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IRIS (INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY)

Par Tim Ahern

The Incorporated Research Institutions for Seismology (IRIS) is a United States not-for-profit corporation funded primarily by the United States National Science Foundation (NSF). IRIS is composed of three directorates that include 1) Instrumentation Services (IS), 2) Data Services (DS), and 3) Education and Publication Outreach (EPO). It has several programs within it including the IRIS Global Seismograph Network (GSN), portable deployments within the PASSCAL program, the Transportable Array project, the OBS Instrumentation project, and an Electro-Magnetic Facility. EPO has a variety of projects intended to promote seismology within the K-12 community (Primary and secondary education community) as well as the general public.

both passive and active source seismologists. The DMC was designated the first FDSN Archive for Continuous Data and has contributions from more than 200 seismograph networks around the world. In addition to seismological data, the IRIS DMC also manages significant amounts of data from other sensors including barometric data, infrasound data, in-situ meteorological data, data from ocean bottom seismometers as well as several cabled arrays in the ocean with a variety of physical parameters being measured.

IRIS Data Services manages primary observational data as well as routinely deriving higher level data products from the observational data. The DMC is best known for its archive over of 331 terabytes of primary observational data that is growing at a current rate of more than 60 terabytes per year. As of May 2015, these data have come from 30,585 stations worldwide. While this is a very large amount of data, it is even more significant how actively used the IRIS DMC is. Figure 1 shows the amount of data distributed by year, projected to the end of 2015. The red columns show how much data were shipped as a result of traditional email requests, (such as Breqfast), the yellow columns show the amount of data distributed in real time via the IRIS SeedLink server, and the blue column shows the distribution of data to users outside the DMC using primarily the FDSN web services. In 2015, we project that the IRIS DMC will distribute approximately 1 petabyte of data to the research and monitoring communities.

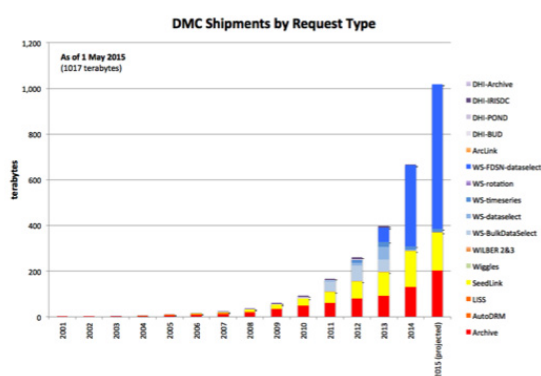


Figure 1 : Amount of data in terabytes distributed per year by the IRIS DMC since 2001

IRIS Data Services has several nodes including the IRIS Data Management Center (DMC) in Seattle, Washington, Data Collection Centers at the Albuquerque Seismological Laboratory, UC San Diego (IRIS/IDA DCC and the Array Network Facility (ANF)), and the Kazakh National Nuclear Center all of which address metadata and data quality issues. The IRIS DMC is the largest seismological datacenter in the world serving the global community of

Figure 2 shows the amount of cumulative data the IRIS DMC has distributed between 2001 and 2005, it first moved to its current location in Seattle, Washington in 1991. Roughly 2.7 terabytes have been distributed since 1991 and remember about 1 perabyte of that amount is the amount distributed in 2015 alone. Both the rate at

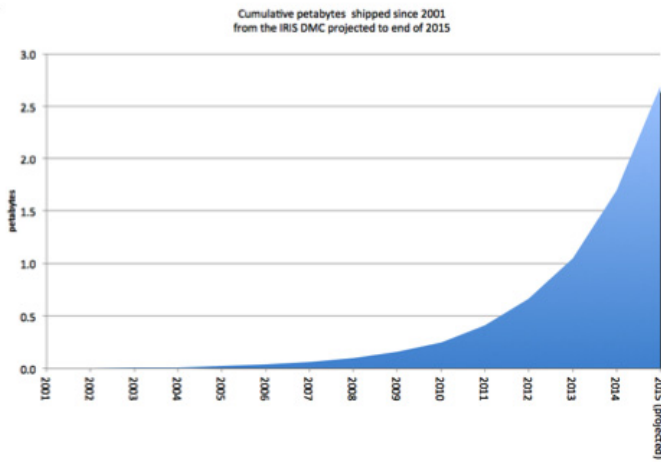


Figure 2 : Amount of cumulative data in petabytes distributed by the IRIS DMC since 2001

which data enters the DMC and the rate that data are shipped to external users continue to increase exponentially attesting to the active use of the IRIS DMC as a major data center in seismology. Currently, the IRIS DMC is working closely with several European partners to implement and promote the use of standardized web services to deliver data to the user community. As shown in Figure 1, users of the DMC have rapidly moved from using traditional methods to the new web services adopted by the FDSN. Internally, the IRIS DMC also accesses data from its archives using the same web services that are exposed to the outside community in the generation of Quality Assurance (QA) metrics, data products and in a variety of curation projects at the DMC.

In addition to distribution of primary data as shown in Figure 1 and 2, the IRIS DMC also derives higher level products from its holdings of data as well as working with the research community to ingest, manage, and distribute products resulting from their research.

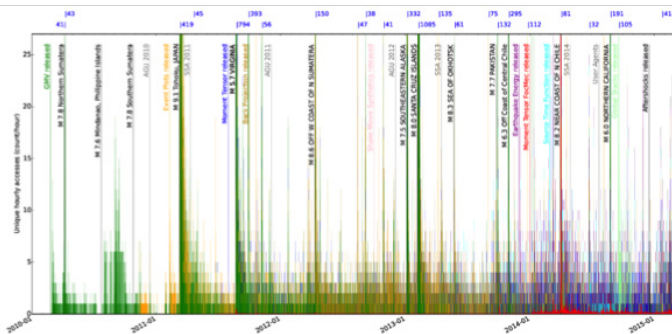


Figure 3 : Pattern of acces correlated to the occurrence of large earthquakes.

Information about the higher level products can be found through the SPUD product management system found

at <http://ds.iris.edu/spud/> or can be found at ds.iris.edu/ds/products/. Presently, IRIS DS manages 25 products including 8 that were community products funded by IRIS, 10 that were contributed by the research community sometimes with IRIS DMC assistance, and 12 products that were developed by DMC staff. Higher level products have a robust access pattern that is highly correlated with significant earthquakes around the globe. Figure 3 shows this pattern of increased access correlated to when larger events occurred. Table1 shows the distribution of products over the past 17 months for some of the more popular DMC products including Ground Motion Visualizations, Event Plot Suite, Moment Tensors, Focal Mechanisms, Back Projections, Synthetic seismograms, Source Time Functions, Plots of Earthquake Energy, Global Stacks, and After Shock sequences. The various columns show the total number of that type of product that has been distributed, the maximum distributed in one hour, and the daily average.

	total	hourly max	daily avg
GMV	101,204	1,079	53
EventPlot	18,623	160	11
MomentTensor	11,607	25	8.1
entTensor-FocMec	35,988	700	25
BACK_PROJECTION	14,511	312	11
SYNTHETIC	2,124	11	2.2
STF	2,721	16	3.5
EQ_ENERGY	3,426	19	5.4
GLOBALSTACKS	1,221	101	15
AFTER_SHOCK	2,358	44	14

Figure 4 : the 10 most popular products at the DMC over the last 17 months

Nearly 200,000 products were distributed by the IRIS DMC from 2010 through May 25, 2015. As Figure 3 shows, many of the bursts of product access occur in response to specific larger earthquakes.

IRIS Data Services continues to work in close collaboration with other partners in the FDSN and in addition to the standardized FDSN web services, believes that the work between European data centers and IRIS was particularly successful with the implementation of Digital Object Identifier (DOI) methods within the FDSN. In the coming years, IRIS is committed to furthering the adoption of DOIs and FDSN web services over the entire globe.