Observing Conditions

Astronomy on earth is governed by seeing, transparency, and darkness, which are *not* the same, and it is helpful to know about them when observing.

What

Seeing = air turbulence
  (amount of wind eddies, jet stream currents, etc.)
Transparency = air clarity
  (amount of haze or humidity/soot particles, cloudiness, etc.)
Darkness = amount of light
  (from artificial lights, sky ionization, cloud reflections, Moon/planets, etc.)

Note that steady (or laminar flow) air often allows humidity and particulates to remain, hence transparency generally suffers. Similarly, clearing the air of moisture and particles generally requires air movement, hence seeing generally suffers. High elevations have less stuff (air, moisture, particulates) to look through, but also enhance night-time radiative cooling, which may result in either sinking air (thus movement) or moisture condensation (fog formation/dewing, thus haze). The polar front jet stream speeds up when it drops to NM latitudes in winter, increasing high elevation air turbulence much more than in the hot summer months.

Relevance

Good seeing means detail can be seen at high magnification.
Good transparency means very faint light sources can be seen (this is also related to darkness).
Good darkness means small variations of light intensity can be seen (high eyeball sensitivity).

Effect on Observing

Large versus Small Aperture Optics
If seeing is good, then a large aperture telescope will show more detail (resolution) than a smaller one, will show fainter objects, and will split (separate) stars that are closer together ("Aperture rules!"). If seeing is not good, then small details are blurred and a small aperture telescope may be an easier effort for that session ("Portability rules!"). Good transparency and darkness help *all* telescopes.

SLAP Observing (Solar, Lunar, and Planetary)
Seeing is most important because blurring at high magnification obscures details and SLAP observing needs magnification. Transparency is almost as important as seeing because thin clouds and haze obscure SLAP details. Darkness is least important (many observers even turn on lights when looking at the Moon or Jupiter to enhance color perception and use a reference or sketch pad), and thus urban observers often focus on SLAP objects. Also, seeing is always changing (which is why stars to twinkle), so visually observing for several minutes may result in a few moments of great visual detail, or capturing many images may produce a few showing excellent detail. Solar observing needs good seeing to discern small features, but this may be hard to find in daytime (at least one solar observatory is located on a lake island to help stabilize air movement, hence seeing).

DSO Observing (Deep-Sky Objects)
Darkness is most important to allow for viewing differences between areas of very low contrast differences (i.e., small changes in brightness). Transparency is almost as important as darkness because thin clouds and haze obscure DSO details. Good seeing is desired but not as important because low magnifications are used, which minimizes the blurring effects of air turbulence.

Evaluating
Seeing is typically best when a somewhat bright star is seen at very high magnification (typically 30-50x/inch of aperture) as having a tiny, solid (Airy) disk surrounded by a couple of unbroken concentric (diffraction) rings of light. Seeing can be so bad that a bright star shows many colors of the rainbow to the naked eye. The Pickering-Douglass stellar, Antoniadi planetary, Danjon-Couder arc-second, Mt. Wilson solar, Kiepenheuer solar, and Tombaugh-Smith double star scales are typical rating standards for seeing.

Transparency is typically best when a naked eye can see many faint stars, clusters, and even galaxies (such as the Triangulum Galaxy/M33 or Bode's Galaxy/M81), or when the glow (scattered light) around bright objects (Moon, Sun, etc.) is minimal, and clouds are non-existent. Transparency also diminishes greatly as the view drops below 30-deg elevation above the horizon (more air, moisture, and particulates to see through), which is known as extinction. Rating scales generally (and arbitrarily) range from 1 (poor/overcast) to 10 (outstanding/extremely clear) -- or 0-10, or 1-7, or 1-5.

Darkness is typically best when there are no urban light domes or planets or light-scattering distant clouds, sunset and sunrise are hours away, and the Milky Way is on the horizon, giving a SQM (Sky Quality Meter -- basically a calibrated light meter) reading of about 22 magnitudes/square-arc-second (as compared to 19 for average suburban skies and 17 for urban skies). Note that thick clouds may produce a very dark sky without any transparency.

Some use the Bortle scale to evaluate both transparency and darkness, others use NELM (Naked Eye Limiting Magnitude) by one of several methods: determining the faintest star seen (at zenith, or near Polaris, or somewhere else) and finding its magnitude from a reference, or counting stars in a certain region of the sky and comparing it to published tabulations. These techniques may be problematic because everyone's eyeball receptors are slightly different, and faintness may be limited by amount of dark adaptation, experience in seeing faint objects, cornea fogging (pre-cataract), a less reactive iris (entrance pupil shrinkage), near-sightedness (including night myopia), and/or astigmatism. Eyeglasses/contacts may correct for some of these issues, but then there are differences in the polish and/or coatings of these optics that may also alter the results. Some have noted that the Bortle scale is difficult to use at somewhat dark sites. Although an SQM reading of itself is of minimal value[1], the readings do allow for reasonably objective comparisons between observing sites, seasons, or even wide areas of the sky.

Bottom Line
Earth's atmosphere interferes with astronomy, and optimum seeing/transparency/darkness sky conditions rarely exist simultaneously, so preferentially one should observe those objects that the local conditions favor at that time, noting that many locations often have a predominant sky condition. In the summer (less jet stream turbulence), just after a storm passes through (more air clarity), and after midnight (less air turbulence), *may* be the best observing time for many locations, but it won't last long, and sometimes it just doesn't work out that way. So make the best of what you have and keep looking up.

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[1] A section in the The Royal Astronomical Society "Observer's Handbook 2015" (p54-57) has a detailed article on using a sky's magnitude/square-arc-second value to determine/calculate the visibility of a faint, extended DSO.

Source: Jim Kaminski, July 2015