Light pollution
- a global threat to biodiversity

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Starlight

Twilight

Sunlight

8 log units between starlight and sunlight

1

10

100

1000

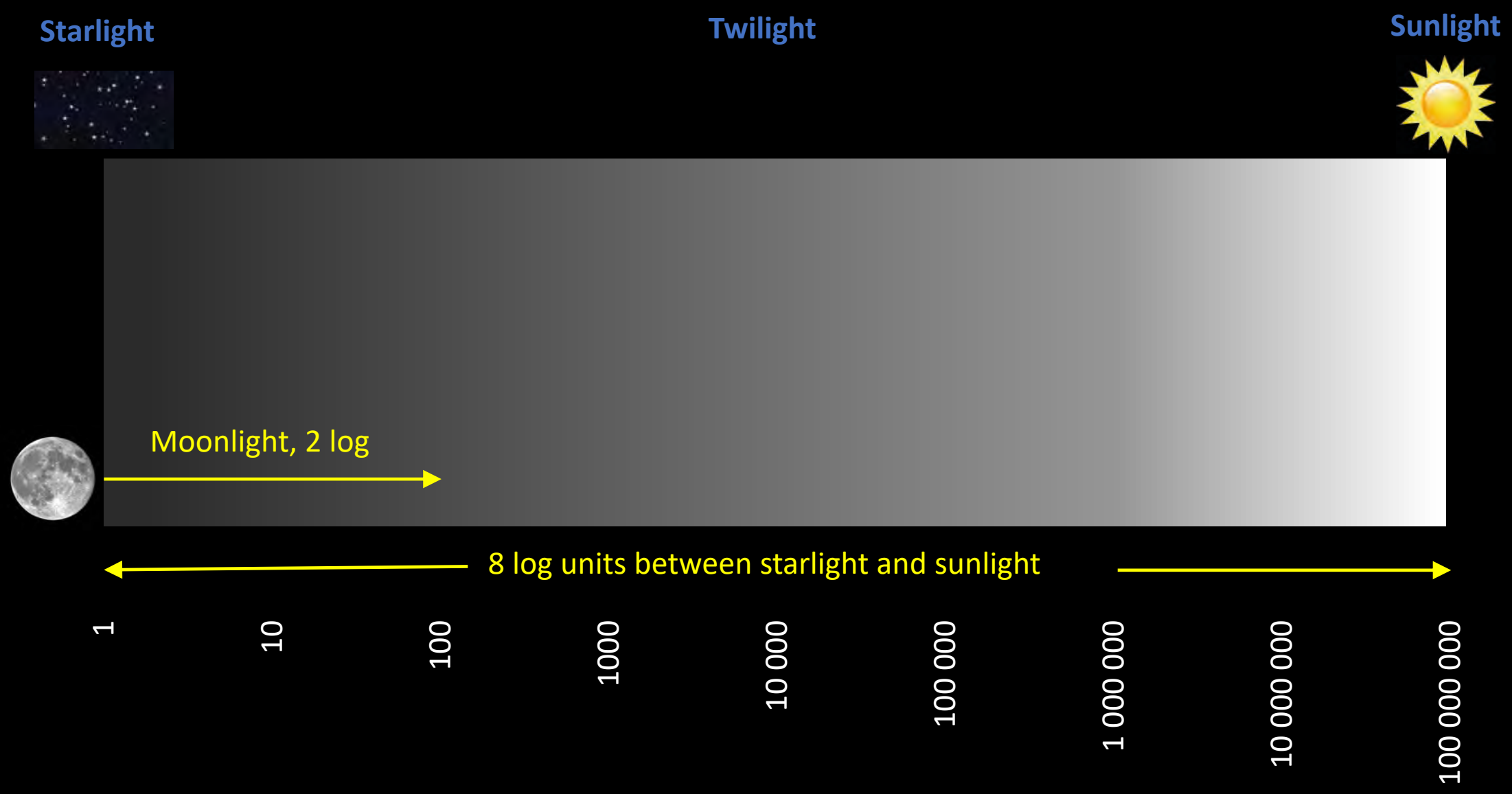
10 000

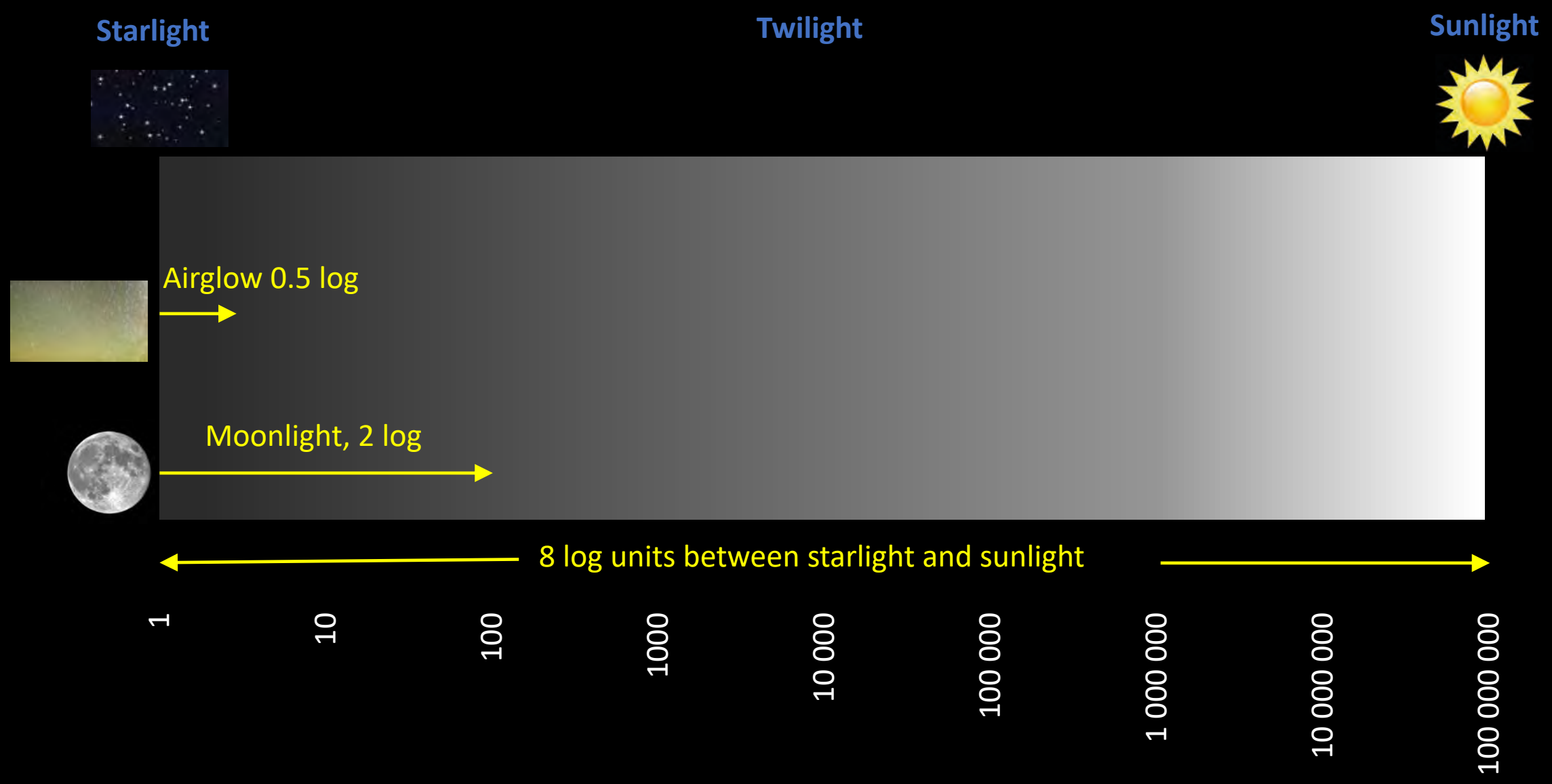
100 000

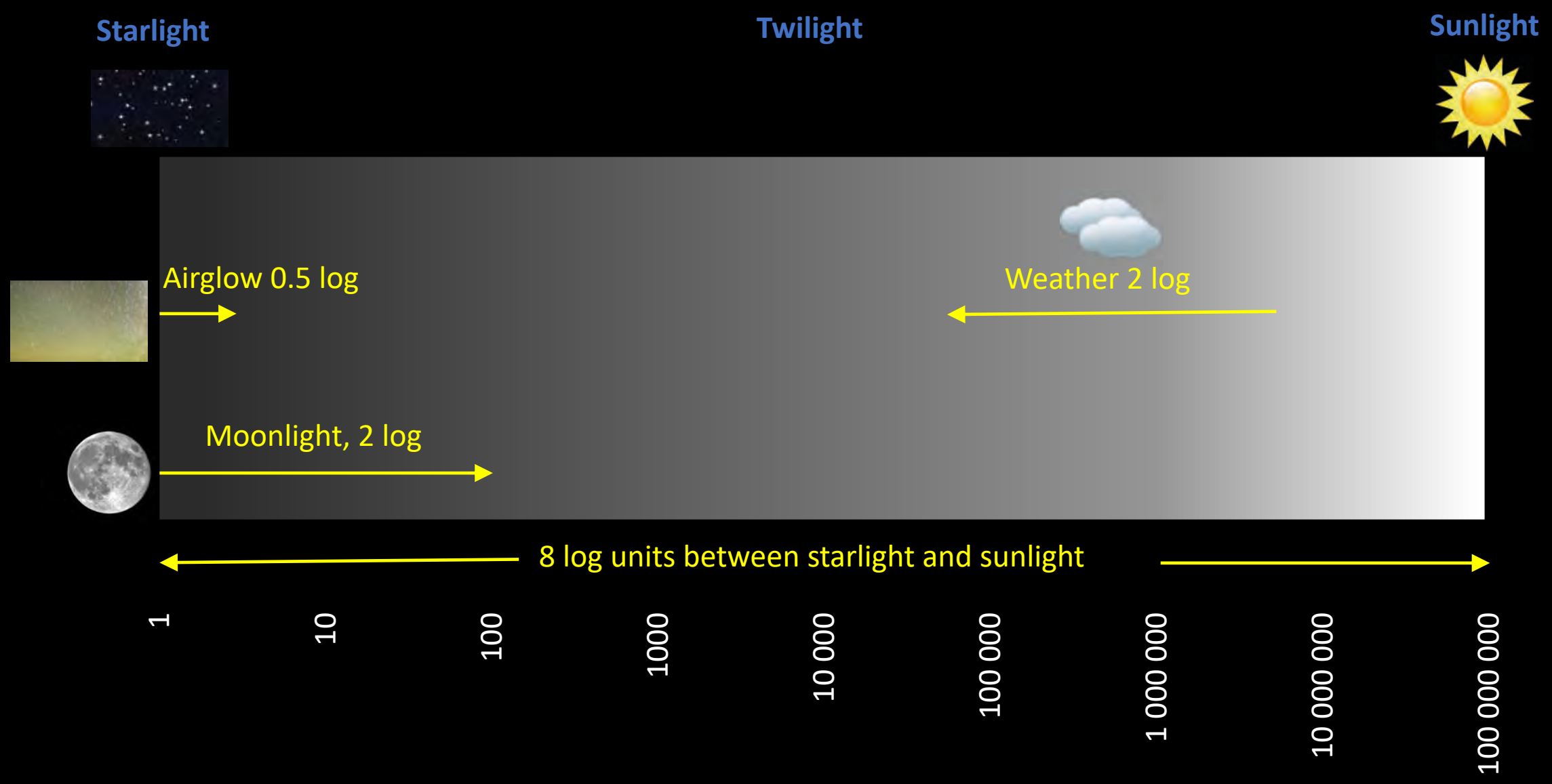
1 000 000

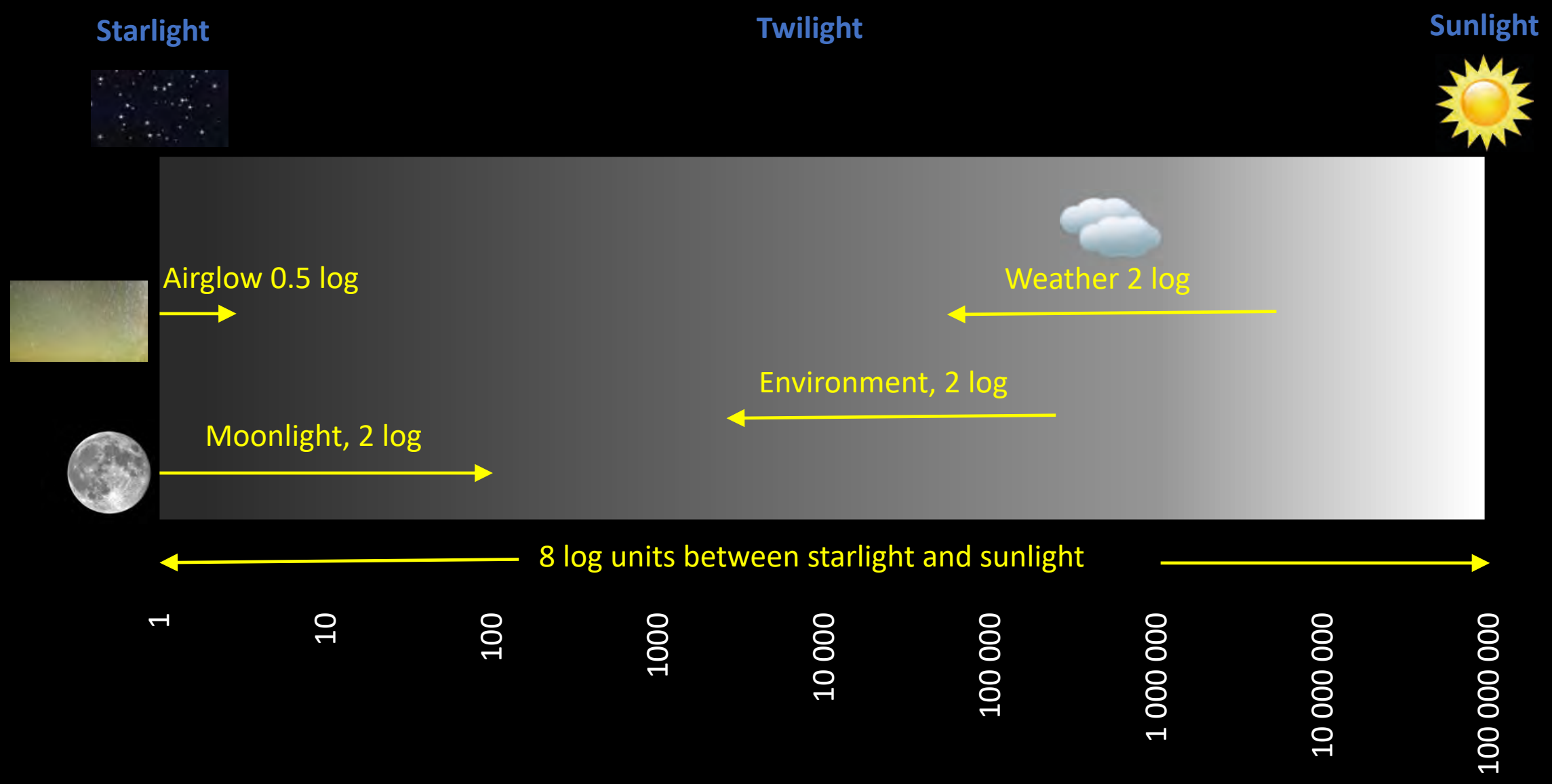
10 000 000

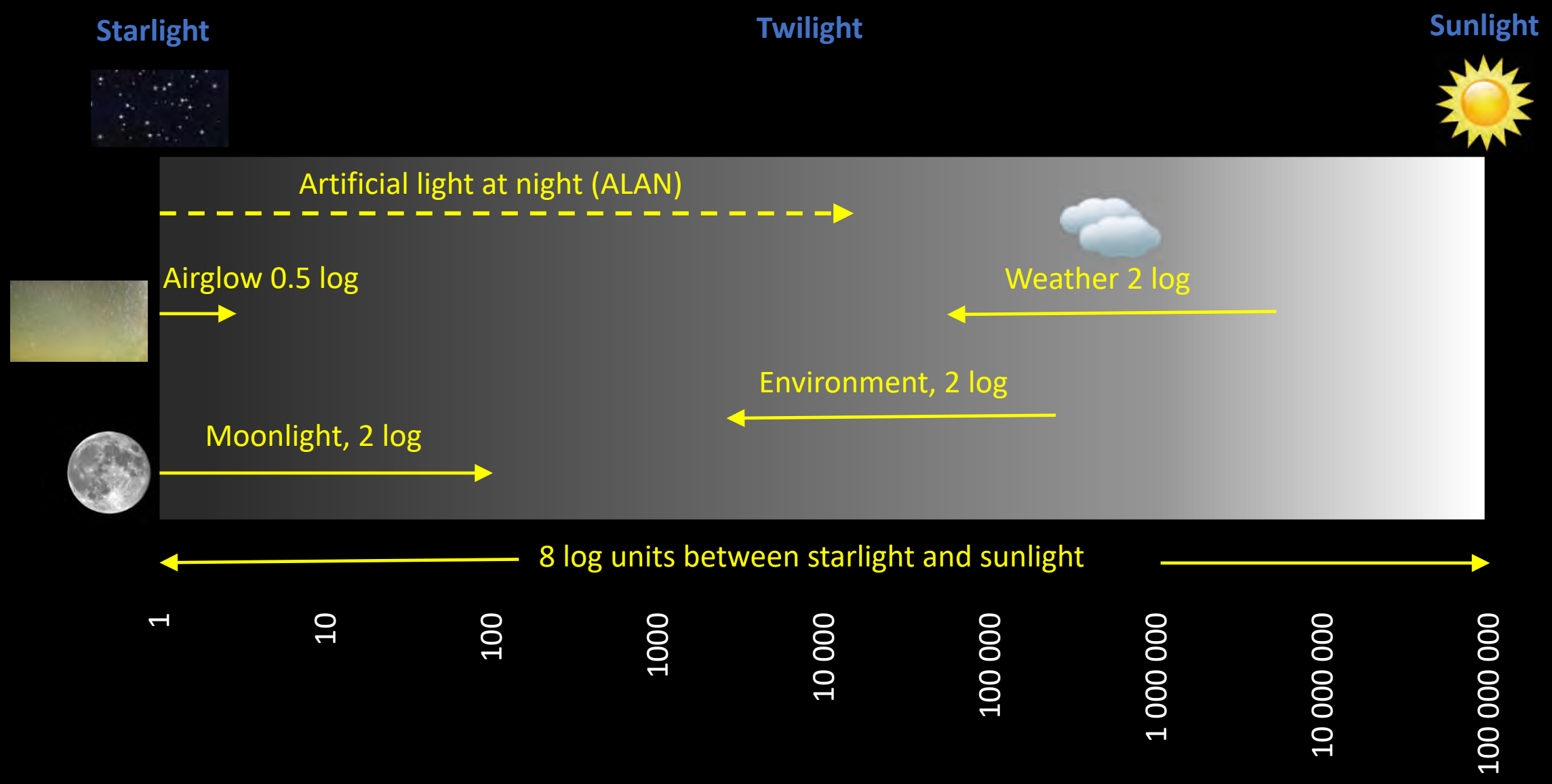
100 000 000

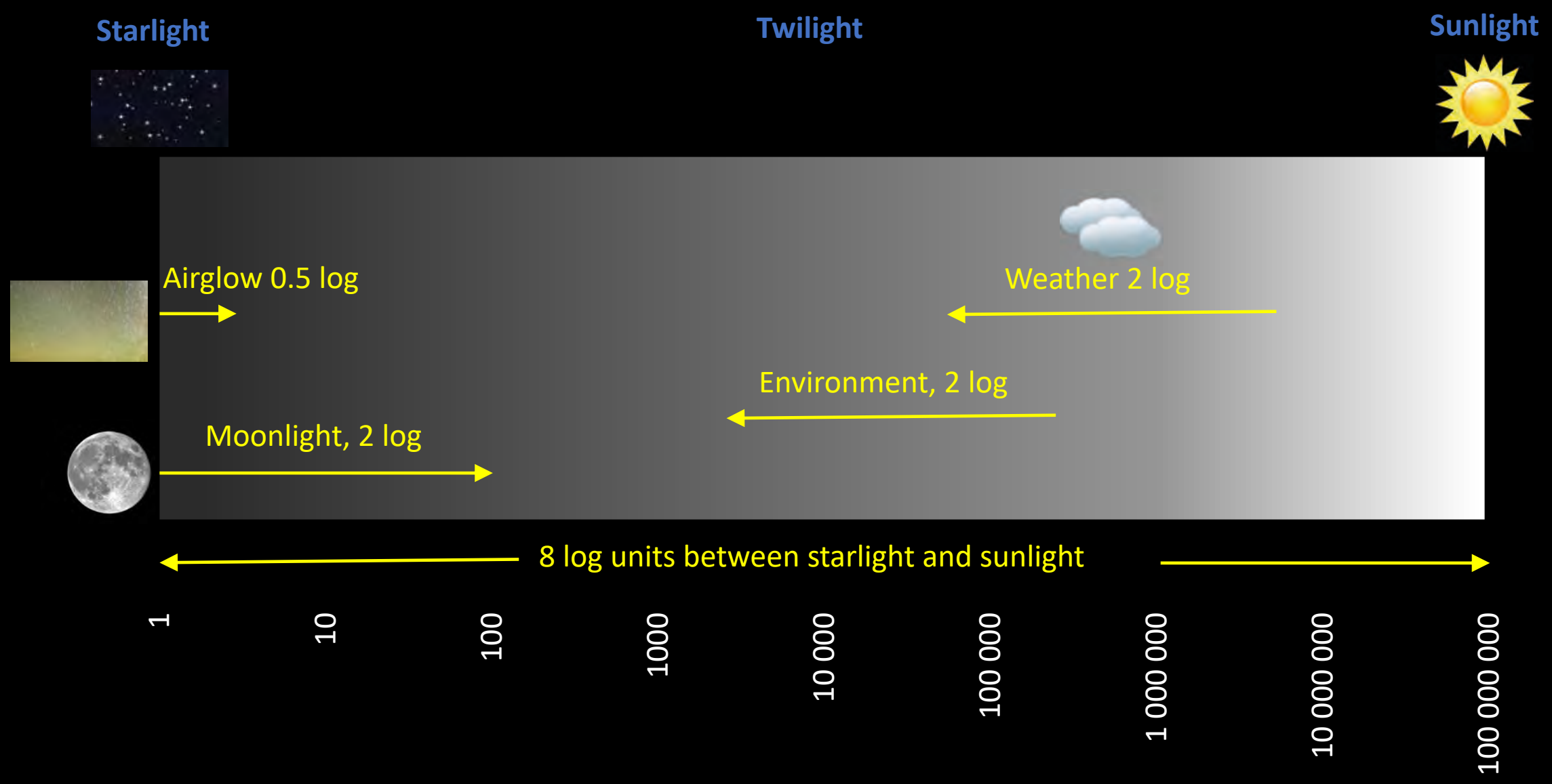

Starlight
Twilight
Sunlight
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

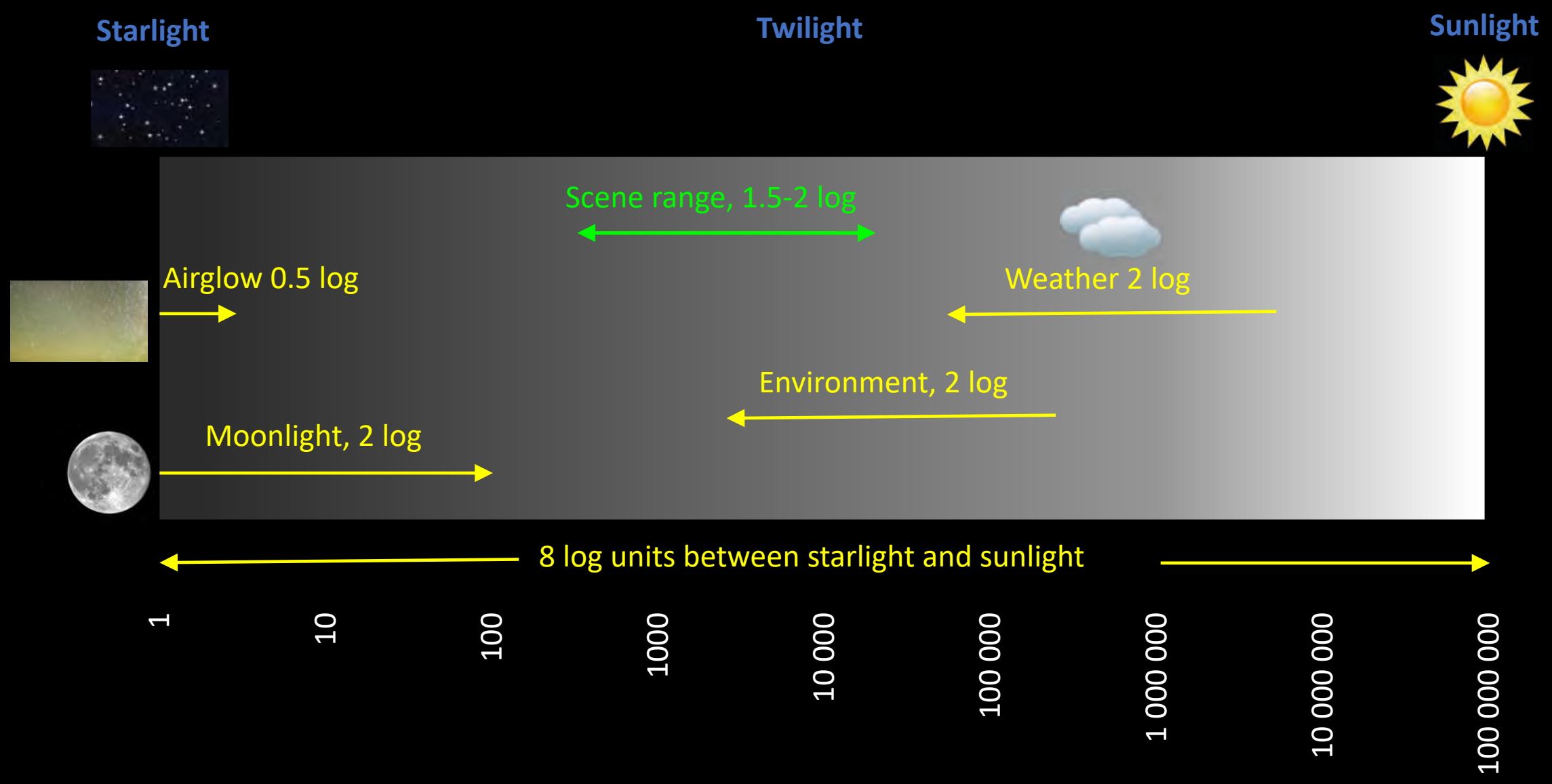

Starlight
Twilight
Sunlight
Airglow 0.5 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

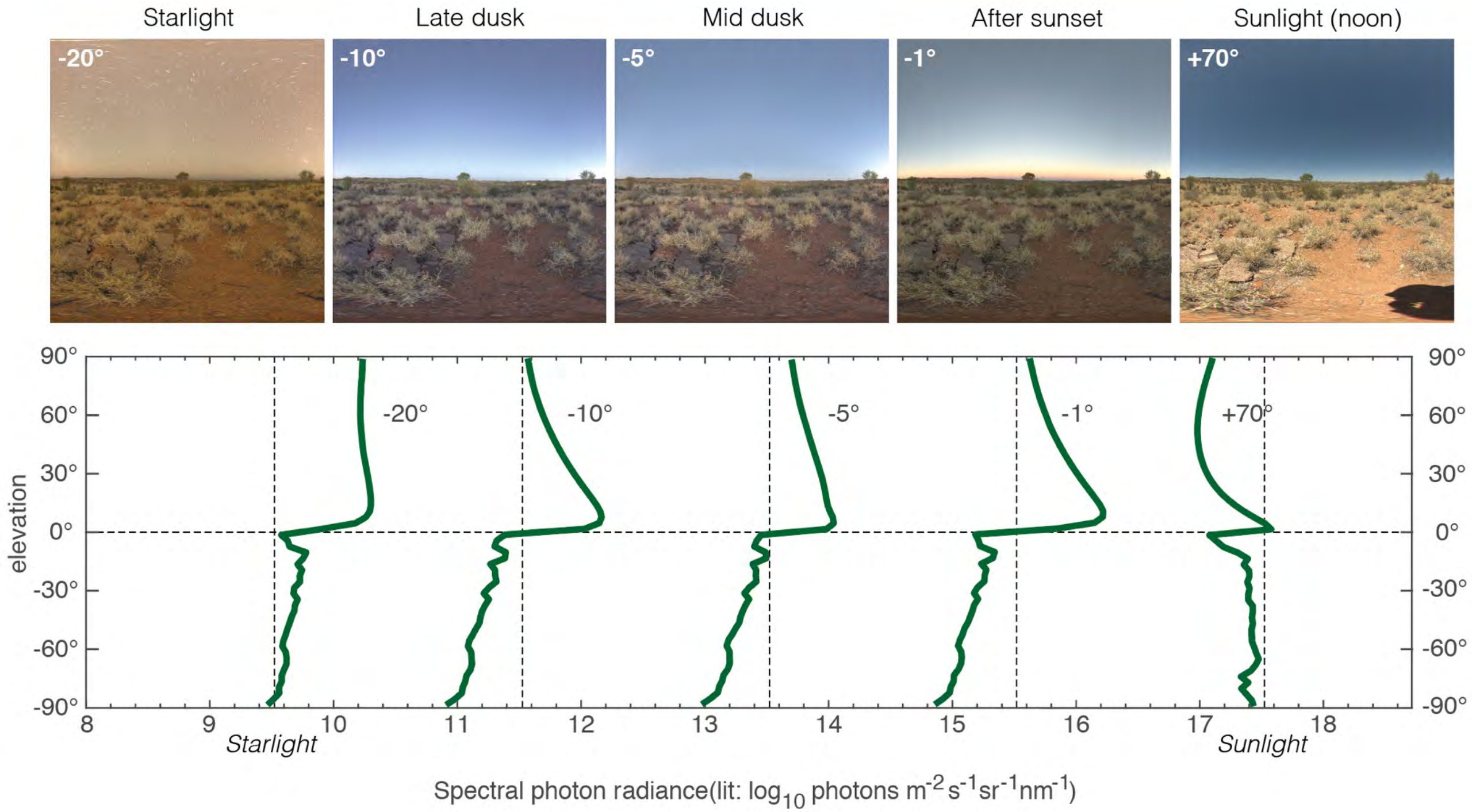

Starlight
Twilight
Sunlight
Airglow 0.5 log
Weather 2 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

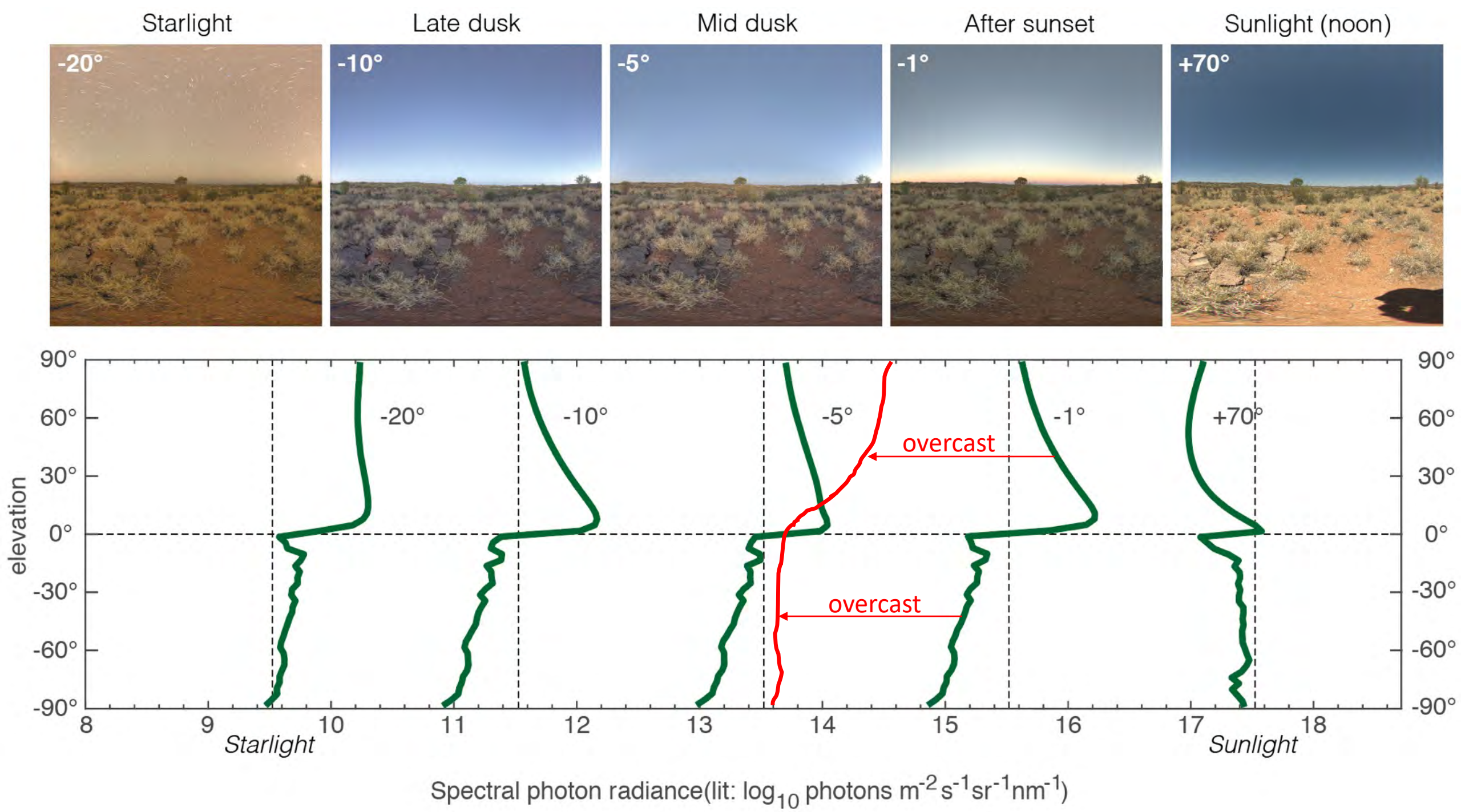

Starlight
Twilight
Sunlight
Airglow 0.5 log
Weather 2 log
Environment, 2 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

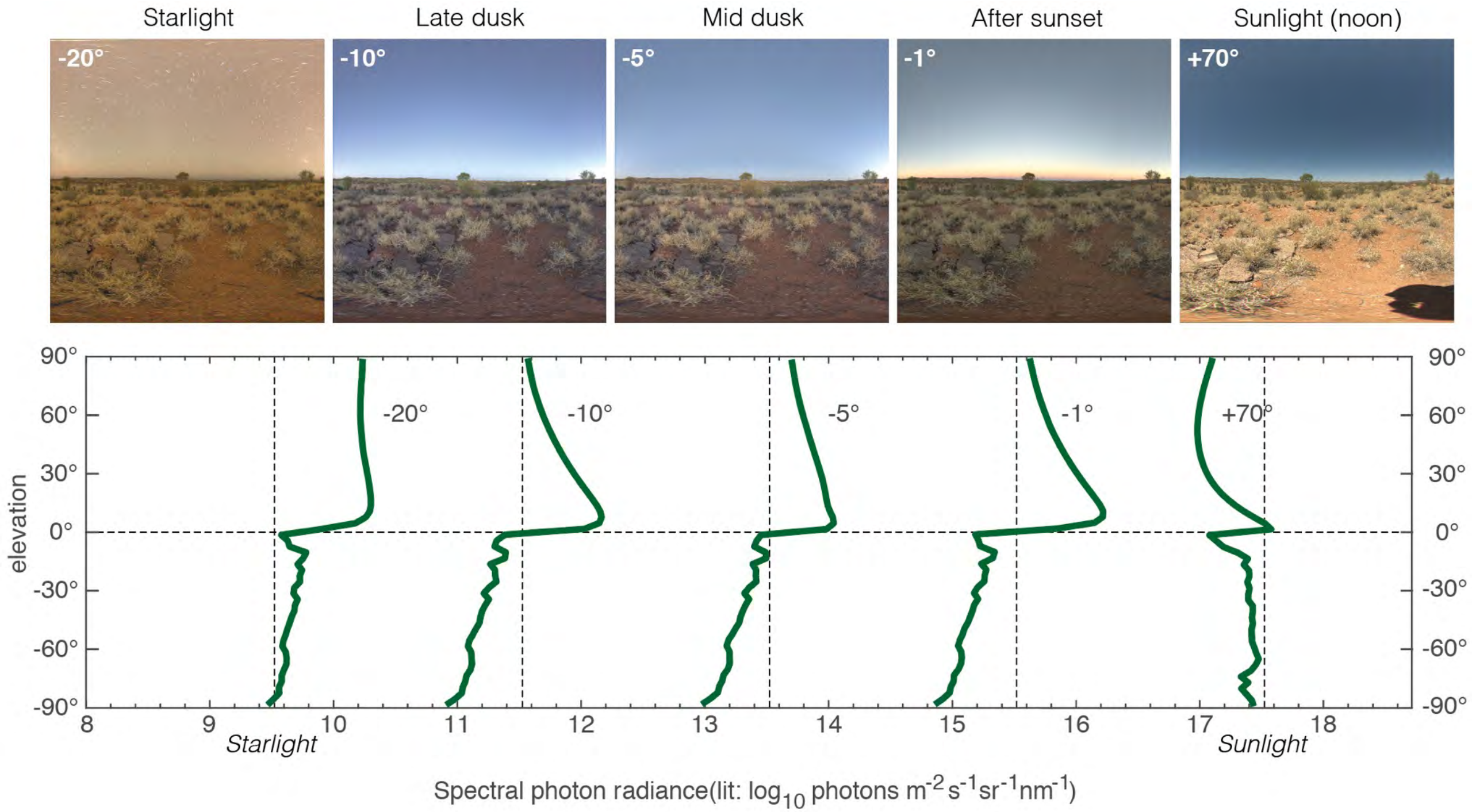

Starlight
Twilight
Sunlight
Artificial light at night (ALAN)
Airglow 0.5 log
Weather 2 log
Environment, 2 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

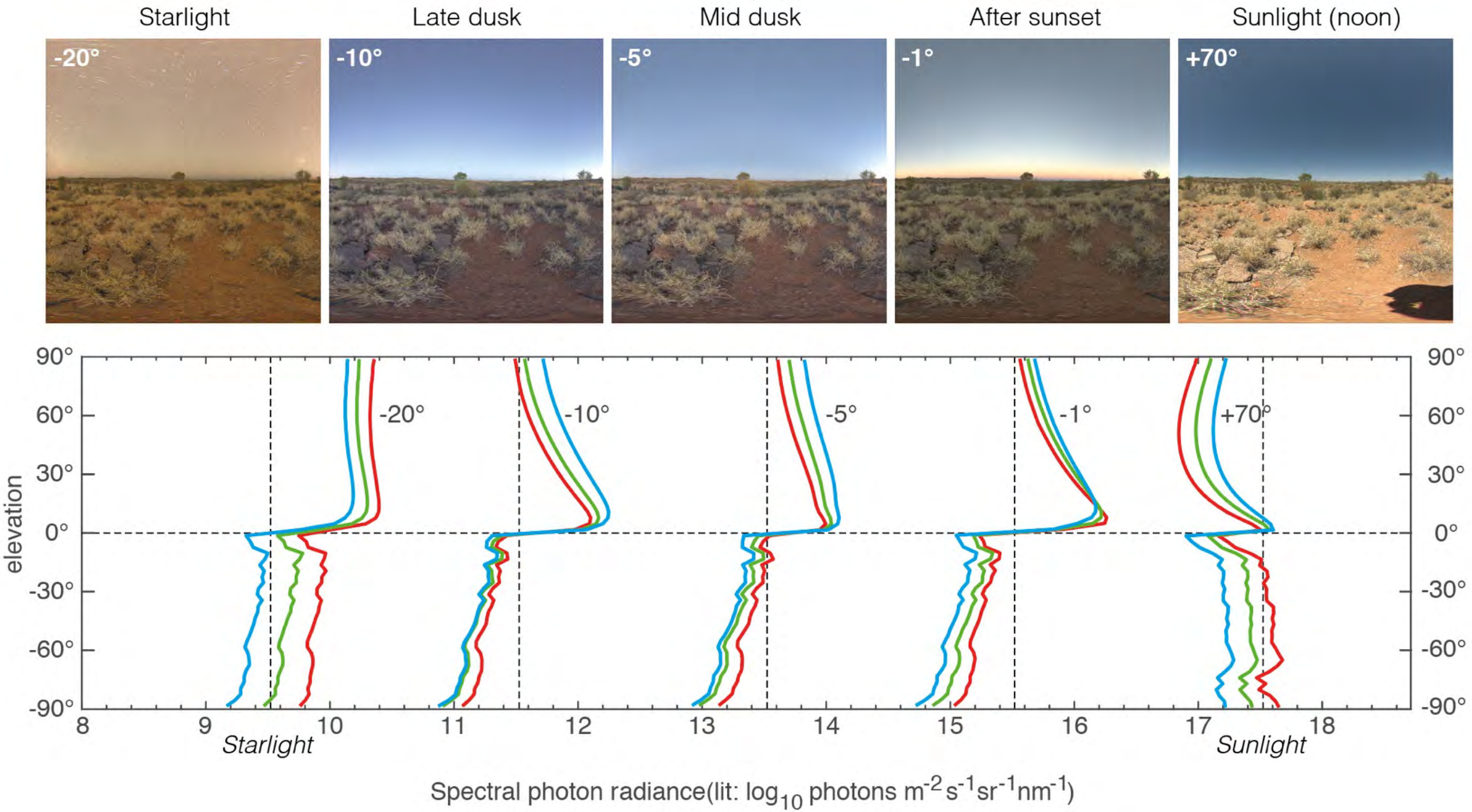

Starlight
Twilight
Sunlight
Airglow 0.5 log
Weather 2 log
Environment, 2 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

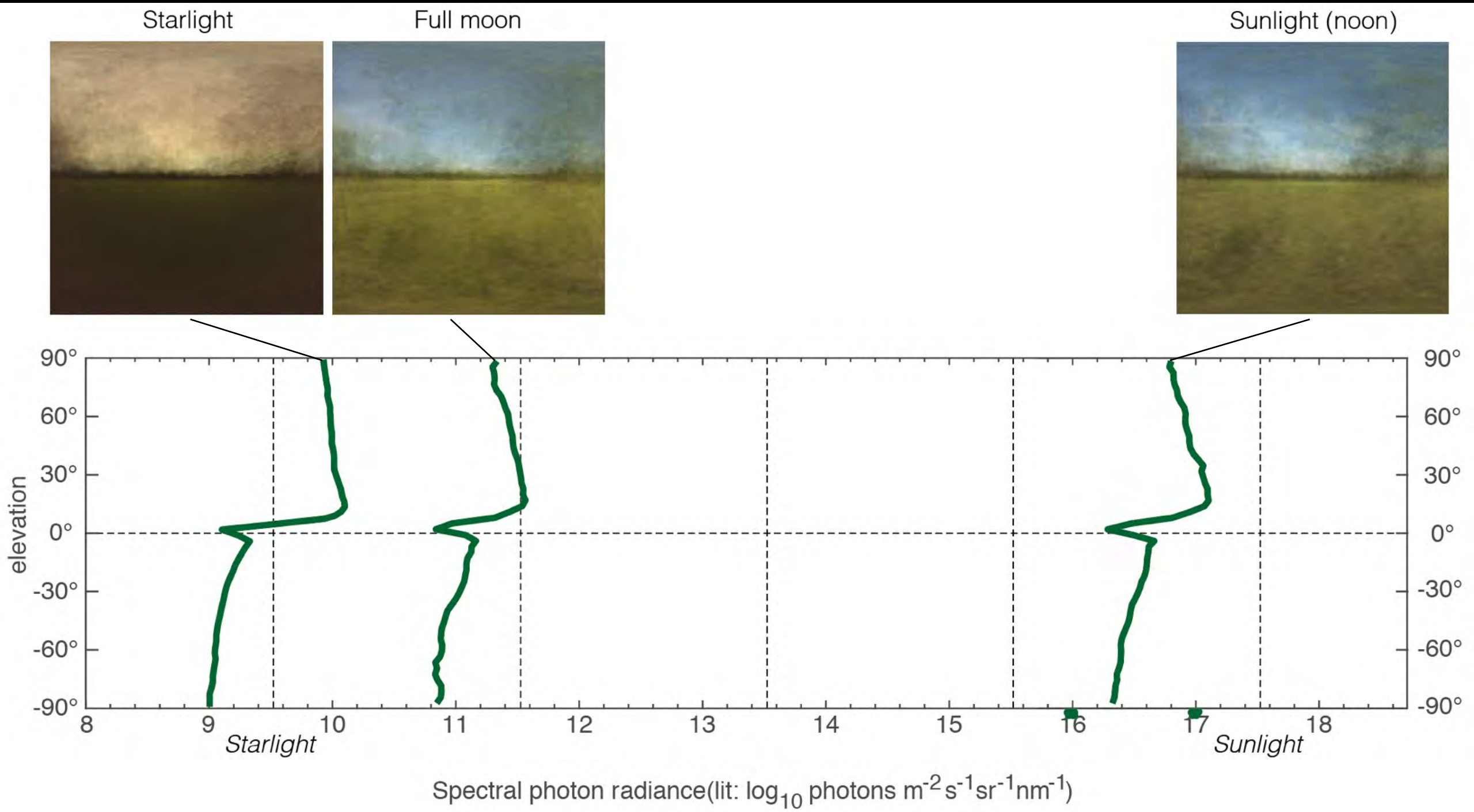

Starlight
Twilight
Sunlight
Scene range, 1.5-2 log
Airglow 0.5 log
Weather 2 log
Environment, 2 log
Moonlight, 2 log
8 log units between starlight and sunlight
1
10
100
1000
10 000
100 000
1 000 000
10 000 000
100 000 000

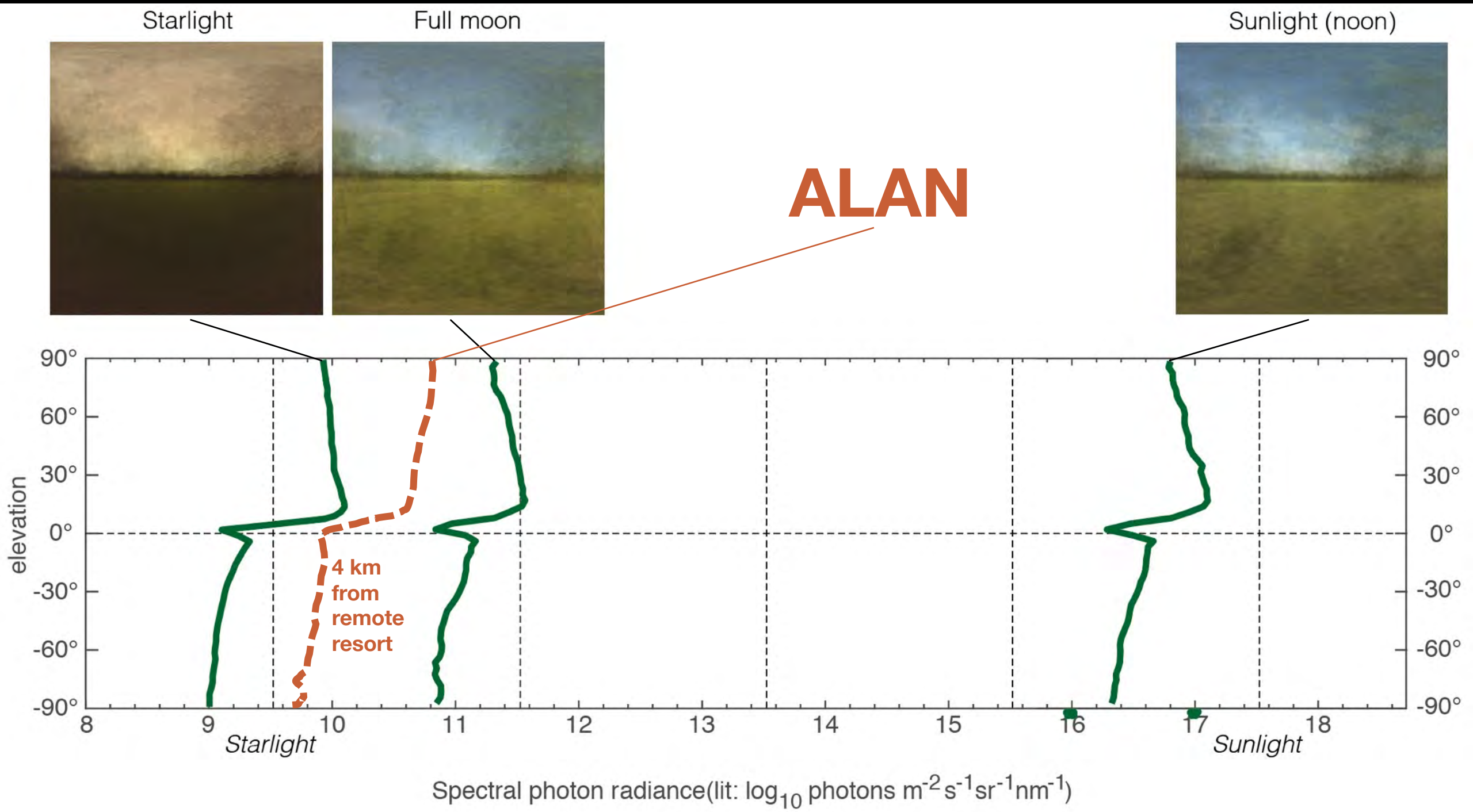

Starlight
Late dusk
Mid dusk
After sunset
Sunlight (noon)
-20°
-10°
-5°
-1°
+70°
90°
60°
30°
0°
-30°
-60°
-90°
elevation
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)

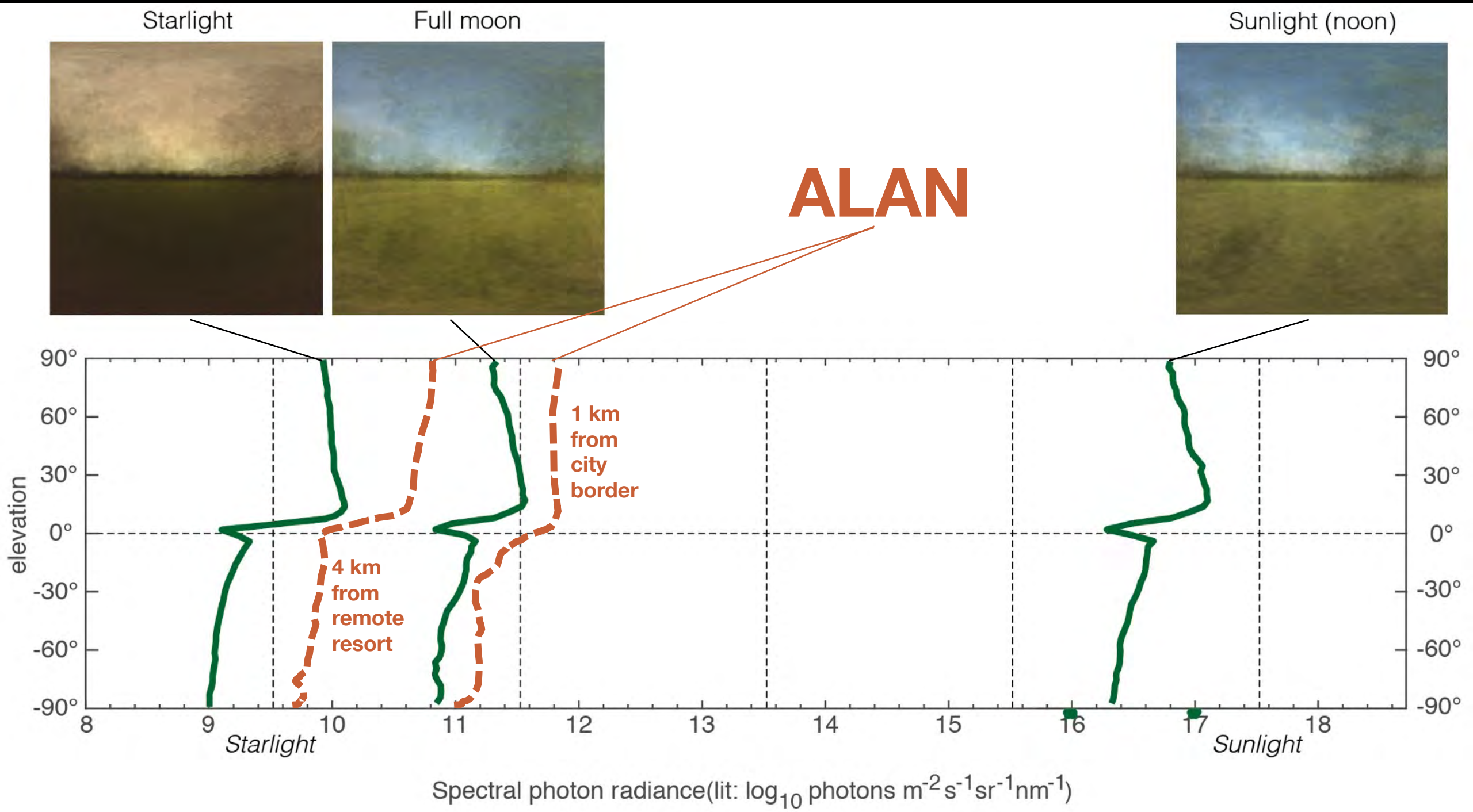

Starlight
Late dusk
Mid dusk
After sunset
Sunlight (noon)
-20°
-10°
-5°
-1°
+70°
90°
60°
30°
0°
-30°
-60°
-90°
elevation
overcast
overcast
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)

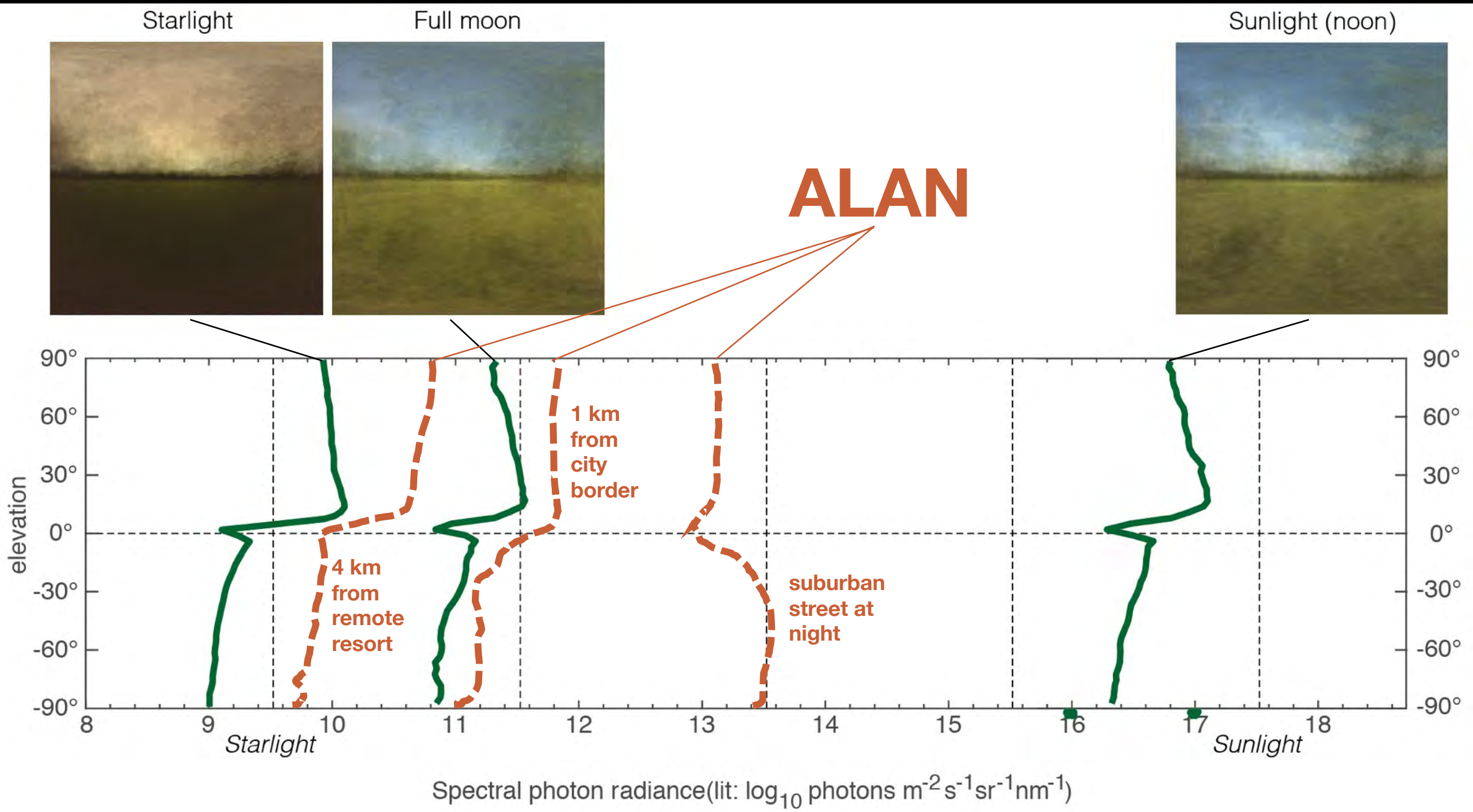

Starlight
Late dusk
Mid dusk
After sunset
Sunlight (noon)
-20°
-10°
-5°
-1°
+70°
90°
60°
30°
0°
-30°
-60°
-90°
elevation
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)

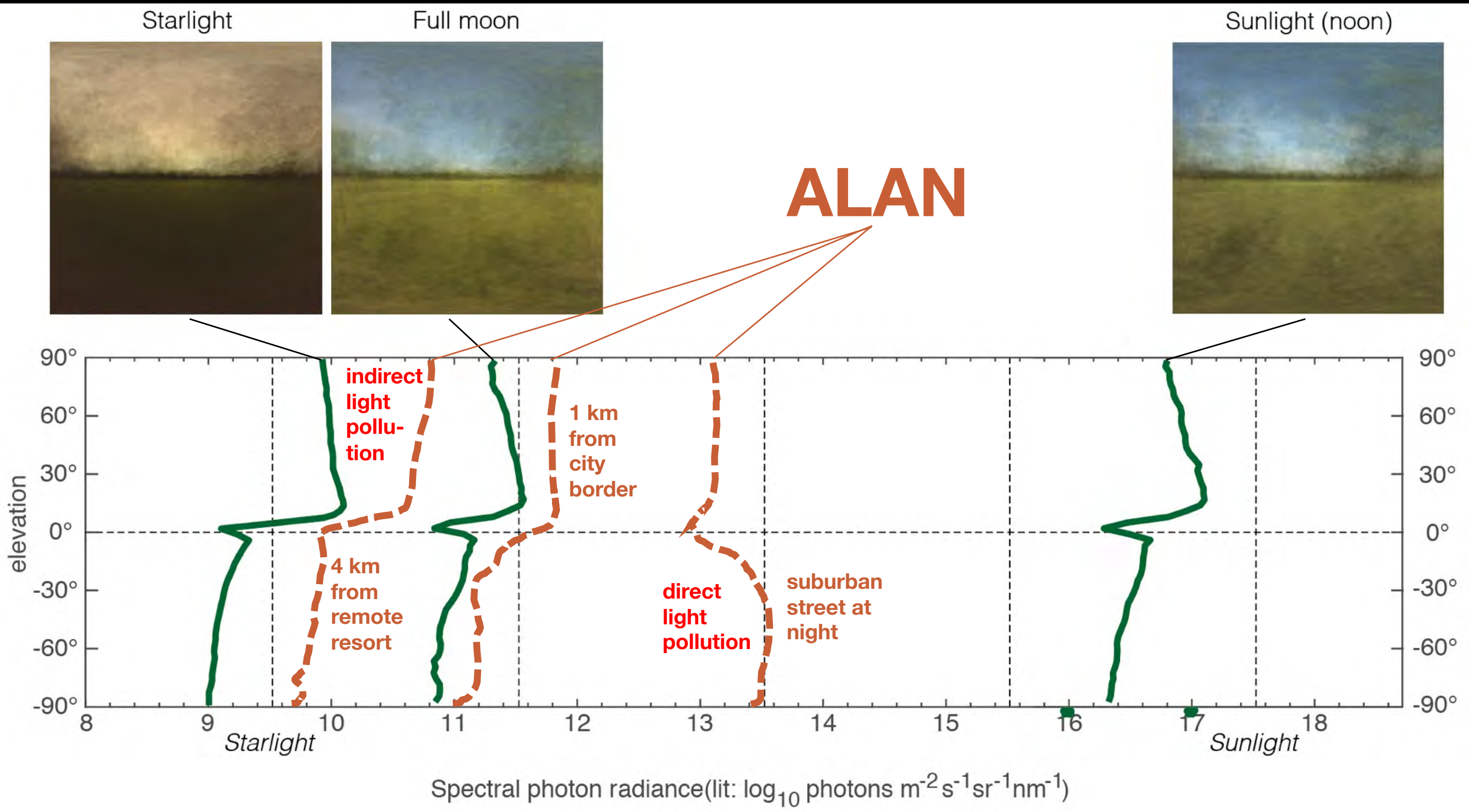

Starlight
Late dusk
Mid dusk
After sunset
Sunlight (noon)
-20°
-10°
-5°
-1°
+70°
90°
60°
30°
0°
-30°
-60°
-90°
elevation
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)


Starlight
Full moon
Sunlight (noon)
90°
60°
30°
0°
-30°
-60°
-90°
elevation
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)


Starlight
Full moon
Sunlight (noon)
ALAN
4 km from remote resort
elevation
90°
60°
30°
0°
-30°
-60°
-90°
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)


Starlight
Full moon
Sunlight (noon)
ALAN
1 km from city border
4 km from remote resort
elevation
90°
60°
30°
0°
-30°
-60°
-90°
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)


Starlight
Full moon
Sunlight (noon)
ALAN
1 km from city border
4 km from remote resort
suburban street at night
elevation
90°
60°
30°
0°
-30°
-60°
-90°
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)


Starlight
Full moon
Sunlight (noon)
ALAN
indirect light pollu-tion
1 km from city border
4 km from remote resort
direct light pollution
suburban street at night
elevation
90°
60°
30°
0°
-30°
-60°
-90°
8
9
10
11
12
13
14
15
16
17
18
Starlight
Sunlight
Spectral photon radiance(lit: log10 photons m-2 s-1 sr-1 nm-1)

What does light pollution do?

- Nocturnal animals change their activity pattern and move to other places
- This disrupts ecological interactions with other species and affect all animals
- The result is a decline in biodiversity and a loss of species
- Both terrestrial and shallow aquatic environments are severely affected

What can we do to mitigate the adverse effects of ALAN?

What can we do to mitigate the adverse effects of ALAN?

Actions and regulations risk be marginal or at least insufficient

We need to identify sweet spots where reduced or altered ALAN provides the largest reduction of impact

We need to improve our understanding of how light pollution propagates

1. in different environments
2. in different positions in the environment
3. under different weather conditions
4. at different seasons or states of vegetation

Measure vertical light gradients: radiance and spectral balance including UV

Animals use visual information to decide where to be and what to do.

We need to quantify how this information is modified by ALAN

- this is a novel approach to mitigate light pollution
- the tools are already available
- the results will directly identify actions and regulations with the best effect
- the results will identify urgent ecological studies

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Thank you