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 coming soon 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.

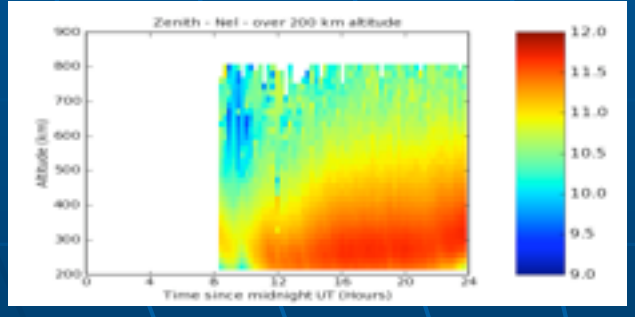
Incoherent Scatter Radar

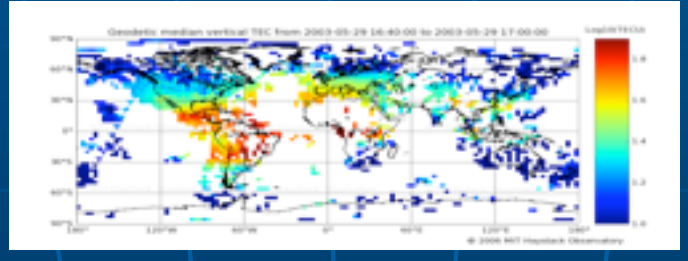
TEC via GPS

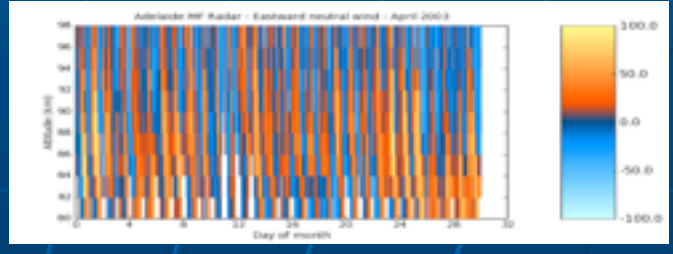
MF Radar

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

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- File format defined in
  - http://cedarweb.hao.ucar.edu/cgi-bin/cedar_file_access.pl?filename=documents/cedar_fmt.pdf

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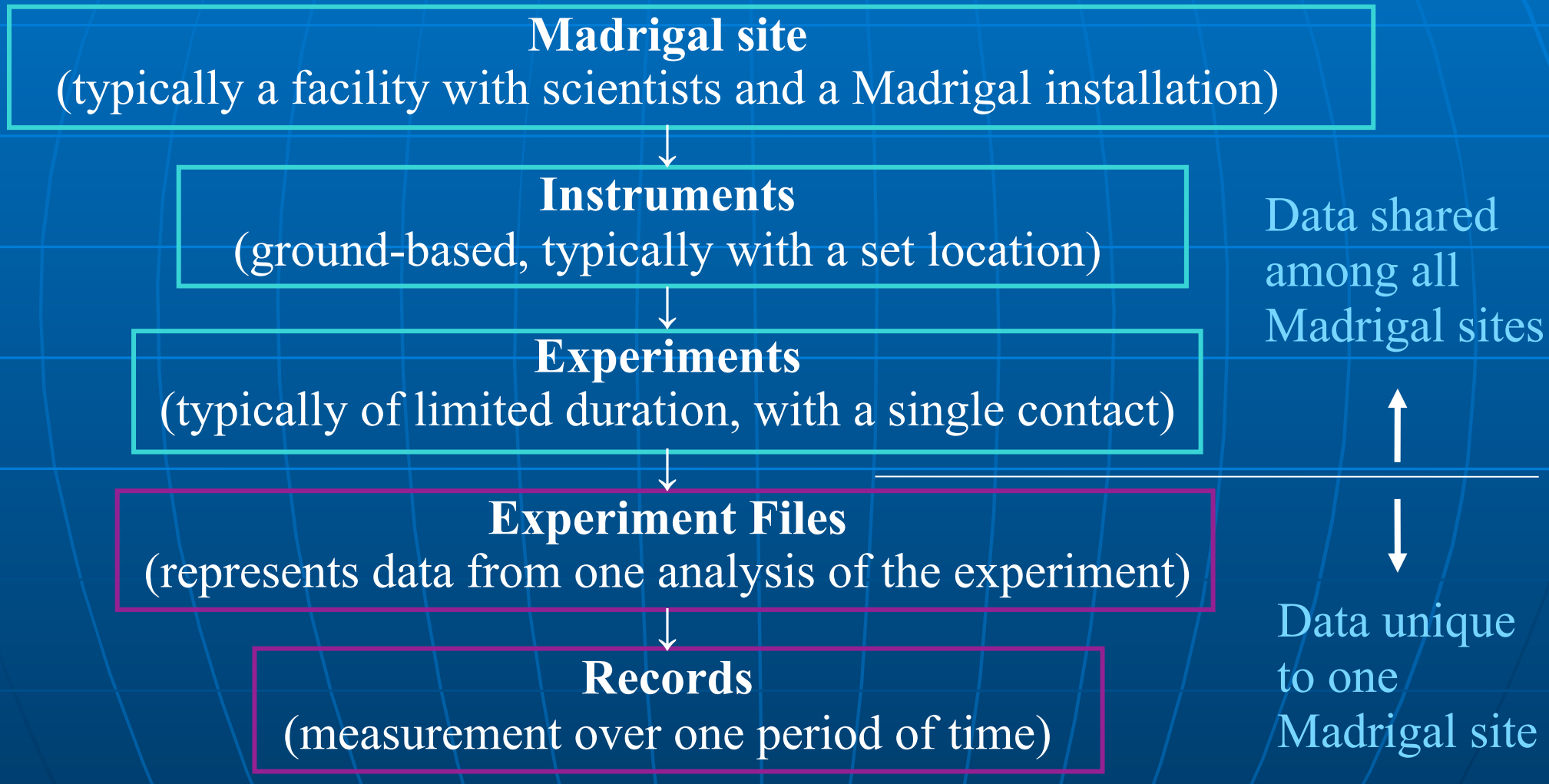
Madrigal Data Model



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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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- 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
madrigalUrl = "http://www.haystack.mit.edu/madrigal"
testData = madrigalWeb.madrigalWeb.MadrigalData(madrigalUrl)

# 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/

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/

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 globallsprint.*

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

globallsprint 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)

```
./globalIsprint.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
```

What's coming soon for Madrigal?

- NSF funded development
  - Release 2.6
  - Release 3.0
- Open source development with Jicamarca

NSF funded development for next release

- Transition of CEDAR database to Madrigal platform
  - Ability of Madrigal to automatically import data from other Madrigal sites
  - Importing of existing non-Madrigal data into Madrigal
- Ability to extend Madrigal with external hard drives

Next release development, continued

- Work with Jicamarca to integrate new UI into Madrigal
- Export HDF5 format
- FTP like interface added?
- Users can register interest in experiment
- Experiment PI, analyst now shared metadata
- IDL API added to Matlab, python

Following release (Madrigal 3.0)

- Conversion of CEDAR format to CEDAR HDF5/NetCDF4 format
  - Parameter definitions/data model unchanged
  - Each file will be self-describing
  - No more scale factors, integer storage
  - No more duplicate parameters with different ranges
  - Madrigal derivation engine will interface with it

Madrigal 3.0 continued

- Conversion of CEDAR format to CEDAR HDF5/NetCDF4 format
  - Conversion will be automatic using script
  - To create new CEDAR format
    - Create file old way, run convert script
    - Using python API, change one line of code
- Community standard
  - Interface to download latest standard, request new parameters

Open source development with Jicamarca

- Project is one of 3 based on Oct 2010 meeting
- Development of
  - New simple web UI
  - Export HDF5 format
- Modern open source project
  - Shared access to source control (Subversion)
- Millstone responsible for final testing, release, support

Extending/contributing to Madrigal

- Madrigal is completely open source
- See 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
- Web practice
- Script practice using python, Matlab, or IDL