

How to use the Madrigal database for atmospheric science

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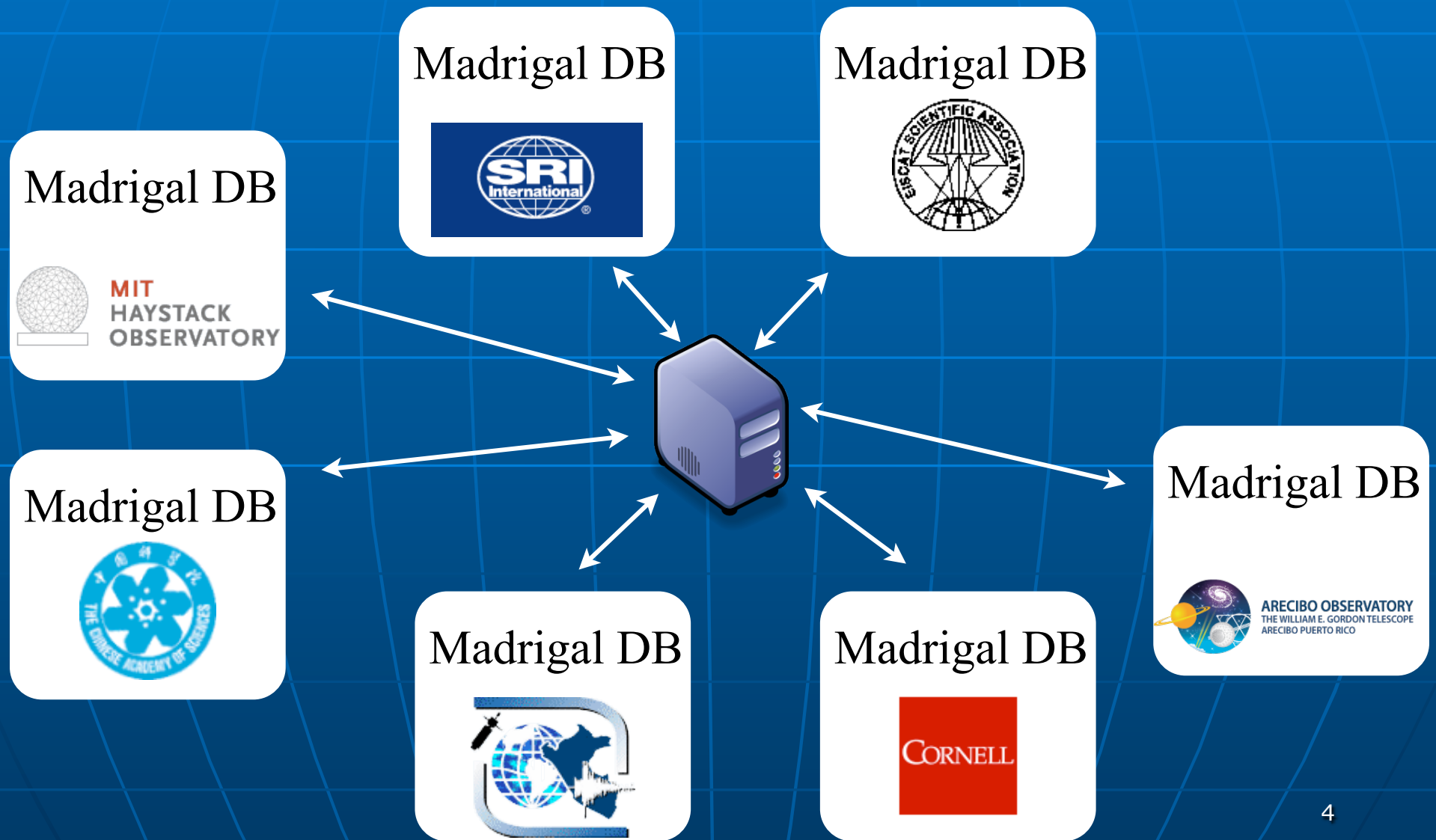
ISR workshop
Banff, Alberta, Canada
July 30, 2012

Outline

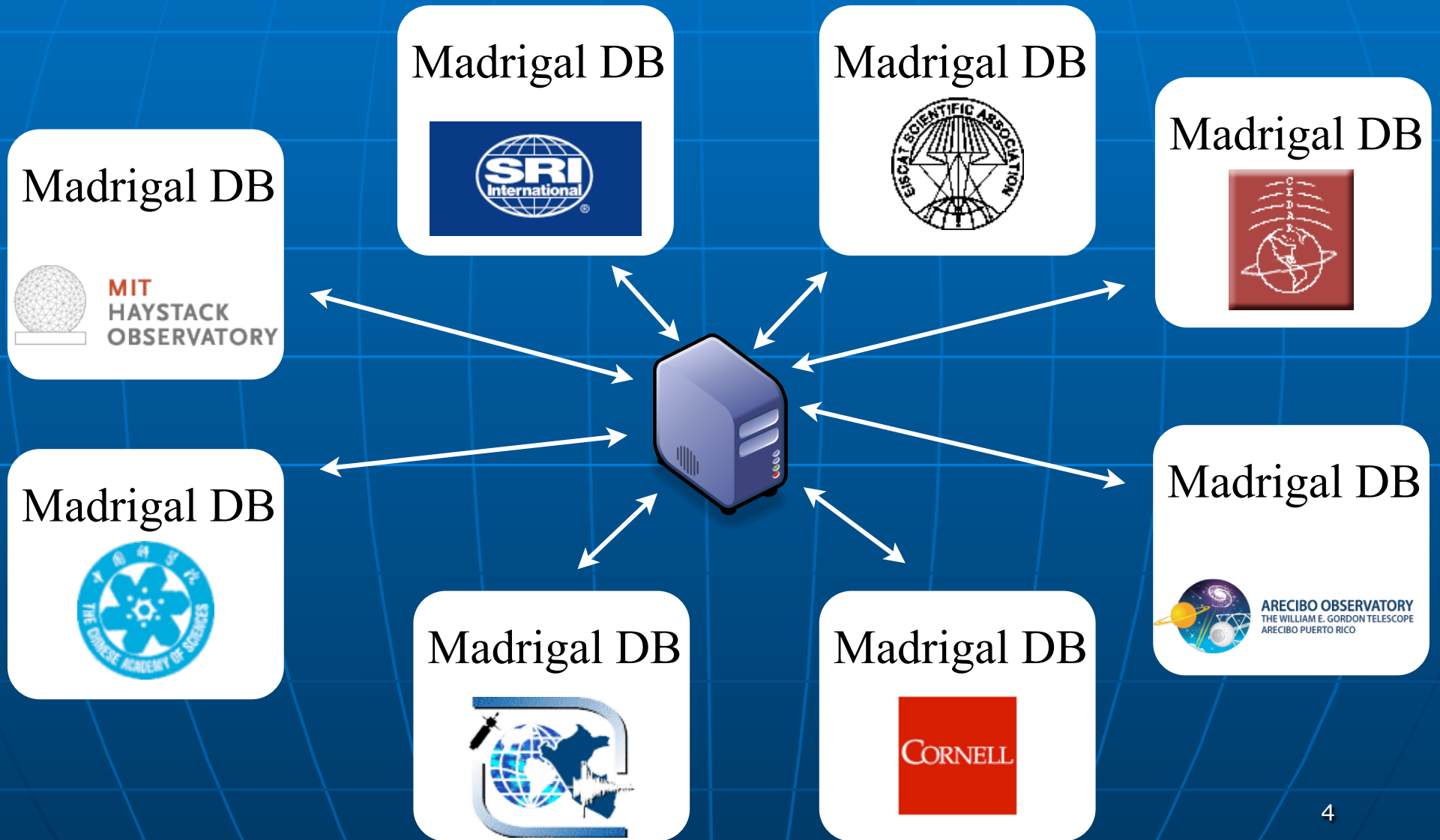
- What is Madrigal?
- What is the CEDAR database format?
- In what formats can I get Madrigal data?
- How do I use Madrigal?
 - Background
 - The website
 - Simple local data access
 - Full Access
 - Script data access

What is Madrigal?

Madrigal is a distributed database



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Cedar Madrigal archive imports all data weekly

Madrigal DB



Madrigal DB



Madrigal DB



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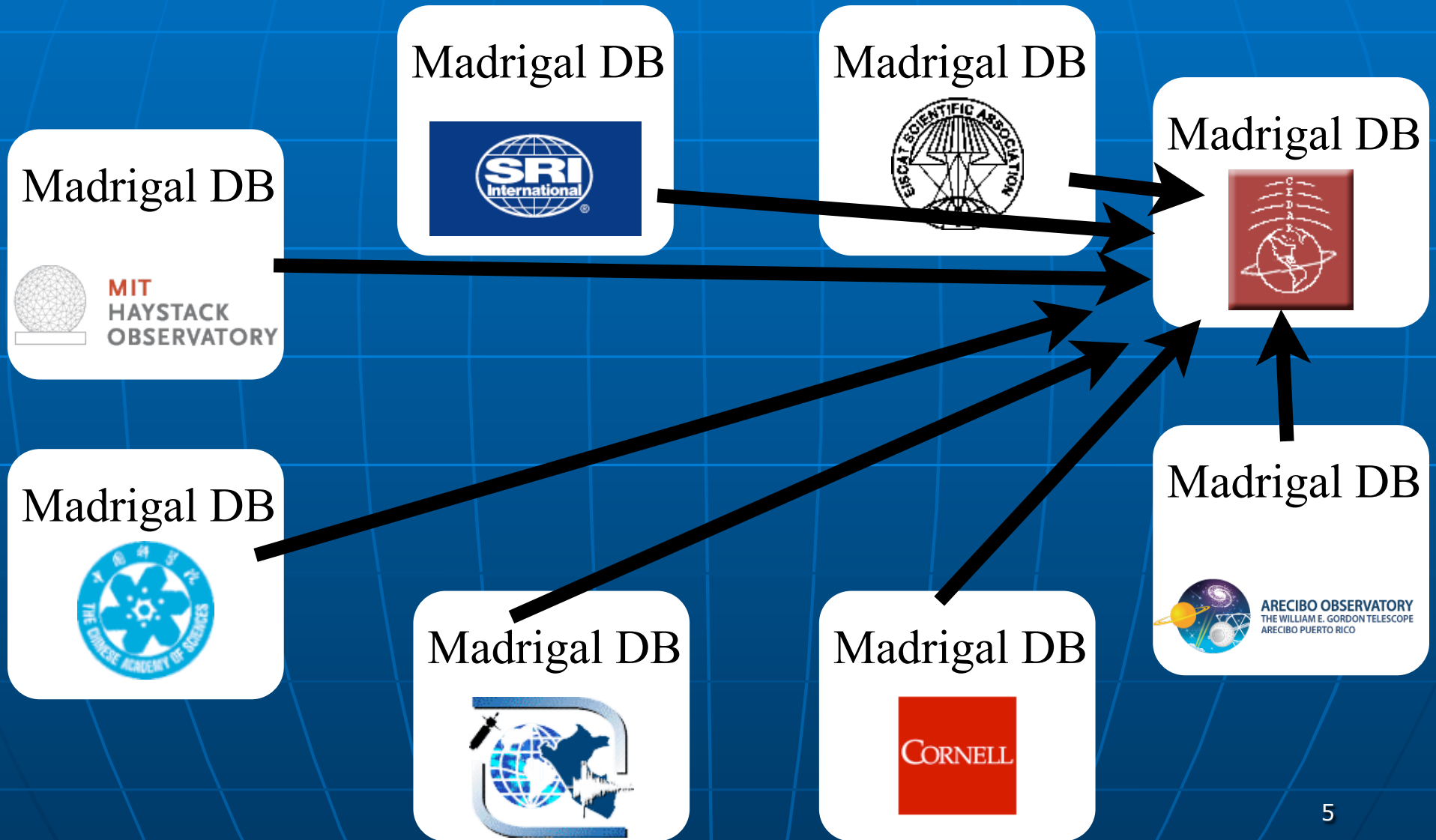
Madrigal DB



Madrigal DB



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The Madrigal database stores data from a wide variety of upper atmosphere research instruments

Incoherent Scatter Radar



TEC via GPS



MF Radar



Number of instruments in Madrigal:

- Incoherent scatter radars: 22
- MST radars: 3
- MF radars: 16
- Meteor radars: 7
- FPI: 23
- Michelson Interferometers: 6
- Lidars: 4
- Photometers: 4

Madrigal is open-source

Madrigal Database

http://www.openmadrigal.org/

The Open Madrigal Initiative

- [What is Madrigal?](#)
- [Download/update Madrigal](#) - includes Madrigal server and client APIs
- [Documentation](#)
 - [Web access](#)
 - [Script access](#)
- [Empirical Ionospheric Models](#)
- [Subversion Source Control](#)
- [Mailing Lists](#)
- [Administering Open Madrigal](#)

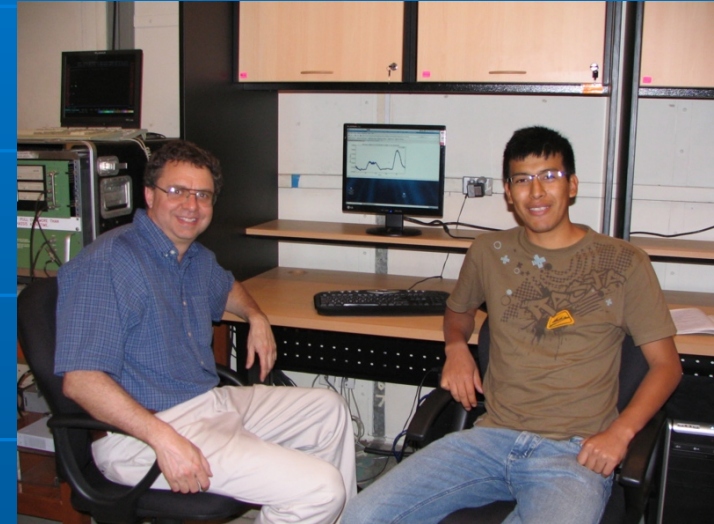
The OpenMadrigal project seeks to develop and support an on-line database for geospace data. The project has been led by [MIT Haystack Observatory](#) since 1980, but now has active support from [Jicamarca Observatory](#) and other community members. Madrigal is a robust, World Wide Web based system capable of managing and serving archival and real-time data, in a variety of formats, from a wide range of ground-based instruments. Madrigal is installed at a number of sites around the world. 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 from any Madrigal site.

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Suggestions and comments should be directed to madrigal@haystack

Link to Subversion (source code)



Madrigal Database Access

http://cedar.openmadrigal.org/cgi-bin/gSimpleUIAccessData.py

Madrigal home page

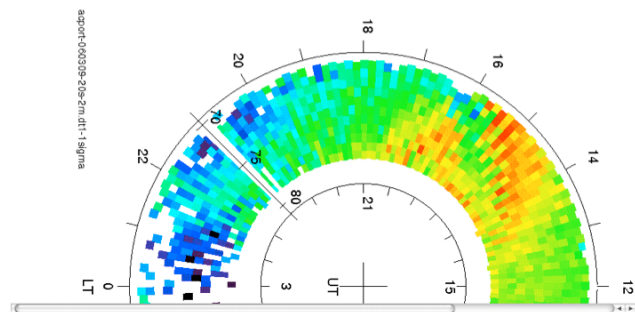
Choose instrument type:
Incoherent Scatter Radars
Sondrestrom IS Radar (1983-2012)

Selected Instrument: Experiment: 2006-03-09 00:05:37 - 2006-03-10 00:02:12
Selected File: son060309g.003-ACPORT - FITTED GATE DATA (A16) FROM DWELLS - acport-060309-20s-
Selected date: 2006-03-09

Year: 2006
Month: March

March 2006

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
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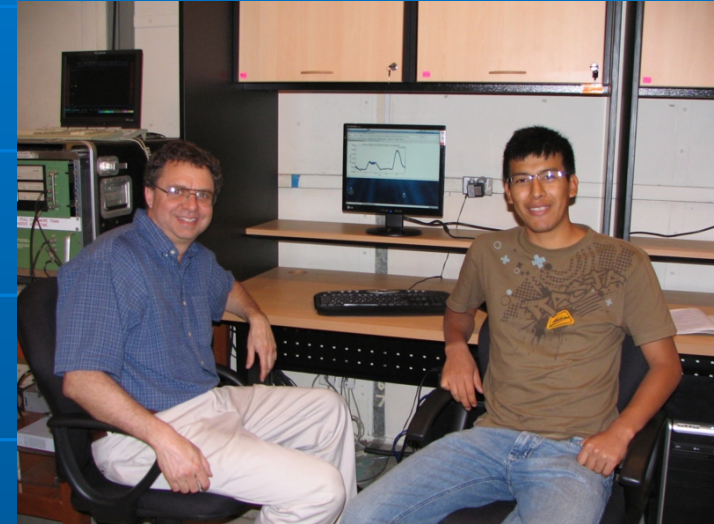
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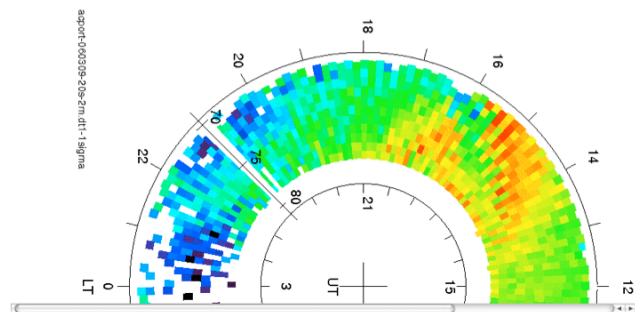
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Download data Print data View info Show Plots More parameters

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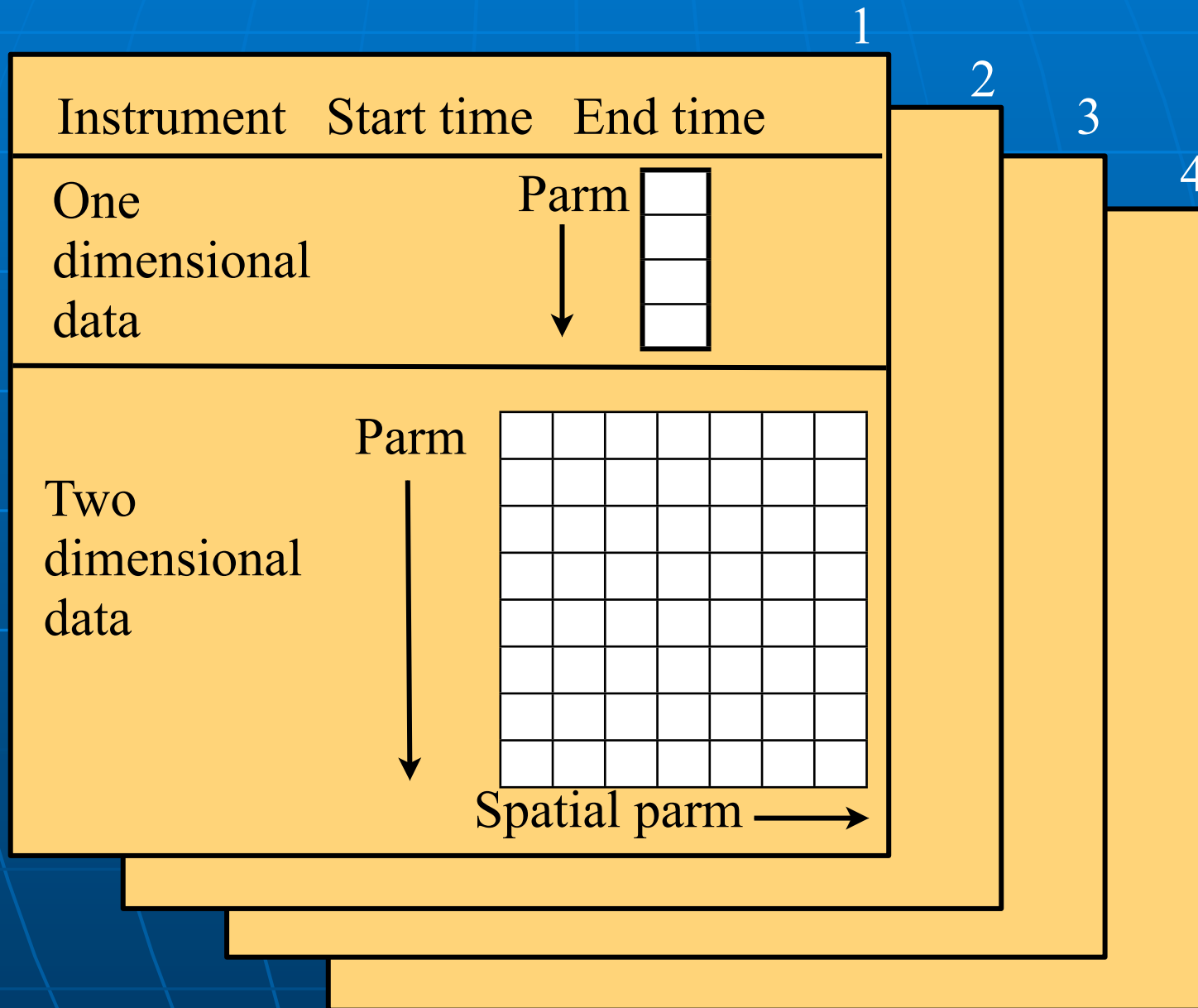
www.openmadrigal.org

- What is the CEDAR database format?

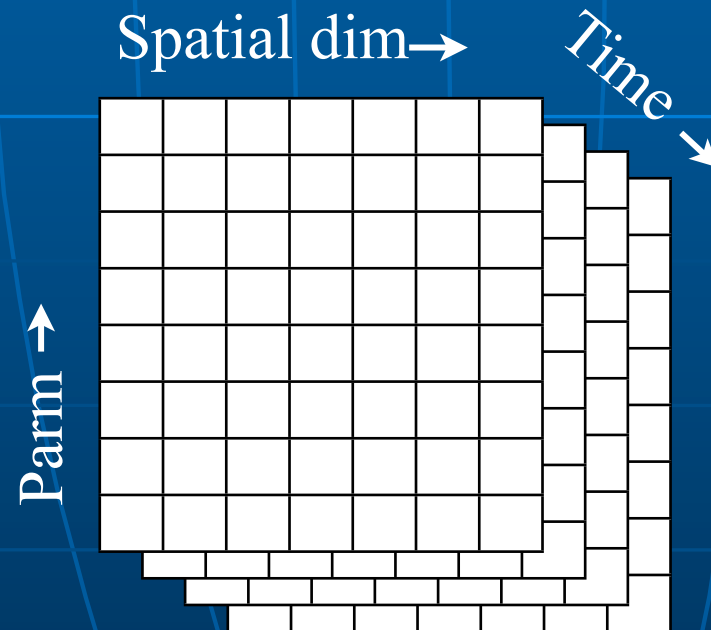
Well defined parameters

- Standard descriptions of all parameters
- Allows the existence of derivation engine
- Madrigal allows extended descriptions
- All parameters have corresponding error parameters
- Missing, Assumed

Cedar file data model

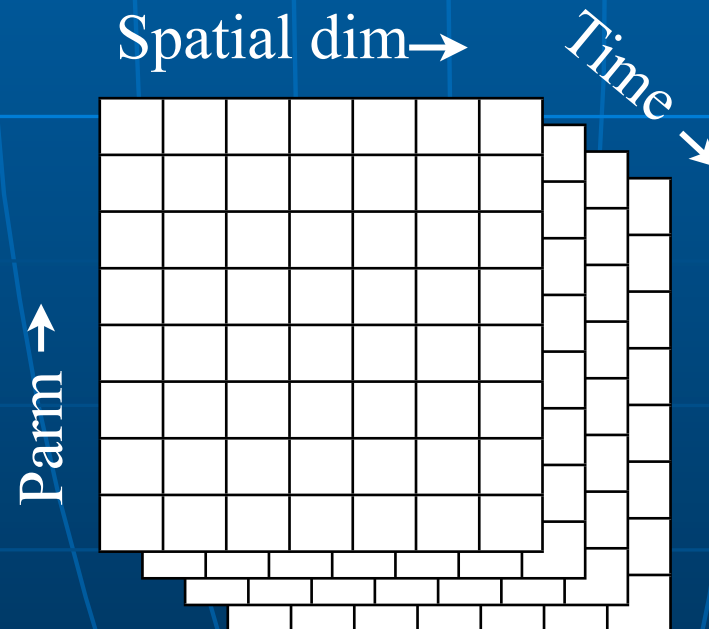


Flexibility versus ease-of-plotting



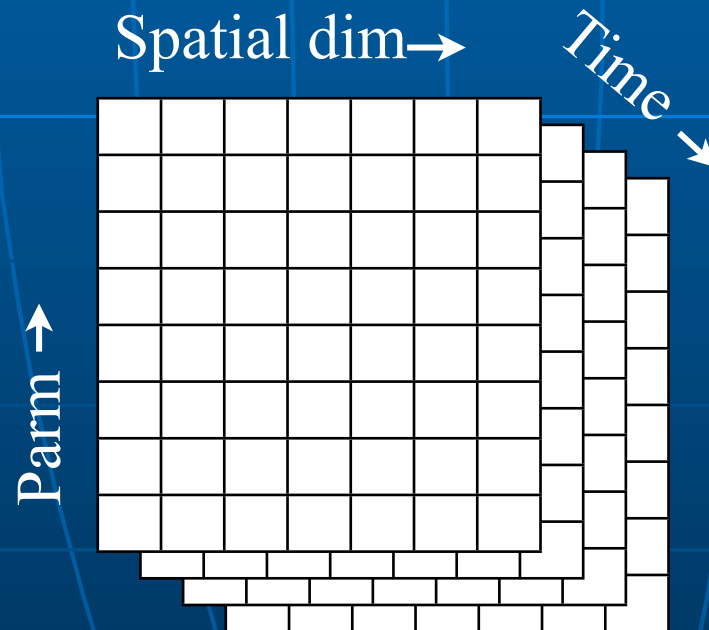
Flexibility versus ease-of-plotting

- Does not require consistent parameters



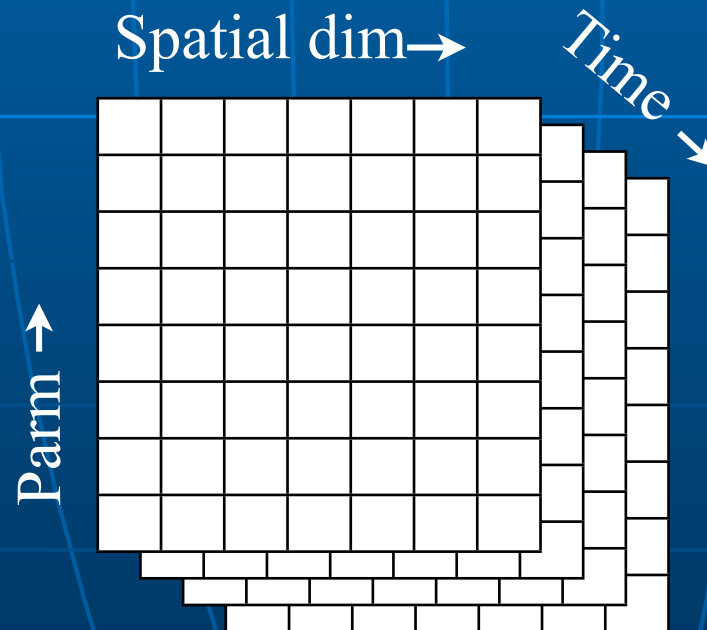
Flexibility versus ease-of-plotting

- Does not require consistent parameters
- Does not require consistent spatial steps



Flexibility versus ease-of-plotting

- Does not require consistent parameters
- Does not require consistent spatial steps
- Often data is uniform



In what formats can I get
Madrigal data?

Cedar file format: past and future

Cedar file format

- Developed in 1980
- 16 bit integer
 - Dynamic range problems

Hdf5

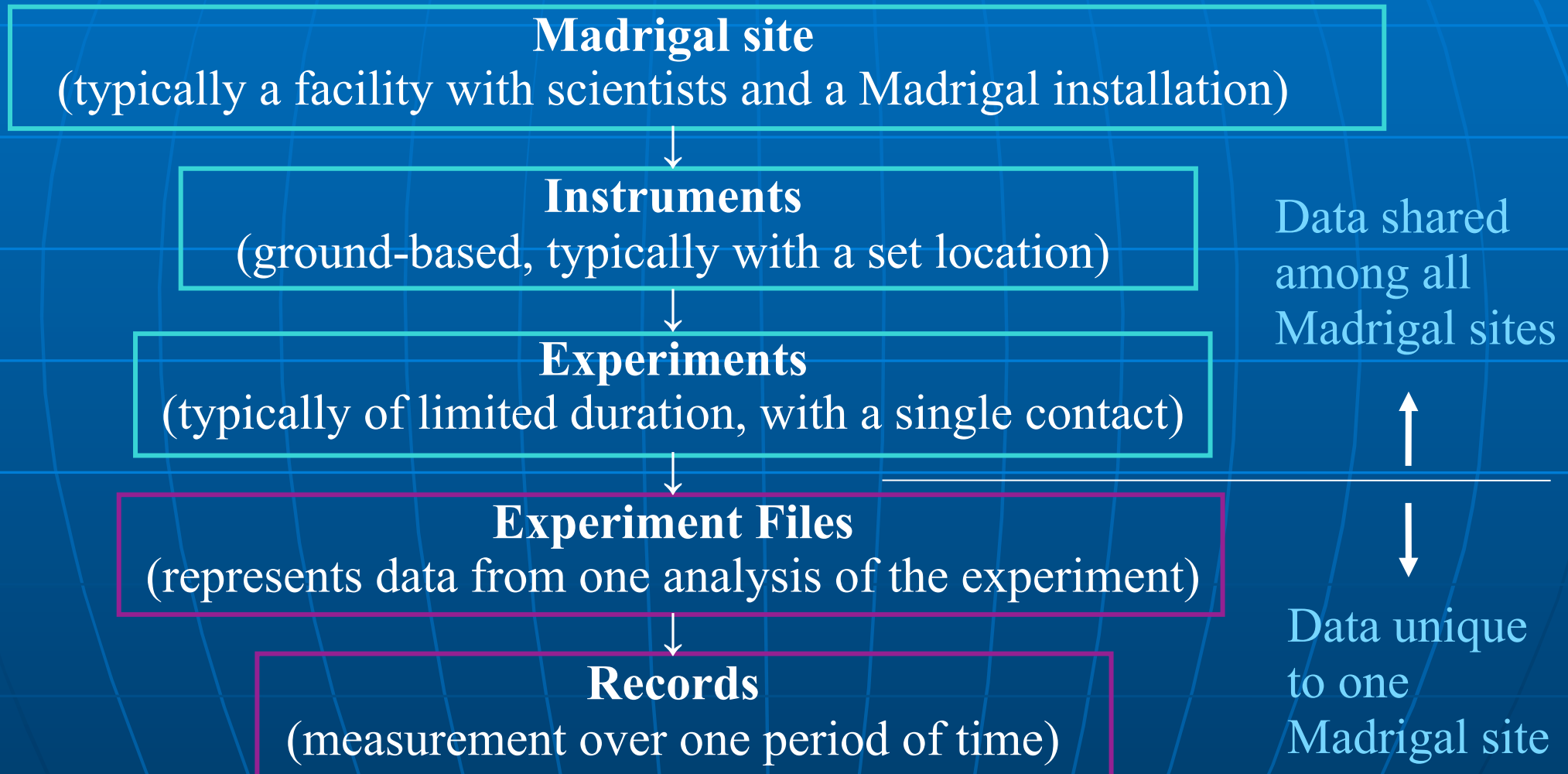
- Scientific standard
- Float based
- Flexible arrangement
- Table data, optional grid

Madrigal versions

Release	Madrigal 2.6 (now)	Madrigal 3.0
Underlying format	Cedar file format	Hdf5
Output formats	Ascii, Hdf5, Cedar file format	Ascii, Hdf5, netCDF4 Cedar file
Formats with deriv parms	Ascii	Ascii, Hdf5, netCDF4

- How do I use Madrigal?

Madrigal Data Model



Madrigal Derivation Engine

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Madrigal Derivation Engine

- Derived parameters appear to be in file
- 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

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://cedar.openmadrigal.org> or <http://isr.sri.com/madrigal>)

Remote Access to Madrigal Data

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Remote Access to Madrigal Data

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- Like the web, available from anywhere on any platform
- Read only API
- Complete Python, Matlab, and IDL APIs written
- More APIs available on request or via contribution

Madrigal Web Services

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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
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
- Links
 - **Reference:** <http://madrigan.haystack.mit.edu/madrigan/madpyDoc/remotePythonAPI/index.html>
 - **Tutorial:** http://madrigan.haystack.mit.edu/madrigan/rt_python.html

Live Python API demo

- See `demoMadrigalWebServices.py` at http://atlas.haystack.mit.edu/cgi-bin/millstone_viewvc.cgi/openmadrigal/trunk/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**



■ Matlab API Links

- Reference: http://madrigal.haystack.mit.edu/madrigal/rr_matlab.html
- Tutorial: http://madrigal.haystack.mit.edu/madrigal/rt_matlab.html

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

■ IDL API Links

- Reference: http://madrigan.haystack.mit.edu/madrigan/rr_idl.html
- Tutorial: http://madrigan.haystack.mit.edu/madrigan/rt_idl.html

Madrigal application globalssprint.*

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

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 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