Running CLOUDY at GSU

Getting on to the system:

1. Log on to a Linux machine and open a terminal window.
2. Create a text file for your input parameters (e.g., model.in) and type:
   cloudy < model.in > model.out
3. Cloudy will give you an output file (e.g., model.out).

Cloudy facts:
Cloudy is a photoionization code written by Gary Ferland and associates at the University of Kentucky. The version we are using is C07.02.00, which is written in C++ (earlier versions were in Fortran and C+). The web site for Cloudy and Hazy is located at: http://www.nublado.org.

Documentation:
The documentation is called Hazy and is located on our system in /usr/local/cloudy/hazy. There are four documents to look over:

1. quick_start_07_02_00.pdf: overview of code and its documentation
2. hazy1_07_02_00.pdf: complete list of commands, totally up to date
3. hazy2_c9601.pdf: physics of the simulation, badly out of date
4. hazy3_06_02.pdf: how to call Cloudy as subroutine; other details

Getting started:
To calculate a model, Cloudy needs at least the following: density, spectral energy distribution (SED), ionizing flux at the face of the cloud. Each of these can be specified in many different ways. For example, to specify the ionizing flux, one could enter the radius of the inner surface and the luminosity of the ionizing source. For the SED, there are a range of options, including blackbodies, stellar atmospheres, power-laws, user-specified, etc. There are many, many other options, including altering the abundances, terminating the calculations at a certain optical depth, etc.

To calculate a model on our system, create an input text file and use the above command. Alternatively, Cloudy can be run by typing commands individually, as shown below.

Example) Calculating a planetary nebula spectrum:

```
/usr/local/bin/cloudy > pn.txt (or use an input file like above)
title Planetary Nebula         (gives a title on the output)
radius 17                      (log of inner radius in cm)
hden 4                         (log of hydrogen density)
blackbody temp=100000 lumin=38   (temperature, log of luminosity in ergs/sec)
filling factor 0.3             (fraction of geometry that is filled)
sphere                         (diffuse radiation field allowed to interact with other side)
print last iter                (print results from last zone, 1st zone printed automatically)
<ret>
```

Note that the above calculation is for a very optically thick nebula, and terminates when the temperature reaches ~ 4000K (not much emission at this point).