# Introducing Radiosonde Data into Simulations of Atmospheric Cherenkov Telescopes

Michael Daniel

Iowa State University

# Introduction

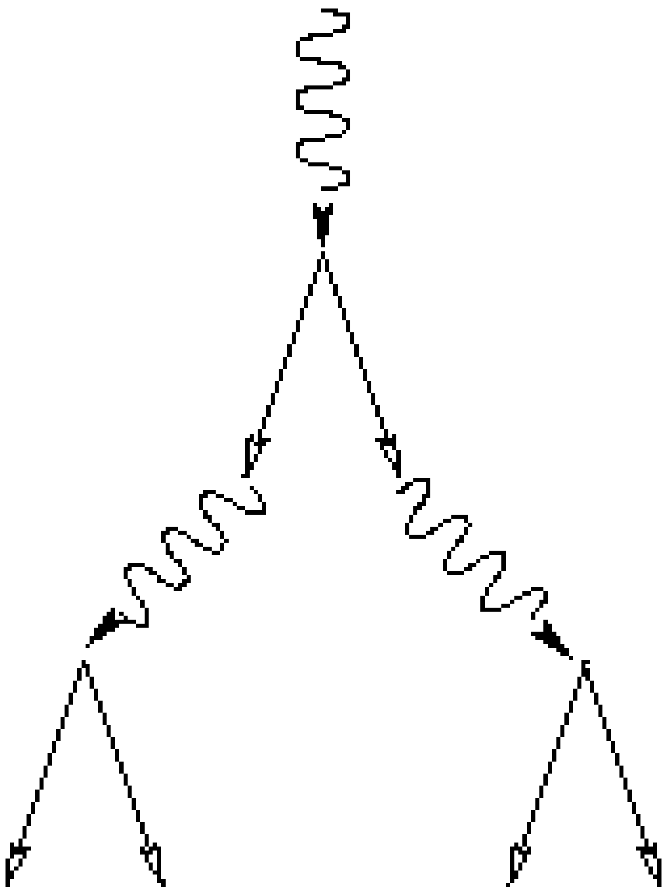
- The atmosphere and Cherenkov astronomy
- The models vs the data
- Conclusions

The development of an air shower is related to the thickness of the material travelled through.

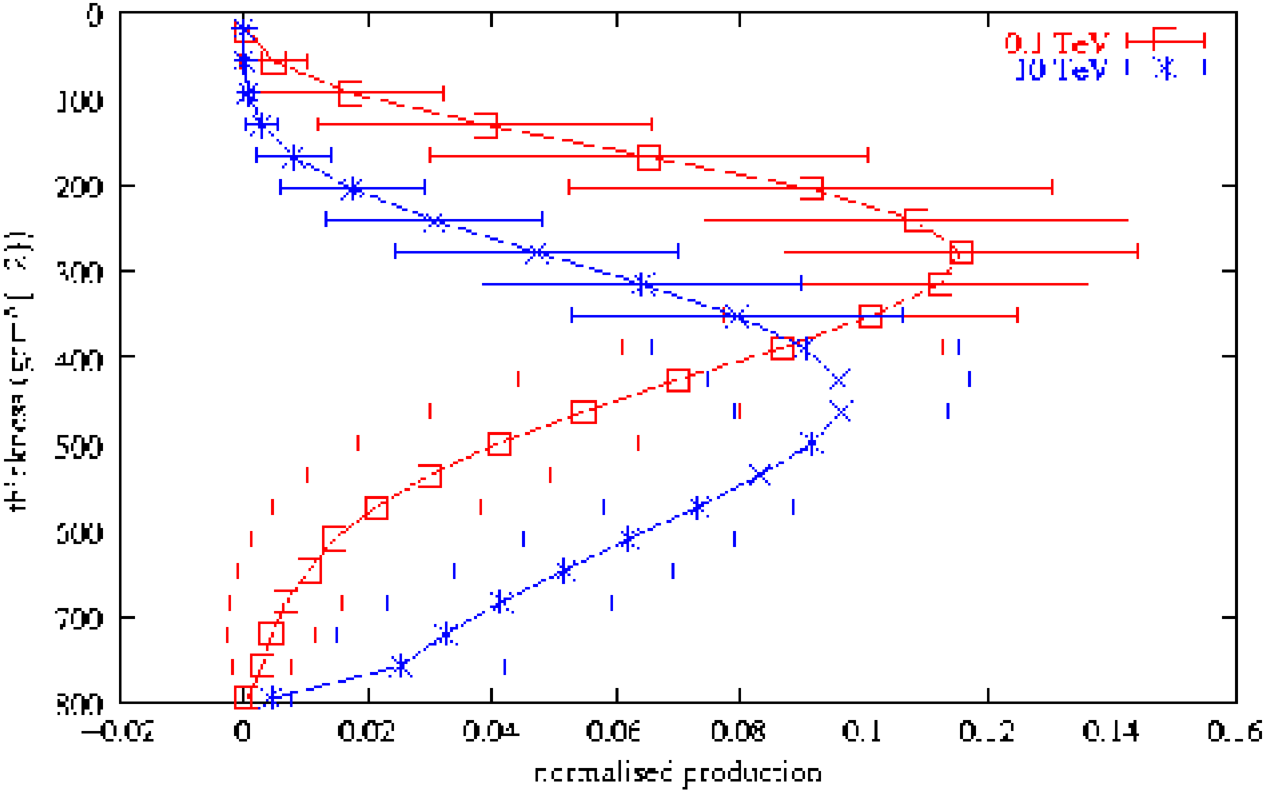
The thickness is the integral of the density profile along the path travelled. $T = \int \rho dz$

The density can be found from the pressure (p) and temperature (T).

$$pV = NkT$$

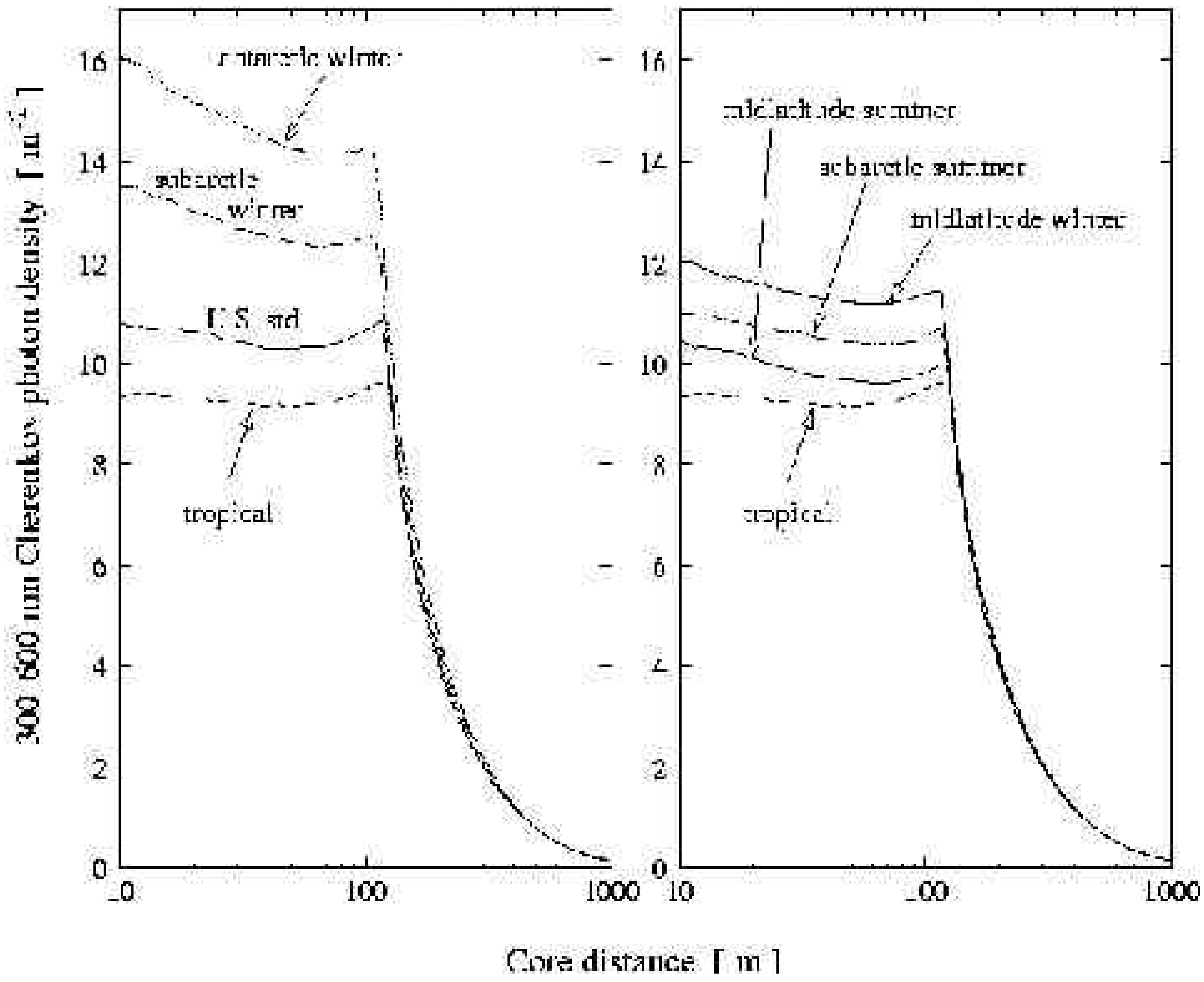


# More energetic primaries penetrate deeper into the atmosphere




Altitude ?

<u>Motivation</u>: The impact of atmospheric parameters on the atmospheric Cherenkov technique

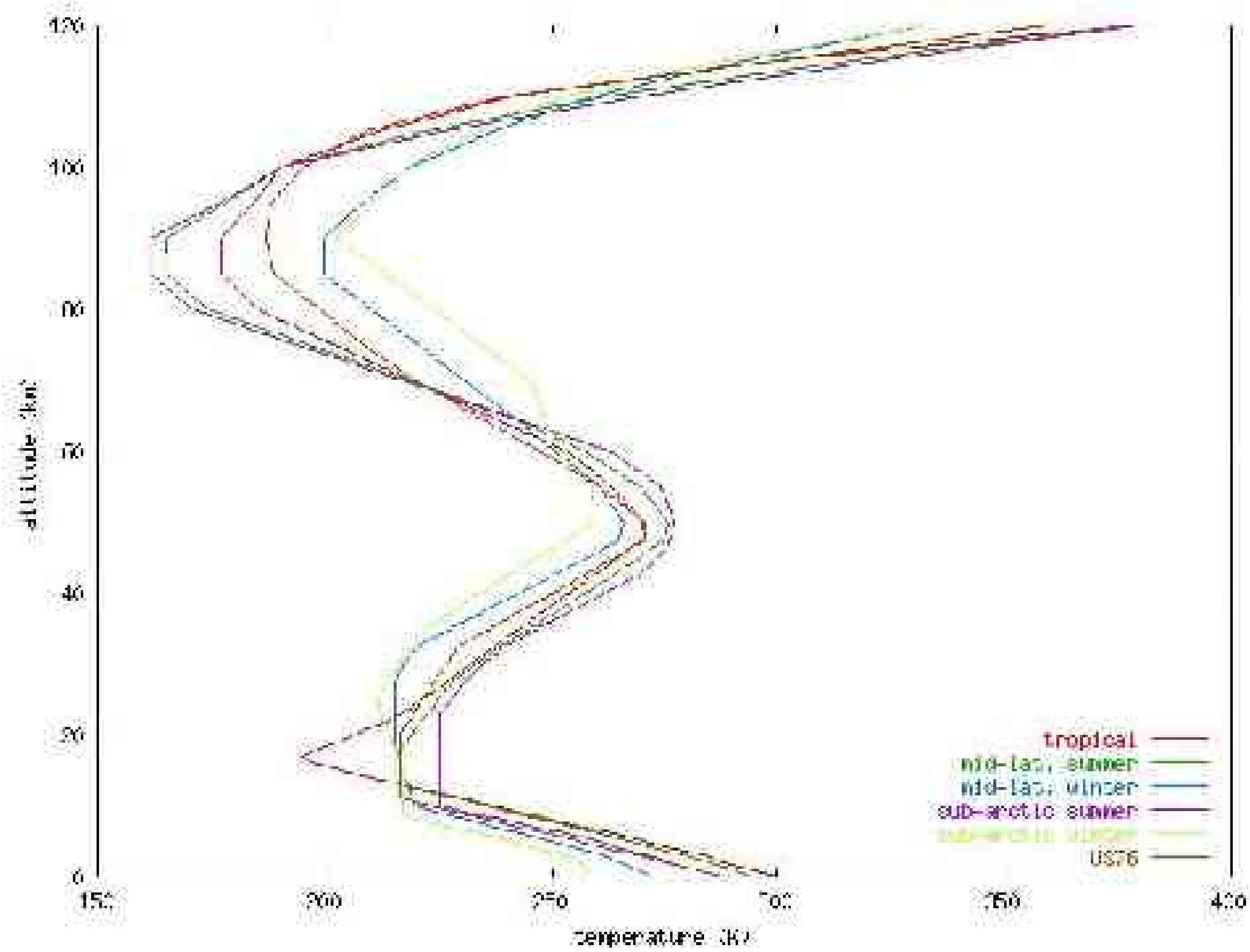



`Impact of atmospheric parameters on the atmospheric Cherenkov technique'
Konrad Bernlöhr, Astroparticle Physics, volume 12 issue 4 pages 255-268 (2000).

The Models.

- Tropical profile: 15 degrees North, annual average.
- Mid-latitude summer: 45N, July.
- Mid-latitude winter: 45N, January.
- Sub-polar summer: 60N, July.
- Sub-polar winter: 60N, January.
- US Standard atmosphere: profile representing the idealised, steady-state atmosphere for moderate solar activity based on the work of the U.S. Comittee on Extension to the Standard Atmosphere (COESA).

# Temperature profiles of the model atmospheres

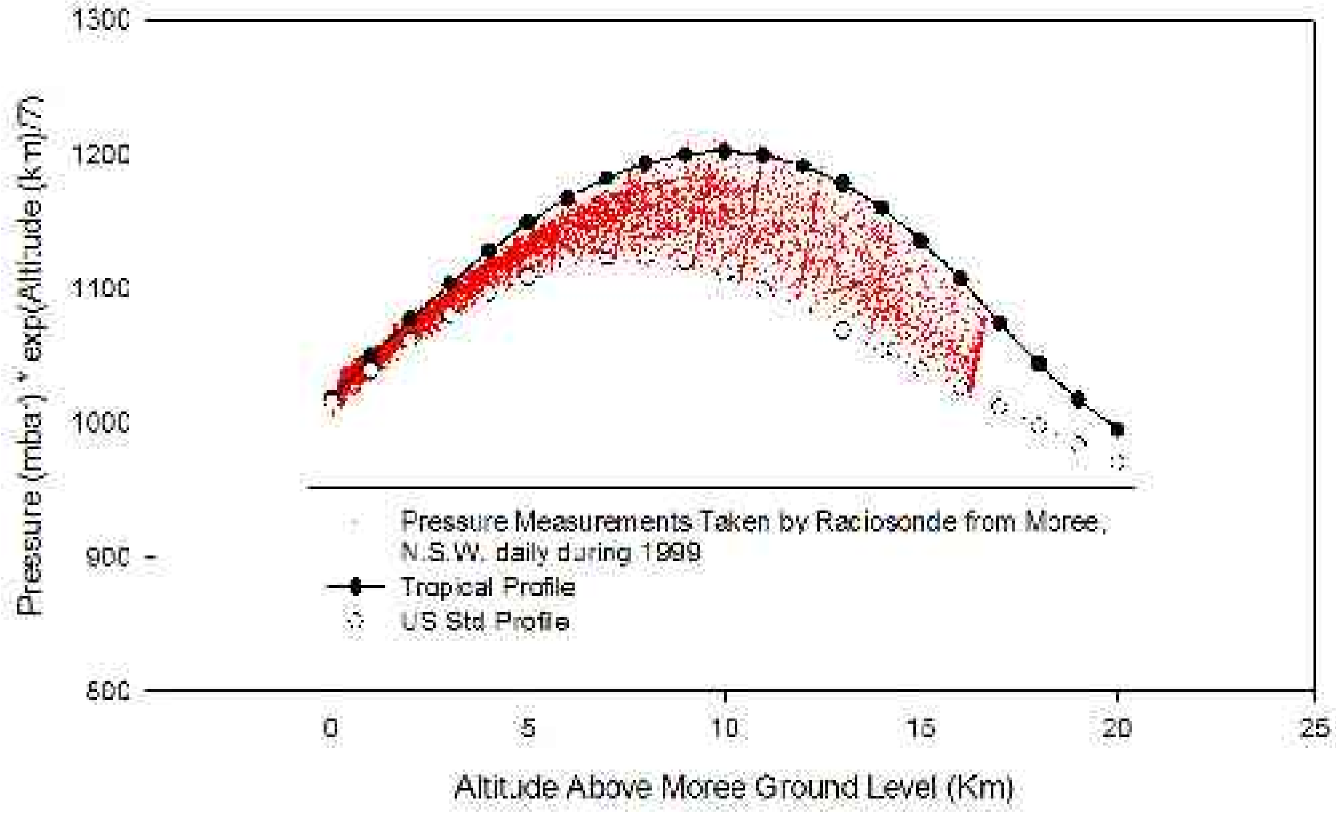


Motivations: Atmospheric profile used in Kascade

```
function gms(zgms)
c     Calulate gm/cm2 as funtion of altitude zgms(meters)

c     Palfrey's fit to the U.S. standard atmosphere.  Data is from
c     Handbook of Chemistry and Physics (70'-71') pg f148.  He uses
c     the altitude vs density data to calculate the parameters for
c     his fits.  He see 2 breaks in the density vs altitude curve
c     and breaks his algorithum up accordingly.  This is much faster
c     then the Gaisser fit and I know where it comes from.

c     Assume that the density as a function of altitude is strickly an
c     exponential.
c     Break Atm up into 3 regions.  Use data from CRC Handbook of Chemistry
c     and physics (70'-71') pg F-148.

c     Written by: #### #######
c     Purdue
c     April 1 1989
```

# Moree pressure profile: Durham Mk6 telescope

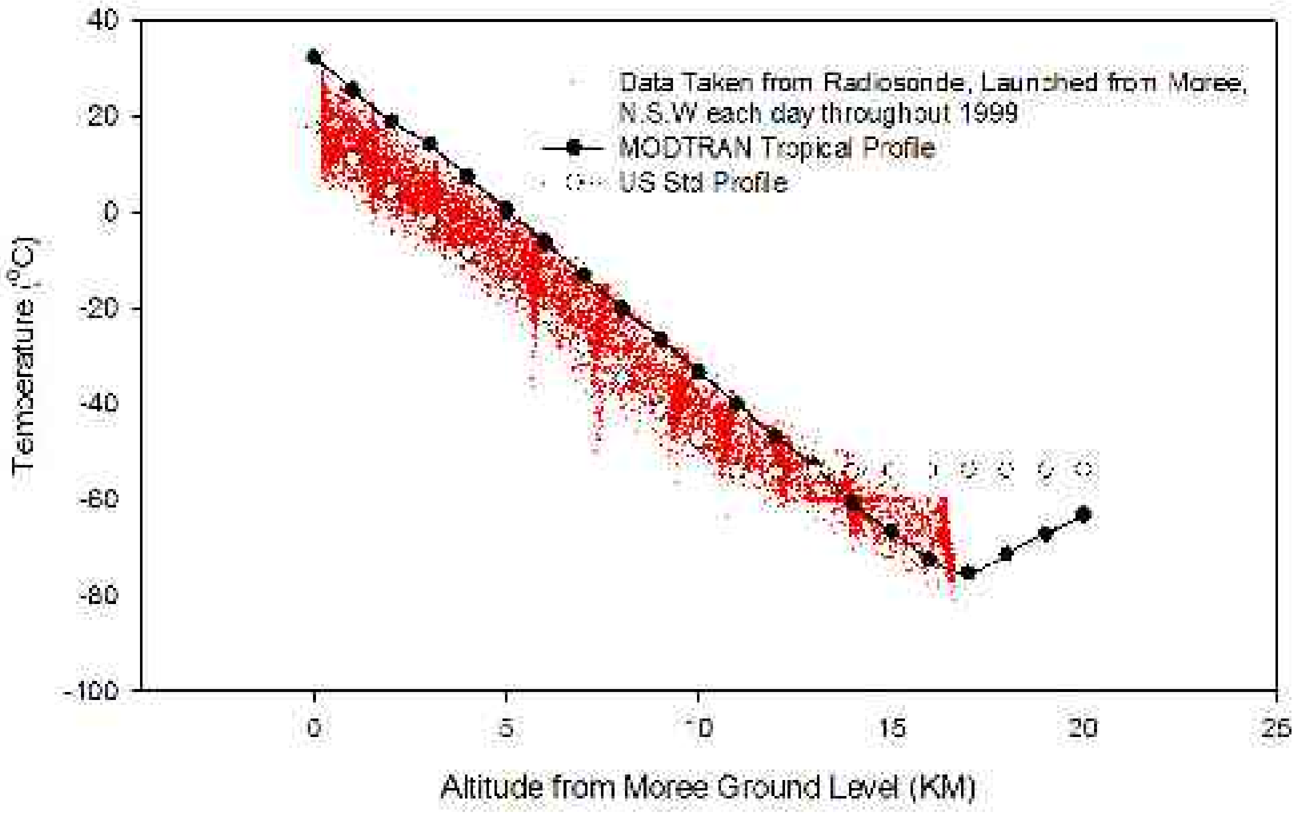
-29.48° 149.83°                    -30.32° 149.57°




Nolan, S.J. PhD Thesis (2002).

# Moree temperature profile: Durham Mk6 telescope

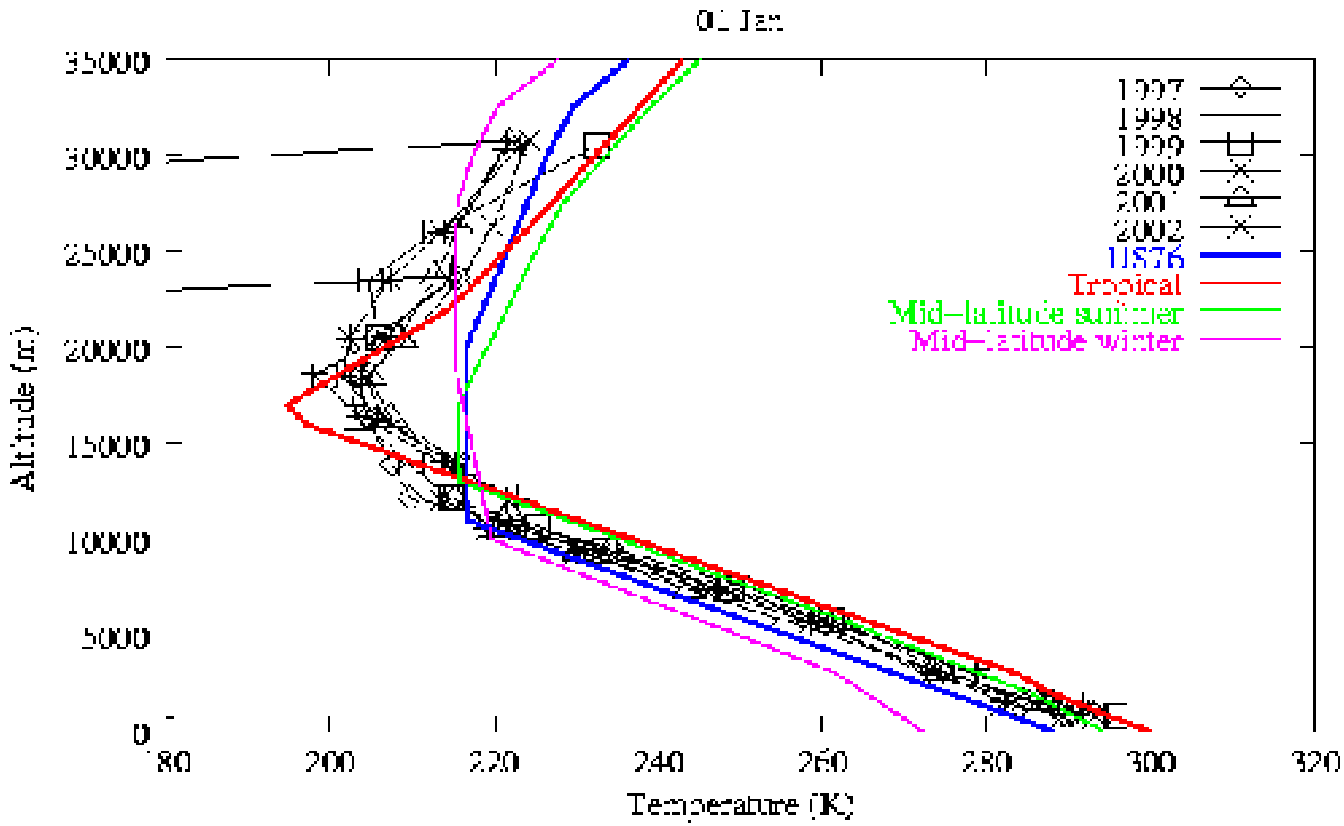
-29.48° 149.83° -30.32° 149.57°




Nolan, S.J. PhD Thesis (2002).

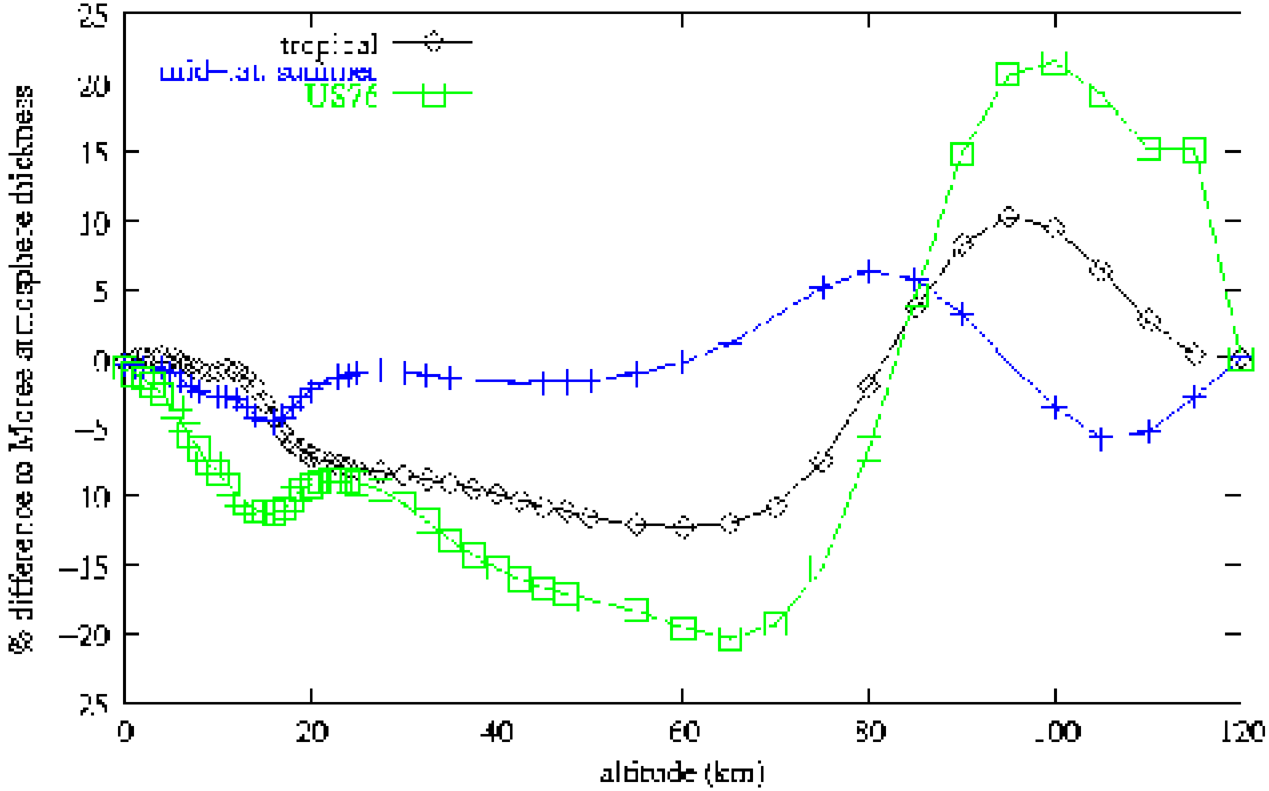
# Tucson: Whipple telescope

32.12° -110.93°     31.96° -110.95°



Australia

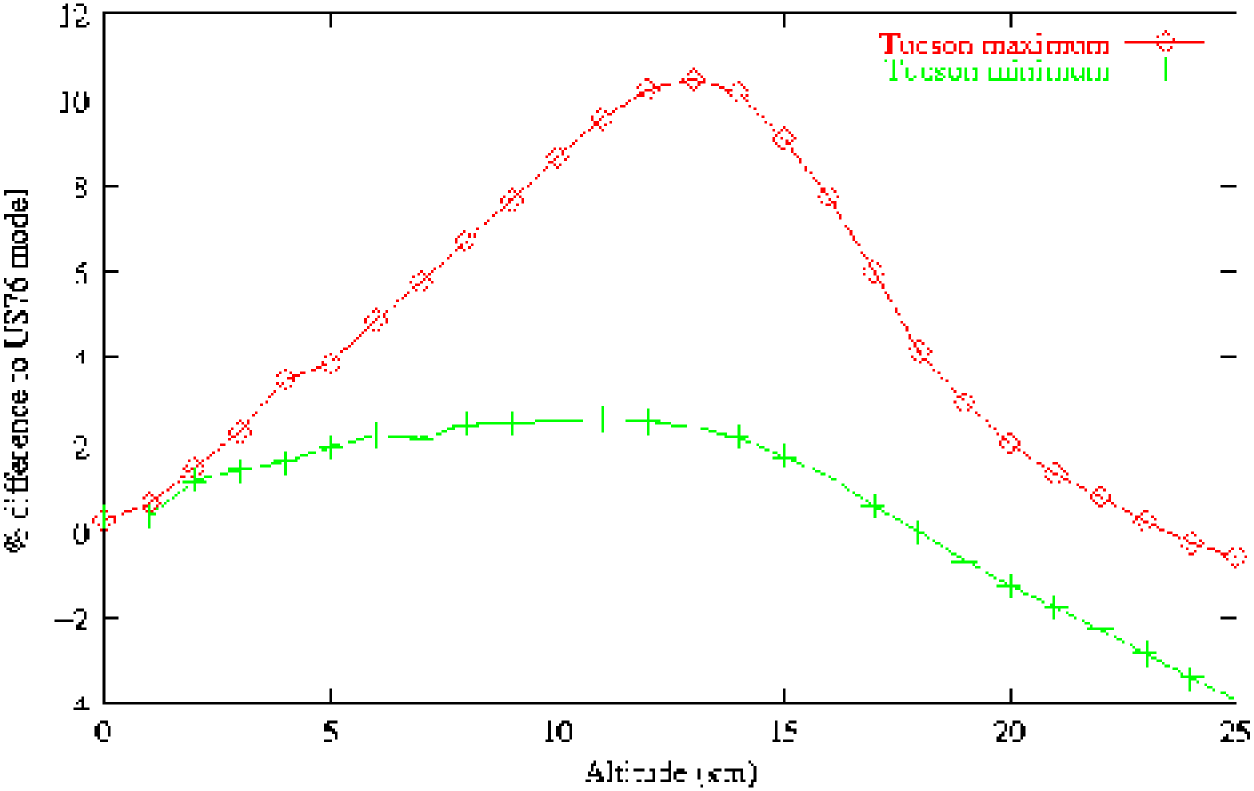
Percentage difference in inferred atmospheric thickness from model to actual data as a function of altitude.




Moree atmosphere constructed from radiosonde readings taken February 1999

Arizona

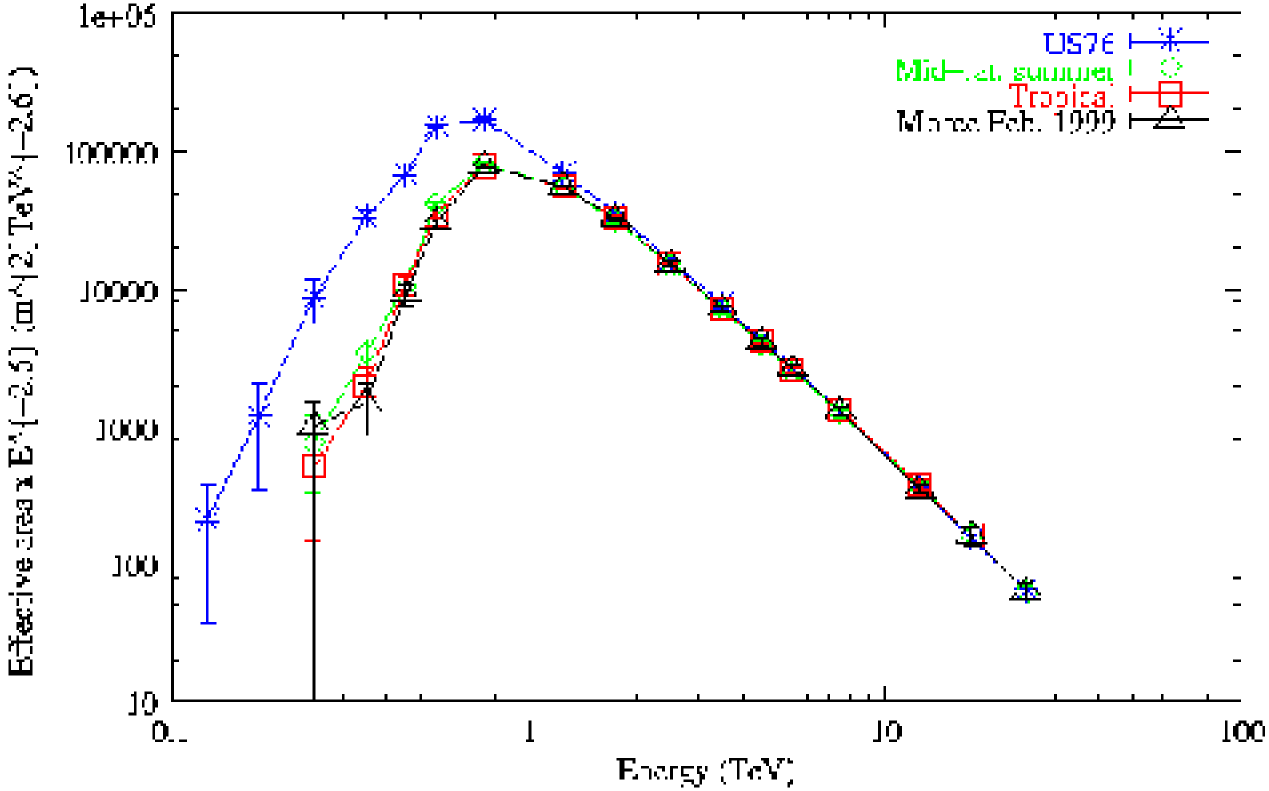
Percentage difference in inferred atmospheric thickness from US76 model to actual data as a function of altitude.




Maximum corresponds to September, minimum to April

# The impact of atmospheric model choice on effective collection for an IACT.

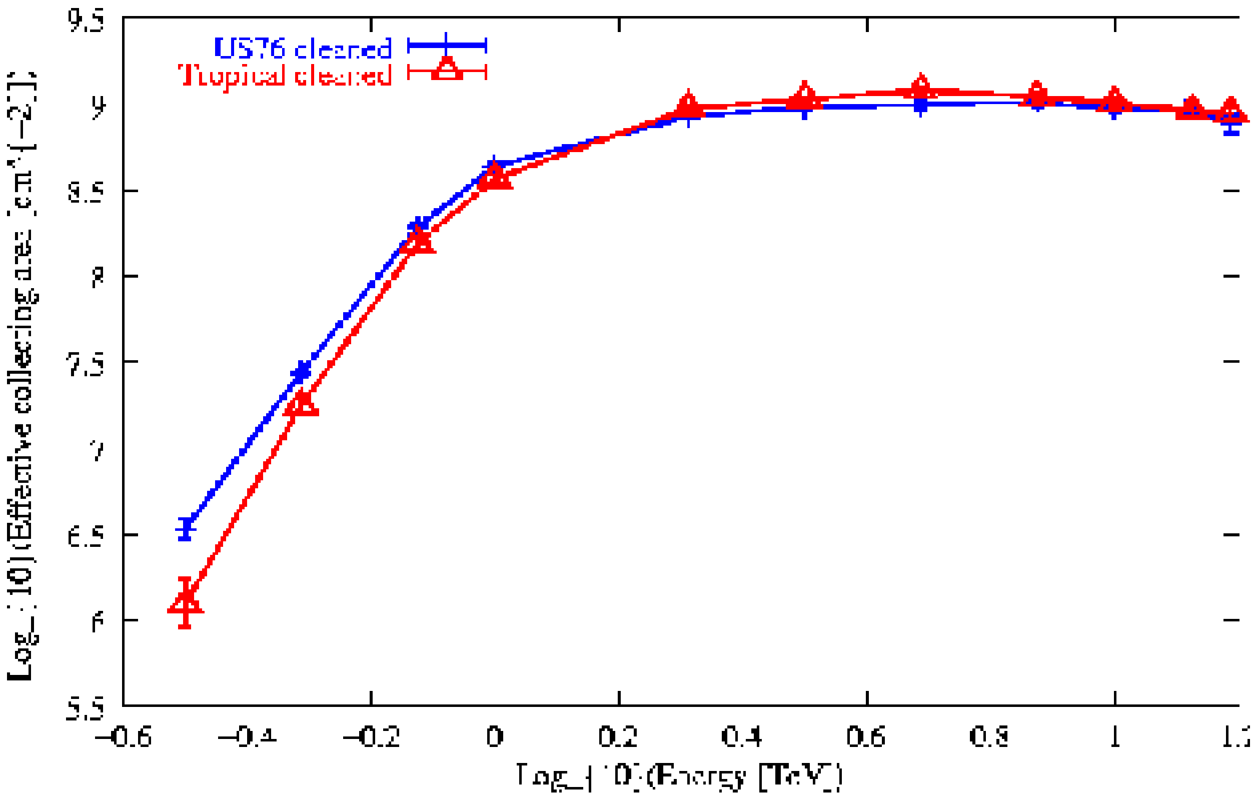
3x7m reflectors at sea level




Daniel, M.K., PhD Thesis (2002).

# The impact of atmospheric model choice on effective collection for an IACT.

For a 10m reflector at2300m altitude.



## Summary

- Simulations of atmospheric Cherenkov telescopes have traditionally employed the US Standard model atmosphere. Radiosonde data show that this model atmosphere is often an inadequate description of the atmospheric conditions.

- Whilst at high energies (> TeV) the choice of atmosphere does not yield a noticeable difference in collection area, for low energies (100's of GeV and below) there can be a large overestimation of the effective area.

- As the new generation of atmospheric Cherenkov installations wish to probe this largely unexplored low energy region of the spectrum it becomes important to have a clear idea of atmospheric conditions at the telescope site.