

# How to use the Madrigal database for atmospheric science

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# Outline

- What is Madrigal?
- How is Madrigal different from an ftp site?
- How do I use Madrigal?
  - The website
  - Script data access
- What's new with Madrigal?

# What is Madrigal?

Open-source, standard-based local databases that share metadata



Madrigal is a **Science** database.

# The Madrigal database stores data from a wide variety of upper atmosphere research instruments in the Cedar database format.

Incoherent Scatter Radar



TEC via GPS

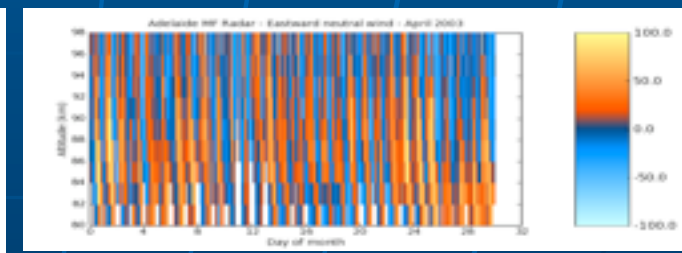
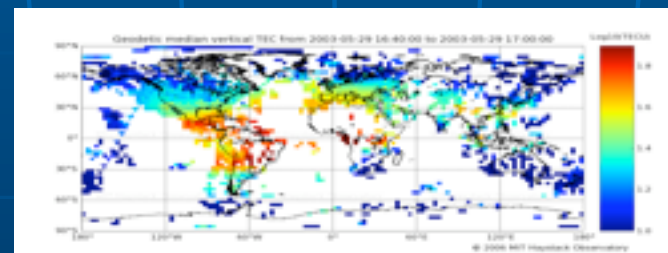
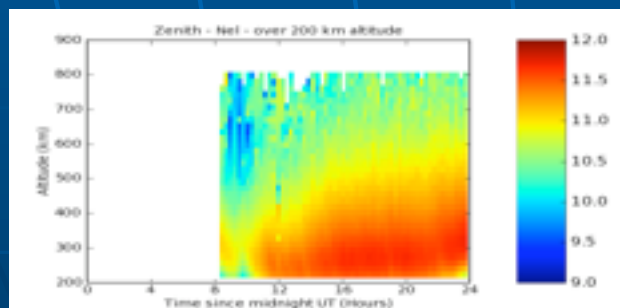


MF Radar



Cedar database format

Loading programs can be written in Python, C, or Tcl



Other instrument types in Madrigal: Meteor radar, Digisonde, Fabry-Perot, Geophysical indices

# Madrigal is open-source

**The Open Madrigal Initiative**

[MIT Haystack Observatory](#), home of the [Millstone Hill](#) Incoherent Scatter Radar, has supported an on-line incoherent scatter database since 1980. This early database evolved into both the [CEDAR Database](#) at the National Center for Atmospheric Research (NCAR) and the Madrigal Database at Millstone Hill. The CEDAR and Madrigal Databases have very different user interfaces and capabilities, but use the same basic data format, and data files are easily exchanged between the two systems.

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 instruments. Data can be accessed from the Madrigal sites at [Millstone Hill, USA](#), [EISCAT](#), Norway, [SRI International](#), USA, [Arecibo](#), Puerto Rico, [Cornell University](#), USA, [Jicamarca](#), Peru, [The Institute of Solar-Terrestrial Physics](#), Russia, and Wuhan Ionospheric Observatory, the Chinese Academy of Science., using standard Web browsers; and directly, using APIs which are available for several popular programming languages.

The distributed Madrigal Database has been recognized by a Sun Microsystems Academic Excellence Award which included the Haystack Observatory server which hosts the Open Madrigal project.

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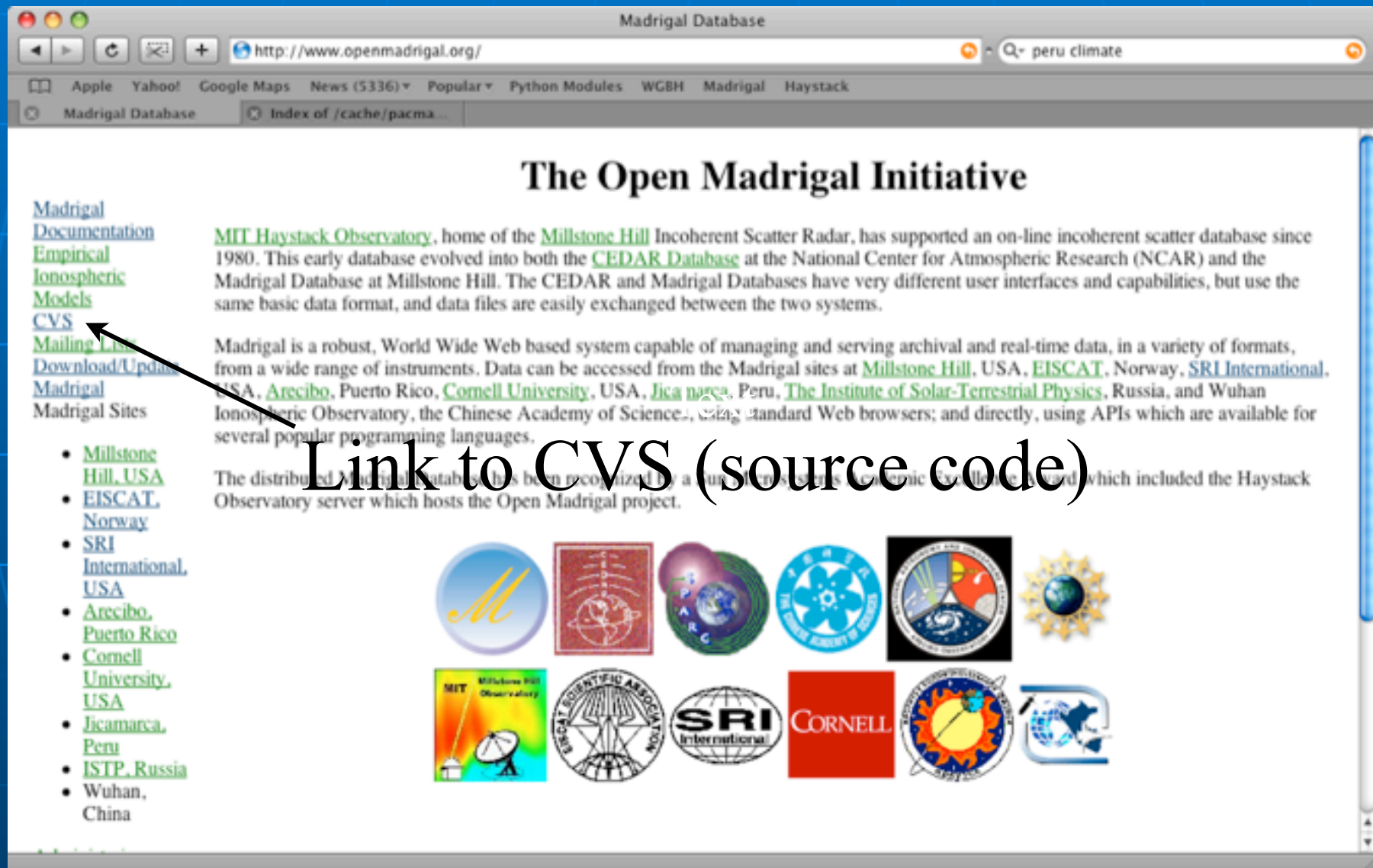
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**Madrigal**  
[Documentation](#)  
[Empirical](#)  
[Ionospheric](#)  
[Models](#)  
[CVS](#)  
[Mailing Lists](#)  
[Download/Update](#)  
[Madrigal](#)  
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[www.openmadrigal.org](http://www.openmadrigal.org)

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**Link to CVS (source code)**

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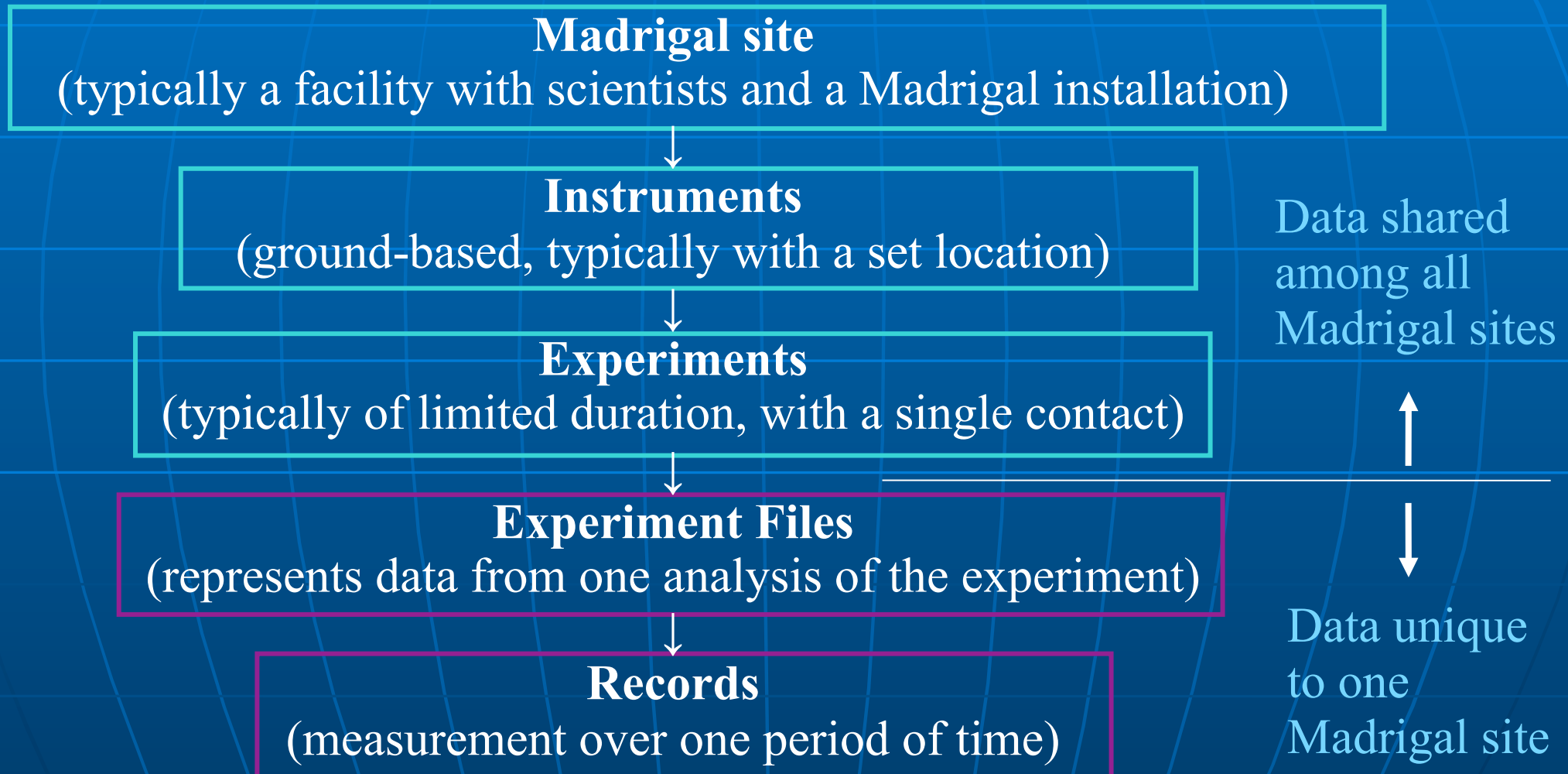
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# Madrigal Data Model



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- Engine determines all parameters that can be derived
- Easy to add new derived parameters using code written in C or Fortran

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- Models
  - Examples: MSIS, IRI

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# Example data search problem

- Find out how well the a model compares with measured data depending on geophysical conditions.

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- Write analysis code

# Madrigal approach



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- Use script `globalIsprint.py` - done

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- Use script `globalIsprint.py` - done
- Use global search web interface - done

# How can the Madrigal database be accessed?



User



Web interface

Web services API

- From anywhere on internet
- Python API
- Matlab API
- IDL API
- Other could be written

# Live demo of Madrigal web page

- Start at any Madrigal server (e.g., <http://isr.sri.com/madrigal>)

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- More APIs available on request or via contribution

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- Not based on SOAP or XmlRpc since no support in languages such as Matlab
- CGI arguments and output fully documented at <http://www.haystack.edu/madrigal/remoteAPIs.html>

# Simple Python example

```
# create the main object to get all needed info from Madrigal
madrigoalUrl = "http://www.haystack.mit.edu/madrigoal"
testData = madrigalWeb.madrigoalWeb.MadrigoalData(madrigoalUrl)

# get all MLH experiments in 1998
expList = testData.getExperiments(30, 1998, 1, 1, 0, 0, 0, 1998,
                                   12, 31, 23, 59, 59)

for exp in expList:
    # print out all experiments
    print exp

# print list of all files in first experiment
fileList = testData.getExperimentFiles(expList[0].id)
    for thisfile in fileList:
        print thisfile
```

# Python Remote API

- Can run on any platform with python (PC, Unix, Mac, etc)
- Fully documented with examples
- See <http://madrigal.haystack.edu/madrigal/remotePythonAPI.html> for documentation, more examples, and source



# Live Python API demo

- See `demoMadrigalWebServices.py` at [http://www.haystack.mit.edu/cgi-bin/madrigal\\_viewcvs.cgi/madroot/source/madpy/madrigalWeb/examples/](http://www.haystack.mit.edu/cgi-bin/madrigal_viewcvs.cgi/madroot/source/madpy/madrigalWeb/examples/)

# Matlab Remote API

## ■ Methods

- getInstrumentsWeb
- getExperimentsWeb
- getExperimentFilesWeb
- getParametersWeb
- isprintWeb
- madDownloadFile
- madCalculatorWeb
- globalIsprint

## ■ Methods match Madrigal model

# Simple Matlab example

```
filename = '/usr/local/madroot/experiments
           /2003/tro/05jun03/NCAR_2003-06-05_tau2pl_60_uhf.bin';

eiscat_cgi_url = 'http://www.eiscat.se/madrigal/cgi-bin/';

% download the following parameters from the above file: ut, gdalt, ti

parms = 'ut,gdalt,ti';

filterStr = 'filter=gdalt,200,600 filter=ti,0,5000';

% returns a three dimensional array of double with the dimensions:
%
% [Number of rows, number of parameters requested, number of records]
%
% If error or no data returned, will return error explanation string instead.
data = isprintWeb(eiscat_cgi_url, filename, parms, filterStr);
```

**Matlab  
Madrigal  
API call**



# Simple Matlab example, continued

- See <http://madrigal.haystack.edu/madrigal/remoteMatlabAPI.html> for complete documentation and more examples

# Live Matlab API demo

- See `demoMadrigalWebServices.m` at [http://www.haystack.mit.edu/cgi-bin/madrigal\\_viewcvs.cgi/madroot/source/madmatlab/](http://www.haystack.mit.edu/cgi-bin/madrigal_viewcvs.cgi/madroot/source/madmatlab/)

# IDL Remote API

- Methods
  - madGetAllInstruments
  - madGetExperiments
  - madGetExperimentFiles
  - madGetExperimentFileParameters
  - madSimplePrint
  - madPrint
  - madDownloadFile
  - madCalculator
  - madGlobalPrint
- Methods again match Madrigal model
- Just added in July 2010

# Madrigal application global sprint.\*

- Installed with all three remote API's.
- More robust than global search web UI.
  - Data stored locally
  - Error messages on local terminal
- Documented under Documentation-> Command line interface and in API doc.

# globalsprint example

- Poker Flat
- March 10-20, 2007
- Alternating code (File kindat 5951)
- Kp above 4
- Alt between 240 and 260 and
- Ne > 2e11



# Example command line (python version)

```
./globalSprint.py \  
--url=http://isr.sri.com/madrigal \  
--parms=year,month,day,hour,min,sec,elm,azm,gdalt,gdlat,glon,kp,ne,te,ti \  
--output=demo.txt \  
--user_fullname="Bill Rideout" \  
--user_email=brideout@haystack.mit.edu \  
--user_affiliation=MIT \  
--startDate=02/01/2007 --endDate=02/28/2007 \  
--inst="Poker*" \  
--kindat=5951 \  
--filter=ap3,15, \  
--filter=gdalt,240,260 \  
--filter=ne,2e11, \  
--filter=te,1000, \  
--verbose
```

# Extending/contributing to Madrigal

- Madrigal is completely open source
- See [www.openmadrigal.org](http://www.openmadrigal.org) for CVS
- All new code is Python or C. Imported derivation methods sometimes in Fortran.
- I appreciate all contributions
  - Suggestions and ideas
  - Finding bugs
  - Code

# Madrigal hands-on exercises

- Fully described on wiki at [http://www.haystack.mit.edu/cgi-bin/asg\\_science/science.cgi/Using\\_Madrigal\\_practically\\_and\\_productively](http://www.haystack.mit.edu/cgi-bin/asg_science/science.cgi/Using_Madrigal_practically_and_productively)
- Web practice
- Script practice using python, Matlab, or IDL