

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 Photoc Environment



Illuminance
from the
Whole Sky

Horizontal
0.8 mlux

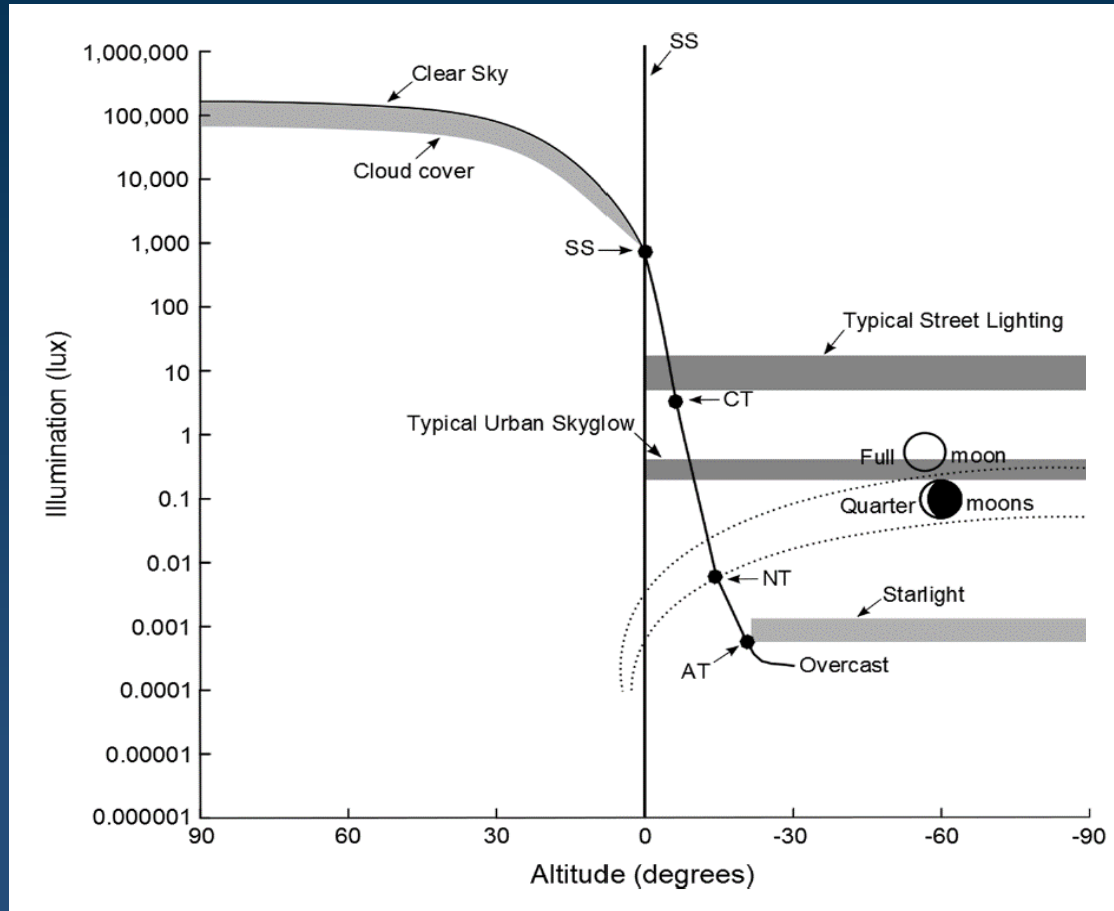
Vertical
0.3-0.7 mlux

All-sky
1.6 mlux

The Natural Photic Environment



The Natural Photoc Environment



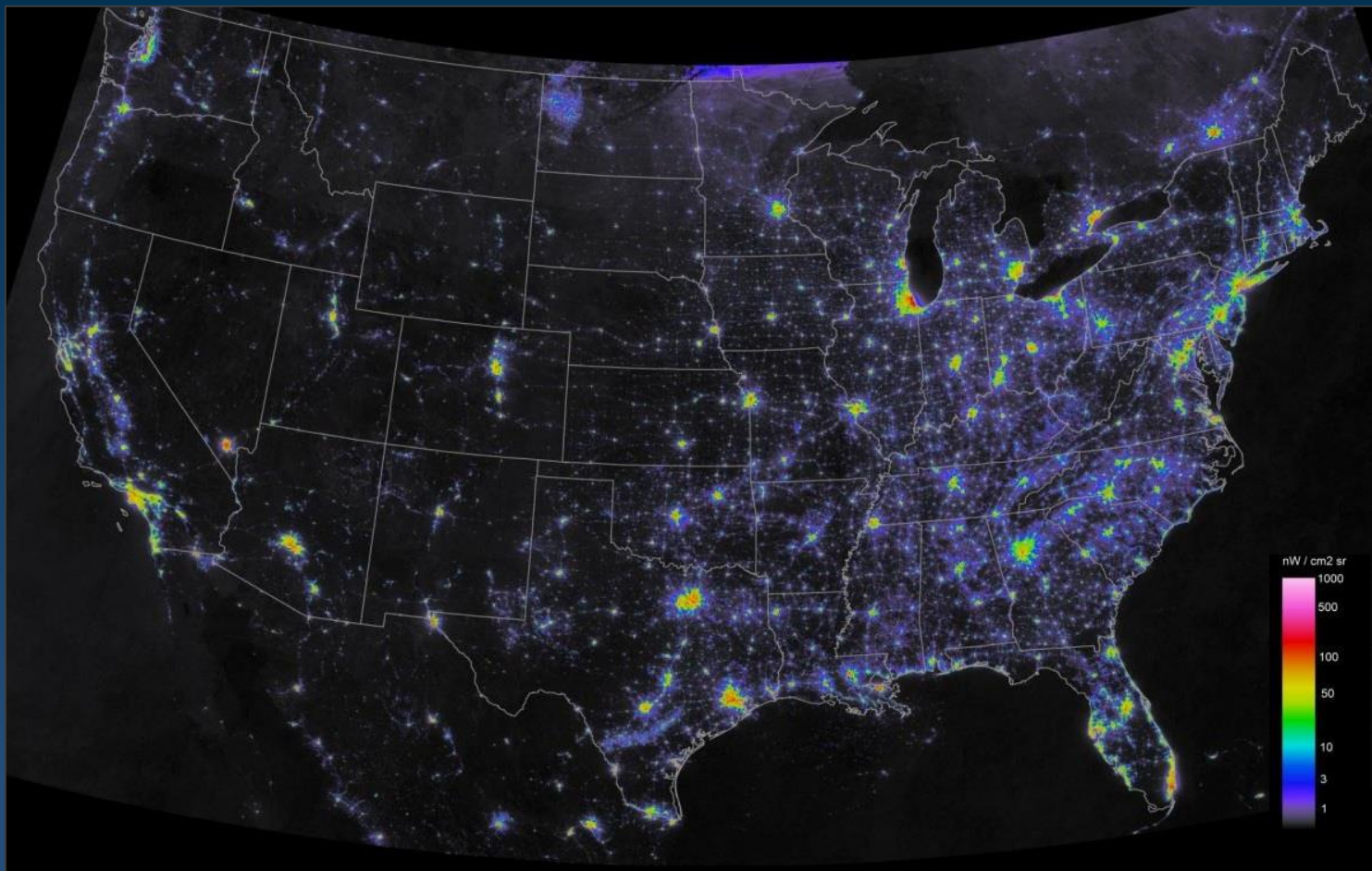
What is Light Pollution

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

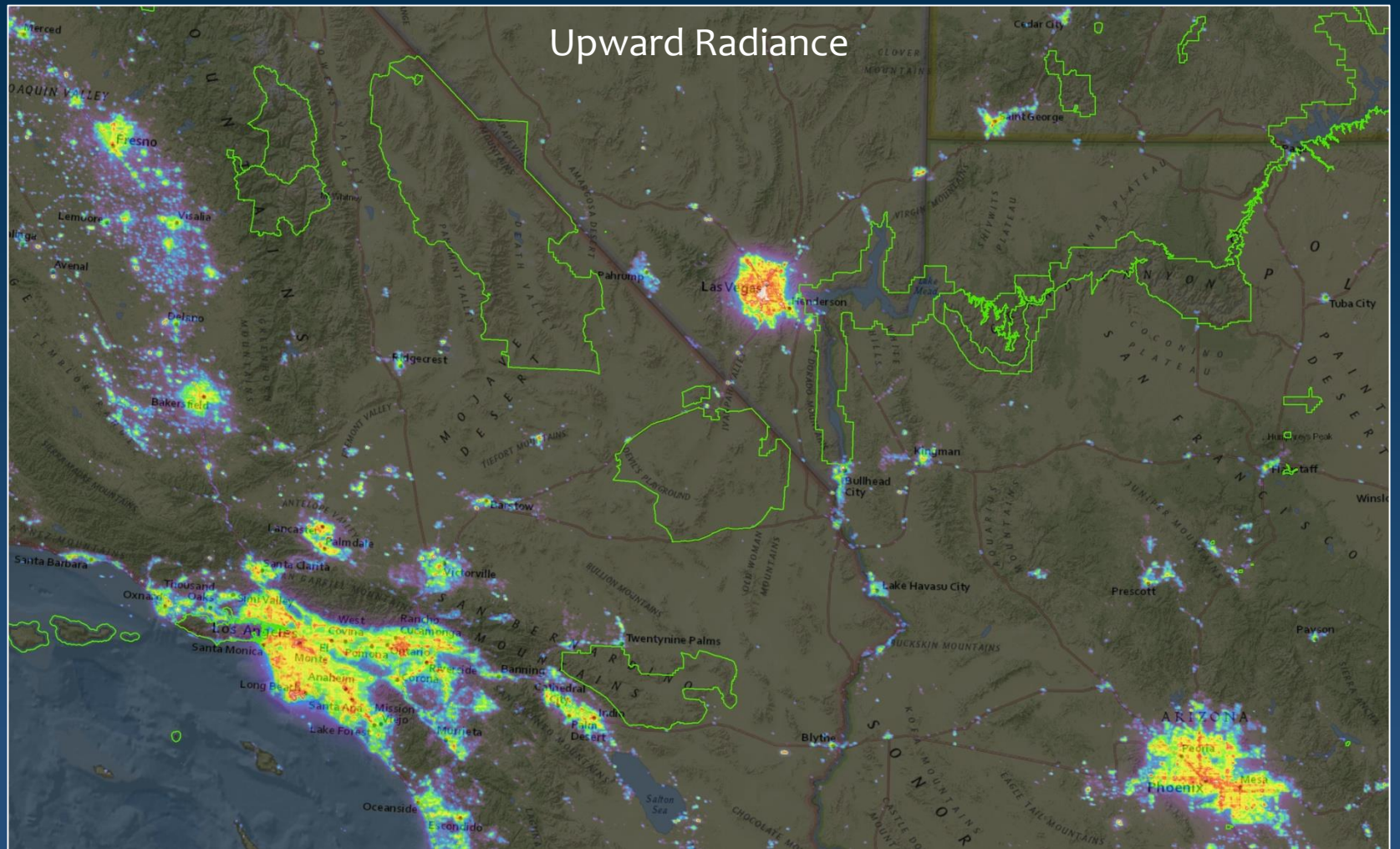




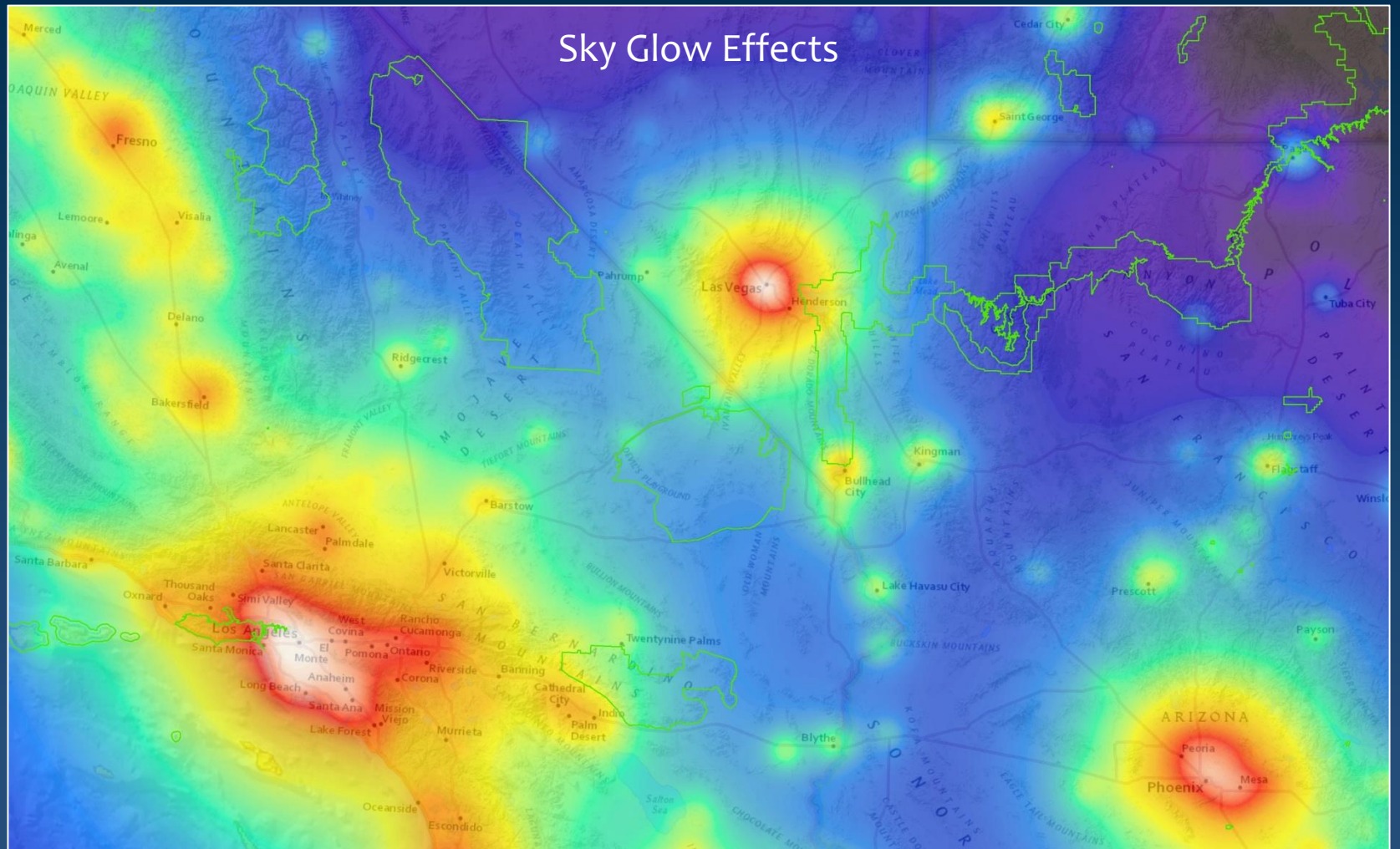


VIIRS Day / Night Band Radiance Data

Upward Radiance



Sky Glow Effects





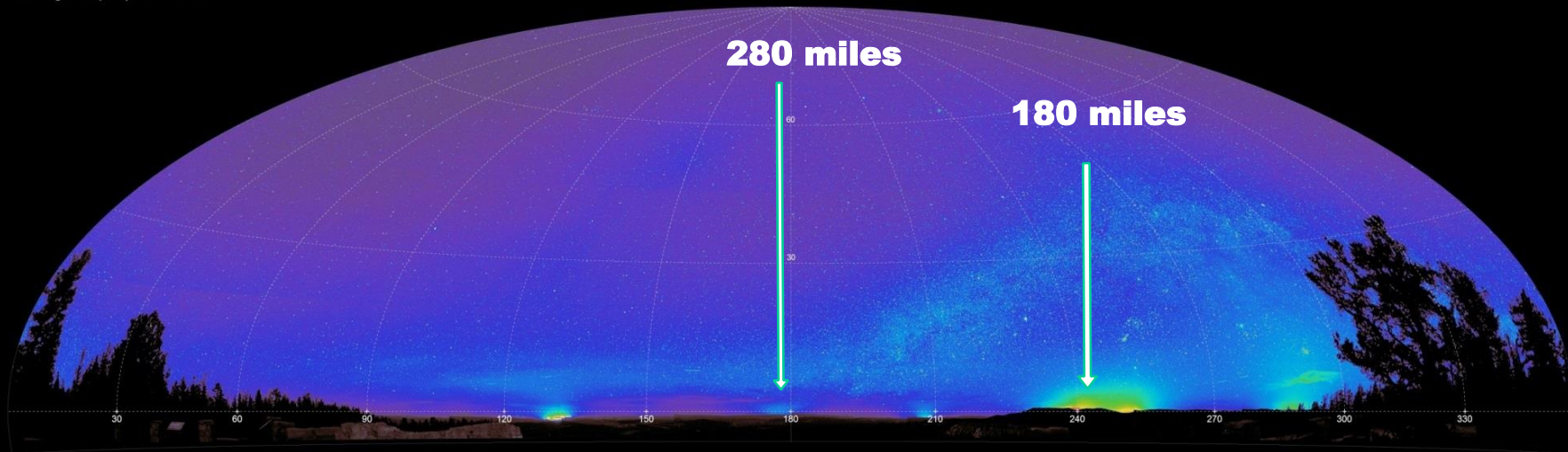
Visual Magnitudes per square arc-second

Bryce Canyon NP (Yovimpa Point) March 14, 2007 22.79 LMT

Full Resolution Mosaic

280 miles

180 miles



US National Park Service
Night Skies Program

Data collected by: C Moore, M Nijuis
Data processed by: B Meadows

Hammer-Aitoff Equal Area Projection South Centered

Bryce Canyon National Park, UT



16.4

19:13

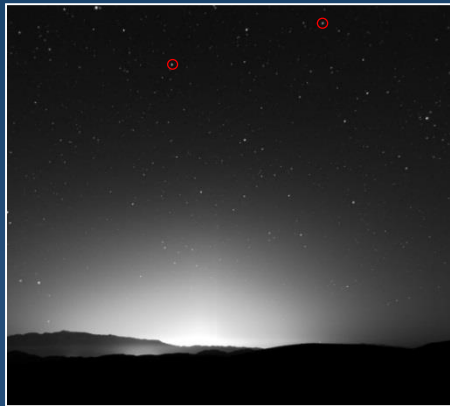
Light pollution is amplified locally from cloud cover, fog, and haze.

This low cloud bank increased overhead sky brightness by 15x

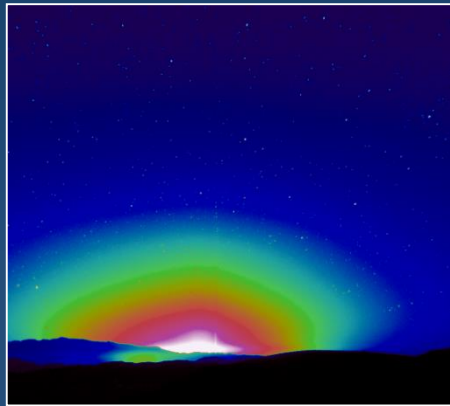
Measuring the Night Sky



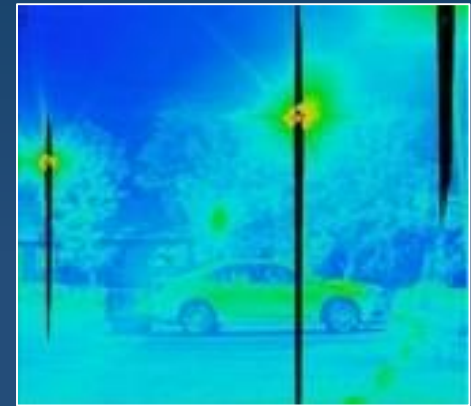
16 bit monochrome image,
photometric calibration
from standard stars



Calibration applied to each
pixel gives brightness
measurement (luminance)



Same system to measure
local scene luminance



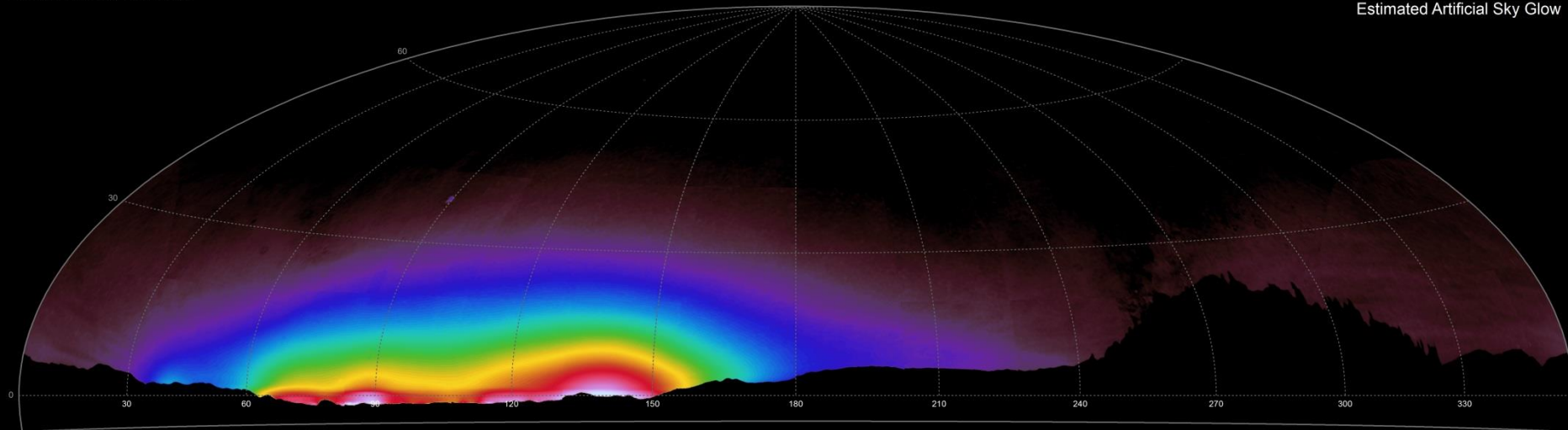
Measuring the Night Sky



Visual Magnitudes per square arc-second

Rocky Mountain National Park Rainbow Curve September 24, 2008 23.5 hours LMT

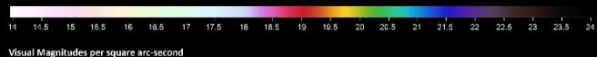
Estimated Artificial Sky Glow



U.S. National Park Service
Night Skies Program

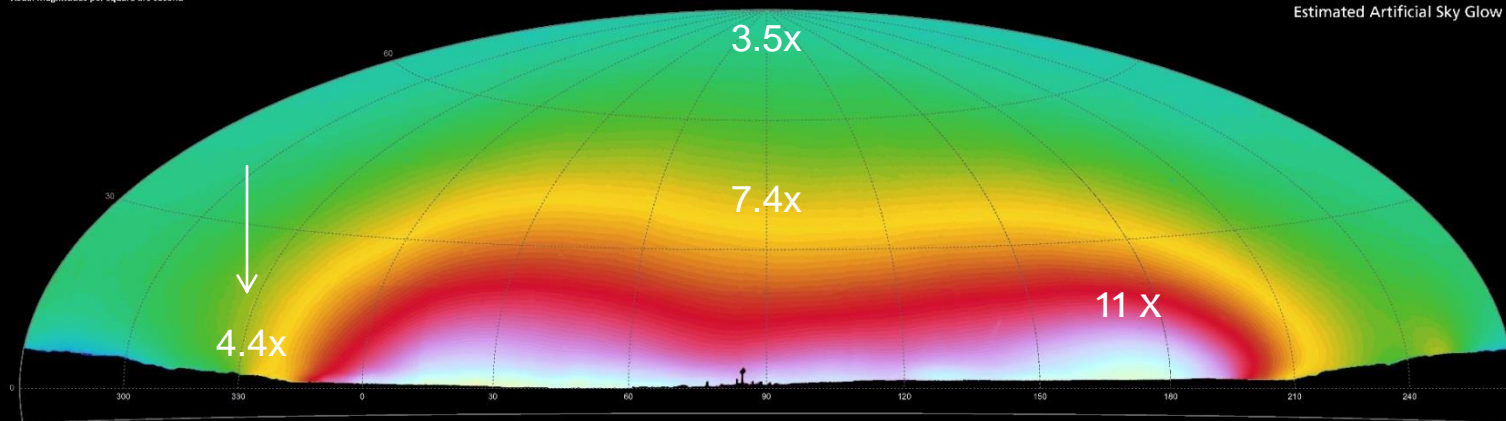
Data collected by: C Moore
Data processed by: J White

Hammer-Aitoff Equal Area Projection



Fort Collins Natural Area Coyote Ridge Parking January 18, 2017 23.1 hours LMT

Estimated Artificial Sky Glow



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

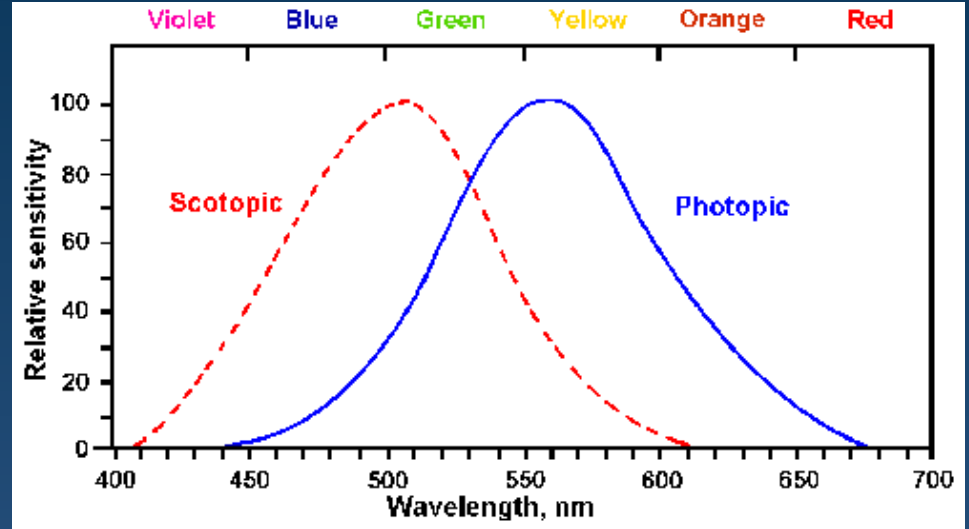
Measuring the Night Sky



Sky Quality
Meter

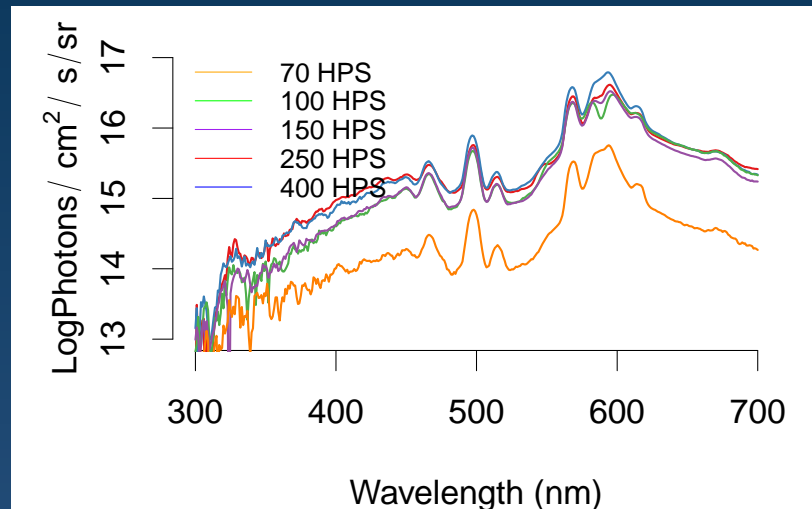


Lux Meter



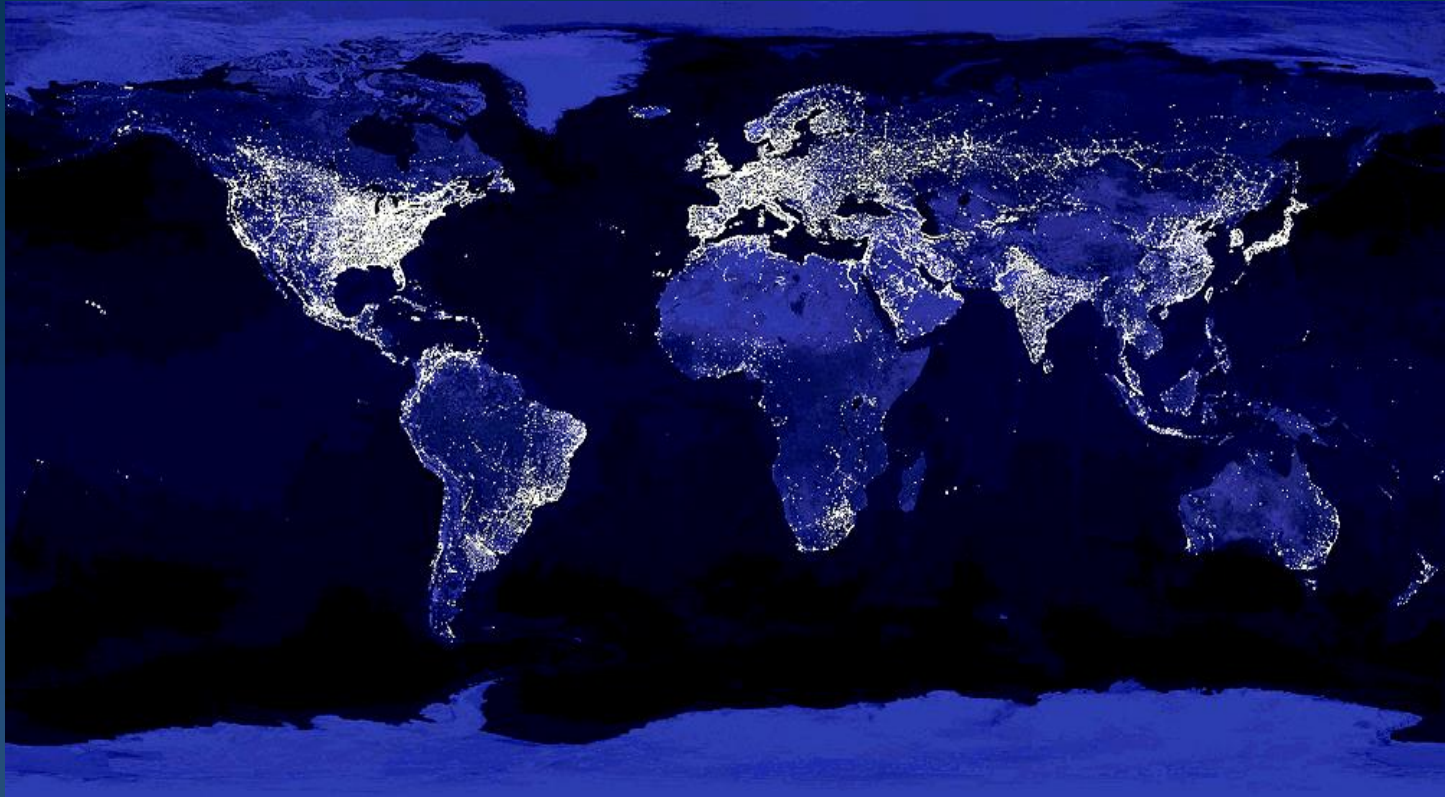
Human Vision (Photopic = Color Vision)

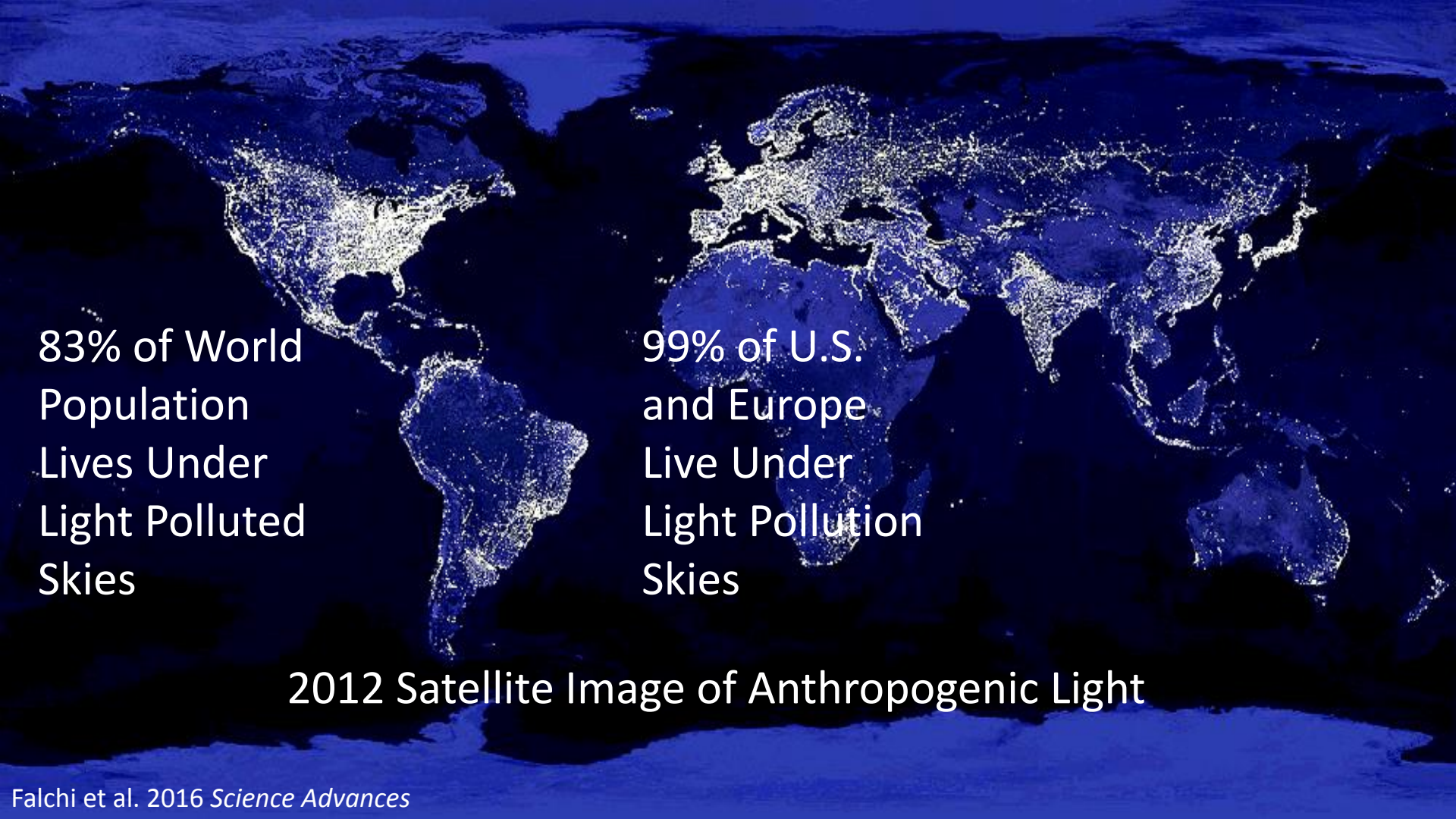
Measuring the Night Sky



Spectrometers

Impacts of Light Pollution





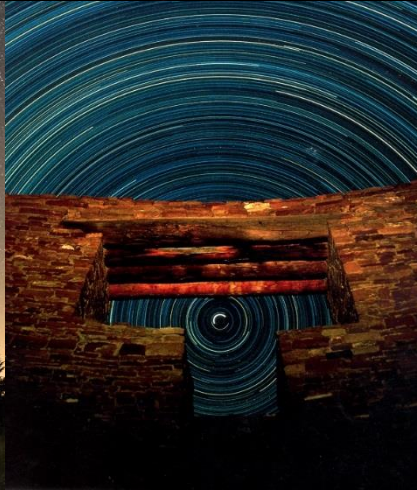
83% of World
Population
Lives Under
Light Polluted
Skies

99% of U.S.
and Europe
Live Under
Light Pollution
Skies

2012 Satellite Image of Anthropogenic Light

Impacts of Light Pollution



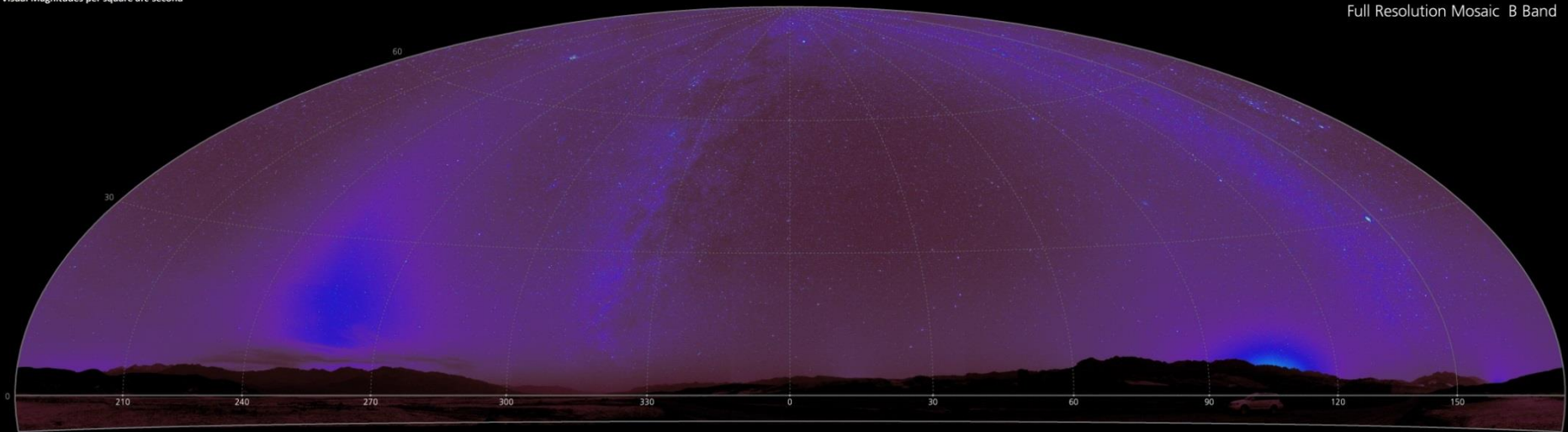




Visual Magnitudes per square arc-second

Death Valley NP Harmony Borax Works February 6, 2016 19.7 Hours LMT

Full Resolution Mosaic B Band



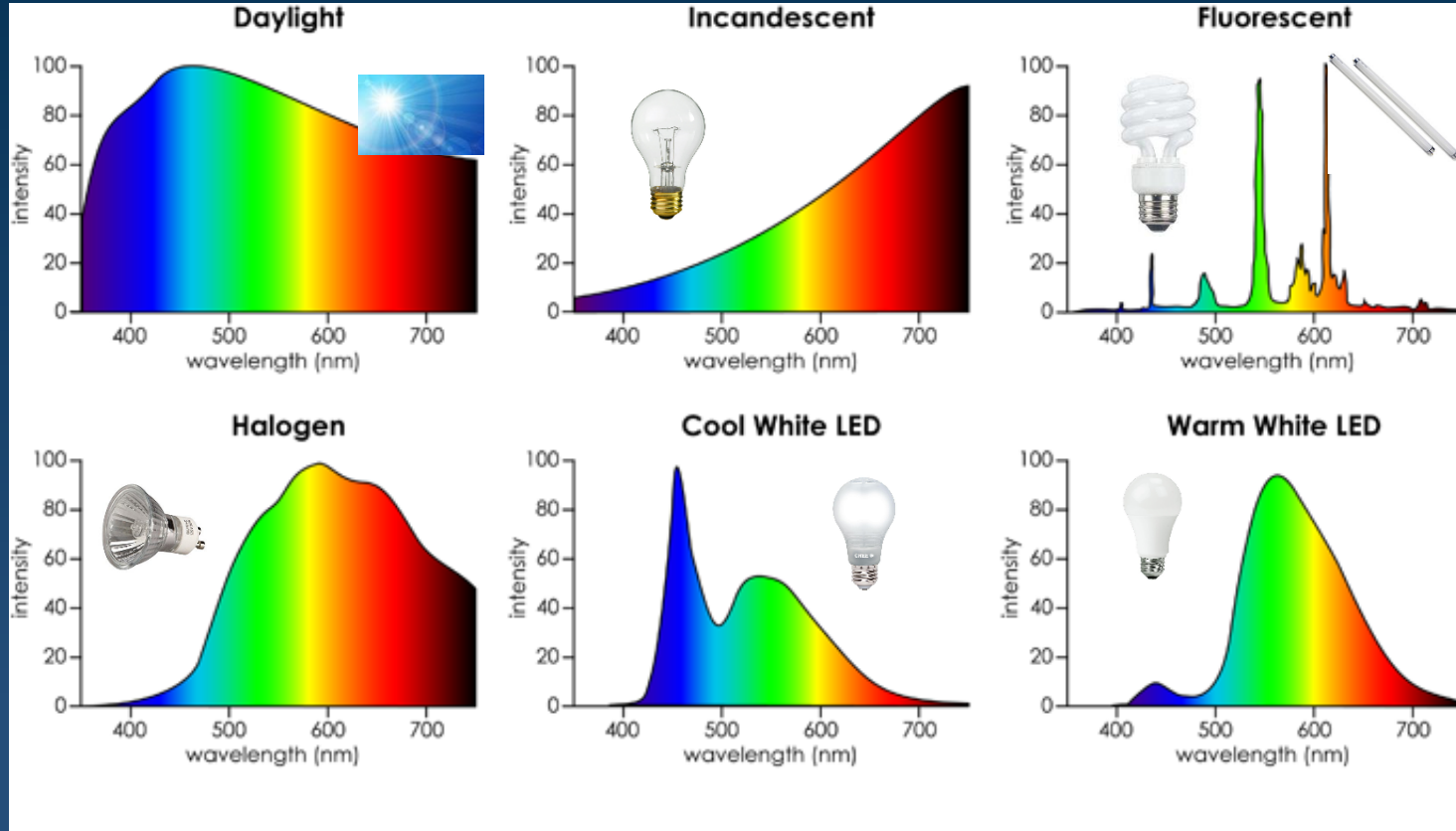
U.S. National Park Service
Night Skies Program

Data collected by: A Pipkin, D Duriscoe
Data processed by: D Duriscoe

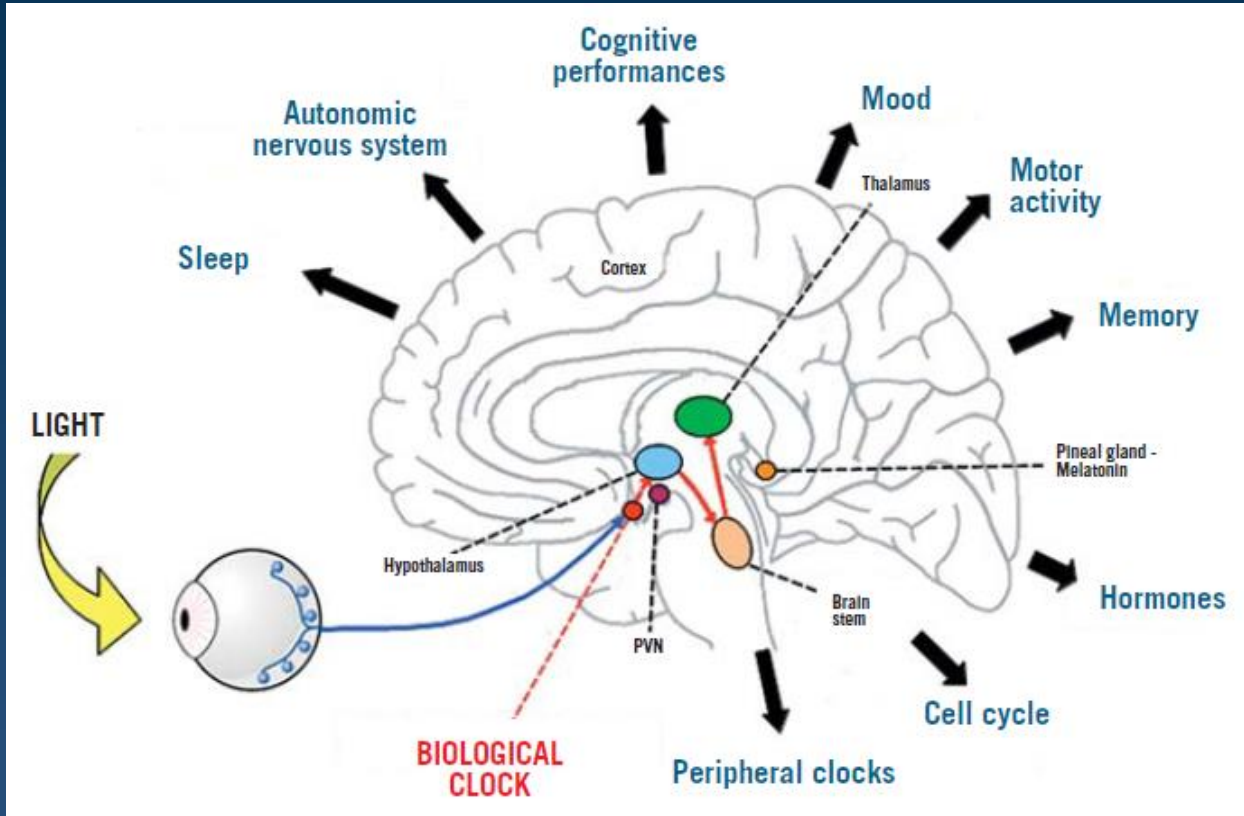
All-sky Mosaic – B Band

Hammer-Aitoff Equal Area Projection

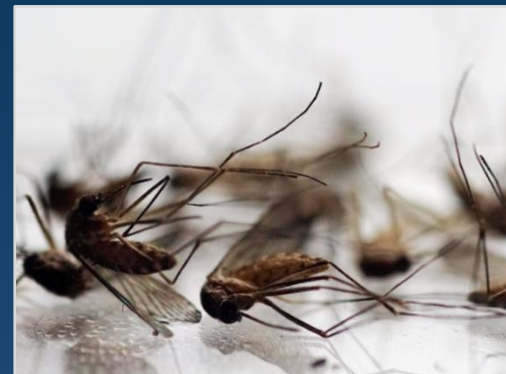
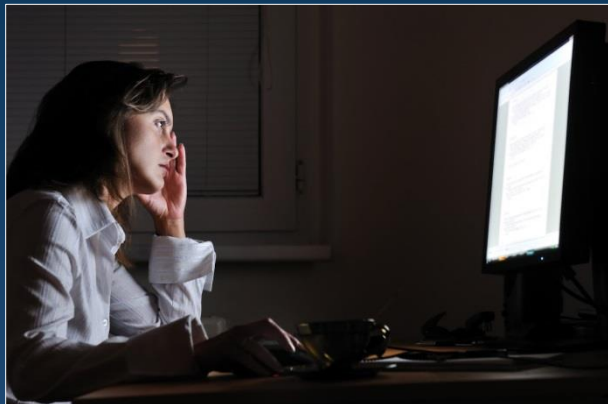
All Lights Are NOT Created Equally



Human Health



Human Health



International Agency for Research on Cancer

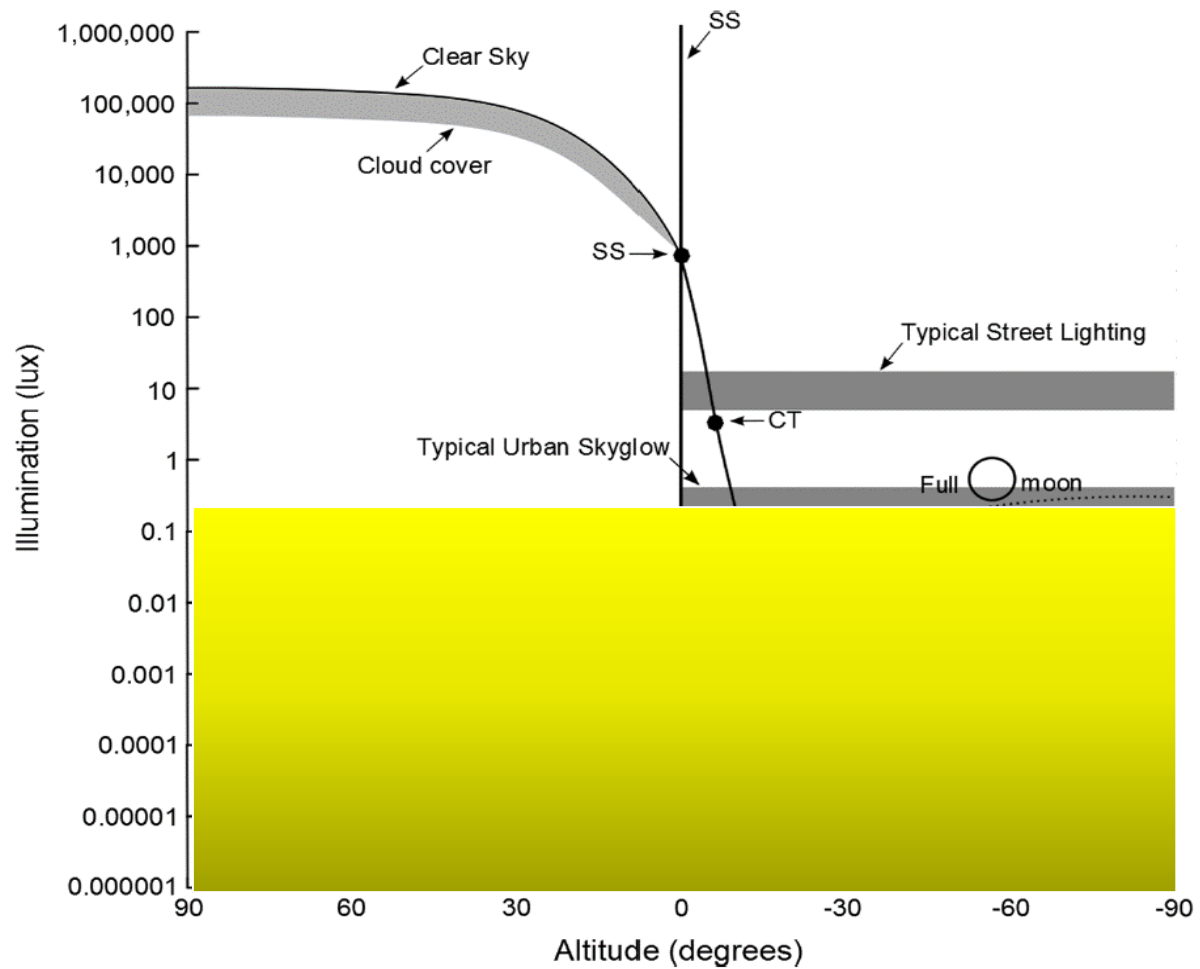


U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Environmental Health Sciences

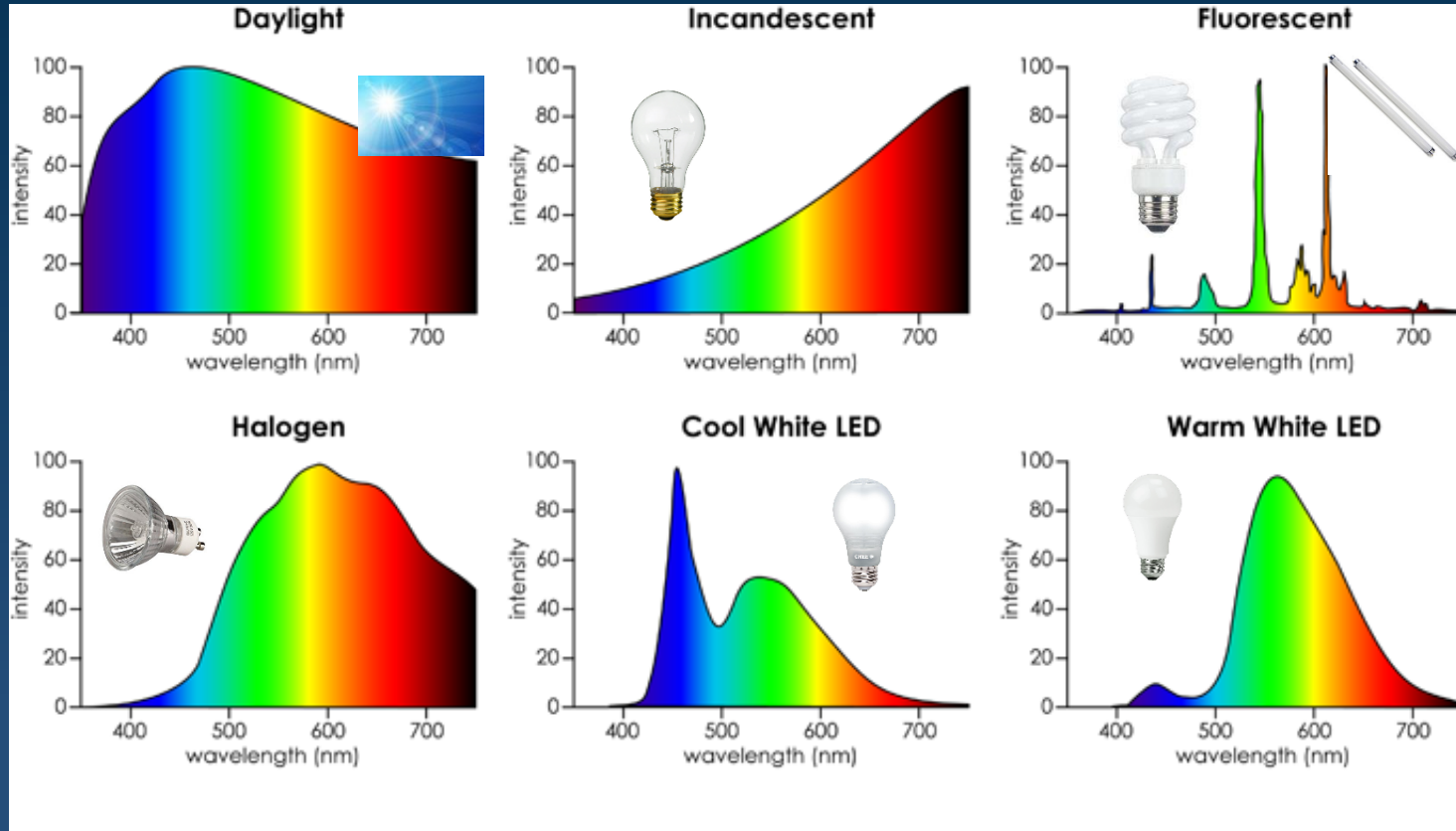


Ecological

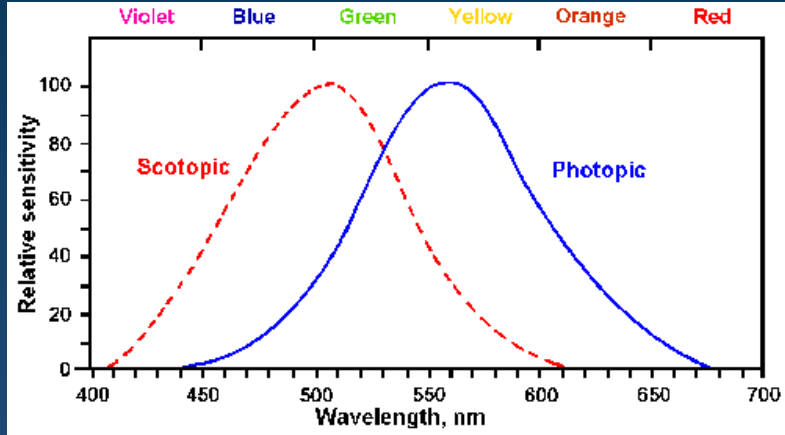




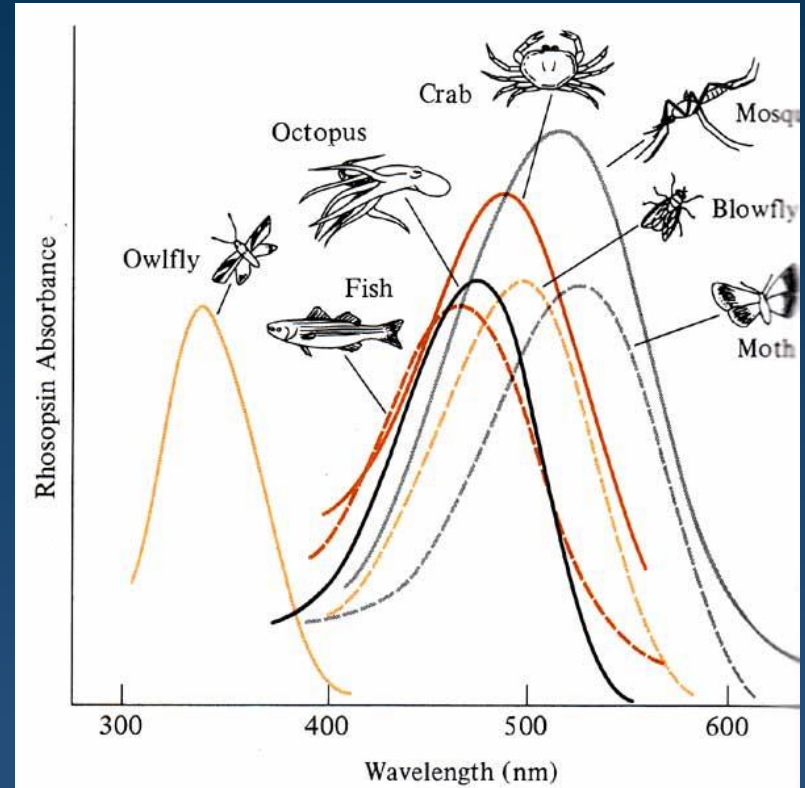
Ecological



Ecological



Human Vision (Photopic = Color Vision)



Ecological



Movement

Migration

Fragmentation



Foraging

Predator Prey

Competition

Community Structure

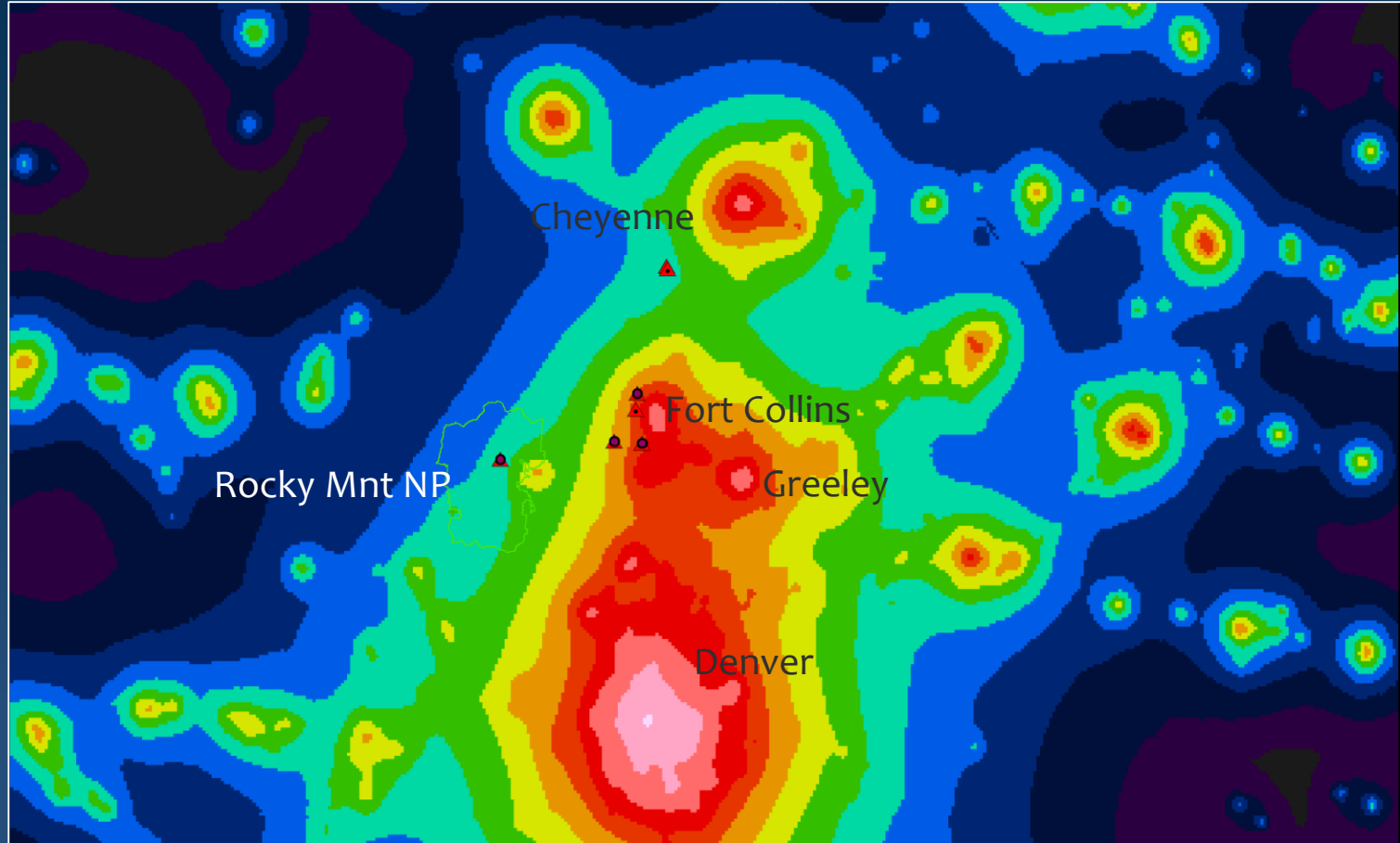


Communication

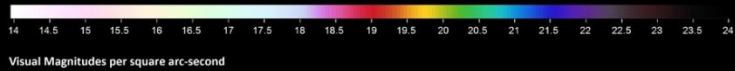
Reproduction

Physiology

Local Conditions

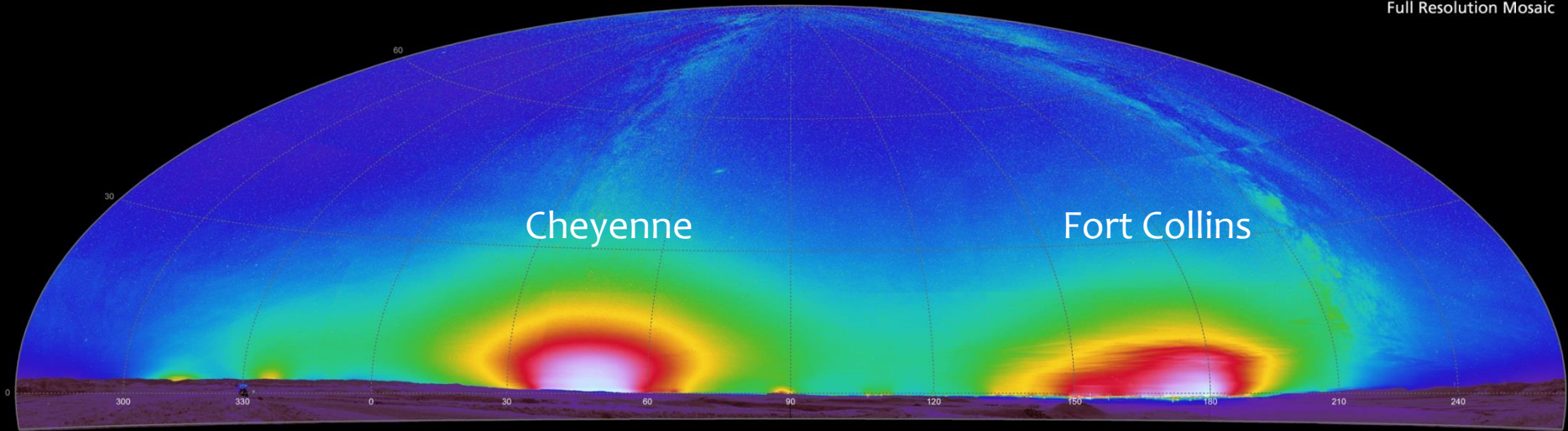


Soapstone Prairie



Fort Collins Natural Area Soapstone Prairie August 2, 2016 23.8 hours LMT

Full Resolution Mosaic



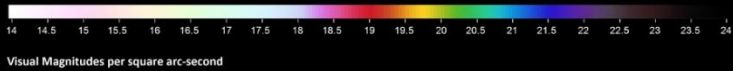
U.S. National Park Service
Night Skies Program

Data collected by: L Hung, D Duriscoe
Data processed by: L Hung

Hammer-Aitoff Equal Area Projection

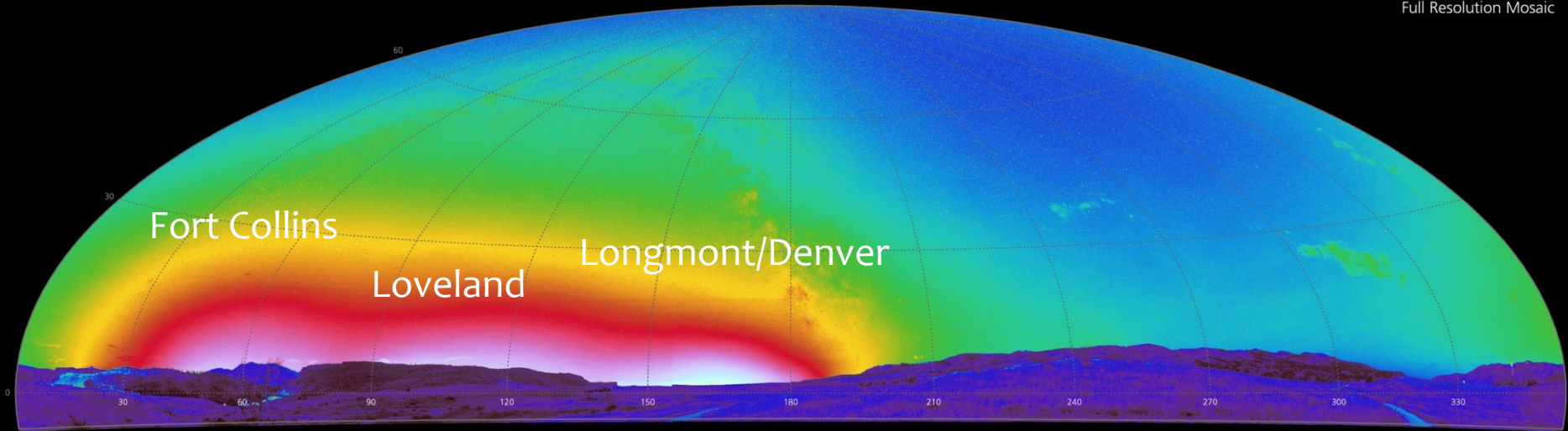
1.4x brighter than natural
.7x zenith brightness
1.7x vertical illuminance
0.6x horizontal illuminance
78% stars visible

Bobcat Ridge



Fort Collins Natural Areas Bobcat Ridge July 8, 2013 23.1 hours LMT

Full Resolution Mosaic



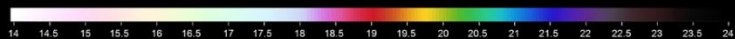
U.S. National Park Service
Night Skies Program

Data collected by: J White, C Moore, S Moore
Data processed by: J White

Hammer-Aitoff Equal Area Projection

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

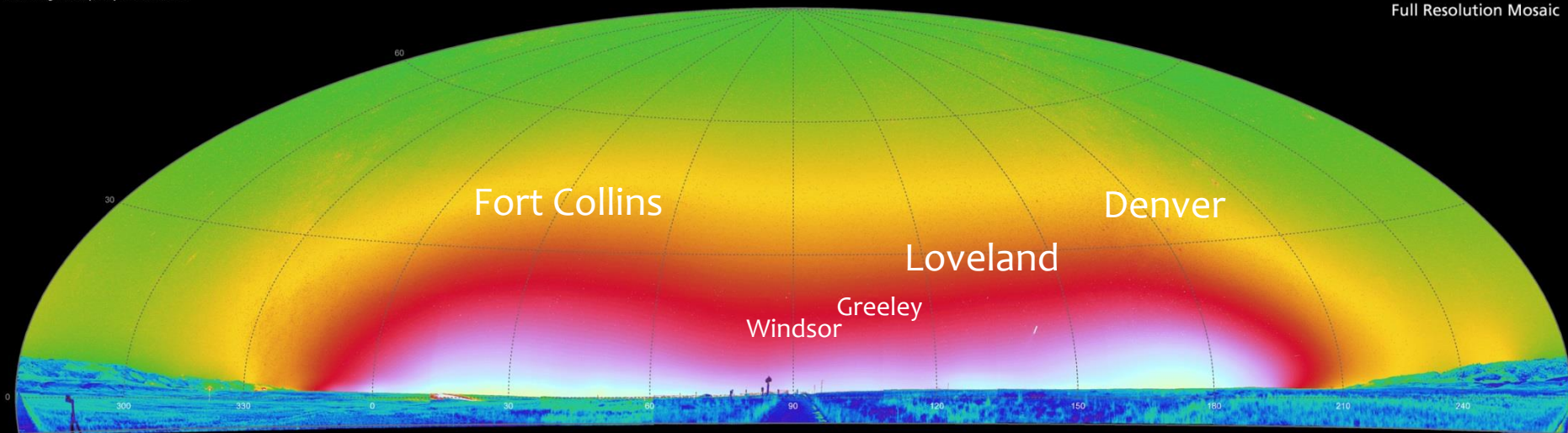
Coyote Ridge



Visual Magnitudes per square arc-second

Fort Collins Natural Area Coyote Ridge Parking January 18, 2017 23.1 hours LMT

Full Resolution Mosaic



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

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

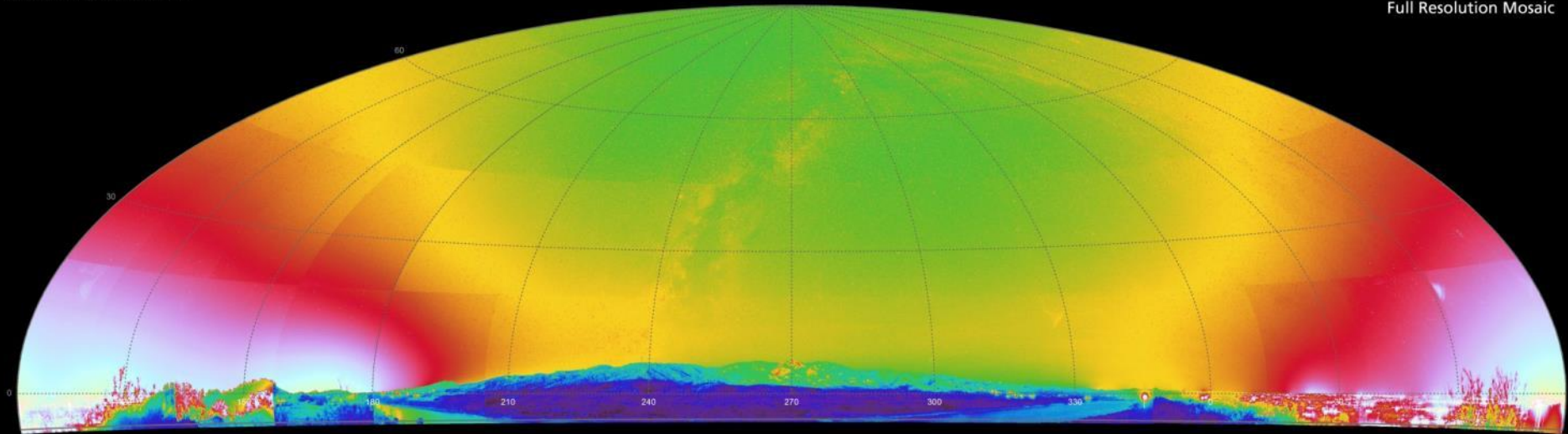
Horsetooth Reservoir



Visual Magnitudes per square arc-second

Rotary Park Horsetooth Reservoir October 14, 2017 21.0 hours LMT

Full Resolution Mosaic

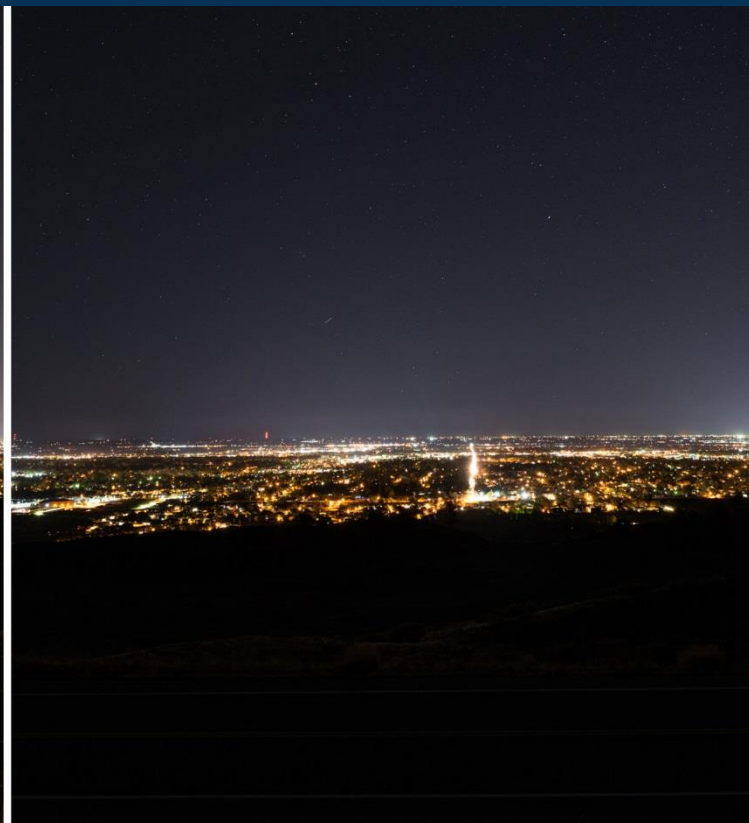
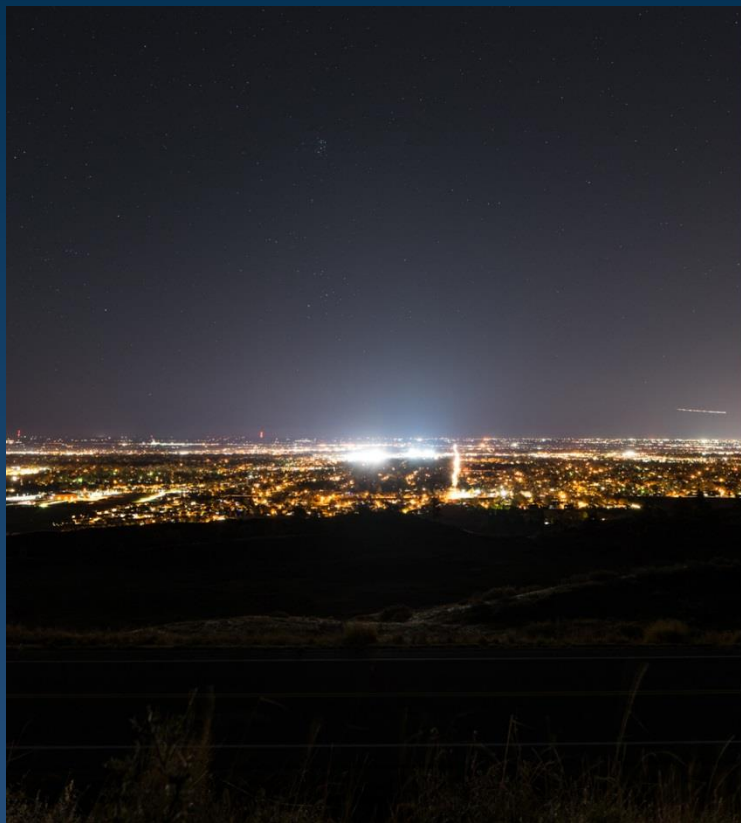


U.S. National Park Service
Night Skies Program

Data collected by: J White
Data processed by: J White

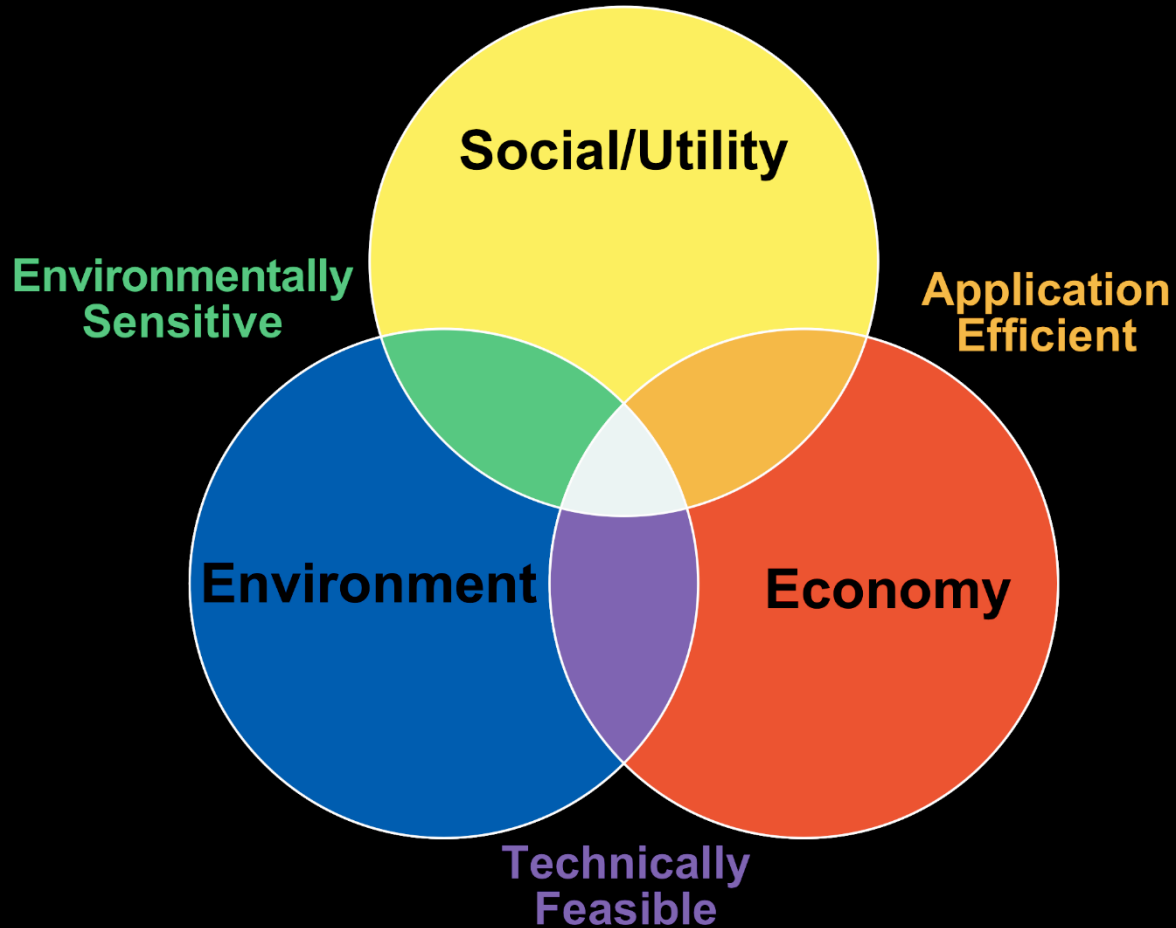
Hammer-Aitoff Equal Area Projection

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





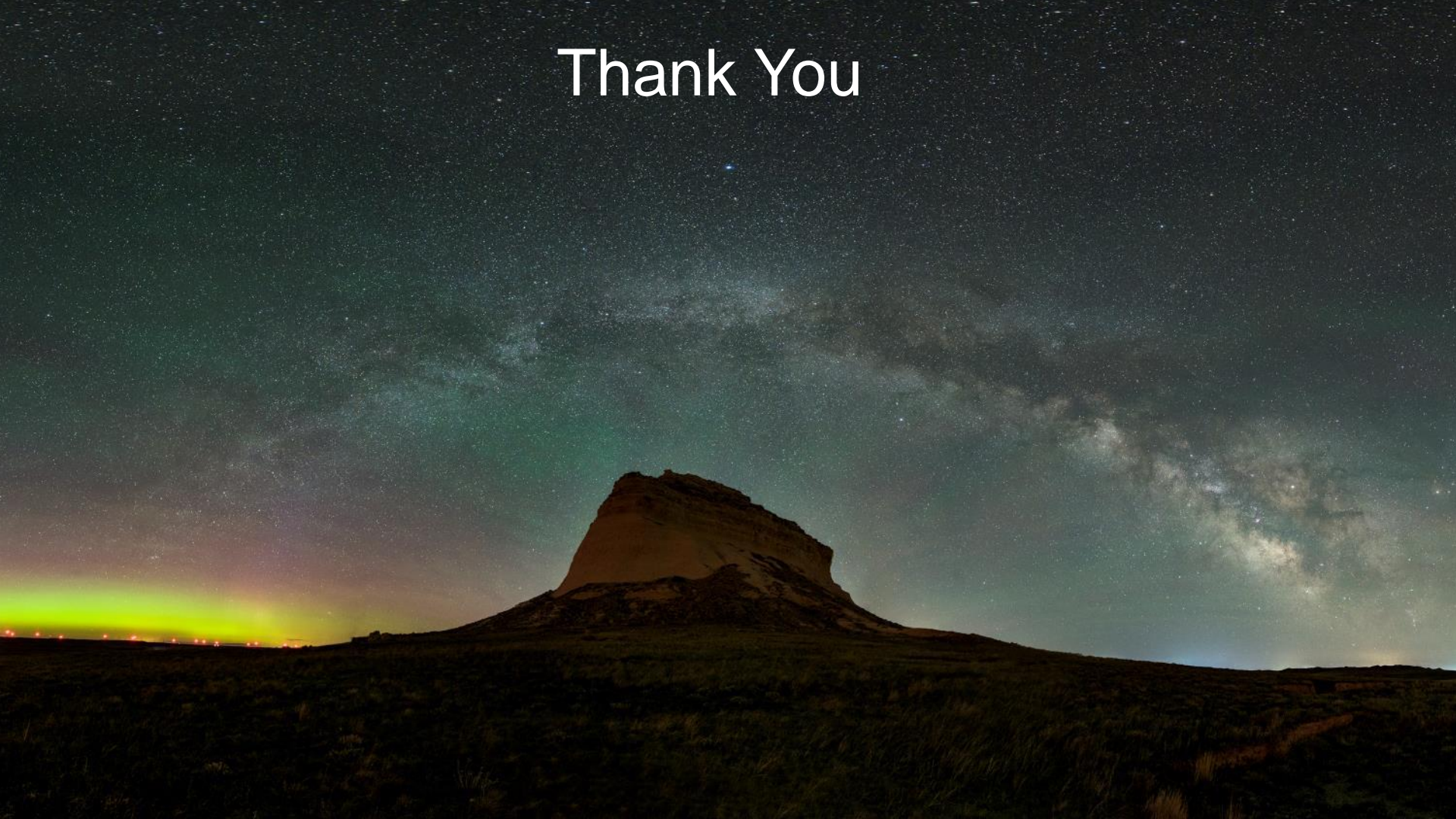
Fully Sustainable Lighting



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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