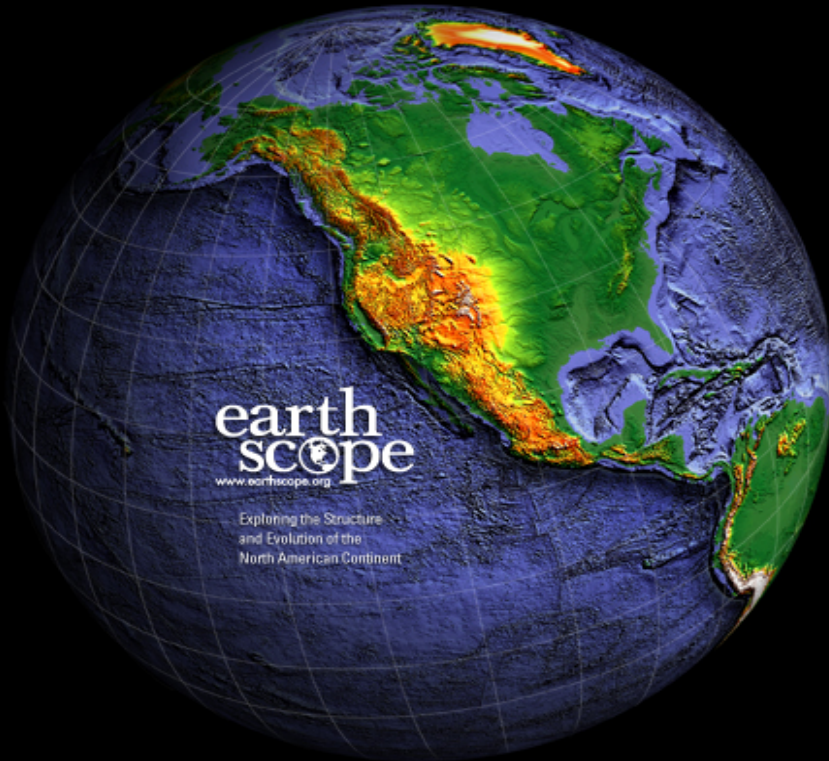


Measuring Success: Metrics in the EarthScope USArray Project



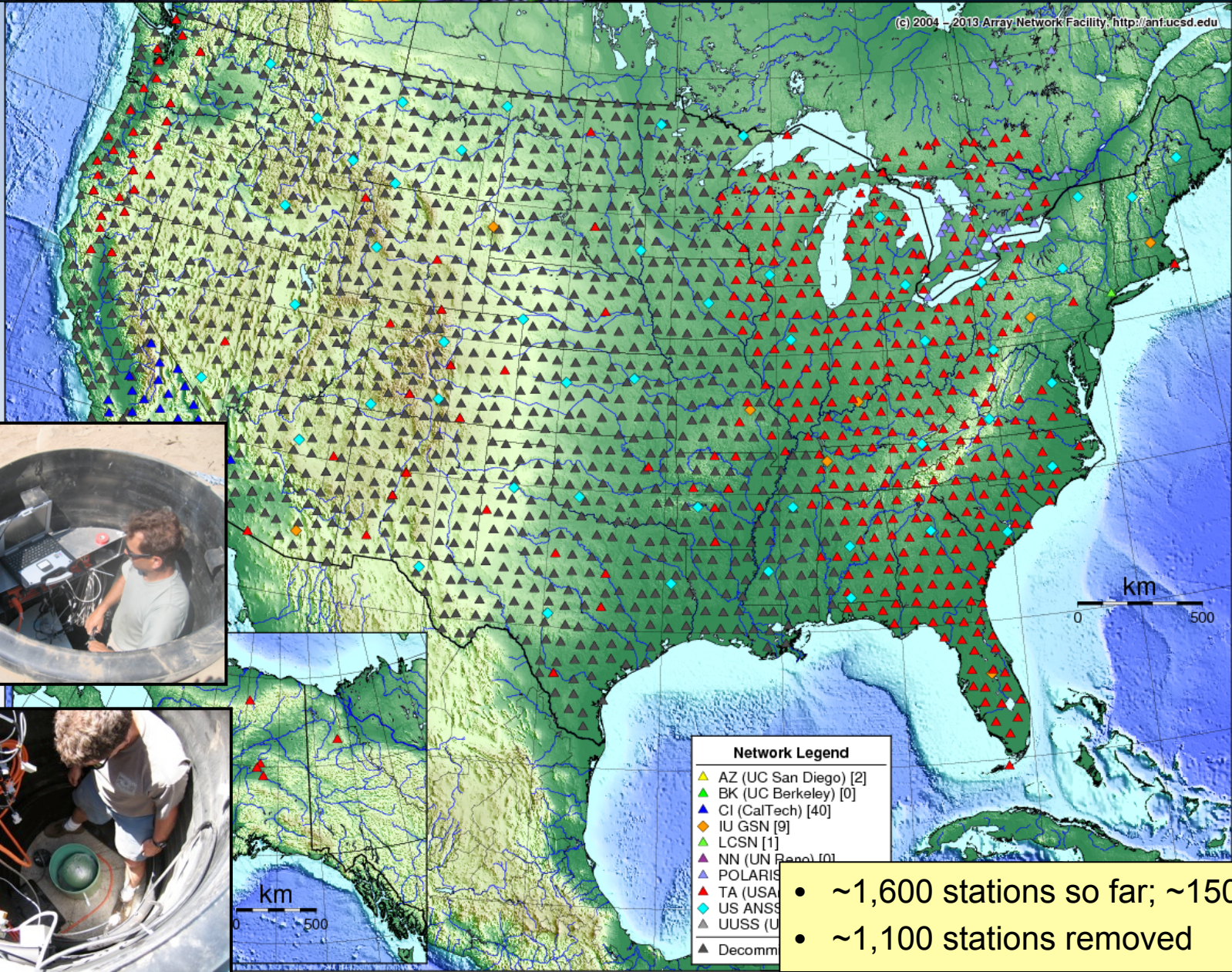
Bob Woodward
USArray Director, IRIS
David Simpson
President, IRIS

NSF Large Facilities Operations Workshop

Hosted by:
National Radio Astronomy Observatory
Socorro, NM
April 23-25, 2013

- EarthScope is a 15 year project funded by NSF
 - Study the structure and dynamics of the North American continent
 - EarthScope is in its 10th year
- The USArray component of EarthScope is conducting a systematic seismic and magnetotelluric survey of a large part of North America
 - Past 9.5 years focused on lower-48 states
 - Next five years focused on lower-48 plus Alaska
- All EarthScope data are completely open and unrestricted
- The Incorporated Research Institutions for Seismology (IRIS) operates USArray
 - Non-profit; Consortium of 117 universities; Community governance
 - Does not have “in-house” research component

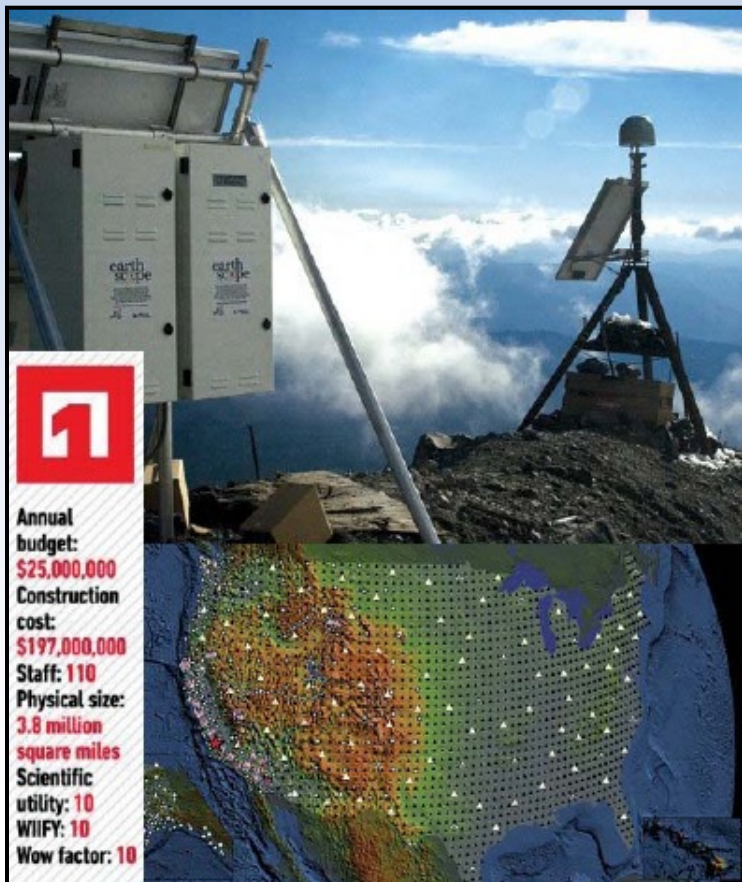
Transportable Array



- ~1,600 stations so far; ~150 to go
- ~1,100 stations removed

Popular Science Ranks Most Epic Science Projects

#1 EarthScope



Annual
budget:
\$25,000,000
Construction
cost:
\$197,000,000
Staff: **110**
Physical size:
3.8 million
square miles
Scientific
utility: **10**
WIIFY: **10**
Wow factor: **10**

Some of the “metrics” used:

- **Scientific utility**
- **What’s in it for you**
- **Wow factor**

Fun – but maybe not so precise!

- 2 – Large Hadron Collider
- 3 – Spallation Neutron Source
- 4 – International Space Station
- 5 – Advanced Light Source
- 6 – Juno (Jupiter Orbiter)
- 7 – National Ignition Facility
- 8 – The Very Large Array
- 9 – Neptune Undersea Obs.
- 10 – Heavy Ion Collider

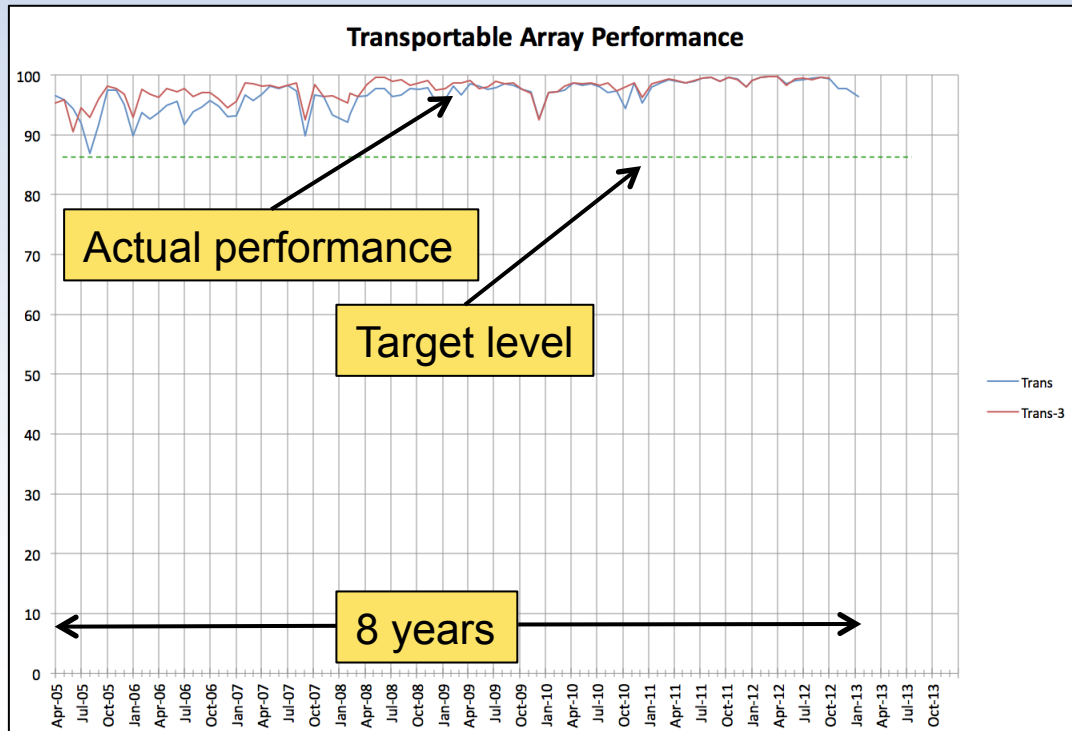
Basics of a good metric

- Integrative
- Stable over time (don't need to redefine)
- Simple to understand and present
- Measures an aspect of the facility operation that is fundamentally aligned with overarching objectives
- Facility is able to influence

Uptime is a fundamental and well understood metric in seismic network operations

Uptime relates to the ability of the network to record earthquakes

Challenge: set target numbers at the right point on the cost-benefit tradeoff curve



- Identify changes and how they accumulate over time
- Alerts and notifications
- Visible to management, staff, public

Home Stations Tools Earthquakes Projects About

Home » Online Tools » Real-Time USArray Web-Based Data Logger Monitor V.2.0

Data in this table is 212 seconds old | [Customize the table fields for this browser](#) | [View the legend for the table](#) | [Show information about this page](#) | [Problems with this](#)

diname	comp	gp24	nr24	pmp	dltnoy	runtrn	tp	ome	bufr	nl24	np24	nt24	dr	br24	bw24	loq	m0
TA_446A	Att	0s	0			8d16h2m39s	0			0	0	0	0	0k	0k		
TA_A27A	WB	0s	0	1	32m44s	51m35s	0			8	7	0	0	24m	658k	100%	-
TA_I04D	VZ	0s	0		8d11h29m53s	8d11h28m41s	0			0	0	0	0	0k	0k		
TA_002D	WB	0s	0	1	2m27s	1m13s	0.01			4	3	0	33	48m	591k	100%	
TA_P28A	VZ	0s	0		1d4h12m24s	1d4h11m0s	0			0	0	0	0	0k	0k		
TA_P29A	VZ	0s	0		3h3m13s	3h7m4s	0			2	1	0	0	26m	792k	60%	2
TA_P30A	VZ	0s	0		6h51m9s	6h50m5s	0			2	1	0	0	19m	660k	100%	2
TA_Q35A	Att	0s	0	1	2m7s	59s	0.06	100%		19	75	0	33	51m	703k	100%	
TA_T32A	WB	0s	0	1	2h3m8s	1h16m12s	0			25	39	0	0	30m	836k	100%	
TA_WHTX	Att	0s	0	1	10m35s	8m11s	0			161	33	0	24	23m	729k	100%	
TA_024A	Att	0s	0	1	3s	14h2m44s	1	100%	0%	2	1	0	2.4k	26m	901k	100%	
TA_031A	VZ	0s	0	1	3s	3h40m33s	1	100%	0%	26	359	0	2.7k	29m	822k	100%	2
TA_026D	VZ	0s	0	1	3s	17h48m27s	1	100%	0%	2	1	0	2.8k	30m	904k	100%	1
TA_109C	I	0s	0	1	2s	17h47m58s	1	95%	0%	1	1	0	2.8k	30m	911k	100%	-
TA_121A	VZ	0s	0	1	9s	17h48m35s	1	100%	0%	1	1	0	2.4k	22m	839k	100%	2
TA_132A	VZ	0s	0	1	3s	10h51m58s	1	99%	0%	3	2	1	2.9k	30m	912k	100%	10
TA_134A	VZ	0s	0	1	3s	17h48m37s	1	100%	0%	2	1	0	2.9k	30m	904k	100%	34
TA_135A	Att	0s	0	1	3s	8h59m28s	1	100%	0%	2	1	0	2.9k	30m	900k	100%	-24
TA_136A	Att	0s	0	1	3s	10h46m3s	1	100%	0%	2	44	0	2.8k	30m	904k	100%	9
TA_137A	VZ	0s	0	1	3s	9h39m53s	1	100%	0%	2	1	0	2.9k	31m	903k	100%	-19
TA_138A	VZ	0s	0	1	3s												
TA_139A	Att	0s	0	1	3s												
TA_140A	VZ	0s	0	1	3s	4h54m5s	1	99%	0%	3	2	0	3.6k	39m	868k	100%	15
TA_141A	VZ	45m	1	1	3s	17h48m7s	1	99%	0%	2	2	0	4.3k	44m	882k	100%	9
TA_142A	VZ	0s	0	1	3s	17h48m5s	1	100%	0%	2	1	0	5.1k	46m	906k	100%	28

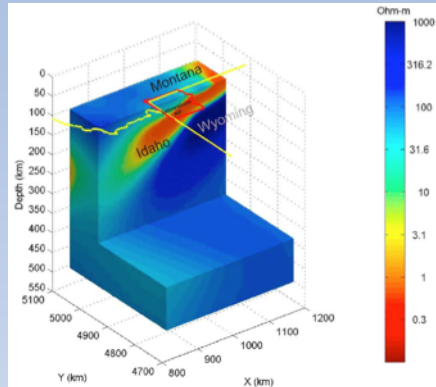
<http://anf.ucsd.edu/tools/webdlmon>

■ dt Latest value for dt: 20
■ dv Latest value for dv: 13
■ Normalized (x 100) da Latest value x 100 for da: 6

- Monitoring system renders information and metrics into **actionable** format
- Metrics feed weekly management prioritization of service activities

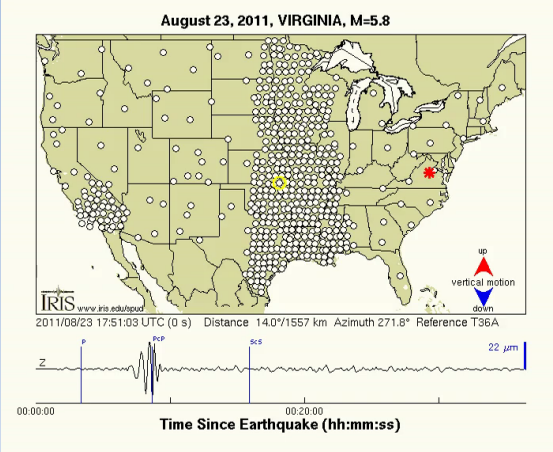
Intellectual Merit: Science Results

TA (Magnetotellurics)



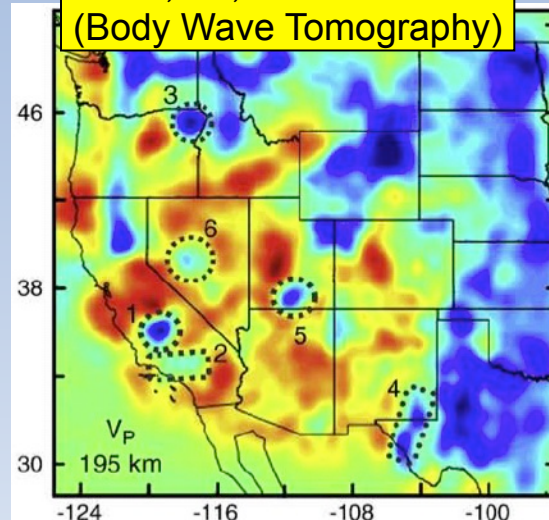
Plumes : Zhdanov et al.

TA (Array Processing)



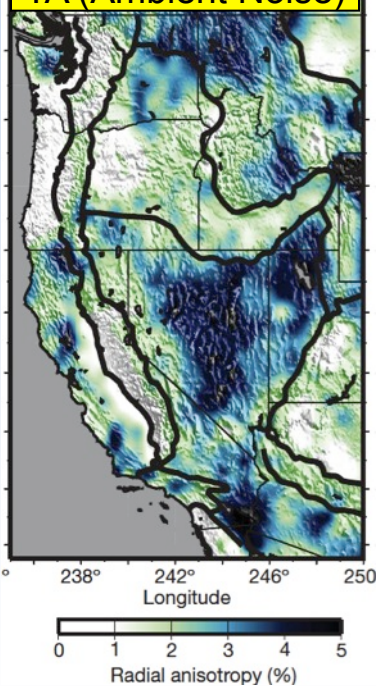
Visualizing earthquakes: IRIS DMC

TA, FA, & PASSCAL (Body Wave Tomography)



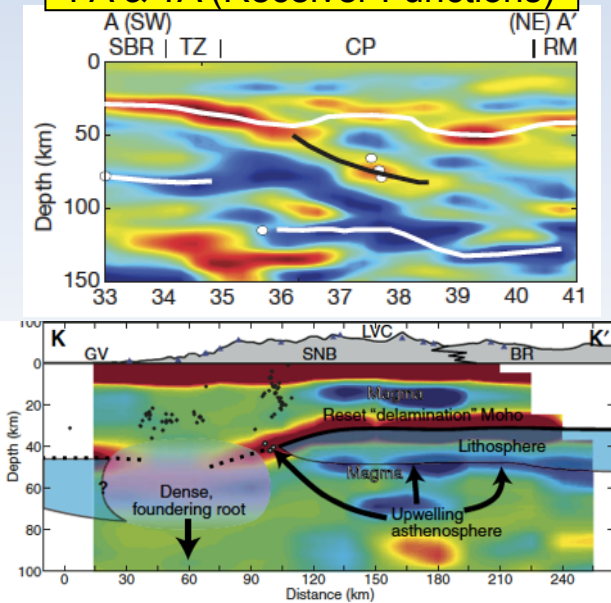
Mantle convection: Schmandt & Humphreys

TA (Ambient Noise)



Crustal anisotropy: Moschetti et al.

FA & TA (Receiver Functions)

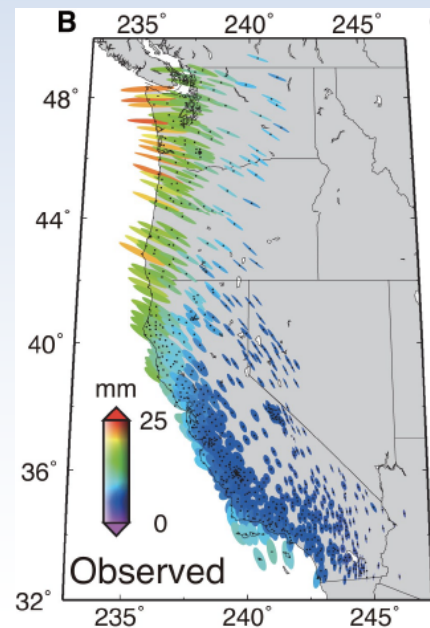


Lithospheric foundering: Levander et al., Frassetto et al.

PBO (GPS)

Modeling mantle rheology: Ito & Simons

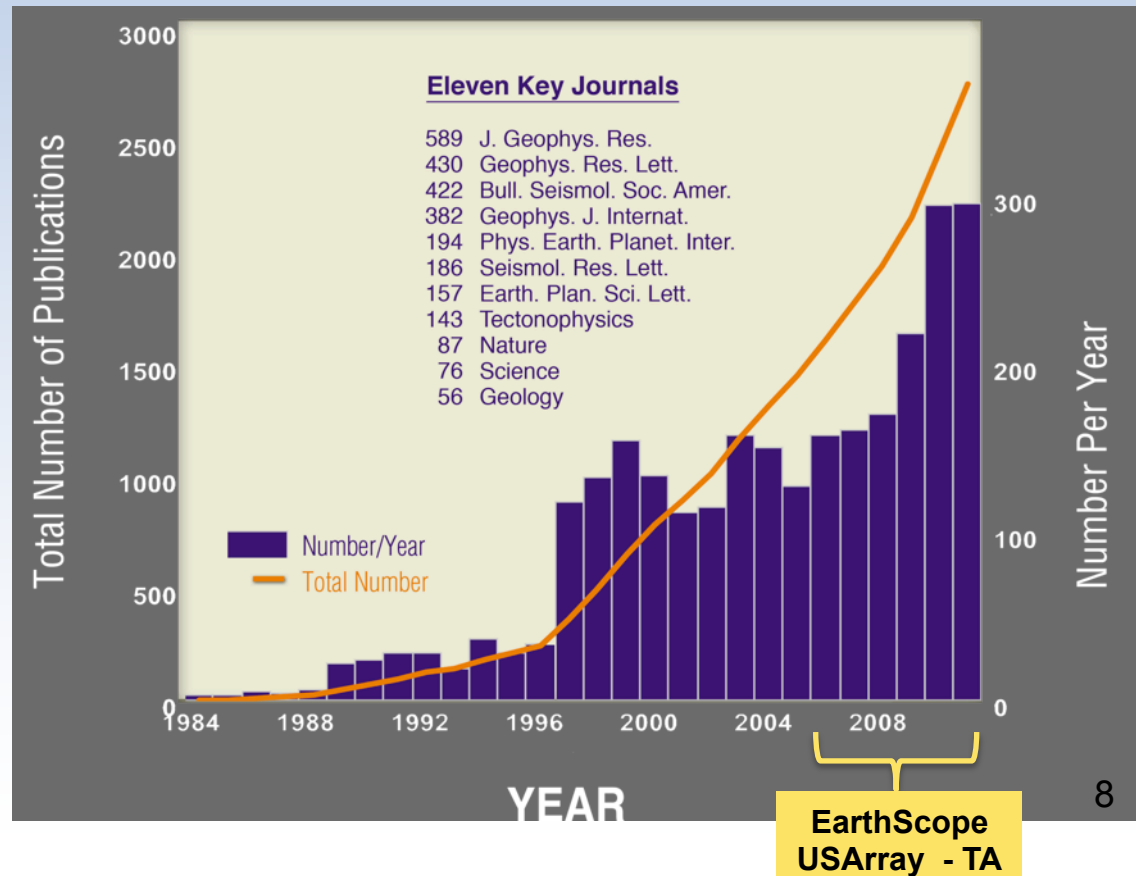
~150 papers in 2012



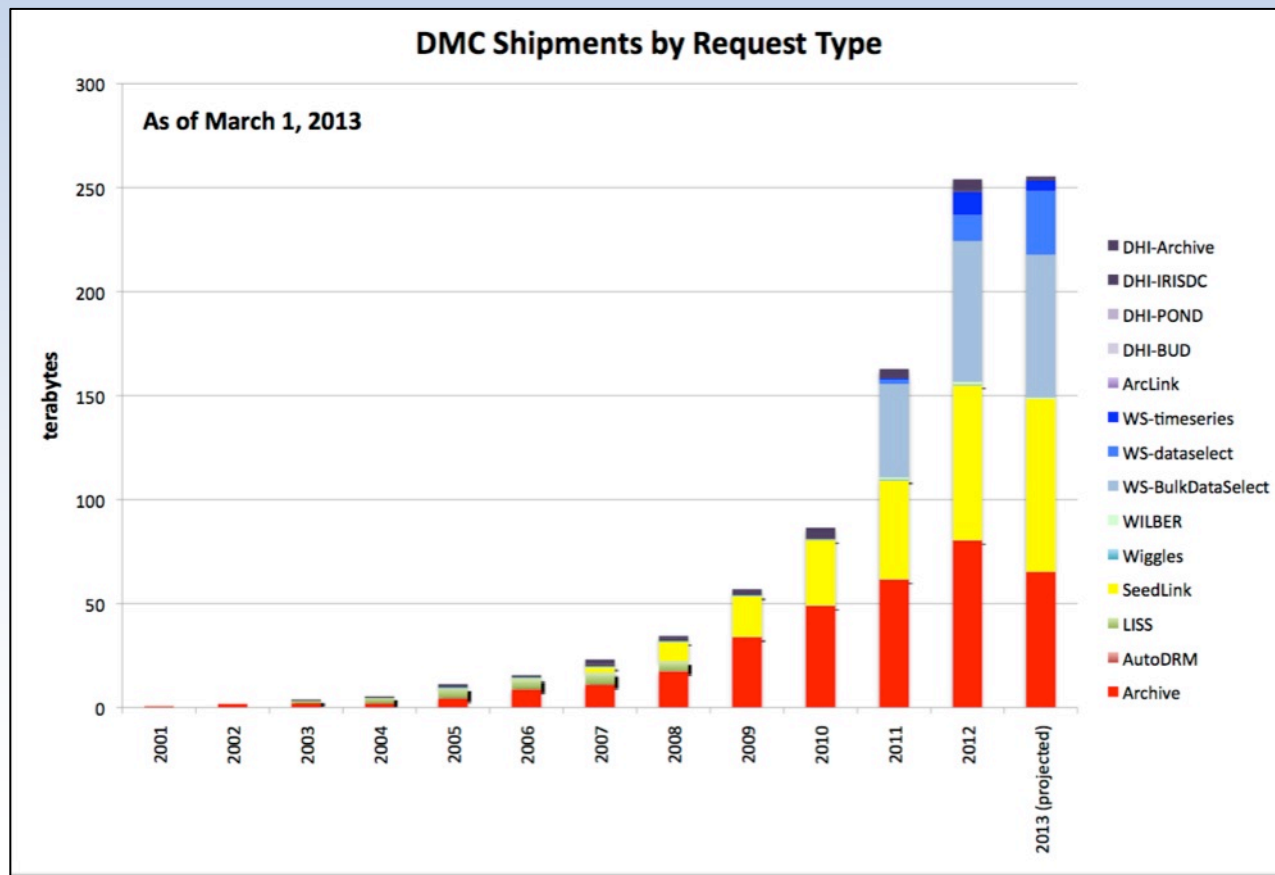
- Measure research publications that utilize facility-produced data
- Use a discrete set of journals, for consistent tracking with time
- Measurements made manually
- Benefits: Excellent indicator of intellectual merit

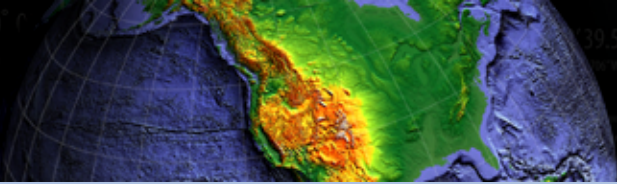
Challenges

- Facility not always cited / acknowledged in papers
- Undercounts “secondary” research use
- Counting scheme does not measure “importance”



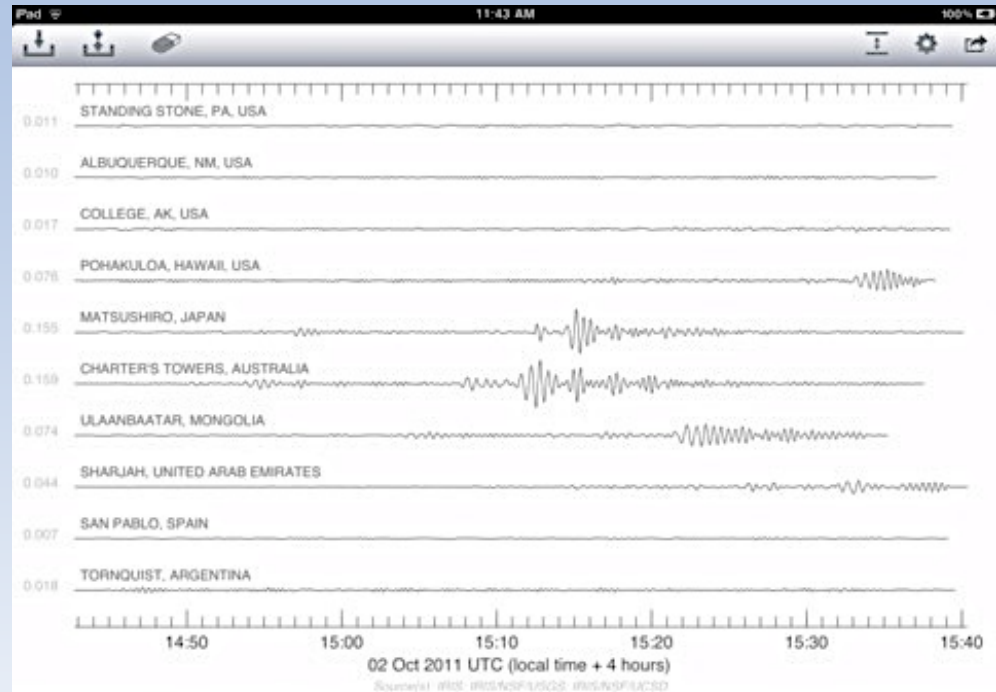
- Volume of shipments can be readily tracked through time
- Benefit:
 - Strong (definitive?) indicator of data utilization
- Challenge
 - Some trend towards treating data archive as “the cloud”





Don't "Over" Count

- Completely open data encourages research and novel applications
- Unanticipated applications and benefits outweigh loss of ability to "count" users



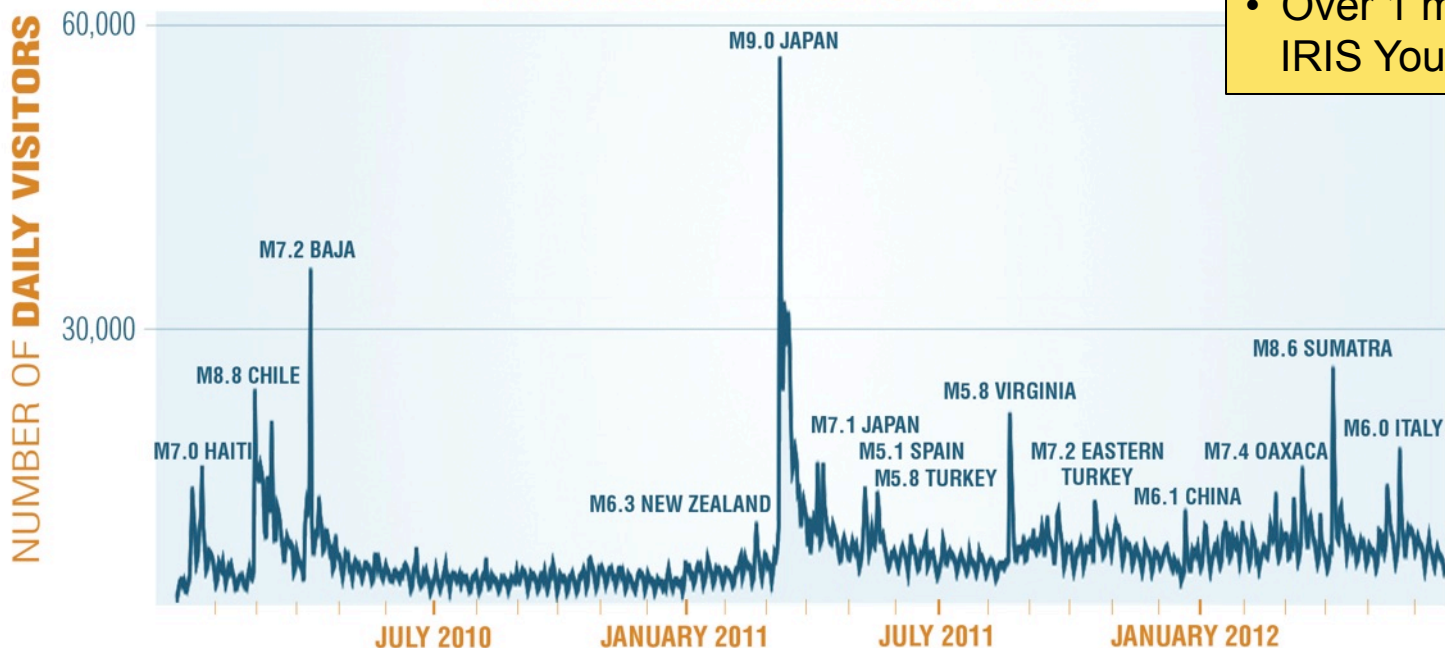
iPad app that retrieves real time seismic data via webservice

Broader Impacts

- Measuring impact in educational and public context usually relies on counting “downloads” or “eyeballs”
- Benefit: Large numbers certainly indicate more impact
- Challenge: Assessing level and nature of impact is beyond facility mandate or resources

- 6 million visits /year to website
- Over 1 million total hits to IRIS YouTube channel

IRIS WEB VISITS 2010 - 2012



Technology » Science & Space • Shop for Gadgets



An EarthScope field engineer piles dirt on the sealed vault for Transportable Array station I28A near Midland, S.D. The station is powered by solar energy and continuously transmits its data via cellphone.

Incorporated Research Institutions for Seismology

Nationwide project lends new details on earthquakes

Updated 8/17/2010 11:31 AM | Comments 47 | Recommend 21 | E-mail | Save | Print | Reprints & Permissions | RSS

By Jeff Martin, USA TODAY

When it comes to studying earthquakes, Oregon State University geology professor Bob Lillie has a simple theory: The more that is known, the better people can prepare and protect themselves.

More knowledge about faults in certain parts of the nation could lead to stricter building codes in those places so structures are less likely to topple, he says.

"If we know about the hazards, then we can put ourselves at less risk," Lillie says.

Lillie is part of a group of scientists involved in USArray, a nationwide research project that allows scientists to study earthquakes in



Enlarge
By Incorporated Research Institutions for Seismology

A seismometer is installed on a cement floor in the EarthScope Transportable Array station H28A lower compartment. A lid is placed on the vault before it is sealed and covered with dirt to insulate it from temperature fluctuations.

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QUAKE MONITORING DEVICES

Seismographs to study earthquakes are being installed across the USA in phases, says Woodward, USArray director.

- Devices placed in 2010
- Devices to be placed in 2011



Source: USArray
By Julie Snider, USA TODAY



...y sites, measure to Maine, vices are ia, number, scientists USA, he ment to 04, is y of, ments, is before it is from the pader dation. on of North lakes and

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X-RAY EARTH

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THE REAL BATMAN How to see with sound
 COLLAPSING UNIVERSE Is dark energy getting weaker?
 QUANTUM LASERS Half light, half matter

What is down there?
 Earth's deep secrets revealed at last

...thers are creating 3-D models of what the

NEWSFOCUS

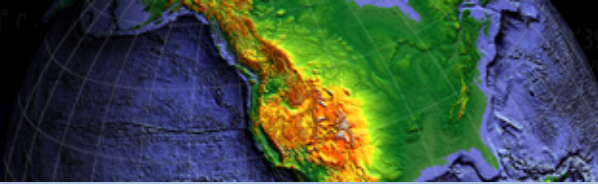
Scoping Out Unseen Forces Shaping North America

As it sweeps across America, the USArray network of seismometers is revealing a...
 ...ers are creating 3-D models of what the

Science

25 September 2009 \$10

...d scientists try to probe beneath...
 ...ck's varying effect on the velocity of...
 ...one of the most powerful...
 ...had to be long waiting...
 ...A messy crater comes...
 ...What a great...
 ...



Student Impact

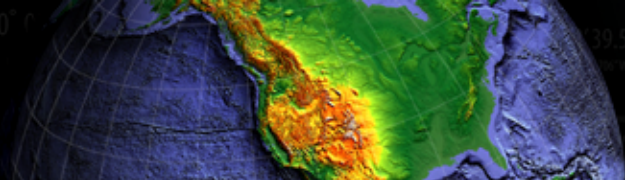
Loaning sensors to PIs
and their teams



EarthScope - Flexible Array
SESAME



EarthScope - Flexible Array
IDOR – Idaho Oregon
Active Source



On the Web

- EarthScope
www.earthscope.org
- USArray
www.usarray.org
- PBO
pboweb.unavco.org
- National Science Foundation
www.nsf.gov

EarthScope is funded by the National Science Foundation.



EarthScope is operated and maintained as a collaborative effort with UNAVCO, and IRIS, with contributions from the US Geological Survey, NASA and several other national and international organizations.

IRIS PASSCAL Instrument Center



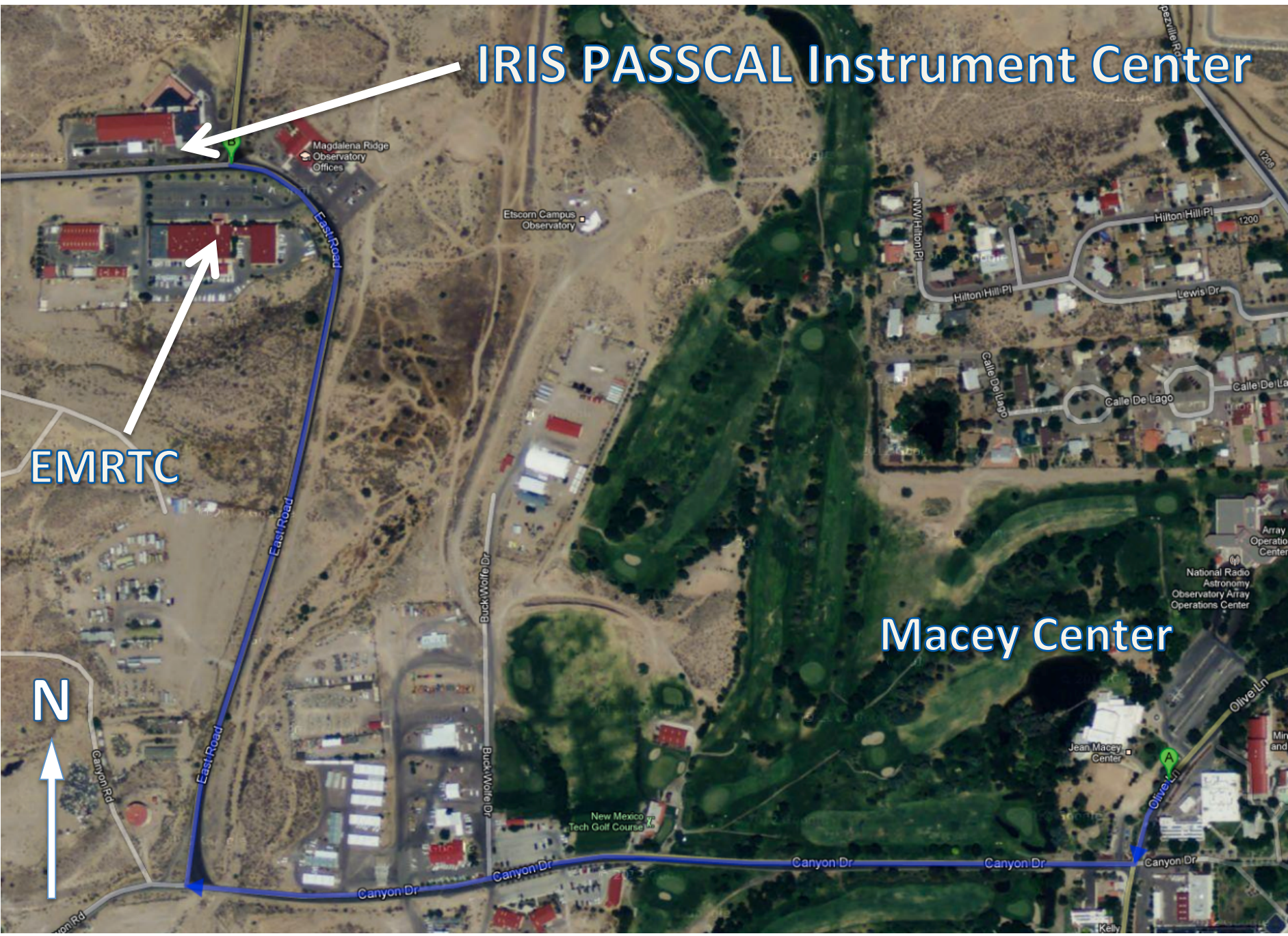
EMRTC

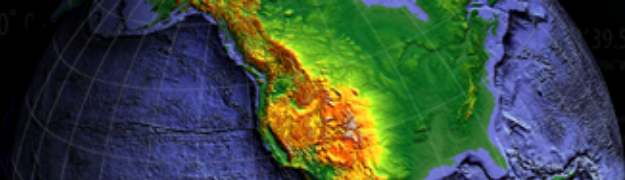


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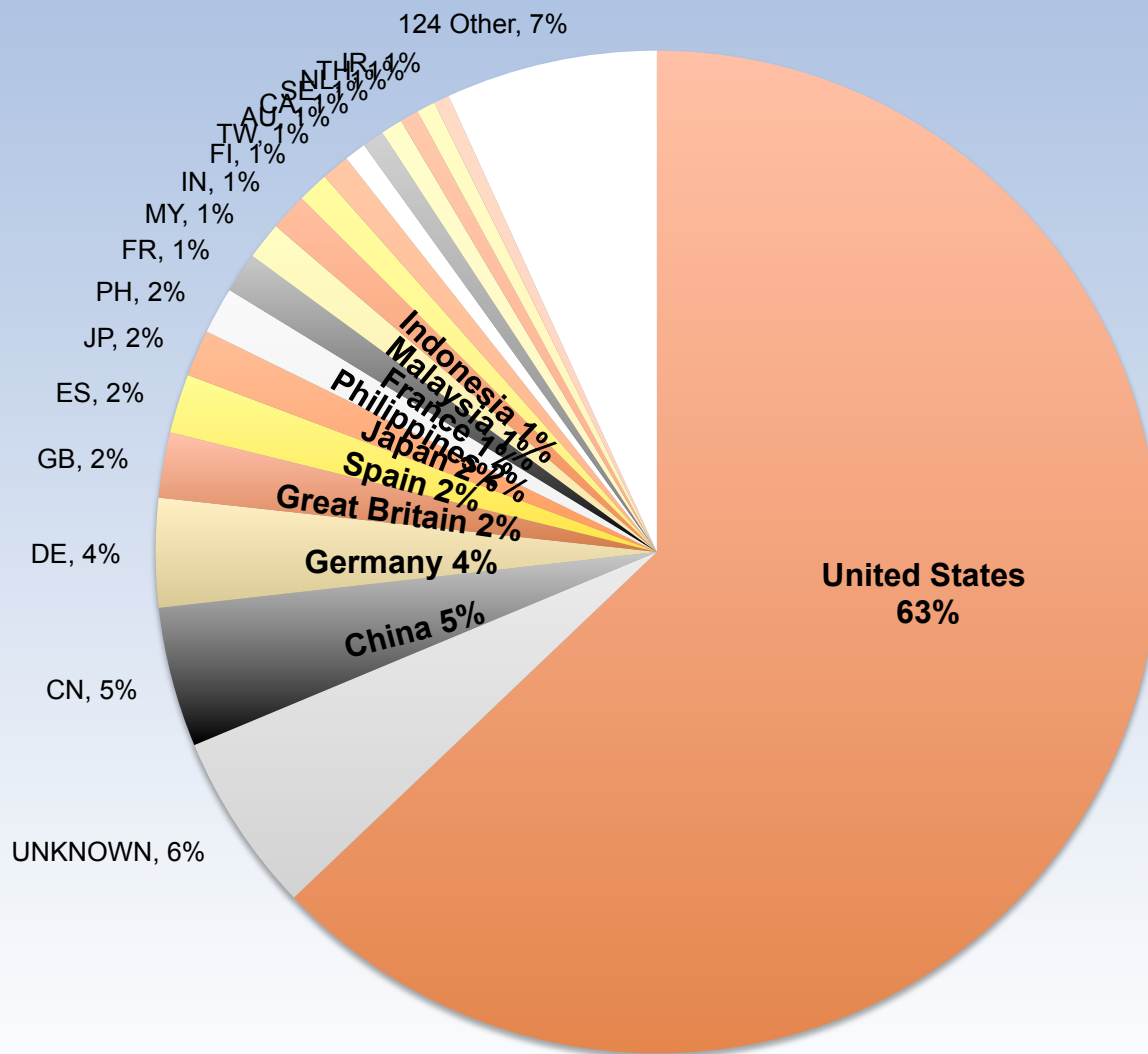


Macey Center



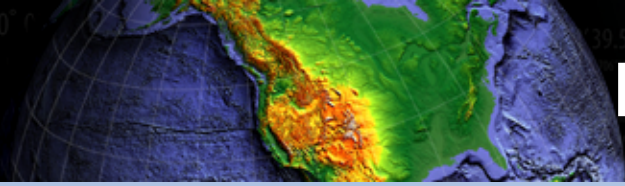


Data Usage Metrics



- 275 terabytes of data sent to 143 countries
- Tens of thousands of users
- Several thousand unique IP domains

- Knowing where data go can help to understand the user base
- Can encourage reciprocal sharing by international partners



- Workshops, abstracts, . . .
 - # of papers, # of sessions, # of authors, etc.
- Benefits
 - Good indicator of research use of facility data
 - Good early indicator (before journal pubs)
- Challenges
 - Counting
 - Key words in titles and abstracts
 - Limited by search tools on meeting websites
 - Differences in workshops from year to year