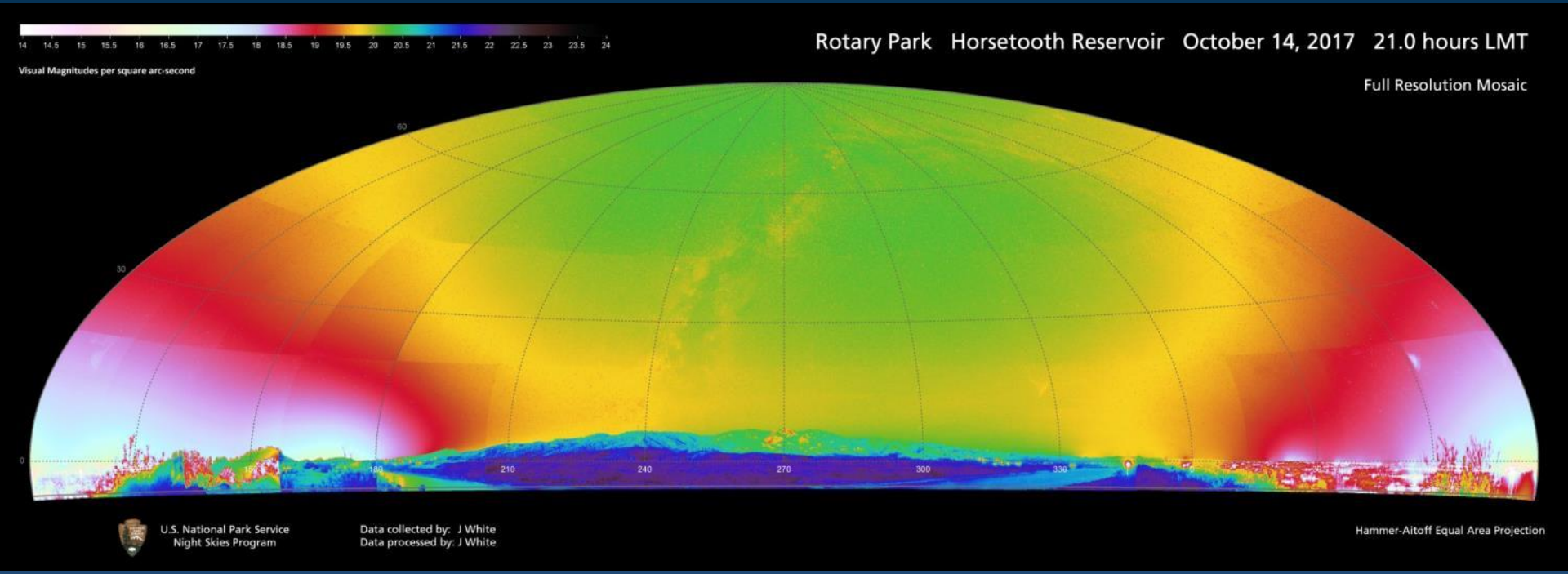
3.5x brighter than natural
1x zenith brightness
3.5x vertical illuminance
2x horizontal illuminance
54% stars visible

Coyote Ridge



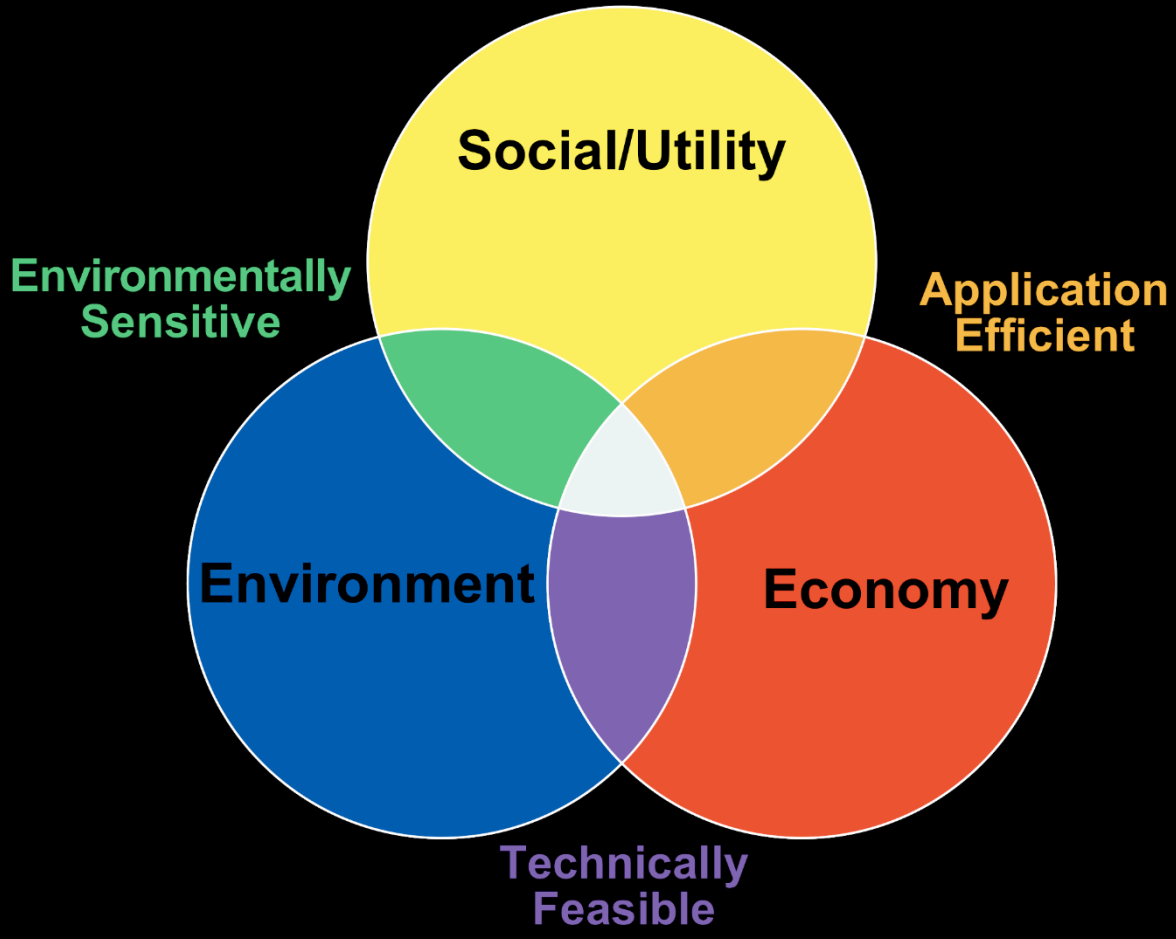
7.4x brighter than natural
3.5x zenith brightness
7.8x vertical illuminance
4.4x horizontal illuminance
58% stars visible

Horsetooth Reservoir



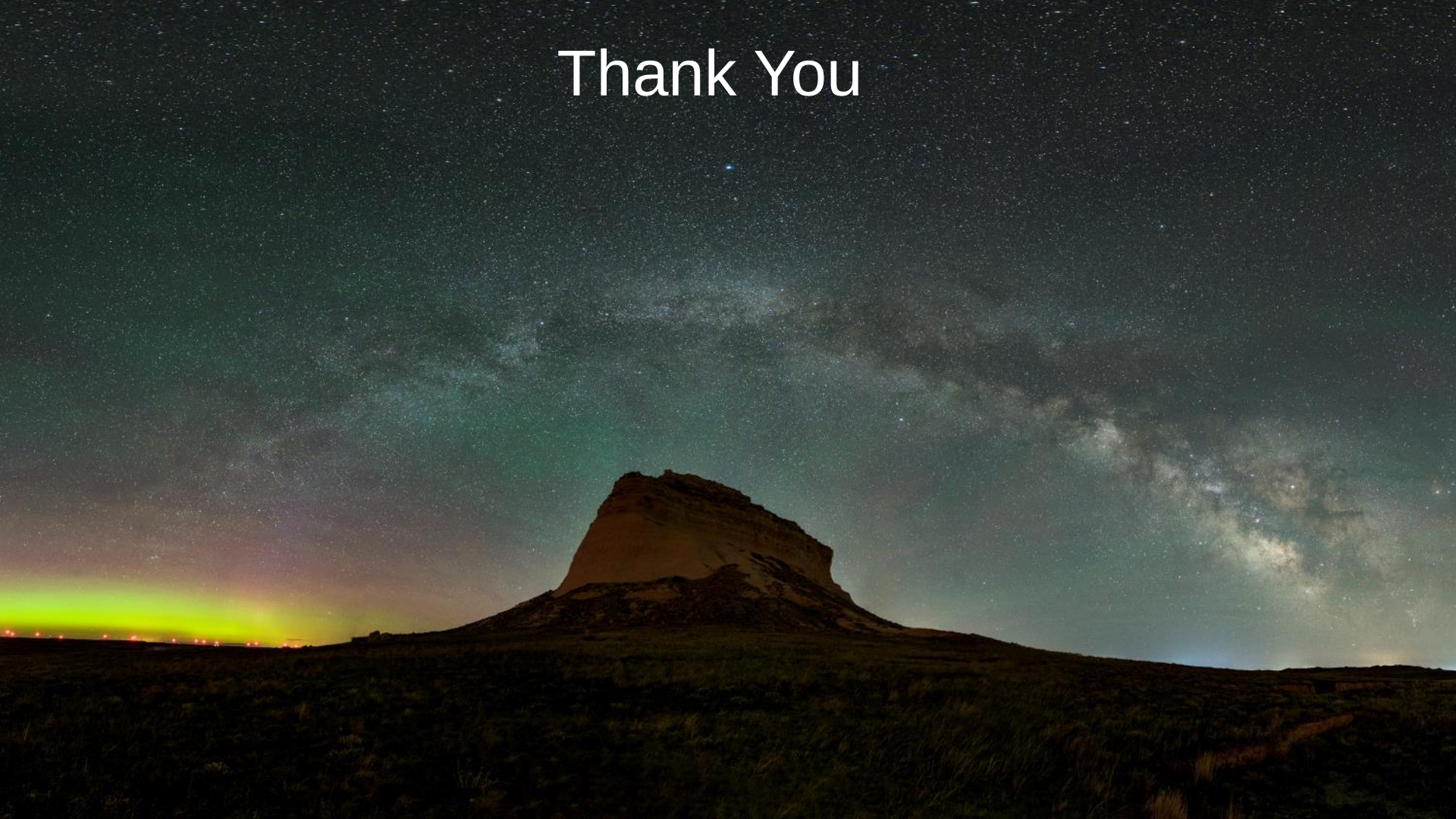
29x brighter than natural
3.9x zenith brightness
8.7x vertical illuminance
3.8x horizontal illuminance
35% stars visible

Fully Sustainable Lighting



Fully Sustainable Outdoor Lighting

- Light only where you need it
- Light only when you need it
- Shield lights and direct them downward
- Use the minimum amount of light necessary
- Select lamps with warmer colors
- Use the most energy efficient lamps and fixtures


Thank You

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