Subject: A potential alternative to determining Tcold for Hot-Cold tests
Date: Thu, 18 Feb 2021 22:06:05 -0500
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On obs-node1, try the utility:

% /home/caluser/bin/TsysContrib.tcl -help

As you'll see, the program takes four options:

-az	Azimuth of the observation. Default is 0.
-el	Elevation of the observation. Default is 23.
-utc	A UTC date and time string, embedded in quotes. Default is the current moment.
-table	If specified, produces a table of coefficients. If not specified, produces an equation

Your typical usage will be to specify the Az of the Hot-Cold and the UTC date and time. El =23 is assumed, though you can specify a different one if something different comes up. For example:

% /home/caluser/bin/TsysContrib.tcl -az 230 -utc "2/12/2021 14:53"

Note you'll need to use quotes around the UTC adate + time. You can specify a date from about Aug 1, 2020 to a few days into the future, though the accuracy can be off for future times. It will throw an error if you go beyond the range of days we have stored weather information.

You have two choices for output format, as I didn't know the best way you'd want to ingest the model into your analysis. If you *don't* specify '-table':

% /home/caluser/bin/TsysContrib.tcl -az 230 -utc "2/12/2021 14:53"

returns:

8.924 + 0.4359*f + -0.01629*pow(f,2) + 0.003129*pow(f.3) + -1.495e-05*pow(f,4) + 14.63*pow(f/0.408,-2.727) ,

an equation for Tcold that you can cat & paste into an analysis program. The equation gives Tcold as a function of frequency, in GHz, for the position and time of your test. The last term is the contribution from the Milky Way. The other terms are a 4th order polynomial that was fit to the sum of the

contributions from the atmosphere, spillover (using the results of our August tests), and the CMB.

If you specify '-table':

```
%   /home/caluser/bin/TsysContrib.tcl     -az 230     -utc "2/12/2021 14:53" -table
```

You'll get a different format for the output, not an equation but the coefficients that go into the same equation arranged into a table

```
a(0) = 8.924
a(1) = 0.4359
a(2) = -0.01629
a(3) = 0.003129
a(4) = -1.495e-05
T408 = 14.63
Beta = -2.727
```

Here, your analysis program would need to read in the table and use the last field on each line to set the value for internal coefficients.

I don't expect using the above will change results by more than a few K at high frequencies from the model you have been using. It may make a significant difference at low frequencies. There's a potential that TsysContrib.tcl might improve the consistency between Hot-Cold tests since it uses more specifics of the observing conditions than the model you've been using. For example, it uses NWS vertical weather profiles to determine the contributions to Tsys from 70 atmosphere layers, extending into the stratosphere above the observatory at the time of the observing (i.e., equivalent of sending aloft a weather balloon at the time the hot-cold is performed). It also uses the Haslam et al all-sky map of the radio sky to estimate the MW's contribution at the RA and Dec of your 'cold' observation.

The only way I think we can test whether TsysContrib.tcl is any better than what you've been using is to do multiple Hot-Colds on the same antenna at multiple Az on the same day and/or under different weather conditions on multiple days. But, I'm not even hinting that we explicitly do any tests that check for improved consistency.