The "Green Flash" Phenomenon As Observed During Sunrise Over Mt. Hood

A casual search for green flash imagery on the Internet produces results dominated by sunsets over horizons formed by large bodies of water. Ignoring atmospheric refraction, a solar light ray's point of tangency on a water horizon as observed 30 m above the water's surface is nearly 20 km distant. Depending on atmospheric conditions, with high transparency being a major contributor, this path length is sufficient to generate refractive and prismatic effects briefly imparting a green hue to observed sunlight. Fine examples of a green flash at sunset, as photographed over the Pacific Ocean from the northern California coast, are posted at http://www.mendonomasightings.com/tag/green-flash/page/2/ (accessed 22 July 2017). These and other examples observed over water indicate stratified atmospheric layers play a significant role in producing such events. Optical aid may be required to observe colors in such layers.

However, as noted in the blog at https://photographytuition.wordpress.com/2012/02/22/how-to-photograph-the-green-flash/ (accessed 22 July 2017), green flash can occur at sunrise or sunset as well as over a mountainous horizon. This paper documents multiple sunrise green flash events observed on 21 July 2017 from the author's residence near Salem, Oregon. These events appeared over the north slope and summit of Mt. Hood at a distance of over 120 km. In addition to relatively long path length, this geometry is thought to have enhanced green flash duration because Mt. Hood's north slope nearly parallels the Sun's apparent motion when it rises over locations near 45° N latitude. It should be noted all the colors photographed in the following figures were also observed without optical aid, green flash hues giving an impression akin to a glittering emerald. Visual perception served as the only cue for when photographs were taken.

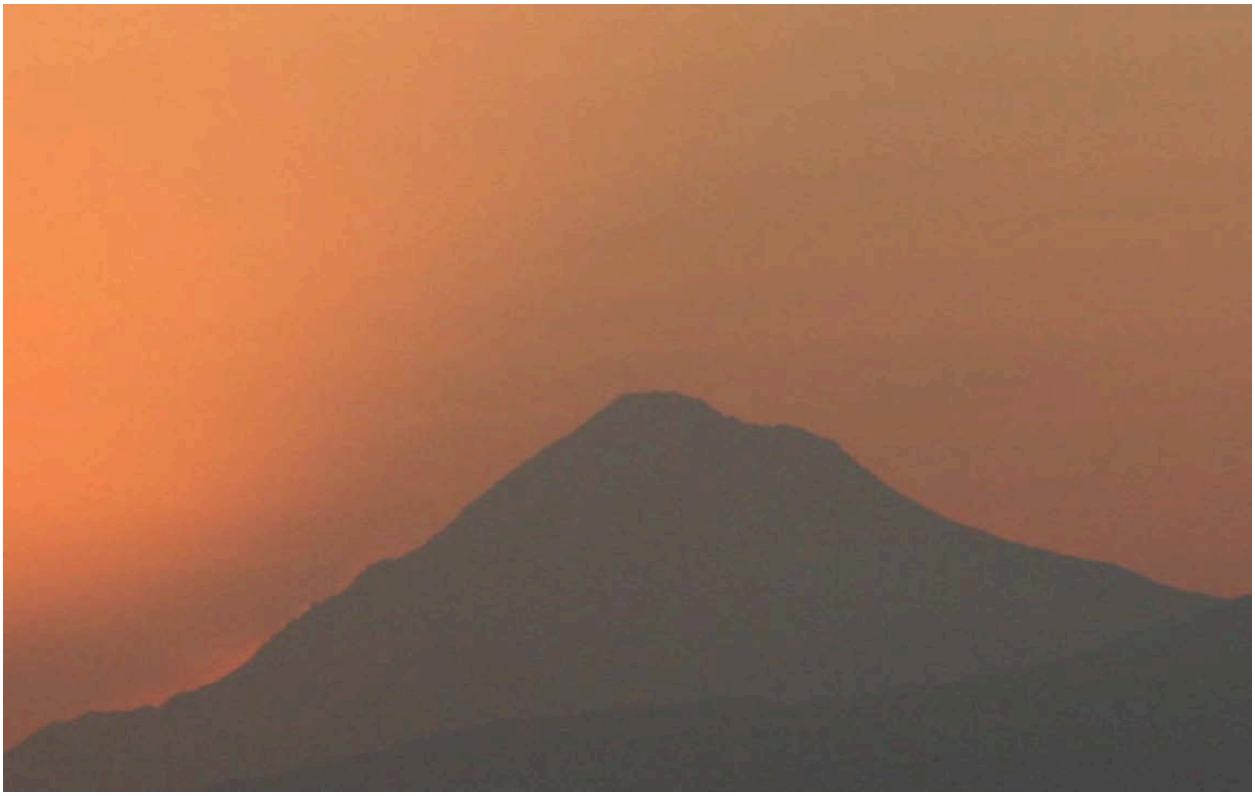

Figure 1. Mt. Hood is photographed at 12:49:59 UT (local PDT is 7 hours earlier), about 2.3 minutes before the initial green flash observation. Note the mountain's shadow cast in the observer's direction and how it changes in subsequent figures.

Figure 2. An initial sliver of solar photosphere is visible over Mt. Hood's north (left) slope at 12:52:18 UT. Close examination of this sliver shows it to be of violet hue.

Figure 3. By 12:52:19 UT, the sliver has grown and assumes a green hue.

Figure 4. The initial sliver of visible photosphere continues to enlarge and has assumed a yellow hue at 12:52:26 UT.

Figure 5. A second sliver of solar photosphere appears upslope of the first with a distinctly green hue at 12:52:33 UT.

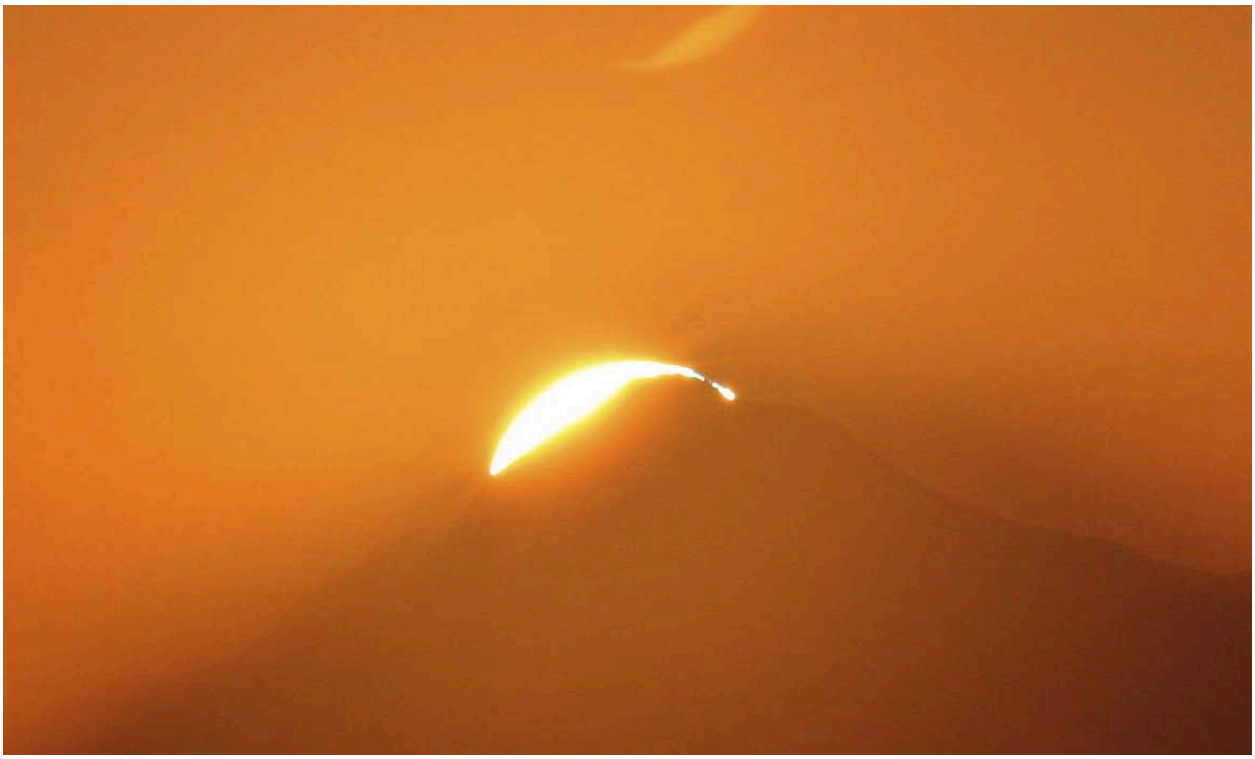

Figure 6. Mt. Hood's summit is silhouetted against the solar photosphere at 12:54:22 UT. Note the green hue in sunlight passing near the point of tangency between the Sun's limb and terrain immediately south of Mt. Hood's summit.

Preceding figures illustrate no less than three distinct green flash events in a single sunrise, and all were visually observable without optical aid. Particularly when located over Mt. Hood's north slope, these events enjoy protracted durations exceeding one second.

Table 1. The following prediction data from JPL's *Horizons* ephemeris server at http://ssd.jpl.nasa.gov/?horizons (accessed 22 July 2017) ignore atmospheric refraction and summarize geometry for the Sun's center during the observed sunrise. Note the refracted Sun's upper limb is predicted by *Horizons* to move from below to above a no-terrain horizon between 12:46 and 12:47 UT.

UT (hh:mm)	Apparent True Right Ascension, Declination (deg)	Apparent True Azimuth, Elevation (deg)
12:48	121.08438, +20.36415	59.8790, -0.6366
12:49	121.08508, +20.36402	60.0562, -0.4833
12:50	121.08577, +20.36388	60.2332, -0.3296
12:51	121.08647, +20.36375	60.4099, -0.1757
12:52	121.08716, +20.36361	60.5864, -0.0215
12:53	121.08786, +20.36348	60.7627, +0.1329