YOUR EYES

JAMES ELKINS

ROUTLEDGE

NEW YORK • LONDON

26

how to look at sunsets

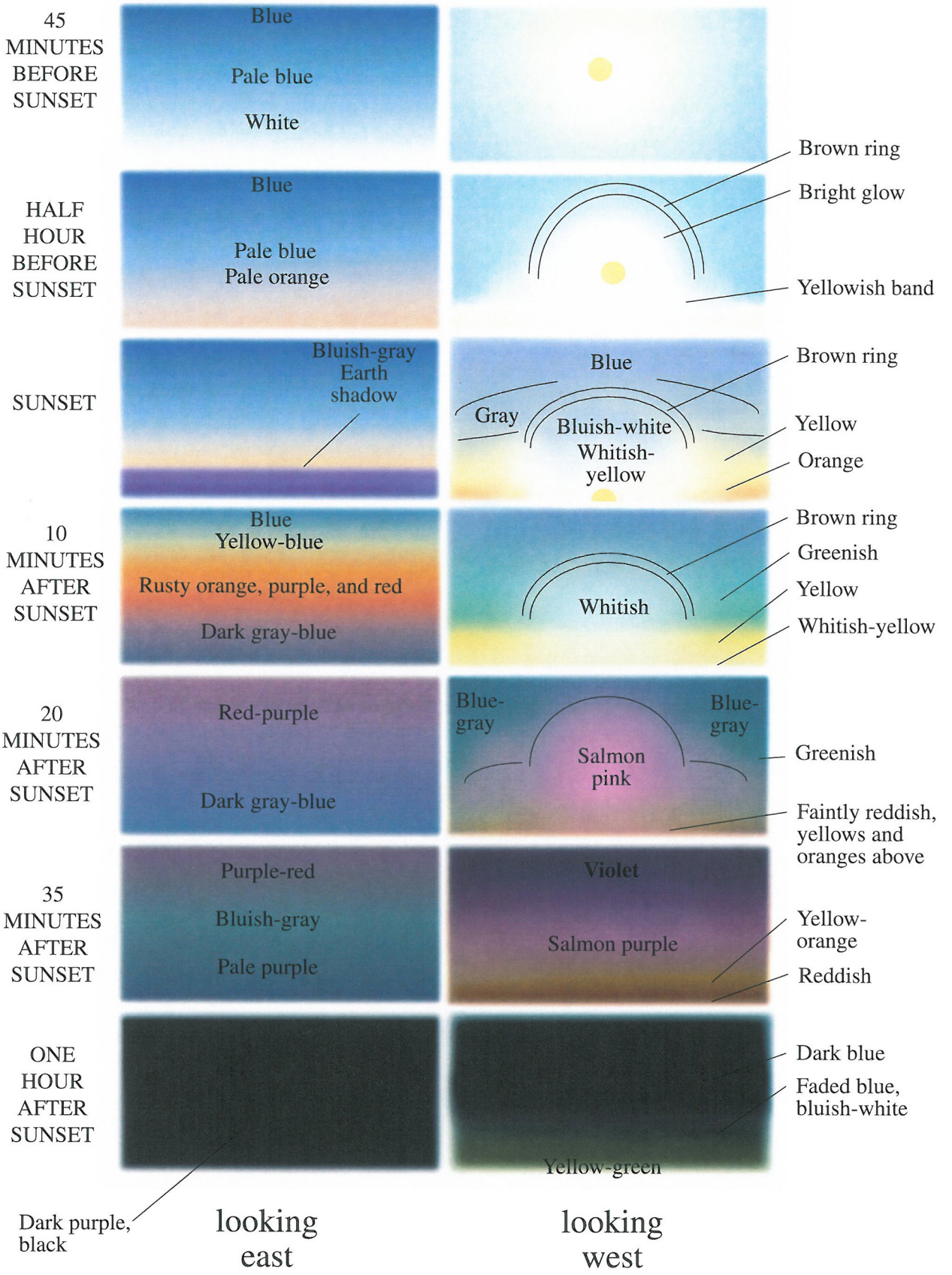
When there are clouds in the air, sunsets can be any color. Occasionally a cloud might even be bright apple-green. But when the sky is cloudless, the colors follow a certain sequence. It was worked out, with typical precision, by several German meteorologists in the 1920s. Figure 26.1 summarizes their results.

During the day, the sky is blue above and white at the horizon (top left). About a half hour before sunset in the west, the sun begins to affect the color of the sky just below it (second picture down, on the right). The light at the horizon begins to turn faintly yellow; in the next few minutes it will often differentiate into horizontal stripes. The stripes are due to layers in the atmosphere, which you see nearly edge on. At the same time the sun may develop a dull brownish halo, which I have outlined because it is too faint to show up well in reproduction. At sunset the sun is surrounded by a bright whitish glow with bluish-white above. If there is orange and red in the sunset sky, this is when the colors are at their most intense.

If you look to the east away from the sun just at sunset, you will see the *counter-twilight* or *antitwlilight arch,* which soon differentiates and brightens into various

figure 26.1

Colors of the cloudless sunset.


45 MINUTES BEFORE SUNSET
Blue
Pale blue
White
Brown ring
Bright glow
Yellowish band
HALF HOUR BEFORE SUNSET
Blue
Pale blue
Pale orange
SUNSET
Bluish-gray Earth shadow
Blue
Gray
Bluish-white
Whitish-yellow
Brown ring
Yellow
Orange
10 MINUTES AFTER SUNSET
Blue
Yellow-blue
Rusty orange, purple, and red
Dark gray-blue
Whitish
Brown ring
Greenish
Yellow
Whitish-yellow
20 MINUTES AFTER SUNSET
Red-purple
Dark gray-blue
Blue-gray
Blue-gray
Salmon pink
Greenish
Faintly reddish, yellows and oranges above
35 MINUTES AFTER SUNSET
Purple-red
Bluish-gray
Pale purple
Violet
Salmon purple
Yellow-orange
Reddish
ONE HOUR AFTER SUNSET
Dark blue
Faded blue, bluish-white
Yellow-green
Dark purple, black
looking east
looking west

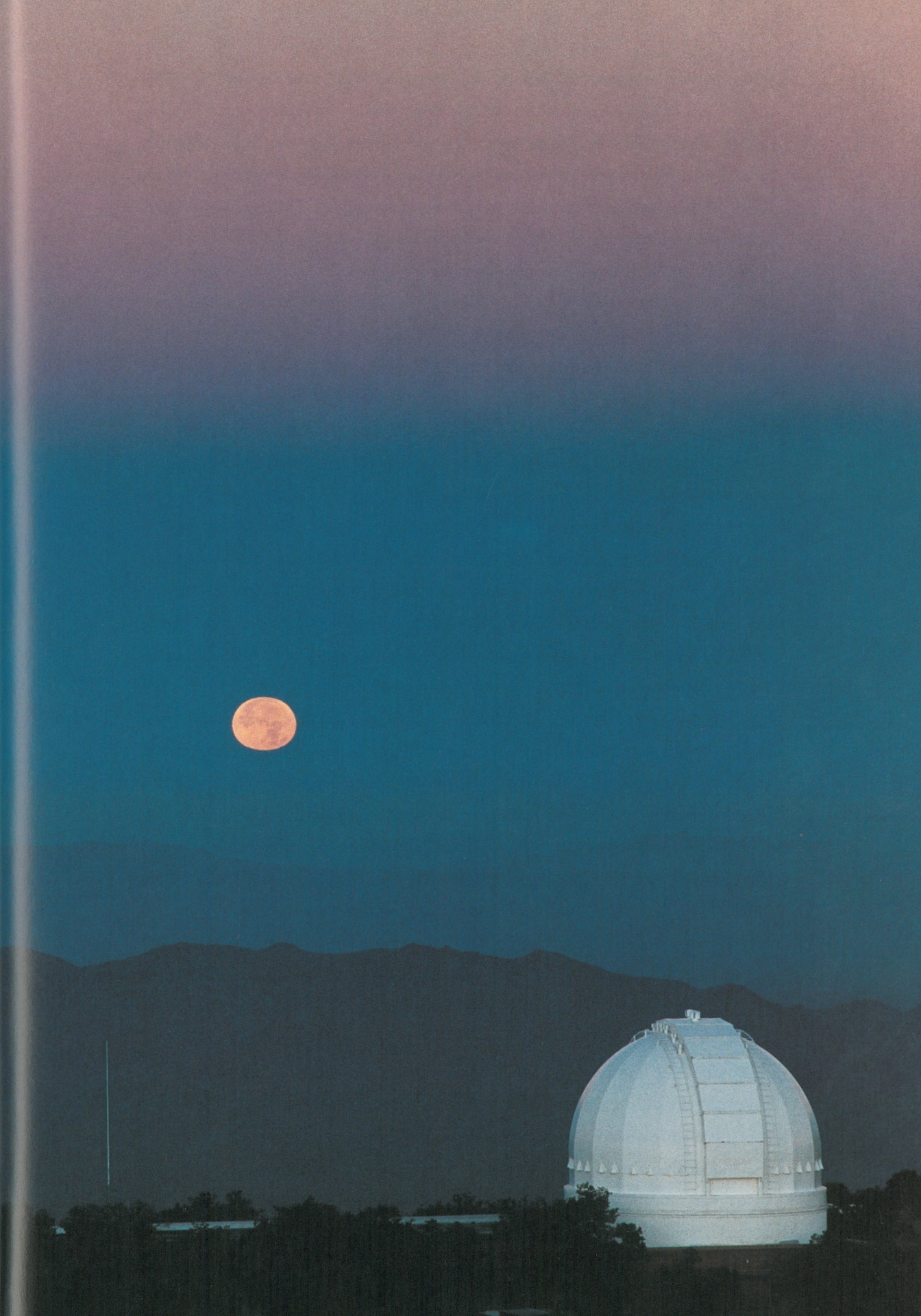
colors (third and fourth pictures down, in the left row). At its fullest the countertwilight is orange or reddish below and cooler above, which shows that it is not a simple reflection of the sunset in the west. The explanation is that some colors are scattered more than others by the atmosphere; blue is scattered most easily and most thoroughly, which is why the sky looks blue in the daytime. Red is scattered least, which means it can penetrate very far through the atmosphere. As the sun sets, its light travels through increasingly greater thicknesses of atmosphere, so the top of the countertwilight reflects light that has traveled through less atmosphere, and the bottom reflects light that has traveled the farthest. It stands to reason, then, that the bottom of the countertwilight is reddish, and the top cooler. In effect, it is a spectrum of the sun produced by the natural prism of the atmosphere.

A few moments before the sun sets, the dark *Earth shadow* begins to rise in the east. The Earth shadow is easily one of the most awe-inspiring sights in nature, and also one of the most rarely noticed. It is nothing less than the shadow of the entire Earth, cast upward onto the atmosphere itself. Figure 26.2 shows a typical scene: the Earth shadow is the dark gray-blue portion of the sky. As the sun disappears below the horizon, the Earth shadow slowly rises and becomes less distinct. People who climb mountains sometimes see the shadow of the mountain that they are on, cast far away across the landscape and even up onto the clouds. But mountain shadows are tiny compared to the Earth shadow. You can see the Earth shadow in nearly every sunset, though it is most spectacular when there is some haze in the air. (The air-driven dust gives more of a backdrop for the shadow.) I have been amazed by the Earth shadow several times. The first time I saw it was over Lake Michigan, and as it rose, it was as if I could see the waters of the lake casting their shadow up onto the sky. Another time I saw it over the Great Plains, and I felt as if I could sense the Earth pivoting silently under my feet, turning downward toward the shadow.

The Earth shadow is one of two sublime events of the sunset. The other is the *purple light* or *purple glow,* which appears roughly fifteen or twenty minutes after sunset. (Figure 26.1, five pictures down, on the right side.) At first it looks like an isolated bright spot fairly high in the sky over the place where the sun has set, and

figure 26.2

Looking east shortly after sunset: the Earth shadow and the antitwilight arch. December 14, 1978.



then it quickly expands and sinks until it blends with the colors underneath. The purple light is a large, diffuse, bright area of salmon- or magenta-colored light. It can be quite startling, as if there were a huge fire over the horizon. It is caused by a layer of fine particles between 6 and 12 miles up in the air; even after the sun no longer illuminates the place where you are standing, it still shines far up in the atmosphere, and the purple glow is the reflection of that light.

Since it was first described, the purple light has been the subject of several debates. It seems to be very difficult to describe its exact color. To me it looks magenta, as I have painted it in Figure 26.1. Other people describe it as "salmon pink," which I think of as a warmer tone. I wonder if some of the controversy might not stem from the fact that the purple glow contains reddish light from both ends of the spectrum: true red from the long-wavelength end near the infrared, and also magenta or purple from the short-wavelength end near the ultraviolet. The purple light itself is short-wavelength light, but it may well be mixed with long-wavelength light from the earlier sunset.

In the east at the same time, the Earth shadow rises, softens, and finally dissolves (third picture from the bottom, left-hand row). Above it is the *bright reflection* of the sunset, lingering on after the antitwilight arch has also scattered. It sometimes reflects the light of the purple glow, as I have shown it in Figure 26.1. On other evenings it carries an echo of the spectral colors of the antitwilight arch. In the photograph, the rust- or meat-colored band just above the Earth shadow is the lower portion of the antitwilight arch. In a few more minutes it will grow darker and sometimes more purplish (reflecting the purple glow), and eventually it will disperse into the general haze of the bright reflection.

Like the Earth shadow, the purple light can be an amazing sight. When it is strong, it gives a warm, light-violet tint to rocks, trees, and sand, and it has been reported that it can make buildings in a city look purplish if they face west.

In temperate latitudes the twilight does not end until 45 to 60 minutes after sunset. At that point the purple light diminishes, leaving a dark bluish-white *twilight glow,* which reaches a height of 20° above the horizon. That is the last tip of the illuminated atmosphere (bottom right picture in Figure 26.1). If you have ever tried to stay outdoors after sunset in order to finish something you were reading, you may have used the purple light. When it finally fades, the light diminishes rapidly, and that is probably when you gave up trying to read and went indoors.

Sunset colors can be hard to pick out because they all blend into one another. One observer recommends drawing imaginary lines between the colors, like the arcs

I have drawn in Figure 26.1. But at least in real life the colors are clearly visible. Even in this age of technological sophistication, no one has captured a satisfactory photographic record of the ordinary colors of the sunset. The range in brightness from the purple glow to the dark sky above is too great for most films, and naturally it is beyond the range of printed pictures. The best simulations are done on computer, because the screen has a range from black to white that is ten times the range of printed books. (Figure 26.1 looked quite realistic when I saw it onscreen before it was printed.) Most people would guess that the sun is fifty or a hundred times brighter than the moon, but it's actually a half million times brighter (and a million times brighter than the late twilight sky)—evidence of the amazing capacity of our eyes to adjust to light and dark. Figure 26.1 is just a guide; these things have to be seen with your own eyes.

If you live in the tropics, you'll know that the sunset happens very fast, because the sun sinks down almost vertically. Twilight is over in half the time. Conversely, beyond the temperate regions, these frames can be spun out into hours, and finally into days and months north of the Arctic Circle. Depending on the condition of the atmosphere, you may see much brighter colors, or much fainter ones. In Alaska north of the Arctic Circle I have seen very gray sunsets with just the faintest touches of color. On warmer vacations I have seen blazing sunsets with colors so bright they looked like retouched tourist postcards. The phenomena of later twilight are very sensitive to conditions in the upper atmosphere. The purple glow, in particular, comes and goes; one night it might be brilliant, and the next night almost absent. Dawns are very much like sunset, except in reverse, and they are said to be better for this kind of observation, because the air is generally less turbulent.

Things change, but these are the basics. With this information you can watch a sunset from beginning to end, feel the Earth rotating, and see the sky being lit—at first all around you, and then higher and higher, until only the thinnest air high up over the Earth is still illuminated. Even the colors of the sunset, so famous because they are nothing but pure meaningless beauty, can say a great deal about the Earth, the sun, and the path of the sun's light through the air. And it's also a wonderful way to spend an evening—looking into the air and trying to find invisible boundaries between colors that mutate slowly and continuously into one another, blending imperceptibly and growing imperceptibly darker.