Atmospheric monitoring for the H.E.S.S. experiment

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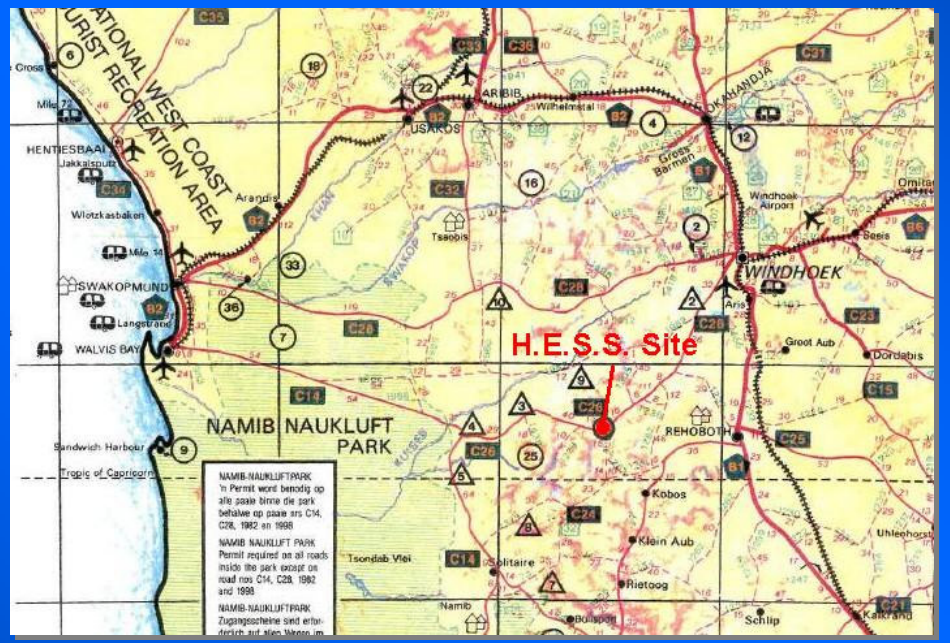
For the H.E.S.S. collaboration*

* http://www.mpi-hd.mpg.de/HESS/collaboration

The H.E.S.S. site

- A plateau in Namibia, near the Gamsberg
- Location: 23°16’18’’ S, 16°30’00’’ E, 1800m a.s.l
- Temperatures: 0 to 35°, little rain, no snow, low winds



Atmospheric monitoring instruments

- weather station
- paraxial radiometer
- scanning radiometer
- ceilometer (LIDAR)

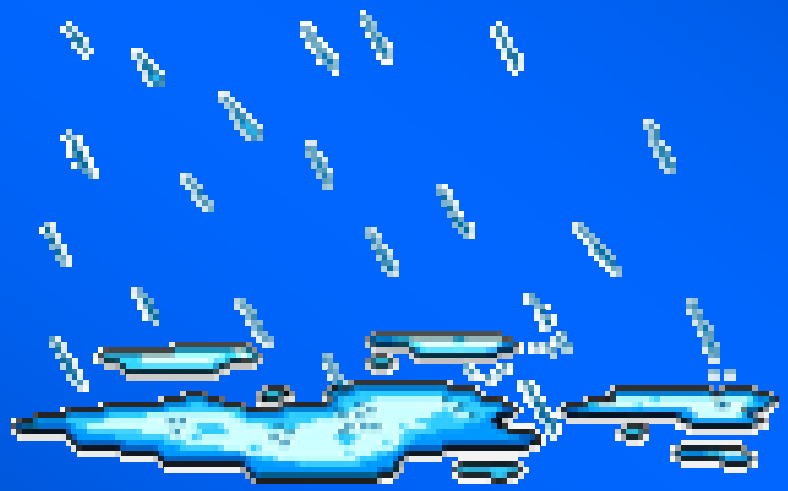
The Weather Station

Campbell Scientific weather station, using a CR510 datalogger

Data is read out every 2 seconds by the central data acquisition system (DAQ) to issue warnings quickly if needed

Measures routinely:

- temperature
- pressure
- relative humidity
- wind direction and velocity
- precipitations

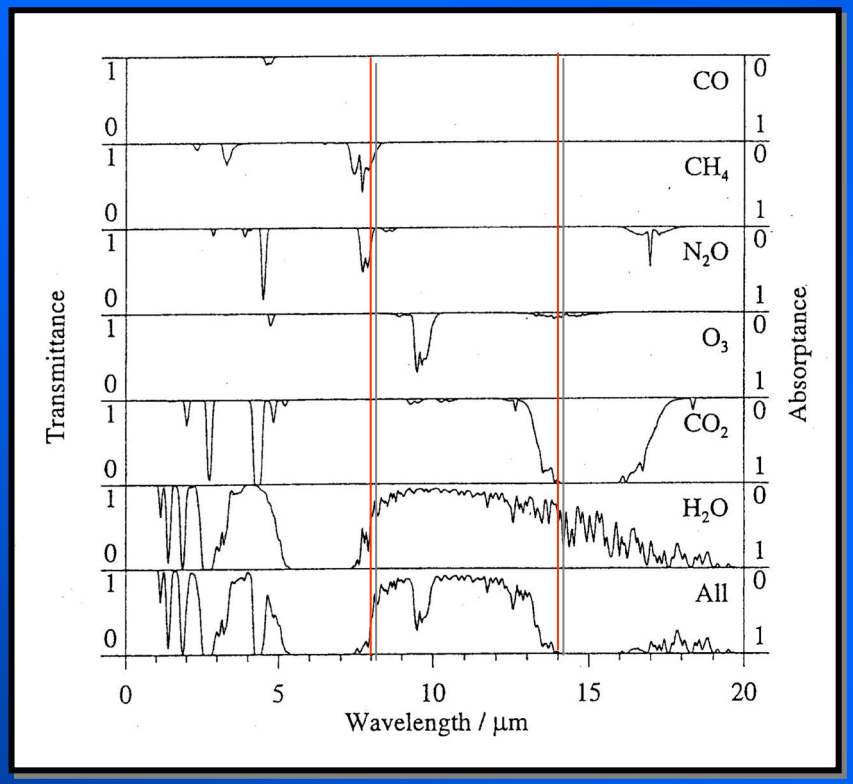


The radiometers

- Brand: Heitronics, KT19 I and II
- Sensitivity: 8-14 μm
- uses a pyroelectric element and the chopped radiation method
- Operating range down to -100° C according to manufacturer
- Field of view: 2.9°
- Control via built-in RS232 interface
- cost: ~3600 euros + taxes

Why 8-14 μm ?

- 8 and 14 μm: where the atmosphere is transparent
- Sensitive to the water vapour continuum emission



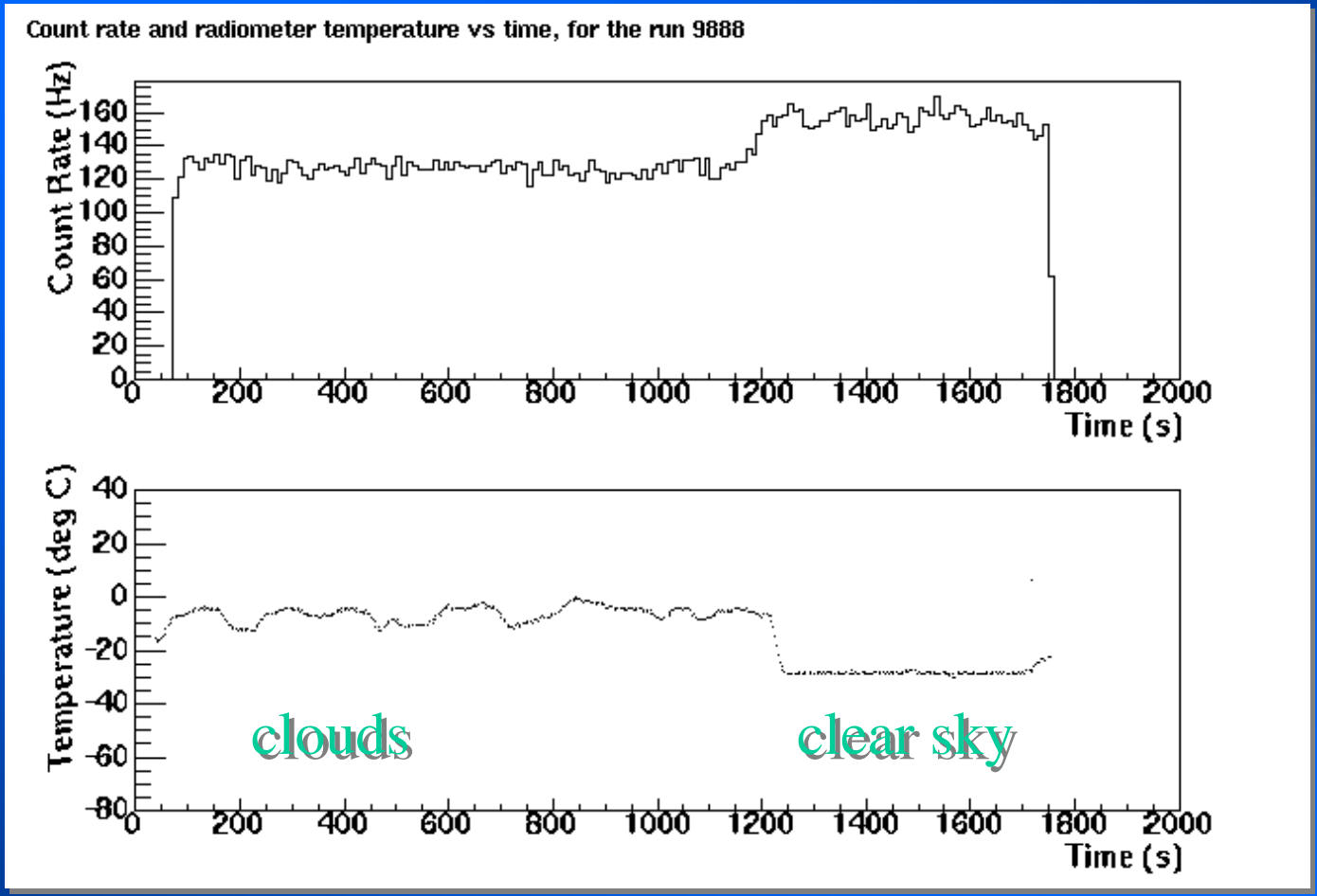
What measure does it give ?

- The radiometer is sensitive to a flux
- An in-built algorithm calculates a temperature assuming a black body spectrum, and gives it in output
- The presence of water vapour or droplets (clouds) in the atmosphere increases its emissivity, hence the measured flux and the output temperature

The paraxial radiometers

- one per telescope
- goal: to detect clouds in the field of view
- field of view of the camera: 5°
- field of view of the radiometer: 2.9°
- Data used for run selection

- Example: run with a passing cloud

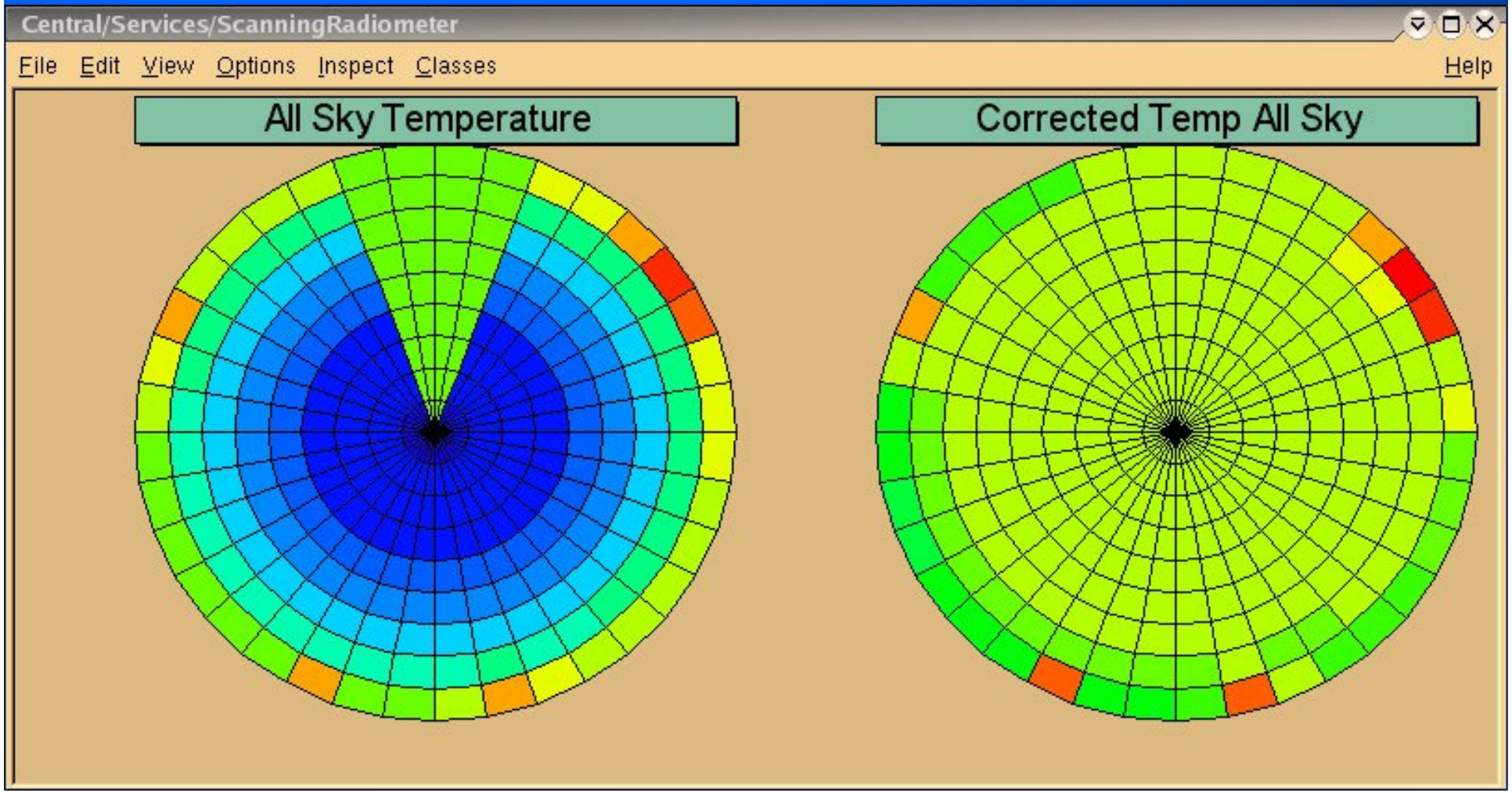


The count rate is correlated to the sky clarity.

The scanning radiometer

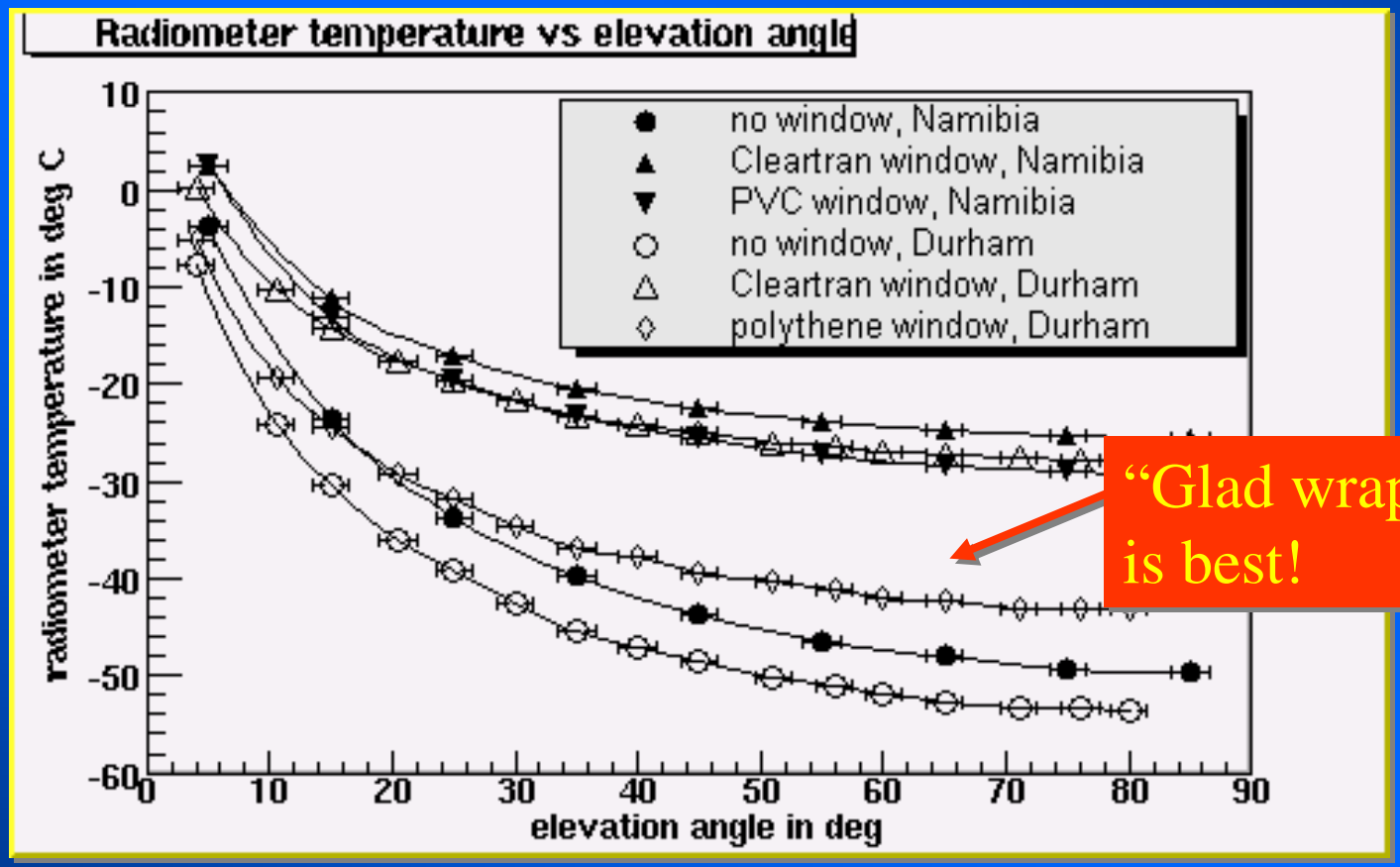
- Scans the sky all the time by steps of 10°
- Provides a useful monitoring of the cloud cover to the shift crew
- Provides a temperature profile which can be analysed to give the water vapour profile of the atmosphere
- Knowledge of this profile can be used to give an accurate calibration of the Cherenkov light absorption

Cloud monitoring for the shift crew:



Temperature profiles

And choice of the window material



"Glad wrap" is best!

Expected elevation angle dependence is more contrasted using the polythene window, the "Glad Wrap" cling film.

Study of the temperature profile

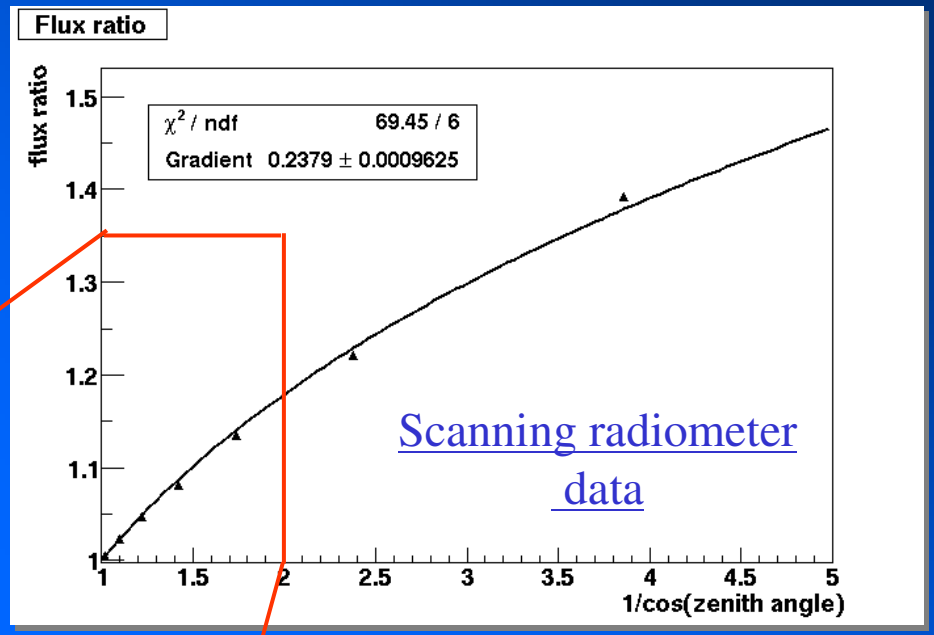
- Let us follow Michael Daniel's thesis and fit the temperature as follows:

$$\frac{F(\theta)}{F(\theta=0)} = \frac{1}{\cos^n(\theta)}$$

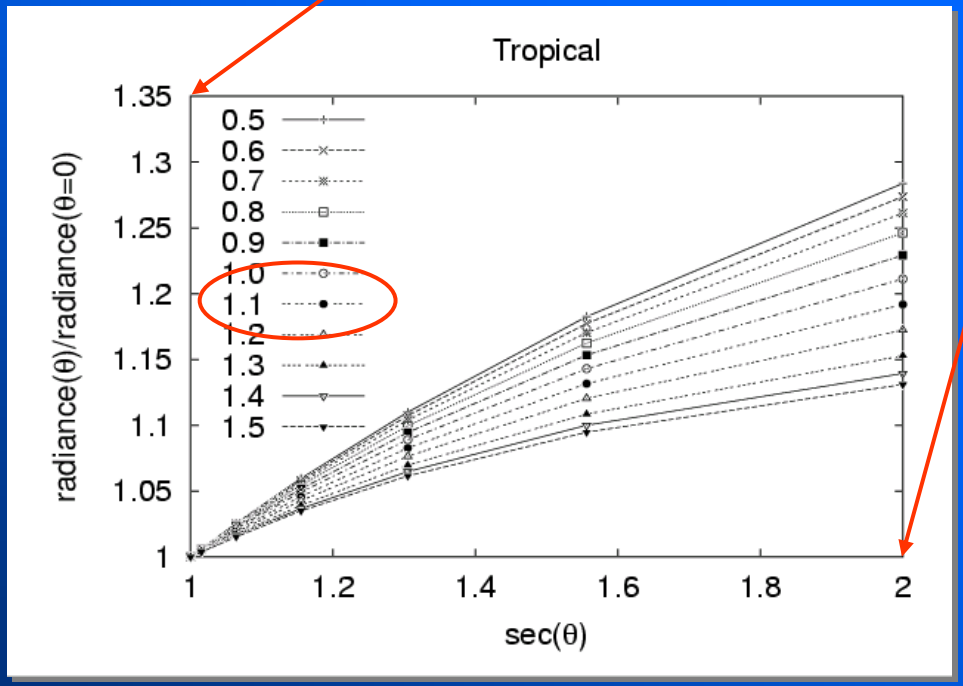
where F is the flux, and θ the zenith angle.

Example of what we can do:

$$\frac{F(\theta)}{F(\theta=0)} = \frac{1}{\cos^{n}(\theta)}$$



Scanning radiometer data



Prediction from MODTRAN, for the tropical model atmosphere and different water vapour column density scale factors. Plot from Michael Daniel's thesis.

but, before:

- Is the model atmosphere adapted to the site ?
- Redo simulation at the proper altitude
- Take into account the effect of the window material