

How to use the Madrigal database for atmospheric science

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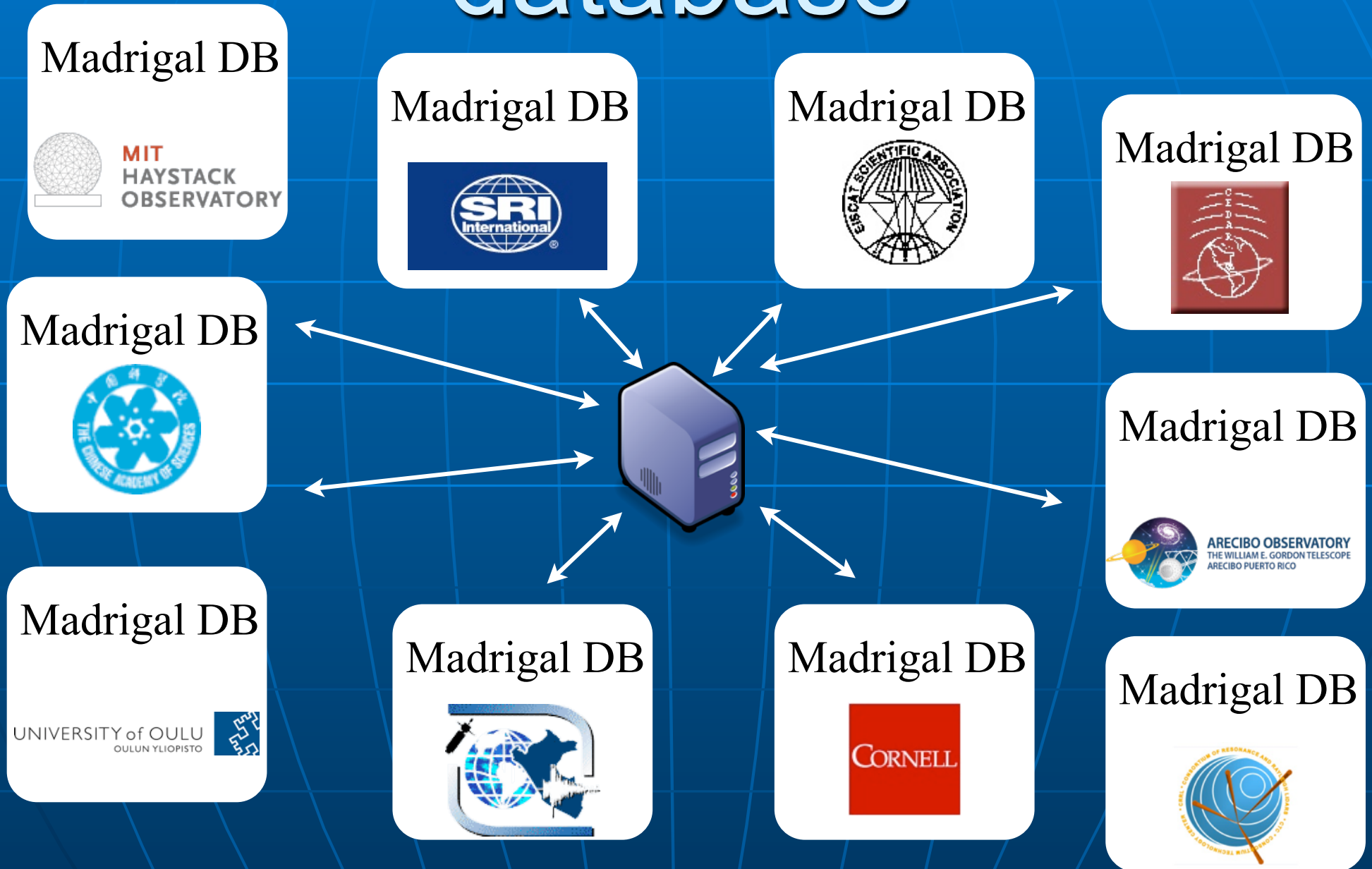
1

Outline

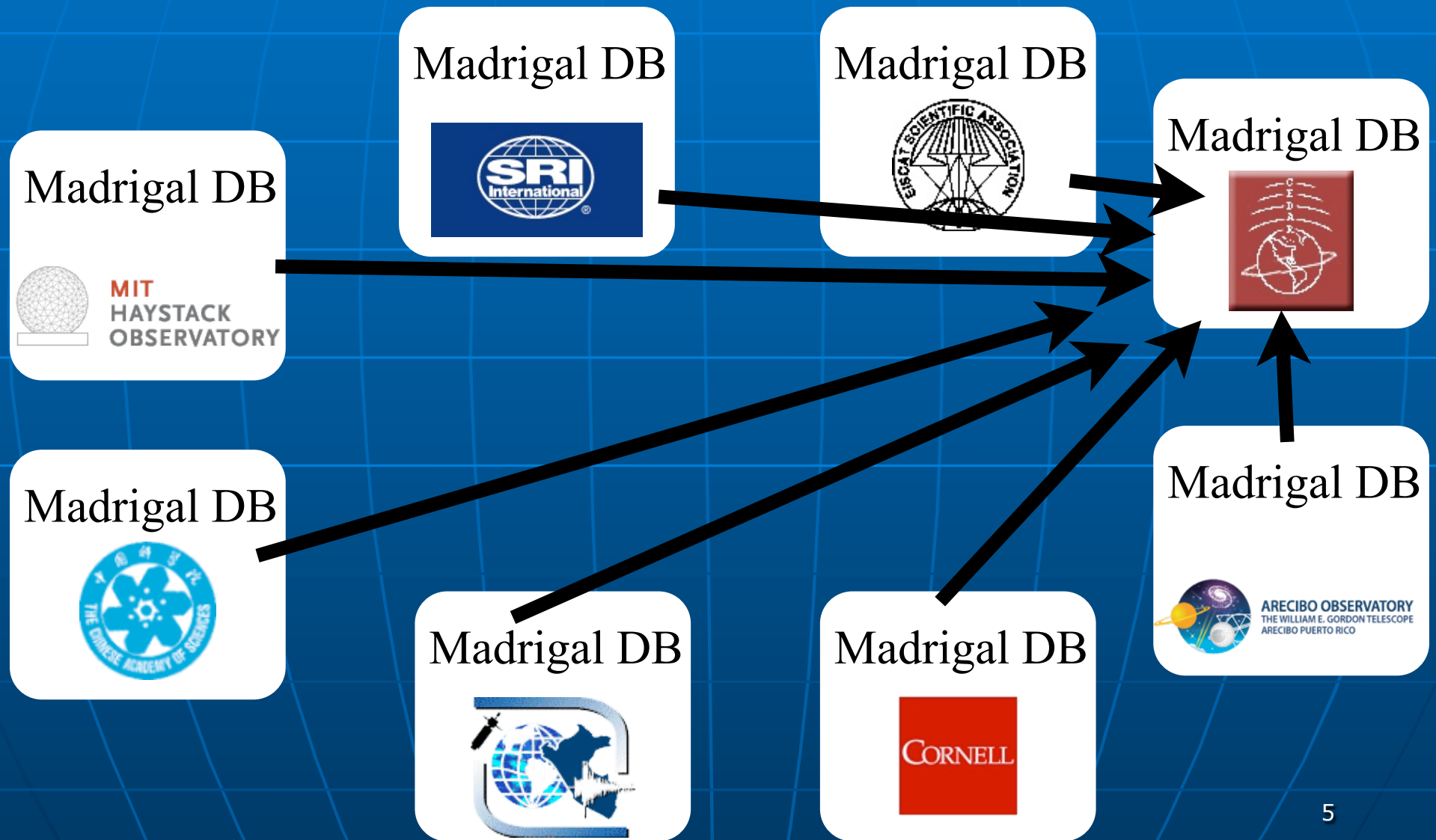
- What is Madrigal?
- What is the CEDAR database format?
- In what formats can I get Madrigal data?
- How do I use Madrigal?
 - Background
 - The website
 - Simple local data access
 - Full Access
 - Script data access

What is Madrigal?

Madrigal is a distributed database



Cedar Madrigal archive imports all data weekly



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

Incoherent Scatter Radar



TEC via GPS



MF Radar



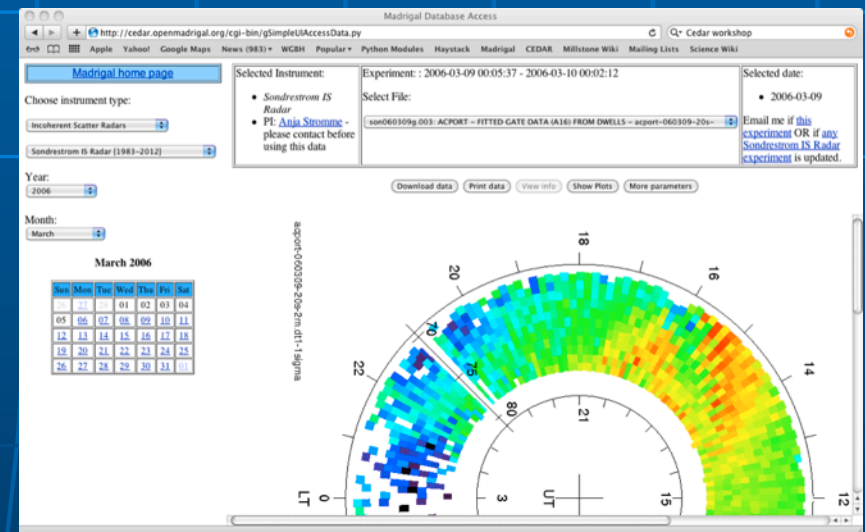
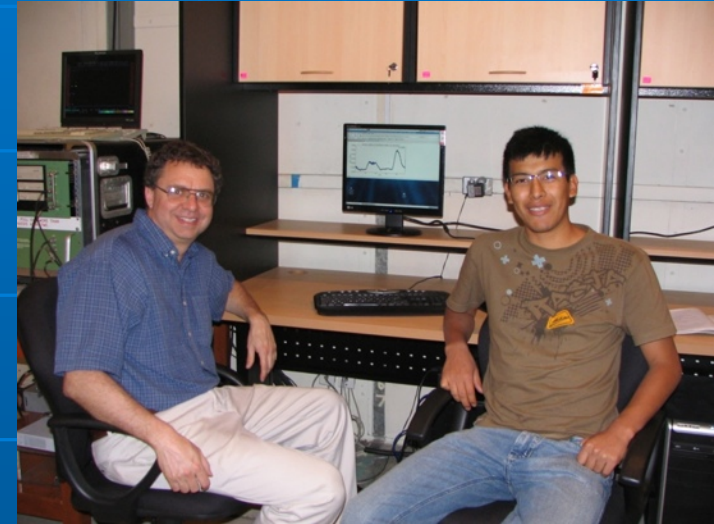
Number of instruments in Madrigal:

- 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



The screenshot shows the Madrigal Database website. The main heading is "The Open Madrigal Initiative". Below it, there is a list of links: "What is Madrigal?", "Download/update Madrigal - includes Madrigal server and client APIs", "Documentation" (with sub-links for "Web access" and "Script access"), "Empirical Ionospheric Models", "Subversion Source Control", "Mailing Lists", and "Administering Open Madrigal". A black arrow points from the "Subversion Source Control" link to the text "Link to Subversion (source code)". Below the text, there is a grid of logos for various institutions: MIT Haystack Observatory, Millstone Hill, EISCAT, SRI International, Cornell University, and the Institute of Geology and Geophysics. At the bottom left, there is a text box: "Suggestions and comments should be directed to madrigal@haystack".



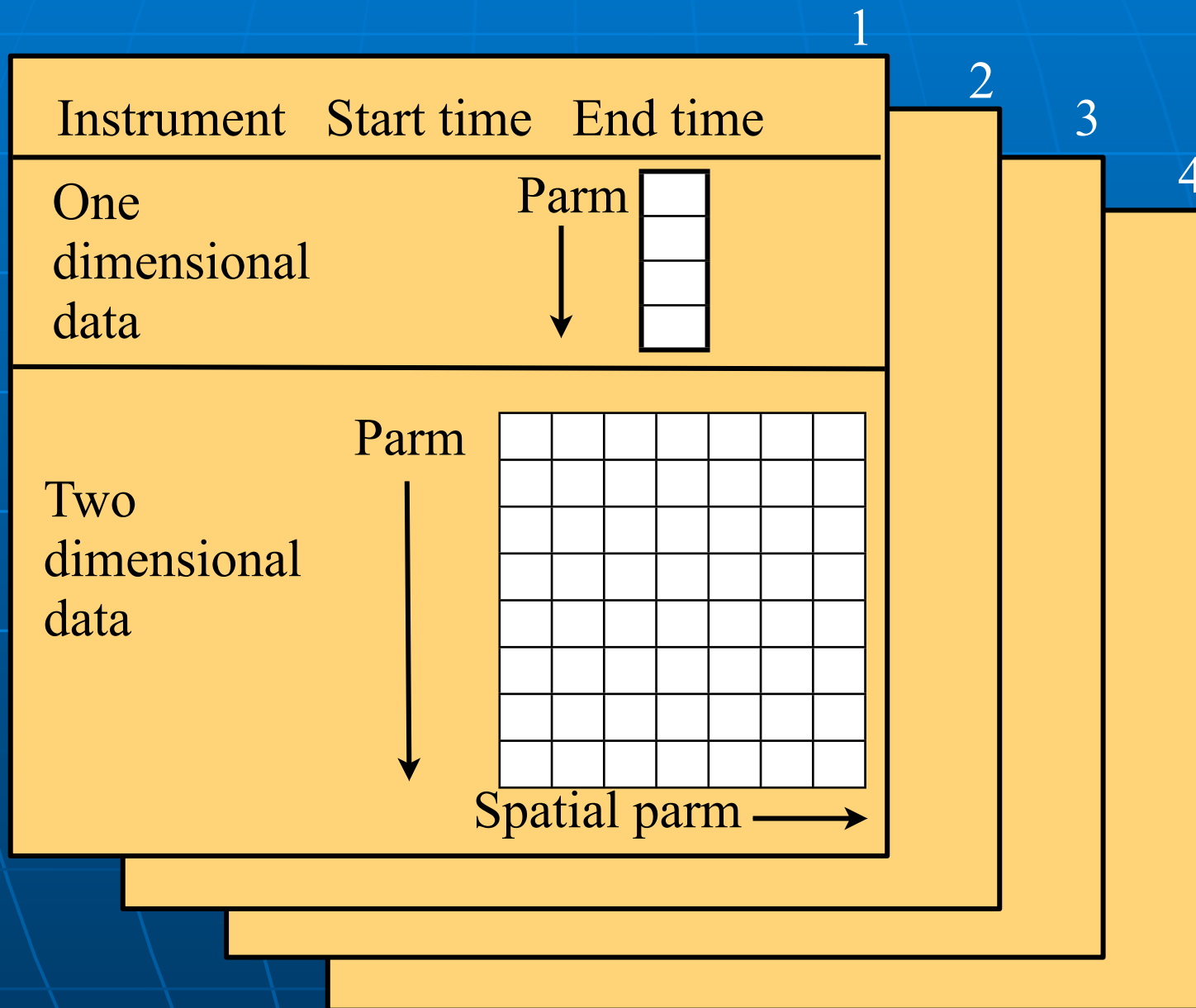
www.openmadrigal.org

- What is the CEDAR database format?

Well defined parameters

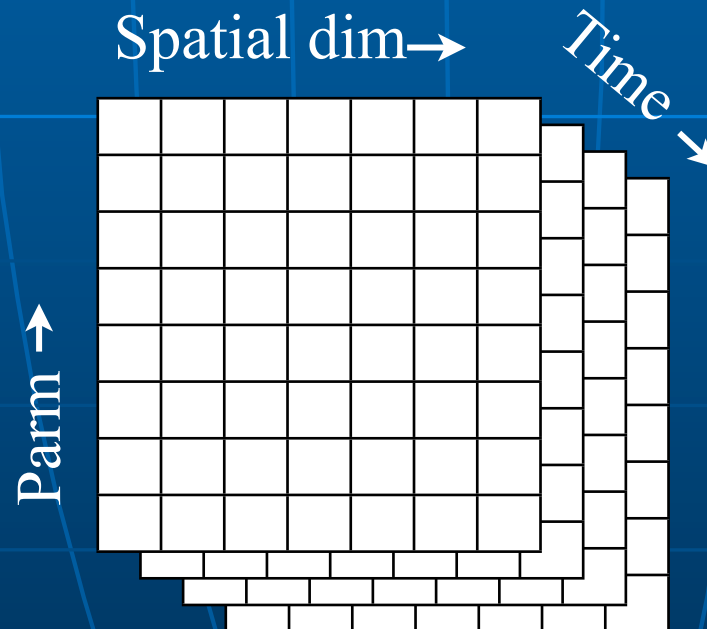
- Standard descriptions of all parameters
- Allows the existence of derivation engine
- Madrigal allows extended descriptions
- All parameters have corresponding error parameters
- Missing, Assumed

Cedar file data model



Flexibility versus ease-of-plotting

- 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

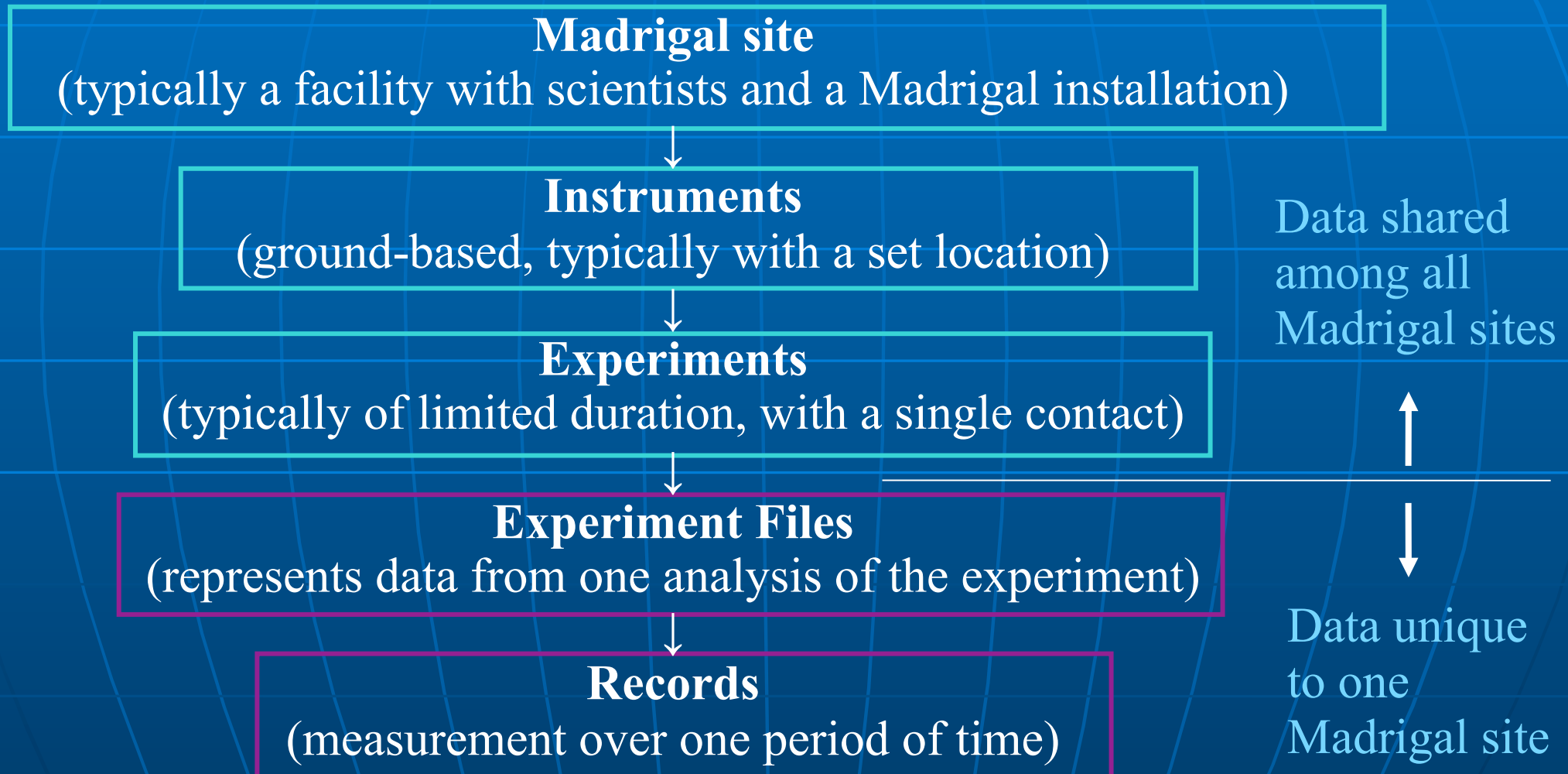
- Scientific standard
- Float based
- Flexible arrangement
- Table data, optional grid

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

- What do I need to understand about Madrigal to use it?

Madrigal Data Model



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

Classes of derived parameters

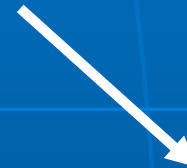
- Space, time
 - Examples: Local time, shadow height
- Geophysical
 - Examples: Kp, Dst, Imf, F10.7
- Magnetic
 - Examples: Bmag, Mag conjugate lat and long, Tsyganenko magnetic equatorial plane intercept
- Models
 - Examples: MSIS, IRI

- Using Madrigal

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>)

Group exercise 1

- Break into your groups
- See tinyurl.com/2013ISR -> Madrigal Exercise 1
- Talk starts again in 20 minutes

Remote Access to Madrigal Data

- Built on web services
- 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

- Simple delimited output via CGI scripts
- 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
- 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://madrigal.haystack.mit.edu/madrigal/rr_idl.html
- Tutorial: http://madrigal.haystack.mit.edu/madrigal/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
```

globalDownload scripts

- Scripts that download files rather than ascii data
 - Instrument
 - Date range
 - Kindat (optional)
 - Specify format
- Python, Matlab, IDL versions
- Madrigal 3.0 will have a web generator
- Optional exercise

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

Group exercise 2

- Break into your groups
- See tinyurl.com/2013ISR -> Madrigal Exercise 2