ATMOSPHERIC NOISE CONTRIBUTION TO COSMIC MICROWAVE BACKGROUND MEASUREMENTS

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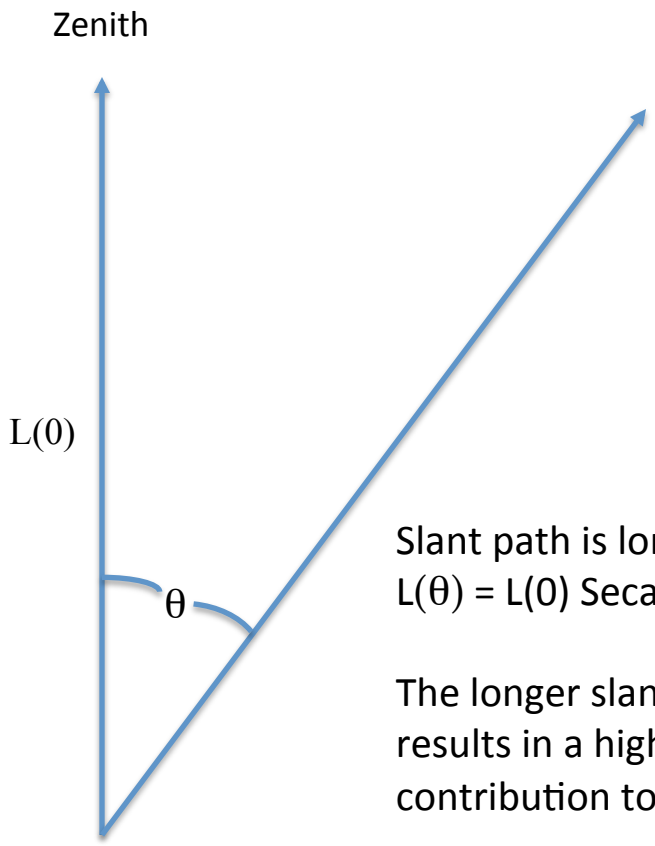
ATMOSPHERIC EMISSION

- When pointing at the CMB through the atmosphere, we see the glow of atmospheric gases added to the sky temperature.
- The emission is principally from oxygen and water vapor.
- The table below shows the range of added noise temperature under different conditions.
- The atmospheric contribution at 10 GHz at sea level is 5 K – 15 K, depending on the level of moisture.
- It is a substantial correction to the sea level measurement for amateurs, who typically are not using a balloon or a satellite platform.
- Note that the temperature decreases significantly at higher altitudes.

Method	LOCATION	Altitude (Ft)	CLOUDS	ATMOSPHERIC NOISE (K)	AUTHOR YEAR
Measured	Germany	0	Clear	5.2	Stein & Forster (2008)
Modeled	Std Atmosphere	0	Clear	6.9	Weger (1959)
Modeled	Std Atmosphere	0	Moderate clouds	8.5	"
Modeled	Std Atmosphere	0	Moderate rain	14.8	"
Measured	White Mtn, CA	12,500	Clear	1.1 - 1.27	Bersanelli et al. (1995)

MEASURING ATMOSPHERIC EMISSION

We can isolate the atmospheric contribution to the measured sky temperature by measuring the sky temperature at different angles



Slant path is longer
$L(\theta) = L(0)\ \text{Secant}\ (\theta)$

The longer slant path results in a higher contribution to T (Atm).

Using 2 equations in 2 unknowns at pointing angles of 0 degrees (zenith) and 45 degrees from the zenith we have,

$T(sky, 0) = T(CMB) + T(atm,0)$
$T(sky,45) = T(CMB) + T(atm,0)Sec(45)$

Note that T(CMB) is the same in all directions. From these equations we can determine T(CMB) and T (atm) for the zenith

However, we modified the receiving antenna for a 10 degree beamwidth.

HORN ANTENNA EXTENSION

- The angle measurement requires a much narrower beamwidth than the original horn beamwidth of 75 degrees.
- Horn extension optimized for beamwidth of 10 degrees.
- Horn extension made from .010 brass sheet.
- I chose to use an extended horn because it has less scatter than using a dish.

POINTING AT ZENITH AND 45 DEGREES