
AtModWeb Documentation

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The very creatively named AtModWeb is an Atmospheric Model Web Application. It gives users a way to run data-derived (empirical) models of the neutral atmosphere with strong emphasis on the top-most layer of the atmosphere (the [thermosphere](#)).

The models currently included in AtModWeb:

1. [NRLMSISE00](#)

AtModWeb allows you to do two main things with the output of these models:

1. Make Graphs / Plots [How To Make A Plot](#)
2. Download Data [How To Download Model Results](#)

1.1 Getting Started Using AtModWeb

We designed AtModWeb to be intuitive and easy to use, but this guide will help you get started if you're stuck.

The main thing to remember is the interface is designed to be explored. If you don't understand what something does, mouse over it, or click it and see. You can always click the 'Restart' button if things go wrong.

1.2 How To Make A Plot

1.2.1 Map

This is a 2 dimensional plot, which means that the program will run the model for a grid of latitude and longitude points at a FIXED ALTITUDE. This will show you how the quantity you are investigating varies over the entire atmosphere. It will draw your data over outlines of all of the continents in, by default a [Mollweide](#) projection, which is a type of map which tries to visualize the 3D earth in a way that accurately represent relative size (remember how huge Greenland looks in some maps? It's not actually that big, that's the projection's fault).

You only have two choices when you are making a map:

1. What model output variable you want to look at (Temperature, Density, Amount of Oxygen, etc.)
2. The Altitude, in kilometers, that you want to run the model at.

Example: Say you want to investigate where on earth you would expect a spacecraft in low earth orbit to encounter the most wind resistance (A.K.A [satellite drag](#)), then you would choose your altitude to be 400 km, and your 'Color' variable to be 'dens', for the density of the atmosphere. Wherever the density was higher than average, the spacecraft would experience greater drag.

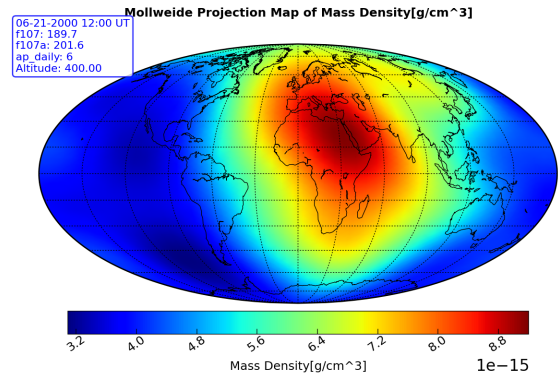


Fig. 1: Example of AtModWeb output graph for the satellite drag example, the temperature at a constant altitude of 400 km.

1.2.2 Cross-Section

A cross-section plot (sometimes called a heatmap or pseudocolor plot) is another type of 2 dimensional plot, which lets you visualize how the model result you are looking at (Temperature, Atmospheric Density, etc.) organizes in a slice of the atmosphere. This means that the program creates a grid of points at all altitudes along a line of latitude or longitude and then plots the output of the model along this slice. This lets you see trends that depend both on how high you are in the atmosphere, and where you are on the earth.

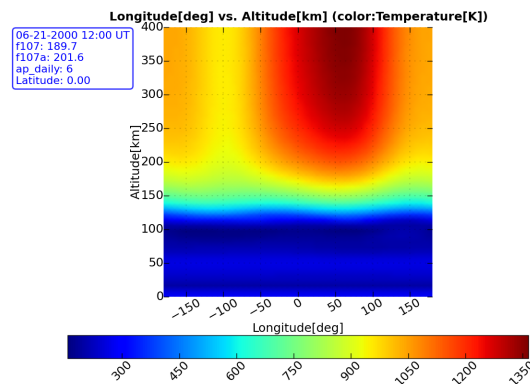


Fig. 2: An example of a cross-section plot. Note that the upper atmosphere is much hotter than the lower atmosphere, and that the equator is hotter than either of the poles. This example is for the peak of summer (solstice).

1.2.3 Line

A line plot is simply an X vs. Y plot. One of the variables, either X or Y, must be one of the locations (Altitude, Latitude, or Longitude), because it doesn't make sense to draw the line that relates temperature to density. Since you vary one of the location variables, the other two must, by definition, be fixed. For example, if you wanted to see how the atmospheric temperature changes for a balloon launched on a windless day over the University of Colorado, in Boulder you would enter 40.0274 and 105.2519 in the latitude and longitude controls, and change the Y selector to be 'Altitude', and the X variable selector to be 'Temperature', and then click 'Plot'.

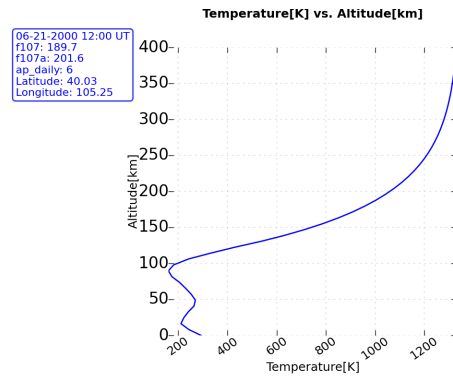


Fig. 3: An example of a line plot, showing the altitude profile of atmospheric temperature above Boulder, Colorado.

1.3 How To Download Model Results

The 'Download' button just above your plot will download all of the data that went into your plot as a comma separated value (CSV) file. The number of columns and their identity depends on what you were plotting. For example, a map plot or cross-section will have 3 columns, latitude, longitude and whatever model output variable you're visualizing. Line plots may have 2 or more columns depending on how many variables you have chosen to plot.



Fig. 4: Click the *Download* button to download a CSV file. In this case it would have 2 columns, Altitude and Temperature.

1.4 Frequently Asked Questions

1.4.1 Help! I broke the application!

If the application has stopped working properly for you (you made a plot which caused an error and now the application won't make any plots) you can click the 'Restart' button in the upper right corner of the user interface to start your session over again.

1.4.2 The application looks weird in the Safari web browser on my iPhone/iPad/Macbook

Try using the Firefox web browser. If you are using a phone, try looking at the site in 'Desktop mode'.

1.4.3 How do I plot multiple variables on a line plot?

When you have selected 'Line Plot' from the 'Type of Plot' pulldown menu, you can hold the *Shift* key and then click multiple values in the 'X' or 'Y' selection boxes.

1.4.4 How do I download my graphs?

Right-click on the graph and select 'Save as' to save the plot to your computer.

1.4.5 Who Made AtModWeb?

This application was created by, and is maintained by, a single developer at the University of Colorado, Boulder. I made this tool to give community college students interested in space sciences a way to experiment with models of the upper atmosphere. However, it can be used by anyone and I hope that it will.

1.5 Models Available in AtModWeb

1.5.1 NRLMSISE00

This version of the venerable mass-spectrometer and incoherent scatter radar model also incorporates mass density data derived from drag measurements and orbit determination. It includes the same database as the Jacchia family of models, and has been seen to outperform both the older MSIS90 and the ubiquitous Jacchia-70. Its purpose is to specify the mass-density, temperature and neutral species composition from the ground to the bottom of the exosphere (around 1400km altitude). It provides number densities for the major neutral atmosphere constituents: atomic and molecular nitrogen and oxygen, argon, helium and hydrogen. Additionally it includes a species referred to as anomalous oxygen which includes O⁺ ion and hot atomic oxygen, which was added to model these species' significant contributions to satellite drag at high latitude and altitude, primarily during the summer months [picone]. The model inputs are the location, date, and time of day, along with the 10.7 cm solar radio flux (F10.7) and the AP planetary activity index.

Variables Available for MSIS:

- Temperature - the temperature of atmosphere in Kelvin
- mass - mass density of the atmosphere in g/cm³
- HE - number density of helium in molecules/cm³
- O - number density of atomic oxygen in molecules/cm³
- N2 - number density of molecular nitrogen in molecules/cm³
- O2 - number density of molecular oxygen in molecules/cm³
- AR - number density of argon in molecules/cm³
- H - number density of atomic hydrogen in molecules/cm³
- N - number density of atomic nitrogen in molecules/cm³
- AO - number density of 'Anomalous Oxygen' in molecules/cm³
- T_{exo} - the temperature at the exobase (the highest altitude / top boundary of the model)

Technical Notes on Input Variables

- UT, Local Time, and Longitude are used independently in the model and are not of equal importance for every situation. For the most physically realistic calculation these three variables should be consistent (SLT=SEC/3600+GLONG/15). The Equation of Time departures from the above formula for apparent local time can be included if available but are of minor importance.
- F107 and F107A values used to generate the model correspond to the 10.7 cm radio flux at the actual distance of the Earth from the Sun rather than the radio flux at 1 AU. The following site provides both classes of values: [NOAA NGDC/NCEI FTP](#)

References

Picone, J. M., Hedin, A. E., Drob, D. P., and Aikin, A. C., NRLMSISE-00 empirical model of the atmosphere: Statistical comparisons and scientific issues, J. Geophys. Res., 107(A12), 1468, doi:10.1029/2002JA009430 , 2002

1.6 For Developers

AtModWeb used the atmodbackend module of the QT version of this GUI, AtModExplorer

CHAPTER 2

Indices and tables

- `genindex`
- `modindex`
- `search`