Pacific Northwest Efforts for Climate Science Data Integration and Analysis

Pacific Northwest Climate Science Conference 2013
Portland, Oregon

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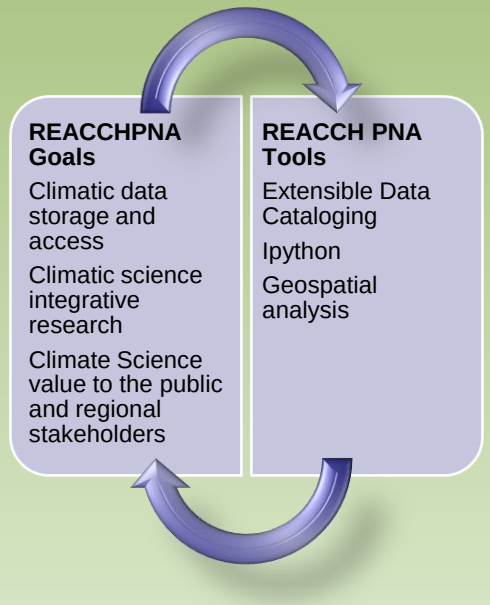
Overview

- Climate science data, perception vs. reality
- Why is data integration important?
- Aligning tools with achieving climatic science success (communication, policy, analysis)
- Focus point: REACCHPNA

Materials for presentation can be found here:
http://bit.ly/14oqonb



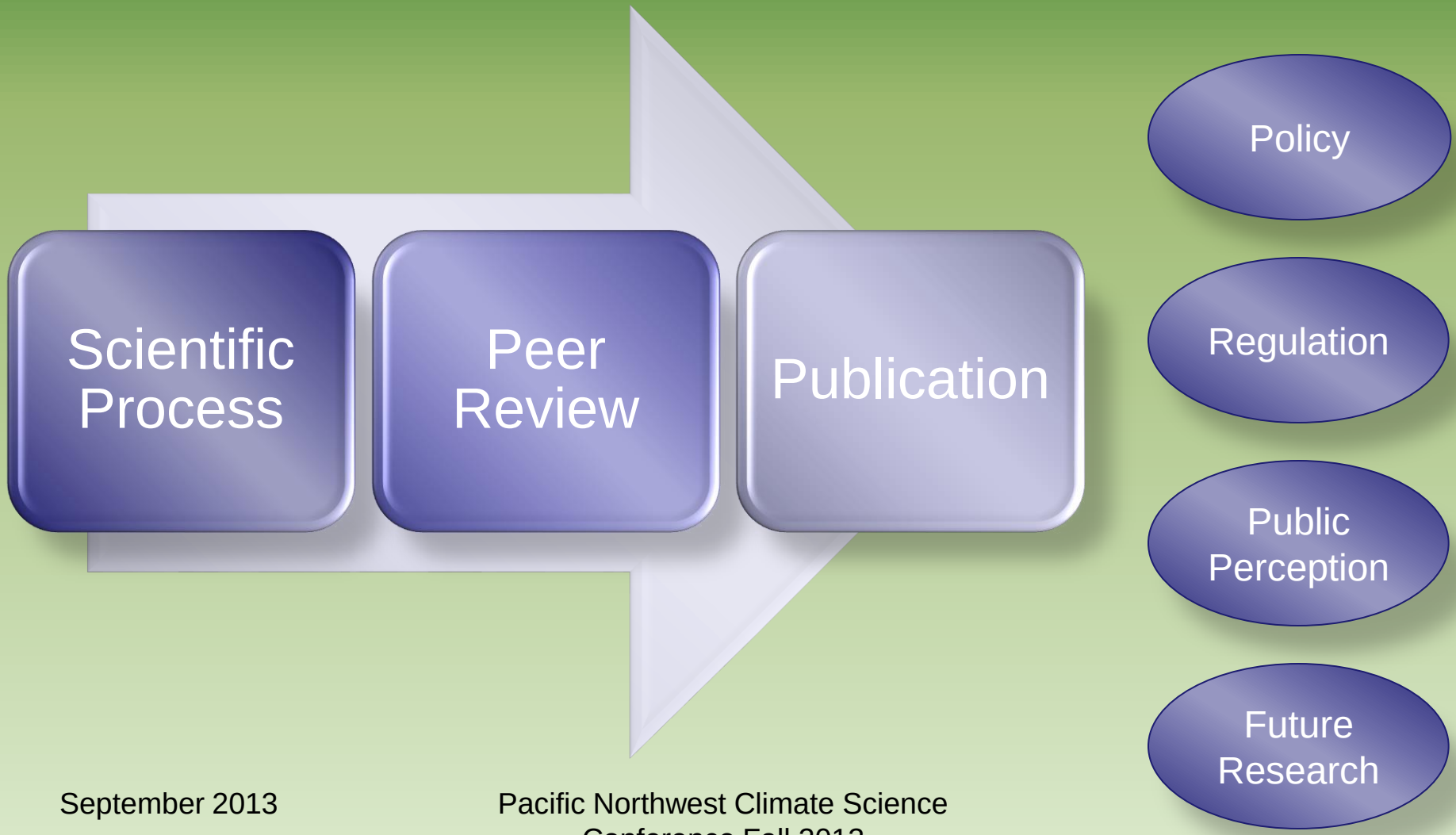
REACCH PNA and Climate Change

The **Re**gional **A**pproaches to **C**limate **Ch**ange project is a coordinated regional agricultural project, funded by the National Institute for Food and Agriculture to improve the long-term profitability of the cereal production systems in the Pacific Northwest under ongoing and projected climate change, while contributing to climate change mitigation by reducing emissions of greenhouse gases.

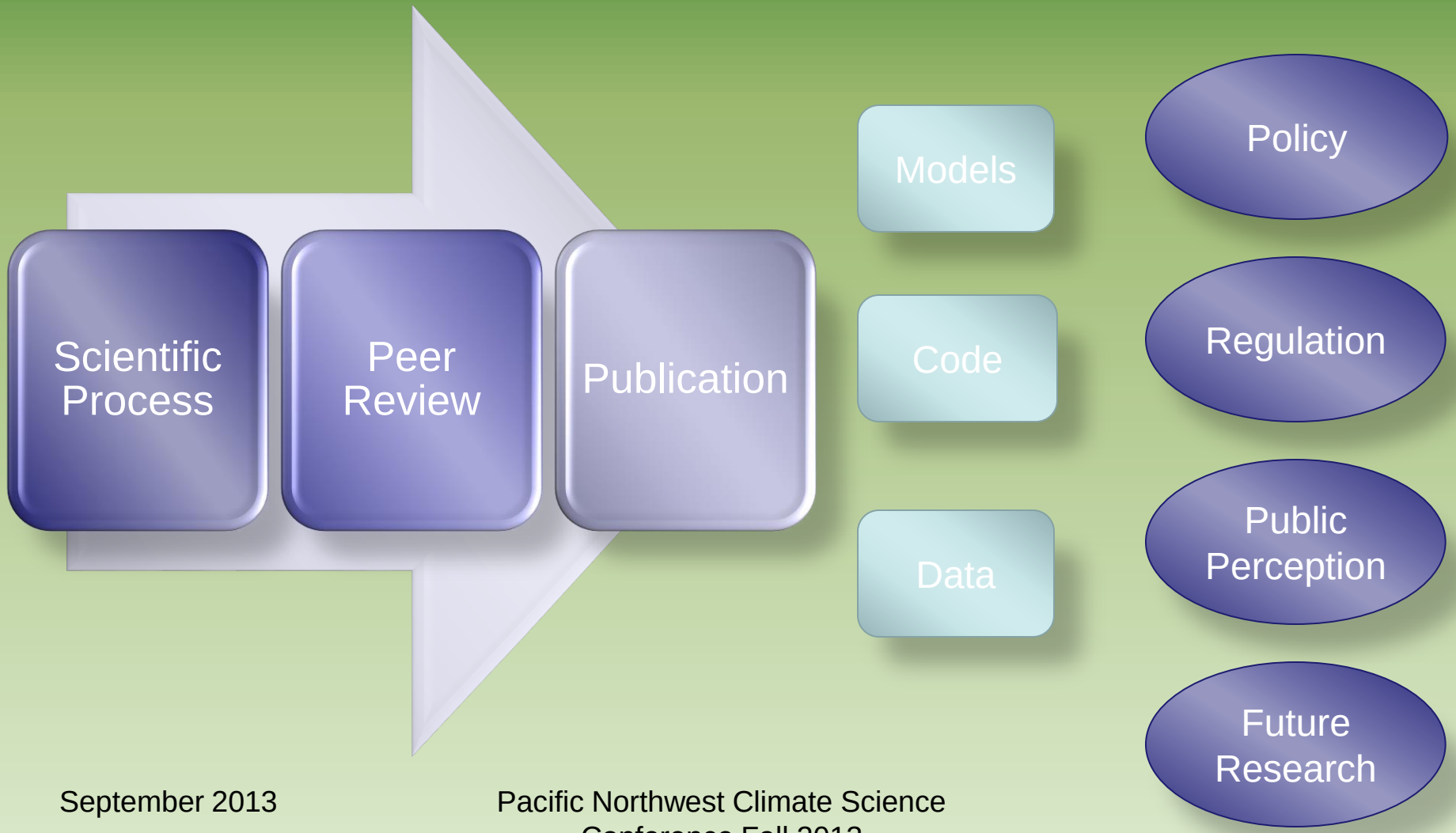
REACCH includes efforts in research, extension, and education that integrates diverse elements including climate modeling, cropping systems modeling, economics, agronomy, crop protection, and others in a trans disciplinary manner.

www.reacchpna.org

Climate science data, perception vs. reality



Climate science data, perception vs. reality (con'd)



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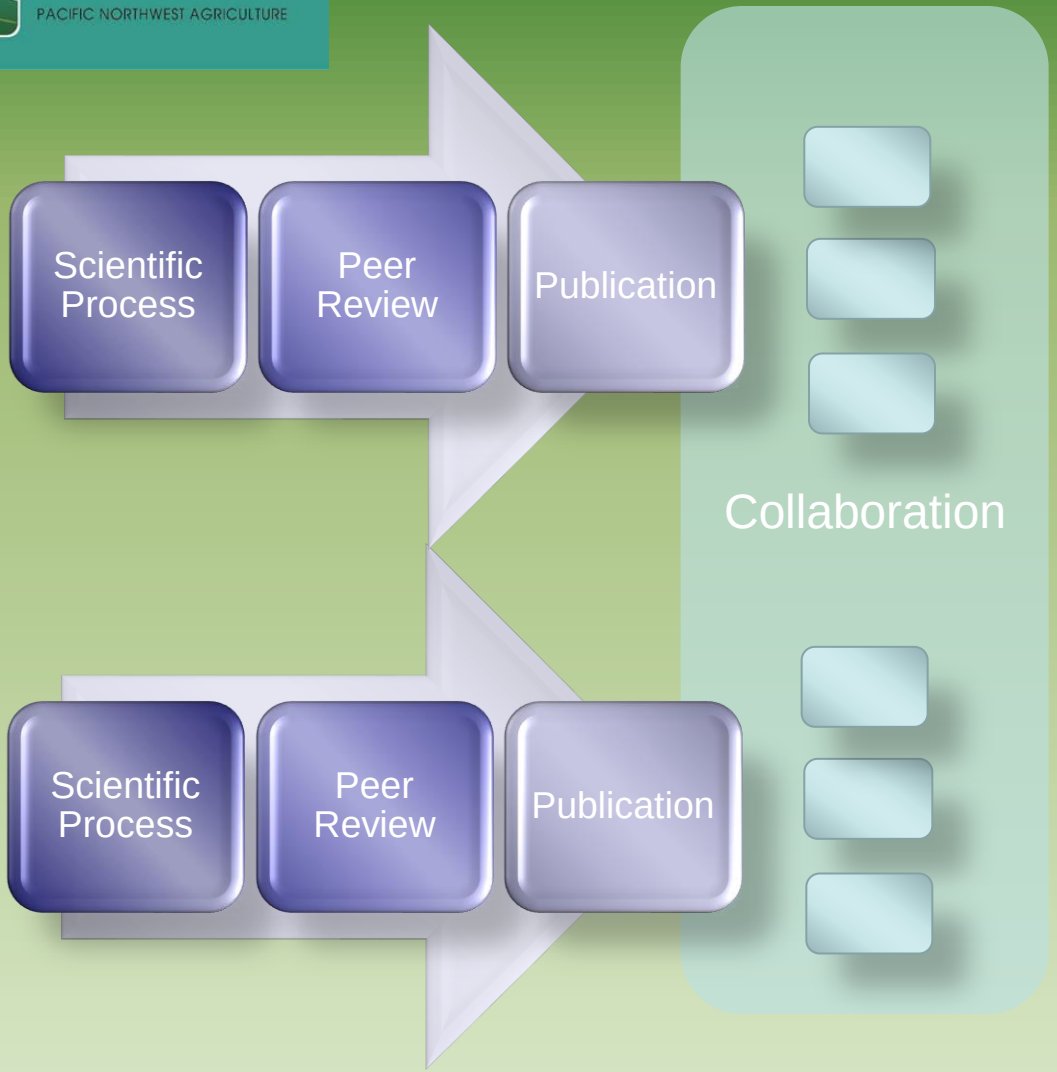
The Value of Data Integration



- Policy
- Regulation
- Public Perception
- Future Research

The Value of Data Integration (con'd)

- Backup, recovery, common server location
- Integration capabilities increase tremendously
- Facilitates structure, organizationof data

- Requires time and energy, commitment
- Pre-configured standards
- Common location of data lessens data control
- Perceived concerns regarding security, confidentiality

Federal agencies moving towards the interconnection of data and publications RE: funding
Example: NSF

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COMMENT

Value all research products

A new funding policy by the US National Science Foundation represents a sea-change in how researchers are evaluated, says **Heather Piwowar**.

What a difference a word makes. For all new grant applications from 14 January, the US National Science Foundation (NSF) asks a principal investigator to list his or her research "products" rather than "publications" in the biographical sketch section. This means that, according to the NSF, a scientist's worth is not dependent solely on publications. Data sets, software and other non-traditional research products will count too.

There are more diverse research products now than ever before. Scientists are developing and releasing better tools to document their workflow, check each other's work and share information, from data repositories to post-publication discussion systems. As it gets easier to publish a wide variety of material online, it should also become easy to recognize the breadth of a scientist's intellectual contributions.

But one must evaluate whether each product has made an impact on its field — from a data set on beetle growth, for instance, to the solution to a colleague's research problem posted on a question-and-answer website. So scientists are developing and assessing alternative metrics, or 'altmetrics' — new ways to measure engagement with research output.

The NSF policy change comes at a time when around 1 in 40 scholars is active on Twitter[1], more than 2 million researchers use the online reference-sharing tool Mendeley (see go.nature.com/xs5cwe), and more than 25,000 blog entries have been written about peer-reviewed research papers and indexed on the Research Blogging platform[2].

In the next five years, I believe that it will become routine to track — and to value — citations to an online lab notebook, contributions to a software library, bookmarks to data sets from content-sharing sites such as Pinterest and Delicious. In other words, to value a wider range of metrics that suggest a research product has made a difference. For example, my colleagues and I have estimated that the data sets added to the US National Center for Biotechnology Information's Gene Expression Omnibus in 2007 have contributed to more than 1,000 papers[3,4]. Such attributions continue to accumulate for several years after data sets are first made publicly available.

In the long run, the NSF policy change will do much more than just reward an investigator who has authored a popular statistics package, for instance. It will change the game, because it will alter how scientists assess research impact.

The new NSF policy states: "Acceptable products must be citable and accessible including but not limited to publications, data sets, software, patents, and copyrights." By contrast, previous policies allowed only "patents, copyrights and software systems" in addition to research publications in the biography section of a proposal, and considered their inclusion to be a substitute for the main task of listing research papers.

Still, the status quo is largely unchanged. Some types of NSF grant-renewal applications continue to request papers alone. Indeed, several funders — including the US National Institutes of Health, the Howard Hughes Medical Institute and the UK Medical Research Council — still explicitly ask for a list of research papers rather than products.

"Altmetrics give a fuller picture of how research products have influenced conversation, thought and behaviour."

Even when applicants are allowed to include alternative products in grant applications, how will reviewers know if they should be impressed? They might have a little bit of time to watch a short video on YouTube demonstrating a wet-lab technique, or to read a Google Plus post describing a computational algorithm. But what if the technique takes more time to review, or is in an area that is outside the reviewer's expertise? Existing evaluation mechanisms often fail for alternative products — a YouTube video, for example, has no journal title to use as a proxy for anticipated impact. But it will definitely receive a number of downloads, some 'likes' on Facebook, a few Pinterest bookmarks and discussion in blogs.

TRACKING TRENDS

Many altmetrics have already been gathered for a range of research products. For example, the data repositories Dryad and figshare track download statistics (figshare is supported by Digital Science, which is owned by the same parent company as *Nature*). Some repositories, such as the Inter-university Consortium for Political and Social Research, provide anonymous demographic breakdowns of usage.

Specific tools have been built to aggregate altmetrics across a wide variety of content. Altmetric.com (also supported by Digital Science) reveals the impact of anything with a digital object identifier (DOI) or other standard identifier. It can find mentions of a data set in blog posts, tweets and mainstream media (see go.nature.com/rcha8g). The non-profit organization ImpactStory (http://impactstory.org), of which I am a co-founder, tracks the impact of articles, data sets, software, blog posts, posters and lab websites by monitoring citations, blogs, tweets, download statistics and attributions in research articles, such as mentions within methods and acknowledgements[5]. For example, a data set on an outbreak of *Escherichia coli* has received 43 'stars' in the GitHub software repository, 18 tweets and two mentions in peer-reviewed articles (see go.nature.com/dzbdgh).

Such altmetrics give a fuller picture of how research products have influenced conversation, thought and behaviour. Tracking them is likely to motivate more people to release alternative products — scientists say that the most important condition for sharing their data is ensuring that they receive proper credit for it[6].

The shift to valuing broad research impact will be more rapid and smooth if more funders and institutions explicitly welcome evidence of impact. Scientists can speed the shift by publishing diverse research products in their natural form, rather than shoehorning everything into an article format, and by tracking and reporting their products' impact. When we, as scientists, build and use tools and infrastructure that support open dissemination of actionable, accessible and auditable metrics, we will be on our way to a more useful and nimble scholarly communication system. ■

Heather Piwowar *is a postdoctoral research associate in informatics at the National Evolutionary Synthesis Center, Duke University, Durham, North Carolina, USA. She is a co-founder of ImpactStory.*
e-mail: heather@impactstory.org

1. Priem, J., Costello, K. & Dzuba, T.figshare http://dx.doi.org/10.6084/m9.figshare.104629 (2012).
2. Fausto, S. *et al. PLoS ONE* **7**, e50109 (2012).
3. Piwowar, H. A., Vision, T. J. & Whitlock, M. C. *Nature* **453**, 285 (2011).
4. Piwowar, H. A., Vision, T. J. & Whitlock, M. C. *Dryad Digital Repository* http://dx.doi.org/10.5061/dryad.j1fd7 (2011).
5. Oebl, A. *Nature* **489**, 496–497 (2012).
6. Tenopir, C. *et al. PLoS ONE* **6**, e21101 (2011).

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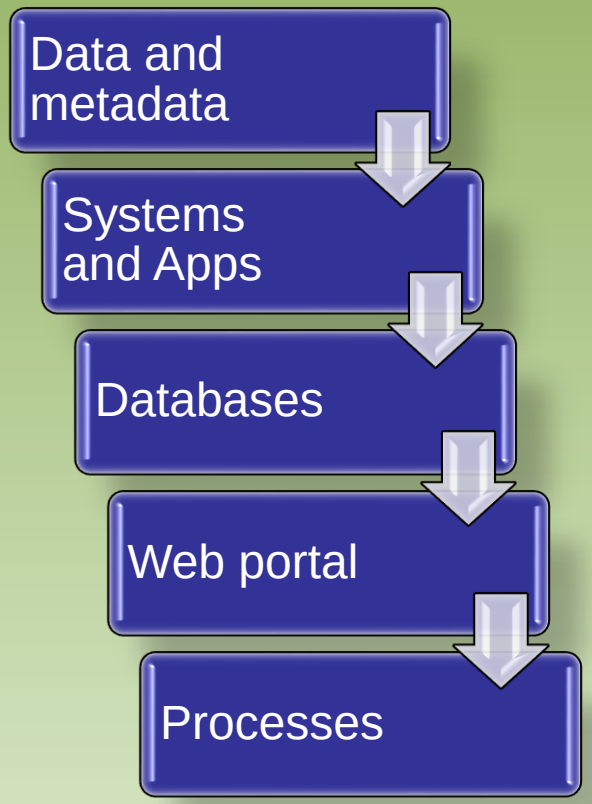
10 JANUARY 2013 | VOL 493 | NATURE | 159

REACCH Data Model

REACCH Data Model



REACCH Data Model (con'd)

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Data and metadata

Systems and Apps

Databases

Web portal

Processes

THREDDS

PostgresQL

IPython

ArcGIS Server

Geoportal Server

Climate Science Researchers

What does all that mean?

- **THREDDS** – Thematic Realtime Environmental Data Distribution Services – developed by UCAR. Aggregation and interrogation of netcdf datasets
- **IPython** – Interactive Python. Python in a web browser! Can be used to compile and document research processes
- **ArcGIS Server** – web server technology used for geospatial mapping processes

...and why do I care?

- These and comparable technologies are vital tools for merging and interrogating data in unique ways – which in turn, assist in developing more clearly understood, scientifically-based positions on climate science.

- Searching for, or add data to the REACCH Data Library

REACCH PNA Examples

- Data examination via
  - THREDDS
  - ArcGIS Server/Javascript
  - IPython

thredds.reacchpna.org

data.reacchpna.org

viewer.reacchpna.org

You may request a login using our request form on the front page of www.reacchpna.org

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Home | What's New | About | Mission | Resources | Login

data.reacchpna.org

- **Search for data**
- **Based on ESRI's geoportal server software**
- **Linux/tomcat/java**

REACCH Data Library SEARCH

How do I? | Video Instruction | Concept | REACCH Data Viewer | THREDDS | REACCH IPython | REACCH ArcGIS Online

REACCH Data Library

Home | Advanced Data Search | Browse | Login

Welcome to the REACCH Data Library

The REACCH Data Library provides easy and convenient ways to share and search for REACCH data. From this location, you can upload, search, view, and download REACCH-related datasets.

Recently added data...

36 results Filter Clear

Showing 1-10 1 2 3 4

REACCHPNA CMIP5 Climate Model Catalog
REACCHPNA CMIP5 Climate Model Catalog
Download Preview Details Metadata

REACCHPNA Models - Major Resource Land Areas
The United States, Caribbean and Pacific Basin Major Land Resource Areas (MLRA) Geographic Database serves as the geospatial expression of the map products presented and described in Agricultural Handbook 296 (2006). Land resource categories historically ...
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata

REACCHPNA Base - Study Area
REACCHPNA Base - Study Area
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata

REACCHPNA Models - Douglas Rosefill Agroecozones
REACCHPNA Models - Douglas Rosefill Agroecozones
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata

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thredds.reacchpna.org

- **Aggregates netcdf data**
- **Allows for extraction of data by variable, time, geography**

REACCH THREDDS Server

Updated: Oct 25, 2012

REACCH Data Access
Tier 1 (Public)

The REACCH THREDDS Data Server (TDS) is a web server that provides metadata and data access for scientific datasets, using OPeNDAP, OGC WMS and WCS, HTTP, and other remote data access protocols. The TDS technology is developed and supported by Unidata, a division of the University Corporation for Atmospheric Research (UCAR), and is sponsored by the National Science Foundation.

The REACCH Data Library harvests information from the REACCH THREDDS Server - so you may examine climatic modeling datasets via the THREDDS Catalog directly - or you may search using the REACCH Data Library.

Catalog http://inside-dev1.nkn.uidaho.edu:8080/thredds/catalog.html

Dataset	Size	Last Modified
Test Enhanced Catalog/		--
REACCH Climatic Modeling MET Catalog/		--
REACCH Climatic Modeling CMIP5 Catalog/		--
REACCH CROPSYS Catalog/		--
REACCH Greenhouse Gas Monitoring Catalog/		--
REACCH Backup Catalog/		--
TEST FMRC Catalog/		--
REACCH MET Test Catalog/		--

REACCHPNA THREDDS INSTALLATION at University of Idaho - REACCH PNA
THREDDS Data Server [Version 4.2.9 - 20111108.1758] Documentation

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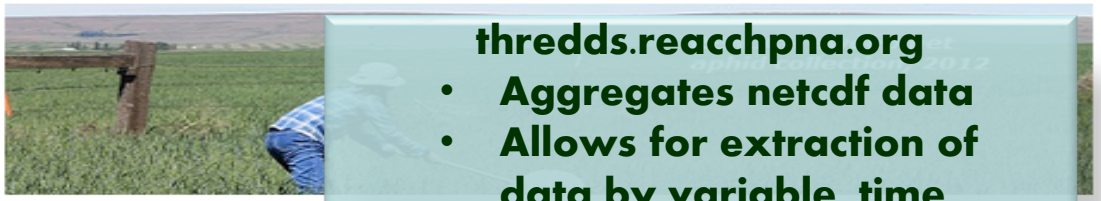

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Catalog http://inside-dev1.nkn.uidaho.edu:8080/thredds/reacch_climate_CMIP5_catalog.html

Dataset	Size	Last Modified
REACCH CMIP5 Aggregation by Near Surface Specific Humidity - Historical		--
MACA huss BNU-ESM HISTORICAL 1950-2005 Aggregated		--
MACA huss CNRM-CM5 HISTORICAL 1950-2005 Aggregated		--
MACA huss CSIRO-Mk3-6-0 HISTORICAL 1950-2005 Aggregated		--
MACA huss bcc-csm1-1 HISTORICAL 1950-2005 Aggregated		--
MACA huss CanESM2 HISTORICAL 1950-2005 Aggregated		--
MACA huss GFDL-ESM2G HISTORICAL 1950-2005 Aggregated		--
MACA huss GFDL-ESM2M HISTORICAL 1950-2005 Aggregated		--
MACA huss HadGEM2-CC HISTORICAL 1950-2005 Aggregated		--
MACA huss HadGEM2-ES HISTORICAL 1950-2005 Aggregated		--
MACA huss inmcm4 HISTORICAL 1950-2005 Aggregated		--
MACA huss MIROC5 HISTORICAL 1950-2005 Aggregated		--
MACA huss MIROC-ESM HISTORICAL 1950-2005 Aggregated		--
MACA huss MIROC-ESM-CHEM HISTORICAL 1950-2005 Aggregated		--
MACA huss MRI-CGCM3 HISTORICAL 1950-2005 Aggregated		--
REACCH CMIP5 Aggregation by Near Surface Specific Humidity - rcp45		--
MACA huss BNU-ESM rcp45 2006-2100 Aggregated		--
MACA huss CNRM-CM5 rcp45 2006-2100 Aggregated		--
MACA huss CSIRO-Mk3-6-0 rcp45 2006-2100 Aggregated		--

REACCHPNA THREDDS INSTALLATION

THREDDS Data Server

Catalog http://inside-dev1.nkn.uidaho.edu:8080/thredds/reacch_climate_CMIP5_catalog.html

Dataset: UIDAHO REACCHPNA THREDDS DEVELOPMENT SERVER/REACCH CMIP5 Aggregation by Near Surface Specific Humidity - Historical/MACA huss BNU-ESM HISTORICAL 1950-2005 Aggregated

- *Data format:* NetCDF
- *Data type:* GRID
- *Harvest:* true
- *Naming Authority:* reacchpna.org
- *ID:* agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA

Documentation:

- **rights:** Freely available
- **abstract:** REACCH CMIP5 Abstract
- Multivariate Adaptive Constructed Analogs (MACA) Statistical Downscaling Method

Access:

1. **OPENDAP:** /thredds/dodsC/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc
2. **HTTPServer:** /reacchspace/obj1/netcdf/CMIP5/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc
3. **NCML:** /thredds/ncml/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc
4. **ISO:** /thredds/iso/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc
5. **UDDC:** /thredds/uddc/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc
6. **NetcdfSubset:** /thredds/ncss/grid/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc

Creators:

- **Dr. John Abatzoglou, University of Idaho**
  - *email:* reacch@uidaho.edu
  - *http://www.reacchpna.org/*

Publishers:

- **REACCHPNA**
  - *email:* reacch@uidaho.edu
  - *http://www.reacchpna.org*

TimeCoverage:

- *Start:* 2013-08-14 18:52:59Z
- *End:* 2013-08-28 18:52:59Z
- *Duration:* 14 days

Metadata:

- Full REACCH metadata XML documentation

thredds.reacchpna.org

- **Aggregates netcdf data**
- **Allows for extraction of data by variable, time, geography**

Thredds Data Server

NetCDF Subset Service for Grids

Dataset: /thredds/ncss/grid/agg_maca_huss_BNU-ESM_historical_1950_2005_WUSA.nc

Base Time: 1949-12-20T00:00:00Z

Gridded Dataset Description
As Point Dataset

Select Variable(s):

☐ specific_humidity

Choose Spatial Subset:

◉ **All**
○ **Bounding Box (decimal degrees):**

North 49.3960
West -124.7721 -103.0225 East
31.0213 South

Choose Time Subset:

◉ **All**
○ **Time Range:**

Starting: 1949-12-20T00:00:00Z
Ending: 2005-12-05T00:00:00Z

Horizontal Stride:

Add Lat/Lon to file

☐ Add Lat/Lon variables

Submit Reset

thredds.reacchpna.org

- **Aggregates netcdf data**
- **Allows for extraction of data by variable, time, geography**

NetCDF Subset Service Documentation

REACCH IPython Notebook Server

Updated: 2013-05-07

REACCH Data Access

Tier 1 and 2 (REACCH)

The REACCH IPython Notebook Server is a way to collaborate using Interactive Python notebooks.

IPython is an interactive shell for the Python programming language that offers enhanced introspection, additional shell syntax, tab completion and rich history.

For more information on how to use the REACCH IPython Notebook Server - watch our REACCH Data Management Web Module 3 - Accessing the REACCH Analysis Library

REACCHPNA.ORG IP [y]: Notebook

To access the REACCH Notebook Server, please use the general password listed below:

[redacted]

Password: Log in

REACCH IPython Notebook Server

Updated: 2013-05-07

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To access the REACCH Notebook Server, please use the general password listed below:

password: reacch

REACCHPNA.ORG IP [y]: Notebook

Logout

Notebooks | Clusters

To import a notebook, drag the file onto the listing below or **click here**.

New Notebook

C:\Users\iPython\REACCHipythondata\notebooks

1 - REACCH - IPython Instructions	Delete
10 - REACCH - IPython Tutorial for Scientists	Delete
11 - REACCH - IPython and R Tutorial	Delete
2 - REACCH - Data Management Access Methods	Delete
3 - REACCH - Data Management Access Methods - Testing	Delete
4 - REACCH - Data Management Training Modules	Delete
5 - REACCH - Solving Problems with Python (Calculations)	Delete
6 - REACCH - Solving Problems with Python (Data Access)	Delete
7 - REACCH - Solving Problems with Python (Lecture Notes)	Delete

REACCH REST api data search for "anthromes"

In [7]:
```
from IPython.core.display import HTML
HTML('<iframe src=http://reacchapp2.nkn.uidaho.edu:8080/geoportal3/rest/find/document?searchText=anthromes&start=1&max=10&f=html&dojo.preventCache=1371676252313 width=1
```

Out[7]:

REACCHPNA Models - Anthromes 2008
REACCHPNA Models - Anthromes 2008
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata
REACCHPNA Models - Anthromes 2011
REACCHPNA Models - Anthromes 2011
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata
REACCHPNA Models - Anthromes 2010
REACCHPNA Models - Anthromes 2010
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata
REACCHPNA Models - Anthromes 2009
REACCHPNA Models - Anthromes 2009
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REACCHPNA Models - Anthromes 2007
REACCHPNA Models - Anthromes 2007
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REACCHPNA Models - Cropland Data Layer 2010
REACCHPNA Models - Cropland Data Layer 2010
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REACCHPNA Models - Cropland Data Layer 2010
REACCHPNA Models - Cropland Data Layer 2010
Download Preview Globe (.kml) ArcGIS (.nmf) ArcGIS (.lyr) Add To Map Details Metadata
REACCHPNA Models - Cropland Data Layer 2009

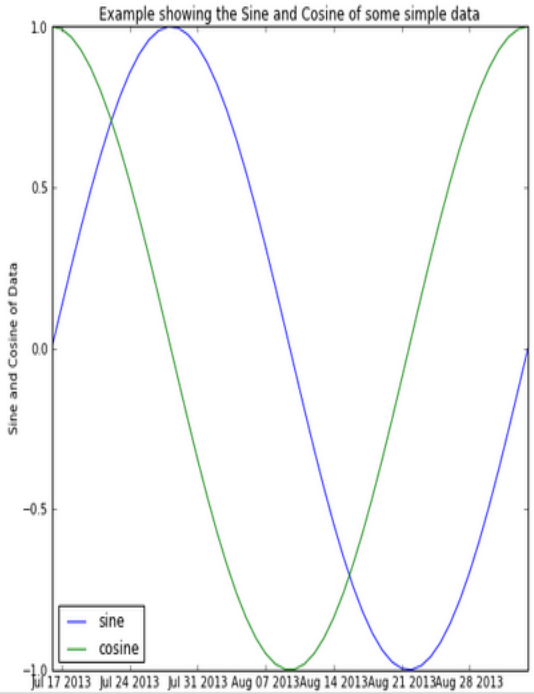
Create and annotate the graph of the sine wave that we created before.

In [6]:
```
from datetime import datetime, timedelta

vector = linspace(0.,2.*pi)
today = datetime(2013,7,16)
t = array([])
for dt in range(50):
    t = append(t,today+timedelta(dt))

figure(figsize=[8,8])
plot(t,sin(vector),t,cos(vector))
xlabel('Date')
ylabel('Sine and Cosine of Data')
title('Example showing the Sine and Cosine of some simple data')
legend(('sine','cosine'),'best')
```

Out[6]: <matplotlib.legend.Legend at 0x5709250>



REACCHPNA
IPython Example

September 2013

Pacific Northwest Climate Science
Conference Fall 2013

Presentation takeaways

- Data integration and collaboration have far reaching advantages in multiple areas
- Core best practice approaches for data integration frameworks include:
    - Metadata
    - Harvesting
    - Aggregation
    - Geospatial
    - Search compliant

Extra Slides

THREDDS

- Netcdf
  - Dimensions, coordinate variables, temporal components
- NCML
- Tomcat running on Linux

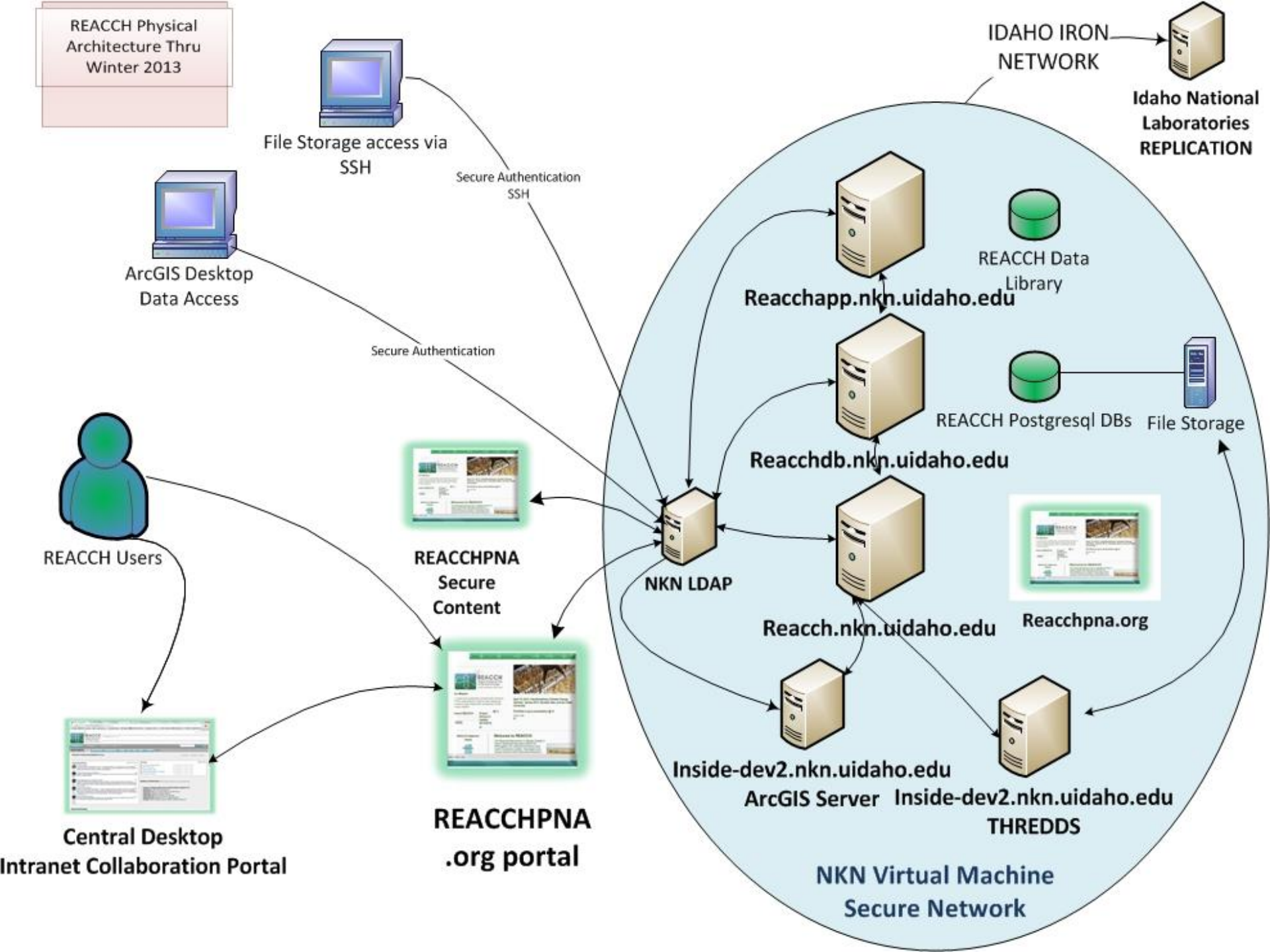
IPython

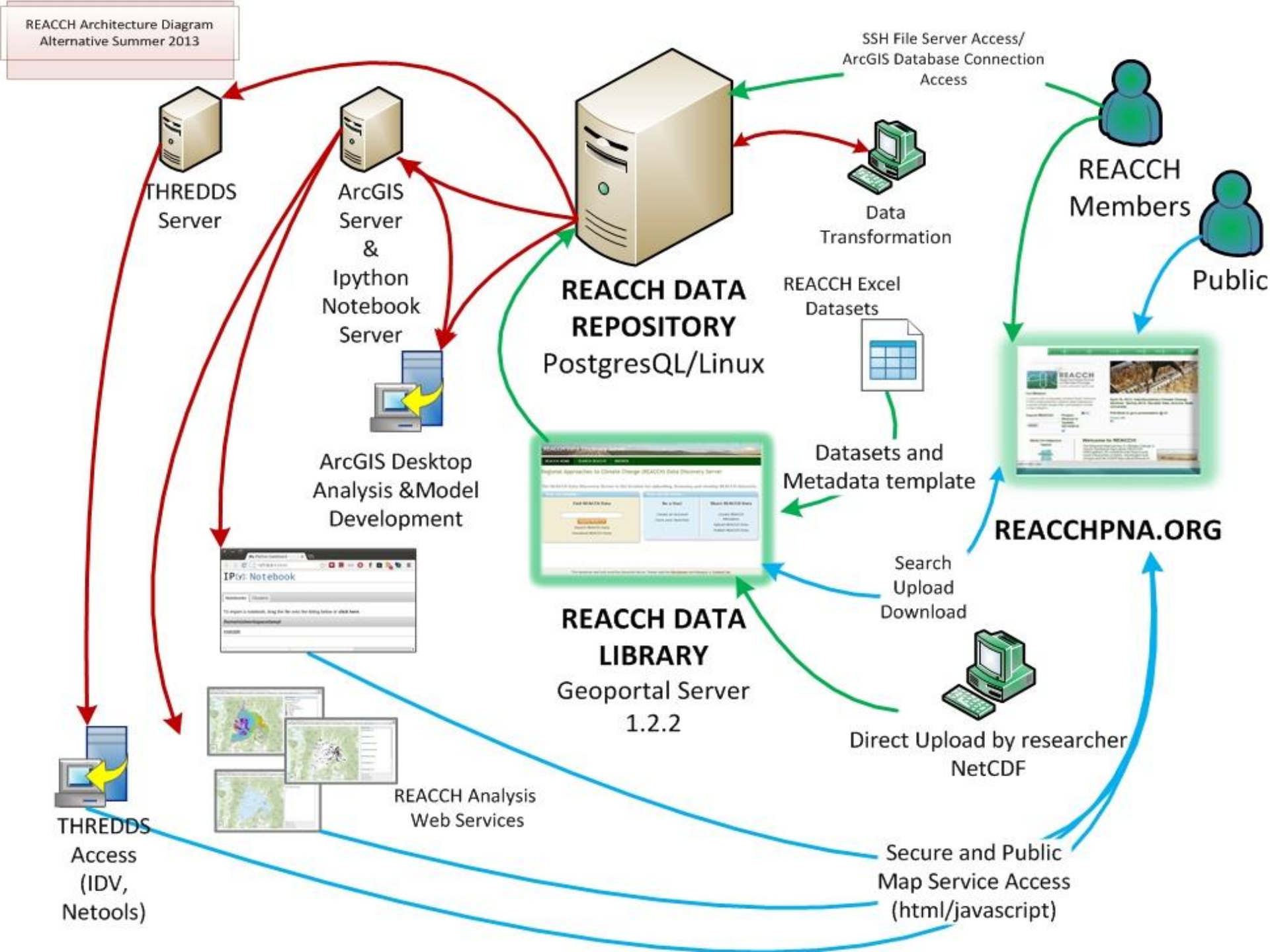
- Python language overall
- JSON (javascript object notation) - .ipynb files are .json
- Review other LIVE Ipython research notebooks @ nbviewer.python.org

REACCH PNA Architecture Slides

September 2013

Pacific Northwest Climate Science Conference Fall 2013


REACCH Physical Architecture Thru Winter 2013
File Storage access via SSH
Secure Authentication SSH
ArcGIS Desktop Data Access
Secure Authentication
IDAHO IRON NETWORK
Idaho National Laboratories REPLICATION
REACCH Data Library
Reacchapp.nkn.uidaho.edu
REACCH Postgresql DBs
File Storage
Reacchdb.nkn.uidaho.edu
REACCH Users
REACCHPNA Secure Content
NKN LDAP
Reacch.nkn.uidaho.edu
Reacchpna.org
Inside-dev2.nkn.uidaho.edu ArcGIS Server
Inside-dev2.nkn.uidaho.edu THREDDS
Central Desktop Intranet Collaboration Portal
REACCHPNA .org portal
NKN Virtual Machine Secure Network


REACCH Architecture Diagram
Alternative Summer 2013
SSH File Server Access/
ArcGIS Database Connection
Access
THREDDS
Server
ArcGIS
Server
&
Ipython
Notebook
Server
Data
Transformation
REACCH
Members
Public
REACCH DATA
REPOSITORY
PostgresQL/Linux
REACCH Excel
Datasets
ArcGIS Desktop
Analysis &Model
Development
Datasets and
Metadata template
REACCHPNA.ORG
Search
Upload
Download
REACCH DATA
LIBRARY
Geoportal Server
1.2.2
Direct Upload by researcher
NetCDF
REACCH Analysis
Web Services
THREDDS
Access
(IDV,
Netools)
Secure and Public
Map Service Access
(html/javascript)