Clear Skies and Wet Shoes

How one telescope stays dry

Robert Bunge

On August 15th, 2015, I set up my 20-inch f/6 truss tube dobsonian, nicknamed "TJ" at the Almost Heaven Star Party at The Mountain Institute on Spruce Knob in West Virginia, one of the darkest locations in the eastern US. I set up the scope like I have perhaps a 100 times before since building this form of the telescope in 1999. The weather looked perfect. The few clouds that were in the sky disappeared as the energy source for their vapor vanished to the west. The sky darkened and the temperature dropped. Even before it was completely dark, dew started to form on many horizontal surfaces. By midnight, many telescopes on the field were shut down because of moisture on the optics. Much of the conservation the next day was about the "heavy" dew and how some were coping, or not-coping. But as in the past, the biggest dew impact for me was wiping the moisture off the screen of my laptop so I could read numbers off the screen and see where in the sky the telescope was pointing. Well, truth be told, my wet shoes were also a problem the next day.

The skies were almost perfect the next night as well. Only a very light wind from the East was present. So with new toy in hand, I decided to collect a little data to help document why my telescope didn't dew up and if the thermodynamics around TJ were working the way I thought.

TJ was set up in a large, perhaps 75 acre field, with tall, but cut grass. The site, at about 3000 feet, is in the hollow of two ridges, the eastern most which forms the backbone of Spruce Knob as it rises to 4800 feet about 2 miles north east. To the south, the field is perhaps 30 feet higher, with a gentle slope to the north and the low point in the hollow. In the photo this point is in the background and has low laying fog at 7:30am on the 17th.

At 1 am I used a low cost ($9-$25 depending on online source) infrared temperature sensor that is packaged and marketed to measure reptile habitat temperatures. My unit was originally purchased to measure the temperature of a Gecko habitat which also has several wired sensors. The reliability of the IR unit over the course of many checks was quite impressive, with agreement within 1-2 degrees of the control sensors.

The telescope is more or less a clone of the Obsession telescopes, with a few changes. The mirror box was inherited from an earlier form of the telescope and has a closed back (and uses a nine point cell and a Dobson style seat belt sling). The Upper Tube Assembly (UTA) is open, except for a plastic Kydex light baffle across from the focuser. I do usually duct tape a piece of 16x20 black card board to the top of the UTA to cut down on dew. I observe without a shroud. The scope has a "roster tail" table attached to the rocker box. I keep a vintage 1997 laptop on this table. The laptop displays Megastar and is

interfaced with Sky Commander DSC's so I routinely "push to" objects and forgo using a finder telescope. However, I do keep a heavy card board tube 4.25-inch f/4 reflector on the back of the mirror box. This is used to aid in the set up two-star alignment for the DSC's, to glaze at wide angle objects and to sometimes to re-center the telescope when a guest is at the top of the 10 foot ladder.

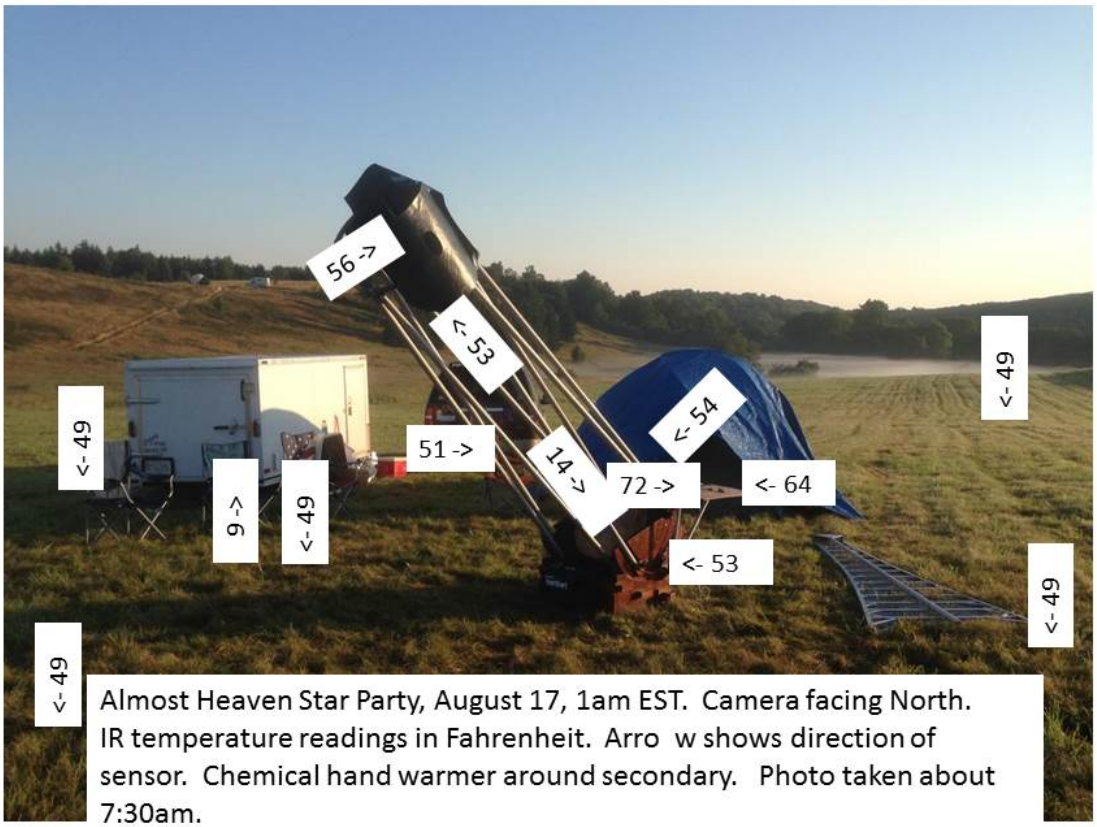
The 3.1-inch minor axis secondary mirror, on a spider of my own making, is glued to a piece of 1.5x1.5-inch pine shaft, which is attached, via several adjustment screws, to a thin sheet steel spider. Before each observing session, I open a chemical hand warmer and use a rubber band to wrap it around the pine mirror support. On the finder telescope, I keep a small cardboard can over the eyepiece. When I have to look through the finder, I remove the can. The can is actually an empty cat treat can and is about 2-inches in diameter. The finder eyepiece never dews and is unheated. Buried in the tube, and sitting on top of the large primary mirror box, the finder's primary has never dewed over.

I usually pull the eyepiece from the focuser if I walk away from the telescope, even if it is to make a note or finish up a drawing (I draw most things I observe). I keep this active eyepiece in a pocket. I sometimes keep two eyepieces in pockets. Other eyepieces are kept in a case that is usually in the back of a car or trailer. Sometimes I do leave the eyepiece in the focuser and it will fog up. For my most used eyepieces, I have two, so I will usually swap one out for another while the other gets warmed up in the pocket. I do not heat the eyepiece at the telescope.

A chart of the collected data:

Location	Temperature	Notes
Grass	49	Waist level, pointing down several points around the field. All readings the same.
Sky	9	Waist level, pointing up.
Above mirror box	51	Waist level, through struts.
Towards secondary	53	Center of tube, two feet from secondary mirror.
Towards primary	14	Center of tube, three feet from primary mirror.
Top inside of UTA	56	Pointing up, just behind secondary mirror.
4-inch finder	54	45 degrees down, towards finder tube.
Side of mirror box	53	About two feet off the ground.
Exhaust fan of laptop	72	Pointing towards the exhaust fan opening.
Laptop keyboard	64	Pointing down toward keyboard.

Data collected using: Zoo Med ReptiTemp Digital Infrared Thermometer, Model RT1



The data was pretty much what was expected. Dew forms when an object cools to below the dew point of the air around the object. While I wish I had collected the air and dew point temperatures at the site, it is safe to say since there was dew on the grass, the temperature of the grass at the time was at or near the dew point.

The dew point is usually below the air temperature. When the dew point and air temperature meet, fog will form in the air. Under a clear sky, warm objects radiate any heat into space. Objects made from material that transfers heat easily can cool so fast as to drop below the air temperature and reach the dew point. Glass and metal are excellent conductors and so cool off very fast. Wood is less of a conductor and will cool slower. This is regardless of surface paint and color, so a piece of metal painted black will cool just as fast as one painted white.

So the trick is to keep exposed optics above the dew point by providing some cover (like a dew shield) or heat (like from a dew heater). But too much heat will create pockets of warm air along an optical path that will interfere with the optical train and distort the image. Astronomers call this “seeing.”

Perhaps what I was most interested in was just how much warm air pools above the hand warmer, up under the cardboard. Indeed, there was a pocket of warmer air there that was seven degrees warmer

than the grass. I might decide to experiment with one or two openings in the cardboard to see if this improves the seeing conditions while using the telescope.

As expected, the area around the large wood mirror box was four or five degrees warmer than the grass. There is a lot of mass here and even by 1am, it is still cooling off. Wood is a poor thermal conductor, so it would cool faster if it was made of metal. However, metal could cool too fast, which would cause dewing. So I believe I have met a happy medium for a telescope that mostly uses passive anti-dewing properties.

Current thinking suggests much bad seeing in large dobsonians is related to heat currents just above the surface of the primary mirror. Blowing air may help this in some setups. The open backed mirror box of the Obsession design may also help. I was not able to measure these currents; as expected, when pointed to at the reflective surface of the mirror the temperature was just a little higher than that of pointing the sensor directly at the sky. I'll call this a success, as much cooler, and I suspect the primary would be at risk of dewing over.

At the time of the experiment, I subjectedly rated the "seeing" through the telescope as 7 out of 10, with 10 being perfectly still images. I had rated the seeing as an eight about an hour before the experiment.

Fun was noting that the exhaust coming out of the computer was 72 degrees and the keyboard was 64 degrees. While I've never linked bad seeing conditions to the computer, it can't be ruled out. The exhaust fan does not point to the optical path.

Amateur astronomers, by nature, are usually gadget friendly. Those who want to explore why their telescope dews up, may want to consider a visit to a local pet supply store for one of these devices and conduct their own experiments.