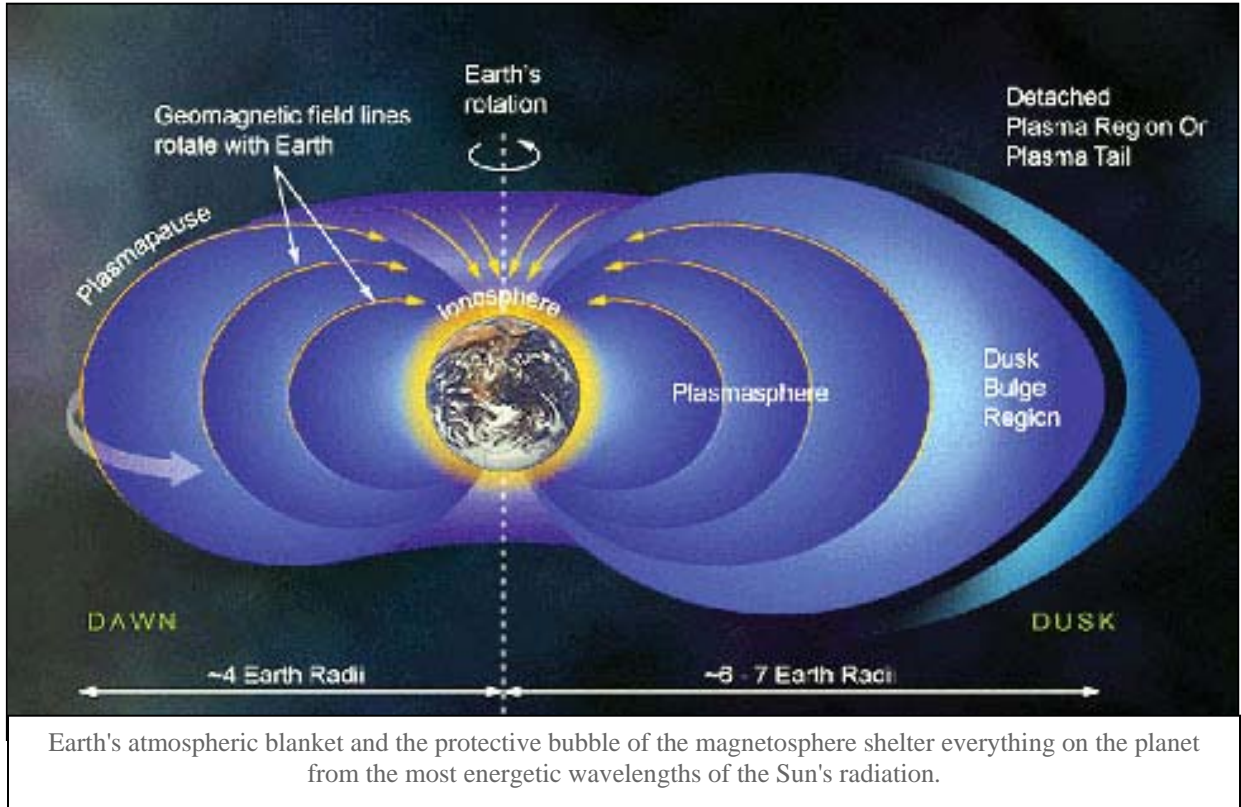


The Collection and Analysis of Atmospheric Science Data

The following can be found on the Haystack website:

<http://www.haystack.mit.edu/atm/index.html>



From the Haystack website: Haystack Observatory's Atmospheric Sciences Group studies all levels of the atmosphere using [Incoherent Scatter Radar \(ISR\)](#) and [distributed arrays of radiowave](#) instruments such as [Global Positioning System \(GPS\)](#) receivers.

For more than forty years the group has been operating and collecting ionospheric measurements spanning a range of latitudes covering most of Eastern North America. Most of these measurements are available from the [Madrigal Database](#).

The ISR's extensive field of view for ionospheric observations encompasses the full extent of mid-latitude, sub-auroral and auroral features and processes. The unique location of Millstone Hill near the Earth's plasmapause, combined with the wide reach of the Millstone Hill steerable antenna, have made it a premier facility for mid-latitude ionospheric research, magnetospheric studies and thermospheric measurements. In addition to improving our fundamental understanding of the near-Earth environment, this research has immediate relevance to the welfare of people and our technological society since it contributes to the development of improved space weather alerts and storm predictions.

After reading the description, liberally sprinkled with scientific jargon, you may be wondering, "But how do we get the data?"

Accessing the Space Weather Data

First of all, it states, "Most of these measurements are available from the Madrigal Database." What is Madrigal?

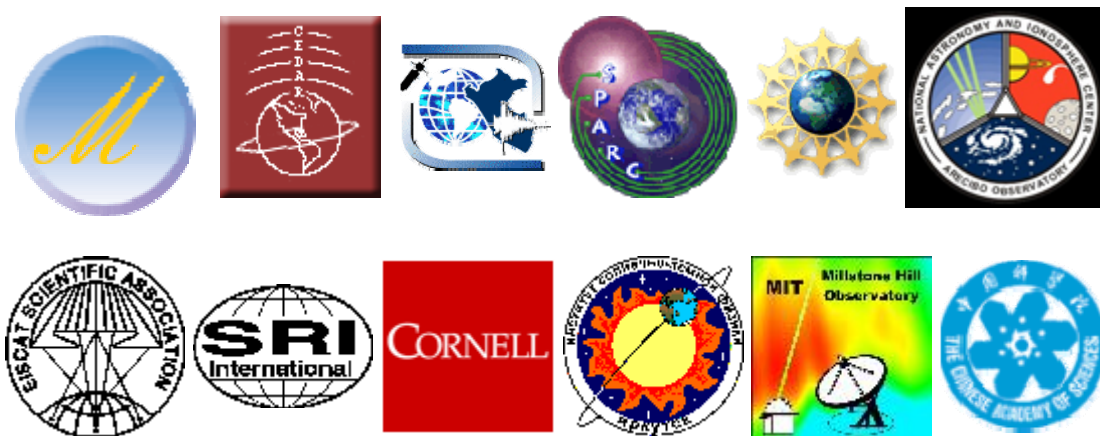
The following website describes Madrigal:

<http://madrigal.haystack.mit.edu/madrigal/>

Welcome to the Madrigal Database at Haystack Observatory

Madrigal is an upper atmospheric science database used by groups throughout the world. Madrigal is a robust, World Wide Web based system capable of managing and serving archival and real-time data, in a variety of formats, from a wide range of upper atmospheric science instruments. The basic data format is the same as that used by the National Science Foundation supported Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) program, which maintains a CEDAR Database at the National Center for Atmospheric Research (NCAR). Data files are easily exchanged between the two sites, but Madrigal has a significantly different emphasis. Data at each Madrigal site is locally controlled and can be updated at any time, but shared metadata between Madrigal sites allow searching of all Madrigal sites at once.

Data can be accessed from the Madrigal sites at Millstone Hill, USA, Arecibo, Puerto Rico, EISCAT, Norway, SRI International, USA, Cornell University, USA, Jicamarca, Peru, The Institute of Solar-Terrestrial Physics, Russia, and Wuhan Ionospheric Observatory, the Chinese Academy of Sciences. And directly, using APIs which are available for several popular programming languages. A CVS archive of all Madrigal software and documentation is available from the Open Madrigal Web site. The latest version of Madrigal may also be downloaded from there.



Instructions to use Madrigal are given so that researchers can access the international upper atmospheric database. And there are a plethora of parameters to cover almost **any** situation **any** researcher through the world would want. Things like:

- The specific instrument,
- The different kinds of data available,
- The specific time span (e.g. year, month, day, hour, minute, etc.),
- The specific measurements needed,
- The type of restrictions on the instrument, and
- The data filters required. For example, an altitude greater than 275 km and less than 325 km.

Our Data Set

The Madrigal data we used contained a restricted set of parameters so that data would be easier to analyze and to glean the important information from it.

- We used only the Millstone Hill IS Radar.
- We looked at only the altitude centering around 300 km, from 275 km to 325 km.
- Our radar angle was directly overhead, from 85 to 90 degrees.
- Except for the 24 hour runs, we used data that was taken around noon, from 11 AM to 1 PM
- The measurements we examined were the
 - ❖ The electron temperature in K, T_e ,
 - ❖ The ion temperature in K, T_I , and
 - ❖ The log of the electron density, N_{EL} .

In spite of the fact that we used a limited set of parameters, the data we received from Madrigal was far from ideal. For example, some of the data was bad or missing. Or sometimes we had multiple readings over a small time spans. We carefully examined all the data and fixed it up when we could or else eliminated it. Then we categorized it into more useful time blocks.

It is important to remember this when you access our space weather data files. **The scientific data is not as pretty as it seems!** And this is often true about other scientific data sets.

